Appendix N
Biological Assessment and Biological Opinions

BIOLOGICAL ASSESSMENT
MISSISSIPPI COASTAL IMPROVEMENTS PROGRAM (MsCIP)
BARRIER ISLAND RESTORATION
MISSISSIPPI SOUND
HANCOCK, HARRISON AND JACKSON COUNTIES, MISSISSIPPI AND MOBILE COUNTY, ALABAMA

U.S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT, WITH COOPERATING AGENCIES
U.S. DEPARTMENT OF INTERIOR,
NATIONAL PARK SERVICE, AND
BUREAU OF OCEAN AND ENERGY MANAGEMENT,
GULF OF MEXICO REGION

AMENDED, JANUARY, 2015

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Introduction

The Final MsCIP Comprehensive Plan and Integrated Programmatic Environmental Impact Statement (EIS) dated June 2009 describes a Comprehensive Plan to support the long-term recovery of Hancock, Harrison, and Jackson Counties, Mississippi (MS) from the devastation caused by the hurricanes of 2005 and ways to increase of resiliency of the Mississippi coast for the future. The MsCIP Study was conducted under the authority of the Department of Defense Appropriation Act of 2006 (Public Law 109-148), dated December 30, 2005, and was completed in June 2009. The Report of the Chief of Engineers dated September 15, 2009 and the Record of Decision signed by the Assistant Secretary of the Army for Civil Works dated January 14, 2010 were submitted to Congress on January 15, 2010. The plan established improvements in the coastal areas of MS in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources purposes. The barrier island restoration plan discussed in this Biological Assessment (BA) is one component of the MsCIP Comprehensive Plan which addresses preservation of fish and wildlife and prevention of saltwater intrusion. In addition, the plan would provide for storm wave attenuation along a portion of the mainland.

The MsCIP Barrier Island Restoration Plan as identified in the MsCIP Comprehensive Plan and Integrated Programmatic EIS includes restoration of the barrier islands for preservation of fish and wildlife and sustaining water quality in the MS Sound. The Comprehensive Barrier Island Restoration consists of the placement of up to approximately 22 million cubic yards (mcy) of sand within the Ship Island portion of the National Park Service's Gulf Islands National Seashore, MS unit to close Camille Cut, a 3.5 mile gap located between East and West Ship Islands, and to ameliorate erosion of the southern shoreline of East Ship Island. In addition, the plan includes the restoration of the eastern shoreface of Cat Island using an additional approximate 2 mcy of sand. A third related action to maximize the beneficial placement of sandy maintenance dredged material from the Pascagoula Federal navigation project includes the redefinition of littoral zone disposal site south and west of Disposal Area (DA) 10.

Ship Island Restoration

The MsCIP Comprehensive Plan identifies the restoration of the offshore barrier islands as a critical feature towards increasing the resiliency of the coast. The main focus of the barrier island restoration plan is focused towards Ship Island which is located approximately 16 miles southeast of Gulfport, MS. Ship Island was split into two pieces by Hurricane Camille in 1969, hence the name of the Cut. Since that time the cut shoaled and prior to Hurricane Georges in 1998 was identified as a shallow shoal. Hurricane Georges and subsequent storms, notably Hurricane Katrina widened and deepened the cut to the point that there is unlikely enough sediment in the system to heal the island naturally (Morton, R.A., 2008). In addition, erosion to the East Ship Island has worsened over time and now this area is a low barrier island.

The Ship Island restoration is composed of 2 parts: the rejoining of West and East Ship Islands through the closing of Camille Cut and the restoration of the southern shore of East Ship Island through the placement of up to approximately 22 million cubic yards of suitable sandy material. A total of approximately 19.0 mcy would be required to be dredged from six borrow areas, not including Cat Island. Approximately 13.5 mcy would be placed in Camille Cut and approximately 5.5 mcy would be placed along the southern shore of East Ship Island.

The constructed Camille Cut project area would be approximately 1,100 feet (ft) wide. The fill would tie into the existing West and East Ship Island's shoreline just below the frontal dune line at an elevation of approximately +7 ft extending below the mean high water line (MHWL) with a 1V:20H slope. The construction slope is primarily dependent on the grain size of the fill. Overtime, typically 6 months to a year the constructed slopes would naturally adjust due to waves and currents to milder slopes, which mimic the existing island nearshore slopes in the range of 1:50 to 1:100.

Sand placement along East Ship Island would consist of an approximate 1,200 ft wide restored shoreline. The equilibrium design widths average approximately 700-ft for Camille Cut and 1,000-ft for East Ship Island. The sand placement layout for Camille Cut and East Ship Island fill are shown in Figure 1. The combined Camille Cut and East Ship Island equilibrated fill will encompass approximately 1,500 acres of which approximately 800 acres will be above the MHWL, and 700 acres will lie below the MHWL. The newly restored areas will be planted with suitable beach and dune vegetation following construction.

Most of the sand on the Mississippi barrier island beaches is light gray, and subangular to rounded in shape, with a median particle diameter (D50) ranging from 0.30–0.51 millimeter (mm). Sand distributed across the islands tends to exhibit greater variation in D50 grain size with depth, ranging from 0.21–0.48mm as indicated by sampling below the surface at West Ship Island. Composite samples to depths of -4 or -5 feet at West Ship Island have D50 grain size ranging from 0.27–0.37mm. For compatibility with the native material on the island and fill stability, well sorted to poorly sorted subangular sands, light gray to gray in color, with median grain size greater than 0.28mm and percent fines less than 10 percent were considered to be optimum for barrier island restoration efforts. Other material was considered provided that the overfill ratio, which is a principal value in comparing the general suitability of fill material, as a function of grain size compatibility, was equal to or less than 1.3. The Supplemental Environmental Impact Statement (SEIS) for this project provides additional information on the compatibility analysis and suitability of sand for placement.

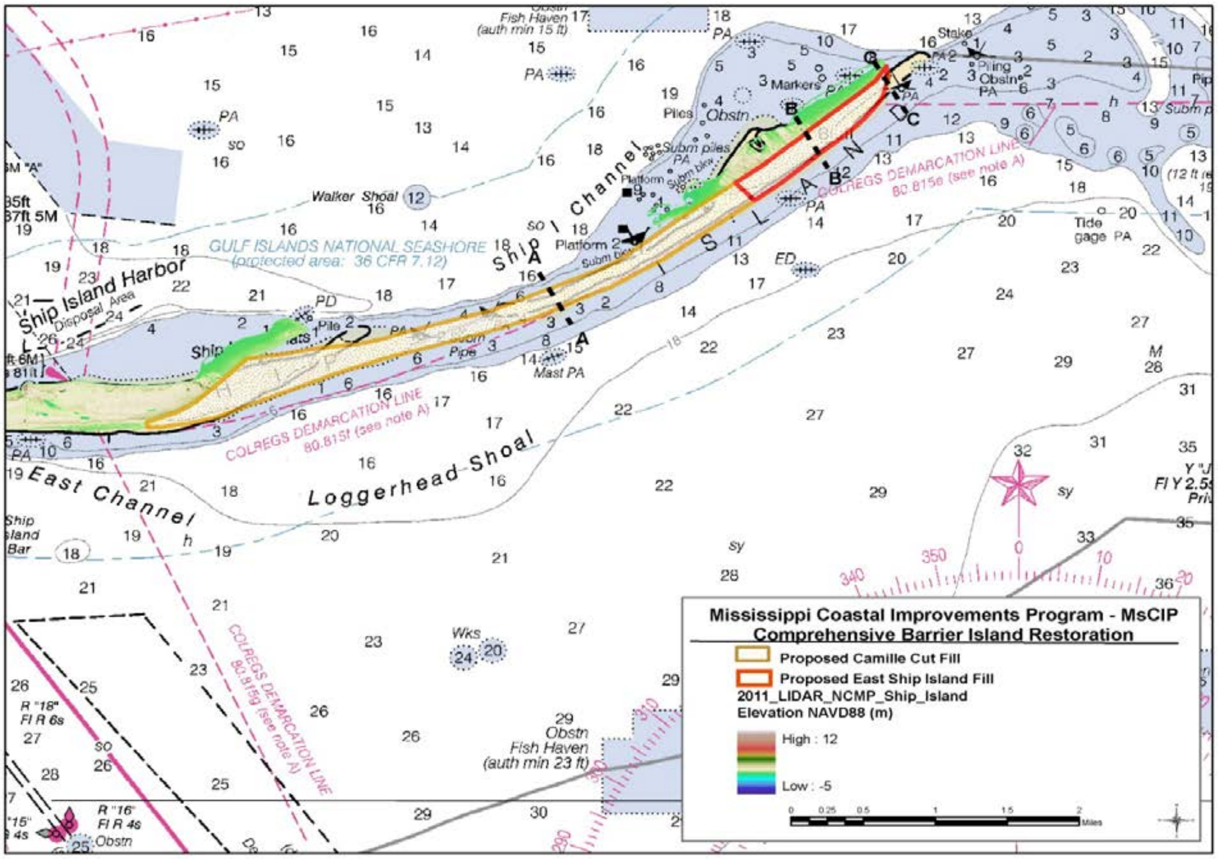


Figure 1. Camille Cut & East Ship Island Placement Layout

Sand would be obtained from seven main borrow area sources, which some are subdivided, within the Gulf of Mexico of Mississippi (MS) and Alabama (AL) including Ship Island borrow area, Horn Island Pass, Petit Bois Pass- MS, Petit Bois-AL East and West, and two Outer Continental Shelf (OCS) borrow areas, which are Petit Bois Pass- OCS West, Petit Bois Pass-

OCS East, and Cat Island (see Figure 2).

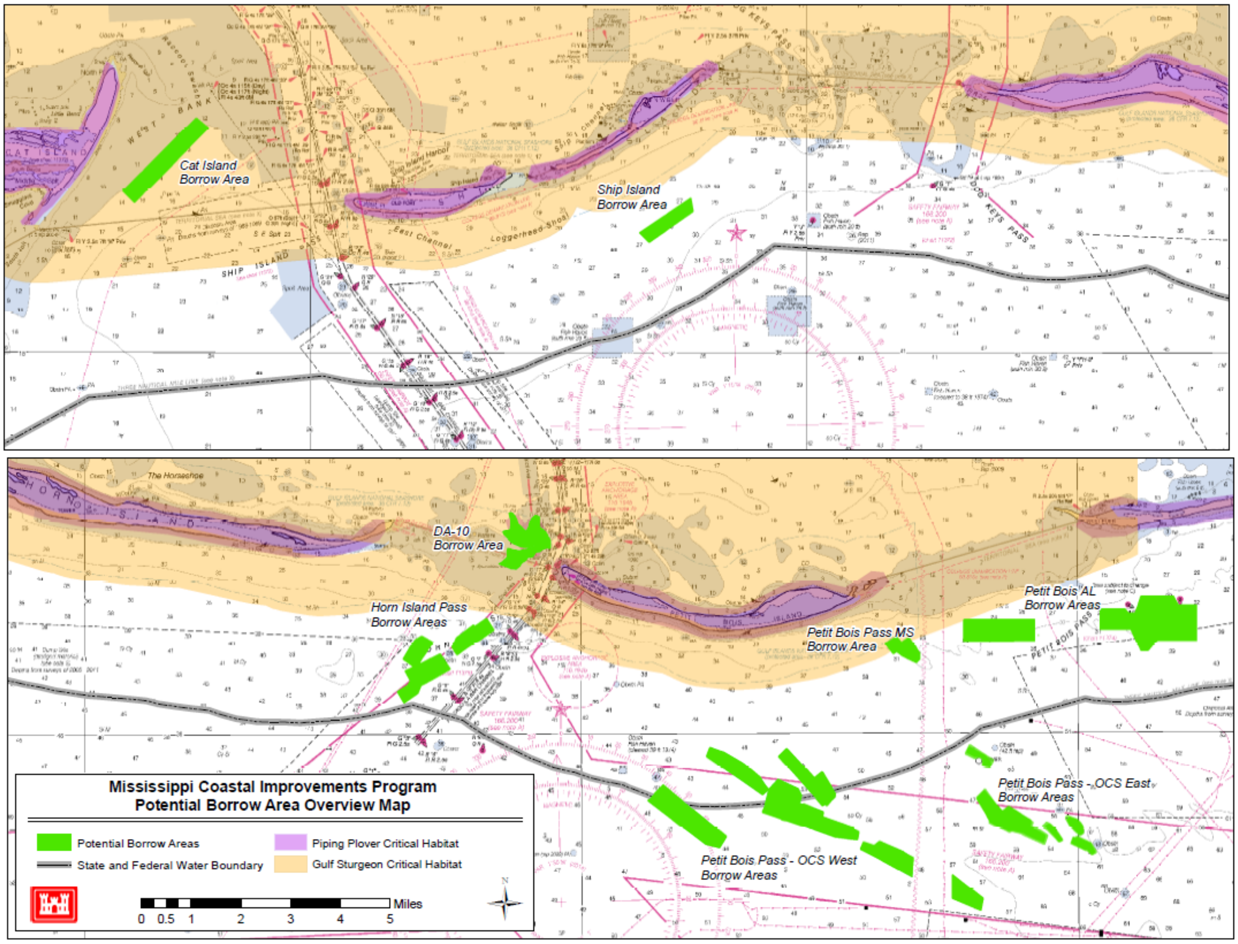
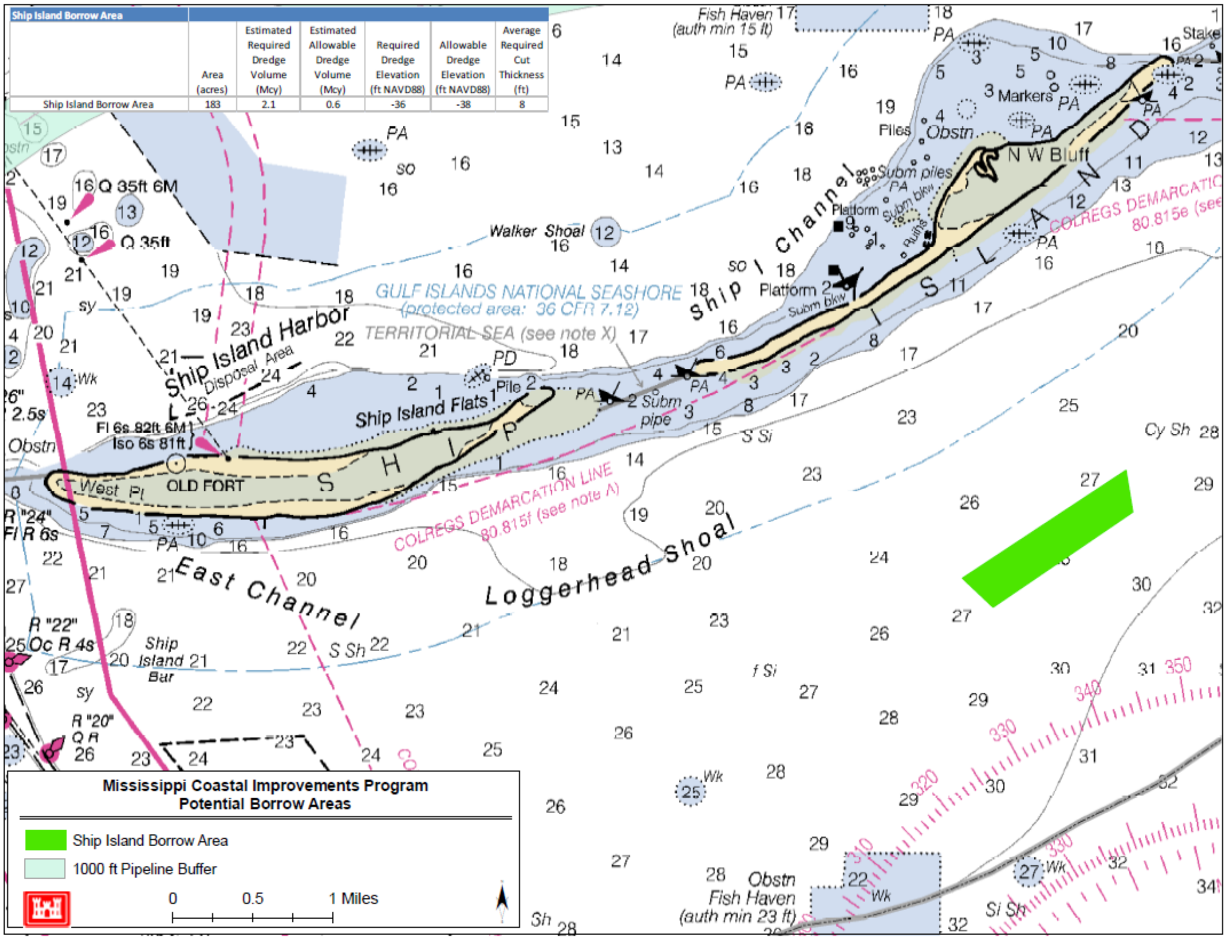


Figure 2- All Borrow Sites

Borrow Area Descriptions for Ship Island Restoration

Ship Island Borrow Area

Ship Island borrow area is located approximately 2 miles south of Ship Island in an ambient water depth of approximately 30 ft. The characteristics of the sand consist of an average grain size of 0.21 millimeters (mm), with 9.0 percent fines, and a light gray color. The borrow area is approximately 600 ft wide (north-south direction) and 6,000 ft wide (east-west direction) covering a total area of approximately 183 acres with an average cut depth of approximately 8 ft. The cut elevation for dredging is approximately -36 ft NAVD88 (see Figure 3) and side slopes for cut areas are estimated in the design to be 1V:5H. An estimated 2.1 mcy of sand is available within the proposed delineated borrow area limits.



Ship Island Borrow Area	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)
Ship Island Borrow Area	183	2.1	0.6	-36	-38	8

Figure 3. Ship Island Borrow Area

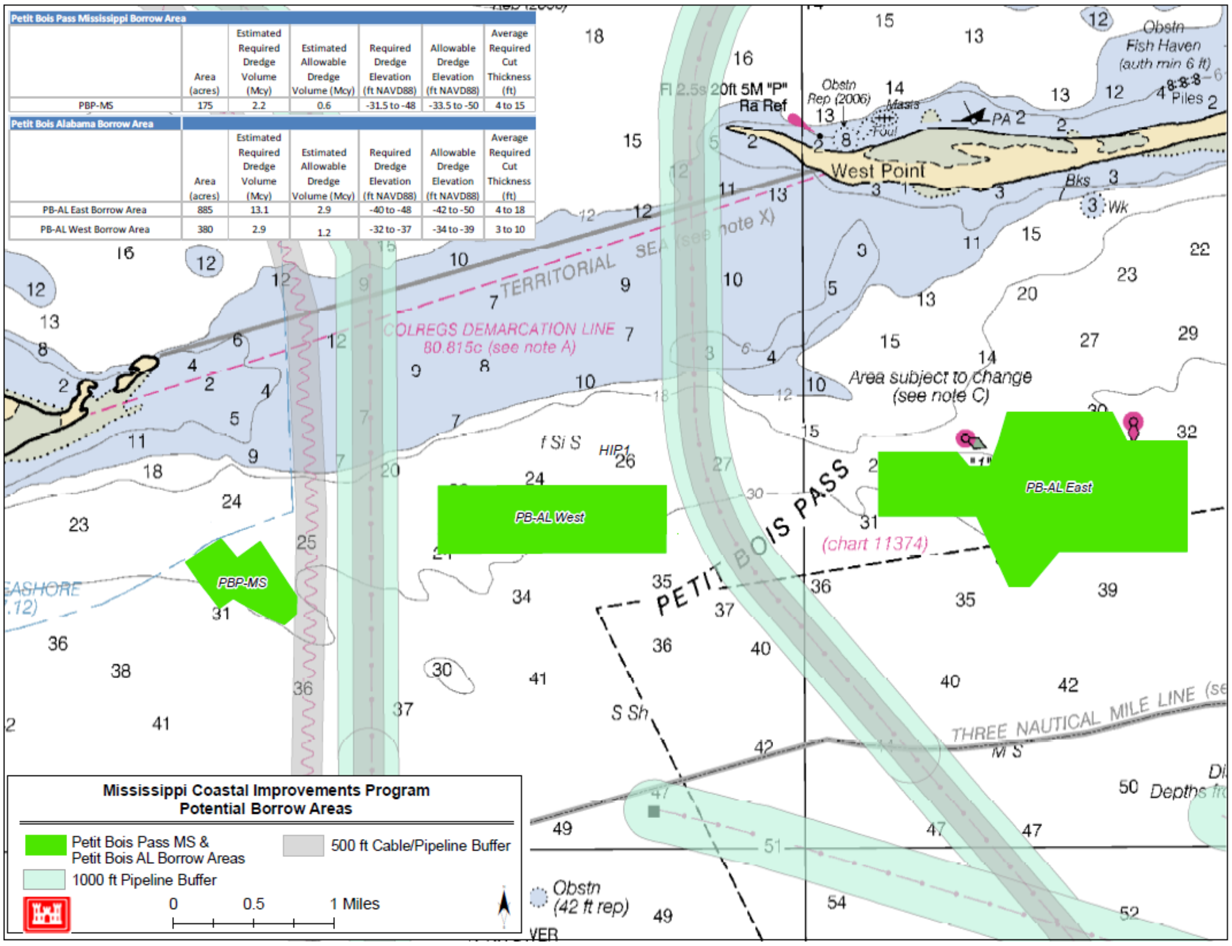
Petit Bois Pass Mississippi and Petit Bois Alabama Borrow Areas

The Petit Bois borrow area consists of three separate sites (Petit Bois Pass- Mississippi; Petit Bois- Alabama East, and Petit Bois-Alabama West).   The Petit Bois-Alabama West (PB-AL West) site is approximately 380 acres in size. The characteristics of the sand at PB-AL West consist of an average grain size of 0.32 mm, and has light gray to white colored sand. The estimated quantity of the required dredged volume is 2.9 mcy. An additional 1.2 mcy of allowable volume is added to this for a maximum potential volume of 4.1 mcy. The additional allowable dredge volume is to compensate for dredging inaccuracies. The sand deposit is broken into three sub-sections that extend down to dredging elevations, -32.0, -34.0 and -37.0 ft

NAVD88, the maximum dredging depth is -44 ft. This depth includes the maximum dredging depth of -39 ft plus an additional disturbance layer of 5 feet. The disturbance layer, also known as the non-paid overdepth, involves dredging outside the paid allowable overdepth that may occur due to such factors as unanticipated variation in substrate and/or wind or wave conditions that reduce the operators' ability to control the excavation head. Due to the potential of this layer possibly being disturbed by equipment, it has been included in the maximum depth but is not considered a layer that would be dredged.

The Petit Bois-Alabama East (PB-AL East) borrow site is approximately 885 acres in size. The characteristics of the sand at PB-AL East consist of an average grain size of 0.33mm, and contains light gray to white colored sand. The estimated quantity of the required dredged volume is 13.1 mcy. An additional 2.9 mcy of allowable volume is added to this for a maximum potential volume of 16.0 mcy. The sand deposit is broken into five sub-sections that range from -40.0 to -48.0 ft deep, the maximum dredging depth is -55.0 ft. This depth includes the maximum dredging depth of -50 ft plus an additional disturbance layer of 5 feet (see Figure 4).

The Petit Bois Pass-Mississippi (PBP-MS) site is located about 1 mile southeast of the eastern tip of Petit Bois Island and is approximately 175 acres in size. Sand from this site has an average grain size of 0.31 mm. The estimated quantity of the required dredged volume is 2.2 mcy. An additional 0.6 mcy of allowable volume is added to this for a maximum potential volume of 2.8 mcy. The additional allowable dredge volume is needed to compensate for dredging inaccuracies. The sand deposit is broken into 5 sub-sections that range from -31.5 to -48.0 ft. The maximum dredging depth is -55.0 ft. This depth includes the maximum dredging depth of -50 ft plus an additional disturbance layer of 5 feet (see Figure 4).



Petit Bois Pass Mississippi Borrow Area	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)
PBP-MS	175	2.2	0.6	-31.5 to -48	-33.5 to -50	4 to 15

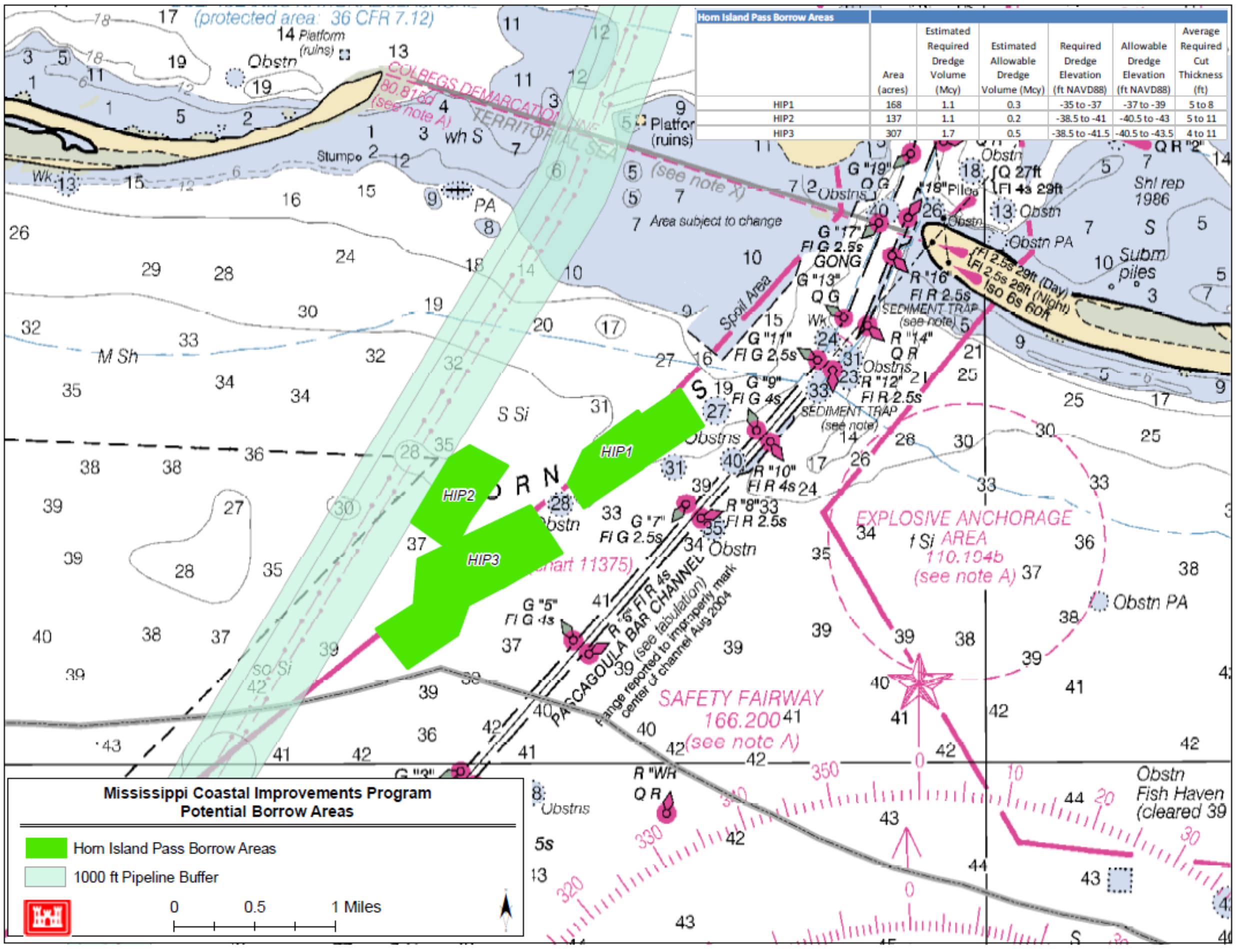
Petit Bois Alabama Borrow Area	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)
PB-AL East Borrow Area	885	13.1	2.9	-40 to -48	-42 to -50	4 to 18
PB-AL West Borrow Area	380	2.9	1.2	-32 to -37	-34 to -39	3 to 10

Figure 4- PBP- MS & PB-AL

Horn Island Pass

The Horn Island Pass borrow area site is located west of the Pascagoula Harbor entrance channel (see Figure 5). Within this site, there are three sub-sections that will be utilized (HIP1, HIP2, HIP3) for sand. The approximate sizes of these sites are as follows: HIPI- 168 acres, HIP2- 137 acres, HIP3- 307 acres.

Sand from these sites has an average grain size that ranges from 0.27 to 0.30 mm, and a predominant grey color. The estimated total quantity of the required dredged volume is 3.9 mcy for all three sites (Figure 5). An additional sum of 1.0 mcy of allowable volume is added to this for a maximum potential volume of 4.9 mcy. The sand deposit is divided into sub-sections that range from -35.0 to -41.5 ft. The maximum dredging depth is -46.5 ft. This depth includes the maximum dredging depth of -41.5 ft plus an additional disturbance layer of 5 feet (Figure 5).



Horn Island Pass Borrow Areas	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)
HIP1	168	1.1	0.3	-35 to -37	-37 to -39	5 to 8
HIP2	137	1.1	0.2	-38.5 to -41	-40.5 to -43	5 to 11
HIP3	307	1.7	0.5	-38.5 to -41.5	-40.5 to -43.5	4 to 11

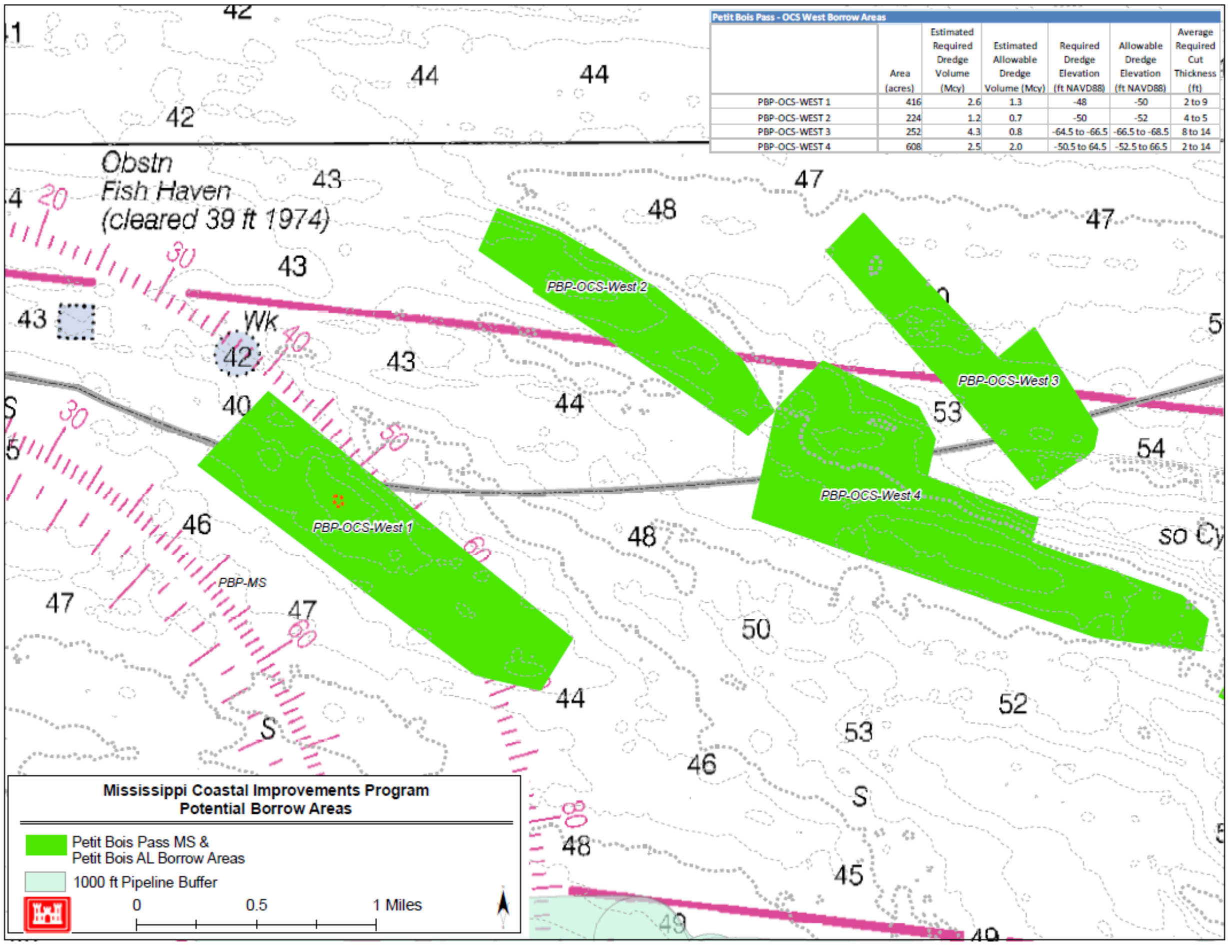
Figure 5- Horn Island Pass

Petit Bois-OCS West

The Petit Bois-OCS West borrow area is located approximately 3.5 miles offshore southeast of Petit Bois Island, Alabama (See Figure 6). Within this site, there are six sub-sections that will be utilized (PBP-OCS-W1, PBP-OCS-W2, PBP-OCS-W3, PBP-OCS-W4, PBP-OCS-W5, PBP-OCS-W6) for sand. The approximate sizes of these sites are as follows: PBP-OCS-W1 (416 acres), PBP-OCS-W2 (224 acres), PBP-OCS-W3 (252 acres), PBP-OCS-W4 (608 acres), PBP-OCS-W5 (203 acres), and PBP-OCS-W6 (140 acres).

The average grain size of sand from these sites is 0.26 to 0.30 mm, and it ranges in color from gray to light greenish gray. The estimated total quantity of the required dredged volume is 12.8

mcy for all six sites (Figure 6). An additional sum of 6.0 mcy of allowable volume is added to this for a maximum potential volume of 18.8 mcy. The sand deposit sub-sections range from -48.0 to -66.5 ft. The maximum dredging depth is -73.5 ft. This depth includes the maximum dredging depth of -68.5 ft plus an additional disturbance layer of 5 feet.



	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)
PBP-OCS-WEST 1	416	2.6	1.3	-48	-50	2 to 9
PBP-OCS-WEST 2	224	1.2	0.7	-50	-52	4 to 5
PBP-OCS-WEST 3	252	4.3	0.8	-64.5 to -66.5	-66.5 to -68.5	8 to 14
PBP-OCS-WEST 4	608	2.5	2.0	-50.5 to 64.5	-52.5 to 66.5	2 to 14

Figure 6- PBP OCS West

Petit Bois-OCS East

The Petit Bois-OCS East borrow area is located in approximately 3.5 miles offshore, southeast of Petit Bois Island (See Figure 7). Within this site, there are five sub-sections that will be utilized (PBP-OCS-E1, PBP-OCS-E2, PBP-OCS-E3, PBP-OCS-E4, PBP-OCS-E5, PBP-OCS-E6) for sand. The approximate sizes of these sites are as follows: PBP-OCS-E1 (416 acres), PBP-OCS-E2 (224 acres), PBP-OCS-E3 (252 acres), PBP-OCS-E4 (608 acres), and PBP-OCS-E5 (203 acres).

The average grain sizes of sand from these sites range from 0.26 to 0.33 mm and it ranges in color from light gray to light greenish or pale yellow. The estimated total quantity of the required dredged volume is 3.8 mcy for all five sites. An additional sum of 1.5 mcy of allowable volume is added to this for a maximum potential volume of 5.3 mcy. The sand deposit sub-sections at all five sites range from -50.0 to -63.0 ft. The maximum dredging depth is -70.0 ft. This depth includes the maximum dredging depth of -65.0 ft plus an additional disturbance layer of 5 feet (Figure 7).

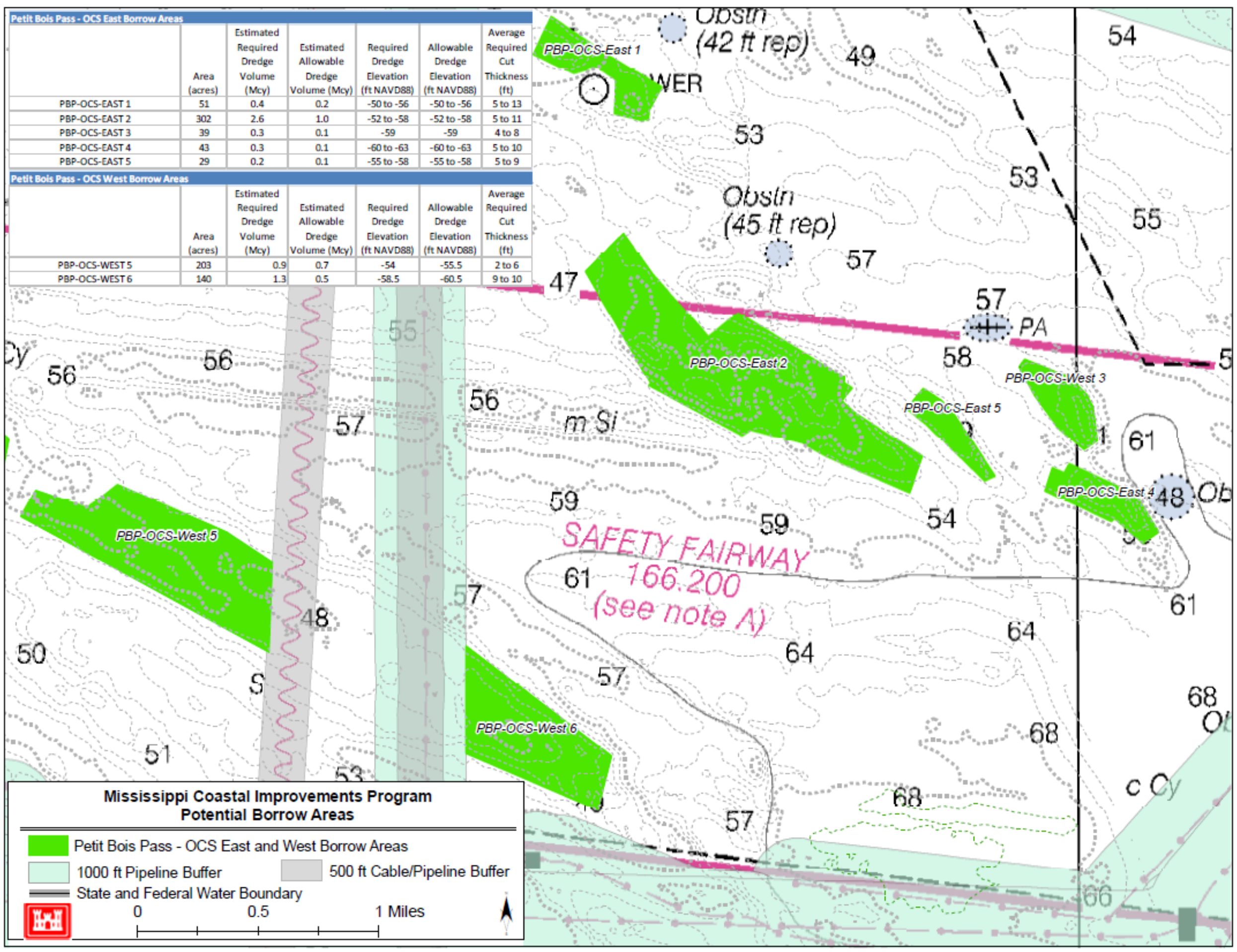


Figure 7- PBP OCS East and West

DA-10 Littoral Placement of Dredged Material

There would be a modification in the future placement location of dredged material for the Pascagoula Federal Navigation Channel. Sandy material dredged from the Horn Island Pass as part of the Pascagoula Federal Navigation Channel, would be potentially be placed in the combined DA-10/ littoral zone along the shallow shoals exposed to the open Gulf waves. The area of potential direct placement would encompass 1,600 acres between DA-10 and the southern boundary of the Pasacagoula Harbor littoral zone site at depths of 5 to 30 feet. Approximately up to 1 mcy of material would be placed into the DA-10 littoral transport system every 18 months.

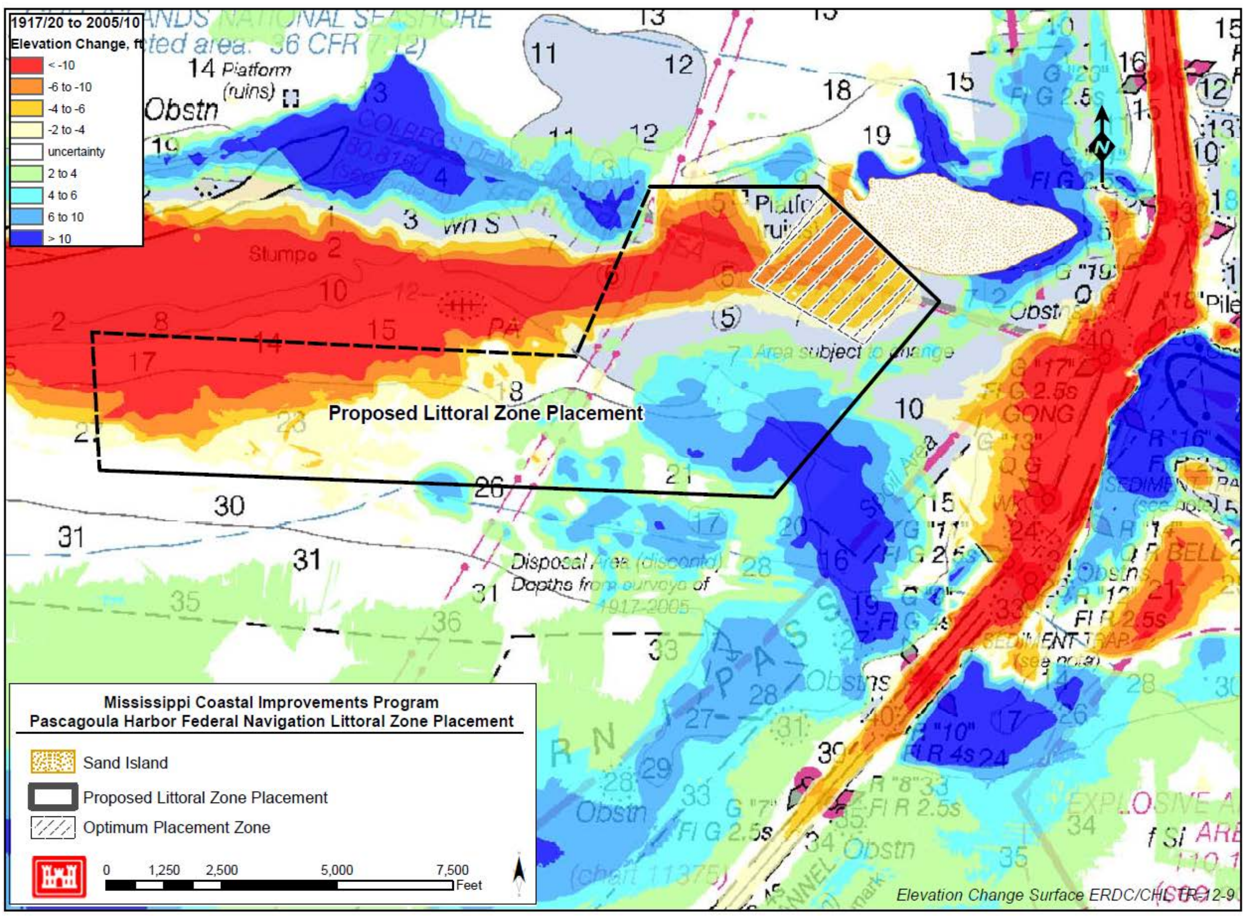


Figure 8. DA-10/ Littoral Zone Placement Area

Equipment Access Routes

Sediment transport equipment could include several types of conveyances, such as scows, crane barges, and jack-up barges, pipelines (submerged, floating, and land), and booster pumps. Heavy machinery would be used to move sand and facilitate construction. The equipment could include bull-dozers, front-end loaders, track-hoes, marshbuggy trackhoes, and backhoes. Various support equipment also would be used, such as crew and work boats, trucks, trailers, construction trailers, all-terrain vehicles, and floating docks or channels with pilings to facilitate loading and unloading of personnel and equipment.

Temporary floatation docks or channels locations are preliminary based on avoidance of environmentally sensitive areas, but would likely be along the northward sides of the Camille cut, and or near islands tips of the placement areas. Channels would be placed outside of environmentally sensitive areas to the maximum extent possible.

Along with the dredges, this equipment could be staged offshore and outside the restoration area during use. Equipment also would be staged onshore. Heavy machinery, vehicles, sediment retaining structures, and other construction equipment could be parked or staged before and during use.

Contractor access floatation channels/ pipeline corridor areas are estimated to be a maximum of 200 ft wide with a maximum depth of -12 NGVD 29. All surface impacts from excavating, pile driving, floatation channels, pipelines, constructed ramps, etc. will be contained within the width and depth parameters (see Figure 9).

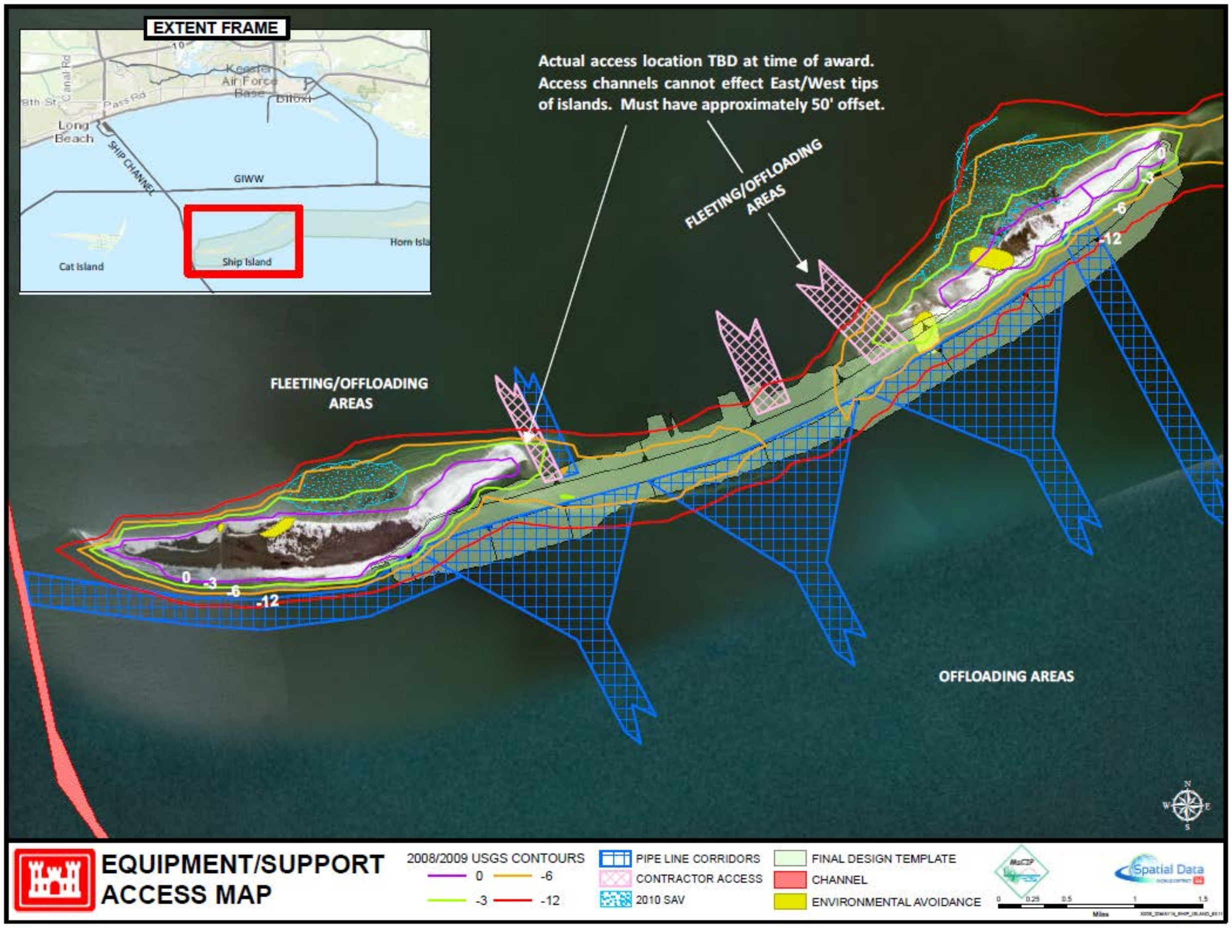


Figure 9- Equipment Access Map

Cat Island Restoration

The Cat Island Restoration consists of the placement of an estimated 2 mcy of sand along the eastern shoreline. The construction template will consist of an average dune crest width of 40 ft at an elevation of approximately +7.5 ft NAVD88. The construction berm will have an average crest width of approximately 250 ft at an elevation of approximately +5 ft NAVD88 with a 1V:20H slope from the seaward side of the berm to the toe of the fill. The construction profile is expected to adjust rapidly through the erosion of the upper profile, and mimic the natural nearshore profile once it reaches equilibrium. The equilibrium design berm width averages approximately 175 to 200 ft. The total equilibrated fill area encompasses approximately 305 acres. The work will likely be performed using a hydraulic dredge. The portion of Cat Island to be restored was acquired by BP following the Deepwater Horizon incident to allow for the ease of clean-up. The restoration will not begin until the property is under public ownership however the restoration should be considered as part of this assessment to assure that the full impacts and benefits of the comprehensive restoration are considered.

Cat Island Borrow Area

Sand for construction of the project will be dredged from an approximate 282-acre borrow area located approximately one mile east of the island in ambient water depths of approximately -12 to -14 ft NAVD88. The material within the borrow site is classified as poorly graded sand, with an average grain size of 0.21 mm, 5.5 percent fines, and a gray to olive-gray color. The Cat Island borrow and placement areas are shown in Figure 10.

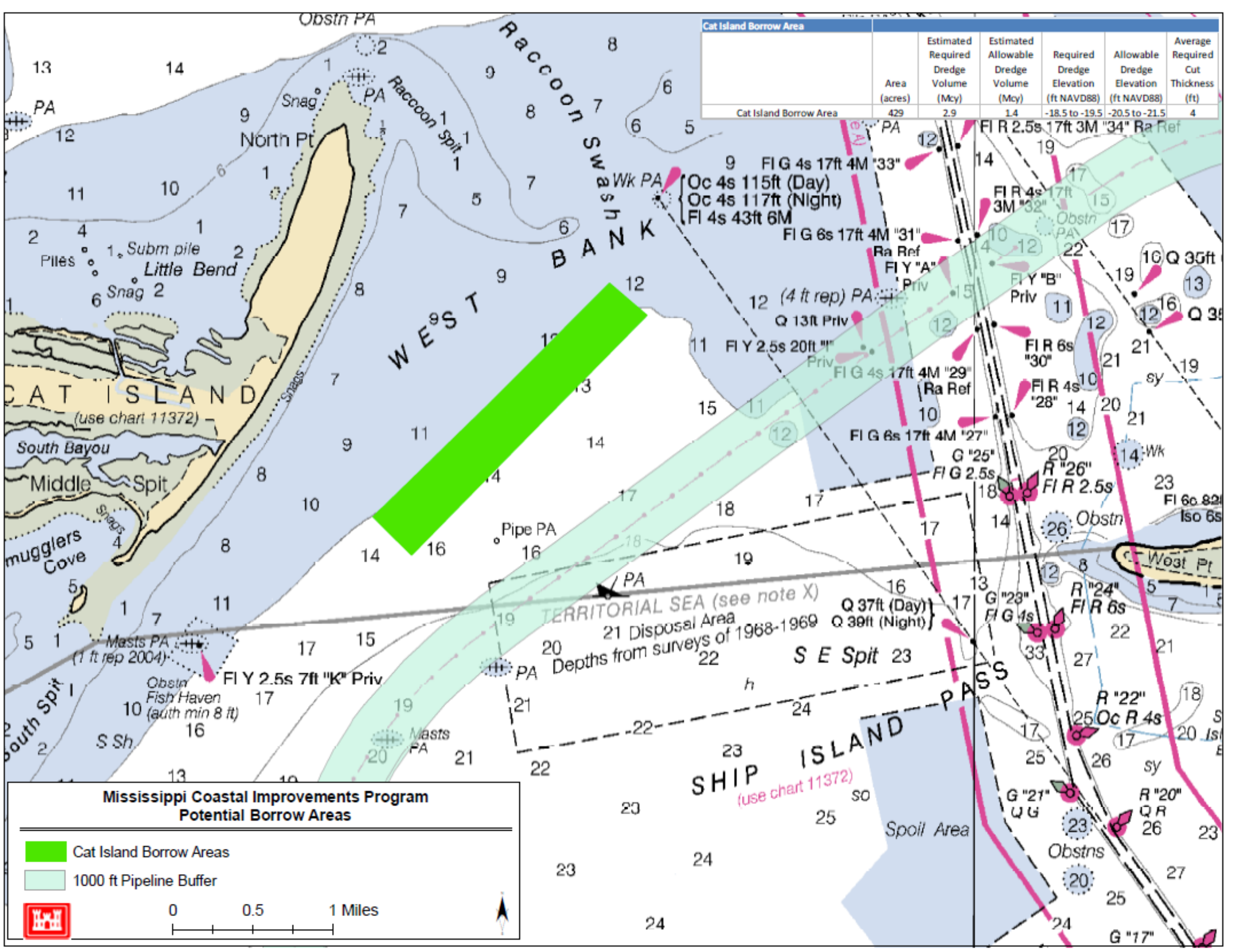


Figure 10- Cat Island Borrow Area

Construction Phases for Ship Island Restoration

The Ship Island restoration component would be constructed in five phases utilizing a variety of equipment including hopper, mechanical, and/or hydraulic pipeline dredges and dump scows. Four of the phases would consist of dredging and placement activities and the fifth phase would consist of dune planting activities on the newly restored Ship Island. Phases 3, 4, and 5 would be constructed concurrently. Work being performed under Phases 3 and 4 would be completed at different locations (i.e., Camille Cut and East Ship Island). Work completed under Phases 3 and 5 would occur in the same location (i.e. Camille Cut), but Phase 5 would begin approximately 2 months after Phase 3 begins, to allow for the Phase 5 effort to occur on the portion of the Phase 3 work that would have already been completed. It is estimated that the five phases would be completed over a period of 2.5 years. Each phase is detailed below.

- **Phase 1:** Approximately 6.0 mcy of in-placed sand volumes based on 2012 surveys would be used to construct the initial berm across Camille Cut and approximately 0.8 mcy would be used to construct a portion of the berm on East Ship Island. Material for Phase 1 would likely be dredged from a combination of the Petit Bois Pass - OCS East and West, Horn Island Pass and Petit Bois Mississippi borrow sites. The initial berm at Camille Cut would have a crest width of approximately 500 feet, a top elevation of +5 feet NAVD88, and a length of approximately 22,500 feet. The berm along East Ship Island would have crest width of approximately 500 feet, a top elevation of +5 feet NAVD88, and a length of approximately 3,000 feet including the appropriate taper to transition into the existing island. The East Ship Island berm would be constructed adjacent to the Camille Cut berm along the west end of the southern shoreline of East Ship Island. It would serve as a feeder source for Camille Cut until the remaining portion of the East Ship Island berm is constructed under Phase 3. Work is anticipated to occur generally from east to west, but depending on the contractor and equipment may also occur west to east. It is estimated that Phase 1 would be completed over a period of 15 months.

- **Phase 2:** Approximately 5.0 mcy of in-placed sand volumes would likely be dredged from a combination of the Petit Bois Pass - OCS West and Petit Bois Alabama borrow sites to raise and widen the initial Camille Cut berm constructed in Phase 1 to elevation +7 ft NAVD88 and approximately 1,000 feet respectively. The berm would be approximately 24,500 feet long including the taper to tie into the East Ship Island berm. The upper interior portion of the berm would be left void during this phase and would be filled using finer grained sand from the Ship Island borrow site during Phase 4. It is estimated that Phase 2 would be completed over a period of 10 months.

- **Phase 3:** Approximately 4.2 mcy of in-placed sand would be used to extend and expand the initial East Ship Island berm constructed in Phase 1 and complete the restoration of the southern shoreline of the East Ship Island. Material for Phase 3 would likely be dredged from a combination of Petit Bois Pass - OCS West and Petit Bois Alabama borrow sites. The final berm along the southern shoreline of East Ship Island would have a crest width of approximately 1,100 feet, a top elevation of +6 feet NAVD88, and a length of approximately 8,000 feet. It is estimated that Phase 3 would be completed over a period of 7 months.

- **Phase 4:** Approximately 1.1 mcy of in-placed sand would be used to fill the void left from Phase 2 in the upper interior portion of the Camille Cut fill. Material for Phase 4 would be dredged from the Ship Island borrow site. The sand in the Ship Island borrow site is finer grained than the other borrow sites and would serve as a more suitable substrate for vegetation growth. The final Camille Cut berm would have a crest width of approximately 1,000 feet with a top elevation of +7 feet NAVD88 after the Phase 4 cap is constructed. It is estimated that Phase 4 would be completed over a period of 5 months.

- **Phase 5:** Work under Phase 5 would consist of planting the Camille Cut restoration berm with native dune vegetation. The newly created island segment would be planted with native dune vegetation, including sea oats (Uniola paniculata), gulf bluestem (Schizachyrium maritimum), and or other grasses and forbs, to restore stable dune habitat. Planting would include vegetation similar to that found in the existing coastal habitats (Section 4.5.1 of MsCIP SEIS). It is estimated that Phase 5 would be completed over a period of 7 months.

- **Cat Island:** Restoration work at Cat Island would be conducted in one phase. The proximity of the borrow area to the island's eastern shoreline in relatively shallow water would allow the rapid placement of sand on the beach likely using a pipeline dredge. The material would be pumped onto the beach and shaped using land-based equipment. Following placement, the area would be vegetated with native grasses. Restoration would occur over approximately 6 months. Work on Cat Island would begin after the State of MS obtains ownership. Restoration work at Cat Island would be done under a separate contract, but the timing of the construction could occur concurrently with the Ship Island Restoration efforts.

Previous Coordination

The Corps, Mobile District has routinely coordinated with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), Protected Resource Division, St. Petersburg Field Office for its federally authorized navigation and restoration projects in Alabama and Mississippi. These coordinations pertain to restoration, improvements and continued operations and maintenance projects. The latest coordination was in 2011/2012 for the Regional BA for all operations and maintenance navigation projects in Mobile District. In 2010 and 2009, the Mobile District consulted with your agencies for the construction of Pascagoula and Gulfport Harbors to their authorized project dimensions. In addition, the Bayou Caddy marsh restoration and Bay St. Louis projects were also coordinated as part of the MsCIP interim projects. Additional coordination for the MsCIP Comprehensive EIS occurred with both USFWS and NMFS, Protected Resource Division in 2009.

Other coordination resulted in the Gulf Regional Biological Opinion (GRBO) for Dredging of Gulf of Mexico Navigation Channels and Sand Mining Areas Using Hopper Dredges, which was prepared by COE Galveston, New Orleans, Mobile, and Jacksonville Districts (Consultation Number F/SER/2000/01287) and dated November 19, 2003 and subsequent revisions.

Description of Listed Species under USFWS Jurisdiction

The USFWS, Southeast Region, Jackson, MS office, lists the following species under their purview as either threatened or endangered for Hancock, Harrison and Jackson Counties, MS. In addition, the Mobile County for AL list is included (Table 1).

Table 1. USFWS T& E list Hancock, Harrison Jackson Counties, MS and Mobile, AL 2012			
Species	**Scientific Name**	**Status**	**County**
Louisiana black bear	*Ursus americanus luteolus*	T	Jackson, Hancock, Harrison
West Indian manatee	*Trichechus manatus*	E	Jackson, Hancock, Harrison, Mobile
Piping plover	*Charadrius melodus*	TCH	Jackson, Hancock, Harrison, Mobile
MS sandhill crane	*Grus canadensis pulla*	ECH	Jackson
AL red-bellied turtle	*Psuedemys alabamensis*	E	Jackson, Harrison, Mobile
Red-cockaded woodpecker	*Picoides borealis*	E	Jackson, Harrison
Gopher tortoise	*Gopherus polyphemus*	T	Jackson, Hancock, Harrison
Gulf sturgeon	*Acipenser oxyrhynchus desotoi*	TCH	Jackson, Hancock, Harrison, Mobile
Yellow-blotched map turtle	*Graptemys flavimaculata*	T	Jackson
MS gopher frog	*Rana capito sevosa*	E	Jackson, Harrison
Louisiana quillwort	*Isoetes louisianensis*	E	Jackson, Hancock, Harrison
Green sea turtle	*Chelonia mydas*	T	Jackson, Hancock, Harrison, Mobile
Loggerhead sea turtle	*Caretta caretta*	E	Jackson, Hancock, Harrison
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	Jackson, Hancock, Harrison, Mobile
Ringed map turtle	*Graptemys oculifera*	T	Hancock
Inflated heelsplitter	*Potamilus inflatus*	T	Hancock
Leatherback sea turtle	*Dermochelys comacea*	E	Jackson, Hancock, Harrison, Mobile
Wood Stock	*Mycteria americana*	E	Mobile
Red Knot	*Calidris cantus rufa*	T	Mobile, Jackson, Hancock, Harrison
Eastern indigo snake	*Drymarchon coraisc*	T	Mobile
T- Threatened, E- Endangered, CH-Critical Habitat			

The federally protected species under the USFWS jurisdiction, such as the Louisiana (LA) black bear, MS sandhill crane, red-cockaded woodpecker, gopher tortoise, eastern indigo snake, LA quillwort, MS gopher frog, gopher tortoise, AL red-bellied turtle, wood stock, Inflated heelspitter, ringed mapped turtle, and the yellow-blotched map turtle, would not be adversely impacted by the proposed restoration project because these species are not typically found in the project areas due to the lack of suitable habitat. It has been noted that several AL red-bellied turtle hatchlings have been found on Horn Island (Necaise personal comm., 2012). These turtles were perhaps introduced to the island by humans. However, the habitats on the MS barrier islands are not suitable to sustain a viable, healthy population of these species.

Bald eagles, not listed above, are no longer federally threatened or endangered, but are still protected under the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act. Bald eagles have been known to utilize the MS barrier islands for nesting since their reintroduction to the Mississippi Gulf Coast in the mid 1990s. During the 2011-2012 nesting season, there were 4 documented nests, one nest each on Cat Island and East Ship Island with 2 fledglings and 2 nests on Horn Island with 3 fledgings. Historically, there has also been a nest on Petit Bois Island, however, in 2011, it was not active (Hopkins personal comm., 2012). However, the nests locations are found within the interior areas of the islands well outside of the project area. The restoration project activities will take place in the nearshore and along the primary dune line and will be far removed from where bald eagle nesting or perching may occur. Therefore, bald eagles or their nests are not likely to be affected by the project restoration activities.
Manatees may be occasionally found in the shallow waters of the project area during the warmer months of the year. Given their slow-moving and low visibility nature, it is possible that manatees could wander into close proximity of the placement operations. However, to minimize contact and potential injury to manatees in shallow water/placement areas, the Manatee Construction Conservation Measures as specified by the USFWS will be observed.

Species of Concern

Of particular concern in this BA are the species that may likely occur within the project vicinity which include: piping plover and its designated critical habitat, and the red knot under USFWS jurisdiction, and loggerhead, leatherback, Kemp's ridley, and green sea turtles and the Gulf sturgeon/designated critical habitat under NMFS jurisdiction in the water/marine systems and USFWS jurisdiction on land/riverine systems, respectively. The Red Knot (*Calidris canutus rufa*) has recently been listed as a threatened species under Section 7 of the Endangered Species Act of 1973 as amended. The final rule was published in the Federal Register on December 11, 2014, and the final rule becomes effective January 12, 2015.

Piping Plovers

The piping plover is a small, pale-colored North American shorebird. The bird's light sand-colored plumage blends in with the sandy beaches and shorelines that are its primary habitat. It weighs 1-2 ounces (43-63 grams) and is 6-6 ½ inches (17-18 centimeters) long. During the breeding season, the legs are bright orange and the short stout bill is orange with a black tip. There are two single dark bands, one around the neck and one across the forehead between the eyes. Plumage and leg color help distinguish this bird from other plovers. The female's neck band is often incomplete and is usually thinner than the male's neck band. In winter, the bill turns black, the legs remain orange but pale, and the black plumage bands on the head and necks are lost. Chicks have speckled gray, buff, and brown down, black beaks, orange legs, and a white collar around the neck. Juveniles resemble wintering adults and obtain their adult plumage the spring after they fledge.

Historically, piping plovers bred across three geographic regions. These regions include: the United States and Canadian Northern Great Plains from Alberta to Manitoba and south to Nebraska; the Great Lakes beaches; and the Atlantic coastal beaches from Newfoundland to North Carolina. Currently, piping plovers live in an area similar to their historical range, although the numbers of those breeding in the Great Lakes region have decreased significantly since the 1930s. The Great Lakes breeding population is now found mainly in Michigan, with one pair nesting in Wisconsin. Generally, piping plovers favor open sand, gravel, or cobble beaches for breeding. Breeding sites are generally found on islands, lake shores, coastal shorelines, and river margins.

Red Knots

Red knots (*Calidris cantus rufa*) a species of the sandpiper shorebird, have been observed wintering on the majority of the barrier islands, especially at Cat Island and Petit Bois in few numbers. Similar wintering habitat requirements to the piping plover exist for red knots. The USFWS has recently listed the subspecies, the red knot (*Calidris canutus rufa*), as a threatened species under the ESA. The USFWS lists Mississippi and Alabama as states where *C. canutus rufa* are known or believed to occur. The red knot migrates annually between its breeding grounds in the Canadian Arctic and several wintering regions, including the Southeast United States, the Northeast Gulf of Mexico, northern Brazil, and Tierra del Fuego at the southern tip of South America. During both the northbound and southbound migrations, red knots use key staging and stopover areas to rest and feed. Suitable habitat for the wintering species exists within the project area, the MS barrier islands. Bird surveys, conducted in support of the MsCIP barrier island restoration project during the period December 28, 2012 and December 18, 2013, identified a total of 292 red knots in the project area. Red knots were observed on DA-10/Sand Island (11), East Ship Island (265), and West Ship Island (16) (Appendix J). Most red knots were observed in January 2013 (75) and May 2013 (61).

Other various species of shorebirds such as snowy plover, Wilson’s plover, various species of terns, black skimmer, and others have been documented to utilize the project area and mainland beaches for nesting and feeding. However, an assessment of native and migratory shorebirds within the project area, and any impacts to shorebirds are discussed in the MsCIP SEIS.

Critical Habitat Boundaries for Ship Island Restoration

Within the Ship Island restoration area, there are designated critical habitat for piping plovers and Gulf sturgeon. Of the 1,500 acres of the proposed placement area at Camille Cut and East Ship Island, approximately 820 acres of the 2002 USFWS designated piping plover critical habitat are located within the proposed project footprint; however, only approximately 139 acres of this currently lies above mean lower low water (MLLW) within the construction limits.
For Gulf sturgeon, approximately 980 acres are located within the boundaries of 2003 NMFS designated Gulf sturgeon critical habitat; currently approximately 1,366 acres within the construction project limits lie below mean high water (MHW). Critical habitat boundaries for of the piping plover and Gulf sturgeon for Ship Island are shown in Figure 11.

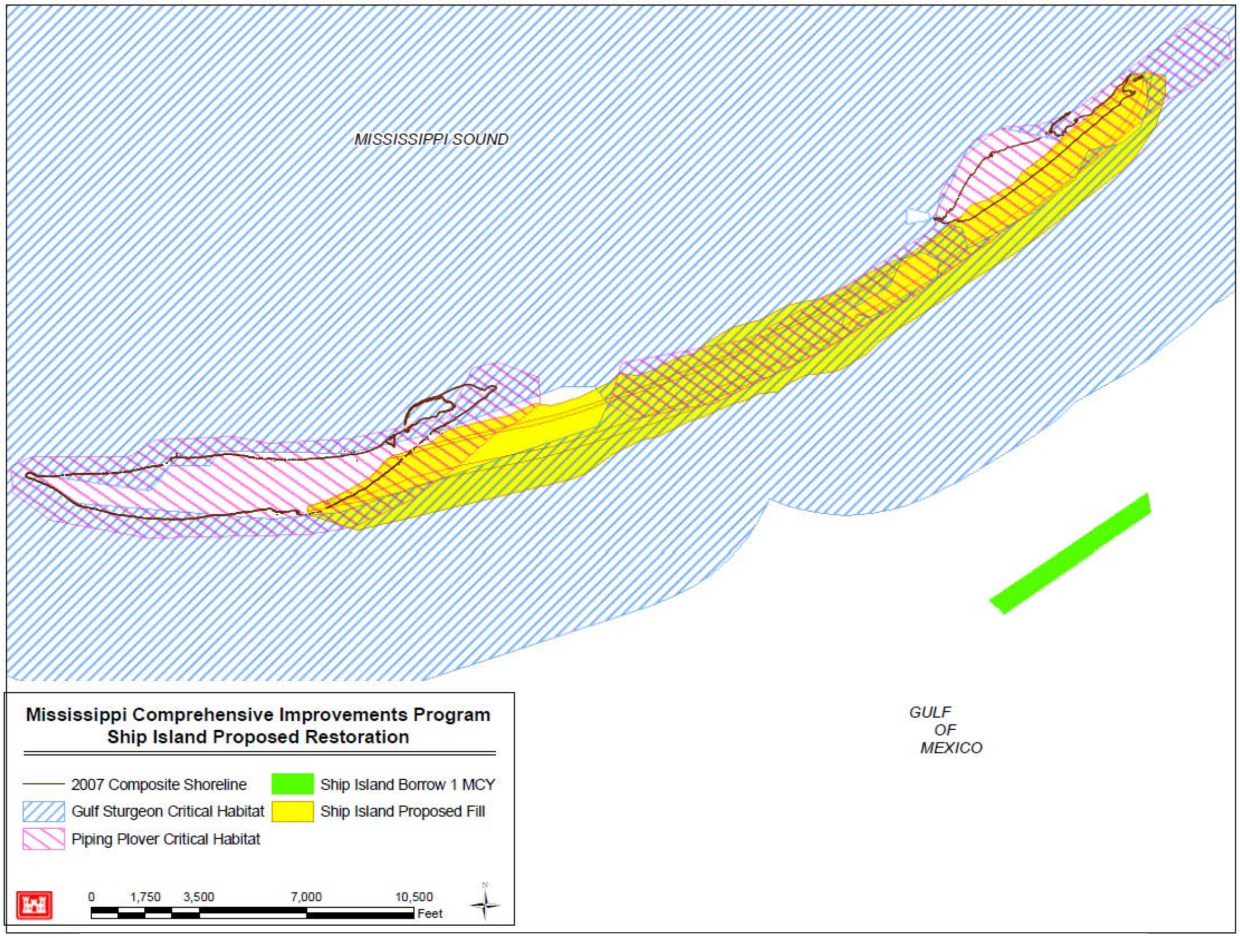


Figure 11. Critical Habitat boundaries for Ship Island Restoration Area

Critical Habitat for Borrow Areas

The Ship Island borrow area is outside of critical habitat for designated piping plovers and Gulf sturgeon. The site at its closest location is approximately 4,000 ft seaward of designated Gulf sturgeon critical habitat.

Likewise, the Petit Bois, Alabama and Petit Bois OCS borrow areas are submerged and outside of designated critical habitat areas for both Gulf Sturgeon and piping plover. The site at its closest location is approximately 1,000 ft seaward of designated Gulf sturgeon critical habitat. However, about 32.0 acres of Petit Bois Pass- MS borrow site is located within Gulf sturgeon critical habitat. This site is also submerged (Figure 2).

Cat Island restoration area is located within critical habitat for Gulf sturgeon and Piping plover. The Cat Island borrow area is only located within gulf sturgeon critical habitat. The portion of restored area that is in the 2003 designated Gulf sturgeon critical habitat boundary is approximately 45 acres. In addition, the 305 acres of restored area is located within the 2002 designated Piping plover critical habitat; however, only approximately 99 acres within the constructed project limits currently lie above MLLW (see Table 3).

In addition, the proposed DA-10/littoral zone future placement area is located within Gulf sturgeon critical habitat.

Piping Plover Critical Habitat

The project area is located within piping plover critical habitat, MS Unit 14. The final rule designating critical habitat for the wintering population of the piping plover was published in the Federal Register on July 10, 2001.

The primary constituent elements for the piping plover wintering habitat are those habitat components that are essential for the primary biological needs of foraging, sheltering, and roosting, and only those areas containing these primary constituent elements within the designated boundaries are considered critical habitat. The primary constituent elements are found in geologically dynamic coastal areas that support or have the potential to support such as intertidal beaches and flats and the sparsely vegetated back beach areas. Important components of intertidal flats include sand and or mud flats with no or sparse emergent vegetation. Critical habitat for MS-14 extends to the MLLW.

Piping plovers winter in coastal areas of the United States from North Carolina to Texas (TX). piping plovers begin arriving on the wintering grounds in July, with some late-nesting birds arriving in September. Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging (Nicholls and Baldassarre 1990; Drake 1999a, 1999b). Of the birds located on the United States wintering grounds, past censuses found that 89 percent were found on the Gulf Coast and eight percent were found on the Atlantic

Coast. All piping plovers are considered threatened species under the Endangered Species Act when on their wintering grounds.

Breeding and wintering plovers feed on exposed wet sand in wash zones; intertidal ocean beach; wrack lines; washover passes; mud-, sand-, and algal flats; and shorelines of streams, ephemeral ponds, lagoons, and salt marshes by probing for invertebrates at or just below the surface. They use beaches adjacent to foraging areas for roosting and preening. Small sand dunes, debris, and sparse vegetation within adjacent beaches provide shelter from wind and extreme temperatures (USFWS). Primary prey for piping plovers includes worms, various crustaceans, insects, and occasionally bivalve mollusks. Many of the coastal beaches traditionally used by piping plovers for nesting, feeding, and roosting have been lost to commercial, residential, and recreational developments. Also, developments near beaches provide food that attracts increased numbers of predators such as raccoons, skunks, and foxes. Water level manipulation along the major rivers may also lead to loss of breeding habitat. In order to recover the piping plover and remove it from the endangered species list, threats to reproductive success at breeding grounds must be addressed. Availability of quality foraging and roosting habitat in the regions where this species winters is necessary in order to insure that an adequate number of adults survive to migrate back to breeding sites and successfully nest.

Surveys for piping plovers on Mississippi barrier islands and mainland beaches indicate a mid-winter period when most of the birds are winter residents and a spring – fall migration when many more birds move through the islands staying for only a short time. During the migration, these areas serve as refueling spots on the long migratory journey. Within the project area, piping plovers are known to congregate primarily along the tidal flats and tips of West and East Ship Islands, and at Petit Bois, Horn, and Cat Islands.   A survey for the 2009 migratory period was conducted, in which approximately 24-34 piping plovers on Petit Bois, Horn and West and East Ship Islands (Zdravkovic, 2009) were counted. However, higher numbers of plovers were observed for Cat, West, and East Ship Islands during the 2010-11 migratory period (Necaise, person comm., 2012).

During the 2008-09 wintering period, piping plovers were surveyed from Boca Chica, Texas to Marco Island, FL (Maddock, 2010). Over a 9-day period, the MS mainland and barrier islands were observed. A maximum of 41 birds were observed on Cat Island, 24 on East Ship, 25 on West Ship, 29 on Horn, and 14 on Petit Bois. Moderate numbers of piping plovers were counted on the mainland beaches. Maddock observed higher frequencies of plovers use on areas that had large exposed flats, overwash areas, or newly created inlets.

In a 2011 wintering survey, the majority of birds were recorded at East Ship, Cat and Horn Islands; and of the three, Cat Island had the most, with 45 birds (Winstead, personal comm., 2012). In addition, a 2012 survey noted at least 38 piping plovers on Cat Island, 55 on East Ship Island, 3 on West Ship Island, and 5 on Horn Island (Winstead, personal comm., 2012). Also, piping plovers are regularly observed on DA-10, although, their frequency of use has not been well-documented.

During bird surveys conducted in support of the MsCIP barrier island restoration project between December 2012 and December 2013, a total of 1,154 piping plovers were observed in the project area. Piping plover were observed on DA-10/Sand Island (17), East Ship Island (779), and West Ship Island (358). On East Ship Island, the largest number of piping plover was observed during the month of October (416 birds). Relatively large numbers of piping plovers were observed on East Ship Island during the months August through December, while relatively large numbers were observed on West Ship Island during the months January through April. On Sand Island, the month of February had the largest number (12) of piping plovers, and all other months had much lower numbers of this species.

Sea Turtles

Loggerhead Sea Turtles

<u>Biology</u>

The loggerhead sea turtle is a medium to large turtle. Adults are reddish-brown in color and generally 31 to 45 inches in shell length with the record set at more than 48 inches. Loggerheads weigh between 170 and 350 pounds with the record set at greater than 500 pounds. Young loggerhead sea turtles are brown above and whitish, yellowish, or tan beneath, with three keels on their back and two on their underside.

Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Gulf of Mexico, Pacific, and Indian Oceans. This species may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, and the mouths of large rivers. Loggerhead sea turtles are considered turtles of shallow water. Juvenile loggerheads are thought to utilize bays and estuaries for feeding, while adults prefer waters less than 165 ft deep (Nelson 1986). Aerial surveys suggest that loggerheads (young and adults) 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. During aerial surveys of the Gulf of Mexico, the majority (97 percent) of loggerheads was seen off the east and west coasts of Florida (FL) (Fritts 1983). Most were observed around mid-day near the surface, possibly related to surface basking behavior (Nelson 1986). Although loggerheads were seen off the coast of AL, MS, and LA, they were 50 times more abundant in FL than in the western Gulf. The majority of the sightings were in the summer (Fritts et al. 1983). An individual tagged in Perdido Bay, AL was recaptured one year later only about a mile from the original capture site.

Loggerhead turtles are essentially carnivores, feeding primarily on sea urchins, sponges, squid, basket stars, crabs, horseshoe crabs, shrimp, and a variety of mollusks. Their strong beak-like jaws are adapted for crushing thick-shelled mollusks. Although loggerhead sea turtles are primarily bottom feeders, they also eat jellyfish and mangrove leaves obtained while swimming and resting near the sea surface. Presence of fish species, such as croaker in stomachs of stranded individuals may indicate feeding on the by-catch of shrimp trawling (Landry, 1986). Caldwell et al. (1955) suggest that the willingness of the loggerhead to consume any type of invertebrate food permits its range to be limited only by the presence of cold water.

As loggerheads mature, they travel and forage through nearshore waters until their breeding season, when they return to the nesting beach areas. The majority of mature loggerheads appear to nest on a two or three year cycle. Major nesting beaches for loggerheads include the Sultanate of Oman, southeastern United States, and eastern Australia. Within the U.S., this species nests from TX to Virginia, although the major nesting concentrations are found along the Atlantic coast of FL, Georgia, South Carolina, and North Carolina. About 80 percent of all loggerhead nesting in the southeastern U.S. occurs in six FL counties (Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties).

Nesting in Project Area

Nesting in the northern Gulf outside of FL occurs primarily on the Chandeleur Islands in LA and to a lesser extent on adjacent Ship, Horn, and Petit Bois Islands in MS (Ogren 1977). Ogren (1977) reported a historical reproductive assemblage of sea turtles, which nested seasonally on remote barrier beaches of eastern LA, MS, and AL. These sea turtles have historically nested on MS's barrier islands (e.g., Ship, Horn, Petit Bois), situated about 19 km south of the mainland (Carr et al. 1982). The more recent occurrences of sea turtles nesting on the MS barrier islands have been documented by the NPS. From 1990- 2011, loggerhead sea turtle nesting and/ or false crawls have been documented at several barrier islands (Cat, West and East Ship, Horn, and Petit Bois). Among the barrier islands, most of the nesting occurred on Petit Bois and Horn Islands, with few nesting documented on the other islands. There was one nest documented on East Ship Island (1992), two nests on Cat Island (1998), 16 nests on Horn Island (1998), and 12 nests on Petit Bois Island (1998). For the 2012 nesting season, there were several documented nests on East, and West Ship Island and Cat Island. A total of 4 nests were documented on West Ship, with 3 nests located on the southern shoreline and 1 nest on the northern shoreline (Hopkins personal comm., 2012). Likewise, a total of 3 nests were observed by Hopkins on the southern shoreline of East Ship Island. There were 3 confirmed nests and one potential nest on Cat Island (Necaise personal comm., 2012). In addition, four confirmed nests were reported on the MS mainland, including one on Deer Island (Coleman personal comm., 2012) and several on Petit Bois and Horn Islands.

Green Sea Turtle

Biology

The green sea turtle is mottled brown in color. The name is derived from the greenish fat of the body. The carapace is light or dark brown. It is sometimes shaded with olive, often with radiating mottled or wavy dark markings or large dark brown blotches. This species is considered medium to large in size for sea turtles with an average length of 36 to 48 inches. The record was set at about 60 inches in length. Its weight ranges from about 250 to 450 pounds with the record at more than 650 pounds. The upper surfaces of young green turtles are dark brown, while the undersides are white.

Although green sea turtles are found worldwide, this species is concentrated primarily between the 35° North and 35° South latitudes. Green sea turtles tend to occur in waters that remain warmer than 68° F; however, there is evidence that they may be buried under mud in a torpid state in waters to 50° F (Ehrhart 1977; Carr et al. 1979).

This species migrates often over long distances between feeding and nesting areas (Carr and Hirth 1962). During their first year of life, green sea turtles are thought to feed mainly on jellyfish and other invertebrates. Adult green sea turtles prefer an herbivorous diet frequenting shallow water flats for feeding (Fritts et al. 1983). Adult turtles feed primarily on seagrasses, such as *Thalassia testudinum*. This vegetation provides the turtles with a high fiber content and low forage quality (Bjorndal 1981a). Caribbean green sea turtles are considered by Bjorndal (l981b) to be nutrient-limited, resulting in low growth rate, delayed sexual maturity, and low annual reproductive effort. This low reproductive effort makes recovery of the species slow once the adult population numbers have been severely reduced (Bjorndal 1981). In the Gulf of Mexico, principal foraging areas are located in the upper west coast of FL (Hirth 1971). Nocturnal resting sites may be a considerable distance from feeding areas, and distribution of the species is generally correlated with grassbed distribution, location of resting beaches, and possibly ocean currents (Hirth 1971).

<u>Nesting</u>

Major nesting areas for green sea turtles in the Atlantic include Surinam, Guyana, French Guyana, Costa Rica, the Leeward Islands, and Ascension Island in the mid-Atlantic. Historically in the U.S., green turtles have been known to nest in the FL Keys and Dry Tortugas. These turtles primarily nest on selected beaches along the coast of eastern FL, predominantly Brevard through Broward Counties. The turtles are not known to nest on the MS coast or barrier islands, but could been found feeding in the seagrass beds in nearshore waters. However, nesting has occurred in AL, and therefore it is possible in MS.

In the southeastern U.S., nesting season is roughly June through September. Nesting occurs nocturnally at 2, 3, or 4-year intervals. Only occasionally do females produce clutches in successive years. Estimates of age at sexual maturity range from 20 to 50 years (Balazs 1982; Frazer and Ehrhart 1985) and they may live over 100 years. Immediately after hatching, green turtles swim past the surf and other shoreline obstructions, primarily at depths of about 8 inches or less below the water surface, and are dispersed both by vigorous swimming and surface currents (Balzas 1980). The whereabouts of hatchlings to juvenile size is uncertain. Green turtles tracked in TX waters spent more time on the surface, with less submergence at night than during the day, and a very small percentage of the time was spent in the federally maintained navigation channels. The tracked turtles tended to utilize jetties, particularly outside of them, for foraging habitat (Renaud et. al. 1993).

Kemp's Ridley Turtle

Biology

The Kemp's ridley occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean with occasional individuals reaching European waters. Adults of this species are generally confined to the Gulf of Mexico, although some adults are sometimes found on the east coast of the U.S. Females return to their nesting beach about every other year with nesting occurring from April into July and usually limited to the western Gulf of Mexico. The mean clutch size for this species is about 100 eggs per nest and an average of 2.5 nests per female per season.

Immature turtles have been found along the eastern seaboard of the U.S. and in the Gulf of Mexico, including the MS Sound. In the Gulf, studies suggest that immature turtles stay in shallow, warm, nearshore waters in the northern Gulf until cooling waters force them offshore or south along the FL coast (Renaud 1995). Little is known of the movements of the post-hatching stage (pelagic stage) within the Gulf. Studies have indicated that this stage varies from 1 to 4 or more years and the immature stage lasts about 7 to 9 years (Schmid and Witzell 1997). The maturity age of this species is estimated to be 7 to 15 years.

Nesting

Kemp's ridley sea turtles are regularly seen in the MS Sound, and although no nesting has been documented, they could potentially nest on the MS barrier islands. Immature Kemp's ridelys have been incidentally caputured by recreational fishermen at MS fishing piers. In 2012, almost 200 Kemp's ridleys were captured and rehabilitated (Coleman personal comm., 2012). Nests have been documented on Santa Rosa Island in the Florida District of the Gulf National Seashore Along the gulf coast. In addition, nesting is being reestablished in Texas through conservation programs; however, its primary nesting area is near Rancho Nuevo in Tamaulipas, Mexico (Rothschild, 2004).

Leatherback Sea Turtle

Biology

The leatherback sea turtles are the largest of all sea turtles. These turtles may reach a length of about 7 ft and weigh as much as 1,600 pounds. The carapace is smooth and gray, green, brown, and black. The plastron is yellowish white. Juveniles are black on top and white on the bottom.

This species is highly migratory and is the most pelagic of all sea turtles (NMFS and USFWS 1992). They are commonly found along continental shelf waters (Pritchard 1971; Hirth 1980; Fritts et al. 1983). Leatherback sea turtles' range extends from Cape Sable, Nova Scotia, south to Puerto Rico and the U.S. Virgin Islands. Leatherbacks are found in temperate waters while migrating to tropical waters to nest (Ross 1981). Distribution of this species has been linked to thermal preference and seasonal fluctuations in the Gulf Stream and other warm water features (Fritts et al. 1983). General decline of this species is attributed to exploitation of eggs (Ross 1981).

Leatherback sea turtles are omnivorous. They feed mainly on pelagic soft-bodied invertebrates, such as jellyfish and tunicates. Their diet may also include squid, fish, crustaceans, algae, and floating seaweed. Highest concentrations of these prey animals are often found in upwelling areas or where ocean currents converge.

Nesting

Nesting of leatherback sea turtles is nocturnal with only a small number of nests occurring in the Florida portion of the Gulf of Mexico from April to late July (Pritchard 1971; Fuller 1978; Fritts et al. 1983). There is very little nesting in the U. S except in the western Atlantic, where leatherback and hawksbill primarily nest at sites in the Caribbean, with isolated nesting on FL beaches (Gunter 1981, Rothschild, 2004). However, leatherback sea turtles have been occasionally seen feeding in the drift lines of jelly fish in the Mississippi Sound and the Gulf waters surrounding the Mississippi barrier islands (Hopkins, personal comm., 2012). Leatherback sea turtles prefer open access beaches possibly to avoid damage to their soft plastron and flippers. Unfortunately, such open beaches with little shoreline protection are vulnerable to beach erosion triggered by seasonal changes in wind and wave direction. Thus, eggs may be lost when open beaches undergo severe and dramatic erosion. The Pacific coast of Mexico supports the world's largest known concentration of nesting leatherbacks.

Hawksbill Sea Turtle

Biology

The hawksbill sea turtle is the second smallest sea turtle and is somewhat larger than the Kemp's ridley. The hawksbill sea turtle is small to medium size with a very attractively colored shell of thick overlapping scales. The overlapping carapace scales are often streaked and marbled with amber, yellow, or brown. Hawksbill turtles have a distinct, hawks-like beak. The name of the turtle is derived from the tapered beak and narrow head.

Hawksbill sea turtles are highly migratory species. These turtles generally live most of their life in tropical waters, such as the warmer parts of the Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea (Carr 1952 and Witzell 1983). FL and TX are the only states where hawksbills are sighted with any regularity (NMFS and USFWS 1993). Juvenile hawksbills are normally found in waters less than 45 ft in depth. They are primarily found in areas around coral reefs, shoals, lagoons, lagoon channels and bays with marine vegetation that provides both protection and plant and animal food. Hawksbills can tolerate muddy bottoms with sparse vegetation unlike the green turtles. They are rarely seen in LA, AL, and MS waters.

Nesting

Hawksbills nest throughout their range, but most of the nesting occurs on restricted beaches, to which they return each time they nest. These turtles are some of the most solitary nesters of all the sea turtles. Depending on location, nesting may occur from April through November (Fuller et al. 1987). Hawksbills prefer to nest on clean beaches with greater oceanic exposure than those preferred by green sea turtles, although they are often found together on the same beach. The nesting sites are usually on beaches with a fine gravel texture. Hawksbills have been found in a variety of beach habitats ranging from pocket beaches only several yards wide formed between rock crevices to a low-energy sand beach with woody vegetation near the waterline. These turtles tend to use nesting sites where vegetation is close to the water's edge.

Description of Listed Species under NMFS Jurisdiction

The NMFS, Protected Resource Division, St. Petersburg Field Office lists the following species under their purview as either threatened and/or endangered that may occur within the area (Table 2):

Table 2. NMFS T&E list		
Species	**Scientific Name**	**Status**
green sea turtle	*Chelonia mydas*	T
hawksbill sea turtle	*Eretmochelys imbricate*	E
Kemp's ridley sea turtle	*Lepidochelys kempii*	E
leatherback sea turtle	*Dermochelys coriacea*	E
loggerhead sea turtle	*Caretta caretta*	T
Gulf sturgeon (fish)	*Acipenser oxyrinchus desotoi*	T/CH
Smalltooth sawfish	*Pristis pectinata*	E
blue whale	*Balaenoptera musculus*	E
finback whale	*Balaenoptera physalus*	E
humpback whale	*Megaptera novaeangliae*	E
sei whale	*Balaenoptera borealis*	E
sperm whale	*Physeter macrocephalus*	E

The federally protected species under the NMFS jurisdiction, such as the blue whale, finback whale, humpback whale, sei whale, and sperm whale, are not considered in this BA as these species are unlikely to be found in the project area. Typically no threatened or endangered species of whales occur in the nearshore waters over the continental shelf of the Gulf of Mexico. Occasionally, North Atlantic right whales and humpback whales may be found in nearshore waters of the Gulf of Mexico, usually during the winter season. However, sightings of these species are relatively uncommon (NOAA, 2006).

Smalltooth sawfish are rare in the action area and the chances of the proposed action affecting them are discountable (F/SER/2010/01062). This species is not likely to be adversely affected.

Of particular concern in this BA are the species that may likely occur within the project vicinity which include: loggerhead, leatherback, Kemp's ridley, hawksbill, and green sea turtles, and the Gulf sturgeon.

The placement areas are located within Gulf sturgeon (*Acipenser oxyrinchus desotoi*) critical habitat Unit 8, which consists of areas within Lake Pontchartrain (east of causeway), Lake Catherine, Little Lake, the Rigolets, Lake Borgne, Pascagoula Bay, and MS Sound systems in LA and MS, and sections of the state waters within the Gulf of Mexico.

Species of Concern

Sea Turtles

(see previous descriptions in USFWS section)

Gulf Sturgeon

The NMFS and USFWS listed the Gulf sturgeon as a threatened species on September 30, 1991. The Gulf sturgeon, also known as the Gulf of Mexico sturgeon, is a subspecies of the Atlantic sturgeon. It is a large fish with an extended snout, vertical mouth, and with the upper lobe of the tail longer than the lower. Adults are 180 to 240 cm (71-95 inches) in length, with adult females larger than adult males. The skin is scale less, brown dorsally and pale ventrally and imbedded with 5 rows of bony plates.

Adult fish are bottom feeders, eating primarily invertebrates, including brachiopods, insect larvae, mollusks, worms and crustaceans. Gulf sturgeon are anadromous, with reproduction occurring in freshwater. Most adult feeding takes place in the Gulf of Mexico and its estuaries. The fish return to breed in the river system in which they hatched. Spawning occurs in areas of deeper water with clean (rock and rubble) bottoms. The eggs are sticky and adhere in clumps to snags, outcroppings, or other clean surfaces. Sexual maturity is reached between the ages of 8 and 12 years for females and 7 and 10 years for males.

Historically, the Gulf sturgeon occurred from the MS River to Charlotte Harbor, FL. It still occurs, at least occasionally, throughout this range, but in greatly reduced numbers. The fish is essentially confined to the Gulf of Mexico. River systems where the Gulf sturgeon are known to be viable today include the MS, Pearl, Pascagoula, Escambia, Blackwater, Yellow, Choctawhatchee, Apalachicola, and Suwannee Rivers, and possibly others.

Gulf Sturgeon Critical Habitat

NMFS and USFWS jointly designated Gulf sturgeon critical habitat on April 18, 2003 (68 FR 13370, March 19, 2003). The term “critical habitat” is defined in section 3(5)(A) of the Endangered Species Act (ESA) as (i) the specific areas within the geographic area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) that may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. “Conservation” is defined in section 3(3) of the ESA as the use of all methods and procedures that are necessary to bring any endangered or threatened species to the point at which listing under the ESA is no longer necessary. Critical habitat for the Gulf sturgeon within the project vicinity is identified as Unit 8 (approximately 881,280 acres), Lake Pontchartrain, (east of causeway), Lake Catherine, Little Lake, the Rigolets, Lake Borgne, Pascagoula Bay, and MS Sound systems in LA and MS, and sections of the state waters within the Gulf of Mexico. The primary constituent elements (PCEs) essential for the conservation of the Gulf sturgeon are those habitat components that support foraging, water quality, sediment quality, and safe unobstructed migratory pathways. These are further discussed under the Effects of the Proposed Action Section of this document.

This unit provides juvenile, subadult and adult feeding, resting, and passage habitat for Gulf sturgeon from the Pascagoula and the Pearl River subpopulations (68 FR 13395). One or both of these subpopulations have been documented by tagging data, historic sightings, and incidental captures as using Pascagoula Bay, the Rigolets, the eastern half of Lake Pontchartrain, Little Lake, Lake St. Catherine, Lake Borgne, MS Sound, within 1 nautical mile of the nearshore GOM adjacent to the barrier islands and within the passes (Reynolds, 1993; Morrow et al., 1998; and Ross et al., 2001). Substrate in these areas ranged from sand to silt, all of which contain known Gulf sturgeon prey items (Menzel, 1971; Abele and Kim, 1986; and American Fisheries Society, 1989).

Incidental captures and recent studies confirm that both Pearl River and Pascagoula River adult Gulf sturgeon winter in the MS Sound, particularly around barrier islands and passes (Reynolds, 1993, and Ross et al., 2009). Gulf sturgeon exiting the Pascagoula River move both east and west, with telemetry locations as far east as Dauphin Island and as far west as Cat Island and the entrance to Lake Pontchartrain, LA (Ross et al., 2009). Tagged Gulf sturgeon from the Pearl River subpopulation have been located between Cat Island, Ship Island, Horn Island, and east of Petit Bois Island to the AL state line (Rogillio et al., 2002). Habitat used by Gulf sturgeon in the vicinity of the barrier islands is 6.2 to 19.4 ft deep (average 13.8 ft), with clean sand substrata (Heise et al., 1999 and Ross et al., 2001).

An ongoing Mobile District Gulf sturgeon monitoring effort at Ship Island is being conducted by U.S. Army Engineer Research and Development Center (ERDC). The objective is to characterize the seasonal occurrences and movements of the sturgeon around Ship Island and within Camille Cut.

In late Spring 2011, a total of 21 receivers were placed around 3 areas (western tip of West Ship Island, Camille Cut, and eastern tip of East Ship Island) and monitored for Gulf sturgeon detections. No detections were documented during this period. The receivers were placed in the same locations in September 2011, and remained in place through June 2012. A total of 13,720 detections from approximately 14 Gulf sturgeons that originated from 5 rivers (Pearl, Pascagoula, Escambia, Blackwater, and Yellow) were found at all three sites (Figure 11). However, the largest number of detections was found along the eastern side of East Ship Island (Figure 12) (ERDC, 2012).

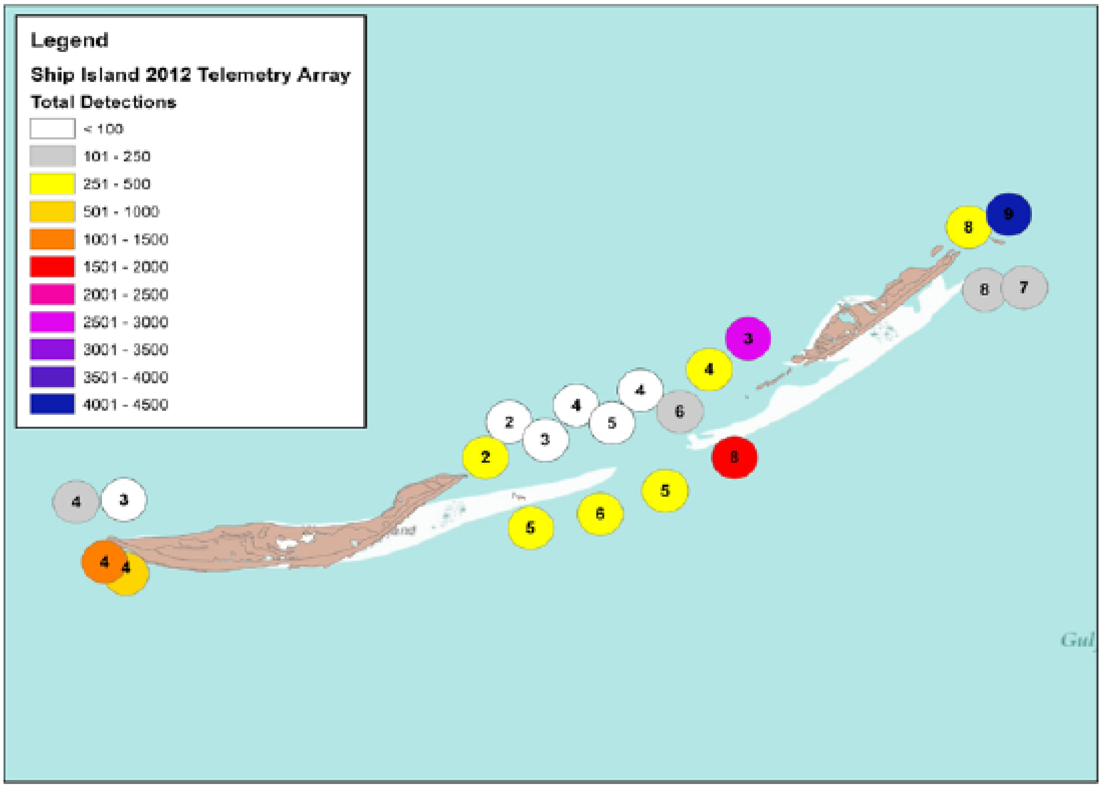


Figure 12. Number of sturgeon per total detections

Foraging: Unit 8 provides foraging habitat for the Gulf sturgeon. Generally, adults and subadults could be described as opportunistic benthivores typically feeding on benthic marine invertebrates including amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, mollusks, and crustaceans. As Gulf sturgeon feed principally on benthic invertebrates, potential impacts to the foraging constituent element would be confined to possible impacts to the benthic community. Benthic samples taken within the MS barrier island passes, where Gulf sturgeon were located, were dominated by Florida lancelets, sand dollars, annelids, haustoriid amphipods, and mollusks, which are documented prey of large subadult and adult Gulf sturgeon (Ross et al. 2009).

Vittor and Associates, a contractor of the Mobile District, is conducting a similar ongoing study to identify benthic communities of the MS Sound and Gulf of Mexico, with a focus at MS barrier islands. For the study, there were three sampling periods, June and Sept 2010, and May 2011, and 636 samples collected, with taxa densities ranging from 257 to 10,206 individuals per square meter. Results show that the benthic community within the project area provides suitable forage habitat for adult and subadult fish. A wide variety of benthic invertebrates were found in the placement and borrow sites, including polychaetes, chordates, nemerteans, gastropods, amphipods, and bivalves, but polychaete worms dominated majority of the sampling areas. However, taxa densities and richness was extremely variable between the sampling stations.

ERDC (2012) correlated the Gulf sturgeon locations with the abundance of eight principal prey benthic species and identified a direct relationship between the number and detections of Gulf sturgeon and the availability of primary prey, as shown in Figure 13, where the larger circles represent higher densities of those prey species. The sturgeons were found more frequently in the areas with the higher abundance of principal prey species. Further, Camille Cut and eastern side of Ship Island have relatively high overall abundances of these prey taxa compared to the west side of Ship Island (ERDC, 2012).

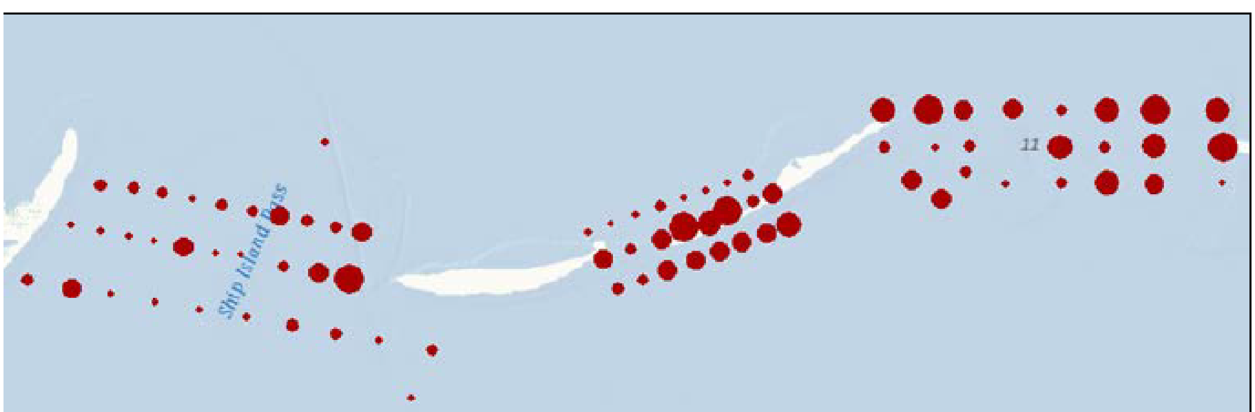


Figure 13. Densities of eight principal prey for sturgeon

Water Quality: The “water quality” constituent element is of concern to Gulf sturgeon critical habitat. Temperature, salinity, pH, hardness, turbidity, oxygen concentrations, and other chemical characteristics must be protected in order to preserved normal behavior, growth, and viability of all Gulf sturgeon life stages. If water quality is severely degraded, adverse impacts to Gulf sturgeon and its critical habitat may result. Water quality within the MS Sound is influenced by several factors, including the discharge of freshwater from rivers, seasonal climate changes, and variations in tide and currents. The primary driver of water quality is the rivers, including the Pascagoula River that feed into the Sound. Freshwater inputs provide nutrients and sediments that serve to maintain productivity both in the Sound and in the extensive salt marsh habitats bordering the estuaries of the Sound. The salt marsh habitats act to regulate the discharge of nutrients to coastal waters and serve as a sink for pollutants. Suspended sediments enter the Sound from freshwater sources, but are hydraulically restricted due to the barrier islands. The barrier islands, combined with the Sound’s shallow depth and mixing from wind, tides, and currents, promote re-suspension of sediments. These suspended sediments give MS Sound a characteristic brownish color (MDEQ, 2006).

Sediment Quality: The “sediment quality” constituent element is listed to ensure sediment suitable (i.e. texture and other chemical characteristics) for normal behavior, growth, and viability of all life stages. In addition, sediment quality is of a concern to support a viable benthic community in order to allow the Gulf sturgeon continual foraging of the area. The Mobile District has routinely conducted sediment analyses on its federally authorized navigation projects which include several within the MsCIP’s barrier island restoration effort proximity. This material has been sampled using the protocols of the Inland and Ocean Testing manuals (EPA and USACE) and found to be suitable based on physical, chemical and biological parameters.

Migration Habitat: The “migration habitat” constituent element is concerned with ensuring safe unobstructed passage for the species. It is intended primarily for the more confined areas near the river mouths or the rivers themselves. Gulf sturgeon exiting the Pascagoula River move both east and west, with telemetry locations as far east as Dauphin Island and as far west as Cat Island and the entrance to Lake Pontchartrain, LA (Ross et al., 2001). Tagged Gulf sturgeon from the

Pearl River subpopulation have been located between Cat Island, Ship Island, Horn Island, and east of Petit Bois Island to the AL state line (Rogillio et al., 2007, Ross et al. 2009). Gulf sturgeons occupy the coastal waters of MS beginning in October or November to March. They move offshore, primarily to the barrier island passes, to feed (Rogillio et al. 2007, Ross et. al 2009). Work by Rogillio et al (2009) and others indicate that Gulf sturgeon move along the nearshore area at depths of 10 m or less. A total of 71 tagged Gulf sturgeons were located in the MS Sound and adjoining barrier islands over a 5-yr study period (Ross et al., 2009). Winter telemetry locations of Gulf sturgeons from the Pascagoula and Pearl Rivers were primarily along the barrier islands, and only four fish were found north of the barrier islands and south of the West Pascagoula River mouth (Ross et al. 2009). The spatial distribution of Gulf sturgeon within the marine environment was strongly nonrandom, but was highly structured, and likely caused by the distribution of preferred prey taxa (Ross et al. 2009). Of the fish located in the barrier island region, 93% were found in the passes between the islands, including the two small passes between Ship Island (Ross et al. 2009). The occurrence of Gulf sturgeon in the barrier island passes was consistent over the 5-yr period of study (Ross et al. 2009).

Similarly, preliminary data by ERDC (2012) indicates tagged sturgeons from five rivers, including the Pearl and Pascagoula Rivers, migrate from the rivers to the mainland shoreline, barrier islands and passes in search of food. There are five passes within the MS and AL barrier island chain, which include Ship Island Pass, Dog keys Pass, Little Dog keys Pass, Horn Island Pass, Petit Bois Pass. These passes provide adequate shallow, sandy areas where Gulf sturgeons have been documented to congregate and feed (Rogillio, et al. 2007; Ross, et al. 2009). As previously mentioned, the area east of East Ship Island (Little Dog Keys Pass) and the Camille Cut had the overall higher abundances of Gulf sturgeon compared to the area west of Ship Island (Ship Island Pass) (ERDC, 2012). Multiple detections of these fish within the barrier island passes, suggest these are feeding areas (this study; Rogillio et al. 2007; Ross et. al 2009, ERDC, 2012). Gulf sturgeon tagged in the Pascagoula and Pearl Rivers occupy the same marine feeding habitats (Ross et al. 2009).

Effects of Proposed Action

Sea Turtles

<u>Effects Associated with Dredging Activities</u>

The Proposed Action will utilize a combination of mechanical, hydraulic cutterhead and/or hopper dredges for borrow and placement activities. The existing Regional Biological Opinion on hopper dredging in the Gulf of Mexico waters have established that non-hopper type dredging methods have discountable effects on, or are not likely to adversely affect, currently listed sea turtles (I/SER/2006/02953); I/SER/2006/01096). Hydraulic or mechanical dredging is not known to take sea turtles. Sea turtles are highly mobile and will likely avoid the area due to project activity and noise. Normal behavior patterns of sea turtles are not likely to be significantly disrupted by the project activities because of the short-term localized nature of the activities and the ability of sea turtles to avoid the immediate area. Sea turtles are not known to nest on the DA-10 site, and there are no records of nesting.

A hopper dredge would likely be used to remove material from Petit Bois and Ship Island borrow areas. Hopper dredges are known to adversely impact federally-listed species (i.e. sea turtles and Gulf sturgeon) by entrainment in the suction dragheads. To reduce the possibility of protected species interactions, the Corps intends to have the dredge dragheads equipped with sea turtle deflector devices. In addition, 100% of the material dredged will pass through 4-inch screening boxes where it will be screened by a NMFS-approved observer for evidence of protected species interactions. There will be 100% observer coverage aboard the dredge (i.e. two observers) according to the RBO. The Corps will adhere to the terms and conditions of the RBO and will incorporate relocation trawling as described in the Reasonable and Prudent Measures of the RBO. These trawling relocation efforts are currently perceived as an effective method of protection for both sea turtles and Gulf sturgeon during hopper dredging projects where the species are likely to be present. As such, the Corps has no reason to anticipate that properly conducted trawling efforts as described in the Reasonable and Prudent Measures of the 2003 RBO would result in significant adverse impacts to the species. Considering the lack of potential effects by hydraulic dredges and the precautionary steps taken when utilizing a hopper dredge, we believe the proposed project will not jeopardize the continued existence of the species.

Effects Associated with Land-Based Construction Activities

Potential adverse impacts or incidental takes to nesting sea turtles and their habitat could occur during project implementation. The project action could result in displacement of nesting turtles to other areas due to the temporary unavailability of the nesting habitat during construction, harassment of turtles in the form of disturbing or interfering with turtles attempting to nest within the construction area or on adjacent beaches, or destruction of nests or mishandling of eggs during relocation efforts. In addition, any missed nests during the survey could result in an incidental take. Incidental takes could also be caused by pedestrian and vehicular traffic, natural factors such as predation, wind, rainfall and tides. Project lighting and noise could disturb or misdirect potential nesting turtles and deter them from nesting within the construction area or nearby beaches.

To avoid and minimize potential impacts to nesting sea turtles, the Corps will conduct daily surveys during project construction for nest(s) and monitor the active construction areas for potential nesting activity throughout the nesting season (April 15 - November 30). A pre-construction survey would be done to document any existing nests as recommended in the Long-Term Monitoring Plan. If nests are discovered within the work area, nests would be relocated if possible, utilizing the USFWS, Jackson, MS field office guidelines for turtle nest relocations and the Long-Term Monitoring Plan developed as part of the MsCIP Barrier Island effort. However, although appropriate measures will be implemented to avoid impacts to nesting turtles, due to the nature of the construction work at the point of closure, there could be unavoidable adverse impacts to a few nesting turtles within the project footprint, if nest relocations are not an option. The MS barrier islands are not known to have high occurrences of turtle nesting compared to the other Gulf shore areas of AL and FL. In 2012, there were between 3 to 4 loggerhead turtle nests documented on Cat, West and East Ship Islands, and there were several more on Petit Bois and Horn Islands. The potential adverse impacts to the species when compared to the overall benefits from restoring the island (i.e. restoring and sustaining nesting habitat) are far greater.

The restored Ship Island would add about 600 acres of beach habitat which the turtles will likely utilize for nesting. The newly restored beach would be suitable for nesting turtles since the compaction, gradation, and color of the borrowed sand would be the similar to the existing beach. These types of restoration projects have been successful in providing suitable turtle nesting habitat in which the turtles use. Two examples are the recent Deer Island Restoration Project and Harrison County Beach Restoration Project, both in Biloxi, MS, where there were turtle nests documented on the newly restored beach areas.

Gulf Sturgeon

The Project will likely utilize both a hydraulic cutterhead and hopper dredge for placement and dredging activities. The RBO on hopper dredging in the Gulf of Mexico waters have established that non-hopper type dredging methods have discountable effects on, or are not likely to adversely affect, currently listed Gulf sturgeon (I/SER/2006/02953; I/SER/2006/01096). Hydraulic or mechanical dredging is not known to take Gulf sturgeons. Gulf sturgeons are highly mobile and will likely avoid the area due to project activity and noise. Normal behavior patterns of Gulf sturgeon are not likely to be significantly disrupted by the project placement and dredging activities because of the short-term localized nature of the activities and the ability of Gulf sturgeon to avoid the immediate area.

However, hopper dredges are known to adversely impact federally-listed species (i.e. sea turtles and Gulf sturgeon) by entrainment in the suction dragheads. The Corps will adhere to the RBO terms and conditions. Considering the lack of potential effects by hydraulic dredges and the precautionary steps taken when utilizing a hopper dredge, we do not anticipate the proposed project will jeopardize the continued existence of the species.

Gulf Sturgeon Critical Habitat

Unit 8 of Gulf sturgeon critical habitat encompasses a total of approximately 881,424 acres. The placement activities would result in a loss of approximately 511 acres of Gulf sturgeon critical habitat within the Camille Cut and East Ship placement areas, and approximately 168 acres would be lost at Cat Island. For the entire project area, there would be an overall net loss of 679 acres (Table 4). Within Unit 8, of the total 881,424 acres, approximately 679 acres of designated critical habitat would be directly lost. The action area constitutes approximately 0.08 percent of the total area within Unit 8. Within, Unit 8, the four PCEs that could be impacted by the project and are addressed in the next sections. These PCE's include water quality, sediment quality, prey abundance, and migratory pathways. Temporary and permanent impacts to designated Gulf Sturgeon Critical Habitat would occur from dredging and placement activities in borrow areas and placement areas. In addition, the submerged borrow areas of Cat Island, a portion of Petit Bois Pass-MS and the entire DA-10/littoral zone placement area are located GSCH. In these three areas, the PCEs that would be temporarily affected include would include water quality and prey abundance.

Table 3. Critical Habitat Impact Summary

Piping Plover Critical Habitat

	Total Project Area (acres)	Area within 2002 Desingated PPCH Boundaries* (acres)	Existing Usable Piping Plover Habitat within the constructed project limits (acres above MLLW)***	Usable Piping Plover Habitat within the constructed project limits after Equlibrium (acres above MLLW)	Habitat Change Gain or Loss (acres)
Restoration Areas PPCH					
Camille Cut	1500	820	139	738	599
East Ship Island					
Cat Island	305	305	99	261	162
Total Area	***1805***	***1125***	**238**	**999**	**762**

Gulf Sturgeon Critical Habitat

	Total Project Area (acres)	Area within 2003 Desingated GSCH Boundaries** (acres)	Existing Usable Gulf Sturgeon Habitat within the construction project limits (acres below MHW)***	Usable Gulf Sturgeon Habitat within the constructed project limits after Equilbrium (acres below MHW)	Habitat Change Gain or Loss (acres)
Restoration Areas GSCH					
Camille Cut	1500	980	1366	855	-511
East Ship					
Cat Island	305	45	212	44	-168
Borrow Areas GSCH					
Petit Bois Pass-MS	175	32	175	175	0
Cat Island	282	282	282	282	0
Total Area	***2262***	**1339**	**2035**	**1356**	**-679**

**Note acres are obtained from Geographic Information System (GIS) layers obtained from http://Criticalhabitat.fws.gov/crihab*

***Note acres are obtained from GIS layers obtained from http://www.nmfs.noaa.gov/gis/data/critical.htm#se*

****Using current MHW and MLLW line*

Water Quality

Dredging within the borrow sites and subsequent placement at Camille Cut and Ship Island will create some degree of turbidity in excess of the natural condition. This turbidity is generated by the fines fraction of the sediments. However, the material to be dredged is predominantly sandy in nature with low fines percentage therefore. Impacts from sediment disturbance during these operations are expected to be temporary, minimal, and similar to conditions seen during routine frontal storm events. It is expected during dredging, placement, and equilibrium of the project that suspended particles will settle out within a short time frame, with no measurable effects on water quality, especially in that this is predominantly sandy material.

During dredging and placement operations, turbidity levels would be monitored. Conservative preliminary modeling revealed that state water quality criteria could be exceeded by turbidity levels. This modeling effort assumed dredging in an area that had material with the greatest concentration of fines (~13%). It also assumed all of these fines would be retained in the material (i.e. no losses from that initial dredging event) and placed at the placement site with that same concentration of fines (~13%). However, during those operations, some percentage of the fines will be lost at the borrow area and another percentage would be lost at the placement area so exceedance of state water quality criteria could occur but likely only for a short period (i.e. hours to a few days). Temperature, salinity, and density profiles would be affected as a result of water column mixing during dredging and placement activities. Profiles would return to previous conditions following completion of the operations. Any impacts to profiles would be temporary and minor. No significant long term changes in temperature, salinity, Ph, hardness, oxygen content and other chemical characteristics are expected. The Corps does not expect measurable impacts to Gulf sturgeon critical habitat as a result of water quality impacts related to the proposed action.

Sediment Quality

The Corps does not expect measurable impacts to Gulf sturgeon critical habitat as a result of sediment impacts related to the proposed action.

The material from the borrow areas consists primarily of fine to coarse grained sand with less than 10% fines. The mean grain size at the borrow sites ranges from 0.22 to 0.33 mm and is within a similar range to the material at the placement sites which range between (0.29 to 0.33 mm). This material is consistent with that of the shorelines of the MS Barrier Islands. In addition, the Mobile District has routinely conducted sediment analyses of its federally authorized navigation projects, which include several within the MsCIP's barrier island restoration effort proximity. This material has been sampled using the protocols of the Inland and Ocean Testing manuals (EPA and Corps) and found to be suitable based on physical, chemical and biological parameters. The percent fines within the project area are outside the areas of contamination.

In addition, as a result of the Deepwater Horizon Oil Spill, the Corps conducted statistically random sediment testing on all borrow and placement areas in June 2010. Grab samples were taken and tests for TPHs were conducted. Concentrations of TPH of the tested samples were below method/laboratory detection limits for over 98% of the samples. Random samples within the sampling grid were found to contain concentrations of TPH but there was no pattern to the presence. Based on conversations with U.S. Coast Guard (USCG) and the lead of the Operational Science Agency Team (OSAT3), the likelihood of the presence of oil in offshore borrow sites in low. However it has been has reported that DA-10 has had repetitive tar bar issues. The Corps is coordinating any work activities in general with the USCG and the OSAT3. Should the Corps discover the presence of any oil substance, including tar balls, we will notify the USCG and other appropriate agencies for appropriate action and clean-up activities.

The presence of tar balls on DA-10 is not expected to result in significant impacts to any resources using that area or the placement area. Tar balls are composed primarily of sand mixed with degraded oil product. These features are formed when the degraded oils become entrained within the surf zone and adhere to the sand particles. The repetitive movement within the surf zone causes the oil-sand particles to coalesce into various size and shape balls. The toxicity of these materials has been tested and due to the degraded nature of the oils is very low.

<u>Prey Abundance</u>

Past and current observances have recorded subpopulations found within the Pearl, Pascagoula, Yellow, Escambia, and Blackwater Rivers utilize the project area located within and around the barrier islands. The NMFS, in previous biological opinions that addressed impacts associated with maintenance activities within MS Sound, concluded the actual number of the species utilizing the project area for foraging is likely few based on the small population sizes. Current monitoring results by ERDC has shown a total of at least 14 tagged Gulf sturgeons originating from 5 rivers utilizing the Camille Cut opening, and ends of Ship island for staging and foraging.

The non-motile benthic community within the footprint of dredging, pipeline corridors and placement areas would be lost as a result of project. Dredging impacts would be localized and affect the benthic community within the immediate footprint of the project. Thus, within the placement areas (Cat Island, East Ship Island, Camille Cut), sturgeon will no longer be able to forage. The shoreline line will expand approximately 800-1,000 feet at Cat and East Ship Islands, and sturgeons will forage further out within the shifted shoreline. In addition, littoral movement of these supplemented sandy sediments could possibly increase benthic habitat by providing additional areas colonized with the sturgeon's preferred benthic diet species, such as lancelets.

The closure of Camille cut will remove that foraging area for the sturgeon, but they will still be able to utilize the sheltered northern side of the restored Ship Island. Although, long-term impacts to the prey species are expected to occur from the placement activities; as previously quantified, the filled areas within the placement sites at Cat, Ship and Camille Cut are very small relative to the dimension of Unit 8.

Areas within borrow sites, DA-10/littoral zone placement area and temporary pipeline corridors should recover and recolonize with similar benthic species within 1-year of completion of the project (Saloman, 1982), and therefore, these have temporary impacts to sturgeon foraging.

With the closure of Camille Cut, it is anticipated that the Gulf sturgeons will redistribute and continue to feed within the adjacent passes, i.e. Little Dog Keys pass and Ship Island Pass, which are currently utilized by sturgeons for feeding (ERDC, 2010). Further east in the MS Sound are

Dog keys Pass, Little Dog keys Pass, Horn Island Pass, Petit Bois Pass, which provide additional adequate areas where Gulf sturgeons have been documented to congregate and feed (Rogillio, et al. 2007; Ross, et al. 2009). The Corps anticipates the minor footprint reduction of benthic prey available within placement areas and the temporary reduction from dredging activities at the borrow sites is not expected to significantly affect the critical habitat's ability to support the Gulf sturgeon's conservation in the short or long term. Once Camille Cut is closed, Gulf sturgeons will still continue to feed along the north side of the restored Ship Island.

Migratory Pathways

Within Unit 8, subadult and adult Gulf sturgeon move from the rivers through estuarine and marine areas to feeding areas. Unit 8 is known to support migratory pathways for Gulf sturgeon sub-populations (Pascagoula and Pearl Rivers). It is believed that Gulf sturgeon swim through the action area during intermittent inter-riverine movements. The species is known to utilize Camille Cut inlets as well as the other 5 passes (Ship Island, Dog keys, Little Dog keys, Horn Island, Petit Bois) for feeding and congregating (Rogillio, et al. 2007; Ross, et al. 2009, ERDC, 2012).

In addition, these adjacent passes provide access for Gulf sturgeons to connect to the Gulf of Mexico. However, the loss of Gulf sturgeon critical habitat as a result of the barrier island restoration activities represents a small area in relation to the entire MS Sound, approximately 679 acres of 881,424 acres (0.08 percent). Historically, the area which is now known as Camille Cut, was Ship Island, and there was no passage between West and East Ship Island prior to 1969, pre Hurricane Camille. Therefore, this area was not historically used by Gulf sturgeons. The area of Camille Cut is also very shallow, compared to the adjacent passes. The average depth is approximately 5 ft NAVD within the cut. With the closure of the cut, Gulf sturgeons will utilize adjacent areas for pathways to the Gulf of Mexico. It is not likely that the project action would alter critical habitat due to changes in migration since both Horn Island pass and Dog Keys pass to the east remain unaffected by the action. Also, as previously quantified, this area is very small relative to the dimension of Unit 8 (approximately 0.08%). Given this information, no adverse impacts to migratory pathways are anticipated.

Piping Plover and Red Knots

Dredging and placement activities are expected to adversely impact wintering piping plovers and red knots. Although these species are opportunistic and could utilize the other suitable adjacent barrier islands for feeding, roosting, and sheltering, there could be some temporary adverse impacts to the species. Potential adverse impacts and incidental take could result from the project implementation in the form of harassment caused by temporary human disturbance and vehicular traffic, temporary loss of benthic prey, displacement of wintering birds, and the temporary unavailability of the wintering habitat for foraging and roosting during construction and until the benthic fauna recovers after the project is completed. Although in other similar renourishment projects, it has been noted that birds are seen feeding at the sediment discharge due to the increase in potential food supply.

To reduce the risk of potential impacts, shorebird monitoring will be conducted pre-construction, daily during construction and bi-weekly post construction to identify habitat recovery as identified in the MsCIP Long-Term Monitoring and Adaptive Management Plan. Equipment access corridors, and temporarily pipeline routes would be staged to minimize disturbance to birds to the maximum extent possible. However, the overall implementation of this restoration project would benefit piping plovers and red knots by providing several hundred acres of wintering habitat once the project is completed. The benefits of the project far outweigh any potential temporary adverse impacts to the species and wintering habitat.

Piping Plover Critical Habitat

The restoration at Camille Cut and East Ship Island will benefit piping plovers, by restoring approximately 599 acres of wintering piping plover critical habitat. When the Cat Island portion is constructed, this would create an additional 162 acres of piping plover usable critical habitat (see Table 4). The majority of the tips of the islands were purposefully avoided in the design to minimize impacts to bird habitat (see Figure 14). However, there will be some minor adverse temporary impacts associated with closing the cut and tying into the islands and as described above. Impacts would likely cause the area to be unavailable for birds during construction, but once construction is completed, the birds will likely return to the area once the benethic fauna recovers. Equipment access corridors, and temporarily pipeline routes would be staged to minimize disturbance to birds to the maximum extent possible. Overall a total of approximately 762 acres of critical habitat will be restored from restoration efforts of the entire project.

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Figure 14. Ship Island Placement Area

Conservation Measures

The following conservation measures and conditions are provided for the dredging work within borrow and beach placement areas.

While hopper dredging equipment is being used, all operations will abide by the terms and conditions of the Gulf of Mexico RBO, November 19, 2003 and subsequent amendments. While pipeline dredging equipment is being used, in an effort to minimize adverse affects, the following measures will be observed: a) disengage dredging pumps when the cutter heads are not in the substrate to reduce entrainment of animals in the dredging equipment and b) monitor the dredge discharge as appropriate for turtle or fish carcasses or parts to document the occurrence of mortality due to dredging operations. Should such evidence occur, dredging operations will be suspended and proper authorities notified immediately.

The USACE has worked together with both USFWS and NMFS to establish a Long-Term Monitoring and Adaptive Management Plan for this project. Section 7(a)(1) of ESA encourages Federal agencies to enter into agreements to establish such management plans for the conservation and recovery of listed species. Within the Long-term Adaptive Management Plan, monitoring efforts will be conducted (pre/post and active construction) for listed species, including migratory birds (piping plover and red knot), sea turtles (nesting), gulf sturgeon (detections) and benthic habitats potentially affected within the Ship Island Restoration areas. Monitoring efforts will include the relocation of turtle nests that could be directly affected by the project.

During turtle nesting season, project lighting will be limited to the immediate area of active construction, and will be minimal necessary to comply with USCG and Occupational Safety and Health Administration (OSHA) requirements.

Best management practices would be used to minimize impacts to adjacent biological resources during placement operations. Best management practices to be used include, monitoring turbidity levels to ensure compliance with water quality permit, restoring any vegetation disturbed, and ensuring borrow material is compatible with the native beach sand.

Conclusions

Based upon the findings of this BA, the Corps has found that the proposed action “may affect” the following species under the purview of the NMFS:

Dredging Operations

Loggerhead Sea Turtle – The dredging operations associated with this project may affect, but are not likely to adversely affect and will not jeopardize the continued existence of the species.

Green Sea Turtle – The operations associated with this project may affect, but is not likely to adversely affect and will not jeopardize the continued existence of the species.

Leatherback Sea Turtle –The operations associated with this project may affect, but is not likely to adversely affect and will not jeopardize the continued existence of the species.

Kemp’s Ridley Sea Turtle- The operations associated with this project may affect, but is not likely to adversely affect and will not jeopardize the continued existence of the species.

Hawksbill Sea Turtle- The operations associated with this project may affect, but is not likely to adversely affect and will not jeopardize the continued existence of the species.

Gulf Sturgeon - May affect, but not likely to adversely affect and will not jeopardize the continued existence of the species.

Gulf Sturgeon Critical Habitat – For the borrow and placement areas that fall within Gulf sturgeon critical habitat; however, it has been determined that the activities associated with this project will not adversely modify designated Gulf sturgeon critical habitat.

The Corps has made the following conclusions regarding the effect of placement activities on the following species under the purview of USFWS:

<u>Land Based Operations</u>

Loggerhead Sea Turtle – Known to nest in project area. The activities associated with the placement of sand for this project are likely to adversely affect the species but will not jeopardize the continued existence of the species. Although appropriate measures will be implemented to avoid impacts to nesting turtles, due to the nature of the construction work, there could be unavoidable adverse impacts to turtles and their nesting habitat within the project area during the project construction. However, the potential adverse impacts to the species, are far greater outweighed by the benefits of the hundreds of acres of suitable nesting habitat for the species once the project is completed.

Green Sea Turtle – Not known to nest in MS, but could possibly nest. The activities associated with the placement of sand for this project are likely to adversely affect the species and its nesting habitat and but will not jeopardize the continued existence of the species. However, although appropriate measures will be implemented to avoid impacts to nesting turtles, due to the nature of the construction work, there could be unavoidable adverse impacts to turtles and their nesting habitat within the project area during construction. However, the potential adverse impacts to the species, are far greater outweighed by the benefits of the hundreds of acres of suitable nesting habitat for the species once the project is completed.

Leatherback Sea Turtle – May be seen in the area, but are not known to nest in the project area. The activities associated with the placement of sand for this project are not likely to adversely affect and will not jeopardize the continued existence of the species.

Kemp’s Ridley Sea Turtle- Are seen in the project area and are known to nest in the area, particularly in Harrison County, Biloxi, MS. The activities associated with the placement of sand for this project are likely to adversely affect the species and its nesting habitat and but will not jeopardize the continued existence of the species. However, although appropriate measures will be implemented to avoid impacts to nesting turtles, due to the nature of the construction work, there could be unavoidable adverse impacts to turtles and their nesting habitat within the project area during construction. However, the potential adverse impacts to the species, are far greater outweighed by the benefits of the hundreds of acres of suitable nesting habitat for the species once the project is completed.

Hawksbill Sea Turtle- Rarely seen in the project area, are not known to nest in the area and is not listed in MS. The activities associated with the placement of sand for this project are not likely to adversely affect and will not jeopardize the continued existence of the species.

Piping Plover- The activities associated with the placement of sand for this project are likely to adversely affect but will not jeopardize the continued existence of the species. However, the potential adverse impacts to the species are far greater outweighed by the benefits of the hundreds of acres of suitable wintering habitat for the species once the project is completed and the benthic fauna community has recovered.

Red knot- The activities associated with the placement of sand for this project are likely to adversely affect but will not jeopardize the continued existence of the species. However, the potential adverse impacts to the species are far greater outweighed by the benefits of the hundreds of acres of suitable wintering habitat for the species once the project is completed and the benthic fauna community has recovered.

Piping Plover Critical Habitat - It has been determined that the activities associated with the placement of sand for this project will not jeopardize the species or modify designated Piping Plover critical habitat. There would be some temporary adverse impacts to the species and the critical habitat, but the overall effect of the proposed action is beneficial.

Manatee- The activities associated with the placement of sand for this project are not likely to adversely affect and will not jeopardize the continued existence of the species.

Bald Eagle- The activities associated with the placement of sand for this project are not likely to adversely affect and will not jeopardize the continued existence of the species.

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Appendix I

GIS Coordinates for Borrow Areas

Cat Island Borrow Area Bottom Boundary Coordinates	
X	Y
-89.038	30.235
-89.034	30.232
-89.059	30.210
-89.063	30.214

Ship Island Borrow Area Bottom Boundary Coordinates	
X	Y
-88.889	30.202
-88.872	30.212
-88.871	30.208
-88.886	30.199

Horn Island Pass Borrow Areas Bottom Boundary Coordinates Bottom Boundary Coordinates	
X	Y
HIP 1	
-88.529	30.197
-88.536	30.199
-88.536	30.198
-88.532	30.201
-88.542	30.190
-88.543	30.192
-88.542	30.195
HIP 2	
-88.550	30.194
-88.556	30.194
-88.554	30.196
-88.555	30.187
-88.560	30.189
HIP 3	
-88.556	30.186
-88.554	30.181
-88.555	30.178
-88.560	30.175
-88.563	30.179
-88.559	30.181
-88.559	30.185
-88.544	30.186

Petit Bois Pass Mississippi Borrow Area Bottom Boundary Coordinates	
X	Y
-88.390	30.188
-88.393	30.190
-88.394	30.189
-88.390	30.195
-88.392	30.193
-88.398	30.193
-88.394	30.195
-88.386	30.190
-88.386	30.188
-88.388	30.187

Petit Bois Pass Alabama Borrow Areas Bottom Boundary Coordinates	
X	Y
PB-AL West	
-88.371	30.200
-88.371	30.194
-88.348	30.194
-88.348	30.200
PB-AL East	
-88.293	30.193
-88.307	30.194
-88.310	30.190
-88.312	30.190
-88.316	30.201
-88.293	30.204
-88.314	30.201
-88.312	30.206
-88.301	30.206
-88.300	30.204
-88.315	30.197
-88.325	30.197
-88.325	30.203
-88.317	30.203

-88.547	30.190

Petit Bois Pass - OCS East Borrow Areas	Bottom Boundary Coordinates		
X	Y	X	Y
PBS-OCS1		PBS-OCS4	
-88.362	30.159	-88.331	30.132
-88.363	30.157	-88.335	30.134
-88.365	30.157	-88.335	30.136
-88.365	30.159	-88.331	30.133
-88.366	30.160	-88.334	30.135
-88.371	30.161	-88.334	30.136
-88.369	30.163	-88.329	30.134
-88.368	30.160	-88.328	30.132
		-88.329	30.131
PBS-OCS2			
-88.363	30.141	PBS-OCS5	
-88.359	30.144	-88.345	30.139
-88.348	30.139	-88.344	30.140
-88.351	30.136	-88.343	30.140
-88.352	30.137	-88.342	30.139
-88.356	30.138	-88.344	30.138
-88.363	30.141	-88.339	30.135
-88.357	30.145	-88.340	30.135
-88.348	30.141		
-88.349	30.140		
-88.367	30.148		
-88.365	30.150		
-88.344	30.136		
-88.345	30.134		
PBS-OCS3			
-88.337	30.142		
-88.334	30.141		
-88.332	30.139		
-88.332	30.137		
-88.333	30.137		
-88.336	30.140		
-88.335	30.138		

Petit Bois Pass - OCS West Borrow Areas	Bottom Boundary Coordinates		
X	Y	X	Y
PBS-OCSW 1		PBS-OCSW 4	
-88.451	30.137	-88.409	30.139

-88.454	30.134
-88.458	30.134
-88.478	30.147
-88.473	30.152

PBS-OCSW 2

-88.440	30.154
-88.439	30.149
-88.458	30.160
-88.457	30.163
-88.452	30.161
-88.446	30.158
-88.437	30.151

PBS-OCSW 3

-88.431	30.162
-88.424	30.155
-88.427	30.153
-88.434	30.160
-88.416	30.148
-88.419	30.145
-88.422	30.154
-88.419	30.155
-88.415	30.149
-88.423	30.150

-88.407	30.138
-88.408	30.136
-88.415	30.137
-88.439	30.144
-88.434	30.153
-88.427	30.151
-88.426	30.149
-88.427	30.146
-88.419	30.144
-88.419	30.142
-88.437	30.150

PBS-OCSW 5

-88.392	30.132
-88.389	30.130
-88.389	30.125
-88.406	30.133
-88.405	30.135
-88.402	30.134
-88.400	30.135
-88.366	30.118
-88.367	30.115
-88.376	30.119
-88.376	30.125

Petit Bois Pass - OCS East Borrow Areas Boundary Coordinates			Bottom
X	Y	X	Y
-88.348	30.139	-88.345	30.139
-88.351	30.136	-88.344	30.140
-88.352	30.137	-88.343	30.140
-88.356	30.138	-88.342	30.139
-88.356	30.138	-88.344	30.138
-88.363	30.141	-88.339	30.135
-88.357	30.145	-88.340	30.135
-88.348	30.141	-88.344	30.136
-88.349	30.140	-88.345	30.134
-88.367	30.148	-88.337	30.142
-88.365	30.150	-88.337	30.142
-88.362	30.159	-88.334	30.141
-88.363	30.157	-88.332	30.139
-88.365	30.157	-88.334	30.136
-88.365	30.159	-88.329	30.134
-88.366	30.160	-88.328	30.132
-88.371	30.161	-88.329	30.131
-88.369	30.163	-88.332	30.137
-88.368	30.160	-88.333	30.137
-88.331	30.132	-88.336	30.140
-88.335	30.134	-88.335	30.138
-88.335	30.136	-88.363	30.141
-88.331	30.133	-88.359	30.144
-88.334	30.135		

Mississippi Coastal Improvement Program
The Comprehensive Barrier Island Restoration Project
Mississippi Sound
Hancock, Harrison AND Jackson Counties, Mississippi AND
Mobile County, Alabama

Biological Opinion
September 8, 2015

Prepared by:
U.S. Fish and Wildlife Service
6578 Dogwood View Parkway, Suite A
Jackson, MS

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Acronyms

Act	Endangered Species Act
BA	Biological Assessment
BO	Biological Opinion
BRP	Barrier Island Restoration Project
CAHA	Cape Hatteras Access Preservation
CFR	Code of Federal Regulations
CLTMAMP	Comprehensive Long Term Monitoring and Adaptive Management Plan
COE	U.S. Army Corps of Engineers
CY	Cubic yards
DA	Disposal Area
DCP	Digital Cone Penetrometer
DPS	Distinct Population Segment
EIS	Environmental Impact Statement
FR	Federal Register
FT	Feet
GPS	Global Positioning System
HIP	Horn Island Pass
MBTA	Migratory Bird Treaty Act
MCY	Million Cubic Yards
MHWL	Mean High Water Line
MLLW	Mean Low Low Water
MsCIP	Mississippi Coastal Improvements Program
NAD	North American Datum
NAVD	North American Vertical Datum 1988
NGMRU	Northern Gulf of Mexico Recovery Unit
NMFS	National Marine Fisheries Service
NPS	National Park Service
NRDAR	Natural Resource Damage Assessment and Restoration
NWAO	Northwest Atlantic Ocean Loggerhead Population
OCS	Outer Continental Shelf
ORV	Off-road vehicle
PBP	Petit Bois Pass
PCE	Primary Constituent Element
RPM	Reasonable and Prudent Measures
SCAT	Shoreline Cleanup Assessment Team
SEIS	Supplemental Environmental Impact Statement
Service	U.S. Fish and Wildlife Service
U.S.	United States
UTM	Universal Transverse Mercator

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mississippi Field Office
6578 Dogwood View Parkway, Suite A
Jackson, Mississippi 39213

September 8, 2015

Mr. Curtis M. Flakes
U.S. Army Corps of Engineers
Post Office Box 2288
Mobile, Alabama 36628

Attn: Ms. Susan Rees

Re:	Project Title:	Mississippi Coastal Improvements Program, Barrier Island Restoration Project
	Location:	Hancock, Harrison and Jackson Counties, Mississippi and Mobile County, Alabama

Dear Mr. Flakes:

This document transmits the Fish and Wildlife Service's (Service) biological opinion (BO) based on our review of the U.S. Army Corps of Engineers Mobile District (COE) proposed implementation of the Mississippi Coastal Improvements Program (MsCIP) Barrier Island Restoration Project (BRP) located in Hancock, Harrison and Jackson Counties, Mississippi and Mobile County, Alabama, and its effects on the endangered West Indian manatee (*Trichechus manatus*), the threatened red knot (*Calidris canutus rufa*), the threatened piping plover (*Charadrius melodus*) and its designated critical habitat, and four species of sea turtles including, Northwest Atlantic Ocean loggerhead population (NWAO) (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*) and Kemp's ridley (*Lepdiochelys kempii*), in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 United States Code [U.S.C.] 1531 *et seq*.).

This BO is based on information provided in the COE's Biological Assessment (BA) dated September 16, 2014, and revised BA dated January 20, 2015, telephone conversations, electronic mails, various shorebird and sea turtle surveys, and other sources of information.

The Service concurs with the COE's determination that the proposed project is not likely to adversely affect the endangered West Indian manatee because: (1) manatees are not permanent inhabits of the project area; and (2) the COE would implement, as part of the project construction plan, standard conditions for in-water work in areas that may have manatees (Appendix A). The conservation measures described in Appendix A would also avoid take under the Marine Mammal Protection Act of 1972. The Service also concurs that the proposed action is not likely to adversely affect nesting leatherback sea turtles, since these turtles are not known to nest in the northern Gulf region. Bald eagles are no longer federally threatened or endangered, but are still protected under the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act. Bald eagles have been known to utilize the Mississippi barrier islands for nesting since their reintroduction to the Mississippi Gulf Coast in the mid-1990s. During the 2011-2012 nesting season, there were four documented nests, one nest each on Cat Island and East Ship Island with two fledglings and two nests on Horn Island with three fledglings. Historically, there has also been a nest on Petit Bois Island, however, in 2011, it was not active (Hopkins personal comm., 2012). However, the nest locations are found within the interior areas of the islands away from the immediate project area. The sand placement project activities will take place in the nearshore and along the primary dune line and will be far removed from where bald eagle nesting or perching may occur. Therefore, bald eagles and their nests are not likely to be adversely affected by the project restoration activities. It is our understanding that the COE is conducting a separate consultation with the National Marine Fisheries Service (NMFS) regarding project-related effects to sea turtles offshore as a result of dredging activities during project implementation. The NMFS is also responsible for section 7 consultation for the threatened Gulf sturgeon (*Acipenser oxyrhynchus desotoi*) in marine waters. Accordingly, none of the federally listed species mentioned in this paragraph will be discussed further in our BO (Table 1).

Table 1- Species and Critical Habitat Evaluated for Effects from the Proposed Action but not discussed further in this Biological Opinion.

Species or Critical Habitat	**Present in Action Area**	**Present in Action Area but “Not Likely to Adversely Affect”**
West Indian manatee	Possible	Yes
leatherback sea turtle	Possible	Yes
bald eagle	Possible	Yes

Consultation History

<u>2013 - 2015</u> The Service works with the COE and National Park Service (NPS) to develop guidelines for sea turtle monitoring, shorebird monitoring, and benthic sampling. These guidelines were revised numerous times as project plans have changed and are included in this BO as appendices A, B, and C. Also, the Service works with the COE, NPS, US Geological Survey, and numerous state and NGO partners, referred to as a Technical Advisory Group, to develop a Comprehensive Long Term Monitoring and Adaptive Management Plan (CLTMAMP) specifically detailed for this project. The monitoring requirements associated with the above-referenced appendices are also outlined in the CLTMAMP.

September 16, 2014 — BA provided by the COE to the Service, which included revised project plans.

December 11, 2014 — Red knot final rule is published in the Federal Register, which becomes effective on January 12, 2015.

January 20, 2015 — The Service receives amended BA, which includes the red knot as a listed species.

June 8, 2015 — The Service transmits a letter requesting an extension of time (until June 26, 2015) to submit Draft BO to the COE.

June 12, 2015 — The Service works with the COE and NPS to discuss their comments on the draft terms and conditions. The agencies agree to work together to resolve issues through the development of a Memorandum of Understanding.

June 26, 2015 — The Service transmits a Draft BO to the COE.

July 2, 2015 — The Service receives comments on the Draft BO from the COE.

July 7, 2015 — The Service has a teleconference with the COE to discuss their comments.

July 10, 2015 — The Service receives additional comments on the Draft BO from the COE.

August 4, 2015 — The Service has a teleconference with the COE to discuss their comments

August 19, 2015 — The Service receives the final comments on the Draft BO from the COE

August 28, 2015 — The Service receives additional comments from the NPS on most recent Draft BO

September 8, 2015 — The Service transmits a Final BO to the COE.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The Final MsCIP Comprehensive Plan and Integrated Programmatic Environmental Impact Statement (EIS) dated June 2009 describes a Comprehensive Plan to support the long-term recovery of Hancock, Harrison, and Jackson Counties, Mississippi from the devastation caused by the hurricanes of 2005 and ways to increase the resiliency of the Mississippi coast for the future. The MsCIP Study was conducted under the authority of the Department of Defense Appropriation Act of 2006 (Public Law 109-148), dated December 30, 2005, and was completed in June 2009. The Report of the Chief of Engineers dated September 15, 2009, and the Record of Decision signed by the Assistant Secretary of the Army for Civil Works dated January 14, 2010, was submitted to Congress on January 15, 2010. The plan established improvements in the coastal areas of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources purposes. The barrier island restoration plan discussed in this BO is one component of the MsCIP Comprehensive Plan which addresses preservation of fish and wildlife and prevention of saltwater intrusion. In addition, the plan would provide for storm wave attenuation along a portion of the mainland.

The MsCIP BRP consists of the placement of up to approximately 22 million cubic yards (mcy) of sand within the Ship Island portion of the NPS's Gulf Islands National Seashore, Mississippi unit to close Camille Cut, a 3.5 mile gap located between East and West Ship Islands, and to ameliorate erosion of the southern shoreline of East Ship Island. In addition, the plan includes the restoration of the eastern shoreface of Cat Island using an additional approximate 2 mcy of sand. A third related action to maximize the beneficial placement of sandy maintenance dredged material from the Pascagoula Federal navigation project includes the redefinition of littoral zone dredged material placement site south and west of Disposal Area (DA) 10, locally known as Spoil and/or Sand Island.

The Project Area is defined as the Mississippi barrier island chain, and the open water areas around the barrier islands in Hancock, Harrison and Jackson Counties, Mississippi, Mobile County, Alabama and the Outer Continental Shelf (OCS). The Mississippi barrier island chain includes; Petit Bois, Spoil (also known as Sand Island), Horn, East and West Ship, and Cat Islands as they exist on the landscape from east to west respectively. For the purposes of this document, the Action Area (Figure 1) is the same as the Project Area.

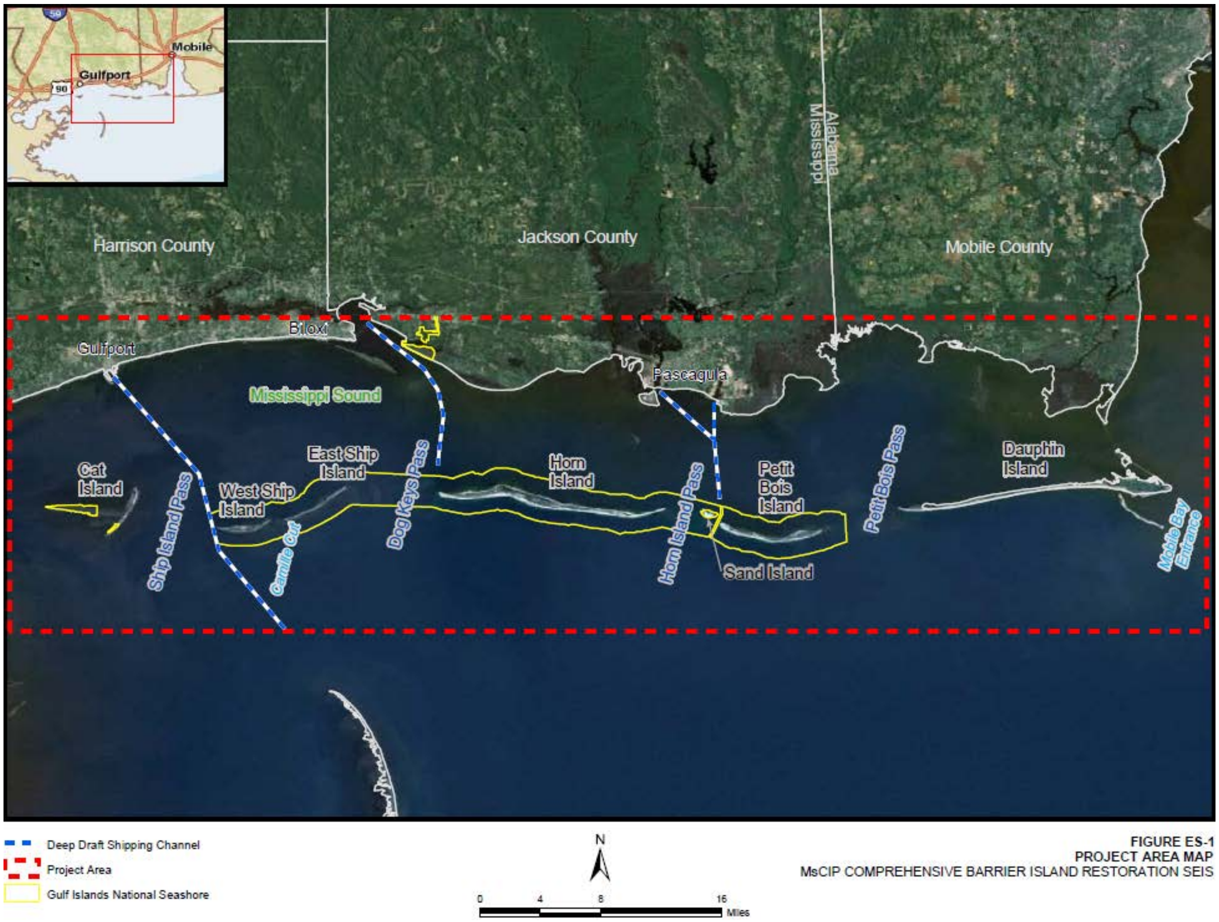


Figure 1 - Action Area

Ship Island Restoration

The MsCIP Comprehensive Plan identifies the restoration of the offshore barrier islands as a critical feature towards increasing the resiliency of the coast. The barrier island restoration plan's main focus is towards Ship Island which is located approximately 16 miles southeast of Gulfport, Mississippi. Ship Island was breached by Hurricane Camille in 1969, splitting the island into two pieces, hence the name of the Cut. Since that time the cut shoaled and prior to Hurricane Georges in 1998 was identified as a shallow shoal. Hurricane Georges and subsequent storms, notably Hurricane Katrina widened and deepened the cut to the point that there is unlikely enough sediment in the system to heal the island naturally (Morton, R.A., 2008). In addition, erosion to the East Ship Island has worsened over time and now this area is primarily a low barrier island.

The Ship Island restoration is composed of two parts: the rejoining of West and East Ship Islands through the closing of Camille Cut and the restoration of the southern shore of East Ship Island through the placement of up to approximately 22 mcy of suitable sandy material. A total of approximately 19.0 mcy based on 2012 surveys would be required to be dredged from eighteen borrow areas, within five geographic areas, not including Cat Island. Approximately 13.5 mcy would be placed in Camille Cut and approximately 5.5 mcy would be placed along the southern shore of East Ship Island.

The constructed Camille Cut project area would be approximately 1,100 feet (ft) wide. The fill would tie into the existing West and East Ship Island just below the frontal dune line at an elevation of approximately +7 ft extending below the mean high water line (MHWL) with a 1V:20H slope. The construction slope is primarily dependent on the grain size of the fill. Overtime, typically six months to a year the constructed slopes would naturally adjust due to waves and currents to milder slopes, which mimic the existing island nearshore slopes in the range of 1:50 to 1:100.

Sand placement along East Ship Island would consist of an approximate 1,200 ft wide restored shoreline. The equilibrium design widths average approximately 700-ft for Camille Cut and 1,000-ft for East Ship Island. The sand placement layout for Camille Cut and East Ship Island fill are shown in Figure 2. The combined Camille Cut and East Ship Island equilibrated fill will encompass approximately 1,500 acres of which approximately 800 acres will be above the MHWL and 700 acres will lie below the MHWL. The newly restored areas will be planted with suitable beach and dune vegetation following construction.

Most of the sand on the Mississippi barrier island beaches is light gray, and subangular to rounded in shape, with a median particle diameter (D50) ranging from 0.30–0.51 millimeter (mm). Sand distributed across the islands tends to exhibit greater variation in D50 grain size with depth, ranging from 0.21–0.48 mm as indicated by sampling below the surface at West Ship Island. Composite samples to depths of -4 or -5 ft at West Ship Island have D50 grain size ranging from 0.27–0.37 mm. For compatibility with the native material on the island and fill stability, well sorted to poorly sorted subangular sands, light gray to gray in color, with median grain size greater than 0.28mm and percent fines less than 10 percent were considered to be optimum for barrier island restoration efforts. Other material was considered provided that the overfill ratio, which is a function of grain size compatibility of the composite fill, was within acceptable limits. Placed sands with up to 10 percent fine sediment content are considered acceptable, while 15 percent fines content is considered the maximum allowable content for dredging. The dredging process typically winnows out fine sediments when the sand is being mined, transported, and placed because these sediments tend to remain suspended in the slurry water. Therefore, sands containing up to 15 percent silts or clays are expected to have a percentage closer to 10 percent following placement as compared to their in situ condition. Natural coastal processes further winnow out fine sediments over time following placement. The Supplemental Environmental Impact Statement (SEIS) for this project provides additional information on the compatibility analysis and suitability of sand for placement.

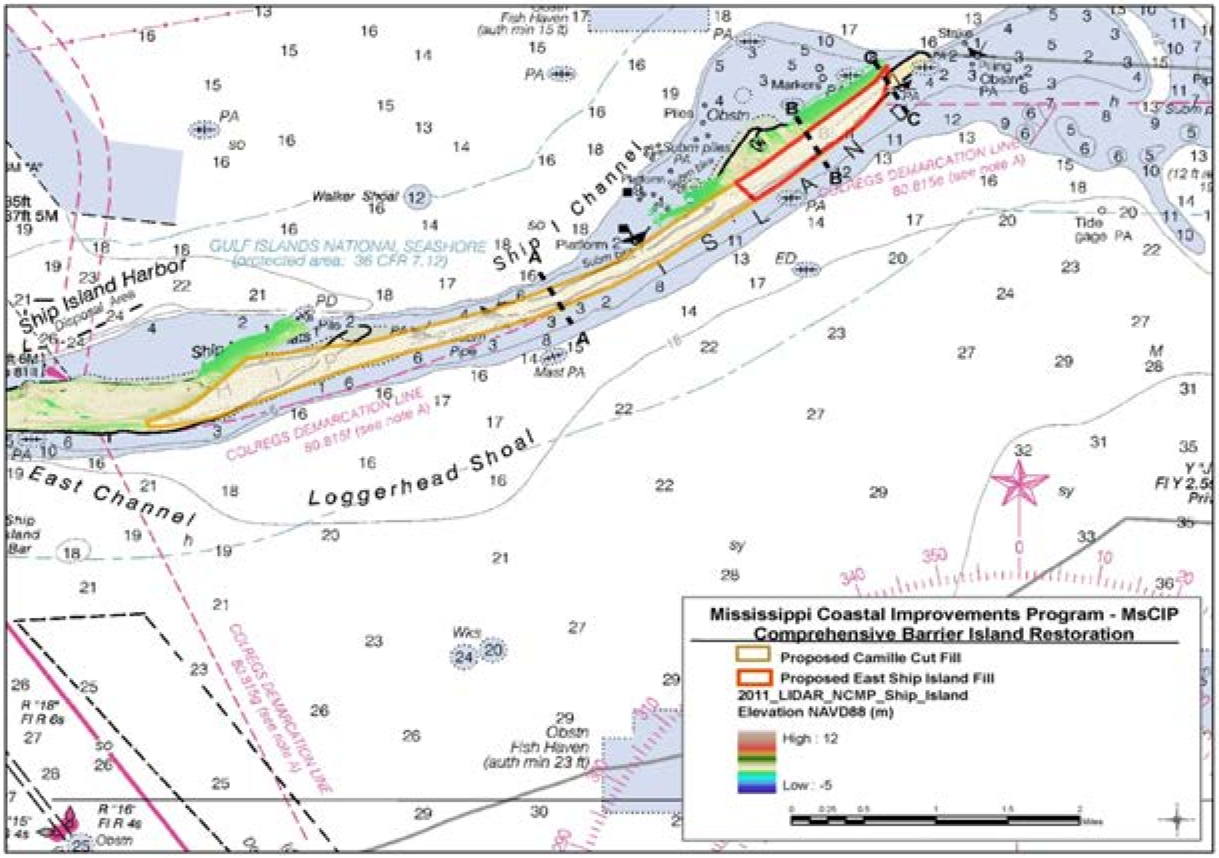


Figure 2 - Camille Cut and East Ship Island Placement Layout

Sand would be obtained from nineteen borrow areas within six main geographic areas, including Cat Island within the Gulf of Mexico of Mississippi, Alabama and the OCS including Ship Island borrow area, Horn Island Pass, Petit Bois Pass- Mississippi, Petit Bois-Alabama (East and West), and OCS borrow areas (Petit Bois Pass- OCS West 1-6, Petit Bois Pass- OCS East 1-5), and Cat Island (see Figure 3).

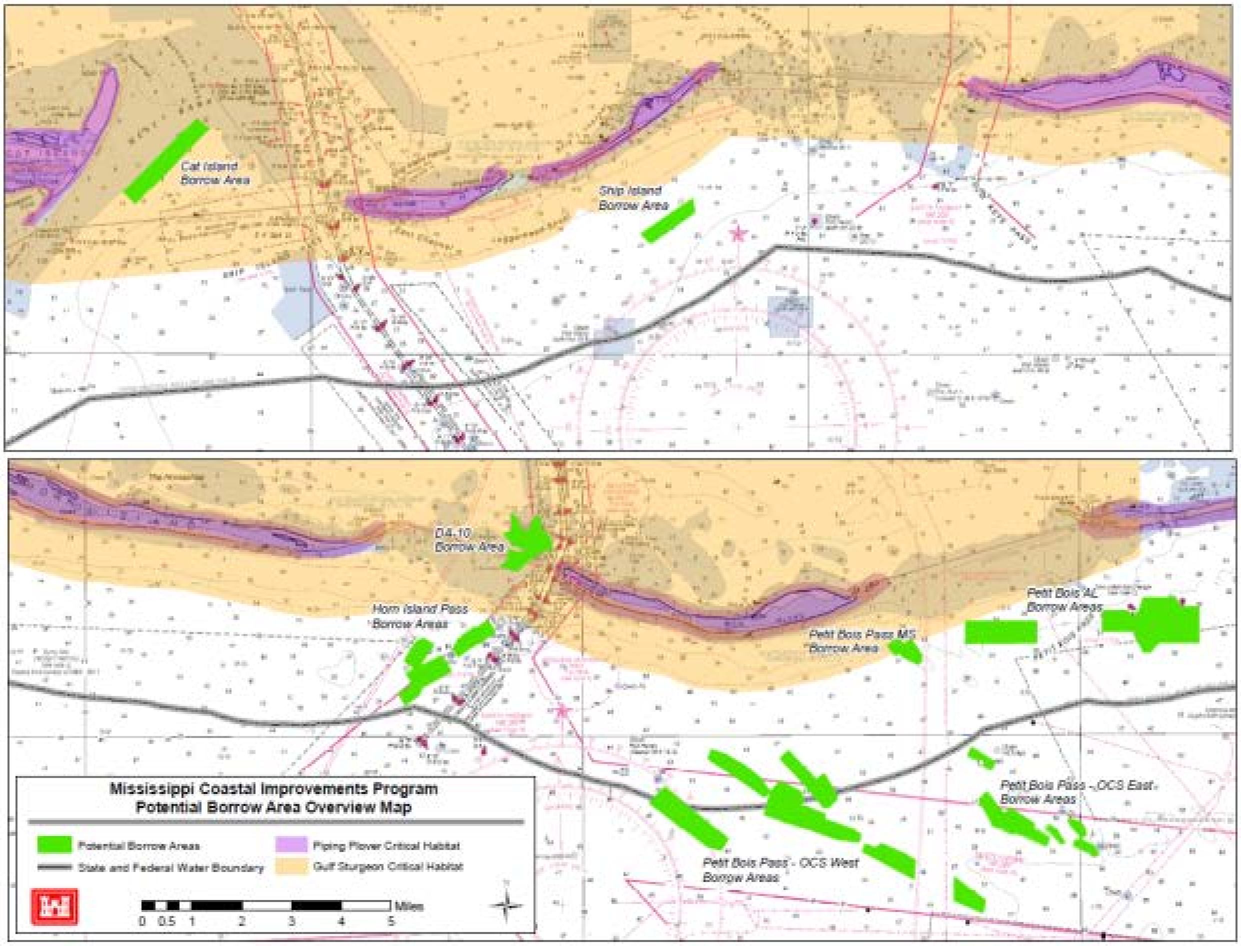


Figure 3 - All Borrow Sites

Borrow Area Descriptions for Ship Island Restoration

Ship Island Borrow Area

Ship Island borrow area is located approximately two miles south of Ship Island in an ambient water depth of approximately 30 ft. The characteristics of the sand consist of an average grain size of 0.21 millimeters (mm), with 6.0 percent fines, and a light gray color. The borrow area is approximately 600 ft wide (north-south direction) and 6,000 ft wide (east-west direction) covering a total area of approximately 183 acres with an average cut depth of approximately 7 ft. The max cut elevation for dredging is approximately -38 ft NAVD88 (see Figure 4) and side slopes for cut areas are estimated in the design to be 1V:5H. The maximum disturbance depth is -43 ft. This depth includes the maximum dredging depth of -38 ft plus an additional disturbance layer of 5 ft. The disturbance layer, also known as the non-paid overdepth, involves dredging outside the paid allowable overdepth that may occur due to such factors as unanticipated variation in substrate and/or wind or wave conditions that reduce the operators' ability to control the excavation head. Due to the potential of this layer possibly being disturbed by equipment, it has been included in the maximum depth. An estimated 2.7 mcy of sand is available within the proposed delineated borrow area limits.

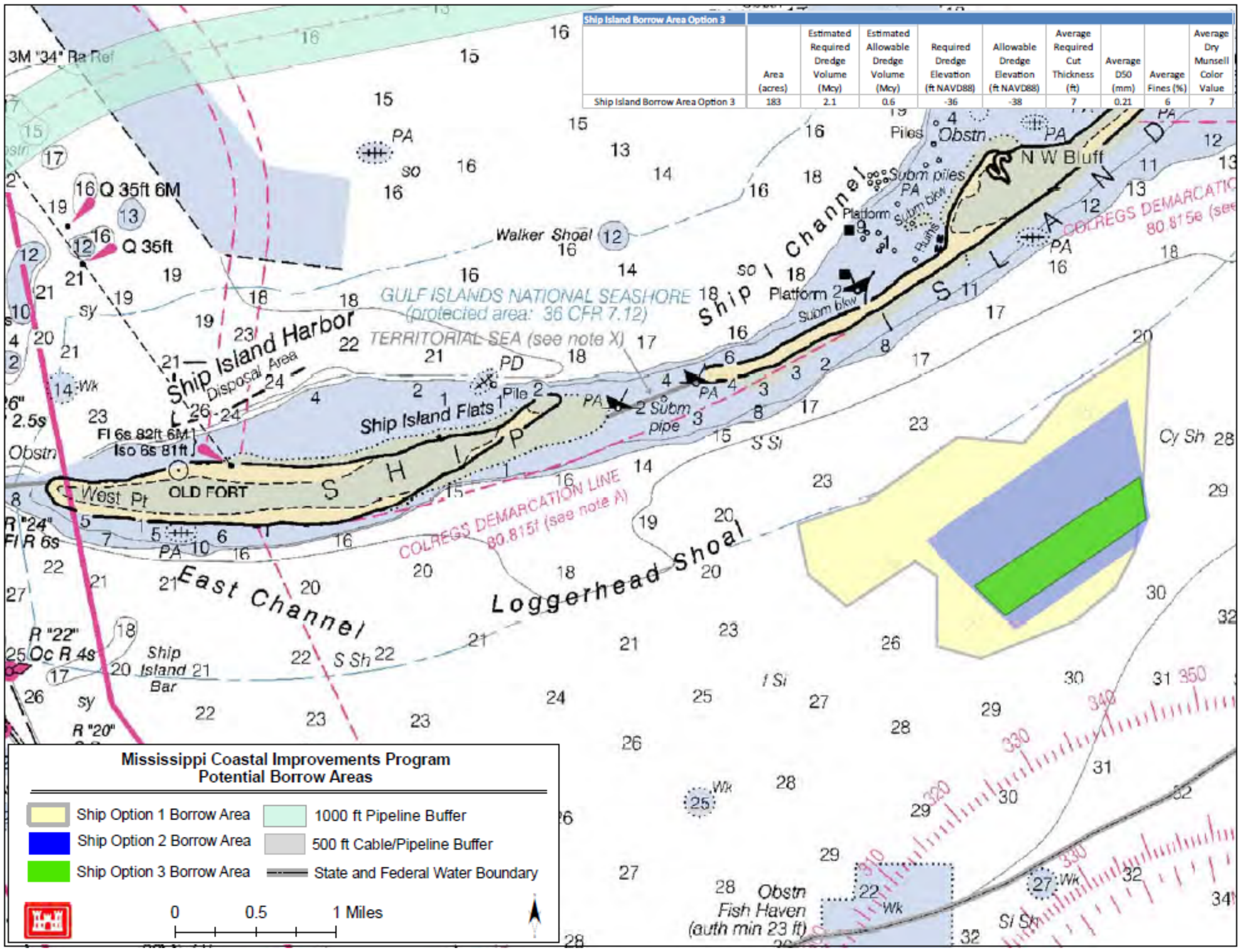


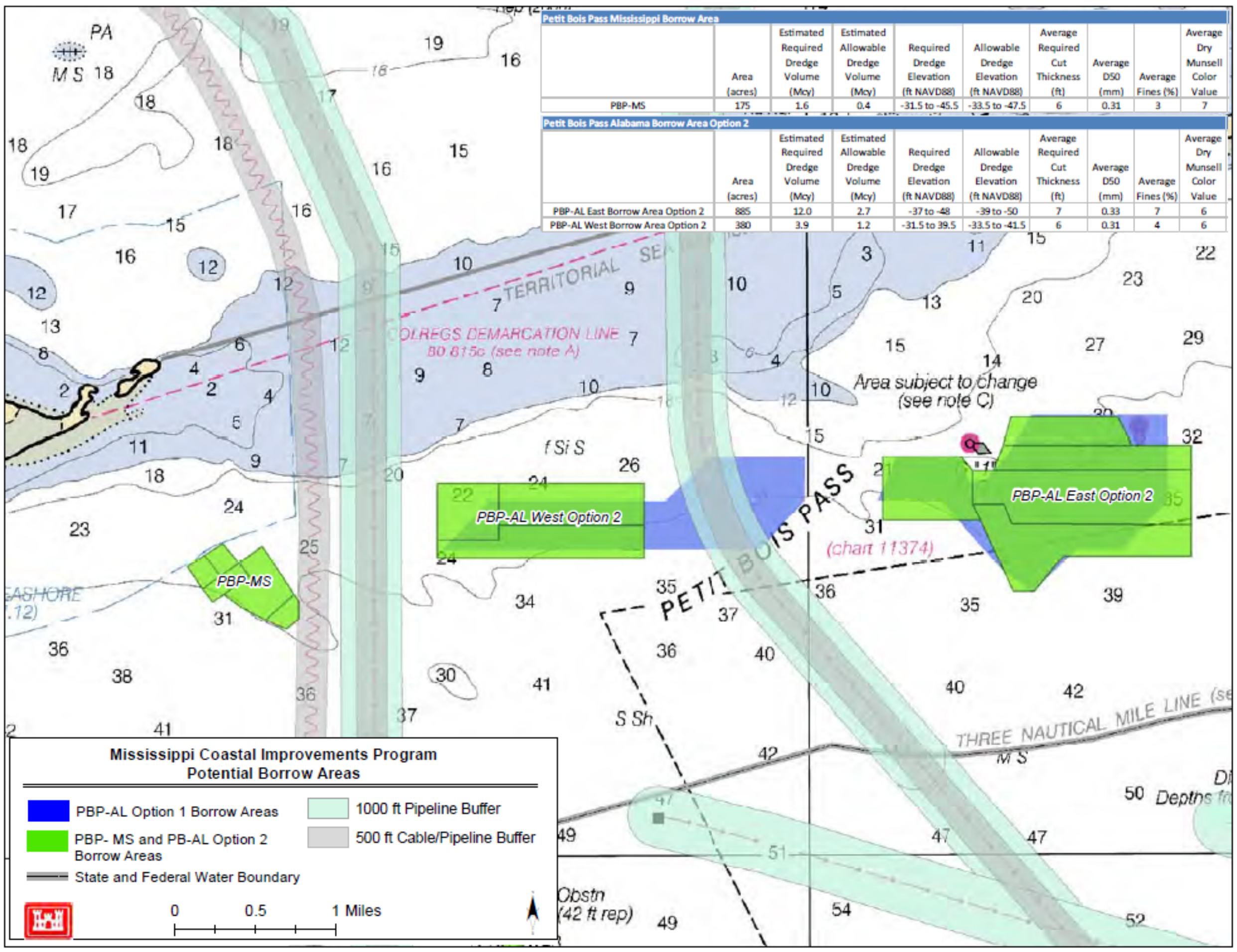
Figure 4 - Ship Island Borrow Area

Petit Bois Pass Mississippi and Petit Bois Alabama Borrow Areas

The Petit Bois borrow area consists of three separate sites (Petit Bois Pass- Mississippi, Petit Bois- Alabama East, and Petit Bois-Alabama West). The Petit Bois-Alabama West (PB-AL West) site is approximately 380 acres in size. The characteristics of the sand at PB-AL West consist of an average grain size of 0.31 mm, and has light gray to white colored sand. The estimated quantity of the required dredged volume is 3.9 mcy. An additional 1.2 mcy of allowable volume is added to this for a maximum potential volume of 5.1 mcy. The additional allowable dredge volume is to compensate for dredging inaccuracies. The maximum disturbance depth is 46.5 ft.

The Petit Bois-Alabama East (PB-AL East) borrow site is approximately 885 acres in size. The characteristics of the sand at PB-AL East consist of an average grain size of 0.33mm, and contains light gray to white colored sand. The estimated quantity of the required dredged volume is 12.0 mcy. An additional 2.7 mcy of allowable volume is added to this for a maximum potential volume of 14.7 mcy. The maximum dredging depth is -55.0 ft. This depth includes the maximum dredging depth of -50 ft plus an additional disturbance layer of 5 ft (see Figure 5).

The Petit Bois Pass-Mississippi (PBP-MS) site is located about one mile southeast of the eastern tip of Petit Bois Island and is approximately 175 acres in size. Sand from this site has an average grain size of 0.31 mm. The estimated quantity of the required dredged volume is 1.6 mcy. An additional 0.4 mcy of allowable volume is added to this for a maximum potential volume of 2.0mcy. The additional allowable dredge volume is needed to compensate for dredging inaccuracies. The maximum dredging depth is -52.5.0 ft. This depth includes the maximum dredging depth of -47.5 ft plus an additional disturbance layer of 5 ft (see Figure 5).



Petit Bois Pass Mississippi Borrow Area

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBP-MS	175	1.6	0.4	-31.5 to -45.5	-33.5 to -47.5	6	0.31	3	7

Petit Bois Pass Alabama Borrow Area Option 2

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBP-AL East Borrow Area Option 2	885	12.0	2.7	-37 to -48	-39 to -50	7	0.33	7	6
PBP-AL West Borrow Area Option 2	380	3.9	1.2	-31.5 to 39.5	-33.5 to -41.5	6	0.31	4	6

Figure 5 – Petit Bois Pass-Mississippi & Petit Bois-Alabama East and West

Horn Island Pass

The Horn Island Pass (HIP) borrow area site is located west of the Pascagoula Harbor entrance channel (see Figure 6). Within this site, there are three sub-sections that will be utilized (HIP1, HIP2, HIP3) for sand. The approximate sizes of these sites are as follows: HIP1-168 acres, HIP2-137 acres, HIP3- 307 acres.

Sand from these sites has an average grain size that ranges from 0.27 to 0.30 mm, and a predominant grey color. The estimated total quantity of the required dredged volume is 2.8 mcy for all three sites (Figure 6). An additional sum of 2.1 mcy of allowable volume is added to this for a maximum potential volume of 4.9 mcy. The maximum dredging depth is -46.0 ft. This depth includes the maximum dredging depth of -41.0 ft plus an additional disturbance layer of 5 ft (Figure 6).

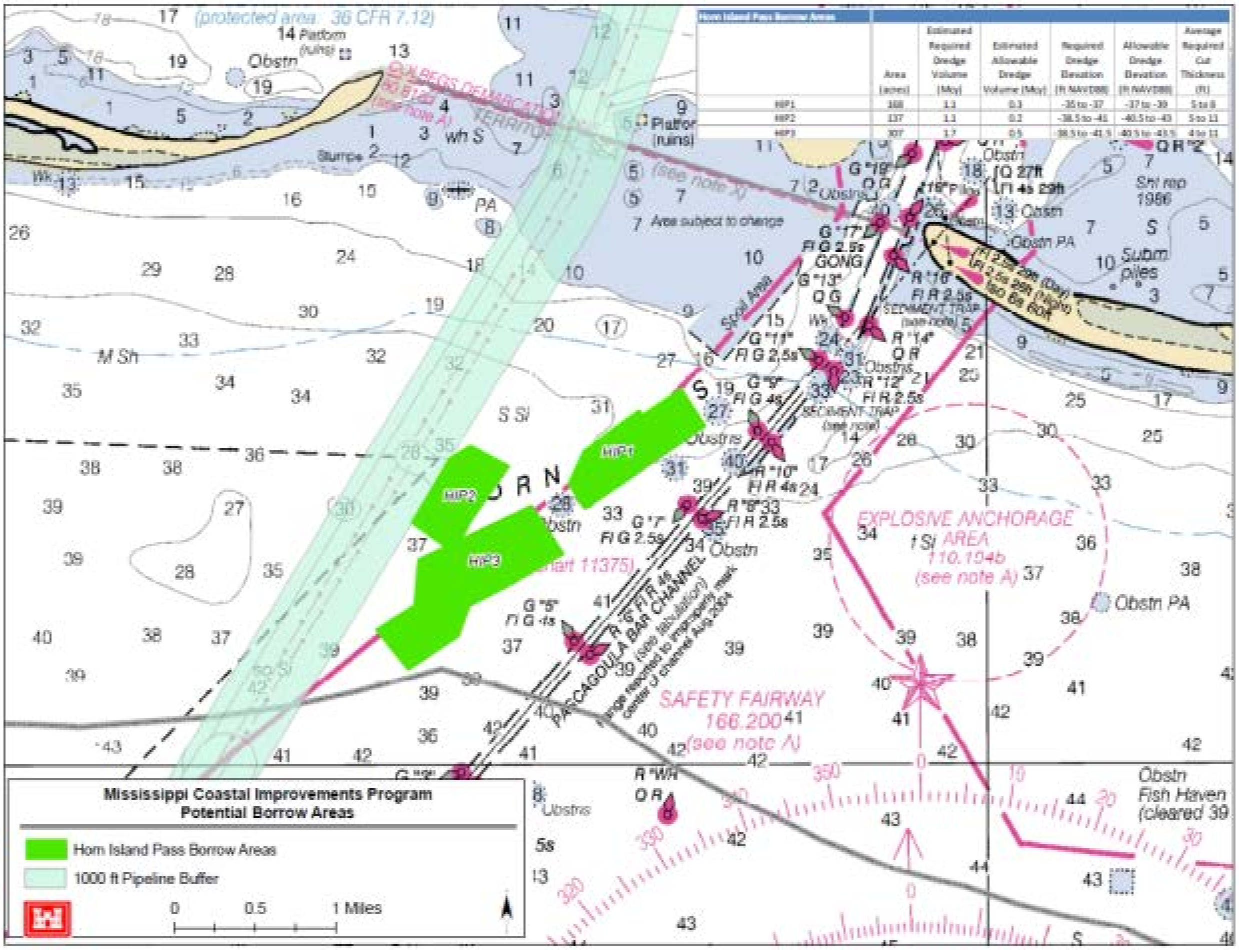
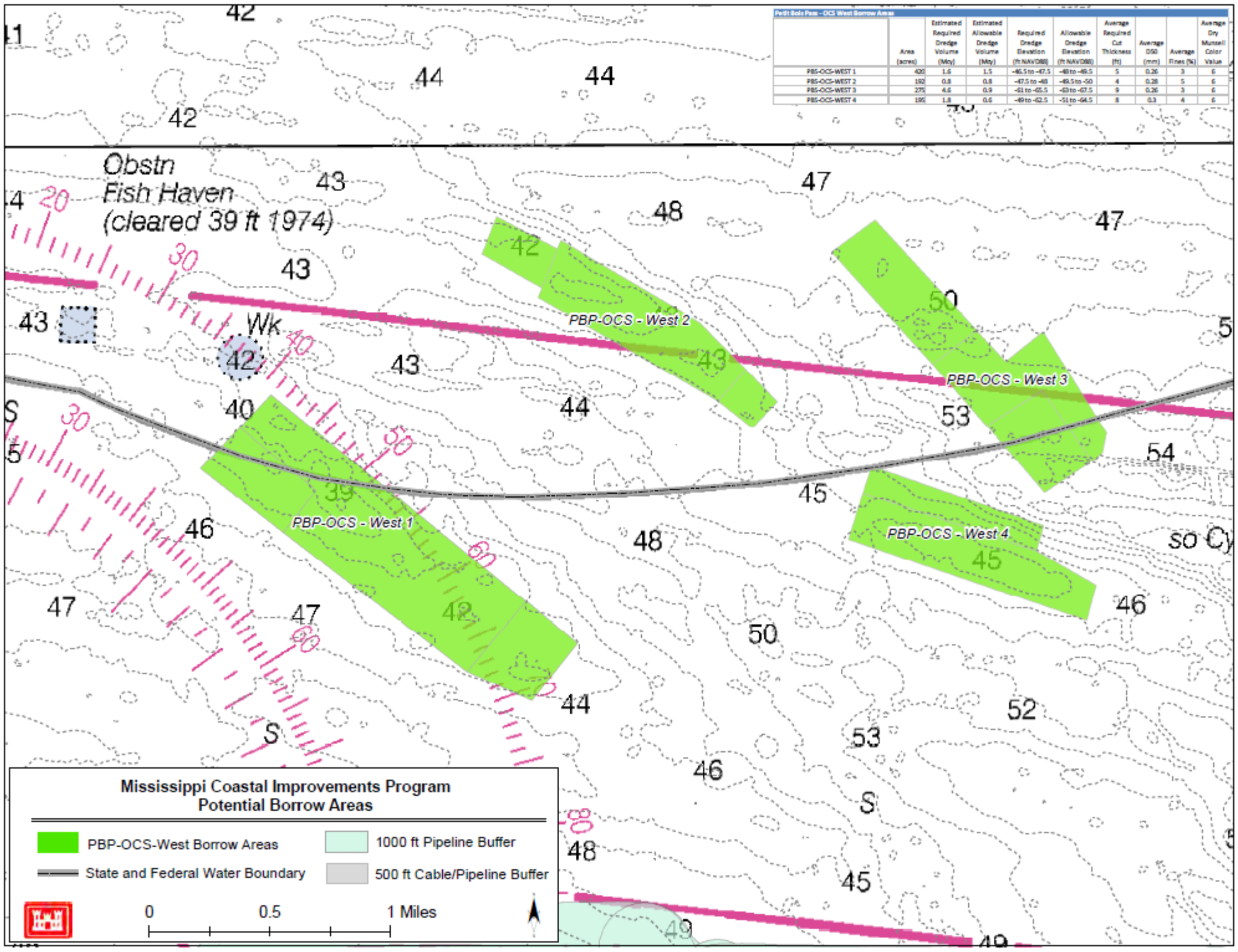


Figure 6 - Horn Island Pass

Petit Bois-OCS West

The Petit Bois Pass-OCS West (PBP-OCS-W) borrow area is located approximately 3.5 miles offshore southeast of Petit Bois Island, Alabama (See Figure 7). Within this site, there are six sub-sections that will be utilized (PBP-OCS-W1, PBP-OCS-W2, PBP-OCS-W3, PBP-OCS-W4, PBP-OCS-W5, PBP-OCS-W6) for sand. The approximate sizes of these sites are as follows: PBP-OCS-W1 (420 acres), PBP-OCS-W2 (192 acres), PBP-OCS-W3 (275 acres), PBP-OCS-W4 (195 acres), PBP-OCS-W5 (155 acres), and PBP-OCS-W6 (146 acres).

The average grain size of sand from these sites is 0.26 to 0.30 mm, and it ranges in color from gray to light greenish gray. The estimated total quantity of the required dredged volume is 10.3 mcy for all six sites (Figure 7). An additional sum of 5.1 mcy of allowable volume is added to this for a maximum potential volume of 15.4 mcy. The sand deposit sub-sections range from -48.0 to -67.5 ft. The maximum dredging depth is -72.5 ft. This depth includes the maximum dredging depth of -67.5 ft plus an additional disturbance layer of 5 ft.



Petit Bois Pass - OCS West Borrow Areas

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBS-OCS-WEST 1	420	1.6	1.5	-46.5 to -47.5	-48 to -49.5	5	0.26	3	6
PBS-OCS-WEST 2	192	0.8	0.8	-47.5 to -48	-49.5 to -50	4	0.28	5	6
PBS-OCS-WEST 3	275	4.6	0.9	-61 to -65.5	-63 to -67.5	9	0.26	3	6
PBS-OCS-WEST 4	195	1.8	0.6	-49 to -62.5	-51 to -64.5	8	0.3	4	6

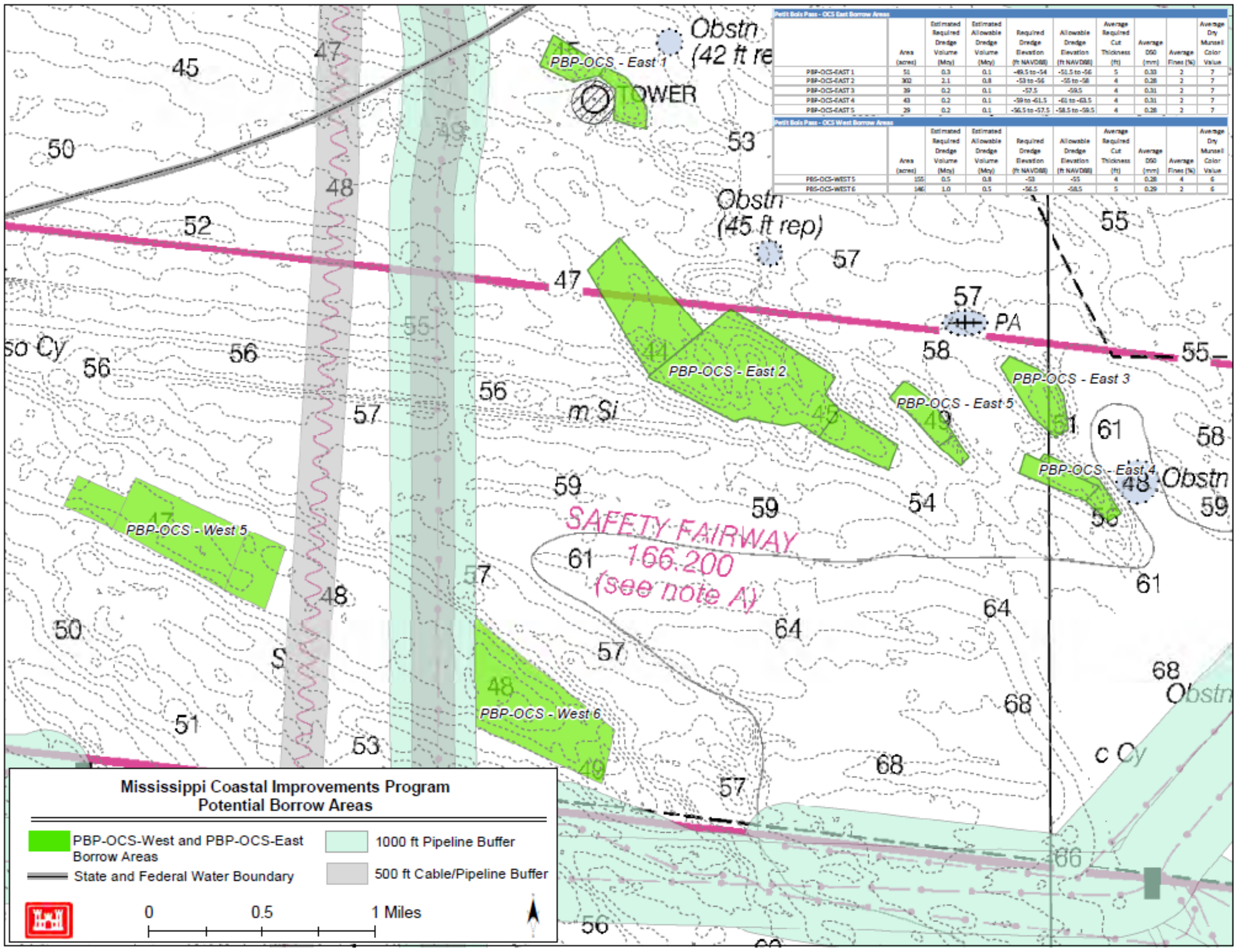
Figure 7 – Petit Bois Pass Outer Continental Shelf West

Petit Bois-OCS East

The Petit Bois Pass-OCS East (PBP-OCS-E) borrow area is located in approximately 3.5 miles offshore, southeast of Petit Bois Island (See Figure 8). Within this site, there are five sub-sections that will be utilized (PBP-OCS-E1, PBP-OCS-E2, PBP-OCS-E3, PBP-OCS-E4, PBP-OCS-E5, PBP-OCS-E6) for sand. The approximate sizes of these sites are as follows: PBP-OCS-E1 (51 acres), PBP-OCS-E2 (320 acres), PBP-OCS-E3 (40 acres), PBP-OCS-E4 (43 acres), and PBP-OCS-E5 (29 acres).

The average grain sizes of sand from these sites range from 0.26 to 0.33 mm and it ranges in color from light gray to light greenish or pale yellow. The estimated total quantity of the required dredged volume is 3.0 mcy for all five sites. An additional sum of 1.2 mcy of allowable volume is added to this for a maximum potential volume of 4.2 mcy. The sand deposit sub-sections at all five sites range from -50.0 to -63.5 ft. The maximum dredging depth is -68.5 ft.

This depth includes the maximum dredging depth of -63.5 ft plus an additional disturbance layer of 5 ft (Figure 8).



Petit Bois Pass - OCS East Borrow Areas	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBP-OCS-EAST 1	51	0.3	0.1	-49.5 to -54	-51.5 to -56	5	0.33	2	7
PBP-OCS-EAST 2	302	2.1	0.8	-53 to -56	-55 to -58	4	0.28	2	7
PBP-OCS-EAST 3	39	0.2	0.1	-57.5	-59.5	4	0.31	2	7
PBP-OCS-EAST 4	43	0.2	0.1	-59 to -61.5	-61 to -63.5	4	0.31	2	7
PBP-OCS-EAST 5	29	0.2	0.1	-56.5 to -57.5	-58.5 to -59.5	4	0.28	2	7

Petit Bois Pass - OCS West Borrow Areas	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBS-OCS-WEST 5	155	0.5	0.8	-53	-55	4	0.28	4	6
PBS-OCS-WEST 6	146	1.0	0.5	-56.5	-58.5	5	0.29	2	6

Figure 8 – Petit Bois Pass Outer Continental Shelf East and West

DA-10 Littoral Placement of Dredged Material

There would be a modification in the future placement location of dredged material for the Pascagoula Federal Navigation Channel. Sandy material dredged from the Horn Island Pass as part of the Pascagoula Federal Navigation Channel would be potentially placed in the combined DA-10/ littoral zone along the shallow shoals exposed to the open Gulf waves. The area of potential direct placement would encompass 1,600 acres between DA-10 and the southern boundary of the Pascagoula Harbor littoral zone site at depths of 5 to 30 ft. Approximately 800,000 cubic yards per year of material would be placed into the DA-10 littoral transport system. Placement is anticipated to occur on an approximate 18 month cycle.

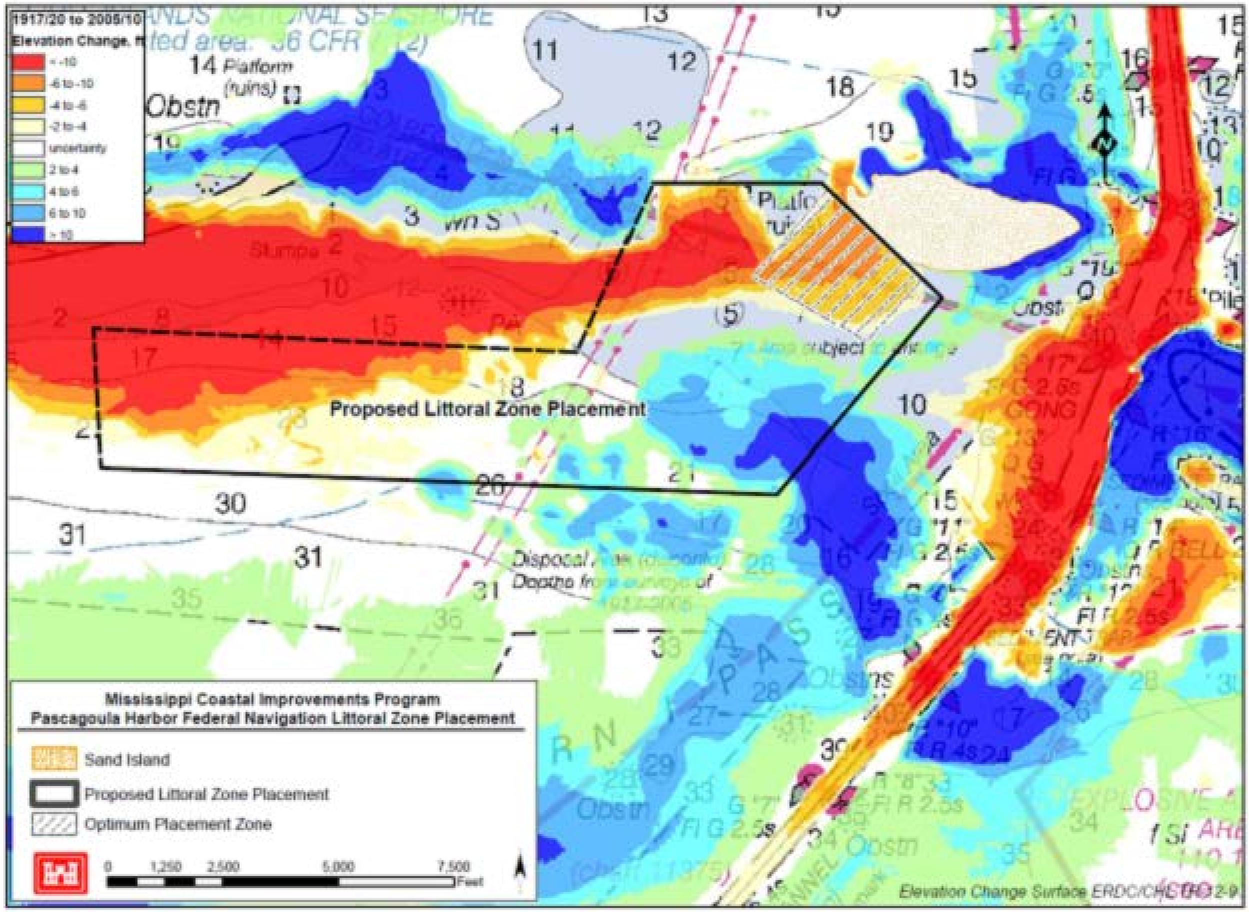


Figure 9 - DA-10/ Littoral Zone Placement Area

Equipment Access Routes

Sediment transport equipment could include several types of conveyances, such as scows, crane barges, and jack-up barges, pipelines (submerged, floating, and land), and booster pumps. Heavy machinery would be used to move sand and facilitate construction. The equipment could include bull-dozers, frontend loaders, trackhoes, marsh-buggy trackhoes, and backhoes. Various support equipment also would be used, such as crew and work boats, trucks, trailers, construction trailers, all-terrain vehicles, and floating docks or channels with pilings to facilitate loading and unloading of personnel and equipment.

Temporary floatation docks or channels locations are preliminary based on avoidance of environmentally sensitive areas, but would likely be along the northward sides of the Camille cut, and or near islands tips of the placement areas. Channels would be placed outside of environmentally sensitive areas to the maximum extent possible.

Along with the dredges, this equipment could be staged offshore and outside the restoration area during use. Equipment also would be staged onshore. Heavy machinery, vehicles, sediment retaining structures, and other construction equipment could be parked or staged before and during use.

Contractor access floatation channels/ pipeline corridor areas are estimated to be a maximum of 200 ft wide with a maximum depth of -12 feet NAVD88. All surface impacts from excavating, pile driving, floatation channels, pipelines, constructed ramps, etc. will be contained within the width and depth parameters (see Figure 10).

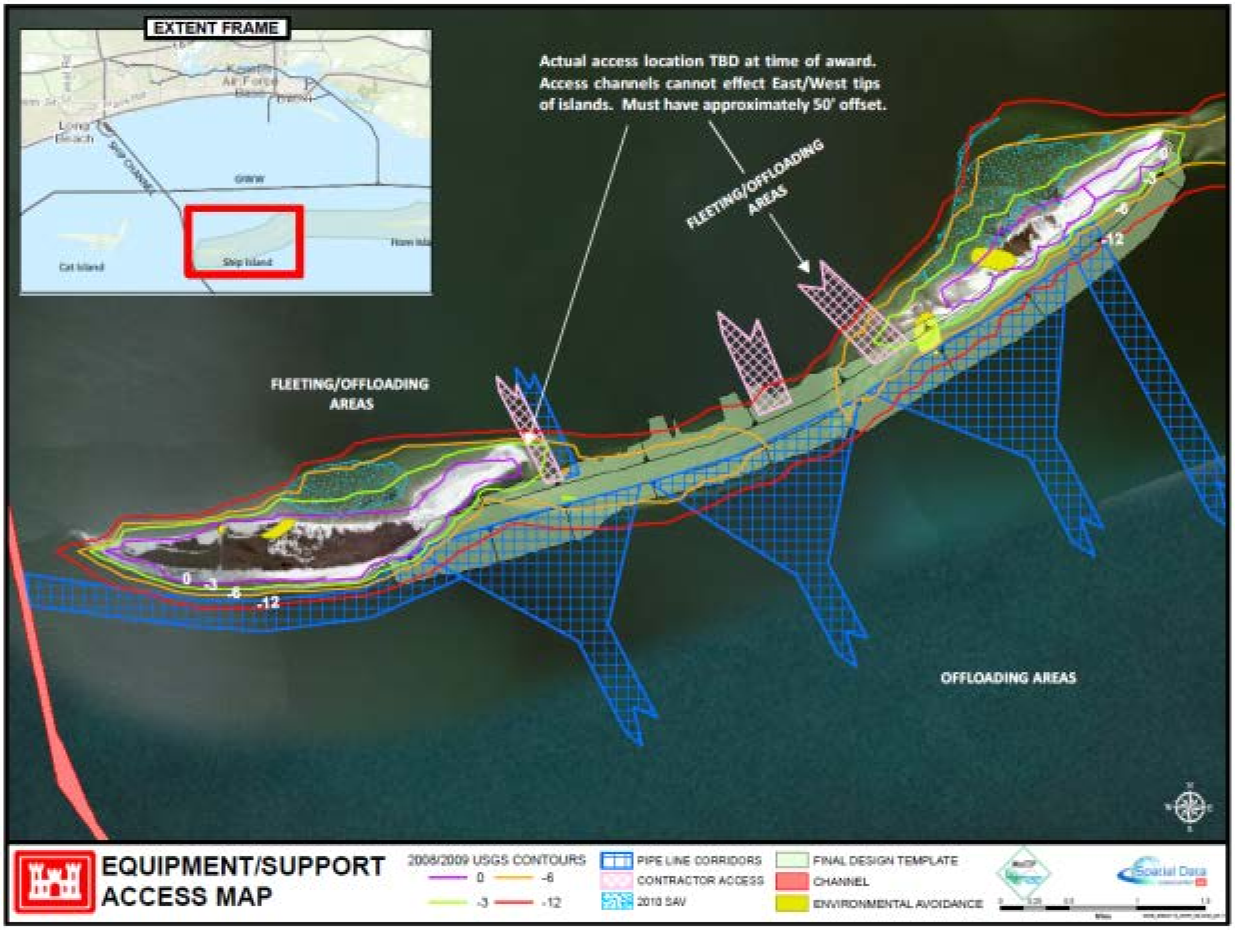


Figure 10 - Equipment Access Map for East and West Ship Islands and Camille Cut

Cat Island Sand Placement

The Cat Island sand placement consists of the placement of an estimated two mcy of sand along the eastern shoreline. The construction template will consist of an average dune crest width of 40 ft at an elevation of approximately +7.5 ft NAVD88. The construction berm will have an average crest width of approximately 250 ft at an elevation of approximately +5 ft NAVD88 with a 1V:12H to 1V:20H slope from the seaward side of the berm to the toe of the fill. The construction profile is expected to adjust rapidly through the erosion of the upper profile, and mimic the natural nearshore profile once it reaches equilibrium. The total equilibrated fill area encompasses approximately 305 acres. The work will likely be performed using a hydraulic dredge. The portion of Cat Island to be restored was acquired by BP following the Deepwater Horizon incident to allow for the ease of clean-up. The construction activity will not begin until the property is under public ownership however the proposed activity should be considered as part of this assessment to assure that the full impacts and benefits of the comprehensive restoration are considered.

Cat Island Borrow Area

Sand for construction of the project will be dredged from an approximate 429-acre borrow area located approximately one mile east of the island in ambient water depths of approximately -12 to -14 ft NAVD88. The material within the borrow site is classified as poorly graded sand, with an average grain size of 0.20 mm, 5 percent fines, and a gray to olive-gray color. The Cat Island borrow and placement areas are shown in Figure 11.

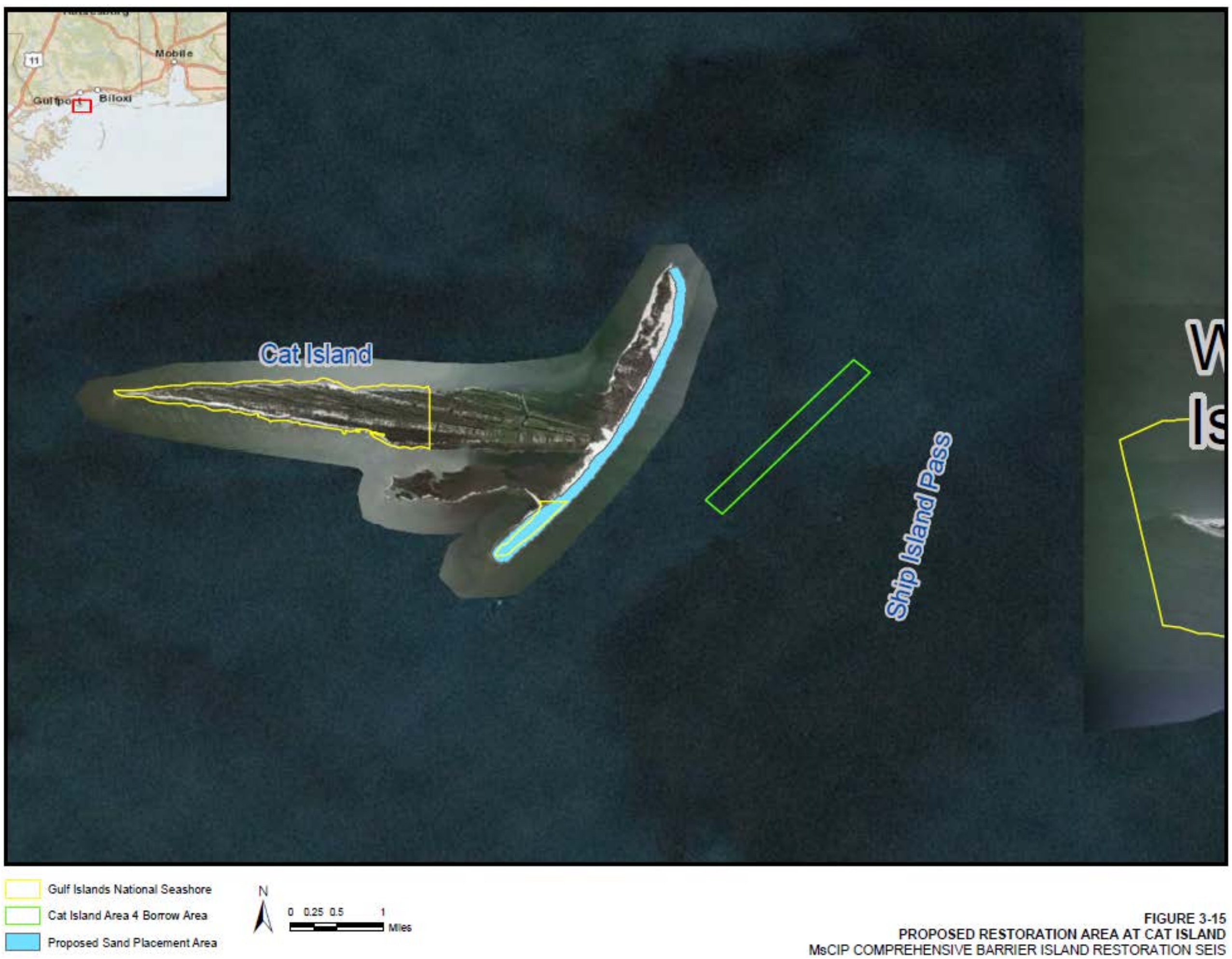


Figure 11 - Cat Island Borrow and Placement Areas

Construction Phases for Ship Island Restoration

The Ship Island restoration component would be constructed in five phases utilizing a variety of equipment including hopper, mechanical, and/or hydraulic pipeline dredges and dump scows. Four of the phases would consist of dredging and placement activities and the fifth phase would consist of dune planting activities on the newly restored Ship Island. Phases 3, 4, and 5 may be constructed concurrently. Work being performed under Phases 3 and 4 would be completed at different locations (i.e., Camille Cut and East Ship Island). Work completed under Phases 4 and 5 would occur in the same location (i.e. Camille Cut), but Phase 5 would begin approximately 2 months after Phase 4 begins, to allow for the Phase 5 effort to occur on the portion of the Phase 4 work that would have already been completed. It is estimated that the five phases would be completed over a period of 2.5 years. Each phase is detailed below.

- **Phase 1:** Approximately 6.0 mcy of in-placed sand volumes based on 2012 surveys would be used to construct the initial berm across Camille Cut and approximately 0.8 mcy would be used to construct a portion of the berm on East Ship Island. Material for Phase 1 would likely be dredged from a combination of the PBP-OCS East and West, HIP and Petit Bois Mississippi borrow sites. The initial berm at Camille Cut would have a crest width of approximately 500 ft, a top elevation of +5 ft NAVD88, and a length of approximately 22,500 ft. The berm along East Ship Island would have crest width of approximately 500 ft, a top elevation of +5 ft NAVD88, and a length of approximately 3,000 ft including the appropriate taper to transition into the existing island. The East Ship Island berm would be constructed adjacent to the Camille Cut berm along the west end of the southern shoreline of East Ship Island. It would serve as a feeder source for Camille Cut until the remaining portion of the East Ship Island berm is constructed under Phase 3. Work is anticipated to occur generally from east to west, but depending on the contractor and equipment may also occur west to east. It is estimated that Phase 1 would be completed over a period of 15 months.

- **Phase 2:** Approximately 6.3 mcy of in-placed sand volumes would likely be dredged from a combination of the PBP-OCS West and Petit Bois Alabama borrow sites to raise and widen the initial Camille Cut berm constructed in Phase 1 to elevation +7 ft NAVD88 and approximately 1,100 ft respectively. The berm would be approximately 24,500 ft long including the taper to tie into the East Ship Island berm. The upper interior portion of the berm would be left void during this phase and would be filled using finer grained sand from the Ship Island borrow site during Phase 4. It is estimated that Phase 2 would be completed over a period of ten months.

- **Phase 3**: Approximately 4.7 mcy of in-placed sand would be used to extend and expand the initial East Ship Island berm constructed in Phase 1 and complete the restoration of the southern shoreline of the East Ship Island. Material for Phase 3 would likely be dredged from a combination of PBP-OCS West and Petit Bois Alabama borrow sites. The final berm along the southern shoreline of East Ship Island would have a crest width of approximately 1,200 ft, a top elevation of +6 ft NAVD88, and a length of approximately 8,000 ft. It is estimated that Phase 3 would be completed over a period of 7 months.

- **Phase 4:** Approximately 1.1 mcy of in-placed sand would be used to fill the void left from Phase 2 in the upper interior portion of the Camille Cut fill. Material for Phase 4 would be dredged from the Ship Island borrow site. The sand in the Ship Island borrow site is finer grained than the other borrow sites and would serve as a more suitable substrate for vegetation growth. The final Camille Cut berm would have a crest width of approximately 1,100 ft with a top elevation of +7 ft NAVD88 after the Phase 4 cap is constructed. It is estimated that Phase 4 would be completed over a period of five months.

- **Phase 5:** Work under Phase 5 would consist of planting the Camille Cut restoration berm with native dune vegetation. The newly created island segment would be planted with native dune vegetation, including sea oats (Uniola paniculata), gulf bluestem (Schizachyrium maritimum), and or other grasses and forbs, to restore stable dune habitat. Planting would include vegetation similar to that found in the existing coastal habitats (Section 4.5.1 of MsCIP SEIS). It is estimated that Phase 5 would be completed over a period of 7 months.

- **Cat Island:** Restoration work at Cat Island would be conducted in one phase. The proximity of the borrow area to the island's eastern shoreline in relatively shallow water would allow the rapid placement of sand on the beach likely using a pipeline dredge. The material would be pumped onto the beach and shaped using land-based equipment. Following placement, the area would be vegetated with native grasses. Restoration would occur over approximately 6 months. Work on Cat Island would begin after the State of Mississippi obtains ownership. Restoration work at Cat Island would be done under a separate contract, but the timing of the construction could occur concurrently with the Ship Island Restoration efforts.

STATUS OF THE SPECIES/CRITICAL HABITAT

PIPING PLOVER

Species/critical habitat description

The piping plover is a small (7 inches long), pale, sand-colored shorebird with a wingspan of 15 inches (Palmer 1967). On January 10, 1986, the piping plover was listed as endangered in the Great Lakes watershed and threatened elsewhere within its range, including migratory routes outside of the Great Lakes watershed and wintering grounds (Service 1985). Piping plovers were listed principally because of habitat destruction and degradation, predation, and human disturbance. Protection of the species under the Act reflects the species' precarious status range-wide. Three separate breeding populations have been identified, each with its own recovery criteria: the northern Great Plains (threatened), the Great Lakes (endangered), and the Atlantic Coast (threatened). The piping plover winters in coastal areas of the United States (U.S.) from North Carolina to Texas, and along the coast of eastern Mexico and on Caribbean islands from Barbados to Cuba and the Bahamas (Haig and Elliott-Smith 2004). Piping plover subspecies are phenotypically indistinguishable, and most studies in the nonbreeding range report results without regard to breeding origin. Although a recent analysis shows strong patterns in the wintering distribution of piping plovers from different breeding populations, partitioning is not complete and major information gaps persist. Therefore, information summarized here pertains to the species as a whole (i.e., all three breeding populations), except where a particular breeding population is specified.

The Service has designated critical habitat for the piping plover on three occasions. Two of these designations protected different breeding populations. Critical habitat for the Great Lakes breeding population was designated May 7, 2001 (Service 2001a), and critical habitat for the northern Great Plains breeding population was designated September 11, 2002 (Service 2002). Critical habitat for the piping plover breeding populations does not occur in Mississippi; therefore, critical habitat for breeding plovers will not be discussed further in this document.

The Service also designated critical habitat for wintering piping plovers on July 10, 2001 (Service 2001b). Wintering piping plovers may include individuals from the Great Lakes and northern Great Plains breeding populations as well as birds that nest along the Atlantic coast. Designated wintering piping plover critical habitat originally included 142 areas (the rule states 137 units; this is in error) encompassing about 1,793 miles of mapped shoreline and 165,211 acres of mapped areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. Since the designation of wintering critical habitat, 19 units (TX- 3,4,7-10, 14-19, 22, 23, 27,28, and 31-33) in Texas have been vacated and remanded back to the Service for reconsideration by Court order (Texas General Land Office v. U.S. Department of Interior, Case No. V-06-CV-00032). On May 19, 2009, the Service published a final rule designating 18 revised critical habitat units in Texas, totaling approximately 139,029 acres (Service 2009a). The Courts also vacated and remanded back to the Service for reconsideration, four units in North Carolina (Cape Hatteras Access Preservation Alliance v. U.S. Department of Interior, 344 F. Supp. 2d 108 (D.D.C. 2004)). The four critical habitat units vacated were NC-1, 2, 4, and 5, and all occurred within Cape Hatteras National Seashore (CAHA). A revised designation for these four units was published on October 21, 2008 (Service 2008).

The primary constituent elements (PCEs) for piping plover wintering habitat are those biological and physical features that are essential to the conservation of the species. The PCEs are those habitat components that support foraging, roosting, and sheltering and the physical features necessary for maintaining the natural processes that support these habitat components. These areas typically include coastal areas that support intertidal beaches and flats and associated dune systems and flats above annual high tide (Service 2001a). PCEs of wintering piping plover critical habitat include sand or mud flats (or both) with no or sparse emergent vegetation. Adjacent unvegetated or sparsely vegetated sand, mud, or algal flats above high tide are also important, especially for roosting piping plovers (Service 2001a). Important components of the beach/dune ecosystem include surf-cast algae, sparsely vegetated back beach and salterns, spits, and over-wash areas. Over-wash areas are broad, unvegetated zones, with little or no topographic relief, that are formed and maintained by the action of hurricanes, storm surge, or other extreme wave action. The units designated as critical habitat are those areas that have consistent use by piping plovers and that best meet the biological needs of the species. The amount of wintering habitat included in the designation appears sufficient to support future recovered populations, and the existence of this habitat is essential to the conservation of the species. Additional information on each specific unit included in the designation can be found in the Service's final rule (Service 2001a).

Activities that affect PCEs include those that directly or indirectly alter, modify, or destroy the processes that are associated with the formation and movement of barrier islands, inlets, and other coastal landforms. Those processes include erosion, accretion, succession, and sea-level change. The integrity of the habitat components also depends upon daily tidal events and regular sediment transport processes, as well as episodic, high-magnitude storm events (Service 2001b).

Also, see **appendix D** for information on: **Life History, Population Dynamics, and Status and Distribution** for piping plover.

Analysis of the species/critical habitat likely to be affected

The proposed action has the potential to adversely affect migrating and wintering piping plovers, including piping plover designated critical habitat in Unit MS-14, within the action area. The construction activities may lead to temporarily diminished quantity and quality of intertidal foraging and roosting habitats within the project area and action area, resulting in decreased survivorship of migrating and wintering plovers and temporary adverse effects to critical habitat. The length of construction activities (which will take several years) may delay the recovery of prey species due to the prolonged disturbance of the benthic fauna. Ultimately, the project goal is to increase the longevity and restore the diversity of coastal barrier island habitats, but the temporary effects of construction will require time for natural recovery and would extend beyond more than one migration and wintering season. However, as shown in the table below the project is expected to result in 762 acres of additional habitat.

Table 2 - Impact Summary for Piping Plover Critical Habitat

	Total Project Area (acres)	Area within 2002 Desingated PPCH Boundaries* (acres)	Existing Usable Piping Plover Habitat within the constructed project limits (acres above MLLW)	Usable Piping Plover Habitat within the constructed project limits after Equilbrium (acres above MLLW)	Habitat Change Gain or Loss (acres)
Restoration Areas					
Camille Cut	1500	820	139	738	599
East Ship Island					
Cat Island	305	305	99	261	162
Total	**1805**	**1125**	**238**	**999**	**762**

RED KNOT

Species/critical habitat description

The red knot (*Calidris canutus rufa*) is a medium-sized shorebird about 9 to 11 inches (in) (23 to 28 centimeters (cm)) in length. The red knot is easily recognized during the breeding season by its distinctive rufous (red) plumage (feathers). The face, prominent stripe above the eye, breast, and upper belly are a rich rufous-red to a brick or salmon red, sometimes with a few scattered light feathers mixed in. The feathers of the lower belly and under the tail are whitish with dark flecks. Upperparts are dark brown with white and rufous feather edges; outer primary feathers are dark brown to black (Harrington 2001; Davis 1983). Females are similar in color to males, though the rufous colors are typically less intense, with more buff or light gray on the dorsal (back) parts (Niles *et al*. 2008). Red knots have a proportionately small head, small eyes, and short neck, and a black bill that tapers from a stout base to a relatively fine tip. The bill length is not much longer than head length. Legs are short and typically dark gray to black, but sometimes greenish in juveniles or older birds in nonbreeding plumage (Harrington 2001). Nonbreeding plumage is dusky gray above and whitish below. Juveniles resemble nonbreeding adults, but the feathers of the scapulars (shoulders) and wing coverts (small feathers covering base of larger feathers) are edged with white and have narrow, dark bands, giving the upperparts a scalloped appearance (Davis 1983).

There are six recognized subspecies of red knots (*Calidris canutus*), and on December 11, 2014, the Service published a final rule in the *Federal Register* listing the rufa subspecies of red knot (*Calidris canutus rufa*) as a threatened species under the Act (Service 2013). The Service accepts the characterization of *C.c. rufa* as a subspecies because each recognized subspecies is believed to occupy separate breeding areas, in addition to having distinctive morphological traits (i.e., body size and plumage characteristics), migration routes, and annual cycles. The Service has determined that the rufa red knot is threatened due to loss of both breeding and nonbreeding habitat; potential for disruption of natural predator cycles on the breeding grounds; reduced prey availability throughout the nonbreeding range; and increasing frequency and severity of asynchronies (‘‘mismatches’’) in the timing of the birds’ annual migratory cycle relative to favorable food and weather conditions. Main threats to the rufa red knot in the United States include: reduced forage base at the Delaware Bay migration stopover; decreased habitat availability from beach erosion, sea level rise, and shoreline stabilization in Delaware Bay; reduction in or elimination of forage due to shoreline stabilization, hardening, dredging, beach replenishment, and beach nourishment in Massachusetts, North Carolina, and Florida; and beach raking which diminishes red knot habitat suitability. These and other threats in Canada and South America are detailed in the December 11, 2014 listing rule (Service 2014)..Species Assessment and Listing Priority Assignment Form (Service 2011b) and the proposed listing rule (Service 2013). Unknown threats may occur on the breeding grounds. (Throughout this document, the “rufa red knot” will be referred to as the “red knot” unless there is specific reference to a distinct subspecies.)

Critical habitat has not been proposed or designated for the red knot at the time of this document’s writing. However, important habitat characteristics for the red knot are discussed further in the **Life history** found in appendix E of this document.

Also, see **appendix E** for information on: **Life History, Population Dynamics, and Status and Distribution** for red knot.

Analysis of the species/critical habitat likely to be affected

The proposed action has the potential to adversely affect migrating and wintering red knots and their habitat within the action area. The construction activities may lead to temporarily diminished quantity and quality of intertidal foraging and roosting habitats within the project area and action area, resulting in decreased survivorship of migrating and wintering knots and temporary adverse effects to suitable foraging and roosting habitat. The length of construction activities (which varies from six months to one year or more) may delay the recovery of prey species due to the prolonged disturbance of the benthic fauna. Ultimately, the project goal is to increase the longevity and restore the diversity of coastal barrier island habitats, but the temporary effects of construction will require time for natural recovery and would extend beyond more than one migration and wintering season. Critical Habitat for the red knot has not been designated at this time.

Sea Turtles

Species/critical habitat description

Loggerhead Sea Turtle

The loggerhead sea turtle, which occurs throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans, was federally listed worldwide as a threatened species on July 28, 1978 (43 Federal Register (FR) 32800). On September 22, 2011, the loggerhead sea turtle's listing under the Act was revised from a single threatened species to nine distinct population segments (DPS) listed as either threatened or endangered. The Northwest Atlantic Ocean DPS, which is listed as threatened, occurs in the Southeast Region from Texas to Florida and north from Georgia to Virginia.

The loggerhead sea turtle grows to an average weight of about 200 pounds and is characterized by a large head with blunt jaws. Adults and subadults have a reddish-brown carapace. Scales on the top of the head and top of the flippers are also reddish-brown with yellow on the borders. Hatchlings are a dull brown color (NMFS 2009a). The loggerhead feeds on mollusks, crustaceans, fish, and other marine animals.

The loggerhead may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Coral reefs, rocky places, and ship wrecks are often used as feeding areas. Within the Northwest Atlantic, the majority of nesting activity occurs from April through September, with a peak in June and July (Williams-Walls *et al*. 1983, Dodd 1988, Weishampel *et al*. 2006). Nesting occurs within the Northwest Atlantic along the coasts of North America, Central America, northern South America, the Antilles, Bahamas, and Bermuda, but is concentrated in the southeastern United States and on the Yucatán Peninsula in Mexico on open beaches or along narrow bays having suitable sand (Sternberg 1981, Ehrhart 1989, Ehrhart *et al*. 2003, NMFS and Service 2008).

Critical habitat was designated for the Northwest Atlantic Ocean DPS loggerhead sea turtle on July 10, 2014, which includes Horn Island and Petit Bois Island in Mississippi.

Green Sea Turtle

The green sea turtle was federally listed on July 28, 1978 (43 FR 32800). Breeding populations of the green turtle in Florida and along the Pacific Coast of Mexico are listed as endangered; all other populations are listed as threatened. The green sea turtle has a worldwide distribution in tropical and subtropical waters.

The green sea turtle grows to a maximum size of about 4 ft and a weight of 440 pounds. It has a heart-shaped shell, small head, and single-clawed flippers. The carapace is smooth and colored gray, green, brown, and black. Hatchlings are black on top and white on the bottom (NMFS 2009b). Hatchling green turtles eat a variety of plants and animals, but adults feed almost exclusively on seagrasses and marine algae.

Major green turtle nesting colonies in the Atlantic occur on Ascension Island, Aves Island, Costa Rica, and Surinam. Within the U.S., green turtles nest in small numbers in the U.S. Virgin Islands and Puerto Rico, and in larger numbers along the east coast of Florida, particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties (NMFS and Service 1991). Nests have been documented, in smaller numbers, north of these Counties, from Volusia through Nassau Counties in Florida, as well as in Georgia, South Carolina, North Carolina, and as far north as Delaware in 2011. Nests have been documented in smaller numbers south of Broward County in Miami-Dade. Nesting also has been documented along the Gulf coast of Florida from Escambia County through Franklin County in northwest Florida and from Pinellas County through Monroe County in southwest Florida (FWC/FWRI 2010b).

Green sea turtles are generally found in fairly shallow waters (except when migrating) inside reefs, bays, and inlets. The green turtle is attracted to lagoons and shoals with an abundance of marine grass and algae. Open beaches with a sloping platform and minimal disturbance are required for nesting.

Critical habitat for the green sea turtle has been designated for the waters surrounding Culebra Island, Puerto Rico, and its outlying keys.

Kemp’s Ridley Sea Turtle

The Kemp’s ridley sea turtle was federally listed as endangered on December 2, 1970 (35 FR 18320). The Kemp's ridley, along with the flatback sea turtle (*Natator depressus*), has the most geographically restricted distribution of any sea turtle species. The range of the Kemp’s ridley includes the Gulf coasts of Mexico and the U.S., and the Atlantic coast of North America as far north as Nova Scotia and Newfoundland.

Adult Kemp's ridleys and olive ridleys are the smallest sea turtles in the world. The weight of an adult Kemp’s ridley is generally between 70 to 108 pounds with a carapace measuring approximately 24 to 26 inches in length (Heppell *et al*. 2005). The carapace is almost as wide as it is long. The species’ coloration changes significantly during development from the grey-black dorsum and plastron of hatchlings, a grey-black dorsum with a yellowish-white plastron as post-pelagic juveniles and then to the lighter grey-olive carapace and cream-white or yellowish plastron of adults. Their diet consists mainly of swimming crabs, but may also include fish, jellyfish, and an array of mollusks.

The Kemp’s ridley has a restricted distribution. Nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico (NMFS *et al*. 2011). Nesting also occurs in Veracruz and a few historical records exist for Campeche, Mexico (Marquez-Millan 1994). Nesting also occurs regularly in Texas and infrequently in a few other U.S. states. However, historic nesting records in the U.S. are limited to south Texas (Werler 1951, Carr 1961, Hildebrand 1963).

Most Kemp's ridley nests located in the U.S. have been found in south Texas, especially Padre Island (Shaver and Caillouet 1998, Shaver 2002, 2005). Nests have been recorded elsewhere in Texas (Shaver 2005, 2006a, 2006b, 2007, 2008), and in Florida (Johnson *et al*. 1999, Foote and Mueller 2002, Hegna et al. 2006, (FWC/FWRI 2010b), Alabama (J. Phillips, Service, personal communication, 2007 cited in NMFS et al. 2011; J. Isaacs, Service, personal communication, 2008 cited in NMFS et al. 2011), Georgia (Williams et al. 2006), South Carolina (Anonymous 1992), and North Carolina (Marquez et al. 1996), but these events are less frequent. Kemp's ridleys inhabit the Gulf of Mexico and the Northwest Atlantic Ocean, as far north as the Grand Banks (Watson et al. 2004) and Nova Scotia (Bleakney 1955). They occur near the Azores and eastern north Atlantic (Deraniyagala 1938, Brongersma 1972, Fontaine et al. 1989, Bolten and Martins 1990) and Mediterranean (Pritchard and Marquez 1973, Brongersma and Carr 1983, Tomas and Raga 2007, Insacco and Spadola 2010).

Hatchlings, after leaving the nesting beach, are believed to become entrained in eddies within the Gulf of Mexico. Most Kemp's ridley post-hatchlings likely remain within the Gulf of Mexico. Others are transported into the northern Gulf of Mexico and then eastward, with some continuing southward in the Loop Current, then eastward on the Florida Current into the Gulf Stream (Collard and Ogren 1990, Putman et al. 2010). Juvenile Kemp's ridleys spend on average 2 years in the oceanic zone (NMFS SEFSC unpublished preliminary analysis, July 2004, as cited in NMFS et al. 2011) where they likely live and feed among floating algal communities. They remain here until they reach about 7.9 inches in length (approximately 2 years of age), at which size they enter coastal shallow water habitats (Ogren 1989); however, the time spent in the oceanic zone may vary from 1 to 4 years or perhaps more (Turtle Expert Working Group (TEWG) 2000, Baker and Higgins 2003, Dodge et al. 2003).

No critical habitat has been designated for the Kemp's ridley sea turtle.

Also, see **appendix F** for information on: **Life History, Population Dynamics, and Status and Distribution** for loggerhead, green, and Kemp's ridley sea turtles.

Analysis of the species/critical habitat likely to be affected

The proposed action has the potential to adversely affect nesting females, nests, and hatchlings within the proposed project area. The effects of the proposed action on sea turtles will be considered further in the remaining sections of this biological opinion. Potential effects include destruction of nests deposited within the boundaries of the proposed project, harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities, disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting, and behavior modification of nesting females due to escarpment formation within the project area during a nesting season resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs. The quality of the placed sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest

Critical habitat has been designated in the continental United States for loggerhead sea turtles. However, the project area does not contain designated critical habitat.

ENVIRONMENTAL BASELINE

Because the piping plover and red knot share similar coastal habitats within Mississippi, the environmental baseline is the same for both species. Therefore, in order to produce an efficient and effective consultation, the following sections discuss the mutual environmental baseline conditions for both species.

Mississippi's loss of wetlands and barrier islands to open water is now a well-documented fact in numerous studies. The sediment transport process has been interrupted by the deepening and widening of the adjacent navigation channels, recent hurricane events, etc. Mississippi barrier islands are part of a complex and dynamic coastal system that continually respond to tidal passes, tides, wind, waves, erosion and deposition, long-shore sediment transport and depletion, fluctuations in sea level, and weather events. During storm events, over-wash is common across the barrier islands, depositing sediments on the bay-side or landward side, clearing vegetation and increasing the amount of open, sandflat habitat ideal for shoreline dependent shorebirds. Winds move sediment across the dry beaches forming low dunes. The natural communities contain plants and animals that are subject to shoreline erosion and deposition, salt spray, wind, drought conditions, and sandy soils. Vegetative communities include fore dunes, occasional primary dunes, salt marsh, and forested areas.

Status of the species within the action area

Red Knot and Piping Plover

Assessing the number of piping plovers and red knots within the action area during winter and migration periods is difficult for two main reasons: (1) the number of birds utilizing the island varies from year to year and throughout each migration and wintering season; and (2) the islands are difficult to assess due to their remote locations and generally poor winter weather conditions. Because winter generally produces inclement weather conditions, daily surveys over any length of time during the migration and wintering seasons are also difficult to coordinate. Consequently, surveys for non-breeding (e.g., over-wintering and migrating) plovers and red knots within the action area are sporadic and opportunistic, and even more so for Cat Island due to it having been in private ownership. Bird surveys, conducted in support of the MsCIP barrier island restoration project during the period December 28, 2012, and December 18, 2013, identified a total of 292 red knots in the project area. Red knots were observed on DA-10/Sand Island (11), East Ship Island (265), and West Ship Island (16). Most red knots were observed in January 2013 (75) and May 2013 (61).

Surveys for piping plovers on Mississippi barrier islands and mainland beaches indicate a mid-winter period when most of the birds are winter residents and spring and fall migration periods when many more birds move through the islands staying for only a short time. During the migration, these areas serve as refueling spots on the long migratory journey. Within the project area, piping plovers are known to congregate primarily along the tidal flats and tips of West and East Ship Islands, and at Petit Bois, Horn, and Cat Islands. A survey for the 2009 migratory period was conducted, in which approximately 24-34 piping plovers on Petit Bois, Horn and West and East Ship Islands (Zdravkovic, 2009) were counted. However, higher numbers of plovers were observed for Cat, West, and East Ship Islands during the 2010-11 migratory period).

During the 2008-09 wintering period, piping plovers were surveyed from Boca Chica, Texas to Marco Island, Florida (Maddock, 2010). Over a nine-day period, the MS mainland and barrier islands were observed. A maximum of 41 birds were observed on Cat Island, 24 on East Ship, 25 on West Ship, 29 on Horn, and 14 on Petit Bois. Moderate numbers of piping plovers were counted on the mainland beaches. Maddock observed higher frequencies of plover use on areas that had large exposed flats, overwash areas, or newly created inlets.

In a 2011 wintering survey, the majority of birds were recorded at East Ship, Cat and Horn Islands; and of the three, Cat Island had the most, with 45 birds (Winstead, personal comm., 2012). In addition, a 2012 survey noted at least 38 piping plovers on Cat Island, 55 on East Ship Island, 3 on West Ship Island, and 5 on Horn Island (Winstead, personal comm., 2012). Also, piping plovers are regularly observed on DA-10, although their frequency of use has not been well-documented.

During bird surveys conducted in support of the MsCIP barrier island restoration project between December 2012 and December 2013, a total of 1,154 piping plovers were observed in the project area. Piping plovers were observed on DA-10/Sand Island (17), East Ship Island (779), and West Ship Island (358). On East Ship Island, the largest number of piping plover was observed during the month of October (416 birds). Relatively large numbers of piping plovers were observed on East Ship Island during the months August through December, while relatively large numbers were observed on West Ship Island during the months January through April. On Sand Island, the month of February had the largest number (12) of piping plovers, and all other months had much lower numbers of this species. To date, none of the bird surveys conducted in support of this project have been conducted on Cat Island, since it has been in private ownership.

The proposed project would be located within Unit MS-14 of piping plover critical habitat, which includes the Mississippi barrier island chain in Harrison and Jackson counties, Mississippi. The Final Determinations of Critical Habitat for Wintering Piping Plovers (Service 2001b) describes critical habitat within the project action area as: “This unit includes all of Cat, East and West Ship, Horn, Spoil, and Petit Bois Islands where primary constituent elements occur to MLLW. Cat Island is privately owned, and the remaining islands are part of the Gulf Islands National Seashore.” At the time of designation, July 10, 2001, approximately 9,525 acres of wintering habitat were designated in Mississippi, and Unit MS-14 consisted of approximately 7,828 acres of that total.

Sea Turtles

Historically, loggerhead sea turtles nesting has been incidentally reported in the northern Gulf of Mexico, outside of Florida primarily on the Chandeleur Islands in Louisiana and to a lesser extent on adjacent Ship, Horn, and Petit Bois Islands in Mississippi (Ogren 1977). Ogren (1977) reported a historical reproductive assemblage of sea turtles, which nested seasonally on remote barrier beaches of eastern Louisiana, Mississippi, and Alabama. These sea turtles have historically nested on Mississippi's barrier islands (e.g., Ship, Horn, Petit Bois), situated about 19 km south of the mainland (Carr *et al.* 1982). The more recent occurrences of sea turtles nesting on the Mississippi barrier islands have been documented by the NPS. From 1990- 2011, loggerhead sea turtle nesting and/ or false crawls have been documented at several barrier islands (Cat, East and West Ship, Horn, and Petit Bois). Among the barrier islands, most of the nesting occurred on Petit Bois and Horn Islands, with few nesting documented on the other islands. There was one nest documented on East Ship Island (1992), two nests on Cat Island (1998), 16 nests on Horn Island (1998), and 12 nests on Petit Bois Island (1998). For the 2012 nesting season, there were several documented nests on East, and West Ship Island and Cat Island. A total of four nests were documented on West Ship, with three nests located on the southern shoreline and one nest on the northern shoreline (Hopkins personal comm., 2012). Likewise, a total of three nests were observed by Hopkins on the southern shoreline of East Ship Island. There were three confirmed nests and one potential nest on Cat Island. In addition, four confirmed nests were reported on the Mississippi mainland, including one on Deer Island (Coleman personal comm., 2012) and several on Petit Bois and Horn Islands. These reports were from incidental observations and were not the result of consistent sea turtle nesting surveys.

Major nesting areas for green sea turtles in the Atlantic include Surinam, Guyana, French Guyana, Costa Rica, the Leeward Islands, and Ascension Island in the mid-Atlantic. Historically in the U.S., green turtles have been known to nest in the Florida Keys and Dry Tortugas. These turtles primarily nest on selected beaches along the coast of eastern Florida, predominantly Brevard through Broward Counties. The turtles are not known to nest on the Mississippi coast or barrier islands, but could been found feeding in the seagrass beds in nearshore waters. However, nesting has occurred in Alabama, and therefore it is possible in Mississippi.

Kemp's ridley sea turtles are regularly seen in the Mississippi Sound, and although no nesting has been documented, they could potentially nest on the Mississippi barrier islands. Immature Kemp's ridleys have been incidentally captured by recreational fishermen at Mississippi fishing piers. In 2012, almost 200 Kemp's ridleys were incidentally captured and rehabilitated (Coleman personal comm., 2012). Along the Gulf of Mexico coast, nesting occurs primarily in a nesting area near Rancho Nuevo in Tamaulipas, Mexico (Rothschild, 2004). Nesting occurs to a lesser extent in Texas, with marginal nesting in Alabama and Florida. Eighty Kemp's ridley nests have been documented in Florida from 1979-2013 in Duval, Flagler, Volusia, Brevard, Martin, Palm Beach, Lee, Charlotte, Sarasota, Pinellas, Franklin, Gulf, Walton, Okaloosa, Santa Rosa, and Escambia counties (FWC/FWRI 2014).

Factors affecting species' environment within the action area

The MS barrier islands are only accessed by the public via boat. However, visitation does regularly occur through commercial vessel transportation of visitors to Ship Island. The islands are regularly frequented by the public for fishing, wildlife observation, photography and visitation. The National Park Service restricts access to some areas of the barrier islands during bird nesting season, but this does not include Cat Island since it is not within the National Park. This does have some effect on migratory shorebirds, including the red knot and piping plover, and may affect nesting sea turtles and unmarked sea turtle nests.

In 2010, the presence of oil from the Deepwater Horizon spill was confirmed on many of the Mississippi barrier islands. The islands were oiled repeatedly and Shoreline Cleanup Assessment Team (SCAT) reports throughout the duration of the spill documented various degrees of oiling on all of the barrier islands in Mississippi. Human disturbance was increased during cleanup operations for several years. At this time, it is unknown if there are any current or lasting effects to piping plovers and red knots migrating through or wintering in the action area (i.e., the number of oiled piping plovers or other shorebirds observed during NRDAR studies has not yet been released) or to the inter-tidal invertebrate food source used by piping plovers and red knots from either oil or oil dispersants and resulting cleanup activities within the action area. A greater impact to the piping plover, its critical habitat, and red knots might have occurred due to the prolonged human disturbance associated with cleanup activities, wildlife response, and damage assessment crews highly visible on the shorelines, as well as SCAT surveys and any future cleanup activities. Except for future occasional cleanup actions, no further disturbance is anticipated within the action area as a result of the Deepwater Horizon incident.

The only known sand placement project that occurred in close proximity to the project area occurred shortly after hurricane Katrina around the perimeter of Fort Massachusetts located on Ship Island. Other sand placement projects have taken place in Jackson County on Sand Island, which is a corps disposal site.

EFFECTS OF THE ACTION

This section is an analysis of the beneficial, direct, and indirect effects of the proposed action on nesting sea turtles, nests, eggs, hatchling sea turtles in addition to wintering red knots and piping plovers within the action area. The analysis includes effects interrelated and interdependent of the project activities. An interrelated activity is an activity that is part of a proposed action and depends on the proposed activity. An interdependent activity is an activity that has no independent utility apart from the action.

Factors to be considered

Proximity of the action

The Service expects direct short-term effects to piping plovers and red knots in the form of: (1) disturbance due to human presence and equipment noise during pipeline construction activities, sediment placement, dune/beach construction, and vegetative planting; and (2) a temporary loss of food base within the intertidal zone on both the island and its associated mudflats for up to two years following completion of sediment placement until the benthic community re-colonizes the project area. Approximately 238 acres of the existing island containing PCEs of piping plover critical habitat within Unit MS-14 and red knot suitable habitat would be temporarily disturbed until the benthic fauna recover.

Distribution

We expect direct effects to migrating and wintering piping plovers and red knots along the 238 acres of existing habitat proposed to be impacted by placement of sand. Although studies have shown that plovers tend to remain within a 2-mile wintering home range, it is unknown how far piping plovers and red knots will travel within specific areas during migration stopovers and within wintering areas due to local disturbance or to find a more abundant food source. Other surrounding suitable habitat areas do exist and may provide adequate habitat to support red knots and piping plovers. However, these species will be displaced to potentially lower quality habitat areas and will potentially have to compete for optimum foraging and roosting habitats with other shorebirds.

Timing

Construction of the MsCIP BRP project will likely overlap with multiple piping plover and red knot wintering/migrating seasons (mid-July to late May) pending the time of year construction is initiated, the duration of construction activities (i.e., two or more years), logistical challenges, and weather conditions. There may be ongoing construction related to several other barrier headland and island restoration projects along the Mississippi coast, but those would all be located on the mainland and/or near nearshore islands several miles north of the MsCIP BRP project area.

Nature of the adverse effect

The effects to piping plovers and red knots may be direct and/or short-term or indirect. Activities that impact or alter the use of optimal habitat or increase disturbance to the species may directly decrease the survival and recovery potential of the piping plover and red knot by limiting the ability of birds to rest and replenish their fat reserves for spring migration and summer breeding. We expect direct, short-term impacts from human disturbance during project construction to both the birds and their habitats. We anticipate a temporary (i.e., up to two years post-construction) decrease in benthic prey species within all existing piping plover and red knot foraging habitat within the project footprint as a result of sand and marsh material placement and loss of natural wrack. Following one or two growing seasons, the dune portion of the project may become densely vegetated and would no longer be suitable roosting habitat for piping plovers and red knots until a storm event creates over-wash fans. Until the benthic community recovers and new over-wash fans are created, a temporary decrease in prey items and roosting habitat may result in a decrease in the survival of birds on migrating or wintering grounds due to lack of optimal habitat. That situation can contribute to decreased survival rates and may indirectly result in decreased productivity on the breeding grounds. Such effects may temporarily result in increased vulnerability to any of the three piping plover breeding populations and the red knot population.

The effects to 238 acres of critical habitat in Unit MS-14 result from activities that impact or alter the PCEs (disturbance to the species) which may decrease the survival and recovery potential of the piping plover. Such effects consist of temporary reductions in the value of the unit from disturbance to foraging and roosting piping plovers due to human activity during construction, temporary removal of wrack, and a temporary decrease in benthic prey species due to sand placement. Existing intertidal areas and mudflats would be covered by placement of new material until natural coastal processes (e.g., daily tidal events, storm events, etc.) are allowed to re-work the additional sediment to create new over-wash areas.

Duration

Construction could take two or more years given potential logistics, equipment availability (e.g., dredging contractor), optimal planting times, and weather conditions. The COE would also incorporate monitoring of fish and wildlife resources in the construction plan, which would include baseline (prior to construction), construction (to direct activities around resources), and post-construction (for a period after construction to evaluate physical and biological responses to project implementation) monitoring phases.

The activities associated with construction of the beach, dune, and marsh creation are a one-time occurrence and no renourishment events are proposed. Timing of construction activities may vary in duration depending on the amount of work needed, weather conditions, and equipment mobilization and maintenance. The Service does not expect long-term, permanent alteration of the natural coastal processes, and the island would remain untouched after initial construction (e.g., ground disturbance and vegetative plantings) is completed. The addition of sand material on 238 acres of piping plover critical habitat in Unit MS-14 is expected to temporarily decrease the quality of the existing foraging habitat for six months up to two years until the intertidal benthic fauna recovers to normal population levels and natural wrack returns to the newly created island shoreline.

Disturbance frequency, intensity, and severity

We anticipate that construction activities would have short-term, temporary effects on piping plover and red knot populations. We expect short-term disturbance to the birds and their habitats from construction activities and temporary effects to intertidal and mud flat habitats due to sand and marsh material placement. Direct effects to 238 acres of piping plover critical habitat in Unit MS-14 would include temporary removal of wrack, temporary smothering of intertidal benthic prey species, and the creation of a dune that may eventually become densely vegetated until new over-wash fans are created. We anticipate that: (1) piping plovers and red knots located within the construction area would move outside of the construction zone due to disturbance; (2) natural wrack would be deposited on the island shoreline following normal tidal events; (3) the intertidal benthic fauna would recover within six months up to two years following completion of material placement; and (4) the density of dune and marsh vegetation will ebb and flow as tidal and storm events naturally affect dune and marsh vegetation growth. We do not anticipate any permanent adverse changes to barrier island morphology because initial construction elevations would not prevent island over-wash during storm events and the created marsh platform would allow for natural island retreat or "rollover."

There would not be any increased or continual disturbance within piping plover critical habitat Unit MS-14 as a result of the project beyond normal state and federal management activities as previously discussed in the **Environmental Baseline** section. Over the long-term the additional sediment would allow for creation of piping plover and red knot habitat on the subject islands as natural processes re-work the sediment to create over-wash areas, sand flats, mud flats, and sand spits.

Analysis for the effects of the action

Red Knot and Piping Plover

Direct effects

Direct effects are those direct or immediate effects of a project on the species and/or its habitat. Implementation of the proposed action is not likely to directly kill piping plovers or red knots since the birds are highly mobile and can quickly move out of harm's way. The construction window will likely extend through several piping plover and red knot wintering seasons and multiple migration seasons. Heavy machinery and equipment (e.g., ORVs and bulldozers operating on project area beach and sand and mud flats, the placement of the dredge pipeline on/near the island, and sand and marsh material disposal) may directly affect migrating and wintering piping plovers and red knots in the project area by disturbance and disruption of normal activities such as roosting and foraging, and possibly forcing birds to expend valuable energy reserves to seek available habitat elsewhere.

Direct effects to critical habitat Unit MS-14 consist of sand and marsh material placement over 238 acres of existing sand, intertidal, and mud flat habitat which would result in temporary loss of wrack, temporary loss of over-wash areas, and burial and suffocation of intertidal benthic prey species. The natural wrack would be restored following normal tidal events. Over-wash areas would eventually be re-created during storm events. Burial and suffocation of invertebrate intertidal prey species will occur during initial sand and marsh material placement throughout the project area. Impacts will affect the project action area on and around East and West Ship and Cat Islands. Timeframes projected for benthic recruitment and re-establishment following sand and marsh material placement are from 6 months up to 2 years.

Indirect effects

Indirect effects are those that are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. The short-term increase in human disturbance to normal piping plover and red knot foraging and roosting behavior, as well as to suitable foraging and roosting habitat, during construction and immediately post-construction is likely to result in indirect effects via increased energy expenditure and a potential lack of adequate food supplies which can then lead to temporarily reduced fitness, fecundity, and over-wintering survival.

However, such effects would be temporary for those birds wintering in or migrating through the action area over the course of several wintering and migration seasons.

Reducing the potential for the formation of optimal habitats (such as over-wash or ephemeral pool formations) is a possible indirect effect to designated critical habitat. The piping plover's rapid response (within six months) to habitats formed by over-wash areas demonstrates the importance of over-wash created sand and mud flats for wintering and migrating piping plovers. Implementation of the proposed project will temporarily cover existing over-wash habitat within the entire action area. Given time, the intertidal zone along the newly created island footprint will re-establish and with daily tidal processes and occasional storm events natural over-wash and ephemeral pool habitat would again be created throughout the action area.

The proposed project would not contribute to increased human disturbance on Mississippi's barrier islands because the all of Ship Island and a portion of Cat Island would continue to be managed under current NPS conservation goals and objectives. The remainder of Cat Island is proposed to be managed by the Mississippi Department of Marine Resources' Coastal Preserves Program conservation goals and objectives. The MS barrier island's remote location and limited access from the mainland restricts regular use of the island to those who can safely cross open waters in an appropriate motorized vessel.

Beneficial effects

Beneficial effects are wholly positive without any adverse effects. We expect the prolonged existence and restoration/creation of foraging and roosting habitat for piping plovers and red knots on East and West Ship and Cat Islands and within Unit MS-14 of piping plover critical habitat as an overall result of the proposed MsCIP BRP project.

Historical analysis of barrier island change by Morton (2008) and recent analysis by Byrnes *et al*. (2012) indicate that East Ship Island would continue to narrow and lose land area in a without project scenario. Sand transport from East Ship Island would be depleted in a matter of decades, as storm and other normal transport processes reduce the island to a shoal. Dog Keys Pass would become wider as East Ship Island evolves to a shoal, and natural sediment bypassing to West Ship Island would be greatly diminished. Cat Island would continue to lose land area from persistent erosion due to increased exposure to southeast waves from the Gulf.

Under the No-Action Alternative described in the (MsCIP EIS Feb 2004), East and West Ship Islands would continue to narrow and lose land area as a result of updrift erosion (Morton, 2008). Given historical rates of shoreline recession (15 to 20 ft/yr) and associated beach erosion (300,000 to 400,000 cy/yr) along East Ship Island, the island could become a subaqueous shoal within the next decade (Morton *et al*., 2004). Cat Island would continue to experience beach erosion and the gradual conversion of upland areas to shallow sub-aqueous areas. DA-10, including Sand Island, would continue to be used for disposal of dredged material. However, the material would not be placed primarily in the portion of that site within the littoral transport zone. Therefore, the majority of the placed sand would not be transported to downdrift barrier islands. Without restoration of the barrier islands, wave conditions on the mainland coast would increase from 0.2 to 0.4 meter during storm events. According to the MsCIP EIS Feb 2004, the

No-Action Alternative would result in long-term significant impacts to hydrology and coastal processes.

A with project scenario would result in a net gain of 762 acres of sand beach and intertidal habitat. Much of the existing system is sediment-starved, and the proposed action would introduce sediment into that system that would be reworked and redistributed through the natural processes of wind and wave action and storm events. The additional sediment would allow for natural reformation of optimal piping plover and red knot habitat in the form of over-wash areas, sand flats, mud flats, and sand spits through those natural processes, thus maintaining the features of piping plover critical habitat and suitable red knot habitat. The restoration and maintenance of such intertidal habitats are important for the restoration of piping plover and red knot populations to healthy levels.

Sea Turtles

Beneficial Effects

The placement of sand on a beach with reduced dry foredune habitat may increase sea turtle nesting habitat if the placed sand is highly compatible (i.e., grain size, shape, color, etc.) with naturally occurring beach sediments in the area, and compaction and escarpment remediation measures are incorporated into the project. In addition, a nourished beach that is designed and constructed to mimic a natural beach system may benefit sea turtles more than an eroding beach it replaces.

Adverse Effects

Through many years of research, it has been documented that beach nourishment can have adverse effects on nesting and hatchling sea turtles and sea turtle nests. Results of monitoring sea turtle nesting and beach nourishment activities provide additional information on how sea turtles respond to nourished beaches, minimization measures, and other factors that influence nesting, hatching, and emerging success. Science-based information on sea turtle nesting biology and review of empirical data on beach nourishment monitoring is used to manage beach nourishment activities to eliminate or reduce impacts to nesting and hatchling sea turtles and sea turtle nests so that beach nourishment can be accomplished. Measures can be incorporated pre-, during, and post-construction to reduce impacts to sea turtles.

Direct Effects

Placement of sand on a beach in and of itself may not provide suitable nesting habitat for sea turtles. Although sand placement activities may increase the potential nesting area, significant negative impacts to sea turtles may result if protective measures are not incorporated during project construction. Sand placement activities during the nesting season, particularly on or near high density nesting beaches, can cause increased loss of eggs and hatchlings and, along with other mortality sources, may significantly impact the long-term survival of the species. For instance, projects conducted during the nesting and hatching season could result in the loss of sea turtles through disruption of adult nesting activity and by burial or crushing of nests or hatchlings. While a nest monitoring and egg relocation program would reduce these impacts, nests may be inadvertently missed (when crawls are obscured by rainfall, wind, or tides) or misidentified as false crawls during daily patrols. In addition, nests may be destroyed by operations at night prior to beach patrols being performed. Even under the best of conditions, about 7 percent of the nests can be misidentified as false crawls by experienced sea turtle nest surveyors (Schroeder 1994).

1. Nest relocation

Besides the potential for missing nests during surveys and a nest relocation program, there is a potential for eggs to be damaged by nest movement or relocation, particularly if eggs are **not relocated within 12 hours of deposition** (Limpus *et al*. 1979). Nest relocation can have adverse impacts on incubation temperature (and hence sex ratios), gas exchange parameters, hydric environment of nests, hatching success, and hatchling emergence (Limpus *et al*. 1979, Ackerman 1980, Parmenter 1980, Spotila *et al*. 1983, McGehee 1990). Relocating nests into sands deficient in oxygen or moisture can result in mortality, morbidity, and reduced behavioral competence of hatchlings. Water availability is known to influence the incubation environment of the embryos and hatchlings of turtles with flexible-shelled eggs, which has been shown to affect nitrogen excretion (Packard *et al*. 1984), mobilization of calcium (Packard and Packard 1986), mobilization of yolk nutrients (Packard *et al*. 1985), hatchling size (Packard *et al*. 1981, McGehee 1990), energy reserves in the yolk at hatching (Packard *et al*. 1988), and locomotory ability of hatchlings (Miller *et al*. 1987).

In a 1994 Florida study comparing loggerhead hatching and emerging success of relocated nests with nests left in their original location, Moody (1998) found that hatching success was lower in relocated nests at nine of 12 beaches evaluated. In addition, emerging success was lower in relocated nests at 10 of 12 beaches surveyed in 1993 and 1994. Many of the direct effects of beach nourishment may persist over time. These direct effects include increased susceptibility of relocated nests to catastrophic events, the consequences of potential increased beachfront development, changes in the physical characteristics of the beach, the formation of escarpments, repair/replacement of groins and jetties, and future sand migration.

2. Equipment

The use of heavy machinery on beaches during a construction project may also have adverse effects on sea turtles. Equipment left on the nesting beach overnight can create barriers to nesting females emerging from the surf and crawling up the beach, causing a higher incidence of false crawls and unnecessary energy expenditure.

The operation of motor vehicles or equipment on the beach to complete the project work at night affects sea turtle nesting by: interrupting or colliding with a nesting turtle on the beach, headlights disorienting or misorienting emergent hatchlings, vehicles running over hatchlings attempting to reach the ocean, and vehicle ruts on the beach interfering with hatchlings crawling to the ocean. Apparently, hatchlings become diverted not because they cannot physically climb out of a rut (Hughes and Caine 1994), but because the sides of the track cast a shadow and the hatchlings lose their line of sight to the ocean horizon (Mann 1977). The extended period of travel required to negotiate tire ruts may increase the susceptibility of hatchlings to dehydration and depredation during migration to the ocean (Hosier *et al*. 1981). Driving directly above or over incubating egg clutches or on the beach can cause sand compaction, which may result in adverse impacts on nest site selection, digging behavior, clutch viability, and emergence by hatchlings, as well as directly kill pre-emergent hatchlings (Mann 1977, Nelson and Dickerson 1987, Nelson 1988).

Depending on duration of the project, vegetation may have become established in the vicinity of dune restoration sites. The physical changes and loss of plant cover caused by vehicles on vegetated areas or dunes can lead to various degrees of instability and cause dune migration. As vehicles move over the sand, sand is displaced downward, lowering the substrate. Since the vehicles also inhibit plant growth, and open the area to wind erosion, the beach and dunes may become unstable. Vehicular traffic on the beach or through dune breaches or low dunes may cause acceleration of overwash and erosion (Godfrey *et al*. 1978). Driving along the beachfront should be between the low and high tide water lines. To minimize the impacts to the beach and recovering dunes, transport and access to the dune restoration sites should be from the road. However, if the work needs to be conducted from the beach, the areas for the truck transport and bulldozer/bobcat equipment to work in should be designated and marked.

3. Artificial lighting

Visual cues are the primary sea-finding mechanism for hatchling sea turtles (Mrosovsky and Carr 1967, Mrosovsky and Shettleworth 1968, Dickerson and Nelson 1989, Witherington and Bjorndal 1991). When artificial lighting is present on or near the beach, it can misdirect hatchlings once they emerge from their nests and prevent them from reaching the ocean (Philibosian 1976, Mann 1977, FWC 2007). In addition, a significant reduction in sea turtle nesting activity has been documented on beaches illuminated with artificial lights (Witherington 1992). Therefore, construction lights along a project beach and on the dredging vessel may deter females from coming ashore to nest, misdirect females trying to return to the surf after a nesting event, and misdirect emergent hatchlings from adjacent non-project beaches.

Guidance on construction lighting from the dredge is further outlined in the “Terms and Conditions” section of this document. Artificial lighting resulting from surrounding development is not expected to be an issue because the subject islands are not available for public development and are several miles away from the developed mainland of Mississippi.

Indirect Effects

Many of the direct effects of beach nourishment may persist over time and become indirect impacts. These indirect effects include increased susceptibility of relocated nests to catastrophic events, the consequences of potential increased beachfront development, changes in the physical characteristics of the beach, the formation of escarpments, and future sand migration.

1. Increased susceptibility to catastrophic events

Nest relocation within a nesting season may concentrate eggs in an area making them more susceptible to catastrophic events. Hatchlings released from concentrated areas also may be subject to greater predation rates from both land and marine predators, because the predators learn where to concentrate their efforts (Glenn 1998, Wyneken *et al*. 1998).

2. Increased beachfront development

No increased development on the subject islands is anticipated due to their being owned and managed by state and federal agencies with conservation goals outlined for the islands associated with the proposed project.

3. Changes in the physical environment

Beach nourishment may result in changes in sand density (compaction), beach shear resistance (hardness), beach moisture content, beach slope, sand color, sand grain size, sand grain shape, and sand grain mineral content if the placed sand is dissimilar from the original beach sand (Nelson and Dickerson 1988a). These changes could result in adverse impacts on nest site selection, digging behavior, clutch viability, and hatchling emergence (Nelson and Dickerson 1987, Nelson 1988).

Beach nourishment projects create an elevated, wider, and unnatural flat slope berm. Sea turtles nest closer to the water the first few years after nourishment because of the altered profile (and perhaps unnatural sediment grain size distribution) (Ernest and Martin 1999, Trindell 2005) (Figure 12).

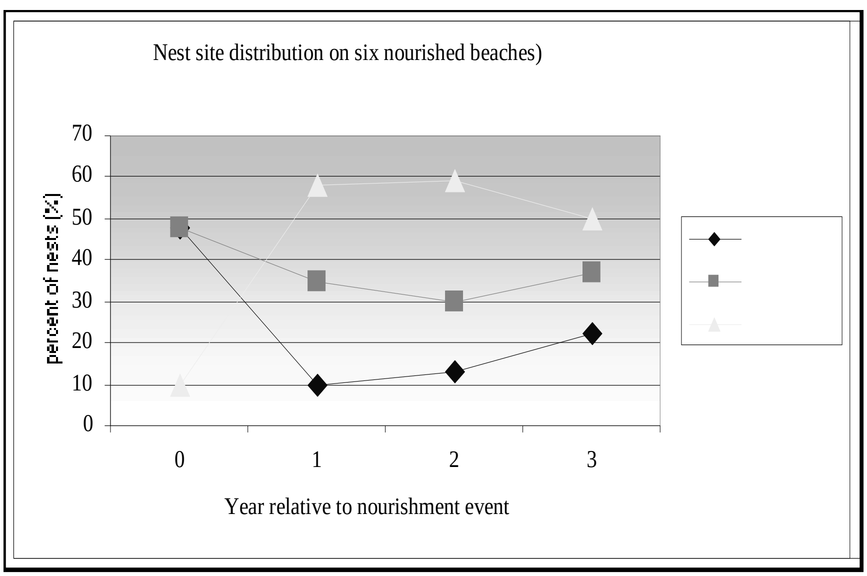


Figure 12 - Review of sea turtle nest site selection following nourishment (Trindell 2005).

Beach compaction and unnatural beach profiles resulting from beach nourishment activities could negatively impact sea turtles regardless of the timing of projects. Very fine sand or the use of heavy machinery can cause sand compaction on nourished beaches (Nelson *et al*. 1987, Nelson and Dickerson 1988a). Significant reductions in nesting success (i.e., false crawls occurred more frequently) have been documented on severely compacted nourished beaches (Fletemeyer 1980, Raymond 1984, Nelson and Dickerson 1987, Nelson *et al*. 1987), and increased false crawls may result in increased physiological stress to nesting females. Sand compaction may increase the length of time required for female sea turtles to excavate nests and cause increased physiological stress to the animals (Nelson and Dickerson 1988b). Nelson and Dickerson (1988c) concluded that, in general, beaches nourished from offshore borrow sites are harder than natural beaches, and while some may soften over time through erosion and accretion of sand, others may remain hard for 10 years or more.

These impacts can be minimized by using suitable sand and by tilling (minimum depth of 24 inches) compacted sand after project completion. The level of compaction of a beach can be assessed by measuring sand compaction using a cone penetrometer (Nelson 1987). Tilling of a nourished beach with a root rake may reduce the sand compaction to levels comparable to unnourished beaches. However, a pilot study by Nelson and Dickerson (1988c) showed that a tilled nourished beach will remain uncompacted for only up to 1 year. Thus, multi-year beach compaction monitoring and, if necessary, tilling would help to ensure that project impacts on sea turtles are minimized.

A change in sediment color on a beach could change the natural incubation temperatures of nests in an area, which, in turn, could alter natural sex ratios. To provide the most suitable sediment for nesting sea turtles, the color of the nourished sediments should resemble the natural beach sand in the area. Natural reworking of sediments and bleaching from exposure to the sun would help to lighten dark nourishment sediments; however, the timeframe for sediment mixing and bleaching to occur could be critical to a successful sea turtle nesting season.

4. Escarpment formation

On nourished beaches, steep escarpments may develop along their water line interface as they adjust from an unnatural construction profile to a more natural beach profile (Coastal Engineering Research Center 1984, Nelson *et al*. 1987). Escarpments can hamper or prevent access to nesting sites (Nelson and Blihovde 1998). Researchers have shown that female sea turtles coming ashore to nest can be discouraged by the formation of an escarpment, leading to situations where they choose marginal or unsuitable nesting areas to deposit eggs (e.g., in front of the escarpments, which often results in failure of nests due to prolonged tidal inundation). This impact can be minimized by leveling any escarpments prior to the nesting season.

Species response to the proposed action

Red Knot and Piping Plover

This biological opinion addresses the direct and indirect effects that are anticipated to wintering and migrating piping plovers and their critical habitat and red knots, respectively, as a result of restoring beach and tidal flat habitat, on the Mississippi barrier islands, as well as the temporary disruption of existing plover and red knot foraging and roosting habitat for the long-term benefit of maintaining existing barrier island habitat. Survey data indicate that various numbers of piping plover and red knot could be using the action area in any given year. Therefore, it is difficult for the Service to estimate the number of birds migrating through or wintering within the proposed action area because piping plover and red knot numbers fluctuate daily, seasonally, and from year to year. Therefore, the Service anticipates that all migrating and wintering piping plovers and red knot utilizing East and West Ship Islands and Cat Island and up to 238 acres of existing critical habitat will be impacted by: (1) disturbance due to human activity and equipment noise during construction within the action area; and (2) temporary habitat loss within the project footprint for the duration of construction activities (two or more years) and up to two years post-construction for the recovery of intertidal benthic prey species.

It is unknown how far piping plovers and red knots would move into nearby habitats due to disturbance or a lack of food source. The nearest available sand and mud flat habitat exists on the adjacent portions of the islands that will be undisturbed by project activity. Additional flats are also available on other barrier island beaches and mainland beaches within Harrison and Jackson County, Mississippi, and Mobile County, Alabama. Suitable habitat also exists on the Chandeleur Island chain (located west of Cat Island). In addition, coastal restoration projects have been completed or under construction on Deer Island and Round Island in Harrison and Jackson County, Mississippi.

The proposed action is anticipated to take two to three years or more of disturbance activities for the construction period, plus an additional two years of recovery for the intertidal benthic community following material placement. The project would not, however, result in permanent changes to the natural processes that maintain the PCEs of piping plover critical habitat. Daily tidal processes and occasional storm events would re-work the additional sediment to recreate over-wash areas, sand and mud flats, and sand spits. Without the additional sediment from the project, critical habitat associated with some, if not all, of the Mississippi barrier islands would eventually erode below sea level.

Although restoration of the Mississippi barrier islands would follow within a few years of the Deepwater Horizon oil spill and would result in temporary disturbance within the action area, in time the proposed action would ultimately benefit the piping plover and its critical habitat and red knots by restoring diverse barrier island habitats used by those species. The proposed action would also allow for the continued existence and creation of habitat within critical habitat Unit MS-14 throughout the project life.

Sea Turtles

The following summary illustrates sea turtle responses to and recovery from a nourishment project comprehensively studied by Ernest and Martin (1999). A significantly larger proportion of turtles emerging on nourished beaches abandoned their nesting attempts than turtles emerging on natural or pre-nourished beaches. This reduction in nesting success is most pronounced during the first year following project construction and is most likely the result of changes in physical beach characteristics associated with the nourishment project (e.g., beach profile, sediment grain size, beach compaction, frequency and extent of escarpments). During the first post-construction year, the time required for turtles to excavate an egg chamber on untilled, hard-packed sands increases significantly relative to natural conditions. However, tilling (minimum depth of 24 inches) is effective in reducing sediment compaction to levels that did not significantly prolong digging times. As natural processes reduced compaction levels on nourished beaches during the second post-construction year, digging times returned to natural levels (Ernest and Martin 1999).

During the first post-construction year, nests on nourished beaches are deposited significantly seaward of the toe of the dune and significantly landward of the tide line than nests on natural beaches. More nests are washed out on the wide, flat beaches of the nourished treatments than on the narrower steeply sloped natural beaches. This phenomenon may persist through the second post-construction year monitoring and result from the placement of nests near the seaward edge of the beach berm where dramatic profile changes, caused by erosion and scarping, occur as the beach equilibrates to a more natural contour.

The principal effect of beach nourishment on sea turtle reproduction is a reduction in nesting success during the first year following project construction. Although most studies have attributed this phenomenon to an increase in beach compaction and escarpment formation, Ernest and Martin (1999) indicated that changes in beach profile may be more important. Regardless, as a nourished beach is reworked by natural processes in subsequent years and adjusts from an unnatural construction profile to a natural beach profile, beach compaction and the frequency of escarpment formation decline, and nesting and nesting success return to levels found on natural beaches.

CUMULATIVE EFFECTS

The proposed project would occur on federally and State-owned lands and State-owned water bottoms. Cumulative effects include the effects of future State, tribal, 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.

The proposed project would not contribute to increased human disturbance on Mississippi's barrier islands because all of Ship Island and a portion of Cat Island would continue to be managed under current NPS conservation goals and objectives. The remainder of Cat Island is proposed to be managed by the Mississippi Department of Marine Resources' Coastal Preserves Program conservation goals and objectives. In addition, the remoteness of the island limits human disturbance to those who can safely access it with a motorized vessel. Overall recreational use of the Mississippi barrier islands is in the form of nearby fishing and bird watching and photography. Any future proposed actions that are within endangered or threatened species habitat will require section 7 or 10 permitting from the Service to be covered under the Act.

Impacts to the action area from the Deepwater Horizon oil spill includes occasional cleanup actions and possibly ongoing NRDAR surveys and studies, as well as limited human disturbance from those cleanup and monitoring activities. Although the final breadth of the oil spill impacts to the Mississippi Gulf shoreline and shoreline-dependent species remains unknown, section 7 consultation is currently in progress with the lead Federal agency for the Deepwater Horizon incident, the U.S. Coast Guard.

CONCLUSION

Red Knot and Piping Plover

The survival and recovery of all breeding populations of piping plovers and red knots are fundamentally dependent on the continued availability of sufficient habitat in their coastal migration and wintering ranges, where those species spend more than two-thirds of their annual cycle. All piping plover and red knot populations are inherently vulnerable to even small declines in their most sensitive vital rates (i.e., survival of adults and fledged juveniles). Mark-recapture analysis of resightings of uniquely banded piping plovers from seven breeding areas by Roche *et al*. (2010) found that apparent adult survival declined in four populations and increased in none over the life of the studies. Some evidence of correlation in year-to-year fluctuations in annual survival of Great Lakes and eastern Canada populations, both of which winter primarily along the southeastern U.S. Atlantic Coast, suggests that shared over-wintering and/or migration habitats may influence annual variation in survival. Further concurrent mark-resighting analysis of color-banded individuals across piping plover breeding populations has the potential to shed light on threats that affect survival in the migration and wintering range. Progress towards piping plover recovery (which is attained primarily through intensive protections to increase productivity on the breeding grounds) would be quickly slowed or reversed by even small sustained decreases in survival rates during migration and wintering. Similar data are not yet available for the red knot.

Implementation of the proposed action is not likely to directly kill any piping plovers or red knots since they are highly mobile and can move out of harm's way. The increased disturbance to normal piping plover and red knot foraging/roosting behaviors and suitable habitat would likely result in increased energy expenditure and a potential lack of food supply, which may indirectly affect fitness, fecundity, and over-wintering survival. Such effects to migrating and wintering piping plovers and red knots would be sporadic and temporary over the course of the construction window and the two-year recovery of benthic prey populations. After reviewing the current status of the piping plover wintering population of the northern Great Plains, the Great Lakes, and the Atlantic Coast; the current status of the red knot population; the environmental baseline for the action area; the effects of the proposed MsCIP BRP project; and cumulative effects, it is the Service's biological opinion that implementation of the MsCIP BRP project, as proposed, is not likely to jeopardize the continued existence of the piping plover or the red knot. As noted previously, the overall status of the piping plover species is stable, if not increasing. More data is needed to determine if the red knot species is increasing, declining, or stable at this time. However, it is the Service's determination that the project-related effects to the red knot would be temporary and are not anticipated to affect the status of the overall wintering/migrating population of that species.

Critical Habitat

Critical habitat for the piping plover has been designated within the project area and the action area. The project has been designed to mimic natural barrier island habitat and, in the long-term, would aid natural processes in creating and maintaining the PCEs of critical habitat on

Mississippi barrier islands, Unit MS-14, by providing sediment within the sediment-starved barrier island system. Critical habitat for MS-14 extends to the mean lower low water (MLLW). Within the Ship Island and Cat Island sand placement areas, there is designated critical habitat for piping plovers. Of the 1,500 acres of the proposed sand placement area at Camille Cut and East and West Ship Islands, approximately 820 acres of the designated piping plover critical habitat is located within the proposed project footprint; however, approximately 139 acres of this currently lies above MLLW within the construction limits. In addition, the 305 acres of sand placement proposed at Cat Island is located within designated piping plover critical habitat; however, approximately 99 acres within the constructed project limits currently lie above MLLW (see Table 2). So, a total of 238 acres of existing critical habitat above MLLW will be directly impacted by the placement of sand by the project.

The project area would be temporarily disturbed during construction activities which would impede piping plovers attempting to roost and forage in the area during the migration and wintering months that coincide with construction. Temporary disturbance to 238 acres of Unit MS-14 equates to 3.04 percent of designated critical habitat in Mississippi and 0.14 percent of all designated critical habitat throughout the Southeast (i.e., North Carolina to Texas) at the time critical habitat was listed on July 10, 2001. However, there would also be a net gain of approximately 762 acres (999 new acres minus 238 filled acres) of critical habitat post construction on Ship and Cat Islands. Because the effects to critical habitat would be temporary in nature and the overall project would be beneficial in the long-term, it is the Service's biological opinion that implementation of the MsCIP BRP project is not likely to destroy or adversely modify designated critical habitat in Unit MS-14. Please note that we have not relied on the regulatory definition of "destruction or adverse modification" of habitat at 50 Code of Federal Regulations (CFR) 402.02; instead, we have relied on the statutory provisions of the Endangered Species Act.

Sea Turtles

Loggerhead sea turtle critical habitat does exist within the action area on Horn and Petit Bois Islands. Specifically, LOGG-T-MS-01—Horn Island: This unit consists of 18.6 km (11.5 mi) of island shoreline along the Gulf of Mexico and extends from Dog Keys Pass to the easternmost point of the ocean facing island shore and LOGG-T-MS-02—Petit Bois Island: This unit consists of 9.8 km (6.1 mi) of island shoreline along the Gulf of Mexico and extends from HIP to PBP. However, sand placement activities are proposed on East and West Ship Islands and Cat Island, which are not designated critical habitat for the loggerhead sea turtle.

The Service concurs with the COE that the project as proposed will not have any direct impacts of any significance to Horn or Petit Bois Islands (designated loggerhead critical habitat). This determination is based on Horn and Petit Bois Islands being far removed from the proposed sand placement activities aside from the littoral placement activities located on to the east of Horn Island. Littoral zone placement could have a beneficial effect in replenishing lost nesting habitat should the sand migrate east to Horn Island as projected based on the currents, etc. Further, it is not anticipated that the proposed project would cause erosion to or have indirect adverse impacts to Horn or Petit Bois Islands.

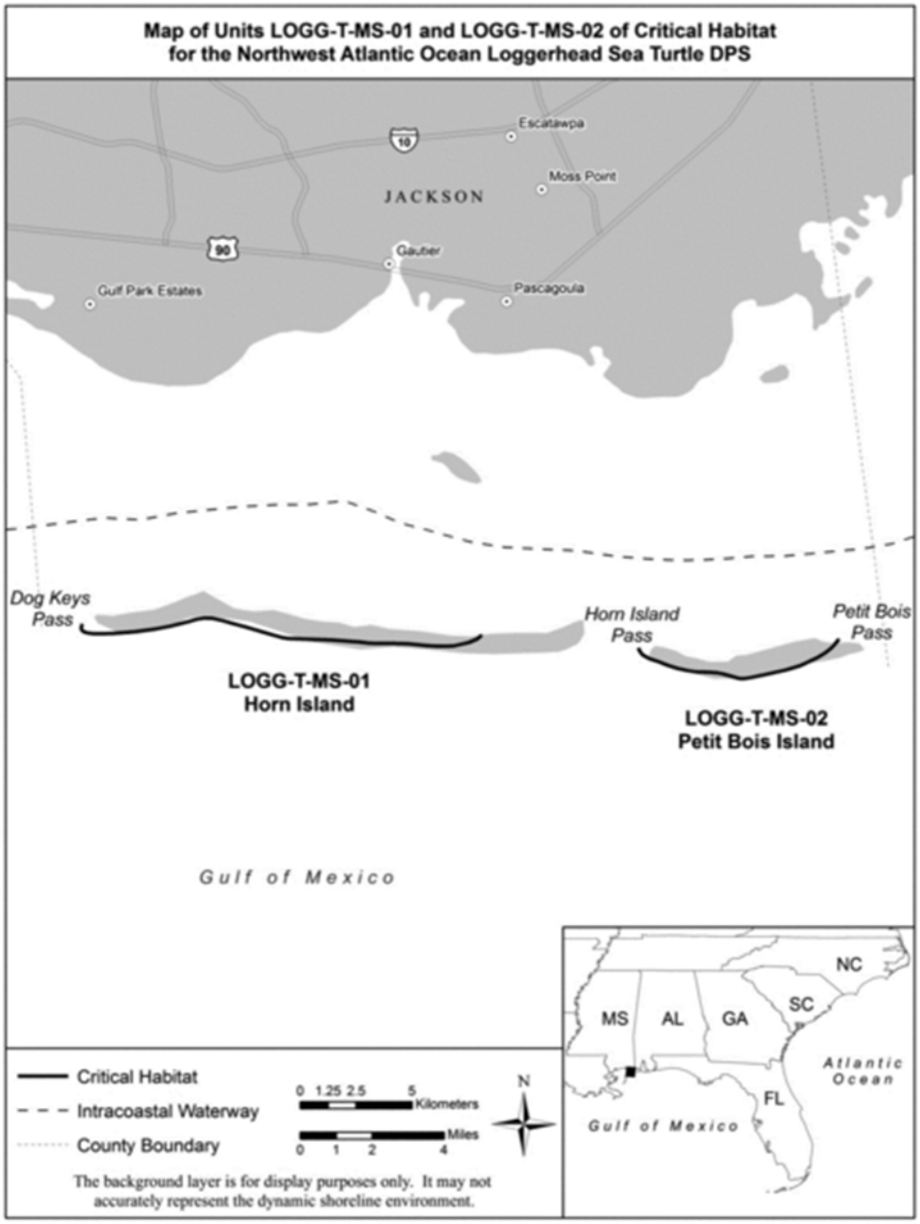


Figure 13 - Loggerhead Sea Turtle Critical Habitat map for Mississippi

After reviewing the current status of the Northwest Atlantic loggerhead population, green turtle, and Kemp's ridley sea turtles**,** the environmental baseline for the action area, the effects of the proposed beach nourishment, and the cumulative effects, it is the Service's biological opinion that the beach nourishment project, as proposed, is not likely to jeopardize the continued existence of the Northwest Atlantic loggerhead population, green turtle, and Kemp's ridley sea turtles**,** and is not likely to destroy or adversely modify designated critical habitat.

The conservation of the five loggerhead recovery units in the Northwest Atlantic is essential to the recovery of the loggerhead sea turtle. Each individual recovery unit is necessary to conserve genetic and demographic robustness, or other features necessary for long-term sustainability of the entire population. Thus, maintenance of viable nesting in each recovery unit contributes to the overall population. The Northern Gulf of Mexico Recovery Unit (NGMRU) of the five loggerhead recovery units in the Northwest Atlantic occurs within the action area.

The NGMRU averages about 906 nests per year (based on 1995-2007 nesting data). Northwest Florida accounts for approximately 92 percent of nesting within this recovery unit and consists of approximately 234 miles of nesting shoreline. Of the available nesting habitat within the NGMRU, sand placement activities will occur on approximately 4.87 miles of existing shoreline. Further, the project will result in a net gain of approximately 8.84 miles of additional barrier island shoreline habitat as a result of filling in Camille Cut and rebuilding the southern tip of Cat Island.

Generally, green and ridley nesting overlaps with or occurs within the beaches where loggerhead sea turtles nest on both the Gulf of Mexico beaches. The proposed project will affect only approximately 4.87 miles of the approximately 1,400 miles of available sea turtle nesting habitat in the southeastern U.S.

Research has shown that the principal effect of sand placement on sea turtle reproduction is a reduction in nesting success, and this reduction is most often limited to the first year or two following project construction. Research has also shown that the impacts of a nourishment project on sea turtle nesting habitat are typically short-term because a nourished beach will be reworked by natural processes in subsequent years, and beach compaction and the frequency of escarpment formation will decline. Although a variety of factors, including some that cannot be controlled, can influence how a nourishment project will perform from an engineering perspective, measures can be implemented to minimize impacts to sea turtles.

INCIDENTAL TAKE STATEMENT

Because the proposed action is likely to result in the taking of two listed shorebird species and possibly result in the taking of three sea turtle listed species incidental to that action, the Service has included an incidental take statement pursuant to section 7(b)(4) of the Act. Section 9 of the 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.

The measures described below are non-discretionary, and must be undertaken by the COE so that they become binding conditions of any contract, grant, or permit issued to the COE's contractor(s), as appropriate, for the exemption in section 7(o)(2) to apply. The COE has a continuing duty to regulate the activity covered by this incidental take statement. If the COE (1) fails to assume and implement the terms and conditions or (2) fails to require its contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, grant, or permit document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the COE and/or its contractor(s) must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(I) (3)].

AMOUNT OR EXTENT OF TAKE ANTICIPATED

Red Knot and Piping Plover

The Service expects incidental take of piping plover and red knot for the following reasons:

1. Migration and wintering bird survey data indicate that various numbers of piping plovers and red knots could be within the action area at any point in time. The number of birds within the action area for the duration of project construction and intertidal benthic recovery is difficult to detect because the remote project location makes consistent surveying problematic, wintering piping plover and red knot numbers within the action area vary from year to year, and migrating piping plover and red knot numbers vary between both fall and spring migrations from year to year.

2. Harassment to the level of harm may only be apparent on the breeding grounds the following year as a result of reduced fitness or fecundity, or as lack of over-wintering survival. It would be difficult to detect because of our inability to track individual birds from their wintering grounds to their breeding grounds.

3. Over-wintering survival would be difficult to detect because it is difficult to detect birds that do not survive migration back to the breeding grounds. This is also difficult to detect because we would need to track individually marked birds between wintering and breeding grounds.

However, the following level of take of this species can be expected by disturbance to the affected acreage of bare sand, mud flat, and intertidal habitats because disturbance to suitable habitat within the action area would affect the ability of piping plovers and red knots to find foraging and roosting habitat throughout the migrating and wintering periods for the duration of project construction and intertidal benthic recovery. The Service anticipates that directly and indirectly all piping plovers and red knots using the affected 238 acres (all of which is also designated piping plover critical habitat) of suitable habitat on East and West Ship and Cat Islands could be taken in the form of harm and harassment as a result of the proposed action.

The level (i.e., all piping plovers and red knots using the 238 acres of bare sand, mud flat, and intertidal habitats) of take of these species can be anticipated by the proposed activities because:

1. Piping plovers and red knots are known to winter in and migrate through the action area.

2. The placement of sand is expected to temporarily affect (e.g., in the form of increased human disturbance during construction, temporary loss of benthic prey, and temporary loss of wrack) 238 acres of bare sand, mud flat, and intertidal habitats over multiple migrating and wintering seasons until construction is complete and until the benthic fauna recover.

3. Temporarily increased levels of human disturbance are expected for the duration of construction activities which would make the 238 acres of bare sand, mud flat, and intertidal habitats less desirable habitat for piping plovers and red knots, which may cause increased energy expenditure as birds move away from construction activities.

4. A temporary reduction of food base (up to two years following construction) will occur due to sand placement which would affect the piping plover's and red knot's ability to forage and store enough fat reserves for migration back to the breeding grounds for multiple wintering seasons. Such an effect could result in reduced fitness or fecundity.

The Service has reviewed the biological information and other information relevant to this action. The take is expected in the form of harm and harassment because of: (1) temporarily decreased fitness and survivorship of wintering piping plovers and red knots; (2) temporarily decreased fitness and survivorship of piping plovers and red knots attempting to migrate to breeding grounds, due to temporary loss of and disturbance to foraging and roosting habitat; and (3) an indirect temporary reduction of fecundity on the breeding grounds due to the temporary decrease in fitness and survivorship of wintering and migrating piping plovers and red knots. This Incidental Take Statement covers take of the species within the action area. If the COE expands the action outside of the existing 238 acres of existing piping plover critical habitat and red knot suitable habitat above MLLW, as outlined in this document, then consultation must be reinitiated.

Sea Turtles

The Service anticipates approximately 4.87 miles of nesting beach habitat could be taken as a result of this proposed action. The take is expected to be in the form of: (1) destruction of all nests that may be constructed and eggs that may be deposited and missed by a nest survey and egg relocation program within the boundaries of the proposed project; (2) destruction of all nests deposited during the period when a nest survey and egg relocation program is not required to be in place within the boundaries of the proposed project; (3) reduced hatching success due to egg mortality during relocation and adverse conditions at the relocation site; (4) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities; (5) misdirection of nesting and hatchling turtles on beaches adjacent to the sand placement or construction area as a result of project lighting including the ambient lighting from dredges; (6) behavior modification of nesting females due to escarpment formation within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; and (7) destruction of nests from escarpment leveling within a nesting season when such leveling has been approved by the Service.

Incidental take is anticipated for only approximately 4.87 miles of beach that have been identified for sand placement. The Service anticipates incidental take of sea turtles will be difficult to detect for the following reasons: (1) the turtles nest primarily at night and all nests are not found because [a] natural factors, such as rainfall, wind, and tides may obscure crawls and [b] human-caused factors, such as pedestrian and vehicular traffic, may obscure crawls, and result in nests being destroyed because they were missed during a nesting survey and egg relocation program; (2) the total number of hatchlings per undiscovered nest is unknown; (3) the reduction in percent hatching and emerging success per relocated nest over the natural nest site is unknown; (4) an unknown number of females may avoid the project beach and be forced to nest in a less than optimal area; (5) lights may misdirect an unknown number of hatchlings and cause death; and (6) escarpments may form and prevent an unknown number of females from accessing a suitable nesting site. However, the level of take of these species can be anticipated by the disturbance and nourishment of suitable turtle nesting beach habitat because: (1) turtles nest within the project site; (2) beach nourishment will likely occur during a portion of the nesting season; (3) the nourishment project will modify the incubation substrate, beach slope, and sand compaction; and (4) artificial lighting will deter and/or misdirect nesting and hatchling turtles.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the piping plover, red knot, loggerhead sea turtle, green sea turtle, or Kemp's ridley sea turtle species or destruction or adverse modification of any critical habitat. Incidental take of up to 238 acres of existing piping plover and red knot suitable habitat including; bare sand, mud flat, and intertidal habitats is anticipated to occur during project construction. It is the Service's opinion that it could take up to two or more years following construction for the intertidal benthic community to recover.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to monitor and minimize take on non-breeding piping plovers and red knots in addition to nesting loggerhead, green, and Kemp's ridley sea turtles during implementation of the proposed MsCIP BRP project within the action area

I. The COE should carefully mark and stake the boundaries of the active work areas on/near East and West Ship and Cat Islands and ensure that those markers are maintained for the duration of project construction activities. Should the project actions (e.g., personnel, equipment, etc.) affect suitable habitat outside of those boundary markers and beyond the action area as described in the biological opinion, then the level of incidental take (i.e., all piping plovers using the existing 238 acres of bare sand, mud flat, and intertidal habitats) for this project would be exceeded and the COE should reinitiate section 7 consultation with the Service as soon as possible.

II. Monitoring protocols for manatees should be implemented as outlined in Appendix A.

III. Monitoring for sea turtles should be conducted within sea turtle nesting and hatching season as outlined in Appendix B and as outlined in the Terms and Conditions.

IV. Surveys for piping plovers and red knots should be conducted within the migrating and wintering seasons as outlined in Appendix C and as outlined in the Terms and Conditions.

V. Diversity and abundance surveys of the intertidal benthic prey species community should be conducted as outlined in appendix C and as outlined in the Terms and Conditions.

VI. A comprehensive report describing the actions taken to implement the RPMs and terms and conditions associated with this incidental take statement shall be submitted to the Service's Mississippi Field Office by June 30 of the year following completion of all required bird surveys, and December 31 of the year following completion of all required sea turtle surveys.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the COE shall execute the following terms and conditions, which implement the RPM's described above and outline required reporting/monitoring requirements. These terms and conditions are nondiscretionary.

I. *Marking Project Boundaries*

1. The COE should carefully survey and mark the boundaries of the entire project footprint on East and West Ship Islands and Cat Island.
2. Boundary markers should be semi-permanent such that they should be maintained throughout the active work areas and should persist until all construction-related activities are completed.
3. The Service's **Jackson MS Field Office** at **(601)965-4900** should be notified immediately if any work or project-related actions exceed the boundary markers on the islands throughout the various sand placement areas of the project**, so that reinitiation** of **section 7 consultation** can proceed as quickly and efficiently as possible to avoid delay in the project schedule.

II. *Monitoring protocols for Manatees Shall be Implemented as Outlined in Appendix A.*

III. *Monitoring for sea turtles should be conducted within sea turtle nesting and hatching season as outlined in Appendix B (Sea Turtle Monitoring Plan). Additional measures for sea turtles include:*

1. Beach quality sand suitable for sea turtle nesting, successful incubation, and hatchling emergence must be used on the project site.
2. The beach profile template for the sand placement project should be designed to mimic, native beach berm elevation and beach slopes landward and seaward of the equilibrated berm crest to the maximum extent possible.
3. If nests are constructed in the area of sand placement, the eggs must be relocated as outlined in Appendix B. Nest relocation will be on a pre-selected area of beach through coordination among FWS, NPS, and COE that is not expected to experience daily

inundation by high tides or known to routinely experience severe erosion and egg loss, predation, or subject to artificial lighting to the maximum extent possible.

4. During the nesting season, construction equipment and materials must be stored in a manner that will minimize impacts to sea turtles to the maximum extent practicable.
5. During the nesting season, lighting associated with the project must be minimized to the maximum extent possible but still comply with OSHA safety requirements to reduce the possibility of disrupting and misdirecting nesting and/or hatchling sea turtles.
6. Prior to the commencement of work, the COE shall submit a lighting plan for the dredge that will be used in the project. The plan shall include a description of each light source that will be visible from the beach and the measures implemented to minimize this lighting. Direct lighting of the beach and nearshore waters must be limited to the immediate construction area during peak nesting season (May 1 through September 30) and must comply with safety requirements. Lighting on all equipment must be minimized through reduction, shielding, lowering, and appropriate placement to avoid excessive illumination of the water's surface and nesting beach while meeting all Coast Guard, Corps EM 385-1-1, and OSHA requirements. Light intensity of lighting equipment must be reduced to the minimum standard required by OSHA for General Construction areas, in order to not misdirect sea turtles. Shields must be affixed to the light housing and be large enough to block light from all on-beach lamps from being transmitted outside the construction area or to the adjacent sea turtle nesting beach (Figure 14).

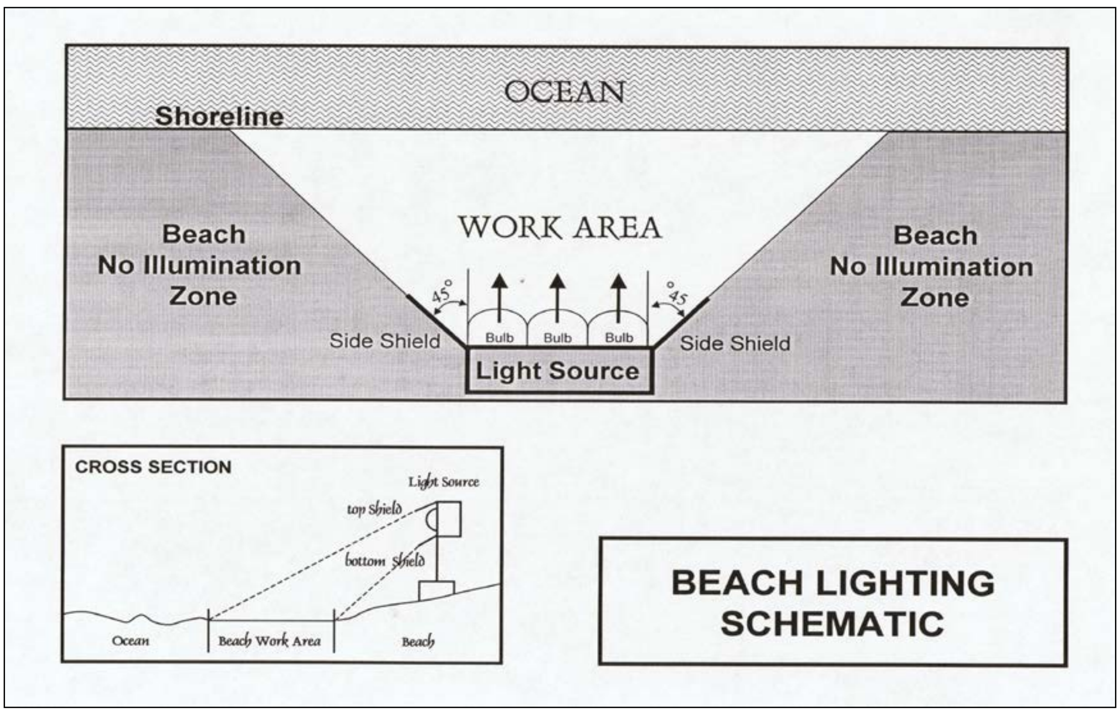


Figure 14 - Beach lighting schematic.

7. The placement and design of the dune must emulate the natural dune system to the maximum extent possible, including the dune configuration and shape.
8. No trash or food should be left on the island, utilize trash receptacles, leave no trace, and pack it in pack it out. All other construction debris should be confined to the staging area

and consist of construction debris during the construction period only, which will be removed when the construction period is over and demobilized.

9. For sea turtle nesting surveys during construction, a meeting between representatives of the contractor, the COE, the Service, the NPS, the Service permitted sea turtle surveyor, and other species surveyors, as appropriate, must be held prior to the commencement of work. At least 10 business days advance notice must be provided prior to conducting this meeting. The meeting will provide an opportunity for explanation and/or clarification of the sea turtle protection measures, as well as additional guidelines when construction occurs during the sea turtle nesting season, such as storing equipment, minimizing driving, and reporting within the work area, as well as follow-up meetings during construction. At that meeting the **COE** must provide the Service and the NPS with specific information on the actual project that is going to proceed (form on the following web link: http://www.fws.gov/northflorida/SeaTurtles/Docs/Corp%20of%20Engineers%20Sea%20Turtle%20Permit%20Information.pdf) and emailed to the Service at seaturtle@fws.gov.

10. Sand compaction [*sic* the shear strength of the beach sand] must be monitored in the area of sand placement during the post construction period, for up to 3 subsequent years. This should occur after the project is completed and outside of the turtle nesting season and prior to May 1 in subsequent years. The Service and NPS shall be notified when Post Construction monitoring starts.

    a. The dynamic cone penetrometer (DCP) test method will be used to collect the shear strength ("compaction") data for the preconstruction in situ beach conditions of the islands and the post-construction template fill. This data will be analyzed and compared using an appropriate statistical analysis to determine if tilling is necessary.

    b. Shear strength testing stations must be located on shore-normal transects. Transects shall extend from the seaward base of the dune to the high water line (normal wrack line) at intervals separated no more than 500-feet within the sand placement template. One station must be at the seaward edge of the dune line (when material is placed in this area), and one station must be midway between the dune line and the high water line (normal wrack line) = 1 transect. There will be two test stations located on each of the transect lines.

    c. For establishment of a pre-construction in situ shear strength baseline DCP measurements should be conducted on no less than thirty (30) transects per island (East Ship, West Ship and Cat Island). The testing station intervals should be no greater than five-hundred (500) feet apart. The purpose of the thirty (30) station minimum is to collect enough data to perform a statistical analysis of the results obtained from the DCP testing (n >/= 30).

    d. Each testing station will include a cluster of three spatially-independent DCP sites tested to a minimum depth of eighteen inches (18"), logged at 6-inch deep intervals. Replicates must be located as close to each other as possible, without interacting with the previous hole or disturbed sediments. The three replicate compaction values for each six (6) inch depth interval must be averaged to produce the final values for each station.

e. The statistical significance of the difference between the shear strength of the in situ pre and post construction conditions should be determined through the application of the appropriate statistical analysis. The statistical methods of data analysis will be determined through the joint efforts of the Mobile District COE and the Service. The final DCP testing and statistical analysis procedures are also to be jointly agreed upon by the Mobile District COE and the Service.

f. The in situ shear strength of the pre-construction stations and post construction stations will be compared according to the depth at which the measurements were taken, e.g., the DCP measurements at a depth of six (6) inches from station X will be compared to the DCP measurements at a depth of six inches at station Y. If the average value for any six (6) inch depth interval exceeds the pre-construction value as established by the methods described in this document for any two or more adjacent stations, further coordination with the Service should occur to determine if tilling shall be required. If only a small area of the constructed project is found to be statistically different from the pre project conditions then tilling will not be required. A report on the pre and post construction results of the in situ shear strength condition of the beach sediments will be submitted to the Service.

g. An electronic copy of the results of the shear strength (compaction) monitoring must be submitted to the Service and the NPS prior to any tilling actions being taken or if a request not to till is made based on shear strength (compaction) results. Report should include size of areas failing the compaction test and compare percentage of those sites that were compacted (failed the compaction test) to percent non-compacted area (those that passed the compaction test). The variance between the pre and post project conditions will be reported to the Service and the NPS. The Service and the NPS will review the Compaction Sampling Report and determine whether tilling is needed to decrease the compaction. Allow two weeks for the Service and the NPS to make a determination whether tilling is needed.

h. If the project site fails to meet the mean threshold value of the reference site(s), a decision will made via coordination with the Service and NPS whether tilling is necessary. If tilling is necessary, the COE will submit a plan of equipment to use and method of island access for Service and NPS approval. If tilling is needed, the area must be tilled to a depth of 24 inches. Each pass of the tilling activity must be overlapped to allow more thorough and even tilling. All tilling activity must be completed at least once outside of turtle nesting season and prior to the beginning of sea turtle nesting season (prior to May 1).

i. If required, tilling must occur landward of the wrack line and avoid all vegetated areas 3 square feet or greater with a 3 foot buffer around the vegetated areas and at least 10 feet from the toe of the vegetated dune line. (NOTE: If tilling occurs during shorebird nesting season (March 1-September 15), shorebird surveys prior to tilling are required per the Migratory Bird Treaty Act; see http://myfwc.com/media/1393838/BeachNestingBirdsBrochure.pdf)

12. Visual surveys for escarpments along the project area must be made during the post construction period outside of turtle nesting season and prior to May 1 for 3 subsequent years post construction. Escarpment surveys should include the height and length of escarpments observed must be shared with the Service and NPS.

    Escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet or more must be leveled and the beach profile must be reconfigured to mimic native beach slopes to minimize scarp formation during the post construction period but outside of turtle nesting season. If the post construction period ends during turtle nesting season, coordination with the USFWS and NPS will be conducted no later than the following January and a decision will be made whether escarpment removals are necessary. All escarpment removal activities must be completed before the following sea turtle nesting season begins, which is prior to May 1. Any escarpment removal must be reported by location. Escarpments must be reconfigured to mimic native beach slopes while protecting nests that have been relocated or left in place. The Service and the NPS will be notified and provided a report from the escarpment surveys if subsequent reformation of escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet occurs during the nesting and hatching season (May 1 through November 30), to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service, after coordination with the NPS, will provide a brief written authorization within 30 days that describes methods to be used to reduce the likelihood of impacting existing nests. An annual summary of escarpment surveys and actions taken must be submitted to the Service with a copy to the NPS**.** This condition must be coordinated with the Service and the NPS post construction to verify whether or not this condition will be required. Factors considered when determining whether escarpment removal will be necessary will be determined within the year that the project is completed and prior to May 1 and continue annually for the duration of the project and up to 3 years post construction.

13. Meetings: Annually, no later than each January during construction and for 3 years post construction, the Service, the COE, and the NPS will meet to review escarpment formation, beach compaction, and other beach conditions to determine actions necessary to insure that the project beaches contain viable sea turtle nesting habitat. Some of the parameters to consider in determining the feasibility of tilling are: percent of beach face

compacted, island access points and travel routes, timing with bird nesting seasons, control of windblown sand, and identification of the minimum sized equipment that can effectively accomplish the task. Some of the parameters to consider in determining the feasibility of escarpment removal are: evaluating mechanical escarpment removal, and the length and height of escarpments compared to the length of beach with a natural slope.

14. Memorandum of Understanding:

    The Memorandum of Understanding in place will serve as an agreement between the COE, the NPS and the USFWS, that all parties will work together to achieve compliance with the terms and conditions of the BO while minimizing environmental impacts. Moreover that all parties agree that they will implement all reasonable measures to resolve any issues to comply with the terms and conditions of the BO for the MsCIP Barrier Island Restoration Project such as the post-construction monitoring activities, including the logistics of escarpment removals, compaction tilling, associated surveys, turtle nests relocations, access routes to Ship or Cat Island and travel corridors necessary to move equipment to the work site and post-construction monitoring activities. If the listed agencies are unable to agree to resolve any of these issues such that it affects the COE's ability to be in compliance with the BO's terms and conditions; the USFWS agrees to re-consult with COE to insure ESA compliance.

IV. *Monitoring for piping plovers and red knots should be conducted within sea turtle nesting and hatching season as outlined in Appendix C. Additional measures for piping plovers and red knots include:*

1. A survey schedule (with dates) is listed in Appendix C. The Service recognizes that given the remoteness of the project area and the potential for inclement weather conditions during the piping plover and red knot migration and wintering season, surveys may be difficult to achieve. If conditions require a deviation from the survey schedule outlined in Appendix C, such information should be carefully documented in a detailed monitoring plan, including an explanation why any deviation from the recommended schedule was deemed necessary.
2. Piping plover and red knot identification, especially when in non-breeding plumage, can be difficult. Qualified personnel with shorebird/habitat survey experience must conduct the required survey work. Piping plover and red knot monitors must be capable of detecting and recording locations of roosting and foraging birds, and documenting observations in legible, complete field notes. Aptitude for monitoring includes keen powers of observation, familiarity with avian biology and behavior, experience observing birds or other wildlife for sustained periods, tolerance for adverse weather, experience in data collection and management, and patience.
3. At a minimum, binoculars, a global positioning system (GPS) unit, a 10-60x spotting scope with a tripod, and datasheet used in preconstruction surveys thus far should be used to conduct the surveys.

4. Negative (i.e., no plovers or knots seen) and positive survey data shall be recorded and reported.
5. Piping plover and red knot locations shall be recorded with a GPS unit set to record in decimal degrees in universal transverse mercator (UTM) North American Datum 1983 (NAD83).
6. Habitat, landscape, and substrate features used by piping plovers and red knots when seen shall be recorded.
7. Behavior of piping plovers and red knots (e.g., foraging, roosting, preening, bathing, flying, aggression, walking) shall be documented.
8. Any bands/flags seen on piping plovers and red knots shall also be carefully documented, and should also be reported according to the information found at the following websites. Information regarding piping plover band/flag observations can be found at: http://www.fishwild.vt.edu/piping_plover/Protocols_final_draft.pdf, http://www.waterbirds.umn.edu/Piping_Plovers/piping2.htm, and http://www.fws.gov/northeast/pipingplover/pdf/BahamasBandReporting2010.pdf. Information regarding red knot band/flag observations can be found at: http://www.bandedbirds.org/Reporting.html, http://www.flshorebirdalliance.org/resources-pages/bands.html, and http://www.pwrc.usgs.gov/bbl/.

V. *Requirements for surveying benthic prey species*

1. Qualified personnel with sediment/macroinvertebrate sampling experience must conduct the benthic prey species surveys.
2. A baseline macroinvertebrate survey is required to be conducted during the December/January timeframe of the wintering season. Additional surveys will be conducted during the same time of year between **3 to 5 years** post-construction during normal conditions (ie. not following a significant hurricane event) to determine benthic prey species recovery. Depending on the degree of recovery, a second post-construction sampling event may be warranted (see success criteria defined in the Long Term Monitoring and Adaptive Management Plan developed through an interagency effort for this project.
3. Sampling will be conducted using a basic before and after control and impact design method. Sampling will be coordinated with piping plover and red knots foraging observations based on low tide surveys.
4. In addition to recording benthic species abundance and diversity, a qualitative measure of sediment characteristics (sand, shell, mud) should also be recorded.
5. An appropriate detailed sampling methodology and schedule should be developed in coordination with the Service prior to initiating pre-construction and post-construction surveys.
6. A report, including all data, should be submitted to the USFWS and the NPS upon completion of each benthic survey.

VI. *Reporting Requirements*

1. Due to the duration between receiving construction funds and letting out contracts, the remoteness of the project area, weather conditions, potential logistical constraints, and the need to closely coordinate with Service and NPS staff. Periodic monitoring reports should be submitted to the Service as outlined in the attached appendices containing monitoring guidelines.
2. Incorporate all data collected into an appropriate database.
3. In addition to routine monitoring reports as outlined in the attached appendices containing monitoring guidelines a comprehensive report describing the actions taken to implement the RPMs and terms and conditions associated with this incidental take statement shall be submitted to the Service's MS Field Office by June 30 of the year following completion of all required bird surveys, and December 31 of the year following completion of all required sea turtle surveys.
4. If the COE foresees any problematic issues that would require a change in the recommended survey schedule due to work conditions or project delays, the COE should immediately notify the Service's **Jackson MS Field Office** at **(601)965-4900** so that we can resolve/correct any such issues.
5. At least two months prior to mobilization of construction equipment, the COE should notify the Service in writing. That notification should include whether there are any changes in the anticipated project footprint or design.

COORDINATION OF INCIDENTAL TAKE STATEMENT WITH OTHER LAWS, REGULATIONS, AND POLICIES

Migratory Bird Treaty Act (MBTA)

The MBTA implements various treaties and conventions between the U.S., Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Under the provisions of the MBTA it is unlawful "by any means or manner to pursue, hunt, take, capture or kill any migratory bird except as permitted by regulations issued by the Service. The term "take" is not defined in the MBTA, but the Service has defined it by regulation to mean to pursue, hunt, shoot, wound, kill, trap, capture or collect any migratory bird, or any part, nest or egg or any migratory bird covered by the conventions or to attempt those activities.

In order to comply with the MBTA and potential for this project to impact nesting shorebirds, the COE should follow the Service and NPS's guidelines (Appendix C) to protect against impacts to nesting shorebirds during implementation of this project. Please note that a bird abatement plan may be necessary to avoid disturbance to nesting water birds and shorebirds.

The Service will not refer the incidental take of piping plovers or red knots associated with this project for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-712), if such take is in compliance with the terms and conditions specified here.

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.

Conservation Recommendations for Red Knot and Piping Plover

1. We encourage the COE to continue to coordinate with the Service during the pre-planning phases of future Deepwater Horizon NRDAR Early Restoration and any other restoration projects that include sand placement projects within piping plover designated critical habitat.

2. We encourage the COE to incorporate winter and migratory season surveys for piping plovers and red knots for one additional year beyond the required two years post construction outlined in the attached monitoring guidelines (see Appendix C). The one additional year of surveys should be the same year as the post construction benthic sampling, which is projected to take place between 3 and 5 years post construction as outlined in Appendix C. Such data would facilitate our knowledge of the biology of those species and their wintering habitats within the Mississippi barrier islands which may facilitate decision making options on future projects.

Conservation Recommendations for Sea Turtles

1. Construction activities for this project and similar future projects should be planned to take place outside of sea turtle nesting and hatching season to the maximum extent practicable.

2. Appropriate native salt-resistant dune vegetation should be established on the restored dunes.

3. Surveys for nesting success of sea turtles should be continued for a minimum of 3 years post construction to determine whether sea turtle nesting success has been adversely impacted.

4. Educational signs should be placed where appropriate at beach access points explaining the importance of the area to sea turtles and/or the life history of sea turtle species that nest in the area.

In order for the Service to be kept informed of actions that minimize or avoid adverse effects or that benefit listed and proposed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes consultation for the piping plover and red knot as well as the loggerhead, green, and Kemp's ridley sea turtles.

As provided in 50 CFR §402.16, reinitiation of formal consultation for the piping plover (and its critical habitat), red knot, loggerhead sea turtle, green sea turtle, and Kemp's ridley sea turtle 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 238 acres of bare sand, mud flat, and intertidal habitats 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 biological 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 final biological opinion, please contact Mr. Paul Necaise of this office at 228/493-6631.

Sincerely,

Stephen Ricks
Field Supervisor
Mississippi Field Office

cc: FWS, Atlanta, GA (Attn: Jerry Ziewitz and Holly Herod)
NPS, Gulf Islands National Seashore (Attn: Jolene Williams)
FWS, Daphne, AL (Dianne Ingram)
FWS, Panama City, FL (Attn: Patty Kelly)
FWS, Panama City, FL (Attn: Ann Marie Lauritsen)
MDWF&P, Natural Heritage Museum, Jackson, MS (Attn: Nick Winstead)

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APPENDIX A

Standard Conditions for In-water Work in the Presence of Manatees

Guidelines for Activities in Proximity to Manatees and Their Habitat

A. All personnel associated with the project should be informed of the potential presence of manatees, manatee speed zones, and the need to avoid collisions with and injury to manatees. Such personnel instruction should also include a discussion of the civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973.

B. All contract and/or construction personnel are responsible for observing water-related activities for the presence of manatee(s).

C. 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.

D. Siltation barriers, if used, should be made of material in which manatees could not become entangled, and should be properly secured and regularly monitored. Barriers should not impede manatee movement.

E. 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 ft of a manatee; all vessels should 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.

F. Any manatee sighting should be immediately reported to the Dauphin Island Sea Lab's Manatee Sighting Network Hotline at (866-493-5803) or at manatee.disl.org and the U.S. Fish and Wildlife Service's Jackson MS Field Office (228-493-6631).

APPENDIX B

Monitoring Procedures for Sea Turtles

Guidelines for Monitoring Procedures for Sea Turtles

The following monitoring procedures will provide information necessary to evaluate project objectives for the MsCIP Barrier Island Restoration project. This plan proposes and builds upon existing data to establish a detailed baseline condition. This monitoring will continue during and post-construction to evaluate short-term and long-term response to the proposed restoration. These procedures will be updated as required to provide the necessary information to evaluate ecological success and inform the adaptive management program.

Threatened and endangered species, critical habitat, nesting shorebirds, and sea turtles must be monitored for this project to determine impacts pursuant to the Endangered Species Act and the Migratory Bird Treaty Act. This project is located within the boundaries of Gulf Islands National Seashore, whose barrier island beaches are used by nesting endangered and threatened sea turtles. The U.S. Army Corps of Engineers (USACE), to also include its Contractor/Subcontractor, shall keep construction activities under surveillance, management, and control to prevent impacts to sea turtles, their nests and hatchling sea turtles. The USACE may be held responsible for harming or harassing sea turtles, their eggs or their nests as a result of the construction. Sea turtle nests are easily missed by those unaware, making it easy for people and equipment to accidentally crush the eggs; young sea turtle hatchlings can get stuck in deep tire ruts; bright construction lights at night can disorientate adults and hatchlings causing them to migrate in the wrong direction away from the ocean which almost assures the hatchlings' death.

Sea turtle monitoring includes documenting defined parameters of sea turtle nesting activity including species, abundance, locating crawls, marking nests and relocating vulnerable nests (see FWS/NPS monitoring protocol). Monitoring will be conducted on the project beaches of Cat Island (when/if implemented), West Ship Island, and East Ship Island. In order to prevent disturbance to nesting shorebirds, monitoring of sea turtles should be done in the morning prior to the required shorebird monitoring.

There are 5 species of sea turtles: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), Kemp's Ridley (*Lepidochelys kempii*), that may be found in the Gulf of Mexico. Green, Loggerhead and Kemp's Ridley sea turtles are regularly documented in the waters surrounding the barrier islands of Gulf Islands National Seashore. Of these, loggerhead and green sea turtles have been documented nesting on the barrier islands in the MS Sound. Though never documented, Kemp's Ridley sea turtles are likely to nest on the MS islands and nests have been documented on Santa Rosa Island in the Florida District of the Seashore.

Sea turtle nesting and hatching season for MS starts around April 15 and ends around November 30. Incubation for the loggerhead sea turtle ranges from about 45 to 95 days and incubation for the green sea turtle ranges from about 45 to 75 days. Potential hatching dates will be determined for each crawl documented and monitored for nesting success 95 days beyond the crawl date.

MONITORING PERIODS:

There are three monitoring periods: **pre construction, during construction, and post construction.** An NPS Biologist will be available for assistance if needed during all periods of the monitoring.

A. **Pre Construction:**

If project activities are initiated between Nov 30 and April 15, then no pre-project surveys will be required for nesting sea turtles. If the project will be initiated between April 15 and Nov 30, daily pre-project surveys should begin at least 100 days prior to commencement of work in the immediate vicinity of construction.

B. **During Construction:**

Nesting surveys, marking, and potential relocation activities must be conducted daily, weather permitting, while construction activities are on-going during nesting and hatching season, April 15-Nov. 30 in work areas. Surveys will take place where construction activities will be occurring within the next 100 days as the project progresses across the project footprint.

C. **Post Construction:**

Weekly sea turtle monitoring shall be conducted and include 2 full nesting and hatching seasons (April 15th thru November 30th) once the project reaches equilibrium, approximately one to two years after the end of construction. The goal of the post construction monitoring is to ensure that suitable habitat for sea turtles is established.

MONITORING PROTOCOLS:

SURVEY METHODS:

1. On native beaches, surveys will be conducted first thing in the morning by All-Terrain Vehicles (ATV/UTV), foot or boat. The ATV will be operated at <6 mph, to provide adequate opportunity to view the beach, to avoid obstacles and hazards, and to visually investigate all possible turtle crawls. **The ATV will be operated low on the beach, on the unvegetated dune face, at or below the last high tide line.** This will allow even the shortest turtle crawls to be located and minimize impacts to bird nests. **Be careful not to drive through a bird nesting area.** Back track on foot if necessary to survey the area not accessible by ATV. If it is high tide during your survey, do not attempt to drive the ATV through water. Also, do not drive the vehicle over dunes and vegetation. If there is a path wide enough for the ATV to drive through without impacting vegetation, use the path to circumvent the area where there is no beach. **Be careful not to drive through a bird nesting area.** Back track on foot if necessary to survey the area that was missed.
2. During the survey, be alert for tracks, stranded turtles, nests uncovered by predators, hatchlings, etc., or any evidence of a sea turtle incident. Check any marked nests found during previous surveys.

Investigating Nesting Activities:

1. If a turtle crawl is discovered, stop and evaluate the incident as thoroughly as possible. A completed "MS Sea Turtle Nest Data Sheet" form is required for all incidents, false crawl

or nest. A copy of the data sheet form is located at the end of this document. The monitor should; identify the species of the turtle crawl, record the GPS location, take photos of the turtle crawl, etc.

2. Mark the turtle crawl and/or a nest to prevent double-counting. Look for evidence of a body pit. A body pit will look like a roughly circular area of disturbed sand which may or may not be slightly lower than surrounding areas. If there is not a body pit discovered, the crawl will be assumed to be a false crawl. False crawls will be recorded on a report form. If a conspicuous area of disturbed sand is found (body pit), assume that a nesting event has occurred. Look for signs of animal depredation or human tampering.

3. Measure the crawl at three different locations and taking an average of the three. Straight-line measurements should be taken from the tip of the flipper mark on one side to the tip of the flipper mark on the other. With loggerheads, since the flipper marks alternate, the measurements should be from flipper mark on one side to an extended straight line from the flipper mark on the other side.

4. If the incident was a nest, record the distance from the water to the nest site. This does not need to be exact (water level fluctuates with each wave) but it should be fairly accurate. Also, note if the nest is above or below the rack line (highest debris line on the beach).

5. When estimating egg cavity location, determine the direction of travel along the crawl, locate a body pit, and locate an escarpment in the shape of an arc at the front of the pit. Typically, the female faces away from the water during nesting, although this is not always the case. The escarpment is the result of the turtle using her front flippers to cover the nest with sand when she is done laying. The egg cavity is usually centered behind this escarpment, approximately 3-5 ft back. It may be further back, if the turtle was moving forward while covering the nest site.

6. Occasionally, a nest may be uncovered by predators or beach erosion. If you find a nest where eggs or the remains of eggs are visible, the incident will be reported as a nest. If the nest was predated, the nest must be checked for viable eggs. Do not assume the nest has been totally predated.

If a nest is partially depredated, the remaining eggs can be reburied with the necessary precautions. Eggs must be rinsed off with freshwater to remove all albumen and other fluids that came from the damaged eggs. Rough handling and turning of the eggs should be avoided. The nest cavity, if still intact, should be emptied out down to clean sand before the eggs are replaced. Do not dig too deep. Occasionally, most eggs can be left in place and only the top few will need to be removed, cleaned and returned to the nest. The nest should then be filled with moist sand. Compress the sand with your hands using slight to moderate pressure. Damaged eggs and shells should be removed from the area.

If the nest was totally depredated, fill in the hole and clean up the area. If you find an area where eggs are strewn about and there is a hole in the sand, but no crawl, this is an old nest that has been depredated. Fill in a nest report (photo and GPS).

MARKING NESTS FOR PRE AND DURING CONSTRUCTION:

Equipment for nest perimeter buffer zone marking:

1. 4 wooden perimeter buffer zone stakes. Dimensions 1" x 2", 4 ft long.
2. 1 roll of 3/16" fluorescent orange flagging tape

Marking Nest Sites to Protect Buried Eggs from Hazardous Activities

The goal of this marking method is to clearly identify the nest area and protect it from human activities such as vehicular traffic or other disturbances.

A series of stakes and highly visible survey ribbon or string shall be installed to establish a 10-foot radius around the nest. No activity shall occur within this area nor will any activity occur that could result in impacts to the nest. Nest sites shall be inspected daily to assure nest markers remain in place and that the nest has not been disturbed by the project activity. The stakes should extend more than 36" above the sand. To further identify the nest site, surveyor's ribbon can be tied from the top of one stake to another to create a perimeter around the nest site.

Additionally, a nest sign can be attached to one of the stakes used to create the perimeter. A nest-identifying number and the date the eggs were laid should be placed on at least one of the nest perimeter stakes. At least one additional stake should be placed a measured distance from the clutch location at the base of the dune or seawall to ensure that future location of the nest is possible should the nest perimeter stakes be lost.

Signs should contain the information located between the two dashed lines below:

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SEA TURTLE NEST - DO NOT REMOVE

VIOLATORS SUBJECT TO FINES AND IMPRISONMENT

The Endangered Species Act of 1973: No person may take, harass, harm, pursue, hunt, shoot, wound, kill, trap, or capture any sea turtle, turtle nest, and/or eggs, or attempt to engage in any such conduct. Any person who knowingly violates any provision of this Act may be assessed a civil penalty up to $25,000 or a criminal penalty up to $100,000 and up to one year imprisonment.

SHOULD YOU WITNESS A VIOLATION OR OBSERVE AN INJURED OR STRANDED TURTLE OR MISORIENTED HATCHLINGS, PLEASE CONTACT:

US Fish and Wildlife Service at (601) 965-4900

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Nests Relocation Protocol:

After a nest is identified, three circumstances would warrant nest relocation:

(1) If eggs have been exposed as a result of erosion,
(2) If you observe a nest, due to its location on the beach, is in danger of being inundated by daily tides or lost through erosion, or
(3) The nest is within active construction zone or any zone that will be active within 95 days from the date of discovery.

Do not move the nest unless you are completely confident the nest will be lost.

If the nest requires relocation, then call the designated person(s) permitted to relocate nest and contact Paul Necaise (FWS: 228-493-6631) as soon as possible. Gary Hopkins (NPS: 228-230-4104) will provide input on where relocation should occur if available. Relocation areas should not include newly constructed areas due to sand compaction being unsuitable. Relocation zone maps of East and West Ship Islands and Cat Island are located at the end of this monitoring plan.

Nests requiring relocation must be completely moved no later than 9 a.m. the morning following deposition to a nearby self-release beach site (see maps at the end of this monitoring plan and be sure you have the most up-to-date maps for they are subject to change over time) in a secure setting where artificial lighting will not interfere with hatchling orientation. The specific site for nest relocation will be determined in coordination with FWS and NPS if possible. Relocated nests must not be placed in organized groupings. Relocated nests must be randomly staggered along the length and width of the beach in settings that are not expected to experience daily inundation by high tides or known to routinely experience severe erosion and egg loss, or subject to artificial lighting. Relocated nests should have a predator proof screen/cage as outlined in the nest marking protocols where raccoons are a problem. Nest relocations in association with construction activities must cease when construction activities no longer threaten nests.

A new nest location can be excavated above the high tide line, but not above the dune line in an area that is not impacted by construction The top of the new nest, or egg cavity should be located approximately 10-12 inches below the level of the sand. The bottom of the new cavity should be about 22 inches deep. The nest cavity should be in the shape of a vase with a round bottom and long neck. Dig the new nest cavity before you begin to move the eggs. Move the eggs with care but in a timely manner. Move them one by one to the container. **Handle the eggs with care, and do not rotate and roll the eggs. .** Use the supply container to store the eggs, or a cooler if one is available. Fill the bottom with some sand from the nest area to prevent the eggs from rolling in the container. The sand will also cushion the eggs. Use the lid to shade the eggs. Large temperature changes need to be avoided. After all the eggs have been deposited (not dropped) carefully in the new nest cavity one a time, fill cavity with moist sand using the sand from the original nest site. Then use surrounding sand as needed. Compress the sand with your hands with slight to moderate pressure. Mark these nests in accordance with the general guidelines for a positive nest.

Recording Data:

Completely fill in the FWS form provided for all nests and false crawls. Be as accurate as possible. Pay particular attention to describing the location of the nest and how the nest was marked. Use the back of the sheets for additional information or maps/diagrams. Use a separate data sheet for each nest.

Routine Monitoring of all existing Nest Sites:

1. All sea turtle nests will be monitored throughout the incubation period. This monitoring is for the purpose of determining the duration of incubation, and identifying the incidence of depredation, damage from beach erosion, or disturbance by human activities.

2. Make sure all the stakes are readable and in good condition. If a stake or sign is missing, replace it and note the replacement in the log book and on the nest sheet.

Sites will be evaluated for evidence of disturbance including tracks, digging, ghost crab holes, tire tracks, beach erosion or washovers, or any other indication of nest disturbance. Photographs and observations of any disturbance should be recorded and provided in the report.

Monitoring at Expected Time of Hatching

1. Beginning at the 50th day from initial discovery, each nest will be monitored more closely. This intensive regime of monitoring will be conducted to determine the precise duration of incubation, and to gather data on hatchling emergence, depredation, and disorientation.

2. Nest sites will be evaluated to determine if hatching has occurred by looking for tracks of hatched turtles which have left the nest. In general, the majority of hatchlings will leave the nest as a group during the night. Their tracks will appear as a clutter of small, approximately 2" wide tracks which radiate out from the nest. The area where the eggs are located will usually appear collapsed.

3. Look for evidence of depredation such as ghost crab or bird and any indication of turtle remains. Look for evidence of hatchling disorientation. Note any tracks which deviate from a straight course to the water and attempt to follow any tracks which have headed in the wrong direction. If disoriented hatchlings have been located, contact Paul Necaise (FWS, 228-493-6631) and Gary Hopkins (NPS: 228-230-4104) as soon as possible.

4. Record all observations made at the site on the specific FWS form developed for that nest. Please be as complete as possible. Any information which can be learned about the fate of the hatchlings after they emerged from the nest is of value.

Final Nest Assessment and Excavation:

1. All nests will be assessed at the conclusion of the nesting process to gather data on overall nesting success.

2. In general, the final assessment will be conducted 3 days after hatchlings have been documented as emerging from the nest or 80 days after initial discovery of a nest if no evidence of hatching has been recorded. (This is dependent upon the identified species).

3. When excavated, the sites are evaluated to determine the fate of the nest. The data collected includes, at minimum, the total number of eggs found (both hatched and unhatched), the presence of any hatchlings inside the nest, the number of unhatched eggs with embryonic development, the number of eggs without embryonic development, and any evidence regarding factors which may have affected the nest, such as ghost crab burrows, vegetation roots, etc.

4. Results will be recorded on the FWS form and all protective material including screens

and stakes will be removed from the nest location.

Construction protection measures to be monitored (compliance/noncompliance observations should be included in weekly report):

1. During turtle nesting and hatching season, staging areas for construction equipment must not be located in the natural dunes and vegetation on the island. In project areas on natural beaches, construction pipes will be as short in length as possible to allow nesting sea turtles use of the natural beach and limit trapping of nesting sea turtles behind the construction/dredge pipes. In addition, all construction pipes placed on the beach must be located as far landward as possible without compromising the integrity of the dune system. Pipes placed parallel to the dune must be 5 to 10 ft away from the toe of the dune if the width of the beach allows. Temporary storage of pipes must be off the beach to the maximum extent possible. If the pipes are stored on the beach, they must be placed in a manner that will minimize the impact to nesting habitat and must not compromise the integrity of the dune systems.

2. To minimize possible boat impact to nesting sea turtles feeding and loafing in the surf off the outer bar of the south beach support vessels should observe a no wake zone 300 yards from the south shoreline.

3. Direct lighting of the beach and nearshore waters must be limited to the immediate construction area during the nest laying season through end of hatching season (April 15 – November 30) and must comply with safety requirements. Lighting on all equipment must be minimized through reduction, shielding, lowering, and appropriate placement to avoid excessive illumination of the water's surface and nesting beach while meeting all Coast Guard, Corps EM 385-1-1, and OSHA requirements. Light intensity of lighting equipment must be reduced to the minimum standard required by OSHA for General Construction areas, in order to not misdirect sea turtles.

4. Sea Turtle Signs: If nesting occurs within the construction area, the nest should be relocated, and the construction contractor shall place and maintain a bulletin board in the contracting shed with the location map of the construction site showing the sea turtle nesting areas and a warning, clearly visible, stating that "SEA TURTLE NESTING AREAS ARE PROTECTED BY THE THREATENED AND ENDANGERED SPECIES ACT".

5. **Beach Rutting:** Ruts created by heavy equipment located along the beach face between the nest and the water will be smoothed to avoid trapping of hatchlings as they move down the beach face to feed.

Reporting:

1. Report any activity as soon as possible; including nesting, false crawls, etc. (datasheets located at the end of this document, and monitoring reports can be submitted via email). The datasheets shall summarize sea turtle species observed (adults and hatchlings), the location of turtle crawls and/ or nests (GPS coordinates), and construction compliance/noncompliance observations. In addition to datasheet

submission, monitoring reporting shall summarize upon locating a dead or injured sea turtle that may have resulted from direct or indirect results of the project. Nests with estimated hatch dates should be supplied with the submitted logs. If an injured or dead sea turtle is discovered, contact Paul Necaise (FWS), and Gary Hopkins (NPS) immediately to ensure treatment or disposition of the dead sea turtle. A NOAA Sea Turtle Stranding and Salvage Network – Stranding Report should be completed and filed with NOAA, and provide a copy to NPS (Gary Hopkins 228-230-4104).

2. Report Submission: A monitoring report should be submitted weekly to FWS and NPS (including logs and all data forms/sheets). All data must be entered into a web-based form provide by the Corps.

3. Following completion of the project, a summary report of the monitoring and nesting activities shall be forwarded within 30-days to USFWS and NPS.

Requirements for monitor:

Monitoring will be conducted by trained individuals with proven sea turtle experience and identification skills. Credentials of the Sea Turtle Monitor will be submitted to the USFWS and NPS Biologists for review and approval. Not every monitor will require relocation experience and permits, however at least two individuals approved for relocation should be available to allow one person to monitor the construction site every day during the nesting season when there are active construction activities occurring. An NPS Biologist will be available if needed during all periods of the monitoring.

MDWFP, USFWS, NPS, and anyone permitted by MDWFP or USFWS shall be allowed on work site during construction as needed, to assist with sea turtle monitoring and nest search or to post nest buffers when needed with the approval of the USACE on-site inspector in order to comply with safety regulations.

CONTACT LIST:

US Fish and Wildlife Service, 6578 Dogwood View Pkwy, Jackson, MS 39213
Mr. Paul Necaise at 228-493-6631 or paul_necaise@fws.gov
Mr. David Felder at 601-321-1131 or david_felder@fws.gov

National Park Service, Gulf Islands National Seashore, 3500 Park Road, Ocean Springs, MS 39564
Mr. Gary Hopkins, at 228-230-4104 or gary_hopkins@nps.gov

US Army Corps of Engineers
Ms. Jennifer Jacobson at 251-690-2724.

West Ship Island Sea Turtle Nest Relocation Map

East Ship Island Sea Turtle Nest Relocation Map

Cat Island Sea Turtle Nest Relocation Map

Mississippi Sea Turtle Nest Data Sheet

Date: __________________ STAKE #_____________

Species: ________________ Time Discovered: _________________

Investigators Present: ____

NEST LOCATION:

Nest GPS location: _______________N, _______________W

Hidden Stake: __________m Obvious Stake: __________m

SITE DECRIPTION: ____

CLUTCH DATA

CLUTCH DEPOSITED: YES NO UNKNOWN CLUTCH: MOVED MARKED

If moved, state reason: ____

TOTAL CLUTCH SIZE: ____________ BROKEN: _________

Inventory Date: _____________

Total Clutch Size: __________ Emerged: Yes No

Broken:__________ Stakes: Yes No

Hatched: _________ Buffer Stakes? Yes No

Live Hatchlings: _________ Dead Hatchlings: __________

DEVELOPMENT ARRESTED AT:

Early stage mortality: __________ Addled: __________

Late stage mortality: __________ Infertile: __________

Pipped dead: __________ Pipped live: _________

EGGS AFFECTED BY (please describe if nest was affected by predators or inundation): ________________

HATCHING SUCCESS % (number of hatched shells/total clutch size X 100): ____________

EMERGING SUCCESS % ((number of hatched shells - (live + dead hatchlings)/total clutch size) X 100: ____

APPENDIX C

Monitoring Procedures for Shorebirds and Benthic Sampling

Guidelines for Monitoring Procedures for Shorebirds and Benthic Sampling

The following monitoring procedures will provide information necessary to evaluate project objectives for the MsCIP Barrier Island Restoration project. This plan proposes and builds upon existing data to establish a detailed baseline condition. This monitoring will continue during and post-construction to evaluate short-term and long-term response to the proposed restoration. These procedures will be updated as required to provide the necessary information to evaluate ecological success and inform the adaptive management program.

Threatened and endangered species, critical habitat, and nesting shorebirds must be monitored for this project to determine impacts pursuant to the Endangered Species Act and the Migratory Bird Treaty Act. This project is located within the boundaries of Gulf Islands National Seashore, whose barrier island beaches are listed as critical habitat for the threatened piping plover, and contain similar suitable habitat for the threatened red knot. The U.S. Army Corps of Engineers (USACE) (and its contractor and/or subcontractor) shall keep construction activities under surveillance, management, and control to prevent impacts to shorebirds and/or their nests. The Piping plover is a federally protected species that occurs in the construction area. The USACE and its Contractor may be held responsible for harming or harassing the birds, their eggs or their nests as a result of the construction. Eggs and chicks of beach-nesting birds blend in with their surroundings and are nearly invisible on the ground, making it easy for people and equipment to accidentally crush the eggs or kill young chicks; young chicks can get stuck in deep tire ruts, etc.

Monitoring includes bird identification, counts, habitat use, behavior observed, and GPS locations of the main groups of birds using the beach areas on West Ship Island and East Ship Island, and Cat Island. The three main groups of birds are solitary nesters, colonial nesters, and winter migrants (including the federally listed piping plover and red knot). Species identification information will be provided by the U.S, Fish and Wildlife Service, (USFWS), Jackson, MS. An NPS Biologist will be available for assistance if needed during all periods of the monitoring (Gary Hopkins 228-230-4104).

Specific time frames for monitoring will vary with the avian season, weather, and actual construction logistics. As the project moves from place to place, the Bird Monitor will also have to be able to move with the project and/or with the birds.

There are two monitoring periods:

-Fall, Mid-Winter, Spring Migration from July 15 to May 30. During this time, the Bird Monitor will focus on migratory shorebirds including Piping Plover and Red Knot, but should also report on other birds like osprey and eagle.

-Nesting from March 1 to September 30. Monitoring for nesting birds is only required during construction.

There are three monitoring periods: **pre construction, during construction and post construction.** Monitoring for nesting shorebirds (during construction) will focus on colonial and solitary shorebird species but will also report on other birds like osprey and eagle. Species documented to nest on the MS barrier islands include solitary nesting species such as: Wilson's Plover, Snowy Plover, Semi-palmated Plover, Willet and American Oystercatcher. Documented colonial species include: Least Tern, Gullbilled Tern, Royal Tern, Sandwich Tern, Common Tern and Black Skimmer.

1. Monitoring Periods:

a. Pre Construction: (see dates on previous page)

The Contractor has completed the one-year requirement for pre-construction shorebird monitoring activities for West and East Ship Island, with the exception of the following 2 weekly migration period surveys in 2013: (Aug 19-23); (Aug 26-30) that were missing due to contractual issues. These weekly surveys have been obtained in August, 2014.

Similarly, pre-construction monitoring for Cat Island has been initiated as part of the 1 year pre-construction monitoring. Construction activities will be planned once the Cat Island property has been acquired by the COE.

(1) Fall, Mid-Winter, Spring Migration: Monitoring should take place on a weekly basis at Cat Island, except in the event of adverse weather conditions.

(2) Nesting Shorebirds: No requirement for preconstruction.

(3) Benthic Monitoring: Benthic monitoring along beach transects on Cat, East and West Ship Island will be performed in accordance with the shorebird benthic sampling protocol, located at the end of this monitoring report.

b. During Construction: (see dates on previous page)

The Contractor shall start this frequency of monitoring activity for a period of 2 weeks prior to work commencement and continue with this frequency until completion of the construction and the current bird season ends. A site survey should be conducted before the resumption of any break in activity.

(1) Fall, Mid-Winter, Spring Migration Shorebirds: Monitoring frequency a minimum of weekly throughout entire project area where sand will be placed on Cat, East and West Ship Islands, except in the event of adverse weather conditions.

(2) Nesting Shorebirds: Monitoring frequency daily during active construction except in the event of adverse weather conditions. However, nesting surveys only need to take place within the project area where activities are ongoing or will be within 90 days prior to active construction in order to prevent impacts to nests/nesting activities. If a nest is found to impede construction work, the USACE must contact USFWS as soon as possible.

c. Post Construction: (see dates on previous page)

The Contractor shall start this frequency of monitoring activities once the project equilibrates, approximately one to two years after the end of construction and continue for two years.

(1) Fall, Mid-Winter, Spring Migration Shorebirds: Monitoring will occur every other

week, throughout the entire project areas of Cat, East and West Ship Islands, except in the event of adverse weather conditions.

(2) Nesting Shorebirds: No requirement for post construction.

(3) **Benthic Monitoring**: Benthic monitoring along beach transects on East and West Ship Island will be performed 3-5 years after construction based on optimal conditions, i.e. lack of sand shifting, hurricane events, etc., during the December – January timeframe in accordance with the shorebird benthic sampling protocol, located at the end of this monitoring report.

2. Visual Surveys and Survey Protocols:

Shorebird monitoring is dependent upon the avian season, shall include species, observed breeding behavior, nest location, chicks observed, and location of recently fledged chicks. Surveys shall be conducted during the dawn or dusk time frames by a trained or experienced Bird Monitor contractor, approved by the USACE/FWS. Bird monitoring should not take place immediately following turtle monitoring where birds have been disturbed by the use of ATVs.

Surveys should be conducted by traversing the length of the project/construction area and visually inspecting, using binoculars or spotting scope, for the presence of shorebirds exhibiting courtship or nesting behavior. The preferred method for monitoring is by foot patrol. During the construction phase, if an ATV or other vehicle is needed to cover large project areas, the vehicle must be operated at a speed <6 mph, shall be run at or below the high-tide line, and the Bird Monitor will stop at no greater than 200 meter intervals to visually inspect for nesting activity. An ATV will be used only on the unvegetated beach face of the new beach, not on the natural beach face of East Ship or West Ship Islands. Even with the use of an ATV, the Bird Monitor will use a drive and walk technique coupled with scanning ahead to detect secretive solitary nesting species. During post construction monitoring, an ATV will not be used, surveys will be conducted by foot or boat.

Surveys shall be conducted using survey protocols outlined here and the form provided.

(1) **<u>During Construction (Nesting):</u>** A daily report of nesting shorebird monitoring and nest activity shall be kept by the contractor's Bird Monitor. Daily logs shall summarize each shorebird species observed (adults and chicks/fledglings) and provide a rough estimate of numbers of each species, the location of species (GPS coordinates preferred), leg bands (if applicable), and their activity (e.g. foraging, resting, nesting, courtship behavior, feeding chicks). In addition, daily logs shall summarize upon locating a dead or injured bird that may have resulted from direct or indirect results of the project, the USACE shall notify the USFWS as soon as possible (Paul Necaise: 228-493-6631, or paul_necaise@fws.gov). Also, Gary Hopkins (228-230-4104) of the NPS may be contacted in addition to the USFWS. Care shall be taken in handling an injured bird, contact a local permitted wildlife rehabilitation center to ensure treatment or disposition of the dead bird. Banded birds should also be noted and recorded (color of bands and location on bird, i.e. one red band on lower right leg and one green band on upper right leg). All activity will be submitted in a report format, and provided within one week of data collection during construction. Contractor will also enter all

data into the USACE Mobile District's database for MSCIP on a weekly basis.

Nesting season surveys for detecting new nesting activity will be completed prior to movement of equipment, operation of vehicles, or other activities that could potentially disrupt nesting behavior or cause harm to the birds or their eggs or young (see aforementioned 90 day requirement). Once nesting activity is confirmed by the presence of a scrape, eggs, or young, the USACE will notify the USFWS as soon as possible. This is only required when there is "new" nesting activity (this is defined as a new species seen and/or new area). Bird Monitor will install red wire flags in area identifying location until buffer zone is established (see number 3 below).

(2) **During Construction, and Post Construction (Migration/Mid-Winter)**: Monitoring will be done on a weekly basis during construction and bi-weekly for post construction. The areas to be monitored should include the east tip of West Ship Island, specifically from the vegetation line to the water's edge and East Ship Island, specifically the from the edge of the forested area to the water's edge and covering the east tip, the south shore, and west tip. When construction timeframes are identified, the east shoreline of Cat Island from the vegetation line to the water's edge shall be monitored. Reports shall be submitted once a month during the construction time frames. Contractor will also enter all data into the USACE Mobile District's database for MSCIP on a monthly basis.

The following data shall be included in the surveys:

a) Negative and positive survey data;
b) Piping Plover and Red Knot locations with a Global Position System (GPS-decimal degrees, preferred);
c) Habitat features used by Piping Plovers and Red Knots when seen (i.e. intertidal, fresh wrack, old wrack, dune, mid-beach, vegetation, other);
d) Landscape features where Piping Plovers or Red Knots are located (i.e. Gulf of Mexico shoreline, bayside shorelines, inlet spit, tidal creek, shoals, lagoon shoreline, lakeside sand flats, ephemeral pools, etc.);
e) Substrate used by Piping Plovers and Red Knots (i.e. sand, mud/sand, mud, algal mat, etc.);
f) Behavior of Piping Plovers or Red Knots (i.e. foraging, roosting, preening, bathing, flying, aggression, walking);
g) Color-bands seen on Piping Plovers or Red Knots;
h) All other shorebirds/waterbirds seen within the survey area.

3. **Buffer Zones:** A temporary, 300-foot buffer zone, or as approved by the USFWS, shall be created around any nesting or courtship behavior, or around areas where Piping Plovers, Red Knots, or winter migrants congregate in significant numbers. Designated buffer zones must be posted with clearly marked "Area Closed" signs around the perimeter and left undisturbed until nesting is completed or terminated, and the chicks fledge. No access to the nesting sites by humans, equipment under control of the Contractor (except limited access when approved by USFWS and accompanied by the Bird Monitor). Construction activities, movement of vehicles, or stockpiling of equipment are prohibited in the buffer zone. Buffer zones shall be increased if birds appear agitated or disturbed by construction or other activities in the adjacent

area. Disturbed adult birds will attempt to drive a predator away by calling out, dive bombing, or dropping feces on the predators. Other times adult birds will pretend to have a broken wing to lure a predator away from their young.

4. **Equipment:** Travel corridors and staging areas outside of buffer zones near nesting sites shall be coordinated with the Service's Jackson MS Field Office (Mr. Paul Necaise at 228- 493-6631), and these areas shall be designated and marked outside the buffer areas. Heavy equipment, other vehicles or pedestrians may transit past nesting areas in the corridors.

5. **Shorebird Signs:** If nesting occurs within the construction area, the Contractor shall place and maintain a bulletin board in the contracting shed with the location map of the construction site showing the bird nesting areas and a warning, clearly visible, stating that "BIRD NESTING AREAS ARE PROTECTED BY THE MIGRATORY BIRD TREATY ACT."

6. **Report Submission:** The results of the daily shorebird monitoring and nest activities report shall be forwarded weekly or monthly (depending on the time of surveys) to the USFWS and USACE. Following completion of the project, a summary report of the shorebird monitoring and nesting activities shall be forwarded within 30-days to USFWS (Attn: Mr. Paul Necaise (228-493-6631) at paul_necaise@fws.gov, 6578 Dogwood View Pkwy, Jackson, MS 39213), NPS (Mr. Gary Hopkins, 3500 Park Road, Ocean Springs, MS 39564 or email: gary_hopkins@nps.gov), and USACE.

7. **Shorebird Benthic Sampling Protocol**

Purpose: To perform biological surveys required to collect surface sediment samples, sort and identify benthic macroinfauna organisms on beaches located on Cat, East and West Ship Island and Horn Island as associated with piping plover and red knot foraging areas to support the MS Coastal Improvements Program (MsCIP) barrier island restoration project.
Objective:

- To establish a pre-construction baseline of macroinfaunal taxonomy and abundance within future project influenced and reference beaches on Cat, Ship and Horn Islands.
- Perform sampling between 3 to 5 years post construction to allow optimum conditions to develop for recolonization of benthic macroinfauna in order to determine the level of recolonization success. More detailed information regarding the post construction success criteria can be found in the comprehensive Long Term Monitoring and Adaptive Management Plan being developed through an interagency effort for this project.

Sampling and Analysis Plan: The protocol is to determine the characterization of benthic communities along the eastern shore of Cat Island and at the tips of Eastern and Western Ship Islands near Camille Cut, and appropriate reference areas, and includes the sorting, identification, and enumeration of benthic macroinvertebrate organisms collected in each area. Sediment texture and organic content will be determined at each location where benthic macroinfaunal samples are collected. Hydrographic measurements will also be taken at each sampling location. Benthic community studies will be conducted during the November/December timeframe prior to construction activities and post construction. This winter benthic community survey is for determination of the pre-construction and post construction habitat characteristics and macroinfaunal assemblages on beaches used by piping plover and red knot.

<u>Benthic Sample Locations and Schedule:</u> Benthic community samples will be collected along beach transects on Cat Island, East and West Ship Island and Horn Island associated with piping plover and red knot foraging areas. Sample locations will include sites in which piping plover and red knot are actively foraging on the tips and pre-sand placement and reference sites. The same number of post construction samples will be collected on similar micro habitat features that exist at the time samples are collected. The sample locations are anticipated to include:

- 4 beach transects on eastern shoreline of Cat Island (including 1 on north tip, 2 on south tip, and 1 through tidal inlet area).
- 3 beach transects on west tip of East Ship Island (including 1 through tidal pool area, 1 on northern shoreline area, and 1 on the southern area of tip).
- 3 beach transects on east tip of West Ship Island (including 1 through tidal pool area, 1 on northern shoreline area, and 1 on the southern area of tip).
- 1 transect on Gulf front shoreline of East Ship Island (pre-placement location).
- 1 transect on Gulf front shoreline of West Ship Island (reference for pre-placement location).
- 3 beach transects on west tip of Horn Island as reference (including 1 through tidal pool area, 1 on northern shoreline area, 1 on the southern area of tip).

Two sampling stations will be arrayed along each transect at mean lower low water and mean high tide line to capture tidally exposed flats and wet sand samples. Both wet sand and high tide line intertidal samples will be collected within a 1 square-meter sampling zone in homogenous beach or flat environment.

<u>Benthic Sample Replication</u>: Adequate replication of benthic sampling is necessary to provide statistical power for comparisons of pre-construction and post-construction data. Based upon earlier USACE benthic community studies, four (4) replicate samples per sample station are estimated to be required to represent over 75% of the taxa present at the sample sites. Both wet sand and high tide line intertidal samples will be collected within a 1 square-meter sampling zone in homogenous beach or flat environment.

<u>Benthic Sample Collection Methods:</u> Beach/subtidal samples will be collected with a 3” hand core (to a depth of 6”) which samples an area approximately $0.0044m^2$. The samples may be rinsed in the field through a 0.5-mm mesh screen if silty sediments are encountered; sand sediments generally will not be rinsed in the field. All cores will be preserved with 10% buffered formalin.

At each station, standard hydrographic measurements will be taken at mean lower low water surface, depths prior to benthic sampling. A YSI® Model 600XL Datasonde or equivalent will be used to measure temperature, conductivity, salinity, pH, and dissolved oxygen (DO) concentration. The table below provides a summary of the benthic macroinfaunal and sediment texture/TOC sampling program.

Summary of benthic community characterization sampling, pre-construction

STATIONS/SURVEY	
STUDY AREA	**Winter**
Beach/Intertidal Benthos	
Project	12
Reference	3
Total Stations (2 per station)	30
Replicates	4
Total Samples	120
Sediment Texture	30
Sediment TOC	30

Laboratory Analyses:

Infauna: In the laboratory, benthic samples will be inventoried, rinsed through a 0.5–mm mesh sieve to remove preservatives and sediment, stained with Rose Bengal, and stored in 70% isopropanol solution until processing. Sample material will be sorted and all macroinvertebrates will be removed and placed in labeled glass vials containing 70% isopropanol, with each vial representing a major taxonomic group (*e.g.* Oligochaeta, Mollusca, Arthropoda) **NOTE**: Any sample materials not destroyed in sample analysis, and retained must have a NPS museum collection number.

Oligochaetes will be individually mounted and cleared on microscope slides prior to identification. All sorted macroinvertebrates will be identified to the lowest practical identification level (LPIL), which in most cases will be to species level unless the specimen is a juvenile, damaged, or otherwise unidentifiable. The number of individuals of each taxon, excluding fragments, will be recorded. A voucher collection will be prepared, composed of representative individuals of each species not previously encountered in samples from the region. Additionally each sample will be analyzed for wet-weight biomass (g/m^2) of the major taxonomic groups identified, to facilitate evaluation of piping plover and red knot feeding habitats.

Sediment Grain Size Analysis and Sediment Total Organic Carbon (TOC): One sample will be collected at each station for sediment grain size analysis. Each sample will be washed with deionized water, dried, and weighed. The coarse and fine fractions (sand/silt) will be separated by sieving through a U.S. Standard Sieve Mesh #230 (62.5 □m). Median grain size and percentages of gravel, sand, silt, and clay will be calculated for each sample.

A subsample of each sediment sample will be analyzed for total organic carbon (TOC). Sediment TOC analyses will be performed according to the guidelines in EPA-600/4-79-020, 1983, Method 415.1 for determination of total organic carbon in sediment and soils.

Data Analyses:

The number of replicate samples taken with the 3” hand core will be sufficient to permit statistical comparisons of pre- and post- placement data. The macroinfaunal data will be analyzed using univariate and multivariate approaches to identify any differences in community structure between project and reference station groups.

The following numerical indices will be calculated for each sample:

1) Infaunal abundance (total number of individuals per station);
2) Infaunal density (total number of individuals per square meter);
3) Species richness (total number of taxa represented in a given station and by Margalef's D);
4) Taxa diversity (Pielou's Index H`); and
5) Evenness (Pielou's Index J`).

An appropriate test of significance will be performed on the univariate indices to determine significant differences between groups (stations). Multivariate analyses will be used consisting of ordination of station species abundance data by multi-dimensional scaling using the Bray-Curtis similarity coefficient, displayed in two dimensions. Classification analyses will be used including the Bray-Curtis similarity measure and hierarchical clustering of similarity values using the group-average sorting strategy. A test of the significance of dissimilarities determined by the ordination will be conducted using a non-parametric permutation procedure on the ordination similarity matrix. The Analysis of Similarities (ANOSIM) module in the Primer statistics program or an analogous routine will be acceptable. A species analysis will be done to determine the contribution of taxa to the average dissimilarity between groups. The SIMPER module of the Primer statistical package or an analogous routine will be acceptable.

Macroinfaunal Data Interpretation: Data interpretation will consist of habitat characterization (water depth, salinity, sediment texture) and benthic community characterization including faunal composition, abundance, and community structure, numerical classification analysis and taxa assemblages. A discussion should also include a comparison of relevant samples collected as part of previous surveys.

Macroinfaunal and sediment data will be used to evaluate the suitability of the sediment for feeding habitat for the piping plover. Potential prey species will be identified and an interpretive report will be prepared to describe use of the study area by piping plover and red knot. A report, including all data, should be submitted to the USFWS and the NPS upon completion of each benthic survey.

APPENDIX D

Piping Plover Life History, Population Dynamics, and Status and Distribution

Life History for Piping Plover

Piping plovers live an average of five years, although studies have documented birds as old as 11 (Wilcox 1959) and 15 years. Breeding activity begins in mid-March when birds begin returning to their nesting areas (Coutu et al. 1990; Cross 1990; Goldin et al. 1990; MacIvor 1990; Hake 1993). Plovers are known to begin breeding as early as one year of age (MacIvor 1990; Haig 1992); however, the percentage of birds that breed in their first adult year is unknown. Piping plovers generally fledge only a single brood per season, but may re-nest several times if previous nests are lost.

The most consistent finding in the various population viability analyses conducted for piping plovers indicates that even small declines in adult and juvenile survival rates will cause very substantial increases in extinction risk (Ryan et al. 1993; Melvin and Gibbs 1996; Plissner and Haig 2000; Wemmer et al. 2001; Larson et al. 2002; Amirault et al. 2005; Calvert et al. 2006; Brault 2007). This suggests that maximizing productivity does not ensure population increases. Efforts to partition survival within the annual cycle are beginning to receive more attention, but current information remains limited. Some evidence of correlation in year-to-year fluctuations in annual survival of Great Lakes and eastern Canada populations, both of which winter primarily along the southeastern U.S. Atlantic Coast, suggests that shared over-wintering and/or migration habitats may influence annual variation in survival. Further concurrent mark-resighting analysis of color-banded individuals across piping plover breeding populations has the potential to shed light on threats that affect survival in the migration and wintering range. However, very little to no information exists specifically for birds wintering along the northern Gulf of Mexico. An ongoing NRDAR study of piping plovers that are potentially affected by the 2010 Deepwater Horizon oil spill may provide such information once the data gathered are eligible for release to the public.

Migration

Plovers depart their breeding grounds for their wintering grounds from July through late August, but southward migration extends through November. Piping plovers spend up to 10 months of their life cycle on their migration and winter grounds, generally July 15 through as late as May 15. Piping plovers migrate through and winter in coastal areas of the U.S. from North Carolina to Texas and in portions of Mexico and the Caribbean. The pattern of both fall and spring counts at many Atlantic Coast sites demonstrates that many piping plovers make intermediate stopovers lasting from a few days up to one month during their migrations (Noel et al. 2005; Stucker and Cuthbert 2006). Use of inland stopovers during migration is also documented (Pompei and Cuthbert 2004). The source breeding population of a given wintering individual cannot be determined in the field unless it has been banded or otherwise marked. Information from observation of color-banded piping plovers indicates that the winter ranges of the breeding populations overlap to a significant degree. See the **Status and distribution** section for additional information pertaining to population distribution on the wintering grounds. While piping plover migration patterns and needs remain poorly understood and occupancy of a particular habitat may involve shorter periods relative to wintering, information about the energetics of avian migration indicates that this might be a particularly critical time in the species' life cycle.

Foraging (nonbreeding portion of annual cycle)

Behavioral observation of piping plovers on the wintering grounds suggests that they spend the majority of their time foraging (Nicholls and Baldassarre 1990a; Drake 1999a, 1999b). Feeding activities may occur during all hours of the day and night (Staine and Burger 1994; Zonick 1997), and at all stages in the tidal cycle (Goldin 1993; Hoopes 1993). Wintering plovers primarily feed on invertebrates such as polycheate marine worms, various crustaceans, fly larvae, beetles, and occasionally bivalve mollusks (Bent 1929; Nicholls 1989; Zonick and Ryan 1995). They peck these invertebrates on top of the soil or just beneath the surface. Plovers forage on moist substrate features such as intertidal portions of ocean beaches, over-wash areas, mudflats, sand flats, algal flats, shoals, wrack lines, sparse vegetation, shorelines of coastal ponds, lagoons, ephemeral pools and adjacent to salt marshes (Gibbs 1986; Zivojnovich 1987; Nichols 1989; Nicholls and Baldassarre 1990a; Nicholls and Baldassarre 1990b; Coutu et al. 1990; Hoopes et al. 1992; Loegering 1992; Goldin 1993; Elias-Gerken 1994; Wilkinson and Spinks 1994; Zonick 1997; Service 2001a). Cohen et al. (2006) documented more abundant prey items and biomass on bay-side islands and beaches than the ocean beach. On the wintering grounds, Ecological Associates, Inc. (2009) observed that during piping plover surveys at St. Lucie Inlet, Martin County, Florida, intertidal mudflats and/or shallow subtidal grass flats appear to have greater value as foraging habitat than the unvegetated intertidal areas of a flood shoal.

Roosting

Several studies identified wrack (organic material including seaweed, seashells, driftwood, and other materials deposited on beaches by tidal action) as an important component of roosting habitat for nonbreeding piping plovers. Lott et al. (2009) found greater than 90 percent of roosting piping plovers in southwest Florida in old wrack with the remainder roosting on dry sand. In South Carolina, 45 percent of roosting piping plovers were in old wrack, and 18 percent were in fresh wrack. The remainder of roosting birds used intertidal habitat (22 percent), backshore (defined as zone of dry sand, shell, cobble and beach debris from mean high water line up to the toe of the dune)(8 percent), over-wash and ephemeral pools 2 percent and 1 percent respectively (Maddock et al. 2009). Thirty percent of roosting piping plovers in northwest Florida were observed in wrack substrates with 49 percent on dry sand and 20 percent using intertidal habitat (Smith 2007). In Texas, sea grass debris (bay-shore wrack) was an important feature of piping plover roost sites (Drake 1999b).

Natural protection

Cryptic coloration is a primary defense mechanism for this species. Nests, adults, and chicks all blend in with their typical beach surroundings. Piping plovers on wintering and migration grounds respond to intruders (pedestrian, avian, and mammalian) usually by squatting, running, and flushing (flying).

Wintering habitat

Wintering piping plovers prefer coastal habitat that include sand spits, islets (small islands), tidal flats, shoals (usually flood tidal deltas), and sandbars that are often associated with inlets (Harrington 2008). Sandy mud flats, ephemeral pools, and over-wash areas are also considered primary foraging habitats. These substrate types have a richer infauna than the foreshore of high energy beaches and often attract large numbers of shorebirds (Cohen et al. 2006). Wintering plovers are dependent on a mosaic of habitat patches and move among these patches depending on local weather and tidal conditions (Nicholls and Baldassarre 1990a). However, piping plovers have been observed to exhibit wintering site fidelity. Mean home range size (95 percent of locations) for 49 radio-marked piping plovers in southern Texas in 1997-98 was 3,113 acres, mean core area (50 percent of locations) was 717 acres, and mean linear distance moved between successive locations (1.97 $\pm$ 0.04 days apart), averaged across seasons, was 2.1 miles (Drake 1999b; Drake et al. 2001). Seven radio-tagged piping plovers used a 4,967-acre area (100 percent minimum convex polygon) at Oregon Inlet in 2005-2006, and piping plover activity was concentrated in 12 areas totaling 544 acres (Cohen et al. 2008a). Noel and Chandler (2008) observed high fidelity of banded piping plovers to 0.62 to 2.8 miles sections of beach on Little St. Simons Island, Georgia.

Study results in North Carolina, South Carolina, and Florida complement information from earlier investigations in Texas and Alabama (summarized in the 1996 Atlantic Coast and 2003 Great Lakes Recovery Plans) regarding habitat use patterns of piping plovers in their coastal migration and wintering range. Lott et al. (2009) identified bay beaches (bay shorelines as opposed to ocean-facing beaches) as the most common landform used by foraging piping plovers in southwest Florida and found approximately 75 percent of foraging piping plovers on intertidal substrates. In northwest Florida, however, Smith (2007) reported landform use by foraging piping plovers about equally divided between Gulf of Mexico (ocean-facing) and bay beaches. Exposed intertidal areas were the dominant foraging substrate in South Carolina (accounting for 94 percent of observed foraging piping plovers; Maddock et al. 2009) and in northwest Florida (96 percent of foraging observations; Smith 2007). Atlantic Coast and Florida studies highlighted the importance of inlets for non-breeding piping plovers. Almost 90 percent of observations of roosting piping plovers at ten coastal sites in southwest Florida were on inlet shorelines (Lott et al. 2009). Piping plovers were among seven shorebird species found more often than expected ($p = 0.0004$; Wilcoxon Scores test) at inlet locations versus non-inlet locations in an evaluation of 361 International Shorebird Survey sites from North Carolina to Florida (Harrington 2008).

Recent geographic analysis of piping plover distribution on the upper Texas coast noted major concentration areas at the mouths of rivers and over-wash passes (low, sparsely vegetated barrier island habitats created and maintained by temporary, storm-driven water channels) into major bay systems (Arvin 2008). Earlier studies in Texas have drawn attention to over-wash passes, which are commonly used by piping plovers during periods of high bay-shore tides and during the spring migration period (Zonick 1997; Zonick 2000). Cobb (*in* Elliott-Smith et al. 2009) reported piping plover concentrations on exposed sea grass beds and oyster reefs during seasonal low water periods in 2006.

The effects of dredge-material deposition on piping plover habitat use merit further study. Drake et al. (2001) concluded that conversion of southern Texas mainland bay-shore tidal flats to dredged material impoundments results in a net loss of habitat for wintering piping plovers, because impoundments eventually convert to upland habitat not used by piping plovers. Zonick et al. (1998) reported that dredged material placement areas along the Intracoastal Waterway in Texas were rarely used by piping plovers, and noted concern that dredge islands block wind-driven water flows, which are critical to maintaining important shorebird habitats. By contrast, most of the sound islands used by foraging piping plovers at Oregon Inlet, North Carolina, were created by the USACE by deposition of dredged material in the subtidal bay bottom, with the most recent deposition ranging from 28 to less than 10 years prior to the study (Cohen et al. 2008a).

Population dynamics

The 2006 International Piping Plover Census (IPPC) documented 3,497 breeding pairs with a total of 8,065 birds throughout all of the Canadian and U.S breeding populations (Elliott-Smith et al. 2009). Results from the 2011 IPPC have not yet been released. A detailed status of each breeding population can be found in the Service's 2009 species status review; however, some information is provided here for clarity of overall population stability.

Northern Great Plains Population

The IPPC, conducted every five years, estimates the number of piping plover adults and breeding pairs in the Northern Great Plains. As illustrated in **Table 1**, none of the IPPC estimates of the number of pairs in the U.S. suggests that the Northern Great Plains population has yet satisfied the recovery criterion as stated in the Service's Recovery Plan (Service 1988) of 2,300 pairs (Plissner and Haig 1997; Ferland and Haig 2002; Elliot-Smith et al. 2009). The 2006 IPPC count in prairie Canada is also short of the recovery goal of 2,500 adult piping plovers.

Table 1 - The number of adult piping plovers and breeding pairs reported in the U.S. Northern Great Plains by the IPPC efforts (Plissner and Haig 1997; Ferland and Haig 2002; Elliot-Smith et al. 2009).

YEAR	ADULTS	PAIRS REPORTED BY THE CENSUS
1991	2,023	891
1996	1,599	586
2001	1,981	899
2006	2,959	1,212

The IPPC indicates that the U.S. population decreased between 1991 and 1996, then increased in 2001 and 2006. The Canadian population showed the reverse trend for the first three censuses, increasing slightly as the U.S. population decreased, and then decreasing in 2001. Combined, the IPPC numbers suggest that the population declined from 1991 through 2001, then increased almost 58 percent between 2001 and 2006 (Elliott-Smith et al. 2009).

The increase in 2006 is likely due in large part to a multi-year drought across much of the region starting in 2001 that exposed thousands of acres of nesting habitat. The USACE ran low flows on the riverine stretches of the Missouri River for most of the years between censuses, allowing more habitat to be exposed and resulting in relatively high fledging ratios (USACE 2009b). The USACE also began to construct habitat using mechanical means (dredging sand from the riverbed) on the Missouri River in 2004, providing some new nesting and foraging habitat. The drought also caused reservoir levels to drop on many reservoirs throughout the Northern Great Plains (e.g., Missouri River Reservoirs in North and South Dakota, and Lake McConaughey in Nebraska), providing previously unavailable shoreline habitat. The population increase may also be partially due to more intensive management activities on the alkali lakes, with increased management actions to improve habitat and reduce predation pressures.

While the IPPC provides an index to the piping plover population, the design does not always provide sufficient information to understand the population's dynamics. The five-year time interval between IPPC efforts may be too long to allow managers to get a clear picture of what the short-term population trends are and to respond accordingly if needed. As noted above, the first three IPPCs (1991, 1996, and 2001) showed a declining population, while the fourth (2006) indicated a dramatic population rebound of almost 58 percent for the combined U.S. and Canada Northern Great Plains population between 2001 and 2006. With only four data points over 15 years, it is impossible to determine if and to what extent the apparent upswing reflects a real population trend versus error(s) in the 2006 census count and/or a previous IPPC. The 2006 IPPC included a detectability component, in which a number of pre-selected sites were visited twice by the same observer(s) during the two-week window to get an estimate of error rate. This study found an approximately 76 percent detectability rate through the entire breeding area, with a range of between 39 percent to 78 percent detectability among habitat types in the Northern Great Plains.

Such a reported large increase in population may indeed indicate a positive population trend, but with the limited data available, it is impossible to determine how much. Furthermore, with the 2011 IPPC results yet to be published and with the next IPPC not scheduled until 2016, there is limited feedback in many areas on whether this increase is being maintained or if the population is declining in the interim. Additionally, the results from the IPPC have been slow to be released, adding to the time lag between data collection and possible management response.

Great Lakes Population

The Recovery Plan (Service 2003) sets a population goal of at least 150 pairs (300 individuals), for at least 5 consecutive years, with at least 100 breeding pairs (200 individuals) in Michigan and 50 breeding pairs (100 individuals) distributed among sites in other Great Lakes states.

The Great Lakes piping plover population, which has been traditionally represented as the number of breeding pairs, has increased since the completion of the recovery plan in 2003 (Cuthbert and Roche 2007; 2006; Westbrock et al. 2005; Stucker and Cuthbert 2004; Stucker et al. 2003). The census conducted in 2008 indicated an increase of approximately 23 percent from the 2002 census numbers. The nesting pairs in Michigan represent approximately 50 percent of the recovery criterion. The breeding pairs outside Michigan in the Great Lakes basin, represents 20 percent of the goal, albeit the number of breeding pairs outside Michigan has continued to increase over the past five years. Breeding pairs increased in 2009 but fell in 2010, and that decline is of particular concern because productivity of the Great Lakes population in 2008 and 2009 was very close to rates associated with earlier population growth. In addition, the number of non-nesting individuals has increased annually since 2003. Although there was some fluctuation in the total population from 2002 to 2008 the overall increase in breeding pairs combined with the increased observance of non-breeding individuals indicates the population is increasing.

Atlantic Coast Population

Available data suggest that the most recent population decline began in the late 1940s or early 1950s (Haig and Oring 1985). Reports of local or statewide declines between 1950 and 1985 are numerous, and many are summarized by Cairns and McLaren (1980) and Haig and Oring (1985). There was little focus on gathering quantitative data on piping plovers in Massachusetts through the late 1960s because the species was commonly observed and presumed to be secure. However, numbers of piping plover breeding pairs declined 50 to 100 percent at seven Massachusetts sites between the early 1970s and 1984 (Griffin and Melvin 1984). Piping plover surveys in the early years of the recovery effort found that counts of these cryptically colored birds sometimes went up with increased census effort, suggesting that some historic counts of piping plovers by one or a few observers may have underestimated the piping plover population. Thus, the magnitude of the species decline may have been more severe than available numbers imply.

Since its 1986 listing under the Act, the Atlantic Coast population estimate (Service 2011a) has increased 234 percent by 2009, and the U.S. portion of the population has almost tripled. Even discounting apparent increases in New York, New Jersey, and North Carolina between 1986 and 1989, which likely were due in part to increased census effort (Service 1996), the population nearly doubled between 1989 and 2008. The largest population increase between 1989 and 2009 has occurred in New England (266 percent), followed by New York-New Jersey (70 percent). In the Southern (DE-MD-VA-NC) Recovery Unit, net growth between 1989 and 2009 was 52 percent, but almost all of this increase occurred in two years, 2003 to 2005. The eastern Canada population fluctuated from year to year, with increases often quickly eroded in subsequent years; net growth between 1989 and 2009 was 8 percent. The overall population growth pattern was tempered by periodic rapid declines in the Southern and Eastern Canada Recovery Units. The eastern Canada population decreased 21 percent in just three years (2002 to 2005), and the population in the southern half of the Southern Recovery Unit declined 68 percent in seven years (1995 to 2001). The recent 64 percent decline in the Maine population from 2002 to 2008, following only a few years of decreased productivity, provides an example of the continuing risk of rapid and precipitous reversals in population growth.

Status and distribution

Nonbreeding (migrating and wintering) Range

Piping plovers spend up to 10 months of their life cycle on their migration and wintering grounds, generally July 15 through as late as May 15. Piping plover migration routes and habitats overlap breeding and wintering habitats, and, unless banded, migrants passing through a site usually are indistinguishable from breeding or wintering piping plovers. Migration stopovers by banded piping plovers from the Great Lakes have been documented in New Jersey, Maryland, Virginia, and North Carolina (Stucker and Cuthbert 2006). Migrating breeders from eastern Canada have been observed in Massachusetts, New Jersey, New York, and North Carolina (Amirault et al. 2005). Staging piping plovers have been tallied at various sites in the Atlantic breeding range (Perkins 2008 pers. comm.), but the composition (e.g., adults that nested nearby and their fledged young of the year versus migrants moving to or from sites farther north), stopover duration, and local movements are unknown. Review of published records of piping plover sightings throughout North America by Pompei and Cuthbert (2004) found more than 3,400 fall and spring stopover records at 1,196 sites. Published reports indicated that piping plovers do not concentrate in large numbers at inland sites and that they seem to stop opportunistically. In most cases, reports of birds at inland sites were single individuals. In general, distance between stopover locations and duration of stopovers throughout the coastal migration range remains poorly understood.

Piping plovers migrate through and winter in coastal areas of the U.S. from North Carolina to Texas and in portions of Mexico and the Caribbean. Four range-wide, mid-winter (late January to early February) IPPC population surveys, conducted at five-year intervals starting in 1991, are summarized in **Table 2**. Total numbers have fluctuated over time, with some areas experiencing increases and others decreases. In 2001, only 40 percent of the known breeding birds recorded during a breeding census were accounted for during a winter census (Ferland and Haig 2002). About 89 percent of birds that are known to winter in the U.S. do so along the Gulf Coast (Texas to Florida), while 8 percent winter along the Atlantic Coast (North Carolina to Florida).

Table 2 - Results of the 1991, 1996, 2001, and 2006 IPPCs of wintering birds (Haig et al. 2005, Elliott-Smith et al. 2009).

Location	**1991**	**1996**	**2001**	**2006**
Virginia	not surveyed (NS)	NS	NS	1
North Carolina	20	50	87	84
South Carolina	51	78	78	100
Georgia	37	124	111	212
Florida	551	375	416	454
-Atlantic	*70*	*31*	*111*	*133*
-Gulf	*481*	*344*	*305*	*321*
Alabama	12	31	30	29
Mississippi	59	27	18	78
Louisiana	750	398	511	226
Texas	1,904	1,333	1,042	2,090
Puerto Rico	0	0	6	NS
U.S. Total	3,384	2,416	2,299	3,355
Mexico	27	16	NS	76
Bahamas	29	17	35	417
Cuba	11	66	55	89
Other Caribbean Islands	0	0	0	28
GRAND TOTAL	3,451	2,515	2,389	3,884
Percent of Total International Piping Plover Breeding Census	62.9%	42.4%	40.2%	48.2%

Regional and local fluctuations may reflect the quantity and quality of suitable foraging and roosting habitat, which vary over time in response to natural coastal formation processes as well as anthropogenic habitat changes (e.g., inlet relocation, dredging of shoals and spits). See, for example, discussions of survey number changes in Mississippi, Louisiana, and Texas by Winstead, Baka, and Cobb, respectively, in Elliott-Smith et al. (2009). Fluctuations may also represent localized weather conditions (especially wind) during surveys, or unequal survey coverage. For example, airboats facilitated first-time surveys of several central Texas sites in 2006 (Cobb in Elliott-Smith et al. 2009). Similarly, the increase in the 2006 numbers in the Bahamas is attributed to greatly increased census efforts; the extent of additional habitat not surveyed remains undetermined (Maddock and Wardle *in* Elliott-Smith et al. 2009). Changes in wintering numbers may also be influenced by growth or decline in the particular breeding populations that concentrate their wintering distribution in a given area. Major opportunities to locate previously unidentified wintering sites are concentrated in the Caribbean and Mexico (see pertinent sections in Elliott-Smith et al. 2009). Further surveys and assessment of seasonally emergent habitats (e.g., sea grass beds, mudflats, oyster reefs) within bays lying between the mainland and barrier islands in Texas are also needed.

Mid-winter surveys may substantially underestimate the abundance of nonbreeding piping plovers using a site or region during other months. Local movements of nonbreeding piping plovers may also affect abundance estimates. At Deveaux Bank, South Carolina, five counts at approximately 10-day intervals between August 27 and October 7, 2006, oscillated from 28 to 14 to 29 to 18 to 26 birds (Maddock et al. 2009). Noel and Chandler (2008) detected banded Great Lakes piping plovers known to be wintering on their Georgia study site in 73.8 $\pm$ 8.1 percent of surveys over three years. Abundance estimates for nonbreeding piping plovers may also be affected by the number of surveyor visits to the site. Preliminary analysis of detection rates by Maddock et al. (2009) found 87 percent detection during the mid-winter period on core sites surveyed three times a month during fall and spring and one time per month during winter, compared with 42 percent detection on sites surveyed three times per year (Cohen 2009 pers. comm.).

Gratto-Trevor et al. (2009; Figure 4) found strong patterns (but no exclusive partitioning) in winter distribution of uniquely banded piping plovers from four breeding populations. All eastern Canada and 94 percent of Great Lakes birds wintered from North Carolina to southwest Florida. However, eastern Canada birds were more heavily concentrated in North Carolina, and a larger proportion of Great Lakes piping plovers were found in South Carolina and Georgia. Northern Great Plains populations were primarily seen farther west and south, especially on the Texas Gulf Coast. Although the great majority of Prairie Canada individuals were observed in Texas, particularly southern Texas, individuals from the U.S. Great Plains were more widely distributed on the Gulf Coast from Florida to Texas.

The findings of Gratto-Trevor et al. (2009) provide evidence of differences in the wintering distribution of piping plovers from these four breeding areas. However, the distribution of birds by breeding origin during migration remains largely unknown. Other major information gaps include the wintering locations of the U.S. Atlantic Coast breeding population (banding of U.S. Atlantic Coast piping plovers has been extremely limited) and the breeding origin of piping plovers wintering on the Caribbean islands and in much of Mexico. Banded piping plovers from the Great Lakes, Northern Great Plains, and eastern Canada breeding populations showed similar patterns of seasonal abundance at Little St. Simons Island, Georgia (Noel et al. 2007). However, the number of banded plovers originating from the latter two populations was relatively small at this study area.

This species exhibits a high degree of intra- and inter-annual wintering site fidelity (Nicholls and Baldassarre 1990a; Drake et al. 2001; Noel et al. 2005; Stucker and Cuthbert 2006). Gratto-Trevor et al. (2009) reported that six of 259 banded piping plovers observed more than once per winter moved across boundaries of the seven U.S. regions. Of 216 birds observed in different years, only eight changed regions between years, and several of these shifts were associated with late summer or early spring migration periods (Gratto-Trevor et al. 2009; Figure 4).

Local movements are more common. In South Carolina, Maddock et al. (2009) documented many cross-inlet movements by wintering banded piping plovers as well as occasional movements of up to 11 miles by approximately 10 percent of the banded population; larger movements within South Carolina were seen during fall and spring migration. Similarly, eight banded piping plovers that were observed in two locations during 2006-2007 surveys in Louisiana and Texas were all in close proximity to their original location, such as on the bay and ocean side of the same island or on adjoining islands (Maddock 2008).

The 2004 and 2005 hurricane seasons affected a substantial amount of habitat along the Gulf Coast. Habitats such as those along Gulf Islands National Seashore have benefited from increased over-wash events, which created optimal habitat conditions for piping plovers. Conversely, hard shoreline structures put into place following storms throughout the species range to prevent such shoreline migration prevent habitat creation. Four hurricanes between 2002 and 2005 are often cited in reference to rapid erosion of the Chandeleur Islands, a chain of low-lying islands off the coast of Louisiana where the 1991 IPPC tallied more than 350 piping plovers. Those same storms, however, created habitats such as over-wash fans and sand spits on barrier islands and headlands in other portions of MS. (See the Storm events section below for more details on their effects to habitat.)

The Service is aware of the following site-specific conditions that benefit several habitats piping plover use while wintering and migrating, including critical habitat units. In Texas, one critical habitat unit was afforded greater protection due to the acquisition of adjacent upland properties by the local Audubon chapter. On another unit in Texas, vehicles were removed from a portion of the beach decreasing the likelihood of automobile disturbance to plovers. Exotic plant removal that threatens to invade suitable piping plover habitat is occurring in a critical habitat unit in South Florida. The Service and other government agencies remain in a contractual agreement with the U.S. Department of Agriculture (USDA) for predator control within limited coastal areas in the Florida panhandle, including portions of some critical habitat units. Continued removal of potential terrestrial predators is likely to enhance survivorship of wintering and migrating piping plovers. In North Carolina, one critical habitat unit was afforded greater protection when the local Audubon chapter agreed to manage the area specifically for piping plovers and other shorebirds following the relocation of the nearby inlet channel.

Recovery criteria

<u>Northern Great Plains Population (Service 1988, 1994)</u>

1. Increase the number of birds in the U.S. northern Great Plains states to 2,300 pairs (Service 1994).

2. Increase the number of birds in the prairie region of Canada to 2,500 adult piping plovers (Service 1988).

3. Secure long term protection of essential breeding and wintering habitat (Service 1994).

<u>Great Lakes Population (Service 2003)</u>

1. At least 150 pairs (300 individuals), for at least 5 consecutive years, with at least 100 breeding pairs (200 individuals) in Michigan and 50 breeding pairs (100 individuals) distributed among sites in other Great Lakes states.

2. Five-year average fecundity within the range of 1.5-2.0 fledglings per pair, per year, across the breeding distribution, and ten-year population projections indicate the population is stable or continuing to grow above the recovery goal.

3. Protection and long-term maintenance of essential breeding and wintering habitat is ensured, sufficient in quantity, quality, and distribution to support the recovery goal of 150 pairs (300 individuals).

4. Genetic diversity within the population is deemed adequate for population persistence and can be maintained over the long-term.

5. Agreements and funding mechanisms are in place for long-term protection and management activities in essential breeding and wintering habitat.

<u>Atlantic Coast Population (Service 1996)</u>

1. Increase and maintain for five years a total of 2,000 breeding pairs, distributed among 4 recovery units.

Recovery Unit	Minimum Subpopulation
Atlantic (eastern) Canada	400 pairs
New England	625 pairs
New York-New Jersey	575 pairs
Southern (DE-MD-VA-NC)	400 pairs

2. Verify the adequacy of a 2,000 pair population of piping plovers to maintain heterozygosity and allelic diversity over the long term.

3. Achieve a 5-year average productivity of 1.5 fledged chicks per pair in each of the 4 recovery units described in criterion 1, based on data from sites that collectively support at least 90 percent of the recover unit's population.

4. Institute long-term agreements to assure protection and management sufficient to maintain the population targets and average productivity in each recovery unit.

5. Ensure long-term maintenance of wintering habitat, sufficient in quantity, quality, and distribution to maintain survival rates for a 2,000-pair population.

Threats to piping plovers/critical habitat

In the following sections, we provide an analysis of threats to piping plovers in their migration and wintering range. We update information obtained since the 1985 listing rule, the 1991 and 2009 status reviews, and the three breeding population recovery plans. Both previously identified and new threats are discussed. With minor exceptions, this analysis is focused on threats to piping plovers within the continental U.S. portion of their migration and wintering range. Threats in the Caribbean and Mexico remain largely unknown.

<u>Present or threatened destruction, modification, or curtailment of its habitat or range</u>

The status of piping plovers on winter and migration grounds is difficult to assess, but threats to piping plover habitat used during winter and migration (identified by the Service during its designation of critical habitat) continue to affect the species. Unregulated motorized and pedestrian recreational use, inlet and shoreline stabilization projects, beach maintenance and nourishment, and pollution affect most winter and migration areas. Conservation efforts at some locations have likely resulted in the enhancement of wintering habitat.

The 1985 final listing rule stated that the number of piping plovers on the Gulf of Mexico coastal wintering grounds might be declining as indicated by preliminary analysis of Christmas Bird Count data. Independent counts of piping plovers on the AL coast indicated a decline in numbers between the 1950s and early 1980s. At the time of listing, the Texas Parks and Wildlife Department stated that 30 percent of wintering habitat in Texas had been lost over the previous 20 years. The final rule also stated that in addition to extensive breeding area problems, the loss and modification of wintering habitat was a significant threat to the piping plover.

The three recovery plans state that shoreline development throughout the wintering range poses a threat to all populations of piping plovers. The plans further state that beach maintenance and nourishment, inlet dredging, and artificial structures, such as jetties and groins, could eliminate wintering areas and alter sedimentation patterns leading to the loss of nearby habitat. Priority 1 actions in the 1996 Atlantic Coast and 2003 Great Lakes Recovery Plans identify tasks to protect natural processes that maintain coastal ecosystems and quality wintering piping plover habitat and to protect wintering habitat from shoreline stabilization and navigation projects. The 1988

Northern Great Plains Recovery Plan states that, as winter habitat is identified, current and potential threats to each site should be determined.

Important components of ecologically sound barrier beach management include perpetuation of natural dynamic coastal formation processes. Structural development along the shoreline or manipulation of natural inlets upsets the dynamic processes and results in habitat loss or degradation (Melvin et al. 1991). Throughout the range of migrating and wintering piping plovers, inlet and shoreline stabilization, inlet dredging, beach maintenance and nourishment activities, and seawall installations continue to constrain natural coastal processes. Dredging of inlets can affect spit formation adjacent to inlets and directly remove or affect ebb and flood tidal shoal formation. Jetties, which stabilize an island, cause island widening and subsequent growth of vegetation on inlet shores. Seawalls restrict natural island movement and exacerbate erosion. As discussed in more detail below, all these efforts result in loss of piping plover habitat. Construction of these projects during months when piping plovers are present also causes disturbance that disrupts the birds' foraging efficiency and hinders their ability to build fat reserves over the winter and in preparation for migration, as well as their recuperation from migratory flights. Additional investigation is needed to determine the extent to which these factors cumulatively affect piping plover survival and how they may impede conservation efforts for the species.

Any assessment of threats to piping plovers from loss and degradation of habitat must recognize that up to 24 shorebird species migrate or winter along the Atlantic Coast and almost 40 species of shorebirds are present during migration and wintering periods in the Gulf of Mexico region (Helmers 1992). Continual degradation and loss of habitats used by wintering and migrating shorebirds may cause an increase in intra-specific and inter-specific competition for remaining food supplies and roosting habitats. In Florida, for example, approximately 825 miles of coastline and parallel bayside flats (unspecified amount) were present prior to the advent of high human densities and beach stabilization projects. We estimate that only about 35 percent of the Florida coastline continues to support natural coastal formation processes, thereby concentrating foraging and roosting opportunities for all shorebird species and forcing some individuals into suboptimal habitats. Thus, intra- and inter-specific competition most likely exacerbates threats from habitat loss and degradation.

<u>Sand placement projects</u>

In the wake of episodic storm events, managers of lands under public, private, and county ownership often protect coastal structures using emergency storm berms; this is frequently followed by beach nourishment or renourishment activities (nourishment projects are considered "soft" stabilization versus "hard" stabilization such as seawalls). Berm placement and beach nourishment deposit substantial amounts of sand along Gulf of Mexico and Atlantic beaches to protect local property in anticipation of preventing erosion and what otherwise will be considered natural processes of over-wash and island migration (Schmitt and Haines 2003). On unpopulated islands, the addition of sand and creation of marsh are sometimes used to counteract the loss of roosting and nesting habitat for shorebirds and wading birds as a result of erosional storm events.

Past and ongoing stabilization projects may fundamentally alter the naturally dynamic coastal processes that create and maintain beach strand and bayside habitats, including those habitat components that piping plovers rely upon. Although impacts may vary depending on a range of factors, stabilization projects may directly degrade or destroy piping plover roosting and foraging habitat in several ways. Front beach habitat may be used to construct an artificial berm that is densely planted in grass, which can directly reduce the availability of roosting habitat. Over time, if the beach narrows due to erosion, additional roosting habitat between the berm and the water can be lost. Berms can also prevent or reduce the natural over-wash that creates roosting habitats by converting vegetated areas to open sand areas. The vegetation growth caused by impeding natural over-wash can also reduce the maintenance and creation of bayside intertidal feeding habitats. In addition, stabilization projects may indirectly encourage further development of coastal areas and increase the threat of disturbance.

At least 668 of 2,340 coastal shoreline miles (29 percent of beaches throughout the piping plover winter and migration range in the U.S.) are bermed, nourished, or renourished, generally for recreational purposes and to protect commercial and private infrastructure (**Table 3**). However, only approximately 54 miles or 2.31 percent of these impacts have occurred within critical habitat.

Table 3 - Summary of the extent of nourished beaches in piping plover wintering and migrating habitat within the conterminous United States. Data extracted from service unpublished data (project files, gray literature, and field observations) as of 2009.

State	Sandy beach shoreline miles available	Sandy beach shoreline miles nourished to date (within CH[g] units)	Percent of sandy beach shoreline affected (within CH[g] units)
North Carolina	301[a]	117[e] (unknown)	39 (unknown)
South Carolina	187[a]	56 (0.6)	30 (0.32))
Georgia	100[a]	8 (0.4)	8 (0.40)
Florida	825[b]	404 (6)[f]	49 (0.72)
Alabama	53[a]	12 (2)	23 (3.77)
Mississippi	110[c]	≥6 (0)	5 (0)
Louisiana	397[a]	Unquantified (generally restoration-oriented)	Unknown
Texas	367[d]	65 (45)	18 (12.26)
Overall Total	2,340 (does not include Louisiana)	≥668 does not include Louisiana (54 in CH)	29% (≥2.31% in CH)

(a) Data from www.50states.com; (b) Clark 1993; (c) N. Winstead, Mississippi Museum of Natural Science, in lit. 2008; (d) www.Surfrider.org; (e) Hall 2009 pers. comm.; (f) Partial data from Lott et al. (2009); (g) CH = critical habitat.

In MS, the sustainability of the coastal ecosystem is threatened by the inability of the barrier islands to maintain geomorphologic functionality (USACE 2011). Consequently, most of the planned sediment placement projects are conducted as environmental restoration projects by various Federal and State agencies because without the sediment many areas would erode below sea level since the Mississippi coastal systems are starved for sediment sources. Agencies conducting coastal restoration projects aim to design projects that mimic the natural existing elevations of coastal habitats (e.g., beach, dune, and marsh) in order to allow their projects to work within and be sustained by the natural ecosystem processes that maintain those coastal habitats. Due to the low elevation of barrier islands and coastal headlands, placement of additional sediment in those areas generally does not reach an elevation that would prevent the formation of over-wash areas or impede natural coastal processes, especially during storm events. Such careful design of these restoration projects allows daily tidal processes or storm events to re-work the sediments to reform the Gulf/beach interface and create over-wash areas, sand flats, and mud flats on the bay-side of the islands, as well as sand spits on the ends of the islands; thus, the added sediment aids in sustaining the barrier island system.

Sediment placement also temporarily affects the benthic fauna found in intertidal systems by covering them with a layer of sediment. Some benthic species can burrow through a thin layer (varies from 15 to 35 inches for different species) of additional sediment since they are adapted to the turbulent environment of the intertidal zone; however, thicker layers (i.e., greater than 40 inches) of sediment are likely to smother the benthic fauna (Greene 2002). Various studies of such effects indicate that the recovery of benthic fauna after beach renourishment or sediment placement can take anywhere from six months to two years (Rakocinski et al. 1996; Peterson et al. 2000; Peterson et al. 2006). Such delayed recovery of benthic prey species temporarily affects the quality of piping plover foraging habitat.

Inlet stabilization/relocation

Many navigable mainland or barrier island tidal inlets along the Atlantic and Gulf of Mexico coasts are stabilized with jetties, groins, or by seawalls and/or adjacent industrial or residential development. Jetties are structures built perpendicular to the shoreline that extend through the entire near-shore zone and past the breaker zone to prevent or decrease sand deposition in the channel (Hayes and Michel 2008). Inlet stabilization with rock jetties and associated channel dredging for navigation alter the dynamics of long-shore sediment transport and affect the location and movement rate of barrier islands (Camfield and Holmes 1995), typically causing down-drift erosion. Sediment is then dredged and added back to the islands which are subsequently widened. Once the island becomes stabilized, vegetation encroaches on the bayside habitat, thereby diminishing and eventually destroying its value to piping plovers. Accelerated erosion may compound future habitat loss, depending on the degree of sea-level rise. Unstabilized inlets naturally migrate, re-forming important habitat components, whereas jetties often trap sand and cause significant erosion of the down-drift shoreline. These combined actions affect the availability of piping plover habitat (Cohen et al. 2008b).

Using Google Earth© (accessed April 2009), Service biologists visually estimated the number of navigable mainland or barrier island tidal inlets throughout the wintering range of the piping plover in the conterminous U.S. that have some form of hardened structure. This includes seawalls or adjacent development, which lock the inlets in place.

Table 4 - Visually estimated numbers of navigable mainland and barrier island inlets and hardened inlets by state.

State	Number of navigable mainland and barrier island inlets	Number of hardened inlets	Percent of inlets affected
North Carolina	20	2.5*	12.5%
South Carolina	34	3.5*	10.3%
Georgia	26	2	7.7%
Florida	82	41	50%
Alabama	14	6	42.9%
Mississippi	16	7	43.8%
Louisiana	40	9	22.5%
Texas	17	10	58.8%
Overall Total	249	81	32.5%

*An inlet at the state line is considered to be half an inlet counted in each state.

Tidal inlet relocation can cause loss and/or degradation of piping plover habitat; although less permanent than construction of hard structures, effects can persist for years. For example, a project on Kiawah Island, South Carolina, degraded one of the most important piping plover habitats in the State by reducing the size and physical characteristics of an active foraging site, changing the composition of the benthic community, decreasing the tidal lag in an adjacent tidal lagoon, and decreasing the exposure time of the associated sand flats (Service and Town of Kiawah Island 2006). In 2006, pre-project piping plover numbers in the project area recorded during four surveys conducted at low tide averaged 13.5 piping plovers. This contrasts with a post-project average of 7.1 plovers during eight surveys (four in 2007 and four in 2008) conducted during the same months (Service and Town of Kiawah Island 2006), indicating that reduced habitat quality was one possible cause of the lower usage by plovers. Service biologists are aware of at least seven inlet relocation projects (two in North Carolina, three in South Carolina, two in Florida), but this number likely under-represents the extent of this activity.

Sand mining/dredging

Sand mining, the practice of extracting (dredging) sand from sand bars, shoals, and inlets in the near-shore zone, is a less expensive source of sand than obtaining sand from offshore shoals for beach nourishment. Sand bars and shoals are sand sources that move onshore over time and act as natural breakwaters. Inlet dredging reduces the formation of exposed ebb and flood tidal shoals considered to be primary or optimal piping plover roosting and foraging habitat. Removing these sand sources can alter depth contours and change wave refraction as well as cause localized erosion (Hayes and Michel 2008). Exposed shoals and sandbars are also valuable to piping plovers, as they tend to receive less human recreational use (because they are only accessible by boat) and therefore provide relatively less disturbed habitats for birds. We do not have a good estimate of the amount of sand mining that occurs across the piping plover wintering range, nor do we have a good estimate of the number of inlet dredging projects that occur. This number is likely greater than the number of total jettied inlets shown in Table 5, since most jettied inlets need maintenance dredging, but non-hardened inlets are often dredged as well.

Groins

Groins (structures made of concrete, rip rap, wood, or metal built perpendicular to the beach in order to trap sand) are typically found on developed beaches with severe erosion. Although groins can be individual structures, they are often clustered along the shoreline. Groins can act as barriers to long-shore sand transport and cause down-drift erosion (Hayes and Michel 2008), which prevents piping plover habitat creation by limiting sediment deposition and accretion. These structures are found throughout the southeastern Atlantic Coast, and although most were in place prior to the piping plover's 1986 listing under the Act, installation of new groins continues to occur.

Seawalls and revetments

Seawalls and revetments are vertical hard structures built parallel to the beach in front of buildings, roads, and other facilities to protect them from erosion. However, these structures often accelerate erosion by causing scouring in front of and down-drift from the structure (Hayes and Michel 2008), which can eliminate intertidal foraging habitat and adjacent roosting habitat. Physical characteristics that determine microhabitats and biological communities can be altered after installation of a seawall or revetment, thereby depleting or changing composition of benthic communities that serve as the prey base for piping plovers. At four California study sites, each comprised of an unarmored segment and a segment seaward of a seawall, Dugan and Hubbard (2006) found that armored segments had narrower intertidal zones, smaller standing crops of macrophyte wrack, and lower shorebird abundance and species richness. Geotubes (long cylindrical bags made of high-strength permeable fabric and filled with sand) are softer alternatives, but act as barriers by preventing over-wash. We did not find any sources that summarize the linear extent of seawall, revetment, and geotube installation projects that have occurred across the piping plover's wintering and migration habitat.

Exotic/invasive vegetation

A recently identified threat to piping plover habitat, not described in the listing rule or recovery plans, is the spread of coastal invasive plants into suitable piping plover habitat. Like most invasive species, coastal exotic plants reproduce and spread quickly and exhibit dense growth habits, often outcompeting native plant species. If left uncontrolled, invasive plants cause a habitat shift from open or sparsely vegetated sand to dense vegetation, resulting in the loss or degradation of piping plover roosting habitat, which is especially important during high tides and migration periods.

Beach vitex (*Vitex rotundifolia*) is a woody vine introduced into the southeastern U.S. as a dune stabilization and ornamental plant (Westbrooks and Madsen 2006). It currently occupies a very small percentage of its potential range in the U.S.; however, it is expected to grow well in coastal communities throughout the southeastern U.S. from Virginia to Florida, and west to Texas (Westbrooks and Madsen 2006). In 2003, the plant was documented in New Hanover, Pender, and Onslow counties in North Carolina, and at 125 sites in Horry, Georgetown, and Charleston counties in South Carolina. One Chesapeake Bay site in Virginia was eradicated, and another site on Jekyll Island, Georgia, is about 95 percent controlled (Suiter 2009 pers. comm.). Beach vitex has been documented from two locations in northwest Florida, but one site disappeared after erosional storm events. The landowner of the other site has indicated an intention to eradicate the plant, but follow through is unknown (Farley 2009 pers. comm.). The task forces formed in North and South Carolina in 2004 and 2005 have made great strides to remove this plant from their coasts. To date, about 200 sites in North Carolina have been treated, with 200 additional sites in need of treatment. Similar efforts are underway in South Carolina.

Unquantified amounts of crowfoot grass (*Dactyloctenium aegyptium*) grow invasively along portions of the Florida coastline. It forms thick bunches or mats that may change the vegetative structure of coastal plant communities and alter shorebird habitat. The Australian pine (*Casuarina equisetifolia*) also changes the vegetative structure of the coastal community in south Florida and islands within the Bahamas. Shorebirds prefer foraging in open areas where they are able to see potential predators, and tall trees provide good perches for avian predators. Australian pines potentially impact shorebirds, including the piping plover, by reducing attractiveness of foraging habitat and/or increasing avian predation.

The propensity of these exotic species to spread, and their tenacity once established, make them a persistent threat, partially countered by increasing landowner awareness and willingness to undertake eradication activities.

Wrack removal and beach cleaning

Wrack on beaches and baysides provides important foraging and roosting habitat for piping plovers (Drake 1999a; Smith 2007; Maddock et al. 2009; Lott et al. 2009) and many other shorebirds on their winter, breeding, and migration grounds. Because shorebird numbers are positively correlated with wrack cover and biomass of their invertebrate prey that feed on wrack (Tarr and Tarr 1987; Hubbard and Dugan 2003; Dugan et al. 2003), beach grooming will lower bird numbers (Defeo et al. 2009).

There is increasing popularity along developed beaches in the Southeast, especially in Florida, for beach communities to carry out “beach cleaning” and “beach raking” actions. Beach cleaning occurs on private beaches, where piping plover use is not well documented, and on some municipal or county beaches that are used by piping plovers. Most wrack removal on state and federal lands is limited to post-storm cleanup and does not occur regularly.

Man-made beach cleaning and raking machines effectively remove seaweed, fish, glass, syringes, plastic, cans, cigarettes, shells, stone, wood, and virtually any unwanted debris (Barber Beach Cleaning Equipment 2009). These efforts remove accumulated wrack, topographic depressions, and sparse vegetation nodes used by roosting and foraging piping plovers. Removal of wrack also eliminates a beach’s natural sand-trapping abilities, further destabilizing the beach. In addition, sand adhering to seaweed and trapped in the cracks and crevices of wrack is removed from the beach. Although the amount of sand lost due to single sweeping actions may be small, it adds up considerably over a period of years (Nordstrom et al. 2006; Neal et al. 2007).

Beach cleaning or grooming can result in abnormally broad unvegetated zones that are inhospitable to dune formation or plant colonization, thereby enhancing the likelihood of erosion (Defeo et al. 2009).

We estimate that 240 of 825 miles (29 percent) of sandy beach shoreline in Florida are cleaned or raked on various schedules (i.e., daily, weekly, monthly) (FDEP 2008). Service biologists estimate that South Carolina mechanically cleans approximately 34 of its 187 shoreline miles (18 percent), and Texas mechanically cleans approximately 20 of its 367 shoreline miles (5.4 percent). In Louisiana, beach raking occurs on Grand Isle (the state's only inhabited island) along approximately 8 miles of shoreline, roughly 2 percent of the state's 397 sandy shoreline miles. We are not aware of what percentage of mechanical cleaning occurs elsewhere in piping plover critical habitat.

Tilling beaches to reduce soil compaction, as sometimes required by the Service for sea turtle protection after beach nourishment activities, also has similar impacts. Recently, the Service improved sea turtle protection provisions in Florida; these provisions now require tilling, when needed, to be above the primary wrack line, not within it.

Disease

Neither the final listing rule nor the recovery plans state that disease is an issue for the species, and no plan assigns recovery actions to this threat factor. Based on information available to date, West Nile virus and avian influenza are a minor threat to piping plovers (Service 2009a).

Predation

The impact of predation on migrating or wintering piping plovers remains largely undocumented. Except for one incident reported in 2007 by the New York Times involving a cat in Texas, no depredation of piping plovers during winter or migration has been noted, although it would be difficult to document. Avian and mammalian predators are common throughout the species' wintering range. Predatory birds are relatively common during fall and spring migration, and it is possible that raptors occasionally take piping plovers (Drake et al. 2001). The 1996 Atlantic Coast Recovery Plan summarized evidence that human activities affect types, numbers, and activity patterns of some predators, thereby exacerbating natural predation on breeding piping plovers. It has been noted, however, that the behavioral response of crouching when in the presence of avian predators may minimize avian predation on piping plovers (Morrier and McNeil 1991; Drake 1999a; Drake et al. 2001).

Piping plovers may reap some collateral benefits from predator management on their migration and wintering grounds conducted for the primary benefit of other species. In 1997, the USDA implemented a public lands predator control partnership in northwest Florida that included the Department of Defense, National Park Service (NPS), the State of Florida (state park lands), and the Service (National Wildlife Refuges and Ecological Services). The program continues with all partners except Florida – in 2008, lack of funding precluded inclusion of Florida state lands (although Florida Department of Environmental Protection staff conduct occasional predator trapping on state lands, trapping is not implemented consistently). The NPS and individual state park staff in North Carolina participate in predator control programs (Rabon 2009 pers. comm.). The Service issued permit conditions for raccoon eradication to Indian River County staff in Florida as part of a coastal Habitat Conservation Plan (Adams 2009 pers. comm.). Destruction of turtle nests by dogs or coyotes in the Indian River area justified the need to amend the permit to include an education program targeting dog owners regarding the appropriate means to reduce impacts to coastal species caused by their pets. The Service partnered with Texas Audubon and the Coastal Bend Bays and Estuaries Program in Texas to implement predator control efforts on colonial water bird nesting islands (Cobb 2009 pers. comm.). Some of these predator control programs may provide limited protection to piping plovers, should they use these areas for roosting or foraging. The table below summarizes predator control actions on a state-by-state basis. The Service is not aware of any current predator control programs targeting protection of coastal species in Georgia, Alabama, Mississippi, or Louisiana.

Table 5 - Summary of predator control programs that may benefit piping plovers/red knot on winter and migration grounds (as of 2009).

State	Entities with Predator Control Programs
North Carolina	State Parks, Cape Lookout and Cape Hatteras National Seashores.
South Carolina	As needed throughout the state, targets raccoons and coyotes.
Georgia	No programs known.
Florida	Merritt Island NWR, Cape Canaveral AFS, Indian River County, Eglin AFB, Gulf Islands NS, northwest Florida state parks (up until 2008), St. Vincent NWR, Tyndall AFB.
Alabama	Late 1990's and 2009-2010 Gulf State Park and Orange Beach for beach mice, no current programs known.
Mississippi	No programs known.
Louisiana	No programs known.
Texas	Aransas NWR (hog control for habitat protection), Audubon (mammalian predator control on colonial water bird islands that have occasional piping plover use).

Regarding predation, the magnitude of this threat to nonbreeding piping plovers remains unknown, but given the pervasive, persistent, and serious impacts of predation on other coastal reliant species, it remains a potential threat. Focused research to confirm impacts as well as to ascertain effectiveness of predator control programs may be warranted, especially in areas frequented by Great Lakes birds during migration and wintering months. We consider predator control on their wintering and migration grounds to be a low priority at this time.[1]

Human disturbance

Disturbance (i.e., human and pet presence that alters bird behavior) disrupts piping plovers as well as other shorebird species. Intense human disturbance in shorebird winter habitat can be functionally equivalent to habitat loss if the disturbance prevents birds from using an area for a significant amount of time (Goss-Custard et al. 1996), which can lead to roost abandonment and local population declines (Burton et al. 1996). Pfister et al. (1992) implicate anthropogenic disturbance as a factor in the long-term decline of migrating shorebirds at staging areas. Disturbance can also cause shorebirds to spend less time roosting or foraging and more time in alert postures or fleeing from the disturbances (Johnson and Baldassarre 1988; Burger 1991;

[1] The threat of direct predation should be distinguished from the threat of disturbance to roosting and feeding piping plovers posed by dogs off leash.

Burger 1994; Elliott and Teas 1996; Lafferty 2001a, 2001b; Thomas et al. 2002), which limits the local abundance of piping plovers (Zonick and Ryan 1995; Zonick 2000). Shorebirds that are repeatedly flushed in response to disturbance expend energy on costly short flights (Nudds and Bryant 2000) and may not feed enough to support migration and/or subsequent breeding efforts (Puttick 1979; Lafferty 2001b).

Elliott and Teas (1996) found a significant difference in actions between piping plovers encountering pedestrians and those not encountering pedestrians. Piping plovers encountering pedestrians spend proportionately more time in non-foraging behavior. This study suggests that interactions with pedestrians on beaches cause birds to shift their activities from calorie acquisition to calorie expenditure. In wintering and migration sites, human disturbance continues to decrease the amount of undisturbed habitat and appears to limit local piping plover abundance (Zonick and Ryan 1995).

Shorebirds are more likely to flush from the presence of dogs than people, and birds react to dogs from farther distances than people (Lafferty 2001a, 2001b; Thomas et al. 2002). Dogs off leash are more likely to flush piping plovers from farther distances than are dogs on leash; nonetheless, dogs both on and off leashes disturb piping plovers (Hoopes 1993). Pedestrians walking with dogs often go through flocks of foraging and roosting shorebirds, which may increase the likelihood that dogs would chase birds. Although the timing, frequency, and duration of human and dog presence throughout the wintering range are unknown, studies in AL and South Carolina suggest that most disturbances to piping plovers occur during periods of warmer weather, which coincides with piping plover migration (Johnson and Baldassarre 1988; Lott et al. 2009; Maddock et al. 2009). Smith (2007) documents varying disturbance levels throughout the nonbreeding season at northwest Florida sites.

Off-road vehicles can significantly degrade piping plover habitat (Wheeler 1979) or disrupt the birds' normal behavior patterns (Zonick 2000). The 1996 Atlantic Coast Recovery Plan cites tire ruts crushing wrack into the sand, making it unavailable as cover or as foraging substrate (Hoopes 1993; Goldin 1993). The plan also notes that the magnitude of the threat from off-road vehicles is particularly significant, because vehicles extend impacts to remote stretches of beach where human disturbance will otherwise be very slight. Godfrey et al. (1978, 1980 as cited in Lamont et al. 1997) postulated that vehicular traffic along the beach may compact the substrate and kill marine invertebrates that are food for the piping plover. Zonick (2000) found that the density of off-road vehicles negatively correlated with abundance of roosting piping plovers on the ocean beach. Cohen et al. (2008a) found that radio-tagged piping plovers using ocean beach habitat at Oregon Inlet in North Carolina were far less likely to use the north side of the inlet where off-road vehicle use is allowed, and recommended controlled management experiments to determine if recreational disturbance drives roost site selection. Ninety-six percent of piping plover detections occurred on the south side of the inlet even though it was farther away from foraging sites (1.1 miles from the sound side foraging site to the north side of the inlet versus 0.25-mile from the sound side foraging site to the north side of the inlet) (Cohen et al. 2008a).

Based on surveys with land managers and biologists, knowledge of local site conditions, and other information, the Service has estimated the levels of eight types of disturbance at sites in the U.S. with wintering piping plovers. **Table 6** summarizes the disturbance analysis results

(Service 2009b). Data are not available on human disturbance at wintering sites in the Bahamas, other Caribbean countries, or Mexico. There are few areas used by wintering piping plovers that are devoid of human presence, and just under half have leashed and unleashed dog presence (Smith 2007; Lott et al. 2009, Service unpublished data 2009; Maddock and Bimbi unpublished data).

Table 6 - Percent of known piping plover winter and migration habitat locations, by state, where various types of anthropogenic disturbance have been reported.

	Percent by State							
Disturbance Type	AL	FL	GA	LA	MS	NC	SC	TX
Pedestrians	67	92	94	25	100	100	88	54
Dogs on leash	67	69	31	25	73	94	25	25
Dogs off leash	67	81	19	25	73	94	66	46
Bikes	0	19	63	25	0	0	28	19
ATVs[a]	0	35	0	25	0	17	25	30
ORVs[b]	0	21	0	25	0	50	31	38
Boats	33	65	100	100	0	78	63	44
Kite surfing	0	10	0	0	0	33	0	0

(a) ATV = all-terrain vehicle; (b) ORV = off-road vehicle

LeDee et al. (2010) collected survey responses in 2007 from 35 managers (located in seven states) at sites that were designated as critical habitat for wintering piping plovers. Ownership included federal, state, and local governmental agencies and non-governmental organizations managing national wildlife refuges; national, state, county, and municipal parks; state and estuarine research reserves; state preserves; state wildlife management areas; and other types of managed lands. Of 43 reporting sites, 88 percent allowed public beach access year-round and four sites were closed to the public. Sixty-two percent of site managers reported greater than 10,000 visitors from September through March, and 31 percent reported greater than 100,000 visitors. Restrictions on visitor activities on the beach included automobiles (at 81 percent of sites), all-terrain vehicles (89 percent), and dogs during the winter season (50 percent). Half of the survey respondents reported funding as a primary limitation in managing piping plovers and other threatened and endangered species at their sites. Other limitations included “human resource capacity” (24 percent), conflicting management priorities (12 percent), and lack of research (3 percent).

Disturbance can be addressed by implementing recreational management techniques such as vehicle and pet restrictions and symbolic fencing (usually sign posts and string) of roosting and feeding habitats. In implementing conservation measures, managers need to consider a range of site-specific factors, including the extent and quality of roosting and feeding habitats and the types and intensity of recreational use patterns. In addition, educational materials such as informational signs or brochures can provide valuable information so that the public understands the need for conservation measures.

In summary, although there is some variability among states, disturbance from human activities and pets poses a moderate to high and escalating threat to migrating and wintering piping plovers. Systematic review of recreation policy and beach management across the nonbreeding range will assist in better understanding cumulative impacts. Site-specific analysis and implementation of conservation measures should be a high priority at piping plover sites that have moderate or high levels of disturbance. The Service and state wildlife agencies should increase technical assistance to land managers to implement management strategies and monitor their effectiveness.

Military Actions

Twelve coastal military bases are located in the Southeast. To date, five bases have consulted with the Service under section 7 of the Act, on military activities on beaches and baysides that may affect piping plovers or their habitat (see table below). Camp Lejeune in North Carolina consulted formally with the Service in 2002 on troop activities, dune stabilization efforts, and recreational use of Onslow Beach. The permit conditions require twice-monthly piping plover surveys and use of buffer zones and work restrictions within buffer zones. Naval Air Station-Mayport in Duval County, Florida, consulted with the Service on Marine USACE training activities that included beach exercises and use of amphibious assault vehicles. The area of impact was not considered optimal for piping plovers, and the consultation was concluded informally. Similar informal consultations have occurred with Tyndall Air Force Base (Bay County) and Eglin Air Force Base (Okaloosa and Santa Rosa counties) in northwest Florida. Both consultations dealt with occasional use of motorized equipment on the beaches and associated baysides. Tyndall Air Force Base has minimal on-the-ground use, and activities, when conducted, occur on the Gulf of Mexico beach, which is not considered the optimal area for piping plovers within this region. Eglin Air Force Base conducts bi-monthly surveys for piping plovers, and habitats consistently documented with piping plover use are posted with avoidance requirements to minimize direct disturbance from troop activities. A 2001 consultation with the Navy for one-time training and retraction operations on Peveto Beach, in Cameron Parish, Louisiana, concluded informally.

Table 7 - Military bases that occur within the wintering/migration range of piping plovers and contain piping plover habitat.

State	Coastal Military Bases
North Carolina	Camp Lejeune*
South Carolina	No coastal beach bases
Georgia	Kings Bay Naval Base
Florida	Key West Base, Naval Air Station-Mayport*, Cape Canaveral Air Force Station, Patrick AFB, MacDill AFB, Eglin AFB*, Tyndall AFB*
Alabama	No coastal beach bases
Mississippi	Keesler AFB
Louisiana	No coastal beach bases
Texas	Corpus Christi Naval Air Station

*Bases which conduct activities that may affect piping plovers or their habitat.

Overall, project avoidance and minimization actions currently reduce threats from military activities to wintering and migrating piping plovers to a minimal threat level. However, prior to removal of the piping plover from protection under the Act, Integrated Resource Management Plans or other agreements should clarify if and how a change in legal status would affect plover protections.

Environmental contaminants

Contaminants have the potential to cause direct toxicity to individual birds or negatively affect their invertebrate prey base (Rattner and Ackerson 2008). Depending on the type and degree of contact, contaminants can have lethal and sub-lethal effects on birds, including behavioral impairment, deformities, and impaired reproduction (Rand and Petrocelli 1985; Gilbertson et al. 1991; Hoffman et al. 1996). The Great Lakes Recovery Plan (Service 2003) states that concentration levels of polychlorinated biphenol (PCB) detected in Michigan piping plover eggs have the potential to cause reproductive harm. The recovery plan also states that analysis of prey available to piping plovers at representative Michigan breeding sites indicated that breeding areas along the upper Great Lakes region are not likely the major source of contaminants to this population.

Petroleum products are the contaminants of primary concern, as opportunities exist for petroleum to pollute intertidal habitats that provide foraging substrate. Impacts to piping plovers from oil spills have been documented throughout their life cycle (Chapman 1984; Service 1996; Burger 1997; Massachusetts Audubon 2003; Amirault-Langlais et al. 2007; Amos 2009 pers. comm.). This threat persists due to the high volume of shipping vessels (from which most documented spills have originated) traveling offshore and within connected bays along the Atlantic Coast and the Gulf of Mexico. Additional risks exist for leaks or spills from offshore oil rigs, associated undersea pipelines, and onshore facilities such as petroleum refineries and petrochemical plants. Beach-stranded 55-gallon barrels and smaller containers, which may fall from moving cargo ships or offshore rigs and are not uncommon on the Texas coast, contain primarily oil products (gasoline or diesel), as well as other chemicals such as methanol, paint, organochlorine pesticides, and detergents (Lee 2009 pers. comm.). Federal and state land managers have protective provisions in place to secure and remove the barrels, thus reducing the likelihood of contamination.

Lightly oiled piping plovers have survived and successfully reproduced (Chapman 1984; Amirault-Langlais et al. 2007; Amos 2009 pers. comm.). Chapman (1984) noted shifts in habitat use as piping plovers moved out of spill areas. This behavioral change was believed to be related to the demonstrated decline in benthic infauna (prey items) in the intertidal zone and may have decreased the direct impact to the species. To date, no plover mortality has been attributed to oil contamination outside the breeding grounds, but latent effects would be difficult to prove.

<u>Oil spills</u>

On April 20, 2010, an explosion and fire occurred on the mobile offshore drilling unit Deepwater Horizon, which was being used to drill a well in the Macondo prospect (Mississippi Canyon 252) (Natural Resource Trustees 2012). The rig sank and left the well releasing tens of thousands of barrels of oil per day into the Gulf of Mexico. It is estimated that 5 million barrels (210 million gallons) of oil were released from the Macondo wellhead. Of that, approximately 4.1 million barrels (172 million gallons) of oil were released directly into the Gulf of Mexico over nearly three months. In what was the largest and most prolonged offshore oil spill in U.S. history, oil and dispersants impacted all aspects of the coastal and oceanic ecosystems (Natural Resource Trustees 2012). At the end of July 2010, approximately 625 miles of Gulf of Mexico shoreline were oiled. By the end of October, 93 miles were still affected by moderate to heavy oil, and

483 miles of shoreline were affected by light to trace amounts of oil (Service 2012a; Unified Area Command 2010). These numbers reflect weekly snapshots of shorelines experiencing impacts from oil and do not include cumulative impacts or shorelines that had already been cleaned (Bimbi 2012 pers. comm.; Service 2012a). Limited cleanup operations were still ongoing throughout the spill area in November 2012 (Service 2012a). A NRDAR case to assess injury to wildlife resources is in progress (Natural Resource Trustees 2012), but due to the legal requirements of the NRDAR process, avian injury information, including any impacts to red knots, has not been released (Tuttle 2012 pers. comm.).

The USCG, the states, and responsible parties that form the Unified Area Command (with advice from federal and state natural resource agencies) initiated protective measures and clean-up efforts per prepared contingency plans to deal with petroleum and other hazardous chemical spills for each state's coastline. The contingency plans identify sensitive habitats, including all federally listed species' habitats, which receive a higher priority for response actions. Those plans allow for immediate habitat protective measures for clean-up activities in response to large contaminant spills. While such plans usually ameliorate the threat to piping plovers, their effectiveness has yet to be determined in this particular incident.

The Operational Science Advisory Team (OSAT-2) of the Gulf Coast Incident Management Team published the *Summary Report for Fate and Effects of Remnant Oil Remaining in the Beach Environment* on February 10, 2011. The OSAT-2 report indicates that:

> "Much of the oil residue on and near the shoreline has been cleaned during the Response phase of the oil spill. As the Gulf shoreline is a dynamic environment, oil residue that is uncovered or moved onto beaches (for example, tar residue balls) will continue to be removed as part of the Monitoring and Maintenance phase of the recovery. Three types of located oil residue were identified as particularly challenging, or potentially damaging to the environment if removed. These three types are the following: supratidal buried oil (SBO), small surface residual balls (SSRBs), and surf zone submerged oil mats (SOM). Previous oil spills have demonstrated that removing oil residue from shoreline environments can cause more harm to the ecosystem than leaving the residue in place."

Thus, specific guidelines for the Monitoring and Maintenance phase of recovery have been developed to determine whether certain oiled habitats warrant further cleaning depending upon the anticipated damage to the environment by oil removal activities. In addition, NRDAR studies regarding potential effects to fish and wildlife resources are still underway along the northern Gulf of Mexico coast.

Throughout the 2010-2011 wintering season piping plovers were observed along the northern Gulf of Mexico coast. Casual observations from local birders and surveys conducted by oil spill responders reported visibly oiled piping plovers at various locations in Louisiana. However, exact numbers of oiled piping plovers documented from this spill and the potential expanse of effects to those birds are currently being assessed through specific NRDAR studies; those results have yet to be released to the public. Impacts to the species and its habitat are expected but the extent of those impacts remains hard to predict. Based on all available data prior to the Deepwater Horizon oil spill, the risk of impacts from contamination to piping plovers and their habitat was recognized, but the safety contingency plans were considered adequate to alleviate most of these concerns. The Deepwater Horizon incident has brought heightened awareness of the intensity and extent to fish and wildlife habitat from large-scale releases. In addition to potential direct habitat degradation from oiling of intertidal habitats and retraction of stranded boom, impacts to piping plovers may occur from ingestion of oiled benthic prey, loss of benthic prey from shoreline/beach cleaning, and the prolonged human disturbance associated with boom deployment and retraction, clean-up activities, wildlife response, and damage assessment crews working along affected shorelines.

Pesticides

In 2000, mortality of large numbers of wading birds and shorebirds, including one piping plover, at Audubon's Rookery Bay Sanctuary on Marco Island, Florida, occurred following the county's aerial application of the organophosphate pesticide Fenthion for mosquito control purposes (Williams 2001). Fenthion, a known toxin to birds, was registered for use as an avicide by Bayer, a chemical manufacturer. Subsequent to a lawsuit being filed against the Environmental Protection Agency (EPA) in 2002, the manufacturer withdrew Fenthion from the market, and EPA declared all uses of the chemical were to end by November 30, 2004 (American Bird Conservancy 2007). All other counties in the U.S. now use less toxic chemicals for mosquito control. It is unknown whether pesticides are a threat for piping plovers wintering in the Bahamas, other Caribbean countries, or Mexico.

Climate change

Over the past 100 years, the globally averaged sea level has risen approximately 3.9 to 9.8 inches (Rahmstorf et al. 2007), a rate that is an order of magnitude greater than that seen in the past several thousand years (Douglas et al. 2001 as cited in Hopkinson et al. 2008). The Intergovernmental Panel on Climate Change (IPCC) suggests that by 2080 sea-level rise could convert as much as 33 percent of the world's coastal wetlands to open water (IPCC 2007). Although rapid changes in sea level are predicted, estimated time frames and resulting water levels vary due to the uncertainty about global temperature projections and the rate of ice sheets melting and slipping into the ocean (IPCC 2007; CCSP 2008).

Potential effects of sea-level rise on coastal beaches may vary regionally due to subsidence or uplift as well as the geological character of the coast and near-shore (CCSP 2009; Galbraith et al. 2002). In the last century, for example, sea-level rise along the U.S. Gulf Coast exceeded the global average by 5.1 to 5.9 inches, because coastal lands west of Florida are subsiding (EPA 2009). Sediment compaction and oil and gas extraction compound tectonic subsidence (Penland and Ramsey 1990; Morton et al. 2003; Hopkinson et al. 2008). Low elevations and proximity to the coast make all nonbreeding coastal piping plover foraging and roosting habitats vulnerable to the effects of rising sea level. Furthermore, areas with small astronomical tidal ranges (e.g., portions of the Gulf Coast where intertidal range is less than 1 meter) are the most vulnerable to loss of intertidal wetlands and flats induced by sea-level rise (EPA 2009). Sea-level rise was cited as a contributing factor in the 68 percent decline in tidal flats and algal mats in the Corpus Christi area (i.e., Lamar Peninsula to Encinal Peninsula) in Texas between the 1950s and 2004 (Tremblay et al. 2008). Mapping by Titus and Richman (2001) showed that more than 80 percent of the lowest land along the Atlantic and Gulf coasts was in Louisiana, Florida, Texas, and North Carolina, where 73.5 percent of all wintering piping plovers were tallied during the 2006 IPPC (Elliott-Smith et al. 2009).

Inundation of piping plover habitat by rising seas could lead to permanent loss of habitat if natural coastal dynamics are impeded by numerous structures or roads, especially if those shorelines are also armored with hardened structures. Without development or armoring, low undeveloped islands can migrate toward the mainland, pushed by the over-washing of sand eroding from the seaward side and being re-deposited in the bay (Scavia et al. 2002). Over-wash and sand migration are impeded on developed portions of islands. Instead, as sea-level increases, the ocean-facing beach erodes and the resulting sand is deposited offshore. The buildings and the sand dunes then prevent sand from washing back toward the lagoons, and the lagoon side becomes increasingly submerged during extreme high tides (Scavia et al. 2002), diminishing both barrier beach shorebird habitat and protection for mainland developments.

Modeling for three sea-level rise scenarios (reflecting variable projections of global temperature rise) at five important U.S. shorebird staging and wintering sites predicted loss of 20 to 70 percent of current intertidal foraging habitat (Galbraith et al. 2002). These authors estimated probabilistic sea-level changes for specific sites partially based on historical rates of sea-level change (from tide gauges at or near each site); they then superimposed this on projected 50 percent and 5 percent probability of global sea-level changes by 2100 of 13.4 inches and 30.3 inches, respectively. The 50 percent and 5 percent probability sea level change projections were based on assumed global temperature increases of 35.6° Fahrenheit (F) (50 percent probability) and 40.46° F (5 percent probability). The most severe losses were projected at sites where the coastline is unable to move inland due to steep topography or seawalls. The Galbraith et al. (2002) Gulf Coast study site at Bolivar Flats, Texas, is a designated critical habitat unit known to host high numbers of piping plovers during migration and throughout the winter (e.g., 275 individuals were tallied during the 2006 IPPC) (Elliott-Smith et al. 2009). Under the 50 percent likelihood scenario for sea-level rise, Galbraith et al. (2002) projected approximately 38 percent loss of intertidal flats at Bolivar Flats by 2050; however, after initially losing habitat, the area of tidal flat habitat was predicted to slightly increase by the year 2100, because Bolivar Flats lacks armoring, and the coastline at this site can thus migrate inland. Although habitat losses in some areas are likely to be offset by gains in other locations, Galbraith et al. (2002) noted that time lags may exert serious adverse effects on shorebird populations. Furthermore, even if piping plovers are able to move their wintering locations in response to accelerated habitat changes, there could be adverse effects on the birds' survival rates or reproductive fitness.

The table below displays the potential for adjacent development and/or hardened shorelines to impede response of habitat to sea-level rise in the eight states supporting wintering piping plovers. Although complete linear shoreline estimates are not readily obtainable, almost all known piping plover wintering sites in the U.S. were surveyed during the 2006 IPPC. To estimate effects at the census sites, as well as additional areas where piping plovers have been found outside of the census period, Service biologists reviewed satellite imagery and spoke with other biologists familiar with the sites. Of 406 sites, 204 (50 percent) have adjacent structures that may prevent the creation of new habitat if existing habitat were to become inundated. These threats will be perpetuated in places where damaged structures are repaired and replaced, and exacerbated where the height and strength of structures are increased. Data do not exist on the amount or types of hardened structures at wintering sites in the Bahamas, other Caribbean countries, or Mexico.

Table 8 - Number of sites surveyed during the 2006 winter IPPC with hardened or developed structures adjacent to the shoreline. Those marked with an asterisk (*) are additional sites that were not surveyed in the 2006 IPPC.

State	Number of sites surveyed during the 2006 winter Census	Number of sites with some armoring or development	Percent of sites affected
North Carolina	37 (+2)*	20	51
South Carolina	39	18	46
Georgia	13	2	15
Florida	188	114	61
Alabama	4 (+2)*	3	50
Mississippi	16	7	44
Louisiana	25 (+2)*	9	33
Texas	78	31	40
Overall Total	406	204	50

Sea-level rise poses a significant threat to all piping plover populations during the migration and wintering portion of their life cycle. Ongoing coastal stabilization activities may strongly influence the effects of sea-level rise on piping plover habitat. Improved understanding of how sea-level rise will affect the quality and quantity of habitat for migrating and wintering piping plovers is an urgent need.

Storm events

Although coastal piping plover habitats are storm-created and maintained, the 1996 Atlantic Coast Recovery Plan also notes that storms and severe cold weather may take a toll on piping plovers, and the 2003 Great Lakes Recovery Plan postulates that loss of habitats, such as over-wash passes or wrack, where birds shelter during harsh weather, poses a threat. Storms are a component of the natural processes that form coastal habitats used by migrating and wintering piping plovers, and positive effects of storm-induced over-wash and vegetation removal have been noted in portions of the wintering range. For example, Gulf Islands National Seashore habitats in the NPS' Florida district benefited from increased over-wash events that created optimal habitat conditions during the 2004 and 2005 hurricane seasons, with biologists reporting piping plover use of these habitats within six months of the storms (Nicholas 2005 pers. comm.). Hurricane Katrina (2005) over-washed the mainland beaches of MS, creating many tidal flats where piping plovers were subsequently observed (Winstead 2008). Hurricane Katrina also created a new inlet and improved habitat conditions on some areas of Dauphin Island, AL (LeBlanc 2009 pers. comm.). Conversely, localized storms, since Katrina, have induced habitat losses on Dauphin Island (LeBlanc 2009 pers. comm.).

Noel et al. (2005) suspect that changes in habitat caused by multiple hurricanes along the Georgia coastline altered the spatial distribution of piping plovers and may have contributed to mortality of three Great Lakes piping plovers wintering along the Georgia coastline. Following Hurricane Ike in 2008, Arvin (2009) reported decreased numbers of piping plovers at some heavily eroded Texas beaches in the center of the storm impact area and increases in plover numbers at sites about 100 miles to the southwest. However, piping plovers were observed later in the season using tidal lagoons and pools that Ike created behind the eroded beaches (Arvin 2009).

The adverse effects on piping plovers attributed to storms are sometimes due to a combination of storms and other environmental changes or human use patterns. For example, four hurricanes between 2002 and 2005 are often cited in reference to rapid erosion of the Chandeleur Islands, a chain of low-lying islands in Louisiana where the 1991 IPPC tallied more than 350 piping plovers. Comparison of imagery taken three years before and several days after Hurricane Katrina found that the Chandeleur Islands lost 82 percent of their surface area (Sallenger et al. 2009), and a review of aerial photography prior to the 2006 IPPC suggested little piping plover habitat remained (Elliott-Smith et al. 2009). However, Sallenger et al. (2009) noted that habitat changes in the Chandeleur Islands stem not only from the effects of these storms but rather from the combined effects of the storms, long-term (i.e., greater than 1,000 years) diminishing sand supply, and sea-level rise relative to the land. Sallenger et al. (2009) went on to explain that although the marsh platform of the Chandeleur Islands continued to erode for 22 months post-Katrina, some sand was released from the marsh sediments which in turn created beaches, spits, and welded swash bars that advanced the shoreline seaward. Thus, although intense erosional forces have affected the Chandeleur Islands, they are still providing high quality shorebird habitat in the form of sand flats, spits, and beaches, until they are eroded below sea level. On January 18 and 19, 2011, piping plover surveys of the Chandeleur Islands were conducted by the piping plover NRDAR study team. Catlin et al. (2011) observed 194 piping plovers utilizing the Chandeleur Islands, and the birds were not distributed uniformly across the islands but were clumped mostly in three locations. Because the survey was conducted within a two-day window, Catlin et al. (2011) believe that higher numbers of piping plovers are likely using the islands during spring and fall migration.

Other storm-induced adverse effects include post-storm acceleration of human activities such as beach nourishment, sand scraping, and berm and seawall construction. Such stabilization activities can result in the loss and degradation of feeding and resting habitats. Storms also can cause widespread deposition of debris along beaches. Removal of debris often requires large machinery, which can cause extensive disturbance and adversely affect habitat elements such as wrack. Another example of indirect adverse effects linked to a storm event is the increased access to Pelican Island (LeBlanc 2009 pers. comm.) due to merging with Dauphin Island following a 2007 storm (Gibson et al. 2009).

Recent climate change studies indicate a trend toward increasing hurricane numbers and intensity (Emanuel 2005; Webster et al. 2005). When combined with predicted effects of sea-level rise, there may be increased cumulative impacts from future storms. Storms can create or enhance piping plover habitat while causing localized losses elsewhere in the wintering and migration range. Available information suggests that some birds may have resiliency to storms and move to unaffected areas without harm, while other reports suggest birds may perish from storm events. Significant concerns include disturbance to piping plovers and habitats during cleanup of debris along shorelines and post-storm acceleration of shoreline stabilization activities, which can cause persistent habitat degradation and loss.

Threats summary

Habitat loss and degradation on winter and migration grounds from shoreline and inlet stabilization efforts, both within and outside of designated critical habitat, remain a serious threat to all piping plover populations. Modeling strongly suggests that the population is very sensitive to adult and juvenile survival. Therefore, while there is a great deal of effort extended to improve breeding success, and thus improve and maintain a higher population over time, it is also necessary to ensure that the wintering habitat, where birds spend most of their time, is secure. On some of the wintering grounds, the shoreline areas used by wintering piping plovers are being developed, stabilized, or otherwise altered, generally making the habitat unsuitable. Even in areas where habitat conditions are appropriate, human disturbance on beaches may negatively impact piping plovers' energy budget, as they may spend more time being vigilant and less time in foraging and roosting behavior. In many cases, the disturbance is severe enough that piping plovers appear to avoid some areas altogether. In addition, natural events (e.g., climate change, hurricanes, etc.) can pose a potential threat to piping plover habitat on an irregular basis. Threats on the wintering grounds may impact piping plovers' breeding success if they start migration or arrive at the breeding grounds with a poor body condition.

APPENDIX E

Red Knot Life History, Population Dynamics, and Status and Distribution

Life history

Breeding

Based on estimated survival rates for a stable population, few red knots live for more than about seven years (Niles et al. 2008). Age of first breeding is uncertain but for most birds is probably at least two years (Harrington 2001). Red knots generally nest in the Canadian Arctic in dry, slightly elevated tundra locations, often on windswept slopes with little vegetation. Breeding territories are located inland, but near arctic coasts, and foraging areas are located near nest sites in freshwater wetlands (Niles et al. 2008; Harrington 2001). Breeding occurs in June (Niles et al. 2008), and flocks of red knot sometimes arrive at breeding latitudes before snow-free habitat is available. Upon arrival or as soon as favorable conditions exist, male and female red knots occupy breeding habitat, and territorial displays begin (Harrington 2001). In red knots, pair bonds form soon after arrival on the breeding grounds and remain intact until shortly after the eggs hatch (Niles et al. 2008). Female red knots lay only one clutch (group of eggs) per season, and, as far as is known, do not lay a replacement clutch if the first is lost. The usual clutch size is four eggs, though three-egg clutches have been recorded. The incubation period lasts approximately 22 days from the last egg laid to the last egg hatched, and both sexes participate equally in egg incubation. Young are precocial, leaving the nest within 24 hours of hatching and foraging for themselves (Niles et al. 2008). No information is available regarding chick survival rates (Niles et al. 2008). Females are thought to leave the breeding grounds and start moving south soon after the chicks hatch in mid-July. Thereafter, parental care is provided solely by the males, but about 25 days later (around August 10) they also abandon the newly fledged juveniles and move south. Not long after, they are followed by the juveniles (Niles et al. 2008).

Breeding success of High Arctic shorebirds such as red knot varies dramatically among years in a somewhat cyclical manner. Two main factors seem to be responsible for this annual variation: weather that affects nesting conditions and food availability and the abundance of arctic lemmings (*Dicrostonyx torquatus* and *Lemmus sibericus*). Production of shorebird young is sensitive to adverse weather during the breeding season. Red knot chicks grow poorly during cold weather due to higher rates of energy expenditure, shorter foraging periods, and reduced prey availability (Piersma and Lindström 2004; Schekkerman et al. 2003). Growth rate of red knot chicks is very high compared to similarly sized shorebirds nesting in more temperate climates and is strongly correlated with weather-induced and seasonal variation in availability of invertebrate prey (Schekkerman et al. 2003). Second, successful shorebird reproduction occurs almost exclusively during peak lemming years when snowmelt is early (Piersma and Lindström 2004; Blomqvist et al. 2002; Summers and Underhill 1987). Arctic fox (*Alopex lagopus*) and snowy owl (*Nyctea scandiaca*) feed largely on lemmings, which are easily caught when their abundance is high. However, in years when lemming numbers are low, the predators turn to alternative prey, such as shorebird eggs, chicks, and adults. Lemming abundance is often cyclical, and the variation in shorebird production closely follows variations in lemming abundance due to their affected predation rates.

Nonbreeding Birds

Little information is available about nonbreeding red knots. Unknown numbers of nonbreeding red knots remain south of the breeding grounds during the breeding season, and many, but not all, of these knots are 1-year-old (i.e., immature) birds (Niles et al. 2008). Nonbreeding knots, usually individuals or small groups, have been reported during June along the U.S. Atlantic and Gulf coasts, with smaller numbers around the Great Lakes and Northern Plains in both the United States and Canada (eBird.org 2012). There is also little information on where juvenile red knots spend their winter months (Service and Conserve Wildlife Foundation 2012), and there may be at least partial segregation of juvenile and adult red knots on the wintering grounds. All juveniles of the Tierra del Fuego wintering region are thought to remain in the Southern Hemisphere during their first year of life, possibly moving to northern South America, but their distribution is largely unknown (Niles et al. 2008). Because there is a lack of specific information on juvenile red knots, the Service uses the best available data from adult red knots to draw conclusions about juvenile foraging and habitat use.

Migration

The red knot migrates annually between its breeding grounds in the Canadian Arctic and several wintering regions, including the Southeast United States (Southeast), the Northeast Gulf of Mexico, northern Brazil, and Tierra del Fuego at the southern tip of South America (Figure 5). Departure from the breeding grounds begins in mid-July and continues through August. Red knots tend to migrate in single-species flocks with departures typically occurring in the few hours before twilight on sunny days. Based on the duration and distance of migratory flight segments estimated from geolocator results, red knots are inferred to migrate during both day and night (Normandeau Associates. Inc. 2011). The size of departing flocks tends to be large (greater than 50 birds) (Niles et al. 2008), and females are thought to leave first followed by males and then juveniles (Niles et al. 2008; Harrington 2001).

Red knots make one of the longest distance migrations known in the animal kingdom, traveling up to 19,000 miles annually, and may undertake long flights that span thousands of miles without stopping. As red knots prepare to depart on long migratory flights, they undergo several physiological changes. Before takeoff, the birds accumulate and store large amounts of fat to fuel migration and undergo substantial changes in metabolic rates. In addition, leg muscles, gizzard (a muscular organ used for grinding food), stomach, intestines, and liver all decrease in size, while pectoral (chest) muscles and heart increase in size. Due to these physiological changes, red knots arriving from lengthy migrations are not able to feed maximally until their digestive systems regenerate, a process that may take several days. Because stopovers are time-constrained, red knots require stopovers rich in easily digested food to achieve adequate weight gain (Niles et al. 2008; van Gils et al. 2005a; van Gils et al. 2005b; Piersma et al. 1999) that fuels the next leg of migratory flight and, upon arrival in the Arctic, fuels a body transformation to breeding condition (Morrison 2006). At each stopover, the adults gradually replace their red breeding plumage with white and gray, but generally they do not molt their flight or tail feathers until they reach their wintering areas (Niles et al. 2008; Morrison and Harrington 1992).

During both the northbound (spring) and southbound (fall) migrations, red knots use key staging and stopover areas to rest and feed (Figure 6). Major spring stopover areas along the Atlantic coast include Río Gallegos, Península Valdés, and San Antonio Oeste (Patagonia, Argentina); Lagoa do Peixe (eastern Brazil, State of Rio Grande do Sul); Maranhão (northern Brazil); the Virginia barrier islands (United States); and Delaware Bay (Delaware and New Jersey, United States) (Cohen et al. 2009; Niles et al. 2008; González 2005). Important fall stopover sites include southwest Hudson Bay (including the Nelson River delta), James Bay, the north shore of the St. Lawrence River, the Mingan Archipelago, and the Bay of Fundy in Canada; the coasts of Massachusetts and New Jersey and the mouth of the Altamaha River in Georgia, United States; the Caribbean (especially Puerto Rico and the Lesser Antilles); and the northern coast of South America from Brazil to Guyana (Newstead et al. in press; Niles 2012a; Mizrahi 2011 pers. comm.; Niles et al. 2010; Schneider and Winn 2010; Niles et al. 2008; Harrington 2006 pers. comm.; Antas and Nascimento 1996; Morrison and Harrington 1992; Spaans 1978). However, large and small groups of red knots, sometimes numbering in the thousands, may occur in suitable habitats all along the Atlantic and Gulf coasts from Argentina to Canada during migration (Niles et al. 2008).

Red knots are restricted to the ocean coasts during winter, and occur primarily along the coasts during migration. However, small numbers of red knots are reported annually across the interior United States (i.e., greater than 25 miles from the Gulf or Atlantic Coasts) during spring and fall migration. Such reported sightings are concentrated along the Great Lakes, but multiple reports have been made from nearly every interior State (eBird.org 2012). For example, Texas knots follow an inland flyway to and from the breeding grounds, using spring and fall stopovers along western Hudson Bay in Canada and in the northern Great Plains (Newstead et al. in press; Skagen et al. 1999). Some red knots wintering in the Southeastern United States and the Caribbean migrate north along the U.S. Atlantic coast before flying over land to central Canada from the mid-Atlantic, while others migrate over land directly to the Arctic from the Southeastern U.S. coast (Niles et al. in press). These eastern red knots typically make a short stop at James Bay in Canada, but may also stop briefly along the Great Lakes, perhaps in response to weather conditions (Niles et al. 2008; Morrison and Harrington 1992). Thus, red knots from different wintering areas appear to employ different migration strategies, including differences in timing, routes, and stopover areas. However, full segregation of migration strategies, routes, or stopover areas does not occur among red knots from different wintering areas.

Wintering

Red knots occupy all known wintering areas from December to February, but may be present in some wintering areas as early as September or as late as May. In the Southern Hemisphere, these months correspond to the austral summer (i.e., summer in the Southern Hemisphere). Wintering areas for the red knot include the Atlantic coasts of Argentina and Chile (particularly the island of Tierra del Fuego that spans both countries), the north coast of Brazil (particularly in the State of Maranhão), the Northwest Gulf of Mexico from the Mexican State of Tamaulipas through Texas (particularly at Laguna Madre) to Louisiana, and the Southeast United States from Florida (particularly the central Gulf coast) to North Carolina (Newstead et al. in press; Patrick

2012 pers. comm.; Niles et al. 2008). Smaller numbers of knots winter in the Caribbean, and along the central Gulf coast (AL, MS), the mid-Atlantic, and the Northeast United States. Red knots are also known to winter in Central America and northwest South America, but it is not yet clear if those birds are the *rufa* subspecies. Little information exists on where juvenile red knots spend the winter months (Service and Conserve Wildlife Foundation 2012), and there may be at least partial segregation of juvenile and adult red knots on the wintering grounds.

Examples of red knots changing wintering regions do exist but are few. Generally red knots are thought to return to the same wintering region each year. Re-sightings of marked birds indicate few or no inter-annual movements of red knots between the Brazil and Tierra del Fuego wintering areas, or between the Southeast and Tierra del Fuego wintering areas (Baker et al. 2005; Harrington 2005a).

Migration and Wintering Habitat

Long-distance migrant shorebirds are highly dependent on the continued existence of quality habitat at a few key staging areas. These areas serve as stepping stones between wintering and breeding areas. Habitats used by red knots in migration and wintering areas are generally coastal marine and estuarine habitats with large areas of exposed intertidal sediments. In many wintering and stopover areas, quality high-tide roosting habitat (i.e., close to feeding areas, protected from predators, with sufficient space during the highest tides, free from excessive human disturbance) is limited (Kalasz 2012 pers. comm.; Niles 2012 pers. comm.). The supra-tidal (above the high tide) sandy habitats of inlets provide important areas for roosting, especially at higher tides when intertidal habitats are inundated (Harrington 2008). In some localized areas, red knots will use artificial habitats that mimic natural conditions, such as nourished beaches, dredged spoil sites, elevated road causeways, or impoundments; however, there is limited information regarding the frequency, regularity, timing, or significance of red knots’ use of such artificial habitats.

In South American wintering areas, red knots are found in intertidal marine habitats, especially near coastal inlets, estuaries, and bays. Habitats include sandy beaches, mudflats, mangroves, saltwater and brackish lagoons, and “restinga” formations (an intertidal shelf of densely packed dirt blown by strong, offshore winds) (Niles et al. 2008; Harrington 2001). Red knots were recently observed using rice fields in French Guiana (Niles 2012b) and in Trinidad (eBird.org 2012). In Suriname in the early 1970s, small numbers of red knots were observed on firm and tough clay banks emerging from the eroding coastline and in shallow lagoons, but knots were never found on soft tidal flats (Spaans 1978); those observations suggest a deviation from the red knot’s typical nonbreeding habitats.

In North America, red knots are commonly found along sandy, gravel, or cobble beaches, tidal mudflats, salt marshes, shallow coastal impoundments and lagoons, and peat banks (Cohen et al. 2010; Cohen et al. 2009; Niles et al. 2008; Harrington 2001; Truitt et al. 2001). In Massachusetts, red knots use sandy beaches and tidal mudflats during fall migration. In New York and the coast of New Jersey, knots use sandy beaches during spring and fall migration (Niles et al. 2008). In Delaware Bay, red knots are found primarily on beaches of sand or peat at the mouths of tidal creeks, along the edge of tidal marshes dominated by salt marsh cordgrass

(*Spartina alterniflora*) and saltmeadow cordgrass (*S. patens*), and in salt pannes (shallow, high salinity, mud-bottomed depressions on the marsh surface) and shallow coastal ponds or embayments (Clark 2012 pers. comm.; Cohen et al. 2009; Niles et al. 2008; Karpanty et al. 2006; Meyer et al. 1999; Burger et al. 1997). In the southeastern U.S., red knots forage along sandy beaches during spring and fall migration from Maryland through Florida. During migration, knots also use tidal mudflats in Maryland and along North Carolina's barrier islands. In addition to the sandy beaches, red knots forage along peat banks for mussel spat in Virginia and along small pockets of peat banks where the beach is eroding in Georgia (Niles et al. 2008). In Florida, the birds also use mangrove and brackish lagoons. Along the Texas coast, red knots forage on beaches, oyster reefs, and exposed bay bottoms and roost on high sand flats, reefs, and other sites protected from high tides. Red knots also show some fidelity to particular migration staging areas between years (Duerr et al. 2011; Harrington 2001).

Foraging

The red knot is a specialized molluscivore, eating hard-shelled mollusks, sometimes supplemented with easily accessed softer invertebrate prey, such as shrimp- and crab-like organisms, marine worms, and horseshoe crab (*Limulus polyphemus*) eggs (Piersma and van Gils 2011; Harrington 2001). Mollusk prey are swallowed whole and crushed in the gizzard (Piersma and van Gils 2011). From studies of other subspecies, Zwarts and Blomert (1992) concluded that the red knot cannot ingest prey with a circumference greater than 1.2 inches (in) (30 millimeters (mm)). Foraging activity is largely dictated by tidal conditions, as the red knot rarely wades in water more than 0.8 to 1.2 in (2 to 3 centimeters (cm)) deep (Harrington 2001). Due to bill morphology, the red knot is limited to foraging on only shallow-buried prey, within the top 0.8 to 1.2 in (2 to 3 cm) of sediment (Gerasimov 2009; Zwarts and Blomert 1992).

On the breeding grounds, the red knot's diet consists mostly of terrestrial invertebrates such as insects (Harrington 2001). In non-breeding habitats, the primary prey of the red knot include blue mussel (*Mytilus edulis*) spat (juveniles); Donax and Darina clams; snails (*Littorina spp.*), and other mollusks, with polycheate worms, insect larvae, and crustaceans also eaten in some locations. A prominent departure from typical prey items occurs each spring when red knots feed on the eggs of horseshoe crabs, particularly during the key migration stopover within the Delaware Bay of New Jersey and Delaware. Delaware Bay serves as the principal spring migration staging area for the red knot because of the availability of horseshoe crab eggs (Clark et al. 2009; Harrington 2001; Harrington 1996; Morrison and Harrington 1992), which provide a superabundant source of easily digestible food.

Red knots and other shorebirds that are long-distance migrants must take advantage of seasonally abundant food resources at intermediate stopovers to build up fat reserves for the next nonstop, long-distance flight (Clark et al. 1993). Although foraging red knots can be found widely distributed in small numbers within suitable habitats during the migration period, birds tend to concentrate in those areas where abundant food resources are consistently available from year to year.

Population dynamics

Localized and regional red knot surveys have been conducted across the subspecies' range with widely differing levels of geographic, temporal, and methodological consistency. Available survey data are presented in detail in the Service's September 30, 2013, Proposed Rule (Service 2013). However, some general characterizations of the available data are noted as follows:

- No population information exists for the breeding range because, in breeding habitats, red knots are thinly distributed across a huge and remote area of the Arctic. Despite some localized survey efforts, (e.g., Bart and Johnston 2012; Niles et al. 2008), there are no regional or comprehensive estimates of breeding abundance, density, or productivity (Niles et al. 2008).
- Few regular surveys are conducted in fall because southbound red knots tend to be less concentrated than during winter or spring.
- Some survey data are available for most wintering and spring stopover areas. For some areas, long-term data sets have been compiled using consistent survey methodology.
- Because there can be considerable annual fluctuations in red knot counts, longer-term trends are more meaningful. At several key sites, the best available data show that numbers of red knots declined and remain low relative to counts from the 1980s, although the rate of decline appears to have leveled off since the late 2000s.
- Inferring long-term population trends from various national or regional datasets derived from volunteer shorebird surveys and other sources, Andres (2009) and Morrison et al. (2006) also concluded that red knot numbers declined, probably sharply, in recent decades.

Wintering Areas

Counts in wintering areas are particularly useful in estimating red knot populations and trends because the birds generally remain within a given wintering area for a longer period of time compared to the areas used during migration. This eliminates errors associated with turnover or double-counting that can occur during migration counts.

<u>Argentina and Chile</u>

Aerial surveys of Tierra del Fuego (Chile and Argentina) and the adjacent Patagonian coast to the north (Argentina) have been conducted since 2000, and previously in the early 1980s, by the same observers using consistent methodology (Morrison et al. 2004). This is the best available long-term data set for a wintering area. However, as those are not the only red knot wintering areas, the survey results are best interpreted as one indicator of population trends rather than estimates of the total population.

Counts have been markedly lower in recent years. Comparing the average counts for Tierra del Fuego from 1985 and 2000 with counts from 2010 to 2012, the recent counts are about 75 percent lower than the earlier counts. An independent population estimate, using re-sighting data from Río Grande fitted to binomial models, supports the observation that declines did not begin until after 2000. This same model produced population estimates that were within 5 to 15 percent of the aerial counts from 2001 to 2003, giving confidence in the model results. Declines were even sharper (about 96 percent) along the roughly 1,000 miles of Patagonian coast than in the core area on Tierra del Fuego. Thus, the population appears to have contracted to the core sites, leaving few birds at the "peripheral" Patagonian sites (COSEWIC 2007). Reflecting the larger downward trend in Patagonia, local winter counts at Península Valdés also show an overall decline in bird numbers from 1994 to 2010 (Western Hemisphere Shorebird Reserve Network (WHSRN) (2012).

Northern South America and Central America

Counts of wintering red knots along the north coast of South America have been sporadic and have varied in geographic coverage. Morrison and Ross (1989, Vol. 2) conducted aerial surveys of the entire South American coast in the 1980s. In northern Brazil, red knots were found in three out of four survey segments: North, North-Central, and Northeast. No red knots were observed in the Amazon survey segment of Brazil, which is between North and North-Central (Morrison and Ross 1989, Vol. 2). Using the same surveyor team and methods as the 1986 survey, the North-Central segment of Brazil was again surveyed by air in 2011 (Mizrahi 2012 pers. comm.; Morrison et al. 2012) and results may suggest a decline. These 2011 results require further confirmation; however, redistribution of birds to the west is an unlikely explanation for the lower numbers in 2011, based on recent surveys of Guyana, Suriname, and French Guiana (discussed below) (Morrison et al. 2012).

Covering about 30 percent (by linear miles of coastline) of the North-Central Brazil survey segment, Baker et al. (2005) counted knots in western Maranhão during an aerial survey in February 2005. In a repeat of this survey in December 2006 (winter of 2007), fewer knots were counted (Niles et al. 2008). The shores of Maranhão are complex and highly fragmented making accurate counting more difficult. To allow for this, aerial coverage was more extensive and included not only the ocean shore but also a variety of back bays and channels (Niles et al. 2008). In December 2007 (winter of 2008), ground surveys were conducted at two sites in the Brazilian State of Ceará, within the Northeast Brazil survey segment (where only 15 red knots had been counted in 1983). Only small numbers of knots (average peak of 8 ± 8.5) were observed at Ilha Grande, but an average peak count of 481 ± 31 red knots was recorded at Cajuais Bank (Carlos et al. 2010). Lower numbers (up to 80) of red knots have been observed in winter at four other sites in Ceará (Serrano 2007).

Morrison and Ross (1989, Vol. 2) documented 520 red knots in western Venezuela in 1982. Ruiz-Guerra (2011, p. 194) documented 20 red knots at Musichi (Department of La Guajira) on the Caribbean coast of Colombia near Venezuela in January 2008. It is not known if the birds observed around the Colombia-Venezuela border were all of the *rufa* subspecies, but recent geolocator results suggest at least some of the winter birds in this area are *C. c. rufa* (Niles et al. in press). During the 1980s surveys, no red knots were observed between western Venezuela and the west end of Brazil (the North segment), with no knots recorded in eastern Venezuela, Trinidad, Guyana, Suriname, or French Guiana (Morrison and Ross 1989, Vol. 1). With the same survey team and methods from the 1980s, aerial shorebird surveys were recently repeated in Guyana (January 2010), Suriname (December 2008, January 2010, and January 2011), and French Guiana (December 2008 and January 2010) (Morrison et al. 2012). No red knots were detected in 2011, and a negligible number in December 2008 (i.e., winter 2009) and in 2010 (Mizrahi 2011, 2012 pers. comm.). However, small, isolated groups of wintering red knots may extend along most of the northern coast of South America (Niles 2013 pers. comm.).

On the southern (Pacific) coast of Panama, Buehler (2002) counted 100 red knots near Panama City and another 100 near Chitré in February 2002. Another researcher has also surveyed this area and agrees with an estimate of about 200 wintering red knots (Watts 2012 pers. comm.). It is not known if all the birds observed in Panama were of the *rufa* subspecies, but three marked birds resighted in Panama were all banded in known rufa red knot areas (Watts 2012 pers. comm.; Niles et al. 2008; Buehler 2002). Thus, as least some of these birds are considered rufa red knots. Also on the Pacific, Laguna Superior (State of Oaxaca, Mexico) is a recently documented wintering area for red knots (Newstead 2012 pers. comm.), with over 300 birds reported in the winters of 2011 and 2012 (eBird.org 2012). Three birds marked in Texas in April 2010 were resighted at Laguna Superior in February 2012; it is unknown if those three birds or others in this wintering area are *C.c. rufa*, *C.c. roselaari*, or both (Carmona et al. in press).

The North American Atlantic Coast

Small numbers of wintering red knots have also been reported from Maryland, United States, to Nova Scotia, Canada (Burger et al. 2012; BandedBirds.org 2012; eBird.org 2012; Hanlon 2012 pers. comm.; Dey 2012 pers. comm.), but no systematic winter surveys have been conducted in these northern areas. In surveys of five sites within North Carolina's Outer Banks in 1992 and 1993, Dinsmore et al. (1998) found over 500 red knots per year.

Southeastern United States and Caribbean

Extensive data for Florida are available from the International Shorebird Survey and other sources. However, geographic coverage has been inconsistent, ranging from 1 to 29 sites per year from 1974 to 2004. Statewide annual totals ranged from 5 knots (1 site in 1976) to 7,764 knots (7 sites in 1979). The greatest geographic coverage occurred in 1993 (4,265 knots at 25 sites) and 1994 (5,018 knots at 29 sites) (Niles et al. 2008). Harrington et al. (1988) reported that the mean count of birds wintering in Florida was 6,300 birds (± 3,400, one standard deviation) based on four aerial surveys conducted from October to January in 1980 to 1982. These surveys covered the Florida Gulf coast from Dunedin to Sanibel-Captiva, sometimes going as far south as Cape Sable (Harrington 2012 pers. comm.). Based on those surveys and other work, the Southeast wintering group was estimated at roughly 10,000 birds in the 1970s and 1980s (Harrington 2005a).

Sprandel et al. (1997) identified the top 60 sites for wintering shorebirds in Florida and surveyed those areas in 1994. Red knots were found at 27 sites, mainly on the central Gulf coast. Adding the average number of birds counted at each site, these authors estimated a statewide total of 1,452 red knots across three sites in the Florida Panhandle, 18 sites in southwest Florida, four sites in the Everglades, and two sites in northeast Florida (Sprandel et al. 1997). During frequent surveys of nine sites along about 55 miles of the central Florida Panhandle, Smith (2010) found a mean of about 84 wintering red knots in the winter of 2007. Smith (2010) covered roughly 25 percent of the Panhandle region as delineated by Sprandel et al. (1997), with the survey sites clustered on the eastern end of that region.

Niles (2009) conducted winter aerial and ground counts along Florida's Gulf coast from 2006 to 2010, covering essentially the same area in which Harrington et al. (1988) had reported an average of 6,300 red knots (± 3,400) in the winters of 1980 to 1982. As the more recent aerial counts were lower, red knot numbers may have decreased in western Florida, perhaps due to birds shifting elsewhere within the larger Southeast wintering region (Harrington 2005a). However, a comparison of the geographic coverage of Sprandel et al. (1997) with Niles (2009) suggests that red knot numbers did not change much from 1994 to 2010.

Based on resightings of birds banded in South Carolina and Georgia from 1999 to 2002, the Southeast wintering population was estimated at 11,700 ± 1,000 (standard error) red knots. Although there appears to have been a gradual shift by some of the southeastern knots from the Florida Gulf coast to the Atlantic coasts of Georgia and South Carolina, population estimates for the Southeast region in the 2000s were at about the same level as during the 1980s (Harrington 2005a). Based on recent modeling using resightings of marked birds staging in Georgia in fall, as well as other evidence, the Southeast wintering group may number as high as 20,000 (Harrington 2012 pers. comm.), but field survey data are not available to corroborate this estimate.

Two recent winter estimates are available for the central Gulf of Mexico. During the IPPCs in 2006 and 2011 (Patrick 2012 pers. comm.), 250 to 500 knots were counted from Alabama to Louisiana. From work related to the Deepwater Horizon oil spill, an estimated 900 red knots were reported from the Florida Panhandle to MS (Hunter 2012 pers. comm.). Older surveys recorded similar numbers from the central Gulf coast, with peak counts of 752 red knots in AL (1971) and 40 knots in MS (1979) (Morrison and Harrington 1992). Numbers of red knots wintering in the Caribbean are essentially unknown, but in the course of piping plover surveys in February 2011 in the Bahamas, 70 red knots were observed on the Joulters Cays just north of Andros Island, and 7 knots were observed on the Berry Islands. In December 2012 (i.e., winter 2013), 52 red knots were observed in the Green Turtle Cay flats in Abaco, Bahamas (Jeffery 2013 pers. comm.). Roughly 50 red knots occur annually on Green Turtle Cay (eBird.org 2012; Pover 2012 pers. comm.).

Northwest Gulf of Mexico

Except for localized areas, there have been no long-term systematic surveys of red knots in Texas or Louisiana, and no information is available about the number of knots that winter in northeastern Mexico. From survey work in the 1970s, Morrison and Harrington (1992) reported peak winter counts of 120 red knots in Louisiana and 1,440 in Texas, although numbers in Texas between December and February were typically in the range of 100 to 300 birds. Records compiled by Skagen et al. (1999) give peak counts of 2,838 and 2,500 red knots along the coasts of Texas and Louisiana, respectively, between January and June over the period 1980 to 1996, but these figures could include spring migrants. Morrison et al. (2006) estimated only about 300 red knots wintering along the Texas coast, based on surveys in January 2003 (Niles et al. 2008). Higher counts of roughly 700 to 2,500 knots have recently been made on Padre Island, Texas, during October, which could include wintering birds (Newstead et al. in press; Niles et al. 2009).

Foster et al. (2009) found a mean daily abundance of 61.8 red knots on Mustang Island, Texas, based on surveys every other day from 1979 to 2007. Similar winter counts were reported by Dey et al. (2011b) for Mustang Island from 2005 to 2011. From 1979 to 2007, mean abundance of red knots on Mustang Island decreased 54 percent, but this may have been a localized response to increasing human disturbance, coastal development, and changing beach management practices (Newstead et al. in press; Foster et al. 2009) (i.e., it is possible these birds shifted elsewhere in the region).

There are no current estimates for the size of the Northwest Gulf of Mexico wintering group as a whole (Mexico to Louisiana). The best available current estimates for portions of this wintering region are about 2,000 in Texas (Niles 2012a), or about 3,000 in Texas and Louisiana, with about half in each State and movement between them (Hunter 2012 pers. comm.).

Spring Stopover Areas

Records of migrating red knots have been collected at many sites along the Atlantic coast. Not all migration areas are well surveyed, and considerable turnover of individuals occurs as birds migrate through an area. Consequently, using counts of migrating red knots as a basis for population estimates may lead to inaccuracies due to errors associated with turnover or double-counting. However, long-term counts made at a specific location are good indicators of usage trends for that area and, considered together, may reflect trends in the overall population of the red knot.

<u>South America</u>

Peak counts of red knots declined at three South American stopover sites (i.e., Fracasso Beach, Argentina; Bahía San Antonio, Argentina; and Lagoa do Peixe, Brazil) from the 1990s through the mid-2000s. Although trends at stopover areas can reflect changing usage of the site, the timing of these declines over roughly the same period as those in Tierra del Fuego and Delaware Bay (late 1990s to early 2000s) is more suggestive of a decrease in the overall subspecies. At Fracasso Beach on Península Valdés in Argentina, ground surveys were conducted weekly from February through April (González 2005). At Bahía San Antonio in Argentina, the surveys were ground-based counts conducted January to April, weekly through 1999, but varying from daily to every 10 days from 2000 to 2005 (González 2005). Counts at Lagoa do Peixe in Brazil were obtained during expeditions that covered the peak spring passage in April (Niles et al. 2008). Other observers noted 5,000 red knots at Lagoa do Peixe in April 2005 (Fedrizzi and Carlos in Lanctot 2009) suggesting that usage of this site had partially rebounded from lower numbers seen in the early 2000s.

Virginia

Aerial surveys of the entire chain of barrier island beaches in Virginia have been conducted since 1995 using consistent methods and observers. Although the number of surveys has varied from one to six per year, the aerial survey effort has consistently covered the peak period during the last week of May (Watts 2012 pers. comm.). Since 2007, Karpenty et al. (2012) have estimated total red knots based on ground counts at 100 to 150 randomly selected points throughout Virginia's barrier island beaches including peat banks, with each location visited from one to three times per stopover season. Although the recent ground surveys show an upward trend, the aerial counts have been relatively steady since the mid-1990s. Because of differences in methodology and timing, the two data sets are not comparable.

Because birds pass in and out of a stopover area, the peak count (the highest number of birds seen on a single day) for a particular year is lower than the total passage population (i.e., the total number of birds that stopped at that site over the course of that migration season). Using resightings of marked birds, several attempts have been made to estimate the total passage population of Virginia through mathematical modeling.

Delaware Bay

Aerial surveys have been conducted in Delaware Bay since 1981. Methods and observers were consistent from 1986 to 2008. The methodology during this period involved weekly counts; thus, it was possible the absolute peak number of birds was missed in some years. However, since most shorebirds remain in Delaware Bay at least a week, it is likely that the true peak was captured in most years (Clark et al. 1993). The surveys covered consistent areas of New Jersey and Delaware from the first week of May to the second week of June. All flights were conducted 3 to 4 hours after high tide, a period when birds are usually feeding on the beaches (Clark et al. 2009).

Methodologies and observers changed several times from 2009 to 2012. Flights are now flown only during the end of May. In addition, aerial counts for 2010 and 2011 were adjusted with ground counts from Mispillion Harbor, Delaware, to more accurately reflect large concentrations of birds at this key site (Dey et al. 2011b). Further, problems in 2009 and 2012 prevented accurate aerial counts, and ground counts have been substituted. Caution should be used in comparing ground and aerial counts (Laursen et al. 2008). Differences between the two methods may account for markedly higher counts in 2009 and 2012. Although aerial counts had typically been higher than ground counts prior to 2009, this was likely because many areas that could be surveyed by air were inaccessible on the ground. Since 2009, ground survey crews have attempted to minimize the access problem by using boats in remote areas (Dey 2013 pers. comm.; Clark 2013 pers. comm.).

As with other stopover areas, it is impossible to separate population-wide trends from trends in usage of a particular spring site. Because birds pass in and out of a stopover area, the peak count for a particular year is lower than the total passage population. Thus, differences in the number of birds in Delaware Bay may reflect stopover patterns rather than (or in addition to) trends in the overall red knot population (Clark et al. 1993). Using resightings of marked birds, several attempts have been made to estimate the total passage population of Delaware Bay through mathematical modeling. However, the pattern and timing of these declines in Delaware Bay relative to Tierra del Fuego and other stopovers is suggestive of a decrease in the overall population. Comparing four different time periods, average red knot counts in Delaware Bay declined by approximately 70 percent from 1981 to 2012.

<u>Other areas along the U.S. Atlantic Coast</u>

Beginning in 2006, coordinated red knot surveys have been conducted from Florida to Delaware Bay during two consecutive days from May 20 to 24. This period is thought to represent the peak of the red knot migration. There has been variability in methods, observers, and areas covered. From 2006 to 2010, there was no change in counts that could not be attributed to varying geographic survey coverage (Dey et al. 2011b); thus, we do not consider any apparent trends in these data before 2010. Because red knot numbers peak earlier in the Southeast than in the mid-Atlantic (Bimbi 2013 pers. comm.), the late-May coast-wide survey data likely reflect the movement of some birds north along the coast, and may miss other birds that depart for Canada from the Southeast along an interior (overland) route prior to the survey window. Thus, greater numbers of red knots may utilize Southeastern stopovers than suggested by the data.

Fall Stopover Areas

Few regular surveys are conducted in fall because southbound red knots tend to be less concentrated than during winter or spring. No regular surveys are conducted in Hudson Bay or James Bay, Canada. However, aerial surveys of the Ontario coastlines of James Bay and Hudson Bay in the late 1970s produced totals of 7,000 to 10,000 red knots, with more recent surveys reporting 5,000 to 10,000 (Morrison and Harrington 1992). There were numerous reports of 100 to 1,300 red knots at James Bay (Ontario) in August 2011, and one report of nearly 4,000 birds in this area (eBird.org 2012). Based on intensive field work and analysis of resightings of marked birds, at least 7,200 red knots are estimated to have used the Mingan Islands Archipelago (Canada) in fall 2008 (Service 2011b; Wilson et al. 2010).

Using daily checklist data submitted by birdwatchers during fall migrations from 1976 to 1998 in southern Quebec, Canada, Aubry and Cotter (2001) found a statistically significant decline in sightings of red knots. In surveys of Eastern Canada (New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland), fall counts of red knots dropped 5.3 to 15.3 percent per year (depending on the statistical method used) from 1974 to 1991, with considerably greater decreases later in the study period; however, the findings were not statistically significant

(Morrison et al. 1994). Analyzing more years from this same data set from 1974 to 1998, Morrison et al. (2001) found a statistically significant annual decrease of 17.6 percent.

Fall peak counts from International Shorebird Survey sites along the U.S. Atlantic coast ranged from 6,000 to 9,000 red knots during the mid- to late-1970s (Morrison and Harrington 1992). In a review of numbers and distribution of red knots on the Massachusetts coast during southward migration, Harrington et al. (2010a) found that overall red knot numbers increased from the late 1940s to the early 1970s, especially on the mainland (western Cape Cod Bay), with a smaller increase on outer Cape Cod. After 1975, counts declined significantly on the mainland, but increased significantly on outer Cape Cod (Harrington et al. 2010b). Evidence suggests that both the mainland and the Cape Cod areas were historically used by knots having Argentina-Chile destinations, but that recently the Cape Cod locations have increasingly been used by knots with wintering destinations in the Southeast United States, thus balancing out the declining numbers of knots with Argentina-Chile wintering destinations (Harrington et al. 2010b). By 2008, peak counts of Argentina-Chile knots in Massachusetts had fallen to about 1,000 birds, while birds from the Southeast group increased to about 800 (Harrington et al. 2010a).

No regular counts are currently conducted in Massachusetts (Koch 2012 pers. comm.), but flocks of over 100 knots are routinely reported from Monomoy National Wildlife Refuge (eBird.org 2012). About 1,500 red knots were present in Avalon on the coast of New Jersey in the fall of 2011 (Service 2011c). Also on the coast of New Jersey, hundreds of red knots are regularly reported from North Brigantine and Stone Harbor, sometimes in flocks of over 500 (eBird.org 2012). Islands at the mouth of the Altamaha River, Georgia, support the only known late summer and fall staging site on the east coast of the United States, attracting as many as 12,000 knots at one time (Schneider and Winn 2010).

The Caribbean islands may be an important refuge for migrating shorebirds during storms (Nebel 2011). Puerto Rico and the some of the Lesser Antilles (e.g., St. Croix in the U.S. Virgin Islands, Guadeloupe, Barbados, and Trinidad) are also used as fall stopover areas (Niles et al. 2010; eBird.org 2012), with birds occurring regularly but in small numbers. In Guadeloupe, the red knot is an uncommon but regular visitor during fall migration, typically in small groups of up to 3 birds, but as many as 16 have been observed in a flock (Levesque 2011 pers. comm.). In Barbados, the red knot is a fairly regular fall transient in small numbers, usually occurring as single individuals and in small groups, but occasionally knots may occur in flocks of up to a dozen birds, and a group of 63 birds was recorded in 1951. Detailed records from 1950 to 1965 show an average of about 20 red knots per year in Barbados (Hutt and Hutt 1992). Flocks of up to a dozen red knots were reported from Trinidad each year from 2008 to 2011, with multiple sightings each fall (eBird.org 2012).

In late August 2012, 1,700 knots were observed in rice fields near Mana, French Guiana, and a large number of these birds had been marked in the Chile portion of Tierra del Fuego (Niles 2012b). Based on this survey and recent geolocator results, French Guiana is emerging as an important fall stopover area (Niles 2012b). Adjacent Suriname and Brazil are also used in fall (Niles et al. 2010; Spaans 1978), but little information is available regarding the numbers of birds in these areas. In Suriname, a total of nearly 160 red knots were counted during two surveys conducted in late August of 1970 to 1973. Larger red knot numbers apparently do not occur in Suriname as the habitat is not ideal (Harrington 2006 pers. comm.). In September 2007, the average peak count of red knots at Cajuais Bank in the Brazilian State of Ceará was 434 ± 95 (Carlos et al. 2010). During aerial surveys of Panama Bay in the fall of 1997, Watts (1998) documented a peak count of 2,460 red knots in September; the subspecies composition is unknown. Watts (1998) also reported that red knot counts in Panama were likely underestimated.

Summary

After a careful review of available survey data from areas regularly used by substantial numbers of red knots in spring, fall, and winter, the Service has determined that: (1) for some areas, available data are insufficient to substantiate any conclusions regarding population trends over time; (2) for other areas, there are apparent trends, but they are associated with relatively low confidence; and, (3) for a few key areas, the consistency of geographic coverage, methodologies, and surveyors lead us to greater confidence in apparent trends. Those population data are summarized as follows:

- Patagonia and Tierra del Fuego wintering region: There are declines through the 2000s, possibly stabilizing at a relatively low level since 2008, which are associated with higher confidence.

- North-Central Brazil wintering region: There is apparent decline when comparing surveys with similar methods, coverage, and observers in 1982 and 2011, which are associated with lower confidence due to the availability of only two data points, and the complexity of the shoreline that makes surveying difficult. Partial surveys in the winters of 2005 and 2007 suggest that any declines occurred after 2005.

- Northwest Gulf of Mexico wintering region: There are insufficient data for trend analysis.

- Southeast wintering region: There is apparent decline on Florida's Gulf coast when comparing aerial surveys from 1980 to 1982 with similar surveys (using different surveyors) of approximately the same area from 2006 to 2010, which are associated with lower confidence because birds may have simply shifted elsewhere within this large wintering region. The two region-wide survey efforts to date (from the 2006 and 2011 piping plover surveys) are associated with lower confidence inherent in the methodology (red knots are not the focus of this survey), but do tend to support the perception that knots shift from state to state within this region among years. A long-term data set from Georgia, showing wide inter-annual fluctuations, also supports this perception. Data from the Caribbean are insufficient to infer any trends. Comparing ground surveys of Florida's Gulf coast in 1994 to aerial surveys of about this same area from 2006 to 2010, red knot counts were roughly the same over this time period.

- South American spring stopover sites: There are apparent declines at three key stopover sites from the late 1990s through the mid-2000s, which are associated with moderate confidence because we have little information regarding the consistency of methodologies or surveyors and because no data are available after 2005.

- Virginia barrier islands spring stopover area: There is no apparent trend based on aerial surveys since 1995, which is associated with high confidence. A newer data set based on ground surveys suggests an increase since 2007.

- Delaware Bay spring stopover area: There is a highly variable data set showing possible declines in the 1990s, and more consistent and substantial declines through the mid-2000s, which are associated with high confidence during the core years of 1986 to 2008. Numbers may have stabilized from 2009 to 2012, but we have lower confidence in trends over this later period due to multiple shifts in methodology and surveyors.

- Atlantic coast spring window survey: There is an apparent increase from 2010 to 2012, but it is associated with lower confidence because, despite improvements, methodology and geographic coverage are still stabilizing and because only three years of (relatively consistent) data are available.

- Fall stopover areas: There are insufficient data for trend analysis in most areas. Since the 1970s, there were probable declines in some parts of eastern Canada and changes in red knot usage of Massachusetts (mainland versus Cape Cod, proportion of birds bound for Southeast versus Argentina-Chile wintering destinations).

In conclusion, we have high confidence in two data sets from key red knot areas, Tierra del Fuego and Delaware Bay, showing declines over roughly the same period. Data sets associated with lower confidence from the Brazil wintering region and three South American spring stopovers also suggest declines roughly over this same timeframe. We conclude that the Virginia spring stopover was stable during this period (the 2000s). We do not conclude that the Southeast wintering region declined, due to the likelihood that knot usage shifted geographically within this region from year to year. Our analysis of the best available data concludes that an overall, sustained decline of red knot numbers occurred in the 2000s, and that red knot populations may have stabilized at a relatively low level in the last few years. Inferring long-term population trends from various national or regional datasets derived from volunteer shorebird surveys and other sources, Andres (2009) and Morrison et al. (2006) also concluded that red knot numbers declined, probably sharply, in recent decades.

Status and distribution

The red knot's range spans 40 states, 24 countries, and their administrative territories or regions extending from their breeding grounds in the Canadian Arctic to migration stopover areas along the Atlantic and Gulf coasts of North America to wintering grounds throughout the Southeastern U.S., the Gulf coast, and South America (reaching as far south as Tierra del Fuego at the southern tip of South America). In Delaware Bay and Tierra del Fuego, the era of modern surveys for the red knot and other shorebird species began in the early 1980s. Systematic red knot surveys of other areas began later, and for many portions of the knot's range, available survey data are patchy. Prior to the 1980s, numerous natural history accounts are available, but provide mainly qualitative or localized population estimates. Nonetheless, a consistent narrative emerges across many historical accounts that red knots were extremely abundant in the early 1800s, decreased sharply starting in the mid-1800s, and may have begun to recover by the mid-1900s. Most writers agree the cause of that historical decline was intensive sport and market hunting. It is unclear whether the red knot population fully recovered its historical numbers (Harrington 2001) following the period of unregulated hunting.

The current geographic distribution of the red knot has not changed relative to that recorded in historical writings with the notable exception of Delaware Bay (discussed in detail below). Several early writers reported that red knots breed in the Arctic and winter along the U.S. Gulf coast and in South America including Brazil and Tierra del Fuego (Lowery 1974; Hellmayr and Conover 1948; Bent 1927; Ridgway 1919; Forbush 1912; Eaton 1910; Shriner 1897; Mackay 1893; Audubon 1844). Bent (1927) included Jamaica and Barbados as part of the possible wintering range of red knots, and described knots as "rarely" wintering in parts of Louisiana and Florida. Hellmayr and Conover (1948) noted the use of the West Indies (Jamaica, Barbados, and Trinidad) during migration. Several writers described the red knot as occurring primarily along the coasts with relatively few sightings inland, but interior migration routes through the central United States were also known (Lowery 1974; Hellmayr and Conover 1948; Bent 1927; Ridgway 1919; Forbush 1912; Eaton 1910; Audubon 1844). As with the geographic distribution, a number of historical accounts suggest that the timing of the red knot's spring and fall migrations along the Atlantic coast was generally the same in the past as it is today (Myers and Myers 1979; Urner and Storer 1949; Stone 1937; Bent 1927; Forbush 1912; Shriner 1897; Dixon 1895 in Barnes and Truitt 1997; Mackay 1893; Stearns and Coues 1883; Roosevelt 1866; Giraud 1944; Wilson 1829).

Although the large-scale geographic distribution of migration stopover habitats does not seem to have changed, some authors have noted regional changes in the patterns of red knot stopover habitat usage along the U.S. Atlantic coast. For example, based on a review of early literature, Cohen et al. (2008c) suggest that red knots had a more extensive spring stopover range a century ago than now, with thousands of birds noted in spring in Massachusetts, New York, New Jersey, and Virginia. Harrington et al. (2010a) found changes in the regional patterns of stopover habitat usage in Massachusetts, as well as a shift in the wintering destination of birds stopping in Massachusetts during fall migration.

Delaware Bay

Delaware Bay was not recognized as a major shorebird stopover area until the early 1980s, despite detailed shorebird studies (e.g., Urner and Storer 1949; Stone 1937) in the South Jersey region (Clark et al. 2009; Botton et al. in Shuster et al. 2003; Clark in Farrell and Martin 1997; Clark et al. 1993). There were some early anecdotal reports involving horseshoe crabs, as summarized by Botton et al. (in Shuster et al. 2003). Wilson (1829) noted that ruddy turnstones in the bay fed "almost wholly on the eggs, or spawn, of the great King Crab," but no similar accounts were made of red knots. Forbush (1912) noted that red knots "are fond of the spawn of the horsefoot crab, which, often in company with the Turnstone, they dig out of the sand…" Stone (1937) observed ruddy turnstones and black-bellied plovers regularly feeding on dead horseshoe crabs in Delaware Bay. Stone (1937) also mentions flights of ruddy turnstones across the Cape May Peninsula in the spring, as happens today when they go to roost at night along the Atlantic coastal marshes (Botton et al. in Shuster et al. 2003). Interestingly, no mention of horseshoe crab eggs as food is found in Stone's (1937) accounts of any shorebird in the Cape May area, or in the decade-long study by Urner and Storer (1949) (Botton et al. in Shuster et al. 2003). During his early studies of horseshoe crabs in 1951, Shuster observed many shorebirds feeding along Delaware Bay beaches, including red knots. However, another 30 years elapsed before scientists began to study the shorebird/horseshoe crab relationship in detail, and documented the very large numbers of shorebirds using the bay as a stopover (Botton et al. in Shuster et al. 2003). Lack of earlier scientific documentation cannot be attributed to remoteness. Delaware Bay is located within a few hours' drive of millions of people, and university marine laboratories were established many years ago on both shores of the bay (Botton et al. in Shuster et al. 2003).

It is unclear if the large magnitude of the shorebird-horseshoe crab phenomenon was simply missed by science until 1981, or if the distribution of the red knot and other shorebird species changed over the period of the historical record. For much of the 20th century, this phenomenon in Delaware Bay may have been much reduced (relative to 1980s levels), and therefore easier to miss, due to the occurrence of low points in the abundance of both shorebirds (caused by hunting) and horseshoe crabs (caused by intensive harvest) (Botton et al. in Shuster et al. 2003; Clark in Farrell and Martin 1997). Alternatively, it may be that the red knot did not make extensive use of Delaware Bay prior to its population decline a century ago. Under this scenario, red knots came to rely on Delaware Bay because their populations were recovering at the same time that Atlantic-side stopover habitats in the region were becoming developed and the shorelines stabilized (Cohen et al. 2008c). We have no means to determine how long shorebirds have been reliant on horseshoe crab eggs in Delaware Bay (Botton et al. in Shuster et al. 2003) prior to the early 1980s.

The middle part of the 20th century coincided with the recovery of shorebird populations following the regulation of hunting (Urner and Storer 1949; Bent 1927), a low point in horseshoe crab abundance following a period of intensive harvest (Atlantic States Marine Fisheries Commission (ASMFC) 2009), and the large-scale development and stabilization of Atlantic coast beaches in the mid-Atlantic region (Nordstrom and Mauriello 2001; Nordstrom 2000). Any or all of these factors may have influenced the red knot's use of, and reliance on, Delaware Bay as its primary Atlantic stopover site in spring.

Threats to Red Knots and Their Habitat

In this section, we provide an analysis of threats to red knots and their habitat in their migration and wintering range, with some specific references to their breeding range. Although the red knot's range extends farther than the piping plover's, some similarities exist in habitat use between the species within the U.S. portion of their migration and wintering ranges. Subsequently, there are similarities in the threats to those shared habitat features. The information presented in this section, however, is specific to the red knot and may cover a broader area and/or spectrum of similar threats than the information presented in the *Threats to piping plover/critical habitat* section. Because we lack information on threats to red knots for many countries outside the U.S. (with a few exceptions), this analysis is mainly focused on threats to red knots within the continental U.S. portion of their migration and wintering range, unless otherwise noted.

The inadequacy of existing regulatory mechanisms

There are some conservation efforts and regulatory mechanisms in place throughout the red knot's range that may help reduce threats to the subspecies. In the United States, the Migratory Bird Treaty Act of 1918 (MBTA) (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.) is the only federal law currently providing specific protection for the red knot due to its status as a migratory bird by prohibiting the following actions, unless permitted by Federal regulation: to "pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird…or any part, nest, or egg of any such bird." Through issuance of Migratory Bird Scientific Collecting permits, the Service ensures that best practices are implemented for the careful capture and handling of red knots during banding operations and other research activities. However, there are no provisions in the MBTA that prevent habitat destruction unless the activity causes direct mortality or the destruction of active nests, which would not apply since red knots do not breed in the United States. The MBTA does not address threats to the red knot from further population declines associated with habitat loss, insufficient food resources, climate change, or the other threats discussed in the remainder of the threats section.

Reduced food availability at the Delaware Bay stopover site due to commercial harvest of the horseshoe crab is considered a primary causal factor in the decline of the red knot in the 2000s. The Atlantic Coastal Fisheries Cooperative Management Act of 1993 set forth the current role of the Atlantic States Marine Fisheries Commission (ASMFC), which had been established under an interstate compact among all States from Maine to Florida and previously approved by Congress (P.L. 77-539 and 81-721). Under the 1993 law, the ASMFC develops coastal fishery management plans and monitors each State's compliance with the plans. If a State fails to implement and enforce a fishery plan, NOAA declares a moratorium on the fishery in question within the waters of the non-complying State. The ASMFC adopted a horseshoe crab management plan in 1998, with different provisions for the bait industry versus the biomedical industry. In 2012, the ASMFC adopted Addendum VII to the plan, which utilizes an Adaptive Resource Management (ARM) framework to manage the bait fishery in the Delaware Bay Region (New Jersey, Delaware, and parts of Maryland and Virginia) (ASMFC 2012). Under the ARM, bait harvest levels are tied to red knot populations via scientific modeling. There have been no instances of State noncompliance with the horseshoe crab management plan. In 2008, New Jersey enacted a law (N.J.S.A. 23.2b.21) extending an earlier (2006) statewide moratorium on the bait harvest until specific red knot recovery targets are achieved. Thus, New Jersey does not use its bait harvest quota as allocated by the ASMFC. Regulation of the horseshoe crab harvest is discussed in further detail below.

There are some state wildlife laws that also protect the red knot from direct take resulting from scientific study and hunting. Other Federal laws (e.g., the Sikes Act, the National Park Service Organic Act, and the National Wildlife Refuge System Improvement Act) provide protection for the red knot from habitat loss and inappropriate management on many Federal lands. Although shorebirds are not their focus, some laws do regulate shoreline stabilization and coastal development, including section 404 of the Clean Water Act, the Rivers and Harbors Act, the Coastal Barrier Resources Act, and the Coastal Zone Management Act as implemented by Federal and State regulations. We have limited information regarding State and local regulations regarding beach cleaning or recreational disturbance. Several Federal and State policies are in effect to stem the introductions and effects of invasive species, but collectively these do not provide complete protection for the red knot from impacts to its habitats or food supplies resulting from beach or marine invaders or the spread of harmful algal species. Although threats to the horseshoe crab egg resource remain, the current regulatory management of the horseshoe crab fishery is adequately addressing threats to the knot's Delaware Bay food supply from direct harvest. Although we lack information regarding the overall effect of recreation management policies on the red knot, we are aware of only a few locations in which beaches are closed, regulated, or monitored to protect nonbreeding shorebirds. Relatively strong Federal laws likely reduce risks to red knots from oil spills and pesticides, but both have caused documented shorebird mortalities and other impacts in recent decades. Similarly, existing Federal laws and policies are likely to reduce the red knot's collision risks from new wind turbine development, but some level of mortality is expected upon build-out of the Nation's wind energy infrastructure.

Canada also has laws (e.g., Canadian Species at Risk Act and Migratory Birds Convention Act) that provide protections to the red knot and its habitat both on and off Federal lands. We also know that red knots are legally protected from direct take and hunting in several Caribbean and Latin American countries, but we lack information regarding the implementation or effectiveness of those measures. We also lack information for countries outside the United States regarding protection or management of red knot habitat, and regarding the regulation of other activities that threaten the red knot such as development, disturbance, oil spills, environmental contaminants, and wind energy development.

Climate change

The natural history of Arctic-breeding shorebirds makes this group of species particularly vulnerable to global climate change (e.g., Meltofte et al. 2007; Piersma and Lindström 2004; Rehfisch and Crick 2003; Piersma and Baker 2000; Zöckler and Lysenko 2000; Lindström and Agrell 1999). Relatively low genetic diversity, which is thought to be a consequence of survival through past climate-driven population bottlenecks, may put shorebirds at more risk from human-induced climate variation than other avian taxa (Meltofte et al. 2007); low genetic diversity may result in reduced adaptive capacity as well as increased risks when population sizes drop to low levels.

In the short term, red knots may benefit if warmer temperatures result in fewer years of delayed horseshoe crab spawning in Delaware Bay (Smith and Michaels 2006) or fewer occurrences of late snow melt in the breeding grounds (Meltofte et al. 2007). However, there are indications that changes in the abundance and quality of red knot prey are already under way (Escudero et al. 2012; Jones et al. 2010), and prey species face ongoing climate-related threats from warmer temperatures (Jones et al. 2010; Philippart et al. 2003; Rehfisch and Crick 2003), ocean acidification (National Research Council (NRC) 2010; Fabry et al. 2008), and possibly increased prevalence of disease and parasites (Ward and Lafferty 2004). In addition, red knots face imminent threats from loss of habitat caused by sea level rise (NRC 2010; Galbraith et al. 2002; Titus 1990), and increasing asynchronies (‘‘mismatches’’) between the timing of their annual breeding, migration, and wintering cycles and the windows of peak food availability on which the birds depend (Smith et al. 2011; McGowan et al. 2011; Meltofte et al. 2007; van Gils et al. 2005a; Baker et al. 2004).

Several threats are related to the possibility of changing storm patterns. While variation in weather is a natural occurrence and is normally not considered a threat to the survival of a species, persistent changes in the frequency, intensity, or timing of storms at key locations where red knots congregate (e.g., key stopover areas) can pose a threat. Storms impact migratory shorebirds like the red knot both directly and indirectly. Direct impacts include energetic costs from a longer migration route as birds avoid storms, blowing birds off course, and outright mortality (Niles et al. 2010). Indirect impacts include changes to habitat suitability, storm-induced asynchronies between migration stopover periods and the times of peak prey availability, and possible prompting of birds to take refuge in areas where shorebird hunting is still practiced (Niles et al. 2012; Dey et al. 2011a; Nebel 2011).

With arctic warming, vegetation conditions in the red knot’s breeding grounds are expected to change, causing the zone of nesting habitat to shift and perhaps contract, but this process may take decades to unfold (Feng et al. 2012; Meltofte et al. 2007; Kaplan et al. 2003). Ecological shifts in the Arctic may appear sooner. High uncertainty exists about when and how changing interactions among vegetation, predators, competitors, prey, parasites, and pathogens may affect the red knot, but the impacts are potentially profound (Fraser et al. 2013; Schmidt et al. 2012; Meltofte et al. 2007; Ims and Fuglei 2005).

Due to background rates of sea level rise and the naturally dynamic nature of coastal habitats, we conclude that red knots are adapted to moderate (although sometimes abrupt) rates of habitat change in their wintering and migration areas. However, rates of sea level rise are accelerating beyond those that have occurred over recent millennia. In most of the red knot’s nonbreeding range, shorelines are expected to undergo dramatic reconfigurations over the next century as a result of accelerating sea level rise. Extensive areas of marsh are likely to become inundated, which may reduce foraging and roosting habitats. Marshes may be able to establish farther inland, but the rate of new marsh formation (e.g., intertidal sediment accumulation, development of hydric soils, colonization of marsh vegetation) may be slower than the rate of deterioration of existing marsh, particularly under higher sea level rise scenarios. The primary red knot foraging habitats (i.e., intertidal flats and sandy beaches) will likely be locally or regionally inundated, but replacement habitats are likely to reform along the shoreline in its new position. However, if shorelines experience a decades-long period of high instability and landward migration, the formation rate of new beach habitats may be slower than the inundation rate of existing habitats. In addition, low-lying and narrow islands (e.g., in the Caribbean and along the Gulf and Atlantic coasts) may disintegrate rather than migrate, representing a net loss of red knot habitat. Superimposed on these changes are widespread human attempts to stabilize the shoreline, which are known to exacerbate losses of intertidal habitats by blocking their landward migration. The cumulative loss of habitat across the nonbreeding range could affect the ability of red knots to complete their annual cycles, possibly affecting fitness and survival, and is thereby likely to negatively influence the long-term survival of the red knot.

In summary, climate change is expected to affect red knot fitness and, therefore, survival through direct and indirect effects on breeding and nonbreeding habitat, food availability, and timing of the birds' annual cycle. Ecosystem changes in the arctic (e.g., changes in predation patterns and pressures) may also reduce reproductive output. Together, these anticipated changes will likely negatively influence the long-term survival of the red knot.

<u>Reduced food availability</u>

Commercial harvest of horseshoe crabs has been implicated as a causal factor in the decline of the red knot populations in the 2000s, by decreasing the availability of horseshoe crab eggs in the Delaware Bay stopover (Niles et al. 2008). Due to harvest restrictions and other conservation actions, horseshoe crab populations showed some signs of recovery in the early 2000s, with apparent signs of red knot stabilization (survey counts, rates of weight gain) occurring a few years later (as might be expected due to biological lag times). Since about 2005, however, horseshoe crab population growth has stagnated for unknown reasons. Under the current management framework, the present horseshoe crab harvest is not considered a threat to the red knot. However, it is not yet known if the horseshoe crab egg resource will continue to adequately support red knot populations over the next 5 to 10 years. In addition, implementation of the current management framework could be impeded by insufficient funding.

The causal role of reduced Delaware Bay food supplies in driving red knot population declines shows the vulnerability of red knots to declines in the quality or quantity of their prey. This vulnerability has also been demonstrated in other *C. canutus* subspecies, although not to the severe extent experienced by the *rufa* subspecies. In addition to the fact that horseshoe crab population growth has stagnated, red knots now face several emerging threats to their food supplies throughout their nonbreeding range. These threats include: small prey sizes (from unknown causes) at two key wintering sites on Tierra del Fuego; warming water temperatures that may cause mollusk population declines and range contractions (including the likely loss of a key prey species from the Virginia spring stopover within the next decade); ocean acidification to which mollusks are particularly vulnerable; physical habitat changes from climate change affecting invertebrate communities; possibly increasing rates of mollusk diseases due to climate change; invasive marine species from ballast water and aquaculture; and the burial and crushing of invertebrate prey from sand placement and recreational activities. Although threats to food quality and quantity are widespread, red knots in localized areas have shown some adaptive capacity to switch prey when the preferred prey species became reduced (Escudero et al. 2012;

Musmeci et al. 2011), suggesting some adaptive capacity to cope with this threat. Nonetheless, based on the combination of documented past impacts and a spectrum of ongoing and emerging threats, we conclude that reduced quality and quantity of food supplies is a threat to the rufa red knot at the subspecies level, and the threat is likely to continue into the future.

Asynchronies ("mismatches") in the red knot's annual cycle

The red knot's life history strategy makes this species inherently vulnerable to mismatches in timing between its annual cycle and those periods of optimal food and weather conditions upon which it depends. For unknown reasons, more red knots arrived late in Delaware Bay in the early 2000s, which is generally accepted as a key causative factor (along with reduced supplies of horseshoe crab eggs) behind red knot population declines that were observed over this same timeframe. Thus, the red knot's sensitivity to timing asynchronies has been demonstrated through a population-level response. Both adequate supplies of horseshoe crab eggs and high-quality foraging habitat in Delaware Bay can serve to partially mitigate minor asynchronies at this key stopover site. However, the factors that caused delays in the spring migrations of red knots from Argentina and Chile are still unknown, and we have no information to indicate if this delay will reverse, persist, or intensify.

Superimposed on this existing threat of late arrivals in Delaware Bay are new threats of asynchronies emerging due to climate change. Climate change is likely to affect the reproductive timing of horseshoe crabs in Delaware Bay, mollusk prey species at other stopover sites, or both, possibly pushing the peak seasonal availability of food outside of the windows when red knots rely on them. In addition, both field studies and modeling have shown strong links between the red knot's reproductive output and conditions in the Arctic including insect abundance and snow cover. Climate change may also cause shifts in the period of optimal arctic conditions relative to the time period when red knots currently breed.

The red knot's adaptive capacity to deal with numerous changes in the timing of resource availability across its geographic range is largely unknown. A few examples suggest some flexibility in migration strategies. However, available information suggests that the timing of the red knot's annual cycle is controlled at least partly by celestial and endogenous cues, while the reproductive seasons of prey species, including horseshoe crabs and mollusks, are largely driven by environmental cues such as water temperature. These differences between the timing cues of red knots and their prey suggest limitations on the adaptive capacity of red knots to deal with numerous changes in the timing of resource availability across their geographic range. Based on the combination of documented past impacts and a spectrum of ongoing and emerging threats, we conclude that asynchronies (mismatches between the timing of the red knot's annual cycles and the periods of favorable food and weather upon which it depends) are likely to cause deleterious subspecies-level effects.

Shoreline stabilization and coastal development

Much of the U.S. coast within the range of the red knot is already extensively developed. Direct loss of shorebird habitats occurred over the past century as substantial commercial and residential developments were constructed in and adjacent to ocean and estuarine beaches along the Atlantic and Gulf coasts. In addition, red knot habitat was also lost indirectly, as sediment supplies were reduced and stabilization structures were constructed to protect developed areas. Sea level rise and human activities within coastal watersheds can lead to long-term reductions in sediment supply to the coast. The damming of rivers, bulk-heading of highlands, and armoring of coastal bluffs have reduced erosion in natural source areas and consequently the sediment loads reaching coastal areas. Although it is difficult to quantify, the cumulative reduction in sediment supply from human activities may contribute substantially to the long-term shoreline erosion rate. Along coastlines subject to sediment deficits, the amount of sediment supplied to the coast is less than that lost to storms and coastal sinks (inlet channels, bays, and upland deposits), leading to long-term shoreline recession (Coastal Protection and Restoration Authority of Louisiana 2012; Florida Oceans and Coastal Council 2010; CCSP 2009b; Defeo et al. 2009; Morton et al. 2004; Morton 2003; Herrington 2003; Greene 2002).

In addition to reduced sediment supplies, other factors such as stabilized inlets, shoreline stabilization structures, and coastal development can exacerbate long-term erosion (Herrington 2003). Coastal development and shoreline stabilization can be mutually reinforcing. Coastal development often encourages shoreline stabilization because stabilization projects cost less than the value of the buildings and infrastructure. Conversely, shoreline stabilization sometimes encourages coastal development by making a previously high-risk area seem safer for development (CCSP 2009b). Protection of developed areas is the driving force behind ongoing shoreline stabilization efforts. Large-scale shoreline stabilization projects became common in the past 100 years with the increasing availability of heavy machinery. Shoreline stabilization methods change in response to changing new technologies, coastal conditions, and preferences of residents, planners, and engineers. Along the Atlantic and Gulf coasts, an early preference for shore-perpendicular structures (e.g., groins) was followed by a period of construction of shore-parallel structures (e.g., seawalls), and then a period of beach nourishment, which is now favored (Morton et al. 2004; Nordstrom 2000).

The mid-Atlantic coast from New York to Virginia is the most urbanized shoreline in the country, except for parts of Florida and southern California. In New York and New Jersey, hard structures and beach nourishment programs cover much of the coastline. Farther south, there are more undeveloped and preserved sections of coast (Leatherman 1989). Along the entire Atlantic, most of the ocean coast is fully or partly (intermediate) developed, less than 10 percent is in conservation, and about one-third is undeveloped and still available for new development (**Table 1**).

Table 1 - Percent* of dry land within 3.3 ft (1 m) of high water by intensity of development along the U.S. Atlantic Coast (Titus et al. 2009).

State	Developed	Intermediate	Undeveloped	Conservation
Massachusetts	26	29	22	23
Rhode Island	36	11	48	5
Connecticut	80	8	7	5
New York	73	18	4	6
New Jersey	66	15	12	7
Pennsylvania	49	21	26	4
Delaware	27	26	23	24
Maryland	19	16	56	9
District of Columbia	82	5	14	0
Virginia	39	22	32	7
North Carolina	28	14	55	3
South Carolina	28	21	41	10
Georgia	27	16	23	34
Florida	65	10	12	13
Coastwide	42	15	33	9

* Percentages may not add up to 100 due to rounding.

The U.S. southeastern coast from North Carolina to Florida is the least urbanized along the Atlantic coast, although both coasts of Florida are urbanizing rapidly. Texas has the most extensive sandy coastline in the Gulf, and much of the area is sparsely developed (Leatherman 1989). **Table 2** gives the miles of developed and undeveloped beach from North Carolina to Texas. Region-wide, about 40 percent of the southeast and Gulf coast is already developed, as shown in **Table 2**. Not all of the remaining 60 percent in the ‘‘undeveloped’’ category, however, is still available for development because about 43 percent (about 910 miles) of beaches across this region are considered preserved. Preserved beaches include those in public or nongovernmental conservation ownership and those under conservation easements.

Table 2 - The lengths and percentages of developed and undeveloped sandy, oceanfront beaches along the Southeast Atlantic and Gulf coasts (Rice 2013 pers. comm.; Rice 2012a; Service 2012a).

State	Miles of Shoreline	Miles and percent of developed beach	Miles and percent of undeveloped beach*
North Carolina	326	159 (49%)	167 (51%)
South Carolina	182	93 (51%)	89 (49%)
Georgia	90	15 (17%)	75 (83%)
Florida	809	459 (57%)	351 (43%)
Alabama	46	25 (55%)	21(45%)
Mississippi barrier islands	27	0 (0%)	27 (100%)
Mississippi mainland**	51	41 (80%)	10 (20%)
Louisiana	218	13 (6%)	205 (94%)
Texas	370	51 (14%)	319 (86%)
Coast-wide	2,119	856 (40%)	1,264 (60%)

* Beaches classified as ‘‘undeveloped’’ occasionally include a few scattered structures.

** The mainland Mississippi coast along Mississippi Sound includes 51.3 mi of sandy beach as of 2010–2011, out of approximately 80.7 total shoreline miles (the remaining portion is non-sandy, either marsh or armored coastline with no sand).

Past and ongoing stabilization projects fundamentally alter the naturally dynamic coastal processes that create and maintain beach strand and bayside habitats, including those habitat components that red knots rely upon. Past loss of stopover and wintering habitat likely reduce the resilience of the red knot by making it more dependent on those habitats that remain, and more vulnerable to threats (e.g., disturbance, predation, reduced quality or abundance of prey, increased intraspecific and interspecific competition) within those restricted habitats.

Hard structures

Hard structures constructed of stone, concrete, wood, steel, or geotextiles have been used for centuries as a coastal defense strategy (Defeo et al. 2009). The most common hard stabilization structures fall into two groups: structures that run parallel to the shoreline (e.g., seawalls, revetments, bulkheads) and structures that run perpendicular to the shoreline (e.g., groins, jetties). Groins are often clustered in groin fields, and are intended to protect a finite section of beach, while jetties are normally constructed at inlets to keep sand out of navigation channels and provide calm-water access to harbor facilities (USACE 2002). Descriptions of the different types of stabilization structures can be found in Rice (2009), Herrington (2003), and USACE (2002, Parts V and VI).

Prior to the 1950s, the general practice in the United States was to use hard structures to protect developments from beach erosion or storm damages (USACE 2002). The pace of constructing new hard stabilization structures has since slowed considerably (USACE 2002). Many states within the range of the red knot now discourage or restrict the construction of new, hard oceanfront protection structures, although the hardening of bayside shorelines is generally still allowed (Kana 2011; Greene 2002; Titus 2000). Most existing hard oceanfront structures continue to be maintained, and some new structures continue to be built. While some states have restricted new construction, hard structures are still among the alternatives in the Federal shore protection program (USACE 2002).

Hard shoreline stabilization projects are typically designed to protect property (and its human inhabitants) not beaches (Kana 2011; Pilkey and Howard 1981). Through effects on waves and currents, sediment transport rates, Aeolian (wind) processes, and sand exchanges with dunes and offshore bars, hard structures change the erosion/accretion dynamics of beaches and constrain the natural migration of shorelines (CCSP 2009b; Defeo et al. 2009; Morton 2003; Scavia et al. 2002; Nordstrom 2000). There is ample evidence of accelerated erosion rates, pronounced breaks in shoreline orientation, and truncation of the beach profile down-drift of perpendicular structures, and of reduced beach widths (relative to unprotected segments) where parallel structures have been in place over long periods of time (Hafner 2012; CCSP 2009b; Morton 2003; Scavia et al. 2002; USACE 2002; Nordstrom 2000; Pilkey and Wright 1988). In addition, marinas and port facilities built out from the shore can have effects similar to hard stabilization structures (Nordstrom 2000).

Structural development along the shoreline and manipulation of natural inlets upset the naturally dynamic coastal processes and result in loss or degradation of beach habitat (Melvin et al. 1991).

As beaches narrow, the reduced habitat can directly lower the diversity and abundance of biota (life forms), especially in the upper intertidal zone. Shorebirds may be impacted both by reduced habitat area for roosting and foraging, and by declining intertidal prey resources, as has been documented in California (Defeo et al. 2009; Dugan and Hubbard 2006). In an estuary in England, Stillman et al. (2005) found that a two to eight percent reduction in intertidal area (the magnitude expected through sea level rise and industrial developments including extensive stabilization structures) decreased the predicted survival rates of five out of nine shorebird species evaluated (although not of red knots). In Delaware Bay, hard structures also cause or accelerate loss of horseshoe crab spawning habitat (CCSP 2009b; Botton et al. in Shuster et al. 2003; Botton et al. 1988), and shorebird habitat has been, and may continue to be, lost where bulkheads have been built (Clark in Farrell and Martin 1997). In addition to directly eliminating red knot habitat, hard structures interfere with the creation of new shorebird habitats by interrupting the natural processes of over-wash and inlet formation. Where hard stabilization is installed, the eventual loss of the beach and its associated habitats is virtually assured (Rice 2009), absent beach nourishment, which may also impact red knots as discussed below. Where they are maintained, hard structures are likely to significantly increase the amount of red knot habitat lost as sea levels continue to rise.

In a few isolated locations, however, hard structures may enhance red knot habitat, or may provide artificial habitat. In Delaware Bay, for example, Botton et al. (1994) found that, in the same manner as natural shoreline discontinuities like creek mouths, jetties and other artificial obstructions can act to concentrate drifting horseshoe crab eggs and thereby attract shorebirds. Another example comes from the Delaware side of the bay, where a seawall and jetty at Mispillion Harbor protect the confluence of the Mispillion River and Cedar Creek. These structures create a low energy environment in the harbor, which seems to provide highly suitable conditions for horseshoe crab spawning over a wider variation of weather and sea conditions than anywhere else in the bay (Breese 2013 pers. comm.). Horseshoe crab egg densities at Mispillion Harbor are consistently an order of magnitude higher than at other bay beaches (Dey et al. 2011b), and this site consistently supports upwards of 15 to 20 percent of all the knots recorded in Delaware Bay (Lathrop 2005). In Florida, Schwarzer (2013 pers. comm.) has observed multiple instances of red knots using artificial structures such as docks, piers, jetties, causeways, and construction barriers; we have no information regarding the frequency, regularity, timing, or significance of this use of artificial habitats. Notwithstanding localized red knot use of artificial structures, and the isolated case of hard structures improving foraging habitat at Mispillion Harbor, the nearly universal effect of such structures is the degradation or loss of red knot habitat.

<u>Mechanical sediment transport</u>

Several types of sediment transport are employed to stabilize shorelines, protect development, maintain navigation channels, and provide for recreation (Gebert 2012; Kana 2011; USACE 2002). The effects of these projects are typically expected to be relatively short in duration, usually less than 10 years, but often these actions are carried out every few years in the same area, resulting in a more lasting impact on habitat suitability for shorebirds. Mechanical sediment transport practices include beach nourishment, sediment back-passing, sand scraping, and dredging.

Since the 1970s, 90 percent of the Federal appropriation for shore protection has been for beach nourishment (USACE 2002), which has become the preferred course of action to address shoreline erosion in the United States (Kana 2011; Morton and Miller 2005; Greene 2002). Beach nourishment requires an abundant source of sand that is compatible with the native beach material. The sand is trucked to the target beach or hydraulically pumped using dredges (Hafner 2012). Sand for beach nourishment operations can be obtained from dry land-based sources; estuaries, lagoons, or inlets on the backside of the beach; sandy shoals in inlets and navigation channels; near-shore ocean waters; or offshore ocean waters; with the last two being the most common sources (Greene 2002).

Where shorebird habitat has been severely reduced or eliminated by hard stabilization structures, beach nourishment may be the only means available to replace any habitat for as long as the hard structures are maintained (Nordstrom and Mauriello 2001), although such habitat will persist only with regular nourishment episodes (typically on the order of every two to six years). In Delaware Bay, beach nourishment has been recommended to prevent loss of spawning habitat for horseshoe crabs (Kalasz 2008; Carter et al. in Guilfoyle et al. 2007; Atlantic States Marine Fisheries Commission (ASMFC) 1998), and is being pursued as a means of restoring shorebird habitat in Delaware Bay following Hurricane Sandy (Niles et al. 2013; USACE 2012). Beach nourishment was part of a 2009 project to maintain important shorebird foraging habitat at Mispillion Harbor, Delaware (Kalasz 2013 pers. comm.; Siok and Wilson 2011). However, red knots may be directly disturbed if beach nourishment takes place while the birds are present. On New Jersey's Atlantic coast, beach nourishment has typically been scheduled for the fall, when red knots are present, because of various constraints at other times of year. In addition to causing disturbance during construction, beach nourishment often increases recreational use of the widened beaches that, without careful management, can increase disturbance of red knots. Beach nourishment can also temporarily depress, and sometimes permanently alter, the invertebrate prey base on which shorebirds depend.

In addition to disturbing the birds and impacting the prey base, beach nourishment can affect the quality and quantity of red knot habitat (Bimbi 2012 pers. comm.; Greene 2002). The artificial beach created by nourishment may provide only suboptimal habitat for red knots, as a steeper beach profile is created when sand is stacked on the beach during the nourishment process. In some cases, nourishment is accompanied by the planting of dense beach grasses, which can directly degrade habitat, as red knots require sparse vegetation to avoid predation. By precluding over-wash and Aeolian transport, especially where large artificial dunes are constructed, beach nourishment can also lead to further erosion on the bayside and promote bayside vegetation growth, both of which can degrade the red knot's preferred foraging and roosting habitats (sparsely vegetated flats in or adjacent to intertidal areas). Preclusion of over-wash also impedes the formation of new red knot habitats. Beach nourishment can also encourage further development, bringing further habitat impacts, reducing future alternative management options such as a retreat from the coast, and perpetuating the developed and stabilized conditions that may ultimately lead to inundation where beaches are prevented from migrating (Bimbi 2012 pers. comm.; Greene 2002).

Following placement of sediments much coarser than those native to the beach, Peterson et al. (2006) found that the area of intertidal-shallow sub-tidal shorebird foraging habitat was reduced by 14 to 29 percent at a site in North Carolina. Presence of coarse shell material armored the substrate surface against shorebird probing, further reducing foraging habitat by 33 percent, and probably also inhibiting manipulation of prey when encountered by a bird's bill (Peterson et al. 2006). In addition to this physical change from adding coarse sediment, nourishment that places sediment dissimilar to the native beach also substantially increases impacts to the red knot's invertebrate prey base.

Sediment back-passing is a technique that reverses the natural migration of sediment by mechanically (via trucks) or hydraulically (via pipes) transporting sand from accreting, downdrift areas of the beach to eroding, up-drift areas of the beach (Kana 2011; Chasten and Rosati 2010). Currently less prevalent than beach nourishment, sediment back-passing is an emerging practice because traditional nourishment methods are beginning to face constraints on budgets and sediment availability (Hafner 2012; Chase 2006). Beach bulldozing or scraping is the process of mechanically redistributing beach sand from the littoral zone (along the edge of the sea) to the upper beach to increase the size of the primary dune or to provide a source of sediment for beaches that have no existing dune; no new sediment is added to the system (Kana 2011; Greene 2002; Lindquist and Manning 2001). Beach scraping tends to be a localized practice. In Florida beach scraping is usually used only in emergencies such as after hurricanes and other storms, but in New Jersey this practice is more routine in some areas. Many of the effects of sediment back-passing and beach scraping are similar to those for beach nourishment (Service 2011c; Lindquist and Manning 2001), including disturbance during and after construction, alteration of prey resources, reduced habitat area and quality, and precluded formation of new habitats. Relative to beach nourishment, sediment back-passing and beach scraping can involve considerably more driving of heavy trucks and other equipment on the beach including areas outside the sand placement footprint, potentially impacting shorebird prey resources over a larger area (Service 2011c). In addition, these practices can directly remove sand from red knot habitats, as is the case in one red knot concentration area in New Jersey (Service 2011c). Back-passing and sand scraping can involve routine episodes of sand removal or transport that maintain the beach in a narrower condition, indefinitely reducing the quantity of back-beach roosting habitat.

Sediments are also manipulated to maintain navigation channels. Many inlets in the U.S. range of the red knot are routinely dredged and sometimes relocated. In addition, near-shore areas are routinely dredged (''mined'') to obtain sand for beach nourishment. Regardless of the purpose, inlet and near-shore dredging can affect red knot habitats. Dredging often involves removal of sediment from sand bars, shoals, and inlets in the near-shore zone, directly impacting optimal red knot roosting and foraging habitats (Harrington 2008; Harrington in Guilfoyle et al. 2007; Winn and Harrington in Guilfoyle et al. 2006). These ephemeral habitats are even more valuable to red knots because they tend to receive less recreational use than the main beach strand. In addition to causing this direct habitat loss, the dredging of sand bars and shoals can preclude the creation and maintenance of red knot habitats by removing sand sources that would otherwise act as natural breakwaters and weld onto the shore over time (Hayes and Michel 2008; Morton 2003). Further, removing these sand features can cause or worsen localized erosion by altering depth contours and changing wave refraction (Hayes and Michel 2008), potentially degrading other nearby red knot habitats indirectly because inlet dynamics exert a strong influence on the adjacent shorelines. Studying barrier islands in Virginia and North Carolina, Fenster and Dolan (1996) found that inlet influences extend 3.4 to 8.1 mi (5.4 to 13.0 km), and that inlets dominate shoreline changes for up to 2.7 mi (4.3 km). Changing the location of dominant channels at inlets can create profound alterations to the adjacent shoreline (Nordstrom 2000).

Wrack removal and beach cleaning

The effects of wrack removal and beach cleaning to red knot migration and wintering habitat are similar to those described in the *Threats to piping plovers/critical habitat* section on page 22 of this document. Therefore, that information will not be reiterated here and we provide the following summary.

The occurrence of beach raking in the Southeast and Gulf coasts were discussed in the *Threats to piping plovers/critical habitat* section on page 22. Only minimal disturbance is likely to occur on mid-Atlantic and northern Atlantic beaches because raking in these areas is most prevalent from Memorial Day to Labor Day, when only small numbers of red knots typically occur in this region. However, the practice of intensive beach raking may cause physical changes to beaches that degrade their suitability as red knot habitat. Removal of wrack may also have an effect on the availability of red knot food resources, particularly in those times and places that birds are more reliant on wrack-associated prey items. Beach cleaning machines are likely to cause disturbance to roosting and foraging red knots, particularly in the U.S. wintering range. Mechanized beach cleaning is widespread within the red knot's U.S. range, particularly in developed areas. We anticipate beach grooming may expand in some areas that become more developed but may decrease in other areas due to increasing environmental regulations, such as restrictions on beach raking in piping plover nesting areas (e.g., Nordstrom and Mauriello 2001).

Invasive vegetation

The effects of invasive vegetation to red knot migration and wintering habitat are similar to those described in the *Threats to piping plovers/critical habitat* section on page 21 of this document. Therefore, that information will not be reiterated here and we provide the following summary.

Although the extent of the threat is uncertain, that uncertainty may be due to poor survey coverage more than an absence of species invasions. The propensity of invasive species to spread, and their tenacity once established, make them a persistent problem that is only partially countered by increasing awareness and willingness of beach managers to undertake control efforts (Service 2012a). Red knots require open habitats that allow them to see potential predators and that are away from tall perches used by avian predators. Invasive species, particularly woody species, degrade or eliminate the suitability of red knot roosting and foraging habitats by forming dense stands of vegetation. Although not a primary cause of habitat loss, invasive species can be a regionally important contributor to the overall loss and degradation of the red knot's nonbreeding habitat.

Aquaculture and agriculture

In some localized areas within the red knot's range, aquaculture or agricultural activities are impacting habitat quality and quantity. Those impacts, however, occur mainly in Canada, Brazil, Río Gallegos (southern Argentina), and Bahía Lomas (Chilean Tierra del Fuego). In the United

States, Luckenbach (2007) found that aquaculture of clams (*Mercenaria mercenaria*) in the lower Chesapeake Bay occurs in close proximity to shorebird foraging areas. The current distribution of clam aquaculture in the very low intertidal zone minimizes the amount of direct overlap with shorebird foraging habitats, but if clam aquaculture expands farther into the intertidal zone, more shorebird impacts (e.g., habitat alteration) may occur. However, these Chesapeake Bay intertidal zones are not considered the primary habitat for red knots (Cohen et al. 2009), and red knots were not among the shorebirds observed in this study (Luckenbach 2007). Likewise, oyster aquaculture is practiced in Delaware Bay (NJDEP 2011), but we have no information to indicate that this activity is affecting red knots.

Hunting

Since the late 19th century, hunters concerned about the future of wildlife and the outdoor tradition have made countless contributions to conservation. In many cases, managed hunting is an important tool for wildlife management. However, unregulated or illegal hunting can cause population declines, as was documented in the 1800s for red knots in the United States. While no longer a concern in the United States, under-regulated or illegal hunting of red knots and other shorebirds is ongoing in parts of the Caribbean and South America.

Scientific study

Considerable care is taken to minimize disturbance caused to shorebirds from these research activities. Numbers of birds per catch and total numbers caught over the season are limited, and careful handling protocols are followed, including a 3-hour limit on holding times (Niles et al. 2010; Niles 2008 pers. comm.; Sitters 2008 pers. comm.; Niles et al. 2008). Despite these measures, hundreds of red knots are temporarily stressed during the course of annual research, and mortality, though rare, does occasionally occur (Clark 2013 pers. comm.; Taylor 1981). However, we conclude that these research activities are not a threat to the red knot because evaluations have shown no effects of these short-term stresses on red knot survival. Further, the rare, carefully documented, and properly permitted mortality of an individual bird in the course of well-founded research does not affect red knot populations or the overall subspecies.

Disease

Red knots are exposed to parasites and disease throughout their annual cycle. Susceptibility to disease may be higher when the energy demands of migration have weakened the immune system. Studying red knots in Delaware Bay in 2007, Buehler et al. (2010) found that several indices of immune function were lower in birds recovering protein after migration than in birds storing fat to fuel the next leg of the migration. These authors hypothesized that fueling birds may have an increased rate of infection or may be bolstering immune defense, or recovering birds may be immuno-compromised because of the physical strain of migratory flight or as a result of adaptive energy tradeoffs between immune function and migration, or both (Buehler et al. 2010). A number of known parasites (e.g., sporozoans, hookworms, flatworms, and ectoparasites) and viruses (e.g., avian influenza and avian paramyxovirus) have been documented in red knots, but we have no evidence that disease is a current threat to the red knot.

Predation

In wintering and migration areas, the most common predators of red knots are peregrine falcons, harriers, accipiters, merlins, short-eared owls, and greater black-backed gulls (Niles et al. 2008). In addition to greater black-backed gulls, other large gulls (e.g., herring gulls) are anecdotally known to prey on shorebirds (Breese 2010). Predation by a great horned owl has been documented in Florida (Schwarzer 2013 pers. comm.). Nearly all documented predation of wintering red knots in Florida has been by avian, not terrestrial, predators (Schwarzer 2013 pers. comm.). However in migration areas like Delaware Bay, terrestrial predators such as red foxes and feral cats may be a threat to red knots by causing disturbance, but direct mortality from these predators may be low (Niles et al. 2008).

Raptor predation has been shown to be an important mortality factor for shorebirds at several sites (Piersma et al. 1993). However, Niles et al. (2008) concluded that increased raptor populations have not been shown to affect the size of shorebird populations. Based on studies of other *C. canutus* subspecies in the Dutch Wadden Sea, Piersma et al. (1993) concluded that the chance for an individual to be attacked and captured is small, as long as the birds remain in the open and in large flocks so that approaching raptors are likely to be detected. Although direct mortality from predation is generally considered relatively low in nonbreeding areas, predators also impact red knots by affecting habitat use and migration strategies (Niles et al. 2008; Stillman et al. 2005) and by causing disturbance, thereby potentially affecting red knots' rates of feeding and weight gain.

In wintering and migration areas, predation is not directly impacting red knot populations despite some direct mortality. At key stopover sites, however, localized predation pressures are likely to exacerbate other threats to red knot populations, such as habitat loss, food shortages, and asynchronies between the birds' stopover period and the occurrence of favorable food and weather conditions. Predation pressures worsen these threats by pushing red knots out of otherwise suitable foraging and roosting habitats, causing disturbance, and possibly causing changes to stopover duration or other aspects of the migration strategy.

Although little information is available from the breeding grounds, the long-tailed jaeger is prominently mentioned as a predator of red knot chicks in most accounts. Other avian predators include parasitic jaeger, pomarine jaeger, herring gull, glaucous gull, gyrfalcon, peregrine falcon, and snowy owl. Mammalian predators include arctic fox and sometimes arctic wolves (Niles et al. 2008; COSEWIC 2007). Predation pressure on Arctic-nesting shorebird clutches varies widely regionally, inter-annually, and even within each nesting season, with nest losses to predators ranging from close to 0 percent to near 100 percent (Meltofte et al. 2007), depending on ecological factors. In the Arctic, 3- to 4-year lemming cycles give rise to similar cycles in the predation of shorebird nests. When lemmings are abundant, predators concentrate on the lemmings, and shorebirds breed successfully. When lemmings are in short supply, predators switch to shorebird eggs and chicks (Niles et al. 2008; COSEWIC 2007; Meltofte et al. 2007; Service 2003; Blomqvist et al. 2002; Summers and Underhill 1987).

In addition to affecting reproductive output, these cyclic predation pressures have been shown to influence shorebird nesting chronology and distribution. Studying 12 shorebird species, including red knot, over 11 years at four sites in the eastern Canadian Arctic, Smith et al. (2010) found that both snow conditions and predator abundance have significant effects on the chronology of breeding. Higher predator abundance resulted in earlier nesting than would be predicted by snow cover alone (Smith et al. 2010). Based on the adaptations of various species to deal with predators, Larson (1960) concluded that the distribution and abundance of red knots and other Arctic-breeding shorebirds were strongly influenced by arctic fox and rodent cycles, such that birds were in low numbers or absent in areas without lemmings because foxes preyed predominately on birds in those areas (as cited in Fraser et al. 2013). Unsuccessful breeding seasons contributed to at least some of the observed reductions in the red knot population in the 2000s. However, rodent-predator cycles have always affected the productivity of Arctic-breeding shorebirds and have generally caused only minor year-to-year changes in otherwise stable populations (Niles et al. 2008).

We conclude that cyclic predation in the Arctic results in years with extremely low reproductive output but does not threaten the red knot. The cyclical nature of this predation on shorebirds is a situation that has probably occurred over many centuries, and under historic conditions likely had no lasting impact on red knot populations. Where and when rodent-predator cycles are operating, we expect red knot reproductive success will also be cyclic. However, these cycles are being interrupted for reasons that are not yet fully clear. The geographic extent and duration of future interruptions to the cycles cannot be forecasted but may intensify as the arctic climate changes. Disruptions in the rodent-predator cycle pose a substantial threat to red knot populations, as they may result in prolonged periods of very low reproductive output. Superimposed on these potential cycle disruptions are warming temperatures and changing vegetative conditions in the Arctic, which are likely to bring about additional changes in the predation pressures faced by red knots on the breeding grounds; we cannot forecast how such ecosystem changes are likely to unfold.

Human disturbance

In some wintering and stopover areas, red knots and recreational users (e.g., pedestrians, ORVs, dog walkers, boaters) are concentrated on the same beaches (Niles et al. 2008; Tarr 2008). Recreational activities affect red knots both directly and indirectly. These activities can cause habitat damage (Schlacher and Thompson 2008; Anders and Leatherman 1987), cause shorebirds to abandon otherwise preferred habitats, negatively affect the birds' energy balances, and reduce the amount of available prey. Effects to red knots from vehicle and pedestrian disturbance can also occur during construction of shoreline stabilization projects including beach nourishment. Red knots can also be disturbed by motorized and non-motorized boats, fishing, kite surfing, aircraft, and research activities (Kalasz 2011 pers. comm.; Niles et al. 2008; Peters and Otis 2007; Harrington 2005b; Meyer et al. 1999; Burger 1986) and by beach raking. In Delaware Bay, red knots could also potentially be disturbed by hand-harvest of horseshoe crabs during the spring migration stopover period, but under the current management of this fishery, State waters from New Jersey to coastal Virginia are closed to horseshoe crab harvest and landing from January 1 to June 7 each year (ASMFC 2012); thus, disturbance from horseshoe crab harvest is no longer occurring. Active management can be effective at reducing and minimizing the adverse effects of recreational disturbance (Burger and Niles in press; Forys 2011; Burger et al. 2004), but such management is not occurring throughout the red knot's range.

Red knots are exposed to disturbance from recreational and other human activities throughout their nonbreeding range. Excessive disturbance has been shown to preclude shorebird use of otherwise preferred habitats and can impact energy budgets. Both of these effects are likely to exacerbate other threats to the red knot, such as habitat loss, reduced food availability, asynchronies in the annual cycle, and competition with gulls (such competition is greater in Delaware Bay when foraging on horseshoe crab eggs; in other areas, the two species' diets do not tend to overlap).

Harmful algal blooms

A harmful algal bloom (HAB) is the proliferation of a toxic or nuisance algal species (which can be microscopic or macroscopic, such as seaweed) that negatively affects natural resources or humans (Florida Fish and Wildlife Conservation Commission (FFWCC) 2011). The primary groups of microscopic species that form HABs are flagellates (including dinoflagellates), diatoms, and blue-green algae (which are actually cyanobacteria, rather than true algae). Of the approximately 85 HAB-forming species currently documented, almost all of them are plant-like microalgae that require light and carbon dioxide to produce their own food using chlorophyll (FFWCC 2011). Blooms can appear green, brown, or red-orange, or may be colorless, depending upon the species blooming and environmental conditions. Although HABs are popularly called ''red tides,'' this name can be misleading, as it includes many blooms that discolor the water but cause no harm, while also excluding blooms of highly toxic cells that cause problems at low (and essentially invisible) concentrations (Woods Hole 2012). In this document, the term ''red tide'' refers only to blooms of the dinoflagellate *Karenia brevis*.

For shorebirds, shellfish are a key route of exposure to algal toxins. When toxic algae are filtered from the water as food by shellfish, their toxins accumulate in those shellfish to levels that can be lethal to animals that eat the shellfish (Anderson 2007). Several shellfish poisoning syndromes have been identified according to their symptoms. Those shellfish poisoning syndromes that occur prominently within the range of the red knot include: Amnesic Shellfish Poisoning (ASP), occurring in Atlantic Canada, caused by *Pseudo-nitzchia* spp.; Neurotoxic Shellfish Poisoning (NSP, also called ''red tide''), occurring on the U.S. coast from Texas to North Carolina, caused by *Karenia brevis* and other species; and Paralytic Shellfish Poisoning (PSP), occurring in Atlantic Canada, the U.S. coast in New England, Argentina, and Tierra del Fuego, caused by *Alexandrium* spp. and others (Woods Hole 2012; FAO 2004). The highest levels of PSP toxins have been recorded in shellfish from Tierra del Fuego (International Atomic Energy Agency 2004), and high levels can persist in mollusks for months following a PSP bloom (FAO 2004). In Florida, the St. Johns, St. Lucie, and Caloosahatchee Rivers and estuaries have also been affected by persistent HABs of cyanobacteria (FFWCC 2011).

Algal toxins may be a direct cause of death in seabirds and shorebirds via an acute or lethal exposure, or birds can be exposed to chronic, sub-lethal levels of a toxin over the course of an extended bloom. Sub-acute doses may contribute to mortality due to an impaired ability to forage productively, disrupted migration behavior, reduced nesting success, or increased vulnerability to predation, dehydration, disease, or injury (VanDeventer 2007). It is commonly believed that the primary risk to shorebirds during an HAB is via contamination of shellfish and other invertebrates that constitute their normal diet. Coquina clams and other items that shorebirds feed upon can accumulate marine toxins during HABs and may pose a risk to foraging shorebirds. In addition to consuming toxins via their normal prey items, shorebirds have been observed consuming dead fish killed by HABs (VanDeventer 2007). Brevetoxins were found both in the dead fish and in the livers of dead shorebirds that were collected from beaches and rehabilitation centers (VanDeventer et al. 2011). Although scavenging has not been documented in red knots, clams and other red knot prey species are among the organisms that accumulate algal toxins.

Sick or dying birds often seek shelter in dense vegetation; thus, those that succumb to HAB exposure are not often observed or documented. Birds that are debilitated or die in exposed areas are subject to predation or may be swept away in tidal areas. When extensive fish kills occur from HABs, the carcasses of smaller birds such as shorebirds may go undetected. Some areas affected by HABs are remote and rarely visited. Thus, mortality of shorebirds associated with HABs is likely underreported.

To date, direct impacts to red knots from HABs have been documented only in Texas, although a large die-off in Uruguay may have also been linked to an HAB. We conclude that some level of undocumented red knot mortality from HABs likely occurs most years, based on probable underreporting of shorebird mortalities from HABs and the direct exposure of red knots to algal toxins (particularly via contaminated prey) throughout the knot's nonbreeding range. We have no documented evidence that HABs were a driving factor in red knot population declines in the 2000s. However, HAB frequency and duration have increased and do not show signs of abating over the next few decades. Combined with other threats, ongoing and possibly increasing mortality from HABs may affect the red knot at the population level.

<u>Environmental contaminants</u>

Although red knots are exposed to a variety of contaminants across their nonbreeding range, we have no evidence that such exposure is impacting health, survival, or reproduction at the subspecies level. Exposure risks exist in localized red knot habitats in Canada, but best available data suggest shorebirds in Canada are not impacted by background levels of contamination. Levels of most metals in red knot feathers from the Delaware Bay have been somewhat high but generally similar to levels reported from other studies of shorebirds. One preliminary study suggests organochlorines and trace metals are not elevated in Delaware Bay shorebirds, although this finding cannot be confirmed without updated testing. Levels of metals in horseshoe crabs are generally low in the Delaware Bay region and not likely impacting red knots or recovery of the crab population.

Horseshoe crab reproduction does not appear impacted by the mosquito control chemical methoprene (at least through the first juvenile molt) or by ambient water quality in mid-Atlantic estuaries. Shorebirds have been impacted by pesticide exposure, but use of the specific chemical that caused a piping plover death in Florida has subsequently been banned in the United States. Exposure of shorebirds to agricultural pollutants in rice fields may occur regionally in parts of

South America, but red knot usage of rice field habitats was low in the several countries surveyed. Finally, localized urban pollution has been shown to impact South American red knot habitats, but we are unaware of any documented health effects or population-level impacts. Thus, we conclude that environmental contaminants are not a threat to the red knot.

Oil spills

The red knot has the potential to be exposed to oil spills and leaks throughout its migration and wintering range. Oil, as well as spill response activities, can directly and indirectly affect both the bird and its habitat through several pathways. Red knots can be exposed to petroleum products via spills from shipping vessels, leaks or spills from offshore oil rigs or undersea pipelines, leaks or spills from onshore facilities such as petroleum refineries and petrochemical plants, and beach-stranded barrels and containers that can fall from moving cargo ships or offshore rigs. Several key red knot wintering or stopover areas also contain large-scale petroleum extraction, transportation, or both activities. With regard to potential effects on red knot habitats, the geographic location of a spill, weather conditions (e.g., prevailing winds), and type of oil spilled are as important, if not more so, than the volume of the discharge.

Red knots are exposed to large-scale petroleum extraction and transportation operations in many key wintering and stopover habitats including Tierra del Fuego, Patagonia, the Gulf of Mexico, Delaware Bay, and the Gulf of St. Lawrence. To date, the documented effects to red knots from oil spills and leaks have been minimal; however, information regarding any oiling of red knots during the Deepwater Horizon spill has not yet been released. We conclude that high potential exists for small or medium spills to impact moderate numbers of red knots or their habitats, such that one or more such events is likely over the next few decades, based on the proximity of key red knot habitats to high-volume oil operations. Risk of a spill may decrease with improved spill contingency planning, infrastructure safety upgrades, and improved spill response and recovery methods. However, these decreases in risk (e.g., per barrel extracted or transported) could be offset if the total volume of petroleum extraction and transport continues to grow. A major spill affecting habitats in a key red knot concentration area (e.g., Tierra del Fuego, Gulf coasts of Florida or Texas, Delaware Bay, Mingan Archipelago) while knots are present is less likely but would be expected to cause population-level impacts.

Wind energy development

Within the red knot's U.S. wintering and migration range, substantial development of offshore wind facilities is planned, and the number of wind turbines installed on land has increased considerably over the past decade. The rate of wind energy development will likely continue to increase into the future as the United States looks to decrease reliance on the traditional sources of energy (e.g., fossil fuels). Wind turbines can have a direct (e.g., collision mortality) and indirect (e.g., migration disruption, displacement from habitat) impact on shorebirds. We have no information on wind energy development trends in other countries, but risks of red knot collisions would likely be similar wherever large numbers of turbines are constructed along migratory pathways, either on land or offshore.

We analyzed shorebird mortality at land-based wind turbines in the United States, and we considered the red knot's vulnerability factors for collisions with offshore wind turbines that we expect will be built in the next few decades. Based on our analysis of wind energy development in the United States, we expect ongoing improvements in turbine siting, design, and operation will help minimize bird collision hazards. However, we also expect cumulative avian collision mortality to increase through 2030 as the number of turbines continues to grow, and as wind energy development expands into coastal and offshore environments. Shorebirds as a group have constituted only a small percentage of collisions with U.S. turbines in studies conducted to date, but wind development along the coasts (where shorebirds might be at greater risk) did not begin until 2005.

We are not aware of any documented red knot mortalities at any wind turbines to date, but low levels of red knot mortality from turbine collisions may be occurring now based on the number of turbines along the red knot's migratory routes and the frequency with which red knots traverse these corridors. Based on the current number and geographic distribution of turbines, if any such mortality is occurring, it is likely not causing subspecies-level effects. However, as build-out of offshore, coastal, and inland wind energy infrastructure progresses, increasing mortality from turbine collisions may contribute to a subspecies-level effect due to the red knot's vulnerability to direct human-caused mortality. We anticipate that the threat to red knots from wind turbines will be primarily related to collision or behavioral changes during migratory or daily flights. Unless facilities are constructed at key stopover or wintering habitats we do not expect wind energy development to cause significant direct habitat loss or degradation or displacement of red knots from otherwise suitable habitats.

Threats summary

The Service has assessed the best scientific and commercial data available regarding past, present, and future threats to the red knot. The primary threats to the red knot are from habitat loss and degradation due to sea level rise, shoreline stabilization, and Arctic warming, and reduced food availability and asynchronies in the annual cycle. Other threats are moderate in comparison to the primary threats; however, cumulatively, they could become significant when working in concert with the primary threats if they further reduce the species' resiliency. Such secondary threats include hunting, predation, human disturbance, harmful algal blooms, oil spills, and wind energy development, all of which affect red knots across their range. Although conservation efforts (e.g., management of the horseshoe crab population and regulatory mechanisms for the species and its habitat) are being implemented in many areas of the red knot's range and reduce some threats, significant risks to the subspecies remain.

APPENDIX F

Sea Turtle Life History, Population Dynamics, and Status and Distribution

Life history

Loggerhead Sea Turtle

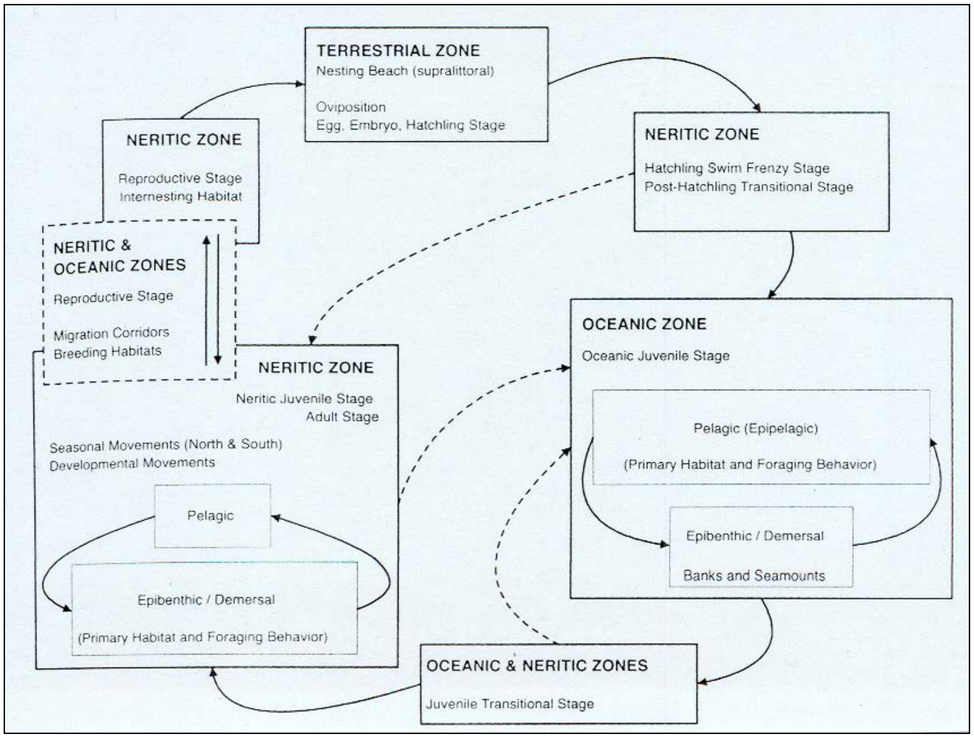
Loggerheads are long-lived, slow-growing animals that use multiple habitats across entire ocean basins throughout their life history. This complex life history encompasses terrestrial, nearshore, and open ocean habitats. The three basic ecosystems in which loggerheads live are the:

1. Terrestrial zone (supralittoral) - the nesting beach where both oviposition (egg laying) and embryonic development and hatching occur.

2. Neritic zone - the inshore marine environment (from the surface to the sea floor) where water depths do not exceed 656 ft. The neritic zone generally includes the continental shelf, but in areas where the continental shelf is very narrow or nonexistent, the neritic zone conventionally extends to areas where water depths are less than 656 ft.

3. Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 656 ft.

Maximum intrinsic growth rates of sea turtles are limited by the extremely long duration of the juvenile stage and fecundity. Loggerheads require high survival rates in the juvenile and adult stages, common constraints critical to maintaining long-lived, slow-growing species, to achieve positive or stable long-term population growth (Congdon et al. 1993, Heppell 1998, Crouse 1999, Heppell et al. 1999, 2003, Musick 1999). The generalized life history of Atlantic loggerheads is shown in the figure below (from Bolten 2003).



Life history stages of a loggerhead turtle. The boxes represent life stages and the corresponding ecosystems, solid lines represent movements between life stages and ecosystems, and dotted lines are speculative (Bolten 2003).

Numbers of nests and nesting females are often highly variable from year to year due to a number of factors including environmental stochasticity, periodicity in ocean conditions, anthropogenic effects, and density-dependent and density-independent factors affecting survival, somatic growth, and reproduction (Meylan 1982, Hays 2000, Chaloupka 2001, Solow *et al.* 2002). Despite these sources of variation, and because female turtles exhibit strong nest site fidelity, a nesting beach survey can provide a valuable assessment of changes in the adult female population, provided that the study is sufficiently long and effort and methods are standardized (Meylan 1982, Gerrodette and Brandon 2000, Reina et al. 2002). **Table 13** summarizes key life history characteristics for loggerheads nesting in the U.S.

Typical values of life history parameters for loggerheads nesting in the U.S. (NMFS and Service 2008).

Life History Trait	**Data**
Clutch size (mean)	100-126 eggs[1]
Incubation duration (varies depending on time of year and latitude)	Range = 42-75 days[2,3]
Pivotal temperature (incubation temperature that produces an equal number of males and females)	84˚F[5]
Nest productivity (emerged hatchlings/total eggs) x 100 (varies depending on site specific factors)	45-70 percent[2,6]
Clutch frequency (number of nests/female/season)	3-4 nests[7]
Internesting interval (number of days between successive nests within a season)	12-15 days[8]
Juvenile (<34 inches Curved Carapace Length) sex ratio	65-70 percent female[4]
Remigration interval (number of years between successive nesting migrations)	2.5-3.7 years[9]
Nesting season	late April-early September
Hatching season	late June-early November
Age at sexual maturity	32-35 years[10]
Life span	>57 years[11]

1 Dodd (1988).
2 Dodd and Mackinnon (1999, 2000, 2001, 2002, 2003, 2004).
3 Witherington (2006) (information based on nests monitored throughout Florida beaches in 2005, n = 865).
4 National Marine Fisheries Service (2001); Foley (2005).
5 Mrosovsky (1988).
6 Witherington (2006) (information based on nests monitored throughout Florida beaches in 2005, n = 1,680).
7 Murphy and Hopkins (1984); Frazer and Richardson (1985); Hawkes et al. 2005; Scott 2006.
8 Caldwell (1962), Dodd (1988).
9 Richardson et al. (1978); Bjorndal et al. (1983).
10 Snover (2005).
11 Dahlen et al. (2000).

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2002). Despite these sources of variation, and because female turtles exhibit strong nest site fidelity, a nesting beach survey can provide a valuable assessment of changes in the adult female population, provided that the study is sufficiently long and effort and methods are standardized (Meylan 1982, Gerrodette and Brandon 2000, Reina *et al*. 2002).

Loggerheads nest on ocean beaches and occasionally on estuarine shorelines with suitable sand. Nests are typically laid between the high tide line and the dune front (Routa 1968, Witherington 1986, Hailman and Elowson 1992). Wood and Bjorndal (2000) evaluated four environmental factors (slope, temperature, moisture, and salinity) and found that slope had the greatest influence on loggerhead nest-site selection on a beach in Florida. Loggerheads appear to prefer relatively narrow, steeply sloped, coarse-grained beaches, although nearshore contours may also play a role in nesting beach site selection (Provancha and Ehrhart 1987).

The warmer the sand surrounding the egg chamber, the faster the embryos develop (Mrosovsky and Yntema 1980). Sand temperatures prevailing during the middle third of the incubation period also determine the sex of hatchling sea turtles (Mrosovsky and Yntema 1980). Incubation temperatures near the upper end of the tolerable range produce only female hatchlings while incubation temperatures near the lower end of the tolerable range produce only male hatchlings.

Loggerhead hatchlings pip and escape from their eggs over a 1- to 3-day interval and move upward and out of the nest over a 2- to 4-day interval (Christens 1990). The time from pipping to emergence ranges from 4 to 7 days with an average of 4.1 days (Godfrey and Mrosovsky 1997). Hatchlings emerge from their nests en masse almost exclusively at night, and presumably using decreasing sand temperature as a cue (Hendrickson 1958, Mrosovsky 1968, Witherington et al. 1990). Moran et al. (1999) concluded that a lowering of sand temperatures below a critical threshold, which most typically occurs after nightfall, is the most probable trigger for hatchling emergence from a nest. After an initial emergence, there may be secondary emergences on subsequent nights (Carr and Ogren 1960, Witherington 1986, Ernest and Martin 1993, Houghton and Hays 2001).

Hatchlings use a progression of orientation cues to guide their movement from the nest to the marine environments where they spend their early years (Lohmann and Lohmann 2003). Hatchlings first use light cues to find the ocean. On naturally lighted beaches without artificial lighting, ambient light from the open sky creates a relatively bright horizon compared to the dark silhouette of the dune and vegetation landward of the nest. This contrast guides the hatchlings to the ocean (Daniel and Smith 1947, Limpus 1971, Salmon *et al.* 1992, Witherington and Martin 1996, Witherington 1997, Stewart and Wyneken 2004).

Loggerheads in the Northwest Atlantic display complex population structure based on life history stages. Based on mitochondrial deoxyribonucleic acid (mtDNA), oceanic juveniles show no structure, neritic juveniles show moderate structure, and nesting colonies show strong structure (Bowen et al. 2005). In contrast, a survey using microsatellite (nuclear) markers showed no significant population structure among nesting populations (Bowen *et al*. 2005), indicating that while females exhibit strong philopatry, males may provide an avenue of gene flow between nesting colonies in this region.

Green Sea Turtle

Green sea turtles deposit from one to nine clutches within a nesting season, but the overall average is about 3.3 nests. The interval between nesting events within a season varies around a mean of about 13 days (Hirth 1997). Mean clutch size varies widely among populations. Average clutch size reported for Florida was 136 eggs in 130 clutches (Witherington and Ehrhart 1989). Only occasionally do females produce clutches in successive years. Usually two or more years intervene between breeding seasons (NMFS and Service 1991). Age at sexual maturity is believed to be 20 to 50 years (Hirth 1997).

Kemp's Ridley

Nesting occurs primarily from April into July. Nesting often occurs in synchronized emergences, known as "arribadas" or "arribazones," which may be triggered by high wind speeds, especially north winds, and changes in barometric pressure (Jimenez et al. 2005). Nesting occurs primarily during daylight hours. Clutch size averages 100 eggs and eggs typically take 45 to 58 days to hatch depending on incubation conditions, especially temperatures (Marquez-Millan 1994, Rostal 2007).

Females lay an average of 2.5 clutches within a season (TEWG 1998) and inter-nesting interval generally ranges from 14 to 28 days (Miller 1997; Donna Shaver, Padre Island National Seashore, personal communication, 2007 as cited in NMFS et al. 2011). The mean remigration interval for adult females is 2 years, although intervals of 1 and 3 years are not uncommon (Marquez et al. 1982; TEWG 1998, 2000). Males may not be reproductively active on an annual basis (Wibbels et al. 1991). Age at sexual maturity is believed to be between 10 to 17 years (Snover et al. 2007).

Population dynamics

Loggerhead Sea Turtle

The loggerhead occurs throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd 1988). However, the majority of loggerhead nesting is at the western rims of the Atlantic and Indian Oceans. The most recent reviews show that only two loggerhead nesting beaches have greater than 10,000 females nesting per year (Baldwin et al. 2003, Ehrhart et al. 2003, Kamezaki et al. 2003, Limpus and Limpus 2003, Margaritoulis et al. 2003): Peninsular Florida (U.S.) and Masirah (Oman). Those beaches with 1,000 to 9,999 females nesting each year are Georgia through North Carolina (U.S.), Quintana Roo and Yucatán (Mexico), Cape Verde Islands (Cape Verde, eastern Atlantic off Africa), and Western Australia (Australia). Smaller nesting aggregations with 100 to 999 nesting females annually occur in the Northern Gulf of Mexico (U.S.), Dry Tortugas (U.S.), Cay Sal Bank (Bahamas), Sergipe and Northern Bahia (Brazil), Southern Bahia to Rio de Janerio (Brazil), Tongaland (South Africa), Mozambique, Arabian Sea Coast (Oman), Halaniyat Islands (Oman), Cyprus, Peloponnesus (Greece), Island of Zakynthos (Greece), Turkey, Queensland (Australia), and Japan.

The loggerhead is commonly found throughout the North Atlantic including the Gulf of Mexico, the northern Caribbean, the Bahamas archipelago, and eastward to West Africa, the western Mediterranean, and the west coast of Europe.

The major nesting concentrations in the U.S. are found in South Florida. However, loggerheads nest from Texas to Virginia. Total estimated nesting in the U.S. has fluctuated between 49,000 and 90,000 nests per year from 1999-2010 (NMFS and Service 2008, FWC/FWRIa). About 80 percent of loggerhead nesting in the southeast U.S. occurs in six Florida counties (Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties). Adult loggerheads are known to make considerable migrations between foraging areas and nesting beaches (Schroeder et al. 2003, Foley et al. 2008). During non-nesting years, adult females from U.S. beaches are distributed in waters off the eastern U.S. and throughout the Gulf of Mexico, Bahamas, Greater Antilles, and Yucatán.

From a global perspective, the U.S. nesting aggregation is of paramount importance to the survival of the species as is the population that nests on islands in the Arabian Sea off Oman (Ross 1982, Ehrhart 1989, Baldwin et al. 2003). Based on standardized daily surveys of the highest nesting beaches and weekly surveys on all remaining island nesting beaches, approximately 50,000, 67,600, and 62,400 nests, were estimated in 2008, 2009, and 2010, respectively (Conant et al. 2009). The status of the Oman loggerhead nesting population, reported to be the largest in the world (Ross 1979), is uncertain because of the lack of long-term standardized nesting or foraging ground surveys and its vulnerability to increasing development pressures near major nesting beaches and threats from fisheries interaction on foraging grounds and migration routes (Possardt 2005). The loggerhead nesting aggregations in Oman and the U.S. account for the majority of nesting worldwide.

Green Sea Turtle

There are an estimated 150,000 females that nest each year in 46 sites throughout the world (NMFS and Service 2007a). In the U.S. Atlantic, there are about 100 to 1,000 females estimated to nest on beaches in Florida annually (FWC 2009c). In the U.S. Pacific, over 90 percent of nesting throughout the Hawaiian archipelago occurs at the French Frigate Shoals, where about 200 to 700 females nest each year (NMFS and Service 1998a). Elsewhere in the U.S. Pacific, nesting takes place at scattered locations in the Commonwealth of the Northern Marianas, Guam, and American Samoa. In the western Pacific, the largest green turtle nesting aggregation in the world occurs on Raine Island, Australia, where thousands of females nest nightly in an average nesting season (Limpus *et al.* 1993). In the Indian Ocean, major nesting beaches occur in Oman where 30,000 females are reported to nest annually (Ross and Barwani 1995).

Kemp's Ridley

Most Kemp's ridleys nest on the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico. Nesting also occurs in Veracruz and Campeche, Mexico although a small number of Kemp's ridleys nest consistently along the Texas coast (NMFS et al. 2011). In addition, rare nesting events have been reported in AL, Florida, Georgia, South Carolina, and North Carolina. Historical information indicates that tens of thousands of ridleys nested near Rancho Nuevo, Mexico, during the late 1940s (Hildebrand 1963). The Kemp's ridley population experienced a devastating decline between the late 1940s and the mid-1980s. The total number of nests per nesting season at Rancho Nuevo remained below 1,000 throughout the 1980s, but gradually began to increase in the 1990s. In 2009, 16,273 nests were documented along the 18.6 miles of coastline patrolled at Rancho Nuevo, and the total number of nests documented for all the monitored beaches in Mexico was 21,144 (Service 2009). In 2011, a total of 20,570 nests were documented in Mexico, 81 percent of these nests were documented in the Rancho Nuevo beach (Burchfield and Peña. 2011). In addition, 153 and 199 nests were recorded during 2010 and 2011, respectively, primarily in Texas.

Status and distribution

Loggerhead Sea Turtle

Five recovery units have been identified in the Northwest Atlantic based on genetic differences and a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries (NMFS and Service 2008). Recovery units are subunits of a listed species that are geographically or otherwise identifiable and essential to the recovery of the species. Recovery units are individually necessary to conserve genetic robustness, demographic robustness, important life history stages, or some other feature necessary for long-term sustainability of the species. The five recovery units identified in the Northwest Atlantic are:

1. Northern Recovery Unit (NRU) - defined as loggerheads originating from nesting beaches from the Florida-Georgia border through southern Virginia (the northern extent of the nesting range);

2. Peninsula Florida Recovery Unit (PFRU) - defined as loggerheads originating from nesting beaches from the Florida-Georgia border through Pinellas County on the west coast of Florida, excluding the islands west of Key West, Florida;

3. Dry Tortugas Recovery Unit (DTRU) - defined as loggerheads originating from nesting beaches throughout the islands located west of Key West, Florida;

4. Northern Gulf of Mexico Recovery Unit (NGMRU) - defined as loggerheads originating from nesting beaches from Franklin County on the northwest Gulf coast of Florida through Texas; and

5. Greater Caribbean Recovery Unit (GCRU) - composed of loggerheads originating from all other nesting assemblages within the Greater Caribbean (Mexico through French Guiana, The Bahamas, Lesser Antilles, and Greater Antilles).

The mtDNA analyses show that there is limited exchange of females among these recovery units (Ehrhart 1989, Foote et al. 2000, NMFS 2001, Hawkes et al. 2005). Based on the number of haplotypes, the highest level of loggerhead mtDNA genetic diversity in the Northwest Atlantic has been observed in females of the GCRU that nest at Quintana Roo, Mexico (Encalada et al. 1999, Nielsen 2010).

Nuclear DNA analyses show that there are no substantial subdivisions across the loggerhead nesting colonies in the southeastern U.S. Male-mediated gene flow appears to be keeping the subpopulations genetically similar on a nuclear DNA level (Francisco-Pearce 2001).

Historically, the literature has suggested that the northern U.S. nesting beaches (NRU and NGMRU) produce a relatively high percentage of males and the more southern nesting beaches (PFRU, DTRU, and GCRU) a relatively high percentage of females (e.g., Hanson et al. 1998, NMFS 2001, Mrosovsky and Provancha 1989). The NRU and NGMRU were believed to play an important role in providing males to mate with females from the more female-dominated subpopulations to the south. However, in 2002 and 2003, researchers studied loggerhead sex ratios for two of the U.S. nesting subpopulations, the northern and southern subpopulations (NGU and PFRU, respectively) (Blair 2005, Wyneken et al. 2005). The study produced interesting results. In 2002, the northern beaches produced more females and the southern beaches produced more males than previously believed. However, the opposite was true in 2003 with the northern beaches producing more males and the southern beaches producing more females in keeping with prior literature. Wyneken et al. (2005) speculated that the 2002 result may have been anomalous; however, the study did point out the potential for males to be produced on the southern beaches. Although this study revealed that more males may be produced on southern recovery unit beaches than previously believed, the Service maintains that the NRU and NGMRU play an important role in the production of males to mate with females from the more southern recovery units.

The NRU is the second largest loggerhead recovery unit within the Northwest Atlantic Ocean DPS. Annual nest totals from northern beaches averaged 5,215 nests from 1989-2008, a period of near-complete surveys of NRU nesting beaches, representing approximately 1,272 nesting females per year (4.1 nests per female, Murphy and Hopkins 1984) (NMFS and Service 2008). In 2008, nesting in Georgia reached what was a new record at that time (1,646 nests), with a downturn in 2009, followed by yet another record in 2010 (1,760 nests). South Carolina had the two highest years of nesting in the 2000s in 2009 (2,183 nests) and 2010 (3,141 nests). The previous high for that 11-year span was 1,433 nests in 2003. North Carolina had 847 nests in 2010, which is above the average of 715. The Georgia, South Carolina, and North Carolina nesting data come from the seaturtle.org Sea Turtle Nest Monitoring System, which is populated with data input by the State agencies. The loggerhead nesting trend from daily beach surveys was declining significantly at 1.3 percent annually from 1983 to 2007 (NMFS and USFWS, 2008). Nest totals from aerial surveys conducted by the South Carolina Department of Natural Resources showed a 1.9 percent annual decline in nesting in South Carolina from 1980-2007. Overall, there is strong statistical data to suggest the NRU has experienced a long-term decline (NMFS and Service 2008). Currently, however, nesting for the NRU is showing possible signs of stabilizing (76 FR 58868, September 22, 2011).

The PFRU is the largest loggerhead recovery unit within the Northwest Atlantic Ocean DPS and represents approximately 87 percent of all nesting effort in the DPS (Ehrhart et al. 2003). A near-complete nest census of the PFRU undertaken from 1989 to 2007 revealed a mean of 64,513 loggerhead nests per year representing approximately 15,735 females nesting per year (4.1 nests per female, Murphy and Hopkins 1984) (FWC 2008b, NMFS and Service 2008). This near-complete census provides the best statewide estimate of total abundance, but because of variable survey effort, these numbers cannot be used to assess trends. Loggerhead nesting trends are best assessed using standardized nest counts made at INBS sites surveyed with constant effort over time. In 1979, the Statewide Nesting Beach Survey (SNBS) program was initiated to document the total distribution, seasonality, and abundance of sea turtle nesting in Florida. In 1989, the INBS program was initiated in Florida to measure seasonal productivity, allowing comparisons between beaches and between years (FWC 2009b). Of the 190 SNBS surveyed areas, 33 participate in the INBS program (representing 30 percent of the SNBS beach length).

Using INBS nest counts, a significant declining trend was documented for the Peninsular Florida Recovery Unit, where nesting declined 26 percent over the 20-year period from 1989–2008, and declined 41 percent over the period 1998–2008 (NMFS and USFWS 2008, Witherington et al. 2009). However, with the addition of nesting data through 2010, the nesting trend for the PFRU did not show a nesting decline statistically different from zero (76 FR 58868, September 22, 2011).

The NGMRU is the third largest nesting assemblage among the four U.S. recovery units. Nesting surveys conducted on approximately 186 miles of beach within the NGMRU (AL and Florida only) were undertaken between 1995 and 2007 (statewide surveys in AL began in 2002). The mean nest count during this 13-year period was 906 nests per year, which equates to about 221 females nesting per year (4.1 nests per female, Murphy and Hopkins 1984, (FWC 2008b, NMFS and Service 2008). Evaluation of long-term nesting trends for the NGMRU is difficult because of changed and expanded beach coverage. Loggerhead nesting trends are best assessed using standardized nest counts made at INBS sites surveyed with constant effort over time. Using Florida INBS data for the NGMRU (FWC 2008b), a log-linear regression showed a significant declining trend of 4.7 percent annually from 1997-2008 (NMFS and Service 2008).

The DTRU, located west of the Florida Keys, is the smallest of the identified recovery units. A near-complete nest census of the DTRU was undertaken from 1995 to 2004, excluding 2002, (9 years surveyed) revealed a mean of 246 nests per year, which equates to about 60 females nesting per year (4.1 nests per female, Murphy and Hopkins 1984) (FWC 2008b, NMFS and Service 2008). The nesting trend data for the DTRU are from beaches that are not part of the INBS program, but are part of the SNBS program. A simple linear regression of 1995-2004 nesting data, accounting for temporal autocorrelation, revealed no trend in nesting numbers. Because of the annual variability in nest totals, it was determined that a longer time series is needed to detect a trend (NMFS and Service 2008).

The GCRU is composed of all other nesting assemblages of loggerheads within the Greater Caribbean and is the third largest recovery unit within the Northwest Atlantic Ocean DPS, with the majority of nesting at Quintana Roo, Mexico. Statistically valid analyses of long-term nesting trends for the entire GCRU are not available because there are few long-term standardized nesting surveys representative of the region. Additionally, changing survey effort at monitored beaches and scattered and low-level nesting by loggerheads at many locations currently precludes comprehensive analyses. The most complete data are from Quintana Roo and Yucatán, Mexico, where an increasing trend was reported over a 15-year period from 1987-2001 (Zurita et al. 2003). However, TEWG (2009) reported a greater than 5 percent annual decline in loggerhead nesting from 1995-2006 at Quintana Roo.

Recovery Criteria (only the Demographic Recovery Criteria are presented below; for the Listing Factor Recovery Criteria, see NMFS and Service 2008)

1. Number of Nests and Number of Nesting Females

    a. Northern Recovery Unit

        i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is 2 percent or greater resulting in a total annual number of nests of 14,000 or greater for this recovery unit (approximate distribution of nests is North Carolina =14 percent [2,000 nests], South Carolina =66 percent [9,200 nests], and Georgia =20 percent [2,800 nests]); and

        ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

    b. Peninsular Florida Recovery Unit

        i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is statistically detectable (one percent) resulting in a total annual number of nests of 106,100 or greater for this recovery unit; and

        ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

    c. Dry Tortugas Recovery Unit

        i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is three percent or greater resulting in a total annual number of nests of 1,100 or greater for this recovery unit; and

ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

d. Northern Gulf of Mexico Recovery Unit

i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is three percent or greater resulting in a total annual number of nests of 4,000 or greater for this recovery unit (approximate distribution of nests (2002-2007) is Florida= 92 percent [3,700 nests] and AL =8 percent [300 nests]); and

ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

e. Greater Caribbean Recovery Unit

i. The total annual number of nests at a minimum of three nesting assemblages, averaging greater than 100 nests annually (e.g., Yucatán, Mexico; Cay Sal Bank, Bahamas) has increased over a generation time of 50 years; and

ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

2. Trends in Abundance on Foraging Grounds

A network of in-water sites, both oceanic and neritic across the foraging range is established and monitoring is implemented to measure abundance. There is statistical confidence (95 percent) that a composite estimate of relative abundance from these sites is increasing for at least one generation.

3. Trends in Neritic Strandings Relative to In-water Abundance

Stranding trends are not increasing at a rate greater than the trends in in-water relative abundance for similar age classes for at least one generation.

Green Sea Turtle

Annual nest totals documented as part of the Florida SNBS program from 1989-2010 have ranged from 435 nests laid in 1993 to 13,225 in 2010 Nesting occurs in 26 counties with a peak along the east coast, from Volusia through Broward Counties. Although the SNBS program provides information on distribution and total abundance statewide, it cannot be used to assess trends because of variable survey effort. Therefore, green turtle nesting trends are best assessed using standardized nest counts made at INBS sites surveyed with constant effort over time (1989-2010). Green sea turtle nesting in Florida is increasing based on 22 years (1989-2010) of INBS data from throughout the state ((FWC/FWRI 2010b). The increase in nesting in Florida is likely a result of several factors, including: (1) a Florida statute enacted in the early 1970s that prohibited the killing of green turtles in Florida; (2) the species listing under the Act afforded complete protection to eggs, juveniles, and adults in all U.S. waters; (3) the passage of Florida's constitutional net ban amendment in 1994 and its subsequent enactment, making it illegal to use any gillnets or other entangling nets in State waters; (4) the likelihood that the majority of Florida green turtles reside within Florida waters where they are fully protected; (5) the protections afforded Florida green turtles while they inhabit the waters of other nations that have enacted strong sea turtle conservation measures (e.g., Bermuda); and (6) the listing of the species on Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which stopped international trade and reduced incentives for illegal trade from the U.S (NMFS and Service 2007).

Recovery Criteria

The U.S. Atlantic population of green sea turtles can be considered for delisting if, over a period of 25 years, the following conditions are met:

1. The level of nesting in Florida has increased to an average of 5,000 nests per year for at least six years. Nesting data must be based on standardized surveys;

2. At least 25 percent (65 miles) of all available nesting beaches (260 miles) is in public ownership and encompasses at least 50 percent of the nesting activity;

3. A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds; and

4. All priority one tasks identified in the recovery plan have been successfully implemented.

Kemp’s Ridley

Nesting aggregations of Kemp’s ridleys at Rancho Nuevo were discovered in 1947, and the adult female population was estimated to be 40,000 or more individuals based on a film by Andres Herrera (Hildebrand 1963, Carr 1963). Within approximately 3 decades, the population had declined to 924 nests and reached the lowest recorded nest count of 702 nests in 1985. Since the mid-1980s, the number of nests observed at Rancho Nuevo and nearby beaches has increased 15 percent per year (Heppell et al. 2005), allowing cautious optimism that the population is on its way to recovery. This increase in nesting can be attributed to full protection of nesting females and their nests in Mexico resulting from a bi-national effort between Mexico and the U.S. to prevent the extinction of the Kemp’s ridley, the requirement to use Turtle Excluder Devices (TEDs) in shrimp trawls both in the U.S. and Mexico, and decreased shrimping effort (NMFS *et* *al*. 2011, Heppell et al. 2005).

Recovery Criteria

The goal of the recovery plan is for the species to be reduced from endangered to threatened status. The Recovery Team members feel that the criteria for a complete removal of this species from the endangered species list need not be considered now, but rather left for future revisions of the plan. Complete removal from the federal list would certainly necessitate that some other instrument of protection, similar to the MMPA, be in place and be international in scope. Kemp's ridley can be considered for reclassification to threatened status when the following four criteria are met:

Downlisting Criteria

1. A population of at least 10,000 nesting females in a season (as measured by clutch frequency per female per season) distributed at the primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained. Methodology and capacity to implement and ensure accurate nesting female counts have been developed.

2. Recruitment of at least 300,000 hatchlings to the marine environment per season at the three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained to ensure a minimum level of known production through *in situ* incubation, incubation in corrals, or a combination of both.

Delisting Criteria

1. An average population of at least 40,000 nesting females per season (as measured by clutch frequency per female per season) over a 6-year period distributed among nesting beaches in Mexico and the U.S. is attained. Methodology and capacity to ensure accurate nesting female counts have been developed and implemented.

2. Ensure average annual recruitment of hatchlings over a 6-year period from *in situ* nests and beach corrals is sufficient to maintain a population of at least 40,000 nesting females per nesting season distributed among nesting beaches in Mexico and the U.S into the future. This criterion may rely on massive synchronous nesting events (i.e., arribadas) that will swamp predators as well as rely on supplemental protection in corrals and facilities.

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SER-2012-09304

SEP 14 2015

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Ref.: U.S. Army Corps of Engineers, Mississippi Coastal Improvements Program (MsCIP) Barrier Island Restoration, Mississippi Sound- Hancock, Harrison, and Jackson Counties, Mississippi, and Mobile County, Alabama (NMFS Consultation Number, SER-2012-09304)

Dear Sir or Madam:

This document constitutes the National Marine Fisheries Service's (NMFS) Final Biological Opinion ("Opinion") in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, on the U.S. Army Corps of Engineers' (USACE) planned restoration of the barrier islands in the Mississippi Sound using a combination of mechanical, hydraulic cutterhead and/or hopper dredges for borrow and placement activities. You determined that the proposed activities may affect, but are not likely to adversely affect, the following ESA-listed species: Northwest Atlantic (NWA) loggerhead distinct population segment (DPS), Kemp's ridley sea turtle, green sea turtle, hawksbill sea turtle, leatherback sea turtle, Gulf sturgeon, smalltooth sawfish, blue whale, humpback whale, sperm whale, finback whale, sei whale. Additionally, you determined that the proposed activities may affect, but are not likely to adversely affect the following critical habitat: Gulf sturgeon critical habitat (GSCH) and the recent designation of NWA loggerhead sea turtle critical habitat.

It is NMFS's Opinion that the action, as proposed, is not likely to adversely affect hawksbill sea turtle, smalltooth sawfish, blue whale, humpback whale, sperm whale, finback whale, sei whale or NWA loggerhead sea turtle critical habitat. However, we believe it is likely to adversely affect, but is not likely to jeopardize, the continued existence of NWA loggerhead DPS, Kemp's ridley sea turtle, green sea turtle, leatherback sea turtle, and Gulf sturgeon. Additionally, we believe that the proposed activities may affect, but are not likely to destroy or adversely modify, GSCH. It is NMFS's Opinion that the dredging and disposal of material associated with the project will not reduce the critical habitat's ability to support the Gulf sturgeon's conservation. NMFS does not expect the adverse impacts to abundance of prey items resulting from this proposed action to appreciably reduce the conservation function of GSCH. NMFS's determinations regarding the effects of the proposed actions are based on the description of the action in this formal consultation. You are reminded that any changes to the proposed actions may negate the findings of the present consultation and may require reinitiation of consultation with NMFS.

We look forward to further cooperation with you on other USACE projects to ensure the conservation and recovery of our threatened and endangered marine species. If you have any questions regarding this consultation, please contact Ryan Hendren, Consultation Biologist, at (727) 551-5610, or by email at Ryan.Hendren@noaa.gov.

Sincerely,

for Roy E. Crabtree, Ph.D.
Regional Administrator

Enclosure: Final Biological Opinion

File: 1514-22.F.5; 1514-22.F.6

Endangered Species Act - Section 7 Consultation
Final Biological Opinion

Activity:	Mississippi Coastal Improvements Program (MsCIP) Barrier Island Restoration, Mississippi Sound- Hancock, Harrison, and Jackson Counties, Mississippi, and Mobile County, Alabama (NMFS Consultation Number, SER-2012-09304)
Federal Action Agencies:	U.S. Army Corps of Engineers, Mobile District (USACE), as the lead agency, in cooperation with the Bureau of Ocean Energy Management (BOEM), and National Park Service (NPS)

Affected Species and Critical Habitat Determinations:

Table 1. Action Agencies Effects Determination (E = endangered, T = threatened, NLAA = not likely to adversely affect, LAA = likely to adversely affect)

Common Name	Scientific Name	Status	Action Agencies Effect Determination	NMFS Effect Determination
Turtles				
Green	*Chelonia mydas*[1]	E/T	NLAA	LAA
Kemp's ridley	*Lepidochelys kempii*	E	NLAA	LAA
Leatherback	*Dermochelys coriacea*	E	NLAA	LAA
Loggerhead	*Caretta caretta*[2]	T	NLAA	LAA
Hawksbill	*Eretmochelys imbricata*	E	NLAA	NLAA
Fish				
Smalltooth sawfish	*Pristis pectinata*[3]	E	NLAA	NLAA
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	T	NLAA	LAA
Marine Mammals				
Blue whale	*Balaenoptera musculus*	E	NLAA	NLAA
Finback whale	*Balaenoptera physalus*	E	NLAA	NLAA
Humpback whale	*Megaptera novaeangliae*	E	NLAA	NLAA
Sei whale	*Balaenoptera borealis*	E	NLAA	NLAA
Sperm whale	*Physeter macrocephalus*	E	NLAA	NLAA

[1] Currently, green sea turtles in U.S. waters are listed as threatened except for the Florida breeding population, which is listed as endangered. On March 23, 2015, NMFS published a proposed rule (80 FR 15271) listing 11 DPSs for green sea turtles; the proposed North Atlantic DPS for green sea turtles is listed as threatened, and is the only DPS whose individuals can be expected to be encountered in the action area.
[2] Northwest Atlantic Ocean (NWA) DPS
[3] The U.S. DPS

Table 2. Designated Critical Habitat Likely to Occur In or Near the Action Area

Species	Unit	Action Agencies Effect Determination	NMFS Effect Determination
Gulf sturgeon	Estuarine and marine (NMFS) – Unit 8	Will not adversely modify	Will not adversely modify
Loggerhead sea turtle	Unit LOGG-N-35 through LOGG-N-36 for Nearshore Reproductive Habitat, Breeding Habitat, and/or Migratory Habitat and Unit	Will not adversely modify	Will not adversely modify

Consulting Agency: National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS), Southeast Regional Office, Protected Resources Division, St. Petersburg, Florida

Approved by:

For Roy E. Crabtree, Ph.D., Regional Administrator
NMFS, Southeast Regional Office
St. Petersburg, Florida

Date Issued: SEP 14 2015

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ACRONYMS AND ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
BA	Biological Assessment
BACI	Before–After Control–Impact
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
CMPR	Coastal Migratory Pelagic Resources
DA-10	Disposal Area 10
DEIS	Draft Environmental Impact Statement
DPS	Distinct Population Segment
DWH	Deepwater Horizon
EIS	Environmental Impact Statement
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
FMP	Fishery Management Plan
GINS	Gulf Islands National Seashore
GMFMC	Gulf of Mexico Fishery Management Council
GRBO	Gulf of Mexico Regional Biological Opinion
GSCH	Gulf Sturgeon Critical Habitat
HMS	Highly Migratory Species
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
LCS	Large Coastal Sharks
MHWL	Mean High Water Line

m	Meter (m)
mt	Metric Tons
mm	Millimeter(s)
MMPA	Marine Mammal Protection Act
MsCIP	Mississippi Coastal Improvements Program
MSFCA	Magnuson-Stevenson Fishery Conservation and Management Act
NAVD 88	North American Vertical Datum of 1988
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWA	Northwest Atlantic
OCS	Outer Continental Shelf
OSAT3	Operational Science Agency Team
PBP-AL	Petit Bois Pass–Alabama
PBP-MS	Petit Bois Pass–Mississippi
PBP-OCS	Petit Bois Pass–Outer Continental Shelf
PEIS	Programmatic Environmental Impact Statement
PLL	Pelagic Longline
PRD	Protected Resources Division
RPM	Reasonable and Prudent Measure
SCS	Small Coastal Shark
SEFSC	Southeast Fisheries Science Center
SEIS	Supplemental Environmental Impact Statement
TPH	Total Petroleum Hydrocarbons
USACE	U.S. Army Corp of Engineers
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
yd^3	cubic yards

1 INTRODUCTION

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. § 1531 et seq.), requires that each federal agency "insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species." To fulfill this obligation, Section 7(a)(2) requires federal agencies to consult with the appropriate Secretary on any action that "may affect" listed species or designated critical habitat. The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) share responsibilities for administering the ESA. Consultations on most listed marine species and their designated critical habitat are conducted between the action agency and NMFS.

Consultation is concluded after the appropriate Secretary (NMFS or USFWS) determines that the action is not likely to adversely affect listed species or critical habitat, or issues a Biological Opinion ("Opinion") that identifies whether a proposed action is likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical habitat. If either of those circumstances is expected, the Secretary identifies reasonable and prudent alternatives (RPAs) to the action as proposed that can avoid jeopardizing listed species or resulting in the destruction/adverse modification of critical habitat. In the Opinion, the Secretary states the amount or extent of incidental take of the listed species that may occur, develops reasonable and prudent measures (RPMs) to reduce the effect of take by the action, delineates methods of monitoring to validate the expected effects of the action, and recommends conservation measures to further conserve the species.

The U.S. Army Corps of Engineers (USACE) Mobile District, proposes to restore the Mississippi barrier islands in the Gulf of Mexico through the placement of sand within the National Park Service's (NPS) Gulf Islands National Seashore (GINS), Mississippi units. This action is proposed to help address the consequences of Hurricane Katrina, other hurricanes in the Gulf of Mexico, and past navigational dredging activities that have altered sediment transport along the islands and contributed to substantial erosion and island land loss. The tentatively selected plan is part of the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Programmatic Environmental Impact Statement prepared in June 2009 (USACE 2009), which was developed to support the long-term recovery of Hancock, Harrison, and Jackson Counties, Mississippi from the devastation caused by these hurricanes, as well as to help lessen the impacts of future storms.

This document represents NMFS's Opinion based on our review of impacts associated with the planned restoration of the barrier islands in the Mississippi Sound using a combination of mechanical, hydraulic cutterhead and/or hopper dredges for borrow and placement activities. This Opinion is based on information provided by the U.S. Army Corps of Engineers (USACE) Mobile District, which is the lead federal agency, in coordination with cooperating agencies U.S. Department of Interior's NPS, and Bureau of Ocean Energy Management's (BOEM) Gulf of Mexico Region. The Opinion analyzes project effects on sea turtles (Northwest Atlantic (NWA) loggerhead distinct population segment (DPS), Kemp's ridley, green, hawksbill, and leatherback); sperm, blue, fin, humpback, and sei whales; Gulf sturgeon, smalltooth sawfish, Gulf sturgeon critical habitat (GSCH) (Unit 8), and the recently listed NWA loggerhead sea turtle critical habitat (LOGG-N-35; LOGG-N-36) in accordance with Section 7 of the ESA of 1973. This Opinion is based on project information provided by USACE and other sources of information, including published literature and summary reports provided by USACE, NPS, and BOEM.

The activities associated with this project are similar to those assessed in the Gulf of Mexico Regional Biological Opinion (GRBO) in the Gulf of Mexico (NMFS 2003a; NMFS 2005b; NMFS 2007c). The GRBO evaluated the effects of maintenance dredging of authorized federal navigation channels, placement of dredged material in designated areas, dredging and placement of material for beach nourishment and restoration, relocation trawling, and associated support activities such as installation of discharge pipelines. The GRBO did not assess potential effects associated with dredging or disposal activities in GSCH, and also did not assess potential effects associated with dredging activities on the Outer Continental Shelf (OCS). Activities that are consistent with the scale and scope of the GRBO, but involve dredging or disposal activities in GSCH or dredging from the OCS, may be "stacked" on that Opinion (i.e., use of one Opinion (Opinion A) by reference to cover the majority of the action in a separate Opinion (Opinion B), and addressing the portions of the action not covered in the referenced Opinion (Opinion A) within the separate individual Opinion (Opinion B)) to avoid authorization of duplicate takes or impacts to ESA managed resources. NMFS, Southeast Regional Office, must differentiate between projects that are consistent with the nature and scope of the GRBO and may be "stacked" from those projects that are not appropriate for stacking. Projects that are beyond the intended scale and scope of activities evaluated in the GRBO or projects that have characteristics that prevent clear separation of effects evaluated in the GRBO from those not considered in the GRBO, are not appropriate for stacking.

The MsCIP project is not appropriate for stacking due to the large scale, scope, and complexity of the project. Generally, the types of projects considered in the GRBO were dredging volumes less than 7 million cubic yards of material in one project. The MsCIP proposes to dredge and dispose 53.3 million yd^3 within the expected 3 year time period, which is well in excess of the amounts analyzed in the GRBO. Additionally, the complexity of the MsCIP project, which has multiple action agencies, dredge areas located both in the OCS as well as state waters, and disposal areas located both in and outside of designated GSCH, prevents clear allocation of additional effects that were not evaluated in the GRBO. Consequently, this Opinion will evaluate the entire scope of the MsCIP project.

2 CONSULTATION HISTORY

This section includes information associated with NMFS's current and past involvement with the MsCIP pursuant to the Section 7 consultation process with USACE.

June 16, 2006: USACE submitted a cover letter and document titled, "Environmental Assessment, Mississippi Coastal Improvements Program (MsCIP), Near-Term Improvements for Hancock, Harrison, and Jackson Counties, Mississippi," (SER-2006-2695) to NMFS regarding the MsCIP.

June 21, 2006: NMFS replied to the USACE submittal regarding the MsCIP project area with a list of federally-protected species and designated critical habitat under NMFS's jurisdiction that may occur with the MsCIP project area. NMFS requested a 30-day extension to comment on Section 7 issues related to this project; however, the preliminary analysis determined that federally-listed species and/or designated critical habitat may be adversely affected by the proposed action.

June 30, 2006: After reviewing the 15 projects summarized in the MsCIP, NMFS determined that most of the proposed activities would not adversely affect listed species or designated critical habitat. Details provided for some projects were insufficient to fully assess potential project impacts, therefore NMFS recommended that once project specifications were finalized, the USACE should carefully consider impacts to listed species and designated critical habitat, and then request ESA Section 7 consultation if the project may affect listed species or designated critical habitat.

August 9, 2006: USACE Mobile District published in the Federal Register (71 FR 45537) the Notice of Intent to prepare a DEIS to address the potential impacts associated with actions to comprehensively address hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes in coastal Mississippi. These actions are related to the consequences of hurricanes in the Gulf of Mexico in 2005. The USACE will forward recommendations to Congress authorized by the Department of Defense Appropriations Act, 2006 (Pub. L. 109-148) dated December 30, 2005. The Environmental Impact Statement (EIS) will be used as a basis for ensuring compliance with the National Environmental Policy Act.

February 2, 2009: NMFS received the Draft Comprehensive Plan/Integrated Programmatic EIS, which was circulated for public review.

February 13, 2009: The EIS Notice of Availability was posted in the Federal Register.

June 15, 2009: The Final MsCIP Comprehensive Plan Report, which includes an Integrated Programmatic EIS, dated June, 2009, describes a Comprehensive Plan to support of the long-term recovery of Hancock, Harrison, and Jackson Counties, Mississippi, from impacts caused by the hurricanes of 2005.

February 11, 2010: A recurring multi-agency conference call was established as a platform to provide updates and exchange information regarding the MsCIP project.

March 10, 2010: After reviewing information from prior meetings, NMFS Protected Resources Division (PRD) became concerned with the issue of the USACE's proposed filling of Camille Cut. Per a discussion during a conference call between the USACE and NMFS on December 7, 2009, NMFS commented that the filling of Camille Cut would not be looked at favorably (i.e., may result in an adverse modification [to GSCH] finding under the ESA). NMFS PRD has information that Gulf sturgeon utilize barrier islands, with the majority of the fishes sampled strongly favoring the passes, including the cut through Ship Island (Ross et al. 2009). NMFS believes that impact to this area (which is in GSCH) may need to be removed from the barrier island restoration plan. NMFS PRD recommended adding Camille Cut to the March 2010 agenda of the multi-agency conference call in an effort to address issues foreseen by PRD.

May 27, 2010: A meeting was held in Mobile, Alabama, at the University of South Alabama, Brookley Center with a multi-agency workgroup to discuss long-term monitoring and how to assess the progress of the restoration and short- and long-term impacts to the barrier island system and cultural resources in light of the Deepwater Horizon (DWH) Oil Spill. The result of the meeting was the MsCIP long-term monitoring and adaptive management plan for the comprehensive barrier island restoration plan. The plan outlined a series of goals and objectives and included the anticipated approach needed, team that would implement the project and general timeline. Several drafts of this document have been created; the version available as of October 2011 is version 9.

November 17, 2010: A meeting was held during the 12th annual Gulf sturgeon workshop to discuss the concerns NMFS and USACE have in reference to the filling of Camille Cut. The meeting resulted in a monitoring program that compared both ends of Ship Island and at Camille Cut (i.e., project zones). Monitoring would be done with automated acoustic telemetry arrays during the winter months to monitor Gulf sturgeon presence within the project zones. Eighteen telemetry receivers/buoys will be deployed during pre-fill assessment period, and 16 telemetry receivers/buoys deployed during and after fill. Monitoring will also incorporate active telemetry monitoring and side-scan sonar (Humminbird SI sonar device) to evaluate fine-scale habitat association within project zones (i.e., fish on bottom [presumed feeding], fish within column [non-feeding; specific current velocity affiliation]). Additional active netting and tagging (long-lived acoustic telemetry tags) of Gulf sturgeon within Pearl and Pascagoula River during summer months would be implemented to complement existing telemetry based work currently being conducted as part of National Oceanic and Atmospheric Administration (NOAA) - USFWS long-term population status projects. Monitoring timeline would be the following: 1-2 years pre-fill baseline assessment (depending on success and timing of funding); 5 year post-fill assessment.

November 20, 2012: The USACE submitted a Biological Assessment (BA) that analyzed the potential effects of placement of 22 million cubic yards (yd^3) of sand to close Camille Cut between East and West Ship Island and the placement of 2 million yd^3 of sand on the eastern shoreline of Cat Island.

April 24, 2013: The USACE held the MsCIP Borrow Area Technical Working Group kickoff meeting at the Gulf Island National Seashore Mississippi Welcome Center. This meeting held a series of presentations that focused on the proposed filling of Camille Cut. Of particular importance was the review of the borrow areas for the required amounts of compatible fill material.

September 13, 2013: The USACE submitted a BA addendum that will go in the Supplemental Environmental Impact Statement (SEIS). This addendum contained slight modifications, which were adjusted in the Biological Opinion.

March 7, 2014: Since the BA was submitted in 2012, the USACE expanded the areas investigated as potential borrow areas at Horn Island Pass and South Petit Bois OCS sites. Petit Bois areas 1 and 2 have been expanded and renamed to sub-areas B-F, K-N. Horn Island Pass has been renamed to A, and has 3 polygons (2 are shaded blue, which were added in January 2013). The USACE eliminated areas G-J and added area N, which is north of areas D and E. Quantities of sand had not been finalized at this time. The pending design was waiting on the lab results of the sand borings. The USACE has provided the description and sizes of the areas, which will be used to analyze impacts to the potential aerial footprint.

July 10, 2014: NMFS issued the final rule to designate critical habitat for the Northwest Atlantic (NWA) Ocean Distinct Population Segment (DPS) of the loggerhead sea turtle (*Caretta caretta*) within the Atlantic Ocean and the Gulf of Mexico pursuant to the ESA. Specific areas for designation include 38 occupied marine areas within the range of the NWA Ocean DPS. These areas contain one or a combination of habitat types: nearshore reproductive habitat, winter area, breeding areas, constricted migratory corridors, and/or Sargassum habitat. The USFWS is issuing a Final Rule for loggerhead critical habitat for terrestrial areas (nesting beaches) in a separate document.

September 16, 2014: The USACE submitted a revised BA that includes changes primarily to the OCS borrow area discussions and other minor revisions/updates. This revised BA includes NPS and BOEM, Gulf of Mexico Region as cooperating agencies. Consultation on the draft opinion was resumed on this date.

July 1, 2015: NMFS submitted a draft formal Biological Opinion to the USACE, NPS, and BOEM for review and comment. NMFS requested that the action agencies provide comments within 30 days of receipt.

July 20, 2015: The USACE, NPS, and BOEM submitted comments on the draft Biological Opinion to be considered by NMFS.

In addition to the above documents, NMFS, USACE, NPS, and BOEM have coordinated monthly on the MsCIP Camille Cut project in a multi-agency conference call since December 2009.

NMFS initiated formal consultation on December 18, 2012; however, the consultation was placed on hold by the USACE in the fall of 2013 due to changes to the project description. We resumed consultation on September 16, 2014 and submitted a draft Biological Opinion on July 1, 2015. Comments were received from the USACE, NPS, and BOEM on July 20, 2015, which required some modifications to the project description details. NMFS began drafting modifications for the final Biological Opinion on August 4, 2015.

3 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

The Comprehensive Barrier Island Restoration consists of the placement of approximately 22 million yd^3 of sand within the Ship Island portion of NPS's Gulf Islands National Seashore (GINS), Mississippi unit, to close Camille Cut, a 3.5-mile gap located between East and West

Ship Islands, and to ameliorate erosion of the southern shoreline of East Ship Island. In addition, the plan includes the restoration of the eastern shoreline of Cat Island using an additional approximately 2 million yd^3 of sand. A third related action to maximize the beneficial placement of sandy maintenance dredged material from the Pascagoula Federal Navigation Project includes the redefinition of littoral zone disposal site south and west of Disposal Area (DA) 10.

3.1 Proposed Action

The proposed action for this project is based on the description of the tentatively selected plan from the SEIS and the revised BA provided in September 2014. These updated descriptions are based on refined design configurations of sand sources and quantities. This action will consist of the following 3 activities: (1) Restoration of Ship Island, including sand placement in Camille Cut and replenishment of the southern shoreline of East Ship Island from offshore borrow areas, (2) Beach-front placement of sand along Cat Island from a borrow area within GSCH, (3) and management of future dredged material from Pascagoula Ship Channel, and will be discussed in detail below.

3.1.1 Ship Island Restoration

The main focus of the barrier island restoration plan is Ship Island, which is located approximately 16 miles southeast of Gulfport, Mississippi. Ship Island was split into 2 pieces by Hurricane Camille in 1969, hence the name Camille Cut. Since that time, the cut shoaled and, prior to Hurricane Georges in 1998, was identified as a shallow shoal. Hurricane Georges and subsequent storms, notably Hurricane Katrina, widened and deepened the cut to the point that there is unlikely to be enough sediment in the system to heal the island naturally (Morton 2008). In addition, erosion to East Ship Island has worsened over time and now this area is primarily a low barrier island.

The Ship Island restoration is composed of 2 parts: (1) the rejoining of West and East Ship Islands through the closing of Camille Cut and (2) the restoration of the southern shore of East Ship Island. Both parts will be accomplished through the placement of up to approximately 22 million yd^3 of suitable sandy material. However, based on 2012 surveys, the USACE expects to place a total of approximately 19.0 million yd^3 on Ship Island. This material would be dredged from 19 borrow areas within 6 geographic areas. Approximately 13.5 million yd^3 would be placed in Camille Cut and approximately 5.5 million yd^3 would be placed along the southern shore of East Ship Island. Should additional material be needed, the USACE has the ability to dredge and place an additional 3 million yd^3 (total of 22 million yd^3) of material.

The constructed Camille Cut project area would be approximately 1,100 feet (ft) wide. The fill would tie into the existing West and East Ship Island just below the frontal dune line at an elevation of approximately +7 ft North American Vertical Datum of 1988 (NAVD 88) with a 1V:12H (vertical:horizontal) slope to the mean high water line (MHWL) and a 1V:20H slope below it. Over time, typically 6 months to a year, the constructed slopes would naturally adjust to milder slopes due to waves and currents which mimic the existing island nearshore slopes in the range of 1:50 to 1:100.

Sand placement along East Ship Island would consist of an average berm crest width of approximately 1,200 ft at an elevation of +6 ft NAVD 88 with a 1V:12H to 1V:20H slope from the seaward edge of the berm to the toe of the fill (intersection with the existing bottom). The equilibrium design widths average approximately 700 ft for Camille Cut and 1,000 ft for East Ship Island. The sand placement layout, typical section for Camille Cut and East Ship Island fill, and all borrow sites are shown in Figures 1, 2, 3, and 4. Sand placement within the Ship Island fill footprint is entirely inside of GSCH. The combined Camille Cut and East Ship Island equilibrated fill will encompass approximately 1,500 acres, of which approximately 800 acres will be above the MHWL and 700 acres will lie below the MHWL. The newly restored areas will be planted with suitable beach and dune vegetation following construction.

Sand would be obtained from borrow area sources within the Gulf of Mexico off Mississippi (MS) and Alabama (AL) including: Ship Island, Horn Island Pass, Petit Bois Pass- MS, Petit Bois-AL East, Petit Bois-AL West, and OCS borrow areas, which are Petit Bois Pass- OCS West (sub-areas 1-6), Petit Bois Pass- OCS East (sub-areas 1-5), and Cat Island (see Figure 4).

Sand from borrow sites would be dredged with hopper, mechanical, and/or hydraulic pipeline dredges, loaded into dump scows, hauled to the placement vicinity, and then pumped directly onto the site. Placement of the material would be concurrent with the fill of Camille Cut. The proposed borrow sites which are located outside waters of the State of Mississippi include: the Petit Bois-AL East, Petit Bois-AL West, Petit Bois Pass- OCS West, and Petit Bois Pass- OCS East.

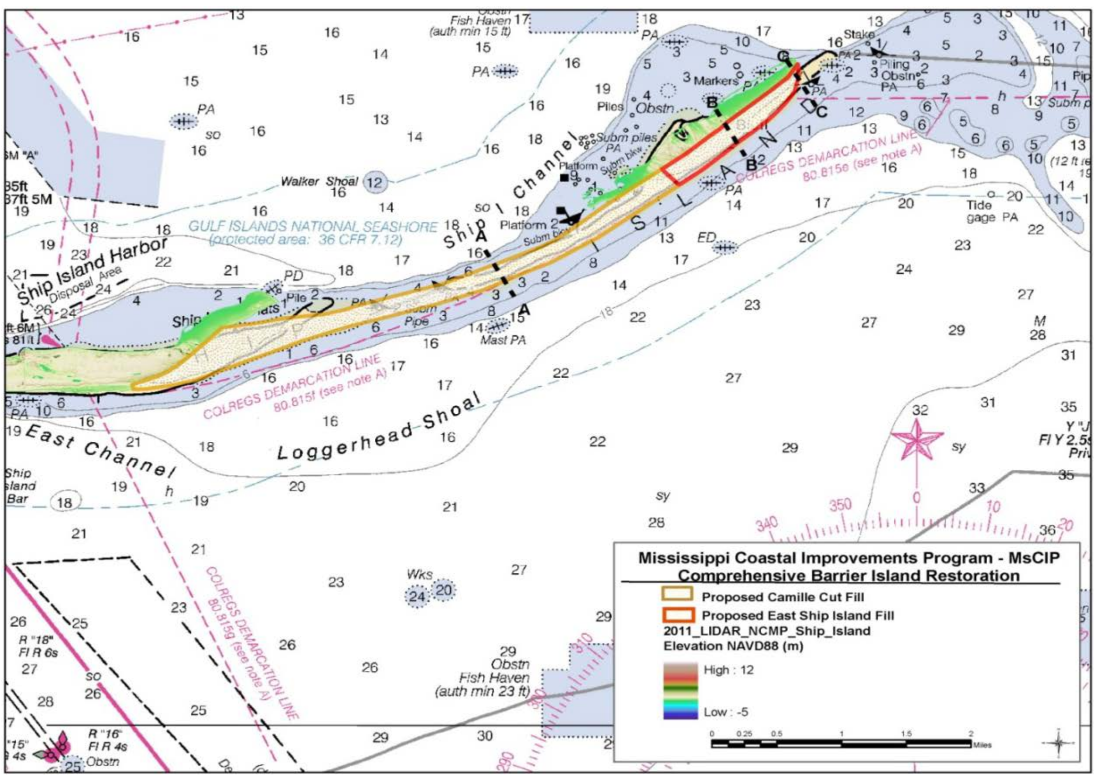


Figure 1. Camille Cut and East Ship Island placement layout from, Biological Assessment- MsCIP. USACE 2012

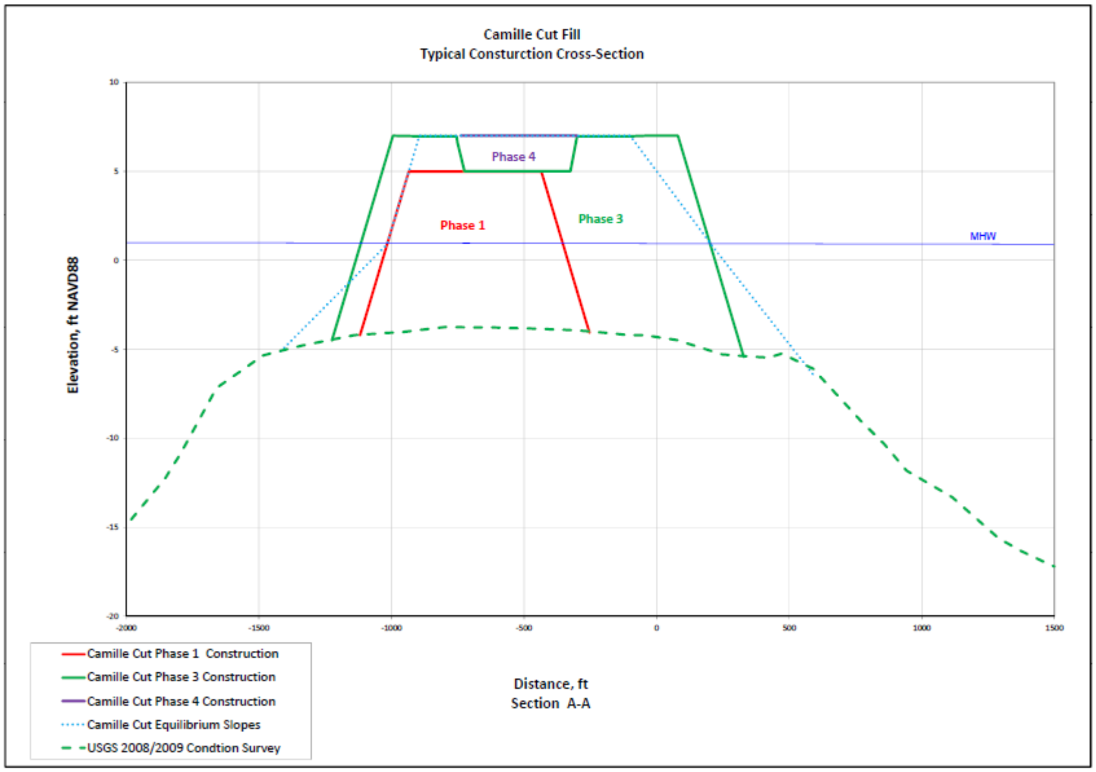


Figure 2. Camille Cut typical section from, Biological Assessment- MsCIP. USACE 2012

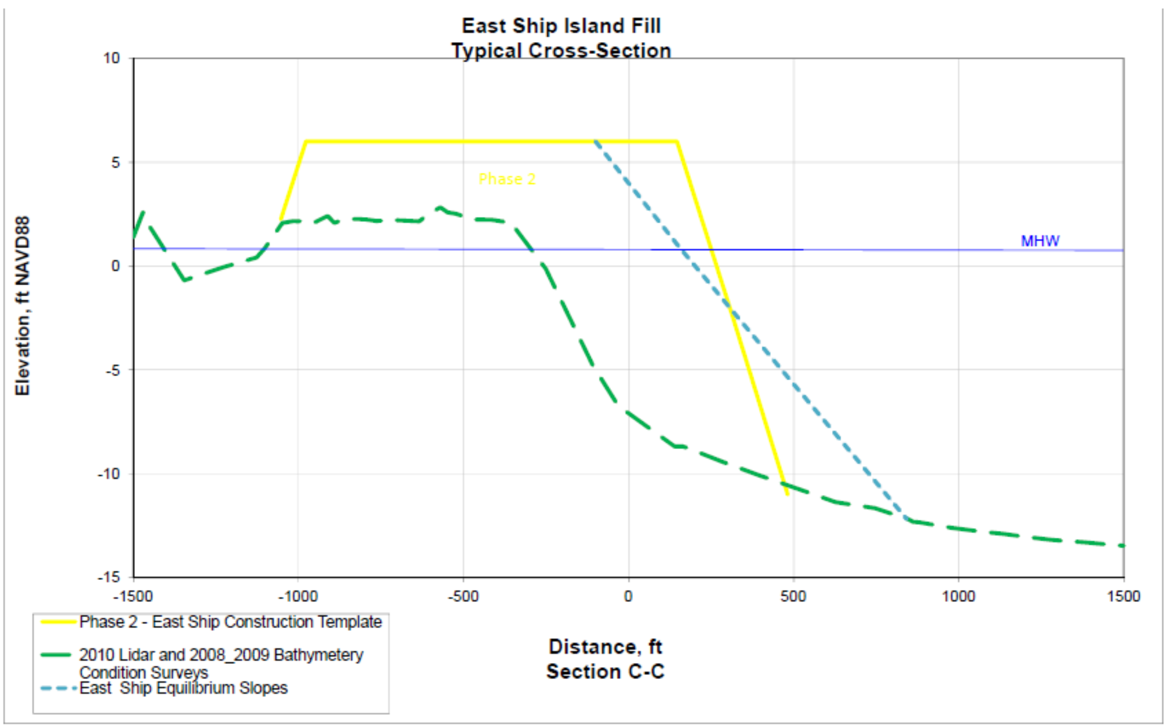


Figure 3. East Ship Island typical section from, Biological Assessment- MsCIP. USACE 2012

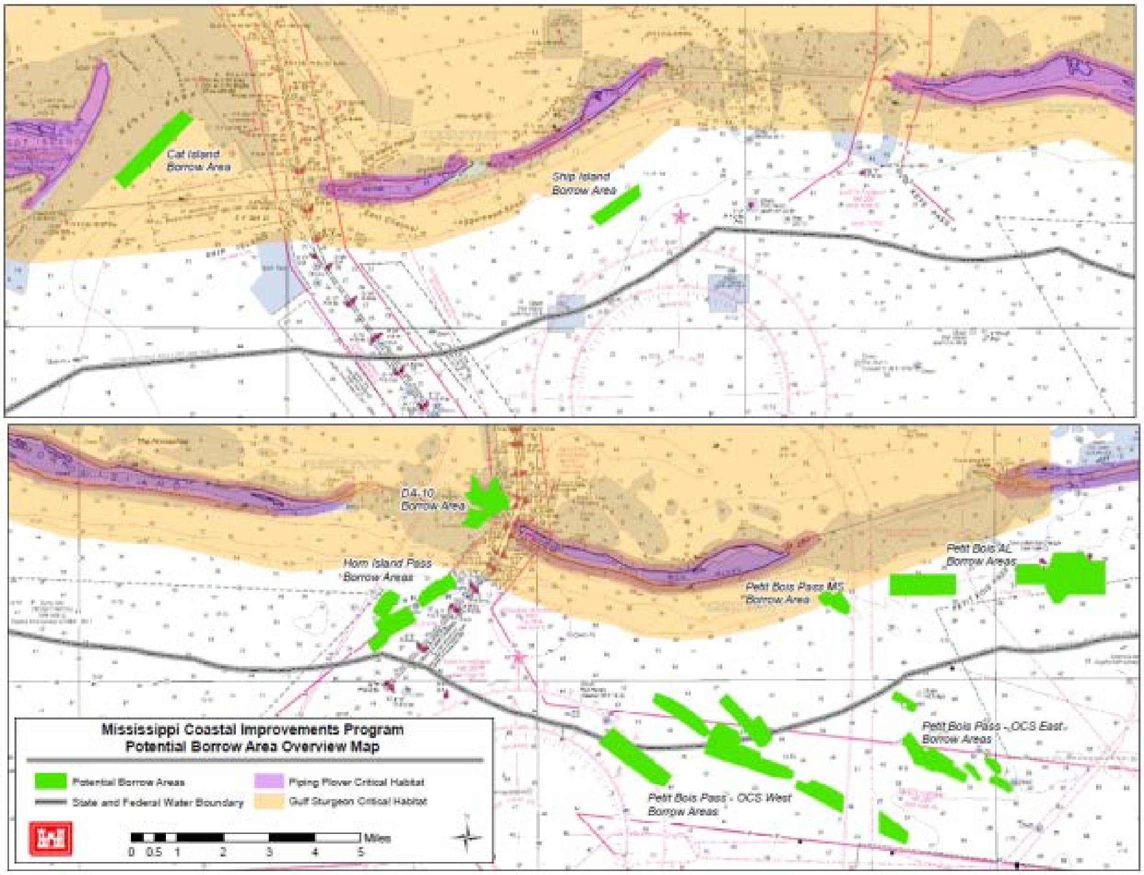
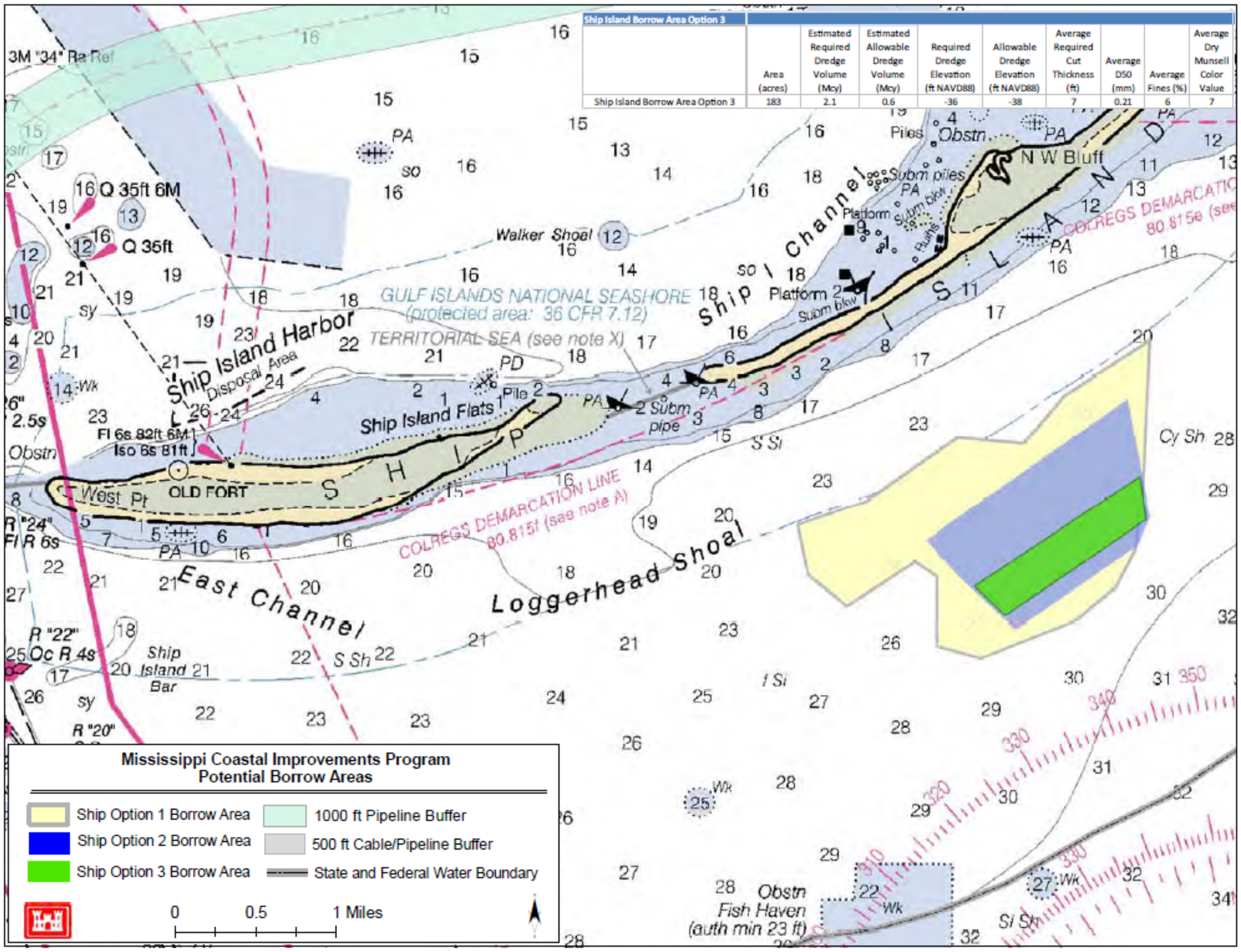


Figure 4. Sand borrow area locations from, Biological Assessment- MsCIP. USACE 2012

3.1.2 Borrow Area Descriptions for Ship Island Restoration

3.1.2.1 Ship Island Borrow Area

Ship Island borrow area is located approximately 2 miles south of Ship Island in an ambient water depth of approximately 30 ft. The borrow area is approximately 600 ft wide (north-south direction) and 6,000 ft wide (east-west direction) covering a total area of approximately 183 acres with an average cut depth of approximately 7 ft. The max cut elevation for dredging is approximately -38 ft NAVD 88 (see Figure 5) and side slopes for cut areas are estimated in the design to be 1V:5H (see Figure 6). The maximum dredging depth includes the required elevation of -36 ft NAVD88 plus 2 ft of allowable overdepth dredging. An additional disturbance layer of 5 ft, also known as the non-paid overdepth, is also considered due to potential disturbance of under layers from such factors as unanticipated variation in substrate and/or wind or wave conditions that reduce the operators' ability to control the excavation head. Due to the potential of this layer possibly being disturbed by equipment, it has been included but is not considered a layer that would be dredged. An estimated 2.7 million yd^3 of sand are available within the proposed delineated borrow area limits. Ship Island borrow area is entirely outside GSCH.



Ship Island Borrow Area Option 3	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
Ship Island Borrow Area Option 3	183	2.1	0.6	-36	-38	7	0.21	6	7

Figure 5. Ship Island borrow area from, Biological Assessment- MsCIP. USACE 2012

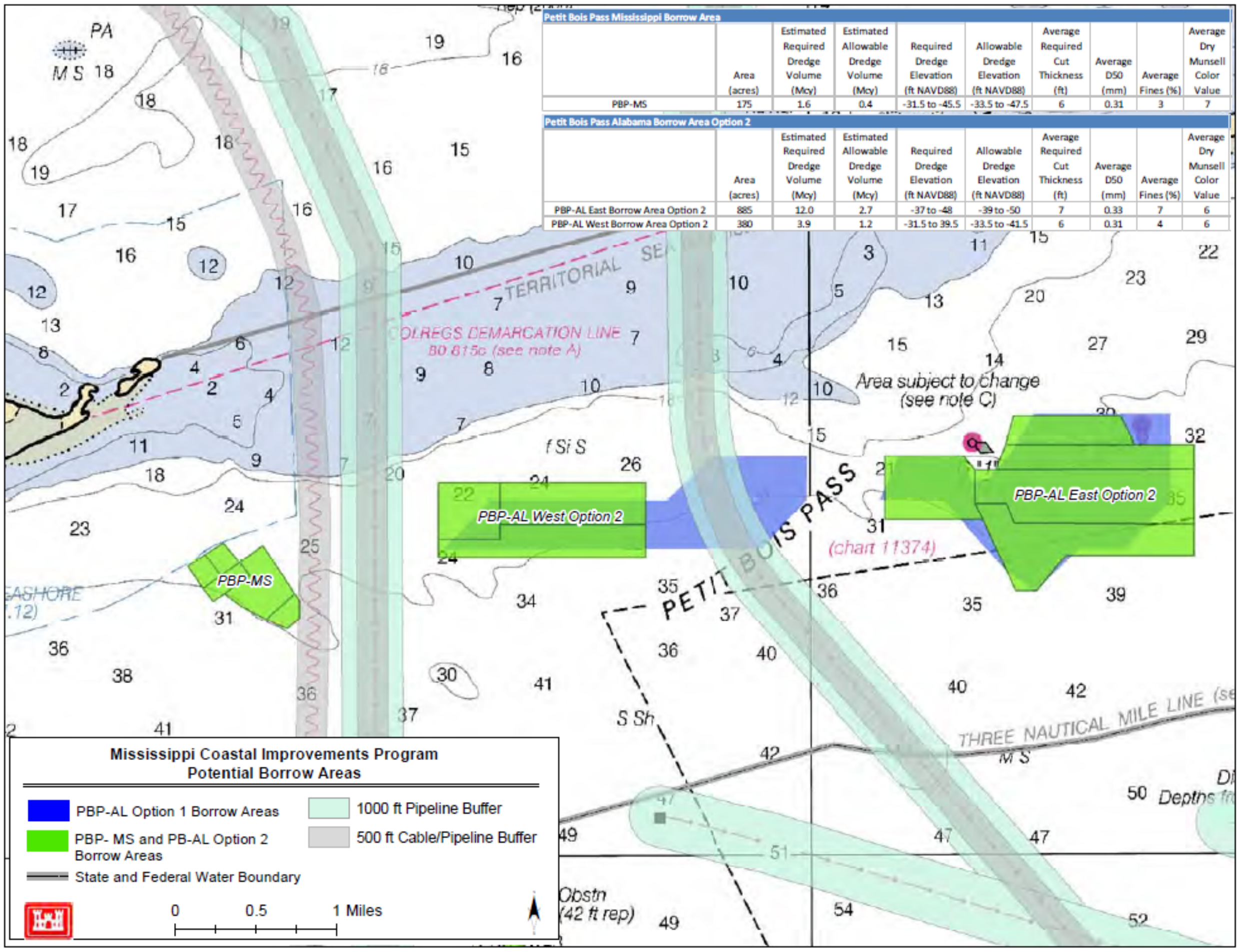
Figure 6. Ship Island borrow area typical cross section from, Biological Assessment- MsCIP. USACE 2012

Petit Bois Pass Mississippi and Petit Bois Alabama Borrow Areas

The Petit Bois borrow area within state limits consists of 3 separate sites (Petit Bois Pass-Mississippi; Petit Bois-Alabama East, and Petit Bois-Alabama West). The Petit Bois-Alabama West (PB-AL West) site is approximately 380 acres in size. The estimated quantity of the required dredged volume is 3.9 million yd^3. An additional 1.2 million yd^3 of allowable volume is added to this for a maximum potential volume of 4.5 million yd^3. The additional allowable dredge volume is to compensate for dredging inaccuracies. The maximum disturbance elevation is -46.5 ft (see Figure 7). PB-AL West borrow area is entirely outside GSCH.

The Petit Bois-Alabama East (PB-AL East) borrow site is approximately 885 acres in size. The estimated quantity of the required dredged volume is 12 million yd^3. An additional 2.7 million yd^3 of allowable volume is added to this for a maximum potential volume of 14.7 million yd^3. The maximum dredging elevation is -55.0 ft. This depth includes the maximum dredging elevation of -50 ft plus an additional disturbance layer of 5 ft (see Figure 7). PB-AL East Borrow Area is entirely outside GSCH.

The Petit Bois Pass-Mississippi (PBP-MS) site is located about 1 mile southeast of the eastern tip of Petit Bois Island and is approximately 175 acres in size. The estimated quantity of the required dredged volume is 1.6 million yd^3. An additional 0.4 million yd^3 of allowable volume is added to this for a maximum potential volume of 2.0 million yd^3. The additional allowable dredge volume is needed to compensate for dredging inaccuracies. The maximum dredging elevation is -52.5 ft. This depth includes the maximum dredging elevation of -47.5ft plus an additional disturbance layer of 5 ft (see Figure 7). PBP-MS borrow area is entirely outside GSCH.



Petit Bois Pass Mississippi Borrow Area

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBP-MS	175	1.6	0.4	-31.5 to -45.5	-33.5 to -47.5	6	0.31	3	7

Petit Bois Pass Alabama Borrow Area Option 2

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBP-AL East Borrow Area Option 2	885	12.0	2.7	-37 to -48	-39 to -50	7	0.33	7	6
PBP-AL West Borrow Area Option 2	380	3.9	1.2	-31.5 to 39.5	-33.5 to -41.5	6	0.31	4	6

Figure 7. Petit Bois Pass Mississippi and Alabama borrow areas from, Biological Assessment- MsCIP. USACE 2012

Horn Island Pass Borrow Areas

The Horn Island Pass borrow area site is located west of the Pascagoula Harbor entrance channel (see Figure 8). Within this site, there are 3 sub-sections that will be utilized (HIP1, HIP2, HIP3) for sand. The approximate sizes of these sites are as follows: HIPI - 168 acres, HIP2 - 137 acres, HIP3 - 307 acres.

The estimated total quantity of the required dredged volume is 2.8 million yd^3 for all 3 sites (Figure 8). An additional sum of 2.1 million yd^3 of allowable volume is added to this for a maximum potential volume of 4.9 million yd^3. The maximum dredging elevation is -46.0 ft. This depth includes the maximum dredging elevation of -41.0 ft plus an additional disturbance layer of 5 ft (Figure 8). Horn Island Pass borrow area is entirely outside GSCH.

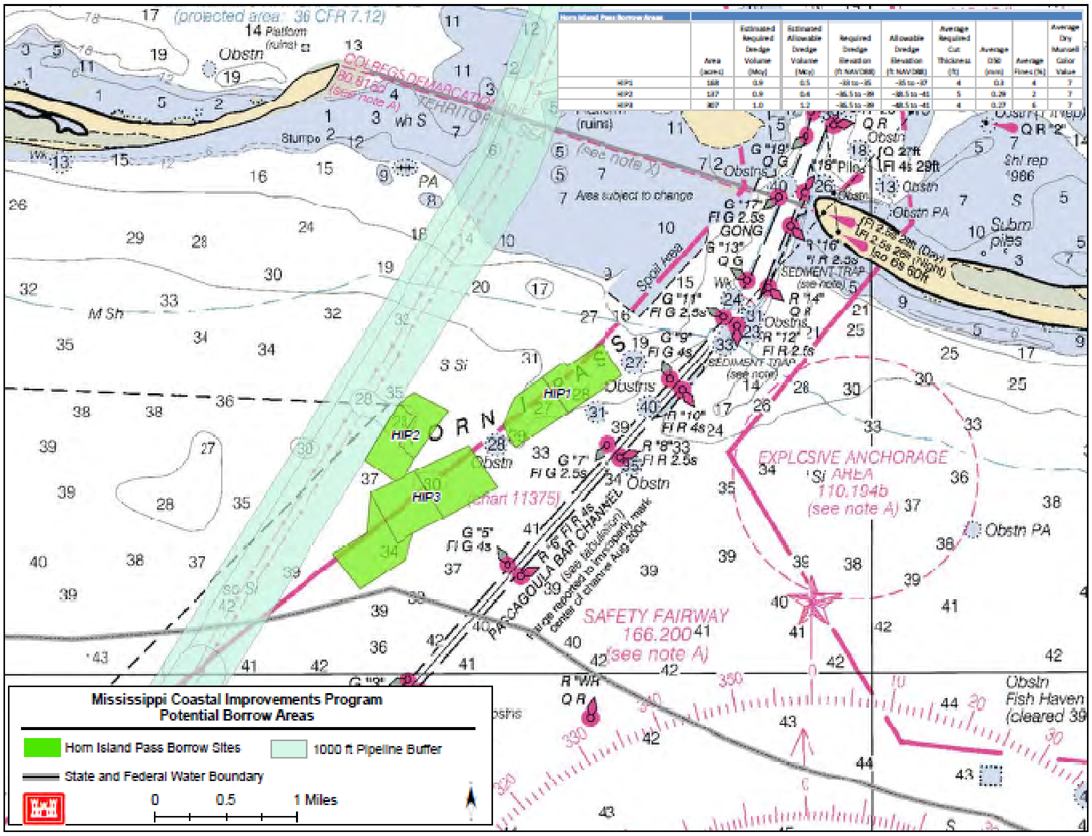


Figure 8. Horn Island Pass borrow areas from, Biological Assessment- MsCIP. USACE 2012

Petit Bois Pass Outer Continental Shelf West and East

Petit Bois-OCS West

The Petit Bois-OCS West borrow area is located approximately 3.5 miles offshore southeast of Petit Bois Island, Alabama (See Figure 9). Within this site, there are 6 sub-sections that will be utilized (PBP-OCS-W1, PBP-OCS-W2, PBP-OCS-W3, PBP-OCS-W4, PBP-OCS-W5, PBP-OCS-W6) for sand. The approximate sizes of these sites are as follows: PBP-OCS-W1 (420 acres), PBP-OCS-W2 (192 acres), PBP-OCS-W3 (275 acres), PBP-OCS-W4 (195 acres), PBP-OCS-W5 (155 acres), and PBP-OCS-W6 (146 acres) (see Figures 9 and 10).

The estimated total quantity of the required dredged volume is 10.3 million yd^3 for all 6 sites (see Figures 9 and 10). An additional sum of 5.1 million yd^3 of allowable volume is added to this for a maximum potential volume of 15.4 million yd^3. The sand deposit sub-sections range from -48.0 to -67.5 ft. The maximum dredging elevation is -72.0 ft. This depth includes the maximum dredging elevation of -67.5 ft plus an additional disturbance layer of 5 ft. Petit Bois-OCS West borrow area is entirely outside GSCH.

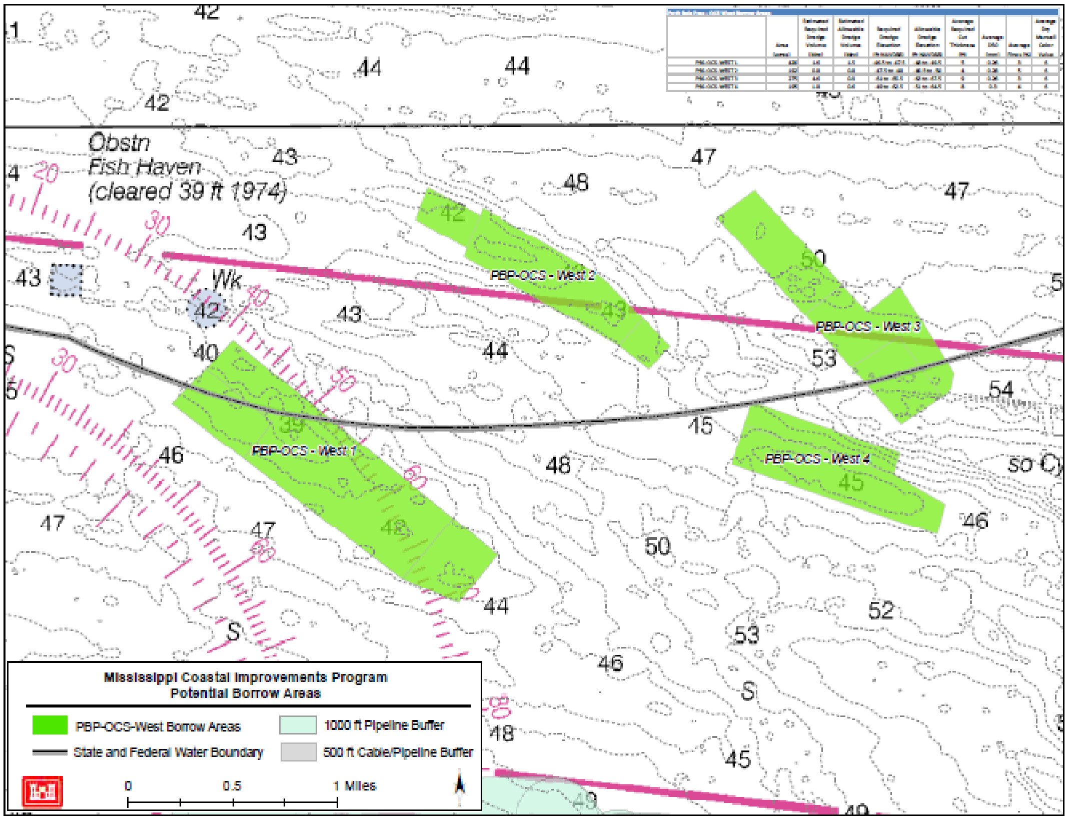


Figure 9. Petit Bois-OCS West borrow areas from, Biological Assessment- MsCIP. USACE 2012

Petit Bois-OCS East

The Petit Bois-OCS East borrow area is located in approximately 3.5 miles offshore, southeast of Petit Bois Island (see Figure 10). Within this site, there are 5 sub-sections that will be utilized (PBP-OCS-E1, PBP-OCS-E2, PBP-OCS-E3, PBP-OCS-E4, PBP-OCS-E5, PBP-OCS-E6) for sand. The approximate sizes of these sites are as follows: PBP-OCS-E1 (51 acres), PBP-OCS-E2 (302 acres), PBP-OCS-E3 (39 acres), PBP-OCS-E4 (43 acres), and PBP-OCS-E5 (29 acres).

The estimated total quantity of the required dredged volume is 3.0 million yd^3 for all 5 sites. An additional sum of 1.2 million yd^3 of allowable volume is added to this for a maximum potential volume of 4.2 million yd^3. The sand deposit sub-sections at all 5 sites range from -50.0 to -63.5 ft. The maximum dredging elevation is -68.0 ft. This depth includes the maximum dredging elevation of -63.5 ft plus an additional disturbance layer of 5 ft (Figure 10). Petit Bois-OCS East borrow area is entirely outside GSCH.

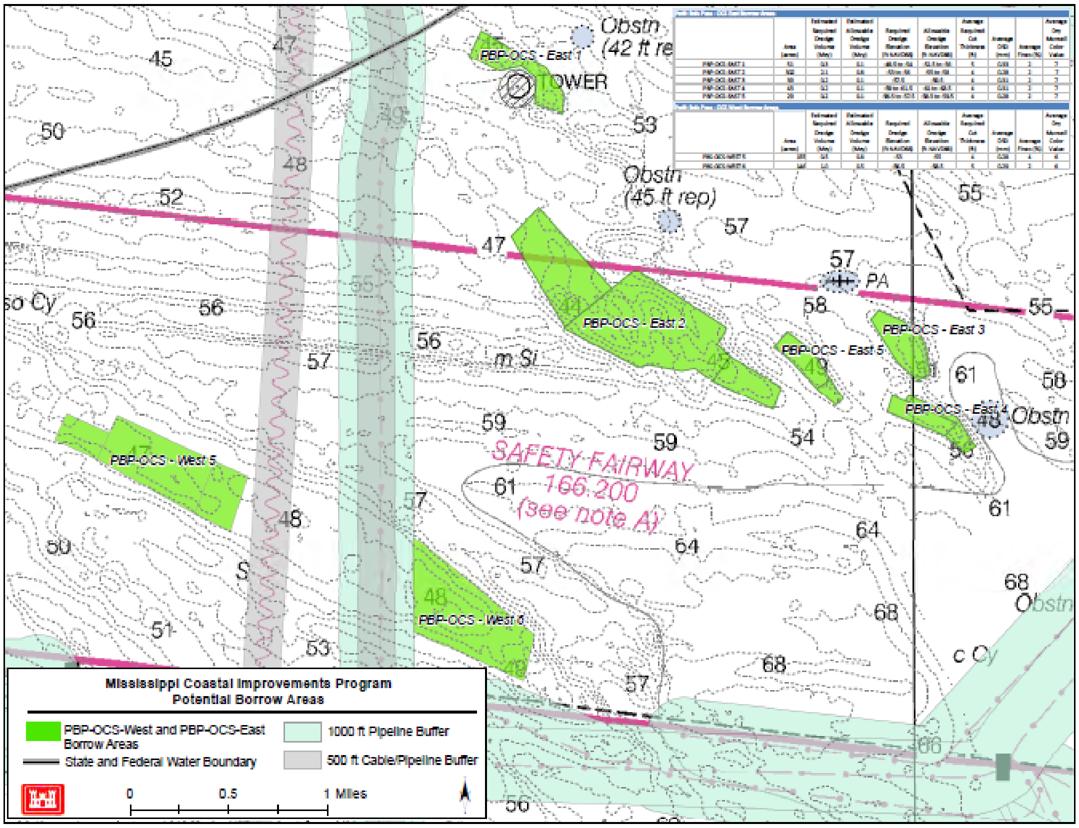


Figure 10. Petit Bois-OCS east and west borrow areas from, Biological Assessment- MsCIP. USACE 2012

3.1.3 Construction Phases for Ship Island Restoration

The overall barrier island restoration project will be constructed in 5 contract phases. Direct sand placement at Camille Cut and East Ship Island will be accomplished in 4 phases using a combination of hydraulic dredges, hopper dredges, bottom dump scows, hydraulic unloaders, and mechanical equipment such as bulldozers and trackhoes. The total construction time to execute all 4 phases is approximately 3 years and the details of each phase are provided below. Phase 5 will consist of dune planting activities on the newly restored Ship Island. Phases 3, 4, and 5 may be constructed concurrently. Work being performed under Phases 3 and 4 may be completed at different locations (i.e., Camille Cut and East Ship Island). Work completed under Phases 4 and 5 would occur in the same location (i.e., Camille Cut), but Phase 5 would begin approximately 2 months after Phase 4 begins to allow for the Phase 5 effort to occur on the portion of the Phase 4 work that is already completed. It is estimated that the 5 phases would be completed over a period of 2.5 - 3 years. Each phase is detailed below.

Phase 1: Approximately 6 million yd^3 of in-place sand volumes based on 2012 surveys would be used to construct the initial berm across Camille Cut and approximately 0.8 million yd^3 would be used to construct a portion of the berm on East Ship Island. Material for Phase 1 would likely be dredged from a combination of the Petit Bois Pass- OCS East and West, Horn Island Pass and Petit Bois Mississippi borrow sites. The initial berm at Camille Cut would have a crest width of approximately 500 ft, a top elevation of +5 ft NAVD 88, and a length of approximately 22,500 ft. The berm along East Ship Island would have crest width of approximately 500 ft, a top elevation of +5 ft NAVD 88, and a length of approximately 3,000 ft including the appropriate taper to transition into the existing island. The East Ship Island berm would be constructed adjacent to the Camille Cut berm along the west end of the southern shoreline of East Ship Island. It would serve as a feeder source for Camille Cut until the remaining portion of the East Ship Island berm is constructed under Phase 3. Work is anticipated to occur generally from east to west, but depending on the contractor and equipment, it may also occur west to east. It is estimated that Phase 1 would be completed over a period of 15 months.

<u>Phase 2:</u> Approximately 6.3 million yd^3 of in-place sand volumes would likely be dredged from a combination of the Petit Bois Pass- OCS West and Petit Bois Alabama borrow sites to raise and widen the initial Camille Cut berm constructed in Phase 1 to elevation +7 ft NAVD 88 and approximately 1,100 ft respectively. The berm would be approximately 24,500 ft long including the taper to tie into the East Ship Island berm. The upper interior portion of the berm would be left void during this phase and would be filled using finer grained sand from the Ship Island borrow site during Phase 4. It is estimated that Phase 2 would be completed over a period of 10 months.

<u>Phase 3:</u> Approximately 4.7 million yd^3 of in-place sand would be used to extend and expand the initial East Ship Island berm constructed in Phase 1 and complete the restoration of the southern shoreline of the East Ship Island. Material for Phase 3 would likely be dredged from a combination of Petit Bois Pass- OCS West and Petit Bois Alabama borrow sites. The final berm along the southern shoreline of East Ship Island would have a crest width of approximately 1,200 ft, a top elevation of +6 ft NAVD 88, and a length of approximately 8,000 ft. It is estimated that Phase 3 would be completed over a period of 7 months.

<u>Phase 4:</u> Approximately 1.1 million yd^3 of in-place sand would be used to fill the void left from Phase 2 in the upper interior portion of the Camille Cut fill. Material for Phase 4 would be dredged from the Ship Island borrow site. The sand in the Ship Island borrow site is finer grained than the other borrow sites and would serve as a more suitable substrate for vegetation growth. The final Camille Cut berm would have a crest width of approximately 1,100 ft with a top elevation of +7 ft (NAVD 88) after the Phase 4 cap is constructed. It is estimated that Phase 4 would be completed over a period of 5 months.

<u>Phase 5:</u> Work under Phase 5 would consist of planting the Camille Cut restoration berm with native dune vegetation. The newly-created island segment would be planted with native dune vegetation, including sea oats (*Uniola paniculata*), gulf bluestem (*Schizachyrium maritimum*), and or other grasses and forbs to restore stable dune habitat. Planting would include vegetation similar to that found in the existing coastal habitats (Section 4.5.1 of MsCIP SEIS). It is estimated that Phase 5 would be completed over a period of 7 months.

3.1.3.1 Equipment Access Routes

Sediment transport equipment could include several types of conveyances, such as scows, crane barges, and jack-up barges, pipelines (submerged, floating, and land), and booster pumps. Heavy machinery would be used to move sand and facilitate construction. The equipment could include bulldozers, frontend loaders, trackhoes, marshbuggy-trackhoes, and backhoes. Various support equipment also would be used, such as crew and work boats, trucks, trailers, construction trailers, all-terrain vehicles, and floating docks or channels with pilings to facilitate loading and unloading of personnel and equipment.

Locations of temporary floatation docks or channels locations are preliminarily based on avoidance of environmentally sensitive areas, but would likely be along the northward sides of the Camille Cut, and or near islands tips of the placement areas. Channels would be placed outside of environmentally-sensitive areas to the maximum extent possible.

Along with the dredges, this equipment could be staged offshore and outside the restoration area during use. Equipment also would be staged onshore. Heavy machinery, vehicles, sediment retaining structures, and other construction equipment could be parked or staged before and during use.

Contractor access floatation channels/pipeline corridor areas are estimated to be a maximum of 200 ft wide with a maximum elevation of -12 ft NAVD88. All surface impacts from excavating, pile driving, floatation channels, pipelines, constructed ramps, etc., will be contained within the width and depth parameters (see Figure 11).

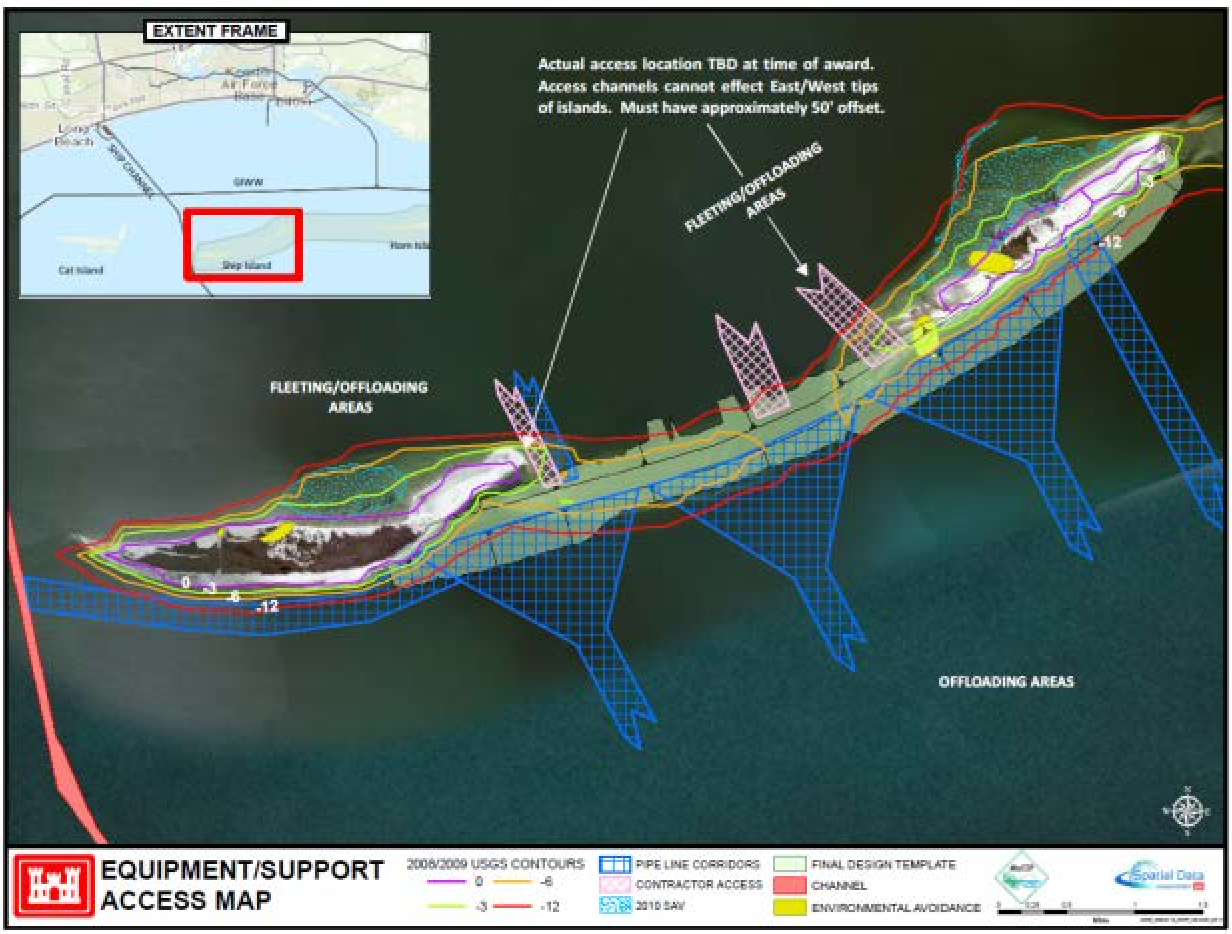


Figure 11. Equipment access map from, Biological Assessment- MsCIP. USACE 2012

3.1.4 DA-10 Littoral Placement of Dredged Material

There would be a modification in the future placement location of dredged material for the Pascagoula Federal Navigation Channel. Sandy material dredged from the Horn Island Pass as part of the Pascagoula Federal Navigation Channel would be potentially placed in the combined DA-10/littoral zone along the shallow shoals exposed to the open Gulf waves. The area of potential direct placement would encompass 1,600 acres between DA-10 and the southern boundary of the Pascagoula Harbor littoral zone site at depths of 5-30 ft. Up to 800,000 yd^3 per year of material would be placed into the DA-10 littoral transport system. Placement is anticipated to occur on an approximate 18-month cycle (see Figure 12).

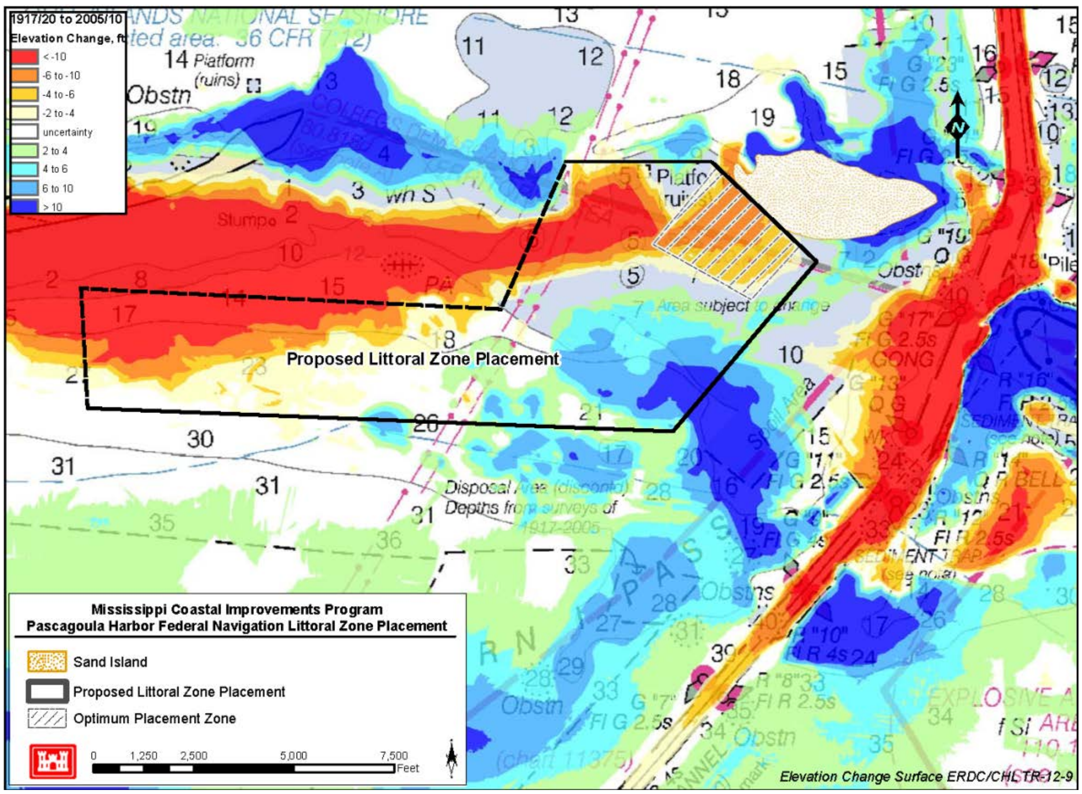


Figure 12. DA-10/ Littoral Zone placement area from, Biological Assessment- MsCIP. USACE 2012

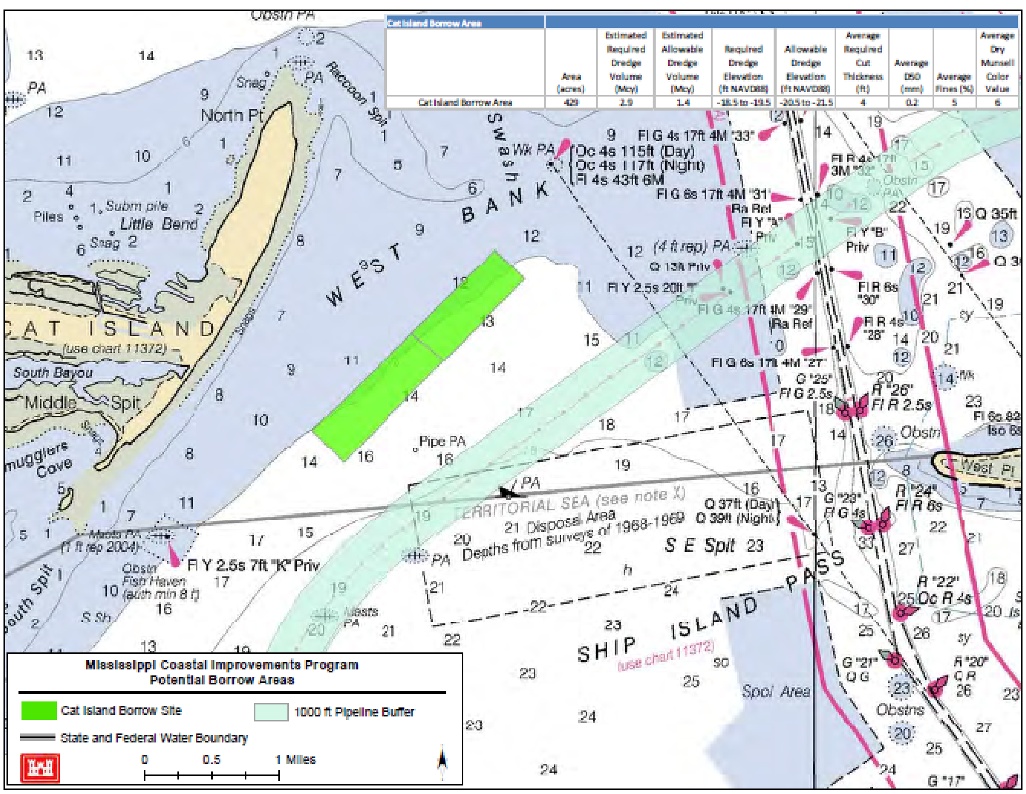
3.1.5 Cat Island Restoration

Cat Island Restoration consists of the placement of an estimated 2 million yd^3 of sand along the eastern shoreline. The construction template will consist of an average dune crest width of 40 ft at an elevation of approximately +7.5 ft NAVD 88. The construction berm will have an average crest width of approximately 250 ft at an elevation of approximately +5 ft NAVD 88 with a 1V:12H to 1V:20H slope from the seaward side of the berm to the toe of the fill (Figure 15). The construction profile is expected to adjust rapidly through the erosion of the upper profile, and mimic the natural nearshore profile once it reaches equilibrium. The total equilibrated fill area encompasses approximately 305 acres, of which approximately 168 acres is within GSCH (Figure 16). The work will likely be performed using a hydraulic cutterhead dredge. The portion of Cat Island to be restored was acquired by BP Public Limited Company (BP) following the DWH incident to allow for the ease of cleanup. The restoration will not begin until the property is under public ownership; however, the restoration should be considered as part of this assessment to assure that the full impacts and benefits of the comprehensive restoration are considered.

Restoration work at Cat Island would be conducted in 1 phase. The proximity of the borrow area to the island's eastern shoreline in relatively shallow water would allow the rapid placement of sand on the beach likely using a pipeline dredge. The material would be pumped onto the beach and shaped using methods similar to the methods used on Ship Island. Following placement, the area would be vegetated with native grasses. Restoration would occur over approximately 6 months.

3.1.6 Borrow Area Descriptions for Cat Island

Sand for construction of the project will be dredged from an approximate 429-acre borrow area, centered about 1.25 miles off the eastern shoreline of Cat Island in ambient water depths of approximately -12 to -14 ft NAVD 88. The Cat Island borrow and placement areas are shown in Figures 13-15 below. The borrow site would be dredged to a required depth of 3–5 ft to minimize disruption of habitat and to minimize the effects of wave refraction over the site after excavation. The maximum dredging elevation is -26.5 ft. This includes the maximum dredging elevation of -21.5 ft plus an additional disturbance layer of 5 ft. An estimated 2.0 million yd^3 of sand are available within the proposed delineated borrow area limits. The borrow area design is configured to prevent significant adverse impacts to the transport system. The Cat Island borrow area is entirely within GSCH.



Cat Island Borrow Area	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
Cat Island Borrow Area	429	2.9	1.4	-18.5 to -19.5	-20.5 to -21.5	4	0.2	5	6

Figure 13. Cat Island borrow area from, Biological Assessment- MsCIP. USACE 2012

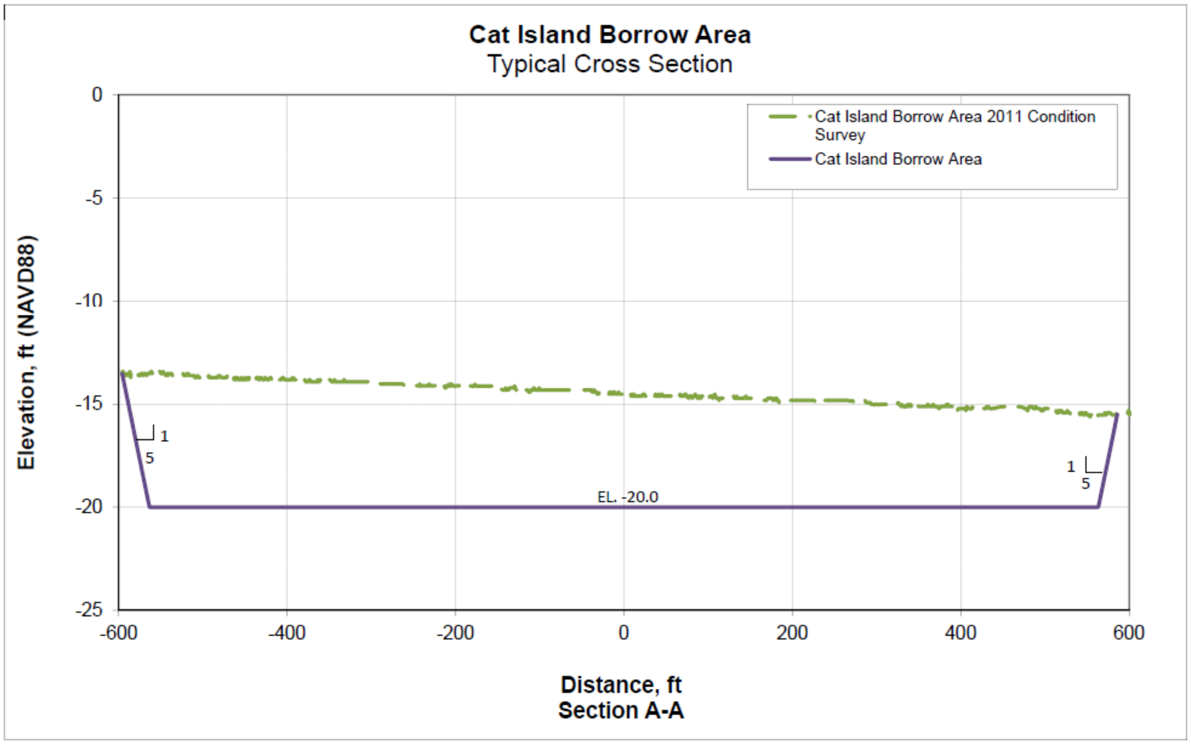


Figure 14. Cat Island borrow area cross section from, Biological Assessment- MsCIP. USACE 2012

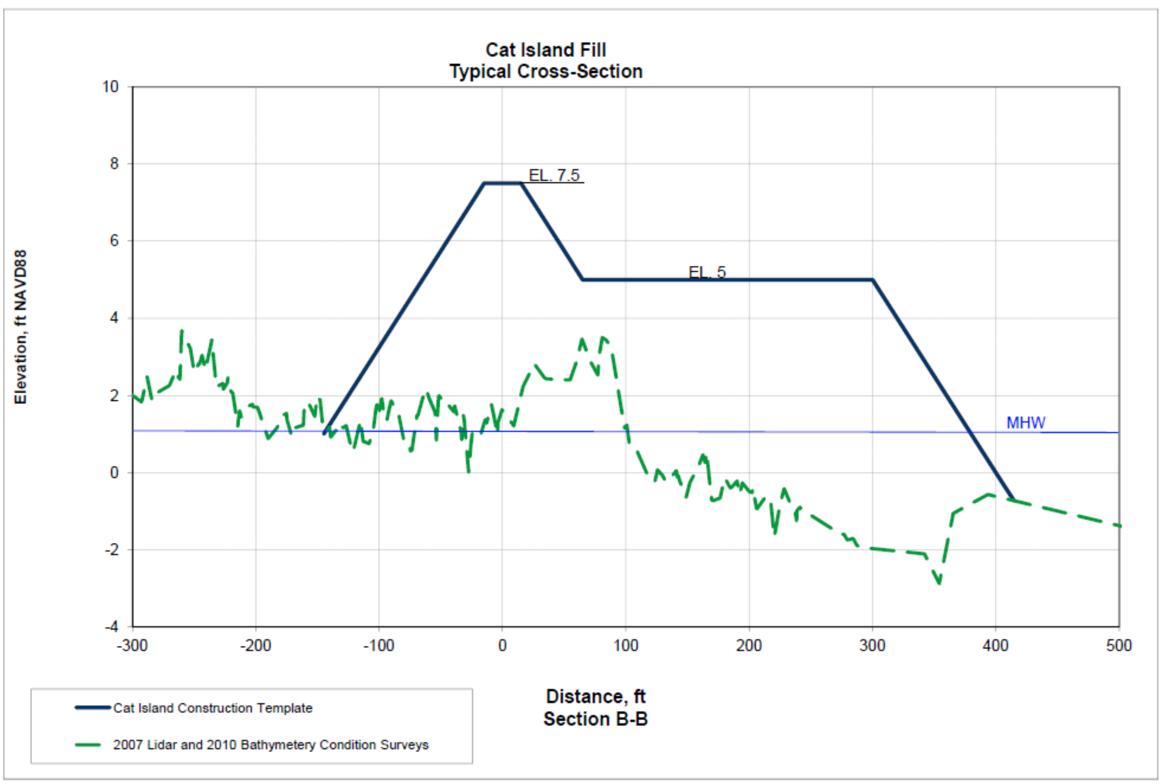


Figure 15. Cat Island fill typical cross section from, Biological Assessment- MsCIP. USACE 2012

Figure 16. Cat Island fill placement area from, Biological Assessment- MsCIP. USACE 2012

3.1.7 Long-Term Gulf Sturgeon Monitoring

At the request of NMFS, an ongoing USACE Mobile District Gulf sturgeon monitoring effort at Ship Island is being conducted by the USACE's Engineer Research and Development Center (ERDC) and others. The objective is to characterize the seasonal occurrences and movements of Gulf sturgeon around Ship Island and within Camille Cut by monitoring Gulf sturgeon that have been implanted with a VEMCO©[4] acoustic transmitter tag. This monitoring effort is possible through a series of smaller localized Gulf sturgeon monitoring projects (throughout the other spawning river populations) that are utilizing acoustic transmitter tags. Tags are detected through passive VEMCO receivers that are strategically placed throughout the monitoring areas and log tag detections of sturgeon that pass within the range of the receivers.

A summary of the Gulf sturgeon detections to date is presented below. Compilation of annual detection histories at the Ship Island project area indicates 63 Gulf sturgeon have been recorded on the acoustic array since the 2011-2012 deployment period including 51 adult and 12 subadult individuals. During this combined period 32 Gulf sturgeon occurred only during a single deployment period. A number of sturgeon have been documented on the acoustic array during multiple deployment periods which includes 23 individuals occurring in 2 deployment periods (21 in successive periods); 6 occurring in three periods (all successive) and 2 individuals occurring in all four deployment periods.

[4] VEMCO© is the manufacturer of fish tracking and monitoring equipment that enables researchers to study the behavior and migration patterns of marine and freshwater animals over time.

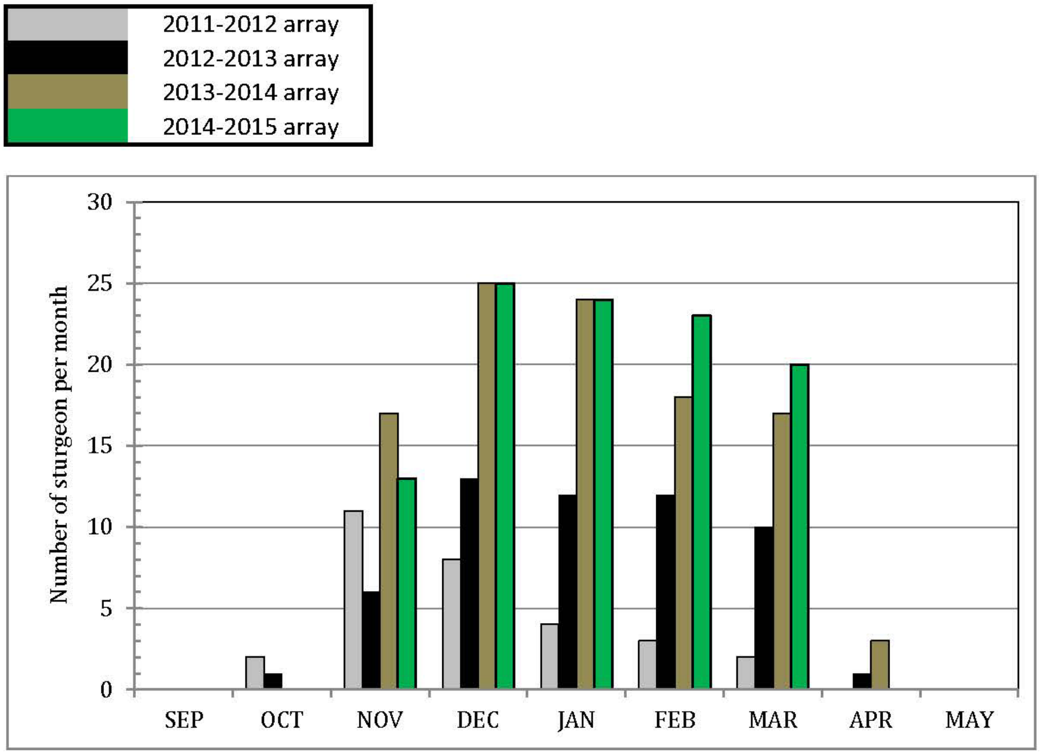


Figure 17. Monthly Gulf Sturgeon Detection Summary 2011-2015 from, revised Gulf sturgeon monitoring plan 2015

Table 3. Summary of Gulf Sturgeon detections (2011-2015)

River of Origin	Transmitter	Date tagged	Size Class	FL (cm)	Weight (kg)	2011-2012	2012-2103	2013-2014	2014-2015
Pearl	A69-1303-45711	9/13/2013	A	136.0	23.8			*	*
Pearl	A69-1303-45714	9/10/2013	SA	101.0	17.8				*
Pearl	A69-1303-45717	9/28/2010	A	162.5	47.7	*	*	*	
Pearl	A69-1303-45720	10/13/2010	A	170.0	43.6	*	*		
Pearl	A69-1303-45721	10/13/2010	A	148.0	16.5		*		
Pearl	A69-1303-45731	9/11/2013	A	160.0	31.8			*	*
Pearl	A69-1303-45737	9/11/2013	A	151.0	26.4			*	
Pearl	A69-1303-45746	9/28/2010	A	132.0	29.9	*	*	*	
Pearl	A69-1303-45747	9/30/2010	SA	123.5	10.7				*
Pearl	A69-1303-45748	9/9/2013	A	159.0	NA			*	*
Pearl	A69-1303-45752	9/28/2011	A	127.6	14.3			*	
Pearl	A69-1303-45753	9/9/2013	A	137.0	NA			*	*
Pearl	A69-1303-45765	9/28/2010	SA	121.0	26.4		*		
Pearl	A69-1303-45767	10/15/2010	A	148.0	24.2		*		
Pearl	A69-1303-62661	4/15/2010	A	167.0	51	*			
Pearl (ERDC)	A69-1601-32244	6/20/2013	A	135.9	27				*
Pascagoula	A69-1303-45053	9/20/2011	SA	104.0	14.45		*		
Pascagoula	A69-1303-46208	10/24/2011	A	138.0	19.5	*	*		
Pascagoula	A69-1303-46210	10/31/2012	A	147.2	26.7			*	*
Pascagoula	A69-1303-46215	10/7/2010	A	147.0	23.6	*	*		
Pascagoula	A69-1303-46567	10/7/2010	SA	102.0	7.98	*			
Pascagoula	A69-1601-30162	10/14/2014	SA	89.9	5.2				*
Pascagoula	A69-1601-31790	10/25/2012	SA	123.5	16.3			*	*
Pascagoula	A69-1601-31791	10/22/2014	SA	93.2	5.3				*
Pascagoula	A69-1601-32246	11/5/2014	A	127.0	15.8				*
Pascagoula	A69-1601-32283	11/5/2014	SA	125.0	13.6				*
Pascagoula	A69-1601-32284	11/6/2014	SA	91.0	4.8				*
Pascagoula	A69-9001-25595	11/5/2014	A	138.4	22.8				*
Pascagoula	A69-9001-29896	10/28/2013	A	152.8	27.2			*	*
Pascagoula	A69-9001-29898	11/5/2014	SA	115.2	11.1				*
Pascagoula	A69-9001-29899	10/31/2012	A	131.6	17.7		*	*	*
Pascagoula	A69-9001-29902	11/5/2013	A	135.0	21.8			*	*
Pascagoula	A69-9001-29903	10/29/2014	SA	103.8	8.15				*
Pascagoula	A69-9001-29904	11/6/2013	A	142.2	24.7			*	*
Pascagoula	A69-9001-30587	5/30/2012	A	139.8	25			*	*
Pascagoula	A69-9001-30589	11/3/2011	A	146.1	29	*		*	
Escambia	A69-1303-45751	10/19/2010	A	148.0	22	*		*	
Escambia	A69-1303-46447	9/9/2010	A	145.0	25.9				*
Escambia	A69-1303-61008	9/30/2009	A	177.8	53.6		*		
Escambia	A69-9001-30598	10/17/2011	A	137.0	22.1			*	*
Blackwater	A69-1303-45716	10/7/2010	A	147.0	22.4		*		
Blackwater	A69-1303-45734	10/15/2010	A	142.0	22.4			*	
Blackwater	A69-1303-45768	10/7/2010	A	158.0	NA			*	
Blackwater	A69-1303-46420	9/10/2010	A	153.0	NA			*	
Blackwater	A69-1303-46423	9/10/2010	A	188.0	56	*	*	*	*
Blackwater	A69-1303-46434	9/2/2010	A	163.0	33.1		*	*	
Blackwater	A69-1303-61028	9/21/2009	A	188.0	60.21				*
Blackwater	A69-1303-61034	9/22/2009	A	186.7	57.8	*	*	*	
Blackwater	A69-1303-61035	9/22/2009	A	166.4	31.86				*
Blackwater	A69-1303-61037	9/21/2009	A	137.0	23.8			*	
Blackwater	A69-1303-61040	10/2/2009	A	185.0	62.5		*	*	
Blackwater	A69-1303-61041	10/2/2009	A	146.0	23.8	*	*	*	
Blackwater	A69-9001-30534	10/5/2011	A	129.0	16.9	*	*		
Blackwater	A69-9001-30539	10/4/2011	A	139.0	22.3			*	*
Blackwater	A69-9001-30542	10/3/2011	A	155.0	33.5			*	*
Blackwater	A69-9001-30545	10/3/2011	A	179.0	46.6				*
Yellow	A69-9001-30554	10/7/2011	A	173.0	48.35	*	*	*	*
Yellow	A69-9001-30564	10/4/2011	A	195.0	54.7		*	*	*
Yellow/Blackwater	A69-1303-46432	4/4/2012	A	160.0	37.7			*	*
Choctawhatchee	A69-1303-45862	10/9/2010	A	186.0	54		*		
Choctawhatchee	A69-1303-46183	10/12/2010	A	133.0	20			*	
Choctawhatchee	A69-9001-26238	10/10/2013	A	178.0	NA				*
Choctawhatchee	A69-9001-29907	10/5/2012	A	171.0	44.5			*	*
TOTAL	63					14	21	34	35
		ADULT	51						
		SUBADULT	12						
		JUVENILE	0						
		TOTAL	63						

In addition to the sturgeon telemetry monitoring, a study to identify benthic communities of Mississippi Sound and the Gulf of Mexico with a focus at Mississippi barrier islands was conducted during 3 sampling periods: June and September 2010 and May 2011. A total of 636 samples were collected, with taxa densities ranging from 257–10,206 individuals per square meter (m^2). Results show that the benthic community within the project area provides suitable forage habitat for adult and subadult fish.

A wide variety of benthic invertebrates were found in the placement and borrow sites, including polychaetes, chordates, nemerteans, gastropods, amphipods, and bivalves, with polychaete worms dominating the majority of the sampling areas. However, taxa densities and richness were extremely variable between the sampling stations (Vittor 2013). Additional benthic invertebrate sampling was conducted in October 2011 to support the evaluation of Gulf sturgeon habitat conditions in the project area (Vittor 2013).

ERDC (2012) correlated the Gulf sturgeon locations with the abundance of 8 principal prey benthic species and identified a direct relationship between the number and detections of Gulf sturgeon and the availability of primary prey. The sturgeon were found more frequently in the areas with the higher abundance of principal prey species. Further, Camille Cut and the eastern side of Ship Island have relatively high overall abundances of these prey taxa compared to the west side of Ship Island (ERDC 2012).

The USACE proposes to continue with the telemetry monitoring during construction on Ship Island and after construction has been finalized (post-construction) and conduct additional benthic community sampling post-construction. This monitoring will refine the benthos assessment applied to the 2011-2012 deployment period (e.g., re-evaluate metrics for defining high/low categories), refine and finalize description of “important” prey items (applicable to other regions – Pascagoula estuary), and apply this new approach to current benthos dataset. Finally, the monitoring plan will provide the data to conduct a more detailed evaluation of detection history of individual fish to identify movement patterns (i.e., corridors) in comparison to long duration residency areas (i.e., feeding).

The following is a detailed outline of the existing monitoring timeline (what has already occurred) and proposed monitoring plan to be implemented in the future as part of this project:

<u>Year 1</u>[5]

- Telemetry array deployed April 14-May 9, 2011 (21 total receivers).
- Monitoring of telemetry zones 1, 4, 5, and 8
- Acoustic Doppler Current Profiler (ADCP) conducted May 2011.
- Conducted in-river netting and tagging (Pearl and Pascagoula rivers); 3-5 year tag life.

[5] Year designation pertains to annual telemetry deployment period, generally September through June.

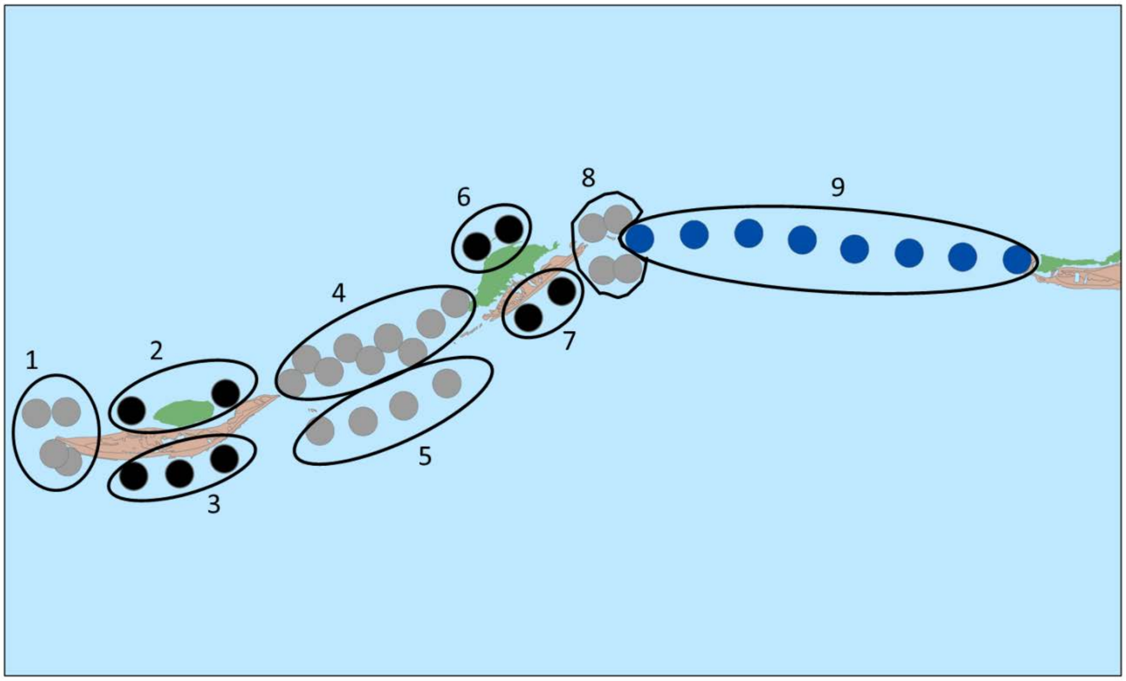


Figure 18. Sturgeon acoustic array placement from, Biological Assessment- MsCIP. USACE 2012

Year 2

- Telemetry array deployed September 20, 2011–June 30, 2012 (21 total receivers).
- Monitoring of telemetry zones 1, 4, 5, and 8
- Vittor and Associates were contracted by Mobile District to conduct an additional number of benthic samples in habitats associated with deployed array (November 2011). Conducted initial analyses and interpretation of benthos dataset in association with Gulf sturgeon detection patterns. Conducted in-river netting and tagging (Pearl and Pascagoula rivers); 3-5 year tag life.

Year 3

- Telemetry array deployed September 13, 2012–June 11, 2013; array expanded to include Dog Keys Pass (29 total receivers).
- Monitoring of telemetry zones 1, 4, 5, 8, and 9
- Conducted in-river netting and tagging (Pearl and Pascagoula rivers); 3-5 year tag life.

Year 4

- Telemetry array deployed September 30, 2013–June 12, 2014Complete array (i.e., Year 3) was deployed, including an additional 10 receivers on Ship Island (North and South shorelines on each side of Camille Cut) to obtain a full season of monitoring of those new areas.

- Monitoring of telemetry zones 1, 2, 3, 4, 5, 6, 7, 8, and 9.
- Monitoring group began reevaluating and refining benthos/Gulf sturgeon associations originally presented in Year 2 and expand to include Year 3 and 4 Gulf sturgeon detection datasets. This included exploring the use of grain size as a surrogate for benthos predictability and exploring options to map out extent of "favorable Gulf sturgeon habitat" using comprehensive benthic community dataset.
- Monitoring group expanded analyses of Gulf sturgeon detection patterns to include a form of occupancy modeling (Peterson et al. 2013) "Macrobenthic prey and physical habitat characteristics in a western Gulf sturgeon population: differential estuarine habitat use patterns" to allow robust statistical analysis of detection patterns between years and array zones.
- Monitoring group continued to conduct in-river netting and tagging (Pearl and Pascagoula rivers); 3-5 year tag life.

Year 5

- The last pre-construction monitoring year (i.e., baseline assessment)
- Telemetry array deployed October 1, 2014–June 4, 2015
- Complete Year 4 array deployed except for receivers positioned within Camille Cut (north and south shorelines). These receivers were redeployed to alternative locations in Dog Keys Pass and/or Horn Island. This will provide some ability to detect relative occurrence of Gulf Sturgeon within western Mississippi Sound that do not occur within the Ship Island project area. In addition, this may help to document shifts in habitat zones by previously tracked Gulf sturgeon (based on prior telemetry deployment years) that may move to other habitat zones during the Construction Period rather than frequent zones noted during pre-construction monitoring (e.g., Camille Cut).
- Monitoring of telemetry zones 1, 2, 3, 6, 7, 8, and 9.
- Conduct in-river netting and tagging (Pearl and Pascagoula rivers); 3-5 year tag life
- Monitoring data analysis, interpretation and reporting conducted

Year 6, 7, & 8[6] (During Construction Period)

- Arrays will not be deployed until after completion of Phase 1 and 2 construction.
- In-river netting and tagging (Pearl and Pascagoula rivers) is planned during construction; 3-5 year tag life
- Monitoring data analysis, interpretation and reporting will be conducted during construction
- Current Construction Schedule:

[6] Current construction period information from J. McDonald (pers. comm., 15 July 2015).

Construction - Phase 1
Duration: 15 months
Start: 12 August 2016 Finish: 5 November 2017
Comment: Placement of initial Camille Cut and East Ship Island berms with placement of the initial plug along N shore of Camille Cut and western East Ship Island, proceeding E to W; however Contractor may propose his own construction scheme.

Construction – Phase 2
Duration: 10 months
Start: 5 July 2017 Finish: 10 April 2018
Comment: Raise Camille Cut berm with placement of material along S shore of Camille Cut; initiate approximately 10-12 months after Phase 1 start to reduce sediment loss from N shore placement as Phase 1 proceeds.

Construction – Phase 3
Duration: 7 months
Start: 5 March 2018 Finish: 14 September 2018
Comment: East Ship Island restoration; complete East Ship Island berm proceeding westwardly from East Ship Island

Construction – Phase 4
Duration: 5 months
Start: 12 March 2018 Finish: 27 July 2018
Comment: Cap Camille Cut berms with Ship Island borrow; building elevation of entire fill between sediment deposited during Phase 1 and 2.

Construction – Phase 5
Duration: 7 months
Start: 23 April 2018 Finish: 2 November 2018
Comment: Planting Camille Cut fill

Year 9 (During construction)

- Camille Cut closure complete (plug in place) (Phase 1 and 2)
- Phases 3-5 ongoing
- Re-deploy Year 5 array. Array deployment period will be July 2018-June 2019.
- Monitoring of telemetry zones 1, 2, 3, 6, 7, 8, and 9
- Conduct FALL and WINTER benthic sampling (August-September and October-November) similar in scale to Year 2 sampling event. These efforts will be conducted approximately 6 months following the completion of Phase 2 construction activities and will be assessed to evaluate general benthos recolonization by examining relative

abundance, taxonomic diversity and geographic pattern of opportunistic/early colonizing benthos. We propose expanding the benthic sampling of Year 9 to include all designated telemetry zones (1-9). The Year 2 sturgeon-related benthic sampling event by Vittor and Associates was restricted to the footprint of telemetry zones 1, 4, 5, and 8. These efforts will be conducted during the same time period of the pre-construction benthic sampling in Year 2 and will provide an adequate comparison to pre-construction conditions.

- Conduct SPRING AND SUMMER benthic sampling (April-June) by Vittor and Associates following the protocols developed for Year 9 FALL and WINTER benthos sampling.
- Conduct in-river netting and tagging (Pearl and Pascagoula rivers); 3-5 year tag life.

<u>Year 10 (Post Construction)</u>

- Re-deploy Year 5 array. Array deployment period will be July 2019-June 2020.
- Monitoring of telemetry zones 1, 2, 3, 6, 7, 8, and 9
- Conduct in-river netting and tagging (Pearl and Pascagoula rivers); 3-5 year tag life.
- Experimental approach for comprehensive detection and benthos assessments will follow a modified Before–After Control–Impact (BACI) design with Gulf sturgeon detection patterns (annual and zone) quantified with occupancy model approach developed in Year 4. The robustness of the BACI design is based on sufficient data representing both the before and after conditions. A minimum coverage for this particular analysis would be 1 year for each condition (before/after), but improvements in statistical robustness would be achieved by expanding the coverage to 2 years for each condition.
- Complete analysis of full telemetry monitoring dataset (January 2020-July 2020). This includes compiling data, removing duplicate entries and summarizing basic activity patterns.
- Interpretation of full telemetry monitoring dataset (May 2020-July 2021).

<u>Year 11</u>

- Monitoring group will present a report on project findings (January 2021) with an evaluation of whether the project has had an adverse impact on Gulf sturgeon using acoustic monitoring data, benthic prey availability, and grain size data sets. Assumptions are:

  H0 (Null Hypothesis): Project has no adverse effect on Gulf sturgeon. We propose to approach this by evaluating impacts at 2 levels.
  H0: No appreciable change in sturgeon activity patterns based on normalized detection indices (our modified occupancy model).

- Determinations can be assessed across years (baseline: Years 2, 3, 4 and 5; construction: Year 8; post-construction: Years 9) and telemetry zones.
- The expectation is that if there were no impacts, then we would not see much change in activity patterns in telemetry zones 1, 2, 3, 6, 7, 8, and 9 regardless of the deployment

year (e.g., variance in post-construction occupancy index values would be within 2 standard deviations of pre-construction values). However, zones 4 and 5 would likely illustrate a typical "disturbance" inflection where activity levels would be reduced during and after the construction period but those associated zones would then rebound to the baseline level at some time afterwards. This would require that the USACE monitor the outer shoreline areas of zones 4 and 5 following the end of construction (redeploy partial array in these zones).

- If there is an appreciable change in sturgeon activity patterns (i.e., drastic shift in detection patterns), the USACE will re-deploy telemetry array and continue to evaluate movement/detection patterns of Gulf sturgeon within the project area. This will initiate Year 11 Protocol (See Scenario B).

H0: No appreciable change in the benthic assemblage among the telemetry zones.

- USACE proposes a measure of percentage similarity (e.g., ≥ 70% faunal similarity) between sampled zones for baseline and post-construction periods as the means of assessing changes in the benthic assemblage).
- If both levels (baseline and post-construction) indicate no appreciable change (e.g., ≥ 70% faunal similarity), this data will conclude the end of the project. No additional Gulf sturgeon monitoring will be needed and benthos is considered to be not impacted to the level that would adversely affect Gulf sturgeon feeding habitat.
- If there are no appreciable change in sturgeon activity patterns, but there are changes in the benthic assemblage, the USACE will cease the telemetry based portion of the project (no array, no tagging, and no tracking) and shift the primary emphasis to monitoring benthos. This will initiate Year 11 Protocol (See Scenario A).
- No in-river netting or tagging will be required.

Post Construction - Scenario A

- Conduct Summer and Fall benthic sampling (August-September 2020) following the protocols developed for Year 9 benthos sampling.
- USACE will incorporate benthos data from Year 11 fall sampling deployment within master database compiled for Year 9 analyses. Reanalyze complete database (Year 1-11) based on previously established protocols and present report on project findings in Year 12 (September 2021).
- No in-river netting or tagging will be required.

Post Construction - Scenario B

- Re-deploy Year 5 array. Array deployment period will be July 2020-June 2021.
- Monitoring of telemetry zones 1, 2, 3, 6, 7, 8, and 9.

- Incorporate telemetry data from Year 11 deployment within master database compiled for Year 10 analyses. Reanalyze complete database (Year 1-10, 11) based on previously established protocols and present report on project findings (September 2021).
- No in-river netting or tagging will be required.

Year 12

Post Construction - Scenario C

- Following implementation of Scenario A if data show a failure of benthos community to return to baseline conditions; or demonstrate an appreciable/significant change in benthos community assessments (i.e., decreased abundance, shift in faunal composition) between pre-construction and post-construction periods Scenario C will be implemented.
- Conduct additional Fall and Winter benthic sampling (2021-2022) following the developed protocols.
- USACE will incorporate benthos data from Year 12 fall sampling deployment within master database compiled for the previous analyses. Reanalyze complete database (Year 1-12) based on previously established protocols and present report on project findings in Year 12 (September 2022).

Post Construction - Scenario D

- Following implementation of Scenario B if data show failure to return to baseline conditions; significant change in Gulf sturgeon occupancy patterns between pre-construction and post-construction periods Scenario D will be implemented
- Re-deploy Year 5 array deploy and monitor Gulf sturgeon acoustic array; 2021-2022).
- No in-river netting or tagging will be required.
- Efforts would include proposed overall team analyses, interpretation and reporting following the retrieval of the acoustic array in June 2022.
- Incorporate telemetry data from Year 12 deployment within master database compiled for Year 10 analyses. Reanalyze complete database based on previously established protocols and present report on project findings (September 2022).

Table 4. Activities and Tentative Timetable for Major Tasks Associated with Ship Island-Camille Cut Gulf Sturgeon Monitoring Project
Conducted activities and tentative timetable for major tasks associated with Ship Island Camille Cut Gulf sturgeon monitoring project (Netting = Gulf sturgeon river netting effort; Array = deployment periods for Gulf sturgeon acoustic telemetry array denoted with black shading and non-deployment periods during periods of active construction are noted with yellow shading; Benthos-Vittor = acquisition and identification of benthic samples by Vittor and Associates; Benthos-ERDC = analysis, interpretation and reporting of benthos samples; Monitoring = subtasks associated with analyses, interpretation and reporting of Gulf sturgeon activity patterns depicted on deployed telemetry array). ADCP efforts were conducted during YEAR 1 but were discontinued in future years due to uninformative data. Year designation (1-13) corresponds to the annual telemetry deployment period.

Federal Fiscal Year	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YR 7

	2010–2011	2012–2013	2014–2016	
Original schedule	PRE-FILL	CONSTRUCTION	POST-FILL	
Amended Schedule[1]	PRE-FILL	PRE-FILL	CONSTRUCTION	
Amended Schedule[2]	PRE-FILL	PRE-FILL	PRE-FILL	CONSTRUCTION
Amended Schedule[3]	PRE-FILL	PRE-FILL	PRE-FILL	CONSTRUCTION

	2010				2011				2012				2013				2014				2015				2016			
	J-M	A-J	J-S	O-D	J-M	A-J	J-S	O-D	J-M	A-J	J-S	O-D	J-M	A-J	J-S	O-D	J-M	A-J	J-S	O-D	J-M	A-J	J-S	O-D	J-M	A-J	J-S	O-D
Construction																												
Phase 1																												
Phase 2																												
Phase 3																												
Phase 4																												
Phase 5																												
Netting																												
Array-deploy																												
Benthos-Vittor																												
Benthos-ERDC																												
Monitoring																												
- Analyses																												
- Interpretation																												
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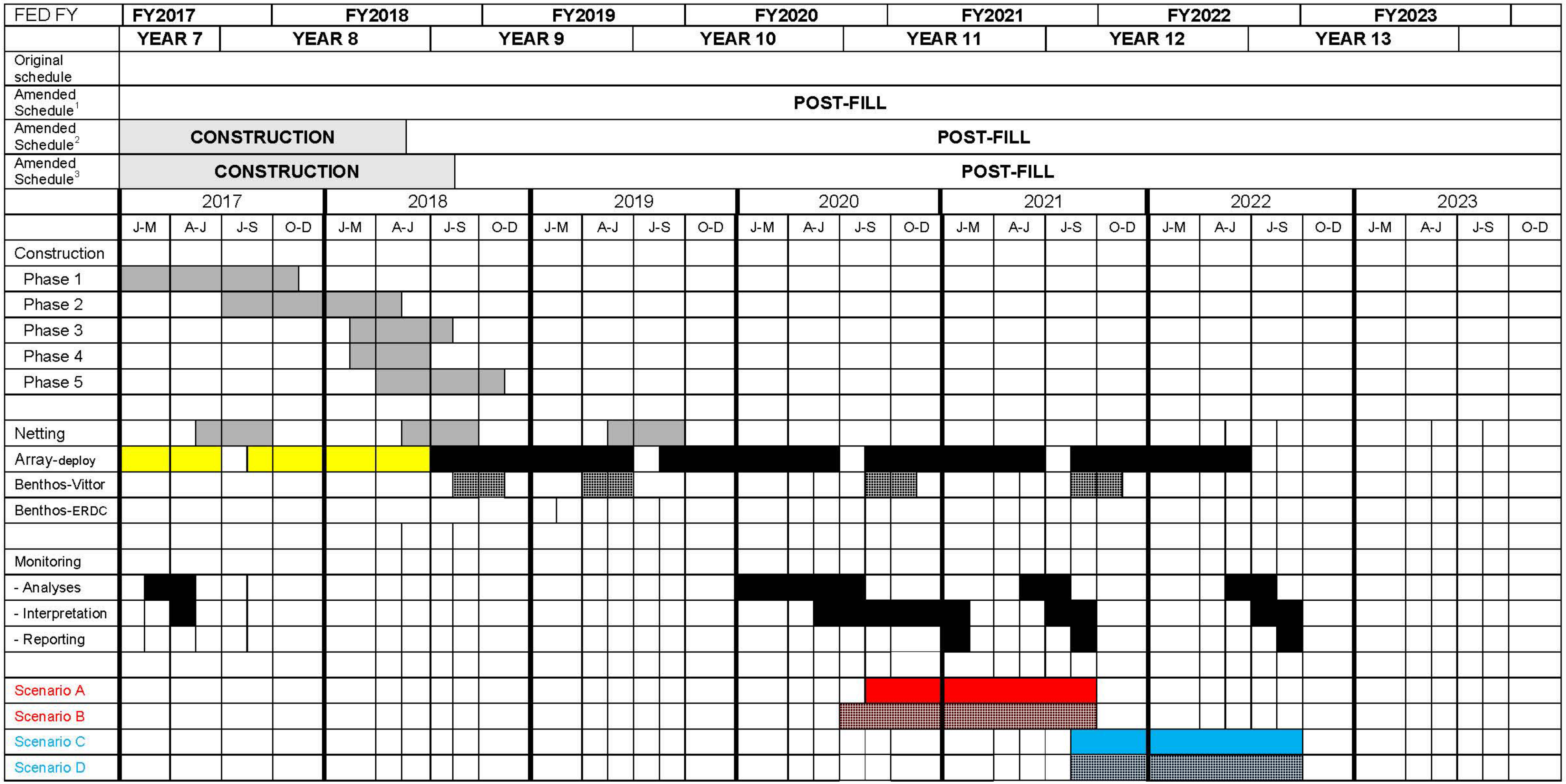
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Benthos-Vittor
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Monitoring
- Analyses
- Interpretation
- Reporting
Scenario A
Scenario B
Scenario C
Scenario D

3.2 Action Area

The action area is defined by regulation as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 CFR 402.02). The proposed projects are bounded by the limits of the projects described in Section 3.1. The description of the proposed action details the restoration of the offshore barrier islands and the use of borrow sites needed for restoration spanning an area from east to west, the islands are Dauphin Island in Alabama and Petit Bois, Horn, East Ship, West Ship, and Cat Islands in Mississippi and the northern Gulf of Mexico to about 8 miles seaward of the barrier islands. In addition, Sand Island, which has been created through the deposition of dredged material within DA-10 of the Pascagoula Harbor Federal Navigation project, lies between Petit Bois and Horn Islands (Figure 19).

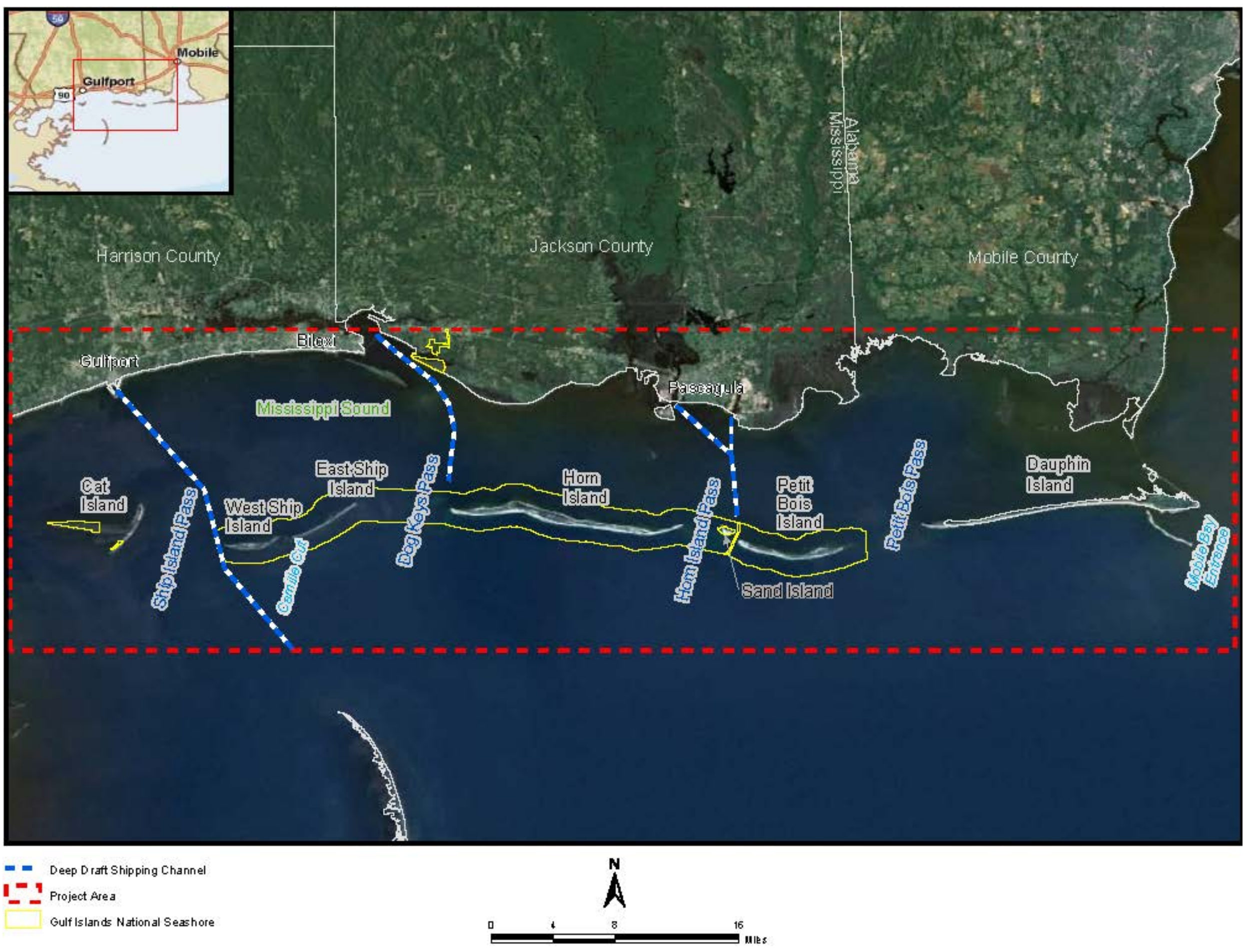


Figure 19. Action area map from, Biological Assessment- MsCIP. USACE 2012

4 STATUS OF LISTED SPECIES AND CRITICAL HABITAT

The following endangered (E) and threatened (T) marine mammal, sea turtle, and fish species, and designated critical habitat under the jurisdiction of NMFS may occur in or near the action area:

Table 5. Status of Listed Species in the Action Area (E = Endangered, T =Threatened)

Species		Scientific Name	Status
Sea Turtles	Loggerhead sea turtle, Northwest Atlantic (NWA) DPS	*Caretta caretta*	T
	Green	*Chelonia mydas*	E/T[7]
	Leatherback	*Dermochelys coriacea*	E
	Hawksbill	*Eretmochelys imbricata*	E
	Kemp's ridley	*Lepidochelys kempii*	E
Fish	Gulf sturgeon	*Acipenser oxyrinchus desotoi*	T
	Smalltooth sawfish[8]	*Pristis pectinata*	E
Marine Mammals	Blue whale	*Balaenoptera musculus*	E
	Finback whale	*Balaenoptera physalus*	E
	Humpback whale	*Megaptera novaeangliae*	E
	Sei whale	*Balaenoptera borealis*	E
	Sperm whale	*Physeter macrocephalus*	E

Table 6. Critical Habitats in the Action Area

	Species
Critical Habitat For:	Gulf Sturgeon - Unit 8 Lake Pontchartrain/Mississippi Sound
	NWA Loggerhead sea turtle - Unit LOGG-N-35 through LOGG-N-36 for Nearshore Reproductive Habitat

4.1 Species and Critical Habitat not Likely to be Adversely Affected

Marine Mammals

NMFS believes that sperm, blue, fin, humpback, or sei whales will not be adversely affected by hopper dredges, relocation trawlers, cutterhead dredges, mechanical dredges, dump scows, or placement operations. The possibility of collisions with the dredge vessels is believed to be remote since these are deepwater species unlikely to be found in the project area. There has never been a report of a whale taken by a dredge vessel in the Gulf of Mexico. Given their likely absence, and very low likelihood of interaction, the above-mentioned cetaceans are not considered further in this opinion. However, it should be noted that incidental take of any marine mammals (listed or non-listed) is not authorized through the ESA Section 7 process. If such take may occur, an incidental take authorization under the Marine Mammal Protection Act

[7] Currently, green sea turtles in U.S. waters are listed as threatened except for the Florida breeding population, which is listed as endangered. On March 23, 2015, NMFS published a proposed rule (80 FR 15271) listing 11 DPSs for green sea turtles; the proposed North Atlantic DPS for green sea turtles is listed as threatened, and is the only DPS whose individuals can be expected to be encountered in the action area.

[8] The U.S. DPS

(MMPA) Section 101 (a)(5) is necessary. For more information regarding MMPA permitting procedures, contact NMFS Headquarters' Protected Resources staff at (301) 713-2323.

Smalltooth Sawfish

The U.S. DPS of smalltooth sawfish was listed as endangered under the ESA effective May 1, 2003 (68 FR 15674, April 1, 2003). Within the United States, smalltooth sawfish have been captured in estuarine and coastal waters from New York southward through Texas, although peninsular Florida has historically been the region of the United States with the largest number of recorded captures (NMFS 2000). Recent records indicate there is a resident reproducing population of smalltooth sawfish in south and southwest Florida from Charlotte Harbor through the Dry Tortugas, which is also the last U.S. stronghold for the species (Poulakis and Seitz 2004; Seitz and Poulakis 2002; Simpfendorfer and Wiley 2004). Recent sawfish records are limited to Georgia, Florida (Simpfendorfer 2003), and most recently, Texas (S. Norton, NMFS, pers. comm., to R, Hendren, NMFS, January 27, 2015). Notably, the Texas sighting was not verified and may have been either the endangered smalltooth sawfish or the similar largetooth sawfish (*Pristis pristis*); records of both are rare throughout the western Gulf of Mexico. Therefore, NMFS believes smalltooth sawfish are rare in the action area and it is extremely unlikely that proposed action will adversely affect them. Furthermore, there has not been any observed incidental takes of smalltooth sawfish by dredge, and NMFS believes this species can easily avoid the slow-moving dredge. This species will not be discussed further in this opinion.

Sea Turtles

Sea turtles that may use the Action Area include green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles. The dredge and placement operation poses a threat to some species of sea turtles via incidental capture and/or entrainment by dredges and relocation trawling vessels. NMFS evaluated the threats posed by the proposed project to the above-listed sea turtles. Based on dredge and trawl take data, turtle diets, and preferred habitats, NMFS believes that only green, Kemp's ridley, leatherback, and loggerhead sea turtles are likely to be adversely affected by the proposed action, as discussed further below.

Hawksbill sea turtles could occasionally be found in the action area; however, hawksbills are the most tropical sea turtle species, ranging from approximately 30°N latitude to 30°S latitude. They are closely associated with coral reefs and other hardbottom habitats, but may also be found in other habitats including inlets, bays, and coastal lagoons (NMFS and USFWS 1993). Adult foraging habitat, which may or may not overlap with developmental habitat, is typically coral reefs, although other hardbottom communities and occasionally mangrove-fringed bays may be occupied. Hawksbills show fidelity to their foraging areas over several years (Van Dam and Diez 1998). The hawksbill's diet is highly specialized and consists primarily of sponges (Meylan 1988). Other food items, notably corallimorphs and zooanthids, have been documented to be important in some areas of the Caribbean (León and Diez 2000; Mayor et al. 1998; Van Dam and Diez 1997). Due to hawksbill sea turtles' preferred habitat and diet, it is not expected that interactions with dredges and/or relocation trawls will occur in the action area. Therefore, any effect of the proposed action on this species is discountable. This species will not be discussed further in this opinion.

Northwest Atlantic Loggerhead DPS Critical Habitat

NMFS and USFSW published a proposed rule (78 FR 43006, July 18, 2013) to designate critical habitat for the threatened Northwest Atlantic Ocean DPS and a Final Rule was published on July 10, 2014 (79 FR 39855). NMFS designated 38 marine areas within the Northwest Atlantic Ocean DPS as critical habitat. Each of these areas consists of 1 or a combination of the following habitat types: nearshore reproductive habitat (directly off USFWS-designated critical habitat nesting beaches out to 1.6 km [1 mile]), wintering habitat, breeding habitat, constricted migratory corridors, and *Sargassum* habitat.

The proposed action will occur near the boundaries of 2 loggerhead critical habitat units, LOGG-N-35 and LOGG-N-36. Both of these units contain only 1 critical habitat type: nearshore reproductive habitat.

LOGG-N-35—Petit Bois Island, Jackson County, Mississippi: This unit contains nearshore reproductive habitat only. The boundaries of the unit are nearshore areas from Horn Island Pass to Petit Bois Pass from the MHW line and seaward to 1.6 km (Figure 20).

LOGG-N-36—Horn Island, Jackson County, Mississippi: This unit contains nearshore reproductive habitat only. The boundaries of the unit are nearshore areas from Dog Keys Pass to the easternmost point of the ocean facing island shore from the MHW line and seaward to 1.6 km (Figure 20).

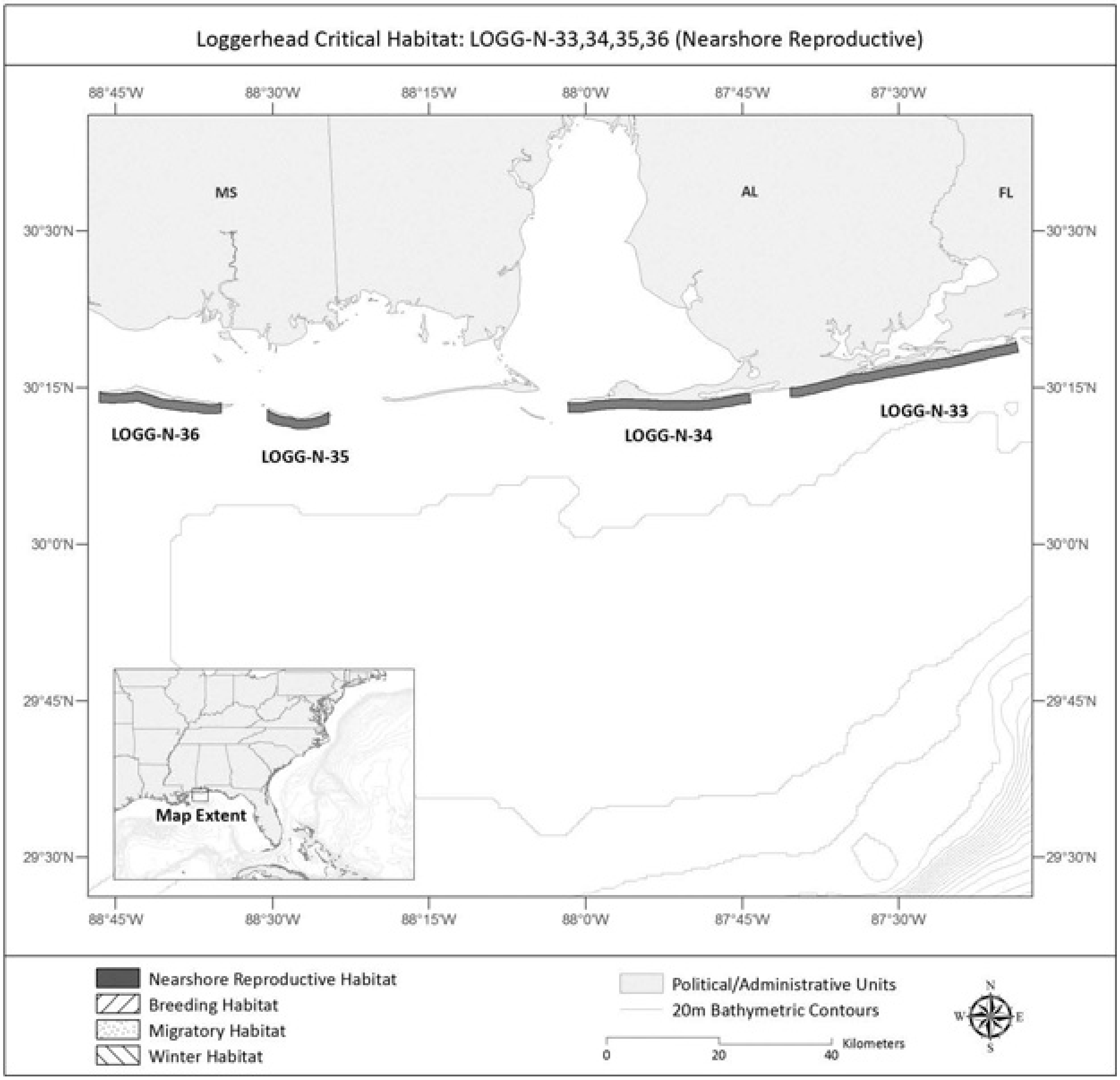


Figure 20. Nearshore Reproductive Habitat (LOGG-N-33-36) from, (79 FR 39855)

While both designated critical habitat areas (LOGG-N-35 and -36) for loggerheads exist in the action area, the dredging and placement/disposal activities will not occur within the 1-mile (1.6 km) area between MHW and outward toward open water. All waters within this 1-mile area will be sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water. Last, no man-made structures that could promote predators (e.g., submerged offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents will be created within this area. Therefore, NMFS expects the dredging and placement/ disposal will not adversely affect the ability of LOGG-N-35 and -36 to provide efficient passage of hatchlings or females and we do not expect measurable impacts to the status of these essential features to nearshore reproductive habitat.

4.2 Overview of Status of Sea Turtles

There are 4 species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead) that travel widely throughout the South Atlantic, Gulf of Mexico and the Caribbean. These species are highly migratory and therefore could occur within the action area. Section 4.2.1 will address the general threats that confront all sea turtle species. Sections 4.3–4.6 will address information on the distribution, life history, population structure, abundance, population trends, and unique threats to each species of sea turtle.

4.2.1 General Threats Faced by All Sea Turtle Species

Sea turtles face numerous natural and man-made threats that shape their status and affect their ability to recover. Many of the threats are either the same or similar in nature for all listed sea turtle species; those identified in this section are discussed in a general sense for all sea turtles. Threat information specific to a particular species is then discussed in the corresponding status sections where appropriate.

Fisheries

Incidental bycatch in commercial fisheries is identified as a major contributor to past declines, and threat to future recovery, for all of the sea turtle species (NMFS and USFWS 1992b; NMFS and USFWS 1993; NMFS and USFWS 2008a; NMFS et al. 2011; USFWS and NMFS 1991). Domestic fisheries often capture, injure, and kill sea turtles at various life stages. Sea turtles in the pelagic environment are exposed to U.S. Atlantic pelagic longline fisheries. Sea turtles in the benthic environment in waters off the coastal United States are exposed to a suite of other fisheries in federal and state waters. These fishing methods include trawls, gillnets, purse seines, hook-and-line gear (including bottom longlines and vertical lines [e.g., bandit gear, handlines, and rod-reel], pound nets, and trap fisheries. Refer to the Environmental Baseline section of this opinion for more specific information regarding federal and state managed fisheries affecting sea turtles within the action area). The southeast U.S. shrimp fisheries have historically been the largest fishery threat to benthic sea turtles in the southeastern United States, and continue to interact with and kill large numbers of sea turtles each year.

In addition to domestic fisheries, sea turtles are subject to direct as well as incidental capture in numerous foreign fisheries, further impeding the ability of sea turtles to survive and recover on a global scale. For example, pelagic stage sea turtles, especially loggerheads and leatherbacks, circumnavigating the Atlantic are susceptible to international longline fisheries including the Azorean, Spanish, and various other fleets (Aguilar et al. 1994; Bolten et al. 1994; Crouse 1999). Bottom longlines and gillnet fishing is known to occur in many foreign waters, including (but not limited to) the northwest Atlantic, western Mediterranean, South America, West Africa, Central America, and the Caribbean. Shrimp trawl fisheries are also occurring off the shores of numerous foreign countries and pose a significant threat to sea turtles similar to the impacts seen in U.S. waters. Many unreported takes or incomplete records by foreign fleets make it difficult to characterize the total impact that international fishing pressure is having on listed sea turtles. Nevertheless, international fisheries represent a continuing threat to sea turtle survival and recovery throughout their respective ranges.

Non-Fishery In-Water Activities

There are also many non-fishery impacts affecting the status of sea turtle species, both in the ocean and on land. In nearshore waters of the United States, the construction and maintenance of federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly and can entrain and kill sea turtles (NMFS 1997). Sea turtles entering coastal or inshore areas have also been affected by entrainment in the cooling-water systems of electrical generating plants. Other nearshore threats include harassment and/or injury resulting from private and commercial vessel operations, military detonations and training exercises, in-water construction activities, and scientific research activities.

Coastal Development and Erosion Control

Coastal development can deter or interfere with nesting, affect nesting success, and degrade nesting habitats for sea turtles. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997). These factors may decrease the amount of nesting area available to females and change the natural behaviors of both adults and hatchlings, directly or indirectly, through loss of beach habitat or changing thermal profiles and increasing erosion, respectively. (Ackerman 1997; Witherington et al. 2003; Witherington et al. 2007). In addition, coastal development is usually accompanied by artificial lighting which can alter the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings that are drawn away from the water (Witherington and Bjorndal 1991). In-water erosion control structures such as breakwaters, groins, and jetties can impact nesting females and hatchling as they approach and leave the surf zone or head out to sea by creating physical blockage, concentrating predators, creating longshore currents, and disrupting of wave patterns.

Environmental Contamination

Multiple municipal, industrial, and household sources, as well as atmospheric transport, introduce various pollutants such as pesticides, hydrocarbons, organochlorides (e.g., dichlorodiphenyltrichloroethane [DDT], polychlorinated biphenyls [PCB], and perfluorinated chemicals [PFC]), and others that may cause adverse health effects to sea turtles (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata et al. 1993). Acute exposure to hydrocarbons from petroleum products released into the environment via oil spills and other discharges may directly injure individuals through skin contact with oils (Geraci 1990), inhalation at the water's surface and ingesting compounds while feeding (Matkin and Saulitis 1997). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability in the action area.

The April 20, 2010, explosion of the Deepwater Horizon oil rig affected sea turtles in the Gulf of Mexico. There is an on-going assessment of the long-term effects of the spill on Gulf of Mexico marine life, including sea turtle populations. Following the spill, juvenile Kemp's ridley, green, and loggerhead sea turtles were found in *Sargassum* algae mats in the convergence zones, where currents meet and oil collected. Sea turtles found in these areas were often coated in oil and/or had ingested oil. Approximately 536 live adult and juvenile sea turtles were recovered from the Gulf and brought into rehabilitation centers; of these, 456 were visibly oiled (these and the following numbers were obtained from http://www.nmfs.noaa.gov/pr/health/oilspill/). To date, 469 of the live recovered sea turtles have been successfully returned to the wild, 25 died during rehabilitation, and 42 are still in care but will hopefully be returned to the wild eventually.

During the cleanup period, 613 dead sea turtles were recovered in coastal waters or on beaches in Mississippi, Alabama, Louisiana, and the Florida Panhandle. As of February 2011, 478 of these dead turtles had been examined. Many of the examined sea turtles showed indications that they had died as a result of interactions with trawl gear, most likely used in the shrimp fishery, and not as a result of exposure to or the ingestion of oil.

During the spring and summer of 2010, nearly 300 sea turtle nests were relocated from the northern Gulf to the east coast of Florida with the goal of preventing hatchlings from entering the oiled waters of the northern Gulf. From these relocated nests, 14,676 sea turtles, including 14,235 loggerheads, 125 Kemp's ridleys, and 316 greens, were ultimately released from Florida beaches.

A thorough assessment of the long-term effects of the spill on sea turtles has not yet been completed. However, the spill resulted in the direct mortality of many sea turtles and may have had sublethal effects or caused environmental damage that will impact other sea turtles into the future. The population level effects of the spill and associated response activity are likely to remain unknown for some time.

Marine debris is a continuing problem for sea turtles. Sea turtles living in the pelagic environment commonly eat or become entangled in marine debris (e.g., tar balls, plastic bags/pellets, balloons, and ghost fishing gear) as they feed along oceanographic fronts where debris and their natural food items converge. This is especially problematic for sea turtles that spend all or significant portions of their life cycle in the pelagic environment (i.e., leatherbacks, juvenile loggerheads, and juvenile green turtles).

Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. NOAA's climate information portal provides basic background information on these and other measured or anticipated effects (see http://www.climate.gov).

Climate change impacts on sea turtles currently cannot be predicted with any degree of certainty; however, significant impacts to the hatchling sex ratios of sea turtles may result (NMFS and USFWS 2007n). In sea turtles, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25°-35°C (Ackerman 1997). Increases in global temperature could potentially skew future sex ratios toward higher numbers of females (NMFS and USFWS 2007n).

The effects from increased temperatures may be intensified on developed nesting beaches where shoreline armoring and construction have denuded vegetation. Erosion control structures could potentially result in the permanent loss of nesting beach habitat or deter nesting females (NRC 1990a). These impacts will be exacerbated by sea level rise. If females nest on the seaward side of the erosion control structures, nests may be exposed to repeated tidal overwash (NMFS and USFWS 2007n). Sea level rise from global climate change is also a potential problem for areas with low-lying beaches where sand depth is a limiting factor, as the sea may inundate nesting sites and decrease available nesting habitat (Baker et al. 2006; Daniels et al. 1993; Fish et al. 2005). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis et al. 2006; Baker et al. 2006).

Other changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish) which could ultimately affect the primary foraging areas of sea turtles.

Other Threats

Predation by various land predators is a threat to developing nests and emerging hatchlings. The major natural predators of sea turtle nests are mammals, including raccoons, dogs, pigs, skunks, and badgers. Emergent hatchlings are preyed upon by these mammals as well as ghost crabs, laughing gulls, and the exotic South American fire ant (*Solenopsis invicta*). In addition to natural predation, direct harvest of eggs and adults from beaches in foreign countries continues to be a problem for various sea turtle species throughout their ranges (NMFS and USFWS 2008b).

Diseases, toxic blooms from algae and other microorganisms, and cold stunning events are additional sources of mortality that can range from local and limited to wide-scale and impacting hundreds or thousands of animals.

Actions Taken to Reduce Threats

Actions have been taken to reduce man-made impacts to sea turtles from various sources, particularly since the early 1990s. These include lighting ordinances, predation control, and nest relocations to help increase hatchling survival, as well as measures to reduce the mortality of pelagic immatures, benthic immatures, and sexually mature age classes from various fisheries and other marine activities. Some actions have resulted in significant steps towards reducing the recurring sources of mortality of sea turtles in the environmental baseline and improving the status of all sea turtle populations in the Atlantic and Gulf of Mexico.

4.3 Green Sea Turtle

The green sea turtle was listed as threatened under the ESA on July 28, 1978, except for the Florida and Pacific coast of Mexico breeding populations, which were listed as endangered. On March 23, 2015, NMFS published a proposed rule (80 FR 15271) listing 11 DPSs of green sea turtle. This includes 8 DPSs listed as threatened (Central North Pacific, East Indian-West

Pacific, East Pacific, North Atlantic, North Indian, South Atlantic, Southwest Indian, and Southwest Pacific) and 3 as endangered (Central South Pacific, Central West Pacific, and Mediterranean). The proposed North Atlantic DPS for green sea turtles is listed as threatened, and is the only DPS whose individuals can be expected to be encountered in the action area.

Species Description and Distribution
The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (lb) (159 kg) and a straight carapace length of greater than 3.3 ft (1 m). Green sea turtles have a smooth carapace with 4 pairs of lateral (or costal) scutes and a single pair of elongated prefrontal scales between the eyes. They typically have a black dorsal surface and a white ventral surface, although the carapace of green sea turtles in the Atlantic Ocean has been known to change in color from solid black to a variety of shades of grey, green, or brown and black in starburst or irregular patterns (Lagueux 2001).

With the exception of post-hatchlings, green sea turtles live in nearshore tropical and subtropical waters where they generally feed on marine algae and seagrasses. They have specific foraging grounds and may make large migrations between these forage sites and natal beaches for nesting (Hays et al. 2001). Green sea turtles nest on sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands in more than 80 countries worldwide (Hirth 1997). The 2 largest nesting populations are found at Tortuguero, on the Caribbean coast of Costa Rica, and Raine Island, on the Pacific coast of Australia along the Great Barrier Reef.

Differences in mitochondrial DNA properties of green sea turtles from different nesting regions indicate there are genetic subpopulations (Bowen et al. 1992; FitzSimmons et al. 2006). Despite the genetic differences, sea turtles from separate nesting origins are commonly found mixed together on foraging grounds throughout the species' range. Such mixing occurs at extremely low levels in Hawaiian foraging areas, perhaps making this central Pacific population the most isolated of all green sea turtle populations occurring worldwide (Dutton et al. 2008).

In U.S. Atlantic and Gulf of Mexico waters, green sea turtles are distributed throughout inshore and nearshore waters from Texas to Massachusetts. Principal benthic foraging areas in the southeastern United States include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty 1984; Hildebrand 1982; Shaver 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957; Carr 1967), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon system in Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Guseman and Ehrhart 1992; Wershoven and Wershoven 1992). The summer developmental habitat for green sea turtles also encompasses estuarine and coastal waters from North Carolina to as far north as Long Island Sound (Musick and Limpus 1997). Additional important foraging areas in the western Atlantic include the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Miskito Coast of Nicaragua, the Caribbean coast of Panama, scattered areas along Colombia and Brazil (Hirth 1971), and the northwestern coast of the Yucatán Peninsula.

The complete nesting range of green sea turtles within the southeastern United States includes sandy beaches between Texas and North Carolina, as well as the U.S. Virgin Islands and Puerto

Rico (Dow et al. 2007; NMFS and USFWS 1991). Still, the vast majority of green sea turtle nesting within the southeastern United States occurs in Florida (Johnson and Ehrhart 1994; Meylan et al. 1995). Principal U.S. nesting areas for green sea turtles are in eastern Florida, predominantly Brevard south through Broward counties. For more information on green sea turtle nesting in other ocean basins, refer to the 1991 publication, *Recovery Plan for the Atlantic Green Turtle* (NMFS and USFWS 1991) or the 2007 publication, *Green Sea Turtle 5-Year Status Review* (NMFS and USFWS 2007a).

Life History Information

Green sea turtles reproduce sexually, and mating occurs in the waters off nesting beaches. Mature females return to their natal beaches (i.e., the same beaches where they were born) to lay eggs (Balazs 1982; Frazer and Ehrhart 1985) every 2-4 years while males are known to reproduce every year (Balazs 1983). In the southeastern United States, females generally nest between June and September, and peak nesting occurs in June and July (Witherington and Ehrhart 1989). During the nesting season, females nest at approximately 2-week intervals, laying an average of 3-4 clutches (Johnson and Ehrhart 1996). Clutch size often varies among subpopulations, but mean clutch size is approximately 110-115 eggs. In Florida, green sea turtle nests contain an average of 136 eggs (Witherington and Ehrhart 1989). Eggs incubate for approximately 2 months before hatching. Hatchling green sea turtles are approximately 2 inches (in) (5 cm) in length and weigh approximately 0.9 ounces (25 grams). Survivorship at any particular nesting site is greatly influenced by the level of anthropogenic stressors, with the more pristine and less disturbed nesting sites (e.g., along the Great Barrier Reef in Australia) showing higher survivorship values than nesting sites known to be highly disturbed [e.g., Nicaragua (Campell and Lagueux 2005; Chaloupka and Limpus 2005)].

After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. This early oceanic phase remains one of the most poorly understood aspects of green sea turtle life history (NMFS and USFWS 2007j). Green sea turtles exhibit particularly slow growth rates of about 0.4-2 in (1-5 cm) per year (Green 1993; McDonald Dutton and Dutton 1998), which may be attributed to their largely herbivorous, low-net energy diet (Bjorndal 1982). At approximately 8-10 in (20-25 cm) carapace length, juveniles leave the pelagic environment and enter nearshore developmental habitats such as protected lagoons and open coastal areas rich in sea grass and marine algae. Growth studies using skeletochronology indicate that green sea turtles in the western Atlantic shift from the oceanic phase to nearshore developmental habitats after approximately 5-6 years (Bresette et al. 2006; Zug and Glor 1998). Within the developmental habitats, juveniles begin the switch to a more herbivorous diet, and by adulthood feed almost exclusively on seagrasses and algae (Rebel 1974), although some populations are known to also feed heavily on invertebrates (Carballo et al. 2002). Green sea turtles mature slowly, requiring 20-50 years to reach sexual maturity (Chaloupka and Musick 1997; Hirth 1997).

While in coastal habitats, green sea turtles exhibit site fidelity to specific foraging and nesting grounds, and it is clear they are capable of "homing in" on these sites if displaced (McMichael et al. 2003). Reproductive migrations of Florida green sea turtles have been identified through flipper tagging and/or satellite telemetry. Based on these studies, the majority of adult female Florida green sea turtles are believed to reside in nearshore foraging areas throughout the Florida Keys and in the waters southwest of Cape Sable, with some post-nesting turtles also residing in Bahamian waters as well (NMFS and USFWS 2007j).

Status and Population Dynamics
Population estimates for marine turtles do not exist because of the difficulty in sampling turtles over their geographic ranges and within their marine environments. Nonetheless, researchers have used nesting data to study trends in reproducing sea turtles over time. A summary of nesting trends is provided in the 2007 5-year status review for the species (NMFS and USFWS 2007j) organized by ocean region (i.e., Western Atlantic Ocean, Central Atlantic Ocean, Eastern Atlantic Ocean, Mediterranean Sea, Western Indian Ocean, Northern Indian Ocean, Eastern Indian Ocean, Southeast Asia, Western Pacific Ocean, Central Pacific Ocean, and Eastern Pacific Ocean). Nesting data shows trends at 23 of the 46 nesting sites: 10 appeared to be increasing, 9 appeared to be stable, and 4 appeared to be decreasing. With respect to regional trends, the Pacific, the Western Atlantic, and the Central Atlantic regions appeared to show more positive trends (i.e., more nesting sites increasing than decreasing) while the Southeast Asia, the Eastern Indian Ocean, and possibly the Mediterranean Sea regions appeared to show more negative trends (i.e., more nesting sites decreasing than increasing). These regional determinations should be viewed with caution, because trend data was only available for about half of the total nesting concentration sites examined in the review and site specific data availability appeared to vary across all regions.

The Western Atlantic region (i.e., the focus of this Opinion) was one of the best performing in terms of abundance in the entire review, as there were no sites that appeared to decrease. The 5-year status review for the species reviewed the trend in nest count data for each identified 8 geographic areas considered to be primary sites for green sea turtle nesting in the Atlantic/Caribbean (NMFS and USFWS 2007a): (1) Yucatán Peninsula, Mexico; (2) Tortuguero, Costa Rica; (3) Aves Island, Venezuela; (4) Galibi Reserve, Suriname; (5) Isla Trindade, Brazil; (6) Ascension Island, United Kingdom; (7) Bioko Island, Equatorial Guinea; and (8) Bijagos Achipelago, Guinea-Bissau. Nesting at all of these sites was considered to be stable or increasing with the exception of Bioko Island and the Bijagos Archipelago where the lack of sufficient data precluded a meaningful trend assessment for either (NMFS and USFWS 2007a). Seminoff (2004) likewise reviewed green sea turtle nesting data for 8 sites in the western, eastern, and central Atlantic, including all of the above with the exception that nesting in Florida was reviewed in place of Isla Trindade, Brazil. Seminoff (2004) concluded that all sites in the central and western Atlantic showed increased nesting, with the exception of nesting at Aves Island, Venezuela, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea turtle nesting in the Atlantic; however, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS 2007a). More information about site-specific trends for the other major ocean regions can be found in the most recent 5-year status review for the species (see NMFS and USFWS (2007a).

By far, the largest known nesting assemblage in the western Atlantic region occurs at Tortuguero, Costa Rica. According to monitoring data on nest counts, as well as documented emergences (both nesting and non-nesting events), there appears to be an increasing trend in this nesting assemblage since monitoring began in the early 1970s. For instance, from 1971-1975 there were approximately 41,250 average annual emergences documented and this number increased to an average of 72,200 emergences from 1992-1996 (Bjorndal et al. 1999). Troëng and Rankin (2005) collected nest counts from 1999-2003 and also reported increasing trends in the population consistent with the earlier studies, with nest count data suggesting 17,402-37,290 nesting females per year (NMFS and USFWS 2007a). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more resulted in an estimate of the Tortuguero, Costa Rica, population's growing at 4.9% annually.

In the continental United States, green sea turtle nesting occurs along the Atlantic coast, primarily along the central and southeast coast of Florida where an estimated 200-1,100 females nest each year (Meylan et al. 1994; Weishampel et al. 2003). Occasional nesting has also been documented along the Gulf Coast of Florida (Meylan et al. 1995). More recently, green sea turtle nesting has occurred in North Carolina on Bald Head Island, just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. In 2010, a total of 18 nests were found in North Carolina, 6 nests in South Carolina, and 6 nests in Georgia (nesting databases maintained on www.seaturtle.org).

In Florida, index beaches were established to standardize data collection methods and effort on key nesting beaches. Since establishment of the index beaches in 1989, the pattern of green sea turtle nesting has generally shown biennial peaks in abundance with a positive trend during the 10 years of regular monitoring (Figure 21). According to data collected from Florida's index nesting beach survey from 1989-2012, green sea turtle nest counts across Florida have increased approximately ten-fold from a low of 267 in the early 1990s to a high of 25,553 in 2013. Two consecutive years of nesting declines in 2008 and 2009 caused some concern, but this was followed by increases in both 2010 and 2011, a decrease in 2012, and another increase in 2013 (Figure 21). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%.

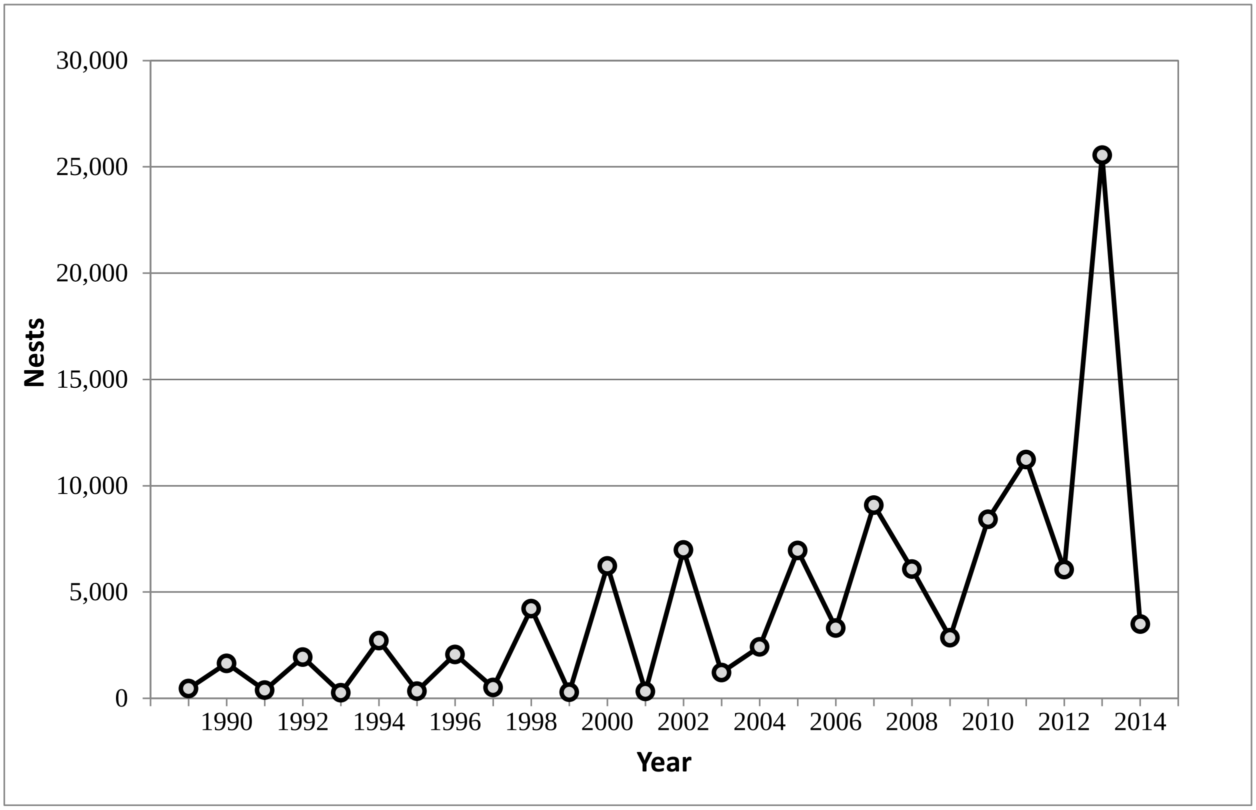


Figure 21. Green sea turtle nesting at Florida index beaches since 1989

Threats

The principal cause of past declines and extirpations of green sea turtle assemblages has been the overexploitation of the species for food and other products. Although intentional take of green sea turtles and their eggs is not extensive within the southeastern United States, green sea turtles that nest and forage in the region may spend large portions of their life history outside the region and outside U.S. jurisdiction, where exploitation is still a threat. Green sea turtles also face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (e.g., plastics, petroleum products, petrochemicals), ecosystem alterations (e.g., nesting beach development, beach nourishment and shoreline stabilization, vegetation changes), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 4.2.1.

In addition to general threats, green sea turtles are susceptible to natural mortality from Fibropapillomatosis (FP) disease. FP results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) of turtles (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). These tumors range in size from 0.04 in (0.1 cm) to greater than 11.81 in (30 cm) in diameter and may affect swimming, vision, feeding, and organ function (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). Presently, scientists are unsure of the exact mechanism causing this disease, though it is believed to be related to both an infectious agent, such as a virus (Herbst et al. 1995), and environmental conditions (e.g., habitat degradation, pollution, low wave energy, and shallow water (Foley et al. 2005). Presently, FP is cosmopolitan, but it has been found to affect large numbers of animals in specific areas, including Hawaii and Florida (Herbst 1994; Jacobson 1990; Jacobson et al. 1991).

Cold-stunning is another natural threat to green sea turtles. Although it is not considered a major source of mortality in most cases, as temperatures fall below 46.4°-50°F (8°-10°C) turtles may lose their ability to swim and dive, often floating to the surface. The rate of cooling that precipitates cold-stunning appears to be the primary threat, rather than the water temperature itself (Milton and Lutz 2003). Sea turtles that overwinter in inshore waters are most susceptible to cold-stunning because temperature changes are most rapid in shallow water (Witherington and Ehrhart 1989). During January 2010, an unusually large cold-stunning event in the southeastern United States resulted in around 4,600 sea turtles, mostly greens, found cold-stunned, with hundreds found dead or dying. A large cold-stunning event occurred in the western Gulf of Mexico in February 2011, resulting in approximately 1,650 green sea turtles found cold-stunned in Texas. Of these, approximately 620 were found dead or died after stranding, while approximately 1,030 turtles were rehabilitated and released. Additionally, during this same time frame, approximately 340 green sea turtles were found cold-stunned in Mexico, though approximately 300 of those were subsequently rehabilitated and released.

4.4 Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle was listed as endangered on December 2, 1970, under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Internationally, the Kemp's ridley is considered the most endangered sea turtle (Groombridge 1982; TEWG 2000; Zwinenberg 1977).

Species Description and Distribution

The Kemp's ridley sea turtle is the smallest of all sea turtles. Adults generally weigh less than 100 lb (45 kg) and have a carapace length of around 2.1 ft (65 cm). Adult Kemp's ridley shells are almost as wide as they are long. Coloration changes significantly during development from the grey-black dorsum and plastron of hatchlings, a grey-black dorsum with a yellowish-white plastron as post-pelagic juveniles, and then to the lighter grey-olive carapace and cream-white or yellowish plastron of adults. There are 2 pairs of prefrontal scales on the head, 5 vertebral scutes, usually 5 pairs of costal scutes, and generally 12 pairs of marginal scutes on the carapace. In each bridge adjoining the plastron to the carapace, there are 4 scutes, each of which is perforated by a pore.

Kemp's ridley habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 ft (37 m) deep, although they can also be found in deeper offshore waters. These areas support the primary prey species of the Kemp's ridley sea turtle, which consist of swimming crabs, but may also include fish, jellyfish, and an array of mollusks.

The primary range of Kemp's ridley sea turtles is within the Gulf of Mexico basin, though they also occur in coastal and offshore waters of the U.S. Atlantic Ocean. Juvenile Kemp's ridley sea turtles, possibly carried by oceanic currents, have been recorded as far north as Nova Scotia. Historic records indicate a nesting range from Mustang Island, Texas, in the north to Veracruz, Mexico, in the south. Kemp's ridley sea turtles have recently been nesting along the Atlantic Coast of the United States, with nests recorded from beaches in Florida, Georgia, and the Carolinas. In 2012, the first Kemp's ridley sea turtle nest was recorded in Virginia. The Kemp's ridley nesting population is exponentially increasing, which may indicate a similar increase in the population as a whole (NMFS et al. 2011).

Life History Information

Kemp's ridley sea turtles share a general life history pattern similar to other sea turtles. Females lay their eggs on coastal beaches where the eggs incubate in sandy nests. After 45-58 days of embryonic development, the hatchlings emerge and swim offshore into deeper, ocean water where they feed and grow until returning at a larger size. Hatchlings generally range from 1.65-1.89 in (42-48 mm) straight carapace length (SCL), 1.26-1.73 in (32-44 mm) in width, and 0.3-0.4 lb (15-20 g) in weight. Their return to nearshore coastal habitats typically occurs around 2 years of age (Ogren 1989), although the time spent in the oceanic zone may vary from 1-4 years or perhaps more (TEWG 2000). Juvenile Kemp's ridley sea turtles use these nearshore coastal habitats from April through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops.

The average rates of growth may vary by location, but generally fall within 2.2-2.9 ± 2.4 in per year (5.5-7.5 ± 6.2 cm/year) (Schmid and Barichivich 2005; Schmid and Woodhead 1997). Age to sexual maturity ranges greatly from 5-16 years, though NMFS et al. (2011) determined the best estimate of age to maturity for Kemp's ridley sea turtles was 12 years. It is unlikely that most adults grow very much after maturity. While some sea turtles nest annually, the weighted mean remigration rate for Kemp's ridley sea turtles is approximately 2 years. Nesting generally occurs from April to July and females lay approximately 2.5 nests per season with each nest containing approximately 100 eggs (Márquez M. 1994).

Population Dynamics

Of the 7 species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Most of the population of adult females nest on the beaches of Rancho Nuevo, Mexico (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 mid-1980s, however, nesting numbers from Rancho Nuevo and adjacent Mexican beaches were below 1,000, with a low of 702 nests in 1985. Yet, nesting steadily increased through the 1990s, and then accelerated during the first decade of the twenty-first century (Figure 22), which indicates the species is recovering. It is worth noting that when the Bi-National Kemp's Ridley Sea Turtle Population Restoration Project was initiated in 1978, only Rancho Nuevo nests were recorded. In 1988, nesting data from southern beaches at Playa Dos and Barra del Tordo were added. In 1989, data from the northern beaches of Barra Ostionales and Tepehuajes were added, and most recently in 1996, data from La Pesca and Altamira beaches were recorded. Currently, nesting at Rancho Nuevo accounts for just over 81% of all recorded Kemp's ridley nests in Mexico. Following a significant, unexplained 1-year decline in 2010, Kemp's ridley nests in Mexico reached a record high of 21,797 in 2012 (Gladys Porter Zoo nesting database 2013). In 2013 through 2014, there was a second significant decline, with only 16,385 and 11,279 nests recorded, respectively. A small nesting population is also emerging in the United States, primarily in Texas, rising from 6 nests in 1996 to 42 in 2004, to a record high of 209 nests in 2012 (National Park Service data, http://www.nps.gov/pais/naturescience/strp.htm, http://www.nps.gov/pais/naturescience/current-season.htm).

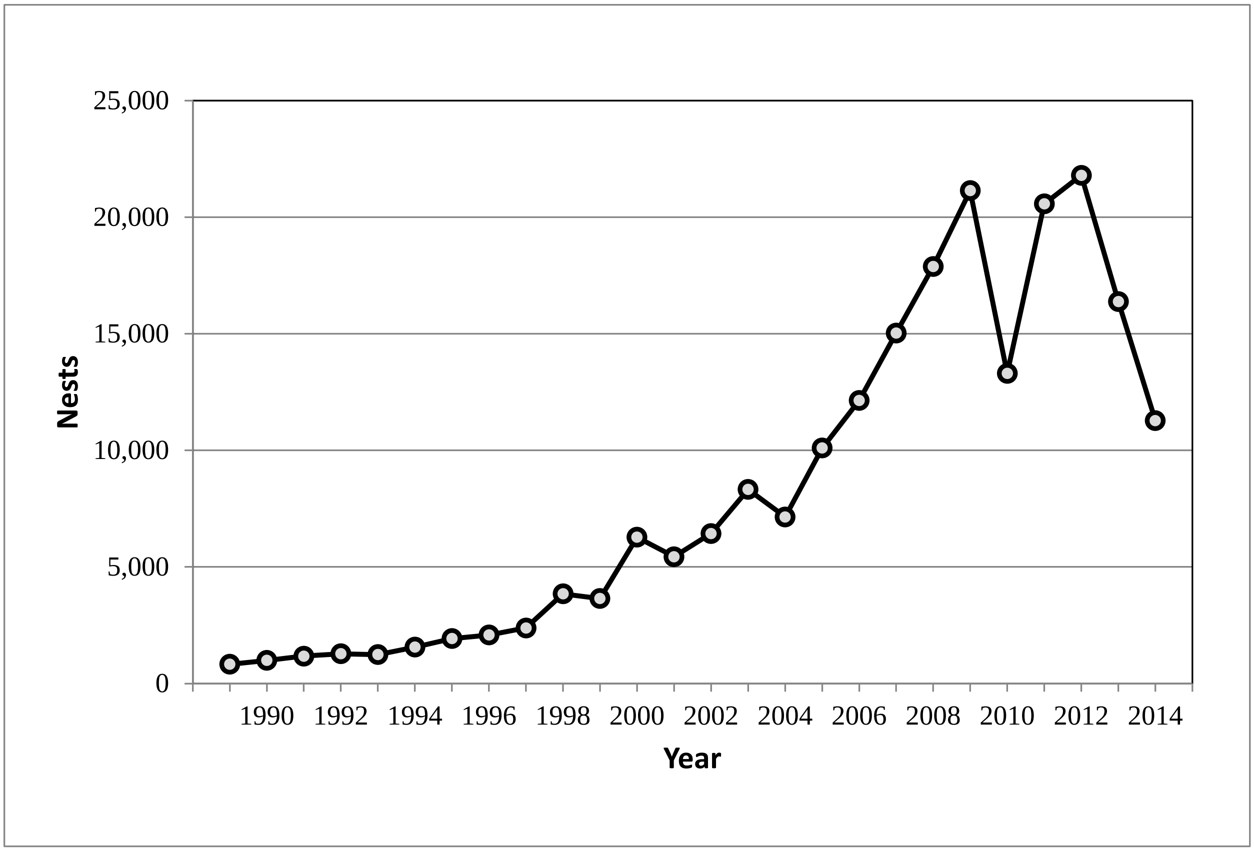


Figure 22. Kemp's ridley nest totals from Mexican beaches (Gladys Porter Zoo nesting database 2014)

Heppell et al. (2005) predicted in a population model that the population is expected to increase at least 12%-16% per year and that the population could attain at least 10,000 females nesting on Mexico beaches by 2015. NMFS et al. (2011) produced an updated model that predicted the population to increase 19% per year and attain at least 10,000 females nesting on Mexico beaches by 2011. Approximately 25,000 nests would be needed for an estimate of 10,000 nesters on the beach, based on an average 2.5 nests/nesting female. Although the Kemp's ridley nesting has seen decreases since 2012, the increases in Kemp's ridley sea turtle nesting seen in the last 2 decades is likely due to a combination of management measures including elimination of direct harvest, nest protection, the use of TEDs, reduced trawling effort in Mexico and the United States, and possibly other changes in vital rates (TEWG 1998; TEWG 2000). While these results are encouraging, the species limited range as well as low global abundance makes it particularly vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Additionally, the significant nesting declines observed in 2010 and 2013-2014 potentially indicate a serious population-level impact, and there is cause for concern regarding the ongoing recovery trajectory.

Threats
Kemp's ridley sea turtles face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 4.2.1; the remainder of this section will expand on a few of the aforementioned threats and how they may specifically impact Kemp's ridley sea turtles.

As Kemp's ridley sea turtles continue to recover and nesting arribadas[9] are increasingly established, bacterial and fungal pathogens in nests are also likely to increase. Bacterial and fungal pathogen impacts have been well documented in the large arribadas of the olive ridley at Nancite in Costa Rica (Mo 1988). In some years, and on some sections of the beach, the hatching success can be as low as 5% (Mo 1988). As the Kemp's ridley nest density at Rancho Nuevo and adjacent beaches continues to increase, appropriate monitoring of emergence success will be necessary to determine if there are any density-dependent effects.

Over the past 3 years, NMFS has documented (via the Sea Turtle Stranding and Salvage Network data, http://www.sefsc.noaa.gov/species/turtles/strandings.htm) elevated sea turtle strandings in the Northern Gulf of Mexico, particularly throughout the Mississippi Sound area. In the first 3 weeks of June 2010, over 120 sea turtle strandings were reported from Mississippi and Alabama waters, none of which exhibited any signs of external oiling to indicate effects associated with the DWH oil spill event. A total of 644 sea turtle strandings were reported in 2010 from Louisiana, Mississippi, and Alabama waters, 561 (87%) of which were Kemp's ridley sea turtles. During March through May of 2011, 267 sea turtle strandings were reported from Mississippi and Alabama waters alone. A total of 525 sea turtle strandings were reported in 2011 from Louisiana, Mississippi, and Alabama waters, with the majority (455) occurring from March through July, 390 (86%) of which were Kemp's ridley sea turtles. During 2012, a total of 428 sea turtles were reported from Louisiana, Mississippi, and Alabama waters, though the data is incomplete. Of these reported strandings, 301 (70%) were Kemp's ridley sea turtles. These stranding numbers are significantly greater than reported in past years; Louisiana, Mississippi, and Alabama waters reported 42 and 73 sea turtle strandings for 2008 and 2009, respectively. It should be noted that stranding coverage has increased considerably due to the DWH oil spill event.

Nonetheless, considering that strandings typically represent only a small fraction of actual mortality, these stranding events potentially represent a serious impact to the recovery and survival of the local sea turtle populations. While a definitive cause for these strandings has not been identified, necropsy results indicate a significant number of stranded turtles from these events likely perished due to forced submergence, which is commonly associated with fishery interactions (B. Stacy, NMFS, pers. comm. to M. Barnette, NMFS, March 2012). Yet, available information indicates fishery effort was extremely limited during the stranding events. The fact

[9] Arribada is the Spanish word for "arrival" and is the term used for massive synchronized nesting within the genus *Lepidochelys*.

that in both 2010 and 2011 approximately 85% of all Louisiana, Mississippi, and Alabama stranded sea turtles were Kemp's ridleys is notable; however, this could simply be a function of the species' preference for shallow, inshore waters coupled with increased population abundance as reflected in recent Kemp's ridley nesting increases.

In response to these strandings, and due to speculation that fishery interactions may be the cause, fishery observer effort was shifted to evaluate the inshore skimmer trawl fishery during the summer of 2012. During May-July of that year, observers reported 24 sea turtle interactions in the skimmer trawl fishery, all but one of which were identified as Kemp's ridleys (1 sea turtle was an unidentified hardshell turtle). Encountered sea turtles were all very small, juvenile specimens ranging from 7.6-19.0 in (19.4-48.3 cm) curved carapace length (CCL), and all sea turtles were released alive. The small average size of encountered Kemp's ridleys introduces a potential conservation issue, as over 50% of these reported sea turtles could potentially pass through the maximum 4-inch bar spacing of TEDs currently required in the shrimp fishery. Due to this issue, a proposed 2012 rule to require TEDs in the skimmer trawl fishery (77 FR 27411) was not implemented. Based on anecdotal information, these interactions were a relatively new issue for the inshore skimmer trawl fishery. Given the nesting trends and habitat utilization of Kemp's ridley sea turtles, it is likely that fishery interactions in the Northern Gulf of Mexico may continue to be an issue of concern for the species, and one that may potentially slow the rate of recovery for Kemp's ridley sea turtles.

4.5 Leatherback Sea Turtle

The leatherback sea turtle was listed as endangered throughout its entire range on June 2, 1970, (35 FR 8491) under the Endangered Species Conservation Act of 1969.

Species Description and Distribution

The leatherback is the largest sea turtle in the world, with a CCL often exceeding 5 ft (150 cm) and front flippers that can span almost 9 ft (270 cm) (NMFS and USFWS 1998). Mature males and females can reach lengths of over 6 ft (2 m) and weigh close to 2,000 lb (900 kg). The leatherback does not have a bony shell. Instead, its shell is approximately 1.5 in (4 cm) thick and consists of a leathery, oil-saturated connective tissue overlaying loosely interlocking dermal bones. The ridged shell and large flippers help the leatherback during its long-distance trips in search of food.

Unlike other sea turtles, leatherbacks have several unique traits that enable them to live in cold water. For example, leatherbacks have a countercurrent circulatory system (Greer et al. 1973),[10] a thick layer of insulating fat (Davenport et al. 1990; Goff and Lien 1988), gigantothermy (Paladino et al. 1990),[11] and they can increase their body temperature through increased metabolic activity (Bostrom and Jones 2007; Southwood et al. 2005). These adaptations allow leatherbacks to be comfortable in a wide range of temperatures, which helps them to travel

[10] Countercurrent circulation is a highly efficient means of minimizing heat loss through the skin's surface because heat is recycled. For example, a countercurrent circulation system often has an artery containing warm blood from the heart surrounded by a bundle of veins containing cool blood from the body's surface. As the warm blood flows away from the heart, it passes much of its heat to the colder blood returning to the heart via the veins. This conserves heat by recirculating it back to the body's core.

[11] "Gigantothermy" refers to a condition when an animal has relatively high volume compared to its surface area, and as a result, it loses less heat.

further than any other sea turtle species (NMFS and USFWS 1995). For example, a leatherback may swim more than 6,000 miles (10,000 km) in a single year (Benson et al. 2007a; Benson et al. 2011; Eckert 2006; Eckert et al. 2006). They search for food between latitudes 71°N and 47°S, in all oceans, and travel extensively to and from their tropical nesting beaches. In the Atlantic Ocean, leatherbacks have been recorded as far north as Newfoundland, Canada, and Norway, and as far south as Uruguay, Argentina, and South Africa (NMFS 2001).

While leatherbacks will look for food in coastal waters, they appear to prefer the open ocean at all life stages (Heppell et al. 2003b). Leatherbacks have pointed tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied prey such as jellyfish and salps. A leatherback's mouth and throat also have backward-pointing spines that help retain jelly-like prey. Leatherbacks' favorite prey (e.g., medusae, siphonophores, and salps) occur commonly in temperate and northern or sub-arctic latitudes and likely has a strong influence on leatherback distribution in these areas (Plotkin 2003). Leatherbacks are known to be deep divers, with recorded depths in excess of a half-mile (Eckert 1989), but they may also come into shallow waters to locate prey items.

Genetic analyses using microsatellite markers along with mitochondrial DNA and tagging data indicate there are 7 groups or breeding populations in the Atlantic Ocean: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guianas, West Africa, South Africa, and Brazil (TEWG 2007). General differences in migration patterns and foraging grounds may occur between the 7 nesting assemblages, although data to support this is limited in most cases.

Life History Information

The leatherback life cycle is broken into several stages: (1) egg/hatchling, (2) post-hatchling, (3) juvenile, (4) subadult, and (5) adult. Leatherbacks are a long-lived species that delay age of maturity, have low and variable survival in the egg and juvenile stages, and have relatively high and constant annual survival in the subadult and adult life stages (Chaloupka 2002; Crouse 1999; Heppell et al. 1999; Heppell et al. 2003b; Spotila et al. 1996; Spotila et al. 2000). While a robust estimate of the leatherback sea turtle's life span does not exist, the current best estimate for the maximum age is 43 (Avens et al. 2009). It is still unclear when leatherbacks first become sexually mature. Using skeletochronological data, Avens et al. (2009) estimated that leatherbacks in the western North Atlantic may not reach maturity until 29 years of age, which is longer than earlier estimates of 2-3 years by Pritchard and Trebbau (1984); of 3-6 years by Rhodin (1985); of 13-14 years for females by Zug and Parham (1996); and 12-14 years for leatherbacks nesting in the U.S. Virgin Islands by Dutton et al. (2005). A more recent study that examined leatherback growth rates estimated an age at maturity of 16.1 years (Jones et al. 2011).

The average size of reproductively active females in the Atlantic is generally 5-5.5 ft (150-162 cm) CCL (Benson et al. 2007a; Hirth et al. 1993; Starbird and Suarez 1994). Still, females as small as 3.5-4 ft (105-125 cm) CCL have been observed nesting at various sites (Stewart et al. 2007).

Female leatherbacks typically nest on sandy, tropical beaches at intervals of 2-4 years (Garcia M. and Sarti 2000; McDonald and Dutton 1996; Spotila et al. 2000). Unlike other sea turtle species, female leatherbacks do not always nest at the same beach year after year; some females may even nest at different beaches during the same year (Dutton et al. 2005; Eckert 1989; Keinath and Musick 1993; Steyermark et al. 1996). Individual female leatherbacks have been observed with fertility spans as long as 25 years (Hughes 1996). Females usually lay up to 10 nests during the 3-6 month nesting season (March through July in the United States), typically 8-12 days apart, with 100 eggs or more per nest (Eckert et al. 2012; Eckert 1989; Maharaj 2004; Matos 1986; Stewart and Johnson 2006; Tucker 1988). Yet, up to approximately 30% of the eggs may be infertile (Eckert 1989; Kobari and Ikeda 1999; Maharaj 2004; Matos 1986; Stewart and Johnson 2006; Tucker 1988). The number of leatherback hatchlings that make it out of the nest on to the beach (i.e., emergent success) is approximately 50% worldwide (Eckert et al. 2012), which is lower than the greater than 80% reported for other sea turtle species (Miller 1997). In the United States, the emergent success is higher at 54%-72% (Eckert and Eckert 1990; Stewart and Johnson 2006; Tucker 1988). Thus the number of hatchlings in a given year may be less than the total number of eggs produced in a season. Eggs hatch after 60-65 days, and the hatchlings have white striping along the ridges of their backs and on the edges of the flippers. Leatherback hatchlings weigh approximately 1.5-2 ounces (40-50 g), and are approximately 2-3 in (51-76 mm) in length, with fore flippers as long as their bodies. Hatchlings grow rapidly with reported growth rates for leatherbacks from 2.5-27.6 in (6-70 cm) in length, estimated at 12.6 in (32 cm) per year (Jones et al. 2011).

In the Atlantic, the sex ratio appears to be skewed toward females. The Turtle Expert Working Group (TEWG) reports that nearshore and onshore strandings data from the U.S. Atlantic and Gulf of Mexico coasts indicate that 60% of strandings were females (TEWG 2007). Those data also show that the proportion of females among adults (57%) and juveniles (61%) was also skewed toward females in these areas (TEWG 2007). James et al. (2007) collected size and sex data from large subadult and adult leatherbacks off Nova Scotia and also concluded a bias toward females at a rate of 1.86:1.

The survival and mortality rates for leatherbacks are difficult to estimate and vary by location. For example, the annual mortality rate for leatherbacks that nested at Playa Grande, Costa Rica, was estimated to be 34.6% in 1993-1994 and 34.0% in 1994-1995 (Spotila et al. 2000). In contrast, leatherbacks nesting in French Guiana and St. Croix had estimated annual survival rates of 91% (Rivalan et al. 2005) and 89% (Dutton et al. 2005), respectively. For the St. Croix population, the average annual juvenile survival rate was estimated to be approximately 63% and the total survival rate from hatchling to first year of reproduction for a female was estimated to be between 0.4% and 2% (assuming age at first reproduction is between 9-13 years. Spotila et al. (1996) estimated first-year survival rates for leatherbacks at 6.25%.

Migratory routes of leatherbacks are not entirely known; however, recent information from satellite tags have documented long travels between nesting beaches and foraging areas in the Atlantic and Pacific Ocean basins (Benson et al. 2007a; Benson et al. 2011; Eckert 2006; Eckert et al. 2006; Ferraroli et al. 2004; Hays et al. 2004; James et al. 2005). Leatherbacks nesting in Central America and Mexico travel thousands of miles through tropical and temperate waters of the South Pacific (Eckert and Sarti 1997; Shillinger et al. 2008). Data from satellite tagged leatherbacks suggest that they may be traveling in search of seasonal aggregations of jellyfish (Benson et al. 2007d; Bowlby et al. 1994; Graham 2009; Shenker 1984; Starbird et al. 1993; Suchman and Brodeur 2005).

Status and Population Dynamics
The status of the Atlantic leatherback population has been less clear than the Pacific population, which has shown dramatic declines at many nesting sites (Santidrián Tomillo et al. 2007; Sarti Martínez et al. 2007; Spotila et al. 2000). This uncertainty has been a result of inconsistent beach and aerial surveys, cycles of erosion, and reformation of nesting beaches in the Guianas (representing the largest nesting area). Leatherbacks also show a lesser degree of nest-site fidelity than occurs with the hardshell sea turtle species. Coordinated efforts of data collection and analyses by the leatherback Turtle Expert Working Group have helped to clarify the understanding of the Atlantic population status (TEWG 2007).

The Southern Caribbean/Guianas stock is the largest known Atlantic leatherback nesting aggregation (TEWG 2007). This area includes the Guianas (Guyana, Suriname, and French Guiana), Trinidad, Dominica, and Venezuela, with most of the nesting occurring in the Guianas and Trinidad. The Southern Caribbean/Guianas stock of leatherbacks was designated after genetics studies indicated that animals from the Guianas (and possibly Trinidad) should be viewed as a single population. Using nesting females as a proxy for population, the TEWG (2007) determined that the Southern Caribbean/Guianas stock had demonstrated a long-term, positive population growth rate. TEWG observed positive growth within major nesting areas for the stock, including Trinidad, Guyana, and the combined beaches of Suriname and French Guiana (TEWG 2007). More specifically, (Wallace et al. 2013) report an estimated three-generation abundance change of +3%, +20,800%, +1,778%, and +6% in Trinidad, Guyana, Suriname, and French Guiana, respectively.

Researchers believe the cyclical pattern of beach erosion and then reformation has affected leatherback nesting patterns in the Guianas. For example, between 1979 and 1986, the number of leatherback nests in French Guiana had increased by about 15% annually (NMFS 2001). This increase was then followed by a nesting decline of about 15% annually. This decline corresponded with the erosion of beaches in French Guiana and increased nesting in Suriname. This pattern suggests that the declines observed since 1987 might actually be a part of a nesting cycle that coincides with cyclic beach erosion in Guiana (Schulz 1975). Researchers think that the cycle of erosion and reformation of beaches may have changed where leatherbacks nest throughout this region. The idea of shifting nesting beach locations was supported by increased nesting in Suriname,[12] while the number of nests was declining at beaches in Guiana (Hilterman et al. 2003). Though this information suggested the long-term trend for the overall Suriname and French Guiana population was increasing.

The Western Caribbean stock includes nesting beaches from Honduras to Colombia. Across the Western Caribbean, nesting is most prevalent in Costa Rica, Panama, and the Gulf of Uraba in Colombia (Duque et al. 2000). The Caribbean coastline of Costa Rica and extending through Chiriquí Beach, Panama, represents the fourth largest known leatherback rookery in the world (Troëng et al. 2004). Examination of data from index nesting beaches in Tortuguero, Gandoca, and Pacuaré in Costa Rica indicate that the nesting population likely was not growing over the 1995-2005 time series (TEWG 2007). Other modeling of the nesting data for Tortuguero

[12] Leatherback nesting in Suriname increased by more than 10,000 nests per year since 1999, with a peak of 30,000 nests in 2001.

indicates a possible 67.8% decline between 1995 and 2006 (Troëng et al. 2007). Wallace et al. (2013) report an estimated three-generation abundance change of -72%, -24%, and +6% for Tortuguero, Gandoca, and Pacuare, respectively.

Nesting data for the Northern Caribbean stock is available from Puerto Rico, St. Croix (U.S. Virgin Islands), and the British Virgin Islands (Tortola). In Puerto Rico, the primary nesting beaches are at Fajardo and on the island of Culebra. Nesting between 1978 and 2005 has ranged between 469-882 nests, and the population has been growing since 1978, with an overall annual growth rate of 1.1% (TEWG 2007). (Wallace et al. 2013) report an estimated three-generation abundance change of -4% and +5,583% at Culebra and Fajardo, respectively. At the primary nesting beach on St. Croix, the Sandy Point National Wildlife Refuge, nesting has varied from a few hundred nests to a high of 1,008 in 2001, and the average annual growth rate has been approximately 1.1% from 1986-2004 (TEWG 2007). From 2006-2010, Wallace et al. (2013) report an annual growth rate of +7.5% in St. Croix and a three-generation abundance change of +1,058%. Nesting in Tortola is limited, but has been increasing from 0-6 nests per year in the late 1980s to 35-65 per year in the 2000s, with an annual growth rate of approximately 1.2% between 1994 and 2004 (TEWG 2007).

The Florida nesting stock nests primarily along the east coast of Florida. This stock is of growing importance, with total nests between 800-900 per year in the 2000s following nesting totals fewer than 100 nests per year in the 1980s (Florida Fish and Wildlife Conservation Commission, unpublished data). Using data from the index nesting beach surveys, the TEWG (TEWG 2007) estimated a significant annual nesting growth rate of 1.17% between 1989 and 2005. FWC Index Nesting Beach Survey Data indicates biennial peaks in nesting abundance beginning in 2007 (Figure 23 and Table 7). A similar pattern was also observed statewide (Table 6). This up-and-down pattern is thought to be a result of the cyclical nature of leatherback nesting, similar to the biennial cycle of green turtle nesting. Overall, the trend shows growth on Florida's east coast beaches. (Wallace et al. 2013) report an annual growth rate of 9.7% and a three-generation abundance change of +1,863%.

Table 7. Number of Leatherback Sea Turtle Nests in Florida

Nests Recorded	2007	2008	2009	2010	2011
Index Nesting Beaches	517	265	615	552	625
Statewide	1,442	728	1,747	1,334	1,652

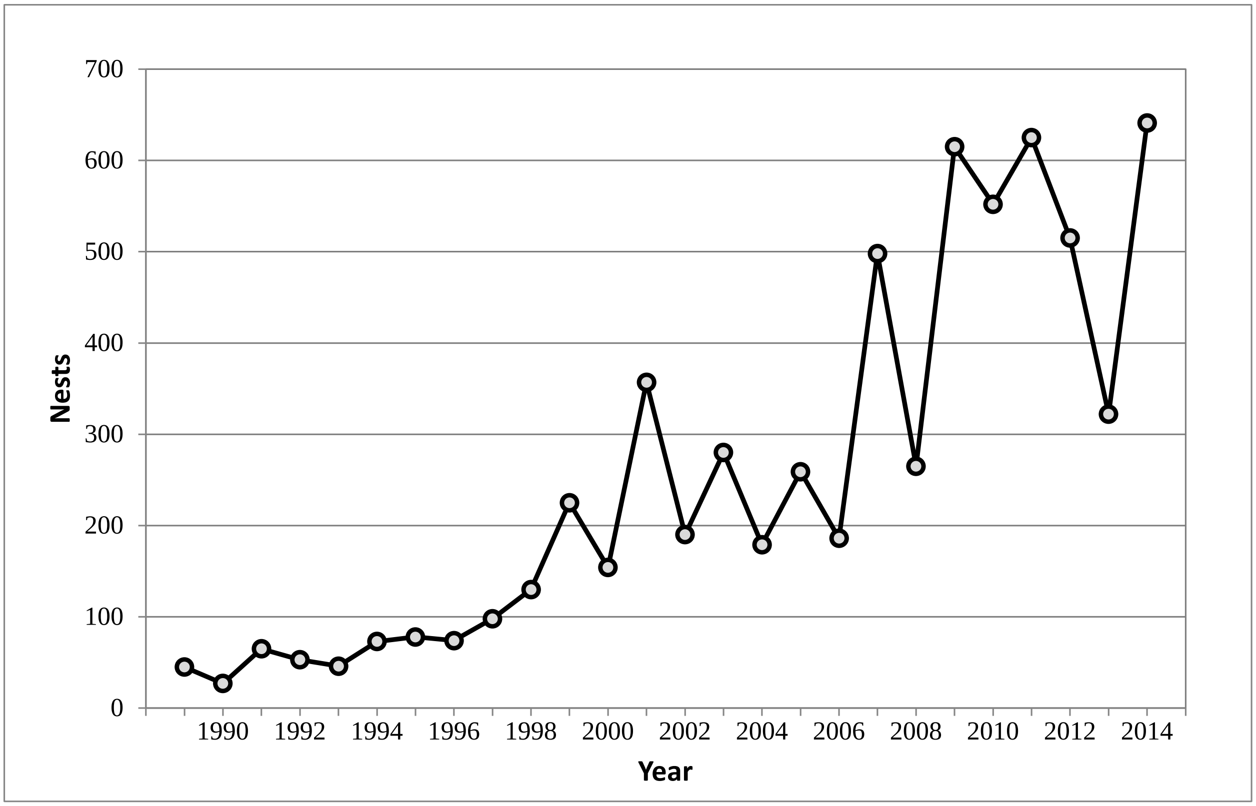


Figure 23. Leatherback sea turtle nesting at Florida index beaches since 1989

The West African nesting stock of leatherbacks is large and important, but it is a mostly unstudied aggregation. Nesting occurs in various countries along Africa's Atlantic coast, but much of the nesting is undocumented and the data are inconsistent. Gabon has a very large amount of leatherback nesting, with at least 30,000 nests laid along its coast in a single season (Fretey et al. 2007). Fretey et al. (2007) provide detailed information about other known nesting beaches and survey efforts along the Atlantic African coast. Because of the lack of consistent effort and minimal available data, trend analyses were not possible for this stock (TEWG 2007).

Two other small but growing stocks nest on the beaches of Brazil and South Africa. Based on the data available, TEWG (2007) determined that between 1988 and 2003, there was a positive annual average growth rate between 1.07 and 1.08% for the Brazilian stock. TEWG (2007) estimated an annual average growth rate between 1.04 and 1.06% for the South African stock.

Because the available nesting information is inconsistent, it is difficult to estimate the total population size for Atlantic leatherbacks. Spotila et al. (1996) characterized the entire Western Atlantic population as stable at best and estimated a population of 18,800 nesting females. Spotila et al. (1996) further estimated that the adult female leatherback population for the entire Atlantic basin, including all nesting beaches in the Americas, the Caribbean, and West Africa, was about 27,600 (considering both nesting and inter- nesting females), with an estimated range of 20,082-35,133. This is consistent with the estimate of 34,000-95,000 total adults (20,000-56,000 adult females; 10,000-21,000 nesting females) determined by the TEWG (2007). The TEWG (2007) also determined that at of the time of their publication, leatherback sea turtle populations in the Atlantic were all stable or increasing with the exception of the Western Caribbean and West Africa populations. The latest review by NMFS USFWS (2013) suggests the leatherback nesting population is stable in most nesting regions of the Atlantic Ocean.

Threats

Leatherbacks face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 4.2.1; the remainder of this section will expand on a few of the aforementioned threats and how they may specifically impact leatherback sea turtles.

Of all sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear, especially gillnet and pot/trap lines. This may be because of their body type (large size, long pectoral flippers, and lack of a hard shell), their attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, their method of locomotion, and/or perhaps their attraction to the light sticks used to attract target species in longline fisheries. From 1990-2000, 92 entangled leatherbacks were reported from New York through Maine and many other stranded individuals exhibited evidence of prior entanglement (Dwyer et al. 2003). Zug and Parham (1996) point out that a combination of the loss of long-lived adults in fishery-related mortalities and a lack of recruitment from intense egg harvesting in some areas has caused a sharp decline in leatherback sea turtle populations and represents a significant threat to survival and recovery of the species worldwide.

Leatherback sea turtles may also be more susceptible to marine debris ingestion than other sea turtle species due to their predominantly pelagic existence and the tendency of floating debris to concentrate in convergence zones that adults and juveniles use for feeding and migratory purposes (Lutcavage et al. 1997; Shoop and Kenney 1992). The stomach contents of leatherback sea turtles revealed that a substantial percentage (33.8% or 138 of 408 cases examined) contained some form of plastic debris (Mrosovsky et al. 2009). Blocking of the gut by plastic to an extent that could have caused death was evident in 8.7% of all leatherbacks that ingested plastic (Mrosovsky et al. 2009). Mrosovsky et al. (2009) also note that in a number of cases, the ingestion of plastic may not cause death outright, but could cause the animal to absorb fewer nutrients from food, eat less in general, etc. – factors which could cause other adverse effects. The presence of plastic in the digestive tract suggests that leatherbacks might not be able to distinguish between prey items and forms of debris such a plastic bags (Mrosovsky et al. 2009). Balazs (1985) speculated that the plastic object might resemble a food item by its shape, color, size, or even movement as it drifts about, and therefore induce a feeding response in leatherbacks.

As discussed in Section 4.2.1, global climate change can be expected to have various impacts on all sea turtles, including leatherbacks. Global climate change is likely to also influence the distribution and abundance of jellyfish, the primary prey item of leatherbacks (NMFS and USFWS 2007r). Several studies have shown leatherback distribution is influenced by jellyfish abundance (e.g., (Houghton et al. 2006; Witt et al. 2007; Witt et al. 2006); however, more studies need to be done to monitor how changes to prey items affect distribution and foraging success of leatherbacks so population-level effects can be determined.

4.6 Loggerhead Sea Turtle – Northwest Atlantic DPS

The loggerhead sea turtle was listed as a threatened species throughout its global range on July 28, 1978. NMFS and USFWS published a final rule designating 9 DPSs for loggerhead sea turtles (76 FR 58868, September 22, 2011, and effective October 24, 2011). This rule established several DPSs: (1) Northwest Atlantic Ocean (threatened), (2) Northeast Atlantic Ocean (endangered), (3) South Atlantic Ocean (threatened), (4) Mediterranean Sea (endangered), (5) North Pacific Ocean (endangered), (6) South Pacific Ocean (endangered), (7) North Indian Ocean (endangered), (8) Southeast Indo-Pacific Ocean (endangered), and (9) Southwest Indian Ocean (threatened). The Northwest Atlantic (NWA) DPS is the only one that occurs within the action area and therefore is the only one considered in this Opinion.

Species Description and Distribution

Loggerheads are large sea turtles. Adults in the southeast United States average about 3 ft (92 cm) long, measured as a straight carapace length (SCL), and weigh approximately 255 lb (116 kg) (Ehrhart and Yoder 1976). Adult and subadult loggerhead sea turtles typically have a light yellow plastron and a reddish brown carapace covered by non-overlapping scutes that meet along seam lines. They typically have 11 or 12 pairs of marginal scutes, 5 pairs of costals, 5 vertebrals, and a nuchal (precentral) scute that is in contact with the first pair of costal scutes (Dodd Jr. 1988).

The loggerhead sea turtle inhabits continental shelf and estuarine environments throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd Jr. 1988). Habitat uses within these areas vary by life stage. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd Jr. 1988). Subadult and adult loggerheads are primarily found in coastal waters and eat benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

The majority of loggerhead nesting occurs at the western rims of the Atlantic and Indian Oceans concentrated in the north and south temperate zones and subtropics (NRC 1990a). For the NWA DPS most nesting occurs along the coast of the United States, from southern Virginia to Alabama. Additional nesting beaches for this DPS are found along the northern and western Gulf of Mexico, eastern Yucatán Peninsula, at Cay Sal Bank in the eastern Bahamas (Addison 1997), off the southwestern coast of Cuba (Moncada Gavilan 2001), and along the coasts of Central America, Colombia, Venezuela, and the eastern Caribbean Islands.

Non-nesting, adult female loggerheads are reported throughout the U.S. Atlantic, Gulf of Mexico, and Caribbean Sea. Little is known about the distribution of adult males who are seasonally abundant near nesting beaches. Aerial surveys suggest that loggerheads as a whole are distributed in U.S. waters as follows: 54% off the southeast U.S. coast, 29% off the northeast U.S. coast, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Within the NWA DPS, most loggerhead sea turtles nest from North Carolina to Florida and along the Gulf Coast of Florida. Previous Section 7 analyses have recognized at least 5 western

Atlantic subpopulations, divided geographically as follows: (1) a Northern nesting subpopulation, occurring from North Carolina to northeast Florida at about 29ºN; (2) a South Florida nesting subpopulation, occurring from 29°N on the east coast of the state to Sarasota on the west coast; (3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez M. 1990; TEWG 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (NMFS 2001).

The recovery plan for the Northwest Atlantic population of loggerhead sea turtles concluded that there is no genetic distinction between loggerheads nesting on adjacent beaches along the Florida Peninsula. It also concluded that specific boundaries for subpopulations could not be designated based on genetic differences alone. Thus, the recovery plan uses a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to identify recovery units. The recovery units are as follows: (1) the Northern Recovery Unit (Florida/Georgia border north through southern Virginia), (2) the Peninsular Florida Recovery Unit (Florida/Georgia border through Pinellas County, Florida), (3) the Dry Tortugas Recovery Unit (islands located west of Key West, Florida), (4) the Northern Gulf of Mexico Recovery Unit (Franklin County, Florida, through Texas), and (5) the Greater Caribbean Recovery Unit (Mexico through French Guiana, the Bahamas, Lesser Antilles, and Greater Antilles) (NMFS and USFWS 2008b). The recovery plan concluded that all recovery units are essential to the recovery of the species. Although the recovery plan was written prior to the listing of the NWA DPS, the recovery units for what was then termed the Northwest Atlantic population apply to the NWA DPS.

Life History Information

The Northwest Atlantic Loggerhead Recovery Team defined the following 8 life stages for the loggerhead life cycle, which include the ecosystems those stages generally use: (1) egg (terrestrial zone), (2) hatchling stage (terrestrial zone), (3) hatchling swim frenzy and transitional stage (neritic zone[13]), (4) juvenile stage (oceanic zone), (5) juvenile stage (neritic zone), (6) adult stage (oceanic zone), (7) adult stage (neritic zone), and (8) nesting female (terrestrial zone) (NMFS and USFWS 2008b). Loggerheads are long-lived animals. They reach sexual maturity between 20-38 years of age, although age of maturity varies widely among populations (Frazer and Ehrhart 1985; NMFS 2001). The annual mating season occurs from late March to early June, and female turtles lay eggs throughout the summer months. Females deposit an average of 4.1 nests within a nesting season (Murphy and Hopkins 1984), but an individual female only nests every 3.7 years on average (Tucker 2010). Each nest contains an average of 100-126 eggs (Dodd Jr. 1988) which incubate for 42-75 days before hatching (NMFS and USFWS 2008b). Loggerhead hatchlings are 1.5-2 in long and weigh about 0.7 ounces (20 grams).

As post-hatchlings, loggerheads hatched on U.S. beaches enter the “oceanic juvenile” life stage, migrating offshore and becoming associated with *Sargassum* habitats, driftlines, and other convergence zones (Carr 1986; Conant et al. 2009; Witherington 2002). Oceanic juveniles grow at rates of 1-2 in (2.9-5.4 cm) per year (Bjorndal et al. 2003; Snover 2002) over a period as long as 7-12 years (Bolten et al. 1998) before moving to more coastal habitats. Studies have

[13] Neritic refers to the nearshore marine environment from the surface to the sea floor where water depths do not exceed 200 meters.

suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic juveniles, followed by permanent settlement into benthic environments (Bolten and Witherington 2003; Laurent et al. 1998). These studies suggest some turtles may either remain in the oceanic habitat in the North Atlantic longer than hypothesized, or they move back and forth between oceanic and coastal habitats interchangeably (Witzell 2002). Stranding records indicate that when immature loggerheads reach 15-24 in (40-60 cm) SCL, they begin to reside in coastal inshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico (Witzell 2002).

After departing the oceanic zone, neritic juvenile loggerheads in the Northwest Atlantic inhabit continental shelf waters from Cape Cod Bay, Massachusetts, south through Florida, The Bahamas, Cuba, and the Gulf of Mexico. Estuarine waters of the United States, including areas such as Long Island Sound, Chesapeake Bay, Pamlico and Core Sounds, Mosquito and Indian River Lagoons, Biscayne Bay, Florida Bay, and numerous embayments fringing the Gulf of Mexico, comprise important inshore habitat. Along the Atlantic and Gulf of Mexico shoreline, essentially all shelf waters are inhabited by loggerheads (Conant et al. 2009).

Like juveniles, non-nesting adult loggerheads also use the neritic zone. However, these adult loggerheads do not use the relatively enclosed shallow-water estuarine habitats with limited ocean access as frequently as juveniles. Areas such as Pamlico Sound, North Carolina, and the Indian River Lagoon, Florida, are regularly used by juveniles but not by adult loggerheads. Adult loggerheads do tend to use estuarine areas with more open ocean access, such as the Chesapeake Bay in the U.S. mid-Atlantic. Shallow-water habitats with large expanses of open ocean access, such as Florida Bay, provide year-round resident foraging areas for significant numbers of male and female adult loggerheads (Conant et al. 2009).

Offshore, adults primarily inhabit continental shelf waters, from New York south through Florida, The Bahamas, Cuba, and the Gulf of Mexico. Seasonal use of mid-Atlantic shelf waters, especially offshore New Jersey, Delaware, and Virginia during summer months, and offshore shelf waters, such as Onslow Bay (off the North Carolina coast), during winter months has also been documented (Hawkes et al. 2007c) Georgia Department of Natural Resources, unpublished data; South Carolina Department of Natural Resources, unpublished data). Satellite telemetry has identified the shelf waters along the west Florida coast, The Bahamas, Cuba, and the Yucatán Peninsula as important resident areas for adult female loggerheads that nest in Florida (Foley et al. 2008; Girard et al. 2009; Hart et al. 2012). The southern edge of the Grand Bahama Bank is important habitat for loggerheads nesting on the Cay Sal Bank in The Bahamas, but nesting females are also resident in the bights of Eleuthera, Long Island, and Ragged Islands. They also reside in Florida Bay in the United States, and the north coast of Cuba (A. Bolten and K. Bjorndal, University of Florida, unpublished data). Moncada et al. (2010) report the recapture in Cuban waters of 5 adult female loggerheads originally flipper-tagged in Quintana Roo, Mexico, indicating that Cuban shelf waters likely also provide foraging habitat for adult females that nest in Mexico.

Status and Population Dynamics

A number of stock assessments and similar reviews (Conant et al. 2009; Heppell et al. 2003a; NMFS-SEFSC 2009b; NMFS 2001; NMFS and USFWS 2008b; TEWG 1998; TEWG 2000;

TEWG 2009) have examined the stock status of loggerheads in the Atlantic Ocean, but none have been able to develop a reliable estimate of absolute population size.

Numbers of nests and nesting females can vary widely from year to year. Nesting beach surveys, though, can provide a reliable assessment of trends in the adult female population, due to the strong nest site fidelity of female loggerhead sea turtles, as long as such studies are sufficiently long and survey effort and methods are standardized (e.g., (NMFS and USFWS 2008b). NMFS and USFWS (2008b) concluded that the lack of change in 2 important demographic parameters of loggerheads, remigration interval and clutch frequency, indicate that time series on numbers of nests can provide reliable information on trends in the female population.

Peninsular Florida Recovery Unit

The Peninsular Florida Recovery Unit (PFRU) is the largest loggerhead nesting assemblage in the Northwest Atlantic. A near-complete nest census (all beaches including index nesting beaches) undertaken from 1989-2007 showed an average of 64,513 loggerhead nests per year, representing approximately 15,735 nesting females per year (NMFS and USFWS 2008b). The statewide estimated total for 2013 was 77,975 nests (FWRI nesting database).

In addition to the total nest count estimates, the Florida Fish and Wildlife Research Institute (FWRI) uses an index nesting beach survey method. The index survey uses standardized data-collection criteria to measure seasonal nesting and allow accurate comparisons between beaches and between years. This provides a better tool for understanding the nesting trends (Figure 24). FWRI performed a detailed analysis of the long-term loggerhead index nesting data (1989-2013) (http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/). Over that time period, 3 distinct trends were identified. From 1989-1998 there was a 30% increase that was then followed by a sharp decline over the subsequent decade. Large increases in loggerhead nesting occurred since then. FWRI examined the trend from the 1998 nesting high through 2013 and found the decade-long post-1998 decline had reversed and there was no longer a demonstrable trend. Looking at the data from 1989 through 2014 (an increase of over 32%), FWRI concluded that there was an overall positive change in the nest counts (http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/).

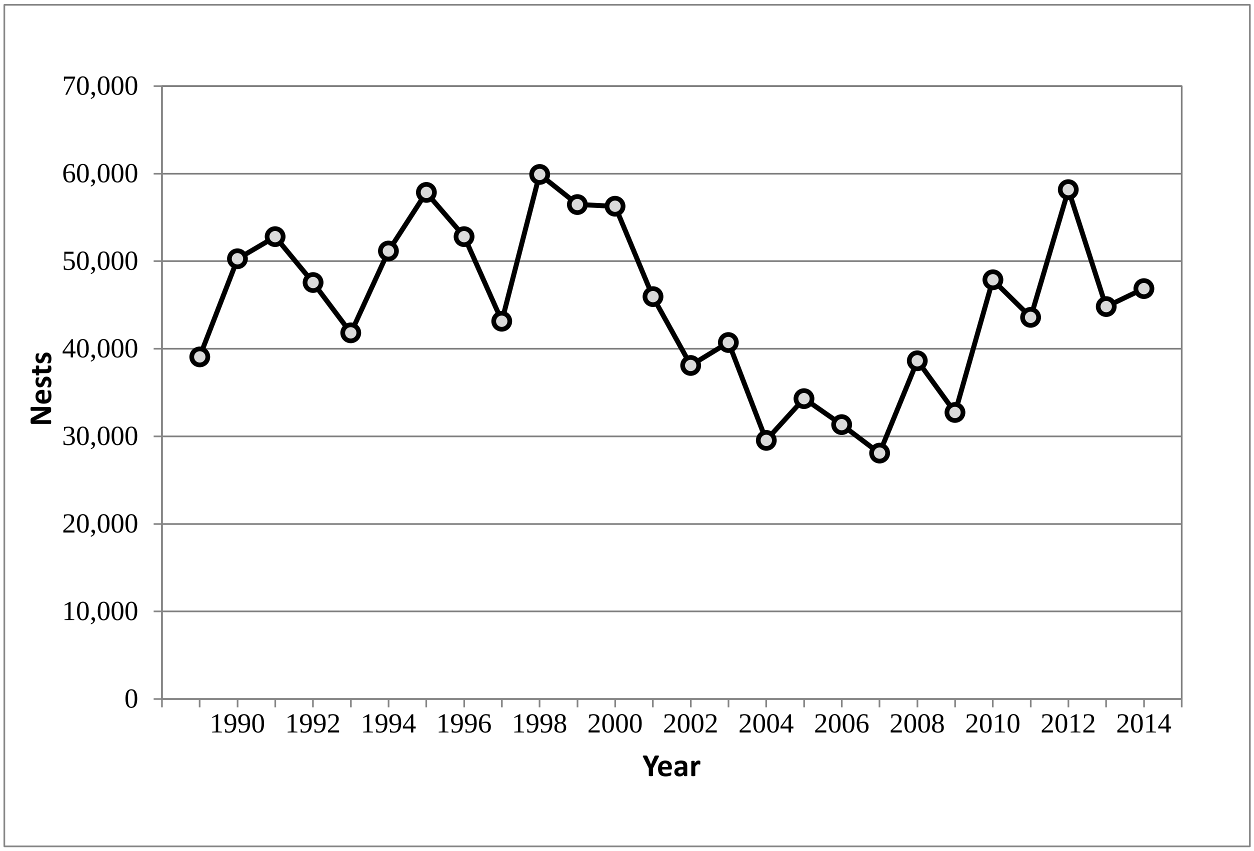


Figure 24. Loggerhead sea turtle nesting at Florida index beaches since 1989

<u>Northern Recovery Unit</u>

Annual nest totals from beaches within the Northern Recovery Unit (NRU) averaged 5,215 nests from 1989-2008, a period of near-complete surveys of NRU nesting beaches (Georgia Department of Natural Resources [GADNR] unpublished data, North Carolina Wildlife Resources Commission [NCWRC] unpublished data, South Carolina Department of Natural Resources [SCDNR] unpublished data), and represent approximately 1,272 nesting females per year, assuming 4.1 nests per female (Murphy and Hopkins 1984). The loggerhead nesting trend from daily beach surveys showed a significant decline of 1.3% annually from 1989-2008. Nest totals from aerial surveys conducted by SCDNR showed a 1.9% annual decline in nesting in South Carolina from 1980-2008. Overall, there is strong statistical data to suggest the NRU had experienced a long-term decline over that period of time.

Data since that analysis (Table 8) are showing improved nesting numbers and a departure from the declining trend. Georgia nesting has rebounded to show the first statistically significant increasing trend since comprehensive nesting surveys began in 1989 (Mark Dodd, GADNR press release, http://www.georgiawildlife.com/node/3139). South Carolina and North Carolina nesting have also begun to show a shift away from the declining trend of the past.

Table 8. Total Number of NRU Loggerhead Nests (GADNR, SCDNR, and NCWRC nesting datasets)

Nests Recorded	2008	2009	2010	2011	2012	2013	2014
Georgia	1,649	998	1,760	1,992	2,241	2,289	1,196
South Carolina	4,500	2,182	3,141	4,015	4,615	5,193	2,083
North Carolina	841	302	856	950	1,074	1,260	542
Total	6,990	3,472	5,757	6,957	7,930	8,742	3,821

South Carolina also conducts an index beach nesting survey similar to the one described for Florida. Although the survey only includes a subset of nesting, the standardized effort and locations allow for a better representation of the nesting trend over time. Increases in nesting were seen for the period from 2009-2012, with 2012 showing the highest index nesting total since the start of the program (Figure 25).

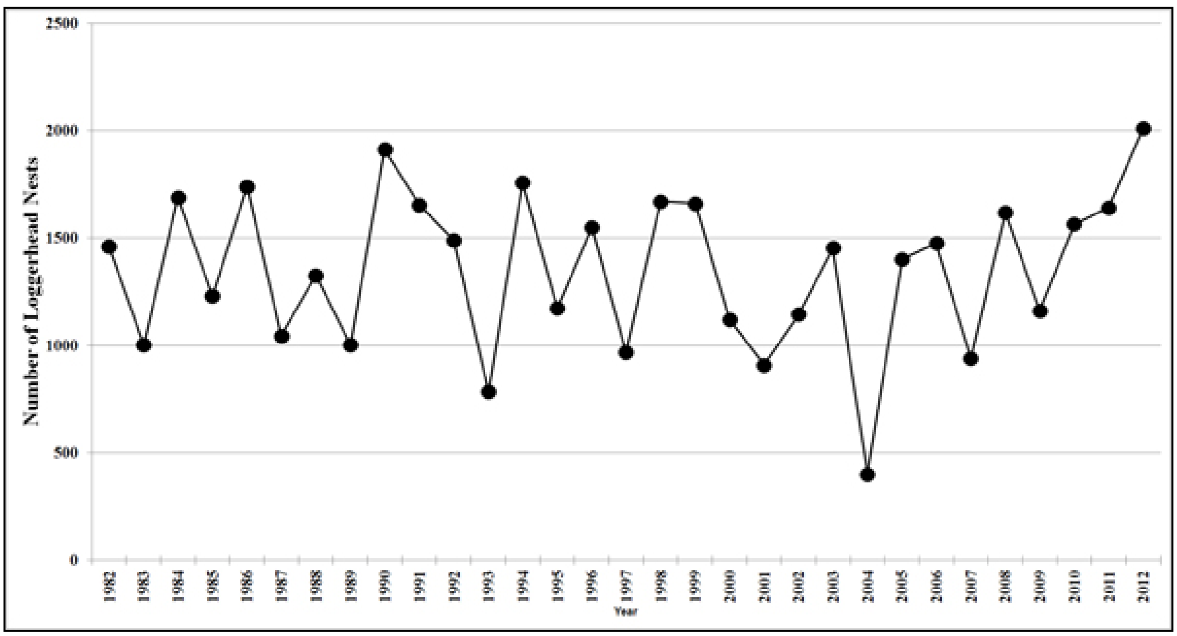


Figure 25. South Carolina index nesting beach counts for loggerhead sea turtles (from the SCDNR website, http://www.dnr.sc.gov/seaturtle/nest.htm)

<u>Other NW Atlantic DPS Recovery Units</u>

The remaining 3 recovery units—Dry Tortugas (DTRU), Northern Gulf of Mexico (NGMRU), and Greater Caribbean (GCRU)—are much smaller nesting assemblages, but they are still considered essential to the continued existence of the species. Nesting surveys for the DTRU are conducted as part of Florida's statewide survey program. Survey effort was relatively stable during the 9-year period from 1995-2004, although the 2002 year was missed. Nest counts ranged from 168-270, with a mean of 246, but there was no detectable trend during this period (NMFS and USFWS 2008b). Nest counts for the NGMRU are focused on index beaches rather than all beaches where nesting occurs. Analysis of the 12-year dataset (1997-2008) of index nesting beaches in the area shows a statistically significant declining trend of 4.7% annually. Nesting on the Florida Panhandle index beaches, which represents the majority of NGMRU nesting, had shown a large increase in 2008, but then declined again in 2009 and 2010 before rising back to a level similar to the 2003-2007 average in 2011. Nesting survey effort has been inconsistent among the GCRU nesting beaches, and no trend can be determined for this subpopulation (NMFS and USFWS 2008b). Zurita et al. (2003) found a statistically significant increase in the number of nests on 7 of the beaches on Quintana Roo, Mexico, from 1987-2001, where survey effort was consistent during the period. Nonetheless, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS and USFWS 2008b).

In-water Trends

Nesting data are the best current indicator of sea turtle population trends, but in-water data also provide some insight. In-water research suggests the abundance of neritic juvenile loggerheads is steady or increasing. Although Ehrhart et al. (2007) found no significant regression-line trend in a long-term dataset, researchers have observed notable increases in catch per unit effort (CPUE) (Arendt et al. 2009; Ehrhart et al. 2007; Epperly et al. 2007). Researchers believe that this increase in CPUE is likely linked to an increase in juvenile abundance, although it is unclear whether this increase in abundance represents a true population increase among juveniles or merely a shift in spatial occurrence. Bjorndal et al. (2005), cited in NMFS and USFWS (2008b), caution about extrapolating localized in-water trends to the broader population and relating localized trends in neritic sites to population trends at nesting beaches. The apparent overall increase in the abundance of neritic loggerheads in the southeastern United States may be due to increased abundance of the largest oceanic/neritic juveniles (historically referred to as small benthic juveniles), which could indicate a relatively large number of individuals around the same age may mature in the near future (TEWG 2009). In-water studies throughout the eastern United States, however, indicate a substantial decrease in the abundance of the smallest oceanic/neritic juvenile loggerheads, a pattern corroborated by stranding data (TEWG 2009).

Population Estimate

The NMFS Southeast Fisheries Science Center developed a preliminary stage/age demographic model to help determine the estimated impacts of mortality reductions on loggerhead sea turtle population dynamics (NMFS-SEFSC 2009b). The model uses the range of published information for the various parameters including mortality by stage, stage duration (years in a stage), and fecundity parameters such as eggs per nest, nests per nesting female, hatchling emergence success, sex ratio, and remigration interval. Resulting trajectories of model runs for each individual recovery unit, and the western North Atlantic population as a whole, were found to be very similar. The model run estimates, from the adult female population size for the western North Atlantic (from the 2004-2008 time frame), suggest the adult female population size is approximately 20,000 to 40,000 individuals, with a low likelihood of being up to 70,000 (NMFS-SEFSC 2009b). A less robust estimate for total benthic females in the western North Atlantic was also obtained, yielding approximately 30,000-300,000 individuals, up to less than 1 million (NMFS-SEFSC 2009b). A preliminary regional abundance survey of loggerheads within the northwestern Atlantic continental shelf for positively identified loggerhead in all strata estimated about 588,000 loggerheads (interquartile range of 382,000-817,000). When correcting for unidentified turtles in proportion to the ratio of identified turtles, the estimate increased to about 801,000 loggerheads (interquartile range of 521,000-1,111,000) (NMFS-NEFSC).

Threats (Specific to Loggerhead Sea Turtles)
The threats faced by loggerhead sea turtles are well-summarized in the general discussion of threats in Section 4.2.1. Yet the impact of fishery interactions is a point of further emphasis for this species. The joint NMFS and USFWS Loggerhead Biological Review Team determined that the greatest threats to the NWA DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant et al. 2009).

Regarding the impacts of pollution, loggerheads may be particularly affected by organochlorine contaminants; they have the highest organochlorine concentrations (Storelli et al. 2008) and metal loads (D'Ilio et al. 2011) in sampled tissues among the sea turtle species. It is thought that dietary preferences were likely to be the main differentiating factor among sea turtle species. Storelli et al. (2008) analyzed tissues from stranded loggerhead sea turtles and found that mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals, and porpoises (Law et al. 1991).

Specific information regarding potential climate change impacts on loggerheads is also available. Modeling suggests an increase of 2°C in air temperature would result in a sex ratio of over 80% female offspring for loggerheads nesting near Southport, North Carolina. The same increase in air temperatures at nesting beaches in Cape Canaveral, Florida, would result in close to 100% female offspring. Such highly skewed sex ratios could undermine the reproductive capacity of the species. More ominously, an air temperature increase of 3°C is likely to exceed the thermal threshold of most nests, leading to egg mortality (Hawkes et al. 2007a). Warmer sea surface temperatures have also been correlated with an earlier onset of loggerhead nesting in the spring (Hawkes et al. 2007a; Weishampel et al. 2004), short inter-nesting intervals (Hays et al. 2002), and shorter nesting seasons (Pike et al. 2006).

4.7 Gulf Sturgeon

Gulf sturgeon (*Acipenser oxyrinchus desotoi)* were listed as threatened effective October 30, 1991 (56 CFR 49653, September 30, 1991), after their stocks were greatly reduced or extirpated throughout much of their historic range by overfishing, dam construction, and habitat degradation. NMFS and the USFWS jointly manage Gulf sturgeon. In riverine habitats, USFWS is responsible for all consultations regarding Gulf sturgeon and critical habitat. In estuarine habitats, responsibility is divided based on the action agency involved. USFWS consults with the Department of Transportation, the Environmental Protection Agency (EPA), the U.S. Coast Guard, and the Federal Emergency Management Agency; NMFS consults with the Department of Defense, USACE, BOEM, and any other Federal agencies not specifically mentioned at 50 CFR 226.214. In marine areas, NMFS is responsible for all consultations regarding Gulf sturgeon and critical habitat. In 2009, NMFS and USFWS conducted a 5-year review and found Gulf sturgeon continued to meet the definition of a threatened species (USFWS and NMFS 2009).

Species Description and Distribution
The Gulf sturgeon is a subspecies of the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Gulf sturgeon are nearly cylindrical fish with an extended snout, vertical mouth, 5 rows of scutes (bony plates surrounding the body), 4 chin barbels (slender, whisker-like feelers extending from the head used for touch and taste), and a heterocercal (upper lobe is longer than lower) caudal fin (tail fin). Adults range from 6-8 ft in length and weigh up to 200 pounds; females grow larger than males. Gulf sturgeon spawn in freshwater and then migrate to feed and grow in estuarine/marine (brackish/salt) waters. Large subadults and adults feed primarily on lancelets, brachiopods, amphipods and other crustaceans, polychaetes, and gastropods. Small Gulf sturgeons feed on benthic infauna such as amphipods, grass shrimp, isopods, oligochaetes, polychaetes, and chironomid and ceratopogonid larvae, found in the intertidal zone. Subadults of more than 5 kg and adults in the freshwater middle river reaches essentially fast during the summer and fall (Mason Jr. and Clugston 1993).

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

Life History
Gulf sturgeon are long-lived, with some individuals reaching at least 42 years in age (Huff 1975). Age at sexual maturity ranges from 8-17 years for females and 7-21 years for males (Huff 1975). Chapman and Carr (1995) estimated that mature female Gulf sturgeon weighing between 64 and 112 lb (29-51 kg) produce an average of 400,000 eggs. Spawning intervals range from 1-5 years for males, while females require longer intervals ranging from 3-5 years (Fox et al. 2000; Huff 1975).

Gulf sturgeon move from the Gulf of Mexico into coastal rivers in early spring (i.e., March through May). (Fox et al. 2000) found water temperatures at time of river entry differed significantly by reproductive stage and sex. Individuals entered the river system when water temperatures ranged anywhere between 11.2°C and 27.1°C. Spawning occurs in the upper reaches of rivers in the spring when water temperature is around 15^{o}C to 20^{o}C. While Sulak and Clugston (1999) suggested that sturgeon spawning activity is related to moon phase, other researchers have found little evidence of spawning associated with lunar cycles (Fox et al. 2000; Slack et al. 1999). Fertilization is external; females deposit their eggs on the river bottom and males fertilize them. Gulf sturgeon eggs are demersal, adhesive, and vary in color from gray to brown to black (Huff 1975; Vladykov and Greely 1963). Parauka et al. (1991) reported that hatching time for artificially spawned Gulf sturgeon ranged from 85.5 hours at 18.4°C to 54.4 hours at about 23°C. Published research on the life history of younger Gulf sturgeon is limited. After hatching, young-of-year individuals generally disperse downstream of spawning sites, though some may travel upstream as well (Clugston et al. 1995; Sulak and Clugston 1999), and move into estuarine feeding areas for the winter months.

Tagging studies confirm that Gulf sturgeon exhibit a high degree of river fidelity (Carr 1983). Of 4,100 fish tagged, 21% (860 of 4,100 fish) were later recaptured in the river of their initial collection, 8 fish (0.2%) moved between river systems, and the remaining fish (78.8%) have not yet been recaptured (USFWS and GSMFC 1995). There is no information documenting the presence of spawning adults in non-natal rivers. Still, there is some evidence of movements by both male and female Gulf sturgeon (n = 22) from natal rivers into non-natal rivers (Carr et al. 1996; Craft et al. 2001; Fox et al. 2002; Ross et al. 2001a; Wooley and Crateau 1985).

Gene flow is low in Gulf sturgeon stocks, with each stock exchanging less than one mature female per generation (Waldman and Wirgin 1998). Genetic studies confirm that Gulf sturgeon exhibit river-specific fidelity. Stabile et al. (1996) analyzed tissue taken from Gulf sturgeon in 8 drainages along the Gulf of Mexico for genetic diversity and noted significant differences among Gulf sturgeon stocks, which suggests region-specific affinities and likely river-specific fidelity. Five regional or river-specific stocks (from west to east) have been identified: (1) Lake Pontchartrain and Pearl River, (2) Pascagoula River, (3) Escambia and Yellow Rivers, (4) Choctawhatchee River, and (5) Apalachicola, Ochlockonee, and Suwannee Rivers (Stabile et al. 1996).

After spawning, Gulf sturgeon move downstream to areas referred to as summer resting or holding areas. Adults and subadults are not distributed uniformly throughout the river, but show a preference for these discrete holding areas usually located in the lower and middle river reaches (Hightower et al. 2002). While it was suggested these “holding areas” were sought for cooler water temperatures (Carr et al. 1996; Chapman and Carr 1995; Hightower et al. 2002) found that water temperatures in holding areas where Gulf sturgeon were repeatedly found in the Choctawhatchee River were similar to temperatures where sturgeon were only occasionally found elsewhere in the river.

In the fall, movement from the rivers into the estuaries and associated bays begins in September (at water temperatures around 23°C) and continues through November (Foster and Clugston 1997; Huff 1975; Wooley and Crateau 1985). Because the adult and large subadult sturgeon have spent at least 6 months fasting or foraging sparingly on detritus (Mason Jr. and Clugston 1993) in the rivers, it is presumed they immediately begin foraging. Telemetry data indicate Gulf sturgeon are found in high concentrations near the mouths of their natal rivers with individual fish traveling relatively quickly between foraging areas where they spend an extended period of time (Edwards et al. 2007; Edwards et al. 2003).

Most subadult and adult Gulf sturgeon spend the cool winter months (October/November through March/April) in the bays, estuaries, and the nearshore Gulf of Mexico (Clugston et al. 1995; Fox et al. 2002; Odenkirk 1989). Tagged fish have been located in well-oxygenated shallow water (less than 7 m) areas that support burrowing macro invertebrates (Craft et al. 2001; Fox and Hightower 1998; Fox et al. 2002; Parauka et al. 2001; Rogillio et al. 2007; Ross et al. 2001a; Ross et al. 2009). These areas may include shallow shoals 5-7 ft (1.5-2.1 m), deep holes near passes (Craft et al. 2001), unvegetated sand habitats such as sandbars, and intertidal and subtidal energy zones (Abele and Kim 1986; Menzel 1971; Ross et al. 2009). Subadult and adult Gulf sturgeon overwintering in Choctawhatchee Bay (Florida) were generally found to occupy the sandy shoreline habitat at depths of 4-6 ft (2-3 m) (Fox et al. 2002; Parauka et al. 2001).

These shifting, predominantly sandy, areas support a variety of potential prey items including estuarine crustaceans, small bivalve mollusks, ghost shrimp, small crabs, various polychaete worms, and lancelets (Abele and Kim 1986; Menzel 1971; Williams et al. 1989), (M. Brim, USFWS, pers. comm. to S. Bolden, NMFS, December 2, 2002). Preference for sandy habitat is supported by studies in other areas that have correlated Gulf sturgeon presence to sandy substrate (Fox et al. 2002).

Gulf sturgeon are described as opportunistic and indiscriminate benthivores that change their diets and foraging areas during different life stages. Their guts generally contain benthic marine invertebrates including amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, molluscs, and crustaceans (Carr et al. 1996; Fox et al. 2002; Huff 1975; Mason Jr. and Clugston 1993). Generally, Gulf sturgeon prey are burrowing species that feed on detritus and/or suspended particles, and inhabit sandy substrate. In the river, young-of-the-year sturgeon eat aquatic invertebrates and detritus (Mason Jr. and Clugston 1993; Sulak and Clugston 1999) and juveniles forage throughout the river on aquatic insects (e.g., mayflies and caddis flies), worms (oligochaete), and bivalves (Huff 1975; Mason Jr. and Clugston 1993). Adults forage sparingly in freshwater and depend almost entirely on estuarine and marine prey for their growth (Gu et al. 2001). Both adult and subadult Gulf sturgeon are known to lose up to 30% of their total body weight while in fresh water, and subsequently compensate the loss during winter feeding in marine areas (Carr 1983; Clugston et al. 1995; Heise et al. 1999; Morrow et al. 1998; Ross et al. 2000; Sulak and Clugston 1999; Wooley and Crateau 1985).

Status and Population Dynamics

Abundance of Gulf sturgeon is measured at the riverine scale. Currently, 7 rivers are known to support reproducing populations of Gulf sturgeon: Pearl, Pascagoula, Escambia, Yellow, Choctawhatchee, Apalachicola, and Suwannee. Gulf sturgeon abundance estimates by river and year for the 7 known reproducing populations are presented in Table 9. The number of individuals within each riverine population is variable across their range, but generally over the last decade (USFWS and NMFS 2009) populations in the eastern part of the range (Suwannee, Apalachicola Choctawhatchee) appear to be relatively stable in number or have a slightly increasing population trend. In the western portion of the range, populations in the Pearl and Pascagoula Rivers have never been nearly as abundant as those to the east, and their current status, post-hurricanes Katrina and Rita, is unknown as comprehensive surveys have not occurred.

Table 9. Gulf Sturgeon Abundance Estimates by River and Year (with Confidence Intervals (CI) for the 7 Known Reproducing Populations. Data from USFWS and NMFS 2009)

River	Year of data collection	Abundance Estimate	Lower Bound 95% CI	Upper Bound 95% CI	Source
Suwannee	2007	14,000	not reported	not reported	Sulak 2008
Apalachicola	1991	144	83	205	Zehfuss et al. 1999
Choctawhatchee	2008	3314	not reported	not reported	USFWS 2009
Yellow	2003 fall	911	550	1,550	Berg et al. 2007
Escambia	2006	451	338	656	USFWS 2007
Pascagoula	2000	216	124	429	Ross et al. 2001
Pearl	2001	430	323	605	Rogillio et al. 2001

Both acute and episodic events are known to impact individual populations of Gulf sturgeon that in turn affect overall population numbers. For example, on August 9, 2011, an overflow of "black liquor" (an extremely alkaline waste byproduct of the paper industry) was accidentally released by a paper mill into the Pearl River near Bogalusa, Louisiana, that may have affected the status and abundance of the Pearl River population. While paper mills regularly use acid to balance the black liquor's pH before releasing the material, as permitted by the Louisiana Department of Environmental Quality, this material released was not treated.[14] The untreated waste byproduct created a low oxygen ("hypoxic") environment lethal to aquatic life. These hypoxic conditions moved downstream of the release site killing fish and mussels in the Pearl River over several days. Within a week after the spill, the dissolved oxygen concentrations returned to normal in all areas of the Pearl River tested by Louisiana Department of Wildlife and Fisheries (LDWF). The investigation of fish mortality began on August 13, 2011, several days after the spill occurred. Twenty-eight Gulf sturgeon carcasses (38-168 cm TL) were collected in the Pearl River after the spill (Sanzenbach 2011a; Sanzenbach 2011b) and anecdotal information suggests many other Gulf sturgeon carcasses were not collected. The smaller fish collected represent young-of-the-year and indicate spawning is likely occurring in the Pearl River. The spill occurred during the time when Gulf sturgeon were still occupying the freshwater habitat. Because the materials moved downriver after the spill, the entire Pearl River population of Gulf sturgeon was likely impacted.

Threats

The 1991 listing rule for Gulf sturgeon cited the following impacts and threats: (1) Dams on the Pearl, Alabama, and Apalachicola rivers; also on the North Bay arm of St. Andrews Bay; (2) channel improvement and maintenance activities: dredging and de-snagging; (3) water quality degradation; and (4) contaminants.

In 2009, NMFS and USFWS conducted a 5-year review of the Gulf sturgeon and identified several new threats to the Gulf sturgeon (USFWS and NMFS 2009). The following is a comprehensive list of threats to Gulf sturgeon, additional details can be found in the 5-year status review (USFWS and NMFS 2009):

[14] The extreme alkalinity of the untreated black liquor caused it to quickly bond with oxygen (aerobic) to dissociate in water. This reduced the amount of oxygen available within the water column, creating a hypoxic environment (< 1mg/L of dissolved oxygen) lethal to aquatic life.

Pollution from industrial, agricultural, and municipal activities is believed responsible for a suite of physical, behavioral, and physiological impacts to sturgeon worldwide. Specific impacts of pollution and contamination on sturgeon have been identified to include muscle atrophy, abnormality of gonad, sperm, and egg development, morphogenesis of organs, tumors, and disruption of hormone production.

Chemicals and metals such as chlordane, dichlorodiphenyldichloroethylene, dichlorodiphenyltrichloroethane, dieldrin, polychlorinated biphenyls, cadmium, mercury, and selenium settle to the river bottom and are later incorporated into the food web as they are consumed by benthic feeders, such as sturgeon or macroinvertebrates.

Bycatch from fisheries may continue although all directed fisheries of Gulf sturgeon have been closed since 1990 (USFWS and GSMFC 1995). Although confirmed reports are rare, it is a common opinion among Gulf sturgeon researchers that bycatch mortality continues.

Dredging activities can pose significant impacts to aquatic ecosystems by: (1) direct removal/burial of organisms; (2) turbidity/siltation effects; (3) contaminant re-suspension; (4) noise/disturbance; (5) alterations to hydrodynamic regime and physical habitat; and (6) loss of riparian habitat. Dredging operations may also destroy benthic feeding areas, disrupt spawning migrations, and re-suspend fine sediments causing siltation over required substrate in spawning habitat. Because Gulf sturgeon are benthic omnivores, the modification of the benthos affects the quality, quantity, and availability of prey.

Collisions between jumping Gulf sturgeon and fast-moving boats on the Suwannee River and elsewhere are a relatively recent and new source of sturgeon mortality and pose a serious public safety issue as well. The Florida Fish and Wildlife Commission documented 3 collisions in the Suwannee River in 2008, and 1 incident in 2009.

Dams represent a significant impact to Gulf sturgeon by blocking passage to historical spawning habitats, which reduces the amount of available spawning habitat or entirely impede access to it. The ongoing operations of these dams also affect downstream habitat.

Global climate change may affect Gulf sturgeon by leading to accelerated changes in habitats utilized by Gulf sturgeon through saltwater intrusion, changes in water temperature, and extreme weather periods that could increase both droughts and floods.

Hurricanes have resulted in mortality of Gulf sturgeon in both Escambia Bay after Hurricane Ivan in 2004 (USFWS 2005) and Hurricane Katrina in 2005.

Red tide is the common name for a harmful algal bloom (HAB) of marine algae (*Karenia brevis*) that produces a brevetoxin that is absorbed directly across the gill membranes of fish or through ingestion of algal cells. Fish mortalities associated with *K. brevis* events are very common and widespread. Blooms of red tides have been in increasing in frequency in the Gulf of Mexico since the 1990s and have likely killed Gulf sturgeon at both the juvenile and adult life stages.

Aquaculture: although the state of Florida has Best Management Practices to reduce the risk of hybridization and escapement, the threat of introduction of captive fishes into the wild continues.

Summary of the Status of Gulf Sturgeon

In summary, the Gulf sturgeon population is estimated to number approximately 19,000 individuals. The number of individuals within each riverine population is variable across their range, but generally over the last decade (USFWS and NMFS 2009) populations in the eastern part of the range (Suwannee, Apalachicola, Choctawhatchee) appear to be relatively stable in number or have a slightly increasing population trend. Recovery of depleted populations is an inherently slow process for a late-maturing species such as Gulf sturgeon. Their late age at maturity provides more opportunities for individuals to be removed from the population before reproducing. While a long life-span also allows multiple opportunities to contribute to future generations, this is hampered within the species range by habitat alteration, pollution, and bycatch.

A wide range of threats continue to dictate the status of Gulf sturgeon and their recovery. Modification of habitat through dams, the operation of dams, and dredging particularly impact Gulf sturgeon. The presence of dams reduces the amount of available spawning habitat or entirely impedes access to it, while ongoing operation of these dams affects downstream water quality parameters such as depth, temperature, velocity, and DO. Similarly, dredging projects modify Gulf sturgeon spawning and nursery habitat through direct removal of habitat features or reduced water quality due to nutrient-loading, anoxia, and contaminated sediments. Water quality can be further influenced by inter-basin water transfers and climate change which may exacerbate existing water quality issues. Further, access to habitat and water quality continues to be a problem even with NMFS's authority under the Federal Power Act to prescribe fish passage and existing controls on some pollution sources. The inadequacy of regulatory mechanisms to control habitat alterations is contributing to the status of Gulf sturgeon.

Bycatch is also a current threat to the species that is contributing to its status. Although confirmed reports are rare, it is a common opinion among Gulf sturgeon researchers that bycatch mortality continues. While many of the threats to Gulf sturgeon have been ameliorated or reduced due to the existing regulatory mechanisms, such as the moratorium on directed fisheries, bycatch is not currently being addressed. Therefore, losses of Gulf sturgeon as bycatch likely continue.

4.8 Gulf Sturgeon Critical Habitat

Gulf sturgeon critical habitat (GSCH) was jointly designated by NMFS and USFWS on April 18, 2003 (*see,* 50 CFR 226.214). Critical habitat is defined in Section 3(5)(A) of the ESA as: (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features: (a) essential to the conservation of the species, and (b) that may require special management considerations or protection; and (2) specific areas outside the geographic area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. The term "conservation" is defined in Section 3(3) of the ESA as the use of all methods and procedures that are necessary to bring any endangered or threatened species to the point at which listing under the ESA is no longer necessary.

Gulf sturgeon use rivers for spawning, larval and juvenile feeding, adult resting and staging, and to move between the areas that support these components. Gulf sturgeon use the lower riverine, estuarine, and marine environment during winter months primarily for feeding and for inter-river migrations. Estuaries and bays adjacent to riverine areas provide unobstructed passage of sturgeon from feeding areas to spawning grounds.

Fourteen areas (Units) are designated as GSCH. Critical habitat units encompass a total of 2,783 river kilometers (km) and 6,042 km^2 of estuarine and marine habitats, and include portions of the Gulf of Mexico and connected rivers, tributaries, estuarine, and marine areas (Figure 26). NMFS jurisdiction encompasses 7 units in marine and estuarine waters (Units 8-14).

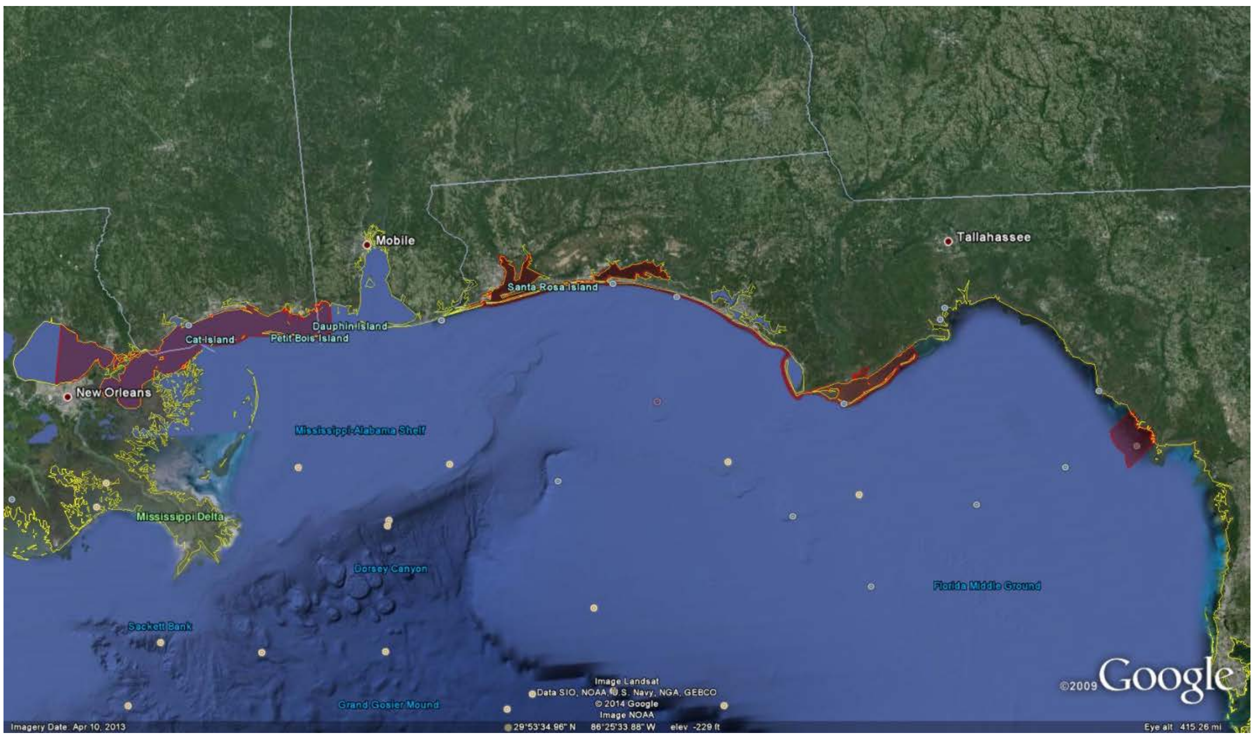


Figure 26. Gulf Sturgeon Critical Habitat in Estuarine and Marine Waters (Units 8-14) (©2014 Google, Data SIO, NOAA, U.S. Navy, NGA, GEBCO)

Critical habitat determinations focus on those physical and biological features (formerly called "primary constituent elements," now called "essential features") that are essential to the conservation of the species (50 CFR 424.12). Federal agencies must ensure that their activities are not likely to result in the destruction or adverse modification of the essential features within defined critical habitats. Therefore, proposed actions that may impact designated critical habitat require an analysis of potential impacts to each essential feature.

Features identified as essential for the conservation of the Gulf sturgeon in marine and estuarine waters are:

- Abundant food items, such as detritus, aquatic insects, worms, and/or mollusks, within riverine habitats for larval and juvenile life stages; and abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, mollusk and/or crustaceans, within estuarine and marine habitats and substrates for subadult and adult life stages
- Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages
- Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages
- Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., an unobstructed river or a dammed river that still allows for passage)

As stated in the final rule designating GSCH, the following activities, when authorized, funded or carried out by a federal agency, may destroy or adversely modify critical habitat:

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

This project is located in Unit 8. This unit encompasses Lake Pontchartrain east of the Lake Pontchartrain Causeway, all of Little Lake, The Rigolets, Lake St. Catherine, Lake Borgne, including Heron Bay, and the Mississippi Sound (Figure 27). Critical habitat follows the shorelines around the perimeters of each included lake. The Mississippi Sound includes adjacent open bays including Pascagoula Bay, Point aux Chenes Bay, Grand Bay, Sandy Bay, and barrier island passes, including Ship Island Pass, Dog Keys Pass, Horn Island Pass, and Petit Bois Pass.

The northern boundary of the Mississippi Sound is the shoreline of the mainland between Heron Bay Point, Mississippi and Point aux Pins, Alabama. Critical habitat excludes St. Louis Bay, north of the railroad bridge across its mouth; Biloxi Bay, north of the U.S. Highway 90 bridge; and Back Bay of Biloxi. The southern boundary follows along the broken shoreline of Lake Borgne created by low swamp islands from Malheureux Point to Isle au Pitre. From the northeast point of Isle au Pitre, the boundary continues in a straight north-northeast line to the point 1 nautical mile (nmi) (1.9 km) seaward of the western most extremity of Cat Island (30°13′N, 89°10′W). The southern boundary continues 1 nmi (1.9 km) offshore of the barrier islands and offshore of the 72 COLREGS lines at barrier island passes (defined at 33 CFR80.815), (d) and (e) to the eastern boundary. Between Cat Island and Ship Island there is no 72 COLREGS line. We, therefore, defined that section of the unit southern boundary as 1 nm (1.9 km) offshore of a straight line drawn from the southern tip of Cat Island to the western tip of Ship Island. The eastern boundary is the line of longitude 88°18.8′W from its intersection with the shore (Point aux Pins) to its intersection with the southern boundary. The lateral extent of Unit 8 is the MHW line on each shoreline of the included water bodies or the entrance to rivers, bayous, and creeks.

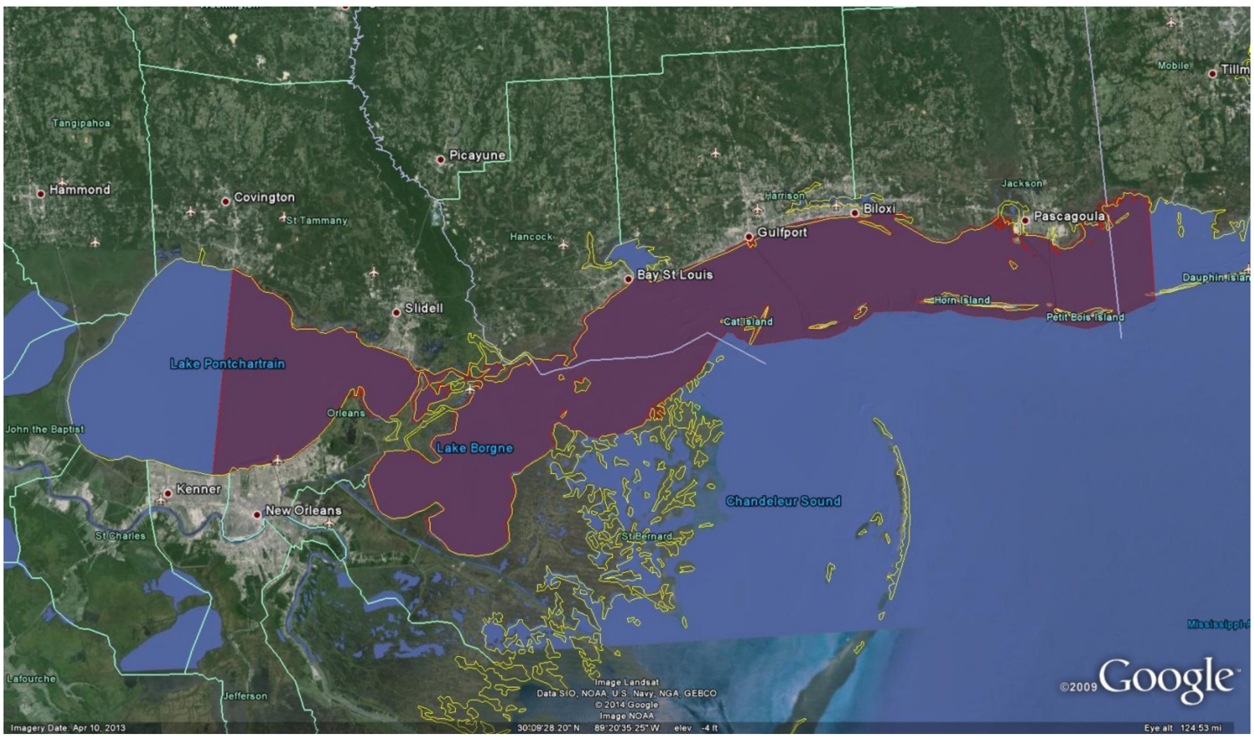


Figure 27. Gulf sturgeon critical habitat Unit 8 (©2014 Google, Data SIO, NOAA, U.S. Navy, NGA, GEBCO)

The Pearl River and its distributaries flow into The Rigolets, Little Lake, and Lake Borgne, the western extension of Mississippi Sound. The Rigolets connect Lake Pontchartrain and Lake St. Catherine with Little Lake and Lake Borgne. The Pascagoula River and its distributaries flow into Pascagoula Bay and Mississippi Sound. This unit provides juvenile, subadult, and adult feeding, resting, and passage habitat for Gulf sturgeon from the Pascagoula and the Pearl River subpopulations. One or both of these subpopulations have been documented by tagging data, historic sightings, and incidental captures as using Pascagoula Bay, The Rigolets, the eastern half of Lake Pontchartrain, Little Lake, Lake St. Catherine, Lake Borgne, Mississippi Sound, within 1 nm (1.9 km) of the nearshore Gulf of Mexico adjacent to the barrier islands and within the passes (Morrow Jr. et al. 1996; Reynolds 1993; Rogillio 1993; Rogillio et al. 2001; Ross et al. 2001a)(F. Parauka, USFWS, pers. comm. to S. Bolden, NMFS, December 2, 2002). Substrate in these areas ranges from sand to silt, all of which contains known Gulf sturgeon prey items. The Rigolets is an 11.3 km (7 mi) long and about 0.6-km (0.4 mi) wide passage connecting Lake Pontchartrain and Lake Borgne. This brackish water area is used by adult Gulf sturgeon as a staging area for osmoregulation and for passage to and from wintering areas (Rogillio et al. 2001). Lake St. Catherine is a relatively shallow lake with depths averaging approximately 1.2 m (4 ft), connected to The Rigolets by Sawmill Pass. Bottom sediments in Sawmill Pass are primarily silt; Lake St. Catherine's are composed of silt and sand (Barrett 1971). Incidental catches of Gulf sturgeon are documented from Lake St. Catherine and Sawmill Pass (H. Rogillio, Louisiana Department of Wildlife and Fisheries, pers. comm. to S. Bolden, NMFS, December 2, 2002). Based on the proximity of Little Lake, Lake St. Catherine, and Sawmill Pass to The Rigolets and Pearl River, we believe these areas are also used for staging and feeding and, therefore, were included with The Rigolets as critical habitat.

Rogillio (1993) and (Morrow Jr. et al. 1996) indicated that Lake Pontchartrain and Lake Borgne were used by Gulf sturgeon as wintering habitat, with most catches during late September through March. Lake Pontchartrain is 57.9 km (36 mi) long, 35.4 km (22 mi) wide at its widest point, and 3 to 4.9 m (10-16 ft) deep. (Morrow Jr. et al. 1996) documented Gulf sturgeon from the Pearl River system using Lake Pontchartrain (verified by tags) and summarized existing Gulf sturgeon records, which indicated greater use of the eastern half of Lake Pontchartrain. Although (Rogillio et al. 2001) did not relocate any of their sonic tagged adult Gulf sturgeon in Lake Pontchartrain, the eastern part of this lake is believed to be an important winter habitat for juveniles and subadults (H. Rogillio, Louisiana Department of Wildlife and Fisheries, pers. comm. to S. Bolden, NMFS, December 2, 2002). Furthermore, we believe that Gulf sturgeon forage in Lake Pontchartrain during the winter. The Lake Pontchartrain Causeway, twin toll highway bridges, extends 33.6 km (20.9 mi) across Lake Pontchartrain from Indian Beach on the south shore to Lewisburg and Mandeville on the north shore. Sediment data from Lake Pontchartrain indicate sediments have a greater sand content east of the causeway than west (Schusterman et al. 1975). Most records of Gulf sturgeon from Lake Pontchartrain are located east of the causeway, with concentrations near Bayou Lacombe and Goose Point, both on the eastern north shore (Morrow Jr. et al. 1996; Reynolds 1993). While Gulf sturgeon have also been documented west of the causeway, generally near the mouths of small river systems (Davis et al. 1970), we excluded the western portion of Lake Pontchartrain because we believe that the sturgeon utilizing this area are coming from western tributaries and not the Pearl River. Lake Pontchartrain connects by The Rigolets with Lake Borgne. Lake Borgne, the western extension of Mississippi Sound, is partly separated from Mississippi Sound by Grassy Island, Half Moon (Grand) Island, and Le Petit Pass Island. Lake Borgne is approximately 14.3 km (23 mi) in length, 3-6 km (5-10 mi) in width and 1.8-3 m (6-10 ft) in depth. Many Gulf sturgeon were anecdotally reported as taken incidentally in shrimp trawls in Lake Borgne 0.6-1.2 km (1-2 mi) south of the Pearl River between August and October from the 1950s through the 1980s (Reynolds 1993). There are 22 additional records of Gulf sturgeon in Lake Borgne (D. Walther, USFWS, pers. comm. to S. Bolden, NMFS, December 2, 2002). Known locations are spread out around the perimeter of the Lake, including at the mouth of The Rigolets, Violet Canal, Bayou Bienvenue, Polebe, Alligator Point, and at Half Moon Island (Reynolds 1993).

The Mississippi Sound is separated from the Gulf of Mexico by a chain of barrier islands, including Cat, Ship, Horn, and Petit Bois Islands. Natural depths of 3.7–5.5 m (12-18 ft) are found throughout the Sound and a channel (the Gulf Intracoastal Waterway) 3.7 m (12 ft) deep has been dredged where necessary from Mobile Bay to New Orleans. Incidental captures and studies confirm that both Pearl River and Pascagoula River adult Gulf sturgeon winter in the Mississippi Sound, particularly around barrier islands and barrier islands passes (Reynolds 1993; Rogillio et al. 2001; Ross et al. 2001a). Pascagoula Bay is adjacent to the Mississippi Sound. Gulf sturgeon exiting the Pascagoula River move both east and west, with telemetry locations as far east as Dauphin Island and as far west as Cat Island and the entrance to Lake Pontchartrain (Ross et al. 2001a). Tagged Gulf sturgeon from the Pearl River subpopulation have been located between Cat Island, Ship Island, Horn Island, and east of Petit Bois Islands to the Alabama State line (Rogillio et al. 2001). Gulf sturgeon have also been documented within 1 nmi (1.9 km) off the barrier islands of Mississippi Sound. We, therefore, included 1 nmi (1.9 km) offshore of the barrier islands of Mississippi Sound.

Habitat used by Gulf sturgeon in the vicinity of the barrier islands is 1.9-5.9 m (6.2-19.4 ft) deep (average 4.2 m [13.8 ft]), with clean sand substrata (Heise et al. 1999; Rogillio et al. 2001; Ross et al. 2001j). Preliminary data from substrate samples taken in the barrier island areas indicate that all samples contained lancelets (Ross et al. 2001j). Inshore locations where Gulf sturgeon were located (Deer Island, Round Island) were 1.9-2.8 m (6.2-9.2 ft) deep and all had mud (mostly silt and clay) substrata (Heise et al. 1999), typical of substrates supporting known Gulf sturgeon prey.

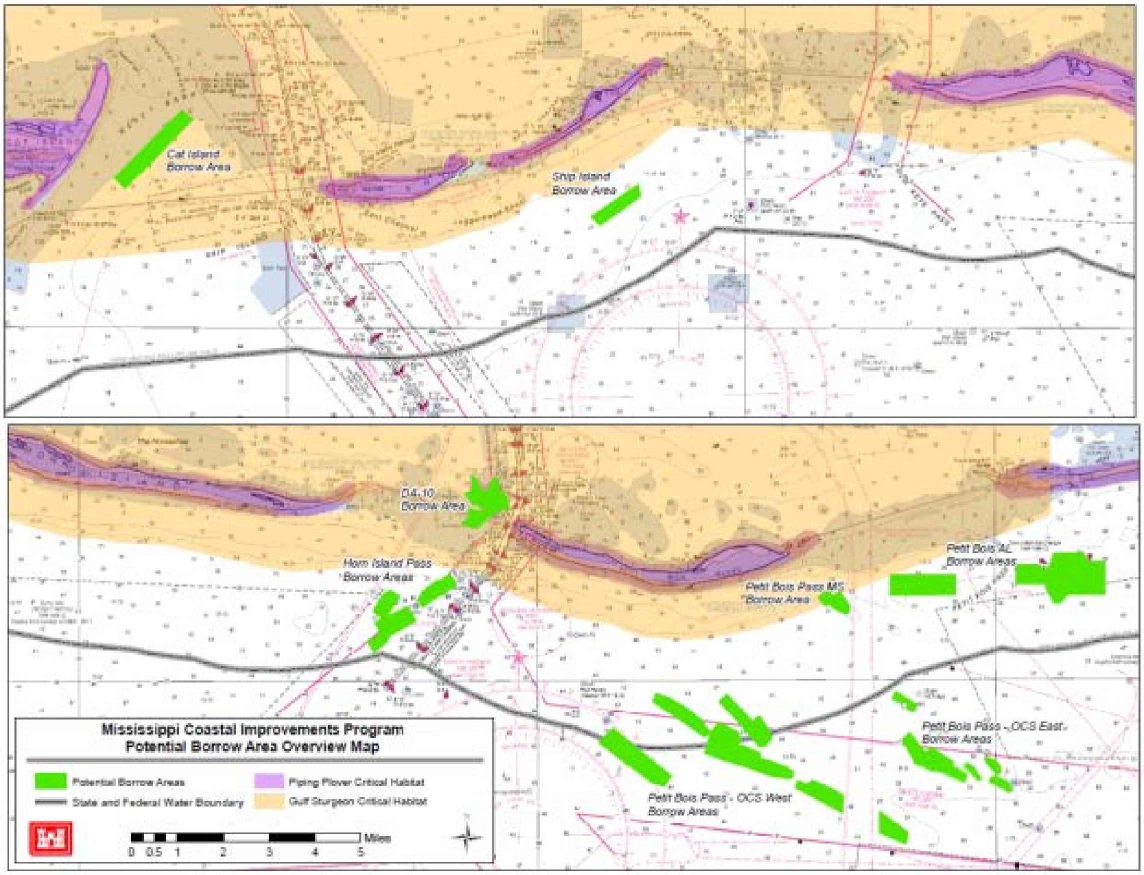


Figure 28. Critical habitat boundaries for the action area from, Biological Assessment- MsCIP. USACE 2012

NMFS believes that GSCH may be adversely affected by project dredging and placement of dredged material (Figure 28). Within Unit 8, essential features potentially affected by proposed dredging and placement activities include prey abundance. The potential for effects to the other essential features potentially affected such as water quality, sediment quality, and migratory pathways are insignificant for the reasons listed below. Impacts to prey abundance will be discussed in Section 6.

Water quality impacts from sediment disturbance as a result of disposal are expected to be temporary and minimal, with suspended particles settling out within a short time frame without measurable effects on water quality. Dredging within the borrow sites and subsequent placement at Ship Island and Cat Island will create some degree of turbidity in excess of the natural condition. This turbidity is generated by the fines fraction of the sediments. However, the material to be dredged is predominantly sandy in nature with low fines percentage. Therefore, impacts from sediment disturbance during these operations are expected to be temporary, minimal, and similar to conditions seen during routine frontal storm events. It is expected during dredging, placement, and equilibrium of the project that suspended particles will settle out within a short time frame, with no measurable effects on water quality, especially in that this is predominantly sandy material.

According to the USACE, turbidity levels would be monitored during dredging and placement operations. Conservative preliminary modeling revealed that state water quality criteria could be exceeded by turbidity levels. This modeling effort assumed dredging in an area that had material with the greatest concentration of fines (~ 13%). It also assumed all of these fines would be retained in the material (i.e., no losses from that initial dredging event) and placed at the placement site with that same concentration of fines (~ 13%). However, during those operations, some percentage of the fines will be lost at the borrow area and another percentage would be lost at the placement area; therefore, exceedance of state water quality criteria could occur but likely only for a short period (i.e., hours to a few days). Temperature, salinity, and density profiles would be affected as a result of water column mixing during dredging and placement activities. Profiles would return to previous conditions following completion of the operations. Any impacts to profiles would be temporary and minor. No significant long term changes in temperature, salinity, pH, hardness, oxygen content and other chemical characteristics are expected. Therefore, NMFS only expects insignificant effects to GSCH as a result of water quality impacts related to this project.

NMFS does not expect adverse impacts to sediment quality from the proposed dredging and sand placement actions. Sediment quality analyses have been routinely conducted by the Mobile District on its federally-authorized navigation projects, which include several within the MsCIP's barrier island restoration effort. This material has been sampled using the protocols of the Inland and Ocean Testing manuals (EPA and USACE 1998) and found to be suitable based on physical, chemical, and biological parameters. The composition of the sand to be dredged from the borrow sites is expected to be the same as that found at Camille Cut, East Ship Island, and Cat Island placement areas. Sediment quality and texture of the dredged material areas have been described by (USACE 2012) as similar to that found at all disposal sites.

NMFS also considered the potential of contamination in the project area due to the effects of the DWH incident, which could impact Gulf sturgeon health. The USACE conducted statistically-random sediment testing on all borrow and placement areas in June 2010. Grab samples were taken and tests for Total Petroleum Hydrocarbons (TPH) were conducted. Concentrations of TPH of the tested samples were below method/laboratory detection limits for over 98% of the samples. Random samples within the sampling grid were found to contain concentrations of TPH but there was no pattern to the presence. Based on conversations with USCG and the lead of the Operational Science Agency Team (OSAT3), the likelihood of the presence of oil in offshore borrow sites is low. However, it has been has reported that DA-10 has had repetitive tar ball issues. The USACE is coordinating any work activities at any borrow site and the barrier island restoration in general with the USCG and the OSAT3. Should the USACE discover the presence of any oil substance, including tar balls, the USACE has stated that they will notify the USCG and other appropriate agencies for appropriate action and cleanup activities. The presence of tar balls within the borrow areas is not expected to result in significant impacts to any resources using these areas or the placement area. Tar balls are composed primarily of sand mixed with degraded oil product. These features are formed when the degraded oils become entrained within the surf zone and adhere to the sand particles. The repetitive movement within the surf zone causes the oil-sand particles to coalesce into various size and shape balls. The toxicity of these materials has been tested and due to the degraded nature of the oils is very low (USACE 2012). Therefore, based on the information provided, NMFS concludes the proposed action will have only insignificant effects on sediment quality of GSCH Unit 8.

The primary migration routes through the geographic area are in the nearshore area near the river mouths or through the barrier island passes. Incidental captures and recent studies confirm that both Pearl River and Pascagoula River adult Gulf sturgeon winter in the Mississippi Sound, particularly around barrier islands and passes (Reynolds 1993; Ross et al. 2009). Gulf sturgeon exiting the Pascagoula River move both east and west, with telemetry locations as far east as the west coast of Florida and as far west as Cat Island and the entrance to Lake Pontchartrain, Louisiana (Ross et al. 2009). Tagged Gulf sturgeon from the Pearl River subpopulation have been located between Cat Island, Ship Island, Horn Island, and east of Petit Bois Island to the Alabama state line (Balazs and Pooley 1994; Ross et al. 2009). Habitat used by Gulf sturgeon in the vicinity of the barrier islands is 6.2-19.4 ft deep (average 13.8 ft), with clean sand substrata (Heise et al. 1999; Ross et al. 2001a). The species is known to utilize Camille Cut inlets as well as the other 5 barrier island passes (Ship Island, Dog Keys, Little Dog Keys, Horn Island, Petit Bois) for feeding and congregating (ERDC 2012; Rogillio et al. 2007; Ross et al. 2009).

The project area includes winter migration for adult and subadult Gulf sturgeon in Mississippi Sound, which includes individuals from the Pascagoula and the Pearl River sub-populations. Dredging operations for this project will be continuous, operating 24 hours each day, 7 days a week. In open-water areas, it is likely that the highly mobile Gulf sturgeon will avoid the area due to project activities (noise and the physical presence of machinery). Historically, the area which is now known as Camille Cut was roughly the center of Ship Island, and there was no passage between West and East Ship Island prior to 1969, pre-Hurricane Camille. Over time, aerial photos of the island showed signs that Camille Cut had begun to close. The distance between West and East Ship Island was approximately 1,052 ft prior to Hurricane Katrina in 2005, however after Hurricane Katrina, the gap between the two islands was approximately 3.5 miles. While the sand placement activities will fill a current gap between East and West Ship Island that is now utilized by Gulf sturgeon, this activity will not impair migratory passage. NMFS believes there will be sufficient passage opportunity for Gulf sturgeon to move through the area via adjacent passes during and after completion of dredging. Both Horn Island Pass and Dog Keys Pass to the east remain unaffected by the action. Furthermore, the majority of the area of open water between East and West Ship Island is shallow compared to the adjacent passes. The average depth is approximately -5 ft (NAVD 88) within the cut and shallower outside of it. This is an important detail given that Fox et al. (2002) determined that Gulf sturgeon were typically found in water 2-4m (6.5- 13 ft) deep in areas with high (>80%) sand composition. As noted above, much of this habitat does not meet this criterion. Additionally, more than half of the project (dredging) is occurring in an open-water environment, most of which is outside of GSCH, and those areas of dredging that are within GSCH, will allow sufficient area for undisturbed passage of individual sturgeon. No other short-term or long-term impacts to the migratory passage essential feature have been identified. Therefore, NMFS expects the dredging and disposal will have an insignificant effect on the ability of Unit 8 to provide migratory pathways for Gulf sturgeon.

Project effects on the prey abundance essential feature of GSCH will be discussed in Section 6.3.1 of the Effects of the Action section of this Opinion.

5 ENVIRONMENTAL BASELINE

By regulation, environmental baselines for Opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02).

This section contains a description of the effects of past and ongoing human factors leading to the current status of the species, their habitat, and ecosystem, within the action area. The environmental baseline is a snapshot of the factors affecting the species and includes state, tribal, local, and private actions already affecting the species, or that will occur contemporaneously with the consultation in progress. Unrelated future federal actions affecting the same species that have completed consultation are also part of the environmental baseline, as are implemented and ongoing federal and other actions within the action area that may benefit listed species. The purpose of describing the environmental baseline in this manner is to provide context for the effects of the proposed action on the listed species.

5.1 Status of Species in the Action Area

Sea turtles

The five species of sea turtles that occur in the action area are all highly migratory. Therefore, the status of the 5 species (or DPS where applicable) of sea turtles in the action area, as well as the threats to these species, are best reflected in their range-wide statuses and supported by the species accounts in Section 4 (Status of Species).

Gulf sturgeon

Gulf sturgeon are known to inhabit and forage in Gulf of Mexico nearshore estuarine and marine habitats during the winter months. Incidental catch of Gulf sturgeon in both federally and state-regulated fisheries has been documented. There have been incidental captures of Gulf sturgeon in the shrimp and gillnet fisheries in Apalachicola Bay (Swift et al. 1977; Wooley and Crateau 1985). Similar incidental catches have been reported in Mobile Bay, Tampa Bay, and Charlotte Harbor. Louisiana Department of Wildlife and Fisheries (LDWF) reported 177 Gulf sturgeon were incidentally captured by commercial fishers in southeast Louisiana during 1992. There are 3 confirmed reports of Gulf sturgeon entrainment (lethal) from hopper dredging in 2004-2005. Nearshore telemetry receivers indicate winter habitat for Gulf sturgeon as mostly alongshore the northern coast of Mississippi Sound extending out to the Gulf Islands. Edwards et al (2007) reported on data collected from pop-up archival transmitting tags and found all relocations were consistent with alongshore migration and utilization of relatively shallow habitats. There are no data indicating Gulf sturgeon inhabit the deep Gulf of Mexico. NMFS believes that although the affected species occur in the action area during winter months, few, if any, Gulf sturgeon will be found in offshore federal waters (OCS). The status of Gulf sturgeon in the action area, as well as the threats to this species, is supported by the species account in Section 4 (Status of the Species).

5.2 Factors Affecting Sea Turtles in the Action Area

As stated in Section 3.2 (Action Area), the action area includes the area between Dauphin Island in Alabama and Petit Bois, Horn, East Ship, West Ship, and Cat Islands in Mississippi and the northern Gulf of Mexico to about 8 miles seaward of the barrier islands. The following analysis examines the impacts of past and on-going actions that may affect these species' environment specifically within this defined action area. The environmental baseline for this opinion includes the effects of several activities affecting the survival and recovery of ESA-listed sea turtle and sturgeon species in the action area. The activities that shape the environmental baseline in the action area of this consultation are primarily federal maintenance dredging projects. Other environmental impacts include effects of dredging, vessel operations, oil and gas exploration, permits allowing take under the ESA, private vessel traffic, and marine pollution.

5.2.1 Federal Actions

NMFS has undertaken a number of Section 7 consultations to address the effects of federally-permitted dredging and other federal actions on threatened and endangered sea turtle species, and when appropriate, has authorized the incidental taking of these species. Each of those consultations sought to minimize the adverse effects of the action on sea turtles. The summary below of federal actions and the effects these actions have had on sea turtles includes only those federal actions in the action areas which have already concluded or are currently undergoing formal Section 7 consultation.

5.2.1.1 Federal Dredging Activity

Marine dredging vessels are common within U.S. coastal waters. Although the underwater noises from dredge vessels are typically continuous in duration (for periods of days or weeks at a time) and strongest at low frequencies, they are not believed to have any long-term effect on sea turtles. However, the construction and maintenance of federal navigation channels and dredging in sand mining sites (borrow areas) have been identified as sources of sea turtle mortality. Hopper dredges in the dredging mode are capable of moving relatively quickly compared to sea turtle swimming speed and can thus overtake, entrain, and kill sea turtles as the suction draghead(s) of the advancing dredge overtakes the resting or swimming turtle. Entrained sea turtles rarely survive. NMFS completed Regional Opinions on the impacts of USACE's hopper-dredging operation in 2003 for operations in the Gulf of Mexico (NMFS 2003a; NMFS 2005c; NMFS 2007f). In the Gulf of Mexico Regional Opinion (GRBO), NMFS determined that (1) Gulf of Mexico hopper dredging would adversely affect Gulf sturgeon and 4 sea turtle species (i.e., green, hawksbill, Kemp's ridley, and loggerheads), but would not jeopardize their continued existence, and (2) dredging in the Gulf of Mexico would not adversely affect leatherback sea turtles, smalltooth sawfish, or ESA-listed large whales. An ITS for those species adversely affected was issued.

The above-listed Regional Opinion considers maintenance dredging and sand mining operations. Numerous other "free-standing" Opinions have been produced that analyzed hopper dredging projects that did not fall (partially or entirely) under the scope of actions contemplated by these Regional Opinions. For example, in the Gulf of Mexico, in 1998 the Houston-Galveston Navigation Channel dredging project was a major port improvement dredging project that was consulted on separately from the then-existing 1995 Gulf of Mexico Regional Opinion on "maintenance" hopper dredging (the predecessor of the 2003 GRBO). Numerous other Opinions have been issued in the Gulf of Mexico since 2003, covering navigation channel improvements and beach restoration projects, including: dredging of Ship Shoal in the Gulf of Mexico Central Planning Area for coastal restoration projects (Opinion issued to MMS, now BOEM, in 2005 (NMFS 2005a), Gulfport Harbor Navigation Project (to USACE in 2007 (NMFS 2007c), East Pass dredging, Destin, Florida (to USACE in 2009 (NMFS 2009a), Mississippi Coastal Improvements Program (federal restoration project) dredging and disposal of sand along West Ship Island barrier island (to USACE in 2010 (NMFS 2010), and dredging of City of Mexico beach canal inlet (to USACE in 2012 (NMFS 2012a). Each of the above free-standing Opinions had its own ITS and determined that hopper dredging during the proposed action would not jeopardize any species of sea turtles or other listed species, or destroy or adversely modify critical habitat of any listed species.

5.2.1.2 Federal Vessel Activity

Watercraft are the greatest contributors to overall noise in the sea and have the potential to interact with sea turtles though direct impacts or propellers. Sound levels and tones produced are generally related to vessel size and speed. Larger vessels generally emit more sound than smaller vessels, and vessels underway with a full load, or those pushing or towing a load, are noisier than unladen vessels. Vessels operating at high speeds have the potential to strike sea turtles. Potential sources of adverse effects from federal vessel operations in the action area include operations of the BOEM, FERC, USCG, NOAA, and USACE.

Recreational Boat Traffic

Data show that vessel traffic is one cause of sea turtle mortality (Lutcavage et al. 1997), Sea Turtle Stranding Database). Stranding data for the Gulf of Mexico coast show that vessel-related injuries are noted in stranded sea turtles. Data indicate that live- and dead-stranded sea turtles showing signs of vessel-related injuries continue in a high percentage of stranded sea turtles in coastal regions of the southeastern United States. Although the USACE-permitted docks and boats may determine the location of recreational vessels, for most projects the docks themselves are not believed to result in increases of the number recreational vessels on the water.

Offshore Energy

NMFS has also conducted Section 7 consultations related to energy projects in the Gulf of Mexico (BOEM, FERC, and USCG) to implement conservation measures for vessel operations. Through the Section 7 process, where applicable, NMFS has and will continue to establish conservation measures for all these agency vessel operations to avoid or minimize adverse effects to listed species. However, at the present time they present the potential for some level of interaction.

Operations of vessels by other federal agencies within the action area (NOAA, BOEM) may adversely affect sea turtles. Yet, the in-water activities of those agencies are limited in scope, as they operate a limited number of vessels or are engaged in research/operational activities that are unlikely to contribute a large amount of risk.

5.2.1.3 Oil and Gas Exploration and Extraction

Federal and state oil and gas exploration, production, and development are expected to result in some sublethal effects to protected species, including impacts associated with the explosive removal of offshore structures, seismic exploration, marine debris, oil spills, and vessel operation. Many Section 7 consultations have been completed on BOEM oil and gas lease activities. Until 2002, these Opinions concluded only one sea turtle take may occur annually due to vessel strikes. Opinions issued on July 11, 2002 (NMFS 2002d), November 29, 2002 (NMFS 2002a), August 30, 2003 (Lease Sales 189 and 197 (NMFS 2003i), and June 29, 2007 (2007-2012 Five-Year Lease Plan (NMFS 2007a) have concluded that sea turtle takes may also result from vessel strikes, marine debris, and oil spills.

Explosive removal of offshore structures and seismic exploration may adversely affect sea turtles. In July 2004, BOEM completed a programmatic environmental assessment (PEA) on geological and geophysical exploration on the Gulf of Mexico OCS. In an August 28, 2006 Opinion, NMFS issued incidental take for BOEM-permitted explosive structure removals (NMFS 2006a). On April 18, 2011, NMFS received a revised complete application from the BOEM requesting an authorization for the take of marine mammals incidental to seismic surveys on the OCS in the Gulf of Mexico (see 76 FR 34,656, June 14, 2011). NMFS intends to conduct a programmatic consultation with BOEM prior to issuing the requested MMPA authorization that will consider the effects to listed sea turtles for BOEM-authorized seismic activities throughout the northern Gulf of Mexico.

NMFS's June 29, 2007, Opinion issued to BOEM concluded that the 5-year leasing program for oil and gas development in the coastal and the Western Planning Areas of the Gulf of Mexico and its associated actions were not likely to jeopardize the continued existence of threatened or endangered species or destroy or adversely modify designated critical habitat. NMFS estimated the number of listed species that could potentially experience adverse effects as the result of exposure to an oil spill over the lifetime of the action. However, as discussed below, on April 20, 2010, a massive oil well explosion, and then subsequent release of oil at the DWH MC252 well occurred. Given the effects of the spill, on July 30, 2010, BOEM requested reinitiation of interagency consultation under Section 7 of the ESA on the June 29, 2007, Opinion on the 5-Year OCS Oil and Gas Leasing Program (2007-2012) in the Central and Western Planning Areas of the Gulf of Mexico.

NMFS has begun synthesizing data from the spill, and it is clear that BOEM underestimated the size, frequency, and impacts associated with a catastrophic spill under the 2007-2012 lease sale program. The size and duration of the DWH oil spill (see following paragraph) were greater than anticipated, and the effects on listed species have exceeded NMFS's projections. However, NMFS has not yet issued an Opinion concluding the reinitiated consultation.

Impact of Deep Water Horizon Oil Spill on Status of Sea Turtles

On April 20, 2010, while working on an exploratory well approximately 50 miles offshore Louisiana, the semi-submersible drilling rig Deepwater Horizon (DWH) experienced an explosion and fire. The rig subsequently sank and oil and natural gas began leaking into the Gulf of Mexico. Oil flowed for 86 days, until the well was finally capped on July 15, 2010. Millions of barrels of oil were released into the Gulf. Additionally, approximately 1.84 million gallons of chemical dispersant was applied both subsurface and on the surface to attempt to break down the oil. There is no question that the unprecedented DWH event and associated response activities (e.g., skimming, burning, and application of dispersants) have resulted in adverse effects on listed sea turtles.

At this time, the total effects of the oil spill on species found throughout the Gulf of Mexico, including ESA-listed sea turtles, are not known. Potential DWH-related impacts to all sea turtle species include direct oiling or contact with dispersants from surface and subsurface oil and dispersants, inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, loss of foraging resources which could lead to compromised growth and/or reproductive potential, harm to foraging, resting and/or nesting habitats, and disruption of nesting turtles and nests. There is an ongoing investigation and analyses being conducted under the Oil Pollution Act (33 U.S.C. 2701 et seq.) to assess natural resource damages and to develop and implement a plan for the restoration, rehabilitation, replacement or acquisition of the equivalent of the injured natural resources. The final outcome of that investigation may not be known for many months to years from the time of this Opinion. Consequently, other than some emergency restoration efforts, most restoration efforts that occur pursuant to the Oil Pollution Act have yet to be determined and implemented, and so the ultimate restoration impacts on the species are unknowable at this time.

During the response phase to the DWH oil spill (April 26 – October 20, 2010) a total of 1,146 sea turtles were recovered, either as strandings (dead or debilitated generally onshore or nearshore) or were collected offshore during sea turtle search and rescue operations (Table 10). Subsequent to the response phase a few sea turtles with visible evidence of oiling have been recovered as strandings. The available data on sea turtle strandings and response collections during the time of the spill are expected to represent a fraction (currently unknown) of the actual losses to the species, as most individuals likely were not recovered. The number of strandings does not provide insights into potential sublethal impacts that could reduce long-term survival or fecundity of individuals affected. It does, however, provide some insight into the potential relative scope of the impact among the sea turtle species in the area. Kemp’s ridley sea turtles may have been the most affected sea turtle species, as they accounted for almost 71% of all recovered turtles (alive and dead), and 79% of all dead turtles recovered. Green turtles accounted for 17.5% of all recoveries (alive and dead), and 4.8% of the dead turtles recovered. Loggerheads comprised 7.7% of total recoveries (alive and dead) and 11% of the dead turtle recovered. The remaining turtles were hawksbills and decomposed hardshell turtles that were not identified to species. No leatherbacks were among the sea turtles recovered in the spill response area. (Note: leatherbacks were documented in the spill area, but they were not recovered alive or dead).

Table 10. Sea Turtles Recovered in the DWH Spill Response Area (April 26 – October 20, 2010)

Turtle Species	Alive	Dead	Total
Green turtle (*Chelonia mydas*)	172	29	201
Hawksbill turtle (*Eretmochelys imbricata*)	16	0	16
Kemp's ridley turtle	328	481	809

(*Lepidochelys kempii*)			
Loggerhead turtle (*Caretta caretta*)	21	67	88
Unknown turtle species	0	32	32
Total	537	609	1146

(http://www.nmfs.noaa.gov/pr/health/oilspill/turtles.htm)

Although extraordinarily high numbers of threatened and endangered sea turtles were documented stranded (primarily within Mississippi Sound), during the DWH oil spill the vast majority of sea turtles recovered by the stranding network have shown no visible signs of oil. The DWH oil spill event increased awareness and human presence in the northern Gulf of Mexico, which likely resulted in some of the increased reporting of stranded turtles to the stranding network. However, we do not believe this factor fully explains the increases observed in 2010. We believe some of the increases in strandings may have been attributed to bycatch mortality in the shrimp fishery. As a result, on August 16, 2010, NMFS reinitiated Section 7 consultation on Southeast state and federal shrimp fisheries based on a high level of strandings, elevated nearshore sea turtle abundance as measured by trawl catch per unit of effort, and lack of compliance with TED requirements. These factors indicated sea turtles may be affected by shrimp trawling to an extent not previously considered in the 2002 shrimp Opinion.

Another period of high stranding levels occurred in 2011, similar to that in 2010. Investigations, including necropsies, were undertaken by NMFS to attempt to determine the cause of those strandings. Based on the findings, the 2 primary considerations for the cause of death of the turtles that were necropsied are forced submergence or acute toxicosis. With regard to acute toxicosis, sea turtle tissue samples were tested for biotoxins of concern in the northern Gulf of Mexico. Environmental information did not indicate a harmful algal bloom of threat to marine animal health was present in the area. With regard to forced submergence, the only known plausible cause of forced submergence that could explain this event is incidental capture in fishing gear. NMFS has assembled information regarding fisheries operating in the area during and just prior to these strandings. While there is some indication that lack of compliance with existing TED regulations and the operations of other trawl fisheries that do not require TEDs may have occurred in the area at the time of the strandings, direct evidence that those events caused the unusual level of strandings is not available. More information on the stranding event, including number of strandings, locations, and species affected, can be found at http://www.nmfs.noaa.gov/pr/species/turtles/gulfofmexico.htm.

In addition to effects on subadult and adult sea turtles, the 2010 May through September sea turtle nesting season in the northern Gulf may also have been adversely affected by the DWH oil spill. Setting booms to protect beaches, cleanup activities, lights, people, and equipment all may have had unintended effects, such as preventing females from reaching nesting beaches and thereby reducing nesting in the northern Gulf.

The oil spill may also have adversely affected emergence success. In the northern Gulf area, approximately 700 nests are laid annually in the Florida Panhandle and up to 80 nests are laid annually in Alabama. Most nests are made by loggerhead sea turtles; however, a few Kemp's ridley and green turtle nests were also documented in 2010. Hatchlings begin emerging from nests in early to mid-July; the number of hatchlings estimated to be produced from northern Gulf sea turtle nests in 2010 was 50,000. To try to avoid the loss of most, if not all, of 2010's northern Gulf of Mexico hatchling cohort, all sea turtle nests laid along the northern Gulf coast were visibly marked to ensure that nests were not harmed during oil spill cleanup operations that are undertaken on beaches. In addition, a sea turtle late-term nest collection and hatchling release plan was implemented to provide the best possible protection for sea turtle hatchlings emerging from nests in Alabama and the Florida Panhandle. Starting in June, northern Gulf nests were relocated to the Atlantic to provide the highest probability of reducing the anticipated risks to hatchlings as a result of the DWH oil spill. A total of 274 nests, all loggerheads except for 4 green turtle and 5 Kemp's ridley nests, were translocated just prior to emergence from northern Gulf of Mexico beaches to the east coast of Florida so that the hatchlings could be released in areas not affected by the oil spill (Table 11). In mid-August, it was determined that the risks to hatchlings emerging from beaches and entering waters off the northern Gulf coasts had diminished significantly and all nest translocations were ceased by August 19, 2010.

Table 11. Number of Turtle Nests Translocated from the Gulf Coast and Hatchlings Released in the Atlantic Ocean
(The sea turtle nest translocation effort ceased on August 19, 2010.)

Turtle Species	Translocated Nests	Hatchlings Released
Green turtle (*Chelonia mydas*)	4	455
Kemp's ridley turtle (*Lepidochelys kempii*)	5	125
Loggerhead turtle (*Caretta caretta*)	265*	14,216

*Does not include 1 nest that included a single hatchling and no eggs.
(http://www.nmfs.noaa.gov/pr/health/oilspill/turtles.htm)

The survivorship and future nesting success of individuals from one nesting beach being transported to and released at another nesting beach is unknown. The loggerheads nesting and emerging from nests in the Florida Panhandle and Alabama are part of the Northern Gulf of Mexico Recovery Unit (NGMRU) and differ genetically from loggerheads produced along the Atlantic Coast of Florida, but they are part of Northwest Atlantic Ocean DPS. Evidence suggests that some portion of loggerheads produced on Northern Gulf beaches are transported naturally into the Atlantic by currents and spend portions of their life cycle away from the Gulf of Mexico. This is based on the presence of some loggerheads with a northern Gulf of Mexico genetic signature in the Atlantic. These turtles are assumed to make their way back to the Gulf of Mexico as sub-adults and adults. It is unknown what the impact of the nesting relocation efforts will be on the NGMRU in particular, or the Northwest Atlantic DPS generally.

Loggerhead nesting in the northern Gulf of Mexico represents a small proportion of overall Florida loggerhead nesting and an even smaller proportion of the Northwest Atlantic Ocean DPS. The 5-year average (2006-2010) for the statewide number of loggerhead nests in the state of Florida is 56,483 nests annually (Florida Fish and Wildlife Conservation Commission nesting database) versus an average of well under 1,000 nests per year for the northern Gulf of Mexico (approximately 700 in 2010). We do not know what the impact of relocating 265 nests will be on the 2010 nesting cohort compared to the total of approximately 700 nests laid on Northern Gulf beaches. While there may be a risk of possible increased gene flow across loggerhead recovery units, all are within the Northwest Atlantic Ocean DPS and would likely not be on a scale of conservation concern. However, recovery units are subunits of the listed species that are geographically or otherwise identifiable and essential to the recovery of the species. Recovery units are individually necessary to conserve genetic robustness, demographic robustness, important life history stages, or some other feature necessary for long-term sustainability of the species. Recovery units are not necessarily self-sustaining viable units on their own, but instead need to be collectively recovered to ensure recovery of the entire listed entity. Recovery criteria must be met for all recovery units identified in the Recovery Plan before the Northwest Atlantic DPS can be considered for delisting.

As noted earlier, the vast majority of sea turtles collected in relation to the DWH oil release were Kemp's ridleys; 328 were recovered alive and 481 were recovered dead. We expect that additional mortalities occurred that were undetected and are, therefore, currently unknown. It is likely that the Kemp's ridley sea turtle was also the species most impacted by the DWH event on a population level. Relative to the other species, Kemp's ridley populations are much smaller, yet recoveries during the DWH oil spill response were much higher. The location and timing of the DWH event were also important factors. Although significant assemblages of juvenile Kemp's ridleys occur along the U.S. Atlantic coast, Kemp's ridley sea turtles use the Gulf of Mexico as their primary habitat for most life stages, including all of the mating and nesting. As a result, all mating and nesting adults in the population necessarily spend significant time in the Gulf of Mexico, as do all hatchlings as they leave the beach and enter the pelagic environment. However, not all of those individuals will have encountered oil and/or dispersants, depending on the timing and location of their movements relative to the location of the subsurface and surface oil. In addition to mortalities, the effects of the spill may have included disruptions to foraging and resource availability, migrations, and other unknown effects as the spill began in late April just before peak mating/nesting season (May-July) although the distance from the MC252 well to the primary mating and nesting areas in Tamaulipas, Mexico greatly reduces the chance of these disruptions to adults breeding in 2010. However, turtle returns from nesting beaches to foraging areas in the northern Gulf of Mexico occurred while the well was still spilling oil. At this time, we cannot determine the specific reasons accounting for year-to-year fluctuations in numbers of Kemp's ridley nests (the number of nests increased in 2011 as compared to 2010); however, there may yet be long-term population impacts resulting from the oil spill. How quickly the species returns to the previous fast pace of recovery may depend in part on how much of an impact the DWH event has had on Kemp's ridley food resources (Crowder and Heppell 2011).

Eighty-eight loggerhead sea turtles have been documented within the designated spill area as part of the response efforts; 67 were dead and 21 were alive. It is unclear how many of those without direct evidence of oil were actually impacted by the spill and spill-related activities versus other sources of mortality. There were likely additional mortalities that were undetected and, therefore, currently unknown. Although we believe that the DWH event had adverse effects on loggerheads, the population level effect was not likely as severe as it was for Kemp's ridleys. In comparison to Kemp's ridleys, we believe the relative proportion of the population exposed to the effects of the event was much smaller, the number of turtles recovered (alive and dead) are fewer in absolute numbers, and the overall population size is believed to be many times larger. Additionally, unlike Kemp's ridleys, the majority of nesting for the Northwest Atlantic Ocean loggerhead DPS occurs on the Atlantic coast. However, it is likely that impacts to the Northern Gulf of Mexico Recovery Unit of the NWA loggerhead DPS would be proportionally much greater than the impacts occurring to other recovery units because of impacts to nesting (as described above) and a larger proportion of the NGMRU recovery unit, especially mating and nesting adults, being exposed to the spill. However, the impacts to that recovery unit, and the possible effect of such a disproportionate impact on that small recovery unit to the NWA DPS and the species, remain unknown.

Green sea turtles comprised the second-most common species recovered as part of the DWH response. Of the 201 green turtles recovered 29 were found dead or later died while undergoing rehabilitation. The mortality number is lower than that for loggerheads despite loggerheads having far fewer total strandings, but this is because the majority of green turtles came from the offshore rescue (pelagic stage), of which almost all (of all species) survived after rescue, whereas a greater proportion of the loggerhead recoveries were nearshore neritic stage individuals found dead. While green turtles regularly use the northern Gulf of Mexico, they have a widespread distribution throughout the entire Gulf of Mexico, Caribbean, and Atlantic. As described in the Status of the Species section, nesting is relatively rare on the northern Gulf coast. Therefore, similar to loggerhead sea turtles, while it is expected that adverse impacts occurred, the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event, and thus the population-level impact, is likely much smaller than for Kemp's ridleys.

Available information indicates hawksbill and leatherback sea turtles were least affected, at least directly, by the oil spill. Potential DWH-related impacts to leatherback sea turtles include direct oiling or contact with dispersants from surface and subsurface oil and dispersants, inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those impacts, if they occurred.

5.2.1.4 ESA Permits

Sea turtles are the focus of research activities authorized by Section 10 permits under the ESA. Regulations developed under the ESA allow for the issuance of permits allowing take of certain ESA-listed species for the purposes of scientific research under Section 10(a)(1)(a) of the ESA. Authorized activities range from photographing, weighing, and tagging sea turtles incidentally taken in fisheries, to blood sampling, tissue sampling (biopsy), and performing laparoscopy on intentionally captured sea turtles. The number of authorized takes varies widely depending on the research and species involved, but may involve the taking of hundreds of sea turtles annually. Most takes authorized under these permits are expected to be (and are) nonlethal. Before any research permit is issued, the proposal must be reviewed under the permit regulations. In addition, since issuance of the permit is a federal activity, issuance of the permit by NMFS must also be reviewed for compliance with Section 7(a)(2) of the ESA to ensure that issuance of the permit does not result in jeopardy to the species or adverse modification of its critical habitat.

5.2.1.5 Fisheries

Threatened and endangered sea turtles are adversely affected by fishing gears used throughout the continental shelf of the action area. Gillnet, pelagic and bottom longline, other types of hook-and-line gear, trawl, and pot fisheries have all been documented as interacting with sea turtles.

For all fisheries for which there is a Fishery Management Plan (FMP), impacts have been evaluated under Section 7. Formal Section 7 consultations have been conducted on the following fisheries, occurring at least in part within the action area, found likely to adversely affect threatened and endangered sea turtles: Southeast shrimp trawl fisheries, Atlantic HMS pelagic longline, HMS directed shark, reef fish, and coastal migratory pelagic resources fisheries. Anticipated take levels associated with these fisheries are presented in Appendix 1; the take levels reflect the impact on sea turtles and other listed species of each activity anticipated from the date of the ITS forward in time.

Southeast shrimp trawl fisheries
Formal consultation has previously been conducted on Southeast shrimp fisheries, most recently in 2014. Although there are many different fisheries that affect sea turtles, shrimp trawling is believed to have had the greatest adverse effect on sea turtles in the action area in the past.

Shrimp trawling increased dramatically in the action area between the 1940s and the 1960s. By the late 1970s, there was evidence thousands of sea turtles were being killed annually in the Southeast (Henwood and Stuntz 1987). In 1990, the NRC concluded the Southeast shrimp trawl fishery affected more sea turtles than all other activities combined and was the most significant anthropogenic source of sea turtle mortality in the U.S. waters, in part due to the high reproductive value of turtles taken in this fishery (NRC 1990a).

The level of annual mortality described in NRC (1990a) is believed to have continued until 1992-1994, when U.S. law required all shrimp trawlers in the Atlantic and Gulf of Mexico to use turtle excluder devices (TEDs), which allowed some turtles to escape nets before drowning (NMFS 2002c). TEDs approved for use have had to demonstrate 97% effectiveness in excluding sea turtles from trawls in controlled testing. Despite the apparent success of TEDs for some species of sea turtles (e.g., Kemp's ridleys), it was later discovered that TEDs were not adequately protecting all species and size classes of sea turtles. Analyses by Epperly and Teas (2002) indicated that the minimum requirements for the escape opening dimension in TEDs in use at that time were too small for some sea turtles and that as many as 47% of the loggerheads stranding annually along the Atlantic and Gulf of Mexico were too large to fit the existing openings. In February 2003, NMFS implemented revisions to the TED regulations addressing that problem (68 FR 8456, February 21, 2003). The revised TED regulations were expected to reduce shrimp trawl related mortality by 94% for loggerheads and 97% for leatherbacks.

Interactions between sea turtles and otter trawls in the years leading up to the May 8, 2012 consultation were thought to be declining because of reductions in fishing effort that were unrelated to fisheries management actions, as well as improvements in TED designs. Low shrimp prices, rising fuel costs, competition with imported products, and the impacts of hurricanes in the Gulf of Mexico have all impacted shrimp fleets; in some cases reducing fishing effort by as much as 50% in offshore waters of the Gulf of Mexico (GMFMC 2007). For example, the estimated annual number of interactions and mortalities between sea turtles and shrimp trawls in the Gulf shrimp fisheries (state and federal) under the new regulation (68 FR

8456, February 21, 2003) based on Epperly et al. (2002) estimated CPUEs and 2007 effort data in Nance et al. (2008) were significantly less than predicted in the 2002 opinion (Table 12).

Table 12. Estimated annual number of interactions between sea turtles and shrimp trawls in the Gulf of Mexico shrimp fisheries associated estimated mortalities based on 2007 Gulf effort data taken from Nance et al. (2008) (December 8, 2008, Memorandum from Dr. Ponwith to Dr. Crabtree; Data Analysis Request: Update of turtle bycatch in the Gulf of Mexico shrimp fishery.

Species	**Estimated Interactions**	**Estimated Mortalities**
Leatherback	520	15
Loggerhead	23,336	647
Kemp's ridley	98,184	2,716
Green	11,311	319

On August 16, 2010, reinitiation of consultation on sea turtle effects was triggered by based on elevated strandings in the Northern Gulf of Mexico suspected to be attributable to shrimp trawling, compliance concerns with TED and tow-time regulations, and elevated nearshore sea turtle abundance trawl catch per unit of effort (CPUE). These factors collectively indicated that sea turtles were being affected by shrimp trawling, under the sea turtle conservation regulations and federal FMPs, to an extent not considered in the 2002 opinion, despite lower fishing effort levels.

On May 8, 2012, NMFS completed the new opinion which analyzed the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the Magnuson-Stevenson Fishery Conservation and Management Act (MSFCA)(NMFS 2012b). Sea turtle interactions and captures for otter trawls were estimated to be significantly higher than estimated in the 2002 opinion and the 2008 memorandum due to increases in Kemp's ridley and green sea turtle population abundance, incorporation of the TED compliance data and the effects those violations have on expected sea turtle captures rates, and incorporation of interactions in shrimp trawl gear types previously not estimated (i.e., skimmer trawls and try nets). An ITS was provided that used trawl effort and capture rates as surrogates for numerical sea turtle take levels. The opinion required NMFS to minimize the impacts of incidental takes through monitoring of shrimp effort and regulatory compliance levels, conducting TED training and outreach, and continuing to research the effects of shrimp trawling on listed species.

Subsequent to the completion of this Opinion, NMFS withdrew the proposed amendment to require TEDs in skimmer trawls, pusher-head trawls, and wing nets. Consequently, NMFS reinitiated consultation on November 26, 2012. Consultation was completed in April 2014 and determined the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the MSFCMA was not likely jeopardize the continued existence of any sea turtle species. The ITS maintained the use of anticipated trawl effort and fleet TED compliance as surrogates for numerical sea turtle takes.

Atlantic pelagic longline fisheries
Atlantic pelagic longline fisheries targeting swordfish and tuna are also known to incidentally capture and kill large numbers of loggerhead and leatherback sea turtles. U.S. pelagic longline fishermen began targeting highly migratory species in the Atlantic Ocean in the early 1960s. The fishery is comprised of 5 relatively distinct segments, including: the Gulf yellowfin tuna fishery (the only segment in our action area); southern Atlantic (Florida East Coast to Cape Hatteras) swordfish fishery; Mid-Atlantic and New England swordfish and bigeye tuna fishery; U.S. Atlantic Distant Water swordfish fishery; and the Caribbean tuna and swordfish fishery. Pelagic longlines targeting yellowfin tunas in the Gulf are set in the morning (pre-dawn) in deep water and hauled in the evening. Although this fishery does occur in the action area, fishing occurs further offshore than where shrimp trawling occurs. The fishery mainly interacts with leatherback sea turtles and pelagic juvenile loggerhead sea turtles, thus, younger, smaller loggerhead sea turtles than the other fisheries described in this environmental baseline.

Over the past 2 decades, NMFS has conducted numerous consultations on this fishery, some of which required RPAs to avoid jeopardy of loggerhead and/or leatherback sea turtles. The estimated historical total number of loggerhead and leatherback sea turtles caught between 1992-2002 (all geographic areas) is 10,034 loggerhead and 9,302 leatherback sea turtles of which 81 and 121 were estimated to be dead when brought to the vessel (NMFS 2004). This does not account for post-release mortalities, which historically were likely substantial.

NMFS reinitiated consultation in 2003 on pelagic longline fisheries as a result of exceeded incidental take levels for loggerheads and leatherbacks (NMFS 2004). The resulting 2004 opinion stated the long-term continued operation of this sector of the fishery was likely to jeopardize the continued existence of leatherback sea turtles, but RPAs were implemented allowing for the continued authorization of pelagic longline fishing that would not jeopardize leatherback sea turtles.

On July 6, 2004, NMFS published a final rule to implement management measures to reduce bycatch and bycatch mortality of Atlantic sea turtles in the Atlantic pelagic longline fishery (69 FR 40734). The management measures include mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality. The rulemaking, based on the results of the three-year Northeast Distant Closed Area research experiment and other available sea turtle bycatch reduction studies, is expected to have significantly benefitted endangered and threatened sea turtles by reducing mortality attributed to this fishery.

On March 31, 2014, the NMFS, Office of Sustainable Fisheries, Highly Migratory Species (HMS) Management Division requested that SERO reinitiate formal Section 7 consultation for the Atlantic pelagic longline (PLL) fishery based on the availability of information revealing effects of the action that may affect listed species in a manner or to an extent not previously considered (see 50 C.F.R. § 402.16 (b)). Specifically, the request is based on information indicating that the net mortality rate and total mortality estimates for leatherback sea turtles specified in the reasonable and prudent alternative were exceeded (although the take level specified in the incidental take statement has not been exceeded), changes in information about leatherback and loggerhead sea turtle populations, and new information about sea turtle mortality associated with PLL gear.

Gulf of Mexico Reef Fish Fishery
The Gulf of Mexico reef fish fishery uses two basic types of gear: spear or powerhead, and hook-and-line gear. Hook-and-line gear used in the fishery includes both commercial bottom longline and commercial and recreational vertical line (e.g., handline, bandit gear, rod-and-reel).

Prior to 2008, the reef fish fishery was believed to have a relatively moderate level of sea turtle bycatch attributed to the hook-and-line component of the fishery (i.e., approximately 107 captures and 41 mortalities annually, all species combined, for the entire fishery) (NMFS 2005b). In 2008, SEFSC observer programs and subsequent analyses indicated that the overall amount and extent of incidental take for sea turtles specified in the incidental take statement of the 2005 opinion on the reef fish fishery had been severely exceeded by the bottom longline component of the fishery (approximately 974 captures and at least 325 mortalities estimated for the period July 2006-2007).

In response, NMFS published an emergency rule prohibiting the use of bottom longline gear in the reef fish fishery shoreward of a line approximating the 50-fathom depth contour in the eastern Gulf of Mexico, essentially closing the bottom longline sector of the reef fish fishery in the eastern Gulf of Mexico for 6 months pending the implementation of a long-term management strategy. The Gulf of Mexico Fishery Management Council (GMFMC) developed a long-term management strategy via a new amendment (Amendment 31 to the Reef Fish FMP). The amendment included a prohibition on the use of bottom longline gear in the Gulf of Mexico reef fish fishery, shoreward of a line approximating the 35-fathom contour east of Cape San Blas, Florida, from June through August; a reduction in the number of bottom longline vessels operating in the fishery via an endorsement program; and a restriction on the total number of hooks that may be possessed onboard each Gulf of Mexico reef fish bottom longline vessel to 1,000, only 750 of which may be rigged for fishing.

On October 13, 2009, SERO completed an opinion that analyzed the expected effects of the continued operation of the Gulf of Mexico reef fish fishery under the changes proposed in Amendment 31 (NMFS-SEFSC 2009m). The opinion concluded that sea turtle takes would be substantially reduced compared to the fishery as it was previously prosecuted, and that operation of the fishery would not jeopardize the continued existence of any sea turtle species. Amendment 31 was implemented on May 26, 2010. In August 2011, consultation was reinitiated to address the DWH oil release event and potential changes to the environmental baseline. Reinitiation of consultation was not related to any material change in the fishery itself, violations of any terms and conditions of the 2009 opinion or exceedance of the ITS. The resulting September 11, 2011, opinion concluded the continued operation of the Gulf reef fish fishery is not likely to jeopardize the continued existence of any listed sea turtles, and an ITS was provided (NMFS 2011).

South Atlantic Snapper-Grouper Fishery
The South Atlantic snapper-grouper fishery uses spear and powerheads, black sea bass pots, and hook-and-line gear. Hook-and-line gear used in the fishery includes commercial bottom longline gear and commercial and recreational vertical line gear (i.e., handline, bandit gear, and rod-and-

reel). The most recent consultation was completed in 2006 (NMFS 2006c) and found only hook-and-line gear likely to adversely affect, green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles. The consultation concluded the proposed action was not likely to jeopardize the continued existence of any of these species, and an ITS was provided.

Atlantic HMS Directed Shark Fisheries
Atlantic HMS commercial directed shark fisheries also adversely affect sea turtles via capture and/or entanglement in the action area. The commercial component uses bottom longline and gillnet gear. Bottom longline is the primary gear used to target large coastal sharks (LCS) in the Gulf. The largest concentration of bottom longline fishing vessels is found along the central Gulf coast of Florida, with the John’s Pass - Madeira Beach area considered the center of directed shark fishing activities. Gillnets are the dominant gear for catching small coastal sharks (SCS); most shark gillnetting occurs off southeast Florida, outside of the action area.

Growing demand for shark and shark products encouraged expansion of the commercial shark fishery through the 1970s and 1980s. As catches accelerated through the 1980s, shark stocks started to show signs of decline. Peak commercial landings of large coastal and pelagic sharks were reported in 1989.

Atlantic LCS, SCS, and pelagic sharks have been managed by NMFS since the 1993 under an FMP for Atlantic Sharks. At that time, NMFS identified LCS as overfished and implemented commercial quotas for LCS (2,436 metric tons (mt) dressed weight) and established recreational harvest limits for all sharks. In 1994, under the rebuilding plan implemented in the 1993 Shark FMP, the LCS quota was increased to 2,570 mt dressed weight; in 1997, NMFS reduced the LCS commercial quota by 50% to 1,285 mt dressed weight and the recreational retention limit to 2 LCS, SCS, and pelagic sharks combined per trip with an additional allowance of 2 Atlantic sharpnose sharks per person per trip (62 FR 16648, April 2, 1997). Since 1997, the directed LCS fishing season was generally open for the first 3 months of the year and then a few weeks in July/August.

Observation of directed HMS shark fisheries has been ongoing since 1994, but a mandatory program was not implemented until 2002. Neritic juvenile and adult loggerhead sea turtles are the primary species that have been taken, but leatherback sea turtles have also been observed caught, and a few observations have been unidentified species of turtles. Between 1994 and 2002, the program covered 1.6% of all hooks, and over that time period caught 31 loggerhead sea turtles, 4 leatherback sea turtles, and 8 unidentified with estimated annual average take levels of 30, 222, and 56, respectively

In 2008, NMFS completed a Section 7 consultation on the continued authorization of directed Atlantic HMS shark fisheries under the Consolidated HMS FMP, including Amendment 2 (NMFS 2008). To protect declining shark stocks, Amendment 2 sought to greatly reduce the fishing effort in the commercial component of the fishery. These effort reductions are believed to have greatly reduced the interactions between the commercial component of the fishery and sea turtles. Amendment 2 to the Consolidated HMS FMP (73 FR 35778, June 24, 2008, corrected at 73 FR 40658, July 15, 2008) established, among other things, a shark research fishery to maintain time series data for stock assessments and to meet NMFS's 2009 research objectives. The shark research fishery permits authorize participation in the shark research fishery and the collection of sandbar and non-sandbar LCS from federal waters in the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea for the purposes of scientific data collection subject to 100% observer coverage. The commercial vessels selected to participate in the shark research fishery are the only vessels authorized to land/harvest sandbars subject to the sandbar quota available for each year. The base quota was 87.9 mt dressed weight per year through December 31, 2012, and has been 116.6 mt dressed weight /year since January 1, 2013. The selected vessels have access to the non-sandbar LCS, SCS, and pelagic shark quotas. Commercial vessels not participating in the shark research fishery are subject to 4-6% observer coverage and may only land non-sandbar LCS, SCS, and pelagic sharks subject to the retention limits and quotas per 50 CFR 635.24 and 635.27, respectively.

During 2007-2011, 10 sea turtle (all loggerheads) takes were observed on bottom longline gear in the sandbar shark research fishery and 5 were taken outside the research fishery. The 5 non-research fishery takes were extrapolated to the entire fishery, providing an estimate of 45.6 sea turtle takes (all loggerheads) for non-sandbar shark research fishery from 2007-2010 (Carlson and Richards 2011). No sea turtle takes were observed in the non-research fishery in 2011 (NMFSs unpublished data). Since the research fishery has a 100% observer coverage requirement those observed takes were not extrapolated (Carlson and Richards 2011).

The most recent ESA Section 7 consultation was completed on December 12, 2012, on the continued operation of shark fisheries and Amendments 3 and 4 to the Consolidated HMS FMP (NMFS 2012). Amendment 3 to the Consolidated HMS FMP (74 FR 36892; July 24, 2009) implemented measures to bring smoothhound sharks under federal management and end overfishing of blacknose and shortfin mako sharks. The amendment also implemented measures to rebuild blacknose sharks consistent with the 2007 SCS stock assessment, the MSFCA, and other domestic law. Amendment 4 to the Consolidated HMS FMP amended HMS fishery management regulations related to Atlantic sharks in the U.S. Caribbean to address substantial differences between some segments of the U.S. Caribbean HMS fisheries and the HMS fisheries that occur off the mainland of the United States. The 2012 shark opinion analyzed the potential adverse effects from the smoothhound fishery on sea turtles for the first time. Few smoothhound trips have been observed and no sea turtle captures have been documented in the smoothhound fishery. The opinion concluded the entire proposed action was not likely to jeopardize the continued existence of sea turtles, and an ITS was provided.

Coastal Migratory Pelagic Resources (CMPR) Fishery

NMFS completed a Section 7 consultation on the continued authorization of CMPR fishery in the Gulf of Mexico and South Atlantic (NMFS 2007d). Commercial fishermen target king and Spanish mackerel with hook-and-line (i.e., handline, rod-and-reel, and bandit), gillnet, and cast net gears. Recreational fishermen use only rod-and-reel. Trolling is the most common hook-and-line fishing technique used by both commercial and recreational fishermen. A winter troll fishery operates along the east and south Gulf coast. Although run-around gillnets accounted for the majority of the king mackerel catch from the late 1950s through 1982, in 1986, and in 1993, handline gear has been the predominant gear used in the commercial king mackerel fishery since 1993 (NMFS 2007d). The gillnet fishery for king mackerel is restricted to the use of “run-around” gillnets in Gulf to Monroe and Collier Counties in January. Run-around gillnets are still the primary gear used to harvest Spanish mackerel, but the fishery is relatively small because Spanish mackerel are typically more concentrated in state waters where gillnet gear is prohibited. The 2007 opinion concluded that green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles may be adversely affected only by the gillnet component of the fishery. The continued authorization of the fishery was not expected to jeopardize the continued existence of any of these species and an ITS was provided.

On November 26, 2012, NMFS requested reinitiation of consultation to evaluate the potential impact of this fishery on the recently listed 5 distinct population segments of Atlantic sturgeon. That consultation is ongoing.

Spiny Lobster Fishery
NMFS completed a Section 7 consultation on the Gulf and South Atlantic Spiny Lobster FMP on August 27, 2009 [i.e., (NMFS 2009b)]. The commercial component of the fishery consists of diving, bully net and trapping sectors; recreational fishers are authorized to use bully net and hand-harvest gears. Of the gears used, only traps are expected to result in adverse effects on sea turtles. The consultation determined the continued authorization of the fishery would not jeopardize any listed species. An ITS was issued for takes in the commercial trap sector of the fishery. Fishing activity is limited to waters off south Florida and, although the FMP does authorize the use of traps in federal waters, historic and current effort is very limited. Thus, potential adverse effects on sea turtles are believed to also be very limited (e.g., no more than a couple sea turtle entanglements annually).

Stone Crab Fishery
NMFS completed a Section 7 consultation on the Gulf of Mexico Stone Crab FMP on September 28, 2009 (NMFS 2009b). The commercial component of the fishery is traps; recreational fishers use traps or wade/dive for stone crabs. Of the gears used, only commercial traps are expected to result in adverse effects on sea turtles. The number of commercial traps actually in the water is very difficult to estimate, and the number of traps used recreationally is unquantifiable with any degree of accuracy. The consultation determined the continued authorization of the fishery was likely to adversely affect sea turtles, but would not jeopardize their continued existence; an ITS was issued for takes in the commercial trap sector of the fishery. On October 28, 2011, NMFS repealed the federal FMP for this fishery, and the fishery is now managed exclusively by the State of Florida.

Dolphin/Wahoo Fishery
The South Atlantic FMP for the dolphin/wahoo fishery was approved in December 2003. The stated purpose of the Dolphin and Wahoo FMP is to adopt precautionary management strategies to maintain the current harvest level and historical allocations of dolphin (90% recreational) and ensure no new fisheries develop. At that time, HMS pelagic logline vessels were also fishing for dolphin using small hooks attached to their surface buoys. NMFS conducted a formal Section 7 consultation to consider the effects on sea turtles of authorizing fishing under the FMP (NMFS 2003k). The August 27, 2003, opinion concluded that green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles may be adversely affected by the longline component of the fishery, but it was not expected to jeopardize their continued existence. An ITS for sea turtles was provided with the opinion. Pelagic longline vessels can no longer target

dolphin/wahoo with smaller hooks because of hook size requirements in the pelagic longline fishery, thus little longline effort targeting dolphin is currently believed to be present in the action area.

5.2.2 State or Private Actions

5.2.2.1 State Fisheries

Various fishing methods used in state commercial and recreational fisheries, including gillnets, fly nets, trawling, pot fisheries, pound nets, and vertical line are all known to incidentally take sea turtles, but information on these fisheries is sparse (NMFS 2001). Most of the state data are based on extremely low observer coverage, or sea turtles were not part of data collection; thus, these data provide insight into gear interactions that could occur but are not indicative of the magnitude of the overall problem.

Gillnet Fisheries

A detailed summary of the gillnet fisheries currently operating along the Gulf of Mexico, which are known to incidentally capture loggerheads, can be found in the TEWG reports (1998; 2000). Louisiana, Mississippi, and Alabama have placed restrictions on gillnet fisheries within state waters such that very little commercial gillnetting takes place.

Trawl Fisheries

On February 15, 2007, NMFS published an advanced notice of proposed rulemaking (ANPR) regarding potential amendments to the regulatory requirements for TEDs (72 FR 7382). The objective of the proposed measures were to effectively protect all life stages and species of sea turtle in Atlantic and Gulf of Mexico trawl fisheries where they are vulnerable to incidental capture and mortality. On June 24, 2011, NMFS published a proposed rule stating its intent to prepare an EIS and conduct public scoping meetings regarding potential amendments to the regulatory requirements for TEDs (76 FR 37050). Scoping meetings were held from July 12-18, 2011, in Louisiana, Mississippi, Alabama, and North Carolina, but a DEIS was never published. Ultimately, NMFS decided more research and development on TEDs for these fisheries was needed prior to any regulatory proposals and is focusing on those efforts.

Fixed Net Fisheries

Beyond commercial fisheries, observations of state recreational fisheries have shown that loggerhead, leatherback, Kemp’s ridley, and green sea turtles are known to bite baited hooks, and loggerheads and Kemp’s ridleys frequently ingest the hooks. Data reported through Marine Recreational Fisheries Statistics Survey (MRFSS) and Sea Turtle Stranding and Salvage Network (STSSN) show recreational fishers have hooked sea turtles when fishing from boats, piers, and beach, banks, and jetties.

Although few of these state regulated fisheries are currently authorized to incidentally take listed species, several state agencies have approached NMFS to discuss applications for a Section 10(a)(1)(B) incidental take permit. Since NMFS’s issuance of a Section 10(a)(1)(B) permit requires formal consultation under Section 7 of the ESA, any fisheries that come under a Section 10(a)(1)(B) permit in the future will likewise be subject to Section 7 consultation. Although the past and current effects of these fisheries on listed species are currently not determinable, NMFS believes that ongoing state fishing activities may be responsible for seasonally high levels of observed strandings of sea turtles on Gulf of Mexico coasts.

5.2.2.2 Vessel Traffic

Commercial traffic and recreational boating pursuits can have adverse effects on sea turtles via propeller and boat strike damage. The STSSN includes many records of vessel interactions (propeller injury) with sea turtles off Gulf of Mexico.

5.2.3 Other Potential Sources of Impacts in the Environmental Baseline

5.2.3.1 Marine Debris and Acoustic Impacts

A number of activities that may indirectly affect listed species in the action area of this consultation include anthropogenic marine debris and acoustic impacts. The impacts from these activities are difficult to measure. Where possible, conservation actions are being implemented to monitor or study impacts from these sources.

5.2.3.2 Marine Pollution and Environmental Contamination

Sources of pollutants along the action area include atmospheric loading of pollutants such as polychlorinated biphenyl (PCB), stormwater runoff from coastal towns and cities into rivers and canals emptying into bays and the ocean (e.g., Mississippi River into the Gulf of Mexico), and groundwater and other discharges. Nutrient loading from land-based sources such as coastal community discharges is known to stimulate plankton blooms in closed or semi-closed estuarine systems. The effects on larger embayments are unknown. Although pathological effects of oil spills have been documented in laboratory studies of marine mammals and sea turtles (Vargo et al. 1986), the impacts of many other anthropogenic toxins have not been investigated.

Coastal runoff, marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased under water noise and boat traffic can degrade marine habitats used by sea turtles (Colburn et al. 1996). The development of marinas and docks in inshore waters can negatively impact nearshore habitats. An increase in the number of docks built increases boat and vessel traffic. Fueling facilities at marinas can sometimes discharge oil, gas, and sewage into sensitive estuarine and coastal habitats. Although these contaminant concentrations do not likely affect the more pelagic waters, the species of turtles analyzed in this Opinion travel between near shore and offshore habitats and may be exposed to and accumulate these contaminants during their life cycles.

The Gulf of Mexico is an area of high-density offshore oil extraction with chronic, low-level spills and occasional massive spills (such as the recent DWH oil spill, Ixtoc I oil well blowout and fire in the Bay of Campeche in 1979, and the explosion and destruction of a loaded supertanker, the Mega Borg, near Galveston in 1990). Oil spills can impact wildlife directly through 3 primary pathways: ingestion – when animals swallow oil particles directly or consume prey items that have been exposed to oil, absorption – when animals come into direct contact with oil, and inhalation – when animals breath volatile organics released from oil or from “dispersants” applied by response teams in an effort to increase the rate of degradation of the oil in seawater. Several aspects of sea turtle biology and behavior place them at particular risk, including the lack of avoidance behavior, indiscriminate feeding in convergence zones, and large pre dive inhalations (Milton et al. 2003). When large quantities of oil enter a body of water, chronic effects such as cancer, and direct mortality of wildlife becomes more likely (Lutcavage et al. 1997). Oil spills in the vicinity of nesting beaches just prior to or during the nesting season could place nesting females, incubating egg clutches, and hatchlings at significant risk (Fritts and McGehee 1982; Lutcavage et al. 1997; Witherington 1999). Continuous low-level exposure to oil in the form of tar balls, slicks, or elevated background concentrations also challenge animals facing other natural and anthropogenic stresses. Types of trauma can include skin irritation, altering of the immune system, reproductive or developmental damage, and liver disease (Keller et al. 2004; Keller et al. 2006). Chronic exposure may not be lethal by itself, but it may impair a turtle's overall fitness so that it is less able to withstand other stressors (Milton et al. 2003).

The earlier life stages of living marine resources are usually at greater risk from an oil spill than adults. This is especially true for hatchlings, since they spend a greater portion of their time at the sea surface than adults; thus, their risk of exposure to floating oil slicks is increased (Lutcavage et al. 1995). One of the reasons might be the simple effects of scale: for example, a given amount of oil may overwhelm a smaller immature organism relative to the larger adult. The metabolic machinery an animal uses to detoxify or cleanse itself of a contaminant may not be fully developed in younger life stages. Also, in early life stages, animals may contain proportionally higher concentrations of lipids, to which many contaminants such as petroleum hydrocarbons bind. Most reports of oiled hatchlings originate from convergence zones, ocean areas where currents meet to form collection points for material at or near the surface of the water.

Unfortunately, little is known about the effects of dispersants on sea turtles, and such impacts are difficult to predict in the absence of direct testing. While inhaling petroleum vapors can irritate turtles' lungs, dispersants can interfere with lung function through their surfactant (detergent) effect. Dispersant components absorbed through the lungs or gut may affect multiple organ systems, interfering with digestion, respiration, excretion, and/or salt-gland function—similar to the empirically demonstrated effects of oil alone (Shigenaka et al. 2003). Oil cleanup activities can also be harmful. Earth-moving equipment can dissuade females from nesting and destroy nests, containment booms can entrap hatchlings, and lighting from nighttime activities can misdirect turtles (Witherington 1999).

There are studies on organic contaminants and trace metal accumulation in green and leatherback sea turtles (Aguirre et al. 1994; Caurant et al. 1999; Corsolini et al. 2000). Mckenzie et al. (1999) measured concentrations of chlorobiphenyls and organochlorine pesticides in sea turtles tissues collected from the Mediterranean (Cyprus, Greece) and European Atlantic waters (Scotland) between 1994 and 1996. Omnivorous loggerhead turtles had the highest organochlorine contaminant concentrations in all the tissues sampled, including those from green and leatherback turtles (Storelli et al. 2008). It is thought that dietary preferences were likely to be the main differentiating factor among species. Decreasing lipid contaminant burdens with turtle size were observed in green turtles, most likely attributable to a change in diet with age. Sakai et al. (1995) found the presence of metal residues points for material at or near the surface of the water. Sixty-five of 103 post-hatchling loggerheads in convergence zones off Florida's east coast were found with tar in the mouth, esophagus or stomach (Loehefener et al. 1989). Thirty-four percent of post-hatchlings captured in *Sargassum* off the Florida coast had tar in the mouth or esophagus and more than 50% had tar caked in their jaws (Witherington 1994). These zones aggregate oil slicks, such as a Langmuir cell, where surface currents collide before pushing down and around, and represents a virtually closed system where a smaller weaker sea turtle can easily become trapped (Carr 1987; Witherington 2002). Lutz (1989) reported that hatchlings have been found apparently starved to death, their beaks and esophagi blocked with tarballs. Hatchlings sticky with oil residue may have a more difficult time crawling and swimming, rendering them more vulnerable to predation.

Frazier (1980) suggested that olfactory impairment from chemical contamination could represent a substantial indirect effect in sea turtles, since a keen sense of smell apparently plays an important role in navigation and orientation. A related problem is the possibility that an oil spill impacting nesting beaches may affect the locational imprinting of hatchlings, and thus impair their ability to return to their natal beaches to breed and nest (Milton et al. 2003). Whether hatchlings, juveniles, or adults, tar balls in a turtle's gut are likely to have a variety of effects – starvation from gut blockage, decreased absorption efficiency, absorption of toxins, effects of general intestinal blockage (such as local necrosis or ulceration), interference with fat metabolism, and buoyancy problems caused by the buildup of fermentation gases (floating prevents turtles from feeding and increases their vulnerability to predators and boats), among others. Also, trapped oil can kill the seagrass beds that turtles feed upon.

Unfortunately, little is known about the effects of dispersants on sea turtles, and such impacts are difficult to predict in the absence of direct testing. While inhaling petroleum vapors can irritate turtles' lungs, dispersants can interfere with lung function through their surfactant (detergent) effect. Dispersant components absorbed through the lungs or gut may affect multiple organ systems, interfering with digestion, respiration, excretion occurring in loggerhead turtle organs and eggs. Storelli et al. (2008) analyzed tissues from twelve loggerhead sea turtles stranded along the Adriatic Sea (Italy) and found that characteristically, mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals and porpoises (Law et al. 1991). No information on detrimental threshold concentrations is available, and little is known about the consequences of exposure of organochlorine compounds to sea turtles. Research is needed on the short- and long-term health and fecundity effects of chlorobiphenyl, organochlorine, and heavy metal accumulation in sea turtles.

Nutrient loading from land-based sources, such as coastal communities and agricultural operations, are known to stimulate plankton blooms in closed or semi-closed estuarine systems. The effects on larger embayments are unknown. An example is the large area of the Louisiana continental shelf with seasonally-depleted oxygen levels (< 2 mg/Liter) is caused by eutrophication from both point and non-point sources. Most aquatic species cannot survive at such low oxygen levels and these areas are known as "dead zones." The oxygen depletion, referred to as hypoxia, begins in late spring, reaches a maximum in mid-summer, and disappears in the fall. Since 1993, the average extent of mid-summer, bottom-water hypoxia in the northern Gulf of Mexico has been approximately 16,000 km^2, approximately twice the average size measured between 1985 and 1992. The hypoxic zone attained a maximum measured extent in 2002, when it was about 22,000 km^2—larger than the state of Massachusetts (USGS 2005). The hypoxic zone has impacts on the animals found there, including sea turtles, and the ecosystem-level impacts continue to be investigated.

5.2.4 Conservation and Recovery Actions Benefiting Sea Turtles

NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles from commercial fisheries in the action area. These include sea turtle release gear requirements for Gulf of Mexico reef fish and TED requirements for the Southeast shrimp trawl fisheries. These regulations have relieved some of the pressure on sea turtle populations.

Under Section 6 of the ESA, NMFS may enter into cooperative research and conservation agreements with states to assist in recovery actions of listed species. NMFS has agreements with all states in the action area. Prior to issuance of these agreements, the proposal must be reviewed for compliance with Section 7 of the ESA.

Outreach and Education, Sea Turtle Entanglements, and Rehabilitation

NMFS and cooperating states have established an extensive network of Sea Turtle Stranding and Salvage Network (STSSN) participants along the Gulf of Mexico that not only collect data on dead sea turtles, but also rescue and rehabilitate any live stranded sea turtles.

Other Actions

Five-year status reviews were completed in 2007 for green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles. These reviews were conducted to comply with the ESA mandate for periodic status evaluation of listed species to ensure that their threatened or endangered listing status remains accurate. Each review determined that no delisting or reclassification of a species status (i.e., threatened or endangered) was warranted at this time. Further review of species data for the green, hawksbill, leatherback, and loggerhead sea turtles was recommended to evaluate whether distinct population segments (DPS) should be established for these species (NMFS and USFWS 2007a; NMFS and USFWS 2007j; NMFS and USFWS 2007n; NMFS and USFWS 2007r; NMFS and USFWS 2007v). The Services completed a revised recovery plan for the loggerhead sea turtle on December 8, 2008 (NMFS and USFWS 2008b) and published a Final Rule on September 22, 2011, listing loggerhead sea turtles as separate DPSs. A revised recovery plan for the Kemp's ridley sea turtle was completed on September 22, 2011. On October 10, 2012, NMFS announced initiation of 5-year reviews of Kemp's ridley (*Lepidochelys kempii*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*) sea turtles and requested submission of any pertinent information on those sea turtles that has become since their last status review in 2007. Further review of species data for the green sea turtles was recommended, and a new rule was proposed on March 23, 2015 to list 11 separate DPSs.

5.2.5 Summary and Synthesis of Environmental Baseline for Sea Turtles

In summary, several factors adversely affect sea turtles in the action area. These factors are ongoing and are expected to occur contemporaneously with the proposed action. Dredging in the action area likely had the greatest adverse impacts on sea turtles in the mid- to late-80s, when most maintenance dredge activity was being conducted without current conservation measures. Since the late 90s, the impacts associated with maintenance dredging have been reduced through the Section 7 consultation process and regulations implementing effective conservation strategies. Other environmental impacts including effects of fishing operations, vessel operations, oil and gas exploration, permits allowing take under the ESA, private vessel traffic, and marine pollution have also had and continue to have adverse effects on sea turtles in the action area in the past. The recent DWH oil spill event is expected to have had an adverse impact on the baseline for sea turtles, but the extent of that impact is not yet well understood.

5.3 Factors Affecting Gulf Sturgeon in the Action Area

As stated in Section 3.2 (Action Area), the action area includes the area between Dauphin Island in Alabama and Petit Bois, Horn, East Ship, West Ship, and Cat Islands in Mississippi and the northern Gulf of Mexico to about 8 miles seaward of the barrier islands. The environmental baseline for Gulf sturgeon includes the effects of several activities that may affect the survival and recovery of the threatened Gulf sturgeon in the action area.

5.3.1 Federal Actions

5.3.1.1 Federal Maintenance Dredging

Riverine, estuarine, and coastal navigation channels are often dredged to support commercial shipping and recreational boating. Dredging activities can pose significant impacts to aquatic ecosystems by (1) direct removal/burial of organisms, (2) turbidity/siltation effects,(3) contaminant re-suspension, (4) noise/disturbance, (5) alterations to hydrodynamic regime and physical habitat, and (6) loss of riparian habitat (Chytalo 1996; Winger et al. 2000). Dredging operations may also destroy benthic feeding areas, disrupt spawning migrations, and re-suspend fine sediments causing siltation over required substrate in spawning habitat. Because Gulf sturgeon are benthic omnivores, the modification of the benthos affects the quality, quantity, and availability of prey.

Hydraulic dredges (e.g., hopper) can lethally harm sturgeon directly by entraining sturgeon in dredge drag arms and impeller pumps. Mechanical dredges have also been documented to kill shortnose, Atlantic, and Gulf sturgeon (Dickerson 2005). Dickerson (2013) summarized observed takings of 37 sturgeon from dredging activities conducted by the USACE and observed between October 1990 and January 2013 (3 Gulf; 11 shortnose; and 23 Atlantic). Of the 3 types of dredges included (hopper, clam, and pipeline) in the report, hopper dredges captured the most sturgeon. Notably, reports include only those limited trips when an observer was on board to document capture and does not include sturgeon purposefully removed from the project area prior to dredging activities.

To reduce take of listed species, relocation trawling may be utilized to capture and move sea turtles and sturgeon. In relocation trawling, a boat equipped with nets precedes the dredge to capture sturgeon and sea turtles and then releases the animals out of the dredge pathway, thus avoiding lethal take. Relocation trawling has been successful and routinely moves sturgeon in the Gulf of Mexico. Between January 2005 and April 2006, relocation trawling captured and successfully moved 2 Gulf sturgeon near Mobile Bay, Alabama; 5 near Gulf Shores, Alabama; 1 near Destin, Florida; and 8 near Panama City Beach, Florida. Seasonal in-water work periods, when the species is absent from the project area, also assists in reducing incidental take.

In 2003, NMFS completed a Regional Opinion on hopper dredging in the Gulf of Mexico that includes impacts to Gulf sturgeon and its critical habitat via maintenance dredging. NMFS concluded 8 Gulf sturgeon may be killed or injured annually in USACE Gulf of Mexico hopper dredging operations and up to one killed or injured annually during annual relocation trawling in the Gulf of Mexico.

In summary, dredging and disposal to maintain navigation channels, and removal of sediments for beach renourishment occurs frequently and throughout the range of the Gulf sturgeon and within designated Gulf sturgeon habitat annually. This activity has, and continues to, threaten the species and affect its designated critical habitat.

5.3.1.2 Fisheries

Federal fisheries in the Gulf of Mexico use a variety of gear types including trawls, gillnet, pelagic and bottom longline, and other types of hook-and-line. Of these gear types, Gulf sturgeon are believed to be susceptible to capture only in trawl and gillnet gear via entanglement. Federal fisheries that NMFS authorizes in the Gulf of Mexico have likely had a minor impact on Gulf sturgeon. This is because Gulf sturgeon occur in the Gulf of Mexico only during winter months and during that time, most migrate alongshore and to barrier island habitats within shallower state waters. A shrimp trawl capture observed on December 15, 2009, was the first and only observed bycatch record in federal waters and was released alive. Prior to the May 2012 shrimp Opinion, Section 7 consultations on federal fisheries have always discounted effects on Gulf sturgeon because of their rarity on federal waters. The new record indicates that past captures in at least trawl gear likely have occurred, but they are still believed to have been rare.

5.3.1.3 Vessel Operations and Additional Military Activities

NMFS has recently completed 4 consultations on Eglin Air Force Base testing and training activities in the Gulf of Mexico. These activities have not been found to adversely Gulf sturgeon.

5.3.1.4 Oil and Gas Exploration and Extraction

NMFS has analyzed federal and state oil and gas exploration, production and development, explosive removal of offshore structures, and seismic exploration for potential effects to Gulf sturgeon. Opinions issued by NMFS on August 28, 2006 (NMFS 2006a), July 11, 2002 (NMFS 2002d), November 29, 2002 (NMFS 2002a), August 30, 2003 (Lease Sales 189 and 197 (NMFS 2003i), and June 29, 2007 (2007-2012 5-Year Lease Plan (NMFS 2007a) all concluded that these activities have had no effect on Gulf sturgeon.

5.3.1.5 Deepwater Horizon Oil Spill

On April 20, 2010, there was a massive oil spill in the Gulf of Mexico at British Petroleum’s DWH well. Million barrels of oil were released into the Gulf, with some experts estimating even higher volumes. The full environmental impact of this disaster will not be known for years to come and may never be known. Assessing the current impacts of this oil spill on Gulf sturgeon and their designated critical habitat is difficult because so much remains unknown or unclear about the impacts to the environment and habitat. Given these uncertainties, it is not practical to speculate on spill effects to the Gulf sturgeon environmental baseline at this time. However, we expect the primary route of effects to designated critical habitat from the release of oil and subsequent cleanup efforts is to the benthos and the benthic community it supports. There are at least 2 routes of exposure: suffocation of infaunal organisms and toxicity of substrate. Both of these effects would impact the abundance of Gulf sturgeon prey. The long-term impact to Gulf sturgeon and their designated critical habitat from exposure to oil and the subsequent response and clean-up efforts is currently unknown.

5.3.1.6 Federally-Permitted Discharges

Federally-regulated stormwater and industrial discharges and chemically-treated discharges from sewage treatment systems may impact Gulf sturgeon and their critical habitat. NMFS continues to consult with EPA to minimize the effects of these activities on both listed species and designated critical habitat. In addition, other federally-permitted construction activities, such as beach restoration, have the potential to impact Gulf sturgeon critical habitat.

5.3.1.7 ESA Permits

There are no federal permits for Gulf sturgeon research. The states have permitting authority (56 FR 49658; September 30, 1991) and no annual reporting is required.

5.3.2 State or Private Actions

The Gulf sturgeon recovery plan (NMFS and USFWS 1995) documents that Gulf sturgeon are occasionally incidentally captured in state fisheries in bays and sounds along the northern Gulf of Mexico. There is a single recorded interaction (E. Scott-Denton, NOAA, pers. comm. to J. Rueter, NMFS, August 8, 2014) of a Gulf sturgeon with the shrimp trawl fishery: 1 in state waters (December 15, 2009).

In the Pearl River a trammel/gillnet fishery is conducted for gar. Because of the gear (minimum of 3-inch square mesh, up to 3,000 ft in length) and the year-round nature of the fishery, it is probable that Gulf sturgeon are intercepted in this fishery. While state regulations prohibit taking or possession of whole or any body parts, including roe, there is no reporting to determine capture or release rates.

A number of activities that may indirectly affect Gulf sturgeon including discharges from wastewater systems, dredging, ocean pumping and disposal, and aquaculture facilities. The impacts from these activities are difficult to measure. However, where possible, conservation actions through the ESA Section 7 process, ESA Section 10 permitting, and state permitting programs are being implemented to monitor or study impacts from these sources.

Increasing coastal development and ongoing beach erosion will result in increased demands by coastal communities, especially beach resort towns, for periodic privately-funded or federally-sponsored beach renourishment projects. These activities may affect Gulf sturgeon and their critical habitat by burying nearshore habitats that serve as foraging areas.

5.3.3 Other Potential Sources of Impacts in the Environmental Baseline

5.3.3.1 Marine Pollution and Environmental Contamination

Pollution from industrial, agricultural, and municipal activities is believed responsible for a suite of physical, behavioral, and physiological impacts to sturgeon worldwide (Agusa et al. 2004; Barannikova 1995; Barannikova et al. 1995; Bickham et al. 1998; Billard and Lecointre 2000; Kajiwara 2003; Karpinsky 1992; Khodorevskaya et al. 1997; Khodorevskaya and Krasikov 1999). Although little is known about contaminant effects on Gulf Sturgeon, a review estimating potential reactions has been performed (Berg 2006). It was found that loss of habitat associated with pollution and contamination has been documented for sturgeon species (Barannikova et al. 1995; Shagaeva et al. 1993; Verina and Peseridi 1979). Specific impacts of pollution and contamination on sturgeon have been identified to include muscle atrophy, abnormality of gonad, sperm and egg development, morphogenesis of organs, tumors, and disruption of hormone production (Altuf'yev et al. 1992; Dovel et al. 1992; Georgi 1993; Graham 1981; Heath 1995; Khodorevskaya et al. 1997; Kruse and Scarnecchia 2002; Romanov and Sheveleva 1993).

More recently, pharmaceuticals and other endocrinologically active chemicals have been found in fresh and marine waters at effective concentrations (reviewed in (Fent et al. 2006). These compounds enter the aquatic environment via wastewater treatment plants, agricultural facilities, and farm runoff (Culp et al. 2000; Folmar et al. 1996; Wallin et al. 2002; Wildhaber et al. 2000). These products are the source of both natural and synthetic substances including, but not limited to, PCBs, phthalates, pesticides, heavy metals, alkylphenols, polycyclic aromatic hydrocarbons, 17β-estradiol, 17α-ethinylestradiol, and bisphenol A (Aguayo et al. 2004; Björkblom et al. 2009; Iwanowicz et al. 2009; Nakada et al. 2004; Pait and Nelson 2002). The impact of these exposures on Gulf sturgeon is unknown, but other species of fish are affected in rivers and streams. For example, one major class of endocrine disrupting chemicals, estrogenic compounds, have been shown to affect the male to female sex ratio in fish in streams and rivers via decreased gonad development, physical feminization, and sex reversal (Folmar et al. 1996). Settlement of these contaminants to the benthos may affect benthic foragers to a greater extent than pelagic foragers due to foraging strategies (Geldreich and Clarke 1966).

Several characteristics of the Gulf sturgeon (i.e., long lifespan, extended residence in riverine and estuarine habitats, benthic predator) predispose the species to long-term and repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants. Chemicals and metals such as chlordane, dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyltrichloroethane (DDT), dieldrin, PCBs, cadmium, mercury, and selenium settle to the river bottom and are later incorporated into the food web as they are consumed by benthic feeders, such as sturgeon or macroinvertebrates. Some of these compounds may affect physiological processes and impede the ability of a fish to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing DO, altering pH, and altering other water quality properties.

While laboratory results are not available for Gulf sturgeon, signs of stress observed in shortnose sturgeon exposed to low DO included reduced swimming and feeding activity coupled with increased ventilation frequency (Campbell and Goodman 2004). Niklitschek (2001) observed that egestion levels for Atlantic and shortnose sturgeon juveniles increased significantly under hypoxia, indicating that consumed food was incompletely digested. Behavioral studies indicate that Atlantic and shortnose sturgeon are quite sensitive to ambient conditions of oxygen and temperature: in choice experiments juvenile sturgeons consistently selected normoxic over hypoxic conditions (Niklitschek 2001). Beyond escape or avoidance, sturgeons respond to hypoxia through increased ventilation, increased surfacing (to ventilate relatively oxygen-rich surficial water), and decreased swimming and routine metabolism (Crocker and Cech Jr. 1997; Niklitschek 2001; Nonnotte et al. 1993; Secor and Gunderson 1998).

The majority of published data regarding contaminants and sturgeon health are limited to reports of tissue concentration levels. While these data are useful and allow for comparison between individuals, species, and regions, they do not allow researchers to understand the impacts of the concentrations. There is expectation that Gulf sturgeon are being negatively impacted by organic and inorganic pollutants given high concentration levels (Berg 2006). Gulf sturgeon collected from a number of rivers between 1985 and 1991 were analyzed for pesticides and heavy metals (Bateman et al. 1994); concentrations of arsenic, mercury, DDT metabolites, toxaphene, polycyclic aromatic hydrocarbons, and aliphatic hydrocarbons were sufficiently high to warrant concern. More recently, 20 juvenile Gulf sturgeon from the Suwannee River, Florida, exhibited an increase in metals concentrations with an increase in individual length (Alam et al. 2000).

Federal and state water quality standards are protective of most taxa in many habitats. However, impacts of reduced water quality continue to be realized at species-specific and habitat-specific scales, and magnification through the trophic levels continues to be assessed. The effects of most of these chemicals on the Gulf sturgeon or other protected species are poorly understood. Also, because there are thousands of chemicals interacting in our natural environment, many of them of human design, many do not have federal or state water quality standards associated with them.

5.3.4 Conservation and Recovery Actions Benefiting Gulf sturgeon

5.3.4.1 Cooperation with the States

Anthropogenic marine debris, pollution, runoff, and nutrient loading, stimulate plankton blooms in closed or semi-closed estuarine systems. The effects on larger embayments are unknown. Coupled with atmospheric loading of pollutants such as PCBs, these impacts are difficult to measure. Where possible, conservation actions are being implemented to monitor or study impacts from these sources. For example the State of Florida recently required the USACE to conduct pre- and post-construction prey surveys as part of a permit to remove sand for a beach renourishment project. NMFS is working with Florida to ensure that data and results will be useful in determining project impacts.

Cooperative conservation partnerships between NMFS and states can be formalized by entering into agreements pursuant to Section 6 of the ESA. NMFS has established partnerships for cooperative research on Gulf sturgeon via conservation agreements in the Gulf of Mexico with the States of Florida, Alabama, Mississippi, and Louisiana. Prior to issuance of these agreements, the proposal must be reviewed for compliance with Section 7 of the ESA.

Implementation of the Florida Net Ban (Amendment 3 of the Florida Constitution) in 1995 has likely benefited sturgeon. The Net Ban made unlawful the use of entangling nets (i.e., gill and trammel nets) in Florida waters and likely benefitted or accelerated Gulf sturgeon recovery given residence of sturgeon in near-shore waters where tangling gear is commonly used during much of their life span. Capture of small Gulf sturgeon in mullet gill nets was documented by state fisheries biologists in the Suwannee River fishery in the early 1970s. Large mesh gill nets and runaround gill nets were the fisheries gear of choice in historic Gulf sturgeon commercial fisheries. Absence of this gear in Florida eliminates it as a potential source of mortality of Gulf sturgeon.

5.3.4.2 Use of Turtle Excluder Devices in Trawl Fisheries

Gulf sturgeon benefit from the use of devices inserted into trawl nets designed to exclude other species, such as sea turtles and fish. Evidence of exclusion from a shrimp trawl net was documented when an Atlantic sturgeon caught off South Carolina by a shrimp trawler in December 2011 exited the through the TED alive. TEDs and bycatch reduction device requirements are expected to reduce bycatch of the conspecific (organism belonging to the same species) Atlantic sturgeon in Southeast trawl fisheries (ASSRT 2007). NMFS has required the use of TEDs in some Gulf of Mexico shrimp trawls since 1989 and the regulations have been refined over the years to ensure effectiveness is maximized through more widespread use, and proper placement, installation, configuration (e.g., width of bar spacing), and floatation.

5.3.4.3 Gulf Sturgeon Sampling Protocol

NMFS and USFWS established a standardized sampling protocol with the Gulf sturgeon researchers in 2010. Procedures for tagging were established, PIT tag frequencies were standardized, and a common datasheet was established. Tag information and morphometric data are being stored in a shared database managed by NMFS. A similar workshop to discuss and establish monitoring protocols occurred in 2012.

5.3.4.4 Other Actions

In 2009, NMFS and USFWS completed a 5-year status review for Gulf sturgeon (USFWS and NMFS 2009) and concluded that the species continues to meet the status of a threatened species. As part of that review, NMFS and USFWS also critiqued the recovery criteria listed in the 1995 Recovery Plan (USFWS and GSMFC 1995) and concluded that new criteria are necessary to (1) reflect the best available and most up-to date information on the biology of the species, (2) address the 5 statutory listing/recovery factors, and (3) improve monitoring methods for demonstrating progress towards reducing threats and for determining when the protections of the Act are no longer necessary. NMFS and USFWS are actively working to revise and update the 1995 Gulf Sturgeon Recovery Plan.

5.3.5 Summary and Synthesis of Environmental Baseline for Gulf sturgeon

In summary, few factors adversely affect Gulf sturgeon in the Gulf of Mexico. However, these factors are ongoing and are expected to occur contemporaneously with the proposed action. Gulf sturgeon will be taken annually through activities to maintain federal channels and sand mining for beach renourishment. Point and non-point runoff will continue to have adverse effects on estuarine and marine habitats. The recent DWH oil spill event is expected to have had an adverse impact on the baseline for Gulf sturgeon critical habitat, but the extent of that impact is not yet well understood. Actions to conserve and recover Gulf sturgeon have significantly increased over the past 10 years and are expected to continue.

5.4 Status of Gulf Sturgeon Critical Habitat within the Action Area

The status of GSCH in the action area, as well as the threats to this critical habitat, are supported by the critical habitat account in Section 4.8 (Status of the Critical Habitat).

5.5 Factors Affecting Gulf Sturgeon Critical Habitat Critical Habitat within the Action Area

The April 2003 joint designation of GSCH by NMFS and USFWS will benefit the species primarily through the ESA Section 7 consultation processes. When critical habitat is designated, other federal agencies are required to consult with NMFS on actions they carry out, fund, or authorize, to ensure that their actions will not destroy or adversely modify critical habitat. In this way, a critical habitat designation will protect physical and biological features that are essential to the conservation of the species. Designation of critical habitat may also enhance awareness within federal agencies and the general public of the importance of GSCH and the need for special management considerations. Further, federal Essential Fish Habitat (EFH) consultation requirements pursuant to the Magnuson-Stevens Fishery Management and Conservation Act may minimize and mitigate for losses of wetlands and preserve valuable GSCH. Since designation, over 66,500.42 acres have been impacted (temporarily and permanently) in Unit 8 from NMFS-consulted actions.

DWH Legacy Effects on *Gulf Sturgeon Critical Habitat*
According to an analysis conducted by NMFS on the DWH spill oiling legacy (M. Press, NMFS, memo to D. Bernhart, NMFS, December 8, 2014), indirect impacts to water quality could occur if the authorized activities disturbed a submerged oil mats (SOMs) remnant of the DWH spill. Contributors to Operational Science Advisory Team (OSAT III) report have stated that while there is a possibility that dredging activities could re-suspend oil into the water column in certain areas, the likelihood of this happening is low. Additionally, an analysis of the matrix of material (oil plus sand) stranded in mats revealed that SOMs were composed mostly of sand: 83.2%-90.6% sand and 9.4%-16.8% oil (OSAT II). Furthermore, the likelihood of any re-suspended DWH oil being toxic is low, and should not have measurable effects on water quality (or on listed species directly) (W. Bryant, OSAT III Science Team Lead, pers. comm. to M. Press, NMFS, July 31, 2014).

Indirect impacts to sediment quality could occur if the authorized activities disturbed a SOM as described above, and release chemical pollutants into sediments. Based on information presented in OSAT II and III, NMFS believes that the likelihood of encountering a SOM during the dredging activity in this area is extremely low. Furthermore, if a SOM is disturbed and oil is suspended into the water column or mixed into the sediment, NMFS believes that the toxicity levels would be minimal and would dissipate quickly. Therefore, NMFS concludes the proposed effects on the sediment quality essential feature will be insignificant.

Direct effects to prey abundance could occur if the authorized activities expose aquatic invertebrates to chemical pollutants emanating from disturbed SOMs. However, OSAT II reports that concentrations of oil constituents in the aquatic environment are predicted to drop off exponentially within millimeters from the micro-layer around SOMs, as a result of mixing. Given this and the fact that the likelihood of SOMs being disturbed is very low, NMFS concludes that effects on the Gulf sturgeon prey abundance will be insignificant.

5.6 Status of Northwest Atlantic Loggerhead DPS Critical Habitat within the Action Area

The status of NWA loggerhead DPS critical habitat in the action area, as well as the threats to this critical habitat, are supported by the critical habitat account in Section 4.11 (Status of the Critical Habitat).

6 EFFECTS OF THE ACTION

Effects of the action include the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). At this time, NMFS does not foresee any interrelated or interdependent effects. When determining the potential impacts to critical habitat this Biological Opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. Ultimately, we seek to determine if, with the implementation of the proposed action (i.e., MsCIP Project), critical habitat would remain functional (or retain the current ability for the essential features to be functionally established) to serve the intended conservation role for the species.

Activities Likely to Adversely Affect Listed Species and Critical Habitat
Potential routes of effects of the proposed action on sea turtles, Gulf sturgeon, and Gulf sturgeon critical habitat include direct and indirect effects of the proposed action attributable to hopper dredging, movement of the dredge, placement of dredge spoil and re-handling of spoil, and relocation trawling, and will be discussed below. Therefore, effects must be evaluated from dredging of material and its disposal in the gap between West and East Ship Island, Cat Island, and future placement of dredged material from Pascagoula Ship Channel in the littoral area off of DA-10. These actions are analyzed individually and additively in the following paragraphs.

6.1 Effects to Sea Turtles

We first review the range of responses an individual sea turtle may have when exposed to different aspects of the proposed action, and then the factors affecting the likelihood, frequency, and severity of sea turtle exposure. Effects are generally broken down into 3 categories: interactions, captures, and mortalities. An interaction occurs anytime sea turtles come into contact with hopper dredges, cutterhead dredges, pipelines, sand being dumped, and/or relocation trawls. Finally, we discriminate between lethal and nonlethal effects for the various components of the proposed action where applicable.

6.1.1 Hopper Dredge

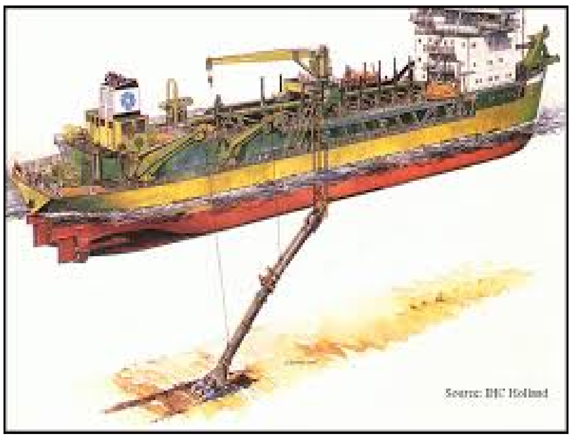
It has been previously documented in NMFS Biological Opinions that hopper dredges have captured, injured, and killed sea turtles. Hopper dredges move relatively rapidly (compared to sea turtle swimming speeds) and can entrain and kill sea turtles as the drag arm(s) of the moving dredge overtakes the slower moving or stationary sea turtle. In U.S. waters, loggerhead, hawksbill, Kemp’s ridley, and green sea turtles are vulnerable to entrainment in the suction draghead of the hopper dredge. These sea turtle species are likely to be feeding on or near the bottom of the water column during the warmer months, with loggerhead and Kemp’s ridley sea turtles being the most common species in this area of the Gulf, however, green sea turtles are also likely to occur within this area. Leatherback sea turtles are generally not vulnerable to entrainment due to their large size and generally pelagic habits. Furthermore, the USACE has no records of leatherback sea turtles being entrained in hopper dredge operations within the Gulf of Mexico or elsewhere (USACE Sea Turtle Data Warehouse 2013).

Sea turtles can become entrained in hopper dredges as the draghead moves along the bottom. Entrainment occurs when sea turtles cannot escape from the suction of the dredge. Sea turtles can also be crushed on the bottom by the moving draghead. Mortality most often occurs when turtles are sucked into the dredge draghead, pumped through the intake pipe, and then killed as they cycle through the centrifugal pump and into the hopper. Because entrainment is believed to occur primarily while the draghead is operating on the bottom, it is likely that only those species feeding or resting on or near the bottom would be vulnerable to entrainment. Turtles can also be entrained if suction is created in the draghead by current flow while the device is being placed or removed, or if the dredge is operating on an uneven or rocky substrate and rises off the bottom.

Recent information from the USACE suggests that the risk of entrainment is highest when the bottom terrain is uneven or when the dredge is conducting “cleanup” operations at the end of a dredge cycle when the bottom is trenched and the dredge is working to level out the bottom. In these instances, it is difficult for the dredge operator to keep the draghead buried in the sand, thus sea turtles near the bottom may be more vulnerable to entrainment. Sea turtles have been found resting in deeper waters, which could increase the likelihood of interactions from dredging activities conducted there.

6.1.1.1 Hopper Dredge Impingement/Entrainment

Dredged material is raised by dredge pumps through dragarms (see figure below) connected to drags in contact with the channel bottom and discharged into hoppers built in the vessel. Hopper dredges are equipped with large centrifugal pumps similar to those employed by other hydraulic dredges. Suction pipes (dragarms) are hinged on each side of the vessel with the intake (drag) extending downward toward the stern of the vessel. The dragarm is moved along the bottom as the vessel moves forward at speeds up to 3 miles per hour (mph). The dredged material is sucked up the pipe and deposited and stored in the hoppers of the vessel.



Most sea turtles are able to escape from the oncoming draghead due to the slow speed that the draghead advances (up to 3 mph or 4.4 ft/second). Interactions with a hopper dredge result primarily from crushing when the draghead is placed on the bottom or when an animal is unable to escape from the suction of the dredge and becomes stuck on the draghead (impingement). Entrainment occurs when organisms are sucked through the draghead into the hopper. Mortality most often occurs when animals are sucked into the dredge draghead, pumped through the intake pipe and then killed as they cycle through the centrifugal pump and into the hopper.

Interactions with the draghead can also occur if the suction is turned on while the draghead is in the water column (i.e., not seated on the bottom). USACE implements procedures to minimize the operation of suction when the draghead is not properly seated on the bottom sediments which reduce the risk of these types of interactions.

Sea turtles have been killed in hopper dredge operations along the South Atlantic and Gulf coasts of the United States. Turtle mortalities documented during dredging operations in the USACE South Atlantic Division (SAD), which includes North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Puerto Rico, and the U.S. Virgin Islands, are more common in the South Atlantic presumably due to the greater abundance of turtles in these waters and the greater frequency of hopper dredge operations. On the South Atlantic coast (North Carolina, South Carolina, Georgia, Florida), approximately 622 sea turtles have been entrained in hopper dredges since 1980 and in the Gulf Region (Texas, Louisiana, Mississippi, Alabama, and Florida) approximately 208 sea turtles have been killed since 1995 (Tables 13 and 14).

Table 13. Gulf Region Dredging Turtles Takes (including New Orleans, Mobile, Jacksonville, and Galveston districts) 1995-2013

Loggerhead	Kemps	Green	Leatherback	Hawksbill	Unknown	Total	Number of projects
118	46	41	0	0	3	208	202

Table 14. South Atlantic Region Dredging Turtle Takes (including Jacksonville, Savannah, Charleston, and Wilmington) 1980-2013

Loggerhead	Kemps	Green	Leatherback	Hawksbill	Unknown	Total	Number of projects
417	35	80	0	0	90	622	297

Interactions are likely to be most numerous in areas where sea turtles are resting or foraging on the bottom. When sea turtles are at the surface or within the water column, they are not likely to interact with the dredge because there is little, if any, suction force in the water column. Sea turtles have been found resting in deeper waters, which could increase the likelihood of interactions from dredging activities. In 1981, observers documented the take of 71 loggerheads by a hopper dredge at the Port Canaveral Ship Channel, Florida (Slay and Richardson 1988). This channel is a deep, low-productivity environment in the Southeast Atlantic where sea turtles are known to rest on the bottom, making them extremely vulnerable to entrainment. The large number of turtle mortalities at the Port Canaveral Ship Channel in the early 1980s resulted in part from turtles' being buried in the soft bottom mud, a behavior known as brumation. Chelonid turtles have been found to make use of deeper, less productive channels as resting areas that afford protection from predators because of the low energy, deep water conditions. Habitat in the action area is not consistent with areas where sea turtle brumation has been documented; therefore, we do not anticipate any sea turtle brumation in the action area. Very few interactions with sea turtles have been recorded in offshore borrow areas such as the ones considered in this Opinion. This may be because the area where the dredge is operating is more wide-open providing more opportunities for escape from the dredge as compared to a narrow river or harbor entrance. Sea turtles may also be less likely to be resting or foraging at the bottom while in open ocean areas, which would further reduce the potential for interactions.

In the 2003 GRBO (NMFS 2003a), NMFS acknowledges that documented takes represent partial estimates of total takes and believes that some takes may pass undetected by observers through inflow screening devices, due to the force of the water pressure, or because the animals are killed but not entrained; NMFS estimates that unseen (thus, undocumented) takes represent roughly 50% of total documented takes and has evaluated the effects of the action including the expected undocumented takes. NMFS-approved observers monitor dredged material inflow and overflow screening baskets on many projects; however, screening is only partially effective and observed, documented takes provide only partial estimates of total sea turtle mortality.

It is NMFS's opinion that some listed species taken by hopper dredges go undetected because body parts are forced through the sampling screens by the water pressure and are buried in the dredged material, or animals are crushed or killed but not entrained by the suction and so the takes may go unnoticed. The only mortalities that are documented are those where body parts either float, or are large enough to be caught in the screens, and can be identified as from sea turtle species. However, the GRBO estimates that with 4-inch inflow screening in place, the observers probably detect and record at least 50% of total mortality.

6.1.1.2 Lethal Takes by Hopper Dredge (State Waters)

We analyzed the numbers of turtles killed by hopper dredging in previous hopper dredge projects in the Mobile District to estimate take from the proposed action. The USACE has posted reported sea turtle takes from hopper dredging activities for operations for the Mobile District beginning in 2002 on the Sea Turtle Data Warehouse website (http://el.erdc.usace.army.mil/seaturtles/info.cfm?Type=District&Code=SAM). For the recorded activity between 2002 and 2013 within the Mobile District, there have been over 50 projects that have required a hopper dredge. During that 11-year time period, the project site-specific available data on sea turtle interactions with hopper dredges shows that 15 sea turtles (6 loggerhead, 8 Kemp's, 1 green) have been documented as killed by hopper dredging activities. While this information demonstrates that loggerhead, Kemp's ridley, and green sea turtles are known to occur in the action area, it does not provide quantitative information on status, trends, or density of these species in the action area. It does help us anticipate which species are likely to be within the action area in the absence of specific population data (e.g., nesting, migration). As noted in Section 4, leatherback sea turtles are generally found in deep, pelagic, offshore waters. The typical leatherback turtle would be as large or larger than the large, industry-standard hopper dredge draghead. Impacts to leatherback sea turtles by hopper dredges will not be considered further in this Opinion based on the unlikelihood of their presence nearshore and their non-benthic feeding habits which combine to produce a very low likelihood of hopper dredge entrainment.

The above data shows that Kemp's ridleys sea turtles have been the predominant species for both hopper dredge and relocation trawl captures, followed by loggerhead, and green. Specifically, USACE Mobile District data above show that Kemp's ridleys are taken lethally in a ratio of 1.3 Kemp's ridley to 1 loggerhead in hopper dredges. Because of the location of the dredge site where hopper dredging and relocation trawling will occur and the location of the disposal area, NMFS believes Kemp's ridleys are more likely to be in the action area in greater abundance than either loggerheads or green sea turtles and we expect that Kemp's ridleys will be encountered more than the other 2 species.

To estimate the number of sea turtles that may be killed by the proposed action, we examined the ratio of sea turtles killed to the total number of cubic yards (yd^3) hopper dredged, as we have in past Opinions on similar actions. The total cubic yards of material dredged for the entire Mobile District for the 11-year time period is 57,250,112 yd^3. The number of sea turtles that were documented by onboard observers as killed by hopper dredging in association with these projects totaled 15 turtles (6 loggerhead, 8 Kemp's, 1 green). If we divide the total cubic yards dredged (57,250,112) by the total number of sea turtles observed as killed by hopper dredge (15), this equals 1 *observed* sea turtle mortality for every 3,816,112 yd^3 dredged. The proposed action could dredge approximately 33.7 million yd^3 of material from the proposed borrow sites in state waters. Based on the calculations above (33,700,000/3,816,112 = 8.83 ≈ 9), we might estimate that 9 sea turtles would be observed as killed by the proposed action in state waters. Due to the encounter data discussed above, we believe that Kemp's ridleys are more likely to be in the action area in greater abundance than either loggerheads or green sea turtles and we expect that Kemp's ridleys will be encountered more than the other 2 species. Therefore, NMFS believes that the proposed action in state waters will result in 9 *observed* killed turtles (by hopper dredge) for the estimated 33.7million yd^3 dredged. These individuals will most likely be 5 Kemp's ridleys and 4 loggerheads; or 5 Kemp's ridley and 3 loggerhead and 1 green turtle.

Table 15. State Water Borrow Area Acreage and Volume Estimates

Borrow Area	**Acres**	**Estimated Dredge Volume (Required) million yd^3**	**Estimated Additional Dredge Volume (Allowed) million yd^3**	**Estimated Dredge Volume million yd^3 (Total)**
State Waters Borrow Areas				
Ship Island	183	2.1	0.6	2.7
Petit Bois Pass- MS	175	1.6	0.4	2.0
Petit Bois- AL East	885	12.0	2.7	14.7
Petit Bois- AL West	380	3.9	1.2	5.1
Cat Island	429	2.9	1.4	4.3
Horn Island Pass				
HIP1	168	0.9	0.5	1.4
HIP2	137	0.9	0.4	1.3
HIP3	307	1.0	1.2	2.2
Total	**2,664**	**25.3**	**8.4**	**33.7**

As discussed above, dredged material screening by observers on hopper dredges is only partially effective, and observed interactions are expected to document only 50% of sea turtles entrained and killed by a hopper dredge (NMFS 2003a). Thus, the total anticipated lethal take of sea turtles by the proposed action in state waters is 10 Kemp's ridleys and 8 loggerheads; or 10 Kemp's ridleys, 6 loggerheads, and 2 green turtles.

6.1.1.3 Lethal Takes by Hopper Dredge (OCS Waters)

To estimate the number of sea turtles that may be killed by the proposed action in the OCS, we utilized the same data discussed in Section 6.1.1.2. The proposed action could dredge approximately 19.6 million yd^3 of material from the proposed borrow sites in state waters and the OCS. Based on the calculations above (19,600,000/3,816,112 = 5.13 ≈ 5), we estimate that 5 sea turtles would be observed as killed by the proposed action. Due to the encounter data discussed above, we believe that Kemp's ridleys are more likely to be in the action area in greater abundance than either loggerheads or green sea turtles and we will assume that Kemp's ridleys will be encountered more than the other 2 species. Therefore, NMFS believes that the proposed action in the OCS will result in 5 *observed* killed turtles (by hopper dredge) for the estimated 19.6 million yd^3 dredged. These individuals will most likely be 4 Kemp's ridleys and 1 loggerheads; or 3 Kemp's ridley and 1 loggerhead and 1 green turtle.

Table 16. Outer Continental Shelf Borrow Area Acreage and Volume Estimates

Borrow Area	**Acres**	**Estimated Dredge Volume (Required) million yd^3**	**Estimated Additional Dredge Volume (Allowed) million yd^3**	**Estimated Dredge Volume million yd^3 (Total)**
Petit Bois Pass- OCS West				
PBP-OCS West 1	420	1.6	1.5	3.1
PBP-OCS West 2	192	0.8	0.8	1.6
PBP-OCS West 3	275	4.6	0.9	5.5
PBP-OCS West 4	195	1.8	0.6	2.4
PBP-OCS West 5	155	0.5	0.8	1.3
PBP-OCS West 6	146	1.0	0.5	1.5
Petit Bois Pass- OCS East				
PBP-OCS East 1	51	0.3	0.1	0.4
PBP-OCS East 2	302	2.1	0.8	2.9
PBP-OCS East 3	39	0.2	0.1	0.3
PBP-OCS East 4	43	0.2	0.1	0.3
PBP-OCS East 5	29	0.2	0.1	0.3
Total	**1,847**	**13.3**	**6.3**	**19.6**

As discussed above, dredged material screening by observers on hopper dredges is only partially effective, and observed interactions are expected to document only 50% of sea turtles entrained and killed by a hopper dredge (NMFS 2003a). Thus, the total anticipated lethal take of sea turtles by the proposed action in OCS waters is 8 Kemp's ridleys and 2 loggerheads; or 6 Kemp's ridleys and 2 loggerheads and 2 green turtles.

6.1.2 Hydraulic Dredging (*State and OCS Waters*)

A hydraulic dredge (cutterhead) may be used to excavate material from the project borrow areas and a pipeline would be used to transport and disperse the material within the disposal site. NMFS has previously determined in Biological Opinions that, while hopper dredges may lethally entrain protected species, non-hopper type dredging methods (e.g., clamshell or bucket dredging, cutterhead dredging, pipeline dredging, sidecast dredging) are unlikely to adversely affect motile listed species, and deems the risk of interactions with motile protected species to be discountable. Despite rare reports of cold-stunned turtles (i.e., torpid, moribund, or previously dead) being taken by cutterhead dredges in the Laguna Madre, Texas, NMFS has no new information that would change the basis of our conclusion that the risk of these takes is discountable when using hydraulic (cutterhead) dredging equipment.

The dredge-and-fill activities will not be seasonally limited, but hopper dredging activities will follow temperature- and date-based dredging windows which have been established within the GRBO for minimizing impacts to Gulf sturgeon and sea turtles (NMFS 2003a; NMFS 2005c; NMFS 2007f). Working within these windows, to the extent feasible, will further reduce the risk to listed species, for an activity that is already discountable.

6.1.3 Mechanical Dredging (*State and OCS Waters*)

Clamshell dredging has the potential to kill or injure sea turtles if the bucket is dropped onto a sea turtle that enters the dredging area and is directly beneath the bucket when it is dropped. NMFS believes this risk is extremely low as sea turtles are highly mobile and are likely to avoid the active construction area, and because a sea turtle would have to be directly under the dredge bucket at the precise moment the bucket dropped. Dredging operations for this project will be continuous, operating 24 hours each day, 7 days a week. The USACE will follow NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*, so turtles that do enter the dredging area can be detected and dredging suspended. There has only been 1 reported sea turtle take by clamshell dredging from all dredging projects in the Southeast over the past 20+ years. Thus, we believe the potential take of a sea turtle by a clamshell dredge in this project is extremely unlikely and therefore discountable.

6.1.4 Relocation Trawling

Relocation trawling, when it can be done safely, is a means to reduce sea turtle mortalities because it is a proven method of reducing sea turtle density in front of an advancing hopper dredge and very likely results in reduced sea turtle/hopper dredge interactions. Nets are dragged on the sea bottom for 30 minutes or less before each retrieval and re-setting. Their effects are mostly nonlethal and non-injurious to trawl-captured sea turtles. Over the course of 20+ years that relocation trawling has been conducted by the USACE, very few sea turtle mortalities (approximately 8, of which 3 died under unusual circumstances [NMFS post-mortems determined the turtles drowned] during intensive relocation trawling efforts associated with the Deepwater Horizon event and subsequent emergency oil barrier sand berm construction) have occurred, while approximately 2,000 sea turtles have been safely relocated.

6.1.4.1 Nonlethal Take by Relocation Trawling (State and OCS Waters)

Calculation of Sea Turtle Relocation Rates during Hopper Dredging

To calculate the number of each species of turtle expected to be relocated, we consulted the USACE Sea Turtle Data Warehouse for the number of turtles captured from 2006-2013 in relocation trawls and the corresponding number of days of relocation trawling for each year. This was necessary to find the most applicable historic relocation trawling information for the project area. This data is summarized for both sea turtles and Gulf sturgeon in Table 17 below. A total of 426 sea turtles and 32 Gulf sturgeon were safely trawl-captured and released over 1,183 days of relocation trawling.

The probability for future capture is calculated based on the combined number of captures. This averages out to be approximately 0.387 (458÷1183 = 0.387) listed species captured per relocation trawling day, as the possibility for capturing each species during a relocation trawl is possible. Estimating the expected number of trawl captured turtles during this project is difficult and necessarily imprecise because of the uncertainties associated with the project, the various seasons, varying water temperatures, differences in availability and location of sea turtle potential foraging habitat from year to year (which may cause turtles to move into or out of the action area), and different bottom substrates (sand and mud to hard clay) and topography (smooth vs. rough and undulating) over which the trawling may be performed (which affects capture trawling effectiveness). On average, 0.387 sea turtles and Gulf sturgeon were captured per day of relocation trawling. Relocation trawling for the MsCIP will only occur during hopper dredging which will take 3 years (~1,110 days) to complete.

Table 17. Sea Turtle Relocation Trawling Efforts in Mobile District, 2006-2013

Fiscal Year	Days of Trawling	Loggerhead	Kemp's ridley	Green	Leatherback	Hawksbill	Gulf Sturgeon	Total Relocated Species
2006	269	62	43	4	2	0	0	**111**
2007	52	1	1	0	1	0	0	**3**
2008	0	0	0	0	0	0	0	**0**
2009	184	28	9	0	0	0	0	**37**
2010	123	2	2	0	0	0	0	**4**
2011	318	20	72	1	0	0	0	**93**
2012	82	5	3	0	0	0	0	**8**
2013	155	62	100	6	2	0	32	**202**
		Sum of Individual Relocated Species						
Total Mobile District Relocation Trawling Days	**1183**	**180**	**230**	**11**	**5**	**0**	**32**	**458**
Species Percentage		39.3%	50.2%	2.4%	1.1%	0.0%	**7.0%**	**100%**
Total Turtles Relocated	**426**							
Listed Species per day	**0.387**							

To determine the number of each species of turtle expected to be relocated, we multiplied the species per day from Table 17 (0.387) times the number of possible relocation trawling days (1,110), which gives us the total anticipated amount of species to be captured by relocation trawl during the project (0.387 x 1,110=429.7≈430). We then calculate the species percentage of capture for previous relocation trawling efforts in the area from Table 16. This is calculated by dividing the sum of the captured turtle species by the total of all listed species captured [39.3% loggerhead,(180÷458=0.393); 50.2% Kemp's ridley, (230÷458=0.502); 2% green, (11÷458=0.025); and 1.1% for leatherback, (5÷458=0.011)] to determine the quantity and species composition of the expected relocated sea turtles (Table 17). As calculated above, we expect 430 sea turtles and Gulf sturgeon to be relocated via relocation trawl, and when we apply the species percentages (and round to the nearest whole number because a fraction of a species cannot be taken), we end up with 169 loggerhead; 216 Kemp's ridley; 10 green; and 5 leatherback sea turtles; —a total of 400 sea turtles relocated during the expected 1,110 days of relocation trawling.

Table 18. Sea Turtle Relocation Trawling Species Composition

Trawling days: 1,110	Loggerhead	Kemp's ridley	Green	Leatherback	Hawksbill	Gulf Sturgeon	Total Turtles Relocated	Total Relocated
Species Percentage	39.3%	50.2%	2.4%	1.1%	0.0%	7.0%	-	100%
Turtles relocated	168.89	215.80	10.32	4.69	0	30.02	399.72	429.74
Rounded to nearest whole number	169	216	10	5	0	30	400	430

The effects of capture and handling during relocation trawling can result in raised levels of stressor hormones and can cause some discomfort during tagging procedures. Based on past observations obtained during similar research-trawling for turtles, these effects are expected to dissipate within a day (Stabenau and Vietti 2003). Since turtle recaptures are not common, and recaptures that do occur typically happen several days to weeks after initial capture, cumulative adverse effects of recapture are not expected. The reasoning behind this is turtles that are non-lethally taken by a closed net trawl, which is observing trawl speed and tow-time limits, will be safely relocated to an area outside of the trawl area (typically 3-5 miles). If the turtle is to be captured again, the turtle will have had ample time to recover from the stress of the experience of the trawl net.

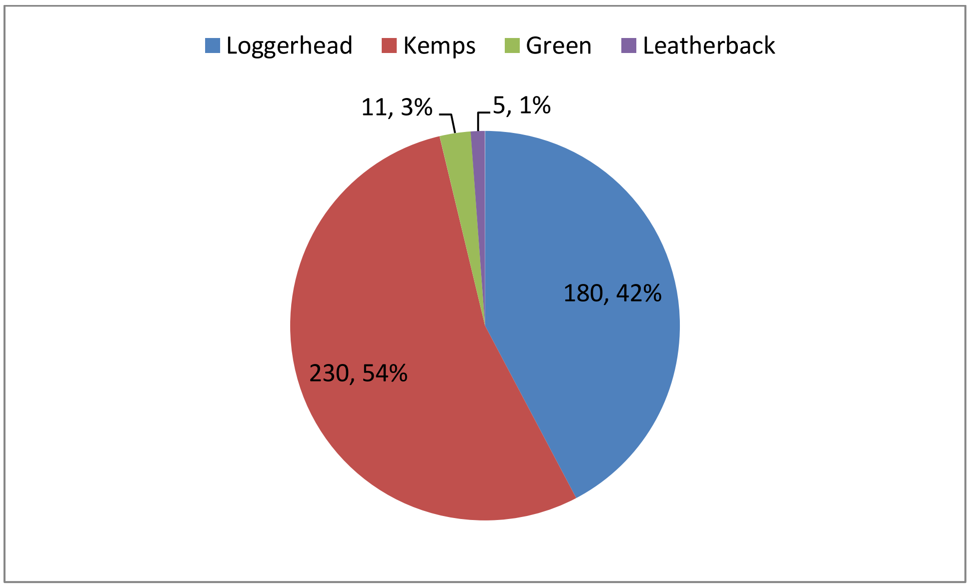


Figure 29. USACE hopper dredge relocation trawling captures (2006-2013) Gulf of Mexico region

Relocation trawling will be undertaken by the USACE where any of the following conditions are met: (a) 2 or more turtles are taken in a 24-hour period in the project; or (b) total dredge takes in the project approach 75% (rounded-down) of any of the incidental take limits (Table 18), i.e., 6 Kemp's ridleys, 4 loggerheads, or 1 green taken. Handling of sea turtles captured during relocation trawling in association with hopper dredging shall be conducted by NMFS-approved endangered species observers. Based on the facts above, NMFS will conservatively estimate that relocation trawling will take place during all 1,110 days and that up to 400 sea turtles may be nonlethally caught in relocation trawls for this project.

6.1.4.2 Lethal Take by Relocation Trawl (State and OCS Waters)

NMFS believes there is a remote possibility that the proposed relocation trawling could injure or kill sea turtles that may already have impaired health. Stressed or unhealthy turtles or turtles exposed to repeated forced submergences are more likely to be injured or killed during relocation trawling than healthy turtles NMFS estimates that for this action, sea turtle trawling and relocation efforts will result in lethal take. Although there has not been any lethal take via relocation trawls in the Mobile District during the 2006-2013 time period, lethal take has occurred in other USACE Districts in the Gulf of Mexico. Over the course of the last 20+ years that relocation trawling has been conducted by the USACE in the Gulf of Mexico, very few sea turtle mortalities (approximately 8, of which 3 died under unusual circumstances (apparently drowned) during intensive relocation trawling efforts associated with the Deepwater Horizon event) have occurred, while approximately 2,000 sea turtles have been safely relocated. NMFS has previously estimated in dredging Opinions that the risk of a sea turtle being killed in a capture trawl net is less than 0.4% and has no new information to alter the basis of that conclusion. While NMFS believes that it is unlikely that a sea turtle will be killed or injured during capture trawling (using modified shrimp trawl nets), the possibility of lethal take is still present. Given that our estimate of nonlethal take is 400 sea turtles captured by relocation trawling; multiplying 400 by that the estimated 0.4% mortality would equal $1.6 \approx 2$ sea turtle killed ($400 \times 0.004 = 1.6 \approx 2$). NMFS conservatively estimates 2 sea turtle lethal takes by relocation trawl for this project. Mortality associated with relocation trawling is primarily due to turtles being previously stressed or diseased, or being struck by trawl doors or accidents on deck when brought on board. Because the risk of injury and death does exist, it will also be necessary to authorize potential lethal interactions associated with relocation trawling. NMFS believes that the turtle mortalities will most likely be a Kemp's ridley, but it may also consist of either a loggerhead or green. Given the limited number of estimated encounters and no record of lethal take from relocation trawling activities, no lethal take of leatherback sea turtles is expected or authorized. This estimate of 2 lethal takes by relocation trawling is not in addition to the estimates provided above; rather, it is part of the total estimated takes by relocation trawling.

In summary, we believe the proposed action may capture by relocation trawling up to 400 sea turtles consisting of 169 loggerhead, 216 Kemp's ridley, 10 green, and 5 leatherback sea turtles in both state and OCS waters. Of the estimated captures by relocation trawling, NMFS believes that 2 will be captured lethally. NMFS estimates that the lethal trawling interaction will consist of a Kemp's ridley sea turtle, the most common species in the action area, but it may also consist of a loggerhead or green sea turtle.

6.1.5 Other Dredge Related Effects

Vessel Collisions with Sea Turtles

Sea turtles have been documented with injuries consistent with vessel interactions. It is reasonable to believe that the dredge vessels considered in this Opinion could inflict such injuries on sea turtles, should they collide. Interactions between vessels and sea turtles occur and can take many forms, from the most severe (death or bisection of an animal or penetration to the viscera), to severed limbs or cracks to the carapace which can also lead to mortality directly or indirectly. Sea turtle stranding data for the U.S. Gulf of Mexico and Atlantic coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993, about 9% of living and dead stranded sea turtles had propeller or other boat strike injuries (Lutcavage et al. 1997). From 1997 to 2005, 14.9% of all stranded loggerheads in the U.S. Atlantic and Gulf of Mexico were documented as having sustained some type of propeller or collision injuries although it is not known what proportion of these injuries were post or ante-mortem (NMFS and USFWS 2008b). The incidence of propeller wounds has risen from approximately 10% in the late 1980s to a record high of 20.5% in 2004 (NMFS, unpublished data). Propeller wounds are greatest in southeast Florida (Palm Beach through Miami-Dade County); during some years, as many as 60% of the loggerhead strandings found in these areas had propeller wounds (Florida Fish and Wildlife Conservation Commission, unpublished data).

Information is lacking on the type or speed of vessels involved in turtle vessel strikes. However, there does appear to be a correlation between the number of vessel struck turtles and the level of recreational boat traffic (NRC 1990e). Although little is known about a sea turtle's reaction to vessel traffic, it is generally assumed that turtles are more likely to avoid injury from slower moving vessels since the turtle has more time to maneuver and avoid the vessel. The speed of the dredge is not expected to exceed 3-5 knots while dredging or while transiting to the pump out site with a full load and it is expected to operate at a maximum speed of 10 knots while empty. In addition, the risk of ship strike will be influenced by the amount of time the animal remains near the surface of the water. For the proposed action, the greatest risk of vessel collision will occur during transit between shore and the areas to be dredged. The presence of a lookout who can advise the vessel operator to slow the vessel or maneuver safely when sea turtles are spotted will further reduce the potential risk for interaction with vessels. Therefore between the slow moving vessels and the presence of a lookout while the dredge is in transit, the risk of interaction between sea turtles and vessels in the action area will be discountable.

Material Placement/Disposal

Material dredged from the 6 borrow area sources, Ship Island, Horn Island Pass, Petit Bois Pass-MS, Petit Bois-AL East and West, and OCS borrow areas, which are Petit Bois Pass- OCS West (sub-areas 1-6), Petit Bois Pass- OCS East (sub-areas 1-5), and Cat Island (see Figure 4), will either be pumped via pipeline directly from the dredging area to the Ship Island placement area, or the hopper dredge will transit from the dredging area to the disposal area and pump-out directly onto the disposal area. Dredging from the Pascagoula Federal Navigation Channel will be pumped via pipeline directly from the dredging area to a variety of adjacent disposal areas and/or direct placement of material within the DA-10/littoral zone placement area. NMFS believes neither of these activities is likely to adversely affect sea turtles because these species are extremely unlikely to be in the exact disposal site area where material is being dumped, due the lack of foraging, shelter, and migratory significance to sea turtles. In addition, there are no nearshore hardgrounds within the project area that would potentially serve as foraging/sheltering habitat for sea turtles, attracting them to the area and thus exposing them to impacts from material placement.

6.2 Effects to Gulf Sturgeon

As explained in the project description, dredging will be primarily conducted in borrow sites sea ward of the barrier islands. The effects of dredging on Gulf sturgeon will be different depending on the type of method used. As such, the following discussion of effects of the project will be organized by type. Below, the discussion will consider the effects of dredging, including the risk of entrainment or capture of Gulf sturgeon. We also consider effects of dredge vessel traffic.

Following, there is a discussion of dredging with a mechanical dredge. Last, we discuss relocation trawling effects.

6.2.1 Hopper Dredging

Dredge entrainment of Gulf sturgeon by hopper dredging has previously been assessed by NMFS in many Section 7 consultations. NMFS determined that the hopper dredge projects may adversely affect the species, however would not jeopardize the species existence given either the projects' limited scope and/or the seasonal presence of Gulf sturgeon. The USACE SAD reports that from 1990-2013, 37 interactions with sturgeon (Atlantic, shortnose, and Gulf) occurred during dredge operations division wide. Of these, 3 were reported as Gulf sturgeon, all of which were entrained in hopper dredges (December 13 and 28, 2004, and January 5, 2005) during the Gulfport Harbor and Mobile Bar Channel dredging (Table 19). All of these interactions occurred in the Mobile District.

Several factors are thought to contribute to the likelihood of entrainment. The hopper dredge draghead operates on the bottom and is typically at least partially buried in the sediment. Sturgeon are benthic feeders and are often found at or near the bottom while foraging. Gulf sturgeon are more likely to be present in estuarine and coastal waters, and passes between the barrier islands, during winter-time dredging. Gulf sturgeon may be more sensitive to vibrations transmitted along the bottom (by a noisy, approaching hopper dredge draghead) than other fishes due to their physostomus (a pneumatic duct that connects gas bladder and gut to allow gas to be taken in and emitted) swim bladder. Gulf sturgeon are known to rest and forage for long periods along the marine bottom, but they are mobile and are not likely to be entrained, even by a rapidly approaching (approximately 3-5 knots) hopper dredge deflector draghead.

Table 19. USACE SAD Gulf Sturgeon Entrainment Records from Hopper Dredge Operations 1990-2013.

Project Location	Corps Division/District	Take Date	Project Cubic Yards Removed	Observed Entrainment
‡Gulfport Harbor Channel	Mobile District	December 13, 2004	No Data	1
‡Mobile Bar Channel	Mobile District	December 28, 2004; January 1, 2005	3,231,166	2

‡Records based on sea turtle observer reports which record listed species entrained as well as all other organisms entrained during dredge operations.

In the 2003 GRBO (NMFS 2003a), NMFS acknowledges that documented takes represent partial estimates of total takes and believes that some takes may pass undetected by observers through inflow screening devices, due to the force of the water pressure, or because the animals are killed but not entrained; NMFS estimates that unseen (thus, undocumented) takes represent roughly 50% of total documented takes and has evaluated the effects of the action including the expected undocumented takes. NMFS-approved observers monitor dredged material inflow and overflow screening baskets on many projects; however, screening is only partially effective and observed, documented takes provide only partial estimates of total Gulf sturgeon mortality.

It is NMFS's opinion that some listed species taken by hopper dredges go undetected because body parts are forced through the sampling screens by the water pressure and are buried in the dredged material, or animals are crushed or killed but not entrained by the suction and so the takes may go unnoticed. The only mortalities that are documented are those where body parts either float, or are large enough to be caught in the screens, and can be identified as sturgeon species.

6.2.1.1 Lethal Takes by Hopper Dredge (State Waters)

Because observers have been present on the hopper dredges in the Mobile District, we expect that any observed interactions with Gulf sturgeon would have been reported to NMFS. The interaction rate between hopper dredges and Gulf sturgeon is documented to be low, even just considering the projects listed in Table 19, where entrainment was recorded. Since 2002, the Mobile District has had 50 projects with cubic yardage calculations totaling 57,250,112 yd^3. During this time period, 3 Gulf sturgeon were taken. If we calculate the amount of cubic yardage dredged per the amount of sturgeon entrained, we would expect approximately 1 Gulf sturgeon for approximately every 19,083,370 yd^3 of material removed (57,250,112 $yd^3 \div 3$ Gulf sturgeon = 19,083,370 yd^3). Given that the project anticipates the removal of 33.7 million yd^3 of material from the proposed borrow sites in state waters, the expected entrainment rate is approximately 2 (33,700,000 $yd^3 \div$ 19,083,370 yd^3 = 1.77).

Based on the calculations above, we would estimate that 1.8 Gulf sturgeon would be observed as killed by the proposed action. In order to more conservatively estimate take, we round up to 2 Gulf sturgeon *observed* killed for the 33.7 million yd^3 projected to be dredged for this project.

Additionally, as discussed above, dredged material screening by observers on hopper dredges is only partially effective, and observed interactions are expected to document only 50% of sturgeon entrained and killed by a hopper dredge (NMFS 2003a). Thus, the total anticipated lethal take of Gulf sturgeon (by hopper dredge) in state waters is 4 Gulf sturgeon.

6.2.1.2 Lethal Takes by Hopper Dredge (OCS Waters)

To estimate the number of Gulf sturgeon that may be killed by the proposed action in the OCS, we utilized the same data discussed in Section 6.2.1.1. Given that the project anticipates the removal of 19.6 million yd^3 of material from the proposed borrow sites in the OCS, the expected entrainment rate is approximately 1 (19,600,000 $yd^3 \div$ 19,083,370 yd^3 = 1.03).

Based on the calculations above, we would estimate that 1.03 Gulf sturgeon would be observed as killed by the proposed action. However, in order to more conservatively estimate take, we round up to 2 Gulf sturgeon *observed* killed for the 19.6 million yd^3 projected to be dredged for this project. Additionally, as discussed above, dredged material screening by observers on hopper dredges is only partially effective, and observed interactions are expected to document only 50% of sturgeon entrained and killed by a hopper dredge (NMFS 2003a). Thus, the total anticipated lethal take of Gulf sturgeon (by hopper dredge) in the OCS is 4 Gulf sturgeon.

6.2.2 Hydraulic Cutterhead Dredge (*State and OCS Waters*)

The USACE has stated that some dredging for this project may be accomplished with a cutterhead dredge. The cutterhead dredge operates with the dredge head buried in the sediment;

however, a flow field is produced by the suction of the operating dredge head. The amount of suction produced is dependent on linear flow rates inside the pipe and the pipe diameter (Clausner and Jones 2004). High flow rates and larger pipes create greater suction velocities and wider flow fields. The suction produced decreases exponentially with distance from the dredge head (Boysen and Hoover 2009). With a cutterhead dredge, material is pumped directly from the dredged area to a disposal site. As such, there is no opportunity to monitor for biological material on board the dredge; rather, observers work at the disposal site to inspect material. It is generally assumed that sturgeon are mobile enough to avoid the suction of an oncoming cutterhead dredge (due to the noise and vibration created by the cutterhead) and that any sturgeon in the vicinity of such an operation would be able to avoid the intake and escape.

To date, there are no reports from dredge contractors or the USACE of Gulf sturgeon being captured or killed by cutterhead dredges in the Gulf of Mexico. However, there have been several reports of sturgeon (shortnose and Atlantic) that have been killed during the use of cutterhead dredges. On February 1, 1996, 2 shortnose sturgeon were found in a dredge discharge pool on Money Island, near Newbold Island on the Delaware River. The dead sturgeon were found on the side of the spill area into which the hydraulic pipeline dredge was pumping. An assessment of the condition of the fish indicated that the fish were likely alive and in good condition prior to entrainment. One was adult male and the other was an adult female with eggs. The area where dredging was occurring was a known overwintering area for shortnose sturgeon and large numbers of shortnose sturgeon were known to be concentrated in the general area. Since that time, dredging operations occurring in the winter months in the Newbold – Kinkora range on the Delaware River require that inspectors conduct daily inspections of the dredge spoil area in an attempt to detect the presence of any sturgeon. In January 1998, 3 shortnose sturgeon carcasses were discovered in the Money Island Disposal Area on the Delaware River. The sturgeon were found on 3 separate dates: January 6, January 12, and January 13. Dredging was being conducted in the Kinkora and Florence ranges at this time, which also overlaps with the shortnose sturgeon overwintering area. While it is possible that not all shortnose sturgeon killed during dredging operations were observed at the dredge disposal pool, USACE has indicated that due to flow patterns in the pool, it is expected that all large material (i.e., sturgeon, logs) will move towards the edges of the pool and be readily observable. In 1998, the USACE Wilmington District had a report of an Atlantic sturgeon killed in a hydraulic pipeline dredge from the Cape Fear River. No documentation or evidence was found to confirm this citation.

The risk of an individual sturgeon being entrained in a cutterhead dredge is difficult to calculate. While a large area overall will be dredged, the dredge operates in an extremely small area at any given time (i.e., the bottom in the immediate vicinity of the intake). Per recent studies, Gulf sturgeon are well distributed throughout the Mississippi Sound; however, they tend to aggregate around the barrier islands during the winter months (October through March). The sturgeon taken by cutterhead dredges mentioned above were in river systems with significantly larger populations, and the dredging was being performed in tight areas where sturgeon were known to aggregate. Given the constraints of the rivers, the probability for take in the river systems is increased. In contrast, relatively few sturgeon have been found in the area between the barrier islands and the proposed borrow sites. One or both of the local subpopulations (Pascagoula and the Pearl) have been documented by tagging data, historic sightings, and incidental captures as using Mississippi Sound, within 1 nmi (1.9 km) of the nearshore Gulf of Mexico adjacent to the barrier islands and within the passes (Morrow Jr. et al. 1996; Reynolds 1993; Rogillio 1993; Rogillio et al. 2001; Ross et al. 2001a; Ross et al. 2009) and F. Parauka, pers. comm. to S. Bolden, NMFS, December 2, 2002. With the exception of the Cat Island borrow area, all of the borrow sites for this project are farther out than the majority of the documented sightings. This being said, Gulf sturgeon would need to be in the borrow areas, where they are not likely to aggregate in a manner consistent with the takes in the Cape Fear or Delaware River, within 1 meter of the dredge head to be entrained. Therefore, given the fact that Gulf sturgeon tend to aggregate in areas near the mouth of natal rivers and barrier islands, and based on the lack of incidental take from past projects in the Gulf of Mexico (none have been taken in the Gulf of Mexico to date), the overall risk of entrainment is discountable.

6.2.3 Mechanical Dredging (*State and OCS Waters*)

Clamshell dredging has the potential to kill or injure Gulf sturgeon if the bucket is dropped onto a Gulf sturgeon that enters the dredging area. NMFS believes this is extremely unlikely because Gulf sturgeon are highly mobile and are likely to avoid the active construction area. Since 1990, there have been no reports of Gulf sturgeon takes by clamshell dredging in the Gulf of Mexico. Thus, we believe the potential take of a Gulf sturgeon by a clamshell dredge in this project is discountable.

6.2.4 Relocation Trawling

Only adult Gulf sturgeon migrate into marine waters; other life stages have little to no movement into marine waters. Adult Gulf sturgeon are only susceptible to interaction with relocation trawls during the 4-5 months (November through March) they spend feeding in and around the barrier islands. During those winter months, because Gulf sturgeon are found near the bottom of the water column, they are likely to be captured by relocation trawls, which operate by dragging their nets along the sea floor bottom. Data describing the Gulf sturgeon's swimming ability in the Suwannee River strongly indicated that they cannot continually swim against prevailing currents of greater than 1-2 m per second (Wakeford 2001). Thus, even though relocation trawls travel through the water at slow speeds, it is still highly unlikely that a Gulf sturgeon would be able to out-swim a relocation trawl. Relocation data indicate most Gulf sturgeon prefer sandy shoreline habitats in more shallow waters. In the single documented occurrence of an observed Gulf sturgeon capture by trawl net in federal waters, the depth of the tow and was much deeper 56.8 ft (17.3 m) than where Gulf sturgeon have previously been documented, showing that interactions can occur in deeper waters than previously believed. However, such deep-water interactions are still thought to be very rare, and the best available data indicate most sturgeon in the Gulf remain inshore.

Estimating the Extent of Effects

Data relating to Gulf sturgeon captures is spotty; however, state and federal fishery data is the most reliable source. The federal fishery observer program in the U.S. shrimp fishery was voluntary between 1992 through June 2007 with coverage typically less than 1% of total shrimping effort. No Gulf sturgeon were observed in a shrimp trawl during that period. Mandatory observer coverage was initiated in the Gulf of Mexico shrimp fishery in July 2007, and since then only 2 Gulf sturgeon have been observed captured: 1 in federal waters and 1 in state waters (Figure 30). Both of these captures were in main trawl nets in relatively shallow waters. The capture in federal waters (December 15, 2009) was nearby the Gulf barrier islands where preferred winter foraging habitat is located. Both of the Gulf sturgeon observed captured in shrimp trawls were released alive.

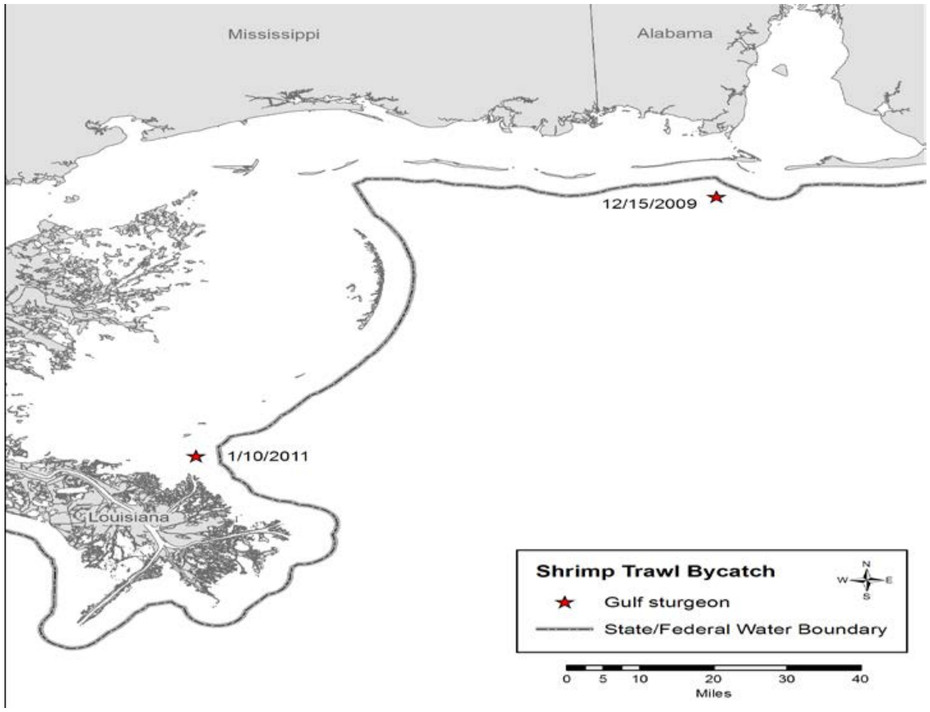


Figure 30. Location of observed Gulf sturgeon captures in shrimp trawls by date relative to state and federal fishing boundaries from Federal Fishery Observer Program 2012)

With only 2 Gulf sturgeon observed captured in NMFS's Shrimp Observer Program, attempting to extrapolate them to the Gulf of Mexico and then estimate the number of Gulf sturgeon captured by the federal fishery is inappropriate (i.e., too little data). However, given the low level of observer coverage (~ 2% since becoming mandatory), it seems unreasonable to assume that the only captures in Gulf of Mexico shrimp fisheries in the past 6 years (July 2007 through March 2012) were the 2 observed.

One of the few recorded projects in the Gulf where Gulf sturgeon were captured in a relocation trawl was the Gulf Shores/Orange Beach renourishment project. This project borrowed sand from an offshore borrow site and placed it along the beach profile using a hopper dredge and therefore was required to use a relocation trawl while this activity was in process. Over the course of 155 days (October 15, 2012 – November 25, 2012; November 19, 2012 – March 12, 2013) of dredging, relocation trawlers made 4,881 trawls and captured 95 sea turtles and 32 Gulf sturgeon. The 32 Gulf sturgeon capture occurred in 2013. It should be noted that the capture of 32 Gulf sturgeon is extremely rare and is not expected to be the norm in any trawling event. This series of encounters was the result of relocation trawling on a productive winter feeding area. For contrast, the GRBO estimated that approximately 8 trawl captured Gulf sturgeon would be taken in one year for the entire Gulf, although since 2006 no Gulf sturgeon have been taken in the relocation trawl until 2013, and none have been taken in 2014.

6.2.4.1 Nonlethal Take by Relocation Trawl (State and OCS Waters)

Calculation of Gulf Sturgeon Relocation Rates during Hopper Dredging

To calculate the number of Gulf sturgeon expected to be relocated, we consulted the USACE Sea Turtle Data Warehouse and ERDC for the number of Gulf sturgeon captured from 2006-2013 in relocation trawls and the corresponding number of days of relocation trawling for each year. This was necessary to find the most applicable historic relocation trawling information for the project area. This data is summarized for both sea turtles and Gulf sturgeon in Table 20 below. A total of 426 sea turtles and 32 Gulf sturgeon were safely trawled-captured and released over 1,183 days of relocation trawling.

The probability for future capture is calculated based on the combined number of captures. This averages out to be approximately 0.387 (458÷1183 = 0.387) listed species captured per relocation trawling day as the possibility for capturing each species during a relocation trawl is possible. Estimating the expected number of trawl captured Gulf sturgeon during this project is difficult and necessarily imprecise, because of the uncertainties associated with the project, the various seasons, varying water temperatures differences in availability and location of Gulf sturgeon potential foraging habitat from year to year (which may cause Gulf sturgeon to move into or out of the action area), and different bottom substrates (sand and mud to hard clay) and topography (smooth vs. rough and undulating) over which the trawling may be performed (which affects capture trawling effectiveness). On average, 0.387 sea turtles and Gulf sturgeon were captured per day of relocation trawling. Relocation trawling for the MsCIP will only occur during hopper dredging which will take 3 years (~1,110 days) to complete.

Table 20. Gulf Sturgeon Relocation Trawling Efforts in Mobile District, 2006-2013

Fiscal Year	Days of Trawling	Loggerhead	Kemp's ridley	Green	Leatherback	Hawksbill	Gulf Sturgeon	Total Relocated Species
2006	269	62	43	4	2	0	0	**111**
2007	52	1	1	0	1	0	0	**3**
2008	0	0	0	0	0	0	0	**0**
2009	184	28	9	0	0	0	0	**37**
2010	123	2	2	0	0	0	0	**4**
2011	318	20	72	1	0	0	0	**93**
2012	82	5	3	0	0	0	0	**8**
2013	155	62	100	6	2	0	32	**202**
Total Mobile District Relocation Trawling Days	**1183**	**180**	**230**	**11**	**5**	**0**	**32**	**458**
Species Percentage		39.3%	50.2%	2.4%	1.1%	0.0%	**7.0%**	**100%**
Total Gulf Sturgeon Relocated	**32**							
Listed Species per day	**0.387**							

To determine the number of Gulf sturgeon expected to be relocated, we multiplied the species per day from Table 20 (0.387) times the number of possible relocation trawling days (1,110), which gives us the total anticipated amount of species to be captured by relocation trawl during the project (0.387x 1,110=429.7≈430). We then calculate the species percentages or capture for previous relocation trawling efforts in the area from Table 19. This is calculated by dividing the sum of the captured Gulf sturgeon species by the total of all listed species captured [7.0% Gulf sturgeon, (32÷458=0.07)] to determine the expected number of relocated Gulf sturgeon (Table 20). As calculated above, we expect 430 sea turtles and Gulf sturgeon to be relocated via relocation trawl, and when we apply the species percentages (and round to the nearest whole number because a fraction of a species cannot be taken), we end up with 30 Gulf sturgeon relocated during the expected 1,110 days of relocation trawling.

Table 21. Gulf Sturgeon Relocation Trawling Species Composition

Trawling days: 1,110	Loggerhead	Kemp's ridley	Green	Leatherback	Hawksbill	Gulf Sturgeon	Total Gulf Sturgeon Relocated	Total Relocated
Species Percentage	39.3%	50.2%	2.4%	1.1%	0.0%	7.0%	-	100%
Turtles relocated	168.89	215.80	10.32	4.69	0	30.02	30.02	429.74
Rounded to nearest whole number	169	216	10	5	0	30	30	430

Handling of Gulf sturgeon captured during relocation trawling in association with hopper dredging shall be conducted by NMFS-approved endangered species observers. Based on the above, NMFS will conservatively estimate that up to 30 Gulf sturgeon may be nonlethally caught in relocation trawls for this project for both state and OCS waters.

6.2.4.2 Lethal Take by Relocation Trawl (State and OCS Waters)

Relatively few sturgeon have been reported as captured in trawl nets, and of those, many were released alive. Louisiana Division of Wildlife and Fisheries (LADWF) documented 177 Gulf sturgeon incidentally captured reported by commercial fishers in southeastern Louisiana during 1992, of which 76 were captured in trawls, 10 in wing nets, and 91 in gillnets. LADWF noted an overall mortality rate of less than 1% (USFWS and GSMFC 1995). Although this information is dated, more recently, LADWF Gulf sturgeon researchers indicated they are often contacted by fishers who wish to have the live sturgeon tagged and released (H. Rogillio, LADWF, pers. comm. to S. Bolden, NMFS, December 2, 2002). Studies in a variety of trawl fisheries have shown that mortality of the conspecific Atlantic sturgeon incidentally caught in trawl gear is very low, with most surveys showing 0% mortality (e.g., (Stein et al. 2004). Based on observer data from South Atlantic shrimp fisheries, 1 mortality was observed out of 9 Atlantic sturgeon that were incidentally captured in otter trawl gear between 2008 and 2011 (E. Scott-Denton, NOAA, pers. comm. Jenny Lee, NMFS PRD, April 18, 2014), for a mortality rate of 1 out of 9 captures or 11%. This is high compared to most reports for trawl fisheries. It may be an artifact of the low number of observed incidental captures of Atlantic sturgeon in shrimp trawl fisheries, or it may reflect some difference between shrimp trawling and other trawl fisheries, perhaps an effect of warmer, southern waters.

With the limited available data, based on the 1 Atlantic sturgeon mortality observed between 2008 and 2011, we anticipate 1 Gulf sturgeon mortality in the relocation trawl once every 4 years. Therefore, we believe that observed lethal captures will not exceed 1 for the entire project for both state and OCS waters.

6.2.5 Dredge and Disposal Vessel Traffic (*State and OCS Waters*)

Available information on the risk of vessel operations to Gulf sturgeon is discussed in the Environmental Baseline section above. Aside from the incidents discussed there, no information on the characteristics of vessels that are most likely to interact with Gulf sturgeon is available and there is no information on the rate of interactions. Because of their benthic habits and feeding strategy, Gulf sturgeon are unlikely to be struck by vessels or vessel propellers. Nonetheless, assuming that the likelihood of interactions increases with the number of vessels present in an area, we have considered the likelihood that an increase in ship traffic associated with dredging and disposal would increase the risk of interactions between Gulf sturgeon and vessels in the action area. Dredging and disposal for the proposed project are likely to result in an increase of 2-4 slow-moving vessels during project operations. Based on the ship traffic currently experienced in the action area, it is unlikely that an increase of only 2-4 slow-moving vessels per day would increase the risk of interactions between Gulf sturgeon and vessels operating in the project area. As such, the increase in risk is likely to be insignificant and interactions between project vessels and Gulf sturgeon are extremely unlikely to occur and, therefore, discountable.

6.2.5.1 Effects of Dredged Material Placement/Disposal on Gulf Sturgeon

NMFS has reviewed the dredging projects that occur in the Gulf of Mexico on a recurring basis and the placement/disposal sites and methods which the USACE uses to dispose of dredged material. Typically, dredged materials from maintenance dredging activities are disposed of downcurrent of the navigation channels (such as the DA-10/littoral zone site) being maintained (by agitation dredging, sidecasting, or direct placement), or in designated disposal areas which are adjacent to and run approximately parallel to the navigation channels, or in nearby designated offshore disposal areas (to minimize transit time of the hopper dredge to and from the dredging site). Alternatively, they are used beneficially for barrier island restoration and creation of island, wetland, marsh, and shallow-water habitats, or to re-nourish eroded mainland beaches. NMFS believes that disposal activities proposed are not likely to adversely affect Gulf sturgeon. These species are highly mobile and should be able to easily avoid a descending sediment plume discharged at the surface by a hopper dredge opening its hopper doors, or pumping its sediment load over the side. Therefore we believe the effects of dredged material disposal on Gulf sturgeon will be discountable.

6.3 Effects to Gulf Sturgeon Critical Habitat

The project area includes winter migration and feeding habitats for adult and subadult Gulf sturgeon in Mississippi Sound, which includes individuals from the Pascagoula and the Pearl River sub-populations. Dredging operations for this project will be continuous, operating 24 hours each day, 7 days a week. The sand placement activity in Camille Cut, East Ship Island, and Cat Island will fill actively utilized foraging areas (ERDC 2012). Additionally, sand dredging from Cat Island Borrow Area will temporarily impact potential foraging areas within GSCH through the temporary displacement of pray items.

6.3.1 Prey Abundance

The Final Rule which designates GSCH states that the abundance of prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, mollusks, and/or crustaceans within estuarine and marine habitats and substrates for subadult and adult life stages, are essential for the conservation of the species.

Past and current observances have recorded that Gulf sturgeon subpopulations found within the Pearl, Pascagoula, Yellow, Escambia, and Blackwater Rivers utilize the project area located within and around the barrier islands. As noted in Section 3.1.7, annual detection histories at the Ship Island project area indicates 63 Gulf sturgeon have been recorded on the acoustic array since the 2011-2012 deployment period including 51 adult and 12 subadult individuals (see Table 3).

The non-motile benthic community within the footprint of this project's dredging, pipeline corridors, and placement areas would be lost (both temporarily and permanently) as a result of project activities. Dredging impacts would be localized and affect the benthic community within the immediate footprint of the borrow area. In contrast, sturgeon will be displaced from the proposed above-water fill footprints at Cat Island, East Ship Island, and Camille Cut, eliminating the ability to forage within this area given the conversion of habitat. As a result of this conversion, from shallow bottom to emergent barrier island, the shoreline will expand approximately 800-1,000 ft at Cat and East Ship Islands; sturgeons will have the opportunity to forage further out within the shifted shoreline once it recolonizes.

While both temporary and permanent impacts to the prey species are expected to occur from the placement activities, it is important to note that Ship Island is a barrier island with a history of breaching and accreting over the years, so the proposed action is not dissimilar to the region's natural processes. The closure of Camille Cut will remove the more recently created potential foraging area for the sturgeon; however, the species will continue to utilize both sides of the restored Ship Island littoral area (adjacent littoral area to former Camille Cut) once the benthic fauna recovers, typically within 1 year of completion of the project (Saloman et al. 1982) (see also Section 6.3.6 Recovery of Benthic Biota). Also, the filled areas within the placement sites at Cat Island, Ship Island, and Camille Cut are very small relative to the overall foraging area available within Unit 8. This fact is highlighted by the sturgeon detections observed in Dog Keys Pass, which had higher detections than all other areas monitored. It is likely that the other passes in the Gulf barrier island chain have similar utilization rates. Unit 8 of GSCH encompasses a total of 881,421 acres; the combined areas affected by the project (both temporarily and permanently) are less than 0.08% of that total (Section 6.3.3. Gulf Sturgeon Foraging Behavior, elaborates on this discussion).

As noted in Section 6.3.1., with the closure of Camille Cut, it is anticipated that Gulf sturgeon will redistribute and continue to feed within the adjacent passes (i.e., Little Dog Keys Pass and Ship Island Pass), which are currently utilized by sturgeon for feeding (ERDC 2012). Further east of the action area in the Mississippi Sound are Dog Keys Pass, Little Dog Keys Pass, Horn Island Pass, Petit Bois Pass, which provide additional adequate areas where Gulf sturgeon have been documented to congregate and feed (Rogillio et al. 2007; Ross et al. 2009).

6.3.2 Gulf Sturgeon Subpopulations Using Affected Critical Habitat

The total number of Gulf sturgeon using the affected critical habitat is unknown as there are no current population estimates for either the Pearl or Pascagoula Rivers since Hurricanes Ivan (2004) and Katrina (2005); however, populations in the Pearl and Pascagoula Rivers have never been nearly as abundant as those to the east. Prior to the hurricanes, the number of Gulf sturgeon was estimated at about 430 in the Pearl River (Rogillio et al. 2001) and around 216 in the Pascagoula River (Ross et al. 2001a). Effects of the hurricanes to the populations within the Pearl and Pascagoula Rivers are unknown as research has since been limited in those systems (USFWS and NMFS 2009). However, as previously noted, ERDC monitoring results have documented at least 63 tagged Gulf sturgeon originating from 6 rivers: Pearl (16), Pascagoula (20), Blackwater (16), Choctawhatchee (4), Yellow (3) and Escambia (4). These Gulf sturgeon utilize the Camille Cut opening and ends of Ship Island for staging and foraging (T. Slack, USACE ERDC, pers. comm. to R. Hendren, NMFS PRD, July 27, 2015).

6.3.3 Gulf Sturgeon Foraging Behavior

Gulf sturgeons possess a highly protrusible mouth that extends downward to vacuum up sediments containing their prey (i.e., infaunal macroinvertebrates). This suction feeding requires an expandable mouth cavity and a relatively narrow mouth through which to funnel water and food items (Westneat 2001). Success of suction feeding relies on the ability of the predator's mouth to protrude into the proximity of prey (Westneat 2001); the suction tube of the sturgeon's mouth must be able to maintain contact with the benthos their prey inhabit. Findeis (1997) described sturgeon as exhibiting evolutionary traits adapted for cruising the benthos in search of prey. Notably, their caudal fin morphology has presumably been adapted for benthic cruising; the hypochordal lobe is often reduced to allow sweeping of the tail while close to the substrate (Findeis 1997).

Research supports that Gulf sturgeon are typically found foraging in depths greater than 1 m. Lower energy areas, where water depth is greater than 3-6 ft (1-2 m), would likely assist foraging success given their feeding biology and the dissipation of wave energy. The protrusible mouth of these suction feeders must make contact with the benthos in order to vacuum prey out of the sediments while benthic cruising. The slightly deeper depths 6-12 ft (2-4 m) the sturgeon seem to prefer would have less wave energy at the substrate compared to the shallower swash zone (Craft et al. 2001; Fox et al. 2002; Parauka et al. 2001; Ross et al. 2001a). Downward cycloidal movement of waves dissipates energy through the water column (i.e., wave energy is exponentially dissipated with depth). A sturgeon attempting to forage in a high-energy, shallow-water environment (i.e., the swash zone) would likely be challenged to retain position and maintain contact with the benthos. Therefore, Gulf sturgeon foraging success would likely be greater in the slightly deeper, lower energy areas compared to the high-energy swash zone.

As benthic cruisers, sturgeon forage extensively in an area, presumably until preferred prey is depleted/reduced, relocate, and resume foraging. Tracking observations by (Edwards et al. 2003; Fox et al. 2002; Sulak and Clugston 1999) support that individual Gulf sturgeon move over an area until they encounter suitable prey type and density, at which time they forage for extended periods of time. Individual Gulf sturgeon often remain in localized areas (less than 1 square kilometer [km^2]) for extended periods of time (greater than 2 weeks) and then move rapidly to another area where localized movements occurred again (Fox et al. 2002). In a multi-year study, Ross et al. (2009) found Gulf sturgeon from both the Pascagoula and Pearl Rivers broadly overlap and use the shallow water along the Gulf barrier islands as foraging grounds in the winter. These marine habitats utilized by the Gulf sturgeon were all less than 21 ft (7 m) deep, generally well-oxygenated, and with relatively clear water; bottom substrates were mostly coarse sand and shell fragments or fine sand (Ross et al. 2009). Edwards et al. (2007) also discussed mixing of Gulf sturgeon from different populations and overlap of winter habitat utilization. Gulf sturgeon tagged in 7 Florida Panhandle river systems were monitored from Carrabelle, Florida, to Mobile Bay, Alabama, during the winter period in the coastal waters of the Gulf of Mexico; Gulf sturgeon from different river systems were located occupying the same area of marine habitat (Ross et al. 2009).

Unit 8 of GSCH encompasses a total of 881,421 acres. Dredging of material within the Cat Island borrow area will temporarily impact 429 acres of potential foraging habitat within Unit 8 of designated GSCH. The placement activities would result in a loss of approximately 511 acres of GSCH within the Camille Cut and East Ship placement areas, and approximately 168 acres would be lost at Cat Island for a total of 679 acres (see Table 22). The amount of benthos impacted by the placement of material (679 acres or 2.75 km^2) constitutes 0.08% (679 acres/ 881,421= 0.00077 x 100 = 0.077 ≈ 0.08%) of the total area within the unit. While the exact amount of benthic area required to sustain Gulf sturgeon health and growth is unknown (and likely dependent on fish size and reproductive status), Gulf sturgeon have been known to travel distances greater than 100 miles (161 kilometers) during their winter feeding period (Fox et al. 2002). The impact on benthic prey in the borrow areas will be temporary (see Section 6.3.6 Recovery of Benthic Biota), and overall impact to the critical habitat's ecological function will be minimal given that the majority of the borrow areas impacted are outside of GSCH and not within the barrier islands (except Ship Island) where the majority of foraging will occur. Gulf sturgeon have been described as opportunistic and indiscriminate benthivores (see Section 6.3.4 Prey Items); thus, Gulf sturgeon in the project area will likely find appropriate and abundant prey in the areas adjacent to the project location, given the proximity to nearby sandy areas and nearby barrier islands.

Table 22. Gulf Sturgeon Critical Habitat Impact Summary

	Total Project Area (acres)	Area within 2003 Designated GSCH Boundaries** (acres)	Existing Usable Gulf Sturgeon Habitat within the construction project limits (acres below MHW)***	Usable Gulf Sturgeon Habitat within the constructed project limits after Equilibrium (acres below MHW)	Habitat Change Gain or Loss (acres)
Restoration Areas GSCH					
Camille Cut / *East Ship*	1500	980	1366	855	-511
Cat Island	305	45	212	44	-168
Borrow Areas GSCH					
Petit Bois Pass-MS	175	32	175	175	0
Cat Island	429	429	429	429	0
Total Area	***2409***	**1486**	**2182**	**1503**	**-679**

*Note acres are obtained from Geographic Information System (GIS) layers obtained from http://Criticalhabitat.fws.gov/crihab
**Note acres are obtained from GIS layers obtained from http://www.nmfs.noaa.gov/gis/data/critical.htm#se
***Using current MHW and MLLW line

6.3.4 Prey Items

Ontogenetic changes in Gulf sturgeon diet and foraging area have been documented. Young-of-the-year forage in freshwater on aquatic invertebrates and detritus (Mason Jr. and Clugston 1993; Sulak and Clugston 1999); juveniles forage throughout the river on aquatic insects (e.g., mayflies and caddis flies), worms (oligochaetes), and bivalves (Huff 1975; Mason Jr. and Clugston 1993); adults forage sparingly in freshwater and depend almost entirely on estuarine and marine prey for their growth (Gu et al. 2001). Both adult and subadult Gulf sturgeon are known to lose up to 30% of their total body weight while in freshwater, and subsequently compensate the loss during winter feeding in marine areas (Carr 1983; Clugston et al. 1995; Heise et al. 1999; Morrow et al. 1998; Ross et al. 2000; Sulak and Clugston 1999; Wooley and Crateau 1985). Therefore, once Gulf sturgeon leave the river after having spent at least 6 months in the river fasting, it is presumed that they immediately begin feeding. Upon exiting the rivers, Gulf sturgeon concentrate around the mouths of their natal rivers in lakes and bays. These areas are very important for the Gulf sturgeon as they offer the first foraging opportunity for the Gulf sturgeon exiting the rivers. Few data have been collected on the food habits of Gulf sturgeon; their threatened status limits sampling efforts and gastric lavaging has only recently become successful. Gulf sturgeon have been described as opportunistic and indiscriminate benthivores; their guts generally contain benthic marine invertebrates including amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, mollusks, and crustaceans (Carr et al. 1996; Fox et al. 2000; Fox et al. 2002; Huff 1975; Mason Jr. and Clugston 1993). During the early fall and winter, immediately following downstream migration, Gulf sturgeon are most often located in depths less than 20 ft in sandy areas that support burrowing macroinvertebrates, where the fish are presumably foraging (Craft et al. 2001; Fox et al. 2002; Parauka et al. 2001; Ross et al. 2001j). Generally, Gulf sturgeon prey are burrowing species (e.g., annelids: polychaetes and oligochaetes, amphipods, isopods, and lancelets) that feed on detritus and/or suspended particles, and inhabit sandy substrate.

As with foraging behavior, NMFS expects that prey items will be adversely affected in the 679 acres of benthos that will be filled, and the 429 acres of benthos that will be impacted temporarily from the dredging in borrow areas. Details of effects are discussed further in the following sections: Benthic Community Structure and Recovery of Benthic Biota.

6.3.5 Benthic Community Structure

In general, Mississippi Sound has predominantly muddy sediments dominated by polychaete and nemertean worms that are, in general, tolerant to habitat disturbances (EPA 1999). However, it has been concluded that Gulf sturgeon are foraging in sandy areas where they are repeatedly located, as this habitat supports their prey (see preceding section, Prey Items, for specifics). The benthic community structure within the project footprint was recently assessed by Vittor and Associates, Inc. (Vittor 2013). The substrate in the action area was found to support a wide array of macrobenthic infauna across taxonomic groups including polychaete taxa (Vittor 2013), a known Gulf sturgeon prey item. Polychaete worms dominated the benthic community at every station except for Station BS1 (see Figure 31) (Vittor 2013). Other common taxa found were gastropods, bivalves, chordates, nemerteans, and amphipods, common inhabitants within the action area. Thus, NMFS expects that the proposed action will adversely affect GSCH by reducing the amount of area that supports Gulf sturgeon prey in fill areas and temporarily reducing the amount of area that supports Gulf sturgeon prey in borrow areas.

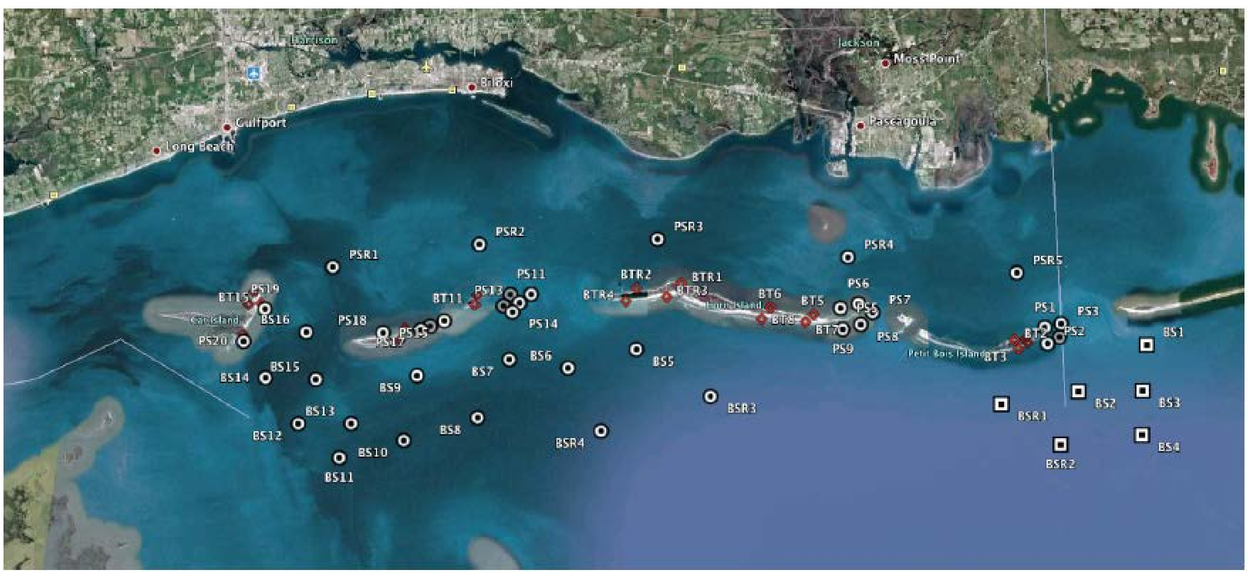


Figure 31. Station locations For the Benthic Macroinfaunal Community Assessment, MsCIP, 2010 -2011 from, Biological Assessment- MsCIP. USACE 2012

6.3.6 Recovery of Benthic Biota

When similar sediments are deposited, many beach restoration studies document fairly rapid macrobenthic recovery (i.e., < 1 year) partly because resident nearshore assemblages are well adapted to disturbance from shifting sediments (Nelson et al. 1993; Nelson and Dickerson 1989; Rakocinski et al. 1996). On the other hand, offshore (> 3 m depth) groupings of organisms that live at the bottom of a water column and are visible to the naked eye (such as polychaete worms, pelecypods, anthozoans, echinoderms, sponges, ascidians, crustaceans) may take longer to recolonize following disturbance or burial because of their greater species diversity (Nelson et al. 1993; Rakocinski et al. 1993). Negative impacts of beach renourishment usually occur when deposited sediments do not match local sediments in grain-size distributions or sediment composition (Rakocinski et al. 1996).

Dredging of material within the Cat Island borrow area will temporarily impact 429 acres of potential foraging habitat within Unit 8 of designated GSCH; however, the affected areas will recover within 3-24 months (Culter and Mahadevan 1982; Wilber et al. 2007). Deposition of dredged material (which is similar to existing substrate) in the Cat Island and Camille Cut/East Ship Island placement areas (168 acres and 511 acres, respectively) will "permanently" impact most of the 679 acres of GSCH within Unit 8. Given the fact that the barrier islands are dynamic in nature, they will naturally accrete and erode with time and during stochastic weather events such as hurricanes and winter storms. Therefore, although prey abundance within the GSCH portion of the action area will be adversely affected, NMFS expects these effects to be temporary for the borrow areas and recovery of prey abundance and availability will occur within a relatively short period of time. The area within Cat Island and Camille Cut/East Ship Island placement areas will be permanently converted to upland sand dune and intertidal swash zone communities, and the loss of this habitat will adversely affect the GSCH.

6.3.7 Summary of Effects on Gulf Sturgeon Critical Habitat

Gulf sturgeon prey abundance has the ability to recover as prey recolonizes the impacted areas, and therefore its resilience to the action should be considered. Recovery of the macrobenthic assemblages is expected, as sediment composition pre- and post-construction at the deposition areas will be similar and nearshore benthic assemblages are known to recover relatively quickly from physical disturbance. Conversion of subtidal habitat to emergent beach is expected to reverse over time as coastal erosion processes continue to erode the beach and upland dunes. However, with the USACE's plan to place the spoil from navigational channel maintenance to the littoral shelf of adjacent barrier islands and therefore reintroduce sediment into the littoral transport system, we expect some accretion to occur providing some balance (stability) to the barrier island erosion/accretion process. This of course is the intent of this project, to restore this barrier island to its former un-breached condition, providing a stable barrier island.

Based on the outcome of similar restoration projects, the USACE and NMFS anticipate that the temporary reduction of benthic prey available within the placement areas' minor footprint is not expected to affect the critical habitat's ability to support the Gulf sturgeon's conservation in the short or long term. Although the exposed area, which will be filled by this project, could theoretically be utilized by Gulf sturgeon, much of the newly created habitat is too shallow for the sturgeon to forage upon. In fact telemetry data shows that of the sturgeon that are found in the area between the two islands, the deeper area where Camille Cut existed is where sturgeon were located most frequently compared to other detections in the area of the island exposed by Hurricane Katrina in 2005. This indicates that while there is now a larger area exposed that may be accessible to Gulf sturgeon, this has not translated into more useful habitat. As mentioned above, in the terms of ecological function, while the restoration of the barrier island permanently impacts a small amount of area that is currently providing foraging habitat, the restoration ultimately provides stability of a significant geologic feature—known to be an important winter foraging area for many populations of Gulf sturgeon.

The project impact is expected to be temporary for the borrow areas and submerged portions of the fill area. Alternately, much of the permanent impacts are within currently shallow areas that were historically uplands, part of Ship Island as recently as 2005. While the fill is considered an adverse impact to GSCH, the loss of foraging habitat will be short-term and conversion to upland has benefits to GSCH by stabilizing and promoting sandy littoral foraging habitat.

While habitat known to support prey will be impacted, it is likely that any Gulf sturgeon in the project area have the ability to find appropriate and abundant prey in the areas adjacent to the project location, as many other nearby similar prey-rich sandy areas exist. Given that Gulf sturgeon forage opportunistically while benthic cruising, they can just as easily locate prey and fulfill nutritional requirements in areas adjacent to those impacted. As noted above, based on the outcome of similar restoration projects, the USACE anticipates the temporary reduction of benthic prey available within the placement areas footprint is not expected to significantly affect the critical habitat's ability to support the Gulf sturgeon's conservation in the short or long term.

It is NMFS's Opinion that although the newly exposed area could theoretically be utilized by Gulf sturgeon, much of the newly created habitat is too shallow for the sturgeon to forage upon, seeking instead the deeper waters with stronger currents located at the tips of the island and the area known as Camille Cut. As mentioned above, in the terms of ecological function, while the restoration of the barrier island will impact a small amount of area that is currently providing foraging habitat, the restoration ultimately provides some stability of the barrier island which is known to be an important winter foraging area for many populations of Gulf sturgeon. To continue to allow the unchecked erosion of this highly productive geological feature, (which has been hastened by the removal of sand from longshore sediment dispersal processes caused by the dredging of deep shipping channels) may be more damaging to GSCH if allowed to continue. Thus, the temporary reduction of benthic prey availability (3-24 months) (Culter and Mahadevan 1982; Wilber et al. 2007) resulting from the borrow area and submerged placement areas and permanent displacement of the barrier island (which was severely eroded by Hurricane Katrina in 2005) through placement of sand in the historical footprint of the barrier island and littoral zone totaling less than 0.08% of GSCH Unit 8 is not expected to reduce the critical habitat's ability to support the Gulf sturgeon's conservation in the short or long term. This is supported by the current population estimates and the ability of the benthic community to recover.

7 CUMULATIVE EFFECTS

ESA Section 7 regulations require NMFS to consider cumulative effects in formulating their Biological Opinions (50 CFR 402.14). Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Because many activities that affect marine habitat involve some degree of federal authorization (e.g., through USACE), NMFS expects that ESA Section 7 will apply to most major, future actions that could affect sea turtles. In addition, other activities identified in the environmental baseline are expected to continue to affect sea turtles, at similar levels into the foreseeable future.

8 JEOPARDY ANALYSIS

The analyses conducted in the previous sections of this Opinion serve to provide a basis to determine whether the proposed action would be likely to jeopardize the continued existence of affected ESA-listed sea turtles and sturgeon. In Section 6, we outlined how the proposed action can affect sea turtles and sturgeon and the extent of those effects in terms of estimates of the numbers of each species expected to be killed or captured. Now, we turn to an assessment of each species' response to this impact, in terms of overall population effects from the estimated take, and whether those effects of the proposed action, when considered in the context of the status of the species (Section 4), the environmental baseline (Section 5), and the cumulative effects (Section 7), will jeopardize the continued existence of the affected species.

It is the responsibility of the action agency to ensure that "any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species…" (ESA Section 7(a)(2)). Action agencies must consult with and seek assistance from the Services to meet this responsibility. The Services must ultimately determine in a Biological Opinion whether the action jeopardizes listed species. "To jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and the recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02). Thus, in making this determination, NMFS must look at whether the action directly or indirectly reduces the reproduction, numbers, or distribution of a listed species. Then, if there is a reduction in one or more of these elements, we evaluate whether it would be expected to cause an appreciable reduction in the likelihood of both the survival and the recovery of the species. In the following section, we evaluate the responses of loggerhead (NWA DPS), green, and Kemp's ridley sea turtles, to the effects of the action.

Effects of the Action on Sea Turtles' Likelihood of Survival and Recovery in the Wild
The lethal (observed and unobserved) take of 28 sea turtles (consisting of 18 Kemp's ridleys and 10 loggerheads; or a combination of 16 Kemp's ridleys and 8 loggerheads and 4 green turtles) by hopper dredges and 2 Kemp's ridleys by relocation trawls (but it may also consist of either a loggerhead or green) over the life of the project will result in a temporary reduction in total population numbers. An estimated non-lethal take of 5 leatherback sea turtles will result from this action through the relocation trawling effort. No lethal take of leatherback sea turtles is expected in the action and none is authorized. Sea turtle mortality resulting from hopper dredges could result in the loss of reproductive value of an adult turtle. The death of an adult female eliminates an individual's contribution (thousands of hatchlings over a lifetime of nesting) to future generations, and the action will result in a reduction in sea turtle reproduction. While the death of any individual is regrettable, its value in terms of reproductive potential is considerably less than that of an equal number of adults.

8.1 Loggerhead NWA DPS

The maximum potential lethal take of up to 10 loggerhead sea turtles (5 observed and 5 unobserved) by hopper dredge and possibly 1 loggerhead sea turtle during relocation trawls in both state and OCS waters is a reduction in numbers. These lethal takes would also result in a reduction in reproduction as a result of lost reproductive potential, as some of these individuals could be females who could have survived other threats and reproduced in the future, thus eliminating each female individual's contribution to future generations. For example, an adult female loggerhead sea turtle can lay 3 or 4 clutches of eggs every 2-4 years, with 100-130 eggs per clutch. The annual loss of adult female sea turtles, on average, could preclude the production of thousands of eggs and hatchlings of which a small percentage would be expected to survive to sexual maturity. The non-injurious capture of 169 loggerhead turtles due to relocation trawling is not expected to result in a reduction in numbers or in reproduction for the species, as the capture and release are not expected to reduce the fitness and growth prior to maturity of any juveniles that are captured. Because all the potential interactions are expected to occur at random throughout the proposed action area and sea turtles generally have large ranges in which they disperse, the distribution of loggerhead sea turtles in the action area is expected to be unaffected.

Whether or not the reductions in loggerhead sea turtle numbers and reproduction attributed to the proposed action would appreciably reduce the likelihood of survival for loggerheads depends on what effect these reductions in numbers and reproduction would have on overall population sizes and trends, i.e., whether the estimated reductions, when viewed within the context of the environmental baseline and status of the species, are of such an extent that adverse effects on population dynamics are appreciable. In Section 4.6, we reviewed the status of the species in terms of nesting and female population trends and several recent assessments based on population modeling (e.g., (Conant et al. 2009; NMFS-SEFSC 2009b). Below we synthesize what that information means in general terms and also in the more specific context of the proposed action and the environmental baseline.

Loggerhead sea turtles are a slow growing, late-maturing species. Because of their longevity, loggerhead sea turtles require high survival rates throughout their life to maintain a population. In other words, late-maturing species cannot tolerate much anthropogenic mortality without going into decline. Conant et al. (2009) concluded loggerhead natural growth rates are small, natural survival needs to be high, and even low to moderate mortality can drive the population into decline. Because recruitment to the adult population is slow, population modeling studies suggest even small increased mortality rates in adults and subadults could substantially impact population numbers and viability (Chaloupka and Musick 1997; Crouse et al. 1987; Crowder et al. 1994; Heppell et al. 1995).

The best available information indicates that the NWA DPS of loggerheads is still large, but is possibly experiencing more mortality than it can withstand. All of the results of population models in both NMFS SEFSC (2009b) and Conant et al. (2009) indicated western North Atlantic loggerheads were likely to continue to decline in the future unless action was taken to reduce anthropogenic mortality. The 2012 Florida index nesting number was the largest since 2000, however numbers dipped in 2013 with a slight recovery in 2014. The 2011, 2012, and 2013 nesting data for NRU Loggerhead Nests was on an upward trend as compared with 2010, however in 2014 nesting numbers dropped off to levels just above those seen in 2009 providing evidence that the nesting trend may have slowed.

NMFS SEFSC (2009b) estimated the minimum adult female population size for the western North Atlantic in the 2004-2008 time frame to likely be between 20,000 to 40,000 (median

30,050) individuals, with a low likelihood of being as many as 70,000 individuals. Estimates were based on the following equation: Adult females = (nests/nests per female) x remigration interval. The estimate of western North Atlantic adult loggerhead female was considered conservative for several reasons. The number of nests used for the western North Atlantic was based primarily on U.S. nesting beaches. Thus, the results are a slight underestimate of total nests because of the inability to collect complete nest counts for many non-U.S. nesting beaches. In estimating the current population size for adult nesting female loggerhead sea turtles, NMFS SEFSC (2009b) simplified the number of assumptions and reduced uncertainty by using the minimum total annual nest count over the relevant 5-year period (2004-2008) (i.e., 48,252 nests). This was a particularly conservative assumption considering how the number of nests and nesting females can vary widely from year to year (2008's nest count of 69,668 nests, which would have increased the adult female estimate proportionately, to between 30,000 and 60,000). Also, minimal assumptions were made about the distribution of remigration intervals and nests per female parameters, which are fairly robust and well-known parameters.

Although not in NMFS SEFSC (2009b), NMFS SEFSC, in conducting its loggerhead assessment, also produced a much less robust estimate for total benthic females in the western North Atlantic, with a likely range of approximately 60,000 to 700,000, up to less than 1 million. This estimate was discussed during the SEFSC's presentation on the loggerhead assessment to the Gulf Council's Reef Fish Committee at its June 16, 2009, meeting (NMFS-SEFSC 2009k). The estimate of overall benthic females is considered less robust because it is model-derived, assumes a stable age/stage distribution, and is highly dependent upon the life history input parameters. Relative to the more robust estimate of adult females, this estimate of total benthic female population is consistent with our knowledge of loggerhead life history and the relative abundance of adults and benthic juveniles: the benthic juvenile population is an order of magnitude larger than adults. Therefore, we believe female benthic loggerheads number in the hundreds of thousands, and therefore smaller pelagic stage individuals would occur in similar or even greater numbers.

As described in the Environmental Baseline section, we believe that the DWH oil spill event had an adverse impact on loggerhead sea turtles, and resulted in mortalities to an unquantified number of individuals, along with unknown lingering impacts resulting from nest relocations, nonlethal exposure, and foraging resource impacts. It is also possible that the DWH oil spill event reduced that survival rate of all age classes to varying degrees, and may continue to do so for some undetermined time into the future. There is no information at this time that it has, or should be expected to have, substantially altered the long-term survival rates in a manner that would significantly change the population dynamics compared to the conservative estimates used in this Opinion.

Also described in the Environmental Baseline section, we believe that climate change has the potential to adversely impact loggerhead sea turtles through rising sea levels, increased frequency of severe weather events, and changes in air and water temperatures. But there is not enough information yet to determine exactly how climate change will affect the long term survivability of sea turtles.

Recent studies (Conant et al. 2009; Merrick and Haas 2008; NMFS-SEFSC 2009a; NMFS and USFWS 2008b; TEWG 2009; Witherington et al. 2009) have all concluded that loggerhead nesting and adult female populations in the western North Atlantic are in decline and likely to continue to decline, while more recent analyses have indicated that the trend may have stabilized (NMFS and USFWS 2010). While the nesting and adult female populations are in decline, there is information on increases of abundance in some juvenile age classes (TEWG 2009). The population is clearly not at a stable age distribution, given past population perturbations, thus making an assessment of overall population trends is difficult (adults decreasing, juveniles increasing, etc.). It is possible that observed declines may be transitory effects, which will be compensated for by a wave of recruitment, which may be what we are seeing with the latest data. Yet, the fact remains that NMFS-SEFSC (2009k) is still the most comprehensive demographic model to date even though it was completed prior to nesting data from 2008-2010. It predicted that a continued decline in the total population is likely, given our present knowledge of loggerhead life history parameters. The most current data is from 2008-2010; therefore, it is not enough to determine if the trend has been altered or reversed, we believe a conservative assessment of the NWA DPS is to consider the effects of the action as if the population is still in an overall minor declining trend.

Despite the recently observed decline of the NWA DPS, its total population remains large. Adult female population size is conservatively estimated, based on the minimum nesting year of 2007, in the range of 20,000 to 40,000. The adult male population would be similar. Benthic juveniles number into the hundreds of thousands. As detailed previously, although the DWH event is expected to have impacted individuals within the Gulf of Mexico, there is no information at this time to indicate population-level impacts occurred that were significant enough to alter the population status in such a manner that it would change the relative impact of the proposed action on the NWA DPS.

We believe that the effects on loggerhead turtles associated with the proposed action are not reasonably expected to cause an appreciable reduction in the likelihood of survival of the NWA DPS of loggerheads, even in light of the impacts of the DWH oil release event. We believe the currently large population is still under the threat of possible future decline until large mortality reductions in fisheries and other sources of mortality (including impacts outside U.S. jurisdiction) are achieved or the impacts of past protection and conservation efforts are realized within the population. However, over at least the next several decades, we expect the NWA population of adult females to remain large and to retain the potential for recovery. Although the effects of the proposed action may have an effect on the overall size of the population, the action will not measurably reduce the size of the population, which we believe will remain sufficiently large for several decades to come even if the population were still in a minor decline, cause the population to lose genetic heterogeneity or broad demographic representation, impede successful reproduction, or affect loggerheads' ability to meet their life cycle requirements, including reproduction, sustenance, and shelter.

The Services' recovery plan for the NWA population of the loggerhead turtle (NMFS and USFWS 2008b), which is the same population of turtles as the NWA DPS, provides additional explanation of the goals and vision for recovery for this population. The objectives of the recovery plan most pertinent to the threats posed by the proposed action are numbers 1 and 2:

1. Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females.

2. Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes.

Recovery objective No. 1, "Ensure that the number of nests in each recovery unit is increasing…," is the plan's overarching objective and has associated demographic criteria. Currently, none of the plan's criteria are being met, but the plan acknowledges that it will take 50-150 years to do so. Further reduction of multiple threats throughout the North Atlantic, Gulf of Mexico, and Greater Caribbean will be needed for strong, positive population growth, following implementation of more of the plan's actions. Although any continuing mortality in what might be an already declining population can affect the potential for population growth, we believe that given the large total population size, the lethal take of up to 10 loggerhead sea turtles (5 observed and 5 unobserved) by hopper dredge and possibly 1 loggerhead sea turtle during relocation trawls in both state and OCS waters will not impede or prevent achieving this recovery objective over the anticipated 50- to 150-year time frame.

Recovery objective No. 2 states, "Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes." Currently, there are not enough data to determine if this objective is being met. The NWA DPS nesting trend for loggerhead sea turtles remains slightly negative, although as mentioned above the trend has likely stabilized and in some areas improved. Overall, loggerhead populations may require many years before the population decline is reversed and numerical increases in population meet the goals of the recovery plan. As with recovery objective No. 1 above, we believe that given the large total population size, the lethal take of up to 10 loggerhead sea turtles (5 observed and 5 unobserved) by hopper dredge and possibly 1 loggerhead sea turtle during relocation trawls in both state and OCS waters will not impede or prevent achieving this recovery objective over the anticipated 50- to 150-year time frame.

We believe that the proposed action is not reasonably expected to cause an appreciable reduction in the likelihood of recovery of the NWA DPS of loggerheads. Recovery is the process of removing threats so self-sustaining populations persist in the wild. The proposed action would not impede progress on achieving the identified relevant recovery objectives or achieving the overall recovery strategy.

8.2 Green Sea Turtles

The maximum potential lethal take of up to 4 green sea turtles (2 observed and 2 unobserved by hopper dredge) and possibly 1 green sea turtle during relocation trawls in both state and OCS waters is a reduction in numbers. These lethal takes would also result in a potential reduction in future reproduction, assuming some individuals would be females and would have survived otherwise to reproduce. For example, an adult green sea turtle can lay 1-7 clutches (usually 2-3) of eggs every 2-4 years, with 110-115 eggs/nest of which a small percentage is expected to survive to sexual maturity. The non-injurious capture of 10 green turtles due to relocation trawling is not expected to result in a reduction in numbers or in reproduction for the species, as the capture and release are not expected to reduce the fitness and growth prior to maturity of any juveniles that are captured. Green sea turtles are highly migratory, and individuals from all Atlantic nesting populations may range throughout the Gulf of Mexico, Atlantic Ocean, and Caribbean Sea. This is consistent for the proposed North Atlantic DPS as well. While the potential lethal take and relocation of turtles captured in trawls would result in a displacement of individuals from important developmental habitat, the loss is not significant in terms of local, regional, or global distribution as a whole. The majority of reproductive effort for green sea turtles comes from Florida and the Florida population distribution would be expected to remain the same. Therefore, we believe the anticipated impacts will not affect the species' distribution.

Whether the reductions in numbers and reproduction of green sea turtles species would appreciably reduce the species' likelihood of survival depends on the probable effect the changes in numbers and reproduction would have on current population sizes and trends.

The 5-year status review for green sea turtles states that of the 7 green sea turtle nesting concentrations in the Atlantic Basin for which abundance trend information is available, all were determined to be either stable or increasing (NMFS and USFWS 2007a). The Atlantic Basin includes the proposed North and South Atlantic DPS for green sea turtles. Both DPS's as proposed are considered large and stable. The 2007 review also states that the annual nesting female population in the Atlantic basin ranges from 29,243-50,539 individuals. Additionally, the pattern of green sea turtle nesting shows biennial peaks in abundance, with a generally positive trend during the 10 years of regular monitoring since establishment of index beaches in Florida in 1989. According to data collected from Florida's index nesting beach survey from 1989-2012, green sea turtle nest counts across Florida have increased approximately ten-fold from a low of 267 in the early 1990s to a high of 25,553 in 2013. Two consecutive years of nesting declines in 2008 and 2009 caused some concern, but this was followed by increases in both 2010 and 2011, a decrease in 2012, and another increase in 2013 (Figure 21). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%.

Also described in the Environmental Baseline section, we believe that climate change has the potential to adversely impact green sea turtles through rising sea levels, increased frequency of severe weather events, and changes in air and water temperatures. But there is not enough information yet to determine exactly how climate change will affect the long term survivability of sea turtles.

For a population to remain stable, sea turtles must replace themselves through successful reproduction at least once over the course of their reproductive lives, and at least one offspring must survive to reproduce itself. If the hatchling survival rate to maturity is greater than the mortality rate of the population, the loss of breeding individuals would be exceeded through recruitment of new breeding individuals from successful reproduction of non-taken sea turtles. Since the abundance trend information for green sea turtles is clearly increasing, we believe the lethal interactions attributed to the proposed action will not have any measurable effect on that trend. As described in the Environmental Baseline section, although the DWH oil spill event is expected to have resulted in adverse impacts to green turtles, there is no information to indicate, or basis to believe, that a significant population-level impact has occurred that would have changed the species' status to an extent that the expected interactions from the proposed action would result in a detectable change in the population status of green turtles in the Atlantic. Any impacts are not thought to alter the population status to a degree in which the number of mortalities from the proposed action could be seen as reducing the likelihood of survival of the species. Therefore, we conclude the proposed action is not likely to appreciably reduce the likelihood of survival of green sea turtles in the wild.

The Recovery plan for the population of Atlantic green sea turtles (NMFS and USFWS 1991) lists the following relevant recovery objectives over a period of 25 continuous years:

- The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years
  - Status: Green sea turtle nesting in Florida between 2001-2006 was documented as follows: 2001 – 581 nests, 2002 – 9,201 nests, 2003 – 2,622, 2004 – 3,577 nests, 2005 – 9,644 nests, 2006 – 4,970 nests. This averages 5,039 nests annually over those 6 years (2001-2006) (NMFS and USFWS 2007a). Subsequent nesting has shown even higher average numbers (i.e., 2007 – 9,455 nests, 2008 – 6,385 nests, 2009 – 3,000 nests, 2010 – 13,247 nests, 2011 – 15,369 nests, 2012 – 9,617 nests, 2013 – 36,195 nests, 2014 – 5,895 nests) [15]; thus, this recovery criterion continues to be met.
- A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds
  - Status: Several actions are being taken to address this objective; however, there are currently no estimates available specifically addressing changes in abundance of individuals on foraging grounds. Given the clear increases in nesting, however, it is likely that numbers on foraging grounds have increased by at least the same amount. This Opinion's effects analysis assumes that in-water abundance has increased at the same rate as Tortuguero nesting.

The cumulative lethal take of up to 4 green sea turtles (2 observed and 2 unobserved) by hopper dredge and possibly 1 green sea turtle during relocation trawls in both state and OCS waters are not likely to reduce population numbers over time due to current population sizes, nesting increases and expected recruitment. Thus, the proposed action is not likely to impede the recovery objectives above and will not result in an appreciable reduction in the likelihood of green sea turtles' recovery in the wild.

8.3 Kemp's Ridley Sea Turtles

The maximum potential lethal take of 18 Kemp's ridley sea turtles (9 observed and 9 unobserved by hopper dredge) and 2 Kemp's ridley sea turtles during relocation trawl in both state and OCS waters is a reduction in numbers. These lethal takes would also result in a potential reduction in future reproduction, assuming some individuals would be females and would have survived otherwise to reproduce. For example, females lay approximately 2.5 nests per season with each nest containing approximately 100 eggs, though only a small percentage is expected to survive to sexual maturity. The non-injurious capture of up to 216 Kemp's ridleys due to relocation

[15] Source: FWC/FWRI Statewide Nesting Beach Survey Program Database as of 20 February 2015

trawling is not expected to result in a reduction in numbers or a reduction in reproduction for the species, as the capture and release is not expected to reduce the fitness and growth prior to maturity of any juveniles that are captured. Kemp's ridleys are wide ranging throughout the Gulf of Mexico and along the Atlantic coast, and while the potential lethal take and relocation of turtles captured in trawls would result in a displacement of individuals from important developmental habitat, the loss is not significant in terms of the species' rangewide distribution as a whole.

The proposed action's reductions in numbers and reproduction would reduce the species' population compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Whether the reductions in numbers and reproduction of Kemp's ridley sea turtles species would appreciably reduce this species' likelihood of survival depends on the probable effect the changes in numbers and reproduction would have on current population sizes and trends.

Heppell et al. (2005) predicted in a population model that the Kemp's ridley sea turtle population is expected to increase at least 12-16% per year and that the population could attain at least 10,000 females nesting on Mexico beaches by 2015. NMFS et al. (2011) contains an updated model which predicted that the population is expected to increase 19% per year and that the population could attain at least 10,000 females nesting on Mexico beaches by 2011. Approximately 25,000 nests would be needed for an estimate of 10,000 nesters on the beach, based on an average 2.5 nests/nesting female. In 2009, the population consisted of 21,144 nests, but an unexpected and as yet unexplained drop in nesting occurred in 2010 (13,302), deviating from the NMFS et al. (2011) model prediction. Following the decline in 2010, a subsequent increase to 20,570 nests in 2011 occurred. Kemp's ridley nests in Mexico reached a record high of 21,797 in 2012 (Gladys Porter Zoo nesting database 2013). In 2013 through 2014, there was a second significant decline, with only 16,385 and 11,279 nests recorded, respectively. Though we will not know if the population is continuing the recovery trajectory and timeline predicted by the model until future nesting data is available, there is nothing to indicate the trend of increases in this species' population will cease.

It is likely that the Kemp's ridley sea turtle was the sea turtle species most affected by the DWH oil spill on a population level. In addition, the sea turtle strandings documented in 2011 in Alabama, Louisiana, and Mississippi primarily involved Kemp's ridley sea turtles (see Environmental Baseline section). Also, as described in the Environmental Baseline section, we believe that climate change has the potential to adversely impact Kemp's ridley sea turtles through rising sea levels, increased frequency of severe weather events, and changes in air and water temperatures. Yet, there is not enough information yet to determine exactly how climate change will affect the long term survivability of sea turtles. Nevertheless, the one-time loss of 18 Kemp's ridley sea turtles from hopper dredging and 2 Kemp's ridley sea turtles during relocation trawls is not likely to measurably affect overall population numbers due to current large population sizes, expected recruitment, and continuing strong nesting numbers (including, based on preliminary information, in 2011), even in light of the adverse impacts expected to have occurred from the DWH oil spill event and the strandings documented in 2011. Thus, we believe the proposed action will not result in an appreciable reduction in the likelihood of Kemp's ridley sea turtles' survival in the wild.

The recovery plan for the Kemp's ridley sea turtle (NMFS et al. 2011) lists the following relevant recovery objectives:

- A population of at least 10,000 nesting females in a season (as measured by clutch frequency per female per season) distributed at the primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained. Methodology and capacity to implement and ensure accurate nesting female counts have been developed.

The recovery plan states average nests per female is 2.5 and sets a recovery goal of 10,000 nesting females that would be represented by 25,000 nests in a season. As discussed above, nesting levels had been steadily increasing to a high of 21,144 nests in 2009, exhibited a substantial decline in 2010, but rebounded markedly in 2011 to 20,570 nests and again in 2012 with 21,797 nests. In 2013 through 2014, there was a second significant decline, with only 16,385 and 11,279 nests recorded, respectively. The potential nonlethal relocation of 216 Kemp's ridley turtles and the cumulative lethal take of 18 Kemp's ridley sea turtles from hopper dredging and 2 Kemp's ridley sea turtles during relocation trawls in both state and OCS waters will not affect the overall level or trend in adult female nesting population numbers or number of nests per nesting season. Thus, the proposed action will not result in an appreciable reduction in the likelihood of Kemp's ridley sea turtle recovery in the wild.

8.4 Leatherback Sea Turtles

Amongst sea turtles, leatherbacks are the species least likely to be adversely affected by the proposed action. As noted in the effects analysis, leatherback sea turtles are generally not vulnerable to entrainment due to their large size and further offshore favored pelagic habits. The USACE has no records of leatherback sea turtles being entrained in hopper dredge operations within the Gulf of Mexico or elsewhere (USACE Sea Turtle Data Warehouse 2013). We do not expect or authorize any lethal take of leatherback sea turtles from the proposed action. Based on the encounter data, we estimated that only non-lethal take will result from this action through the relocation trawling effort.

The maximum potential non-lethal take of 5 leatherback sea turtles during relocation trawling in both state and OCS waters is not a reduction in numbers. This non-lethal take will not result in a reduction in future reproduction because these relocated leatherback sea turtles will continue to contribute to future generations. Because the anticipated non-lethal take is expected to occur anywhere in the action area, no reduction in the distribution of leatherback sea turtles is expected from the proposed action. In summary, the proposed action is not expected to result in any reduction in numbers, reproduction or distribution of leatherback sea turtles. Therefore, we believe the proposed action is not reasonably expected to cause, directly or indirectly, a reduction in the likelihood of survival or recovery of leatherback sea turtles in the wild.

8.5 Gulf Sturgeon

The maximum lethal take of 9 Gulf sturgeon (4 observed and 4 unobserved by hopper dredge, and 1 lethal take by relocation trawler) in both state and OCS waters is a reduction in numbers. A reduction in the distribution of Gulf sturgeon is not expected from the 8 lethal hopper dredge takes or the 1 lethal and 30 non-lethal capture by relocation trawling during the proposed action. The number of Gulf sturgeon that are likely to die as a result of the dredge project, represents a small percentage of the estimated Gulf sturgeon population in the Gulf of Mexico. Populations in the Pearl and Pascagoula Rivers, 2 of the 7 confirmed spawning river populations, have never been nearly as abundant as those to the east, and their current status, post-Hurricanes Katrina and Rita, is unknown as comprehensive surveys have not occurred. Currently, it is estimated that there are approximately 216 spawners in the Pascagoula and 430 spawners in the Pearl. The project will primarily dredge in areas greater than 3-miles from the existing barrier islands, which will temporarily affect the amount of potential foraging area. However since the majority of foraging takes place around the barrier islands and not off the OCS, the overall effects to Gulf sturgeon will not be significant. While the death of 9 Gulf sturgeon will reduce the number of Gulf sturgeon in the population compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this population or its trend as this loss represents a small percentage of the population.

It is unlikely that the loss of 9 Gulf sturgeon will affect the success of spawning. Given the action area, the dredging and relocation trawling will most likely only effect adults. This small reduction in potential spawners is expected to result in a small reduction in the number of eggs laid or larvae produced in future years and similarly, a small effect on the strength of subsequent year classes. Additionally, the proposed action will not affect spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds.

The proposed action is not likely to reduce distribution because the action will not impede Gulf sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Gulf of Mexico.

Based on the information provided above, the death of 9 Gulf sturgeon resulting from the project will not appreciably reduce the likelihood of survival of the population or of this species. The action will not affect Gulf sturgeon in a way that prevents the species from having a sufficient population, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Gulf sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter (i.e., it will not increase the risk of extinction faced by this species).

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur to an extent that the species' continued existence is jeopardized. NMFS has determined above, that the proposed action will not appreciably reduce the likelihood that Gulf sturgeon will survive in the wild. Here, NMFS considers the potential for the action to reduce the likelihood of recovery. Recovery is defined as the improvement in status such that listing is no longer appropriate. The Gulf Sturgeon Recovery/Management Plan was created in 1995 (USFWS and GSMFC 1995). During the most recent 5-year review (USFWS and NMFS 2009), it was determined that the 1995 criteria do not directly address the 5 statutory listing/recovery factors. Five-factor-based criteria are necessary for measuring progress towards reducing threats and for determining when the protections of the Act are no longer necessary for the taxon. New criteria in a revised recovery plan should use demographic parameters that can be estimated from mark-recapture studies, including population abundance, and other appropriate metrics organized according to the statutory 5 factors. To evaluate whether the reductions in numbers and reproduction from the proposed action will appreciably reduce the Gulf sturgeons likelihood of recovery in the wild, we evaluated whether these reductions would in turn reduce the likelihood that the status of the Gulf sturgeon can improve to the point where it is recovered and could be delisted.

The proposed action is not expected to modify, curtail or destroy the range of the species since it will result in a small reduction in the number of Gulf sturgeon in the Gulf of Mexico and therefore, it will not affect the overall distribution of Gulf sturgeon. The proposed action is likely to result in the mortality of 9 Gulf sturgeon (4 observed and 4 unobserved by hopper dredge, and 1 lethal take by relocation trawler) in both state and OCS waters and the non-lethal capture of 30 Gulf sturgeon by relocation trawling during the proposed action; however, the loss of these individuals are not expected to affect the population within the Gulf of Mexico. The reduction in numbers and future reproduction is small, therefore the loss of these individuals will not change the status of the species. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery since the action will cause the mortality of a small percentage of the species as a whole and this mortality is not expected to result in the reduction of overall reproductive fitness for the species as a whole.

We therefore conclude that the proposed action is not expected to appreciably reduce the likelihood of the Gulf sturgeon's recovery in the Gulf of Mexico.

9 DESTRUCTION OR ADVERSE MODIFICATION ANALYSIS

When determining the potential impacts to critical habitat for this Biological Opinion, NMFS does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat (50 CFR 402.02). Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

Ultimately, we seek to determine if, with the implementation of the proposed action, critical habitat would remain functional (or retain the current ability for the essential features to become functional) to serve the intended conservation role for the species. This analysis takes into account the geographic and temporal scope of the proposed action, recognizing that "functionality" of critical habitat necessarily means that it must now and must continue in the future to support the conservation of the species and progress toward recovery. The analysis must take into account any changes in amount, distribution, or characters of the critical habitat that will be required over time to support the successful recovery of the species.

Gulf Sturgeon Critical Habitat

The project will impact 679 acres of benthos that will be filled, and the 429 acres of benthos that will be impacted temporarily from the dredging in the borrow area. However, the area to be impacted by dredging is a narrow patch within GSCH. While the likelihood of Gulf sturgeon usage is probable, Gulf sturgeon will have access to adjacent foraging habitat and will not be displaced permanently from this area. Gulf sturgeon are suction feeders, but due to their feeding morphology, they usually feed in waters 6.5-13 ft deep, where lower wave energy at the substrate interferes less with feeding. In addition, this habitat and depth (6.5-13 ft) is found in abundance in areas adjacent to the borrow sites and placement sites. Much of the area to be converted to upland is shallow and while this area is considered GSCH, ecologically speaking much of the area in the placement footprint is not the preferred location for Gulf sturgeon to forage. In fact telemetry data shows that of the sturgeon that are found in the area between the two islands, the deeper area where Camille Cut existed is where sturgeon were located most frequently compared to other detections in the area of the island exposed by Hurricane Katrina in 2005. This indicates that while there is now a larger area exposed that may be accessible to Gulf sturgeon, this has not translated into more useful habitat. Additionally, in the terms of ecological function, while the restoration of the barrier island impacts a small amount of area that is currently providing foraging habitat, the restoration ultimately provides some stability of a significant feature which is known to be an important winter foraging area for many populations of Gulf sturgeon. Although the barrier islands are dynamic by nature, their recent decay has undoubtedly been hastened by the removal of sand from the littoral sediment budget caused by the dredging of deep shipping channels, which act as a trap preventing the accretion of sediment and promoting the erosion of the barrier islands. To continue to allow the unchecked erosion of this geological feature—known to provide conditions that promote highly productive foraging areas for Gulf sturgeon—would appreciably diminish the value of GSCH within Unit 8.

Gulf sturgeon are opportunistic feeders that forage over large distances, and thus have the ability to locate prey throughout adjacent sandy areas in Unit 8. Therefore, while the temporary impact of 429 acres and permanent impact of 679 acres of habitat containing Gulf sturgeon prey will adversely affect the prey abundance essential feature, it will not destroy or adversely modify GSCH. The conservation function of Unit 8 will remain intact.

Finally, the proposed action will not interfere with recovery objectives, actions, or tasks identified in the Gulf sturgeon recovery plan (USFWS and GSMFC 1995). The proposed action will not affect population size or distribution, disrupt research activities, or interfere with any proposed habitat assessments. NMFS concludes that the effects of the project will not impact the ecological function of Unit 8, and that it will continue to serve its intended conservation role for Gulf sturgeon.

10 CONCLUSION

Green, Kemp’s Ridley, Leatherback, and Loggerhead Sea Turtles, and Gulf Sturgeon
We have analyzed the best available data, the current status of the species, the environmental baseline, the effects of the proposed action, and cumulative effects to determine whether the proposed action is likely to jeopardize the continued existence of any listed species. Our green sea turtle analysis focused on the impacts to, and the population response of, sea turtles in the Atlantic Basin, which includes the population the is proposed for listing as the North Atlantic DPS. However, the impacts of the effects of the proposed action on this Atlantic population must be directly linked to the global population and there must be a final jeopardy analysis for the global population that is currently listed under the ESA. Because the proposed action will not reduce the likelihood of survival and recovery of the Atlantic Basin population (or proposed North Atlantic DPS), it is our Opinion that the proposed action is not likely to jeopardize the continued existence of green sea turtles (both the Florida breeding population and non-Florida breeding population, as well as the proposed North Atlantic DPS). It is also our Opinion that the proposed action is not likely to jeopardize the continued existence of NWA DPS of loggerhead, leatherback, or Kemp’s ridley turtles, or Gulf sturgeon.

Gulf Sturgeon Critical Habitat
After reviewing the current status of GSCH in Unit 8, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is NMFS's Biological Opinion that the dredging and placement of material associated with the project will not reduce the critical habitat's ability to support the Gulf sturgeon's conservation. NMFS does not expect the adverse impacts to abundance of prey items resulting from this proposed action to appreciably reduce the conservation function of GSCH. NMFS concludes the action, as proposed, is not likely to destroy or adversely modify designated GSCH.

11 INCIDENTAL TAKE STATEMENT (ITS)

Section 9 of the ESA and protective regulations issued pursuant to Section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined by NMFS 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. 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 ESA provided that such taking is in compliance with the RPMs and terms and conditions of the ITS.

11.1 Anticipated Amount or Extent of Incidental Take

Based on historical distribution data, hopper dredge observer reports, observations of past strandings, and increasing turtle populations of loggerhead, Kemp's ridley, and green sea turtles in the action area, we estimate that these 3 species may occur in the action area and may be taken by the hopper dredging operations of this project, by crushing and/or entrainment in suction dragheads. NMFS anticipates incidental take in both state and OCS waters will consist of up to 14 sea turtles[16] observed (9 Kemp's ridleys and 5 loggerheads; or a combination of 8 Kemp's ridley and 4 loggerhead and 2 green turtle) or 28 total (observed and unobserved - 18 Kemp's ridleys and 10 loggerheads; or a combination of 16 Kemp's ridley and 8 loggerhead and 4 green turtle) and 8 (observed and unobserved) Gulf sturgeon killed during dredging, which will be detected and documented by onboard protected species observers (Table 23). NMFS also anticipates that capture trawling may result in up to 400 non-injurious captures and relocations of an estimated (up to) 169 loggerhead, 216 Kemp's ridley, 10 green, and 5 leatherback sea turtles and 30 Gulf sturgeon in both state and OCS waters. Trawl capture will also result in 2 lethal captures of Kemp's ridleys sea turtles (but it may also consist of either a loggerhead or green) and 1 lethal capture of Gulf sturgeon both state and OCS waters.

[16] The species-specific take numbers do not sum to the total take number from which they were derived due to rounding up all the species-specific take estimates.

Table 23. Amount of Authorized Observed Take During the MsCIP Project and Associated Relocation Trawling

During Dredging	**Loggerhead**	**Kemp's ridley**	**Green**	**Leatherback**	**Gulf sturgeon**
Total Species Observed Lethally Taken	5 or 4	9 or 8	2	0	4
During Relocation Trawling					
Total Species Nonlethally Taken	169	216	10	5	30
Total Species Lethally Taken	1[17]	2[18]	1[19]	0	1

11.2 Effect of the Take

NMFS has determined the anticipated level of incidental take specified in Section 11.1 is not likely to jeopardize the continued existence of loggerhead (NWA DPS), Kemp's ridley, green, or leatherback sea turtles or Gulf sturgeon.

11.3 Reasonable and Prudent Measures

Section 7(b)(4) of the ESA requires NMFS to issue a statement specifying the impact of any incidental take on listed species, which results from an agency action otherwise found to comply with Section 7(a)(2) of the ESA. It also states the RPMs necessary to minimize the impacts of take and the terms and conditions to implement those measures, must be provided and must be followed to minimize those impacts. Only incidental taking by the federal agency that complies with the specified terms and conditions is authorized.

The RPMs and terms and conditions are specified as required, by 50 CFR 402.14(i), to document the incidental take of ESA-listed species by the proposed action, to minimize the impact of that take, and to specify the procedures to be used to handle any individuals taken. These measures and terms and conditions are non-discretionary and must be implemented by the USACE, BOEM, and NPS in order for the protection of Section 7(o)(2) to apply. The USACE, as the lead agency, in cooperation with BOEM and NPS has a continuing duty to regulate the activity covered by this incidental take statement. If the USACE fails to adhere to the terms and conditions through enforceable terms, and/or fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of Section 7(o)(2) may lapse.

Current Regional Opinions for hopper dredging require observers to document takes, deflector dragheads, and conditions and guidelines for relocation trawling, which NMFS believes are necessary to minimize effects dredging activities on listed sea turtle species that occur in the action area. NMFS has determined that the following RPMs, patterned after long-standing hopper dredging requirements, are necessary and appropriate to minimize impacts of the incidental take of sea turtles during the proposed action. The RPMs that NMFS believes are necessary to minimize and monitor the impacts of the proposed hopper dredging have been

[17] NMFS believes that 2 sea turtles will be captured lethally. NMFS estimates that the lethal trawling interaction will most likely consist of a Kemp's ridley sea turtle, the most common species in the action area, for one or both of the takes, but it may also be either a loggerhead or green sea turtle.
[18] *Id*.
[19] *Id*.

discussed with the USACE, BOEM, and NPS in the past and are standard operating procedures, including use of sea turtle deflector dragheads, use of dredged material inflow and overflow screening, observer and reporting requirements, and relocation trawling. The following RPMs and associated terms and conditions are established to implement these measures, to document incidental takes, and to specify procedures for handling individuals taken. Only incidental takes that occur while these measures are in full implementation are authorized.

1. The USACE as the lead agency, in cooperation with BOEM and NPS shall implement best management measures, including use of temperature- and date-based dredging windows, sea turtle deflector dragheads, disengagement of dredging pumps when they are not on the bottom, limiting dredge lights seasonally, and relocation trawling to reduce the risk of injury or mortality of listed species and lessen the number of sea turtles killed by the proposed action.

   Rationale: Temperature- and date-based dredging windows appear to be very effective in reducing sea turtle entrainments, by avoiding times and places either where turtle densities are high or their behaviors may make them less susceptible to entrainment. Draghead deflectors provide a last line of defense, by acting as physical barriers, reducing the likelihood that turtles that are close to the draghead are actually entrained. When the suction dragheads are not firmly placed on the bottom during dredging operations, sea turtles encountered by the dragheads can be crushed underneath them and/or impinged or sucked into the suction pipes by the powerful suction, almost always resulting in death. Seasonally limiting dredge lights will help reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches. Relocation (i.e., capture) trawling reduces the risk of turtle entrainment even when turtle densities are high, possibly by either temporarily reducing the local density of turtles in the channel where the dredge is working or by modifying the turtles' behavior temporarily and making them less susceptible to entrainment. In addition, the use of relocation trawling provides the USACE, BOEM, and NPS with valuable real-time estimates of sea turtle abundance, takes, and distribution which have been helpful to USACE, BOEM, and NPS project planning efforts to reduce sea turtle impacts, for example by delaying or changing the location of hopper dredge deployment in response to sea turtle density information in the channel.

2. The USACE, as the lead agency, in cooperation with BOEM and NPS shall have measures in place to detect and report all interactions with any protected species (ESA or Marine Mammal Protection Act) resulting from the proposed action. These measures include endangered species observers aboard the hopper dredge and relocation trawlers, screening of dredged material to allow discovery of any entrained turtles and sturgeon, and handling procedures for incidentally taken animals.

   Rationale: NMFS-approved observers monitor dredged material inflow and overflow screening baskets and relocation trawling efforts to monitor and report incidental take. Gathering basic biological information (e.g., size which will help determine the age class) will enable monitoring of the impact of the take on the species taken. PIT tagging, external flipper tagging, and tissue sampling of turtles and Gulf sturgeon captured pursuant to relocation trawling, including genetic analysis of tissue samples taken from dredge- and trawl-captured turtles, will provide important monitoring information about the animals taken during relocation trawling. Tagging will inform about the fate of the turtles and Gulf sturgeon relocated should they be recaptured or strand subsequent to being relocated. Tissue sampling will identify which sea turtle and Gulf sturgeon stocks are being impacted and their geographic origin.

3. The USACE as the lead agency, in cooperation with BOEM and NPS will continue Gulf sturgeon monitoring efforts at Ship Island which are being conducted by the USACE's Engineer Research and Development Center (ERDC) and others. The objective is to characterize the seasonal occurrences and movements of the sturgeon around Ship Island and within Camille Cut and adjacent passes. In particular, the telemetry monitoring during construction on Ship Island and after construction has been finalized (post-construction). This monitoring will refine the benthos assessment applied to the 2011-2012 deployment period (e.g., re-evaluate metrics for defining high/low categories), refine and finalize description of "important" prey items, and apply this new approach to current benthos dataset.

   The USACE will provide more detailed evaluation of detection history of individual fish to identify movement patterns (i.e., corridors) in comparison to long duration residency areas (i.e., feeding). The USACE will follow a detailed outline of the proposed monitoring plan to be implemented as discussed in Section 3.1.7 and detailed in the T&C's below.

11.4 Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the ESA, the USACE must comply with the following terms and conditions, which implement the reasonable and prudent measures (RPMs) described above and outline required reporting and monitoring requirements. These terms and conditions are non-discretionary.

1) Hopper Dredging (RPM 1): Hopper dredging activities shall be completed, whenever possible, between December 1 and March 31, when sea turtle abundance is lowest throughout Gulf coastal waters.
2) Non-hopper Type Dredging (RPM 1): Pipeline or hydraulic dredges, because they are not known to take healthy sea turtles and have not taken Gulf sturgeon, must be used whenever possible between April 1 and November 30.
3) Operational Procedures (RPM 1): During periods in which hopper dredges are operating and NMFS-approved protected species observers are *not* required, (December 1 through March 31, if water temperatures are under 11°C), the USACE must:
   a) Advise inspectors, operators, and vessel captains about the prohibitions on taking, harming, or harassing sea turtles
   b) Instruct the captain of the hopper dredge to avoid any turtles encountered while traveling between the dredge site and offshore disposal area, and to immediately contact the USACE if sea turtles are seen in the vicinity

c) Notify NMFS immediately by email (takereport.nmfsser@noaa.gov) if a sea turtle or other threatened or endangered species is taken by the dredge, and reference this Biological Opinion (SER-2012-09304)

4) Dredging Pumps (RPM 1): Standard operating procedure shall be that dredging pumps shall be disengaged by the operator when the dragheads are not firmly on the bottom, to prevent impingement or entrainment of sea turtles within the water column. This precaution is especially important during the cleanup phase of dredging operations when the draghead frequently comes off the bottom and can suck in turtles resting in the shallow depressions between the high spots the draghead is trimming off.

5) Dredge Lighting (RPM 1): From May 1 through October 31, sea turtle nesting and emergence season, all lighting aboard hopper dredges and hopper dredge pumpout barges operating within 3 nmi of sea turtle nesting beaches shall be limited to the minimal lighting necessary to comply with U.S. Coast Guard and/or Occupational Safety and Health Administration requirements. All non-essential lighting on the dredge and pumpout barge shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to minimize illumination of the water to reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches.

6) Sea Turtle Deflecting Draghead (RPM 1): State-of-the-art, solid, plow-type rigid deflector dragheads must be used on all hopper dredges at all times. The use of alternative, experimental dragheads is not authorized without prior written approval from NMFS, in consultation with USACE. Slotted draghead deflectors or chain-type deflectors are currently not authorized.

7) Training – Personnel on Hopper Dredges (RPM 1): The USACE must ensure that all contracted personnel involved in operating hopper dredges receive thorough training on measures of dredge operation that will minimize takes of sea turtles. It shall be the goal of the hopper dredging operation to establish operating procedures that are consistent with those that have been used successfully during hopper dredging in other regions of the coastal United States, and which have proven effective in reducing turtle/dredge interactions. Therefore, USACE's experts or other persons with expertise in this matter shall be involved both in dredge operation training, and installation, adjustment, and monitoring of the rigid deflector draghead assembly.

8) Observers (RPM 2): The USACE shall arrange for NMFS-approved protected species observers to be aboard the hopper dredges to monitor the hopper bin, screening, and dragheads for sea turtles and their remains. Observer coverage sufficient for 100% monitoring (i.e., 2 observers) of hopper dredging operations is required aboard the hopper dredges between April 1 and November 30, or whenever surface water temperatures are 11°C or greater.

9) Screening (RPM 2): When sea turtle observers are required on hopper dredges, 100% inflow screening of dredged material is required and 100% overflow screening is recommended. If conditions prevent 100% inflow screening, inflow screening may be reduced gradually, as further detailed in the following, but 100% overflow screening is then required.

a) Screen Size: The hopper's inflow screens should have 4-inch by 4-inch screening. If the USACE, in consultation with observers and the draghead operator, determines that the draghead is clogging and reducing production substantially, other than in sand borrow areas the screens may be modified sequentially. Mesh size may be increased to 8-in by 8-in; if that fails to solve the clogging problem, then 16-in by 16-in openings may be used. Clogging should be greatly reduced or eliminated with these options; however, further clogging may compel removal of the screening altogether, in which case effective 100% overflow monitoring and screening is mandatory. The USACE shall notify NMFS beforehand if inflow screening is going to be reduced or eliminated, what attempts were made to reduce the clogging problem, and provide details of how effective overflow screening will be achieved.

b) Need for Flexible, Graduated Screens: NMFS believes that this flexible, graduated-screen option is necessary, since the need to constantly clear the inflow screens will increase the time it takes to complete the project and therefore increase the exposure of sea turtles to the risk of impingement or entrainment. Additionally, there are increased risks to sea turtles in the water column when the inflow is halted to clear screens, since this results in clogged intake pipes, which may have to be lifted from the bottom to discharge the clay by applying suction.

10) Dredge Take Reporting and Final Report (RPM 2): Observer reports of incidental take by hopper dredges must be emailed to the Southeast Regional Office (takereport.nmfsser@noaa.gov) with reference to this Biological Opinion (SER-2012-9304) by onboard NMFS-approved protected species observers, the dredging company, or the USACE within 24-hours of any sea turtle, Gulf sturgeon, or other listed species take observed.

A final report summarizing the results of the hopper dredging and any documented sea turtle, Gulf sturgeon, or other listed species takes must be submitted to NMFS (takereport.nmfsser@noaa.gov) with reference to this Biological Opinion (SER-2012-9304) within 60 working days of completion of the dredging project. The reports shall contain information on project location (specific channel/area dredged), start-up and completion dates, cubic yards of material dredged, problems encountered, incidental takes and sightings of protected species, mitigative actions taken (if relocation trawling, the number and species of turtles relocated), screening type (inflow, overflow) utilized, daily water temperatures, name of dredge, names of endangered species observers, percent observer coverage, and any other information the USACE deems relevant.

11) Sea Turtle Strandings (RPM 2): The USACE Project Manager or designated representative shall notify the STSSN state representative (contact information available at: http://www.sefsc.noaa.gov/seaturtleSTSSN.jsp) of the start-up and completion of hopper dredging operations and bed-leveler dredging operations and ask to be notified of any sea turtle strandings in the project area that, in the estimation of STSSN personnel, bear signs of potential draghead impingement or entrainment, or interaction with a bed-leveling type dredge.

a) Information on any such strandings shall be reported in writing within 30 days of project end to NMFS's Southeast Regional Office (takereport.nmfsser@noaa.gov) with reference to this Biological Opinion (SER-2012-09304) with a report detailing incidents, with photographs when available, of stranded sea turtles that bear indications of draghead impingement or entrainment. Because the deaths of these turtles, if hopper dredge related, have already been accounted for in NMFS's jeopardy analysis as turtles not observed being taken during hopper dredging operations, these strandings will not be counted against the USACE's take limit if they do not exceed the take limits set forth in this consultation.

12) Conditions Requiring Relocation Trawling (RPM 1): The USACE shall require trawling to start as soon as possible within 72 hours of either:

    a) Two or more turtles are taken by hopper dredges in a 24-hour period, or

    b) Total dredge takes in the project approach 75% (rounded-down) of any of the incidental take limits (Table 23); i.e., 6 Kemp's ridleys, 4 loggerheads, or 1 green taken.

    Relocation trawling may be suspended if no relocation or dredge takes occur within 14 days.

13) Relocation Trawling (RPM 1): Any relocation trawling conducted or contracted by the USACE to temporarily reduce abundance of these listed species during hopper dredging in order to reduce the possibility of lethal hopper dredge interactions, is subject to the following conditions:

    a) Trawl Time: Trawl tow-time duration shall not exceed 42 minutes (measured from the time the trawl doors enter the water until the time the trawl doors are out of the water) and trawl speeds shall not exceed 3.5 knots.

    b) Protected Species Handling During Trawling: Handling of sea turtles and Gulf sturgeon captured during relocation trawling in association with the dredging project shall be conducted by NMFS-approved protected species observers. Sea turtles and Gulf sturgeon captured pursuant to relocation trawling shall be handled in a manner designed to ensure their safety and viability, and shall be released over the side of the vessel, away from the propeller, and only after ensuring that the vessel's propeller is in the neutral, or disengaged, position (i.e., not rotating). Sea turtle resuscitation guidelines are attached (Appendix B). Any handling of Gulf sturgeon captured in the relocation trawling will comply with the NMFS's *Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons* (Attachment A) http://www.nmfs.noaa.gov/pr/pdfs/species/kahn_mohead_2010.pdf.

    c) Captured Sea Turtle Holding Conditions: Sea turtles may be held briefly for the collection of important biological information, prior to their release. Captured sea turtles shall be kept moist, and shaded whenever possible, until they are released, according to the requirements of Term and Condition No. 13-e, below.

    d) Biological Data Collection: When safely possible, all sea turtles and Gulf sturgeon shall be measured, tagged, weighed, and a tissue sample taken prior to release. When handling Gulf sturgeon, NMFS's *Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons* (Attachment A) will be used. Any external tags shall be noted and data recorded into the observers' log. Gulf sturgeon data will also be recorded on the Gulf Sturgeon Catch Datasheet & Gulf Sturgeon Survey Effort Datasheet (Attachment B). Only NMFS-approved protected species observers or observer candidates in training under the direct supervision of a NMFS-approved protected species observer shall conduct the tagging/measuring/weighing/tissues sampling operations. All Gulf sturgeon data will be submitted to Dr. Brian Kreiser, Department of Biological Sciences, 118 College Drive Ste.5018, University of Southern Mississippi, Hattiesburg, MS 39406, Phone: (601) 266-6556.

e) Take and Release Time During Trawling – Turtles: Turtles shall be kept no longer than 12 hours prior to release and shall be released not less than 3 nmi from the dredge site. Turtles to which satellite tags will be affixed may be held up to 24 hours before release. If 2 or more released turtles are later recaptured, subsequent turtle captures shall be released not less than 5 nmi away. If it can be done safely, turtles may be transferred onto another vessel for transport to the release area to enable the relocation trawler to keep sweeping the dredge site without interruption.

f) Injuries: Injured sea turtles shall be immediately transported to the nearest sea turtle rehabilitation facility. Minor skin abrasions resulting from trawl capture are considered non-injurious. The USACE shall ensure that logistical arrangements and support to accomplish this are pre-planned and ready. The USACE shall bear the financial cost of all sea turtle transport, treatment, rehabilitation, and release.

g) Flipper Tagging: All sea turtles captured by relocation trawling shall be flipper-tagged prior to release with external tags which shall be obtained prior to the project from the University of Florida's Archie Carr Center for Sea Turtle Research. This Opinion serves as the permitting authority for any NMFS-approved protected species observer aboard these relocation trawlers to flipper-tag with external tags (e.g., Inconel tags) captured sea turtles. Columbus crabs or other organisms living on external sea turtle surfaces may also be sampled and removed under this Opinion's authority.

h) PIT-Tag: This Opinion serves as the permitting authority for any NMFS-approved protected species observer aboard a relocation trawler to PIT-tag captured sea turtles and Gulf sturgeon. Tagging of sea turtles and Gulf sturgeon is not required to be done if the NMFS-approved protected species observer does not have prior training or experience in said activity; however, if the observer has received prior training in PIT tagging procedures, then the observer shall tag the animal prior to release (in addition to the standard external tagging):

   i) Sea turtle PIT tagging must then be performed in accordance with the protocol detailed at NMFS's Southeast Fisheries Science Center's webpage: http://www.sefsc.noaa.gov/seaturtlefisheriesobservers.jsp. (See Appendix C on SEFSC's "Fisheries Observers" webpage);

   ii) PIT tags used must be sterile, individually-wrapped tags to prevent disease transmission. PIT tags should be 125-kHz, glass-encapsulated tags–the smallest ones made. Note: If scanning reveals a PIT tag and it was not difficult to find, then do not insert another PIT tag; simply record the tag number and location, and frequency, if known. If for some reason the tag is difficult to detect (e.g., tag is embedded deep in muscle, or is a 400-kHz tag), then insert one in the other shoulder.

   iii) All Gulf sturgeon handled shall be scanned for a PIT tag; codes shall be included in the take report submitted to NMFS. The PIT tag reader shall be able to read both 125 kHz and 134 kHz tags. Sturgeon without PIT tags will have one installed per guidance in Attachment A. Previously PIT-tagged fish must not be re-tagged.

iv) All unmarked Gulf sturgeon less than 300 mm in total length would be tagged using 11.9 mm x 2.1 mm PIT tags injected using a 12-gauge needle at an angle of 60º to 80º in the dorsal musculature (left and just anterior to the dorsal fin) with the copper antenna oriented up for maximum signal strength. No fish would be double-tagged with PIT tags. The last step after injecting PIT tags would be to verify and record the PIT tag code with a tag reader. PIT tags may also be inserted under scutes after discussing with NMFS.

i) Sea Turtle PIT-Tag Scanning and Data Submission Requirements: All sea turtles captured by relocation trawling or dredges shall be thoroughly scanned for the presence of PIT tags prior to release using a multi-frequency scanner powerful enough to read multiple frequencies (including 125-, 128-, 134-, and 400-kHz tags) and read tags deeply embedded in muscle tissue (e.g., manufactured by Trovan, Biomark, or Avid). Turtles whose scans show they have been previously PIT tagged shall nevertheless be externally flipper tagged. Sea turtle data collected (PIT tag scan data and external tagging data) shall be submitted to NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Attn: Lisa Belskis, 75 Virginia Beach Drive, Miami, Florida 33149. All sea turtle data collected shall be submitted in electronic format within 60 days of project completion to Lisa.Belskis@noaa.gov. Sea turtle external flipper tag and PIT tag data generated and collected by relocation trawlers shall also be submitted to the Cooperative Marine Turtle Tagging Program (CMTTP), on the appropriate CMTTP form, at the University of Florida’s Archie Carr Center for Sea Turtle Research.

j) Handling Fibropapillomatose Turtles: NMFS-approved protected species observers are not required to handle viral fibropapilloma tumors if they believe there is a health hazard to themselves and choose not to. When handling sea turtles infected with fibropapilloma tumors, observers must maintain a separate set of sampling equipment for handling animals displaying fibropapilloma tumors or lesions.

k) Additional Data Collection Allowed During the Handling of Sea Turtles, Gulf sturgeon, and Other Incidentally-caught ESA-listed species: The USACE shall allow NMFS-approved protected species observers to conduct additional investigations that may include more invasive procedures (e.g., blood-letting, laparoscopies, external tumor removals, anal and gastric lavages, mounting satellite or radio transmitters, etc.) and partake in or assist in research projects but only if 1) the additional work does not interfere with any project operations (dredging activities, relocation trawling, etc.), 2) the observer holds a valid federal research permit (and any required state permits) authorizing the activities, either as the permit holder, or as designated agent of the permit holder, 3) the additional work does not incur any additional expenses to the USACE or the USACE approves of the expense, and 4) the observer has first coordinated with USACE Mobile District and notified NMFS’s Southeast Regional Office, Protected Resources Division (takereport.nmfsser@noaa.gov) with reference to this Biological Opinion (SER-2012-09304).

14) Relocation Trawling Report (RPM 2): The USACE shall provide NMFS’s Southeast Regional Office (takereport.nmfsser@noaa.gov) with reference to this Biological Opinion

(SER-2012-09304) with an end-of-project report within 30 days of completion of any relocation trawling. This report may be incorporated into the final report summarizing the results of the hopper dredging project.

15) Requirement and Authority to Conduct Tissue Sampling for Genetic Analyses (RPM 2): All live or dead sea turtles and/or Gulf sturgeon captured by relocation trawling and hopper dredging shall be tissue-sampled by a NMFS-approved protected species observer prior to release. This Opinion serves as the permitting authority for any NMFS-approved protected species observer aboard a relocation trawler or hopper dredge to tissue-sample live- or dead-captured sea turtles and/or Gulf sturgeon without the need for an ESA Section 10 permit.

    a) Sea turtle tissue samples shall be taken in accordance with NMFS SEFSC's procedures for sea turtle genetic analyses (Appendix II of this Opinion). The USACE shall ensure that tissue samples taken during the dredging project are collected, stored properly, and mailed no later than 60 days of completion of the dredging project to: NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Attn: Lisa Belskis, 75 Virginia Beach Drive, Miami, Florida 33149.

    b) Gulf sturgeon tissue samples shall be taken in accordance with NMFS's *Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons* (Attachment A). Care must be used when collecting genetic tissue samples (soft fin clips). Instruments should be changed or disinfected and gloves changed between each fish sampled to avoid possible disease transmission or cross contamination of genetic material.

        i) Submission and of genetic tissue samples must be coordinated with Dr. Brian Kreiser, Department of Biological Sciences, 118 College Drive Ste.5018, University of Southern Mississippi, Hattiesburg, MS 39406, Phone: (601) 266-6556. Additional questions will be directed to Jason Rueter, the NMFS PRD species coordinator for Gulf sturgeon, (727) 824-5312. Samples must be submitted within 6 months after collection.

16) Construction Period Monitoring (RPM 3) (Years 5 - 10) will consist of deploying and retrieving a series of VEMCO[20] receivers in various telemetry zones (Figure 32), benthic sampling, and yearly in-river netting and tagging (Pearl and Pascagoula Rivers). The USACE and/or its authorized agents will provide yearly reports on information gathered from long term monitoring plan detailed in Section 3.1.7. Reports may be submitted to NMFS at the following email address: (takereport.nmfsser@noaa.gov) or by hard copy mailed or faxed to the NOAA Southeast Regional Office, Assistant Regional Administrator, Protected Resources Division, National Marine Fisheries Service, 263 13th Avenue South, St. Petersburg, Florida 33701, phone (727) 824-5312; fax (727) 824-5309. This Opinion's issuance date, title, and identifier number (SER-2012-09304) shall be referenced in the correspondence.

[20] VEMCO© is the manufacturer of fish tracking and monitoring equipment that enables researchers to study the behavior and migration patterns of marine and freshwater animals over time.

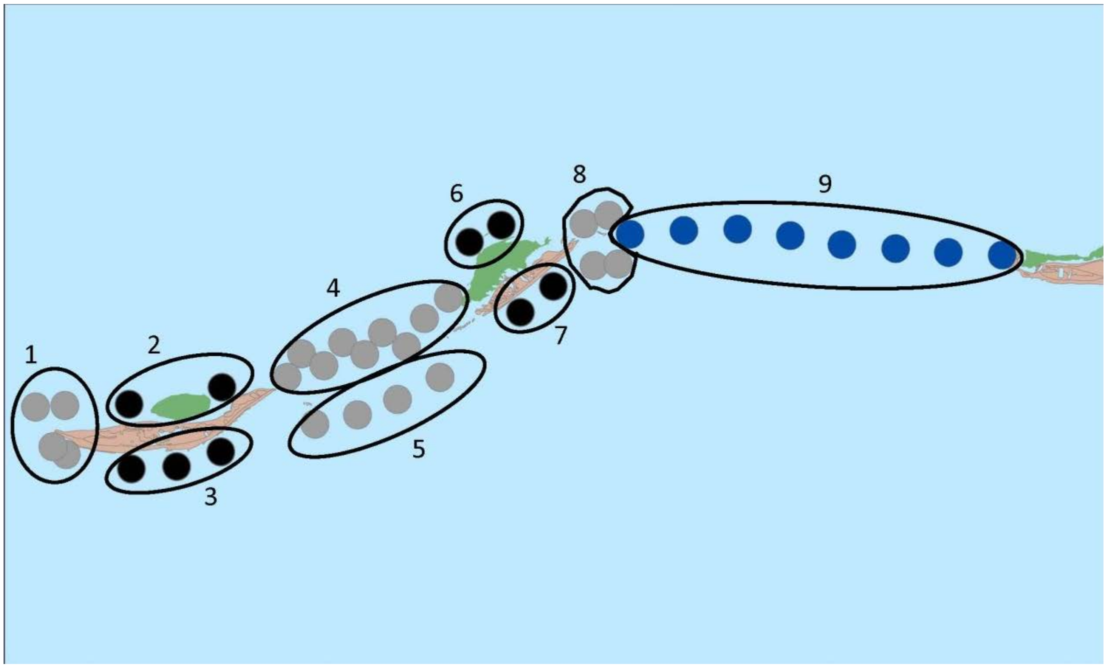


Figure 32. Telemetry Zones from, Biological Assessment- MsCIP. USACE 2012

12 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authority to further the purposes of the ESA 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, to help implement recovery plans, or to develop information. NMFS believes that USACE should implement the following conservation recommendations:

1. Gather data describing recovery rates of specific Gulf sturgeon prey impacted by the cyclical deposition of material into the adjacent disposal areas that would assist in future assessments of impacts to Gulf sturgeon prey items.

2. Gather additional data describing presence and movement of juvenile Gulf sturgeon within Mississippi Sound and the inland rivers and bays.

3. Gather data on Gulf sturgeon responses to dredging and construction noise.

4. Gather data describing Gulf sturgeon movement within the Pearl River, Pascagoula River, and Mississippi Sound.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

13 REINITIATION OF CONSULTATION

This concludes formal consultation on the MsCIP Barrier Island Restoration, Mississippi Sound, Hancock, Harrison, and Jackson Counties, Mississippi, and Mobile County, Alabama. 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 taking specified in the incidental take statement is exceeded;
2. New information reveals effects of the action may affect listed species or critical habitat in a manner or to an extent not previously considered;
3. The identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the Biological Opinion; or
4. A new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of take is exceeded, USACE must immediately request reinitiation of formal consultation.

Dredging/Trawling Operations During Reinitiation of Consultation:
To ensure that the specified levels of take are not exceeded early in the project the appropriate action agency (the USACE in cooperation with NPS and BOEM) should immediately reinitiate consultation with NMFS's Southeast Regional Office, Protected Resources Division, if any of the following conditions are met: when more than one turtle is taken by a dredge in any 24-hour period; once 4 turtles are taken by a dredge during a single project; if the dredge take reaches 75% of the take level established for any one species; a turtle species dredge take limit is close to being met; if 2 Gulf sturgeon are taken by a dredge; a hawksbill turtle is taken by a dredge; if more than 2 turtles or 1 Gulf sturgeon is injuriously or lethally taken by a relocation trawler; or the relocation trawling incidental take limit for non-lethally taken turtles or sturgeon is reached. The NMFS's Southeast Regional Office will work with the action agencies to quickly review such incidents to determine the need to implement further mitigating measures or to terminate the remaining dredging activity. However, the affected action agency is not required to suspend dredging or relocation trawling operations during the notification or consultation process, as long as NMFS concurs with the affected action agencies determination that continuation of operations during the reinitiated consultation will not violate Section 7(d) of the ESA.

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15 Attachment A

Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons

A Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons

Jason Kahn and Malcolm Mohead

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA Technical Memorandum NMFS-OPR-45
March 2010

Atlantic sturgeon (Robert Michelson, Photography by Michelson, Inc.)

Gulf sturgeon (Oscar Sosa, *New York Times*)

Green sturgeon (Thomas Dunklin)

Cover: shortnose sturgeon (credit: Robert Michelson)

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U.S. Department of Commerce
Gary Locke, Secretary of Commerce

National Oceanic and Atmospheric Administration
Jane Lubchenco, Ph.D., Administrator of NOAA

National Marine Fisheries Service
Eric C. Schwaab, Assistant Administrator for Fisheries

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Introduction

The goal of the National Marine Fisheries Service (NMFS) protocols for the use of sturgeon is standardization of research practices to benefit the recovery of Gulf of Mexico (Gulf), green, Atlantic, and shortnose sturgeon while also minimizing potentially negative impacts of research. As with *A Protocol for the Use of Shortnose and Atlantic Sturgeon* (Moser *et al.* 2000a), these protocols provide guidelines for consistent and safe sampling methods when conducting research on sturgeon. They were developed from a comprehensive review of the best available scientific information at the time of publication, including peer reviewed journals, technical memorandums, species status reviews, interviews with researchers, and empirical evidence provided by researchers. Currently, some state agencies have been delegated authority for issuing research permits for Gulf and green sturgeon. However, due to previous lack of protocols established for these species, they were incorporated into this document.

The majority of research conducted on sturgeon falls into several categories: capturing, handling, holding, standard research, anesthetization, tagging, gastric lavage, sex identification and stage of maturation, and age estimation. First, sturgeon must be captured, which may also require consideration of the waterway sampled to mitigate impacts on other federally listed threatened or endangered species. NMFS has determined that measuring, passive integrated transponder (PIT) tagging, and genetic sampling are essential procedures to provide NMFS with the most basic information on each fish and therefore those procedures are strongly recommended. After those procedures are completed, other discretionary research might include telemetry tagging, gastric lavage, sex identification, and age estimation. These discretionary procedures should use either chemical or physical anesthesia, potentially increasing risks to sturgeon.

These protocols were developed to allow for safe, non-lethal research on sturgeon, balancing the necessary negative impacts of research while still allowing researchers to gather information vital to the recovery of listed species under the Endangered Species Act (ESA). These protocols are based on a thorough and comprehensive review of the best available scientific information on current research methods and the subsequent risk to these species. When researchers or managers have reason to exceed recommendations in this document using less known or riskier techniques, NMFS recommends first using surrogate Acipenserids or hatchery-reared sturgeon. When researchers or managers feel non-recommended methods must be conducted on wild listed or candidate species, the researchers should consult with the appropriate permitting agency in order to justify why their methodology is necessary to provide information for the recovery of these species.

Non-Targeted Species Concerns in the Research Area

When sampling shortnose, Atlantic, Gulf, and green sturgeon, the potential exists for researchers to encounter other ESA or Marine Mammal Protection Act (MMPA) listed species, in addition to other locally or state protected species. These circumstances will vary with location and NMFS encourages consultation with the appropriate management authority in all cases.

When other ESA protected species are potentially present in an action area, the researcher must contact NMFS or the US Fish and Wildlife Service (USFWS) for clarification on the likelihood to adversely impact any listed species, or destroy or adversely modify any critical habitat for that species. The presence of listed species may require researchers to alter sampling plans to avoid taking listed fish, such as Pacific or Atlantic salmonids, or mammals, such as Stellar sea lions or manatees.

In many other locations, marine mammals, protected under the MMPA but not the ESA, may be present. The MMPA places a moratorium, with certain exceptions, on the taking and importing of marine mammals and marine mammal products. In 1981, Congress amended the MMPA to allow the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region. If marine mammals, including non-ESA listed pinnipeds or cetaceans, have the potential to be taken incidental to scientific research activities on sturgeon (e.g., there is a chance of entanglement), the researcher should consult with NMFS under section 101(a)(5) of the MMPA to determine if an incidental take authorization is warranted. Contact: Office of Protected Resources, Silver Spring, Maryland (301-713-2289).

In other instances, predators may frequent sampling areas posing threats to listed sturgeon species. In such cases, nets must be monitored at all times and pulled if predators are evidenced. Pinnipeds have been seen feeding on listed sturgeon by researchers (Fernandez 2008, Marty Gingras, California Department of Fish and Game, pers. comm.), potentially other predatory species such as odontocetes and sharks could take sturgeon while trapped in gillnets or trammel nets. If there are reasons to believe sturgeon could be harmed by predators while captured in gillnets or trammel nets, those nets should be continuously monitored.

Capture

Researchers most often capture Gulf, Atlantic, green, and shortnose sturgeon using a variety of gears including gillnets (drift and anchored), trammel nets, seine nets, trawls, trot lines, pound nets, and electrofishing. Nets of varying length and mesh size are chosen to target different life stages of sturgeon (Mason and Clugston 1993, DeVries 2006).

Generally, sturgeon are hardy, allowing some research methods lethal to other fish. These methods can still be stressful to sturgeon, occasionally resulting in lethal and, more often, sub-lethal effects. For example, during pre-spawning activities, capture and handling is thought to have resulted in immediate downstream migration or aborted spawning runs (Moser and Ross 1995, Kynard *et al.* 2007, Gail Wippelhauser, Maine Department of Marine Resources, pers. comm.). Also, during periods of warm water or low dissolved oxygen (DO), fish have been lethally stressed (Hastings *et al.* 1987, Secor and Gunderson 1998). NMFS recommends capturing adult sturgeon while they are still in their winter staging areas, but does not recommend targeting sturgeon during their upstream spawning migration due to the risks of aborted spawning runs. However, when the purpose of the research is to document the size of the spawning run, managers must determine whether the information to be gained is worth the risk posed by the research.

Dissolved Oxygen, Temperature, and Salinity

For all sturgeon species, research has revealed that survival is affected by a relationship between temperature, DO, and salinity and this vulnerability may be increased by the research-related stress of capture, holding, and handling. The following environmental information is considered relevant for establishing recommendations for directed sampling on early life stages to adult life stages of sturgeon.

Jenkins *et al.* (1993), Secor and Gunderson (1998), Niklitschek (2001), Secor and Niklitschek (2001 and 2002), and Niklitshek and Secor (2009a and 2009b) demonstrated shortnose and Atlantic sturgeon survival in a laboratory setting was affected by reduced DO, increased temperature, or increased salinity. Other researchers have demonstrated similar relationships between temperature, DO, and salinity in green sturgeon (Van Eenennaam *et al.* 2005, Allen *et al.* 2006, Allen and Cech 2007). Likewise, Altinok *et al.* (1998), Sulak and Clugston (1998), Sulak and Clugston (1999), and Waldman *et al.* (2002) reported high temperatures, low DO, and high salinities result in lower survival of Gulf sturgeon.

Though there may be differences between populations in different geographical regions, optimal growth for both Atlantic and shortnose sturgeon has been shown to occur at 70% oxygen saturation with a temperature of approximately 20°C (Niklitschek 2001). Shortnose sturgeon have also been shown to experience significant reductions in food consumption when temperatures exceed 25.8°C (Niklitschek 2001). Green sturgeon require cooler temperatures, growing optimally between 15° and 19°C, and experiencing reduced growth rates between 20° and 24°C (Mayfield and Cech 2004). However, larval green sturgeon grow more optimally at 24°C compared to 19°C (Allen *et al.* 2006). Gulf sturgeon also appear dependent on temperature for optimal growth, fasting during hot summer months and feasting during winter when water temperatures and DO in the Gulf of Mexico and tributaries are more optimal (Sulak and Randall 2002).

Considerable work has been conducted on temperature tolerances of sturgeon (Wang *et al.* 1985, Wehrly 1995, Kynard 1997, Campbell and Goodman 2004, Cech and Doroshov 2004, Van Eenennaam *et al.* 2005, Ziegeweid *et al.* 2007, Sardella *et al.* 2008). In recent work on critical thermal maximum, Ziegeweid *et al.* (2007) demonstrated hatchery-raised young of year shortnose sturgeon can tolerate between 28° and 30°C, while the maximum safe temperature limits for adults ranges between 28° and 31°C. Kynard (1997) also notes empirical temperatures of 28° to 30°C in summer months creates unsuitable shortnose sturgeon habitat. Atlantic sturgeon experience lower survival when water temperatures exceed 28°C (Niklitshek and Secor 2005). Mayfield and Cech (2004) estimated the lethal water temperature for green sturgeon in the wild at 27°C. Sardella *et al.* (2008) found green sturgeon lethal limits in a laboratory is approximately 33°C, in freshwater and sea water, although the maximum respiratory response evidenced is 26° to 28°C. Although Gulf sturgeon reside in freshwater during summer months where water temperatures range from 28° to 32°C, there have been no studies estimating lethal temperature limits for Gulf sturgeon. It is worth noting, however, the healthiest population of Gulf sturgeon occurs in the Suwannee River, where temperatures are generally maintained at 28°C by springs in parts of the river.

There is no clear evidence to suggest minimum water temperatures negatively affect sturgeon when captured beyond the early life stages. Therefore, this document identifies only upper water temperature restrictions to establish safe sampling limits for threatened or endangered sturgeon. However, when air temperatures are below freezing, handling procedures should be limited to less than two minutes to prevent exposure of a sturgeon's skin to freezing temperatures.

Because warm water can hold less DO, percent oxygen saturation is a measurement that accounts for water temperatures and DO concentrations, providing a general index of how much DO is available to sturgeon under various environmental conditions. All three measures are used in this document to highlight risks to sturgeon survival (Table 1). The 24 hour LC50 (concentration lethal to 50% of the test fish) of DO for shortnose sturgeon is documented between 2.2 and 3.1 mg/L at temperatures ranging from 22°C to 29°C (Campbell and Goodman 2004). Secor and Niklitschek (2002) reported the critical DO concentration for Eurasian sturgeons to be 4.5 mg/L at 24°C, but also found 3.6 mg/L DO critical at 20°C. Following a similar pattern, critical concentrations of DO between 4.3 and 4.7 mg/L were found for shortnose and Atlantic sturgeon at temperatures ranging from 22° and 27°C respectively. Further, acute lethal effects to shortnose and Atlantic sturgeon were observed when DO was 3.3 mg/L at temperatures between 22° and 27°C (Secor and Niklitschek 2002). Survival of Atlantic sturgeon was observed to be 100% in water temperatures of 26°C with 7 mg/L DO; however, 12% survival was observed in waters with 3 mg/L DO at the same temperature (Secor and Gunderson 1998). Even when water temperatures were only 19°C and DO was 3 mg/L, 25% of the Atlantic sturgeon died. Similar to reduced growth rates experienced by shortnose sturgeon when temperatures are above 25°C, both shortnose and Atlantic sturgeon growth is impaired when DO is less than 4.7 mg/L (Secor and Niklitschek 2002). Jenkins *et al.* (1993) confirmed 12% mortality for 339 mm juvenile sturgeon when held at 2.5 mg/L DO and 22.5°C, while no sturgeon died when DO was above 4 mg/L at any temperature. Likewise, Secor and Gunderson (1998) found the DO level required avoiding mortality was 5 mg/L. Specific DO tolerance levels have not been established for green or Gulf sturgeon, although hypoxia for many *Acipenser* species has been documented to begin at 4 mg/L (Cech *et al.* 1984, Jenkins *et al.* 1993, Secor and Gunderson 1998). Similarly, Cech and Crocker (2002) identified hypoxia for sturgeon as 58% oxygen saturation.

Table 1. Water temperature, dissolved oxygen, percent oxygen saturation of the water, and survival rates of sturgeon tested.

Authors	Species	Temp (°C)	DO (mg/L)	% Saturation	Effects
Jenkins *et al.* 1993	Shortnose	22.5	2.5	29%	88% survival
Campbell and Goodman 2004	Shortnose	22 – 29	2.2 – 3.1	25 - 41%	50% survival
Secor and Niklitschek 2002	Atlantic and shortnose	22 – 27	3.3	38 – 42%	Acute lethal effects
Secor and Gunderson 1998	Atlantic	26	3	37%	12% survival
Secor and Gunderson 1998	Atlantic	19	3	33%	75% survival
Secor and Niklitshek 2002	Eurasian	24	4.5	54%	Critical DO concentration, onset of sub-lethal effects
		20	3.6	40%	
Secor and Niklitshek 2002	Atlantic and shortnose	22 – 27	4.3 – 4.7	50 – 60%	Critical DO concentration, onset of sub-lethal effects

NMFS recognizes the synergistic effects of water temperature and DO present difficulties when establishing finite levels for safe sturgeon sampling (Table 1). It is clear from reported empirical catch data and scientific literature, higher temperatures and lower DOs stress sturgeon even if the percent oxygen saturation remains constant or increases. Water temperature and DO can be responsible for mortality events. Each individual sturgeon will react differently to changes in environmental conditions such as water quality, salinity, and stress associated with capture and handling, which compounds the difficulty of conducting a risk assessment.

Using data reported from capture of shortnose and Atlantic sturgeon from the 1970s to present and the critical thresholds and LC50s reported in the scientific literature as reference points, NMFS established safe environmental limits for capturing and handling sturgeon species. NMFS recommends not capturing or handling Gulf, Atlantic and shortnose sturgeon when DO concentrations are below 4.5 mg/L. Green sturgeon should not be captured or handled when DO concentrations are below 5 mg/L. Additionally, NMFS recommends not sampling for Gulf, shortnose, or Atlantic sturgeon when temperatures exceed 28°C and green sturgeon should not be captured when water temperatures exceed 25°C. When establishing these recommendations, NMFS also considered the percent oxygen saturation of water and recommends not sampling for Gulf, Atlantic, or shortnose sturgeon when oxygen saturation is below 55% or green sturgeon when oxygen saturation is below 58%. Sampling at higher temperatures or lower DO levels may be possible if the percent oxygen saturation in water is maintained at these levels.

Gillnets and Trammel Nets

Researchers typically use gillnets and trammel nets to capture sturgeon. These netting techniques, while potentially lethal for many species of fish, are somewhat safer for sturgeon. However, given the implications of water temperature, DO, and percent oxygen saturation, both soak times and mesh size are important factors considered for safely capturing and handling sturgeon. Mesh size that is too small for the targeted life stage is more likely to constrict gills resulting in mortality via suffocation. The mesh size chosen for gill netting sturgeon, therefore, should be carefully considered and appropriate for the species and life stage targeted. Experimental nets with multiple mesh sizes may be appropriate for researchers to discover the safest and most effective mesh size. For example, due to disproportionately high reports of mortality using ten inch stretch mesh with Atlantic sturgeon (Balazik *et al.* 2009), this size mesh should not be used to sample adult Atlantic or Gulf sturgeon.

Safe net soak times are influenced by water temperature, DO, and, to a lesser extent, salinity. While there are no publications documenting the effects of soak times on mortality rates of sturgeon, there is consensus amongst sturgeon researchers that shorter soak times are safer than longer soak times (Mark Collins, South Carolina Department of Natural Resources; Matt Fisher, Delaware Division of Fish and Wildlife; Dewayne Fox, Delaware State University; Chris Hager, Virginia Institute of Marine Science; Doug Peterson, University of Georgia; William Post, South Carolina Department of Natural Resources; Mike Randall, United States Geological Survey (USGS); and Ken Sulak, USGS, pers. comm.). By monitoring signs of stress such as excessive redness, mucous production, or lethargy, experienced researchers will often shorten net deployment regardless of measured environmental conditions (Kathryn Hattala, New York State Department of Environmental Conservation; Tom Savoy, Connecticut Department of Environmental Protection; and Doug Peterson, University of Georgia, pers. comm.).

When using anchored gillnets while targeting Atlantic and shortnose sturgeon, soak times of 14 hours are safe when water temperatures at the sampling depth are under 15°C. However, soak times should not exceed four hours in waters up to 20°C, two hours in waters up to 25°C, and one hour in waters up to 28°C at the sampling depth (Table 2). Similar effects were alluded to in Moser *et al.* (2000a), but were not clearly defined. Gulf sturgeon net set durations should not exceed four hours under any conditions. Mortalities have been documented in the empirical records of researchers while fishing above 20°C at net set durations ranging from 45 minutes to 24 hours. However, mortalities have been extremely rare when fishing nets less than two hours and at temperatures between 20° and 25°C. The one hour soak time at water temperatures between 25° and 28°C (Table 2) accommodates standard research practices of netting at slack tides (i.e., the occurrence of relatively still water at the turn of the low tide). There have been only two recorded sturgeon mortalities documented when fishing in this manner.

Table 2. Appropriate fishing protocols for Gulf, Atlantic, and shortnose sturgeon.

Net set duration (hours)	Temperature at sampling depth	Minimum DO at sampling depth	% oxygen saturation at sampling depth
14†	Up to 15°C	4.5 mg/L	55%
4	15° to 20°C	4.5 mg/L	55%
2	20° to 25°C	4.5 mg/L	55%
1	25° to 28°C	4.5 mg/L	55%
No sampling	Over 28°C	4.5 mg/L	55%

† Net set duration for Gulf sturgeon should not exceed four hours for all temperatures up to 20°C.

When fishing for green sturgeon, NMFS recommends that gill net fishing not be conducted in the Sacramento River, California all year to prevent interactions with listed salmonids and to also protect green sturgeon during their upstream migrations. NMFS also recommends that no gillnetting or trammel netting occur in the Feather River between October 31st and March 1st of each year to protect spawning salmonids. When fishing for green sturgeon in other locations, the risk of interactions between gillnets or trammel nets and listed salmonids or pinnipeds requires the nets to be manned at all times. Additionally, pinnipeds are protected by the MMPA and the presence of gillnets in the water could pose an entanglement risk and require an Incidental Take Authorization (Section 101(a)(5) of the MMPA). NMFS recommends net soak times should not exceed four hours in water temperature up to 19°C, two hours between 19° and 23°C, and one hour for water temperature between 23° and 25°C (Table 3).

Table 3. Appropriate fishing protocols for green sturgeon.

Net soak times (hours)	Temperature at sampling depth	Minimum DO at sampling depth	% oxygen saturation at sampling depth
4	Up to 19°C	5 mg/l	58%
2	19° to 23°C	5 mg/l	58%
1	23° to 25°C	5 mg/l	58%
No netting	Over 25°C	5 mg/l	58%

When following the protocols in Table 2 between 2005 and 2009, East Coast sturgeon researchers recorded over 3,800 captures of shortnose sturgeon resulting in no mortality.

However, while fishing outside of these recommended criteria, the same researchers experienced a 0.6% mortality rate of captured shortnose sturgeon. This is the same mortality rate documented for shortnose sturgeon captured between 2000 and 2004 when researchers followed the Moser *et al.* (2000a) protocols.

When drift gillnetting, nets are allowed to drift on the rising tide or in slack tide until just after high tide for approximately thirty minutes to several hours, depending on the location and swiftness of the tide. Water quality conditions and net soak times for drift gill nets are the same as for anchored gillnets. However, drift nets must be tended because of the risk of gear entanglement or loss of gear resulting in ghost nets. For drift gillnet fishing, gear should be pulled immediately if it is obvious a sturgeon has been captured.

Electrofishing

Electrofishing gear poses documented risks and potentially lethal effects to all sturgeon species (Moser *et al.* 2000b, Holliman and Reynolds 2002). Sturgeon have exceptional electro-sensory abilities and actively avoid electrofishing gear (Moser *et al*. 2000b). If sturgeon are likely present in areas where agencies are using electrofishing gear to target other species, only low voltage direct current should be used if no alternative sampling method is available. While electrofishing likely reduces feeding and alters spawning behavior (Moser *et al.* 2000b), such sub-lethal effects may not be significantly different than effects caused by other capture methods. However, due to more effective and safer methods of capture, NMFS prohibits electrofishing to capture Gulf, green, Atlantic, or shortnose sturgeon.

Other Non-Lethal Sampling Gear

While fyke, hoop, and pound nets are not commonly used by researchers to capture sturgeon, they occasionally capture sturgeon as bycatch in several fisheries. Usually sturgeon captured as bycatch in these gear types are found in relatively good condition. Large numbers of sturgeon captured in fyke, hoop, and pound nets have been used by researchers in cooperation with these commercial fisheries in Canada. Because these nets are less stressful to sturgeon, they are an acceptable alternative to gillnets.

Set lines have also been used to effectively sample white, pallid, shovelnose, and lake sturgeon and are approved options for sampling Gulf, green and Atlantic sturgeon as well. Shortnose sturgeon are less likely to be taken on a set line because of their diets. The two concerns with set lines are predation and hooking mortality. If there are predators such as pinnipeds in the area, the set line should be monitored constantly and pulled if any predators are seen surfacing. The hooks can be swallowed, damaging organs such as the gills and stomach, if the hook sizes are too large or small for the targeted sturgeon life stage. Every effort should be made to limit and monitor adverse effects, including not using set lines in some locations if they cannot be fished without mortality.

Trawling
While gillnets and trammel nets are most commonly used for targeting adult and sub-adult sturgeon, they are not as effective as trawls at capturing young of the year juvenile sturgeon. In larger river systems such as the Mississippi and Missouri River, and more recently in Atlantic coastal rivers, researchers have successfully employed a modified "Missouri trawl" (Herzog *et al.* 2005) — a two-seam (i.e., standard) slingshot balloon trawl (Gutreuter *et al.* 1995) completely covered with heavy, delta-style mesh.

Trawls in general are limited by shallow water (less than 20 inches) and benthic obstacles. The location of trawling should be monitored using a sounding device and global positioning system to avoid snags and limit repeated disturbance of the same location. The tow rope should be quickly released from the boat if any debris is caught and the trawl unengaged to minimize damage to the substrate or catch. Ideally, a chase boat is recommended to assist with recovery of the cod end or assisting with snags, but if that is not possible, a buoy should be attached to a single 70 to 100 foot rope line fastened to the cod end of the trawl to assist retrieval if the trawl becomes snagged.

The footrope of a trawl should maintain contact with the substrate during conditions of heavy current, fast tow speeds, or undulating bottom surfaces (e.g., sand waves). The trawl should be operated attached to the boat with 100 to 200 foot towlines, the length dependent on water depth (i.e., deeper water required longer towlines as reported in Brabant and Nedelec 1979). The trawl should be manually deployed and retrieved by powering the boat in reverse (bow upstream) with continued movement downstream. A standard haul should be approximately 300 to 500 feet, lasting approximately 10 minutes, and towed at a range of three to five knots (Gutreuter *et al.* 1995).

Areas successful for trawling are characterized by a variety of habitat substrate including fine and course sands with mobile bedforms (sand dunes) and mudflats. Particularly productive areas are located at the mouths of tributaries entering a larger river. However, any large, straight river segment, devoid of benthic material that may entangle nets, can be successfully trawled.

D-Nets
When targeting eggs and early life stage (ELS) sturgeon, the two commonly used sampling methods are D-nets and artificial substrates. Both techniques can be non-lethal, but due to the risk of mortality, no more eggs and ELS sturgeon should be captured than are absolutely necessary. While not mandatory, in rivers with unknown spawning populations, adults can be tagged and tracked to document possible spawning runs and spawning areas prior to sampling for eggs (Kieffer and Kynard 1996). Otherwise, D-nets should be deployed well before the earliest time spawning would be expected. Due to the risks associated with capturing and impinging ELS sturgeon in the D-Nets, however, they should be checked at least every three hours to minimize incidental mortality (Boyd Kynard, USGS, pers. comm.). D-nets should also be equipped with flow meters to calculate filtered water volume when developing an index of abundance and spawning success (# ELS/ volume of water sampled) (Taubert 1980). If the purpose of the research is to verify the occurrence of spawning, nets should be checked every hour. As soon as

ELS are captured, sampling should be discontinued. If the purpose of the research is to verify duration of the spawning period, then additional samples may need to be taken, but the acceptable number of ELS fish to be captured would depend on the status of the sturgeon populations in the river.

Egg Mats

Artificial substrates consist of floor buffing pads or similar materials, approximately two feet in diameter (described in Fox *et al.* 2000) for the purpose of collecting eggs as they are deposited in the water column. These pads should be anchored to the river bottom in suspected spawning areas. No more pads should be fished than is necessary. If the researcher is unsure of the number of pads required to identify spawning areas and success, no more than 100 to 150 pads should be fished at once across several sites. Pads should be checked at least twice a week or more frequently if circumstances allow. The artificial substrates should be examined in the field for sturgeon eggs and only returned to the river if more samples are needed. If it is not necessary to remove the eggs from the mat, the mat can be returned to the river bottom allowing the eggs to incubate and hatch before being removed. For every artificial substrate that collects an egg, environmental conditions such as latitude, longitude, velocity, substrate type, depth, dissolved oxygen, etc. should be collected.

Other Methods of Egg Collection

There are other methods of sampling eggs and ELS, such as epibethic sleds, ichthyoplankton nets, and pump sampling. These methods are not considered as effective as the other described methods, though they are acceptable sampling methods.

Recommendations

General

- NMFS recommends capturing adult sturgeon while they are still in their winter staging areas, but does not recommend targeting sturgeon during their upstream spawning migration due to the risks of aborted spawning runs.

Water Temperature, Dissolved Oxygen, and Salinity

- When air temperatures are below freezing, handling procedures should be limited to less than two minutes to prevent exposure of a sturgeon’s skin to freezing temperatures.
- NMFS recommends Gulf, Atlantic, and shortnose sturgeon are not captured or handled when DO concentrations are below 4.5 mg/L. Green sturgeon should not be captured or handled when DO concentrations are below 5 mg/L.
- NMFS recommends not sampling for Gulf, shortnose, or Atlantic sturgeon occur when temperatures exceed 28°C; while sampling for green sturgeon should not occur when temperatures exceed 25°C.
- NMFS recommends not sampling for Gulf, Atlantic, or shortnose sturgeon when the oxygen saturation is below 55% and not sampling green sturgeon when the oxygen saturation is below 58%.

Gillnets and Trammel Nets

- Due to disproportionately high reports of mortality using ten inch stretch mesh with Atlantic sturgeon, this size mesh should not be used to sample adult Atlantic or Gulf sturgeon.
- NMFS recommends no gill net fishing be conducted in the Sacramento River, California all year round to prevent interactions with listed salmonids and also to protect green sturgeon during their upstream migrations.
- NMFS also recommends that no gillnetting or trammel netting take place in the Feather River, California between October 31st and March 1st of each year to protect spawning salmonids.
- NMFS recommends net soak times should not exceed four hours in water temperature up to 19°C, should not exceed two hours between 19° and 23°C, and one hour for water temperature between 23° and 25°C.
- Gillnets should be used sparingly and carefully in waters where other listed species may be encountered. The researcher must contact NMFS or the USFWS when other listed species may be incidentally affected.

Electrofishing

- NMFS prohibits electrofishing to capture Gulf, green, Atlantic, or shortnose sturgeon.

Other Non-Lethal Sampling Gear

- Fyke, hoop, and pound nets are an acceptable alternative to gillnets for Gulf, green, Atlantic, and shortnose sturgeon.
- Set lines are approved options for sampling Gulf, green, and Atlantic sturgeon.

Trawling

- NMFS recommends trawling as safe, efficient sampling gear to target small juvenile Gulf, Atlantic, shortnose, and green sturgeon; however, small mesh gillnets and trammel nets are also acceptable.

D-Nets

- NMFS recommends D-nets and egg mats to sample rivers for eggs or ELS of Gulf, Atlantic, shortnose, or green sturgeon.
- Due to risks associated with capturing and impinging ELS sturgeon in D-Nets, they should be checked at least every three hours to minimize incidental mortality.

Egg Mats

- No more egg mats should be fished than is necessary. If the researcher is unsure of the number of pads required to identify spawning areas and success, no more than 100 to 150 pads should be fished at once.

Handling and Holding

Handling of sturgeon refers to the time period actual research activities are conducted on live fish and does not refer to the time a fish is held in live cars before and after research activities. Holding is the period of time a sturgeon is in possession but kept in live cars either waiting to be handled or recovered from handling prior to being released.

Proper Handling of Sturgeon

Improper handling can result in lethal or sub-lethal impacts to sturgeon. In some cases, sturgeon may display altered behavior after being released, for example, swimming towards the ocean rather than remaining in the river, or, in some instances, aborting spawning runs completely (Moser and Ross 1995, Schaffter 1997, Kelly *et al.* 2007, Benson *et al.* 2007, Moser and Lindley 2007). There are no other alternatives to handling sturgeon during research; however, the researcher's primary focus should be the well-being of the sturgeon.

NMFS strongly recommends standard handling procedures performed on all sturgeon captured including measuring, weighing, PIT tagging, and tissue sampling. The total time required to complete routine research procedures should not exceed 15 minutes. Additional procedures such as internal tagging, lavage, boroscoping, etc. will take more time for handling and recovery. However, only one additional discretionary procedure to the standard handling procedures should be performed on each sturgeon, thus minimizing handling time prior to release. For example, if a sturgeon is fitted with a telemetry tag, it should not also undergo gastric lavage. And when water temperatures are above 23°C for green sturgeon or 25°C for Gulf, shortnose, or Atlantic sturgeon, the extent of research should be limited to the standard handling procedures of measuring, weighing, PIT tagging, and tissue sampling.

Fish should be handled rapidly, but with care and kept in water to the maximum extent possible during handling. During handling procedures, each fish should be immersed in a continuous stream of ambient water passing over the sturgeon's gills. Many sturgeon researchers provide sturgeon with supplemental compressed oxygen, thereby reducing stress and ensuring DO does not fall below acceptable saturation levels.

Researchers should also attempt to support larger sturgeon in slings preventing struggle during transfer. Sturgeon should be weighed using hand held sling scales or a platform scale for larger sturgeon. Also, because sturgeon are sensitive to direct sunlight, they should be covered and kept moist.

Short-Term Holding

All captured sturgeon should be removed from the capture gear and immediately transferred to short-term holding. When multiple fish are captured, those not processed immediately should be held in a net pen or live car while waiting to be transferred by hand or sling to a processing station on board. Net pens measuring three feet wide, six feet long, and three feet deep can safely hold about 20 adult shortnose sturgeon or comparably sized juvenile Atlantic, Gulf or green sturgeon when temperatures are below

15°C (Doug Peterson, University of Georgia, pers. comm.). Larger net pens (8 feet long) are required for holding adult Atlantic, green, and Gulf sturgeon or they should be processed as quickly as possible (or scheduled first) instead of subjected to confined holding conditions. When water temperature is between 15° and 25°C, fewer fish should be held in the same enclosure because overcrowding animals amplifies short term stress, particularly at higher temperatures (Safi *et al.* 2006). If the fish are being held on-board a vessel in a holding tank, compressed oxygen should be added to increase DO in the water. If the researcher observes a visually stressed sturgeon, efforts should be made to revive the fish and release it in a healthy condition. In some cases, recovery can be achieved by allowing a sturgeon to rest in an appropriately sized net pen for several hours prior to release.

Sturgeon should never be held in gillnets if there isn't enough room to safely hold them in net pens. In some rivers with large populations of sturgeon, catches can exceed the number of fish that can possibly be held safely in live cars or net pens. In such cases, researchers should have multiple holding bins at their disposal. If more fish are captured than can be processed and released within two hours, those excess fish may need to be released to minimize stress or lethal injury.

When sturgeon are held on-board research vessels, they should be placed in flow through tanks where the total volume of water is replaced every 15 to 20 minutes. Traditionally, some species of sturgeon have been held for research purposes by tethering with ropes looped around tails to the sides of research vessels until they can be handled. In a study of lake sturgeon (Axelsen and Mauger 1993 cited in Dick *et al.* 2006), tethered fish experienced greater stress and higher mortality than sturgeon kept in uncrowded cages. Therefore, NMFS recommends only using on-board holding tanks or net pens large enough to hold a large sturgeon. NMFS does not recommend holding any sturgeon by tethering its caudal peduncle to the research vessel. However, while a rope should never be tied around the caudal peduncle, it may be necessary to use a rope placed under the sturgeon immediately posterior to the pectoral fins when moving large sturgeon from net pens onto the boat.

Following handling procedures, fish should be returned to the net pen for observation and to ensure full recovery prior to release. Total holding time in the net pens would be variable depending on water temperature and the condition of each fish, however, the maximum amount of time a fish should be held after removal from capture gear is approximately two hours, unless more time is needed to recover from the effects of an anesthetic or because prolonged holding would benefit a sturgeon. When water temperature is above 25°C for Gulf, shortnose, and Atlantic sturgeon, or 23°C for green sturgeon, they should be held for as little time as possible. Holding time includes the time to remove any other captured sturgeon, time to process other fish, and time necessary for recovery ensuring the safety of the fish.

Prior to release, sturgeon should be examined and, if necessary, recovered by holding fish upright and immersed in river water, gently moving the fish front to back, aiding freshwater passage over the gills to stimulate it. The fish should be released when showing signs of vigor and able to swim away under its own power. A spotter should watch the fish, making sure it stays submerged and does not need additional recovery.

Recommendations

Proper Handling of Sturgeon

- NMFS strongly recommends standard handling procedures performed on all sturgeon captured including measuring, weighing, PIT tagging, and tissue sampling.
- Only one additional discretionary procedure to the standard handling procedures should be performed on each sturgeon, thus minimizing handling time prior to release.
- When water temperatures are above 23°C for green sturgeon or 25°C for Gulf, shortnose, or Atlantic sturgeon, the extent of research should be limited to the standard handling procedures of measuring, weighing, PIT tagging, and tissue sampling.
- During handling procedures, each fish should be immersed in a continuous stream of ambient water passing over the sturgeon's gills.
- Researchers should attempt to support larger sturgeon in slings preventing struggle during transfer.
- If the researcher observes a severely stressed sturgeon, efforts should be made to revive the fish and release it in a healthy condition.

Short-Term Holding

- Sturgeon should never be held in gillnets while waiting to be handled, but should instead be transferred to a net pen for holding.
- NMFS recommends only using on-board holding tanks or net pens large enough to hold a large sturgeon. NMFS does not recommend tethering sturgeon to the boat by its caudal peduncle.
- The maximum amount of time a fish should be held after removal from capture gear is approximately two hours, unless more time is needed to recover from the effects of an anesthetic or because prolonged holding would benefit a sturgeon.
- Adult Atlantic, green, and Gulf sturgeon over six feet in length should be processed as quickly as possible (or scheduled first) instead of subjected to confined holding conditions.

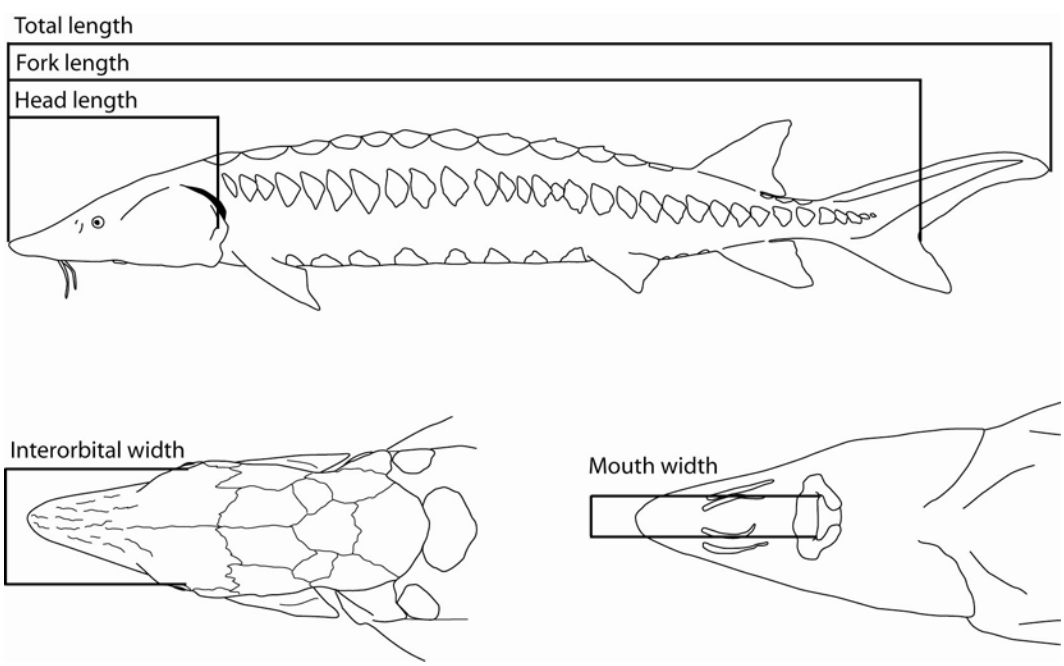
Standard Research Methods

Upon capturing a green, Gulf, shortnose, or Atlantic sturgeon, there are several research procedures strongly recommended on all sturgeon. First, the captured fish is to be measured. The sturgeon should also be weighed if possible. It can also be photographed, if possible. Then, their entire bodies should be scanned for previously inserted PIT tags; and, if none are found, one should be properly inserted. Finally, a small sample of the soft tissue of the pelvic fin should be removed for genetic identification.

Measuring

Standardized length measurements for all sturgeon should be taken from the snout to the fork in the tail (i.e., fork length – FL). The measuring device should be a solid ruler or board, so the measurement does not measure the curvature of the body. Additional length measurements should be taken at the researcher's discretion for total length (TL) or head length (Figure 1). While the heterocercal tail of larger fish may be damaged or shortened, the total length can still be obtained by pressing down the tail at the caudal peduncle and measuring to the tip of the tail. Girth measurements should also be taken at the widest part of the body. While not mandatory, measurements of the ratio of mouth width to interorbital width can also be obtained to differentiate between shortnose and Atlantic sturgeon (Dadswell *et al.* 1984). Interorbital width is measured as the distance between the lateral margins of the bony skull at the midpoint of the orbit and mouth width is measured as the distance between the left and right inside corners of the closed mouth (i.e., excluding the lips) (Figure 1).

Figure 1. Diagram of different types of measurements for sturgeons. Drawings by Eric Hilton, Virginia Institute of Marine Science.



Weighing
All captured sturgeon should be weighed if possible. Weights allow a better understanding of the conditioning of captured sturgeon during various seasons of the year or life span of the fish. For weighing sturgeon, animals should be supported with a sling or net and handling should be minimized throughout the procedure.

Boats used for researching green, Gulf, and Atlantic sturgeon should accommodate larger fish with scales available to safely weigh a 200 pound fish. When targeting shortnose sturgeon (or juvenile green, Gulf, or Atlantic sturgeon), hand-held sling scales are acceptable. When using a bench scale or platform scale to weigh large sturgeon, a five to six foot flat platform will be necessary to support the fish.

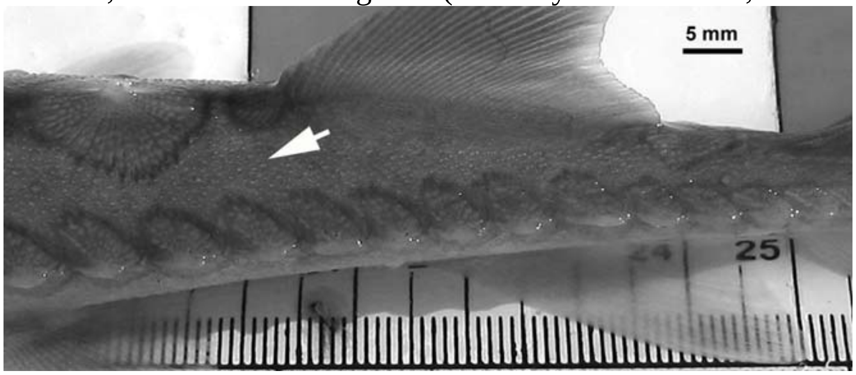
Photographing
When handling sturgeon, optional photography is often used to document the health of fish, research methods, and any identifying marks on the sturgeon potentially useful in the future. Although it is recommended to take as many pictures as needed, researchers should do so without interfering with other research activities.

PIT Tags
Every sturgeon should be scanned for PIT tags along its entire body surface ensuring it has not been previously tagged. Untagged sturgeon should then be appropriately PIT tagged (Figure 2) and the identifying number recorded. Each PIT tag consists of integrated circuitry and an antenna encapsulated in glass. PIT tags are “passive” because they contain no batteries; their internal code is activated and transmitted to the receiver when exposed to the transceiver’s electromagnetic signal. The newest PIT tags, and those recommended by NMFS, use a frequency of 134.2 kHz.

Standardized PIT tag placement for Gulf, green, Atlantic, and shortnose sturgeon would enable subsequent researchers to locate prior PIT tags quickly and consistently. Sturgeon, are large fish growing a considerable amount from the time they’re first PIT-tagged until they reach their adult size. If muscles grow over the PIT tag as they mature, the tag can become increasingly more difficult to read.

For this reason, NMFS strongly recommends PIT tag placement in all four sturgeon species to be located to the left of the spine, immediately anterior to the dorsal fin, and posterior to the dorsal scutes (Figure 2). This positioning would optimize PIT tag readability over the animal’s lifetime as sturgeon experience the least new muscle growth in this location during their lifetimes (Berg 2004, Simpson and Fox 2006). After the tag is inserted, it should be scanned to ensure it is readable before the fish is released. If necessary, to ensure tag retention and prevent harm or mortality to small juvenile sturgeon of all species, the PIT tag can also be inserted at the widest dorsal position just to the left of the 4^{th} dorsal scute.

Figure 2. Standardized location for PIT tagging all green, Gulf, Atlantic, and shortnose sturgeon. (Photo by James Henne, USFWS)



PIT tags have the highest reported retention rate of all identification tags, though they are not visible to the researcher or fisherman upon capture. Clugston (1996) found PIT tags implanted in gulf sturgeon have approximately a 90% retention rate. Musick and Hager (2007) tagging 445 Atlantic sturgeon reported a 99% retention rate of PIT tags after 96 hours. Smith *et al.* (1990) noted 100% retention after 60 days in wild shortnose sturgeon. In the Penobscot River, retention rates for PIT tags in Atlantic sturgeon were 93% after as much as 8.8 years (Gayle Zydlewski, University of Maine, pers. comm.). Nelson *et al.* (2007) report approximately 100% retention of PIT tags in recaptured white sturgeon.

Other researchers have had different results. Researchers with EDI Environmental Dynamics (2006) reported recapturing three white sturgeon, with 66% retention of PIT tags. DeHaan *et al.* (2008) recorded 51 to 95% retention when PIT-tagging juvenile pallid sturgeon, which is similar to rates observed by Henne *et al.* (unpublished).

As with all research procedures, there is a risk of injury or mortality either directly or indirectly related to PIT tagging. When PIT tags are inserted into animals having large body sizes relative to tag size, empirical studies generally conclude they have no adverse effect on the growth, survival, reproductive success, or behavior of individual animals (Brännäs *et al.* 1994, Elbin and Burger 1994, Keck 1994, Jemison *et al.* 1995, Clugston 1996, Skalski *et al.* 1998, Hockersmith *et al.* 2003). However, smaller sturgeon may experience mortality within the first 24 hours, usually as a result of inserting the tags too deeply or from pathogenic infection. When analyzing mortality of small sturgeon caused by PIT tags, Henne *et al.* (2008) found 11 and 14 mm tags inserted into shortnose sturgeon longer than 300 mm was safe. In this study, they found that when fish are under 300 mm, factors other than length, such as weight or condition, most influence the likelihood of mortality. Therefore, NMFS recommends only sturgeon over 300 mm should receive PIT tags.

A negative aspect of using PIT tags in sturgeon research is the difficulty for NOAA observers or non-researchers to detect tags in recaptured sturgeon without the benefit of a PIT tag reader. Rien *et al.* (1994) and Nelson *et al.* (2004) recommend removal of the second left lateral scute indicating the presence of a PIT tag in white sturgeon. This methodology has been subsequently used for green sturgeon as well. While removal of scutes rarely results in bleeding, and is not considered deleterious, there are other, safer means for externally marking sturgeon. NMFS believes a standardized PIT tag location is less stressful to animals and is easily located. If an external mark is necessary, NMFS recommends using other external tags identified in this document. Those external tags are not only obvious to other researchers, but also to the general public for identifying recaptured animals to alert researchers of their recapture. NMFS therefore recommends using external tags to identify the presence of a PIT tag, if necessary, but researchers should not remove scutes from sturgeon for any reason.

Genetic Tissue Sampling
Tissue sampling is a common practice in fisheries science characterizing the genetic "uniqueness" and quantifying the level of genetic diversity within a population. NMFS strongly recommends genetic tissue samples be taken from every sturgeon captured unless, due to marks or tags, the researcher knows a genetic sample has already been obtained. Tissue samples should be a small (1.0 cm^2) fin-clip collected from soft pelvic fin tissues using a pair of sharp scissors. Tissue samples should be preserved in individually labeled vials containing 95% ethanol. There is no evidence that this procedure harms any species of sturgeon.

Recommendations

Strongly Recommended
- Researchers should measure all captured green, Gulf, Atlantic, and shortnose sturgeon. The sturgeon should also be weighed, if possible.
- Researchers should scan captured sturgeon for previously inserted PIT tags; and, if none are found, one should be properly inserted.
- Researchers should remove a small tissue sample by clipping the soft tissue of the pelvic fin.

Measuring
- Standardized length measurements for all sturgeon should be taken from the snout to the fork in the tail.
- NMFS recommends measuring the ratio of mouth width to interorbital width to differentiate shortnose and Atlantic sturgeon.

PIT Tags
- NMFS recommends PIT tag placement in all four sturgeon species to be located to the left of the spine, immediately anterior to the dorsal fin, and posterior to the dorsal scutes.
- NMFS recommends using 134.2 kHz PIT tags.
- If necessary, to ensure tag retention and prevent harm or mortality to small juvenile sturgeon of all species, the PIT tag can also be inserted at the widest dorsal position just to the left of the 4th dorsal scute.
- NMFS recommends only sturgeon over 300 mm should receive PIT tags.
- NMFS recommends using external tags to identify the presence of a PIT tag, if necessary, but researchers should not remove scutes from sturgeon for any reason.

Genetic Tissue Sampling

- NMFS strongly recommends genetic tissue samples be taken from every sturgeon captured unless, due to marks or tags, the researcher knows a genetic sample has already been obtained.
- Tissue samples from Gulf, green, Atlantic, and shortnose sturgeon should be archived at the NOAA/NOS Tissue Archive in Charleston, South Carolina. Proper certification, identity, and chain of custody of samples should be maintained during transfer of tissue samples.

Anesthetization

Anesthetics are physical or chemical agents preventing the initiation and conduction of nerve impulses (Summerfelt and Smith 1990). Therefore, the primary functions of anesthetics on ESA listed sturgeon are to immobilize the animal allowing precise, autorized procedures to be performed while blocking nerve impulses which might otherwise adversely affect the fish. This section, therefore, attempts to balance the risk of stress from invasive procedures with the risk posed by using an anesthetic, while also considering the risk of an unanesthetized sturgeon moving suddenly during a procedure resulting in trauma or hemorrhaging.

Invasive research activities can be stressful to fish, even if immobilized. The use of an anesthetic reduces the potential for short term stress response and risk of mortality during those procedures (Iwama *et al.* 1989, Small 2003, Wagner *et al.* 2003, Coyle *et al.* 2004, Roubach *et al.* 2005, Wanner *et al.* 2007). However, the use of some anesthetics have also proven to be stressors to fish (Iwama *et al.* 1989) as evidenced by the buildup of the cortisol hormone. NMFS recommends that noticeably stressed sturgeon should not be anesthetized.

Documented lethal or sub-lethal effects caused by improper dosage or exposure of anesthetics (Iwama *et al.* 1989, Summerfelt and Smith 1990) raises concerns whether it is acceptable to use anesthetic when handling listed Gulf, green, shortnose, or Atlantic sturgeon. In tests where anesthetics were not used during invasive procedures, cortisol levels were found significantly higher than when fish were anesthetized with tricaine methanesulfonate (MS-222) or clove oil (Wagner *et al.* 2003). Conversely, Wagner *et al.* (2003) found unanesthetized fish had lower cortisol levels than either of two anesthetized groups after one hour, demonstrating recovery of fish is more rapid without anesthetization. Nevertheless, in controlled studies when prolonged handling took place (30 minutes or more), Strange and Schreck (1978) documented fish had a higher survival rate when anesthetized.

Summerfelt and Smith (1990) and Bowser (2001) note a normal condition and six stages of anesthesia: light sedation, deep sedation, partial loss of equilibrium, total loss of equilibrium, loss of reflex reactivity, and asphyxia (Table 4). Light sedation occurs when there is a slight loss of reactivity, while deep sedation occurs when only the strongest external stimuli will elicit a response, but in both cases, the fish is able to maintain equilibrium. Partial loss of equilibrium is also characterized by partial loss of muscle tone and an increase in opercular movement, while total loss of equilibrium is characterized by total loss of muscle tone, the loss of spinal reflexes, and slow and steady opercular rate. The loss of reflex reactivity is when the fish losses all reflex response, but also when the heart rate becomes very slow and the opercular movements become slow and irregular. The final stage of anesthesia is a complete medullary collapse, when opercular movement ceases. Death is typically caused by an overdose or overexposure leading to eventual mortality.

Table 4. Stages of anesthesia (Summerfelt and Smith 1990).

Stage	Descriptor	Behavioral Response of Fish
0	Normal	Reactive to external stimuli; opercular rate and muscle tone normal
I	Light sedation	Slight loss of reactivity to external stimuli; opercular rate slightly decreased; equilibrium normal
II	Deep sedation	Total loss of reactivity to all but strong external stimuli; slight decrease in opercular rate; equilibrium normal
III	Partial loss of equilibrium	Partial loss of muscle tone; swimming erratic; increased opercular rate; reactivity only to strong tactile and vibration stimuli
IV	Total loss of equilibrium	Total loss of muscle tone and equilibrium; slow but regular opercular rate; loss of spinal reflexes
V	Loss of reflex reactivity	Total loss of reactivity; opercular movements slow and irregular; heart rate very slow; loss of all reflexes
VI	Medullary collapse (asphyxia)	Opercular movements cease; cardiac arrest usually follows quickly

The primary risks associated with anesthetizing sturgeon are overexposure and overdosing. Overexposure can occur when sturgeon are left in an anesthetic bath longer than necessary to achieve narcosis. Fish often have difficulty recovering with normal response time when overexposed, and sometimes will not respond for extended periods requiring continuous respiration to revive them. Overdosing can take place when the concentration of anesthetic is higher or more toxic than fish can tolerate. Both conditions often result in immediate or delayed mortality. As an anesthetic is applied, the sturgeon's opercular movement should be monitored closely. It should not be allowed to stop as this condition could result in blood hypoxia and high stress response, or even mortality of the anesthetized animal (Iwama *et al.* 1989).

There are various research activities commonly performed on sturgeon that present enough risk to the fish that they should only be done using anesthesia (Table 5). However, the same level of narcosis is not needed for each activity and therefore the researcher would not use the same concentrations of anesthetic. Physical restraint is not an appropriate substitute for anesthetization.

The rate at which anesthesia is induced in a fish is also important at minimizing stress. Prolonged induction generally leads to increased stress responses (e.g. prolonged thrashing during excited phase), while excessively rapid induction times (<1 minute) risks taking the fish beyond the surgical anesthesia plane because animals may skip typical behavioral signs characterizing stages of anesthesia. NMFS recommends initiating anesthesia gradually to reduce the risks of overdosing. NMFS also recommends monitoring the sturgeon during induction to avoid overexposure. If the desired stage of narcosis cannot be reached within 15 minutes (Summerfelt and Smith 1990), the sturgeon should be placed in freshwater to recover before being released.

Table 5: Procedures and stages of anesthesia.

Procedure	Stage of Anesthesia (see Table 4)
Internal tagging	III
Biopsy	III
Laparoscopy	IV
Gastric lavage	I
Boroscope	0 or I
Fin ray sectioning	II
Genetic fin clip	0
Blood sample	0
PIT tag	0
External tagging	0 but I is acceptable if necessary

Cold water species respond more rapidly and at lower doses to chemical anesthetics than do warm water species (Bowman *et al.* 2003, Coyle *et al.* 2004). Currently, it has not been demonstrated if shortnose, Atlantic, Gulf, or green sturgeon exhibit variable inter- or intra-species responses to chemical anesthetics with respect to temperature. As identified previously, however, larger green sturgeon grow more optimally at cooler temperatures than do shortnose or Atlantic sturgeon. This suggests green sturgeon are better adapted to cooler waters, may also be more likely to respond to lower levels of anesthetic than shortnose or Atlantic sturgeon. Correspondingly, Gulf sturgeon may need higher doses than the other species at cooler temperatures. Likewise, northern populations of shortnose and Atlantic sturgeon may be better adapted to cooler waters and respond differently to anesthesia.

Chemical Anesthetic

<u>MS-222</u>

A wide variety of chemical compounds have been utilized to anesthetize fish in fisheries research. However, tricaine methanesulfonate (MS-222) is the only anesthetic with a label for use with fish granted by the Food and Drug Administration (FDA) and as such, is the only chemical anesthetic recommended by NMFS for use on green, Gulf, Atlantic, and shortnose sturgeon.

MS-222 is absorbed rapidly through the gills and it prevents the generation and conduction of nerve impulses, with direct actions on the central nervous system and cardiovascular system. MS-222 is excreted in fish urine within 24 hours and tissue levels decline to near zero in the same amount of time (Coyle *et al.* 2004).

Proper dosing depends on the degree of anesthetization desired, the species and size of fish, water temperature and water hardness. In general, levels of MS-222 recommended do not typically exceed 100mg/L for salmonids or 250 mg/L for warm water fish (Coyle *et al.* 2004). To euthanize fish using MS-222, the recommended dosage varies from 150 to 500 mg/L for one minute or more depending on the species (DeTolla *et al.* 1995, Cho and Heath 2000, Callahan and Noga 2002, Borski and Hodson 2003).

There are two methods commonly used by sturgeon researchers to anesthetize sturgeon. The first method incorporates a “knockout” initiation dose of MS-222 followed by a safer maintenance concentration (DeTolla *et al.* 1995, Callahan and Noga 2002, Thorsteinsson 2002, Borski and Hodson 2003). Alternately, researchers anesthetize sturgeon using the lowest possible dose of MS-222, raising it to achieve the desired stage of narcosis based on the procedure (Table 5). Neither method, when performed correctly, is safer than the other. However, more risk is associated with overdosing fish exposed to higher induction rates.

For most procedures, sturgeon should initially be lightly anesthetized with MS-222, and if needed, more should be added only to the level considered necessary to perform the appropriate procedures. MS-222 solutions are highly acidic, therefore the pH of the solution should be buffered to a neutral pH with equal amounts of sodium bicarbonate prior to use. In cooler water temperatures, either higher doses or longer exposure times may be necessary to achieve the proper narcosis because the absorption rate is lower at lower temperatures (Coyle *et al.* 2004). Additionally, because MS-222 is a hypoxic agent, the anesthetic container should be vigorously aerated to maintain DO levels equivalent to ambient river water.

Total loss of equilibrium (Stage IV) is the deepest level of narcosis acceptable for anesthetizing listed sturgeon. It may not be possible to reach this stage of narcosis by gradually increasing the dosage and instead, the researcher would need to begin with a high induction dose and then drop back to a maintenance dose. Because of the risks associated with this type of anesthetization, NMFS recommends inexperienced researchers first conduct this type of anesthesia in a laboratory using a heart rate monitor to prevent overdose. Only once a researcher has demonstrated the ability to consistently perform this type of anesthetization safely should they do this in the field.

When immersed in MS-222, sturgeon will initially experience rapid gill movement followed by marked reduced gill movement as the agent begins to have an effect. As gill movement slows, sturgeon will lose equilibrium and eventually turn upside down or float to the surface. At this stage, sturgeon should be watched closely to confirm continuous involuntary gill movement. If the procedure is brief, once the desired stage of anesthesia has been reached, sturgeon may be placed on a surgical cradle and the gills irrigated with fresh water to ensure respiration and to begin recovery as the procedure is quickly completed. After completing the procedure, the fish should be placed in a clean, anesthetic free recovery tank and observed until fully recovered. Once recovered, the sturgeon can be released.

Following is a review of the various concentrations and induction methods of MS-222 when anesthetizing Gulf, Atlantic, shortnose, and green sturgeon. Fleming *et al.* (2003a) suggested concentrations of MS-222 of up to 400 mg/L failed to adequately anesthetize Gulf sturgeon. These researchers concluded the anesthetic was potentially dangerous to the sturgeon. However, Hernandez-Divers *et al.* (2004) successfully anesthetized Gulf sturgeon submerging them in an initiating dose of 250 mg/L followed by a maintenance bath of 87.5 mg/L. Harris *et al.* (2005) anesthetized Gulf sturgeon using 160 mg/L MS-

222. Parkyn *et al.* (2006) anesthetized Gulf sturgeon using a single phase induction of 150 mg/L MS-222. Lankford *et al.* (2005) anesthetized green sturgeon placing them in concentrated baths of 350 mg/L of MS-222 followed by less concentrated doses of 150 mg/L. Kaufman *et al.* (2007) anesthetized green sturgeon using 350 mg/L removing them from the solution when anesthetized. However, Serge Doroshov, (University of California Davis, pers. comm.) regularly uses 100 mg/L when working on green sturgeon. Joe Cech (University of California Davis, pers. comm.) starts green sturgeon anesthesia in baths of 150 mg/L and then when respiration stops, places them in a second, less concentrated bath of 75 mg/L. The majority of shortnose and Atlantic sturgeon researchers interviewed for this document reported concentrations of MS-222 from 50 to 100 mg/L were sufficient to induce anesthesia for most invasive procedures (Boyd Kynard Permit #1549, Mark Collins Permit #1447, Michael Kennison Permit #1595, Doug Peterson Permit #10037, Haley 1998, Oakley and Hightower 2007, Savoy 2007). The USFWS' Biological Procedures and Protocols for Researchers and Managers Handling Pallid Sturgeon recommends using MS-222 at doses between 50 and 150 mg/L (USFWS 2008).

Induction and recovery times for chemical anesthetics vary based on the dosage level and duration the fish is under anesthesia. For rainbow trout in MS-222, Wagner *et al.* (2003) found induction takes two to three minutes at 60 mg/L with recovery taking 5 to 6 minutes. For Gulf sturgeon in MS-222, Hernandez-Divers *et al.* (2004), when initiating anesthesia at 250 mg/L, induction took 5 to 11 minutes before lowering the dosage to 87.5 mg/L, after which recovery took 3 to 13 minutes. For green sturgeon at 50 to 100 mg/L MS-222, induction and recovery both required 10 to 15 minutes at 18° to 21°C, but at cooler temperatures it took longer (Joel Van Eenannaam, University of California Davis, pers. comm.).

Sturgeon face several risks posed by MS-222, such as overdose, increased stress, or being released prior to recovering. Weakened fish are more susceptible to anesthetic shock and thus are more likely to be accidentally overdosed (Coyle *et al.* 2004). Even when anesthetized with MS-222, fish still experience elevated levels of plasma cortisol, indicating they are stressed either by handling or by additive stress of MS-222 (Coyle *et al.* 2004). After being handled under anesthesia, plasma cortisol levels increased 8 times over base in channel catfish (Small 2003) and nine times over base in rainbow trout (Wagner *et al.* 2003). Studies by Pirhonen and Schreck (2003) found fish anesthetized with MS-222 ate significantly less (15-20%) than control fish. If the dose of MS-222 is too high or the exposure is too long, recovery is longer if it occurs at all. Therefore, NMFS recommends monitoring sturgeon closely during recovery and taking protective measures if fish appear stressed and not recovering normally (e.g., providing supplementary DO and moving water across the gills until fully recovered).

Recovery is also influenced by the size and sexual condition of fish. Because MS-222 is fat soluble (Coyle *et al.* 2004) longer recovery times are experienced by larger sturgeon and gravid females. Holcomb *et al.* (2004) showed doses of 225 mg/L MS-222 had no effect to eggs or sperm of white sturgeon and could be used to harvest gametes. However, doses of 2,250 mg/L resulted in lower hatching success and doses of 22,500 mg/L resulted in complete loss of fertility. At the dosages typically used by researchers to anesthetize sturgeon, however, no impact to their eggs is expected.

Although the FDA permits the use of MS-222, it also requires a 21 day withdrawal period before an anesthetized fish can be consumed. This poses concerns for humans when non listed fish are released into the wild where they may be consumed. However, a 21 day withdrawal is not a consideration for threatened or endangered sturgeon, as taking or possessing them is prohibited by the ESA. Therefore, no external marks or tags are required for Gulf, green, Atlantic, or shortnose sturgeon following anesthetization with MS-222.

Clove Oil

Clove oil is approximately 90 to 95% eugenol with smaller portions of methyleugenol and isoeugenol and was initially experimented with as a substitute for MS-222 (Bowman *et al.* 2003). Showing promise as an anesthetic, it was marketed as AQUI-S (isoeugenol , 2-methoxy-4-propenylphenol) in an attempt to gain FDA approval. However, in 2007, the National Toxicology Program concluded exposure of male mice to isoeugenol resulted in clear evidence of cancer. As a result of its concern that isoeugenol's carcinogenic properties could be transmitted through the food web, the FDA's Center for Veterinary Medicine officially rescinded authorization for the "investigational food use" of AQUI-S under INAD 10-541 (AADAP 2008). Consequently, both NMFS and the FDA (2007) are concerned isoeugenol could have direct adverse effects to threatened and endangered aquatic species. NMFS does not authorize the use of clove oil or AQUI-S on Atlantic, green, Gulf, or shortnose sturgeon.

Physical Anesthetic

Electronarcosis

Electronarcosis (also referred to as electroanesthesia and galvanonarcosis) is a non-chemical method of anesthetization and, as such, does not require FDA approval. Researchers investigating the use of electricity to immobilize fish have used various methods and species of fishes. Alternating current (AC), rectified AC, constant direct current (CDC), and pulsed direct current (PDC) have all been tested (Hartley 1967, Walker *et al.* 1994, Barton and Dwyer 1997, Henyey *et al.* 2002). Some researchers leave the electricity on for the entire time the fish is immobilized (Gunstrom and Bethers 1985) while others apply a short burst of relatively high voltage resulting in immobization of the fish for several minutes after the electric current is discontinued (Sterritt *et al.* 1994). Much of what has been learned about electronarcosis is based on the same principles applied during electrofishing.

Fish exposed to electric current may show electrotaxis (forced swimming), electrotetanus (muscle contractions), or electronarcosis (muscle relaxation). AC causes tetanus (Henyey *et al.* 2002) and at higher voltages pulsed direct current causes tetanus, whereas constant direct current causes narcosis first, and then will eventually cause tetanus as the voltage is increased (Summerfelt and Smith, 1990). Typically, when researchers have studied electronarcosis, the electricity used was either AC or PDC, or was CDC of a sufficiently high voltage that the fish were immobilized by electrotetanus. Further, most studies using AC and PDC reported adverse effects including some bruising, burning, hemorrhaging, and mortality (Tipping and Gilhuly 1996, Redman *et al*. 1998, Holliman and Reynolds 2002). Consequently, NMFS does not recommend using AC or PDC currents for inducing anesthesia in listed sturgeon. When using CDC, the risks to sturgeon are over-applying the direct current resulting in either tetany or cessation of opercular movement. These adverse affects can be avoided by monitoring the sturgeon and reducing the voltage depending on the fish's behavior.

Henyey *et al.* (2002) describe using low voltage CDC to induce electronarcosis (muscle relaxation) in shortnose sturgeon without any changes in swimming or feeding behavior, burns, bruising, or mortality after monitoring the fish for six weeks (Boyd Kynard, USGS, pers. comm.). All evidence indicates electronarcosis induced by the method described is similar to the condition induced by chemical anesthetics; nevertheless, more research is needed on the physiological mechanisms by which it works. NMFS recommends low voltage direct current electronarcosis as described by Henyey *et al.* (2002) as a viable alternative to chemical anesthesia.

Electronarcosis has been used successfully by Boyd Kynard (USGS, pers. comm.) to anesthtize shortnose sturgeon since the 1980s. Since 2004, USFWS researchers in Maryland have also followed the Henyey *et al.* (2002) protocol to anesthetize Atlantic and shortnose sturgeon on the Potomac River and Chesapeake Bay with no adverse affects reported (Mike Mangold, USFWS, pers. comm.). Researchers in South America have also followed these methods reporting similar success (Alves *et al.* 2007).

As described in Henyey *et al.* (2002), a tank is prepared by positioning positive cathode and negative anode plates at opposite ends. With the sturgeon oriented head towards the cathode, a CDC is applied quickly so the fish loses equilibrium and then the voltage is adjusted downward until the fish is relaxed and exhibiting strong opercula movement. In practice, when inducing electronarcosis, if gill ventilation becomes irregular or stops, the electric current should be decreased and the fish will recover steady ventilation immediately (Boyd Kynard, USGS, pers. comm.). The amperes should be set to the minimal level (0.01A). Depending on the individual sturgeon and water chemistry, about 0.3 to 0.5 volts per centimeter is recommended to immobilize sturgeon. Typically, sturgeon should be supported by a net so only half of the body either dorsal or ventral depending on the work being conducted, is out of the water. Under these conditions, the researcher will feel nothing while working in the water (Hartley 1967, Boyd Kynard, USGS, pers. comm.) but researchers with sensitive skin or hand abrasions are also encouraged to wear rubber gloves during the procedure.

Induction and recovery from electronarcosis both require less than 10 seconds because as soon as fish are placed in or removed from the electrical current, it is no longer anesthetized (Gunstrom and Bethers 1985, Summerfelt and Smith 1990, Henyey *et al.* 2002). Henyey *et al.* (2002) state electronarcosis is ideal for non-invasive research. The methods in Henyey *et al.* (2002) elicited narcosis, not tetany; and Boyd Kynard (USGS, pers. comm.) states narcosis is induced by blocking nerve impulses at the medulla oblongata. Kynard and Lonsdale (1975) demonstrated electronarcosis and MS-222 yielded similar states of muscle relaxation and immobility.

Recommendations

General

- NMFS recommends that noticeably stressed sturgeon should not be anesthetized.
- Physical restraint is not an appropriate substitute for anesthetization in procedures requiring anesthesia.
- NMFS recommends initiating both chemical and physical anesthesia gradually to reduce the risks of overdosing.

Chemical Anesthetic

- Because of the risks associated with high initial induction doses followed by a lower maintenance dose of MS-222, NMFS recommends using this technique in a controlled environment such as a laboratory and also using a heart rate monitor to prevent overdosing.
- NMFS also recommends monitoring the sturgeon during induction to avoid overexposure and if the desired stage of narcosis cannot be reached within 15 minutes, the sturgeon should be placed in freshwater to recover before being released.
- Tricaine methanesulfonate (MS-222) is the only chemical anesthetic with a label for use on fish granted by the FDA and as such, is the only chemical anesthetic recommended by NMFS for use on green, Gulf, Atlantic, and shortnose sturgeon. Dosages of MS-222 should be between 50 and 150 mg/L as identified in the pallid sturgeon protocols (USFWS 2008) and by green, Gulf, Atlantic, and shortnose sturgeon researchers.
- NMFS recommends monitoring sturgeon closely during recovery and taking protective measures if fish appear stressed and not recovering normally (e.g., providing supplementary DO and moving water across the gills until fully recovered).
- A 21 day withdrawal, normally associated with the use of MS-222 on food fish, is not a consideration for threatened or endangered sturgeon, as taking or possessing them is prohibited by the ESA.
- NMFS does not authorize the use of clove oil and AQUI-S on Atlantic, green Gulf, or shortnose sturgeon.

Physical Anesthetic

- NMFS recommends low voltage direct current electronarcosis as described by Henyey *et al.* (2002) as a viable alternative to chemical anesthesia but does not recommend using AC or PDC currents for inducing anesthesia in listed sturgeon.

Tagging

Tagging is an essential function of sturgeon research, serving to identify unique information about a captured or recaptured animal. PIT tags, as discussed earlier, should be inserted in all Gulf, green, shortnose, and Atlantic sturgeon without a PIT tag. Determining the life history, morphology, behavior, movement, and physiology of sturgeons are all highly dependent on proper tagging methods. Because sturgeon can live for decades, it is essential tags be retained for extended periods. In addition, because sturgeon exhibit very rapid juvenile growth rates and can achieve very large sizes, tags must be retained even as the tag placement area changes size and shape. Moreover, sturgeon are adept at shedding external tags and can also extrude internal tags through the body wall (Kieffer and Kynard 1993). Consequently, sturgeon researchers should keep well informed on the effectiveness of tagging methods and the technology best suited for local conditions.

Tagging varies based on tag function, location, method, technology, retention rates, and size. Internal tags (acoustic or radio) are surgically implanted in sturgeon for tracking movements, whereas externally mounted tags can be used for tracking or identification. Despite lower retention rates for some external tags, there are situations where external tags are the only option, such as tracking pre-spawning females. External archival tags and satellite tags can also passively record water quality information or geographic position without arrays. Other types of external-identifier tags are useful when non-researchers are involved in research activities, such as studies relying on fishermen to return data from tags on marked fish.

Telemetry Tags

Acoustic tags outperform radio tags in deeper water (or saline water) where sturgeon spend a majority of their lives; however, acoustic tags have disadvantages associated with limited range and ineffectiveness in turbulent or turbid waters. Acoustic signals can be monitored by field crews using either mobile hydrophones or, more commonly, stationary hydrophone arrays. Because the stationary arrays are designed to passively capture the location of transmitted signals from near-by fish, many researchers are converting to acoustic tag technology, collecting data over a longer period of time and downloading it at later intervals (Reine 2005).

Radio transponders emit radio signals from transmitter antennae to the atmosphere where they can then be monitored by researchers with a receiving antenna. For highly migratory species such as sturgeon, researchers can locate and track fish at distances up to three kilometers via airplane. Radio signals are also effective in environments having more physical disruptions such as turbidity (Thorsteinsson 2002). Combined acoustic and radio transmitter (CART) tags provide the researcher the advantages of each transmitter type.

Implanting internal telemetry tags is stressful to sturgeon and should be done using anesthesia. To gain access to the abdominal cavity, a two to four centimeter incision is made between the 3rd and 4th ventral scute between the anal and pelvic fin slightly left or right of the mid-ventral line. Internal tags should be coated with a biologically inert substance, soaked in alcohol and allowed to dry, and then pushed deeply into the abdominal cavity to prevent tags from rubbing against the incision (Kynard and Kieffer 1991). In studies by Kynard and Kieffer (1997) no tags were rejected from shortnose sturgeon when they were coated in biologically inert material but when uncoated tags were used, they were rejected 33% of the time. Of those rejected, sonic tags were expelled within two weeks, while the radio tags were rejected within 14 weeks (Kynard and Kieffer 1997). Collins *et al.* (2002) recorded no mortality using completely internal tags during a three month study on tagging methods. Due to slower recovery time at lower temperatures, internal tags should not be implanted when water temperatures are below 8°C (Moser *et al.* 2000a, Ream *et al.* 2003, Kieffer and Kynard *in press*). Also, due to increased stress at higher temperatures, incisions should not be made in sturgeon when water temperatures exceed 27°C (Moser *et al.* 2000a, Kieffer and Kynard *in press*).

Some researchers have experimented with an internal tag having external trailing antennae threaded through a permanent hole in the lateral wall of sturgeon. These tags, allowing for better transmission of radio frequencies, are known as Internal/External tags (I/E tag). However, depending on the surgical procedure used to anchor the trailing antennae at the exit point, certain harmful effects resulted from the chaffing and cutting of the trailing antenna. In one lake sturgeon I/E tagging study, Peterson and Bezold (2008) tagged both wild and hatchery raised fish, allowing them to recover for 14 to 21 days prior to release. In this study, wild fish experienced 9% mortality but hatchery-reared sturgeon experienced 90% mortality. In an I/E tagging study by Collins *et al.* (2002), laboratory sturgeon tagged in this manner endured large exit wounds resulting from the trailing antenna and eventually suffered 100% mortality. In the same study, internal telemetry tagging techniques and two methods of external tagging resulted in only one mortality.

More recent results documented by Kieffer and Kynard (*in press*) found trailing antennae did not appear deleterious to the health of shortnose sturgeon when designed to exit the body wall through holes drilled in lateral scutes. Five wild fish tagged in the Connecticut River with I/E tags exiting through the scute were tracked for a year. All fish were recaptured, but the exit holes in all scutes had become larger. Until these techniques are better documented, NMFS recommends I/E tagging should not be done on green, Gulf, shortnose, or Atlantic sturgeons.

Historically, external tags were easily shed. Collins *et al.* (2002) showed hatchery shortnose sturgeon were able to shed 100% of their external transmitters (9 cm long, 1.7 cm diameter) when attached with a wire through the dorsal fin. However, the same researcher reported no external transmitter tags lost when attached to a dart tag using heat shrunk plastic wrap. Counihan and Frost (1999) found no external tags were shed by juvenile white sturgeon after one to three weeks. Sutton and Benson (2003) reported a 14.4% shedding rate for external tags (2.1 – 4.0 cm), with 27% of the larger tags (3.4 - 4.0 cm) shed.

More recently, researchers have documented higher retention rates with the advent of newer, smaller external tags and better methods of attachment (Figure 3). These external tags range in size between 18 and 46 mm long and only 7 to 9 mm in diameter. Using 70 to 100 lb test monofilament line, Mike Randall and Ken Sulak (USGS, pers. comm.) described a method for attaching such tags bound externally to the dorsal fin using lightweight heat shrink electrical splice tubing and five minute, two-part epoxy. These researchers documented over 96% retention rates on Gulf sturgeon during 2005 to 2008 using the following method. Their method (Mike Randall and Ken Sulak, USGS, pers. comm.) is described as:

> About 25 cm of monofilament is centered in approximately 20 mm length of heat shrink. A small quantity of epoxy is added to the tag which is then seated into the heat shrink tubing. The tubing is then shrunk with a heat gun until snug. This also warms up the mono line enough to make right angle bends at the ends of the heat shrink tubing. A small amount of epoxy should extrude from each end of the heat shrink tubing making a smooth union. Once the attachment is cooled and the epoxy hardened, the tag should be re-checked and the tag's magnet affixed to the tag. A tape label with the identifying tag number is also wrapped around the monofilament. A hole is then made through the base of the sturgeon's dorsal fin with a PIT tag needle which is also used as a guide to thread the mono line through the dorsal fin. Similarly another hole is made through the dorsal fin anterior to the first hole and the aft monofilament line is passed through. As the transmitter tag is pulled snugly to fit within the crease at the base of the dorsal fin and the body, the two monofilaments ends are joined on the opposite side of the dorsal fin by a short length of steel leader. The external tag is then secured by threading the monofilament through crimps pre-fastened on the ends of the steel leader. As the monofilament lines are pulled with opposite pressure, the leader line crimps are compressed. Finally any trailing ends of the monofilament or leader are cut. The leader will eventually corrode freeing the external tag from the fish.

Figure 3: Location of external telemetry tag (USGS Southeast Ecological Science Center).

NMFS recommends acoustic telemetry tags for tracking the movements of Gulf, green, Atlantic, and shortnose sturgeon. NMFS would suggest tagging sturgeon externally, though both methods are acceptable.

External Identifier Tags

NMFS has authorized a variety of external-identifier tag designs and placement sites on shortnose sturgeon over the past 10 years. Some examples of external-identifier tags are: Carlin (Peterson) tags, coded wire tags, dart tags, disk anchors, double barb tag, elastomer, and Floy T-bar tags. Minimal research has been conducted on the effects of these types of tags on sturgeon species.

The need for researchers to identify sturgeon with external-identifier tags has been called into question by Bergman *et al.* (1992) as sturgeon can be uniquely recognized by PIT tags. Additionally, the effectiveness and retention of these external-identifier tags is uncertain (Bergman *et al.* 1992). However, using external identifier tags can be helpful for identifying wide ranging sturgeon, like the Gulf, Atlantic, and green sturgeons that can be captured in distant locations by other researchers or commercial fishermen. Shortnose sturgeon are less likely to travel great distances through the ocean and into different rivers; therefore, external identifier tags are not as beneficial for them. Consequently, NMFS recommends the use of external tags to assist with the identification of migratory sturgeon when that information will contribute to the species' recovery.

Smith *et al.* (1990) compared the effectiveness of dart tags with nylon T-bars, anchor tags, and Carlin tags in shortnose and Atlantic sturgeon. Carlin tags applied to scutes had low retention rates as did dart tags; however, they also noted the dart tags caused some tissue damage. Carlin tags applied at the dorsal fin and anchor tags inserted in the abdomen showed the best retention. Although anchor tags resulted in lesions and eventual breakdown of the body wall if fish entered brackish water prior to their wounds healing, Collins *et al.* (1994) found no significant difference in healing rates between fish tagged in freshwater or brackish water. Clugston (1996) also looked at T-bar anchor tags placed at the base of the pectoral fins, finding beyond two years, retention rates were about 60%. Collins *et al.* (1994) compared T-bar tags inserted near the dorsal fin, T-anchor tags implanted abdominally, dart tags attached near the dorsal fin, and disk anchor tags implanted abdominally. He found that T-anchor tags were most effective long-term (92%), but also noted that all of the insertion points healed slowly or not at all and, in many cases, lesions developed. Collins *et al.* (1994) also inserted coded wire tags into the sturgeons' snout and found a 100% retention after 62 days, but only 74% after two years, though the tags may not have been inserted deeply enough. Bordner *et al.* (1990) inserted coded wire tags deeply into the snouts of white sturgeon and found 100% retention after 180 days; and Isely and Fontenot (2000) also found that coded wire tags inserted near the dorsal fin have a 98% retention rate after 120 days.

Winter (1983) suggested the appropriate tag weight to body weight ratio for fish was 2% for the tag weight in air and 1.25% for the tag weight in water. Generally, heavier tags reduce growth or affect the swimming ability of tagged fish. But, as noted by Brown *et al.* (1999), different species of fish are better able to respond to tag weight, handling higher ratios of tag weight to body weight. In a tag to body weight ratio study conducted on lake sturgeon, Sutton and Benson (2003) recommended tag weight in air not to exceed 1.25% of body weight. In a separate study by Counihan and Frost (1999), using the ratio of wet tag weight to sturgeon weight of less than 1.25%, they found the swimming performance of white sturgeon was affected. However, this effect was more attributed to the tag placement rather than the weight itself as external tags attached to the rear dorsal fin resulted in increased drag and unbalanced weight. Currently, NMFS is sponsoring directed research on a variety of sturgeon species to determine the appropriate tag to body weight ratio. However, until resolved, NMFS recommends not exceeding a tag to body weight ratio of 1.25% in water and 2% weight in air for all tags cumulatively.

Recommendations

General

- PIT tags are strongly recommended to be inserted in all Gulf, green, shortnose, and Atlantic sturgeon without a PIT tag.
- NMFS recommends not exceeding a tag to body weight ratio of 1.25% in water and 2% weight in air.

Telemetry Tags

- NMFS recommends I/E tagging should not be done on green, Gulf, shortnose, or Atlantic sturgeons.
- NMFS recommends acoustic telemetry tags for tracking the movements of Gulf, green, Atlantic, and shortnose sturgeon. NMFS would suggest tagging sturgeon externally, though both methods are acceptable.

External Identifier Tags

- When appropriate, NMFS recommends the use of external tags to assist with the identification of migratory sturgeon.

Gastric Lavage

The pulsed gastric lavage technique, demonstrated by Foster (1977) to sample diets of pickerel and largemouth bass, has not worked well for sturgeon species. This is largely due to the difficulty in navigating the lavage tube past the U-shaped bend of the alimentary canal in sturgeon, which begins after the pneumatic duct of the swim bladder joins the anterior end of the stomach (Figure 4, also see Haley 1998 and Brosse *et al.* 2002). Serious injury and mortality has occurred when lavaging sturgeon. Sprague *et al.* (1993), showed gastric lavage tubes positioned prior to the pneumatic duct filled and burst the swim bladder and when passed beyond the bend of the alimentary canal, those tubes were capable of puncturing the canal and stomach lining of an unrelaxed gut.

Haley (1998) modified the Foster (1977) protocols for gastric lavage to create a lavage technique appropriately safe and effective for use on sturgeon (Figure 4). Haley's (1998) technique has been modified a few times with different methods created for water delivery into the stomach through intramedic tubing. Murie and Parkyn (2000), Savoy and Benway (2004), and Collins *et al.* (2008) each used slight variations of the water delivery system, but essentially used the procedures described in Haley (1998) to safely lavage sturgeon. NMFS recommends researchers follow these methods, as described below, when conducting gastric lavage of Gulf, green Atlantic, or shortnose sturgeon.

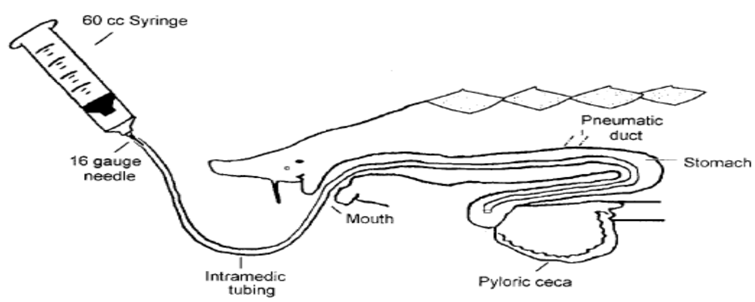


Figure 4: Depiction of the gastric lavage technique used by Haley *et al.* (1998).

> First the sturgeon is anesthetized to the appropriate stage (Table 5, Stage I) causing the sturgeon's esophageal and gastric muscles to relax. The sturgeon is then placed ventrally head down on a stretcher or sling with an irrigation tube in its mouth to irrigate the gills during the procedure to ensure respiration. With water running over the gills, a fine mesh strainer is positioned under the sturgeon's mouth to capture the regurgitated contents of the stomach as it is lavaged. With the sturgeon correctly positioned, a soft, flexible intramedic tubing (typically polyethylene) is inserted into the mouth of the sturgeon and carefully directed down the alimentary canal past the pneumatic duct into the stomach region. At the point of resistance reached at the U-shaped bend of the stomach, the flexible tube is twisted ventrally and gently pushed further down the alimentary canal until the tube can be felt on the ventral surface of the fish. If the researcher is more conservative, the lavage procedure can begin once the tube reaches the point of resistance at the U-shaped bend in the stomach, as this method has been shown to be equally effective.

> Once the tube is correctly positioned, the stomach contents are evacuated with injected pulses of water. Haley used a syringe to inject water into the stomach, flushing the contents into a strainer. Variations of Haley's technique have been used by other researchers to inject water using a garden sprayer holding a larger reservoir of water to administer the flushing, either timed (Savoy and Benway 2004) or manually (Collins *et al.* 2008). The contents are collected into an appropriately small meshed sieve, preserved in an alcohol filled container and the contents later identified in the laboratory.

In order to conduct gastric lavage procedures, researchers should have the following items:

- Garden sprayer or another appropriately sized water delivery device
- Intramedic tubing
- Means of anesthetization
- 500 micrometer sieve
- A sling or stretcher for holding the fish in the head down position
- Jars filled with alcohol for preserving gut content samples

Kamler and Pope (2001) and Shuman and Peters (2007) report Haley's (1998) protocols are more effective for smaller fish because the syringe can only deliver a small volume of water. Brosse *et al.* (2002), Nilo *et al.* (2006), Savoy (2007), and Collins *et al.* (2008) developed their methods to deliver larger volumes of water to effectively lavage larger Atlantic and shortnose sturgeon. These researchers used varying diameter tubes and depending on the size of the fish, flushing slightly less than a gallon of water into the sturgeon's stomach to completely evacuate its contents.

When gastric lavage was first used with sturgeon, there were serious perceived risks to the individual fish. Sprague *et al.* (1993) reported 33% mortality (4 of 12) of white sturgeon they attempted to lavage. Farr *et al.* (2001) practiced their technique on three dead green sturgeon but were unable to maneuver the tubing around the bend of the alimentary canal. In both methods, the swim bladder filled with water resulting in damage to the alimentary canal and stomach. Both of these studies however used a less flexible aquarium tubing, a factor which potentially prevented the tubing from bending with the stomach and reaching the ventral portion of the stomach near the pyloric caeca. To avoid adverse affects in future research, NMFS recommends practicing on non-listed or hatchery-reared sturgeon before attempting the procedure in the wild.

Several sturgeon researchers have also expressed concerns that delayed mortality and other risks associated with gastric lavage remains unknown and may not be worth the risks of data collection. The only way to adequately measure adverse affects is conducting gastric lavage on sturgeon in a laboratory setting and subsequently monitoring post-lavage survival, growth, and behavior. Brosse *et al.* (2002), Wanner (2006), and Mark Collins (South Carolina Department of Natural Resources, pers. comm.) practiced gastric lavage on captive fish with no delayed mortality prior to conducting lavage in the field. And in Collins *et al.* (2008), three Atlantic sturgeon were sacrificed to monitor adverse effects from lavage on wild fish. No adverse effects were discovered. Brosse *et al.* (2002) reported all lavaged sturgeon were in poorer condition than control fish after 60 days due to weight loss. However, Collins *et al.* (2008) recaptured fish (over 70 days apart) and documented normal weight gains in the intervals between capture and re-lavage. Other researchers have reported successful gastric lavage work in the field with no immediate mortalities (Haley 1998, Brosse *et al.* 2002, Savoy and Benway 2004, Nilo *et al.* 2006, Guilbard *et al.* 2007, Nellis *et al.* 2007, Savoy 2007, Collins *et al.* 2008). Even if mortality is prevented by using appropriate lavage techniques on sturgeon, NMFS recognizes the potential risks to individual sturgeon from anesthesia, improper lavage technique, and individual sturgeon reacting negatively to the procedure.

Recommendations

- NMFS recommends researchers follow the methods presented in this document and Haley (1998) when conducting gastric lavage on Gulf, green, Atlantic, or shortnose sturgeon. Other documents detail acceptable ways to deliver larger volumes of water for adult Atlantic, Gulf, and green sturgeon.
- NMFS recommends using soft, flexible tubing (polyethylene tubing such as is used in hospitals) to maneuver the bend in the alimentary canal during gastric lavage procedures.
- NMFS recommends practicing on non-listed or hatchery-reared sturgeon before attempting the procedure in the wild.
- Sturgeon must be anesthetized to ensure relaxation of the gut walls to properly position gastric tubes during the procedure.

Sex Identification

The validation of techniques to accurately identify the sex and stage of maturation of sturgeon that leads to the conservation of Gulf, green, Atlantic, and shortnose sturgeon should be a priority. All sturgeon biologists should use safe and effective methods of sexual identification and maturity with the fewest adverse effects to the fish's health. Ideally, the sex of a sturgeon could be identified externally. A study by Vecsei *et al.* (2003) examined the urogenital openings of a variety of species of male and female sturgeon and was able to determine the sex correctly 82% of the time. However to date, the sample size is too small to be confident in the methods described.

Methods commonly used by sturgeon researchers to identify the sex and stage of gametogenesis of sturgeon include borescope (endoscope in the gonoduct), laparoscopy (endoscope through an incision in the ventral body wall), surgery and gonadal biopsy, ultrasound, and blood plasma. These techniques collect different information and have different success rates posing different risks to sturgeon.

The safest forms of sexual identification are methods not requiring anesthetic, like ultrasound (Moghim *et al.* 2002, Colombo *et al.* 2004, Wildhaber *et al.* 2006), borescoping (Kynard and Kieffer 2002), plasma lipophosphoprotein analysis (Craik and Harvey 1984), and plasma vitellogenin analysis (Wildhaber *et al.* 2006). However these methods are time or labor intensive, as with blood and plasma analyses where researchers may not receive the results of their analysis until weeks later.

Endoscopy

<u>Borescope</u>

Borescopic examination has proven an effective method for sexing sturgeon using fiber optic technology. Kynard and Kieffer (2002), Wildhaber and Bryan (2006), and Wildhaber *et al.* (2006) described the technique using a flexible borescope on shortnose, pallid, and shovelnose sturgeon where the head and body of the fish is examined under a lightly anesthetized condition. This procedure, lasting one to two minutes, is conducted with a flexible fiber optic endoscope (16cm long x 4mm diameter) inserted carefully through the urogenital opening and into place within the urogenital canal (Kynard and Kieffer 2002). Sampled females are verified by positively identifying eggs through the urogenital wall. Developed eggs are staged as either "early stage" or "late stage" individuals to identify potential spawners for the coming spring. This is done by carefully comparing the coloration and separation of oocytes viewed through the urogenital wall. Undeveloped eggs are often almond or cream-colored and sometimes indistinguishable from male testes, while mature eggs appear darker, separated, and well formed. It is noted that there are variations of this technique using a trocar to first pierce the genital canal to view and/or biopsy the gonads with an inserted fiber optic borescope; however, NMFS does not recommend this procedure on listed sturgeon.

The above borescope is easily passed through the urogenital opening (average 7.6mm) of adult shortnose, juvenile Atlantic, and other sturgeon species, although there are no similar morphological data for green sturgeon reported. Van Eenennaam *et al.* (2008) have suggested that the diameter of the urogenital canal of green sturgeon is smaller than other sturgeon species. The greatest potential for injury with this procedure, according to Kynard and Kieffer (2002), is internally at the juncture of the oviduct and urogenital canal, located approximately 9 to 20% of a sturgeon's body length from the vent, regardless of species. The borescope must be maneuvered carefully beyond the oviduct to clearly see and stage eggs. However, when using a 16-cm long borescope, the probe tip will reach beyond the oviduct in most sturgeon of one meter length or less. Further, Kynard and Kieffer (2002) reported repeated probing of the oviduct valve by 4-mm and smaller diameter probes did not penetrate the oviduct valve or damage the urogenital canal regardless of species or fish length. They concluded that careful use of a properly sized borescope would not harm reproductive structures and would be suitable for most sturgeon species.

Kynard and Kieffer (2002) examined 443 adults using a boroscope over six years. Of those viewed, 173 were identified as female and 270 were unidentified — either as females with immature eggs or identified as males. However, Wildhaber *et al.* (2006) was able to correctly identify 85% (93% accurate for males, 63% for females) of shovelnose and pallid sturgeon examined using a similar borescope. During their work, Wildhaber and Bryan (2006) and Wildhaber *et al.* (2006) did not document any injuries or mortalities associated with their borescope activities.

Borescopy requires less time than more invasive surgery, making it a safer alternative to laparoscopy (described below) for field use when handling large numbers of sturgeon under adverse conditions. However, the borescope has limited ability to distinguish between females with immature eggs and male fish as compared to laparoscopy or biopsy.

<u>Laparoscope</u>
Several sturgeon researchers have described using laparoscopic procedures in the lab and field to identify the sex and egg maturity of individual sturgeon. The method for laboratory laparoscopy is described thoroughly by Mohler (2003), Hernandez-Divers *et al.* (2004), and Matsche and Bakal (2008). As with borescopy, the sturgeon should be anesthetized and held in water as much as possible. An incision (approximately 4 mm) is made on the ventral (Hernandez-Divers *et al.* 2004, Wildhaber *et al.* 2006) side or between the lateral scutes (Conte *et al.* 1988) of the sturgeon and the endoscope is inserted through the incision and maneuvered internally to allow the researcher to view the gonads. In Hernandez-Divers *et al.* (2004), the body cavities were insufflated and the swim bladders collapsed, but NMFS recommends avoiding either of these procedures when conducting laparoscopy on Gulf, shortnose, Atlantics, or green sturgeon. Although NMFS considers laparoscopy a more invasive endoscopic procedure than boroscopy, it is a more reliable method for determining the sex and stage of maturity of sturgeons (Wildhaber *et al.* 2006) and therefore recommends laparoscopy as the endoscopic procedure of choice.

Hernandez-Divers *et al.* (2004) laparoscoped 17 Gulf sturgeon. During these procedures, seven fish were positively identified by endoscopy alone and the other 10 were identified by biopsy samples of the gonad tissue. Wildhaber and Bryan (2006) examining 34 pallid sturgeon with both ultrasound and endoscope, positively identified the sex of 100% of the fish. Wildhaber *et al.* (2006) found that laparoscopy could positively identify the sex of shovelnose sturgeon 93% of the time (93% for males, 92% for females).

Adverse effects were not reported in any of the papers discussing laparoscopy. Hernandez-Divers *et al.* (2004) reported 100% survival after extensive surgeries (45 minutes to an hour) for their 17 Gulf sturgeon. Unfortunately this work was conducted in a controlled laboratory setting by three surgeons and does not represent typical field research conditions. Additional research determining adverse effects associated with laparoscopic procedure still need to be documented, particularly on gravid females captured prior to initiating a spawning run. Several researchers have reported capturing sturgeon can may be related to abandoned spawning runs (Moser and Ross 1995, Kynard *et al.* 2007), but there have been no studies addressing the effects of anesthesia or laparoscopy on mature, late stage females still occupying their winter staging habitat prior to spawning.

Surgical Biopsy

Surgical biopsy and histological examination of a sturgeon's gonadal tissue is the most accurate while also the most invasive way to identify the sex and stage of maturity of a sturgeon (Van Eenennaam *et al.* 1996, Van Eenennaam and Doroshov 1998, Fox *et al.* 2000, Webb and Erickson 2007, Flynn and Benfey 2007). Chapman and Park (2005) conducted gonad biopsies on Gulf sturgeon by anesthetizing them and placing them in a sling on their backs. A two to four cm ventral incision was made, after which, a small gonadal biopsy was removed (Chapman and Park 2005, Webb and Erickson 2007). Surgical biopsy, usually removing about 1 cm^3 of tissue (Fox *et al.* 2000, Webb and Erickson 2007), lasts two to three minutes (Chapman and Park 2005). After biopsies are completed, the gonadal tissue is microscopically examined to verify the sex as well as the precise stage of maturation of sturgeon (Van Eenennaam *et al.* 1996, Van Eenennaam and Doroshov 1998).

As with other forms of surgery, the risks are minimized when performed in the laboratory but there is little to no information available on the extent of infection or delayed mortality. Although there is documentation of surgically sterilized sturgeon regenerating gonadal tissue, there is little information regarding the loss of reproductive potential due to the removal of small samples of gonadal tissue (Kersten *et al.* 2001, Hernandez-Divers *et al.* 2004). And, while it is known that the gonads deliver hormones to the fish that influence behavior (Hernandez-Divers *et al.* 2004), there have been no studies dealing with potential changes in behavior from small losses of gonadal tissue. Chapman and Park (2005) monitored Gulf sturgeon for 30 days following biopsy and reported no mortality.

In situations when knowing the stage of gametogenesis could lead to recovery of the listed species, laparoscopy or biopsy would be appropriate, but due to the increased risk of these procedures, NMFS only recommends using these procedures in a laboratory setting. If there are situations when these methods would be more likely to contribute to the recovery of these species than other available methods, NMFS would recommend their use under limited circumstances. Gonadal biopsy should only be performed in the field opportunistically while a researcher is implanting an acoustic tag.

Ultrasound

One of the safest and least invasive methods of sexual identification is the use of ultrasound. These devices, although costly, allow researchers to observe the sex organs of sturgeon without surgical incision or sedation. Ultrasound is the technique with the most potential and is becoming more accurate as both technologies improve and readers become more experienced (Joel Van Eenennaam, University of California Davis, pers. comm.).

When conducting ultrasound analyses, the procedures described by Wildhaber *et al.* (2006), or slight variation of these techniques, appear to be the safest described in the literature. Sturgeon are placed in a prone position in a tank of water with their ventral surfaces exposed to air. The ultrasound transducer is coated with ultrasound gel and then covered in a protective plastic sheath to prevent any scratches to the ultrasound from the sturgeon's scutes. During scanning, output power, focus depth, and frame rate are kept constant. The transducer is maneuvered along the abdomen between the gills and the anus, keeping the wide end of the transducer facing the head and tail. The ultrasound cannot penetrate the hard calcium of the scutes, so there is no reason to attempt to ultrasound the sides or back of the sturgeon (Wildhaber *et al.* 2006).

Moghim *et al.* (2002) examined 249 anesthetized stellate sturgeon with ultrasound and then performed necropsies to verify the accuracy of the ultrasound. Overall, ultrasound was 97.2% accurate in determining sex with the procedure taking only 30 seconds to complete. Mature females were the easiest to identify (100%), followed by immature females (99.3%), mature males (96.5%), and then immature males (76.2%). Colombo *et al.* (2004) examined 51 euthanized shovelnose sturgeon and determined ultrasound was a viable method of sex identification. They were able to correctly identify the sex of sturgeon 88% of the time, though only 40% of post-spawned females were accurately identified. Excluding post-spawned female sturgeon, the ultrasound correctly identified the sex of sturgeon 94% of the time. Additionally, Wildhaber and Bryan (2006) accurately identified the sex of 100% of pallid and shovelnose sturgeon using ultrasound coupled with borescope. In another study, Wildhaber *et al.* (2006) correctly identified only 68% of fish in the field and 70% of fish in the laboratory. In both of these cases, males were more often correctly identified, which is similar to the results from Colombo *et al.* (2004) but opposite the findings from Moghim *et al.* (2002).

When performed without anesthesia, there are no risks associated with ultrasound examination of sturgeon. However, while ultrasound is able to identify gender, it is not a promising method for determining the stage of eggs. When working with listed Gulf, shortnose, Atlantic, and green sturgeon, NMFS generally recommends using ultrasound for instant sexual identification of fish in the field. This method is the least stressful and comparably accurate to other available methods that provide immediate identification. Due to the expense of ultrasound technology, boroscoping shortnose, Gulf, and Atlantic sturgeon is an acceptable alternative. More research is needed to determine if boroscoping is safe for green sturgeon.

Blood Plasma

Potentially one of the most promising, most accurate, and least stressful procedures used to sex sturgeon is an analysis of blood plasma. Researchers have used vitellogenin or sex steroids such as testosterone, 11-ketotestosterone, and estradiol to assess the sex and stage of maturity for pallid, shovelnose, hybrid bester, and white sturgeon (Amiri *et al.* 1996, Webb *et al.* 2002, Wildhaber *et al.* 2006).

Blood samples are obtained from the caudal vein (Figure 5) and centrifuged to isolate the plasma where it is then analyzed by radioimmunoassay or frozen for later analysis. In initial studies, testosterone was used to discern sexual maturation (79% accuracy for males, 85% for females), as it is significantly elevated in mature male and female sturgeon (Webb *et al.* 2002). If testosterone indicates the sturgeon is maturing, estradiol levels of female white sturgeon exceed 2 ng/ml 93% of the time, while males and immature white sturgeon estradiol levels never exceed 2 ng/ml (Webb *et al.* 2002), resulting in reasonably accurate identification of immature males (72%), immature females (88%), mature males (96%), and mature females (98%). Later, researchers studied vitellogenin along with the sex steroids testosterone and estradiol (Wildhaber *et al.* 2006). At all stages of development, vitellogenin was significantly elevated in females when compared to males, predicting the sex of the sturgeon with over 99% accuracy. After sex determination, the same steps taken by Webb *et al.* (2002) can determine whether each gender of fish is sexually mature, as estradiol is significantly higher in maturing females and ketotestosterone is significantly higher in maturing males.

Figure 5: Blood collection from a shortnose sturgeon.
Photograph by J. Gibbons, SCDNR

Techniques for blood plasma analysis show promise in identifying sex and egg maturation of sturgeon, and should continue to be evaluated for use on Gulf, shortnose, Atlantic, and green sturgeon. However, this technique can only identify the sex and stage of maturity of a sturgeon after the sturgeon has been captured and released. Therefore this technique is not useful if researchers only need to know the sex of a sturgeon to identify optimal fish for an acoustic tag. If the sex of the fish is not needed immediately, but rather for later population analyses, blood samples are the preferred method. Ultrasound would also be an acceptable method even if the results are not needed immediately. These methods are least stressful and highly accurate in this situation.

Recommendations

Endoscopy

- During borescope procedures, NMFS does not recommend using a trocar to first pierce the genital canal to view and/or biopsy the gonads.
- Althought NMFS considers laparoscopy a more invasive endoscopic procedure than boroscopy, it is a more reliable method for determining the sex and stage of maturity of sturgeons (Wildhaber *et al.* 2006) and therefore recommends laparoscopy as the endoscopic procedure of choice.

Gonadal Biopsy

- NMFS does not recommend the use of laparoscopy or biopsy on wild Gulf, green, Atlantic, or shortnose sturgeon, but does recommend their use on hatchery and laboratory sturgeon. However, if there are situations when these methods would be more likely to contribute to the recovery of these species than other available methods, NMFS would recommend their use under limited circumstances.
- Gonadal biopsy should only be performed in the field opportunistically while a researcher is implanting an acoustic tag.

Ultrasound

- NMFS generally recommends using ultrasound for instant sexual identification of fish in the field.

Blood Plasma

- Blood samples are the preferred method for determining the sex and stage of maturity of sturgeon when that information is not needed at the time of sampling.

Age Estimation

Age estimates of sturgeon populations help researchers and managers understand sturgeon growth rates, ages at maturity, mortality rates, productivity, longevity, and year class strength (Campana 2001, Paragamian and Beamesderfer 2003). Such knowledge is critical for designing appropriate fisheries management policies.

Bony structures form opaque and transparent age rings each year in most fish species in response to changes in temperature or other annual cycles. These rings, or annuli, are roughly correlated to sturgeon age. Unfortunately, most bony structures, such as clavicles, cleithra, opercles, and medial nuchals are not options for listed species of sturgeon because such sampling is lethal (Brennan and Cailliet 1989, Stevenson and Secor 1999, Jackson *et al.* 2007). Other structures such as dorsal scutes and pectoral fin spines, so named because of a dermal bone sheath (Feindeis 1997), are more viable options, but scutes are more difficult to read than fin spines (Huff 1975, Brennan and Cailliet 1989, Stevenson and Secor 1999, Jackson *et al.* 2007).

Pectoral fin spines are sampled by researchers similarly across the United States. The following methodology is therefore recommended for sampling pectoral fin spines of Gulf, green, Atlantic, and shortnose sturgeon (Figure 6).

> Using a hacksaw or bonesaw, two parallel cuts are made across the leading pectoral fin spine approximately 1-cm deep. The blade of the first cut is positioned no closer than 0.5-cm from the point of articulation of the flexible pectoral base to avoid an artery at this location (Rien and Beamesderfer 1994, Rossiter *et al.* 1995, Collins and Smith 1996). The second cut is made approximately 1-cm distally (Everett *et al.* 2003, Fleming *et al.* 2003b, Hurley *et al.* 2004, Hughes *et al.* 2005), where a pair of pliers can be used to remove the resulting fin spine section. The section is then placed in an envelope and air-dried for several days or weeks. Later it is cut into thin slices (usually about 0.5 to 2 mm thickness) typically using a jeweler's saw or a double bladed saw (Stevenson and Secor 1999, Everett *et al.* 2003, Fleming *et al.* 2003b, Hurley *et al.* 2004, Hughes *et al.* 2005, Johnson *et al.* 2005, Collins *et al.* 2008). The sections are then mounted onto the substrate of choice including clear glue, fingernail polish, cytosel, or thermoplastic cement. The cross-section detail of the fin spine annuli are then studied using stereoscopic readers.

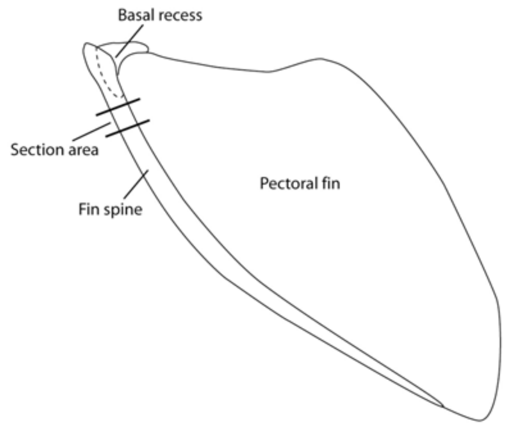


Figure 6: Diagram of the appropriate method for removing a small section of fin spine for age analysis.

Accuracy and Precision of Estimates

Accuracy and precision of the fin spine age estimates are concerns of fishery biologists and management agencies. Precision is a measurement of the distance between two reader's interpretations of the same fin spine sample, while accuracy is a measurement between the reader estimate of a sturgeon's age and the actual age (Beamish and MacFarlane 1983, Campana *et al.* 1995, Campana 2001, Hurley *et al.* 2004). To estimate precision, mark-recapture studies, oxytetracycline chemical marking studies, hatchery release studies, and in hatchery studies have been conducted to validate the age estimation process and also verify the assumption of one opaque and one translucent ring are formed each year (Clugston *et al.* 1990, Rien and Beamesderfer 1994, Campana *et al.* 1995, Rossiter *et al.* 1995, Stevenson and Secor 1999, Campana 2001, Paragamian and Beamesderfer 2003, LeBreton and Beamish 2004, Hurley *et al.* 2004, Jackson *et al.* 2007). Most studies of age estimates measure precision using at least two individual readings of the same slide. Subsequently, either the variability is recorded between readers, or the differences in reader's estimates are reconciled immediately after measurement.

Most age estimation studies suggest the results obtained should be used with caution because, while fin spines may provide the safest and most accurate estimation of age, they also consistently underestimate the actual age. The typical sources of error reported have been: 1) the rings are too close together or not clearly differentiated; 2) the original ring is difficult to identify; 3) the rings are missing within deteriorating sections; or 4) secondary fin spines, split rings, false rings, or spawning bands tend to create more or fewer rings than the actual age (Nakamoto 1995, Rossiter *et al.* 1995, Lai *et al.* 1996, Stevenson and Secor 1999, Farr *et al.* 2001, LeBreton and Beamish 2004, Whiteman *et al.* 2004). Moreover, fin spines from hatchery fish are often shaped differently, resulting in a more difficult age comparison control.

<u>Accuracy of Estimates</u>

The accuracy of fin spine estimates has been measured for Atlantic, pallid, shovelnose, white, lake, and Gulf sturgeon. Rossiter *et al.* (1995) and Stevenson and Secor (1999) monitored fish after one to three years between capture and found for lake and Atlantic sturgeon respectively, growth rings did develop once a year. But LeBreton and Beamish (2000) determined only five of seven populations of lake sturgeon exhibited a series of one opaque and one translucent ring formed per year. This was also seen by Morrow *et al.* (1998) who documented two bands forming annually in shovelnose sturgeon fin spines during warmer years. Van Eenennaam *et al.* (1996) showed reader error of one to two years underestimation for Atlantic sturgeon at true ages ranging between 15 and 30 years. For shovelnose sturgeon and Atlantic sturgeon, age estimates underestimate actual age. The age underestimation was 1.6 years for fish under 15 years, 1.7 years for fish between 16 and 20 years, and 4.3 years for fish over 21 (Whiteman *et al.* 2004). A similar result was reported by Paragamian and Beamesderfer (2003) and also by Rien and Beamesderfer (1994) for white sturgeon, each finding age underestimation for white sturgeon under 60cm was over 70%, while the accuracy fell to below 60% for fish above 100cm. Moreover, using length to estimate age of sturgeon has proven unreliable. Clugston *et al.* (1990) recorded lengths of Gulf sturgeon after one year in the laboratory and then noted the inconsistent growth of fish in the wild during all months of the year. They concluded fish of similar sizes captured in the wild yield variable growth rates, suggesting length at age charts are flawed because growth is not constant among individuals. Paragamian and Beamesderfer (2003) provided additional evidence of invalid length at age charts using wild sturgeon. However, Peterson *et al.* (2000) and Schueller and Peterson (*in press*) demonstrated that juvenile sturgeon younger than three can be aged using length at age charts.

In the most extensive mark-recapture study to date, analyzing sturgeon at large over five years, Paragamian and Beamesderfer (2003) examined 760 marked (known age) white sturgeon recaptured up to 23 years later. They found ages were underestimated between 30 and 60%, depending on the time spent at large, meaning that age estimates were 1.5 to 2 times below the actual age of the fish. For marked-recaptured shortnose sturgeon, there was 96% accuracy between the readers' age estimates and the time the sturgeon spent at large. However, when using known-age fish, only 34% of the readers' estimates were accurate within one year (Collins *et al.* 2008). Also, when using multiple slides from the same fin spines of known-age hatchery fish, Hurley *et al.* (2004) reported only 28% of the estimates were correct, while 56% were within one year and 89% were within two years.

<u>Precision of Estimates</u>
As discussed previously, when measuring the precision of fin spine aging estimates, multiple readers estimate the age of identical sturgeon fin spines and then their results are compared to determine the variance between readers' estimates. Fleming *et al.* (2003b) studied 88 shortnose sturgeon fin spines where multiple readers were able to reach an agreement after consultation 100% of the time. Everett *et al.* (2003) analyzed shovelnose sturgeon using multiple readers and found the readers could not reach agreement on 26 of 736 (3.5%) of the samples when they attempted to reconcile measurements. Rossiter *et al.* (1995) also showed agreement between reader measurements while analyzing 20 lake sturgeon. They found high precision between readers for fish under 15 years old; however, for fish over 18 years old, reader agreement dropped to 80%. In the first two studies mentioned above, the readers reconciled measurements when there was a

disagreement in age estimation, while the latter study was conducted on only 20 samples without reconciliation of estimates.

While some studies have found general precision and agreement between readers, others were less successful. Van Eenennaam *et al.* (1996) showed multiple readers agreed on readings of Atlantic sturgeon fin spine samples approximately 33 to 40% of the time. Stevenson and Secor (1999) also evaluated reader agreement of Atlantic sturgeon fin spines and found no significant difference, but the disagreement error was approximately 1.2 years on average between readers. Nakamoto (1995) analyzed 154 green sturgeon fin spines and found readings from 34% differed by fewer than two years and 66% of the readings differed by fewer than five years. Rien and Beamesderfer (1994) measuring 935 white sturgeon fin spines twice, found only 37% agreement between readers and 68% agreement within one year. Jackson *et al.* (2007) found 80% of the time multiple readers estimated the age of shovelnose sturgeon within one year and 100% were estimated within two years. However Whiteman *et al.* (2004) found reader agreement on 234 shovelnose sturgeon samples of only 18% and within one year was still only 46%. NMFS recommends all sturgeon age estimates derived from fin spine analysis should test for precision between readers.

As discussed above, one major assumption for fin spine age estimation is each fin spine develops a ring each year; but there is evidence to suggest each fin spine may be different. Jackson *et al.* (2007) simultaneously removed both fin spines from shovelnose sturgeon and showed the spines from the same fish resulted in the same estimated age 36% of the time, within one year 66% of the time, and within two years 84% of the time. But this could be a result of how the fin spines are prepared, as measurements of 64 slides made from 16 pallid sturgeon fin spines resulted in only 25% agreement from the same spines (Hurley *et al.* 2004). Jackson *et al.* (2007) concluded the preparation of fin spines must be standardized so results can be reproducible.

Age Validation

Several researchers have suggested slow growth of adult and pre-spawn females may explain why some fin spine rings are closely spaced and become more closely spaced as fish get older (Beamish and MacFarlane 1983, Nakamoto 1995). It is thought the distance between rings is influenced by changes in food supply, metabolism, behavior, and environmental conditions as the sturgeon mature.

Accordingly, sturgeon researchers have begun to develop age estimate correction factors to validate age estimates of populations of different species. Bruch *et al.* (2009), while researching lake sturgeon, found growth increments on pectoral fin spine cross sections underestimated true age of fish older than 14 years and error increased with age, whereas otoliths accurately estimated true age up to at least 52 years. Increment formation in juvenile lake sturgeon pectoral fin spines was clearer and easier to interpret than otoliths. A power function developed by Bruch *et al.* (2009) provided a means for correcting existing age estimates obtained from lake sturgeon pectoral fin spines. For that reason, NMFS recommends using salvage specimens of Gulf, green, Atlantic, and shortnose sturgeon to establish age estimation correction factors.

Deleterious Effects of Fin Spine Sampling

Kohlhorst (1979) first reported potentially deleterious effects of fin spine removal from white sturgeon during a mark-recapture study where an incidence of mortality was recorded. The percentage mortality reported could have been magnified by a small sample size, but concern over this result triggered additional research in the laboratory.

Collins *et al.* (1995) and Collins and Smith (1996) monitored the effects of fin spine removal of juvenile shortnose and Atlantic sturgeon in a laboratory. Removing the entire leading fin spine from the base, a method not currently recommended for sampling fin-rays, they found wounds healed rapidly and that the remaining secondary pectoral fin spine grew in circumference until appearing very similar to the original fin spine. There were no significant differences for growth or survival between treatment and control sturgeon.

In other laboratory studies testing fin spine function, Wilga and Lauder (1999) found pectoral fins function by orienting the body vertically in the water column, but they are not used during locomotion. Following this study, Parsons *et al.* (2003) removed pectoral fin spines from shovelnose sturgeon placing them in tanks, where the current could then be increased to test their ability to hold position in a current. Without fin spines, treatment sturgeon were able to hold their position in a current as well as control sturgeon.

Most recently, while conducting mark-recapture surveys of Atlantic and shortnose sturgeon, Collins *et al.* (2008) discovered secondary fin spines had grown abnormally on older, mature Atlantic sturgeon after the leading fin spine had been taken months earlier. Concluding this regrowth could be due to slower growth of mature, adult fish and possibly become detrimental to the sturgeons' health, their team no longer samples fin spines from larger, adult sturgeon. Because of increased error in reading fin spines of older fish and evidence of abnormal regrowth, NMFS does not recommend taking fin spine samples from mature Gulf, shortnose, Atlantic, or green sturgeon.

Alternative Methods for Age Estimation

NMFS recommends developing newer, more accurate and precise methods of aging Gulf, green, Atlantic, and shortnose sturgeon. In recent years, Bruch et al. (2009) analyzed the use of radiocarbon bombing to estimate the ages of lake sturgeon using otolith cores. This is not a non-lethal technique, but if further testing indicates using other bony structures such as scutes for accurate and precise age estimates, this may become a useful method for age estimation. Likewise, telomeres have recently been used to estimate fish age. Hatakeyama *et al.* (2008), testing small teleost fish, found that telomere length shortens through the life of the fish and is inversely related to the length of the fish. However, no change in telomere length was noted for European sea bass between 12 and 94 months of age (Horn *et al.* 2009). Specific studies should be conducted on sturgeon to determine if telomere analysis could determine the age of sturgeon.

Recommendations

General

- NMFS recommends removing a 1cm portion of the pectoral fin spine from just above the point of articulation to estimate the age of Gulf, green, Atlantic, and shortnose sturgeon.

Accuracy and Precision of Estimates

- NMFS recommends fin spine derived age estimates be used with caution because they consistently underestimate the actual age.
- NMFS recommends all sturgeon age estimates derived from fin spine analysis should test for precision between readers.
- NMFS acknowledges the preparation of fin spines must be standardized so the results are reproducible and encourages future research to achieve this goal.

Age Validation

- NMFS does not recommend using lethal methods or length/age charts to estimate ages of Gulf, Atlantic, green, or shortnose sturgeon, except when working with juvenile sturgeon under three years of age.
- NMFS recommends using salvage specimens of Gulf, green, Atlantic, and shortnose sturgeon to establish age estimation correction factors.

Deleterious Effects of Fin Spine Sampling

- Because of increased error in reading fin spines of older fish and evidence of abnormal regrowth, NMFS does not recommend taking fin spine samples from mature Gulf, shortnose, Atlantic, or green sturgeon.

Alternative Methods for Age Estimation

- NMFS recommends developing newer, more accurate and precise methods of aging Gulf, green, Atlantic, and shortnose sturgeon.

Salvage Specimens

Dead or salvaged specimens can be invaluable for a number of basic and applied aspects of sturgeon biology and conservation. Scientific uses include, but are not limited to, morphology, genetics, histopathology, contaminants, age and growth, food habits, cryopreservation of sperm, and human impact/anthropogenic mortality. Educational uses of sturgeon collected include, but are not limited to, taxidermy, collection of hard parts (e.g., scutes, bones, and entire skeleton), necropsy, and development of sampling and necropsy procedures and manuals.

Although it is important to maintain salvaged specimens and their derivative tissues, making them available for future researchers and educators, listed sturgeon are protected and transfer of specimens must still be carefully documented under the ESA. Persons/laboratories receiving specimens must be authorized to possess listed species. All sturgeon research permits issued by NMFS currently include provisions for preserving incidental mortality resulting from research or found opportunistically.

If dead Gulf, green, shortnose, or Atlantic sturgeon are found or a researcher has a need for salvaged sturgeon or sturgeon parts, contact NMFS Headquarters in Silver Spring, Maryland at (301) 713-2289.

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16 Attachment B

Gulf Sturgeon Catch Datasheet
&
Gulf Sturgeon Survey Effort Datasheet

GULF STURGEON CATCH DATASHEET

EFFORT ID___________ STRETCH MESH (cm) _______ NET LENGTH (m) _______ NET DEPTH (m) ________ HR _____ TWINE SIZE ______

Tend or Haul? (T/H)	Tend/ Haul #	Time begin	Time end	Fish #	FL (cm)	TL (cm)	Wt (kg)	Sex (M,F, U)	Scan type (AVID or BIO)	Old or new tag	Tbar L	Tbar R	Color L	Color R	Other tag type	Other tag #	Samples taken	Sample #
										OLD								
										NEW								
										OLD								
										NEW								
										OLD								
										NEW								
										OLD								
										NEW								
										OLD								
										NEW								
										OLD								
										NEW								

PIT TAGS

Animal #	Old or New?	PIT Tag #															Animal #	Old or New?	PIT Tag #													

Notes____

____

Gulf Sturgeon Survey Effort Datasheet

Page _____ of _____

Date:______________________ **Researcher:**____ **Set#:**____________________

Bay, River, or Marine?:____________________ **Location Name Abbreviation (see key for names):**____________________________________

Latitude (dd.mmsss):____ **Longitude (dd.mmsss):**____

Survey Type:___________________________(**Spring** Mar 1-May 31; **Summer** Jun 1-Sep 30; **Outmigration** Oct 1-Nov 30; **Winter** Dec 1-Feb 28)

Gear Set Time (military time, first part of gear in water):______________________________ **Set End Time:**___________________________

Gear Type Abbreviation:__________ Gear Type = Drift Gillnet – DG; Anchored Gillnet – AG; Commercial Gillnet – CG; Survey Trawl – ST; Relocation Trawl – RT; Commercial Trawl – CT; Recreational Hook and Line – HL

If Gear = ST or RT

Upper Panel Mesh Size(s) (cm):_________________ **Cod End Mesh Size:**____________________________________

Net Length (m):____________________________ **Mouth Width:**________________________________ **Height:**_________________________

If a Commercial or Recreational capture, please provide contact information.

____

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Environmental Data

	Water Temp °C	Salinity (ppt)	Depth (m)	DO (mg/L)	Refractometer	Conductivity (µS/m)	Flow (m/s)	pH
Surface								
Bottom								

Notes:____

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ID (database assignment):____