Appendix Q
Fish and Wildlife Coordination Act Report

SUPPLEMENTAL FISH AND WILDLIFE COORDINATION ACT REPORT

FOR

MISSISSIPPI COASTAL IMPROVEMENTS PROGRAM (MsCIP)

BARRIER ISLAND RESTORATION PROJECT

Prepared by:

Paul O. Necaise
U.S. Fish and Wildlife Service
Ecological Services
Mississippi Field Office
Jackson, Mississippi
January 2013

EXECUTIVE SUMMARY

The purpose of the Mississippi Coastal Improvements Program (MsCIP) is to identify risk reduction measures that can be integrated to form a system that will address the congressional mandates authorized in response to Hurricane Katrina by Public Law 109-148 (30 December 2005).

MsCIP has not followed traditional US Army Corp of Engineers (USACE) planning processes. There has not been a selected plan or preferred alternative as in most USACE projects, however there have been several levels of projects and studies recommended for authorization. The Comprehensive Barrier Island Restoration project is only one of many MsCIP projects; hence this is a supplemental Fish and Wildlife Coordination Act Report.

The Comprehensive Barrier Island Restoration project could have both adverse and favorable impacts to fish and wildlife resources. Our preliminary recommendations are:

1. When practical, construction activities that can be delayed would be conducted outside of peak breeding or migration periods to reduce potential impacts to shorebirds and nesting sea turtles.

2. Adhere to the shorebird and sea turtle monitoring plans/protocols that have been developed by the Fish and Wildlife Service (Service), in conjunction with other agencies, specifically for this project.

3. Avoid impacts (disturbances) to nesting bald eagles and ospreys.

4. Avoid impacts to submerged aquatic vegetation.

5. Use an adaptive management approach to manage the sediment and habitat resources to ensure the project area will be viable for fish and wildlife in the future. Continue to coordinate with the Service in the future when making decisions regarding the adaptive management plan.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Project Background

The U.S. Army Corps of Engineers (USACE), Mobile District, proposes to restore some of 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 (GUIS), Mississippi units. This action is related to the consequences of Hurricane Katrina, other hurricanes in the Gulf of Mexico in 2005, and past navigational dredging activities that have altered sediment transport along the islands and contributed to substantial erosion and island land loss. The MsCIP Comprehensive Plan (USACE, 2009a) was subsequently developed to support the long-term recovery of Hancock, Harrison, and Jackson Counties, Mississippi from the devastation caused by these hurricanes, as well as future storms.

The Mississippi barrier islands are dynamic coastal landforms that act as the first line of defense between the ocean and the Mississippi mainland coast. The islands bear the full impact of atmospheric and oceanic energy from tropical storms, hurricanes, and cold fronts passing through the region. In addition, the barrier islands contribute to the maintenance of the highly productive Mississippi Sound estuarine ecosystem. Hurricanes, variations in sediment supply, and relative sea level change drive changes in island location and morphology, and effective barrier island management requires adaptation to these dynamics for adequate sand replenishment of the islands.

The Mississippi barrier islands have experienced substantial changes in shoreline position, configuration, and island landmass since the mid-1800s, and these changes have progressively increased to the present day. Lateral island migration (erosion along the eastern end of the islands and sand deposition to the west) and island narrowing and segmentation have occurred, driven by dominant east-to-west sediment transport and a progressively diminishing sand supply. When the sand supply is reduced, land loss is exacerbated because sand removed by erosion is not replenished via deposition by the sediment transport system (Morton, 2008). Much of the littoral drift zone through which sand historically has migrated along the barrier islands is contained within the boundaries of GUIS. The long-term and accelerating land loss and morphological changes experienced by the barrier islands are of major concern to NPS. Moreover, they threaten the ecosystem of Mississippi Sound, and expose the mainland coast and its associated wetlands and coastal habitats to increasing saltwater intrusion and damage from future storms.

Factors contributing to the erosion, land loss, and translocation of the Mississippi barrier islands include frequent intense storms, a relative rise in sea level, and anthropogenic activities disrupting the longshore sediment transport system, including dredging of sand from Pascagoula Bar Channel in Horn Island Pass (USACE, 2009; Morton, 2008). Such activities have likely resulted in a progressive reduction in sand supply downdrift to Horn Island and Ship Island (now East and West Ship Islands). Significant storm events and a reduction in sand supply have contributed to substantial upland land area losses between the late 1840s and 2007, ranging from 19 percent at Horn Island to 60 percent at East Ship Island and West Ship Island (Morton, 2008). In addition, Petit Bois Island, which is located east (updrift) of Horn Island Pass, experienced a 52 percent reduction in upland land area since the late 1840s.

All of the Mississippi barrier islands, including Cat Island, experienced their highest rates of land loss between 2000 and 2007, which includes the losses attributable to Hurricane Katrina (Morton, 2008). The regional shortage of littoral sand for barrier island maintenance is most profound at East Ship Island and West Ship Island located at the terminus of the sediment transport system along the Mississippi barrier islands. Cat Island, located west of West Ship Island, is not part of the longshore sand-sharing system and is considered to be a separate entity (USACE, 2009).

As noted above, Ship Island has been separated into east and west segments since 1969. The center portion of the island was also breached during previous hurricanes, and while most of the island has

reformed to a low bar over time, it never gained enough sand to form dunes and establish vegetation along this center portion. Consequently, Ship Island's vulnerability to breaching has progressively increased with time. Natural healing from the littoral drift is hindered by the large amount of sand needed to rebuild the bar across the breach from the east. This is further aggravated by the fact that East Ship Island and West Ship Island are the last islands in a littoral system that extends westward from its main source of sand on the panhandle of Florida, a distance of about 250 miles. Numerous opportunities exist along this pathway for the amount of sand in the system to be diminished. Because of the island's diminished state, it may now have lost the ability to restore and maintain itself as in the past (Morton, 2008), placing the island's natural resources and cultural resources, which include historic Fort Massachusetts and the French Warehouse archaeological site, at great risk of being lost or permanently altered.

Although Cat Island is not a part of the longshore east-west barrier island littoral system represented by the other barrier islands and has experienced more limited migration, it also has lost substantial land area and narrowed as a result of erosion. Cat Island lost 40 percent of its land area to erosion between 1848 and 2007, with the highest loss rates occurring since 2000 (Morton, 2008). Replenishing sand to the eastern beach front of Cat Island is necessary to stabilize the island, restore a sand supply contributing to natural shoreline maintenance processes, and preserve its role as part of the first line of defense in maintaining and protecting the diverse ecosystems of the barrier islands, Mississippi Sound, and the mainland coast.

Given the altered state of natural resource processes, due in part to human-caused intervention as well as the resulting threats to cultural resources, NPS in collaboration with other agencies (USACE, United States Geological Survey [USGS], NOAA Fisheries Service, United States Environmental Protection Agency [EPA], USFWS, and the Mississippi Department of Marine Resources [MDMR]) concluded in the MsCIP Programmatic EIS that specific emergency actions and long-term restoration of the sediment transport system and budget are crucial for preserving and protecting the Mississippi barrier islands and their natural and cultural resources. Thus, the Proposed Action for Mississippi barrier island restoration represents the results of extensive interagency consultation and collaboration.

Proposed Action

The comprehensive barrier island restoration plan consists of placing 22 million cubic yards of sand within GUIS at East Ship Island and West Ship Island. The placement of sand along or on this island would offset the volume of sand that has been removed from the coastal sediment system. In addition, the proposed project includes the restoration of Cat Island using another 2 million cubic yards of sand not included in the 22 million cubic yards of sand for East and West Ship Islands.

<u>Direct Sand Placement in Camille Cut</u>

To restore East Ship Island and West Ship Island to a single elongated barrier island, the approximately 3.25-mile-long Camille Cut would be filled with sand obtained from three offshore sources (Petit Bois East, Petit Bois West and Ship Island borrow areas). The newly formed land mass would be constructed as a low-level dune system connecting West Ship Island and East Ship Island. The constructed Camille Cut fill section would consist of an average crest width of approximately 1,100 feet at an elevation of +7 feet North American Vertical Datum of 1988 (NAVD88) with a 1:20 (vertical: horizontal) slope from the edge of the island's top crest to the toe of the fill (intersection with the existing bottom). The fill at its western and eastern ends would tie into the existing berm along the eastern end of West Ship Island and transition into the East Ship Island placement described below. Because the seaward slope of the construction profile would be steeper than the native slope, the construction profile would be expected to adjust over a 6-month to 2-year period through the erosion of the upper profile with deposition near the

toe of the fill until its shape, termed "equilibrium profile," mimics the natural nearshore profile shape. The construction and equilibrium beach profiles would contain essentially equal volumes of sand; the volume eroded from the upper profile during the adjustment process would equal the volume deposited at the toe of the fill. The equilibrium design width would average approximately 800 feet. The tie-in points of the fill area at both ends would grade into existing contours without substantial breaks or gaps in elevation. The fill configuration would preserve existing spits protruding northward from West Ship Island and East Ship Island at either end of Camille Cut. Assuming an average water depth of about 5 feet in the existing breach, approximately 16 million cubic yards of sand would be required to fill Camille Cut in this manner. Approximately 14 million cubic yards of sand is predicted to remain after placement losses occur. As sand placement in Camille Cut progresses, the newly created land mass would be planted with native dune vegetation, including sea oats and/or other grasses and forbs, to restore stable dune habitat. The planting would include dune grasses in strips extending along all shorelines with newly created beach. Upon becoming established, the dune grasses would trap wind-blown sand, forming naturally shaped sand contours similar to those of other dunes in the Mississippi barrier islands.

The sand used to fill Camille Cut would come from offshore borrow areas near Petit Bois Pass and south of East and West Ship Islands. Coarser sand from the two Petit Bois Pass borrow areas would be placed first as fill within Camille Cut and then capped with the finer sand from the Ship Island borrow area. The coarser sand would provide the desired 30-plus-year stability for the project, while the finer sand deposits would allow for the establishment of native dune vegetation. The direct placement of sand to fill Camille Cut would be a one-time event.

Replenishment of East Ship Island

To support replenishment of Ship Island, sand would be placed along the southern shoreline of East Ship Island. Ship Island is affected by the presence of navigation channels that limit westward migration of sand through the littoral drift system. Placement of sand into this area would add sediment to the island building system of Ship Island that has been lost in large part through historical dredging activities. This placement would allow the littoral currents to move the sand along the island where the natural process of island restoration and building could take place. The restoration plan for East Ship Island calls for approximately 6 million cubic yards of sand to be placed along its southern shoreline. The results of sediment transport modeling were used to determine the best placement location for restoring littoral transport of sand along the island for natural maintenance and restoring beach and foreshore habitats along East Ship Island. Sand placement along East Ship Island would consist of constructing an average berm crest width of approximately 1,200 feet at an elevation of +6 feet NAVD88 with a 1:20 slope from the seaward edge of the berm to the toe of the fill (intersection with the existing bottom). Of the sand placed along East Ship Island, approximately five million cubic yards of material is expected to remain after placement losses occur. The sand used in this component of the ecosystem restoration effort would come primarily from offshore borrow area DA-10. Sand would likely be dredged at DA-10 with a cutterhead dredge due to depth limitations at that borrow site. Material would be loaded into scows, hauled approximately 25 miles to the vicinity of East Ship Island, and pumped off directly to the southern shoreline of East Ship Island. Placement of the material would be concurrent with the fill of Camille Cut. Replenishment of East Ship Island would occur as the second phase of the overall restoration work proposed for East and West Ship Islands. This phase of work would begin approximately six months after the commencement of Phase 1 and would take approximately 16 months to complete. The combined Camille Cut and East Ship Island equilibrated fill would encompass approximately 1,500 acres, of which approximately 800 acres would be above the mean high water line. The placement of sand would be a one-time event.

Summary of Camille Cut and East Ship Island Construction

The restoration work at Camille Cut and East Ship Island would be conducted in five phases:

1. The first phase of the project consists of the construction of an initial berm across Camille Cut. The berm would have a crest width of approximately 500 feet and a top elevation of +5 feet NAVD88. The sand for Phase 1, approximately seven million cubic yards (mcy), would be dredged from the Petit Bois East borrow area, hauled approximately 30 miles, and placed directly in Camille Cut. The work would take approximately one year to complete. Temporary obstructions including but not limited to sheet pile walls and biodegradable geotubes may be used during Phase 1 to minimize sand losses by quickly cutting off the flow through the cut. These obstructions would either be removed or completed degrade after the work is complete.

2. The second phase of the project consists of the restoration of the southern shoreline of East Ship Island. The restoration berm would have a constructed crest width of approximately 1,100 feet and a top elevation of +6 feet NAVD88. The sand for Phase 2 (approximately 6 mcy) would be dredged from DA-10, hauled approximately 25 miles, and placed along the southern shoreline of East Ship Island. This phase of work is estimated to begin approximately six months after the commencement of Phase 1 and would take approximately 16 months to complete.

3. The third phase of work consists of the placement of the remaining sand from the Petit Bois East and West borrow areas in Camille Cut (approximately 8 mcy). The Camille Cut berm, after the completion of Phase 3, would be built to a crest width of approximately 1,000 feet with a top elevation of +7 feet NAVD88. There would be a portion of the berm (upper-center) that would be left void and would be filled in Phase 4. Work under Phase 3 would begin immediately upon completion of Phase 1 and is estimated to take approximately one year to complete.

4. The fourth phase of work would commence after completion of Phase 3 and consists of the placement of approximately one mcy of sand in the void left in the upper-center portion of the Camille Cut berm. The material for Phase 4 would be dredged from the Ship Island borrow area and the work is estimated to take approximately three months to complete. Due to its finer grain size, the material from the Ship Island borrow area would be used as a cap on the Camille Cut fill section to facilitate the establishment of beach vegetation.

5. The fifth and final phase of the project consists of the planting of the Camille Cut restoration berm with native dune vegetation. This work would begin upon completion of Phase 4 and is estimated to take approximately one year to complete.

Beach-front Placement of Sand along Cat Island

The following description of work to be performed on Cat Island is preliminary, pending completion of detailed studies, donation of land to GUIS, final design decisions by the MsCIP team, and determination of the construction method. To reduce erosion and land loss of Cat Island, dune and beach restoration, including revegetation, would be implemented through the direct placement of approximately two million cubic yards of sand on the eastern beach front of Cat Island.

The construction template would consist of an average dune crest width of 40 feet at an elevation of approximately +7.5 feet NAVD88. The construction berm would have an average crest width of approximately 250 feet at an elevation of roughly +5 feet NAVD88 with a 1V:20H slope from the seaward side of the berm to the toe of the fill. The direct placement of sand on the eastern beach front would reinforce the beach ridge in this portion of the island, thereby enhancing the island's ability to

absorb energy from westward propagating waves and replenishing sand for island maintenance. 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 feet. The total equilibrated fill area encompasses approximately 305 acres.

According to the USACE, studies of the sediment budget and associated transport processes have determined that Cat Island would benefit more from the direct placement of sand on the existing beach rather than placing sand offshore in the littoral zone, as there is little or no natural migration of sand across Ship Island Pass. The sand used in the restoration of Cat Island would come from an approximately 282 acre sand deposit in an area about two miles long and 0.2-mile wide centered about 1.25 miles offshore from, and oriented parallel to, the eastern beach of Cat Island. The borrow site would be located east of the placement area and outside of the GUIS boundaries.

Also according to the USACE, geophysical survey data indicate that extensive sand deposits are available in this area. The borrow site would be dredged to a depth of approximately 3 to 5 feet to minimize disruption of habitat and to minimize the effects of wave refraction over the site after excavation. The proximity of the borrow area to the eastern face of Cat Island in relatively shallow water would allow for the rapid placement of sand on the beach front using a pipeline dredge. The material would be pumped directly onto the beach and reworked (shaped) by land-based equipment. Restoration would occur over approximately six months. The direct placement of sand on the eastern beach front of Cat Island would be a one-time event. No additional beach maintenance would be performed in the future as part of the Proposed Action.

Purpose of Proposed Project

According to the USACE, the restoration of the Mississippi barrier island system is needed to achieve the following:

- Protect and maintain the estuarine ecosystem of Mississippi Sound as well as reduced the amount of storm damage incurred along the mainland coast of Mississippi.

- Preserve and protect the Mississippi barrier islands and their natural and cultural resources.

- Reduce the erosion and land loss of the barrier islands, especially what are now East and West Ship Islands, and Cat Island to the west.

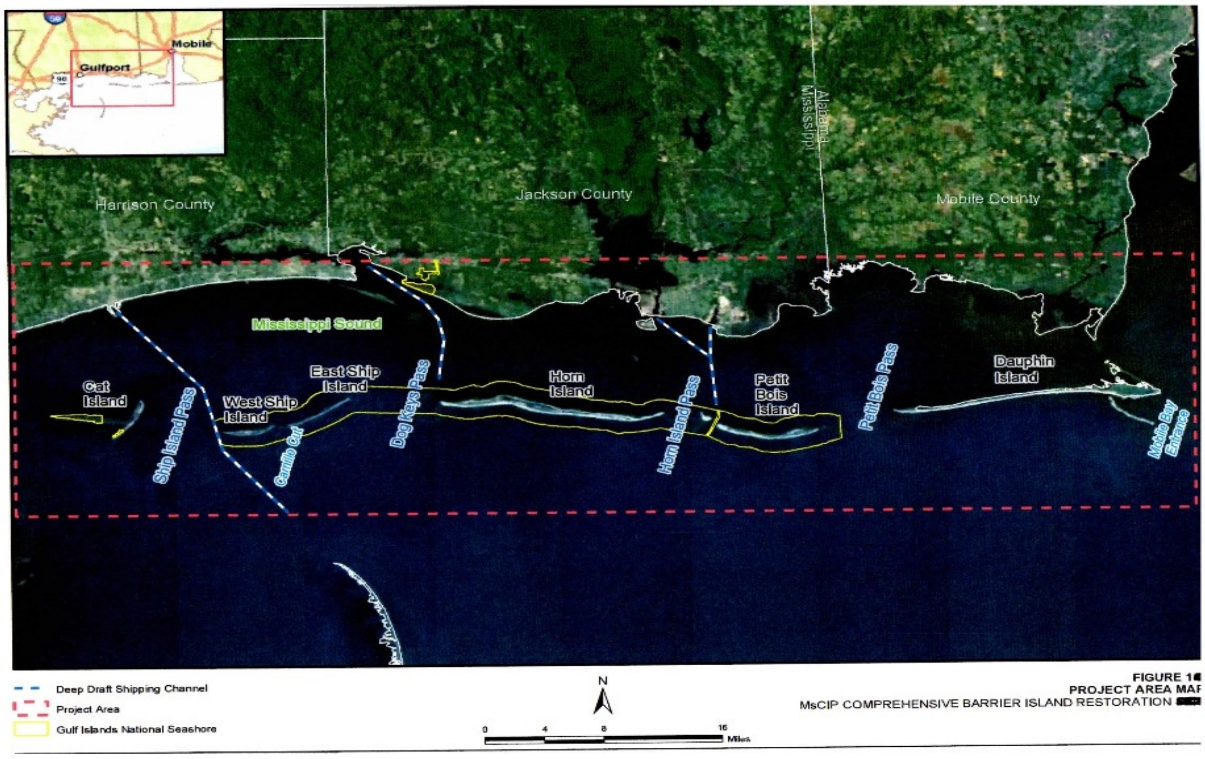
- Offset the long-term reduction in sand supply to the littoral drift system, which historically has maintained the Mississippi barrier island through natural processes.

Project Area

The project area (see Figure 1 below) for the comprehensive restoration of the Mississippi barrier islands extends from the mainland coast of Mississippi (Hancock, Harrison, and Jackson Counties) and Alabama (Mobile County) to the south across Mississippi Sound and the Mississippi-Alabama barrier islands into the northern Gulf of Mexico to a distance about 5 miles seaward of the barrier islands. The Mississippi Sound is a shallow, estuarine body of water averaging about eight to ten miles wide and extending along the coast from Mobile Bay, Alabama west to Lake Borgne, Louisiana. Several navigation channels traverse the Mississippi Sound. The Gulf Intracoastal Waterway (GIWW) provides a shallow-draft channel for navigation that parallels the mainland coast through the entire length of Mississippi Sound. Five deepened navigation channels extend into the Mississippi Sound from Gulfport, Biloxi, Pascagoula,

Bayou Cassotte, and Bayou La Batre. The USACE dredges these channels on a regular basis. A chain of six sandy barrier islands located six to 12 miles offshore in Mississippi and Alabama separates Mississippi Sound from the northern Gulf of Mexico. From east to west, the islands are Dauphin Island in Alabama and Petit Bois, Horn, East Ship, West Ship, and Cat Islands in Mississippi. The barrier island chain includes dynamic and diverse habitats that are part of a complex integrated system of beaches, dunes, marshes, bays, tidal flats, and inlets. The five eastern barrier islands (Dauphin, Petit Bois, Horn, and East Ship Island and West Ship Island) are located along a littoral drift zone that moves sand westward across the islands, resulting in their elongated shapes and westward migration over time. The westernmost island, Cat Island, is isolated from the littoral drift system that supplies sand to the other islands and has experienced a more limited migration. Ship Island currently exists as two island segments, East Ship Island and West Ship Island, separated by Camille Cut. Hurricane Camille breached Ship Island in 1969, and the breach remains today as a 3.5-mile-wide shallow sandbar between the two small islands. Two maintained navigation channels pass through the Mississippi barrier islands. The Pascagoula Bar Channel passes through Horn Island Pass near the west end of Petit Bois Island. The Gulfport Bar Channel passes through Ship Island Pass near the west end of West Ship Island. All of Petit Bois, Horn, and East Ship Island and West Ship Island and portions of Cat Island are located within the boundaries of the GUIS Mississippi units under NPS jurisdiction. Petit Bois and Horn Islands also have been designated by the U.S. Congress as the Gulf Islands Wilderness under the Wilderness Act. The designation affords additional significance and protection to these islands. NPS also manages the wilderness area.

Figure 1. MSCIP Barrier Island Restoration Project Area



Gulf Islands National Seashore

GUIS is a unit of NPS that includes outstanding natural, cultural, and recreational resources along the northern Gulf of Mexico coasts of Mississippi and Florida. These resources include several coastal defense forts spanning more than two centuries of military activity, archaeological values, pristine examples of intact coastal barrier islands, salt marshes, bayous and submerged seagrass beds, complex terrestrial communities, emerald green water, and white sand beaches. The barrier islands within GUIS are nationally significant for several reasons. Specifically, these islands:

- Contain one of the most complete collections of publicly accessible seacoast defense structures in the U.S., representing a continuum of development from early French and Spanish exploration and colonization through World War II.

- Provide for public recreational opportunities on natural and scenic island, beach, and water areas which possess the rare combination of remaining undeveloped land in a wilderness state, yet are located in close proximity to major population centers.

- Provide habitat for several endangered species in diverse ecosystems, stop-over habitat for migratory birds, and critical nursery habitat for marine flora and fauna, and serve as an enclave for complex terrestrial and aquatic plant and animal communities that characterize the northern Gulf Coast, and fully illustrate the natural processes which shape these unique areas.

- Contain land and marine archaeological resources which represent a continuum of human occupation in a coastal environment and are important in enhancing the knowledge of the past, including interactions between the earliest settlers and original inhabitants of this area of the Gulf Coast.

- Provide a benchmark to compare conditions in developed areas of the Gulf Coast to natural areas within the park.

The Mississippi barrier islands located within GUIS are Petit Bois, Horn, and East Ship Island and West Ship Island and portions of Cat Island. In most cases, the boundaries extend one mile from the shore of the island. NPS also administers the 401-acre Davis Bayou area on the mainland near Ocean Springs, Mississippi. The purposes of GUIS include the following:

- Preserving, protecting, and interpreting its Gulf Coast barrier island and bayou ecosystems and its system of historic coastal defense fortifications

- Providing for public use and enjoyment of these resources to the extent possible

Fish and Wildlife Concerns and Planning Objectives

The project area provides important habitat for several species of wildlife including shorebirds, colonial water birds, wading birds, as well as various species of mammals, reptiles and amphibians. The objective is to plan the proposed project in a fashion that minimizes impacts to fish and wildlife and their habitats to the maximum extent practicable. The Service has been working with the USACE and other agencies in a collaborative manner for several years on the planning aspects of this project. Therefore, many issues have already been address during this planning process, including various documents that have been developed for this project such as the Shorebird Monitoring Plan, Sea Turtle Monitoring and Relocation Plan, and Submerged Aquatic Vegetation Surveys.

Habitats

Coastal Wetlands

These wetlands include tidal marshes, swamps, estuaries, and submerged aquatic vegetation (SAV), which are important as habitat for larval, juvenile, and adult species and for shoreline protection. Coastal wetlands, such as freshwater and tidal or salt marshes, swamps, and bayous are found in the project area along the Mississippi coast, estuaries, and tidal inlets. Freshwater marshes are often tidally influenced, with varying elevations and functioning buffers, and are dominated by grasses. Freshwater flows through the marshes are necessary to limit saltwater intrusion. These freshwater flows also maintain suitable habitat for many species of marine flora and fauna that begin their lives in the marsh, as well as foraging, breeding, and nesting areas. Salt marshes in the area are tidally influenced and are characterized by their low position within the tidal zone, increased exposure to higher water salinities, and increasing salinity in the soils. They often have functioning buffers and marsh zonation.

Approximately 30,000 acres of SAV, primarily seagrasses, occur in the 1,850 square miles that make up Mississippi Sound (EPA, 1999). Approximately 2,000 acres of seagrass beds have been identified along coastal Mississippi (MDWFP, 2005). Within the project area, SAV is found along the northern shores of the barrier islands and in small patches throughout the immediate shorelines.

SAV within the project area was surveyed in July, 2010. Overall, 3,614 acres of SAV were mapped. SAV consisted of shoal grass (*Halodule wrightii*) at all locations. Bed densities were mostly patchy (< 50% coverage) (Vittor, 2012).

Suitable habitat for seagrass is determined by the depth and clarity of the water, sediment characteristics, salinity, and wave energy. It is estimated that 50 to 90 percent of all marine species utilize SAV at some point in their life cycle (Moncreiff et al., 1998). SAV provides spawning, nursery, refuge, and feeding areas for many species in the project area, including shrimp, crabs, scallops, redfish, speckled trout, and mullet. SAV areas are currently restricted to the northern shores of the barrier islands and small patches throughout the immediate shorelines. These areas are characterized by shoal grass (*H. wrightii*), manatee grass (*Cymodocea manatorum*), turtle grass (*Thalassia testudinum*), and widgeon grass (*Ruppia maritime*) (USACE, 2009a).

The health, continued survival, and future growth of many SAV areas have been threatened by both natural processes such as disease, fluctuations in salinity, declining water quality, storm events, and man-made activities. There are also significant seasonal and annual variations in SAV abundance and species composition (Cho and May, 2006). As more stable, climax community seagrasses such as turtle grass and manatee grass have declined the relative abundance of opportunistic, pioneer species such as widgeon grass and shoal grass in estuaries and along barrier islands of the northern Gulf of Mexico has increased. These changes accentuate the temporal and spatial fluctuations of SAV because aerial coverage and distribution of both widgeon grass and shoal grass change substantially from season to season and year to year (Cho and May, 2006).

Decreases in seagrass in the project area have been documented between 1969 and 1992. Horn Island has seen a decrease of approximately 5,000 acres during this period, with Cat Island, East Ship Island and West Ship Island, and Petit Bois Island losing approximately 430 acres, 1,280 acres, and 1,300 acres, respectively (USACE, 2009). A 1999 survey estimated remaining SAV and seagrasses at approximately 1,594 acres around Cat Island, 242 acres around East Ship Island and West Ship Island, 578 acres around Horn Island, and 425 acres around Petit Bois Island (Handley et al., 2007). Because Mississippi Sound's seagrasses and other SAV provide critical habitat for recreational and commercial marine species, The

Nature Conservancy (TNC) has named the area a priority conservation area on the Gulf Coast. Threats to this area include increased inshore fishing pressure, recreational boating, increased turbidity from incompatible development, and nutrient runoff (Beck et al., 2000).

Upland Coastal Flora and Fauna

The Mississippi coast contains a wide diversity of flora and fauna. The upland coastal habitats include barrier islands, beaches, dry meadows, dunes, and shell middens. These habitats provide essential services for the plants and animals that live within them, such as physical habitat for many of the species and storm buffering capacity. Many migratory birds use these coastal habitats as a stopover during migrations and other birds are known to roost or forage in these areas.

Beaches, Islands, Dry Meadows, and Dunes

Beach and island habitat in the project area consists of areas frequently windblown and overwashed by storm surges. These areas are also subject to impacts from marine debris. In addition, these areas are generally sparsely vegetated due to excessive exposure to heat, wind, and salt spray. Moving inland and parallel to the shore, swales and dune ridges are present. The dunes, often referred to as "relict dunes," have a crust of microscopic organisms and can be either stable and firm, with little movement, or semi-stable with some active sand movement. Backbeaches and semi-stable dunes commonly support a sparse cover of a variety of grasses including gulf bluestem (*Schizachyrium maritimum*), sea oats (*Uniola paniculata*), rosette grass (*Dichanthelium sp*.), and dropseed (*Sporobolus sp.).* Common herbs are squareflower (*Paronychia erecta*), pineland scalypink (*Stipulicida setacea*), Dixie sandmat (*Chamaesyce bombensis*), and camphorweed (*Pluchea sp*.). The dry meadows are dominated by torpedo grass (*Panicum repens*), broomsedge bluestem (*Andropogon virginicus*), needlepod rush (*Juncus scirpoides*), panic grass (*Panicum sp.)* and contain lesser amounts of saltmeadow cordgrass (*Spartina patens*). Relict dunes are dominated by shrubby species including woody goldenrod (*Chrysoma pauciflosculosa*), prickly pear (*Opuntia sp*.), and saw palmetto (*Serenoa repens*) and occasionally sand live oak (*Quercus geminate*) (Mississippi Museum of Natural Science, 2005). Many shorebirds and waterbirds use these areas for resting and feeding. Common birds known to frequent these areas include the black skimmer (*Rynchops niger*), black necked stilt (*Hiamantopus mexicanus*), American avocet (*Recurvirostra americana*), laughing gull (*Larus atricilla*), and gull billed tern (*Sterna nilotica*). (Turcotte and Watts, 2009). Bryzoans, a type of floating aquatic colonial animal, are seasonally important and provide both structural habitat and nutrient sources for marine invertebrates, fishes, and wading birds. Common reptiles in these areas include loggerhead sea turtle (*Caretta caretta*) and Mississippi diamondback terrapin (*Malaclemys terrapin pileata*) (Mississippi Museum of Natural Science, 2005).

Shell Middens/Shrublands

Shell middens occur along edges of bayous in the project area as small circular patches and are formed when the breakdown of oyster shells creates soil conditions that support a unique shrub community. Plants found on shell middens include southern red cedar (*Juniperus virginiana L. var. silicicola*), coral bean (*Erythrina flabelliformis*), buckthorn (*Frangula sp.),* red buckeye (*Aesculus Pavia*), yucca (*Yucca sp.*) and prickly pear. Estuarine Shrublands follow the shoreline of marshes and adjoin upland areas along intertidal marsh fringes and on small islands. Common vegetation in these areas includes eastern Baccharis (*Baccharis halimifolia*) and southern bayberry (*Morella caroliniensis*) (Mississippi Museum of Natural History, 2005). Many of the same birds that are found in the beach/island/dune habitat are found in shell middens and shrublands.

Fisheries

Sports fish potentially occurring within the project area include red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus)*, black drum (*Pogonias cromis*), southern flounder (*Paralichthys lethostigma*), red snapper (*Lutjanus campechanus*), and star drum (*stellifer lanceolatus*). Other common fisheries include striped mullet (*mugil cephalus*), sheepshead (*archosargus probatocephalus*), Atlantic croaker (*Micropogonia undulates*), and hardhead catfish (*Arius felis*). Shellfish include blue crab (*Callinectes sapidus*), American oyster (*Crassostrea virginica*) and a variety of shrimp species (*Penaeus spp.).* Dredging activities suspend sediments and increased turbidity in the water column, and can cause temporary impacts to fish that inhabit the area. Increased suspended sediments in turbid waters can affect all feeding, avoidance, territoriality, and homing behaviors. Wilber and Clarke (2001) noted that changes in fish cough reflex, erratic swimming and pronounced gill flaring can occur due to suspended sediments. The impacts are usually temporary, as fish have the capability to leave the area and return when impacts have subsided.

Threatened and Endangered Species

Below is a list of threatened and endangered species found within the project area. The official designations are also included after the species names including; T- threatened, E- endangered, C-candidate, CH- critical habitat, TCH- threatened with critical habitat.

Gulf sturgeon (*Acipenser oxyrhynchus desotoi*) - TCH
Piping plover (*Charadrius melodus*) - TCH
Red knot (*Calidris canutus*) - C
Alabama re-bellied turtle (*Psuedemys alabamensis*) - E
West Indian manatee (*Trichechus manatus*) - E
Green sea turtle (*Chelonia mydas*) - T
Leatherback sea turtle (*Dermochelys comacea*) - E
Kemp's ridely sea turtle (*Lepidochelys kempii*) - E
Loggerhead sea turtle (*Caretta caretta*) - T

The threatened Gulf sturgeon (*Acipenser oxyrhynchus desotoi*) and designated critical habitat for this species is located within the proposed project study area. The Service and the National Marine Fisheries Service (NMFS) have jurisdictional purview over this species and designated critical habitat for this species. However, it has been determined that all of the project area will occur within NMFS jurisdiction for this species. Therefore, NMFS will have the lead for this species.

The barrier islands also serve as habitat for the federally protected piping plover (*Charadrius melodus*). Cat, Ship, Horn, Petit Bois, Sand (Disposal Area-10) and Round Islands have been designated as critical habitat for the wintering piping plover. Wintering and migratory plovers arrive on wintering grounds from mid-July through September. Many plovers will use the Mississippi barrier islands as stop over areas for rest and forage before continuing their journey further south across the Gulf of Mexico in the Fall and then again when migrating back north in the spring. Therefore, numbers of individuals are typically higher during the fall and spring migration seasons. Although some individuals can be found on the wintering grounds throughout the year, most plovers depart in spring and sightings are rare in June and early July (USFWS, 2010). The Service has participated in numerous meetings and conference calls with the USACE, NPS, MDWFP, and other agencies regarding measures to prevent impacts to piping plover and other migratory and nesting shorebirds. As a result, a shorebird monitoring plan has been developed as part of the effort to avoid potential impacts to migratory and nesting shorebirds.

The red knot (*Calidris canutus*), is a candidate species for federal listing as a threatened or endangered species. The red knot is a medium-sized shorebird about 9 to 11 inches in length with a proportionately small head, small eyes, short neck, and short legs. The black bill tapers steadily from a relatively thick base to a relatively fine tip; bill length is not much longer than head length. Legs are typically dark gray to black, but sometimes greenish in juveniles or older birds in non-breeding plumage. Non-breeding plumage is dusky gray above and whitish below. The red knot can be found in Mississippi during the fall migration, winter, and spring migration months (generally late July through May).

In the southeastern United States, red knots forage along sandy beaches, tidal mudflats, salt marshes, and peat banks. Observations along the coast indicate that 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. In wintering and migration habitats, red knots commonly forage on bivalves, gastropods, and crustaceans. Coquina clams (*Donax variabilis*), a frequent and often important food resource for red knots, are common along many gulf beaches. Major threats to this species along the Gulf of Mexico include the loss and degradation of habitat due to erosion and shoreline stabilization development, disturbance by humans and pets, and predation.

The endangered Alabama red-bellied turtle (*Psuedemys alabamensis*) is also found within the study area for this project. The Service has limited information regarding the Alabama red-bellied turtle's range and known nesting locations. The Service does not anticipate any impacts to this species as a result of the project.

The endangered West Indian manatee (*Trichechus manatus*) may occasionally be found within the study area. The USACE has best management practices for dredging activities that should provide adequate measures to prevent impacts to this species. The Service recommends these best management practices be implemented into the project plans.

Also, several species of sea turtles have been known to nest on the barrier islands in the study area. Sea turtles are within the purview of the Service when they are on land (nesting). Sea turtles commonly found in Mississippi include the Green sea turtle (*Chelonia mydas*), Leatherback sea turtle (*Dermochelys comacea*), Kemp's ridely sea turtle (*Lepidochelys kempii*), and Loggerhead sea turtle (*Caretta caretta*).

Late juvenile stages of sea turtles are benthic feeders and without protective measures these animals could be captured or entrained by dredging equipment. The USACE is proposing to comply with the Gulf of Mexico Regional Biological Opinion (NFMS, November 19, 2003) in order to prevent capturing or entraining sea turtles from dredging operations.

Loggerhead sea turtles and green sea turtles are known to nest on the barrier islands within the project area. The Service has participated in numerous meetings and conference calls with the USACE, NPS, and other agencies regarding measures to prevent impacts to nesting sea turtles. As a result, a sea turtle monitoring plan has been developed to avoid potential impacts to nesting sea turtles.

Nesting Shorebirds and the Migratory Bird Treaty Act

Barrier Islands

The Mississippi Sound barrier islands represent the primary marine and coastal bird habitat in the project area. These islands consist of a variety of habitat types, including subtidal estuarine habitat, open beaches, lagoon, freshwater and saltwater marshes, wooded inland, etc.

More than 280 species of birds have been identified within the island boundaries. The islands serve as a rest stop for seasonal neotropical and neoarctic bird migrations across the Gulf of Mexico (NPS, 2010). Between 1992 and 1994 bird research was conducted on Horn Island, East Ship Island and West Ship Island and found that approximately 74 species of land-based migratory birds use the area as a stopover (University of Southern Mississippi [USM], 2010). The greatest number of migrating birds is typically observed in April and May and early September through mid-October (Moore et al., 1990).

The barrier islands serve as important breeding habitat and contain rookeries for several species, including least tern, sandwich tern, black skimmer, bald eagle, tricolored heron, brown pelican, and osprey (MDMR, 2010). Some of the bird species known to breed on the islands are noted in Table 1. Breeding seasons for these species typically occur between April and June with young birds remaining through August.

Table 1. Known Bird Breeding Locations on Barrier Islands

Species	Cat Island	East and West Ship Island	Horn Island	Petit Bois Island
Great Blue Heron			X	
Tricolored Heron				X
American Oystercatcher	X	X	X	X
Snowy Plover		X	X	X
Wilsons Plover	X	X	X	X
Gull-billed Tern		X	X	
Least Tern	X	X	X	X
Sandwich Tern			X	X
Royal Tern			X	
Black Skimmer	X	X	X	
Osprey	X	X	X	X
Bald Eagle	X	X	X	

Sources: Gulf Islands National Seashore (GUIS), 2007. (Zdravkovic 2007).

The reddish egret (*Egretta rufescens*) has been observed on East Ship, West Ship, Horn, and Petit Bois Islands during fall migration (Zdravkovic, 2010). The great blue heron (*Ardea herodias*) occurs in areas that include brackish marshes and ocean beaches. It nests commonly high in trees in swamps and forested areas. The tricolored heron (*Egretta tricolor*) can be found in several types of habitats ranging from marshes to salt- and freshwater islands. It mainly nests near saltwater marshes or bare coastal islands. The least tern (*Sterna antillarum*) requires open sandy coastal beaches and river sandbars for nesting. It nests in scrapes in sand above ordinary tides and breeds during the summer months. The sandwich tern (*Thalasseus sandvicensis*) prefers seacoasts, bays, estuaries, mudflats, and lagoons. It nests with the royal tern on unvegetated bare sand or sand-shell substrates. The royal tern (*Thalasseus maximus*) nests typically on open sandy beaches, sandbars, and sand/shell substrates. The black skimmer (*Rynchops niger*) nests primarily near coasts on sandy beaches, coastal and estuary islands, on wrack and drift of salt marshes, and on dredged material sites. These birds usually nest in association with or near terns. The bald eagle breeding habitat is generally close to coastal areas and large bodies of freshwater; the bald eagle usually nests in tall trees or on cliffs near water. Ospreys (*Pandion haliaetus*) nest in coastal areas on living and dead trees, but also on several different types of man-made structures (NatureServe, 2010).

DA-10 (Sand Island)

Disposal Area 10 contains a 165-acre island, commonly referred to as Little Sand Island, created by placement of dredged material from navigation maintenance activities. This island would be partially utilized for borrow material. The island is sparsely vegetated and serves as habitat for shorebirds. Historically, the island has been a consistent colonial shorebird nesting site and will have the largest numbers and diversity of species within the MS District of Gulf Islands National Seashore. Pre-Katrina, nesting colonies were documented to consist of several thousand birds. The island supports a variety of bird habitats including tidal flats, open beach, vegetated beach dune, tidal marsh, marsh meadow, and interior relic dune (NPS, 2011).

Colonial nesting species observed on the island include Least Terns, Black Skimmers, Royal Terns, Sandwich Terns, Black Terns (*Chlidonias niger*), Common Terns (*Sterna hirundo*), and Gull-billed Terns. These species nest in mixed colonies on the high sparsely or unvegetated beach (Hopkins, 2011). Once the chicks have matured into feathered plumage, the adults move them down to the water's edge until they are able to forage and fledge.

Since 2005, colonies have ranged between 350 to over 500 birds. In 2010 the nesting colony consisted of 409 pairs of Least Terns, 103 Black Skimmers and 11 Gull-billed Terns.

Solitary nesting shorebirds observed includes Willet, American Oystercatcher, Snowy Plover and the Wilson's Plover. The Willet and plover species can be found along the shoreline up toward the vegetation. Most nests are found on the bare sand, high on the beach with scattered vegetation. Adult plovers and young move down to the tidal flats and shoreline to feed and retreat to the vegetation for cover. Willets feed openly along the shoreline.

The American Oystercatcher nests on the open beach, usually next to a clump of vegetation or other cover. The adults are quite vocal and are easily seen feeding at the water's edge. In 2010, two pairs of Snowy Plovers, one pair of Willets, one pair of American Oystercatchers and one pair of Wilson's Plover were observed nesting (NPS, 2011).

The reddish egret has also been observed on Sand Island during the fall migration (Zdravkovic, 2010).

Biological Effects of the Project on Migratory and Resident Shorebirds

Marine and coastal birds are common in the area and could utilize the sites within the Proposed Action Area for foraging, nesting, roosting, or stopovers during migration. Nesting birds typically occupy the area between April and August. Migrants are typically present from mid-April through early May and early September through mid-October. Resident species are present year-round. Birds could be displaced during sediment dredging as well as island placement of the sand. The noise and activity of sediment removal and placement operations would likely deter birds from using areas in the immediate vicinity of equipment during active periods. In addition, the benthic macro-invertebrate community, in which many shorebirds forage on, would be adversely affected in the areas of sand placement and disposal for an undetermined amount of time.

Increased turbidity associated with sediment removal and placement operations could temporarily decrease foraging success of diving and plunging birds that feed in deepwater areas; however, these birds are not dependent upon the sediment removal and placement sites for survival. Foraging habitat is readily available in the northern Gulf and Mississippi Sound and it is expected that plunging and diving birds would shift to other areas if temporarily displaced.

The Proposed Action would disrupt resident birds and breeding migrants at DA-10. Approximately 105 acres of habitat for birds would be permanently lost, representing 69 percent of the available upland habitat. Species known to nest at DA-10 include Least Terns, Black Skimmers, Royal Terns, Sandwich Terns, Gull-billed Terns, Willet, American Oystercatcher, Snowy Plover and Wilson's Plover (NPS, 2011). These species would likely experience a permanent decline in population at this location. However, there is the potential for creation of additional new bird habitat and shoaling areas at DA-10. This potential habitat could be associated with future dredged material placements to the south and west of DA-10.

The Proposed Action could temporarily disrupt resident birds and breeding migrants (e.g., black skimmers, gulls, pelicans, terns, ospreys, and herons) within the project sediment removal and placement boundaries. On West and East Ship Islands this would include disrupting birds on the island ends facing Camille Cut, including 22 acres of swash habitat (between MHHW and mean low-low water [MLLW]) preferred by shorebirds. Significant short-term impacts to nesting, foraging, and roosting behavior could occur in the vicinity of removal and placement activities. However, potential long-term beneficial impacts to birds would occur from the improved island stability, enhanced nearshore foraging habitat, and increased 800 acres of upland habitat and 700 acres of habitat below the mean high water line, including a net gain of 90 acres of swash zone habitat available on Ship Island and 305 acres of enhanced upland habitat on Cat Island following restoration. The East Ship Island placement would also function as a feeder berm to support the downdrift movement of sand and associated island habitat they support.

Migratory birds using the barrier islands as a stopover point normally arrive in a stressed condition due to low body reserves of fat. Disturbance from sediment removal and placement could cause some migrants to avoid portions of the barrier islands during restoration activities and could cause additional stress. These migrants would likely seek other unaffected nearby areas. The peak numbers of migrants occur from mid-April through early May and early September through mid-October (Moore et al., 1990). Closure of Camille Cut between East Ship Island and West Ship Island and sand placement on East Ship Island would result in both beneficial and adverse impacts to migratory and resident shorebirds. Permanent impacts would occur to existing shoreline features in the areas that will be lost due to sand excavation and deposition. However, the creation of approximately 800 acres of new upland habitat will be a beneficial impact to migratory and resident shorebirds. In order to help stabilize the existing East and West Ship Islands and the newly created area between the two islands, the sand must be placed so that all of the sand is connected in order to prevent continual breaching of the area and loss of habitat. Therefore, this project can only be accomplished by impacting some existing shoreline habitat. Through previous communications between the USACE and the Service the most sensitive areas will be avoided to the maximum extent practicable. However, there may be some direct and indirect impacts associated with the filling of Camille Cut that is unavoidable primarily due to the linear shape and the east-west orientation of the existing islands (See Figure 1).

Although the bald eagle was officially removed from the List of Endangered and Threatened Species as of August 8, 2007, it continues to be protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (BGEPA). Bald eagles nest in Mississippi from December through mid-May in mature trees (e.g., bald cypress, sycamore, willow, etc.) near fresh to intermediate marshes or open water. Nest sites typically include at least one perch with a clear view of the water or area where the eagles usually forage. Bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Nesting bald eagles are known to occur within the project area.

The Service developed the National Bald Eagle Management (NBEM) Guidelines to provide landowners, land managers, and others with information and recommendations regarding how to minimize potential project impacts to bald eagles, particularly where such impacts may constitute "disturbance," which is

prohibited by the BGEPA. A copy of the NBEM Guidelines is available at http://www.fws.gov/migratorybirds/issues/BaldEagle/NationalBaldEagleManagementGuidelines.pdf.

Summary and Recommendations

As mentioned above, the Service has been working with the USACE and other agencies for several years to plan this project in a fashion to minimize adverse impacts to fish and wildlife and their habitats to the maximum extent practicable. Therefore, most of the issues have already been resolved during this planning process. Below is a list of recommendations the Service has regarding the project at this time;

- When practical, construction activities that can be delayed would be conducted outside of peak breeding or migration periods to reduce potential impacts to shorebirds and nesting sea turtles.

- Adhere to the shorebird and sea turtle monitoring plans that have been developed by the Service, in conjunction with other agencies, specifically for this project.

- Avoid impacts (disturbances) to nesting bald eagles, ospreys, etc.

- Avoid impacts to SAV's.

- Use an adaptive management approach, to manage the sediment and habitat resources to ensure the project area will be viable for fish and wildlife in the future. Continue to coordinate with the Service in the future when making decisions regarding the adaptive management plan.

- Pre-project and post-project sampling should take place in order to fully determine the effects of the project on the benthic community in the areas of sand placement/shorebird foraging areas. This sampling data along with shorebird survey data may assist in making decisions relative to the above-referenced adaptive management plan and potential future sand placement at DA-10, etc.

LITERATURE CITED

Beck, M. W., M. Odaya, J. J. Bachant, J. Bergan, B. Keller, R. Martin, R. Mathews, C. Porter, G. Ramseur. 2000. Identification of Priority Sites for Conservation in the Northern Gulf of Mexico: An Ecoregional Plan. The Nature Conservancy, Arlington, VA.

Cho, H. C. and C. A. May. 2006. An Initial Restoration Tool for Submersed Aquatic Vegetation. National wetlands newsletter, Vol. 28, No. 6.

Gulf Islands National Seashore (GUIS). 2007. Eagle observations.

Handley, L., D. Altsman, and R. DeMay, eds., 2007, Seagrass Status and Trends in the Northern Gulf of Mexico: 1940-2002. U.S. Geological Survey Scientific Investigations Report 2006-5287 and U.S. Environmental Protection Agency 855-R-04-003. 267 p.

Hopkins, G. 2011. Spoil Island/Sand Island - Shorebird nesting data. June 1.

Mississippi Department of Marine Resources (MDMR). 2010. Gulf Ecological Management Sites. http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Round-Island.htm, http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Ship-Island.htm, http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Petit-Bois.htm, http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Horn-Island.htm, and http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Cat-Island.htm. Accessed November 30, 2010.

Mississippi Department of Wildlife, Fisheries and Parks (MDWFP). 2005. Mississippi's Comprehensive Wildlife Conservation Strategy 2005-2015. Mississippi Museum of Natural Science. Version 1.1.

Mississippi Museum of Natural Science. 2005. Mississippi's Comprehensive Wildlife Conservation Strategy. Mississippi Department of Wildlife, Fisheries and Parks. Mississippi Museum of Natural Science, Jackson, Mississippi.

Moncreiff, C. A., T. A. Randall, and J. D. Caldwell, 1998. Mapping of Seagrass Resources in Mississippi Sound. Report to the MS Department of Marine Resources. BY3-156-3238. Ocean Springs, Mississippi: University of Southern Mississippi, Gulf Coast Research Laboratory.

Moore, F.R., P. Kerlinger, and T.R. Simons. 1990. Stopover on a Gulf Coast barrier island by spring trans-Gulf migrants. Wilson Bulletin 102(3):487-500.

Morton, R.A. 2008. Historical changes in the Mississippi-Alabama barrier-island chain and the roles of extreme storms, sea level, and human activities. Journal of Coastal Research 24(6):1587-1600.

National Park Service (NPS). 2010. Gulf Islands National Seashore. http://www.nps.gov/guis/index.htm and http://www.nps.gov/guis/naturescience/animals.htm, http://www.nps.gov/guis/parknews/park-significance.htm, http://www.nps.gov/guis/parknews/presskit.htm, and

http://www.nps.gov/guis/historyculture/fort-massachusetts.htm. Accessed November 30, 2010, December 1, 2010, and December 2, 2010.

National Park Service (NPS). 2011. Sand Island Shorebird Nesting Summary. July 14.

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life. NatureServe, Arlington, Virginia. Website: http://www.natureserve.org/explorer.

Turcotte, W. H. and D.L. Watts, 2009. Birds of Mississippi. Mississippi Department of Wildlife, Fisheries and Parks.

University of Southern Mississippi (USM). 2010. Migratory Bird Research Group Research Data Archive. http://www.usm.edu/mbrg/Archive.html. Accessed December 2, 2010.

U.S. Army Corps of Engineers (USACE). 2009. Mississippi Coastal Improvements Program (MsCIP), Hancock, Harrison, and Jackson Counties, Mississippi, Comprehensive Plan and Integrated Programmatic Environmental Impact Statement. Main report and appendices. June.

U.S. Environmental Protection Agency (USEPA). 1999. The ecological condition of estuaries in the Gulf of Mexico. EPA 620-R-98-004. July.

U.S. Fish and Wildlife Service (USFWS). 2010. Piping Plover Critical Habitat Questions and Answers. http://www.fws.gov/plover/q&a.html. Accessed December 15, 2010.

Vittor and Associates, Inc. 2012. Mississippi Coastal Improvement Program (MsCIP), Mississippi Sound and the Gulf of Mexico Benthic Macroinfauna Assessment. Submitted to U.S. Army Corps of Engineers, Mobile District.

Wilber, D.H., and Clarke, D.G. 2001. "Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries, "*North American Journal of Fisheries Management* " 21(4):855-875.

Zdravkovic, M. 2007. 2007 Beach-nesting bird census and report for coastal Mississippi.

Zdravkovic, M. 2010. Coastal Bird Conservation. 2009-2010 Mississippi Coast Survey Data.