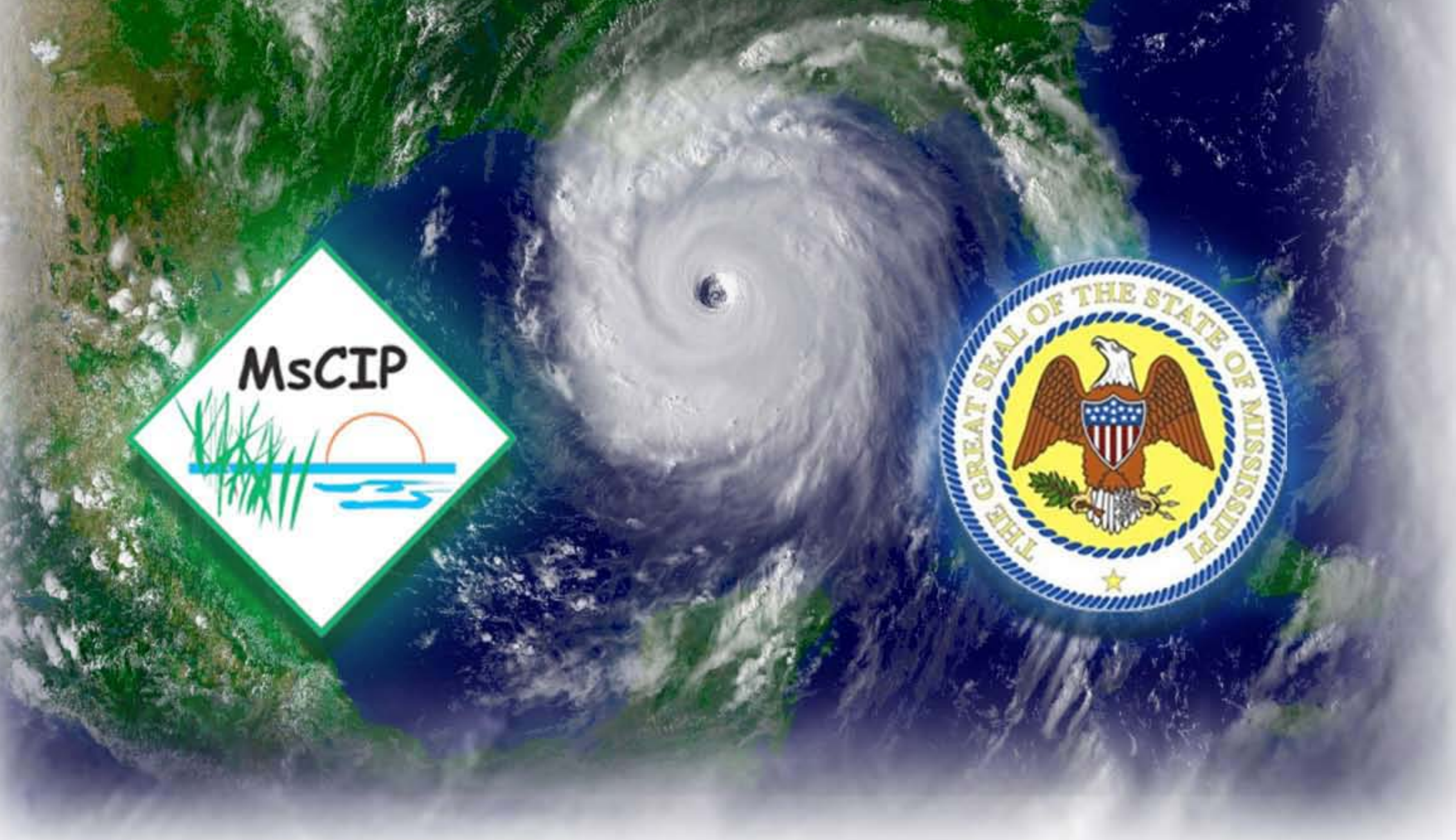
US Army Corps
of Engineers
Mobile District

June 2009

Mississippi Coastal Improvements Program (MsCIP)
Hancock, Harrison, and Jackson Counties, Mississippi

Comprehensive Plan and Integrated Programmatic Environmental Impact Statement

VOLUME 2 - APPENDIX A: ENVIRONMENTAL



Contents

SECTION 1

ENVIRONMENTAL BASELINE AND RECOVERY

1.1 Coastal Mississippi – The Ecosystem Pre- and Post-Hurricanes & Recovery Analyses

FOREWORD

This document is one of a number of technical appendices to the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Feasibility Report and Programmatic Environmental Impact Statement.

The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan Integrated Feasibility Report and Programmatic Environmental Impact Statement provides systems-based solutions and recommendations that address: hurricane and storm damage reduction, ecosystem restoration and fish and wildlife preservation, reduction of damaging saltwater intrusion, and reduction of coastal erosion. The recommendations contained in the Integrated Main Report/Programmatic Environmental Impact Statement (EIS) also provide measures that aid in: greater coastal environmental and societal resiliency, regional economic re-development, and measures to reduce long-term risk to the public and property, as a consequence of hurricanes and coastal storms. The recommendations cover a comprehensive package of projects and activities, that treat the environment, wildlife, and people, as an integrated system that requires a multi-tiered and phased approach to recovery and risk reduction, irrespective of implementation authority or agency.

Source: Corps

Figure 1. The MsCIP Study Area

The purpose of the Comprehensive Plan Report is to present, to the Congress of the United States, the second of two packages of recommendations (i.e., the first being the “interim” recommendations funded in May 2007, and this “final” response, as directed by the Congress), directed at recovery of vital water and related land resources damaged by the hurricanes of 2005, and development of recommendations for long-term risk reduction and community and environmental resiliency, within the three-county, approximately 70 mile-long coastal zone, including Mississippi Sound and its barrier islands, of the State of Mississippi.

This appendix, the Integrated Main Report/Programmatic EIS, and all other appendices and supporting documentation, were subject to Independent Technical Review (ITR) and an External Peer Review (EPR). Both review processes will have been conducted in accordance with the Corps "Peer Review of Decision Documents" process, has been reviewed by Corps staff outside the originating office, conducted by a Regional and national team of experts in the field, and coordinated by the National Center of Expertise in Hurricane and Storm Damage Protection, North Atlantic Division, U.S. Army Corps of Engineers.

The report presents background on the counties that comprise the Mississippi coastline most severely impacted by the Hurricanes of 2005, their pre-hurricane conditions, a summary of the effects of the 2005 hurricane season, problem areas identified by stakeholders and residents of the study area, a summary of the approach used in analyzing problems and developing recommended features directed at assisting the people of the State of Mississippi in recovery, recommended actions and projects that would assist in the recovery of the physical and human environments, and identification of further studies and immediate actions most needed in a comprehensive plan of improvements for developing a truly resilient future for coastal Mississippi.

This appendix contains detailed technical information used in the analysis of existing and future without-project conditions, in the development of problem-solving measures, and in the analysis, evaluation, comparison, screening, and selection of alternative plans, currently presented as recommendations contained in the Integrated Main Report/Programmatic EIS.

Each appendix functions as a complete technical document, but is meant to support one particular aspect of the feasibility study process. However, because of the complexity of the plan formulation process used in this planning study, the information contained herein should not be used without parallel consideration and integration of all other appendices, and the Integrated Main Report/Programmatic EIS that summarizes all findings and recommendations.

An Environmental Appendix has been prepared to evaluate the environmental recovery of Coastal Mississippi as a result of the hurricane damage. Environmental effort focuses on the preservation of fish and wildlife [i.e. prior to the 1950s development period (Corps 1984)], prevention of saltwater intrusion, and prevention of erosion. Environmental efforts selected in this Environmental Appendix have been included in the Integrated MsCIP Comprehensive Report/Programmatic Environmental Impact Statement (EIS).

ES – 1 Executive Summary

An Environmental Appendix has been prepared to evaluate the ecological recovery of Coastal Mississippi. Environmental effort focuses on the preservation of fish and wildlife [i.e. prior to the 1950s development period (Corps 1984)], prevention of saltwater intrusion, and prevention of erosion. In order for Coastal Mississippi to environmentally recover, the MsCIP Environmental project delivery team (PDT) identified ecological issues throughout the three coastal counties – Jackson, Harrison, and Hancock – of Mississippi and the offshore ecosystem. During this effort, both a non-structural PDT and a structural PDT developed measures to benefit Coastal Mississippi from a flood-proofing stand-point (i.e. non-structural) and an engineered (i.e. hardened structures) stand-point, respectively. The environmental effort also involved close coordination with both the structural and non-structural PDTs of the MsCIP study effort to ensure environmental consistency. Environmental efforts selected in this Environmental Appendix have been included in the Integrated MsCIP Comprehensive Report/Programmatic EIS. The Integrated Programmatic EIS – Effected Environment section contained within this Environmental Appendix provides the impact analysis for those projects screened out early during the plan formulation process.

ES – 1.1 Description of Natural System

The primary study area consists of the three coastal counties in the State of Mississippi: Hancock, Harrison, and Jackson counties; and the coastal (offshore) ecosystem, including its barrier islands. This area ranges in elevation from sea level to about 30 feet above mean sea level. The essentially flat to gently undulating, locally swampy Coastal Lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits and merge with the fluvial-deltaic plains of the streams and rivers of the area. This portion of Coastal Mississippi has been classified as an alluvial coast, a terraced, and deltaic plain. According to the Cowardin et al (1979), *Classification of Wetlands and Deepwater Habitat of the United States*, there are five major wetland and deepwater systems, four of which are found within Coastal Mississippi. They include marine, estuarine, riverine, and palustrine wetland systems.

ES – 2.1 Problems and Opportunities

In response to major damages on the coast of Mississippi as a result of Hurricane Katrina, Congress directed the U.S. Army Corps of Engineers (Corps) to conduct an analysis and design for comprehensive modifications and improvements in the Mississippi coastal area for the purposes of hurricane damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources purposes. Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the United States (U.S.) in its recorded history. Hurricane Katrina affected over 90,000 square miles (m^2) of the Gulf Coast region and caused almost complete destruction of several large coastal communities while seriously damaging numerous others. The destruction was on a scale unmatched by any natural disaster in U.S. history. The loss to Coastal Mississippi is unprecedented and has presented a high cost to the nation with a complete fisheries failure being declared by the Commerce Secretary, marine debris covering valuable productive water bottoms and coastal wetlands, exacerbated coastal erosion, loss to maritime forests, degraded water quality, increased pollution, widespread debris fields throughout coastal wetlands, degraded coastal preserve lands owned and maintained by the State of Mississippi, Department of Marine Resources (MDMR), increased risks to infrastructure and human life, danger to fish and wildlife including threatened and endangered (T&E) species and their critical habitats, and the loss of an entire way of life. Losses to many commercially important fisheries stock, foraging areas, nurseries, and etc. have been felt economically in the overall region. Spawning, breeding, and foraging grounds of fish and shellfish were severely impacted resulting in rising prices and once readily available resources are now becoming limited. The ability of wetlands to enhance protection from future storm surges, coastal erosion, and flooding has been greatly reduced. Human activities add another layer of complexity to the natural processes of coastal lands and materials. People's activities are often conducted without an adequate understanding of coastal geology and processes. As a result, they can lead to unforeseen degradation of coasts. Even human actions intended to save or improve the coast may inadvertently increase erosion. Cooperative scientific investigations are starting to provide the crucial information needed to minimize the unintended effects of human disturbances along coasts.

The Governor of the State of Mississippi has developed a *Seven-Point Strategy* for rebuilding coastal resources of the State. It is anticipated to be an on-going effort over the next 10 to 15 years. The strategy is summarized as follows:

- Implementation of breakwater structures for surge protection (natural surge diffusers, breakwaters, jetties seawalls, etc.);
- Deer Island restoration to pre-1900 footprint with fortification of the south side;
- Barrier Island restoration to pre-Camille conditions;
- Restoration of 10,000 acres of coastal marshes, beaches, and forests;
- Restoration of historical water flow to Coastal Mississippi watersheds to provide water quality and quantity critical to estuarine and marine habitats, including efforts to divert freshwater from Louisiana into the Biloxi marshes;
- Restoration of submerged aquatic vegetation (SAV) in Mississippi Sound; and the
- Restoration and enhancement of reef systems in Mississippi waters and adjacent Federal waters (i.e. oysters, nearshore low-profile reefs, and offshore artificial reefs).

The Governor of the State of Mississippi has also provided extensive guidance in the rebuilding of communities, infrastructure, the economy, and human services which were devastated by the hurricanes of 2005. Much of this guidance has been incorporated into the formulation of the environmental approach detailed in the Environmental Appendix and also in the Integrated MsCIP Comprehensive Report/Programmatic EIS. The Integrated MsCIP Comprehensive Plan/Programmatic EIS will address and consider a wide array of environmental restoration techniques to include vegetative plantings, river diversions, hydrologic restoration, marsh creation, shoreline protection, and sediment trapping and stabilization of the barrier islands.

ES – 3.1 Development of Environmental Measures and Alternatives

The formulation of measures was based on coastal resources assessments of hurricane and stormwater damage, saltwater intrusion, preservation of fish and wildlife, coastal erosion, flooding, navigation, and other problems and opportunities, in a collaborative approach involving Federal, state and local agencies, stakeholders, and citizen groups. The strategy for analyzing post-storm conditions, both for past and potential future events, was developed by the interagency PDT, and reviewed by an ITR team and an ETR team, with approval by the U.S. Army Corps of Engineers, Headquarters (Corps-HQ). This analyzing strategy was required to formulate measures and alternatives.

The interagency PDT is comprised of representatives from the following:

- U.S. Environmental Protection Agency (USEPA)
- Federal Emergency Management Agency (FEMA)
- U.S. Fish and Wildlife Service (USFWS)
- National Park Service (NPS)
- National Oceanic and Atmospheric Administration (NOAA) Fisheries, Protective Resource Division (PRD) and Habitat Conservation Division (HCD)
- National Weather Service (NWS)
- Natural Resources and Conservation Service (NRCS)
- U.S. Geological Survey (USGS)
- MDMR
- Mississippi Department of Environmental Quality (MDEQ)
- Mississippi Department of Transportation (MDOT)
- Mississippi State Historic Preservation Officer (SHPO)
- Hancock, Harrison and Jackson Counties
- Communities of Bay St. Louis, Biloxi, D'Iberville, Gautier, Gulfport, Long Beach, Moss Point, Ocean Springs, Pascagoula, Pass Christian, and Waveland
- Engineering Research and Development Center (ERDC)
- Mississippi State University (MSU)
- University of Southern Mississippi (USM) – Including the Gulf Coast Research Lab
- Coastal Restoration Network
- Audubon Society
- Sierra Club
- The Nature Conservancy (TNC)

In analyzing potential measures, the Environmental PDT has considered, in all cases in which it would be appropriate, integration of environmental measures within structural and non-structural potential solutions.

The following environmental measures were evaluated and screened by the Environmental PDT based on applicability to the specific problem area.

ES – 3.1.1 Freshwater Diversions

Consists of evaluation of current conditions of expansive marsh systems located in western and eastern portions of Coastal Mississippi. Diversions of freshwater from existing river systems would be evaluated based on ecosystems needs.

ES – 3.1.2 Ecosystem Restoration of Historical Wetlands Previously Developed

Development of a Geographical Information System (GIS) based – Spatial Decision Support System (SDSS) – by which to prioritize potential areas based on historical conditions, damages from storm surge and coastal flooding, and location to existing natural undisturbed lands (i.e. potentially State of Mississippi or Federal lands).

ES – 3.1.3 Barrier Island Restoration

Partnering with NPS to develop a vision for the barrier islands that would restore lost and damaged ecosystems including beach and dune restoration, restoration of salt and freshwater marshes, and revegetation of maritime forests. Supplemental information can be found in the Barrier Island Appendix.

ES – 3.1.4 SAV Restoration

Development of a program to determine conditions of SAVs and to determine causes of resource degradation. Identify opportunity to partner with other Federal and state agencies, as well as universities, to establish research necessary to establish potential solutions and projects.

ES – 3.1.5 Incorporation of State of Mississippi Initiative

Continue partnership with MDMR to develop and compliment the State of Mississippi projects as opportunities arise.

ES – 3.1.6 Restoration of Coastal Forests

Continue partnership with NPS to further evaluate restoration of coastal forests destroyed by the hurricanes along the barrier islands. Continue partnership with MDMR to develop and compliment the State of Mississippi projects as opportunities arise concerning the mainland of Coastal Mississippi.

ES – 3.1.7 Clean-up of Impaired Waterbodies

Determine which waterbodies in Coastal Mississippi were not cleared of deposited sediment and debris as part of the FEMA mission. Establish partnering opportunities with local and state governments to determine increased risks of flooding and develop potential projects that would lessen that risk.

ES – 3.1.8 Restoration of Degraded Coastal Wetlands

Continue to assess the degradation of coastal wetlands (i.e. wet pine savannah, etc.) using the GIS analysis tool – SDSS – in conjunction with the resource agencies to identify additional potential restoration opportunities.

ES – 3.1.9 Reduction of Coastal Flooding

Work with the Corps, non-structural PDT to assess coastal flooding impacts to developed commercial and residential areas in order to reduce adverse impacts while also restoring historical ecosystems.

ES – 3.1.10 Restoration of Oyster Resources

Continue developing and coordinating with MDMR to implement their restoration of oyster resources wherever feasible. Also incorporate oyster restoration in any applicable proposed projects.

ES – 3.1.11 Restoration of Fishing Reefs

Develop a partnership with MDMR to assist in their existing fishing reef program in order to identify any additional potential locations while also addressing any potential improvements in Mississippi Sound's water quality.

ES – 3.1.12 Restoration of Marshes

Development of a GIS analysis tool – SDSS – by which to prioritize potential homeowners assistance and relocation project areas based on historical conditions, damages from storm surge and coastal flooding, and location to existing natural undisturbed lands (i.e. potentially State of Mississippi or Federal lands).

ES – 4.1 Plan Formulation

ES – 4.1.1 Goals and Objectives

ES – 4.1.1.1 Objectives

- Recommend solutions that would assist the people of Coastal Mississippi in their efforts toward recovery of pre-hurricane conditions in the areas of coastal erosion, preservation of fish and wildlife, and prevention of saltwater intrusion;
- Recommend measures that would provide for sustainability of the overall natural system;
- Recommend continued study of specific problem areas that require further study to arrive at viable solutions;
- Recommend implementable projects directed at recovery of biological resources along the coast of Mississippi to pre-hurricane conditions, and to examine potential measures that might be implemented to increase sustainability of those resources during future events;
- Recommend measures that would provide short-term or long-term recovery of natural resources;
- Recommend implementable projects directed at either the stabilization or retreat of saltwater intrusion in the coastal zone exacerbated by the hurricanes, and to examine opportunities for minimization of saltwater intrusion during future events; and
- Recommend implementable projects directed at recovery of shore erosion protection measures along the coast of Mississippi to their pre-hurricane conditions, and to examine the opportunity for potential increases in the level of protection.

ES – 4.1.2 Planning Constraints

Development of some potential measures is constrained by legal and technical laws and/or regulations and they consist of the following:

- NPS Management Policies, Wilderness Act, and Gulf Islands National Seashore Enabling Legislation
- T&E Species and/or Critical Habitat
- State of Mississippi, Coastal Zone Management Plan
- State of Mississippi, Water Quality Standards
- Clean Water Act (CWA)
- National Historic and Preservation Act (NHPA)
- Clean Air Act (CAA)
- Essential Fish Habitat (EFH)
- Environmental Justice
- Protection of Children
- Coastal Barrier Resources Act (CBRA)

Managing sediment to benefit a region potentially saves money, allows use of natural processes to solve engineering problems, and improves the ecosystem. As a management method, Regional Sediment Management (RSM) includes the entire environment, from the watershed to the sea, accounts for the effect of human activities on sediment erosion as well as its transport in streams, lakes, bays, and oceans, and protects and enhances the nation's natural resources while balancing national security and economic needs. RSM is the Corps's standard operating practice for managing sediment on a holistic approach (i.e. regionally) rather than a project specific approach. The Corps recognizes that actions at one specific location have affects regionally. RSM will be considered during evaluation, design, and implementation of potential measures.

The State of Mississippi as part of Gulf of Mexico Alliance has acknowledged that sediment resources are integral to accomplishing many restoration initiatives. It is also recognized that there is a need for a better understanding of regional sediment systems and processes to inform decisions about projects and actions that use or affect sediment resources. Mississippi is actively involved in the development of a Gulf RSM Master Plan as an implementation action for the Gulf Alliance Conservation and Restoration Workgroup with the objective to develop a regional master plan that uses the understanding of sediment dynamics (inputs, outputs, movement) to manage sediment resources towards implementing environmental restoration, conservation, and preservation while reducing coastal erosion, storm damages, and associated costs of sediment management. The regional sediment management plan will also help link sources of sediment with sediment needs, provide a basis for assessing competing needs for sediment, and foster more cost-effective sediment management.

ES – 4.1.3 Public and Agency Involvement

- Meetings with Federal, State, and local entities
- Public Scoping
- Public Workshop
- Public Hearing

ES – 4.1.4 Plan Formulation Process

The plan formulation process began with defining the overall comprehensive natural system and its current state post-hurricanes. Development of a comprehensive list of problem areas consisting of single or multiple problems associated with a given site that were first identified as having been caused or exacerbated by the hurricane events identified with a) coastal erosion; b) damage to fish and wildlife resources; and c) saltwater intrusion.

Hurricane-caused problem areas were solicited from, and then discussed, with members of the public, state, local, and other Federal agencies, representatives of industry and commerce, and resource agencies concerned with study area resources, at a series of open meetings. The meetings also included web-casts intended on reaching those that could not physically attend one of the in-field meetings.

Hurricane-caused problems were investigated in a series of site investigations conducted in partnership with local representatives including municipalities, state resource agencies, and Federal partners, to ensure a comprehensive list of the problem areas were developed to address a full range of suitable measures and plans to deal with the identified problems.

ES – 4.1.4.1 Screening Criteria

After an initial screening of problem areas to determine their link to the hurricanes, a list of potential problem-solving measures was developed for each problem area. Each problem area was then evaluated in relation to:

a) its potential inclusion as a project recommended for Construction;

b) its potential inclusion as a project requiring additional preconstruction engineering design for specific features (i.e. a long-term solution that needs more technical analyses based on the complexity of the system);

c) its potential for inclusion as project(s) under a Longer Term Comprehensive Plan;

d) its potential inclusion as a project requiring additional Feasibility Studies (i.e. requiring extensive evaluation); and

e) its potential inclusion as a project requiring Advanced Design Studies for Innovative Concepts.

The list of measures developed for each problem area was more fully developed, and specific measures formulated for each site. These measures were then evaluated and screened once again, according to their continued technical, environmental, and cost-effectiveness feasibility, based on more detailed input from the resource agencies, public and private entities, and technical staff, and their ability to be combined into multi-purpose alternatives, capable of dealing with more than one identified problem at a given site. Selection of a measure and/or multiple measures would accomplish the overall goals and objectives - hurricane damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources purposes - of the MsCIP effort. One measure may reduce saltwater into an area(s); however, it does not adequately reduce hurricane and storm damages and/or preservation of fish and wildlife. Thus, several measures will likely be combined in order to fully accomplish the MsCIP goals and objectives.

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural and if applicable, structural measures that could potentially address the entire suite of ecological problems plaguing an individual site or problems area. Formulation of these alternatives also incorporated the following criteria:

- Does a potential alternative provide for potential preservation of fish and wildlife and their habitats?
- Does a proposed action or project negatively impact low income or minority populations and/or children [i.e. Executive Orders (EOs) Environmental Justice and Protection of Children]?
- Does a proposed alternative provide a potential reduction in coastal erosion?
- Does a proposed alternative provide a potential reduction in the extent or level of saltwater intrusion?
- Does the proposed project fit in, with, or compliment the objectives of the State of Mississippi and/or locals plans and desires for the area?
- Does the proposal contribute to the short-term or long-term recovery of Coastal Mississippi?

Using these questions, as screening criteria in a narrowing of the potential list of measures, the MsCIP PDT provided for formulation of better project components and alternative plans. This guided the process so that each alternative formulated incorporated measures that would be complimentary while also being mutually exclusive measures that would be evaluated as components of separate alternatives for the following criteria.

- Effectiveness
- Completeness
- Acceptability
- Efficiency (cost-effectiveness)

The following measures were forwarded for potential inclusion in a list of alternatives for the study area:

- Ecosystem Restoration for Preservation of Fish and Wildlife;
- Freshwater Diversion for Prevention of Saltwater Intrusion;
- Barrier Islands Restoration; and
- SAV Restoration Program

The screened list of measures was then combined into a group of well-balanced alternatives that addresses the entire suite of problems plaguing an individual site or problem area. The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Freshwater Diversion at Violet, Louisiana
3. Purchase, removal of structures, and ecosystem restoration within historical wetlands previously developed
4. Restoration of Barrier Island Ecosystems
5. Restoration of SAVs within Mississippi Sound
6. Projects from Interim Report carried for further consideration

7. State of Mississippi *Seven-Point Strategy* Initiative Plan

ES – 4.1.5 Recommended Plans

The Environmental Recommended Plan, which will be incorporated into the overall Integrated MsCIP Comprehensive Main Report/Programmatic EIS, envisions the construction of environmental restoration projects that would ensure preservation of fish and wildlife, prevent saltwater intrusion, and provide stabilization of the State of Mississippi's shorelines in order to reduce or eliminate coastal erosion and restore lost fish and wildlife habitat by identifying degraded critical components of the vital coastal system. Potential projects include freshwater diversion projects at Violet, Louisiana in order to physically move freshwater into the Western Hancock County Marshes, which have severely degraded over the years due to levee systems in eastern Louisiana and along the Pearl River. Comprehensive restoration of barrier islands (i.e. Ship Island Breach and the supplemental placement of sand source in the littoral zones) would also be recommended in order to restore the islands and continue Mississippi Sound's biological productivity. Restoration of lost ecosystem functions where restoration needs are immediate due to unchecked wetland deterioration. As Coastal Mississippi residents are rebuilding much needed housing, there is an increase in development pressures on these valuable ecosystems due to housing shortages. The Environmental Recommended Plan would allow for restoration of storm damaged habitats and coastal systems and would prevent further destruction of these vital habitats. Wetlands in Coastal Mississippi can be restored to a sustainable level, one that coexists with human uses and communities. Restoring critical landforms, barrier shorelines, and historical hydrologic patterns are crucial to sustaining ecological and geomorphological function. The Environmental Recommended Plan has emphasized interagency cooperation as dedicated staff members include representatives from the MDMR, USFWS, and NPS. Additionally, we have collaborated with other resource agencies that include USEPA, USGS, NRCS, NOAA Fisheries, MDEQ, NWS, MDOT, and SHPO. The Environmental Recommended Plan partners with the State and recommends for construction of those state projects that allows for recovery of badly damaged ecosystems. Additional collaboration has and will continue to occur with non-governmental organizations (NGOs), including TNC, Gulf Restoration Network, Sierra Club, Audubon Society, etc., in addition to Mississippi academic coastal engineers and biologists, such as USM, Gulf Coast Research Lab, and MSU, in order to accomplish widespread support for this environmental effort. A strong public involvement campaign has been used to ensure contributions have been submitted by local constituencies and stakeholders in order to create strong *buy-in* on potential restoration projects. All recommended plans on ecosystem restoration have incorporated adaptive management capabilities, where needed.

ES – 5.1 Potential Projects

The Environmental Recommended Plan proposes for the construction of two (2) initial projects (i.e. Turkey Creek – Harrison County and Bayou Cumbest – Jackson County) identified based on the GIS SDSS analysis tool inputs. These two projects are identified as part of Phase I of a two Phased approach. These two initial projects give a basis for future ecological restoration sites identified to be developed under a longer term comprehensive effort (i.e. Phase II). Also, the plan recommends construction of a freshwater diversion structure project at Violet, Louisiana. The MsCIP PDT will closely work in partnership with the State of Louisiana in order to achieve both states diversion goals. Comprehensive barrier island ecosystem restoration (i.e. filling of the Ship Island Breach and littoral zones placement) and SAV restoration selected features are included in the project recommendation plans. Continued coordination with NPS, MDMR, MDEQ, USFWS, NOAA-PRD, NOAA-HCD, and other NGOs will also continue. The Governor of the State of Mississippi's *Seven-Point Strategy* for rebuilding coastal resources of the State has also been included as part of the ecological recommended plan. Two State projects – Dantzler and Admiral Island – are being recommended for construction. Again, these are part of the Phase I effort. During development of the interim report, several of the approximately 180 potential projects were developed in conjunction with local city and county government representatives and several were of an environmental nature. These will be recommended under five separate categories as specified in *Section ES 4.1.4.1 Screening Criteria*. Franklin Creek, Jackson County is included in the 180 project list that is being recommended for construction.

ES – 6.1 Summary

The MsCIP Comprehensive Plan establishes an environmental program for Coastal Mississippi that addresses specific concerns stated as required in the legislation which include prevention of saltwater intrusion, preservation of fish and wildlife, prevention of coastal erosion, and other water related issues, such as reduction in coastal flooding. This approach allows us to establish a program that can be carried forward into the future while building and fostering necessary partnerships and relationships with the citizens and local governments within the study area. This will provide for comprehensive solutions based on changing policies, future land-use trends, and availability of property.

CONTENTS

FIGURES

TABLES

ACRONYMS

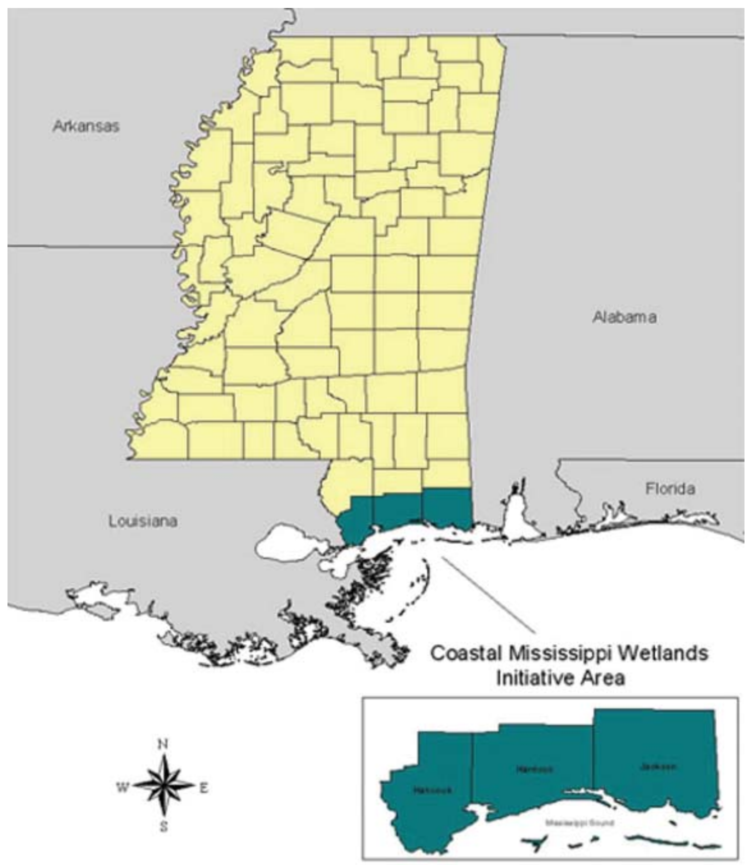
AAFU	Average Annual Functional Units
BFE	Base Flood Elevation
CAA	Clean Air Act
CEQ	Council of Environmental Quality
CFR	Code of Federal Register
Corps	U.S. Army Corps of Engineers
Corps-HQ	U.S. Army Corps of Engineers, Headquarters
CRBA	Coastal Barrier Resources Act
CWA	Clean Water Act
DOI	U.S. Department of Interior
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
ER	Ecosystem Restoration
ERDC	Engineering Research and Development Center
ETR	External Technical Review
FCCE	Flood Control and Coastal Emergency
FDR	Flood Damage Reduction
FEMA	Federal Emergency Management Agency
FHI	Functional Habitat Index
FIS	Flood Insurance Study
ft^3/s	cubic feet per second
GIS	Geographic Information System
GMEI	Cooperative Gulf of Mexico Estuarine Inventory and Study
HARP	High Hazard Area Risk Reduction Plan
HCD	Habitat Conservation Division
HEC-FDA	Hydrologic Engineering Center’s Flood Damage Analysis
HGM	Hydrogeomorphic Model
HSDR	Hurricane storm damage & reduction
ITR	Independent Technical Review
LOD	Line of Defense
m^2	square mile

MDEQ	Mississippi Department of Environmental Quality
MDMR	Mississippi Department of Marine Resources
MDOT	Mississippi Department of Transportation
MsCIP	Mississippi Coastal Improvements Program
MSU	Mississippi State University
NAVD	North American Vertical Datum
NEPA	National Environmental Protection Act
NERR	National Estuarine and Research Reserve
NHPA	National Historic and Preservation Act
NGOs	Non-Government Organizations
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources and Conservation Service
NWS	National Weather Service
PDT	Project Delivery Team
ppt	Parts Per Thousand
PRD	Protective Resources Division
PSGH	Potential Seagrass Habitat
RSM	Regional Sediment Management
SAVs	Submerged Aquatic Vegetation
SDSS	Spatial Decision Support System
SHPO	State Historic Preservation Officer
T&E	threatened and endangered
TED	Turtle Excluder Device
TNC	The Nature Conservancy
U.S.	United States
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
USM	University of Southern Mississippi
WRDA	Water Resources and Development Act

CHAPTER 1. COASTAL MISSISSIPPI ENVIRONMENT

1.1 Introduction - An Environmental Framework for Coastal Mississippi

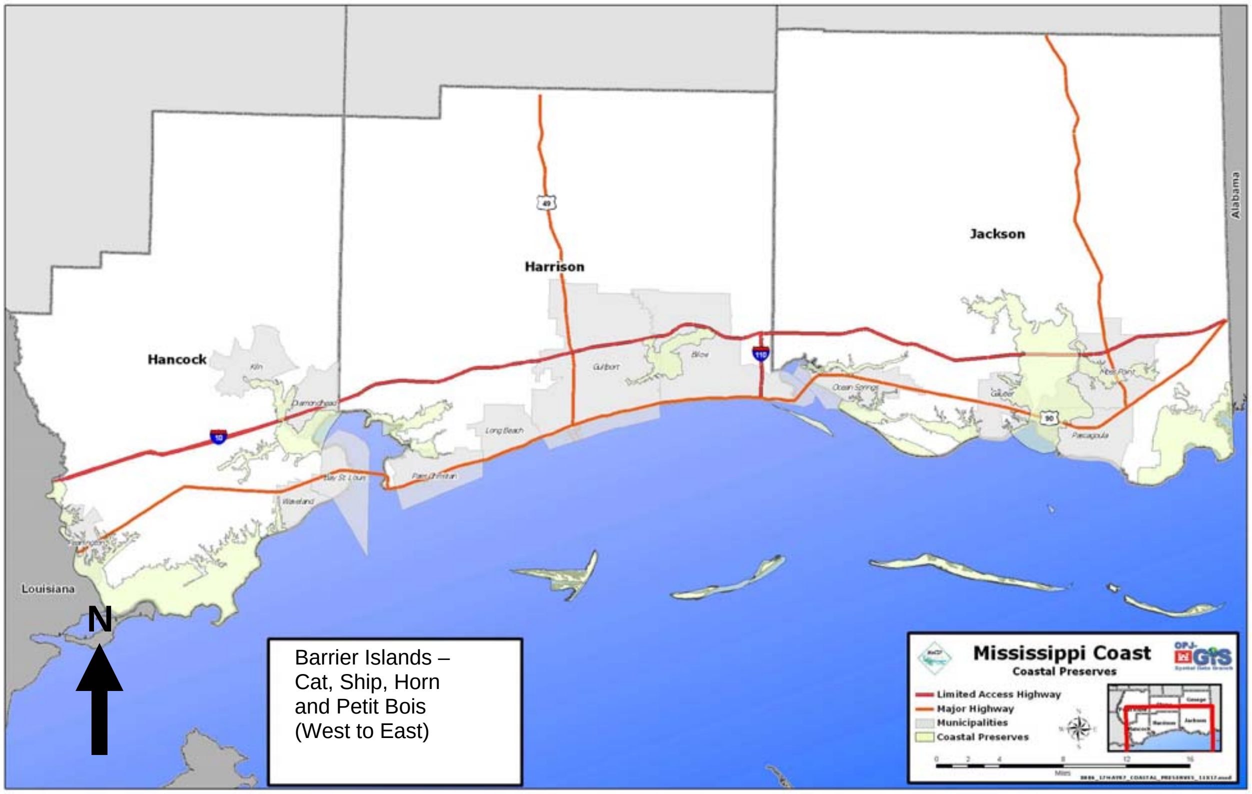
In response to major damages on the coast of Mississippi as a result of the 2005 Hurricane Katrina, Congress directed the Corps to conduct an analysis and design for comprehensive modifications and improvements in the Mississippi Coastal area for the purposes of hurricane damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife [i.e. prior to the 1950s development period (Corps 1984)], prevention of erosion, and other related water resources purposes. Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the U.S. in its recorded history. Hurricane Katrina affected over 90,000 m^2 of the Gulf Coast region and caused almost complete destruction of several large coastal communities while seriously damaging numerous others. The destruction was on a scale unmatched by any other natural disaster in U.S. history. The loss to Coastal Mississippi is unprecedented and has presented a high cost to the nation with a complete fisheries failure being declared by the Commerce Secretary, marine debris covering valuable productive water bottoms, exacerbated coastal erosion, loss of maritime forests, degraded water quality, increased pollution, widespread debris fields throughout coastal wetlands, degraded coastal preserve lands owned and maintained by the MDMR (Figures 1.1-1 and 1.1-2), increased risks to infrastructure and human life, danger to fish and wildlife including T&E species and their critical habitats, and the loss of an entire way of life. Losses to many commercially important fisheries stock, foraging areas, nurseries, and etc. have been felt economically in the overall region. Spawning, breeding, and foraging grounds of fish and shellfish were severely impacted resulting in rising prices and once readily available resources are experiencing shortages.



Source: MDMR

Figure 1.1-1. Coastal Mississippi Map

Wetlands have historically provided natural protection from storm surges, coastal erosion, and flooding and a reduction in these natural systems (i.e. filling in of wetlands) has greatly impacted the Gulf Coast. The Comprehensive Plan will address and employ a wide array of restoration techniques to include vegetative plantings, river diversions, hydrologic restoration, marsh creation, shoreline protection, sediment trapping, and stabilization of the barrier islands.



Source: MDMR

Figure 1.1-2. MDMR Coastal Preserves – State Lands Map

The area or the zone where water meets land can be described in various terms – it is a buffer area, the land-water interface, or an ecotone - an area where the terrestrial ecosystem transitions into the aquatic ecosystem. Critical habitats exist in this ecotone area: swamps, marshes, coastal ridges, coastal forests, littoral zone, dunes, and beaches. These areas serve as vital breeding areas, nursery grounds, and areas where much of the massive amounts of organic carbon needed to fuel aquatic food chains are produced. These are areas where sediments, nutrients and even contaminants eroded from the uplands can be detained before entering the aquatic system and energy from the water, through waves, tides, and surges can be captured and mitigated before impinging upon the upland. These sediments can contain nutrients that are critical to water quality and wetland building. And when terrestrial organisms, like humans beings, encroach upon this ecotone between land and water, there can be devastating consequences, such as flooding, loss of property and even loss of life.

Fundamentally, the environmental framework (as well as much of the recommended comprehensive plan) for the MsCIP is the protection, restoration, enhancement and re-establishment of the natural buffering capacities of these **coastal ecotone** areas. These land-water ecotone areas outline every barrier island, beach, bay, stream, and river on the coast, thereby creating a comprehensive, system-wide, network of areas that are critical both to the ecosystem and to society. These coastal ecotones have been eroded by natural and man-made forces, thus decreasing the resiliency of the Mississippi Coastal system.

1.1.1 Creation and Dynamic Nature of the Coastal Ecotones

The current geomorphology, and by extension, the ecology of coastal Mississippi is defined by its geological history. Oivanki (1993) states that the last major low-stand of sea level was about 18,000 years ago, and sea level has been rising ever since that time. The sea level at that time was about 350 feet below its present level, which shifted the shoreline to about 70 to 80 miles of its present position. Streams and rivers cut deep valleys into the landscape. As the glacial ice melted, these valleys were covered with water. The Back Bay of Biloxi, St. Louis Bay and the Pascagoula River valley are all present day expressions of these drowned valleys. As the landscape eroded, the drowned valleys began to fill, creating the extensive riverine swamp systems, such as those in the Pascagoula and Pearl River basins. Thus, the eastern and western ends of the MsCIP project area have broad expanses of riverine swamps, which are largely absent from Harrison County.

These geologic patterns have resulted in very different present day shoreline types in the three coastal counties. For example, Hancock County shoreline is 50% marsh, Harrison County shoreline is dominated by artificial beach, and Jackson County is 18% marsh and 32% washover terrace (Oivanki 1993a).

The five principal barrier islands, Petit Bois, Horn, East Ship, West Ship and Cat, are the result of the emergence of offshore sand shoals approximately 3,000 to 4,000 years ago. The location of the islands and the source of their sand was determined by the longshore drift pattern established by Dauphin Island in Alabama, which accumulated sand from the Florida shoreline and directed it parallel to the coast offshore (Otvos 1979).

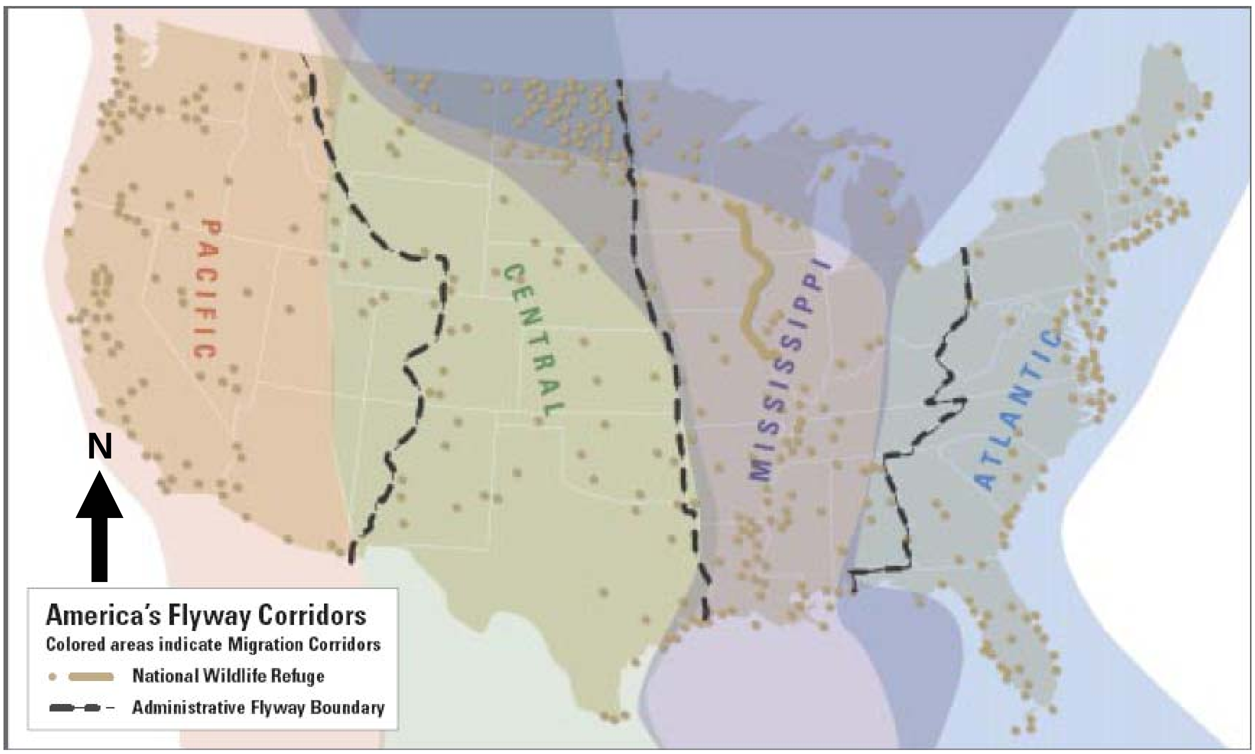
All of these geologic processes have formed, shaped and continue to rework the coastal ecotone. The ecotone, the ribbon of area at the land-water interface is dynamic, constantly shifting based on the local geology, re-working itself after extreme events and human perturbation. The current expression of eustatic sea level rise causes the coastal ecotone to move “upland” or northward. It is a continuation of a trend that started about 18,000 years ago. In some places, subsidence or compaction or other factors have caused the relative sea level rise to be locally greater than eustatic sea level rise. When the upland migration of the coastal ecotone is limited due to geology or manmade features, such as seawalls, bulkheads, or waterways, a net loss of the ecotone can occur, as well as damage to the manmade structures.

The anthropogenic loss of the coastal ecotone can be documented by looking at estimations of wetland loss on the Mississippi Coast. Eleuterius (1973) noted that approximately 1,000 acres of marshland was filled on the Mississippi Coast prior to the 1930’s. However, wetland loss accelerated after that time. Oivanki et al. (1995) conducted a study that showed that 13% of the total coastal marsh area in the Mississippi coast zone was lost between the 1950’s and 1992. The amount of wetland loss was highest in Jackson County and lowest in Harrison County. Developed land use tripled during the study period. It is the desire of the State of Mississippi to replace about 10,000 acres of this loss as stated.

1.1.2 Importance of the Coastal Ecotones to the Fish and Wildlife Resources of Coastal Mississippi

The coastal ecotone in Mississippi provides a vital habitat for fish and wildlife that is found in no other place in the world. The annual waterfowl migrations, both spring and fall, are one of the most amazing spectacles in nature. Driven by changing weather conditions and the search for food, certain species of waterfowl will migrate thousands of miles stopping only briefly to rest and replenish their nutrient reserves. Others migrate more slowly and have longer stopovers en route. Yearly variation in weather, food supplies, and available habitat will greatly affect these migration patterns. Largely because of the success of early banding programs, it became possible in the early

1930’s to map the main migration corridors or flyways, used by waterfowl on their annual fall migration. That information became the concept of the four flyway corridors – Atlantic, Mississippi, Central, and Pacific – upon which biologists now focus their management (Figure 1.1.2-1). The MsCIP study area falls within the Mississippi Flyway. The longest migration route of any in the Western Hemisphere lies in this flyway. Its northern terminus is on the Arctic coast of Alaska and its southern end in Patagonia. Well timbered and watered, the entire region affords ideal conditions for the support of hosts of migrating birds. The two rivers that mark it, the Mackenzie emptying on the Arctic coast and the Mississippi in the Gulf of Mexico, have a general north-and-south direction, another factor in determining the importance of this route which is used by large numbers of ducks, geese, shorebirds, blackbirds, sparrows, warbler and thrushes. The majority of North American land birds, seeking winter homes in the tropics that come south through the Mississippi Flyway take the short cut across the Gulf of Mexico in preference to the longer, though presumably safer, land or island journey by way of Texas or the Antilles (Association of Fish and Wildlife Agencies 2008).



Source: USFWS

Figure 1.1.2-1. America’s Flyway Corridors (*USFWS 1996b)*

Although waterfowl are what most people think of when they hear the word flyway or migration, many other birds migrate as well. Approximately two thirds of the breeding bird species of eastern United States forests migrate to tropical wintering areas in the Caribbean, Mexico, and Central and South America (Keast and Morton 1980). The movement of birds across the Gulf of Mexico each spring and fall is a prominent feature of Nearctic-Neotropical bird migration system (Ramos 1988). From early April through mid-May, the day-to-day consistency of migration across the Gulf of Mexico is rarely interrupted, and then only when strong cold fronts are positioned over the southern Gulf of Mexico (Gauthreaux 1971). Even with favorable weather, migrants use coastal habitats in large numbers.

The coastal woodlands and narrow barrier islands that lie scattered along the northern coast of the Gulf of Mexico provide important stopover habitat for Neotropical landbird migrants (Moore et al.

1990). They represent the last possible stopover before fall migrants make a non-stop flight (18-24 hr) of greater than 1,000 km, and the first possible landfall for birds returning north in spring (Moore and Kerlinger 1987). Unfortunately, the loss of coastal habitat suitable for forest-dwelling migrants is fast accelerating due to the extensive development of coastal regions (Moore and Simons 1989). Habitats along the northern coast of the Gulf of Mexico are fragmented, and many woodlands average only a few hectares in area. Development in the coastal zone is likely to continue the fragmentation of stopover habitat in the future (Moore and Simons 1989). As stopover habitat is transformed or degraded, continued migration of these species is jeopardized. A study of the distribution of spring trans-Gulf migrants among five plant habitats on Horn Island found that the distribution of migrants deviated from that expected based on availability of habitats. Migrants settled most frequently in scrub-shrub, forest, and relic dune habitats (Moore et al. 1990). Birds are the ultimate indicator of ecological quality. Clean air, clean water, and abundant, diverse habitats are essential for birds to continue to survive and flourish. Without a healthy ecosystem, bird populations will diminish and species will disappear, along with the quality of life for people on this planet.

Approximately two (2) dozen large estuaries are present along the coastline of the Gulf of Mexico between the Mexican border and the Florida Keys. Over one-half of all stream discharge that takes place to the oceans bordering the United States is discharged into the Gulf of Mexico. A substantial portion of this first enters the estuaries, carrying with it large quantities of suspended sediment and nutrients.

Mississippi Sound is fed from the north by eight coastal mainland watersheds and drainage from the south by tidal exchange from the Gulf of Mexico. From west to east the mainland drainages include: Lake Borgne, the Pearl River, the Jourdan River, the Wolf River, the Tchoutacabouffa River, the Pascagoula River, and Mobile Bay. Combined drainage area from streams and rivers entering the Mississippi estuarine basin is approximately 19,660 square miles (mi^2). The Pearl River and Pascagoula River drainage areas far exceed those of Biloxi and St. Louis Bays. Pascagoula River has a drainage area of 9,400 mi^2 with an average discharge of 15,185 cubic feet per second (ft^3/s). Pearl River drains 8,700 mi^2 and has an average discharge of 12,890 ft^3/s. The combined drainage area for rivers emptying into Biloxi and St. Louis Bays is 1,400 mi^2 with an average discharge of 2,790 ft^3/s (NMFS 1998).

The influx of rivers creates a salinity gradient within the Sound (Priddy et al. 1955). Both east-west and north-south gradients occur in the Sound in addition to vertical gradients. Generally, positive salinity gradients exist from the mainland seaward and vertically, surface to bottom (Gulf of Mexico Fisheries Management Council 1998). Surface salinity is influenced by the discharge of freshwater from large rivers and is reduced during periods of higher flow in late spring and early summer (Thompson et al. 1999). Temperature follows expected salinity trends. Levels of dissolved oxygen are usually above lethal limits. The Pascagoula and Pearl Rivers, Bayou Casotte, and Biloxi Bay are the primary sources of nutrients entering the Mississippi Sound. The temporal and spatial variability of estuarine salinity is dependent on water supply, evaporation, and mixing, and also management, which includes the direct influence of activities, such as water withdrawal for inland irrigation projects and diversions, and the indirect effects of global climate change. Oysters grow faster in areas with fluctuating salinities within their normal ranges, compared to constant salinity (Pierce and Conover 1954). Oyster reefs of commercial importance are subtidal and form aggregates that cover thousands of acres of the Mississippi Sound. The aerial extent of oyster reefs in Mississippi is estimated at 10,000 to 12,000 acres, of which over half is located in the western Mississippi Sound south of Pass Christian.

The eighty-mile-long body of water north of the string of five barrier islands is the Mississippi Sound, a large dynamic estuary extending from Mobile Bay in Alabama on the east to Lake Borgne in Louisiana to the west. Mississippi Sound is located within the very center of what fisheries biologists term the Fertile Fisheries Crescent. The Gulf of Mexico produces 28 to 30 percent of the total fishery products of the United States. Gunter (1963) showed that between 1936 and 1962, production from the Gulf of Mexico increased at a rate of 7 times its former production, with the shrimp fishery being the most valuable in the country. The Fertile Fisheries Crescent has been called "the core of the Gulf's $800 million fishing industry." Mississippi Sound forms a major part of the Fertile Fisheries Crescent within the northern Gulf of Mexico.

Large quantities of freshwater are emptied into Mississippi Sound by the Pascagoula and Alabama Rivers on the east and Pearl River along the western state line and to an extent, the Mississippi River further west. Several freshwater coastal streams empty into Mississippi Sound in-between the Pascagoula and Pearl Rivers providing nutrient rich freshwater which results in the Sound's great productivity. It is within this brackish estuarine water that several species of fish, classified as aquatic resources of national importance, thrive from the shallow waters to the deep sea 70 miles offshore.

The Fertile Fisheries Crescent can be divided into three sections, the West Florida Shelf, The Mississippi-Alabama Shelf and the Louisiana-Texas Shelf. The Mississippi-Alabama Shelf extends from the DeSoto Canyon westward to the Mississippi River Delta. Sediments within this area range from more carbonate in the eastern part to mostly terrigenous nearer the Mississippi River Delta. Bottom features within the area are small peaks of cemented together sediments called "pinnacles", dense fields of reef-like mounts, and low ridges that run parallel to shore. Also located within nearshore waters are hard bottoms and rock outcroppings.

Recent studies have determined of the total fishes found within the northern Gulf of Mexico, excluding the southern Florida reef habitats, approximately 1,200 species, almost 400 species are found within the Mississippi-Alabama Continental Shelf. The Mississippi Sound estuary plays a key role in these numbers by providing prime habitat for various lifestages of red snapper, tuna, redfish, Spanish and king mackerel, grouper, speckled trout, jack crevalle, cobia, amberjack, marlin, and various species of sharks. Mississippi Sound's productivity is unequalled in the Gulf which makes it ideal for avid sport fishermen, commercial fishing, and local recreational use. Biloxi, Mississippi, located in the center of Coastal Mississippi was once known as "The Seafood Capital of the World" and in 1910 canning factories located here shipped over 15 million cans of oysters, more than any place else in the world.

The fishing industry contributed $1.1 billion to the state's economy prior to the devastation by Hurricane Katrina. According to Mississippi Department of Marine Resources, during a five-year average before the storm, Mississippi shrimp accounted for five to seven percent of all the shrimp landings in the U.S. The commercial seafood industry which includes the harvesting, processing and distribution of all seafood products created a total economic impact of $900 million in 2003. The total ex-vessel value of commercial landings amounted to $46 million while the total plant-gate value of commercial seafood production was $338 million in 2003. The recreational fishing industry which includes saltwater and freshwater fishing produced a total economic impact of $463 million in 2001 and $1,306 million in 1996. This once thriving commercial fishery always has and will continue to play a significant role in the overall economy, both on a regional and national level.

1.1.3 Impacts from Hurricanes of 2005

The destruction caused by the hurricanes of 2005 came in two forms: the wind and tidal action of the hurricane itself. When Hurricane Katrina struck the Gulf Coast, it was a Category 3 hurricane; it had been as high as Category 5 as it moved through the Gulf of Mexico. The hurricane was also massive, which meant that these intense winds were spread over a wide area – in fact the entire Gulf Coast. The same forces that wrecked New Orleans damaged or destroyed wetlands along the Gulf Coast. Barrier islands took the initial damage. Wetlands suffered less from wind damage than from flood waters that dumped saltwater, trash, and toxic chemicals into the fragile ecosystems.

When saltwater is introduced into a freshwater habitat it kills the vegetation – i.e. valuable wet pine savannah habitat.

Disturbance of soils and vegetation, such as vegetation covered by trash or complete removal of trees and/or marsh grasses, in coastal wetlands has allowed an excessive amount of exotic species to colonize the area. The destruction of wetlands and coastal habitat occurred in a sensitive area for birds. As previously discussed, the northern Gulf Coast is a stopping point for birds in migration; it also serves as nesting ground for many species of terns and other waterbirds. Damage to the barrier islands was particularly bad for the nesting species; nests the following couple of years were lower for several species. Threatened birds in the area include a rare sandhill crane subspecies. Twelve important bird areas lay in Hurricane Katrina's path: two in Florida and ten on the northern Gulf Coast. The hardest hit were Breton NWR and the Gulf Islands National Seashore.

The habitats of several endangered species were altered by the hurricanes. The endangered Alabama beach mouse has lost several acres of primary and secondary dunes that serve as habitat, and has lost scrub forest habitat, where it finds prey, to saline ocean waters. Along the Alabama coast, some nesting sites for the endangered Kemp’s ridley sea turtle have been destroyed, and forested areas have been blown down in the Noxubee National Wildlife Refuge in Mississippi, where the listed red-cockaded woodpecker has habitat.

The Gulf Coast states are significantly forested and are major producers of lumber and plywood. The U.S. Department of Agriculture (USDA) Forest Service estimated 19 billion board feet of timber damaged on over 5 million acres in Mississippi, Alabama, and Louisiana. This would translate into an estimated $5 billion loss in potential timber revenues according to the Forest Service. The forested area damaged represents 30% of the total timberland in the affected region, 90% of which occurred on non-federal lands. Eighty percent of the damage occurred in Mississippi. The Mississippi Forestry Commission issued a news release estimating that 1.3 million acres of forestland in the state had been damaged, with commercial timber valued at about $1.3 billion; urban tree damage in Mississippi was estimated at $1.1 billion.

Some scientists believe that the risk of long-term damage of toxic floodwaters entering the Gulf of Mexico is not high. They contend that tidal flows and flushing of Gulf waters will dilute substances to non-harmful levels. Specifically, scientists contend that bacterial contaminants will die off quickly, and that other organic material will degrade with natural processes. Other scientists offer a different perspective on the impacts of toxic waters in the Gulf of Mexico. They contend that toxic chemicals and excess nutrients will severely deplete fisheries by killing fish and will contaminate sediments.

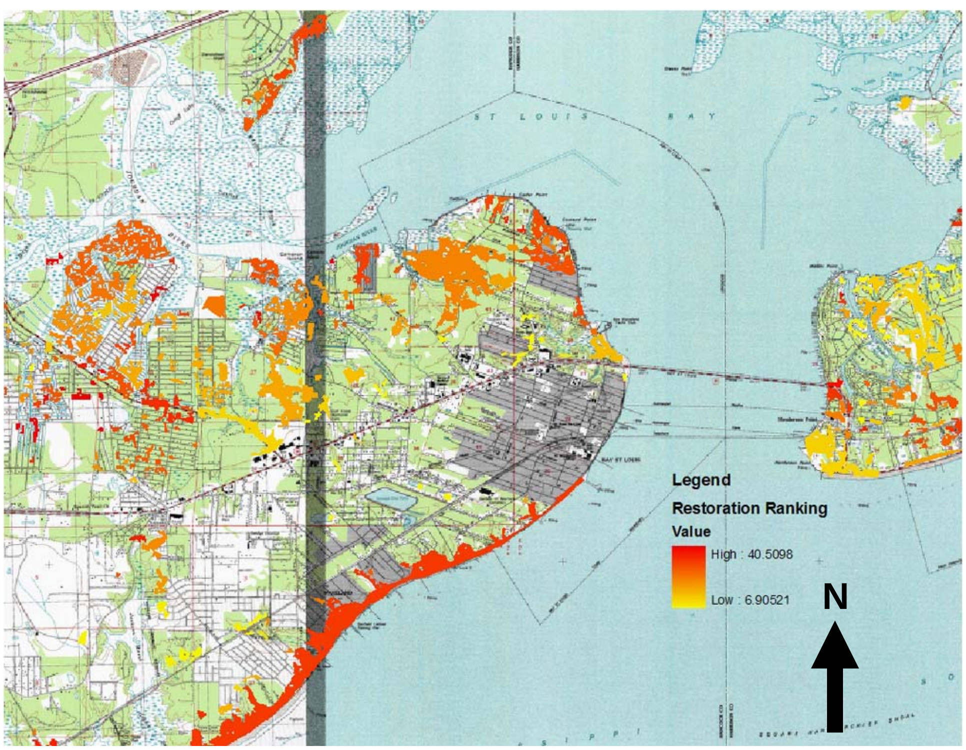
The Gulf Coast where Hurricane Katrina struck is an especially important center of commercial and recreational fishing, producing 10% of the shrimp and 40% of the oysters consumed in the U.S. Further, commercial shrimpers fishing out of or delivering to Alabama, Mississippi, and Louisiana ports account for almost half of all U.S. shrimp production. Hurricane Katrina has destroyed or severely damaged fishing boats and processing and storage facilities throughout this area. The impact of Katrina on fish populations, habitat, and their viability for consumption was significant.

1.1.4 Relationship Between the Coastal Ecotones and the Multiple Line of Defenses Concept

The MsCIP effort developed multiple arrays of Line of Defenses (LODs) to protect the Mississippi coast and its citizens from future storm events. These LODs are structural measures that have specific locations along Coastal Mississippi starting from the barrier islands moving inland to north of Interstate-10. LOD 1 restores lost habitats – beaches, dunes, coastal forests, and emergent marshes - at the barrier islands offshore of Mississippi to provide that first natural barrier against future storms. The barrier island ecotone – water and land interface – covers the entire area and is essential for numerous fish and wildlife species. Furthermore, this area is an essential coastal ecotone allowing the future persistence of Mississippi Sound – i.e. creating the fertile brackish waters from the mixing of freshwater from the rivers and salty waters from the Gulf of Mexico. LOD 2 restores lost beach and dune habitat along the coastal mainland while also providing an added natural buffer to the mainland. This ecotone – water and land interface – provides an important habitat to many migratory bird species stopovers to farther destinations, nesting least terns, wintering piping plovers, and many other important bird species. LOD 3 elevates existing roadways and seawalls while also protecting communities by ring levees. This defense protects the very people dependent upon these vital coastal resources. This structural defense along with LODs 4 and 5 - inland barriers and surge gates across water bodies and a critical boundary north of Interstate-10 – provides the required protection and enables future sustainability of human beings living along the Gulf Coast as they have done for hundreds of years. These LODs provide sustainable living the coastal resources and also for the people of Coastal Mississippi.

1.1.5 Relationship Between the Coastal Ecotones and Storm Damages

A hydric soil is one that is defined as “a soil formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part.” (Federal Register, 1994) Since the soils of these areas formed under hydric conditions due to the proximity of water. The spatial extent of the coastal ecotone can be indicated by the presence of these hydric soils. Analysis through GIS shows that 76% of all of the houses seriously damaged (damage estimated as greater than 90%) by Katrina, as defined by FEMA, were also located in areas mapped as hydric soils or areas composed of dredged material from adjacent channels. Figure 1.1.5-1 provides the overlay of the FEMA-damaged maps with the soil conditions that shows the ranking of ecological restorability potential. This correlation is an additional demonstration that the importance of restoring the coastal ecotone extends beyond ecological interests into insuring the well-being of the human population.



Source: Corps

Figure 1.1.5-1. FEMA Damaged Maps Overlaid upon Soil Conditions

1.1.6 Relationship between the Proposed Restoration Projects and the Environmental Framework

The MsCIP Comprehensive Plan presents a very complex challenge to identify Mississippi coast recovery plans. The investigation was focused on 3 components – environmental, non-structural and structure plans – to achieve an array of protection and restoration measures. While developing these components, the team ensured that the specific measure or a compilation of measures addressed the 2005 congressional authorization of:

- future hurricane storm and flood damage reduction;
- prevention of saltwater intrusion;
- prevention of coastal erosion;
- preservation of fish and wildlife; and
- other water related resources (reduction of flooding).

Ultimately, several hundred measures were identified ranging from restoring the barrier islands at varying levels, raising existing structures' elevation, constructing ring levees around communities, building surge gates across water bodies, restoring dune and beaches, developing housing assistance and relocation programs, and restoring wet pine savannah, emergent tidal marsh, and scrub shrub habitats. These measures were screened throughout the plan formulation process in order to develop alternatives. The comprehensive nature of the MsCIP effort resulted in the ability to implement certain alternatives while others required additional study. Thus, the team categorized identified measures into the following management components:

- Additional Study and Design (designated as orange in Table 1.1.6-1);
- Advanced Engineering and Design (designated as green in Table 1.1.6-1); and
- Construction (designated as purple in Table 1.1.6-1).

Table 1.1.6-1.
MsCIP Comprehensive Approach

Proposed Restoration Project	Portion of the Ecotone to be Addressed	Ecological/Societal Functions to be Addressed	Comprehensive Plan Objectives to be Addressed
Freshwater Diversion, Escatawpa River, MS	Littoral areas, emergent wetland areas	Enhanced oyster production, enhanced productivity of brackish marshes	3, 4, 5, 6
Other Coastal Wetland and Forest Restoration	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
Levee Projects – Belle Fontaine, Gulf Park Estates, Pascagoula/ Moss Point, Pearlington, Gautier, Ocean Springs, Bay St. Louis	Reduces flooding	Adds protection to human development out of the coastal ecotone for public safety zone	1, 2, 6
Long-term High Hazard Area Risk Reduction Plan	Restore natural flooding buffer	Restore natural buffer zone, relocation of human development out of the coastal ecotone for public safety	1, 2, 6
Freshwater Diversion of the Mississippi River	Littoral areas, emergent wetland areas	Enhanced oyster production, enhanced productivity of brackish marshes	3, 4, 5, 6
High Hazard Area Risk Reduction Plan	Emergent tidal marsh, forested wetlands	Enhanced productivity of wetlands and forested wetlands in order to restore natural buffer zone	1, 2, 6
Moss Point Municipal Relocation Component	Restore natural flooding buffer	Restore natural buffer zone, relocation of human development out of the coastal ecotone for public safety	1, 2, 6
Waveland Floodproofing	Restore natural flooding buffer	Restore natural buffer, relocation of human development out of the coastal ecotone for public safety zone	1, 2, 6
Forest Heights Hurricane and Storm Damage Reduction Component	Reduces flooding	Adds protection to human development out of the coastal ecotone for public safety zone	1, 2, 6
Turkey Creek Ecosystem Restoration	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands Removes structures from project area	1, 2, 3, 6
Dantzler Restoration Area, Ansley	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands	1, 3, 6

Table 1.1.6-1.
MsCIP Comprehensive Approach (continued)

Proposed Restoration Project	Portion of the Ecotone to be Addressed	Ecological/Societal Functions to be Addressed	Comprehensive Plan Objectives to be Addressed
Franklin Creek Ecosystem Restoration	Wet Pine Savannah Wetlands	Moves Residents out of Harms Way (MsCIP Interim Project) Enhanced productivity of wetlands	1, 2, 3, 5, 6
Bayou Cumbest Ecosystem Restoration, Pearlington, Pearlington South, Port/West, Chapman Road, Diamondhead, Delisle, Ellis Property, Brickyard Bayou, Biloxi River – Shorecrest , Biloxi River – Eagle, Jourdan River – I-10 Development, Pine Island, Fort Point, St. Martin, Keegan Bayou	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
Admiral Island Ecosystem Restoration Lakeshore, Bayou Caddy/Lakeshore, Clermont Harbor Bayou La Croix, Shoreline Park, Pine Point East, Pine Point West, Pass Christian Site – Bayou Portage,	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
SAV Pilot Project at Bayou Cumbest	SAV – *Ruppia maritime*	Enhance fishery production	3, 6
Beach and Dune Ecosystem Restoration	Coastal Dune Habitat	Buffer mainland from storm surge and waves energy	1, 2, 3, 5, 6
Barrier Island Restoration, Biloxi Front Beach – South of Highway 90	Littoral zones, beach, dunes, emergent tidal marsh	Buffer mainland from storm surge and waves energy, enhanced productivity of emergent tidal marsh, enhance productivity of SAVs in littoral areas, enhance fisheries production	1, 2, 3, 4, 5, 6
Deer Island Ecosystem Restoration	Coastal Forests, Emergent Tidal Marsh	Enhanced productivity of wetlands	1, 2, 3, 5, 6

Footnote: Objectives - Green –Recommended Elements, Purple – Site Specific Elements, Orange – System Wide Elements. 1. Reduce loss of life caused by hurricane and storm surge by 100%; 2. Reduce damages caused by hurricane and storm surge by $150M-$200M annually; 3.Restore 10,000 acres of fish and wildlife habitat including coastal forests, coastal wetlands, wet pine savannah, submerged aquatic seagrasses, oyster reefs, and beaches and dunes by the year 2040; 4. Manage seasonal salinities within the western Mississippi Sound, such that optimal conditions for oyster growth (surrogate for other aquatic resources, 15 ppt during summer months) are achieved on an annual basis by 2015; 5. Reduce erosion to barrier islands, mainland, and interior bay shorelines by 50%; 6. Create opportunities for collaboration with local, state, and Federal agencies to facilitate implementation of programs and activities that maximize the use of resources in achieving the comprehensive goal.

1.1.7 Analysis Tools Used in the MsCIP Project to Identify and Assess the Coastal Ecotones

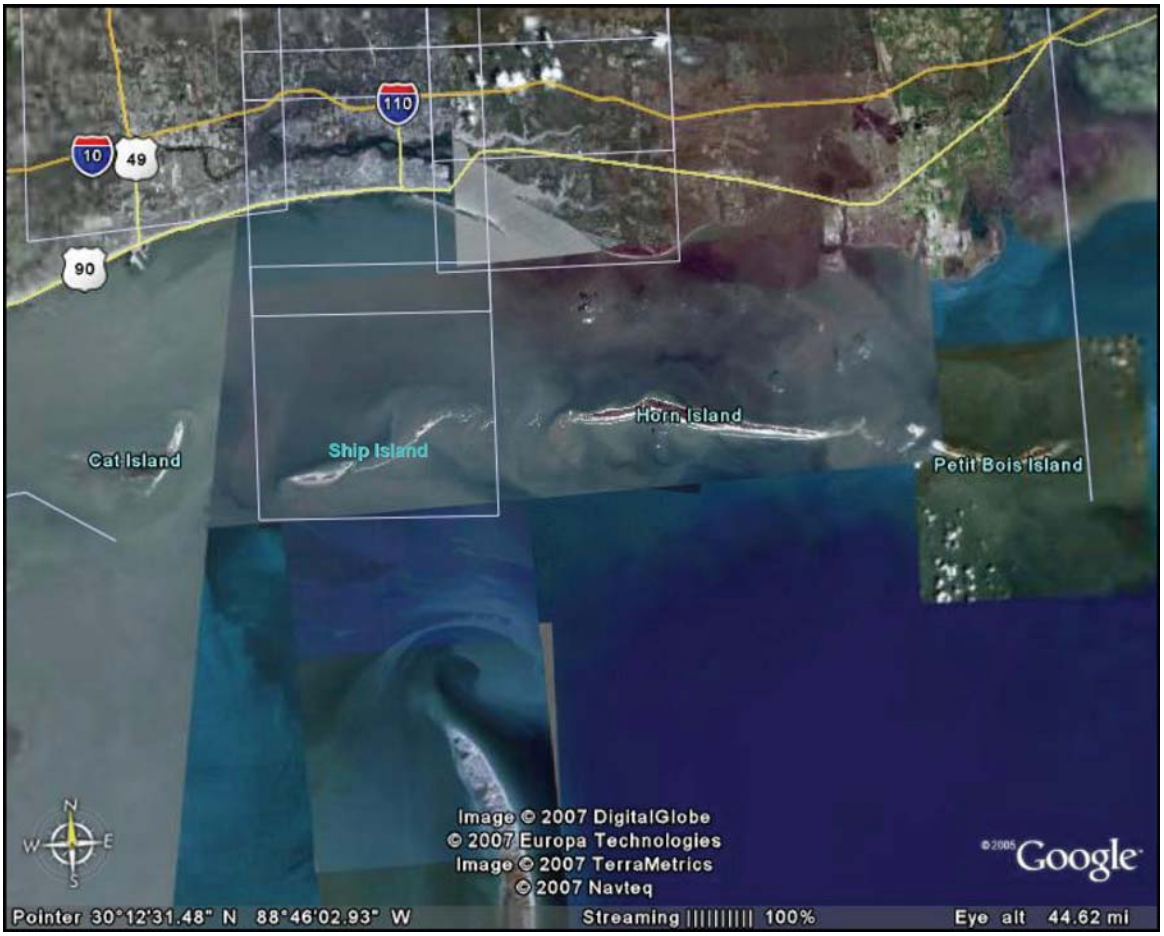
At the 8th Annual Coastal Development Strategies Conference in Biloxi, Governor Haley Barbour said in his keynote speech, "Our goal is not to get it like it was; our goal is to get it how it can be." Governor Barbour urged local officials among some 400 attendees to take the advantage of post-hurricane recommendations from the Governor's Commission on Recovery, Rebuilding and Renewal, and create smart growth community plans for generations ahead. This is still to date the worst disaster in the history of the U.S. yet it provides great potential for ecological recovery and associated sustainable development. Hurricane Katrina provided a blank canvas to make the coast of Mississippi the premier ecological setting that promotes sustainable development. This once-in-a-lifetime opportunity allows us to restore natural resources, provide protection to coastal residents, while also promoting future use of Coastal Mississippi by generations to come.

In other U.S. disasters, those impacted areas are bought by the Federal government – typically the FEMA – for the sole purpose of moving humans out of hazardous areas. Unfortunately, the natural ecosystem is not considered and those remaining structures are left behind. The vacant land is not restored to its historical ecological setting. With the MsCIP effort, not only would the land be purchased but also restored to its historical ecological habitat – i.e. emergent tidal marsh, wet pine savannah, dunes, beaches, scrub shrub, etc. The MsCIP team developed a GIS based SDSS tool to quickly identify and prioritize potential wetland restoration areas throughout Coastal Mississippi. The SDSS tool evaluated potential wetland restoration sites that had been initially selected based on having a non-natural land cover (i.e. urban, deforested, and agricultural land cover, based on MDMR 2001 land cover GIS layer) and were located in the 100-year floodplain. Numerous potential environmental restorations sites were initially identified but later screened by certain ecological characteristics. Ultimately, what the environmental team found was the SDSS identified areas that were historically wetlands – i.e. emergent tidal marsh – which were also developed. These ecotones – water and land interface – were and are still essential for fish and wildlife, natural buffers from storm surge, and overall health of the ecosystem. Restoring these systems provides benefits to both the ecosystem and humans.

The HGM approach was applied to develop functional indices and protocols for the assessment of wetland functions at those site-specific scales. HGM allowed the team to quantifiably evaluate biological, chemical, and physical functions of wetlands - a critical part of the coastal ecotone. Thus, allowing the MsCIP team to select the optimal environmental restoration plan based on the biological, chemical, and physical benefits.

1.2 Description of the Natural System

The primary study area consists of the three coastal counties comprising the State of Mississippi: Hancock, Harrison, and Jackson counties; and the coastal (offshore) ecosystem including its barrier islands (Figures 1.2-1 and 1.2-2). This area ranges in elevation from sea level to about 30 feet. The essentially flat to gently undulating, locally swampy Coastal Lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits and merge with the fluvial-deltaic plains of the streams of the area. This portion of Coastal Mississippi has been classified as an alluvial coast, a terraced, and deltaic plain (Corps, Mobile District 1984). According to the Cowardin et al (1979), *Classification of Wetlands and Deepwater Habitat of the United States*, there are five major wetland and deepwater systems, four of which are found within Coastal Mississippi. They include marine, estuarine, riverine, and palustrine wetland systems.



Source: Google Earth

Figure 1.2-1. Aerial Photograph of Mississippi Coast

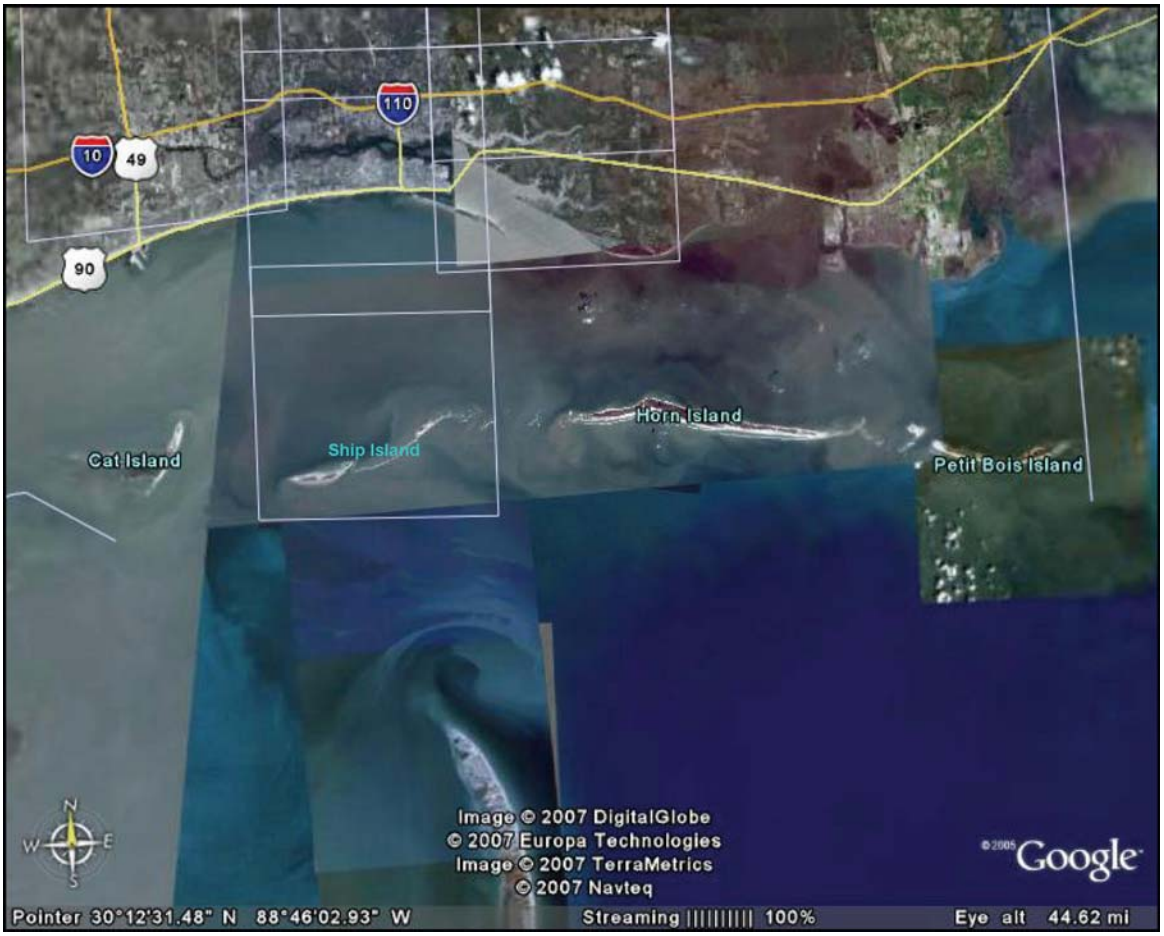
Source: Corps
Figure 1.2-2. Coastal Mississippi Ecological Resources

1.2.1 Marine System

The marine system is defined as the open ocean overlying the continental shelf and its associated high energy coastline. Within Coastal Mississippi, the marine system is the area along the Gulf of Mexico front south of the barrier islands. It is comprised of the intertidal beachfront of the barrier islands along the Gulf of Mexico, and subtidal habitat which consists of the unconsolidated sandy or silty water bottoms.

1.2.1.1 Barrier Islands

Mississippi's mainland is bordered on the south by Mississippi Sound, a shallow body of water that separates the coast from four (4) barrier islands that lie approximately 11 to 13 miles offshore (Figure 1.2.1.1-1). The string of barrier islands are comprised of dynamic and diverse habitats and are part of a complex integrated system of beaches, dunes, marshes, bays, tidal flats, and inlets. These barrier islands are located along a littoral drift zone that moves sand westward creating three elongated islands and then to the westward most island (i.e. Cat) where littoral currents are not as well defined.

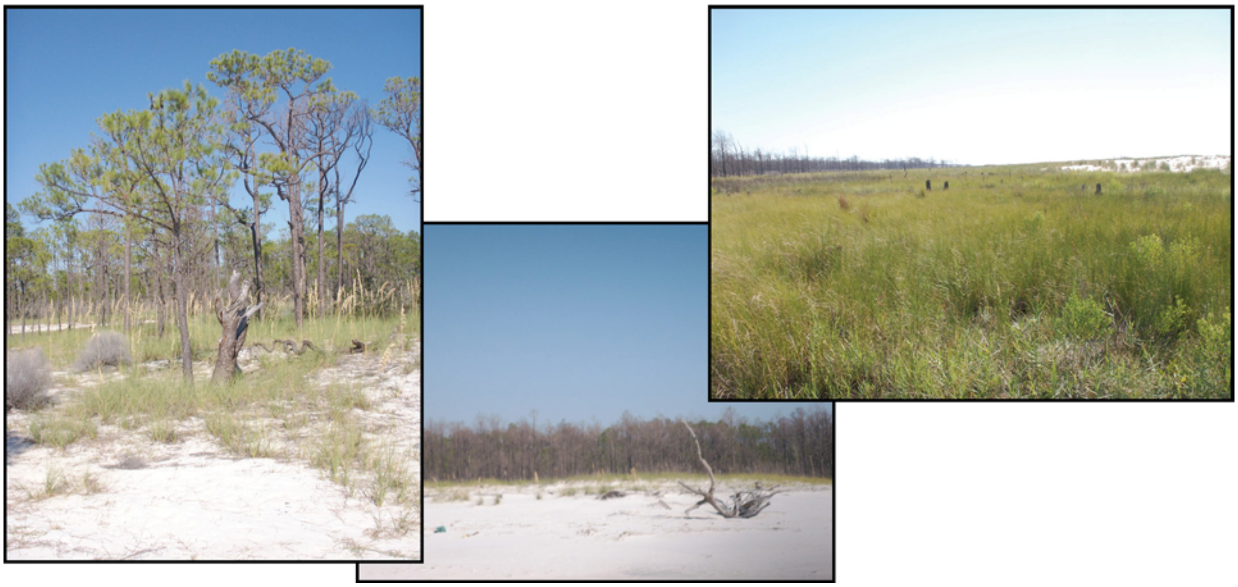


Source: Google Earth

Figure 1.2.1.1-1. Coastal Mississippi

From east to west, the islands are Petit Bois, Horn, Ship, and Cat. Ship Island was breached by prior hurricanes and now is actually two small islands, West Ship Island and East Ship Island, with a shallow sand bar between the two. Since Hurricane Camille in 1969, this breach has existed with varying amounts of natural rebuilding between later storms. The western ends of both Petit Bois and Ship Islands have migrated westward into maintained navigation channels and the continuing littoral drift of the sand into the channels is causing an artificial termination of the migration. However, recent redirect of placing dredged sand in the designated littoral zone disposal sites (i.e. sand-bypassing) assists in continuing the littoral drift. A new island has emerged on the west side of the channel from Petit Bois Island, created from dredged sand being placed on the west side of the channel. This island is known as Sand Island.

All of Petit Bois, Horn, and Ship Islands and part of Cat Island are within the boundaries of the Gulf Islands National Seashore under the jurisdiction of the NPS (Figure 1.2.1.1-2). In most cases, the boundary extends one mile seaward from the shore of the island. Petit Bois and Horn Islands have also been designated as Wilderness Areas by Congress, which affords additional significance and protection than is applicable to the other islands.



Source: Corps

Figure 1.2.1.1-2. Horn Island

Under current conditions, the islands provide a natural boundary between the water's salinity [~33 parts per thousand (ppt)] of the open Gulf of Mexico and the brackish water found in Mississippi Sound. Salinity in the Sound during low flow periods range from 10 to 30 ppt. Highest salinities occur just south of Pascagoula and Gulfport and the lowest salinities in the Lake Borgne-Pearl River area.

Loss of the barrier islands would increase salinity in Mississippi Sound; thus, greatly changing ecological habitats that exist, which could lead to saltwater intrusion, increased wave action, and the destruction of wetlands. Increased salinity within Mississippi Sound would impact shellfish and many other forms of marine life. At the Chandeleur Islands in Louisiana, loss of those island masses allows us to anticipate potentially similar environmental changes. Initial assessments in the Chandeleur system are showing SAVs diminishing, marsh erosion ongoing/accelerating, and wave energy having no natural barrier. Unlike the Mississippi barrier islands, Chandeleur Islands are a remnant of a delta lobe from the Mississippi River where wave action created a beach that remained as a island after sea level rise and erosion removed the land mass between the island and the mainland.

The NPS is currently assessing eventual fate of the barrier islands in light of climate change, sea level rise, and other anthropogenic impacts that have already, or could lead to a disruption of the natural sediment transport and budget system that the islands are dependent upon for their very survival. The Service is concerned East and West Ship Islands will not recover naturally due to the aforementioned causes. Consequently, NPS is contemplating management actions focused upon restoring the sediment transport and budget system in order to sustain the barrier islands in perpetuity.

1.2.2 Estuarine System

Estuarine systems within Coastal Mississippi consist of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open partly obstructed or sporadic access to the open ocean and in which ocean water is occasionally diluted by freshwater runoff from the land. Mississippi Sound consists of both sub-tidal and inter-tidal estuarine systems.

1.2.2.1 Mississippi Sound

Mississippi Sound is a shallow coastal lagoon along northern Gulf of Mexico from Mobile Bay, Alabama, in the east to Lake Borgne, Louisiana, in the west. It extends from the Mississippi coastline to a string of sandy barrier islands, which separate it from the Gulf of Mexico. The Gulf Intracoastal Waterway parallels the mainland coast offshore through the entire length of Mississippi Sound. Mississippi Sound receives both high saline waters from the Gulf of Mexico and freshwater from the streams/rivers, which drain some 20,000 m^2 of land area (Corps 1984). Circulation is driven by tides modified slightly with the wind. Gulf waters enter the Sound through the deep passes between the barrier islands with the help of tidal forces. This mixing of freshwater runoff and saline waters has created a dynamic estuarine ecosystem. Mississippi Sound receives its major freshwater flow from the Pascagoula and Pearl Rivers and is critical to the survival of numerous birds, mammals, fish, and other marine organisms of national importance.

Many different habitat types are found in and around the estuarine ecosystem, including shallow open-waters, salt marshes, sandy beaches, mud and sand flats, oyster reefs, river deltas, tidal pools, and SAVs. These diverse ecosystems serve a variety of critical functions necessary to sustain a vital thriving commercial fishing industry of national economic significance.

Mississippi Sound is identified as EFH for postlarval and juvenile red drum, Spanish mackerel, and white and brown shrimp. In addition to EFH designated for white and brown shrimp, Spanish mackerel, and red drum, the estuary provides nursery and foraging habitat that supports various species including economically-important marine fishery species, such as black drum, spotted seatrout, southern flounder, Gulf menhaden, bluefish, croaker, mullet, and blue crab. These estuarine-dependent organisms serve as prey for other important fisheries, such as mackerels, snappers, and groupers, and highly migratory species, such as billfishes and sharks. These habitats produce nutrients and detritus, important components of the aquatic food web, which contribute to the fishery productivity of the Mississippi Sound estuary. Several of the species, such as T&E species, brown shrimp (*Penaeus aztecus*), red drum (*Sciaenops oellatus*), and pink shrimp (*P. duorarum*) listed by NOAA Fisheries, are identified as being of national economic importance in Section 906(e)(1) of the Water Resources Development Act (WRDA) of 1986 and, therefore, are aquatic resources of national importance. Mudflats and sand flats provide valuable habitat for oysters and other important shellfish. SAVs provide vital foraging habitat and refuge for all stages of fish.

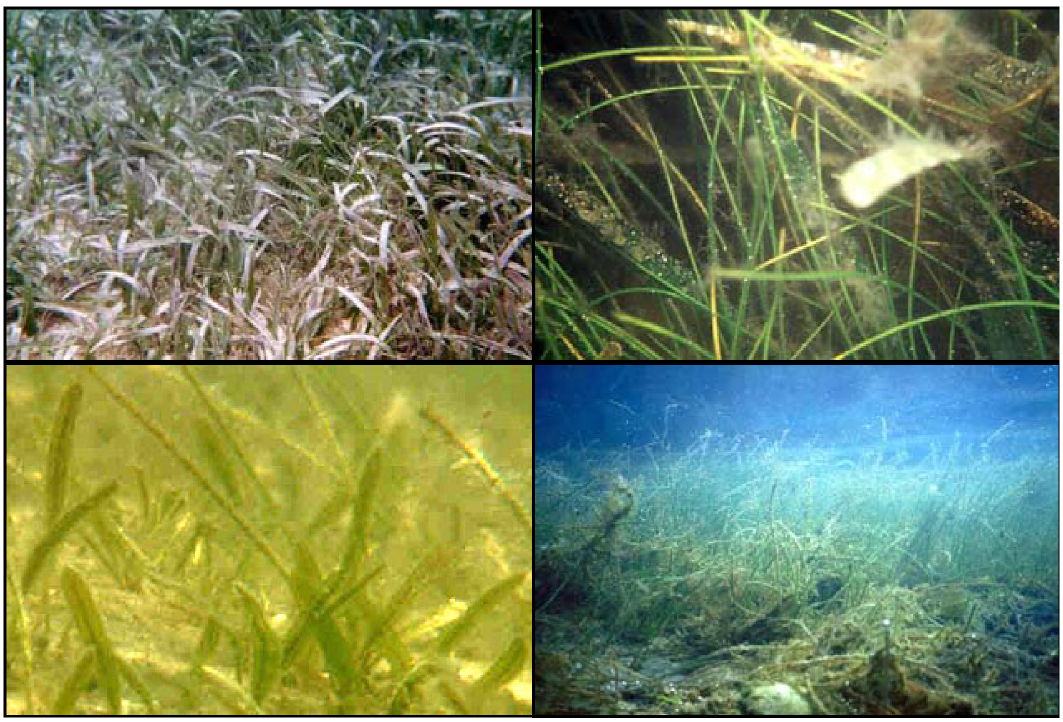
Marshes act as filters removing pollution from runoff with wetland plants and soils that act as natural buffers improving water quality, storing floodwaters, and reducing coastal erosion. Diminished and degraded habitats are less available to support healthy populations of wildlife and marine organisms and less able to perform the economic, environmental, and aesthetic functions that help to sustain Coastal Mississippi. According to the National Coastal Condition Report II, Gulf Coast estuaries are among the most productive natural systems, producing more food per acre than the most productive Midwestern farmland and are second only to Alaska for domestic landings of commercial fish and shellfish. Shrimp landings in the Gulf of Mexico accounted for 80% of the total U.S. shrimp landings in 2000.

The hurricane-induced loss of fisheries to Coastal Mississippi is unprecedented in national history and has presented a high cost to the nation. Following Hurricane Katrina, the Commerce Secretary declared a complete fisheries failure due to the extensive devastation to the processing facilities, docks, loss of boats, degradation of habitat, deposition of marine debris, and degraded water quality. Losses to many commercially important fisheries stock, foraging areas, nurseries, etc. have been felt economically in the region. Increased salinity due to continued degradation of the barrier islands will result in detrimental impacts to the vital economic fisheries industry that the estuarine environment sustains. Furthermore, increased turbidity decreases foraging efficiency of certain fish species.

Increased turbidity disperses pollutants and contaminants found in bottom sediments throughout the water column. Marine debris causes obvious adverse effects on coastal resources detrimental to various species' survival, such as T&E sea turtles mistaking plastic bags for their preferred diet of jellyfish. Aesthetics and recreational activities are also negatively impacted by the presence of marine debris. An essential ingredient to reduce marine debris generated on a long-term basis is the use of educational and outreach efforts. Opportunities exist to partner with local, state, and Federal outreach programs as part of an overall comprehensive approach.

1.2.2.2 SAVs

SAVs or seagrasses are currently restricted to the northern shores of the barrier islands and small patches throughout the immediate shorelines. These areas are characterized by *Diplanthera wrightii* (Shoal grass), *Cymodocea manatorum* (Manatee grass), *Thalassia testudinum* (Turtle grass), and *Ruppia maritime* (Widgeon grass) (Figure 1.2.2.2-1). Approximately 20,000 acres of SAVs were present in Mississippi Sound prior to 1969; however, in late 1969, Hurricane Camille caused a substantial destruction of these areas (Moncrieff 1998).



Source: Unknown
Figure 1.2.2.2-1. Seagrasses

SAVs serve as nursery areas for fish and shellfish, such as shrimp and crabs, and as food for ducks. The continued survival and growth of SAVs may be threatened by the cumulative effects of man's activities, in addition to, natural processes in the coastal marine environment. Natural causes of SAV decline, such as disease, storm events, salinity fluctuation, and hypoxic (i.e. low oxygen) events, coupled with declining water quality caused by anthropogenic eutrophication (i.e. man-made overloading of nutrients) currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1999). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species to utilize this vital habitat at some point in their life stage.

As of 1998, only 2,000 acres remained (Moncrieff 1998). Dramatic decreases in SAVs along the north shoreline of Horn Island have been observed. An approximate 5,000 acre decrease in coverage was calculated for the period between 1969 and 1992. The overall distribution of SAVs among Mississippi's other barrier islands has also decreased considerably in the same time period, with Cat Island losing approximately 430 acres, Ship Island losing approximately 1,280 acres, and Petit Bois Island losing approximately 1,300 acres. Areas of SAVs along Coastal Mississippi's mainland have also declined. Buccaneer State Park is estimated to have lost about 150 acres while Point-aux-Chenes Bay has lost approximately 680 acres. The following three (3) areas were documented in which the potential seagrass habitat was less than the historical distribution of SAVs, indicating habitat loss. Dog Keys Pass, Horn Island, and Point-aux-Chenes Bay all exhibited this pattern with approximately 930 acres, 1,200 acres, and a 770 acres loss, respectively. By 1975, vascular seagrasses had been reduced to 33% and algal cover had been reduced by 41%. Additional losses of seagrass beds from 1971 to 1975 occurred as a result of the prolonged exposure to low salinity-water during the springs and winters of those years.

Seagrasses in Mississippi Sound are threatened by the cumulative effects of both natural events and anthropogenic activities in the coastal environment. The primary factors contributing to the decline of seagrass populations in Mississippi Sound are an overall decline in water quality, physical loss of habitat, decreased availability of light, extended periods of depressed salinity, and physical disturbances, such as tropical storms and hurricanes. In 1973, 67.6% of potential seagrass habitat was vegetated; however this amount was reduced to 13.4% percent by 1992 (Eleuterius 1973, Moncrieff 1998). The loss of previously vegetated areas in Mississippi Sound that are considered potential seagrass habitat totals 54.2% (Moncrieff 1998). Seagrass habitat loss in Mississippi Sound coincides with areas where rapid coastal erosion and massive long-term movement of sand have occurred (Moncrieff et al 1998). The coastal development is likely to result in indirect and cumulative adverse affects on seagrass beds by contributing to elevated nutrient levels, higher sediment loads, and the introduction of contaminants, leading to degraded water quality.

The adverse effects from natural perturbations, as evident by the catastrophic effects from Hurricane Camille on the seagrass beds, have been substantial and long-lasting. Continued physical loss of habitat, fluctuating salinity (i.e. erosion of barrier islands), and declining water quality will weaken the condition of existing beds and inhibit the revegetation of those areas that represent potential seagrass habitat. Opportunities exist to partner with other Federal or State resource agencies or with established NGOs, such as TNC. TNC has named the Mississippi Sound's marine habitat as one of their priority conservation areas on the Gulf Coast, which involves identification of SAVs, specifically seagrasses, as a critical target for protection and restoration. TNC states numerous publications have demonstrated that seagrass beds or meadows are critical habitat for many recreational and commercial marine fisheries species, such as shrimp, crabs, scallops, redfish, speckled trout, and mullet, and due to an increase in activities related to inshore fisheries and the increase in shallow draft recreational boating in most areas around the Gulf, propeller scarring has been identified as a serious threat to the integrity of seagrasses. Propeller scarring destabilizes the substrate as well as uproots the seagrasses themselves. This damage has been shown to be reversible, provided the seagrasses have the time to regenerate, and even then, can be unpredictable according to studies done in Texas in Redfish Bay.

Increased turbidity within Mississippi Sound causes less light penetration through the water column, which results in the lack of SAVs photosynthesis. Replanting seagrass beds has been found to be expensive and not always successful. It is imperative that a public outreach and awareness building campaign begin that would include signage and materials to promote recreational boat use that is compatible with these sensitive areas. Opportunities exist to partner with Federal, state, and local resource agencies as well as NGOs. Extensive coordination with the NPS, responsible for managing and operating the Gulf Islands National Seashore, would be required for areas of potential restoration within park boundaries. Involvement of local schools, colleges and universities with ongoing research programs would also help to identify and pinpoint specific problems for development of potential solutions.

1.2.2.3 Mississippi Shoreline-Manmade beaches and seawalls

The majority of the shoreline in Coastal Mississippi consists of manmade beaches beyond concrete seawalls. A few remaining areas along the shoreline consist of more natural areas, such as expanses of marsh along the western and eastern borders of the state. Before the construction of roadways along the Coastal Mississippi shorelines, the beach did not exist as it does today. The shoreline facing Mississippi Sound was a natural marsh, similar to that found along stretches of the South Carolina “Low Country” (Corps, Mobile District 1984). As development occurred and the beachfront roads and seawalls were constructed, i.e., U.S. Highway 90 along the entire stretch of shoreline in Harrison County, this marsh was filled in to create the sandy beach. This beach was built for protection of the roadways and seawalls and also added esthetic benefits to the region. The marsh habitat was destroyed and/or eliminated along with its associated storm surge protection.

A natural beach and dune system, located along Belle Fontaine in the central portion of Coastal Mississippi, is the only natural beach remaining and has experienced severe erosion to a point that it is virtually non-existent. Seawalls have been constructed along portions of this eroding beach for protection of property, which has exacerbated beach erosion. The seawalls confine the wave energy and intensify the erosion by concentrating the sediment transport processes in an increasingly narrow zone. The beaches continue to disappear resulting in the seawalls directly exposed to the full force of the waves.

Two major deep draft Federal navigation projects are located along Coastal Mississippi, Gulfport Harbor in Harrison County and Pascagoula Harbor in Jackson County. These Federal channels serve two international ports located along the shoreline. Numerous small navigation projects and boat harbors are also located along Coastal Mississippi’s shoreline. The ports, harbors, and navigation channels received major damage as a result of Hurricane Katrina and repairs and/or reconstruction is still on-going.

Deer Island is a small mainland island located just offshore of Ocean Springs and Biloxi. The island experienced some hurricane damaged. The Corps, Mobile District has an existing Section 204: Beneficial Use of Dredged Material project and is currently working on a Section 528 of WRDA of 2000 project at the island. This recent project will restore the island to its 1850s footprint (i.e. beach/dune system, coastal maritime forest, and emergent marsh). The island is protected under the Coastal Barrier Resources Act of 1990 which replaced and reauthorized the Coastal Barrier Resources Act of 1982.

The beach of Coastal Mississippi provides a unique habitat for a variety of plants and animals. For example, 75% of migratory waterfowl live in or depend on coastal beaches during their lifespan (USFWS 1990b). Dune vegetation provides nesting areas for several kinds of birds, such as least terns, and animals, such as mole crabs and rodents. The beaches also provide numerous recreational opportunities for people. Boating, fishing, swimming, walking, beachcombing, bird-watching, and sunbathing are among the numerous activities enjoyed by beachgoers. The esthetic aspects of a beach/dune system provide additional benefits, even inspiring works of art and literature.

Beaches provide some protection to residents living near the waterfront by acting as a buffer against the high winds and waves of powerful storm systems or turbulent seas. MDMR has obtained funding through Federal Coastal Impact Assistance Program (CIAP) to begin initial phases of a project that would create manmade marshes along parts of the Coastal Mississippi shoreline. This project would provide a measure of bio-filtration of water-borne pollutants, and mitigate wind erosion of sand, as well as prevention of coastal erosion and siltation protection for sites selected for construction. Projects of this nature would be consistent with and offer additional opportunities for partnering with the State of Mississippi, especially during preliminary development of project goals, evaluation, and public input as potential sites are identified and evaluated.

1.2.2.4 Wetlands – Tidal Marsh

Coastal wetlands include swamps and tidal flats, coastal marshes, and bayous. They form in sheltered coastal environments often in conjunction with river deltas, barrier islands, and estuaries. They are rich in wildlife resources and provide nesting grounds and important stopovers for waterfowl and migratory birds, as well as spawning areas and valuable habitats for commercial and recreational fish. Intertidal and subtidal bottoms are populated by communities of macrofauna whose structure is dependent upon substrate, salinity, temperature, depth, and ecological relationships.

Coastal wetlands can be dominated by saltwater, as found along the Gulf coast of Louisiana, or they can contain a complex and changing mixture of salt and freshwater, like the estuaries of the Chesapeake, Galveston, and San Francisco Bays. Mississippi Sound is bordered to the east and west by two expansive marsh systems, Grand Bay Marshes along the eastern boundary and Hancock County Marshes along the western boundary. The Pascagoula River marsh system is located primarily inland of the shoreline and will be discussed in context with the freshwater rivers.

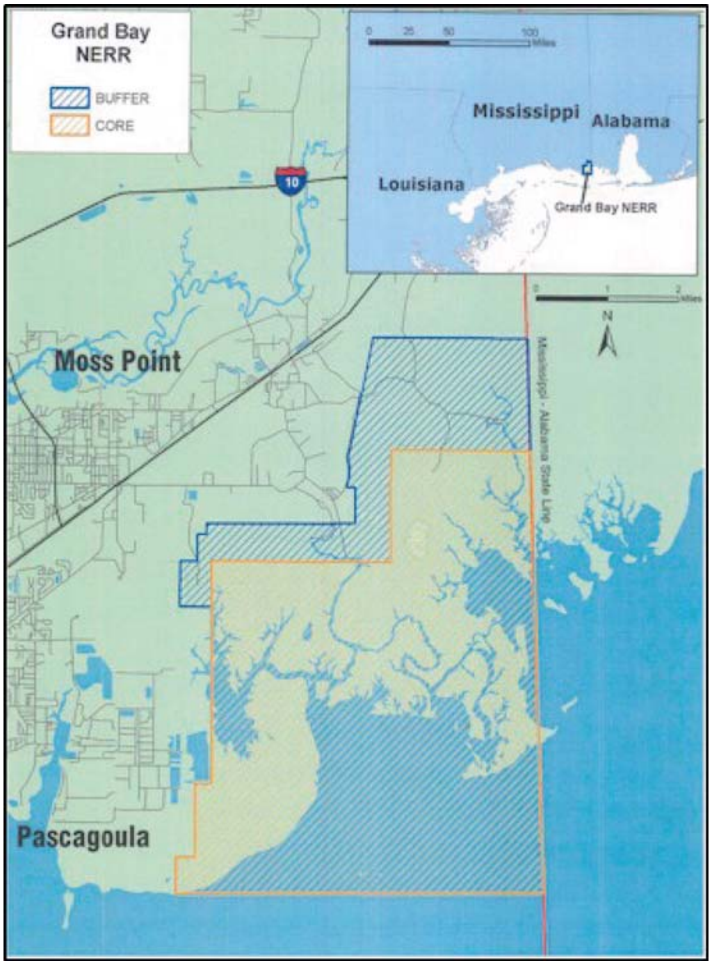
Western Hancock County along Mississippi Sound consists of extensive marshes that have suffered from lack of sediment and freshwater flows resulting in increased saltwater intrusion and coastal erosion. The lack of sediment has resulted in a reduction of natural accretion and marsh building. The Grand Bay marshes and wet pine savannahs along the eastern portion of the state have also experienced severe coastal erosion and are further threatened by increased saltwater intrusion.

Wetlands, marshes, and nearshore marine and estuarine habitat are the nursery grounds for the entire marine food chain in the Gulf of Mexico. Pollution, development, and other factors are destroying such habitat throughout the Gulf region. As this habitat is destroyed, it further depletes the species that form the base of the food chain throughout the Gulf of Mexico. Numerous species of marine flora and fauna begin their life cycles in marshes and wetlands. Ultimately, the entire Gulf of Mexico ecosystem is threatened by the accelerated destruction of this habitat. Failure to address the loss of this habitat in the Gulf of Mexico region threatens the long-term health of the entire ecosystem and human culture, with the attendant loss of billions of dollars of marine-related resources.

1.2.2.4.1 Grand Bay Marsh – Jackson County

Historically, the estuarine marsh within the Grand Bay National Estuarine Research Reserve (NERR) represented the former deltaic environments of the Pascagoula and Escatawpa Rivers in eastern Jackson County (Figures 1.2.2.4.1-1 and 1.2.2.4.1-2). The outlets of these rivers have shifted westward over time, severely limiting the inflow of freshwater, nutrients and sediments into the Bayou Cumbest area of the NERR. Several attempts have been made over the past 50 years to reroute freshwater from the marshes to the north to add additional freshwater to the estuary. Until recent years, minimal flow from the Escatawpa River existed into Bayou Cumbest through the system of meandering oxbows from the Holocene Pascagoula River.

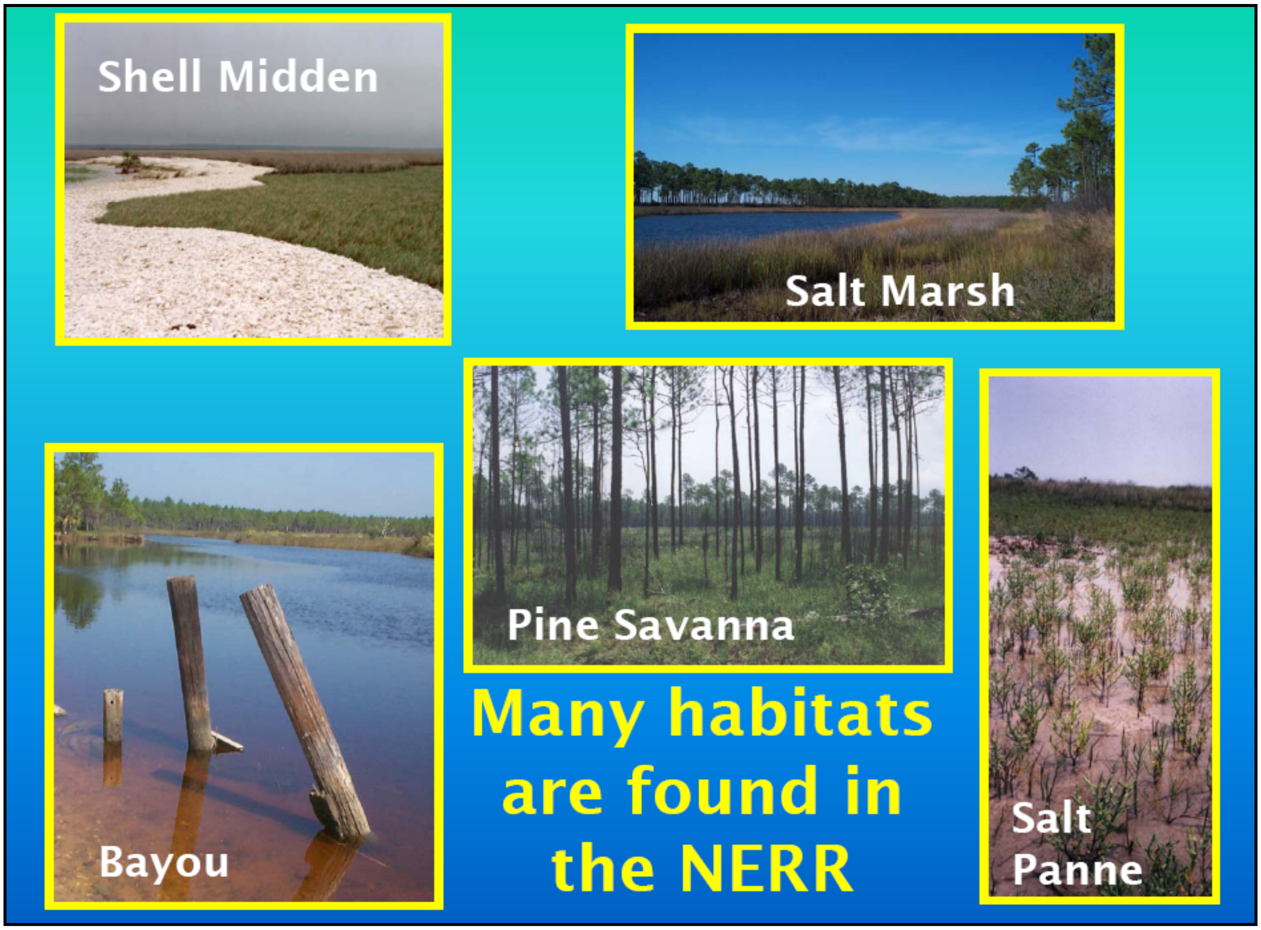
Currently it is speculated that much of the freshwater entering the Grand Bay NERR estuary is from surface runoff through Bayou Cumbest and Bayou Heron, within the Bangs Lake Hydrologic Unit, measuring approximately 21,374 acres. Human disturbances to the area have altered historic sheet flow and surface water flows into the area, as well as the natural migration of the Pascagoula and Escatawpa Rivers.



Source: MDMR

Figure 1.2.2.4.1-1. Grand Bay Marsh – Jackson County

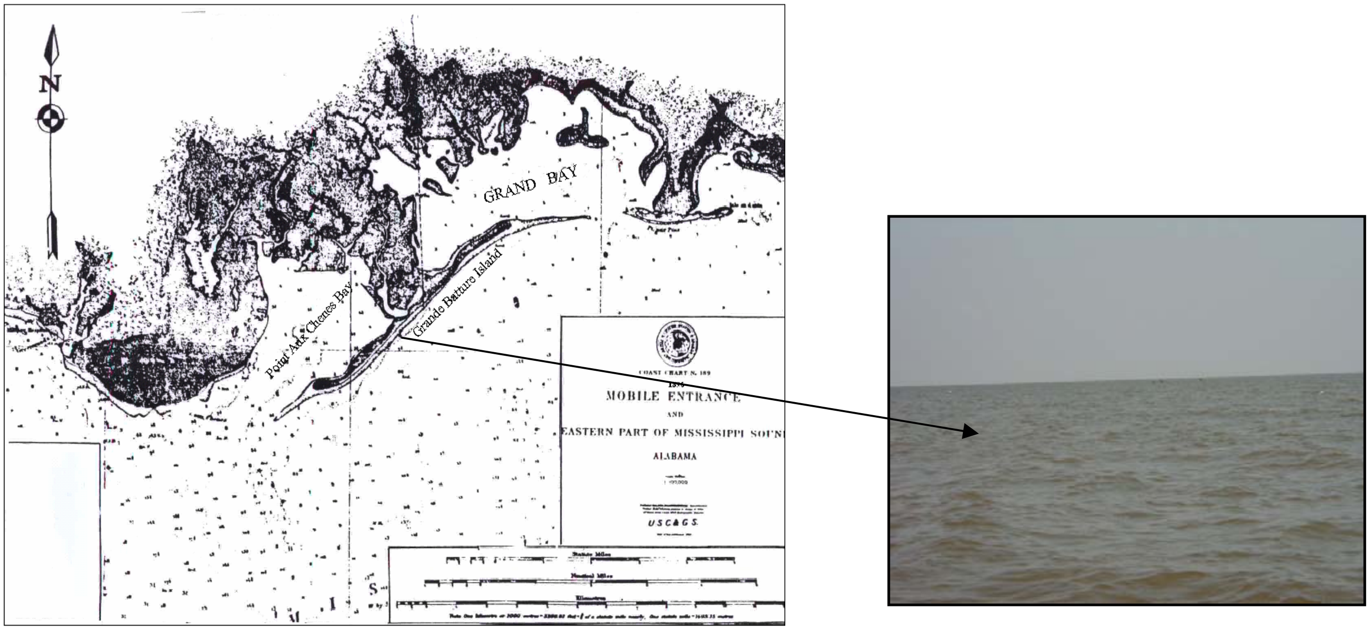
The Grand Bay marshes lie within the gently sloping, lower Gulf coastal plain. It is thought that the Pascagoula River once flowed through these marshes, emptying into Point Aux Chenes Bay, forming a rich delta. Sometime after the sea reached its current level, however, the river changed its course and now flows into the Mississippi Sound approximately five miles west of the Grand Bay NERR. This natural diversion of the river water and its associated sediments away from Point Aux Chenes Bay has led to a condition that has resulted in the retrograding (erosion) of this estuarine system. Currently, the only major channels within the NERR are Bayou Cumbest and Bayou Heron. These tidal bayous are relatively small and have slow-moving, tea-colored waters that are rich in tannins, a natural by-product of decaying vegetation.



Source: MDMR

Figure 1.2.2.4.1-2. Grand Bay Marsh – Jackson County

The Grand Batture Islands located at the mouth of Point Aux Chenes Bay once formed a significant chain of islands on the southern boundary of the reserve (Figure 1.2.2.4.1-3). However, between the years of 1853 and 1950, coastal erosional forces ate away at the islands until today they are little more than giant mud lumps (i.e. shoals). Because these islands are no longer large enough to protect the bay from high winds and waves, the sensitive coastal salt marshes located along the fringe of the bay are being eroded away at an alarming rate (over 30 feet per year).



Source: MDMR and Corps

Figure 1.2.2.4.1-3. Grand Batture Islands – Remnants of only a Shoal

1.2.2.4.2 Hancock County Marsh – Hancock County

This is the second largest continuous marsh area in the state. The boundary of this 13,570-acre preserve includes all of the adjoining marshlands bordering Mississippi Sound from the Pearl River to Point Clear (Figure 1.2.2.4.2-1). This saline marsh area includes a historically significant captured relic barrier island (Campbell Island) and an Indian shell midden (Cedar Island) over 1,600 years old. Included within the marshes are several low ridges and small hummocks that are above mean high tide. Most important of these areas are Point Clear Island and Campbell Island, which are sandy areas with characteristics similar to the barrier islands. The islands of this marsh support several rare plant species including one of the rarest shrubs in the U.S., the tiny-leaved buckthorn (*Sageretia minutiflora*), found on the shell midden. The marsh area is also well-known for an abundance of waterfowl.

Source: Corps

Figure 1.2.2.4.2-1. Hancock County Marsh – Hancock County

The largely mesohaline area of Bayou Caddy and Point Clear Island consists of a mosaic of elevation zones bordering both sides of old dune/ridge systems (Point Clear Island and Campbell Island to the west) that are forested (pines, cedar, oak). The Pearl River and associated river swamp are freshwater tidal with bald-cypress (*Taxodium distichum),* blackgum (*Nyssa sylvatica var biflora* and *Nyssa aquatica*) balancing the swamp canopy. This area is experiencing saltwater intrusion as less freshwater inflows from the west due to extensive levee systems of the Mississippi River and smaller systems in Plaquemines Parish in Coastal Louisiana. As the salt tolerance of species in the tidal marshes and seagrasses is exceeded, changes in the food web and reductions in fish and shellfish productivity occur. Also, the yield of estuarine-dependent fisheries, such as shrimp, will be influenced by the quality of the habitat over time.

1.2.3 Riverine System

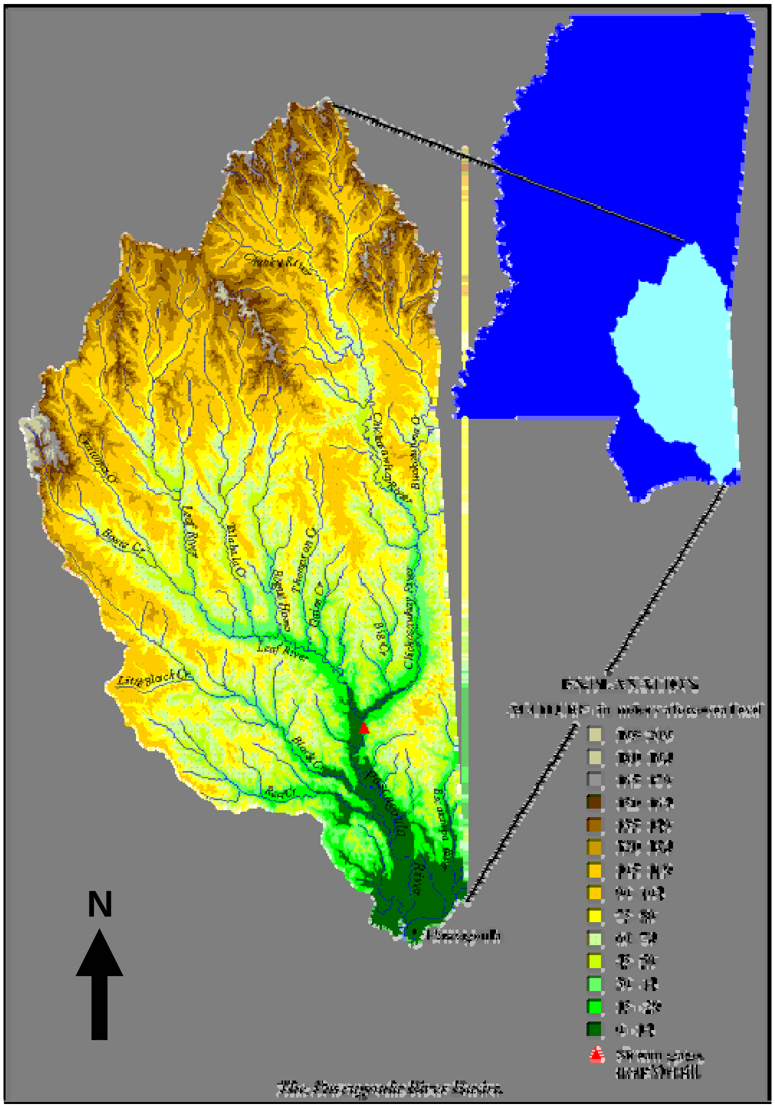
Riverine systems are bounded on the landward side by upland, by the channel bank, or by wetlands dominated by trees, shrubs, and persistent emergents. Cowardin et al (1979) divides the riverine system into four sub-systems: tidal, lower perennial, upper perennial, and intermittent, two of which are found in Coastal Mississippi. These include freshwater tidal marsh and lower perennial emergent wetlands. Coastal Mississippi's freshwater resources are very important in maintaining healthy aquatic ecosystems and are under continuing urban and industrial development pressure as the population continues to grow and rebuilding efforts are underway. Coastal marshes and forested wetlands located throughout the many freshwater coastal streams play a vital role in the sustainability of Coastal Mississippi for the future. Most rivers cutting through the low-lying coastal plain flow slowly to the sea and deposit their sand-sized sediment in bays and estuaries before reaching the coast. The river's suspended load of finer particles settles out in the sounds and bays that are protected by barrier islands and spits. Freshwater and sediments from these systems are essential to the continued existence of estuaries, marshes, and the species that depend on these habitats for survival. As wetlands continue to degrade or are being filled as development continues, valuable habitat available to support healthy populations of wildlife and marine organisms are lost and are not being effectively replaced. Additionally, water quality suffers due to many point and non-point sources of contamination near the coastal population centers. A comprehensive review and appropriate measures for preservation, restoration, and enhancement of the many components that make-up the diverse and vital coastal ecosystems will ensure sustainability of Coastal Mississippi. Additionally, the wetlands associated with the rivers storage floodwaters, both from the river systems and from storm surge, buffer the upland areas.

1.2.3.1 Tidal and Lower Perennial Riverine Systems

The USGS lists approximately 10 major drainage basins within the State of Mississippi and of these, two are located within the Coastal Mississippi Study Area (Corps 1984). These two basins include the Pascagoula River and its tributaries within the eastern portion of the state and the Coastal Streams Basin located within Coastal Mississippi. Additionally, the Pearl River makes up the western boundary of the state within Coastal Mississippi.

1.2.3.1.1 Pascagoula River Basin – Jackson County

The Pascagoula River Basin covers an area of about 8,800 m^2 in southeastern Mississippi (Figure 1.2.3.1.1-1). The Pascagoula River is formed by the confluence of the Chickasawhay and the Leaf Rivers. From this confluence, the river flows southward for about 80 miles before emptying into the Gulf of Mexico. Okatoma Creek, a tributary of the Leaf River, is a particular favorite to canoeists. The Escatawpa River, located mostly in Alabama, flows into the Pascagoula River very near the Gulf Coast. Elevations in the Pascagoula River Basin range from sea level to about 650 feet above sea level. About 72% of the basin is forested and about 21% is agricultural land. Near the coast are low-lying flatlands and marshlands. Farther inland, the landforms consist primarily of low rolling hills and broad, flat flood plains. The economy of the area is based, as it has been since prior to the Civil War, heavily on lumber, the manufacture of wood products, and shipbuilding. The City of Pascagoula on the densely populated Mississippi Gulf Coast is one of the great shipbuilding centers of the world. Tourism, commercial fishing, and oil and gas production are also significant components of the economy in the basin.



Source: USGS

Figure 1.2.3.1.1-1. Pascagoula River Basin

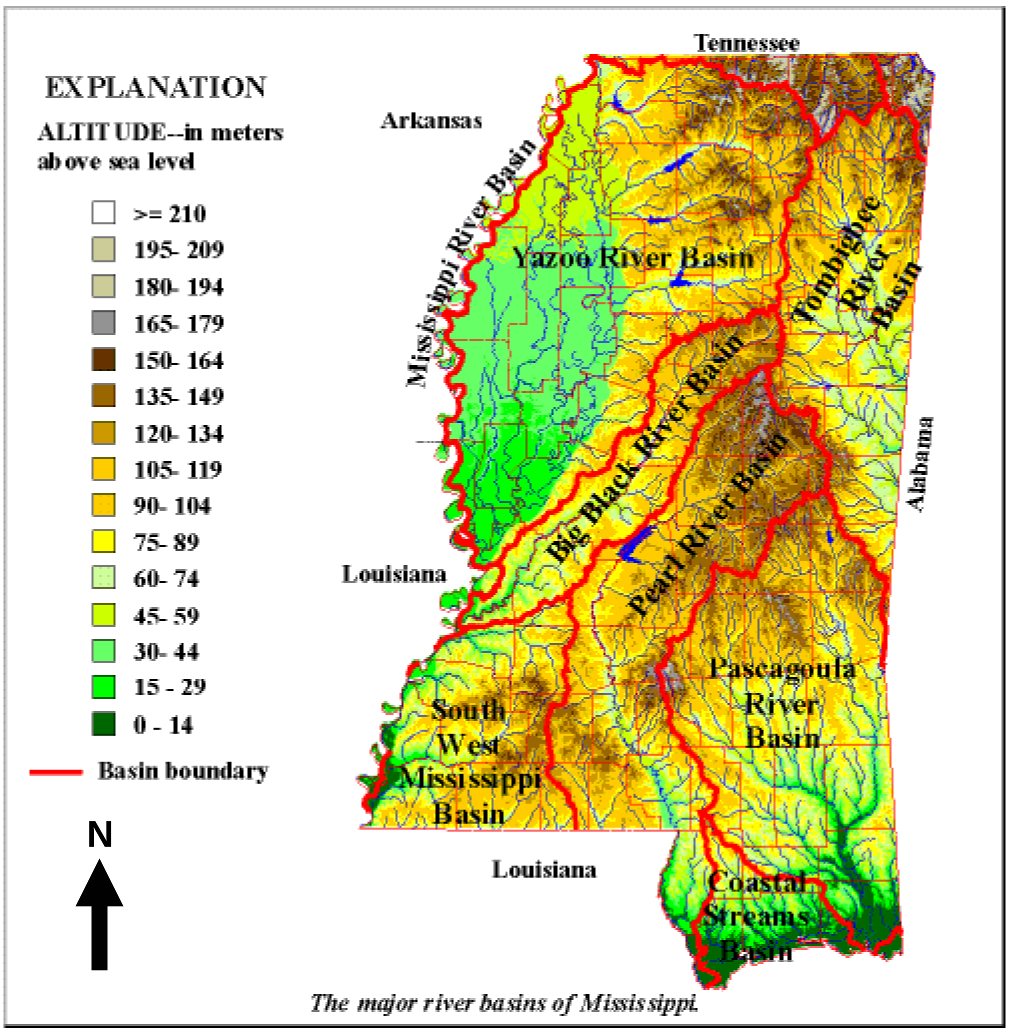
Stream conditions in the Pascagoula River Basin are mostly natural, or unmodified in appearance, and have clear water. Some streams are considered “black-water streams” because they are stained by tannic acid leached from vegetation. Water quality generally is good to excellent with only localized contamination problems. Historically, industrial point sources and urban runoff near major population centers have caused water quality problems. Pascagoula River Basin is critical habitat for

Gulf sturgeon and represents critical breeding, migrating, and wintering habitat for 327 additional species of birds.

1.2.3.1.2 Coastal Streams Basin – Harrison County

The Coastal Streams Basin (Figure 1.2.3.1.2-1) covers an area of about 1,650 m^2. Unlike most of the other basins in Mississippi, the streams and creeks do not all flow into a single main stream within the basin. Instead, most of the streams discharge directly into the Gulf of Mexico. Some of the larger streams in the basin include Bayou la Croix, Tuxachanie Creek, and the Tchoutacabouffa, Biloxi, Little Biloxi, Wolf, and Jourdan Rivers. Headwaters for these streams generally are in the northern part of the basin, and the streams discharge into either St. Louis Bay or the Back Bay of Biloxi. Elevations in the Coastal Streams Basin range from sea level to almost 420 feet above sea level. Much of the basin consists of gently rolling to hilly terrain. Silviculture and agriculture are principal uses of the basin. About 74% of the basin is forested, and about 12% is agricultural land. Most industries are located near the larger population centers.

Use of surface water in the Coastal Streams Basin is relatively large. About 300,000 gallons/day are used for irrigation, about 400,000 gallons/day are used for livestock, and about 20 million gallons/per day are used for industry.



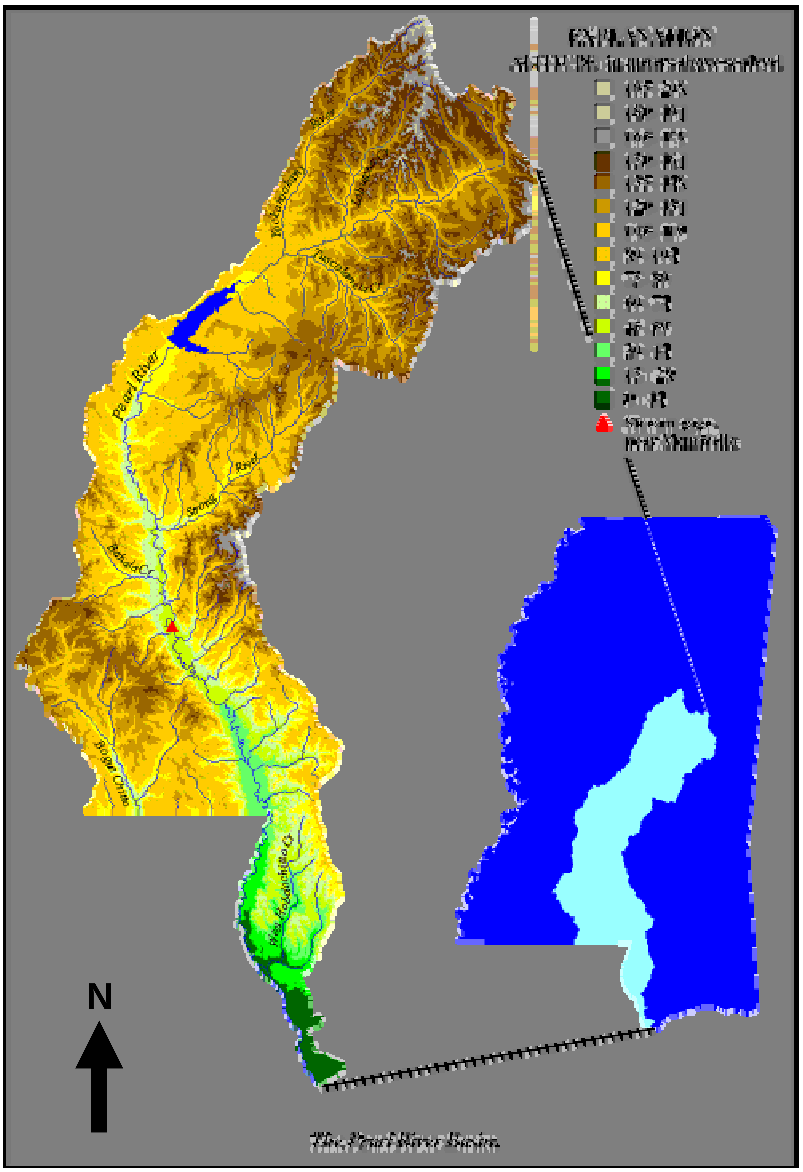
The major river basins of Mississippi.

Source: USGS

Figure 1.2.3.1.2-1. Coastal Streams Basin

1.2.3.1.3 Pearl River

The Pearl River Basin covers an area of about 7,800 m^2 (Figure 1.2.3.1.3-1). The headwaters of the Pearl River consist of several tributaries in east-central Mississippi. From there the Pearl River flows southwesterly, forming the boundary between Louisiana and Mississippi in the southern part of the basin, and discharging into the Gulf of Mexico. Near the coast, the river becomes estuarine, bounded by salt marsh and affected by tidal influence.



Source: USGS

Figure 1.2.3.1.3-1. The Pearl River Basin in Mississippi

The Pearl River is about 490 miles long and divides into the Pearl River and the West Pearl River about 50 miles above the mouth. Significant tributaries include the Yockanookany and Strong Rivers. Elevations in the Pearl River Basin range from sea level to almost 700 feet above sea level. Much of the upper two-thirds of the Pearl River Basin consist of gently rolling to hilly terrain. In the southern part of the basin, the land is much flatter. About 65% of the basin is forested, and about 30% is agricultural land. The timber industry and the manufacture of wood products dominate the economy of the lower basin, whereas soybeans and poultry are the major components of the economy in the upper basin. This is the largest urban area in the State, the Jackson Metropolitan area, is located in this basin.

The flow of the Pearl River near Monticello averages 54,600 gallons/second. However, in the past, flow has been as low as about 2,000 gallons/second and as high as about 913,000 gallons/second. Use of surface water in the Pearl River basin is relatively large. About 1.2 million gallons/day are used for irrigation, about 6.2 million gallons/day are used for livestock, about 30.7 million gallons/day are used for industry, about 220,000 gallons/day are used for sand and gravel mining, and about 33 million gallons/day are used for municipal drinking-water supply.

Turbidity is often high in the upper two-thirds of the Pearl River basin; however, the water quality of streams is generally fair. In the southern third of the basin, streams generally have a fast, deep flow and generally are of fair to good water quality. Water quality impacts occur below Jackson and at Columbia due to point and non-point sources of contamination.

Channel diversions at the lower end of the Pearl River can leave the original river channel near Picayune virtually dry during low-flow conditions. Deforestation and water diversion are major concerns in the portion of the Pearl River basin nearing Coastal Mississippi. Deforestation and lack of streamside management zones increase the occurrence of cut banks and bank erosion contributing unnatural amounts of sediment into the system. Use of pesticides has also created problems with runoff.

1.2.3.2 General Problems in Riverine Systems

Increased development adjacent to streams and rivers and within their floodplains have caused extreme flooding conditions within most watersheds. The storm surge associated with Hurricane Katrina was so severe that it depicted this problem on an extreme scale. An example of this is what happened throughout the Pascagoula River watershed where the limits of the storm surge were seen several miles north of the coastline. Businesses and residences were flooded as far as 30 miles north due to the low elevations found within the watershed. Areas were flooded that had never experienced problems with flooding before. As a result of this, the base flood elevation maps throughout Coastal Mississippi are undergoing changes.

Numerous watersheds within close proximity to the coast and associated connected drainageways are flood hazards due to past development and associated impacts by landuse modification. Additionally, a number of these waterbodies have been determined impaired by the USEPA and MDEQ due to nutrient levels. A prime example of this can be seen in the Turkey Creek watershed. Turkey Creek, a small flowing channel, has been named by MDEQ as an impaired body of water that has been impacted by encroachment, changing landuse patterns, and channel modifications resulting in loss of habitat, flooding, and degradation of a once natural waterway.

Ongoing programs through local waterway citizen groups are in the process of identifying sensitive habitat that is at risk due to negative impacts associated with increased development. This development results in the loss of valuable adjacent wetlands, fragmentation and loss of vital wildlife habitat, loss of channel structure that provides fisheries habitat, and increased sedimentation due to runoff associated with natural landuse modification. Opportunities exist to partner with these waterway user groups (i.e. NGOs) in order to supplement their ongoing efforts of ecosystem restoration and habitat enhancement around these sensitive waterbodies and their associated wetlands, which would help reduce coastal flooding and erosion. A large part of the comprehensive plan will develop the framework needed to build these relationships with local efforts that are underway and gaining momentum.

1.2.3.3 Freshwater Emergent marsh

Freshwater marshes act in many ways like salt marshes, but the biota reflect the increased diversity made possible by the reduction of the salt stress found in saltwater marshes. Plant diversity is high, and more birds use these freshwater marshes than any other marsh type. Because they are inland from the saline parts of the estuary, they are close to urban centers, which make them more prone to human impacts associated with urbanization, runoff, development pressures, etc. The freshwater newly emergent marshes are formed in pro-grading deltas that depend on flooding waters to supply their nutrient needs. One of the challenges facing the sustainability of the freshwater marsh is a lack of sediment from upstream. Also, pollutants from upstream wash downstream, which could cause an eutrophic environment that harms the plants. Lack of sediment hampers natural accretion and causes further erosion and subsidence. Old fill, houseboats, sewage runoff pollution, and erosion further exacerbate the problems. Marshes serve as floodwater retention and over time, the loss of these marshes has contributed to increased flooding throughout the coast, especially in the developed areas south of Interstate-10.

Oyster Bayou is a prime example of what has been described. Oyster Bayou was once a small tributary to Mississippi Sound that meandered through the historic grounds of Jefferson Davis' mansion, known as Beauvoir. As a result of the U.S. Highway 90 construction, development of the Mississippi Coast Coliseum, and many other residential and commercial developments, Oyster Bayou has been degraded and no longer functions as a natural system. Local efforts are currently underway to restore Oyster Bayou; however, additional study/efforts are needed to effectively restore this natural system. Projects like this one provide opportunities for the MsCIP efforts to again partner with local restoration efforts.

Emergent marshes absorb and dissipate wave energy and somewhat reduce storm surge. The Pascagoula River basin received major flooding damage during Hurricane Katrina due to the large storm surge. Even though the tidal range is low, because the inland slope is so slight, freshwater marsh still are tidally influenced but are mostly overridden by wind driven tides and storm runoff. Many species of ducks and waterfowl use these freshwater systems, which are important components of the Mississippi Flyway, the direct route of migrating waterfowl (i.e. their north-south route). Many species use Coastal Mississippi as overwintering grounds for foraging of diverse invertebrates, plant roots, and tubers. These freshwater systems have been designated as critical habitat for the threatened Gulf sturgeon, an anadromous fish that use both the Pearl and Pascagoula River systems for staging, spawning, migration routes, and feeding. The juvenile Gulf sturgeon may spend several years upriver before migrating back to the ocean. This valuable habitat is important for survival of the species. The freshwater marsh serves as havens for shrimp, crabs, etc, during periods of droughts which causes higher salinity within the estuary and salt marshes.

1.2.4 Palustrine System

The palustrine system includes all nontidal wetlands dominated by trees, shrubs, and persistent emergents. It also includes small, shallow, permanent or intermittent waterbodies, such as ponds or coastal plain depressional wetlands. Coastal Mississippi is interlaced with a rich and diverse complex system of vital wetlands that provide floodwater storage, groundwater recharge, water filtering and purification systems, as well as wildlife habitat that include Pine Savannahs, headwater slopes (Bayhead Drain), swamps, and ephemeral pools.

1.2.4.1 Pine Savannah

Pine Savannah wetlands found in Coastal Mississippi provide for diverse habitat for a number of plants and animals including many T&E species found only in these unique habitats. Pine Savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. This wetland habitat is under increased developmental pressures due to the extreme and urgent housing need faced by Mississippians as they are trying to rebuild. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform. Due to the nature of the flat coastal plains with little relief, these lands are some of the first to be considered for housing development. Urbanization and developmental pressure have created what are commonly referred to as forested wetlands. These wetlands are significantly different than what occurred naturally in Pine Savannah habitats. Lack of fire and altered hydrology allow hardwoods, various shrub species, and increased pine basal area to dominate what should be emergent grasses with very few pines in the overstory layer. Fragmentation causes loss of wildlife corridors and contiguous expanses of habitat necessary for continued species existence. Coastal Mississippi has lost over half of its Pine Savannahs due to urbanization throughout the area; thus, creating a threatened ecosystem that in turn is home to many T&E species. Because of the loss of these habitats, the species dependent upon them are increasingly becoming diminished.

1.2.4.2 Depressional Wetlands

A unique depressional wetland type, locally just known as “ponds” exists in the central Gulf coastal plain. Ponds are rain filled by mid-winter, remain high until mid-April, and then drop through October with some drying completely through the heat of the summer. They are typically shallow and flat bottomed. Vegetation changes abruptly from surrounding lands.

Ponds are widespread throughout the southeast but are especially prevalent in the coastal plain because of the flat terrain. Based on substrate which is predominantly citronelle soil-based ponds and are formed through the dissolution and removal of kaolinitic clays from surface rainfalls on a runoff, and shallow seepages. These are naturally occurring and are located in the central Gulf coastal plain from Pearl River County, Mississippi to Okaloosa, Florida. These areas are not afforded protection through the CWA through the Corps’ regulatory program due to isolation rules. These habitats are lost directly by conversion to agriculture and forestry. They are temporarily wet portions of the year and landowners may not realize they exist. Additionally, they’re adversely affected by land management of the adjacent uplands. The resultant changes in hydrology, and management of uplands degrades water quality. Lack of burning also results in tree growth and a reduction of the herbaceous community.

The ephemeral nature of the ponds prevents the persistence of fish, which allows uninhibited use by breeding amphibians. Amphibians have very important functions within the food chains of both aquatic and terrestrial systems. Amphibians consume aquatic vegetation as well as invertebrates and other vertebrates, and in the absence of fish, are usually the top predators in freshwater systems. Consequently amphibians influence the population dynamics of other organisms, as well as the cycling of nutrient and the flow of energy. Concerns have increased about declines and disappearances of the amphibian populations worldwide, with habitat destruction and modification being major causes cited (Wake and Morowitz 1991). These small wetlands are extremely valuable for obtaining biodiversity. Loss causes direct reduction in the connectivity in the remaining species population. They’re also being lost to invasive exotics, such as privet and Chinese Tallow.

1.2.4.3 Headwater Slopes – Seeps, Bayhead Drains

Slope wetlands normally are found where there is a discharge of groundwater to the land surface. They normally occur on sloping lands; elevation gradients may range from steep hillsides to slight slopes. Slope wetlands are usually incapable of depressional storage because they lack the necessary closed contours. Principal water sources are usually groundwater return flow and interflow from surrounding uplands as well as precipitation. Hydrodynamics are dominated by downslope unidirectional waterflow. Slope wetlands can occur in nearly flat landscapes, if groundwater discharge is a dominant source to the wetland surface. Slope wetlands lose water primarily by saturation subsurface and surface flows and by evapotranspiration. Slope wetlands may develop channels, but the channels serve only to convey water away from the slope wetland. Changes in hydrology and deforestation and landclearing for development have caused a decline in these type wetlands throughout Coastal Mississippi.

1.2.4.4 Swamps – Bottomland Hardwood, Cypress – Tupelo

Trees in forested wetlands have developed several unique adaptations to the wetland ecosystem, creating what is commonly referred to as swamps. Tree adaptations commonly seen in swamps include cypress knees, wide buttresses and adventitious roots that provide gas transport to the rhizosphere. Swamp primary productivity is closely tied to hydrologic conditions, such as standing water, pulsing hydro-periods, and high water. Swamps have been shown to be nutrient sinks. This is true particularly in studies of nitrogen budget (i.e. farm fields runoff, golf courses, and yards fertilizer) and the swamps have been investigated for their value as nutrient sinks when wastewater is applied. Coastal Mississippi swamps are predominantly vegetated with cypress – tupelo species and bottomland hardwoods, known as river swamps, specifically the Pascagoula River Swamp and the Pearl River Swamp.

1.2.4.4.1 Cypress Tupelo Swamp

Cypress tupelo swamps were once common throughout the southeastern U.S. and only a small portion now remains (Figure 1.2.4.4.1-1). These swamps were abundant throughout the Pascagoula and Pearl River basins but have declined due to extensive logging operations during the late 1800s. Brandt and Ewel (1989) estimated only approximately 10% of cypress tupelo swamps found in pre-settlement times still remain in the U.S., particularly in the southeast including Coastal Mississippi. Removal of these trees created changed conditions, which altered hydrology and converted natural systems into open water and sometimes even mesic forests. When deepwater swamps are drained or when their dry period is extended dramatically, they become invaded by pine or hardwood species, which results in changes to functions of the wetlands. An example of reduced functions would be the loss of water purification, which results in a decline in overall water quality. Historically, farming, community development and urbanization resulted in portions of natural lands becoming developed while communities that thrived around the logging industry, such as Moss Point, Pascagoula, Gautier, and Pearlington, emerged. The remaining swamps continue to be impacted by non-point source runoff from surrounding urbanization. Ongoing logging operations continue to threaten and degrade these coastal swamps. This valuable commodity still exists today. Demands for housing continue to threaten the resource as filling occurs for future development further inland from the coastline and is commonly referred to as urban sprawl.

1.2.4.4.2 Bottomland hardwood forests

E. P. Odum describes these as an interface of man's most vital resource, mainly water and his living space, the land (1981). Major expanses of riparian ecosystems have been drained and cleared for agriculture and development. Bottomland hardwood forests are generally low-lying flat extensive floodplain swamps with strong seasonal hydrologic pulses with well developed soils.

Source: Corps

Figure 1.2.4.4.1-1. Cypress Tupelo Swamp

Bottomland hardwood forests provide floodwater retention and are valuable for many animals that seek its refuge, diversity of habitat, and abundant water, or that use it as a corridor for migration (Figure 1.2.4.4.2-1). The bottomland hardwood is an essential component of the Mississippi Coastal Birding Trail, ecotourism in South Mississippi that is part of the National Audubon Society. These areas are crucial for supporting neo-tropical migrant species. Protecting habitat produces more eco-tourism dollars. One of the major attractions and highly used sites exist along the Pascagoula River swamp, especially on the Lower Pascagoula Wildlife Management Area. The bird watching industry is large in the country and is growing in popularity. This area is part of the global network of Important Bird Areas. As these habitats are altered, filled, or destroyed, this ecosystem becomes fragmented causing decreases in populations of the dependent species. Increased flooding to nearby communities and residential development leads to further channelization to streams throughout the developed area, which creates further habitat destruction and fragmentation causing species to further decline. Thus, reduced breeding habitat and wintering habitat along with threats during migration, predation, or competition from other species, such as exotics and possible contaminants, such as direct exposure to chemicals, further negatively impact these habitats. It has been estimated that approximately $104 billion dollars are spent in the U.S. on eco-tourism per year (USFWS 2001a). In comparison, we, as a nation, only spent $88 billion on new car sales.

1.2.5 *Upland Forests*

Source: Corps

Figure 1.2.4.4.2-1. Bottomland Hardwood Forests

Coastal Mississippi upland forests are comprised of pine plantations, mixed pine hardwood, and maritime forests. Healthy forests are an important resource in the southeastern U.S. They provide clean air, jobs, recreation, tourism, healthy habitats for wildlife, and construction materials for homes. Coastal Mississippi has abundant uplands forests and some of those areas are owned by the USDA Forest Service. However, the majority of uplands forests are privately owned. The USDA Forest Service uses numerous practices to restore the health of the South's forests, such as thinning forests to reduce the risk of devastating diseases and insects from both private and public forestlands. The South's forests are different from those of 200 years ago and they continue to change. Urbanization, the absence of fire, harvesting, fragmentation, forest ownership, and forest uses are but a few components of this change. Current threats to upland forests in Coastal Mississippi are urbanization, lack of fire management, and harvesting of timber.

Maritime forests are located primarily along the coastline, coastal ridges, and on the barrier islands and are predominantly vegetated with live oaks, southern magnolia, redbay, yaupon, saw palmetto, and Spanish moss. These forests act as a barrier between the mainland and the sea because of their great tolerance of salt spray. This absorbs the salt spray before it can reach more sensitive species found further inland. Live oaks are disease resistant and are very dense, which helps them to stand up to hurricane winds. The live oak forests, historically referred to as Naval Live Oaks were harvested in early naval vessel construction during the 1800s. When migratory birds fly from South and Central Americas, this forest is important habitat because it is the first land the birds reach for several hundred miles. Migratory birds stop here to rest before continuing their migration northward.

The majority of upland forests in Coastal Mississippi is comprised of the mixed pine hardwood forest. These are widespread throughout and are under increased pressure due to urban sprawl as more and more residential and commercial ventures are developed. These forests are a result of past logging operations that changed the natural succession of native forests forever. They provide good hard mast for several species of wildlife including the Louisiana Black Bear, a federally listed threatened species.

An unnatural forest found throughout Coastal Mississippi consists of pine plantations, which are planted for harvesting. This is an agriculturally regulated crop throughout the southeast. Intensive pine plantation management practices are aimed at short rotation (12 or 15 years or less) and managed intensively with herbicides and fertilizers for maximum production for pulpwood and paper. These areas also require an intense site preparation to clear debris for planting, control residual vegetation, and to improve drainage. This often results in excessive sedimentation, changes in hydrology and non-point source pollution that includes runoff from herbicide treatments and fertilization. The areas frequently experience heavily compacted soils with fragipan development, which permanently alters the sites. Natural forests are lost to pine plantations and are planted with loblolly pines, a non-native plant. As a result of Hurricane Katrina and the associated losses of loblolly pines, studies were conducted that proved the native Longleaf was able to withstand higher winds and more people are becoming interested in planting this native species. This practice would be more beneficial even within a non-natural plantation setting.

1.3 Fauna

Many species of invertebrates and vertebrates make up the various fauna population along the Gulf coast. Invertebrate populations in Mississippi Sound and the nearshore area of the Gulf of Mexico transfer energy through the coastal food web. Microscopic estuarine zooplankton live throughout the water column with limited mobility. Larval stages of benthic forms and eggs and larval stages of many fish species are often interspersed throughout zooplankton. Many important commercial species feed upon zooplankton.

Vittor and Associates (1982) investigated the macrofauna of Mississippi Sound and selected areas in the Gulf of Mexico. Over 532 taxa from offshore Mississippi and Alabama and 437 taxa from the Mississippi Sound were identified. Densities of individuals varied from 910 to 19,536 individual/ yard^2 for the offshore and 1,200 and 38,863 individual/ yard^2 for the Sound area. Abundance of macrofauna is temporal with greatest densities occurring from fall to spring.

Oyster production in Mississippi depends on public reefs managed by the MDMR. The State of Mississippi accounts for about 13% to 17% of Gulf oyster landings. Reefs are located along the coast across the entire state with the largest reefs near the western boundary. According to a 1966 survey by W.J. Demoran, there were 9,934 acres of oysters. At that time, there were 582 acres of planted oyster beds. Additional acreage has been planted. A few small areas of oyster bottom have been leased for private development; however, production from these areas has been negligible. There have been considerable annual variations in size of productive areas due to natural ecological fluctuations, such as freshwater flow into the oyster beds. Many of Jackson County’s most productive areas have been closed to harvest due to increased pollution associated with coastal development.

Many commercially important species of crustaceans are harvested in Mississippi Sound and the nearshore of the Gulf of Mexico. Brown shrimp (*Penaeus aztecus*) is the main shrimp species harvested by commercial fishermen in the Gulf of Mexico and is the most important commercial species in the Mississippi Sound and Mobile Bay area. White shrimp and blue crab are also harvested within the study area. In addition to those commercial species, there is a very diverse community of crustaceans within Mississippi Sound and adjacent waters including a wide variety of forms and habitat preferences. Epibenthic crustaceans dominate the diet of flounder, catfish, croaker, porgy, and drum.

Christmas and Waller (1973) reported 138 fish species in 98 genera and 52 families taken from areas across Mississippi Sound. The major fisheries landed along the Mississippi Gulf coast are anchovies, menhaden, mullet, croakers, shrimp, and oyster. Jackson County, primarily the ports of Pascagoula and Moss Point, receives greater than 85% of all Mississippi landings, including all industrial fish (menhaden), 95% of the mullet, trout, and red snapper, and 74% of the croaker landed (Corps 1992).

The Cooperative Gulf of Mexico Estuarine Inventory and Study (GMEI) observed 251 fish species in its estuarine study area from a list of 294 fish species from Mississippi estuaries and continental shelf waters off Mississippi (Christmas and Waller 1973). The bay anchovy (*Anchoa mitchilli*), Gulf menhaden (*Brevoortia patronus*), Atlantic croaker (*Micropogon undulates*), spot (*Leiostomus xanthurus*), butterfish (*Perilus burti*), and sand seatrout (*Cynoscion areanarius*) composed 93 percent of the total number of fish collected. Over 93 percent of the fish caught were in the families *Engraulidae* (bay anchovy), *Clupeidae* (Gulf menhaden), and *Sciaenidae* (seatrout and spot).

The finfish industry in Mississippi is composed of two segments: menhaden and edible finfish (Posadas 2001). The state's menhaden industry is centered in Pascagoula and is responsible for Mississippi's fifth-place national ranking in total pounds of seafood landed. The Gulf fishing fleet contains approximately 50 large vessels owned by individual processing firms. Mississippi is a very small producer of edible finfish obtained commercially, with fewer than 30 individuals participating full-time (Posadas 2001). More than 300 commercial licenses are sold annually for the harvest of edible finfish, however, indicating many part-time participants. In addition, trawlers catch foodfish incidental to shrimping and industrial fishing. Total foodfish landings average about one million pounds annually.

The blue crab, *Callinectes sapidus*, and its smaller cogener, the Gulf crab, *Callinectes similes*, are abundant in Mississippi coastal waters. About 200 commercial crab licenses are sold annually in Mississippi, but only about 60 fishermen trap crabs. The other licenses are sold to allow for incidental harvest in other fisheries.

Annual landings from 1972 to 1992 averaged 1,378,831 pounds. Average annual landings from 1993 through 2000 declined markedly to 524,383 pounds; however, the reduced landings can be attributed to social, economic, and regulatory changes that have taken place in the fishery rather than major declines in stock abundance. The average number of blue crab trappers declined from 61 during the 1970s and 1980s to 42 during the 1990s (Guillory 2001). These accounts of the landings do not include crabs taken in local waters and landed in neighboring states, nor those taken on a subsistence or recreational basis.

While seafood landings in Mississippi are significant, the bulk of economic activity is generated by the processing sector. Much of the seafood processed in Mississippi is landed in other Gulf states. There are 32 processing plants and 22 wholesale operations in Mississippi, employing about 1,300 people. A study by Mississippi State University's Coastal Research and Extension Center documents the total economic impact of the Mississippi seafood industry: $489 million annually, including $256 million in income and about 28,000 man-years of employment (Posadas 2001).

Coastal wetlands of Mississippi Sound, St. Louis Bay, Biloxi Bay, Pascagoula Bay, and the tidal Pascagoula River provide the resource base for commercial and marine recreational fishing and tourism in Mississippi. The dockside value of commercial fish landings in Mississippi was almost $42 million in 1995. Recreational fisheries also play an important role in the state's economy. In 1991, 500,000 people spent more than $236 million fishing in Mississippi's waters, generating almost $14 million in state sales tax, resulting in $131 million in earnings, and supporting more than 8,000 jobs. Approximately one-quarter of the recreational fishing occurs in coastal waters. Communities such as Moss Point, Pascagoula, Gautier, Ocean Springs, Biloxi, Long Beach, Gulfport, Pass Christian and Bay St. Louis all depend on fishing to support their local economies (NOAA 2002).

Coastal Mississippi supports an array of reptiles, amphibians, birds, and mammals. Reptiles and amphibians found in the area include snakes, turtles, lizards, toads, frogs, salamanders, and crocodilians. Coastal Alabama and Mississippi have a great diversity of reptiles including 23 species of turtles, 10 species of lizards, 39 species of snakes, and the alligator. Eighteen species of salamanders and 22 species of frogs and toads are indigenous to the coastal region.

Mammals found within the area include marsupials, moles and shrews, bats, armadillos, rabbits, rodents, carnivores, even-toed hoofed mammals, and dolphins. Mammals occur within all habitats of the system, using underground burrows, the soil surface, vegetative strata, the air, and the water for feeding, resting, breeding, and bearing and rearing young. There are 57 species of mammals found in the area. Several species of mammals include the raccoon, river otter, gray fox, striped skunk, mink, whitetailed deer, bottlenose dolphin, beaver, possum, and nine-banded armadillo. A number of whales are known to occur offshore Mississippi and Alabama and occasionally are sighted within the Mississippi Sound.

Over 300 species of birds have been reported as migratory or permanent residents within the area, several of which breed there as well. Shorebirds include osprey, great blue heron, great egret, piping plover, sandpiper, gulls, brown and white pelicans, American oystercatcher, and terns. Birds of the area eat a great variety of foods, are also food to many predators, and exhibit a diversity of nesting behaviors.

On September 9, 2005, within 2 weeks after Hurricane Katrina struck coastal Mississippi, the U.S. Commerce Secretary announced a formal determination of a fishery failure in the Gulf of Mexico due to the devastation. This declaration was in response to a virtual fishery shutdown in the affected states, including Mississippi, due to major flooding, damage to fishing boats and fishing ports, waterways clogged with debris and closed processing facilities. This action was made through provision of the Magnuson-Stevens Fishery Conservation and Management Act, which makes Federal relief funds available to assess the impacts, restore the fisheries, prevent future failure and assist fishing communities' recovery efforts. The Administration is working with Congress and the State to identify on-the-ground needs and develop an emergency plan to meet those needs.

Environmental monitoring including analyses of fish, water, and sediment samples collected from coastal waters of the Mississippi has begun by Federal and State resource agencies including the MDMR, MDEQ, PRD and HCD of NOAA, USEPA, the Food and Drug Agency, and others. Toxicology surveys taken from Gulf of Mexico waters, marine species, and sediment samples, after Hurricane Katrina have determined no elevated toxins of bacteria exist and NOAA has stated no cause for concern. The samples were tested for toxins that might have been released into the marine ecosystem after hurricane flooding, such as pesticides and fire retardants, and results have shown all levels are well below Federal guidelines for safe seafood consumption. The samples were tested for potential bacteria such as *E. coli* and none harbored the bacteria. The presence of *Vibrio* bacteria was found as expected and all fish, crab, and shrimp should be thoroughly cooked prior to consumption as recommended by the Food and Drug Agency. It has been concluded that Gulf seafood was deemed safe for human consumption; NOAA is continuing its sampling program to detect potential trends or changes that might occur over time.

NOAA recently completed a survey which depicts that Hurricane Katrina did not cause a reduction in fish and shrimp populations in offshore areas for the Gulf of Mexico. Additionally, NOAA annual surveys of shrimp and bottomfish, completed in November 2006, shows some species, such as the commercially valuable and overfished red snapper, to have a higher population in 2005 than the average populations between 1972 and 2004 which could be a result of the reduction in fishing activities in the Gulf of Mexico since Hurricane Katrina. NOAA will continue to monitor potential population changes due to damaged habitats, nursery areas and wetlands.

Oyster reefs have been seriously impacted by Hurricane Katrina and all reefs in coastal Mississippi will remain closed until further notice. Many boats were damaged or lost, and many processing facilities were damaged or destroyed. There are signs the reefs are beginning some of the healing processes on their own; however, much work will be needed to restore the oyster reefs to their former prime condition. Extensive sampling of the reefs is currently being conducted by the MDMR to provide information needed to plan extensive long-term recovery activities. Initial assessments of the reef conditions are underway but at present, are incomplete. Conditions of the reefs are highly variable. Generally, offshore areas were heavily scoured. Recent very heavy oyster spat set (less than one inch in length) was found in some of these areas with no spat set in other areas. Some light SAVs, marsh grass and drift wood were found. Inshore reefs generally had moderate to very low numbers of live oysters in some areas with other areas revealing no live oysters. Some of these areas had a good recent oyster spat set, typically lower than the offshore reefs (MDMR Press Release September 23, 2005).

Greater amounts of debris were found closer to shore than in the offshore areas and consisted of housing materials, such as lumber, siding and wire screens, SAVs, marsh grass, roots, twigs, pine needles, branches, palmetto and other leaves. Some oysters were found to be spawning. Deep gullies and holes were cut into the waterbottoms in many places by the extreme currents of Hurricane Katrina. Mud also covered many of the samples collected both inshore and offshore. Dredging proved to be very difficult due to the amount of debris in the water and reef contours having changed (MDMR Press Release September 23, 2005).

The initial assessments indicate that a majority of the commercial oyster resource and substrate have been scoured away, buried by sedimentation and debris, or moved. Additional assessments will be conducted by MDMR to better define the extent of loss of oyster resource or habitat. Cooperation from all parties is vital for reconstruction and revitalization of the Mississippi Oyster Program and reefs. Assistance has been received and additional assistance is expected from many local, state, and federal agencies in order to develop programs to involve the oyster fishermen and industry in this recovery effort.

1.4 Federal T&E Species and Their Critical Habitats

1.4.1 Baseline Conditions

Coastal Mississippi is home to 19 federally listed T&E, or candidate species. Federally listed species known to occur within the project area are shown on Table 1.4.1-1. Several other T&E species are known from marine habitats in the Gulf of Mexico. These species are blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), Sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), hawksbill sea turtle (*Eretmochelys imbricata*), and leatherback sea turtle (*Dermochelys coriacea*). These T&E marine species might be occasional visitors to the project area.

Table 1.4.1-1.
Federally Listed Rare T&E Species

Common Name	Scientific Name	Status	County	Habitat
Alabama red-bellied turtle	*Pseudemys alabamensis*	LE	Harrison, Jackson	Submerged aquatic vegetation in brackish coastal rivers; freshwater reaches
Black pine snake	*Pituophis melanoleucus ssp. lodingi*	C	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Brown pelican	*Pelecanus occidentalis*	LE	Hancock, Harrison, Jackson	Feeds over water in coastal areas, nests on small islands.
Eastern indigo snake	*Drymarchon corais couperi*	LT	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Gopher tortoise	*Gopherus polyphemus*	LT	Hancock, Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Green sea turtle	*Chelonia mydas*	LT	Hancock, Harrison, Jackson	Shallow coastal waters with SAV and algae, nests on open beaches.
Gulf sturgeon	*Acipenser oxyrhynchus desotoi*	LT	Hancock, Harrison, Jackson	Migrates from large coastal rivers to coastal bays and estuaries

Inflated Heelsplitter	*Potamilus inflatus*	LT	Harrison	Soft, stable substrata in slow to moderate currents of tributaries and large rivers
Kemp's Ridley sea turtle	*Lepidochelys kempii*	LE	Hancock, Harrison, Jackson	Nearshore and inshore coastal waters, often in salt marshes
Loggerhead sea turtle	*Caretta caretta*	LT	Hancock, Harrison, Jackson	Open ocean; also inshore areas, bays, salt marshes, ship channels, and mouths of large rivers
Louisiana black bear	*Ursus americanus luteolus*	LT	Hancock, Harrison, Jackson	Bottomland hardwood forest; frequently ranges into other habitats
Louisiana quillwort	*Isoetes louisianensis*	LE	Hancock, Harrison, Jackson	Small blackwater streams with sand and gravel substrate and forest cover
West Indian Manatee	*Trichechus manatus*	LE	Hancock, Harrison, Jackson	Fresh and salt water in large coastal rivers, bays and estuaries.
Mississippi gopher frog	*Rana capito sevosa*	LE	Harrison, Jackson	Fire-dependent, upland longleaf pine forests; open, ephemeral upland pools
Mississippi sandhill crane	*Grus canadensis pulla*	LE	Jackson	Wet pine savannah
Pearl darter (Pascagoula River System)	*Percina aurora*	C	Jackson	Rivers and large creeks with sand and gravel bottoms and flowing water.
Piping Plover	*Charadrius melodus*	LT	Hancock, Harrison, Jackson	Barrier islands and coastal beaches
Red-cockaded woodpecker	*Picoides borealis*	LE	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Yellow-blotched map turtle	*Graptemys flavimaculata*	LT	Jackson	Rivers and large creeks with habitat suitable for basking

LT = listed threatened, LE = listed endangered, C = candidate for listing
Source: Mann, 2000. Bald eagle was delisted from threatened in August 9, 2007.

1.4.1.1 Alabama Red-bellied Turtle

The Alabama red-bellied turtle (*P. seudemys alabamensis*) is a relatively large freshwater turtle with a carapace (top shell) length of up to 13 inches (Figure 1.4.1.1-1). The plastron (bottom shell) is orange to red in color; the carapace is olive green, brown, or black, accompanied by distinct vertical markings in yellow, orange or red. The Alabama red-bellied turtle is distinguished from other similar species by the stripes of color on its head, and also the shape of the upper jaw (USFWS 1989). This turtle primarily feeds on aquatic plants and is most common in sluggish bays and bayous in brackish marshes adjacent to the main channels of large coastal rivers (Mann 2001). In Alabama, the turtle is known from the lower reaches of the Alabama River and its tributaries in Baldwin and Mobile Counties. In Mississippi, recent surveys have located Alabama red-bellied turtles in the lower reaches of the Old Ft. Bayou, Escatawpa, and Pascagoula Rivers in Jackson County, and Tchoutacabouffa and Biloxi Rivers in Harrison County (Mann 2001).

Source: USFWS

Figure 1.4.1.1-1. Alabama Red-Bellied Turtle Photograph

This turtle was listed as endangered by the USFWS on 16 June 1987; it is threatened by low reproductive success and taking of adult turtles. Although adult turtles spend most of their time feeding and basking in SAV, they must return to land to lay eggs. Disturbance of nests and destruction of eggs has been identified as major threats to the population; local residents collect eggs and live turtles for food. Recreational use of natural sand beaches have also disturbed nests and dredged material areas, such as Gravine Island in Alabama (USFWS 1989). Feral pigs, crows, and fire ants also raid nests to eat turtle eggs. Some collection of these turtles for the pet trade still persists, as does trawling to collect turtles for food. Some turtles are harvested accidentally by commercial fishermen in nets, traps, and trawls. Recovery efforts include learning more about the life history of the species; protecting nests in recreational areas; preventing destruction of aquatic vegetation used for basking, cover, and food; preventing taking of eggs and adult turtles through law enforcement; and educating the public about turtle conservation.

1.4.1.2 Black Pine Snake

The black pine snake (*P. melanoleucus lodingi*) is one of 15 subspecies of a widespread snake species commonly called bullsnake or gopher snake (Figure 1.4.1.2-1). This non-venomous snake with black or dark brown scales and a reddish or white snout can grow up to 8.3 feet in length (Jordan 1998). Black pine snakes feed on small mammals, but will also take other vertebrates, such as birds, lizards and other snakes. The black pine snake was once known in longleaf pine forests from extreme southeastern Louisiana, east to southern Mississippi, to extreme southwestern Alabama (Jordan 1998). Recent surveys have found the highest concentration of black pine snakes in DeSoto National Forest in Mississippi, including habitat in Harrison County (USFWS 2001b). The snakes are known from eight other Mississippi counties and three counties in Alabama. Black pine snake is believed to be extirpated from Louisiana (Natureserve 2001a), and has been listed as a candidate for protection under the Endangered Species Act.

Source: USFWS
Figure 1.4.1.2-1. Black Pine Snake Photograph

Black pine snakes require well-drained, upland longleaf pine forest with few shrubs and abundant herbaceous vegetation. Historically, these conditions were maintained with frequent wildfires. Longleaf pine forests were once abundant in the southeastern U.S., but have been reduced to less than 5% of their former range (USFWS 2001b). Degradation, fragmentation, and fire suppression of upland longleaf forests is thought to be responsible for the decline of black pine snakes (Natureserve 2001a). Conversion of upland habitats to urban development, agriculture, and pine plantation have made habitat unsuitable for the species. Pine snakes avoid forests with a dense mid-story shrub layer, which is often the result of fire suppression (USFWS 2001b). There is evidence that the snakes use the underground portions of rotting pine stumps for shelter. Modern forestry practices that remove stumps and downed trees before replanting threaten the survival of black pine snakes (Natureserve 2001a). Direct human impacts such as roadkill, shooting, and collecting black pine snakes for the pet trade are thought to be significant threats to the snake's survival (USFWS 2001b).

1.4.1.3 Brown Pelican

The brown pelican (*P. occidentalis*) is a large brown and gray seabird with a characteristic long bill attached to an expandable pouch used for capturing prey (Figure 1.4.1.3-1). Brown pelicans can reach up to 8 pounds and have wingspans of more than 7 feet (USFWS 2001c). These birds are known from marine environments in coastal areas of the U.S.; they feed by diving for small fish. Breeding pairs use small coastal islands for nesting, building nests in trees or on the ground. The brown pelican suffered dramatic population losses during the middle of the 20^{th} century because DDT poisoning impaired reproductive success. Since DDT use was banned in the U.S., brown pelican populations have increased or stabilized. In the Southeastern U.S., the brown pelican is considered endangered only in Mississippi and Louisiana (USFWS 2001c). Threats to brown pelicans include disturbance of nesting colonies, entanglement in fishing gear, oil and toxic chemical spills, severe storms, heavy tick infestations, and unpredictable food availability (USFWS 2001c).

Source: USFWS

Figure 1.4.1.3-1. Brown Pelican Photograph

1.4.1.4 Eastern Indigo Snake

The Eastern indigo snake (*D. corais couperi*) is a large constrictor, usually 5 to 7 feet in length, with a heavy black body and red or orange on the chin and throat (Figure 1.4.1.4-1). This snake actively forages along wetland edges to feed on rodents, birds, reptiles, and amphibians. In coastal Mississippi, Eastern indigo snakes prefer high, dry, mature pinelands dominated by longleaf pine (*P. palustris*), wiregrass (*Aristida stricta*), and turkey oak (*Q. laevis*). They are often found in association with gopher tortoises, using gopher tortoise burrows for shelter. The species is most abundant in peninsular Florida and south Georgia, although scattered populations persist in coastal Mississippi, Alabama, the Florida panhandle, and coastal South Carolina (Natureserve 2001b).

Source: USFWS

Figure 1.4.1.4-1. Eastern Indigo Snake Photograph

The eastern indigo snake is listed threatened by the USFWS. Species decline is thought to be directly related to the loss of mature longleaf pine forest in the Southeast coastal plain. Much of this habitat has been converted to pine plantation stocked with species other than longleaf pine. In other areas, fire suppression has allowed hardwood trees to invade and become dominant in former mature longleaf pine forests. The decline in the Eastern indigo snake may also be related to the decline in the gopher tortoise. Fewer gopher tortoises create fewer burrows, reducing shelter for the Eastern indigo snake as well as many other vertebrates and invertebrates. Research indicates that Eastern indigo snakes might require large areas of contiguous habitat in excess of 10,000 acres in order to thrive. Efforts are underway to restore longleaf pine forests in the southeastern U.S. and maintain these areas with prescribed fire. Commercial collection of these snakes for the pet trade (now illegal) has also caused the species to decline. However, Eastern indigo snakes are able to reproduce in captivity, which might facilitate captive breeding programs to reintroduce the species to appropriate habitat (Natureserve 2001b).

1.4.1.5 Gopher Tortoise

The gopher tortoise (*G. polyphemus*) is a terrestrial turtle with a carapace (top shell) length between 12 to 24 inches (USFWS 1990a). The carapace is dark brown to gray-black, and often worn smooth from moving through the deep burrows it digs for shelter (Figure 1.4.1.5-1). The gopher tortoise is found in the southeastern coastal plain from Louisiana to South Carolina, although it is rare and scattered throughout its range. Gopher tortoises can live for several decades. Depending on habitat quality, it may take between 10 and 20 years for tortoises to become sexually mature. Egg laying and nesting takes place in the spring months. Clutch size is usually between 5 and 9 eggs. Nest predation is high, with roughly 90 percent of gopher tortoise nests destroyed by predators such as raccoons, armadillos, and opossums. Predation on hatchling tortoises is also very high. Research indicates that hatchling mortality rates of more than 90 percent are not unusual (Natureserve 2001c).

Source: USFWS

Figure 1.4.1.5-1. Gopher Tortoise Photograph

Gopher tortoises are found in a variety of upland habitats. The best tortoise habitat consists of open upland woodlands with well-drained sandy soils suitable for easy burrowing. An open tree canopy lets in sunlight necessary for the growth of grasses and herbaceous plants on which the gopher tortoise feeds (USFWS 1990a). Sunlight is thought to be necessary for tortoise basking thermoregulation, and also for egg incubation while nesting (Natureserve 2001c). Periodic low-intensity fires have been observed to be beneficial to maintaining gopher tortoise habitat. In the western part of its range, including Mississippi, gopher tortoises inhabit xeric longleaf pine–scrub oak forests located on sand ridges. They may also found on the edges of crop fields, in pastures, and power line right-of-ways (USFWS 1990a).

The gopher tortoise has been listed threatened by the USFWS. The species population has undergone an 80 percent decline in the past 100 years (Natureserve 2001c). Decline is expected to continue because of habitat elimination and fragmentation. In the early 20th Century, gopher tortoises were collected for food. This problem has decreased, although tortoises continue to be adversely impacted by rattlesnake collectors who pour toxic substances down gopher tortoise burrows in order to flush out resident rattlesnakes. Road kill is also a persistent problem for adult turtles (Puckett and Franz 2001). The most frequently cited reason for gopher tortoise decline throughout its range is loss of habitat. Conversion of pinelands to agricultural lands has reduced gopher tortoise habitat in Mississippi (Natureserve 2001c). Fire suppression in longleaf pine natural communities has resulted in an increase in shrub cover and a decrease in herbs and grasses used for food. Throughout its range, conversion of open woodlands to dense slash pine plantation monocultures has eliminated large tracts of suitable habitat. In Florida, urbanization has also eliminated gopher tortoises and tortoise habitat.

1.4.1.6 Green Sea Turtle

The green sea turtle (*C. mydas*) was listed on July 28, 1978. The breeding population off Florida and the Pacific coast of Mexico is listed as endangered while all others are threatened (NOAA 2001). Green sea turtles range throughout the Atlantic, Pacific, and Indian Oceans, primarily in tropical regions and shallow waters (except during migration), inside reefs, bays, and inlets. The green sea turtles are attracted to lagoons and shoals with abundant marine grass and algae on which the turtles feed.

Green sea turtles have been observed in the Mississippi Sound (Figure 1.4.1.6-1). In fact, a juvenile green sea turtle was captured in the mouth of Back Bay of Biloxi several years ago (Mann 2000, Mann, T. 2003. Personal comm.). The turtles are not known to nest on the Mississippi coast or barrier islands, but might be attracted to seagrass beds as a food source in nearshore waters (Gunter 1981).

Source: USFWS

Figure 1.4.1.6-1. Green Sea Turtle Photograph

Exploitation of green sea turtle nesting grounds either by human interference or pollution poses the greatest threat to these turtles. The greatest cause of decline in green turtle populations is commercial harvest for eggs and food in nesting areas outside the U.S. Incidental catch during commercial shrimp trawling is a continuing source of mortality that adversely affects recovery in North America (NOAA 2001). Today, turtle excluder devices (TEDs) pulled by shrimp boats help reduce mortality from net entanglement.

1.4.1.7 Gulf Sturgeon

The Gulf sturgeon (*A. oxyrhynchus desotoi*) was listed throughout its range as a threatened subspecies on September 30, 1991. The Gulf sturgeon, considered a subspecies of the Atlantic sturgeon *(A. oxyrhynchus)*, is an anadromous fish, migrating from saltwater into large coastal rivers (Figure 1.4.1.7-1). Historically, the Gulf sturgeon occurred in rivers from the Mississippi River to the Suwannee River, and in bays and estuaries from Florida to Louisiana. Little is known about current population levels outside the Suwannee, Apalachicola and Pearl Rivers, but they are thought to have declined from historic levels.

Source: USFWS
Figure 1.4.1.7-1. Gulf Sturgeon Photograph

Adult fish spend 8 to 9 months each year in rivers and 3 to 4 of the coolest months in estuarine Gulf rivers. In the Suwannee River, adult sturgeons frequent areas near the mouths of springs and cool water rivers during the summer months. Adult fish tend to congregate in deeper waters of rivers with moderate currents and sandy and rocky bottoms. Seagrass beds with mud and sand substrates appear to be important marine habitats (Mason and Clugston 1993). The adult Gulf sturgeon is known to spend the fall and winter months in the estuary of Mississippi Sound and migration routes extend from the Sound to the Back Bay of Biloxi. Occurrences of the Gulf sturgeon have been documented within Mississippi Sound, Biloxi River, and Pascagoula River area. The Gulf sturgeon is known to spawn in the Pearl River system. Major threats to this rare, primitive species include physical barriers (e.g., locks and dams) to spawning grounds, habitat loss, and poor water quality.

On March 19, 2003, USFWS and NOAA designated 14 geographic areas among the Gulf of Mexico rivers and tributaries as critical habitat for the Gulf sturgeon (FR Vol. 68, No. 53). These 14 geographic areas encompass approximately 1,739 river miles and 2,333 square miles of estuarine and marine habitat. In Mississippi, the critical habitat includes 392 kilometers of the Pearl River, including Bogue Chitto, and 126 miles of the Pascagoula River, including the Leaf, Bouie, Chickasawhay, and Big Black Creek tributaries (FR Vol. 68, No. 53).

1.4.1.8 Inflated Heelsplitter

The inflated heelsplitter (*P. inflatus*), also known as the Alabama heelsplitter, was listed was listed as threatened throughout its range on September 28, 1990 (Figure 1.4.1.8-1). The inflated heelsplitter is a large freshwater mussel with a brown to black shell with green rays in young individuals (USFWS 1993). Like other freshwater mussels, the inflated heelsplitter feeds by filtering food particles from the water column. The specific food habits of the species are unknown, but other juvenile and adult freshwater mussels have been documented to feed on detritus, diatoms, phytoplankton, and zooplankton. The diet of inflated heelsplitter, like other freshwater mussels, comprises water (until encysted on a fish host) and fish body fluids (once encysted). The preferred habitat of this species is soft, stable substrata in slow to moderate currents. It has been found in sand, mud, silt and sandy-gravel, but not in large or armored gravel. It is usually collected on the protected side of bars and may occur in depths over 20 feet. The occurrence of this species in silt does not necessarily indicate that the species can be successful in that substratum. Adult mussels may survive limited amounts of silt, whereas juveniles would suffocate. In addition, it is possible that the species was established in an area prior to deposition of the silt (USFWS 1993). George et al (1996) documented this species in the Lower Pearl River in 1996.

Source: USFWS

Figure 1.4.1.8-1. Inflated Heelsplitter

1.4.1.9 Kemp's Ridley Sea Turtle

The Kemp's Ridley sea turtle *(L. kempii)* was listed as endangered throughout its range (Gulf of Mexico and Atlantic Ocean) on December 2, 1970, and its status has remained unchanged (Figure 1.4.1.9-1). The Kemp's Ridley population has declined since 1947 (when an estimated 42,000 females nested in one day) to a nesting population of approximately 1,000 in the mid-1980s. The decline of this species was primarily due to human activities including collection of eggs, fishing for juveniles and adults, killing adults for meat and other products, and direct take for indigenous use. In addition to these sources of mortality, Kemp's Ridley sea turtles have been subject to high levels of incidental take by shrimp trawlers. Kemp's Ridley turtles are occasionally caught on fishing hooks and incidentally injured by recreational anglers and boaters (Mann personal communication, 2003). Today, under strict protection, the population appears to be in the earliest stages of recovery. The increase can be attributed to two primary factors: full protection of nesting females and their nests in Mexico, and the requirement to use TEDs in shrimp trawls both in the U.S. and Mexico (NOAA 2001).

Source: USFWS

Figure 1.4.1.9-1. Kemp's Ridley Sea Turtle Photograph

The major habitat for Kemp's Ridley sea turtle is the nearshore and inshore waters of the northern Gulf of Mexico, especially Louisiana waters outside of the nesting season. Kemp's ridley sea turtles are often found in salt marsh habitats; the majority nest on approximately 4.9 miles of beach between Barra del Tordo and Ostional in the state of Tamaulipas, Mexico. It is the only known major nesting beach in the world for this turtle.

1.4.1.10 Loggerhead Turtle

The loggerhead turtle (*C. caretta*) was listed as threatened throughout its range on July 28, 1978 (43 FR 82808), and its status has not changed (Figure 1.4.1.10-1). The loggerhead sea turtle is widely distributed throughout its range and 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 (Corps, Mobile District 2000). Loggerheads are known to migrate over long distances, with tagged specimens having been recaptured 1,200 to 1,500 miles from the point of release. Loggerheads are seen annually inshore in Mississippi Sound, but are more commonly seen offshore in the proximity of oil rigs (Mann personal communication, 2003). Most recent evidence suggests that the number of nesting females in South Carolina and Georgia may be declining, while the number of nesting females in Florida appears to be stable. Until the 1970s, loggerhead turtles were commercially harvested for their meat, eggs, leather, and fat. Its meat and leather are not as valuable as the green sea turtle, and its shell is of less value than the hawksbill. However, in places where regulations are not enforced, the harvest of turtle meat and eggs remains a problem. Because of their feeding behavior and their habit of wintering in shallow waters, loggerheads, along with Kemp's Ridley sea turtles, are more likely to be caught in large shrimp trawl nets and drown. Today, TEDs pulled by shrimp boats help reduce mortality from net entanglement by allowing turtles to escape from the nets. However, loggerhead turtles are hooked by recreational fishermen offshore near oil rigs and are frequently injured by being struck by boats and boat propellers (Mann personal comm. 2003).

Source: USFWS
Figure 1.4.1.10-1. Loggerhead Sea Turtle Photograph

Source: USFWS
Figure 1.4.1.11-1. Louisiana Black Bear Photograph

Loggerheads are capable of living in a variety of environments, such as in brackish waters of coastal lagoons and river mouths. During the winter, they may remain dormant, buried in the mud at the bottom of sounds, bays, and estuaries. The major nesting beaches are located in the southeastern U.S., primarily along the Atlantic coast of Florida, North Carolina, South Carolina, and Georgia. As of 1981, there was no record of loggerhead turtles nesting in Mississippi, although a small group of these turtles were seen swimming off the western end of Horn Island in 1976. Mississippi Heritage Program database includes a record for loggerhead turtle southeast of Deer Island (Mann 2000).

Loggerheads are know to nest annually in small numbers on the Gulf Island National Seashore in Mississippi, with one nest being documented on the mainland beach and one nest several years ago on Round Island (Mann personal comm. 2003).

1.4.1.11 Louisiana Black Bear

The Louisiana black bear (*U. americanus luteolus*) is one of 16 subspecies of American black bear (Figure 1.4.1.11-1). Black bears are large, bulky mammals that can grow to more than 600 pounds. The Louisiana black bear differs from other subspecies by having a longer, narrower skull and larger molar teeth (USFWS 1995). The Louisiana black bear was listed as threatened in its former range of Louisiana, southern Mississippi, and eastern Texas on January 7, 1992. Other black bear species that could occur in this area are treated as threatened due to similarity of appearance. Black bears are opportunistic omnivores that rely heavily on plant foods such as acorns and berries. Bears are also known to eat insects and carrion, and to raid garbage cans, agricultural crops, and bee hives (USFWS 1995).

Louisiana black bears typically inhabit bottomland hardwood forests, but may also use other habitat types, especially when food is available. Bottomland hardwood forests feature the food sources and denning sites that are necessary for successful bear reproduction. Many different species of hardwood trees, shrubs, vines, and herbaceous plants provide food at different times of the year. Large hollow trees common in swamps provide ideal dens for winter hibernation and birthing young. Reproducing populations of Louisiana black bear are thought to be restricted to two large bottomland hardwood forest areas in Louisiana (USFWS 1995). The Tensas River Basin and Atchaflaya River Basin support several reproducing sub-populations of bears. Louisiana black bears can range long distances in search of food and have been sighted far from the Tensas and Atchaflaya River Basins. Bottomland hardwood forests along lower Pearl River and lower Pascagoula River have suitable habitat that might be occupied by Louisiana black bears (USFWS 1995). It is difficult to determine whether bears seen outside Louisiana are reproducing females, or only wandering subadult bears. There has been at least one confirmed sighting of a female with cubs in Mississippi, and USFWS monitoring data indicate that females will cross the Mississippi River from Louisiana to Mississippi (Rummel 2002).

Habitat loss is thought to be the primary threat to the survival of the Louisiana black bear. Former bear habitat had been reduced by 80 percent within its historic range by 1980 (USFWS 1995). Remaining bear habitat has been fragmented and degraded; degraded habitats often do not provide sufficient food for bears. As bears travel in search of food, they are more likely to come into conflict with humans, and human-related mortality is thought to pose a direct threat to Louisiana black bears. Education programs and strong penalties for poachers have been implemented to help reduce intentional harm to bears (USFWS 1995). Land acquisition and bottomland hardwood forest restoration efforts are underway to increase habitat available to bears. Fewer than 160 Louisiana black bears were thought to exist in breeding habitats in Louisiana in 1995 (USFWS 1995).

1.4.1.12 Louisiana Quillwort

Louisiana quillwort (*I. louisianensis*) is a primitive seedless wetland plant with a grass-like appearance, although it is actually more closely related to ferns (Figure 1.4.1.12-1). It has many simple, hollow leaves 1 to 2 inches wide and up to 24 inches long. Quillworts reproduce by producing spores in special structures embedded in the leaves. The Louisiana quillwort is restricted to gravel bars and sandy soils in or near shallow blackwater creeks and overflow channels in narrow riparian woodlands or bayheads in pine flatwoods and upland longleaf pine vegetative communities (USFWS 1996). This species has been documented in the Pleistocene High Terraces ecoregion in southern Mississippi. Louisiana quillwort was discovered in southeastern Louisiana in 1972. In 1996, it was known from a handful of sites in southeastern Louisiana and in two Mississippi counties, Jackson and Perry (USFWS 1996). Recent survey work however, has discovered this plant in more than 50 locations spread over 10 Mississippi counties (Natureserve 2001d).

Source: USFWS

Figure 1.4.1.12-1. Louisiana Quillwort Photograph

Louisiana quillwort is listed as endangered by the USFWS. Threats to quillwort populations include timber harvest, sand and gravel mining, construction, and other activities with potential to alter the hydrology of small stream habitats (Natureserve 2001d). Louisiana quillwort is adapted to dynamic stream ecosystems in which natural processes scour and redeposit individual plants and spores on constantly changing gravel bars and sandy streambanks. This species has not been observed to grow on silt substrates even when other habitat factors are appropriate (USFWS 1996).

1.4.1.13 West Indian Manatee

The West Indian or Florida manatee (*T. manatus*) was listed as an endangered species in 1967 (under a law that preceded the Endangered Species Act of 1973) throughout all or a significant portion of its range (USFWS 2001g). The West Indian manatee also is protected at the federal level under the Marine Mammal Protection Act of 1972.

The West Indian manatee (sometimes called sea cow) is found primarily along the coast of Florida. Most adult manatees are about 10 feet long and weigh 800 to 1,200 pounds, although some larger than 12 feet and weighing as much as 3,500 pounds have been recorded (Figure 1.4.1.13-1). These “gentle giants” have a tough, wrinkled brown-to-gray skin that is continuously being sloughed off. Hair is distributed sparsely over the body. With stiff whiskers around its mouth, the West Indian manatee’s face looks like a walrus without tusks.

Source: USFWS
Figure 1.4.1.13-1. West Indian Manatee Photograph

Manatees spend their lives moving between freshwater, brackish, and saltwater ecosystems. They prefer large, slow-moving rivers, river mouths, and shallow coastal areas, such as coves and bays. Great distances may be covered as the animals migrate between winter and summer grounds. During the winter, the U.S.' West Indian manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. During summer months, manatees may migrate as far north as coastal Virginia on the east coast and the Louisiana coast on the Gulf of Mexico. Manatees are known to migrate through the study area, and several have been rescued in the study area during cold weather outbreaks (USFWS personal communication 2003). In fact, one or more West Indian manatees have been seen annually in Mississippi waters each year for the past decade (Mann personal communication 2003).

Manatees are adversely impacted by collisions with boats, crushing and drowning in canal locks, harassment by skin divers and boaters, entanglement in fishing line, toxins ingested during red tide (toxic algae bloom) events, and destruction of seagrass beds for boating facilities. Manatee population trends are poorly known, but deaths are thought to have increased steadily (6.1% a year, exponential regression, 1976 to 1991). Mortalities from collisions with watercraft are up 10.3% a year from 21% of all deaths in 1976–1980 to 29% in 1986–1991. Deaths of dependent calves are up 12% a year, from 14% to 24% of all deaths. The manatee has difficulty rebounding from these threats because of its late breeding maturity and its low reproductive rate. In general, the birth rate is not able to keep up with manatees killed by boats. The combination of high mortality rates and low reproductive rates have led to serious doubts about the species' ability to survive in the U.S.

1.4.1.14 Mississippi Gopher Frog

The Mississippi gopher frog (*R. capito sevosa*) is a medium-sized, stocky frog with brown, black, or gray coloration and many dark spots and warts (Figure 1.4.1.14-1). Adult frogs reach approximately 3 inches in body length. These frogs spend considerable time underground in abandoned gopher tortoise burrows, mammal burrows, and under tree stumps (USFWS 2000). Mississippi gopher frogs breed in isolated ponds surrounded by sandy, upland, longleaf pine forest. Breeding ponds only fill with water after substantial winter rains; Mississippi gopher frogs, therefore, do not reproduce successfully in drought years. The Mississippi gopher frog population has been reduced to approximately 100 known individuals near one breeding pond in Harrison County, Mississippi.

Development projects in the vicinity of the pond have severed movement corridors that formerly helped sustain the frog population and otherwise have deteriorated remaining frog habitat. The species was at one time known from coastal counties and parishes from the Mississippi River in Louisiana east to the Mobile River in Alabama (USFWS 2000).

The Mississippi gopher frog was listed as endangered whenever found west of the Mobile and Tombigbee Rivers in Alabama, Mississippi, and Louisiana (USFWS 2001). Threats to the last remaining frog population include inbreeding, local changes in hydrology, fire suppression, sedimentation, toxic chemical runoff, and habitat destruction and fragmentation. The last remaining breeding pond used by the species is located within 656 feet of a proposed highway, housing development, and golf course (USFWS 2000).

Source: USFWS

Figure 1.4.1.14-1. Mississippi Gopher Frog Photograph

1.4.1.15 Mississippi Sandhill Crane

Mississippi sandhill crane (*G. canadensis pulla*) is a large wading bird similar in appearance to herons and other cranes (Figure 1.4.1.15-1). Sandhill cranes have gray feathers with long legs and neck. Adult sandhill cranes have a red patch on the forehead (USFWS 2001d). The Mississippi sandhill crane is a non-migratory subspecies of sandhill crane found only in Jackson County, Mississippi. Most sandhill cranes are migratory, but there are three recognized subspecies that do not migrate: Florida sandhill crane (*G. canadensis pratensis*), Cuban sandhill crane (*G. canadensis nesiotes*), and Mississippi sandhill crane. Somewhere between 110 to 120 Mississippi sandhill cranes existed in the wild in 2000 (Natureserve 2001e). An USFWS captive breeding program has been successful in reintroducing several breeding cranes to the Mississippi Sandhill Crane National Wildlife Refuge. These cranes are found in wet and dry open forests and savannahs with longleaf pine, slash pine, and cypress (*T. ascendens*). Mississippi sandhill cranes feed on live prey, such as amphibians, worms and insects. At certain times of the year, the cranes also eat plant foods, such as corn, roots, tubers, and pecans. Mississippi sandhill cranes reproduce slowly, raising only one chick per year. Hatching success is low, and very few young birds have been observed. Low population levels and inbreeding might be responsible for low hatching success and a high rate of disease in Mississippi sandhill cranes (USFWS 2001d).

Source: USFWS
Figure 1.4.1.15-1. Mississippi Sandhill Crane Photograph

Critical habitat for the Mississippi sandhill crane covers about 26,000 acres in Jackson County. The main threat to the survival of this subspecies is loss and fragmentation of habitat. Conversion of open forests to dense pine plantation, fire suppression, encroachment of residential and commercial developments, roads that facilitate access to and fragment crane habitat, and chemical spraying on roadsides all contribute to population decline (Natureserve 2001e, USFWS 2001d). These cranes are territorial when nesting. Nests can be separated by a half mile or more. If the Mississippi sandhill crane population recovers, more suitable habitat will be needed so that adult cranes have space to hatch and rear young. Habitat maintenance, which requires occasional fire—either prescribed or wild, is increasingly difficult with the encroachment of suburbia and urban areas on crane habitat.

1.4.1.16 Pearl Darter

The pearl darter (*P. aurora*) is a small fish in the perch family that usually grows to just over 2 inches in length. It has a blunt nose, horizontal mouth, large eyes placed high on the head, and a black spot on the caudal fin (Figure 1.4.1.16-1). Pearl darters have been collected in rivers and large creeks with moderate current and sand and gravel substrates. It is not found in deep, sluggish pools, lacustrine ecosystems, or headwater creeks with insufficient flow. Chironomids and small crustaceans probably make up a large part of pearl darter diet (USFWS 2001e).

Never considered abundant, the pearl darter was once found in both the Pearl and Pascagoula River systems. It has not been collected in the Pearl River system since 1973. The pearl darter is thought to be restricted to 88 river miles of the Pascagoula River watershed (USFWS 2001e). The pearl darter has the potential to occur in the Pascagoula River and its tributaries in Jackson County. Threats include sedimentation from forestry and development in the watershed, permitted industrial and municipal discharges of toxic chemicals and sewage, sand and gravel mining, and proposed impoundments for reservoirs. Sand and gravel mining activities are ongoing in the Pascagoula River system. In-stream mining not only removes substrates preferred by the pearl darter, it also delivers sediment to aquatic habitats downstream. Holes in river channels left by sand and gravel mining activities function similar to lake habitats, which pearl darters avoid (Natureserve 2001f).

Source: USFWS
Figure 1.4.1.16-1. Pearl Darter Photograph

1.4.1.17 Piping Plover

The piping plover *(C. melodus)* is a small, stocky, sandy-colored bird resembling a sandpiper (Figure 1.4.1.17-1). The adult has yellow-orange legs, a black band across the forehead from eye to eye, and a black ring around the base of its neck. Like other plovers, it runs in short starts and stops. When still, the piping plover blends into the pale background of open, sandy habitat on outer beaches where it feeds and nests. The bird's name derives from its call notes, plaintive bell-like whistles which are often heard before the birds are seen.

Source: USFWS
Figure 1.4.1.17-1. Piping Plover Photograph

The piping plover is listed as a federally threatened species within the watershed of the Gulf Coast as listed in the Federal Register, December 11, 1985. The piping plover breeds on sandy or pebble coastal beaches of Newfoundland and southeastern Quebec to North Carolina. These birds winter primarily on the Atlantic coast from North Carolina to Florida, although some migrate to the Bahamas and West Indies. Decline in piping plover populations has been linked to loss of breeding habitat. Shoreline development, river flow alteration, river channelization, and reservoir construction have all led to loss of breeding habitat. The piping plover is a federally threatened and state endangered shorebird. All piping plovers are considered threatened species under the Endangered Species Act when on their wintering grounds. The piping plover winters along the Gulf coast but does not nest in Mississippi. The Mississippi Natural Heritage Program database indicates three over-wintering sightings of piping plovers: one along the beaches of Gulfport, one on Deer Island, and one on Ship Island.

Several factors are contributing to the decline of the piping plover along the Atlantic coast. Commercial, residential, and recreational development have decreased the amount of coastal habitat available for piping plovers to nest and feed. Human disturbance often curtails breeding success. Foot and vehicular traffic may crush nests or young. Excessive disturbance may cause the parents to desert the nest, exposing eggs or chicks to the summer sun and predators. Interruption of feeding may stress juvenile birds during critical periods in their development. Pets, especially dogs, may harass the birds. Developments near beaches provide food that attracts increased numbers of predators, such as raccoons, skunks, and foxes. Domestic and feral cats are also very efficient predators of plover eggs and chicks. Stormtides may inundate nests.

Piping plovers winter in coastal areas of the U.S. from North Carolina to Texas. 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). The international piping plover winter censuses of 1991 and 1996 located only 63 percent and 42 percent of the estimated number of breeding birds, respectively (Haig and Plissner 1992; Haig and Plissner 1993). Of the birds located on the U.S. wintering grounds during these two censuses, 89% were found on the Gulf Coast and 8% were found on the Atlantic Coast.

1.4.1.17.1 Critical Habitat for the Piping Plover

On August 9, 2001, the USFWS designated 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for the wintering population of the piping plover. This includes approximately 1,798.3 miles of mapped shoreline and approximately 165,211 acres of mapped area along the Gulf and Atlantic coasts and along margins of interior bays, inlets, and lagoons.

Critical habitat identifies specific areas that are essential to the conservation of a listed species, and that may require special management considerations or protection. 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 coastal areas that support intertidal beaches and flats (between annual low tide and annual high tide) and associated dune systems and flats above annual high tide.

1.4.1.17.2 Critical Habitat Designation/Land Ownership

The critical habitat areas contained within the conservation units described below constitute USFWS's best evaluation of areas needed for the conservation of the wintering piping plover. The USFWS may revise critical habitat through a rulemaking process if new information becomes available. USFWS calculated linear distances of critical habitat shoreline (in kilometers and miles) by ownership for the state of Mississippi. In addition, state-level values of area in hectares and acres were calculated for the critical habitat units by ownership (Table 1.4.1.17.2-1). Ownership for both the shoreline and units were broken into three classes (Federal—federally owned lands, State—state owned lands, and Other—non-Federal or non-state mapped lands). Assignment of ownership was based on existing digital state-level managed/protected lands geodata set (GIS data set) where possible. If no existing digital data were available, ownership was assigned based on other data sources. Detailed descriptions of critical habitat units for the piping plover are provided in Table 1.4.1.17.2-2.

Table 1.4.1.17.2-1.
Approximate Land Area of Designated Critical Habitat Units for Wintering Piping Plover (Rows)

Land Owner	Shoreline Ownership in Hectares (acres)	Shoreline Ownership in Kilometers (miles)
Federal	2,376 (5,870)	98.2 (61.4)
State	0 (0)	0 (0)
Other	1,479 (3,655)	105.9 (66.2)
Total	3,855 (9,525)	204.1 (127.6)

USFWS, 2001i

Table 1.4.1.17.2-2.
Piping Plover Critical Habitat in Mississippi

Unit	Description
MS-1	Lakeshore through Bay St. Louis. 41 ha (101 ac) in Hancock County. This unit extends from the north side of Bryan Bayou outlet and includes the shore of the Mississippi Sound following the shoreline northeast approximately 15.0 km (9.3 mi) and ending at the southeast side of the Bay Waveland Yacht Club. The landward boundary of this unit follows the Gulf side of South and North Beach Boulevard and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-2	Henderson Point. 34 ha (84 ac) in Harrison County. This unit extends from 0.2 km (0.12 mi) west of the intersection of 3rd Avenue and Front Street and includes the shore of the Mississippi Sound following the shoreline northeast approximately 4.4 km (2.7 mi) to the west side of Pass Christian Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-3	Pass Christian. 77 ha (190 ac) in Harrison County. This unit extends from the east side of Pass Christian Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 10.5 km (6.5 mi) to the west side of Long Beach Pier and Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-4	Long Beach. 38 ha (94 ac) in Harrison County. This unit extends from the east side of Long Beach Pier and Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 4.4 km (2.7 mi) to the west side of Gulfport Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-5	Gulfport. 39 ha (96 ac) in Harrison County. This unit extends from the east side of Gulfport Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 4.8 km (3.0 mi) to the west side of the groin at the southern terminus of Courthouse Road, Mississippi City, MS. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-6	Mississippi City. 62 ha (153 ac) in Harrison County. This unit extends from the east side of the groin at the southern terminus of Courthouse Road, Mississippi City, MS, and includes the shore of the Mississippi Sound following the shoreline northeast approximately 7.9 km (4.9 mi) to the west side of President Casino. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-7	Beauvoir in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.
MS-8	Biloxi West in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.

Table 1.4.1.17.2-2.
Piping Plover Critical Habitat in Mississippi (continued)

Unit	Description
MS-9	Biloxi East in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.
MS-10	Ocean Springs West. 11 ha (27 ac) in Jackson County. This unit extends from U.S. 90 and includes the shore of Biloxi Bay following the shoreline southeast approximately 1.9 km (1.2 mi) to the Ocean Springs Harbor inlet. The landward boundary of this unit follows the Bay side of Front Beach Drive and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-11	Ocean Springs East. 7 ha (17 ac) in Jackson County. This unit extends from the east side of Weeks Bayou and includes the shore of Biloxi Bay following the shoreline southeast approximately 1.8 km (1.1 mi) to Halstead Bayou. The landward boundary of this unit follows the Bay side of East Beach Drive and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-12	Deer Island. 194 ha (479 ac) in Harrison County. This unit includes all of Deer Island, where primary constituent elements occur to the MLLW. Deer Island is privately owned
MS-13	Round Island. 27 ha (67 ac) in Jackson County. This unit includes all of Round Island to the MLWW and is privately owned.
MS-14	Mississippi Barrier Islands. 3,168 ha (7,828 ac) in Harrison and Jackson Counties. 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.
MS-15	North and South Rigolets. 159 ha (393 ac) in Jackson County, MS, and 12 ha (30 ac) in Mobile County, AL. This unit extends from the southwestern tip of South Rigolets Island and includes the shore of Point Aux Chenes Bay, the Mississippi Sound, and Grand Bay following the shoreline east around the western tip, then north to the south side of South Rigolets Bayou; then from the north side of South Rigolets Bayou (the southeastern corner of North Rigolets Island) north to the northeastern most point of North Rigolets Island. This shoreline is bounded on the seaward side by MLLW and on the landward side to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur. Approximately 4.4 km (2.7 mi) are in Mississippi and 2.9 km (1.8 mi) are in Alabama. Almost half the Mississippi shoreline length is in the Grand Bay National Wildlife Refuge.

1.4.1.18 Red-Cockaded Woodpecker

Red-cockaded woodpeckers (*P. borealis*) are small- to medium-sized woodpeckers 8 to 16 inches long, with a 20 to 24 inch wingspan (Figure 1.4.1.18-1). White spots on black feathers give the bird a “ladder- back” appearance. Red-cockaded woodpeckers have a white cheek patch on either side of the head, as well as a black cap. Male woodpeckers have thin red streaks on the cheeks that are barely visible (Natureserve 2000). Red-cockaded woodpeckers nest and forage in mature pine stands frequently burned to promote an open understory and thick herbaceous layer. Research indicates that red-cockaded woodpeckers excavate nest cavities in pines 60 years or older (USFWS 1998a). The birds were once abundant in pinelands throughout the southeastern U.S., but fire suppression, subsequent hardwood encroachment, conversion to short-rotation pine plantations, and development have eliminated most suitable habitat.

Source: USFWS

Figure 1.4.1.18-1. Red-Cockaded Woodpecker Photograph

The red-cockaded woodpecker is listed by the USFWS as endangered throughout its range. Scattered populations exist from southeastern Oklahoma to southern Virginia, south to Florida and eastern Texas. In Mississippi, red-cockaded woodpeckers have been reported in Harrison and Jackson Counties.

1.4.1.19 Yellow-Blotched Map Turtle

The yellow-blotched map turtle (*G. flavimaculata*) is a small turtle that gets its name from the distinctive yellow blotches on its carapace (top shell) (Figure 1.4.1.19-1). The turtle has a greenish-black body covered with yellow stripes. The plastron (bottom shell) is yellow to tan in color. Adult male turtles have been observed with carapace length between 3.5 to 4.8 inches, while the normally larger female turtles have been observed with carapace length of 4.1 to 8.5 inches (USFWS 1993). Several prominent spine-like projections extend from the top of the carapace. Yellow-blotched map turtles are endemic to the Pascagoula River system. They live in the main channels of rivers and large creeks; they have also been observed in oxbow lakes (USFWS 1993). These turtles have been observed in the Pascagoula and Escawtawpa Rivers in Jackson County. Yellow-blotched map turtles avoid small streams where the surface of the water is shaded by bank vegetation. Aquatic insects and snails are thought to make up a large part of the turtles' diet. Turtles often bask on snags and logs that have fallen in the water. Nesting occurs during the summer months on sandbar beaches (USFWS 1993).

Source: USFWS

Figure 1.4.1.19-1. Yellow-Blotched Map Turtle Photograph

Yellow-blotched map turtle populations in the upper Pascagoula watershed have been in decline since the early 1990s. Navigation improvement projects to remove logs and snags from the Pascagoula River have taken away structures needed by the turtles for basking (USFWS 1993). Snag removal has also adversely impacted populations of the turtles' invertebrate prey that use snags as habitat. Gravel mining activities in the watershed have increased sedimentation and further impacted aquatic invertebrate populations. Four reservoirs and ongoing channel modification projects in the Pascagoula River system have altered or eliminated sandbars that turtles use for nesting. These small, colorful turtles are illegally collected for the pet trade, and basking turtles are used for target practice by some individuals (USFWS 1993). Some turtles have been observed to drown in illegal catfish traps.

Water pollution is a serious problem in some Pascagoula River tributaries. Permitted industrial and municipal effluents degrade water quality (USFWS 1993). Brine discharge from oil fields and a dioxin spill that once prompted a fishing ban in the Pascagoula River have also impacted river water quality. Sedimentation and water pollution are threats to aquatic invertebrates, a main food source for the turtles. Food availability is thought to be a limiting factor for turtle populations. Nest predation is likely to average between 90% and 100%, typical for similar turtle species. Few juvenile turtles were observed in a 1989 survey. Reproduction might be impaired by lack of nesting habitat, exclusion of the turtles from suitable nesting beaches by excessive human presence, or effects of chemical pollutants on turtle reproductive biology. Direct and indirect adverse impacts to yellow-blotched map turtles would be expected from point and non-point source discharges of toxic chemicals, brine, sewage, and sediment to the Pascagoula River system (USFWS 1993).

1.4.2 Historical Trends

1.4.2.1 Introduction

There are 14 T&E species that use terrestrial or freshwater aquatic habitats, in the three coastal counties in Mississippi. Several of these species are endemic to Mississippi or the Gulf Coast, while others migrate long distances to breed or winter in coastal Mississippi. Population declines in some of these species are linked to effects of habitat loss, taking for food or pets, or water pollution in Mississippi. In other species, declines have been linked to phenomena outside the study area. Because most T&E species are rare, population information is difficult to obtain. A review of current literature shows most of the populations of listed species appear to be in decline or have stabilized at levels below what many scientists believe will ensure the long-term survival of the species. Populations of two listed bird species—the bald eagle (recently delisted) and brown pelican—appear to be increasing throughout the Southeast as effects of the now-banned pesticide DDT decrease with time. Although most of the listed species have habitat requirements more specific than the land use categories in the land use analysis, some useful conclusions can be drawn from the available data.

1.4.2.1.1 The Period of 1972 through 1992

Land area in Hancock, Harrison, and Jackson counties combined (excluding surface water) is just over 1.1 million acres. From 1972 to 1992, the largest land use change observed was a loss of more than 200,000 acres of pine forest. At the same time, agricultural lands and shrub-scrub and cutover land together increased by slightly more than 150,000 acres. Deciduous forest cover increased by about 40,000 acres. Urban land and land devoted to transportation infrastructure increased by more than 20,000 acres, while emergent wetlands declined by about the same amount. Overall, natural land cover declined by approximately 8 % from 1972 to 1992, while agricultural and shrub-scrub lands increased by more than half, and urban land by a third.

The decline of frequently burned, open-canopy longleaf pine woodlands has occurred throughout the southeastern U.S. in the past century. From 1972 to 1992, just over 200,000 acres of pine forest (including wet pine savannah) were lost in the three-county study area. Loss and fragmentation of mature pine forests are thought to be caused by a combination of fire suppression, hardwood encroachment, timber harvest, conversion to short-rotation pine plantations, and development (USFWS 1990a). Part of the observed increase of 40,000 acres of deciduous forest might be explained by fire suppression and hardwood encroachment in pine forests. The loss of the once-dominant longleaf pine forest has been implicated in the population declines for a number of now T&E species in the Southeast, including several species known from Hancock, Harrison, and Jackson Counties. Black pine snake, eastern indigo snake, gopher tortoise, Mississippi gopher frog, and red-cockaded woodpecker are all in some way dependent on frequently burned, open-canopy pine woodlands, and are in decline because of loss and fragmentation of their habitats throughout their range. Similarly, the population of the Mississippi sandhill crane that forages and breeds only in coastal wet slash pine savannah has been reduced to just over 100 birds. Population declines that led to the listing of these species were observed before 1992, and in many instances were underway before 1972.

Although habitat loss is frequently cited as a major cause for localized extinction of endangered species, the effects of habitat fragmentation are in many cases equally important. From 1972 to 1992, land use analysis shows losses of pine forests and emergent wetlands. Likewise, increases were observed in cutover land, shrublands, and deciduous forest, which reflect conversion of pine forest to these other types. Large areas of pine forest and wetlands have been fragmented into smaller habitats that are in many cases less suitable for the long-term survival of many species. For example, research indicates that eastern indigo snakes might require large areas of contiguous habitat in excess of 10,000 acres in order to thrive (Natureserve 2001b). Habitat fragmentation undoubtedly increased during the period from 1972 to 1992, and has been implicated as one of many continuing cumulative adverse impacts to T&E species.

Many species are listed as T&E for reasons beyond habitat loss and fragmentation. Trends in human behavior can be also significant to population dynamics of T&E species. Many of the federally listed reptiles in coastal Mississippi were at one time collected for the pet trade or for food. For example, Alabama red-bellied turtle eggs and adults have been collected for food by local residents (USFWS 1989). Gopher tortoises were also collected for food during the mid-20th century (USFWS 1990a), and eastern Indigo snakes were collected for the pet trade (Natureserve 2001b). The taking of listed reptiles and turtle eggs probably continued up until the time most the species were protected under the Endangered Species Act in the 1980s. Illegal and accidental take is still likely to occur into the future, but take has been observed to decline as exploitable species become scarcer and more difficult to locate (USFWS 1989).

Land use in urban and agricultural settings has indirect effects upon the rest of the watershed. For example, pesticides and herbicides can run off agricultural lands and leave residues in nearby streams and wetlands. The pesticide DDT was implicated in the drastic population declines of the bald eagle and brown pelican in the middle part of the 20th century. Since DDT was banned, bald eagle and brown pelican populations have rebounded. Although the effects of DDT appear to be waning, other pollutants are thought to be responsible for declines in some aquatic species in the three-county study area. For example, populations of yellow-blotched map turtle and pearl darter are thought to have been adversely impacted by point and non-point source discharges of toxic chemicals, brine, sewage, sediment, discharge from oil fields, and a dioxin spill (USFWS 1993). Some of these sources of pollution could be reflected in the observed increases from 1972 to 1992 of more than 20,000 acres of urban and transportation land in the three-county area. Along with increases in urban land come increases in impervious surface, which increased by about 10,000 acres from 1972 to 1992. Impervious surface is known to increase the rate at which runoff reaches streams. Urban runoff is a known non-point source of sediment and chemical pollutants that can have adverse effects to aquatic life.

1.4.2.1.2 The Period of 1992 through 2000

The years 1992—2000 saw an increase of about 8,000 acres of urban land and about 50,000 acres of cutover/scrubland in the three-county study area. At the same time, the 1.1 million-acre three-county area lost about 15,000 acres of agricultural lands, about 6,000 acres of deciduous forest, about 5,000 acres of emergent wetlands, and roughly 34,000 acres of pine forests. Losses in agricultural lands and deciduous forest represent a reversal from the observed increases in these land use types from 1972–1992. The rate of pine forest loss slowed by about half in the period 1992–2000, while the rate of increase in cutover/shrub land stayed about the same. It is likely that efforts to replant pine trees in timber production lands are catching up to the rate of timber harvest in the region. Under natural conditions there is some degree of change expected between cutover land, pine forest, and deciduous forest. Natural phenomena, such as fires, floods, and hurricanes, can dramatically rearrange the landscape. Also, species dominance in vegetative communities can change as old trees die and new trees of different species take their place. Forests, wetlands, and agricultural lands that are converted to urban uses tend to remain in urban use for long periods of time however and seldom change back to natural environments.

Agricultural lands were not considered “natural” for the purposes of this study. Some T&E species (such as the gopher tortoise and Louisiana black bear), however, have been observed foraging in pastures and field edges (USFWS 1990a, USFWS 1995). If left uncultivated, agricultural lands have the potential to revert to forests, floodplains, or other natural land use types. The small increase in natural lands seen from 1992 to 2000 in the three-county area most likely came at the expense of agricultural lands; agricultural lands lost about 15,000 acres during that time. That 15,000 acres was split to supply the acreage increases seen in natural and developed lands. Although agricultural lands are not considered primary T&E species habitat, conversion of pastures and farms to urban lands represents a loss of land available for habitat restoration projects.

1.5 Essential Fish Habitat

The Magnuson Fisheries Conservation and Management Act of 1976 (the Act) was passed to promote sustainable fish conservation and management. Under the Act, the NOAA, HCD was granted legislative authority for fisheries regulation in the United States within a jurisdictional area located between three miles to 200 miles offshore, Exclusive Economical Zone depending on geographical location. The NOAA, HCD was also granted legislative authority to establish eight regional fishery management councils responsible for the proper management and harvest of fish and shellfish resources within these waters. Measures to ensure the proper management and harvest of fish and shellfish resources within these waters are outlined in Fisheries Management Plans prepared by the eight councils for their respective geographic regions. The Mississippi Sound system and nearshore Gulf of Mexico is within the management jurisdiction of the Gulf of Mexico Fisheries Management Council.

NOAA, HCD recognized that many marine fisheries are dependent on nearshore and estuarine ecosystems for at least part of their life cycles. The Act was reauthorized, and changed extensively via amendments in 1996 (P.L. 104-297), which aimed to stress the importance of habitat protection to healthy fisheries. The authority of the NOAA, HCD and their councils was strengthened by the reauthorization to promote more effective habitat management and protection of marine fisheries. Specific marine environments important to marine fisheries are referred to as EFH in the Act and are defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (16 U.S.C. § 1802 (10)). The EFH regulations (at 50 C.F.R. 600 Subpart J) provide additional interpretation of the definition of EFH: “*Waters* include aquatic areas and their associated physical, chemical, and biological properties that are used by fishes and may include areas historically used by fishes. *Substrate* includes sediment, hardbottom, structures underlying the waters, and any associated biological communities. *Necessary* means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. *Spawning, breeding, feeding, or growth to maturity* covers all habitat types used by a species throughout its life cycle.” Tables 1.5-1 and 1.5-2 provide those species managed by the Gulf of Mexico Fishery Management Council and those species managed in the Gulf of Mexico under federally implemented Fishery Management Plans.

Table 1.5-1. Gulf of Mexico Fishery Management Council

Shrimp Fishery Management Plan
- brown shrimp - *Farfantepenaeus aztecus*
- pink shrimp - *F. duorarum*
- royal red shrimp - *Pleoticus robustus*
- white shrimp - *Litopenaeus setiferus*

Red Drum Fishery Management Plan
- red drum - *Sciaenops ocellatus*

Reef Fish Fishery Management Plan
- almaco jack – *Seriola rivoliana*
- anchor tilefish - *Caulolatilus intermedius*
- banded rudderfish – *S. zonata*
- blackfin snapper - *Lutjanus buccanella*
- blackline tilefish - *Caulolatilus cyanops*
- black grouper- *Mycteroperca bonaci*
- blueline tilefish – *C. microps*
- cubera snapper – *L. cyanopterus*
- dog snapper – *L. jocu*
- dwarf sand perch - *Diplectrum bivittatum*
- gag grouper - *M. microlepis*
- goldface tilefish – *C. chrysops*
- goliath grouper - *Epinephelus itajara*
- gray snapper – *L. griseus*
- gray triggerfish - *Balistes capriscus*
- greater amberjack – *S. dumerili*
- hogfish - *Lachnolaimus maximus*

Stone Crab Fishery Management Plan
- Florida stone crab - *Menippe mercenaria*
- Gulf stone crab – *M. adina*

Spiny Lobster Fishery Management Plan
- spiny lobster - *Panulirus argus*
- slipper lobster - *Scyllarides nodife*

Coral and Coral Reef Fishery Management Plan
- varied coral species and coral reef communities comprised of several hundred species

Coastal Migratory Pelagic Fishery Management Plan
- cobia - *Rachycentron canadum*
- king mackerel – *Scomberomorus cavalla*
- Spanish mackerel - *S. maculatus*

lane snapper - *Lutjanus synagris*
lesser amberjack - *S. fasciata*
mahogany snapper – *L. mahogoni*
marbled grouper – *E. inermis*
misty grouper – *E. mystacinus*
mutton snapper – *L. analis*
Nassau grouper – *E. striatus*
queen snapper - *Etelis oculatus*
red hind - *Epinephelus guttatus*
red grouper – *E. morio*
red snapper - *L. campechanus*
rock hind – *E. adscensionis*
sand perch - *Diplectrum formosum*
scamp grouper - *M. phenax*
schoolmaster – *L. apodus*
silk snapper – *L. vivanus*
snowy grouper – *E. niveatus*
speckled hind - *E. drummondhayi*
tilefish - *Lopholatilus chamaeleonticeps*
vermilion snapper - *Rhomboplites aurorubens*
Warsaw grouper – *E. nigritus*
wenchman - *Pristipomoides aquilonaris*
yellowedge grouper *E .lavolimbatus*
yellowfin grouper – *M. venenosa*
yellowmouth grouper – *M. interstitialis*
yellowtail snapper - *Ocyurus chrysurus*

Table 1.5.2. Species Managed in the Gulf of Mexico under Federally Implemented Fishery Management Plans.

Billfish
blue marlin - *Makaira nigricans*
longbill spearfish - *Tetrapturus pfluegeri*
sailfish - *Istiophorus platypterus*
white marlin - *T. albidus*

Swordfish
swordfish - *Xiphias gladius*

Tuna
albacore - *Thunnus alalunga*
Atlantic bigeye - *T. obesus*
Atlantic yellowfin - *T. albacares*
skipjack - *Katsuwonus pelamis*
western Atlantic bluefin - *T. thynnus*

Sharks
Atlantic angel shark - *Squatina dumerili*
Atlantic sharpnose shark - *Rhizoprionodon terraenovae*
basking shark - *Cetorhinus maximus*
bigeye sand tiger - *Odontaspis noronhai*
bigeye sixgill shark - *Hexanchus vitulus*
bigeye thresher shark - *Alopias superciliosus*
bignose shark - *Carcharhinus altimus*
blacknose shark - *C. acronotus*
blacktip shark - *C. limbatus*
blue shark - *Prionace glauca*
bonnethead - *Sphyrna tiburo*

bull shark - *C. leucas*
Caribbean sharpnose shark - *R. porosus*
common thresher shark - *A. vulpinus*
dusky shark - *C. obscurus*
finetooth shark - *C. isodon*
Galapagos shark - *C. galapagensis*
great hammerhead - *S. mokarran*
lemon shark - *Negaprion brevirostris*
longfin mako shark - *Isurus paucus*
narrowtooth shark - *C. brachyurus*
Caribbean reef shark - *C. perezi*
oceanic whitetip shark - *C. longimanus*
porbeagle shark - *Lamna nasus*
sandbar shark - *C. plumbeus*
sand tiger shark - *O. taurus*
scalloped hammerhead - *S. lewini*
shortfin mako shark - *I. oxyrinchus*
silky shark - *C. falciformis*
sixgill shark - *H. griseus*
smalltail shark - *C. porosus*
smooth hammerhead - *S. zygaena*
spinner shark - *C. brevipinna*
whale shark - *Rhinocodon typus*
white shark - *Carcharodon carcharias*
night shark - *C. signatus*
nurse shark - *Ginglymostoma cirratum*
sharpnose sevengill shark – *Heptranchias perlo*
tiger shark - *Galeocerdo cuvieri*

CHAPTER 2. PROBLEMS AND OPPORTUNITIES

2.1 Problems

The problems caused by Hurricane Katrina within Coastal Mississippi are in association with the unprecedented storm surge and associated coastal flooding as a result of the large volumes of storm surge introduced into the system from the south, during the landfall of the tidal surge. Sediment and debris carried by the surge into many areas of the coastal system further impeded flow through drainage systems and has exacerbated existing coastal flooding, making the entire study area even more susceptible to inundation from smaller hurricanes, tropical storms, or even severe rainfall events.

The unprecedented storm surge has caused increased coastal erosion along the barrier islands coastline, the mainland shoreline, and along tidal and freshwater bodies throughout the study area. Some small communities in Coastal Mississippi suffered complete destruction, while others received unprecedented damage. The natural systems have further been degraded and in some cases, suffered complete destruction. Salt marshes and freshwater marshes suffered erosion and debris fill deposits on top of them. Coastal forests lost numerous trees as a result of the winds and numerous trees were killed due to salt spray as far inland as 20 miles. As a result, the natural environment has experienced further losses to fish and wildlife habitats and an overall decline in water quality. Due to the widespread destruction, there is increased development pressure being felt on remaining natural lands as people return and begin looking for housing. A number of residential and commercial developments are being proposed further inland of the coast, which has resulted in once natural lands becoming increasingly urbanized. This contributes to the ongoing problems that have faced Coastal Mississippi throughout the last two decades.

2.2 Opportunities

A comprehensive ecological analysis is being considered as part of the long-term efforts in Coastal Mississippi. This will ensure the stability and future sustainability of the natural system within Coastal Mississippi while enhancing the productivity of fish and wildlife habitat and restoring critical loss of fish and wildlife habitat that once existed. In addition to the environmental benefits, the economic benefits to the area will be realized for decades by preventing future damages to structures. Ongoing Corps programs, such as Continuing Authorities Programs, and opportunities exist to partner with the State of Mississippi and various other local NGOs to take advantage of ongoing established restoration programs. This partnering effort enables the Corps, Mobile District to ensure no duplication of efforts occurs while also building onto valuable relationships with State and local city and/or county governments and NGOs in order to ensure preservation of fish and wildlife habitat, restoration of ecosystems, prevention of saltwater intrusion, and ensure future sustainability of the diverse natural system that used to exist in Coastal Mississippi. Opportunities associated with the environmental component of the Comprehensive Report and Integrated Programmatic EIS include:

- Reduction of future hurricane and storm damage created by storm surge;
- Prevention of future saltwater intrusion exacerbated by storm surge associated with Hurricane Katrina;
- Reduction of coastal erosion due to shoreline instability;
- Restoration of ecosystems for preservation of fish and wildlife; and

- Reduction of loss of life and property by moving people out of low-lying, environmentally sensitive areas.

2.3 Study Goals and Objectives

Congress directed the Corps to conduct an analysis and design for comprehensive modifications and improvements in the Mississippi coastal area for the purposes of hurricane damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources purposes. Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the U.S. in its recorded history.

Around the 1950s, Coastal Mississippi had heightened development with both commercial and residential structures. Population began to increase during this period also. This increase continued with the onset of Hurricane Camille and has continued with each hurricane event. It is anticipated to increase following Hurricane Katrina.

With this development came the filling in of various kinds of wetland habitats. Natural ecosystem habitats, such as tidal marsh, freshwater marsh, wet pine savannah, and beaches, were altered, if not, completely destroyed. This development was severely impacted by the storm surge associated with Hurricane Katrina. Unfortunately much of Coastal Mississippi has been completely lost – both environmentally and culturally. The MsCIP effort will formulate alternatives that address Congress directives. In order to fully accomplish Congress directives - hurricane damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources purposes - the MsCIP efforts were divided between non-structural, structural, and environmental. These three PDTs worked closely to develop alternative(s) that accomplished all directives.

CHAPTER 3. DEVELOPMENT OF ENVIRONMENTAL MEASURES AND ALTERNATIVES

3.1 Environmental Restoration Measures Evaluated

The formulation of measures was based on watershed-scale assessments of hurricane and stormwater damage, saltwater intrusion, preservation of fish and wildlife, coastal erosion, flooding, navigation, and other problems and opportunities, in a collaborative approach involving Federal, state and local agencies, stakeholders, citizen groups, and NGOs. The strategy for analyzing post-storm conditions, both for past and potential future events, was developed by the interagency PDT, and reviewed by ITR Team, with approval by the Corps-HQ.

The interagency PDT is comprised of representatives from the following:

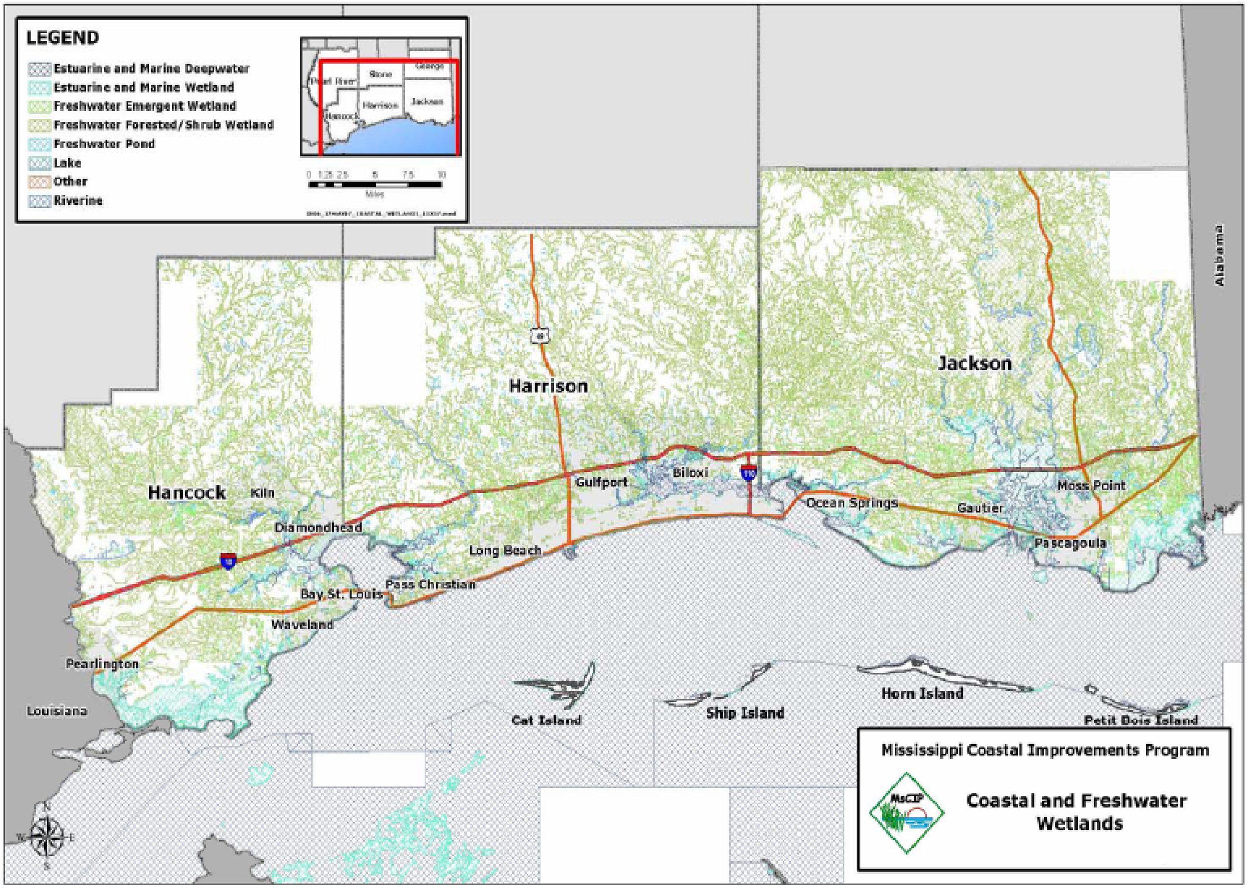
- USEPA
- FEMA
- USFWS
- NPS
- NOAA Fisheries, PRD and HCD
- NWS
- NRCS
- USGS
- MDMR
- MDEQ
- MDOT
- Mississippi SHPO
- Hancock, Harrison and Jackson Counties
- Communities of Bay St. Louis, Biloxi, D'Iberville, Gautier, Gulfport, Long Beach, Moss Point, Ocean Springs, Pascagoula, Pass Christian, and Waveland
- Coastal Restoration Network
- TNC
- Audubon Society
- Sierra Club

In analyzing potential measures, the PDT considered, in all cases in which it would be appropriate, integration of environmental measures within structural and non-structural potential solutions. The following measures have been identified as measures to be examined.

In order to manage all potential measures, the lines of defenses (LOD) concept were developed as a means to effectively address Coastal Mississippi. The LODs moving from offshore, to nearshore, shoreline, and inland, effectively reduce damage potential from large hurricane and storm events. The LOD concept is intended to extend the damage reducing attributes of natural or man-made features and to limit, as far as practicable, the inland reach of destruction. The concept is reasonably flexible and can be tailored to topographic and physical advantage, public preference, and economy.

LOD 1 consists of the four barrier islands that lie several miles to the south. These barrier islands are located along a littoral drift zone that moves sand westward creating three elongated islands and then to the westward most island where littoral currents are not as well defined. LOD 2 consists of essentially all the beaches along coastal Mississippi. Harrison County has the most beachfront with 26 miles extending from Biloxi Bay to St. Louis Bay. Hancock and Jackson County have several miles of beach. The beaches extend along less than half of the Mississippi coastline. Most of the dunes that existed along these beaches were destroyed by Katrina and much of the beach was damaged. LOD 3 consists of raising the roadway or seawall. All of the beaches described as LOD 2 have a roadway landward of the beach. The roads vary from local or county roads to U.S. Highway 90, a four-lane highway that extends across the entire Harrison County coast. The roadways vary in elevation from a few feet to several feet above sea level. All of these roads are evacuation routes and all have been damaged in past hurricanes. This coastal barrier will connect to public right-of-ways that will structurally tie these roadways to other, higher, LODs inland. Also associated with this continuous barrier will be several ring structures that will encircle areas that cannot be included behind the primary line. This will include the cities of Pascagoula, Moss Point, Gautier and Pearlington as well as some large residential developments. LOD 4 is would be the highest line. In order to protect much of the developed areas around Biloxi and St. Louis Bays, this line would be a structural barrier that would also cross the mouth of these bays. These barriers would be to prevent storm surge from moving in through the inlets of the bays. The structural barrier across the bays could be similar to designs used in Europe for storm surge protection. The general alignment of line 4 is envisioned along the path of a railway that crosses the coast of Mississippi. Computer simulations have predicted how far inland storm surge will extend if the worse-case hurricane hits the Mississippi coast. This would consist of LOD 5 and represents a line of safety where homes, facilities or transportation routes north of this line should not be affected by storm surge. This would be an area where hospitals, schools, emergency response and management facilities might be located. Present predictions based on modeling sets this line near elevation 40 feet.

The following environmental measures were evaluated and screened by the MsCIP Environmental PDT based on applicability to the specific problem area. Preliminary measures were assessed by the interagency PDT that included excavating, planting native species, removing exotic species, microtopographic contouring, and restoring of hydrologic connections (Figure 3.1-1). These were all carried further for additional development. The following measures were developed for ecosystem restoration. Several of these measures include integration of non-structural and structural components.



Source: Corps

Figure 3.1-1. Coastal and Freshwater Wetlands

3.1.1 Measures Addressing Saltwater Intrusion

Consists of evaluation of current conditions of saltwater effects on expansive marsh systems located in western and eastern portions of Coastal Mississippi. Diversions of freshwater from existing river systems and other potential measures would be evaluated based on ecosystems needs.

3.1.2 Ecosystem Restoration of Historical Wetlands Previously Developed

Development of an analysis tool – SDSS – by which to prioritize potential environmental restoration and/or homeowners assistance and relocation project areas based on historical conditions, damages from storm surge and coastal flooding, and location to existing natural undisturbed lands (i.e. potentially State of Mississippi or Federal lands).

3.1.3 Barrier Island Restoration

Partnering with the NPS to develop a vision for the barrier islands that would restore the sediment transport and budget system by implementing beach, dune, and littoral system restoration projects, as well as further evaluate the merits of additional restoration of damaged ecosystems including beach and dune restoration, restoration of salt and freshwater marshes, and revegetation of maritime forests.

3.1.4 SAVs Restoration

Development of a program to determine conditions of SAVs and to determine causes of resource degradation. Identify opportunities to partner with other Federal and state agencies, as well as universities and/or NGOs, to establish research necessary to establish potential solutions and projects.

3.1.5 Incorporation of State of Mississippi Initiative

Continued partnership with MDMR to develop and compliment State of Mississippi projects as opportunities arise.

3.1.6 Restoration of Coastal Forests

Continue partnership with the NPS to further evaluate the feasibility of restoring coastal forests destroyed by the hurricane along the barrier islands. Continue partnership with MDMR to develop and compliment State of Mississippi projects as opportunities arise concerning the mainland of Coastal Mississippi.

3.1.7 Clean-up of Impaired Waterbodies

Determine which waterbodies in Coastal Mississippi were not cleared of deposited sediment and debris as part of the FEMA mission. Establish partnering opportunities with local and state governments to determine increased risks of flooding and develop potential projects that would lessen that risk.

3.1.8 Restoration of degraded coastal wetlands

Continue to assess the degradation of coastal wetlands using the analysis tool – SDSS – in conjunction with the resource agencies to identify additional potential restoration opportunities.

3.1.9 Restoration of Oyster Resources

Continue developing and coordinating with MDMR to implement their restoration of oyster resources wherever feasible. Also incorporate oyster restoration in any applicable proposed projects.

3.1.10 Restoration of Fishing Reefs

Develop a partnership with MDMR to assist in their existing fishing reef program to identify any additional potential locations while also addressing any potential improvements in Mississippi Sound's water quality.

3.1.11 Restoration of Marshes

Development of an analysis tool – SDSS – by which to prioritize potential homeowners assistance and relocation project areas based on historical conditions, damages from storm surge and coastal flooding, and location to existing natural undisturbed lands (i.e. potentially State of Mississippi or Federal lands).

3.2 Development and Evaluation of Mitigation Measures

3.2.1 Potential Mitigation Associate with Non-Structural, Hurricane Storm Damage Measures

Work with the Corps, Non-Structural Team to assess mitigation requirements associated with implementation of the non-structural plans.

3.2.2 Potential Mitigation Associated with Structural, Hurricane Storm Damage Measures (LODs 1-5)

Work with the Corps, Structural Team to assess mitigation requirements associated with implementation of the structural plans.

3.2.3 Potential Mitigation Associated with Structural and Non-Structural Hurricane Storm Damage Measures (LODs 1-5)

Work with both Corps teams to assess mitigation requirements associated with implementation of components of both plans.

3.2.4 Potential Mitigation Associated with Saltwater Intrusion Reduction in Mississippi Sound

Evaluate impacts of diverting freshwater from existing river systems would be evaluated based on ecosystems needs.

3.2.5 Potential Mitigation Associated with Erosion Reduction Measures

Work with both Corps team to assess erosion reduction measures.

CHAPTER 4. PLAN FORMULATION

4.1 Plan Formulation

The development of measures to address ecosystem restoration integrated the input of the multi-disciplinary, and the potential areas as discussed in *Chapter 3*. The multi-disciplinary PDT assessed potential restoration sites in Coastal Mississippi based on the following initial screening criteria:

- Does not require human intervention for recovery
- Does require human intervention for recovery

The multidisciplinary PDT then evaluated sites based on their significance on the following three levels:

- National
- Regional
- Local

The environmental PDT was faced with assessing the three counties in Coastal Mississippi, which consists of hundreds of thousands of acres of uplands, wetlands, urban, coastal forest, etc. This assessment had to be conducted in a consolidated amount of time in order to meet the MsCIP condensed schedule; therefore, the team quickly began compiling various data, such as topographic maps, navigational charts, water quality reports, soil maps, etc, that would be useful in assessing potential restoration efforts. The environmental PDT also had ERDC develop the GIS-based SDSS analysis tool that could effectively assist the team in quickly narrowing down evaluation sites. In addition, the environmental PDT also coordinated closely with both the non-structural and structural PDTs to assess impacts of implementing those measures. The environmental PDT provided ample input to minimize environmental impacts, such as moving the footprint(s) and/or providing natural defenses rather than hardened structures against storm damage.

4.1.1 Goals and Objectives

- Recommend solutions that would assist the people of Coastal Mississippi in their efforts toward recovery of pre-hurricane conditions in the areas of coastal erosion, preservation of fish and wildlife, and prevention of saltwater intrusion
- Recommend measures that would provide for sustainability of the overall natural system
- Recommend measures which integrate ecosystem restoration with storm damage reduction and non-structural plans
- Recommend continued analysis of specific problem areas that require further study to arrive at viable solutions
- Recommend implementable projects directed at recovery of ecological resources along the coast of Mississippi to pre-hurricane conditions, and to examine potential measures that might be implemented to increase sustainability of those resources during future events
- Recommend measures that would provide short-term or long-term recovery of natural resources

- Recommend implementable projects directed at either the stabilization or retreat of saltwater intrusion in the coastal zone exacerbated by the hurricanes, and to examine opportunities for minimization of saltwater intrusion during future events
- Recommend implementable projects directed at recovery of shore erosion protection measures along the coast of Mississippi to their pre-hurricane conditions, and to examine the opportunity for potential increases in the level of protection

4.1.2 Planning Constraints

There are a number of issues that constrain development of certain potential measures that include:

- NPS Policy and Wilderness Areas
- T&E Species and/or Critical Habitat
- State of Mississippi Coastal Zone Management Plan
- State of Mississippi Water Quality standards
- CWA
- NHPA
- CAA
- EFH
- Environmental Justice
- Protection of Children
- CBRA

A detailed discussion of these can be found in the Integrated Comprehensive Main Report/Programmatic EIS.

Managing sediment to benefit a region potentially saves money, allows use of natural processes to solve engineering problems, and improves the ecosystem. As a management method, RSM includes the entire environment, from the watershed to the sea, accounts for the effect of human activities on sediment erosion as well as its transport in streams, lakes, bays, and oceans, and protects and enhances the nation's natural resources while balancing national security and economic needs. RSM is the Corps's standard operating practice for managing sediment on a holistic approach (i.e. regionally) rather than a project specific approach. The Corps recognizes that actions at one specific location have affects regionally. RSM will be considered during evaluation, design, and implementation of potential measures.

The State of Mississippi as part of Gulf of Mexico Alliance has acknowledged that sediment resources are integral to accomplishing many restoration initiatives. It is also recognized that there is a need for a better understanding of regional sediment systems and processes to inform decisions about projects and actions that use or affect sediment resources. Mississippi is actively involved in the development of a Gulf RSM Master Plan as an implementation action for the Gulf Alliance Conservation and Restoration Workgroup with the objective to develop a regional master plan that uses the understanding of sediment dynamics (inputs, outputs, movement) to manage sediment resources towards implementing environmental restoration, conservation, and preservation while reducing coastal erosion, storm damages, and associated costs of sediment management. The regional sediment management plan will also help link sources of sediment with sediment needs, provide a basis for assessing competing needs for sediment, and foster more cost-effective sediment management.

4.1.3 Public and Agency Involvement

- April 7, 2006 – Over 60 Federal, State and local government agency representatives and other community leaders from business and industry gathered in Biloxi to identify early needs, opportunities and recommendations for the MsCIP process.
- April 10, 11, and 13, 2006 – Public Meetings were held in Harrison, Jackson and Hancock Counties to examine a broad range of potential coastal protection options and solicit public input on designing comprehensive improvements.
- April 18, 2006 – An online agenda of the April 10-13, 2006 public meetings was held for displaced coastal residents or those who could not attend the public meetings.
- April 24 and 25, 2006 – A second Regional Coordination meeting of governmental, business and industry stakeholders was held in Biloxi. The session probed for missing or overlooked ingredients in the near-term planning process.
- May 1, 2, and 4, 2006 – A second round of public workshops was conducted where near-term projects and the screening criteria used to select them were presented.
- May 3, 2006 – A follow-up online workshop was held for displaced coastal residents or those unable to attend public meetings.
- August 21-22, 2006 – A third Regional Coordination Meeting including government partners, business and industry was held in Biloxi. Issue-related subgroups for structural, non-structural, barrier island restoration, and environmental solutions offered specific comments and recommendations to Corps planners and subject matter experts.
- December 19, 2006 – A scoping workshop session was held at MDMR to gather public input for the Integrated Programmatic EIS.
- February 6 and 9, 2007 – Online meetings for structural, nonstructural, environmental, and barrier island working groups took place. Participants had the opportunity to submit comments and be part of a facilitated discussion.
- April 5, 2007 – A public workshop was held to help finalize MsCIP measures for structural, nonstructural, environmental issues, and barrier islands. A 2-part session enabled participants to interact with Corps planners on emerging planning concepts in the first segment and formally comment on the plan during the second part.
- July 9 and 10, 2007 – A Risk Analysis workshop was held at the MDMR to weight the risk impacts to the proposed effort.
- August 13 and 14, 2007 – A follow-up to the Risk Analysis workshop was held at MDMR.
- March 16, 18, and 19, 2009 – Public Hearings for the Draft Comprehensive Main Report/Draft Integrated Programmatic EIS document.

4.1.4 Plan Formulation Process

The screening of measures discussed above and also in the Integrated MsCIP Comprehensive Report and Programmatic EIS resulted in the following measures being forwarded for potential inclusion in a list of plans for the study area:

- Ecosystem Restoration for preservation of fish and wildlife;
- Freshwater Diversions for prevention of saltwater intrusion;
- Barrier Islands Restoration;
- SAVs Restoration;
- Potential Projects Developed During Interim Report Preparation; and
- Ecosystem Restoration coupled with Storm Damage Reduction through relocations.

The screened list of measures was then combined into a group of well-balanced alternatives that address the suite of problems plaguing Coastal Mississippi. Formulation of these alternatives also incorporated the following complementary measures:

- Integration of projects associated with ongoing recovery efforts;
- Compatibility with other Federal, state, and local programs; and
- Acceptability with the public citizens within the study area.

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The plan formulation process began with defining the overall comprehensive natural system and its current state post-hurricane impacts. The MsCIP environmental team compared the post-hurricane conditions to the pre-hurricane conditions. In some cases, ecological contrasts were very great while in other instances not much change had occurred. The environmental team worked with a variety of Federal, state, and local entities to adequately address the magnitude of problems plaguing Coastal Mississippi. Minor problems to complex integrated problems were identified and discussed amongst the team members – structural, environmental, and non-structural. Development of a comprehensive list of problem areas consisted of single or multiple problems associated with a given site that were first identified as having been caused or exacerbated by the hurricane events. These sites were identified with a) coastal erosion; b) damage to fish and wildlife resources, and/or c) saltwater intrusion.

Hurricane-caused problem areas were solicited from, and then discussed, with members of the public, state, local, and other Federal agencies, representatives of industry and commerce, and resource agencies concerned with study area resources, at a series of open meetings previously discussed. The meetings also included a web-cast intended on reaching those that could not physically attend one of the in-field meetings.

Hurricane-caused problems have been investigated in a series of on-going site visits conducted in partnership with local representatives including municipalities, state resource agencies, and Federal partners, to ensure a comprehensive list of the problem areas are developed to address a full range of suitable measures and plans to deal with the identified problems.

4.1.4.1 Screening Criteria

After an initial screening of problem areas to determine their link to the hurricanes, a list of potential problem-solving measures was developed for each problem area. Problem-solving components consists of an array of potential solutions, such as excavating fill at a site, re-planting a destroyed area, restoring tidal flow into an area, or increasing freshwater into an estuarine system. Each problem area was then evaluated in relation to; a) its potential for inclusion as a project recommended for construction; b) its identification as a long-term solution that needs more technical analyses based on the complexity of the system; c) longer term effort; and d) detailed technical analysis required to adequately address the system. If these criteria could be satisfied, each problem area was then evaluated for their inclusion in the MsCIP Comprehensive Report and Integrated Programmatic EIS. For those projects screened out early during the plan formulation process a section included in this Environmental Appendix entitled Integrated Programmatic EIS – Effected Environment provides the impact analysis for those screened projects.

The list of measures developed for each problem area was more fully developed, and specific measures formulated for each site. These measures were then evaluated and screened once again, according to their continued technical, environmental, and cost-effectiveness feasibility, based on more detailed input from the resource agencies, public and private entities, and technical staff, and their ability to be combined into multi-purpose alternatives, capable of dealing with more than one identified problem at a given site.

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural and if applicable, structural measures that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following criteria:

- Does a proposed alternative provide for potential preservation of fish and wildlife and their habitats?
- Does a proposed action or project negatively impact low income or minority populations and/or protection of children?
- Does a proposed alternative provide a potential reduction in coastal erosion?
- Does a proposed alternative provide a potential reduction in the extent or level of saltwater intrusion?
- Does the proposed project fit in, with, or compliment the objectives of the State and/or locals plans and desires for the area?
- Does the proposal contribute to the short-term or long-term recovery of Coastal Mississippi?

Using these questions, as screening criteria in a narrowing of the potential list of measures, the PDT provided for formulation of better project components and alternative plans. This guided the process so that each alternative formulated incorporated measures that would be complimentary while also being mutually exclusive measures that would be evaluated as components of separate alternatives for the following criteria:

- Effectiveness
- Completeness
- Acceptability (Applies to existing Laws and Regulations)
- Efficiency (cost-effectiveness)

The following measures were forwarded for potential inclusion in a list of alternatives for the Coastal Mississippi study area:

- Ecosystem Restoration for Preservation of Fish and Wildlife;
- Freshwater Diversions for prevention of saltwater intrusion;
- Barrier Islands restoration; and
- SAV Restoration

The screened list of measures was then combined into a group of well-balanced alternatives that addresses the entire suite of problems plaguing an individual site or problem area. The following alternatives were then developed and carried forward for further analysis:

1. The No-Action Plan
2. Freshwater Diversions within the Hancock County and Grand Bay Marshes
3. Purchase, removal of structures, and ecosystem restoration within historical wetlands previously developed
4. Restoration of Barrier Island Ecosystems
5. Restoration of SAVs within Mississippi Sound
6. Projects from Interim Report carried for further consideration
7. State Initiative Projects

4.1.4.1.1 Results of Initial Screening Criteria

- Assess barrier island restoration (i.e. entire restoration – including littoral placement, vegetation only, SAV)
- Assess LOD 2 benefits of dunes
- Saltwater Intrusion was assessed through ERDC's water quality models evaluation to assess if a change would occur from freshwater diversion (reference Section 1.1.7)
- Identify environmental restoration in Coastal Mississippi by reducing potential areas through running the GIS-based SDSS analysis tool

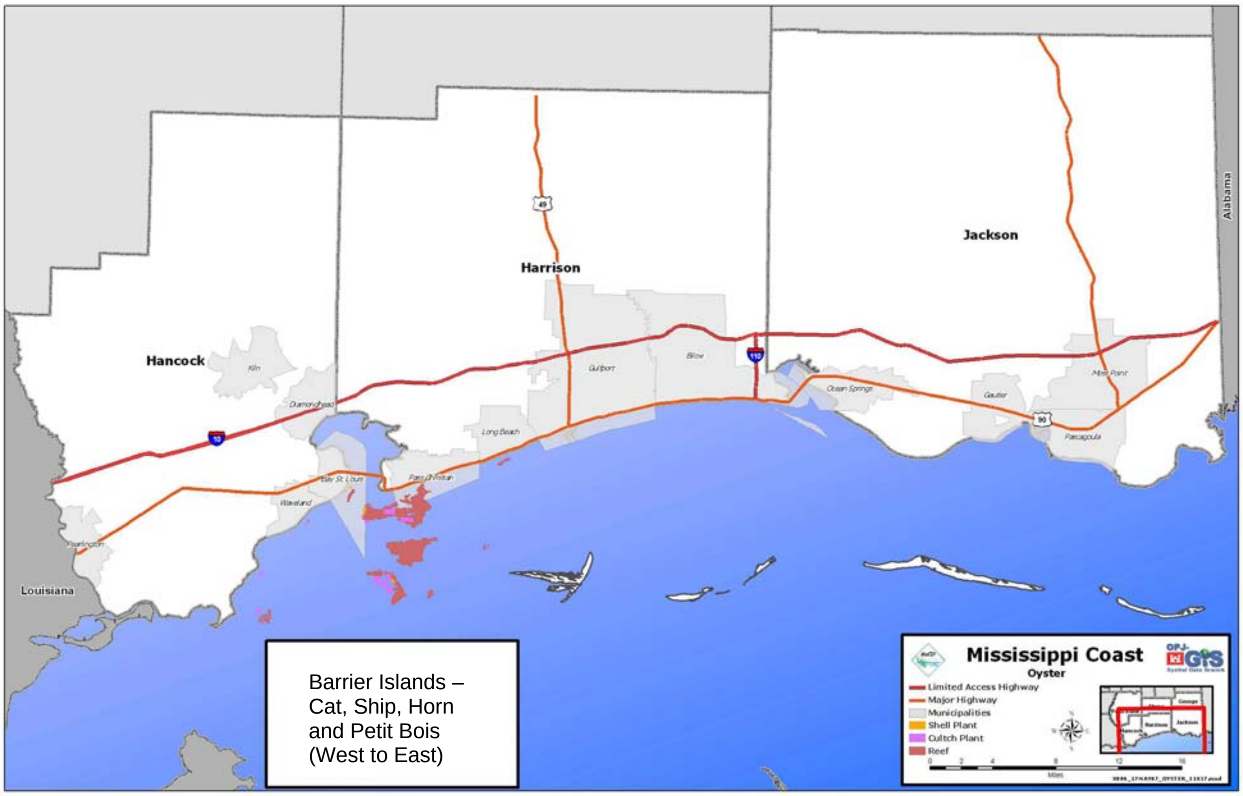
4.1.4.1.2 Results of Secondary Screening Criteria

- Barrier Island restoration options would be carried forward for further study
- Water quality model indicated freshwater diversion on the western and eastern portion of the state did change the salinities in Mississippi. Further study is required due to the complex ecosystem.
- Utilized local knowledge and ground-truthing to narrow down potential environmental restoration
- Identified the need for SAV advanced monitoring and mapping needs in Mississippi Sound
- Established a potential partnership with the State of Mississippi Universities and identified a potential pilot project

4.1.5 Environmental Restoration Measures

4.1.5.1 Freshwater Diversion

A freshwater diversion project may serve to enhance the wildlife resources of the area. While there is some disagreement to the benefits of freshwater diversion projects (Turner 2006), further study will assist in determining if such diversions are ecologically feasible in eastern Jackson County, Grand Bay Savannahs and Marshes, and in western Hancock County, Hancock County Marshes. Freshwater diversions enable redistribution of freshwater and much needed sediments to these systems that are experiencing losses and erosion. Hydrodynamic circulation, salinity, and water quality model calibrations have been conducted for Mississippi Sound. Existing or baseline salinity and water quality distributions were established for March – September 1997 and 1998. Alternative freshwater diversion scenarios were developed and simulated with the calibrated models to examine changes to the baseline salinity and water quality distributions. Freshwater diversion did impact the ecosystem in Jackson and Hancock Counties. Oysters are sensitive to specific ranges of salinity; therefore, freshwater diversions have the potential to either enhance or threaten the resource (Figure 4.1.5.1-1).



Source: MDMR

Figure 4.1.5.1-1. Active Oyster Resources in Mississippi Sound

4.1.5.2 Environmental Restoration of Historical Wetland Sites

The Corps, Mobile District began investigations for identifying potential environmental restoration sites for the purposes of storm-and flood-damage reduction, flood reduction, preservation of fish and wildlife habitat, and removal of habitable structures within high hazard areas. When residential and/or commercial structures and/or land are purchased for the purpose of restoring floodplain areas (i.e. non-structural component), the structures are demolished and the land is no longer available for residential and/or commercial development. Historically, when land is purchased across the U.S., it is left with all or some of the infrastructure at the site rather than restoring it to its historic setting. With the MsCIP environmental plan, land that is purchased (i.e. non-structural component – refer to Non-structural Appendix) would then be restored into functional wetlands. The Hydrogeomorphic (HGM) Approach is a collection of concepts and methods for developing functional indices and subsequently using them to assess the capacity of a wetland to perform functions relative to similar wetlands in a region. The Corps, Mobile District, in cooperation with ERDC, developed a tool to help identify potential restoration sites throughout the study area. A more comprehensive explanation of the SDSS effort used to identify historical wetlands is located in ERDC's *A Wetland Restoration SDSS for the Mississippi Gulf Coast* report (Linn 2007) included in this Environmental Appendix.

Development of a GIS based SDSS tool allowed the Corps, Mobile District, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout Coastal Mississippi. A subset of potential restoration sites were identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. This interagency team allowed us to both confirm the accuracy of the SDSS results and to collect additional on-site information pertinent to restoration efforts. There are some major benefits in using a GIS-based SDSS approach to wetland restoration. First, it allows for the relatively rapid assessment of the large number of restoration sites across the wide study area. Second, potential sites can be evaluated and restored in a watershed or landscape context, which allows us to comprehensively evaluate the overall natural system. This approach can maximize the benefits of wetland restoration, as opposed to simply restoring wetlands where convenient or where property is available. Essentially use of this SDSS tool allowed the MsCIP environmental team to assess the entire coastline as a holistic natural system; thus, the team was more effectively able to analyze needs in Coastal Mississippi.

The SDSS effort resulted in the following products:

1. A ModelBuilder based SDSS tool, which can be subsequently edited and applied to other areas along Coastal Mississippi in the future as funding becomes available;

2. Maps, such as aerial photography, topographic, soil layers, etc., depicting areas in the study region that have a high probability of being successfully restored into wetland functions that buffer and/or store stormwater, and provide suitable habitat for fish and wildlife;

3. Photograph documentation and data sheets containing information on ground-truthed potential restoration sites.

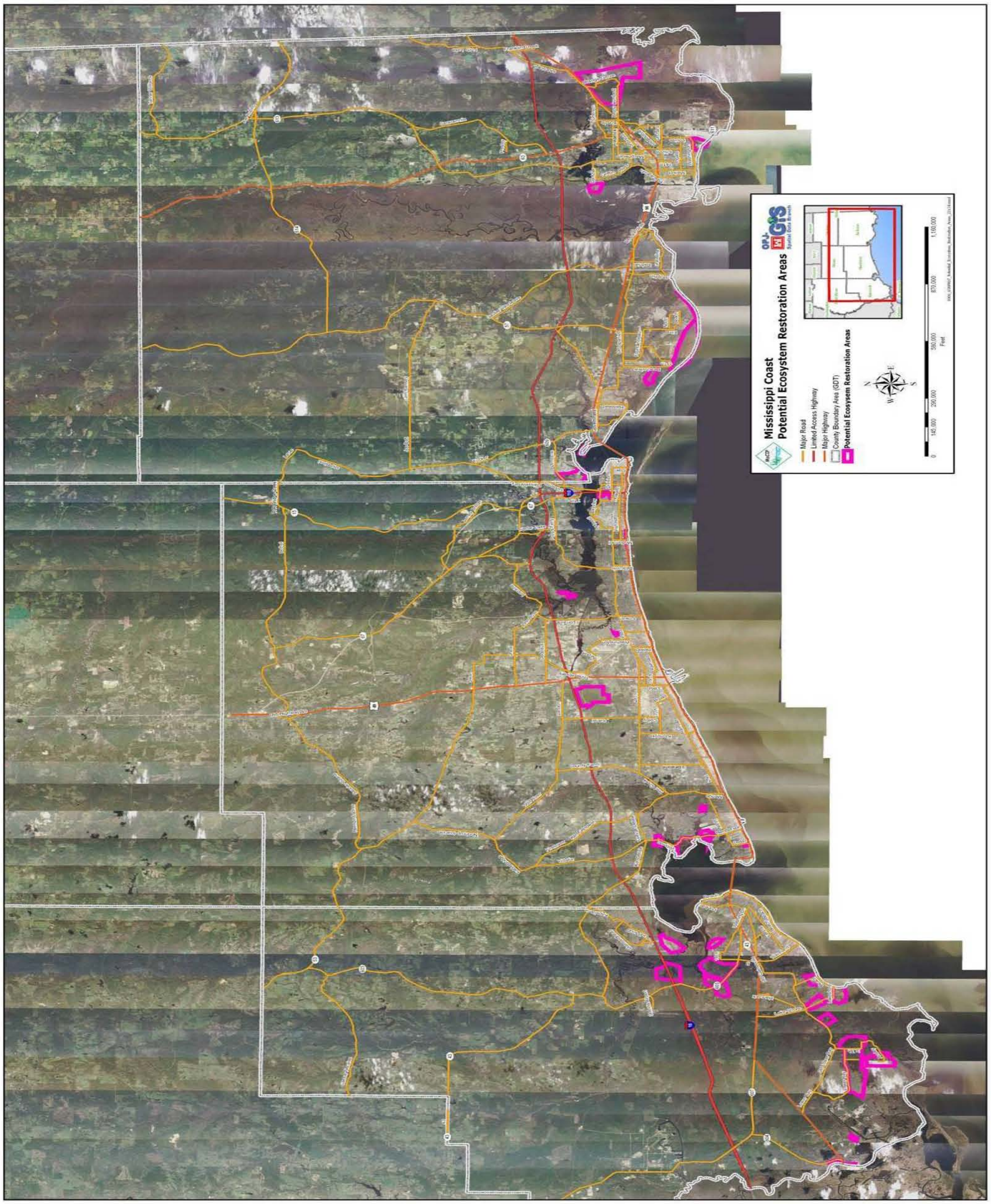
Initial runs of the SDSS tool yielded numerous sites that had to be screened by the Corps, Mobile District, MDMR, and USFWS personnel. The professional team ranked several variables, such as land ownership, proximity to State and other preserved lands, such as the Grand Bay NERR and wildlife management areas, acreage of site, proximity to water, site complexity, potential diversity of natural ecosystem at the site, existing and historical soils, etc., to screen the large list of SDSS sites. The team used these ranked variables for evaluation in order to identify those critical natural systems that would benefit the comprehensive system. Identified environmental restoration sites include a combination of those identified based on the SDSS results, as well as some additional sites (i.e. State Initiatives). These were made using only the non-natural land-use and 100-year flood calculations as the original site selectors (i.e. no damage layers were used), and sites were greater than or equal to 5 acres.

The sites contained the following characteristics:

- Sites were greater than 5 acres in size;
- Sites contained an SDSS Restorability class greater than Low or Medium Low;
- Sites contained an SDSS Habitat class greater than Low or Medium Low; and
- Sites contained an SDSS Storm Surge/Flood Protection class greater than Low.

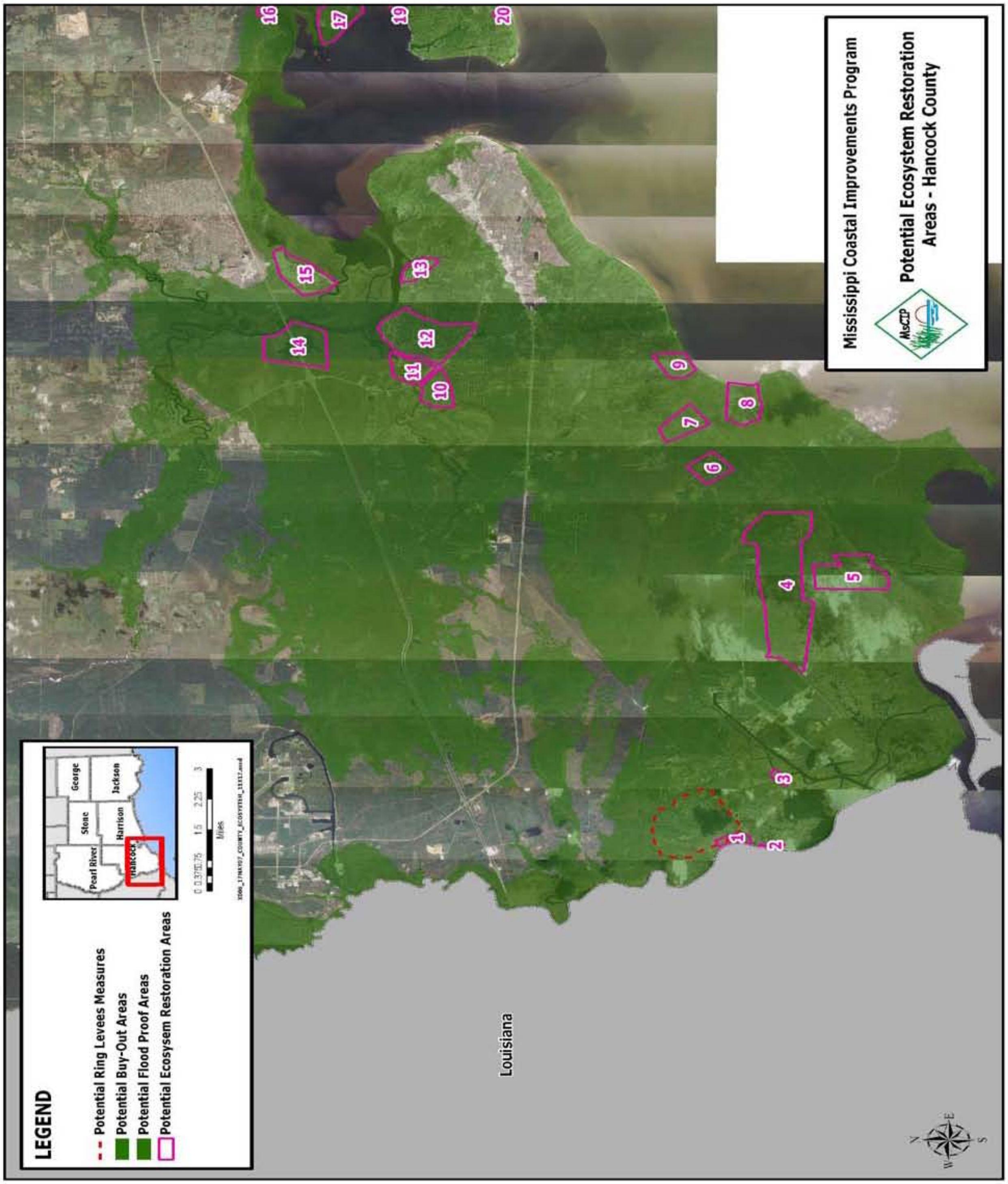
This project has been further coordinated with the ongoing efforts of the MsCIP non-structural flood-proofing committee, and their results were used as the team identified potential restorations sites in Coastal Mississippi. The following selection of 34 restoration sites was based on a combination of results from the SDSS tool and input from MDMR personnel based on local knowledge of the study area and adjacency to existing sensitive protected natural areas (i.e. State and/or Federal lands). Each of the environmental sites were evaluated and screened by using the following criteria:

availability, acceptability, location (i.e. proximity to State of Mississippi owned-lands and greenspace), accessibility, and recreational possibilities. Reference Figures 4.1.5.2-1 to 4.1.5.2-4 and Table 5.1.1.1.1-1 for the specific identified environmental restoration sites.



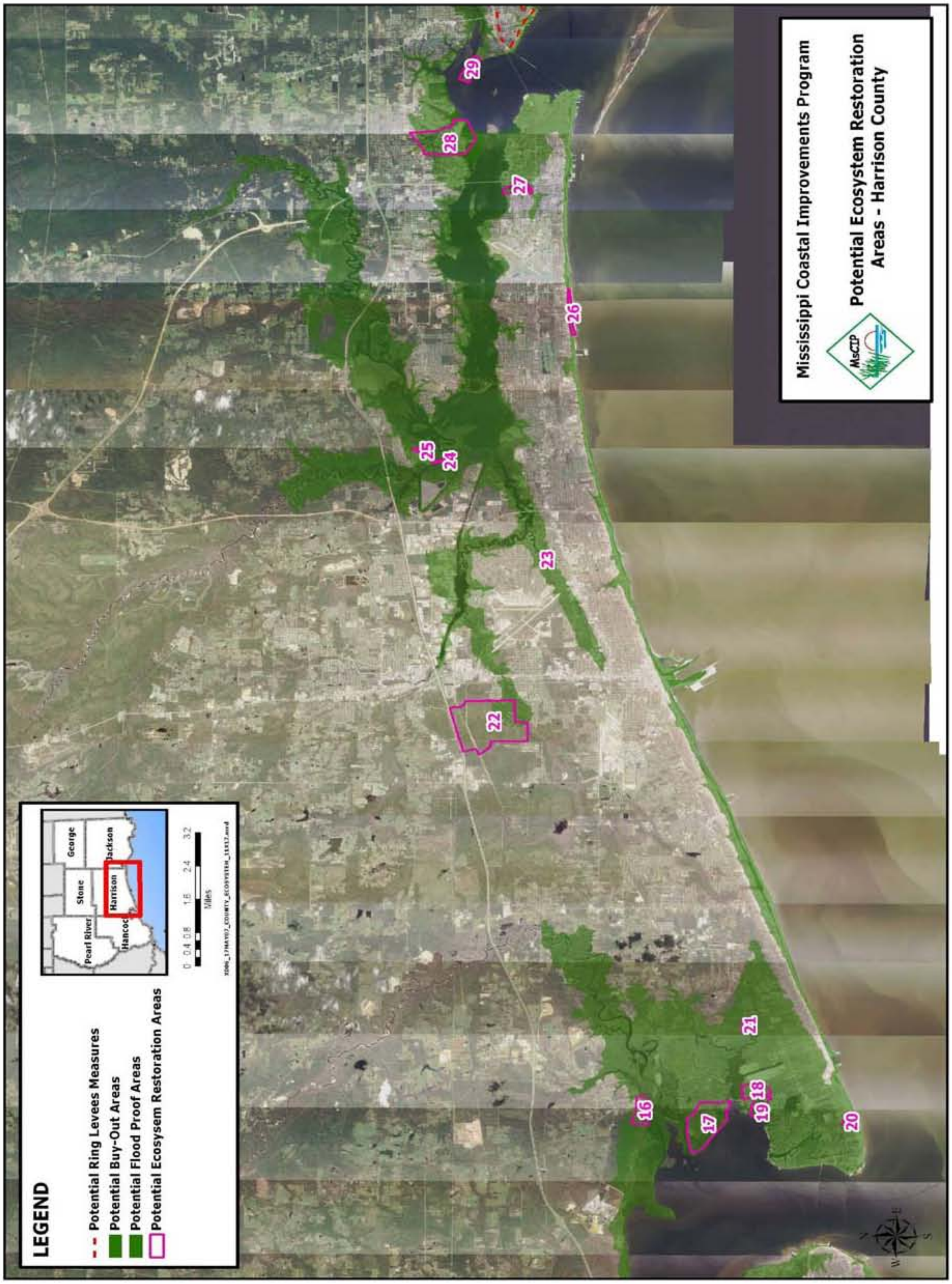
Source: Corps

Figure 4.1.5.2-1. Environmental Restoration of Historical Wetland Sites



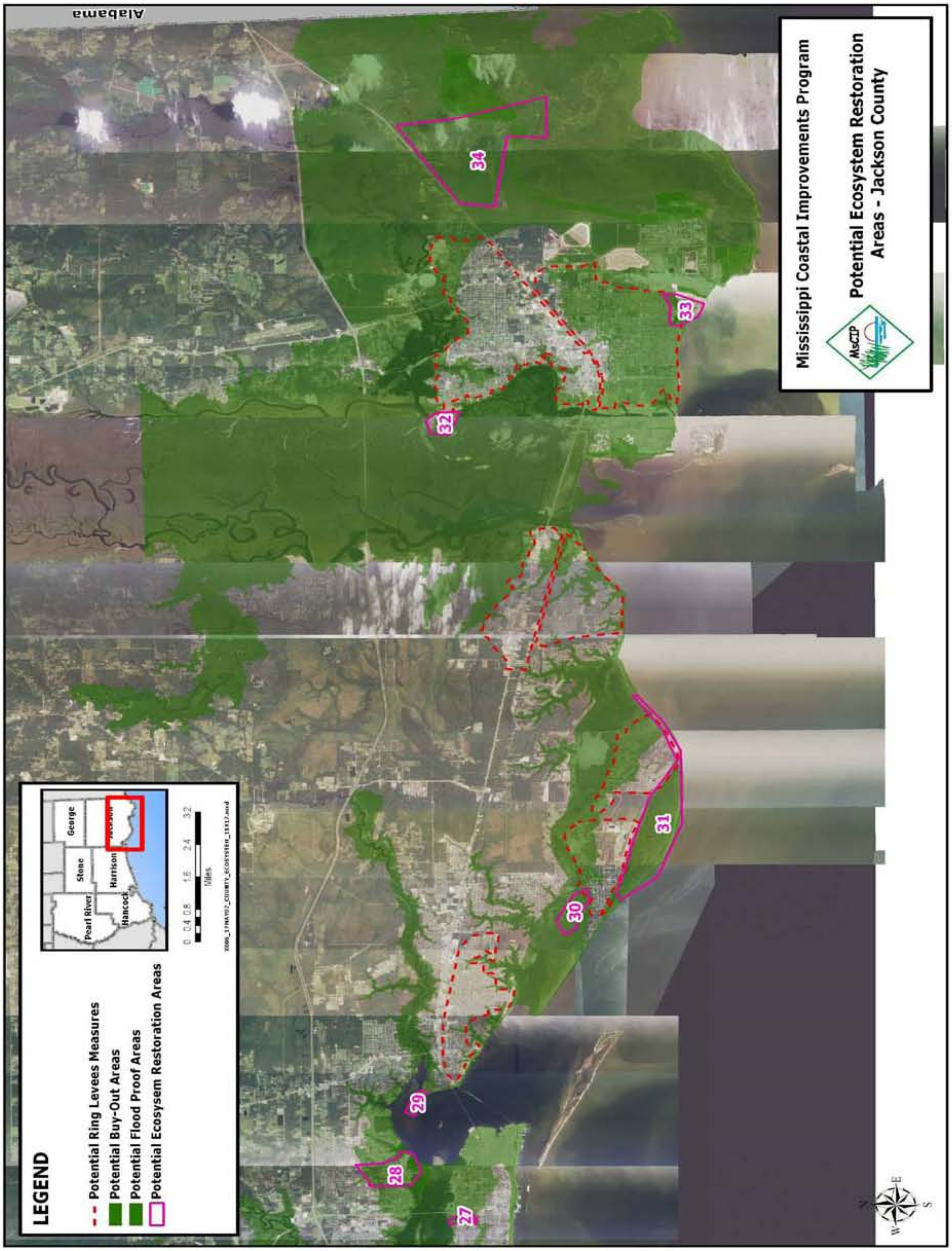
Source: Corps

Figure 4.1.5.2-2. Hancock County Restoration Sites



Source: Corps

Figure 4.1.5.2-3. Harrison County Restoration Sites



Source: Corps

Figure 4.1.5.2-4. Jackson County Restoration Sites

1. Pearlington

- **ACRES:** 76 (State owns 2,200 acres in the Pearlington area)
- **DEMOLITION:** Demolition will be required. Areas found at this site consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to bayhead swamps, excavation will be required to between +3 and +4 feet (i.e. the elevation must be just above the fringing marsh elevation). The slope of the site must be very gradual (i.e. slope should not result in high flow rates.)
- **PLANTING:** Emergent aquatic vegetation would be planted at the site. *Spartina alterniflora* (saltmarsh cordgrass), the low marsh species, would be planted at an elevation ranging from -0.5 to 1-foot. The middle marsh species, *Juncus roemerianus* (black needlerush), would be planted at elevations ranging between 1- and 2-foot while *S. patens* (saltmeadow cordgrass) would be planted above the 2-foot as the high marsh species. Bayhead Swamps trees to be planted consist of *Magnolia virginiana, Nyssa sylvatica*, *Acer rubrum*, and *Taxodium distichum* on a 10- to 30- foot spacing. Bayhead Swamps shrubs to be planted consist of *Persea palustris, Lyonia lucida*, and *Viburnum nudum*. Riverine/levee forests will be planted with *Quercus nigra*, *Celtis laevigata*, *N. aquatica*, *T. distichum*, *A. rubrum*, *Seronea repens*, and *Sabal minor*.

2. Pearlington South

- **ACRES:** 11
- **DEMOLITION:** Demolition will be required. Areas found at this site consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to bayhead swamps, excavation will be required to between +3 and +4 feet (i.e. the elevation must be just above the fringing marsh elevation). The slope of the site must be very gradual (i.e. slope should not result in high flow rates.)
- **PLANTING:** Emergent aquatic vegetation would be planted at the site. *Spartina alterniflora* (saltmarsh cordgrass), the low marsh species, would be planted at an elevation ranging from -0.5 to 1-foot. The middle marsh species, *Juncus roemerianus* (black needlerush), would be planted at elevations ranging between 1- and 2-foot while *S. patens* (saltmeadow cordgrass) would be planted above the 2-foot as the high marsh species. Bayhead Swamps trees to be planted consist of *Magnolia virginiana*, *Nyssa sylvatica*, *Acer rubrum*, and *Taxodium.*

3. Port /West

- **ACRES:** 49
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of high-end residential development and an old golf course. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.

- **PLANTING:** Emergent aquatic vegetation would be planted at the site. *S. alterniflora,* the low marsh species, would be planted at an elevation ranging from -0.5 to 1-foot. The middle marsh species, *J. roemerianus*, would be planted at elevations ranging between 1- and 2-foot while *S. patens* would be planted above the 2-foot as the high marsh species.

4. Ansley

- **ACRES:** 2,023 (State owns 6,000 acres west of Lakeshore Road)
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to a wet pine savannah habitat, the higher areas will be designated as this type of habitat. These areas have depression areas within them, which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*. Wet pine savannah habitat will be restored and planted with wet pine flatwoods, such as *Pinus elliottii*, *Morella cerifera*, *Ilex glabra*, *S. patens*, and *Panicum virgatum*.

5. Heron Bay

- **ACRES:** 594 (State owns 6,000 acres west of Lakeshore Road)
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

6. Lower Bay Road

- **ACRES:** 226 (State owns 6,000 acres west of Lakeshore Road)
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

7. Lakeshore

- **ACRES:** 275
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of commercial development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential and commercial infrastructure and various utilities will be required.

- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

8. Bayou Caddy/Lakeshore

- **ACRES:** 362
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of commercial development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential and commercial infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

9. Clermont Harbor

- **ACRES:** 209
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the 3. *Port/West site*.

10. Bayou La Croix

- **ACRES:** 259
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

11. Admiral Island

- **ACRES:** 245 (State owns 123 acres) (This site is an expansion of the State Initiatives identified in Section 4.1.5.5.)
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.

- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

12. Shoreline Park

- **ACRES:** 889
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

13. Chapman Road

- **ACRES:** 146
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

14. Jourdan River – Interstate-10 Development

- **ACRES:** 638
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of highend residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

15. Diamondhead

- **ACRES:** 433
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

Jourdan River Estates

Jourdan River Estates is an existing housing development that received flooding damage. This area has been restored or is in the process of completing repairs to their homes. Very little restoration opportunity exists due to the elevation and small drainage size for this project site. Therefore, it is not being considered any further for environmental restoration opportunities.

16. Delisle

- **ACRES:** 120 (State owns 1,000 acres)
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to bayhead swamps, excavation will be required to between +3 and +4 feet (i.e. the elevation needs to be just above the fringing marsh). The slope of the site must be very gradual (i.e. the slope should not result in high flow rates.)
- **PLANTING:** Emergent aquatic vegetation would be planted at the site. *S. alterniflora* (saltmarsh cordgrass), the low marsh species, would be planted at an elevation ranging from -0.5 to 1-foot. The middle marsh species, *J. roemerianus* (black needlerush), would be planted at elevations ranging between 1- and 2-foot while *S. patens* (saltmeadow cordgrass) would be planted above the 2-foot as the high marsh species. Bayhead swamps trees to be planted consist of *M. virginiana*, *N. sylvatica*, *A. rubrum*, and *T. distichum* on a 10- to 30-foot spacing. Bayhead Swamps shrubs to be planted consist of *P. palustris*, *L. lucida*, and *V. nudum*.

17. Ellis Property

- **ACRES:** 443 Acres
- **DEMOLITION:** Very minor demolition would be required.
- **EXCAVATION:** Minor excavation would be required.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as described in *16. Delisle*. Preservation with restoration of half tidal marsh and half pine savannah probably more like wet pine flatwoods.

18. Pine Point East

- **ACRES:** 103 (State owns 40-50 tax forfeited lots)
- **DEMOLITION:** Demolition will be required. Residential development exists at this site. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site, such as *S. alterniflora*, *J. roemerianus*, and *S. patens*. Wet pine savannah habitat will be restored and planted with wet pine flatwoods, such as *P. elliottii*, *M. cerifera*, *I. glabra*, *S. patens*, and *P. virgatum*.

19. Pine Point West

- **ACRES:** 83 (State owns 40-50 tax forfeited lots)
- **DEMOLITION:** Demolition will be required. Residential development exists at this site. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site, such as *S. alterniflora*, *J. roemerianus,* and *S. patens*. Wet pine savannah habitat will be restored and planted with wet pine flatwoods, such as *P. elliottii*, *M. cerifera*, *I. glabra*, *S. patens*, and *P. virgatum*.

20. Pass Christian low forested drainage way

- **ACRES:** 21
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to bayhead swamps, excavation will be required to between +3 and +4 feet. The slope of the site must be very gradual.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as described in *13. Delisle.* Bayhead swamps trees to be planted consist of *M. virginiana*, *N. sylvatica*, *A. rubrum*, and *T. distichum* on a 10- to 30-foot spacing. Bayhead Swamps shrubs to be planted consist of *P. palustris*, *L. lucida*, and *V. nudum*.

21. Pass Christian Site – Bayou Portage

- **ACRES:** 43
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to bayhead swamps, excavation will be required to between +3 and +4 feet. The slope of the site must be very gradual.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as described in 16. Delisle.

22. Turkey Creek

- **ACRES:** 948 (Of this total, 689 acres are being selected for construction which is discussed in detail in Section 5.1.1.1.2.1.)
- **DEMOLITION:** None
- **EXCAVATION:** In order to restore the area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them, which will enable water to flow down to the depression areas; thus, holding water.

- **PLANTING:** Wet pine savannah habitat will be restored and planted with wet pine flatwoods, such as *P. elliottii*, *M. cerifera*, *I. glabra*, *S. patens*, and *P. virgatum*.

23. Brickyard Bayou

- **ACRES:** 14
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no anticipated hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to a Wet Pine Savannah habitat, the higher areas will be designated as Wet Pine Savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as described in *16. Delisle.* Bayhead swamps trees to be planted consist of *M. virginiana*, *N. sylvatica, A. rubrum*, and *T. distichum* on a 10- to 30-foot spacing. Bayhead swamps shrubs to be planted consist of *P. palustris*, *L. lucida*, and *V. nudum*.

24. Biloxi River – Shorecrest Drive

- **ACRES:** 15
- **DEMOLITION:** Demolition will be required. Areas found in this site consist of only residential development/bulkheads. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** Excavation of old fill material will be required to remove the foreign material.
- **PLANTING:** Plantings will consist of what has been described in *23. Brickyard Bayou at Courthouse Road*. In addition, riverine/levee forests will be planted with *Q. nigra*, *C. laevigata, N. aquatica*, *T. distichum*, *A. rubrum*, *S. repens*, and *S. minor*.

25. Biloxi River – Eagle Point

- **ACRES:** 17
- **DEMOLITION:** Demolition will be required. Areas found in this site consist of only residential development/bulkheads. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** Excavation of old fill material will be required to remove the foreign material.
- **PLANTING:** Plantings will consist of what has been described in *23. Brickyard Bayou at Courthouse Road*. In addition, riverine/levee forests will be planted with *Q. nigra*, *C. laevigata*, *N. aquatica*, *T. distichum*, *A. rubrum*, *S. repens*, and *S. minor*.

26. Biloxi Front Beach – South of Highway 90

- **ACRES:** 40

- **DEMOLITION:** Demolition will be required. Areas consist of only commercial retail outlet development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of commercial infrastructure and various utilities will be required.
- **EXCAVATION:** Excavation of old fill material will be required to remove the foreign material.
- **Fill:** This site is proposed as part of the Interim Report's project and as LOD 2 and 3. This proposed restoration site purchases the remaining parcels that are commercial property located directly on the beach. Dunes will be constructed to provide added protection.
- **PLANTING:** Sea oats will be planted on the dune system.

27. Keegan Bayou

- **ACRES:** 54
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them, which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site. Wet Pine Savannah habitat will be restored and planted.

28. St. Martin

- **ACRES:** 467
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential and commercial development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential and commercial infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site.

29. Fort Point

- **ACRES:** 83
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site.

30. Pine Island:

- **ACRES:** 2,531

- **DEMOLITION:** Demolition will be required. Areas found in this area consist of high-end residential development and an old golf course. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site.

31. Belle Fontaine

- **ACRES:** 1,516
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of only residential development/bulkheads. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** Excavation of old fill material will be required to remove the foreign material. In addition, seawalls and bulkheads will be needed to be excavated.
- **FILL:** The beach is developed from sand eroded from the Gulfport Formation, a Pleistocene sand deposit in the center of the area; the sand is spread along the shore by longshore currents driven by wave action. Sandy material will be required to restore the lost beach back to its historic footprint (about 100 to 200 feet seaward). In addition, dunes will be constructed to provide added protection.
- **PLANTING:** Sea oats will be planted on the dune system.

32. Griffin Point

- **ACRES:** 182
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site.

33. Bayou Chico

- **ACRES:** 258
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site.

34. Grand Bay Marsh/Bayou Cumbest

- **ACRES:** 2,666 (Of this total, 148 acres are selected for construction. A detailed discussion is provided below in Section 5.1.1.1.2.2.)
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. Higher areas will be restored to wet pine savannah habitat. These areas have depression areas within them, which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site. Wet pine savannah habitat will be restored and planted with wet pine flatwoods, such as *P. elliottii*, *M. cerifera*, *I. glabra*, *S. patens*, and *P. virgatum*.

Mary Walker Bayou

Mary Walker Bayou area was not considered as a feasible environmental restoration site. Mary Walker Bayou area is located up high on a bluff with only a few businesses in the low area; thus, the site was eliminated from any further study.

Gautier South

There are several drainage areas within the proposed environmental restoration site. This site is located within the City of Gautier and adjacent to the State of Mississippi's Shepard Park. The potential restoration site is located within several residential communities. In evaluating this in greater detail, the team, including MDMR, decided not to carry this proposed potential project any further.

Johnson Bayou Site

This site was eliminated from further consideration by the MsCIP environmental team due to it not being a feasible site for restoration as it was being redeveloped.

Ocean Springs Inner Harbor

In evaluating this potential site, several factors were considered – availability, acceptability, location, and accessibility, to determine if the proposal would be feasible to carry forward in the proposed environmental restoration effort. This site consists of a harbor with predominantly private crafts with residential housing within the area. This site has been mostly restored back to pre-2005 hurricane conditions; therefore, this area is not available as a potential restoration site at this time and would not be acceptable to the citizens of Ocean Springs. This site may be considered in the future as a possible long-term environmental restoration site as the site becomes more feasible.

East Beach – Ocean Springs

East Beach – Ocean Springs is proposed as an Interim Project consisting of beach/dune restoration. Additionally, the East Beach – Ocean Springs site is part of Lines of Defense 2 (beach/dune) and 3 (elevated roadway). This site has also been designated as a non-structural solutions consisting of homeowners assistance and relocation. Restoration of the site would consist of greenspace/recreational site, other upland habitat, and maritime forest habitat, which is a high priority habitat for the USFWS.

4.1.5.3 Restoration of Barrier Island Ecosystems

Barrier islands provide a boundary between the sea water salinity of the open Gulf of Mexico and the brackish water found in Mississippi Sound. Loss of the islands would greatly increase salinity in Mississippi Sound; thus, changing ecological habitats that exist now. This would impact, if not devastate, shellfish and many other forms of marine life. Prior to Hurricane Katrina, the State of Mississippi was working on a coastal storm protection plan and proposition to submit to NPS for consideration that included restoring the barrier islands to the condition that existed prior to Hurricane Camille. While unsubstantiated through scientific study, it was reported that many in Mississippi felt that if the islands had been in the condition that existed prior to Hurricane Camille, there would have been less damage along the coast from Hurricane Katrina. This idea was also included in the Mississippi Governor's Recovery Plan, which called for restoring the islands to a pre-Camille footprint.

Another positive effect that the barrier islands have is to provide a natural offshore breakwater for the large sea waves that are generated from hurricanes. The presence of the islands and the relatively shallow water of the Mississippi Sound between the islands and the mainland prevent the sea waves from maintaining their considerable size as they move towards the mainland. Sea waves, often reported at heights of 40 feet and higher in large storms, would break as they approach the chain of islands. The open water between the islands and the mainland, generally ten miles or more, would have enough fetch for waves to regenerate, but at a much lower height due to the shallower water. The generally accepted relationship between water depth and wave height is that the wave can sustain itself at a height that is one-half the depth of the water.

Sand of sufficient quality and quantity required for this proposed restoration of the barrier islands is not known to occur in close proximity to the islands. Prior studies of the St. Bernard Shoals (USGS personal comm. 2006) indicate that this site is probably the best source of the sand. Vegetation and a dune system would also be incorporated as prescription components as part of any sand placement on the barrier islands in order to further stabilize these restoration projects. The presence of the islands and the relatively shallow water of Mississippi Sound between the islands and the mainland prevent the sea waves from maintaining their considerable size as they move towards the mainland (i.e. a natural breakwater defense). Possible supplement of sand (i.e. from St. Bernard Shoals or an offsite source) in the littoral system is another option that could help restore the islands. This could be accomplished by adding sand in specific locations based on sediment transport modeling. Any improvements to the barrier islands must be closely coordinated with NPS because they are within the NPS boundaries and Petit Bois and Horn Islands are congressionally designated Wilderness Areas.

4.1.5.4 Restoration of SAVs in Mississippi Sound

Continued survival and growth of seagrasses (i.e. SAVs) may be threatened by the cumulative effects of man's activities, in addition to, natural processes in the coastal marine ecosystem. Natural causes of SAV (i.e. *Diplanthera wrightii, Cymodocea manatorum, Thalassia testudinum*, and *Ruppia maritime*) decline, such as disease, storm events, salinity fluctuation, and hypoxic events, coupled with declining water quality caused by anthropogenic eutrophication currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1994, Kock and Beer 1996). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species to utilize this vital habitat at some point in their life state. Opportunities exist to partner with Federal, state, and local resource agencies as well as NGOs. Extensive coordination with the NPS, responsible for managing and operating the Gulf Islands National Seashore, would be required for areas of potential restoration within park boundaries. Involvement of local colleges and universities with ongoing research programs would also help to identify and pinpoint specific problems for development of potential solutions.

4.1.5.5 State Initiative Projects

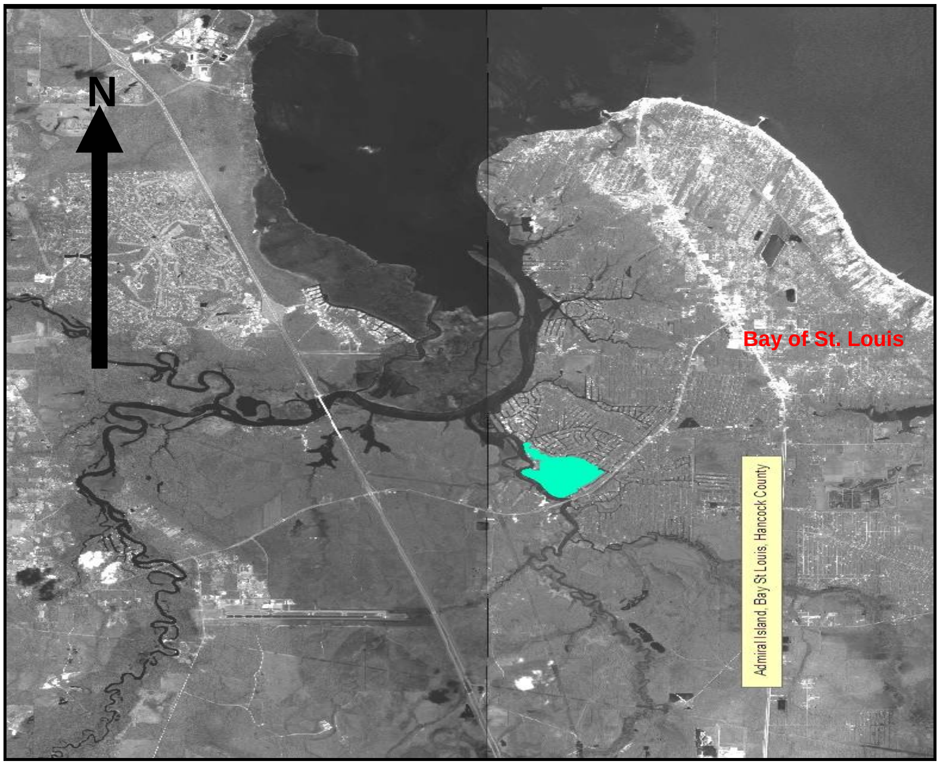
The Governor of the State of Mississippi's *Seven-Point Strategy* for rebuilding coastal resources of the State is anticipated to be an on-going effort over the next 10 to 15 years. The strategy is summarized as follows:

- Implementation of breakwater structures for surge protection (natural surge diffusers, breakwaters, jetties seawalls, etc.);
- Deer Island restoration to pre-1900 footprint with fortification of the south side;
- Barrier Island restoration to pre-Camille conditions;
- Restoration of 10,000 acres of coastal marshes, beaches, and forests;
- Restoration of historical water flow to Coastal Mississippi watersheds to provide water quality and quantity critical to estuarine and marine habitats, including efforts to divert freshwater from Louisiana into the Biloxi marshes;
- Restoration of submerged aquatic vegetation in Mississippi Sound; and the
- Restoration and enhancement of reef systems in Mississippi waters and adjacent Federal waters (i.e. oysters, nearshore low-profile reefs, and offshore artificial reefs).

MDMR has identified the following 11 restoration sites. These are being included in the ecological approach detailed in this Environmental Appendix and also in the MsCIP Comprehensive Main Report/Integrated Programmatic EIS.

Hancock County:

- **SITE:** Admiral Island, Hancock County
- **DESCRIPTION:** 123 acres total – 62 marsh and 61 forested scrub shrub
- **CONDITION:** Admiral Island has extensive debris fields washed in from Bayou Lacroix during Hurricane Katrina (Figure 4.1.5.5-1 and Figure 4.1.5.5-2). Approximately 10 acres are covered in a mat of crushed houses, boats, and other debris. Mechanized removal of these debris fields via the central road on Admiral Island will be necessary before prescribed burning takes place. Foot reconnaissance will be necessary to gather plastic and other potentially hazardous burnable materials on the remaining acreage before conducting a prescribed burn.



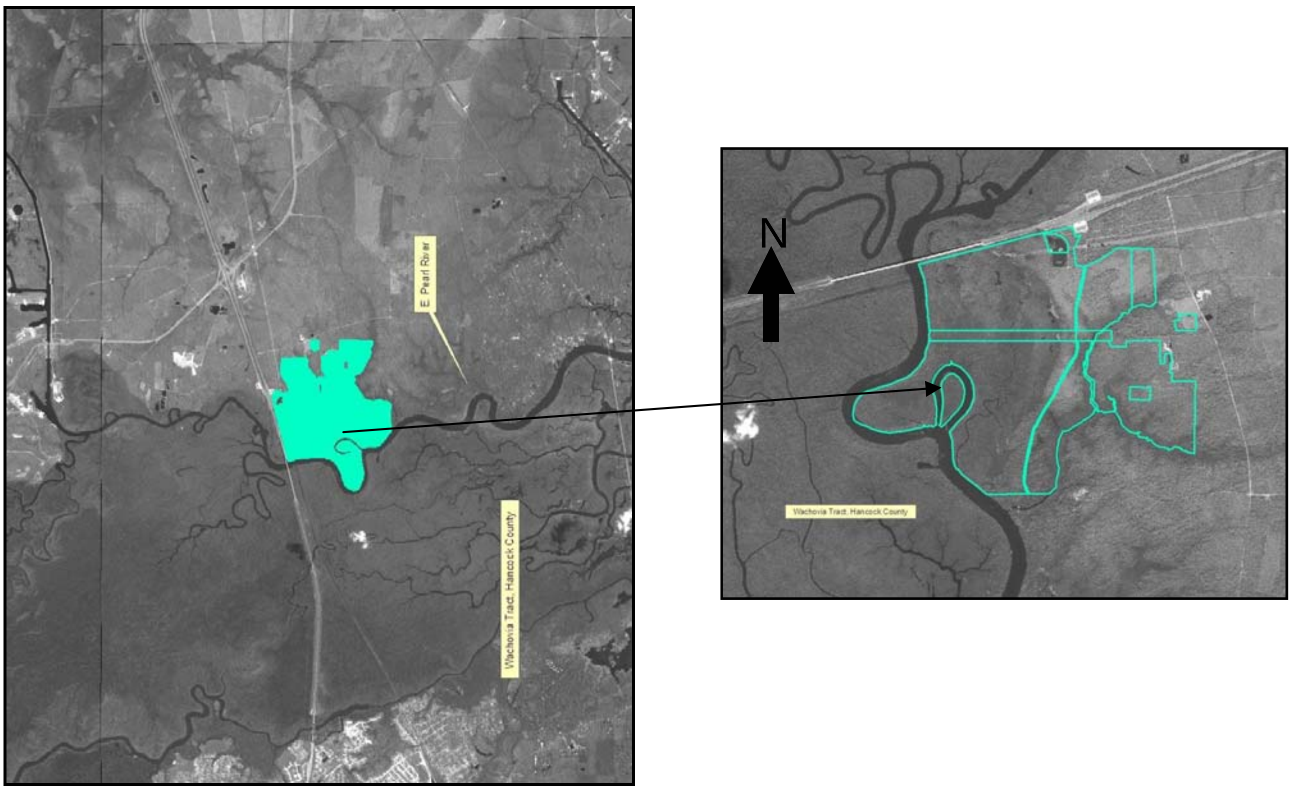
Source: MDMR

Figure 4.1.5.5-1. Admiral Island, Hancock County State Initiative Projects

Source: MDMR

Figure 4.1.5.5-2. Admiral Island, Hancock County State Initiative Projects

- **PLANTING:** Chinese tallow trees have heavily infested the property and mature trees were significantly damaged by Hurricane Katrina. However, new seedlings are property wide and are forming virtual carpets in some areas. Treatment needs to begin this year while the other vegetation is dead. It is easy to move through and makes it much easier to distinguish growing "tallows". Treatment would be even easier if a prescribed burn can be conducted first.
- **SITE:** Wachovia, Hancock County
- **DESCRIPTION:** 1,200 acres total – 800 marsh, 200 forested, 200 savannah
- **CONDITION:** Wachovia has significant marsh debris and scour from storm surge. However, the scoured areas appear to be forming high quality open-water habitat evident by a high level of dragon fly activity and breeding. The scours are several feet deep and would require an invasive operation to be filled and replanted (Figure 4.1.5.5-3). The debris is predominantly natural material, mostly the marsh "rolled up" from the scoured areas.



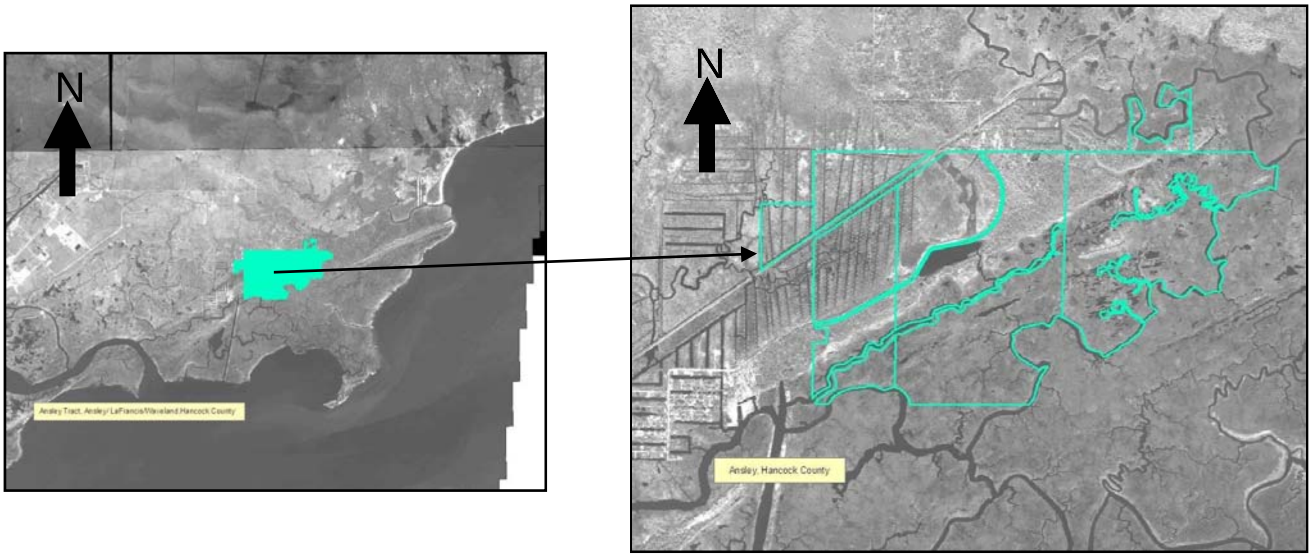
Source: MDMR

Figure 4.1.5.5-3. Wachovia, Hancock County State Initiative Project

Much of the remainder of the tract is forest and savannah, which has suffered wind damage in the form of downed trees and vegetation. This has increased fuel loads and complicated access across the property. This is significant because the fuel loads at Wachovia were already high. The tract is very much in need of prescribed burning, particularly areas that were planted with longleaf pine several years back. The tract is immediately south of Interstate-10 so special considerations will be necessary to facilitate a safe and effective burn. Invasive species, particularly Chinese tallow, are present site wide and will require special attention in the post Katrina environment.

- **SITE:** Ansley, Hancock County

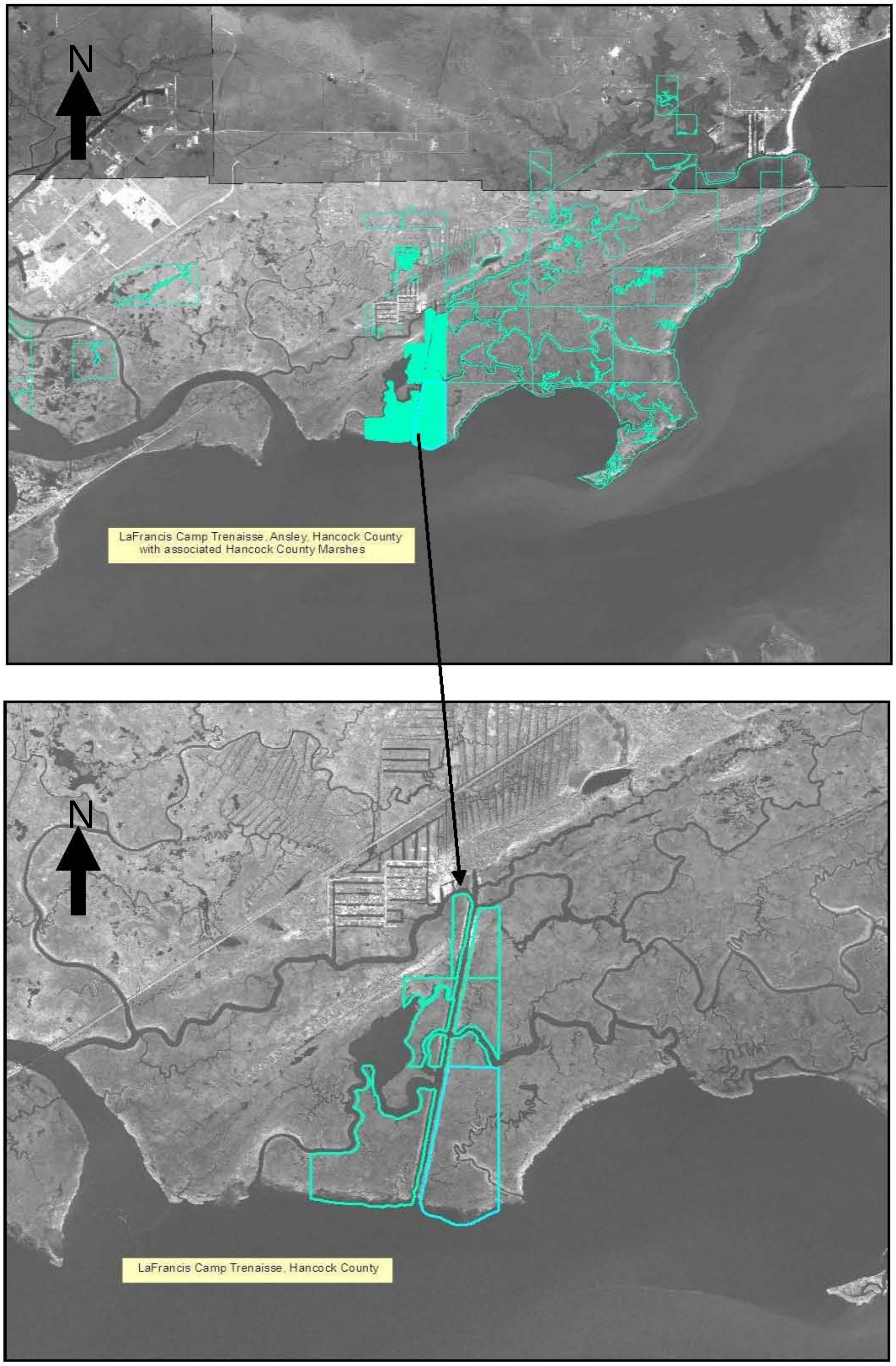
- **Description:** 900 acres total – 800 marsh, 100 forested
- **Condition:** The site is primarily marsh, which has experienced limited scouring (Figure 4.1.5.5-4). The recovery from scouring will require further monitoring and assessment. There are significant debris fields within the marsh that extend into the forested areas. Pine timber fared relatively well but hardwoods were heavily damaged. There are significant invasive infestations, primarily Chinese tallow tree. Extensive mosquito ditching disrupts hydrology and creates vectors for invasive species.



Source: MDMR

Figure 4.1.5.5-4. Ansley, Hancock County State Initiative Project

- **Site:** LaFrancis Camp Trenaisse, Hancock County
- **Description:** 45 acres total – all open water
- **Condition:** This “trenaisse” (canal) may simply be the right of way of the underlying gas pipeline that has been progressively widened by small boat traffic and tidal flow (Figure 4.1.5.5-5). Regardless, it intersects two bayous and has significantly reduced their flow and sediment carrying capacity, resulting in a loss of navigability. It is also likely that this canal serves as a direct conduit for storm surge into the LaFrancis/ Heron bay / Ansley community. It is recommended that this channel be closed and restored to its original marsh cover. It is also recommended that the north most bayou (Campbell’s Inside Bayou) be dredged to the west if necessary to reestablish navigation to the LaFrancis marina and associated community.
- **Site:** Gulf Islands National Seashore in Mississippi: Petit Bois, Horn, Ship and Cat Islands in Jackson, Harrison and Hancock Counties
- **Description:** 7,000 acres total
- **Condition:** Hurricane Katrina and other recent storms have over washed all barrier islands in the Northern Gulf causing severe erosion, severely damaging or destroying facilities and resources, depositing massive amounts of debris, degrading habitats, and setting the stage for rampant infestations of noxious, invasive plant and animal species. The following proposal is based directly on a post-storm needs assessment prepared by Gulf Islands National Seashore science and management staff.

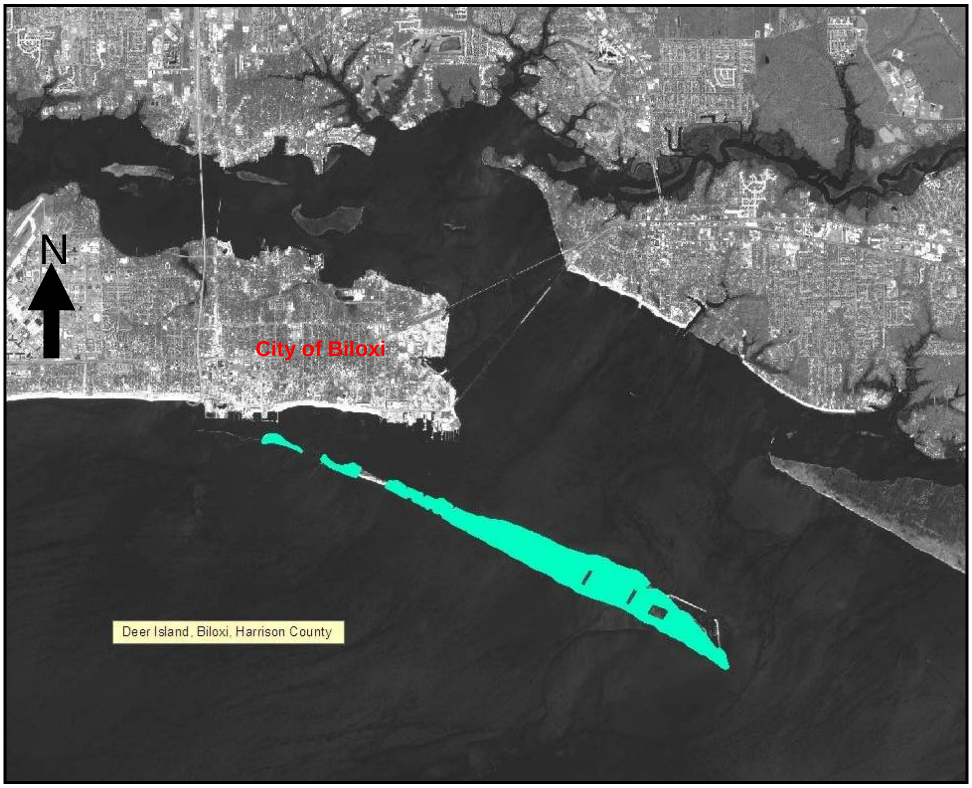


Source: MDMR

Figure 4.1.5.5-5. LaFrancis Camp Trenaisse, Hancock County State Initiative Project

- **SITE:** Deer Island, Harrison County
- **DESCRIPTION:** 450 acres total, 200 marsh, 250 forested

- **CONDITION:** During Katrina, Deer Island lost little actual land area but a significant amount of sand beach and dunes at higher elevations (Figure 4.1.5.5-6). Related to this, a large number of slash pine trees were killed with mortalities approaching 100% near the east end. These trees will need to be replaced to maintain soil stability and avoid more catastrophic erosion in the future. Planting with additional storm hardy tree species, such as live oak should be examined. Advanced, high yield nursery trees would be ideal for this purpose.



Source: MDMR

Figure 4.1.5.5-6. Deer Island, Harrison County State Initiative Project

The stability of current and future created marsh on Deer Island may also be improved. The existing marsh creation project survived relatively well and indicates that marsh creation should be expanded to help provide additional erosion protection and estuarine habitat. However, the very fine grain material used for substrate needs to be augmented with coarser grain sandy sediments to improve consolidation and resistance to erosion. Rip-rap breakwaters could be augmented and protected by adding shell and soil then planting with storm tolerant plants, such as live oaks.

Remaining natural marshes on Deer Island have some invasive species issues, primarily torpedo grass. Chinese tallow trees occur at the site but not as severe infestations and appear to have been stressed by Katrina so the time to treat is now. As with most of the other Coastal Preserve projects, prescribed fire is an important consideration for both for ecological and management related financial reasons.

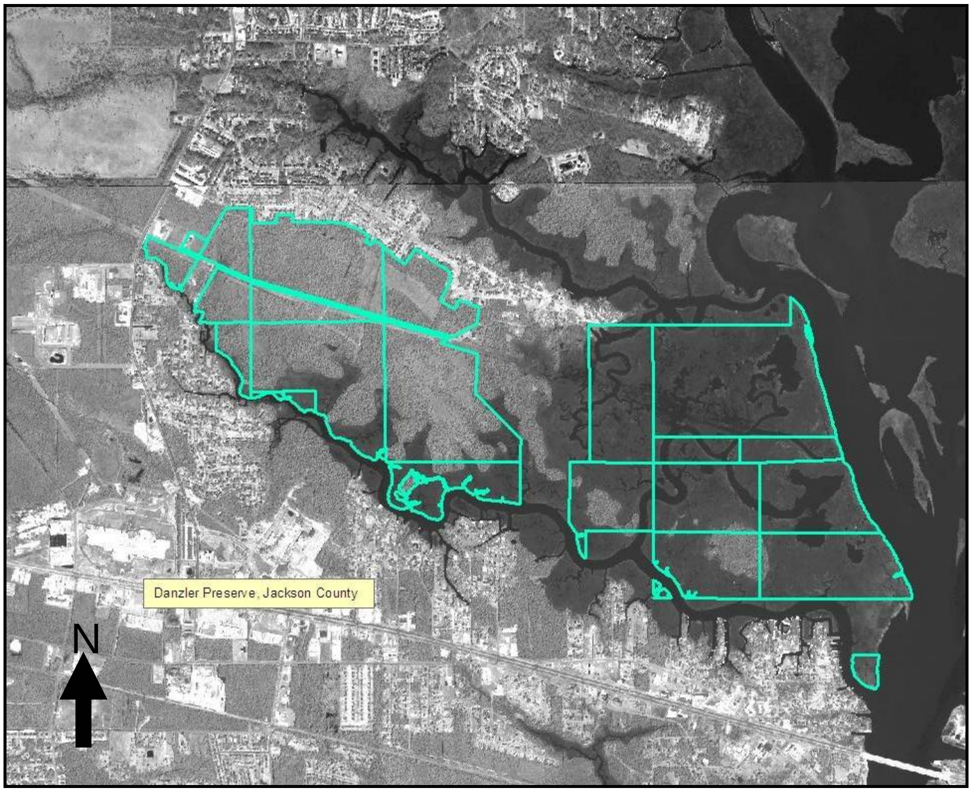
- **SITE:** DuPont, Harrison County
- **DESCRIPTION:** 650 acres total – 170 marsh, 480 forested

- **CONDITION:** The site is dominated by a 20- to 40-year rough (unburned vegetation) (Figure 4.1.5.5-7). Hurricane Katrina placed many acres of debris into the marshes and forest and downed a very high percentage of hardwoods on the property. There are massive debris fields that will require implementation of clearing and prescribed burns.

Source: MDMR

Figure 4.1.5.5-7. DuPont, Harrison County State Initiative Project

- **SITE:** Danzler, Jackson County
- **DESCRIPTION:** 900 acres total – 500 marsh, 385 forested
- **CONDITION:** The Danzler property was further from Katrina's core and suffered less direct wind and tidal surge damage than many of the other Coastal Preserves (Figure 4.1.5.5-8). However, serious long term consequences are anticipated due to the distribution of Chinese tallow tree propagules across the site. The effort to regain control of Chinese tallow site wide and clean up residual storm debris will be greatly aided by first conducting Comprehensive prescribed burns. Restoring access lost due to storm downfall can be accomplished as part of the preparation for prescribed burning.



Source: MDMR

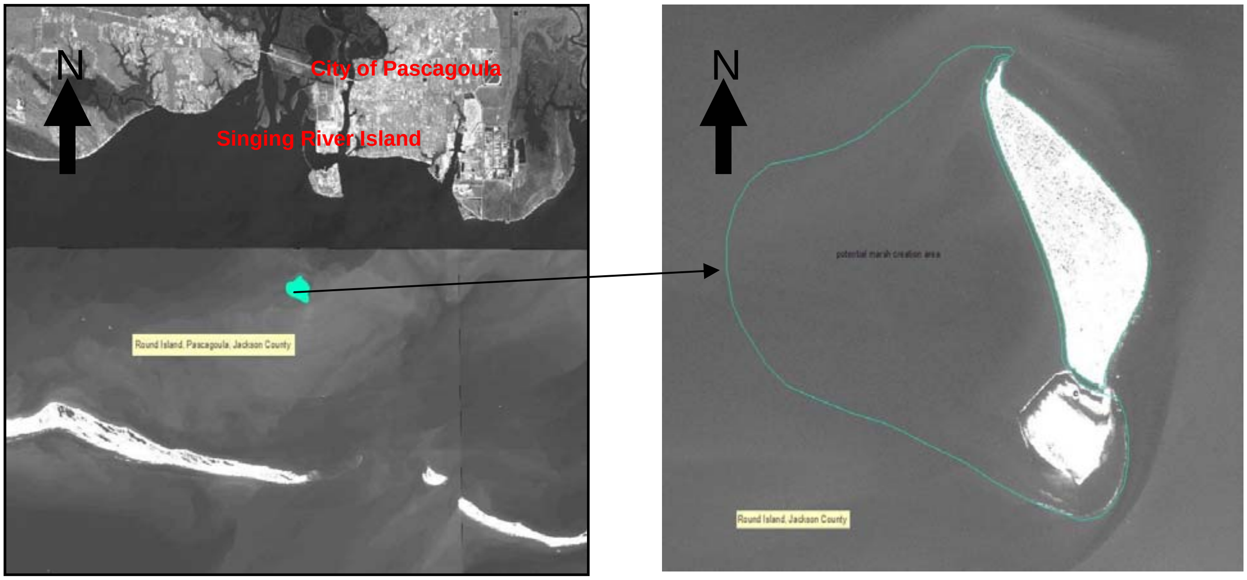
Figure 4.1.5.5-8. Danzler, Jackson County State Initiative Project

- **SITE:** Pascagoula River Marsh, Jackson County
- **DESCRIPTION:** This preserve consists of 11,150 acres that includes essentially all marsh associated with the mouth of the Pascagoula River. This drainage consist primary of tidal oligohaline marshes which give way to tidal freshwater marshes and tidal Bald Cypress forests and woodlands.
- **CONDITION:** Katrina didn't significantly impact the integrity of the Pascagoula marsh system, but left it exposed to an explosion of invasion exotic species (Figure 4.1.5.5-9). Gaps left by vegetation lost and disturbances in hydrology regimes will increase the recruitment and growth of such species. The two species that are of the greatest concern are *Salvinia molesta* (Giant Salvinia) and *Sapium sebiferum* (Chinese tallow) can truly be considered noxious. Also disturbed areas often support dense, nearly monospecific colonies of *Phragmites australis* common reed which is becoming a greater threat to native species population. Control measures are recommended.

Source: MDMR

Figure 4.1.5.5-9. Pascagoula River Marsh, Jackson County State Initiative Project

- **SITE:** Round Island, Jackson County
- **DESCRIPTION:** 65 acres total, predominantly forested
- **CONDITION:** Round Island has eroded extensively in the past decade (Figure 4.1.5.5-10). Hurricanes George, Dennis, Ivan, Katrina, and numerous tropical storms have all taken their toll. The Island needs basic management to deal with post-storm conditions. Prescribed burning is needed to reduce fuel loads, improve access, and restore ecological integrity. Invasive species control is required primarily for Chinese tallow trees. Limited planting of new trees will be conducted to improve stand quality and diversity to help insure long-term stability of the remaining original island.

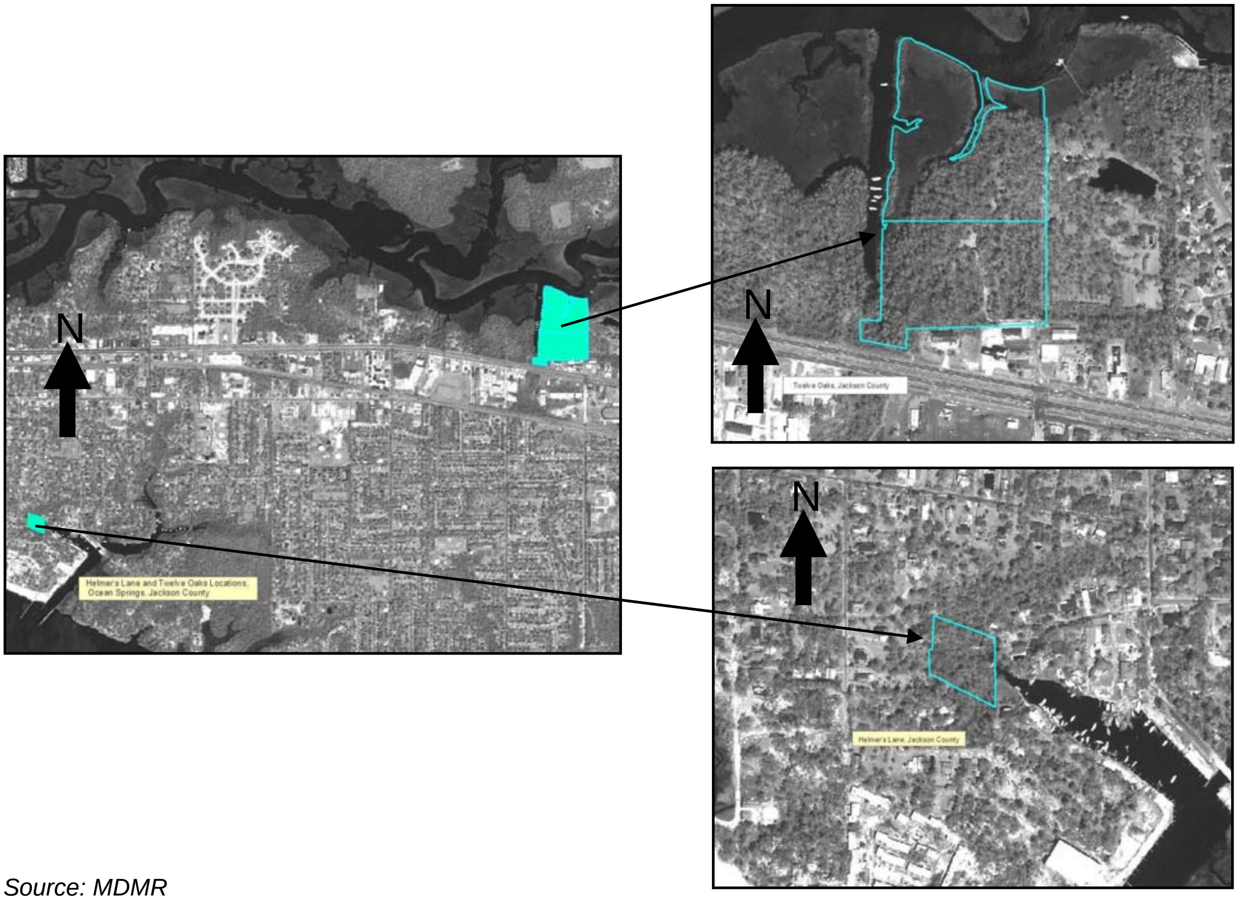


Source: MDMR

Figure 4.1.5.5-10. Round Island, Jackson County State Initiative Project

Round Island also represents an excellent opportunity to restore and create marsh and other estuarine systems. It is proposed that marsh be created on the west side, protected from the prevailing long shore current. In turn the island would be protected on its east and south by a vegetated breakwater (i.e. essentially an artificial chenier). Marsh would also be created on the lee side of the breakwater to the south.

- **SITE:** Twelve Oaks and Helmer's Lane, Jackson County
- **DESCRIPTION:** 30 forested
- **CONDITION:** These properties are in the Coastal Preserve boundary and are partially owned by the Land Trust for the Mississippi Coastal Plain (Figure 4.1.5.5-11). Both tract suffered significant blow down and Helmer's received a massive amount of debris from the Ocean Spring's Harbor, which has been largely removed by volunteers. Funding is requested to help remove dangerous snagged trees, some of the heavy downed timber, treat noxious invasive weeds and reforest as needed.



Source: MDMR

Figure 4.1.5.5-11. Twelve Oaks and Helmer's Lane, Jackson County State Initiative Project

4.1.6 Projects from Interim Report carried for further Consideration

Table 4.1.6-1.
180 Projects – Environmental

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Coastal Mississippi Artificial Reef Project for Remediation of 2005 Hurricane Damage	Other			Hurricane Storm Damage & Reduction (HSDR), Sub-surface Erosion, Fish & Wildlife Habitat Degradation.	MDMR
Restore more natural freshwater flows by closing the MRGO	Ecosystem Restoration (ER)				Corps, New Orleans
Restore grassbeds in MS Sound	HSDR	ER			MsCIP Comprehensive - SAV Restoration
Replace structures with marshes.	ER	Flood Damage Reduction (FDR)			MsCIP Comprehensive - SDSS/Non-structural
Provide 100 acres of oyster reef restoration	ER	HSDR			MsCIP Interim & Comprehensive - Partnership with MDMR
Provide an incentive for replacing failing septic systems in rural areas to improve water quality along bayous and bays.	Other				USEPA
Add wetlands along main drainage systems in each location to increase capacity of the systems during rainfall and surge flooding events.	ER	FDR			MsCIP Comprehensive - SDSS
Consider brown water system to minimize demand on ground and surface waters and limit saltwater intrusion.	Other				USEPA
Consider all archaeological sites in planning process Many significant coastal sites are eroding and need to be preserved.	HSDR				MsCIP Comprehensive - Programmatic EIS

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Marsh Restoration where Feasible This can be done in conjunction with private and government dredging projects	ER	HSDR	FDR		MsCIP Comprehensive - SDSS & Barrier Islands
Partnership Efforts with Louisiana to Marsh Island Areas	OTHER				LaCPR Comprehensive
Barrier Islands - Restoration (to a natural setting)	ER	HSDR			MsCIP Comprehensive - SDSS & Barrier Islands
Allow nature to dictate wetlands vs. beach to a greater degree	FDR	EC			MsCIP Comprehensive - SDSS
Hancock County Comprehensive HSDR - Ecosystem Restoration	HSDR	ER		HSDR and Erosion of beach, seawall, and road raising and/or repair; sand placement, dune restoration; potential 5-8 miler reach.	MsCIP Interim & Comprehensive
Jackson Wetland Restoration	ER	HSDR		HSDR, Erosion to drainage outfalls and interior drainage facilities.	MsCIP Interim
St. Louis Bay Comprehensive ER	ER	HSDR		HSDR, Erosion, Fish & Wildlife Habitat Degradation.	MsCIP Comprehensive - Future Studies
Lakeshore Beach ER	ER	HSDR		HSDR, Erosion, Fish & Wildlife Habitat Degradation.	Environmental Concerns - Potential SAVs
Biloxi Marshes Comprehensive ER	ER	HSDR	FDR	HSDR, Fish & Wildlife Habitat Degradation, Silt Deposition, Saltwater Intrusion.	MsCIP Comprehensive - Freshwater Diversion/Future Studies
Clermont Lake ER	ER	FDR	HSDR	HSDR, Erosion, Fish & Wildlife Habitat Degradation, Saltwater Intrusion and/or contamination.	MsCIP Comprehensive - SDSS
Magnolia Branch ER	HSDR	ER		Use conservation easements to restore magnolia branch.	MsCIP - SDSS

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Jordan River Shores ER. Home owner assistance and relocation, return hydrology, begin mitigation, prohibit new/more development	FDR	ER		Return hydrology, begin mitigation, prohibit new/more development.	MsCIP Comprehensive - Non-Structural/SDSS
Pearlington ER – Home owner assistance and relocation and return hydrology	FDR	ER		Homeowners assistance and relocation project and return hydrology.	MsCIP Comprehensive - Non-Structural/SDSS
Shoreline Park Home owner assistance and relocation	FDR	ER		See Shoreline Park Home owner assistance and relocation.	MsCIP Comprehensive - Non-Structural/SDSS
Restore all Hancock (all coastal MS) marshes damaged by storm	HSDR	ER			MsCIP Comprehensive - Freshwater Diversion/Non-Structural/SDSS
Restore Hancock County Beaches to Pre-Katrina conditions	HSDR	ER			MsCIP Interim
Widen Hancock County Beaches, jump-start dunes	HSDR	ER			MsCIP Interim
Preserve Bayou Caddy Area	ER				MsCIP Interim
Protect Hancock County wetlands from filling for development	FDR	ER			MsCIP Comprehensive - SDSS
Turkey Creek Watershed Improvements	FDR	HSDR		HSD exacerbation to existing drainage systems.	MsCIP Comprehensive - Non-Structural/SDSS/ Future Studies
Tchoutacabuffa River Flood Damage and Watershed Improvement	FDR	ER		HSD to existing development, marsh damage due to surge.	MsCIP Comprehensive - Future Studies
Biloxi Back Bay Watershed Management and Ecosystem Restoration	ER	FDR		HSD, Erosion, FW Habitat Degradation, Saltwater Intrusion and/or contamination.	MsCIP Comprehensive - Future Studies
Courthouse Road Wetlands Ecosystem Restoration and Preservation	ER	FDR		HSD, Erosion, FW Habitat Degradation.	MsCIP Interim
Deer Island Ecosystem Restoration	ER	HSDR		HSD, Erosion, FW Habitat Degradation.	Section 528 Construction General & FCCE Funds

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
DÆIberville Wetlands Ecosystem Restoration	ER	HSDR		HSD, Erosion, FW Habitat Degradation.	MsCIP Comprehensive - Non-Structural/SDSS
Acquire wildlife corridors in lands that repeatedly flood	FDR	ER		Acquire and set aside green corridors in areas that have flooded often, such as Turkey Creek in Harrison, Bay Side Park). The Land Trust would hold land in perpetuity.	MsCIP Comprehensive - Non-Structural/SDSS
Develop Concrete Staging Center in Industrial Canal. Develop Harrison county industrial canal artificial reef staging area to stockpile concrete debris for oyster reef and other useful projects.	OTHER			Develop Harrison county industrial canal artificial reef staging area to stockpile concrete debris for oyster reef and other useful projects.	MDMR and MsCIP Comprehensive - Partnership with State
Restore or enhance Mississippi oyster reefs.	HSDR	ER		90-95% of the reefs were destroyed by Katrina. MS had around 12,000 areas of productive reefs prior to Katrina.	MDMR and MsCIP Comprehensive - Partnership with State
Utilize HW 90 bridge as artificial reef material	OTHER			Utilizing Highway 90 Bridge as Artificial Reef Material	MDMR Completed
Wiers (low level dams) within estuaries to control water flow	OTHER				MsCIP Comprehensive - Freshwater Diversion
Purchase riparian buffers, wetland areas.	FDR	ER			MsCIP Comprehensive - Non-Structural/SDSS
Reconsider dioxin cleanup on navy base post Katrina.	OTHER				USEPA
Reduce toxic exposure which exacerbates storm damage - Dioxin, Creosote, Titanium Dioxide, Gypsum.	OTHER				USEPA
Turkey Creek watershed Greenway	ER				MsCIP Comprehensive - Future Studies

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Forrest Height Levee :- Restore; Vegetate with native species; Footbridges; Nature trail atop	HSDR	FDR			MsCIP Comprehensive
Turkey Creek: Mt. Pleasant UME Audubon site 41, Tidal Creek restoration of flood plain.	FDR	ER		Tidal Creek restoration of floodplain.	MsCIP Comprehensive - Future Studies
Possibly add height to the existing beach elevation and redevelop lost dune vegetation.	HSDR	ER			MsCIP Interim & Comprehensive
Front Beach Boulevard ER and Erosion Control	HSDR	ER			MsCIP Comprehensive - Non-Structural/SDSS
Front Beach Road Wetlands	ER	HSDR			MsCIP Comprehensive - Non-Structural/SDSS
East Beach Road ER	ER	HSDR			MsCIP Comprehensive - Non-Structural/SDSS
Belle Fontaine Marsh	HSDR	ER			MsCIP Comprehensive - Non-Structural/SDSS
Biloxi Back Bay	FDR	ER	HSDR		MsCIP Comprehensive - Future Studies
Davis Bayou ER	ER	HSDR			MsCIP Comprehensive - Future Studies
Jackson County Marsh Outlet ER	HSDR	ER	FDR	HSD and sediment infilling of existing drainageways and drains.	MsCIP Comprehensive - Non-Structural/SDSS
Gautier Hurricane Storm Damage Reduction and Ecosystem Restoration/Ladnir Rd	HSDR			HSD, Erosion, Storm-caused failure of bulkhead, road damage, severance of evacuation route, threats to bridge.	MsCIP Interim & Comprehensive - Non-Structural/SDSS
Pascagoula beaches, offshore breakwater/dunes/reefs/marshes to dissipate wave energy	HSDR	ER		HSD and sediment infilling of existing drainageways and drains.	MsCIP Interim

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Restore natural drainage ways upper Bayou Castelle (vic Fishhawk Rd, Meadow Dale Dr., Longwood Dr, and Bayou Castelle Dr)	FDR	HSDR		Restore natural drainage ways upper Bayou Castelle (vic Fishhawk Rd, Meadow Dale Dr., Longwood Dr, and Bayou Castelle Dr).	MsCIP Comprehensive - Non-Structural/SDSS
Robert Hiram Bridge (Gautier) Hurricane evacuation route. Wetlands restoration, drainage	HSDR	FDR	ER	Hurricane evacuation route. Wetlands restoration drainage.	MsCIP Comprehensive - Non-Structural/SDSS
Graveline Road Bridge at Shepard St Park (County)	HSDR	FDR	ER	Hurricane evacuation route. Wetlands restoration drainage.	MsCIP Comprehensive - Non-Structural/SDSS
W River Delta restoration. Bulkhead western channel. Beneficial use. Wave protection for subdivisions.	HSDR	ER		Bulkhead western channel. Beneficial use. Wave protection for subdivisions.	MsCIP Comprehensive - Freshwater Diversion
Bennett Bayou tidal marsh restoration	HSDR	ER		Provide wetland function in a highly visible project area for public education and promote the Gov's Restoration Initiative.	MsCIP Comprehensive - Non-Structural/SDSS
Pascagoula Beach Restoration. Dunes, grasses, trees, with intermittent pockets of sand beach	HSDR	ER		HSD, Erosion, Bridge abutment damage.	MsCIP Interim
Ebb and flow of Intracoastal veins from the MS Sound to rebuild property with the erosion in the bayous near potential project #66.	HSDR	FDR			MsCIP Comprehensive
Cedar Point/West River-Restore beaches, sand, work, sediment management in this area	HSDR				MsCIP Comprehensive
ER along Hwy 90, Jackson County	ER	HSDR			MsCIP Comprehensive - Non-Structural/SDSS

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Improve the Jackson-county seawall. Provide additional county-wide seawall construction, boardwalks, beach construction, marsh construction, or a combination of these elements	HSDR	ER			Duplicate
Rebuild and enlarge Marsh Island	ER	HSDR			Corps, New Orleans
Divert water from Escatawpa River into Bayou Cumbest to restore freshwater flow to the bayou and improve water quality.	ER				MsCIP Comprehensive - Freshwater Diversion
Pascagoula brown water system study	OTHER			Brown water system study.	USEPA
Pascagoula Beach Blvd. Restoration (Boardwalk, beach, and marsh addition along Pascagoula front beach)	HSDR	ER		Boardwalk, beach, and marsh addition along Pascagoula front beach.	MsCIP Interim/FEMA/City of Pascagoula

4.1.7 Mitigation Measures

The Council of Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provisions of National Environmental Protection Act (NEPA) [40 Code of Federal Register (CFR) 1500-1508] clarify the requirements by defining direct effects, indirect effects, and cumulative effects.

- **Direct Effects.** Those effects caused by the action and occurring at the same time and place. [40 CFR 1508.8].
- **Indirect Effects.** Those effects caused by the action and occurring later in time or farther removed in distance, but still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. [40 CFR 1508.8].
- **Cumulative Impacts.** Those impacts on the environment, which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. [40 CFR 1508.7].

Implementation of structural plans identified in the Engineering Appendix would require placement of fill in wetlands, including open-water habitats, in Coastal Mississippi. These structural plans involve direct, indirect and cumulative impacts, such as the filling in of wetlands and loss of wetlands in the future. A more detailed discussion of these impacts can be found in the MsCIP Comprehensive Report and Integrated Programmatic EIS and also in the Engineering Appendix. Overall, structural measures have been developed in ways that avoid or minimize wetland impacts. The Environmental PDT worked closely with the Engineering PDT to ensure that levee alignments went through land that would result in the least impact. This has resulted in several alternative alignments of structural components; however, there are still some wetland impacts anticipated.

The direct loss of wetlands by structural measures would be mitigated in order to ensure no net loss occurs in Coastal Mississippi. The Environmental PDT utilized as a guide the current mitigation bank ratio policies currently implemented in Coastal Mississippi as an early surrogate to preliminarily assess mitigation costs. Mitigation for impacts to wetlands would be accomplished by creation of tidal and non-tidal wetlands throughout the three coastal drainage basins. Should any of these structural plan elements be recommended for construction and/or additional study, the actual development of the mitigation plan and associated costs would be developed at that time.

LOD 3 (i.e. elevation of the existing roadway and seawall along the mainland shoreline) would result in the loss of 2.6 acres of tidal wetlands and 13.1 acres of non-tidal wetlands. There are no alternative designs due to the technical feasibility.

LOD 3 (i.e. ring levees around coastal communities) would result in the loss of up to 81.4 acres of tidal wetlands and up to 182.8 acres of non-tidal wetlands. Several optional layouts have been considered, which would result in less wetland acreage impacts. The Forrest Heights Levee project located in the City of Gulfport, Harrison County is recommended for construction. Under this 21-foot alternative, there is an expected loss of 3.6 acres of wetland vegetation impacted by construction of the levee. Although native vegetation under the levee footprint would be lost, the levee itself would be vegetated with non-native species for stabilization of the structure. Alternative alignments results in impacts being reduced to approximately 12 acres of tidal wetlands and 67 acres non-tidal wetlands. LOD 4 (i.e. inland barrier and surge gates) would result in the loss of up to 138.1 acres of tidal wetlands and up to 287.4 acres of non-tidal wetlands. The alternate ring levee alignment can be found in the Engineering Appendix.

The surge gates crossing Bay of St. Louis would result in the loss of approximately 35 acres of waterbottoms. Detailed discussion regarding the design, location, and operations and maintenance of these structures are discussed in the Engineering Appendix. Mitigation would be accomplished by the creation of 175 acres of tidal fringe wetlands throughout the Bay of St. Louis vicinity. An alternative ring levee around Bay St. Louis would impact up to 1.4 acres tidal wetlands and up to 54.6 acres non-tidal wetlands. An alternate alignment of the inland barrier in the western portion of Harrison County along Menge Avenue would reduce impacts to waterbottoms. Implementation of this alternative alignment would impact up to 33 acres of non-tidal wetlands. By implementation of these two alternate alignments, the need for a surge gate crossing the Bay of St. Louis would be eliminated.

The surge gates crossing of Biloxi Bay would result in the loss of 27 acres of waterbottoms. Mitigation would be accomplished by creation of 135 acres of tidal fringe wetlands throughout Biloxi Bay vicinity. No alternatives have been developed.

Further development of alterative alignments are being currently refined in order to reduce potential impacts and to include all necessary structural components. An example of this is the construction of a ring levee around Bay St. Louis and an alternate alignment along Menge Avenue (i.e. LOD 4), which would eliminate the surge gate crossing the Bay of St. Louis. This is an ongoing formulation process in order to determine the best possible alignments.

4.2 Recommended Plans

The environmental component of the MsCIP Comprehensive Report and Integrated Programmatic EIS consists of the construction of environmental restoration projects that would ensure preservation of fish and wildlife, prevent saltwater intrusion, and provide stabilization of shorelines, in order, to reduce or eliminate coastal erosion and restore lost fish and wildlife habitat. These potential environmental restoration projects would restore low-lying areas; thus, reducing future storm damages to Coastal Mississippi. Residents and structures (i.e. commercial and residential) would be moved from these areas. In addition, the restoration of historic environmental settings would provide a natural buffer to future storm damages while also benefiting fish and wildlife.

Potential projects include freshwater diversion projects into Western Hancock County Marshes that have severely degraded over the years due to levee systems in eastern Louisiana and along the Pearl River, causing a decline in oyster resources.

Restoration of lost ecosystem functions where restoration needs are immediate due to unchecked wetland deterioration. As Coastal Mississippi residents are rebuilding much needed housing, there is an increase in developmental pressures on these valuable ecosystems due to housing shortages. The Environmental Recommended Plan would allow for restoration of storm damaged habitats and coastal systems and would prevent further destruction of these vital habitats. Wetlands in Coastal Mississippi can be restored to a sustainable level, one that coexists with human uses and communities.

Restoring critical landforms, barrier island shorelines, historical hydrologic patterns, and the sediment transport and budget system are crucial in order to sustain ecological and geomorphological function in perpetuity. The Environmental Recommended Plan has an emphasized interagency cooperation as dedicated staff members include representatives from the Corps, Mobile District, USFWS, and NPS. Additionally, we have collaborated with other resource agencies that include USEPA, USGS, NRCS, NOAA Fisheries (PRD & HCD), MDEQ, and MDMR.

The Environmental Recommended Plan partners with the State and recommends for construction of state recommended initiative projects that allow for recovery of badly damaged ecosystems. Additional collaboration has and will continue to occur with NGOs, including TNC, Gulf Restoration Network, The Sierra Club, The Audubon Society, etc., in addition to Mississippi academic coastal engineers and biologists, such as USM, Gulf Coast Research Lab, and MSU, in order to accomplish widespread support for this environmental effort. A strong public involvement campaign has been used to ensure contributions have been submitted by local constituencies and stakeholders in order to create strong buy-in on potential restoration projects.

CHAPTER 5. RECOMMENDED PLANS

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended approach presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration. All recommended plans on ecosystem restoration have incorporated adaptive management capabilities, where needed.

The **Recommended Environmental Plans for Coastal Mississippi** consists of the following:

5.1 Ecosystem restoration of historical wetlands previously developed

5.1.1 Plan Formulation

The Corps, Mobile District began investigations for identifying potential environmental restoration sites for the purposes of storm and flood damage reduction, flood reduction, preservation of fish and wildlife habitat, and removal of habitable structures within high hazard areas. When residential and/or commercial structures and/or land are purchased for the purpose of restoring floodplain areas (i.e. non-structural component), the structures are demolished and the land is no longer available for residential and/or commercial development. Historically, when land is purchased across the U.S., it is left with all or some of the infrastructure at the site rather than restoring it to its historic setting. With the MsCIP environmental plan, land that is purchased (i.e. non-structural component – refer to Non-structural Appendix) would then be restored into historical functional wetlands. The Corps, Mobile District, in cooperation with ERDC, developed a tool to help identify potential restoration sites throughout the study area.

Development of a GIS based SDSS tool allowed the Corps, Mobile District, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout Coastal Mississippi (Lin 2007). A detailed discussion of this GIS based SDSS tool is included in this Environmental Appendix. A subset of potential restoration sites were identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. This interagency team allowed us to both confirm the accuracy of the SDSS results and to collect additional on-site information pertinent to restoration efforts. There are some major benefits in using a GIS-based SDSS approach to wetland restoration. First, it allows for the relatively rapid assessment of the large number of restoration sites across the wide study area. Second, potential sites can be evaluated and restored in a watershed or landscape context, which allows us to comprehensively evaluate the overall natural system. This approach can maximize the benefits of wetland restoration, as opposed to simply restoring wetlands where convenient or where property is available. Essentially use of this SDSS tool allowed the MsCIP environmental team to assess the entire coastline as a holistic natural system; thus, the team was more effectively able to analyze needs in Coastal Mississippi.

The SDSS effort resulted in the following products:

1. ModelBuilder based SDSS tool, which can be subsequently edited and applied to other areas along Coastal Mississippi in the future as funding becomes available;

2. Maps, such as aerial photography, topographic, soil layers, etc., depicting areas in the study region that have a high probability of being successfully restored into wetland functions that buffer and/or store stormwater, and provide suitable habitat for fish and wildlife; and

3. Photograph documentation and data sheets containing information on ground-truthed potential restoration sites.

This project has been further coordinated with the ongoing efforts of the MsCIP non-structural flood-proofing committee, and their results were used as the team identified potential restorations sites in Coastal Mississippi. The selection of 34 restoration sites, identified in Section *4.1.5.2 Environmental Restoration of Historical Wetland Sites*, was based on a combination of results from the SDSS tool and input from MDMR personnel based on local knowledge of the study area and adjacency to existing sensitive protected natural areas (i.e. State and/or Federal lands). A summary discussion of this effort follows.

5.1.1.1 SDSS

The SDSS tool evaluated potential wetland restoration sites that had been initially selected based on having a non-natural land cover (i.e. urban, deforested, and agricultural land cover, based on MDMR 2001 land cover GIS layer) and were located in the 100-year floodplain (Lin 2007). Numerous potential environmental restorations sites were initially identified. This initial group of sites was narrowed down based on the results of the SDSS. Sites with the following characteristics were screened out:

- < 5 acres in size
- Restorability class of Low or Medium Low
- Habitat class of Low or Medium Low
- Storm Surge/Flood Protection class of Low

5.1.1.1.1 Environmental Restoration Sites

Screening yielded numerous sites that were then reviewed by the Corps, Mobile District, MDMR, and USFWS personnel and based on this input the recommended sites identified as Phase I as Turkey Creek, Bayou Cumbest, Admiral Island, Dantzler and Franklin Creek (discussed in the following sections in detail) and the other 38 final restoration sites identified as Phase II (shown in Table 5.1.1.1.1-1) were selected. These final environmental restoration sites include a combination of those identified based on the SDSS results, as well as some additional sites (i.e. State Initiatives). These were made using only the non-natural land-use and 100-year flood calculations as the original site selectors (i.e. no damage layers were used), and sites were greater than or equal to 5 acres.

Table 5.1.1.1.1-1.
Environmental Restoration Sites in Coastal Mississippi

Site	Restoration Acres	Environmental Habitat Setting	Cost
(1) Pearlington, Hancock	76 acres (State owns 2,200 acres in the Pearlington area)	Emergent aquatic vegetation Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$ 30,200,000
(2) Pearlington South, Hancock	11 acres	Emergent aquatic vegetation Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$ 23,400,000
(3) Port /West, Hancock	49 acres	Emergent aquatic vegetation	$ 19,800,000
(4) Ansley, Hancock	2,023 acres (State owns 6,000 acres west of Lakeshore Road)	Emergent aquatic vegetation Wet pine savannah	$ 482,100,000
(5) Heron Bay	594 acres	Emergent aquatic vegetation	$ 192,100,000
(6) Lower Bay	226 acres	Emergent aquatic vegetation	$53,000,000
(7) Lakeshore, Hancock	275 acres	Emergent aquatic vegetation	$ 69,200,000
(8) Bayou Caddy/Lakeshore, Hancock	362 acres	Emergent aquatic vegetation	$ 113,400,000
(9) Clermont Harbor, Hancock	209 acres	Emergent aquatic vegetation	$ 208,300,000
(10) Bayou La Croix, Hancock	259 acres	Emergent aquatic vegetation	$ 207,100,000
(11) Shoreline Park, Hancock	889 acres	Emergent aquatic vegetation	$ 1,259,200,000
(12) Chapman Road, Hancock	146 acres	Emergent aquatic vegetation	$ 174,100,000
(13) Jourdan River – Interstate 10 Development, Hancock	638 acres	Emergent aquatic vegetation	$ 155,900,000
(14) Diamondhead, Hancock	433 acres	Emergent aquatic vegetation	$ 267,700,000
(15) Delisle, Harrison	120 acres (State owns 1,000 acres)	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs	$ 41,900,000
(16) Ellis Property, Harrison	443 acres	Emergent aquatic vegetation Pine savannah - wet pine flatwoods.	$ 60,300,000
(17) Pine Point East, Harrison	103 acres (State owns 40-50 tax forfeited lots)	Emergent aquatic vegetation Wet pine savannah habitat	$ 47,500,000

Table 5.1.1.1.1-1.
Environmental Restoration Sites in Coastal Mississippi (continued)

Site	Restoration Acres	Environmental Habitat Setting	Cost
(18) Pine Point West, Harrison	83 acres (State owns 40-50 tax forfeited lots)	Emergent aquatic vegetation Wet pine savannah habitat	$ 36,700,000
(19) Pass Christian, Harrison	21 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs	$ 10,700,000
(20) Pass Christian Site – Bayou Portage, Harrison	43 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs	$ 27,800,000
(21) Brickyard Bayou, Harrison	14 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs	$ 7,000,000
(22) Biloxi River – Shorecrest, Harrison	15 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs Riverine/levee forests	$ 12,500,000
(23) Biloxi River – Eagle Point, Harrison	17 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs Riverine/levee forests	$ 17,400,000
(24) Biloxi Front Beach - South of Highway 90, Harrison*	40 acres	Dune System	$ 60,500,000
(25) Keegan Bayou, Harrison	54 acres	Emergent aquatic vegetation Wet Pine Savannah habitat	$ 31,500,000
(26) St. Martin, Jackson	467 acres	Emergent aquatic vegetation	$ 147,500,000
(27) Fort Point, Jackson	83 acres	Emergent aquatic vegetation	$ 29,400,000
(28) Pine Island, Jackson	237 acres	Emergent aquatic vegetation	$ 518,600,000
(29) Belle Fontaine, Jackson*	1,516 acres	Dune System	$ 373,700,000
(30) Griffin Point, Jackson	182 acres	Emergent aquatic vegetation	$ 70,900,000
(31) Bayou Chico, Jackson	258 acres	Emergent aquatic vegetation	$ 82,900,000
(32) Grand Bay/Bayou Cumbest, Jackson	2,666 acres	Emergent aquatic vegetation	$ 621,400,000
(33) Wachovia, Hancock	1,200 acres total – 800 marsh, 200 forested, 200 savannah	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$2,830,000 Env. Rest $ 0 Real Estate
(34) Ansley, Hancock	900 acres – 800 marsh, 100 forested	Emergent aquatic vegetation, Wet pine savannah	$2,420,000 Env. Rest $ 0 Real Estate
(35) LaFrancis Camp Trenaisse, Hancock	45 acres total – all open water	Open Water	$ 8,770,000 Env. Rest $ 0 Real Estate
(36) DuPont, Harrison	650 acres – 170 marsh, 480 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$6,597,000 Env. Rest $ 0 Real Estate
(37) Dantzler, Jackson (Alternate)	900 acres – 500 marsh, 385 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$2,230,000 Env. Rest $ 0 Real Estate

Table 5.1.1.1.1-1.
Environmental Restoration Sites in Coastal Mississippi (continued)

Site	Restoration Acres	Environmental Habitat Setting	Cost
(38) Pascagoula River Marsh, Jackson	11,150 acres	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$ 2,420,000 Env. Rest $ 0 Real Estate
	27,397 acres	**Grand Total**	**$ 5,478,967,000**

* - Removed as a result of further evaluating

Source: MsCIP Environmental Team

The MsCIP environmental team then re-evaluated potential environmental restoration sites to see if there were any additional potential sites based on local knowledge of the coast. Existing wetlands targeted by MDMR for improvements, rather than restoration, were quickly identified by the team members. Because these sites are classified as having a natural land cover, they were not included in the initial selection of potential sites evaluated by the SDSS. Sites targeted by MDMR for restoration to upland habitat were also identified as potential restoration. Since the SDSS tool was evaluating sites based on wetland restoration potential, these sites were screened out for having a *Restorability class of Low or Medium Low*. Therefore, the local knowledge assisted in identifying and including these sites in the list.

For example, Shoreline Park was screened out after the SDSS evaluation because it had a *Medium Low restorability classification*. This Medium Low score was a result of large portions of Shoreline Park having been mapped in the state's soil survey as essentially a *spoil/fill* category, which is classified as non-hydric. However, it is known that historically the Shoreline Park area contained hydric soils, which could easily be restored through the removal of the existing fill and spoil. Therefore, this restoration site was then reinstated.

5.1.1.1.2 Initial Projects – Two Environmental Restoration Sites

Two potential restoration sites were chosen as *Phase I initial projects* to be carried forward in the environmental component of the MsCIP Comprehensive Plan. The potential restoration sites are located throughout the study area. One of the sites consists of restoring emergent tidal marsh and scrub/shrub habitat and the other site restores wet pine savannah habitat. The two sites allow the Corps, Mobile District to demonstrate the planning process involved in developing environmental restoration measures, development of alternatives, and selection of a cost-effective restoration plan (refer to the Economic Appendix for a detailed cost-effective discussion) for each potential environmental restoration site. This short-term effort was classified by the PDT as Phase I of a two phased approach, which allows for short-term and long-term comprehensive efforts. Phase II includes environmental restoration projects that require a longer timeframe to complete. If selected for further study, all 38 potential sites would go through a similar planning and evaluation process under the Phase II – Longer Term Comprehensive effort. Table 5.1.1.1.2-1 demonstrates how the identified environmental restoration projects allow the Environmental and overall MsCIP PDTs to achieve the overall project goals and objectives.

Table 5.1.1.1.2-1.
MsCIP Comprehensive Approach

Proposed Restoration Project	Portion of the Ecotone to be Addressed	Ecological/Societal Functions to be Addressed	Comprehensive Plan Objectives to be Addressed
Freshwater Diversion, Escatawpa River, MS	Littoral areas, emergent wetland areas	Enhanced oyster production, enhanced productivity of brackish marshes	3, 4, 5, 6
Other Coastal Wetland and Forest Restoration	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
Levee Projects – Belle Fontaine, Gulf Park Estates, Pascagoula/Moss Point, Pearlington, Gautier, Ocean Springs, Bay St. Louis	Reduces flooding	Adds protection to human development out of the coastal ecotone for public safety zone	1, 2, 6
Long-term High Hazard Area Risk Reduction Plan	Restore natural flooding buffer	Restore natural buffer zone, relocation of human development out of the coastal ecotone for public safety	1, 2, 6
Freshwater Diversion of the Mississippi River	Littoral areas, emergent wetland areas	Enhanced oyster production, enhanced productivity of brackish marshes	3, 4, 5, 6
High Hazard Area Risk Reduction Plan	Emergent tidal marsh, forested wetlands	Enhanced productivity of wetlands and forested wetlands in order to restore natural buffer zone	1, 2, 6
Moss Point Municipal Relocation Component	Restore natural flooding buffer	Restore natural buffer zone, relocation of human development out of the coastal ecotone for public safety	1, 2, 6
Waveland Floodproofing	Restore natural flooding buffer	Restore natural buffer, relocation of human development out of the coastal ecotone for public safety zone	1, 2, 6
Forest Heights Hurricane and Storm Damage Reduction Component	Reduces flooding	Adds protection to human development out of the coastal ecotone for public safety zone	1, 2, 6
Turkey Creek Ecosystem Restoration	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands Removes structures from project area	1, 2, 3, 6
Dantzler Restoration Area Ansley	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands	1, 3, 6
Franklin Creek Ecosystem Restoration	Wet Pine Savannah Wetlands	Moves Residents out of Harms Way (MsCIP Interim Project) Enhanced productivity of wetlands	1, 2, 3, 5, 6

Table 5.1.1.1.2-1.
MsCIP Comprehensive Approach (continued)

Proposed Restoration Project	Portion of the Ecotone to be Addressed	Ecological/Societal Functions to be Addressed	Comprehensive Plan Objectives to be Addressed
Bayou Cumbest Ecosystem Restoration Pearlington, Pearlington South, Port/West, Chapman Road, Diamondhead, Delisle, Ellis Property, Brickyard Bayou, Biloxi River – Shorecrest , Biloxi River – Eagle, Jourdan River – I-10 Development, Pine Island, Fort Point, St. Martin, Keegan Bayou	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
Admiral Island Ecosystem Restoration Lakeshore, Bayou Caddy/Lakeshore, Clermont Harbor Bayou La Croix, Shoreline Park, Pine Point East, Pine Point West, Pass Christian Site – Bayou Portage	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
SAV Pilot Project at Bayou Cumbest	SAV – *Ruppia maritime*	Enhance fishery production	3, 6
Beach and Dune Ecosystem Restoration	Coastal Dune Habitat	Buffer mainland from storm surge and waves energy	1, 2, 3, 5, 6
Barrier Island Restoration Biloxi Front Beach – South of Highway 90	Littoral zones, beach, dunes, emergent tidal marsh	Buffer mainland from storm surge and waves energy, enhanced productivity of emergent tidal marsh, enhance productivity of SAVs in littoral areas, enhance fisheries production	1, 2, 3, 4, 5, 6
Deer Island Ecosystem Restoration	Coastal Forests, Emergent Tidal Marsh	Enhanced productivity of wetlands	1, 2, 3, 5, 6

Footnote: Objectives - Green –Recommended Elements, Purple – Site Specific Elements, Orange – System Wide Elements. 1. Reduce loss of life caused by hurricane and storm surge by 100%; 2. Reduce damages caused by hurricane and storm surge by $150M-$200M annually; 3.Restore 10,000 acres of fish and wildlife habitat including coastal forests, coastal wetlands, wet pine savannah, submerged aquatic seagrasses, oyster reefs, and beaches and dunes by the year 2040; 4. Manage seasonal salinities within the western Mississippi Sound, such that optimal conditions for oyster growth (surrogate for other aquatic resources, 15 ppt during summer months) are achieved on an annual basis by 2015; 5. Reduce erosion to barrier islands, mainland, and interior bay shorelines by 50%; 6. Create opportunities for collaboration with local, state, and Federal agencies to facilitate implementation of programs and activities that maximize the use of resources in achieving the comprehensive goal.

Part of the reason these two sites were selected for the initial projects is because published HGM Functional Assessment models (Shafer et al, 2007; Rheinhardet et al 2002) exist for the regional wetland classes being restored at these sites (different HGM models exist for different regional wetland subclasses across the country), and thus could be used to measure restoration benefits. HGM models evaluate functions that are specific to a particular regional subclass by mathematically combining variable data (such as vegetation, soil, landscape, or hydrologic indicators) that have been scaled, based on a set of reference wetlands, to a value between 0.0 and 1.0, in order to obtain an index score for each function that is also between 0.0 and 1.0. Functional units are calculated by multiplying each functional index score by the total number of acres of the site. An example assessment HGM table is shown below in Table 5.1.1.1.2-2. For the two initial project sites, the functional units calculated for each function were combined so that a single functional unit benefit number was reported for each plan.

Table 5.1.1.1.2-2.
Cover Classes and Midpoint Values for Each Class

Cover Class %	Class Midpoint %	Cover Value
0	0.0	0.000
0-5	2.5	0.025
5-25	15.0	0.150
25-50	37.5	0.375
50	50.0	0.500
50-75	62.5	0.625
75-95	85.0	0.850
95-100	97.5	0.975
100	100.0	1.000
>100	100.0	1.000

Note: These midpoint values are used to estimate cover in plots. First determine if cover is more, less, or equal to 50%, If cover is >50%, decide if cover ismore or less than 75%. If >75%, decide if cover is more or less than 95%. If cover is <95%, then cover is 75-95% with a midpoint of 85% (0.85).

Because HGM functional assessments allow for restoration benefits to be evaluated in terms of functional unit gains or losses, rather than simply in acres, an advantage to using this method is that both the quality and quantity of wetland being affected are measured. Furthermore, since the variables used in the assessment are often ones that can be manipulated through restoration activities, the HGM assessment can determine the functional unit benefits for specific restoration measures.

It should also be noted several of the variables used in both HGM models require field data collection in order to accurately calculate their value pre-restoration. Because of current project time constraints, field data collection was unable to be conducted. However, the environmental team selected these sites due to their high familiarity with them which would allow effective and accurate assessment. Therefore, in order to estimate functional unit benefits, values for these variables were estimated using local, professional knowledge and assumptions concerning the areas in question. Prior to any actual restoration activities, the necessary field work could be conducted in order to obtain a more accurate measure of pre-restoration site conditions and, subsequently, the functional unit benefits resulting from restoration.

The following plans are being considered for being recommended as part of the overall MsCIP Comprehensive Report/Integrated Programmatic EIS. This effort serves as a Phase I initial project that will be enhanced by the recommended Phase II longer term comprehensive effort. The MsCIP environmental PDT has identified potential environmental restoration projects specified in Table 5.1.1.1.1-1 that would be studied further and restored under this recommended longer term effort.

5.1.1.1.2.1 Turkey Creek, Harrison County

This project site is located north of Gulfport, Mississippi, adjacent to U.S. Highway 49, a major north-west thoroughfare, and within the impaired Turkey Creek watershed. The area is becoming increasingly urbanized and development pressures are resulting in increased wetland degradation and loss by the direct filling. The project site is comprised of 689 acres south of the existing railway located on top of an elevated berm. Approximately 190 acres are located north of the railway and functions separately. The site is primarily comprised of a degraded pine savannah wetland. Several miles of ditches have been excavated throughout the site. Additionally the elevated railway berm fragments the wetland habitat and substantially alters the hydrology of the wetlands located to the north. Several plans were evaluated in order to determine the most cost-effective plan for restoration.

The Turkey Creek site had an HGM assessment performed in 2000, using the *Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains* (Rheinhardt et al 2002). Results from this earlier assessment are being used to establish baseline (current) conditions at the site. The site has been divided into 8 separate assessment areas (Figure 5.1.1.1.2.1-1), as there were different baseline conditions for each area. The same HGM model is also being used to measure functional unit benefits at the site resulting from different restoration plans.

Objectives:

1. Restore native vegetation.
2. Restore natural hydrology.
3. Restore fish and wildlife habitat.
4. Provide storm water storage protection.
5. Restore and maintain State water quality.

Assumptions:

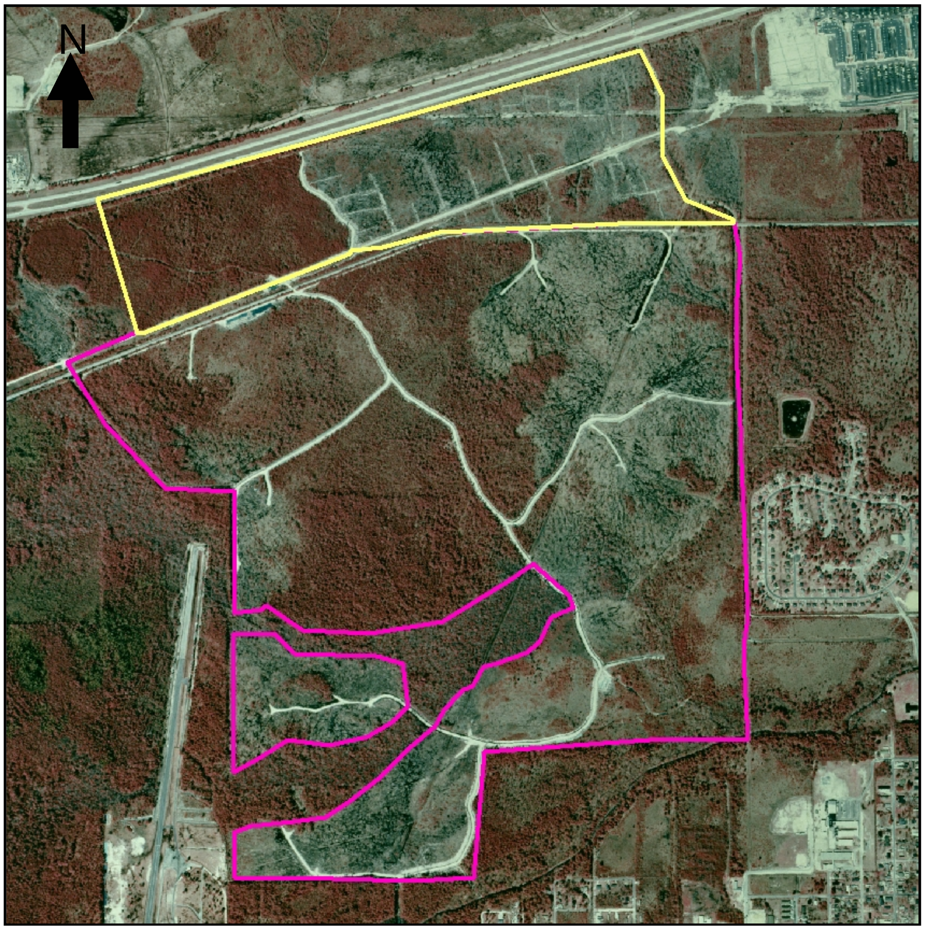
1. Mandatory homeowners assistance and relocation effort.

Measures:

Listed below are the proposed restoration measures and their expected effect on variables used in the HGM model.

1. Filling in ditches (Mandatory to achieve overall restoration project).

   This measure affects the “Outflow of Water” variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.0 to 1.0 under this measure.



Source: Corps

Figure 5.1.1.1.2.1-1. Turkey Creek Restoration Site, Broken into Assessment Areas North (yellow border) and South (pink border) of the Railroad

2. Maintain vegetation (Mandatory to achieve overall restoration project).

   Alternatives:

   a) Burn (3-year cycle).

   b) Mow (annual).

   This measure affects the “area of contiguous fire-maintained landscape”, as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the “area of contiguous fire-maintained” landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory to achieve overall restoration project).

   This measure affects the “surface water storage” variable, which measures the presence of excavation or fill at the site. This variable score would increase from 0.0 to 1.0 in areas with existing roadbeds/fill.

A combination of the measures resulted in the following plan combinations listed in Table 5.1.1.1.2.1-1:

Table 5.1.1.1.2.1-1.
Turkey Creek Restoration Measures

Plans 1-2.	Restoring areas north and south of railroad Plan 1. 1, 2a, 3	Plan 2. 1, 2b, 3
Plans 3-4.	Restoring just areas south of railroad Plan 3. 1, 2a, 3	Plan 4. 1, 2b, 3
Plans 5-6.	Restoring just areas north of railroad Plan 5. 1, 2a, 3	Plan 6. 1, 2b, 3

Table 5.1.1.1.2.1-2 shows the total functional units of the site under each plan, and the Average Annual Functional Unit (AAFU) benefit. It is assumed here that functional units will remain the same under existing conditions and the no-action plan. To calculate the AAFU, it is assumed all benefits are immediately accrued following plan implementation, and that the benefits are sustainable over the life of the project. Therefore, the AAFU was simply calculated as the difference between the total functional units for the restoration plan the total functional units for the no-action plan.

Table 5.1.1.1.2.1-2.
Summary of Functional Unit Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Total Functional Units	Average Annual Functional Unit Benefit
Turkey Creek	879	Existing Condition (plans 1-2)	1,222	-
Turkey Creek	689	Existing Condition (plans 3-4)	1,012	-
Turkey Creek	190	Existing Condition (plans 5-6)	210	-
Turkey Creek	879	No-action plan (plans 1-2)	1,222	0
Turkey Creek	689	No-action plan (plans 3-4)	1,012	0
Turkey Creek	190	No-action plan (plans 5-6)	210	0
Turkey Creek	879	plan 1	3,268	2,046
Turkey Creek	879	plan 2	2,574	1,352
Turkey Creek	689	plan 3	2,577	1,565
Turkey Creek	689	plan 4	2,037	815
Turkey Creek	190	plan 5	691	481
Turkey Creek	190	plan 6	537	327

(1) AAFU's are based on a 50-year period of analysis.
(2) See economic appendix for cost-effective analysis.

5.1.1.1.2.1.1 Plan Selection

These management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, three plans were eliminated because they produced less benefit at greater cost than a subsequent plan. Of the three remaining plans, one proved to be more cost-effective and consists of restoration of 689 acres south of the railway by restoration maintained by burning.

The recommended plan requires filling ditches, maintaining vegetation growth by burning and mowing the project area in the initial year of construction as well as maintaining it by burning every three years over the life of the project, and excavating and removing existing roadbeds and any additional fill.

5..1.1.1.2.1.2 Benefits

In order to restore this area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water. The wet pine savannah habitat will be restored with wet pine flatwoods, such as *Pinus elliotti, Morella cerifera, Ilex glabra, Spartina patens, and Panicum virgatum*.

Many species of wildlife are indigenous to the wet pine savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American chaffseed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, Venus flytrap, and sundews. Rare, T&E birds that may occur in these areas include Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi sandhill crane. This ecosystem may also benefit the Mississippi gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

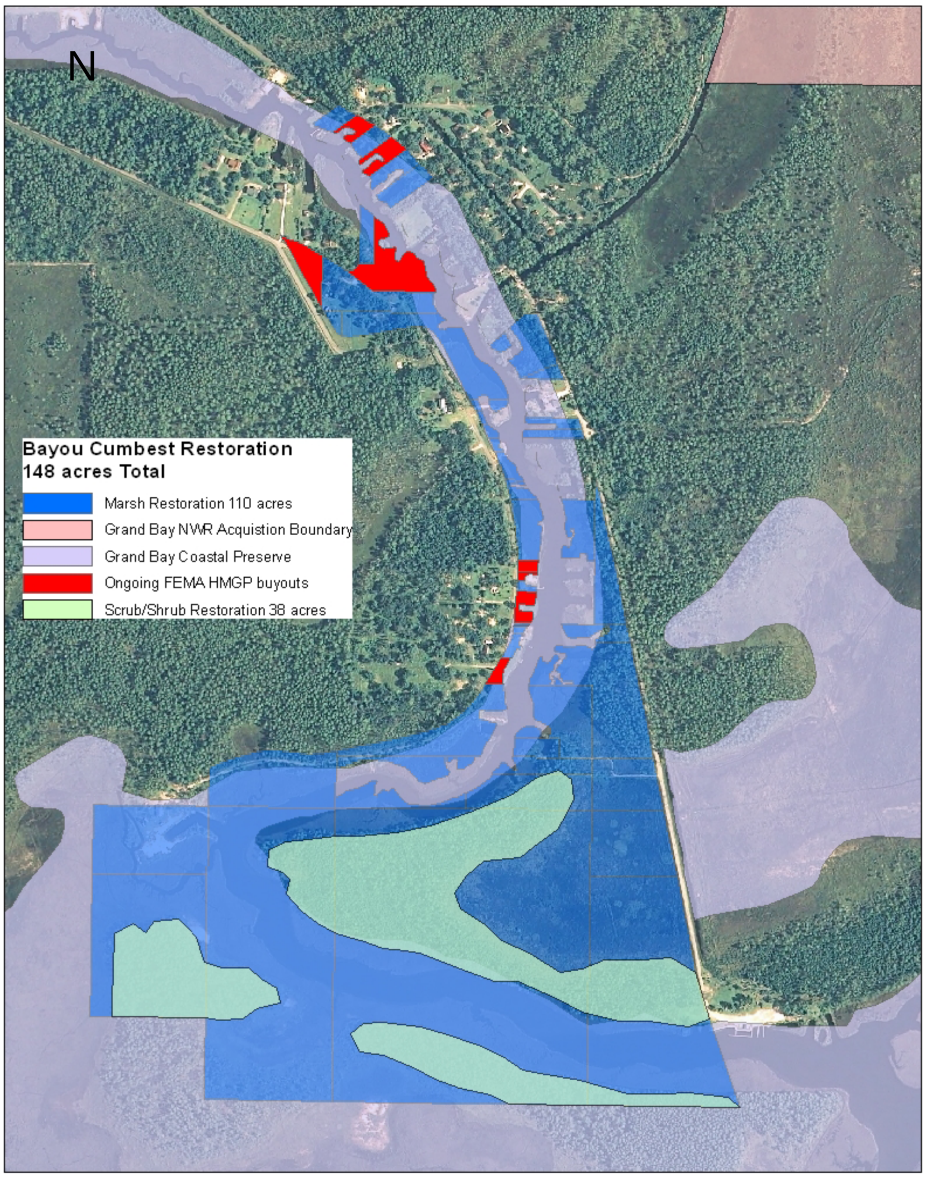
Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration plans. Table 5.1.1.1.2.1.2-1 shows the total functional units under the recommended plan and the AAFU net benefit. It is assumed that functional units will remain the same under existing conditions and the no action plan. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. An essential component necessary when selecting the recommended plan at Turkey Creek was the need for burning. Burning allows the wet pine savannah environment to continue naturally as a functioning system. Although mowing does effectively keep understory plants from over colonizing the area, it does not simulate the natural conditions (i.e. seed germination, heating the pine bark, etc.) Therefore, the environmental PDT ranked the burning measure higher than that of the mowing. This resulted in Plan 2 being eliminated due to its mowing component. When evaluating between Plan 1 and 3, the AAFU units were very different. The acreages were also very different due to Plan 1 including both the north and south parcels while Plan 3 included only the south parcel. The team noted that the man-made barrier within the project site produced hydrology constraints. Dominant flora species in wet pine savannah habitats are dependent upon burning; thus, the MsCIP environmental team selected the following plan knowing that most of these plant species would colonize the area upon establishment of routine burning and hydrology. The Environmental PDT then noted that the desired environmental restoration outputs (i.e. a functioning wet pine savannah) could be achieved by selecting Plan 3 which would also provide a cost-effective plan.

Table 5.1.1.1.2.1.2-1.
Summary of Benefits

Plan	Plan Description	Total Functional Units	AAFU Net Benefit
Existing Condition	Existing Condition	1,012	-
No Action	No Action	1,012	0
Recommended Plan – Plan 3	689 Acre Restoration Fill Ditches Remove Structures Excavate Fill Burn Every Three Years	2,577	1,565

5.1.1.1.2.2 Bayou Cumbest, Jackson County

The project site is located in the extreme southeastern portion of Jackson County adjacent to Bayou Cumbest and Mississippi Sound. The Bayou Cumbest restoration area (Figure 5.1.1.1.2.2-1) contains approximately 148 acres to be restored consisting of 110 acres of emergent tidal marsh and 38 acres of scrub/shrub wetland habitat. Existing scrub shrub vegetation at the site supports natural propagation through removal of exotic species that currently outcompete native vegetation. The area also consists of existing tidal marsh as well as filled and developed areas. Due to the severity of Hurricane Katrina, most of the residential development was severely damaged or destroyed. The site has low elevations and since most residential structures have been destroyed, an opportunity exists to excavate the old fill material and restore the once existent marsh. For increased habitat diversity, the team proposed to leave some of the higher elevations as is and plant shrub/scrub species in order to enhance ecological benefits at the restoration site.



Source: USFWS

Figure 5.1.1.1.2.2-1. Bayou Cumbest Restoration Site

Objectives:

1. Restore marsh to historical (pre-development ~1950's) conditions.
2. Provide storm surge protection.
3. Restore native tidal wetland plant community.
4. Provide fish and tidal wildlife habitat.
5. Prevent saltwater intrusion.

Assumptions:

1. Mandatory property purchase.
2. 100% removal of existing structures.

Measures:

1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas). (Mandatory to achieve overall restoration in all plans)

   This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.50, on the assumption that approximately half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic species, such as Chinese Tallow, Phragmites, Cogon Grass, in all areas over project lifetime. (Mandatory in all plans).

   This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans.

3. Filling in 100% of existing artificial ditches/channels.

   If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting.

   Alternatives:

   a) 0.5 meter spacing
   b) 1 meter spacing
   c) 2 meter spacing

This measure affects the "percent cover by woody plant species", "wildlife habitat diversity", "vegetation height", "wetland indicator status" and "mean percent cover emergent plant species" variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the 50 -year project life, Variable subindex scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter.

A combination of the measures resulted in the following plan combinations listed in Table 5.1.1.1.2.2-1:

Table 5.1.1.1.2.2-1.
Bayou Cumbest Restoration Measures

Plan 1. 1,2,3,4a	Plan 2. 1,2,3,4b	Plan 3. 1,2,3,4c
Plan 4. 1,2,4a	Plan 5. 1,2,4b	Plan 6. 1,2,4c

Table 5.1.1.1.2.2-2 shows the AAFU benefit under each plan.

Table 5.1.1.1.2.2-2.
Summary of AAFU Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	AAFU Benefit[1]
Bayou Cumbest	110	No-action plan	0
Bayou Cumbest	110	plan 1	191
Bayou Cumbest	110	plan 2	188
Bayou Cumbest	110	plan 3	184
Bayou Cumbest	110	plan 4	172
Bayou Cumbest	110	plan 5	169
Bayou Cumbest	110	plan 6	164

(1) AAFU's are based on a 50-year period of analysis.
(2) See economic appendix for cost-effective analysis.

5.1.1.1.2.2.1 Plan Selection

These management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, two plans were eliminated because they produced less benefit at greater cost than a subsequent plan.

The recommended plan will restore 110 acres of emergent marsh and 38 acres of scrub shrub habitat. Existing scrub shrub vegetation at the site supports natural propagation with exotic species management. The recommended plan consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, filling existing artificial ditches, and planting native vegetation, such as *Spartina alterniflora* (Smooth Cordgrass) at the seaward edge of marsh; *Juncus roemerianus* (Black Needle Rush) at a slightly higher elevation; and *Spartina patens* (Saltmeadow Cordgrass) at a slightly higher elevation at a density of 1 meter. For those higher elevation areas identified in Figure 5.1.1.1.2.2-1, exotics would be removed and replanted with scrub/shrub species in order to enhance habitat diversity at the restoration site.

5.1.1.1.2.2.2 Benefits

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function. A HGM assessment was performed. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration plans. Table 5.1.1.1.2.2.2-1 shows the total functional units under each implemented plan and the AAFU net benefit. To calculate the AAFU net benefit, it is assumed that benefits will be maximized at year 5 with 0.5 meter spacing of vegetation, at year 7 with 1.0 meter spacing of vegetation, and at year 10 with 2.0 meter spacing of vegetation. These benefits are estimated to be sustainable over the life of the project. Net AAFU benefits are calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan.

The environmental MsCIP team selected the 1.0 meter spacing based on professional experience by the Corps, universities, NGOs, State, and other Federal agencies with restoration of emergent marsh habitats. Past experience in Coastal Mississippi has proven that spacings, elevation, and hydrology are the three key essential components to obtain a successful emergent marsh site. The three spacing scenarios (i.e. 0.5, 1.0, 2.0 meters) have been used at a local Coastal Mississippi project (i.e. Deer Island, Harrison County). Upon assessing the propagation of those different spacings, the environmental PDT determined that although the 0.5 meter spacing is the desired planting technique, the overall goal of the restoration project can be achieved by spacing the tidal emergent plants out to 1.0 meters per plant. The 2.0 meter spacing was determined to leave the site too vulnerable to storms and/or hurricanes; thus, this spacing technique proofed to be rather risky. Marsh restoration along Coastal Mississippi will provide nursery habitat for various vertebrates and invertebrates while also providing a natural storm protection buffer from future storms. Therefore, the environmental PDT recommended Plan 2 because it provides both the optimal elevation and hydrology requirements while also providing suitable spacings for the tidal marsh plants that will allow the plants the ability to quickly colonize the site.

Table 5.1.1.1.2.2.2-1.
Summary of Benefits

Plan	Plan Description	AAFU Units	Net AAFU Units
Existing Condition	Existing Condition	1,052	-
No Action	No Action	1,052	0
Recommended Plan 2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	1240	188

5.2 Freshwater Diversions

5.2.1 Plan Formulation

Several projects are presently being considered to divert freshwater from the Mississippi River or other sources as a mechanism to promote reversing a historic increase in salinity in the Mississippi Sound/Biloxi marshes area in order to support fresher marshes and oyster reef health and productivity thus enhancing both their economic value and the ecological services they provide.

Oysters not only support a commercial fishery but interact directly with local hydrodynamic conditions, affecting currents, flow conditions, and sedimentation patterns (Lenihan 1999). They filter large amounts of phytoplankton and detritus exerting a powerful influence on water quality, phytoplankton productivity, and nutrient cycling of estuaries (Dame 1996). Oyster reefs provide habitat for a wide range of other invertebrates present either on the oyster shell itself or in the interstices between shells. Oyster reefs also support numerous resident, transient, and juvenile fish and decapod species and may provide a refuge from predation and poor water quality conditions.

Oysters are sensitive to specific ranges of salinity; therefore, freshwater diversions have the potential to either enhance or threaten the resource. For instance, where the average salinity exceeds 15 ppt oysters often experience increased predation rates by oyster drills whereas young oysters are more susceptible to certain diseases at salinities greater than 9 ppt (Cake 1983; Chatry et al. 1983). Similarly, salinities averaging below 7.5 ppt can inhibit oyster growth and sexual maturation while salinities that persist for extended periods of time below 2 ppt can result in direct mortality (Sellers and Stanley 1984). The relationship between oyster productivity and river flow is a complex one and there does not appear to be a close link between oyster harvests and freshwater inflow (Turner 2006).

Alternately, the water diverted from riverine sources not only has lower salinity, but it usually carries more sediment and nutrients. Diversions may result in areas of excess nutrients and thus cause algal blooms, lower light attenuation and other signs of eutrophication.

Therefore, any proposed diversion project needs to be carefully evaluated in order to insure the maximum probability that proper habitat and water quality conditions are met. Because of the potentially large number of projects that might require evaluation, it is essential that a screening tool be developed to cost effectively identify those proposals which warrant the level of detailed study required to make informed decisions. It is essential that proposals that have no likelihood of success are eliminated early in the evaluation process in order to maximize the effectiveness, eliminated negative impacts from poorly designed projects, and reduce costs of evaluating the remaining candidates.

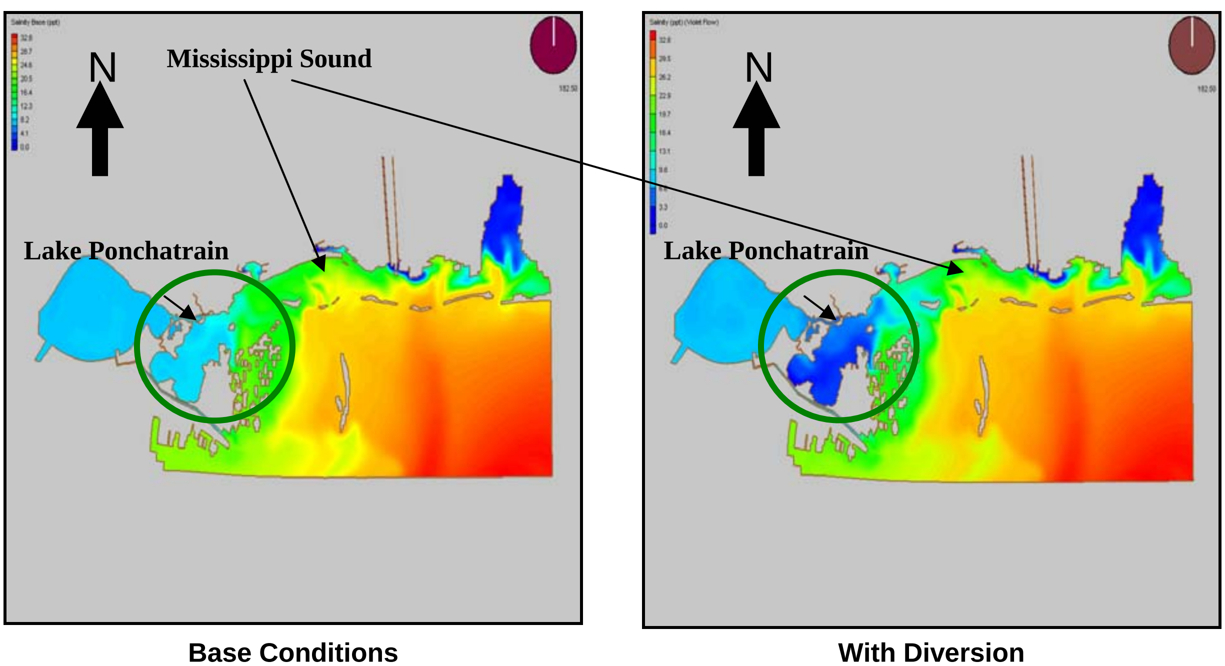
In an effort to initiate the proper evaluation of freshwater diversions, a water quality model, which is based on the CE-QUAL-ICM water quality model code, is coupled to output from a three-dimensional hydrodynamic model of the region, which is based on the CH3D hydrodynamic model (Dorth et al 2007). The version of CH3D with sigma coordinate in the vertical dimension is being used. The model grid extends seaward beyond the Chandeleur Island and includes Mobile Bay, Lake Borge, Lake Pontchartrain, the Inner Harbor Navigation Channel of New Orleans and the Mississippi river Gulf Outlet Channel. Predicted water quality constituents, including nutrients, phytoplankton, dissolved oxygen, temperature, salinity, and underwater light intensity, were evaluated for several scenarios and compared to modeled existing baseline conditions to assess relative changes.

The water quality model was applied for three alternative scenarios: (1) diversion of freshwater flow from the Mississippi River at Bonnet Carre’ spillway, (2) diversion of freshwater flow from the Mississippi River at Violet Marsh, and (3) diversion of all of the Escatawpa River flow into Grand Bay. The Bonnet Carre’ diversion varied by month while the Violet Marsh diversion was a constant flow of 7,500 ft^3/s. The Escatawpa diversion is the flow that occurred in the Escatawpa River during 1998, and those values were varied daily in the model. The water quality model was applied for the period April through September 1998 using the same inputs as the final calibration run except for different hydrodynamics and different boundary conditions for the diverted flow and associated concentrations of the flow. The hydrologic model was run with the same conditions as used for the base conditions used in the water quality model calibrations for 1998 except that the additional freshwater flows were introduced.

In an effort to apply this water quality data to ecological issues, MsCIP and ERDC convened a panel of representatives from TNC, MDMR, USM at the Gulf Coast Research Laboratory. The aim of the panel is to suggest simplistic ecological models that can be incorporated with projections from the combined hydrodynamic and water quality models to identify simulations which might result in an improvement in oyster habitat quality. The panel has identified several key attributes that need to be incorporated into the evaluation of freshwater diversion options. The first is that salinities average as closely as possible to the optimal range for oyster health and productivity. This is clearly of critical importance since the primary purpose for contemplating freshwater diversions is to improve habitat conditions for oysters. Second, a diversion should not result in extended periods of low salinity resulting in mortality or poor growth and reproduction. This consideration is particularly critical during times of high river flow or other extreme conditions. Third, a diversion should not unduly influence habitat conditions for other critical resources. Diversions that result in favorable conditions for oyster health may not be conducive to other equally important resources. For instance, most seagrasses do poorly at salinities less than 20 ppt. A diversion that results in excellent conditions over the prime commercial beds but drives salinities below 20 ppt in the seagrass elsewhere would not be acceptable. Other important habitat requirements that should also be considered for seagrass health include light availability and nutrient concentrations. These ecological concerns associated with water diversions, in addition to potential impacts on important fisheries species of those areas, require conservative actions and more study of potential impacts (positive and negative) of such practices for the long-term sustainability of nearshore and estuarine resources.

As an example, the results from a simulated diversion of 7,500 ft^3/s of Mississippi River water near Violet, Louisiana are presented in Figure 5.2.1-1. The results suggest that 180 days after initiation of the diversion salinities were lowered in western Mississippi Sound. Dortch et al. (2007) sufficiently warrant additional examination. However, at present, absolute salinity values predicted by the model poorly match calibration data. Further refinement of the models should correct this limitation and must be made to allow the usefulness of the model results for estimating potential beneficial or deleterious effects on oysters and other coastal resources.

Results also showed that diversion through the Bonnet Carre and through the Escatawpa/Grand Bay system have the potential to significantly influence coastal salinities.



Source: Corps

Figure 5.2.1-1. Projected Salinity Values 180 Days after Initiation of a Diversion of 7,500 cfs of Mississippi River Water at Violet, LA Simulated Diversion of Mississippi River into Lake Borgne Near Violet, Louisiana

Ongoing and future studies can be used to refine the hydrodynamic and water quality model and tighten the calibrations. This will allow for better integrating the water quality results to ecological concepts. Also, this preliminary effort just developed information for some possible discharge scenarios in order to do a sensitivity analysis as to whether diversion could potentially affect the areas of concern. These efforts showed the potential for freshening the systems. Future studies and model runs will need to be performed to test precise operational discharge plans and seasonal influences.

5.2.1.1 Grand Bay Savannahs and Marshes

Historically, the estuarine marsh within the Grand Bay NERR represented the former deltaic ecosystems of the Pascagoula and Escatawpa Rivers in eastern Jackson County. The outlets of these rivers have shifted westward over time, severely limiting the inflow of freshwater, nutrients, and sediments into the Bayou Cumbest area of the reserve.

Currently, it is speculated that much of the freshwater entering the Grand Bay NERR estuary is from surface runoff through Bayou Heron and Bayou Heron, within the Bangs Lake Hydraulic Unit, measuring approximately 21,374 acres. Human disturbances to the area have also altered historic sheet flow and surface water flows into the area, as well as the natural migration of the Pascagoula and Escatawpa Rivers. A freshwater diversion project in the area, if feasible, may serve to enhance the wildlife resources of the area. The need for freshwater diversion at the Grand Bay savannahs and marshes would help restore the predominant wet pine savannah habitat. Shoreline erosion along the Grand Bay area (i.e. loss of the Grand Batture Islands) has also contributed to the increased salinity in the area.

The proposed project will seek to develop a refined hydrodynamic model for the area, inputting biological, water quality, and physical data into the model to evaluate a variety of freshwater diversion scenarios. This work represents a critical first step in the final assessment of potential water diversion projects for this area. Community information will be solicited and a public workshop will be held to share the results.

5.2.2.2 Hancock County Marshes

Diversion of Mississippi River freshwater and/or sediments in the vicinity of Violet, Louisiana has been strongly considered because of a number of positive factors. These include proximity of the river to target coastal wetlands restoration areas, strong public support, and high confidence in potential environmental benefits. The Violet Diversion Project is under consideration by the MsCIP (Corps, Mobile District) and Corps, New Orleans District as a freshwater diversion project that could potentially have a positive impact to the Hancock County Marshes. Preliminary results from modeling a simulated diversion of 7,500 ft^3/s of Mississippi River water near Violet, Louisiana, suggest that after 180 days of initiation of the diversion, salinities were lowered in Western Mississippi Sound sufficiently to warrant additional examination (Dortch et al 2007). Further refinement of the models should address current limitations and must be made to estimate potential beneficial or deleterious effects on oysters, seagrasses, marsh systems, and other coastal resources. Although the idea is viable, at this point, additional information is needed to determine current problems within Hancock County Marshes and potential impacts to existing coastal resources as well as navigational impacts.

5.2.2 Recommended Plan

Due to the time constraint of this MsCIP Comprehensive Report/Integrated Programmatic EIS, the MsCIP team was only able to qualitatively determine that freshwater input into the systems does change the overall environment. It is known that these systems have been altered and/or starved by lack of freshwater inflow. An integrated environmental web exists in these rivers and also in

Mississippi Sound, which needs to be fully identified, in order, to completely understand various effects that could possibly occur.

The MsCIP environmental team recommends additional study, such as water quality and quantity, of this freshwater diversion plan (i.e. Hancock County Marshes and Grand Bay Savannahs and Marshes) as part of the MsCIP Comprehensive Report/Integrated Programmatic EIS. This study is necessary to assess the quantitative amount of freshwater flows required to positively impact each ecosystem.

In a collaborative effort, the MsCIP Environmental PDT closely worked with the Louisiana Coastal Protection and Restoration PDT to coordinate efforts. This close coordination allowed both the States of Mississippi and Louisiana to accomplish its respective goal of increasing sedimentation and freshwater via diverting water from the Mississippi River. Congress recently passed a law authorizing water resources projects and investigations throughout the U.S. WRDA of 2007 recommended a freshwater diversion project at Violet, Louisiana. The project is authorized to produce the same benefits for the Biloxi Marshes and Mississippi Sound as an earlier project (1988) at the Bonnet Carre Spillway in Louisiana. As authorized this effort would be designed and built by the Corps in partnership with the States of Mississippi and Louisiana.

The Louisiana Coastal Protection and Restoration and MsCIP PDTs will accomplish the following:

- Investigation of hurricane protection and coastal restoration for south Louisiana lead by the Corps, New Orleans and Mobile Districts in cooperation with the States of Louisiana and Mississippi.
- Evaluates four options for freshwater diversion at Violet for enhancement and preservation of wetlands in eastern St. Bernard Parish, Louisiana. Recommend construction of a freshwater diversion at Violet for salinity reduction in Mississippi Sound to improve oyster bed habitat.
- Flow rate alternatives range from 250 ft^3/s to 50,000 ft^3/s and estimated construction costs range from $1 million to $279 million.
- The Louisiana Coastal Mississippi Protection and Restoration and MsCIP final technical reports are due in December 2007 but it will not contain a construction plan for any of these alternatives.

5.3 Beach and Dune Restoration – LOD-2

5.3.1 Plan Formulation

Essentially all the beaches along Coastal Mississippi are man-made. Harrison County has the most beachfront with a 26-mile stretch extending from Biloxi Bay to St. Louis Bay. This beach is the longest man-made beach in the U.S. Hancock County has several miles of beach while Jackson County only has a small beach located in the Cities of Pascagoula and Ocean Springs. In total, the beaches extend along less than half of the Mississippi coastline.

Most of the dunes that previously existed along these beaches were destroyed by Hurricane Katrina and much of the beach was damaged. Many Federal, state, and local entities raised environmental concerns regarding the various Mississippi beaches as part of the 180 projects previously discussed. In some areas, such as in the City of Pascagoula, the beach was completely gone. Reconstruction of the dunes, where beaches exist, will provide a reduction of damaging wave action from smaller storms (i.e. normal summer storms, tropical storms, and/or lower energy hurricanes).

A project to restore the beaches in Harrison County has been funded and is underway as part of the Flood Control and Coastal Emergencies (FCCE). Other projects to construct dunes to a height of 5-

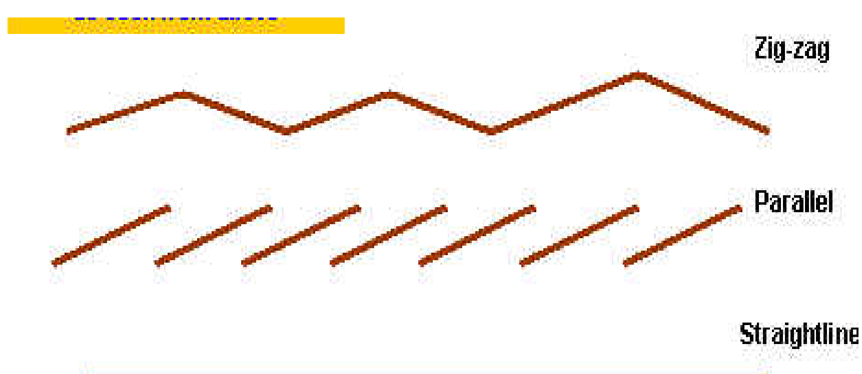
foot in Harrison County and to 2-foot in Hancock and Jackson County were proposed as part of the MsCIP Interim Report. That dune restoration project has since been funded and the Corps, Mobile District is underway preparing the plans and specifications.

The beaches, situated immediately seaward of developed areas, provide an excellent location where elevated dunes could be constructed to provide some additional protection against smaller hurricanes. Furthermore, the seaward side of the dunes also provides excellent feeding grounds at the nearshore and intertidal shore areas for various birds, crabs, and other fauna. The MsCIP environmental and engineering PDTs cooperatively assessed various dune elevations. The teams quickly designated this component of the plan as LOD 2. The engineering team evaluated the structural benefits while the environmental team evaluated habitat benefits to the Coastal Mississippi ecosystem.

Original concepts were to look at crest elevations of +10.0 feet and +15.0 feet as options for all dunes. Further discussions made it clear that the top elevation of the dunes needed to be below the elevation of the adjoining roadway. This was to help mitigate the migration of the sand onto the roadway as aeolian (wind blown) deposits. It was decided to correlate the top of the dune to an elevation that would be +1-foot lower than the adjacent road that would be included in LOD-3. LOD-3 elevated roadway elevations of +11.0 feet were selected for Jackson and Hancock Counties and +16.0 feet for Harrison County. These decisions for LOD-3 then dictated dune crest elevations of +10.0 feet for Jackson and Hancock Counties and +15.0 feet for Harrison County. Supplemental information can be found in the Barrier Island Appendix.

Dunes are consistent with public preference for a more natural appearing defense mechanism rather than a hardened structure. Construction of dunes will include planting vegetation, such as sea oats (*Uniola paniculata*), and sand fencing to help stabilize the dunes (Figures 5.3.1-1 and 5.3.1-2). Sand dunes are naturally occurring dynamic coastal features, which are formed by the accumulation of wind blown sand. Sand is naturally carried along the beach by the wind. Sand fences help facilitate the building of sand dunes by trapping and collecting this wind driven sand. Sand fences are usually made of wood or biodegradable material. Without dune vegetation, sand dunes become unstable; thus, the MsCIP environmental team recommended planting dune vegetation. Dune plants tolerate harsh beach conditions including wind, salt spray, storms, scarce nutrients, limited freshwater, and intense sunlight and heat. The plants and/or seedlings provide feeding sources to a variety of animals while also providing nesting and roosting habitat.

These dunes would be a sacrificial barrier, but could also be important by providing additional protection for the toe of the existing roadway, especially in an elevated seawall or roadway configuration as LOD-3. Placement of the dunes directly against a raised seawall or roadway would also serve aesthetically to mask the appearance of a structural barrier. Thus, adding to the public acceptance and/or appeal of this other proposal.



Source: Corps

Figure 5.3.1-1. Examples of Sand Fence Patterns

Source: Corps

Figure 5.3.1-2. Dune Vegetation with Sand Fencing

While the measure described above joins LOD-2 with the adjoining roadway (i.e. LOD-3), consideration could be given to having a stand-alone LOD-2 dune system that is on the existing beach, but separated from the road. The quantity of sand for an option, such as this, would increase since the northern slope of the dune is adjacent to the roadway. The grade elevation would go down to about +5.0 feet and not abut against the roadway. By doing so, the top elevation of the dune could vary and be above the roadway as necessary. This may increase the need for maintaining the sand in the designated dune alignment since it would be expected that the sand dune would tend to migrate under the prevailing wind direction. This option was not fully designed as many unanswered questions remain that may have to be simulated with models. This includes the width of the dune crest and the width of the beach berm that might be required in front of the dune. This option would also block any view of the water from the existing roadway in most areas, replacing the view with a dune scene including plantings of sea oats or other beach type vegetation.

5.3.2 Recommended Plan

A dune system, 60-foot wide and 2-foot high, planted with sea oats along the mainland coast is recommended for construction. Sand fencing would be used to stabilize the dune feature. A detailed description is conducted in the Engineering Appendix.

5.4 Barrier Island Restoration

5.4.1 Plan Formulation

A significant environmental impact from the barrier islands continuing to diminish is the increase in Mississippi Sound’s salinity. Under current conditions, the islands provide a boundary between the sea water salinity [~33 ppt] of the open Gulf of Mexico and the brackish water found in the Sound. Salinity in the Sound during low flow periods range from 10 ppt to 30 ppt. Highest salinities occur just south of Pascagoula and Gulfport and the lowest salinities in the Lake Borgne-Pearl River area. Loss of the islands would allow the salinity to greatly increase changing the ecological habitats that now exist. This would impact, if not devastate, shellfish and many other forms of marine life. Oysters currently found in concentrated Mississippi Sound areas would possibly cease to exist.

The degradation of the Chandeleur Islands in southeastern Louisiana allows us to anticipate potential environmental changes. Initial assessments are showing SAVs diminishing, marsh erosion rates accelerating, and wave energy along the mainland having no natural barrier. Unlike the Mississippi barrier islands, Chandeleur Islands are a remnant of a delta lobe from the Mississippi River where wave action created a beach that remained as a island after sea level rise and erosion removed the land mass between the island and the mainland.

5.4.1.1 Entire Restoration

Prior to Hurricane Katrina, the State of Mississippi was working on a coastal storm protection plan and proposition to submit to NPS for consideration that included restoring the barrier islands to the condition that existed prior to Hurricane Camille. Soon after Hurricane Katrina, it was reported that many in Mississippi felt that if the islands had been in the condition that existed prior to Hurricane Camille, there would have been less damage along the coast from Hurricane Katrina. This idea was also included in the Mississippi Governor's Recovery Plan, which called for restoring the islands to a pre-Camille footprint. In addition, this restoration concept was raised in the initial 180 projects previously discussed. This concept was included in the hurricane protection study as LOD-1, which is discussed more fully in the Engineering Appendix.

Modeling efforts have concluded that over a wide range of storms, there would be some protection provided to the eastern coast of Mississippi along the Jackson County shoreline if the islands are in the pre-Camille condition. This area is the most protected from the restored islands and this protection may result in only up to a 10% reduction in storm surge. The effect of this protection diminishes rapidly to the west from Jackson County. A detailed discussion of this modeling effort can be found in the Engineering Appendix.

The post-Hurricane Katrina condition can be considered a baseline condition for the modeling and the pre-Camille condition would be an improved condition (Table 5.4.1.1-1). The pre-Camille footprint of the islands was obtained from historical records and an assumption was made as to a top of dune elevation of +20 feet. [It should be noted that some of the islands have migrated to the west and any reconstruction would be to increase their footprint at their present location and not move them back to historical locations.] Restoration of Ship Island in a pre-Camille configuration includes closing the post-Hurricane Katrina, 4-mile long breach between East and West Ship Islands to a 2,000-foot width and with 20-foot high dunes, along with some rebuilding of the other islands to a larger land area. This option will only include new land mass that is being added to the islands by bringing sand dredged from an offshore location. Sand of sufficient quality in the quantities required for this type of project is not known to occur in close proximity to the islands. Prior studies of the St. Bernard Shoals (Oral Communication, USGS 2006) are probably the best source of the sand. Additional studies and sampling will be required to ensure the source. The shaping of the sand into beaches, dunes, and marsh areas will not affect the existing islands other than that narrow strip of land that will form the Gulf Island National Seashore boundary between the existing island and the new land mass.

A detailed discussion of the St. Bernard Shoals can be found in the Engineering Appendix. The average water depth over the shoals is 60 feet, which puts the sand within reach of a hopper type dredge; however, the water depth near the islands is too shallow for the draft of hopper dredge that would be used in this type of operation. In order to accomplish this, a basin would be dredged near each of the islands to discharge the sand being transported from the borrow area. Using this procedure, the hopper dredge could enter the basin and bottom dump the sand near the islands. This would be much faster than pumping off the sand. Doing this would also allow the basin to be placed outside of the NPS's National Seashore boundary. As the basin is filled, a suction dredge would be mobilized to the site and the sand could be moved to the area where it is needed to create additional land mass. As the sand was placed on the new land mass, it would be sculpted into dunes and swales, which would vary from sea level up to heights of approximately 20 feet. As the new land mass is added to the existing islands, portions of the new island will be planted with various type of vegetation to provide habitat and to aid against erosion. Vegetation would increase stabilization of the dune systems. The percentage of maritime forest varied among the islands from 1% up to 23%. For the new land mass of the islands additions, it was decided to use a quantity of 20% percent of the land mass for planting the trees consisting of longleaf pine. The lower elevations of the new land mass would be planted with emerging marsh species that would cover 38% of the area. Dunes planted with sea oats would make up 2% of the area and the beach areas would be left as open berms.

Table 5.4.1.1-1.
The Amount of Land Mass Lost from Each of the Mississippi Barrier Islands from Pre-Camille Conditions to Post-Katrina Conditions

Island	Pre-Camille (acres)	Post-Katrina (acres)	Land Loss (acres)
Cat	2,344	1,957	387
Ship	1,172	631 (East and West)	541
Horn	3,612	3,077	535
Petit Bois	1,329	1,098	231

The difference in the land mass over this period was then converted to an acreage that it would take to restore the size of the footprint. The width of the islands was maintained with the additional land mass being added as length. Each of the surface areas was converted to a quantity by using an average water depth of 7 feet and raising the sand up to elevation of +10.0. It was assumed that approximately 25% loss of the material would occur during the process of placement.

5.4.1.2 Breakwater Construction to Restore the Barrier Islands

One positive affect the islands have is to provide a natural offshore breakwater for the large sea waves that are generated from hurricanes. The presence of the islands and the relatively shallow water of Mississippi Sound between the islands and the mainland prevent sea waves from maintaining their considerable size as they move towards the mainland. Sea waves, often reported at heights of 40 feet and higher in large storms, would break as they approach the chain of islands. The open-water between the islands and the mainland, generally ten miles or more, would have enough fetch for waves to regenerate, but at a much lower height due to the shallower water. The generally accepted relationship between water depth and wave height is that the wave can sustain itself at a height that is one-half the depth of the water. Construction of breakwaters to restore the barrier island system was found technically unfeasible due to it not providing enough protection to the islands and the mainland of Coastal Mississippi.

5.4.1.3 Littoral Supplement to the Barrier Islands

With the consideration that the barrier islands lands administered by the NPS and the core preservation and protection mission and management policies applicable to the agency, any proposed improvements would be required to be subjected to additional environmental impact analysis and compliance. Additionally, Petit Bois and Horn Islands are congressionally designated Wilderness areas, an added layer of resource protection requiring proposed management actions be subjected to review according to the Wilderness Management Act. One other consideration to help restore the islands including restoration of the sediment transport and budget system they are dependent upon, is to supplement the sand in the littoral system. This could be accomplished by adding sand in specific locations based on sediment transport modeling. This would allow the littoral currents to move the sand onto the islands where the natural process of island building could take place. The source of these sands may be from inland sources and/or from offshore borrow areas. A detailed discussion pertaining to the sources of sand (i.e. inland and offshore) can be found in the Engineering Appendix. This would not directly affect the present-day islands; however, on a long-term basis, supplement of the littoral zone could continue the sustainability of this important barrier island system and ultimately protect Mississippi Sound and its very productive fisheries.

The construction of inland waterways in Alabama and Mississippi has resulted in continuing maintenance dredging to maintain the channel depths and alignments. This dredged material is now accumulated in numerous disposal areas along the banks of the river. Dredging of some of the areas along the river has produced large quantities of sand that have potential use for replenishment of littoral zones, such as are found along the Mississippi barrier islands.

An inventory of current disposal sites indicates that approximately 30,000,000 cubic yards of sand is available. Only disposal sites that contain a minimum of 100,000 cubic yards of sand were included in the inventory. Of interest to this study are disposal sites that are located along the Black Warrior–Tombigbee River system and the Tennessee–Tombigbee Waterway. The cost to store this type of dredged material is high and it has recently been estimated that removing the sand from the existing disposal areas would save the Government over $100,000,000 at today's cost.

Sand from the river was typically a finer grain size than that of the beach sand. It was also noted that the beach sand was more rounded than the river sand. All of the river sand had a brown tint described as "very pale brown" or "light yellow brown." Adding this sand into the littoral zone may diminish the differences between the natural sand in the system and the river sand that would be added. By spreading the sand over large areas to a small thickness, approximately 1-foot, it is anticipated that the natural sediment transport process would blend the two sands together. The transport process would also tend to remove any staining from the sand grains and help to round the individual particles through abrasion. Further evaluation, modeling, and study would be required in cooperation with the NPS before this riverine source could be sanctioned as a viable alternative to increase volumes of beach compatible (grain size, color, and texture) sand within the barrier island system.

The entire process would consist of loading the sand onto river barges at various disposal areas, moving the barges downriver, and into Mississippi Sound via tugboat tows, unloading the barges with a "hydraulic unloader", and spreading the sand with a "spreader barge." The process would require a continuous supply of loaded barges as the unloader only needs about an hour to remove the sand from a typical river barge. Staging this process from within Mississippi Sound would also help with down time due to weather that would be more affected on the south side of the islands. Preliminary analysis has indicated the St. Bernard Shoals source is likely compatible (grain size, color, and texture) with existing beach sand on the Mississippi barrier islands.

Another consideration to help restore the islands is to supplement the sand in the littoral system with sand obtained from offshore borrow areas. Like the upland source, this could be accomplished by adding sand in specific locations based on sediment transport modeling. The sand that could be used in this option may come from the same offshore borrow area as the St. Bernard Shoals located about 45 miles south of the barrier islands.

5.4.1.4 Reshaping the Islands

Another option with the least impact on the existing post-Hurricane Katrina barrier islands would be to re-establish the vegetation that was destroyed. This option could involve restoration of the existing islands through adding sand dunes on the beaches along with planted vegetation (i.e. *U. paniculata*), planting of marshes (i.e. *S. alterniflora, J. roemerianus*, and *S. patens*) and maritime forests (i.e. *P. elliottii engelm*, *S. repens, S. minor*, etc.), and planting seagrasses (i.e. *D. wrightii, C. manatorum, T. testudinum*, and *R. maritime*) in the nearshore areas of the islands.

Historically, large areas of seagrasses existed north of the islands. Much of this seagrasses is now gone and the loss of these areas have been mapped. Replanting the grass will aid in establishing valuable habitat that is part of the ecological system that has been destroyed near the islands. Foremost, the vegetation would restore the island's natural setting, which allows for the diverse array of flora and fauna to persist. This plan would not involve adding any land mass to the islands other than the possibility of adding to the dune system. Vegetation would aid in reducing erosion from wind; thus helping in maintaining the stability of the islands. The vegetation would also aid in preventing erosion in the event that the islands get overtopped by storm surge in a large hurricane. Sources of this sand could be from the beach area behind the dunes or from sources off the island.

5.4.1.4.1 Two-Foot Dune System

The dune would be shaped from sand that would be removed from the surface between the constructed dune and the edge of the vegetation north of the dune. The dune would have a height of 2-foot, with a 1-foot vertical to 3-foot horizontal slopes and a crest width of 6 feet. The dune would be continuous for the length of the gulf-side, south beach. The construction of a small 2-foot high dune on the islands' south beach could be accomplished by utilizing the existing sand on the beach berm. The sand could be scraped from the beach surface between the dune line and the vegetation that grows inland. This small dune would be used as a planting platform for establishing sea oats that have been destroyed by the recent hurricanes. While this small dune would provide very little damage reduction for the island, it would build with time as wind driven deposits of sand become trapped by the vegetation and increase the size of the dune.

5.4.1.4.2 Six-Foot Dune System

This proposal is similar to above except that it would consist of a 6-foot dune rather than a 2-foot dune. The sand that could be used may come from the same offshore borrow area as the St. Bernard Shoals located about 45 miles south of the barrier islands. In order to accomplish this restoration effort, sand would be moved from a hopper dredge to a staging area on the beach, then the sand would again be moved to the area of placement along the beach.

5.4.2 Recommended Plan

Further study is required to adequately address comprehensive barrier island restoration due to their complex ecosystem and impacts on the environment. Options of littoral zone placement and filling of the Ship Island breach (i.e. comprehensive barrier island restoration) are being recommended for construction through the need for additional detailed analysis. The MsCIP PDT will closely coordinate those efforts in cooperation with the NPS, USGS, and the State of Mississippi.

A detailed study analyzing sand movement throughout the coast of Mississippi littoral drift is ongoing by ERDC. Results from this assessment will be used to develop these two options more fully. The MsCIP environmental PDT anticipates detail analysis/study of this sand movement will be needed at Ship Island in order to restore the breached area. Other specific areas (i.e. littoral zone placement sites) will also be identified during the developments. Additional study is required in order to supplement the comprehensive restoration of barrier islands with littoral zone sand placement and to fill Ship Island's breach.

The Corps, Mobile District applied the Functional Habitat Index (FHI) tool for the recommended plan - placement of sand in the littoral zone and filling in Ship Island breach - in order to quantify the environmental outputs generated from various measures/alternatives. Potential benefits associated with restored habitat types were assessed using past scientific studies and best professional judgment. This environmental output unit (i.e. number) generated from the FHI tables was used to assess the cost-effectiveness of various ecosystem restoration at the barrier islands. An environmental output unit quantifies the expected improvements in target functions as related to project objectives. Tables 5.4.2-1 and 5.4.2-2 provide the FHI benefits that would be achieved by implementation of this proposed construction compared to the no action.

Table 5.4.2-1.
Comprehensive Barrier Island Restoration – Littoral Zone Placement & Fill of Breach Between West & East Ship Islands

Habitat Units										
Assessment Variables	*Shorebirds*	*Waterfowl*	*Migratory Birds*	*Raptors*	*Beach Fauna*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*T&E Species*	*FHI Unit*
Island Persistence	10	8	10	8	10	10	10	10	10	86
Shoreline Stabilization	10	8	8	8	10	10	10	6	10	80
Reproduction Habitat	10	0	0	0	8	10	10	10	10	58
Feeding Habitat	10	6	10	8	8	10	10	10	10	82
Roosting Habitat	10	6	8	6	10	10	10	10	10	80
Wintering Habitat	10	6	8	6	10	10	10	10	10	80
Dune Habitat	10	10	10	10	10	10	10	10	10	90
Beach Habitat	10	10	10	10	10	10	10	10	10	90
Water Column Habitat	8	8	8	8	8	8	10	10	10	78
Water-Land Interface Habitat	10	10	10	10	10	10	10	10	10	90
Fishery Habitat	10	10	10	10	10	10	10	10	10	90
Oyster Habitat	6	6	6	6	6	8	10	8	8	64
									TOTAL FHI	**968**

Table 5.4.2-2.
No Action

Habitat Units										
Assessment Variables	*Shore birds*	*Waterfowl*	*Migratory Birds*	*Raptors*	*Beach Fauna*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*T&E Species*	*FHI Unit*

Island Persistence	0	0	0	0	0	0	0	0	0	0
Shoreline Stabilization	0	0	0	0	0	0	0	0	0	0
Reproduction Habitat	0	0	0	0	0	0	0	0	0	0
Feeding Habitat	0	0	0	0	0	0	0	0	0	0
Roosting Habitat	0	0	0	0	0	0	0	0	0	0
Wintering Habitat	0	0	0	0	0	0	0	0	0	0
Dune Habitat	0	0	0	0	0	0	0	0	0	0
Beach Habitat	0	0	0	0	0	0	0	0	0	0
Water Column Habitat	2	2	2	2	2	2	2	2	2	18
Water-Land Interface Habitat	0	0	0	0	0	0	0	0	0	0
Fishery Habitat	2	2	2	2	2	2	2	2	2	18
Oyster Habitat	2	2	2	2	2	2	2	2	2	18
									TOTAL FHI	**54**

For similar projects (i.e. Deer Island - Section 204: Beneficial Use of Dredged Material, Mississippi and Deadman's Islands, Florida - Section 206: Aquatic Ecosystem Restoration Project), multi-disciplinary teams of biologists, scientists, ecologists, engineers, hydrologists, and planners were formed to assess what functions a particular project could potentially provide. Functions are defined as specific habitat and environmental features that would benefit from the recommended project. A variety of functions are generated by a proposed alternative. During past FHI table development with the multi-disciplinary teams, it was determined best to group fauna generally rather than specifically identifying each species that would potentially use, or benefit from, the restored project area. If specifically listed, the team was concerned that the FHI table could quickly become unmanageable.

Functional production was quantified as an output that the fauna could potentially use. Functions evaluated in the matrix included substrates, habitat types, stabilization, and vegetation. The output was identified between a scaling of 1 and 10 – 10 being the highest benefit. The "No Action" still has a FHI score even though there is no work proposed for the area. The barrier islands provide a function to the resources *currently* even though no action is being proposed; however, this benefit is considerably reduced over time. Specifically speaking, re-establishing the barrier islands via filling the breach and littoral sand placement has a *benefit* to shorebirds because they use the shoreline for feeding, nesting, and roosting. Many of these shoreline birds would cease to be on the island without it. The FHI tables quantify expected biological output by linking biophysical benefits (termed functions) to specific restoration activities. The term biophysical, in this case, refers to the living and non-living components and processes of the ecosphere. The functions identify aspects of the project beneficial to the overall habitat quality. Adding all of these outputs together from the table provides a FHI score.

5.5 Restoration of SAVs

SAV benefits an array of ecosystems in Mississippi including the following:

- Primary production (food for other animals);
- Improves water quality;
- Storm protection (dampens waves, currents, and storm surge);
- Value to commercial and recreational fisheries by providing;
- Protection to juveniles from predators;
- Nursery habitat;
- Foraging habitat;
- Nutrient cycling (estimated to be $7,700 per acre per year in 1996);
- Sediment filtration and trapping (offset sea-level rise);
- Oxygen production;
- Organic-matter production and export (provides materials used in other habitats, such as adjacent wetlands and marsh, offsets sea-level rise);
- Prevents/reduces erosion; and
- Increased species diversity (in both the sediments and SAV beds).

Table 5.5-1 provides the fish species collected in SAV beds at Grand Bay NERR from April 2005 through February 2006.

Table 5.5-1.
Fish Species Collected at Grand Bay NERR SAV beds

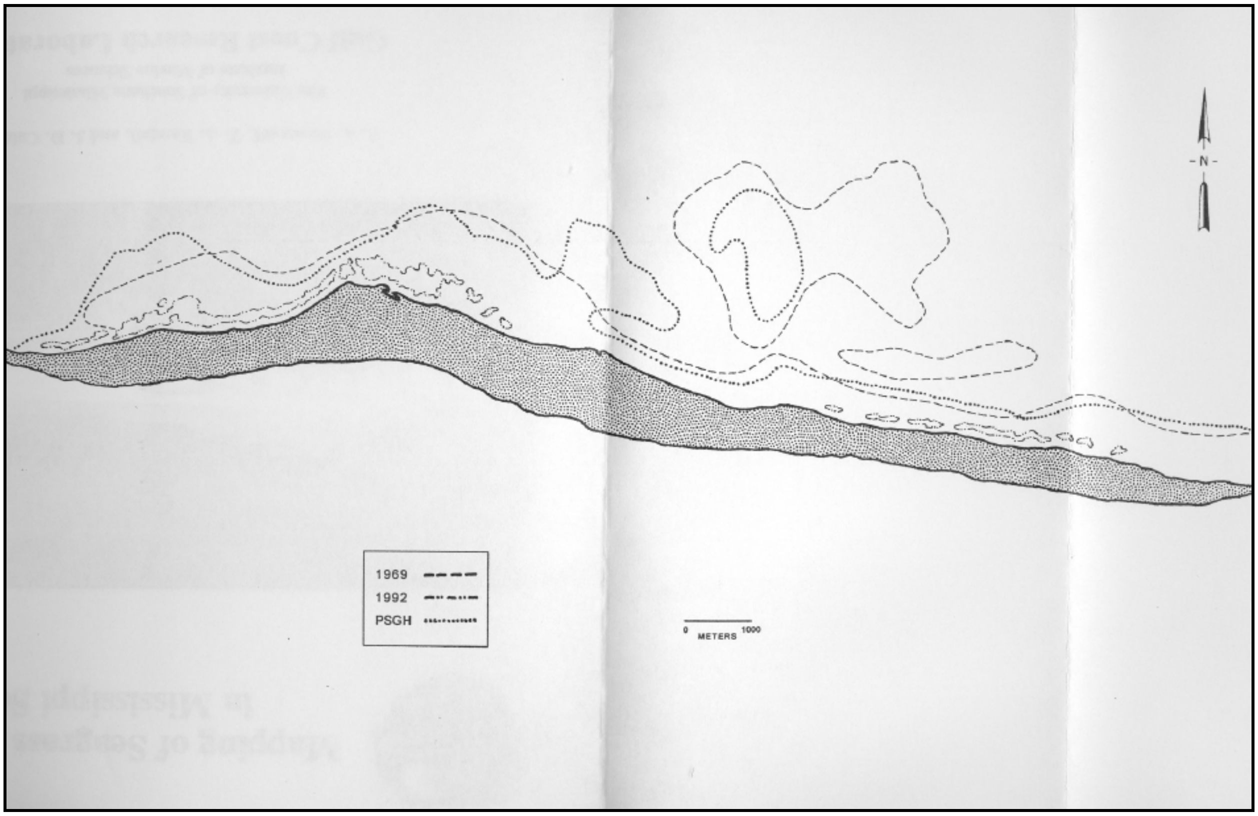
Scientific Name	Common Name
Anchoa mitchilli	Bay anchovy
Bairdiella chrysoura	Silver perch (drum family)
Brevoortia patronus	Gulf menhaden
Citharichthys spilopterus	Bay whiff (flounder)
Ctenogobius boleosoma	Darter goby
Cynoscion nebulosus	Spotted seatrout
Eucinostomus argenteus	Spot-fin mojarra
Lagodon rhomboides	Pinfish
Leiostomus xanthurus	Spot
Lucania parva	Rainwater killifish
Lutjanus grisues	Grey snapper (mangrove snapper)
Menidia beryllina	Inland silverside
Mugil cephalus	Striped mullet
Oligoplites saurus	Leatherjack
Sphoeroides parvus	Least puffer

Sphyraena guachancho	Guaguanche (barracuda family)
Sygnathus louisianae	Chain pipefish
Sygnathus scovelli	Gulf pipefish
Symphurus plagiusa	Black cheeked toungefish (flounder-like)
Synodus foetens	Inshore lizardfish
Archosargus probatacephalus	Sheepshead
Mycteroperca microlepis	Gag grouper
Chasmodes saburrae	Florida blenny
Orthopristis chrysoptera	Pigfish

In addition, the SAV beds support shrimp and blue crabs, both of which have value as commercial and recreational fisheries.

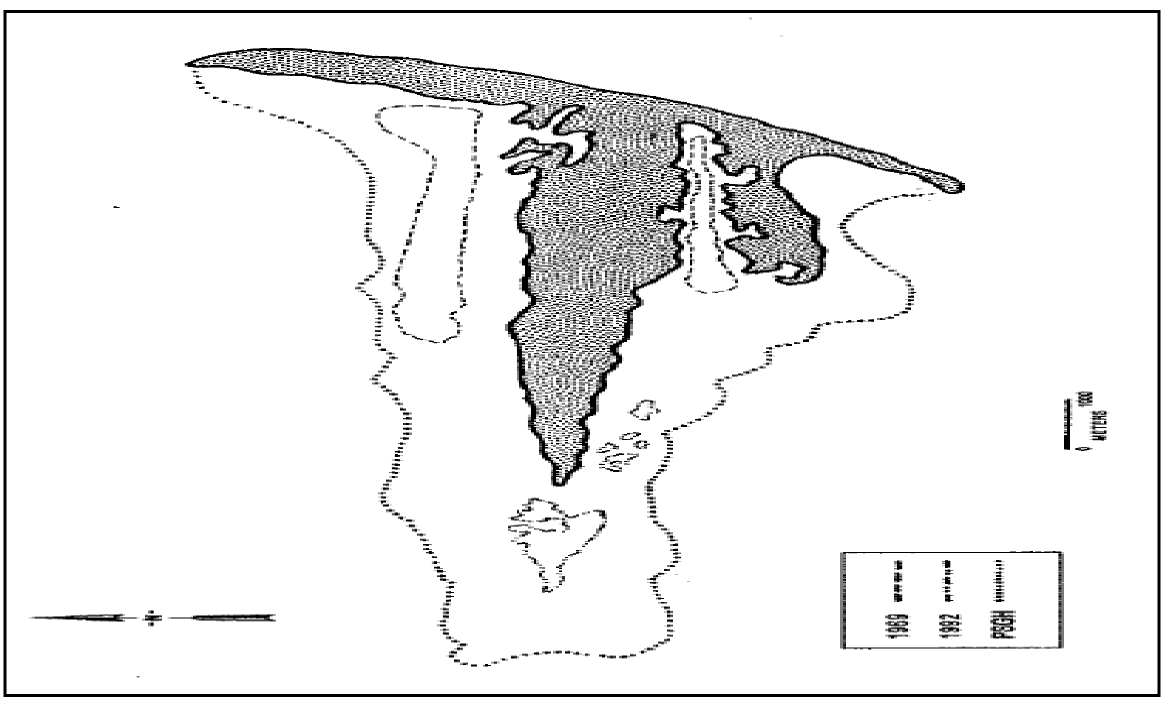
The continued survival and growth of seagrasses (i.e. SAVs) may be threatened by the cumulative effects of man's activities, in addition to, natural processes in the coastal marine environment. Natural causes of SAV (i.e. *D. wrightii, C. manatorum, T. testudinum*, and *R. maritime*) decline, such as disease, storm events, salinity fluctuation, and hypoxic events, coupled with declining water quality caused by anthropogenic eutrophication currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1994). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species to utilize this vital habitat at some point in their life state.

In 1969, an estimated 20,000 acres of SAVs were documented and as of 1998, only 2000 acres were documented (Moncrieff 1998). Dramatic decreases in SAVs along the north shoreline of Horn Island have been observed. An approximate 5,040-acre decrease in coverage was calculated for the period between 1969 and 1992 (Figure 5.5-1). The overall distribution of SAVs among Mississippi's other barrier islands has also decreased considerably in the same time period, with Cat Island losing approximately 430 acres (Figure 5.5-2), Ship Island losing approximately 1,280 acres (Figure 5.5-3), and Petit Bois Island losing approximately 1,330 acres (Figure 5.5-4). Areas of SAVs along coastal Mississippi's mainland have also decline. Buccaneer State Park is estimated to have lost approximately 150 acres while Point-aux-Chenes Bay has lost approximately 680 acres (Figure 5.5-5).



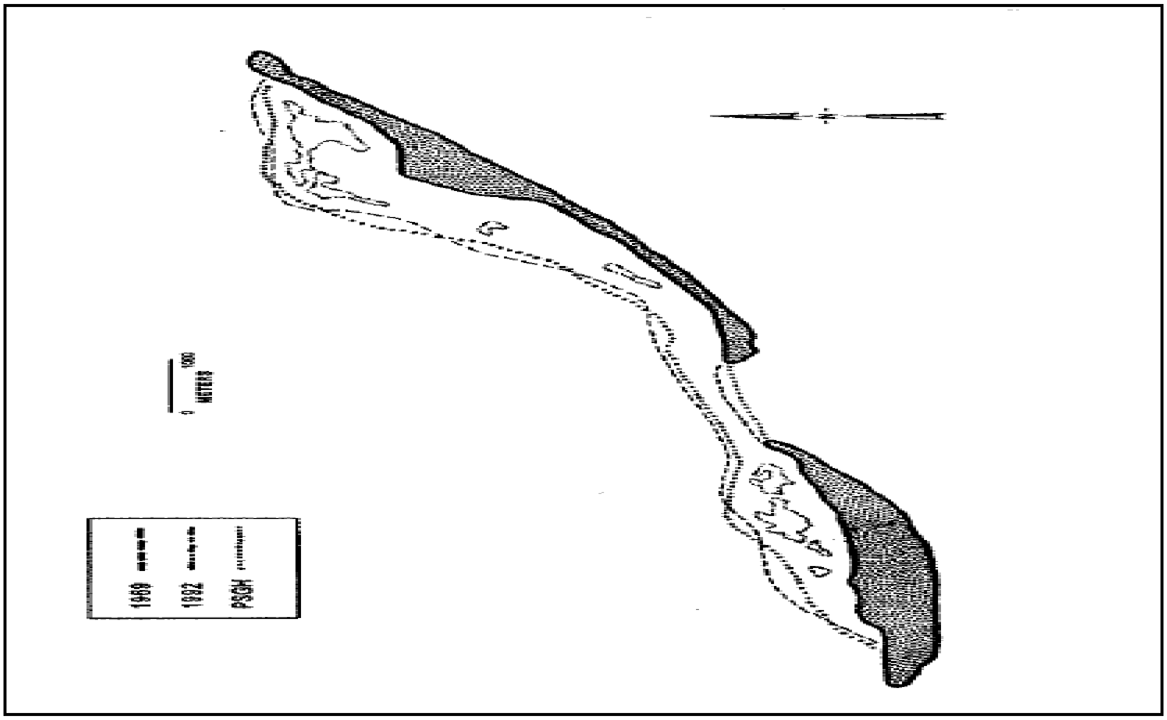
Source: GMEI

Figure 5.5-1. Horn Island – Historical, 1992, and Potential Seagrass Habitat (PSGH)



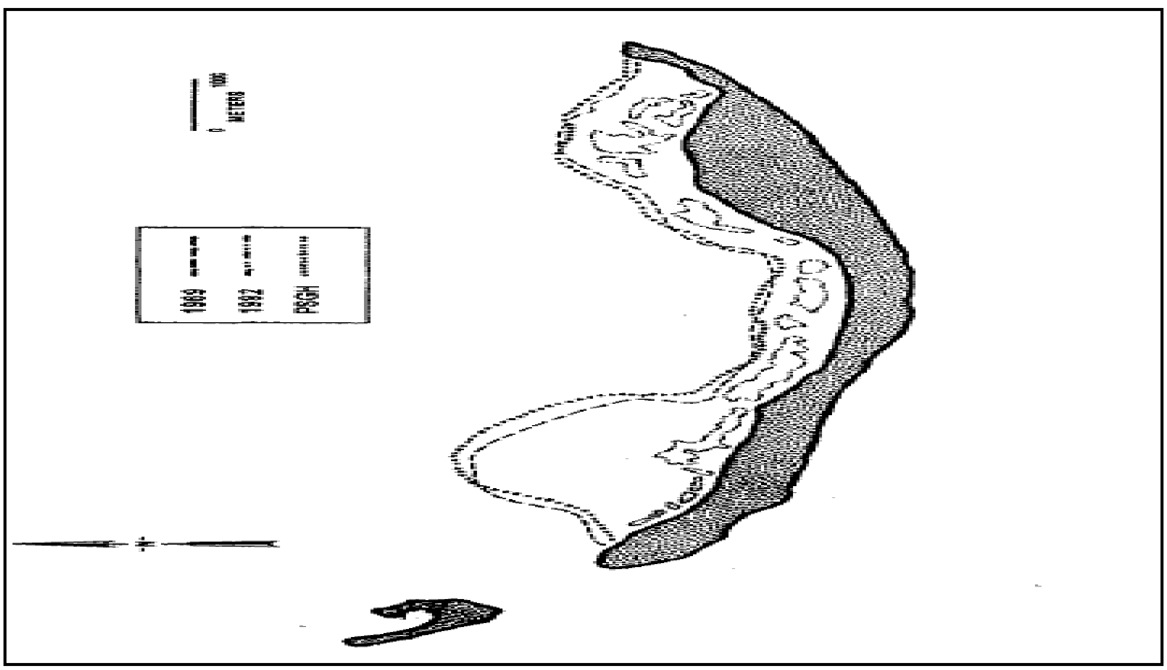
Source: GMEI

Figure 5.5-2. Cat Island – Historical, 1992, and Potential Habitat (i.e. PSGH)



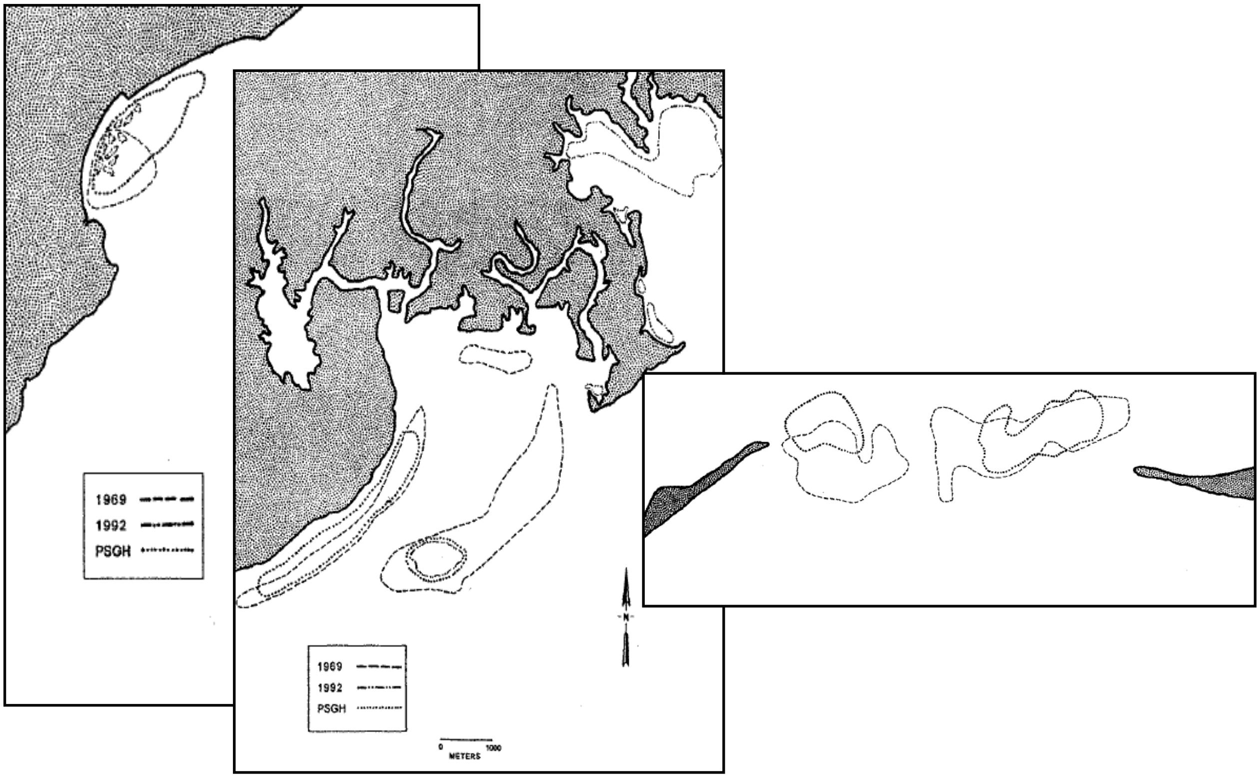
Source: GMEI

Figure 5.5-3. Ship Island – Historical, 1992, and Potential Habitat (i.e. PSGH)



Source: GMEI

Figure 5.5-4. Petit Bois Island – Historical, 1992, and Potential Habitat (i.e. PSGH)



Source: GMEI

Figure 5.5-5. Buccaneer State Park, Point-aux-Chenes Bay, Dog Keys Pass (Left to Right, respectively) – Historical, 1992, and Potential Habitat (i.e. PSGH)

Three areas were documented in which PSGH was less than the historical distribution of SAVs, indicating habitat loss. Dog Keys Pass, Horn Island, and Point-aux-Chenes Bay all exhibited this pattern with 930 acres, 1,220 acres, and 770 acres loss, respectively (Table 5.5-2).

Table 5.5-2.
SAV Historical, 1992 and Potential Habitat

Location	1969 (acres)	1992 (acres)	PSGH
Buccaneer State Park	206	55	316
Cat Island	598	169	5,128
Ship Island	1,536	253	1,603
Dog Keys Pass	2,079	0	1,149
Horn Island	5,567	530	4,350
Petit Bois Island	1,690	364	1,810
Point-aux-Chenes Bay	1,306	627	534
Totals	12,982	1,998	14,890

Reference: Moncrieff 1998

Areas of SAV habitat loss coincide with areas where rapid coastal erosion and massive long-term movement of sand has been well-documented (Otvos 1981 and Oivanki 1994). Loss of vegetated areas corresponds with potential loss in water clarity over time due either to: (1) anthropogenic influences, (2) cyclic shifts in precipitation patterns, which would affect both salinity and turbidity, or

(3) a combination of these factors (Moncrieff 1998). Primary reasons for the disappearance of SAVs are most likely an overall decline in water quality, extended periods of depressed salinities, and physical disturbances, such as tropical storms and hurricanes (Moncrieff 1998). Physical loss of habitat and decreased light availability coupled with declining water quality are the most visible features that directly affect SAVs (Moncrieff 1998). Moncrieff (1998) identified approximately 14,900 acres as being suitable SAV habitat (i.e. PSGH).

Mapping techniques have very much advanced since Moncrieff's last mapping of Mississippi Sound in the late 1990s. In discussing a potential SAV restoration project with the scientific community, the one consistent need was to re-inventory the existing SAVs in Mississippi Sound. Mississippi Sound and barrier island sedimentary processes as related to seagrass biomes are important, but not currently available. The nature, extent and volumes of sediment types within both Mississippi Sound and the barrier islands are constantly in flux, necessitating a comprehensive and ongoing assessment of sedimentary dynamics. Further studies would determine existing conditions and remaining problems that challenge establishment of SAVs within Mississippi Sound. Opportunities exist to create partnerships with other Federal and state resource agencies, and NGOs to begin identifying potential SAV restoration and establishment projects. Restoration efforts should target historical locations as a starting point to begin determining current conditions and challenges, including water quality issues, available nursery stock of plants, etc., prior to implementation of actual projects.

5.5.1 Recommended Plan

Additional study is required to assess the complex environmental make-up impacting SAVs in Mississippi Sound due to the fact that mere planting would possibly not survive. Many questions must be answered (i.e. water quality, circulation, etc.) prior to SAV restoration implementation. SAV restoration efforts across the nation have proven to be rather challenging and many examples can be identified close to Mississippi, such as in Florida. Therefore, the MsCIP environmental team is recommending additional study and re-inventory the existing SAVs in Mississippi Sound. Opportunities exist to partner with Federal, state, and local resource agencies as well as NGOs. Extensive coordination with the NPS, responsible for managing and operating Gulf Islands National Seashore, would be required for areas of potential restoration within park boundaries. Involvement of local colleges and universities with ongoing research programs would also help to identify and pinpoint specific problems for development of potential solutions. For those brackish SAV systems, limited knowledge of the functional restoration prohibited the team in developing cost effective alternatives; thus, a pilot project was identified at Bayou Cumbest to obtain the much needed described data.

Coordination with the Grand Bay NERR identified restoration of the Bayou Cumbest site to produce data, such as salinity, water quality, currents, substrates, composition of sediments, boating traffic (propellor scarring/turbidity), transplant success rates, and heterogenoity of species composition in order to determine the success criteria for future recovery efforts of SAV within brackish systems in Coastal Mississippi. As noted in other areas in the country, such as Florida, SAV restoration sometimes proves to be challenging. Thus, the MsCIP team has developed the foresight to identify these parameters to increase the recovery rates during the restoration efforts. Parameters, such as water quality/turbidity, sediment compositions, and currents will provide necessary data to better characterize other restoration sites likelihood of success. Turbidity has been noted as a constraint for SAV recovery; thus, this parameter must be quantified. Boating traffic may also limit recovery rates while increasing the species diversity could increase habitat diversity for various species of important shrimp, crabs, and juvenile fish. Until this criteria is obtained, successful recovery of SAV within these systems would prove to be very difficult if not impossible. The data gathered would be used to ensure conditions at historical SAV sites are existing to ensure the success. Future SAV restoration site could include area north of Deer Island, Bayou La Croix, Bayou Cumbest, adjacent to Round Island, Old Fort Bayou, Davis Bayou, West Pascagoula River, and Mary Walker Bayou.

SAVs are a federally designated Essential Fisheries Habitat under the Magnuson-Stevens Act of 1996. They provide numerous ecosystem services, which include: (1) nursery for juvenile stages of finfish and shellfish, (2) an important food-source to marine species and wading birds, (3) sediment stabilization and increased water clarity, and (4) nutrient uptake and sequestration to mitigate eutrophication.

Species that will benefit directly or indirectly include the SAV - estuarine invertebrates, such as blue crabs (*Callinectes sapidus*) and brown and white shrimp (*Farfantepenaeus spp.*); waterfowl, such as dabbling ducks (*Anas spp.*), numerous anadromous fish species including spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), and mullet (*Mugil cephalus, M. curema*), and marine mammals, such as dolphins (*Terciops truncatus*) and manatees (*Trichechus manatus*), a protected species, that utilize SAV beds as nursery habitat. The economic valuation of the fisheries industry in Mississippi provided by the Center for Fisheries Research and Development at the GCRL indicates that there are more than 50 species of finfish and shellfish commercially harvested in state waters with a market value of $900 million in 2003, and a recreational industry valued conservatively at over $400 million in 2000 (Perry, unpubl data). Clearly loss of habitat would have a disproportionate impact on the socio-economic activities of coastal Mississippi.

This small initial brackish SAV recovery project will investigate the larger issue of SAV losses nationally and rates of natural recovery versus recovery after restoration. SAV are sensitive indicators of estuarine condition because of their high light requirements (Dennison et al 1993) and susceptibility to eutrophication-induced algal blooms and hypoxia (Hauxwell et al 2001). Furthermore, loss of SAV promotes the alteration of the sediment characteristics and nutrient cycling, causing long-term changes in habitat suitability for natural plant recolonization. These changes include loss of fine sediments through resuspension and transport, promoting a feedback loop that further inhibits natural recovery. Therefore, it is vitally important that restorative replanting be undertaken soon after damage or loss of plants to inhibit a negative change in system dynamics (Fonseca et al 2004).

For the SAV restoration effort, MsCIP team assessed the continued survival and growth of seagrasses (i.e. SAVs) and found them threatened by the cumulative effects of man's activities, in addition to, natural processes in the coastal marine environment. Natural causes of SAV decline, such as disease, storm events, salinity fluctuation, and hypoxic events, coupled with declining water quality caused by anthropogenic eutrophication currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1994). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species to utilize this vital habitat at some point in their life state. In 1969, an estimated 20,000 acres of SAVs were documented and as of 1998, only 2,000 acres were documented (Moncrieff 1998).

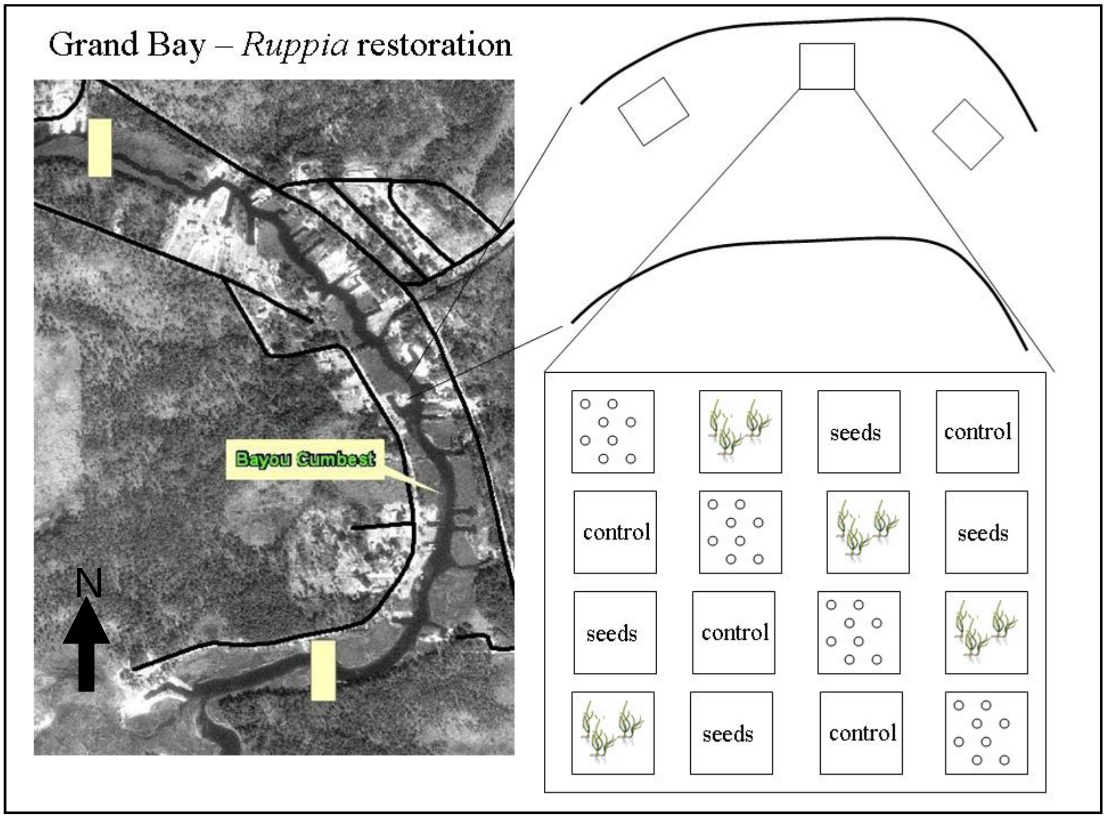
SAV restoration efforts across the nation have proven to be rather challenging and many examples can be identified close to Mississippi, such as in Florida. Thus, Bayou Cumbest was chosen due to its small size to produce data such as salinity, water quality, currents, substrates, composition of sediments, boating traffic (propellor scarring/turbidity), transplant success rates, and heterogenoity of species composition in order to determine the success criteria for future recovery efforts of SAV within brackish systems in Coastal Mississippi. Future SAV restoration site could include area north of Buccaneer State Park, Cat Island, Ship Island, Dog Keys Pass, Horn Island, Petit Bois Island, and Point aux-Chenes.

After discussing the potential SAV pilot project with biologists at ERDC, it has been determined there currently are no assessment tools for quantifying benefits of SAV restoration projects. Although quantified outputs of ecosystem projects have traditionally been used as the basis for justification, little data is available for use in establishing baseline conditions of existing SAVs, organisms currently using established beds, and the specific causes for the overall decline of brackish SAVs. As part of the data collection described above, an index would be developed most likely using acreages and density quantifying environmental outputs generated through the success of the SAV restoration pilot project. This quantifiable environmental output would then be used to demonstrate cost effective criteria for future brackish SAV systems.

SAV Pilot Project – Bayou Cumbest

The first goal of the proposed community-based restoration project in the Grand Bay NERR will result in restoration of up to 5 acres of *R. maritima* resulting in the recovery of an equal amount of SAV habitat to that lost during the 2005 hurricane season (Figure 5.5.1-1). Secondly, the Corps, Mobile District proposed to evaluate 3 restoration techniques to demonstrate their feasibility for larger restoration projects. Finally, the volunteer involvement and educational outreach will increase awareness of the importance of SAV habitat in Mississippi Sound and provide coastal managers and restoration practitioners with the knowledge of techniques to maximize their return on dollars spent.

The MsCIP environmental effort will: (1) restore SAV beds in Bayou Cumbest adjacent to the Grand Bay NERR that have been lost since the 2005 hurricanes through transplanting involving participation by the local community groups and students of the local universities and (2) determine the effectiveness of three transplanting methods (i.e. (1) a donor site, (2) harvesting plant sprigs with one or more meristems (growth regions), or (3) spreading seeds or mature flowering shoots over the restoration site) for restoring *R. maritima* in bayous, streams, and brackish marshes by quarterly monitoring using volunteers. After transplanting, quarterly monitoring for two years will be conducted to determine plant establishment, photosynthesis, growth, and expansion.



Source: MDMR

Figure 5.5.1-1. Grand Bay NERR Low Salinity Restoration Area in Bayou Cumbest using *Ruppia maritima*

The education and outreach components of the project will consist of volunteer involvement and dissemination of results through a professional workshop conducted at the end of the project. Volunteers will be recruited from Grand Bay NERR's established volunteer base, which includes local schools, universities, agencies, and civic groups. Our proposed study will also help determine the most successful and cost- and labor-effective transplanting method for restoring SAV. This information will be used in workshops and dissemination materials developed by Grand Bay NERR to inform commercial and recreational boat users/fishermen and the general public. Results will be disseminated through Grand Bay NERR's Coastal Training Program to inform coastal decision-makers and resource managers of successful restoration techniques.

This community restoration project will address the larger issue of SAV losses nationally and rates of natural recovery versus recovery after restoration. SAV are sensitive indicators of estuarine condition because of their high light requirements (Dennison et al 1993) and susceptibility to eutrophication-induced algal blooms and hypoxia (Hauxwell et al 2001). Furthermore, loss of SAV promotes the alteration of the sediment characteristics and nutrient cycling, causing long-term changes in habitat suitability for natural plant recolonization. These changes include loss of fine sediments through resuspension and transport, promoting a feedback loop that further inhibits natural recovery. Therefore, it is vitally important that restorative replanting be undertaken soon after damage or loss of plants to inhibit a negative change in system dynamics (Fonseca et al 2004).

5.6 Projects from Interim Report Carried Further

During the MsCIP Interim Report development, approximately 180 potential projects were identified. Upon further evaluation, 15 of these potential projects were recommended for immediate construction and have since been funded by Congress as a result of the MsCIP Interim effort. Of the remaining identified projects, the MsCIP PDT categorized each project into the following disciplines - structural, non-structural, environmental, and/or other. The environmental PDT then reassessed those projects identified in Table 4.1.6-1. As a result, some of those projects have been carried forward.

Due to the extreme time constraints, and ultimately funding constraints, given the enormous scope of study, the MsCIP Comprehensive Report and Integrated Programmatic EIS presents recommended features at a number of levels (presented below in decreasing order) of detail:

1) a feasibility-level of detail sufficient for selection for construction;

2) a level of detail requiring only final resolution of technical issues, but containing sufficiently-detailed cost-estimates that would not likely violate the 902 limit on that particular project (i.e., at an "Advanced Engineering" level of detail);

3) a level of detail sufficient to make selections for longer term comprehensive implementation that would require only limited additional data for refining of the final alternative and development of an Microcomputer Aided Cost Engineering System-compliant cost estimate for a selection, and;

4) detail at a "less-than-feasibility" level of analysis requiring a recommendation to seek further study in order to resolve remaining technical, societal, or environmental compliance or analysis of issues, for which a cost estimate will be supplied for both the additional study and Project Engineering and Design.

If it was found applicable to the Corps's MsCIP recovery mission, the remaining projects were incorporated, in some manner, into the previously discussed Recommended Plans. In addition, Turkey Creek: Mt. Pleasant UME Audubon site 41, tidal creek restoration of floodplain, Davis Bayou ER, Biloxi Back Bay, Turkey Creek watershed Greenway projects that are environmental in nature and are being recommended.

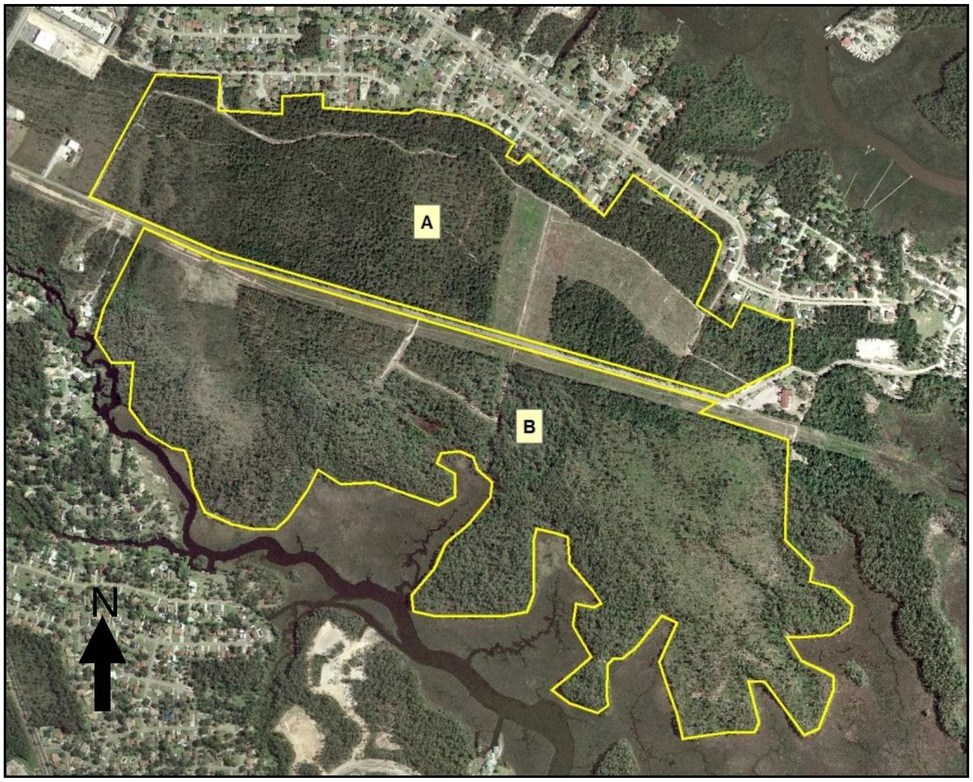
5.6.1 Construction

Two initial environmental restoration projects previously discussed – Turkey Creek and Bayou Cumbest – are being recommended for construction.

As previously discussed in *Section 4.1.5.5 State Initiative Projects*, the Governor of the State of Mississippi's 7-*Point Strategy* for rebuilding coastal resources of the State is anticipated to be an on-going effort over the next 10 to 15 years and included 11 restoration projects. Of those, both Admiral Island and Dantzler were included in that list and were selected to be carried forward in as being recommended for construction.

State of Mississippi Initiative Plans – Dantzler, Jackson County

The original estimate for the Dantzler restoration site was 900 acres – 500 acres of marsh and 385 acres of wet pine savannah habitats (Figure 5.6.1-1). After much discussion between the Environmental PDT, it was decided that the marsh area did not need to be restored (i.e. elevations lowered, hydrology restored, and entire site replanted) but rather the site needed to be cleaned of debris. Therefore the Environmental PDT, then decided to restore only the 385 acres of wet pine savannah habitat.



Source: MDMR

Figure 5.6.1-1. Dantzler Restoration Site

The Dantzler restoration area contains 385 acres to be restored to wet pine savannah. The restorable area is split by a road, 151 of the acres are north of the road and the remaining 234 acres are south of the road. This area was planted in plantation pine during the 1960s and ditches and stormwater lines were constructed in the early 1970s in anticipation of residential development of the site. The long-term exclusion of fire and the invasion of non-native species, such as Cogon grass and Chinese Tallow tree, have severely degraded the site.

Objective:

1. Restore the natural hydrology.
2. Restore natural fire regime.
3. Restore native wetland plant communities.
4. Provide storm surge protection.
5. Provide fish and tidal wildlife habitat.

Measures:

1. Maintain native savanna vegetation. (Mandatory)
2.

Alternatives:

a) prescribed burning on a 3-5 year cycle.

b) mowing annually.

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained" landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

2. 100% removal of exotics and plantation pine; maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

   This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches. (Mandatory)

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

Table 5.6.1-1.
Dantzler Restoration Measures

Plans 1-2.	Restoring areas both north and south of road (areas A and B)	
	Plan 1. 1a,2,3	Plan 2. 1b,2,3
Plans 3-4.	Restoring only area north of road (Area A)	
	Plan 3. 1a,2,3	Plan 4. 1b,2,3
Plans 5-6.	Restoring only area south of road (Area B)	
	Plan 5. 1a,2,3	Plan 6. 1b,2,3

Benefits:

The following table (Table 5.6.1-2) shows the AAFU benefit under each plan.

Table 5.6.1-2.
Summary of AAFU Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	AAFU Benefit
Dantzler	385	No-action plan	0
Dantzler	385	Plan 1	1,244
Dantzler	385	Plan 2	943
Dantzler	151	Plan 3	488
Dantzler	151	Plan 4	370
Dantzler	234	Plan 5	756
Dantzler	234	Plan 6	573

The management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, three plans were eliminated because they produced less benefit at greater cost than a subsequent plan. Of the three remaining plans, one proved to be more cost-effective and consists of restoration of 385 acres of restoration maintained by burning.

The recommended plan requires filling ditches, maintaining vegetation growth by burning and mowing the project area in the initial year of construction as well as maintaining it by burning every three years over the life of the project, and excavating and removing existing roadbeds and any additional fill.

In order to restore this area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them which will enable water to flow downward to the depression areas; thus, holding water. The wet pine savannah habitat will be restored with wet pine flatwoods, such as *P. elliotti, M. cerifera, L. glabra, S. patens and P. virgatum.*

Many species of wildlife are indigenous to the wet pine savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American chaffseed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, Venus flytrap, and sundews. Rare, threatened or endangered birds that may occur in these areas include Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi sandhill crane. This ecosystem may also benefit the Mississippi gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise. The importance of this habitat and the need for burning has been previously described in the Turkey Creek discussion in *Section 5.1.1.1.2.1.2 Benefits*.

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Turkey Creek. Table 5.6.1-3 shows the AAFU net benefit under each plan. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan.

Table 5.6.1-3.
Summary of Benefits

Plan	Plan Description	AAFU Net Benefit
No Action	No Action	0
Plan 1	385 Acre Restoration Burn Remove Exotics Fill	1,244

Admiral Island, Hancock County

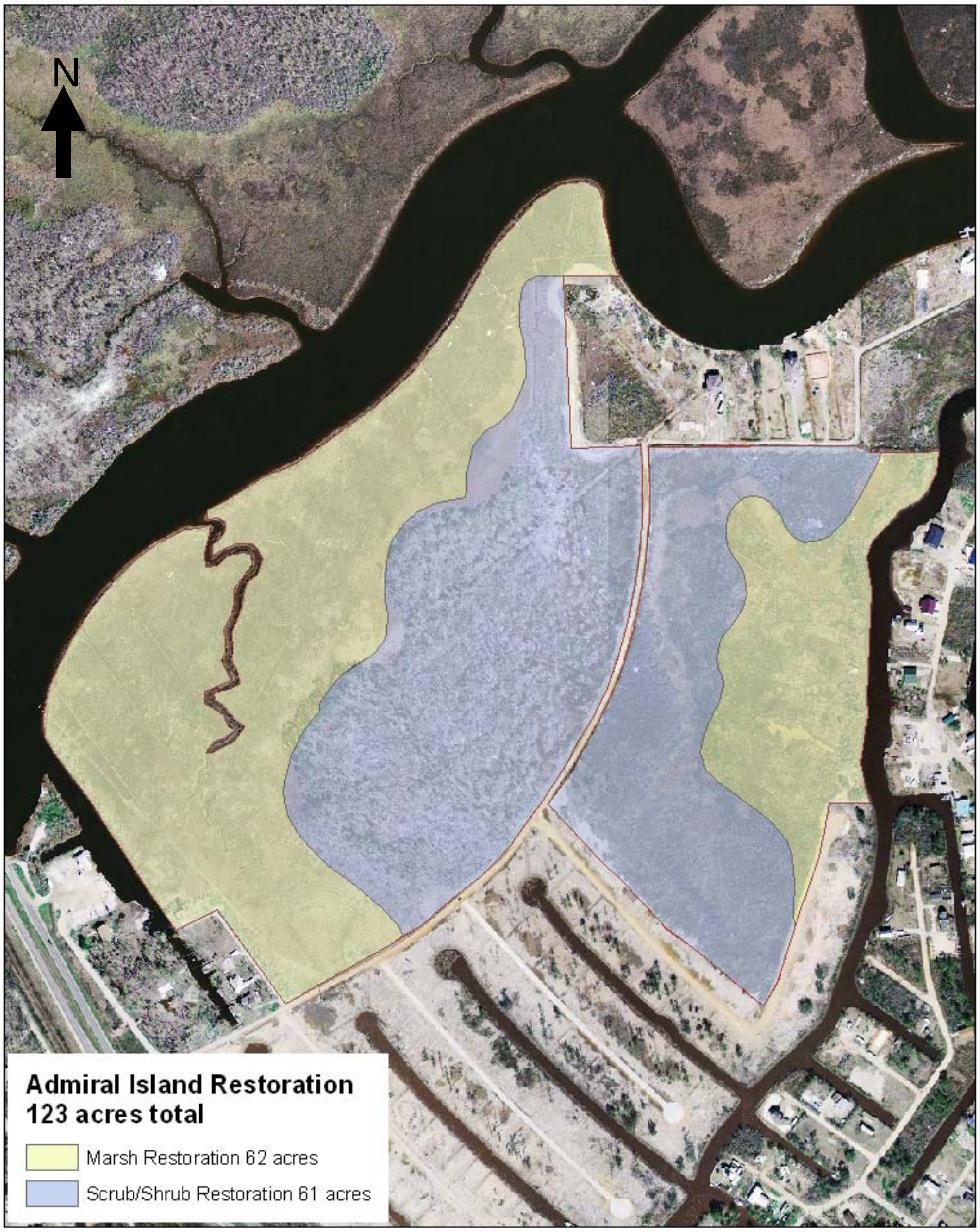
The Admiral Island restoration area contains 123 acres to be restored to 62 acres of emergent tidal marsh and 61 acres of scrub shrub habitats (Figure 5.6.1-2). Existing scrub shrub vegetation at the site supports natural propagation through removal of exotic species that currently outcompete native vegetation. The tidal marshes in this area were ditched during the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation in the area and destroyed many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow tree, which is invading the marshes and the adjacent flatwoods. For increased habitat diversity, the team proposed to leave some of the higher elevations as is and plant shrub/scrub species in order to enhance environmental benefits at the restoration site. The diverse habitat allows for a variety of fish and wildlife to utilize the area which increases the environmental benefits.

Objective:

1. Restore the natural hydrology.
2. Restore native wetland plant communities.
3. Provide storm surge protection.
4. Provide fish and tidal wildlife habitat.
5. Prevent saltwater intrusion

Measures:

1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas) (Mandatory).



Source: MDMR

Figure 5.6.1-2. Admiral Island Restoration Site

This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.25, on the assumption that greater than half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

   This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches/channels.

   If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting

Alternatives:

a) 0.5 meter spacing

b) 1 meter spacing

c) 2 meter spacing

This measure affects the “percent cover by woody plant species”, “wildlife habitat diversity”, “vegetation height”, “wetland indicator status” and “mean percent cover emergent plant species” variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the project life (50 years). Variable subindex scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter (Tables 5.6.1-4 and 5.6.1-5).

Table 5.6.1-4.
Measures

Plan 1. 1,2,3,4a	Plan 2. 1,2,3,4b	Plan 3. 1,2,3,4c
Plan 4. 1,2,4a	Plan 5. 1,2,4b	Plan 6. 1,2,4c

Table 5.6.1-5.
Summary of AAFU Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	AAFU Benefit
Admiral Island	62	No-action plan	0
Admiral Island	62	Plan 1	61
Admiral Island	62	Plan 2	60
Admiral Island	62	Plan 3	59
Admiral Island	62	Plan 4	51
Admiral Island	62	Plan 5	50.5
Admiral Island	62	Plan 6	49

The management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, two plans were eliminated because they produced less benefit at greater cost than a subsequent plan.

The recommended plan consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 1.0 meter, and filling existing artificial ditches. The planting of native vegetation consist of *S. alteniflora, J. roemerianus, and S. patens*.

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Bayou Cumbest. Table 5.6.1-6 shows the total functional units under each implemented plan and the AAFU net benefit. To calculate the AAFU net benefit, it is assumed that benefits will be maximized at year 5 with 0.5 meter spacing of vegetation, at year 7 with 1.0 meter spacing of vegetation, and at year 10 with 2.0 meter spacing of vegetation. These benefits are estimated to be sustainable over the life of the project. Net AAFU benefits are calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. The recommended plan was selected based on the criteria used for Bayou Cumbest.

Table 5.6.1-6.
Summary of Benefits

Plan	Plan Description	Net AAFU Net Benefits
No Action	No Action	0
Recommended Plan 2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	60

Franklin Creek Restoration Area

The project site is located in eastern Jackson County and has been funded for homeowners assistance and relocation as part of the MsCIP Interim Report and/or the 180 projects previously discussed. The restoration project consists of 149 acres located north and south of the CSX Railroad line, a major thoroughfare through the community. The site received severe flood damages from a decade of hurricanes. Historically, the site consisted of wet pine savannah wetlands. It is assumed that removal of utilities, building slabs, and roadways would be completed as part of the ongoing interim project. The following restoration measures were developed.

Objectives:

The following objectives were developed for ecosystem restoration:

1. Restore native vegetation

2. Restore natural hydrology

3. Restore fish and wildlife habitat

4. Provide storm water storage protection.

Assumptions:

1. Mandatory purchases of the residents as part of the MsCIP Interim Project.

Measures:

Proposed restoration management measures are listed in the following table. Narrative descriptions of each management measure follow this table.

1. Filling in ditches (Mandatory).

This measure affects the "Outflow of Water" variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.1 to 1.0 under this measure.

2. Maintain vegetation (Mandatory).

Alternatives:

a. Burn (3 year cycle)

b. Mow (annual)

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained landscape variable will score a 0.05 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory).

This measure affects the "surface water storage" variable, which measures the presence of excavation or fill, at the site. This variable score would increase from 0.1 to 1.0 in areas with existing roadbeds/fill.

4. Add culverts (Mandatory).

This measure increases the hydrologic connection between the two existing wetland areas separated by an elevated railway. The wetlands are primarily precipitation driven resulting in sheet flow drainage. Additional culverts will result in increased sheet flow drainage reducing standing surface water in the northern wetland area.

A combination of measures resulted in the following plan combinations and a summary of functional unit benefits are shown in the table below:

Table 5.6.1-7.
Measures

Plan 1. 1,2a,3,4	Plan 2. 1,2b,3,4
Plan 3. 1,2a,3	Plan 4. 1,2b, 3

Table 5.6.1-8.
Summary of AAFU Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit
Franklin Creek	149	No-action plan (plans 1-2)	0
Franklin Creek	56	No-action plan (plans 3-4)	0
Franklin Creek	149	plan 1	516
Franklin Creek	149	plan 2	399
Franklin Creek	56	plan 3	194
Franklin Creek	56	plan 4	150

Plan Selection:

The management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, three plans were eliminated because they produced less benefit at greater cost than a subsequent plan. Of the three remaining plans, one proved to be more cost effective and consists of restoration of 149 acres of restoration maintained by burning.

The recommended plan requires filling ditches, maintaining vegetation growth by burning and mowing the project area in the initial year of construction as well as maintaining it by burning every three years over the life of the project, and excavating and removing existing roadbeds and any additional fill.

Benefits:

In order to restore this area to a Wet Pine Savannah habitat, the higher areas will be designated as Wet Pine Savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water. The Wet Pine Savannah habitat will be restored with Wet Pine Flatwoods as previously discussed.

Benefits are measured in terms of AAFU and HGM. Table 5.6.1-9 shows the AAFU net benefit under each plan. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. The recommended plan was selected based on previous criteria discussed.

Table 5.6.1-9.
Franklin Creek Benefits

Plan	Plan Description	AAFU Net Benefit
No Action	No Action (149 acres)	0
Recommended Plan	149 Acre Restoration Maintain by Burning	516

5.6.2 Longer Term Comprehensive Plan

Environmental Restoration Sites (i.e. 38 sites in the coastal counties – ex. Bayou Cumbest and Turkey Creek).

5.6.3 Preconstruction Engineering Design for specific features

State Initiative Plans:

- Wachovia, Hancock County – There are roadways to be removed.
- Ansley, Hancock County – There are roadways to be removed.
- DuPont, Harrison County – There are roadways to be removed.

5.6.4 Additional Feasibility Studies

State Initiative Plans:

- LaFrancis Camp Trenaisse, Hancock County (water modeling needed)
- Enhancement of the Barrier Islands – Restoring Vegetation and Dune systems
- SAV Restoration on the Northern Portions of the Barrier Islands

- Round Island, Jackson County
- Pascogoula River Marsh, Jackson County
- Twelve Oaks and Helmer’s Lane, Jackson County

5.6.5 Advanced design studies for innovative concepts

- Freshwater Diversion Structures – Grand Bay, Pearl River, Escatawpa
- Biloxi Marsh Comprehensive Ecosystem Restoration
- West Pascagoula Delta Ecosystem Restoration
- Watershed Planning Approach
- Maximize Beneficial Use of Dredged Material
- Littoral Placement of Sandy Material adjacent to Barrier Islands
- Coastal Mississippi Artificial Reef Projects for Remediation of Hurricane Damage
- Oyster Reef Restoration
- Wetland Restoration along main drainage systems to increase capacity of flood storage during rainfall and storm events
- Prevention of coastal erosion of archaeological sites
- SAV long-term monitoring program (i.e. advanced technological mapping)

5.6.6 State of Mississippi Environmental Initiative

Several projects have been recommended for construction by the State of Mississippi.

5.7 Forrest Heights Levee, City of Gulfport, Harrison County

5.7.1 General

The culturally historical Forest Heights residential community in the City of Gulfport, Harrison County, Mississippi, has frequently been inundated by flood waters due to storm surges from Mississippi Sound and from inland flooding along the lower Turkey Creek. Water reached a depth of 2- to 8-foot over the entire community during Hurricane Katrina inundation. The Forest Heights levee is proposed to be constructed as a pilot project for the MsCIP comprehensive plan. The levee will address the combination of storm surge protection, inland flooding protection, and evacuation. The levee is intended to be constructed to a height, such that the levee might be certified under the National Flood Insurance Program. A preliminary engineering analysis suggests a levee built to approximately elevation 21 feet North American Vertical Datum (NAVD) 88 would satisfy or exceed certification elevation criteria.

Engineering performance and economic evaluations of protection options were done using the Hydrologic Engineering Center’s (HEC) Flood Damage Analysis (FDA) computer application HEC-FDA. HEC-FDA modeling was done using variations in with-project conditions compared to the future without-project conditions for the Turkey Creek study. Details regarding the methodology are presented in the Economic Appendix. Additional evaluation to determine the precise levee height will be performed during final engineering and design based upon analyzing the risk and uncertainty associated with the coincident occurrence of inland flooding and storm surge impacts.

5.7.2 Location

The Forrest Heights community is located in an area known as North Gulfport within the City of Gulfport on the Mississippi Gulf Coast. The location of the levee at Forrest Heights is shown below in Figures 5.7.2-1 and 5.7.2-2. The community lies along the lower Turkey Creek floodplain, which has a tendency to frequently exceed its stream channel capacity and flood adjacent low-lying areas.

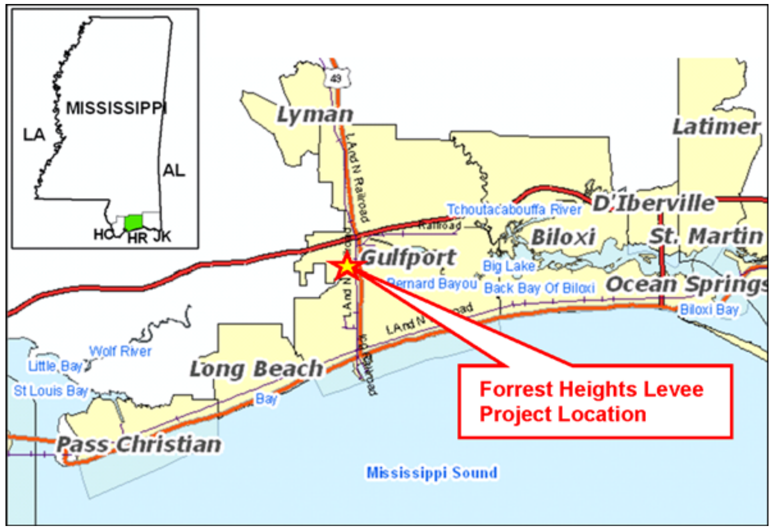
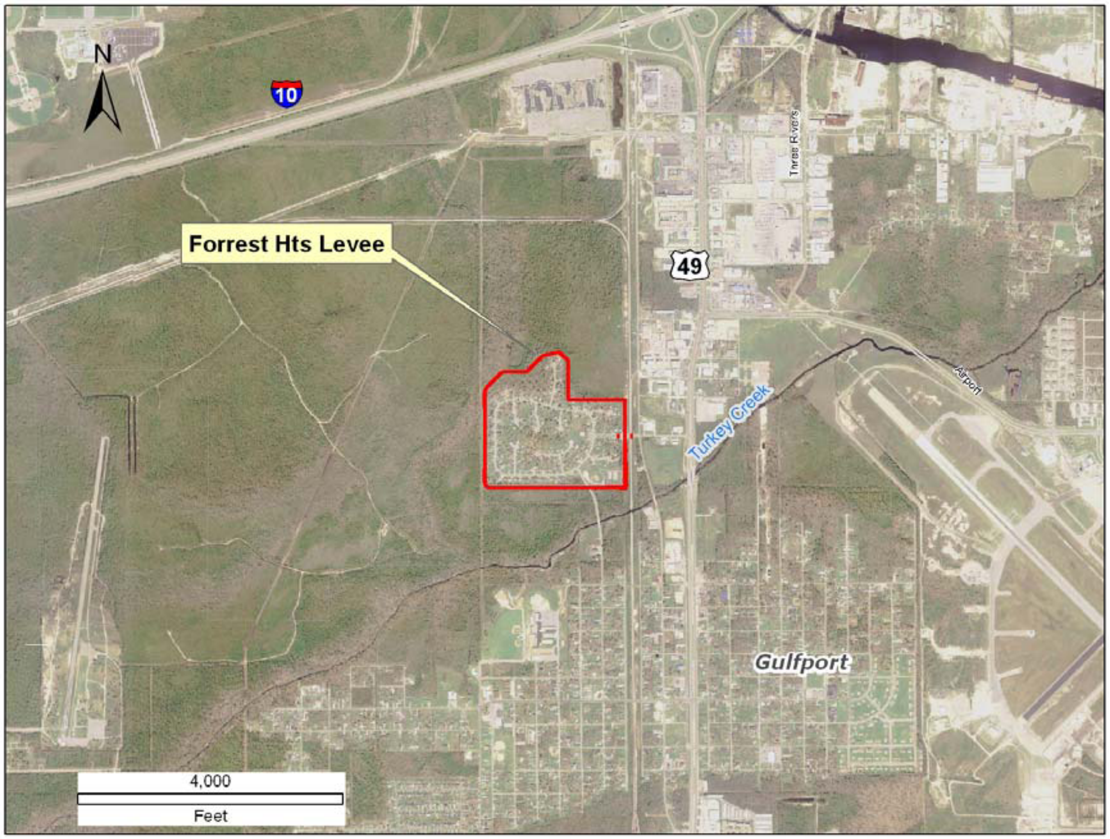


Figure 5.7.2-1. Vicinity Map



Source: Corps

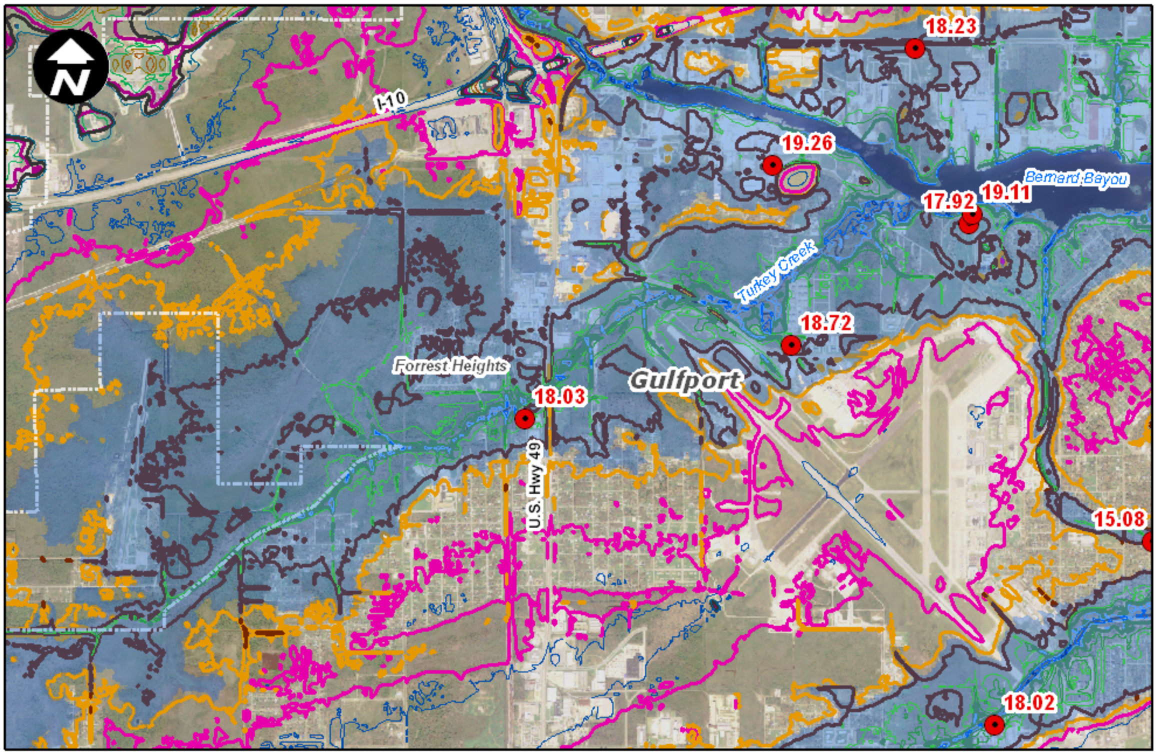
Figure 5.7.2-2. Forrest Heights Ring Levee Location

5.7.3 Existing Conditions

The community of Forrest Heights lies on the bank of Turkey Creek about 2.6 miles from the mouth at Bernard Bayou. Ground elevations over most of the residential area are between elevations 10-14-foot NAVD88. Drainage is mostly along streets and through natural drainage ways to the Turkey Creek. Impacts from flooding and hurricanes have been devastating. Hurricane Katrina in August, 2005 resulted in significant flood damages to residences in the Forrest Heights community. A levee with top width of 6 feet was constructed around the community to elevation 16.5 feet NGVD with sideslopes of 1 vertical to 1.5 horizontal in 1969, prior to Hurricane Camille. It has not had adequate maintenance and is a state of disrepair. It is scheduled to be restored to as-built condition by January of 2009. However, the restored levee will not be sufficient to meet the present day standard for certification according to the existing FEMA flood profiles in the vicinity. It is assumed that the as-built condition of this restored levee will be the existing condition for this report.

5.7.4 Coastal and Hydraulic Data

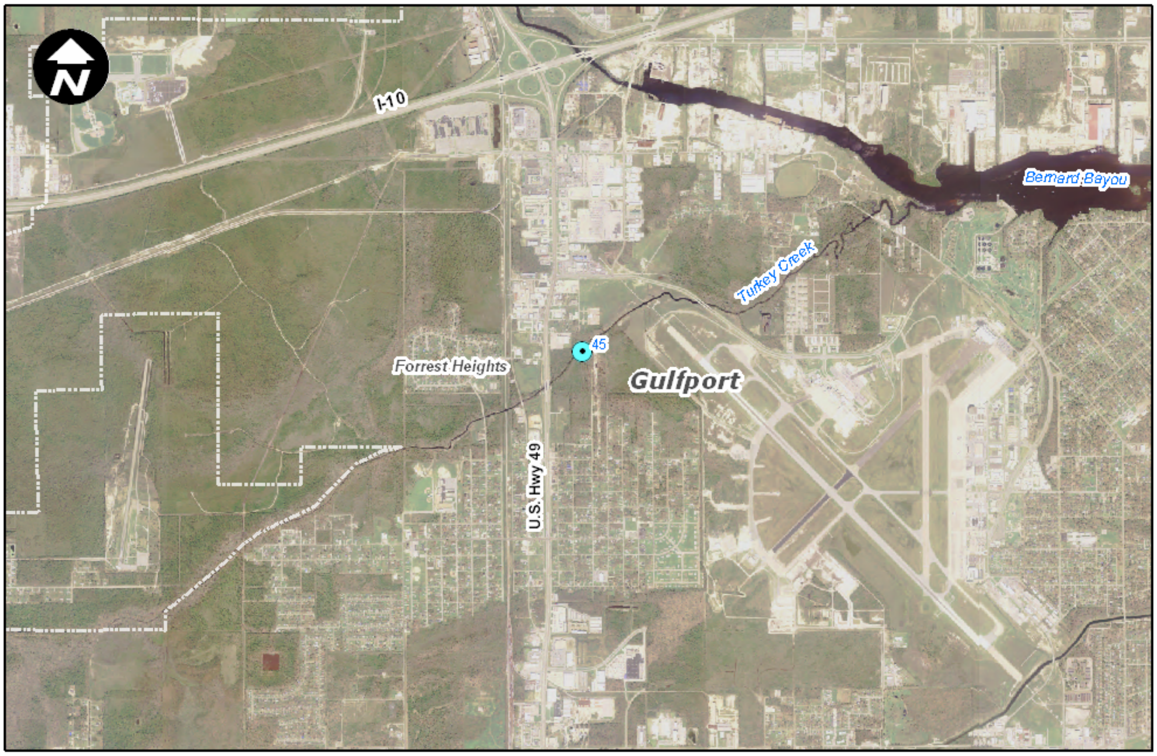
High water marks taken by FEMA after Hurricane Katrina in 2005 as well as the 4-foot (blue), 8-foot (dark green), 12-foot (green), 16-foot (brown), 20-foot (orange), and 20-foot (pink) ground contour lines and Hurricane Katrina inundation limits are shown below in Figure 5.7.4-1. The data indicates the water was as high as 18-20 feet NAVD88 near the site, totally inundating the entire area.



Source: Corps

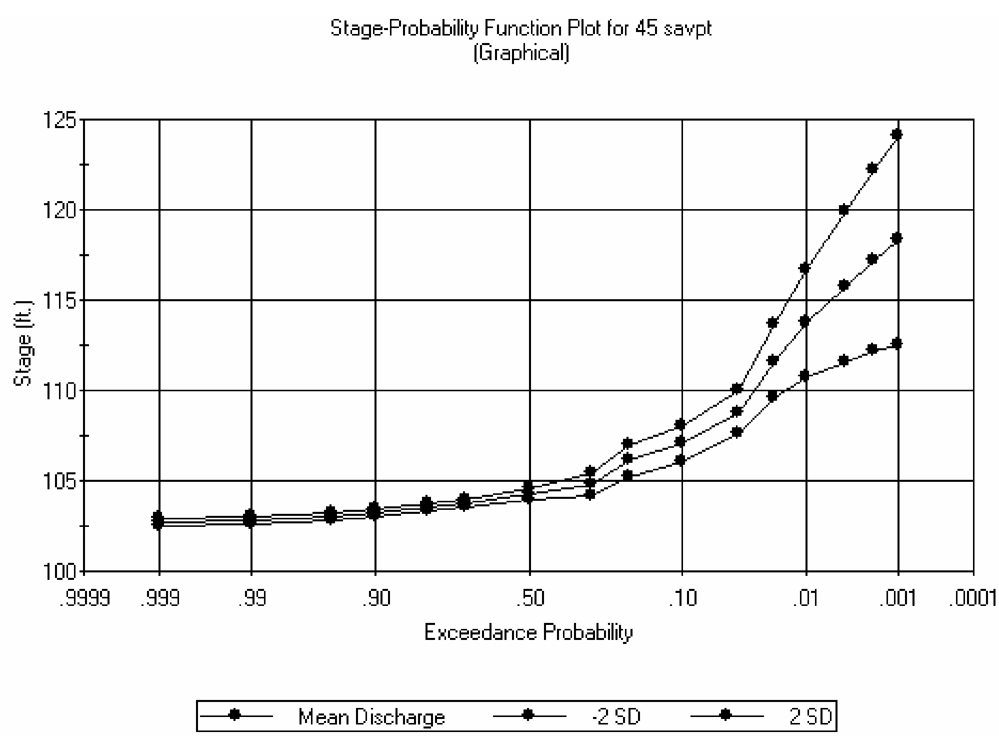
Figure 5.7.4-1. Hurricane Katrina Inundation and High Water, Forrest Heights

Stage-Frequency data for a suite of severe storms using Joint Probability Method (JPM) and hydrodynamic modeling were developed by ERDC for 80 locations along the study area. These data were combined with historical coastal tide gage frequencies for smaller storms to establish stage-frequency curves at 54 economic reaches in the study area. Points near Forrest Heights at which data from hydrodynamic modeling was saved are shown below in Figure 5.7.4-2, and the stage frequency curve for that location is shown in Figure 5.7.4-3. Hydrodynamic output stage-frequency pairs, with uncertainty, are displayed in Table 5.7.4-1.



Source: Corps

Figure 5.7.4-2. Hydrodynamic Modeling Save Point near Forrest Heights



Source: Corps

Figure 5.7.4-3. Surge-only Stage Frequency Curve, Vicinity of Forrest Heights

Table 5.7.4-1.
Surge Stage-Probability and Uncertainty

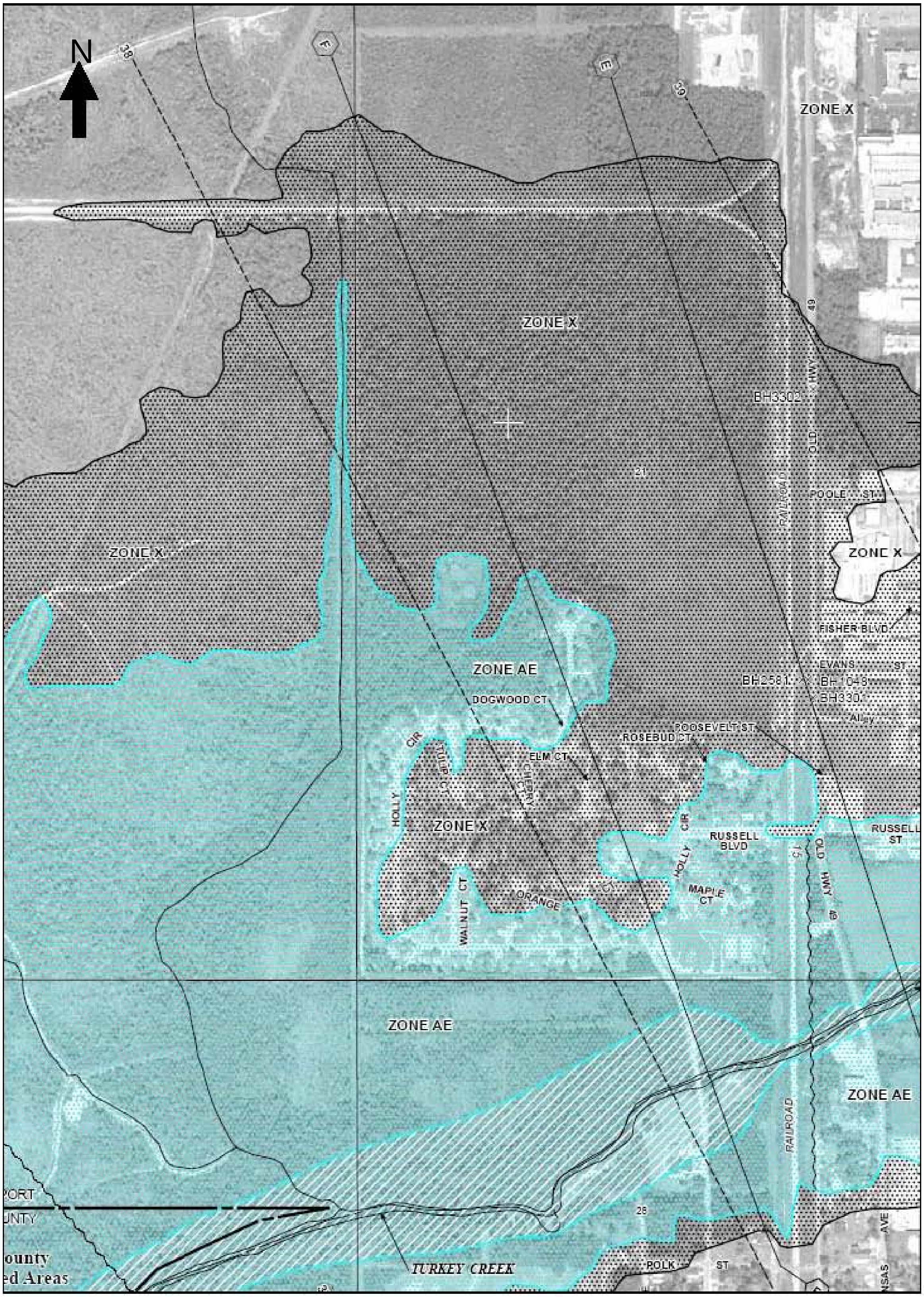
Annual Probability	Stage (Ft. NAVD88)	Standard Deviation (Feet)
0.04	8.8	0.6
0.02	11.6	1
0.01	13.7	1.5
0.002	17.2	2.5
0.001	18.3	2.9

It should be noted that the frequency curve reflects only that flooding resulting from storm surge in the Gulf. The Forrest Heights community is also subject to riverine flooding by Turkey Creek. The preliminary FEMA Harrison County Flood Insurance Study (FIS) dated November 2007 provides computed Turkey Creek flood profiles which appear to have been adjusted for the effects of coincident surge in Back Bay of Biloxi. Table 5.7.4-2 shows relevant discharge and stage information from the FIS for Turkey Creek at Ohio Avenue, the southern entrance to the Forrest Heights community. In comparison to the preliminary FEMA Flood Insurance Study dated November 2007, which is based on contemporary (post-Katrina) FEMA contractor hydrodynamic modeling, the ERDC frequency curve, which is based on surge alone, suggests a lower stage associated with the annual one in one hundred chance (0.01 exceedance probability) event.

Table 5.7.4-2.
Turkey Creek Flood Stages at Ohio Avenue, Harrison County FIS.

Exceedance Probability	Discharge (cfs)	Stage (ft. NAVD '88)
0.1	2600	12
0.02	3650	14.2
0.01	5500	15.5
0.002	7950	18.3

Figure 5.7.4-4 shows a portion of the preliminary Harrison County Flood Insurance Rate Map in the vicinity of Forrest Heights. Low-lying peripheral areas of the neighborhood are shown in a shaded blue field as being in the 1% annual chance ('100-yr') regulatory floodplain, with the remainder of the community occupying a shaded Zone X field, being areas subject to shallow flooding at annual probabilities of occurrence between 0.02 (2%) and 0.01 (1%).



Source: Corps

Figure 5.7.4-4. Preliminary FEMA Flood Insurance Rate Map, Vicinity of Forrest Heights.

Hydraulic data was developed for use in the HEC-FDA program. The HEC-FDA program uses risk-based analysis methods for evaluating flood damage and flood damage reduction alternatives. The program relies on hydrologic, hydraulic, and economic data input. Uncertainties in these data are input and used by the model for computing annual damages. Version 1.2.3b dated August 2007 was used. As described in Engineering Appendix - Chapter 2, this is a customized version of the current official release version 1.2 dated March 2000. This section describes the model's hydrologic and hydraulic input as applied to the Forrest Heights community. The Economic appendix describes the economic input and results. The Main Report describes how the model output was examined and used in the plan formulation process. Additional explanation is provided in the Engineering Appendix.

5.7.5 Engineering Performance

Project engineering performance was computed using HEC-FDA. Engineering performance was computed for the existing and future without project conditions; and a variety of existing and future with-project conditions. Performance was computed with risk and uncertainty. The base year was assumed to be 2012, and the future year was assumed to be 2061 (50 year period of analysis). Scenarios were also evaluated assuming (a) existing sea level, (b) expected sea level rise, and (c) high sea level rise.

The existing condition assumes that the NRCS has reconstituted their levee around the Forest Heights community to a crest elevation of 16.5 feet. The existing and future hydrologic and hydraulic conditions are presumed to be as represented by the FIS hydrology and flood profiles with uncertainty. Typically, one would consider increasing future flood discharges to account for possible increases in runoff due to development and urbanization. However, in this case, the underlying FIS hydrologic information is dated, being circa 1976, and subsequent studies have suggested that the effective tributary drainage area in this relatively flat and undifferentiated portion of the Turkey Creek watershed is less than the 25 or so square miles attributed to the creek at the location of Forest Heights. The existing hydrology is most likely conservative, and revisions downward for an un-gauged stream seem ill-advised. Additionally, the area in question benefits from an updated and contemporary FIS, where the Turkey Creek profiles have been adjusted for coincident surge elevations, and the floodplain has been re-mapped accordingly. In the end, it seems advisable to rely on the existing FIS profiles and hydrology for conservative results.

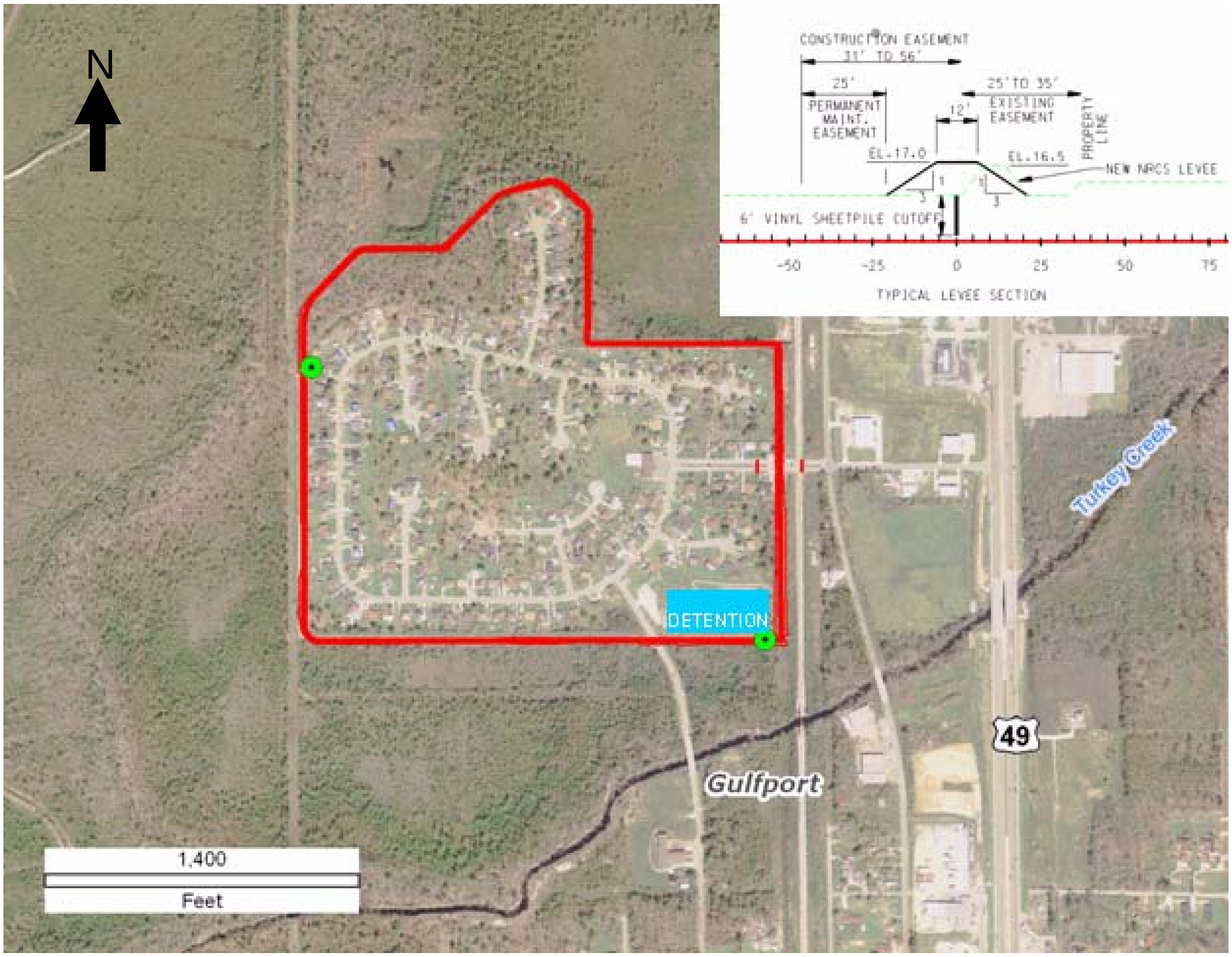
With-project conditions were evaluated for levees with crest elevations of 17 and 21 feet. The existing with-project condition assumes clearing and snagging of debris in Turkey Creek will counteract any local water surface profile impact due to flow obstruction by the levee. Future with-project conditions assume that the channel maintenance has been neglected, and thus the rating curve at Ohio Avenue is shifted upwards by 0.3 feet.

Performance was also evaluated assuming a levee built to the local Base Flood Elevation (BFE) - the regulatory one in one hundred annual chance water surface elevation plus three feet. Historically, FEMA required levees to be built to the BFE plus three feet for certification. This condition no longer in and of itself satisfies certification criteria, which now requires that risk and uncertainty also be considered. This condition was evaluated for the purposes of levee certification. Assuming the BFE is defined by the FIS water surface elevation at Ohio Avenue as described on the FIS Turkey Creek Flood Profile, this elevation is 15.5 feet plus 3 feet, or elevation 18.5 feet.

Forest Heights occupies a small fringe of the floodplain, and the FDA simulations assume that when the levee is overtopped, the interior floods to the exterior flood elevation.

5.7.5.1 Option A - Elevation 17 ft NAVD88

This option consists of an earthen dike around the Forrest Heights community as shown on the following Figure 5.7.5.1-1, along with the levee culvert/interior pump/detention location. The earth dike will be trapezoidal in shape with a 12-foot top width with one foot vertical to three foot horizontal slopes on both sides. For this option, the two existing roadway entrances will be ramped over the restored levee. The total length of the levee will be approximately 7,900 feet.



Source: Corps

Figure 5.7.5.1-1. 17-ft Elevation Levee Alignment with Culvert and Pump/Detention Basin Locations

Levees reduce the storage capacity and overbank flow conveyance of the adjacent floodplain. The reductions in overbank flow area could induce higher water levels upstream. An HECRAS model was used to evaluate the potential for induced damages and solutions. The modeling indicates that selective clearing and snagging would prevent increases in water surface elevations upstream that would occur due the placement of the levees in the floodplain.

The selective clearing and snagging would extend for approximately 4.5 miles from the mouth of Turkey Creek at Bernard Bayou to the upstream limits as shown in Figure 5.7.5.1-2. Selective clearing and snagging would remove obstructions such as debris dams and excessive sedimentation that hinders the flow through the Turkey Creek channel. While the selective clearing and snagging component of the plan does not eliminate flooding along Turkey Creek, the plan does reduce flood damages along the creek and at the upper end of the canals at 28th Street. The main purpose of the selective clearing and snagging is to make sure that induced damages do not occur due to the construction of the levee.

The selective clearing and snagging work will follow Stream Obstruction Removal Guidelines established by the American Fisheries Society. Only debris, snags and sediment that obstruct the flow will be removed. Material to be removed includes: 1) fine sediment accumulations that obstruct flows and alter flow patterns; 2) Debris blockages that currently or in the near future cause obstructed flow and altered flow patterns; and 3) Rooted trees that obstruct flow or need to be cleared for equipment access. Access areas that are cleared will be reestablished at the conclusion of the selective clearing and snagging activities. Some access points, however, may remain for the non-Federal sponsor to use for maintenance activity of the completed project. The existing bank alignment along the entire reach will not be changed, including the downstream reaches of Turkey Creek along the meander bends. Specific reaches to be cleared and snagged will be identified by an interdisciplinary team prior to construction.

Source: Corps

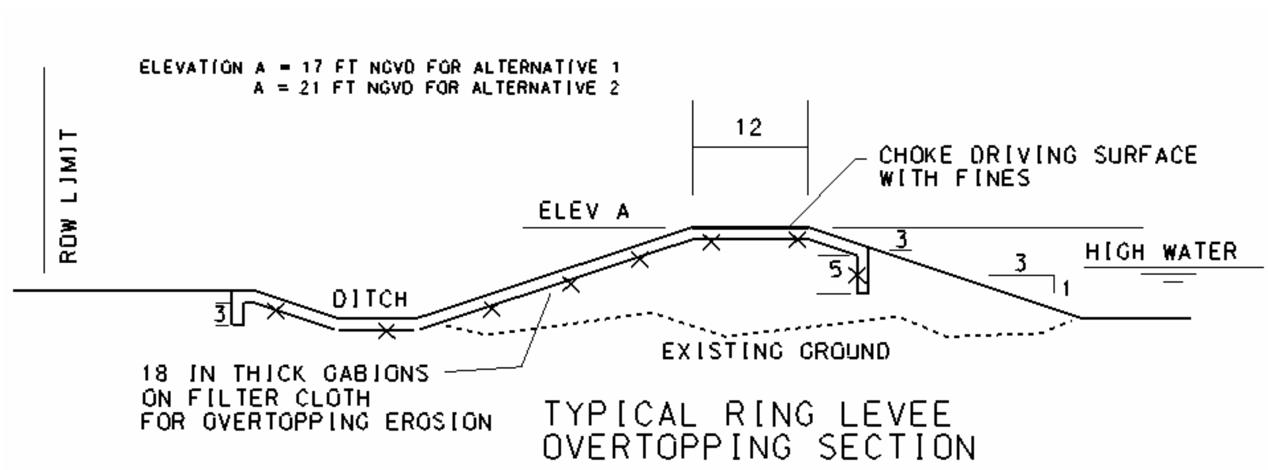
Figure 5.7.5.1-2. Channel Clearing and Snagging Limits

Damage and failure by overtopping of levees could be caused by storm surges greater than the levee crest. Overtopping failures are caused by the high velocity of flow on the top and back side of the levee. Although significant wave attack on the seaward side of some of the New Orleans levees occurred during Hurricane Katrina, the duration of the wave attack was for such a short time that major damage did not occur from wave action. The erosion shown below in Figure 5.7.5.1-3 was caused by approximately 1-2 foot of overtopping crest depth.

Source: Corps

Figure 5.7.5.1-3. Crown Scour from Hurricane Katrina at Mississippi River Gulf Outlet Levee in St. Bernard Parish, New Orleans, LA

An overtopping reach of the levee with a revetment at the detention/culvert location would be included in the levee design to prevent overtopping failure. The levee would be protected by gabions on filter cloth as shown in Figure 5.7.5.1-4, extending across a drainage ditch which carries water to nearby culverts and which would also serve to dissipate some of the supercritical flow energy during overtopping conditions.



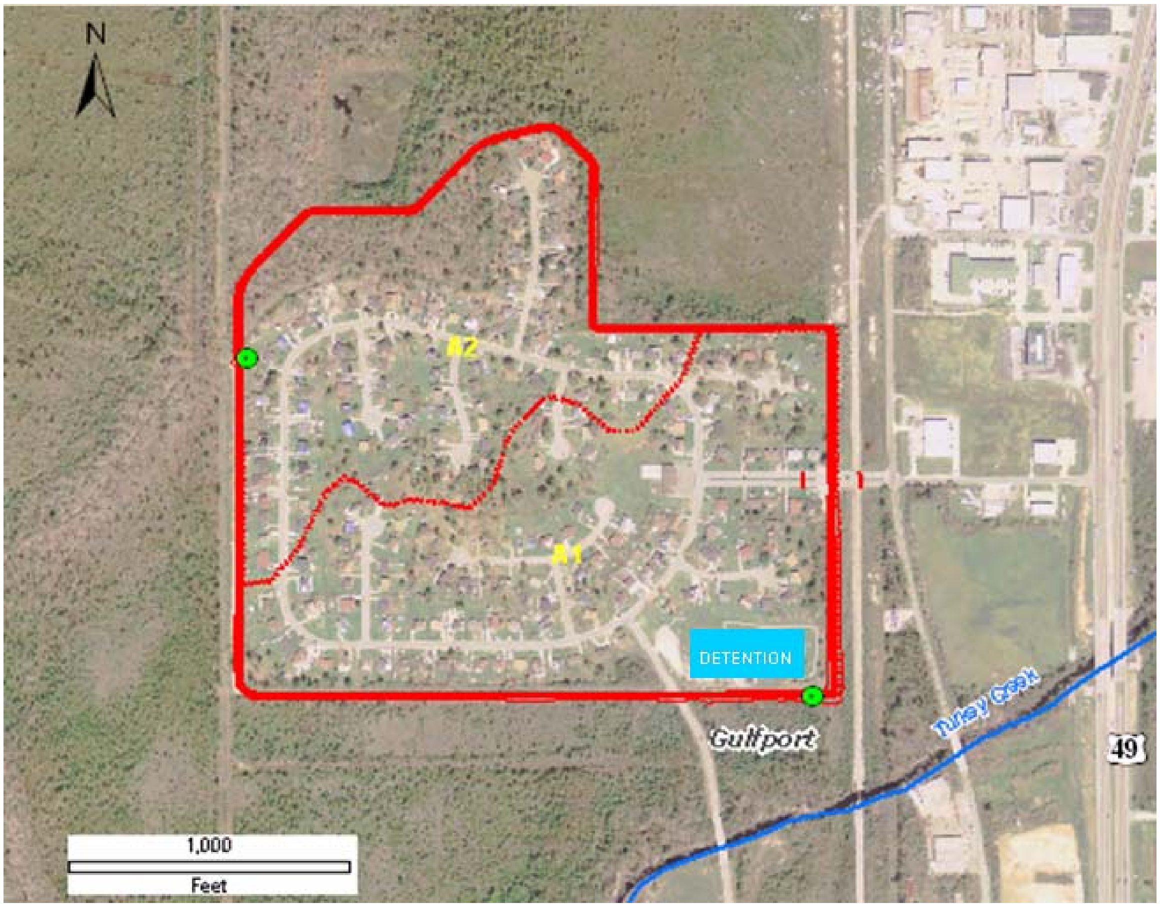
Source: Corps

Figure 5.7.5.1-4. Typical Levee Overtopping Section

5.7.5.1.1 Interior Drainage

Drainage at the site is impacted by hurricanes in the Gulf and by adjacent flooding from Turkey Creek. Backwater from each of these sources prevents water from running off. The existing NRCS levee at elevation 16.5 NAVD 88 protects the neighborhood to some degree from these sources, but does not eliminate the flooding during times when the water outside the levee is up and there is rainfall inside the levee. This is the present condition at the site. Construction of the Corps levee will follow the footprint of the NRCS levee and provide additional protection from flooding from hurricanes and Turkey Creek. The interior flooding will be improved by adding a detention basin and pumping facility.

Flow within the levee interior was determined by subdividing the interior of the ring levee into major sub-basins shown below in Figure 5.7.5.1.1-1 and computing flow for each sub-basin by USGS computer application WinTR55. The method incorporates soil type and land use to determine a run-off curve number. The curve number was determined from previous studies done for Turkey Creek.



Source: Corps

Figure 5.7.5.1.1-1. 17-ft Elevation Levee Sub-basins

Peak flows for the 1-year to 100-yr storms were computed. Levee culverts were then sized to evacuate the peak flow from a 25-year rain in accordance with practice for new construction in the area using Bentley Culvert Master application. For the culvert design, headwater elevations at the culverts were maintained at an elevation no greater than 10 feet NAVD88 with a tailwater elevation of 6 feet NAVD 88 assumed. Drainage ditches along the toe of the levee will be required to assure that smaller basins can be drained to a culvert/pump site. These ditches were sized using a normal depth flow computation. Curve numbers and culvert capacity tables are not included in the report beyond that necessary to obtain a cost estimate. The data are considered beyond the level of detail required for this report.

During periods of high water in Turkey Creek or Mississippi Sound, pumping would be required to evacuate rainfall. Pump size was determined for the peak flow resulting from a 10-year rainfall.

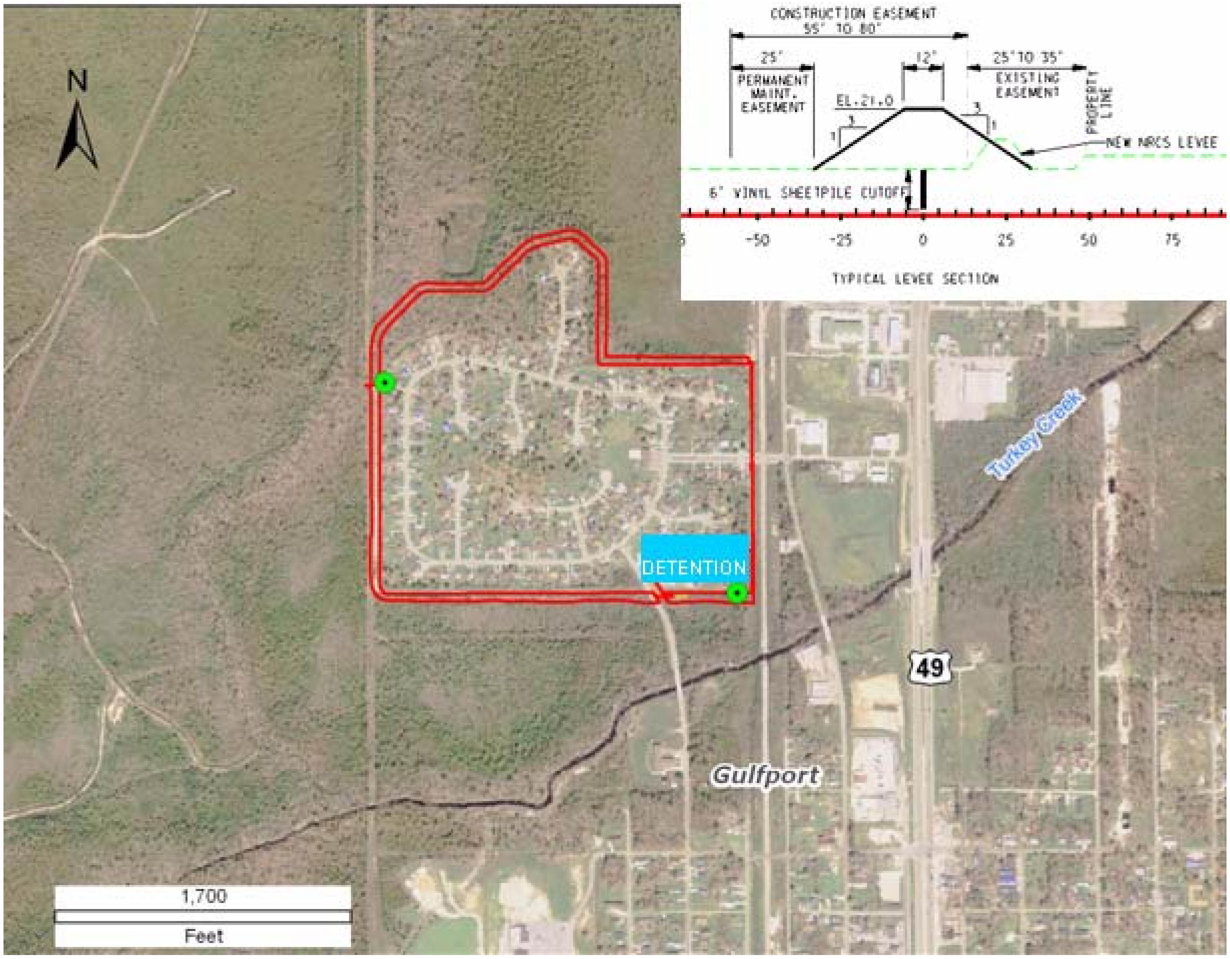
Additional information concerning this decision is included in the Engineering. During some hurricane events or high water in Turkey Creek, when the culvert gates are shut, and rainfall exceeds the average 10-year intensity over the basin, some ponding from rainfall will occur. A detention basin was added to help reduce the size of required pumps. The detention basin would have an area of approximately 3 acres but would not be excavated. The area is the lowest site in the subdivision and is presently used for recreation facilities, such as baseball and tennis. Detailed modeling of the area was not possible for this report; therefore, the exact extent of the detention basin is not precisely defined. Designing the pumps for the peak 10-year flow provides a significant pumping capacity. Further design during construction will refine the requirement for the appropriate detention area and pump sizes to provide protection from 100-year rainfall.

During non-hurricane periods of low water in the sound, when rainfall greater than the 25-year event occurs, the pump could also be used to augment the flow capacity of the levee culverts.

Additional details concerning the levee at Forest Heights are located in the Engineering Appendix.

5.7.5.2 Option B - Elevation 21 ft NAVD 88

This option consists of an earthen levee around northern, western, and southern sides of the Forrest Heights community. Because of the height of the levee, the eastern side will be constructed with a concrete “T”-wall structure. The “T” wall will take less space than an earthen levee and encroach less into property along the alignment. The alignment of the levee is generally the same as Option A, but is shown below in Figure 5.7.5.2-1. Closure gates across the two access roads to the subdivision will be required. The lengths of the levee culverts will be slightly longer than those used in Option A. Other features and methods of analysis are the same.



Source: Corps

Figure 5.7.5.2-1. 21-ft Elevation Levee Alignment with Culvert and Detention Basin/Pump Locations

5.7.5.2.1 Interior Drainage

Interior drainage analysis and culverts are the same as those for Option A, above, except that the culvert lengths through the levees would be longer.

5.7.6 Summary

The proposed action would consist of raising the existing levee to an elevation of 21 feet along the current alignment of the lower existing levee. Under this alternative, there is an expected loss of 3.62 acres of non-tidal wetland vegetation impacted by construction of the levee. Under the 17 feet raising alternative, there is an expected loss of 1.47 acres of non-tidal wetland vegetation impacted by construction of the levee. Although native vegetation under the levee footprint would be lost, the levee itself would be vegetated with non-native species for stabilization of the structure.

5.8 High Hazard Area Risk Reduction Plan (HARP)

Although the coastal areas of the nation are attractive to commercial, industrial, and residential developers, the consequences (as evidenced by Hurricane Katrina and past large hurricanes) associated with locating damageable property and unwary residents along the Gulf Coast can be extreme. Despite ongoing regulation through FEMA and other coastal zone management techniques, damageable property would still remain in high-hazard areas and people would still be in danger during hurricanes.

The non-structural team formulated a series of non-structural measures that would work either independently of structural measures or in concert with them to provide substantial reductions in flood damages due to surge inundation and waves associated with future hurricane or storm events. Additional information would need to be collected and analyzed in order to address uncertainties regarding the cost and effectiveness of non-structural measures; however the team identified primary measures that include permanent acquisitions, floodproofing by elevation and other means, relocations of public buildings, flood preparedness and evacuation planning, public education, changes in the current municipal and county National Flood Insurance Program and building codes, implementation of either a transfer of development rights or purchase of development rights program, potential changes in zoning ordinances, development impact fees, and redirection of new development. These measures have been combined into eight separate plans that could be implemented by either Federal, State, or local agencies, county and local governmental units, or some collaboration thereof. The following projects have been developed further for implementation under this MsCIP Comprehensive Plan and are discussed in the following paragraphs.

5.8.1 High Risk HARP

The HARP alternative would provide an effective means to induce and assist devastated and displaced property owners in relocating outside of high-hazard surge-plain throughout coastal Mississippi. Acquisition of those properties where the residential owners have not yet rebuilt and continue to be displaced presents a unique window of opportunity to assist landowners while minimizing cost to the U.S. Government. The HARP, a voluntary acquisition strategy, would provide a non-structural alternative for reducing property damage resulting from hurricanes, storm surge and flooding, and by extension, reducing threats to lives in those areas, in the most hazardous areas throughout coastal Mississippi.

5.8.2 Moss Point Municipal Relocation Component

This component consists of relocating the City of Moss Point's municipal buildings to a lower risk site with regards to flooding within the incorporated limits. This will aid the city in providing basic community services in a more timely fashion after future storm events, and further demonstrate the effectiveness of relocations projects as a hurricane and storm damage reduction measure along the Mississippi coast. These buildings include the city hall, police station, fire station and community services building and will be replaced to current standards and based upon the existing community needs. Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area.

5.8.3 Waveland Floodproofing

The City of Waveland is located in Hancock County, Mississippi and was directly in the path of Hurricane Katrina. Because of the critical habitat surrounding the city and its low lying areas, the only flood damage reduction measures available to a portion of Waveland are either acquisition or floodproofing the individual structures. In order to evaluate the different foundation and building types, 25 structures would be selected in the Waveland area that could be safely elevated out of the 1% chance storm event, and which could not be protected by any other structural measures evaluated as part of this study.

5.9 Deer Island Restoration

Deer Island is located within the boundaries of Harrison County, Mississippi near the mouth of the Biloxi Bay and offshore of the City of Biloxi. The island is considered a mainland remnant and is not part of the coastal barrier system of islands along the Mississippi coast. It is unique in that it is one of the only few islands along the Northern Gulf of Mexico, which are totally surrounded by an estuarine environment. The storms of 2005 and other past storm events have exacerbated an already eroding shoreline and degrading interior marshes and coastal maritime forest areas. The island contains a diverse habitat of beach/dunes, emergent tidal marshes, and coastal maritime forests. The island is protected under the Coastal Barrier Resources Act of 1990 which replaced and reauthorized the Coastal Barrier Resources Act of 1982.

Without intervention (i.e. the No Action Plan), Deer Island would continue its degradation and ultimately increased wave action would occur along the mainland at the City of Biloxi. The southern shorelines would continue to erode; thus, adversely impacting those dependant species, such as birds and crabs. Wave action from daily occurrences and storm events would eventually erode the beach and then begin eroding the emergent tidal marsh and coastal maritime forests. Furthermore, the Section 204 emergent tidal marsh restoration site would continue to degrade. Ultimately, this unique habitat would continue to change from a productive beach/dune, emergent tidal marsh, and coastal maritime forest habitat to stressed and non-functioning habitats.

Deer Island contains a diverse habitat of beach/dunes, emergent tidal marshes, and coastal maritime forests. Its proximity to the City of Biloxi provides a certain amount of protection to the city from waves generated by approaching hurricanes. Currently, the uninhabited island is part of the MDMR Coastal Preserves Program. Restoration efforts have been funded under the Section 528 of WRDA of 2000 for breaches at the west end and near Grand Bayou, and parts of the southern shoreline. Although a substantial restoration effort in its own right, there are significant opportunities to further restore the island and repair hurricane-caused damage to the islands' ecosystems. Deer Island restoration consists of a combination of the following alternatives to form the recommended plan:

- Continued restoration for the southern shoreline as part of the Section 528 of WRDA of 2000 project (assessed in the *Environmental Restoration in Coastal Mississippi: Deer Island Restoration Projects, Harrison County, Mississippi Environmental Assessment* dated September 2007);
- Repair/Replace the Section 204 containment dike (containment dike assessed in the *Section 204 Ecosystem Restoration Project In Connection with Construction, Operations, or Maintenance Dredging of a Federally Authorized Project, Environmental Restoration in Coastal Mississippi Marsh Re-Establishment Project, Harrison and Jackson Counties, Mississippi Environmental Assessment* dated July 2002);
- Add/Replace material in the Section 204 containment dike (placement of material assessed in the *Section 204 Ecosystem Restoration Project In Connection with Construction, Operations, or Maintenance Dredging of a Federally Authorized Project, Environmental Restoration in Coastal Mississippi Marsh Re-Establishment Project, Harrison and Jackson Counties, Mississippi Environmental Assessment* dated July 2002);
- Analyze new stone training dikes on the northern and southern ends of the islands as a result of Section 204 (requires minor additional study);
- Lengthen stone containment dikes on northern and southern ends as a result of Section 204 (various alignments assessed in the *Section 204 Ecosystem Restoration Project In Connection with Construction, Operations, or Maintenance Dredging of a Federally Authorized Project,*

Environmental Restoration in Coastal Mississippi Marsh Re-Establishment Project, Harrison and Jackson Counties, Mississippi Environmental Assessment dated July 2002 but requires some minor additional study); and

- Create additional marsh habitat area adjacent to the existing created marsh area (requires minor additional study).

Tables 5.9-1 and 5.9-2 provide an overview of benefits associated with implementation of the proposed project:

Table 5.9-1.
Functional Habitat Index Restoration of Grand Bayou, the West End Breach and Entire Southern Shoreline

							Proposed Alternative		**Future Without**	
Functions	**Shoreline Birds**	**Migratory Birds**	**Native Fish**	**Sport Fish**	**Macro Invertebrates & Primary Producers**	**Bivalves**	**Functional Habitat Index (FHI)**	**FHI 525 acres**	**Future w/o FHI**	**FHI 0 acres**
Restoration of Emergent Beach and Dune System	0.10	0.10	0.05	0.05	0.05	-	0.35	183.75	-	0.0
Restoration of Maritime Forest Habitat	0.10	0.10	-	-	0.05	-	0.25	131.25	-	0.0
Soft Substrate	0.05	0.05	0.10	0.10	0.05	0.05	0.40	210	-	0.0
Reestablishment of pre-disturbance shoreline	0.05	0.05	-	-	-	-	0.10	52.5	-	0.0
Reduced Wave Energy along Grand Bayou and the Southern Shoreline	0.10	0.10	0.05	0.05	0.05	0.05	0.40	210	-	0.0
Shoreline Stabilization	0.05	0.05	0.05	0.05	-	-	0.20	105	-	0.0
Roosting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Nesting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Native Vegetation Propagation	0.10	0.10	0.05	0.05	0.10	-	0.40	210	0.10	0.0
Shoreline Foraging Habitat	0.10	0.10	0.10	0.10	0.05	0.05	0.50	262.5	0.10	0.0
Erosion Control	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Sediment Stabilization	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Water Quality	-	-	0.05	0.05	0.05	0.05	0.20	105	-	0.0
Hard Substrate-ocean bottom or submerged rip-rap	-	-	0.05	0.05	-	0.10	0.20	105	-	0.0

Direct Benefit = 0.10 Indirect Benefit = 0.05

Table 5.9-2
Functional Habitat Index Re-establishment of marsh adjacent to Deer Island in conjunction either concrete rubble or riprap dike project

Functions	Shoreline Birds	Migratory Birds	Native Fish	Sport Fish	Macro Invertebrates & Primary Producers	Bivalves	FHI	FHI 15 acres	FHI 30-45 acres	FHI 90 acres
Hard Substrate – ocean bottom or submerged riprap	-	-	0.05	0.05	0.10	0.10	0.30	4.5	9-13.5	27
Soft Substrate	-	-	0.05	0.05	0.10	-	0.20	3	6-9	18
Containment Dike along the Northeast Portion of Deer Island	0.05	0.05	0.05	0.05	0.05	-	0.25	3.75	7.5-11.25	22.5
Breakwater along northeastern portion of Deer Island, (composed of riprap and within site sediment)	0.05	0.05	0.05	0.05	0.10	0.10	0.40	6	12-18	36
Reduced Wave Energy along Deer Island	0.05	0.05	0.05	0.05	0.05	0.05	0.30	4.5	9-13.5	27
Substrate Diversity	0.05	0.05	0.05	0.05	0.10	0.05	0.35	5.25	10.5-15.75	31.5
Nutrient Input	0.10	0.10	0.10	0.10	0.10	0.10	0.60	9	18-27	54
Nutrient Processing	0.05	0.05	0.05	0.05	0.05	0.05	0.30	4.5	9-13.5	27
Shoreline Stabilization	0.10	0.10	-	-	0.10	-	0.30	4.5	9-13.5	27
Roosting Habitat	0.10	0.10	-	-	-	-	0.20	3	6-9	18
Nesting Habitat	0.10	0.10	-	-	-	-	0.20	3	6-9	18
Native Vegetation Propagation	0.05	0.05	0.10	0.10	0.10	-	0.40	6	12-18	36
Shoreline Foraging Habitat	0.10	0.10	-	-	0.10	-	0.30	4.5	9-13.5	27
Erosion Control	0.05	0.05	-	-	0.05	-	0.15	2.25	4.5-6.75	13.5
Sediment Stabilization	0.05	0.05	0.05	0.05	0.05	0.05	0.30	4.5	9-13.5	27
Planted Vegetation Protection from Predation	-	-	0.10	0.10	0.10	-	0.30	4.5	9-13.5	27
400-foot long Breakwater Protection from Predation	-	-	0.10	0.10	0.10	0.10	0.40	6	12-18	36
Adjacent marsh re-establishment	0.05	0.05	-	-	0.05	-	0.15	2.25	4.5-6.75	13.5
Offset marsh re-establishment	-	-	-	-	-	-	0	0	0	0
Channel flow between Deer Island and marsh creation	-	-	-	-	-	-	0	0	0	0

Functions	Shoreline Birds	Migratory Birds	Native Fish	Sport Fish	Macro Invertebrates & Primary Producers	Bivalves	FHI	FHI 15 acres	FHI 30-45 acres	FHI 90 acres
Dissolved Oxygen Concentration in Channel	-	-	-	-	-	-	0	0	0	0
Erosion due to offset marsh	0.05	0.05	-	-	0.05	-	0.15	2.25	4.5-6.75	13.5

Direct Benefit = 0.10 Indirect Benefit = 0.05

5.10 Longer Term Comprehensive Effort For Environmental Restoration

5.10.1 Introduction

Development of the GIS based SDSS tool allowed the MsCIP environmental team, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout Coastal Mississippi (Lin 2007). A detailed explanation of this GIS based SDSS tool has been discussed earlier and also is provided in ERDC's technical report included as part of this Environmental Appendix. Using Phase II - Longer Term Comprehensive Effort allows the Corps, Mobile District to approach environmental restoration throughout Coastal Mississippi holistically while evaluating the natural ecosystems using an overall systems wide approach. Establishment of a Longer Term Comprehensive Effort for environmental restoration would allow us to further evaluate the results and prioritize potential projects for construction as funding becomes available. Establishment of this program would ensure our commitment to restoration of the damaged and destroyed ecosystems in Coastal Mississippi; thus, allowing us to meet the overall objectives found in the Emergency Supplemental legislation authorizing this Comprehensive Report.

Unique habitats exist in Coastal Mississippi that are critical to the continued health of a number of fish and wildlife species. Most of these proposed restoration habitats have been impacted and/or destroyed nationally, regionally, and locally by development and/or natural events. These sites require man-intervention in order to restore to their historical environmental setting. Failure to restore these sites could impact all Coastal Mississippi.

5.10.2 Program Development

Using the GIS based SDSS model, the MsCIP environmental team was able to effectively analyze needs in Coastal Mississippi. A subset of potential restoration sites was identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. Using this interagency team allowed us to both confirm the accuracy of the SDSS results and to collect additional on-site information pertinent to restoration efforts. The MsCIP environmental team recommends immediate construction of the above 2 initial environmental restoration projects – Turkey Creek, Harrison County and Bayou Cumbest, Jackson County. In addition, the team recommends potential environmental restoration projects specified in *Table 5.1.1.1-1* that would be studied further and restored under a MsCIP Environmental Restoration Longer Term Comprehensive Effort. The Environmental PDT anticipates studies, such as Project Information Reports, would range from $100,000 to $500,000 depending upon the specific project complexness. This cost has been incorporated into the cost estimates. The Environmental PDT anticipates in order to accomplish the MsCIP Longer Term Comprehensive Effort for environmental restoration of Coastal Mississippi an upward estimated limit of $5,478,967,000 would be required. The Environmental PDT will utilize the SDSS tool to prioritize environmental restoration site construction. The Longer Term Comprehensive Effort for environmental restoration of Coastal Mississippi is anticipated to require $5,478,967,000.

5.10.3 Partnerships

Development of partnerships with Federal resource agencies, state agencies, and NGOs is crucial to the success of this program. These partnerships would provide opportunities to access local knowledge of the existing environment. Specialists in specific restoration techniques would be available as well as opportunities to build on existing programs.

5.10.4 Planning and Evaluation Teams

Development of teams would be necessary to organize the program, establish prioritization of projects, development and evaluation of project plans, and future monitoring. Development of assessment models as well as monitoring plans would be accomplished by various interdisciplinary planning and evaluation teams.

5.10.5 Projects

The SDSS model identified many potential restoration sites. The list was verified in the field and through existing partnerships with Federal and state agencies, and based on personal knowledge of the overall comprehensive natural system, these sites were screened further. A list of 38 restoration sites has been proposed. Two of the sites have been chosen as initial projects and have been recommended for construction through this technical report. Additionally, two state projects have been targeted for restoration through this technical report. The remaining projects are found in *Section 4.1.5.5 State Initiatives.* Further prioritization and ranking of importance would ensure best use of future funding.

5.10.6 Sequencing Plan

Once the restoration sites have been prioritized, a sequencing plan would need to be developed identifying the events necessary to accomplish restoration. This would ensure prioritized sites received immediate attention and further details developed for the required analysis. This plan would serve as an outline of the longer term comprehensive structure.

5.10.7 Project Information Reports

As projects are being developed, specific details would be necessary to ensure compliance with regulations, policies, and acts. This information would be complied in a Project Information Report (PIR) and would consist of NEPA documents, project designs and details, economic analysis including incremental cost analysis for use in selection of a best buy plan, and other necessary documentation for approvals. The level of detail contained in a PIR should be commensurate with the complexity and cost of the project while including the information necessary to meet requirements.

5.10.8 Costs

A rough order of magnitude cost estimate has been prepared for each project based on existing conditions and restoration measures. This would serve as an upward limit of funding for this longer term comprehensive effort. Cost covers site acquisitions including associated relocation costs, removal and site demolition activities, and planting activities. A summary of costs is provided in the Cost Appendix .

5.10.9 Construction

Once the PIR received approvals, a contracting mechanism would need to be put forward. The District Project Delivery Team would need to incorporate Contracting Division in order to establish the most efficient type and beneficial use of contracting options and/or existing construction contracts. Oversight and quality assurance would ensure restoration was accomplished as envisioned.

5.10.10 Adaptive Management

Monitoring project performance, followed by adaptive changes to the project if necessary, is a responsible means of ensuring project performance. Monitoring determines if the projected outputs are being achieved and provides feed back for future projects. Post-implementation monitoring of ecosystem restoration components of the Comprehensive Plan is projected to be conducted for no more than five years at a cost of less than 1% of the total first cost of the project's ecosystem restoration features.

Adaptive management of proposed comprehensive ecosystem restoration programs and projects is an important aspect of project success. It is generally anticipated that some post-implementation project modifications will be required based on the feed back provided by project monitoring. Because the nature of the recommended plans made in this Comprehensive Report is not extremely risky in terms of projected outputs, it is anticipated that adaptive management would not be a major project expense. Adaptive management of ecosystem restoration features is expected to cost no more than 3% of ecosystem restoration feature first costs, and may in some cases be less than that figure. Monitoring and adaptive management costs have been accommodated in the cost estimates for each potential ecosystem restoration component as part of the contingency estimate.

Information gained from post-implementation monitoring and adaptive management of recommended ecosystem restoration plans will be used to provide "lessons learned" for the design and implementation of future ecosystem restoration projects. These "lessons learned" will provide important information, which will be used to improve the effectiveness and reduce the costs of future ecosystem restoration components of the Comprehensive Plan.

5.10.11 Program Status Reports

Program Status Reports would accomplish a system-wide reevaluation that would consider program and project-level considerations, and the level of success of overall met program goals and objectives. Project level formulation activities would address optimization of the overall program's contribution to the system-wide goals and objectives in general, and project goals and objectives would be more specific. The individual project monitoring reports may result in project modifications that impact or modify system output, however, these modifications would not address system-wide issues within the comprehensive plan. Status reports would provide updates on the overall success of environmental restoration throughout Coastal Mississippi.

CHAPTER 6. CONCLUSIONS

The recommended MsCIP Environmental Plan has been developed and discussed during numerous interagency PDT workshops and online meetings. Further, this approach has been coordinated with MDEQ and MDMR.

The recommended plan has been determined to be suited for long-term implementation as a key component of the MsCIP Comprehensive Plan. The environmental restoration projects could be implemented within the near-term with longer term approval allowing for development of the remaining environmental restoration sites based on the SDSS results and as land becomes available. Additionally, the recommended approach establishes a program that would allow for important data collection in the expanse marsh systems located on the western and eastern portions of the state. Upon collection and further analysis of this data, appropriate freshwater diversions could be developed that would mitigate saltwater intrusion. Continued coordination and future partnering with the NPS and other Federal, state, and local NGOs allows us to establish a program to restore lost and damaged ecosystems found on the barrier islands and SAVs throughout Mississippi Sound. The recommended environmental approach allows for establishment of programs under longer term comprehensive effort or through existing authorities to partner with local efforts with ongoing restoration program.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued flood and storm damages throughout the study area;
- Continued damage to fish and wildlife habitat;
- Continued coastal erosion and loss of valuable marsh systems;
- Continued saltwater intrusion and loss of valuable fisheries and oyster resources;
- Continued loss of barrier island exacerbating saltwater intrusion; and
- Change of Mississippi Sound estuarine conditions converting to marine conditions.

The recommended environmental plan addresses the following stated goals and objectives in the guidance of the Coastal Mississippi Comprehensive Hurricane Protection and Restoration effort:

a) future hurricane storm and flood damage reduction;

b) prevention of saltwater intrusion;

c) prevention of coastal erosion;

d) preservation of fish and wildlife; and

e) other water related resources (reduction of flooding).

Further, **the recommended plan complements and supports the objectives of the State and/or local plans and desires for this area**, including Governor Barbour's Seven Point Strategy for Coastal Recovery. This environmental approach allows us to establish a program for coastal wetland restoration. The 2 previously identified sites have been identified as initial environmental projects that will specifically depict problems and opportunities for restoration. By restoration of these sites, we will be able to ensure that homes will not be reconstructed within the 100-year floodplains, restore vital functions of historical wetlands, and remove people out of areas subject to future damaged by storm surge, erosion, flooding.

CHAPTER 7. REFERENCES

American Fisheries Society. 1985. Aquatic habitat inventory, glossary of stream habitat terms. W. T. Helm (ed.). Habitat Inventory Committee, Western Division, American Fisheries Society, Logan, Utah. 33 pp.

Association of Fish and Wildlife Agencies. Flyways. www.fishwildlife.org. Accessed May 30, 2008.

Bates, R. L. and J. A. Jackson. 1980. Glossary of geology, 2nd Edition. American Geological Institute.

Bates, R. L. and J. A. Jackson. 1984. Dictionary of geological terms. Anchor Press / Doubleday, New York.

Bedinger, M. S. 1979. Wetland function and values: The state of our understanding. American Water Resources Association., Minneapolis, MN.

Brandt, K., and K. C. Ewel. 1989. Ecology and management of cypress swamps: A review. Florida Cooperative Extension Service, Gainesville, FL.

Cake, E. 1983. Habitat Suitability Index Models: Gulf of Mexico American Oyster. USFWS FWS/OBS-82/10.57

Caputo, M. V., and S. M. Oivanki, 1992, Barrier islands, Mississippi Gulf Coast: Classification of geomorphic features: Journal of the Mississippi Academy of Sciences, v. 37, no. 1, p. 41.

Caputo, M. V., and S. M. Oivanki, 1992, Low-order morpho-sedimentary changes on barrier islands, Mississippi Gulf Coast: Journal of the Mississippi Academy of Sciences, v. 37, no. 1, p. 42

Chandler, Sabrina C. 2007. USFWS – Personal Communication.

Chatry, M., R. J. Dugas, and K. A. Easley. 1983. Optimum salinity regime for oyster production on Louisiana's state seed grounds. Contributions in Marine Science 26: 81-94.

Christmas, J.Y. and R.S. Waller. 1973. Estuarine Vertebrates. In: Christmas, J.Y. (ed.). Cooperative GMEI. Phase IV, Biology. Gulf Coast Research Lab. pp. 320-434.

Churchill, E.P., Jr., and S.I. Lewis. 1924. Food and feeding in freshwater mussels. Bull. U.S. Bur. Fish. 39: 439-471.

Clewell, A. F., and R. Lea. 1990. Creation and restoration of forested wetland vegetation in the southeastern United States. Pages 195-232 *in* J. A. Kusler and M. E. Kentula, eds. Wetland creation and restoration: The status of the science. Island Press, Washington D.C.

Corps, Mobile District. Project Modification for Improvement of the Environment and Aquatic Ecosystem Restoration. 1997. Corps, Mobile District.

Corps, Mobile District. Revised 1992. General Design Memorandum, Main Report Improvement of the Federal Deep-Draft, Pascagoula, Mississippi. Corps, Mobile District.

Corps, Mobile District. 1990. General Design Memorandum, Main Report Improvement of the Federal Deep-Draft, Pascagoula, Mississippi. Corps, Mobile District.

Corps, Mobile District. 1985. Feasibility Report – Improvement of the Federal Deep-Draft Navigation Channel, Volume I Main Report & Environmental Impact Statement. Corps, Mobile District.

Corps, Mobile District. 1984. Mississippi Sound and Adjacent Areas: Dredged Material Disposal Study, Feasibility Report. Corps, Mobile District.

Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Office of Biological Sciences, USFWS, U. S. Dept. of the Interior, Washington, DC. FWS/OBS-79/31.

Dame, R. F. 1996. Ecology of Marine Bivalves. An Ecosystem Approach. CRC Press. New York. Pp. 254.

Demoran, W.J. 1979. A survey and assessment of reef shell resources in Mississippi Sound. University of Mississippi, Mississippi Mineral Resources Institute. Report of Investigations No. 794, 19 p.

Dennison, W., R. Orth, K. Moore, J. Stevenson, V. Carter, S. Kollar, P. Bergstrom et al. 1993. Assessing water quality with submersed aquatic vegetation. Bioscience 43:86-95.

Dickson, R. E., and T. C. Broyer. 1972. Effects of aeration, water supply, and nitrogen source on growth and development of tupelo gum and bald cypress. Ecology 53:616-634.

Dortch, M.S., M. Zakikhani, M. Noel, and S.-C. Kim. 2007. Application of a Water Quality Model to Mississippi Sound to Evaluate Impacts of Freshwater Diversions. Technical Report TR-07-XX. ERDC, Vicksburg, MS

Durako, M. J. 1994. Seagrass die-off in Florida Bay (USA): changes in shoot demography and populations dynamics. Mar. Ecol. Prog. Ser. 110:59-66.

Durako, M.J. 1995. Indicators of seagrass ecological condition: An assessment based on spatial and temporal changes associated with the mass mortality of the tropical seagrass *Thalassia testudinum*. Pp. 261-266 In: K.R. Dyer and C. F. D'Elia (eds.) Changes in fluxes in estuaries: implications for science to management. Olsen and Olsen, Fredensborg, Denmark.

Durako, M. J. and K. M. Kuss. 1994. Effects of *Labyrinthula* infection on the photosynthetic capacity of *Thalassia testudinum*. Bull. Mar. Sci. 54(3):727-732.

Eleuterius, Lionel N. and S. B. Jones, Jr. 1969. A floristic and ecological study of pitcher plants bogs in southern Mississippi. Rhodora 71: 29-34.

Eleuterius, Lionel N. 1973. The marshes of Mississippi. In: Christmas, J.Y. (ed.). Cooperative GMEI. Phase IV, Biology. Gulf Coast Research Lab. pp. 147-190.

Eleuterius, Lionel N. 1976. The distribution of Juncus roemerianus in the salt marshes of North America. Chesapeake Science. 17(4): 289-292.

Eleuterius, Lionel N. 1976a. Vegetative morphology and anatomy of the salt marsh rush, *Juncus roemerianus*. Gulf Research Reports. 5(2): 1-10.

Eleuterius, C. 1976. Mississippi Sound, Temporal and Spatial Distribution of Nutrients. Mississippi-Alabama Sea Grant Consortium, MASGP-76-024. 20 pp.

Ewel, K. C., and H. T. Odum. 1984. Cypress swamps. University Presses of Florida, Gainesville, Florida.

Fonseca M.S. 1994. A guide to planting seagrasses in the Gulf of Mexico. Texas A&M Sea Grant publication TAMU-SG-94-601: 25p.

Gauthreaux, S.A., Jr. 1971. A radar and direct visual study of passerine spring migration in southern Louisiana. Auk 88:343-365.

George, S.G., Dickerson, D.D., and Reine, K.J. 1996. Rediscovery of the inflated heelsplitter mussel, *Potamilus inflatus,* from the Pearl River drainage. Journal of freshwater ecology. 11(2): 245-246.

Guillory, V. 2001a. Blue Crab Home Page. Available at: http://www.blue-crab.net.

Haig, S.M. 1992. Piping Plover. In *The Birds of North America, No. 2.,* ed. A. Poole, P. Stettenheim, and F. Gill. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, DC.

Haig, S.M., and J.H. Plissner. 1992. The 1991 International Piping Plover Census. USFWS, Twin Cities, MN.

Haig, S.M., and J.H. Plissner. 1993. Distribution and abundance of piping plovers: Results and implications of the 1991 International Census. *Condor* 95:145–156.

Hanna, W. H., 1981. Potential site disturbance from harvesting timber in wetlands. Pages 92-96 *in* Jackson, B. D. and J. L. Chambers eds., timber harvesting wetlands. Proceedings of the 30th annual forestry symposium. Louisiana State University Press, Baton Rouge, Louisiana.

Hartfield, Paul. 1988. Status Survey for the Alabama heelsplitter mussel. *Potamilus inflatus* (Lea 1831). A report to the USFWS. 27 pp. + Appendix.

Hauxwell, J., J. Cebrian, C. Furlong, and I. Valiela. 2001. Macroalgal canopies contribute to eelgrass (*Zostera marina*) decline in temperature estuarine ecosystems. Ecology 82:1007-1022.

Hutchins, P. S., and S. M. Oivanki. 1994. A comparison of shoreline measurement techniques: GPS survey, air photo interpretation, and total station survey: Journal of the Mississippi Academy of Sciences, v. 39, no. 1, p. 48

Jordan, R.A. 1998. Species Profile: Pine Snakes (*Pituophis melanoleucus ssp.*) on Military Installations in the Southeastern United States. Technical Report SERDP-98-5. ERDC, Vicksburg, MS.

Keast, A. and E.S. Morton, eds. 1980. Migrant Birds in the Neotropics: Ecology, Behavior, Distribution, and Conservation. Washinton. Smithsonian Institution Press.

Langbein, W. B. and K. T. Iseri. 1960. General introduction and hydrology definitions manual of hydrology. Part 1. General surface-water techniques. USGS. Water Supply Paper 1542-A. 29 pp.

Lenihan, H. S. 1999. Physical-biological coupling on oyster reefs: how habitat structure influences individual performance. Ecological Monographs 69, 251-275.

Levinton, J.S. 1982. Marine ecology. Prentice-Hall, Englewood Cliffs.

Lin, J.P and Kleiss, B.A. (2007). "A Wetland Restoration Decision Support System for the Mississippi Gulf Coast," ERDC/EL TR-07-12, U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Lincoln, R.J., G.A. Boxshall and P.F. Clark. 1982. A dictionary of ecology, evolution, and systematics. Cambridge University Press, Cambridge.

Little, R. J. and C. E. Jones. 1980. A dictionary of botany. Van Nostrand Reinhold Company, New York.

Mann, C. Baxter, Jr. 2000. A Phase I Cultural Resource Survey of the East Harrison County Connector, Harrison County, Mississippi. MDOT Project No. 94-1145-00-001-10/101212001000. Manuscript on file, Mississippi Department of Archives and History, Jackson, MS.

Mann, T., Mississippi Department of Wildlife, Fisheries and Parks. 2000, June 22. Letter to Susan Ivester Rees, Corps, Mobile District.

Mann, T., Mississippi Department of Wildlife, Fisheries and Parks. 2001, February 4. Letter to Claiborne Barnwell, MDOT. In Draft Environmental Impact Statement, East Harrison County Connector.

Mann, T. 2003. Personal communication. Zoologist, Mississippi Natural Heritage Program, MS Museum of Natural Science.

Mason, W.T., Jr., and J.P. Clugston. 1993. Foods of the Gulf sturgeon (*Acipenser oxyrinchus desotoi*) in the Suwannee River, Florida. *Transactions of the American Fisheries Society* 122:378–385.

McBride, R.A., Penland, S., Hiland, M., Williams, S.J., Westphal, K.A., Jaffe, B., and Sallenger, A.H., Jr., 1992. Louisiana barrier shoreline change analysis- 1853 to 1989: methodology, database, and results. In: Williams, S.J., Penland, S., and Sallenger, A.H., (editors), Atlas of Shoreline Changes in Louisiana from 1853 to 1989. USGS, Reston, Virginia.

MDEQ. 1994. Belle Fontaine, Jackson County, Mississippi: Human History, Geology, and Shoreline Erosion. MDEQ.

MDEQ. 2000. State of Mississippi Water Quality Assessment 2000 Section 305(b) Report. MDEQ, Office of Pollution Control, Surface Water Division, Water Quality Assessment Branch. Jackson, Mississippi.

MDMR. 2003. Press Release September 23, 2005.

MDMR. 1998. Marine Resources and History of Mississippi Gulf Coast, Volume One: History, Art, and Culture of the Mississippi Gulf Coast. MDMR.

MDMR. 1998. Marine Resources and History of Mississippi Gulf Coast, Volume Two: Mississippi's Coastal Environment. MDMR.

MDMR. 1998. Marine Resources and History of Mississippi Gulf Coast, Volume Three: Mississippi's Marine Industry, Economics, and Law. MDMR.

Meyer-Arendt, K. J. 1991. Human impacts on coastal and estuarine environments in Mississippi: GCS SEPM Foundation, Twelfth Annual Research Conference, Program and Abstracts, p. 141-148.

Meyer-Arendt, K. J. 1991. Human response to coastal erosion: Modification of the Mississippi shoreline: Journal of the Mississippi Academy of Sciences, v. 36, no. 1, p. 41.

Meyer-Arendt, K. J. 1992. Human-environment relationships along the Mississippi coast: Mississippi Journal for the Social Studies, v. 3, no. 1, p. 1-10.

Meyer-Arendt, K. J. 1992. Shoreline changes at Ocean Springs, Mississippi, 1900-1992: Journal of the Mississippi Academy of Sciences, v. 37, no. 1, p. 41.

Meyer-Arendt, K. J. 1993. Historical human impacts upon the Bellefontaine coast, Mississippi: Journal of the Mississippi Academy of Sciences, v. 38, no. 1, p. 40.

Meyer-Arendt, K. J. 1995. Beach and nearshore sediment budget of Harrison County, Mississippi: a historical analysis: MDEQ, Open-File Report 43, 65 p.

Meyer-Arendt, K. J., and S. M. Oivanki. 1994. Shorefront changes in Biloxi, Mississippi, 1853-1992: geologic and geographic foundations of "Casino Row": Journal of the Mississippi Academy of Sciences, v. 39, no. 1, p. 48.

Meyer, K. D., and M. W. Collopy. 1990. The status, distribution, and habitat requirements of the American swallow-tailed kite (*Elanoides forficatus*) in Florida. Final report, Florida Game and Freshwater Fish Commission, Nongame Wildlife Program; Tallahassee, Florida.

Moncrieff, C.A., T.A. Randall, and J.D. Caldwell. 1998. Mapping of Seagrass Resources in Mississippi Sound. The University of Southern Mississippi, Institute of Marine Sciences, Gulf Coast Research Laboratory. Ocean Springs, Mississippi.

Montague, C. L. and J. A. Ley. 1993. A possible effect of salinity fluctuation on abundance of benthic vegetation and associated fauna in northeastern Florida Bay. Estuaries 16:703-717.

Moody, J. S., and S. M. Oivanki. 1992. Historical shoreline analysis of the Mississippi coastline: Journal of the Mississippi Academy of Sciences, v. 37, no. 1, p. 42.

Moody, J. and K. Schmid, 2003, Hurricane season 2002- Hancock County beaches [abs]: Mississippi Academy of Sciences, v. 48, 1, p. 45.

Moore, F.R. and P. Kerlinger. 1987. Stopover and fat deposition by North American wood warblers (Parulinae) following spring migration over the Gulf of Mexico. Oecologia 74:47-54

National Coastal Condition Report II. 2005. www.epa.gov/owow/oceans/nccr/2005/nccr2-factsheet.html

Natureserve. 2000. An Online Encyclopedia of Life: Comprehensive Report: Red-Cockaded Woodpecker. <http://www.natureserve.org/>. Accessed October 9, 2000.

Natureserve. 2001a. *An Online Encyclopedia of Life: Comprehensive Report: Black Pine Snake.* <http://www.natureserve.org/>. Accessed November 13, 2001.

Natureserve. 2001b. *An Online Encyclopedia of Life: Comprehensive Report: Eastern Indigo Snake.* <http://www.natureserve.org/>. Accessed September 17, 2001.

Natureserve. 2001c. *An Online Encyclopedia of Life: Comprehensive Report: Gopher Tortoise* <http://www.natureserve.org/>. Accessed October 4, 2000.

Natureserve. 2001d. *An Online Encyclopedia of Life: Comprehensive Report: Louisiana Quillwort.* <http://www.natureserve.org/>. Accessed September 17, 2001.

Natureserve. 2001e. An Online Encyclopedia of Life: Comprehensive Report: Mississippi Sandhill Crane. <http://www.natureserve.org/>. Accessed September 17, 2001.

Natureserve. 2001f. *An Online Encyclopedia of Life: Comprehensive Report: Pearl Darter* <http://www.natureserve.org/>. Accessed November 13, 2001.

Natureserve Explorer. 2002. *An Online Encyclopedia of Life.* <http://www.natureserve.org/explorer>. Accessed January 2, 2002.

Nelson, J. 1989. Agriculture, wetlands, and endangered species: The Food Security Act of 1985. Endangered Species Technical Bulletin 14:1, 6-8.

Nicholls, J.L. 1989. Distribution and Other Ecological Aspects of Piping Plovers *(Charadrius melodus)* Wintering Along the Atlantic and Gulf Coasts. Master's thesis. Auburn University, Auburn, AL.

Nicholls, J.L., and G.A. Baldassarre. 1990. Habitat selection and interspecific associations of piping plovers along the Atlantic and Gulf Coasts of the United States. *Wilson Bulletin* 102:581–590.

NOAA. 1998. Marine Recreational Fisheries Statistics Survey. MRFSS Facts and Figures: Mississippi 1998. <http://www.st.nmfs.gov>.

NOAA. 1999. Essential Fish Habitat: New Marine Fish Habitat Conservation Mandate for Federal Agencies. NOAA, HCD, Southeast Regional Office.

NOAA. 2000. *Fisheries Statistics and Economics*. <http://www.st.nmfs.gov/>.

NOAA. 2001a. *Threatened and Endangered Species.* <http://nmfs.noaa.gov/prot-res/species/turtles>.

NOAA. 2001b. www.nmfs.noaa.gov/pr/acoustics/bibliography.htm

NOAA. 2002. Habitat Connections: Wetlands, Fisheries, & Economics in the Gulf of Mexico Coastal States. <http://www.nmfs.noaa.gov/habitat/habitatconservation/publications/habitatconnections/>.

Noss, R. F., E. T. LaRoe III, and J. M. Scott. 1995. Endangered ecosystems of the United States: A preliminary assessment of loss and degradation. U.S. Department of the Interior, National Biological Service, Washington, D.C.

Odum, E. P. *Ecology: A Bridge Between Science and Society.* Sunderland, MA: Sinauer Associates, 1996.

Odum, E.P. *Fundamentals of Ecology.* 3rd ed. Philadelphia: W.B. Saunders Company, 1971.

Odum, E. P. The Emergence of Ecology as a New Integrative Discipline. *Science* 195, no. 4284 (March 25, 1977).

Odum, E. P. 1992. "Great Ideas in Ecology for the 1990s." *BioScience* 42, no. 7 (July 1992): 542–545.

Olesen B & Sand-Jensen K. 1993. Seasonal acclimatization of eelgrass *Zostera marina* growth to light. Mar. Ecol. Prog. Ser. 94: 91-99

Olesen B & Sand-Jensen K. 1994. Patch dynamics of eelgrass *Zostera marina*. Mar. Ecol. Prog. Ser. 106: 147-156

Olesen B & Sand-Jensen K. 1994. Biomass-density patterns in the temperate seagrass *Zostera marina*. Mar. Ecol. Prog. Ser. 109: 283-291

Olesen B & Sand-Jensen K. 1994. Demography of shallow eelgrass (*Zostera marina*) populations - shoot dynamics and biomass development. J. Ecol. 82: 379-390

Otvos, E.G. 1979. Barrier island evolution and history of miagration, north-central Gulf Coast. In: S.P. Leatherman, ed., Barrier Islands: New York, Academic Press, p. 291-319.

Otvos, E. G., Jr. 1981. “Barrier Island Formation Through Nearshore Aggravation – Stratigraphic and Field Evidence,” Marine Geology, Vol 43, pp 195-243.

Otvos, E.G. 1985. Coastal Evolution, Louisiana to northwest Florida: Guidebook. American Association of Petroleum Geologists Meeting, New Orleans Geological Society. 91 p.

Otvos, E. G. 1988. Pliocene Age of Coastal Units, Northeastern Gulf of Mexico: 38th Annual meeting of the Gulf Coast Association of Geological Societies and American Association of Petroleum Geologists Regional Meeting, and the 35th Annual convention of the Gulf Coast Section of the Society of Economic Paleontologists and Mineralogists, p. 485-494.

Oivanki, S. M., and J. S. Moody. 1992. A profile analysis of the beach and nearshore, Hancock County, Mississippi: Journal of the Mississippi Academy of Sciences, v. 37, no. 1, p. 42.

Oivanki, S. M. 1993. Global Positioning System (GPS) in Mississippi, a status report: Journal of the Mississippi Academy of Sciences, v. 38, no. 1, p. 40.

Oivanki, S. M. 1993a. Geology and geomorphology of the Mississippi Gulf coast. In: Marine Resources and History of the Mississippi Gulf Coast, Vol. II. Mississippi Department of Marine Resources, Biloxi, Mississippi.

Oivanki, S. M., J. S. Moody, and B. Yassin. 1993b. Historical shoreline analysis of the Mississippi Gulf Coast: Coastal Zone ‘93, Eighth Symposium on Coastal and Ocean Management, Proceedings, p. 3347-3354.

Oivanki, S. M., B. Yassin, and J. S. Moody. 1993c. Man-made and natural changes on the Mississippi Gulf Coast: Gulf Coast Association of Geological Societies, Transactions, v. 43, p. 529.

Oivanki, S. M., M. B. E. Bograd, and E. G. Otvos. 1993d. Bibliography of Mississippi Gulf Coast geology and related topics: MDEQ, Office of Geology, Circular 5, 34 p.

Oivanki, S. M., and B. E. Yassin. 1994. Geomorphic analysis and inventory of the Mississippi mainland coast: Journal of the Mississippi Academy of Sciences, v. 39, no. 1, p. 50.

Oivanki, S. M., and J. N. Suhayda. 1994. Past and future erosion trends at Belle Fontaine, Jackson County, Mississippi: Journal of the Mississippi Academy of Sciences, v. 39, no. 1, p. 48.

Otvos, E. G. 1994. Mississippi’s Revised Neogene Stratigraphy in Northern Gulf Context: 44th Annual convention of the Gulf Coast Association of Geological Societies and American Association of Petroleum Geologists Regional Meeting, and the 41st Annual convention of the Gulf Coast Section of the Society of Economic Paleontologists and Mineralogists, p. 541-554.

Oivanki, S. M., and B. E. Yassin. 1994a. Geomorphic analysis and inventory of the Mississippi mainland coast: Journal of the Mississippi Academy of Sciences, v. 39, no. 1, p. 50.

Oivanki, S. M., and J. N. Suhayda. 1994b. Past and future erosion trends at Belle Fontaine, Jackson County, Mississippi: Journal of the Mississippi Academy of Sciences, v. 39, no. 1, p. 48.

Oivanki, S. M., ed. 1994c. Belle Fontaine, Jackson County, Mississippi: human history, geology, and shoreline erosion: Mississippi Office of Geology, Bulletin 130, 136 p.

Oivanki, S. M., Meyer-Arendt, K. J. and Yassin, B. 1995. Analysis of Land Use and Land Cover Changes on the Mississippi Coast: 1950s-1992. Gulf Coast Association of Geological Societies Transactions, Vol. XLV, pp. 467-473.

Oivanki, S. M. 1996. Round Island, Jackson County, Mississippi: sand resources and restoration alternatives: Journal of the Mississippi Academy of Sciences, v. 41, no. 1, p. 55.

Oivanki, S. M. 1997. Belle Fontaine shoreline evolution model field test results: Journal of the Mississippi Academy of Sciences, v. 42, no. 1, p. 41.

Penland, S., Williams, S.J., Davis, D.W., Sallenger, A.H., Jr., and Groat, C.G., 1992. Barrier island erosion and wetland loss in Louisiana, in Williams, S.J., Penland, S., and Sallenger, A.H., Jr., eds., Louisiana Barrier island erosion study--atlas of barrier shoreline changes in Louisiana from 1853 to 1989: USGS Miscellaneous Investigations Series I-2150_A, p.2-7.

Posadas, Benedict C. 2001. Comparative Economic Analysis of Using Constructed Wetlands in Recirculating Catfish Pond Production. Journal of Applied Aquaculture, 11(3): 1-20.

Puckett, C., and R. Franz. 2001. Gopher Tortoise: a Species in Decline. <http://edis.ifas.ufl.edu/Body_UW048>. Accessed August 27, 2001.

Putnam, J. A., G. M. Furnival, and J. S. McKnight. 1960. Management of southern hardwoods. Agriculture handbook 181. USDA, Forest Service. U.S. Government Printing Office, Washington, D.C.

Rheinhardt, R. D., Rheinhardt, M. C., and Brinson, M. M. 2002. A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. ERDC/EL TR-02-9, U.S. Army ERDC, Vicksburg, MS.

Rummel, R.G. 2002. Black bear activities in Mississippi. Black Bear Conservation Committee Newsletter 10(1). <http://bbcc.org/Newsletters/Volume10/Mississippi_Update.html>.

Sallenger, A.H., Jr, Penland, S., Williams, S.J., and Suter, J.R., 1987. Louisiana barrier island erosion study: Coastal Sediments ‘87, American Society of Civil Engineers, p. 1503-1516.

Sallenger, A.H., Jr., and Williams, S.J., 1989. U.S. Geological Survey studies of Louisiana barrier island erosion and wetlands loss: An interim report on status and results: USGS Open File Report 89-372, 17 p.

Schmid, K., B. Yassin, and J. Lana, 1999, Geo-Forensic applications for coastal resource inventory: Biloxi, Mississippi: Coastal Geo-Tools 99, Charleston, S.C.

Schmid, K., and B. Yassin, 1999, Ship Island, Mississippi: an example of rapid hurricane-driven evolution: The Impact of Hurricane Camille: A Storm Impact Symposium to Mark the 30th Anniversary, New Orleans, LA.

Schmid, K., 1999, Geomorphic expression of erosion on the Mississippi Gulf Coast islands caused by Hurricane Georges: Journal of the Mississippi Academy of Science, Abstract with Programs, v. 44, 1.

Schmid, K., 2000a, Biennial Report of Sand Beaches; Hancock County, 1999: MDEQ, Office of Geology, Open File Report 110, 17 p.

Schmid, K., 2000b, Biennial Report of Sand Beaches; Harrison County, 1999: MDEQ, Office of Geology Open File Report 111, 16 p.

Schmid, K., 2000c, Effects of culverts on Mississippi’s renourished beaches: Journal of the Mississippi Academy of Science, v. 45, 1, p. 42.

Schmid, K., 2000d, Historical evolution of Mississippi’s barrier islands: Mississippi Environment, v. January/February, 2000.

Schmid, K., 2001a, Cat Island evolution, morphology, and hurricane response - 1995 to 2000: MDEQ, Office of Geology, Open File Report 132, 32 p.

Schmid, K., 2001b, Determining artificial vs. natural Holocene sedimentation, Hancock County, Mississippi: Mississippi Academy of Sciences, v. 46, 1, p. 40.

Schmid, K., 2001c, Using vibracore and profile data to quantify volumes of renourished sediments, Holocene thickness, and sedimentation patterns: Hancock County, Mississippi: MDEQ, Office of Geology, Open File Report 131, 33 p.

Schmid, K., 2001d, West Ship Island evolution, morphology, and hurricane response - 1995 to 2000: MDEQ, Office of Geology, Open File Report 133, 36 p.

Schmid, K., 2001e, Long-term nearshore sedimentation on a renourished beach: Hancock County, Mississippi: Geological Society of America Abstracts with Programs, Boston, MA, v. 33, 6, p. 340.

Schmid, K., 2002a, Bar morphology and relationship to shoreline change on a renourished beach: Harrison County, Mississippi: Mississippi Academy of Sciences, v. 47, 1, p. 40.

Schmid, K., 2002b, Biennial Report of Sand Beaches; Harrison County, 2001: MDEQ, Office of Geology, Open File Report, 111B, 33 p.

Schmid, K., 2002c, Biennial Report of Sand Beaches: Hancock County, 2001: MDEQ, Office of Geology, Open File Report 110B, p.

Schmid, K., 2003a, East Ship Island evolution, morphology, and hurricane response - 1994 to 2000: MDEQ, Office of Geology, Open File Report 134, 49 p.

Schmid, K., 2003b, Nearshore bar morphology with relationship to shoreline change on a renourished beach: Harrison County, MS: Proc. Coastal Sediments ‘03, May 18-23, Clearwater Beach, FL, CD-ROM

Schmid, K., and E.O. Otvos, 2003, Deer Island, Coastal Mississippi - a geological and historical story: Mississippi Academy of Sciences, v. 48, 1, p. 45.

Schmid, K., and B. Yassin, 2004, Mississippi coastal data node and value added GIS data products [abs]: Mississippi Academy of Sciences, v. 49, 1, p. 59.

Shafer, D. J., T. H. Roberts, M. S. Peterson, and K. Schmid. (in press). A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing the Functions of Tidal Fringe Wetlands Along the Mississippi and Alabama Gulf Coast. U.S. Army ERDC, Vicksburg, Mississippi.

Shamban, A., 1982, Coastal processes and geomorphology, Barataria Pass, Louisiana: Baton Rouge, Louisiana State University unpublished M.S. theses, 121p.

Stern, E.M. 1976. The freshwater mussels (*Unionidae*) of the Lake Maurepas-Pontchartrain- Borgne drainage system, Louisiana and Mississippi. Ph.D. Dissertation, Louisiana State University, Baton Rouge, LA. 206 pp.

Stout, J. P. 1984. The ecology of irregularly flooded salt marshes of the northeastern Gulf of Mexico: a community profile. Biol. Rep. 85(7.1). Washington, DC: U.S. Department of the Interior, USFWS.

Stout. J.P. and M.G. LeLong. 1981. Wetland habitats of the Alabama coastal zone. Alabama Coastal Area Board, Mobile, Alabama. Technical Publication CAB81-01, MESC Contribution No. 040. 27 pp.

Thornbury, W. D. 1969. Principles of geomorphology. John Wiley & Sons, Inc., New York. Corps, 2000. Dredged Material Management Plan for Maintenance of Bayou Casotte Inner Harbor, Pascagoula, Mississippi. Corps, Mobile District.

Turner, R.E. 2000. Wetland management IS fisheries management for Gulf of Mexico shrimp. Environmental Law Institute. National Wetlands Newsletter 22(6).

Turner, E. R. 2006. Will lowering estuarine salinity increase Gulf of Mexico landings? Estuaries and Coasts 29: 345-352.

USFWS. 1987. Habitat Management Guidelines for the Bald Eagle in the Southeast Region. USFWS, Southeast Regional Office.

USFWS. 1989. Alabama Red-bellied turtle Recovery Plan*.* USFWS, Jackson, MS.

USFWS. 1990a. Gopher Tortoise Recovery Plan*.* USFWS, Jackson, MS.

USFWS. 1990b. Recovery Plan for the Interior Population of the Least Tern *(Sterna antillarum).* USFWS, Twin Cities, MN.

USFWS. 1993. Yellow-blotched Map Turtle *(Graptemys flavimaculata)* Recovery Plan*.* USFWS, Jackson, MS.

USFWS. 1994. Draft Revised Recovery Plan for Piping Plovers Breeding in the Great Lakes and Northern Great Plains. USFWS, Twin Cities, MN.

USFWS. 1995. Louisiana Black Bear Recovery Plan*.* USFWS, Jackson, MS.

USFWS. 1996a. Recovery Plan for Louisiana quillwort *(Isoetes louisianensis Thieret).* USFWS, Atlanta, GA.

USFWS. 1996b. Draft Environmental Assessment: Restoration of Avian Diversity on Monomoy National Wildlife Refuge. USFWS, Chatham, MA.

USFWS. 1998a, October 7. Letter to Mr. Henry Borovich, Post, Buckley, Schuh & Jernigan, Inc., from Larry E. Goldman, USFWS, Daphne, AL.

USFWS. 1998b. *Sea Turtles.* <http://www.fws.gov>.

USFWS. 2000. Endangered and Threatened Wildlife and Plants; Proposed Rule to List the Mississippi Gopher Frog Distinct Population Segment of Dusky Gopher Frog as Endangered. USFWS. Federal Register, 50 CFR Part 17., Vol. 65, No. 100.

USFWS. 2001a. *ESA Basics:* Over 25 years of protecting endangered species. <http://endangered.fws.gov/pubs/esa%20basics.pdf>. Accessed April 13, 2001.

USFWS. 2001b. Candidate and Listing Priority Assignment Form: *Pituophis melanoleucus lodingi.* <http://es.southeast.fws.gov/pdf/BPSform.PDF>. Accessed November 13, 2001.

USFWS. 2001c. Species Account: Brown Pelican, from Endangered and Threatened Species of the Southeastern United States (The Red Book). <http://endangered.fws.gov/i/b/sab2s.html>. Accessed November 13, 2001.

USFWS. 2001d. *Mississippi Sandhill Crane (Grus canadensis pulla)* Fact Sheet. <http://endangered.fws.gov/i/b/sab4n.html>. Accessed September 17, 2001.

USFWS. 2001e. Candidate and Listing Priority Assignment Form: *Percina aurora.* <http://es.southeast.fws.gov/pdf/PD.PDF>. Accessed November 14, 2001.

USFWS. 2001f. National Wetlands Inventory (NWI) GIS Data for Selected Quadrangles in Coastal Mississippi. USFWS, Arlington, VA.

USFWS. 2001g. Threatened and Endangered Species in the Southeast Region. <http://endangered.fws.gov>.

USFWS. 2001h. Endangered and Threatened Wildlife and Plants; Final Determination of Critical Habitat for Wintering Piping Plovers. USFWS. *Federal Register,* July 10, 2001, (Volume 66, Number 132), 50 CFR Part 17, RIN 1018-AG13, pp. 36037–36086.

USFWS. 2001i. Critical Habitat for Piping Plover *(Charadrius melodus)* <http://plover.fws.gov>. Accessed February 17, 2001.

USFWS. 2003a. Personal communication.

USFWS. 2003b. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for the Gulf Sturgeon. *Federal Register*, March 19, 2003, 50 CFR Part 17, Vol. 68. No. 53.

USFWS and NOAA. 2003. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Gulf Sturgeon; Final Rule. USFWS and NOAA.

USFWS. 1990. Endangered and threatened species recovery program: report to Congress. 406 pp.

USFWS. 1993. Inflated Heelsplitter (*Lampsilis powelli*) Recovery Plan. USFWS Region 4, Atlanta, GA. 15 pp.

Vittor, B.A. and Associates. 1982. Benthic macroinfauna community characterizations in Mississippi Sound and adjacent waters. Final Report Contract No. DACW01-80-C-0427. Corps, Mobile District. 287 pp. plus appendices.

Wake, D.B. 1991. Declining amphibian populations. Science 253(5022):860.

Wake, D.B., and H.J. Morowitz. 1991. Declining amphibian populations--a global phenomenon? Findings and recommendations. Alytes 9(1):33-42.

Williams, S.J., Penland, S., and Sallenger, A.H., Jr., eds., 1992, Louisiana Barrier island erosion study--atlas of barrier shoreline changes in Louisiana from 1853 to 1989: USGS Miscellaneous Investigations Series I-2150_A, 103 p.

Zieman, J.C., J.W. Fourqurean and T.A. Frankovich. 1999. Seagrass die-off in Florida Bay (U.S.A.): Long-term trends in abundance and growth of *Thalassia testudinum. Estuaries* 22:460-470.

CHAPTER 8. PREPARERS

Ms. Linda Brown, Landscape Architect, Planning and Environmental Division, Coastal Environment Team, Corps, Mobile District

Ms. Sabrina Chandler, Biologist, USFWS, Jackson Field Office, Jackson, Mississippi.

Mr. Jeff Clark, Biologist. MDMR, Biloxi, Mississippi.

Ms. Jennifer Jacobson, Biologist, Planning and Environmental Division, Coastal Environment Team, Corps, Mobile District

1.2 CULTURAL RESOURCES

CONTENTS

TABLES

ACRONYMS

CFR	Code of Federal Register
FEMA	Federal Emergency Management Agency
MDMR	Mississippi Department of Marine Resources
NCPTT	National Center for Preservation Training and Technology
NEPA	National Environmental Protection Act
NHPA	National Historic and Preservation Act
NPS	National Park Service
NRHP	National Register of Historic Places
SHPO	State Historic Preservation Officer

CHAPTER 1. CULTURAL RESOURCES

1.1 Introduction

Cultural resources are pre-contact and historic sites, structures, districts, artifacts, or any other physical evidence of human activity considered important to a culture, subculture, or community for traditional, religious, scientific, or any other reason. Cultural resources are discussed here in terms of archaeological sites, including both pre-contact and historical occupations, architectural resources, and locations of concern to Native American groups, including Traditional Cultural Properties (Table 1.1-1).

Procedures for the identification, evaluation, and treatment of cultural resources are contained in a series of Federal and state laws and regulations and agency guidelines. Archaeological, architectural, and Native American resources are protected by a variety of laws and their implementing regulations: the National Historic Preservation Act (NHPA) of 1966 as amended in 2000; the Archeological and Historic Preservation Act of 1974; the Archaeological Resources Protection Act of 1979; the American Indian Religious Freedom Act of 1978; and the Native American Graves Protection and Repatriation Act of 1990. The Advisory Council on Historic Preservation further guides treatment of archaeological and architectural resources through the regulations, Protection of Historic Properties [36 Code of Federal Regulation (CFR) 800]. Historic properties, as defined by the NHPA, represent the subset of cultural resources listed on, or are eligible for, inclusion on the National Register of Historic Places (NRHP).

Table 1.1-1.
Federally-Recognized American Indian Tribes Associated with Southern Mississippi

Muscogee (Creek) Nation of Oklahoma
Choctaw Nation of Oklahoma
Tunica-Biloxi Tribe of Louisiana
Coushatta Tribe of Louisiana
Mississippi Band of Choctaw Indians
Miccosukee Tribe of Indians of Florida
Seminole Nation of Oklahoma
Seminole Tribe of Florida
Poarch Band of Creek Indians
The Chickasaw Nation
Thlopthlocco Tribal Town
Alabama-Coushatta Tribe of Texas
Alabama-Quassarte Tribal Town of the Creek Nation

1.2 Evaluation Criteria

The NRHP's standards for evaluating the significance of properties were developed to recognize the accomplishments of all peoples who have made a significant contribution to our country's history and heritage. The criteria are designed to guide State and local governments, Federal agencies, and others in evaluating potential entries in the NRHP.

1.2.1 Criteria for Evaluation

The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

A. That are associated with events that have made a significant contribution to the broad patterns of our history; or

B. That are associated with the lives of persons significant in our past; or

C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. That have yielded or may be likely to yield, information important in prehistory or history.

1.2.2 Criteria Considerations

Ordinarily cemeteries, birthplaces, graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years shall not be considered eligible for the NRHP. However, such properties will qualify if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

A. A religious property deriving primary significance from architectural or artistic distinction or historical importance; or

B. A building or structure removed from its original location but which is primarily significant for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

C. A birthplace or grave of a historical figure of outstanding importance if there is no appropriate site or building directly associated with his or her productive life; or

D. A cemetery which derives its primary importance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

E. A reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

F. A property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own exceptional significance; or

G. A property achieving significance within the past 50 years if it is of exceptional importance.

CHAPTER 2. MISSISSIPPI COAST CULTURAL RESOURCES OVERVIEW

2.1 Introduction

The Mississippi Gulf Coast is rich in history and as a result is rich in the resources left behind by past cultures. Mississippi's coastline has been home to some of America's earliest peoples, as well as the crossroads for several of the earliest European colonial efforts in North America. The accessibility and numerous natural resources that lured people here initially have kept people here to the present day. All of the comings and goings of these people left behind artifacts in the form of houses or buildings or tools and sometimes just articles of daily life. These artifacts that remain from human life and industry form cultural resources that can be honored and studied and maintained as sentimental reminders of the people who have come before us. The following discussion will briefly define what cultural resources are, how they are categorized in the disciplines of archaeology and history, and summarize the types and condition of the cultural resources that were known to exist along the Mississippi Coast prior to hurricane Katrina in August 2005.

Cultural resources can include buildings or other structures; historic or prehistoric districts, such as the historic districts in Biloxi and Ocean Springs; archaeological sites, such as Indian mounds or other remains of prehistoric life; objects, such as statues or paintings; or sunken vessels, such as those that have been found in Mississippi Sound. Traditional cultural properties can also be considered significant cultural resources because of their traditional religious or cultural importance to an Indian tribe or other traditional community. The NHPA of 1966 established the Federal government's policy on historic preservation, as well as the national historic preservation program through which that policy is implemented. The NHPA also established the NRHP, which is a list of important resources that experts have identified as significant to our national heritage. The NRHP is the nation's official list of buildings, structures, objects, sites, and districts considered worthy of preservation because of their significance in American history, architecture, archaeology, engineering, and culture. The National Park Service (NPS) maintains the list.

Resources on the NRHP must meet criteria for evaluation established by the NHPA. Nominations to the NRHP are submitted from each state by its State Historic Preservation Officer (SHPO). Resources are nominated and considered to be significant when they have integrity of location, design, setting, materials, workmanship, feeling, and association, and:

They are associated with events that have made significant contributions to the broad patterns of our history; They are associated with the lives of persons who are significant in our past; They embody the distinctive characteristics of a type, period, or method of construction, represent the work of a master, or have high artistic value, or they represent a significant and distinguishable entity whose components might lack individual distinction; or They have yielded, or might be likely to yield, information important in prehistory or history. Properties, such as cemeteries or buildings that are less than 50 years old, are usually not considered eligible for the NRHP, but there are exceptions. For example, certain buildings associated with the Cold War are considered so important to our history that they are eligible for the NRHP.

The National Environmental Policy Act (NEPA), under which this document is being prepared, states that potential effects on cultural resources that are listed or might be eligible for listing on the NRHP must be considered when Federal agencies are considering an action.

This section discusses the prehistoric and historic context of the cultural resources along the Mississippi coast, and provides a table that lists some of the area's historic structures. The project area for cultural resources analysis is bounded to the north by a line 2 miles north of Interstate-10 and on the south by the Mississippi border. It is bounded on the west by the Louisiana border and on the east by the eastern edge of the Biloxi Bay watershed. The area includes most of Hancock, Harrison, and Jackson Counties; part of the Mississippi Sound; and Cat, Ship, Horn, Round, and Deer Islands. The known cultural resources in the project area are discussed in this section.

2.2 Baseline Conditions

Cultural resources in the project area considered eligible for listing on the NRHP include historic standing structures, submerged shipwrecks, historic cemeteries, and prehistoric and historic archaeological sites. There are currently 298 known archeological sites within the project area (Tables 2.2-1 – 2.2.3), including submerged shipwrecks and historic cemeteries. Of these, 63 sites are listed on or are eligible for the NRHP, 80 have been determined ineligible by the Mississippi SHPO, and the remainders are potentially eligible. Sites whose NRHP status is listed as "unknown" in the appendix might be eligible for listing. Because of the risk of looting, the specific locations of cultural resource sites are not shown in this document.

The potential for identifying additional buried archaeological sites and submerged historic shipwrecks in the project area is considered high, based on the number of known resources (Mississippi SHPO, 2001).

Many of the cultural resource sites contain shell middens, which are mounds of discarded shells that offer evidence of the early use of certain shellfish (mollusks). Some of the sites are prehistoric Indian mounds. The sites also include the remains of ancient villages, historic forts, campsites, and cemeteries. The sunken vessels that have been found include schooners, barges, and sailing vessels.

Table 2.2-1.
Archaeological Sites Within the Hancock County Project Area

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ha-502	Lakeshore Midden	Eligible	Shell midden	Unknown Prehistoric
22-Ha-505	Cowand Point	Eligible	Shell midden	Late Woodland
22-Ha-510	Joe's Bayou	Unknown	Village site, Shell midden	Middle Woodland
22-Ha-510	Joe's Bayou	Unknown	Village site, Shell midden	Historic Indian
22-Ha-512	Campbell Bayou I	Unknown	Processing camp area, no kitchen midden	Unknown Prehistoric
22-Ha-512	Campbell Bayou I	Unknown	Processing camp area, no kitchen midden	Unknown Prehistoric
22-Ha-519	Owen Heitzman	Eligible	Shell midden	Mississippian
22-Ha-520	Cedar Island	Eligible	Shell midden	Woodland
22-Ha-521	Carver Site	Eligible	Shell midden	Late Woodland
22-Ha-522	Bryan Bayou	Eligible	Shell midden	Unknown Prehistoric
22-Ha-524	Brush Bayou	Eligible	Shell midden	Unknown Prehistoric
22-Ha-525	Redfish Bayou	Eligible	Shell midden	Unknown Prehistoric
22-Ha-526	Ebeneezer Reese	Eligible	Shell midden	Unknown Prehistoric

Table 2.2-1.
Archaeological Sites Within the Hancock County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ha-527	East Side Jourdan River	Unknown	Shell midden	Mississippian
22-Ha-528	Ramsay Mound	Eligible	Flat top mound. Sank pit in top 15 years ago.	Unknown Prehistoric
22-Ha-536		Ineligible		Late Archaic
22-Ha-541	Gibbens	Ineligible	Chenier	Unknown Prehistoric
22-Ha-542	Lambert Site	Unknown	Light disturbance	Unknown Prehistoric
22-Ha-542	Lambert Site	Unknown	Light disturbance	Woodland: Middle, Late
22-Ha-543		Unknown		Unknown Prehistoric
22-Ha-543		Unknown		Unknown Prehistoric
22-Ha-544		Ineligible	Chenier	Historic
22-Ha-545		Ineligible	Estuary	Mississippian
22-Ha-546	Schaefer Mound	Eligible	Small conical mound	Middle Woodland
22-Ha-550	Diamondhead	Eligible	Large shell midden	Woodland
22-Ha-550	Diamondhead	Eligible	Large shell midden	Woodland: Middle, Late
22-Ha-551		Ineligible	Estuary	Unknown Prehistoric
22-Ha-553	#GCS-21	Unknown		Woodland: Middle, Late
22-Ha-554		Unknown	Must be real location of Ha-518	Historic
22-Ha-555	1	Unknown		Mississippian
22-Ha-556		Unknown		Unknown Prehistoric
22-Ha-557		Unknown	Ammunition magazine	Historic
22-Ha-558		Unknown	Subdivision; British soldiers reputedly buried there during War of 1812	Historic
22-Ha-581		Eligible	*Rangia* (clam) shell midden	Early Woodland, 2680 +/- 75 years before present
22-Ha-591		Eligible	Mounds: conical, pyramidal, indeterminate	Middle Woodland
22-Ha-593		Ineligible		Woodland
22-Ha-593		Ineligible		Woodland: Early
22-Ha-597		Ineligible		Late Archaic
22-Ha-605	B.W.Y.C.	Unknown	Material on shoreline on north peninsula of Yacht Club	Unknown Prehistoric
22-Ha-605	B.W.Y.C.	Unknown	Material on shoreline on north peninsula of Yacht Club	Woodland
22-Ha-605	B.W.Y.C.	Unknown	Material on shoreline on north peninsula of Yacht Club	Unknown Prehistoric
22-Ha-606	Cuevas Home	Unknown	Found during street construction, Diamondhead subdivision	Historic: 19th century
22-Ha-608	Rotten Bayou West	Unknown	Material eroded and scattered along bayou bank	Woodland
22-Ha-613		Unknown		Unknown Prehistoric
22-Ha-614	Dix	Unknown		Woodland

Table 2.2-1.
Archaeological Sites Within the Hancock County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ha-614	Dix	Unknown		Unknown Prehistoric
22-Ha-614	Dix	Unknown		Archaic: Late
22-Ha-626		Unknown		Woodland

Source: Mississippi SHPO, 2001.

1 **Table 2.2-2.**
2 **Archaeological Sites Within the Harrison County Project Area**

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-500	Deer Island Shell Midden	Eligible	Shell midden	Unknown Prehistoric
22-Hr-500	Deer Island Shell Midden	Eligible	Shell midden	Historic: Early
22-Hr-501	Bayou Park Mound	Eligible	Mound	Unknown Prehistoric
22-Hr-502	Oak Grove I, II, & II	Eligible	Shell midden, possible village or camp	Unknown Prehistoric
22-Hr-502	Oak Grove I, II, & II	Eligible	Shell midden, possible village or camp	Historic: 1719-1722
22-Hr-503		Eligible	Shell midden	Unknown Prehistoric
22-Hr-504	Irby	Eligible		Historic
22-Hr-504	Irby	Eligible		Unknown Prehistoric
22-Hr-505		Unknown	Eroded shell midden	Unknown Prehistoric
22-Hr-509	Back Bay Beach	Unknown	Shell ridge	Mississippian
22-Hr-510	Lopez Place	Unknown	Shell ridge	Unknown Prehistoric
22-Hr-511	Joe Moran	Unknown	Burials of Eastern European settlers	Historic
22-Hr-513	Old Fort Louis Site	Unknown	Old Fort Louis site	Unknown Prehistoric, Historic
22-Hr-515	Brodie II	Unknown		Unknown Prehistoric
22-Hr-516	Brodie I	Unknown		Unknown Prehistoric
22-Hr-517	O'Neal	Unknown		Unknown Prehistoric
22-Hr-518	Atcheson	Unknown		Unknown Prehistoric
22-Hr-520	Caron Site	Eligible	Dense *Rangia* (clam) midden, many sherds only	Mississippian
22-Hr-524	Fritz Site	Unknown		Mississippian
22-Hr-529	Jim Parker	Unknown		Woodland
22-Hr-531	Boiler Point, Cat Island	Unknown	Old village site	Unknown Prehistoric
22-Hr-532	Little Bay I, Cat Island	Unknown	Shell midden heap	Unknown Prehistoric
22-Hr-532	Little Bay I, Cat Island	Unknown	Shell midden heap	Woodland
22-Hr-533	Little Bay II, Cat Island	Unknown	Midden	Unknown Prehistoric

Table 2.2-2.
Archaeological Sites Within the Harrison County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-533	Little Bay II, Cat Island	Unknown	Midden	Unknown Prehistoric
22-Hr-536	Brodie III	Unknown		Woodland
22-Hr-537	Williams	Unknown		Mississippian
22-Hr-538	Acadian Bayou I	Unknown	Shell midden	Middle Woodland
22-Hr-539	Discovery Bay	Unknown	Shell midden	Middle Woodland
22-Hr-540	Leon	Unknown	Shell midden	Middle Woodland
22-Hr-541	De Metz Site	Eligible	Shell midden	Middle Woodland
22-Hr-542	Sutter Site	Eligible	Shell midden	Woodland
22-Hr-543	Cedar Bayou	Unknown	Low shell midden	Middle Woodland
22-Hr-544	DeLisle	Unknown		Late Woodland
22-Hr-545	Diane	Eligible	Small clam shell midden	Historic: French- 19th and 20th century
22-Hr-546	Dupont	Eligible	Shell midden; possible mounds	Middle Woodland
22-Hr-550	Carron	Unknown	Probably Marksville permanent station	Late Archaic
22-Hr-554	Jaycee Hill	Unknown	Apparently once a large station	Historic: mid-19th century
22-Hr-556	Alpha	Ineligible	Camp site	Unknown Prehistoric
22-Hr-565	Rail Spur #1	Ineligible		Unknown Prehistoric
22-Hr-566	Rail Spur #2	Ineligible		Unknown Prehistoric
22-Hr-567	Wreck of the Pelican	Unknown	Shipwreck: 1848 steamboat, the Pelican	Historic
22-Hr-571		Ineligible		Late Mississippi
22-Hr-572		Ineligible		Early Woodland
22-Hr-573		Unknown	Shell midden	Early Mississippi
22-Hr-574	DeLisle Cemetery	Unknown	Shell midden	Early Mississippi
22-Hr-575	Tom Parker	Unknown		Early Archaic
22-Hr-576		Unknown		Late Woodland
22-Hr-577		Unknown		Early Archaic
22-Hr-578		Unknown	Shell midden	Early Woodland
22-Hr-579		Unknown	Shell midden	Middle Mississippian
22-Hr-591	Godsey	Unknown	Issaquena phase shell midden	Unknown Prehistoric
22-Hr-630		Ineligible		Woodland and Mississippian
22-Hr-630		Ineligible		Historic
22-Hr-631	Morse	Ineligible		Historic
22-Hr-632	AAA	Unknown	Shell midden	Woodland
22-Hr-633	AAE	Unknown	Shell midden	Late Archaic
22-Hr-634	AAD	Unknown	Shell midden	Woodland
22-Hr-635	Richard Site	Eligible	Burial and shell midden	Mississippian
22-Hr-636	Raymond Bass	Accepted 1987	Coal black midden and burial site	Historic: 1910-1920

Table 2.2-2.
Archaeological Sites Within the Harrison County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-638	French Warehouse	Accepted 1991	French warehouse-keepers' house	Historic, Unknown Prehistoric
22-Hr-639	Quarantine Station	Unknown		Archaic: Middle, Late
22-Hr-640	Ship Island Lighthouse	Unknown		Paleo-Indian: Late
22-Hr-641	Ft. Massachusetts /GUIS 102	Unknown	Standing mid-19th century brick masonry fort	Historic
22-Hr-643		Ineligible	On small knoll adjacent to creek	Woodland
22-Hr-647	Biloxi Beach Loop	Unknown		Woodland: Middle, Late
22-Hr-647	Biloxi Beach Loop	Unknown		Unknown Prehistoric
22-Hr-647	Biloxi Beach Loop	Unknown		Woodland
22-Hr-659	Catchment No. 11	Ineligible		Woodland
22-Hr-673		Ineligible	1m2-pit dug; 12 sherds at ca. –10 cm	Woodland
22-Hr-683	DeLisle West Shell	Eligible	Shallow shell midden	Unknown Prehistoric
22-Hr-684	Rusty Skillet	Ineligible		Woodland
22-Hr-685	Pine Hill Northwest	Ineligible	Disturbed by bulldozing	Woodland
22-Hr-686	Pine Hill Central	Ineligible	Destroyed by bulldozing	Unknown Prehistoric
22-Hr-690		Ineligible		Unknown Prehistoric
22-Hr-691		Ineligible		Woodland
22-Hr-740		Ineligible		Early Archaic
22-Hr-741		Unknown	Reported by informant; not field checked	Paleo-Indian: Middle
22-Hr-831		Ineligible		Woodland
22-Hr-843	Wreck of the Josephine	Accepted 2000	Sunken iron-hull sidewheeler shipwreck	Historic
22-Hr-844		Unknown		
22-Hr-845	Holley Cemetery/ "Sunkist" Cemetery	Unknown	Mid to late 19th-century family cemetery	Historic
22-Hr-847		Ineligible		
22-Hr-848		Ineligible		
22-Hr-848		Ineligible		
22-Hr-857		Ineligible		Unknown Prehistoric
22-Hr-859	Schooner *Oleander*	Unknown	Sunken wreck of 1903 schooner *Oleander*	Historic
22-Hr-860	Cedar Lake 1	Unknown	Sunken vessel, possibly a schooner	Historic
22-Hr-861	Cedar Lake 2	Unknown	Sunken vessel, possibly a schooner	Historic
22-Hr-862	Cedar Lake 3	Unknown	Sunken wooden vessel, possibly a ferry barge	Historic
22-Hr-863	Schooner Graveyard	Unknown	10–15 sunken Biloxi-style schooner hulls	Historic
22-Hr 869		Ineligible		Unknown Prehistoric

Table 2.2-2.
Archaeological Sites Within the Harrison County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-870		Ineligible		Unknown Prehistoric
22-Hr-871		Ineligible		Unknown Prehistoric
22-Hr-872	Hamilton Cemetery	Ineligible		Unknown Prehistoric
22-Hr-878		Ineligible		Late Archaic
22-Hr-879		Ineligible		Unknown Prehistoric
22-Hr-880		Ineligible		Unknown Prehistoric
22-Hr-897	Florence Garden # 1	Ineligible		Archaic: Early, Middle

Source: Mississippi SHPO, 2001.

Table 2.2-3.
Archaeological Sites Within the Jackson County Project Area

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-500	Point Aux Chenes	Unknown	3 mounds	Unknown Prehistoric
22-Ja-502	Green; Buena Vista	Eligible	Shell midden	Unknown Prehistoric
22-Ja-503	Graveline Mound	Accepted 1987	Rectangular ramped platform mound	Mississippian
22-Ja-503	Graveline Mound	Accepted 1987	Rectangular ramped platform mound	Unknown Prehistoric
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Mississippian
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Woodland: Middle, Late
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Historic: 19th century
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Unknown Prehistoric
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Gulf Formational: Middle, Late
22-Ja-507	Gollotte, S.P. Starks~	Eligible	Low earth mound	Historic
22-Ja-530	Apple Street	Accepted 1985	Shell midden, no app. submidden feature	Woodland: Early, Late
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Unknown Prehistoric
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Historic: 18th century
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Mississippian
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Unknown Prehistoric
22-Ja-531	North Street; Elizabeth	Unknown		Late Mississippian
22-Ja-531	North Street; Elizabeth	Unknown		Historic: Early Colonial

Table 2.2-3.
Archaeological Sites Within the Jackson County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-531	North Street; Elizabeth	Unknown		Unknown Prehistoric
22-Ja-531	North Street; Elizabeth	Unknown		Archaic: Middle, Late
22-Ja-532	Soy Caphil Point	Unknown		Woodland: Middle, Late
22-Ja-534	Fort Maurepas I, Old Fort	Unknown		Gulf Formational: Late
22-Ja-535	Lemon	Unknown		Early Woodland
22-Ja-538	Fort Maurepas IB	Eligible		Woodland: Early, Middle, Late
22-Ja-539	Maurepas II	Eligible	Stake roots of old wall or bulkhead	Historic Indian
22-Ja-540	Ocean Springs I			Protohistoric~
22-Ja-542	Biloxi Bay Shipwreck	Eligible	Sunken wreck of 18th-century sailing vessel	Historic
22-Ja-553	Stone Site	Unknown		Late Mississippian
22-Ja-554	Old Shell Landing	Unknown	Shell midden	Historic
22-Ja-554	Old Shell Landing	Unknown	Shell midden	Late Archaic
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Mississippian
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Woodland: Middle, Late
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Middle Mississippian
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Late Woodland
22-Ja-556	Mrs. C.M. Shepard, B	Unknown	Thin shell midden	Late Mississippian
22-Ja-556	Mrs. C.M. Shepard, B	Unknown	Thin shell midden	Late Mississippian
22-Ja-557	Steve's Site	Unknown	Scattered shell midden	Middle Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Woodland: Middle, Late
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Late Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Middle Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Middle Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Historic: 20th century
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Woodland
22-Ja-559	Camp Lamotte	Unknown	Heavy extensive oyster shell midden	Mississippian
22-Ja-559	Camp Lamotte	Unknown	Heavy extensive oyster shell midden	Late Woodland
22-Ja-569	Dolphin	Unknown		Mississippian

Table 2.2-3.
Archaeological Sites Within the Jackson County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-572	Winchester	Unknown	Large Marksville campsite	Middle Woodland
22-Ja-573	Blue Heron Bayou	Unknown	Camping area	Mississippian
22-Ja-590	Debbie T.	Unknown		Middle Woodland
22-Ja-591	Shepherds' Tree Farm	Unknown		Early Mississippian
22-Ja-591	Shepherds' Tree Farm	Unknown		Early Woodland
22-Ja-594	Porteaux Bay I	Ineligible		Mississippian: Early, Middle, Late
22-Ja-595	Point Ascot, Porteaux Bay II	Ineligible		Late Woodland
22-Ja-596	Porteaux Bay III	Ineligible		Historic: 19th century
22-Ja-597	Caldwell Home, Porteaux Bay IV	Ineligible		Middle Mississippian
22-Ja-598	Dundolph Home, Porteaux Bay V	Ineligible		Woodland: Middle, Late
22-Ja-599	Albert Tiblier	Ineligible		Historic
22-Ja-600	Bijou Tiblier Home, Porteaux #7	Ineligible		Woodland: Early, Middle
22-Ja-601	Scarbrough Saw Mill, Porteaux 8	Ineligible		Middle Woodland
22-Ja-602	Graveline Mound #2	Unknown	Large sand mound	Historic
22-Ja-602	Graveline Mound #2	Unknown	Large sand mound	Early Woodland
22-Ja-602	Graveline Mound #2	Unknown	Large sand mound	Late Archaic
22-Ja-610	Buena Vista	Ineligible		Middle Woodland
22-Ja-610	Buena Vista	Ineligible		Middle Mississippian
22-Ja-611	Swetman	Ineligible		Woodland
22-Ja-611	Swetman	Ineligible		Early Woodland
22-Ja-612	Marlin	Ineligible		Middle Woodland
22-Ja-619	Janice–Gulf Hills	Ineligible		Middle Mississippian
22-Ja-622	Tiblier	Ineligible		Late Woodland
22-Ja-623	Gulf Hills	Ineligible		Late Woodland
22-Ja-624	Riviera I –II	Ineligible		Late Woodland
22-Ja-626	Magnolia Bank, Four H Club	Unknown		Unknown Prehistoric
22-Ja-628	Eagle Point	Unknown	Buried remnant of Chenier-Bayou site	Unknown Prehistoric
22-Ja-629	Aunt Jennys	Eligible	Aunt Jenny's, Marksville Period campsite possible Marksville	Historic Indian: Early to Middle 18th century
22-Ja-629	Aunt Jennys	Eligible	Aunt Jenny's, Marksville Period campsite	Mississippian: Late
22-Ja-630	Stark Bayou I	Eligible		Mississippian: Middle, Late
22-Ja-635	Morning Site	Ineligible	Shell midden	Middle Mississippian

Table 2.2-3.
Archaeological Sites Within the Jackson County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-636	Picnic Site	Ineligible	Oyster shell midden	Protohistoric
22-Ja-637	Hilltop Site	Ineligible		Late Woodland
22-Ja-638	Upper Crossing Site	Ineligible		Late Mississippian
22-Ja-638	Upper Crossing Site	Ineligible		Middle Woodland
22-Ja-639	Office Site	Ineligible		Unknown Prehistoric
22-Ja-640	Desk Site	Ineligible		Unknown Prehistoric
22-Ja-641	Second Chance Site	Ineligible		Unknown Prehistoric
22-Ja-642	West Bank Site	Unknown		Woodland
22-Ja-643	Old Ladder Site	Unknown	Oyster shell midden	Archaic: Early
22-Ja-646		Unknown	Shell midden	Historic: 19th century
22-Ja-647	Belle Fountain Beach	Unknown		Historic Indian
22-Ja-648	Y	Unknown		Woodland
22-Ja-649	Tapp Site	Unknown		Woodland: Middle, Late
22-Ja-650	Brown Street Site	Ineligible		Late Woodland
22-Ja-651	Stone II	Eligible	Intact midden present	Unknown Prehistoric
22-Ja-651	Stone II	Eligible	Intact midden present	Late Woodland
22-Ja-651	Stone II	Eligible	Intact midden present	Woodland
22-Ja-651	Stone II	Eligible	Intact midden present	Historic
22-Ja-652	Seymour Lane	Ineligible	Small Late Woodland site	Late Woodland
22-Ja-653	Britt, Cedar Point	Unknown		Woodland, Historic
22-Ja-653	Britt, Cedar Point	Unknown		Unknown Prehistoric
22-Ja-654	Tyler Site	Unknown		Unknown Prehistoric
22-Ja-655	Carluse Bayou	Unknown		Unknown Prehistoric
22-Ja-656	Bilbo	Ineligible		Historic
22-Ja-657		Unknown		Mississippian
22-Ja-658		Unknown		Woodland: Middle, Late
22-Ja-658		Unknown		Gulf Formational: Late
22-Ja-659		Unknown		Historic
22-Ja-660		Unknown		Woodland
22-Ja-660		Unknown		Archaic
22-Ja-662	Guis 107	Ineligible		Late Woodland
22-Ja-663	Guis 106	Unknown		Woodland
22-Ja-672	CCC Training Camp	Unknown		Woodland
22-Ja-673	Magnolia Park	Unknown		Woodland
22-Ja-673	Magnolia Park	Unknown		Mississippian
22-Ja-687	Cooking Ball Corner	Unknown		Mississippian
22-Ja-688	Mary Mahoney	Unknown	Rangia (clam) and oyster shell midden	Mississippian
22-Ja-689	Point Clear Pier	Unknown	Material apparently washing down from bluff	Woodland
22-Ja-689	Point Clear Pier	Unknown	Material apparently washing down from bluff	Unknown Prehistoric
22-Ja-695		Ineligible		Unknown Prehistoric
22-Ja-696		Ineligible		Late Archaic

Table 2.2-3.
Archaeological Sites Within the Jackson County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-697		Ineligible		Middle Archaic
22-Ja-697		Ineligible		Unknown Prehistoric
22-Ja-698		Ineligible	Material from eroded slope	Unknown Prehistoric
22-Ja-704		Ineligible		Early Archaic
22-Ja-704		Ineligible		Unknown Prehistoric
22-Ja-707		Unknown		Unknown Prehistoric
22-Ja-707		Unknown		Unknown Prehistoric
22-Ja-715		Ineligible		Woodland: Middle, Late
22-Ja-716		Ineligible		Mississippian
22-Ja-723	Oak North	Unknown	Intact deposits possible	Woodland
22-Ja-725		Unknown		Woodland
22-Ja-726		Unknown	Midden exposed in road cuts	Woodland
22-Ja-726		Unknown	Midden exposed in road cuts	Woodland
22-Ja-727		Unknown	Midden exposed in road cuts	Unknown Prehistoric
22-Ja-727		Unknown	Midden exposed in road cuts	Unknown Prehistoric
22-Ja-727		Unknown	Midden exposed in road cuts	Woodland
22-Ja-729	Graveline West Mounds	Eligible	2 mounds	Unknown Prehistoric
22-Ja-730	Graveline East Mounds	Eligible	3 mounds	Unknown Prehistoric
22-Ja-733		Ineligible		Unknown Prehistoric
22-Ja-734		Ineligible		Unknown Prehistoric

Source: Mississippi SHPO, 2001.

2.2.1 Prehistoric Period Resources

Archaeologists divide the prehistoric occupation in the Coastal Mississippi region into six major periods: the Paleo-Indian Period, which began around 10,000 B.C.; the Archaic Period; the Gulf Formational Period; the Woodland Period (Middle and Late); and the Mississippian Period, which ended in colonial times (the 1600s). Most of the resources from prehistoric times have been found along the rivers, especially the river mouths, and on the barrier islands. It is worth noting, though, that most of the known sites were identified in surveys conducted at only limited locations and, therefore, their locations cannot predict exactly where other (currently unknown) sites might exist.

2.2.1.1 Paleo-Indian Period (circa [ca.] 10,000 B.C. to ca. 8,000 B.C.)

The Paleo-Indian Period is the period with the earliest evidence of humans' existence in the North America. The climate during this time period was cooler than our present environment, and large animals, such as mammoth and sloth, flourished. Paleo-Indian peoples were nomadic hunters and gatherers who lived in small groups and ate wild plants and animals. This period is distinguished by a low population density with groups residing in seasonal or base camps. As a result, Paleo-Indian sites are rare and usually very small. The Paleo-Indian Period is also noted for diagnostic fluted projectile points and the exploitation of Pleistocene megafauna. Some artifacts from this period have been recovered from the Mississippi Sound area (Pearce and Mikell 2000).

2.2.1.2 Archaic Period (ca. 8,000 B.C. to ca. 1,000 B.C.)

The Archaic Period is divided into three time frames: Early, Middle, and Late. Between 10,000 B.C. and 5,000 B.C. substantial ecological changes occurred across the North American continent. These changes were accompanied by a shift from Paleo-Indian to Archaic traditions. During the Archaic Period the cold, dry climate that had existed during the Paleo-Indian Period changed to a warmer and wetter one. Deciduous (leafy) forests gradually replaced coniferous (evergreen) forests. Mammals present included white-tailed deer, turkey, bear, and smaller mammals and birds. Groups responded to these changes; archaeological evidence shows an increasing use of the new forested environment. Stone axes and fishing paraphernalia appear in larger numbers.

During the Late Archaic Period, the ecology and climate became much the same as they are today. The sea level rose, and the climate became wetter than that of the previous period. These changes led to greater floral and faunal diversity, accompanied by an increase in human population in response to this rich environment. Late Archaic sites are more common as a result of this population increase. Settlement patterns reconstructed by archaeologists indicate that sites were located on terraces, ridges, and bluffs above bodies of water that included rivers, creeks, and swamps. Sites are also found at the edges of floodplains and marshes, where edible plants and animals existed in large numbers and species were diverse. Some sites might now be submerged. Late Archaic sites can also include remains of larger “base camps” and shell middens. The Pearl River phase has been defined for the Late Archaic Period (Pearce and Mikell 2000).

2.2.1.3 Gulf Formational Period (ca. 2,000 B.C. to ca. 100 B.C.)

This period is identified by the first appearance of fired ceramics along the Gulf Coast, as well as the earliest mound construction. Based on size and artifacts recovered, some of the sites from this period represent a sedentary, possibly permanent, society. Two sites at the mouth of the Pearl River, the Claiborne and Cedarland Plantation sites, have large Early Gulf Formational components. Reflecting the Late Gulf Formational Period, the larger sites were replaced by more numerous but smaller sites representing smaller villages as well as food collection sites such as shellfish collection camps. Evidence of domesticated plants, including squash and bottle gourd, has been recovered at some sites dating to this period.

2.2.1.4 Woodland Period—Middle and Late (ca. 100 B.C. to A.D. 1100)

The Woodland Period is represented in the project area by artifacts from the Middle and Late Woodland Periods. This period was similar to the Late Archaic Period in climate and ecology. Dramatic changes in social structure occurred at this time from somewhat egalitarian, nomadic hunter-gatherers who relied primarily on wild plants and animals, to more settled villagers who practiced agriculture. The remains of large villages reflect the change from nomadic to settled life. Burial mounds as well as evidence of far-flung trade networks have been identified for this period. Archaeological remains include the appearance of stockaded villages, ceramic pottery, storage pits and hearths, and small triangular stone projectile points. According to Pearce and Mikell (2000, p. 16), the sites “are clustered along major rivers and usually located on high bluffs above the rivers or along tributary creeks above the floodplain and on coastal high ground near a freshwater source. Coastal sites are usually located in hardwood hammocks. Burial mounds are present on some larger village sites and isolated Woodland burial mounds are also known . . . .”

2.2.1.5 Mississippian Period (ca. A.D. 1200 to A.D. 1600)

To date no artifacts or sites from the Early Mississippian Period phase have been identified in the project area. The Middle Mississippian Period has been identified for the Gulf Coast area. Artifacts include shell-, sand-, or grog- (crushed ceramic fragments) tempered pottery. (Tempering material is added to the clay during the manufacturing process to strengthen it when fired.) The groups living in the project area at this time were mainly hunters and gatherers along the coast and river valleys; they probably practiced horticulture as well. Sites, including the remains of small villages and camps, have been found along the coast and along the major rivers. Most of the sites in the region are coastal shell middens. Although the Mississippian Period was generally one of stratified societies with chiefdoms, evidence of those types of such large-scale settlements has not been found in the Coastal Study Area.

2.2.2 Historic Period Resources

The historic time periods are the Protohistoric Period and Historic Period, which date from colonial times (1600s) forward.

2.2.2.1 Protohistoric Period

The first contact between the American Indians that lived in the project area and Europeans occurred during the Protohistoric Period. The first European to arrive was most likely Don Diego Miruelo, who probably sailed into the Mississippi Sound in 1516. Spanish explorers, likely including Cabeza de Vaca and Panfilo de Narvaez, were in the region during the 16th century as well.

2.2.2.2 Historic Period

In the 17th century French explorers began to arrive in the region, and soon French settlers also arrived, cleared the land, and built settlements. Pierre LeMoyne, Sieur d'Iberville, established the first French settlement at Old Biloxi (now Ocean Springs) in 1699. In 1723, Biloxi became the capital of the French colony. With the Treaty of Paris in 1763, the French abandoned the Mississippi coast to the English; in 1779 the English ceded the coast to Spain. With the Louisiana Purchase in 1812 the area became part of the United States; Mississippi became a state in 1817. The cultural influence of early French settlers continued over the years; a local form of French was spoken in the area until just before World War II (Moreton 1998).

Historic American Indians who lived in the region included the Pascagoula, Biloxi, Moctobi, Capinan, and Mobile peoples. The Apalachee also lived along the Pearl River during the 17th century (Pearce and Mikell, 2000). The American Indians were decimated by disease and warfare associated with European contact, and by the 19th century very few remained in the region.

Early French settlements grew up around the waterways and developed into thriving port towns. The economy was centered on agriculture, including dairy, cattle, and poultry; timber harvesting (primarily yellow pine) and charcoal and tar production; sheep and wool production; and commercial fishing and oyster and shrimp processing (Hancock Bank 1982; Sullivan 1985). Tremendous oyster reefs lay offshore. In the mid-19th century the region also began to develop as a resort area. For example, Pass Christian was a summer retreat for plantation owners and wealthy citizens of Louisiana, Mississippi, and Alabama (Ellis 1998). Many people came to escape yellow fever. In addition, seafood factories became a mainstay of the area. The area's seafood industry continues to be important, although it has experienced a significant decline in recent years (Ellis 1998).

During the Civil War the area's economy suffered because of the Federal blockade of southern ports. After the war, however, a number of transportation improvements were instituted. The New

Orleans, Mobile & Chattanooga Railroad was constructed through the project area. With the railroad, truck farming expanded and farmers prospered through the early part of the 20th century (Alexander 1998). A deep-water channel was completed at Gulfport in 1902 (Sullivan 1985). The seafood industry was also stimulated by post-Civil War innovations in preserving and exporting seafood. As a result, the shrimping industry boomed (Hancock Bank 1982). The region's lumbering business also thrived during this period. These traditional businesses continued into the present.

One nontraditional business that developed during the 1920s and continued through the Great Depression was bootlegging [Mississippi Department of Marine Resources (MDMR) 1998]. Bootlegging grew in part because those out of work during the Depression turned to this means of supporting their families. Liquor was made in stills in isolated areas along the coast and sold locally or to bootleggers that brought the alcohol up the coast and to the west (for example, deliveries to Chicago by truck and rail). In addition to the locally made alcohol, rumrunners smuggled alcohol, including rum, from Cuba and other Caribbean ports. According to M.H. Powell (1998), "by the mid-1920s more illegal alcohol entered the United States through the Gulf Coast than any other point of entry, including Canada." Along with the bootlegging, gambling casinos were built—in 1939, for example, the Broadwater Beach Hotel was constructed in Biloxi to accommodate gamblers. These hotels were the forerunners of today's coastal casinos and hotels.

2.2.3 Historic Architectural Resources

Numerous historic architectural resources are present in the project area. To date 62 standing structures, 14 historic districts, and one ship have been listed on the NRHP. Historic districts have been designated in Biloxi, Ocean Springs, and Bay St. Louis. Table 2.2.3-1 lists these resources and their locations.

Table 2.2.3-1.
NRHP Standing Structures and Historic Districts

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Hewes Building	2505 14th Street	10/7/1982		Gulfport	E298840 N3361212
Bailey House	1333 East Beach Blvd.	5/18/1984		Biloxi MRA	E321040 N3363630
E. Barq Pop Factory	224 Keller Ave.	5/18/1984		Biloxi MRA	E319590 N3363970
Biloxi's Tivoli Hotel	863 East Beach Dr.	5/18/1984		Biloxi MRA	E319980 N3363750
Bond House	925 West Howard Ave.	5/18/1984		Biloxi MRA	E318060 N3364110
Brunet-Fourchy House	138 Magnolia Street Mall	5/18/1984		Biloxi MRA	E318580 N3363805
Church of the Redeemer	Bellman Street	5/18/1984		Biloxi MRA	E319205 N3363725
Clemens House	120 West Water Street	5/18/1984		Biloxi MRA	E318650 N3363825
Gulf Coast Center for the Arts	138 Lameuse Street	5/18/1984		Biloxi MRA	E318740 N3363790

Table 2.2.3-1.
NRHP Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
House at 121 West Water Street	121 West Water Street	5/18/1984		Biloxi MRA	E318635 N3363800
Nativity BVM Cathedral	West Howard Ave. and Fayard Street	5/18/1984		Biloxi MRA	E318310 N3364120
Peoples Bank of Biloxi	318 Lameuse Street	5/18/1984		Biloxi MRA	E318740 N3363980
Redding House	126 West Jackson Street	5/18/1984		Biloxi MRA	E318640 N3363950
Saenger Theater	416 Reynoir Street	5/18/1984		Biloxi MRA	E318420 N3364100
Scherer House	206 West Water Street	5/18/1984		Biloxi MRA	E318600 N3363850
Seashore Campground School	Leggett Dr. and Chalmers Street	5/18/1984		Biloxi MRA	E315540 N3363990
Suter House	165 Suter Pl.	5/18/1984		Biloxi MRA	E317580 N3364140
Glenn Swetman House	2770 Wilkes Ave.	5/18/1984		Biloxi MRA	E314340 N3363990
U.S. Post Office and Customhouse	2421 13th Street	3/19/1984	Second Renaissance Revival	Gulfport	E298910 N3361080
Beauvoir	200 West Beach Blvd.	9/3/1971	Raised cottage	Biloxi	E310470 N3364271
Harbor Square Historic District	Roughly bounded by L & N Railroad, 23rd Ave., 13th Street, and 27th Ave.	8/13/1985	Georgian Revival	Gulfport	E299130 N3361430
West Beach Historic District	Roughly U.S. 90 between Rosell and Chalmers Ave.	5/18/1984		Biloxi MRA	E317300 N336428
Fort Massachusetts	South of Gulfport on Ship Island, in Gulf Islands National Seashore	6/21/1971		Gulfport	E309633
Louisville and Nashville Railroad Depot at Ocean Springs	1000 Washington Ave.	12/31/1979	Picturesque Eclecticism	Ocean Springs	E324520 N3366030
Biloxi Lighthouse	On U.S. 90 at Porter Ave.	10/3/1973		Biloxi	E317350 N3363815
U.S. Post Office, Court house, and Custom house	216 Lameuse Street	1/30/1978		Biloxi	E318850 N3364000

Table 2.2.3-1.
NRHP Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Magnolia Hotel	137 Magnolia Street	3/14/1973		Biloxi	E318499 N3363826
Biloxi Garden Center	410 East Bayview Ave.	1/18/1973		Biloxi	E319145 N3365756
Beach Boulevard Historic District	Roughly bounded by Beach Blvd., Necaise Ave., Seminary Dr., 2nd and 3rd Streets	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E276620 N3357610
Main Street Historic District	Main Street	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E274660 N3355910
Sycamore Street Historic District	Sycamore Street	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E274580 N3355140
W.J. Quarles House and Cottage	120 and 122 East Railroad Street	10/16/1980		Long Beach	E293260 N3359470
Scenic Drive Historic District	Scenic Drive	5/7/1979		Pass Christian	E280840 N3354730
Washington Street Historic District	Washington Street	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E274820 N3354920
Toledano-Philbrick-Tullis House	947 East Beach Blvd.	11/5/1976		Biloxi	E320310 N3363660
Milner House	720 East Beach Blvd.	7/31/1972		Gulfport	E301643 N3361965
Gillis House	513 East Beach Blvd.	7/7/1978	French Colonial	Biloxi	E319270 N3363730
Taylor House	808 North Beach Blvd.	11/21/1986		Bay St. Louis MRA	E275910 N3357170
Glen Oak-Kimbrough House	806 North Beach Blvd.	11/21/1986		Bay St. Louis MRA	E275920 N3357130
House at 407 East Howard Avenue	407 East Howard Ave.	7/17/1986			E319100 N3363980
Webb School/Gulf Coast Community Action Agency	300 Third Street	11/21/1986		Bay St. Louis MRA	E275100 N3354620
Taylor School	116 Leonard Street	1/15/1987		Bay St. Louis MRA	E275660 N3357520
Building at 242 St. and Charles Street	242 Street and Charles Street	11/25/1980		Bay St. Louis MRA	E274670 N3354500
Carter-Callaway House	916 State Street	4/20/1987		Ocean Springs MRA	E324810 N3365850

Table 2.2.3-1.
NRHP Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Cochran-Cassanova House	9000 Robinson Street	4/20/1987		Ocean Springs MRA	E324390
					N3365870
Hansen-Dickey House	108 Shearwater Dr.	4/20/1987	Prairie Renaissance	Ocean Springs MRA	E325090
					N3364460
House at 1112 Bowen Avenue	1112 Bowen Ave.	4/20/1987		Ocean Springs MRA	E324620
					N3365610
House at 1410 Bowen Avenue	1410 Bowen Ave.	4/20/1987		Ocean Springs MRA	E324910
					N3364570
Thomas Isaac Keys House	1017 DeSoto Ave.	4/20/1987		Ocean Springs MRA	E324630
					N3365790
O'Keefe-Clark Boarding House	2122 Government Street	4/20/1987		Ocean Springs MRA	E325815
					N3365660
Old Farmers and Merchants State Bank	998 Washington Ave.	4/20/1987		Ocean Springs MRA	E324440
					N3365870
Vancleave Cottage	1302 Government Street	4/20/1987		Ocean Springs MRA	E324770
					N3365700
Sullivan-Charnley Historic District	Shearwater Dr. and Holcomb Blvd.	4/20/1987		Ocean Springs MRA	E326095
					N3364000
Hermann House	523 East Beach Blvd.	5/18/1984		Biloxi MRA	E319340
					N3363740
Pleasant Reed House	928 Elmer Street	1/11/1979	Shotgun house	Biloxi	E318940
					N3364820
Saint John’s Episcopal Church	NW corner of Rayburn and Porter Ave.	4/20/1987		Ocean Springs MRA	E324090
					N3365600
Indian Springs Historic District	Iberville Street, Church Street, and Washington Ave. ,N	4/20/1987		Ocean Springs MRA	E324460
					N3366460
Lover’s Lane Historic District	Lover's Lane	6/9/1987		Ocean Springs MRA	E322980
					N3366520
Bertuccini House and Barbershop	619–619A Washington Ave.	6/9/1987		Ocean Springs MRA	E324420
					N3365590
Marble Springs Historic District	Along Iberville Ave., between Washington Ave., N, and Sunset Ave.	4/20/1987		Ocean Springs MRA	E324760
					N3366610
Miss La-Bama	243 Front Beach Dr.	4/20/1987		Ocean Springs MRA	E323580
					N3365123
Elmwood Manor	902 North Beach Blvd.	11/21/1986	French Colonial	Bay St. Louis MRA	E275850
					N3357610
Delcastle	4010 Government Street	4/20/1987	Spanish Eclectic	Ocean Springs MRA	E329270
					N3364070

Table 2.2.3-1.
NRHP Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Halstead Place	East Beach Dr.	4/20/1987		Ocean Springs MRA	E3 26970 N3363590
Shearwater Historic District	Shearwater Dr.	8/24/1989		Anderson, Walter, MPS	E325090 N3364880
Ocean Springs Community Center	Washington Ave.	8/24/1989		Anderson, Walter, MPS	E324460 N3365520
Old Ocean Springs Historic District	Roughly bounded by Porter and Dewey Aves., Front Beach Dr., Martin Ave., Cleveland Street, and Rayburn Ave.	10/7/1987		Ocean Springs MRA	E324310 N3365660
Margaret Emilie (schooner)	1036 Fred Haise Blvd.	5/30/1989			E317352 N3363876
G.B. Dantzler House	1238 East Beach Blvd.	12/1/1989		Biloxi	E300765 N3361650
Fisherman's Cottage	138 Lameuse St reet	3/9/1990	Creole Cottage	Biloxi MRA	E319190 N3365730
Old Ocean Springs High School	Magnolia and Government Street	8/2/1990	English Renaissance	Ocean Springs MRA	E325140 N3365660
Col. Alfred E. Lewis House	1901 Watersedge Dr.	10/16/1980		Walter Anderson MPS (AD) (Gautier)	E342400 N3359700
James Krebs House	4702 River Rd.	12/20/1991		Pascagoula MPS	E331575 N3361775
French Warehouse Site	Gulf Islands National Seashore	12/13/1991		Ocean Springs	E318150 N3346300
Brielmaier House	710 Beach Blvd.	9/28/1995		Biloxi MRA	E318830 N3363670
Onward Oaks	972 South Beach Blvd.	11/1/1996	Creole Cottage	Bay St. Louis MRA	E274730 N3353690
West Central Historic District	Roughly bounded by U.S. 90, Hopkins Blvd., Howard and Benachi Aves.	5/18/1984		Biloxi MRA	E317960 N3364195

Notes: MRA = multiple-resource area, a term used before 1984, when it was replaced with MPS.
MPS = multiple-property submission
Walter Anderson MPS = Walter Inglis Anderson (1903–1965) was a well-known artist who lived in the project area.
UTM = universal transverse mercator spatial coordinate system, serves to locate a place exactly in the world
Source: Mississippi SHPO, 2001.

2.2.4 Underwater Resources

Underwater resources in the project area include remains of prehistoric sites and of Protohistoric and Historic Period shipwrecks. To date, at least 13 shipwreck sites have been identified along the coast. One, the wreck of the *Josephine*, is listed on the NRHP. The others are potentially eligible for listing. Shipwrecks in the Coastal Study Area could date from the colonial period (French, Spanish, and English) through the Civil War and into the early 20th century (McGahey, personal communication, 2001).

2.3 Previous Cultural Resources Work Along the Mississippi Gulf Coast

Several cultural resource surveys have been conducted in the past for a variety of projects in the study area as summarized below.

In 1980, a survey was conducted for the route of proposed Interstate Highway 110, to be located between Chartres Street, Biloxi, and U.S. Highway 90, in Harrison County. No potentially significant cultural resources were identified in that project area (Hyatt 1980).

In 1987, a 75-mile-long cultural resources survey was conducted along a route paralleling the southern boundary of Interstate-10, across Hancock, Harrison, and Jackson counties (Lauro 1987 and Sims 1999). No cultural resources were identified.

In 1998, a reconnaissance-level survey of seven submerged vessels found in the Biloxi and Tchoutacabouffa Rivers, Harrison County, was conducted (Sims 1999).

In 1998, a cultural resources survey was conducted in the project area of the proposed Broadwater Beach Resort Complex, in Biloxi, Harrison County (Lauro 1998; U.S. Army Corps of Engineers, Mobile District 2000). The survey found no archaeological sites in the project area, in part because of extensive disturbance associated with previous construction, including offshore dredging projects. The survey identified four standing structures within the viewshed of the Broadwater Complex project area: Beauvoir, the last home of Jefferson Davis; the Southern Memorial Park Cemetery; the Broadwater Beach Hotel, constructed in 1937 and greatly altered since then; and the Old Brick House, a historic home constructed in about 1850. The Old Brick House and Beauvoir are listed on the NRHP; Beauvoir is also a National Historic Landmark.

The Mississippi Gulf Coast Research Project, conducted a survey in the eastern portion of Harrison County and in all of coastal Jackson County south of Interstate-10 (Mann 2000).

In 1999, a Phase I cultural resources survey was completed for five alternative routes proposed for the East Harrison County Connector (Mann 2000). The proposed routes are located in the current project area and run roughly north-south from Interstate-10 to Highway-90. Existing cultural resources site files were examined, and a total of about 22.4 miles were surveyed. The review of the site files identified a total of nine archaeological sites within 1 mile of the proposed alternative routes. Shovel tests were conducted at 30.48-meter intervals along the alternate routes; in areas with well-drained soils adjacent to flowing water, the spacing was 15 meters. Shovel tests were also conducted at 30-meter intervals along the centerline of each of the five routes. Structures identified in this survey include the Veterans Administration Center, which is eligible for the NRHP. The remaining structures were recommended as ineligible. Three new prehistoric archaeological sites (22-Hr-881, 22-Hr-882, and 22-Hr-883) and two isolated artifacts were identified within the alternative routes.

Finally, in 2000 a Phase IA survey (background/literature search, site file check) was conducted for a proposed fiber-optic line to run through Hancock, Harrison, and Jackson Counties (Pearce and Mikell, 2000). All together, 99 sites, including prehistoric shell middens, submerged vessels, and historic cemeteries were identified within a one-mile radius of that project area during the archival research. Six of the sites were adjacent to or within the cable corridor: 22-Ha-586, 22-Ha-527, 22-Hr-

524, 22-Ja-568, 22-Ja-586, and 22-Ja-608. Site 22-Ja-608 was ineligible. Information for 22-Ha-586 is missing. Site 22-Ha-586 is located near the Pearl River in a high-probability area. In a previous study, the remaining sites did not yield any cultural material. (The consultant completed a Phase I cultural resource excavation survey). Two high-probability areas were identified and one site was identified. One site was recommended as ineligible for NRHP listing. Site Ha-527 was identified as a Mississippian Period shell mound.

CHAPTER 3. EARLY DAMAGE ASSESSMENT EFFORTS FOLLOWING HURRICANE SEASON OF 2005

Cultural building and site assessments began almost immediately after the storm in early September 2005. The NPS and the Mississippi Department of Archives and History have led efforts in damage assessments to cultural properties and still have much work ahead of them. Additionally, the Mississippi Heritage Trust, and the National Trust for Historic Preservation have been working closely with assessment teams. The National Center for Preservation Training and Technology (NCPTT), a branch of the NPS, developed a series of checklists designed to be used by Federal Emergency Management Agency (FEMA) volunteers and professional preservationists to compile uniform data on the post-storm condition of cultural properties. The checklists, known as a "Rapid Building and Site Condition Assessment" and a "Detailed Building and Site Condition Assessment" incorporate information including the property description, potential safety hazards that would prevent someone from getting near the property, basic evaluations of structural integrity or the presence of exposed archaeological material, recommendations, and graphs for a field sketch of the site. These forms made it possible for a task force to gather enough data to create an initial status report for Hancock, Harrison, and Jackson counties as well as several other counties to the north. Although the report released by the NPS Task Force is general in nature, the extreme extent of the damage recorded is readily noticeable (Table 3-1). Most efforts have been directed at studying the architectural rather than archaeological resources, but the amount of damage suffered by both types is staggering. The efforts documented in Table 3-1 below are some of the earliest accounts, and much more work remains to be done to fully account for and assess the damage sustained to Mississippi's coastal cultural properties.

Table 3-1.
General Cultural Property Assessment for the Mississippi Coast
(NPS Status Report 30 December 2005)

State of Mississippi	Institution or Site	Status
Hancock County		
Bay St. Louis	Multiple properties	Two of 5 National Register Districts destroyed. 90% of remaining properties that were assessed are judged salvageable.
Harrison County		
Biloxi	Beauvoir, The Jefferson Davis Home and Presidential Library	Home: Aerial photo shows holes torn in slate roof and galleries (porches) missing. Library: Built to withstand category 5 hurricane; first floor washed out by storm surge. Portraits salvaged after event additional recovery of artifacts begun. Archeologist assisting in recovering artifacts from debris scattered over 60-acre site. Historic library pavilion, Hayes cottage, Soldier's Home Barracks replica, Confederate Soldier's Museum, Giftshop, and director's home destroyed. Replicas of destroyed buildings will be built after restoration of Beauvoir and Presidential Library. Sewage contamination to pond behind Beauvoir to be addressed (as of 11/14).
Biloxi	Breilmaier House (c. 1895)	Destroyed.
Biloxi	Biloxi Cemetery	Many trees uprooted; markers broken.
Biloxi	Dantzler House	Destroyed.
Biloxi	Maritime and Seafood	A portion of the building remains. Some artifacts salvaged,

State of Mississippi	Institution or Site	Status
	Industry Museum	including lens from Ship Island lighthouse.
Biloxi	Ohr-O'Keefe Museum of Art	Aerial photo shows two of five buildings in new museum complex left (JLH). Pleasant Reed House destroyed (DP).
Biloxi	Tullis-Toledano Manor	Aerial photo shows Tullis-Toledano House (c. 1860) destroyed (under the displaced casino barge); Tullis Slave Quarters (c. 1860) destroyed; Crawford House (c. 1850) destroyed
East Ship Island	Gulf Islands National Seashore, French Warehouse and associated cemetery, Quarantine Station	Quarantine Station site submerged, under 5-6 feet of water; French Warehouse site and cemetery sustained damage but are accessible.
Jackson County		
Ocean Springs	Gulf Coast Research Laboratory	Coast Guard permitted access to collections on 9/15/05. Collections flooded. NPS Incident Management Team assisting with recovery of herbarium and hazardous tree and debris removal.
Ocean Springs	Gulf Islands National Seashore	Storm surge flooded exhibits and museum collections at Davis Bayou Visitor Center. Museum Emergency Response Team is stabilizing collections. Collections moved to NPS Southeast Archeological Center and Timucuan Ecological and Historic Preserve. Frozen archives to be shipped and treated off-site. See report for Gulf Coast Research Laboratory where some park herbarium specimens are stored.
Ocean Springs	Shearwater	Most of the work of Anderson Family potters destroyed; 12 of 15 buildings destroyed
West Ship Island	Gulf Islands National Seashore Ft. Massachusetts; reconstructed Ship Island Lighthouse	Storm surge flooded and damaged fort: earthen berm damaged, large granite blocks dislodged and in moat, interior filled with mud and debris several inches thick. Most of the mud removed by 10/13/05. Extent of damage to Rodman cannon, artifacts and exhibits unknown. Conservator visit scheduled. Reconstructed lighthouse destroyed. Archeologist surveyed 9/19. Parts of the fort's rampart were breached by storm surge. Domed surface of casements exposed when earthen berm removed by storm. Sally Port damaged, extensive beach erosion. Cannon carriage flooded by salt water, but not cannon. Brick foundation and scattered brick, probably associated with archeological remains of lighthouse, identified.

3.1 Expected Impacts to Resources

Once a full assessment of damage is complete, we can expect to see the destructive impacts to cultural properties caused by Hurricane Katrina to fall under two categories: direct and indirect. Direct impacts should include damage directly caused during the storm by surging water, wind and flying debris, while indirect impacts would be those caused largely by the effects of standing water, exposure to the elements, or mold and decay due to water saturation. These impacts will differ slightly between archaeological and architectural resources.

3.1.1 Direct Impacts

Properties directly in the path of the storm surge appear to have suffered the most damage. Many of the historic homes and mansions that lined the shoreline highways were completely demolished. Some of the more well known historic properties along Beach Boulevard in Biloxi that are now completely gone include the Dantzler House, the Breilmaier House, the Pleasant Reed House, and the Tullis-Toledano mansion.

The Dantzler House lay in splinters behind the bronze statue of Pierre Le Moyne d'Iberville. The Breilmaier House, built in 1895, was reported missing and may have been sighted "floating down the street during the storm" (Williams 2005). The only remaining evidence of the Pleasant Reed House, a shotgun style house built in 1887, is the chimney (ibid). Also, the Tullis-Toledano mansion was found flattened under a casino barge (ibid). Reassuringly, the Beauvoir Mansion, Jefferson Davis's home designated as a National Historic Landmark is substantially damaged, but the main portion of the house remains standing. The first floor of the presidential library is destroyed as well as several cottages on the grounds, but many of the most valuable artifacts were removed prior to Katrina's landfall and survive. Additionally, because of Beauvoir's status as a National Historic Landmark, funds will be set aside eventually for its refurbishment.

Because archaeological sites are unique resources in that they cannot be recreated or restored, the damage many have sustained is irreparable. Several have had huge chunks gouged out by wayward fishing vessels beached on top of the remains of ancient American Indian coastal settlements. Wave scour, and giant uprooted trees have cleared 2,000 year old mounds immediately along the coastline of vegetation and exposed them for further erosion and looting. Shipwrecks that were once buried under several feet of sand have been exposed, and will suffer accelerated degradation as the wooden hull timbers dry into dust. The full extent of the loss is yet to be fully documented, and the work and funding required to salvage any remaining information is yet to be fully estimated.

3.1.2 Indirect Impacts

Archaeological resources where most of the resources lie below the ground or on the ground surface can be expected to suffer indirect effects from exposure of materials to sunlight that previously were kept in the dark moist earth. Materials, such as bone, oxidized metal, and organic remains, will dry and become brittle or may disintegrate. Also, the loss of vegetation that once held a site in place and obscured artifacts from view will cause site erosion. Other issues will occur as a result of materials becoming exposed that may be attractive to looters. Alternately, archaeological resources close to the shore that were on dry ground before the storm may now be permanently inundated, or in a surf zone and subject to constant erosion by sand and tidal action. Conversely, architectural resources where most of the resource lies above the ground can be expected to suffer from mold and mildew, and the rotting of wood and other materials. Additionally, sunlight and air can access portions of the structure and allow vegetation to take over and cause damage with the roots. Wood and cellulose eating insects will cause a loss of structural integrity and irreversible damage to furnishings that otherwise made it through the storm intact. As with archaeological resources, the threat of theft is present when objects of value are exposed to the outside or left unattended.

CHAPTER 4. MSCIP COMPREHENSIVE EFFORT RECOMMENDED PROJECTS

The Corps, Mobile District has a responsibility under the NHPA Section 106 process, to consider the effects that projects may have on Historic Properties [sites eligible for or listed on the NRHP]. The process involves a number of steps which include: establishing an undertaking has the potential to cause effects to historic properties; determination of the projects APE; determination of interested and consulting parties; creation of inventory strategy; completion of inventory (identification of cultural resources); identification of property NRHP eligibility; determination of effects; consultation; avoidance strategies (if needed); and resolution of adverse effects (if required).

As such, the Corps has been working to comply with Section 106 and its implementing regulations at 36 CFR 800 while moving forward with the mission of MsCIP. Initial plans as outlined for coastal recovery included a number of very large, complex projects. These projects, including ring levees, flood walls, and other massive civil works efforts, which would have involved huge impact areas and multiple state and Federal agencies. As such, the Corps recommended pursuing a Programmatic Agreement (PA) as an alternative method to Subpart B of 36CFR800, as outlined in 36CFR800.14(b). This would have allowed for greater involvement of interested parties and a streamlined process for compliance with NHPA. However, after consultation with the Mississippi SHPO and interested tribes (Mississippi Band of Choctaw Indians have responded to date), it was requested that the idea of approaching cultural compliance through the use of a PA be dropped for the MSCIP program.

There were two primary reasons for the dropping of the PA approach. First, the nature of the projects has become less complex from a cultural compliance standpoint than was first envisioned. Therefore, the PA approach was thought to be “overkill” for the most likely actions that would be approved for construction. Second, both the SHPO representatives and the tribal representatives expressed a reluctance to pursue a PA due to what they described as “PA overload”. It was the thought of the participants that pursuing compliance on a project by project basis would be the most efficient and economical way to handle the program.

A list of those projects for which funding and authorization have been requested is provided below. Details of the plans for each project are available in Chapter 5 of the Environmental Appendix and in the Main report, in Chapter 4. Should funding be approved, these projects would be the first to be constructed. The list does not include all of the possible plans, since all of the possible plans have not been identified.

MsCIP Projects currently proposed or awaiting funding:

- Turkey Creek Environmental Restoration
- Bayou Cumbest Environmental Restoration
- Franklin Creek Environmental Restoration
- Coast-wide Beach/Dune
- Forrest Heights Levee
- Moss Point Municipal Relocation
- Admiral Island Ecosystem Restoration
- Barrier Island Restoration

- Deer Island Ecosystem Restoration
- HARP Buyout
- Waveland Flood proofing
- Mississippi Sound Sub-aquatic Vegetation (SAV) Restoration
- Violet Louisiana Freshwater Diversion

To date, since none of the listed projects has been fully authorized and funded, only preliminary cultural resources compliance work has taken place. This includes meeting with the Mississippi SHPO staff, with FEMA, and with some of the cultural resource consultants that are currently working on non-Corps recovery efforts on the coast. Discussions included the determination of APE, inventory strategy, and preferred consultation method. The Mississippi SHPO staff expressed concern that many of the current efforts the Corps, Mobile District is working on appear similar to those being worked on by other agencies from a cultural resource aspect. In the aftermath of the storm, a number of Federal agencies and federally funded state agencies have been conducting and proposing to conduct activities that have the potential to effect historic properties. As such, these agencies have been conducting cultural resources compliance work and are planning more work, in order to deal with their legal responsibilities. Agencies involved include, but are not limited to, the Corps (New Orleans District, Mobile District and Vicksburg District), FEMA, Coast Guard, MMS, HUD and the Mississippi Development Authority. In many cases, there is the potential for a "duplication" of efforts, such as creation of cultural histories; historical documentation scanning; creation of GIS data layers for archaeological sites, standing structures, monuments, cemeteries, etc.; inventory for cultural resources; site testing and evaluation of cultural properties; and consultation. As a proactive measure to reduce duplication, the Mobile District will continue coordination with these agencies on the proposed projects.

In addition to meeting with the SHPO and other agencies, the Corps, Mobile District has conducted a literature review for all the project locations. This includes the gathering of base line historic and archaeological information of the proposed above project sites. This could best be described in the BLM terminology as a "Class I survey" or as it is also called, a background search. This includes viewing local histories, historic maps, and gray literature for the project areas. Also checked were the state archaeological and architectural data bases. State site location and survey maps were checked. Previous surveys conducted in the areas were reviewed. Informal discussions were held with local informants as well.

As projects become authorized and funded, the Corps will proceed with Section 106 consultation. Project APE's will be formally identified. Through consultation, inventory strategies will be outlined. The resulting inventory work will identify potential historic properties. Determination of NRHP eligibility and project effects to historic properties will be made. Consultation with the SHPO and other agencies and interested tribes will be continued. Should historic properties be identified within the project APE, avoidance will be the preferred mitigation measure. Should avoidance not be possible, resolution of potential adverse effects to historic properties will be handled as outlined in 36CFR800. This will include requiring the signing of a Memorandum of Agreement, notification of Adverse Effect to historic properties, offering the Advisory Council on Historic Preservation an opportunity to participate in the process, and possibly archaeological mitigation or historic documentation.

CHAPTER 5. REFERENCES

Christmas, J.Y. and R.S. Waller. 1973. Estuarine Vertebrates. In: Christmas, J.Y. (ed.). Cooperative GMEI. Phase IV, Biology. Gulf Coast Research Lab. pp. 320-434.

Demoran, W.J. 1979. A survey and assessment of reef shell resources in Mississippi Sound. University of Mississippi, Mississippi Mineral Resources Institute. Report of Investigations No. 794, 19 p.

Lincoln, R.J., G.A. Boxshall and P.F. Clark. 1982. A dictionary of ecology, evolution, and systematics. Cambridge University Press, Cambridge.

Mann, C. Baxter, Jr. 2000. A Phase I Cultural Resource Survey of the East Harrison County Connector, Harrison County, Mississippi. MDOT Project No. 94-1145-00-001-10/101212001000. Manuscript on file, Mississippi Department of Archives and History, Jackson, MS.

Mann, T., Mississippi Department of Wildlife, Fisheries and Parks. 2000, June 22. Letter to Susan Ivester Rees, Corps, Mobile District.

Mann, T., Mississippi Department of Wildlife, Fisheries and Parks. 2001, February 4. Letter to Claiborne Barnwell, MDOT. In Draft Environmental Impact Statement, East Harrison County Connector.

Mann, T. 2003. Personal communication. Zoologist, Mississippi Natural Heritage Program, MS Museum of Natural Science.

MDEQ. 1994. Belle Fontaine, Jackson County, Mississippi: Human History, Geology, and Shoreline Erosion. MDEQ.

MDMR. 2003. Press Release September 23, 2005.

MDMR. 1998. Marine Resources and History of Mississippi Gulf Coast, Volume One: History, Art, and Culture of the Mississippi Gulf Coast. MDMR.

MDMR. 1998. Marine Resources and History of Mississippi Gulf Coast, Volume Two: Mississippi's Coastal Environment. MDMR.

MDMR. 1998. Marine Resources and History of Mississippi Gulf Coast, Volume Three: Mississippi's Marine Industry, Economics, and Law. MDMR.

NPS. 2005. Heritage Emergency National Task Force: NPS Status Report. December 30, 2005.

http://www.fema.gov/ehp/ehp_katrina.shtm

http://www.heritagepreservation.org/PROGRAMS/KatrinaTF.HTM. Accessed 3/20/2006.

http://www.mississippiheritage.com/HurricanKatrina.html

http://www.ncptt.nps.gov/

http://www.nytimes.com/2005/09/08/garden/08history.html. Accessed 3/24/2006.

http://www.si.edu/hurricane/default.htm

Wake, D.B., and H.J. Morowitz. 1991. Declining amphibian populations--a global phenomenon? Findings and recommendations. Alytes 9(1):33-42.

Williams, Florence. 2005. In Mississippi, History is Now a Salvage Job, The New York Times. September 8, 2005.

Williams, S.J., Penland, S., and Sallenger, A.H., Jr., eds., 1992, Louisiana Barrier island erosion study--atlas of barrier shoreline changes in Louisiana from 1853 to 1989: USGS Miscellaneous Investigations Series I-2150_A, 103 p.

Woodrick, Jim. 2006. Personal Communication, *Mississippi Department of Archives and History*. March 21, 2006.

CHAPTER 6. PREPARERS

Joe Giliberti, Planning and Environmental Division, Inland Environmental Team, U.S. Army Corps of Engineers, Mobile District.

Ree Rodgers, Planning and Environmental Division, Inland Environment Team, U.S. Army Corps of Engineers, Mobile District

1.3 Impact Analysis of Alternatives Not Being Considered in Main Report

Contents

CHAPTER 1 ENVIRONMENTAL EFFECTS

The environmental effects section in the MsCIP Comprehensive Main Report/Integrated EIS provides an evaluation of proposed projects being recommended for construction or advanced engineering and design and their effects to the environment. The environmental effects analysis is conducted on two different levels which include an evaluation of the overall Comprehensive Plan and its components that require further study before being recommended for construction in the future. The second level of analysis considers effects of specific projects being recommended for construction and/or advanced engineering and design. Due to this complex nature, the projects screened out early during the plan formulation process are addressed for their environmental impacts in this attachment of the Environmental Appendix.

Hurricane Katrina caused tremendous damage to the overall natural environment within coastal Mississippi as documented in Chapter 2, Effected Environment Section in the MsCIP Comprehensive Main Report/Integrated EIS. The extent of the damage to many resources is still unknown and additional research, studies, surveys, etc, are ongoing. In some instances, the extent of damaged resources may never be known.

Many measures that may be recommended in the Comprehensive Plan have been categorized in either structural, non-structural, or environmental restoration types of projects; however, further study is needed in order to assess benefits, effects, and to obtain specific details needed for development of plans. Numerous projects have been developed to a feasibility-type level and are being recommended for construction although some will need advanced engineering and design prior to development of plans and specifications. Still other measures will establish a framework within which future projects have been identified under continuing authorities that would require specific Project Information Reports after development of plans and specifications.

As a result of the diversity of potential projects that have come forth from this Comprehensive Report, further environmental considerations and analyses will be required prior to projects being implemented. There could be supplemental EISs to evaluate projects that would result in significant impacts and further EAs for projects that are less complex in nature with less impacts associated with them. During development of NEPA documentation, detailed discussions of potential impacts and subsequent mitigation will be incorporated as measures and alternatives are being developed.

Provisions for “tiering” of EISs are found in 40 CFR 1502.20 whenever a broad EIS has been prepared (such as a program or policy statement) and a subsequent statement or EA would then be prepared on an action included within the entire program or policy. This EIS will serve as the basis from which further required environmental analyses and documentation could be tiered from. Additionally, the projects being recommended for construction or for advanced engineering and design will be evaluated for environmental impacts as part of this integrated EIS. These impacts are discussed in the following sections and paragraphs.

Due to the complexity of this comprehensive project for coastal Mississippi, the measures and alternatives that were screened out during the plan formulation effort have been included in the following information. This was done in order to allow the reader an easier path forward in this complex recovery approach of coastal Mississippi.

CHAPTER 2 BARRIER ISLAND ANALYSIS

2.1 Soils

Soils would persist as they are today.

2.2 Sediments

Re-suspension of sediments would likely occur within specific project sites. Silt fences and other BMPs would be used to minimize the adverse impacts to the environment during construction activities to the maximum extent practicable. Containment structures, silt curtains, and other BMPs would be used to contain sediment deposition at restoration sites. It is expected that solids that remain suspended in the water column would migrate by littoral drift. Any impacts that might occur would typically be isolated to each construction site, minor and of short duration.

2.3 Geology

There should be no effects to geology. Potential projects have been or would be designed to avoid impacts to current geological formations.

2.4 Climate

There should be no effects to the existing climate.

2.5 Air Quality

Currently all areas within coastal Mississippi are in attainment with the NAAQS. Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. The standards would not be violated by the implementation of the proposed project.

2.6 Noise

Noise from the construction type equipment is expected to increase during the proposed operations in the project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise during implementation of these measures.

2.7 Vegetation

2.7.1 Line of Defense 1 – Barrier Island Restoration

Several measures have been developed which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Restoration of the barrier islands could provide a benefit to vegetation.

2.7.1.1 Option A: Restore Island Footprint

It is anticipated there would be no adverse impacts to vegetation from implementation of this measure because this would consist of open-water habitat to expand the actual islands' footprint. In fact, restoring the islands to historical footprints would provide a benefit to the existing vegetation already on the island due to it providing additional habitat for colonization.

2.7.1.2 Option B: Replenish Sand in Littoral Zone, Inland Source

It is anticipated there would be no impacts to vegetation from implementation of this measure. Addition of land to the barrier islands would provide a positive benefit to the vegetation through natural colonization.

2.7.1.3 Option C: Replenish Sand in Littoral Zone, Offshore Source

It is anticipated there would be no impacts to vegetation from implementation of this measure. Addition of land to the barrier islands would provide a positive benefit to the vegetation through natural colonization.

2.7.1.4 Option D: Environmental Restoration With 2-Foot Dune

This measure would involve environmental restoration of the barrier islands consisting of shaping existing sand into dunes on the beaches. Dune features would be planted with native vegetation. Planting of marshes, maritime forests, and sea grasses in the near-shore areas of the islands would serve to restore or enhance lost habitat. Implementation of this measure would provide significant benefits to the existing damaged vegetation as a result of the hurricanes of 2005. Further studies during project development would determine the specific benefits gained by implementation of this measure.

2.7.1.5 Option E: Environmental Restoration With 6-Foot Dune

This measure would involve environmental restoration of the barrier islands consisting of shaping existing sand into dunes on the beaches. Dune features would be planted with native vegetation. Planting of marshes, maritime forests, and sea grasses in the near-shore areas of the islands would serve to restore or enhance lost habitat. Implementation of this measure would provide significant benefits to the existing damaged vegetation as a result of the hurricanes of 2005. Further studies during project development would determine the specific benefits gained by implementation of this measure.

2.7.1.6 Option F: Environmental Restoration of Sea Grass Beds

This measure would involve enhancement and restoration of historical sea grasses located in Mississippi Sound. Implementation of this measure would provide significant benefits to the existing vegetation that has suffered as a result of the hurricanes of 2005. Further studies during project development would determine the specific benefits gained by implementation of this measure.

2.7.1.7 Option G: Restoration of Ship Island Breach

Implementation of this measure would provide a benefit to vegetation as a result of reforestation of the beach and dune system that once existed.

2.8 Fish and Wildlife

2.8.1 Line of Defense 1 – Barrier Island Restoration

Several measures have been developed which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Restoration of the barrier islands would require a large amount of high quality sand being placed on or around the sandy string of barrier islands.

2.8.1.1 Option A: Restore Island Footprint

Generally, restoration of the island footprint would entail filling of existing water bottoms to pre-Hurricane Camille conditions. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional overwintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Filling of water bottoms would remove essential fish habitat, foraging areas for sea turtles and other marine species.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact essential fish habitat consisting of epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NGVD 88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

2.8.1.2 Option B: Replenish Sand in Littoral Zone, Inland Source

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. A large amount of water bottoms would be filled as a result. These areas currently provide essential fish habitat for managed fisheries and designated critical habitat for the threatened Gulf sturgeon. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. Filling of water bottoms would remove some foraging areas for sea turtles and other marine species including the Gulf sturgeon. Sand would be obtained from inland sources comprised of previous dredged river sands. Past analyses and comparisons have found the river sands are typically a finer grain size than native beach sands, which are mostly medium sized. Additionally, these comparisons determined the beach sands are slightly more rounded than river sands. One factor that would warrant further analysis is the differences in color of the two sands with the river sands having a slight brown tint compared to the beach sand samples which are described as white or light grey. It is believed the river sands would undergo bleaching from the ultraviolet radiation from the sun if the color variation was caused by a mineral staining. Adding this sand into the littoral system would diminish the differences between the natural sands by spreading it over large areas with shallow thicknesses. Although, the littoral zone placement via shallow thickness would increase the impact area to essential fish habitat, sea turtles' foraging, and Gulf sturgeon and/or its designated critical habitat, this impact would be temporary due to the sediment placement within the littoral zone and its associated movement. No significant impacts are anticipated either due to the other large total of acreages available in the region to these species. The natural sediment transport process would blend the two sands together while removing staining from the sand grains and rounding the individual particles through abrasion. Further study during project development would determine the extent of impacts of incorporating river sands into the marine system and filling of water bottoms.

2.8.1.3 Option C: Replenish Sand in Littoral Zone, Offshore Source

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. A large amount of water bottoms would be filled as a result. These areas currently provide essential fish habitat for managed fisheries and designated critical habitat for the threatened Gulf sturgeon. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. Filling of water bottoms would remove foraging areas for sea turtles and other marine species including the Gulf sturgeon. Sand would be obtained from an offshore source and would consist of high quality beach sands. The natural sediment transport process would blend this sand into the existing littoral system. Further study during project development would determine the extent of impacts of filling of water bottoms and incorporation of the offshore sands.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NGVD 88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

2.8.1.4 Option D: Environmental Restoration With 2-Foot Dune

It is anticipated that implementation of this measure would provide significant benefits to fish and wildlife by restoration of existing damaged and lost habitat. Dunes provide natural island habitat and by restoration, the island dwelling species gain lost habitat. The barrier islands provide important stopover habitat for many species of migratory birds. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional overwintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Further studies during project development would determine specific benefits resulting from implementation of this measure.

2.8.1.5 Option E: Environmental Restoration With 6-Foot Dune

It is anticipated that implementation of this measure would provide significant benefits to fish and wildlife by restoration of existing damaged and lost habitat. Dunes provide natural island habitat and by restoration, the island dwelling species gain lost habitat. The barrier islands provide important stopover habitat for many species of migratory birds. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional overwintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Further studies during project development would determine specific benefits resulting from implementation of this measure.

2.8.1.6 Option F: Environmental Restoration of Sea Grass Beds

Many marine species depend on sea grass beds for foraging opportunities and cover. Restoration of this vital habitat would provide significant benefits to fish and wildlife and their habitats. Establishment of a comprehensive program would allow for further education regarding the sustainability of the resource.

2.8.1.7 Option G: Restoration of Ship Island Breach

Generally, restoration of the island footprint would entail filling of existing water bottoms to circa 1916-17 geomorphic conditions. These areas currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional overwintering critical habitat for the piping plover. Filling of water bottoms would remove foraging areas for sea turtles and other marine species. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NGVD 88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

2.9 Threatened and Endangered Species

2.9.1 Line of Defense 1 - Barrier Island Restoration

Close coordination with resource agencies has allowed for better planning and development of alternatives in order to further avoid potential significant impacts to listed species. A more detailed assessment of these threatened and endangered species issues can be found in the Environmental Appendix. Adverse impacts to threatened and endangered species were part of an initial screening process used during early planning. Further consultation with appropriate resource agencies would occur during project development and subsequent biological opinions of the agency would be issued.

Overall implementation of this measure would benefit Piping Plover and its critical habitat by the increased amount of overwintering foraging areas. Temporary impacts could occur during construction but could be avoided during the times the Piping Plover are on the overwintering grounds. Impacts associated with construction activities should be temporary and isolated to actual construction limits. Brown Pelicans could utilize the project areas, however, it is anticipated these species would avoid the construction area due to noise and activity. These impacts would be temporary and isolated to actual construction limits. Surveys to determine if nesting brown pelicans are present could be conducted to avoid any impacts. If nests cannot be avoided during construction, a take could occur. Manatees, Gulf sturgeon and Sea Turtles could be in the project area and there is potential for adverse impacts to occur. It is anticipated these species would primarily avoid the construction areas due to noise and activity resulting in less risk for harm or harassment. Methods of dredging would be utilized to avoid adverse impacts to listed species. Placement activities would be accomplished using appropriate best management practices to reduce turbidity and other potential adverse impacts to species and its critical habitat. Further consultation would be required to determine adverse impacts to critical habitat for the Gulf sturgeon. Bald Eagles (recently de-listed) should avoid the project area during construction activities due to noise and activity. Surveys to determine if nesting bald eagles are present could be conducted to avoid any impacts. If nests cannot be avoided during construction, a take, under the Bald and Golden Eagle Protection Act (BGEPA), could occur. It is anticipated whale species would avoid the project area during construction activities due to noise and activity and no collisions should occur. Further consultation would occur to determine potential impacts to listed species. Biological Assessments of particular project components would need to be evaluated under future programmatic consultations.

2.10 Water Quality

2.10.1 Line of Defense 1 - Barrier Island Restoration

Water quality within coastal Mississippi is being evaluated as part of their ongoing program and monitoring data are compared to the "*State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*" in order to make decisions on whether a water body is supporting or not supporting its designated uses such as aquatic life support, water contact recreation, fish/shellfish consumption, and drinking water. A more detailed assessment pertaining to water quality issues in coastal Mississippi can be found in the Environmental Appendix. There are specific problems in certain waterbodies throughout the study area; however, many are isolated associated with certain conditions due to industrial discharge, historical problems, and increased run-off in conjunction with development.

Restoration of the barrier islands would require a large amount of high quality sand being placed on or around the sandy string of barrier islands. Overall, this should not cause significant impacts to existing water quality within Mississippi Sound. Restoration of the barrier islands would actually ensure estuarine conditions within Mississippi Sound remain.

2.10.1.1 Option A: Restore Island Footprint

This would require direct placement of approximately 66 million cubic yards of sand dredged from St. Bernard Shoals. Approximately 31 million cubic yards would be placed within the breach (Camille Cut) on Ship Island with the remaining 20 million cubic yards to be placed along the island shorelines expanding the footprints causing many acres of waterbottoms to be filled. The sand found at St. Bernard Shoals is of a quality similar to what is found in the present day Mississippi islands and sufficient quantity to meet the need. There should be no problems associated with turbidity at the borrow site in association with the dredging. The sandy material should pose no turbidity problems during placement activities as sand settles quickly. BMPs would be utilized in order to decrease any impacts associated with Water Quality. It is expected no impacts to water quality would result from implementation of this measure.

2.10.1.2 Option B: Replenish Sand in Littoral Zone, Inland Source

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. The sand would not be placed on the islands, but in areas between the islands where the currents that make up the littoral drift zone could transport the sand to the islands. This would result in a large amount of water bottoms to be filled at shallow depths, up to one-foot thicknesses. Sand would be obtained from inland sources comprised of previous dredged river sands. BMPs would be utilized to reduce turbidity associated with placement activities. It is anticipated there would be little impacts to water quality in association with implementation of this measure.

2.10.1.3 Option C: Replenish Sand in Littoral Zone, Offshore Source

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. The sand would not be placed on the islands, but in areas between the islands where the currents that make up the littoral drift zone could transport the sand to the islands. This would result in a large amount of water bottoms to be filled at shallow depths, up to one-foot thicknesses. Sand would be obtained from St. Bernard Shoals which is of a quality similar to what is found in the present day Mississippi islands. BMPs would be utilized to reduce turbidity associated with placement activities. It is anticipated there would be minimal impacts to water quality in association with implementation of this measure.

2.10.1.4 Option D: Environmental Restoration With 2-Foot Dune

Implementation of this measure would provide positive impacts to water quality by restoration of existing wetlands and marshes on the islands. It is anticipated there would be a benefit to water quality as a result of this measure. Although there may be a slight increase in turbidity during construction, it is anticipated this would be localized and short in duration.

2.10.1.5 Option E: Environmental Restoration With 6-Foot Dune

Implementation of this measure would provide positive impacts to water quality by restoration of existing wetlands and marshes on the islands. It is anticipated there would be a benefit to water quality as a result of this measure. Although there may be a slight increase in turbidity during construction, it is anticipated this would be localized and short in duration.

2.10.1.6 Option F: Environmental Restoration of Sea Grass Beds

Improved water quality within Mississippi Sound would help to establish sea grasses.

2.10.1.7 Option G: Restoration of Ship Island Breach

This would require direct placement of approximately 13 million cubic yards of sand dredged from St. Bernard Shoals within the breach (Camille Cut) on Ship Island causing a large amount of water bottoms to be filled. BMPs would be utilized to reduce turbidity associated with placement activities. It is anticipated there would be minimal impacts to water quality in association with implementation of this measure.

2.11 Water Supply

There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.

2.12 Socio-Economics

2.12.1 Line of Defense 1 - Barrier Island Restoration

Several measures have been developed which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Restoration of the barrier islands would require a large amount of high quality sand being placed on or around the sandy string of barrier islands. It is anticipated there would be positive effects to socio-economics as a result of the implementation of this measure.

2.12.1.1 Population

It is anticipated there would be a positive benefit associated with this measure to the population within coastal Mississippi as restoration of the barrier islands would enhance the existing natural system and allow for sustainability of this natural resource that produces much of the quality of life that currently exists today, especially prior to Hurricane Katrina.

2.12.1.2 Employment and Income

Implementation of this measure could result in a positive increase to the income of the area and its residents. This measure could also result in the creation of numerous jobs, ranging from construction to retail and others, in order to accommodate the significant infrastructure investment. These jobs could potentially be long-term in nature given the size and scope of the measure. Refer to the Economic Appendix for more details on the increases to income and employment and the full extent of impacts.

2.12.1.3 Housing

It is anticipated this measure would have no effect to current housing within coastal Mississippi. There are no residential structures located on the barrier islands.

2.12.1.4 Quality of Life

Implementation of this measure would provide for a continuation and enhancement of the existing quality of life as much of the local economy is driven by the seafood industry. This measure would provide for sustainability and enhancement of the barrier islands and prevention of coastal erosion. Stabilization of the barrier islands will ensure the future of the estuary within Mississippi Sound by ensuring no additional saltwater intrusion occurs. This will ensure the productivity of Mississippi Sound, which provides the basis of the seafood driven economy as well as additional recreational opportunities.

2.12.1.5 Schools

It is anticipated there would be no effect to schools by implementation of this measure.

2.12.1.6 Public Safety

It is anticipated there would be no negative impacts to public safety by implementation of this measure. Additionally, it is expected implementation of this measure would provide significant benefits by a reduction of damages caused by waves and storm surge.

2.12.1.7 Recreation

Within 85 miles of Gulf of Mexico coastline, coastal Mississippi has many recreational opportunities for its residents and for potential tourists. Restoration of the barrier islands will ensure water sports, fresh and saltwater fishing, camping, historic tours, and cultural sites remain available for residents and tourists. The barrier islands are popular spots for swimming, wind surfing, parasailing, motor boating, water skiing, and sailing. Data from fiscal year 2000 depicts the Gulf Islands National Seashore had 875,000 visitors, and 26,000 of these visitors stayed overnight. There are 200 varieties of saltwater fish in and around the Mississippi Sound and the Gulf of Mexico. A climate suitable for year-round fishing makes this even more popular. More than 30 public boat ramps, marina slips, and an umber of private camps and launches provide rental boats, charger boats, and bait. A wide variety of charter boats were available prior to Hurricane Katrina, for small groups of one to six passengers or for large parties. Fishing trips could be scheduled for from 4 hours up to an overnight stay. Numerous fishing tournaments are held every year, including the Mississippi Deep Sea Fishing Rodeo, which is the large event of its kind in the world (Mississippi Gulf Coast, 2001). Restoration of the barrier islands would ensure the continuation of the recreational opportunities as well as its sustainability well into the future.

2.12.1.8 Transportation and Traffic

It is anticipated there will be no effect to transportation or traffic by implementation of this measure. There are two deepwater ports and one shallow water port located within the vicinity of the barrier islands.

2.13 Land Use

2.13.1 Line of Defense 1 - Barrier Island Restoration

Several measures have been developed which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Restoration of the barrier islands would require a large amount of high quality sand being placed on or around the sandy string of barrier islands. It is anticipated there would be no adverse effects to current or future land use as a result any potential projects.

2.13.1.1 Option A: Restore Island Footprint

This project would require direct placement of approximately 66 million cubic yards of sand dredged from St. Bernard Shoals. Approximately 21 million cubic yards would be placed within the breach (Camille Cut) on Ship Island with the remaining 45 million cubic yards to be placed along the island shorelines expanding the footprints. Alteration of land use is expected due to the change from filling in of water bottoms being converted to sandy barrier islands resulting in expanded acreage. It is anticipated this change in land use would be insignificant as the islands would be expanded to historical sizes and the relative size of the project to the surrounding land use.

2.13.1.2 Option B: Replenish Sand in Littoral Zone, Inland Source

A large amount of water bottoms would be filled at shallow depths up to one-foot in depth in association with implementation of this measure. There would be alteration of current land use due to the changes associated with filling in of water bottoms; however, it is anticipated the difference would be insignificant due to the relative size of the proposed project to the surrounding land use.

2.13.1.3 Option C: Replenish Sand in Littoral Zone, Offshore Source

A large amount of water bottoms would be filled at shallow depths up to one-foot in depth in association with implementation of this measure. There would be alteration of current land use due to the changes associated with filling in of water bottoms; however, it is anticipated the difference would be insignificant due to the relative size of the proposed project to the surrounding land use.

2.13.1.4 Option D: Environmental Restoration With 2-Foot Dune

Implementation of this measure would provide a benefit to current land use as restoration would provide enhancement to the existing environment.

2.13.1.5 Option E: Environmental Restoration With 6-Foot Dune

Implementation of this measure would provide a benefit to current land use as restoration would provide enhancement to the existing environment.

2.13.1.6 Option F: Environmental Restoration of Sea Grass Beds

The project would result in an enhancement of the water bottoms and existing sea grass beds as a result of implementation of this measure. The project would result in a positive benefit to land use.

2.13.1.7 Option G: Restoration of Ship Island Breach

This would require direct placement of approximately 21 million cubic yards of sand dredged from St. Bernard Shoals within the breach (Camille Cut) on Ship Island causing a large amount of water bottoms to be filled. Alteration of land use is expected due to the changes associated with filling in of water bottoms being converted to sandy barrier island resulting in expanded acreage. It is anticipated this change in land use would be insignificant as the island would be expanded to its historical size and the relative size of the project to the surrounding land use.

2.14 Aesthetic Resources

As restoration occurs, aesthetics would be temporarily reduced in the immediate vicinity of the proposed project sites. Many recreational vessels utilize Mississippi Sound within the project vicinities and it is believed some residents and visitors may be disturbed by the presence of required heavy equipment during any construction phases. However, construction activities would be temporary in nature so the disturbance would be anticipated to be minimal at each potential project site. There could be times when numerous projects throughout coastal Mississippi would be occurring at once or potential project phases could be scheduled upon completion of requisite projects which would take extended amounts of time. The projects should provide residents and visitors with an overall more aesthetically pleasing view as projects are completed.

The environmental restoration projects would provide additional fish and wildlife habitat to numerous shore birds and various wildlife species which would enhance coastal Mississippi and its diverse aquatic habitats while providing future sustainability of the natural system.

2.15 Cultural Resources

Significant cultural resources as defined by the NHPA are those sites that are considered eligible for or are included in the National Register. These sites are known as historic properties. Historic properties can include buildings or other standing structures; historic or prehistoric districts (such as the historic districts in Biloxi and Ocean Springs); archaeological sites, such as Indian mounds or other remains of prehistoric life; objects, such as statues or paintings; or sunken vessels. Traditional cultural properties can also be considered significant cultural resources because of their traditional religious or cultural importance to an Indian tribe or other traditional community.

Along the Mississippi Gulf Coast, historic properties can be roughly defined within two categories. The categories are the built environment (standing structures) and archaeological sites. The vast majority of historic properties listed on the National Register are those of the built environment. To date 62 standing structures, 14 historic districts, and one ship have been listed.

In contrast, very few archaeological sites have been formally nominated to the National Register. However, numerous sites still meet the criterion of definition as historic properties. These include prehistoric earthworks and mounds, shell middens, village sites, and historic occupation areas including extinct town sites. Currently, over 200 recorded archaeological sites are considered potential historic properties.

The vast majority of historic and prehistoric sites are found along the immediate coastal strand and adjacent to estuarine systems. Preference for well-drained, sandy soils adjacent to water sources is apparent. Coast wide survey work performed by both state (Giliberti n.d.) and private researchers (Blitz and Mann 2000) have found a distinctive focus on the immediate coastal and estuarine locations. Unfortunately, the geographic placement of these resources has made them extremely vulnerable to destruction from continued occupation and development, as well as vulnerable to the effects of tropical storms and hurricanes.

Previous archaeological and architectural studies along the Mississippi Gulf Coast have documented the destruction caused by natural forces, most notably hurricanes. Standing structures are often the most dramatic and visible witnesses to this destruction. However, prehistoric and historic archaeological sites are also extremely vulnerable. Shell middens, found along the immediate shoreline and within coastal marshes and estuaries, often are flipped and re-deposited by the storm surge and wave action of hurricanes. This effectively destroys much of the value of the sites. Sites, such as Indian villages, and historic town sites, such as those along the bluff on Bay St. Louis, can also be destroyed by such wave action. In addition, post storm activities offer many more mechanisms for site destruction. These include clearing of timber by use of skidders and other heavy equipment, debris removal, and reconstruction. The destructiveness of these activities is well documented from the years following Hurricane Camille which struck the area in 1969.

The Corps, Mobile District Archaeologists, through long standing coordination relationships developed throughout the years, coordinated closely with the Mississippi Department of Archives and History staff in determining effects of the storm event. Hurricane Katrina has been documented to have destroyed a vast majority of the standing historic properties within Hancock County, and a large number of those within Harrison and Jackson Counties. The size and strength of the storm surge has also undoubtedly had as much destruction on archaeological sites. Post hurricane activities have further impacted the remaining historic properties.

Historic Fort Massachusetts is on West Ship Island, a barrier island 12 miles off the Mississippi Coast. The fort is accessible only by private boat or passenger ferry with scheduled public tours given March through October.

Fort Massachusetts was built on Ship Island for national defense. Both domestic and foreign powers recognized the strategic significance of the natural deep water harbor on the north side of the island. After lengthy debate fort construction began in the summer of 1859. Storms, disease, climate, isolation and the Civil War made construction on this remote barrier island a challenge. Construction on Fort Massachusetts halted in 1866 although the fort was not fully completed.

The fort has not only withstood actions of war but also the more subtle enemies of time and neglect. The devastating and powerful Hurricanes Camille (1969) and Katrina (2005) washed over and through the building but failed to significantly undermine the structure. However, decades of salt air and wave action began to erode the historic mortar. Employees from the Historic Preservation Training Center came to the rescue in 2001 and repaired the 135-year old brick walls. In addition the remains of the French Warehouse are located east of the fort. Various ships could be located around the barrier islands.

Protection from the immediate and post-effects of hurricanes should be considered as beneficial to cultural resources. While some historic properties may be adversely affected by protection plans, long term prevention of damage should be considered a positive measure for historic properties, in particular standing structures. Mobile District archaeologists are closely coordinating with the State of Mississippi Department of Archives and History regarding potential impacts associated with potential measures being considered in the Comprehensive Plan.

2.16 Hazardous, Toxic, and Radioactive Wastes

Quickly after Hurricane Katrina, the EPA working with the National Strike Team and other national search and rescue teams began identification and cleanup of the Household Hazardous Wastes and other hazardous type debris. The EPA established partnerships with other national and local teams involved with debris cleanup. The Corps, Mobile District team coordinated with them regularly and provided coordinates/locations of HHW and HTRW that were located during vegetative and construction type debris cleanup. The EPA working with others were charged with the responsibility of final cleanup of this type debris after the storm event.

Site inspections would be conducted at and adjacent to the various components of the Comprehensive Plan during development of specific plans and specifications in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527.

2.17 Environmental Justice

EO 12898, Federal Actions to address Environmental Justice in Minority and Low-Income Populations (February 11, 1994) requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin. On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that EPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

Any potential measures would not create disproportionately high or adverse human health or environmental impacts on minority or low-income populations within the study area. Review and evaluation of the overall comprehensive plan have not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted by proposed measures. Further studies during project development would determine specific impacts associated with implementation of potential measures. The following analysis will serve as a beginning point from which further analyses can be built upon during the comprehensive plan components.

Historic and Existing Conditions Data from the U.S Department of Commerce, Census of Population and Housing were used for this Environmental Justice analysis. The population in 1990 for Mississippi was 2,573,216. Minority populations included in the census are identified as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, Hispanic, of two or more races, and other. Mississippi is only second to the District of Columbia as having the largest Black or African American population. Poverty status, used in this coastal Mississippi report to define low-income status, is reported as the number of persons with income below poverty level. The 2005 Census defines the poverty level as $9,973 of annual income, or less, for an individual, and $19,971 of annual income, or less, for a family of four. In 2005, Mississippi ranked number one out of the 50 states for individuals living below the poverty level in the past 12 months. Unfortunately, Mississippi had 21.3% of its population living in poverty in 2005.

Coastal Mississippi has a lower percentage of minority residents than the State of Mississippi and the U.S. In 2000 (the most up-to-date data available), 79.6 percent of the population was white and 16.3 percent was black. All other racial groups combined totaled approximately 4.1 percent of the population, while 2.2 percent were of Hispanic origin. In Mississippi, 61.4 percent of the population was white, 36.3 percent was black, 2.3 percent was of another minority racial group, and 1.4 percent was of Hispanic origin. For the U.S., 75.1 percent of the population was white, 12.3 percent was black, and 12.6 percent was of other minority racial groups. Approximately 12.5 percent of the U.S. population was Hispanic.

The Census Bureau bases the poverty status of families and individuals on 48 threshold variables, including income, family size, number of family members under the age of 18 and over the age of 65, and amount spent on food. In 1997, approximately 14.6 percent of the residents were classified as living in poverty, lower than the State of Mississippi but slightly higher than the poverty rate for the U.S. as a whole.

As of 2006, the population in Mississippi was 2,910,540 – of this 135,940 individuals live in Jackson County, 193,810 live in Harrison County, and at this time a population count for Hancock County was not available. Hurricane Katrina drew focus on the number of residents unable to flee the Gulf coast due to lack of funds. There is a longstanding legacy of unfair and disproportionate harmful exposures to low income, predominantly African American communities in much of Mississippi. Predominantly in the Biloxi area but also in other coastal Mississippi communities, there was a large population of Asian Americans that depended upon fishing for their livelihood. Adverse impacts from Hurricane Katrina have resulted in a large number of these individuals leaving the area.

Environmental Justices have resulted from years of industrial activity and waste disposal practices that hit these communities harder than higher income, predominantly white communities. Impacted areas, such as superfund facilities, are located more often in low-income areas and therefore are at greater risk to post-Katrina exposure. As clean-up proceeds and rebuilding begins, every effort must be made to remedy these environmental injustices through full clean-up, fair rebuilding practices, and full partnership with affected communities. Over 30,000 families are being helped through Administration on Children and Families TANF program by the provision of short term, non-recurrent cash benefits to families who traveled to another State from the disaster designated States. The hurricane-damaged States of Mississippi, Louisiana, and Alabama also received additional funding for the TANF program to provide assistance and work opportunities to needy families ($69 million for loan forgiveness and $25 million in contingency funds for State Welfare Programs.) Counties along the Mississippi Gulf coast lost a sizeable share of their white residents and homeowners immediately following Hurricane Katrina, while other Gulf Coast metropolitan areas, especially those that gained residents, experienced little overall shifts in their demographic profiles. Coastal counties of Mississippi, which include Gulfport-Biloxi and Pascagoula metropolitan areas, in contrast to New Orleans, were left with a population that had a larger share of minority residents, a lower level of homeownership, and no significant decline in poverty. In essence, while the poor and less well-off residents of New Orleans bore the greatest brunt of Katrina, the storm had a more egalitarian effect on the population of coastal Mississippi. Our examination of the data for other hurricane impacted areas in the Gulf Coast region reveals that while a great deal of population shifting had occurred, only minor changes have taken place in the race and ethnic, economic and socio-demographic profiles for most of these areas.

Specifically, restoration of the barrier islands would not adversely impact any minority or low-income populations because those individuals are not living within the island's vicinity. In fact, restoration of the barrier islands would indirectly benefit those individuals living on the mainland through the anticipated environmental benefits, such as fishing. Each and every measure or alternative (i.e. Forest Heights) examined in the MsCIP study was evaluated for its potential for adverse impacts to minority and/or low-income populations, in adherence with EO 12898. In no case was there any identified negative impact to any of these communities in regards to human health and environmental conditions, from any proposed actions or projects.

2.18 Protection of Children

EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

It is anticipated that no disproportionate risks to children would occur as a result of implementation of the No Action Plan and any potential measures. Specifically, restoration of the barrier islands would not adversely impact children because those individuals are not living within the island's vicinity. In fact, restoration of the barrier islands would indirectly benefit those individuals living on the mainland through the anticipated environmental benefits, such as fishing. Further studies during project development phase would determine any activities that might pose any disproportionate environmental health risks or safety risks to children.

2.19 Unavoidable Adverse Environmental Effects

It is anticipated that any adverse environmental effects which could not be avoided should potential projects be implemented should be temporary and localized and would be minor individually and cumulatively.

2.20 Irreversible and Irretrievable Commitments of Resources

Any irreversible or irretrievable commitments of resources involved in any potential proposed projects have been considered and are either unanticipated at this time or will be considered to determine if any would present minor impacts.

CHAPTER 3 ENVIRONMENTAL RESTORATION ANALYSIS

A detailed analyses has been conducted for the following five environmental restoration plans to determine the impacts associated with alternatives that were considered during development of projects being recommended for construction. It is expected that no further environmental analysis is required prior to the projects being constructed. Full details of all alternative plan impacts are presented below.

3.1 Environmental Effects

The following recommended plan impacts are grouped together because the impacts are the same for each proposed restoration efforts.

- **Soils** - Alteration of soils is anticipated within environmental restoration projects; however, in some instances, old fill material would be removed for reestablishment of more native types soils generally found in the natural system.
- **Sediments** - Re-suspension of sediments would likely occur within specific project sites. Silt fences and other BMPs would be used to minimize the adverse impacts to the environment during construction activities to the maximum extent practicable. Containment structures, silt curtains, and other BMPs would be used to contain sediment deposition at construction and environmental restoration sites. It is expected that solids that remain suspended in the water column would migrate by littoral drift. Any impacts that might occur would typically be isolated to each construction site, minor and of short duration.
- **Geology** - There should be no effects to geology. Potential projects have been or would be designed to avoid impacts to current geological formations.
- **Climate** - There should be no effects to the existing climate.
- **Air Quality** - Currently all areas within coastal Mississippi are in attainment with the NAAQS. Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. The standards would not be violated by the implementation of the proposed project.
- **Noise** - Noise from the construction type equipment is expected to increase during the proposed operations in the project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise during implementation of these measures.
- **Water Supply** - There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.
- **Socio-Economics** -

    Population - It is expected minimal impacts to population would occur by implementation.

    Employment and Income - Implementation of this measure could result in a positive increase to the income of the area and its residents. This effort could also result in the creation of jobs in order to accommodate the investment. Refer to the Economic

Appendix for more details on the increases to income and employment and the full extent of impacts.

Housing - Implementation of this measure would not impact housing within coastal Mississippi because most of the existing housing has been destroyed and only minimal impacts would occur in obtaining the property due to the hardships associated with rebuilding.

Quality of Life - Implementation of this measure could improve quality of life within coastal Mississippi as additional wetland restoration would benefit water quality, wildlife habitat, and various natural resource functions as a result of restoration activities.

S*chools* - Implementation of this measure would not impact schools within coastal Mississippi.

Public Safety - It is anticipated there would be intrinsically significant positive effects to public safety by implementation of this measure as wetland restoration would displace humans and capital improvements preventing loss of life and allowing "attractive nuisances" from luring people into high-risk areas and increasing the economic loss of capital improvements within high-risk areas. Wetland restoration would also benefit water quality, wildlife habitat, and various natural resource functions.

Recreation - It is anticipated there would be minimal benefits to recreation associated with implementation of this measure.

Transportation and Traffic - It is anticipated there would be no impacts associated with implementation of this measure.

- **Aesthetics** - As projects would be constructed, aesthetics would be temporarily reduced in the immediate vicinity of the proposed project sites. Many recreational vessels utilize Mississippi Sound within the project vicinities and it is believed some residents and visitors may be disturbed by the presence of required heavy equipment during any construction phases. However, construction activities would be temporary in nature so the disturbance would be anticipated to be minimal at each potential restoration project site. There could be times when numerous projects throughout coastal Mississippi would be occurring at once or potential project phases could be scheduled upon completion of requisite projects which would take extended amounts of time. The restoration projects should provide residents and visitors with an overall more aesthetically pleasing view as projects are completed.

  The environmental restoration projects would provide additional fish and wildlife habitat to numerous shorebirds and various wildlife species, which would enhance coastal Mississippi and its diverse aquatic habitats while providing future sustainability of the natural system.

- **Cultural Resources** - The vast majority of historic and prehistoric sites are found along the immediate coastal strand and adjacent to estuarine systems. Preference for well-drained, sandy soils adjacent to water sources is apparent. Coast wide survey work performed by both state (Giliberti n.d.) and private researchers (Blitz and Mann 2000) have found a distinctive focus on the immediate coastal and estuarine locations. Unfortunately, the geographic placement of these resources has made them extremely vulnerable to destruction from continued occupation and development, as well as vulnerable to the effects of tropical storms and hurricanes.

Modern development along the Mississippi coast has affected both archaeological sites and standing structures, including individual structures and historic districts in the project area. Key issues are soil disturbance and construction. Soil disturbance affects archaeological sites, and construction of new buildings and associated infrastructure can affect the view shed and "feel" of a historic building or district or cause demolition or alteration of historic buildings.

From the early 1970s to the present, construction in the project area has greatly increased. In fact, more development and construction has occurred in the three counties that are part of the project area than anywhere else in the state. Land use studies show that between 1972 and 2000 both medium-density and high-density urban land use areas increased by more than 90 percent in the study area; overall, developed land use increased by almost 70 percent during that period (MARIS 1992, 2000; USGS 1972; USGS and USEPA 1992). This sizeable increase in developed land is caused in part by the casinos and related infrastructure, residential, and commercial construction. The development involves large areas of soil disturbance, which destroys archaeological sites.

Previous archaeological and architectural studies along the Mississippi Gulf Coast have documented the destruction caused by natural forces, most notably hurricanes. Standing structures are often the most dramatic and visible witnesses to this destruction. However, prehistoric and historic archaeological sites are also extremely vulnerable. Shell middens, found along the immediate shoreline and within coastal marshes and estuaries, often are flipped and re-deposited by the storm surge and wave action of hurricanes. This effectively destroys much of the value of the sites. Sites such as Indian villages and historic town sites such as those along the bluff on Bay St. Louis can also be destroyed by such wave action. In addition, post storm activities offer many more mechanisms for site destruction. These include clearing of timber by use of skidders and other heavy equipment, debris removal, and reconstruction. The destructiveness of these activities is well documented from the years following hurricane Camille which struck the area in 1969.

Corps, Mobile District Archaeologists, through long standing coordination relationships developed throughout the years, coordinated closely with the Mississippi Department of Archives and History staff in determining effects of the storm event. Hurricane Katrina has been documented to have destroyed a vast majority of the standing historic properties within Hancock County, and a large number of those within Harrison and Jackson Counties. The size and strength of the storm surge has also undoubtedly had as much destruction on archaeological sites. Post hurricane activities have further impacted the remaining historic properties.

Protection from the immediate and post-effects of hurricanes should be considered as beneficial to cultural resources. While some historic properties may be adversely affected by protection plans, long term prevention of damage should be considered a positive measure for historic properties, in particular standing structures. Mobile District archaeologists are closely coordinating with the State of Mississippi Department of Archives and History regarding potential impacts associated with potential measures being considered in the Comprehensive Plan. Plans are underway to develop an overall Programmatic Agreement to address potential impacts to cultural and historic resources.

- **Hazardous, Toxic, and Radioactive Wastes** - Quickly after Hurricane Katrina, the EPA working with the National Strike Team and other national search and rescue teams began identification and cleanup of the Household Hazardous Wastes and other hazardous type debris. The EPA established partnerships with other national and local teams involved with debris cleanup. The Corps team coordinated with them regularly and provided coordinates/locations of HHW and HTRW that were located during vegetative and construction type debris cleanup. The EPA working with others were charged with the responsibility of final cleanup of this type debris after the storm event.

Site inspections would be conducted at and adjacent to the various components of the Comprehensive Plan during development of specific plans and specifications in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527.

Inspections would be accomplished to determine the presence or evidence of landfills, surface areas unable to support vegetation, visible sheens of petroleum product, nearby contaminated industrial facilities, or any type of visible indication that HTRW concerns exist that may impact any component of the recommended plans during specific project development. Site inspections of adjacent properties, reviews of historic aerial photographs, on site interviews, and environmental database record searches would be conducted to determine any evidence of HTRW concerns that may impact any component of the recommended plans during specific project development.

Based on the findings of the HTRW site assessments, specific or unusual environmental concerns that are identified that could affect construction of any proposed projects would be addressed appropriately. Additional supplemental environmental impacts statements or environmental analyses may be necessary once specific projects have been identified and development of project plans has begun. HTRW issues and concerns would be addressed during the required NEPA compliance and documentation.

- **Environmental Justice** - EO 12898, Federal Actions to address Environmental Justice in Minority and Low-Income Populations (February 11, 1994) requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin. On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that EPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

The No Action and Comprehensive plan and potential measures are not designed to create a benefit for any specific group or individual. Any potential measures would not create disproportionately high or adverse human health or environmental impacts on minority or low-income populations within the study area. Review and evaluation of the overall comprehensive plan have not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted by proposed measures. Further studies during project development would determine specific impacts associated with implementation of potential measures.

A detailed discussion on the *Historic and Existing Conditions Data from the U.S Department of Commerce, Census of Population and Housing* has been provided in Section 2.17. This analysis will serve as a beginning point from which further analyses can be built upon during the comprehensive plan components. Ultimately, the plan adopted for the Mississippi coast will not be a plan forced on them by the Corps or other Federal agencies, but a plan coordinated, discussed, and finally adopted by the numerous entities and individuals that will live with that plan, the residents and local government of coastal Mississippi.

- **Protection of Children** - The EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

  It is anticipated that no disproportionate risks to children would occur as a result of implementation of the No Action Plan and any potential measures. Further studies during project development phase would determine any activities that might pose any disproportionate environmental health risks or safety risks to children.

- **Unavoidable Adverse Environmental Effects** - It is anticipated that any adverse environmental effects which could not be avoided should potential projects be implemented should be temporary and localized and would be minor individually and cumulatively.

- **Irreversible and Irretrievable Commitments of Resources** - Any irreversible or irretrievable commitments of resources involved in any potential proposed projects have been considered and are either unanticipated at this time or will be considered to determine if any would present minor impacts.

The following section provided completed detailed analysis of the alternatives considered for each restoration project during development of each proposed recommended plan.

3.2 Admiral Island

Tidal marshes in this area were ditched in the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation in the area destroying many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow Tree, which is invading the marshes and adjacent flatwoods.

3.2.1 Vegetation

3.2.1.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

3.2.1.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to vegetation as this plan will restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future.

3.2.1.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to vegetation as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.2.1.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.2.1.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is such that ensures high rates of survival and increases per-cent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future.

3.2.1.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.2.1.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.2.2 Fish and Wildlife

3.2.2.1 No Action

The invasive species would continue to thrive threatening to take over the site reducing available native forage for fish and wildlife species to use the area. Lack of available habitat could cause fish and wildlife species to move from the area seeking more suitable habitat.

3.2.2.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan would restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. This will provide valuable forage and cover for fish and wildlife species.

3.2.2.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species.

3.2.2.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Increased maintenance activities could disrupt established use patterns by species and increased spacing would reduce the overall quality of the habitat to support foraging and cover.

3.2.2.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. This will provide valuable forage and cover for fish and wildlife species.

3.2.2.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species, including essential fish habitat for managed species, that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species.

3.2.2.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species, including essential fish habitat for managed species, that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Increased maintenance activities could disrupt established use patterns by species and increased spacing would reduce the overall quality of the habitat to support foraging and cover.

3.2.3 Threatened and Endangered Species

As these vital resources are restored, it is anticipated that various threatened and endangered species would begin to utilize those valuable habitats. Birds, such as piping plovers and brown pelicans, and sea turtles would likely begin to utilize the filled breached area at Ship Island and nourished mainland beaches. Protected species, such as the red-cockaded woodpeckers, Mississippi sandhill cranes, gopher tortoises and the Eastern indigo snakes, would likely benefit from the restored wet pine Savannah habitats.

3.2.3.1 No Action

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 1 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.4 Water Quality

3.2.4.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. Continued degradation of the site would further reduce any water quality functions that currently exist.

3.2.4.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to water quality as this plan will restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases per-cent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.2.4.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to water quality as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.2.4.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Although the project would provide benefits to water quality, the amount of time necessary would increase and a longer period of time would be needed in order for the wetland to reach maturity. The sustainability of the project remains unknown and it may become necessary for the introduction of additional native plants to provide the optimum percent cover necessary to reach a fully functional wetland.

3.2.4.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. The reduced hydrology will reduce the overall water quality functions of the wetlands as compared to filling in the ditches proposed in plans 1 - 3.

3.2.4.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. The reduced hydrology will reduce the overall water quality functions of the wetlands as compared to filling in the ditches proposed in plans 1 - 3.

3.2.4.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. The sustainability of the project remains unknown and it may become necessary for the introduction of additional native plants to provide the optimum percent cover necessary to reach a fully functional wetland. The reduced hydrology will reduce the overall water quality functions of the wetlands as compared to filling in the ditches proposed in plans 1 - 3.

3.2.5 Land Use

3.2.5.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition; however there should be no change to current land use as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.3 Dantzler Environmental Restoration

The area was planted in plantation pines during the 1960s and ditches and stormwater lines were constructed in the 1970s in anticipation of residential development of the site. Long term exclusion of fire and the invasion of non-native species, Cogongrass and Chinese Tallow Trees have severely degraded the site.

3.3.1 Vegetation

3.3.1.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.3.1.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

3.3.1.3 Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species.

3.3.2 Fish and Wildlife

3.3.2.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

3.3.2.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats.

3.3.2.3 Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species.

3.3.3 Threatened and Endangered Species

3.3.3.1 No Action

The invasive species would continue to thrive threatening to take over the site further degrading available habitat for use by the Mississippi sandhill crane.

3.3.3.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit the Mississippi sandhill crane by restoration of the savannah, the main habitat used by the species for nesting and foraging. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. The Alabama Red-bellied turtle has been documented in using channels within Mary Walker Bayou, adjacent to the project site. It is anticipated the species could use the project site for nesting. The Mississippi sandhill crane depends on this type habitat for its continued existence which has experienced declines due to development within coastal Mississippi.

3.3.3.3 Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit the endangered Mississippi Sandhill Crane and Alabama Red-bellied Turtle. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds such as the Mississippi sandhill crane. Mowing creates additional ground litter that could limit foraging efficiency of the Mississippi sandhill crane. The Alabama Red-bellied turtle has been documented in using channels within Mary Walker Bayou, adjacent to the project site. It is anticipated this species could use the project site for nesting.

3.3.4 Water Quality

3.3.4.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.3.4.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.3.4.3 Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.3.5 Land Use

3.3.5.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and creating a mixed pine and hardwood community. There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.3.5.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.3.5.3 Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.4 Turkey Creek Environmental Restoration

The site is primarily comprised of a pine savannah wetland. Several miles of ditches have been excavated throughout the site. Additionally, an elevated railway berm fragments the wetland habitat substantially altering hydrology of the wetlands located to the north.

3.4.1 Vegetation

3.4.1.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.4.1.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

3.4.1.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species.

3.4.1.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

3.4.1.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species.

3.4.1.6 Plan 5 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

3.4.1.7 Plan 6 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species.

3.4.2 Fish and Wildlife

3.4.2.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

3.4.2.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would restore the entire area north and south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species. Unfortunately the railroad berm presents a barrier to hydrology, fire and fish and wildlife species. To accommodate the barrier, additional culverts would be required as well as additional fire breaks for prevention of damages to the railroad berm by fire. Wildlife crossings would aid in dispersal of fish and wildlife species and would reduce train/wildlife collisions.

3.4.2.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. This plan would restore the entire area north and south of the railroad berm which would provide a contiguous habitat which would reduce fragmentation and the need for travel corridors. Unfortunately the railroad berm presents a barrier to hydrology and fish and wildlife species. To accommodate the barrier, additional culverts would be required as well as wildlife crossings. Wildlife crossings would aid in dispersal of fish and wildlife species and would reduce train/wildlife collisions.

3.4.2.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would only restore the area south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species.

3.4.2.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. This plan would restore the entire area south of the railroad berm which would provide a large contiguous habitat. Larger blocks of habitat are more easily managed and less fragmented landscapes provide more benefits to fish and wildlife species.

3.4.2.6 Plan 5 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would only restore the area north of the railroad berm which would provide a much smaller fire maintained landscape. Restoration of this habitat would provide benefits to fish and wildlife species even though the overall area is relatively smaller.

3.4.2.7 Plan 6 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. This plan would restore the entire area north of the railroad berm which would provide a much smaller area for use as habitat. Restoration of this habitat would provide benefits to fish and wildlife species even though the overall area is relatively smaller.

3.4.3 Threatened and Endangered Species

3.4.3.1 No Action

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.6 Plan 5 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.7 Plan 6 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.4 Water Quality

3.4.4.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.4.4.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.4.4.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.4.4.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.4.4.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.4.4.6 Plan 5 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi. This plan would restore the entire area north of the railroad berm which would provide a much smaller area providing water quality functions. Restoration of the water quality functions would replace lost functions even though the overall area is relatively smaller.

3.4.4.7 Plan 6 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi. This plan would restore the entire area north of the railroad berm which would provide a much smaller area providing water quality functions. Restoration of the water quality functions would replace lost functions even though the overall area is relatively smaller.

3.4.5 Land Use

3.4.5.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area undergoes succession and creating a mixed pine and hardwood community. The No Action alternative being implemented would not preclude future development from occurring on the site as the site is owned by a private citizen.

3.4.5.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.4.5.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.4.5.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.4.5.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.4.5.6 Plan 5 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.4.5.7 Plan 6 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.5 Bayou Cumbest Environmental Restoration

The site consists of existing tidal marsh as well as filled and developed residential areas causing changes in the natural hydrology and subsequent losses and fragmentation to marsh. Hurricane Katrina left extensive debris fields and sedimentation in the area destroying many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow Tree, Cogongrass, and Phragmites which are invading the marshes and adjacent flatwoods.

3.5.1 Vegetation

3.5.1.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

3.5.1.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to vegetation as this plan will restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases per-cent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future.

3.5.1.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to vegetation as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.5.1.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.5.1.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future.

3.5.1.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.5.1.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.5.2 Fish and Wildlife

3.5.2.1 No Action

The invasive species would continue to thrive threatening to take over the site reducing available native forage for fish and wildlife species to use the area. Lack of available habitat could cause fish and wildlife species to move from the area seeking more suitable habitat.

3.5.2.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan would restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. This will provide valuable forage and cover for fish and wildlife species.

3.5.2.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species.

3.5.2.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Increased maintenance activities could disrupt established use patterns by species and increased spacing would reduce the overall quality of the habitat to support foraging and cover.

3.5.2.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. This will provide valuable forage and cover for fish and wildlife species.

3.5.2.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species, including essential fish habitat for managed species, that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species.

3.5.2.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species, including essential fish habitat for managed species, that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Increased maintenance activities could disrupt established use patterns by species and increased spacing would reduce the overall quality of the habitat to support foraging and cover.

3.5.3 Threatened and Endangered Species

3.5.3.1 No Action

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species, except for the Alabama Red-bellied Turtle as noted above.

3.5.3.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.3.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.3.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.3.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.3.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.3.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.4 Water Quality

3.5.4.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

3.5.4.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to water quality as this plan will restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases per-cent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.5.4.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to water quality as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.5.4.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Although the project would provide benefits to water quality, the amount of time necessary would increase and a longer period of time would be needed in order for the wetland to reach maturity. The sustainability of the project remains unknown and it may become necessary for the introduction of additional native plants to provide the optimum percent cover necessary to reach a fully functional wetland.

3.5.4.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.5.4.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.5.4.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Although the project would provide benefits to water quality, the amount of time necessary would increase and a longer period of time would be needed in order for the wetland to reach maturity. The sustainability of the project remains unknown and it may become necessary for the introduction of additional native plants to provide the optimum percent cover necessary to reach a fully functional wetland.

3.5.5 Land Use

3.5.5.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The site would remain a severely damaged residential community which may experience moderate rebuilding efforts in the future.

3.5.5.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.5.5.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.5.5.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.5.5.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.5.5.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.5.5.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.6 Franklin Creek Environmental Restoration

The site was identified as an interim project that consists of residential relocations which provides an opportunity for environmental restoration. The site currently consists of degraded pine flatwoods with numerous areas of fill as a result of residential development and the existing railroad which creates a hydrologic barrier between two separate areas.

3.6.1 Vegetation

3.6.1.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.6.1.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by excavation of old roadbeds and any additional fill will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Installation of culverts increases hydrologic connections between the two separate areas which will improve native vegetation.

3.6.1.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by excavation of old roadbeds and any additional fill will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Installation of culverts increases hydrologic connections between the two separate areas which will improve native vegetation.

3.6.1.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit vegetation. Partial restoration of hydrology by removal of old fill will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

3.6.1.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit vegetation. Partial restoration of hydrology by removal of old fill will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species.

3.6.2 Fish and Wildlife

3.6.2.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

3.6.2.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would restore the entire area north and south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species. Unfortunately the railroad berm presents a barrier to hydrology, fire, and fish and wildlife species. To accommodate the barrier, additional culverts would be required as well as additional fire breaks for prevention of damages to the railroad berm by fire. Wildlife crossings would aid in dispersal of fish and wildlife species and would reduce train/wildlife collisions.

3.6.2.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. This plan would restore the entire area north and south of the railroad berm which would provide a contiguous habitat which would reduce fragmentation and the need for travel corridors. Unfortunately the railroad berm presents a barrier to hydrology and fish and wildlife species. To accommodate the barrier, additional culverts would be required as well as wildlife crossings. Wildlife crossings would aid in dispersal of fish and wildlife species and would reduce train/wildlife collisions.

3.6.2.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would only restore the area south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species.

3.6.2.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. This plan would restore the entire area south of the railroad berm which would provide a large contiguous habitat. Larger blocks of habitat are more easily managed and less fragmented landscapes provide more benefits to fish and wildlife species.

3.6.3 Threatened and Endangered Species

3.6.3.1 No Action

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.6.3.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.6.3.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.6.3.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.6.3.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.6.4 Water Quality

3.6.4.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.6.4.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.6.4.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.6.4.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.6.4.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.6.5 Land Use

3.6.5.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area undergoes succession and creating a mixed pine and hardwood community. The No Action plan would result in no changes in current land use; although prior to implementation of the Interim Project, the area consisted primarily of a residential community.

3.6.5.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan would result in significant changes to current land use as the project consists of a prior developed residential community.

3.6.5.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan would result in significant changes to current land use as the project consists of a prior developed residential community.

3.6.5.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan would result in significant changes to current land use as the project consists of a prior developed residential community.

3.6.5.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan would result in significant changes to current land use as the project consists of a prior developed residential community.

1.4 ENVIRONMENTAL RESTORATION BEING CONSIDERED FOR CONSTRUCTION

1.4.1 ADMIRAL ISLAND RESTORATION BENEFITS

Admiral Island, Hancock County

The Admiral Island restoration area contains 123 acres to be restored to 62 acres of emergent tidal marsh and 61 acres of scrub shrub habitats (Figure 5.6.1-2). The tidal marshes in this area were ditched during the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation in the area and destroyed many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow tree, which is invading the marshes and the adjacent flatwoods. For increased habitat diversity, the team proposed to leave some of the higher elevations as is and plant shrub/scrub species in order to enhance environmental benefits at the restoration site. The diverse habitat allows for a variety of fish and wildlife to utilize the area which increases the environmental benefits.

Objective:

1. Restore the natural hydrology.
2. Restore native wetland plant communities.
3. Provide storm surge protection.
4. Provide fish and tidal wildlife habitat.
5. Prevent saltwater intrusion

Measures:

1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas) (Mandatory).

Figure 5.6.1-2. Admiral Island Restoration Site

This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.25, on the assumption that greater than half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

This measure affects the “percent cover by invasive or exotic species” variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches/channels.

   If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting

Alternatives:

a) 0.5 meter spacing

b) 1 meter spacing

c) 2 meter spacing

This measure affects the “percent cover by woody plant species”, “wildlife habitat diversity”, “vegetation height”, “wetland indicator status” and “mean percent cover emergent plant species” variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the project life (50 years). Variable subindex scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter (Tables 5.6.1-4 and 5.6.1-5).

Table 5.6.1-4.
Measures

Plan 1. 1,2,3,4a	Plan 2. 1,2,3,4b	Plan 3. 1,2,3,4c
Plan 4. 1,2,4a	Plan 5. 1,2,4b	Plan 6. 1,2,4c

Table 5.6.1-5.
Summary of AAFU Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	AAFU Benefit
Admiral Island	62	No-action plan	0
Admiral Island	62	Plan 1	61
Admiral Island	62	Plan 2	60
Admiral Island	62	Plan 3	59
Admiral Island	62	Plan 4	51
Admiral Island	62	Plan 5	50.5
Admiral Island	62	Plan 6	49

The management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, two plans were eliminated because they produced less benefit at greater cost than a subsequent plan.

The recommended plan consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 1.0 meter, and filling existing artificial ditches. The planting of native vegetation consist of *S. alteniflora, J. roemerianus, and S. patens*.

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Bayou Cumbest. Table 5.6.1-6 shows the total functional units under each implemented plan and the AAFU net benefit. To calculate the AAFU net benefit, it is assumed that benefits will be maximized at year 5 with 0.5 meter spacing of vegetation, at year 7 with 1.0 meter spacing of vegetation, and at year 10 with 2.0 meter spacing of vegetation. These benefits are estimated to be sustainable over the life of the project. Net AAFU benefits are calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. The recommended plan was selected based on the criteria used for Bayou Cumbest.

1.4.2 BAYOU CUMBEST RESTORATION BENEFITS

Environmental Benefits of Bayou Cumbest Restoration

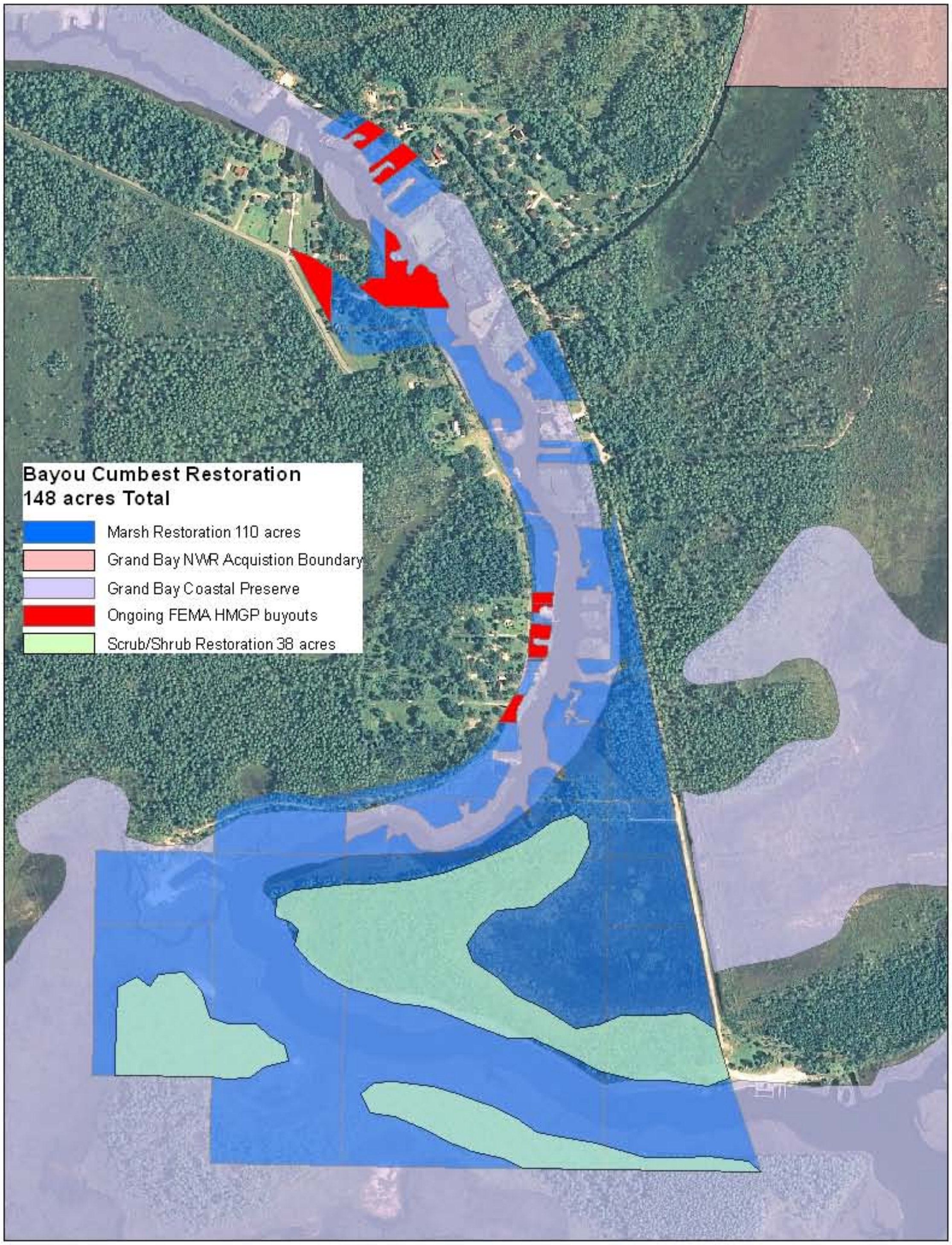


Figure 1. Bayou Cumbest restoration site.

The Bayou Cumbest restoration area (Figure 1) contains 148 acres, of which 110 acres would be restored to tidal marsh and the remaining 38 acres would remain scrub/shrub wetland habitat. The area presently consists of previously filled areas, some tidal marsh, and scrub shrub.

Objective:
1. Restore marsh to historical (pre-development ~1950's) conditions.
2. Provide storm surge protection.
3. Restore native tidal wetland plant community.
4. Provide fish and tidal wildlife habitat.
5. Prevent saltwater intrusion

Assumptions:
1. Mandatory buy-outs.
2. 100% removal of existing structures

Measures:
1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas) (Mandatory)

This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.50, on the assumption that approximately half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic species (Chinese Tallow, Phragmites, Cogon Grass) in all areas over project lifetime. (Mandatory in all plans).

This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches/channels

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting
Alternatives

a) 0.5 meter spacing
b) 1 meter spacing
c) 2 meter spacing

This measure affects the "percent cover by woody plant species", "wildlife habitat diversity", "vegetation height", "wetland indicator status" and "mean percent cover emergent plant species" variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the project life (50 years). Variable subindex scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter.

Plans:
Plan 1: 1,2,3,4a
Plan 2: 1,2,3,4b
Plan 3: 1,2,3,4c
Plan 4: 1,2,4a
Plan 5: 1,2,4b
Plan 6: 1,2,4c

Benefits:

Table 1 shows the average annual functional unit (AAFU) benefit under each plan.

Table 1.
Summary of Average Annual Functional Unit Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit[1]
Bayou Cumbest	110	No-action plan	0
Bayou Cumbest	110	plan 1	191
Bayou Cumbest	110	plan 2	188
Bayou Cumbest	110	plan 3	184
Bayou Cumbest	110	plan 4	172
Bayou Cumbest	110	plan 5	169
Bayou Cumbest	110	plan 6	164

References

Shafer, D. J., T. H. Roberts, M. S. Peterson, and K. Schmid. (in press). "A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing the Functions of Tidal Fringe Wetlands Along the Mississippi and Alabama Gulf Coast." U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

1.4.3 DANTZLER RESTORATION BENEFITS

Environmental Benefits of Dantzler restoration

Source: Corps

Figure 1. Dantzler restoration site.

Source: Corps

The Dantzler restoration area (Figure 1) contains 385 acres to be restored to wet pine savanna. The restorable area is split by a road, 151 of the acres are north of the road and the remaining 234 acres are south of the road. This area was planted in plantation pine during the 1960s and ditches and stormwater lines were constructed in the early 1970s in anticipation of residential development of the site. The long-term exclusion of fire and the invasion of non-native species such as Cogongrass and Chinese Tallowtree have severely degraded the site.

Objective:

1. Restore the natural hydrology.
2. Restore natural fire regime.
3. Restore native wetland plant communities.
4. Provide storm surge protection.
5. Provide fish and tidal wildlife habitat.

Assumptions:

Measures:

1. Maintain native savanna vegetation. (Mandatory)
   Alternative:
      a. prescribed burning on a 3-5 year cycle.
      b. mowing annually.

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained" landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

2. 100% removal of exotics and plantation pine; maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches. (Mandatory)
   If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

Plans:
Plans 1-2: Restoring areas both north and south of road (areas A and B)
Plan 1: 1a,2,3
Plan 2: 1b,2,3
Plans 3-4: Restoring only area north of road (Area A)
Plan 3: 1a,2,3
Plan 4: 1b,2,3
Plans 5-6: Restoring only area south of road (Area B)
Plan 5: 1a,2,3
Plan 6: 1b,2,3

Benefits:

Table 1 shows the average annual functional unit (AAFU) benefit under each plan.

Table 1.
Summary of Average Annual Functional Unit Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit
Dantzler	385	No-action plan	0

Dantzler	385	plan 1	1,244
Dantzler	385	plan 2	943
Dantzler	151	plan 3	488
Dantzler	151	plan 4	370
Dantzler	234	plan 5	756
Dantzler	234	plan 6	573

References

Shafer, D. J., T. H. Roberts, M. S. Peterson, and K. Schmid. (in press). "A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing the Functions of Tidal Fringe Wetlands Along the Mississippi and Alabama Gulf Coast." U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

1.4.4 FRANKLIN CREEK RESTORATION BENEFITS

Environmental Benefits from Franklin Creek Restoration

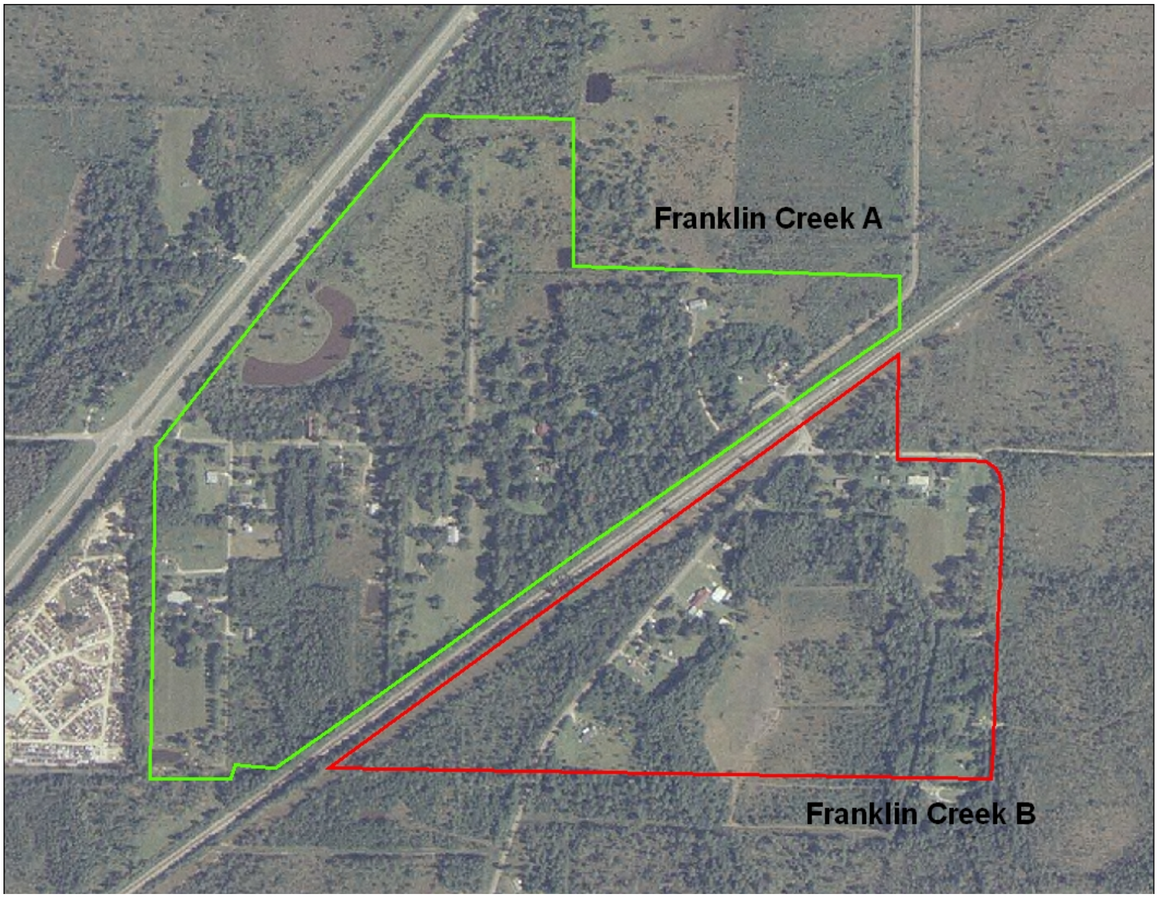


Figure 1. Franklin Creek restoration site, broken into assessment areas north (green border) and south (red border) of the railroad.

The Franklin Creek project site is located in eastern Jackson County and has been funded for homeowners assistance and relocation as part of the MsCIP Interim Report. The project consists of 149 acres located north and south of the CSX railroad.

Restoration Options: Franklin Creek (Pine Savanna)

Objectives:
1. Restore native vegetation
2. Restore natural hydrology
3. Restore fish and wildlife habitat
4. Provide storm water storage protection.

Assumptions:
1. Mandatory buy-outs.

Measures:

Listed below are the proposed restoration measures and their expected effect on variables used in the HGM model.

1. Filling in ditches (Mandatory)

This measure affects the “Outflow of Water” variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.1 to 1.0 under this measure.

2. Maintain vegetation (Mandatory)

Alternatives

a. Burn (3 year cycle)

b. Mow (annual)

This measure affects the “area of contiguous fire-maintained landscape”, as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the “area of contiguous fire-maintained landscape variable will score a 0.05 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory)

This measure affects the “surface water storage” variable, which measures the presence of excavation or fill at the site. This variable score would increase from 0.1 to 1.0 in areas with existing roadbeds/fill.

4. Add culverts (Mandatory)

This measure increases the hydrologic connection between the two existing wetland areas separated by an elevated railway. The wetlands are primarily precipitation driven resulting in sheet flow drainage. Additional culverts will result in increased sheet flow drainage reducing standing surface water in the northern wetland area.

Plans:

Plans 1-2 - Restoring areas A and B

Plan 1: 1, 2a, 3, 4

Plan 2: 1, 2b, 3, 4

Plans 3-4 Restoring just area B

Plan 3: 1, 2a, 3

Plan 4: 1, 2b, 3

Benefits:

Table 1 shows the total functional units of the site under each plan, and the average annual functional unit (AAFU) benefit. It is assumed here that functional units will remain the same under existing conditions and the no-action plan. To calculate the AAFU, it is assumed all benefits are immediately accrued following plan implementation, and that the benefits are sustainable over the life of the project. Therefore, the AAFU was simply calculated as the difference between the total functional units for the restoration plan the total functional units for the no-action plan.

Table 1.
Summary of Functional Unit Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit
Franklin Creek	149	No-action plan (plans 1-2)	0
Franklin Creek	56	No-action plan (plans 3-4)	0
Franklin Creek	149	plan 1	516
Franklin Creek	149	plan 2	399
Franklin Creek	56	plan 3	194
Franklin Creek	56	plan 4	150

References

Rheinhardt, R. D., Rheinhardt, M. C., and Brinson, M. M. (2002). "A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains," ERDC/EL TR-02-9, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

1.4.5 Turkey Creek Restoration Benefits

Environmental Benefits from Turkey Creek Restoration

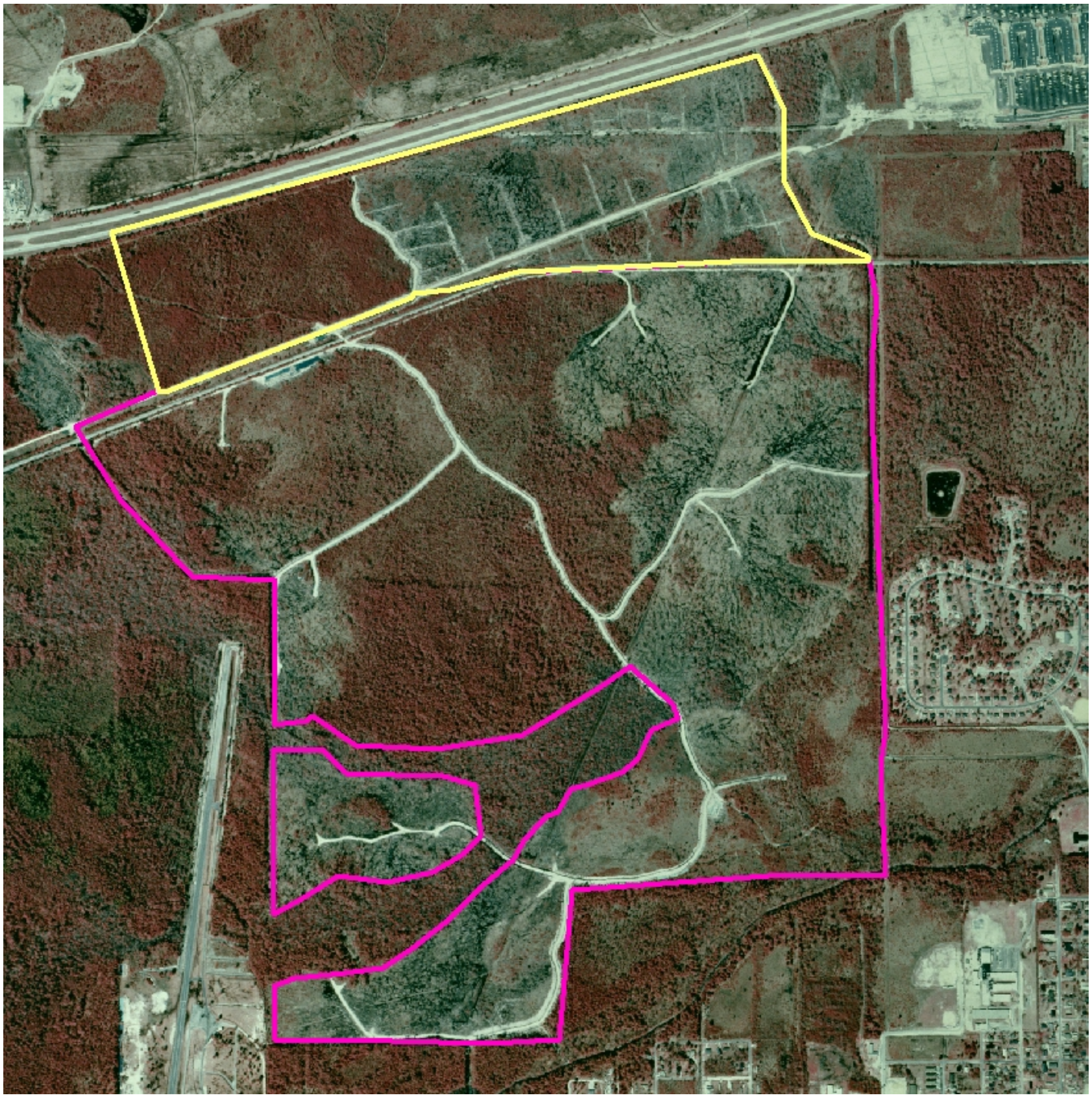


Figure 1. Turkey Creek restoration site, broken into assessment areas north (yellow border) and south (pink border) of the railroad.

The Turkey Creek site had an HGM assessment performed in 2000, using the Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains (Rheinhardt et al 2002). Results from this earlier assessment are being used to establish baseline (current) conditions at the site. The site has been divided into 8 separate assessment areas (figure 1), as there were different baseline conditions for each area. The same HGM model is also being used to measure functional unit benefits at the site resulting from different restoration plans.

Restoration Options: Turkey Creek (Pine Savanna)

Objectives:
1. Restore native vegetation
2. Restore natural hydrology
3. Restore fish and wildlife habitat
4. Provide storm water storage protection.
5. Restore and maintain State water quality.

Assumptions:
1. Mandatory buy-outs.

Measures:
Listed below are the proposed restoration measures and their expected effect on variables used in the HGM model.

1. Filling in ditches (Mandatory)

This measure affects the “Outflow of Water” variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.1 to 1.0 under this measure.

2. Maintain vegetation (Mandatory)
Alternatives
- a. Burn (3 year cycle)
- b. Mow (annual)

This measure affects the “area of contiguous fire-maintained landscape”, as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the “area of contiguous fire-maintained landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory)

This measure affects the “surface water storage” variable, which measures the presence of excavation or fill at the site. This variable score would increase from 0.1 to 1.0 in areas with existing roadbeds/fill.

Plans:
Plans 1-2 - Restoring areas north and south of railroad
Plan 1: 1, 2a, 3
Plan 2: 1, 2b, 3

Plans 3-4 Restoring just areas south of railroad
Plan 3: 1, 2a, 3
Plan 4: 1, 2b, 3

Plans 3-4 Restoring just areas north of railroad
Plan 5: 1, 2a, 3
Plan 6: 1, 2b, 3

Benefits:

Table 1 shows the total functional units of the site under each plan, and the average annual functional unit (AAFU) benefit. It is assumed here that functional units will remain the same under existing conditions and the no-action plan. To calculate the AAFU, it is assumed all benefits are immediately accrued following plan implementation, and that the benefits are sustainable over the life of the project. Therefore, the AAFU was simply calculated as the difference between the total functional units for the restoration plan the total functional units for the no-action plan.

Table 1.
Summary of Functional Unit Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Total Functional Units	Average Annual Functional Unit Benefit
Turkey Creek	879	Existing Condition (plans 1-2)	1,222	-
Turkey Creek	689	Existing Condition (plans 3-4)	1,012	-
Turkey Creek	190	Existing Condition (plans 5-6)	210	-
Turkey Creek	879	No-action plan (plans 1-2)	1,222	0
Turkey Creek	689	No-action plan (plans 3-4)	1,012	0
Turkey Creek	190	No-action plan (plans 5-6)	210	0
Turkey Creek	879	plan 1	3,268	2,046
Turkey Creek	879	plan 2	2,574	1,352
Turkey Creek	689	plan 3	2,577	1,565
Turkey Creek	689	plan 4	2,037	815
Turkey Creek	190	plan 5	691	481
Turkey Creek	190	plan 6	537	327

References

Rheinhardt, R. D., Rheinhardt, M. C., and Brinson, M. M. (2002). "A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains," ERDC/EL TR-02-9, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

1.4.6 Deer Island Restoration Benefits

FUNCTIONAL HABITAT INDEX

Future Without Project Condition

Functions	Shore line Birds	Migratory Birds	Native Fish	Sport Fish	Macro Invertebrates & Primary Producers	Bivalves	Future Without Project Functional Habitat Index (FHI)	Future Without Project FHI 525 acres
Restoration of Emergent Beach and Dune System	-	-	-	-	-	-	-	0.0
Restoration of Maritime Forest Habitat	-	-	-	-	-	-	-	0.0
Soft Substrate	-	-	-	-	-	-	-	0.0
Reestablishment of pre-disturbance shoreline	-	-	-	-	-	-	-	0.0
Reduced Wave Energy along Grand Bayou and the Southern Shoreline	-	-	-	-	-	-	-	0.0
Shoreline Stabilization	-	-	-	-	-	-	-	0.0
Roosting Habitat	-	-	-	-	-	-	-	0.0
Nesting Habitat	-	-	-	-	-	-	-	0.0
Native Vegetation Propagation	0.05	0.05	-	-	-	-	0.10	52.5
Shoreline Foraging Habitat	-	-	0.05	0.05	-	-	0.10	52.5
Erosion Control	-	-	-	-	-	-	-	0.0
Sediment Stabilization	-	-	-	-	-	-	-	0.0
Water Quality	-	-	-	-	-	-	-	0.0
Hard Substrate-ocean bottom or submerged rip-rap	-	-	-	-	-	-	-	0.0
Direct Benefit = 0.10 **Indirect Benefit = 0.05**							**Total FHI = 0.20**	**105**

Total Table FHI = 105

FUNCTIONAL HABITAT INDEX

**Restoration of Grand Bayou (Proposed-Profile 1) and
The West End Breach (Proposed) and
Entire Southern Shoreline**

Functions	Shore line Birds	Migratory Birds	Native Fish	Sport Fish	Macro Invertebrates & Primary Producers	Bivalves	Proposed Alternative Functional Habitat Index (FHI)	Proposed Alternative FHI 525 acres	Future Without Future w/o FHI	Future Without FHI 0 acres
Restoration of Emergent Beach and Dune System	0.10	0.10	0.05	0.05	0.05	-	0.35	183.75	-	0.0
Restoration of Maritime Forest Habitat	0.10	0.10	-	-	0.05	-	0.25	131.25	-	0.0
Soft Substrate	0.05	0.05	0.10	0.10	0.05	0.05	0.40	210	-	0.0
Reestablishment of pre-disturbance shoreline	0.05	0.05	-	-	-	-	0.10	52.5	-	0.0
Reduced Wave Energy along Grand Bayou and the Southern Shoreline	0.10	0.10	0.05	0.05	0.05	0.05	0.40	210	-	0.0
Shoreline Stabilization	0.05	0.05	0.05	0.05	-	-	0.20	105	-	0.0
Roosting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Nesting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Native Vegetation Propagation	0.10	0.10	0.05	0.05	0.10	-	0.40	210	0.10	0.0
Shoreline Foraging Habitat	0.10	0.10	0.10	0.10	0.05	0.05	0.50	262.5	0.10	0.0
Erosion Control	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Sediment Stabilization	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Water Quality	-	-	0.05	0.05	0.05	0.05	0.20	105	-	0.0
Hard Substrate-ocean bottom or submerged rip-rap	-	-	0.05	0.05	-	0.10	0.20	105	-	0.0
Direct Benefit = 0.10 **Indirect Benefit = 0.05**						**Total FHI = 4.1**		**2152.5**	**0.20**	**0.0**

Total Table FHI = 2152.5

1.4.7 BARRIER ISLANDS RESTORATION BENEFITS

Littoral Zone Placement & Fill of Breach Between West & East Ship Islands

Assessment Variables	*Shorebirds*	*Waterfowl*	*Migratory Birds*	*Raptors*	*Beach Fauna*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*Threatened and Endangered Species*	***Functional Habitat Unit***
	Habitat Units									
Island Persistence	10	8	10	8	10	10	10	10	10	86
Shoreline Stabilization	10	8	8	8	10	10	10	6	10	80
Reproduction Habitat	10	0	0	0	8	10	10	10	10	58
Feeding Habitat	10	6	10	8	8	10	10	10	10	82
Roosting Habitat	10	6	8	6	10	10	10	10	10	80
Wintering Habitat	10	6	8	6	10	10	10	10	10	80
Dune Habitat	10	10	10	10	10	10	10	10	10	90
Beach Habitat	10	10	10	10	10	10	10	10	10	90
Water Column Habitat	8	8	8	8	8	8	10	10	10	78
Water-Land Interface Habitat	10	10	10	10	10	10	10	10	10	90
Fishery Habitat	10	10	10	10	10	10	10	10	10	90
Oyster Habitat	6	6	6	6	6	8	10	8	8	64
									TOTAL FHI	**968**

NO ACTION

Assessment Variables	*Shorebirds*	*Waterfowl*	*Migratory Bi*	*Raptors*	*Beach Fa*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*Threatened and Endangered Species*	***Functional Habitat Unit***
	Habitat Units									
Island Persistence	0	0	0	0	0	0	0	0	0	***0***
Shoreline Stabilization	0	0	0	0	0	0	0	0	0	0
Reproduction Habitat	0	0	0	0	0	0	0	0	0	0
Feeding Habitat	0	0	0	0	0	0	0	0	0	0
Roosting Habitat	0	0	0	0	0	0	0	0	0	0
Wintering Habitat	0	0	0	0	0	0	0	0	0	0
Dune Habitat	0	0	0	0	0	0	0	0	0	0
Beach Habitat	0	0	0	0	0	0	0	0	0	0
Water Column Habitat	2	2	2	2	2	2	2	2	2	18
Water-Land Interface Habitat	0	0	0	0	0	0	0	0	0	0
Fishery Habitat	2	2	2	2	2	2	2	2	2	18
Oyster Habitat	2	2	2	2	2	2	2	2	2	18
									TOTAL FHI	**54**

1.4.8 Bayou Cumbest Submerged Aquatic Vegetation Benefits

Species of fishes commonly found in Submerged Aquatic Vegetation Habitats in the Grand Bay National Estuarine Research Reserve.

Scientific Name	Common Name
Anchoa mitchilli	Bay anchovy
Archosargus probatacephalus	Sheepshead
Bairdiella chrysoura	Silver perch (drum family)
Brevoortia patronus	Gulf menhaden
Chasmodes saburrae	Florida blenny
Citharichthys spilopterus	Bay whiff (flounder)
Ctenogobius boleosoma	Darter goby
Cynoscion nebulosus	Spotted seatrout
Eucinostomus argenteus	Spot-fin mojarra
Lagodon rhomboides	Pinfish
Leiostomus xanthurus	Spot
Lucania parva	Rainwater killifish
Lutjanus grisues	Grey snapper (mangrove snapper)
Menidia beryllina	Inland silverside
Mugil cephalus	Striped mullet
Mycteroperca microlepis	Gag grouper
Oligoplites saurus	Leatherjack
Orthopristis chrysoptera	Pigfish
Sphoeroides parvus	Least puffer
Sphyraena guachancho	Guaguanche (barracuda family)
Sygnathus louisianae	Chain pipefish
Sygnathus scovelli	Gulf pipefish
Symphurus plagiusa	Black cheeked tonguefish
Synodus foetens	Inshore lizardfish

SECTION 2

ENVIRONMENTAL AGENCY SUPPORT DOCUMENTS

FISH AND WILDLIFE COORDINATION ACT REPORT AND BIOLOGICAL OPINIONS

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PLANNING AID ASSISTANCE LETTER

The U.S. Army Corps of Engineers (Corps), Mobile District coordinated the identified proposals with the U.S. Fish and Wildlife Service (USFWS), Jackson, Mississippi. The USFWS has provided its Planning Aid Assistance (PAL) letter dated June 12, 2007 concerning the Mississippi Coastal Improvements Program (MsCIP) effort.

United States Department of the Interior

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

June 12, 2007

Dr. Susan Rees
U.S. Army Corps of Engineers
Mobile District
109 St. Joseph St.
Mobile, AL 36602

Dear Dr. Rees:

As you are aware, the U.S. Fish and Wildlife Service (Service) has agreed to be a cooperating agency during the environmental review process of the Mississippi Coastal Improvements Program (MsCIP). In this capacity, we have assisted in drafting the Environmental Impact Statement (EIS) and Environmental Appendix. We have provided input on modeling schemes and selection of potential restoration sites to the Engineering Research and Development Center in Vicksburg, Mississippi. We have also made recommendations regarding potential impacts to wetlands, National Wildlife Refuge lands, Coastal Barrier Resources Act (CBRA) units, and fish and wildlife resources.

This planning aid letter (PAL) is provided to give additional information regarding federally listed species and their habitats that may be adversely affected by some of the program activities. This PAL is submitted under the Endangered Species Act (ESA)(87 Stat. 884, as amended 16 U.S.C. 1531 et seq.) and the Fish and Wildlife Coordination Act (16 U.S.C. 661-667e) but does not constitute the report of the Secretary of the Interior as required by Section 2(b) of the Act.

The program purpose, as authorized by the Department of Defense Appropriations Act 2006 (P.L. 109-148) dated December 30, 2005, is to conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of salt water intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes.

The Service has determined that the following federally listed species and/or their habitats could be located within the project area and should be considered:

The threatened gopher tortoise (*Gopherus polyphemus*) inhabits well-drained sandy soils, especially in areas of longleaf pine. The gopher tortoise digs a burrow used as a shelter and nesting area. Groups of these tortoises dig burrows in the same location forming a colony. In addition, the threatened eastern indigo snake (*Drymarchon corais couperi*) is known to inhabit gopher tortoise burrows.

The endangered red-cockaded woodpecker (*Picoides borealis*) (RCW) is a species of southern pine forests. RCW's excavate nesting cavities in mature pine trees (60+ years old). The preferred nesting habitat is open, park-like, mature pine woodlands with few or no hardwood trees present. A mated pair of birds and all helper birds forms a clan. A cluster of cavity trees where the clan nests and roosts is called a colony. All cavity trees, active and inactive, are important to the colony and should therefore be avoided. Preferred feeding habitats are pine stands with trees 23 cm (9in.) and greater in diameter. Therefore, pine stands with this diameter and greater within a half-mile of a colony should be considered foraging habitat and should not be disturbed. These areas may or may not include a significant hardwood component.

The endangered plant, Louisiana quillwort (*Isoetes louisianensis*), is a nonflowering grasslike plant that lives in or near shallow, blackwater streams in riparian woodland and bayhead forests of pine flatwoods and upland pine forests. Mature plants are six to ten inches high, mostly evergreen, with spore-bearing structures below the ground.

The black pine snake (*Pituophis melanoleucus* ssp. *lodingi*) a candidate species, prefers uplands with well-drained sandy soils in areas of longleaf pine and hardwood tree species.

The endangered Alabama red-bellied turtle *(Pseudemys alabamensis)* is found in the lower Pascagoula River and its tributaries: Bluff Creek and the Escatawpa River. It is also found in Old Fort Bayou, the Tchoutacabouffa River, the Biloxi River, and the Back Bay of Biloxi. Destruction of nesting areas along river banks and feeding areas of submerged aquatic vegetation, and reduced water quality have impacted this species. Red-bellied turtles in Mississippi are somewhat different from those in Alabama, having fewer or less conspicuous head-stripes, a narrower head, less-conspicuous cusps (particularly on hatchlings), darker background color on the carapace and skin, and a relatively longer, narrower shell.

The federally listed threatened Louisiana black bear (*Ursus a. luteolus*) occurs primarily in bottomland hardwood and floodplain forests along the Mississippi River and the southern part of the state. Although the bear is capable of surviving under a range of habitat types, some necessary habitat requirements include hard mast, soft mast, escape cover, denning sites, forested corridors, and limited human access. Forest management practices, agricultural, commercial and industrial development, and highways can cause adverse impacts to bear habitat by increasing human disturbance, fragmenting forests, and removing den trees.

The threatened bald eagle (*Haliaeetus leucocephalus*) is the only species of sea eagle regularly occurring on the North American continent. The bald eagle is predominantly a winter migrant in the southeast; however, increasing occurrences of nesting have been

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observed. The bald eagle nests in the transitional area between forest and water. They construct their nests in dominant living pines or bald cypress trees. Eagles often use alternate nests in different years with nesting activity beginning between September and January of each year. Young are usually fledged by midsummer.

The endangered Mississippi gopher frog (*Rana sevosa*), requires two distinct habitats: temporary pools for breeding and upland foraging sites with a subterranean refuge (tortoise burrows, crawfish burrows, or stumpholes). The only population currently known to exist is located in Harrison County, Mississippi.

The threatened Gulf sturgeon (*Acipenser oxyrhynchus desotoi*) is found in the Pearl, Leaf, and Pascagoula Rivers. Gulf sturgeons are primitive, anadromous fish that annually migrate from the Gulf of Mexico into freshwater streams. Subadults and adults spend eight to nine months each year in rivers. Although Gulf sturgeon activity is not well documented, the species has been found in the Pearl River as far north as the Jackson metropolitan area. The decline of the Gulf sturgeon is primarily due to limited access to migration routes and historic spawning areas, habitat modification, and water quality degradation. Critical Habitat has been designated along the Mississippi Gulf Coast, and the Pearl, Leaf, and Pascagoula Rivers.

The threatened yellow-blotched map turtle (*Graptemys flavimaculata*) is found in the Chickasawhay, Leaf, and Pascagoula Rivers. The yellow-blotched map turtle prefers river stretches with moderate currents, abundant basking sites, and sand bars. Stream modification has significantly contributed to the decline of the species.

The endangered Brown pelican *(Pelecanus occidentalis*) nests mostly on offshore islands, but has been known to nest in onshore estuaries. Nesting areas are usually in low shrubs, trees or on the ground, and contain groups of 25-250 birds. They also congregate to feed near coastal wharves and pilings. Disturbance of nesting areas should be avoided.

The threatened Piping Plover *(Charadrius melodus)* does not nest in Mississippi but winters along the coastal beaches and barrier islands. These feeding areas have been threatened by urban development. Hence, Critical Habitat has been designated along several areas of the Mississippi Gulf Coast.

The endangered Mississippi Sandhill Crane *(Grus canadensis pulla*) is found only in a small area west of the Pascagoula River in Jackson County. Critical Habitat has been established on and adjacent to the Mississippi Sandhill Crane National Wildlife Refuge.

Kemp's ridley, Green, and Loggerhead sea turtles are also listed species found along the coast of Mississippi. The Service has jurisdiction over these species whenever there may be impacts to nesting sea turtles.

Once final project proposals are available, areas of potential habitat for listed species should be surveyed to determine presence or absence. The results of the survey will be included in a Biological Assessment to be provided to the Service as part of ongoing consultation under the ESA.

In addition, we recommend that your agency coordinate with National Marine Fisheries Service (NMFS), which also has jurisdiction for listed marine species, including sea turtles and gulf sturgeon.

We are aware that the Corps is considering structural, non-structural, and environmental approaches to the MsCIP program. Although we understand the need for structural measures in certain circumstances, we recommend that environmental and non-structural measures be utilized wherever practicable. However, minimization and avoidance of impacts should be considered on all project elements.

Upon receipt of the Draft Integrated Comprehensive Report/EIS, the Service will provide comments and recommendations on the projects. We understand that many of the projects plans will be conceptual in nature and therefore, our recommendations will only be as specific as the plans allow.

The Service looks forward to continuing to work with the Corps on the MsCIP program. Should you have any further questions or concerns, please contact Paul Necaise at 228-493-6631 or Sabrina Chandler at 601-321-1135.

Sincerely,

Ray Aycock
Field Supervisor

cc: NMFS, Panama City, FL
MSDMR, Biloxi, MS
MDEQ, Jackson, MS
EPA, Atlanta, GA
NPS, Gulf Breeze, FL

FISH AND WILDLIFE COORDINATION REPORT

The Corps, Mobile District coordinated with the USFWS concerning the MsCIP effort. The USFWS provided its final Draft Fish and Wildlife Coordination Act Report on June 12, 2008 and its Final Fish and Wildlife Coordination Act Report on April 23, 2009. The Corps utilized the USFWS' recommendations, shown below, in the developments of the MsCIP effort. In fact, the Corps had assistance from the USFWS staff member in the actual preparation of this MsCIP documentation.

1. Incorporate sediment control measures during construction including timely revegetation of disturbed areas.

2. Maintain disturbed areas with the use of native vegetation if at all possible. Clean equipment prior to transport to prevent contamination by exotic species such as cogon grass to other sites.

3. Place restrictive easements or covenants on all preserved and restored project areas to prevent future development.

4. Account for secondary development and indirect effects associated with projects during advanced design and feasibility studies.

5. Environmental and non-structural measures should be utilized in place of hard structures wherever practicable.

6. Minimization and avoidance of impacts should be considered on all project elements.

7. Consultation as required by Section 7 of the Endangered Species Act will be completed as necessary.

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United States Department of the Interior

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

April 23, 2009

Colonel Peter F. Taylor, Jr.
District Engineer, Mobile District
U.S. Army Corps of Engineers
P.O. Box 2288
Mobile, AL 36628-0001

Dear Colonel Taylor:

Enclosed is our final Fish and Wildlife Coordination Act (FWCA) report for the Mississippi Coastal Improvements Program (MsCIP), Hancock, Harrison, and Jackson Counties, Mississippi. The Mississippi Department of Wildlife, Fisheries, and Parks and National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA-NMFS) have participated in the environmental planning phase of this program.

The program is authorized to conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area 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. Numerous projects are being recommended under various authorities. Many projects require further design and study.

Our report concluded that implementation of this program will impose both adverse and favorable impacts to fish and wildlife resources. Once more detailed information is available, addendums to the report will be incorporated. We have provided preliminary measures and recommendations that could reduce impacts to fish and wildlife resources. In accordance with provisions of the FWCA, this report should be attached to and made an integral part of your final Comprehensive Report. Thank you for the opportunity to comment on this program.

Sincerely,

Cary Norquist
Acting Field Supervisor

cc:
Environmental Protection Agency, Atlanta, GA
Miss. Dept. of Wildlife, Fisheries, and Parks, Jackson, MS
Miss. Dept. of Environmental Quality, Jackson, MS
Miss. Dept. of Marine Resources, Biloxi, MS
National Marine Fisheries Service, Panama City, FL
National Park Service, Gulf Breeze, FL

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FISH AND WILDLIFE COORDINATION ACT REPORT

MISSISSIPPI COASTAL IMPROVEMENTS PROGRAM (MsCIP)

Prepared by:

U.S. Fish and Wildlife Service
Ecological Services
Mississippi Field Office
Jackson, Mississippi
April 2009

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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). The scope of the proposed project is to address the full range of structural, non-structural, and ecosystem restoration measures available to provide short term, as well as, comprehensive solutions. The study area includes the three coastal counties along the northern Gulf of Mexico within the State of Mississippi: Hancock, Harrison, and Jackson. Also included in the project is the offshore ecosystem of the Mississippi Sound and its barrier islands.

Proposed projects include numerous environmental restoration projects, restoration of the barrier islands, beach and dune construction, submerged aquatic vegetation restoration, freshwater diversions, ring levees, elevated roadways, seawalls, inland barriers and surge gates, residential buyouts and relocations, and retreat and/or relocation of critical facilities. These projects would have both adverse and favorable impacts to fish and wildlife resources. However, in order to provide an adequate evaluation of impacts for some projects, more information and further study is needed. Supplemental Environmental Impact Statements (EIS) will be provided to address impacts in those cases. Additional Fish and Wildlife Coordination Act (FWCA) reports will be prepared based on those Supplemental EIS's. Our preliminary recommendations are:

1. Incorporate sediment control measures during construction including timely revegetation of disturbed areas with native plant species.

2. Maintain disturbed areas with the use of native vegetation if at all possible. Clean equipment prior to transport to prevent contamination by exotic species such as cogon grass to other sites.

3. Place restrictive easements or covenants on all preserved and restored project areas to prevent future development.

4. Account for secondary development and indirect effects associated with projects during advanced design and feasibility studies.

5. Environmental and non-structural measures should be utilized in place of hard structures wherever practicable.

6. Minimization and avoidance of impacts should be considered on all project elements.

7. Consultation as required by section 7 of the Endangered Species Act will be completed as necessary.

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INTRODUCTION

This final Fish and Wildlife Coordination Act (FWCA) report provides planning input and recommendations for the U.S. Army Corps of Engineers Mississippi Coastal Improvements Program (MsCIP) in, Hancock, Harrison, and Jackson Counties, Mississippi. The proposed project is authorized in response to Hurricane Katrina by Public Law 109-148 (30 December 2005) to:

> "Conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area 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…"

This FWCA report is to accompany your Integrated Comprehensive Report/Environmental Impact Statement (EIS) and is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended: 16 U.S.C. 661 et seq.) and the Endangered Species Act (16 U.S.C. 1531 *et seq*.). This final report constitutes the report of the Secretary of the Interior as required by Section 2(b) of the Act. Additional FWCA reports will be provided to evaluate Supplemental EIS's where they may be warranted.

The purpose of the proposed program is to identify risk reduction measures that can be integrated to form a system that will address the interests expressed in the authorization. The scope of the proposed project includes the full range of structural, non-structural, and ecosystem restoration measures available to provide short term, as well as, comprehensive solutions.

The U.S. Fish and Wildlife Service (Service) is a cooperating agency for this project and has had a representative co-located with the U.S. Army Corps of Engineers (Corps), Mobile District throughout the planning process. Other cooperating agencies include over 30 Federal, State, and local governments, Non-Governmental Organizations (NGO's), and business and industries, as well as several private citizens. An environmental team was established to formulate environmental restoration projects and complete the EIS portion of the Comprehensive Report. Representatives on the environmental team include individuals from National Marine Fisheries Service (NOAA-NMFS), National Park Service (NPS), U.S. Geological Survey (USGS), Environmental Protection Agency (EPA), Mississippi Department of Environmental Quality (MDEQ), Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), and Mississippi Department of Marine Resources (MDMR, the local sponsor). Since April 2006, the Corps Mobile District has hosted 12 formal public and agency meetings, a 2-day Regional coordination meeting, a Public Scoping workshop, 3 online meetings, a Public Hearing workshop, and numerous internal meetings in which the Service participated as a full member of the MsCIP planning team. The Corps also launched a website enabling user downloads, project team collaboration, and improved communication and coordination among agencies and the public.

Public Law 109-148 also authorized the Corps to provide interim recommendations for near term improvements. The Corps solicited project proposals from agencies and the public, by which they identified 180 projects that could be classified as hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, or prevention of coastal erosion. Those projects were evaluated, screened, and refined into a list of 15 projects that could be recommended for construction. These 15 projects were included in the MsCIP interim report that was submitted to Congress in August 2006. Together these projects will restore 35 miles of beach and dune systems; protect/enhance 3,300 acres of coastal wetlands; restore 2.5 miles of seawall systems; restore flood storage capacity and circulation in 11 miles of streams/canals; potentially reduce storm damage to over 41,000 structures, and provide $11 million in annual recreation benefits. Congress appropriated $107,000,000 for these recommendations as part of an emergency supplemental bill on May 25, 2007.

The numerous meetings and coordination workshops have allowed the Corps to eliminate some projects based on lack of support or major impacts. The project components found within Chapter 8 of the current Integrated Comprehensive Report/EIS (ICR/EIS) are a result of this input. This report will address those remaining projects in this report.

The Service provided the Corps with a Planning Aid Letter (PAL) dated June 12, 2007 with initial recommendations as well as a list of federally protected threatened and endangered (T&E) species that may be impacted by the proposed project. The Service recommended in the PAL that environmental and non-structural measures be utilized wherever practicable, and that minimization and avoidance of impacts should be considered on all project elements.

A draft FWCA was provided on November 20, 2007 and provided additional recommendations. That report was written based on an earlier version of the ICR/EIS that did not contain all of the components that would be recommended for construction. This final FWCA addresses all of the components that will be recommended for construction. Additional components that are mentioned, but will not be recommended for construction in the ICR/EIS will be evaluated and presented in future Supplemental EIS's which will require an additional FWCA report.

DESCRIPTION OF STUDY AREA

The study area includes the three coastal counties along the northern Gulf of Mexico within the State of Mississippi: Hancock, Harrison, and Jackson. Also included in the project is the offshore ecosystem of the Mississippi Sound and its barrier islands. Areas in Louisiana and Alabama that would be affected by actions considered for improvements to the Mississippi coast will be discussed, if applicable.

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The 75-mile coastal area is bounded on the west by the Pearl River, on the east by the Alabama state line, and to the south by the Gulf of Mexico. The Mississippi Sound is a partially protected body of water averaging 8 to 10 miles wide separated from the Gulf of Mexico by a series of barrier islands (Cat, Ship, Horn, and Petit Bois Island). The Gulf Intra-coastal Waterway encompasses deep water in the Mississippi Sound a few miles from the mainland shore. The mainland shore is broken by the entrances to Bay of St. Louis between Bay St. Louis and Pass Christian, and Biloxi Bay between Biloxi and Ocean Springs. U.S. Highway 90 traverses the area a few miles inland except in Harrison County, where it closely borders the coastline. Two major rivers empty into Mississippi Sound. The Pearl River, which forms the boundary between Mississippi and Louisiana, and the Pascagoula River, which travels North to South through Jackson County and enters the sound at Pascagoula. Major towns along the coast are, from west to east, Waveland, Bay St. Louis, Pass Christian, Long Beach, Gulfport, Biloxi, Ocean Springs, and Pascagoula. This area ranges in elevation from sea level to about 30 feet. The essentially flat to gently undulating, locally swampy Coastal Lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits and merge with the fluvial-deltaic, plains of the streams of the area. This portion of Coastal Mississippi has been classified as an alluvial coast, and terraced, deltaic plain. This area is illustrated in Figure 1.

Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the United States (U.S.) in its recorded history. Hurricane Katrina affected over 90,000 square miles (m2) of the Gulf Coast region. It caused nearly complete destruction of several large coastal communities while seriously damaging numerous others. The destruction was on a scale unmatched by any natural disaster in U.S. history. Losses to Coastal Mississippi were unprecedented and have presented a high cost to the nation with a complete fisheries failure being declared by the Commerce Secretary. Hurricane Katrina produced marine debris covering valuable productive water bottoms, exacerbated coastal erosion, loss to maritime forests, degraded water quality, increased pollution, created widespread debris fields throughout coastal wetlands, degraded coastal preserve lands owned and maintained by the State of Mississippi, increased risks to infrastructure and human life, danger to fish and wildlife including T&E species and their critical habitats, and the loss of an entire way of life. Losses to many commercially important fisheries stock, foraging areas, and nurseries have been felt economically throughout the region. Spawning, breeding, and foraging grounds of fish and shellfish were severely impacted resulting in rising prices, and once readily available resources are in limited supply. The ability of wetlands to enhance protection from future storm surges, coastal erosion, and flooding has been greatly reduced. Human activities can also inhibit the natural processes of coastal lands. Urban and residential development is often conducted without an adequate understanding of coastal geology and processes. There have been an increased number of wetland fill permits due to the apparent need for housing in the area, post-Katrina, that can also impact the coastal area’s natural defenses against storm surge. As a result, they can lead to cumulative degradation of coastal resources. Cooperative scientific investigations are starting to provide the crucial information needed to minimize the unintended effects of human disturbances along coasts.

Figure 1. MsCIP Study Area

FISH AND WILDLIFE CONCERNS AND PLANNING OBJECTIVES

The primary responsibility of the Service is the identification of fish and wildlife habitats and identification of preservation and restoration opportunities for the Mississippi Gulf Coast. Specifically the Service has identified the following needs of the Study Area:

1. Preservation of wetlands and associated fish and wildlife resources found within the Mississippi Gulf coastal area.

2. Restoration of the hydrology and vegetation found within the degraded portions of the Mississippi Gulf coastal area.

3. Minimization of structural measures by optimizing environmental and non-structural measures, such as wetland restoration, residential buyouts and floodproofing.

EVALUATION METHODOLOGY

Projects were evaluated for wetland impacts (acres) and restoration benefits in the form of Functional Capacity Indices (FCI) and Functional Habitat Indices (FHI). The FCI for each function is readily used to evaluate impacts, compare project alternatives, and help design and evaluate mitigation plans. Sites proposed for residential buyout and/or relocation and environmental restoration were selected using the Spatial Decision Support System (SDSS). More information on the SDSS tool can be found in the Environmental Appendix of the Comprehensive Report. This information is summarized in Table 1 below.

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Table 1. Summary of models used in evaluation and analysis of environmental project proposals included in the MsCIP Comprehensive Plan.

Model	Description/Purpose	Use in MsCIP
Spatial Decision Support System	GIS based decision system to identify & evaluate potential sites	Selection of potential Wetland restoration sites
AL/MS Gulf Coast Tidal Fringe HGM Model	Perform functional assessment of tidal fringe wetlands	Evaluate positive/negative impacts to tidal fringe wetlands
MS Wet Pine Savannah HGM Model	Perform functional assessment of wet pine savannah habitats	Evaluate positive/negative impacts to wet pine savannah habitats
Functional Habitat Index Spreadsheet	Assess the environmental values of beach and dune habitat	Evaluate positive/negative impacts to beach and dune habitats

The methodology used for riparian and coastal wetlands is the Hydrogeomorphic Model (HGM) developed by EPA, NOAA-NMFS, Corps, and Service personnel, and is calibrated for wetlands ecosystems found in coastal Mississippi, as used in many prior studies (Shafer et al. 2007). HGM is a science-based quantitative and replicable methodology that establishes functions and values at a variety of sites and reference points that are then used to establish functional values for sites within the area be analyzed. HGM was applied at a landscape-level, using numerous reference sites in the area in the establishment of without-project conditions. The HGM model was used for the functional assessment of Tidal Fringe wetlands and Wet Pine Savannahs within the study area. Because HGM has not been calibrated for use in Maritime Forest or beach and dune analysis in this area, an alternative methodology was used for the small number of these sites. The methodology chosen for this application was FHI.

FISH AND WILDLIFE RESOURCES

Although no site specific sampling of terrestrial or aquatic resources has been completed for this study, fish and wildlife resource estimates are based upon past reports and data pertinent to the study area. Existing fish and wildlife resources along the Mississippi Gulf Coast are a product of the area's response to human alteration and impact.

Many species of invertebrates and vertebrates make up the fauna population along the Mississippi Gulf Coast. Invertebrate populations in Mississippi Sound and the nearshore area of the Gulf of Mexico transfer energy through the coastal food web. Microscopic estuarine zooplankton live throughout the water column with limited mobility. Zooplankton includes such organisms as copepods, protozoans, chaetognaths, pteropods, tunicates, ctenophores, and siphonophores. Larval stages of benthic forms and eggs and larval stages of many fish species are often interspersed throughout zooplankton. Many important commercial fish species feed upon zooplankton.

Vittor and Associates (1982) investigated the macrofauna of Mississippi Sound and selected areas in the Gulf of Mexico. Over 532 taxa from offshore Mississippi and Alabama and 437 taxa from the Mississippi Sound were identified. Densities of individuals varied from 910 to 19,536 individual/ $yard^2$ for the offshore and 1,200 to 38,863 individual/ $yard^2$ for the Sound area. Abundance of macrofauna is temporal with greatest densities occurring from fall to spring.

Oyster production in Mississippi depends on public reefs managed by the Mississippi Department of Marine Resources (DMR). The State of Mississippi accounts for about 13% to 17% of Gulf oyster landings. Reefs are located along the coast across the entire state with the largest reefs near the western boundary. According to W.J. Demoran (1979), there were 9,934 acres of oysters. At that time, that number included 582 acres of planted oyster beds. Additional acreage has been planted. A few small areas of oyster bottom have been leased for private development; however, production from these areas has been negligible. There have been considerable annual variations in size of productive areas due to natural environmental fluctuations, such as freshwater flow into the oyster beds. Many of Jackson County's most productive areas have been closed to harvest due to increased pollution associated with coastal development.

Many commercially important species of crustaceans are harvested in Mississippi Sound and the nearshore of the Gulf of Mexico. Brown shrimp (*Penaeus aztecus*) is the main shrimp species harvested by commercial fishermen in the Gulf of Mexico and is the most important commercial species in the Mississippi Sound and Mobile Bay area. White shrimp (*Litopenaeus setiferus*) and blue crab (*Callinectes sapidus*) are also harvested within the study area. In addition to those commercial species, there is a very diverse community of crustaceans within Mississippi Sound and adjacent waters including a wide variety of forms and habitat preferences. Epibenthic crustaceans dominate the diet of flounder, catfish, croaker, porgy, and drum. Christmas and Waller (1973) reported 138 fish species in 98 genera and 52 families taken from areas across Mississippi Sound. The major fisheries landed along the Mississippi Gulf coast are anchovies, menhaden, mullet, croakers, shrimp, and oyster. Jackson County, primarily the ports of Pascagoula and Moss Point, receives greater than 85% of all Mississippi landings, including all industrial fish (menhaden), 95% of the mullet, trout, and red snapper, and 74% of the croaker landed (Corps 1992).

Coastal wetlands of Mississippi Sound, St. Louis Bay, Biloxi Bay, Pascagoula Bay, and the tidal Pascagoula River provide the resource base for commercial and marine recreational fishing and tourism in Mississippi. The dockside value of commercial fish landings in Mississippi neared $42 million in 1995. Recreational fisheries also play an important role in the state's economy. In 1991, 500,000 people spent more than $236 million fishing in Mississippi's waters, generating almost $14 million in state sales tax, resulting in $131 million in earnings, and supporting more than 8,000 jobs. Approximately one-quarter of the recreational fishing occurs in coastal waters.

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Communities such as Moss Point, Pascagoula, Gautier, Ocean Springs, Biloxi, Long Beach, Gulfport, Pass Christian and Bay St. Louis all depend on fishing to support their local economies.

Coastal Mississippi habitats support an array of reptiles, amphibians, birds, and mammals. There is a great diversity of reptiles including 23 species of turtles, 10 species of lizards, 39 species of snakes, and the American alligator. Eighteen species of salamanders and 22 species of frogs and toads are indigenous to the coastal region.

Mammals occur within all habitats of the coastal system, using underground burrows, the soil surface, vegetative strata, the air, and the water for feeding, resting, breeding, and bearing and rearing young. There are 57 species of mammals found in the area (Corps 2005). Several species of mammals include the raccoon, river otter, gray fox, striped skunk, mink, white-tailed deer, bottlenose dolphin, beaver, possum, and nine-banded armadillo. A number of whales are known to occur offshore and occasionally are sighted within the Mississippi Sound.

Over 300 species of birds have been reported as migratory or permanent residents within the area. Several of these species also breed there. Shorebirds and wading birds include osprey, great blue heron, great egret, piping plover, sandpiper, gulls, brown and white pelicans, American oystercatcher, and terns. These birds eat a great variety of foods and exhibit a diversity of nesting behaviors.

Loss of these habitats is increasing throughout coastal Mississippi largely due to development and habitat degradation. Urban encroachment on fish and wildlife habitats has created direct and indirect affects. Impacts to habitats can include direct loss due to construction, but also come from the inability to properly manage existing habitats. Fire management is a necessary tool in wet pine savannahs, a dominant habitat type across the local landscape. Increased wildland-urban interface (WUI), where forests meet development, prohibits the use of prescribed fire in many cases due to liability associated with fire.

Fish and wildlife habitats within the project area are diverse. Wet pine savannah is a dominant wetland type with the Mississippi Coastal area. A dominant upland habitat type is mixed pine-hardwood forest. Remaining habitats include: fresh and saltwater tidal marsh, non-tidal freshwater marsh, beach and dune, riparian forest, and bottomland hardwood forest. The Service Mitigation Policy (CFR 46(15):7644-7663; Appendix I) classifies wet pine savannah, fresh and saltwater tidal marsh, non-tidal freshwater marsh, bottomland hardwoods, and beach and dune habitats as a Resource Category 2. These habitats are “of high value for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section.” The mitigation goal for a Resource Category 2 habitat is “no net loss of in-kind habitat value.” Mixed-pine hardwood and riparian forests are classified as a Resource Category 4. These habitats are “of medium to low value for evaluation species.” The mitigation goal for Resource Category 4 habitat is “minimization of loss of habitat value.”

Invasive exotic species are also of increasing concern especially in coastal areas. Chinese tallow tree (*Sapium sebiferum*) and Cogongrass (*Imperata cylindrica)* are two major pest plant problems that land managers face. Faunal invasives also persist along the coast. Wild hogs (*Sus scrofa*) and red imported fire ants are two examples of invasive fauna that impact native species and their habitats.

THREATENED AND ENDANGERED SPECIES

There are nineteen (19) species listed under the Endangered Species Act within the project study area (Table 2). These species include both aquatic and terrestrial fauna, as well as one plant species. National Marine Fisheries Service has jurisdiction over off shore species and critical habitat, including sea turtles, Gulf sturgeon, and some whale species.

Due to the scope of this project and associated unknown factors, consultation as required by section 7 of the Endangered Species Act (16 U.S.C. 1531 *et seq.*) will be addressed at least initially through this report. It is the opinion of the Service that some of the “Tentatively Selected Comprehensive Plan Components” may warrant Formal Consultation once more specific plans are available for each project and supplemental EIS documents are prepared. Therefore, the Service reserves the right to request formal consultation if necessary. Affects to T&E species and other fish and wildlife resources associated with each component are listed in the section titled “Description of Project Impacts.”

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Table 2.Threatened and Endangered Species with Associated Habitat Descriptions.

Common Name	Scientific Name	Status	County	Habitat
Alabama red-bellied turtle	Pseudemys alabamensis	E	Harrison, Jackson	Submerged aquatic vegetation in brackish coastal rivers; freshwater reaches
Bald eagle	Haliaeetus leucocephalus	Delisted*	Hancock, Harrison, Jackson	Shorelines near open water
Black pine snake	Pituophis melanoleucus ssp. lodingi	C	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Brown pelican	Pelecanus occidentalis	E	Hancock, Harrison, Jackson	Feeds over water in coastal areas, nests on small islands.
Gopher tortoise	Gopherus polyphemus	T	Hancock, Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Green sea turtle	Chelonia mydas	T	Hancock, Harrison, Jackson	Shallow coastal waters with SAV and algae, nests on open beaches.
Gulf sturgeon,	Acipenser oxyrhynchus desotoi	TCH	Hancock, Harrison, Jackson	Migrates from large coastal rivers to coastal bays and estuaries
Inflated Heelsplitter	Potamilus inflatus	T	Hancock	Soft, stable substrata in slow to moderate currents of tributaries and large rivers
Kemp's Ridley sea turtle	Lepidochelys kempii	E	Hancock, Harrison, Jackson	Nearshore and inshore coastal waters, often in salt marshes
Loggerhead sea turtle	Caretta caretta	T	Hancock, Harrison, Jackson	Open ocean; also inshore areas, bays, salt marshes, ship channels, and mouths of large rivers
Louisiana black bear	Ursus americanus luteolus	T	Hancock, Harrison, Jackson	Bottomland hardwood forest; frequently ranges into other habitats
Louisiana quillwort	Isoetes louisianensis	E	Hancock, Harrison, Jackson	Small blackwater streams with sand and gravel substrate and forest cover
Mississippi gopher frog	Rana capito sevosa	E	Harrison, Jackson	Fire-dependent, upland longleaf pine forests; open, ephemeral upland pools
Mississippi sandhill crane	Grus canadensis pulla	ECH	Jackson	Wet pine savannah
Pearl darter (Pascagoula River System)	Percina aurora	C	Jackson	Rivers and large creeks with sand and gravel bottoms and flowing water.
Piping Plover	Charadrius melodus	TCH	Hancock, Harrison, Jackson	Barrier islands and coastal beaches
Red-cockaded woodpecker	Picoides borealis	E	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
West Indian or Florida Manatee	Trichechus manatus	E	Hancock, Harrison, Jackson	Fresh and salt water in large coastal rivers, bays and estuaries.
Yellow-blotched map turtle	Graptemys flavimaculata	T	Jackson	Rivers and large creeks with habitat suitable for basking

E = endangered T= threatened C= candidate CH= designated critical habitat

*The Bald Eagle continues to be protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act

COASTAL BARRIER RESOURCES ACT

The Coastal Barrier Resources Act (CBRA) of 1982 established the John H. Chafee Coastal Barrier Resources System (CBRS), comprised of undeveloped coastal barriers along the Atlantic, Gulf, and Great Lakes coasts. The law encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting Federal expenditures that encourage development, such as Federal flood insurance through the National Flood Insurance Program. CBRA is a free-market approach to conservation. These areas can be developed, but Federal taxpayers do not underwrite the investments. CBRA saves taxpayer dollars and encourages conservation at the same time. CBRA has saved over $1 billion and will save millions more in the future. Approximately 3.1 million acres of land and associated aquatic habitat are part of the CBRS. The Fish and Wildlife Service maintains the repository for CBRA maps enacted by Congress that depict the CBRS. The Service also advises Federal agencies, landowners, and Congress regarding whether properties are in or out of the CBRS, and what kind of Federal expenditures are allowed in the CBRS.

The Coastal Barrier Resources Act and its amendments prohibit most new Federal expenditures that tend to encourage development or modification of coastal barriers. The laws do not restrict activities carried out with private or other non-Federal funds and only apply to the areas that are within the defined John H. Chafee Coastal Barrier Resource System (CBRS).

Examples of prohibited Federal assistance within System units include subsidies for road construction, channel dredging, and other coastal engineering projects. Federal flood insurance through the National Flood Insurance Program is available in a CBRS unit if the subject building was constructed (or permitted and under construction) before the CBRS unit's effective date. If an existing insured structure is substantially improved or damaged, the Federal flood insurance policy will not be renewed.

Federal monies can be spent within System units for certain exempted activities, after consultation with the U.S. Fish and Wildlife Service. Examples of such activities include emergency assistance, military activities essential to national security, exploration and extraction of energy resources, preservation of fish and wildlife resources, and maintenance of existing Federal navigational channels.

The Coastal Barrier Improvement Act of 1990 expanded the CBRS and created a new category of lands known as otherwise protected areas (OPAs). OPA designations add a layer of Federal protection to coastal barriers already held for conservation or recreation, such as national wildlife refuges, national parks and seashores, state and county parks, and land owned by private groups for conservation or recreational purposes, and discourage development of privately owned inholdings. The only Federal funding prohibition within OPAs is Federal flood insurance. The CBRS currently includes 271 OPAs which add up to approximately 1.8 million acres of land and associated aquatic habitat. These units are designated by the letter ‘P’ found at the end of the unit identifier.

There are seven CBRA units within the MsCIP project area (Table 3). Petit Bois, Horn, and Ship Islands which are part of the Gulf Islands National Seashore (GUIS) are all considered one unit

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(MS-01P). This unit falls into the category of OPAs, thus the letter ‘P’ found at the end of the unit identifier. The remaining island within GUIS is Cat Island which has a separate designation. Those portions of Cat Island that are owned and managed by the National Park Service are designated as unit R03. Note that even though Cat Island could be designated as an OPA this designation was not made due to the fact that the remainder of the island is under private ownership which is not considered a part of CBRA.

Table 3. Coastal Barrier Resources Act units within the Mississippi Coastal Improvement Program Area

Unit Identifier	County	Description
MS-01P	Jackson	Gulf Islands
MS-01P	Jackson	Gulf Islands
MS-01P	Jackson	Gulf Islands
MS-01P	Jackson	Gulf Islands
MS-01P	Harrison	Gulf Islands
R01	Jackson	Round Island
R01A	Jackson	Belle Fontaine Point
MS-02	Jackson	Marsh Point
R02	Harrison	Deer Island
R03	Harrison	Cat Island
MS-04	Hancock	Heron Bay Point

DESCRIPTION OF TENTATIVELY SELECTED COMPREHENSIVE PLAN COMPONENTS

Components of MsCIP can be grouped into five categories. Only those components that are recommended for construction authorization will be addressed within this Report. Other components that require additional engineering and design or study will be addressed in FWCA reports that will correspond with Supplemental EIS’s provided by the Corps upon authorization. Categories of selection of recommended measures are listed below.

- Projects recommended for construction authorization
- Projects recommended for additional pre-construction engineering and design
- Studies recommended for finalization under programmatic plan authorization
- Studies recommended for additional feasibility-level study
- Studies recommended for inclusion as requiring advanced design studies

It is important to note that many measures that may be recommended will be grouped in categories that include projects that will require minimal additional information during preparation of plans and specifications. Many measures will be recommended as potential actions that will need advance design prior to development of plans and specifications and others will establish a framework in which future projects will be identified under continuing authorities that would require specific Project Information Reports (PIR) after development of plans and specifications. There are certain measures that will require additional studies to determine problems and opportunities in order to address any concerns.

As a result of the numerous categorizations of potential projects that might come forth from the MsCIP Comprehensive Report, further environmental considerations and analyses will be required for some projects. There will be additional coordination and consultation on supplemental EIS's for projects that would result in significant impacts to the environment and further environmental assessments for projects that are less complex in nature with less significant impacts associated with them.

This final FWCA report serves as coordination of the current draft EIS, and will serve as the basis from which further required environmental analyses and documentation could be tiered.

Comprehensive plan components have been tentatively selected and are determined to be 'keystone' pieces on which later recommendations would be built. These plan elements have been determined to be engineeringly feasible, environmentally acceptable and beneficial, and cost effective. Each of the tentatively selected plan components have been designed to function as stand alone units that will act independently should additional time be required for design or other components be determined to not be cost effective. Descriptions of tentatively selected components of the comprehensive plan can be found in Chapter 8 of the Main Report.

DESCRIPTION OF PROJECT IMPACTS

Hurricane and Storm Damage Reduction Plan Components

The plan components described below will singly or in combination assist in the reduction of risk to the maximum extent practicable. Other options, both structural and nonstructural, present opportunity for additional risk reduction but are not able to be evaluated in the Comprehensive report at a level required to determine feasibility, acceptability, or cost effectiveness. Potential impacts associated with each project are presented below, however due to the vast number of properties involved and the uncertainties associated with some project footprints, specific affects may not be available at this time.

1. Hurricane Risk Reduction Education

This component is not likely to adversely affect fish and wildlife resources, including T&E species.

2. Hurricane and Storm Warning

This component is not likely to adversely affect fish and wildlife resources, including T&E species.

3. Hurricane Evacuation Planning

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This component is not likely to adversely affect fish and wildlife resources, including T&E species.

4. Floodplain Management

Better management of the floodplain could benefit fish and wildlife resources by restricting impacts of associated with development within the floodplain. This component could also benefit wetlands by reducing the amount hazardous waste, un-anchored structural components, and other infrastructure that is allowed within the floodplain, as well as reduce the amount of fill necessary for development in these areas. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

5. Building Code Update

Updated building codes could reduce the number of structures that would be destroyed during a hurricane or storm event. Fewer structures impacted would reduce the amount of storm debris and hazardous materials that would likely impact surrounding wetlands and other fish and wildlife habitats. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

6. Zoning Code Update

Updated zoning regulations support both the floodplain management and building code update components, by further prohibiting certain types of development and structures from high hazard areas. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

7. Long-term Critical Infrastructure and Services Relocation (LOD 5)

This component would encourage relocation or designation of critical infrastructure outside of the Maximum Probable Intensity (MPI) boundary. This line is drawn based on elevation related to the maximum storm surge inundation depth and can be used as a guide for local county and municipal governments when locating critical facilities. As facilities are relocated and constructed northward of this planning line, losses to existing habitats would occur. Potential impacts could also result from secondary development associated with relocation of infrastructure into undeveloped areas. This component could impact T&E species, specifically the threatened gopher tortoise; however this possibility cannot be assessed at this time and would have to be evaluated on a case by case basis. Due to the vast number of properties involved and the uncertainties associated with project footprints, specific impacts to fish and wildlife resources cannot be determined at this time. Future studies during project development would determine specific impacts associated with implementation of this measure.

8. Homeowner Assistance and Relocation Program (HARP)

The most effective alternative for reducing the risk from future hurricane surge events is to relocate all structures and population centers from the high risk zones. Formulation of alternatives included those which would provide for minimum level of risk reduction (approximate base flood elevation) up to those that would provide for risk reduction from increasing levels of inundation. In addition a smaller alternative concentrating on voluntary acquisition in the high to moderately high hazard areas is being evaluated.

Temporary and minimal effects could occur during implementation of this measure; however, properties that would be purchased as part of a buy-out program would be restored to historical conditions providing potential benefits to fish and wildlife and their habitats. Floodproofing may temporarily impact fish and wildlife species during construction, but should have no long term impacts once projects are completed. Potential impacts could also result from secondary development associated with relocation of infrastructure into undeveloped areas. This component could impact T&E species, specifically the threatened gopher tortoise; however this possibility cannot be assessed at this time and would have to be evaluated on a case by case basis. Due to the vast number of properties involved and the uncertainties associated with project footprints, specific impacts to fish and wildlife resources cannot be determined at this time. Future studies during project development would determine specific impacts associated with implementation of this measure.

9. Moss Point Municipal Relocation Component

Since relocation of facilities is proposed only within the incorporated limits, there are no negative impacts anticipated as a result of this project. Fish and wildlife resources could benefit from additional greenspace that will be created along the riverfront as a result of this relocation proposal. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

10. Waveland Floodproofing

Temporary and minimal impacts may be encountered during construction of floodproofing components; however no major negative impacts are anticipated as this project will involve currently developed areas within an existing footprint. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

11. Forrest Heights Hurricane and Storm Damage Reduction Component

Due to a pre-existing disturbed condition created by the presence of the residential development and partial levee system currently in place, this component would result in minimal impacts to fish and wildlife species from levee expansion. Continued maintenance of the levee reduces natural habitats that are currently available for numerous wildlife species. This component is not likely to adversely affect fish and wildlife resources, including T&E species. It would however require fill of 19.85 acres of non-tidal wetlands due to expansion of the levee footprint. The entire footprint of the levee at elevation 21 feet would total 23 acres. The 19.85 acres of wetlands are classified as wet pine savannah habitats.

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12. Evaluation of Structural Measures

While large structural solutions such as surge gate barriers did not garner much local support, there were viable alternatives, such as smaller ring levees that have the potential of providing cost effective solutions. Possible ring levee alternatives are being evaluated as part of this study including ring levees at: Belle Fontaine, Gulf Park Estates, Pascagoula/Moss Point, Pearlington, Gautier, Ocean Springs, and Bay St. Louis. The development of cost effective, acceptable alternatives however will require additional study and coordination. Because these components will undergo further study and coordination, only a brief overview of potential impacts has been provided below. All of these structural measures will likely impact fish and wildlife resources and potentially affect T&E species.

Ring Levees

Approximately 265 acres of wetland vegetation could be lost based on some alignments (Lin and Shafer 2007). Although impacts to fish and wildlife resources would depend on the exact footprint of the levee, adverse impacts are not expected due to continuous coordination throughout the planning process. The Belle Fontaine ring levee comes close to falling within CBRA Unit R01A, however, through early consultation with the engineering team this was addressed as a potential conflict and should be revisited if there are changes to the alignment.

Line of Defense 4 – Inland Barrier and Surge Gates

The general alignment of the inland barrier would be along the path of the existing railway that crosses the coast of Mississippi. This railway is located atop of a constructed berm. In order to protect much of the developed areas around Biloxi and St. Louis Bays, the inland barrier would need to cross the mouths of these bays which would necessitate construction of structural surge barriers.

Hancock County Inland Barrier (LOD 4)

Impacts to fish and wildlife resources could be avoided or minimized by alternate alignments and/or elevations of the proposed structure. Native vegetation under the levee footprint would be lost, and the levee itself would likely be vegetated with non-native species for stabilization of the structure. Approximately 300 acres of wetlands would be impacted based on some potential alignments and/or elevations (Lin and Shafer 2007). Specific losses would be field verified prior to construction and during project development to determine wetland functions lost. Specific impacts to fish and wildlife species would not be evaluated until final plans are available. Surveys of potential habitats for threatened and endangered species would be required in order to determine impacts to listed species.

St. Louis Bay Surge Barrier

Further studies would be needed during project development to determine the full extent of impacts, to fish and wildlife species, submerged aquatic vegetation (SAV), and other estuarine organisms associated with implementation of this measure.

Harrison County Inland Barrier (LOD 4)

Impacts to fish and wildlife resources could be avoided or minimized by alternate alignments and/or elevations of the proposed structure. Native vegetation under the levee footprint would be lost, and the levee itself would likely be vegetated with non-native species for stabilization of the structure. Approximately 45 acres of wetlands would be impacted based on some potential alignments and/or elevations (Lin and Shafer 2007). Specific losses would be field verified prior to construction and during project development to determine wetland functions lost. An alternate alignment along Menge Ave. in Gulfport would eliminate the need for the Biloxi Bay Surge Barrier. The Service recommends that the Menge Ave. alignment be used in order to avoid the need for that component. Specific impacts to fish and wildlife species would not be evaluated until final plans are available. Surveys of potential habitats for threatened and endangered species would be required in order to determine impacts to listed species.

Biloxi Bay Surge Barrier

Further studies would be needed during project development to determine the full extent of impacts, to fish and wildlife species, SAVs, and other estuarine organisms associated with implementation of this measure. An alternate alignment of the Harrison County Inland Barrier (LOD 4) along Menge Ave. in Gulfport would eliminate the need for this component. The Service recommends that the Menge Ave. alignment be used in order to avoid the need for this component.

Jackson County Inland Barrier (LOD 4)

Impacts to fish and wildlife resources could be avoided or minimized by alternate alignments and/or elevations of the proposed structure. Native vegetation under the levee footprint would be lost, and the levee itself would likely be vegetated with non-native species for stabilization of the structure. Approximately 79 acres of wetlands would be impacted based on some potential alignments and/or elevations (Lin and Shafer 2007). Specific losses would be field verified prior to construction and during project development to determine wetland functions lost. Specific impacts to fish and wildlife species would not be evaluated until final plans are available. Surveys of potential habitats for threatened and endangered species would be required in order to determine impacts to listed species.

Ecosystem Restoration Plan Components

1. Turkey Creek

The Turkey Creek Restoration project will restore 689 acres of wet pine savannah habitat in a severely impaired watershed within an urbanized area in North Gulfport. This area suffers from altered hydrology and habitat degradation through lack of fire and an abundance of invasive exotic species. By restoring this habitat, this watershed will regain much needed flood storage

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capacity and regain its natural wetland function, and will also be protected from development. The HGM approach was used to measure benefits resulting in a total of 2,577 functional units with a net AAFU benefit of 1,565. There will be temporary, localized impacts to fish and wildlife species during construction, but the benefits gained greatly outweigh these impacts. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

2. Dantzler

This 385 acre site owned by the State of Mississippi and managed by the Department of Marine Resources is located in central Jackson County near the Pascagoula River and the Mississippi Sandhill Crane National Wildlife Refuge (NWR). The site currently consists of plantation pine and includes drainage ditches and stormwater lines that were added in anticipation of residential development, and therefore does not provide the benefits that a naturally functioning wet pine savannah should. Hurricane Katrina also introduced an enormous amount of debris to this site. By thinning the pines, removing invasive species, filling ditches to restore hydrology, and implementing a natural fire regime this site could benefit the endangered Mississippi Sandhill Crane found on adjacent Refuge lands. The HGM approach was used to measure benefits resulting in a total of 604 functional units with a net AAFU benefit of 1,244. There will be temporary, localized impacts to fish and wildlife species during construction, but the benefits gained greatly outweigh these impacts. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

3. Franklin Creek

This project is located near the communities of Orange Grove and Pecan in eastern Jackson County, MS. This area has already been funded for acquisition and demolition of 30 structures as part of the MsCIP Interim Report. This restoration will supplement that project by restoring 149 acres of former residential development to wet pine savannah. This site is located adjacent to the Grand Bay NWR /National Estuarine Research Reserve (NERR) and would compliment the management of those protected areas and add to available fish and wildlife habitat in the area. The HGM approach was used to measure benefits resulting in a total of 596 functional units with a net AAFU benefit of 516. There will be temporary, localized impacts to fish and wildlife species during construction, but the benefits gained greatly outweigh these impacts. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

4. Bayou Cumbest

The Bayou Cumbest restoration area contains approximately 348 acres to be restored to tidal marsh and scrub/shrub habitats. This site currently consists of residential development severely damaged by Hurricane Katrina as well as abundant fill material which inhibits the natural ebb and flow of the wetlands in the area. This restoration project would benefit fish and wildlife species as this plan would restore hydrology, remove exotics, and allow for more contiguous suitable habitat. This will provide valuable forage and cover for fish and wildlife species. This project would also remove structures that currently fragment adjacent undeveloped habitat. This site is adjacent to the Grand Bay NWR/NERR and is also near the site of the proposed submerged aquatic vegetation pilot project discussed below. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

5. Admiral Island

The Admiral Island restoration project consists of 123 acres of state owned property managed by the Mississippi Department of Marine Resources (DMR). This site has been degraded over the years and suffered major damage from Hurricane Katrina. The restoration of this site would benefit fish and wildlife resources as this plan would restore hydrology, remove exotics species, and clean up profuse debris that was deposited as a result of Hurricane Katrina. This will provide valuable forage and cover for fish and wildlife species. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

6. Submerged Aquatic Vegetation (SAV) Pilot project

Implementation of this pilot project would provide much needed research and information necessary to restore SAVs and determine the effectiveness of subsequent restoration projects and experimental techniques. Additionally, the project will provide an opportunity to replace SAVs lost as a result of Hurricane Katrina. The functions and resultant values help to sustain productive foraging and refugia habitat for various lifestages of aquatic species. Many fish and wildlife species depend on these seagrasses during different stages of their life cycles. This project would benefit fish and wildlife resources by restoring a quickly diminishing, but necessary, habitat.

7. Additional Ecosystem Restoration Studies

Development of the Spatial Decision Support System (SDSS) tool allowed the MsCIP environmental team, including the Service and DMR, to identify and prioritize potential wetland restoration areas throughout coastal Mississippi (Lin 2007). The SDSS produced numerous areas that qualified for restoration, based on the fact that most of them have been impacted and/or destroyed nationally, regionally, and locally by development and/or natural events. These sites were determined unable to repair themselves therefore, requiring human intervention to restore their historical values and functions. Restoration and protection of these sites are essential to healthy fish and wildlife populations all along the Mississippi Gulf coast. Thirty-eight (38) additional sites were evaluated, screened and selected from the results of the SDSS tool and have been proposed for restoration. These sites will be prioritized and specific details will be developed and integrated into a programmatic type authority. Habitats that would be restored through this component range from emergent aquatic vegetation to wet pine savannah to bayhead swamps and beach and dune systems. Some of the proposed projects fall within CBRA units,

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however these projects would likely be exempt from CBRA prohibitions based on Section 6 of the Act which allows federal funding for projects that would enhance or preserve fish and wildlife resources. This component is not likely to adversely affect fish and wildlife resources, including T&E species. However, complete site assessments should be conducted prior to work to ensure no federally protected species, such as Louisiana quillwort, are present.

8. Violet Freshwater Diversion Project Engineering and Design

The Mississippi Department of Marine Resources (DMR) has been working with the Mississippi congressional delegation in order to address impacts from saltwater intrusion and degradation of the oyster resources found within the Mississippi Sound, primarily those associated with Hancock County. Through collaboration with Louisiana, the two states have agreed on a mutually beneficial proposal for a diversion at or near Violet, Louisiana. Modeling efforts have been ongoing and although a version of the project has been authorized through the Water Resources and Development Act of 2007 (WRDA), no specific plans have been agreed upon. The project may impact the federally listed Pallid and Gulf sturgeon however the extent of those impacts will remain unknown until specific details are available and adequate studies performed. Other fish and wildlife resources may also be affected by the implementation of this project. Further research would be required to determine exact impacts associated with this component.

9. Escatawpa River Diversion – Grand Bay Marsh Ecosystem Restoration

Human disturbances have impacted the Grand Bay marsh ecosystem by altering historic sheet water flows into the area, as well as the natural migration of the Pascagoula and Escatawpa Rivers. These rivers flow into marshes and other wetlands that make up the Grand Bay NWR/NERR. Lack of sheet water flow into the area has caused a loss of valuable pine savannah wetlands that under optimum conditions would provide abundant habitat for numerous fish and wildlife species. Saltwater intrusion due to lack of freshwater input into the system has also degraded available fish and wildlife habitats. Shoreline erosion has also contributed to the increased salinity in the area, as well as a loss of fish and wildlife habitats with the total erosion of landmasses such as the Grand Batture Islands. This project may impact federally listed species however the extent of those impacts will remain unknown until specific details are available and adequate studies performed. Other fish and wildlife resources may also be affected by the implementation of this project. Further research would be required to determine exact impacts associated with this component.

10. Coastwide Beach and Dune Ecosystem Restoration

The man-made beaches that exist along the Mississippi Gulf coast have become the winter home to more than just the human population. These beaches and dune systems were designated critical habitat for the threatened Piping plover in 2002. These birds only overwinter along these beaches, while many other species of shorebirds depend on these habitats for nesting and other life stages. Most of the dunes that previously existed along these beaches were destroyed by

Hurricane Katrina along with much of the beach, leaving numerous species of wildlife without adequate foraging and nesting habitat. Because restoration of these beaches would greatly benefit the fish and wildlife species that depend on them, the temporary and minimal impacts associated with construction should not adversely impact these species. However, time of year and duration of each project should be considered when planning these projects to avoid impacts to fish and wildlife species. Borrow areas should also be evaluated prior to excavation to avoid impacting areas such as mud flats, on which these birds also depend for forage areas.

11. Comprehensive Barrier Island Restoration

The Service agrees that the selected alternative Barrier Island Comprehensive plan (G) described in Section 8.1.2.11.2 of the Main Report would be the most efficient and least damaging alternative. However this alternative will impact fish and wildlife resources and habitats in the vicinity of the project area. These impacts are both positive and negative. The barrier islands are designated critical habitat for wintering Piping Plovers. Direct sand placement in Camille cut and reintroduction of sandy sediments to the littoral zones of Ship, Horn, and Petit Bois Islands could provide additional wintering habitat for this threatened shorebird. However, this option would alter waters within the project area, which are designated critical habitat for the threatened Gulf sturgeon. Federally protected sea turtles also inhabit the area and have the potential to nest on the islands. Sea turtles fall under the jurisdiction of the Service when onshore during nesting. NOAA-NMFS has jurisdiction over listed species and critical habitat offshore. Because restoration and enhancement of these islands would greatly benefit the fish and wildlife species that depend on them, the temporary and minimal impacts associated with construction should not adversely impact terrestrial species found within the project area. However, time of year and duration of each project should be considered when planning these projects to avoid impacts to fish and wildlife species. Changes to water bottoms and introduction of sediments into the system will likely affect aquatic species, such as the Gulf sturgeon. A final project proposal would be required to perform an adequate evaluation of impacts to listed species and habitats.

12. Deer Island Ecosystem Restoration

Deer Island is located within the boundaries of Harrison County, Mississippi near the mouth of the Biloxi Bay and the City of Biloxi, and falls within CBRA unit R02. It is managed by DMR as a coastal preserve. The lands within the interior are privately owned while the State of Mississippi owns much of the property considered tidal wetlands. This island has suffered damage from many storms which was exacerbated by Hurricane Katrina. A breach from previous storms was significantly widened, coastal marshes were impacted by debris and sedimentation, and the maritime forest was killed by saltwater overtopping and wind damage. The island, prior to Hurricane Katrina, was the subject of a restoration project through the beneficial use of dredged material, and the restoration area seems to have faired well under the circumstances. A second restoration effort is currently underway to repair the breach on the western end as well as selective restoration to critical areas on the southern shoreline. Deer Island contains a diversity of habitats valuable to wildlife which would be protected from erosion by the proposed restoration plan. This project would likely be exempt from CBRA prohibitions based on Section 6 of the Act

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which allows federal funding for projects that would enhance or preserve fish and wildlife resources. This option could alter waters within the project area, which are designated critical habitat for the threatened Gulf sturgeon. Changes to waterbottoms and introduction of sediments into the system could affect aquatic species, such as the Gulf sturgeon.

Summary of Impacts

Impacts and effects listed for each component are preliminary in nature and could change with new information as projects go through the planning process. Further study would be required for some of the proposed components. The Service may issue addendums to this FWCA to address concerns, in addition to requesting further consultation under section 7 of the ESA, if warranted. Additional FWCA reports will be issued in the event of Supplemental Environmental Impacts Statements.

FISH AND WILDLIFE CONSERVATION MEASURES

The Service has provided preliminary conservation measures for mitigation of losses and/or restoration of fish and wildlife resources below. More specific measures may be provided in addendums to this report once specific plans are available and plans and/or alternatives are selected.

The Service and the Corps, working together during the MsCIP planning process, have managed to avoid many potential fish and wildlife resource conflicts within project proposals (i.e., National Wildlife Refuges and Coastal Barrier Resources Act (CBRA) units). The Corps invited the Service to participate in the planning process as a full member of the project planning team. The Service applauds the Corps, Mobile District, for the opportunity to actively participate and provide input throughout the process.

Although many major wetland areas were avoided during the planning process, some impacts to wetlands, primarily associated with levee construction, still remain. Overall preliminary estimates suggest that up to approximately 726 acres could be impacted if all projects were constructed at the maximum proposed footprint. The Service suggests avoiding, minimizing, or rectifying this acreage by constructing projects that have the least impact while continuing to meet objectives set forth in the Congressional mandate. The wetland areas that may potentially be impacted by proposed projects are designated as Resource Category 2 under the Service Mitigation Policy. The mitigation goals for Resource Category 2 are physical modification of replacement habitat to convert it to the same type lost; restoration or rehabilitation of previously altered habitat; increased management of similar replacement habitat so that the in-kind value of the lost habitat is replaced, or; a combination of these measures. Specific losses should be field verified prior to construction and during project development to determine functions of wetlands lost. Restoration and enhancement of fish and wildlife habitats within the project area could reduce these impacts, as well as provide benefits to the resource. In addition, restoration and protection of habitats along the Mississippi Gulf Coast could increase overall fish and wildlife resources within the area and improve water quality.

Care should be taken to ensure use of native species to re-vegetate disturbed areas. Precautions should also be taken to prevent the distribution of invasive exotics such as cogon grass (*Imperata cylindrica*) during ground disturbing activities. Cogon grass in rampant across vitually every habitat on the Mississippi Gulf Coast and can outcompete native vegetation if not controlled or prohibited from spreading.

Proposed surge barriers could induce major impacts to fish and wildlife resources. These projects should be adequately studied to determine potential impacts throughout the entire basin.

Secondary development and indirect effects could be associated with several project proposals and would have to be evaluated and in the case of impacts, mitigation would be necessary. By encouraging development in previously undeveloped areas, impacts to fish and wildlife resources and federally listed species (gopher tortoise), as well as the ability to properly manage habitats (prescribed fire), are likely.

The Service recommends that the Planning division and the Regulatory division within the Corps, Mobile District continue to coordinate their activities as they relate to MsCIP. Areas delineated by the SDSS for environmental restoration and/or buyouts should not be eligible for permits for authorized fill under Section 404 of the Clean Water Act. Coordination such as this could potentially be considered a flood damage reduction measure.

RECOMMENDATIONS

Based on information currently available the Service makes the following recommendations to minimize impacts to fish and wildlife resources:

1. Incorporate sediment control measures during construction including timely revegetation of disturbed areas with native plant species.

2. Maintain disturbed areas with the use of native vegetation if at all possible. Clean equipment prior to transport to prevent contamination by exotic species such as cogon grass to other sites.

3. Place restrictive easements or covenants on all preserved and restored project areas to prevent future development.

4. Account for secondary development and indirect effects associated with projects during advanced design and feasibility studies.

5. Environmental and non-structural measures should be utilized in place of hard structures wherever practicable.

6. Minimization and avoidance of impacts should be considered on all project elements.

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7. Consultation as required by section 7 of the Endangered Species Act will be completed as necessary.

SUMMARY OF FINDINGS AND SERVICE POSITION

The Service has determined based on preliminary information, that the Mississippi Coastal Improvements Program would have both adverse and favorable impacts to existing fish and wildlife resources. The majority of the tentatively selected components are environmentally sound projects that would provide a benefit to fish and wildlife resources and preserve habitat by preventing potential future development. These projects also meet the objectives of flood damage reduction and hurricane and storm damage reduction.

Non-structural programs such as buyouts would also likely benefit fish and wildlife resources. However, relocation programs that would encourage development in previously undeveloped areas could create direct and indirect adverse impacts to fish and wildlife resources as well as T&E species. Nevertheless, these relocations would likely have a less damaging effect than other structural options. Major impacts associated with relocations could be avoided by wise selection of relocation areas.

It is unknown at this time how projects such as freshwater diversions and surge barriers will impact fish and wildlife resources. Projects such as these will require much more study than what has been afforded by Congress. These projects will be evaluated once more information is available.

It is the opinion of the Service that some of the “Tentatively Selected Comprehensive Plan Components” may warrant Formal Consultation once more specific plans are available for each project and supplemental EIS documents are prepared. Therefore, the Service reserves the right to request formal consultation if necessary.

The Service recommends that structural measures be avoided such as surge barriers, inland levees, and ring levees. The need for these projects could be avoided by the use of more efficient, less damaging non-structural alternatives, such as environmental restoration and relocations.

This final Fish and Wildlife Coordination Act Report will be programmatic in nature. Consequently, once formal project proposals are received and supplemental EIS’s as required for some projects are received, they will be addressed in additional FWCA reports. These additional reports will contain all requirements for the Secretary of the Interior as required by Section 2(b) of the Act.

LITERATURE CITED

Christmas, J.Y. and R.S. Waller. 1973. Estuarine vertebrates. *Pages 320-434 in* Christmas, J.Y. (ed.). Cooperative GMEI. Phase IV, Biology. Gulf Coast Research Laboratory.

Corps, Mobile District. 1992 revised. General Design Memorandum, Main Report Improvement of the Federal Deep-Draft, Pascagoula, Mississippi.

Corps, Mobile District. 2005. Environmental impact statement for enhanced evaluation of cumulative effects associated with U.S. Army Corps of Engineers permitting activity for large-scale development in coastal Mississippi.

Demoran, W.J. 1979. A survey and assessment of reef shell resources in Mississippi Sound. University of Mississippi, Mississippi Mineral Resources Institute. Report of Investigations No. 794, 19 p.

Lin and Shafer. 2007. Assessment of Mississippi Coastal Plain wetlands potentially impacted by proposed levee alignments (Draft). Prepared for the US Army Engineer Mobile District. Engineer Research and Development Center, Vicksburg, Mississippi.

Shafer, D.J., T.H. Roberts, M.S. Peterson, and K. Schmid. 2007. A regional guidebook for applying the hydrogeomorphic approach to assessing the functions of tidal fringe wetlands along the Mississippi and Alabama Gulf Coast. U.S. Army ERDC, Vicksburg, Mississippi.

Vittor, B.A. and Associates. 1982. Benthic macroinfauna community characterizations in Mississippi Sound and Adjacent Waters. Final Report Contract No. DACW01-80-C-0427. Corps, Mobile District. 287 pp. plus appendices.

BIOLOGICAL ASSESSMENT AND BIOLOGICAL OPINIONS

The Corps coordinated with both the USFWS and National Marine Fisheries Service, Protected Resource Division concerning the anticipated formal consultation and subsequent preparation of a Biological Assessment under Section 7 of the Endangered Species Act. Both agencies concurred that the MsCIP Programmatic Integrated Programmatic Environmental Impact Statement (EIS) would serve also as the Biological Assessment (BA). This decision was reached by the agencies due to the prepared MsCIP Programmatic Integrated EIS document already containing all necessary information required in the BA already. The USFWS provided a letter, dated June 24, 2008, stating its use of the MsCIP Programmatic Integrated EIS as a supplement for the Corps' BA. Future BAs and Biological Opinions could be possibly required on projects being tentatively selected for additional study.

United States Department of the Interior

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

June 24, 2008

Dr. Susan I. Rees
Mississippi Coastal Improvements Program
U.S. Army Corps of Engineers
Mobile District
PO BOX 2288
Mobile, AL 36628-0001

Dear Dr. Rees:

The U.S. Fish and Wildlife Service (Service) has been coordinating with you and your team to accomplish the mandates authorized by Congress through the Mississippi Coastal Improvements Program (MsCIP). The MsCIP team, of which the Service has been a full member, is currently working to complete an Integrated Comprehensive Report/ Environmental Impact Statement (ICR/EIS). This report will address numerous projects that have been proposed and evaluated as a means of helping the Mississippi Gulf Coast not only recover from Hurricane Katrina, but also become better prepared and to be more resilient in the event of future storms.

The Service provided a final draft Fish and Wildlife Coordination Act (FWCA) Report (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) to the Corps on June 12, 2008. This FWCA Report not only provided recommendations for projects, but also addressed potential impacts to threatened and endangered species that are protected by the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*). Due to the broad scope of MsCIP and associated unknown factors, consultation as required by section 7 of the ESA was addressed initially through the FWCA report. Once a Final ICR/EIS has been provided, the Service believes that document will be sufficient for continuation of consultation.

We believe that this is the most efficient way to achieve our common goals of recovery and resiliency throughout the entire Mississippi Gulf Coast. Thank you for the opportunity to work with you on this very important program.

Sincerely,

Ray Aycock
Field Supervisor

SECTION 3
ENVIRONMENTAL COMPLIANCE DOCUMENTATION

3.1 Section 404(b)(1) Evaluation Report for the Mississippi Coastal Improvements Program (MsCIP), Hancock, Harrison, and Jackson Counties, Mississippi

SECTION 404(b)(1) EVALUATION REPORT FOR THE COASTAL MISSISSIPPI IMPROVEMENTS PROGRAM (MsCIP) HURRICANE RESTORATION EFFORT

HANCOCK, HARRISON, AND JACKSON COUNTIES, MISSISSIPPI

I. **PROJECT DESCRIPTION**:

A. **Location**. The Hurricanes of 2005 created unprecedented destruction within the Gulf Region of the United States (U.S.) of America. Beginning with Hurricane Cindy on July 6th 2005, which made landfall near Waveland, Mississippi, peaking with Hurricane Katrina, which made landfall on the 29th of August on the Louisiana-Mississippi border, and ending with Hurricane Rita on the 24th of September, which also caused additional damage to the coastline of Mississippi, this series of tremendous storms caused unparalleled devastation to homes and businesses, industry, livelihoods, regional economies, environmental resources, and most importantly, dealt a life-changing blow to the people that call this region home.

Hurricane Katrina made landfall on August 29, 2005 near Buras-Triumph, Louisiana. Hurricane force winds extended outward 120 statute miles. Landfall of this storm placed Coastal Mississippi in the northeast quadrant, the most destructive quadrant. Destruction spans along all three coastal counties – Hancock, Harrison, and Jackson. Most, if not all, of the infrastructure was destroyed by the hurricane south of Highway 90. South of Interstate-10 had massive flooding and infrastructure damage. Hurricane Katrina destroyed coastal regions of Louisiana, Mississippi, and Alabama making it the most destructive and costliest natural disaster in the history of the U.S. Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the U.S. in its recorded history.

B. **General Description**. The U.S. Army Corps of Engineers (Corps), Mobile District has been authorized by Congress to investigate expedited studies of flood and storm damage reduction. These studies will address hurricane and storm damage reduction, flood control, and ecological restoration as well as other related water resource purposes. With the assistance of Federal, State of Mississippi, and local government agencies, private entities, and other interest groups, the Corps, Mobile District developed measures and specific projects that contribute to the reduction of storm surge, preservation of fish and wildlife, prevention of saltwater intrusion, prevention of coastal erosion, and reduction of coastal flooding. The MsCIP Comprehensive Plan and Integrated Programmatic EIS develop measures and projects for recommended in the following categories:

- Construction;
- Preconstruction Engineering Design for Specific Features;
- Additional Feasibility Studies; and
- Advanced Design Studies for Innovative Concepts.

The potential measures and projects are addressed in the MsCIP Comprehensive Report and Integrated Programmatic EIS. The Corps, Mobile District will coordinate with Federal, state, and local agencies during the required environmental compliance process. This Section 404(b)(1) Evaluation Report addresses potential water quality impacts that could potentially result from constructing the following measures and/or projects in Coastal Mississippi. Each of the measures and/or projects has been fully discussed in the MsCIP Comprehensive Report and Integrated Programmatic EIS to address the potential environmental impacts associated with their implementation. There may be additional analyses required prior to construction of specific components of recommended measures and projects. This would entail development of additional Section 404(b)(1) Evaluations that would assess potential environmental impacts associated with the specific proposed action within a measure or project. All of the potential measures and projects are located in Coastal Mississippi either in Hancock, Harrison, or Jackson County and are referenced in the attached MsCIP Comprehensive Report and Integrated Programmatic EIS.

C. **Authority and Purpose**. The MsCIP was authorized by Congress in the Department of Defense Appropriations Act, 2006 (Public Law 109-359) 30 December 2005. A description of the analysis and design authority contained in the aforementioned act reads as follows:

> *For an additional amount for "investigations" to expedite studies of flood and storm damage reduction related to the consequences of hurricanes in the Gulf of Mexico and Atlantic Ocean in 2005, $37,300,000, to remain available until expended: Provided, That using $10,000,000 of the funds provided, the Secretary shall conduct an* ***analysis and design*** *for comprehensive improvements or modifications to existing improvements in the coastal area 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 resource purposes* ***at full Federal expense****: Provided further, That the Secretary shall recommend a cost-effective project, but* ***shall not perform an incremental benefit-cost analysis*** *to identify the recommended project, and shall not make project recommendations based upon maximizing net national economic development benefits: Provided further, That interim* ***recommendations for near term improvements shall be provided within 6 months*** *of enactment of this Act* ***with final recommendations within 24 months of enactment****: (****emphasis added)***

The National Environmental Policy Act (NEPA) of 1969 excuses or excludes the Corps from the preparation of any formal environmental analysis with respect to actions that result in minor or no environmental effects, which are known as "categorical exclusions." An intermediate level of analysis, an Environmental Assessment (EA), is prepared for an action that is not clearly categorically excluded, but does not clearly require an EIS [40 Code of Federal Regulations (CFR) §1501.3 (a) and (b)]. Based on the EA, the Corps either prepares an EIS, if one appears warranted, or issues a "Finding of No Significant Impact" (FONSI), which satisfies the NEPA requirement. This document is prepared according to the Engineer Regulation (ER) 200-2, *Procedures for Implementing NEPA, and the Council on Environmental Quality (CEQ) Regulations (40 CFR § 1508.27) for Implementing the Procedural Provisions of NEPA (40 CFR § 1500-1508).*

D. **General Description of Dredged or Fill Material**.

(1) **General Characteristics of Material.** Materials used for barrier island restoration and beach/dune nourishment actions would consist of fine to medium grained sand that would be compatible with existing sediments. Material with a mixture of silts, sands and some clay component will be used where sediment is required for marsh/scrub/shrub restoration. Levee construction will require the use of clay fill material. The material will be obtained from either commercial sources, trucked in, and/or existing borrow areas near the project sites. The substrate that will be used as a restoration site for submerged aquatic vegetation (SAV) at Bayou Cumbest would consist of primarily sands with some silts. The freshwater diversion substrate would be similar to that of the marsh restoration and SAVs.

(2) **Quantity of Material**. For the barrier island restoration efforts, it is estimated that a total of up to approximately 31 million cubic yards (cys) of sandy material may be required for the filling of Ship Island Breach. A quantity of sandy material yet to be determined could be used as a feeder source to supplement natural migration of material within the littoral zone. Exact quantities are dependent upon which measure that would be implemented. The volume of material dredged and excavated in association with the ring levee around Forest Heights is yet to be determined. Quantities associated with environmental restoration sites (i.e. filling and excavation) are calculated to rough order of magnitude. No additional fill material would be required for the restoration of SAV.

(3) **Source of Material**. Sand used for barrier island restoration would be obtained from the St. Bernard Shoals, a natural sand deposit located in the Gulf of Mexico south of Mississippi and Louisiana or from river sources (i.e. upland dredged material disposal sites) located along the Black Warrior – Tombigbee River system and the Tennessee – Tombigbee Waterway would be further evaluated for compatibility with existing barrier island beach sand composition, including acceptable grain size, color, and texture. Sources required for ecosystem restoration have yet to be determined. No sources will be used for the SAV restoration.

E. **<u>Description of the Proposed Discharge Site</u>**.

(1) **Location**. The locations of any discharge areas associated with measures and projects described herein are addressed in Section B (General Description) of this report.

(2) **Size**. The sizes of the potential discharge areas associated with measures vary with each component of a measure and/or specific projects. The sizes of these sites may range from approximately 25 acres up to approximately 500 acres.

(3) **Type of Site**. Site types for the variety of projects described herein consist the barrier islands, open-water of Mississippi Sound and the coastal mainland of the State of Mississippi. The types of sites consists of beach and dunes, marine, estuarine, and freshwater marsh, SAVs, wet pine savannah, upland forests, urbanized areas (i.e. residential and commercial), fringes, rivers, and bays.

(4) **Type of Habitat**. The types of habitats consists of beach and dunes, coastal maritime forests, marine, estuarine, and freshwater marsh, scrub/shrub, SAVs, wet pine savannah, urbanized areas (i.e. residential and commercial), fringes, and bays.

(5) **Timing and Duration of Discharge**. Timing and duration of the proposed actions are dependent upon approval and funding of the projects. Beach projects along the mainland could take up to 2 years. Restoration of the barrier islands could take up to 15 years for completion. Ring levee construction would take up to 1 year for completion. The non-structural and environmental component features timeframe will vary from 180 days to several years.

F. **<u>Description of Disposal Method</u>**. Methods of placement and disposal for these projects will utilize a variety of dredges including hydraulic cutterhead, hopper, and mechanical, deep draft, scow, and various shallow draft barges. In addition, track hoes, bulldozers, dump trucks, backhoes, marsh buggies, and other similar earthmoving construction equipment will be utilized dependent on the scope of each project.

II. **<u>Factual Determinations (Section 230.11)</u>**:

A. **Physical Substrate Determinations**.

(1) **Substrate Elevation and Slope**. The barrier islands restoration project would consist of beach/dune restoration projects and would be designed to sustain elevations and slopes consistent with similar habitat types in the vicinity that has been sustained under the typical energy climate. Potential marsh and coastal maritime forest restoration components on the barrier islands will also be further evaluated in accordance with and conformity with the Organic Act, National Park Service (NPS) mission, and NPS management policies. The beach could be constructed to between approximately 0 to 2-foot elevation with a 1:10 slope on the foreshore. Dune elevations along the mainland could be constructed to a maximum height of 6 feet with 1:3 slope. Marsh habitat would be constructed between -0.5 and 2-foot while the scrub/shrub would be constructed to between approximately 4 to 6 feet. The ring levee around Forest Heights would be constructed up to a 12- or 16-foot elevation. The ecosystem restoration projects would be constructed at the appropriate elevations to ensure hydrology at the site. The SAV restoration project would be constructed at about -5 to -10 feet water depth.

(2) **Sediment Type**. Materials used for the beach restoration actions will consist of fine to medium grained sand that is compatible (grain size, color, and texture) with existing beach sediments. Sandy material with a small silty component will be used where sediment is required for marsh restoration. Materials dredged from drainage channels and canals will likely contain soft, fine-grained, organic silts and clays with some fraction of sand. This material will be disposed in approved upland sites.

(3) **Dredged/Fill Material Movement**. Fill material would be pumped or trucked directly onto the beach sites. It is expected that a readjustment phase will occur and sand materials redistributed to form a more natural profile. Restoration areas will utilize material that may contain a higher percentage of fine grained materials. Silt fences/curtains and other best management plans (BMPs) will be utilized to reduce material movement during heavy equipment operations. It is believed that no adverse impacts would occur from movement of materials.

Physical Effects on Benthos. No impacts to benthos are anticipated in the upland areas. There would be temporary disruption of the aquatic community as a result of the proposed projects being constructed. Areas where sand and sediments are laid directly upon the bottom open-water habitat to create marsh or restore barrier islands and/or beaches may result in destruction of sessile benthic fauna. Non-motile benthic fauna within the project sites would be lost as a result of the organisms not being able to penetrate through the thick layer of material that will be used to construct the tidal marsh and sand placement for restoration. This loss of sessile benthic fauna would be minor due to the tidal marsh area and other restoration area sites encompassing only a small percentage of the entire Mississippi Sound. Benthic fauna, such as crabs, are anticipated to re-colonize the area upon restoration and in addition, should provide aquatic habitat for various motile and non-motile benthic fauna. The intertidal zone and sub-tidal zones along the restored beaches should provide rapid recovery of and recruitment of benthos. The marsh would provide additional nursery area along the outer fringes suitable for fishes following the proposed activities. Non-motile benthic fauna within the project area may be destroyed by the proposed operations, but should repopulate within several months after construction activities are completed.

Physical Effects on Wetlands. Restoration projects would restore damaged and filled wetlands providing an overall benefit to wetlands. Implementation of the proposed levee at Forest Heights would not require fill in wetlands. It is anticipated that relocation of city facilities in Moss Point and homeowner assistance relocations would be located in uplands and any required fill material would be obtained from upland sources.

(4) **Other effects**. No other effects are anticipated.

(5) **Actions Taken to Minimize Impacts (Subpart H)**. Actions will be taken to minimize

impacts to all project areas during the construction activities. BMPs and/or silt curtains will be used at the construction sites, where applicable, to minimize turbidity and curtail material migration. Borrow material used in construction will be utilized in such a manner to minimize impacts to surrounding areas.

B. **Water Column Determinations**.

(1) **Salinity**. Projects that are being recommended for construction should have minimal impacts to salinity as a result of its implementation. In fact, the filling of Ship Island breach is anticipated to have a positive benefit to salinity in Mississippi Sound.

(2) **Water Chemistry (pH, etc.)**. All sediment and material used in the construction of the identified projects will be clean materials removed from sources of contamination and considered contaminant free. Such material will have no effect on surrounding water chemistry.

(3) **Clarity**. Construction activities in association with beach nourishment and dune construction and tidal marshes will reduce water clarity due to elevated suspended sediments in the water column; however, BMPs and/or silt curtains will be used, where applicable, to minimize impacts to the project area. Minor increases in turbidity may be experienced in the immediate vicinity of the project areas during construction operations. However, these increases will be temporary and would return to pre-project conditions shortly after completion. In fact, several components of the proposed project may improve water clarity because particles tend to settle out of the water column at tidal marsh areas.

(4) **Color**. No effect.

(5) **Odor**. No effect.

(6) **Taste**. No effect

(7) **Dissolved Gas Levels**. Temporary decreases in dissolved oxygen will likely result from some of the construction activities, but this will only be of a short duration. The construction activities and the return water are not anticipated to adversely impact dissolved gas levels.

(8) **Nutrients**. Slight increases in nutrient concentrations may occur from the proposed construction activities; however, these concentrations would be rapidly dispersed. These described increases would have no significant effect to the water column. Further studies prior to construction and implementation of certain measures would be conducted to determine possible impacts.

(9) **Eutrophication**. The projects recommended for construction would have minimal impacts to eutrophication effects.

C. **Water Circulation, Fluctuation, and Salinity Gradient Determinations**:

(1) **Current Patterns and Circulation**.

(a) **Current Patterns and Flow**. Restoration of the barrier islands would be modeled to determine effects of filling the breach between East and West Ship Islands, creating a feeder source of sand to supplement littoral drift and migration, and filling of water bottoms in order for expansion of the island footprints. The subsequent return water flow is also not anticipated to affect current patterns and flow in the vicinity of the mainland. The environmental restoration sites would restore historic water flow patterns. Levee construction would likely divert water away from the urbanized areas. The non-structural plan would also help restore historic water flow patterns by removing structures all together or raising them from their base elevation.

(b) **Velocity**. No Effect.

(2) **Stratification**. No Effect.

(3) **Hydrologic Regime**. Environmental restoration would result in a benefit to the hydrologic regime as the lost hydrology is restored to historical wetlands.

(4) **Normal Water Level Fluctuations**. No Effect.

(5) **Salinity Gradient**. Salinity in Mississippi Sound is highly variable due to the inflow of freshwater from surrounding rivers and the tidal influence from the Gulf of Mexico. Restoration of barrier islands would affect salinity gradient and further analysis would be conducted to determine the effects of these measures.

D. <u>**Suspended Particulate/Turbidity Determination**</u>:

(1) **Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Placement Site**. The placement of fill material at the proposed project sites within Mississippi Sound and within the vicinity of the barrier islands would reduce light penetration through the water column, thereby reducing photosynthesis and surface water temperatures. Although it is expected an initial high volume loss of sand from the restoration projects at the barrier islands would occur, it is expected that sand movement would decrease once equilibrium is naturally achieved. These conditions could potentially alter visual predator-prey relations in the immediate project vicinity. In addition, sediment adheres to fish gills, resulting in respiratory stresses, and natural movement of eggs and larvae could be potentially altered as a result of the sediment adherence. These are minor, short-term impacts due to the short duration of construction activities. It is expected that distinct bars would develop nearshore by the nature of the waves and depths within the project vicinity and could potentially result in a seaward expansion.

Construction of the levee around Forest Heights, and environmental restoration sites could cause sediment movement and isolated increased turbidity around the construction sites. Changes in substrate are not expected nor will any deleterious materials be added to the sediment during construction activities.

(2) **Effects on Chemical and Physical Properties of the Water Column**.

(a) **Light Penetration**. Light penetration through the water column at the proposed sites may be temporarily affected but is anticipated to return to previous conditions upon completion of construction activities.

(b) **Dissolved Oxygen**. Future studies would be conducted prior to construction and implementation of certain measures to determine impacts within the bays and Mississippi Sound.

(c) **Toxic Metals and Organics**. Sites have been picked to avoid any potential toxic metals and organics.

(d) **Pathogens**. No effect.

(e) **Esthetics**. Esthetics would be reduced within construction areas, due to the physical presence of the heavy equipment used in the construction process; however, these impacts would be temporary and insignificant. Once the construction is complete, the esthetic values provided by barrier island restoration, a restored beach-dune system, and environmental restoration of wetlands would have many beneficial impacts. Construction of the projects would actually result in an improvement to aesthetic quality as coastal Mississippi was devastated as a result of Hurricane Katrina. No adverse impacts are anticipated from the ring levee around Forest Heights and the non-structural plan.

(3) **Effects on Biota**. The proposed beach and ecosystem restoration projects are designed to enhance the barrier island ecosystems. These actions would increase valuable habitat resulting in an overall improvement and continued health of the local wildlife. No adverse impacts are anticipated from the ring levee around Forest Heights and the non-structural plan due to its existing urbanization.

(a) **Primary Production Photosynthesis**. No impacts to primary production photosynthesis are anticipated.

(b) **Suspension/Filter Feeders**. It is anticipated a temporary impact to suspension/filter feeders would occur as a result of the construction activities; however, no long-term impacts are anticipated.

(c) **Sight Feeders**. Shorebirds tend to be attracted to established beach/dune systems. Construction activities (i.e. dredging and subsequent placement to restore the barrier islands) are sometimes attractive sites to many sight feeders due to the presence of food items in the material. Impact of these activities along uplands, beaches, and ecosystem restoration sites on sight feeders is expected to be a beneficial, short-term effect. No adverse impacts are anticipated to occur to sight feeders as they would avoid construction areas.

(4) **Actions Taken to Minimize Impacts (Subpart H)**. BMPs would be incorporated into project designs and specifications during project development.

E. **<u>Contaminant Determinations</u>**. Materials used in the construction of the proposed measures would consist of marine and/or river sand and sediments from sources removed from contamination. Previous construction activities and water quality certifications of these type projects in this region has found that the materials are free of contaminants.

F. **<u>Aquatic Ecosystem and Organism Determinations</u>**.

(1) **Effects on Plankton**. It is anticipated a temporary impact to plankton would occur as a result of the construction activities; however, no long-term impacts are anticipated.

(2) **Effects on Benthos**. Temporary disruption of the aquatic community is anticipated at the beach, dune, and marsh restoration sites. Non-motile benthos at areas where materials will directly covering water bottom would be destroyed. Non-motile benthic fauna within these areas will be lost as a result of the organisms not being able to penetrate through the thick layer of fill material that will be used to construct the tidal marsh and beaches. This loss would be minor due to the project areas encompassing only a small percentage of the entire Mississippi Sound (approximately 750,000 acres). Benthic fauna, such as crabs, are anticipated to rapidly re-colonize these areas upon construction completion. Non-motile benthic fauna within other construction areas may be destroyed by the proposed operations, but should repopulated within several months after completion. Motile benthic and pelagic fauna, such as crabs, shrimp, and fishes, are able to avoid the disturbed area and should return shortly after the activity is completed. Larval and juvenile stages of these forms may not be able to avoid the activity due to limited mobility. Construction activities at the proposed sites are anticipated to have no significant effects to the benthos.

(3) **Effects on Nekton**. No Effect.

(4) **Effects on Aquatic Food Web**. No Effect.

(5) **Effects on Special Aquatic Sites**. No Effect.

(a) **Sanctuaries and Refuges**. The measures have been developed in such a way as to avoid direct impacts to sanctuaries and refuges. The Sandhill Crane Wildlife Refuge and the Grand Bay National Estuarine and Research Reserve are both located in Jackson County. Numerous measures, particularly ecosystem restoration sites, would provide additional wetland functions nearby existing refuges.

(b) **Wetlands**. The ecosystem restoration sites would result in numerous acres of wetland restoration which would provide numerous positive benefits. Under the current Forrest Heights 21-foot levee alignment alternative, there is an expected loss of 3.6 acres of wetland vegetation impacted by construction of the levee. Although native vegetation under the levee footprint would be lost, the levee itself would be vegetated with non-native species for stabilization of the structure. The compensatory mitigation would be incorporated in the project plan development phase.

(c) **Mud Flats**. No Effect.

(d) **Vegetated Shallows**. The measures have been developed in such a way as to avoid vegetated shallows directly; however, the indirect and cumulative effects are unknown and further studies would need to be conducted to determine the full level of impacts prior to project development and construction.

(e) **Coral Reefs**. Not applicable.

(f) **Riffle and Pool Complexes**. The measures have been developed in such a way as to avoid direct impacts.

(6) **Effects on Threatened and Endangered Species**. The Corps, Mobile District is currently coordinating with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration Fisheries concerning the proposed MsCIP Comprehensive Report and Programmatic EIS impacts to any threatened and endangered species. Protective measures will be implemented in order to reduce impacts to listed species.

(7) **Effects on Other Wildlife**. Hurricane Katrina and the associated storm surge resulted in numerous adverse impacts to existing wildlife and wildlife habitat. The proposed projects should enhance overall wildlife and associated habitats. Construction activities may result in temporary impacts to existing vegetation in the immediate areas; however it is expected all impacts would be short-term and minor, and in some cases discountable. Urbanization of rural lands could occur and cumulative impacts of this relocation would need to be evaluated to determine the full level of impacts to wildlife habitat.

(8) **Actions to Minimize Impacts**. BMPs would be incorporated into project designs and specifications during project development. Further studies would be conducted prior to implementation of certain measures and prior to specific project development.

G. **<u>Proposed Disposal Site Determinations</u>**:

(1) **Mixing Zone Determination**. The State of Mississippi will specify a mixing zone not to exceed ambient turbidity by more than 50 nephelometric turbidity units at the outer limits of 750 feet for turbidity compliance. Turbidity from material placed in or near the water is anticipated to quickly settle out of the water column. Thus, not exceeding the proposed water quality criteria issued. No adverse impacts are anticipated from construction sites located at upland sites. Thus, no mixing violations are expected.

(a) **Depth of water at the disposal site**. Placement of material associated with beach and marsh restorations will be along the shoreline or nearshore waters.

(b) **Current velocity, direction, and variability at disposal sites**. Further studies would be conducted to determine the impacts in conjunction with implementation of certain measures, such as restoration of Ship Island and placement of sand into the littoral zone around other barrier islands.

(c) **Degree of turbulence**. No impacts are anticipated.

(d) **Stratification attributable to causes such as obstructions, salinity or density profiles at the disposal site**. No impacts are anticipated.

(e) **Discharge vessel speed and direction, if appropriate**. Further studies during project development would determine impacts.

(f) **Rate of discharge**. Rate of discharge will vary according to the particular type of equipment placing materials.

(g) **Ambient concentrations of constituents of interest**. Not applicable.

(h) **Dredged material characteristics, particularly concentrations of constituents, amount of material, type of material (sand, silt, clay, etc.) and settling velocities**. Materials used for the beach restoration actions will consist of fine to medium grained sand that is compatible with existing beach sediments. Sandy material with a small silty component will be used where sediment is required for marsh restoration. Sandy clay fill material would be used to construct the levee around Forest Heights.

(i) **Number of discharge actions per unit of time**. The number of discharge actions per unit of time will vary depending upon particular project activity.

(2) **Determination of Compliance with Applicable Water Quality Standards**. Coordination will be conducted with the appropriate regulating agencies to ensure compliance with all applicable water quality standards.

(3) **Potential Effects on Human Use Characteristics**.

(a) **Municipal and Private Water Supply**. It is anticipated implementation of any measures would have no effect.

(b) **Recreational and Commercial Fisheries**. Recreational and commercial fishing would be temporarily impacted primarily as a result of the physical presence of heavy equipment during operation activities. Limited navigation would occur at the offshore borrow sites.

(c) **Water Related Recreation**. Water related recreation would be temporarily reduced in the immediate vicinity of project sites during construction.

(d) **Esthetics**. Esthetics will be temporarily reduced in the immediate vicinity of the proposed project sites. Many recreational vessels utilize Mississippi Sound within the project vicinities and it is believed some residents and visitors may be disturbed by the presence of the heavy equipment during construction. However, construction activities are temporary in nature so the disturbance is anticipated to be minimal. Furthermore, upon project completion, the restoration projects should provide residents and visitors with a more esthetically pleasing view. The proposed marsh creation and beach restoration projects would provide additional habitat to numerous marine birds.

(e) **Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves**. Further studies and coordination with resource agencies would need to be conducted to determine the full level of impacts of certain measures. Gulf Island National Seashore, administered by the National Park Service, including Petit Bois, Horn, East Ship, West Ship, and a portion of Cat Island are included within the scope of the restoration plan. The National Park Service is currently providing input regarding the feasibility of restoration involving the barrier islands in compliance with existing agency programs, management policies, and enabling legislation. Petis Bois and Horn Islands are also congressionally designated wilderness areas.

(f) **Other Effects**. No effect.

H. **Determination of Cumulative Effects on the Aquatic Ecosystem**. Further studies would need to be conducted to determine the cumulative impacts of certain measures.

I. **Determination of Secondary Effects of the Aquatic Ecosystem**. Further studies would need to be conducted to determine the cumulative impacts of certain measures.

III. **Finding of Compliance With the Restrictions on Discharge**.

A. No significant adaptations of the Section 404(b)(1) guidelines were made relative to this evaluation.

B. Further studies would need to be conducted to determine that any proposed project in conjunction with implementation of certain measures would represent the least environmentally damaging practicable alternative.

C. The planned construction activities and placement of dredged materials would not violate any applicable State water quality standards; nor will it violate the Toxic Effluent Standard of Section 307 of the Clean Water Act (CWA). Appropriate evaluation of analytical and ecotoxicological testing of sediments, site water, and elutriates results would reveal if any adverse impacts would result from the proposed disposal actions.

D. It is believed that use of the proposed disposal sites will not jeopardize the continued existence of any Federally-listed endangered or threatened species or their critical habitat.

E. It is anticipated construction of the proposed projects and placement of dredged material would not contribute to significant degradation of waters of the United States or result in significant adverse effects on human health and welfare, including municipal and private water supplies; recreation and commercial fishing; life stages of organisms dependent upon the aquatic ecosystem; ecosystem diversity, productivity and stability; or recreational, aesthetic or economic values.

F. Appropriate and practicable steps would be taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.

DATE: ____________________

____
Byron Jorns
Colonel, Corps of Engineers
District Engineer

3.2 Coastal Zone Management Program Federal Consistency Determination

The National Coastal Zone Management (CZM) Program is a voluntary partnership between the Federal government and United States (U.S.) coastal states and territories authorized by the Coastal Zone Management Act (CZMA) of 1972. The Coastal Programs Division, within the National Oceanic and Atmospheric Administration's (NOAA), Office of Ocean and Coastal Resource Management, administers the program at the Federal level and works with state coastal zone management partners to:

- Preserve, protect, develop, and, where possible, restore and enhance the resources of the nation's coastal zone for this and succeeding generations;
- Encourage and assist the states to exercise effectively their responsibilities in the coastal zone to achieve wise use of land and water resources, giving full consideration to ecological, cultural, historic, and aesthetic values, as well as the need for compatible economic development;
- Encourage the preparation of special area management plans to provide increased specificity in protecting significant natural resources, reasonable coastal-dependent economic growth, improved protection of life and property in hazardous areas and improved predictability in governmental decision-making; and
- Encourage the participation, cooperation, and coordination of the public, Federal, state, local, interstate and regional agencies, and governments affecting the coastal zone.

To comprehensively manage our coastal resources and balance often competing land and water uses while protecting sensitive resources, state CZM programs are expected to:

- Protect natural resources;
- Manage development in high hazard areas;
- Manage development to achieve quality coastal waters;
- Give development priority to coastal-dependent uses;
- Have orderly processes for the siting of major facilities;
- Locate new commercial and industrial development in, or adjacent to, existing developed areas;
- Provide public access for recreation;
- Redevelop urban waterfronts and ports, and preserve and restore historic, cultural, and aesthetic coastal features;
- Simplify and expedite governmental decision-making actions;
- Coordinate state and Federal actions;
- Give adequate consideration to the views of Federal agencies;
- Assure that the public and local governments have a say in coastal decision-making; and
- Comprehensively plan for and manage living marine resources.

A unique aspect of CZM is “Federal Consistency,” which ensures that Federal actions that are reasonably likely to affect any land or water use or natural resource of the coastal zone will be consistent with the enforceable policies of a coastal state's or territory’s federally approved CZM Program. Federal consistency is the CZMA requirement where Federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone (also referred to as coastal uses or resources and coastal effects) must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally approved coastal management program. (Federal agency activities, including federally permitted activities, are activities and development projects performed by a Federal agency, or a contractor for the benefit of a Federal agency.)

The Mississippi Coastal Program, approved by NOAA in 1980, is comprised of a network of agencies with authority in the coastal zone. The Mississippi Department of Marine Resources (MDMR), through the Office of Ecology, serves as the lead agency. MDMR is governed by a Commission on Marine Resources appointed by the Governor. The primary authority guiding the Coastal Program is the Coastal Marshlands Protection Act, which includes a wetlands plan designating the allowable use of the state's tidal wetlands. The Mississippi coastal zone includes the three coastal counties as well as all adjacent coastal waters and the barrier islands of the coast.

The Coastal Program is responsible for permitting, Federal consistency review, and the Coastal Nonpoint Pollution Control Program. Through the Coastal Preserves Program, MDMR protects and restores coastal habitats. The Comprehensive Resource Management Plan is the primary program through which MDMR provides technical assistance for managing coastal development, with a focus on stormwater management, smart growth, and GIS training.

The MsCIP environmental team has been working closely with the MDMR technical staff throughout the entire planning process. The Corps, Mobile District has determined that the MsCIP effort described in the MsCIP Comprehensive Report and Integrated Programmatic EIS to be consistent with the requirements of the CZM Act to the maximum extent practicable. The Corps, Mobile District requested formal concurrence with our determination following the completion of the comment period the EIS. Concurrence from MDMR was received in a letter dated May 5, 2009.

STATE OF MISSISSIPPI
Haley Barbour
Governor

MISSISSIPPI DEPARTMENT OF MARINE RESOURCES
William W. Walker, Ph.D., Executive Director

May 5, 2009

Dr. Susan Rees
U.S. Army Corps of Engineers, Mobile District
Planning and Environmental Division
Coastal Environment Team
109 St. Joseph Street
Mobile, AL 36602

Re: DMR-060871; Mississippi Coastal Improvements Program; Hancock, Harrison and Jackson Counties, Mississippi

Dear Dr. Rees:

The Department of Marine Resources (DMR) in cooperation with other state agencies is responsible under the Mississippi Coastal Program (MCP) for managing the coastal resources of Mississippi. Proposed activities in the coastal area are reviewed to ensure that the activities are in compliance with the MCP.

The DMR has reviewed the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Programmatic Environmental Impact Statement (EIS) dated February 2009. We concur that the projects discussed in the referenced document are consistent with the approved MCP and that these actions will not have adverse environmental effects on Mississippi's coastal resources.

If you have any questions regarding this letter, please contact Willa Brantley with the Bureau of Wetlands Permitting at 228-523-4108 or willa.brantley@dmr.ms.gov.

Sincerely,

William W. Walker, Ph.D.
Executive Director

WWW/wjb

cc: Mr. Robert Seyfarth, OPC
Mr. Jason Steele, USACE

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3.3 AIR QUALITY

The Mississippi Department of Environmental Quality (MDEQ) is responsible for protecting the state's air, land, and water. The MDEQ, Air Division is responsible for ensuring that air quality within Mississippi is protective of public health and welfare. This division is charged with controlling, preventing, and abating air pollution to achieve compliance with air emission regulations pursuant to the Mississippi Air and Water Pollution Control Act, applicable regulations promulgated by the U.S. Environmental Protection Agency (USEPA), and the Federal Clean Air Act.

The Ambient Air Quality Standards for Mississippi are in Regulation APC-S-4 as described in the following:

MISSISSIPPI COMMISSION ON ENVIRONMENTAL QUALITY
REGULATION APC-S-4: AMBIENT AIR QUALITY STANDARDS

Adopted February 9, 1983
Last Amended June 27, 2002

Except for odor, as covered below, the ambient air quality standards for Mississippi shall be the Primary and Secondary National Ambient Air Quality Standards as duly promulgated by USEPA in (or to be printed in) 40 Code of Federal Regulation (CFR) Part 50, pursuant to the Federal Clean Air Act, as amended. All such standards promulgated by USEPA as of June 22, 1988, are hereby adopted and incorporated herein by the Commission by reference as the official ambient air quality standards of the State of Mississippi and shall hereafter be enforceable as such (except that the word "Administrator" in said standards shall be replaced by the words "Executive Director" and the word "Agency" in said standards shall be replaced by the word "Department").

There shall be no odorous substances in the ambient air in concentrations sufficient to adversely and unreasonably:

(1) affect human health and well-being;
(2) interfere with the use or enjoyment of property; or
(3) affect plant or animal life.

In determining that concentrations of such substances in the ambient air are adversely and unreasonably affecting human well-being or the use or enjoyment of property of plant or animal life, the factors to be considered by the Commission will include, without limiting the generality of the foregoing, the number of complaints or petitioners alleging that such a condition exists, the frequency of the occurrence of such substances in the ambient air as confirmed by the MDEQ staff, and the land use of the affected area.

Mississippi has adopted Federal Standards (New Source Performance Standards, National Emissions Standards for Hazardous Air Pollutants, etc.) by reference. State specific emissions standards for Mississippi are in:

- Regulation APC-S-1 - Air Emission Regulations for the Prevention, Abatement, and Control of Air Contaminants; and
- Regulation APC-S-8 - Air Toxic Regulations.

Jackson, Harrison, and Hancock Counties have been designated in attainment with the National Ambient Air Quality Standards. The proposed Mississippi Coastal Improvement Program effort will be in attainment with the State of Mississippi's Air Quality Standards.

3.4 Compliance with Environmental Laws and Regulations

Environmental Laws and Regulations

Law/Regulation/ Executive Order (EO)	Description	Principal Federal Responsible Agency(s)
Endangered Species Act (ESA) of 1973	Establishes a national policy designed to protect and conserve threatened and endangered (T&E) species and the ecosystems upon which they depend	U.S. Fish and Wildlife Service (USFWS) National Oceanic and Atmospheric Administration (NOAA) Fisheries
Marine Mammal Protection Act of 1972 (MMPA)	Prohibits the take (i.e., hunting, killing, capture, and/or harassment) of marine mammals, and enacts a moratorium on the import, export, and sale of marine mammal parts and products	NOAA Fisheries USFWS
National Historic Preservation Act of 1966 (NHPA) and EO 11593	Seeks to preserve the historical and cultural foundation of the U.S. EO 11593 of 1991 states the Federal Government will provide leadership in preserving, restoring, and maintaining the historic and cultural environment	Mississippi State Historic Preservation Officer (SHPO)
Clean Water Act (CWA)	Regulates activities resulting in a discharge to navigable waters Section 401 (33 U.S.C. 1341) of the CWA specifies that any applicant for a Federal license or permit to conduct any activity that may discharge into the navigable waters shall obtain a certification that the discharge complies with applicable sections of the CWA Section 402 established the National Pollutant Discharge Elimination System (NPDES), which regulates discharges into waters of the U.S. Section 404 established a program to regulate the discharge of dredged or fill material into waters of the U.S. to include tributaries to navigable waters, interstate wetlands which could affect interstate or foreign commerce, and wetlands adjacent to waters of the U.S.	U.S. Environmental Protection Agency (USEPA)
Clean Air Act (CAA)	Establishes limits on how much of an air pollutant can be present in an area anywhere in the U.S. to promote uniformity in basic health and environmental protections	USEPA
Coastal Zone Management Act (CZMA)	Establishes a national coastal management program that comprehensively manages and balances competing uses of and impacts to any coastal area or resource	NOAA, National Ocean Service
Farmland Protection Policy Act (FPPA)	Minimizes the extent to which Federal programs contribute to the unnecessary conversion of farmland to nonagricultural uses	U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)
Wild and Scenic Rivers Act of 1968	Establishes a National Wild and Scenic Rivers System to protect and preserve the free-flowing waters of the nation’s most spectacular rivers. The act safeguards the special character of these rivers while striving to balance river development with permanent protection. The act prescribes the methods and standards through which additional rivers may be identified and added to the system to study areas and submit proposals to the President and Congress for addition to the system.	Secretary of the Interior and the Secretary of Agriculture
Estuary Protection Act	Authorizes study and inventory of U.S. estuaries, including	Secretary of the Interior

of 1968	land and water of the Great Lakes, to determine whether such areas should be acquired by the Federal Government for protection	
Federal Water Project Recreation Act of 1965	Declares recreation and fish and wildlife enhancement be given full consideration as purposes of Federal water development projects if non-Federal public bodies agree to: (1) bear not less than one-half the separable costs allocated for recreational purposes or twenty-five percent of the cost for fish and wildlife enhancement; (2) administer project land and water areas devoted to these purposes; and (3) bear all costs of operation, maintenance and replacement	Secretary of the Interior
Resource Conservation and Recovery Act (RCRA) of 1976	Provides for comprehensive 'cradle-to-grave' regulation of hazardous waste and authorizes environmental agencies to order the cleanup of contaminated sites	USEPA
Toxic Substances Control Act (TSCA) of 1976	Enacted by Congress to give USEPA the ability to track the 75,000 industrial chemicals currently produced or imported into the U.S.	USEPA
Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA)	Regulates ocean dumping in the territorial seas or the contiguous zone of the U.S. and provides for general research on ocean resources (includes designation of marine sanctuaries) and ocean disposal activities	USEPA/NOAA
Section 9 of the Rivers and Harbors Act of 1899	Prohibits the construction of any bridge, dam, dike, or causeway over or in any port, roadstead, haven, harbor, canal, navigable river, or other navigable water of the U.S. until receiving consent of Congress	Corps
Coastal Barrier Resources Act (CBRA)	Designated various undeveloped coastal barrier islands, depicted by specific maps, for inclusion in the Coastal Barrier Resources System (System). Areas so designated were made ineligible for direct or indirect Federal financial assistance that might support development, including flood insurance, except for emergency life-saving activities. Exceptions for certain activities, such as fish and wildlife research, are provided, and National Wildlife Refuges and other, otherwise protected areas are excluded from the System.	Department of Interior, USFWS
EO 11988, Floodplain Management	Requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative	Federal Emergency and Management Agency (FEMA)
EO 11990, Protection of Wetlands	Minimizes the destruction, loss or degradation of wetlands and preserves and enhances the natural and beneficial values of wetlands	USFWS
EO 12114, Environmental Effects Abroad of Major Federal Actions	Enables Federal agencies responsible for authorizing and approving actions to be informed of pertinent environmental considerations and to take such considerations into account, with other pertinent considerations of national policy, in making decisions regarding such actions	All Federal agencies
EO 12898: Environmental Justice	Requires Federal agencies to incorporate into NEPA documents an analysis of the environmental effects of their proposed programs on minorities and low-income	USEPA

	populations and communities.	
EO 13045: Protection of Children from Environmental Health Risks and Safety Risks	Each Federal agency is to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.	USEPA
Wilderness Act of 1964	Assures that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the U.S. and its possessions, leaving no lands designated for preservation and protection in their natural condition, it is hereby declared to be the policy of the Congress to secure for the American people of present and future generations the benefits of an enduring resource of wilderness.	All Federal agencies
Magnuson Fishery Conservation and Management Act and Essential Fish Habitat (EFH)	Establishes and delineates an area from the states' seaward boundary out 200 nautical miles as a fisheries conservation zone for the U.S. and its possessions Established national standards for fishery conservation and management, and created eight regional Fishery Management Councils (FMCs) to apply those national standards in FMCs EFH is defined as the water and substrate necessary for fish spawning, breeding, feeding, and growth to maturity.	NOAA Fisheries