Coastal Wetlands Initiative: Gulf of Mexico Review

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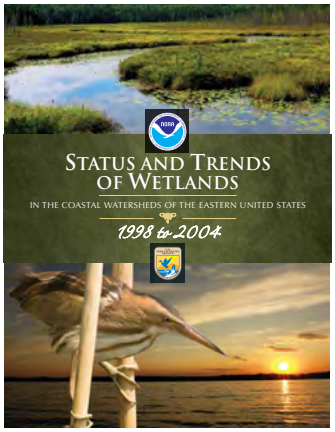
National Picture

Coastal wetlands provide important ecosystem services that are vital to the health and well-being of our nation. They serve as buffers, protecting coastal areas from storm damage and sea level rise. They are vital to the health of commercially and recreationally important fisheries resources, providing food and essential fish and shellfish habitat. Wetlands also serve as nesting and foraging habitat for birds and other wildlife. As "living filters," wetlands improve water quality by removing pollutants, nutrients, and sediments. Furthermore, coastal wetlands provide direct value to people in other ways, such as minimizing erosion of upland, protecting property and infrastructure and supporting the tourism, hunting, and fishing sectors of the economy.

There are a number of threats to coastal areas, in particular wetland habitats. The most significant threats include conversion of wetlands to other land uses and climate change, in particular, sea level rise and increases in hurricane intensity and frequency. In some regions, wetlands are being converted to open water due to land subsidence.

Numerous recent reports have examined coastal wetland loss and potential strategies to address threats like climate change. The Association of State Wetland Managers (ASWM, 2009) recommended a national wetland and climate change initiative. The report contains measures to reduce impacts and adapt coastal/estuarine wetlands to climate change. The U.S. Army Corps of Engineers (Army Corps) and the National Oceanic and Atmospheric Administration (NOAA) both published frameworks to guide how they will consider impacts of climate change and sea level rise as they implement restoration activities, including those in coastal wetlands (Army Corps, 2009; NOAA, 2010a).

NOAA and the U.S. Fish and Wildlife Service (USFWS) analyzed the status and trends of wetland acreage along the Atlantic Coast, Gulf of Mexico, and the Great Lakes to provide an estimate of losses or gains that occurred in those coastal watersheds. Their report, released in 2008, found that 361,000 acres of coastal wetlands were lost in the Eastern United States alone between 1998 and 2004 (Stedman and Dahl, 2008). This amounts to an average net decrease of 59,000 acres each year. The vast majority of the loss (82 percent) occurred in freshwater wetlands, both tidal and non-tidal. Nearly 60 percent of the total loss of coastal freshwater wetlands is attributed to "other development," which includes conversion of wetlands to unknown or undetermined land uses (Figure 1). There were also losses of saltwater tidal wetlands to open water (deeper than 2 meters), particularly in the Mid-Atlantic region. The 2008 NOAA and USFWS Status and Trends report did not examine the loss of wetland condition or function.



In response to these reports, EPA established a two-part Coastal Wetlands Initiative. The first part is the Coastal Wetlands Team, which is a joint effort between NOAA's National Marine Fisheries Service, Office of Habitat Conservation and EPA's Wetlands Division and the Oceans and Coastal Protection Division. The team's goals are: 1) confirming wetland loss and better understanding contributing stressors; 2) identifying and disseminating tools, strategies, policies, and information to protect and restore coastal wetland resources; and 3) raising awareness of the functions and values of coastal wetlands, threats to these resources, and opportunities to protect and restore coastal wetlands. To achieve its goals, the Coastal Wetlands Team met with stakeholders in the Mid-Atlantic, South Atlantic, Gulf of Mexico, and North Atlantic regions (see Figure 2). For each of these Coastal Wetland Reviews (CWRs), the team identified key stressors; examined regulatory and voluntary efforts at the federal, regional, state, and local level to reduce or reverse

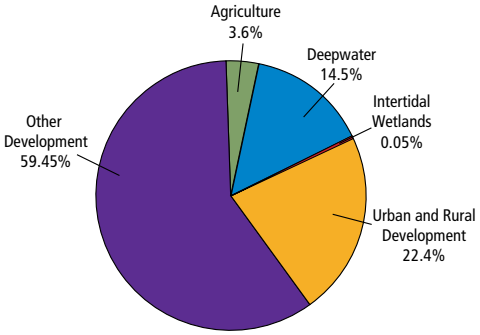
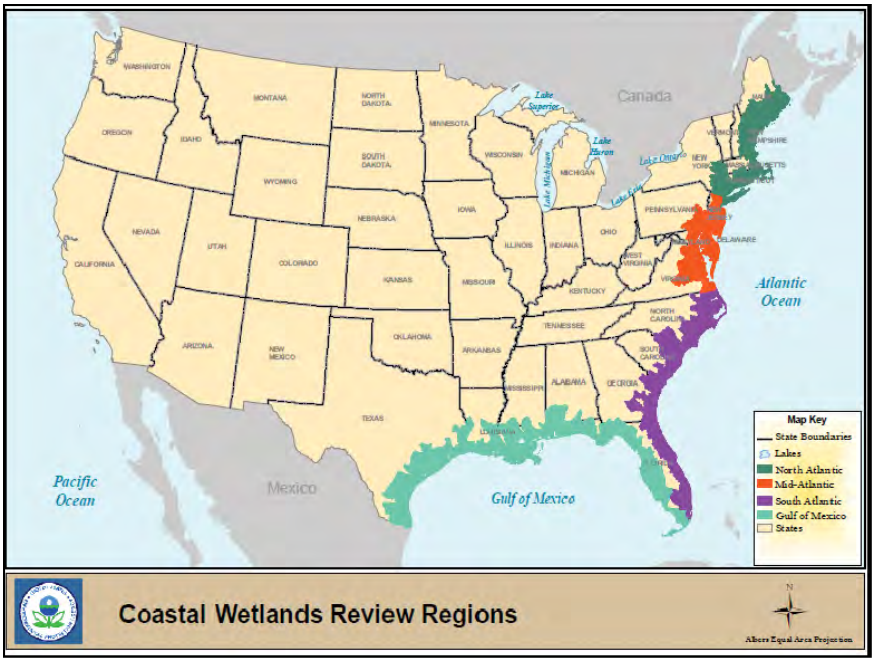


Figure 1. Wetland loss and changes in land cover, 1998-2004: Atlantic, Gulf of Mexico, and Great Lakes. *Source: Stedman and Dahl, 2008.*



Consistent with other federal agencies, EPA is defining "coastal wetlands" as saltwater and freshwater wetlands* within HUC-8 watersheds that drain to the Atlantic, Pacific, or Gulf of Mexico. "Coastal wetland loss" is defined as "a decline in the areal extent and/or ecological integrity of wetlands in coastal watersheds." (Figure 2).**

Figure 2. Coastal wetlands regions identified in EPA's Coastal Wetlands Initiative.

coastal wetland loss; and assessed whether successful strategies can be replicated elsewhere. The information from the reviews could be used to help inform policy decisions, influence program direction, and develop projects to reduce or reverse coastal wetland loss nationally. The results of these CWRs are provided in a report distributed to the respective participants, and will also be posted on EPA's and NOAA's websites. This document is the CWR report for the Gulf of Mexico region.

The second part of the Coastal Wetlands Initiative is the federal Interagency Coastal Wetlands Workgroup, which is composed of members from EPA, NOAA, USFWS, the U.S. Geological Survey, the U.S. Department of Agriculture's Natural Resources Conservation Service, the Army Corps, and the Federal Highway Administration. The Interagency Coastal Wetlands Workgroup serves in an advisory capacity to the Coastal Wetlands Team by helping to identify CWR watersheds, participating in the CWR on-site discussions, and providing input on the reports.

Coastal Wetland Regional Reviews

EPA and NOAA conducted these CWRs to identify and better understand the stressors on coastal wetlands and the strategies needed to protect and restore them. The Coastal Wetlands Team is interested in identifying the cause(s) of losses in the areal extent of wetlands, as well as examining losses in wetland function and/or ecological integrity. Though quantifiable data on functional loss are limited in availability, EPA and NOAA recognize that it is an issue in many watersheds and included qualitative information to reflect this concern where appropriate. EPA and NOAA coordinated with the Interagency Coastal Wetlands Workgroup and stakeholders to gather information on available tools and strategies used to address wetland function and condition within the region(s) of interest. The CWRs and the subsequent regional reports will not be used to evaluate specific wetland assessment tools or methodologies, but rather to describe which tools are being used and discuss participants' views on their experiences and relative success with such tools.

The purpose of the CWRs is to facilitate dialogue among stakeholders who share a vested interest in coastal wetland resource protection such that continued local, regional, and national efforts to stem coastal wetland losses can be increasingly effective. They are not considered a commitment of future resources to address issues identified during the review process. Each CWR is intended to provide information on a particular focal watershed or region and should not be considered a final assessment of the study area. Instead, each review should be considered a baseline reconnaissance to aid in moving the entire Coastal Wetlands Initiative forward.

This report contains points raised during the course of the discussions with stakeholder groups. Participants were afforded an opportunity to comment on CWR notes and draft reports in order to provide the broadest perspective possible. The Coastal Wetlands Team supplemented these perspectives with documentation (e.g., relevant references, citations), but it was not possible to do so for every comment provided. Thus, the information presented in this report cannot be considered the definitive and most comprehensive presentation of issues within the region or within specific focal watersheds. Instead, it can serve as a starting point for identifying priority stressors,

* For the purposes of this initiative, "wetlands" means those areas meeting the definition of wetlands in: Cowardin, L., et al. 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS 79/31. 131 pp.
** EPA recognizes that there are limited quantifiable data currently available regarding loss of wetland ecological integrity.

tools and strategies to address them, and key information and data gaps that need to be filled in order to reduce wetland loss in the future.

The process for the CWRs was intended to be flexible and encouraged participation from a diverse and representative group of stakeholders in each of the focal watersheds. Four steps were followed for each CWR:

1. Identify focal watersheds.

USFWS identified candidate watersheds for the CWRs based on observed wetland loss in the USFWS/NOAA Status and Trends report. These are generally areas where the most wetland loss has occurred, due to development, other human actions, or where losses were attributed to inundation or other coastal processes.

The Coastal Wetlands Team further refined this larger candidate watershed to focus in on specific eight-digit HUC watersheds ("HUC 8 watersheds"). The focal watersheds selected for analysis are based on existing wetland conditions assessments, available data, a variety of efforts to protect and restore coastal wetlands, and the willingness of local stakeholders to participate.

The HUC 8 watersheds identified may correspond directly to National Estuary Program (NEP) study areas (the geographic boundary in which the NEPs work to improve estuary health). In other words, the CWRs often occur in the same watersheds as the NEP study areas or a sub-set thereof.

NEPs provide an effective mechanism to assist the CWRs in a few important ways. They consist of broad-based stakeholder groups that work in close partnership to protect and restore habitats in their study area. These groups represent a wide range of interests and expertise at local, state, and federal levels (e.g., general public, state natural resource agencies, academics, local governments, watershed groups). EPA and NOAA use stakeholder lists from the NEPs along with contacts provided by the Interagency Coastal Wetlands Workgroup to invite participants to attend the CWRs.

NEPs and their partners create and implement a management plan that is based on scientific characterization of the study area, and contains actions to address habitat loss and modification. This characterization is a collection of scientific information that includes an assessment of extent and condition of habitats such as wetlands. These data can help provide key information for the CWR assessments and reports.

2. Conduct a review of current, readily available information.

For the selected review area, the Coastal Wetlands Team gathered more specific existing information on coastal wetland loss, stressors contributing to coastal wetland loss, tools and strategies used to protect and restore coastal wetlands, and key information gaps that, if addressed, could help reverse the trend of wetland loss. Information was gathered from the Internet, reports provided by the "host" organization, and CWR invitees or participants in advance of the local stakeholders discussions. In addition, to estimate coastal wetlands loss, the Coastal Wetlands Team consulted with NOAA's Coastal Change Analysis Program (C-CAP), which uses satellite imagery to measure land cover change in coastal areas. The Team also requested permit data from the Army Corps and state agencies, where applicable, in order to quantify authorized losses and associated mitigation gains for wetlands which are under the jurisdiction of Section 404 of the federal Clean Water Act (CWA) or similar state programs. When made available by the relevant agency, these data were provided in the CWR report. Due to database limitations, permit data provided by the Army Corps did not cover the same time frame as C-CAP (1996-2006) and therefore it was not possible to compare the magnitude of losses identified by each. See Appendices C and D for more information on the CWA Section 404 program and C-CAP, respectively.

NEPs are already employing a variety of efforts to protect and restore wetlands. NEPs can assist by: 1) convening the appropriate stakeholders to participate in the CWRs, 2) providing scientific data on wetland conditions in their study areas, and 3) providing a strong platform and scientific understanding to support the CWRs.

3. Conduct stakeholder discussions.

EPA and NOAA sought an entity to serve as the "host" of each review and to help identify a broad range of local stakeholders to participate in the discussions. The host organization (such as an NEP) helped to arrange the meeting logistics and used their partnerships to invite all the appropriate participants to that dialogue. Invited participants included a

broad cross-section of business, environmental, academic, and government representatives. Invitee lists were collected from the organization hosting the event, as well as suggestions from the Interagency Coastal Workgroup (which includes their regional representatives).

The Coastal Wetlands Team convened a stakeholder forum of the invitees in each selected focal watershed. These one- or two-day facilitated dialogues provided additional insights about on-the-ground (existing) condition of coastal wetlands within the focal watershed and growing pressures within the region; i.e., issues often best identified by those with the most vested interest in the outcome of such efforts. Attendees were asked to provide information on threats to coastal wetlands (including reduction in acreage as well as function and conditions) and tools and techniques used locally to reduce or reverse wetland loss. The term "stressor" was not defined for participants in advance of the reviews. While stressors are traditionally limited to "physical, chemical, or biological entities, or processes that adversely affect the ecological condition of a natural ecosystem" stakeholders in every CWR also identified programmatic issues as stressors related to loss or degradation of coastal wetlands. While state and federal regulatory programs are tools for wetland protection, limits to regulation are captured in the report under the "Stressors" sections in accordance with commonly expressed stakeholder input. A neutral facilitator captured the discussion in meeting notes. While there may be disagreements among parties regarding the validity of the data presented or provided, EPA and NOAA considered all documented sources of information and recognized that reference documents would not be available for all points raised by participants in the discussion.

To coincide with the stakeholder discussions, site visits were scheduled to nearby wetland protection, restoration, or mitigation projects when feasible. This enabled EPA and NOAA to obtain a firsthand view of local stressors or approaches being employed to address wetland loss in that watershed. Collection and analysis of raw field data is outside the scope of these field visits.

4. Assemble a coastal wetland regional review summary.

Once the notes from the stakeholder discussions were vetted with the participants, they were combined with the available data collected in Step 2 to form the basis of a regional report. Although these reports are not exhaustive and only reflect readily available, existing documentation and the viewpoints of participating stakeholders, EPA and NOAA believe they are a good indicator or snapshot of wetland issues in the focal watersheds.

The results of the Gulf of Mexico review are summarized below and are also presented in Tables 1 and 2, and in the "Conclusion" section of this report:

- Major stressors:
  - » Development pressure and its associated impacts (stormwater runoff, shoreline armoring).
  - » Hurricanes and storms.
  - » Hydrologic modifications (channelization, diversion, and dredging).
  - » Resource extraction (groundwater, oil, and gas).
  - » Limited estuarine marsh retreat opportunities in the face of sea level rise.
  - » Subsidence, which was noted as a significant issue in the past, but has become less pronounced today.
- Major tools and strategies:
  - » Beneficial use of dredged material to restore wetlands.
  - » Watershed-based planning for wetlands protection, mitigation, and restoration.
  - » Conservation of existing coastal wetlands through direct purchase of land or through conservation easements.
  - » Property buyouts to remove buildings from flood-prone areas and restore the floodplain to its natural state.
  - » The development of a CWA regional general permit for living shorelines.

- Major gaps:
  - » Outreach and education of both the public and local/regional decision-makers.
  - » Resources (staffing and funding) for regulatory programs, monitoring and assessment, and outreach.
  - » Widespread use and implementation of watershed-based plans and land use planning.
  - » Clarifying CWA jurisdiction and applying results from new studies to isolated wetlands protection (in Texas in particular).
  - » High-resolution aerial photography and mapping of coastal areas to accurately characterize coastal wetland losses and to assist in enforcement.
  - » Accessible database of authorized wetlands impacts/mitigation to compare total losses to authorized losses.
  - » Watershed-based mitigation and customized mitigation approaches based on the wetland type impacted.

Gulf of Mexico Review

The Gulf of Mexico coastline stretches approximately 1,631 miles from the tip of the Gulf-facing coast of Florida west to the border of Texas and Mexico. The Gulf of Mexico region is home to a diverse array of coastal wetlands, from Florida's freshwater Everglades to Texas's estuarine marshes. The coastal watersheds in the region contain 15.6 million acres of wetlands (Stedman and Dahl, 2008). Within this region, the Interagency Coastal Wetlands Workgroup chose two areas for review: the East and West Galveston Bay watersheds in Texas (HUC 12040202 and 12040204) and the Mississippi Coastal watershed (HUC 03170009) in Mississippi and Alabama (see Figures 4 and 17).

The Gulf of Mexico's coastal wetlands are an important economic resource, a critical habitat to a variety of species, and a means of shoreline protection from storms and hurricanes. Numerous rare and endangered bird species depend on the freshwater marshes in Florida, Louisiana, and Texas. Some species, such as the endangered whooping crane, use these coastal marshes as their sole wintering ground (Twilley et al., 2001). Almost 70 percent of waterfowl migrating along the Central and Mississippi flyways winter in the coastal marshes of Louisiana, including the gadwall, green-winged teal, northern shoveler, and snow goose (Bellrose and Trudeau, 1988; as cited in Louisiana Coastal Wetlands Conservation and Restoration Task Force, 2010). Alabama contains the second largest number of federally threatened and endangered species in the contiguous United States (many of which are found in the coastal watersheds), including the Alabama beach mouse, American alligator, piping plover, Alabama red-bellied turtle, and Gulf sturgeon (ELI, 2008; USFWS, 2012).

A diverse assemblage of fish relies on coastal wetlands as nursery areas and as habitats to feed and reproduce. Brown shrimp, blue crab, red drum, spotted sea trout, southern flounder, and Gulf menhaden are just a few of the species that rely on Gulf coastal habitats. Many of these species are economically significant for the area. Commercial fishing is a billion dollar industry for some states, and 97 percent (by weight) of the fish and shellfish caught by U.S. fishermen in the Gulf of Mexico are dependent on estuaries and wetlands at some point in their life cycle (Lellis-Dibble et al., 2008). In 2010 alone, ports in the Gulf region took in more than $639 million worth of commercial fish and shellfish, or 14 percent of total national catch value (NMFS, 2011a). The Gulf region led in oyster and shrimp production, with 55 percent of the national total of oyster meat coming from the region and 68 percent of the national total of shrimp brought to shore for sale. Recreational fishing is an important component of the Gulf region coastal economy as well. Recreational fishing expenditures in the five Gulf States total almost $9.5 billion, with Florida and Texas ranked as the states with the most anglers and highest recreational fishing-related expenditures (USFWS, 2006). These expenditures include money spent on travel, lodging, food, equipment, and other related expenses such as licenses and permits for recreational fishing.

The unique combination of regional and global climate factors in the Gulf region increases the importance of coastal wetlands. Hurricanes and tropical storms, which are prevalent in this region, erode shorelines and cause flooding and wind damage to properties and infrastructure. Climate models predict an increased frequency and intensity of hurricanes in the Atlantic as ocean temperatures rise (UGSCRP, 2009). Wetlands can lessen hurricane damage by reducing wind energy and buffering the impacts of storm surge (Twilley, 2007).

Often, artificial hydrologic modifications impede the ability of wetlands to migrate inland and abate flooding. Levees, dams, and dikes change the source, quality, or quantity of water and sediment that is available to coastal ecosystems, which restricts the ability of coastal wetlands to survive (Day et al., 2000, 2007; Martin et al., 2000; EPA, 1987).

Gulf of Mexico Wetland Stressors

The Gulf States have suffered a high amount of coastal wetland loss over the last century, threatening the wildlife, economy, and resilience of the entire Gulf coastal region. Land loss in coastal Louisiana has been studied most intensively; a recent report by the U.S. Geological Survey (Couvillion et al., 2011) documented 1,833 square miles (1.2 million acres) of land loss from 1932 to 2010, and a more recent annual loss from 1985 to 2010 of 10,605 acres per year. A majority of the land loss tracked in this report is tidal wetlands. Studies also exist for other states, including Mississippi and Texas, where the CWR focal watersheds are located. Before the 1800s, Mississippi had nearly 10 million acres of wetlands. Nearly 60 percent of that acreage has since been lost, including 10,000 acres of salt and brackish marshes (MDEQ, 2007). Wetlands in the Texas coastal plain decreased by 200,000 acres between the mid-1950s and the early 1990s. The greatest losses were of freshwater emergent and forested wetlands (Moulton et al., 1997).

Using the remote sensing and mapping methodology of NOAA's Coastal Change Analysis Program (C-CAP), losses of wetlands in the Gulf of Mexico coastal watersheds from 1996 to 2006 were estimated at approximately 256,100 acres, or an annual average loss of approximately 25,610 acres. This methodology measures only changes in wetland acreage and does not measure change in wetland function (see Appendix D for more information on C-CAP methodology). Conversion to open water accounted for more than a third of those losses, while about 40 percent of the loss was attributed to development and bare land (often a precursor to development), and another 25 percent was attributed to agriculture (which includes pasture) (Figure 3).

Numerous stressors contribute to coastal wetland acreage and functional loss in the Gulf region. Some of the common stressors mentioned in the literature (see Appendix B) are listed below:

- Coastal development resulting in upland conversion, nonpoint and point source pollution, and shoreline hardening.
- Hurricanes and storms.
- Hydrologic modifications, including channelization, surface water diversions, and dredging.
- Agriculture and silviculture practices.
- Resource extraction, including groundwater pumping and oil and gas extraction.
- Limited estuarine marsh retreat opportunities in the face of sea level rise.
- Invasive species.

Rapid population growth is one of the catalysts for stressors on the Gulf region's coastal wetlands. The population of coastal counties in the Gulf region has increased 150 percent from 1960 to 2008, and in 2010 Texas was identified as the state with the fifth fastest growing population (U.S. Census Bureau, 2010). Review participants identified the limited ability of existing regulations to address the projected increase in coastal development as an associated stressor. While many activities may not be regulated by the federal government, state and/or local governments could develop and implement regulations to address these impacts.

Storms and hurricanes are another stressor causing coastal wetland acreage loss in the Gulf region. Hurricanes Katrina and Rita affected coastal Louisiana and surrounding areas in August 2005, and Hurricane Ike struck the coast of Galveston, Texas, in September 2008. These storms caused heavy damage and flooding along the coast, including damage to coastal wetlands. Coastal Louisiana lost approximately 200 square miles of coastal wetlands between October 2004 and October 2005, although it should be noted that this includes some transitory loss which is likely to be recovered within a few growing seasons (Barras, 2006).

In both of the Gulf region focal watersheds, hydrologic alterations were noted as another major stressor causing wetland losses. One of the limiting variables associated with wetland growth is consistent inflow of sediment and nutrients; however, natural riverine input to most of the Gulf of Mexico has been impacted by artificial flood controls, resulting in a decrease in the sediment and nutrients needed for wetlands

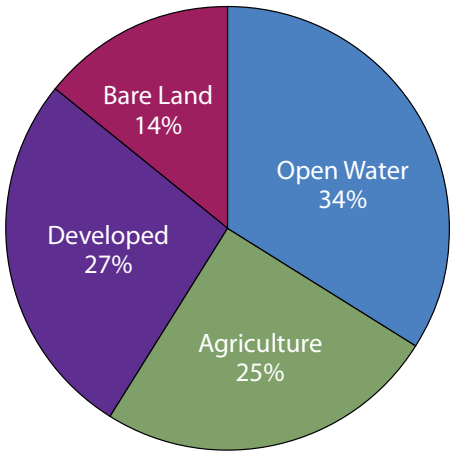


Figure 3. Wetland loss and changes in land use, 1996-2006: Gulf of Mexico.
Source: NOAA, 2011a.

to survive (Ko and Day, 2004). The movement and deposition of sediment can be impeded by a variety of flood control mechanisms (Louisiana Sea Grant, 2010). These structures can also restrict freshwater flow, which in turn can allow toxic metals and organics to accumulate. In addition, the creation of channels and canals, often the result of activity by the gas and oil industry, can lead to saltwater intrusion, which can destroy freshwater marshes (Ko and Day, 2004).

Oil and gas extraction were also identified as stressors in the literature. Oil spills can occur as a result of that activity. In 2010, the Deepwater Horizon spill released the equivalent of almost 5 million barrels of oil into the Gulf marine and coastal environment. While the impacts from the spill have not been fully assessed, the damage done to ecologically, commercially, and recreationally valuable habitats and species is clearly extensive. The spill resulted in the oiling of over 1,000 miles of shoreline, including 400 miles of intertidal marsh in Louisiana, and a countless number of marine species in the spill's path (Deepwater Horizon Natural Resource Trustees, 2012).

Gulf of Mexico Tools and Strategies

Constituencies in the Galveston Bay and Mississippi Coastal watersheds are working with available tools and strategies to manage and conserve coastal wetlands and improve coastal resilience. The Gulf States manage coastal wetlands stressors using both regulatory and non-regulatory tools and strategies.

Various state-level regulatory activities complement federal wetland protection offered by the CWA Section 404 program (see Appendix C for more information on CWA Section 404). Louisiana, Mississippi, and Alabama have varying degrees of state regulation of wetlands in the coastal zone (e.g., Louisiana's Coastal Use Permit, Mississippi's Coastal Wetlands Protection Act, and Alabama's Coastal Area Management Program). Florida has a comprehensive state wetlands management program authorized by state statute, called the Environmental Resources Permit Program.

Watershed planning is beginning to be used as a tool in both focal watersheds to control the impacts from development and identify areas appropriate for mitigation. Galveston Bay, which is part of EPA's National Estuaries Program, has its own Comprehensive Conservation and Management Plan (CCMP) in place to guide conservation and restoration efforts at the watershed scale.

All of the Gulf States except Florida are involved with the federal Coastal Impact Assistance Program (CIAP), which is managed by the U.S. Department of the Interior and authorizes funds for conservation, protection, and preservation of coastal areas, including wetlands. In addition, all the Gulf States use a variety of land conservation programs, including the Natural Resources Conservation Service (NRCS) Wetlands Reserve Program and many active local and regional land trusts. In the wake of Hurricane Katrina, Mississippi has undertaken a variety of projects funded by Congress to improve coastal resilience (Mississippi Coastal Improvement Program). This 1.4 billion dollar effort has become central to coastal wetland restoration, protection, and creation in the state. Wetland conservation has been an important component of the efforts underway in Galveston, Texas, through state and federal grants and the work of local land trusts. Additionally, in both the Galveston and Mississippi focal watersheds, sediment dredged from federal navigation projects is being beneficially reused for wetland restoration and beach nourishment.

Managers in both watersheds have used living shorelines as an alternative to hardened structures (e.g., seawalls, revetments) to protect shorelines and coastal wetlands from sea level rise and storm-associated erosion. The Army Corps Mobile District completed a living shoreline CWA Regional General Permit for the Alabama coast in 2012, and a Mississippi Regional General Permit is being completed as of the date of this publication.

The work of regional organizations like the Gulf of Mexico Alliance will continue to improve coastal wetland management across all the Gulf States as it conducts critical research related to ecosystem services and establishes the groundwork for regional coastal and marine planning.

Gulf of Mexico Gaps and Needs

Based on data collected from available sources, and discussions with review participants, the following gaps and needs were identified for the Galveston Bay and Mississippi Coastal watersheds:

- Outreach and education of both the public and decision-makers, which will allow for more effective planning, conservation, and management at both the state and local level.
- Resources (staffing and funding), which are needed to administer regulatory programs, conduct monitoring and assessment, and conduct effective outreach programs.
- Widespread use and implementation of watershed-based plans to enhance strategic wetland protection and selection of mitigation sites.
- Mapping and aerial photography of coastal areas, which would aid in tracking losses and provide a tool to assist enforcement efforts.
- Consistent application of compensatory mitigation approaches, which compensate for lost functions not only within the watershed, but as close as practicable to the impacts that are authorized.

Tables 1 and 2 summarize key stressors, tools and strategies to address them, and gaps and needs for both focal watersheds in the Gulf of Mexico region.

Table 1. Stressors, Tools and Strategies, and Gaps Identified by Participants During the Galveston Bay CWR

Stressors	Tools and Strategies	Gaps and Needs
Coastal development • **Nonpoint source pollution** • **Shoreline hardening**	• Compensatory mitigation • Watershed plans • Conservation easements • Property buyouts of repeatedly flooded land • Total Maximum Daily Loads (TMDLs)	• Widespread land use planning • Widespread use of watershed plans • Outreach and education (for the public and local decision-makers) • Detailed wetland mapping • Collaboration • Incentives for conservation • Mitigation monitoring
Limitations of regulations	• Land management and conservation programs • Research on hydrologic nexus • Rolling easements	• Clarifying CWA jurisdiction (particularly by conducting scientific studies on geographically isolated wetlands) • Integrated mapping, monitoring, and data collection system (including accessible database of authorized wetland impacts/ mitigation, and other CWA Section 404 permit data) • Locating compensatory mitigation in the same watershed and as close to the coast as the impacts that are authorized • State and/or local regulatory and incentive programs • Sustained funding for studies to better understand wetland functions, values, and loss • Outreach and education • Stronger enforcement (including high-resolution aerial photography to track losses and assist in enforcement)
Hydrologic alterations • **Channelization** • **Dredging** • **Water withdrawal**	• Beneficial use of dredged material • Flood districts • Subsidence districts • Regional sediment management plans	• Increased collaboration • Reduction of regulatory barriers to beneficial use of dredged material
Climate change and sea level rise	• Living shorelines • Conservation (preservation and restoration) funding • Modeling	• Land use planning • Mapping and modeling • Outreach and education

Table 2. Stressors, Tools and Strategies, and Gaps Identified by Participants During the Mississippi Sound Coastal CWR

Stressors	Tools and Strategies	Gaps and Needs
Coastal development • **Interruption of fire regime** • **Nonpoint source pollution**	• Watershed plans • Amended Gaming Control Act (to address historic stressor) • Mitigation • Best Management Practices (BMPs) • Coastal preserves • Land Trust for MS Coastal Plain GIS-based tool	• Widespread land use planning • Education of the public and local officials
Shoreline hardening	• Living shorelines nationwide permit (NWP)	• Living shorelines nationwide permit (a regional general permit is already under development)
Cumulative impacts, including • **Bulkheads** • **Docks and piers** • **Dredge spoil**	• Watershed plans • Mississippi Coastal Improvement Program (MsCIP)	• Detailed wetland maps and trends by watershed
Limitations of regulations	• State regulatory involvement (e.g. Department of Marine Resources) • Education of local municipalities • Collaboration between agencies	• Protection of non-jurisdictional wetlands • Special Area Management Plan (SAMP) implementation
Agriculture and silviculture	• BMPs	• Enforcement
Sea level rise, hurricanes, and subsidence	• MsCIP • Beneficial use of dredged material	• Living shorelines nationwide permit • Education of the public and local officials
Hydrologic modifications	• Beneficial use of dredged material	• Watershed management • SAMPs

Focal Watershed Review: East and West Galveston Bay, Texas

Introduction

The Texas coast extends 367 linear miles from Louisiana to Mexico. With over 3,300 miles of tidal shoreline (which includes the outer coast, islands, sounds, bays, and creeks to the head of tidewater), Texas hosts one of the most ecologically complex and biologically diverse regions in the Gulf. The Texas coast is also home to more than one-third of the state's population and about 70 percent of the state's industrial base (Moulton et al., 1997). The Texas coastal region includes three distinct areas distinguished by particular geomorphology, climatology, hydrology, and ecology: the upper, mid, and lower coasts.

In the East and West Galveston Bay watersheds, extensive salt marshes meet bays and lagoons protected by barrier islands (Moulton et al., 1997). Counties within the smaller West Galveston Bay watershed include Brazoria, Chambers, Fort Bend, Galveston, and Harris. Counties located within East Galveston Bay watershed are Chambers, Galveston, Jefferson, and Liberty. Although these two watersheds were the focus of the review, participants provided information and comments regarding the larger Galveston Bay region, which includes the metroplex of Houston and surrounding cities and municipalities. The entire Galveston Bay watershed, which extends up the Trinity River to the Dallas/Fort Worth area, encompasses 27,000 square miles of land, and nearly half of the population of Texas (Lester and Gonzalez, 2011).

The East and West Galveston Bay watersheds (Figure 4; HUCs 12040202 and 12040204), as their names suggest, drain into Galveston Bay. Galveston Bay is a subtropical, bar-built estuary fed by two rivers, the San Jacinto and the Trinity, and associated coastal streams and bayous (Lester and Gonzalez, 2011). Habitats in the watersheds include salt, brackish, and freshwater marshes, mudflats, submerged aquatic vegetation (SAV) beds, oyster reefs, bottomland and flatwood forests, scrub-shrub, and coastal prairies (EPA, 2007).

As of 2002, one-third of commercial fishing income and half of recreational expenditures in the entire state of Texas were from Galveston Bay (Lester and Gonzalez, 2002). Brown shrimp, blue crab, red drum, spotted sea trout, southern flounder, and Gulf menhaden are abundant here. Oyster reefs are of particular ecological and economic significance in Galveston Bay, which supports nearly 27,000 acres of oyster habitat and produces more oysters than any single U.S. water body (Galveston Bay Foundation, 2010). The Bay traditionally contained up to 80 percent of all

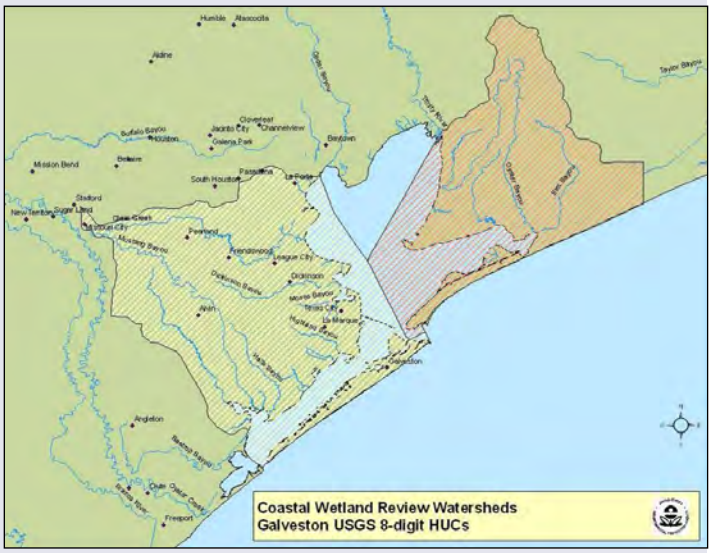


Figure 4. East and West Galveston Bay watersheds (cross-hatched areas).

Eastern oysters (worth approximately $10 million annually) harvested in Texas.[1] Oyster reefs have been surveyed in Galveston Bay since the 1950s, and comparative mapping shows that habitat location and abundance has shifted over time. When Hurricane Ike struck in 2008, it is estimated that sediment deposition associated with the storm surge covered about 60 percent of Galveston Bay's oyster reef habitat. Commercial oyster fishery landings in Matagorda Bay (located approximately 100 miles southwest of Galveston Bay) exceeded Galveston Bay for the first time in history in 2011.

The Galveston Bay watershed provides habitat for an impressive array of bird species, including great and snowy egrets, reddish egrets, piping plovers, roseate spoonbills, tricolored herons, and black skimmers. These include year-round resident, migratory, and wintering species, many of which are wetland dependent (Lester and Gonzalez, 2002; Eubanks et al., 2006). Approximately 430 species of birds overwinter, migrate, or reside here (Eubanks et al., 2006). This area is regarded as one of the top birding spots in the United States. Recreational fishing and bird watching contribute to a robust ecotourism economy.

Despite the value of wetlands to fisheries (providing food, shelter, breeding habitat, and pollutant removal) and the economy, Texas has lost 52 percent of its original wetland base (Mitsch and Gosselink, 1993). The Texas coastal plain experienced a loss of approximately 200,000 acres of wetlands between the mid-1950s and the early 1990s (from 4.1 million acres to 3.9 million acres). This loss equates to

[1] For more information, see http://www.tpwd.state.tx.us/huntwild/wild/species/easternoyster/.

an average annual net loss of about 5,700 acres (Moulton et al., 1997). Of 3.9 million acres remaining in the early 1990s, about 85 percent were freshwater wetlands (3.3 million acres) and about 15 percent were estuarine wetlands (0.6 million acres). The most common types of wetlands lost in Texas coastal areas during this time were freshwater emergent and freshwater forested wetlands.

In examining historical wetland losses within the focal watershed, a trend of continuing coastal wetland losses can be gleaned from a number of studies conducted over a variety of time periods. Although the studies are not directly comparable due to slightly different geographic scopes, methodologies, and study objectives, a downward trend in the areal extent of wetlands is nonetheless apparent. Going back to the 1950s, one study found that from the 1950s until 1989, there was a gross loss of more than 88,500 acres of emergent wetlands in Galveston Bay, 5,700 acres (6 percent) of which were converted to urban uses (White et al., 1993).

More recently, analysis of aerial imagery between 1992 and 2002 indicated that 9,124 acres of freshwater wetlands and 2,913 acres of estuarine marsh in the lower Galveston watershed alone were lost to development, which represents an average overall wetland loss of approximately 1,200 acres annually (an average annual loss of 912 acres of freshwater wetlands and 291 acres of coastal wetlands). Most of the wetlands lost in Galveston Bay watershed occurred in Harris County (Jacob and Lopez, 2005; EPA, 2007).

In preparation for the East and West Galveston Bay focal watershed review, the EPA coastal wetlands team worked with the NOAA C-CAP to develop a general characterization of recent wetland changes in the East and West Galveston Bay watersheds. C-CAP examines overall land use change, including wetlands, for the coastal regions of the United States. The program currently reports changes in wetland acreage only and does not measure change in wetland function. The C-CAP data were used to ensure consistency across all focal watersheds when comparing wetland acreage loss.

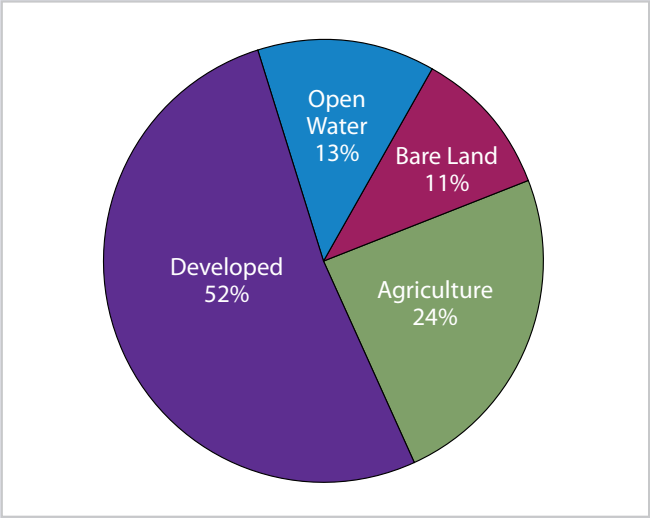


Figure 5. Wetland loss and changes in land cover, 1996-2006: East and West Galveston Bay. *Source: NOAA, 2011a.*

Table 3 and the accompanying pie chart (Figure 5) display C-CAP data for the areas of the two eight-digit hydrological unit code (HUC 8) watersheds that were the focus of the East and West Galveston Bay CWR (see Figure 4). According to the C-CAP analysis, more than 11,900 acres of wetlands were lost in this area between 1996 and 2006. This trend suggests an average loss of nearly 1,200 acres each year (similar to the results of the 1992–2002 analysis referenced above). The vast majority (more than 10,000

Table 3. Losses of Wetland Types to Other Land Uses (Acres) from 1996 to 2006, HUC 12040202 and 12040204

Wetland Types*	Developed	Agriculture	Bare Land	Open Water	Total
Palustrine forested	2,394.08	912.49	514.18	209.72	4,030.46
Palustrine scrub	2,230.84	381.63	120.98	86.29	2,819.75
Palustrine emergent	1,410.21	1,501.83	376.74	721.45	4,010.23
Estuarine forested	0.00	0.00	0.00	0.00	0.00
Estuarine scrub	0.00	0.00	0.22	0.00	0.22
Estuarine emergent	94.07	1.11	131.21	58.71	285.11
Unconsolidated shore	73.17	12.23	206.83	493.27	785.50
Total	**6,202.37**	**2,809.29**	**1,350.16**	**1,569.44**	**11,931.26**

* See Appendix D for wetland classification descriptions. *Source: NOAA, 2011a.*

acres or 90 percent) of wetlands lost in the focal watersheds were non-tidal, with woody freshwater wetlands (palustrine forested and palustrine scrub) constituting 57 percent of the total loss. The majority (63 percent) of overall wetland loss during this time period was attributed to development or conversion to bare land (which is often associated with, or a precursor to development).

It should be noted that the information below is based on the opinions and observations of participants, who provided feedback on draft versions of this document and supplemented statements with documentation, where available.

Stressors

In preparation for the focal watershed review, the Coastal Wetlands Team conducted a literature review to obtain a high-level snapshot of the most common coastal wetland stressors in the East and West Galveston Bay watersheds.

Discussion at the Galveston Bay CWR identified the following key contributors to coastal wetland acreage loss and degradation and confirmed, as well as emphasized and added to, the list of stressors identified during the literature review:

- Development (residential, commercial, infrastructure)
- Limitations of regulations
- Hydrologic modifications (including oil and gas activities, dredging, groundwater pumping, sand and gravel mining, freshwater diversions)
- Climate change, sea level rise, and coastal storms
- Oil spills
- Invasive species

Coastal development. Participants identified development as one of the top three primary stressors to coastal wetlands (particularly freshwater) in the focal watershed. In particular, they noted the lack of growth planning and controls in the greater Houston area (central Galveston Bay watersheds), which, while not specifically included in the geographic review area, were nonetheless of great concern to participants in terms of local wetland loss attributable to development (Figure 5). In addition to direct physical wetland alterations that result from filling and draining wetlands for development, increased development in coastal watersheds leads to increased impervious surfaces and associated hydrologic and water quality impacts on wetlands and associated aquatic systems. Increased impervious surfaces and traditional stormwater drainage infrastructure result in increased runoff during rainstorms (contributing to flooding) and (to a lesser extent, given low permeability of soils) decreased groundwater recharge. Groundwater recharge is needed to maintain water table elevation in wetlands during dry months. In addition to the hydrologic impacts of stormwater on wetlands, stormwater runoff results in water quality impacts due to pollution from nutrients, metals, sediment, and bacteria. Other development-related impacts to wetlands include increased drinking water withdrawals, which can lower water table elevation and impact wetland hydrology.

The impacts associated with population growth and the associated impacts from development sprawl are most pronounced in Harris County, which is part of the Houston–Sugar Land–Baytown metropolitan area and is partially located in West Galveston Bay watershed (see Figure 6). This county has experienced 20.3 percent growth (with a current population of more than 4 million) from 2000 to 2010 (U.S. Census Bureau, 2011a). According to the Texas State Demographer, the population in the Houston–Sugar

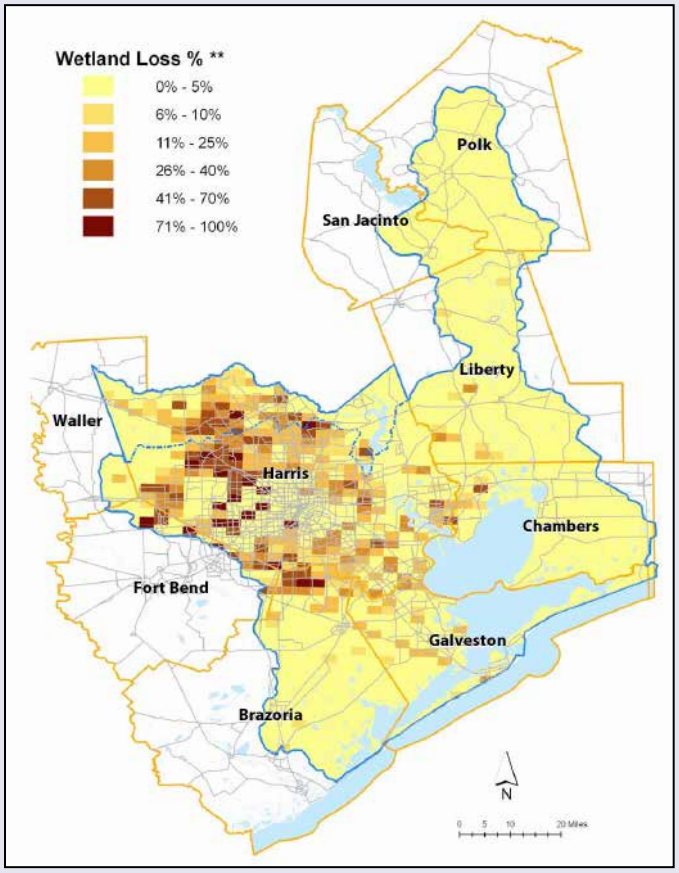


Figure 6. Percent of total freshwater wetlands lost to development (1992–2002), Lower Galveston Bay watershed (note that this area is broader than that chosen as the review area). *Source: Jacob and Lopez, 2005.*

Land–Baytown area is expected to grow to 7.9 million by 2035, an increase of approximately 3.2 million people compared to the 2000 census count (Texas State Data Center, 2008).

At the CWR, participants noted two other major impacts that have resulted from growth and development pressures in the watershed:

- **Shoreline hardening.** Participants noted that shoreline stabilization, which includes the construction of bulkheads, seawalls, and other artificial armoring structures (Figure 7), has impacted coastal wetlands in Galveston Bay. Impacts due to shoreline armoring include increases in erosion along seawall-adjacent marshes from diverted wave energy (Galveston Bay Foundation, n.d.[b]), which often prompts adjacent property owners to stabilize their shorelines, thereby creating a domino effect along the shoreline. In addition to increasing erosion, shoreline hardening impacts coastal wetlands in other ways, including filling of wetlands behind the armoring structure during construction and preventing inland migration of coastal wetlands in response to sea level rise. Hardening is also one factor contributing to decreases in biodiversity and scouring impacts on SAV, which serves as a critical nursery for fish and shellfish (Bilkovic et al., 2006; Bilkovic and Roggero, 2008). Erosion-induced scouring increases the depth of nearshore areas, thereby preventing SAV recruitment and growth (Sime, 2005).

Figure 7. Galveston Seawall (2005). *Source: Bob McMillan, Federal Emergency Management Agency.*

- **Nonpoint source pollution.** Multiple nonpoint sources of pollution, including runoff from impervious surfaces (including residential lawns, parking lots and driveways), oil runoff, septic systems, industrial runoff, and agricultural runoff, decrease the quality of coastal wetland habitats in the Galveston Bay watershed (EPA, 2007). As population and development increase, so too do these nonpoint sources of pollution.

Limitations of regulations. Federal, state, and local regulatory programs are essential tools for protecting coastal wetlands. However, participants identified jurisdictional limitations and implementation issues associated with wetland regulations as being impediments to effective protection. Additionally, participants felt that coordination could be improved between all levels of government, which could inform the development of an overarching policy to manage wetlands in light of projected future changes to coastal communities. While wetland regulation in Texas has traditionally been the primary responsibility of the federal agencies (Army Corps and EPA), state and local governments can use regulatory tools (including zoning, subdivision control, and water pollution regulations) to protect wetlands. Participants thought that heightened awareness of wetland laws among local officials could help steer development away from wetland areas or, at the very least, notify developers that compliance with wetland laws is an important aspect of project siting and design. Participants also expressed the opinion that tidal wetlands are more effectively protected than non-tidal wetlands. This observation is corroborated by C-CAP data, which show more than 90 percent of all wetland losses have occurred in freshwater wetlands (see Table 3).

- **Changes affecting federal jurisdiction.** A major issue raised by participants at the review was a lack of clarity regarding which wetlands are jurisdictional, particularly those that are "isolated." Participants expressed the view that the *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers (SWANCC)* and *Rapanos v. United States (Rapanos)* Supreme Court decisions have resulted in significant development of wetland areas within the Galveston Bay watershed that were previously regulated under Section 404 of the CWA. The participants believed that numerous acres of depressional welands located throughout the watershed are at

Figure 8. Example of development in depressional wetlands. *Photo courtesy of Tom Dahl, USFWS.*

high risk of development due to the potential for loss of protection under Section 404 of the Clean Water Act (see Appendix C, Clean Water Act Jurisdiction).

- **State regulatory role.** Some participants believe the state of Texas and/or local regulatory agencies could improve or create new regulatory programs to address wetland impacts. For example, participants indicated that Texas could use its 401 certification authority more effectively to regulate development in or near wetlands. CWA Section 401 allows states and tribes to condition or deny federal permits (including CWA Section 404 permits) that may adversely impact state water quality. A state can increase its 401 certification authority by attaching stricter conditions to its certifications and/or denying projects with negative water quality impacts. The Texas Commission on Environmental Quality (TCEQ) is the lead for most Section 401 certifications, and the Railroad Commission of Texas issues 401 certifications for activities regarding oil and gas exploration, development, and production operations. In 2001, to streamline the permitting process and focus limited resources on the most significant wetland impacts, TCEQ and the Army Corps executed a Memorandum of Agreement establishing tiered procedures for Section 401 certifications. Currently, developers of wetlands smaller than 3 acres (Tier I projects) are not typically required to seek an individual 401 certification review as long as Best Management Practices (BMPs) are included in their permit application (TCEQ, 2011a). Some review participants considered this minimal oversight to be a programmatic stressor to coastal wetland protection (see additional information under next bullet). Ecologically significant jurisdictional wetlands such as pitcher plant bogs, bald cypress and tupelo gum swamps, and mangrove marshes are not eligible for Tier I processing and must be reviewed under the more intensive Tier II process. Some participants also believed the state could be doing more to protect wetlands that are not covered by the CWA (such as certain isolated wetlands) through the development of state regulations.
- **Incremental losses.** Some participants thought the tiered Section 401 certification process described above could be leading to incremental wetland acreage losses due to the large number of developments affecting less than three acres of wetlands. Similarly, one participant expressed concern that the use of CWA Section 404 nationwide permits (NWPs) may allow incremental wetland losses due to numerous small development activities, each impacting jurisdictional wetlands without the benefit of public notice/review and a compensatory mitigation plan. Army Corps noted however that NWPs are only meant to permit projects that contribute no more than minimal individual and cumulative adverse effects on aquatic resources. Additionally, a number of NWPs have conditions that require pre-construction notification to the local Army Corps District and compensatory mitigation.
- **Mitigation.** Participants described a lack of mitigation site monitoring as a stressor in Galveston Bay. Unavoidable wetland acreage losses permitted under CWA Section 404 must be offset, to the extent appropriate and practicable, through compensatory mitigation (in order to prevent net wetland loss). However, participants expressed concern that mitigation is occurring outside the watershed where the impact occurs and therefore not truly replacing the loss. Additionally, some participants felt that uncompensated loss may be occurring when mitigation is not properly carried out and, therefore, additional monitoring and enforcement is needed. Note that compensatory mitigation requirements are designed to replace wetland functions, and therefore may not result in a one-to-one replacement of lost wetland acreage.
- **Unauthorized wetland loss.** Participants believed that illegal wetland fills may be occurring in the Galveston Bay watersheds due to lack of enforcement and a lack of knowledge on the developers' part. However, a portion of these fills may be occurring in wetlands outside the jurisdiction of the Clean Water Act or as a result of exempt activities, and therefore do not require authorization under CWA Section 404.
- **Rolling easement litigation.** Review participants noted that a Texas Supreme Court decision and ongoing litigation call into question the use of rolling easements to protect public beaches (see the "Tools and Strategies" section for a description of rolling easements), allowing them to potentially remain developed private property, and subject to armoring and other structures (ASWM, 2010). Results of the court decisions will potentially limit the ability to use rolling easements (in Galveston Bay and perhaps within the entire Gulf region) as a tool for protecting public interests in these dynamic coastal shorelines, which include important coastal habitats.

Highlight: Clean Water Act Jurisdiction and Evidence of Surface Connectivity for Texas Gulf Coastal Depressional Wetlands

Within the Galveston Bay watershed, there are wetlands for which the applicability of CWA protections has been difficult to determine. EPA and the Army Corps are responsible for issuing regulations and guidance regarding CWA jurisdiction, such as which wetlands are federally protected under the scope of the Act. In April 2011, EPA and the Army Corps announced the release of the "Draft Guidance Identifying Waters Protected by the Clean Water Act" for public comment and review. The draft guidance clarifies which waters are protected by the CWA and implements the Supreme Court's decisions in *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers* and *Rapanos v. United States*. These two court decisions have created uncertainty over which waters are protected by the CWA. Once final, the EPA/Army Corps guidance will replace previous guidance and provide more certainty and clarity to facilitate accurate field determinations.

The draft guidance includes several clarifications to current guidance documents:

- It clarifies "adjacent" wetlands as including ones in physical proximity to jurisdictional waters or ones with an unbroken surface or shallow sub-surface hydrologic connection.
- It clarifies that all wetlands within a wetland mosaic should be considered collectively when determining adjacency.
- It continues to include adjacent wetlands as per se jurisdictional where they are adjacent to either a traditional navigable water (TNW) or interstate water or where they abut a relatively permanent tributary of a TNW or interstate water.
- It continues to classify wetlands adjacent to non-relatively permanent tributaries as jurisdictional where they have a significant nexus to a TNW or interstate water.
- It clarifies that non-adjacent wetlands are jurisdictional where they individually have a significant physical, chemical, or biological nexus to a TNW water or interstate water.
- It clarifies that groups of waters (e.g., tributaries, adjacent wetlands, other waters) can be considered holistically on the watershed scale when evaluating significant nexus, rather than at a stream reach level.

Even with this EPA/Army Corps draft guidance for how to interpret recent Supreme Court cases, federal jurisdiction for certain waters, including wetlands, would need to be determined on a case-by-case basis to identify whether or not they have a significant nexus to a TNW or interstate water. To learn more about the guidance, visit http://water.epa.gov/lawsregs/guidance/wetlands/CWAwaters.cfm.

There has been ongoing research in Texas to address the nature of wetlands that became non-jurisdictional as a result of the court decisions. A recent study concluded that there are considerable hydrologic connections between certain Texas upper coast depressional wetlands and Galveston Bay and other navigable waters (Wilcox et al., 2011). The study quantified surface discharge characteristics of a wetland complex in the Armand Bayou Nature Preserve, southeast of Houston, on the Texas Gulf of Mexico Coastal Plain. It was found that surface runoff from the wetlands, although intermittent, occurred regularly and accounted for more than 17 percent of watershed precipitation over the 45-month study period. The wetland complex has a direct surface connection via a stream outlet to a tributary of Armand Bayou, a traditional navigable water. Due to this stream connection to Armand Bayou, the authors of this study have suggested that these wetlands should be considered "adjacent" wetlands, and thus could potentially be regulated under federal regulations, requiring a significant nexus evaluation. The results from the study are contrary to the "widespread perception that depressional wetlands on the Texas Gulf Coast are hydrologically isolated" (Wilcox et al., 2011). While exertion of federal jurisdiction upon wetlands must be determined on a case-by-case basis, field-based studies provide vital scientific support for these case-by-case determinations.

Figure 9. League City: example of a non-jurisdictional depressional-pimple-mound wetland complex surrounded by residential development. *Source: USWFS.*

Hydrologic modifications. Hydrologic modifications include the direct and indirect impacts associated with a number of activities, including freshwater diversions, channelizing streams to improve drainage, groundwater withdrawals, as well as extraction of other resources such as sand and gravel, gas, and oil. These activities can result in subsidence, as well as alterations of salinity and flow levels. Hydrologic modifications leading to saltwater intrusion can alter freshwater and forested wetlands and change wetland types. Some studies suggest that "many, and perhaps most, of Galveston Bay's fringing wetlands have been lost to human-induced subsidence, with no corresponding migration of wetlands landward because of the abrupt slopes surrounding most of the Bay" (Jacob and Showalter, 2008).

- **Alterations in freshwater flows.** Reduced freshwater inflows occur as a result of groundwater pumping and surface water diversions. Participants indicated that a reduction in freshwater flows has affected the San Jacinto and Trinity River deltas and riparian wetlands by altering the salinity levels of the Bay. Increased salinities of freshwater and brackish wetlands allow invasive species to spread and flourish. This population shift can decimate native species, including commercially valuable ones such as oysters (Galveston Bay Foundation, n.d.[a]). Increased salinities can also result in major shifts in wetland types to more saline conditions, with potential ecological consequences such as loss of cypress swamp in the Trinity delta. This in turn causes refuge and land managers to opt for structural marsh management, which can restrict access to the marshes for transient marine species and may actually accelerate marsh loss over time (R. Swafford, personal communication, May 16, 2012). Decreased freshwater inflow can also alter the wetland ecosystem by exposing anaerobic soils. Over time, upland plants will out-compete wetlands plants in these altered soil conditions (Texas GLO, 2010a). Conversely, increased flows from diversions and runoff can also be a problem. Inundation can alter a wetland, changing it into an open water habitat that cannot support wetland vegetation. An example is the Addicks Reservoir in Harris County, which is inundated by a combination of natural flows and stormwater runoff, and has controlled releases that affect vegetation downstream in Buffalo Bayou (HCFCD, n.d.[a]).
- **Alterations in sediment.** Sediment budgets play a large role in wetland formation and maintenance. Both increased and decreased flow regimes can lead to changes in sediment budgets and the loss of coastal wetland area. Hydrologic modifications, such as dams, can decrease water flow and restrict sediment and nutrient deposition that normally replenishes and helps to maintain a thick organic soil layer—essential for healthy wetlands. A study on the sediment budgets in the Trinity River indicated that sediment restriction from Livingston Dam has been offset by erosion in the lower coastal plain, which maintains supply to the Bay (Phillips et al., 2004). However, this restriction may lead to coastal wetland acreage loss, since increased sediment supply will be needed to match the rate of sea level rise (Lester and Gonzalez, 2011). Conversely, alterations such as dredging and channelization can increase flow velocity, scouring, and erosion of adjacent wetlands. The response to erosion in Galveston Bay has been development of armored shorelines, which prevent wetlands from migrating inland (Lester and Gonzalez, 2011). In the Galveston Bay area, alterations to water circulation and sediment flows caused by the Houston Ship Channel, the Texas City Dike, and coastal highways have reduced sediment deposition in West Galveston Bay (Lester and Gonzalez, 2011).
- **Flood management practices.** Flood management projects implemented by entities such as the Harris County Flood Control District are designed to improve drainage and prevent flooding, but participants noted that these projects can also significantly impact natural riparian systems. To improve conveyance of water, channels are widened, deepened, and cleared of vegetation. Detention basins are often built adjacent to channels to allow for storage of stormwater. These types of alteration can significantly affect hydrologic regimes, which in turn have direct and indirect effects on wetlands. Additionally, participants noted that herbicides are applied to control riparian vegetation along these modified channels and mosquitoes are treated aerially in some locations, which could have significant effects on wetland habitat.
- **Dredging.** Dredging for navigation, which creates deeper and more distinct channels, can change sediment deposition patterns, increase erosion (where increases in flow velocity occur), and change the freshwater/saltwater regime. In addition, the dredged material needs to be disposed of and, depending on the method of disposal, can either negatively or positively impact coastal habitats. Participants noted the Houston Ship Channel as an example of dredging impacts that have significantly changed Bay circulation and salinity (Lester and Gonzalez, 2011). Additionally, sediment in certain areas of the Houston Ship Channel has been shown to contain hazardous chemicals, such as PCBs, dioxin, DDT, and heavy metals (EPA, 2007; Lester and Gonzalez, 2011).

There are areas of the Houston Ship Channel where sediments are not contaminated, as well as other navigation channels that are not contaminated. These sediments, when dredged, can be used for beneficial purposes—for example, enhancing existing resource areas by restoring wetlands, islands, and beaches.

- **Sand and gravel excavation.** Review participants commented that sand and gravel mining operations occurring within floodplains outside of the state-owned riverbed (e.g., West and East forks of the San Jacinto River) result in direct loss of forested wetlands through excavation. In addition, mining operations can lead to the suspension of fine sediments in adjacent water, which reduces water clarity and can cover wetlands, indirectly resulting in acreage loss. The sand and gravel excavation itself is not a regulated activity in Texas. However, any related deposition of sediments into nearby waters of the United States requires a National Pollutant Discharge Elimination System (NPDES) permit from TCEQ and/or a CWA Section 404 dredge and fill permit from the Army Corps. TCEQ found that about half of mining facilities it investigated in the state were operating without a discharge permit in 2004, and a number were not meeting permit requirements such as implementation of BMPs and monitoring (TCEQ, 2004). Participants believed a CWA Section 404 exemption related to sand and gravel mining may be leading mining operators to believe they do not need a permit, though this exemption is actually for a narrowly defined set of activities.[2]
- **Groundwater pumping.** Groundwater pumping is partly responsible for the subsidence experienced in Galveston Bay over the last 100 years (Texas GLO, 2010a). Subsidence can affect wetland habitats by drowning vegetation, increasing the frequency of saltwater inundation events, and modifying drainage patterns (Coplin and Galloway, n.d.). Participants noted that groundwater withdrawals have decreased significantly around the Bay, but there are still areas, such as Jersey Village, that experience subsidence from groundwater withdrawals (Lester and Gonzalez, 2002; Engelkemeir et al., 2010). The rate of subsidence of the land around the Bay as a whole has decreased due to an increased use of surface water for municipal, agricultural, and industrial purposes (Texas GLO, 2010a).
- **Oil and gas extraction.** Oil and gas extraction historically caused localized land subsidence in upper Galveston Bay and the Bolivar Peninsula (Coplin and Galloway, n.d.). Some participants described how subsurface extraction led to more pronounced geologic faulting, specifically on the Bolivar Peninsula. With increased faulting land surface elevation dropped, and the marshes were left susceptible to inundation. Ten percent of the marsh habitat on the peninsula was lost from the 1950s through 2002 (White et al., 2004). Fluids (both oil and water) are still extracted from salt domes in the area, e.g., High Island. These domes often have wetland areas associated with them as the result of subsidence from faulting. Additionally, oil and gas extraction can introduce new erosive factors by removing established vegetative cover and introducing unimpeded hydrologic flow (e.g., installation of pipeline in an established marsh with a highly erosive substrate).
- **Seismic exploration.** Participants also identified impacts of seismic exploration as an ongoing problem. They observed a recent increase in frequency of these surveys within the study watersheds. Exploration can involve intersecting marshes with access roads, leading to fragmentation of the wetlands and a decrease in water and nutrient circulation and flow. The side cast borehole material covers vegetation and leads to marsh conversion. Three-dimensional seismic exploration is covered under a CWA Section 404 NWP and does not require pre-consultation with the Army Corps unless the activity is planned in a tidal area. Although Section 404 permitting for many survey activities is covered by NWP 6, a regional condition to the permit in the Army Corps' Galveston District requires that a permittee submit a pre-construction notification if three-dimensional seismic test discharges are to occur in the coastal zone.[3]

Climate change and sea level rise. Effects of climate change include inundation of coastal wetlands due to sea level rise, unpredictable or episodic nature of extremes

[2] The exemption pertains to discharge of dredged or fill material incidental to the emergency removal of sandbars, gravel bars, or other similar blockages that are formed during flood flows or other events, where such blockages close or constrict previously existing drainage ways and, if not promptly removed, would result in damage to or loss of existing crops or would impair or prevent the plowing, seeding, harvesting, or cultivating of crops on land in established use for crop production. Such removal does not include enlarging or extending the dimensions of, or changing the bottom elevations of, the affected drainage way as it existed before the formation of the blockage. Removal must be accomplished within a year of the discovery of such blockages in order to be eligible for exemption.

[3] For more information, see http://www.swf.usace.army.mil/pubdata/environ/regulatory/handouts/nwp%20rgnl%20cnd%20for%20tx.pdf.

in weather, and an impact on wetlands from increasing intensity and frequency of storm events (e.g., sediment and debris deposition). Related threats such as changes in precipitation patterns, timing and delivery of water and sediments, increases in atmospheric carbon dioxide, and higher temperatures also affect wetlands (Scavia et al., 2002).

- **Sea level rise.** Galveston Bay experienced a 0.6 meter rise in relative sea level in the 20th century (Yoskowitz et al., 2009). Land subsidence in the Galveston Bay watershed is likely to increase the impact of sea level rise. The most severe effects of sea level rise are predicted to occur in the East and West Bays and the Trinity River Delta where the greatest amount of marsh and swamp erosion is predicted to occur (Warren Pinnacle Consulting, Inc., 2011a).
- **Limited estuarine marsh migration opportunities.** Estuarine marshes can migrate inland as sea level rises, which can help sustain coastal wetlands and provide a buffer for inland properties. However, as global sea levels rises, it is unclear to what extent coastal marshes will move inland due to the location and quantity of development landward of the marshes (Warren Pinnacle Consulting, Inc., 2011a). Shoreline hardening can prevent wetlands from migrating and therefore result in loss of wetland area due to inundation and erosion. A study of sea level rise in Galveston Bay, commissioned by the Harte Research Institute in 2010, shows a significant portion of the Galveston Bay shoreline would be inundated during a 100-year storm given a projected increase in sea level of approximately 0.69 meters (2.3 feet; based on the IPCC A1F1 scenario) (see Figure 10).
- **Impacts to black mangrove.** Galveston Island is currently the northern limit for the black mangrove species due to its strict temperature requirements, a quality which makes it a good indicator of climate change. Increasing temperatures are allowing black mangrove to become more established in Louisiana, and the range of black mangrove is expected to expand northward in Texas as well. Additionally, inundation from increased hurricanes and from sea level rise will expose mangroves to changes in salinity and increased erosion (Montagna et al., 2011).
- **Hurricanes and storms.** Storms have caused damage to Galveston's coastal wetlands and resulted in coastal erosion that is exacerbated by prevailing winds, channelization, and ship traffic. Hurricane Ike (September 13, 2008) hit the coast east of Galveston Bay, causing a 5-meter storm surge, which traveled up to 10 miles inland (USGS, 2009). In addition to causing erosion, storm surges inundate freshwater wetlands with saline water, which can destroy a significant amount of freshwater vegetation (Lester and Gonzalez, 2011). If, as predicted, the intensity of such storms increases due to climate change (USGCRP, 2009), wetland loss associated with hurricanes can be expected to increase.

Figure 10. Land inundation given a 0.69 meter rise in sea level and a 100-year flood. *Source: Yoskowitz et al., 2009.*

Oil spills. Oil spills can negatively impact coastal wetlands and associated wildlife by coating the substrate and introducing toxins into the environment (Ober, 2010; Whigham et al., 2010). Although wetlands can recover from these spills, their ability to recover can be hindered by compounding stressors such as sea level rise and subsidence (Whigham et al., 2010).

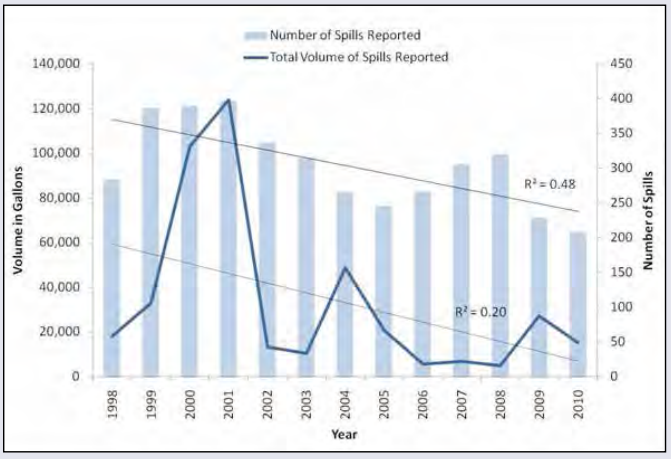


Figure 11. Number and volume of oil spills reported annually by the Texas General Land Office in the Lower Galveston Bay watershed, 1998–2010. *Source: Gonzalez and Lester, 2012; Texas GLO, 2010b.*

Participants noted that while oil spill data reported to the Texas General Lands Office (GLO) are available, there are probably more spills than are reported. Between 1998 and 2010, there were a total of 3,954 oil spills and over 431,000 gallons released in the Lower Galveston Bay watershed as reported by the Texas GLO with a trend of reduced spill incidents and volume over time (See Figure 11).

Invasive species. Participants described invasive vegetation as an important cause of coastal wetland functional loss in the review watersheds. Impacts include loss of species diversity, structural changes in the vegetation community, changes in nutrient cycling, and habitat changes. Participants noted that Chinese tallow tree (*Triadica sebifera*) is a species of particular concern since it has moved into freshwater marsh areas in great numbers within the Galveston Bay area. In addition, its spread has been documented throughout the upper Texas coast and down through other portions of the central coast (TexasInvasives.Org, 2011). A Houston urban forestry study using 2000 LANDSAT satellite data and 2002 field data showed that the Chinese tallow tree is the single most common species in the region, and represents a greater percentage of trees in the Houston area than all oak species combined (Nowak et al., 2005). The spread of such an aggressive species is a concern because it outcompetes native plants and can be a main cause of coastal wetland functional loss. Invasive vegetation can also cause changes in the types of fish and wildlife species present because of the changes in the type and abundance of food and shelter that the wetland vegetation provides. Deep-rooted sedge (*Cyperus entrerianus*) was noted as a plant that was once rare but now outcompetes native vegetation. Giant salvinia, water lettuce, and water hyacinth were mentioned as other examples of invasive vegetation impacting wetlands, along with invasive animals such as nutria and grass carp.

Funding at cross-purposes. Review participants noted some controversy around NRCS funding of projects that may result in unintentional wetland loss. Participants mentioned an instance where NRCS funded the Galveston County Consolidated Drainage District to remove downed trees from riparian zones of Dickson Bayou. Some participants viewed this activity as destruction of the riparian zone vegetation; others believed it restored the area to something closer to its natural state. Chambers County also funded similar riparian zone clearing activities along Double Bayou.

Tools and Strategies

In response to wetland losses, Texas uses several regulatory and non-regulatory programs to manage, protect and restore coastal wetlands. It primarily relies on Section 404 of the federal CWA (which regulates dredge and fill projects in waters of the United States) to protect its coastal and inland wetlands (see Appendix C for an explanation of CWA Section 404 authority and scope). In addition, TCEQ administers the state's Section 401 Certification Program. The program's goal is to ensure that activities requiring a federal permit (including CWA Section 404 permits) undergo state review for compliance with Texas' water quality standards. Since 1995, TCEQ has adopted a "no net loss" policy for preserving wetland functions and values, which is included in its water quality standards and mitigation policies. TCEQ is the lead state agency administering the Section 401 program; the Railroad Commission of Texas is responsible for overseeing oil and gas exploration activities, including issuance of Section 401 certifications for oil and gas development projects in wetlands.[4]

The Texas Coastal Management Program (CMP), within the Texas GLO, helps manage the state's coastal resources through interagency coordination and private/public partnerships. CMP activities include providing data on the health of Gulf waters, reviewing federal actions to ensure consistency with the state's CMP, and awarding grants (approximately $2.2 million annually) for protection and restoration of coastal resources. The Texas Parks and Wildlife Code requires that a State Wetlands Conservation Plan be developed for coastal wetlands (state-owned coastal wetlands exclude most non-tidal wetlands; see Texas Natural Resources Code §33.203). Among other things, the plan must establish a no net loss goal, inventory coastal wetlands, and guide mitigation policies and long-range navigational dredging and disposal plans. The plan for state-owned coastal wetlands was drafted in 1994 and approved in 1997 (Texas Parks and Wildlife, 1997).

In addition to these overarching tools and strategies, a number of effective tools and strategies exist or are under development in the Galveston Bay watersheds to address the stressors discussed in the section above.

[4] For more information, see http://www.tceq.texas.gov/nav/permits/water_qual.html.

Tools to address coastal development.

- **Compensatory mitigation for wetland impacts.** In order to receive a CWA Section 404 permit, developers and other applicants must compensate as appropriate and practicable for jurisdictional wetland loss that cannot be avoided. Compensatory mitigation in Texas, as required under the Army Corps CWA Section 404 program and TCEQ's CWA Section 401 certification program, is determined based on functional assessments or ratios as appropriate. Compensatory mitigation may occur through permittee-responsible on-site or off-site mitigation, mitigation banks, or in-lieu fee programs. For example, the Texas Department of Transportation (TxDOT) developed three wetland mitigation banks—the Anderson Tract with 2,243 acres, the Coastal Bottomlands Bank with 3,552 acres, and the Blue Elbow Swamp with 3,343 acres—in order to increase efficiency, to create long term ecological stability, and to site mitigation projects in high quality areas (FHWA, 2011).
- **Watershed plans.** Participants were enthusiastic about the potential to use watershed plans as a strategic tool for prioritizing problems and developing solutions to watershed-scale stressors. Participants particularly focused on the fact that these plans can serve to identify the location and type of projects that should be prioritized when there is a need for a compensatory wetland mitigation project within a given watershed. Watershed plans can be carefully designed to ensure that mitigation actions will address stressors that are currently degrading the aquatic resource and will sustain or improve the condition of aquatic resources in the watershed. Several participants were surprised and interested to learn that, according to the federal Compensatory Mitigation Rule (*Federal Register* Vol. 73, No. 70, April 10, 2008), watershed plans, where available, are to be considered as a factor in the Army Corps' mitigation decisions (once deemed appropriate by the Army Corps' District Engineer). They indicated that additional watershed plans should be developed to help guide mitigation decisions and noted that the Watershed Resources Assessment Team, a multi-agency state-federal partnership, may be able to help provide baseline information to inform watershed plan development. In the absence of a watershed plan, the Rule states that a watershed-based approach should still be used to determine appropriate compensatory mitigation for wetland impacts.

Highlight: Accomplishments of the Galveston Bay Estuary Program, 1995–2012

The Galveston Bay Estuary Program has made significant progress in improving water quality, restoring wetlands, protecting unique habitats, and educating the public. Those achievements included:

- Restoring and protecting approximately 20,615 acres of wetlands and coastal habitats.
- Using dredged material to restore more than 2,500 acres of wetlands and coastal habitats.
- Cultivating up to a half million wetland plants annually for wetlands restoration projects.
- Forming the Galveston Bay Freshwater Inflows Group to develop management strategies to balance the multiple uses of the estuary, the Invasive Species Work Group to help manage invasive species management in the Bay, and the West Bay Initiative to target conservation opportunities in the West Bay Watershed.
- Implementing BMPs for conservation landscaping, vegetative buffers, and stormwater management, and conducting workshops with local governments and developers on sustainable development practices.
- Conducting over 350 presentations and exhibits for schools, local community events, and workshops and conferences, reaching nearly 25,000 adults and students since 1995.
- Dedicating $10 million to resource conservation and education projects, leveraging an estimated $82 million.

» **Comprehensive Conservation and Management Plans.** One of the most significant watershed management plans for the area is the Galveston Bay Estuary Program's CCMP. The Galveston Bay Estuary Program, part of EPA's National Estuary Program, is implementing their CCMP, which guides the conservation and restoration of the estuary based on scientific research. The CCMP contains actions to acquire, manage, and protect wetlands, calling for improved coordination among the agencies involved in their management. It also includes measures to halt declines in coastal habitat quantity and quality, maximizing beneficial uses of dredged materials. In addition to and in support of the CCMP, the Galveston Bay Estuary Program, in

cooperation with TCEQ and the Houston Advanced Research Center, is undertaking a number of important initiatives to monitor, assess, and improve the health of the estuarine system, including publication of the "State of the Bay" report and a "Status and Trends" report, which included a number of indicators of the Bay's overall health.[5]

  - » **The Armand Bayou and Dickinson Bayou watershed plans.** The Armand Bayou Watershed Working Group, which was organized by the Texas Coastal Watershed Program in partnership with private organizations and the Texas Sea Grant program, was responsible for developing the Armand Bayou watershed plan. The plan examines the current state of the watershed, current management programs, and tools and strategies used to improve the ecological health of the watershed, including identification of habitat that could be designated as mitigation areas.

- **Total Maximum Daily Loads.** The CWA requires states to identify any waterbody that does not meet the water quality standards necessary to support its designated uses, and to create Total Maximum Daily Loads (TMDLs) for these waters. A TMDL is a calculation of the total amount of pollutant a waterbody can receive while still meeting water quality standards for the designated use of that waterbody, and how this budget will be divided between point and nonpoint sources. A state develops an implementation plan with strategies to meet the TMDL goal, which consists of both regulatory and non-regulatory programs. In 2009, TCEQ created fecal coliform TMDLs to meet water quality standards (for oyster water use) in six sub-bays of Galveston Bay. Fecal coliform, a type of bacteria, is an indicator of human and animal waste that can enter the Bay via wastewater discharges, stormwater runoff from urban areas, and other sources. TCEQ and the Galveston Bay Foundation have created a working group that develops and implements reduction measures such as public education campaigns, wastewater treatment facility improvements, and bans on boat discharges into the bay (Galveston Bay Foundation, 2012). This implementation plan contains strategies to minimize the impact that developed area has on surrounding resources.
- **Property buyouts.** Buyout programs are administered by the Federal Emergency Management Agency (FEMA) and funded by five different Hazard Mitigation Assistance Programs. Buyouts permanently keep land from redevelopment; land that is purchased with grant funds must remain as open space, recreational space, or managed wetlands. The Federal Hazard Mitigation Grant Program has a buyout program for municipalities, triggered by events such as natural disasters. Using FEMA funding, the Harris County Flood Control District implements buyouts for flood damage reduction programs (HCFCD, n.d.[b]). In 2009, Galveston County offered a property buyout and elevation program to specific flood-prone unincorporated areas in connection with Hurricane Ike. More than 700 parcels of land were bought out for more than $70 million through this grant program (T. Leugemors, personal communication, Beck Disaster Recovery, Inc., 2011).

Tools to address the limitations of regulations.

- **Research associated with federal jurisdiction.** Some recent research in Texas has been directed toward identifying hydrologic connections between geographically isolated wetlands and navigable or interstate waters (Forbes et al., 2010; Wilcox et al., 2011). Participants felt that these types of studies can provide a scientific basis for establishing federal protection for some "isolated" wetlands whose jurisdictional status was made uncertain by Supreme Court decisions.
- **Land management and conservation programs.** Some participants stated that existing regulations alone are insufficient to protect wetlands and that wetland acquisition and conservation programs are essential to slow coastal wetland loss. Land conservation was cited as one of the most effective strategies for protecting coastal wetlands in Texas. Special valuations, conservation easements, and the work of land trusts are all examples of programs designed to achieve this type of protection. Special valuation allows for landowners to pay property taxes based on significantly below market values. Texas offers special valuations for agricultural and open space lands, which can give landowners an incentive to maintain wetlands and other open areas rather than developing them (Dudensing and Jones, 2010).
  - » **Wetlands Reserve Program.** NRCS administers conservation easement programs and works with individual landowners and governing bodies, including the Farm and Ranch Lands Protection Program, the Grassland Reserve Program (GRP), and the Wetlands Reserve Program (WRP). These programs provide assistance for enhancing, creating, or maintaining wetlands,

[5] For more information, see http://www.gbep.state.tx.us.

riparian areas, and adjacent areas. The WRP is attractive to landowners along the upper Texas Coast because the program offers meaningful incentives and additional funds for wetland enhancements. In the Galveston Bay area, NRCS will pay up to $2,000 per acre for a perpetual easement in GRP. Lifetime easements and enhancements offer larger financial reimbursements than shorter easements.

» The bottomland hardwood forests of the upper Texas coast, known as the Columbia Bottomlands, occupy 72,000 hectares and provide critical stopover habitat for approximately 29 million migrant birds. A portion of the bottomlands has been protected through a land acquisition and conservation program administered by the USFWS, state agencies, and non-governmental partners. The Columbia Bottomlands Conservation Plan emphasizes cooperation with local conservation partners to promote private conservation efforts (Rosen et al., 2008). NRCS designated funds for the protection of the property with a conservation easement through the WRP (The Conservation Fund, 2012).

» **Land use planning.** Land use planning can be used to proactively address coastal wetland conservation. It facilitates the identification of high-value wetlands and priority areas for protection. Review participants noted that widespread land use planning will require more broad-based public and political support than currently exists in Texas, where limited land use regulation and private property rights are highly valued.

  Although this tool is not often used in Texas, some Texas cities could serve as models for planning in the Galveston Bay area. For example, Denton has specific rules protecting environmentally sensitive areas, including riparian areas. Austin has the Balcones Canyonlands Preserve, created as a community-based solution to protect habitat of endangered species threatened by a planned development in western Travis County (USFWS, 1996). And, though it is not strictly a land use plan, the Chambers County Greenprint Plan is a proactive attempt for the county (which is located in Galveston Bay) to establish conservation goals, while still promoting community development. This plan includes several maps related to land conservation priorities that recognize the importance of preserving coastal wetlands and their functions for both the ecosystem's health and the county's economy (The Trust for Public Land, 2009).

» **Eco-Logical habitat map.** The Houston-Galveston Area Council and Texas Sea Grant created an online interactive tool, based on a Federal Highway Administration project that provides ecosystem information for proposed transportation projects. The tool can identify quality habitat areas greater than 100 acres in size, which is useful for identifying areas of environmental concern and potential conflict during the transportation planning process.[6] One participant noted that it could also be useful for identifying high-quality mitigation sites.

» **Conservation organizations.** Local land trusts and conservation organizations also contribute significantly to wetlands conservation through easements. The Bayou Land Conservancy has protected 188 acres of wetlands in its 544 acres of preserves and easements in the study watersheds. Similarly, the Galveston Bay Foundation holds conservation easements in the watershed, in addition to 3,000 acres of land that it owns outright.[7]

» **Conservation grants.** There are a variety of opportunities to apply for conservation grants, including funds to protect wetlands, through various state and federal agencies. Some non-governmental organizations (NGOs) also provide funding streams through grants. Some conservation grants available for wetland conservation include:

  - The Coastal and Estuarine Land Conservation Program, administered by NOAA and the Texas GLO, offers funding for up to three projects per year at a maximum of $3 million per project. This funding is available to state and local governments to acquire coastal and estuarine lands considered important for their ecological, conservation, recreational, historical, or aesthetic value. Lands and conservation easements acquired with the program's funds are protected in perpetuity.[8]
  - National Coastal Wetland Grant Program, administered by USFWS, offers funding to support state-led wetland conservation and restoration projects. Texas Parks and Wildlife Department and the Texas GLO have engaged multiple local partners to

[6] For more information, see http://www.h-gac.com/go/eco-logical.

[7] For more information, see http://www.galvbay.org/conservation_landtrust.html.

[8] For more information, see http://coastalmanagement.noaa.gov/land.

receive funding for a substantial number of projects in Galveston Bay that have received regional and national recognition.

- The Coastal Erosion Planning and Response Act (CEPRA) program, administered by the Texas GLO, implements coastal erosion projects and studies to reduce the effects of and understand coastal erosion processes. When funding is appropriated, the CEPRA program provides funding on a biannual basis toward projects such as dune restorations, habitat protection, and beneficial uses of dredged materials for habitat restoration. Since 2000, CEPRA has received $62 million in state funding and another $62 million in matching funds to implement more than 200 coastal erosion projects.[9]
- The Coastal Impact Assistance Program (CIAP) is a federal program funded through royalties collected from offshore oil and gas leases. CIAP funds are specifically made available to areas that have been impacted by offshore exploration and development. Projects for the conservation, protection, or restoration of coastal areas, including wetlands, are one category of activities funded by CIAP in Texas. In 2010, the state received an allocation of $35 million.[10]

» **Rolling easements.** Rolling easements, where land ownership boundaries migrate inland in response to natural events such as sea level rise, are a tool for protecting coastal wetlands. These easements ensure that beaches and vegetated dunes remain in public ownership, protect them from private development, and offer wetlands the opportunity to migrate inland with changing shorelines. The authority to implement rolling easements in Texas dates back to passage of the Texas Open Beaches Act (TOBA) in 1959. The Act was derived from common law "which recognized that Gulf beaches have been used by the public since 'time immemorial' and that barrier islands are constantly shifting" (Jacob and Showalter, 2007). TOBA requires maintenance of a rolling easement along Galveston Bay (and along most of the Texas Gulf shoreline) to protect public access to state-owned beaches. The state of Texas owns the shoreline that lies below mean high tide, which includes the intertidal zone and the beaches that lie therein. TOBA prohibits construction of any structures on private property that would interfere with the normal coastal shoreline's dynamic processes and would therefore impede public access should the beach shift inland. This restriction applies to buildings, which means that businesses and residences need to be removed or relocated if the shoreline changes to the extent that those buildings become an impediment to public access to the beach. The Texas courts and government are currently revising and refining how rolling easements apply to the coast (Titus, 2011).

Tools to address impacts of hydrologic modifications.

- **Beneficial use of dredged materials.** Sediment that is dredged from waterways within the watershed, such as from the Houston Ship Channel, can be used for coastal marsh restoration and creation projects (Figure 12). The Beneficial Use Group, formed in the early 1990s by the Army Corps, evaluates the possible beneficial uses of dredged material from Houston-Galveston Bay. Though dredged material from the Houston Ship Channel has been used for marsh restoration, review participants noted that there are additional opportunities to use sediments from around the Bay for more widespread coastal

Figure 12. Dredged material was used to restore Goat Island, seen here in an intermediate stage of restoration. *Photo courtesy of Beneficial Use Group.*

[9] For more information, see http://www.glo.texas.gov/what-we-do/caring-for-the-coast/coastal-erosion/index.html and http://www.glo.texas.gov/what-we-do/caring-for-the-coast/grants-funding/index.html.

[10] For more information, see http://www.glo.texas.gov/what-we-do/caring-for-the-coast/grants-funding/ciap/index.html.

wetlands restoration projects. Since 1995, navigational dredge material has been used to restore over 2,000 acres of wetlands and 500 acres of seagrass (GBEP, 2009, as cited in Lester and Gonzalez, 2011). As a result of the discharge of sediments on seagrass beds in West Bay in December 2011 and January 2012 and subsequent comments about this practice from recreational fishermen, the Galveston Bay Foundation, and state and local resource agencies, the Army Corps Galveston District is forming an interagency coordination team to better assess and review dredged material management before projects are initiated.

- **Regional sediment management plans.** The Gulf of Mexico Foundation (GMF) and Gulf of Mexico Alliance (GOMA) Habitat Conservation and Restoration Team have completed a draft of the first regional sediment management plan for West Galveston Bay. The plan includes information on sediment sources and how sediment moves through the system, and 24 regional sediment management recommendations that would support sustainable restoration projects. The draft plan is currently under review and will be finalized in 2012.
- **Flow standards.** Minimum flow standards can help prevent water diversions from resulting in coastal wetland loss. TCEQ adopted environmental flow standards for Galveston Bay in April 2011 (TCEQ, 2011b). These standards outline minimum outflow levels for the San Jacinto and Trinity rivers. The Galveston Bay Foundation is concerned, however, that the new standards are not protective enough and create a stress on the estuarine ecosystem by limiting the freshwater flow into the Bay to levels that are too low for oysters and other organisms. They believe standards should allow for greater freshwater influx, should include standards for the other tributaries—which make up 18 percent of flows into the Bay—and should account for seasonal flow requirements (Galveston Bay Foundation, n.d.[a]).
- **Use of wetlands for stormwater management and flood damage prevention.** The Harris County Flood Control District (HCFCD) uses constructed wetlands to filter stormwater runoff and to provide flood control value within watersheds. HCFCD's Greens Bayou Wetland Mitigation Bank is a 1,400-acre wetland site that combines wetland creation and natural stormwater runoff treatment (HCFCD, 2010b). Additionally, the Army Corps is partnering with the HCFCD on Project Brays, a major flood damage reduction project (Figure 13). This project will use marsh creation as one strategy to reduce the risks associated with flooding in this heavily urbanized watershed (HCFCD, 2010a).
- **Subsidence districts.** The establishment of the Harris Galveston Subsidence District in 1975 restricted the rates of groundwater pumping in Harris and Chambers Counties. The goal of the district is to ensure that withdrawals do not exceed recharge rates. This district could be a model for other coastal areas with subsidence impacts.

Tools to address climate change and sea level rise.

- **Living shorelines.** This management practice addresses shoreline erosion through the strategic placement of vegetation, stone, sand, and other structural and organic materials along the shore, creating a natural buffer that can help protect coastal development from flooding

Figure 13. Designed to reduce the risk of flooding, the Brays Bayou Flood Damage Reduction Project includes wetland creation to collect stormwater and improve water quality. *Photo courtesy of HCFCD.*

Figure 14. Galveston Island living shoreline. *Source: Galveston Bay Foundation, n.d.(b).*

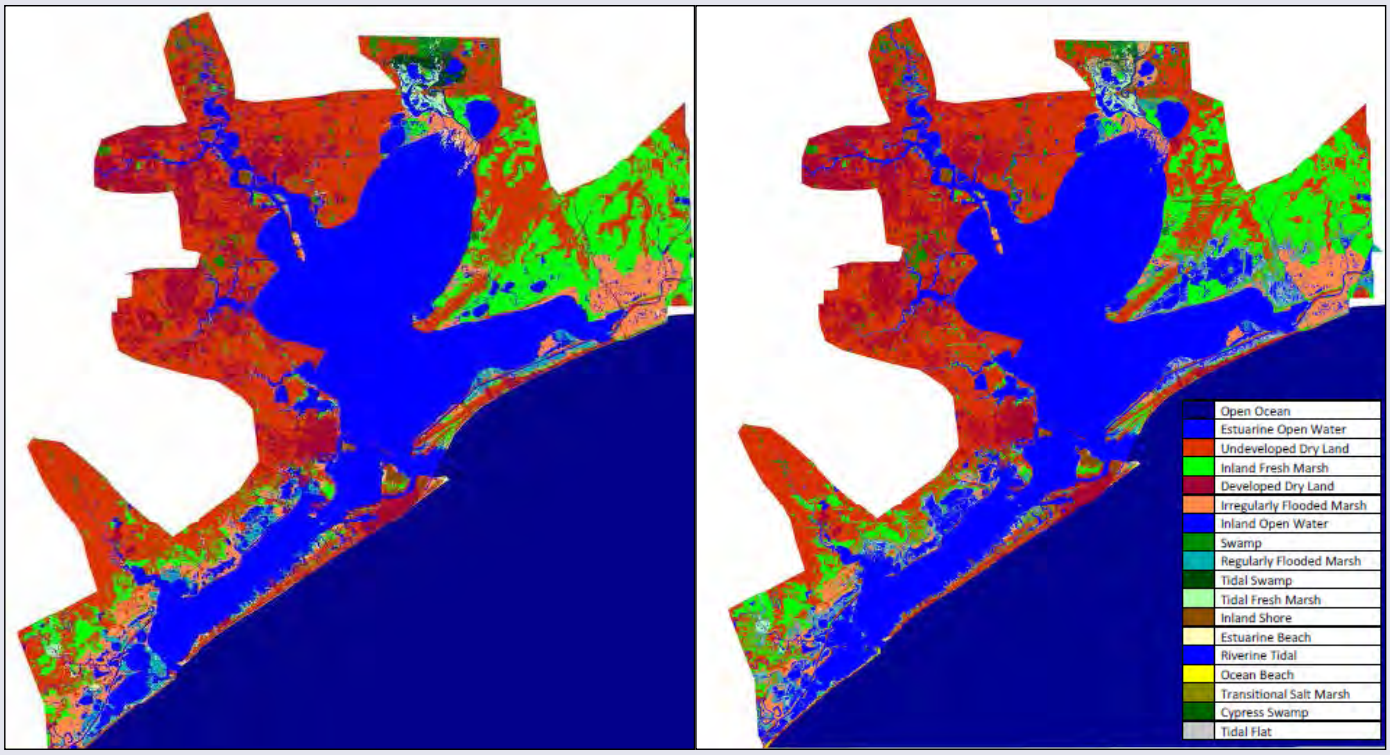


Figure 15. SLAMM for Galveston Bay. Initial conditions in 2004 (left) and under the 1 meter rise by 2100 scenario. *Source: Warren Pinnacle Consulting, Inc., 2011a.*

due to sea level rise (Figure 14). Living shorelines are a specific type of green infrastructure; they are considered to be a viable alternative to traditional shoreline stabilization techniques, which employ engineered structures such as seawalls, groins, and bulkheads. Participants indicated that incentives are needed to make green infrastructure and planning a priority. According to some participants, the use of living shorelines is not a common practice in Galveston Bay. Developers and their engineers have yet to embrace this design change, since they are familiar with more traditional shoreline armoring methods.

- **Modeling and habitat studies.** In 2010 and 2011, The Nature Conservancy and Warren Pinnacle Consulting, Inc., applied the Sea Level Affecting Marshes Model 6 (SLAMM) to assess the impacts of sea level rise on the marshes and other coastal habitats in Galveston Bay. Maps produced by the assessment show the effects predicted from specific sea level rise projections (see Figure 15). For example, the models predict a 67 percent loss of brackish (irregularly flooded) marsh area and an 84 percent loss of tidal swamp area under a projected 1 meter of sea level rise by 2100.[11] The data and maps produced by this SLAMM assessment can be used as a tool to inform managers of where sea level rise is expected to have particular effects on coastal marshes and improve decision-making (Warren Pinnacle Consulting Inc., 2011a). In addition, a study has been proposed that will complement the Galveston Bay Estuary Program's Status and Trends Report on wetlands by examining wetlands habitat changes from 1989 (published in a 1993 study) through 2009 using SLAMM outputs. The study will have a 50-year outlook.

Other tools to address coastal wetlands stressors.

- **Ecosystem services valuation.** The GMF/GOMA habitat team commissioned the Harte Research Institute (HRI) to conduct an analysis of how ecosystem services from marshes in Galveston Bay might be affected by sea level rise. The project will use the outputs from the SLAMM modeling project assessing sea level rise impacts to Galveston Bay marshes.
- **Revised shoreline classifications.** Texas GLO funded Texas A&M University and the HRI to work on a shoreline-mapping project of the upper Texas coast. The project will provide up-to-date, shoreline type classifications in the Environmental Sensitivity Index (ESI) ranking system, improving the accuracy and resolution

[11] 1-meter scenario was selected based on recommendation of a SLAMM model contact who believed this was a likely scenario for the watershed.

of the ESI data in the Texas GLO Oil Spill Planning and Response Atlas. The up-to-date shoreline classifications may also be used for shoreline change analysis and can be a tool for identifying changes in coastal wetland habitats, areas where erosion may be increasing, and areas that might be at greatest risk from sea level rise.

What's Needed? What's Missing?

Despite the array of tools and strategies for addressing stressors to coastal wetlands in the East and West Galveston Bay watersheds, participants identified several gaps in resources and programs, both regulatory and non-regulatory. They expressed the need to address these gaps to enable more effective application of tools and strategies to protect and restore the watersheds' wetlands.

Improve planning to control impacts of coastal development.

- **Land use planning.** Participants noted that the Galveston Bay watersheds lack an overarching policy for managing natural resources in light of expected population growth and development, and that a comprehensive strategy is needed to successfully address growth-related impacts. Review participants felt that land use plans could better guide development to minimize impacts on wetlands. In particular, land use planning at the watershed scale would most benefit wetland protection. Mechanisms to support such development and implementation of plans are lacking.
- **Local and county involvement in wetland protection.** Participants noted the importance of conserving and/or protecting depressional wetlands and suggested that municipalities and counties could play a role in regulating these wetlands. For instance, local authorities could ensure that CWA Section 404 permits are received, as needed, before local building permits are issued or to place restrictions on activities in buffer areas around wetlands.
- **Green infrastructure.** Review participants noted the need for better tools to encourage the use of green infrastructure, which can provide shoreline protection while minimizing impacts on adjacent habitats. As noted in the "Tools and Strategies" section, the development community is not very familiar with living shorelines methods. Examples and visual demonstrations would raise awareness in the development community and encourage these practices.
- **Nonpoint Source Pollution Control Program.** The Texas State Soil and Water Conservation Board administers the Texas Coastal Nonpoint Source Pollution Control Program. Like other Gulf of Mexico states, though, Texas has not received full approval from NOAA and EPA for its program.

Strengthen wetland regulatory programs.

- **Enforcement.** Review participants mentioned the need for the following additional tools to strengthen enforcement of wetlands protection regulations:
  - » Press coverage on wetland enforcement cases to increase the effectiveness of enforcement as a deterrence mechanism and thereby reduce illegal wetland fill activities.
  - » While it is not a replacement for on-site investigations, increased use of available aerial photography may enhance enforcement by detecting changes in wetlands that may not easily be accessed from the ground.
  - » Expansion of the use of field-level agreements, such as those between TxDOT, EPA, and the Army Corps, to improve efficiency of enforcement activities and to include local and state agencies as well. Pursuant to a 1989 Memorandum of Agreement between EPA and the Army Corps, the two agencies share the responsibility for enforcement of the CWA Section 404 program, and the EPA takes the lead on particular unauthorized activities, such as those that are completed by knowing, willful, and flagrant violators.
- **Clarifying CWA jurisdiction.** Participants noted a lack of on-the-ground field staff to verify the jurisdictional status of wetlands on a case-by-case basis. Studies of hydrologic connectivity of so-called isolated depressional wetlands can be used to aid jurisdictional determinations, and could possibly result in more positive jurisdictional determinations and protection of depressional wetlands. While some hydrologic studies already exist, participants noted that additional studies are needed to clarify the hydrologic connectivity of geographically isolated wetlands, and better inform jurisdictional determinations.
- **Increasing compliance.** Participants thought that project proponents that received local and/or county building permits, but failed to file for wetland permits, have filled jurisdictional wetlands without authorization. Increased education of landowners and those issuing the building permits could improve compliance with federal wetland regulations.

- **Increased transparency of CWA Section 404 permitting.** According to participants, it is currently difficult for those outside the permitting process to get information about CWA Section 404 permits and compensatory mitigation. State and local managers believe this information would allow them to more effectively track and document wetlands acreage loss and causes of the loss, as well as increase public participation. Although there is a public notice process during the development of all general permits and during the evaluation of each standard individual permit application, participants noted that a Freedom of Information Act request is needed to obtain detailed information on permit analysis (such as hydrologic calculations), statements of findings, and final permit conditions. Participants also believed that determinations regarding cumulative impacts of multiple permit actions are not transparent and that increased transparency and information availability could lead to better tracking of wetland loss, increased compliance, and targeted enforcement.

  A national-level spatial database, ORM2, has been used by all Army Corps Districts since July 2007. Districts had various degrees of success in converting pre-2007 data from many legacy systems; the Corps continues to refine the granularity and accuracy of the impact and mitigation data and has made significant advances since June 2009. Review participants suggested that all pertinent agencies—such as the Army Corps, EPA, and USFWS—should share one Section 404 permit tracking database, which should provide for applications to be submitted online and made publically accessible. They also suggested a mechanism for spatial tracking and assessment of permits (via GIS-based software) as part of this centralized system.

  It was noted that the Army Corps' new Regulatory In Lieu Fee and Bank Information Tracking System (RIBITS),[12] provides improved transparency for mitigation by allowing public access to information on mitigation banking and in-lieu fee programs across the country. Further, the Corps and USFWS signed an interagency agreement on the use of RIBITS in August 2010, and under this agreement, RIBITS has been modified to also include information on FWS conservation banking activities.

- **Permit coordination.** Participants expressed a desire for more coordination between agencies participating in the permitting process. Previously, the Texas Coastal Coordination Council had established a Permit Service Center and, through a pilot program, offered applicants the opportunity to take advantage of a joint permitting process, where a coordinated permit application could be submitted for a combination of state and federal wetlands permits. Permits eligible for the joint process were: TCEQ Section 401 certifications, Army Corps CWA Section 404 permits, and permits issued by the Texas Parks and Wildlife Department. The purpose of the joint permit application process was to better streamline and coordinate the wetland permitting process. The Coastal Coordination Council was phased out on August 30, 2011, and its powers were transferred to the Texas GLO and TCEQ. Regardless of whether this pilot program continues, participants suggested that before the issuance of local construction permits, applicants should be required to show they have consulted with the Army Corps to determine whether a CWA Section 404 permit is required.

- **Compensatory mitigation.** Review participants noted that the Compensatory Mitigation Rule (see Appendix C) establishes a preference for mitigation projects that focus on wetland restoration rather than preservation. However, they expressed a desire for more preservation of existing freshwater wetlands in circumstances where preservation may be preferred to restoration, such as when encroachment is likely to occur on high-quality wetlands or when the wetland function may be particularly difficult to restore (e.g., forested wetlands).

  Participants expressed concern about mitigation occurring out-of-area and out-of-kind (i.e., a different type of wetland than the one impacted), and thought that strategic regional mitigation planning would maximize the effectiveness of mitigation by expediting the construction process and strengthening the quality of mitigation projects. The Galveston District and the Interagency Review Team are reviewing two mitigation banks that are proposed to provide compensatory mitigation credits for authorized losses of waters in this watershed and a watershed approach will be incorporated into the development of those banking instruments.

- **State programs.** Noting that current federal laws do not protect isolated wetlands, some participants felt this gap could be filled by adopting state wetland protection regulations, or by implementing incentive programs to encourage the avoidance of isolated wetlands. Some

[12] For more information, see https://rsgis.crrel.usace.army.mil/ribits/f?p=107:2:3644572573481910::NO:RP:P27_BUTTON_KEY:9.

participants also noted a need for TCEQ to implement a more rigorous CWA Section 401 certification process. This could include the development of stricter water quality standards, which could give the state a stronger basis on which to review and approve, condition, or deny federal permits that result in a discharge to state waters, including wetlands.

- **Cumulative impacts.** Participants suggested that the CWA Section 404 permit process could benefit from increased permit data availability and increased time for permit review in order to better address cumulative impacts. The Army Corps, however, indicated that cumulative effects are appropriately evaluated pursuant to the National Environmental Policy Act under the current permit process.

Provide additional funding and collaboration for wetland programs (regulatory and non-regulatory).

- **Lack of funding.** Participants noted the lack of resources (both funding and staff) to adequately administer and enforce wetland laws, implement and fund more wetland restoration programs, and provide education and technical assistance to raise awareness and support for wetlands protection. An increase in CWA Section 401 certification fees would make more dedicated funds available to support coastal wetland restoration and protection activities; however, state legislation would be necessary to change the fee structure.
  - » **Conservation funding.** There is no state funding specifically and solely for conservation of coastal wetlands. Review participants noted that the current state legislature has shown little interest in supporting conservation despite public interest. Dedicated state funding for wetland conservation would allow Texas to compete more effectively for federal funds by providing non-federal match.
  - » **Flood control coordination.** Participants commented that flood control districts currently have limited authority to prevent hydrologic alterations that affect coastal wetlands. Cities have planning and zoning authority but are not required to comply with district plans (for example, League City allows development in the floodway and is not obligated to consider the Harris County Flood Control District plans). Participants felt that state funding should be tied to requirements that cities comply with flood control district plans. However, some participants noted that flood control districts can also cause hydrologic alterations that negatively impact wetlands and suggested that municipal floodplain administrators could be better informed about the coastal wetland impacts of specific hydromodification projects through more frequent interaction with wetland managers.
  - » **NGO and government cooperation.** Review participants mentioned that the Houston area does not have enough engagement and cooperation between government agencies and NGOs, and that competition for funding between agencies and NGOs, rather than cooperation, can be problematic.

Develop tools for climate change and sea level rise.

- **Sea level rise tools.** Participants mentioned a need to develop better tools to translate scientific knowledge regarding wetland loss (both area and function) to decision-makers and resource managers. Visualization and mapping tools that show expected sea level rise levels would be valuable. Active training about how to use available tools is also needed. In terms of regulation, some participants recommended revising the CWA Section 404 program to require consideration of the effects of sea level rise on coastal wetlands when evaluating permit applications. The Compensatory Mitigation Rule (*Federal Register* Vol. 73, No. 70, April 10, 2008) recognizes the importance of considering sea level rise when siting and designing mitigation projects. This would be of significance to the entire nation, but especially the Gulf coast.

Other gaps and needs to address multiple wetland stressors.

- **Wetland mapping.** The National Wetland Inventory (NWI) is a web-based tool that the public can use to obtain information on wetland locations. Review participants mentioned that the NWI GIS database is a valuable tool, but has limitations such as the coarse scale of available imagery, difficulty detecting some wetland types, and the possibility that some imagery is out of date. To help address these limitations, users can cross-reference NWI data with other information, such as the NOAA C-CAP data, USDA soil surveys, and local wetland mapping data (if available). For the purposes of jurisdictional determinations under CWA Section 404, the Army Corps has the legal authority to verify wetland delineations and finalize wetland determinations.
- **Beneficial use of sediment.** There are regulatory barriers to beneficial use of dredged material; requirements

to dispose of material in the least costly manner (the federal standard for determining disposal options) do not account for environmental costs and benefits. The Gulf Coast Ecosystem Restoration Task Force has identified this issue in its Gulf Coast Ecosystem Restoration Strategy (EPA, 2011) and the Gulf of Mexico Alliance has also identified beneficial reuse as a priority (Gulf of Mexico Alliance, 2010).

- **Monitoring.** Review participants mentioned that expanded wetlands monitoring is a tool that can be used to better evaluate wetland function at mitigation and restoration sites. For example, participants suggested WRP sites could be monitored on a longer-term basis to identify changes in function. It was also suggested that third party monitoring by certified experts could bolster local, state, or federal agency monitoring.
- **Ecosystem valuation information.** Review participants indicated that effectively communicating quantifiable information related to the economic value of services that are provided by natural systems would allow decision-makers to make more informed choices and examine trade-offs of development or other projects. For example, quantifying the lost benefits associated with channelizing streams in terms of impacts on fish and wildlife habitat—and the subsequent diminution of recreational, aesthetic, and commercial values—could serve to demonstrate that wetlands are vital economic resources (Engle, 2011).
- **Education and incentives.** Review participants felt there is a need for more educational programs that focus on state and local decision-makers and property owners, since public education and outreach currently tends to focus solely on students in K-12 schools. In addition, there is a need to provide incentives, such as tax breaks, for private landowners in order to increase the likelihood that wetlands are preserved.
- **Habitat assessment gaps.** It is difficult to determine the functions and services of wetlands, particularly in urban watersheds. Participants believed there is a need for more guidance regarding what wildlife and habitat characteristics should be assessed, particularly in heavily developed watersheds. There is a nationwide tool that assesses the threat to fish habitat nationwide, compiled through the National Fish Habitat Action Plan[13] that may provide helpful data. EPA also conducts a national coastal condition report, including coastal wetlands, which could be helpful.[14]

[13] For more information, see http://www.fishhabitat.org.

[14] For more information, see http://water.epa.gov/type/oceb/assessmonitor/nccr/index.cfm.

Focal Watershed Review: Mississippi Coastal Watershed, Mississippi

Introduction

Mississippi's coast is characterized by a hot, humid climate; silty and sandy soils; fire-dependent habitat types; and exposure to large-scale storm events (MDWFP, 2005). The region was never glaciated and therefore boasts a diversity of plant and animal species, placing Mississippi among the top 10 states for endemic species of reptiles, amphibians, butterflies, and mammals (MDEQ, 2008). The state's coastal area includes 758 square miles of large estuaries, small bays, tidal rivers, creeks, and bayous. Open-water estuarine systems support patches of SAV and the intertidal zone hosts fringe oyster reefs (Peterson et al., 2007). Four barrier islands help maintain the unique ecology of the Sound while also providing the coast with a first line of defense against hurricanes and storms. Sandy beaches, maritime forests, saltwater marsh complexes, freshwater ponds, and sea grass beds all provide habitat to numerous endangered and threatened species (MDMR, n.d.).

Farther inland are a wide variety of marsh types, including almost 70,000 acres of salt and brackish marshes, and salt pannes (shallow depressions with high salt concentrations) (MDWFP, 2005). Over 100 coastal estuarine ponds, totaling almost 4,000 acres, add to Mississippi's coastal diversity. Moving away from the immediate coast, a variety of tidal and non-tidal wetland habitats such as wet pine savannas, cypress swamps, freshwater marshes, and maritime forests can be found (Peterson et al., 2007; MDMR, 1999).

Mississippi's commercial fishing industry is the second largest in the five Gulf States (by pounds landed), and the aquaculture industry is the most valuable in the nation (NMFS, 2011b; USDA, 2009). Wetlands and estuaries are worth millions of dollars to the Mississippi commercial fishing industry, which generated more than $375 million in the last 10 years (NMFS, 2011b). Harvests of estuarine-dependent shrimp alone account for more than half of Mississippi's commercial fishing revenues during the same period (NMFS, 2011b). Continued loss of coastal wetlands—such as salt marshes—on which healthy fisheries and shellfisheries depend will have large economic impacts on Mississippi coastal communities.

The majority of salt marshes in Mississippi occur at the terminuses of the Pearl and Pascagoula Rivers, at the far western and eastern edges of the Mississippi coastal plain. Overall, Mississippi has lost nearly 60 percent of historic wetland acreage, which prior to the 1800s was estimated to cover nearly 10 million acres. Approximately 9,000 acres of salt marsh alone were lost to open water, development,

Figure 16. Sandhill Crane National Refuge, Gautier, Mississippi. *Source: USFWS.*

and other non-wetland uses between the 1950s and the 1990s (Schmidt, 2001). Wet pine savannas are a particularly endangered ecosystem in coastal Mississippi and the entire Gulf Coastal Plain, where less than approximately 5 percent of the original acreage remains (MDWF, 2005). A number of factors, including suppression of the natural fire regime, urbanization, and silvicultural practices, have all contributed to the loss of this wetland type.

The Mississippi Coastal watershed was selected for review because it is one of the watersheds along the Gulf of Mexico coast that experienced a high amount of wetland acreage loss between 1998 and 2004 (T. Dahl, unpublished data from the USFWS Status and Trends program) and because the watershed contains a diversity of saltwater and freshwater wetland types. Coastal wetlands in this area provide numerous ecosystem services, such as support for commercial and recreational fisheries, wildlife habitat, flood control, and filtration of excess sediments and pollutants.

This focal watershed spans the majority of the state's 369-mile tidal shoreline and three counties (Hancock, Harrison, and Jackson) (Figure 17; MDEQ, 2010; HUC 03170009). It contains several rivers (Jourdan, Wolf, Biloxi, Bayou la Batre, and the Fowl Rivers) as well as three major bays (Bay of St. Louis, Back Bay of Biloxi, and Grand Bay). The initial study area was revised slightly to match the boundaries of the USGS hydrologic unit (03170009), which includes the Grand Bay shoreline (Figure 18).

Palustrine forested wetland was the most prevalent wetland class in the watershed in 2006, covering nearly 178,000 acres (63 percent of the total acres of wetland area) and 16 percent of the watershed's land area (NOAA, 2011a). Estuarine wetland classes covered nearly 50,000 acres, or

Figure 17. Mississippi Coastal watershed (cross-hatched). *Source: USGS.*

about 35 percent of the wetland area and 4.5 percent of the watershed. Specific coastal wetland types found in the watershed include wet pine savannas, salt marshes, salt pannes, and bayous.

Figure 18. Grand Bay National Estuarine Research Reserve. *Source: USFW (P.R. Hoar, NOAA/NESDIS/NCDDC).*

In preparation for the focal watershed review, data from the NOAA Coastal Change Analysis Program (C-CAP) were summarized to illustrate recent wetland changes that have occurred within the Mississippi Coastal watershed between 1996 and 2006. The C-CAP program uses remote sensing data to detect land use change in the coastal regions of the United States. "Wetland" is one of the categories used in the reporting of results. The data set reports changes in acreage only and does not measure changes in wetland function. C-CAP data were used in order to be consistent across all regions when comparing wetland loss.

According to the C-CAP analysis, 4,474 acres of wetlands were lost (e.g., converted to non-wetland categories) in this watershed between 1996 and 2006 (an average of nearly 450 acres per year). The vast majority (about 88 percent) of losses occurred in freshwater wetlands. Seventy-four percent of the wetland acres lost, or 3,283 acres, were forested freshwater wetlands. C-CAP data indicate that the most acres were lost in conversion of wetlands to development (36 percent), followed closely by losses to agriculture (27 percent) including pastureland.

Other wetland acreage losses (25 percent) are attributed to loss of wetlands to bare land (which is often associated with, or a precursor to, development), with the remaining 12 percent of all coastal wetlands lost to open water, which could be a result of a number of factors such as sea level rise, subsidence, erosion, and/or channelization.

The post-change land use of wetlands lost and the types of wetlands lost according to C-CAP data are shown in Figure 19 and Table 4, respectively.

Wetland loss can be authorized under federal and state regulatory programs, which require avoidance and minimization of impacts as well as compensation for lost wetland functions through compensatory mitigation. The Army Corps tracks wetland losses and mitigation authorized by the CWA Section 404. However, the wetland loss tracked by the Army Corps is only a subset of the loss tracked by C-CAP because: (1) wetland loss under C-CAP may include loss of wetlands that are not subject to CWA regulation (see the discussion of jurisdictional waters in Appendix C), (2) wetland loss under C-CAP may include loss due to types of activities that are not subject to CWA regulation (e.g., natural processes or unregulated activities; see Appendix C), and (3) wetland loss under C-CAP may include losses for which a landowner should have sought CWA authorization, but did not.

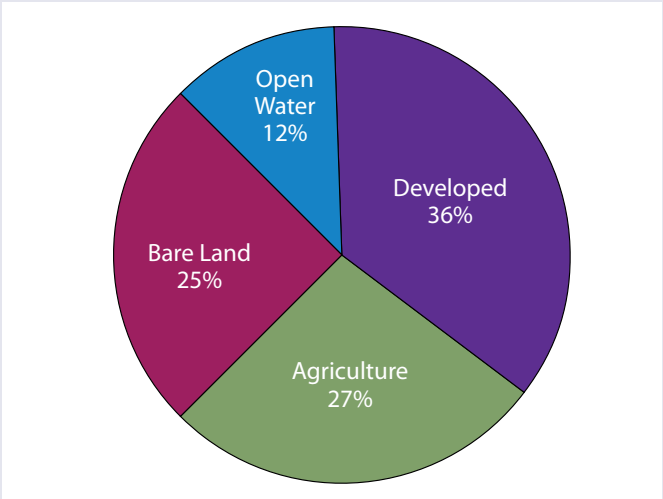


Figure 19. Wetland loss and changes in land cover, 1996-2006: Mississippi Coastal Watershed. *Source: NOAA, 2011a.*

Table 4. Losses of Wetland Types to Other Land Uses (Acres) from 1996 to 2006, HUC 03170009

Wetland Types*	Developed	Agriculture/ Pasture	Bare Land	Open Water	Total
Palustrine forested	1,278.99	1,172.69	572.22	259.31	3,283.22
Palustrine scrub	61.83	31.36	221.28	17.79	332.26
Palustrine emergent	54.93	18.90	31.14	239.74	344.71
Estuarine forested	0.00	0.00	0.00	0.00	0.00
Estuarine scrub	5.34	0.00	0.00	0.00	5.34
Estuarine emergent	125.65	0.00	0.67	20.46	146.78
Unconsolidated shore	64.49	2.00	291.78	4.23	362.50
Total	**1,591.24**	**1,224.95**	**1,117.09**	**541.53**	**4,474.81**

* See Appendix D for wetland classification descriptions. *Source: NOAA, 2011a.*

Permitting data provided by the Army Corps Mobile District indicate 1,222 acres of wetland fill were permitted in the CWR focal watershed between 2006 and 2011(Army Corps, personal communication, 2011). Those records represent the data entered or converted into the ORM2 database from 2006 to November 17, 2011, for HUC 03170009. During this time there were two database changes (ORM1 and ORM2) and several refinements to the data collected. The first major change, in June 2009, further expanded the fields collected for impact and mitigation data entry; the second change, in October 2010, was made to ensure that mandatory data elements were being entered. The Army Corps has worked diligently over the past several years to improve data entry. Training and documentation has increased consistency and accuracy of data entered, and database modifications have improved the overall quality and quantity of data collected. The 2009 impact data changes allow for more granularity in quantifying impacts. When reporting totals, the Army Corps reports on permanent impacts (determined from the duration field), the impact activity, types of discharges of dredged or fill material, and fill associated with excavation.

It should be noted that the information below is based on the opinions and observations of participants, who provided feedback on draft versions of this document and supplemented statements with documentation, where available.

Stressors

As the C-CAP data indicate, the Mississippi Coastal watershed has lost coastal wetlands due to natural and anthropogenic stressors. Workshop participants provided information on what they believed to be some of the underlying causes of that loss, based on their experience as wetland managers and regulators. Although this review focused on one watershed, some of the stressors, tools, and gaps discussed included those observed in all three coastal counties and were not strictly limited to the Mississippi Coastal watershed alone.

The top stressors voted on by the review participants were:

- Development (including nonpoint source pollution and interruption of fire regimes)
- Shoreline hardening
- Cumulative impacts
- Limitations of regulations to address development

Coastal development. Between 1930 and 1973, 8,170 acres of coastal marshes were filled for industrial and residential uses (MDMR, 1999). Since passage of the Mississippi Coastal Wetlands Protection Law in 1973, coastal wetland loss has slowed dramatically (MDMR, 1999). Participants mentioned the Mississippi Gaming Control Act (1990), which legalized dockside gambling, as a catalyst for the construction of casinos along the coast. The gaming industry spurred new housing construction, commercial development, and associated infrastructure, which in turn caused impacts to coastal wetlands. The Gaming Control Act was amended after Hurricane Katrina (2005) to allow for casinos to be built within 800 feet of the mean high-water line; the majority of casinos rebuilt were concentrated along the Sound. Since Hurricane Katrina, no impacts to wetlands have occurred as a result of casino development along the Mississippi coast. Prior to that and dating back

to the early 1990s, less than 20 acres of wetland fill has occurred as a result of casino development along the Mississippi coast, which was required to be mitigated at a minimum of a 3:1 ratio, either on site or at a nearby location.

Review participants reported that development is the single most significant coastal wetlands stressor currently in the focal watershed. This stressor was also the largest cause of coastal wetland acreage loss according to C-CAP data (36 percent of the loss from 1996 to 2006), corroborating participants' impressions. Participants believed that recent development and rebuilding pressures (Mississippi coastal counties' combined populations in 2010 had rebounded to 2.2 percent higher than pre-Katrina levels [U.S. Census Bureau, 2011b]) have been directed toward wetlands that are outside the jurisdiction of the federal regulatory program (Section 404). This assumption has not been verified by any studies, and so it remains uncertain whether, and to what extent, losses might be occurring in wetlands that are not currently regulated under state or federal wetland regulatory programs.

Review participants identified specific secondary aspects of development that threaten coastal wetlands:

- **Post-Katrina development.** The region experienced large increases in insurance premiums after Hurricane Katrina, which participants thought may have discouraged redevelopment in favor of new development. They also speculated that housing development post-Katrina was associated with potential illegal wetland fills for these expedited projects. Concerns were expressed that these projects were hastily constructed due to social and economic pressures to rebuild after the storm. The Army Corps confirmed that minor violations did occur, though some small fills may have been authorized through general permits such as the nationwide permits. New housing construction over the past 20 years in Mississippi peaked in 2006, exceeding 1,400 privately owned single units, as compared to about 1,200 in both 2004 and 2007 (Figure 20).
- **Nonpoint source pollution and stormwater runoff.** In addition to direct loss of wetlands for development purposes, participants mentioned several indirect impacts from increases in development, including increases in runoff and associated pollutants from impervious surfaces. Discharges from urban (as well as agricultural) runoff contain nutrients, sediments, pesticides, and other contaminants that degrade water quality. Increased stormwater runoff can also negatively affect the hydrology of rivers, streams and their associated floodplains by making streamflows more "flashy" (higher velocity and peak flows during rainstorm events), as well as lower flows during dry periods. The lack of natural flooding regimes inhibits sediment delivery to coastal wetlands, and renders the depth of wetland substrate (and hence wetland elevation) difficult to maintain.
- **Loss of natural fire regimes.** Several participants observed that the majority of coastal wetlands in the three coastal counties are wet pine savanna, an ecosystem that requires fire for regeneration and maintenance. Wildfire control practices interfere with natural fire regimes, and encroaching residential and commercial development can make prescribed burning more difficult and less likely to occur. Without fire, the understory of the pine savanna thickens and the excess vegetation increases evapotranspiration rates. The higher number of stems per acre due to underbrush was thought to have similar effects on the ecosystem as ditching,

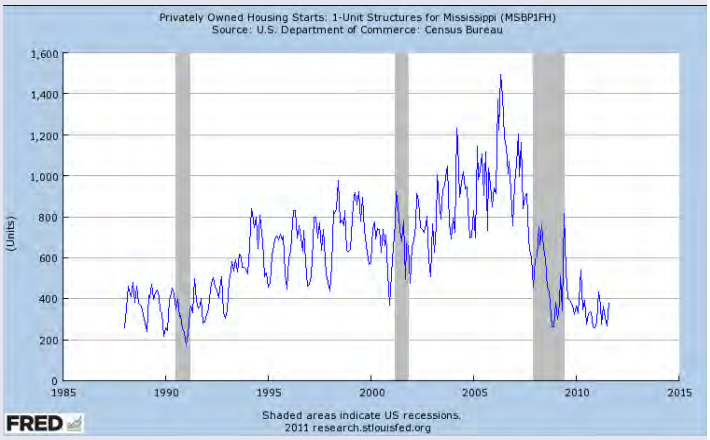


Figure 20. Housing starts data with peak in 2006, a year after Hurricane Katrina made landfall. *Source: Census Bureau, 2011b.*

Figure 21. Prescribed burn in the Sandhill Crane National Wildlife Refuge. *Source: USFWS.*

and participants thought this might cause transition of wetlands into marginally wet forests, making some areas potentially more attractive for silviculture or other activities.

- **Pine plantation closures.** In the 1930s, paper companies bought large tracts of wetlands along the Pascagoula River to establish pine plantations. When these plantations are closed, large tracts of land are available for potential development. In 2002, International Paper Company's Moss Point Plant sold 50,000 (out of 200,000 available) acres of forested land in southern Mississippi to a private development company with plans to subdivide the land (Peterson, 2002). At the time, county officials and environmental interests were concerned about new development leading to pollution from septic tanks and sediment erosion from construction sites. Additionally, pine plantation closures are the primary source of large tracts of lands purchased for mitigation banking on the coast. While the Pascagoula River is not in the study area for this report, it is adjacent; converting this land from forestry to development could have indirect effects in the study area.

Shoreline hardening. Participants noted that approximately three-quarters of the Mississippi Sound shoreline was armored with seawalls and bulkheads by the 1930s. Seawalls and bulkheads occur mostly along sheltered (interior) shorelines and riverine areas as opposed to along the oceanfront. Gulf Hills was noted as an example of a residential development where seawalls and bulkheads are used along interior shorelines (Figure 22). Participants pointed out that as part of the seawall or bulkhead construction, wetland areas were filled behind the armoring to stabilize the slope and provide firm foundation for the structures. Shoreline hardening may also exacerbate coastal erosion of adjacent shoreline and prevent landward migration of coastal wetlands. One participant noted that seawalls and bulkheads might restrict the movement of endangered species, such as the Alabama red-bellied turtle. A majority of the remaining coastal wetland systems in the state are in the far east and far west, where shorelines have not been hardened to any great extent.

Cumulative impacts. The many stressors acting on the coastal wetlands of the Mississippi Coastal watershed are most significant when considered cumulatively, rather than individually. Workshop participants focused on bulkheads as a prominent example of cumulative impacts in the Mississippi Coastal watershed: a single bulkhead's impact may seem small, but rarely do single bulkheads occur without neighboring property owners armoring their own shorelines. Once large areas of shoreline are armored, systemic ecological effects become evident. Several studies provided by participants (Peterson et al., 2000; Hendon et al., 2000, 2001) indicated that stretches of armored shorelines in Mississippi have experienced reduced abundance of commercially and economically viable fish species. Partyka and Peterson (2008) found that epifaunal and nekton richness was greater along unrestricted shorelines as compared to armored shorelines, and Hendon et al. (2001) found that alteration to the marsh edge habitats in the Back Bay/Davis Bayou estuary may adversely affect larval abundance and

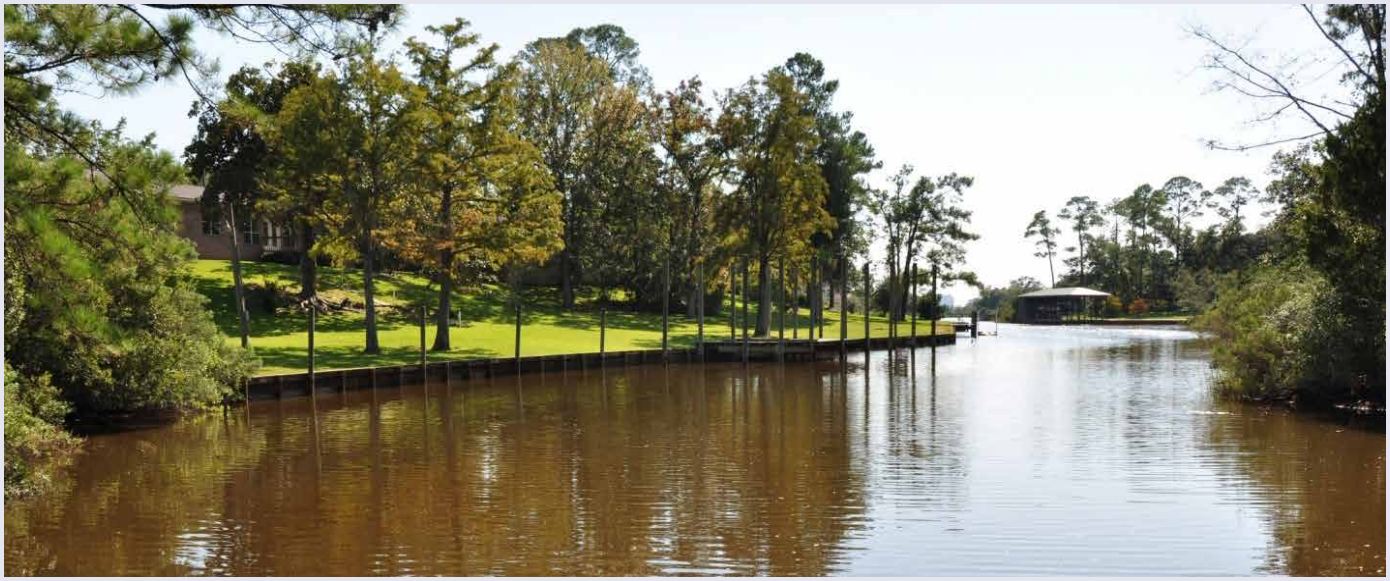


Figure 22. Gulf Hills, an example of a subdivision with extensive bulkheading. *Photo courtesy of Martina McPherson, ERG.*

distribution of gobies, the most abundant fish found in these habitats. Thus, a single bulkhead can have impacts far beyond the small stretch of shoreline it armors. Other small alterations that can have large cumulative impacts include docks, piers, and dredge spoil from channel maintenance (Peterson and Lowe, 2009). Peterson and Lowe (2009) found that cumulative impacts are problematic because they are not immediately noted and build up over time to produce more substantial impacts.

Limitations of regulations. The regulations that guide implementation of CWA Section 404 and the Mississippi Coastal Wetlands Act are limited with respect to the wetlands under their jurisdiction and the activities that are subject to regulation. Neither the federal nor the state regulations comprehensively protect all wetlands from all adverse impacts. The Mississippi Coastal Wetlands Protection Act (Mississippi Code §49-27-71) protects public tidal wetlands and submerged water-bottoms. The Mississippi Department of Marine Resources (MDMR) is responsible for reviewing permits for all regulated activities that affect coastal wetlands in the three coastal counties (Jackson, Harrison, and Hancock). However, the Act's jurisdiction is narrowly limited to just public tidal wetlands and submerged water bottoms. With respect to federal wetland regulations (CWA Section 404), participants noted that recent U.S. Supreme Court decisions (*Rapanos v. United States*, 547 U.S. 715, 810 [2006]; see Appendix C) have impacted jurisdictional status and are contributing to the loss of coastal wetlands by allowing development in unregulated wetland areas such as certain isolated wetlands. In some states, state regulations have been able to fill the gaps in federal wetland protection, but participants expressed concern that the limited scope of CWA jurisdiction is not addressed by the Mississippi Coastal Wetland Act.

Agriculture and silviculture. According to data provided by NOAA C-CAP program, approximately one-third of the 4,500 acres of wetlands lost between 1996 and 2006 in the focal watershed was converted to upland agricultural land uses. Participants stated that row crops, which are typically thought of as "agriculture," were not common in the study area, so the substantial percentage of losses to agriculture in the study area created some initial confusion for participants. However, the C-CAP land use category of "agriculture" includes pasture as well as row crops. Participants confirmed that pasturelands did exist in the study area. Participants also stated that silviculture is a significant economic activity in the area.

- **Pasture.** More than 80 percent of the total area mapped by C-CAP as "agriculture" was also classified as pasture. Non-agricultural features such as lawns in low-density developments are often captured in this category; therefore some of the wetland acreage losses attributed to agriculture may actually be wetland losses to lawns in low-density development.
- **Silviculture bedding.** The potential for silvicultural practices to convert wetlands to uplands is a controversial issue in Mississippi, especially the practice of bedding for pine plantations. There was some debate among participants on that practice, and whether it leads to loss of wetland function.

  Bedding involves creating raised mounds of soil where trees can be planted without the roots being threatened by saturation. The high water table along the Mississippi coast makes this practice not only common but necessary for pine plantation success. Participants mentioned that the timber industry's bedding in wetlands along the coast could have hydrological implications. Some voiced concern that when rows are placed perpendicular to topographic contours, water can be drained and wetlands can be converted to uplands and thus lose jurisdictional status.

  In contrast, participants from the Army Corps indicated that, to their knowledge, jurisdictional wetlands have never been lost to uplands due to silviculture bedding practices, despite some inhibited hydrology of the bedded rows. It was suggested that soil borrow areas tend to remain wet while narrow bedded areas become uplands—not enough, overall, to change the jurisdictional status of the wetland area. A joint Army Corps–EPA memorandum on BMPs for the establishment of pine plantations in the Southeast (Army Corps and EPA, 1995) specifies that BMPs must at least "maintain the natural contour of the site and ensure that activities do not immediately or gradually convert the wetland to a non-wetland." If mechanical silvicultural site preparation is conducted in accordance with the voluntary BMPs, a CWA Section 404 permit is not required.

  Although plausible that bedding practices could result in some hydrologic alterations, the extent to which these practices result in wetland loss remains unclear. The BMPs mentioned above only apply to forested wetlands seasonally flooded or wetter, leaving wetlands that have saturated soils but are not flooded vulnerable to practices not in line with the BMPs. The potential hydrologic effects of bedding aside, silviculture can degrade the

quality of wetland habitats by converting open pine prairie savanna or bottomland hardwood to pine forest.

- **Misunderstanding agriculture exemptions.** Wetland losses to agriculture could be occurring because landowners believe their activity is covered by an exemption from regulatory requirements. There seemed to be some confusion among review participants regarding agricultural exemptions (what types of activities are exempt and what types require a permit), which may indicate a similar lack of clarity for landowners and the general public. Section 404(f)(1)(a) of the Clean Water Act provides exemptions for "normal farming, silviculture, and ranching activities such as plowing, seeding, cultivating, minor drainage, harvesting for the production of food, fiber, and forest products, or upland soil and water conservation practices." Other agricultural activities that result in a discharge of dredged or fill material into jurisdictional wetlands require authorization, and CWA Section 404(f)(2) specifies that even exempt activities require a permit if the activity has "as its purpose bringing an area of the navigable waters into a use to which it was not previously subject" and "where the flow or circulation of navigable waters may be impaired or the reach of such waters be reduced." In addition to wetlands lost through misunderstandings about agricultural exemptions, participants suggested that some landowners engage in farming/silviculture practices in wetlands with the intent of drying out the wetlands, thinking they can later develop them without obtaining a CWA Section 404 permit. In such cases, these activities would require authorization under CWA Section 404.
- **Small impacts.** A few participants mentioned that small agriculture/silviculture parcel ownership might lead to incremental, easily overlooked modifications of wetlands because these landowners are more apt to modify wetlands without being noticed, compared to larger operations making more obvious modifications. However, it is also likely that small wetland losses would be authorized under a general permit such as the nationwide permits or may have been exempt.

Hydrologic modifications. The estuarine wetlands of coastal Mississippi depend on a continuous sediment supply for their maintenance and growth (Gulf of Mexico Restoration Task Force, 2011). Hydrologic modifications of rivers that drain into this coastal area may have contributed to decreases in sediment transport. Participants also cited construction of transportation infrastructure over the last century along the coast (Highway 90, Interstate 10, and railways) as a historical wetland stressor, and significant improvements to this infrastructure after Hurricane Katrina as a recent stressor. Dredging (and specifically channelization for navigational purposes) was cited as a historic stressor that became less prevalent once Mississippi's Department of Environmental Quality (MDEQ) adopted CWA Section 401 certification regulations in 1982 (and amended most recently in 2010).

Sea level rise and storm events. Sea level rise and the increasing intensity and frequency of storm events (USGCRP, 2009) can present major threats to coastal wetlands in the Gulf of Mexico. The region is already vulnerable to destructive storms and hurricanes, which have contributed to substantial erosion of coastal marshes. Over the past 70 years, the average rate of erosion in Hancock County marshes has been 3.9 meters per year (Manlove et al., 2002). In 2005, Hurricane Katrina's storm surge reached a height of 28 feet just east of the Bay of St. Louis (Hancock County, Mississippi) and extended 6 miles inland, up to 12 miles inland along bays and rivers (Knabb et al., 2005). The Interagency Performance Evaluation Task Force study conducted after Hurricane Katrina (2009) found that the coastal area from the Mississippi River to east of Mobile Bay is twice as likely to experience a moderate-to-severe hurricane than the coast of Texas or the Florida Panhandle. In addition to flooding and wind damage, wetland stressors in the aftermath of large storms include the presence of storm debris and the spread of invasive species. Because of Mississippi's high water table and low elevation, a rising sea level could increase the area's vulnerability to storm effects. Mean sea level measured at the eastern edge of the Mississippi Coastal watershed is shown in Figure 23.

Participants noted that hurricanes and coastal flooding could lead to wetland creation in natural systems; however, in developed systems such as those in coastal Mississippi, these events are more apt to change coastal wetlands to open water. In some instances, storms can transport too much sediment into the tidal environment, causing smothering of the vegetation, as was the case with Hurricanes Katrina and Rita. It was estimated that storm-delivered material from Hurricanes Rita and Katrina was far greater than sediment introduced by overbank flow and other inland sources (Turner et al., 2006). During these storm events, 131 million metric tons of sediment and massive amounts of debris from built structures were deposited into wetlands (Turner et al., 2006). Participants were concerned that there may be instances after storms where wetlands

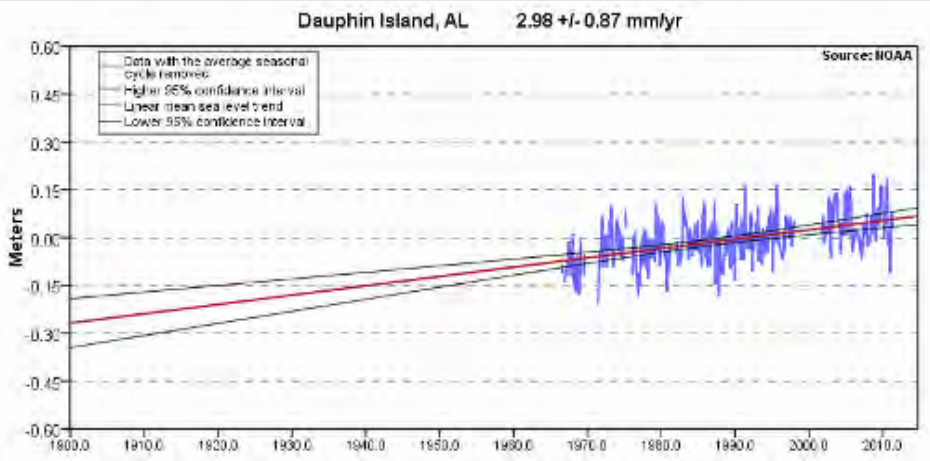


Figure 23. Mean sea level trend measured at Dauphin Island, AL. *Source: NOAA.*

may be erroneously delineated as non-wetlands due to the deposition of thick layers of mud.

Long-term natural stressors. Although most of the review participants' discussion focused on more recent stressors caused by human influences, they also noted that natural stressors have been acting on the area for thousands of years. For example, one participant commented that freshwater inflows to coastal wetlands have fluctuated over the last 6,000 years due to the changing course of the Escatawpa River. Over the last 50 years, five hurricanes of H1 to H5 intensity have made landfall along the Mississippi coast and the Alabama coast east of Mobile Bay (NOAA, 2011b). The area is prone to hurricanes and tropical storms, which cause flooding and exacerbate coastal erosion.

Tools and Strategies

A number of tools and strategies exist or are under development in the Mississippi Coastal watershed to address the above stressors, both regulatory and non-regulatory. In Mississippi, the MDMR and MDEQ work together to regulate wetlands, relying on water quality certification under Section 401 of the federal CWA. The MDMR reviews any Section 404 permit applications and Section 401 certification requests for projects located in the three coastal counties, where the Mississippi Coastal Wetlands Protection Act applies to public tidal wetlands and submerged water bottoms. Currently, the Coastal Preserves program and Mississippi Coastal Improvement Program (MsCIP) are responsible for much of the restoration and preservation of coastal wetlands in the state. Workshop participants

Figure 24. Grand Bay National Estuarine Research Reserve. *Source: USFWS (P.R. Hoar, NOAA/NESDIS/NCDDC).*

highlighted local participation, enforcement, and restoration as the most important strategies for addressing ongoing coastal wetland loss.

Tools to address limitations of regulations.

- **Local participation and education.** Participants agreed that local participation and education are critically important for raising local awareness and involvement; these tools are currently used, to varying degrees and with varying success, to address coastal wetland stressors in the focal watershed. Some work is being conducted to raise awareness of wetland issues and to solicit partnerships with local officials and the public to provide information about which activities require a permit. In several communities, this outreach includes bi-annual community sessions hosted by MDMR where planners, developers, MDMR, the Army Corps, USFWS, MDEQ, and other agencies are invited to talk about their roles in the permitting process. Also during these sessions, the Coastal Preserves Program gives an informative presentation on wetlands and why they are important. Participants thought that this type of outreach was valuable in facilitating inter-agency collaboration and coordination, and could improve wetland protection by expanding information sharing and communication among officials.

  Municipalities have primary authority related to land use planning and development, giving them a unique opportunity to guide coastal resource protection. Pass Christian was noted as an example of a city that coordinates with MDMR to ensure that building permit applicants have sought other appropriate permits (e.g., wetland permits) prior to construction. They also contact the appropriate resource agencies if they are uncertain about how to proceed on a specific proposed project. Participants estimated that approximately 10 municipalities exist in the watershed, and agreed that expanding the type of close coordination that occurs with Pass Christian to all municipalities in the watershed would benefit wetland conservation efforts. Smart Coast[15] was also mentioned as an educational resource that is effective in fostering local coastal wetlands protection through smart growth practices.
- **Enforcement.** Participants stressed the importance of a strong enforcement presence to ensure compliance with state and federal wetlands regulations and to ensure that people conducting activities within jurisdictional wetland areas apply for all necessary permits.
- **Collaboration.** Participants mentioned the value of co-locating federal agencies with state agencies, and in particular, voiced a desire for a stronger NOAA presence. The Army Corps established a field office, co-located with the MDMR, following Hurricane Katrina in late 2005. This allowed for a joint effort in the post-Katrina recovery effort. Since then, the Army Corps continues to maintain the Biloxi field office to support a collaborative relationship with the MDMR, as well as other agencies, and provide closer contact for stakeholders and the regulated public along the Mississippi Coast. The "Roles and Responsibilities" section of Appendix C describes the coastal wetland protection roles of agencies in more detail.

Tools to address coastal development.

Participants discussed wetland mitigation as a tool that can offset wetland losses, citing a number of programs in place to ensure that it is effective. They discussed these programs, pointing to some examples and mentioning improvements that might be considered.

- **Wetland compensatory mitigation.** Under regulations established by the Army Corps (33 CFR 325 and 332) and EPA (40 CFR 230), compensatory mitigation is defined as "the restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization had been achieved."

  The Army Corps implements a watershed-based approach to compensatory mitigation, which is defined in part as: "an analytical process for making compensatory mitigation decisions that support the sustainability or improvement of aquatic resources in a watershed. It involves consideration of watershed needs, and how locations and types of compensatory mitigation projects address those needs" (see 33 CFR 332.2 for complete definition).

  The National Research Council (2001) recommended a watershed approach to compensatory mitigation as a better way to achieve compensation for wetland losses

[15] Smart Coast, an organization supporting sustainable development, is helping move the Gulf region toward a regional long-range comprehensive plan that balances growth with the need to protect important ecological resources. For more information, visit http://smartcoast.org.

than the previous automatic preference for on-site and in-kind compensatory mitigation. This recommendation is a cornerstone of the joint Army Corps/EPA mitigation rule promulgated in 2008.

- **Mitigation banks.** The Mobile District Mitigation Banking Interagency Review Team (IRT) oversees 11 commercial mitigation banks, two private Mississippi Department of Transportation (MDOT) mitigation banks, and three private single-client mitigation banks in the six Mississippi coastal counties. The majority (65 percent) of the acres in these banks has undergone (or will undergo) a type of restoration called "rehabilitation," which involves altering an existing degraded wetland area to increase its function but not increasing total wetland acreage. The next largest category (21 percent) is "enhancement," which also involves increasing function but not acreage (RIBITS, 2011). Within the Mississippi Coastal watershed, there are more than 13,000 acres of wetlands being managed within 15 mitigation sites. Mitigation banks are required to demonstrate to the IRT that the bank has achieved measurable ecologically based success criteria in order to receive marketable mitigation credits. Of these wetlands being managed for wetland credits, approximately 90 percent are being managed for pine savanna wetland restoration, approximately 8 percent for bottomland hardwood enhancement, and 2 percent for bottomland hardwood and emergent marsh preservation.
- **In-lieu fee programs.** The Army Corps, as chair of the IRT, is working with other federal and state agencies to evaluate three in-lieu fee proposals in the Turkey Creek sub-watershed. Cumulatively, the three sites cover nearly 171 acres of wetlands. Review participants mentioned Turkey Creek as a good example of both a watershed management approach and an in-lieu fee program in the focal watershed. The Land Trust for Mississippi Coastal Plain (LTMCP), a local non-profit organization, manages the 171-credit project.[16] The creek itself is an impaired water body—as identified on the CWA Section 303(d) list—with flooding issues in a heavily urbanized area (LTMCP, 2006). Additionally, the creek has important historical and cultural value to the local population, whom review participants noted as having a strong appreciation of the value of wetlands. The active and engaged community fought to pass a local ordinance to require that impacts within the Turkey Creek watershed are mitigated within the watershed. While the Army Corps cannot enforce the ordinance (the city and county do), they still support it. Participants noted Turkey Creek as a good example of how engaged stakeholders using available tools and data can address wetland loss.
- **Location of compensatory mitigation with respect to impacts.** Some participants expressed concern about mitigation occurring outside the watershed where impacts are incurred. It was thought that this out-of-watershed mitigation could be resulting in a significant net loss of wetlands in coastal Mississippi. The Army Corps responded that its approach to mitigation in coastal Mississippi has changed within the last five years. The service area (the geographic area within which impacts are mitigated) for the initial mitigation banks consisted of the six coastal counties (Hancock, Harrison, Jackson, Pearl River, Stone, and George), an area that includes all or part of four watersheds as defined by USGS eight-digit HUCs. This service area was based on the mitigation banker's project feasibility analysis and the needs of the CWA Section 404 permit program. As new banks were approved, they were assigned the same mitigation area as the older banks in order to be competitive. However, pursuant to the 2008 federal mitigation regulations (33 CFR 332.3), the Army Corps has begun to incorporate a watershed-based approach to compensatory mitigation decisions, which includes the requirement that "compensation for impacts to aquatic resources in coastal watersheds (watersheds that include a tidal water body), should also be located in a coastal watershed where practicable" (33 CFR 332.3(b)(1). The Mississippi Coastal watershed comprises about half of the area of the six coastal counties in Mississippi. According to the Army Corps, few, if any, projects on the coast currently mitigate outside the watershed.
- **Watershed management.** MDEQ manages watersheds in collaboration with stakeholders to address water quality issues, holding meetings with agencies such as MDOT and local non-profit organizations. LTMCP applied for and received grant funds from EPA to begin working with communities in six local watersheds to build local partnerships. Turkey Creek (within the focal watershed) and Red Creek (which borders the focal watershed) were the first partnerships established by LTMCP. Each of these partnerships has formed a community group that follows the action plan developed by the community. Both groups have been awarded grants to implement their plans for wetland restoration and environmental education (LTMCP, n.d.).

[16] The Turkey Creek mitigation banking instrument is based upon the formula that an acre of wetland equals one wetland credit.

- **Conservation easements.** A conservation easement is a legally enforceable agreement between a landowner and government agency to protect land so that it can be maintained in its natural condition. Conservation easements have been used in coastal Mississippi, including along the Wolf River, one of two freshwater sources flowing into the Bay of St. Louis, an impaired water body. The Wolf River Basin contains several sources of nonpoint source pollution, including wildlife, livestock, and urban development (MDEQ, 2000). Several state programs and organizations have focused conservation activities in the Wolf River Watershed, including an easement donation by International Paper in September 1999 to the Wolf River Conservation Society (the Society was started in 1998 to conserve, manage, and protect the Wolf River and its watershed). The 950-acre easement requires BMPs such as permanently limiting tree cutting and prohibiting development along both sides of the river, creating a 15-mile-long by 300-foot-wide buffer zone (Southeast Watershed Forum, 2000).
- **Decision-support tools.** Participants noted two important decision-support tools that could be useful in managing and protecting wetlands:
  - **Conservation Legacy Tool.** LTMCP is a non-profit organization based in Biloxi that works to establish a long-term system of conservation that reflects regional priorities. In collaboration with almost two-dozen state agencies, federal agencies, and non-profits, LTMCP is developing a GIS-based tool to rank land based on its conservation priorities. In the future, the tool will be used to develop conservation plans (targeting areas, verifying conservation value), to substantiate grant requests and donations by city and county governments (comprehensive planning, development prioritization), and to inform mitigation efforts.
  - **Low Impact Development Implementation Assessment (LIDIA).** The Northern Gulf Institute has developed a tool to examine the costs of implementing stormwater BMPs. LIDIA began as a tool to assess the water quality impacts of large industrial and commercial sites (Wilkerson et al., 2010). From there, it evolved into a simple tool (based on Excel and a public domain mapping tool) that could inform the design industry about water quality/quantity benefits of implementing BMPs on new or retrofitted projects. It considers site and land use data, hydrological outputs, pollutant removal effectiveness of BMPs, installation cost, and maintenance cost (Wilkerson et al., 2011). Recently, the tool has been linked to Map Windows, a public domain mapping system. Unfortunately, completion of additional project stages has been delayed by lack of funding.

Tools to address shoreline hardening, sea level rise, and storms.

- **Preservation.** Both non-profit organizations and public agencies work to preserve wetland habitats along the coast of Mississippi:
  - **Coastal Preserves Program.** The MDMR Coastal Preserves Program provides effective stewardship of Mississippi's sensitive coastal areas. The Coastal Preserves Program is designed to set preservation priorities, acquire additional sensitive coastal wetland habitats, and ensure that the ecological health of these selected areas is maintained through appropriate resource protection and coordinated management efforts. Twenty sites containing 72,000 acres have been designated as Coastal Preserves. These preserves are mostly estuarine tidal marsh, but they also include freshwater marsh, freshwater swamp, wet pine savanna, and upland and island habitats (Figure 25). The state-owned portions of these preserves (currently about 36,000 acres) are being restored and managed as natural areas. The Mississippi Secretary of State's Office is an active partner in the Coastal Preserves Program through an established cooperative agreement whereby both agencies agree to "effectively preserve, conserve, restore, and otherwise manage selected coastal wetland ecosystems, associated uplands and tidelands."
  - **Grand Bay National Estuarine Research Reserve.** The Reserve, established in 1999, includes approximately 18,000 acres, 75 percent of which is within the Grand Bay National Wildlife Refuge (established in 1992) and the Grand Bay Savanna Coastal Preserve. A majority of the Reserve is in Alabama, but its western edges fall within the study watershed. The

Figure 25. The Hancock County Coastal Preserve. *Photo courtesy of MDMR.*

area is contained entirely within The Nature Conservancy's Grand Bay Savanna project area, a bioreserve containing 31 rare and "imperiled" species and 20 natural community types (TNC, 2011). The core area of the reserve consists of approximately 12,800 acres of estuarine tidal marsh, tidal creeks, or bayous; shallow, open-water habitats; oyster reefs; seagrass beds; maritime forests; salt flats; sandy beaches; and shell middens (Grand Bay NERR, 2011). The Reserve's broad range of wetland habitats provides the ideal setting for numerous research projects and educational programs (Grand Bay NERR, 2011). The Sea Level Affecting Marshes Model (SLAMM) was recently applied to the Grand Bay National Estuarine Research Reserve, and it was determined the salt pannes will be the most impacted wetland type under all simulated sea level rise scenarios (Warren Pinnacle Consulting, Inc., 2011b).

- **Increased coastal resilience.** Several tools and strategies are being used and developed in the Mississippi Coastal watershed to improve the coast's ability to respond to rising seas and hurricanes. Additionally, beneficial use of dredged material can be used for habitat restoration, which can improve coastal resilience.
  - » **Mississippi Coastal Improvement Program (MsCIP).** MsCIP was created in response to the damage and destruction incurred during the 2005 hurricane season. Projects funded by MsCIP have increased the coast's resilience to storms. Types of funded projects include beneficial use of dredge material, living shorelines, and property buyouts. MsCIP incorporates several different strategies and tools to address coastal resiliency along the Mississippi coast in the wake of Hurricanes Katrina and Rita. The unprecedented damage and destruction caused by these hurricanes led Congress to authorize and fund 15 short-term projects (approximately $108 million) to address hurricane and storm damage reduction, salt water intrusion, shoreline erosion, and fish and wildlife preservation. The subsequent comprehensive plan (approximately $1.4 billion) has been submitted to Congress and $439 million has been authorized and appropriated for comprehensive barrier island and ecosystem restoration aspects of the plan. The Army Corps was authorized to develop cost-effective plans along the coast with the involvement of state and municipal officials. The planning process was and continues to be a highly collaborative effort. For example, staffs from USFWS and the National Park Service are co-located in the Army Corps office, and the MsCIP team works closely with USGS. To date, 10 projects have been fully completed and five have been transferred to local sponsors, who are responsible for future operation and maintenance (the remainder are scheduled to be finished in 2012). Projects included shoreline restoration, living shorelines, restoration of existing hardened structures (seawalls), land acquisition, and beneficial use of sediment. When completed, the projects will restore approximately 30,000 acres of natural landscape.

Figure 26. Cypress Swamp, Mississippi. *Source: USFW.*

  - » **Living shorelines for coastal Mississippi.** The Army Corps Mobile District completed a Living Shorelines Regional General Permit (LSGP) for the Alabama coast as part of its 2012 General Permit Program for Minor Structures and Activities, and is currently completing a LSGP for Mississippi. Living shorelines provide for the long-term protection, restoration, and enhancement of both stable and degraded shorelines, which are subjected to a variety of high-energy forces. Living shorelines use plants, stone, sand fill, and other organic or natural materials to stabilize shores. The Army Corps Mobile District took this living shorelines concept and expanded it to include structural and non-structural alternatives, applicable for use over a range of freshwater to marine ecosystems, useable not only by the private landowner but also for larger acreages targeted for restoration and creation.

The LSGP promotes the preservation, protection, and restoration of dunes, beaches, wetlands, submerged aquatic vegetation, protection and propagation of essential fish habitat, shoreline restoration, and nourishment. The LSGP is targeted for use in areas subjected to scour, erosion, sloughing, high energy wave action, storm damage, and other similar areas that are in need of renourishment or restoration, with focus on a minimalistic, naturalized approach with limited or temporary structural enhancement in order to achieve a self-sustaining, stabilized shoreline, in lieu of the traditional seawall or bulkhead revetments. The development of a general permit makes the use of living shorelines a more viable and attractive option because it allows applicants to proceed with work under a streamlined general permit process, rather than going through individual permit procedures.

As of the printing of this report, issuance of the Mississippi Coastal living shorelines regional permit is pending final evaluation by and in coordination with multiple state and federal agencies.

» **Beneficial use of dredged material.** Deer Island (Figure 27), an MDMR Coastal Preserves site, is located in Harrison County, at the mouth of Biloxi Bay. The 4-mile-long, 400-acre island is a mainland remnant, so it is technically not a barrier island, though it does provide some storm protection to the city of Biloxi (NOAA, 2010c). The island once contained a beach and dune system, a salt marsh area, and a maritime forest, but suffered severe damage from the 2005 hurricane season (Army Corps, 2009). Dredged material from Biloxi Harbor maintenance was used before the hurricanes of 2005 to restore the eastern tip of the island, which had been rapidly eroding. The fill placement and marsh planting was a successful use of dredged material and the restored marsh was one of the few areas of the island that survived Hurricane Katrina. Additional restoration of Deer Island, including fill of the western breach and restoration of the southern shoreline with subsequent vegetation planting on the breach fill, was completed in early 2012 using congressionally authorized funding to the Army Corps.

The use of dredged material for coastal restoration projects was mandated through Mississippi House Bill 1440 (March 2010), and the state reactivated the Beneficial Use of Dredged Material Group in 2008. The Group is focused on finding opportunities to use dredged material in restoration activities and beach restoration.

Figure 27. Deer Island, 2012. *Photo provided by Susan Rees, Army Corps.*

Tools to address agriculture, including silviculture.

- **BMPs.** In order to promote silvicultural practices that are in compliance with CWA Section 319, Mississippi has developed a BMP handbook recommending standards, methods, and specifications for forest resource managers and landowners (MFC, 2008). The BMPs implemented in Mississippi include streamside management zones; best practices for skid trails and haul roads, forest harvesting, site preparation, and tree planting; and artificial re-vegetation of disturbed forest sites. The state has also developed a "Stormwater Management Toolbox" consisting of guidance for coastal communities and counties on how to select BMPs and implement management programs to reduce the impacts of stormwater runoff (MDMR, 2003).

Highlight: Buyouts.

One of the MsCIP sites visited during the review field trip was the community of Pecan, Jackson County, near the Mississippi-Alabama state line. Approximately 29 families were living on over 200 acres of low-lying land (Figure 28). The state, working with Jackson County and FEMA, had identified the community as vulnerable following Hurricane Georges and had initiated a hazard mitigation grant program (HMGP) to acquire repetitively damaged properties from willing sellers. The authorization of the MsCIP Interim Projects provided funding to purchase all the properties within the Pecan communities from the willing sellers and—in cooperation with the state, Jackson County, and FEMA—the MsCIP took over the responsibility for this area, with the HMGP funds being applied to other repetitively damaged areas. To date the MsCIP has purchased 165 acres (43 different tracts) and relocated 16 families at a cost of $6.2 million. Restoration efforts under the MsCIP Comprehensive Plan have been authorized to return the area to the natural wet pine savannah landscape. These activities are scheduled to begin in 2012.

Figure 28. Former residences in the Pecan community that were purchased using MsCIP funds. *Photo courtesy of Susan Rees, Army Corps Mobile District, MsCIP Program.*

What's Needed? What's Missing?

Despite the array of tools and strategies available to address stressors to coastal wetlands in the Mississippi Coastal watershed, participants identified several gaps in resources and existing programs that, if addressed, would enable more effective protection and restoration of the watersheds' wetlands.

Increase resources for enforcement and compliance.

- **Additional staffing.** The majority of participants agreed that lack of resources for enforcement and compliance efforts was the largest obstacle in preventing unauthorized loss of wetlands in the watershed (definitive information on how much of the wetland loss is unauthorized is needed to verify this conclusion). The state of Mississippi currently maintains three full-time positions to cover the entire CWA Section 401 certification program, which covers 82 counties. All Army Corps Mobile District coastal team project managers have expertise in enforcement and are responsible for compliance, but only a few are primarily tasked with enforcement. Workshop participants believed that increased funding for state and federal regulators would allow for a greater field presence to deter illegal activities. (For more information on EPA and the Army Corps' enforcement roles and responsibilities, see Appendix C.)

  However, the Army Corps does not believe additional resources are needed to deter illegal activities. The Corps has specific performance metrics related to resolution of non-compliance actions and unauthorized activities, and typically meets or exceeds those targets. Data for fiscal year 2011 show that the Army Corps Mobile District conducted compliance inspections on 22 percent of issued Individual Permits (IPs) and 19 percent of verified General Permits (GPs) (Army Corps Mobile District, 2011). This is in excess of the metrics that require 10 percent on IPs and 5 percent on GPs. They also exceeded performance criteria for resolution of unauthorized and non-compliance actions. The Corps believes these data suggest they have a sufficient field presence to prevent unauthorized actions.

- **Aerial photography.** Participants also mentioned that periodic aerial photography would be very helpful in compliance and enforcement efforts, and that it would benefit the state wetlands program if the fines they collected could be deposited into a dedicated fund restricted to enforcement or other wetlands-related monitoring/data collection efforts.

Increase public/local government education and engagement.

- **Land use planning.** Participants felt strongly that local government should take a more active role in managing development and protecting wetlands through land use planning. They indicated that local communities should develop master plans that embrace smart growth concepts, set watershed-based wetland loss thresholds, and be firm about limiting development in sensitive areas. They

further contended that municipalities need to be educated about the authority they have to enforce building permits, and be willing to exercise that authority instead of expecting the state to do it.

- **Dissemination of information and lessons learned.** Participants also felt the public has not learned some important lessons from Hurricane Katrina, such as the idea that allowing coastal wetlands to stay in their natural state performing flood control functions is valuable ecologically and for society. They added that there needs to be a "paradigm shift" when it comes to what waterfront property owners value. Participants stated that living shorelines need to be embraced as the best option for addressing sea-level rise, erosion, and flooding. Additionally, participants felt that landowners need to be more informed about actions they take that affect adjacent or nearby wetlands and which actions require wetlands permits. (There may be a false perception that, having received a building permit, a developer needs no further permits for additional activities undertaken by the landowner.) One participant suggested providing available wetland maps to municipal building inspectors as a tool to inform both the inspectors and the landowners about locations were wetland permits may be required for development projects.

Strengthen watershed-based management.

- **Require smaller-scale watershed-based mitigation.** The Army Corps/EPA watershed approach to compensatory mitigation often results in a determination that on-site, in-kind mitigation is not the most environmentally preferable option and may not offset authorized losses of waters. Nonetheless, participants expressed a strong preference for compensatory mitigation to occur as close to the wetland impact as possible, to prevent a net loss of wetland functions and values in areas closest to the coast. Using smaller watersheds as the context for mitigation decisions may help in retaining wetland functions closer to the area of impact.
- **Increase watershed management teams.** Participants agreed that watershed management teams are valuable collaborative groups that are underutilized in coastal areas in general and in the Mississippi Coastal watershed in particular. Participants thought that organizing additional watershed management teams would be a major step toward more comprehensive watershed management and more effective protection and management of wetlands.
- **Develop and implement special area management plans (SAMP).** The Coastal Zone Management Act encourages the use of SAMPs to provide for increased specificity in protecting natural resources, reasonable coastal economic growth, and improved predictability in government decision-making. SAMPs are detailed watershed management plans that guide development in a defined geographic area. They generally guide development by making environmentally sensitive areas more difficult to develop. In Mississippi, SAMPs could strengthen the coastal wetlands program by integrating its activities into an overall management plan. Currently, the coastal program only covers a fairly narrow portion of coastal wetlands (as defined by state statute). A SAMP was developed for the Port of Pascagoula in the 1980s and continues to guide development in that portion of Jackson County. MDMR indicated that it would be supportive of developing more SAMPs, but does not have the capacity to be involved due to limited resources.

Other gaps and needs to address multiple wetland stressors.

- **Increase monitoring.** Participants noted that there is currently no long-term geospatially based ecological monitoring in the focal watershed or across the Gulf. These data and ecological history are needed to improve restoration, mitigation, and land use planning efforts. Louisiana's Coastwide Reference Monitoring System was cited as a model of what is needed; participants suggested that the Gulf of Mexico Alliance should be used as a vehicle for developing models, other tools, and collecting relevant data. Other ideas included developing a cumulative impact analysis tool for regulatory decision-making and a tool to model water quality impacts from filling wetlands.
- **MsCIP.** Participants noted a gap in the full implementation of the MsCIP. Although funds have been provided for a portion of the program (e.g., $439 million for barrier island and ecosystem restoration), a critical aspect of the program remains unauthorized and unfunded. An additional $800 million would allow for the acquisition of approximately 2,000 parcels from willing sellers within the high hazard area of the coast. These lands would be subsequently returned to their natural landscape.

Conclusion

The Gulf of Mexico coastal wetland review is the fourth and last in a series that the Coastal Wetlands Team conducted. The Gulf region reviews have given federal agencies a greater understanding of coastal wetland loss in the region, including important insights into the causes of these losses. Several common themes have emerged from the Gulf region focal watershed reviews:

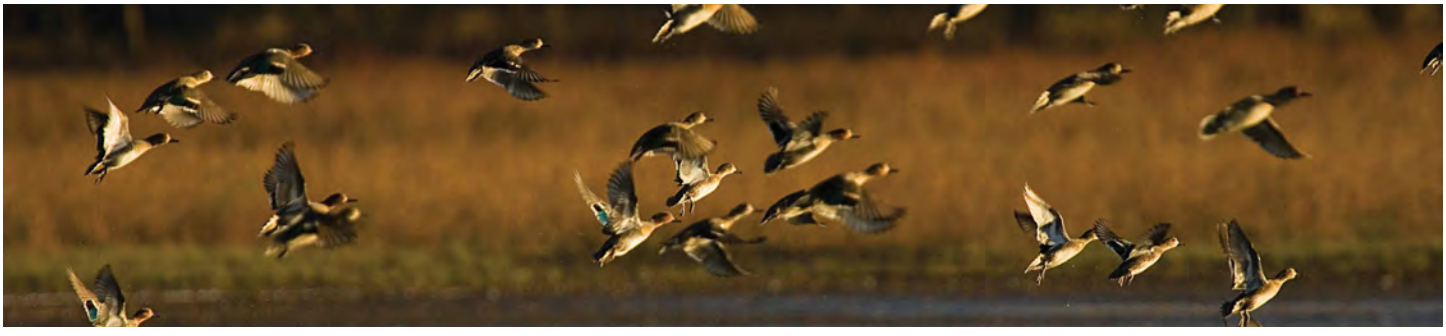
- Development pressure was the primary stressor of concern to participants in both watersheds. This includes both direct impacts (filling) and indirect impacts (stormwater runoff, shoreline armoring, etc.).
- The limitations of regulations and lack of accurate characterization of coastal wetland losses (through mapping, centralized databases) are important issues that hinder the protection of coastal wetlands.
- In Galveston Bay and the Mississippi Coast, recent Supreme Court decisions (*Rapanos* and *SWANCC*) have had significant impacts on coastal wetland loss, specifically limiting federal protection for certain isolated, freshwater wetlands under CWA Section 404.
- The impact of sea level rise, storms, and other climate change issues was raised in both focal watershed reviews as a stressor of concern; participants noted that more information is needed to assess the impacts of climate change.
- Subsidence attributed to oil and groundwater extraction—noted as a significant issue in the past—has become less of a threat to coastal wetlands due to decreases in extraction activities and new management approaches.

A number of tools and strategies were suggested that could effectively address the major stressors discussed on the previous pages, and could be transferred to other watersheds and regions:

- **Beneficial use of dredged material** is a restoration strategy being employed successfully in the Galveston Bay and Mississippi Coastal watersheds.
- **Watershed planning** has been used in both watersheds to protect wetlands and manage growth. Along with **land use planning**, participants believed, this strategy could improve development practices across the Gulf, but continued education and outreach to the public and local municipalities will be needed to increase the strategy's popularity.
- In both watersheds there was strong support for **conservation** of existing coastal wetlands through direct purchase of land or through **conservation easements** as a primary strategy that guarantees preservation of coastal wetland acreage.
- Although not a common strategy, **property buyouts** have been used to remove properties from flood-prone areas in both watersheds.
- The development of a **regional living shorelines permit** by the Mobile Army Corps District will allow "soft" solutions to shoreline erosion to become more viable alternatives to shoreline hardening by streamlining the permitting process.

The participants identified key gaps that need to be filled to reduce the stressors and more effectively use these tools and strategies. Most commonly, they cited the following:

- **Outreach and education** for both the public and local/regional decision-makers to enhance effective planning, conservation, and management of wetlands.
- **Additional resources** to increase monitoring and assessment, compliance and enforcement efforts, and outreach programs.
- Widespread use and implementation of **watershed-based plans and land use planning**.
- **Clarifying CWA jurisdiction** and conducting studies on isolated wetlands (in Texas in particular).
- **Mapping and aerial photography** of coastal areas to aid in accurately tracking losses and assisting enforcement efforts.
- **Enhancing state and/or local programs** for wetland protection.
- Using smaller watersheds to guide the siting of **compensatory mitigation** so it occurs closer to the impact.
- **Oversight of silvicultural practices** is needed, beyond current BMPs.



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Appendix A: Participant Lists

GALVESTON BAY

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Appendix A: Participant Lists

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Scott Wilson, USGS

Appendix B: Document List

Document/Study Title	Author (Date)
GULF OF MEXICO AND EAST AND WEST GALVESTON BAY	
Wetlands Reserve Program	ADCNR (2008)
State of Alabama Coastal and Estuarine Land Conservation Program	ADCNR (2005)
Water Quality in Alabama 2004–2005	Alabama Cooperative Extension System (2006)
Coastal Wetlands of Alabama	Auburn University Marine Extension and Research Center—Sea Grant Extension (1996)
Historical and Projected Coastal Louisiana Land Changes: 1978–2050	Barras et al. [National Wetlands Research Center] (2004)
Results of the FHWA Domestic Scan of Successful Wetland Mitigation Programs	Center for Transportation and the Environment, North Carolina State University (2005)
Barrier Island Plan—Phase I: Evaluation and Recommendation of the Barrier Shoreline Feasibility Study—Final Report	CWPPRA (1997)
Wetlands Losses in the United States, 1780's to 1980's	Dahl, T.E. (1990)
Not All "Isolated" Wetlands Are Isolated: Evidence of Significant Nexus for Coastal Freshwater Wetlands	Dean, D., B. Wilcox, J. Jacob, and A. Sipocz (2011)
Mitigation Banking as an Endangered Species Conservation Tool	Environmental Defense (1999)
State Wetland Program Evaluation: Phase III	Environmental Law Institute (2007)
State Profile: State Wetland Protection: Status, Trends, & Model Approach	Environmental Law Institute (2008)
National Coastal Condition Report II, Chapter 5: Gulf of Mexico Coastal Condition	EPA (2005)
National Estuary Program Coastal Condition Report, Chapter 5: Gulf of Mexico National Estuary Program Coastal Condition, Galveston Bay Estuary Program	EPA (2007)
Wetlands Education Materials	EPA (2010)
Final Report: Freshwater Wetland Functional Assessment Study	Forbes, M., R. Doyle, A. Clapp, J. Yelderman, N. Enwright, and B. Hunter (2010)
Freshwater Wetland Functional Assessment Study (Draft Final Report)	Forbes, M., R. Doyle, J. Yelderman, A. Clapp, N. Enwright, B. Hunter (2010)
The Forever Wild Land Trust: An Interim Report to the Citizens of Alabama—1992 Through 2009	Forever Wild Land Trust (2009)
Living Shorelines: A Natural Approach to Erosion Control	Galveston Bay Foundation (n.d.)
Galveston Bay Plan	GBEP (1994)
Bay Briefings: Shoreline Management	GBEP (2006)
Bay Briefings: Habitat Protection	GBEP (2006)

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GULF OF MEXICO AND EAST AND WEST GALVESTON BAY (continued)	
Bay Briefings: Species Protection	GBEP (2006)
The Lower Galveston Bay Watershed: Potential Oil Spill Impacts (Presentation)	Gonzalez, L., and J. Lester (2010)
Our Estuary	Grand Bay Natural Estuarine Research Reserve
Protecting Coastal Wetlands	Grant, D. (2003)
Gulf of Mexico Alliance White Paper Restoration of Coastal Wetlands/Estuarine Ecosystems	Gulf of Mexico Alliance (2005)
Gulf of Mexico Alliance: Restoration of Coastal Wetlands and Estuarine Ecosystems	Gulf of Mexico Alliance (n.d.)
Wetland Importance	Gulf Restoration Network (2010)
Habitat Loss (Website)	Gulf Restoration Network (n.d.)
A Guide to Protecting Wetlands in the Gulf of Mexico	Gulf Restoration Network (2004)
Vulnerability of Coastal Wetlands in the Southeastern United States: Climate Change Research Results, 1992–1997, Chapter 1: Overview of Coastal Wetland Global Climate Change Research	Guntenspergen, G.R., B. A. Vairin, and V. Burkett (USGS-NWRC) (1998)
Southeast Wetlands Status and Trends, Mid-1970's to Mid-1980's	Hefner, J.M., B.O. Wilen, T.E. Dahl, and W.E. Frayer [USFWS] (1994)
Use of LIDAR in Wetland Delineation on Galveston Island, TX	Henry, R.J., and L.A. Gonzalez (n.d.)
The Resilient Coast: Policy Frameworks for Adapting the Wetlands to Climate Change and Growth in the Coastal Areas of the U.S. Gulf of Mexico	Jacob, J.S., and S. Showalter (2008)
Freshwater, Non-tidal Wetland Loss Lower Galveston Bay Watershed 1992–2002: A Rapid Assessment Method Using GIS and Aerial Photography	Jacob, J.S., and R. Lopez (2005)
Wetlands: Impact of Energy Development in the Mississippi Delta	Ko, J., and J.W. Day (2004)
Historical Trends in Wetlands Loss and Efforts to Intervene	Leininger, T., and P. Hamel (2007)
State of the Bay (3rd Edition)	Lester, L.J., and L.A. Gonzalez (2011)
Galveston Bay Status and Trends Project	Lester, L.J., and L.A. Gonzalez (2006)
The State of the Bay (2nd edition)	Lester, L.J., and L.A. Gonzalez, eds. (2002)
SONRIS	Louisiana Department of Natural Resources
Coastal Preserves Bureau Management Plan (MI)	MDOT (2008)
Wetland Restoration with Sediment Conveyance: An Experimental Approach to Reduce Uncertainties in Attaining Successful Restoration	Mendelssohn, I., and S. Graham (2010)

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GULF OF MEXICO AND EAST AND WEST GALVESTON BAY (continued)	
Coastal Wetlands of Alabama	Mississippi-Alabama Sea Grant Consortium
Wetlands: Status and Trends, Mid-1950s to Early 1990s	Moulton, D.W., T.E. Dahl, and D.M. Dall (1997)
Louisiana Wetlands Reserve Program	Natural Resources Conservation Service
Mississippi Wetlands Reserve Program	Natural Resources Conservation Service
Cumulative Acres Enrolled as of 2008	Natural Resources Conservation Service (2008)
Definition of High Resolution (Lidar) Northern Gulf Coast Geomorphology	Nayegandhi, A. [USGS] (2010)
Final Evaluation Findings: Alabama Coastal Area Management Program, December 2003 Through November 2007	NOAA (2008)
Beneficial Use of Dredge Material in Coastal Mississippi	NOAA (2005)
Evaluation Findings for the Louisiana Coastal Resources Program March 2002 through March 2005	NOAA (2005)
NWRC Education and Outreach	NWRC (2010)
Gulf of Mexico Research Plan	Sempier, S.H., K. Havens, R. Stickney, C. Wilson, and D.L. Swann (2009)
Wetlands, Fisheries, & Economics in the Gulf of Mexico	Stedman, S. and J. Hanson, NMFS
Status and Trends of Wetlands in Coastal Watersheds of the Eastern United States 1998 to 2004	Stedman, S. and T. E. Dahl (2008)
Potential Consequences of Saltwater Intrusion Associated with Hurricanes Katrina and Rita	Steyer, G.D., B.C. Perez, S. Piazza, and G. Suir
Galveston Bay Status & Trends Project 2004–2006	TCEQ (2006)
Voluntary Implementation of Forestry BMPs in East Texas	Texas Forest Service (2008)
Texas State Wetlands Conservation Plan	Texas Parks and Wildlife (1997)
Seagrass conservation plan for Texas	Texas Parks and Wildlife Department (1999)
Maps of Land Vulnerable to Sea Level Rise: Modeled Elevations Along the U.S. Atlantic and Gulf Coasts	Titus, J., and C. Richman (2001)
Wetland Loss in the Northern Gulf of Mexico; Multiple Working Hypotheses	Turner, R.E. (1997)
Coastal Wetlands and Global Climate Change: Gulf Coast Wetland Sustainability in a Changing Climate	Twilley, R.R. (LSU), and Pew Center on Global Climate Change (2007)
Beneficial Uses of Dredged Material (Website)	U.S. Army Corps of Engineers (accessed 2010)
EPA Region 6 CWPPRA (Website)	U.S. EPA (2008)
Wetland Losses in the United States: Scope, Causes, Impacts, and Future Prospects—USGCRP Seminar 7	USGCRP (1997)

Appendix B: Document List

GULF OF MEXICO AND EAST AND WEST GALVESTON BAY (continued)	
Louisiana Fact Sheet	USGS (1999)
Pre-Storm and Post-Storm 3D Lidar Topography: Bolivar Peninsula, TX (Website)	USGS (2008)
Galveston Bay: Estuarine and Marine Habitat Change Analysis	Webb, J.W. (2006)
Status and Trends of Wetland and Aquatic Habitats in the Galveston Bay System, Texas	White, W.A., T.A. Tremblay, E.G. Wermund, Jr., and L.R. Handley (1993)
Coastline Population Trends in the United States: 1960–2008	Wilson, S.G., and T. R. Fischetti (2010)
Socio-Economic Impact of Relative Sea Level Rise in Galveston Bay (Presentation)	Yoskowitz, D.W., J. Gibeaut, and A. McKenzie (2010)
Coastal Louisiana: Attempting to Restore an Ecosystem	Zinn, J. (2004)
CRS Report to Congress, Coastal Louisiana: Attempting to Restore an Ecosystem	Zinn, J. [Congressional Research Service] (2004)
Wetlands Reserve Program	ADCNR (2008)
MISSISSIPPI COASTAL WATERSHED	
Mississippi	Association of State Wetland Managers (2006)
State of the Beach: State Report: Mississippi	Beachapedia (2011)
Wetland Mitigation Banking Study	Environmental Law Institute
State Wetland Protection: Status, Trends, & Model Approaches	Environmental Law Institute (2008)
NOAA Restoration Center	Fish America Foundation (2008)
Beyond Recovery: Moving the Gulf Toward a Sustainable Future	Gordon et al. (2011)
Our Estuary (Website)	Grand Bay Natural Estuarine Research Reserve
Coastal Mississippi-Alabama Initiative Area	Gulf Coast Joint Venture (2005)
Resource Database for Gulf of Mexico Research	GulfBase (2011)
Estuaries Are Nursery for Gulf's Seafood	Harman (2003)
Mississippi	MASGLP
Wetlands Protection	MDEQ (2007)
Coastal Management and Planning (Website)	MDMR
Mississippi's Coastal Wetlands	MDMR (1999)
Coastal Wetland Protection Act	MDMR (2003)
Coastal Preserves Bureau Management Plan	MDOT (September 2008)

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MISSISSIPPI COASTAL WATERSHED (continued)	
Mississippi's Comprehensive Wildlife Conservation Strategy	MDWFP (2009)
Through a Fish's Eye: The Status of Fish Habitats in the United States 2010	National Fish Habitat Board (2010)
Mississippi Wetlands Reserve Program	Natural Resources Conservation Service
What's at Stake: The Economic Value of the Gulf of Mexico's Ocean Resources	Natural Resources Defense Council (2010)
Mississippi's Coastal Program	NOAA (2010)
Evaluation Findings for Mississippi Coastal Management Program from January 2002 to December 2004	NOAA (2005)
Beneficial Use of Dredge Material in Coastal Mississippi	NOAA (2005)
Assessment of Coastal Water Resources and Watershed Conditions at Gulf Islands National Seashore (Florida and Mississippi)	NPS (2005)
Clean Water Act Status: Mississippi Coastal Watershed	Scorecard (2005)
Historical Trends in Wetlands Loss and Efforts to Intervene	Ted Leininger and Paul Hamel (2007)
Conservation Partnerships	The Nature Conservancy
Imperial Palace Casino Donates $1 Million to Coastal Preservation	The Nature Conservancy (2010)
SLAMM Analysis of Grand Bay NERR and Environs	The Nature Conservancy and the Gulf of Mexico Initiative (2011)
DMR Reminds Boaters That Motorized Vehicles Are Prohibited by Law in Mississippi Coastal Preserves	Thompson (2010)
Coastal Wetlands & Global Climate Change: Gulf Coast Wetland Sustainability in a Changing Climate	Twilley (2007)
Mississippi Delta	Union of Concerned Scientists (2009)

Appendix C: Section 404 of the Clean Water Act

Overview: Section 404 of the Clean Water Act establishes a permit program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. Activities in waters of the United States regulated under this program include fill for associated with development, water resource projects (such as dams and levees that are not part of the construction of federal projects specifically authorized by Congress), infrastructure development (such as highways and airports) and mining projects.

Under a rule promulgated pursuant to Section 404(b)(1) of the Clean Water Act, no discharge of dredged or fill material may be permitted if: (1) a practicable alternative exists that is less damaging to the aquatic environment so long as that alternative does not have other significant adverse environmental consequences or (2) the nation's waters would be significantly degraded. Section 404 permitting ensures that dredge and fill projects only proceed if an applicant first has shown that steps have been taken to avoid impacts to wetlands, streams, and other aquatic resources; that potential impacts have been minimized; and — only after the first two measures have been taken — that compensation is provided for all remaining unavoidable impacts.

Permits: Proposed activities are regulated through a permit review process. An **individual permit** is required for projects with more than minimal adverse effects. Individual permits are reviewed by the Army Corps, which evaluates applications under a public interest review, as well as the environmental criteria set forth in the Section 404(b)(1) Guidelines promulgated by EPA in conjunction with the Army Corps. However, for most discharges that will have only minimal adverse effects, a **general permit** may be suitable. General permits are issued on a nationwide, regional, or state basis for particular categories of activities. The general permit process eliminates individual review and allows certain activities to proceed with little or no delay, provided that the general, regional, and any special conditions for the general permit are met. For example, minor road activities, utility line backfill, and bedding are activities that can be considered for a general permit. For more information, see: http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/ and http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx.

Jurisdiction: Though a number of activities may impact the nation's waters, Section 404 applies to **dredge and fill activities** only (Section 402 of the Clean Water Act regulates point source discharges of pollutants into waters of the United States). Additionally, the Clean Water Act only applies to "**waters of the United States**." EPA and the Army Corps have issued regulatory definitions of "waters of the United States" to include waters that are: traditionally navigable; interstate; could affect interstate commerce if used, degraded, or destroyed; territorial seas; impoundments of jurisdictional waters; tributaries of jurisdictional waters; and wetlands adjacent to jurisdictional waters. The agencies' regulatory definition of "waters of the United States" provides exclusions for waste treatment systems and prior converted cropland. U.S. Supreme Court decisions in *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers* and *Rapanos v. United States* and subsequent agency guidance have provided further interpretation of which waterbodies are protected by the Clean Water Act. For the most recent guidance on Clean Water Act geographic jurisdiction, see: http://water.epa.gov/lawsregs/guidance/wetlands/CWAwaters.cfm. Lastly, the **regulatory definition of wetlands**, "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions," may exclude some areas which are defined as wetlands for other purposes (e.g., under the Cowardin classification system).

Exemptions: In general, Section 404 of the Clean Water Act requires permits for the discharge of dredged or fill material into waters of the United States, including wetlands. However, certain activities are exempt from permit requirements under Section 404(f). These include dredge and fill activities related to established (ongoing) farming, silviculture, or ranching practices; certain temporary activities; and certain maintenance activities (e.g., of drainage ditches, farm ponds, or stock ponds). The exemptions are limited in their application. For example, a permit must be obtained for an activity whose purpose is to convert an area of the waters of the United States into a use to which it was not previously subject, where the flow or circulation of waters of the United States may be impaired, or the reach of such waters reduced (33 CFR 323.4). Some projects are also required to implement Best Management Practices in order to remain exempt. See http://water.epa.gov/type/wetlands/outreach/fact20.cfm for more information regarding Section 404 exemptions.

Mitigation: Compensatory mitigation involves actions taken to offset unavoidable adverse impacts to wetlands, streams, and other aquatic resources authorized by Section 404 permits and other Department of the Army permits. Compensatory mitigation can be carried out through four methods: the restoration of a previously existing or degraded wetland or other aquatic site, the enhancement of an existing aquatic site's functions, the establishment (i.e., creation) of a new aquatic site, or the preservation of an existing aquatic site. For impacts authorized under Section 404, compensatory mitigation is not considered until after all appropriate and practicable steps have been taken to first avoid and then minimize

adverse impacts to the aquatic ecosystem. For more information, see: http://water.epa.gov/lawsregs/guidance/wetlands/wetlandsmitigation_index.cfm.

Compensatory Mitigation Rule: In 2008, the Army Corps and EPA issued regulations governing compensatory mitigation for activities authorized by permits issued by the Department of the Army (see http://water.epa.gov/lawsregs/guidance/wetlands/upload/2008_04_10_wetlands_wetlands_mitigation_final_rule_4_10_08.pdf). The regulations establish performance standards and criteria for the use of permittee-responsible compensatory mitigation, mitigation banks, and in-lieu programs to improve the quality and success of compensatory mitigation projects for permitted activities. This rule improves the planning, implementation, and management of compensatory mitigation projects by emphasizing a watershed approach in selecting compensatory mitigation project locations, requiring measurable, enforceable ecological performance standards and regular monitoring for all types of compensation, and specifying the components of a complete compensatory mitigation plan, including assurances of long-term protection of compensation sites, financial assurances, and identification of the parties responsible for specific project tasks. Since a mitigation bank must have an approved mitigation plan and other assurance in place before any of its credits can be used to offset impacts, this rule establishes a preference for the use of mitigation bank credits, which reduces some of the risks and uncertainties associated with compensatory mitigation.

Mitigation Bank: Mitigation banking involves off-site compensation activities generally conducted by a third-party mitigation bank sponsor. A mitigation bank is a site, or suite of sites, where aquatic resources (e.g., wetlands, streams, riparian areas) are restored, established, enhanced, and/or preserved for the purpose of providing compensatory mitigation for impacts authorized by Department of the Army permits. In general, a mitigation bank sells compensatory mitigation credits to permittees to meet their requirements for compensatory mitigation. The value of these "credits" is determined by quantifying the aquatic resource functions or acres restored or created. The bank sponsor is ultimately responsible for the success of the project.

In-lieu Fee Mitigation: In-lieu fee mitigation involves off-site compensation activities generally conducted by a third party in-lieu fee program sponsor. Through an in-lieu fee program, a governmental or non-profit natural resources management entity collects funds from multiple permittees in order to pool the financial resources necessary to build and maintain the mitigation site or suite of sites. The in-lieu fee sponsor is responsible for the success of the mitigation. In-lieu fee mitigation typically occurs after the permitted impacts.

Permittee-Responsible Mitigation: Permittee-responsible mitigation is the restoration, establishment, enhancement, or preservation of aquatic resources undertaken by a permittee in order to compensate for impacts resulting from a specific project. The permittee performs the mitigation after the permit is issued and is ultimately responsible for implementation and success of the mitigation. Permittee-responsible mitigation may occur at the site of the permitted impacts or at an off-site location within the same watershed.

Roles & Responsibilities:

Federal Agencies: The roles and responsibilities of the federal resource agencies differ in scope. The Army Corps administers the day-to-day aspects of the program, makes individual and general permit decisions, and makes determinations regarding the extent and location of jurisdictional waters of the United States. The Army Corps and EPA jointly develop policy and guidance, such as the environmental criteria used in evaluating permit applications. EPA determines the scope of geographic jurisdiction and applicability of exemptions; approves and oversees state and tribal assumption; reviews and comments on individual permit applications; has authority to prohibit, deny, or restrict the use of any defined area as a disposal site; and can elevate specific cases under Section 404(q). In addition to jointly implementing the Section 404 program, EPA and the Army Corps share Section 404 enforcement authority, which is delineated in a 1989 Memorandum of Agreement. The Army Corps acts as the lead enforcement agency for all violations of Corps-issued permits. The Army Corps also acts as the lead enforcement agency for unpermitted discharge violations that do not meet the criteria for forwarding to EPA. EPA acts as the lead enforcement agency when an unpermitted activity involves repeat violator(s), flagrant violation(s), where EPA requests a class of cases or a particular case, or the Army Corps recommends that an EPA administrative penalty action may be warranted.

The U.S. Fish and Wildlife Service (USFWS) and NOAA's National Marine Fisheries Service evaluate impacts on fish and wildlife of all new federal projects and federally permitted projects, including projects subject to the requirements of Section 404 (pursuant to the Fish and Wildlife Coordination Act), and can elevate specific cases or policy issues pursuant to Section 404(q).

States and Tribes: States and tribes also have a role in Section 404 decisions, through state program general permits, water quality certification, or program assumption. Under Section 401 of the Clean Water Act, a federal agency may not issue a permit or license for an activity that may result in a discharge to waters of the United States until the state or tribe where the discharge would originate has granted or waived Section 401 certification. Pursuant to Section 401, a state or tribe may grant, grant with conditions, deny or waive 401 certification. States and tribes make their decisions to deny, certify, or condition permits or licenses based in part on the proposed project's compliance with EPA-approved water quality standards. Through 401 certifications, states and tribes can limit dredge and fill activities or require additional protective requirements.

State programmatic general permits (SPGPs) may be issued by the Army Corps in coordination with states or tribes to allow a state or tribe to review Section 404 permit applications and verify activities without additional Army Corps review, provided the activities have no more than minimal adverse effects individually and cumulatively. SPGPs are often limited to specific activities, geographic areas, resource types, and/or sizes of impacts and can provide a more streamlined permitting process for these activities.

In addition, the Clean Water Act gives states and tribes the option of assuming administration of the federal Section 404 permit program in certain waters within state or tribal jurisdiction. State/tribal assumed programs must be at least as comprehensive as the federal program.

Furthermore, more than a dozen states have developed their own permit programs, which they operate in coordination with the federal program. In some cases, state programs may protect a greater number of aquatic resources than fall under federal jurisdiction as waters of the United States. States may also have their own wetland mitigation, enforcement, and monitoring programs.

Data & Information:

Public Notice: The Army Corps issues public notices to alert the public to new applications for Section 404 permits. Contained in this notice is a project description including the location, the activity, the estimated impacted acres, and details on the conceptual mitigation plan. Subsequent to the release of a public notice, the Army Corps initiates a comment period, usually lasting about 30 days, where the public can submit written comments or request a public hearing. Public notices are posted on the website of the issuing Army Corps District.

Permits: Permit records can be used to summarize and track wetland losses and gains in an area of interest, and to confirm the compliance of a particular dredge and fill project. For this reason, final Section 404 permit information is stored in a database operated by the Army Corps ("Operation and Maintenance Information Business Link Regulatory Module 2," or ORM2). ORM2 has been in operation since 2007. Some states with permit programs operate similar databases which can supplement federal permit information.

Mitigation: The "Regulatory In-lieu fee and Bank Information Tracking System" (RIBITS) is an online database developed by the Army Corps with support from EPA and USFWS to provide better information on mitigation and conservation banking and in-lieu fee programs across the country. RIBITS allows users to access information on the types and numbers of mitigation and conservation bank and in-lieu fee program sites, associated documents, mitigation credit availability, service areas, as well as information on national and local policies and procedures that affect mitigation and conservation bank and in-lieu fee program development and operation. For access, see: http://geo.usace.army.mil/ribits.

Appendix D: NOAA Coastal Change Analysis Program

The Coastal Change Analysis Program (C-CAP) produces a nationally standardized database of land cover and land change information for the coastal regions of the United States. C-CAP products provide inventories of coastal intertidal areas, wetlands, and adjacent uplands, with the goal of monitoring these habitats by updating the land cover maps every five years.

C-CAP products are developed using multiple dates of Landsat (30-meter resolution) imagery and consist of raster based land cover maps for each date of analysis, as well as a file that highlights what changes have occurred between these dates and where the changes were located. C-CAP land cover is produced through documented, repeatable procedures using standard data sources, and includes extensive field sampling, validation, and standard quality control review procedures. It provides the "coastal expression" of the National Land Cover Database, a contribution to the Earth Cover layer of the National Spatial Data Infrastructure.

C-CAP data sets are not jurisdictional or intended for use in litigation. While efforts have been made to ensure that these data are accurate and reliable within the limits of current technology, NOAA cannot assume liability for any damages or misrepresentations caused by inaccuracies in the data, or as a result of the data to be used on a particular system. NOAA makes no warranty, expressed or implied, nor does the fact of distribution constitute such a warranty.

The intended use is in identifying regional landscape patterns and major functional niches (habitat), and for environmental impact assessment, urban planning, and zoning applications. C-CAP data will not identify individual species. This is a national and regional data set that should be used only as a screening tool for very local or site specific management decisions. Small features and changes should be verified with a higher resolution data source.

C-CAP Wetland Classifications

Wetlands are areas dominated by saturated soils and often standing water. Their vegetation is adapted to withstand long-term immersion and saturated, oxygen-depleted soils. Wetlands are divided into two salinity regimes: palustrine for freshwater wetlands and estuarine for saltwater wetlands; they are further divided into forested, shrub/scrub, and emergent wetlands. Unconsolidated shores are also included as wetlands.

Palustrine forested wetland: Includes all tidal and non-tidal wetlands dominated by woody vegetation at least 5 meters in height, as well as all such wetlands in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Total vegetation coverage is greater than 20 percent.

Characteristic species: Tupelo *(Nyssa),* cottonwood *(Populus deltoides),* bald cypress *(Taxodium distichum),* American elm *(Ulmus americana),* ash *(Fraxinus),* and tamarack.

Palustrine scrub/shrub wetland: Includes all tidal and non-tidal wetlands dominated by woody vegetation less than 5 meters in height, as well as all such wetlands in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Total vegetation coverage is greater than 20 percent. The species present could be true shrubs, young trees and shrubs, or trees that are small or stunted due to environmental conditions.[1]

Characteristic species: Alders *(Alnus spp.),* willows *(Salix spp.),* buttonbush *(Cephalanthus occidentalis),* red osier dogwood *(Cornus stolonifera),* honeycup *(Zenobia pulverenta),* spirea *(Spiraea douglassii),* bog birch *(Betula pumila),* and young trees such as red maple *(Acer rubrum)* and black spruce *(Picea mariana).*

Palustrine emergent wetland (persistent): Includes all tidal and non-tidal wetlands dominated by persistent emergent vascular plants, emergent mosses, or lichens, as well as all such wetlands in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Plants generally remain standing until the next growing season. Total vegetation cover is greater than 80 percent.

Characteristic species: Cattails *(Typha spp.),* sedges *(Carex spp.),* bulrushes *(Scirpus spp.),* rushes *(Juncus spp.),* saw grass *(Cladium jamaicaense),* and reed *(Phragmites australis).*

Estuarine forested wetland: Includes all tidal wetlands dominated by woody vegetation at least 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.5 percent. Total vegetation coverage is greater than 20 percent.

Characteristic species: red mangrove *(Rhizophora mangle),* black mangrove *(Avicennia germinans),* and white mangrove *(Languncularia racemosa).*

[1] Reference: Cowardin, L. M., V. Carter, F. C. Golet, and E. T. Laroe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31. U. S. Department of the Interior, Fish and Wildlife Service.

Estuarine scrub/shrub wetland: Includes all tidal wetlands dominated by woody vegetation less than 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.5 percent. Total vegetation coverage is greater than 20 percent.

Characteristic species: Sea-myrtle *(Baccharis halimifolia)* and marsh elder *(Iva frutescens).*

Estuarine emergent wetland: Includes all tidal wetlands dominated by erect, rooted, herbaceous hydrophytes (excluding mosses and lichens), and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is at least 0.5 percent and that are present for most of the growing season in most years. Perennial plants usually dominate these wetlands. Total vegetation cover is greater than 80 percent.

Characteristic species: Cordgrass *(Spartina spp.),* needlerush *(Juncus roemerianus),* narrow-leaved cattail *(Typha angustifolia),* southern wild rice *(Zizaniopsis miliacea),* common pickleweed *(Salicornia virginica),* sea blite *(Suaeda californica),* and arrow grass *(Triglochin martimum).*

Unconsolidated shore: Unconsolidated material such as silt, sand, or gravel that is subject to inundation and redistribution due to the action of water. Characterized by substrates lacking vegetation except for pioneering plants that become established during brief periods when growing conditions are favorable. Erosion and deposition by waves and currents produce a number of landforms representing this class.

Characteristic land cover features: Beaches, bars, and flats.

Barren land: Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earth material. Generally, vegetation accounts for less than 10 percent of total cover.

Characteristic land cover features: Quarries, strip mines, gravel pits, dunes, beaches above the high-water line, sandy areas other than beaches, deserts and arid riverbeds, and exposed rock.

Open water: All areas of open water, generally with less than 25 percent cover of vegetation or soil.

Characteristic land cover features: Lakes, rivers, reservoirs, streams, ponds, and ocean.

Palustrine aquatic bed: Includes tidal and non-tidal wetlands and deepwater habitats in which salinity due to ocean-derived salts is below 0.5 percent and which are dominated by plants that grow and form a continuous cover principally on or at the surface of the water. These include algal mats, detached floating mats, and rooted vascular plant assemblages. Total vegetation cover is greater than 80 percent.

Characteristic vascular species: Pondweed, horned pondweed *(Zannichellia palustris),* ditch grass *(Ruppia),* wild celery, waterweed *(Elodea),* riverweed *(Podostemum ceratophyllum),* water lilies *(Nymphea, Nuphar),* floating-leaf pondweed *(Potamogeton natans),* water shield *(Brasenia schreberi),* and water smartweed *(Polygonum amphibium).*

Floating surface species: Duckweeds *(Lemna, Spirodela),* water lettuce *(Pista stratiotes),* water hyacinth *(Eichhornia crasspies),* water nut *(Trapa natans),* water fern *(Salvinia spp.),* and mosquito ferns *(Azolla).*

Floating below-surface species: Bladderworts *(Utricularia),* coontails *(Ceratophyllum),* and watermeals *(Wolffia).*

Estuarine aquatic bed: Includes tidal wetlands and deepwater habitats in which salinity due to ocean-derived salts is equal to or greater than 0.5 percent and which are dominated by plants that grow and form a continuous cover principally on or at the surface of the water. These include algal mats, kelp beds, and rooted vascular plant assemblages. Total vegetation cover is greater than 80 percent.

Characteristic species: Kelp *(Macrocystis and Laminaria),* rockweeds *(Fucus and Ascophyllum),* red algae *(Laurencia),* green algae *(Halimeda and Penicillus, Caulerpa, Enteromorpha and Ulva),* stonewort *(Chara),* turtle grass *(Thalassia testudinum),* shoal grass *(Halodule wrightii),* manatee grasses *(Cymodocea filiformis),* widgeon grass *(Ruppia maritime),* sea grasses *(Halophila spp.),* and wild celery *(Vallisneria americana).*

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AGENCY	PROGRAM	DESCRIPTION
EPA	Clean Water State Revolving Fund (CWSRF)	CWSRF programs fund water quality protection projects for wastewater treatment, non-point source pollution control, and watershed and estuary management via low-interest loans. SRF fundable projects include wetland protection and restoration, as well as creation of constructed wetlands for stormwater or wastewater treatment (which can include adequate capacity to ensure habitat values as well as treatment of effluents). http://water.epa.gov/grants_funding/cwf/cwsrf_index.cfm
EPA	Ecological Research Program	The Ecological Research Program in EPA's Office of Research and Development is studying ecosystem services to gain a better understanding of how to enhance, protect, and restore the services of nature. Scientists are providing the methods, models, and tools needed by policy decision-makers to make clear how our choices affect the type, quality, and magnitude of the services we receive from ecosystems. The primary objective in the wetland research focus area is to document the range and quantity of wetland services and determine how their position on the landscape alters the provision of ecosystem services. http://www.epa.gov/research/npd/ecoresearch-intro.htm
EPA	Five Star Challenge Grants Program	The purpose of the program is to support community-based efforts to restore wetlands, river streams/corridors, and coastal habitat; build diverse partnerships within the community; and foster local stewardship of resources through education, outreach, and training activities. http://www.nfwf.org/fivestar/
EPA	National Estuary Program (NEP)	This program works to restore and maintain the water quality and ecological integrity of estuaries of national significance. EPA provides funding and technical assistance to NEPs to create and implement a Comprehensive Conservation and Management Plan (CCMP) to address problems facing their estuary and surrounding watershed. NEPs involve community members and other key federal, state, and local partners/stakeholders to articulate goals and actions to address the wide range of issues in their CCMP. Key CCMP focus areas include protecting and restoring habitats such as wetlands. There are 28 NEPs along the coasts each guided by a director and staff. http://water.epa.gov/type/oceb/nep/index.cfm
EPA	Nonpoint Source Management Grants (Section 319 Grants)	Nonpoint source management grants support states, territories, and Indian tribes with a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects, some of which include coastal wetland restoration projects. A state/territory/tribe's Nonpoint Source Management Program serves as the basis for how funds are spent. http://www.epa.gov/owow_keep/NPS/cwact.html

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AGENCY	PROGRAM	DESCRIPTION
EPA	Wetlands Program Development Grants (WPDG)	The Wetlands Program Development Grants give eligible applicants an opportunity to conduct projects that promote the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. While WPDGs can be used by recipients to build and refine any element of a comprehensive wetland program, priority will be given to funding projects that address the three priority areas identified by EPA: developing a comprehensive monitoring and assessment program; improving the effectiveness of compensatory mitigation; and refining the protection of vulnerable wetlands and aquatic resources. States, tribes, local governments, interstate associations, intertribal consortia, and national nonprofit, non-governmental organizations are eligible to apply. http://water.epa.gov/grants_funding/wetlands/grantguidelines/index.cfm
FHWA	Project Funds	All federal highway projects require mitigation for unavoidable wetland impacts. FHWA mitigation regulations require a net gain of wetland acres for new project impacts as well as retroactive for past project impacts.
FHWA	Surface Transportation Environment and Planning Cooperative Research Program (STEP)	STEP is a federally administered research program authorized in the "Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users" (SAFETEA-LU). It improves the understanding of the relationship between surface transportation, environment and planning. STEP implements a national research agenda reflecting national priorities based on input and feedback from partners and stakeholders. STEP funds identify, address, and reassess national research priorities for environment, planning and realty, and develop tools to support these areas. STEP environmental emphasis areas include air quality and global climate change; and water/wetlands/vegetation/wildlife habitat/brownfields. http://www.fhwa.dot.gov/hep/step/
FHWA	Transportation Enhancements	Transportation Enhancement (TE) activities offer funding opportunities to help expand transportation choices and enhance the transportation experience through 12 eligible TE activities related to surface transportation, including landscaping and scenic beautification and environmental mitigation. http://www.fhwa.dot.gov/environment/te/
FWS	Coastal Barrier Resources Act (CBRA)/ Coastal Barrier Resources System (CBRS)	CBRA discourages development on 3.1 million acres of coastal barrier and associated aquatic habitat by prohibiting most federal expenditures (e.g., flood insurance, road construction, new channel dredging). These areas are designated on maps adopted by Congress as the John H. Chafee Coastal Barrier Resources System. In addition to providing a level of protection to 3.1 million acres, CBRA is estimated to have saved taxpayers over $1 billion.
FWS	Coastal Program	Voluntary partnership program to protect, restore, and enhance priority coastal habitat that benefits federal trust species on public and private lands. It provides technical and financial assistance through partnerships with federal, state, local governments; tribes; organizations; academic institutions; and private landowners. The program is delivered through a network of field staff in 23 priority coastal watersheds around the country. Assistance instruments are primarily cooperative agreements but grant agreements and wildlife extension agreements are also used. Decisions regarding partnerships are made at the landscape level. Since 1994, the Coastal Program has executed over 2,000 agreements to restore 295,000 acres of coastal habitat and 1,700 stream miles, and protect close to 2 million acres of coastal habitat. http://www.fws.gov/coastal

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AGENCY	PROGRAM	DESCRIPTION
FWS	Cooperative Endangered Species Conservation Fund	The Cooperative Endangered Species Conservation Fund (CESCF; Section 6 of the Endangered Species Act) is the component of the FWS Endangered Species program that provides grant funding to states and territories for species and habitat conservation actions on non-federal lands, including habitat acquisition, conservation planning, habitat restoration, status surveys, captive propagation and reintroduction, research, and education. Many of these grants involve coastal areas and wetland habitat. http://www.fws.gov/endangered/grants/grant-programs.html
FWS	Endangered Species Conservation Grants	Provides financial assistance to states and territories to implement conservation projects for listed species and at-risk species. Funded activities include habitat restoration, species status surveys, public education and outreach, captive propagation and reintroduction, nesting surveys, genetic studies, and development of management plans. http://www.fws.gov/endangered/grants/grant-programs.html
FWS	Endangered Species HCP Land Acquisition Grants	Provides funding to states and territories to acquire land associated with approved Habitat Conservation Plans (HCP). Grants do not fund the mitigation required of an HCP permittee; instead, they support conservation actions by the state or local governments that complement mitigation. http://www.fws.gov/endangered/grants/grant-programs.html
FWS	Endangered Species Program	The Endangered Species Program conserves imperiled plant and animal species and the ecosystems upon which they depend, while promoting the voluntary conservation of other vulnerable wildlife and their habitat. The program strives to ensure a strong scientific basis for decisions on threatened and endangered species, facilitate large-scale planning to accommodate land use and wildlife habitat, and promote innovative public/private partnerships. Components of the program include technical assistance, outreach and education, grant assistance, and regulatory actions. Many activities involve efforts to conserve coastal areas and wetlands provide important habitat for threatened or endangered species, species at risk of becoming threatened or endangered. http://www.fws.gov/endangered/
FWS	Endangered Species Recovery Land Acquisition Grants	Provides funds to states and territories for acquisition of habitat for endangered and threatened species in support of draft and approved recovery plans. Acquisition of habitat to secure long-term protection is often an essential element of a comprehensive recovery effort for a listed species. http://www.fws.gov/endangered/grants/grant-programs.html
FWS	Migratory Bird Conservation Fund	Provides the DOI with financing for the acquisition of migratory bird habitat, including wetlands. Decisions regarding purchases of land and water areas by FWS are made by the Migratory Bird Conservation Commission based on recommendations from the Service. The Small Wetland Program allows the proceeds from the sale of Federal Duck Stamps to be used to protect waterfowl habitat in perpetuity through fee-title acquisition or easement. The habitat protected consists of small wetlands, and surrounding grassland habitat in the Prairie Pothole Region. Since its creation 50 years ago, the program has protected nearly 3 million acres of habitat. http://www.fws.gov/duckstamps/Conservation/mbcc.htm

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AGENCY	PROGRAM	DESCRIPTION
FWS	National Coastal Wetlands Conservation Grant Program	Authorized by the Coastal Wetlands Planning, Protection, and Restoration Act of 1990. Co-administered by the Coastal Program and the Wildlife and Sport Fish Restoration Program. Annually provides grants of up to $1 million to coastal states, including Great Lakes states, to acquire and restore coastal wetlands. Coastal states are eligible applicants. Program requires cost share of between 50 and 75 percent of the grant request depending on whether the state has an open-space conservation program. Ineligible activities include planning, research, monitoring, and construction or repair of structures for recreational purposes. A national ranking panel made up of FWS biologists recommends a list of projects for funding to the Director. http://www.fws.gov/coastal/CoastalGrants/
FWS	National Fish Passage Program	Voluntary program that provides technical and financial assistance to fish passage barrier removal or bypass projects. The goal of the program is to restore native fishes and other aquatic species to self-sustaining levels by reconnecting habitat that has been fragmented by barriers. Project applications are reviewed and prioritized on a regional basis. Financial assistance is delivered through the regional and local Fish and Wildlife Conservation Offices. The program strives to achieve a 50 percent match overall, including in-kind contributions. Non-federal funds are typically leveraged at a 3:1 ratio. The program uses the National Fish Passage Decision Support System, which catalogues fish passage barriers nationally. Fish passage projects are not eligible for funding if they are eligible for any federal or state compensatory mitigation or if fish passage is a condition provided by existing federal or state regulatory programs. Since 1999, the program has worked with over 700 different partners to remove 749 barriers, and reopen 11,249 miles of river and 80,556 acres to fish passage, benefitting over 85 federal trust fish and other aquatic species. http://www.fws.gov/fisheries/fwco/fishpassage
FWS	National Wetlands Inventory (NWI)	Provides information on the characteristics, extent, and status of U.S. wetlands and deepwater habitats and other wildlife habitats. NWI produces periodic reports on the status and trends of wetlands in the conterminous U.S., which is used for policymaking, assessment, and monitoring. NWI has developed a series of topical maps to show wetlands and deepwater habitats. This geospatial information is used by Congress; federal, state, and local agencies; academic institutions; and the private sector to inform natural resource planning, management, and project development. The NWI website provides a portal to the Wetlands Geodatabase and the Wetlands Mapper, which provide technological tools that allow the integration of large relational databases with spatial information and map-like displays. The Service's wetland data forms a layer of the National Spatial Data Infrastructure. http://www.fws.gov/nwi
FWS	National Wildlife Refuge System (NWRS)	180 of the 552 refuges in the NWRS manage 121 million acres of marine or coastal habitat. Approximately one-quarter of the 150 million-acre NWRS consists of wetlands. The NWRS protects, restores, maintains, and conducts research on these wetlands. The NWRS sustains wetlands to support healthy populations of federal trust species, including threatened and endangered species, migratory birds, interjurisdictional fish, some marine mammals, and many plants. Wetlands in the NWRS provide opportunities for research and outdoor recreational pursuits for the American public. http://www.fws.gov/refuges

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AGENCY	PROGRAM	DESCRIPTION
FWS	Natural Resource Damage Assessment and Restoration Program (NRDAR)	The NRDAR program restores wetland acres that have been harmed by the release of contaminants from hazardous waste sites, and oil and chemical spills. Where possible, FWS partners with other federal agencies, other FWS programs, states, tribes, or non-governmental organizations to enlarge these restoration efforts, which enhances the value of the restoration to fish and wildlife. In FY 2009, the NRDAR program was responsible for the restoration and enhancement of over 23,000 wetland acres and for the protection of nearly 41,000 wetland acres. In addition, the program restored or enhanced 186 riparian stream miles and managed or protected 383 riparian stream miles. The Division of Environmental Quality provides approximately $1.5 million in toxicology, ecology, and habitat restoration expertise to EPA and other federal and state partners to minimize impacts to wetlands dur-ing the cleanup of contaminated areas. http://www.fws.gov/contaminants/Issues/Restoration.cfm
FWS	North American Waterfowl Management Plan—Joint Ventures	Collaborative, regionally based partnership of U.S. and Canadian agencies, nonprofit organizations, corporations, tribes, or individuals that conserves habitat for priority bird species within a specific geographic area. Designed to achieve the regional conservation goals identified in the North American Waterfowl Management Plan. 18 habitat joint ventures and three species specific joint ventures. Activities include biological planning, conservation design, and prioritization; project development and implementation; monitoring, evaluation, applied research; communications, education, and outreach; funding support for projects. To date, joint ventures have invested $4.5 billion to conserve 15.7 million acres of waterfowl habitat. http://www.fws.gov/birdhabitat/nawmp
FWS	North American Wetlands Conservation Grants (NAWCA)	Supports activities under the North American Waterfowl Management Plan, an international agreement that provides a strategy for the long-term protection of wetlands and associated upland habitats needed by waterfowl and other wetland-associated migratory birds in North America. Provides competitive grants to non-governmental organizations, states, local governments, tribes, and individuals to carry out wetland conservation projects in the United States, Canada, and Mexico for the benefit of wetland-associated migratory birds and other wildlife. Projects must provide long-term protection, restoration, and enhancement of wetlands and associated upland habitats. Mexican partnerships may also develop training, educational, and management programs and conduct sustainable-use studies. Standard grants: From FY 1990 to June 2010, some 3,850 partners in 1,518 projects have received more than $1.03 billion in grants. They have contributed another $2.06 billion in matching funds to affect 25.5 million acres of habitat and $1.14 billion in non-matching funds to affect 230,900 acres of habitat. Small grants: From FY1990 to FY 2009, some 1,160 partners in 455 projects have received more than $22.9 million in grants. They have contributed another $101 million in matching funds to affect 172,600 acres of habitat and $57.4 million in non-matching funds to affect 7,400 acres of habitat. http://www.fws.gov/birdhabitat/Grants/NAWCA
FWS	Partners for Fish and Wildlife Program	Voluntary partnership program to restore and enhance priority fish and wildlife habitat on private lands. Provides technical and financial assistance through partnerships with landowners. Delivered through locally based field biologists in each state. Assistance instruments are primarily cooperative agreements. Decisions regarding partnerships are made at the landscape level. Since 1987 the Program has worked with over 42,000 private landowners and restored 975,000 acres of wetlands, 3,000,000 acres of uplands, and 8,700 miles of stream habitat. Statutory authority: Partners for Fish and Wildlife Act of 2006. http://www.fws.gov/partners

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AGENCY	PROGRAM	DESCRIPTION
NOAA	Coastal and Estuarine Land Conservation Program (CELCP)	CELCP, part of the Coastal Zone Management Program, was established in 2002 to protect coastal and estuarine lands considered important for their ecological, conservation, recreational, historical or aesthetic values. The NOAA Ocean Service program provides state and local governments with matching funds to purchase significant coastal and estuarine lands, or conservation easements on such lands, from willing sellers. Lands or conservation easements acquired with CELCP funds are protected in perpetuity so that they may be enjoyed by future generations. http://coastalmanagement.noaa.gov/land/welcome.html
NOAA	Coastal Zone Management Program	The Coastal Zone Management Program supports state planning and programs to protect coastal resources, including wetlands. The NOAA Ocean Service program is a voluntary partnership between the federal government and U.S. coastal and Great Lakes states that takes a comprehensive approach to coastal resource management by balancing the often competing and occasionally conflicting demands of coastal resources use, economic development, and conservation. http://coastalmanagement.noaa.gov/programs/czm.html
NOAA	Coastal Zone Enhancement Program (CZARA Section 309)	The Coastal Zone Enhancement Program, a part of the NOAA Ocean Service Coastal Zone Management Program, is designed to encourage states and territories to develop program changes in one or more of the nine coastal zone enhancement areas of national significance, including wetlands. Every five years, state coastal management programs conduct self-assessments of their programs' activities within the nine enhancement areas to help target the Section 309 funds toward program needs. http://coastalmanagement.noaa.gov/enhanc.html
NOAA	Coastal Zone Nonpoint Pollution Program (CZARA Section 6217)	The Coastal Zone Nonpoint Pollution Program, a part of the NOAA Ocean Service Coastal Zone Management Program, establishes a set of management measures for states to use in controlling polluted runoff from six main sources, including wetlands and vegetated shorelines. State policies and actions to develop coastal nonpoint pollution control programs ensure implementation of the program at the state level. http://coastalmanagement.noaa.gov/nonpoint/welcome.html
NOAA	Community-based Restoration Program	The Community-based Restoration Program, a part of the NOAA Fisheries Habitat Conservation Program, invests funding and technical expertise in high-priority habitat restoration projects that instill strong conservation values and engage citizens in hands-on activities. Through the program, NOAA, its partners, and thousands of volunteers are actively restoring coastal, marine, and migratory fish habitat across the nation. http://www.habitat.noaa.gov/restoration/programs/crp.html
NOAA	Damage Assessment, Remediation, and Restoration Program (DARRP)	The NOAA Ocean Service Damage Assessment, Remediation, and Restoration Program collaborates with other agencies, industry, and citizens to protect and restore coastal and marine resources threatened or injured by oil spills, releases of hazardous substances, and vessel groundings. The program provides permanent expertise within NOAA to assess and restore natural resources injured by release of oil and hazardous substances, as well as by physical impacts such as vessel groundings in National Marine Sanctuaries. http://www.darrp.noaa.gov/

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AGENCY	PROGRAM	DESCRIPTION
NOAA	Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Act	Marine fish depend on healthy habitats to survive and reproduce. Throughout their lives fish use many types of habitats including seagrass, salt marsh, coral reefs, kelp forests, and rocky intertidal areas among others. Various activities on land and in the water constantly threaten to alter, damage, or destroy these habitats. NOAA Fisheries, regional Fishery Management Councils, and federal and state agencies work together to address these threats by identifying EFH for each federally managed fish species and developing conservation measures to protect and enhance these habitats. http://www.habitat.noaa.gov/protection/efh/index.html
NOAA	Great Lakes Habitat Restoration Program	The Great Lakes Habitat Restoration Program, a part of the NOAA Fisheries Habitat Conservation Program, plans, implements, and funds coastal habitat restoration projects throughout the Great Lakes region. The program works to protect and restore coastal habitats through recovery of damages from natural resource damage claims, which are used to implement community-based restoration efforts. Much of NOAA's work in the region is focused on supporting community-identified restoration priorities in Areas of Concern, environmentally degraded areas within the Great Lakes basin. http://www.habitat.noaa.gov/restoration/programs/greatlakes.html
NOAA	Habitat Conservation Program	The Habitat Conservation Program, composed of the Habitat Protection Division, a Restoration Center, and the Chesapeake Bay Office, protects, restores, and promotes stewardship of coastal and marine habitat to support our nation's fisheries and preserve our coastal communities for future generations. The Program carries out various management and research efforts to develop national and regional policies, programs, and science to conserve wetlands. http://www.habitat.noaa.gov/index.html
NOAA	National Estuarine Research Reserve System (NERRS)	The NERRS is a network of 28 areas representing different biogeographic regions of the United States that are protected for long-term research, water-quality monitoring, education, and coastal stewardship. Established by the Coastal Zone Management Act of 1972, as amended, the reserve system is a partnership program between NOAA and the coastal states. NOAA's Ocean Service provides funding, national guidance, and technical assistance. Each reserve is managed on a daily basis by a lead state agency or university, with input from local partners. Reserve staff work with local communities and regional groups to address natural resource management issues, such as non-point source pollution, habitat restoration and invasive species. Through integrated research and education, the reserves help communities develop strategies to deal successfully with these coastal resource issues. http://www.nerrs.noaa.gov/
NOAA	Pacific Coastal Salmon Recovery Fund (PCSRF)	The PCSRF was established by Congress in FY 2000 to protect, restore, and conserve Pacific salmon and steelhead populations and their habitats. Under the PCSRF, NOAA Fisheries manages a program to provide funding to states and tribes of the Pacific Coast region. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/Index.cfm
Army Corps	Clean Water Act 404 Program	Army Corps manages the nation's wetlands through a regulatory program requiring permits for the discharge of dredged and fill material into jurisdictional water of the United States. This important regulatory program helps maintain the wetland base so other federal programs can achieve gains. EPA shares regulatory responsibility with Army Corps under this program.

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AGENCY	PROGRAM	DESCRIPTION
Army Corps	Continuing Authorities Program (CAP)	Standing Authorities to study/build water resource projects for specific purposes and with specified federal spending limits and cost share requirement. CAP project funding varies by program and purpose. There are 10 commonly referenced nationwide programs. Three of these specifically involve ecosystem improvement: the 206 Program is for aquatic ecosystem restoration, the 1135 Program is for project modifications for improvement of the environment, and the 204 Program is for beneficial uses of dredged material. There are also several geographically restricted Regional Programs that relate to environmental infrastructure projects.
Army Corps	Engineer Research and Development Center (ERDC)	The Wetlands Research and Technology Center (WRTC) consolidates administrative, technological, and research skills in the area of wetland science and engineering that are available at the ERDC. The ERDC has long been recognized as a center for wetland expertise, conducting extensive environmental research in wetland systems. The WRTC provides a single point of contact for wetland research and development, guidance, support, and technology transfer. The WRTC provides access to an array of technical specialists and interdisciplinary teams in research areas that emphasize the interrelationships of biological, physical, and chemical environments in order to provide fundamental understanding of ecological processes and dynamics in wetland ecosystems. The WRTC serves the U.S. Army Corps of Engineers, other Department of Defense agencies, other government agencies, academia, industry and the general public. http://el.erdc.usace.army.mil/wetlands/wetlands.html#wrtc
Army Corps	General Investigations	Studies for project authorization that are undertaken in response to either a study-specific authority or a general authority; these are typically larger, complex projects. The reconnaissance phase is 100 percent federally funded, the feasibility phase is cost-shared 50/50, the preconstruction engineering and design phase is cost-shared 75/25, and the construction/ implementation for Ecosystem Restoration Projects is cost-shared 65/35. The maximum cost limit per project is set for each phase. Major projects include the Florida Everglades Restoration, the Upper Mississippi River Restoration, the Louisiana Coastal Area project, the Missouri River Recovery, and the Lower Columbia River and Tillamook Bay Ecosystem Restoration.
USDA FSA	Conservation Reserve Program (CRP)	CRP provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program is funded through the Commodity Credit Corporation. CRP is administered by the Farm Service Agency (FSA), with NRCS providing technical land eligibility determinations, conservation planning and practice implementation. CRP reduces soil erosion, protects the nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filterstrips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost sharing is provided to establish the vegetative cover practices. http://www.nrcs.usda.gov/programs/crp/

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AGENCY	PROGRAM	DESCRIPTION
USDA NRCS	Conservation Technical Assistance Program (CTA)	Through conservation technical assistance, NRCS and its partners help land users address opportunities, concerns, and problems related to the use of natural resources and make sound natural resource management decisions on private, tribal, and other non-federal lands. This assistance may be in the form of resource assessment, practice design, resource monitoring, or follow-up of installed practices. Although the CTA program does not include financial or cost-share assistance, clients may develop conservation plans, which may serve as a springboard for those interested in participating in USDA financial assistance programs. CTA planning can also serve as a door to financial assistance and easement conservation programs provided by other federal, state, and local programs. http://www.nrcs.usda.gov/programs/cta/
USDA NRCS	Emergency Watershed Protection Program (EWP)	The purpose of the Emergency Watershed Protection (EWP) program is to undertake emergency measures, including the purchase of flood plain easements for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood, or any other natural occurrence is causing or has caused a sudden impairment of the watershed. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/ewp
USDA NRCS	Environmental Quality Incentives Program (EQIP)	EQIP provides a voluntary conservation program for farmers, ranchers, and owners of private, non-industrial forest land that promotes agricultural production, forest management, and environmental quality as compatible national goals. EQIP offers financial and technical assistance to help eligible producers install or implement conservation practices on eligible agricultural land. EQIP offers contracts with a minimum term that ends one year after the implementation of the last scheduled practice(s) and a maximum term of 10 years. Owners of land in agricultural production or persons who are engaged in livestock or agricultural production on eligible land may participate in the EQIP program. Program practices and activities are carried out according to a plan of operations, developed in conjunction with the producer, that identifies the appropriate conservation practice or measures needed to address identified natural resource concerns. The practices are subject to NRCS technical standards adapted for local conditions. EQIP may provide payments up to 75 percent of the estimated incurred costs and income foregone of certain conservation practices and conservation activity plans. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip
USDA NRCS	Farm and Ranchlands Protection Program (FRPP)	FRPP provides matching funds to help purchase development rights to keep productive farm and ranchland in agricultural uses. Working through existing programs, USDA part-ners with state, tribal, or local governments and non-governmental organizations to acquire conservation easements or other interests in land from landowners. USDA provides up to 50 percent of the fair market easement value of the conservation easement. To qualify, farmland must be part of a pending offer from a state, tribe, or local farmland protection program; be privately owned; have a conservation plan for highly erodible land; be large enough to sustain agricultural production; be accessible to markets for what the land produces; have adequate infrastructure and agricultural support services; and have surrounding parcels of land that can support long-term agricultural production. Depending on funding availability, proposals must be submitted by the eligible entities to the appropriate NRCS State Office during the application window. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/farmranch

Appendix E: Federal Agency Programs That Support Coastal Wetland Protection, Restoration, and Management

AGENCY	PROGRAM	DESCRIPTION
USDA NRCS	Grasslands Reserve Program (GRP)	GRP is a voluntary conservation program that emphasizes support for working grazing operations, enhancement of plant and animal biodiversity, and protection of grassland under threat of conversion to other uses. Participants voluntarily limit future development and cropping uses of the land while retaining the right to conduct common grazing practices and operations related to the production of forage and seeding, subject to certain restrictions during nesting seasons of bird species that are in significant decline or are protected under federal or state law. A grazing management plan is required for participants. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/grassland
USDA NRCS	Swampbuster	The Highly Erodible Land Conservation and Wetland Conservation Compliance provisions (Swampbuster) were introduced in the 1985 Farm Bill, with amendments in 1990, 1996, and 2002. The purpose of the provisions is to remove certain incentives to produce agricultural commodities on converted wetlands or highly erodible land, unless the highly erodible land is protected from excessive soil erosion. It withholds federal farm program benefits from any person who converts a wetland by clearing, drainage, dredging, leveling, or any other means for the purpose of making agricultural commodity production possible, or who plants a commodity on a converted wetland. http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/alphabetical/camr/?&cid=stelprdb1043554
USDA NRCS	Wetlands Reserve Enhancement Program (WREP)	WREP is a voluntary conservation program which is a component of WRP. Under WREP, NRCS enters into agreements with eligible partners (states and local units of government, Indian tribes, and non-governmental organizations) to help enhance conservation outcomes on wetlands and adjacent lands. WREP targets and leverages resources to carry out high-priority wetland protection, restoration, and enhancement activities and improve wildlife habitat. Once NRCS selects a partner's proposal, landowners within the selected project area may submit an application directly to NRCS for participation in WRP. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/wetlands
USDA NRCS	Wetlands Reserve Program (WRP)	This voluntary program restores and protects wetlands on private lands to cost-effectively maximize wildlife benefits and wetland functions and values that have been degraded or impacted as a result of the production of food and fiber. Since 1992, WRP has restored approximately 2.2 million acres on 11,758 properties. WRP enrollment options include permanent easement, 30-year easement, restoration agreement, 30-year contract on tribal lands, and reserve grazing rights pilot. The perpetual easement option pays landowners 100 percent of the WRP easement value and 100 percent of the costs to restore the wetlands and associated habitats on the land. The 30-year easement and 30-year contracts options provide 75 percent of the easement values and restoration costs. The restoration agreement only option provides 75 percent of the restoration costs and requires the restored habitat to be maintained for a period of 10 years. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/wetlands
USDA NRCS	Wildlife Habitat Incentives Program (WHIP)	WHIP is a voluntary program for conservation-minded landowners who want to develop and improve wildlife habitat on agricultural land, nonindustrial private forest land, and Indian land. NRCS administers WHIP to provide both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP cost-share agreements between NRCS and the participant generally last from one year after the last conservation practice is implemented but not more than 10 years from the date the agreement is signed. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/whip

Appendix E: Federal Agency Programs That Support Coastal Wetland Protection, Restoration, and Management

AGENCY	PROGRAM	DESCRIPTION
USGS	National Wetlands Research Center	The National Wetlands Research Center is a source and clearinghouse of science information about wetlands in the United States and the world for fellow agencies, private entities, academia, and the public at large. Staff members obtain and provide this information by performing original scientific research and developing research results into literature and technological tools. They then disseminate that information through a variety of means. The Center solves wetland-related problems and conducts status and trends inventories of wetland habitats, evaluates wetland problems, and conducts field and laboratory research on wetland issues. Center research includes a broad array of projects on wetland ecology, values, management, restoration and creation, plus research on the ecology of a wide variety of plant and animal species and communities that are found in wetlands. http://www.nwrc.usgs.gov/
USGS	Other scientific research	USGS also conducts scientific studies on other areas related to wetland health, including carbon sequestration, long shore transport processes, water level fluctuations, climate change, and sea level rise. http://www.usgs.gov/
EPA/ FWS/ NOAA/ USDA/ Army Corps	Coastal Wetlands Planning, Protection and Restoration Act (CWP PRA)	CWPPRA is funded by the Aquatic Resources Trust Fund, which was established in 1990 and is authorized until 2019. The fund is created from excise taxes on fishing equipment and on motorboat and small engine fuels. The Louisiana Coastal Wetlands Conservation and Restoration Task Force receives 70 percent of the funds; the North American Wetlands Conservation Act Program and the National Wetlands Conservation Grant Program receive 15 percent each. Funding distributed to the Louisiana Coastal Wetlands Conservation and Restoration Task Force is used to design and construct projects to preserve, re-establish, and enhance Louisiana's coastal landscape. http://www.lacoast.gov/new/About/Default.aspx http://www.fws.gov/birdhabitat/Grants/NAWCA/index.shtm http://www.fws.gov/coastal/coastalgrants/
EPA/ FWS/ NOAA/ USDA/ Army Corps	Estuary Restoration Act (ERA)	The purpose of ERA is to promote the restoration of estuary habitat; to provide federal assistance for estuary habitat restoration projects; to develop a national Estuary Habitat Restoration Strategy for creating and maintaining effective partnerships within the federal government and with the private sector; and to develop and enhance monitoring, data sharing, and research capabilities. Under ERA, NOAA developed and maintains a restoration project database, the National Estuaries Restoration Inventory, and established standards for restoration monitoring. http://www.era.noaa.gov/