1.0 INTRODUCTION

1.1 STUDY BACKGROUND

The Louisiana coastal plain contains one of the largest expanses of coastal wetlands in the contiguous United States (U.S.), and accounts for 90 percent of the total coastal marsh loss in the Nation. The coastal wetlands, built by the deltaic processes of the Mississippi River, contain an extraordinary diversity of coastal habitats that range from narrow natural levee and beach ridges to expanses of forested swamps and freshwater, intermediate, brackish, and saline marshes. Taken as a whole, the unique habitats, with their hydrological connections to each other, upland areas, the Gulf of Mexico, and migratory routes of birds, fish, and other species, combine to place the coastal wetlands of Louisiana among the Nation's most productive and important natural assets. In human terms, these coastal wetlands have been a center for culturally diverse social development.

Approximately 70 percent of all waterfowl that migrate through the U.S. use the Mississippi and Central flyways. With more than 5 million birds wintering in Louisiana, the Louisiana coastal wetlands are crucial habitat to these birds, as well as to neotropical migratory songbirds and other avian species who use them as crucial stopover habitat. Additionally, coastal Louisiana provides crucial nesting habitat for many species of water birds, such as the endangered brown pelican. These economic and habitat values, which are protected and supported by the coastal wetlands of Louisiana, are significant on a National level.

Louisiana's coastal wetlands and barrier island systems enhance protection of an internationally significant commercial-industrial complex from the destructive forces of storm-driven waves and tides. A complex of deep-draft ports includes the Port of South Louisiana, which handles more tonnage than any other port in the Nation, and the most active segment of the Nation's Gulf Intracoastal Waterway (GIWW) (Waterborne Commerce Statistics Center (WCSC) 2002). In 2000, Louisiana led the Nation with production of 592 million barrels of oil and condensate (including the outer continental shelf (OCS)), valued at $17 billion, and was second in the Nation in natural gas production with $1.3 billion (excluding OCS and casing head gas) (Louisiana Department of Natural Resources [LDNR] 2003a). In addition, nearly 34 percent of the Nation's natural gas supply and over 29 percent of the Nation's crude oil supply moves through the state and is connected to nearly 50 percent of U.S. refining capacity (LDNR 2003a).

Additionally, coastal Louisiana is home to over 2 million people, representing 46 percent of the state's population. When investments in facilities, supporting service activities, and the urban infrastructure are totaled, the capital investment in the Louisiana coastal area adds up to approximately $100 billion. Excluding Alaska, Louisiana produced the Nation's highest commercial marine fish landings (about $343 million) excluding mollusk landings such as clams, oysters, and scallops (National Marine Fisheries Service (NMFS) 2003). Recent data from the U.S. Fish and Wildlife Service (USFWS) show expenditures on recreational fishing (trip and equipment) in Louisiana to be nearly $703 million, and hunting expenditures were valued at $446 million in 2001 (USFWS 2002).

Louisiana's coastal wetlands were built by deltaic processes involving the transport of enormous volumes of sediment and water by the Mississippi River. This sediment was eroded from the lands of the vast Mississippi River Basin in the interior of North America. For the last several thousand years, the dominance of the land building or deltaic processes resulted in a net increase of more than four million acres of coastal wetlands. In addition, there was the creation of an extensive skeleton of higher natural levee ridges along the past and present Mississippi River channels, distributaries, and bayous in the Deltaic Plain and beach ridges of the Chenier Plain. The landscape created by these deltaic processes gave rise to one of the most productive ecosystems on Earth.

Today, most of the Mississippi River's fresh water, with its nutrients and sediment, flows directly into the Gulf of Mexico, largely bypassing the coastal wetlands. Deprived of land-building sediment, the wetlands are damaged by saltwater intrusion and other causative factors associated with sea level change and land subsidence, and will eventually convert to open water. Deprived of the nutrients, the plants that define the surface of the coastal wetlands die off. Once the coastal wetlands are denuded of vegetation, the fragile substrate is left exposed to the erosive forces of waves and currents, especially during tropical storm events.

Since the 1930s coastal Louisiana has lost more than 1.2 million acres (485,830 ha) (Barras et al. 2003; Barras et al. 1994; and Dunbar et al. 1992). As recently as the 1970s, the loss rate for Louisiana's coastal wetlands was as high as 25,200 acres per year (10,202 ha per year). The rate of loss from 1990 to 2000 was about 15,300 acres per year (6,194 ha per year), mainly due to the residual effects of past human activity (Barras et al. 2003). It was estimated in 2000 that coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year (2,672 ha per year) over the next 50 years. It is estimated that an additional net loss of 328,000 acres (132,794 ha) may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands (Barras et al. 2003). The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and shifted the coastal area from a condition of net land building to one of net land loss.

In 1990, passage of the Coastal Wetlands Planning, Protection and Restoration Act, (PL-101-646, Title III, CWPPRA), provided authorization and funding for the Louisiana Coastal Wetlands Conservation and Restoration Task Force to begin actions to curtail wetland losses. In 1998, after extensive studies and construction of a number of coastal restoration projects accomplished under CWPPRA, the State of Louisiana, and the Federal agencies charged with restoring and protecting the remainder of Louisiana's valuable coastal wetlands developed the "Coast 2050: Toward a Sustainable Coastal Louisiana" report, known as the Coast 2050 Plan. The underlying principles of the Coast 2050 Plan are to restore or mimic the natural processes that built and maintained coastal Louisiana. This plan proposed ecosystem restoration strategies that would result in efforts larger in scale than any that had been implemented in the past.

The Coast 2050 Plan was the basis for the May 1999 report, entitled Section 905(b) ([Water Resource Development Act] (WRDA) 1986) Analysis Louisiana Coastal Area, Louisiana --Ecosystem Restoration. This reconnaissance-level effort evaluated the Coast 2050 Plan as a whole and expressed a Federal interest in proceeding to the feasibility phase. In 2000, it was envisioned that a series of feasibility reports would be prepared over a 10-year period.

The first feasibility efforts focused on the Barataria Basin and involved marsh creation and barrier shoreline restoration. However, early in fiscal year (FY) 2002, it was recognized that it would be more efficient to develop a comprehensive coastal restoration effort that could be submitted to Congress as a blueprint for future restoration efforts. As a result, the USACE and the State of Louisiana initiated the Louisiana Coastal Area (LCA) Comprehensive Coastwide Ecosystem Restoration Study. In FY 2004, recognition of Federal and state funding constraints and scientific and engineering uncertainties pertaining to some of the restoration features under consideration led to the determination that the coastal area ecosystem restoration effort should begin with the development and implementation of a restoration plan that identifies highly cost-effective restoration features that address the most critical needs of coastal Louisiana, as well as large-scale and long-term restoration concepts.

1.2 STUDY AUTHORITY

This LCA Ecosystem Restoration Study (LCA Study) is authorized through resolutions of the U.S. House of Representatives and Senate Committees on Public Works, 19 April 1967 and 19 October 1967. These resolutions contain the following language:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the reports of the Chief of Engineers on the Mermentau River and Tributaries and Gulf Intracoastal Waterway and connecting waters, Louisiana, published as Senate Document Numbered 231, Seventy-ninth Congress, on the Bayou Teche, Teche-Vermilion Waterway and Vermilion River, Louisiana, published as Senate Document Numbered 93, Seventy-seventh Congress, on the Calcasieu River salt water barrier, Louisiana, published as House Document Numbered 582, Eighty-seventh Congress, and on Bayous Terrebonne, Petit Caillou, Grand Caillou, Dularge, and connecting channels, Louisiana, and the Atchafalaya River, Morgan City to the Gulf of Mexico, published as House Document Numbered 583, Eighty-seventh Congress, and other pertinent reports including that on Bayou Lafourche and Lafourche-Jump Waterway, Louisiana, published as House Document Numbered 112, Eighty-sixth Congress, with a view to determining the advisability of improvements or modifications to existing improvements in the coastal area of Louisiana in the interest of hurricane protection, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and related water resource purposes."

Attachment 1 includes summaries of other pertinent coastal restoration and related water resources authorizations that may be useful for implementing coastal restoration.

1.3 STUDY PURPOSE AND SCOPE

The purpose of the LCA Study is to:

- Identify the most critical human and natural ecological needs of the coastal area;

- Present and evaluate conceptual alternatives for meeting the most critical needs;
- Identify the kinds of restoration features that could be implemented in the near-term (within 5 to 10 years) that address the most critical needs, and propose to address these needs through features that provide the highest return in net benefits per dollar of cost;
- Establish priorities among the identified near-term restoration features;
- Describe a process by which the identified priority near-term restoration features could be developed, approved, and implemented;
- Identify the key scientific uncertainties and engineering challenges facing the effort to protect and restore the ecosystem, and propose a strategy for resolving them;
- Identify, assess and, if appropriate, recommend feasibility studies that should be undertaken within the next 5 to 10 years to fully explore other potentially promising large-scale restoration concepts; and
- Present a strategy for addressing the long-term needs of coastal Louisiana restoration beyond the near-term focus of the Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan).

The goal of the LCA Plan is to reverse the current trend of degradation of the coastal ecosystem. The plan emphasizes the use of restoration strategies that: reintroduce historical flows of river water, nutrients, and sediment to coastal wetlands: restore coastal hydrology to minimize saltwater intrusion; and maintain the structural integrity of the coastal ecosystem. Execution of the LCA Plan would make significant progress towards achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus contribute to the economy and well being of the Nation. Benefits to and effects on existing infrastructure, including navigation, hurricane protection, flood control, land transportation works, agricultural lands, and oil and gas production and distribution facilities were strongly considered in the formulation of coastal restoration plans.

The LCA Plan is based upon the extensive experience gained through the on-going CWPPRA implementation effort, best available science and engineering, professional judgment, and other extensive experience in coastal restoration in Louisiana and beyond. The LCA Plan identifies, evaluates, and recommends to decision makers an appropriate, coordinated, and feasible course of action to address the identified critical water resource problems and restoration opportunities in coastal Louisiana. This report provides a complete presentation of the study process, results, and findings; indicates compliance with applicable statutes, executive orders, and policies; documents the Federal and non-Federal interest; and provides a sound and documented basis for decision makers at all levels to evaluate the request for:

- Specific authorization for implementation of five near-term critical restoration features for which construction can begin within 5 to 10 years, subject to approval of feasibility-level decision documents by the Secretary of the Army (hereinafter referred to as "conditional authorization" in the Main Report and accompanying Final Environmental Impact Statement);
- Programmatic Authorization of a Science and Technology Program;

- Programmatic Authorization of Science and Technology Program Demonstration Projects;
- Programmatic Authorization for the Beneficial Use of Dredged Material;
- Programmatic Authorization for Investigations of Modification of Existing Structures;
- Approval of 10 additional near-term critical restoration features and authorization for investigations to prepare necessary feasibility-level reports to be used to present recommendations for potential future Congressional authorizations (hereinafter referred to as "Congressional authorization"); and
- Approval of investigations for assessing six potentially promising large-scale and long-term restoration concepts.

The approval of the LCA Plan would initiate development of a series of feasibility-level decision documents that would provide detailed project justification, design, and implementation data. These future feasibility-level decision documents would support requests for project construction and would provide the basis for the implementation of the plan documented in this study report.

1.4 STUDY AREA DESCRIPTION

The study area, which includes Louisiana's coastal area from Mississippi to Texas, is comprised of two wetland-dominated ecosystems, the Deltaic Plain of the Mississippi River and the closely linked Chenier Plain, both of which are influenced by the Mississippi River. For planning purposes, the study area was divided into four subprovinces, with the Deltaic Plain comprising Subprovinces 1, 2, and 3, and the Chenier Plain comprising Subprovince 4 (**figure MR 1-1**).

Louisiana parishes included in the study area are: Ascension, Assumption, Calcasieu, Cameron, Iberia, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Martin, St. Mary, St. Tammany, Tangipahoa, Terrebonne, and Vermilion (**figure MR 1-2**). Subprovince 1 covers portions of Livingston, Tangipahoa, St. Tammany, St. Bernard, Orleans, St. Charles, St. John the Baptist, St. James, Ascension, Plaquemines, and Jefferson Parishes. Subprovince 2 covers all or part of Ascension, Plaquemines, Jefferson, Lafourche, St. Charles, St. James, St. John the Baptist, and Assumption Parishes. Subprovince 3 contains all or part of Lafourche, Terrebonne, Assumption, Iberville, St. Martin, Iberia, St. Mary, and Vermilion Parishes. Subprovince 4 contains all or part of Vermilion, Cameron, and Calcasieu Parishes.

Today, the Deltaic Plain is a vast wetland area stretching from the eastern border of Louisiana to Freshwater Bayou. It is characterized by several large lakes and bays, natural levee ridges (up to 20 feet [6.1 meters] above sea level), and bottomland hardwood forests that gradually decrease in elevation to various wetland marshes. The Deltaic Plain contains numerous barrier islands and headlands, such as the Chandeleur Islands, Barataria Basin Barrier Islands, and Terrebonne Basin Barrier Islands. The Chenier Plain extends from the Teche/Vermilion bays to Louisiana's western border with Texas, and is characterized by several large lakes, marshes, cheniers, and coastal beaches.

Within the broadly delineated zones of marsh habitat types, a variety of other wetland habitats (with distinct surface features and vegetative communities) occur in association with the marshes. These include swamp and wetland forests, beach and barrier islands, upland, and other important habitats. There are also unique vegetative communities in the coastal area, such as floating marshes and maritime forests, that contribute to the extensive diversity of the coastal ecosystem and which are essential to the overall stability of the ecosystem.

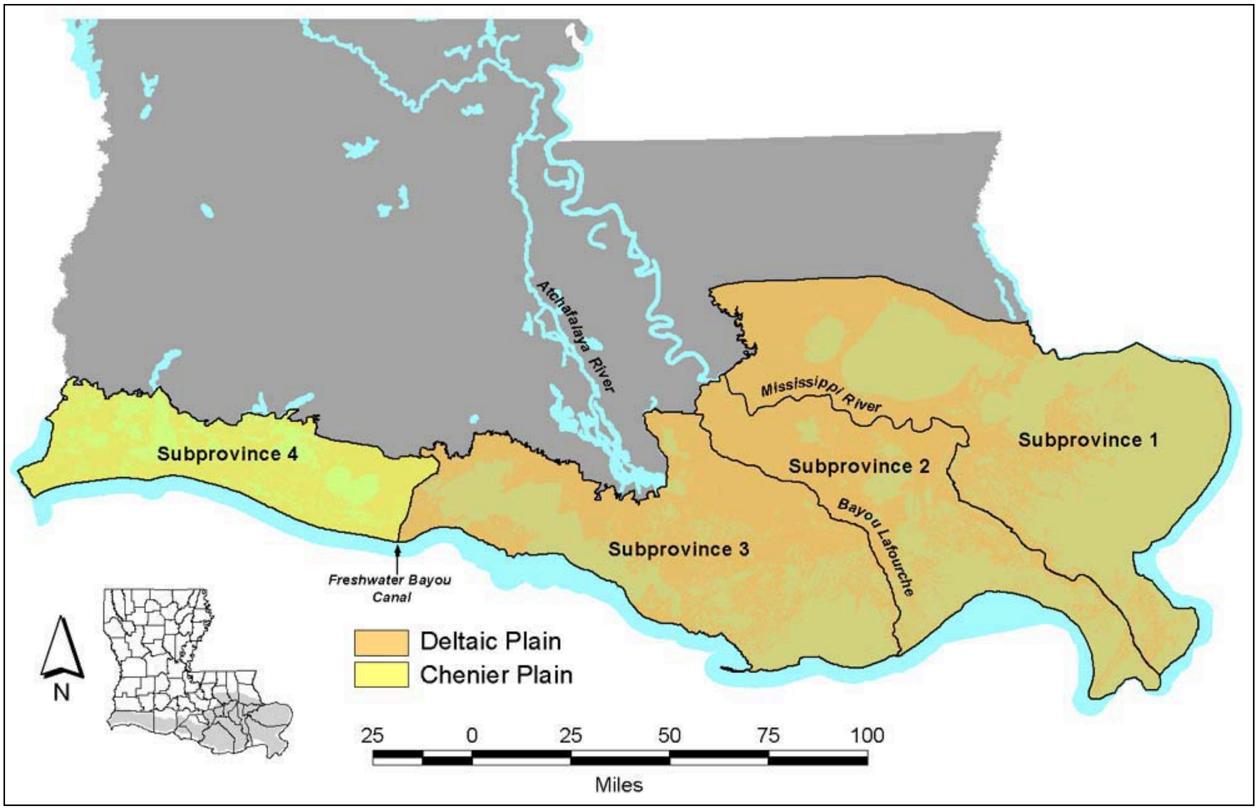


Figure MR 1-1. LCA Study Area and Subprovinces.

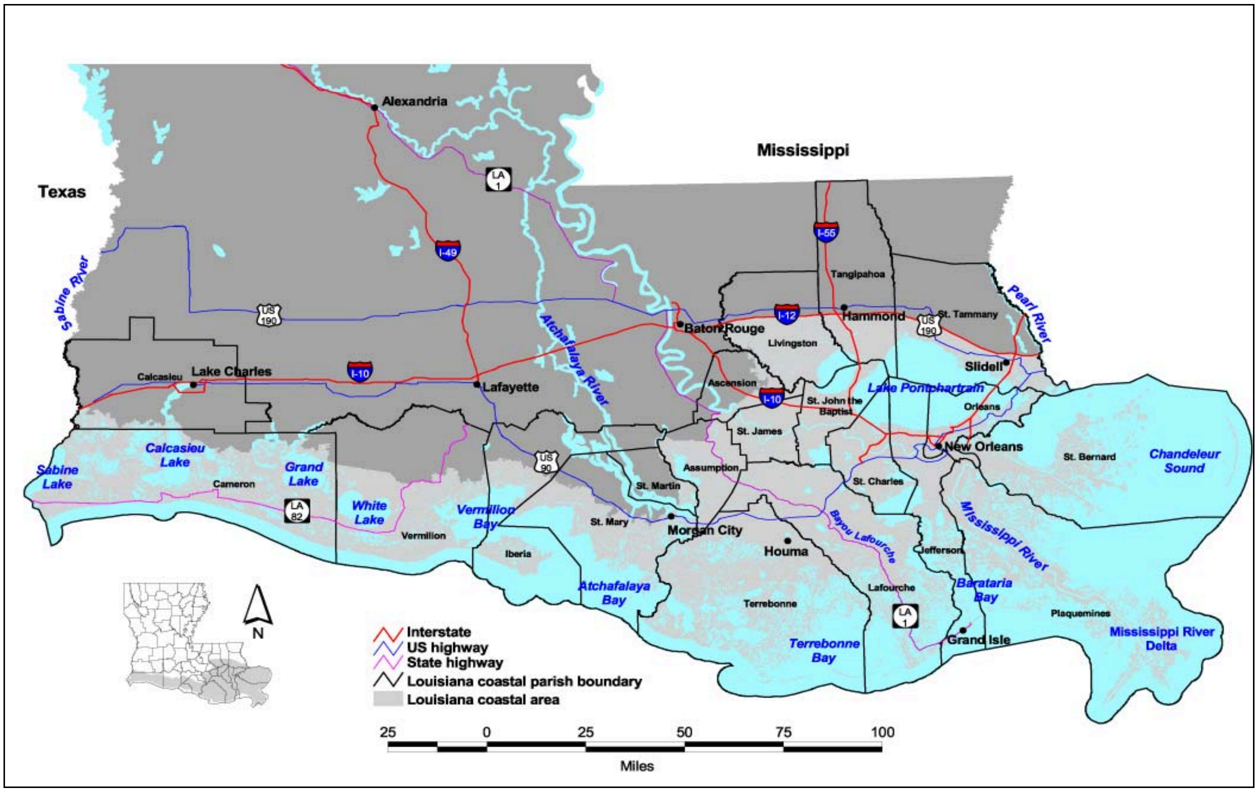


Figure MR 1-2. LCA Study Area Parishes, Major Water Bodies, and Highways.

1.5 COASTAL SYSTEM PROCESSES

1.5.1 Deltaic Cycle

The geologic development of coastal Louisiana and the resulting coastal landscape were dependent upon shifting Mississippi River courses and are influenced by the orderly progression of events related to the "deltaic cycle." The deltaic cycle is a dynamic and episodic process alternating between periods of "delta-building" with seaward advancement (progradation) of deltas and the subsequent landward retreat (degradation). As deltas are abandoned, the seaward edges are reworked into barrier headlands and barrier islands. Subsequently, the wetland complex behind the headlands and islands, without a significant and continuous source of sediment and nutrients, eventually succumbs to subsidence and becomes submerged by marine waters. The Mississippi River has changed its course several times during the last 7,000 year. Each time the Mississippi River has built a major delta it has eventually abandoned that river course in favor of a shorter, more direct route to the Gulf of Mexico. The Deltaic Plain is composed of six major delta complexes: two prograding and four degrading (**figure MR 1-3**).

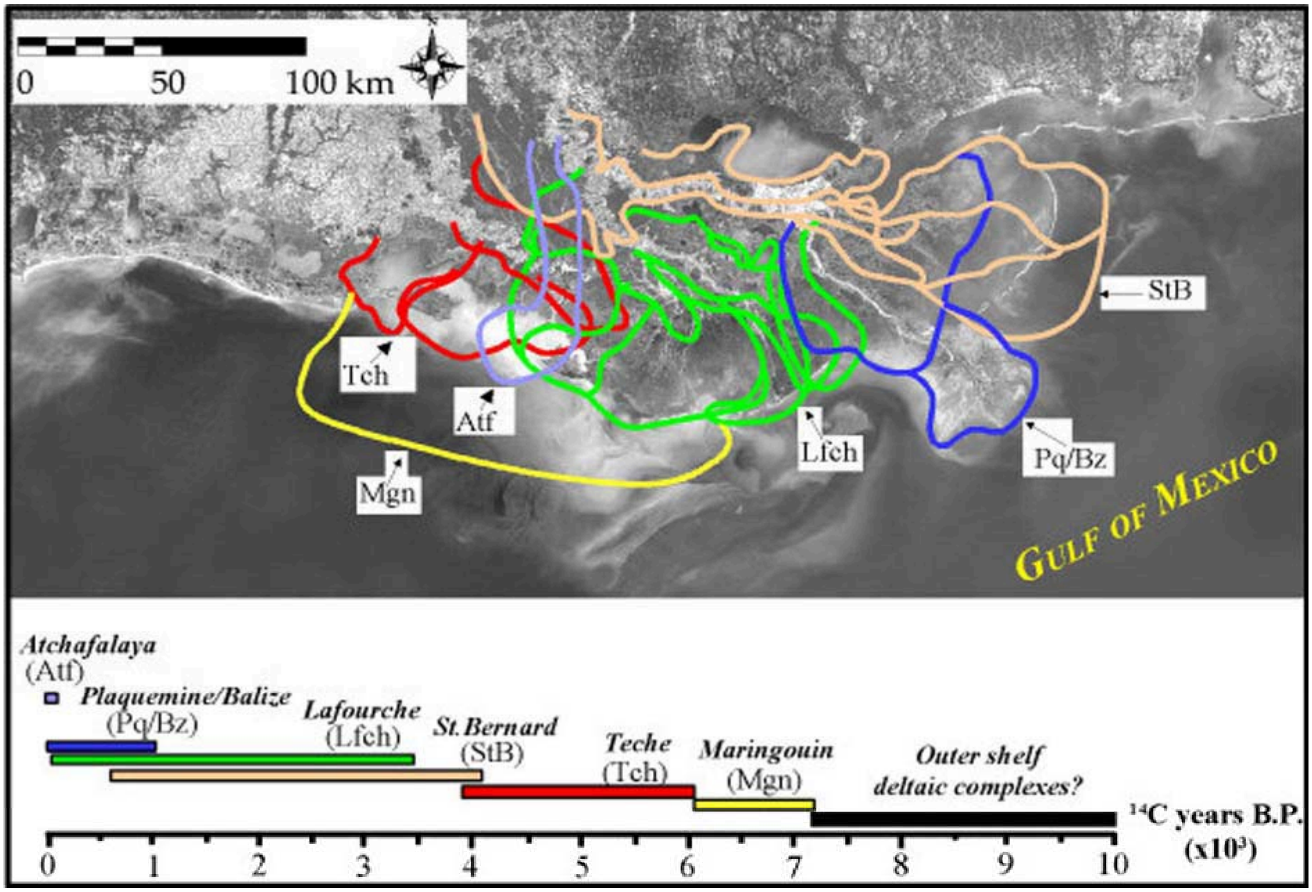


Figure MR 1-3. The Mississippi River Deltaic Plain with locations of major delta complexes. The Atchafalaya and Modern Delta complexes are active and the Teche, Lafourche, and St. Bernard complexes are inactive (*modified from Frazier 1967*)**.**

1.5.2 Delta Advancement

The Deltaic Plain wetland ecosystem developed as a result of delta-building processes, during which sea level conditions were relatively stable. The deltaic cycle is initiated when a stream or river, such as the Mississippi River, enters an open water body, such as a coastal lake or bay, which slows the velocity of the river's flow, thus limiting the river's ability to transport sediment. Consequently, most of the larger-grained sediment carried by the river drops out of the water column and falls to the bottom. Over time, the river deposits enough sediment to create land, which then becomes colonized by wetland plants. The organic deposition from additional river-borne sediment and decomposing wetland vegetation are the primary factors behind the land-building process. In this fashion, large expanses of wetlands, or deltas, form and extend seaward between the distributaries, or "fingers" of the delta, as long as the river continues to supply freshwater, nutrients, and land-building sediment.

Delta building is currently occurring in only two locations along the Louisiana coast. One location is the active Mississippi Delta, where a bird foot pattern of land extends out into the deep water of the Gulf of Mexico. The other location is the Atchafalaya Delta (**figure MR 1-4**) where, since about 1973, a delta has formed at the mouths of the Wax Lake Outlet and the Lower Atchafalaya River.

Figure MR 1-4. Delta Advancement at Wax Lake Outlet and the Lower Atchafalaya River.

Land building and nourishment within the Mississippi River Delta complex also occurred when floodwaters would overflow the riverbanks, or when river water would exit the main channel and travel through natural outlets, or distributaries, of the main river. In addition, floodwaters would periodically burst through weak points in the natural levees along the riverbank to create crevasses. Oftentimes, these floods deposited enormous amounts of sediment and were integral to land-building processes in the Deltaic Plain. Historical records indicate that major flooding events have created crevasses at 20 locations along the river in the Deltaic Plain (**figure MR 1-5**).

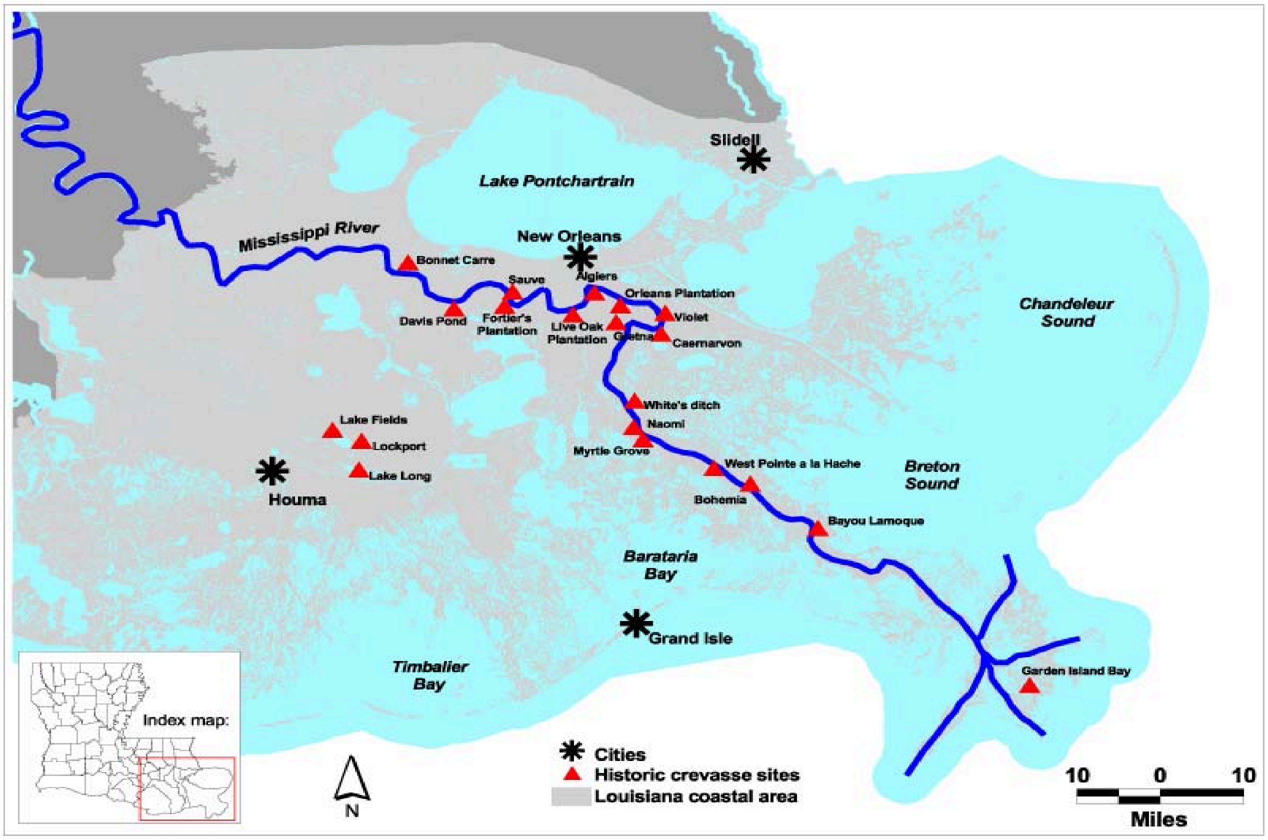


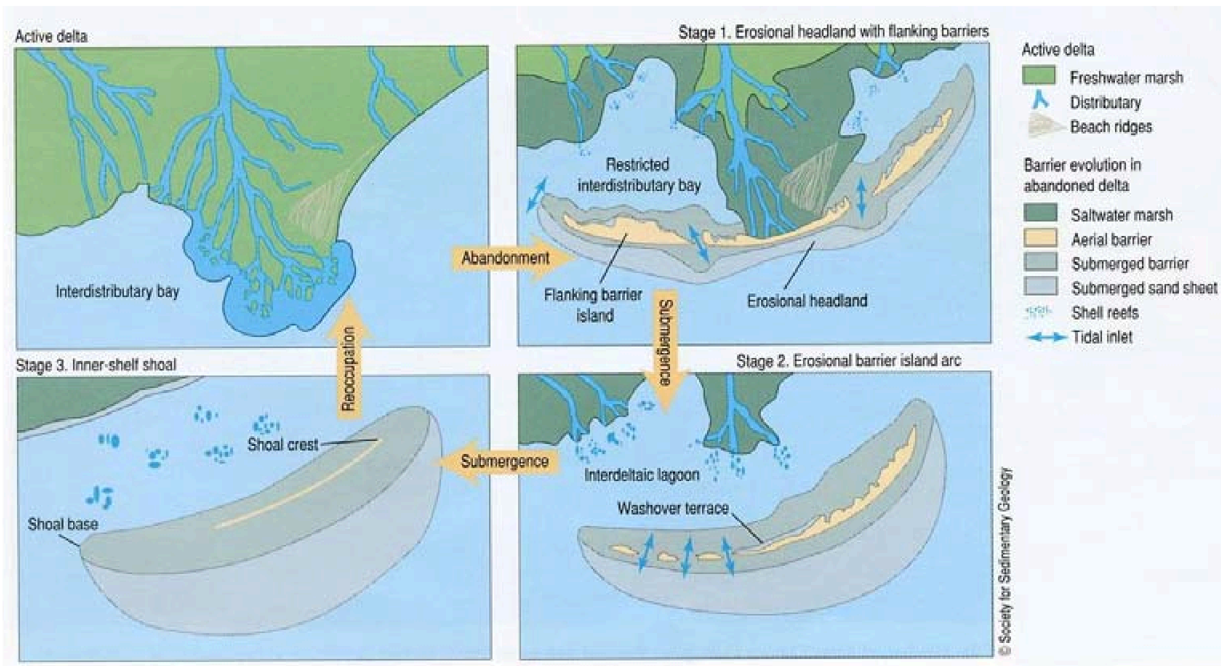
Figure MR 1-5. Locations of Historical Crevasses Along the Mississippi River and Bayou Lafourche in the Deltaic Plain *(adapted from Colten 2001).*

1.5.3 Delta Abandonment

As a delta grows and extends into the Gulf of Mexico, the river stage gradually heightens. Eventually, the river breaks through a weak point in its bank and/or shifts its main water flow into a distributary, thus providing a shorter route for the river to travel to the gulf. About every 1,000 years, the Mississippi River altered its path to the gulf, sometimes flowing down the western portion of the current Deltaic Plain and sometimes down the eastern portion. Whenever the river changed course, the location of active delta building also changed. Areas that no longer received sufficient volumes of freshwater laden with sediment and nutrients began to succumb to subsidence, while those areas that received the majority of river water input began a new phase of delta building. These meandering changes in the course of the Mississippi River and accompanying shifts in centers of sediment deposition are responsible for the distribution of deltaic sediment along the entire Louisiana coast and into Texas.

Once the Mississippi River altered its course and began to form a new delta, tidal influences and a lack of sediment and nutrient inputs slowly degraded the previously active delta location. Over time, the interior wetlands were submerged and marine influences reworked the gulfward edge of the delta into a series of barrier headlands. As the shoreline facing the Gulf of Mexico matured, and as the marshes behind the shoreline broke-up and eventually disappeared, the barrier headlands transitioned into barrier islands (**figure MR 1-6**). As the marsh degraded further, open bays formed behind the barrier islands. Eventually, complete submergence and marine reworking of the islands created sand-rich marine shoals detached from the coastline, such as today's Ship Shoal, which is located on the mid-central Louisiana coastal shelf.

Delta development and degradation occurred simultaneously, with some portions of the Louisiana coast experiencing land gain, while other areas experienced land loss. However, the net effect of this process was the creation of land across the Deltaic Plain. The dynamic nature of these geologic and hydrologic processes provided for an extremely diverse and highly productive wetland ecosystem in the coastal area.



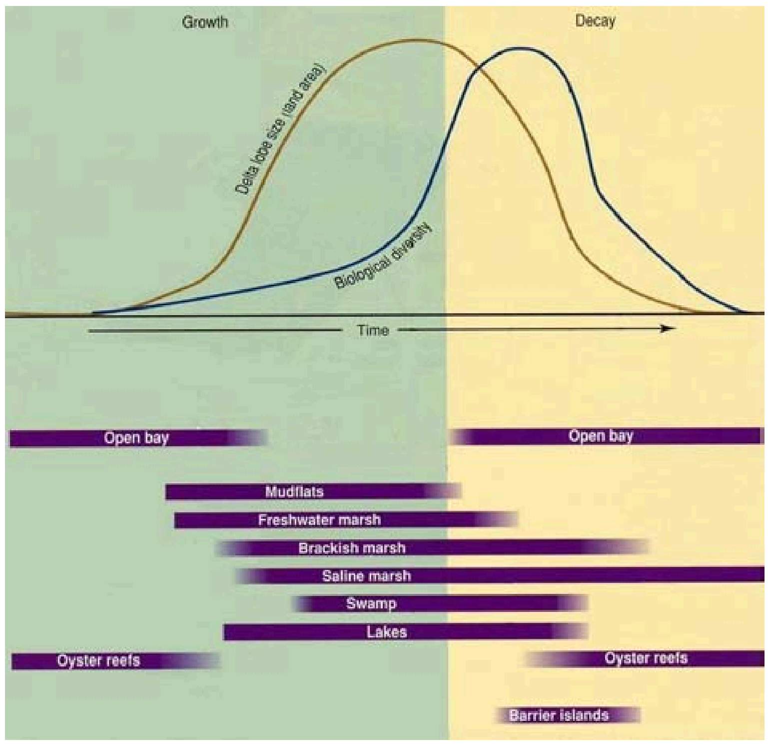
This model summarizes the genesis and evolution of transgressive depositional systems in the Mississippi River Deltaic Plain (Penland and Boyd 1981).

Figure MR 1-6. Three-Stage Geomorphic Model.

1.5.4 Delta Geomorphology and Ecologic Evolution

The distribution and abundance of wetland habitats in the Deltaic Plain has been, and continues to be, in constant flux — a function of the differing salinity gradients that occur during the land building and degradation phases of the deltaic processes. During the delta-building phase, freshwater predominates and creates vast expanses of freshwater marsh and swamp. In the delta degradation phase, marine (saltwater) influences take hold and convert freshwater wetlands into intermediate, brackish, and saline marsh.

The deltaic cycle of land building and land loss is paralleled by cycles of biological diversity and biological productivity. However, these cycles peak slightly after the land building phase of the deltaic cycle and are highest during the early degradation phase (**figure MR 1-7**). In the degradation phase, the marshes become fragmented by natural channels, ponds, lakes, and bays, and have an increasing amount of "edge" habitat (land-water interface). Biological diversity and primary plant and fishery productivity are the highest in this phase, and generally speaking, the more "edge" habitats an ecosystem exhibits, the higher the biological productivity and diversity of the ecosystem. Thus, the highest diversity and productivity of the wetland ecosystems typically occur at the same time freshwater wetlands are transitioning into intermediate, brackish, and saline marshes, and when these transitional marshes are degrading and disappearing. Today, many of Louisiana's coastal wetlands are in the degradation phase of the deltaic cycle and are therefore sources of high biological productivity and diversity. However, as coastal marshes continue to degrade and convert to open water, it is likely that biological productivity and diversity will decline.



Habitat and diversity peak in the early to middle stage of the decay phase (adapted from Gagliano and Van Beek 1975; Neill and Deegan 1986).

Figure MR 1-7. Graphical Depiction of the Growth and Decay of a Delta Lobe.

1.5.5 The Chenier Plain

The Chenier Plain wetland ecosystem developed primarily as a result of the interplay of three coastal plain rivers (Sabine, Calcasieu, and Mermentau Rivers), the intermittent mudstream from Mississippi River outlets, and the Gulf of Mexico. During periods of active delta building in the Deltaic Plain, Gulf currents transport fine-grained sediments (clay and silt) that do not immediately fall to the bottom, thus forming a "mudstream." Twenty-five percent or more of transported sediment in the river escape deposition in the immediate area of delta building. The dominant longshore drift along the Louisiana coast is from east to west. When delta formation occurs in shallow waters of a bay or the inner continental shelf along the western reaches of the

Deltaic Plain, longshore currents carry the fine-grained sediment west in a mudstream towards the Chenier Plain (**figure MR 1-8**). On the other hand, when delta building extends to the edge of the continental shelf or beyond and/or takes place in the eastern reaches of the Deltaic Plain, the mudstream flows offshore into the deep waters of the Gulf and has little effect on the shoreline (**figure MR 1-9**).

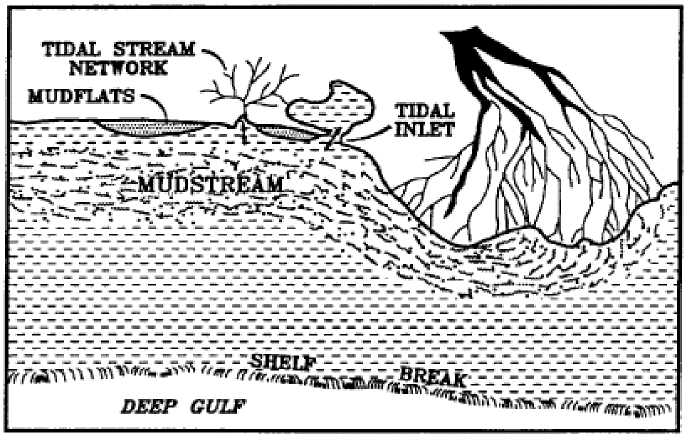


Figure MR 1-8. The Shallow Water Mudstream of the Mississippi River.
(*After Gagliano and van Beek 1993).*

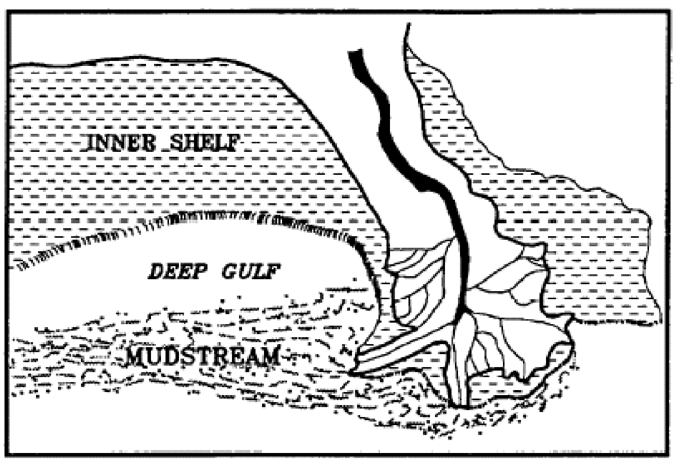


Figure MR 1-9. The Deep Water Mudstream of the Mississippi River.
(*After Gagliano and van Beek 1993).*

Fine-grained sediment transported in the mudstream to the Chenier Plain may be brought into coastal estuaries and marshes along the gulf shoreline by tidal processes and storms and may be deposited along the shore to form mudflats (Gagliano and van Beek 1993). Similar to the Deltaic Plain, the newly formed land is colonized by wetland vegetation, which further promotes the land-building process. Wave action and occasional storm events also deposit sand and shells onto the newly built land.

As the Mississippi River changed course and active delta building switched to the eastern Deltaic Plain or extended to the edge of the continental shelf or beyond, the mudstream ceased to carry sediment to the Chenier Plain and the gulf shore became subject to erosion. Historically, periods of erosion winnowed out fine-grained materials, leaving the deposits of sand and shell to form the gulf beaches. Beach deposits were subsequently shaped by waves and coastal currents to form elevated ridge systems. Once the mudstream returned and land building continued seaward, these elevated ridges were stranded inland where deciduous vegetation growth (e.g., live oak trees) occurred. These inland ridges, which parallel the gulf shoreline, are called "cheniers" (**figure MR 1-10**). The relict shell beach ridges and cheniers blocked drainage and saltwater inflows from the Gulf of Mexico, resulting in the development of large freshwater basins on the landward side of the ridges. On the seaward side, a zone of brackish to saline marshes developed as a result of tidal influences from the gulf.

Image displaying a chenier, which is an elevated ridge that parallels the gulf shoreline. Covered with live oaks and other deciduous vegetation, the cheniers are distinct geomorphic features resulting from the land-building processes in the Chenier Plain.
Figure MR 1-10. A Typical Chenier in the Chenier Plain.

Since 1973, delta-building processes at the mouth of the Atchafalaya River have initiated a new interval of land building via the formation of extensive mudflats along the eastern part of the Chenier Plain.

1.5.6 Factors Controlling Coastal Wetlands Sustainability

For the past 7,000 years, many factors have influenced the sustainability of habitats and ecosystems in coastal Louisiana. Nevertheless, land loss and coastal disturbances attributed to natural factors such as land subsidence, sea level change, storm events, and herbivory were offset by the land building and nourishment processes of the deltaic cycle. Over time, the trend had been one where more land was created than was lost, and much of the coastal ecosystems were sustained with freshwater, sediment, and nutrients. More recently, human settlement and economic development along the Mississippi River, its major tributaries, and in the coastal area, have led to the building of levees, upstream reservoirs, channel dredging, bank stabilization, and other activities. These activities have altered historic hydrology and inputs of land-building sediment and nutrients and have resulted in a situation where more land is being lost than is being created. Without significant intervention, much of coastal Louisiana does not have the necessary ingredients (freshwater, sediment, and nutrients) to sustain the coastal ecosystems.

1.6 PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

This section describes the coastal restoration efforts by the Federal Government and the State of Louisiana over the past three decades, which have culminated in development of this LCA Plan, as well as studies, reports (past and present), and existing water resources projects, that are most relevant to ecosystem restoration in coastal Louisiana.

1.6.1 History of Coastal Restoration Efforts

Over the past 3 decades, both the Federal Government and the State of Louisiana have established policies and programs that are intended to halt and reverse the loss of Louisiana's coastal wetlands and to restore and enhance their functionality.

Awareness of Louisiana's coastal land loss problem resulted in part from the publication of the 1972 report "Environmental Atlas and Multi-Use Management Plan for South-Central Louisiana." That report provided an initial assessment of the extent and magnitude of Louisiana's land loss problem. Coastal resource management in Louisiana also accelerated once Louisiana adopted and began participating in the Federal Coastal Zone Management program in 1978. Shortly thereafter, the state developed its first coastal zone management plan. One of the primary objectives of this plan was to ensure that future development activities within the coastal area would be accomplished with the greatest benefit and the least amount of environmental damage.

In 1989, the constitution of the State of Louisiana was amended with enactment and voter approval of Act 6, LA. R.S. 49:213 *et seq*., also known as the Louisiana Coastal Wetlands Conservation, Restoration and Management Act. Act 6 empowered the LDNR as the lead state agency for the development, implementation, operation, maintenance, and monitoring of coastal restoration projects. Chief among its many functions, LDNR has the lead for the development and implementation of state-sponsored coastal restoration projects. In addition, LDNR acts as the state's designated liaison for the Coastal Impact Assistance Program (CIAP), which was authorized by Congress in 2001 to provide a one-time appropriation of $150 million to assist states in mitigating impacts from OCS oil and gas production. In 2001, Louisiana received a one-time allocation from the CIAP of $26.4 million, which was used to fund various state and local coastal activities and projects including: monitoring, assessment, research, and planning; habitat, water quality, and wetland restoration; coastline erosion control; and control of invasive non-native plant and animal species.

Act 6 also created the Wetlands Conservation and Restoration Fund (WCRF), which dedicates a portion of the state's revenues from severance taxes on mineral production (e.g., oil and gas) to finance coastal restoration activities and projects. Currently, the WCRF provides approximately $25 million per year to support coastal restoration activities and projects. Finally, Act 6 requires the state to prepare and annually update a "Coastal Wetlands Conservation and Restoration Plan." This plan provides location-specific authorizations for the funding of coastal restoration projects from the WCRF.

While the Federal Government has been concerned with and involved in Louisiana's coastal land loss problem for decades, enactment of the CWPPRA in 1990 marked the first Federal statutory mandate for restoration of Louisiana's coastal wetlands. The initial priority of the CWPPRA Task Force, composed of five Federal agencies (U.S. Environmental Protection Agency (USEPA), USFWS, USACE, National Marine Fisheries Service (NMFS), and National Resources Conservation Service (NRCS)), and the State of Louisiana, was to prepare a comprehensive restoration plan that would coordinate and integrate coastal wetlands restoration projects to ensure the long-term conservation of coastal wetlands of Louisiana. The plan was adopted in 1993. The task force was also required to prepare and adopt an annual Project Priority List. As of January 2004, 13 priority lists have been approved; there are 127 active projects approved, of which 61 have been completed. These projects include gulf and inland shoreline protection, sediment and freshwater diversions, terracing, vegetative plantings, marsh creation, hydrologic restoration, marsh management, and barrier island restoration. CWPPRA provides $5 million annually for coastal restoration planning and roughly $50 million each year for the construction of coastal protection and restoration projects.

Another important Federal partnership in coastal Louisiana is the Barataria Terrebonne National Estuary Program (BTNEP). Established in 1990 as part of the USEPA's National Estuary Program, the BTNEP is a partnership for the study of natural and man-made causes of environmental degradation in the Barataria-Terrebonne watershed and for protection of the watershed from further degradation.

While the coastal restoration programs and projects previously described reduced coastal land loss and enhanced the health and functionality of portions of Louisiana's coastal ecosystem, Federal and state agencies, leading scientists, and other stakeholders realized that these efforts were not sufficient to address the magnitude of the land loss problem and to ensure a sustainable coastal ecosystem. In 1998, Federal and state agencies, local governments, academia, numerous non-governmental groups, and private citizens reached consensus on the Coast 2050 Plan, a conceptual plan for restoration of the Louisiana coast. As previously described, the Coast 2050 Plan was a direct outgrowth of lessons learned from implementation of restoration projects through CWPPRA, reflected a growing recognition that a more comprehensive "systemic" approach was needed, and was the basis for the May 1999 905(b) reconnaissance report. The 905(b) report was the precursor to the LCA Ecosystem Restoration Study.

In addition to coastal restoration efforts undertaken through CWPPRA, other Federal and state coastal restoration efforts over the years have resulted in the construction of 39 state projects, 30 Federal projects, and 224 state vegetative plantings (LDNR 2003). One of the more significant contributions to the restoration of coastal wetlands has been a result of the North American Wetlands Conservation Act (NAWCA), administered by the USFWS. The 1999 and 2001 biennial NAWCA report presented to Congress cites 30,558 acres (1,2372 ha) of restoration and 40,348 acres (16,335 ha) where ecosystem function has been improved in coastal Louisiana wetlands.

Non-governmental organizations have also participated in various coastal restoration projects. For example, Ducks Unlimited recently constructed approximately 26 linear miles (42 kilometers) of terraces in eroded marsh areas in Cameron Parish, located in the Chenier Plain, in partnership with a number of state and private sector partners. These terraces are very similar to some of the ones identified as priority projects under CWPPRA. Other examples of public and private parties involved in wetlands preservation or restoration activities in coastal Louisiana include Coastal America, Corporate Wetlands Restoration Partnership, Gulf Coast Joint Venture, Audubon Society, National Fish and Wildlife Foundation, The Nature Conservancy, and the National Wildlife Federation.

1.6.2 Prior Studies, Reports, and Existing Water Projects

A number of studies and reports on water resources development in the study area have been prepared by the USACE, other Federal, state, and local agencies, research institutes, and individuals. Previous studies established an extensive database for the LCA Study. Historical trends and existing conditions were identified to provide insight into future conditions, help isolate the problems, and identify the most critical areas. The following studies, reports, and projects in the coastal area are the most relevant to ecosystem restoration. A more thorough listing of prior studies, reports, and water resources projects can be found in attachment 2 to this report.

1.6.2.1 The Mississippi River and Tributaries (MR&T) Project

The Mississippi River and Tributaries (MR&T) Project is a comprehensive project for flood control on the lower Mississippi River below Cape Girardeau, Missouri. The project was authorized as a result of the 1927 flood of the lower Mississippi River, which resulted in the failure of existing levees and extensive flooding of populated areas. The four major elements of the MR&T Project are: 1) levees for containing flood flows; 2) floodways for the passage of excess flows past critical reaches of the Mississippi River; 3) channel improvement and stabilization to provide an efficient navigation alignment, increase the flood carrying capacity of the river, and protect the levee system; and 4) tributary basin improvements for major drainage and for flood control, such as dams and reservoirs, pumping plants, auxiliary channels, etc. (**figure MR 1-11**). The MR&T system controls and confines the river system before it reaches the coastal area. Several major outlets to the main stem of the river, which are described below, exist for the purposes of flood control during flood stages. The effects of channel and backwater storage are not accounted for in the flow volumes through the Atchafalaya Floodway and Atchafalaya River presented in **figure MR 1-11**.

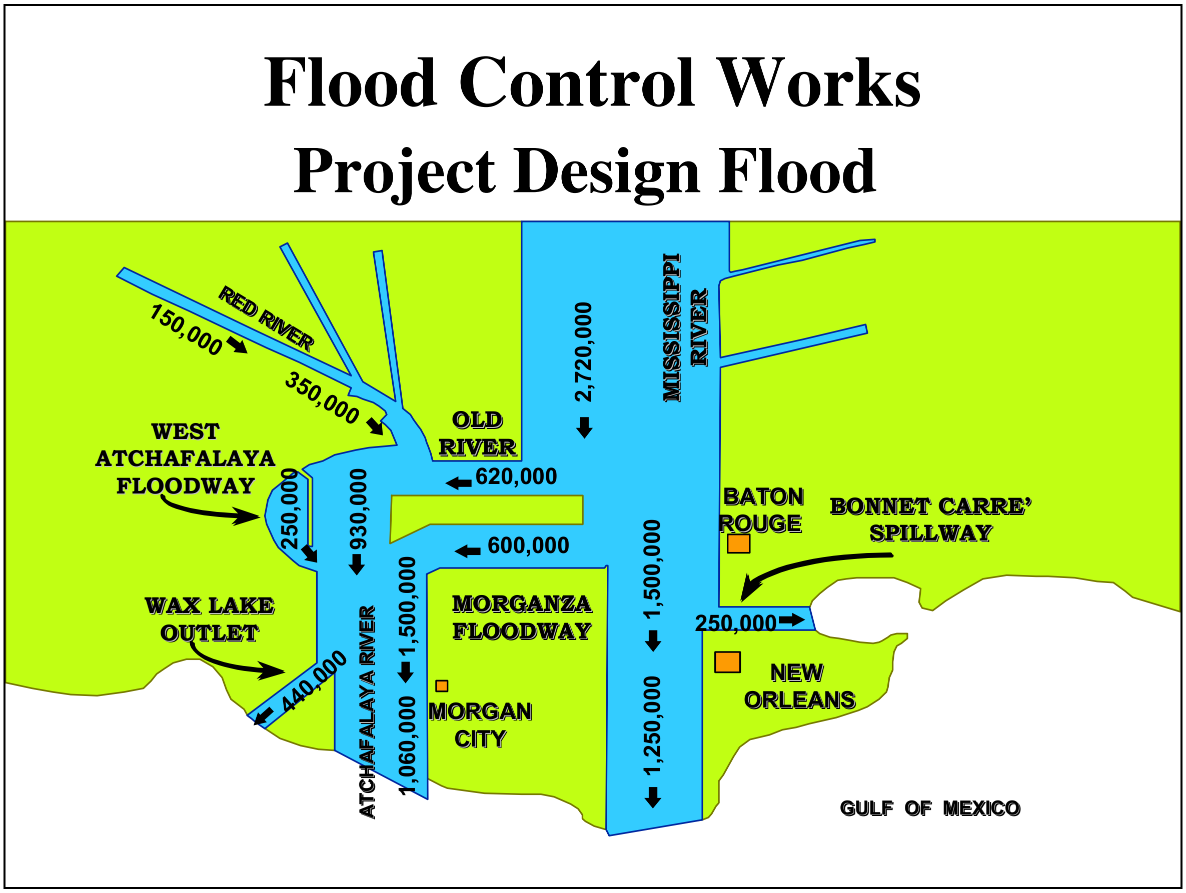


Figure MR 1–11. MR&T Scenario During Maximum Flood Projected Flood Conditions.

The Atchafalaya Basin

At the latitude of the Old River Control Complex, the MR&T Project flood totals 3 million cubic feet per second (cfs) (90,000 cubic meters per second [cms]) consisting of the sum of the Red River and Mississippi River flood flows. The Atchafalaya Basin is designed to convey up to one half of the project flood flows or 1.5 million cfs (45,000 cms). During daily operations, the Old River Control structures are regulated to maintain a 70/30 distribution between the Mississippi/Atchafalaya Rivers. In authorizing the Old River Control Complex (Flood Control Act of 1954), Congress directed that the system distribution should be maintained at the same distribution that existed in 1950 which was 70/30. During a project flood, the Old River Control Complex would divert up to 620,000 cfs (18,600 cms) from the Mississippi River to the Atchafalaya from the Morganza and West Atchafalaya Floodways.

The Morganza Floodway (located to the east of the Atchafalaya River) and the West Atchafalaya Floodway (located to the west of the river) are two floodways that can convey flood waters into the Atchafalaya Basin during severe floods. The West Atchafalaya Floodway is controlled by a fuse plug levee at the Red River, which would overtop or be blown in the event of the project flood, thereby allowing an additional 250,000 cfs (7,500 cms) to enter the basin. The Morganza Floodway is controlled by a structure at the Mississippi River that can allow another 600,000 cfs (18,000 cms) to enter the basin in the event of the project flood.

The basin has two outlets at the southern end, which empty into Atchafalaya Bay and then the Gulf of Mexico. One outlet is the Lower Atchafalaya River, a natural outlet, while the other is a manmade outlet, the Wax Lake Outlet, which was constructed in 1941 to facilitate better conveyance of flood flows.

Bonnet Carré Spillway

The Bonnet Carré Spillway is located at the site of an old crevasse, and contains a control structure at the Mississippi River. The facility is designed to convey a maximum of 250,000 cfs (7,500 cms) of floodwater to Lake Pontchartrain to relieve flood conditions downstream,

Caernarvon and Davis Pond Freshwater Diversion Projects

The "Freshwater Diversion to the Barataria and Breton Sound Basins" report (USACE, 1983), and subsequent technical appendices (USACE 1984), recommended diverting Mississippi River water into Breton Sound Basin near Caernarvon and into Barataria Basin near Davis Pond to increase habitat quality and improve fish and wildlife resources. The Caernarvon Freshwater Diversion was completed in 1991 with a design discharge of 8,000 cfs (240 cms). Since its construction, the Caernarvon structure has been operated as a salinity control measure, with freshwater introductions ranging between 1,000 cfs (30 cms) to 10,000 cfs (300 cms). The Davis Pond Freshwater Diversion was completed in 2002 with a maximum design capacity of 10,650 cfs (319 cms). It is noted that a third freshwater diversion project with a maximum capacity of 30,000 cfs (900 cms) at Bonnet Carré was included in the 1983 report, but the project has not been constructed due to environmental concerns by non-Federal interests.

1.6.2.2 The Gulf Intracoastal Waterway (GIWW)

The GIWW was authorized and construction was begun in the 1920s. It traces the U.S. coast along the Gulf of Mexico from Apalachee Bay near St. Marks, Florida to the Mexican border at Brownsville, Texas. From its intersection with the Mississippi River, the waterway extends eastward for approximately 376 miles (605 kilometers) and westward for approximately 690 miles (1,111 kilometers). In addition to the main stem, the GIWW includes a major alternate channel, 64 miles (103 kilometers) long, which connects Morgan City, Louisiana, to Port Allen, Louisiana. Project dimensions for the main stem channel and the alternate route are 12 feet (3.7 meters) deep and 125 feet (38.1 meters) wide, except for the reach between the Mississippi River and Mobile Bay, which is 150 feet (45.7 meters) wide. Today, portions of the GIWW are deeper and wider than the original construction dimensions. Numerous side channels and tributaries intersect both the eastern and western main stem channel, providing access to inland areas, coastal harbors, and the Gulf of Mexico.

1.6.2.3 Mississippi River Gulf Outlet (MRGO)

The Rivers and Harbors Act of 1956 (PL 84-455) authorized construction of the Mississippi River - Gulf Outlet (MRGO), a deep draft navigation channel that was completed and put into service in the 1960s. The MRGO provides deep draft navigation access to the New

Orleans tidewater port area located along the upper reaches of the MRGO and the Inner Harbor Navigation Canal (IHNC), close to the junction of the GIWW with the Mississippi River. Today, the surface dimensions of the channel have increased beyond those of the original construction, and in some areas, the width of the channel has appreciably widened as a result of erosion. The authorized channel width for the project is 500 feet (152 meters), but the channel is more than 2,000 feet (610 meters) wide at some locations.

The USACE is currently investigating the feasibility of continued operation of the MRGO Navigation Project because of the increased cost of channel maintenance and decreased channel use at maximum depths. The reevaluation study is tentatively scheduled for completion in FY 2005.

1.6.2.4 Morganza to the Gulf

In March 2002, a feasibility report and programmatic environmental impact statement (PEIS) entitled “Mississippi River & Tributaries - Morganza, Louisiana to the Gulf of Mexico -- Hurricane Protection” was prepared by the USACE (USACE 2002). It is noted that there is an addendum 1 to the report dated April 2003 and an addendum 2 dated March 2004. It is further noted that the Chief's Report (which the proposed authorizing language references) is dated August 9, 2002. The Chief's report was also supplemented in 2003. The recommended plan proposed a series of flood protection measures and included the following:

- The construction of approximately 72 miles (116 kilometers) of levee south of Houma;
- The construction of nine gated structures in various waterways and three floodgates in the GIWW;
- The construction of a lock structure and floodgate complex for the Houma Navigation Canal (HNC); and
- The construction and operation of new and replacement fish and wildlife structures in selected locations to maintain tidal exchange.

The area to be protected by the levee system is a former major delta from a previous course of the Mississippi River. As in other locations in south Louisiana, urban and agricultural development has occurred along the banks of the remnant ridges of the delta. Therefore, conveyance of freshwater via the Mississippi River through these remnant channels is not practical. However, the close proximity of the area to the Atchafalaya Basin offers other options of freshwater distribution. The GIWW is linked to the Atchafalaya Basin and conveys water eastward to the area. The HNC intercepts these flows before they reach the area of need and conveys them efficiently to the Gulf of Mexico. If authorized, and with the levee system and water control structures in place, the Atchafalaya River flows can be managed and distributed across the area. The proposed Morganza to the Gulf levees and water control structures would convey Atchafalaya River water eastward and would support the efforts proposed within the LCA Plan, thus helping solve the saltwater intrusion problem in the Houma area.

1.6.2.5 Donaldsonville, Louisiana to the Gulf of Mexico Feasibility Study

In February 2002 the USACE, New Orleans District signed a Feasibility Cost Sharing Agreement with the Lafourche Basin Levee District and the Louisiana Department of Transportation and Development. This agreement continued investigations under the authority of a U.S. House of Representatives Transportation and Infrastructure Committee resolution adopted May 6, 1998. The focus for initial action is within the jurisdictional boundaries of the Lafourche Basin Levee District, which covers portions of the parishes of Ascension, Assumption, Lafourche, St. Charles, St. James, and St. John the Baptist. The study area has been declared a Federal Disaster Area four times since 1985 after flooding events. The basin is subject to heavy rainfall, tidal surges from the Gulf of Mexico, and hurricane flooding.

The purpose of the study is to investigate the feasibility of constructing a hurricane protection levee from Larose, Louisiana, that connects to the authorized West Bank Hurricane Protection Levee Project to investigate possible solutions to improve interior drainage within the Lac des Allemands drainage basin and to investigate restoring and/or protecting the natural and human environment to create a sustainable ecosystem in the Lac des Allemands drainage basin. The investigations are ongoing and scheduled for completion of the feasibility phase in June 2006.

1.6.2.6 Third Delta

In June 1999, a report entitled The Third Delta Conveyance Channel Project was completed by S. M. Gagliano and J. L. van Beek. The primary concept of the "Third Delta Conveyance Channel" is to reestablish the natural processes of Mississippi River land building on a large scale as a fundamental approach to achieving sustainable restoration in coastal Louisiana. The report discusses reintroduction of Mississippi River water and sediment in a manner that mimics natural processes. The implementation of a Third Delta would likely target wetlands in western Barataria Basin and eastern Terrebonne Basin. The LDNR is currently undertaking a reconnaissance-level study to evaluate the feasibility of constructing the Third Delta as proposed, and also to define and evaluate alternatives to the original concept that may also achieve the desired results. This study is projected to be completed by the end of FY 2005.

1.6.2.7 Cooperative River Basin Studies

Cooperative River Basin Studies have also been published by the NRCS. These contain current (as of publication date) and historic descriptions of basins and provide detailed management alternatives of hydrologic units within these basins. The published coastal reports include:

- Lafourche-Terrebonne, 1986
- East Central Barataria, 1989
- Calcasieu-Sabine, 1994
- Mermentau, 1997
- Teche-Vermilion, 1999

1.6.2.8 Watershed Reports

Watershed Reports have also been published by the NRCS. These contain current and historic descriptions of watersheds and provide detailed management alternatives of hydrologic units within these watersheds. The completed coastal projects include:

- Bayou Folse Watershed, Lafourche Parish, completed 1977
- Bell City Watershed, Calcasieu, Cameron and Jefferson Davis Parishes, completed 1994
- Cameron Creole Watershed, Cameron Parish, completed 1994
- English Bayou Watershed, Calcasieu and Jefferson Davis Parishes, completed 1974
- Lake Verret Watershed, Iberville, Ascension and Assumption Parishes, completed 1994
- Seventh Ward Canal Watershed, Vermilion Parish, completed 1971
- West Fork of Bayou Lacassine Watershed, Jefferson Davis and Calcasieu Parishes, completed 1977

Watershed reports authorized, but not yet complete, in coastal areas include:

- Bayou Penchant-Lake Penchant, approved 1987
- West Fork Bayou L'Ours, approved 1987
- Bayou Tigre Watershed, Iberia and Vermilion Parishes, planning authorized 2002
- Hebert Canal Watershed, Vermilion Parish, planning authorized 2002
- Sabine-Black Bayou Watershed, planning authorized 1995