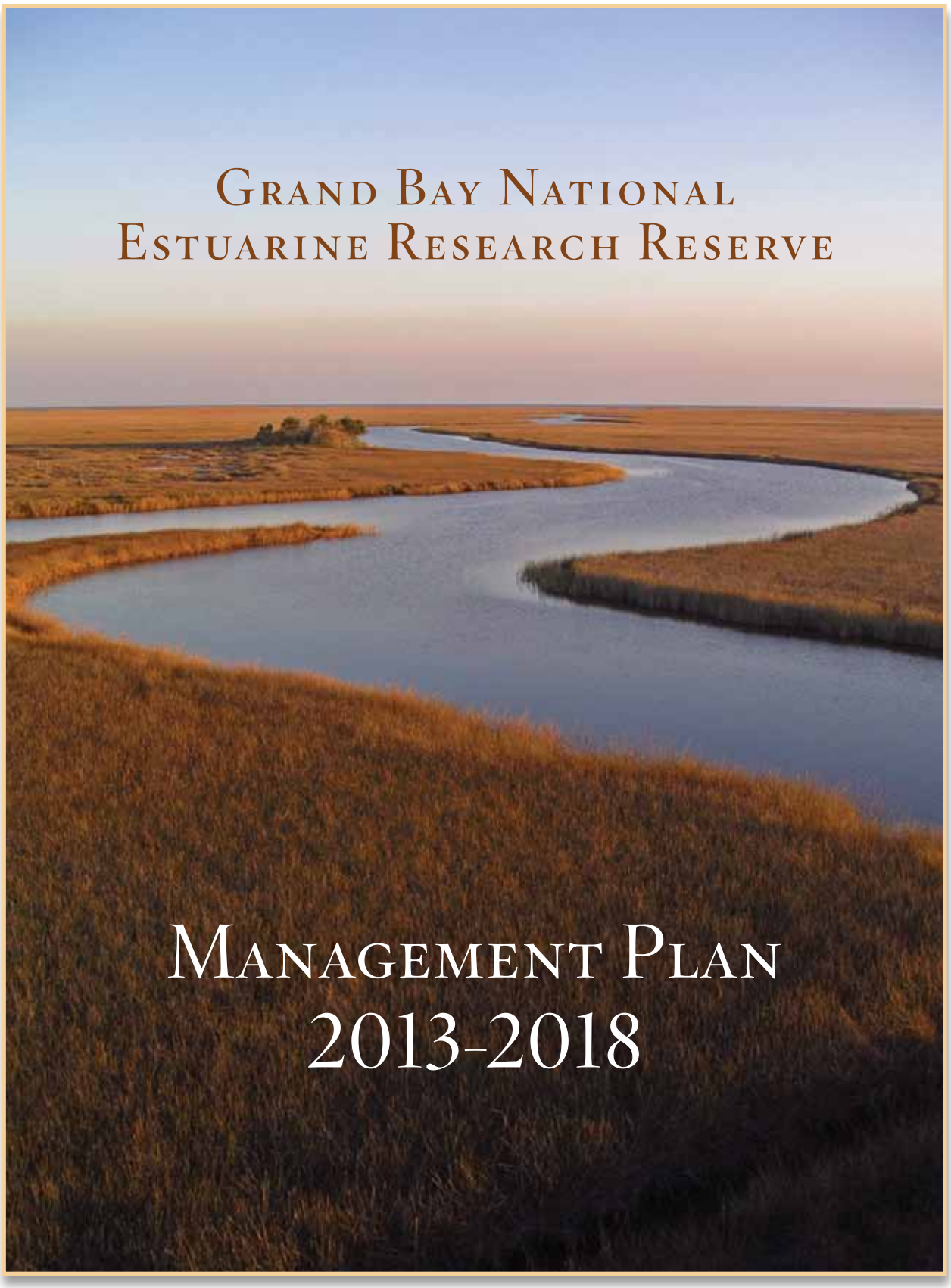
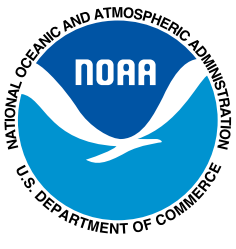


Grand Bay National Estuarine Research Reserve

Management Plan 2013-2018

FEBRUARY 2013



NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

This management plan has been developed in accordance with NOAA regulations, including all provisions for public involvement. It is consistent with the congressional intent of Section 315 of the Coastal Zone Management Act of 1972, as amended and the provisions of the Mississippi Coastal Management Program. February 2013.

This document has been prepared by:

Grand Bay National Estuarine Research Reserve
6005 Bayou Heron Road
Moss Point, MS 39562

www.grandbaynerr.org
228-475-7047

Suggested citation for this document: Grand Bay National Estuarine Research Reserve. 2013. Grand Bay National Estuarine Research Reserve Management Plan 2013-2018: Grand Bay National Estuarine Research Reserve, Mississippi Department of Marine Resources, Moss Point, Mississippi. 104pp.

Table of Contents

List of Tables

List of Figures

List of Appendices

Acronyms

BMP	Best Management Practice
B-WET	Bay-Watershed Education Training
CAC	Citizens Advisory Committee
CORS	Continuously Operating Reference Station
CSC	Coastal Services Center
CTP	Coastal Training Program
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DRC	Disaster Response Center
ECSC	Environmental Cooperative Science Center
ERD	Estuarine Reserves Division
GBCRC	Grand Bay Coastal Resources Center
GBNWR	Grand Bay National Wildlife Refuge
GCPOLCC	Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative
GIS	Geographic Information System
L.E.E.D	Leadership in Energy and Environmental Design
LiDAR	Light Detection and Ranging
GOMA	Gulf of Mexico Alliance
GPS	Global Positioning System
GRF	Graduate Research Fellowship
LTMCP	Land Trust for the Mississippi Coastal Plain
MA/NA	Market Analysis/Needs Assessment
MASGC	Mississippi-Alabama Sea Grant Consortium
MCP	Mississippi Coastal Program
MDA	Mississippi Development Authority
MDAH	Mississippi Department of Archives and History
MDEQ	Mississippi Department of Environmental Quality
MDMR	Mississippi Department of Marine Resources
MDWFP	Mississippi Department of Wildlife Fisheries and Parks
MEEA	Mississippi Environmental Educators Association

MEMA	Mississippi Emergency Management Agency
MGCCC	Mississippi Gulf Coast Community College
MGCNHA	Mississippi Gulf Coast National Heritage Area
MOU	Memorandum of Understanding
MSDH	Mississippi State Department of Health
MSU	Mississippi State University
MSU/CREC	Mississippi State University/Coastal Research and Extension Center
NAAEE	North American Association of Environmental Educators
NMEA	National Marine Educators Association
NERR	National Estuarine Research Reserve
NERRS	National Estuarine Research Reserve System
NGS	National Geodetic Survey
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	Non-Point Source
NRDA	Natural Resource Damage Assessment
NWR	National Wildlife Refuge
OCRM	Office of Coastal Resource Management
PRAC	Pascagoula River Audubon Center
RMB	Reserve Management Board
RTK	Real-time Kinematic
SAME	Southern Association of Marine Educators
SAV	Submerged Aquatic Vegetation
SET	Surface Elevation Table
SOS	Mississippi Secretary of State
STEM	Science, Technology, Engineering and Math Education
SWMP	System-Wide Monitoring Program
TNC	The Nature Conservancy
TOTE	Teachers on the Estuary
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USM	University of Southern Mississippi

Acknowledgments

This management plan represents the collective efforts of several Grand Bay National Estuarine Research Reserve staff members over an extended period, particularly: David Ruple, Jennifer Buchanan, Will Underwood, Mark Woodrey, Kim Cressman, Teresa Stadler and Jay McIllwain. Former staff members Tom Strange and Avia Huisman also provided significant contributions to earlier drafts. Laura Tolar formatted and Billy Dugger edited the final version of the plan. Special thanks to Gretchen L. Grammer for providing the image of Bayou Heron found on the front cover. The Reserve acknowledges the guidance, support and patience of the NOAA Estuarine Reserves Division staff, particularly Erica Seiden and Matthew Chasse.

Executive Summary

The State of Mississippi operates the Grand Bay National Estuarine Research Reserve (Reserve or NERR) encompassing approximately 18,049 acres of coastal wetlands and estuarine waters along the southeastern coast of Mississippi. The Reserve was designated into the National Estuarine Research Reserve System (NERRS) in 1999 as the 24th reserve, as authorized under the provisions of the Coastal Zone Management Act of 1972 (CZMA). The CZMA recognized the significance of coastal resources and authorized the federal government to establish the Coastal Zone Management Program and the NERRS to manage these resources. The Mississippi Department of Marine Resources (MDMR) was designated to manage the Reserve, in conjunction with the National Oceanic and Atmospheric Administration (NOAA) as part of a state-federal partnership to provide for long-term stewardship. In 1972 the Mississippi Legislature also recognized the importance of Mississippi's coastal resources and passed the Coastal Wetlands Protection Act. Subsequently, the Mississippi Coastal Program was established in 1980.

The Reserve is a large relatively intact area of coastal wetlands located in Jackson County, immediately adjacent to the Mississippi-Alabama state line. The site includes a variety of wetland types, including tidal estuary and non-tidal wetlands. The Reserve supports a highly diverse community of plants and animals and includes one of the largest estuarine systems in Mississippi. Estuarine ecosystems serve as vital nursery areas for a large portion of our commercial and recreational species of fish and shellfish, serve as filters to enhance coastal water quality and serve to provide a degree of resilience to buffer human built and natural communities from severe storm events. Within the NERRS, Grand Bay represents an estuarine type dominated largely by black needle rush, more so than any other reserve.

The mission of the Reserve is to practice and promote informed stewardship of the Grand Bay NERR and Mississippi coastal resources through innovative research, education and training. This mission reflects our vision of valuing and conserving the broader Gulf of Mexico, being part of a regional effort to focus increased attention to the economic and environmental value of "America's Sea".

Staff and partners will work collaboratively to address focus areas relating to habitat protection, climate change and water quality. Reserve priorities and specific goals that will support this work include: 1) increase scientific understanding and management of coastal resources, 2) increase appreciation for the significance of coastal resources, and 3) improve science-based decision-making regarding management of coastal resources. The Reserve will address these priorities on a local and regional context and will pursue projects and collaborations relating to promoting resilient communities, promoting sustainable development, monitoring biodiversity, water quality monitoring, conducting habitat restoration and enhancement, understanding impacts of climate change and watershed development on natural communities. Reserve education and training activities will share the results of these projects with the public and local decision-makers. This plan will chart the course of action for the next five years (2013-2018).

I. Introduction

Grand Bay NERR was designated into the NERRS because of its ecological significance as a major estuarine system in the Gulf of Mexico. In addition to habitat diversity and species diversity associated with the Grand Bay area, it also is part of one of the least developed shoreline areas along the northern Gulf of Mexico. As part of the NERRS, Grand Bay is located in the Mississippi Deltaic subregion of the Louisianan biogeographic region and contains unique examples of estuarine and biological features representative of this particular region.

The management plan describes how the Grand Bay NERR will be managed by the Mississippi Department of Marine Resources and presents specific actions relative to priority focus areas and the goals of the national system. The plan describes the operational and landscape context within which the Reserve is situated and describes existing resource protection of areas within and adjacent to the Reserve. The 2012 boundaries of the Reserve are shown along with justifications for lands and waters within the core and buffer zones of the site. An acquisition plan describes the needs and rationale for acquiring remaining lands within the administrative boundaries. A facilities and equipment plan details existing assets and justification for future facilities enhancements. The stewardship plan describes management and monitoring activities and projects coordinated by the stewardship staff in cooperation with partners, particularly the U.S. Fish and Wildlife Service (USFWS) that owns significant lands within the Reserve boundaries. Stewardship activities that address key threats to the site such as fire suppression, hydrologic alterations, invasive species and sea level rise are detailed. The research and monitoring plan describes the ongoing and future research/monitoring projects that focus on Reserve priorities and projects detailed in the Reserve's Site Profile. The education/outreach and coastal training programs at the Reserve are described. Future actions are discussed relating to an increased understanding and awareness of issues addressing water quality, habitat protection and climate change by the public and local decision-makers.

National Estuarine Research Reserve System

The National Estuarine Reserve System was created by Section 315 of the Coastal Zone Management Act (CZMA) of 1972, as amended, 16 U.S.C. Section 1461, to augment the Federal Coastal Zone Management (CZM) Program. The CZM Program is dedicated to comprehensive, sustainable management of the nation's coasts. The reserve system is a network of protected areas established to promote informed management of the Nation's estuaries and coastal habitats. The reserve system currently consists of 28 reserves in 23 states and territories, protecting over one million acres of estuarine lands and waters.

Mission

As stated in the NERRS regulations, 15 C.F.R. Part 921.1(a), the National Estuarine Research Reserve System mission is:

> *the establishment and management, through Federal-state cooperation, of a national system of Estuarine Research Reserves representative of the various regions and*

estuarine types in the United States. Estuarine Research Reserves are established to provide opportunities for long-term research, education and interpretation.

Goals

Federal regulations, 15 C.F.R. Part 921.1(b), provide five specific goals for the reserve system:

1) Ensure a stable environment for research through long-term protection of National Estuarine Research Reserve resources;
2) Address coastal management issues identified as significant through coordinated estuarine research within the System;
3) Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
4) Promote Federal, state, public and private use of one or more Reserves within the System when such entities conduct estuarine research; and
5) Conduct and coordinate estuarine research within the System, gathering and making available information necessary for improved understanding and management of estuarine areas.

National Estuarine Research Reserve System Strategic Goals 2011–2016

Strategic planning has been an integral part of the National Estuarine Research Reserve System for nearly 20 years. The planning process is designed to bridge national program direction with on-the-ground coastal management needs through a representative and participatory process that supports NOAA's mission of science, service and stewardship.

The Reserve System 2011-2016 strategic plan focuses its core strengths of research, education and training on climate change, habitat protection and water quality (NOAA/NERRS 2010). In recognition that estuaries are biologically rich, economically valuable and highly vulnerable ecosystems, the Reserve System adopted a ***Vision:*** Resilient estuaries and coastal watersheds where human and natural communities thrive and a ***Mission:*** To practice and promote stewardship of coasts and estuaries through innovative research, education and training using a place-based system of protected areas. The following goals are outlined in the 2011-2016 Strategic Plan (NOAA/NERRS 2010).

Goals:

1) **Protected Places:** Estuaries and coastal watersheds are better protected and managed by implementing place-based approaches at Reserves.
2) **Science:** NERRS scientific investigations improve understanding and inform decisions affecting estuaries and coastal watersheds.
3) **People:** NERRS education and training increases participants' environmental literacy and ability to make science-based decisions related to estuaries and coastal watersheds.

Biogeographic Regions

NOAA has identified 11 distinct biogeographic regions and 29 subregions in the U.S., each of which contains several types of estuarine ecosystems as found in 15 C.F.R. Part 921 (Appendix 1). When complete, the reserve system will contain examples of estuarine hydrologic and biological types characteristic of each biogeographic region. As of 2013, the NERRS includes 28 reserves (Figure 1).

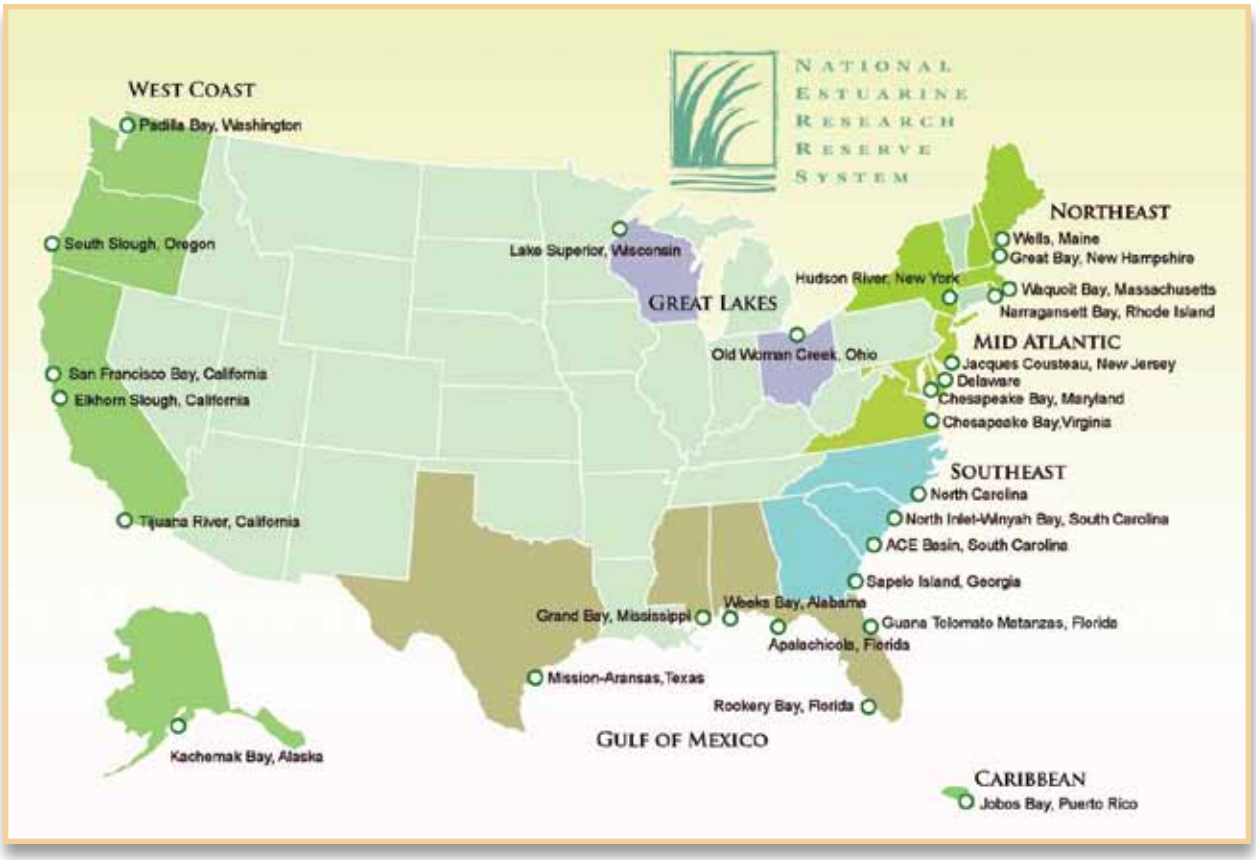


Figure 1. Reserves within the National Estuarine Research Reserve System (NERRS).

Reserve Designation and Operation

Under Federal law (16 U.S.C. Section 1461), a state can nominate an estuarine ecosystem for Research Reserve status so long as the site meets the following conditions:

1) The area is representative of its biogeographic region, is suitable for long-term research and contributes to the biogeographical and typological balance of the System;
2) The law of the coastal State provides long-term protection for the proposed Reserve's resources to ensure a stable environment for research;
3) Designation of the site as a Reserve will serve to enhance public awareness and

understanding of estuarine areas, and provide suitable opportunities for public education and interpretation; and

4) The coastal State has complied with the requirements of any regulations issued by the Secretary [of Commerce].

Reserve boundaries must include an adequate portion of the key land and water areas of the natural system to approximate an ecological unit and to ensure effective conservation.

If the proposed site is accepted into the reserve system, it is eligible for NOAA financial assistance on a cost-share basis with the state. The state exercises administrative and management control, consistent with its obligations to NOAA, as outlined in a memorandum of understanding. A reserve may apply to NOAA's Estuarine Reserves Division (ERD) for funds to help support operations, research, monitoring, education/interpretation, stewardship, development projects, facility construction, and land acquisition.

National Estuarine Research Reserve System Administrative Framework

The Estuarine Reserves Division of the Office of Ocean and Coastal Resource Management (OCRM) administers the reserve system. The Division establishes standards for designating and operating reserves, provides support for reserve operations and system-wide programming, undertakes projects that benefit the reserve system, and integrates information from individual reserves to support decision-making at the national level. As required by Federal regulation, 15 C.F.R. Part 921.40, OCRM periodically evaluates reserves for compliance with Federal requirements and with the individual reserve's Federally-approved management plan.

The Estuarine Reserves Division currently provides support for four system-wide programs: the System-Wide Monitoring Program, the Graduate Research Fellowship Program, the K-12 Estuarine Education Program, and the Coastal Training Program. They also provide support for reserve initiatives on restoration science, invasive species, community education, reserve specific research, monitoring, education and resource stewardship initiatives and programs.

II. Introduction to the Grand Bay National Estuarine Research Reserve

This introduction to the Grand Bay NERR provides for an overview of the physical context in which the Reserve is situated. The site is generally described in relationship to a broader coastal watershed with a description of habitat types found within the Reserve. The Reserve is a large relatively intact area of coastal wetlands immediately adjacent to the Mississippi-Alabama state line.

The Reserve supports a highly diverse community of plants and animals and includes one of the largest estuarine systems in Mississippi. Such estuarine communities in the northern Gulf of Mexico serve as vital nursery areas for a large portion of our commercial and recreational species of fish and shellfish, serve as filters which enhance coastal water quality and provide a degree of resilience that buffer our human built and natural communities from severe storm events. Anthropogenic and natural impacts in recent years are discussed relative to management and use of the site and surrounding area.

Site Description

The Grand Bay NERR is located on the Mississippi/Alabama state line in Jackson County, MS, about 30 miles east of Biloxi, MS and 30 miles southwest of Mobile, AL (Figure 2). Primary Reserve facilities are located on Bayou Heron Road, Moss Point, MS.

The administrative boundaries of the Grand Bay NERR (see Acquisition and Boundary Chapter) include lands and waters in southeastern most Jackson County, MS. Of the 18,049 acres within this boundary there are 3,425 acres of private inholdings and 14,624 acres of public lands and waters. The Reserve includes Middle Bay, Point Aux Chenes Bay, Bayou Cumbest, Crooked Bayou, Bayou Heron and associated coastal wetland habitats and selected portions of tidal and non-tidal habitats including lands and waters within the boundaries of the Grand Bay National Wildlife Refuge (GBNWR) (Figure 3.) It is bounded on the east by the waters of Grand Bay and Middle Bays, and Bayou Heron on the Mississippi-Alabama state line, on the west by Bangs Lake bordering the Bayou Cassotte Industrial Park, on the north by the communities of Bayou Cumbest, Pecan, Kreole and Orange Grove and on the south by the Mississippi Sound.

The Grand Bay NERR is representative of the Louisianan biogeographic region, within the NERRS biogeographical regions structure and is located in the Mississippi Deltaic subregion. No other reserve currently exists within the Louisianan region, which comprises portions of Texas, Louisiana, Mississippi and Alabama west of Mobile Bay. Geologic data suggest this area was formed as part of a larger river complex although it is now characterized as a retrograding delta due to a change in the river course.

Figure 2. Grand Bay NERR vicinity map.

Designation of the Grand Bay NERR did not establish new state or federal regulations or alter most of the traditional uses of the area. Current uses include boating, fishing, hunting, shellfish harvesting, photography and other recreational activities. Traditional uses continue, with limited restrictions that may apply to significant habitats or other areas of special interests (e.g.,facilities, trails) and in accordance with Mississippi and USFWS regulations.

Habitats

The estuarine system at Grand Bay consists of waters that are semi-enclosed by land but have open, partly obstructed, or sporadic access to the ocean, in which seawater is at least occasionally

diluted by freshwater runoff from land. Because large volumes of freshwater do not regularly enter the Grand Bay system, salinities have been recorded above 30 ppt (parts per thousand) at all System-wide Monitoring Program (SWMP) stations within the Reserve, making this one of the saltiest estuarine systems on the Mississippi Coast.

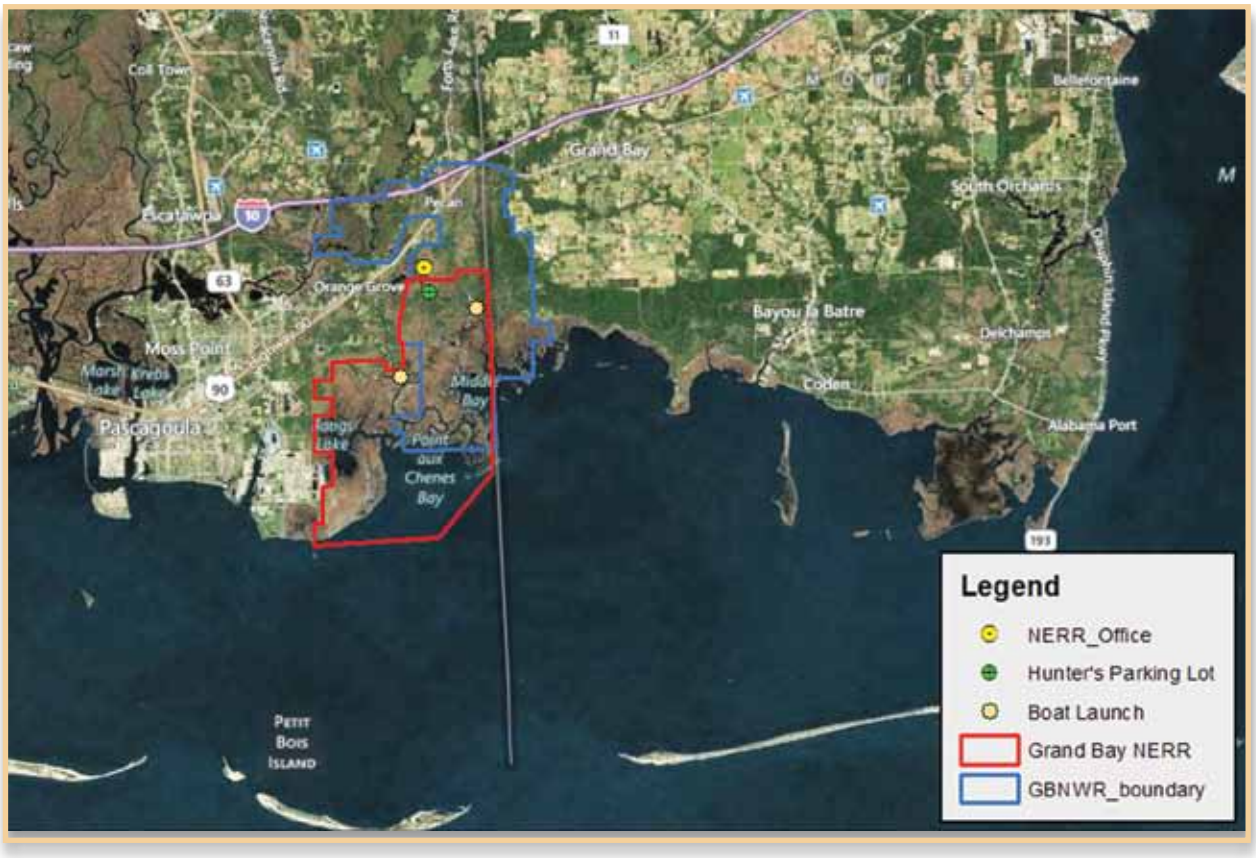


Figure 3. Grand Bay NERR landmarks.

Grand Bay is characterized by a broad mosaic of estuarine and non-estuarine wetland habitats that, together, form a largely intact coastal watershed. (Table 1) The open-water estuarine areas support declining oyster reefs and extensive seagrass habitats. The intertidal portion of the site includes a wide variety of marsh types (low, mid-level and high elevation zones across a wide range of salinity) as well as some of the most extensive, unvegetated salt flats in this part of the Mississippi Sound. The non-tidal areas include wet pine savannas, coastal bayhead and cypress swamps, freshwater marshes and maritime forests.

Various ecological community classifications have been applied to Grand Bay NERR in the past. Wieland (1994, 2007) reflects a combined classification of Cowardin et. al. (1979) and Dethier (1992). In 2004 a classification of reserve habitats was developed by the University of Southern Mississippi's (USM) Gulf Coast Geospatial Center by interpreting aerial images from a 2002 Environmental Cooperative Science Center (ECSC) project at Grand Bay (Figure 4). An updated NERRS-specific classification of habitats is under revision by staff and partners (Figure 4).

Habitat Type	Hectares	Acres
Roads/Driveways	3.2	7.8
Forest/Trees	476.3	1176.5
Wet Herbaceous	463.9	1145.7
Freshwater Marsh/Aquatic Vegetation	8.2	20.2
Industrial Facilities	4.0	9.9
Upland Grasses/Agriculture/Residential	7.9	19.4
Scrub/Shrub/Saplings	343.2	847.8
Beach/Exposed Sand	22.6	55.9
Intermediate Marsh	1129.2	2789.2
Tidal/Inundated Marsh	1611.0	3979.1
High Marsh	297.2	734.0
Water	2835.1	7002.7
Salt Panne	105.7	261.0

Table 1. Extent of habitat types at the Grand Bay NERR, 2008.

Climate and Weather

Grand Bay has a subtropical climate. A Bermuda High exerts the greatest influence on the climate of this area. During spring and summer when the Bermuda High intensifies, warm, humid, south and southeast winds dominant. Wind speeds of spring and summer are generally less than those of fall and winter. Frontal passages are infrequent but squall lines are common and often result in heavy rainfall and violent storm conditions locally. During fall and winter, the Bermuda High diminishes in strength allowing continental pressure systems and associated cold fronts to move south. During this time, the dominant winds are frequently from the north.

Summer is hot and humid, characterized by afternoon thunderstorms. Average annual maximum temperatures as reported from nearby Pascagoula, MS at 24.7°C (76.5° F) with July averages reaching 32.0° C (89.7° F). Winters are mild, with annual minimum temperatures averaging 14.7° C (58.5° F) with January averages at 5.8° C (42. 4° F). Light freezes are common and hard freezes occur occasionally. Average annual rainfall is approximately 1.6 m (63 inches). Extreme rainfall events may result in .25-.76 m (10" to 30") of rainfall over a short period of time. Such events have caused serious flooding on the nearby Escatawpa River. This flooding causes issues at the Reserve, impeding access to the facilities and boat ramps by vehicle.

Tropical Weather

Grand Bay is situated within an active hurricane zone. Hurricane season is from June through November with the majority of hurricanes occurring during August and September. Seven (7) hurricanes have made landfall in Mississippi since 1960 (Ethel – 1960, Camille – 1969, Bob – 1979, Frederic – 1979, Elena – 1985, Georges – 1998 and Katrina – 2005). Although not making landfall along the Mississippi Coast, five (5) other hurricanes have significantly affected the Grand Bay

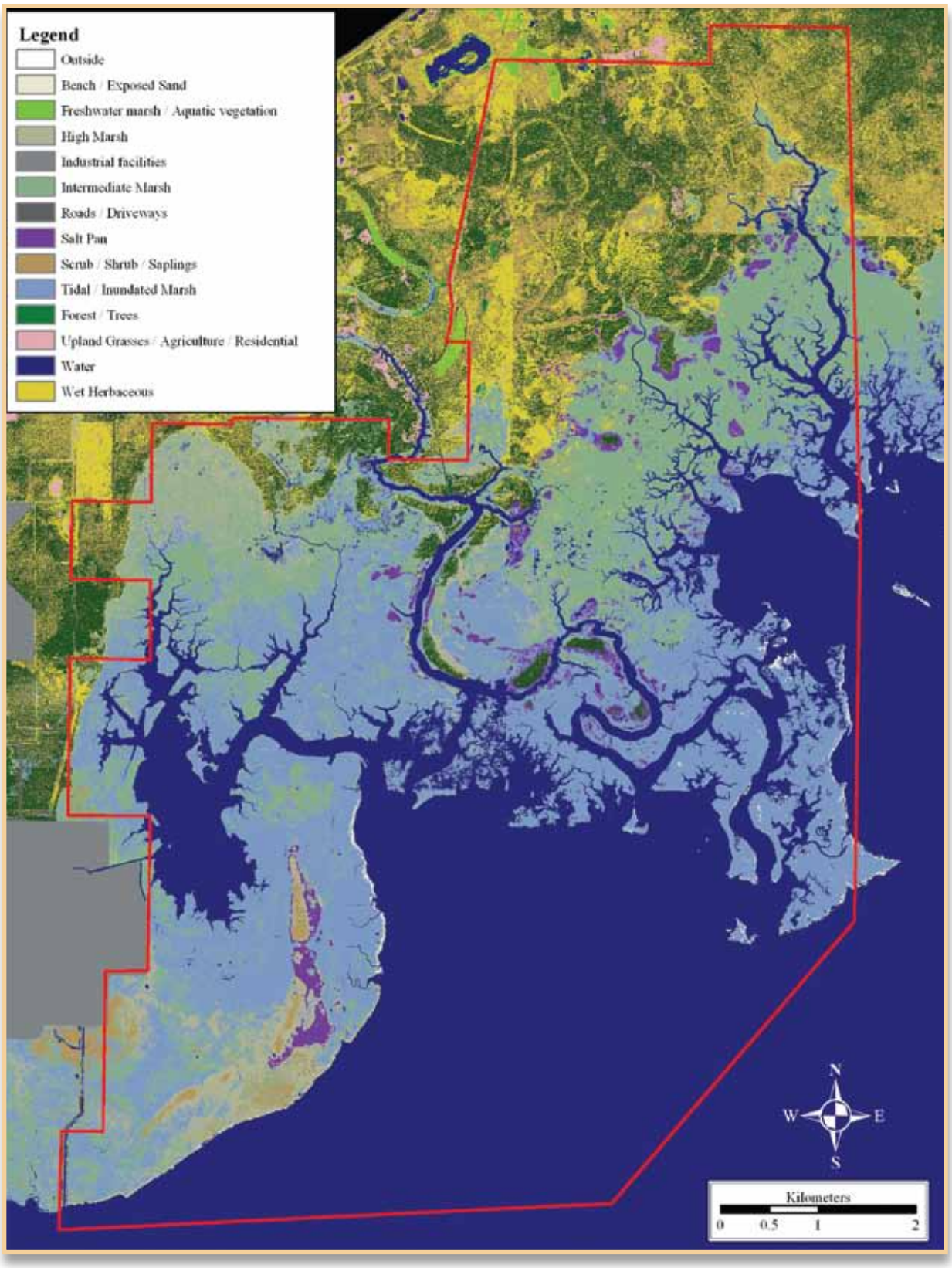


Figure 4. Grand Bay NERR habitat map.

area since 1960 (Betsy – 1965, Erin – 1995, Opal – 1995, Danny – 1997, and Rita – 2005). All of these tropical events dramatically impacted the human and natural communities on the Mississippi Coast.

The Grand Bay NERR was dramatically affected in August 2005 by Hurricane Katrina. Depth recorders measured a maximum of 5.5 m (18 feet) tidal surge at the Reserve in Bayou Heron. The entire Reserve and most of the surrounding landscape was flooded under several feet of water. Approximately 2.4 m (8 feet) of water destroyed the NERR offices during the storm.

Impacts from hurricanes will provide continued disturbance to the landscape through erosion, saltwater inundation/intrusion, displacement of sediments, direct and indirect species mortality and deposition of debris, etc.

Physiography

The Grand Bay area lies within the gently sloping, lower Gulf coastal plain and was part of the previous deltas of the Escatawpa and Pascagoula rivers. The geomorphic evolution of this area is characterized by a long, complex sequence of events and processes evidenced by extensive marsh headlands and riverine scarring across the landscape. The Escatawpa River became a large tributary of the Pascagoula River through a process of stream piracy after the formation of the delta. As a result, the Grand Bay area is characterized as a retrograding delta with low freshwater inflow and sediment load. The question of which river system created the estuary is still relevant and it is likely that both rivers contributed to the formation. Aerial photography and LiDAR analysis reveal a clear system of relict channels that originated from the Pascagoula River floodplain and chart a course to what is presently Bayou Cumbest, Crooked Bayou, North Rigolets, and L'Isle Chaude Bayou (Figure 5). However, more work, including sediment analysis, should be conducted to elucidate origins of bayous and meander scars in the Grand Bay NERR area. Headland erosion of the delta front caused the development of flanking barriers referred to as the Grand Batture Islands and two open embayment areas, Grand Bay to the east and Point Aux Chenes to the west. The Grand Batture islands are now eroded and mostly submerged. They define the southern boundaries of Grand and Point Aux Chenes Bays as well as the Grand Bay NERR site. Simultaneously, the marshy, back delta areas were eroded and retreated northwestward. Sediments in the area consist of sands, silts and clays of coastal and riverine origin. Sediment substrate of the marshes is rich in organic material and clays but also has a sizeable sand/silt component.

Bayous Cumbest and Heron are the primary watercourses discharging into Point Aux Chenes Bay and the Grand Bay/Middle Bay complex respectively. Both bayous are relatively small with slow flowing waters rich in tannic acid from their forested watersheds. Except in extreme flood events, it is believed that freshwater in these waters originates in large part from localized rainfall and groundwater. During moderate flood events, much of the Reserve is connected to the Escatawpa River watershed.

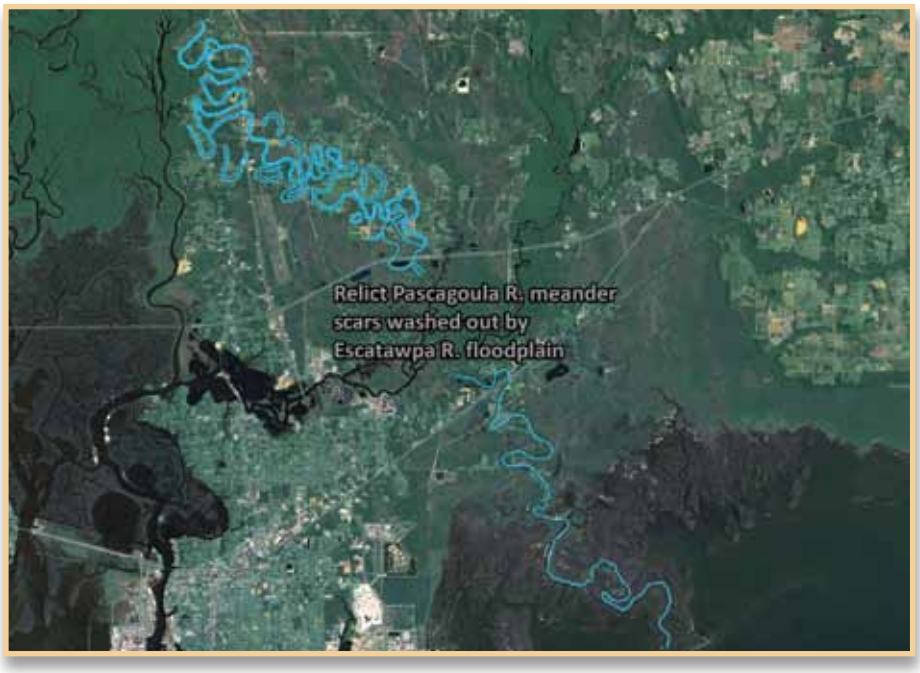


Figure 5. Relic Pascagoula River meander scars.

Geology

Geologic information specific to the Grand Bay area is scarce. However, studies of the geology of coastal Mississippi are numerous including Brown *et al.* (1944) and Otvos (1972a, 1972b, 1973, 2007). Processes and events that shaped the Grand Bay area occurred during relatively recent geologic time. The late Pleistocene (Sangamon) interglacial sea level stood approximately 7 m (23 feet) above the present sea level along the Mississippi Coast. During this time shallow, marine sediments were deposited (Biloxi Formation) in waters fronting the shoreline while alluvial sediments (Prairie Formation) were deposited landward of the shoreline. Strand plain beach ridges (Gulfport Formation) were prograded from the shoreline into the sea covering Biloxi deposits. The Mississippi Sound was dry land covered with Prairie deposits during the last glacial period (Wisconsin). Coastal streams, adjusting to new base levels, entrenched themselves in deep, narrow valleys. At the end of the Wisconsin glaciation, the sea level rose and covered the Mississippi Sound again with shallow, near shore conditions. When sea level reached its approximate, present-day location, river channels were drowned and estuaries were formed.

Hydrology/Oceanography

The Grand Bay area is a shallow, estuarine area (Figure 6) with an average water depth of approximately 0.9 m (3 feet). Water depths can range from 0 ft. at some low tides to 3.1 m (10 feet) in the channel connecting Point Aux Chenes Bay with the Mississippi Sound. Average water depth in Bangs Lake and Middle Bay is less than 0.9 m (3 feet).

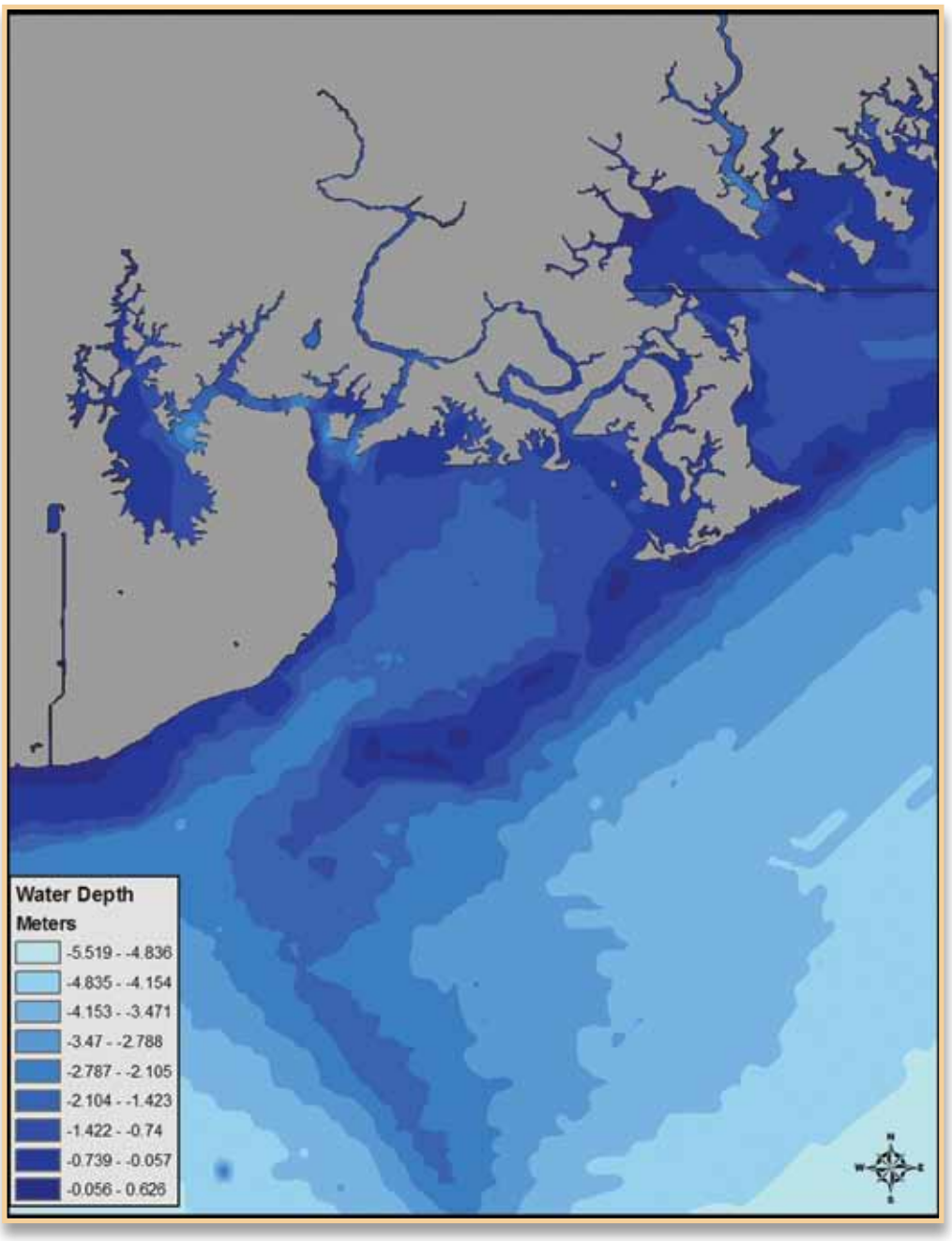


Figure 6. Grand Bay NERR bathymetry (not for navigation purposes).

Dominant water movement results from the flood and ebb of the tide except during heavy rain events when freshwater discharge from the bayous is significant. Both astronomical and meteorological tides influence the Grand Bay area. Astronomical tides are diurnal, i.e., usually one high and one low water per day with an average tidal range of approximately 0.6 m (2 feet). Tidal range fluctuates seasonally with a minimal range of 0–0.5 m (0 to 1.5 feet) during the winter months and a maximum range of 0.6 to 0.9 m (2 to 3 feet) during the summer months. Because of

the minimal tide range of the area, meteorological conditions often exert a strong influence on local tide elevations, making this a wind dominated tidal system. Strong southerly winds push water into the area exaggerating and often maintaining high water conditions. Strong northerly winds push water out of the area exaggerating and maintaining low water conditions often resulting in the exposure of large mudflats and sandy shoals.

Reserve water temperatures recorded at the four current SWMP stations ranged between a low of 1.50 C (34.70 F) in the winter to a high of 35.90 C (96.60 F) in the summer. Average water temperatures at these sites ranged from 22.50 C (72.5 0 F) to 23.1 0 C (73.60 F).

Salinity values vary along a gradient from bayou to bay and with rainfall events. Salinity values have been recorded from fresh or oligohaline conditions 0.0 to 5.0 ppt to polyhaline conditions 18 to 30+ ppt. Salinity is generally highest during the late summer/early fall dry season and lowest during the winter to early spring wet season. Median salinities across all SWMP stations is approximately 22 ppt.

Water Quality

Generally the water quality in the Reserve is considered good. The Grand Bay NERR is bounded on the west by the Bayou Cassotte Industrial Complex and unauthorized discharges from this area have in the past, and may in the future at least temporarily degrade water quality. The areas adjacent to the Reserve are sparsely populated but where population exists, treatment and disposal of domestic wastewater is dependent on individual septic systems. There are no municipal sewage facilities in this area. Nonpoint source pollution associated with improperly treated sewage from malfunctioning individual septic systems is a potential source of contaminants to the site from residential home adjacent to the Reserve. These, as well as, the potential residential and industrial sources to the east from the Bayou LaBatre and Mobile Bay, AL. area and natural levels of bacteria in the waters may contribute to degraded water conditions.

National Pollutant Discharge Elimination System (NPDES) permits at the Mississippi Department of Environmental Quality (MDEQ) indicated that the majority of point source discharges from the adjacent industrial sites are located and discharged to the west of the Grand Bay NERR and do not impact the site directly (Coastal Environments, Inc., 1992). However, one industrial NPDES permit allows discharge into an unnamed tributary to Bangs Lake. This permit regulates total suspended solids discharging from a settling pond. Nitrogen, phosphorous and chlorophyll measurements from Reserve water quality stations are generally very low.

Area VIII oyster-growing waters within the Reserve is currently classified "prohibited". Even though the growing water classification is listed as "prohibited", the origin of periodic high bacteria levels is believed to be at least partially from natural animal populations within the Reserve and not human sources.

Occasional industrial releases have created major issues at the Reserve and in surrounding waters including an April 2005 wastewater spill (67 M l, 17.5 million gal.) from a nearby fertilizer manufacturing company (Figure 7) and the April 2010 Deepwater Horizon Incident due south of

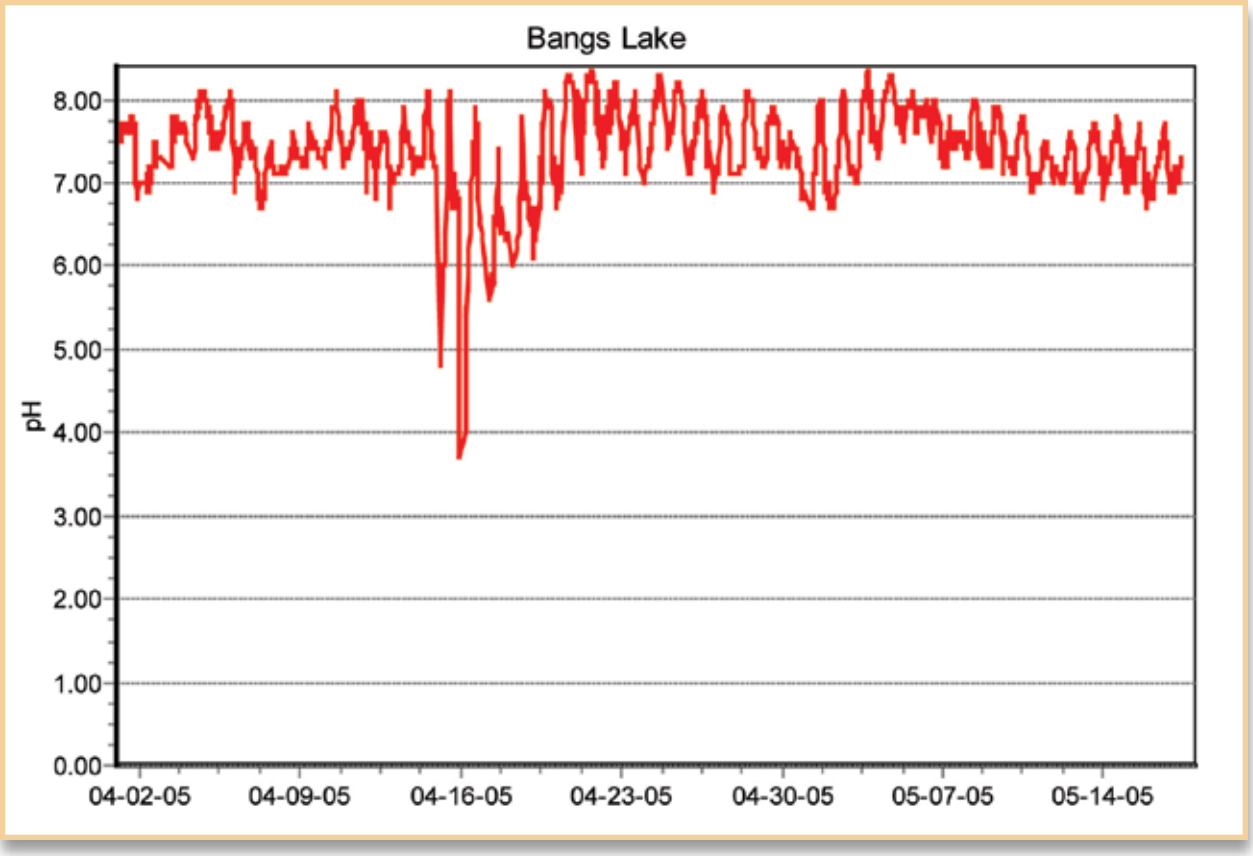


Figure 7. pH levels in Bangs Lake from 2005 Phosphates spill, April 2 –May 14, 2005.

the Reserve in the Gulf of Mexico (Figure 8). Reserve SWMP and other research and monitoring were extremely valuable to resource managers in evaluating impacts from these incidents.

As a result of the Deepwater Horizon incident, the Reserve has worked with NOAA's Disaster Response Center (DRC) and Estuarine Reserves Division (ERD) to formulate a Disaster Response Plan for Grand Bay NERR (Appendix 2) .

Uses of Reserve waters, which may be threatened periodically by impaired water quality in this drainage area include, overall ecological function, wildlife and fish propagation, recreation and commercial fishing and shellfish harvesting.

Figure 8. Response activities at Grand Bay NERR relating to Deepwater Horizon oil spill.

III. Vision, Mission, Focus, Goals and Objectives

The Grand Bay NERR has identified a vision, mission and four strategic goals that reflect the theme of work that will be undertaken to address priority issues within areas of focus as listed below. The responsibility for addressing the goals, related objectives and strategies will be integrated among the various Reserve sectors (Research, Education, Stewardship, Coastal Training Program, Administration) and will be achieved through collaboration with a variety of partners. The objectives and strategies/actions listed in subsequent sections of the management plan specifically relate to the Reserve areas of focus and priorities. While many of the objectives outlined here are specific to efforts at the Reserve, some are broader in scope and reflect work that staff will undertake over larger geographic areas (watershed, county, coastal, regionally).

The 2011-2016 NERRS Strategic Plan (NOAA/NERRS 2010) emphasizes guidance principles that were useful in developing specific objectives for this plan. The NERRS are guided by the following principles:

- Engage local communities and citizens to improve stewardship of coastal resources
- Create strong partnerships to enhance the success of reserve programs
- Integrate science, education, and stewardship to address complex coastal problems
- Implement best management practices at reserves to lead by example
- Seek regional collaborations to extend the influence of reserve programs and products

Areas of Focus and Priorities

The reserve system was founded on the principle that long-term protection of representative estuaries provides stable platforms for research and education and the application of management practices that will benefit the Nation's estuaries and coasts. Individual reserves serve as living laboratories for the study of estuaries and natural and man-made changes. Reserves employ place-based approaches to connect science to people, whether they are teachers, students, decision makers, or coastal residents that are provided with scientific information. Reserves serve as demonstration sites where new ideas are tested.

The Reserve System has identified climate change, water quality and habitat protection as strategic areas of focus and investment over the next five years (NOAA/NERRS 2010). These are the most significant issues for estuaries nationally and require local and regional responses. The Reserve System, as a place-based network of protected areas, is uniquely positioned to address these issues.

Climate Change

Climate change will significantly impact estuaries and coasts by exacerbating existing stressors such as sea level/lake level change, inundation and flooding from storms, intensity of storms, wildfires, drought and changes to freshwater inflows. Ocean acidification and species shifts will also affect our nation's estuaries. These impacts are expected to vary regionally and increasingly affect

coastal communities and economies (USGCRP 2009). Reserves are well positioned to monitor and study the impacts of climate change on estuaries and to work with communities to plan and adapt to these changes. Reserves can design and implement mitigation and adaptation practices in the construction of facilities and through stewardship projects. Reserve training and education programs can help communities understand and adapt to anticipated effects of local and regional climate change.

Climate change priorities at Grand Bay NERR include: 1) Understanding the effects of climate change on the biological, physical, ecological and socio-demographic components of the Reserve and relationships to nearby built communities, and 2) Engaging with citizens and their communities to communicate a message that addresses understanding, adapting and mitigating potential impacts of climate change. Staff is currently engaged in several continuing activities dealing with these priorities, including the NERRS Climate Change Initiative, NERRS Sentinel Sites, NOAA Sentinel Sites, Ecological Effects of Sea Level Rise in the Northern Gulf of Mexico and a Coastal Training Program Initiative for Resilient Communities.

Habitat Protection

Coastal wetlands are being lost at a rate of approximately 60,000 acres per year, largely due to coastal development and inundation (Stedman and Dahl 2008). The biologically rich habitats of estuaries and coastal watersheds provide essential functions such as nurseries for many commercially important fish and shellfish as well as protection for human communities from storm surge, storm water run-off, and flooding. Current stressors on coastal habitats will be amplified by climate change causing greater habitat loss and alteration, which increases the urgency for protection. Reserves are well suited to map, monitor and investigate habitat changes and develop, test and implement methods for habitat protection and restoration. Reserves also transfer these best management practices through coastal training and community education programs.

Priorities at Grand Bay NERR for habitat protection include: 1) Understanding the threats to Reserve resources and ecological function (i.e. invasive species, hydrologic alterations, fire suppression, point and non-point source (NPS) pollution, sea level rise, increased salinities) and how ecosystems respond to these changes (threats), 2) Developing partnerships to implement comprehensive management of resources, addressing acquisition, restoration and enhancement, resource protection, public access and resource manipulation and 3) Communicating the issues relating to Reserve threats and sharing information with citizens and their communities regarding best practices to manage and protect coastal resources.

Water Quality

In the most recent assessment of estuaries by NOAA, the U.S. Environmental Protection Agency and the U.S. Department of Agriculture, a majority of estuaries showed signs of eutrophication and algal blooms, which were influenced strongly by population growth and land use practices (Bricker 2007). Understanding and monitoring water quality trends provides critical information needed to improve ecosystem health and mitigate adverse impacts such as harmful algal blooms and hypoxia. Equally important is promoting and implementing best management practices that address land-based sources of pollution. Reserve's ability to couple long-term monitoring data

with management practices on reserve lands and in adjacent coastal watersheds provides an opportunity to study the effectiveness of different management practices. By implementing consistent protocols, reserves also are in a position to detect regional and national trends over time, particularly for larger scale drivers such as climate change.

Water quality priorities at Grand Bay NERR include: 1) Monitoring and understanding water quality attributes relative to changes over time and correlating changes to species and habitat diversity/condition, 2) Determining the environmental and anthropogenic sources that may cause water quality changes and 3) Communicating water quality conditions at the Reserve and issues relating to maintaining water quality to citizens and their communities. Grand Bay has a 10-year history of water quality monitoring which was formalized in 2004 with the initiation of the Reserve's System-Wide Monitoring Program. This program serves as the backbone of monitoring throughout the NERRS and represents one of the most comprehensive estuarine water quality monitoring programs in the country. The use of these data by researchers, educators, recreational users, coastal managers and local decision-makers makes this information important to understanding and managing quality of our coastal waters.

Vision and Mission

The vision of work at the Grand Bay NERR over the next five years is to contribute to the broader effort that:

"Coastal ecosystems of the Gulf of Mexico will be conserved and valued."

The mission of the Grand Bay NERR is:

"To practice and promote informed stewardship of Grand Bay NERR and Mississippi coastal resources through innovative research, education and training."

The mission of promoting informed stewardship of Mississippi coastal resources reflects the vision of valuing and conserving the broader Gulf of Mexico and being part of a regional effort to focus increased attention to the economic and environmental value of "America's Sea". The reserve staff continues to work on a regional basis with a collaborative approach to address priority issues with partners, including Gulf of Mexico Alliance (GOMA), Northern Gulf Institute (NGI), Environmental Cooperative Science Center (ECSC), Mississippi-Alabama Sea Grant Consortium (MASGC), USFWS, other Gulf NERRs, NOAA's Coastal Services Center (CSC), Gulf Coastal Plains & Ozarks Landscape Conservation Cooperative (GCPOLCC), other NOAA offices and a variety of universities, state and local agencies.

Goals and Objectives

Reserve goals and objectives will be addressed through an integrated approach which will include collaborations and actions between staff and partners. The Reserve manager will support the actions of staff to complete the proposed goals and objectives.

Goal 1: Enhance Grand Bay NERR's role as a distinguished center for estuarine research, sound conservation and resource management.

Objectives:

1-1: Grand Bay NERR staff members are recognized as valued experts relative to Reserve priorities
1-2: Grand Bay NERR partnerships are established, maintained and expanded in support of Reserve priorities
1-3: Grand Bay NERR natural resources, activities, products and services are valued by targeted audiences or user groups
1-4: Grand Bay Coastal Resources Center facility reservations will increase by 5% annually
1-5 Grand Bay NERR operations are maintained at a level adequate to support the mission
1-6 Develop and strengthen connections with local communities and schools

Goal 2: Scientific understanding and knowledge informs the management of coastal resources and ecosystems.

Objectives:

2-1: Reserve facilities and equipment are used by external researchers, with at least 50% of external researchers supported by Reserve staff and facilities
2-2: Grand Bay NERR flora, fauna and ecological conditions are monitored and data are used to improve resource management
2-3: Infrastructure and equipment to monitor long-term environmental changes are maintained
2-4: By 2015, Grand Bay NERR staff, 10 researchers and/or coastal managers are engaged with the Reserve to monitor and study how locally relevant climate impacts affect natural communities
2-5: Grand Bay NERR in collaboration with partners will acquire, protect, restore, manage or enhance lands within the targeted watershed to benefit native landscapes, habitats and species

Goal 3: Local communities appreciate and value the significance of coastal ecosystems.

Objectives:

3-1: Seventy-five percent of people participating in Grand Bay NERR programs recognize the importance of coastal resources and Reserve areas of focus
3-2: Annually, the Grand Bay NERR will provide 25 K-16 experiential environmental or Science, Technology, Engineering and Math (STEM) educational programs/

opportunities that will significantly increase student's awareness and knowledge of coastal ecosystems, including Reserve areas of focus (habitat protection, water quality and climate change)

3-3: Eighty percent of the educators attending professional teacher development, Teachers on the Estuary (TOTE) or TOTE-aligned workshops sponsored by the Reserve will be estuary-literate

3-4: Annually, Grand Bay NERR supports opportunities for volunteer involvement and will seek to increase participation from the previous year

Goal 4: Local communities will make improved science-based decisions regarding management of coastal resources and watersheds.

Objectives:

4-1: Seventy-five percent of local decision-makers participating in Reserve training programs use scientific knowledge and expertise to make informed coastal management decisions

4-2: Seventy-five percent of local decision-makers participating in education or training activities have an increased understanding of coastal resources/ management issues

4-3: Partnerships support and contribute to 25% of Grand Bay NERR's coastal decision-maker training workshops

IV. Administration and Operations Plan

The Administration Plan describes the context in which the Reserve is housed within the MDMR and establishes the framework by which staff addresses Reserve priorities. The MDMR administers Reserve personnel, fiscal and grant management and day-to-day operations, under applicable state and agency policies and procedures. Staffing, volunteer, partner and advisory group support for the Reserve are described in this chapter. The administrative function at the Reserve seeks to provide adequate operational support and integration of programming and staff.

The Grand Bay NERR operates as a federal/state partnership. While the State of Mississippi, through MDMR manages the operations of the Grand Bay NERR, the federal government, represented by NOAA, provides overall system policies, guidelines and funding support. Pursuant to the Coastal Zone Management Act (Sections 312 and 315), NOAA periodically conducts performance evaluations of the operation and management of reserves.

The Grand Bay NERR is administered by the MDMR, which serves as the lead fiscal agent for the program. The MDMR is the management agency for the Reserve and is responsible for the day-to-day operation of the NERR program. The Reserve is situated within the Department's Coastal Ecology Office, which also includes the Coastal Preserves Bureau and Permitting Bureau. The MDMR's Coastal Ecology office serves as the Coastal Zone Management office for the State of Mississippi. Administrative, Financial and Human Resources support is also provided by professional and support staff at the department level. A revised Memorandum of Agreement (MOU) between NOAA and MDMR was signed in 2013 detailing the State-Federal Roles in the operation of the Grand Bay National Estuarine Research Reserve (Appendix 3).

The entire suite of goals and objectives reflects the focus of the administration plan established for the Reserve as discussed in Chapter III of this document. The administrative and operations functions of the Reserve are designed to support the success of all activities and staff as described in the Management Plan. The manager provides program oversight and guidance.

Reserve Staff

The implementation of the goals and objectives for the Grand Bay NERR is dependent in part upon adequate staffing levels (Figure 9). Although staffing levels may change through time with availability of resources, a basic staff is needed to coordinate Reserve activities. Core staff, as required by NOAA, includes the manager and the research and education coordinators. Since Reserve designation, an administrative assistant, facilities manager, education specialist, research assistants, SWMP coordinator, Coastal Training Program (CTP) coordinator and stewardship coordinator have also been added to the staff hired at the Reserve. Cost-sharing with other institutions is also a viable staffing option. Positions have been co-funded with NOAA's Air Resources Laboratory, Florida A&M University, USM, Mississippi State University (MSU) and AmeriCorps as outlined below.

Core staff includes:

Reserve Manager (since 1999)

The Reserve manager provides oversight, coordinates and supervises all aspects of Reserve operations and management including administrative, funding, research, stewardship, training and education activities. The Reserve manager serves as a liaison with federal, state, local and private entities, including advisory committees to generally achieve the goals and objectives of the Grand Bay NERR. The manager is a MDMR employee.

Research Coordinator (since 2001)

The research coordinator oversees the operation and implementation of the Grand Bay NERR research and monitoring programs, coordinates the Graduate Research Fellowship program, interprets research results, promotes the use of the Reserve by other researchers and interacts with other research institutions and individuals to fulfill the research objectives of the Grand Bay NERR. The research coordinator reports to the manager and works to integrate with the other sectors to present scientific data in a user-friendly manner. The current research coordinator is funded in part through Mississippi State University (MSU) and is an MSU employee.

Education Coordinator (since 2000)

The education coordinator oversees the daily operation and implementation of the Grand Bay NERR education programs including on-site and outreach activities and interacts with other environmental education organizations and individuals to fulfill educational goals and objectives. These activities include formal and informal education for the public, teachers and students. The education coordinator reports to the manager and works to integrate with other sectors to present science and stewardship information in a user-friendly manner to schools and the public. The education coordinator is a MDMR employee.

Coastal Training Program Coordinator (since 2003)

The Coastal Training Program coordinator oversees the development, marketing and implementation of a coastal training program targeting local decision-makers and resource professionals supporting the goals and objectives of the Grand Bay NERR. These activities include partnership building, hosting and facilitating technical assistance workshops, providing technical assistance through a variety of media, developing needs assessments and coordinating program evaluations. The coastal training program coordinator reports to the manager and interacts with other coordinators in an effort to exchange information and incorporate reserve science into the training program. The Coastal Training Program coordinator is a MDMR employee.

Stewardship Coordinator (since 2003)

The stewardship coordinator oversees the development of resource management and restoration science monitoring projects at the Reserve in close coordination with USFWS, the research sector and other partners. Other stewardship activities include overseeing and collaborating on various resource monitoring and research projects, including the use of Geographic Information System

(GIS)/Global Positioning System (GPS) technology in project implementation. The stewardship coordinator collaborates with other resource managers on a variety of stewardship issues, including invasive species, prescribed fire, climate change, mapping, monitoring projects, erosion studies and land acquisition. The stewardship coordinator collaborates with other reserve coordinators to assist in research efforts and to contribute to education and training programs. The stewardship coordinator is a MDMR employee.

Technical and support staff includes:

Additional staff assists with the implementation of administrative, stewardship, education, research and training programs and are hired as integral members of the Grand Bay team. The number of staff varies with the amount of available funding, special projects and partner participation.

System-Wide Monitoring Program Coordinator

The SWMP coordinator is key to implementing the SWMP initiative, including water quality, weather and nutrient monitoring. The coordinator maintains equipment, collects samples, troubleshoots system processes and submits data to the NERRS Centralized Data Management Office, as well as assists with other Reserve science and education programming.

Research and Stewardship Assistants

Research and stewardship assistants support field and laboratory research and monitoring, participate in educational programs and assist in the compilation and dissemination of data through presentations, reports and publications. Staff is hired through various funding sources including NOAA cooperative agreement awards, outside grants, state funding and partner funding. NOAA Air Resources Laboratory currently provides partial funding for one research assistant position. A Stewardship assistant conducts resource monitoring studies, assists with resource management activities and assists other research and education efforts as needed.

GIS Coordinator

A GIS coordinator facilitates the integration of GIS technology into all phases of reserve work, including project design, photo-interpretation, map making, land-use/land cover analyses, geodetic surveying, elevation control and erosion monitoring and conducts related field work and ground-truthing for research and stewardship projects.

Education Specialist

An education specialist assists with all phases of the education program at the Reserve. Specific tasks include coordinating K-12 educational outreach and programs at Grand Bay NERR. The education specialist assists with teacher workshops.

Administrative Assistant

An administrative assistant provides support to the manager relating to the activities of the Reserve, including clerical, financial grant management and operational support of the Grand Bay

Coastal Resources Center. Support is also provided to other staff. The administrative assistant is the first point of contact for walk-in visitors in the Reserve's interpretative area.

Facilities Manager

A facilities manager coordinates facility and grounds operation and maintenance at the Grand Bay Coastal Resources Center. Tasks include upkeep of grounds, routine maintenance on vehicles, boats and buildings.

We have had or currently have other institutional staff housed at the NERR in conjunction with joint projects and specific grants, including individuals from Florida A&M University, MSU, and DRC and USFWS.

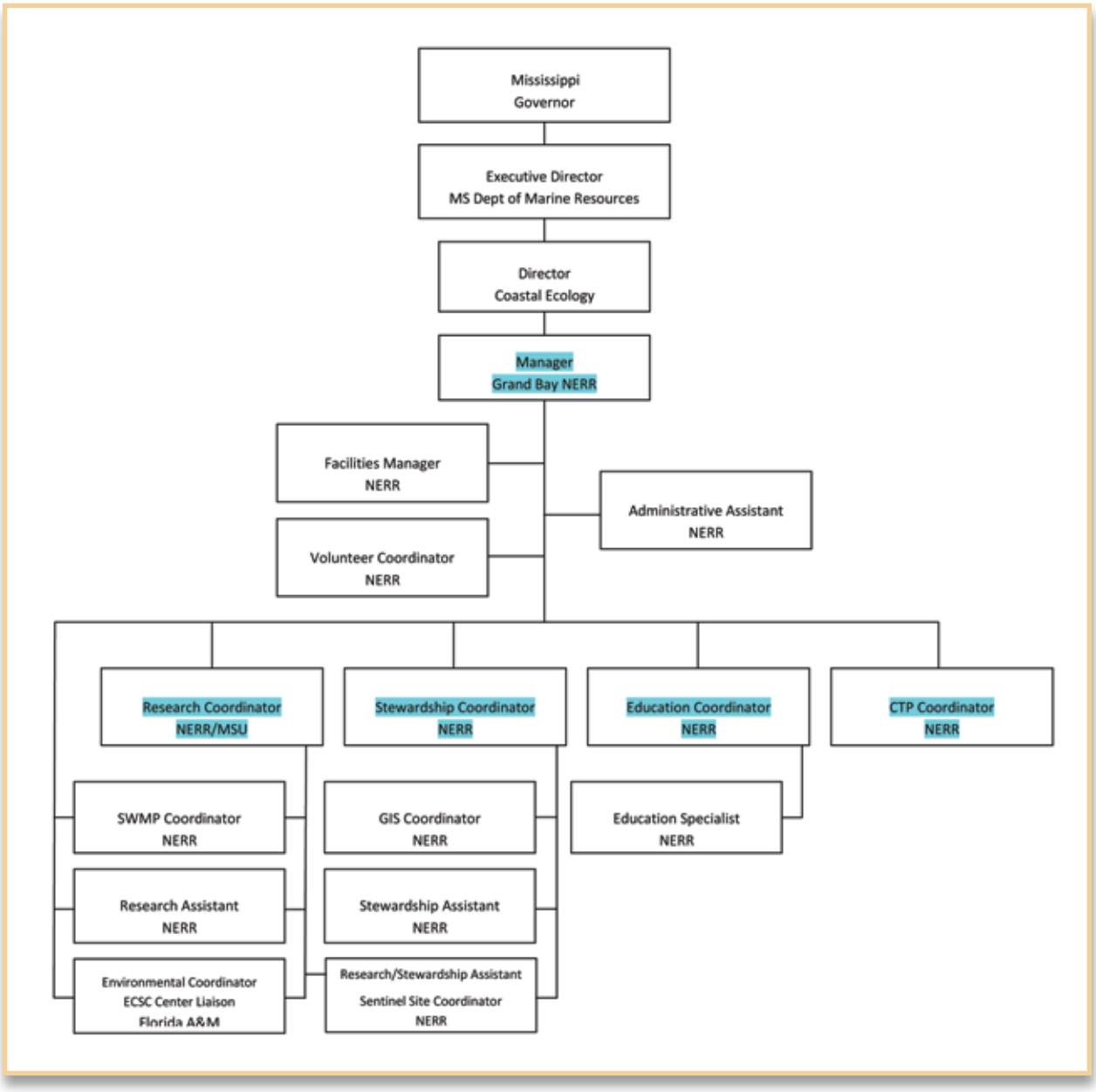


Figure 9. Grand Bay NERR 2012 Organization Chart showing relationships within Department of Marine Resources. Core Reserve staff are highlighted.

Future Staffing Needs

Additional staff may become necessary to accomplish the goals and objectives set forth in this management plan. A volunteer coordinator is needed to support the Goal 3 objective to provide increased opportunities for volunteer support. Other time-limited education, research or stewardship staff may be needed to assist with externally funded projects that may be secured to support Reserve priorities. Additional positions will be established only as funds become available.

Volunteers

Over the years, many volunteers have supported the efforts of the Grand Bay NERR. Objective 3-4 was established to provide continued support for volunteer opportunities at the Reserve. Volunteers have in the past and will continue to assist with restoration projects, cleanups, field sampling, administrative support, laboratory studies, trail construction, field trip support, training event assistance and teaching, etc. This assistance was solicited by individual staff as needed or through local groups seeking volunteer opportunities. In 2010 and 2011, AmeriCorps cost-shared a volunteer coordinator position with the Reserve. Volunteer guidelines and a Volunteer Interest Form are found online at http://grandbaynerr.org/volunteer-opportunities. A volunteer coordinator will be hired as funds allow.

Grand Bay NERR will continue to support opportunities for volunteer involvement to foster a greater appreciation and knowledge of coastal resources by the local community.

Advisory Groups

Primary advisory groups for the Reserve include the Reserve Management Board (RMB) and a Citizens Advisory Committee (CAC). The Partners MOU revised in 2002 (Appendix 4) forms the basis for the RMB. This revision adds an additional partner, USM, with current roles derived from the original Management Plan and includes: ensuring that the Reserve's management plan is implemented, bringing partnership/leveraging resources to the table, helping to coordinate efforts across agencies and establishing dedicated committees or task forces to handle special projects as needed. The CAC has been a strong advocate for the Reserve since before it was designated. Throughout the Reserve's development, the Committee has provided substantial support. The CAC members offer a valuable link to the local coastal community.

The NOAA Final Evaluation-Findings Grand Bay NERR (NOAA/OCRM 2008) suggested the potential evolution of the current advisory framework "encouraging NERR and MDMR to work with the current RMB and the Citizens' Advisory Committee to determine how to best align the roles of these advisory groups with the Reserve's current and future needs". The RMB has agreed to transition into an advisory committee that will include additional stakeholders and broaden the lines of communication to promote the goals and objectives of the Reserve.

MOU Partners (Charter)

Mississippi Department of Marine Resources (MDMR)

The MDMR is a primary landholder for the Grand Bay NERR. As Mississippi's primary Coastal Zone Management agency and managing agency of the Mississippi Coastal Preserve Program, the MDMR is responsible for the coordination of the Grand Bay NERR. The MDMR is the recipient of federal CZMA funding for the Coastal Program and the NERR. MDMR Marine Patrol provides law enforcement protection at the Reserve in conjunction with Jackson County Sheriff's Department, Mississippi Department of Wildlife Fisheries and Parks (MDWPF) and USFWS. The MDMR is a signatory of the original 1999 Partners MOU (Appendix 4).

The MDMR administers the Mississippi Coastal Program (MCP), which was established and approved in 1980 under provisions of various state and federal statutes (e.g., enabling legislation for Bureau of Marine Resources (57-15-1), Mississippi Coastal Wetlands Protection Law (49-27-1-69), federal Coastal Zone Management Act of 1972, as amended).

In addition to Coastal Program and NERR responsibilities, the MDMR manages the state's marine shellfish, fin fish and shrimp/crab resources. The Grand Bay NERR staff coordinates management, research, education, stewardship, training, monitoring, public relations and planning activities with various offices of the MDMR, as well as with other partners.

U.S. Fish & Wildlife Service (USFWS)

The USFWS is also a primary landholder within the Grand Bay NERR. Approximately one-third of the Reserve acreage is located within the boundaries of the GBNWR. Compatible resource management, research, monitoring and public outreach activities occur on joint Grand Bay NERR/NWR properties. The Grand Bay Coastal Resources Center, Bayou Heron Boat Ramp, education pavilion, interpretive trails and some monitoring equipment are located on the GBNWR properties. The Reserve also shares space at the USFWS compound on nearby Independence Road. USFWS enforcement contributes to the protection of property and resources at the Reserve. The MOU between the MDMR and USFWS addresses these and other related joint activities. USFWS staff is co-located with Reserve staff in the Coastal Resources Center.

The Refuge is currently managed through the staff of the nearby Mississippi Sandhill Crane National Wildlife Refuge as part of the Gulf Coast Refuge Complex. The USFWS is a signatory of the original 1999 Partners MOU.

Mississippi Secretary of State (SOS)

The SOS is the trustee of all state-owned water bottoms in Mississippi and performs the functions of the State Land Commissioner. The SOS is co-title holder with MDMR for most of the state-owned properties within the NERR. Matching funding support to the MDMR and NERR are provided through the Tidelands Trust Fund administered by the SOS. The SOS is a signatory of the original 1999 Partners MOU.

Mississippi State University (MSU)

MSU has for several years provided technical assistance through its Coastal Research and Extension Center (CREC), Sea Grant Advisory Service on various coastal management, wetland and fishery issues. As an original partner, MSU provides the Reserve with a research coordinator through an annual contractual agreement where DMR and MSU cost share the funding support for this position. MSU is a signatory of the original 1999 Partners MOU.

The Nature Conservancy (TNC)

The Nature Conservancy is an international, nonprofit, conservation organization. TNC has been a long-time supporter to protect the biological integrity of the wetland ecosystems of eastern Jackson County, Mississippi, and western Mobile County, Alabama. TNC has been active in facilitating acquisition of state and federal lands within the Grand Bay NERR/NWR boundaries, especially in the early 1990's. The TNC is a signatory of the original 1999 Partners MOU.

Other Current Partners

University of Southern Mississippi (USM)

The University of Southern Mississippi was added as a designated reserve partner and signatory of the Partners MOU in 2002. This partnership was formalized because of USM's close relationship with the MDMR relating to research and educational activities. USM provides technical support and promote use of the Reserve by faculty and staff. The Reserve has a long history of coordinating research, monitoring and educational efforts with USM.

Citizens Advisory Committee

A citizens committee was formed to provide public input on local issues to the Reserve. Membership and participation has varied over the years. The chair of this committee also serves on the RMB.

Research, Stewardship, Education, Citizens and CTP Advisory Committees

Research, Education, Citizens and CTP Advisory Committees have met from time to time over the years, typically on a project basis. Reserve staff communicates with technical subject area experts through conferencing, telecommunications or electronic means and frequently in person. Sector representatives engage partners to seek advice on local issues, programs and projects as needed. Committees provide input to the Reserve based upon individual expertise to promote the goals and objectives of the Reserve.

Administration Goals and Objectives

The goals, objectives and strategies/actions for the Administrative Plan include:

Goal 1: Enhance Grand Bay NERR's role as a distinguished center for estuarine research, sound conservation and resource management.

Objectives:

1-1: Grand Bay NERR staff members are recognized as valued experts relative to Reserve priorities

Strategies/Actions

- The manager will provide opportunities and support for staff to attend professional meetings and to serve on technical committees and boards (e.g. Gulf of Mexico Alliance (GOMA), Bays and Bayous, National Estuarine Research Reserve Association, NERRS Annual Meeting, National Marine Educators Association (NMEA), Restore America's Estuaries, Coastal and Estuarine Research Federation, etc.).
- The manager will represent the Reserve on professional boards and committees such as the National Estuarine Research Reserve Association, NGI Advisory Committee and MASGC Advisory Committee, etc.

1-2: Grand Bay NERR partnerships are established, maintained and expanded in support of Reserve priorities

Strategies/Actions

- The manager will seek and maintain partnerships that support Reserve priorities.
- The manager will generate funding and technical support for programming by working with partners such as MASGC, USFWS, MDMR, MDEQ, various universities and regional NERRs.
- Reserve staff will seek input and advice from advisory committees to promote Reserve priorities.
- Reserve staff will seek input and support from the RMB to promote Reserve priorities.
- The RMB will transition into an advisory committee that will include additional stakeholders and broaden the lines of communication to promote the goals and objectives of the Reserve in the next year.

1-4: Grand Bay Coastal Resources Center facility reservations will increase by 5% annually

Strategies/Actions

- Staff will maintain a reservation tracking system for lab use, dormitory and meeting rooms.
- Staff will promote the use of Reserve facilities.
- Staff and volunteers will maintain regular operating hours for the facility, supporting use of the interpretative area, classrooms, laboratories and dormitory.

1-5 Grand Bay NERR operations are maintained at a level adequate to support the mission

Strategies/Actions

- Quality staff will be recruited, hired and retained.
- The manager and sector coordinators will provide supervision of staff as appropriate.
- Staff activities will be integrated across sectors to implement actions relating to Reserve priorities, providing a collaborative workplace.
- Staff will be seek adequate funding support to implement strategies and actions relating to priorities as described in this management plan.

1-6 Develop and strengthen connections with local communities and schools

Strategies/Actions

- The manager will engage local government officials, civic groups and schools to promote Reserve activities and priorities.

Goal 2: Scientific understanding and knowledge informs the management of coastal resources and ecosystems.

Objectives:

2-3: Infrastructure and equipment to monitor long-term environmental changes are maintained

Strategies/Actions

- Adequate staffing will be maintained to support the required level of physical infrastructure for monitoring at the Reserve.
- The manager will seek additional funding support from partners to maintain and expand monitoring infrastructure and equipment for monitoring. [e.g.

MDEQ and NOAA (Mercury), U.S. Geological Survey, University of Central Florida (Sentinel Site network), etc.]

Goal 3: Local communities appreciate and value the significance of coastal ecosystems.

Objectives:

3-4: Annually, Grand Bay NERR supports opportunities for volunteer involvement and will seek to increase participation from the previous year

Strategies/Actions

- The manager will seek to fund and recruit a volunteer coordinator.
- The manager will encourage staff to generate volunteer opportunities and work cooperatively with the volunteer coordinator to implement Reserve priorities.
- The manager will engage interested Reserve supporters to establish and maintain a Friends organization.

V. Facilities and Equipment Plan

The facilities and equipment plan includes information on the primary building and transportation infrastructure found within and used at the Grand Bay NERR. Facilities include the Grand Bay Coastal Resources Center, which provides offices, dormitory space, classrooms, research laboratories and an interpretative area (Figure 10). The reserve also uses a USFWS education pavilion and the nearby I-10 Welcome Center to further promote reserve communication efforts to support Goal 3 that local communities will appreciate and value the significance of coastal resources. A summary of projected construction and facility needs and an overview of vehicle and vessel capacity is also provided. Adequate facilities to support public engagement activities and sufficient transportation assets are critical to the implementation of Reserve priorities.

Grand Bay Coastal Resources Center

In 2004 initial funding was secured through a NOAA construction award to design and build permanent Grand Bay NERR facilities. Over time, additional state and federal funds were obtained to meet total facility costs. Construction of the Grand Bay Coastal Resources Center began in November 2007. Prior to that time, from 2000 until facilities were completed, the Reserve offices and labs were housed in on-site modular office space. The facilities dedication was held December 7, 2009, also marking the 10th Anniversary of the Reserve's original designation (Appendix 5). The nearly 16,000 square foot facility is headquarters for the Grand Bay NERR and NWR, including office space, dormitory, interpretative area, classrooms and laboratory space. A boat shed/workshop was constructed in 2011 adjacent to the Center. These facilities greatly enhance the ability to engage the public and partners on projects and activities supporting Reserve priorities, particularly the understanding and engagement priorities. Dormitory space allows for greater use of the Reserve by researchers and educators who visit overnight. Many training and educational programs are held onsite and these activities along with the interpretative area provide an enhanced platform for staff to communicate Reserve priorities to a variety of audiences.

Reserve facilities are located on properties of the USFWS at Grand Bay National Wildlife Refuge in Moss Point, MS. The Center represents a unique partnership where a state-owned facility is constructed on federal lands. An MOA with the USFWS details the Operational Agreement for the construction and use of the Grand Bay Coastal Resources Center with MDMR (Appendix 6). The Grand Bay NERR also uses a USFWS pavilion located on Gautier Bayou for educational programs.

Figure 10. Grand Bay Coastal Resources Center.

Green Building Design

A major consideration in planning for the Resources Center was to design in the most environmentally sustainable manner as possible. Goals for such a design were to reduce operational costs, reduce construction material waste, reduce the carbon footprint, conserve water and energy and demonstrate an environmental consciousness. This philosophy reflects various mitigating aspects of the NERRS Climate Change Initiative and the Reserve priorities on Climate Change. The green design of the building focused on standards established by the U.S. Green Building Council's (http://www.usgbc.org/) Leadership in Energy and Environmental Design (L.E.E.D.) certification program. The Resources Center achieved a GOLD L.E.E.D Certification (Appendix 7), the second highest level possible for the implementation of its sustainable design. A 7,000-watt solar power system was recently added to the Resources Center power grid, the first of its kind in the local power cooperative's service area. These facility enhancements demonstrate a continued commitment to the Reserve's climate change priorities, by promoting and demonstrating sustainable building practices.

These primary facilities are anticipated to serve the programmatic needs of the Reserve for the next several years.

Projected Facility and Construction Needs

The goals and objectives of future construction focus on enhancing the Reserve's role as a distinguished center by optimizing use of and access to the Reserve land and water and associated facilities. Through access to the Reserve and exposure to programming, local communities will come to better appreciate and value the significance of coastal ecosystems.

Potential future facilities and infrastructure envisioned at the Grand Bay NERR over the next five years may include:

- Project: Exhibit enhancement
    - Location: Grand Bay Coastal Resources Center
    - Reserve Goals: Local communities appreciate and value the significance of coastal resources
    - Project Costs: Planning-$20,000, Construction and Installation-$100,000 to $150,000
    - Project Description: Enhancement to interpretative exhibits at the Resources Center will be needed within three-10 years. Planning for such changes will be necessary during the scope of this plan. Interpretive Area Exhibits and signage on the facility exterior will be constructed as funds allow. Exhibits will be updated or replaced depending upon popularity and Reserve priorities.
- Project: Exhibit enhancement
    - Location: State of Mississippi I-10 Welcome Center
    - Reserve Goals: Local communities appreciate and value the significance of coastal resources
    - Project Costs: Planning-$2,000 (small scale), $100,000 (large scale); Construction and Installation-$10,000 (small scale)$500,000 to $1 Million (large scale)
    - Project Description: Maintaining and enhancing our ecotourism exhibits/ presence at the I-10 Welcome Center will be considered. The Reserve maintains a small pop-up exhibit at the nearby Interstate Welcome Center. We have discussed future opportunities for expansion with Welcome Center staff and have visions of a portion of the Welcome Center, or potentially an addition serving as a gateway to ecotourism opportunities on the Coast. Partnering to secure support and funding for such a project will be key to implementation. Initial discussions to seek partners should occur within five years.
- Project: Energy efficiency enhancements
    - Location: Grand Bay Coastal Resources Center
    - Reserve Goals: Enhance Grand Bay NEER's role as a distinguished center for estuarine research, sound conservation and resource management.
    - Project Costs: $300,000 - 400,000
    - Project Description: In an effort to reduce the Reserve's carbon footprint and to improve energy efficiencies of our operations, several potential improvements may be considered. Conducting an operational energy audit will help determine

where improvements may be made. Examples of improvements include: Upgrades to lighting, expansion of solar panels, installation of solar hot water heaters, and continued purchase and the use of hybrid vehicles and efficient outboard motors.

- Project: Water access improvements
    - Location: Bayou Heron/Gautier Bayou
    - Reserve Goals: Local communities appreciate the value and significance of coastal ecosystems.
    - Project Costs: Planning – $5,000 - $10,000, construction and maintenance – $25,000 - $100,000
    - Project Description: Work with USFWS or other partners to establish estuarine access point to be used for educational purposes. Currently, mainland access locations within the Reserve for school groups are limited. This project would seek to secure such a location and make appropriate improvement such as cleanup, burning, driveway improvements, educational platform, pier, bridging etc. This project will vastly improve access to waters and marsh for educational programming.

Vehicles, Vessels and Equipment

The ability of the Grand Bay NERR to adequately protect and promote coastal resources and provide for appropriate education and research program support depends in part on access to the resources and people. Boats and vehicles are critical for implementing Reserve priorities as their use directly relates to understanding and engagement; transporting staff throughout the site and to local and regional partnering/engagement opportunities. Additionally, boats are used to provide outside researchers access to the Reserve, supporting Objective 2-1 of this plan.

The Prius and Fusion automobiles were the first hybrid vehicles purchased by the MDMR.

Considerable funds are expended annually to operate and maintain this fleet (Table 2). Replacement boat motors have periodically been purchased for some vessels. The staff conducts a portion of boat, trailer and vehicle maintenance. The need to replace three vehicles, one vessel and at least two boat trailers is anticipated over the next five years, as funds allow. The Reserve uses several kayaks and canoes for education and research projects.

The Reserve also utilizes considerable field and laboratory equipment. Purchase of new laboratory is needed from time to time along with the regular maintenance and repair of this equipment. Field equipment used in research and monitoring activities needs periodic replacement and repair. RTKs, GPS units, radios and data sondes for SWMP are classified as equipment by the State. The SWMP is upgrading data sondes over the next five years, converting from 6600 units to EXO models. Upgrades will be made as funds allow.

Periodically, computers and servers to support the Reserve staff need replacement or repair.

Vehicles/Boats/Equipment	Year	Mileage /Hours	Replacement Date this Plan
Chevy 12 Passenger Van	2010	13,673	
Ford Expedition	2003	80,616	2015
Ford F-150 Crew Cab 4x2	2007	61,744	2018
Ford F-150 King Cab 4x4	2007	27,297	
Ford F-150 Crew Cab 4x4	2010	9,893	
Ford F-150 King Cab 4x4	2010	9,243	
Ford Fusion	2011	17,398	
Toyota Prius	2004	101,835	2018
15ft G3 Jon Boat	2007	330	
Yamaha 50hp Motor	2007	330	
Boat Trailer	2007		2017
16ft Duracraft	1999	554	
Mercury 60hp Motor	2006	554	
Boat Trailer	1999		
18ft Lynn Boat	2004	App 1500	2015
E-Tec 60hp Motor	2010	330	
Boat Trailer	2007		2013
20ft Lynn Boat	2004	1641	
E-Tec 115hp Motor	2010	360	
Boat Trailer	2011		
28ft Pontoon Boat	2004	167	
Honda 115 hp Motor	2004	167	
Boat Trailer	2004		
Gravely Riding Mower	2009	73	2017
Kubota RTV	2010	171	2018

Table 2. Grand Bay NERR Vehicle/Vessel Equipment Inventory.

Facilities and Equipment Goals and Objectives

The goals, objectives and strategies/actions for the Facilities and Equipment Plan include:

Goal 1: Enhance Grand Bay NERR's role as a distinguished center for estuarine research, sound conservation and resource management.

Objectives:

1-5 Grand Bay NERR operations are maintained at a level adequate to support the mission

Strategies/Actions

- The manager will secure funding support to adequately maintain the basic levels

of operation and maintenance for facilities and equipment/vessels/vehicles. Funding sources may include NOAA cooperative agreements, State Tidelands Trust Fund, funds from boat, dormitory and office use and grant overhead for electrical use, cleaning service, facility water testing, etc.

- The manager will retain a facilities manager to coordinate grounds, vessel, vehicle and facilities maintenance and operation.
- Staff will seek funding support to initiate planning efforts to enhance exhibits at the Resources Center.
- Staff will seek funding support to initiate planning efforts to enhance exhibits at the nearby I-10 Welcome Center.
- The manager will seek funding support to repair and purchase new vessels, trailers, equipment and vehicles as needed in support of Reserve priorities.
- Staff will continue to support and maintain, and if possible expand green building features of the facility (i.e. solar power, energy efficiency).
- Staff will seek funds to improve water access for educational programs.

VI. Stewardship Plan

This section of the management plan provides a five-year framework for stewardship activities at the Grand Bay NERR. The stewardship activities of the Reserve are linked to broader NOAA priorities through a general discussion of the creation of the NERR system and stewardship efforts more specifically. A discussion of the Grand Bay NERR stewardship program and priorities as they relate to NERR focus areas is included. A brief overview of stewardship integration into research-related programs, including SWMP, biological monitoring and sentinel sites is incorporated to highlight cross sector collaboration at Grand Bay. This chapter concludes with a list of actions and strategies that the Reserve Stewardship staff will implement to address Grand Bay goals and objectives related to Reserve priorities.

Stewardship at Grand Bay NERR

The mission of the National Estuarine Research Reserve System as stated in the 2011-2016 Strategic Plan is: To practice and promote stewardship of coasts and estuaries through innovative research, education and training using a place-based system of protected areas. A key component of this mission is to promote stewardship within the reserves and in adjacent coastal areas, in an effort to maintain water quality and healthy habitats along our nation's coastlines.

Specific goals and objectives of the national program relating to protected areas emphasizes that estuaries and coastal watersheds are better protected and managed by implementing place-based approaches that:

- Increase permanent protection and restoration of key areas in reserve watersheds to improve coastal habitat quantity, quality and resiliency to climate change impacts.
- Develop, demonstrate and evaluate tools and practices at reserves that advance progress on habitat protection, water quality and climate change impacts.
- Expand bio-geographic representation of the nation's estuaries in the reserve system by designating new reserves.

Stewardship activities at Grand Bay are grounded in the three reserve focus areas of climate change, habitat protection and water quality. Effective stewardship is necessary to reach the long-term vision of the Grand Bay NERR that coastal ecosystems of the Gulf of Mexico will be conserved and valued. Many of the activities undertaken on the Reserve fall under a broad definition of stewardship, and in both the short-and long-term these activities work to promote this vision. In addition to managing natural resources, an important goal of the Stewardship sector is to provide opportunities for various audiences to better understand and appreciate the natural resources found on the Reserve. This will enhance and promote the status of the Reserve as a center of knowledge related to sound conservation and management of coastal resources.

The Grand Bay NERR Site Profile (http://grandbaynerr.org/site-profile) provides an excellent summary of historical stewardship and use of resources along the Mississippi Coast including

areas of the Reserve. Many historic land practices, while sometimes conflicting, actually enhanced components of the landscape. Recent land use trends, coupled with fire suppression, have led to a general degradation of many of the upland habitats on the Reserve. Frequent and periodic growing season fires are the primary driver in maintaining the species diversity and open structure of the pine savannas and flat woods on the Reserve. Naturally, lightning-ignited fires shaped the landscape, only interrupted by wet cypress drains and bayous. Early residents to the area used fire to drive game animals and to promote new vegetation for grazing. While somewhat more difficult to accomplish today because of habitat fragmentation, smoke management concerns, private in-holdings and climate change, prescribed fire remains the most important habitat management tool at Grand Bay.

Stewardship at Grand Bay includes a variety of activities including resource monitoring and research, land protection, restoration and enhancement. An important aspect of the Reserve's work is to demonstrate best management practices that other professionals, local decision-makers and the general public can apply in their own communities. Additionally, it is vital that stewardship and resource management activities are consistent with maintaining the integrity of the site for long-term research and monitoring. The Reserve provides an ideal laboratory for examining landscape changes related to human population growth, natural disasters and impacts from climate change. Monitoring environmental changes, sensitive habitats and species provides information on the status and health of our resources. Resource management is driven by science and based upon the principles of adaptive resource management and applying current methods in restoration science to restore and enhance impaired habitats. Long-term monitoring allows an evaluation of the effectiveness of restoration activities and functional integrity of natural processes. Staff actively monitors changes in habitats over time, invasive species, fire managed areas and species-specific occurrences.

The Reserve actively pursues direct upland restoration and enhancement activities and partnerships (i.e. mechanical clearing, hydrologic restorations, fire management and invasive species management) in cooperation and coordination with the USFWS, which owns large portions of land within the Reserve boundaries. The focus in estuarine habitats is primarily on resource monitoring and demonstration of best management practices such as living shoreline installations. Examples of activities closely coordinated between the Reserve and GBNWR include trail development/maintenance, invasive species mapping/treatment, fire management/mechanical treatment, habitat evaluation/mapping and restoration planning. The Reserve and GBNWR, along with other partners are currently involved in a comprehensive resource management planning effort to manage upland and estuarine resources on a landscape scale at Grand Bay in relation to potential funding sources including the Resources and Ecosystems Sustainability, Tourist Opportunities and Revived Economies of the Gulf Coast States Act (RESTORE Act) and Natural Resource Damage Assessment (NRDA) activities related to the Deepwater Horizon Oil Spill. **Details of this process are at this time confidential in nature and as such are only mentioned in this plan in generalities.**

While operating as a distinct sector in the framework of the NERR system, the stewardship staff at Grand Bay actively collaborates on a variety of projects with the research sector. This sharing of resources and personnel allows for greater flexibility and productivity in meeting the shared

objectives of these two sectors. In particular, implementation of the NERRs sentinel site protocol at Grand Bay has evolved as a collaborative effort. At present, the stewardship coordinator oversees the vertical control aspect of the project while a technician shared by both sectors will be tasked with implementing emergent marsh monitoring. In addition, stewardship staff provides GIS support for research staff. In this spirit of collaboration and to maintain clarity and structure for outside readers, some stewardship actions will be included in the research and monitoring chapter.

Stewardship Goals and Objectives

The actions and strategies outlined below align with the goals and objectives described in Chapter III of this document.

Goal 1: Enhance Grand Bay NERR's role as a distinguished center for estuarine research, sound conservation and resource management.

Goal 1 Objectives:

1-1: Grand Bay NERR staff members are recognized as valued experts relative to Reserve priorities

Strategies/Actions

- Stewardship staff will provide technical advice to resource managers, local landowners and the general public relating to invasive species control and identification, fire and fuel management, wildlife management and water resources management as requested.
- Stewardship staff will coordinate and participate in local and landscape scale restoration planning efforts in the targeted watershed in cooperation with resource managers from MDMR, Grand Bay NWR, U.S. Army Corps of Engineers (USACE), Jackson County and others.
- Stewardship staff will serve on at least two technical advisory boards for local and regional restoration planning and implementation efforts.
- Stewardship staff will present project updates and findings related to resource management and monitoring activities at appropriate local, regional, and national forums including Bays and Bayous Symposium, Restore America's Estuaries and the Society of Wetland Scientists at least annually as funding allows.
- Stewardship staff will publish in peer reviewed literature the results of research and monitoring efforts including erosion monitoring and elevation and vegetation change monitoring.

1-2 Grand Bay NERR partnerships are established, maintained and expanded in support of Reserve priorities

Strategies/Actions

- Stewardship staff will coordinate with local and regional partners and resource managers to facilitate restoration and acquisition planning and implementation in the Grand Bay targeted watershed with emphasis on fire management, hydrologic restoration, invasive plant control and landscape scale management.
- Stewardship staff will seek funding partners including USFWS, NOAA, EPA, MDMR, MDEQ, USCOE, National Fish and Wildlife Foundation, and others to address priority issues through NRDA, RESTORE Act and other funding opportunities.
- Stewardship staff will coordinate with USFWS and other partners to develop and maintain boat ramps, trails, firebreaks and parking areas.

1-3 Grand Bay NERR natural resources, activities, products and services are valued by targeted audiences or user groups

Strategies/Actions

- Stewardship staff will work to provide factual and relevant information to audiences and user groups related to the natural history of the Grand Bay area as well as management, research and monitoring activities to promote the valuation of natural resources by these groups.

1-4 Grand Bay Coastal Resources Center facility reservations will increase by 5% annually

Strategies/Actions

- Stewardship staff will work to engage and encourage outside groups to use the facility through a variety of outreach efforts including opportunities for community involvement in stewardship activities (invasive plant control, coastal cleanup, etc.), hosting of college level natural resource field trips and natural history presentations.

1-6 Develop and strengthen connections with local communities and schools

Strategies/Actions

- The stewardship coordinator will work to engage coastal communities through participation as a presenter in the Mississippi Master Naturalist program on an annual basis.
- Stewardship staff will strive to engage in meaningful dialogue with local resource user groups such as hunters, nature enthusiasts and fishermen to promote the mission of the Reserve and enhance their understanding of the natural environment.

Goal 2: Scientific understanding and knowledge informs the management of coastal resources and ecosystems.

Objectives:

2-1: Reserve facilities and equipment are used by external researchers, with at least 50% of external researchers supported by Reserve staff and facilities

Strategies/Actions

- Stewardship staff will promote the availability and use of facilities and equipment to researchers at conferences and other venues to increase collaborative and independent research and monitoring activities on the Reserve.
- Stewardship staff will play a key role in implementing a bi-annual research symposium highlighting Grand Bay research efforts with researchers, coastal managers and the public.
- Stewardship staff will provide technical and logistical support to facilitate research and stewardship projects.

2-2: Grand Bay NERR flora, fauna and ecological conditions are monitored and data are used to improve resource management

Strategies/Actions

- Stewardship staff will work to develop an approved Habitat Mapping and Change Plan and complete a baseline habitat map by the end of 2014.
- Stewardship staff will evaluate the existing submerged aquatic vegetation (SAV) monitoring program and refine sampling efforts to better fit local conditions and needs.
- Stewardship and research staff will coordinate to complete an approved Grand Bay NERR Sentinel Site Plan by the end of 2013 and implement components including:
    - emergent marsh monitoring
    - measure local scale tidal datums
- Stewardship staff in coordination with National Geodetic Survey (NGS) and other partners will continue vertical control efforts as they relate to the NERRS Sentinel Site guidance including the following activities:
    - complete approved Vertical Control Plan by end of 2013
    - periodic GPS surveys of surface elevation tables
    - periodic digital leveling of temporary tide gauge and Continuously Operating Reference Station (CORS)
    - periodic GPS surveys of SWMP stations
    - creation of digital elevation models using Real Time Kinematic (RTK) GPS
    - bathymetric mapping of near-shore waters using RTK GPS

- Stewardship staff will continue quarterly shoreline erosion monitoring efforts on the Reserve.
- Stewardship staff will work to standardize and expand photo-monitoring efforts including game camera surveys, photo-station monitoring and plant photo database.
- Stewardship staff will share relevant ecological data with resource managers from MDMR, NOAA, Grand Bay GBNWR, USFWS, USCOE, Jackson County and others to support regional habitat enhancement and restoration efforts.

2-3: Infrastructure and equipment to monitor long-term environmental changes are maintained

Strategies/Actions

- Stewardship staff will maintain and improve access to surface elevation tables.
- Stewardship staff will maintain access to and periodically verify status of published vertical control benchmarks.
- Stewardship staff will support CORS in cooperation with partners at USM and facilitate relocation of the instrument to improve satellite reception.
- Stewardship staff will maintain Reserve GIS capability and periodically upgrade GPS equipment, computer hardware and software to support continued erosion monitoring, habitat mapping & change analysis and creation of digital elevation models for marsh plots.
- Stewardship staff will maintain and replace sampling station markers as needed to support long-term monitoring.

2-4: By 2015, Grand Bay NEER staff, 10 researchers and/or coastal managers are engaged with the Reserve to monitor and study how locally relevant climate impacts affect natural communities

Strategies/Actions

- Stewardship staff will work with other sectors to fully implement NERRS Sentinel Site monitoring according to appropriate system guidance.
- Stewardship staff will facilitate and conduct research on the natural variability of ecosystems and the potential impacts of climate change by providing technical and logistical support to outside researchers and well as continuing and expanding in-house monitoring and research efforts.

2-5: Grand Bay NERR in collaboration with partners will acquire, protect, restore, manage or enhance lands within the targeted watershed to benefit native landscapes, habitats and species

Strategies/Actions

- Stewardship staff will work with other Reserve staff and partners to plan and

implement acquisition, habitat restoration and enhancement projects within the targeted watershed through a variety of potential funding sources including the Deepwater Horizon NRDA and/or RESTORE Act funding to the Gulf Coast region.

- Stewardship staff will work with partners including the USFWS to identify, track, monitor and, where appropriate, manage invasive species.
- Stewardship staff will work to document hydrologic alterations to the landscape and plan for the restoration of these areas in cooperation with partners as appropriate.
- Stewardship staff will facilitate efforts to reduce fuel loadings and manage native landscapes through the use of mechanical clearing and prescribed fire with the target of managing at least 1,000 acres within the next five years.
- Stewardship staff will work with partners to monitor long-term effectiveness of restoration efforts.
- Staff will maintain and monitor an up-to-date GIS database of private parcels in the administrative boundary to track descriptions, ownership and assessment data to support acquisition planning.
- Staff will determine habitat classification, land use/disturbances and ecological significance for private parcels in the administrative boundary.
- Staff will develop and coordinate land acquisition strategies and acquisition projects with USFWS, MDMR, Jackson County, Land Trust for the Mississippi Coastal Plain (LTMCP) and other NGO's with the goal of protecting 1,000 acres in the NERR targeted watershed within the next five years.
- Stewardship staff will work to maintain communications with private landowners.
- Stewardship staff will seek funding for acquisition (RESTORE Act, NRDA restoration, USFWS, NOAA, Tidelands Funds and Coastal and Estuarine Land Conservation Program).
- Stewardship staff will promote the use of alternative land protection agreements such as conservation easements, donations and cooperative agreements.
- Stewardship staff will work with the USACE, Jackson County and USFWS to coordinate the management of mitigation properties in the community of Pecan and ultimately the transfer of these properties to State ownership.

Goal 3: Local communities appreciate and value the significance of coastal ecosystems.

Objectives:

3-1: Seventy-five percent of people participating in Grand Bay NERR programs recognize the importance of coastal resources and Reserve areas of focus

Strategies/Actions

- Stewardship staff will work to provide factual and relevant information to audiences and user groups related to the natural history of the Grand Bay area as well as management, research and monitoring activities to promote the valuation of natural resources by these groups.

3-2: Annually, the Grand Bay NERR will provide 25 K-16 experiential environmental or Science, Technology, Engineering and Math (STEM) educational programs/ opportunities that will significantly increase student's awareness and knowledge of coastal ecosystems, including Reserve areas of focus (habitat protection, water quality and climate change)

Strategies/Actions

- The stewardship coordinator will annually host a field experience for at least one college level biology class at the NERR site.
- Stewardship staff will provide technical assistance for field trips and demonstrations by interpreting NERR science and providing examples of best management practices as they relate to NERR resources.

3-4: Annually, Grand Bay NERR supports opportunities for volunteer involvement and will seek to increase participation from the previous year

Strategies/Actions

- Stewardship staff will recruit volunteers and facilitate efforts to promote stewardship of coastal resources including:
    - Hosting college age work crews for habitat enhancement
    - Hosting AmeriCorps work teams
    - Promoting and coordinating Coastal Clean Up activities at the Reserve
    - Coordinating derelict crab trap removal in Reserve waters
    - Planning and coordinating community based efforts to restore and monitor degraded habitats through invasive plant removal and citizen science-based monitoring, specifically stewardship trail

Goal 4: Local communities will make improved science-based decisions regarding management of coastal resources and watersheds.

Objectives:

4-1: Seventy-five percent of local decision-makers participating in Reserve training programs use scientific knowledge and expertise to make informed coastal management decisions

Strategies/Actions

- Stewardship staff will work to provide factual and relevant information to

audiences and user groups related to the natural history of the Grand Bay area as well as management, research, and monitoring activities and recommendations to promote the use of this information in the decision-making process.

4-2: Seventy-five percent of local decision-makers participating in education or training activities have an increased understanding of coastal resources/management issues

Strategies/Actions

- Stewardship staff will work to provide information to Reserve audiences to increase their understanding of local coastal issues through demonstration of proven management techniques and their applications along with field-based opportunities to increase understanding of coastal systems.

VII. Acquisition Plan & Reserve Boundaries

This section provides a five-year framework for acquisition activities as well as a description of current administrative and core boundaries at the Grand Bay NERR. The acquisition activities of the Reserve are linked to broader NOAA priorities through a general discussion of core and buffer areas including rational for inclusion in these categories. A discussion of the ownerships and acreages within each boundary is also included. This chapter concludes with a list of actions and strategies that the Reserve staff will implement to address goals and objectives related to Reserve acquisition priorities.

2012 Reserve Boundaries

The administrative boundaries of the Grand Bay NERR include approximately 18,049 acres of lands and waters in southeastern most Jackson County, Mississippi. Administrative boundaries of the Reserve have not changed from the original Management Plan. The NERR includes Middle Bay, Point Aux Chenes Bay, Bayou Cumbest, Crooked Bayou, Bayou Heron and associated coastal wetland habitats and selected portions of coastal uplands within the boundaries of the Grand Bay NWR (Figure 11). It is bounded on the east by the waters of Grand Bay and Middle Bay at the Mississippi-Alabama state line and on the west by the Bangs Lake system and the Bayou Cassotte Industrial Park. The Reserve is bounded on the north by the communities of Bayou Cumbest, Pecan, Kreole and Orange Grove and on the south by the Mississippi Sound. Of the 18,049 acres within the administrative boundaries of the site, approximately 75 % (14,624 acres) are publicly owned (Figure 12). The Grand Bay NERR is part of the Mississippi Coastal Watershed – 03170009 (Figure 13). Reserve staff members developed a sub- watershed depiction that more accurately reflects the surrounding lands and waters that influence the Reserve (Figure 14).

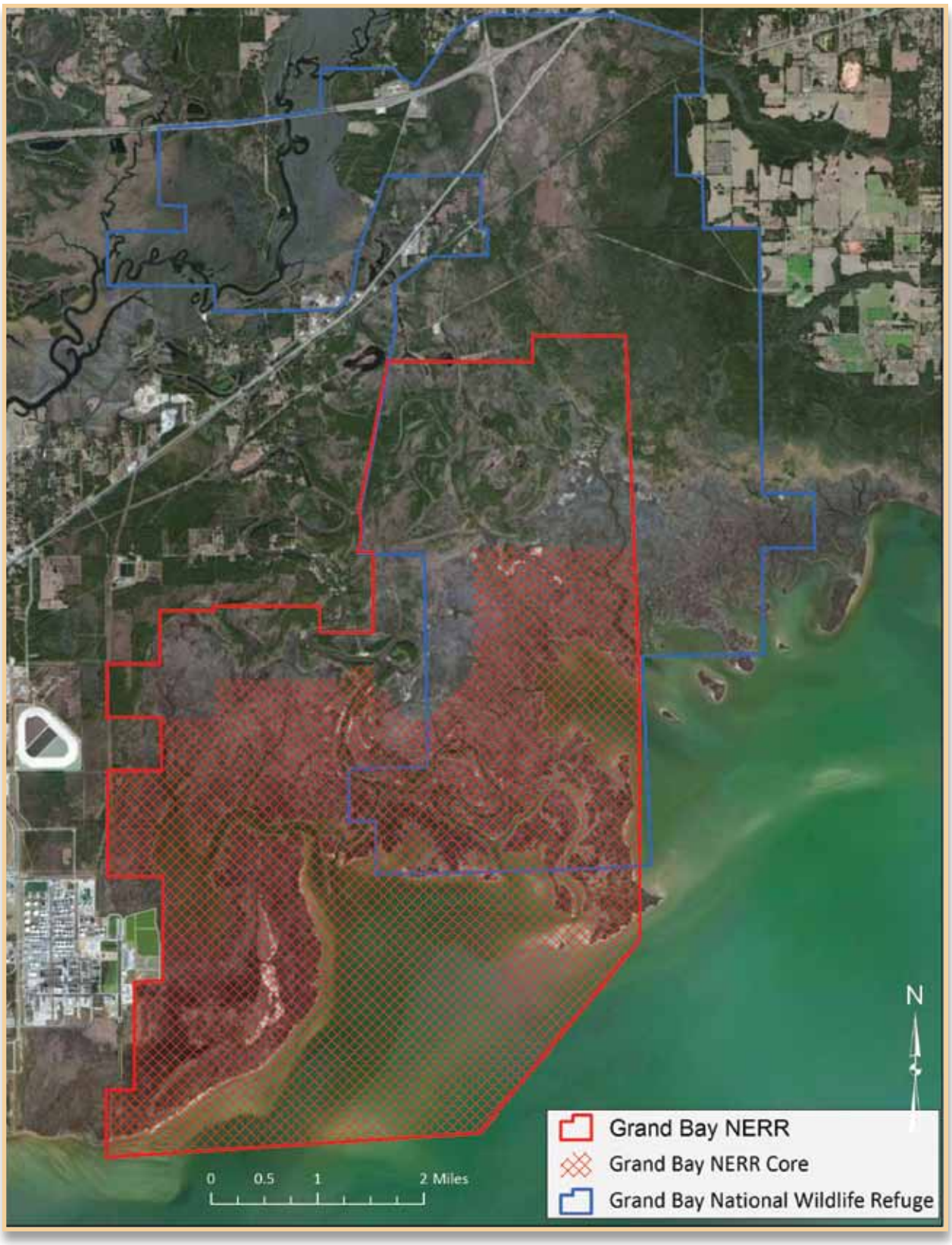


Figure 11. Grand Bay boundaries.

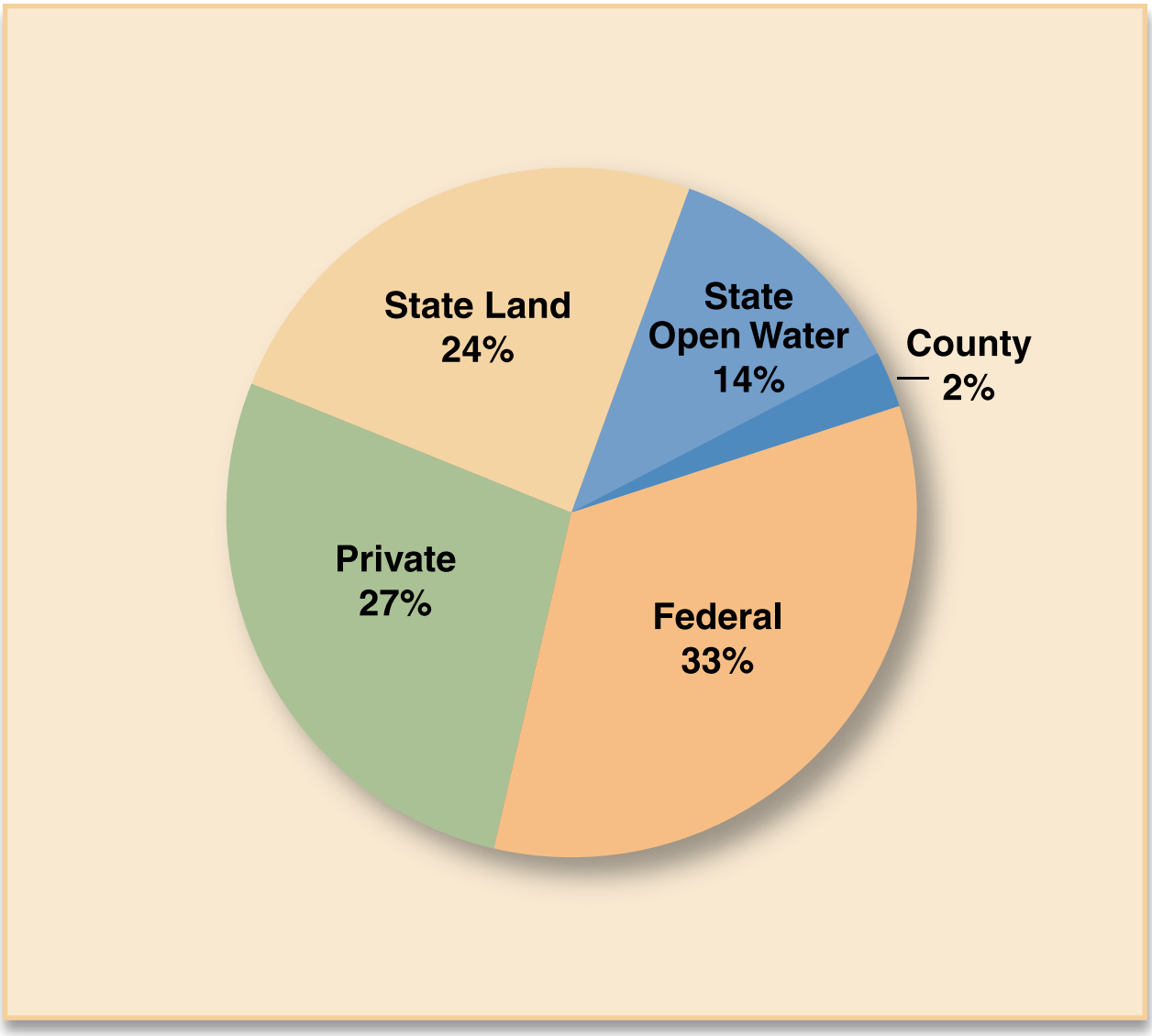


Figure 12. General land ownerships within Grand Bay NERR.

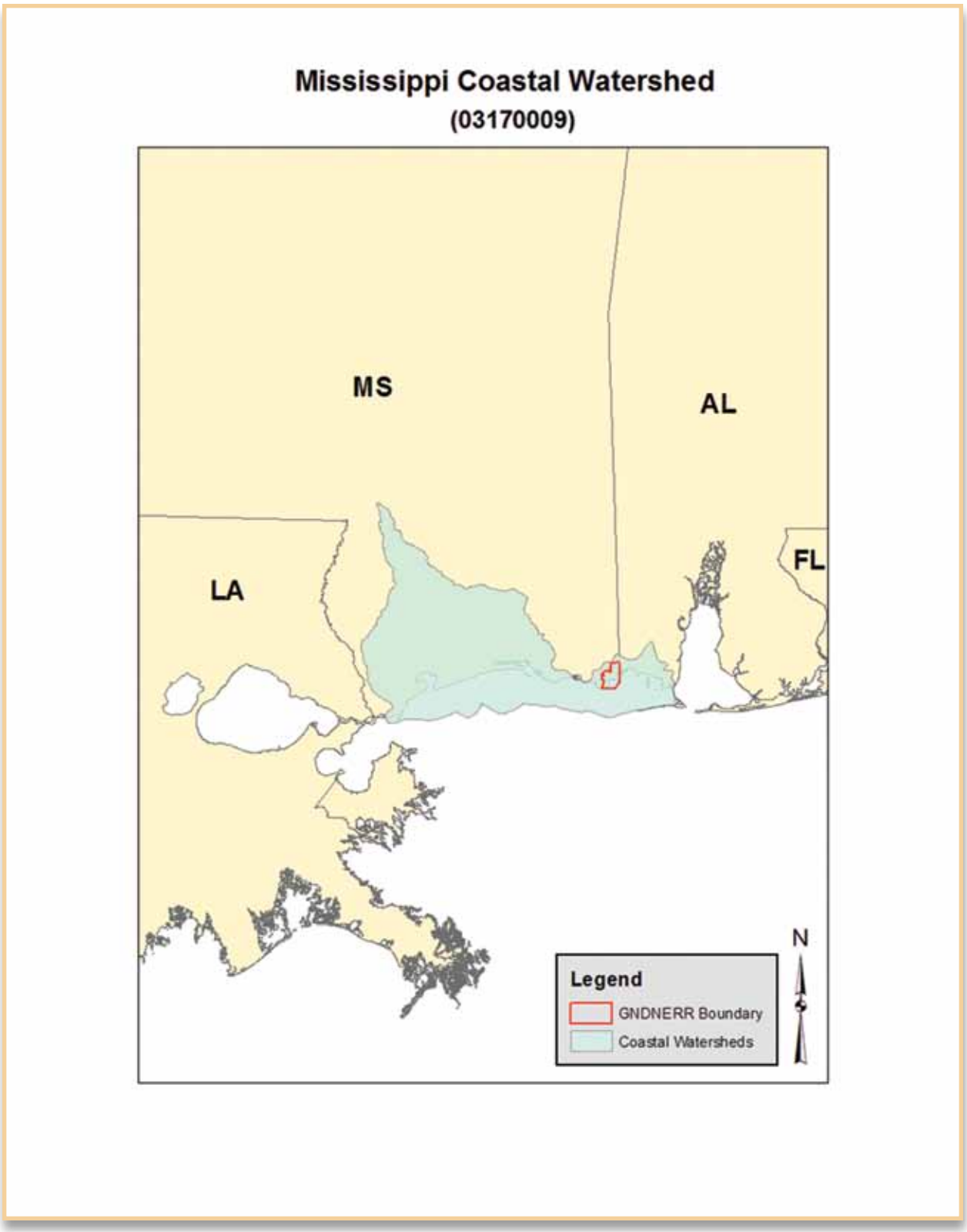


Figure 13. Mississippi Coastal Watershed boundary-03170009.

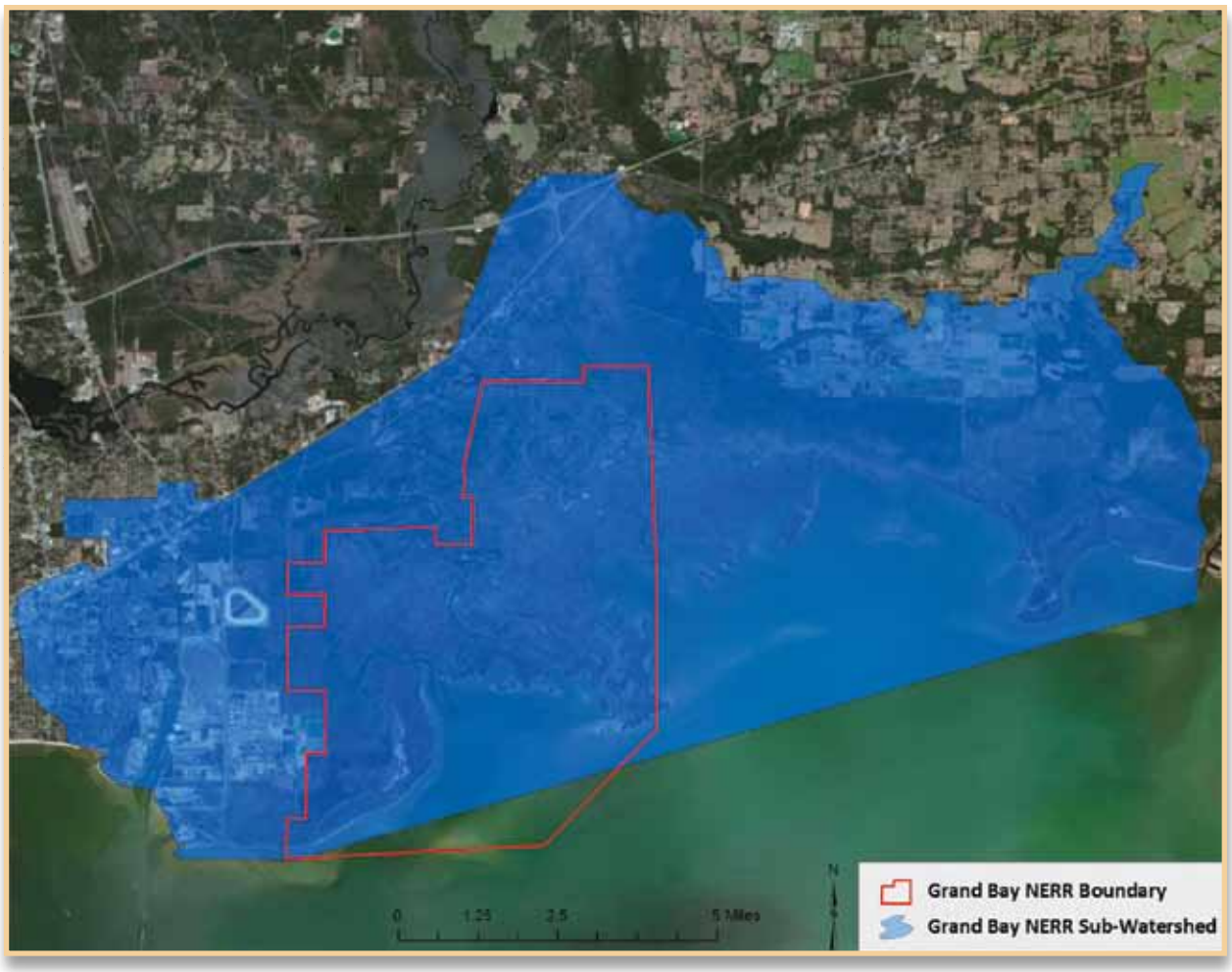


Figure 14. Grand Bay NERR sub-watershed.

Core and Buffer Areas

NOAA regulations define key or "core" land and water areas which contain "ecological units of a natural estuarine system which preserves, for research purposes, a full range of significant physical, chemical, and biological factors contributing to the diversity of fauna, flora and natural processes occurring within the estuary." The core area is "so vital to the functioning of the estuarine ecosystem that it must be under a level of control sufficient to ensure the long-term viability of the reserve for research on natural processes...[These areas] should encompass resources that are representative of the total ecosystem which, if compromised, could endanger the research objectives of the reserve." A buffer area is defined as an "area adjacent to or surrounding key lands and water areas and essential to their integrity. Buffer zones protect the core area and provide additional protection for estuarine-dependent species." The buffer area may include areas for research and education facilities (15 C.F.R Part 921.11).

For the Grand Bay NERR site, the core area was defined by a block of continuous estuarine habitats and waters bounded by the state line to the east and the industrial complex to the west. The core area of the Grand Bay NERR is comprised of approximately 13,280 acres of estuarine tidal marsh, tidal creeks, shallow open-water habitats, oyster reefs, sea grass beds, maritime forest (pine, live oak), salt flats, sandy beach, shell beach and shell middens (Figure 11). Approximately 20 privately owned parcels occur within the core boundary but are not included in core acreage. On many of these parcels, an undetermined acreage is at or below the mark of mean high tide and as such is considered to be public trust tidelands, which are owned in trust by the State of Mississippi and subject to the regulatory authority of the State under provision of the Mississippi Coastal Wetlands Protection Act and the Public Trust Doctrine. The MS SOS documents a general determination of tidelands status while detailed determination is generally considered as individual parcels change ownership.

The buffer area was defined generally as a portion of the non-estuarine habitats within the Grand Bay NWR upslope of the estuarine habitats (Figure 11). The 4,769 acre buffer consists of tidal marsh, scrub-shrub, pine flat wood and wet pine savanna habitats. While not defined specifically, the remaining lands of the Grand Bay NWR outside of the NERR administrative boundary serve as a functional buffer, given their protected status. Additionally, other functional buffers in the vicinity included federal buyout properties owned by government agencies, Grand Bay NWR lands in Alabama, a Mississippi Phosphate Mitigation Bank and a Jackson County Mitigation Bank all located to the north of the NERR buffer areas. Potential buffer expansion could include tidal marsh, scrub-shrub, pine flat woods, wet pine savanna, coastal bay head, cypress swamps and freshwater marshes to the north and west. The majority of these properties has been previously identified in state grant requests or is located within the boundaries of the Grand Bay NWR. Several properties in Alabama just east of the Reserve and Grand Bay NWR are part of the State of Alabama Grand Bay Forever Wild preserve and provide further protection to the Grand Bay savanna complex.

The public lands within the site are owned by a combination of state, federal and local agencies, including the MDMR, the SOS, Jackson County and the USFWS. The state lands are also part of the Grand Bay Coastal Preserve, a state-designated system of key estuarine areas, while the federal lands are part of the Grand Bay National Wildlife Refuge. Approximately 3,425 acres of private in-holdings exist within the administrative boundaries of the Reserve. In addition, the Grand Bay NERR is located completely within The Nature Conservancy's Grand Bay Savanna project area. Because of the rarity and biological significance of the wet pine savanna and estuarine habitat types, respectively, the Grand Bay Savanna project was recognized by TNC in the mid-1990's as an outstanding landscape nationally and designated as a bio-reserve in its "Last Great Places" campaign.

Acquisition Plan at Grand Bay

The objective of acquisition efforts on the Reserve is to acquire lands or secure management rights from willing landowners over private parcels within the administrative boundary of the reserve with priority given to those parcels that are barriers to landscape scale application of fire. This will

be accomplished through fee simple acquisition, conservation easements, management agreements, cooperative agreements and partnerships with willing landowners (Figure 15). Priority may also be given to parcels that allow for upslope migration of marsh habitats given the potential impacts of climate change and rising sea level. Acquisition efforts within the next five years will be driven by the availability of funding and willing landowners. As with restoration activities outlined in the stewardship chapter, the prioritization of parcels for acquisition is an ongoing process occurring with key partners and at present will be treated as confidential within the framework of the Deepwater Horizon Natural Resources Damage Assessment. Specific actions related to acquisition of property on the Grand Bay NERR are listed under objective 2-5 in the Stewardship Plan.

U.S. Army Corps of Engineers/Jackson County mitigation properties north of the Reserve on Bayou Heron and Pecan Roads in the community of Pecan (~350 acres) will be transferred to the State of Mississippi in the future, at which time consideration may be given to expanding the Reserve administrative boundary to include these properties. Reserve staff will coordinate with the USCOE and the USFWS to facilitate management of these properties until the transfer is complete. These mitigation properties are currently being used as research sites by the Grand Bay research coordinator in collaboration with several outside researchers.

Acquisition and Boundaries Goals and Objectives

The actions and strategies outlined below align with the goals and objectives described in Chapter III of this document.

Goal 2: Scientific understanding and knowledge informs the management of coastal resources and ecosystems.

Objective

2-5: Grand Bay NERR in collaboration with partners will acquire, protect, restore, manage or enhance lands within the targeted watershed to benefit native landscapes, habitats and species

Strategies/Actions

- Reserve staff will acquire and protect key land and water resources within Reserve Administrative boundaries (See Stewardship Plan).
- Reserve staff will work to facilitate the transfer of USCOE and Jackson County mitigation properties to the State of Mississippi.
- Reserve staff will continue acquisition-planning efforts as they relate to the Deepwater Horizon Oil Spill NRDA.

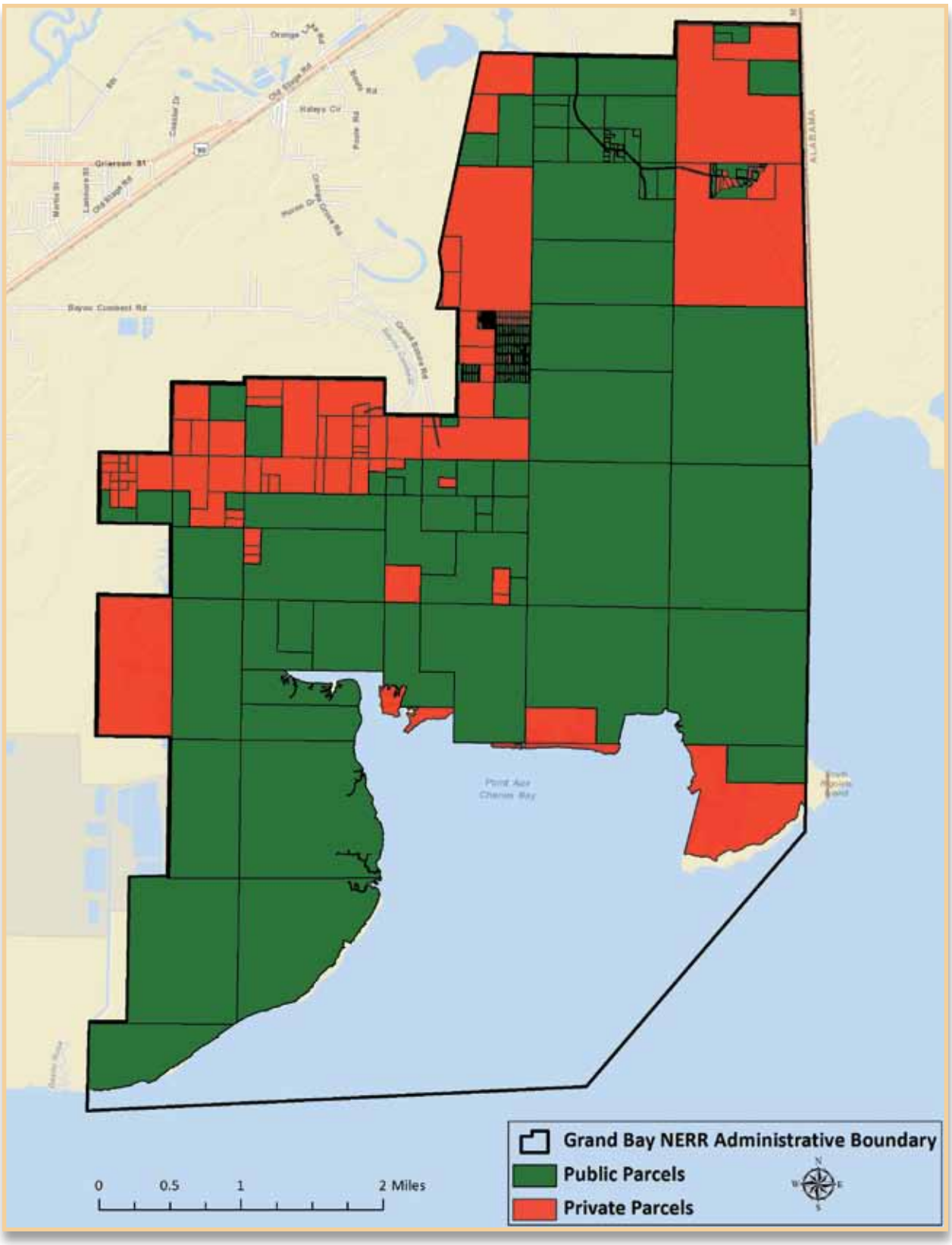


Figure 15. Parcel ownership map.

VIII. Resource Protection Plan

This chapter provides a description of Reserve strategies to provide for the protection of resources in the Grand Bay NERR. The importance of resource protection is discussed, followed by a brief discussion of potential threats to Reserve resources. Strategies and actions to enhance resource of Reserve resources are outlined and aligned with Grand Bay objective 2-5. The chapter ends with a comprehensive listing of existing resource protection regulatory authorities.

The integrity of the Grand Bay landscape and the NERR site in particular must be protected to sustain the area's long-term ecological viability. The Grand Bay NERR must be managed so that it will provide a stable environment for research and monitoring and education programs which are used to address coastal management issues. While existing federal and state regulations provide significant protection to the resources of the Reserve, the potential exists for activities to be proposed that could have a negative impact on the functioning of natural systems in the Reserve. Oil and gas lease blocks adjoin the southern boundary of the Reserve core, and Reserve staff will closely monitor future developments in this area. Proposed shoreline protection measures and sediment management activities will also be closely scrutinized for consistency with both regulation and alignment with the management philosophies of the Reserve and NOAA regulations {(15 C.F.R. 921.1 (d-e)}.

{15 C.F.R. 921.1 (d-e) (Appendix 1)}states:

> (d) Habitat manipulation for research purposes is allowed consistent with the following limitations. Manipulative research activities must be specified in the management plan, be consistent with the mission and goals of the program (see paragraphs (a) and (b) of this section) and the goals and objectives set forth in the Reserve's management plan, and be limited in nature and extent to the minimum manipulative activity necessary to accomplish the stated research objective. Manipulative research activities with a significant or long-term impact on Reserve resources require the prior approval of the state and the National Oceanic and Atmospheric Administration (NOAA). Manipulative research activities which can reasonably be expected to have a significant adverse impact on the estuarine resources and habitat of a Reserve, such that the activities themselves or their resulting short- and long-term consequences compromise the representative character and integrity of a Reserve, are prohibited. Habitat manipulation for resource management purposes is prohibited except as specifically approved by NOAA as: (1) A restoration activity consistent with paragraph (e) of this section; or (2) an activity necessary for the protection of public health or the preservation of other sensitive resources which have been listed or are eligible for protection under relevant Federal or state authority (e.g., threatened/endangered species or significant historical or cultural resources) or if the manipulative activity is a long-term pre-existing use (i.e., has occurred prior to designation) occurring in a buffer area. If habitat manipulation is determined to be necessary for the protection of public health, the preservation of sensitive resources, or if the manipulation is a long-term pre-existing use in a buffer area, then these activities shall be specified in

the Reserve management plan in accordance with Sec. 921.13(a)(10) and shall be limited to the reasonable alternative which has the least adverse and shortest term impact on the representative and ecological integrity of the Reserve.

(e) Under the Act an area may be designated as an estuarine Reserve only if the area is a representative estuarine ecosystem that is suitable for long-term research. Many estuarine areas have undergone some ecological change as a result of human activities (e.g., hydrological changes, intentional/unintentional species composition changes--introduced and exotic species). In those areas proposed or designated as National Estuarine Research Reserves, such changes may have diminished the representative character and integrity of the site. Although restoration of degraded areas is not a primary purpose of the System, such activities may be permitted to improve the representative character and integrity of a Reserve. Restoration activities must be carefully planned and approved by NOAA through the Reserve management plan. Historical research may be necessary to determine the "natural" representative state of an estuarine area (i.e., an estuarine ecosystem minimally affected by human activity or influence). Frequently, restoration of a degraded estuarine area will provide an excellent opportunity for management oriented research.

Existing Resource Protection at Grand Bay

Existing state, federal and local regulatory agencies and programs that apply within the Grand Bay NERR are summarized below.

State Regulatory Agencies and Programs

Mississippi Department of Marine Resources (MDMR)

The MDMR is the state CZM agency in Mississippi. The MCP was established and approved in 1980 under provisions of state and federal statues: Enabling legislation for Department of Marine Resources (57-15), Mississippi Coastal Wetland Protection Law (49-27-1 to 69), the federal Coastal Zone Management Act of 1972, as amended. The MDMR is also responsible for establishing and enforcing regulations regarding commercial and recreational fishing including shellfish harvesting. The MDMR's Coastal Ecology Division administers various portions of the MCP, including wetland permitting and federal consistency (Appendix 8). Likewise, both divisions played an important role in site selection and reserve management plan development. As a unit of the MDMR, the Grand Bay NERR staff regularly interacts and coordinate management, research and public outreach activities. Resource programs and policies are consistent to the maximum extent practical with the Mississippi Coastal Program.

Mississippi Department of Environment Quality (MDEQ)

The MDEQ evaluates and permits regulated activities that affect air and water quality and dredge and fill projects in Mississippi including National Pollutant Discharge Elimination System (NPDES) permits. As a Coastal Program agency, the MDEQ will continue to

coordinate evaluation of these activities in eastern Jackson County. Various divisions within MDEQ have provided, and will continue to provide, technical assistance to the Grand Bay NERR. The MDEQ also is the State Trustee for hazardous material spills along the Coast and coordinated State efforts during Deepwater Horizon and the phosphates spill.

Mississippi Department of Archives and History (MDAH)

The MDAH has oversight of the State Antiquities Act (Mississippi Code Section 39- 7-3) and serves as an advisory agency to assist in the management and protection of all historical and cultural sites located within the Grand Bay NERR through the Mississippi Coastal Program. The MDAH is a Coastal Program agency.

Mississippi State Department of Health (MSDH)

The MSDH enforces state and local regulations relating to sanitation and individual wastewater treatment systems (i.e., septic systems). Under its authority, the MSDH approves and permits the siting of residential septic systems.

Mississippi Department of Wildlife, Fisheries and Parks (MDWFP)

The MDWFP has primary responsibilities for management of the wildlife and fisheries resources of the state including its boat registration, hunting, fishing and boating licensing programs. The MDWFP also provides enforcement of these programs, primarily in freshwater areas of the state. They work closely with USFWS on hunting enforcement at the Refuge/Reserve.

Mississippi Oil and Gas Board/Mississippi Development Authority (MDA)

The Mississippi Oil and Gas Board acts as the permitting agency for development of oil and gas resources within the state. The MDA promotes development activities across the state and establishes certain rules and regulations pertaining to oil and gas exploration and production in marine waters.

Federal Regulatory Agencies and Programs

U.S. Fish and Wildlife Service (USFWS)

The USFWS is a primary Grand Bay NERR partner in that approximately one-quarter of the reserve acreage is located within the Grand Bay NWR. The USFWS has regulatory authority for endangered species and migratory bird issues as they relate to the reserve and joint NERR/NWR research and outreach activities. The USFWS also makes recommendations to the U.S. Army Corps of Engineers regarding wetland permits. An MOU with USFWS addresses these joint activities as well as enforcement within the Grand Bay NERR. The Refuge completed a Comprehensive Conservation Plan in 2008 (USFWS 2008) to guide activities and works cooperatively with Reserve staff on

portions of that plan. Refuge and other USFWS staff are housed in the Coastal Resources Center. USFWS enforcement is a visible presence on the Reserve.

U.S. Army Corps of Engineers (USACE)

The USACE is responsible for administration of the federal wetland permitting programs for tidal and non-tidal wetlands within the Grand Bay NERR and on adjacent waters and wetlands through its Mobile, Alabama District Office. USACE also is implementing the Mississippi Coastal Improvement Program across the Coast, which includes a mitigation buyout project in the Pecan and Bayou Cumbest communities just north of the Reserve boundaries. A transfer of these properties is planned in the future along with Jackson County properties which were part of an earlier buyout program.

NOAA/National Marine Fisheries Service (NMFS)

The NMFS is responsible for identifying essential fish habitats for federally regulated species of fishes and carrying out provisions of the Magnuson-Stevens Act. Further, under the Endangered Species Act, the NMFS helps protect threatened and endangered species such as sea turtles. NMFS has provided funding to the Reserve through the Protected Species Conservation Program. NMFS also is responsible for marine mammal protection under the Marine Mammal Protection Act. NMFS often makes recommendations to the USACE on wetlands permits under the Clean Water Act.

NOAA/Office of Response and Restoration/Disaster Response Center (DRC)

The DRC is the lead office for NOAA in preparing for and responding to oil and chemical releases in marine waters. The Reserve was funded by the DRC to develop a Disaster Response Plan (Appendix 2) for Grand Bay and the other 4 Gulf NERRs to address response and coordination relating to the trust resources of these reserves. This integrated plan is coordinated with other local, state and federal responders and will serve as a template for similar plans for other protected areas. This will aid efforts to protect reserve resources in the event of hazardous releases or other emergencies. The Grand Bay NERR is considered a federal trust resource under provisions of the NRDA, which is jointly addressed by NOAA and other federal agencies.

U.S. Environmental Protection Agency (USEPA)

The USEPA has enforcement and commenting authority for the federal wetlands permitting program in addition to joint responsibilities with the MDEQ for administrating the Clean Air and Clean Water acts in Mississippi.

Local Agencies and Programs

Jackson County, Mississippi

The boundaries of the Grand Bay NERR are located entirely within the Mississippi political subdivision of Jackson County. All local ordinances and restrictions will be followed on the Reserve as applicable, however Refuge lands are exempted. The Jackson County Sheriff's Department provides routine local enforcement. The Reserve has maintained a close working relationship with several county offices and administrators, including District 1 Supervisor, Emergency Response Coordinator and Fire Coordinator.

Resource Protection Goals and Objectives

The resource protection strategies and actions align with goals and objectives to address Reserve priorities.

Goal 2: Scientific understanding and knowledge informs the management of coastal resources and ecosystems.

Objectives:

2-5: Grand Bay NERR in collaboration with partners will acquire, protect, restore, manage or enhance lands within the targeted watershed to benefit native landscapes, habitats and species

Strategies/Actions

- Staff will acquire and protect key land and water resources within Reserve Administrative boundaries (See Acquisition Plan and Stewardship Plan).
- The Reserve will maintain an adequate buffer to key land and water resources.
- Staff will conduct a traffic count on Bayou Heron Road, a major access point into the Reserve (See Public Access Plan).
- Staff will coordinate with local, state and federal enforcement officials with regards to allowable and prohibited activities on the Reserve and Refuge.
- Staff will coordinate with neighboring property owners, local, state and federal agencies regarding local land use issues, which may impact Reserve resources.

Most of these strategies and actions can be achieved through existing programs of resource protection. Continued coordination between the Grand Bay NERR and Grand Bay NWR will help achieve long-term success in protecting the site.

IX. Public Use/Access Plan

This chapter contains narrative describing the importance of maintaining public access to the Reserve as well as the goals related to public use of the area. A general description of the Grand Bay Coastal Resources Center is provided as well as a discussion of public use opportunities associated with the NERR. Access to and appropriate uses of State waters are outlined as well as a description of allowable uses of Reserve uplands. All of the uses outlined below provide exposure for the Reserve and provide opportunities for education and increased public awareness of issues related to the management of coastal resources.

Public Use/Access at Grand Bay

Public access is important to reaching the Reserve vision of conserving and sustaining coastal areas for future generations by allowing for recreational and educational opportunities that promote the image of the Reserve and increase visitor appreciation and understanding of natural resources. In an effort to achieve the goals and objectives of the Reserve, use by the public will provide for opportunities to develop and strengthen connections with local communities and to promote awareness and stewardship of coastal resources. Adequate water access is critical to facilitating and conducting research and monitoring in the southern portions of the Reserve. Boat ramps and trails are also important and are used in a number of the education programs.

The Grand Bay Coastal Resources Center is located on Bayou Heron Road at the north entrance to the Reserve (Figure 16). Current hours of operation at the Center are Monday through Friday 8:00 a.m. to 4:00 p.m. Interpretive displays at the center are designed to teach about the protection and management of Reserve habitats as well as the cultural and natural heritage of the area. Adventure Quencher events coordinated by the education sector are hosted one Saturday per month at the center and provide visitors with educational and recreational opportunities related to a variety of topics. Civic and educational groups are encouraged to use the classrooms and dormitory for meetings and events. The Reserve maintains use records of the Center and dormitory.

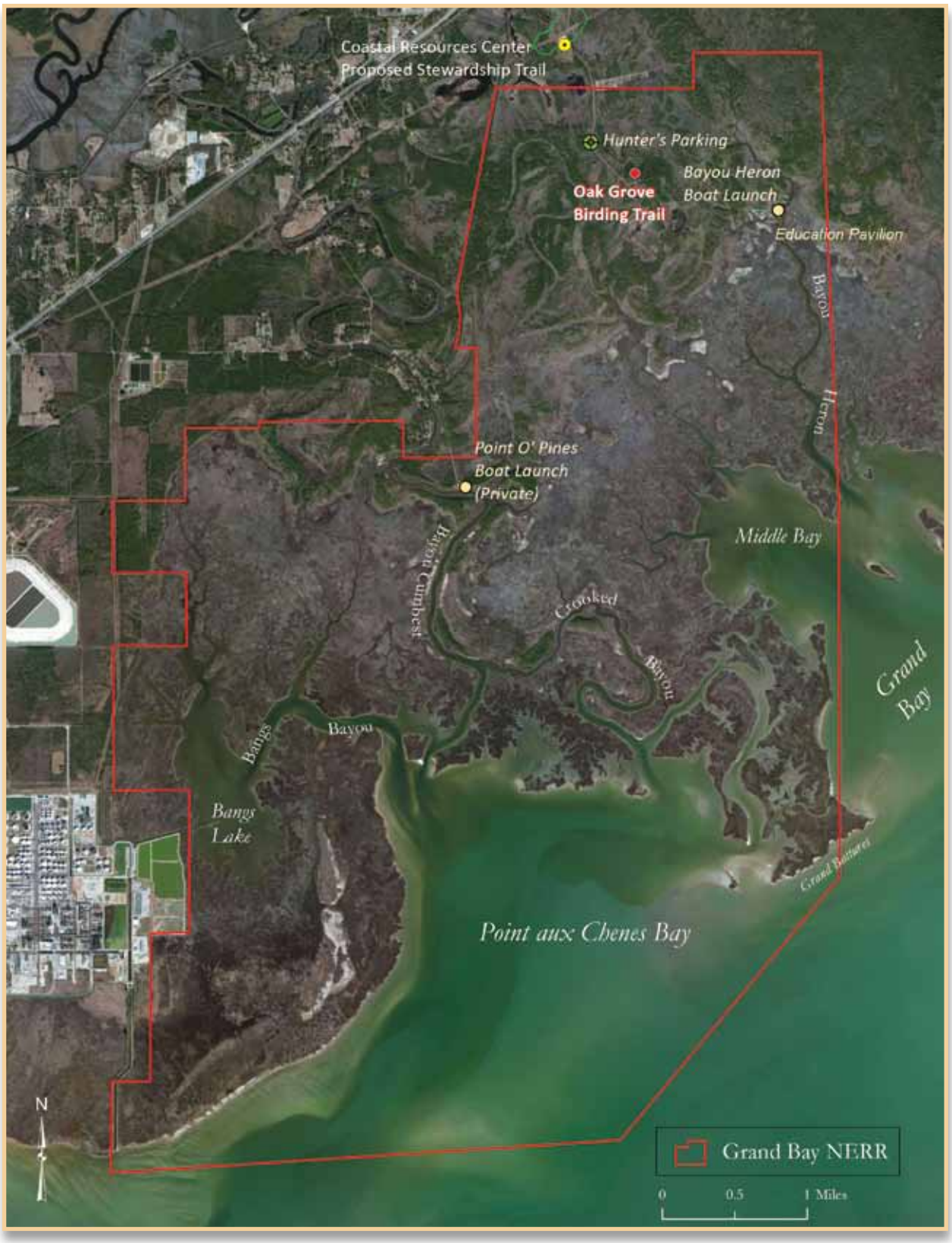


Figure 16. Grand Bay NERR public use map.

The waters of the Reserve are primarily accessed at the State-owned boat ramp located at the end of Bayou Heron Road and at the private boat ramp located at the end of Grand Batture Road. An additional private launch is located on Bayou Cumbest at the Drift Inn. Water access to the Reserve can also be gained from other boat launches in Pascagoula, MS and Bayou LaBatre, AL. Commercial and recreational fishing as per State and Federal regulations as well as non-consumptive uses such as bird watching and kayaking are allowed in the waters of the Reserve.

Public access to the Grand Bay NERR is primarily along Bayou Heron Road, which is maintained by Jackson County. Access to publicly held uplands within the Reserve administrative boundary is controlled by the USFWS. Allowable uses include permit-based archery hunting for deer as well as small game hunting with small caliber long guns and shotguns. The Center serves as a distribution point for hunting permits. Non-consumptive uses such as bird watching, hiking and nature photography are allowed on designated trails including the Oak Grove birding trail and the recently blazed Stewardship trail starting at the Coastal Resources Center.

The Reserve has no law enforcement jurisdiction and relies on the enforcement authorities of the USFWS, MDMR, MDWFP and Jackson County Sheriff's Office to enforce regulations pertaining to public safety, traffic, hunting, fishing, boating, etc. There are no Reserve restrictions or use restraints on outside researchers, however permits may be required by USFWS and MDMR for destructive sampling and collecting of plants and vertebrates.

Public Use/Access Goals and Objectives

The public use/access strategies and actions align with goals and objectives to address Reserve priorities.

Goal 1: Enhance Grand Bay NERR's role as a distinguished center for estuarine research, sound conservation and resource management.

Objectives:

1-4 Grand Bay Coastal Resources Center facility reservations will increase by 5% annually

Strategies/Actions

- Reserve staff will encourage visitor use by civic groups and others to promote the use of Reserve facilities.

1-5 Grand Bay NERR operations are maintained at a level adequate to support the mission

Strategies/Actions

- Reserve staff will work to improve and maintain public access at the Coastal

Resources Center, Bayou Heron Boat Ramp and the Stewardship Trail.

- Reserve staff will conduct traffic counts on Bayou Heron Road to assess visitor use and facility needs.
- Reserve staff will work to improve access points on Bayou Heron/ Gautier Bayou.

1-6 Develop and strengthen connections with local communities and schools

Strategies/Actions

- Reserve staff will encourage the general public to visit and experience the Reserve.
- Staff will coordinate with USFWS and MDMR to distribute information on Grand Bay NERR/NWR recreational activities including birding, hiking, hunting and fishing.

Goal 3: Local communities appreciate and value the significance of coastal ecosystems.

Objectives:

3-4: Annually, Grand Bay NERR supports opportunities for volunteer involvement and will seek to increase participation from the previous year

Strategies/Actions

- Staff will provide opportunities for volunteer involvement in the continued development and maintenance of the Stewardship Trail at the Coastal Resources Center.

X. Research and Monitoring Plan

This section of this management plan provides a five-year roadmap for the Grand Bay NERR research and monitoring program. The science activities of the Reserve are linked to broader NOAA priorities through a general background discussion of the creation of the NERR program, and research and monitoring efforts more specifically. A specific discussion of the Grand Bay NERR research and monitoring program during the first 10 years follows, highlighting NERR focus areas and summarizing the number of projects which have been associated with the Reserve. Brief overviews provide a description of three research-related programs, including SWMP, biological monitoring and sentinel sites. This chapter concludes with a list of actions and strategies, which the Reserve Science staff will implement, to address Grand Bay goals and objectives related to Reserve priorities.

The reserve system provides a mechanism for addressing scientific and technical aspects of coastal management problems through a comprehensive, interdisciplinary and coordinated approach. Research and monitoring programs, including the development of baseline information, form the basis of this approach. Reserve research and monitoring activities are guided by the NERR's Research and Monitoring Plan 2012-2017 (NOAA/NERRS2012a), which identifies goals, priorities and implementation strategies. This approach, when used in combination with the education and outreach programs, will help ensure the availability of scientific information that has long-term, system-wide consistency and utility for managers and members of the public to use in protecting or improving natural processes in their estuaries. Research within the reserves is designed to fulfill the reserve system goals as defined in program regulations [15 C.F.R Part 921.1(b)]. These include:

- Address coastal management issues identified as significant through coordinated estuarine research within the System;
- Promote Federal, state, public and private use of one or more reserves within the System when such entities conduct estuarine research; and
- Conduct and coordinate estuarine research within the System, gathering and making available information necessary for improved understanding and management of estuarine areas.

Reserve System Research Funding Priorities

Federal regulations, 15 C.F.R. Part 921.50 (a), specify the purposes for which research funds are to be used:

- Support management-related research that will enhance scientific understanding of the Reserve ecosystem,
- Provide information needed by reserve managers and coastal ecosystem policy-makers, and
- Improve public awareness and understanding of estuarine ecosystems and estuarine management issues.

The reserve system has identified the following five priority research areas to complement the funding priorities outlined above:

1) Habitat and ecosystem processes
2) Anthropogenic influences on estuaries
3) Habitat conservation and restoration
4) Species management
5) Social science and economics

Reserve System Research Goals

The reserve system research and monitoring goals are embedded in Goal 11 of the Reserve System Strategic Plan 2011-2016, "NERRS scientific investigations improve understanding and inform decisions affecting estuaries and coastal watersheds." Increase the use of reserve science and sites to address priority coastal management issues,' and are outlined in the 2012-2017 Reserve System Research and Monitoring Plan (NOAA/NERRS 2012a), and the NERR System-wide Monitoring Program Plan (NOAA/NERRS 2011). They include:

- Expand capacity to monitor changes in water quality and quantity, habitat and biological indicators in response to land use and climate change drivers.
- Improve understanding of the effects of climate change and coastal pollution on estuarine and coastal ecology, ecosystem processes, and habitat function.
- Characterize coastal watersheds and estuary ecosystems and quantify ecosystem services to support ecosystem-based management of natural and built communities.
- Increase social science research and use of social information to foster coastal stewards that value and protect estuaries.

Historically, there are two reserve system-wide efforts to fund estuarine research. The Graduate Research Fellowship Program (GRF) supports students to produce high quality research in the reserves. The fellowship provides graduate students with funding for 1-3 years to conduct their research, as well as an opportunity to assist with the research and monitoring program at a reserve. Projects must address coastal management issues identified as having regional or national significance; relate them to the reserve system research focus areas; and be conducted at least partially within one or more designated reserve sites. Proposals must focus on the following areas: 1) Eutrophication, effects of NPS pollution and/or nutrient dynamics; 2) Habitat conservation and/or restoration; 3) Biodiversity and/or the effects of invasive species; 4) Mechanisms for sustaining resources within estuarine ecosystems; or 5) Economic, sociological, and/or anthropological research applicable to estuarine ecosystem management.

Students work with the research coordinator or manager at the host reserve to develop a plan to participate in the reserve's research and/or monitoring program. Students are asked to provide up to 15 hours per week of research and/or monitoring assistance to the reserve; this training may take place throughout the school year or may be concentrated during a specific season.

Since the designation in 1999, the Grand Bay NERR has hosted 12 GRF students (Appendix 9).

Secondly, research is funded through the NERRS Science Collaborative, a partnership between NOAA and the University of New Hampshire. The Reserve System Science Collaborative is a program that focuses on integrating science into the management of coastal natural resources. Currently administered through the University of New Hampshire, the program integrates and applies the principles of collaborative research, information and technology transfer, graduate education and adaptive management with the goal of developing and applying science-based tools to detect, prevent and reverse the impacts of coastal pollution and habitat degradation in a time of climate change. The program is designed to enhance the reserve system's ability to support decisions related to coastal resources through collaborative approaches that engages the people who produce science and technology with those who need it. In so doing, the Science Collaborative seeks to make the process of linking science to coastal management decisions, practices and policies more efficient, timely and effective.

System-Wide Monitoring Program

It is the policy of the Grand Bay National Estuarine Research Reserve to implement the System-Wide Monitoring Program, guided by the NERR System-wide Monitoring Program Plan (NOAA/NERRS 2011).

The System-wide Monitoring Program provides standardized data on national estuarine environmental trends while allowing the flexibility to assess coastal management issues of regional or local concern. The principal mission of the monitoring program is to develop quantitative measurements of short-term variability and long-term changes in the integrity and biodiversity of representative estuarine ecosystems and coastal watersheds for the purposes of contributing to effective coastal zone management. The program is designed to enhance the value and vision of the reserves as a system of national references sites. The program focuses on three different ecosystem characteristics.

1) Abiotic Variables: The monitoring program currently measures pH, conductivity, salinity, temperature, dissolved oxygen, turbidity, water level and atmospheric conditions. In addition, the program collects monthly nutrient and chlorophyll a samples and monthly diel samples at one SWMP data logger station. Each reserve uses a set of automated instruments and weather stations to collect these data for submission to a centralized data management office.
2) Biotic Variables: The reserve system is focusing on monitoring biodiversity, habitat and population characteristics by monitoring organisms and habitats, as funds are available.
3) Watershed and Land Use Classifications: This component attempts to identify changes in coastal ecological conditions with the goal of tracking and evaluating changes in coastal habitats and watershed land use/cover. The main objective of this element is to examine the links between watershed land use activities and coastal habitat quality.

These data are compiled electronically at a central data management "hub", the Centralized Data Management Office (CDMO) at the Belle W. Baruch Institute for Marine Biology and Coastal Research of the University of South Carolina. They provide additional quality control for data and metadata and they compile and disseminate the data and summary statistics via the

Web (http://cdmo.baruch.sc.edu) where researchers, coastal managers and educators readily access the information. The metadata meets the standards of the Federal Geographical Data Committee.

Research and Monitoring Plan at the Grand Bay NERR

National Estuarine Research Reserves serve as living laboratories for on-site staff, visiting scientists and graduate students who study coastal ecosystems. In this capacity, the reserves serve as platforms for long-term research and monitoring, as sentinel sites to better understand the effects of climate change and as reference sites for comparative studies. The broad goals of the Reserve System's research and monitoring program include (1) ensuring a stable environment for research through long-term protection of Reserve resources; (2) addressing coastal management issues through coordinated estuarine research within the System; and (3) collecting information necessary for improved understanding and management of estuarine areas and making the information available to stakeholders (NOAA/NERRS 2012a).

The Grand Bay NERR research and monitoring program has evolved over time. Prior to designation in 1999, very few research efforts had been conducted within the Reserve boundaries or vicinity. Currently, approximately 40 research and monitoring projects are conducted on-site annually. Since designation, nearly 170 projects have been tracked in the Grand Bay research database housed at the Reserve. The Ecological Characterization of the Grand Bay, or Site Profile, was completed in 2007 and includes a basic overview of the Grand Bay ecosystem and a comprehensive list of specific research and monitoring needs (Peterson *et al.* 2007; http://grandbaynerr.org/site-profile). While Grand Bay staff conducts a significant number of individual research and monitoring projects, an important objective of the Reserve is to encourage and facilitate the use of the Reserve by external researchers. Thus, staff assists or collaborates with many researchers, frequently as co-principal investigators, as well as provides a variety of ecological data sets to visiting scientists to enhance their monitoring and research efforts. The biannual Grand Bay Research Symposium held in October 2011 attracted nearly 65 invited participants from 10 states, who viewed 30 presentations.

The Grand Bay NERR research staff has developed several focus areas since the Reserve's inception. These focus areas are based in part, on several elements: increased understanding of the Grand Bay ecosystem through Reserve-focused projects, monitoring and research needs and data gaps identified in the Site Profile, research issues identified through conceptual risk assessment models developed in collaboration with the Environmental Cooperative Science Center (ECSC), areas of expertise of reserve staff and opportunities for collaboration with universities, research laboratories and government scientists. The six focus areas of the research program directly inform and provide data relevant to the climate, habitat protection and water quality priorities (identified in Chapter III) for the for the Grand Bay NERR. The six broad focus areas for research at the Reserve include: (1) Ecological Effects of Sea Level Rise, (2) Ecology of Tidal Marsh Vertebrates, (3) Ecology of Special Habitats (e.g., salt pannes, shell middens, submerged aquatic vegetation, etc.) (4) Monitoring Ecosystem Effects of Atmospheric Mercury, (5) Coastal Plant Ecology and Mapping and (6) Long-term Monitoring of Environmental Conditions. Since the inception of the research program at the Grand Bay NERR, more than 70 research projects addressing these focus

areas have taken place on the reserve, involved reserve research staff and/or used data collected for the NERR. As a result, reserve research staff has been involved in more than 60 presentations and 30 scientific publications since 1999.

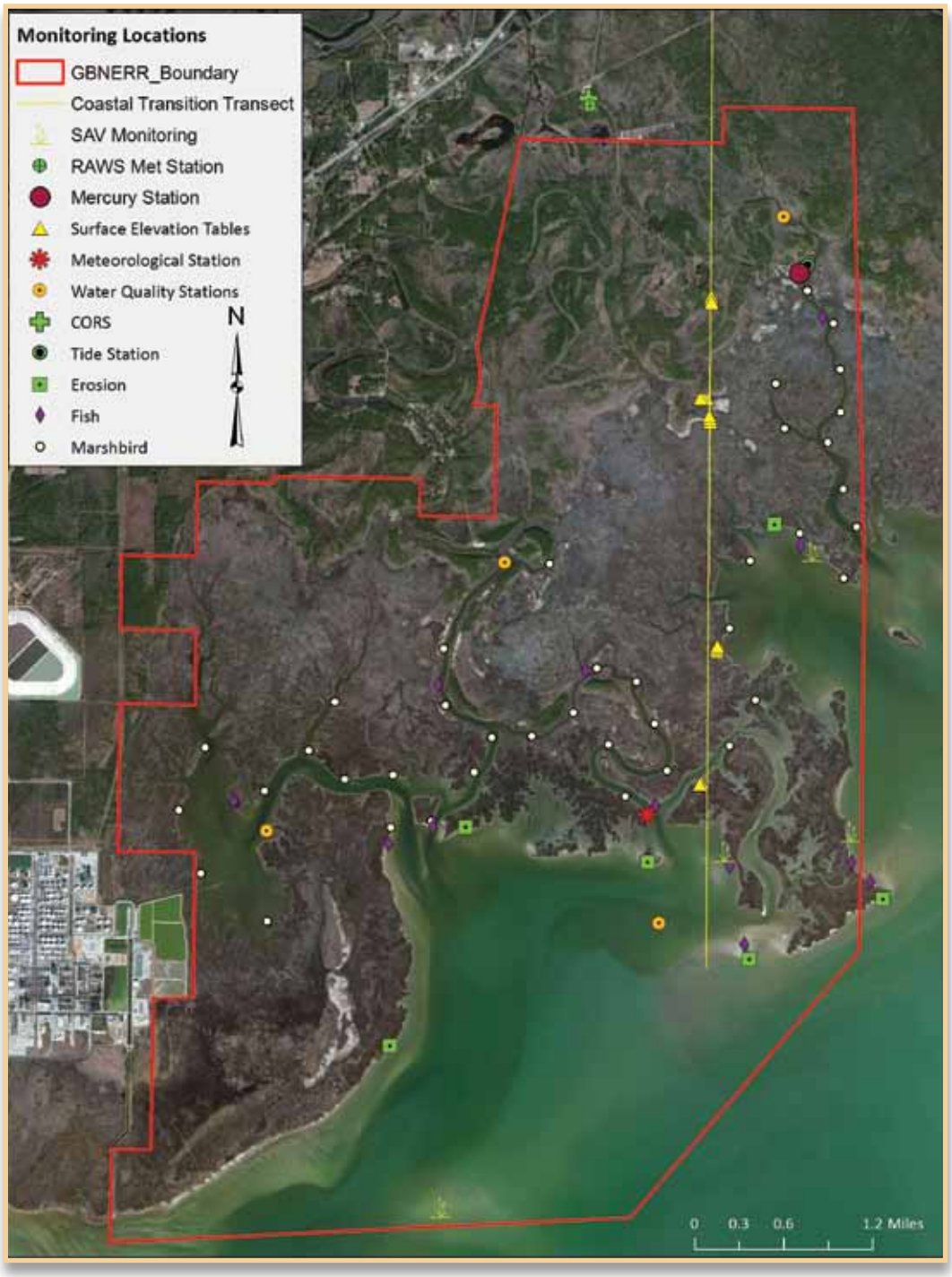


Figure 17. Long-term research and monitoring stations at Grand Bay NERR.

Implementation of SWMP at Grand Bay NERR

Grand Bay research staff, in consultation with local scientists, carefully considered the arrangement of SWMP stations across the Reserve before implementing the program. The weather station was installed in the south-central portion of the Reserve to capture both short-term effects of weather on water quality and long-term trends in meteorological conditions.

The four water quality monitoring stations are intended to represent a gradient of salinity and habitat conditions within the Reserve. One site is located in each of three sub- watersheds within Reserve boundaries, and the fourth site is located to the south in a more marine-influenced location. This arrangement of monitoring stations allows the research staff to capture effects of both freshwater runoff and marine influence on short- term variability and long-term trends in water quality at the Reserve.

Continuous abiotic measurements including water quality data [water depth (m), water temperature (°C), salinity (psu), dissolved oxygen (mg/L and % saturation), pH and turbidity (NTU)] are collected at four sites within the Grand Bay National Estuarine Research Reserve: Bayou Heron, Bayou Cumbest, Crooked Bayou (from January 2004 to August 2005), Pt. aux Chenes Bay (beginning August 2005) and Bangs Lake (Figure 17). The Reserve weather station is located in Crooked Bayou and measures relative humidity (%), barometric pressure (mb), wind speed (m/s), wind direction (o), air temperature (°C), precipitation (mm) and photosynthically active radiation (mmoles/m2). The weather station was destroyed in 2005 during Hurricane Katrina and replaced in 2006. The NERRS SWMP protocol requires the collection of at least 85 % of all possible data points. With a mean depth between 0.6 - 0.9 meters for 70 - 80 % of the waterways in the Grand Bay NERR and a mean tidal range of 0.6 meters, water quality monitors located in shallow bayous, like Crooked Bayou, are often out of water and result in a significant loss of data. In order to comply with SWMP protocol and to characterize the more seaward open waters of the Pt. aux Chenes Bay, the water quality station from Crooked Bayou was moved to Pt. aux Chenes Bay in August 2005. Measurements are made at each station every 30 minutes from January 2004 to June 21, 2006 and every 15 minutes after June 21, 2006 by a YSI 6600 Extended Deployment Sonde. Currently the SWMP data is being transmitted and is available online through the YSI Econet telemetry system (Figure 18).

Figure 18. Rotating data sondes at Grand Bay NERR SWMP station.

Biological Monitoring

In conjunction with the collection of abiotic data across the Reserve via SWMP, the NERR staff have initiated and implemented a variety of long-term biological monitoring projects, including erosion, SAV, estuarine fishes, diamondback terrapins, and breeding marsh birds (Figure 19). In addition, the staff have conducted a series of short-term monitoring efforts focused on winter shorebirds and winter marsh birds. Of the current biological monitoring efforts, submerged aquatic vegetation and breeding marsh bird data are collected following approved standardized NERR system-wide protocols. The goal of these biological monitoring efforts is to understand the abundance and distribution of particular taxa, determine population status and trends, gather data to provide a basic understanding of the ecology of specific taxa, and understand underlying ecological processes and their effects on reserve resources. The collection of these data serve several functions: (1) they provide a basic ecological understanding of important reserve resources, (2) they provide background data to allow for manipulative experimentation, and (3) they provide data for the development of predictive models to understand the future impacts of both anthropogenic and natural stressors on this ecosystem. Further, these efforts directly address

Reserve priorities such as understanding the effects of climate change on biological resources and ecological components of the reserve, understanding threats to Reserve resources and correlating changes in water quality with shifts in resource abundance and distribution.

New monitoring efforts to be initiated early in the five-year period of this plan will focus on the implementation of the Sentinel Site program at Grand Bay. Specific protocols will be followed to monitor the spatial and temporal variability across the Reserve for total suspended solids and marsh accretion rates. Reserve staff will also implement the NERRS-approved emergent marsh monitoring protocol to evaluate the effects of climate change and habitat management on plant associations along an elevation gradient from the open water to the upland wet pine savanna areas of the NERR.

Figure 19. Research and monitoring efforts at Grand Bay NERR.

Sentinel Sites and Climate Change

Reserves are located on the interface between the nation's uplands and waterways, ideally situated to monitor the effects of climate change on coastal ecosystems. Many reserves, including Grand Bay are working to become a NERRS sentinel site for understanding climate change impacts (NOAA/NERRS 2012b). Currently Reserve staff is working to install infrastructure including a CORS, surface elevation tables (SETs) and a temporary tide station. Future efforts will include the development of a sentinel sites program plan, implementation of emergent marsh biological monitoring, establishment of tidal datums and local geodetic control networks to tie together SETs, SWMP stations, vegetation transects and digital elevation models. In 2011, the NERRS began work on a Climate Change Initiative, focusing on understanding, adapting to and mitigating for the impacts of climate change at reserves and local communities (NOAA/NERRS 2012c). The

Reserve is currently engaged in working to build out the Grand Bay Sentinel Site (Figure 20). A NOAA Sentinel Site Cooperative for the Northern Gulf was initiated in 2012 and is currently engaged in developing an implementation plan. Grand Bay is an integral partner in the implementation of both of these initiatives.

Figure 20. Measuring accretion at surface elevation tables.

Research and Monitoring Goals and Objectives

The focus of the research and monitoring plan is reflected by the majority of goals and objectives established for the Reserve as discussed in Chapter III of this document. Reserve staff and sectors are integrated and work collectively on the Reserve goals. In particular, the research staff at Grand Bay actively collaborates with the stewardship sector on various projects. Through sharing resources and personnel, the two sectors have increased flexibility and are more productive, allowing for more effective efforts for meeting shared objectives. Thus, in addition to research-focused actions listed here, this section also incorporates several stewardship actions which overlap with Reserve research and monitoring activities. Research staff will play a valuable role to implement all Reserve goals and a majority of the objectives, however only the most applicable research and monitoring objectives are addressed in this chapter.

Goal 1: Enhance Grand Bay NERR's role as a distinguished center for estuarine research, sound conservation and resource management.

Objectives:

1-1: Grand Bay NERR staff members are recognized as valued experts relative to Reserve priorities

Strategies/Actions

- The Reserve research staff will provide advisory services to researchers, resource managers, local communities and the public.
    - The research coordinator will serve on at least one graduate student committee.
    - The research coordinator will serve on at least two science/technical advisory committees/panels/boards.
    - The Reserve research staff will serve on at least two science/technical advisory committees/panels/boards.
    - The research coordinator will serve on the advisory committee for the Grand Bay NERR Coastal Training Program.
- The Reserve research staff will provide technical advice to visiting scientists relating to research priorities, data and conducting research at the Grand Bay NERR.
- The Reserve research and stewardship staffs will develop and maintain a comprehensive list of past and current Grand Bay research, monitoring and stewardship projects; Reserve list will be coordinated and synchronized with the national NERR project database.
- The Reserve research staff will share potential funding opportunities with external researchers.
- The Reserve research staff will publish the results of research and monitoring projects. Examples of Grand Bay NERR peer-reviewed publications could include:
    - The Grand Bay NERR Conceptual Ecosystem Model
    - Distribution and Abundance of Yellow Rails along the North- Central Gulf of Mexico
    - Distribution and Abundance of Winter Marsh Birds in Gulf of Mexico Salt Marshes
    - Sustained Observations of Estuarine Metabolism in Three Estuaries in the northeast Gulf of Mexico
    - Distribution and Abundance of Diamondback Terrapins Nesting in the Tidal Marshes of Mississippi
    - Nesting Ecology of Diamondback Terrapins on Natural Beaches in Coastal Mississippi
- The Reserve research staff will make poster and oral presentations on Grand Bay NERR-related research and monitoring projects at various conferences

including the Coastal and Estuarine Federation Meeting, the Society of Wetland Scientists Meeting, the American Ornithologists' Union Meeting, the Bays and Bayous Symposium, the Grand Bay Research Symposium and other local, regional or national meetings.

1-2: Grand Bay NERR partnerships are established, maintained and expanded in support of addressing Reserve priorities

Strategies/Actions

- The Reserve research staff will actively engage in partnerships with USFWS, MDMR, universities and other groups to address research priorities at the Grand Bay NERR/NWR. Partnerships could include:
    - Continuation of the Ecosystem Effects of Atmospheric Mercury Monitoring Cooperative with NOAA Air Resources Laboratory, MDEQ, Florida A&M University, the BioDiversity Research Institute, and the Grand Bay NERR
    - Development and expansion of the Grand Bay NERR/NWR Inventory and Monitoring Partnership with the USFWS Inventory & Monitoring Program
    - Continuation of the Ecological Effects of Sea Level Rise partnership with the University of Central Florida and NOAA
    - Expansion of the NOAA Gulf of Mexico Sentinel Site Cooperative
    - Continued participation in the Gulf Coast Vulnerability assessment in partnership with NOAA and GCPOLCC
    - Continued participation in the Beneficial Use Group (i.e., beneficial use of dredge material) under the direction of the MDMR
    - Continuation of support for the ECSC
    - Continuation of participation in and support of the MDMR Science Seminar Series
- The research coordinator and the Reserve research staff will present at least one scientific seminar annually at local and regional academic institutions and laboratories, and research-oriented government agencies – providing an overview of the Grand Bay NERR program, describing research and monitoring projects and partnership opportunities.
- The Reserve research staff will work with partners to seek additional funding to support Reserve research priorities.
    - Potential funding partners include USFWS, NOAA, USEPA, MDMR, MDEQ, USACE, National Fish and Wildlife Foundation, and funding through the NRDA and the RESTORE Act.

1-3: Grand Bay NERR natural resources, activities, products and services are valued by targeted audiences or user groups

Strategies/Actions

- The research coordinator and the Reserve research staff will present at least one scientific seminar annually at local and regional academic institutions and laboratories, and research-oriented government agencies – providing an overview of the Grand Bay NERR program, describing research and monitoring projects.

1-4: Grand Bay Coastal Resources Center facility reservations will increase by 5% annually

Strategies/Actions

- The research coordinator and the Reserve research staff will present at least one scientific seminar annually at local and regional academic institutions and laboratories, and research-oriented government agencies – providing an overview of the Grand Bay NERR program, describing research and monitoring projects.

1-6: Develop and strengthen connections with local communities and schools

Strategies/Actions

- The Reserve research staff will conduct public seminars and workshops with a focus on the general public, describing research and monitoring projects and programs.
- The Reserve research staff will provide regular updates integrating research information on the Grand Bay web site and social media sites.
- The Reserve research staff will regularly lead public-oriented field trips and incorporate relevant research findings into the content of the field activity.
- The research coordinator will continue to be an instructor and support the Reserve partnership with Mississippi State University Master Naturalist Program.

Goal 2: Scientific understanding and knowledge informs the management of coastal resources and ecosystems.

Objectives:

2-1: Reserve facilities and equipment are used by external researchers, with at least 50% of external researchers supported by Reserve staff and facilities

Strategies/Actions

- The Reserve research staff will promote the availability and use of facilities and equipment by external researchers by making presentations at scientific conferences, coastal management symposia and training workshops.
- The Reserve research staff will work with administrative staff to accommodate the needs of visiting researchers as appropriate through policies relating to the use of dormitory, research labs, offices and boats.
- The Reserve research staff, in conjunction with other reserve sectors, will work collaboratively to conduct a bi-annual research symposium to highlight Grand Bay research and management efforts, with a focus on a variety of audiences including other researchers, coastal managers and the public.

2-2: Grand Bay NERR flora, fauna and ecological conditions are monitored and data are used to improve resource management

Strategies/Actions

- The Reserve research and stewardship staff will develop and maintain a list of inventory and research needs for the reserve and/or management units.
- The Reserve research staff will work with and support the Grand Bay NERR SWMP technician to monitor water quality and meteorological conditions throughout the Reserve.
- The Reserve staff will work to quantify distribution, abundance and variability of estuarine faunal communities.
    - Continue long-term monitoring project "Fish Communities of Nearshore Habitats within the Grand Bay NERR"
    - Continue long-term monitoring project "Monitoring Breeding Marsh Bird Populations at the Grand Bay NERR and Pascagoula River Marshes Coastal Preserve"
    - Continue and complete inventory and monitoring project "Distribution and Abundance of Yellow Rails Wintering in Coastal Pine Savanna Habitats in Mississippi and Alabama"
    - Continue the monitoring project "Spotlight Surveys of the Grand Bay NERR"
    - Continue the monitoring project "Mississippi Diamondback Terrapin Surveys in the Grand Bay NERR"
    - Continue and complete research project "Testing Habitat Model Assumptions for the Seaside Sparrow (*Ammodramus maritimus*) in Northern Gulf of Mexico Tidal Salt Marshes"
    - Complete the research project "Longitudinal Differences in Herbivore Pressure across Gulf of Mexico Salt Marsh Habitats"
    - Continue to support the monitoring project "Survey of Lepidoptera and Other Insects of the Grand Bay NWR"

- The Reserve research staff will work to facilitate and conduct research on the natural variability of ecosystems and the potential impacts of human disturbances.
    - Continue to support the monitoring project "Mercury Distribution and Spatial Variability in Sediments"
    - Continue to develop and support monitoring project "Mercury Burden of Selected Biota within the Grand Bay NERR"
    - Continue to support the research project "Monitoring Shifts in Drivers of Primary Production in Two Gulf of Mexico Estuaries Following the Deepwater Horizon Oil Spill"
    - Continue to support the survey project "Survey of Bacterial Communities Found in the Eastern Oyster (*Crassostrea virginica*) Microbiome"
- The Reserve staff will work to develop predictive models to determine how natural and man-made disturbances may impact coastal habitats in the future.
    - Complete research project "Development of a Decision-Support Tool to Assess the Risk of Habitat Degradation Following Watershed Land Use Changes"
    - Support and complete research project "Legacy Effects of Land-use Change and Nitrogen Source Shifts on a Benchmark System: Building Capacity for Collaborative Research Leadership at the Grand Bay Reserve"
    - Support the publication of the research project " Effects of Fire on Water Quality, Plant Production and Biogenic Accretion in a *Juncus roemerianus*-dominated Marsh"
- The research staff will work to complete a "Conceptual Ecosystem Model for the Grand Bay NERR" to assist with identification of key ecological linkages and research data gaps within the Reserve.
- The Reserve research staff will continue to coordinate wet and dry depositional mercury monitoring in coordination with NOAA Air Resources Lab and MDEQ. This program will be expanded to include biological monitoring if funding allows.
    - Continue monitoring project "Long-term Dry Deposition Monitoring of Atmospheric Mercury at the Grand Bay NERR and Gulf of Mexico region"
- The Reserve research staff will assist the stewardship staff to develop an approved Habitat Mapping and Change Plan and complete a baseline habitat map by the end of 2014.
- The Reserve research staff will collaborate with the stewardship staff to evaluate the existing SAV monitoring program and refine sampling efforts to better-fit local conditions and needs.
- Reserve stewardship and research staff will coordinate efforts to complete an approved Sentinel Site plan by the end of 2013 and implement components including:
    - emergent marsh monitoring

    - measure local scale tidal datums
- Stewardship staff, with assistance from the research staff, in coordination with NGS partners will continue vertical control efforts as they relate to the NERRS Sentinel Site guidance including the following activities:
    - complete approved Vertical Control Plan by end of 2013
    - periodic GPS surveys of SETs
    - periodic digital leveling of temporary tide gauge and CORS
    - periodic GPS surveys of SWMP stations
    - creation of digital elevation models using RTK GPS
    - bathymetric mapping of near-shore waters using RTK GPS
- Stewardship staff will continue quarterly shoreline erosion monitoring efforts on the Reserve.
- Stewardship staff will work to standardize and expand photo-monitoring efforts including game camera surveys, photo-station monitoring and plant photo database.
- The Reserve staff will communicate with external researchers and collaborators to facilitate the submission final reports and publications of their research for inclusion in the Reserve Resources Room holdings.
- The Reserve research staff will meet annually with area resource agencies (e.g., MDMR, USFWS, TNC, MDWFP, etc.) to share information on research program and management implications of research results.

2-3: Infrastructure and equipment to monitor long-term environmental changes are maintained

Strategies/Actions

- The Reserve research staff, in conjunction with the stewardship staff, will work to support and maintain SETs, CORS, water level monitors and tidal gauge infrastructure in support of Sentinel Site activities.
- The Reserve research staff will work to support, maintain and replace laboratories, laboratory equipment (e.g., deionized water system, refrigerators/freezers, drying oven and spectrophotometer, etc.) and biological monitoring sampling station markers, as needed to support long-term monitoring.
- The Reserve research staff will work to support and maintain SWMP stations and associated infrastructure, including but not limited to pilings, sonde sleeves and real-time telemetry.

2-4: By 2015, Grand Bay NERR staff, 10 researchers and/or coastal managers are engaged with the Reserve to monitor and study how locally relevant climate impacts affect natural communities

Strategies/Actions

- The Reserve staff will work collaboratively to develop and implement NERRS Sentinel Site monitoring effort (including infrastructure and biological monitoring).
- The Reserve staff will work collaboratively to develop, implement and conduct research projects to describe the natural variability of ecosystems and the potential impacts of climate change.
- The Reserve staff will provide climate-related science and monitoring data to training and education programs to better inform coastal managers/ communities.
- The Grand Bay NERR research coordinator will serve as a member of the NOAA Gulf of Mexico Sentinel Site Cooperative Management Team.

Goal 3: Local communities appreciate and value the significance of coastal ecosystems.

Objectives:

3-2: Annually, the Grand Bay NERR will provide 25 K-16 experiential environmental or Science, Technology, Engineering and Math (STEM) educational programs/ opportunities that will significantly increase student's awareness and knowledge of coastal ecosystems, including Reserve areas of focus (habitat protection, water quality and climate change)

Strategies/Actions

- Reserve-specific research findings into the content of experiential programs.
- The research coordinator will continue to be an instructor and support the Reserve partnership with Mississippi State University Master Naturalist Program.
- The research coordinator will conduct at least one annual field trip for post-graduate classes affiliated with a local or regional academic institution.

3-4: Annually, Grand Bay NERR supports opportunities for volunteer involvement and will seek to increase participation from the previous year

Strategies/Actions

- The Reserve research staff will provide citizen/student volunteer opportunities

through research and monitoring projects. Examples of research-related volunteer opportunities include:

- Data entry of fish and marsh bird monitoring data
- Recording data associated with field-oriented projects
- Assist with the rotation of water quality data sondes

Goal 4: Local communities will make improved science-based decisions regarding management of coastal resources and watersheds.

Objectives:

4-1: Seventy-five percent of local decision-makers participating in Reserve training programs use scientific knowledge and expertise to make informed coastal management decisions

Strategies/Actions

- The Reserve research staff will contribute scientific data to support and enhance reserve-led targeted decision-maker workshops in addressing local issues.
- The Reserve research staff will effectively present research findings to scientists, educators, decision-makers, citizens, etc. through the Reserve Coastal Training Program workshops.
- The Reserve research staff will participate in meetings/workshops, when appropriate, with federal, state, local resource management agencies and municipalities to keep them informed of current research efforts and issues.

4-2: Seventy-five percent of local decision-makers participating in education or training activities have an increased understanding of coastal resources/management issues

Strategies/Actions

- The Reserve research staff will contribute scientific data to support and enhance reserve-led education and training activities to increase understanding of coastal resources/management issues.
- The Reserve research staff will effectively present research findings during education and training activities.

XI. Education and Outreach Plan

The activities of the education and outreach program are outlined in this section of the five-year management plan. This section begins with a broad introduction of the education program from a national perspective, including goal and objectives. This is followed by a more focused overview highlighting current and future education program activities specific to the Grand Bay NERR. The final portion of the narrative provides an outline of specific actions/strategies the education staff will employ to meet the goals and objectives of the Reserve priorities.

The reserve system provides a vehicle to increase understanding and awareness of estuarine systems and improve decision-making among key audiences to promote stewardship of the nation's coastal resources. Education and interpretation in the reserves incorporate a range of programs and methodologies that are systematically tailored to key audiences around priority coastal resource issues and incorporate science-based content. Reserve staff members work with local communities and regional groups to address coastal resource management issues, such as NPS, habitat restoration and invasive species. Through integrated research and education programs, the reserves help communities develop strategies to deal successfully with these coastal resource issues.

Formal and non-formal education and training programs in the NERRS target K-12 students, teachers, university and college students and faculty, as well as coastal decision-maker audiences such as environmental groups, professionals involved in coastal resource management, municipal and county zoning boards, planners, elected officials, landscapers, eco-tour operators and professional associations.

K-12 and professional development programs for teachers include the use of established coastal and estuarine science curricula aligned with state and national science education standards and frequently involves both on-site and in-school follow-up activity. Reserve education activities are guided by national plans that identify goals, priorities and implementation strategies for these programs. Education and training programs, interpretive exhibits and community outreach programs integrate elements of NERRS science, research and monitoring activities and ensure a systematic, multi-faceted and locally focused approach to fostering stewardship.

Reserve System Education Goals

The National Estuarine Research Reserve System's mission includes an emphasis on education, interpretation and outreach. The education policy at the Grand Bay Reserve is designed to fulfill the reserve system goals as defined in the regulations [15 C.F.R Part 921.1(b)]. Education goals include:

- Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
- Conduct and coordinate estuarine research within the system, gathering and making

available information necessary for improved understanding and management of estuarine areas.

Reserve System Education Objectives

Education-related objectives in the Reserve System Strategic Plan 2011-2016 (NOAA/NERRS 2010) include:

- Enhance the capacity and skills of teachers and students to understand and use NERRS data and information for inquiry-based learning.
- Increase estuary literacy and promote active stewardship among public audiences through the development and delivery of tools and programs that address climate change, habitat protection and water quality.

Education and Outreach at Grand Bay NERR

The educational programming at Grand Bay seeks to strengthen connections and understanding of coastal ecosystems within local communities. In order to accurately demonstrate the value and significance of coastal and estuary ecosystems to our audiences, the Reserve's education programs are linked to the Reserve focus areas: climate change, habitat protection and water quality, through an integrative process that involves regular coordination with Reserve research and stewardship staff members.

Currently, the Reserve's Coastal Resources Center (GBCRC) provides a venue for a variety of learning experiences by many K-12 student, teacher, collegiate and community education audiences. Additionally, the varied habitats and associated plants and animals found at the Reserve provide an excellent "living laboratory" for all types of outdoor educational activities. The Reserve also promotes, produces and participates in a number of "on-the road" educational activities at area schools and community events. Monthly onsite field trips and community programs, such as the Adventure Quencher program are hosted at the GBCRC and feature activities such as guided boat tours, wildlife observing events and plant ID walks.

Like other Reserve programs, the education staff has successfully engaged target audiences through the development and implementation of a variety of new community education and interpretation opportunities and communication tools. As in other Reserve activities, building networks and partnerships is key to the success of the educational efforts. Partnerships with other educational organizations include but are not limited to the USM's Marine Education Center, MDEQ, GOMA, MSU, MDMR Education Team, Pascagoula River Audubon Center (PRAC), USFWS, Moss Point School District and Jackson State University (Figure 21). Coordination with our partners also allows us to design and implement more programs and fill identified gaps in environmental education along the north-central Gulf Coast.

The education staff also partner with regional and national professional education organizations such as the GOMA, National Marine Educators Association (NMEA) and its local chapter,

the Southern Association of Marine Educators (SAME), the North American Association of Environmental Educators (NAAEE) and its local chapter the Mississippi Environmental Education Alliance (MEEA), and the South Mississippi Environmental and Agricultural Coordination Organization (SMEACO) to stay up-to-date on current teaching methods and educational technology, new funding opportunities and to promote the products and programs that are developed within the NERRS.

Figure 21. Jackson State University graduate students field sampling during a short course.

Figure 22. Teachers on the estuary during a kayak trip.

The onsite K-12 Estuarine Education Program activities focus on upper elementary, middle and junior high audiences (Figure 22). Lower elementary grades are engaged primarily through our "on-the-road" outreach program in their schools. These "on-the-road" programs are currently being re-worked to address Reserve priority issues. Most of the program topics that the Reserve offers onsite concentrate on the importance of healthy estuaries and coastal habitats, the biodiversity associated with them and the importance of being good coastal stewards. During the next five years, we will be developing specific activities that address weather and climate and the impacts of climate change.

In order to help develop and further the Science, Technology, Engineering and Math Education (STEM) skills of our student audiences, all K-12 programming will be aligned with the Common Core Standards/Curriculum as they are gradually implemented across the State of Mississippi. Additionally, efforts will be made to incorporate the essential principles of estuary, ocean and climate literacy and the use of technology into our programs whenever possible (www.estuaries.noaa.gov) in order to foster the students' excitement for learning, their retention of information, their readiness for the workplace and their investment in stewardship activities (Figure 23).

The Reserve has conducted several professional teacher development-training workshops in coordination with partners in recent years focusing on climate change, watersheds, biodiversity, NOAA's Estuaries 101 curriculum and other estuary-related issues. Although the Reserve plans to align many of its workshops with the NERRS Teacher on the Estuary (TOTE) criteria, we are currently unable to call these workshops official TOTE workshops because the Reserve's required Market Analysis and Needs Assessment (MA/NA) have not been completed. However, workshops that we do offer are generally designed to follow the format of the TOTE workshops whenever possible.

One of the objectives of the Education Program is to design teacher workshops to align with TOTE criteria (at least 15 hours long, nationally advertised, locally relevant, etc), many of our local teachers have indicated in a needs assessments undertaken by the Weeks Bay Reserve (Whiteley 2010) that they would prefer shorter workshops than required by the TOTE criteria. Because of this noted preference, the Reserve plans to offer workshops of varying lengths (i.e., half-day, one-day or multiple days) in addition to TOTE workshops in order to reach out to as many teachers as possible. In order to meet the criteria for the TOTE program, the Reserve currently is working to complete the required MA/NA.

Figure 23. Castlen Elementary students assisting with marsh planting at boat ramp restoration project.

The GBCRC features an interpretive center, classrooms and an educational wet lab, which attract a wide variety of audiences. The theme of the GBCRC is "Living on the Edge—The Nature of Change". The center interprets how the biodiversity and health of our coastal habitats are, in many cases, influenced or changed both by the actions of human populations as well as by naturally-occurring events such as tidal fluctuations. In addition to the environmental information presented in the GBCRC, the heritage and history of the local area are also interpreted through a series of oral histories recorded by many of our community's former citizens and a variety of artifacts collected locally. These interviews and artifacts help us establish a "sense of place" for our site with our visitors. Exhibits address Reserve areas of focus and related priorities such as climate change, habitat protection and water quality.

The reserve was recently designated as a Heritage Site within the Mississippi Gulf Coast National Heritage Area (MGCNHA), a program of the National Park Service, because of the Reserve's rich history and significant archeological and ecological resources. A *National Heritage Area* is a special management area designated by the National Park Service and *includes natural, cultural, historic and recreational resources that combine to form a cohesive, nationally-distinctive landscape resulting from patterns of human activity that have been shaped by geography.* In accordance with this designation, the GBCRC serves as one of the official passport stamping sites for this National Park Service activity and will be receiving a new kiosk from the MGCNHA that will serve as a virtual field guide to Mississippi's heritage sites.

Because the GBCRC facility is certified as a GOLD L.E.E.D. (Leadership in Energy and Environmental Design) building, it serves as an excellent teaching tool to promote best management practices (BMP) for sustainable construction and storm water management. These

BMPs and sustainable designs are interpreted in our exhibits and through pre-arranged group building tours offered in conjunction with onsite meetings, conferences and field trips.

Two sites associated with the Reserve but located away from the GBCRC are often used for educational programs. A GBNWR education pavilion located adjacent to one of the area bayous is often used as an outdoor learning lab. The Reserve's education staff also uses the Oak Grove Birding Trail for interpretive walks addressing invasive species and other issues that relate to the biodiversity of maritime forests. To increase outdoor visitor opportunities, a sustainably designed, self-guided nature trail is planned adjacent to the GBCRC giving visitors access to nearby freshwater marsh and pine savanna habitats. Funds for building the first phase of this trail were recently secured through a Five Star Restoration Grant awarded to one of our partners, the Southeastern Wildlife Group.

The Reserve also works to promote responsible ecotourism within our region. The education coordinator is a representative on a newly formed group called the Mississippi Coast Nature Education Destination Group. This group works together to promote visitation to coastal environmental centers while reducing overlap in programming. To further promote ecotourism along the Mississippi Gulf Coast, Reserve staff routinely coordinate or participate in a variety of community festivals that promote ecotourism and environmental education on the coast (e.g., Celebrate the Gulf, Earth Day, National Estuaries Day and Crane Festival, etc.).

The Reserve has developed and co-produced several popular educational publications, including a plant guide (Grand Bay and Weeks Bay NERRs 2010) and bird finding guide (Woodrey and Walker 2011) that the MDMR distributes to inform our audiences about the importance of coastal conservation and to engage them in activities that promote coastal stewardship. Staff continues to increase use of the Internet and social media to share educational information from the Reserve. The Reserve's Facebook page and web site, www.grandbaynerr.org , serves as a conduit for much of this information.

Education and Outreach Goals and Objectives

The focus of the education plan is reflected by the majority of goals and objectives established for the Reserve as discussed in Chapter III of this document. Reserve staff and sectors are integrated and work collectively on the Reserve goals. Education staff will play a valuable role in all Reserve goals and a majority of the objectives, however, only the most applicable educational objectives are addressed in this chapter.

Goal 1: Enhance Grand Bay NERR's role as a distinguished center for estuarine research, sound conservation and resource management.

Objectives:

1-1: Grand Bay NERR staff members are recognized as valued experts relative to Reserve priorities

Strategies/Actions

- Education staff will provide technical/advisory services pertaining to educational issues such as outdoor classroom design, schoolyard projects, environmental and science fairs, curriculum development, etc., to area school administrators, teachers and local community members as requested.
- Education staff will publish and/or present education papers, posters and/or presentations in journals, at professional conferences or at public events as opportunities arise.
- Education staff will participate in professional organizations (i.e. NMEA and its local chapter, SAME, NAAEE and its local chapter the MEEA, the National and Mississippi Science Teachers Associations) throughout the year.
- The education staff will coordinate with NOAA to more fully market the Reserve System over the next five years in order to increase visitation at the Reserve and promote the opportunities available for partnering with our staff of environmental education specialists.

1-2: Grand Bay NERR partnerships are established, maintained and expanded in support of Reserve priorities

Strategies/Actions

- The education staff will establish and/or maintain existing partnerships with NGOs such as the LTMCP and the PRAC, centers of higher learning such as the USM, MSU, Mississippi Gulf Coast Community College's (MGCCC) Estuarine Education Center and the University of Southern Alabama as well as other state and federal agencies such as the MDEQ, Gulf Islands National Seashore and NOAA's Pascagoula Lab to develop and enhance education programming pertaining to the NERR's priority issues.
- Reserve educators will partner with local schools and universities to provide field-based environmental programs for their students and educators
- Reserve educators and administrators will seek additional partners to help fund programs that will provide for student field trips to the Reserve (i.e. GOMA, Bay-Watershed Education Training (B-WET), MDMR Tidelands and MDEQ).

1-3: Grand Bay NERR natural resources, activities, products and services are valued by targeted audiences or user groups

Strategies/Actions

- Reserve educators will develop and distribute timely, regionally relevant and audience-appropriate educational products that interpret the results of Reserve research and other coastal resource issues.
- Reserve educators will use information gathered from monitoring, feedback from social networking sites and synthesized data from surveys and other assessment tools to enhance and expand existing programming and develop new products for the Reserve's target audiences.

- NERR will maintain and update information such as a calendar of events, current news and educational resources on the Reserve's web site (www.grandbaynerr.org) and social media sites.

1-4: Grand Bay Coastal Resources Center facility reservations will increase by 5% annually

Strategies/Actions

- The education staff will host educational sustainable building tours of the Reserve's facility during special events, workshops and by appointment.
- Reserve staff will encourage local organizations and clubs that have similar missions to that of the Reserve to host at least one of their meetings or a conference that will include a brief education presentation on estuary ecology and the mission of the Reserve at the Grand Bay Coastal Resources Center whenever possible.
- Reserve staff will modify, develop and interpret new exhibits that promote the conservation of Reserve resources (i.e. sustainable buildings, stewardship, fire-wise landscaping, climate change, habitats and water quality).

1-6: Develop and strengthen connections with local communities and schools

Strategies/Actions

- The education staff will implement both formal and informal assessments to improve Reserve staff understanding of local school and community audiences.
- The education coordinator will review and incorporate pertinent findings from Weeks Bay's overlapping K-12 Market Analysis and Needs Assessment (Whiteley 2010) into an updated, supplementary K-12 Needs Assessment for Jackson County, MS and Mobile County in Alabama and submit it for approval to NOAA by the end of 2013.
- Education staff will conduct pre-and post-test evaluations for student and teacher development and selected community programs to assess retention of information.
- Throughout the year, reserve staff will work with undergraduate and graduate professors at local universities and community colleges to facilitate onsite learning experiences for their students through field trips, stewardship opportunities and short-term internships and mentoring programs.
- Staff will coordinate and participate in community festivals and events such as Celebrate the Gulf, Earth Day, National Estuaries Day, etc., to promote Reserve priorities.
- The Staff will regularly partner with the MDMR Public Relations Office to promote education programs especially in southeastern Mississippi and southwestern Alabama.

- Reserve staff, in cooperation with the MDMR Public Relations Office, will produce a quarterly NERR online newsletter beginning in 2014 to promote the Reserve and its resources.

Goal 2: Scientific understanding and knowledge informs the management of coastal resources and ecosystems.

2-2: Grand Bay NERR flora, fauna and ecological conditions are monitored and data are used to improve resource management

Strategies /Actions

- The education coordinator will implement at least one educational phenology biodiversity and/or water quality monitoring project for citizen scientists and visitors to participate in at the Reserve by the end of 2014.
- The education staff will incorporate K-12 and Professional Teacher Development activities that use real-time or archived SWMP data collected at the Reserve and promote inquiry-based educational programming by the end of 2013 to help better prepare students and teachers to be wiser coastal decision-makers in the future.

Goal 3: Local communities appreciate and value the significance of coastal ecosystems.

Objectives:

3-1: Seventy-five percent of people participating in the Grand Bay NERR programs recognize the importance of coastal resources and the Reserve areas of focus

Strategies /Actions

- The Reserve will provide and promote onsite outdoor experiential learning and recreational opportunities such as hiking, boating, fishing, photography and bird watching to educate the public on the importance of conserving coastal resources and move them towards estuary and ocean literacy.
- Staff will manage signage, presentations and exhibits at the Reserve to provide timely and accurate information to increase the public's understanding of sustainable practices and key environmental issues.
- The education coordinator will coordinate at least one Adventure Quencher community education activity each month in order to promote estuary, ocean or climate literacy.
- The education staff will coordinate or participate in at least four off-site community or outreach events each year that promote estuary and ocean and/or climate literacy.

- The Reserve will develop/adopt tools for assessing community programs by the end of 2014.

3-2: Annually, the Grand Bay NERR will provide 25 K-16 experiential environmental or Science, Technology, Engineering and Math (STEM) educational programs/ opportunities that will significantly increase student's awareness and knowledge of coastal ecosystems, including Reserve areas of focus (habitat protection, water quality and climate change)

Strategies /Actions

- The education staff will design and implement at least four relevant, grade-appropriate, hands-on educational experience templates for students that relate to Reserve priorities by 2017.
- The education staff will form partnerships with local school districts and work with selected educators to align NERR educational programs to the Common Core Curriculum as soon as they are adopted locally.
- The education staff will deliver educational programs onsite and "on the road" to reach as many students as possible throughout the year.
- The education staff will participate in career days, science competitions such as science fairs and the Envirothon and other activities throughout the year to help develop STEM skills and ocean, climate and/or estuary literacy in student audiences.
- The education coordinator will seek additional funding partners and sources, such as that provided through the B-WET program, to increase the numbers of students and teachers who can be served each year by the Reserve.
- The education coordinator will prioritize the recruitment of students from minority and other underserved and underrepresented communities to participate in the Reserve's educational programs whenever possible.

3-3: Eighty percent of the educators attending professional teacher development, Teachers on the Estuary (TOTE) or TOTE-aligned workshops sponsored by the Reserve will be estuary-literate

Strategies /Actions

- By the summer of 2014, the Reserve will offer its first official TOTE workshop to formal and informal educators incorporating topics of interest indicated in the Mississippi addendum to the Weeks Bay Needs Assessment-weather and climate, biomes, tides, watersheds and oceans and those that address the Reserve' s priority issues.
- After the summer of 2014, at least three TOTE workshops per year will be offered by the Reserve.
- Pre-and post-assessments will be given to participants in TOTE workshops and compared to see if the participants succeeded in becoming

estuary literate.

- Educators participating in our TOTE workshops will be encouraged to bring their students to the Reserve on future field trips.
- The education staff will work with the SWMP coordinator to ensure that teachers receive the training they need to use the SWMP and NOAA's other real-time data in their classrooms.

3-4: Annually, Grand Bay NERR supports opportunities for volunteer involvement and will seek to increase participation from the previous year

Strategies /Actions

- Education staff will develop roles for volunteers in programming throughout the year.
- The education specialist will coordinate with the stewardship sector to recruit and train volunteers and coordinate their assignments.

XII. Coastal Training Program Plan

This chapter provides strategic direction for the Reserve's Coastal Training Program (CTP) for the next five years. Grand Bay's CTP strategy reflects the primary components of the NERRS CTP, the local needs and priorities identified through assessments of and interactions with decision-makers working in coastal Mississippi and the priority goals and objectives as presented in Chapter III of this Plan. The CTP has been developed to reflect lessons learned and to build upon program successes since its establishment in 2004. It is designed to be directed by adaptive management principles and informed by regular market analyses and needs assessments (formal and informal) that allow for flexibility to emerging decision-maker needs and changing coastal conditions. The program will use scientific understanding of the Reserve focus areas, including climate change, habitat protection and water quality. This chapter concludes with a list of actions and strategies the CTP staff will implement to address goals and objectives related to Reserve priorities.

National Estuarine Research Reserve Coastal Training Program

The CTP provides up-to-date scientific information and skill-building opportunities to coastal decision-makers who are responsible for making decisions that affect coastal resources. Through this program, National Estuarine Research Reserves can ensure that coastal decision-makers have the knowledge and tools they need to address critical resource management issues of concern to local communities.

Coastal Training Programs offered by reserves relate to coastal habitat conservation and restoration, biodiversity, water quality and sustainable resource management and integrate reserve-based research, monitoring and stewardship activities. Programs target a range of audiences, such as land-use planners, elected officials, regulators, land developers, community groups, environmental non-profits, business and applied scientific groups. These training programs provide opportunities for professionals to network across disciplines, and develop new collaborative relationships to solve complex environmental problems. Additionally, the CTP provides a critical feedback loop to ensure that professional audiences inform local and regional science and research agendas. Programs are developed in a variety of formats ranging from seminars, hands-on skill training, participatory workshops, lectures and technology demonstrations. Participants benefit from opportunities to share experiences and network in a multidisciplinary setting; often with a reserve-based field activity.

Partnerships are important to the success of the program. Reserves work closely with State Coastal Programs, Sea Grant College extension and education staff and a host of local partners in determining key coastal resource issues to address as well as the identification of target audiences. Partnerships with local agencies and organizations are critical in the exchange and sharing of expertise and resources to deliver relevant and accessible training programs that meet the needs of specific groups.

The CTP requires a systematic program development process, involving periodic review of the reserve niche in the training provider market, audience assessments, development of a three-to five-year program strategy, a marketing plan and the establishment of an advisory group for guidance, program review and perspective in program development. The CTP implements a performance monitoring system, wherein staff report data in operations progress reports according to a suite of performance indicators related to increases in participant understanding, applications of learning and enhanced networking with peers and experts to inform programs.

Reserve System Coastal Training Goals

The National Estuarine Research Reserve System Coastal Training Program is designed to fulfill the reserve system goals as defined in the regulations (15 C.F.R Part 921.1(b)). Coastal training goals include:

- Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
- Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.

Reserve System Coastal Training Program Objectives

Coastal Training-related objectives in the Reserve System Strategic Plan 2011-2016 (NOAA/ NERRS 2010) include:

- Increase estuarine literacy and promote active stewardship among public audiences through the development and delivery of tools and programs addressing climate change, habitat protection and water quality.
- Improve the capacity and skills of coastal decision-makers to use and apply science-based information in decisions that affect estuaries and coastal watersheds

The CTP provides up-to-date scientific information and skill-building opportunities to coastal decision-makers who are responsible for making decisions that affect coastal resources. Through this program, National Estuarine Research Reserves can ensure that coastal decision-makers have the knowledge and tools they need to address critical resource management issues of concern to local communities.

Coastal Training Program at Grand Bay

In 2005, the Reserve initiated the CTP with approval from the NOAA. The CTP is based on the

principle that coastal decision-makers need to have scientific information available and the means to understand the science in order to make informed decisions about coastal issues and resources. Providing coastal decision-makers with science-based information, tools and skills needed to make informed resource management decisions is one of the primary objectives of the program (Figure 24).

Figure 24. Training workshop at Grand Bay NERR.

Building and maintaining partnerships is critical to the Grand Bay NERR success. Partners play a variety of roles in the development, planning and implementation of the CTP events including providing funds, speakers, venues and logistical support. Recent Grand Bay CTP partners include the MDMR, Mississippi Emergency Management Agency (MEMA), MGCCC, Weeks Bay NERR, Weeks Bay Foundation, NOAA's CSC, NOAA Coastal Storms Program, MASGC, Mississippi State University-Coastal Research and Extension Center (MSU/CREC), GOMA and USEPA's Gulf of Mexico Program.

Currently, the Grand Bay CTP is collaborating on new partnership opportunities with the USFWS's MCP, U.S. Department of Interior's National Conservation Training Center, NOAA's DRC, Gulf Coast Climate Community of Practice and other local, regional and national agencies and organizations.

The Grand Bay CTP's primary priority audiences are local officials and staff, natural resource managers and coastal scientists who work in coastal Mississippi. For the purposes of this document local officials and staff are considered to be individuals who serve in elected, appointed or administrative capacity at the town, municipal, county and state or federal level. Natural resource managers are those individuals who are tasked with the conservation, restoration and management

of natural areas and are responsible for the plant and animal species found within those areas. Coastal scientists are considered to be those individuals who conduct scientific research within

coastal areas in disciplines including but not limited to: geography, geology, archeology, marine biology, ecology, botany, ornithology, entomology, hydrology and climatology.

Most Grand Bay CTP audience members share the ability to make or influence decisions that affect coastal resources through land use, infrastructure and economic development decisions. The Grand Bay CTP seeks to identify key knowledge gaps that impede informed decision-making and offer training events that will fill or bridge these gaps. Training events and educational products that are organized for these audiences may also benefit secondary audiences such as educators, ecotourism operators, volunteers and engaged citizens.

Potential training needs as identified in the 2011 CTP Needs Assessment Survey and the Grand Bay NERR Coastal Training Program-Program Strategy (Grand Bay NERR 2012) are:

Coastal Resource Management

- Grant Writing
- Wetland Mitigation
- Conducting Vulnerability Assessments
- Coastal Processes
- Wetland Protection and Restoration
- Wetland Delineation

Coastal Development

- Geographic Information Systems
- Shoreline Stabilization Alternatives
- Renewable/Green Energy
- Storm Water Management

Coastal Hazards

- Climate Change Impacts
- Oil Spills
- Erosion and Sediment Control
- Coastal Hazards (e.g., floods, storm surge protection and community resilience)
- Nutrient Loading

Although the list above is comprehensive, the CTP will maintain enough flexibility to prioritize training topics based on changing needs and/or to address the Reserve's focus areas (climate change, habitat protection and water quality) and priorities and emerging issues that may not be reflected by this list. When planning events, Grand Bay NERR's CTP staff will also take steps to include relevant Grand Bay NERR research to ensure the transfer of Reserve science to management.

The Reserve seeks to use staff and partner generated research and monitoring results to inform decision-makers of priority issues whenever possible. A critical component of future training designed for decision-makers will be to use relevant science to link local policy, planning and resource management decisions to the viability of coastal resources, which, in turn, promotes conservation and cultivates community resilience.

Climate change is a topic that has begun to receive more interest from Grand Bay CTP audiences. Reserve staff and several partners are involved in climate change research and monitoring projects designed to better understand how the landscape has changed and will continue to change over time. Results of research and monitoring using surface elevation tables, tide gauges, geotechnology and land cover change maps in conjunction with other Reserve research will be used to inform local decision-maker audiences about changes happening along the northern Gulf Coast. The Grand Bay CTP, through a variety of platforms, will share the results of this research and monitoring with management audiences. Anticipated training topics include: planning for climate change, climate change adaptation, climate change communication, conducting climate change vulnerability assessments and the science of climate change.

Coastal Training Program Goals and Objectives

The mission of the Reserve is "To practice and promote informed stewardship of Grand Bay NERR and Mississippi coastal resources through innovative research, education and training." In keeping with the Reserve's mission, the CTP strives to provide science-based information for use by local decision-makers within local communities, which will increase local understanding of coastal management issues. The CTP fosters informed decision-making and resource management across the coastal landscape by enhancing the decision-making abilities of professional audiences whose actions influence the management of natural resources along the north-central Gulf Coast.

The focus of the CTP Plan is reflected by priorities and goals and objectives established for the Reserve as discussed in Chapter III. Reserve staff and sectors are integrated and work collectively on the Reserve goals. Training staff will play a valuable role in all Reserve goals and a majority of the objectives, however only the most applicable training objectives are addressed in this chapter.

Goal 1: Enhance Grand Bay NERR's role as a distinguished center for estuarine research, sound conservation and resource management.

Objectives:

1-1: Grand Bay NERR staff members are recognized as valued experts relative to Reserve priorities

Strategies/Actions

- The CTP staff will provide advisory services to decision-makers, resource managers, local communities and the public.

- The CTP staff will integrate with the Reserve's research, stewardship and education programs to communicate current management information and outreach needs that will be useful in development of sector projects that are timely and relevant to the coastal training program.
- The CTP coordinator will serve on at least two relevant technical advisory committees/panels/boards.
- The CTP staff will make poster and oral presentations on Grand Bay NERR-related training and outreach projects at various meetings including the GOMA, Community of Practice, Grand Bay Research Symposium and other local regional or national meetings.
- The CTP coordinator will contribute at least one peer-reviewed education/training project for publication.
- The CTP staff will contribute to reports and articles on training project/techniques for publication.

1-2: Grand Bay NERR partnerships are established, maintained and expanded in support of Reserve priorities

Strategies/Actions

- The CTP staff will actively engage in new and continuing partnerships with agencies, universities and other groups to address Reserve priorities. Partnerships could include MDMR (including Coastal Program), MEMA, MGCCC, Weeks Bay NERR, Weeks Bay Foundation, NOAA's CSC, MDEQ, NOAA Coastal Storms Program, MASGC, MSU/CREC, GOMA, USEPA Gulf of Mexico Program, USFWS's Northern Gulf Coastal Program, U.S. Department of Interior's National Conservation Training Center, GCPOLCC, NOAA's DRC and Gulf Coast Climate Community of Practice.
- The CTP staff will work with partners to seek additional funding to support Reserve priorities. Potential partners could include GOMA, USFWS, NOAA, USEPA, MDMR, MDEQ and MASGC.

1-3: Grand Bay NERR natural resources, activities, products and services are valued by targeted audiences or user groups

Strategies/Actions

- The CTP staff will distribute the results of Reserve research, stewardship and education projects to applicable resource management audiences and decision-makers.
- The CTP staff will use the unique habitats of the Reserve and management activities at the Reserve as field components to training activities when applicable.
- The CTP staff will facilitate a bi-annual Grand Bay Research Symposium

highlighting Grand Bay research and monitoring efforts with researchers, coastal resource managers and the public.

1-4: Grand Bay Coastal Resources Center facility reservations will increase by 5% annually

Strategies/Actions

- The CTP staff will promote and encourage the use of facilities by partners, decision-makers, civic groups and other organizations.

Goal 2: Scientific understanding and knowledge informs the management of coastal resources and ecosystems.

Objectives:

2-2: Grand Bay NERR flora, fauna and ecological conditions are monitored and data are used to improve resource management

Strategies/Actions

- The CTP staff will integrate the results of Grand Bay research and stewardship projects relating to Reserve priorities to applicable resource management audiences through professional sharing, workshops, printed materials, web site and social media.

2-4: By 2015, Grand Bay NERR staff, 10 researchers and/or coastal managers are engaged with the Reserve to monitor and study how locally relevant climate impacts effect natural communities

Strategies/Actions

- The CTP staff, through a variety of platforms, will share the results of science-based information and specific Reserve research and monitoring relating to climate change and sea level rise with management audiences. Training topics may include: planning for climate change, climate change communication, climate change adaptation, conducting climate change vulnerability assessments and the science of climate change.
- The CTP staff will work with partners to present relevant data and information to local communities on potential effects of climate change and sea level rise on natural and manmade communities.
- The CTP staff will provide audiences with information and tools to better

understand, adapt and mitigate the effects of climate change.

Goal 3: Local communities appreciate and value the significance of coastal ecosystems.

Objectives:

3-1: Seventy-five percent of people participating in Grand Bay NERR programs recognize the importance of coastal resources and Reserve areas of focus

Strategies/Actions

- The CTP staff will assist local communities working with partnerships to provide expertise/advise, workshops and information on funding opportunities to address local resource management issues.
- The CTP staff will facilitate a biannual Legislative Day at the Reserve to highlight programs and activities by engaging state and federal elected officials/representatives.
- The Reserve staff will host a meeting of the Mississippi Commission on Marine Resources.
- The CTP staff will distribute press releases to local media regarding CTP activities to coastal markets such as Biloxi, Pascagoula and Mobile.
- The CTP staff will inform the public of activities through the MDMR and Grand Bay NERR newsletters.
- The CTP coordinator will make presentations at local government meetings and to professional organizations relating to CTP activities and Reserve priorities (e.g. Jackson County Board of Supervisors, Moss Point City Council, Mississippi Commission on Marine Resources, etc.)

3-4: Annually, Grand Bay NERR supports opportunities for volunteer involvement and will seek to increase participation from the previous year

Strategies/Actions

- The CTP staff will provide citizen/student volunteer opportunities assisting with coastal training activities. Examples of training- related volunteer opportunities may include compiling materials for use at workshops, assisting with hosting workshops and assisting to compile results of surveys

and evaluations.

Goal 4: Local communities will make improved science-based decisions regarding management of coastal resources and watersheds.

Objectives:

4-1: Seventy-five percent of local decision-makers participating in Reserve training programs use scientific knowledge and expertise to make informed coastal management decisions

Strategies/Actions

- The CTP will offer at least eight workshops per year that address the scientific and skill needs of local decision-makers. These workshops will foster informed local decision-making by transferring relevant science-based information, tools and skill building opportunities to targeted audiences. The primary targeted audiences are local officials and staff, resource managers and coastal scientists.
- The CTP staff will design training events to focus on Reserve priorities and local resource management issues.
- CTP workshops will be designed to encourage and facilitate networking between participants.
- The CTP staff will seek to provide decision-makers with the information and training needed to make science-based, informed resource management decisions relating to local issues.
- The CTP staff will provide participants with information regarding funding opportunities to address resource management needs.

4-2: Seventy-five percent of local decision-makers participating in education or training activities have an increased understanding of coastal resources/ management issues

Strategies/Actions

- CTP workshops will include post-event evaluations that are used to assess participant's achievement of short-term outcomes relating to the training.
- The CTP staff will seek feedback from workshop participants regarding the mid- and long-term outcomes relating to the use of workshop information.
- The CTP staff will use results of post-event surveys to improve future workshop offerings.

4-3: Partnerships support and contribute to 25% of Grand Bay NERR's coastal decision-maker training workshops

Strategies/Actions

- The CTP coordinator will seek out subject-matter experts with excellent communication skills when developing workshops and other events.
- The CTP staff will provide 25 workshops and training programs that use Reserve or partner specific research and monitoring/stewardship data or expertise to address Reserve priorities.
- The CTP coordinator will seek partners to co-sponsor workshops. Partnerships could serve to provide meeting space, access to expert speakers, meeting facilitation, lodging for participants, travel support, workshops supplies and participant refreshments, etc.

XIII. References

Bricker, S., B., Longstaff, W. Dennison, A. Jones, K. Boicourt, C. Wicks, and J. Woerner. 2007. Effects of nutrient enrichment in the Nation's Estuaries: A decade of change. NOAA Coastal Ocean Program Decision Analysis Series No. 26. National Centers for Coastal Ocean Science, Silver Spring, Maryland. 328 pp.

Brown, G.F., V.M. Foster, R.W. Adams, E.Wm. Reed, and H.D. Padgett, Jr. 1944. Geology and ground-water resources of the coastal area in Mississippi. Mississippi Geology Survey Bulletin 60:1-166.

Coastal Environments, Inc. 1992. Mississippi coastal zone nearshore water quality assessment. Prepared for the Mississippi Department of Wildlife, Fisheries, and Parks, Bureau of Marine Resources, Biloxi, Mississippi.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Biological Services Program. Report FWS/OBS-79/31. 103 pp.

Dethier, M.N. 1992. Classifying marine and estuarine natural communities: an alternative to the Cowardin System. Natural Areas Journal 12(2):90-99.

Grand Bay National Estuarine Research Reserve (Grand Bay NERR). 2012. Coastal Training Program: 2012-2017 Program Strategy (Draft). Grand Bay National Estuarine Research Reserve, Mississippi Department of Marine Resources, Moss Point, Mississippi. 14 pp.

Grand Bay and Weeks Bay National Estuarine Research Reserves (NERRs). 2010. Selected plants of coastal Mississippi & Alabama. Grand Bay National Estuarine Research Reserve, Mississippi Department of Marine Resources, Moss Point, Mississippi. 161 pp.

Mississippi Gulf Coast National Heritage Area (MGCNHA). 2013. http://www.msgulfcoastheritage.ms.gov. Accessed 7 February 2013.

National Oceanic and Atmospheric Administration (NOAA)/National Estuarine Research Reserve System (NERRS). 2010. National Estuarine Research Reserve System Strategic Plan 2011-2016. National Oceanic and Atmospheric Administration, Estuarine Reserves Division, Washington DC. 12 pp.

National Oceanic and Atmospheric Administration (NOAA)/National Estuarine Research Reserve System (NERRS). 2011. National Estuarine Research Reserve System System-wide Monitoring Program Plan. National Oceanic and Atmospheric Administration, Estuarine Reserves Division, Washington DC. 44 pp.

National Oceanic and Atmospheric Administration (NOAA)/National Estuarine Research Reserve System (NERRS). 2012a. National Estuarine Research Reserve System Research and Monitoring Plan: 2012-2017. National Oceanic and Atmospheric Administration, Estuarine Reserves Division, Washington DC. 18 pp.

National Oceanic and Atmospheric Administration (NOAA)/National Estuarine Research Reserve System (NERRS). 2012b. Sentinel Sites Program Guidance for Understanding Climate Change Impacts (Draft: Marsh 2012). National Oceanic and Atmospheric Administration, Estuarine Reserves Division, Washington DC. 20 pp.

National Oceanic and Atmospheric Administration (NOAA)/National Estuarine Research Reserve System (NERRS). 2012c. Climate Change Implementation Plan. National

Oceanic and Atmospheric Administration, Estuarine Reserves Division, Washington DC. 16 pp.
National Oceanic and Atmospheric Administration (NOAA)/Office of Ocean and Coastal Resource Management (OCRM). 2008. Final Evaluation Findings - Grand Bay National Estuarine Research Reserve: March 2004 – November 2007. National Oceanic and Atmospheric Administration, National Ocean Service, Office of Ocean and Coastal Resource Management, Washington, DC. 44 pp.
Otvos, E.G. 2007. Geological framework and evolutionary history. Pages 22-46 *in* Grand Bay National Estuarine Research Reserve: An ecological characterization (Peterson, M.S., G.L. Waggy, and M.S. Woodrey, editors). Grand Bay National Estuarine Research Reserve, Mississippi Department of Marine Resources, Moss Point, Mississippi.
Otvos, E.G., Jr. 1972a. Pre-Sangamon beach ridges along the northeastern Gulf Coast – fact or fiction? Gulf Coast Association of Geological Societies Transactions 22:223-228.
Otvos, E.G., Jr. 1972b. Mississippi Gulf Coast Pleistocene beach barriers and the age problem of the Atlantic-Gulf Coast "Pamlico"-"Ingleside" beach ridge system. Southeastern Geology 14:241-250.
Otvos, E.G., Jr. 1973. Geology of the Mississippi-Alabama coastal area and nearshore zone. New Orleans Geological Society Guidebook. 67 pp.
Peterson, M.S., G.L. Waggy, and M.S. Woodrey (Editors). 2007. Grand Bay National Estuarine Research Reserve: An ecological characterization. Grand Bay National Estuarine Research Reserve, Mississippi Department of Marine Resources, Moss Point, Mississipi. 268 pp.
Stedman, S. and T.E. Dahl. 2008. Status and trends of wetlands in the coastal watersheds of the Eastern United States 1998 to 2004. National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Department of the Interior, Fish and Wildlife Service, Washington DC. 32 pp.
U.S. Fish and Wildlife Service. 2008. Grand Bay National Wildlife Refuge Comprehensive Conservation Plan. U.S. Department of the Interior, Fish and Wildlife Service, Southeast Region, Atlanta, Georgia. 156 pp.
United States Global Climate Research Program (USGCRP). 2009. Global Climate Change Impacts in the United States.
Whiteley, K. 2010. Needs assessment report for Jackson County, MS schools. Mobile, Alabama. 31 pp.
Wieland, R.G. 1994. Marine and estuarine habitat types and associated ecological communities of the Mississippi Coast. Mississippi Museum of Natural Science, Jackson, Mississippi. Museum Technical Report 25. 270 pp.
Wieland, R.G. 2007. Habitat types and associated ecological communities of the Grand Bay National Estuarine Research Reserve. Pages 103-147 *in* Grand Bay National Estuarine Research Reserve: An ecological characterization (Peterson, M.S., G.L. Waggy, and M.S. Woodrey, editors). Grand Bay National Estuarine Research Reserve, Mississippi Department of Marine Resources, Moss Point, Mississippi.
Woodrey, M.S., and J. Walker. 2011. Selected birds of the Grand Bay National Estuarine Research reserve and vicinity. Grand Bay National Estuarine Research Reserve, Mississippi Department of Marine Resources, Mississippi Department of Marine Resources, Moss Point, Mississippi. 124 pp.