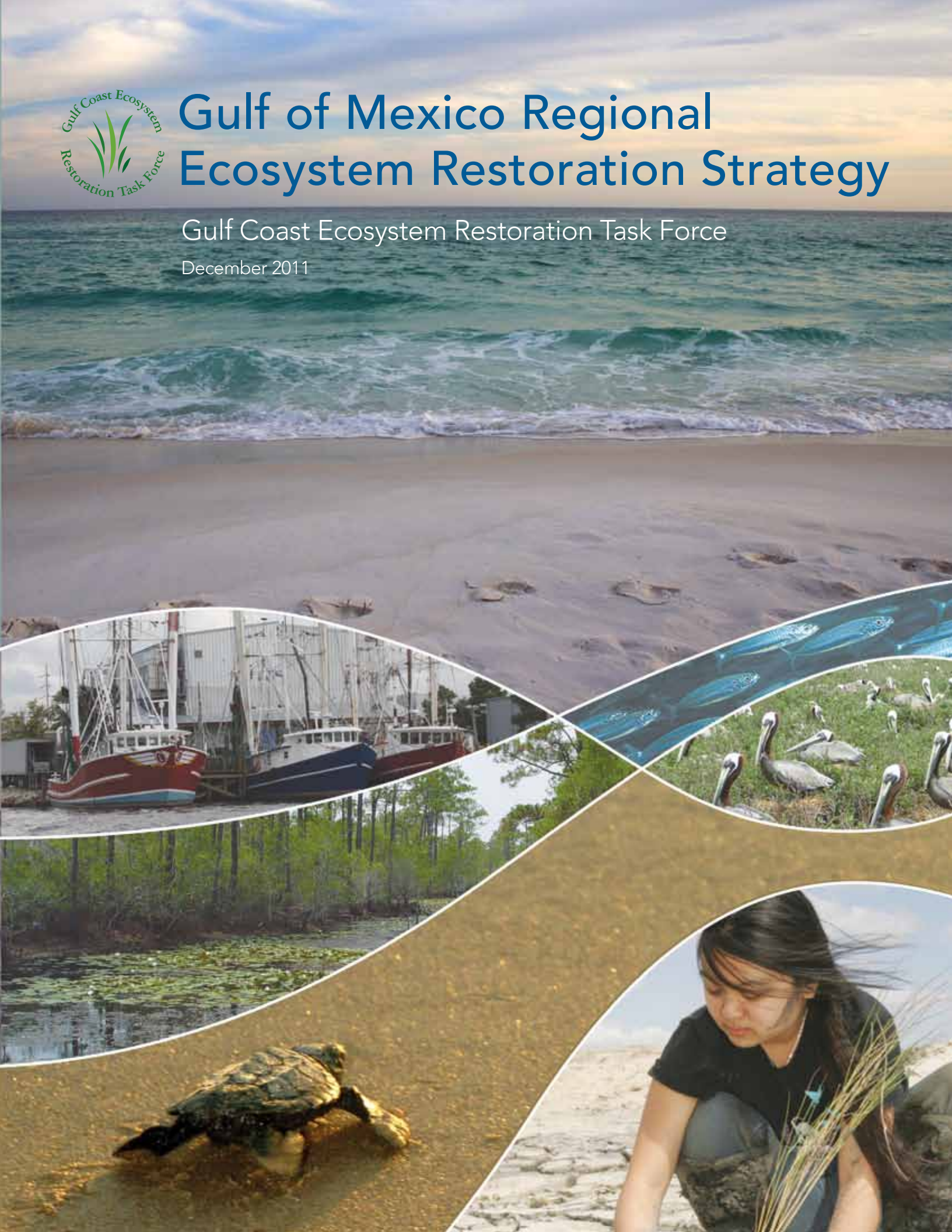
Gulf of Mexico Regional Ecosystem Restoration Strategy

Gulf Coast Ecosystem Restoration Task Force

December 2011



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The Gulf of Mexico boasts rich culture, vital natural resources, billions of dollars in economic activity, and generations of unique history — all of which make it an indispensable part of our nation. The millions of people who call the region home as well as visitors from across America and around the world are drawn to the Gulf Coast's abundant natural resources, its diverse communities and cultures, and a way of life that is truly one-of-a-kind.

This cherished region was at risk following the Deepwater Horizon disaster and oil spill, a tragedy that claimed 11 lives and threatened the long-term health of the entire region. When President Barack Obama issued an executive order establishing the Gulf Coast Ecosystem Restoration Task Force on October 5, 2010, he made an important commitment to the Gulf Coast community that went beyond the crisis of the moment and recognized the decades of significant and persistent decline the region has endured. The task force was given an urgent mission to restore and protect the local ecosystem for future generations. To accelerate progress, the task force brought together five Gulf states and 11 federal agencies in unprecedented collaboration. We are proud now to present the results of our work, the Gulf of Mexico Regional Ecosystem Restoration Strategy.

The President has often noted that the best restoration plans will be those that come to Washington from the people who know the Gulf region best, and this strategy reflects that thinking. The ideas offered here have been shaped through interaction with states, local communities, tribes, fishermen, businesses, conservationists and other Gulf residents. The result is a broadly collaborative strategy to facilitate long-term vitality through restoring and conserving habitat, restoring water quality, replenishing and protecting living coastal and marine resources, and enhancing community resilience. The hundreds of positive comments received from the public throughout the development of the strategy further validate its specific goals and actions.

The next and most important step is to prioritize projects that put the strategy into action and generate substantive results. During this crucial phase, our partnerships will expand even further to involve the people, communities, businesses and other stakeholders invested in the Gulf Coast's future. Specific priorities in the strategy include working to place coastal restoration on an equal footing with other national priorities, stopping the loss of wetlands, working in the Gulf and the upstream Mississippi watershed to reduce the flow of excess nutrients that impair water quality, and supporting local improvement projects that make communities more resilient against threats such as storms and sea-level rise. We will also focus on conserving important pieces of intact Gulf habitat and identifying the needs of key Gulf species that rely on these areas. As President Obama stated in his executive order, all of these steps must — and will — be grounded in science.

The strategy focuses on making the Gulf of Mexico a healthier and more resilient place for the communities that depend on its wealth of resources. Implementation hinges on the continued collaboration among state and federal task force members and the people of the Gulf. The contents of this document reflect the commitment that we as a nation have made to restoring the Gulf Coast ecosystem and ensuring its vibrant environmental and economic future. We are grateful for the opportunity to serve the region we both treasure and look forward to working on the challenging, important tasks ahead of us.

Sincerely,

Lisa P. Jackson, Administrator of the U.S. Environmental Protection Agency;
Chairwoman, Gulf Coast Ecosystem Restoration Task Force

Garret Graves, Chair of the Coastal Protection and Restoration Authority of Louisiana;
Vice Chairman, Gulf Coast Ecosystem Restoration Task Force

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I. Executive Summary

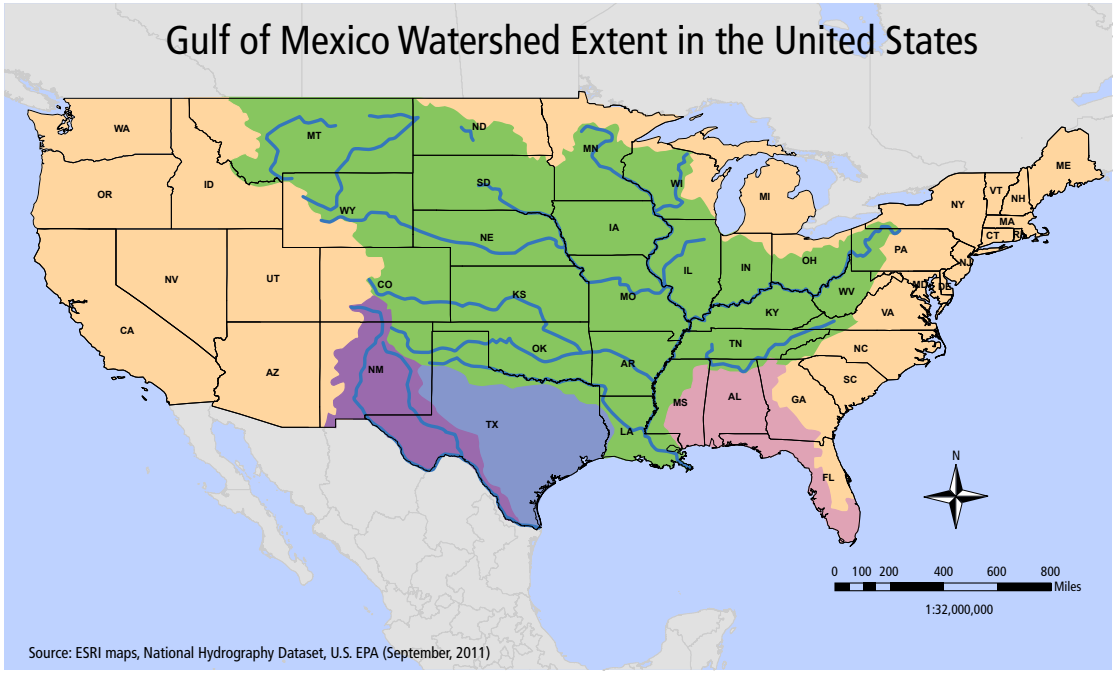
The Gulf of Mexico is among the nation's most valuable and important ecosystems. This ecosystem, consisting of offshore waters and coastal habitats of Alabama, Florida, Louisiana, Mississippi and Texas, is home to ecologically, culturally, commercially and recreationally important species of fish and wildlife. The Gulf of Mexico is an ecosystem composed of both coastal and marine environments and resources that contribute to its function, health and productivity as a single, interconnected system. The Gulf ecosystem and its natural resources are important to the U.S. economy, producing 30 percent of the nation's gross domestic product in 2009.[1] The region provides more than 90 percent of the nation's offshore oil and natural gas production,[2] 33 percent of the nation's seafood,[3] 13 of the top 20 ports by tonnage in the United States in 2009,[4] and significant recreation and tourism benefits. The five U.S. Gulf Coast states, if considered an individual country, would rank seventh in global gross domestic product.[5] The Gulf Coast region's economy is highly intertwined with its natural resource base, including oil and gas deposits, commercial and recreational fisheries, waterfowl, migratory birds and other wetland-dependent life, coastal beaches, and waterways for ports, waterborne commerce and tourism.[6]

The four overarching goals for Gulf Coast restoration are to:

- Restore and conserve habitat
- Restore water quality
- Replenish and protect living coastal and marine resources
- Enhance community resilience

Although the Gulf Coast has significant natural resource and economic value, its long-term future is not secure. Gulf Coast states have experienced coastal land loss due to the alteration of natural hydrology and other human activities, as well as from events such as tropical storms and hurricanes. The building of levees on the Mississippi River and its tributaries since the 18th century has contributed to depriving once-thriving wetlands and barrier islands of the freshwater, sediments and nutrients they need to survive.[7] Sediment is essential to the Gulf ecosystem, where coastal Louisiana was formed over the course of 7,000 years by deltaic processes, including intermittent flooding of the Mississippi River, which delivered sediment to different coastal regions. In the Gulf, communities, commerce and ports have long relied on the extensive network of human-made flood damage risk reduction and navigation structures for their existence. Accordingly, river

management priorities historically have centered on navigation and flood risk reduction. While clearly successful in meeting those two goals, those priorities created unintended consequences to the surrounding environment by accelerating wetland and barrier island erosion and restricting the flow of vital sediments that had sustained the Gulf ecosystem over time. Oil and gas industry canals, pipelines and other infrastructure crisscross the landscape to accommodate exploration, development and commercial activity related to these enterprises; they also contribute to wetland loss. Furthermore, studies indicate that geologic land subsidence exacerbates sea-level rise impacts.[8] Over the last seven decades, approximately 1,883 square miles of wetlands in Louisiana alone have been lost—a land mass roughly the size of Delaware.[9]



Total U.S. Gulf Watershed Extent:

1,741,246 sq miles (56% of continental U.S.)

Contributing U.S. Watershed Regions:

Mississippi 1,295,860 sq miles (41.9%)
Rio Grande 132,845 sq miles (4.2%)
South Atlantic-Gulf 133,263 sq miles (4.3%)
Texas-Gulf 179,278 sq miles (5.8%)

Legend

- Major Rivers
- Mississippi Region
- Rio Grande Region
- South Atlantic-Gulf Region
- Texas-Gulf Region
- State Boundaries

The Gulf of Mexico watershed covers 56 percent of the continental United States (see "Gulf of Mexico Watershed Extent in the United States").[10] The Mississippi River Basin alone drains an estimated 40 percent of the continental United States.[11] Excess nutrients (nitrogen and phosphorus) and pollutants flowing into the Gulf from upstream basins degrade water quality in the Gulf of Mexico. As a result, the Gulf's estuaries have become increasingly degraded for both human use and aquatic life.

Recognizing the importance of the Gulf of Mexico and its ecosystems, and in response to the *Deepwater Horizon* oil spill and the recommendations proposed by Secretary of the Navy Ray Mabus in *America's Gulf Coast: A Long Term Recovery Plan After the Deepwater Horizon Oil Spill* (September 2010), President Barack Obama established the Gulf Coast Ecosystem Restoration Task Force on October 5, 2010.[12] The purpose of the Task Force is to coordinate the long-term conservation and restoration of America's Gulf Coast. The Task Force consists

of senior officials from seven federal cabinet agencies, the Executive Office of the President, and representatives from the five Gulf Coast states of Alabama, Florida, Louisiana, Mississippi and Texas. As part of its mandate, the Task Force is charged with developing a Gulf of Mexico Regional Ecosystem Restoration Strategy to drive action and guide the long-term collaboration that will be necessary to effectively address and reverse widespread environmental degradation and to ensure a healthy environment and economic future for the Gulf. This Strategy considers the important observations and recommendations proposed in the National Commission on the BP *Deepwater Horizon* oil spill and offshore drilling report to the President: *Deep Water, The Gulf Oil Disaster and the Future of Offshore Drilling,* published January 2011 (also called the Oil Spill Commission Report).[13]

The Strategy: Overarching Goals and Framework for Restoration

Many of the Gulf's challenges are complex and long-standing, and addressing the problems will require sustained and consistent effort over time. The Task Force's Strategy was developed through a review of existing plans and efforts and significant public outreach during the last year. The Strategy builds on ongoing work and priorities of each of the Gulf Coast states, local communities, federal partners, academics and nongovernmental organizations (NGOs). The restoration framework consists of four overarching goals to guide the collective actions at the local, state and federal levels that are necessary to reverse the ongoing decline and restore the Gulf Coast's ecosystem. The Task Force's goals for the Gulf Coast restoration effort are the following:

- **Restore and conserve habitat**
- **Restore water quality**
- **Replenish and protect living coastal and marine resources**
- **Enhance community resilience**

The Strategy includes enhanced community resilience as a goal in order to highlight the connectedness of ecosystem restoration with the well-being and sustainability of coastal communities. This goal also emphasizes the planning and technical assistance needs of vulnerable coastal communities as they assess risks, plan for and rebound from natural disasters, and implement sustainable development approaches. As progress is made to improve water quality and protect and enhance the Gulf of Mexico's habitats and resources, communities benefit from improved ecosystem services, such as better storm protection and healthier fisheries.

A key function of the Task Force is to help advance state, federal and tribal activities that will achieve the overarching restoration goals. The Task Force intends to help member agencies address process and other barriers, facilitate program implementation and alignment, and better leverage scientific expertise and fiscal resources in support of Gulf Coast restoration.

In addition to encouraging better collaboration among state and federal agencies and tribal entities, partnerships play an integral role in restoring ecosystem functions throughout the Gulf region. The Task Force believes it is critically important to foster an inclusive dialogue and expand on public-private partnerships in order to achieve ecosystem restoration in the Gulf of Mexico.

Major Actions

Within each of the four goals, the Task Force has identified specific actions that require the most immediate attention, and that will build the initial foundation for an effective regional partnership framework. These are articulated in the following table:

Major Actions	
Goal: **Restore and Conserve Habitat**	■ Prioritize ecosystem restoration in the Gulf of Mexico by ensuring that social, environmental and economic outcomes are fully considered in all river management decisions, and by placing it on equal footing with other priorities such as navigation and flood damage risk reduction. ■ Improve current sediment management practices to maximize to the extent practicable and ecologically acceptable the quantity and effective use of sediments by taking a "strategic use" approach to sediment management. ■ Restore and preserve more natural river processes of sediment and freshwater distribution. ■ Expand the network of state, federal and private conservation areas to ensure healthy landscapes that support the environment and culture of the region and the diverse services provided by the Gulf of Mexico ecosystem. ■ Restore and conserve coastal and near-shore habitats, with a focus on marshes, mangroves, seagrasses, barrier islands, natural beaches and dunes, and coastal forests and prairies.
Goal: **Restore Water Quality**	■ Decrease and manage excess nutrient levels in the Gulf through the development and implementation of state nutrient reduction frameworks. ■ Focus restoration actions in priority watersheds to address excess nutrients in coastal waters and reduce hypoxic conditions. ■ Reduce pollutants and pathogens from stormwater flows and other sources. ■ Improve the quality and quantity of freshwater flow into priority estuaries to protect their health and resiliency. ■ Coordinate and expand existing water quality monitoring efforts supporting adaptive management of programs and projects designed to improve water quality. ■ Collaborate with Mexico to assess and reduce emissions from oceangoing vessels in the Gulf that degrade water quality.
Goal: **Replenish and Protect Living Coastal and Marine Resources**	■ Restore depleted populations of living coastal and marine resources. ■ Conserve and protect offshore environments. ■ Restore and protect oyster and coral reefs, and other coastal environments. ■ Coordinate and expand existing Gulf monitoring efforts to track sentinel species and sites. ■ Minimize, and eliminate where possible, invasive species that impact the Gulf of Mexico.
Goal: **Enhance Community Resilience**	■ Develop and implement comprehensive, scientifically based, and stakeholder-informed coastal improvement programs. ■ Provide analytical support tools to enhance community planning, risk assessment and smart growth implementation. ■ Enhance environmental education and outreach.

The Task Force recognizes the value of intergovernmental collaboration, the need for dedicated funding for large landscape-level restoration efforts, and the importance of a strong scientific foundation for restoration. Accordingly, the Task Force reiterates recommendations made by Secretary Mabus that call for Congress to:

- Formalize the long-term intergovernmental partnership among the Gulf Coast states and the federal government by establishing a successor coordinating body to the Task Force.
- Dedicate a significant portion of the eventual Clean Water Act civil penalties resulting from the *Deepwater Horizon* oil spill for Gulf recovery, in addition to current funding for Gulf programs.

The priorities and recommended actions outlined in the Task Force Strategy should be used to guide the application of resources directed to Gulf ecosystem restoration by Congress. Since Congress has not yet fully addressed these recommendations, this Strategy is built on existing authorities and resources. It is a significant step representing enhanced collaboration and a recognition of the shared responsibility among federal and state governments to restore the Gulf Coast ecosystem. In this time of severe fiscal constraints, Task Force member agencies and states are committed to establishing shared priorities and working together to achieve them.

The Strategy details a restoration framework and series of actions that Task Force member agencies can take to support each of the restoration goals. It also lays out a series of next steps that will better align agency programs and leverage scientific and fiscal resources. Given the inherent complexities of undertaking ecosystem restoration on this scale, a key focus of implementation will be to ensure that ecosystem restoration efforts have a robust scientific foundation and use an effective adaptive management framework, including necessary monitoring, modeling, research and decision-support tools. Integrating adaptive management into restoration efforts will help ensure that progress can be made, even in the absence of scientific certainty. The implementation component of the Strategy will set forth specific on-the-ground actions and milestones by which the intergovernmental partners can achieve and measure progress of the restoration of America's Gulf Coast.

II. Introduction

Importance and Value of the Gulf of Mexico

Spanning nearly 600,000 square miles across five U.S. states (Alabama, Florida, Louisiana, Mississippi and Texas), six Mexican states, and Cuba, the Gulf of Mexico constitutes a diverse and vibrant ecosystem, which is a vital environmental, economic and cultural asset for the United States. Despite many significant environmental and human-made stressors, the Gulf is able to support a host of commercial and recreational uses and provide the backdrop for the unique cultures and heritage of this region. However, unless bold and broad-scale measures are taken soon, the health and future of the Gulf will remain in jeopardy.

The Gulf of Mexico constitutes a diverse and vibrant ecosystem, which is a vital environmental, economic and cultural asset for the United States.

The Gulf is endowed with a variety of coastal and marine habitats, including wetlands, barrier islands, beaches, and coral and oyster reefs. These habitats are integral to the economies and cultural fabric of the Gulf and the nation, providing a range of ecosystem services including fisheries, wildlife-related activities, food production, energy production, infrastructure protection and recreational opportunities. Healthy Gulf Coast habitats also contribute to the resilience of Gulf Coast communities, providing a line of defense for coastal communities and their associated infrastructure against powerful storms. The Gulf's wetlands provide a natural flood attenuation function, which may reduce the impacts of flooding associated with storms. Healthy wetlands could also reduce potential future impacts associated with climate change.

Gulf habitats are rich havens of biodiversity. The Gulf Coast's wetlands, beaches, coastal woodlands and waterbird nesting islands are major nurseries for breeding birds, and provide foraging and stopover sites for millions of migrating birds that converge from several of the most important migratory flyways. Coastal marshes and near-shore habitats provide essential nursery habitat for ecologically, commercially and recreationally important species of fish and invertebrates. Offshore, the Gulf supports biologically diverse marine habitats and species, including deepwater corals, sponges, fish stocks and other unique

communities. The Gulf region is also home to coastal, marine and freshwater species listed as threatened or endangered and several species of protected marine mammals.

The Gulf Coast is a powerful economic engine for the nation and home to a wide range of industries, including more than 90 percent of offshore oil and gas production,[14] one-third of the U.S. seafood harvest,[15] and a vast network of commercially important shipping lanes and ports. Tourism and recreational activities, such as fishing, boating, beachcombing and bird watching, support more than 800,000 jobs[16] across the region, making a significant economic input to Gulf communities and the nation. All of these industries depend on a healthy and resilient Gulf.

Problems Affecting the Gulf

The *Deepwater Horizon* oil spill was a reminder of the delicate balance among the environment, the economy and public health in the region. However, the oil spill was only the most recent in a long line of negative environmental impacts (e.g., hypoxic zone, and effects from navigation canals and energy pipelines) that have plagued the Gulf states for decades. Following the oil spill, Secretary of the Navy Ray Mabus led an assessment of the most pressing challenges facing the Gulf of Mexico ecosystem. The report, *America's Gulf Coast: A Long Term Recovery Plan After the Deepwater Horizon Spill* (September 2010), described them as follows:[17]

- **Loss of wetland habitats, including coastal marshes, forested wetlands, barrier islands, and coastal shorelines that form the Mississippi River Delta and Chenier Plains.** While an issue in every Gulf state, the loss of coastal habitat has been most dramatically illustrated in Louisiana and highlights the need to maintain freshwater and sediment flows to the Gulf of Mexico. Since the 1930s, the coast of Louisiana has lost over 2,000 square miles (25-35 square miles per year) of wetlands. Causes of this loss include a combination of erosion, storm damage, land subsidence, alterations to natural freshwater and sediment flow from the Mississippi River, dredging of canals for oil and gas exploration and pipeline installation activity, and the construction of navigation and flood control structures along the Mississippi River. Climate change (including the impacts of inundation and sea-level rise) threatens to accelerate the loss of these habitats.
- **Erosion of barrier islands and shorelines throughout the Gulf Coast.** From Florida to Texas, continued erosion of the coastal barrier island system undermines storm protection for coastal communities, threatens the beaches that support the local tourism economy, and affects numerous species that rely on these barrier islands for habitat (e.g., Kemp's Ridley and loggerhead sea turtles, numerous shorebirds and the Alabama beach mouse).
- **Loss and degradation of coastal estuarine habitat.** The estuaries and coastal systems of the Gulf Coast—such as Mobile Bay, Apalachicola Bay, Galveston Bay, Tampa Bay, Florida Bay, the Mississippi Sound, Barataria Bay and others—provide the nursery habitat for most of the fishery resources in the Gulf, and support a nationally important oyster industry. These estuaries are impacted by a variety of stressors, including pollution, coastal development, energy development, erosion, hydrological alteration, changes in freshwater inflow, structural marsh management and overfishing. Many of these bay systems have been recognized as estuaries of national significance by the National Estuary Program of the Environmental Protection Agency (EPA) under the Clean Water Act or as National Estuarine

Research Reserves under the Coastal Zone Management Act, and are the focus of existing place-based protection and restoration efforts.

- **Imperiled fisheries.** Several of the major commercially and recreationally important finfish species are currently experiencing pressures from overfishing or have been overfished. In some cases, these conditions have persisted for many years. Additionally, contaminants such as methyl-mercury in fishes, and red tide organisms and human pathogens in shellfish, reduce fishery values and endanger human health. Under the Magnuson-Stevens Fishery Conservation and Management Act, federally managed populations of National Oceanic and Atmospheric Administration (NOAA) trust species such as red snapper, grouper and mackerel are being rebuilt through the efforts of the Gulf of Mexico Fishery Management Council and state fishery management agencies. The impact of the *Deepwater Horizon* oil spill on the rebuilding efforts for these species is as yet unclear.
- **Hypoxia (low oxygen) in the Gulf of Mexico.** Hypoxia occurs where the concentration of dissolved oxygen in the water column decreases to a level that reduces the quality of habitat, resulting in death or migration away from the hypoxic zone. The northern Gulf of Mexico adjacent to the Mississippi River is the site of the largest hypoxic zone in the United States and the second largest hypoxic zone worldwide. This Gulf of Mexico "Dead Zone" is caused by input of excess nutrient pollution to the Gulf most of which comes from upstream through Mississippi River drainage. A federal-state Hypoxia Task Force has been working to address factors leading to low-oxygen conditions, and EPA and the Department of Agriculture (USDA) have jointly worked to develop strategies to reduce nutrient runoff. NOAA has been working on developing models to support better understanding of biological-systems transport, including hypoxia predictions.
- **Climate change.** Our changing climate is already altering, perhaps irreversibly, the physical, chemical and biological characteristics of our oceans, coasts and adjacent watersheds. Increasing air and water temperatures, changing precipitation patterns, rising sea level, and ocean acidification will increasingly confound efforts to restore or sustain system states. Federal and state natural resource managers need the information and tools to develop strategies for mitigating and adapting to a dynamic environment and ongoing habitat reorganization and restructuring.

Other environmental impacts are evident in localized areas of the Gulf. For example:

- Bays and estuaries throughout the Gulf of Mexico, such as Galveston Bay in Texas and Apalachicola Bay in Florida, have been degraded by reduced freshwater input from the upstream construction of dams and the heavy use of river water for municipal, industrial and agricultural purposes.
- Channels and canals for navigation and oil and gas activity in Texas and Louisiana have allowed a greater inflow of salt water from the Gulf of Mexico into the estuaries. In some cases, this has caused saltwater intrusion into freshwater marshes and forested wetlands, stressing these habitats and converting them to open water.
- In Mississippi, past dredging of the Pascagoula River and its economically vital navigation channel has interrupted the natural transport of sediments required for the nourishment of the barrier islands. Recent changes in sediment management practices to include downdrift placement in the littoral zone have minimized current sediment loss; however, this is not sufficient to allow for barrier island recovery.

- In Alabama, the five rivers emptying into Mobile Bay carry excess sediment, which results in high turbidity, or clouding of the water. The clouded water deprives submerged aquatic vegetation of the light it needs to grow. This unique vegetation provides important habitat for marine species and waterfowl.
- In Florida, bay systems near Pensacola, Tampa, Naples and Fort Myers suffer from near-coastal water quality issues, such as periodic harmful algal blooms (HABs) affecting marine life, human health and tourism.
- Populations of key plant species that are culturally significant to a number of federally recognized tribes within the Gulf States have been lost over time. For example, since European settlement of the Gulf, longleaf pines have declined from occupying 90 percent to occupying approximately 3 percent of forests within the Gulf region.[18]

The degradation of coastal and marine environments and the services they provide illustrates the often unintended consequences associated with managing the effects of well-intended and necessary projects such as navigation and flood control in such a complex system. Future impacts associated with storms, land subsidence, sea-level rise and river system management will only amplify the region's vulnerability. Scientific research, models, forecasts and visualization tools will inform steps to curb the impacts of multiple stressors on Gulf ecosystems to reduce the harm to the marine and terrestrial environment, national commerce, maritime industry, energy security, fisheries and cultures of the Gulf Coast. Steps taken to achieve one goal often have a direct impact on others. Solutions to these complex challenges also transcend state, national and international boundaries. This creates not just an opportunity but also a requirement to increase collaboration and communication to more fully understand the Gulf of Mexico and the work that is necessary for its overall restoration.

Role of the Gulf Coast Ecosystem Restoration Task Force

On October 5, 2010, President Barack Obama issued Executive Order 13554 (see Appendix A), establishing the Task Force. The Task Force was created on the recommendation of Secretary of the Navy Ray Mabus in his report on the *Deepwater Horizon* oil spill. Ecosystem restoration, as defined by the Executive Order, means:

> … all activities, projects, methods, and procedures appropriate to enhance the health and resilience of the Gulf Coast ecosystem, as measured in terms of the physical, biological, or chemical properties of the ecosystem, or the services it provides, and to strengthen its ability to support the diverse economies, communities, and cultures of the region. It includes activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity, and sustainability. It also includes protecting and conserving ecosystems so they can continue to reduce impacts from tropical storms and other disasters, support robust economies, and assist in mitigating and adapting to the impacts of climate change.

The Task Force is directed to address the persistent and significant decline of the Gulf ecosystem by working with state and federal agencies, tribes, communities, stakeholders and the public throughout the Gulf Coast to develop an ecosystem restoration Strategy.

Strategy Development

Building on prior federal and state efforts, the Task Force developed a shared vision for the Gulf Coast, which is to achieve a resilient, healthy Gulf of Mexico ecosystem that supports the diverse economies, communities and cultures of the region. The vision requires that the federal government and states align their activities effectively and collaborate to set realistic and measurable goals for restoration and protection of wetlands, barrier islands, and other coastal and marine features. While this Strategy focuses on the restoration of the Gulf ecosystem, it supports and builds on the first line of defense—protection—provided by other essential efforts for maintaining existing areas of healthy habitat across the Gulf Coast.

During the course of their work, Task Force members witnessed first-hand local and state restoration activities and visited with many groups and associations integral to Gulf restoration. The mission of the Task Force was not to develop another "new" plan. Rather, the Task Force set out to build on existing work, learn from those who are actively involved in ecosystem restoration, and craft an agenda that would provide unified and strategic direction for restoration activities across the Gulf. Building on the region's existing work, the Task Force aims to jump-start action to bring about a healthier and more vibrant Gulf ecosystem.

Public and Stakeholder Engagement

In developing this Strategy, the Task Force met at least once in each of the five Gulf states, beginning in Pensacola, Florida, on November 8, 2010, and ending in Biloxi, Mississippi, on August 30, 2011. Each Task Force meeting included public listening sessions to gather valuable individual input from those most connected to the Gulf. Initially, the Task Force designed sessions to generate discussion on specific ecosystem restoration focus areas, and to gather individual ideas and opinions from particular stakeholder groups, including local governments, business and industry, academics and NGOs. Later Task Force meetings focused on specific aspects of the Strategy and included panel presentations by experts in water quality, community resilience, habitat conservation, public engagement and science. In addition to the listening sessions that took place during public meetings, the Task Force held multiple listening sessions throughout the Gulf with partner organizations such as the National Estuary Programs (NEPs), local government leadership and academic institutions. Approximately 2,000 attendees contributed to Strategy development through Task Force listening sessions.

The Task Force also looked to two of EPA's federal advisory committees, the Local Government Advisory Committee (LGAC) and the National Environmental Justice Advisory Council (NEJAC), for input into Strategy development. Both groups were responsive in mobilizing work groups to generate views and recommendations to the EPA Administrator, Lisa P. Jackson, who shared this information with members of the Task Force. In May 2011, based on public input received, Administrator Jackson announced plans to establish a new

Coordination on Health and Economic Concerns

From the first Task Force meetings, public audiences have included many directly affected by the *Deepwater Horizon* oil spill. Public comments from these meetings included oil-spill-related concerns, such as economic claims problems, health-related issues, and seafood safety questions, among others. While the Strategy focuses on ecosystem restoration, the Task Force has shared these concerns relating to the spill with the relevant departments and agencies.

During the course of Task Force meetings, federal, state and local government officials provided the Task Force with updates on seafood safety issues and oil spill recovery activities. In addition, representatives from the Department of Health and Human Services and the Department of Commerce were routinely invited to participate in Task Force public listening sessions to meet individually with and answer questions from members of the public on these matters.

EPA federal advisory committee, a 25-member Gulf of Mexico Citizen Advisory Committee, which will become an additional vehicle for citizen engagement and support as the Strategy recommendations are implemented.

Consultation and Coordination With Tribes

The Task Force conducted consultation and coordination with affected federally recognized tribes in Gulf Coast states during the development of the Strategy. EPA facilitated the Task Force consultation following Executive Order 13175 on consultation and coordination with tribes and EPA's Tribal Consultation Policy, and was also informed by the consultations supporting the oil spill response and Natural Resource Damage Assessment (NRDA) process. The tribal consultation and coordination included face-to-face meetings, webinars and conference calls. Tribes had access to background documents and could provide comments via EPA's Tribal Portal (www.epa.gov/tribal). All comments were summarized and provided via the Tribal Portal. In response to discussions with tribal representatives from the federally recognized tribes, the Task Force also sought input from tribes with ancestral lands in the Gulf.

Science to Inform Gulf Ecosystem Restoration Strategy

Recognizing that successful ecosystem restoration must be based on sound science, the Task Force established teams to examine specific topics that would support the Strategy's restoration goals. These teams sought to identify both the best science available and the critical gaps in our knowledge of the Gulf ecosystem. Specifically, the Task Force Science Coordination Team examined current conditions within the Gulf ecosystem and science needs to help support restoration and conservation. Additionally, Task Force member agencies and states have contributed their extensive expertise and perspectives working on other ecosystem restoration efforts (e.g., the Comprehensive Everglades Restoration Plan, or CERP) to address the long-standing challenges facing the Gulf, including how best to design and implement restoration projects and assess their success using a robust scientific foundation and an adaptive management framework.

Future Efforts for the Task Force

Leveraging Partnerships

Throughout the five Gulf states, partnerships among communities, NGOs, private industry, foundations, landowners and government agencies have played an integral role in the success of prior and ongoing conservation and restoration efforts. The Task Force believes it is critically important to foster an inclusive dialogue and expand public/private partnerships in order to successfully implement the goals of this Strategy. Particularly in times of challenging budgets, partners are an essential component of achieving ecosystem restoration. The Task Force intends to engage with communities, private industry, foundations, landowners and NGOs in order to leverage each partner's investments and identify activities for maximum benefit to the ecosystem.

To optimize efficiency, the Task Force plans to continue to assess efforts and capabilities—its own and others'—to ensure that it is adding value to restoration activities in the Gulf region. The Task Force operates in coordination with multiple intergovernmental bodies, including the Gulf of Mexico Alliance (GOMA), the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Hypoxia Task Force), the NRDA Trustee Council for the *Deepwater Horizon* oil spill, and the National Ocean Council. Each of these entities provides expertise and capacity to address a unique group of problems and issues in the Gulf of Mexico. The Task Force seeks to improve cooperation and coordination among various federal, state, tribal and local entities, reduce duplication of efforts, and help align and move forward sustainable resource management strategies, restoration plans and resiliency projects.

- **The Gulf of Mexico Alliance.** One group that shares important goals for the future of the Gulf is GOMA, which was formed in 2004 with the goal of significantly increasing regional collaboration to enhance the ecological and economic health of the Gulf of Mexico. This regional partnership includes the governors of the states of Alabama, Florida, Louisiana, Mississippi, and Texas, as well as federal partners, including EPA, NOAA, USDA, the U.S. Department of the Interior (DOI), the U.S. Department of Defense, the National Aeronautics and Space Administration (NASA), the U.S. Department of Transportation (DOT), the Council on Environmental Quality, the U.S. Department of State, the U.S. Department of Health and Human Services, the U.S. Department of Energy, and the National Science Foundation. To complement state and federal leadership and provide additional expertise and resources, GOMA has strong established partnerships with academia, Gulf research institutions, industry and NGOs. The six GOMA priority issue working teams focus on: (1) water quality for healthy beaches and seafood, (2) habitat conservation and restoration, (3) ecosystems integration and assessment, (4) reducing nutrient impacts to coastal ecosystems, (5) coastal community resiliency, and (6) environmental education.[19] GOMA achieves its mission through strong and strategically leveraged Gulf-wide interstate and cross-federal-agency research integration, data

sharing, conservation and restoration policy analysis, regional sediment management, and ecosystem-based habitat protection and restoration efforts.

- **The Hypoxia Task Force.** The Hypoxia Task Force includes members from 17 state and federal agencies. EPA currently co-chairs the Task Force with Mississippi. The mission of the Hypoxia Task Force is to understand the causes and effects of hypoxia in the Gulf; coordinate activities to reduce the size, severity and duration of the hypoxic zone; and ameliorate its effects. It provides a forum for state water quality and agriculture agencies to partner on local, state and regional efforts to mitigate nutrient loading, encouraging a holistic approach that takes into account upstream sources and downstream impacts.

  In its most recent Gulf Hypoxia Action Plan (2008), the Hypoxia Task Force emphasized its commitment to work with states to develop nutrient reduction strategies and increase accountability.

  In 2012, Iowa will assume the state co-chair position through 2014.

- **Natural Resource Damage Assessment (NRDA) Trustee Council.** The work of the Task Force is distinct from, but related to, the ongoing work of the Trustee Council, which is conducting a NRDA for the *Deepwater Horizon* oil spill. The Trustee Council focuses on assessing the *Deepwater Horizon* oil-spill-related natural resource injuries. The Task Force has a broader charge, extending to other long-standing challenges facing Gulf Coast ecosystems beyond the *Deepwater Horizon* oil spill. These challenges include significant coastal land and wetland loss, degraded water quality, depletion of marine resources, coastal erosion and the adverse effects of climate change. The Task Force is directed to devise an agenda for the long-term restoration and conservation of the diverse ecosystems of the Gulf Coast that will ensure its long-term environmental, economic and health benefits. Additionally, the Task Force was directed to foster collaboration among governments, the public and diverse stakeholders to build on existing plans and activities designed to address Gulf restoration. Collaboration and coordination will be a key ongoing responsibility of the Task Force in its work to facilitate implementation of state and federal ecosystem restoration programs.

- **The National Ocean Council.** The National Ocean Council and the Task Force, both established by Presidential Executive Order, share important elements for the future of the Gulf Coast. The National Ocean Council is charged with implementing the National Ocean Policy and addressing broad, national enhanced stewardship of our oceans, coasts and Great Lakes, including economic, environmental, social and national security issues. The Task Force is charged with addressing ecosystem restoration needs in the Gulf of Mexico region and supports implementation of an important piece of the overarching National Ocean Policy.

  The National Ocean Council and the Task Force are both engaged in promoting regional-scale protection and restoration, addressing water quality impacts and other large-scale threats, ecosystem-based management, and providing coordination and support among federal and state agencies. The National Ocean Council will reinforce and support the Task Force on regional and geographic initiatives and activities through its national strategies. Furthermore, the Gulf of Mexico Regional Ecosystem Restora-

tion Strategy will inform the National Ocean Council's national strategic action plans. The overlap of federal agency members of both bodies will ensure that they will share best practices, information and advancements in science and management of coastal ecosystems.

The Council and the Task Force will work together to better integrate and coordinate planning, decision-making, and regulatory enforcement and ensure the integration of best practices, information, discoveries, and advancements in science and management of coastal ecosystems. These efforts will promote and sustain a culture of shared stewardship, both across federal agencies and among federal, tribal, state and local jurisdictions. Both efforts share a commitment to openness, transparency and a bottom-up, regionally driven approach to planning and action, with opportunities for tribal, state and local governments; the private sector; academic and nonprofit stakeholders; and the public to engage and help define the way forward. These connections will help ensure a coordinated effort in addressing challenges and opportunities for the Gulf region, and jointly incentivize the effective, efficient and economical restoration of the Gulf Coast's environmental, economic and cultural value.

Promoting Science-Based Decision-Making

The federal government and states must be able to leverage limited resources in a manner that yields maximum benefits to the ecosystem, consistent with this Strategy. Ultimately, successful implementation of the Strategy must be based on the best available science to inform management decisions. Priorities should be implemented according to the principle of adaptive management, allowing for restoration efforts to move ahead while addressing the need to decrease uncertainty and expand and incorporate knowledge of the ecosystem conditions. Adaptive management will help determine the efficacy of restoration actions through a focused effort of monitoring, modeling and research to support effective management and decision-making. This process will help ensure that state and federal investments can be altered if they are not achieving the desired results, ultimately improving the overall effectiveness of restoration and protection efforts. Leveraging the successes of existing state and federal programs and initiatives, addressing critical gaps, and building on the capacity that currently exists within the Gulf of Mexico states are central to supporting adaptive management. Specific needs for successful adaptive management are discussed in Section IV, "Science-Based Adaptive Management."

Resolving Policy and Process Obstacles Impeding Progress

The Task Force evaluated barriers that have hindered implementation and success of past restoration efforts. The majority of plans developed in the region in the last 20 years document the same stressors outlined in this Strategy. A primary focus of the Strategy will be to address the policy and procedural barriers complicating progress on protection, conservation and restoration efforts.

Some of these barriers were identified during Task Force meetings with stakeholders and the public. Budget constraints of federal, state and local governments are a barrier to ecosystem restoration, delaying or restricting restoration efforts. Additionally, inadequate coordination

within and among federal and state agencies impedes movement of projects to construction. Water resource policies also inhibit some ecosystem restoration efforts, such as those designed to use sediment for greater ecosystem benefits. Furthermore, inconsistent or unclear priority-setting undermines cooperation and support for projects. And, limited research and science challenge many aspects of planning, priority-setting and project design.

A greater emphasis on cooperative research, monitoring and data sharing is needed to improve project planning and design and to support adaptive management over time. Alternative financing mechanisms should be explored and implemented to foster progress on restoration projects. Future solutions may involve statutory changes to address obstacles that cannot be overcome through administrative remedies. In the near term, existing resources in regulation and policy need to be fully exercised in order to ensure greater alignment of federal and state actions.

The Strategy Going Forward

This Strategy embraces and builds upon existing efforts at the state, federal and tribal levels. It is a significant step, representing enhanced collaboration and a recognition of the shared responsibility among state, federal and tribal governments to restore the Gulf Coast ecosystem. In this time of severe fiscal constraint across all levels of government, Task Force member agencies are committed to finding common ground, establishing priorities, and working together to achieve them. This may involve reassessing budgets and agency activities to collaboratively align resources to the highest priority Gulf Coast restoration work. This Strategy will be an important tool in the alignment of the agencies' resources needed to carry out implementation.

Gulf Coast States

The Gulf Coast is rich in natural resources that drive economic activity in the area. The beauty and bounty of the coast draws millions of visitors from across the nation and around the world each year, creating a multibillion-dollar tourist industry that contributes both jobs and revenues. Each of the five states boasts a strong fishing industry, and some of the busiest ports in the nation are found on the Gulf Coast. The area is the heart of the U.S. oil and gas industry. Important military bases, space centers and research facilities are also found in the region, increasing the prosperity of individual states, tribes and the nation as a whole.

Although each state has features that make it unique and distinct, the Gulf's interrelated ecosystem connects its people and communities. Together the states face many threats, both natural and human-made. For all of the Gulf states, the ecosystem and its restoration are vital to the region's continued economic well-being.

A brief description of each state's coastal area is provided below, along with a summary of its major environmental and economic assets. Additionally, Appendix B contains a more detailed description of each state's natural resources and the environmental services and economies they support. Appendix B also describes each state's priority actions for the four overarching goals included in this Strategy.

Alabama

Coast[20]	Tidal Shoreline[21]
53 miles	607 miles
State Population[22]	**Gulf Coast Population[23]**
4,779,736	764,613

Alabama's coastal area is located along the northern Gulf of Mexico. The state has a profuse diversity of natural habitats, including rich sediments, seagrass beds, barrier islands, wetlands, plant bogs, bottomland hardwood forests, wet pine savannas and pine and oak forests. The wealth of these habitats makes the Alabama coast unique and draws residents and visitors alike. In terms of biodiversity, Alabama ranks first among the states east of the Mississippi River and fifth among all states in the nation. The Mobile Bay Watershed is the sixth largest river basin in the United States and the fourth largest in terms of stream flow.[24] The Alabama coastal area contributes to the economy of the state and the entire nation in several important ways. These include:

- **Commercial and recreational fishing.** In 2009, commercial fishing trips landed 29.7 million pounds of seafood worth over $40.5 million. Commercial fishing contributes $391 million and over 8,750 jobs to the state's economy annually.[25] Alabama's recreational fishing increases these figures to a yearly economic impact of $865 million and more than 13,680 jobs being created.[26] Seventy-five percent of America's commercial fish catch and 80 to 90 percent of the recreational fish catch are dependent on estuaries such as Alabama's Mobile Bay, Mississippi Sound, Weeks Bay and Perdido Bay.[27]
- **Tourism.** In 2009, more than 7.1 million visitors enjoyed the state's beaches, scenic vistas, access to the Gulf of Mexico, and bays and waterways, spending more than $3.2 billion in Mobile and Baldwin Counties. The counties rank first (Baldwin at 25 percent) and third (Mobile at 9.7 percent) in total travel-related employment for the state, with 56,294 employees.[28]
- **Shipping and maritime services.** The Port of Mobile is a global deepwater gateway for the state. The port ranked 12th in the nation in total tonnage shipped in 2009.[29] Combined with the city of Mobile's industrial center, the port represents a multi-billion-dollar impact on regional, state and world economies. The port contributes 66,617 jobs and $7.92 billion annually to Alabama's economy.
- **Energy production.** Alabama is rich in energy resources and has considerable natural gas resources. The area's shipbuilders are supporting offshore oil and gas exploration by building offshore supply and rig-tending vessels and repairing rigs.

Migratory Birds on Dauphin Island

Dauphin Island is one of the top birding spots in the Southeast. An incredible 347 species have been reported on the island. The island is the first landfall for many migratory birds making the 600-mile flight across the Gulf of Mexico from the Yucatan Peninsula. Strong rains and winds during these flights can trigger spectacular "fall-outs" in which large flocks of many bird species descend on the island to seek shelter.

Source: Dauphin Island Bird Sanctuaries. <http://www.coastalbirding.org>

Florida

Coast[30]	Tidal Shoreline[31]
770 miles	5,095 miles
State Population[32]	**Gulf Coast Population[33]**
18,801,310	7,771,053

Florida's barrier islands, estuaries, coral reefs, beaches, seagrass meadows, coastal wetlands and mangrove forests are world-renowned natural resources and attractions. Along the Gulf Coast alone, Florida has more than 7.4 million acres of tidally submerged lands.[34] The state's sandy beaches are consistently ranked among the best in the nation, and millions of residents and visitors alike come to Florida's Gulf coast each year to fish, dive, swim, and view wildlife. These natural resources also represent Florida's economic engine for the future and support a range of activities, including:

- **Tourism.** In 2010 tourism was responsible for welcoming more than 82.3 million visitors to Florida, who spent more than $62.7 billion, generating 22 percent of the state's sales tax revenue and employing nearly a million Floridians.[35] Each year, almost $15 billion and 141,373 jobs come directly from fish and wildlife in the state, and nearly another $17 billion and another 202,743 jobs are the indirect benefit of boating activities in state waters.[36]

The Beauty and Bounty of Florida's Coral Reefs

Extensive coral reefs off Florida's Gulf Coast support an incredible diversity of fish and other marine life. The beauty and biodiversity of the state's coral reefs attract tourists, fishermen and divers from around the world. The state, particularly the Florida Keys, is recognized as a diving capital of the world.

- **Wildlife viewing.** Wildlife viewing is a significant pastime in Florida, accounting for $5.2 billion and 51,367 jobs in 2006. Also in 2006, almost 1.6 million participated in wildlife viewing in Florida, the majority of whom came to view coastal and marine life.[37]
- **Shipping and cruise services.** Florida ships agricultural and industrial products and transports cruise ship customers through its many Gulf Coast ports—Pensacola, Panama City, Port St. Joe, St. Petersburg, Tampa, Port Manatee and Key West. These Gulf Coast ports account for about $10.6 billion per year in economic activity, supporting 125,000 direct and indirect jobs.[38]
- **Military installations.** Training and testing operations along Florida's Gulf Coast provide significant conservation lands and economic and security benefits to the state and nation. Statewide, defense-related spending was $64.8 billion in 2010 and accounted for 686,181 jobs.[39]
- **Commercial and recreational fishing.** In 2009, Florida's commercial fishing industry ranked second among all states for annual in-state sales ($13 billion) and third for jobs (64,744 jobs).[40] Also in 2009, the state ranked tenth in total landings at $116 million annually and produced 10 percent of the Gulf's oyster catch (by weight), a $6.9 million annual dockside value.[41] Florida also leads all states in economic return for its marine recreational fisheries. Recreational saltwater fishing generates over $5 billion and more than 50,000 jobs each year.[42] In 2008–2009, more than one million people bought marine recreational fishing licenses, a third from out of state. More than 3,400 for-hire fishing licenses were purchased, generating more than $1 million and giving Florida one of the largest charter fleets in the world.[43]

Louisiana

Coast[44]	Tidal Shoreline[45]
397 miles	7,721 miles
State Population[46]	**Gulf Coast Population[47]**
4,533,372	3,548,090

Louisiana has the largest expanse of coastal wetlands in the lower 48 states and is home to the largest delta in North America.[48] Louisiana's coast provides a home to nearly half of the state's population. The state's ecosystems include wetlands, shorelines, and adjacent forested and scrub/shrub areas. The Mississippi River system has shaped Louisiana's uniquely formed coastal zone, which is dominated by wetlands and filled with sensitive resources. These wetlands truly are "America's wetlands." They are important to Louisiana citizens, as well as the nation, who depend on them for a variety of important activities, including:

Ducks Find Prime Wintering Grounds on Louisiana's Coast

More than five million ducks and other water birds (20 percent of the continental population) winter in Louisiana each year. During the peak spring migration season, nearly 25 million neotropical migrant passerines and shorebirds arrive in coastal Louisiana each day.

Source: Louisiana Department of Wildlife and Fisheries. 2011. Waterfowl population estimates in Louisiana's coastal zone below U.S. Highway 90 and on Catahoula Lake. <http://www.wlf.louisiana.gov/sites/default/files/pdf/waterfowl_survey/33575-January%202011%20Survey/waterjan2011.pdf>

- **Shipping and maritime services.** The Mississippi River system significantly contributed to the growth of this nation. Today, more than 30 states depend on coastal Louisiana's navigation channels for imports and exports. In 2009, Louisiana's ports accounted for 20 percent of all waterborne commerce (by tonnage) in the nation.[49] Five of the 15 largest ports in the United States are in Louisiana.[50] The state's top three ports handle an estimated 55 to 70 percent of all U.S.-exported corn, soy and wheat. The state's ports also handle other commodities such as steel, coffee, rubber and chemicals.[51]
- **Energy production.** Louisiana's offshore waters are home to the largest reserves of oil and gas in the nation, producing over 90 percent of the nation's Outer Continental Shelf oil and 70 percent of the country's Outer Continental Shelf natural gas.[52] Louisiana is the top producer of oil and the second-highest producer of natural gas in the nation (including Outer Continental Shelf oil and gas).[53] The U.S. Treasury benefits by up to $8 to $10 billion annually from offshore energy revenues attributable to waters offshore of Louisiana.[54] This constitutes one of the largest contributions to the treasury.
- **Commercial and recreational fishing.** Louisiana's coast includes one of the nation's largest and most productive estuaries. Nearly 26 percent (by weight) of the commercial fish and shellfish in the continental United States are harvested in Louisiana's waters.[55] Louisiana is the nation's top producer of shrimp, oysters, crawfish and blue crabs. Coastal Louisiana is also home to some of the top recreational fishing waters (both fresh and salt water) in the country. Ninety-seven percent (by weight) of the commercial fish and shellfish harvested in the Gulf of Mexico are species that depend on coastal wetlands for reproduction, hatching growth or development. Louisiana alone has approximately 40 percent of the coastal wetlands in the continental United States.[56]
- **Tourism.** Nearly 25 million domestic and international tourists visited Louisiana in 2010, adding an estimated $9.3 billion in spending to the nation's economy.[57] Nearly half of this spending was in the New Orleans area.

Mississippi

Coast[58]	Tidal Shoreline[59]
69 miles[60]	359 miles
State Population[61]	**Gulf Coast Population[62]**
2,967,297	628,502

Mississippi's coastal waters encompass the mainland coast, barrier islands, bays and lagoons, as well as hundreds of rivers, creeks and estuaries. The state's largest estuary is the Mississippi Sound, which encompasses 550 square miles.[63] The state's estuaries and streams are home to a remarkable variety of plants and animals in what is recognized as one of the most biologically diverse regions in North America. The area ranks in the top 10 for native species of reptiles, amphibians, butterflies and mammals.[64] The culture and economy of the Mississippi Gulf Coast are heavily influenced by the industries that rely on the abundance of natural resources for their viability. These include:

- **Commercial fishing and seafood processing.** These industries are a natural extension of life in this coastal area. Hundreds of fishing boats make their home in Mississippi ports, and the seafood they catch and process generates thousands of business opportunities.
- **Tourism.** Mississippi attracts tourists through its recreational fishing opportunities, robust gaming industry, white sand beaches, championship golf courses and other recreational and cultural venues. Tourism in the three counties that border the Gulf Coast accounts for about $1.6 billion in visitor expenditures, 32 percent of state travel and tourism tax revenues, and 24,000 direct jobs.[65]
- **Energy production.** Offshore oil and gas exploration and development further boost the area's economy. Providing experienced offshore workers, necessary logistical support and industrial capacity to generate that support is an important source of fuel for the coast's economic engine.
- **Shipping and maritime services.** The Mississippi State Port at Gulfport is an economic force for jobs and business activity. The port generates more than 2,000 jobs for Mississippi residents, with that number expected to increase substantially with improvements and expansion as the city undergoes a comprehensive recovery from Hurricane Katrina. Pascagoula is the home of the largest military shipbuilder in the United States, and the largest private employer in the state, providing approximately 11,000 jobs for residents of the northern Gulf region.[66]
- **Space center.** NASA's Stennis Space Center is home to more than 30 federal, state, academic and private organizations and numerous technology-based companies. The center's staff includes approximately 2,000 oceanographers, scientists and support staff with a unique capability to study the Gulf Coast from space and in the field.

Reserve Provides Critical Habitats

The 18,000-acre Grand Bay National Estuarine Research Reserve is one of the largest, relatively undisturbed estuarine marsh/pine savanna habitats remaining along the northern Gulf of Mexico. Straddling the Mississippi-Alabama state line, the reserve provides critical habitats for many kinds of migratory birds as well as important commercial and recreational species of fish.

Texas

Coast[67]	Tidal Shoreline[68]
367 miles	3,359 miles
State Population[69]	**Gulf Coast Population[70]**
25,145,561	8,287,623

The Texas coastal zone includes a complex system of barrier islands and peninsulas, with Padre Island being the longest undeveloped barrier island in the world. The Texas coast contains 12 distinct eco-regions and is richly endowed with natural resources, including sand dunes, vast wetlands and aquatic habitats. The Texas coast has tremendous biodiversity. More than 457 species of fish and 343 species of invertebrates are found in the state's estuarine and marine waters. The coast is home to blue crabs, oysters, pelicans, plovers, shrimp, and the endangered whooping crane and Kemp's Ridley sea turtle. The ecologically rich coastal system supports many industries, including:

- **Shipping and maritime services.** Roughly one-third (423 miles) of the Gulf Intracoastal Waterway (GIWW) is located in Texas. The GIWW is the nation's third busiest waterway. Thirteen percent of the nation's freight transported by ship (74 million tons of cargo) traveled the Texas GIWW in 2006, with an estimated value of $25 billion.[71,72] The waterway handles 90 percent of all gasoline shipped to the Lower Rio Grande Valley, and facilities on the Texas Gulf Coast produce two-thirds of the nation's petrochemicals.[73] The Texas coast is also home to four of the top 10 ports in the country (based on total cargo tonnage),[74] which generate more than $9 billion in federal tax revenues annually.
- **Energy production.** The area is home to the nation's largest concentration of oil refineries[75] as well as a sizable chemical industry, which is ranked first in the nation in size and production.[76]
- **Commercial and recreational fishing.** The state's commercial fishing fleets bring in more than $150 million of fish and shellfish annually.[77] Eighty-two percent of shrimp in the United States come from the Gulf states, with Texas supplying 89.7 million pounds per year. The annual oyster harvest is approximately 5.7 million pounds of meat worth over $19 million. The recreational fishing industry is another important part of the Texas coastal economy, with saltwater sport fishing generating almost $2 billion annually.[78] The number of annual saltwater fishing permits increased more than 7 percent between 2006 and 2010.[79]
- **Tourism.** Tourists visiting the Texas coast spend more than $7.5 billion annually for beach recreation, bird watching, fishing and eco-tourism.[80] The coast accounts for more than one-quarter of total travel expenditures in Texas, making the coast the second most popular tourist destination in the state.[81]

The Rich Resources of the Texas Coast

Nearly two-thirds of the state's Gulf shoreline is protected in parks, wildlife refuges, and natural areas off-limits to development, Texas currently operates 93 state parks and natural areas, 50 wildlife management areas, and eight fish hatcheries. These comprise over 1.4 million acres that are managed in the public trust for recreation and conservation.

III. Goals

This restoration Strategy builds upon existing research, planning and program efforts throughout the Gulf that have generated wide interest and participation by Gulf-based citizens, businesses, scientists, industries and governments. Beginning with its first meeting on November 8, 2010, the Task Force solicited individual input from the general public and engaged key stakeholder groups throughout the region. Additionally, the Task Force reviewed numerous publications that address Gulf of Mexico restoration and engaged the broad expertise of the member agencies. This input led the Task Force to identify the following four goals as priorities for Gulf of Mexico ecosystem restoration:

- **Restore and conserve habitat.** The Gulf Coast has endured extensive damage to key coastal habitats such as wetlands, coastal prairies and forests, estuaries, seagrass beds, natural beaches and dunes, and barrier islands. Within this goal, a major focus is to work with Gulf Coast stakeholders to expedite implementation and improve the effectiveness of state and federal programs related to landscape-scale resource management, habitat conservation and restoration strategies.
- **Restore water quality.** The Gulf of Mexico experiences numerous water quality problems, including excess nutrients, altered sediment inputs, pathogens, and mercury and other pollutants. One of the most prevalent signs of such problems in the Gulf of Mexico is hypoxia—low oxygen levels in the water—which can result from excess nutrients in the water and other factors. Within this goal, a major focus is to reduce the amount of nutrients flowing into the Gulf and to undertake other measures to enhance water quality.
- **Replenish and protect living coastal and marine resources.** Living coastal and marine resources are showing visible signs of distress, such as depleted species populations and degraded habitats. Within this goal, a major focus is to promote sustainable resource management that focuses on actions to conserve and restore viable populations of living coastal and marine resources and their coastal and offshore environments.
- **Enhance community resilience.** Gulf Coast communities face a number of pressing challenges, such as storm risk, sea-level rise, land loss, depletion of natural resources, and compromised water quality. Within this goal, a major focus is to integrate the creation of resilient communities with ecosystem restoration through the development of comprehensive coastal planning programs.

This Strategy articulates a series of actions across these four goals. These goals—just like the Gulf of Mexico ecosystem, with its connected processes, functions and elements—are intertwined. The goals, recommendations and actions outlined below are designed to organize the Strategy in a manner that can be easily understood, while at the same time acknowledging the holistic and integrated nature of the Gulf ecosystem.

Restore and Conserve Habitat

The Gulf Coast faces significant habitat restoration and conservation challenges. These challenges include habitat loss from increased development, resource management, alterations to hydrology and sediment transport, land subsidence, erosion, sea-level rise, hurricanes and tropical storms. Unless the rapid rate of coastal land and habitat loss in the region is halted and eventually reversed, the ecosystem and the services it provides could collapse. This collapse would yield negative consequences for the marine and terrestrial environment, national commerce, the maritime industry, energy security, fisheries, and the rich cultural legacy of the Gulf Coast region. In order to restore the Gulf ecosystem, federal, tribal, state and local governments should work to address, moderate and reverse the factors that drive the degradation of Gulf Coast habitats in a scientifically defensible manner. Working with private partners, landowners and NGOs, governments should strive for a sustainable and resilient ecosystem where wetlands, estuaries and barrier shorelines are managed to achieve and maintain a productive balance between ecological, economic and social functions.

A science-based freshwater and sediment management regime coupled with large-scale restoration has significant potential to address some of the leading causes of coastal habitat losses. It should be implemented in a way that ensures the long-term survival and sustainability of the unique coastal cultures and the resource-based livelihoods of the region. The implications of no action would further threaten the future of a number of coastal communities and would lead to a continued decline in ecosystem services. Key ecosystem functions can be protected and enhanced by reconnecting rivers with their deltaic plains and managing or reestablishing freshwater and sediment inflows while maintaining the effectiveness of navigation and flood damage risk reduction. Healthy ecosystems provide functions that improve coastal resilience. A comprehensive watershed-based approach to the management of river systems is required to ensure that current and future ecosystem needs are met. This comprehensive approach would help ensure that these areas are managed for maximum benefit to both the natural and human systems of the region.

Giving ecosystem restoration equal footing with navigation and flood damage risk reduction is an important element of this Strategy and should be applied to river management activities across multiple agencies. Such an approach would ensure that economic, environmental and social needs are appropriately considered and weighed as part of a decision-making processes. Water resource investment decisions at all levels of government have relied too heavily on the economic outcomes and have not appropriately balanced environmental and social outcomes, regardless of the type of action (navigation, flood damage reduction, ecosystem restoration, water treatment, etc.). Given the limited resources at all levels of government, it is important that a broader array of outcomes be considered with

the goal of maximizing public benefits at both site-specific and watershed scales. These new decision-making processes should include consideration of disproportionate impacts and outcomes often faced by economically and socially vulnerable populations from natural hazards and environmental degradation. Through a consideration of a broader array of outcomes, these processes will appropriately advance important ecosystem restoration actions in the Gulf, without adversely impacting actions needed to address flood damage reduction, navigation or other such water resources based needs.

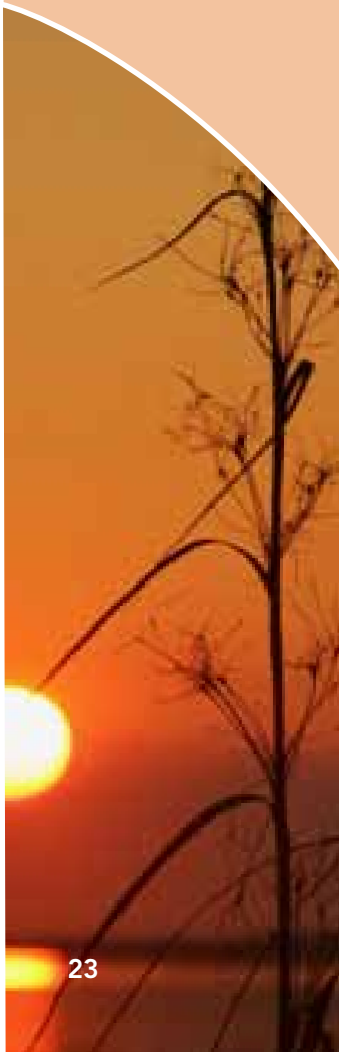
The following major actions are recommended to restore and conserve Gulf Coast habitat.

Major Actions

Prioritize ecosystem restoration in the Gulf of Mexico by ensuring that social, environmental and economic outcomes are fully considered in all river management decisions, and by placing it on equal footing with other priorities such as navigation and flood damage risk reduction

The management of river systems has for too long been focused on addressing issues such as navigation and flood damage risk reduction without commensurate attention to the environmental and social needs of the region. In order to address the resulting coastal sediment distribution issues, stem habitat loss, improve coastal community resilience, and restore water quality to achieve comprehensive restoration, a more modern approach to the management of river systems is needed to ensure that solutions to current and emerging problems can be developed holistically. As a first step and to protect and restore the Gulf of Mexico, stem habitat loss and restore water quality, coordinated action at all levels of government to redefine river management priorities in consideration of a full array of benefits to the public is necessary. To this end, the Task Force should:

- Review all federal, tribal and state authorities, capabilities, plans and activities underway relevant to river management and evaluate the contribution of each to the long-term goal of ecosystem restoration of the Gulf of Mexico.
- Following consultation with member agencies, develop recommendations for needed authorities, funding priorities and policy changes—including actions that may be undertaken within existing authorities.
- Provide input from a regional perspective to agencies developing project implementation guidance that reflects changes to water resources policy; work with agencies to incorporate this guidance, which will be designed to promote more effective, efficient and holistic future use of water resources.



Improve current sediment management practices to maximize to the extent practicable and ecologically acceptable the quantity and effective use of sediments by taking a "strategic use" approach to sediment management

Sediment, delivered by the Gulf river systems, built much of the Gulf Coast and continues to be essential to the health of the Gulf ecosystem. However, river management decisions that prioritized flood protection and navigation, along with other human activities, have turned the natural land-building process into land loss. Throughout the river systems feeding the Gulf, these activities have reduced the amount of sediment for land building; sediments have been significantly reduced from the Mississippi River.

For several years, federal, state and local groups have conducted significant work on sediment management. The Task Force has taken this previous work and expanded it to begin to create a Gulf-wide approach to sediment management. The extensive attention given to this issue is reflected in the level of detail and actions presented.

A sediment management approach referred to as "strategic use" is needed in the Gulf to address land loss through sustainable resource management and land rebuilding and restoration. This strategic use approach should incorporate, where practicable and ecologically appropriate, the following recommended actions:

- Maximize beneficial use of navigational dredged material, where practicable and ecologically acceptable, for effective and sustainable habitat restoration.
- Increase dedicated dredging of river and other sediment sources, such as permitted offshore sediment shoals, for use in habitat restoration projects.
- Implement river reintroduction projects (i.e., diversions) that mimic more natural hydrologic processes and provide freshwater and sediments to rebuild, restore and nourish areas where wetlands have been lost, and to help sustain areas where wetlands have been restored.

Strategic use of sediments will result in long-term benefits to the public by increasing protection from storm surge and sea-level rise, improving navigation, as well as increasing fish and shellfish productivity through restoration of sustainable coastal wetlands and barrier islands. Success with this approach requires process improvements, funding and policies that will advance environmentally beneficial projects based on science. In addition, to advance implementation, better information is needed on the availability of sediment resources for ecosystem restoration, as tools to effectively integrate diversions and dedicated dredging with other management activities, including navigation, flood damage risk reduction and water supply. Tools are also needed to coordinate and schedule beneficial use efforts and to ensure the most efficient and cost-effective transportation of materials for effective beneficial use.

Maximize Beneficial Use Where Practicable

On average in recent years, the U.S. Army Corps of Engineers and local partners contract for the dredging of approximately 100 million cubic yards of sediments annually from federal navigation channels in the Gulf states.[82] Due to such things as funding limitations,

only a small percentage of all material dredged from federal channels in the five Gulf states is currently used beneficially, while the remainder is disposed of in open water or designated disposal facilities. While not all dredged material may be the right consistency or composition to be used beneficially for ecosystem restoration, a large amount of sediment is available as a resource (but not currently used) for effective beneficial use in ecosystem restoration. The time required for implementation of a beneficial use project can vary considerably, from one to three years or longer. It depends upon the time of year, the amount of material being dredged, the distance the material needs to be transported for disposal, the nature of the site to be dredged and of the placement site, weather conditions, and whether the dredging was an emergency response to keep navigation channels open. The opportunities for beneficial use are often missed as a result of such things as funding limitations and lack of coordinated planning. Beneficial use can appear to be a more costly option up front than traditional disposal methods; however, if ecological benefits were factored into cost estimates, beneficial use could be more comparable.

Recommended actions to maximize, where practicable, beneficial use projects:

- Commit to using existing authorities and funding sources in law and policy and improving collaboration among federal, state, tribal and local entities to ensure the maximum beneficial use of sediment, including maintenance-dredged material, where effective, practicable and protective of aquatic life.
- Identify opportunities for immediately improving beneficial use of dredged material by overlaying dredging schedules with restoration project construction.
- Evaluate the potential for the creation of a network of permanent pipeline sediment delivery systems to transport material from dredges to coastal restoration projects.
- Develop options for funding the incremental cost of beneficial use of dredged material, including pooling public and private funds for these activities.
- Pursue implementation of authorized projects to maximize beneficial use where practicable.

Increase Dedicated Dredging

Unlike beneficial use projects, which derive sediments from the routine maintenance of navigation channels, dedicated dredging projects use sediments from ecologically appropriate sources to restore wetlands, barrier islands and shorelines. In sediment-starved coastal areas, the material removed in the course of dredging from river, permitted offshore shoals, and other sources often referred to as “external” sources can be used to restore critical habitats. Additionally, dedicated dredging can help to increase the amount of sediments in the coastal system, which aids in habitat sustainability and resiliency. Dedicated dredging has proven to be an efficient and effective near-term habitat restoration technique. To yield long-term results, dedicated dredging or beneficial use may be coupled with river reintroduction projects to help ensure the sustainability of the restored areas.

Recommended actions to increase dedicated dredging projects include:

- Use a sediment management approach to strategically target project selection and incrementally implement projects using a regional sediment management approach.

The approach should determine the sediment budget, identify ecologically appropriate alternatives, and then place sediment trapping and sediment transport infrastructure to reduce restoration project costs over time. This approach should also consider any potential benefits to the navigation system of removing sediments from rivers for the purpose of habitat restoration, such as the reduced need for navigational maintenance dredging downstream.

- Identify potential sources of public and private funds to help implement dedicated dredging projects for habitat restoration. This effort should include exploring currently available, but potentially underutilized, authorities and funding sources.

Implement River Reintroduction (Diversion) Projects

Use of diversions, or river reintroduction projects, is a technique to restore altered hydrologic patterns by conveying suspended sediments and freshwater from rivers to mimic more natural river delta processes and thereby rebuild land and restore wetlands. River reintroduction projects are important tools for habitat restoration. To yield long-term results, river reintroduction (diversion) projects may be coupled with dedicated dredging projects to help ensure sustainability of restored areas.

Recommended actions to implement river reintroduction projects:

- Expedite construction of river reintroduction projects that have been authorized, planned and designed.
- Develop and implement necessary scientific protocols and monitoring to determine the long-term effectiveness of diversion projects.
- Develop procedures to make diversion project implementation proceed more efficiently, including processes for establishing project partnership agreements between federal and state agencies.
- Identify potential sources of public and private funds, and consider opportunities for increased flexibility to help expedite implementation of reintroduction projects for habitat restoration.
- Explore the development of alternative restoration project delivery approaches that could effectively leverage state, local and private sector partnerships.

Restore and preserve more natural river processes of sediment and freshwater distribution

Inland and coastal wetlands, estuaries, barrier islands and natural beaches and dunes provide critical ecosystem services. These habitats act as storm buffers, foster sustainable commercial and recreational fisheries and other important natural resources, provide habitat for the recovery of threatened and endangered species, protect important cultural resources, and support tourism and other recreational economies and jobs. These functions can be protected and enhanced by reconnecting rivers with their deltaic plains and managing sediment and freshwater inflows while still allowing flood damage risk reduction, navigation and other economic activities to inform appropriate management actions. A comprehensive approach would ensure that these areas are managed for the maximum benefit for the

entire ecosystem. Reintroducing natural deltaic processes that restore sediment to vulnerable areas would help ensure the sustainability of coastal ecosystems.

In the Gulf, communities, commerce and ports have long relied on the extensive network of human-made flood damage risk reduction and navigation structures for their existence. River management priorities historically centered on navigation and flood risk reduction. While successful in meeting those two goals, those priorities created unintended consequences to the surrounding environment by accelerating wetland and barrier island erosion and restricting the flow of vital sediments that had sustained the ecosystem over time. Oil and gas industry canals, pipelines and other infrastructure crisscross the landscape to accommodate exploration, development and commercial activity related to these enterprises, further accelerating coastal land loss.

As a consequence of these and other stresses, Louisiana alone currently experiences about 90 percent of the total coastal marsh loss in the continental United States.[83] Current U.S. Geological Survey (USGS) analyses show that coastal Louisiana has lost 1,883 square miles of land from 1932 to 2010.[84] Between 1985 and 2010, the average rate of land loss was 16.57 square miles per year.[85] If this loss were to occur at a constant rate, it would equate to Louisiana losing a wetland area the size of one football field each hour.[86]

Recommended actions include:

- Expedite the Louisiana Coastal Authority's Mississippi River Hydrodynamic and Delta Management Studies as outlined in the Water Resources Development Act of 2007. These studies, led by the U.S. Army Corps of Engineers and the State of Louisiana, would investigate strategies to take maximum advantage of the water and sediments of a dynamic Mississippi River system for coastal restoration, while also maintaining economically viable navigation and providing storm damage risk reduction. The studies would also identify stakeholder interests, potential outcome targets, and a process for developing decision-support tools. Also, these studies should include a technically thorough exploration of large-scale riverine management strategies and should be informed by the State of Louisiana Master Plan, the Mississippi Coastal Improvement Program, and other programs and plans. This important effort will look at the future needs of the coastal ecosystem with those of navigation, future land use and management, and the sustainability of coastal communities and economies.

Expand the network of state, federal and private conservation areas to ensure healthy landscapes that support the environment and culture of the region and the diverse services provided by the Gulf of Mexico ecosystem

Intact natural and restored ecological systems, watersheds, lands used for the production of food and other crops, recreational areas, and coastlines are essential

to ensure the sustainability of ecosystem function and services. Habitat loss and fragmentation—the division of previously uninterrupted habitat—threaten the ecosystem's ability to support wildlife and recreation. Expanding the existing conservation base and enhancing ecological connectivity will provide greater resiliency to fish and wildlife habitat as well as to coastal communities. State and federal agency collaboration is an important step toward developing a Gulf-wide network of conservation areas to protect habitats and wildlife, support ecosystem services, and ensure recreational and commercial opportunities. This will require improved alignment of federal, state and other land conservation efforts and funding to identify and protect key conservation areas and habitat corridors. A coordinated, stakeholder-driven, science-based effort is needed to identify priority habitats and linkages to serve as core areas, buffers and potential corridors.

State and federal agencies and NGOs are implementing ecosystem-scale planning and protection of important Gulf Coast habitats. For example, Louisiana's existing Coastal Forest Initiative, established to acquire coastal forests including cypress and tupelo from willing sellers, protects a highly significant habitat type while providing natural storm surge buffers. This initiative is the type of conservation effort that should be supported and expanded. Building on these types of efforts will reinforce Gulf-wide actions to restore, conserve and protect important coastal habitats and landscapes.

Recommended actions include:

- Improve collaboration across federal, state, tribal, local and private lands to form habitat corridors of connected areas for key species in mutually designated priority areas.
- Expand collaboration with stakeholders to develop a conservation framework for appropriate protection and compatible use.
- Solicit input regarding public use and conservation priorities in order to prioritize designation of sites.
- Bring together the Land and Water Conservation Fund agencies (DOI, NOAA and USDA), as well as private landowners, private partners, states and other relevant federal agencies, to achieve high-priority landscape-scale conservation projects.

Restore and conserve coastal and near-shore habitats, with a focus on marshes, mangroves, seagrasses, barrier islands, natural beaches and dunes and coastal forests and prairies

A variety of coastal habitat types defines the Gulf of Mexico. These areas provide nurseries, food and habitat for numerous species of commercially and recreationally important finfish and shellfish, as well as migratory birds and a diverse array of mammals, amphibians and reptiles.

- **Fresh, intermediate, brackish and salt marshes and mangroves** trap and hold sediments, improve water quality by filtering input from rivers and runoff from adjacent uplands, and serve as natural coastal buffers to protect shorelines.
- **Seagrasses** are a significant habitat across the Gulf Coast, providing a nursery function for recreationally and commercially important fish and wildlife, stabilizing the bottom, and serving as valuable recreational fishing grounds (see "Seagrasses in the Gulf").
- **Coastal forests and grasslands** such as bottomland hardwoods, longleaf pine, cypress-tupelo swamp and tall grass prairie assist with carbon sequestration and storm barrier protection, wildlife habitat and recreation. These habitats are integral to the hemispheric-scale neotropical bird migration.
- **Barrier islands** serve an important role, protecting mainland shorelines from storms and providing sandy beach and dune habitats and recreational areas.

Overharvesting, development, pollution and a range of other factors have sped the loss of these important habitat types. Restoration efforts should focus on addressing these losses. Water quality protection, living coastal and marine resource conservation, and increasing the pace of direct restoration efforts—including incorporating ecosystem restoration into shoreline stabilization efforts through the use of "living shorelines" and similar approaches—are needed to address these issues.

Seagrasses in the Gulf

Healthy seagrass beds are indicative of productive coastal and estuarine ecosystems, providing habitat and forage for waterfowl, fish, protected species and shellfish; buffering against storms; stabilizing sediments; and improving water quality. However, these important shallow water marine habitats are in trouble, with declines in seagrass acreage ranging from 4 percent to 95 percent in bays and estuaries of the Gulf of Mexico.

Significant declines in seagrasses have been documented for Galveston Bay, coastal Louisiana, the Mississippi Sound, Mobile Bay and most of the bay systems of the Florida Gulf coast, with the coastal bend and Laguna Madre of Texas remaining relatively stable. Not only are seagrasses disappearing, but they are also changing in species composition, densities and patchiness. The causes of loss and changes of seagrasses are many, including tropical storm events, nutrient loading, dredging impacts and direct physical disturbances such as waterfront construction, bottom trawling and propeller scarring.

Source: U.S. Geological Survey. 2004. Seagrass habitat in the Gulf of Mexico: Degradation, conservation and restoration of a valuable resource. USGS 855-R-04-001. <http://gulfsci.usgs.gov/gom_ims/pdf/pubs_gom.pdf>

Recommended actions include:

- Develop an inventory (types, locations, status and other criteria) and tools to set priorities for restoration investments for seagrasses, mangroves, coastal forests and marshes. This inventory will be critical to developing a strategic Gulf-wide approach and assessing its results.
- Provide engineering and design assistance to local governments and private homeowners for creating living shorelines and fish and wildlife habitat.
- Coordinate efforts by private landowners, partner organizations, and local, state, tribal and federal governments to connect conservation activities on coastal lands. This effort will help establish buffers landward of marsh shorelines which may reduce the effects of sea-level rise.

- Implement protective measures to reduce propeller scarring and other physical damage to seagrass beds.
- Increase the acreage of watershed, riparian, wetland and shoreline habitats through conservation, restoration and protection actions to maximize water quality, recreation, and fish and wildlife benefits.

Restore Water Quality

Water quality is a significant indicator of the health of the Gulf of Mexico. The condition of the Gulf's waters reflects alterations in natural hydrology and pollution from urban development, industry, agricultural runoff, atmospheric deposition, and other sources throughout the entire Gulf watershed.

One of the most striking examples of water quality impacts in the Gulf can be found stretching from the mouth of the Mississippi River to the upper Texas coast. There, each summer, a hypoxic (low-oxygen) area or "dead zone" forms, primarily caused by excess nutrients in the water, which deplete oxygen that organisms need to survive. A significant amount of these nutrients (mostly nitrogen and phosphorus) comes from fertilizers, soil erosion, atmospheric deposition, and discharges from wastewater treatment plants and water control structures. These nutrients are carried to the Gulf of Mexico from throughout the entire watershed and upper basin states via the Mississippi and Atchafalaya Rivers. Nitrate loadings in the Mississippi River rose from 200,000 to 500,000 tons per year in the 1950s and 1960s to an average of about 1,000,000 tons per year during the 1980s and 1990s.[87]

Hypoxia in the Gulf of Mexico is an obstacle to achieving healthy, diverse and sustainable fisheries because it creates an uninhabitable environment for marine life. Hypoxia is most detrimental to benthic (bottom-dwelling) organisms such as crabs, oysters and other species in early life stages. These organisms, unable to migrate away from the zone, ultimately die in the low-oxygen conditions. The annual loss of these benthic species affects the entire food web and also has implications for the Gulf economy.

Pathogens, nutrients and other pollutants carried by stormwater and wastewater, as well as HABs (or "red tide") carried by ocean currents, have significant impacts on Gulf water quality, affecting the Gulf's ability to maintain healthy populations of aquatic organisms and healthy recreational waters. Urbanization alters the ecosystem's capacity to absorb runoff, leading to higher stormwater flows with increased flooding and discharge of pollution to receiving waters. Runoff from agricultural operations also contributes to excess sediment and nutrient levels in Gulf waters. Combined, these stressors degrade drinking water sources and recreational waters and commercial fisheries, cause closings of beaches and shellfish-growing areas, and reduce the quality of aquatic habitat and human health.

In addition to inputs of nutrients and pollutants from coastal systems and watersheds, deposition of air emissions also contributes to water quality impacts,

particularly in near-coastal waters. Nitrogen and other airborne pollutants, such as sulfur in the form of sulfuric acid, alter surface seawater alkalinity, pH and inorganic carbon storage. These effects disrupt natural biogeochemical cycles.[88]

Across the Gulf region, freshwater flows need to be restored to more natural conditions. Rivers and streams provide freshwater inputs that help to maintain salinity gradients and are the source of nutrient and sediment inputs that, in proper combination, produce ecologically sound and healthy estuaries. Hydrologic modifications have affected estuaries throughout the Gulf by altering the amount of freshwater delivered. These estuaries depend on freshwater inflow to sustain their fisheries resources, particularly oysters, as well as to support habitats such as seagrass meadows, near-shore reefs, coastal marshes and mangroves.

Water quality in the Gulf can be most effectively improved by focusing on the principal sources of water quality degradation. Major actions to restore water quality in the Gulf of Mexico are described below.

Major Actions

Decrease and manage excess nutrient levels in the Gulf through the development and implementation of state nutrient reduction frameworks

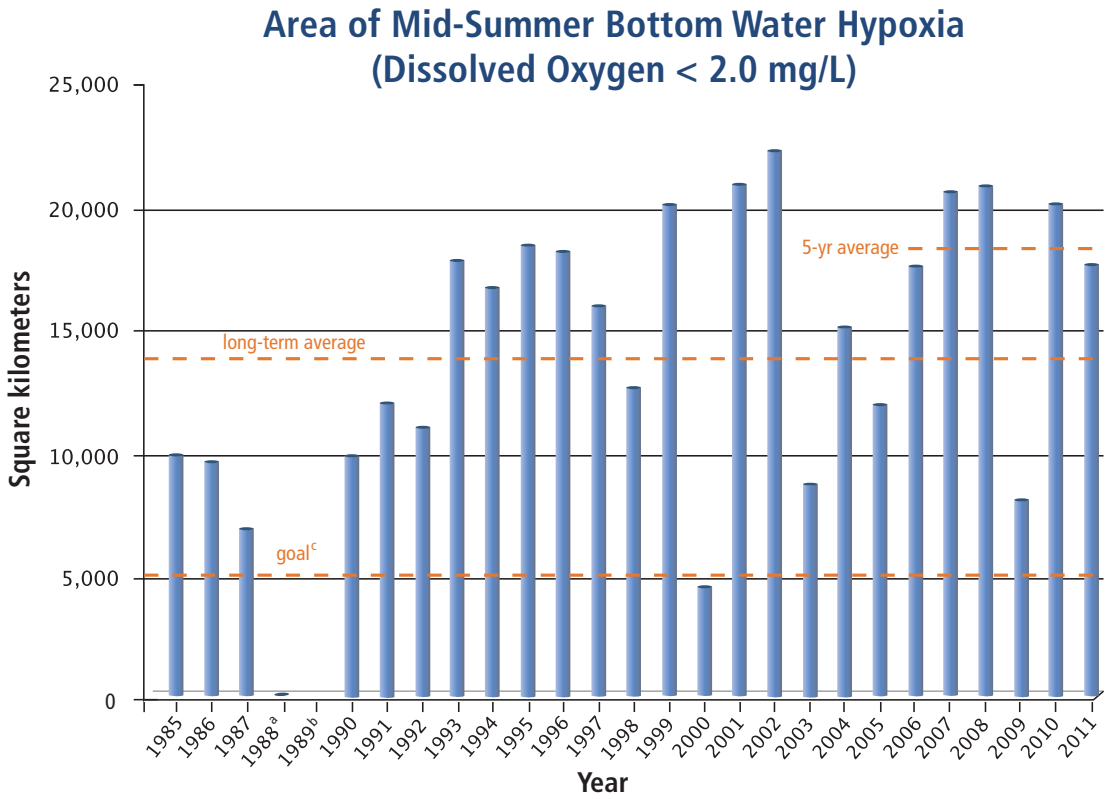
Supporting the development and implementation of state-developed nutrient reduction frameworks in the Gulf and the Mississippi River Basin states will be important for reducing HABs and hypoxic conditions in the Gulf, such as the "dead zone," and improving local water quality conditions.

Beginning with the release of its first Action Plan in 2001, and reaffirmed in the updated 2008 Action Plan, the Hypoxia Task Force established a collaborative interim goal to reduce the five-year running average areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 square kilometers (1,931 square miles).[89] As of the most recent survey (2011), the current five-year average is 17,350 square kilometers, or 6,700 square miles[90] (see "Area of Mid-Summer Bottom Water Hypoxia").

To accelerate progress on and effectiveness of this goal, the Task Force recommends working in cooperation with the Hypoxia Task Force and the Mississippi River Basin states to support the development and implementation of state-developed nutrient reduction strategies. Specifically, the 2008 Action Plan states the objective as:

> Complete and implement comprehensive nitrogen and phosphorus reduction strategies for states within the Mississippi/Atchafalaya River Basin encompassing watersheds with significant contributions of nitrogen and phosphorus to the surface waters of the Mississippi/Atchafalaya River Basin, and ultimately to the Gulf of Mexico.[91]

In combination with this effort, Gulf states not part of the Hypoxia Task Force (Alabama, Florida and Texas) are collaborating, through GOMA, to strengthen supporting science and technical capabilities and to develop their own state nutrient reduction frameworks to restore local water quality conditions.



[a] Only 40 sq km were affected in 1988 (a drought year in the Mississippi Basin).
[b] No data were collected in 1989.
[c] Mississippi River/Gulf of Mexico Nutrient Task Force Hypoxia Action Plan goal.

Data source: N.N. Rabalais, Louisiana Universities Marine Consortium, R.E. Turner, Louisiana State University
Funded by: NOAA, Center for Sponsored Coastal Ocean Research

Building on the states' water quality standards programs, key elements recommended for effective state nutrient reduction frameworks include:

- Prioritizing watersheds on a statewide basis for nitrogen and phosphorus loading reductions.
- Setting watershed load reduction goals based on the best available water quality information.
- Ensuring the effectiveness of point source permits in targeted/priority sub-watersheds.
- Developing more effective reduction measures for nonpoint sources and other point sources of storm water not designated for regulation.
- Partnering with federal and state agencies, NGOs, the private sector, landowners, and other agriculture partners to develop watershed-scale plans and promote adoption of science-based nutrient management conservation practice systems that offer enhanced environmental protection, and may also increase agricultural production.
- Identifying stormwater and septic system tools.
- Establishing accountability and verification measures.
- Conducting annual reporting on load reductions and impacts in targeted watersheds.

Successful implementation of these frameworks could significantly advance the Strategy's goal to restore water quality as it relates in particular to reducing excess nutrients to Gulf of Mexico coastal waters. Consequently, the Task Force, through its coordination

responsibilities with the Hypoxia Task Force, should explore means of providing technical and resource support to this effort.

Recommended actions include:

- Accelerate the development and implementation of the Hypoxia Task Force's state-developed nutrient reduction frameworks by the states in the Mississippi Atchafalaya River Basin.
- Coordinate the Task Force's efforts with the Hypoxia Task Force's next reassessment, scheduled to be completed in 2013. This coordination will help better ensure consistency and focus related to the establishment of performance indicators and supporting actions for the reduction of nutrients.
- Promote the development and implementation of state nutrient reduction frameworks by Gulf states not part of the Hypoxia Task Force (Alabama, Florida and Texas).
- Provide technical assistance and explore additional ways to expand support for implementation of state nutrient reduction frameworks. This includes supporting state-led management efforts such as installation and monitoring of best management practices (BMPs) aimed at reducing excess nutrients flowing into the Gulf.

Focus restoration actions in priority watersheds to address excess nutrients in coastal waters and reduce hypoxic conditions

One of the most cost-effective and efficient ways to reduce sources of excess nutrients is to target program funding and technical assistance for accelerated treatment of areas with the most critical need and in the highest-priority watersheds. This approach, which addresses local water quality and natural resource concerns at a small watershed scale, will contribute to reducing runoff of excess nitrogen and phosphorus on a large scale, and contribute to reducing hypoxia and HABs in the Gulf. As noted above, state nutrient reduction frameworks are useful mechanisms for identifying priority watersheds.

Recommended actions include:

- Using a science-based approach, in collaboration with federal and state agencies, select and target resources for priority sub-watersheds where significant opportunities exist to reduce excess nutrients, sediments and pathogens flowing into the Gulf of Mexico and its estuaries.
- Increase and coordinate conservation practices on agricultural lands to enhance water quality in priority watersheds within the Mississippi River basin and other tributaries in the Gulf states through USDA's Mississippi River Basin Healthy Watersheds Initiative (MRBI) and similar programs (see "Mississippi River Basin Initiative").

Mississippi River Basin Initiative

To improve the health of the Mississippi River Basin, USDA's Natural Resources Conservation Service (NRCS) has established the MRBI. Through this initiative, NRCS and its partners help producers in selected watersheds in the Mississippi River Basin voluntarily implement conservation practices that avoid, control and trap nutrient runoff; improve wildlife habitat; and maintain agricultural productivity.

NRCS dedicated more than $70 million in fiscal years 2010 and 2011 combined to fund conservation projects to improve water quality in priority watersheds throughout the Mississippi River Basin.

- Broaden implementation support for the recommendations in the Conservation Effects Assessment Program (CEAP) in the upper Mississippi River (see "Conservation Effects Assessment Program").
- Increase the number of Comprehensive Nutrient Management Plans (CNMPs) implemented for animal feeding operations and pasture grazing. In conjunction with the CNMPs, implement necessary complementary conservation and BMPs including fencing, hard-bottom cattle crossings, constructed wetlands and other BMPs most appropriate for the individual location and operation to effectively address nutrient transport from agricultural lands. This action would also help to reduce pathogens in the Gulf of Mexico.
- Coordinate among state and federal programs that promote riparian buffer restoration and preservation to better align and maximize efforts.
- Work with agricultural equipment and fertilizer dealers to make precision agriculture equipment and technologies available to private landowners and operators at affordable prices.

Conservation Effects Assessment Project

CEAP is a multi-agency, multi-resource effort led by NRCS to assess the effects of conservation practices on the nation's cropland, grazing lands, wetlands, wildlife and watersheds.

A recent CEAP study, *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Upper Mississippi Basin*,[92] found that farmers have adopted conservation practices resulting in significant reductions in nutrient losses. However, the study also found that conservation plans that include comprehensive nutrient management are generally lacking throughout the region. According to the report, a suite of practices that includes both soil erosion control and comprehensive nutrient management is needed to simultaneously address soil erosion and nitrogen leaching loss.

Reduce pollutants and pathogens from stormwater flows and other sources

Contaminants carried within stormwater and sewer overflows have the potential to affect both aquatic life and human health. These contaminants can include heavy metals from urban infrastructure like roads, guardrails, and construction materials; fertilizers and pesticides from residential and commercial use; petroleum products and paving compounds such as polycyclic aromatic hydrocarbons (PAHs) from commercial and residential sources; bacteria, viruses, protozoa and parasites from fecal waste; and nitrogen and phosphorus pollution. In the Gulf, these contaminants can impact recreational waters and commercial fisheries, as well as the overall quality of aquatic life. The Task Force supports a region-wide effort to reduce pollutants and pathogens stemming from stormwater flows and other sources entering Gulf Coast waters.

Recommended actions include:

- Promote comprehensive solutions that may include green infrastructure and low-impact development approaches in urban and suburban areas to help reduce combined sewer and sanitary sewer overflows, untreated stormwater runoff, as well as producing natural habitat buffering benefits.
- Facilitate the expansion of municipal stormwater permit programs to include fast-growing suburbs and urban areas not currently covered by these programs.

- Encourage states to restrict phosphorus in lawn fertilizer, following the successful examples of Maine, Maryland, Michigan, Minnesota, New Jersey, New York, Virginia, Washington and Wisconsin.

Improve the quality and quantity of freshwater flow into priority estuaries to protect their health and resiliency

Estuaries, transition zones between the coastal watersheds and offshore marine habitats, serve as barometers of the health of the Gulf of Mexico. They provide breeding grounds, forage and nursery areas for recreational and commercially important species of fish and wildlife; habitat for benthic species such as oysters and bay scallops; and transitional and migratory wildlife corridors between upstream freshwater habitats and offshore marine waters.

Gulf estuaries are affected by multiple stressors, including nutrient loading, other pollution, altered hydrology resulting in unnatural tidal exchange and/or salinity gradients, and upstream dams. While levees are sometimes necessary to enable management of unnatural systems in a manner that mimics nature, barriers to natural tidal flow such as weirs, levees, causeways and artificial canals can cause habitat degradation and loss by disrupting the natural salinity variations necessary to support a diversity of coastal organisms (e.g., oysters, saltmarshes, seagrasses). Moreover, as demand for freshwater resources continues to increase throughout the Gulf Coast river basins and underground aquifers, maintaining sufficient freshwater flow into the bays and estuaries will become increasingly challenging.

Recommended actions include:

- Support state and local government efforts to better protect groundwater supplies and instream freshwater flows by minimizing water loss from leaking water supply systems. Also, develop policy and incentives for water reuse on agricultural lands, urban areas (for watering lawns and golf courses), and other non-drinking uses of freshwater in areas where these resources are limited.
- Develop a science-based freshwater inflow regime and monitoring system to improve the timing, quantity and quality of freshwater inflow within managed river systems. This approach would not only benefit wetlands, but also remove nutrients from direct introduction to Gulf waters and reduce hypoxia, and sustain important fisheries, oysters and protected wildlife.
- Identify and develop means and opportunities to improve water management planning, conservation, land-use planning, and barrier evaluations (to tidal flow) to restore and maintain freshwater resources and estuaries along the Gulf. Consider removal, addition or modification of tidal barriers where cost-effective scientifically supported solutions can be shown to improve and restore estuarine habitat.

Coordinate and expand existing water quality monitoring efforts supporting adaptive management of programs and projects designed to improve water quality

Available water quality data throughout the Gulf of Mexico basin (from inland watersheds to estuaries/nearshore areas and the offshore waters) are insufficient or inadequate as

currently collected to allow for the accurate assessment of status and trends. Incomplete data make it difficult to quantify changes and to determine if restoration and protection measures are successful. The Task Force supports the following actions to better coordinate and expand water quality monitoring to support adaptive management:

- In collaboration with federal and state partners, assess current water quality monitoring information and data. Identify gaps in core information needs and performance measures to develop a long-term water quality monitoring program building on existing efforts, including assessment of nutrients, HABs and other water quality parameters.
- Monitor and assess nutrients in the Mississippi River Basin, to better quantify current nutrient loading to the Gulf and target reduction efforts.
- Leverage existing information management infrastructures of EPA, NOAA, USDA and DOI to integrate and provide monitoring data and information supporting local, state and regional decision needs.

Collaborate with Mexico to assess and reduce emissions from oceangoing vessels in the Gulf that degrade water quality

Water quality, particularly in near-coastal waters, can be negatively affected by pollutants emitted from oceangoing vessels. To protect marine and coastal areas, including the Gulf, the United States and Canada adopted the North American Emissions Control Area (ECA) in March 2010. This initiative will put in place lower sulfur marine fuel standards for oceangoing ships operating in the ECA beginning in August 2012, as well as nitrogen oxide standards for engines on ships built in 2016 and later.[93] It will dramatically reduce air pollution from ships and deliver water quality benefits by reducing atmospheric deposition of pollutants to coastal ecosystems.

Ongoing efforts will continue with Mexico to increase awareness of the health and environmental benefits of reducing emissions from oceangoing vessels. Data from a recent U.S.-Mexico fuel switching demonstration, for example, show that particulates and sulfur dioxide emissions from container ships can be reduced by up to 80 percent and 89 percent, respectively.[94] This plan presents a unique opportunity to increase the benefits of reducing ship emissions in the Gulf of Mexico.

Replenish and Protect Living Coastal and Marine Resources

The Gulf Coast is inhabited by a rich diversity of mammals, birds, reptiles, fish, invertebrates and plants. For example, the coral reef systems support some of the most diverse assemblages of life, including anemones, spiny lobsters, yellowtail snapper and nurse sharks. These species provide the underpinning for economically critical commercial and recreational opportunities, as

well as many vital ecosystem services such as filtering pollutants, sequestering carbon, and contributing to a robust and biologically diverse system better capable of rebounding from natural and human-made events. Gulf of Mexico habitats are among the most important on the continent for wintering waterfowl and migrating songbirds. Radar images show hundreds of millions of migrating birds passing through the Gulf each spring and fall, relying on coastal habitats for rest and food. Beach-nesting birds and marsh birds are in decline and other beach-dwelling species are at increasing risk due to threats such as climate change and habitat loss. Anadromous fish such as striped bass, alligator gar and the threatened Gulf sturgeon need healthy, connected coastal waterways and rivers flowing into the Gulf for spawning.

Human communities depend substantially on the productivity of living coastal and marine resources for economic and recreational benefit:

- A 2006 national survey of wildlife-related recreation reported that revenues from fishing, hunting and wildlife viewing in the Gulf region topped $22 billion.[95] In 2006, almost 1.6 million people participated in wildlife viewing in Florida alone. Of those people, about 1.3 million viewed shorebirds, 800,000 viewed fish and 700,000 viewed ocean mammals.[96]
- Recreational and commercial fishing is a multi-billion-dollar industry critical to the economies of each of the Gulf states. From 2007 to 2009, more than 75 percent of the total U.S. shrimp landings and over 60 percent of oyster landings were from the Gulf of Mexico.[97] More than 44 percent of all marine fish caught by recreational anglers in the United States in 2009 were from the Gulf of Mexico.[98]

Many Gulf Coast plant and animal species are in decline or at abundances far below historical levels. Among the threats contributing to the depletion of living coastal and marine resources are development in environmentally sensitive areas, land loss, predation, habitat disturbance, pollution, water quality degradation (including excess nutrient discharge leading to hypoxia), and increases in disease and invasive species.

Implementing the recommendations provided in the "Restore and Conserve Habitat" and "Restore Water Quality" sections of this Strategy will directly and significantly benefit and improve living coastal and marine resources. The sustainability of commercial fish species, for example, depends on healthy coastal habitat; nearly 97 percent of commercial finfish and shellfish landed in the Gulf of Mexico depend on estuaries and coastal waters at some point in their life cycle.[99] The survival and health of estuaries and offshore ecosystems are linked with the riverine processes that deliver freshwater, sediment and nutrients to moderate salinity, sustain floodplain habitats and enhance coastal fisheries. The interconnectedness and complexity of near-shore and offshore habitats create opportunities for multiple benefits from ecosystem restoration actions. Successful restoration of living coastal and marine resources will entail a robust monitoring effort, implementation of species restoration plans, and targeted reintroduction and re-stocking of depleted resources.

Major Actions

Restore depleted populations of living coastal and marine resources

The Gulf is home to a number of endangered and threatened species at risk of extinction. Twenty-eight species listed under the Endangered Species Act occur in the Gulf—three plants, four birds, nine mammals, seven reptiles, three fish and two corals.[100] Additionally, many species of marine mammals in the Gulf are protected under the Marine Mammal Protection Act. Numerous other species are listed in state wildlife protection programs. Recent management efforts of federal and state fisheries have reduced the number of fish stocks on current "overfishing" and "overfished" lists; however, commercially and recreationally important species have been reduced from historical levels. For example, red snapper in the Gulf have been reduced to less than 10 to 15 percent of historic spawning abundance,[101] though recent regulatory accountability measures under the Magnuson-Stevens Fisheries Conservation and Management Act are making significant strides to rebuild this stock.[102]

Restoration actions that improve habitat and restore water quality will substantially improve the health of the living coastal and marine resources of the Gulf. However, some depleted populations need additional management assistance to fully recover and become self-sustaining components of the ecosystem. For example, nesting populations of Kemp's Ridley sea turtle have experienced significant rebuilding as result of the management, restoration and conservation efforts of Mexico and the United States.[103] Additionally, 2011 marked the historic reintroduction of 10 endangered whooping cranes, after a 40-year absence, into the marshes of southwest Louisiana.[104] Restoring reefs in areas of significant vessel groundings and oyster reefs in once-degraded habitat is another example of techniques to replenish living resources.

Recommended actions include:

- Revisions to existing management plans—e.g., Endangered Species Act (ESA) Recovery Plans, Magnuson-Stevens Act Fishery Management Plans, or State Wildlife Action Plans—should use an ecosystem-based approach to improve monitoring and research of living coastal and marine resources, including nursery, spawning and breeding habitats; integrate input from all affected stakeholders; minimize adverse impacts that can result from human activities; maintain sustainable native populations; and protect, restore and maintain critical habitat for fish, wildlife and plants in coastal areas.
- Implement existing plans and, where appropriate, develop plans for conserving threatened and endangered species. Most species listed under the ESA have recovery plans that prioritize actions needed for recovery. Efforts should be made to implement high-priority recovery actions and complete recovery plans for remaining threatened and endangered species currently not addressed in an approved recovery plan.
- Improve the quality and timeliness of fishery-dependent data (e.g., from recreational catches) and implement a Gulf-wide, comprehensive and long-term fishery-independent data collection program (e.g., from scientific research cruises). Decrease the time between data collection and its use for fishery management decisions. Lacking or lagging

data are frequently cited as a major challenge in achieving sustainability and maximizing economic benefits to recreational and commercial fisheries.

- Explore opportunities to enhance depleted fishery stocks through reintroductions, and/or develop and expand capabilities to re-stock native species of fish, shellfish, plants and wildlife.
- Identify beach-nesting bird colonies (e.g., least terns, black skimmers) and solitary nesting species (e.g., piping plover, American oystercatcher).
- Investigate the impacts of mechanical disturbance of subsurface habitat on the sustainability of living coastal and marine resources.

Conserve and protect offshore environments

One hundred fifty million years of biological and geological history have created numerous banks, escarpments and hard grounds that ring the continental margins of the Gulf of Mexico. These hardbottom features are relatively rare, highlighting the importance of conserving these habitats where they do exist. The seafloor environments formed by these features are home to dense communities of corals, sponges and other invertebrates. They also attract resident and migratory fish species, including snapper, grouper, sharks and rays, as well as marine mammals and sea turtles. These ecologically important places extend into deep areas of the Gulf where dense assemblages of deepwater coral species and seeps of methane support unique and biologically rich marine communities. The deepwater environments of the Gulf support schools of squid, which are food sources for many whales, swordfish and marlin. Furthermore, the offshore environment serves as a critical component of the life cycles of many vertebrate and invertebrate species (e.g., white and brown shrimp, Gulf menhaden), so its health is integral to species' survival.

The unique hard-bottom structures found throughout the Gulf (such as the Florida and Texas Snapper Banks, the Alabama Pinnacles, the Alabama Alps, the Florida Middle Grounds and Pulley Ridge, and the Texas and Louisiana Flower Garden Banks) support prolific invertebrate communities and important reef fish spawning areas. Pulley Ridge is a series of drowned barrier islands on the southwest Florida Shelf, which are the deepest known light-dependent coral reefs in the United States. Throughout the Gulf, extensive offshore mats of *Sargassum* provide shelter, nursery habitat and food for deepwater species, including sea turtles. These highly diverse concentrations of marine life are essential to maintaining the Gulf's biodiversity and the productivity of its commercial and recreational fisheries.

The health of these environments, and of all the coastal and offshore habitats of the Gulf of Mexico, relies on the physical and biological connections that link the places and their communities to each other and to the wider Gulf and Caribbean region. Therefore, protecting and managing a network of ecologically significant offshore sites will be important to the Gulf's overall biological productivity and resilience.

Recommended actions include:

- Identify candidate locations for cooperative conservation and restoration of offshore living resources based on biological significance through focused mapping and exploration efforts.
- Use existing conservation frameworks and legal authorities, and develop prioritization criteria for appropriate protection and compatible use that accommodate both economic importance and biological integrity. This effort should be undertaken in collaboration with relevant stakeholders and build on existing efforts.

100-1000 Restore Coastal Alabama Project

100-1000 Restore Coastal Alabama is a collaborative partnership and volunteer effort to restore 100 miles of oyster reefs to help create the conditions needed to plant, support and promote more than 1,000 acres of coastal marsh and seagrass beds. This restoration effort will provide habitat for oyster larvae to settle and colonize, establish nursery habitat for commercially and recreationally important finfish and shellfish, dampen wave energy, decrease erosion, stabilize sediments, and improve water clarity. This coastal restoration project also includes critical job creation and community involvement components to support and sustain the vision of a better coastal Alabama.

Source: 100-1000 Restore Coastal Alabama. <http://100-1000.org>

Restore and protect oyster and coral reefs, and other coastal environments

Oysters have significant economic, environmental and social value throughout the Gulf coast and are considered one of the important economic engines in the region, particularly in rural coastal communities. Coral reefs are among the most diverse and biologically complex ecosystems in the Gulf, supporting high levels of biodiversity and densities of living organisms, as well as providing high regional economic value through ecotourism. Oyster and coral reefs in the Gulf serve many ecological functions, including reducing shoreline erosion and storm surge, creating habitat for other species, and improving water quality by filtering nutrients and sediments. These habitats have declined as a result of altered salinities and sediment, degraded water quality, overfishing, disease, climate change, storms and droughts.

One important opportunity for enhancing coastal resiliency is through restoration of native reefs and other habitats such as salt marsh, mangroves, barrier islands, seagrass beds and other near-shore adapted plants and sessile organisms. This action can create a "living shoreline," which can be a viable alternative to an armored shoreline. These structures also provide the added benefits of improved water quality, and overall increase in habitat diversity and productivity. For example, oyster shell/coral/limestone breakwaters, if properly constructed as part of living shoreline projects, can serve ecological functions similar to those of natural reefs.

Recommended actions include:

- Develop criteria to prioritize oyster reef and coral reef creation, restoration and enhancement projects across the Gulf of Mexico.
- Engage aquaculture industry in oyster and other shellfish restoration efforts, building on successes in other regions of the country. Consider artificial reefs in territorial and coastal waters where appropriate, following best practices to minimize impacts on natural habitats and existing plant and animal communities.

- Restore and manage coral and oyster reefs to support a variety of ecosystem services, including sustainable harvest, fish production, water filtration, nitrogen removal, and shoreline protection and stabilization.

Coordinate and expand existing Gulf monitoring efforts to track sentinel species and sites

Sentinel species are representative plants and animals that can be tracked over time to help alert researchers, decision-makers and the public about current or potential threats, trends and impacts to the ecosystem. Sentinel species are often the first or most obvious species to show effects of environmental change, serving as the proverbial "canary in a coal mine." Sentinel sites are key locations in coastal and marine environments suitable for intensive study and sustained observations to detect and understand physical, chemical and biological changes in the ecosystems they represent. By focusing on sentinel species and sites, scientists can better understand the status and trends in ecosystem health, improve ecosystem risk models, target restoration actions, and better inform management actions.

State and federal agencies in the Gulf are engaged in long-standing efforts to actively monitor fish and wildlife. These efforts provide the foundation for building sentinel programs. The DOI agencies, including the Fish and Wildlife Service (USFWS), the Bureau of Ocean Energy Management, the National Park Service, and USGS—as well as NOAA—all have monitoring programs that track federal trust species on and offshore. Additionally, EPA's NEP and NOAA's National Estuarine Research Reserves and National Marine Sanctuaries support extensive monitoring programs in the Gulf. Examples of long-standing surveys include the state-federal Southeast Area Monitoring and Assessment Program (SEAMAP), USFWS Waterfowl Population Surveys, Marine Mammal Population at-sea and aerial surveys, and bluefin tuna larval monitoring in the Gulf of Mexico. State agencies often have complementary monitoring programs. An accessible, comprehensive database of information is needed to coordinate and link efforts and inform management decisions.

Example Sentinel Species and Sites for Monitoring Gulf Ecosystem Health

Sentinel species could include:

- **Fish:** Atlantic bluefin tuna, red snapper, gag grouper, menhaden, whale sharks, Gulf sturgeon, flounder, speckled trout
- **Birds:** pelicans (brown and white), beach-dependent plovers (snowy, Wilson's, and piping), northern gannet (offshore), American oyster catcher, and colonial nesting birds (least tern, black skimmer, roseate spoonbill)
- **Mammals:** beach mice, sperm whale, manatee, dolphin
- **Turtles:** Kemp's Ridley, loggerhead, green sea turtles, diamondback terrapin
- **Corals:** staghorn, elkhorn, deepwater species
- **Plants:** spartina, mangroves (black and red), sea oats, turtle grass, *Sargassum*, algae
- **Invertebrates:** oysters, shrimp, bluecrab, macroinvertebrates

Sentinel sites could include:

- Deepwater coral reefs
- Fish spawning areas and other marine aggregating areas
- NOAA's National Marine Sanctuaries (NMS) National Estuarine Research Reserve Sites (NERRS) and EPA's National Estuary Program (NEP)

Recommended actions include:

- In collaboration with current partners, identify appropriate sentinel species and sites throughout the Gulf of Mexico that would provide long-term data to inform restoration actions.
- Support and enhance existing monitoring efforts to ensure that the selected suite of sentinel species and sites is sufficiently tracked. Pursue public-private partnerships to expand monitoring capabilities.
- Develop and apply methods to estimate population sizes; determine geographic distribution and abundance trends to implement protection strategies for sentinel species and sites of particular sensitivity.

Minimize, and eliminate where possible, invasive species that impact the Gulf of Mexico

Invasive species are species that are non-native to a specific ecosystem, or native species with a competitive advantage due to significant ecosystem impacts from human development, hurricanes or other factors. Invasive species can be plants, animals, or other organisms occupying terrestrial and/or aquatic habitats. More than 300 nonindigenous aquatic species alone have been found in the Gulf region, some of which are considered potentially harmful to the Gulf of Mexico ecosystem.[105] Some examples include nutria,[106] lionfish,[107] giant salvinia,[108] orange cup coral,[109] Asian tiger shrimp,[110] green mussel,[111] and several species of tilapia.[112] Invasive species are primarily introduced through human actions. For example, international shipping and aquaculture are major means of introduction of aquatic invasive species to the Gulf of Mexico.[113]

Because invasive species have few natural enemies and are often immune to native diseases, they usually spread rampantly. Also, altered habitat conditions from wetland loss and changes in stream flow enable invasive species to proliferate. Invasive species are one of the leading threats to biodiversity and have enormous consequences for agriculture, forestry, fisheries and other human activities, as well as human health. Control costs and environmental damages can add up to millions of dollars per year.[114]

Recommended actions include:

- Develop and implement Gulf states invasive species management plans and pathway-specific risk management plans. Use existing state and regional partnerships, such as the Florida Invasive Species Partnership and the Cooperative Invasive Species Management Areas, as potential model frameworks.
- Evaluate the impact of various introduction mechanisms (such as ship ballast water, aquarium and exotic pet trade, and the movement of large platforms into the Gulf) by collaborating with such entities as the Gulf of Mexico states, the Gulf and South Atlantic Regional Panel on Aquatic Invasive Species, the Aquatic Nuisance Species Task Force, the National Invasive Species Council and the Southeast Aquatic Resources Partnership.

Enhance Community Resilience

About 10 million people live along the Gulf Coast, enjoying the many unique benefits of living in this area. These communities also face challenges from natural disasters such as hurricanes and floods and from long-term hazards such as erosion, land subsidence and sea-level rise. Human-induced challenges also confront communities, including coastal land loss, population change and associated development, and technological disasters such as oil spills. These communities will benefit directly from Gulf restoration activities that will improve ecosystem services, such as better storm protection and healthier fisheries. Actions taken to increase community resilience will reduce future impacts from storms and sea-level rise, decreasing the duration and expense of response and recovery. In just the last 10 years, eight of the costliest hurricanes in American history caused an estimated $225 billion in damages to Gulf states.[115] In 2005, Congress made a supplemental appropriation of $94.8 billion to respond to the impacts of Hurricanes Katrina, Rita and Wilma.[116] A study commissioned by the Federal Emergency Management Agency found that every one dollar invested in proactive mitigation efforts to prevent damages yields four dollars in cost savings.[117] Some studies have shown even greater savings. Improving Gulf communities' capacity to address acute and chronic hazards will contribute to the economic viability of the region and the nation.

Each Gulf Coast community ultimately has its own needs, values and interests, so solutions for ecosystem restoration and coastal planning will be driven by local decisions based on local conditions. At the same time, to effectively meet immediate needs and anticipate future conditions, coastal communities—the decision-makers, residents, and other stakeholders—should collaborate better to identify solutions that consider Gulf-wide needs, regional concerns, and local conditions. Gulf states have initiated efforts to develop coastal improvement programs that address community resilience and ecosystem restoration in a manner that incorporates ecologically sustainable growth and local interests. These programs should be used to identify development priorities, such as maintaining important ecosystems, improving resilience of existing housing stock to better withstand disasters, or relocating housing and infrastructure out of sensitive areas to more appropriate, less-vulnerable locations. In order for communities to better plan, prepare and respond to changes associated with living along the coast, technical assistance and currently available analytical tools should be employed to increase resiliency of communities.

Major Actions

Develop and implement comprehensive, scientifically based and stakeholder-informed coastal improvement programs

Gulf Coast states should build upon and create effective coastal improvement programs to reflect state-based, stakeholder-driven priorities for coastal improvements that incorporate a range of federal and state coastal improvement and restoration programs.

Seafood Safety

The *Deepwater Horizon* oil spill highlighted the value of fishery resources to coastal communities in the Gulf and the region's importance to the nation as a source of high-quality, abundant seafood. The Food and Drug Administration, NOAA's National Marine Fisheries Service, EPA, the U.S. Coast Guard, and the Gulf Coast states have taken unprecedented steps to verify the safety of the seafood harvested from the Gulf, first by closing areas exposed to the oil and then by establishing protocols designed to ensure the safety of seafood as fishing areas were reopened. All federal waters and state waters, with the exception of some small areas near the mouth of the Mississippi River, have been reopened.[118]

Many of the actions highlighted in this strategy will directly affect the quality and abundance of the seafood in the Gulf of Mexico, including addressing the loss of important coastal and marine habitats, improving water quality by reducing excess nutrients, and addressing sources of pathogens and other pollutants into coastal waters. In combination with the Gulf states' ongoing sampling and testing to verify the quality of fish, shrimp, crabs and oysters produced by their local industries, restoring habitat and water quality will contribute to a robust fishing economy in the Gulf of Mexico.

The Mississippi Coastal Improvement Program (MsCIP), for example, is a framework for the protection, restoration, enhancement and re-establishment of more natural buffering capacities of coastal habitats. The State of Mississippi and the U.S. Army Corps of Engineers established this effort in response to Hurricane Katrina, and jointly manage the program. MsCIP addresses community resilience and ecosystem restoration in a manner responsive to natural system concerns and local interests. Although reducing risk was the major theme of the effort, the solutions presented in the plan inherently addressed land and habitat loss, living coastal resources and water quality.

The MsCIP framework offers a model for developing local and state methods to achieve restoration at the local, state and regional ecosystem levels. The other coastal states have or are considering similar approaches. The State of Texas and the U.S. Army Corps of Engineers are pursuing a partnership to develop a comprehensive protection and restoration plan for the Texas coast based on existing authorities. Alabama has expressed interest in developing an effort similar to the MsCIP, and Florida is evaluating the benefits and potential approaches for pursuing a Gulf restoration plan. The State of Louisiana is focused on its State Master Plan update, which is scheduled to be completed in December 2012, and would look to further its partnership with the U.S. Army Corps of Engineers to create a common federal/state vision.

To effectively address ecosystem restoration, federal and state agencies need to coordinate comprehensive implementation efforts. They should identify shared priorities, maximize opportunities for efficiencies, provide scientific and technical support, and identify resources needed to assist in implementation.

Recommended actions include:

- Advance efforts to create and/or implement coastal planning programs with a focus on Gulf-wide coordination.
- Improve the foundation for supporting or establishing these programs by:
  - Undertaking a coordinated effort among state and federal partners to assess critical risks, including anticipated sea-level rise, and increased frequency of storms leading to coastal inundation, to ensure that impacts are addressed at both local and regional scales.
  - Communicating available risk avoidance actions and providing resources about approaches to planning for individuals and communities.
  - Evaluating areas on a system-wide basis to determine the appropriateness of structural or non-structural risk reduction opportunities to include environmentally preferred alternatives.
- Explore opportunities for broadened implementation support for coastal improvement programs.
- Develop alternative implementation processes for coastal improvement projects that can be responsive to community needs.
- Evaluate opportunities to manage environmental mitigation on a watershed basis, with a goal of achieving the greatest overall environmental benefits.

EPA's Climate Ready Estuaries Program

EPA's Climate Ready Estuaries (CRE) is working to promote climate change adaptation with NEP partners in the Gulf of Mexico. Estuaries and coastal areas are particularly vulnerable to climate variability and change. To maintain water quality and protect coastal resources, managers may need to develop and implement adaptation measures. CRE provides resources to NEPs and other coastal managers to (1) assess climate change vulnerabilities, (2) develop and implement adaptation strategies, (3) engage stakeholders, and (4) share lessons learned with their peers and coastal communities.

CRE has supported several projects with Gulf of Mexico NEPs that have taken the lead in regional adaptation planning. Recent work has focused on developing strategies to enhance community resilience through vulnerability assessments and public engagement about sea-level rise. For example, in 2009 the Charlotte Harbor NEP partnered with the City of Punta Gorda, Florida, and finalized a climate change adaptation plan for the municipality. Currently, the Tampa Bay Estuary Program is leading a project with all of the Gulf of Mexico NEPs to develop a Gulf-wide resource guide on how to incorporate climate change into projects that restore coastal habitat. CRE shares lessons from demonstration projects it supports via a website (www.epa.gov/cre), annual progress reports, social media and lessons-learned summaries.

Provide analytical support tools to enhance community planning, risk assessment and smart growth implementation

Many activities are underway in the Gulf to support communities as they examine current and future needs to enhance community resiliency. Coastal communities face significant risk of inundation from storms and sea-level rise. They also face a key challenge in their efforts to reduce this risk: accessing accurate and understandable information and decision-support tools about potential solutions. Models, forecasts and visualization tools will improve understanding of the impacts of coastal hazards and climate impacts on livelihoods and ecosystem services. Communities also need tools such as BMPs for local institutions about storm protection, fire protection, coastal building code improvements, stormwater runoff and nonpoint source pollution. In addition, evaluating coastal areas on a system-wide basis will help communities determine the appropriate portfolio of structural and non-structural risk reduction measures to include ecosystem restoration.

The concept of "smart growth" offers a viable framework for the local response planning efforts of Gulf Coast communities. Smart growth recognizes that communities should be economically vibrant and sustainable while providing a high quality of life and supporting ecosystem integrity. Communities that choose to implement coastal smart growth elements can do so through local zoning policies and building codes, local and regional planning activities, and incentives for private developers created with full stakeholder engagement.

Building on existing efforts, recommended actions include:

- Develop a toolbox of storm buffer options that could be considered by local entities.
- Inventory and evaluate models for storm surge, waves and coastal erosion to determine most appropriate/best ones for use in developing risk assessment of storm surge wave impact and sea-level rise.
- Through the Gulf of Mexico Alliance and the NOAA Coastal Storms Program, refine the risk or vulnerability indices (such as the Mississippi-Alabama Sea Grant Consortium's and the Louisiana Sea Grant's Community Resilience Index) to enhance the local understanding of risk from surge and waves, and to prioritize at-risk populations.
- Integrate and align available analytical tools and resources supporting Smart Growth application as well as potential

Regional Climate Services Partnership

NOAA is committed to promoting healthy ecosystems, communities and economies that are resilient in the face of changing climate conditions. NOAA's Regional Climate Services Partnership, which is made up of federal and non-federal partners such as Regional Integrated Science and Assessments, Regional Climate Centers, the National Integrated Drought Information System and Regional Climate Services Directors (RCSDs), seeks to assess regional needs and vulnerabilities, and then develop and deliver timely climate services that aid mitigation and adaptation choices. The Partnership also works to build a climate-literate public that understands its vulnerabilities so that it can appropriately plan ahead.

In fiscal year 2012, the RCSD for the Southern Region, working with NOAA's Gulf Coast Landscape Conservation Liaison, will lead an effort to develop a Gulf of Mexico climate services "roadmap" that will enhance NOAA-DOI interagency collaboration on climate services in this region. NOAA and DOI programs that focus on climate services, climate science and conservation delivery will be engaged in this effort. The focus of the "roadmap" effort in the Gulf will be a regional workshop that will provide an opportunity to highlight existing capacity and expertise, identify shared priority regional needs, and develop an integrated and coordinated approach to implementation of regional climate services activities.

opportunities for technical assistance. For example, EPA's Sustainable Communities Building Blocks program, the NOAA-EPA Coastal Community Development Partnership, Louisiana's Coastal Land Use Toolkit, and the HUD-DOT-EPA Partnership for Sustainable Communities help communities implement development approaches that protect the environment, improve public health, create jobs, expand economic opportunity and improve overall quality of life.

Enhance environmental education and outreach

Given the ever-changing nature of the Gulf ecosystem and the challenges that communities along the Gulf face, there is a need to increase public awareness of hazards, impacts to ecosystem services, and the interconnected nature of the ecosystem and the communities it supports. Programs that provide citizens with hands-on learning experiences increase understanding of links between the environment and their well-being. This understanding will enhance appreciation for the natural systems on which they depend and better prepare individuals and communities to face complex decisions about their interactions with their environment. This knowledge and awareness are essential for achieving environmental stewardship, which will help to ensure sustainable Gulf communities.

Recommended actions include:

- Increase citizens' awareness of the Gulf by promoting engagement opportunities in their communities, including expanding opportunities for community-based restoration.
- Expand the use of public-private partnerships to enhance the development and delivery of Gulf of Mexico environmental educational programs.
- Include the economic value of the Gulf ecosystems in environmental education.
- Support and increase informal environmental education programs for Gulf of Mexico coastal communities, including reaching K-12 audiences.
- Leverage existing partnerships among state and federal agencies, affected Indian tribal governments, universities, nonprofits and community organizations to engage citizens in addressing current and future restoration and conservation needs, with particular attention to under-represented individuals and communities.

IV. Science-Based Adaptive Management

The Executive Order creating the Task Force highlights the critical need to ensure that restoration efforts have a robust scientific foundation. The need for science to support restoration and conservation is readily apparent, at a whole ecosystem level as well as at the project-specific level, as highlighted throughout many of the actions previously described in the Strategy. However, the dire state of many elements of the Gulf ecosystem cannot wait for scientific certainty and demand immediate action. A process is needed that allows for restoration efforts articulated here to move ahead in a scientifically defensible manner, increasing the fundamental scientific certainty necessary for successful restoration and expanding current knowledge of the state of the system. This process, and its associated resources, should be integrated into restoration planning and projects to ensure that the science is appropriately considered and sufficiently supported. The process should determine the efficacy of the restoration actions through a focused effort of monitoring, modeling and research to support effective management and decision-making. More specific, preliminary monitoring, modeling and research needs are discussed in Appendix C.

The dire state of many elements of the Gulf ecosystem cannot wait for scientific certainty and demand immediate action.

Adaptive management is a process of learning by doing, wherein flexibility is built into projects, and actions can be changed based on their progress toward a defined end-state. A key component is a feedback mechanism that is used to sequentially improve management actions so that management decisions are routinely adjusted to achieve program goals and objectives. Incorporating the best science and technology into project design and implementation would allow for restoration of the ecosystem and protection of coastal communities in light of future uncertainties (e.g., climate change). Critical elements include:

- **Establishing an effective adaptive management framework** with critical research, modeling and monitoring elements to support adaptive management. This framework can provide a foundation for decision-making; ensure that restoration efforts have

clearly defined goals, objectives, and measures of success; provide long-term, continuous scientific data, analysis, and recommendations critical to the design, implementation, and monitoring of restoration and conservation projects; develop enabling tools, methodologies and protocols; resolve uncertainties that limit restoration planning; and assess the immediate and long-term effectiveness of restoration and conservation actions. This framework should ensure that restoration projects include assessment and integration of existing scientific knowledge and data, as well as an evaluation of past successes and failures of similar efforts. This framework would also provide for improved coordination and collaboration among federal and state agencies, industry (e.g., oil and gas, transportation), NGOs and stakeholders.

Central to this framework is the establishment of an integrated, interdisciplinary, interagency effort, under the direction of the Task Force. This can include assembling necessary science working and advisory groups and teams, capitalizing on existing science consortiums, programs, universities, and institutions within Gulf states and across the region, to share resources and information, exchange ideas, identify concerns, and create solutions in the context of adaptive management for sustainability of Gulf Coast ecosystems.

Additionally, implementation of adaptive management should be continuously improved by establishing a review and evaluation process that incorporates a critical assessment of the program and its effectiveness in supporting restoration and protection efforts. Independent scientific guidance and review will help ensure that robust science and peer review are fully integrated into restoration planning and the adaptive management process and that these efforts are routinely assessed and evaluated.

- **Establishing monitoring, modeling, and scientific research** to meet the scientific needs of the Strategy. Monitoring, modeling and research development activities should be integrated from the initial stages of restoration planning through to adaptive management decision-making.
  - **Developing a comprehensive "watershed to Gulf" monitoring program.** Feedback from continuous, long-term, accurate monitoring provides the "adaptive" feature that is the basis of adaptive management and can be used to judge project effectiveness and the impact of collective restoration and conservation efforts across the Gulf ecosystem more broadly. This system should integrate and enhance existing comprehensive watershed, estuarine, coastal, and offshore monitoring networks and observing systems, including existing platforms and structures to improve cost-effective mapping, monitoring, and assessment of inland, estuarine, coastal and offshore environments. This program should also include identification and development of mechanisms for integrated management, synthesis and public availability of data and information, including use of and access to existing data, and development of data products and information services.
  - **Establishing a Gulf of Mexico modeling network** to provide tools to increase certainty in forecasts and estimates of ecosystem function and services for decision-makers and the public. Models can be used to modify or adjust restoration and protection actions, and to inform analysis and guidelines on the efficacy of different

restoration strategies/projects (e.g., re-establishment or modification of freshwater flow, nutrient loads, suspended sediment deposition, storm buffers, barrier island restorations).

- **Investing in research and basic exploration** to understand the ecosystems in the Gulf and how they can be resilient to impacts from episodic events, such as hurricanes or oil spills, and long-term changes such as climate impacts. Humans are part of the ecosystem; focused research linking ecological and community resilience, including human impacts, solutions and risk, is needed. Research is particularly important in supporting management when it increases understanding of how physical, chemical and biological components interact with each other, helping scientists and managers evaluate known and potential impacts of restoration actions on environmental components and processes. Research should be directed at reducing scientific uncertainty to improve confidence in modeling and monitoring tools, and ultimately improve management actions. Identifying needs and implementing research should be included as part of restoration planning; research should be integrated into the adaptive management decision-making process, along with monitoring data and modeling outputs.

- **Providing decision support.** A central component of a strong adaptive management strategy is articulating and conveying results in a compelling and clearly understood format that can help inform effective decision-making and improve public understanding. Effective decision-support must also include a clear articulation of uncertainties and assumptions to help inform planning, assessment and trade-off analysis.
  - **Developing integrated decision-support tools and systems,** including expansion and enhancement of predictive, simulation, and risk assessment models and ecological forecasting capabilities. (See "Integrated Ecosystem Assessments" and "Landscape Conservation Cooperatives.")

Integrated Ecosystem Assessments

NOAA is adopting a comprehensive ecosystem-based management approach where the whole ecosystem, including its human dimensions, is considered at the same time. NOAA's approach to integrated ecosystem assessments (IEAs) is at ecological scales relevant to management questions, allowing resource managers to make more informed and effective decisions to achieve ecological and socioeconomic objectives. IEAs are a synthesis and quantitative analysis of information on relevant physical, chemical, ecological, and human processes in relation to specified management objectives.[119,120]

The national IEA program, which will include eight regions based on the U.S. Large Marine Ecosystems, has been initiated in three regions, including the Gulf of Mexico. The Gulf IEA will identify and accumulate relevant ecosystem data sets, and make them available through a data system and services framework for use in food web and ecosystem models. Trophic linkages data will be used in existing and future food web and ecosystem models. Ecosystem indicators will be developed and inform management through an Ecosystem Status Report.

Landscape Conservation Cooperatives

In 2010, DOI established LCCs, forming a national network of public-private partnerships that provide shared science to ensure the sustainability of America's land, water, wildlife and cultural resources. LCCs provide scientific and technical support for landscape–scale conservation in an adaptive management framework by supporting conservation planning, providing decision support tools, prioritizing and coordinating research, and designing inventory and monitoring programs. Partner agencies, states and organizations coordinate with each other while working within their existing authorities and jurisdictions. In the Gulf of Mexico region, four LCCs are being established: *Gulf Coast Prairie*, which includes coastal Texas and Louisiana; *Gulf Coastal Plains and Ozarks*, which connects with the Louisiana coast and stretches across Mississippi, Alabama and the panhandle of Florida; *South Atlantic*, which includes the big bend area of Florida; and *Peninsular Florida*, which covers the rest of the Florida Gulf coast down through the Keys.

- **Developing decision-making visualization and data aids** that overlay the myriad uses of the Gulf that can potentially interact with energy and mineral development, such as Virtual Louisiana, Virtual Alabama and Gulf Data Atlas.
- **Expanding ecosystem services and benefits analysis tools and capabilities** to determine the socioeconomic benefits that ecosystems provide throughout the Gulf region.
- **Establishing indicators of success** and monitoring assessments to evaluate how well program elements meet their stated goals. The performance measures must be quantifiable and understandable to the public, have outcomes or targets specified for the desired Gulf condition, be sensitive to ecosystem change as a result of the Strategy implementation, and verify restoration and protection effectiveness and answer hypotheses.
- **Developing a Gulf-wide progress report.** This report should provide summary status information on ecosystem endpoints and communicate progress of management in improving ecosystem function (including ecosystem services). It should reflect trends over time to judge progress in an easy-to-understand format for the public and decision-makers, providing information on both how the ecosystem is functioning and why.

V. Next Steps

The Task Force's primary purpose is to support and coordinate efforts of Gulf Coast states, the federal government, tribes and local governments to improve efficiency and effectiveness in the implementation of Gulf Coast ecosystem restoration actions. This Strategy is an initial, significant step in this effort. The Strategy sets forth a shared set of overarching goals based on existing goals, scientific assessments and stakeholder input, and proposes major actions for immediate and longer-term implementation.

In addition to mandating the Task Force's overall coordination role, Executive Order 13554 defines the Task Force's responsibilities to:

- Support the NRDA process by referring potential ecosystem restoration actions to the Trustee Council for consideration and facilitating coordination among the relevant departments and agencies as appropriate.
- Engage local stakeholders, communities and the public to ensure they have an opportunity to share their needs and viewpoints to inform the work of the Task Force.
- Identify major policy areas where coordinated intergovernmental action is necessary.
- Prepare a biennial update to the President on progress toward the goals of Gulf Coast ecosystem restoration as outlined in the Strategy.
- Provide leadership and coordination of research needs in support of ecosystem restoration planning and decision-making and facilitate consideration of relevant scientific and technical knowledge.
- Communicate with affected tribes in a manner consistent with Executive Order 13175.
- Coordinate with relevant agencies and offices on ways to encourage health and economic benefits associated with ecosystem restoration.

Going forward, the Task Force can serve as a valuable intergovernmental forum for senior policy officials at the state and federal levels to support efforts to restore the Gulf Coast ecosystem and address barriers to implementation such as science needs, regulatory complexities and resources. In this time of fiscal constraints, it is important for federal and state agencies to closely collaborate and align resources and actions to support projects that are high priority and ready to begin in the near future. The Task Force intends to work with other entities focused on Gulf Coast restoration to align and coordinate efforts; this includes the Gulf of Mexico Alliance, the National Ocean Council, research institutions

and others. Continued work is needed to translate some of these recommendations into action on the ground and identify ways to track restoration progress. The Task Force plans to build on work already done by developing an implementation framework with specific milestones.

Several of the actions described in this Strategy will be immediately implemented by one or more members of the Task Force. Other actions address long-standing challenges in the Gulf that will require more focused effort over time to determine the course of action. Following the final release of the Strategy, the Task Force intends to begin immediately to develop the activities, outcomes, performance measures, milestones and short-, medium- and long-term tasks necessary to implement this Strategy. The Task Force intends to complete work on defining outcomes and performance measures for the actions described in this Strategy within six months after the final Strategy is released.

Task Force members need to work to more effectively align programs, resources and science to support restoration planning, design, and implementation and will develop tools to measure progress in achieving ecosystem restoration goals. By ensuring greater coordination at all levels of government, the Task Force can promote more effective and efficient management of restoration efforts and support project proponents.

To this end, the Task Force intends to collaborate with member states and agencies to implement the actions set forth in this Strategy. It also intends to establish mechanisms in the near term to facilitate more efficient development and implementation of restoration projects. These efforts should enhance coordination, prioritize ecosystem restoration actions, facilitate leveraging of funds and improve restoration permitting and regulatory review of the programs supporting the Strategy. Many of the actions outlined in the Strategy are currently supported by ongoing plans and supporting programs. The initial focus will be to identify and build upon these efforts. For actions not currently supported, the Task Force intends to:

- Specify the current status of each issue, including which agency is working on the issue, under which authority, and with which resources.
- Identify a lead agency, state or other actor for each task needed to implement the action, along with appropriate partners.
- Create a schedule of specific activities to accomplish each goal, along with any necessary or available resources, authority, science or external support needed.
- Establish a science-based approach for ensuring success of actions undertaken. Key elements include:
  - Building a robust interdisciplinary, interagency effort to guide implementation of project-specific and ecosystem-wide restoration adaptive management
  - Establishing critical monitoring, modeling and research elements that provide the scientific foundation for the restoration goals outlined in the Strategy.
  - Developing analyses and tools that support well-informed, timely decisions based on an up-to-date understanding of ecosystem trends over time, future conditions, effectiveness of past and ongoing restoration efforts, and necessary changes or considerations for future restoration efforts.

- Developing a science advisory capacity to ensure that peer review, science and scientifically based findings are properly incorporated into the adaptive management and decision-making process.

- Provide critical decision-support tools to reflect ecosystem trends over time, communicate progress of restoration projects, and inform critical decisions and necessary changes in restoration efforts.
- Continue to engage the public and communities on the restoration effort by providing a forum for the public to bring its ideas and needs regarding ecosystem restoration to governmental leaders. A citizens' advisory committee to advise the Chair of the Task Force has been approved.
- Establish and maintain the core interagency staff expertise needed to develop the implementation plan and guide its execution as envisioned in this Strategy.
- Expand opportunities for collaboration with local governments, business entities, and NGOs as a critical component of Strategy implementation.

The Task Force envisions that the programs necessary to implement the Strategy will be implemented by the appropriate state or federal agency or agencies. Some programs identified as necessary to achieve restoration might require specific state or Congressional authorization.

The Task Force can undertake critical work, as outlined above, to ensure that the tools and relationships needed for successful Gulf Coast restoration are in place or under development. By assisting other ongoing restoration programs and bringing a comprehensive ecosystem focus to Gulf Coast restoration efforts, underpinned by good science and effective stakeholder involvement, the Task Force strives to fulfill a very important mission: to put America's Gulf Coast on the road to long-term recovery and restoration.

The Task Force reaffirms the importance of Secretary Mabus' two initial recommendations: that Congress (1) set aside a significant portion of any potential Clean Water Act civil penalties associated with the *Deepwater Horizon* oil spill for recovery in the Gulf and (2) create a Gulf Coast Recovery Council to coordinate restoration and recovery in the region as an eventual successor to this Task Force.

The Executive Order directed that this Strategy describe the circumstances under which termination of this Task Force would be appropriate. The Task Force believes that in the event Congress passes legislation establishing a Gulf Coast Recovery Council or similar body with comparable responsibilities, the Task Force would terminate and facilitate any needed transition. There could be other conditions under which the Task Force is no longer needed and it may, by consensus of its members, choose to forward to the President a recommendation to cease its operations. However, there is currently a clear need for federal/state cooperation in support of the actions described in this Strategy. The Task Force intends to revisit this question before the close of fiscal year 2012.

Appendix A. Executive Order 13554

Federal Register / Vol. 75, No. 195 / Friday, October 8, 2010 / Presidential Documents **62313**

Presidential Documents

Executive Order 13554 of October 5, 2010

Establishing the Gulf Coast Ecosystem Restoration Task Force

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1. *Purpose.* The Gulf Coast is a national treasure. Its natural resources are an important economic engine for the entire United States; its waters sustain a diverse and vibrant ecosystem; and the Gulf's culture, natural beauty, and historic significance are unique. Each year, millions of tourists visit the Gulf to vacation, swim, boat, fish, hunt, and bird-watch; and, together, the Gulf's tourism and commercial and recreational fishing industries make a significant contribution to the United States economy. More than 90 percent of the Nation's offshore oil and gas is produced in the Gulf, and it is where nearly one-third of seafood production in the continental United States is harvested.

The United States needs a vibrant Gulf Coast, and the Federal Government is committed to helping Gulf Coast residents conserve and restore resilient and healthy ecosystems in the Gulf of Mexico and surrounding regions that support the diverse economies, communities, and cultures of the region. To effectively address the damage caused by the BP Deepwater Horizon Oil Spill, address the longstanding ecological decline, and begin moving toward a more resilient Gulf Coast ecosystem, ecosystem restoration is needed. Ecosystem restoration will support economic vitality, enhance human health and safety, protect infrastructure, enable communities to better withstand impact from storms and climate change, sustain safe seafood and clean water, provide recreational and cultural opportunities, protect and preserve sites that are of historical and cultural significance, and contribute to the overall resilience of our coastal communities and Nation.

In order to achieve these objectives, it is necessary that Federal efforts be efficiently integrated with those of local stakeholders and that particular focus be given to innovative solutions and complex, large-scale restoration projects. Efforts must be science-based and well-coordinated to minimize duplication and ensure effective delivery of services. This order establishes a Gulf Coast Ecosystem Restoration Task Force to coordinate intergovernmental responsibilities, planning, and exchange of information so as to better implement Gulf Coast ecosystem restoration and to facilitate appropriate accountability and support throughout the restoration process.

Sec. 2. *Establishment of the Gulf Coast Ecosystem Restoration Task Force.* There is established the Gulf Coast Ecosystem Restoration Task Force (Task Force).

(a) The Task Force shall consist of:

(1) A senior official from each of the following executive departments, agencies, and offices, selected by the head of the respective department, agency, or office:

a. the Department of Defense;

b. the Department of Justice;

c. the Department of the Interior;

d. the Department of Agriculture;

e. the Department of Commerce;

f. the Department of Transportation;

g. the Environmental Protection Agency;

h. the Office of Management and Budget;

i. the Council on Environmental Quality;

j. the Office of Science and Technology Policy;

k. the Domestic Policy Council; and

l. other executive departments, agencies, and offices as the President may, from time to time, designate.

(2) Five State representatives, appointed by the President upon recommendation of the Governors of each Gulf State, who shall be elected officers of State governments (or their designated employees with authority to act on their behalf) acting in their official capacities.

(b) The Task Force may include representatives from affected tribes, who shall be elected officers of those tribes (or their designated employees with authority to act on their behalf) acting in their official capacities. The Task Force shall, in collaboration with affected tribes, determine an appropriate structure for tribal participation in matters within the scope of the Task Force's responsibilities.

(c) The President shall designate a Chair of the Task Force from among senior officials of executive departments, agencies, and offices represented on the Task Force. The Chair shall lead the coordination of intergovernmental Gulf Coast ecosystem restoration efforts and oversee the work of the Task Force. The Chair shall regularly convene and preside at meetings of the Task Force, determine its agenda, and direct its work. The Chair's duties shall also include:

(1) facilitating a smooth transition from the response phase of addressing the BP Deepwater Horizon Oil Spill to the restoration phase;

(2) communicating and engaging with States, tribes, local governments, other stakeholders in the Gulf Coast region, and the public on ecosystem restoration, as well as other aspects of Gulf recovery, including economic recovery and public health efforts; and

(3) coordinating the efforts of executive departments, agencies, and offices related to the functions of the Task Force.

(d) Representatives of the Gulf States under subsection (a)(2) of this section shall select from among themselves a Vice-Chair of the Task Force.

Sec. 3. *Functions of the Task Force.* The Task Force shall be an advisory body to:

(a) coordinate intergovernmental efforts to improve efficiency and effectiveness in the implementation of Gulf Coast ecosystem restoration actions;

(b) support the Natural Resource Damage Assessment process by referring potential ecosystem restoration actions to the Natural Resource Damage Assessment Trustee Council for consideration and facilitating coordination among the relevant departments, agencies, and offices, as appropriate, subject to the independent statutory responsibilities of the trustees;

(c) present to the President a Gulf of Mexico Regional Ecosystem Restoration Strategy (Strategy) as provided in section 4 of this order;

(d) engage local stakeholders, communities, the public, and other officials throughout the Gulf Coast region to ensure that they have an opportunity to share their needs and viewpoints to inform the work of the Task Force, including the development of the Strategy;

(e) provide leadership and coordination of research needs in support of ecosystem restoration planning and decisionmaking in the Gulf Coast region, and work with existing Federal and State advisory committees, as appropriate, to facilitate consideration of relevant scientific and technical knowledge;

(f) prepare a biennial update for the President on progress toward the goals of Gulf Coast ecosystem restoration, as outlined in the Strategy;

(g) communicate with affected tribes in a manner consistent with Executive Order 13175 of November 6, 2000, on consultation and coordination with Indian tribal governments; and

(h) coordinate with relevant executive departments, agencies, and offices on ways to encourage health and economic benefits associated with proposed ecosystem restoration actions.

Sec. 4. *Gulf of Mexico Regional Ecosystem Restoration Strategy.* (a) Within 1 year of the date of this order, the Task Force shall prepare a Strategy that proposes a Gulf Coast ecosystem restoration agenda, including goals for ecosystem restoration, development of a set of performance indicators to track progress, and means of coordinating intergovernmental restoration efforts guided by shared priorities. In developing the Strategy, the Task Force shall:

(1) define ecosystem restoration goals and describe milestones for making progress toward attainment of those goals;

(2) consider existing research and ecosystem restoration planning efforts in the region, including initiatives undertaken by the National Ocean Council and the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Gulf Hypoxia Task Force), in order to identify planning and restoration needs and ways under existing authorities to address those needs;

(3) identify major policy areas where coordinated intergovernmental action is necessary;

(4) propose new programs or actions to implement elements of the Strategy where existing authorities are not sufficient;

(5) identify monitoring, research, and scientific assessments needed to support decisionmaking for ecosystem restoration efforts and evaluate existing monitoring programs and gaps in current data collection; and

(6) describe the circumstances under which termination of the Task Force would be appropriate.

(b) The executive departments, agencies, and offices enumerated in section 2(a)(1) of this order shall, to the extent permitted by law, consider ways to align their relevant programs and authorities with the Strategy.

Sec. 5. *Administration.* (a) The Task Force shall have a staff, headed by an Executive Director, which shall provide support for the functions of the Task Force.

(b) The Executive Director shall be selected by the Chair and shall supervise, direct, and be accountable for the administration and operation of the Task Force.

(c) The Departments of Commerce (through the National Oceanic and Atmospheric Administration), the Interior (through the Fish and Wildlife Service), and Justice shall identify linkages and opportunities for the Task Force to complement the restoration progress of the Natural Resource Damage Assessment Trustee Council.

(d) At the request of the Chair, executive departments and agencies, including the Departments of Labor, Health and Human Services, Energy, and Homeland Security, the Small Business Administration, and the National Science Foundation, shall serve in an advisory role to the Task Force on issues within their expertise.

(e) The Task Force may establish such technical working groups as necessary to support its function. These working groups may include additional representatives from State and tribal governments, as appropriate, to provide for greater collaboration.

(f) The first meeting of the Task Force shall be held within 90 days of the date of this order.

Sec. 6. *Definitions.* (a) "Affected tribe" means any Indian tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges

to exist as an Indian tribe as defined in the Federally Recognized Tribe List Act of 1994 (25 U.S.C. 479a(2)), physically located in a Gulf State.

(b) "Ecosystem restoration" means all activities, projects, methods, and procedures appropriate to enhance the health and resilience of the Gulf Coast ecosystem, as measured in terms of the physical, biological, or chemical properties of the ecosystem, or the services it provides, and to strengthen its ability to support the diverse economies, communities, and cultures of the region. It includes activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity, and sustainability. It also includes protecting and conserving ecosystems so they can continue to reduce impacts from tropical storms and other disasters, support robust economies, and assist in mitigating and adapting to the impacts of climate change.

(c) "Gulf State" means any of the States of Texas, Louisiana, Mississippi, Alabama, and Florida.

(d) "Natural Resource Damage Assessment" means the process of collecting and analyzing information to evaluate the nature and extent of natural resource injuries resulting from the BP Deepwater Horizon Oil Spill and to determine the restoration actions needed to bring injured natural resources and services back to baseline conditions and make the environment and public whole for interim losses as defined in 15 CFR 990.30.

(e) "Natural Resource Damage Assessment Trustee Council" means the designated Federal, State, local, and tribal trustees as provided in 33 U.S.C. 2706, with trusteeship over natural resources injured, lost, or destroyed as a result of the BP Deepwater Horizon Oil Spill.

Sec. 7. *General Provisions.* (a) To the extent permitted by law and subject to the availability of appropriations, the department, agency, or office represented by the Chair shall provide the Task Force with such administrative services, funds, facilities, staff, and other support services as may be necessary for the Task Force to carry out its function.

(b) In addition to staff provided by the department, agency, or office represented by the Chair, other executive departments, agencies, and offices represented on the Task Force are requested to make services, staff, and facilities available to the Task Force for the performance of its function to the maximum extent practicable, to the extent permitted by law and subject to the availability of appropriations.

(c) Members of the Task Force shall serve without any additional compensation for their work on the Task Force.

(d) Nothing in this order shall be construed to impair or otherwise affect: (i) authority granted by law to an executive department, agency, or the head thereof, or the status of that department or agency within the Federal Government; or (ii) functions of the Director of the Office of Management and Budget relating to budgetary, administrative, or legislative proposals.

(e) Nothing in this order shall interfere with the statutory responsibilities and authority of the Natural Resource Damage Assessment Trustee Council or the individual trustees to carry out their statutory responsibilities to assess natural resource damages and implement restoration actions under 33 U.S.C. 2706 and other applicable law.

(f) This order shall be implemented consistent with applicable law and subject to the availability of appropriations.

(g) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

THE WHITE HOUSE,
October 5, 2010.

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Filed 10–7–10; 8:45 am]
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Appendix B. The Gulf Coast States

Introduction

The restoration strategy outlined in this document employs a comprehensive ecosystem-based, regional approach. At the same time, the Strategy builds on activities already under way within each of the five Gulf Coast states, as well as collaborative activities among the states. The Strategy acknowledges the fact that while the states have a shared coastline and ecosystem, they also have unique and distinct natural features, cultural heritages, and economic resources. While effective ecosystem restoration will transcend state boundaries, the regional strategy should also be based on an understanding of—and be supportive of—state-specific efforts and perspectives.

Representatives of the five Gulf Coast states were fully involved in the development of the overall Strategy presented in this document. They also have developed the information presented in this appendix. The following sections identify the ecological and economic resources of each state, along with the priority actions being undertaken in each state (organized in terms of the Strategy's four goal areas). As the Task Force develops the supporting implementation plan in the coming months, it will work to find ways, where appropriate, to incorporate, support, and/or harmonize the state-based activities described herein within the context of the overall Strategy.

Alabama

Background

Alabama's coast is located along the northern Gulf of Mexico in Mobile and Baldwin Counties. The state's 607 miles of shoreline include the beach and dune systems along the Gulf of Mexico, approximately 400,000 acres of bay and estuarine waters,[121] and approximately 127,000[122] acres of various types of wetlands: fresh and salt marshes, scrub-shrub, forested and grass beds.

The current population of the state is 4,779,736. The population of Mobile County is 412,992, and the population of Baldwin County is 182,265. Overall, the state population increased 7.5 percent since 2000, while Mobile County increased 3.3 percent, and Baldwin County increased 29.8 percent over the same timeframe.[123] Mobile and Baldwin Counties sit at the crossroads for expanded economic development for the northern Gulf of Mexico. They also serve as a major transition zone, where freshwater rivers mix with the tidally influenced salt water of the Gulf of Mexico.

Alabama's coastal area contains four broad natural ecosystems—terrestrial, freshwater, estuarine and marine/continental shelf—which support an extremely diverse assemblage of plants and animals. In terms of biodiversity (the number of distinct species in a given area), Alabama ranks fifth among states in the United States and first among those east of the Mississippi River.[124,125]

Within these ecosystems, Alabama has a profuse diversity of natural habitats, including rich sediments, seagrass beds, barrier islands, freshwater and saltwater wetlands, pitcher plant bogs, bottomland hardwood forests, wet pine savannas and upland long leaf pine and oak forests. The wealth of these habitats is what makes the Alabama coast unique and draws residents and visitors alike.

Alabama's coast is valued for its protective functions, natural resources and the uses and activities that take place on or near the water's edge, all of which contribute to the economy of the state and the entire nation.

The natural protective functions of Alabama's beach and dune systems, estuaries and wetlands are instrumental in preserving and enhancing ecosystems and in reducing risks to infrastructure and commercial and residential developments. The coastal areas also protect inland regions from erosion, flooding and storms.

The area's natural resources include the Mobile-Tensaw Delta, which is an estimated 280-square-mile area with approximately 20,000 acres of open water, 10,000 acres of fresh-mixed marsh, 69,000 acres of swamp, and 85,000 acres of mixed bottomland forest. It is considered a principal state asset.[126] The Delta, along with Alabama's beaches and dunes, estuaries and wetlands, serves as a breeding and nursery ground for numerous species of finfish, shellfish, waterfowl, migratory birds and other wildlife, including many endangered and threatened species; thus, the coastal area is important in their life cycles. The estuaries of coastal Alabama are economically and environmentally important because of their exceptional biological diversity and productivity.

Gulf and Meaher State Parks

Two state parks are located along the Alabama shoreline:

- **Gulf State Park** is a 6,000-acre park with a 5-mile stretch of sandy beach on the Gulf of Mexico. The park grounds contain small lakes, a large area of wetlands and a maritime forest. There are backcountry nature trails, a 1,520-foot fishing pier, cabins and campsites. The park has 2.5 million visitors and a quarter million overnight guests per year.
- **Meaher State Park** is a 1,327-acre park situated in the wetlands of Mobile Bay. It is a day-use picnicking and scenic park and has camping and bathhouse facilities for overnight guests. There is a boat ramp, fishing pier, and two nature trails that include a boardwalk with a close view of the Mobile Delta.

The Mobile Bay Watershed is the sixth largest river basin in the United States and the fourth largest in terms of stream flow.[127] It drains water from three-quarters of Alabama and portions of Georgia, Tennessee and Mississippi into Mobile Bay. Mobile Bay is also a point of entry for hundreds of smaller recreational and commercial vessels that traverse the lower Mobile Delta. Many of these vessels make the 450-mile trip to the Tennessee River through the inter-basin connector known as the Tennessee-Tombigbee waterway; other vessels cruise to other inland Alabama ports via extensive navigation projects on the Alabama and Warrior River systems.

Seventy-five percent of America's commercial fish catch and 80 to 90 percent of the recreational fish catch are dependent on estuaries, such as those found in Alabama, including Mobile Bay, Mississippi Sound, Weeks Bay and Perdido Bay.[128] The value of Alabama's commercial fishery and recreational boating and fishing statistics are recorded by the Alabama Department of Conservation and Natural Resources. In 2009, records showed 14,291 commercial trips landing 29.7 million pounds of seafood worth over $40.5 million. At present, 271,523 registered boats and 597,785 boat operator licenses are on file in the state. In 2009, 100,290 resident and non-resident saltwater fishing licenses were also issued.

Alabama's coastal resources also support a thriving tourism industry. The state reported that in 2009 more than 7.1 million visitors enjoyed the state's beaches, scenic vistas, access to the Gulf of Mexico and bays and waterways. In 2009, these visitors spent over $3.2 billion in Mobile and Baldwin Counties. These two counties rank first (Baldwin at 25 percent) and third (Mobile at 9.7 percent) in total travel-related employment for the state. In 2009, the total travel-related employment for the two counties was 56,294 employees, and total travel-related earnings by employees were over $1.2 billion.[129]

Essential to Alabama's coastal economy is the Port of Mobile, which is the global deep-water gateway for the state. In 2009, the port ranked 12th in the nation in the amount of total tonnage shipped.[130] The most frequent import and export commodities transferring through the port are coal, aluminum, iron, steel, lumber, wood pulp and chemicals. The Alabama State Port Authority's Mobile Container Terminal (APM Terminals Mobile) provides containerized cargo shippers with access to global networks covering all possible trade routes to and from the Port of Mobile. The port is served by 12 shipping lines offering fixed daily, weekly, bimonthly and monthly ocean carriage services to global destinations. APM Terminals Mobile operates the container terminal, which currently has five fixed-day, weekly vessel calls by Maersk, CMA CGM, Mediterranean Shipping, ZIM, APL and HMM lines. General cargo and project ocean carriage is provided by Grieg Star Shipping, Gearbulk, Westfal-Larsen Lines, C.I.C.-Clipper, Spliethoff, C.G. Railway/International Shipholding, and MWC shipping. With a large number of ship berths with both 40-foot and 45-foot ship channel drafts and a new 1,175-by-715-foot turning basin,[131] the port can accommodate most ship sizes, including post-Panamax-sized vessels. The seaport's public terminals are located just three and one half hours from deepwater U.S. Gulf navigation.[132]

The port, combined with the city of Mobile's industrial center, represents a multi-billion-dollar impact on the regional, state and world economies. The port contributes 66,617 jobs and over $7.92 billion to Alabama's economy annually. In addition, virtually every conceivable service for the maritime industry can be found in the city of Mobile, including barge fleeting, stevedoring, towing, marine surveying, shipbuilding and ship repair, heavy lift and salvage, freight forwarding and Customs House brokerage firms, London Metals Exchange-certified warehousing, Foreign Trade Zones, vessel husbandry and chandlery, industrial diving, marine fumigation, maritime waste disposal, line handling, marine instrument calibration, dunnage removal, container and chassis repair and leasing, fuel bunkering, and many other services.[133]

Alabama is rich in energy resources and has considerable natural gas reserves. Offshore natural gas, shipbuilding and ship repair are among the coastal area's expanding businesses, creating a synergy for growth. As offshore oil and gas exploration continues, the area's

shipbuilders are building offshore supply and rig-tending vessels and repairing rigs at their facilities on the Mobile River.[134] A number of local shipbuilders also build, renovate and repair vessels of all sizes for the U.S. military.

State Priorities

The Task Force Strategy lays out four overarching goals. Alabama's priority actions for each goal are described below.

Restore and Conserve Habitat

The natural habitats of Alabama's coast have experienced changes, primarily through loss, over the last 100 years. Some of these losses are a result of natural events; others are due to human activities, such as population growth, land-use conversion, shoreline hardening, introduction or transfer of invasive species, and runoff and excess sediments. These natural ecosystems are complex and heavily impacted by patterns of land use and changing land cover.

The beaches of Gulf Shores, Orange Beach, Gulf State Park and Dauphin Island have all experienced major erosion in the past decade,[135] starting with Tropical Storm Isidore in September 2002, and Hurricanes Ivan and Katrina in September 2004 and August 2005, respectively. In 2005 and 2006, Alabama placed nearly 8 million cubic yards of sand along more than 15 miles of beach—the largest beach nourishment project in the state's history. This project, and other beach nourishment efforts, have provided additional habitat, storm protection benefits and better recreational capacity. However, these projects totaled more than $31 million, and the cost of properly maintaining them will continue over the years.[136] Accordingly, identifying a consistent source of funding is crucial for their sustainability.

Many successful habitat restoration efforts have also been conducted in the state. Small-scale projects include the restoration of salt marsh and living shoreline projects at Helen Wood Park, numerous marsh planting projects conducted by the "Grasses in Classes Program" in conjunction with the Weeks Bay National Estuarine Research Reserve, the Mobile Bay Oyster Gardening Program, and a number of experimental oyster reef projects. Large-scale projects include the Little Bay Project and the Coffee Island/Alabama Port Shoreline Protection Project, which have restored over 30 acres of salt marsh and/or protected approximately 3 miles of shoreline from further loss from erosion, as well as providing important habitat for oysters, finfish and shellfish. The Coffee Island/Alabama Port Project is a prime example of federal and state partners working with academic, scientific and nonprofit institutions, such as the Dauphin Island Sea Lab, the Mobile Bay NEP, Mobile Baykeeper and The Nature Conservancy. The Alabama Department of Conservation and Natural Resources has also established an oyster reef that is expected to be self-sustaining under appropriate monitoring and management. However, the true success of such restoration projects depends upon dedicated funding for monitoring and ongoing, long-term maintenance needs.

Alabama's priorities for conserving and restoring habitat include:

- Work with the federal government to establish support for and development of a land protection strategy for the Alabama Gulf Coast.

- Develop a strategy and support programs for acquiring and preserving endangered coastal habitat by working with existing state and federal programs for land acquisition.
- Restore wetlands through the use of dredged sediments and identify physical and financial resources to restore critical habitats.
- Restore barrier islands and sandy beaches through beneficial use of dredged material and beach renourishment efforts and identify physical and financial resources to restore critical habitats.
- Enhance existing oyster reefs by planting cultch materials in areas affected by storms, and establish new oyster reefs by planting cultch and relocating live oysters from other areas.
- Implement policy changes to protect freshwater wetlands; value ecosystem services; restore streams, rivers, and creeks; and improve management of stormwater runoff.
- Protect and stabilize salt marsh edges, manage wave energy to deter erosive impacts and restore salt marshes in strategic locations.
- Implement policy changes to encourage living shoreline technologies, and demonstrate appropriate and affordable technologies to private landowners.
- Adopt and implement a statewide plan for the long-term management of invasive species.
- Document patterns of land use and land cover changes and how they will impact habitats in the foreseeable future.
- Enhance and create offshore and inshore natural and artificial fish habitat and structures.
- Review and assess cumulative impacts of dams and other infrastructure that may impact freshwater and sediment inputs.
- Coordinate with the federal government to establish habitat restoration projects that require no federal match; when federal match is required, coordinate with federal agencies to allow for creative match options.

Restore Water Quality

Maintaining adequate supplies of clean water is critical to the high quality of life enjoyed by the citizens of Alabama. Water is necessary for maintaining agricultural production, industrial processes, power generation and public health. The Alabama Gulf Coast also is a main source of recreation for both citizens and visitors. As Alabama grows, the demand for clean water will continue to increase.

Major water quality issues in the Mobile River Basin include nutrient enrichment, sedimentation, pesticides and toxins, habitat degradation, heavy metals, bacterial contamination and the health of the estuarine environment and its fisheries. To track changes in the condition of this basin, the State of Alabama has supported a variety of environmental monitoring programs, including water quality, habitat change and key living resource populations. This monitoring will establish long-term datasets to track change over time.

Alabama's priorities for restoring water quality include:

- Reduce excessive sediment and pathogen loads in waterways through improved management of stormwater runoff, restoration of inland waterways (including streams and creeks) and promotion of sustainable land use policies.

- Improve and enhance infrastructure that promotes centralized wastewater treatment systems to improve water quality.
- Improve understanding of impacts from heavy metals and mercury and how to cycle these metals out of sediments.
- Expand public education and incentives related to nonpoint source pollution and promote local management alternatives.
- Improve water quality and clarity to promote seagrass restoration.

Replenish and Protect Living Coastal and Marine Resources

To protect the rich diversity of coastal and marine resources in the state, Alabama is focusing on gaining a better understanding of the history, habitat requirements, life cycles, and strengths and weaknesses of native species. The state is also examining problems associated with the introduction of exotic species and working to ensure the continued health of commercial and recreational fisheries.

The Alabama coast is recognized for its recreational fishing opportunities and commercial fishing industry. Many of the species that support these fishing opportunities have complex life histories. They usually exhibit onshore/offshore migrations and a strong dependence on estuarine habitats during juvenile stages. Long-term monitoring of estuarine-dependent organisms provides insight into the status of fishery resources, which could help to determine the effectiveness of habitat restoration programs, the consequences of habitat degradation, and the impacts of invasive species.

The state's priorities for protecting and replenishing living coastal and marine resources include:

- Increase large-scale funding for oyster reef restoration and artificial reef creation and enhancement.
- Increase funding for marine resource research and fishery and shellfish production facilities.
- Improve temporal and spatial monitoring of living and coastal marine resources, including nursery habitats and dependent faunal species.
- Develop adaptive policies for the management of supply and demand of commercial and recreational fishery species.
- Maintain and enhance fishery stocks in nearshore, offshore and coastal Alabama waters.
- Promote, develop, monitor and enhance the artificial reef zones in both inshore and offshore Alabama waters.

Enhance Community Resilience

The coastal region from east of the Mississippi River to east of Mobile Bay is more likely to be affected by a moderate to severe climatic event than other area in the Gulf. Over a 15-year period, nine storms have caused some degree of damage in Alabama. These storms include seven named hurricanes—Erin, Opal, Danny, Georges, Ivan, Dennis and Katrina (six of which were Category 2 or higher), and two named tropical storms—Hanna and

Isidore. Hurricane Ivan alone caused over $2 billion in insured losses in 2004.[137] While not every storm was a direct hit, they all caused problems. For example, Tropical Storm Isidore, which made landfall in coastal Louisiana, caused significant coastal beach erosion in Alabama—in fact, the shoreline prior to that storm has served as the restoration standard for local beach nourishment efforts.

The *Deepwater Horizon* oil spill of 2010 is just the latest of a series of disasters to strike the Alabama coast, and it is evident from these events that the entire coastal area of Alabama needs a comprehensive plan to reduce the significant risk and damages to public safety, property, economic viability and environmental resources from future natural and human-made stressors. Being a coastal state brings repeated and ongoing challenges—it goes with the territory. For Alabama, it is essential to understand the cumulative impacts of these stressors, which have long-lasting effects on the natural resources, physical resources and local economies.

A comprehensive plan would ensure the economic and social vitality of the state's coastal communities and their ability to survive crisis, influence change and be healthy places for their residents and visitors. Toward this end, the Coastal Recovery Commission of Alabama recently drafted a roadmap to guide the development and implementation of strategies across a broad range of categories to strengthen the region's communities and their adaptability and sustainability over time. A comprehensive plan for coastal Alabama could be patterned after the successful MsCIP, which acknowledges the importance of a healthy coastal ecosystem to the sustainability and resiliency of both the natural and human-made infrastructure of the coast. A comprehensive plan could also be crafted that would build upon the Coastal Recovery Commission's work in identifying the issues facing coastal Alabama and move toward possible solutions:

- Creating opportunities for the collaboration of local, state and federal agencies and Alabama coastal residents to maximize the use of resources in support of the comprehensive planning effort.
- Reducing the susceptibility of residential, commercial and public infrastructure to storm damages.
- Improving habitats for coastal and marine resources to support commercial and recreational harvest.
- Assisting in the recovery of natural and human-made features damaged by erosion or unwise land use and development decisions.
- Promoting long-term erosion reduction during future natural hazards.
- Promoting diversification of economies within the two coastal counties as a means of economic resilience from future hazards.

All of the above could be included in an Alabama Coastal Resiliency Plan. Currently, there are no existing authorities under which the U.S. Army Corps of Engineers could participate in such a comprehensive planning effort. However, the state has held meetings with the U.S. Army Corps of Engineers to explore possible partners and funding options. The most promising partner is the Alabama Department of Conservation and Natural Resources, whose State Lands Division currently houses a number of coastal programs; a MsCIP-like comprehensive

planning effort would fit well within the Division's existing programs. Other likely sponsors include Mobile and Baldwin Counties. Other partners that would be included in the planning effort are the local municipalities, the Mobile Bay NEP, the Alabama State Port Authority, and NGOs such as Mobile Bay Keeper, Smart Coast Inc., Alabama Coastal Foundation, Partners for Environmental Progress, Envision Coastal Alabama, Mobile Area Chamber of Commerce, Eastern Shore Chamber of Commerce, South Baldwin Chamber of Commerce, Gulf Coast Area Chamber of Commerce, Gulf Shores/Orange Beach Tourism, and the Mississippi-Alabama Sea Grant Consortium.

The state's priorities for enhancing community resilience include:

- Promote the development of community conservation plans that include elements of coastal management, emergency response and community development.
- Improve knowledge of the dollar value associated with environmental protection in terms of long-term community sustainability and resilience.
- Enhance opportunities to promote the understanding of the necessity of economic resilience as a component of community resilience through various programs, such as those offered through Gulf State Park, which increase both visitation to and appreciation for the state's coastal community.
- Implement an Alabama Coastal Resiliency Plan in the aftermath of catastrophic events.
- Enhance and promote tourism and economic development in the coastal area.
- Promote, restore and enhance public access and recreation to coastal resources.

Florida

Background

Florida forms the southernmost terminus of the United States and the eastern boundary of the Gulf of Mexico; it has three miles of territorial seas off the Atlantic and three leagues (approximately 10 miles) in the Gulf. Along its Gulf Coast alone, Florida has 5,095 miles of tidal shoreline,[138] 436 miles of sandy beaches,[139] and over 7.4 million acres of tidally submerged lands.[140]

Florida's population numbers 18,801,310 people. Statewide, 80 percent of this population lives along the coast, and no point in the state is more than 60 miles from the coast. Twenty-three of Florida's 67 counties border the Gulf Coast, with a combined population of more than 6.6 million residents.[141]

Ecologically, the state is very diverse. Geography heavily influences this diversity of coastal and marine habitat, creating essentially an island state, almost entirely surrounded by sea. From temperate Pensacola to tropical Key West, the nearly 900-mile journey crosses seven degrees of latitude through rare coastal dune lakes, pine flatwoods and prairies, scrub, coastal hammocks, a variety of wetlands, and the Florida Everglades and Florida Keys' coral reefs.

Along the Gulf Coast, from Pensacola to Apalachicola, barrier islands help form tidal estuaries near river mouths where hardwood swamps transition to salt marsh wetlands. From

Ocklockonee Bay to Crystal River, crystal clear springs and blackwater swamp forests feed streams and rivers that empty directly to the Gulf Coast, where vast and important seagrass beds cover the sea floor. From Tarpon Springs south, mangroves replace salt marsh and form fringing forests and inland tidal swamps.

The broad, shallow continental shelf along Florida's Gulf Coast supports extensive tropical coral reefs that stretch from the Florida Keys to the Snapper Banks off Pensacola. Strategically placed artificial reefs supplement these natural coral reefs. Together, these coral communities support an incredible diversity of fish and other marine life, including fish populations found nowhere else in the Gulf. The beauty and biodiversity of Florida's coral reefs attract divers and fishermen from around the world. The state, particularly the Florida Keys, is recognized as a diving capital of the world. The reefs, along with intertidal oyster bars, barrier islands, tidal salt marsh, mangroves and submerged seagrass meadows provide a buffer against storms and hurricanes, making adjacent coastal communities safer and more resilient.

The Gulf Loop current is significant for the biodiversity of state resources as it circulates the warm tropical seawater from the Caribbean that is partially responsible for establishing and maintaining the state's coral reefs and other tropical marine habitats. The current also provides energy to feed tropical storms and hurricanes and can transport pollutants, like spilled oil and marine debris, through the Gulf.

The sandy beaches of Florida's Gulf Coast and the Florida Keys provide critical nesting habitat for endangered shore birds, beach mice and sea turtle populations. Seagrasses and patch reefs off both Florida Bay and north Florida's Big Bend cover the sea floor for hundreds of square miles, providing food, important nurseries and shelter for incredible numbers and diversity of marine life and migratory waterfowl.

The state's ecosystems support not only thriving biological communities, but also a world-class tourism industry, providing many service-related and manufacturing jobs. The Everglades drains into the coastal estuaries of South Florida's Ten Thousand Islands and Florida Bay, supporting significant fisheries and wildlife that attract visitors from around the world and generate recreational and business opportunities for Floridians. Florida's Gulf Coast beaches are another example of ecosystem services of economic interest. They include the famed Emerald Coast along the Florida Panhandle and the beaches of Tampa Bay, Clearwater and St. Petersburg. Siesta Beach on Siesta Key, a barrier island southwest of Sarasota, was named the top beach in the country in 2011 by "Dr. Beach," producer of "The Best Beach in America." Each year Florida routinely has at least one beach on the top 10 list since its creation in 1991.[142]

Tourism was responsible in 2010 for welcoming more than 82.3 million visitors, who spent over $62.7 billion, generating 22 percent of the state's sales tax revenue and employing nearly a million Floridians.[143] Each year, almost $15 billion and 141,373 jobs result directly from fish and wildlife in Florida, and an additional nearly $17 billion and another 202,743 jobs are a result of boating activities in state waters.[144] Wildlife viewing is a significant pastime in Florida, accounting for $5.2 billion and 51,367 jobs in 2006. Also in 2006, almost 1.6 million people visiting the state participated in wildlife viewing in Florida, the majority of whom came to view coastal and marine wildlife.[145]

Military installations along Florida's Gulf Coast also provide significant economic activity for the state. Major military training and testing operations off northwest Florida include the Pensacola Naval Air Station and the Eglin, Hulbert Field and Tyndall Air Force Bases. These bases, along with the U.S. Central Command and Special Operations in Tampa, the Key West Naval Air Station, and the Homestead Air Force Base, produce significant economic and security benefits for the state and nation. Statewide, defense-related spending was $64.8 billion in 2010 and accounted for 686,181 direct and indirect jobs.[146] That spending is estimated to approach $67.7 billion in 2013.[147]

Gulf Coast ports at Pensacola, Panama City, Port St. Joe, St. Petersburg, Tampa, Port Manatee and Key West also add significant revenues and jobs to the state. These Gulf Coast ports account for about $10.6 billion per year in economic activity supporting 125,000 direct and indirect jobs.[148] The ports ship agricultural and industrial products and provide cruise ship access to customers and commerce throughout the wider Caribbean, in South America, and around the world. Florida is a top port of departure for cruises in the world, and more cruise ships are berthed here than anywhere else. Florida ports, including Tampa and Key West, provide popular day-long excursions too.

Maintaining healthy, sustainable fisheries is vitally important to the state, as recreational and commercial fishing contribute immensely to the economy, quality of life and character of Florida's coastal communities, particularly in the Gulf. Florida is one of the nation's premiere destinations for recreational fishing and is marketed as the "Fishing Capital of the World." Florida also has more world record fish catches than any other state or country.

Florida also leads all states in economic return for its marine recreational fisheries. Recreational saltwater fishing alone contributes over $5 billion and more than 50,000 jobs to the state's economy each year.[149] In 2008 to 2009, more than a million people—a third of whom were not Florida residents—bought marine recreational fishing licenses.[150] Also during this time, more than 3,400 for-hire fishing licenses were purchased.[151] In 2008, Florida Gulf Coast recreational anglers took 16.9 million trips: 9.6 million private/rental, 6.7 million by shore and 595,000 by party/charter boat.

The Department of Commerce has ranked Florida's commercial fishery as the second highest of all states for in-state sales at $13 billion annually, and the tenth highest in total landings revenue at $116 million annually. Florida is also the third highest state for jobs supported by commercial fishing, providing 64,744 jobs in 2009.[152]

Another important Florida fishery, particularly on the Gulf Coast, is oysters. Florida produces almost 13 percent of the Gulf's oyster catch (by weight), a $6.9 million annual dockside value to the state.[153] Apalachicola alone produces about 90 percent of Florida's oyster harvest.[154]

Florida's ecosystems also support new economic opportunities for fast evolving technological advancements in ocean energy, engineering, pharmaceutical, aquaculture and other marine related industries and jobs. Florida is home to at least 20 major public and private marine research and education facilities that help support these new economies for the future.[155]

State Priorities

The Task Force Strategy lays out four overarching goals. Florida's priority actions for each goal are described below.

Restore and Conserve Habitat

Florida has experienced major land use changes over the past 200 years, which have affected the state's diverse habitats. A great deal of development has occurred, particularly after World War II as people discovered Florida's sandy beaches, sunny climates and cheap land, which they modified to meet their particular needs. Agriculture, silviculture and community development required major changes in forest and wetland cover and drainage. Transportation corridors and fire cessation have resulted in habitat fragmentation and alterations. Ditching and draining, shoreline hardening, runoff and excess sediments all contributed to major losses of productive coastal and some marine habitat.

Florida also has a long history of land acquisition for preservation, protection and restoration of natural resources, which has resulted in an extensive network of protected critical natural habitat throughout the state. Of specific note is the extensive level of federal and state coordination and resource commitment to South Florida ecosystem restoration through the CERP.

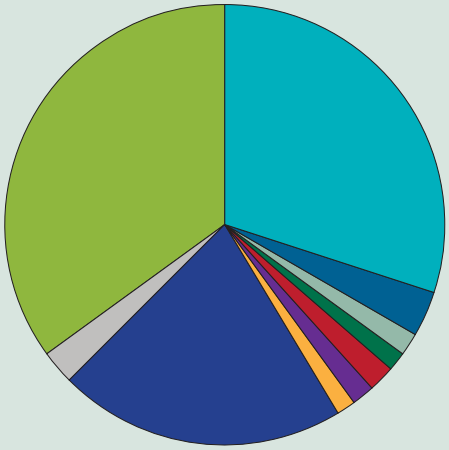
Florida's priority actions for habitat conservation and restoration include:

- Protect, stabilize and restore salt marsh, seagrass, oyster, coral reef, beach, dune mangrove and other important marine bottom habitat in strategic locations where human-made and storm impacts have occurred or are likely to occur in the future.
- Partner with Florida Gulf Coast military installations to integrate their ongoing conservation strategies and land acquisition efforts for military readiness with Florida's ecosystem restoration and protection goals.
- Implement policy and program changes necessary to reestablish natural, historical water flow (quality, quantity, timing and distribution) on the Apalachicola, Suwannee, Peace and Caloosahatchee Rivers; Florida Bay; and other riverine and estuarine systems connecting to the Gulf.
- Strategically acquire, buffer and protect identified properties in state and federal acquisition programs to provide watershed improvements and wildlife corridors to downstream estuarine and marine habitats of ecological and economic importance to the Gulf.
- Work with federal and state partners to establish a financial and public policy process for the beneficial use of sediments and rock from major dredging projects in restoring barrier island, beach, hard bottom and other coastal habitats.
- Continue to work with federal partners, private landowners and stakeholders to implement the CERP where it will improve and protect Gulf ecosystems in Southwest Florida and the Keys.
- Refine and implement inlet management plans to restore the natural flow of sediments around inlets to down drift beaches.

Florida Forever

Florida has the largest public land acquisition program of its kind in the United States —started as the Preservation 2000 program in the late 1980s, followed by the Florida Forever program—which could be used as a model for coastal habitat protection in other Gulf states and the nation. Florida has approximately 9.9 million acres of federal, state and local conservation land (over a quarter of the state); more than 2.5 million acres were purchased under the Florida Forever and Preservation 2000 programs. Since July 2001, Florida Forever has acquired more than 673,753 acres of land, worth $2.83 billion.

Florida Forever Funding Distribution



- Division of State Lands: 35%
- Working Waterfront: 2.5%
- Florida Communities Trust: 21%
- Division of Recreation and Parks: 1.5%
- Office of Greenways and Trails: 1.5%
- Florida Recreation Development Assistance Program (Local Governments): 2%
- Florida Fish and Wildlife Conservation Commission: 1.5%
- Florida Forest Service, Department of Agriculture and Consumer Services: 1.5%
- Rural and Family Lands, Department of Agriculture and Consumer Services: 3.5%
- Water Management Districts: 30%

The Florida Department of Environmental Protection distributes Florida Forever funding to a number of state agencies and programs to purchase public lands in the form of parks, trails, forests, wildlife management areas and more. All of these lands are held in trust for the citizens of Florida.

- Develop and implement invasive species' eradication and management plans to address impacts to natural ecosystems within the Gulf region.
- Restore and manage critically eroded sandy beaches and dunes for upland protection, recreation, tourism and wildlife.
- Work with federal and local agencies to develop and implement a hard bottom mitigation strategy to restore habitats where damage from storms, transportation and navigation projects, beach restoration, and other impacts from public projects have occurred or will occur.

Restore Water Quality

While Florida has some of the clearest and cleanest waters in the Gulf of Mexico, as of 2010 more than 1,300 square miles of the state's estuaries are deemed "impaired" for pollutants other than mercury and therefore not fully meeting their designates uses.[156] Mercury impairments predominantly are caused by atmospheric deposition. In addition to developing a comprehensive statewide Total Maximum Daily Load (TMDL) for mercury, Florida is especially focused on the issue of excess nutrient pollution, and has one of the most robust water quality protection programs in the country.

In addition, surface water and groundwater systems are closely interconnected throughout the state. Therefore, in addition to maintaining and restoring the water quality of estuaries and coastal waters, and the freshwater rivers and streams that flow into them, it is vital to protect the groundwater sources within aquifers.

A growing Florida presents constant challenges in protection of water resources. The need and desire to increase the use of the Gulf Coast ports and other coastal and inland water resources, along with a growing population, increases competition for Florida's water resources. Challenges include cleaning up historical contamination associated with coastal industrial areas, managing the influence on water quality of active ports, and addressing urbanized estuaries near Pensacola, Tampa, Naples and Fort Myers.

One of the most visible impacts of nutrient (nitrogen and phosphorus) enrichment in Florida is freshwater HABs. Understanding the causes of HABs and ways to mitigate them is vital to protecting the downstream estuaries. One of the solutions is beneficial reuse of wastewater

Setting Nutrient Limits for Florida Estuarine and Coastal Waters

The State of Florida began a nationally recognized water quality improvement program with the passage of the Watershed Restoration Act of 1999 (s. 403.067, F. S.), which directs the Department of Environmental Protection to scientifically evaluate the quality of Florida's surface waters and promote the mechanisms necessary to clean up pollution. The Act was created specifically to implement the federal TMDL program, which is a systematic approach to establishing how much pollution water bodies can assimilate while remaining suitable for public uses and meeting quality standards. The Department is working closely with Florida stakeholders to set numeric limits on the amount of nutrients (nitrogen and/or phosphorus) that can be discharged into the state's estuarine and coastal waterways to better protect these waters from the adverse effects of excess nutrient enrichment. The established limits, if attained, ensure that the designated uses of Florida's marine waters are maintained.

The primary purpose of numeric nutrient criteria is to protect healthy, well-balanced natural populations of flora and fauna from the effects of excess nutrient enrichment. Implementation of these criteria can prevent over-enrichment, and can be used to identify waters impaired by nutrients in need of restoration. The criteria would also support full recreational use of the state's marine waters.

in Florida. Although a large percentage of Florida's population uses advanced community collection and wastewater treatment systems, leading to a significant amount of beneficial reuse, a number of coastal communities still use septic tanks or older and inadequate collection and treatment systems, which do not allow beneficial reuse.

In Florida, Gulf HABs are commonly known as red tides, which are a high concentration of naturally occurring, toxic, microscopic marine algae, originating in offshore waters and concentrating in coastal waters. Red tides can kill fish and other marine life, contaminate shellfish, and be dangerous to people as well. Massive blooms can also have a devastating impact to the tourism-based economy when fishing areas are closed and breathing becomes difficult for beach goers due to toxic sea spray along the coast. The exact cause and mechanism for this phenomenon are unknown.

Florida's priority actions for restoring and protecting water quality include:

- Reduce excessive sediment, pollutant and nutrient loads in waterways by improving the management of urban and agricultural stormwater runoff, increasing the treatment levels of wastewater and encouraging their reuse, restoring inland waterways that flow to the Gulf, restoring canals and altered floodplains to represent more natural systems, and promoting more sustainable adjacent land use policies.
- Improve education and incentives related to nonpoint source pollution (agricultural, residential and urban) and promote local BMPs and alternatives.
- Focus water quality and clarity improvements to best promote seagrass, oyster and coral restoration.
- Improve understanding of the sources, bioaccumulation and effects of toxic chemicals (such as pesticides, dioxins and PCBs), metals (such as mercury) and other environmental contaminants, as well as how to cycle these pollutants out of sediments and nearshore waters. Improve understanding of the ecological harm of increasing acidification in Gulf waters and identify ways to reverse this trend.
- Continue to monitor, investigate, and possibly mitigate and ameliorate HABs off Florida's Gulf Coast.
- Evaluate the feasibility of removing or improving control structures that are impeding tidal exchange to estuaries to restore more natural salinity conditions that serve as primary nursery areas.

Replenish and Protect Living Coastal and Marine Resources

Habitat loss and degradation have led to declining wildlife populations in coastal areas. These natural areas are critical to many species, including shorebirds, sea turtles, marine fish, beach mice and marine mammals. In addition, they are vital to tourism, serving as sites that many coastal visitors enjoy for recreation.

Increasing levels of disturbance in coastal areas from beach nourishment, coastal development and recreational activities, as well as the implications of sea-level rise, are all challenges facing coastal and marine fish and wildlife and other resources. An integrated approach among all stakeholders that focuses on fish, wildlife and habitat needs, as well as socioeconomic issues, is greatly needed to address activities that affect coastal and marine resources.

Florida's priority actions for replenishing and protecting living coastal and marine resources include:

- Develop and implement management plans for conserving threatened, endangered, and other protected species and maintaining commercial and recreationally important species. Management plans should include ways to improve monitoring of coastal and marine resources; improve research into those resources; minimize adverse impacts from human activities; maintain sustainable native populations; and protect, restore and maintain critical habitat for listed fish, wildlife and plants in coastal areas.
- Involve the public in developing initiatives to help educate citizens and communities on the importance of coastal wildlife conservation, shorebird protection and sea turtle monitoring.
- Develop and implement programs to balance and integrate the interests and needs of people living and recreating in coastal areas with the needs of fish and wildlife species dependent on marine and coastal habitats.
- Develop large-scale strategies for seagrass, oyster and coral reef restoration and fish hatcheries and aquaculture programs for marine species propagation and enhancement.
- Develop and implement invasive species eradication and management plans to address impacts to natural ecosystems within the Gulf region.
- Develop coral propagation and post-storm and vessel grounding coral restoration plans.

Enhance Community Resilience

Florida's coastal resources face substantial threat from red tides, coastal wildfires, population growth, development, and other natural and human-made hazards. From 1960 to 2009, 63 major disasters were declared in the state, mostly due to hurricanes, tropical storms and coastal flooding.[157] In addition, projected sea-level rise threatens to exacerbate the vulnerability of Florida's at-risk coastal resources. These significant coastal resources often provide the first line of defense from a natural disaster and are, therefore, important to the overall resiliency of the state.

Florida has already taken steps to address community resiliency through projects aimed at post-disaster redevelopment and sea-level rise adaptation. The state has also begun integrating hazard mitigation and community resiliency into the local comprehensive planning process. However, with 80 percent of the state's population living in coastal areas, additional efforts will likely be needed to protect these communities.

The state's priorities for community resiliency include:

- Compile, review and summarize "coastal elements" of Florida's 23 Gulf Coast counties' Comprehensive Growth Management Plans for continuity and consistency in natural resource and community infrastructure protection to aid in Gulf restoration and community resiliency.
- Incorporate projects to address natural resource protection into local coastal hazard mitigation plans.
- Promote the development of Community Conservation Plans that include proven ele-

ments of coastal construction and conservation, emergency response and risk reduction, and economic development.

- Improve knowledge of the economic value of environmental services provided by Gulf resources in terms of long-term community sustainability, growth and resilience.
- Update the Spill Response Contingency Plans through a multi-disciplinary process to incorporate better preparation, local involvement, and updated ecological data. Promote wider understanding of the plans and involvement among potentially affected parties.
- Support local efforts to develop redevelopment plans that address natural resource and economic protection and recovery following a disaster and that support statewide, long-term recovery.
- Coordinate statewide efforts to address sea-level rise, saltwater intrusion and other impacts from climate change for both the natural and built environment, especially potable water sources.

Louisiana

Background

Coastal Louisiana is one of the most productive estuaries in the world.[158] The state's coastal area is composed of the largest deltaic plain in North America and the world's seventh largest delta, tens of thousands of square miles,[159] and more than 7,700 miles of tidal shorelines.[160] This area also plays a critical role in the nation's energy and economic security. South Louisiana is the top source of offshore energy in the country,[161] the largest source of wild seafood in the lower 48 states, and home to five of the top 15 ports in the nation.[162]

Southern Louisiana is America's Wetland, a landscape created by the Mississippi River over the last several thousand years. This land-building occurred as the river periodically switched course to find a more efficient path to the Gulf and spread its sediment, nutrients and freshwater across southeast Louisiana. This process also created the Chenier Plain of southwest Louisiana, a unique area of alternating wetlands and oak ridges from which the area gets its name. Louisiana and much of its adjacent Gulf Coast was literally built by the Mississippi River system.

Since the arrival of Europeans, people have tried to manage the river for their own safety and prosperity. An unintended result of these repeated attempts to manage the river, combined with other factors over the past three centuries, has been significant losses of wetlands and coastal habitat with nearly 2,000 square miles of wetlands lost since the 1930s.[163] The practices of constructing levees, straightening, channelizing, dredging and otherwise managing the river have succeeded in preventing riverine floods, facilitating economic development, and maintaining a deep-draft navigation channel, but have also separated the river from the adjacent lands and wetlands—its deltaic plain. The valuable sediment, nutrients and freshwater resources that once created and sustained Louisiana's and much of the northern Gulf's coastal ecosystem are lost to the deep waters of the Gulf of Mexico. Without reconnecting the river system to its deltaic plain, Louisiana's coast will remain unsustainable and the Gulf ecosystem will degrade further in turn.

Still, Louisiana has the largest expanse of coastal wetlands in the lower 48 states.[164] More than 5,600 square miles of coastal swamp and marsh are present in coastal Louisiana,[165] an area larger than the state of Connecticut. This coastal region is known as a working coast. In addition to having extraordinary ecological diversity and productivity, it encompasses energy resources and infrastructure, national and international commerce, fisheries and wildlife habitat, natural storm protection and water quality enhancements, and a rich cultural heritage.

As the land loss crisis continues in Louisiana, and the Gulf of Mexico encroaches on Louisiana's coastal communities, the vulnerability of this region to damage from tropical storms increases every day. While coastal communities are at risk, so are billions of dollars of infrastructure funded by industry, municipalities, the state, and the United States. Roads and highways, utilities, railways, ports, and navigation systems will be lost and more than a million citizens will be forced to move. In 2005, Congress made a supplemental appropriation of $94.8 billion to respond to the impacts of Hurricanes Katrina, Rita and Wilma.[166] In order to protect this investment and prevent the need for additional large-scale investments in responses to catastrophic events, immediate and meaningful action must be taken to achieve a sustainable coastal Louisiana and Gulf Coast.

Energy infrastructure. The oil and gas industry has established and concentrated coastal and offshore exploration, production, transportation infrastructure, and refining capacity along Louisiana's Gulf Coast. Nearly 125,000 miles of oil and natural gas pipelines pass through the marshes of coastal Louisiana, and throughout the state and its offshore area in the Gulf of Mexico.[167] The Henry Hub in Erath, Louisiana, is the pricing point for natural gas in North America[168] and the nexus of nine interstate and four intrastate pipelines,[169] and Port Fourchon provides a port and supply point for 90 percent of the offshore drilling operations in the Gulf of Mexico.[170] The network of energy facilities in and around Louisiana's Gulf Coast produces or transports nearly one-third of the nation's oil and gas supply and is tied to 50 percent of the nation's refining capacity.[171] Louisiana's coast also contains the Louisiana Offshore Oil Port, the only port in the nation capable of offloading supertankers;[172] about 38,000 oil and gas wells;[173] and two of four storage sites for the Strategic Petroleum Reserve nationwide.[174] Barrier islands and wetlands help buffer this infrastructure from storm damages.

National and international commerce. Ten major navigation routes, including the Mississippi River, are located in coastal Louisiana. Five of the 15 busiest ports in the United States, ranked by total tons,[175] are also located in this region, handling nearly 450 million tons of waterborne cargo each year.[176] This represents 20 percent of annual U.S. waterborne commerce.[177] Each year, the Port of South Louisiana and the Port of New Orleans together account for $150 billion and nearly 20 percent of the U.S. import/export cargo traffic.[178] The state's top three ports handle an estimated 55 to 70 percent of all U.S. exported corn, soy and wheat. Louisiana's ports also handle other commodities such as steel, coffee, rubber and chemicals.[179] Without barrier islands and wetlands, all of this infrastructure would be at greater risk when storms come ashore.

Fisheries and wildlife habitat. This ecosystem is the nation's largest shrimp, oyster, crawfish and blue crab producer and provides 26 percent (by weight) of the commercial fish

landings in the continental United States.[180] In fact, Louisiana is second only to Alaska in annual volume of seafood landings,[181] and three of the nation's top seafood ports by volume are in Louisiana.[182] These resources are processed and shipped throughout the world, providing jobs for almost 30,000 Louisiana citizens, as well as jobs in other states.[183]

The Mississippi Flyway passes directly over south Louisiana, and more than five million migratory waterfowl pass through or spend the winter in Louisiana's marshes.[184] In addition, the coastal landscape provides stopover habitat for millions of neotropical migratory birds on their journeys across the Gulf of Mexico. Hundreds of fish and wildlife species, as well as the jobs and recreational opportunities associated with birding, hunting, fishing and eco-tourism, all depend on the barrier islands and wetlands along Louisiana's Gulf Coast. Sixteen endangered, threatened or otherwise protected species are found in south Louisiana—including the Gulf sturgeon, Louisiana black bear, and several species of sea turtles—as well as the recently recovered bald eagle.[185]

Water quality. Nutrients from farms and other sources in the Mississippi River watershed cause the largest low-oxygen (or hypoxic) conditions off the coast of the United States. The "dead zone" is virtually void of marine life and has averaged over 6,000 square miles since 1990.[186] High concentrations of nutrients in the northern Gulf of Mexico contribute to the growing problem of hypoxia, or low-oxygen conditions, in offshore coastal waters. As increasing amounts of river water are diverted into marshes as part of restoration projects, these nutrients will help sustain wetland plants or be processed in the soil, rather than contributing to a nationally significant water quality problem.

Culture. People have lived in south Louisiana for over 12,000 years, using the abundance of the rivers and Gulf Coast to extract resources and facilitate trade. When New Orleans was founded nearly 300 years ago, it quickly became a center of international commerce, attracting people from around the world. These diverse peoples lived in proximity while retaining their own identities, a trend that defied typical melting pot dynamics and created a multi-faceted culture that endures today. The Native American Chitimacha people have lived on Louisiana's coast for at least 2,500 years and state as part of their beliefs, "We have always been here." The regard for land and family expressed by this sentiment is one that many residents of south Louisiana share.[187] In fact, according to the 2010 Census, Louisiana has the highest percentage of native-born residents (81.9 percent) of any state in the nation.[188]

Coastal Crisis

In spite of these attributes, Louisiana's Gulf Coast and its vital natural resources are greatly imperiled. The effects of four major hurricanes (Katrina, Rita, Gustav and Ike) within a four-year period (2004 to 2008) resulted in a cumulative net loss of 849.5 square kilometers (328 square miles), an amount equivalent to decades of coastal land loss during periods of low storm frequency.[189] Louisiana's coastal crisis was further compounded in 2010 by the *Deepwater Horizon* oil spill, which released millions of barrels of oil into the Gulf, resulting in the closure of state and federal waters to fishing and affecting thousands of miles of shoreline, bayous and bays in Louisiana and other Gulf Coast states. With more of its precious coastal assets lost each year, the state and nation are under increased pressure to identify new tools and resources to protect and restore coastal environments, assets and communities in a re-

silient manner to ensure that Louisiana's vital coastal resources are better equipped to withstand future threats.

The Coastal Protection and Restoration Authority of Louisiana has directed the investment of over $1.7 billion in state and federal funds over the last three years in ecosystem restoration and community sustainability measures and improvements to coastal resource management.[190] Recent reports have indicated that these investments, together with system resilience, have resulted in coastal land gains in some areas; however, an appropriately balanced approach among investment priorities (regardless of the type of action or party involved) is needed to achieve sustainable management of the coast.

Louisiana Coastal Protection and Restoration Plan

Following Hurricanes Katrina and Rita, Congress directed the U.S. Army Corps of Engineers to develop a comprehensive ecosystem restoration and hurricane protection plan for coastal Louisiana (the Louisiana Coastal Protection and Restoration plan, or LACPR) and Mississippi MsCIP. The State of Louisiana is now working with the Corps to further inform project prioritization through the development of the State Master Plan.

Master Plan

In 2007, the state developed the Master Plan for a Sustainable Coastal Louisiana in response to the Louisiana legislature's directive to integrate coastal protection and restoration activities, establishing four broad planning objectives as benchmarks for implementing coastal protection and restoration projects. The 2007 Master Plan also identified large-scale measures needed to achieve a sustainable coast. This initial Master Plan, though groundbreaking, was a conceptual document (which helped to inform LACPR) and was not intended to address all of the numerous complex issues that coastal Louisiana faces. To accommodate the dynamic nature of coastal processes, the Coastal Protection and Restoration Authority of Louisiana is working to update of the Master Plan every five years to incorporate new data and planning tools as they become available. The first update of the Master Plan must be submitted to the Louisiana legislature in March 2012. The State of Louisiana's 2012 Master Plan, which is supported by multiple federal agencies, will present a new approach for considering the future of the coast. This approach will identify protection and restoration projects that achieve multiple objectives (integrated planning). The plan will also propose a specific order for building projects to ensure that the most important projects are constructed first (prioritization). The state began laying the foundation for this new approach in 2010 with the development of a Prioritization Tool designed to help identify portfolios of "high-value" projects. Progress on the Master Plan Update has continued in 2011 with the establishment of a Master Plan Delivery Team that is committed full-time to the development of the 2012 update.

Louisiana's 2012 Master Plan will provide a pathway to sustainability. The plan will answer two questions that coastal residents have long been asking: just how bad is the coastal crisis going to get, and what will be done about it? People are worried about flooding, and they want to know what to expect. The plan will describe solutions to Louisiana's land loss and flooding problems that affect people, businesses and natural areas. This will help communities and their leaders know what to expect as they plan for the future.

People also want action. They want to be protected from flooding and they want wetland

Louisiana's Coastal Resources: *What's at Stake*

Coastal Louisiana currently contains about 40 percent of the coastal marsh in the continental United States, but accounts for about 90 percent of coastal wetland loss in that region.[191] Louisiana's coastal crisis is not merely a state concern, but a national concern. At stake are resources and industries that support millions of jobs nationwide, including:

- The highest rate of crude oil production and second highest rate of natural gas production in the nation (includes Outer Continental Shelf production).[192]
- Eighteen active oil refineries. The operating refineries in Louisiana account for approximately 19 percent of the nation's refining capacity, ranked second in the nation,[193] supported $70.2 billion in sales and $12.7 billion in household earnings, and supported 320,280 jobs in 2005.[194]
- A chemical industry that generates nearly $1 billion each year in tax revenues for Louisiana and billions of dollars to the nation's economy. The Louisiana chemical industry directly employs over 30,000 citizens, paying salaries that total over $1.7 billion per year.[195]
- Nearly 450 million tons of waterborne commerce (20 percent of all waterborne commerce in the nation).[196]
- The largest port in the nation in terms of total tonnage shipped (the Port of South Louisiana).[197]
- Five of the 15 largest ports in the nation.[198]
- Nearly 3,000 miles of deep and shallow draft navigation channels to support waterborne commerce.[199]
- Approximately 26 percent of the total commercial fishing catch in the lower 48 states ($1 billion annually).[200]
- A robust recreational fishing industry with nearly $2 billion in annual revenues.[201]
- The largest fur harvest in the nation.[202]
- More than five million migratory waterfowl that pass through or spend the winter in Louisiana's marshes.[203]
- Eleven National Wildlife Refuges covering an area greater than 524 square miles.[204,205]
- Nearly two million residents living in parishes within the state's coastal zone.[206]
- An estimated 25 million domestic and international visitors in 2010.[207]
- $9.3 billion added to the economy through tourist spending in 2010.[208]

loss addressed. The 2012 Master Plan is focused on taking the action needed to address these concerns. To deliver an effective but feasible action plan, the 2012 Master Plan will propose projects that will reduce flooding risks using a range of methods, from levees to building up landscape features to helping communities flood-proof their homes. The plan will also propose projects that build wetlands, restore coastal landscape features, and help sustain the multitude of ecosystem services that support communities, nationally significant industries, and commercial operations. In order to bring flood risk reduction and wetland restoration together into one integrated plan, the 2012 Master Plan will present portfolios of projects that combine both objectives. The 2012 Master Plan will present the best possible use of dollars based on the current state of knowledge, while laying the groundwork for improvement in coming years.

State Priorities

The Task Force Strategy lays out four overarching goals. The State of Louisiana's priority actions for each goal are described below.

Restore and Conserve Habitat

- **Improve river and federal navigation channel management.** Current management practices have effectively separated the Mississippi River from its floodplain, causing or increasing land loss, nutrient loading to the Gulf and salt water intrusion. Current management practices have resulted in an unsustainable coastal and Gulf of Mexico ecosystem as well as navigation and flood damage risk reduction systems.

  Needed actions:

  - Establish sediment delivery targets to restore coastal wetlands.
  - Mandatory use of dredged sediment for habitat restoration to mitigate negative effects of navigation channel management.
  - Evaluate lower river management holistically.
    - Construct demonstration projects that evaluate alternative management techniques:
      - Sediment traps.
      - Permanent sediment transport infrastructure.
      - Siphons and wetlands for nutrient filtering.
  - Implement river reintroduction projects that mimic or enhance natural hydrologic processes and provide freshwater, sediments and nutrients to help sustain or restore wetlands.
  - Launch a pilot water quality credit program that evaluates wetlands capacity to filter nutrients.
  - Pursue embankment stabilization and shoreline protection measures to maintain federal navigation channels within authorized dimensions.

- **Maximize and stabilize revenue streams.** Current restoration programs (e.g., the Coastal Wetlands Planning, Protection and Restoration Act [CWPPRA], the Coastal Impact Assistance Program [CIAP], State Surplus, the Water Resources Development Act) use a project-by-project planning and implementation approach, limiting capabilities of the overall restoration program.

  Needed actions:

  - Establish a multi-year budget, coordinated among federal agencies, that would allow for a programmatic approach to ecosystem restoration.
  - Issue regulations and projected revenue streams associated with the Gulf of Mexico Energy Security Act.
  - Facilitate and support the development of "ecosystem services credits" and other innovative funding sources for coastal restoration (carbon credit, water quality credits, natural resources damage credits, etc.).
  - Develop options to use mitigation funds and the "pooling" of resources from separate projects which may require changes to existing regulations on mitigation.

- **Expedite project implementation and remove barriers to large-scale restoration.** It has often taken many years to implement projects through the existing water resources planning and implementation process. It is necessary to accelerate the process, especially when dealing with a crisis like the one coastal Louisiana is facing.

  Needed actions:

  - Reevaluate the definition and application of the federal standard for the beneficial use of dredged materials and how it relates to the requirements of the Coastal Zone Management Act.
  - Improve/expedite the process for acquiring sand leases in federal waters.
  - Remove barriers to effectively crediting local cost share of projects.
  - Focus on mitigation for the negative environmental impacts caused by the ongoing operation and maintenance of flood control, navigation and other projects.
  - Use CWPPRA or a similar multi-agency approach for the development and implementation of large-scale projects.
  - Explore modifications to the National Environmental Policy Act process for ecological restoration projects within existing legal authorities.

Restore Water Quality

- **Reduce hypoxia.** Improve water quality by reducing excess nutrients flowing into, and hypoxic conditions in, the Gulf of Mexico.

  Needed actions:

  - Reconstruct distributaries to mimic historic deltaic processes, sustain or restore wetlands, and filter excess nutrients from water entering the Gulf.
  - Launch a pilot water quality credit program that evaluates the effectiveness of the distributaries and associated wetlands to filter nutrients.

- Execute cooperative endeavors with upper-basin states to construct wetlands buffers and other measures to reduce nutrient inputs in the Mississippi River system.

Protect and Replenish Living Coastal Marine Resources

- **Restore historical oyster reefs.** The Louisiana coast was once the location of massive offshore oyster reefs in Bay Gardene and Barataria, Terrebonne, Atchafalaya and Vermilion Bays. The state has a goal of establishing more acres of harvestable oyster reefs and living shorelines than ever before.

  Needed actions:

  - Manage reefs to support a suite of ecosystem services, including sustainable harvest, fish production, water filtration, nitrogen removal and protection of shorelines and marsh land.
  - Assess and implement Gulf-wide restoration of near-shore habitats that promote shoreline stability and habitat diversity, such as oyster reefs, mangroves, marshes and beach/dune systems.
  - Establish buffers landward of marsh shorelines that are under pressure from shoreline development and sea-level rise to allow for marshes to migrate.
  - Integrate living shoreline concepts into comprehensive restoration and protection efforts.

- **Eliminate invasive species.** Louisiana is home to dozens of invasive species that destroy the precious wetlands we are trying to preserve and restore, displace naturally occurring species and reduce habitat value to our native wildlife and fish.

  Needed action:

  - Develop and implement invasive species management and eradication plans. Use existing state and regional partnership models such as the CWPPRA Coast-Wide Nutria Control Program to guide implementation.

Enhance Community Resilience

- **Enhance coastal community resilience.** Use comprehensive, scientifically based, and stakeholder-engaged coastal improvement plans at the state and local levels such as the 2012 Master Plan for a Sustainable Coastal Louisiana.

  Needed actions:

  - Support and expedite implementation of community resilience features of the 2012 Master Plan for a Sustainable Coastal Louisiana.
  - Expedite decision making for federally authorized hurricane protection, flood control and ecosystem restoration efforts.

- **Establish alternative project delivery processes.** A new project development and implementation process must be established that can respond to the urgency in the Gulf. The recovery of 2005 hurricanes alone cost taxpayers an estimated $150 billion. Some of these vulnerabilities continue to exist today. The state-federal CWPPRA, the Gulf of Mexico Energy Security Act, the revised CIAP and some post-hurricane recovery

programs—including alternative environmental compliance processes—are models that can be evaluated to develop this new process. Local, state and federal governments cannot afford to allow this level of risk to continue.

Mississippi

Background

If the best things come in small packages, Mississippi's coast may be the diamond of the Gulf. The state packs a lot of natural beauty, ecological and social diversity, culture, cuisine and entertainment into a small area, which helps drive one of the most important economic engines in the state.

Along the coast, Mississippi spans roughly 69 miles between the Alabama and Louisiana state lines.[209] The state's three counties that border the Gulf Coast, Hancock, Harrison and Jackson, have a population of 370,702, compared to a statewide population of 2,967,297.[210]

The Grand Bay National Estuarine Research Reserve

The Grand Bay National Estuarine Research Reserve straddles the Mississippi/Alabama state line. This 18,000-acre reserve represents one of the largest, relatively undisturbed estuarine marsh/pine savanna habitats remaining along the northern Gulf of Mexico. Diverse habitats such as salt pannes, saltwater and freshwater marshes, bayous, oyster reefs, and seagrass beds provide critical habitats for many of the region's important commercial and recreational species of fish and migratory birds. These habitats serve as nursery areas as well as breeding and feeding grounds for shrimp, red drum, speckled trout, oysters, Wilson's plovers, peregrine falcons, Alabama red-bellied turtles and other species of concern.

The tidal shoreline in this area is 359 miles and encompasses barrier islands, mainland coast, bays, lagoons and river shorelines.[211] Mississippi's coastal waters also include 758 square miles of large estuaries, smaller bays and tidal rivers, creeks, and bayous.[212]

The Mississippi Coastal Plain is laced with scenic streams, both wild and lazy, from the almost unpronounceable Tchoutacabouffa River to the longest undammed river in the lower 48 states, the Pascagoula. These streams are typically shallow and clear blackwater streams, with moderate flow and wide sandbars, gradually becoming wider, deeper and more sluggish as they flow toward the Gulf.

The streams and estuaries of this area are home to a remarkable variety of plants and animals. A large number of threatened and endangered species are found here in what is recognized as one of the most biologically diverse regions in North America. The area is also known for the large number of amphibian, reptile and bird species, and ranks in the top 10 for endemic species of reptiles, amphibians, butterflies and mammals.[213] The beauty of the landscape and the habitats that make this area so popular for outdoor recreation also provide safe haven for the plants and animals that live there. Good water quality and protection of habitat are essential to support these species.

Multiple events have shaped the coastal environment, changing its topography, altering the bottom substrate of the estuaries and disrupting the lives of its residents, including humans and aquatic and terrestrial organisms. In August 1969, Hurricane Camille made landfall in Harrison County, devastating coastal Mississippi with tremendous economic damage and loss of life. This powerful storm eroded the offshore barrier islands and cut Ship Island into two separate islands. In addition, it increased the coast's susceptibility to future storm

The Mississippi Barrier Islands

The Mississippi Barrier Islands dangle off the mainland like a string of pearls in the blue-green waters of the Gulf of Mexico. Petit Bois, Horn, East Ship, West Ship and Cat Islands are mostly owned by the National Park Service and are part of the Gulf Islands National Seashore. Accessible only by boat and virtually untouched by human development, these islands are a great place to view nesting ospreys, and they provide habitat for many shore birds and wildlife species, including the American alligator and piping plover. The islands also serve as a natural barrier, buffering the mainland from storms and from the *Deepwater Horizon* oil spill. These islands have had their lifeline of renourishing sand and sediment severed by navigation channels that have interrupted the natural flow of sand to them, making them prime candidates for restoration efforts.

events. This increased susceptibility manifested itself in August 2005, when Hurricane Katrina made landfall along the Louisiana-Mississippi state line. The accompanying storm surge wreaked havoc on the area, destroying homes, businesses and coastal habitat.

Most recently, in April 2010, the *Deepwater Horizon* platform exploded, leading to the worst oil spill in U.S. history. The spill provided an intense focus on the Gulf, as well as renewed momentum to continue the development of far-sighted strategies to improve the Gulf Coast's ecosystems and economy. Mississippi Governor Haley Barbour appointed the Mississippi Gulf Coast Commission in August 2010, to draft a framework for a coastal restoration program. The Commission, composed of leaders from government, private business, academia and nonprofit organizations, collaboratively produced *Vision for Gulf Coast Recovery, Restoration and Protection*, which was submitted to Secretary of the Navy Ray Mabus.

Mississippi coastal shorelines have been eroding steadily over the past several thousand years, driven primarily by relative sea-level rise, wave action, tropical storms/hurricanes and disruptions in the sediment transport system. From the 1950s to the 1990s, coastal marsh in Mississippi declined from an estimated 67,000 acres to 58,000 acres, a loss of 9,000 acres.[214] The loss of coastal wetlands continues today at rates similar to the historical trends; however, increased development pressure and expected increases in sea-level rise will likely accelerate the rate of loss.

The health and resiliency of the state's ecosystems and the economy are tightly woven together. Commercial and recreational fishing, gaming, tourism, energy production, manufacturing and shipping provide the base of a diverse and vibrant coastal economy. Commercial fishing and seafood processing is a natural extension of life in this coastal area. Hundreds of fishing boats make their home in Mississippi ports, and the seafood they catch generates thousands of business opportunities.

Tourism is driven in part by the seafood industry, as recreational fishing opportunities bring many visitors to Mississippi. The Mississippi Department of Marine Resources has built 200 acres of inshore reefs and approximately 16,000 acres of offshore reefs through its artificial reef program.[215] These reefs provide improved habitat for many bottom-dwelling species, like red snapper and grouper, and increase fishing opportunities for the public.

The Mississippi Gulf Coast has become one of the top gaming destinations in the country, with world-class entertainment, hotels and cuisine. The success of the Mississippi Gulf Coast tourism industry has a direct impact on the revenues generated for the state. Tourism on the Gulf Coast accounts for about $1.7 billion in visitor expenditures, 32 percent of state travel and tourism tax revenues and 23,000 direct jobs.[216] The Mississippi coast also offers attractive beaches, championship golf courses, museums and art galleries to complement its gaming and fishing industries.

Offshore oil and gas exploration and development further boost the area's economy. Providing experienced offshore workers, necessary logistical support and industrial capacity to generate that support are all-important sources of fuel for the coast's economic engine.

The largest cities on the Mississippi coast are Gulfport, Biloxi and Pascagoula. The Mississippi State Port at Gulfport is a hub of national and international commerce. It is an economic force for jobs and business activity alike. The port generates more than 2,000 jobs for Mississippi residents, with that number projected to increase to almost 5,500 with planned improvements and expansion as the city undergoes a comprehensive recovery from Hurricane Katrina.[217] Gulfport also lays claim to hosting "The World's Largest Fishing Rodeo" each Fourth of July, where anglers and sightseers flock each year to show off their catch and to marvel at the huge blue marlin, eerie king snake eel and other creatures from the deep that are brought to the scales. Biloxi is the home of Keesler Air Force Base, which houses the 81st Training Wing, the Air Force's largest Technical Training Group. The 81st Training Wing is the Air Force's computer and electronics training "Center of Excellence," which trained 22,925 airmen, soldiers, sailors and Marines in 2008.[218] Pascagoula is proud to be the home port of the largest military shipbuilder in the United States, having built over 70 percent of the existing U.S. Navy fleet. This shipyard is also the largest private employer in the state, providing approximately 11,000 jobs for residents of the northern Gulf region.[219]

Quaint small towns, like Bay St. Louis (on the western shore of the Bay of St. Louis) and Ocean Springs (at the mouth of Biloxi Bay), dot the Mississippi coast. These small communities offer interesting shops, art galleries and great local restaurants featuring fresh Gulf seafood. They epitomize Mississippi hospitality and attract visitors from all over the world.

State Priorities

The Task Force Strategy lays out four overarching goals. Mississippi's priority actions for each goal are described below.

Restore and Conserve Habitat

The Gulf will continue to have destructive storms and other disasters. The State of Mississippi must work to reduce the damage from these events, thereby protecting lives and homes, lowering repair and rebuilding costs, and improving the region's ability to recover quickly following a disaster. In partnership with the environment, the state can build capacity to protect and restore the coast's ecosystems from both natural and human-made disasters. Coastal communities can be better prepared for changes of all kinds by assessing risks in advance of those changes and making appropriate choices to mitigate harm.

Mississippi's key priorities for conserving and restoring habitat include:

- Conserve and protect the state's existing natural treasures.
- Restore the Gulf barrier islands and wetlands, including the development of a Sediment Management Master Plan to effectively use dredged materials and other sediment for restoration projects.
- Establish restoration and enhancement projects based on continuing investigation and assessment to ensure the renewal and long-term sustainability of fish and shellfish populations and their habitats, including marshes, seagrass beds and oyster reefs.
- Initiate community-based efforts to increase awareness of the importance of coastal resources and the BMPs to support conservation and renewal of these invaluable assets.

Restore Water Quality

It is imperative that the Gulf Coast have clean surface waters, safe drinking water and safe seafood. Good water quality is a critical component of coastal living. Not only is clean water essential for the health of the plants and animals that inhabit coastal waters, but it also supports jobs for those involved in fishing, shipbuilding and tourism; provides recreational opportunities for residents and visitors alike; and supports the local cuisine and lifestyle.

Nutrients, especially nitrogen and phosphorus, are an important water quality concern in the Gulf. The right balance of the kinds and amounts of nutrients carried into the state's estuaries and coastal waters is an important factor affecting the health of Gulf estuaries and open waters. Adequate levels of nutrients are essential for a healthy ecosystem and to support productive sustainable fisheries, but excess nutrients can cause hypoxia, which is a decrease in the levels of oxygen available in the water. Hypoxia can adversely impact fish and other aquatic life, and creates what is commonly called the "dead zone" in the Gulf. An oversupply of nutrients can also increase the amount of algae present and result in HABs. These algal blooms, some of which are called "red tides," can kill fish, cause skin rashes in swimmers, result in respiratory problems for beachgoers and render fish and shellfish unsafe to eat. When these blooms of algae die, they sink to the bottom and decompose—a process that consumes more oxygen. Reducing the excess nutrient levels in inland waters, before they reach the Gulf, is key to reducing the size of the "dead zone," decreasing the extent and frequency of HABs, and maintaining the health of coastal waters.

Important water quality priorities for the state include:

- Conduct regional nutrient characterization studies to identify and evaluate strategies to manage nutrient levels.
- Establish a Gulf states approach to develop coastal nutrient criteria and management.
- Support the goals and actions of the Mississippi/Gulf of Mexico Watershed Nutrient Task Force as identified in the Gulf Hypoxia Action Plan and promote the exchange of information and technology between the upper and lower Mississippi River Basin states and organizations.
- Develop a long-term "watershed to Gulf" monitoring program.
- Enhance and expand offshore monitoring/observing system.

- Maintain safe swimming beaches.
- Learn more about waterborne, disease-causing microorganisms (pathogens) and their sources. Then develop and implement proactive strategies to reduce people's exposure.
- Reduce the effects of HABs by improving the state's ability to detect, track, forecast and mitigate their movement and effects.
- Continue to monitor the conditions of the Gulf and the safety of seafood, with testing protocols and results being clearly and continuously communicated to the public.

Replenish and Protect Living Coastal and Marine Resources

Measures taken must include efforts to protect and restore the Gulf Coast's ecosystems from both natural and human-made disasters. It is imperative that the knowledge, skills, energy, passion and relationships of individuals and groups at all levels be leveraged for the successful creation and implementation of the strategies to keep the Gulf Coast viable and continue its legacy to the state and the nation.

Key priorities for protecting and replenishing coastal and marine resources in the state include:

- Protect and restore important habitats, including wetlands, seagrass beds and oyster reefs.
- Develop a strategic coastal and marine spatial plan that protects critical habitats and life stages.
- Enhance and improve existing long-term monitoring programs.

Enhance Community Resilience

The Mississippi Gulf Coast is an interdependent web of the relationships among the people, the economy and the environment. Mississippi's citizens and officials have long debated, planned and implemented ways to make the Gulf Coast more environmentally healthy and economically vibrant. The Gulf Coast people have the ideas and energy for the restoration and sustainability of their coastal ecosystems. It is imperative that the knowledge, skills, energy, passion and relationships of individuals and groups at the local level be leveraged to create and implement strategies to build community resilience. The power of local input is a common thread among the various plans, strategies and reports prepared before and since the *Deepwater Horizon* incident. Moving forward, local implementation is critical to the success of any restoration effort in the Gulf.

The state's priority actions for enhancing community resilience include:

- Implement the remainder of MsCIP, including voluntary relocation.
- Support GOMA Resilience Actions.
- Promote development of working waterfronts consistent with NOAA's Smart Growth Initiative.
- Establish and enhance capacity-building programs for local governments.
- Promote and enable locally driven solutions.

- Enhance communication of risk and science information to promote resilience.
- Identify and support critical research initiatives.
- Provide uniform storm surge and wave evaluations for all Gulf Coast communities.
- Develop a Gulf-wide sediment budget.
- Identify actions that would help provide sustainable reductions in storm surge risks for high-risk populations.

Texas

Background

The Texas coastal zone includes 367 miles of Gulf shoreline and more than 3,300 miles of bay, estuary and lagoon shorelines. It stretches from Port Arthur, near the Louisiana state line, to Brownsville on the banks of the Rio Grande River. The 18 counties within the Texas coastal zone make up only one-tenth of the total land area of the state, yet are home to approximately six million residents, which represent roughly 26 percent of the state's population of 25 million.[220] The coastal zone includes a complex system of barrier islands and peninsulas, with Padre Island being the longest undeveloped barrier island in the world. Texas also has more than 191,000 miles of rivers and streams, seven major estuaries, and about 200 major springs. Of the 12 major watersheds in Texas, only one does not flow to the Texas coast.

The Texas coast is one of the most productive and ecologically distinctive shorelines in the world. It contains 12 distinct eco-regions, covering 268,500 square miles.[221] It is richly endowed with natural resources, including sand dunes, vast wetlands and aquatic habitats. With nearly two-thirds of the state's Gulf shoreline protected in parks, wildlife refuges and natural areas off-limits to development,[222] the Texas coast is a natural wonder. It is home to blue crabs, oysters, pelicans, plovers, shrimp, the rare whooping crane and the Kemp's Ridley sea turtle, which nests only on western Gulf beaches. Much of the Texas coast is composed of important habitats for breeding, wintering and migrating birds. Coastal Texas prairie wetlands, coastal marshes, bays and seagrass beds are the second most frequented wintering area for waterfowl along the Gulf of Mexico.

The natural beach/dune system of barrier islands and peninsulas on the Texas coast is the first line of defense against coastal storms—such as Hurricane Ike, which caused over $27 billion of damages, making it the second costliest U.S. hurricane between 2004 and 2010.[223] Vegetated and unvegetated sand dunes provide protective barriers for adjacent land and inland water against the erosive action of waves, winds and storm surges.[224]

Dunes along the Texas coast also serve as vital habitat for numerous native plants and species of migratory and shore birds, and provide nesting areas for several species of endangered sea turtles. Wetland and aquatic habitats are also essential components of the Texas estuarine and inland systems. These habitats include salt, brackish, intermediate and fresh marshes, estuarine and palustrine scrub shrubs, bottomland hardwoods, sand and mudflats, mangroves, and seagrasses. Texas wetlands serve as nursery ground for over 95 percent of the recreational and commercial fish species found in the Gulf of Mexico. They

provide breeding, nesting and feeding grounds for more than a third of all threatened and endangered animal species. They also provide permanent and seasonal habitat for a variety of wildlife, including 75 percent of North American bird species.[225]

The Coastal Regions of Texas

The Texas coast lies within three very distinct coastal regions, which differ in both climate and geology:

- The humid ***Upper Coast*** extends from the Sabine River at the Louisiana state line to the vicinity of the mouths of the Brazos and Colorado Rivers. It is generally a sediment-starved system that has some of the highest erosion rates in the nation—up to 30 feet per year in some areas.[226] Between the 1950s and 1989, subsidence and sea-level rise in the Upper Coast converted 26,400 acres of wetlands in the Galveston Bay system to open water and barren flats.
- The less humid ***Middle Coast*** extends from the mouths of the Brazos and Colorado Rivers southward to the north shore of Baffin Bay. Erosion rates are lower than along the Upper Coast due to more sediment in the system; however, wetland loss remains an important concern.
- The semi-arid ***Lower Coast*** extends from the southern shore of Baffin Bay south to the Rio Grande delta area. While it generally has a sufficient supply of sediment, it lacks the dune vegetation to hold the sand dunes in place. The Lower Coast also contains the Laguna Madre of Texas, the only hyper-saline coastal lagoon on the North American continent. The lagoon is known for its vast seagrass meadows, huge wintering bird populations and bountiful fishing grounds.[227]

Roughly one-third (423 miles) of the GIWW is also located in Texas. The GIWW is a navigable inland waterway that stretches 1,300 miles along the Gulf Coast from Florida to Texas.[228] The ecosystems adjacent to the GIWW contain sand dunes, wetlands, seagrasses, coastal prairies, oak mottes, sand and mud flats, and bay-estuary-lagoons that provide habitat for many wildlife and fish species.

The GIWW is vital to the economies of Texas and the nation as a whole. It is the nation's third busiest waterway and an important component of the diversified Texas transportation system. Thirteen percent of the nation's freight traveled the Texas GIWW in 2006, consisting of approximately 74 million tons of cargo with an estimated value of $25 billion.[229] Two-thirds of the nation's petrochemicals are produced by plants along the Texas portion of the GIWW, and the waterway handles 90 percent of all gasoline shipped to the Lower Rio Grande Valley.[230]

The Texas coast is also home to four of the top 10 ports in the country (based on total cargo tonnage),[231] including the ports of Houston, Corpus Christi, Beaumont and Texas City.[232] Texas ports generate over $9 billion in federal tax revenue annually. The four busiest Texas ports handled almost 400 million tons of cargo in 2009.[233] Galveston Bay supports one of the largest metropolitan areas in the United States[234] as well as the Port of Houston, which is the second largest port in the nation.[235]

The Port of Houston handles more total foreign trade and imports than any other U.S. port.[236] It accommodated 220 million tons of cargo and 7,700 vessels in 2009.[237] It provides more than 287,000 jobs and $30 billion to the economy annually. The area is also home to the nation's largest concentration of oil refineries[238] as well as a chemical industry that is ranked first in the nation in size and production.[239]

Ports and petrochemical production are only a part of the economic benefit derived from the Texas coast. Texas commercial fishing fleets bring in more than $150 million of fish and shellfish annually.[240] Eighty-two percent of the shrimp in the United States come from the Gulf states,[241] with Texas supplying 89.7 million pounds per year,[242] or almost 30 percent of the U.S. total shrimp landings. The recreational fishing industry is another important part of the Texas coastal economy with saltwater sport fishing generating almost $2 billion annually.[243] The number of annual saltwater fishing permits increased over 7.1 percent between 2006 and 2010.[244]

Oyster reefs in the bay systems along the Texas coast have both ecological and commercial importance. They provide valuable ecological services, such as supplying habitat for other commercial and recreationally important finfish and shellfish species, improving water quality, reducing turbidity and providing shoreline protection (intertidal reefs) from storm-induced erosion. The annual oyster harvest is approximately 5.7 million pounds of meat worth over $19 million. Prior to Hurricane Ike in 2008, Galveston Bay was responsible for producing approximately 85 percent of the Texas commercial oysters. Approximately 50 percent of the consolidated oyster reefs (8,000 acres) in Galveston Bay were lost due to hurricane-induced sedimentation, resulting in a 46 percent reduction in commercial oyster landings in the season following the hurricane's landfall.

Tourists visiting the Texas coast spend more than $7.5 billion annually for beach recreation, bird watching, fishing and eco-tourism.[245] The coast accounts for more than one-quarter of the total travel expenditures in Texas, making it the second most popular tourist destination in the state.[246] In 2009, Texas Gulf Coast tourism accounted for more than 27 percent of the state total of hotel rooms. It has consistently accounted for around 28 percent of the annual direct travel spending in Texas,[247] which amounts to approximately $14.5 billion[248] annually. Since the opening of the Galveston's first cruise line terminal in 2000, more than a million people have sailed from the Port of Galveston on cruise ships,[249] which contributed more than $1.05 billion to the Texas economy in 2009.[250]

State Priorities

The Task Force Strategy lays out four overarching goals. Texas's priority actions for each goal are described below.

Restore and Conserve Habitat

Erosion is one of the most critical issues facing the Texas coast. Sixty-four percent of the total Texas coast is eroding at an average rate of 5.9 feet per year, with some areas experiencing losses greater than 30 feet per year.[251] One of the primary contributors to this erosion is a lack of sediment in the coastal zone and shoreline currents to balance the effects of coastal storms and sea-level rise.

Erosion decreases the natural resiliency of the Texas coast to weather and storm events; limits public beach access; impacts tourism; threatens roads, structures and property; and affects future growth and development of coastal communities. Erosion has already consumed 26 miles of State Highway 87, which once connected Galveston to Sabine Pass.

Wetland loss is another major threat to Texas habitats. An estimated 4.1 million acres of wetlands existed in Texas in the 1950s. Less than 3.3 million acres were present by the early 1990s.[252] During this period, estuarine wetlands declined from 165,000 acres to 130,400 acres along the Texas coast.[253] Causes of wetland loss include sea-level rise, erosion, saltwater intrusion, urban and rural development, nonpoint source pollution, invasive species and agriculture.

The coastal prairie ecosystem in Texas is listed as critically imperiled by major conservation organizations. Approximately 6.5 million acres of coastal prairie existed in Texas before settlement occurred.[254] Currently less than 1 percent of the coastal prairie remains due to land conversion for cattle grazing or growing crops.[255]

The state's priorities for restoring and protecting habitat include:

- Protect and strengthen existing dunes (increase height and stability) and create new dunes.
- Restore wetlands, barrier islands/peninsulas/headlands and beaches through the beneficial use of dredged material.
- Restore sediments to river delta wetlands.
- Enhance Gulf beach monitoring and maintenance.
- Implement conservation projects to protect coastal habitats, especially on the Middle and Lower Coasts.
- Implement watershed-scale restoration projects that restore freshwater inflows and further restrict saltwater intrusion.
- Restore, protect and enhance severely depleted oyster reefs in the Texas coastal ecosystems because of their ecological and commercial significance.
- Maintain natural Gulf and bay shoreline areas for public recreation while increasing access and opportunities.
- Construct protective breakwaters, especially along the entire 40-mile length of the GIWW along Bolivar Peninsula.
- Adopt and implement a plan for the rapid reporting and long-term management of invasive species.
- Develop public and private strategies that build broad-based support for successful and adaptive management, restoration, and conservation.
- Promote, develop, maintain, monitor and enhance natural habitats along the Texas Coast through restoration and acquisition.

Restore Water Quality

Besides being a source of beauty and wonder, Texas waters are an essential life-supporting resource for animals, plants and humans. Healthy aquatic ecosystems depend on careful and effective water management. The population of Texas is expanding rapidly, bringing incredible pressure to bear on all of the state's natural resources, especially water, which intensifies competition for water among industry, urban areas, agriculture, riverine and coastal wetland wildlife, and fisheries. Protecting water quality and environmental flow regimes will help minimize adverse impacts to aquatic ecosystems. Resource managers should partner with stakeholders to develop science-based strategies designed to protect the aquatic ecosystems of Texas.

The state's priority actions to address water quality issues include:

- Work with public and private entities to integrate planning and management of groundwater, spring, stream, wetland, estuarine and marine ecosystems.
- Protect, maintain or restore appropriate watershed and hydrologic conditions to support healthy aquatic ecosystems.
- Establish and maintain cooperative strategies to incorporate long-term plant, fish and wildlife needs in all statewide, regional and local watershed planning, management, and permitting processes.
- Ensure that the Texas Surface Water Quality Standards increasingly incorporate biological data to protect the health and productivity of Texas waters.
- Identify instream flow and freshwater inflow regimes, especially for estuarine systems, to supply water, sediment and nutrients needed to support coastal habitats under natural and modified scenarios and salinity levels necessary to maintain a sound ecological environment.
- Ensure environmental flow standards protect instream flow and freshwater inflow regimes that are adequate to support fish and wildlife resources.
- Focus restoration of water quality and quantity on watersheds associated with bay ecosystems, including Galveston Bay, San Antonio Bay, Corpus Christi/Nueces Bay, Matagorda (East and West) Bay, Laguna Madre (Upper and Lower) and Aransas Bay.
- Collaborate with Louisiana and Mexico on restoration activities for the Rio Grande River and Sabine Lake.
- Increase implementation of BMPs and native buffers in watersheds.
- Develop and implement watershed-wide nutrient and contaminant reduction strategies. Evaluate and encourage agricultural, residential, industrial and commercial BMPs to reduce nutrient and contaminant inputs to the Gulf.
- Reduce impacts of HABs by improving detection, tracking and forecasting ability.
- Quantify the areal extent of land inundated during flood events to determine the benefits and impacts.
- Continue and enhance beach water quality monitoring.

Replenish and Protect Living Coastal and Marine Resources

The Texas coast has tremendous biodiversity. More than 457 species of fish and 343 species of invertebrates are found in the estuarine and marine waters of Texas. Texas currently operates 93 state parks and natural areas, 51 wildlife management areas,[256] and eight fish hatcheries.[257] These cover over 1.4 million acres that are managed in the public trust for recreation and conservation. As the population of Texas increases, so do land fragmentation, loss of open space, genetic isolation, habitat degradation and other impacts. Protecting and enhancing the living coastal and marine resources is critical to Texans.

The state's priorities to help replenish and protect its coastal and marine resources include:

- Continue to enhance and expand long-term monitoring (>35 years) of dependent and independent fisheries data within Texas bays and Texas Territorial Seas.
- Standardize monitoring (for success) of marsh/wetland and other restoration projects.
- Expand submerged habitat mapping and monitoring by expanding current side-scan sonar mapping efforts through all Texas bay systems and Texas Territorial Seas.
- Expand oyster habitat monitoring to include biomass components, disease, community parameters and commercial harvest potential.
- Quantify and develop indicators of ecosystem health (offshore, near-shore and estuarine) to use in adaptive management.
- Maintain and enhance wildlife and fisheries stocks in estuarine and marine habitats (bays, estuaries, natural and artificial reefs and the Gulf of Mexico).
- Acquire additional wildlife management areas for habitat conservation, demonstration and public hunting, and secure related water rights.
- Protect and assist in the recovery of threatened, endangered and high-priority species (e.g., marine sea turtles, terrapins, and other plant, fish and wildlife species) and their habitats.
- Develop and incorporate a coast-wide habitat interface into a routine monitoring program to identify potential impending large-scale losses of habitat and associated biological communities.
- Create an active network/database for ongoing monitoring, restoration and research efforts in Texas to maximize potential leveraging of effort and funds.
- Publish, disseminate, and promote guidelines and protocols for habitat restoration and management.
- Concentrate on-the-ground conservation efforts on landscapes of high biological value, such as watersheds, recharge zones, wildlife corridors and migratory flyways.
- Support conservation actions that mitigate anticipated climate change impacts to plants, fish and wildlife.
- Encourage development of renewable energy projects that do not adversely affect plant, fish and wildlife communities.
- Assess contaminants, bioaccumulation and diseases in fish and shellfish.
- Promote, develop, monitor and enhance the artificial reef potential of Texas.

Enhance Community Resilience

Population levels within the Texas coastal zone are expected to increase by an additional six million over the next 30 years.[258] The coastal region's largest urban centers—such as Houston and Corpus Christi—are continuing to grow, and the expected population increase will place greater demands on the area's economic and environmental resources.

Some of the most destructive hurricanes in U.S. history since 1875 have struck the Texas coast. The densely populated upper Texas coast is the most vulnerable area. Based on historical records dating back to 1871, on average this area is affected by a tropical storm or hurricane every 2.62 years. Since 1851, the upper Texas coast has received 56 percent of all tropical cyclone landfalls.[259]

However, none of the Texas coast is immune to hurricanes. Since 1953, Texas has experienced 23 federal disaster declarations due to hurricane and tropical storm events. The destructive impacts from hurricanes are not confined to the coastal zone either. As a hurricane or tropical storm moves inland and weakens, it can drop heavy amounts of rain, causing extreme flooding and extensive damage to the central areas of the state.

Another major threat to the Texas coast is subsidence, particularly in the Galveston-Houston vicinity, where the area has experienced a loss of elevation as much as 10 feet from 1906 to 2000. Subsidence increases coastal communities' risk of inundation and saltwater intrusion from storm surge. It also creates and exacerbates shoreline erosion. In Galveston, local sea levels are rising at approximately 0.02 feet per year.[260] At this rate, sea levels in the area could be approximately 1.75 feet higher by the year 2100.

Educating Coastal Decision-Makers

Educating coastal decision-makers on community resiliency and how it depends on ecosystem resiliency can be one of the most important steps in planning and being proactive. Through participation on the GOMA Coastal Community Resilience Workgroup, Texas has helped develop several tools for coastal decision-makers.

The Texas Storm Smart Coast Network provides information to coastal communities on preparing and recovering from storm events. A Community Resiliency Index is available for communities to conduct a self-assessment to develop an idea of how well they might reach and maintain an acceptable level of functioning after a disaster or from potential impacts resulting from sea-level rise.

Priority actions for enhancing community resilience in Texas include:

- Complete the development of a coastal and marine spatial plan to address the unique needs of Texas citizens in the planning process.
- Increase public awareness of the potential risks of living in vulnerable coastal areas, how to prepare for those risks and how to interpret and adapt to future risks.

- Complete development of the *Texas Homeowners Handbook to Prepare for Coastal Natural Hazards*, which will provide information on protecting homes and property from coastal hazards.
- Continue the development of educational workshops for the public so they can learn more about the risks of living in a coastal environment and adapt to future risks.
- Assist coastal communities in developing plans to prevent, adapt to and rebound from disasters, negative economic and social/cultural changes, and chronic long-term ecological stressors.
- Develop post-disaster redevelopment plans that can help guide communities to become more resilient as they make decisions that affect long-term recovery and redevelopment.
- Continue developing a capacity-building program to support ecosystem resilience by bringing together local planners, emergency managers, floodplain managers, building code officials and others.
- Coordinate and integrate coastal regional planning committees and provide technical support and tools to better educate communities about the natural and beneficial use of their coastal ecosystems.

Appendix C. Science to Support Gulf of Mexico Ecosystem Restoration

Introduction

The goals highlighted within the Strategy are oriented around the many components of the ecosystem, including the human component. Fundamental to the success of the Strategy is ensuring that it has a robust and defensible scientific foundation. Given the interconnected nature of the Gulf ecosystem, issues that relate to one goal (e.g., coastal habitats) often have direct bearing on other goals (e.g., living marine resources). The scientific activities highlighted in this appendix—monitoring, modeling and research—overlap among many of the goals and will provide the knowledge and understanding needed to make and implement informed decisions.

Science Priorities

A long-term Gulf of Mexico monitoring program will support a variety of restoration and protection project alternatives and support valid predictions to protect human life and restore the ecosystem. Such a program should be used to determine baseline conditions for inland watersheds and estuarine, coastal, and offshore waters and be used to measure change, assess project effectiveness and support adaptive management decisions for Gulf restoration. A Gulf of Mexico modeling network should also be developed that increases certainty in forecasts and estimates of ecosystem services at a variety of stages along the restoration continuum for decision-makers and the public.

Further, research and basic discovery is needed to improve understanding of the ecosystems in the Gulf and how they can be sustained when the Gulf is undergoing extreme adverse conditions, including human and natural disasters (such as oil spills or hurricanes) and climate change. Focused research on human impacts, solutions, and risk is needed, as well as information about the economic impacts to humans and ecosystem services. There should be a strong reliance on basic research on such subjects as ecosystem loss, adaptability, variability and resiliency in all forms.

These activities will promote learning and help guide the planning, implementation and evaluation of the restoration and protection efforts articulated in the goals of this Strategy, as well as future restoration efforts in the Gulf. As the monitoring, modeling and research priorities identified below are implemented, shared learning among all stakeholders should occur over multiple iterations of the adaptive management process. Science is critical in the development of the projects, but equally critical is to determine the scientific and cost effectiveness of restoration projects and not repeat mistakes or ineffective efforts. The priorities outlined here highlight preliminary needs supporting Gulf ecosystem restoration. Addressing these needs

should include an assessment of the existing capacity (monitoring assets and data streams, model inventories, and research results) and build upon this capacity. Project-specific elements will be defined as restoration and conservation projects are developed.

Monitoring

Performance indicators are used to determine both system-wide and project-level monitoring needs. Monitoring is conducted to address decision-critical uncertainties and to parameterize models needed to assess performance. The data acquisition needed to support monitoring and modeling typically exceeds the resources available to meet those needs and, thus, requires prioritization. The following were identified as high priorities:

Monitoring Programs

- Collect information about existing watershed, estuarine, coastal, offshore, and habitat monitoring programs across the Gulf (e.g., the Gulf Coast Ocean Observing System, the Coastwide Reference Monitoring System) and identify gaps that should be filled to better support adaptive management.
- Recommend ways to integrate these programs and fill gaps to establish a comprehensive network that can provide the information necessary for managers to make informed decisions, adapt their actions as needed, and facilitate effective stewardship of Gulf ecosystem resources. Identify gaps in the monitoring programs that need to be filled to support adaptive management.
- Use a hypothesis-based approach for assessment of system performance.
- Foster data comparability, consistency, and standardization across programs, projects, and habitats.
- Improve data dissemination and visualization tools to provide information to resource managers.

Monitoring Variables

- Collect high-resolution topographic, bathymetric, geodetic and tidal data to develop and maintain (with frequent updates over time) high-quality digital elevation models for the Gulf of Mexico that reflect and quantify changes to a dynamic (i.e., constantly changing) land and seafloor.
- Collect water, sediment, pollution and nutrient loading data from a comprehensive network of inland stream gauges and wetland stations, as well as nearshore/offshore ocean observing stations that also acquire wave, current and sediment transport characteristics.
- Monitor the capacity of Gulf Coast communities to plan and implement resilience programs, to communicate with the public, and to provide feedback to decision-makers and resource managers.

The Task Force identified specific data needs by theme. These are identified in Table 1. Many of these variables can serve multiple goals and would be considered higher-priority; however, each restoration project should be assessed to determine that it incorporates the monitoring elements required to determine project efficacy.

Table 1. Specific Data Acquisition Needs

	Habitats (coastal)	Habitats (inland) and watersheds	Living coastal and marine resources and offshore environments	Coastal communities (including storm buffers)
Physical				
Sediment, nutrient, pollutant loads, and freshwater flow rates	x	x	x	x
Land:water ratios	x	x	x	x
Topography/bathymetry	x	x	x	x
Shoreline position and form and dimensions of beaches and dunes and barrier islands	x		x	x
Erosion and accretion rates	x			x
Seafloor change	x	x		
Hydrology (water surface elevation, current velocity, wave characteristics, salinity, temperature)	x	x	x	x
Meteorology	x		x	
Air quality		x	x	
Marsh elevation (accretion, subsidence, sediment elevation table)	x		x	x
Relative sea-level rise rates (subsidence and global sea-level rise)	x	x	x	x
Geodetic vertical datum	x	x		x
Biological				
Invasive species	x		x	
Fisheries composition/abundance/diversity/productivity/tissue contaminants	x		x	
Fisheries landings			x	x
Wildlife and living marine resources abundance/diversity and distribution (including sentinel species)	x	x	x	
Plant community composition/abundance/diversity/productivity	x	x	x	
Benthic macroinvertebrates or key benthic assemblages	x		x	
Phytoplankton, harmful algae species occurrence, toxin production	x	x	x	
Zooplankton	x		x	
Pathogens	x	x	x	
Microbial ecology		x	x	
Chemical				
Water quality (nutrients, ammonia, silica, turbidty, total suspended solids, water clarity, contaminants [e.g. PAHs, PCBs], metals, dissolved oxygen, salinity, temperature, depth, conductivity, secchi depth, photosynthetically active radiation, pH, chlorophyll a, carbon)	x	x	x	
Coastal, nearshore and offshore seafloor sediment characteristics (sediment composition, bulk density, organic matter, total carbon, total nitrogen, phosphorous, grain size, total organic carbon, sediment toxicity)	x	x	x	

Table 1. Specific Data Acquisition Needs				
	Habitats (coastal)	Habitats (inland) and watersheds	Living coastal and marine resources and offshore environments	Coastal communities (including storm buffers)
Habitat				
Habitat classification (including classification of impaired habitats)	x	x	x	
Areal extent of essential habitat	x	x	x	
Areal extent of sustainable land use		x		
Socioeconomic				
Socioeconomic data on habitat and living marine resources			x	x
Social and community capacity for emergency preparedness				x
Population and development in high-risk or hazardous areas				x
Community networking capacity				x
Environmental awareness and attitudes, as well as barriers to adopting resilience practices				x

Modeling

As highlighted throughout the Strategy, models can be used to modify or adjust restoration and protections actions, and to inform analysis and guidelines to the efficacy of different restoration strategies/projects (such as re-establishment or modification of freshwater flow, nutrient loads, suspended sediment deposition, storm buffers, barrier island restorations). Modeling is used to understand system processes, make predictions related to different management/restoration scenarios/projects, and guide monitoring. Modeling can also be used to address future uncertainties, like the effects of relative sea-level rise. As with the use of adaptive management overall, model assumptions and uncertainties should be clearly articulated to ensure that planning and decisions are fully informed. The following were identified as high priorities:

Modeling Programs

- Document existing watershed (surface water), groundwater, estuarine, offshore, erosion and habitat models across the Gulf and encourage collaboration.
- Use models to modify or adjust restoration and protection actions, and to inform analysis and guidelines for the efficiency of different restoration strategies/projects (such as re-establishment of freshwater flow, nutrient loads, suspended sediment deposition, storm buffers and barrier island restorations) in an adaptive management framework.
- Promote fully coupled surface water–groundwater models linked to watershed, coastal, biological, ecological and offshore models to support adaptive management strategies and evaluate the effects of restoration projects on the ecosystem over time.

Modeling Input

A comprehensive monitoring network with organized data management and quality assurance/control can provide the necessary input for models. The models can also be used to guide data collection and monitoring programs by evaluating the reduction in predictive uncertainty by the inclusion/exclusion of existing data and proposed monitoring sites (i.e., the "worth" of the data).

Modeling Needs

- **Predictions and adaptive management**
  - Employ ecosystem modeling to support planning and explore relationships between management actions and resource response.
  - Develop models and other decision support tools to predict the amount of water, sediment and nutrients needed by coastal habitats to support wetland and marine organisms:
    - Under realistic sea-level rise scenarios
    - Including riverine and marine sources
    - Incorporating water quality data and hydrologic flow data
  - Develop models to predict ecosystem resilience under different stressor paradigms, including:
    - Climate change and sea-level rise
    - Subsidence
    - Storm intensity and frequency, associated wave action, and rainfall
    - River discharge and associated sediment, nutrient and pollutant loading
  - Test models with experimental, natural and hypothetical disturbance events.
  - Identify and address critical model limitations and uncertainties, including compounding uncertainties when linking with one or more models and/or into future years.
  - Develop uniform methodologies for including relative sea-level rise considerations into modeling and project planning for sustainable storm buffers including wetland accretion.
  - Improve models for predicting coastal response to relative sea-level rise and storm impacts.
- **Physical and biological models**
  - Develop/enhance storm surge, wave and coastal erosion models that can be used in developing risk assessments of hurricane, storm surge and wave impacts.
    - Couple storm surge and wave modeling for hindcasting (used in Katrina), and for flood modeling for risk assessments
    - Develop a coherent and robust model for the entire Gulf (all states)
    - Include topographic data

- Include bathymetric data
- Consider offshore topographic data
  - Offshore wave models (e.g., WAM)
  - Storm surge models (e.g., ADCIRC)
  - Nearshore wave models (e.g., STWAVE or UnSWAN)

- Develop and enhance hurricane wind and pressure field models.
- Evaluate the sustainability of storm buffers and barrier islands as habitats using coastal erosion and morphologic evolution models.
- Focus a global climate model to address Gulf needs.
- Develop models to understand the hydrologic regime of targeted watersheds of the Gulf of Mexico. Surface water–groundwater integrated models of coastal systems with transport included.
- Model impacts of hydrological restoration and protection (e.g., diversions, levee realignments) on diversity and/or production of living resources (e.g., vegetation, fish, shellfish).
- Model impacts of habitat loss (e.g., marsh degradation) on diversity and/or production of living resources (e.g., vegetation, fish, shellfish).

Research

The influences of ecosystem variability, gaps in knowledge, and inadequate understanding of complex ecosystem functions and responses cause uncertainty that can greatly influence risk in management actions, thereby increasing the need for ecosystem research to support management decision-making.

Research Programs

Testing underlying assumptions of ecosystem behavior is an integral component of supporting research. Numerous hypotheses have been identified from previous studies conducted across the Gulf Coast; however, results should be focused on clearly meeting the Strategy needs. Supporting research should be directed at reducing scientific uncertainty to improve confidence in modeling and monitoring tools and ultimately management actions. Additionally, a key weakness that basic research must help address is simply discovering what ecosystems exist in the Gulf that are or may be impacted. It is essential to integrate monitoring, modeling and research development activities, from the initial stages of restoration and protection planning, in order to support adaptive management decision-making.

Research Needs

Specific research needs underpinning restoration goals are described in Table 2. Addressing these needs would serve to support broader ecosystem-wide restoration efforts. Additional effort should be directed to addressing questions that inform discrete restoration projects. Research efforts should leverage ongoing planning efforts and programs, where appropriate (e.g., the Gulf of Mexico Research Plan, the Gulf Research Initiative).

Table 2. Research Needs to Support Restoration	
Resilience	■ Develop a shared vision of ecosystem resilience ■ Identify key determinants of resilience for estuarine, coastal wetland, forested ridges and barrier shoreline habitats ■ Examine the relationship between ecological and human community resilience ■ Examine how land change, sediment types, anthropogenic modifications, and flood and storm damage risks can affect ecosystem resilience
Natural Processes	■ Develop an understanding of coastal and marine natural processes, such as sediment transport, currents, and shoreline retreat, and the spatial variability of future sea-level rise ■ Quantify (spatially and temporally) relative sea-level rise (including subsidence) rates ■ Determine the relationship between shallow stratigraphy and natural processes ■ Quantify the Gulf of Mexico sediment budget ■ Quantify the amount of sediment and nutrients that bypass wetlands and are discharged offshore ■ Identify those nutrient levels that are excessive and lead to negative impacts in coastal wetlands, seagrasses and fisheries, and contribute to harmful algal blooms and hypoxic conditions ■ Establish the key relationships between nutrients, sediment and salinity as they relate to water clarity, optimal ecological function, optimal distribution of habitats and species ■ Provide a more comprehensive understanding of life histories of affected living marine resources, food web dynamics, and essential habitat conditions, and what habitat conditions are essential ■ Investigate surge/wave /vegetation interactions and the influence on geomorphologic evolution of landforms ■ Identify agricultural practices that use less fertilizer, water and pesticides and preserve topsoil
Risk	■ Develop a better understanding of critical landscape and geologic features (i.e., geomorphic, geologic, biological, physiochemical, engineered) to reduce storm risk ■ Develop a better understanding of engineering tools used in storm risk assessment such as storm surge models and coastal erosion models ■ Improve understanding of the impact of physical development on flood outcomes ■ Understand vulnerability of communities to storm surge, land loss, subsidence and sea-level rise ■ Refine risk or vulnerability indices ■ Examine approaches to communicate to coastal residents and decision-makers what puts them at risk and what they can do to reduce risk, and identify constraints and incentives to pursue resilient behaviors ■ Identify features that make shoreline habitats more or less vulnerable to stressors such as sea-level rise, high wave energy, storm surge, coastal erosion and sediment loss ■ Establish the relationship between ecosystem restoration and community storm risk reduction ■ Identify the cultural, economic and social impacts of relocation of people out of risky coastal areas

Table 2. Research Needs to Support Restoration	
Ecosystem Services	■ Determine processes and functions supported by Gulf coast habitats and the degree to which optimal function and provision of priority ecosystem services is presently occurring ■ Measure rates and processes that reflect wetland ecosystem condition and the ecosystem services they provide, and consider functional equivalence ■ Determine assessed value of fishing, recreation and ecosystem services that are provided to the community ■ Determine the relationship between nutrient loading and ecological function, along with the potential for: ▶ Development of hypoxia and associated impacts on the benthos ▶ Development of harmful algal blooms ▶ Loss of seagrass meadow acreage ▶ Change in fisheries productivity ▶ Change in soil composition
Assessment	■ Identify measures and criteria to validate restoration effectiveness and thresholds that trigger management actions ■ Identify tipping points that indicate the need for management actions to ensure functionality and sustainability ■ Develop ecological indicators for ecosystem structure and function ■ Identify research-based criteria for meeting water quality standards ■ Identify most efficient paths for various community types to improve resilience
Restoration and Hydrologic Modification	■ Examine impacts of upstream hydrological modification and varying freshwater flow on estuarine vitality ■ Identify optimal water timing, quality and quantity to support sustainable ecosystem habitats ■ Determine the relationship between varying scales of river diversion and ecological function and resilience of wetlands ■ Examine the function and resilience of emergent wetlands and barrier shorelines that have been restored by sediment augmentation ■ Examine how upstream reservoir and dam management practices impact delivery of sediment and freshwater to coastal ecosystems ■ Identify the storm buffering consequences of common coastal engineering projects ■ Identify the optimal size of natural buffers for water filtration ■ Examine the ecological function and resilience of other habitat restoration efforts such as oyster reefs, coral reefs, vegetative plantings and submerged aquatic vegetation
Climate	■ Develop uniform methodologies for including relative sea-level rise considerations into modeling and project planning ■ Develop uniform methodologies for including climate change-induced variations in precipitation, evapotranspiration, and changes in storm intensity and frequency into future planning decisions

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List of Abbreviations

Acronym	Definition
ADCIRC	Coastal Circulation and Storm Surge Model
BMP	best management practice
CEAP	Conservation Effects Assessment Program
CERP	Comprehensive Everglades Restoration Plan
CIAP	Coastal Impact Assistance Program
CNMP	Comprehensive Nutrient Management Plan
CRE	Climate Ready Estuaries
CWPPRA	Coastal Wetlands Planning, Protection and Restoration Act
DOI	United States Department of the Interior
DOT	United States Department of Transportation
ECA	Emissions Control Area
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
GIWW	Gulf Intracoastal Waterway
GOMA	Gulf of Mexico Alliance
HAB	harmful algal bloom
HUD	United States Department of Housing and Urban Development
IEA	integrated ecosystem assessment
LACPR	Louisiana Coastal Protection and Restoration
LGAC	Local Government Advisory Committee
MRBI	Mississippi River Basin Initiative
MsCIP	Mississippi Coastal Improvement Program
NASA	National Aeronautics and Space Administration
NEJAC	National Environmental Justice Advisory Council
NEP	National Estuary Program
NGO	nongovernmental organization
NOAA	National Oceanic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
RCSD	Regional Climate Services Director
SEAMAP	Southeast Area Monitoring and Assessment
STWAVE	STeady-state spectral WAVE
TMDL	Total Maximum Daily Load
UnSWAN	unstructured SWAN (Simulating WAves Nearshore)
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WAM	Wave Action Model

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