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GAO

Report to Congressional Addressees

December 2007

COASTAL WETLANDS

Lessons Learned from Past Efforts in Louisiana Could Help Guide Future Restoration and Protection

GAO-08-130

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Highlights

Highlights of GAO-08-130, a report to congressional addressees

Why GAO Did This Study

Louisiana, home to 40 percent of all coastal wetlands in the lower 48 states, is projected to lose almost 17 square miles of coastline each year for the next 50 years to storms, sea level rise, and land subsidence. Coastal wetlands are an important wildlife and commercial resource, and provide a natural buffer against the storm surge that accompanies storms and hurricanes. The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) established a program in 1990 that undertakes projects to stem coastal wetland losses. Recently, the Congress passed other measures that will make billions in new funding available for coastal Louisiana over the next 20 years. GAO has prepared this report under the Comptroller General's authority as part of a continued effort to assist the Congress. GAO reviewed the CWPPRA program to identify the (1) types of projects that have been designed and constructed to restore and protect coastal wetlands, as well as their estimated costs and benefits, and (2) lessons learned from past and ongoing restoration efforts that can help guide future efforts. GAO's review included interviews with each program agency.

Although GAO is not making any recommendations, this review emphasizes the need for agencies to carefully consider the lessons learned from the CWPPRA program as they propose significantly larger efforts to restore Louisiana's coast. GAO received technical comments from two agencies which have been incorporated as appropriate.

To view the full product, including the scope and methodology, click on GAO-08-130. For more information, contact Anu K. Mittal at (202) 512-3841 or mittala@gao.gov.

What GAO Found

Over the last 17 years under CWPPRA, federal agencies and Louisiana have designed and/or constructed 147 projects to restore and protect over 120,000 acres of coastal wetlands—about 3 percent of the Louisiana coast. Projects have included large-scale efforts that reintroduce freshwater and sediment to declining wetlands, as well as smaller projects such as shoreline barriers and vegetation plantings to protect and restore the coastal landscape. As of June 2007, of these 147 projects, 74 were completely constructed, 16 were under construction, and 57 were being designed and engineered. While the majority of projects are full-scale restoration and protection efforts, 22 were demonstration projects, initiated to test new techniques and materials. The cost of projects can vary considerably from about $9,000 per acre to plant marsh plants to almost $54,000 per acre to restore barrier islands. As of June 2007, the estimated cost to complete all 147 projects was $1.78 billion. Projects also require a continuous source of funding to maintain them over their expected life spans, which in most cases are about 20 years—yet like naturally occurring wetlands, most restored wetlands are also subject to continuous erosion and subsidence over time. Because the CWPPRA program has not implemented a comprehensive evaluation and monitoring approach, it is not possible to determine the collective success of constructed projects.

Previous and ongoing efforts to restore and protect Louisiana's coastal wetlands offer important lessons to guide future restoration plans and strategies. Of particular importance is maintaining the collaborative process used by the CWPPRA program agencies, under which scientists, engineers, and others with a range of experience and expertise work together to plan and design restoration projects that are feasible and achievable. In addition, a number of other issues will need to be addressed as larger and more complex restoration efforts are undertaken in the future. Specifically,

- Increasing project costs can delay individual projects, as well as the overall program—currently 10 CWPPRA projects are on hold waiting for funds because estimated construction costs exceed funds available.
- Without an integrated monitoring system, officials cannot determine whether goals and objectives are being met—even after 4 years such a system is not fully implemented for CWPPRA.
- Identifying and addressing private landowner issues is critical in the project design phase—in some instances, these issues have led to costly project modifications or construction delays for some CWPPRA projects.
- Some projects simply fail to perform as designed due to landscape, structural, or other causes beyond the designers' control—some CWPPRA projects were terminated because such problems were not anticipated or could not be resolved.
- Storms and hurricanes can result in significant setbacks to projects—large areas of both naturally occurring and restored wetlands can be destroyed in just a few days if hit by a powerful storm.

A well-developed implementation strategy that has mechanisms to address these types of uncertainties, when they arise, is more likely to be successful.

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Abbreviations

CIAP	Coastal Impact Assistance Program
Corps	Army Corps of Engineers
CWPPRA	Coastal Wetlands Planning, Protection and Restoration Act
EPA	Environmental Protection Agency
FWS	Fish and Wildlife Service
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
USGS	United States Geological Survey

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United States Government Accountability Office
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December 14, 2007

Congressional Addressees

Since the 1930s, coastal Louisiana has lost over 1.2 million acres of wetlands or other coastal habitats and the U.S. Geological Survey estimates that the region will continue to lose about 10,800 acres—almost 17 square miles—each year for the next 50 years to storms, sea level rise, land subsidence (sinking), and the construction of levees and canals that weaken the sustainability of the landscape. Flood control structures, such as dams, have reduced the amount of suspended sediment in the Mississippi River and levees have disconnected the river from the floodplain, disrupting the natural process by which the river historically deposited sediment in the delta to build and sustain coastal wetlands. Coastal Louisiana is one of the most wetland-rich regions of the world—home to about 2.5 million acres of fresh, brackish, and saltwater marshes, accounting for about 40 percent of the coastal marshland in the lower 48 states. Wetlands support a diverse mix of plants and wildlife, filter rainwater runoff, and provide a natural buffer against the storm surges that accompany tropical storms and hurricanes. For example, based on observations of hurricanes striking the Louisiana coast, the U.S. Army Corps of Engineers estimated that storm surge was reduced about 1 foot for every 2.75 miles of coastal wetlands that the surge had to cross. Coastal wetland losses in Louisiana account for up to 90 percent of the total coastal wetlands loss occurring in the lower 48 states today and expose the state's coastal areas to the devastating effects of hurricane storm surges. It is generally accepted that the deterioration of Louisiana's coastal wetlands exacerbated the degree to which Hurricanes Katrina and Rita and flooding from the associated storm surge affected New Orleans, coastal Louisiana, and the greater Gulf Coast region.

In 1990, the Congress passed the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA),[1] the first federal program specifically directed toward authorizing funding for the restoration of Louisiana's coastal wetlands. CWPPRA created the Louisiana Coastal Wetlands

[1]Pub. L. No. 101-646, Title III. The Coastal Wetlands Planning, Protection and Restoration Act is also referred to as the Breaux Act after Senator John Breaux of Louisiana, one of the act's authors.

Conservation and Restoration Task Force, which includes five federal agencies and the state of Louisiana. The CWPPRA task force makes decisions on coastal restoration projects, including project funding, planning, and the transition of projects from initiation through design and engineering, construction, operations, maintenance, and monitoring. The CWPPRA task force assigns individual projects to member agencies—called federal sponsors—to plan, design, construct, operate, maintain, and monitor the projects. As chair of the CWPPRA task force, the Corps manages project funds and maintains records and data on projects. The other task force members are the U.S. Fish and Wildlife Service (FWS), the Environmental Protection Agency (EPA), the National Marine Fisheries Service (NMFS), the Natural Resources Conservation Service (NRCS), and the Louisiana Governor's Office of Coastal Activities. The U.S. Geological Survey (USGS) also participates in the CWPPRA program, although it is not a member of the task force.

CWPPRA projects are designed to protect and/or restore coastal wetlands and reduce land loss. Projects to protect coastal wetlands include constructing shoreline barriers with rocks, sheet piling, or other engineering materials to reduce the effects of wave energy and removing destructive invasive wildlife species such as nutria, a rodent that damages marsh vegetation. Protection is critical to preventing or slowing the rate of wetlands loss caused by erosion, saltwater intrusion, subsidence, and other factors. Projects to restore coastal wetlands include planting marsh vegetation to promote the return of wildlife, placing dredged sediment in deteriorating marshes to encourage plant growth, blocking or backfilling dredged canals that change natural water flows and contribute to erosion and allow saltwater intrusion, cutting gaps in levees to reestablish natural drainage patterns, and diverting freshwater and sediment to declining swamps and marshes. Individual CWPPRA projects are designed to protect and restore between 10 and 10,000 acres, require an average 5 years to transition from approval to construction, and are funded to operate for 20 years.

While the CWPPRA program has received almost $800 million over the last 17 years to plan, design, construct, operate, maintain, and monitor projects, based on their preliminary estimates, Louisiana state officials told us that they expect to receive more than 10 times this funding—about $8.5 billion—for restoring and protecting the state's coast over the next 20 years from new federal programs. Specifically, they estimate that

Louisiana will receive up to $523 million over 4 years beginning in 2008 through the Coastal Impact Assistance Program (CIAP), which was created by Section 384 of the Energy Policy Act of 2005.[2] CIAP is intended to help certain coastal states and their political subdivisions (parishes and counties) mitigate the effects of oil and gas production by allocating a portion of qualified outer continental shelf oil and natural gas revenues to them. Among other things, these funds may be used for projects and activities to conserve, protect, or restore coastal areas, including projects designed and engineered under CWPPRA. In addition, based on their review of the provisions contained in the Gulf of Mexico Energy Security Act of 2006,[3] Louisiana state officials told us they expect to receive up to $6.2 billion over at least 20 years from certain outer continental shelf oil and gas production revenue; specifically, $200 million in the first 10 years and between $400 and $600 million per year thereafter to fund efforts such as the restoration of coastal wetlands. Finally, the Water Resources Development Act of 2007[4] contains provisions for over $1 billion for coastal restoration in Louisiana.

In anticipation of this potential surge in additional funding for the restoration and protection of the Louisiana coast, both Louisiana and the Corps, with input from other CWPPRA federal agencies, have prepared or are developing specific coastal restoration plans for the state. In June 2007, Louisiana approved a master plan for the restoration and protection of coastal Louisiana that officials estimate will cost more than $50 billion to implement and take up to three decades to complete. In response to the Energy and Water Development Appropriations Act of 2006,[5] the Corps is also conducting a study and plans to issue a preliminary report by December 2007 that will recommend a comprehensive approach to flood, coastal, and hurricane protection for Louisiana. In coastal Louisiana, flood control generally includes interior drainage systems, such as pumps and canals, to reduce rain-induced flooding while hurricane protection includes levees and other structures to reduce the risk of flooding from storm surges. Corps officials told us they plan to submit a final report to the Congress in the fall of 2008.

[2]Pub. L. No. 109-58.

[3]Pub. L. No. 109-432, Division C, Title I.

[4]Pub. L. No. 110-114.

[5]Pub. L. No. 109-103.

In light of the importance of coastal wetlands to help protect against future Katrina-level devastation and the significant efforts under way or proposed to restore Louisiana's coastal wetlands, we undertook this study under the Comptroller General's authority to conduct evaluations on his own initiative as part of our continued effort to assist the Congress. Specifically, we identified the (1) types of CWPPRA projects that have been designed and/or constructed to restore and protect Louisiana's coastal wetlands, including their expected benefits and estimated costs, and (2) lessons learned from past and ongoing restoration efforts that can help guide future plans to restore and protect these coastal wetlands.

To identify the types of projects that have been designed and/or constructed to restore and protect Louisiana's coastal wetlands, we reviewed documentation on every CWPPRA project in design, under construction, completed, or terminated, including project plans and designs, project manager's technical fact sheets, and monitoring plans and reports. We interviewed officials at the headquarters offices of the Corps (within the Department of Defense), EPA, FWS (an agency within the Department of the Interior), NMFS (an agency within the National Oceanic and Atmospheric Administration), NRCS (an agency within the Department of Agriculture), and USGS (an agency within the Department of the Interior), and interviewed officials working in Louisiana for each of these agencies. We also interviewed officials from the Louisiana Department of Natural Resources. We observed the work performed on three CWPPRA projects and two other restoration projects constructed by the Corps. To identify the lessons learned from past restoration efforts that can help guide future plans to restore and protect coastal wetlands, we reviewed program funding reports, minutes of task force and technical committee meetings, and Louisiana annual project reviews. We interviewed federal agency project managers and members of CWPPRA task force committees and work groups in Louisiana, as well as officials from USGS and the Louisiana Department of Natural Resources on the process to protect and restore coastal wetlands under CWPPRA. We also reviewed relevant federal laws and regulations and, where appropriate, state laws and cases. In conducting our work, we concentrated our efforts on the CWPPRA program because of the exceedingly high rate of wetlands loss in Louisiana and because the program is the first federal program specifically directed toward authorizing funding to restore Louisiana's coastal wetlands. We conducted our work between October 2006 and October 2007 in accordance with generally accepted government auditing standards.

Results in Brief

Over the last 17 years under CWPPRA, federal agencies and Louisiana have designed and/or constructed a range of 147 projects to restore and protect over 120,000 acres of coastal wetlands, which is equivalent to about 3 percent of the state's coastal area. As of June 2007, of these 147 projects, 74 were completely constructed, 16 were under construction, and 57 were being designed and engineered. These 147 projects fall into about 12 major categories ranging from large-scale efforts that reintroduce freshwater and sediment across declining wetlands to smaller projects such as shoreline barriers and vegetation plantings to protect and restore the coastal landscape. The majority of projects were full-scale restoration and protection efforts, while 22 were demonstration projects, initiated to test new techniques and materials to restore or protect coastal wetlands. Of the 74 projects constructed since 1990, more than half were one of two types—shoreline protection (building barriers from material such as rock or plants) and hydrologic restoration (restoring natural drainage patterns). These two types of projects also accounted for over one-quarter of the more than 120,000 wetland acreage protected and restored by the CWPPRA program. The cost of CWPPRA projects can vary considerably; for example, projects to plant marsh plants have averaged about $9,000 per acre while projects to protect barrier islands have averaged almost $54,000 per acre. As of June 2007, the total cost to complete all 147 projects was estimated at $1.78 billion, which includes initial funding for operations and maintenance. However, most projects will require continuous funding to maintain them over their expected life span of 20 years. Like naturally occurring wetlands, restored wetlands can experience continuous erosion and subsidence, which over time generally diminishes the amount of restored acreage. As a result, most of these projects are designed with the expectation that they will provide wetland benefits for a 20-year period, after which they may or may not be viable. Because the CWPPRA program has not fully implemented a comprehensive monitoring process, we were unable to determine the extent to which the completed projects have been successful in creating and restoring coastal wetlands in Louisiana.

Past and ongoing efforts to restore and protect Louisiana's coastal wetlands offer important lessons that can help guide future restoration plans and strategies. In particular, officials from Louisiana and the five federal agencies that have collaborated on Louisiana's coastal wetland projects through the CWPPRA task force told us they believe that the CWPPRA program's unique interagency approach and process are the primary reasons that the program has been able to design and construct a range of projects on the Louisiana coast. Specifically, the CWPPRA process brings together biologists, other scientists, civil engineers, and

others, whose broad range of experience and expertise helps ensure that the projects they design and construct are technically feasible and will achieve their environmental objectives. To improve collaboration, the CWPPRA task force formed committees and technical work groups with members from federal agencies and Louisiana to assist each phase of the restoration process. Maintaining this collaborative interagency approach will be essential to future success. Ultimate success, however, will also be dependent upon a project managers' ability to address a number of issues that have surfaced on past CWPPRA projects. Specifically,

- *Increasing project costs*. Over the life of a project, costs can increase significantly causing unanticipated delays for individual projects, as well as the overall restoration program. For CWPPRA projects, costs have increased significantly over original estimates because of the increasing costs of fuel, labor, and building material. As a result, fewer projects are being designed and constructed. For example, as of October 2007, there were 10 fully designed CWPPRA projects awaiting funding because the $190 million estimated cost for construction exceeded the amount of annual program funds available for new construction. Further, the funds were needed to pay for the higher construction, operations, and maintenance costs of other projects.

- *Limited monitoring and assessment capabilities*. Without an integrated monitoring and assessment process, it is difficult to determine whether restoration efforts are meeting their goals and objectives. Further, while Louisiana officials have monitored and prepared reports for projects constructed under the CWPPRA program, task force and USGS officials told us their reports have provided limited performance data on the success of these projects. Since 2003, USGS has been working with the CWPPRA task force to develop a coast-wide monitoring system. The system is expected to be fully implemented in 2008. However, until the system is fully implemented and able to provide sufficient data to support statistical and trend analysis, officials will not know whether projects are collectively restoring the coast or whether these efforts are having adverse unintended effects.

- *Private land ownership issues*. During a project's planning and design phase, it is important to identify and attend to private land ownership issues which, if not addressed, could lead to costly design modifications or construction delays. Coastal Louisiana is about 85 percent privately owned by individuals and businesses. Agency officials have had to spend significant amounts of time locating individual landowners to obtain approval to construct CWPPRA projects. For example, agency officials told us they had to contact from 1 to 100 landowners to obtain approval to

initiate one project. To construct projects on commercially owned lands, federal agencies have had to relocate or temporarily move infrastructure which has, in some instances, significantly increased CWPPRA project costs.

- *Uncertainty of project performance*. Some projects simply fail to perform as designed for reasons largely beyond the designers' control, such as existing drainage patterns or other landscape features. Over the years, about 20 CWPPRA projects have had to be terminated due to, in some cases, technical difficulties and design problems that the designers could not resolve. For example, officials terminated a terracing project after concluding that it would not be technically feasible to construct terraces on the land due to poor sediment quality.

- *Setbacks as a result of storm damage*. Storms and hurricanes can cause significant damage to coastal areas, including both naturally occurring and restored wetlands. Although most CWPPRA projects did not sustain significant damage from Hurricanes Katrina and Rita, other Louisiana coastal restoration projects were significantly impacted by the storms. Specifically, Hurricane Katrina destroyed more than 25,000 acres of wetlands in the Caernarvon Project area, a large Corps' project constructed in 1991 that diverts water from the Mississippi River to restore nearby wetlands.

As federal and state planners move forward with much larger scale efforts to protect and restore Louisiana's coastal wetlands, we believe that it will be critical for them to carefully consider the lessons learned, both the keys to success and the challenges, from the experiences of CWPPRA projects. As the CWPPRA experience demonstrates, while not all of the uncertainties surrounding wetlands protection and restoration projects can be predicted in advance, a well-developed project implementation strategy that includes mechanisms to address these kinds of uncertainties is essential for ensuring project success.

We provided a copy of this report to the Departments of Commerce, Defense, Interior, EPA, and the U.S. Department of Agriculture for review and comment. In commenting on a draft of this report, EPA provided comments indicating agreement with our findings and observations. The Department of Commerce, commenting for the National Oceanic and Atmospheric Administration, generally agreed that our report was accurate and thorough but disagreed with our characterization of CWPPRA monitoring. Specifically, the agency stated that while long term data acquisition will be required before officials are able to develop

scientific conclusions on integrated project effectiveness, it emphasized that individual project monitoring currently taking place offers critical insights into project performance. While we believe that our description of CWPPRA monitoring efforts was accurate, we have revised the report to clarify some of the issues included in the agency's comments. Both the Department of Commerce and Department of Defense also provided technical comments, which we have incorporated throughout the report as appropriate. The Department of the Interior and the U.S. Department of Agriculture did not provide comments on this report.

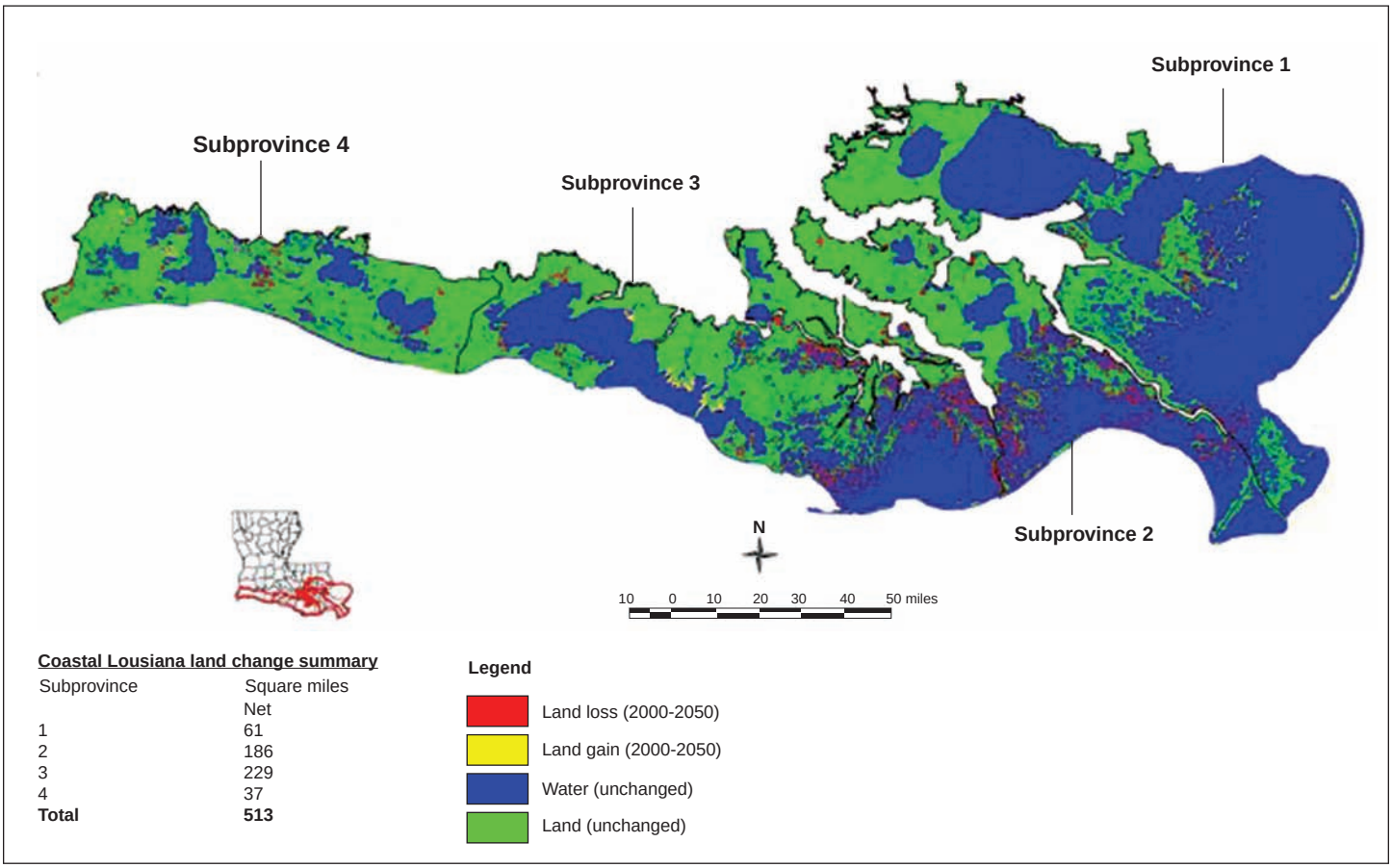
Background

Coastal Louisiana's 2.5 million acres of fresh, brackish, and saltwater marshes support a diverse mix of plants and wildlife, filter rainwater runoff, and help protect the region from damaging storm surges from the Gulf of Mexico. Louisiana's coastal landscape provides a habitat for millions of migratory birds and 17 threatened or endangered species and supports the largest shrimp, oyster, and blue crab production in the United States. Its coastal wetlands also protect coastal regions and critical infrastructure, such as oil and gas platforms and pipelines, from the storm surges that accompany tropical storms and hurricanes.

The Louisiana coast has lost over 1 million acres of wetlands since the 1930s and that loss is expected to continue. In 2004, USGS projected that, between 2000 and 2050, more than 430,000 acres, or about 13 square miles per year, would be lost if no further protection and restoration measures are implemented. If current plans to protect and restore the wetlands were implemented,[6] USGS estimated wetlands losses would slow to 329,000 acres, or just over 10 square miles per year, by 2050. (See fig. 1.)

[6]The USGS estimate of current plans to protect and restore the wetlands includes all CWPPRA projects, two Corps' freshwater diversion projects, and two Corps' delta building projects constructed, or funded for construction, as of October 2002.

Figure 1: Louisiana Coastal Area Projected Land Changes between 2000-2050



Coastal Lousiana land change summary

Subprovince	Square miles Net
1	61
2	186
3	229
4	37
Total	**513**

Source: USGS.

Since the 2005 hurricanes, estimated land loss rates are being revised, in part, to reflect the immediate land loss caused by the storms and estimated rates of recovery. According to a USGS official, up to 16.9 square miles of coastal wetlands may be lost each year over the next 50 years, assuming no future protection and restoration measures are implemented.

In addition to the storms, sea level rise, and land subsidence (sinking) that have contributed to and continue to cause coastal wetlands loss, the construction of levees and canals, such as the hundreds of miles of Mississippi River levees constructed to control flooding, also weaken the sustainability of the landscape and contribute to coastal wetlands loss. Flood control structures such as dams on Mississippi River tributaries and

levees on the lower Mississippi River have disrupted the natural processes by which the river deposited sediment in the delta to build and sustain coastal wetlands. Specifically, dams and levees reduce the amount of suspended sediment in the river, which reduces the amount of sediment reaching the Mississippi River delta—the area of land built up by sediment deposited by the river as it slows down and enters the Gulf of Mexico. Currently the Mississippi River delivers an estimated 141 million tons of sediment to the Gulf each year—less than one-third the amount of sediment the river carried prior to the 1950s and including but not limited to, the hundreds of miles of levees along the Mississippi River and its tributaries constructed to reduce flood damage, also impact the sustainability of the landscape and contribute to coastal wetlands loss. Much of the sediment that reaches the Gulf is carried away from the land and deposited over the continental shelf where it is lost to the ocean and cannot be recovered.

Coastal Wetlands Planning, Protection and Restoration Act

CWPPRA was originally enacted in November 1990, and it authorized funding through 1999.[7] The Congress subsequently extended the program's funding authority through 2009 and later through 2019 providing about 30 years of funding for the program. Federal funding for the CWPPRA program currently comes from the Sport Fish Restoration and Boating Trust Fund (Trust Fund), which is administered by the Department of the Interior and funded by taxes on the sale of motor boat fuel, small engine fuel taxes, and sport fishing equipment. Federal funding for the engineering, design, construction, operation, maintenance, and monitoring of CWPPRA projects has averaged approximately $50 million each year, ranging from about $28 million per year in the early 1990s to $71 million in 2007. Task force officials told us they expect to receive an estimated $76 million in federal funds in 2008 and annual increases each year up to an estimated $108 million in federal funds by 2017, based on Department of the Interior's estimates of increases to the Trust Fund, the source of federal funding for the CWPPRA program. Total estimated funding for all program planning and construction through 2019 is $2.44 billion in federal and nonfederal funds.

Under CWPPRA, the federal government generally is required to fund 75 percent of project costs, with the state providing the remaining 25 percent. However, according to CWPPRA, Louisiana's share may be reduced if the

[7]Pub. L. No. 101-646, Title III, § 308.

state develops a coastal wetlands conservation plan. In 1997, the Corps, EPA, and FWS approved Louisiana's conservation plan so the states' contribution was reduced from 25 percent to 15 percent. Further, in 1996, the Water Resources Development Act authorized the task force to reduce the states' contribution to 10 percent for projects approved in 1996 and 1997. At least one-third of Louisiana's share must be in the form of a cash contribution; the balance may be in the form of providing lands, easements, rights-of-way, or other in-kind contributions that the CWPPRA agency sponsor determines to be appropriate, such as designing and engineering projects. Under CWPPRA, no more than $5 million per year may be used for task force planning purposes; the remainder must be used for the design, construction, operation, maintenance, and monitoring of projects.

Under the CWPPRA program, the annual process to nominate candidate projects typically begins around January when federal CWPPRA agencies and the state meet with local governments and individuals to propose protection and restoration measures to address critical areas of need. In February, the CWPPRA agencies meet with other stakeholders, such as state and parish officials, to review proposals and select up to 20 projects for potential development. From these, the task force's technical committee selects 10 projects for potential engineering and design, designates a lead federal agency to begin developing designs and cost estimates, and evaluates the potential benefits of these projects. For each project, agency officials provide an estimate of how many wetland acres will be created, restored, and/or protected after 20 years based on the proposed design and assumptions, such as anticipated changes in water flow or salinity. After project designs and estimates are prepared, the various CWPPRA work groups meet to review and evaluate proposed project plans, preliminary cost estimates, and projected benefits, and to estimate life-cycle costs for proposed projects. Based on this set of conceptual project planning information, the task force selects a subset of candidate projects, typically in October of each year, to begin engineering and design. Around the following January, the task force approves funding for certain projects that have completed engineering and design to begin construction, operations, maintenance and monitoring. Project implementation averages about 5 years from the time candidate projects are selected through the completion of construction. Following construction, Louisiana typically operates, maintains, and monitors the performance of projects for up to 20 years.

CWPPRA requires that the task force also consider funding small-scale projects that demonstrate the use of new techniques or materials for

coastal wetlands restoration. In 1993, the task force recommended that funding for demonstration projects be limited to about $2 million per year. In 2006, concerned that funding constraints would eliminate demonstration projects, the task force recommended that it consider funding at least one demonstration project per year as long as demonstration projects do not exceed $2 million in total costs. The task force also funds monitoring for demonstration projects.

As chair of the CWPPRA task force, the Corps is responsible for the administration of federal program funds. Based on documentation submitted by federal agencies, the Corps disburses funds from the Trust Fund, as well as the states' share from an escrow account to pay for the planning, design, construction, operations, maintenance, and monitoring of projects. Louisiana and federal agencies also fund individual projects through cost sharing agreements, cooperative agreements, or grants that outline approved project cost estimates, federal and state cost shares, and how the states' cost share payments will be made, such as through work-in-kind or cash payments.

Additional Funding to Restore and Protect Louisiana Coastal Wetlands Will Become Available over the Next 20 Years

Two new federal programs are expected to provide billions of dollars in additional funding for the restoration and protection of coastal Louisiana. Taken together, Louisiana expects to receive between $6.5 billion and $8.5 billion over at least 20 years from these new programs to fund coastal restoration and hurricane protection projects. These new programs are:

- *Coastal Impact Assistance Program (CIAP)*. The Energy Policy Act of 2005 established CIAP, a revenue-sharing program to help coastal states and their parishes and counties mitigate the effects of oil and gas production.[8] Under this program, the Secretary of the Interior is required to disburse $250 million each year for 4 years (fiscal years 2007 through 2010) to certain coastal states based on an allocation formula specified in the law.[9] Funds for the program will come from qualified outer continental shelf oil and natural gas revenue. States must submit a plan to the Department of the Interior's Minerals Management Service by July 1, 2008, which must be approved in order for states to receive CIAP funds. States may use CIAP funds for projects and activities to conserve, protect, or restore coastal areas, and for certain other purposes. In February 2007,

[8]Pub. L. No. 109-58, § 384.

[9]43 U.S.C. § 1356a(b).

Louisiana state officials estimated they would receive up to $523 million over 4 years from CIAP. In June 2007, Louisiana submitted its plan to the Minerals Management Service and plans to fund the construction of six CWPPRA projects using the first year of CIAP funds. In July, Louisiana state officials told us they expected to receive the first funds beginning in 2008. On November 29, 2007, the Minerals Management Service approved Louisiana's plan.

- *Gulf of Mexico Energy Security Act of 2006*. Under this law, four coastal, energy-producing states—Alabama, Louisiana, Mississippi, and Texas—and their parishes and counties will share 37.5 percent of certain revenues from royalties from the production of oil and natural gas in the Gulf of Mexico.[10] They may use the funding for such efforts as coastal restoration and hurricane protection. Under this program, Louisiana expects to receive $200 million over the course of the first 10 years and between $400 and $600 million per year thereafter. Louisiana state officials told us the state expects to receive the first funds under this act in 2008 or 2009.

In addition, the Water Resources Development Act of 2007 included authorizations for hundreds of projects and studies, including about $1.6 billion for the Corps to construct coastal Louisiana restoration projects. At least one of the projects contained in the law was engineered and designed under the CWPPRA program.

In response to the 2005 hurricanes, both the state of Louisiana and the Corps began developing coastal restoration plans for the state, which are expected to be paid for, in part, with this additional funding. The following are summaries of these two plans:

- *Louisiana's Plan*. In June 2007, the Louisiana state legislature approved a comprehensive master plan, developed by a state agency, for ecosystem restoration and hurricane protection for the Louisiana coast. The plan is based on previous hurricane protection initiatives and established flood control and coastal restoration concepts. It outlines several planning objectives and makes a series of recommendations such as restoring the sustainability of the Mississippi River delta, immediately closing the Mississippi River gulf outlet, and it suggests strategies to provide greater hurricane protection to coastal Louisiana. The plan acknowledges challenges and trade-offs, such as the likelihood that not every coastal community will receive the same level of hurricane protection. It also

[10]Pub. L. No. 109-432, Division C, Title I.

acknowledges certain technical unknowns, such as how to balance the effects of protection projects, such as levees, with restoration projects, such as diversions and marsh restoration. Although final cost estimates have not been developed, Louisiana officials estimate that the plan will cost more than $50 billion over several decades. In April 2007, the state released its 2008 annual plan for the restoration and protection of coastal Louisiana that estimated it would cost $1.07 billion to implement the first 3 years (2008 through 2010) of the state's master plan.

- *The Corps' Plan*. The Energy and Water Development Appropriations Act of 2006 required the Corps to conduct a study and recommend a comprehensive approach to flood, coastal, and hurricane protection for Louisiana. To prepare its report, the Corps is conducting a series of public meetings to discuss alternative proposals to restore and protect areas of need. The Corps is also working with other federal agencies and Louisiana to identify cost, performance, and risks for each alternative proposal. In July 2007, Corps officials told us they plan to submit a preliminary report to the Congress by December 2007 and a final report in the fall of 2008.

Various Projects Have Been Designed and Constructed to Restore and Protect Louisiana's Coastal Wetlands

Over the last 17 years under CWPPRA, federal agencies and Louisiana as of June 2007 have designed and/or constructed 147 projects to restore and protect more than 120,000 acres of coastal wetlands—about 3 percent of the Louisiana coast. The total cost of these projects is estimated to be about $1.78 billion. Although costs vary significantly between project types, many projects are generally expected to erode and subside over time, as a result of naturally occurring hydrologic and geologic processes.

The various types of CWPPRA projects that have been designed and/or constructed to protect and/or restore coastal wetlands include the following:

Freshwater reintroduction. Freshwater reintroduction projects move water through a gate, siphon, or pump to drain water from a body of water, such as the Mississippi River, to a nearby area of declining wetlands or marsh. The water carries some sediment and nutrients and helps slow saltwater intrusion, which in turn slows the loss of marsh and creates a small amount of new marsh. For example, the *River Reintroduction into Maurepas Swamp* project sponsored by EPA is designed to restore and protect a deteriorated swampland by reintroducing Mississippi River water, along with sediment and nutrients, into the nearby Maurepas Swamp (see fig. 2) and protect 5,438 acres of wetlands. EPA has been developing the project since August 2001, but construction is not expected to begin until June 2009. As of June 2007, federal agencies and Louisiana were designing and engineering eight projects to reintroduce freshwater to nearby wetlands or marsh.

Figure 2: The Maurepas Swamp Before a River Reintroduction Project

Source: USGS.

Sediment diversion. Sediment diversion projects redirect sediment to nearby wetlands to promote natural land-building processes. A gap, called a crevasse, (see fig. 3) is cut into a river levee, allowing river water, nutrients, and sediment to flow into a marshland. The uncontrolled diversion (where water is allowed to flow freely and is not controlled by a dam or lock) is designed to create new marsh in shallow water. For example, the Corps constructed the *West Bay Sediment Diversion* project in November 2003 to restore wetlands in shallow open water by adding sediment that will restore 9,831 acres of marshlands. As of June 2007, federal agencies and Louisiana were designing and engineering seven projects and had completed five projects to divert sediment to nearby wetlands.

Figure 3: Crevasse in a Sediment Diversion Project

Source: USGS.

Outfall management. Outfall management projects work together with freshwater reintroduction or sediment diversion projects. They use a variety of techniques to control the flow of water and sediment through a combination of gates, locks, weirs, canal plugs, and gaps cut in artificial levee banks (see fig. 4). For example, the *Caernarvon Diversion Outfall Management* project completed by NRCS in June 2002 is designed to restore 802 acres of wetlands by promoting better sediment and nutrient flow from an existing Corps sediment diversion project along the Mississippi River. As of June 2007, federal agencies and Louisiana were designing and engineering one project and had completed two projects to manage the flow of water and sediment.

Figure 4: Gate in an Outfall Management Project

Source: USGS.

Marsh creation. Marsh creation projects restore and protect marshlands using sediment material from river dredging projects or material dredged specifically to create a marsh. The dredged material is placed in open water and/or on declining wetlands to raise land levels so that marsh plants will become established to form new marsh (see fig. 5). For example, the Corps constructed the *Bayou LaBranche Wetland Creation* project in April 1994 by depositing 2.7 million cubic yards of sediment dredged from Lake Pontchartrain into open water areas to create 203 acres of new marsh. As of June 2007, federal agencies and Louisiana were designing and engineering 12 projects, constructing 3 projects, and had completed 7 projects to create marshlands.

Figure 5: Marsh Creation Project Using Dredged Material

Source: USGS.

Shoreline protection. Shoreline protection projects are designed to slow or stop shoreline erosion. Some techniques, such as rock berms (see fig. 6), are built along eroding shorelines to reduce the effect of waves on the shore. Other techniques, such as breakwaters and intertidal dikes, are built in open water to slow waves before they reach the shoreline. For example, NRCS constructed the *Boston Canal/Vermilion Bay Bank Protection* project in November 1995 by creating 1,400 feet of rock dikes and 1,000 feet of fence to protect and trap sediment for land building. As of June 2007, federal agencies and Louisiana were designing and engineering 13 projects, constructing 3 projects, and had completed 23 projects to protect shorelines from erosion.

Figure 6: Rock Berm Built for Shoreline Protection

Source: GAO.

Hydrologic restoration. Hydrologic restoration projects are designed to restore natural drainage patterns and water flow. Gates, locks, or sheet pile dams (see fig. 7) are constructed along rivers and other major waterways to change water flow. For example, FWS designed the *East Sabine Lake Hydrologic Restoration* project that will use various structures, such as a culvert and terraces, to restore and protect 225 acres of marshes by controlling saltwater entering the project area from nearby waterways. Project design began in January 2001 and construction is expected to be completed by July 2008. As of June 2007, federal agencies and Louisiana were designing and engineering 6 projects, constructing 3 projects, and had completed 18 projects to restore hydrologic patterns and flows.

Figure 7: Water Control Structure to Restore Drainage Patterns and Water Flow

Source: USGS.

Marsh management. Marsh management projects are designed to provide a healthy ecosystem for waterfowl and animals. For example, projects to control and maintain fresh and saltwater levels promote the growth of native vegetation and help restore wildlife habitat. NRCS' *East Mud Lake Marsh Management* project, constructed in June 1996, uses gates to control and maintain saltwater levels to manage over 8,000 acres of open water and salt marsh and to restore 1,520 acres of marshland (see fig. 8). As of June 2007, federal agencies and Louisiana had completed one project to manage marshlands.

Figure 8: Gates to Control Saltwater Levels

Source: USGS.

Barrier island restoration. Barrier island restoration projects are designed to protect and restore Louisiana's barrier islands—small island chains separated from the mainland by open water that provide the first line of defense from hurricanes and storm surge (see fig. 9). These projects include adding dredged material to expand barrier islands' height and width, building structures to protect barrier islands from erosion, and erecting sand-trapping fences and planting native vegetation to strengthen sand dunes on barrier island beaches. For example, the *Barataria Barrier Island: Pelican Island and Pass La Mer to Chaland Pass* project sponsored by NMFS is designed to construct 484 acres of sand dunes and marshes and plant them with native plants. The project began in 2002 and construction completed on the Pass La Mer to Chaland Pass portion of the project in December 2006. As of June 2007, federal agencies and Louisiana were designing and engineering five projects, constructing four projects, and had completed five projects to restore barrier islands.

Figure 9: Barrier Islands

Source: USGS.

Vegetation planting. Vegetation planting projects use native marsh plants (see fig. 10) to reduce erosion, hold soil firmly in place, and expand/improve wildlife habitats. For example, NMFS constructed the *Chandeleur Islands Marsh Restoration* project in July 2001 after the storm surge resulting from Hurricane Georges in 1998 reduced the Chandeleur Islands by 40 percent. The project is designed to restore 220 acres of barrier islands using native plants to help trap sediment. As of June 2007, federal agencies and Louisiana were designing and engineering one project and had completed five projects to plant vegetation.

Figure 10: Native Marsh Plants

Source: GAO.

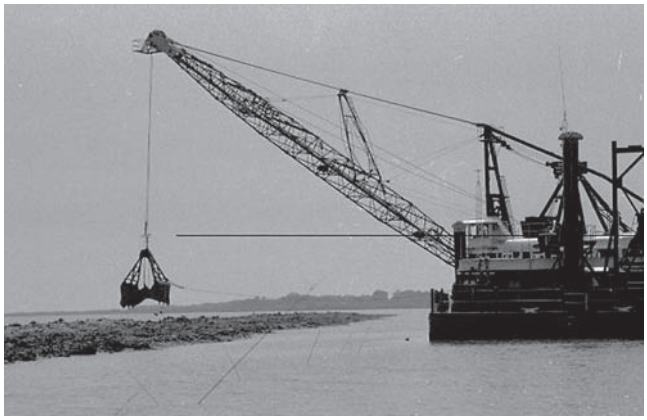
Terracing. Terracing projects involve building low ridges in open water, usually in patterns, to slow water flow and trap sediment for marsh creation (see fig. 11). For example, NMFS' *Little Vermilion Bay Sediment Trapping* project constructed in August 1999 has 23 terraces about 3 and ½ feet above sea level in an area covering almost 1,000 acres of mostly open water to capture sediment previously lost to high winds and waves and to restore 441 acres of wetlands. The project is also expected to improve wildlife habitat and allow access for recreational fishing. As of June 2007, federal agencies and Louisiana were designing and engineering one project and had completed three projects to construct terraces for marsh creation.

Figure 11: Terraces Built to Trap Sediment and Slow Water Flow

Source: USGS.

Sediment and nutrient trapping. Sediment and nutrient trapping projects use brush fences or low land ridges (also called terraces as discussed above) to slow water flow and promote the buildup of sediment in shallow water to restore wetlands (see fig. 12). For example, NMFS completed the *Four Mile Canal Terracing and Sediment Trapping* project in May 2004 using material dredged from nearby waterways to create over 68,000 feet of terraces in open shallow water. NMFS also planted native grass on top of the terraces to help secure the dredged soil and reduce erosion. As of June 2007, federal agencies and Louisiana were designing and engineering one project and had completed three projects to trap sediment and nutrients.

Figure 12: Constructing Terraces to Trap Sediment in Open Water



Source: USGS.

Invasive species control programs. Invasive species control programs pay licensed trappers or hunters to harvest non-native animals, such as nutria (see fig. 13), brought to the United States from South America during the 1930s for the fur trade. Nutria damage marshlands by overgrazing on wetland plants. NRCS introduced the *Coastwide Nutria Control Program* in November 2002 that paid licensed trappers $4 for each nutria tail delivered to a collection center. In 2005, almost 300,000 nutria were caught and killed under this program. As of June 2007, federal agencies and Louisiana were conducting one project and had completed another project to manage programs for the control of invasive species.

Figure 13: Nutria Overgraze on Native Wetland Plants

Source: USGS.

In addition to these projects, four projects are not construction-type projects but are plans or small funds under CWPPRA to support coastal restoration efforts. These four projects are the Storm Recovery Assessment Fund, the Monitoring Contingency Fund, the State of Louisiana Wetlands Conservation Plan, and the Coastwide Reference Monitoring System for Wetlands.

Estimated Cost for CWPPRA Projects That Restore and Protect about 120,000 Acres of Coastal Wetlands Is $1.78 Billion

As of June 2007, federal agencies and Louisiana have designed and/or constructed 147 projects under CWPPRA to protect and restore 121,109 acres of coastal wetlands at an estimated cost of $1.78 billion. Between fiscal years 1992 and 2007, the CWPPRA program has received approximately $794 million, $714 million of which has been provided for the construction of projects, and $80 million of which has been provided for other program activities such as planning. As of June 2007, $356 million had been spent and $616 million had been obligated.

Of the 147 projects designed and/or constructed, 74 were completely constructed, 16 were under construction, and 57 were being designed and engineered. (See app. I for detailed information on each of the 147 CWPPRA projects.) Shoreline protection projects (building barriers from rock or plants) and hydrologic restoration projects (returning areas to their natural drainage patterns) made up more than half of the 90 projects that were completed or under construction and accounted for more than one-quarter of the wetland acreage protected and restored under CWPPRA. Shoreline protection and marsh creation projects accounted for about half of the 57 projects still being designed and engineered, or about one-fifth of the acreage planned for restoration.

Of the 147 projects, 22 were demonstration projects, initiated to test new techniques or materials to restore or protect coastal wetlands, and more than half of these were to test new designs for shoreline protection or marsh creation. For example, in 1997, NRCS constructed eight breakwaters next to a barrier island to demonstrate the effectiveness and feasibility of using multiple breakwaters to reduce shoreline erosion on barrier islands and assess their potential for use in future barrier island restoration projects. NRCS officials concluded that the eight breakwaters have reduced shoreline erosion and increased land coverage over the effected area.

In addition to the projects designed and constructed since 1990, the CWPPRA task force has terminated 20 projects for various reasons but most often due to problems associated with land rights, technical difficulties, and project cost-effectiveness. (See app. I for detailed information about the 20 terminated projects.) For example, an EPA project to create a marsh using dredged sediment was terminated in 2005 because of problems with land rights and technical difficulties building the marshland and finding the sediment. Similarly, a NMFS project to restore a marshland was terminated in 1998 when officials determined the project area was so degraded that the project design was not cost-effective. Most project terminations took place in the first 10 years of the CWPPRA

program, whereas just 3 projects have been terminated in the past 5 years. As of June 2007, however, 17 projects were delayed due to problems such as land rights, oyster leases, and uncertain benefits of the project design, and CWPPRA officials told us that some of these projects may also be terminated if these issues cannot be resolved.

Project Costs Vary Significantly, and Most Restored Wetlands Are Generally Expected to Erode over Time

The cost of CWPPRA projects varies considerably by project type, and most projects require a continuous source of funding to maintain them and ensure that they will deliver benefits over their expected lifetime. Projects to plant marsh plants have averaged about $9,000 per acre, while projects to restore barrier islands have averaged more than $54,000 per acre. Some projects, such as freshwater reintroduction projects, have averaged $11,400 per acre because they covered a larger area and only required the construction of structures, such as culverts and gates. In contrast, officials said freshwater reintroduction projects are relatively less expensive to operate and cost little to maintain because they are generally self-sustaining.

Most CWPPRA projects are generally designed to be maintained in a manner that will protect wetlands and reduce land loss for a 20-year period. Maintenance activities may include replacing rock on a shoreline protection project and repairing routine damage to structures, such as a small dam, on a hydrologic restoration project. As of September 2007, the CWPPRA task force plans to spend an estimated $265 million on operations and maintenance over the life of projects currently in design, under construction, and completed. Despite these maintenance efforts, restored and protected acreage is also subject to the effects of rising seas, subsidence, and erosion that are experienced by naturally occurring wetlands. As a result, most restored and protected wetlands also are generally expected to lose acreage over time, particularly areas that experience high waves from the Gulf, such as restored barrier islands. In some cases, these natural effects preclude the feasibility of certain maintenance. For example, federal agencies may add vegetation or replace sand fences to maintain barrier island restoration projects, but they do not add dredged material to repair erosion. According to agency officials, the high cost of replenishing dredged material on these projects, and the high rate of erosion caused by waves from the Gulf of Mexico, make this kind of maintenance impractical. While barrier islands are expected to continue to erode, agency officials told us that protecting these islands provides a certain level of protection to developed areas and marshes behind the islands, even if only for the short term.

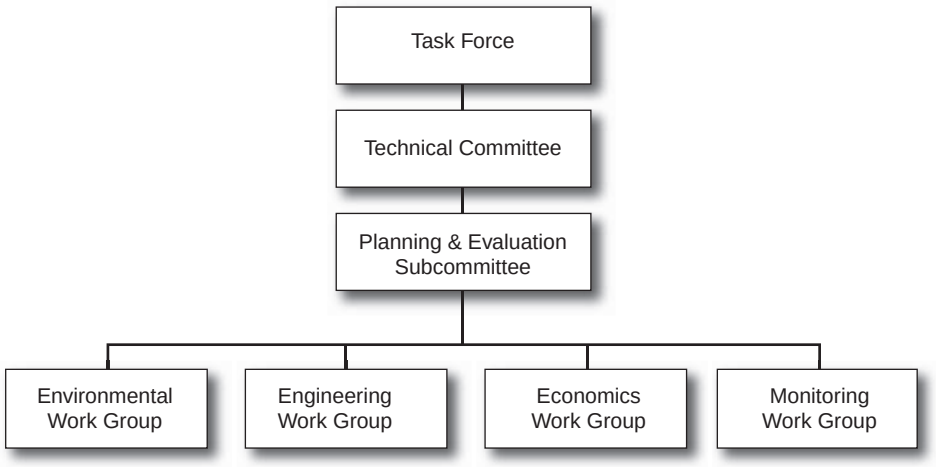
Accomplishments and Challenges to Restoring Louisiana's Coastal Wetlands Provide Lessons Learned for Future Restoration Efforts

Past efforts to restore and protect Louisiana's coastal wetlands offer important lessons that can help guide future restoration plans and strategies. In particular, agency officials attributed the CWPPRA program's progress in restoring and protecting wetlands primarily to the effective interagency collaboration that exists among the participating agencies. However, the CWPPRA program has also faced several challenges such as increasing project costs, limited capability to monitor project effectiveness, and the need to acquire private landowner rights, which are likely to be issues that will extend to the larger and more complex restoration efforts currently being planned.

Agency Officials Consider an Interagency Structure and Collaborative Process a Key to Restoring Coastal Wetlands

Officials from Louisiana and the five CWPPRA agencies that have collaborated on Louisiana's coastal wetlands projects generally told us they believe that the CWPPRA program's unique interagency approach and processes have been critical to designing and constructing a range of projects in the region. To improve collaboration, the CWPPRA task force formed committees and technical work groups with members from the federal agencies and Louisiana to assist in each phase of restoration development and implementation. (See fig. 14 for the organization of the CWPPRA task force.) The multiagency task force, along with its committees and work groups, brings together biologists, other scientists, civil engineers, economists, and other technical experts to provide the collective experience and expertise needed to review project cost estimates, designs, schedules, and work plans.

Figure 14: Organization of the CWPPRA Task Force



Source: GAO.

Through semiannual budgetary task force meetings, the members review and approve projects to begin design or construction. Officials told us that this review process has been critical to designing and constructing projects that are cost-effective, environmentally sound, and technically feasible. For example, during a project's design phase, agency officials present project design proposals to the environmental and engineering work groups for review and comment on the feasibility of the design, the validity of the assumptions, and strategies for success. The task force also requires reviews at various points during a project's development, particularly during the early stages of project design and again when design is nearing completion. During these reviews, federal agency and Louisiana officials meet to review and discuss project designs, cost estimates, and restoration benefits. Some CWPPRA officials told us that these project design reviews are key to resolving potential problems and identifying project cost growth as early as possible.

In November, the Congress passed the Water Resources Development Act of 2007 which includes authorizations for various Corps projects and studies for the restoration of coastal Louisiana. This act also established a task force comprised of representatives from nine federal agencies and Louisiana to make recommendations to the Secretary of the Army on plans and programs for the protection and restoration of the Louisiana coast. The act authorizes the task force to establish working groups—similar to those used by the CWPRRA task force—to integrate the planning, design, and implementation of various Corps projects for flood control, coastal restoration, and hurricane protection and provide a broad range of expertise and representation from Louisiana and local governments.

Restoration Efforts Face Various Planning and Implementation Challenges

In designing, constructing, operating, maintaining, and monitoring projects, the CWPPRA program continues to face challenges, including increasing project costs, limited capability to assess project effectiveness, the need to address private landowner rights, uncertain project performance, and damage from hurricanes and storms. As larger and more complex restoration efforts are planned for the future, we believe that they too are likely to face similar challenges and will, therefore, need to consider how to resolve these issues as part of their project development and implementation processes.

Increasing project costs. The costs of constructing and maintaining many CWPPRA projects have increased beyond their original estimates and, as a result, fewer projects are being designed and constructed. According to CWPPRA agency officials, costs for construction, operations, and

maintenance have increased 25 to 50 percent above estimates since the 2005 hurricanes. Fuel cost increases, for example, have increased the cost to provide building materials, such as rock and sand, especially when such material is not available locally in sufficient quantities. NRCS officials told us there are not any rock quarries in Louisiana so that rock must be purchased and transported from out of state. Similarly, federal agency officials told us that sand suitable for constructing projects is not available locally in sufficient quantities and must be dredged and transported to project sites. In one instance, EPA initiated a project to demonstrate the feasibility of dredging sand deposits 8 miles from shore in the Gulf of Mexico to provide the material needed to restore a barrier island. Officials also told us that the cost of building materials, such as rock which is often used to construct shoreline protection projects, has increased since the 2005 hurricanes. Finally, costs to construct, operate, and maintain projects have also increased due to increasing labor costs. For example, NRCS officials told us that the need for specialized contract labor, such as contractors with the capability to work in water, has increased project costs.

These unexpected cost increases have impacted the overall implementation of CWPPRA projects in a variety of ways. First, it has delayed project construction for new CWPPRA projects. As of October 2007, there were 10 fully designed CWPPRA projects awaiting almost $190 million in funds to begin construction. Funds to construct these projects were not available because their estimated costs exceeded the annual amount of program funds available for new construction, and funds were needed to pay higher costs for construction, operations, and maintenance of other projects. Second, because of the potential for funding shortfalls, the task force has been approving fewer projects to begin design and engineering. Since 1990, the task force has approved an average of about 12 projects per year to begin design and engineering. Since October 2002, however, the task force has approved 5 or fewer projects per year to begin design and engineering. Finally, cost increases for ongoing projects have limited the number of demonstration projects that the CWPPRA program has been able to undertake. The task force did not approve any demonstration projects in 2004 and 2005 even though the authorizing legislation considered this an important aspect of the program. In 2006, the task force approved 1 demonstration project after it decided to consider funding 1 per year, as long as the demonstration project did not exceed $2 million in total costs.

Limited monitoring and assessment capabilities. Although CWPPRA requires the task force to evaluate the effectiveness of each project

following construction, it lacks a coast-wide monitoring program to assess the overall effectiveness of these projects to restore coastal wetlands. Further, according to the CWPPRA task force, it has been unable to fully assess individual project performance due to the limited availability and/or usefulness of monitoring data. According to Louisiana and USGS officials, as of October 2007, Louisiana, USGS, and the CWPPRA federal agencies have developed 85 project monitoring plans. Louisiana and USGS have monitored all constructed projects, and Louisiana has prepared many monitoring reports that are available on its Web site. For example, to monitor an FWS hydrologic restoration project, Louisiana officials measured the ratio of open water to land, salinity, and vegetation composition and reported these measurements compared with preconstruction levels. CWPPRA agency officials told us that they have used monitoring data and reports to assess project performance and adjust project designs, as needed. However, according to the task force and a USGS official, most monitoring reports have provided incomplete and inconsistent data so that officials have not been able to perform the kinds of statistical analysis needed to fully evaluate project effectiveness.

In 1998, a study of coastal restoration prepared by Louisiana concluded that there was a need for coast-wide monitoring to assess the overall effectiveness of coastal restoration and protection projects. Since 2003, USGS and Louisiana have been working with the CWPPRA task force to develop such a coast-wide system. This system is expected to collect data on changes in levels of salinity, water levels, and vegetation and sedimentation in marshlands, as well as monitor the cumulative and wide-ranging effects of multiple CWPPRA projects and help project managers design more effective and better integrated restoration projects. The planned system includes 390 randomly located monitoring stations installed across 3.67 million acres of coastal Louisiana and all stations are expected to be fully operational by the spring of 2008. As of October 2007, 256 of 390 monitoring stations were installed and collecting data. According to officials, the process to implement the system has taken longer than expected due to the time required to design and implement a coast-wide system, survey lands and obtain land rights agreements, and fund the construction of hundreds of monitoring platforms due to rising construction costs. Until a coast-wide monitoring system is fully operational and providing reliable data, federal agencies and the task force will not be able to evaluate whether coastal restoration projects are collectively restoring the Louisiana coast and if these efforts are having adverse unintended effects. Further, even when all monitoring stations are collecting data, CWPPRA and USGS officials estimated the system will not

provide multiyear data needed to assess certain restoration trends, such as sediment elevation tables, for another 5 to 10 years.

Private land ownership issues. Because coastal Louisiana is about 85 percent privately owned, state agency officials, in some cases, have spent a significant amount of time locating landowners to obtain approval to construct CWPPRA projects. For example, according to NMFS officials, one marsh creation and terracing project area had about 1,500 individual landowners, and it was a challenge to locate all of the landowners and obtain permission to construct the project on their land. More often, NMFS and other CWPPRA agency officials told us that they have had to contact from 1 to 100 landowners to obtain approval to begin a project. According to various federal agency officials, obtaining access from landowners has significantly delayed the design process for some projects, sometimes to such an extent that they became concerned that the project might not be feasible because of difficulties locating landowners and obtaining land rights agreements. Most federal agency officials also told us that landrights issues are eventually resolved, however, and projects are designed and engineered.

Implementing a project on commercially owned lands can also present problems, particularly because in Louisiana they often have infrastructure such as oil and gas pipelines, canals, and rail lines constructed on them. To restore coastal wetlands on commercially owned lands, federal agencies or commercial landowners have relocated or temporarily moved infrastructure to construct projects. In some instances where federal agencies have moved commercial infrastructure, moving costs significantly increased the cost of the CWPPRA project. For example, when Corps officials realized a sediment diversion project could not be constructed without disrupting nearby infrastructure, they proposed relocating two pipelines and two power poles, which would have increased project costs by more than $2.15 million. Largely in response to these cost increases, the Corps eventually decided to terminate the project. On another sediment diversion project, Corps officials told us that they relocated a pipeline so that it would not be in open water. However, in this case, the pipeline owner reimbursed the Corps for relocating the pipeline, and construction of the project was able to proceed and be completed in 2003.

In Louisiana, commercial fishermen may also lease publicly owned lands, known as water bottoms and, based on lessons learned from recent court decisions and legislative activity, Louisiana officials told us it is important to notify project sponsors as early as possible about leases of public lands

so that project designs can take these into account. In 2000, a Louisiana state court ruled that the Caernarvon diversion project—a project that diverts freshwater from the Mississippi River to restore freshwater wetlands—had altered the salinity levels and damaged or destroyed oyster beds in state-owned waters that had been leased to commercial fishermen and were near the project. A jury awarded over $1 billion to the oyster leaseholders in a ruling against the Louisiana Department of Natural Resources.[11] In 2004, the Louisiana Supreme Court reversed the judgment of the lower courts, concluding that the state was not liable for changes in water salinity due to restoration projects, and the oyster fishermen's claim was dismissed.[12] However, in 2006, the Louisiana state legislature passed a new law clarifying that oyster leaseholders generally may not sue the state or the federal government for claims arising from projects, plans, acts, or activities related to coastal protection, conservation, or restoration. The new law also established an acquisition and compensation program for oyster leaseholders if dredging or soil placement occurs on leased lands as a result of coastal protection, conservation, or restoration projects.[13] As a result of these developments, during the early stages of a CWPPRA project design, Louisiana provides a map to federal agencies indicating any oyster leases that could be potentially affected by the project. Louisiana also provides data on the leases such as acreage and the name of the lessee so that federal agencies may fully consider existing commercial fishing leases when designing projects.

Uncertainty of project performance. Some projects simply fail to perform as designed for reasons largely beyond the designers' control. A number of uncertainties that cannot always be fully modeled or predicted when designing a project can cause a project to be unsuccessful. A CWPPRA official told us that uncertain landscape features such as drainage patterns, earthen deposits, and soil content have prevented some projects from restoring an area as planned. For example, the Davis Pond Diversion—a structure comprised of large culverts built by the Corps to divert freshwater from the Mississippi River to restore nearby wetlands—releases less than half the amount of water it was designed to release. This has happened because landscape features prevented the water from

[11]The appellate court affirmed this ruling, but slightly increased the damage award. *Avenal v. State of Louisiana, Dep't of Natural Res.*, 858 So. 2d 697 (La. Ct. App. 2003).

[12]*Avenal v. State of Louisiana, Department of Natural Resources*, 886 So. 2d 1085 (La. 2004).

[13]H.B. 1249, 2006 Leg., Reg. Sass. (La. 2006).

flowing to the wetland areas as anticipated, and the flows cannot be increased because they might flood nearby private developments. According to Corps officials, however, most of these unanticipated problems have been corrected and officials expect water flow to increase to design levels by 2009. Although the Davis Pond Diversion project is not a CWPPRA project, some CWPPRA projects have also not performed as designed. For example, a NMFS-sponsored CWPPRA project to repair a breach in a barrier island was unable to reconnect the two portions of the island because the rate of erosion had reached a point where the landscape could no longer be sustained. Additionally, a Corps project constructed in 1996 designed to restore 445 acres of marshland has been able to restore only 9 acres of vegetated wetlands because oyster leases in or adjacent to the project site prevented the use of dredged material to sufficiently elevate the marsh, causing the area to be flooded with saline water and restricting marsh growth. Finally, of the 20 CWPPRA projects terminated since 1990, 8 were terminated due to technical difficulties and design problems. For example, agency officials terminated a terracing project after concluding that it would not be technically feasible to construct terraces on the land due to poor sediment quality. However, some agency officials also told us that uncertain project performance may be anticipated, and it is not uncommon to change project designs after implementation to address problems.

Setbacks as a result of storm damage. Hurricanes can cause significant damage to coastal areas, including both naturally occurring and restored wetlands. For example, although Hurricanes Katrina and Rita did not directly hit and, therefore, cause significant damage to most CWPPRA projects, it destroyed tens of thousands of naturally occurring and other restored wetlands in the region. In particular, Hurricane Katrina destroyed about 25,000 acres of restored and naturally occurring wetlands on the Caernarvon Project. The Caernarvon Project includes a large diversion structure constructed by the Corps in 1991 that diverts water and sediment from the Mississippi River to restore nearby wetlands. Although the Caernarvon Project is not a CWPPRA project, it is similar to some ongoing CWPPRA projects, and the damage that was inflicted by the hurricanes to this project demonstrates the vulnerability of restored areas to storms. With regard to the CWPPRA projects, storm surge from Hurricanes Katrina and Rita damaged 18 of the 90 CWPPRA projects completed or under construction. Typical storm damage included sand fences torn away, storm debris scattered about, and water control structures that were overtopped. According to officials, 16 of the 18 damaged projects appeared to function as designed, but 2 were so damaged that officials

considered them inoperable. Officials told us that plans were in place to repair the 2 inoperable projects but, as of July 2007, repairs had not begun.

In this context, a draft report by the Association of State Wetland Managers[14] noted that although both freshwater and saltwater marshes in Louisiana sustained significant damage from recent hurricanes and storms, freshwater marshlands suffered more long-lasting effects. In many cases, canals and other flood protection structures have cut off freshwater marshes from freshwater and sediment, such as rivers, so that freshwater marshlands are unable to repair themselves. Sediment is necessary for the recovery of freshwater marshlands. In these cases, the study concluded that freshwater marshes may not heal following a hurricane or storm so that some form of restoration effort may be necessary.

Concluding Observations

Since 1990, CWPPRA projects have made an important first step to reducing land loss and ecosystem deterioration in Louisiana by protecting and restoring about 3 percent of the state's coastal areas. However, this level of effort is inadequate to stop coastal wetland losses that are projected to occur over the next 50 years, much less restore the coastal landscape to the condition it was in prior to the 1950s before levees and other flood control structures were constructed to control the Mississippi River. In light of recent proposals to restore and protect all of the roughly 2.5 million acres of Louisiana coastal wetlands through a comprehensive system of large-scale restoration projects and strategies that will receive billions of dollars over at least 20 years, it is important that planners carefully consider the lessons learned from the experiences of the CWPPRA program. As the CWPPRA experience has demonstrated, restoration projects are subject to the same forces of erosion and subsidence as natural wetlands and, therefore, the long-term sustainability of these projects is dependent on the continuous infusion of resources for decades into the future. As recognized by the Water Resources Development Act of 2007, establishing an interagency approach and consultative process similar to that of the CWPPRA program is vital to ensuring that large-scale wetlands restoration efforts are developed in a comprehensive manner using the most cost-effective approaches. Also, critical to assessing the success of these efforts is the design and implementation of a comprehensive monitoring program. Even after 17 years, such a program has not been fully developed and implemented for

[14]Kusler, Jon. Draft of "Wetlands and Natural Hazards." 2007.

the CWPPRA projects and, therefore, a comprehensive assessment of the projects constructed to date is still not possible. Finally, restoration project planners must take into account various uncertainties that could impact the successful implementation of projects and could lead to project delays and cost increases. As the CWPPRA experience demonstrates, not all of these uncertainties can be predicted in advance, however, a well-developed project implementation strategy that includes mechanisms to address these kinds of uncertainties as and when they arise is more likely to be successful.

Agency Comments and Our Evaluation

We provided a copy of this report to the Departments of Agriculture, Commerce, Defense, the Interior, and EPA for review and comment.

EPA agreed with our findings and observations and emphasized the importance of the collaborative approach used by the CWPPPRA agencies to provide for an effective program for coastal restoration. See appendix III for EPA's letter.

The Department of Commerce provided comments on behalf of the National Oceanic and Atmospheric Administration in which it stated that our report was generally accurate and thorough. However, the agency also stated that the report's characterization of CWPPRA monitoring efforts was misleading because it suggested that the program is not able to assess the success of constructed projects. Although the agency acknowledged that proving project success based on statistical and scientific analysis is a challenge because long-term data are not generally available, it also emphasized that current efforts to monitor projects offer critical insights into project performance. While we disagree that our description of the CWPPRA monitoring efforts was misleading, we have revised the report to clarify some of the issues raised by the agency. The Department of Commerce also provided technical comments, which we incorporated throughout our report as appropriate. The Department of Commerce's letter can be found in appendix II.

The Department of Defense provided only technical comments, which we incorporated throughout the report as appropriate. The Departments of Agriculture and the Interior did not provide comments on this report.

We are sending copies of this report to the Secretaries of Agriculture, Commerce, Defense, the Interior; and the Administrator of the Environmental Protection Agency; and interested congressional

committees. We also will make copies available to others upon request. In addition, the report will be available, at no charge, on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or mittala@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff that made major contributions to this report are listed in appendix IV.

Anu K. Mittal
Director, Natural Resources
and Environment

List of Congressional Addressees

The Honorable Peter J. Visclosky
Chairman
The Honorable David L. Hobson
Ranking Member
Subcommittee on Energy and Water Development, and Related Agencies
Committee on Appropriations
House of Representatives

The Honorable Norm D. Dicks
Chairman
The Honorable Todd Tiahrt
Ranking Member
Subcommittee on Interior, Environment, and Related Agencies
Committee on Appropriations
House of Representatives

The Honorable Richard H. Baker
Ranking Member
Subcommittee on Water Resources and Environment
Committee on Transportation and Infrastructure
House of Representatives

The Honorable Mary L. Landrieu
United States Senate

Appendix I: Summary Schedules of CWPPRA Projects

This appendix contains tables listing Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) projects in design and engineering (see table 1), under construction (see table 2), completed construction (see table 3), and terminated (see table 4) as of June 2007.

Table 1: Summary Schedule of CWPPRA Projects in Design and Engineering as of June 2007

	Project name	Agency sponsor	Project type	Anticipated total acres[a]	Project approval date	Total cost estimate
1.	Alligator Bend Marsh Restoration and Shoreline Protection	Corps	Marsh creation	330	Oct. 2006	**$19,620,813**
2.	Southwest Louisiana Gulf Shoreline Nourishment and Protection	Corps	Shoreline protection	888	Oct. 2006	**36,922,487**
3.	Enhancement of Barrier Island Vegetation Demonstration	EPA	Vegetative planting	Data not applicable	Oct. 2006	**919,599**
4.	Madison Bay Marsh Creation and Terracing	NMFS	Marsh creation	372	Oct. 2006	**32,353,377**
5.	West Belle Pass Barrier Headland Restoration Project	NMFS	Marsh creation	299	Oct. 2006	**32,563,747**
6.	Lake Hermitage Marsh Creation	FWS	Marsh creation	438	Feb. 2006	**32,673,327**
7.	Bayou Lamoque Freshwater Diversion	Corps	Freshwater reintroduction	620	Feb. 2006	**5,375,741**
8.	Venice Ponds Marsh Creation and Crevasses	EPA	Marsh creation	511	Feb. 2006	**8,992,955**
9.	South Pecan Island Freshwater Introduction	NMFS	Hydrologic restoration	98	Feb. 2006	**4,438,695**
10.	East Marsh Island Marsh Creation	EPA	Marsh creation	189	Feb. 2005	**16,824,999**
11.	South Shore of the Pen Shoreline Protection and Marsh Creation	NRCS	Shoreline protection	116	Feb. 2005	**17,513,780**
12.	White Ditch Resurrection	NRCS	Freshwater reintroduction	189	Feb. 2005	**14,845,193**
13.	Riverine Sand Mining/Scofield Island Restoration	NMFS	Barrier island restoration	234	Feb. 2005	**44,544,636**
14.	Goose Point/Point Platte Marsh Creation	FWS	Marsh creation	436	Jan. 2004	**20,867,777**
15.	Bayou Sale Shoreline Protection	NRCS	Shoreline protection	329	Jan. 2004	**32,103,020**
16.	Spanish Pass Diversion	Corps	Sediment diversion	433	Jan. 2004	**14,212,169**
17.	Whiskey Island Back Barrier Marsh Creation	EPA	Barrier island restoration	272	Jan. 2004	**22,243,934**

	Project name	Agency sponsor	Project type	Anticipated total acres[a]	Project approval date	Total cost estimate
18.	Mississippi River Sediment Trap	Corps	Sediment and nutrient trapping	1,190	Jan. 2003	**52,180,839**
19.	Avoca Island Diversion and Land Building	Corps	Sediment diversion	143	Jan. 2003	**18,823,322**
20.	Bayou Dupont Sediment Delivery System	EPA	Marsh creation	400	Jan. 2003	**24,925,734**
21.	Lake Borgne and Mississippi River Gulf Outlet Shoreline Protection	Corps	Shoreline protection	266	Jan. 2003	**22,748,889**
22.	Ship Shoal: Whiskey West Flank Restoration	EPA	Barrier island restoration	195	Jan. 2002	**42,918,821**
23.	West Lake Boudreaux Shoreline Protection and Marsh Creation	FWS	Shoreline protection	277	Jan. 2002	**19,585,055**
24.	River Reintroduction into Maurepas Swamp	EPA	Freshwater reintroduction	5,438	Jan. 2002	**57,815,647**
25.	South Grand Chenier Hydrologic Restoration	FWS	Hydrologic restoration	440	Jan. 2002	**19,930,316**
26.	Grand Lake Shoreline Protection	Corps	Shoreline protection	540	Jan. 2002	**11,811,039**
27.	Pass Chaland to Grand Bayou Pass Barrier Shoreline Restoration	NMFS	Barrier island restoration	263	Jan. 2002	**30,217,567**
28.	Dedicated Dredging on the Barataria Basin Landbridge	FWS	Marsh creation	605	Jan. 2002	**15,842,343**
29.	Lake Borgne Shoreline Protection	EPA	Shoreline protection	165	Jan. 2001	**25,581,099**
30.	Terrebonne Bay Shore Protection Demonstration	FWS	Shoreline protection	Data not applicable	Jan. 2001	**2,503,768**
31.	Small Freshwater Diversion to the Northwestern Barataria Basin	EPA	Freshwater reintroduction	941	Jan. 2001	**13,803,361**
32.	Delta Building Diversion North of Fort St. Philip	Corps	Sediment diversion	501	Jan. 2001	**6,297,286**
33.	Rockefeller Refuge Gulf Shoreline Stabilization	NMFS	Shoreline protection	920	Jan. 2001	**50,408,478**
34.	Benneys Bay Diversion	Corps	Sediment diversion	5,706	Jan. 2001	**53,702,881**
35.	Gulf Intracoastal Waterway Bank Restoration of Critical Areas in Terrebonne	NRCS	Shoreline protection	366	Jan. 2001	**29,987,641**
36.	Delta Building Diversion at Myrtle Grove	Corps	Sediment diversion	8,891	Jan. 2001	**3,002,114**
37.	East Grand Terre Island Restoration	NMFS	Barrier island restoration	335	Jan. 2000	**31,226,531**
38.	Little Pecan Bayou Hydrologic Restoration	NRCS	Hydrologic restoration	144	Jan. 2000	**14,597,263**

	Project name	Agency sponsor	Project type	Anticipated total acres[a]	Project approval date	Total cost estimate
39.	South Lake Decade Freshwater Introduction	NRCS	Shoreline protection	201	Jan. 2000	**3,873,744**
40.	Opportunistic Use of the Bonnet Carre Spillway	Corps	Freshwater reintroduction	177	Jan. 2000	**1,121,757**
41.	Freshwater Bayou Bank Stabilization-Belle Isle Canal to Lock	Corps	Shoreline protection	241	Jan. 2000	**17,756,468**
42.	Periodic Introduction of Sediment and Nutrients at Selected Diversion Sites Demonstration	Corps	Sediment diversion	Data not applicable	Jan. 2000	**1,502,817**
43.	Castille Pass Channel Sediment Delivery	NMFS	Sediment diversion	577	Jan. 2000	**19,657,695**
44.	Weeks Bay Marsh Creation and Shore Protection/Commercial Canal/Freshwater Redirection	Corps	Shoreline protection	278	Jan. 2000	**30,027,305**
45.	LaBranche Wetlands Terracing, Planting, and Shoreline Protection	NMFS	Terracing	489	Jan. 2000	**8,828,343**
46.	Sabine Refuge Marsh Creation, Part Two of Five	Corps	Marsh creation	261	Jan. 1999	**9,490,000**
47.	Sabine Refuge Marsh Creation, Part Four of Five	Corps	Marsh creation	163	Jan. 1999	**0**
48.	Sabine Refuge Marsh Creation, Part Five of Five	Corps	Marsh creation	168	Jan. 1999	**0**
49.	Lake Boudreaux Freshwater Introduction	FWS	Freshwater reintroduction	603	Apr. 1997	**10,519,383**
50.	Penchant Basin Natural Resources Plan, Part One	NRCS	Hydrologic restoration	1,155	Apr. 1997	**14,455,551**
51.	Grand Bayou Hydrologic Restoration	FWS	Hydrologic restoration	199	Feb. 1996	**8,209,722**
52.	Mississippi River Reintroduction into Bayou Lafourche	EPA	Freshwater reintroduction	988	Oct. 2001	**11,200,000**
53.	Myrtle Grove Siphon	NMFS	Freshwater reintroduction	1,119	Feb. 1996	**481,803**
54.	West Pointe a la Hache Outfall Management	NRCS	Outfall management	1,087	Oct. 1993	**4,068,045**
55.	Brown Lake Hydrologic Restoration	NRCS	Hydrologic restoration	282	Oct. 1992	**4,002,363**
56.	Storm Recovery Assessment Fund	FWS	Operation and maintenance	Data not applicable	Oct. 2006	**303,359**
57.	Monitoring Contingency Fund	FWS	Monitoring	Data not applicable	Dec. 1999	**1,500,000**
	Grand total			**41,468**		**$1,051,924,598**

Source: GAO analysis of Corps data.

Note: Data as of June 8, 2007.

[a]The CWPPRA program does not report acreage for demonstration projects. Demonstration projects test new techniques and materials for the restoration or protection of coastal wetlands. Other projects, such as the FWS' Storm Recovery Assessment Fund and Monitoring Contingency Fund, are projects that support the CWPPRA program.

Table 2: Summary Schedule of CWPPRA Projects under Construction as of June 2007

	Project name	Agency sponsor	Project type	Anticipated total acres[a]	Project approval date	Current total cost estimate	Construction start date
1.	Coastwide Reference Monitoring System for Wetlands	FWS	Monitoring	Data not applicable	Aug. 2003	$66,890,300	Aug. 2003
2.	Freshwater Floating Marsh Creation Demonstration	NRCS	Marsh creation	Data not applicable	Jan. 2003	1,080,891	Jul. 2004
3.	Coastwide Nutria Control Program	NRCS	Invasive species control program	14,963	Jan. 2002	68,864,870	Nov. 2002
4.	Little Lake Shoreline Protection/Dedicated Dredging near Round Lake	NMFS	Shoreline protection	713	Jan. 2002	38,496,395	Aug. 2005
5.	Raccoon Island Shoreline Protection/Marsh Creation, Part Two	NRCS	Barrier island restoration	167	Jan. 2002	10,609,834	Dec. 2005
6.	Barataria Barrier Island: Pelican Island and Pass La Mer to Chaland Pass	NMFS	Barrier island restoration	534	Jan. 2002	67,349,433	Mar. 2006
7.	North Lake Mechant Landbridge Restoration	FWS	Marsh creation	604	Jan. 2001	30,952,917	Apr. 2003
8.	East Sabine Lake Hydrologic Restoration[b]	FWS	Hydrologic restoration	225	Jan. 2001	6,490,751	Dec. 2004
9.	Barataria Basin Landbridge Shoreline Protection, Part Three	NRCS	Shoreline protection	264	Jan. 2000	34,151,587	Oct. 2003
10.	Timbalier Island Dune and Marsh Restoration[b]	EPA	Barrier island restoration	273	Jan. 2000	16,726,000	Jun. 2004
11.	Black Bayou Culverts Hydrologic Restoration	NRCS	Hydrologic restoration	540	Jan. 2000	6,091,675	May 2005
12.	New Cut Dune and Marsh Restoration	EPA	Barrier island restoration	102	Jan. 2000	13,158,878	Oct. 2006
13.	Sabine Refuge Marsh Creation, Part Three of Five	Corps	Marsh creation	187	Jan. 1999	4,536,666	Oct. 2006
14.	Barataria Basin Landbridge Shoreline Protection, Part One and Two	NRCS	Shoreline protection	1,304	Jan. 1998	31,288,623	Dec. 2000
15.	West Belle Pass Headland Restoration	Corps	Shoreline protection	474	Oct. 1992	6,751,441	Feb. 1998
16.	Jonathan Davis Wetland Restoration	NRCS	Hydrologic restoration	510	Oct. 1992	28,886,616	Jun. 1998
	Grand total			**20,860**		**$432,326,877**	

Source: GAO analysis of Corps data.

Note: Data as of June 8, 2007.

[a]The CWPPRA program does not report acreage for demonstration projects. Demonstration projects test new techniques and materials for the restoration or protection of coastal wetlands. Other projects, such as the Coastwide Reference Monitoring System for Wetlands, support the CWPPRA program.

[b]Damaged by Hurricane Rita in 2005.

Table 3: Summary Schedule of CWPPRA Projects Completed as of June 2007

	Project name	Agency sponsor	Project type	Anticipated total acres[a]	Project approval date	Current total cost estimate	Construction completion date
1.	Shoreline Protection Foundation Improvements Demonstration	Corps	Shoreline protection	Data not applicable	Jan. 2004	**$1,055,000**	Aug. 2006
2.	South White Lake Shoreline Protection	Corps	Shoreline protection	844	Jan. 2003	**19,673,929**	Aug. 2006
3.	Holly Beach Sand Management[b]	NRCS	Shoreline protection	330	Jan. 2002	**14,130,233**	Mar. 2003
4.	Barataria Basin Landbridge Shoreline Protection, Part Four	NRCS	Shoreline protection	256	Jan. 2002	**21,457,097**	Apr. 2006
5.	Delta Management at Fort St. Philip	FWS	Sediment diversion	267	Jan. 2001	**3,183,940**	Dec. 2006
6.	Grand-White Lake Landbridge Restoration	FWS	Shoreline protection	213	Jan. 2001	**8,584,334**	Oct. 2004
7.	State of Louisiana Wetlands Conservation Plan	EPA	Conservation plan	Data not applicable	Dec. 2000	**191,807**	Nov. 1997
8.	Freshwater Introduction South of Highway 82	FWS	Hydrologic restoration	296	Jan. 2000	**6,203,110**	Dec. 2006
9.	Mandalay Bank Protection Demonstration	FWS	Shoreline protection	Data not applicable	Jan. 2000	**1,767,214**	Sept. 2003
10.	Chandeleur Islands Marsh Restoration	NMFS	Vegetative planting	220	Jan. 2000	**937,977**	Jul. 2001
11.	Four Mile Canal Terracing and Sediment Trapping	NMFS	Terracing	167	Jan. 2000	**4,886,818**	May 2004
12.	Perry Ridge West Bank Stabilization	NRCS	Shoreline protection	83	Jan. 2000	**3,747,742**	Jul. 2002
13.	Sabine Refuge Marsh Creation, Part One of Five	Corps	Marsh creation	214	Jan. 1999	**3,421,671**	Feb. 2002
14.	Hopedale Hydrologic Restoration[b]	NMFS	Hydrologic restoration	134	Jan. 1999	**2,432,958**	Jan. 2005
15.	Humble Canal Hydrologic Restoration[b]	NRCS	Hydrologic restoration	378	Jan. 1999	**1,530,812**	Mar. 2003
16.	Lake Portage Land Bridge	NRCS	Hydrologic restoration	24	Jan. 1999	**1,181,129**	May 2004
17.	Grand Terre Vegetative Plantings	NMFS	Vegetative planting	127	Jan. 1998	**492,774**	Jul. 2001
18.	Pecan Island Terracing	NMFS	Terracing	442	Jan. 1998	**2,391,953**	Sept. 2003
19.	Thin Mat Floating Marsh Enhancement Demonstration	NRCS	Marsh creation	Data not applicable	Jan. 1998	**538,101**	May 2000
20.	Flexible Dustpan Demo at Head of Passes Demonstration	Corps	Marsh creation	Data not applicable	Apr. 1997	**1,911,487**	Jun. 2002

	Project name	Agency sponsor	Project type	Anticipated total acres[a]	Project approval date	Current total cost estimate	Construction completion date
21.	Marsh Island Hydrologic Restoration[b]	Corps	Hydrologic restoration	408	Apr. 1997	**5,143,288**	Dec. 2001
22.	Nutria Harvest for Wetland Restoration Demonstration	FWS	Invasive species control program	Data not applicable	Apr. 1997	**804,683**	Oct. 2003
23.	Black Bayou Hydrologic Restoration	NMFS	Hydrologic restoration	3,594	Apr. 1997	**5,972,613**	Nov. 2003
24.	Delta Wide Crevasses	NMFS	Sediment diversion	2,386	Apr. 1997	**4,752,653**	May 2005
25.	Sediment Trapping at The Jaws	NMFS	Sediment and nutrient trapping	1,999	Apr. 1997	**3,392,135**	May 2005
26.	Barataria Bay Waterway East Side Shoreline Protection	NRCS	Shoreline protection	217	Apr. 1997	**5,224,477**	May 2001
27.	Cheniere au Tigre Sediment Trapping Demonstration	NRCS	Sediment and nutrient trapping	Data not applicable	Apr. 1997	**624,999**	Nov. 2001
28.	Oaks/Avery Canal Hydrologic Restoration, Part One	NRCS	Hydrologic restoration	160	Apr. 1997	**2,925,216**	Oct. 2002
29.	Bayou Chevee Shoreline Protection	Corps	Shoreline protection	75	Feb. 1996	**2,589,403**	Dec. 2001
30.	Little Vermilion Bay Sediment Trapping	NMFS	Sediment and nutrient trapping	441	Feb. 1996	**886,030**	Aug. 1999
31.	Freshwater Bayou Bank Stabilization	NRCS	Shoreline protection	511	Feb. 1996	**2,543,313**	Jun. 1998
32.	Naomi Outfall Management	NRCS	Outfall management	633	Feb. 1996	**2,181,427**	Jul. 2002
33.	Raccoon Island Breakwaters Demonstration	NRCS	Shoreline protection	Data not applicable	Feb. 1996	**1,795,388**	Jul. 1997
34.	Sweet Lake/Willow Lake Hydrologic Restoration	NRCS	Shoreline protection	247	Feb. 1996	**4,242,995**	Oct. 2002
35.	East Timbalier Island Sediment Restoration, Part Two[b]	NMFS	Barrier island restoration	215	Dec. 1994	**7,600,863**	Jan. 2000
36.	Barataria Bay Waterway West Side Shoreline Protection	NRCS	Shoreline protection	232	Dec. 1994	**3,013,365**	Nov. 2000
37.	Perry Ridge Shore Protection	NRCS	Shoreline protection	1,203	Dec. 1994	**2,289,090**	Feb. 1999
38.	Plowed Terraces Demonstration	NRCS	Terracing	Data not applicable	Dec. 1994	**325,641**	Aug. 2000
39.	Channel Armor Gap Crevasse	Corps	Sediment diversion	936	Oct.1993	**888,985**	Nov. 1997

	Project name	Agency sponsor	Project type	Anticipated total acres[a]	Project approval date	Current total cost estimate	Construction completion date
40.	Mississippi River Gulf Outlet Disposal Area Marsh Protection	Corps	Hydrologic restoration	755	Oct. 1993	**313,145**	Jan. 1999
41.	Whiskey Island Restoration[b]	EPA	Barrier island restoration	1,239	Oct. 1993	**7,106,586**	Jun. 2000
42.	Sabine Refuge Structure Replacement (Hog Island)[b]	FWS	Hydrologic restoration	953	Oct. 1993	**4,528,418**	Sept. 2003
43.	East Timbalier Island Sediment Restoration, Part One[b]	NMFS	Barrier island restoration	1,913	Oct. 1993	**3,729,587**	May 2001
44.	Lake Chapeau Sediment Input and Hydrologic Restoration	NMFS	Marsh creation	509	Oct. 1993	**5,605,856**	May 1999
45.	Lake Salvador Shore Protection Demonstration	NMFS	Shoreline protection	Data not applicable	Oct. 1993	**2,801,782**	Jun. 1998
46.	Brady Canal Hydrologic Restoration	NRCS	Hydrologic restoration	297	Oct. 1993	**5,279,558**	May 2000
47.	Cameron-Creole Maintenance[b]	NRCS	Hydrologic restoration	2,602	Oct. 1993	**5,840,505**	Sept. 1997
48.	Cote Blanche Hydrologic Restoration	NRCS	Hydrologic restoration	2,223	Oct. 1993	**7,889,103**	Dec. 1998
49.	Clear Marais Bank Protection	Corps	Shoreline protection	1,067	Oct. 1992	**3,696,088**	Mar. 1997
50.	Isles Dernieres Restoration Trinity Island[b]	EPA	Barrier island restoration	109	Oct. 1992	**10,774,974**	Jun. 1999
51.	Bayou Sauvage National Wildlife Refuge Hydrologic Restoration, Part Two	FWS	Hydrologic restoration	1,280	Oct. 1992	**1,642,552**	May 1997
52.	Atchafalaya Sediment Delivery	NMFS	Sediment diversion	2,232	Oct. 1992	**2,532,147**	Mar. 1998
53.	Big Island Mining	NMFS	Marsh creation	1,560	Oct. 1992	**7,077,404**	Oct. 1998
54.	Point Au Fer Canal Plugs	NMFS	Shoreline protection	375	Oct. 1992	**3,235,208**	May 1997
55.	Caernarvon Diversion Outfall Management[b]	NRCS	Outfall management	802	Oct. 1992	**4,536,000**	Jun. 2002
56.	East Mud Lake Marsh Management[b]	NRCS	Marsh management	1,520	Oct. 1992	**4,095,936**	Jun. 1996
57.	Freshwater Bayou Wetland Protection	NRCS	Shoreline protection	1,593	Oct. 1992	**3,455,303**	Aug. 1998
58.	Fritchie Marsh Restoration	NRCS	Hydrologic restoration	1,040	Oct. 1992	**2,201,674**	Mar. 2001
59.	Highway 384 Hydrologic Restoration[b]	NRCS	Hydrologic restoration	150	Oct. 1992	**1,058,554**	Jan. 2000
60.	Vermilion Bay/Boston Canal Shore Protection	NRCS	Shoreline protection	378	Oct. 1992	**1,012,649**	Nov. 1995

	Project name	Agency sponsor	Project type	Anticipated total acres[a]	Project approval date	Current total cost estimate	Construction completion date
61.	Barataria Bay Waterway Wetland Creation	Corps	Marsh creation	445	Oct. 1991	**1,172,896**	Oct. 1996
62.	Bayou Labranche Wetland Creation	Corps	Marsh creation	203	Oct. 1991	**3,817,929**	Apr. 1994
63.	Lake Salvador Shoreline Protection at Jean Lafitte National Historic Park and Preserve	Corps	Shoreline protection	Data not applicable	Oct. 1991	**58,753**	Mar. 1996
64.	Vermilion River Cutoff Bank Protection	Corps	Shoreline protection	65	Oct. 1991	**2,022,987**	Feb. 1996
65.	West Bay Sediment Diversion	Corps	Sediment diversion	9,831	Oct. 1991	**22,312,761**	Nov. 2003
66.	Isles Dernieres Restoration East Island[b]	EPA	Barrier island restoration	9	Oct. 1991	**8,762,416**	Jun. 1999
67.	Bayou Sauvage National Wildlife Refuge Hydrologic Restoration, Part One	FWS	Hydrologic restoration	1,550	Oct. 1991	**1,630,193**	May 1996
68.	Cameron Creole Plugs[b]	FWS	Hydrologic restoration	865	Oct. 1991	**991,295**	Jan. 1997
69.	Cameron Prairie National Wildlife Refuge Shoreline Protection	FWS	Shoreline protection	247	Oct. 1991	**1,227,123**	Aug. 1994
70.	Sabine National Wildlife Refuge Erosion Protection	FWS	Shoreline protection	5,542	Oct. 1991	**1,602,656**	Mar. 1995
71.	Gulf Intracoastal Waterway to Clovelly Hydrologic Restoration[b]	NRCS	Hydrologic restoration	175	Oct, 1991	**8,916,131**	Oct. 2000
72.	Vegetative Plantings-Falgout Canal Planting Demonstration	NRCS	Vegetative planting	Data not applicable	Oct. 1991	**209,284**	Dec. 1996
73.	Vegetative Plantings-Timbalier Island Planting Demonstration	NRCS	Vegetative planting	Data not applicable	Oct. 1991	**293,124**	Jul. 1996
74.	Vegetative Plantings-West Hackberry Planting Demonstration	NRCS	Vegetative planting	Data not applicable	Oct. 1991	**258,805**	Mar. 1994
	Grand total			**58,781**		**$298,606,032**	

Source: GAO analysis of Corps data.

Note: Data as of June 8, 2007.

[a]The CWPPRA program does not report acreage for demonstration projects. Demonstration projects test new techniques and materials for the restoration or protection of coastal wetlands. Other projects, such as the state of Louisiana Wetlands Conservation Plan, support the CWPPRA program. The Lake Salvador Shoreline Protection project at Jean Lafitte National Historic Park and Preserve was designed under CWPPRA but construction was funded by the National Park Service.

[b]Damaged by Hurricane Katrina or Rita in 2005.

Table 4: Summary Schedule of CWPPRA Projects Terminated as of June 2007

	Project name	Agency sponsor	Project type	Project approval date	Project termination date	Current total cost estimate	Reason for termination
1.	LA Highway 1 Marsh Creation	EPA	Marsh creation	Jan. 2000	Feb. 2005	**$343,551**	Cost-effectiveness, technical difficulties
2.	Bayou L'Ours Ridge Hydrologic Restoration	NRCS	Hydrologic restoration	Dec. 1994	Apr. 2003	**371,232**	Land rights
3.	Upper Oak River Freshwater Siphon	NRCS	Freshwater reintroduction	Jan. 1999	Jan. 2003	**56,476**	Cost-effectiveness
4.	Bayou Bienvenue Pump Station Diversion and Terracing	NMFS	Terracing	Jan. 1999	Apr. 2002	**212,153**	Cost-effectiveness
5.	Compost Demonstration	EPA	Marsh creation	Dec. 1994	Jan. 2002	**213,645**	Technical difficulties
6.	Red Mud Demonstration	EPA	Marsh creation	Oct. 1993	Aug. 2001	**470,500**	Technical difficulties
7.	Beneficial Use of Hopper Dredge Material Demonstration	Corps	Marsh creation	Dec. 1994	Oct. 2000	**58,310**	Technical difficulties
8.	Violet Freshwater Distribution	NRCS	Outfall management	Oct. 1993	Oct. 2000	**128,627**	Land rights
9.	Flotant Marsh Fencing Demonstration	NRCS	Vegetation planting	Dec. 1994	Oct. 2000	**106,960**	Technical difficulties
10.	Southwest Shore White Lake Demonstration	NRCS	Shoreline protection	Oct. 1993	Oct. 1998	**103,468**	Technical difficulties
11.	Pass-a-Loutre Crevasse	Corps	Sediment diversion	Oct. 1993	Jul. 1998	**119,835**	Cost-effectiveness
12.	Grand Bay Crevasse	Corps	Sediment diversion	Dec. 1994	Jul. 1998	**65,747**	Land rights
13.	Marsh Creation East of the Atchafalaya River-Avoca Island	Corps	Marsh creation	Apr. 1997	Jul. 1998	**66,869**	Cost-effectiveness
14.	Bayou Boeuf Pump Station	EPA	Hydrologic restoration	Apr. 1997	Jul. 1998	**3,452**	Technical difficulties
15.	Bayou Perot/Bayou Rigolettes Marsh Restoration	NMFS	Marsh creation	Oct. 1993	Jan. 1998	**20,963**	Cost-effectiveness
16.	Eden Isles East Marsh Restoration	NMFS	Hydrologic restoration	Dec. 1994	Jan. 1998	**78,051**	Land rights
17.	White's Ditch Outfall Management	NRCS	Outfall management	Oct. 1993	Jan. 1998	**32,862**	Land rights
18.	Lower Bayou LaCache Hydrologic Restoration	NMFS	Hydrologic restoration	Oct. 1991	Feb. 1996	**99,625**	Land rights

	Project name	Agency sponsor	Project type	Project approval date	Project termination date	Current total cost estimate	Reason for termination
19.	Vegetation Plantings-Dewitt-Rollover Planting Demonstration	NRCS	Vegetation planting	Oct. 1991	Feb. 1996	**184,024**	Design problems
20.	Fourchon Hydrologic Restoration	NMFS	Hydrologic restoration	Oct. 1991	Jul. 1994	**7,703**	Land rights
	Grand total					**$2,744,053**	

Source: GAO analysis of Corps data.

Note: Data as of June 8, 2007.

Appendix II: Comments from the Department of Commerce

THE SECRETARY OF COMMERCE
Washington, D.C. 20230

November 26, 2007

Ms. Anu K. Mittal
Director, Natural Resources
and Environment
U.S. Government Accountability Office
441 G Street, NW
Washington, D.C. 20548

Dear Ms. Mittal:

Thank you for the opportunity to review and comment on the Government Accountability Office's draft report entitled *Coastal Wetlands: Lessons Learned from Past Efforts in Louisiana Could Help Guide Future Restoration and Protection* (GAO-08-130). On behalf of the Department of Commerce, I enclose the National Oceanic and Atmospheric Administration's comments on the draft report.

Sincerely,

Carlos M. Gutierrez

Enclosure

Department of Commerce
National Oceanic and Atmospheric Administration
Comments on the Draft GAO Report Entitled
"Coastal Wetlands: Lessons Learned from Past Efforts in Louisiana Could Help Guide Future Restoration and Protection"
(GAO-08-130/November 2007)

General Comments

The Department of Commerce appreciates the opportunity to review this report on lessons learned in Louisiana coastal restoration. The National Oceanic and Atmospheric Administration (NOAA) has found the report generally accurate and thorough. However, the manner in which the current state of monitoring is described appears somewhat misleading. The report suggests the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) program is not able to assess the success of constructed projects. Given the extremely large scale and complexity of the Louisiana coastal area, statistically proving project success is a challenge, and long term data acquisition will be required prior to drawing scientifically defensible and reproducible conclusions. In the meantime, NOAA believes that ongoing project monitoring offers critical insight into qualitative and quantitative project performance. NOAA integrates this information into planning and design of new projects. In addition, NOAA and partner agencies recognize the usefulness of project-specific data in designing more effective projects. For many projects, NOAA specifically requests that the CWPPRA Task Force allocate CWPPRA funds for project-specific monitoring.

The following are GAO's comments on the Department of Commerce's letter dated November 26, 2007.

GAO Comments

1. We disagree with the agency that the reports' characterization of CWPPRA monitoring is misleading because it suggests that the program is not able to assess the success of constructed projects. However, we have modified the report to clarify some of the issues raised by the agency.

Appendix III: Comments from the Environmental Protection Agency

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NOV 2 1 2007

Ms. Anu K. Mittal
Director
Natural Resources and Environment
U.S. Government Accountability Office
Washington, DC 20548

Dear Ms.Mittal:

Thank you for the opportunity to review the proposed report entitled *Coastal Wetlands: Lessons Learned from Past Efforts in Louisiana Could Help Guide Future Restoration and Protection* (GAO-08-130). As the U.S. Environmental Protection Agency (EPA) representative on the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Task Force, I would like to express my appreciation for the focus and attention given to this very important restoration effort. EPA Region 6 and Headquarters have participated with GAO staff in informational briefings during the development of the report and have provided input on the preliminary statement of facts. We have also reviewed the current draft report and have no additional comments.

I would, however, like to take this opportunity to recognize one of the key points in this report -- the importance of the collaborative approach used by the CWPPRA program agencies. Since 1990, CWPPRA, or the Breaux Act, has been a consistent mainstay in dedicated Federal and State funding for wetland restoration throughout the Louisiana coast. The suite of restoration techniques implemented under this program, including barrier island restoration and the use of renewable Mississippi River freshwater and sediment resources, have served as examples of the critical work that can be accomplished collaboratively.

As the draft report points out, it is the collaborative interagency process that has greatly contributed to the CWPPRA program's effectiveness. Addressing the ongoing wetland loss and increased hurricane risk in coastal Louisiana will continue to require a wide range of expertise and capabilities. By establishing this interagency process for comprehensive project planning and implementation, the CWPPRA program optimizes the diverse array of resources, technical skill, and perspectives of Federal and State agencies with expertise in coastal restoration. Given the experience gained from nearly two decades of coastal wetland restoration project implementation, CWPPRA remains the most effective model for the interagency collaboration and public participation necessary for success.

Thank you again for taking such an active role on the critically important issue of addressing coastal Louisiana wetland loss. I believe that continued collaborative efforts in protecting and restoring such vital aquatic resources offer the long-term promise of benefits to the economy, communities, and natural resources of the State of Louisiana and to the Nation as a whole.

Sincerely,

William K. Honker
Deputy Director
Water Quality Protection Division

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the individual named above, Edward Zadjura, Assistant Director; James Dishmon; Doreen Feldman; Christine Frye; Moses Garcia; Sheila McCoy; and Alison O'Neill made key contributions to this report.

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