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LOUISIANA COASTAL WETLANDS RESTORATION PLAN

MAIN REPORT AND ENVIRONMENTAL IMPACT STATEMENT

PREPARED BY:

LOUISIANA COASTAL WETLANDS CONSERVATION AND RESTORATION TASK FORCE

November 1993

Dedicated to Charles W. "Bill" Savant
(January 16, 1950 to September 21, 1993)

This report is dedicated to the memory of Bill Savant, whose view of life and love of nature were exemplified in his work to preserve the coastal wetlands of Louisiana. The successful completion of this report is due in large measure to Bill's dedicated efforts.

Honest, amiable, sincere, kind and intelligent are words that best describe Bill Savant--a true conservationist who loved the land and all its resources. He committed his life to conservation and everyone who met him or worked with him couldn't help but like his zeal, enthusiasm and personality.

From his humble, rural beginnings near Opelousas, Louisiana, to his final interagency assignment as a soil conservationist serving to protect one of Louisiana's most vital resources, Bill never faltered in his dedication and commitment to conservation. A Magna Cum Laude graduate of Nicholls State University, Bill used his scientific background, simple understanding of life and years of experience in Louisiana's coastal zone to help make coastal conservation programs work and prosper. He was an expert in coastal programs--learning many of the marshes' secrets by working and creating in them.

Bill loved to work with people. He had the unique characteristic of being able to communicate easily and comfortably with everyone, as well as being liked almost immediately. Although he was a large man, his gentle nature always prevailed--he never got angry, even under difficult circumstances in life and on the job.

Bill's view of life and his love of nature live on with his wife Bobbie and two sons, Bret and Jason. His dedication to conservation and work in trying to save Louisiana's coastal marshes will live on for many years into the future.

Coastal Wetlands Planning, Protection and Restoration Act

Louisiana Coastal Wetlands Restoration Plan

November 1993

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Louisiana Coastal Wetlands Conservation and Restoration Task Force

Louisiana Coastal Wetlands Restoration Plan

Executive Summary

EXECUTIVE SUMMARY

INTRODUCTION

The Coastal Wetlands Planning, Protection and Restoration Act (Public Law 101-646, Title III--CWPPRA) was enacted and signed into law by President Bush in 1990. The Act directed that a Task Force consisting of representatives of five federal agencies and the State of Louisiana develop a "comprehensive approach to restore and prevent the loss of coastal wetlands in Louisiana." This legislation provided the first national mandate for a restorative action of this magnitude. Even more importantly, the Act began the prudent process of reinvesting in restoration a tiny fraction of the billions of dollars that these coastal wetlands provide every year in renewable (fish and wildlife) and non-renewable (oil and gas) resources.

The Louisiana coastal plain remains the largest expanse of coastal wetlands in the contiguous United States. It comprises 25 and 69 percent of the fresh and salt marshes, respectively, found on the gulf coast. This translates to 15 and 40 percent of those ecotypes remaining in the contiguous United States. The future of Louisiana's coastal marshes is therefore vitally important to the ecological future of the Nation.

The deterioration of these wetlands is now understood to have been greatly accelerated by human activities which have been critical to the economic growth of the Nation. The unforeseen loss of these coastal wetlands now threatens the future of this region and is a national tragedy in the making. Arresting and reversing the loss of the Mississippi River's deltaic wetlands has become a new national priority, as witnessed by the statement made by the Honorable Bruce Babbitt, Secretary of the Interior, at the April 17, 1993, signing ceremony for the first CWPPRA projects:

> The coastal wetland issue I would characterize as simply the single most important environmental issue of our times. The wetlands are, without any question, the richest and most threatened ecosystem in this country. And in turn the coastal wetlands, where fresh water meets salt water, where land meets sea, are truly the most fragile, delicate, and important link of all.

The State of Louisiana's recognition of this problem can be traced through the success of its Coastal Zone Management program, established in 1980. Since its inception, the program has helped reduce wetlands loss due to development from 3,000 to 800 acres per year. The concern of private citizens and landowners was made clear in 1989 when an amendment to the Louisiana constitution establishing a dedicated trust fund for coastal wetlands restoration was adopted by a three to one margin. Congress, recognizing the environmental and economic threat posed by the continued loss of these coastal wetlands, was quick to act on this declaration of public support through the passage of the Coastal Wetlands Planning, Protection and Restoration Act.

The Louisiana Coastal Wetlands Restoration Plan presented here is a product of communication, coordination, and cooperation not only among the designated participants from the state and federal agencies, but also through the formal, and more often informal, involvement of numerous local government agencies, the academic community, private environmental and business groups, and countless motivated individuals with good ideas. This process has from the beginning involved difficult choices; it is far from perfect today and evolving still. All involved agree, however, on two important findings that form the core of the entire Restoration Plan.

- First, by phasing in an adequate investment now, it is technically feasible to significantly slow or reverse coastal wetlands loss and thereby protect, sustain, and enhance the most valuable environmental and economic assets of the region.

- Second, the no-action alternative condemns the Nation to a far more expensive course of uncoordinated and increasingly futile emergency efforts to protect existing investments in the economic infrastructure without hope of achieving sustainability.

During the preparation of this plan the Task Force has actively pursued its mission, fulfilling a second CWPPRA directive of submitting a series of annual Priority Project Lists. To date three of these lists have been submitted, authorizing 48 projects for construction to hold the line against wetland loss. With the State of Louisiana providing a 25 percent share of the cost, over $120 million has already been directed to this effort. This Restoration Plan, however, is the first major step in responding to the direction of the Congress "to restore and prevent the loss of coastal wetlands in Louisiana." The plan proposes specific projects to restore on a regional scale the natural processes which were responsible for the great productivity of the coastal ecosystem and which will, in the long term, maintain the value of this resource to the Nation.

WHAT'S AT STAKE

When Louisiana became a state in 1812 over 16 million acres of wetlands were incorporated into the resources of the United States. Approximately 4.5 million acres of this total were what would now be considered coastal wetlands. Approximately 74 percent, or 3.3 million acres, of Louisiana's coastal wetlands were still inventoried as such in 1989. However, more than a million acres of coastal wetlands have been lost just within the last 60 years. Current estimates of the loss rate range between 25 and 35 square miles annually (16,000 to 22,000 acres), or about an acre every 25 minutes. This accounts for nearly 80 percent of all coastal wetlands loss in the United States today.

The Mississippi River built the coastal wetlands of Louisiana by depositing enormous volumes of sediment and nutrients, eroded from the vast interior of North America, on the continental shelf at its mouth (Figure 1 illustrates the various delta lobes created as the river changed its course over time). For the last several thousand years, dominance of the building process resulted in a net increase of more than four million acres of coastal wetlands, as well as the creation of an extensive skeleton of higher natural levee ridges along past and present channels in the deltaic plain and the beaches of the chenier plain. The landscape this produced gave rise to one of the most productive ecosystems on earth. Only the most intensively managed agricultural systems, artificially subsidized by large inputs of energy and fertilizer, can rival the ability of these estuarine wetlands to convert sunlight and carbon dioxide into food.

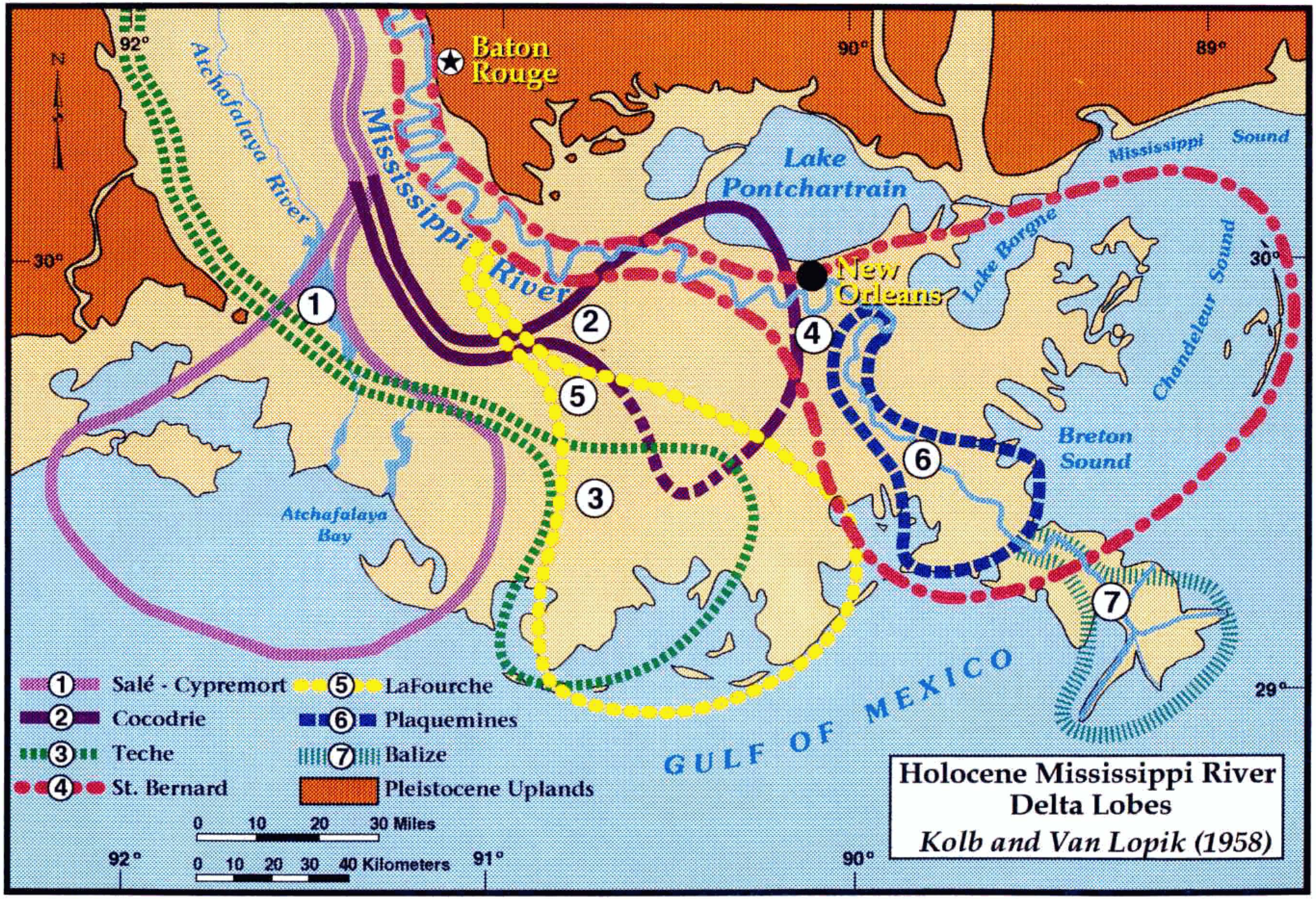

Figure 1. Mississippi River Delta Lobes.

The most visible result of this productivity is the fact that Louisiana's coastal wetlands support a commercial harvest of fish and shellfish comparable in volume to that of the entire Atlantic Seaboard. The market value of the fisheries harvest supported by the state's wetlands averages almost $1 billion annually. Recreational activities, tourism, and other uses of the resource add several hundred million more to the economy each year, and these values do not count the intangible worth of an incredibly diverse wildlife habitat--home to 70 bald eagle nesting pairs, hundreds of thousands of nesting wading birds and seabirds, and five million wintering waterfowl whose summer homes extend over much of North America.

By themselves, these economic and habitat values, which depend on the biological productivity of Louisiana's coastal wetlands, merit national attention. An equally important dimension of their value derives from the fact that these wetlands protect an internationally significant commercial-industrial complex from the destructive forces of storm-driven waves and tides. This complex includes deep-draft ports carrying 25 percent of the nation's export commodities by tonnage, and the most active segment of the nation's intracoastal waterways. Natural gas fields in the coastal zone and adjacent offshore areas produce 21 percent of the nation's annual output, valued at $7.4 billion. Petroleum refining industries in the coastal zone produce $30 billion annually for the domestic market nation-wide. In addition, coastal Louisiana is home to over 2 million people who, ultimately, convert these resources into the products the nation consumes. When investments in facilities, supporting service activities, and the urban infrastructure are totaled, the capital investment in the Louisiana coast adds up to more than $100 billion.

THE PROBLEM

The natural processes that produced the Mississippi River deltaic plain, first through the creation of the land and later through its maintenance by overflow of sediments and nutrients, are at odds with man's desire to comfortably inhabit the area and develop its economic resources. In the eighteenth century, when Europeans began settling in significant numbers along the region's numerous low natural ridges, they began constructing local levees to protect themselves from the annual floods of the river. Later, in the nineteenth century, when the power of steam was harnessed for navigation, Congress initiated actions to clear the Mississippi and maintain it as the nation's most important commercial waterway. In the twentieth century, oil and gas exploration, land reclamation projects, and construction of ports and navigation channels further developed the economic potential of the region and the Nation. By the 1940's, massive flood control levees along the entire course of the Lower Mississippi had effectively confined it to a single channel and controlled the threat posed by annual river floods.

Today flood control projects (such as levees) ensure that most fresh water and sediment now bypass the area where they would naturally build and nourish wetlands; these valuable resources are directed to the deep waters of the Gulf of Mexico. The wetlands continue to sink or subside as they have always done. Deprived of their natural sustenance, the plants that define the surface of the land die off, unable to maintain themselves within the intermittently flooded zone in which they are adapted to live. Once denuded, the fragile substrate is left exposed to the erosive tidal environment.

This problem is compounded in many locales where artificial channels dredged for navigation and oil and gas development provide efficient conduits for seawater to penetrate far inland, and for the limited amount of fresh water provided by local rainfall to drain rapidly seaward. The banks of dredged material piled along these channels, as well as embankments constructed for roads and railroads, further disrupt natural cycles of flooding and draining and isolate large areas of estuaries from the remaining non-riverine sources of sediments and nutrients.

The cumulative effect of human activities has been to tilt the balance between land building and land loss drastically in the direction of loss. As recently as the 1970's the loss rate for Louisiana's coastal wetlands was as high as 40 square miles per year. The current rate of loss is about 25 square miles per year, much of which is due to the residual effects of past human activity.

Today Louisiana, which contains about 40 percent of the estuarine wetlands in the lower forty-eight states, is suffering 80 percent of all coastal wetlands losses. Currently, land building has virtually stopped in the deltaic plain and amounts to only a few hundreds of acres each year in the Atchafalaya River delta and along the eastern shoreline of the chenier plain. Land loss, while most dramatic in several inland hot spots, is ubiquitous and takes many forms, including the destruction of barrier islands; shoreline retreat along the margins of lakes, canals, and the gulf coast; and, perhaps more importantly, in the formation, expansion, and coalescing of ponds in the marsh. Paradoxically, deterioration of the system is believed to have contributed to a short-term increase in fisheries production, but the long-term prospect is for a significant decline (30 percent over the next 50 years) and a future shoreline far inland of its present location (Figure 2).

These losses will have impacts well beyond the borders of Louisiana. The impact on commercial fisheries alone will be enormous: by the year 2041, the harvest will decline by 30 percent. Loss of this resource will aggravate our Nation's trade deficit and place at risk the nearly 50,000 jobs directly related to fishing, processing, and wholesaling activities. In addition, populations of migratory birds and other animals directly dependent on the marsh and swamp will decrease dramatically, an impact which will be felt in much of North America, where these species spend part of their life cycle.

A number of other food staples or basic minerals, such as sugar, rice, salt, sulphur, and lime, are also produced in coastal Louisiana. Lost production of these basic items will impact national markets.

The coastal marshes help protect southern Louisiana from flooding and are integral to the design of the $12 billion worth of flood control works which protect the regional infrastructure. Continued loss of these wetlands will lead to loss or increased maintenance and replacement costs for highways, ports, waterways, railroads, pipelines, oil and gas facilities, and other features. As the coast deteriorates, billions of dollars of infrastructure will be surrendered to the Gulf of Mexico, and billions more will be spent protecting the remainder. Ultimately American consumers and taxpayers will pay these costs.

THE PLAN

It was recognized early in the plan's formulation that the small project orientation of the priority project program could not, of itself, give rise to a comprehensive coastwide Restoration Plan. Accordingly, a basin planning

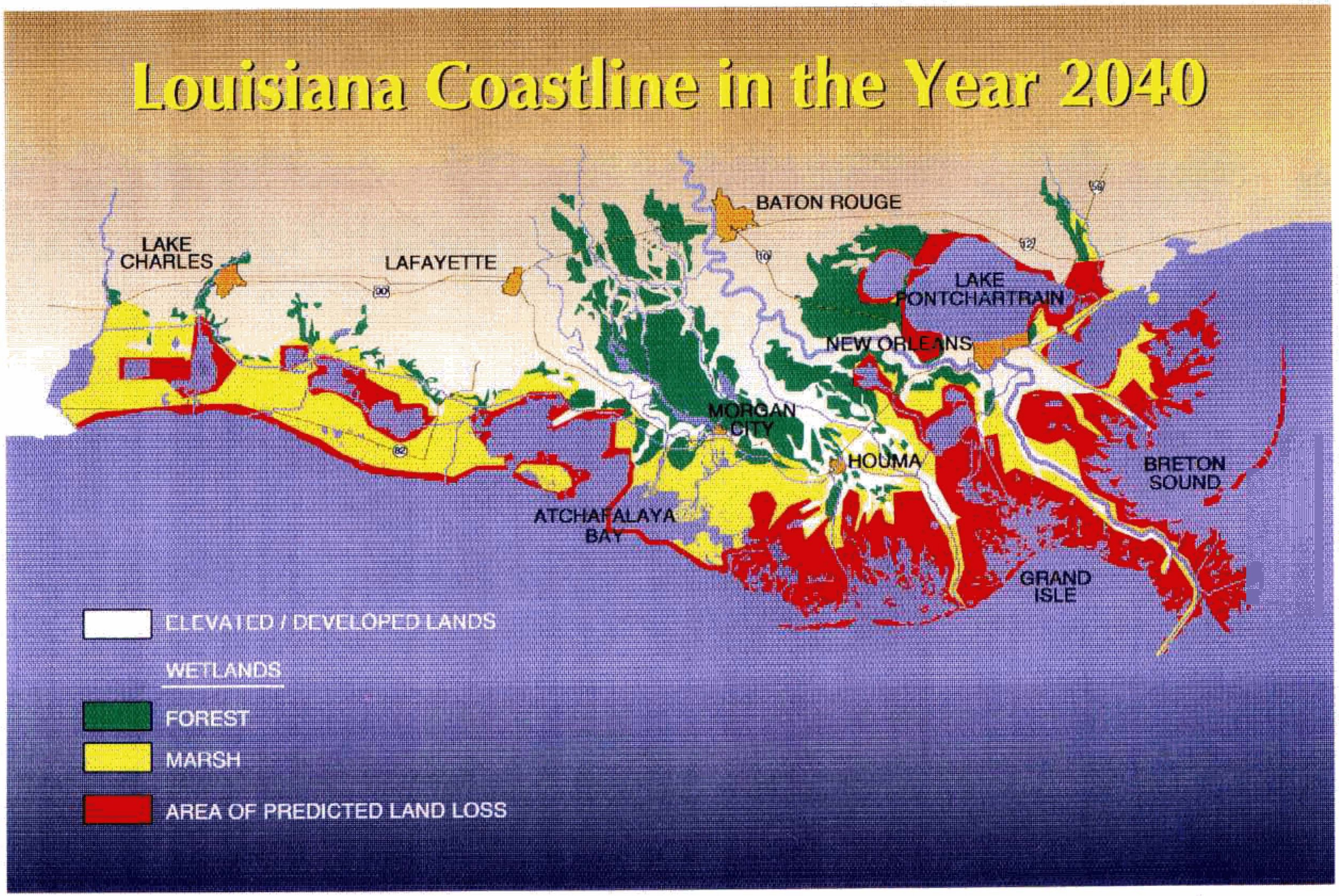

Figure 2. Projected Louisiana Coastline in 2040.

initiative, distinct from the priority project program, was initiated. Nine watersheds, or basins, were distinguished in Louisiana's coastal zone on the basis of their geology and hydrology (see Plate 1). Basin "captains" were designated by the Task Force, and interagency teams were assembled to develop restoration strategies at this level. A team of academic scientists was retained to facilitate and advise this process, and an extensive effort was undertaken to solicit input from local government officials and the public. The result was a set of nine distinct strategic plans reflecting the significant differences among the basins. Through this process the restoration priorities in each basin were established. The basin plans call for numerous short-term projects to be built using the Priority Project List process. Marsh restoration tools such as hydrologic restoration, shoreline protection, marsh creation with dredged material, marsh management, etc. will be used in each basin to preserve or create marsh. In most basins, there are major projects which collectively form the major long-term components of the plan.

The Restoration Plan presented here calls for significant changes in existing management of the lower Mississippi and Atchafalaya rivers to greatly increase sediment and freshwater input into coastal estuaries and restart the natural processes of land building and maintenance (see Figure 3). Specifically, the plan includes such concepts as: (1) a phased abandonment of the existing "bird's foot" delta in favor of a new delta in the shallow waters of an adjacent estuary, possibly Breton Sound, (2) multiple diversions into the Barataria Basin, (3) reactivation of old distributary channels, and (4) seasonal increases in flow down the Atchafalaya River. Additionally, several large projects are identified to reverse hydrologic modifications by (5) rebuilding barrier island chains and (6) controlling tidal flows through large navigation channels. The goal is to restore the natural processes that can bring about sustainability with the lowest requirement for future manipulation. All this is developed based upon a realistic understanding of the countering effects of subsidence and projected sea level rise.

Although designed to work largely within the constraints of the existing infrastructure, regional-scale projects cannot be implemented without accompanying modifications to vital navigation, transportation, flood protection, and oil and gas extraction and conveyance systems. Regional projects, therefore, require urgent additional investigation and involve funding well beyond that currently authorized. The plan presented here involves an estimated investment of $1 billion to $3 billion over the next 20 years to produce a sustainable system. Table 1 summarizes the estimated cost for each of the hydrologic basins. Implementation of the plan would prevent 65 percent of projected wetland loss over the next 20 years.

IMPLEMENTATION

This report presents a wide variety of projects aimed at addressing the problems facing Louisiana's coastal wetlands, from both a defensive, protective posture and a more pro-active, restorative stance. Because it is recognized that implementation of the full restoration plan will take decades to realize, projects of many scales are proposed. Some basin plans are designed to slow land loss in the near-term and preserve the opportunity for the long-term elements of the plan.

The Task Force has adopted a two-phase implementation process executed on parallel tracks. This approach reflects the fact that while the problems and potential

Table 1
Restoration Plan Summary

Basin	Projected Marsh Loss 20 Years (Acres)	Acres Created, Protected, or Restored (Acres)	Total Benefited Area (Acres) 1/	Estimated Cost ($)
Pontchartrain 2/	57,800	16,900	36,500	132,738,000
Breton Sound 3/	13,400	5,200	9,600	11,367,000
Mississippi River Delta 4/	21,400	85,900	89,200	452,630,000
Barataria 5/	76,200	23,100	51,200	114,658,000
Terrebonne	87,800	32,300	106,400	309,809,000
Atchafalaya 6/	-6,800	8,500	16,500	19,388,000
Teche/Vermilion	14,700	4,800	9,800	34,039,000
Mermentau	39,600	9,900	20,900	72,929,000
Calcasieu/Sabine	21,900	24,800	91,800	136,460,000
Total	326,000	211,400	431,900	1,284,018,000

Costs and benefits for Short-Term Critical and Short-Term Supporting projects only are included unless noted otherwise.

1/ Total benefited acreage consists of acres created, protected, or restored; acres of submerged aquatic vegetation; and acres enhanced.

2/ Does not include the Bonnet Carré Freshwater Diversion project, authorized under separate legislation.

3/ Costs and benefits include a sediment diversion at Bohemia.

4/ Costs and benefits of the major Mississippi River Diversion have been adjusted to reflect a 20-year project life. The principal action recommended in this basin would result in created wetlands in the Breton Sound Basin; however, the costs and benefits are shown in the Mississippi River Delta Basin.

5/ Does not include the Davis Pond Freshwater Diversion project, authorized under separate legislation.

6/ Costs and benefits include long-term Delta Management project.

"-" indicates gain in wetlands.

solutions regarding loss of Louisiana's coastal wetlands are generally well understood, there is still much to be learned with regard to the effectiveness of specific approaches. The first phase is a largely defensive, short-term approach; the objective is to prevent additional loss of wetlands, particularly in areas with critical loss or limited opportunity for restoration. The second phase provides long-term solutions: large-scale, generally complex projects which have the potential for major impacts on wetland loss.

NEAR-TERM STRATEGY

The annual priority lists will continue to form the heart of the first phase but will have additional important elements. These lists provide a fast-track process

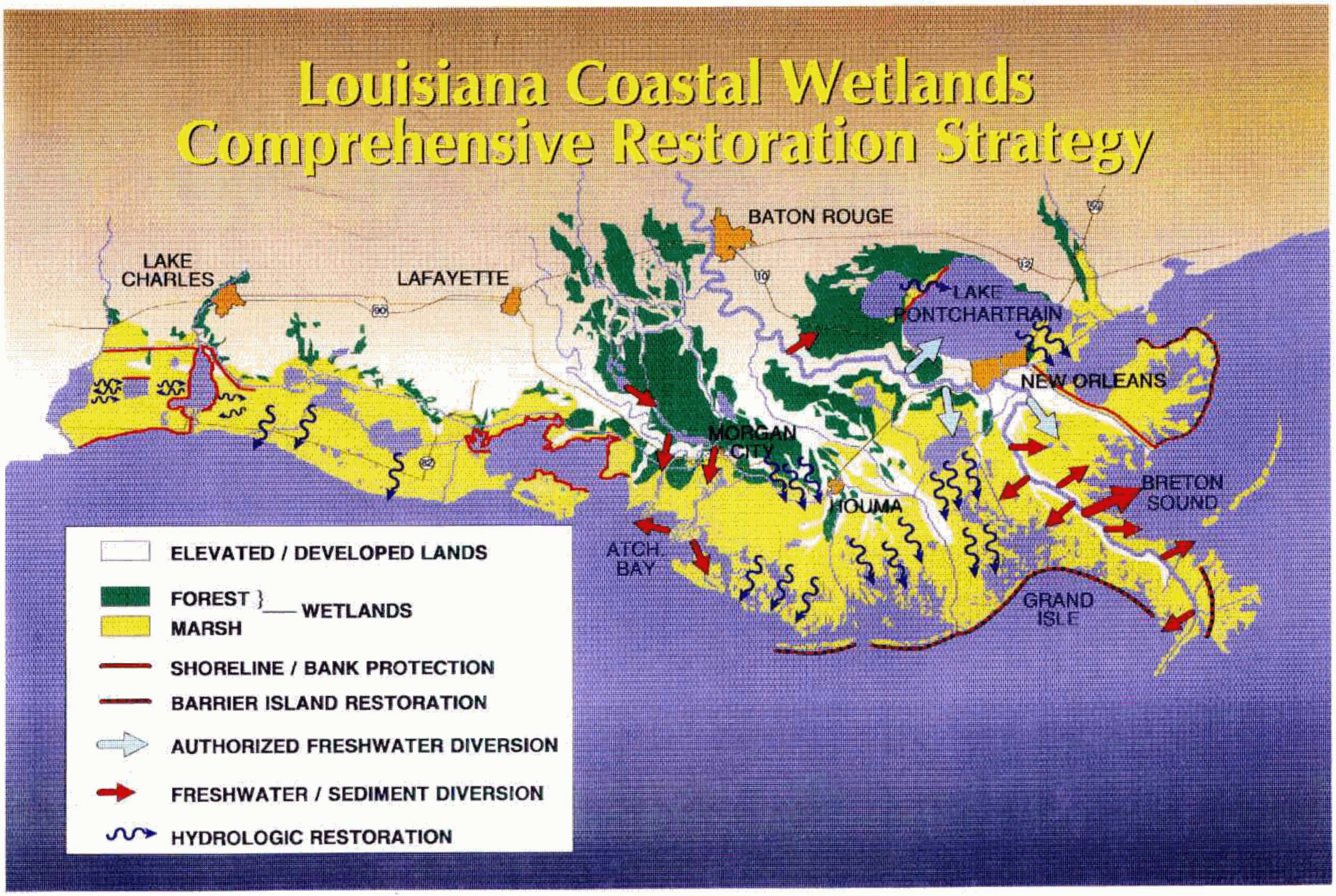

Figure 3. Coastwide Restoration Strategy Map.

through which relatively small-scale projects can be rapidly constructed and monitored. Priority list projects can be implemented in a fairly short period of time with no requirement for additional Congressional action. Elements of this first strategy are listed below:

- The Task Force will improve the priority project selection process to streamline project development and selection and to increase the efficiency with which the current funding stream is applied.

- In early 1994, the Task Force, in conjunction with the Citizen Participation Group, will develop and adopt a strategy to increase public involvement in decision-making and the free flow of information between the Task Force and the academic community; input from the public and from the academic community has been an invaluable part of the planning process.

- The Task Force will immediately begin preparation of detailed feasibility studies on some of the large-scale projects enumerated in the preceding section. The complexity of many of these solutions warrants a level of study beyond any initiated to date.

- The Task Force will continue to learn through both project monitoring and demonstration projects.

LONG-TERM STRATEGY

The second phase of implementation will entail securing authorization and funding for and construction of the large-scale regional projects that are determined to be feasible. Projects with costs of tens of millions of dollars are not easily accommodated by the present funding stream of about $40 million per year (including State contributions). As project feasibility studies initiated under the first phase of this process begin to near completion, a parallel effort will introduce them, through the channels of a designated lead federal agency, into the competitive civil works and water resources authorization and funding arenas.

PROJECT EVALUATION

The detailed monitoring program established for all CWPPRA-funded restoration projects, including demonstration projects, will ensure accountability by objectively determining the degree to which programmatic and project-specific goals are achieved. The program will also provide a basis for improved project design and operation. Monitoring will adhere to rigorous protocols that were developed, with input from the academic community, by the Task Force's Monitoring Work Group. Monitoring results and associated evaluations for CWPPRA-funded projects will be provided to Congress every three years as required by the Act. An accessible data base, maintained by the State of Louisiana, will encourage the publication of monitoring results, so that the ecosystem management techniques developed in Louisiana can be made available to, and be peer-reviewed by, a national and international audience.

The final obstacles in the implementation of many projects involve social and legal issues. The resolution of many of these issues lies outside the authority of this Task Force. As a result it is imperative that emphasis be placed on actively involving the public and all stakeholders in the restoration process to retain and build public support and confidence as difficult decisions are faced.

CONCLUSION

Despite the losses of the past century, the wetlands built by the Mississippi River contain an extraordinary diversity of estuarine habitats that range from narrow levee and beach ridges to expanses of forested swamps and fresh, brackish, and saltmarsh prairies. Taken as a whole the unique interplay of habitats, with their watery connections--to each other, to upland areas, to the Gulf of Mexico, and to migratory routes of birds, fish, and other species--combine to place the coastal wetlands created by the Mississippi River among the Nation's most productive and important natural assets. In human terms, these wetlands have historically been a culturally diverse center for social development. More than two million people live within this region. The economic and environmental futures of all residents, whether in the City of New Orleans or in the homesteads of southwest Acadiana, are threatened by the loss of the coastal marshes.

The CWPPRA has provided the first national mandate for action. Even more importantly, the Act has begun the prudent process of reinvesting a small portion of the hugely diverse harvest of this region to assure the sustainability of this uniquely productive system. The process laid out in the Act has produced results, both tangible and intangible, within its first three years that have surprised many and increased confidence of future success.

The Restoration Plan presented here provides guidance, and an estimate of the cost necessary over the next 20 to 50 years, to return Louisiana's coastal wetlands--with all their human and non-human resources--to a self-maintaining and sustaining future. The strategy outlined in this plan presents a technically sound alternative for accomplishing the Task Force vision of "bringing our wetlands gains to the level to meet or exceed our wetlands losses." Its aggressive implementation would entail the investment of an estimated $1 billion to $3 billion, or some 10 percent of what the system can be expected to produce in the value of fisheries alone over that same period.

The consequence of not meeting this challenge would be the loss, forever, of an additional half million acres of wetlands over the next twenty years. Along with this natural asset would go their potential to produce billions of dollars in renewable resources on into the future. Ultimately, the Nation would lose billions more in commercial productivity and infrastructure. Twenty years from today, we or our children would face the same decision but with far fewer options. This report presents the Nation with a choice and the information to make an informed decision.

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

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INTRODUCTION

PURPOSE OF THE PLAN

In November 1990, Congress passed and President Bush signed Public Law 101-646, Title III, the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA, Exhibit 1). Two key points explain the value and historic importance of this law.

- The vast wetlands of coastal Louisiana support valuable renewable resources that are of local, state, national, and international significance. Approximately one-third of the nation's fishery landings, which add an estimated $680 million to the State's economy annually (Keithly 1991), are dependent on these wetlands. Additionally, this ecologically rich coastal area is the basis for a major sporting and tourism industry that adds $338 million to the State's economy annually. However, unlike any other state in the union, Louisiana loses over 25 square miles annually of the resource base supporting such industries, as a result of natural and human-induced hydrological, geological, and ecological processes. Nearly one million acres of these nationally important coastal wetlands have been lost in the last 60 years (Dunbar et al. 1992).
- Public concern and the tremendous ecological and economic importance of coastal wetlands to Louisiana prompted the Louisiana Legislature to take action in 1989. Louisiana Act 6 provides a long-term revenue source for coastal restoration that may vary from $5 million to $25 million per year (Louisiana Revised Statutes 49:213 and 49:214). A referendum to protect this funding source through an amendment to the Louisiana constitution passed by a margin of three to one, showing the overwhelming state-wide public support for this measure. This commitment of economic resources provided Congress the impetus and assurance of necessary matching funds to launch a parallel federal initiative to address coastal land loss.

The CWPPRA provides the first national mandate for action. Even more importantly, the Act has initiated the prudent process of reinvesting in restoration a tiny fraction of the billions of dollars that these wetlands provide every year in renewable (fish and wildlife) and non-renewable (oil and gas) resources. The Act directed that a Task Force consisting of representatives of five federal agencies and the State of Louisiana develop a "comprehensive approach to restore and prevent the loss of coastal wetlands in Louisiana."

Section 303(b) of the CWPPRA requires preparation of this comprehensive restoration plan and specifies:

> Such plan shall coordinate and integrate coastal wetlands restoration projects in a manner that will ensure the long-term conservation of the coastal wetlands of Louisiana.

This report responds to that Congressional mandate. The Restoration Plan is a product of communication, coordination, and cooperation not only among the designated participants from the state and federal agencies, but also through the formal, and more often informal, involvement of numerous local government agencies, the academic community, private environmental and business groups, and countless motivated individuals with good ideas.

DISTRIBUTION OF THE PLANNING RESPONSIBILITY

INTERAGENCY PLANNING GROUPS

Section 303(a)(1) of the CWPPRA directs the Secretary of the Army to convene the Louisiana Coastal Wetlands Conservation and Restoration Task Force, to consist of the following members:

- the Secretary of the Army (Chairman)
- the Administrator, Environmental Protection Agency
- the Governor, State of Louisiana
- the Secretary of the Interior
- the Secretary of Agriculture
- the Secretary of Commerce.

The State of Louisiana is a full voting member of the Task Force except for selection of the Priority Project List [Section 303(a)(2)], as stipulated in President Bush's November 29, 1990, signing statement (Exhibit 1). In addition, the State of Louisiana may not serve as a "lead" Task Force member for design and construction of wetlands projects of the Priority Project List (the priority list process is described in Exhibit 3).

In practice, the Task Force members named by the law have delegated their responsibilities to other members of their organizations. For instance, the Secretary of the Army authorized the commander of the Corps' New Orleans District to act in his place as chairman of the Task Force.

To assist it in putting the CWPPRA into action, the Task Force established the Technical Committee and the Planning and Evaluation Subcommittee. Each of these bodies contains the same representation as the Task Force--one member from each of the five Federal agencies and one from the State. The Planning and Evaluation Subcommittee established several working groups to evaluate projects for Priority Project Lists and the restoration plan. The Environmental Work Group was charged with estimating the benefits (in terms of wetlands created, protected, enhanced, or restored) associated with various projects. The Engineering Work Group reviewed project cost estimates for consistency. The Economic Work Group performed the economic analysis which permitted comparison of projects on the basis of their cost effectiveness. The Monitoring Work Group established a standard procedure for monitoring of CWPPRA projects and developed a monitoring cost estimating procedure based on project type.

The core of the plan development process was centered in interdisciplinary basin teams for each of the nine hydrologic basins in the coastal area which reported to the Planning and Evaluation Subcommittee. The nucleus of each team consisted of representatives of the five federal Task Force agencies and the State; these six members made the final decisions on team recommendations. However, team meetings frequently involved additional agency representatives, scientific advisors, and local interests. The basin teams developed the comprehensive restoration plans for the basins. They also have served as the first level of screening for proposed Priority Project List projects.

PUBLIC PARTICIPATION

The Task Force also established a Citizen Participation Group to provide general input from the diverse interests across the coastal zone: local officials, landowners, farmers, sportsmen, commercial fishermen, oil and gas developers, navigation interests, and environmental organizations. The Citizen Participation Group was formed to promote citizen participation and involvement in formulating Priority Project Lists and the restoration plan. The need to incorporate another invaluable resource--the state's scientific community--was also recognized. The Task Force therefore retained the services of a scientific advisor, who selected a team of scientists to work with the basin teams in the preparation of Priority Project Lists and the development of the basin restoration plans.

An evolving public involvement program implemented by the Task Force provides an opportunity for all interested parties to express their concerns and opinions and to submit their ideas concerning the problems facing Louisiana's wetlands. Exhibit 2 presents details of the public involvement in this process to date, as well as an outline of a proposal for the future.

The program has utilized a series of meetings to accomplish several purposes: to identify wetland loss problems throughout the coastal zone; to develop potential solutions to those problems (literally hundreds of ideas were submitted to the Task Force through these meetings--Exhibit 4 provides a list of these proposals); to present and receive comments on the conceptual restoration plans developed for each basin; and to obtain public input on the candidate projects for the Priority Project Lists.

Comments and responses pertaining to the draft version of this report (dated June 1993) are contained in Appendix J.

ADDITIONAL ELEMENTS OF THE CWPPRA

In addition to the development of the restoration plan pursuant to Section 303(b) of the Act, a number of related wetland restoration and protection activities are to be implemented. These include the identification and construction of priority restoration projects, preparation of a wetland conservation plan, and implementation of a feasibility study to consider flow distribution between the Atchafalaya and Mississippi rivers.

PRIORITY PROJECT LISTS

Section 303(a) of the CWPPRA authorizes the construction of wetland protection and restoration projects through the development of Priority Project Lists, to be submitted to the Congress annually. These are lists of projects which provide for the creation, protection, restoration, or enhancement of Louisiana's coastal wetlands, ranked in order of the projects' cost effectiveness. Priority list projects are generally relatively small-scale projects which can be brought to fruition within five years of being named to a Priority Project List. At this level, the act provides for a somewhat limited but effective and rapid response to the problem of coastal wetlands loss in Louisiana.

Reports covering the first three Priority Project Lists were submitted in November of 1991, 1992, and 1993 (Exhibit 3 provides the details of the development and selection of these project lists). The three reports recommended the construction of 48 projects , with a fully funded cost of approximately $123 million. The reports also have identified several projects as deferred, to be constructed in the event one or more of the primary projects cannot be implemented within the five-year limit specified by the CWPPRA. It is estimated that the 48 recommended projects will create or prevent the loss of more than 46,000 acres of wetlands over the next 20 years.

On April 17, 1993, the lead Task Force agencies signed cost-sharing agreements with the Louisiana Department of Natural Resources for 11 priority list projects, the first such agreements to be executed under the CWPPRA. The Task Force has granted construction approval for four of these projects. Contracts were awarded in November 1993 for construction of the Vegetative Plantings demonstration project at Hackberry and the Bayou LaBranche Wetland Creation project.

WETLANDS CONSERVATION PLAN

The Restoration Plan and Priority Project Lists represent the initial elements in solving the Nation's most critical coastal wetland loss problem. Equally important is the need for complementary management actions (i.e., improved regulatory control), because much of Louisiana's coastal wetland loss ultimately results from activities conducted or authorized by government agencies. These management actions are to be addressed through the development of a wetland conservation plan under Section 304 of the CWPPRA. The Secretary of the Army, Administrator of the Environmental Protection Agency, Director of the U.S. Fish and Wildlife Service, and Louisiana Department of Natural Resources are preparing a cooperating agreement to specify agency roles and responsibilities for wetlands conservation plan development. The plan's goal is to achieve no net loss of wetlands in the coastal zone resulting from development activities. The conservation plan will complement the restoration plan presented herein, potentially incorporating regulatory and other measures, incentives, and mitigation to achieve its goal.

RIVER FLOW MODIFICATIONS

In addition to actions specified in Sections 303 and 304 of the CWPPRA, Section 307(b) of the act adds another element to the program by authorizing and directing the Secretary of the Army to "study the feasibility of modifying the operation of existing navigation and flood control projects to allow for an increase in the share of the Mississippi River flows and sediment sent down the Atchafalaya River for purposes of land building and wetlands nourishment." The 307(b) study has not been funded yet, but consistent with the spirit of the CWPPRA, this Restoration Plan includes consideration for flow modifications of the type authorized for study. The plan underscores the urgent need for initiating studies of flow distributions between the Mississippi and Atchafalaya rivers to build and nourish wetlands.

DEVELOPMENT OF THE RESTORATION PLAN

To facilitate the problem identification and plan formulation called for in section 303(b) of the CWPPRA, the Louisiana coastal zone was divided into nine hydrologic basins: Pontchartrain, Breton Sound, Mississippi River Delta, Barataria, Terrebonne, Atchafalaya, Teche/Vermilion, Mermentau, and Calcasieu/Sabine. These basins represent the basic components for initiating plan development. The coastal zone, which includes all or part of 20 Louisiana parishes, and the nine basins are shown in Plate 1.

Scoping meetings held in 1991 were the first stage in the process of identifying coastal wetlands problems and developing basin-by-basin solutions. The process continued with a series of basin plan formulation meetings, held in early 1992. These meetings were intense planning sessions, consisting of four three-day meetings with a two-day followup for each of the four meetings. Coastal wetlands problems and their causes were discussed in detail, and strategies were developed for dealing with those problems on a basin-by-basin basis. These strategies were molded into conceptual plans that continue to serve as a guide in selection and evaluation of projects both for Priority Project Lists and for the Restoration Plan.

During these meetings, many of the ideas submitted in the 1991 scoping meetings were integrated into the conceptual plans. The planning effort has refined the conceptual basin plans over the last year so that, taken together, the basin plans form the restoration plan.

The Louisiana Coastal Wetlands Restoration Plan is presented in six logically structured sections:

- The first is this INTRODUCTION to the preparation of the plan.
- Second is the assessment of the wetlands RESOURCES in coastal Louisiana, including their national, regional and local value.
- Third is the evaluation of the complex natural and man-induced processes that are causing the PROBLEM of wetlands loss, and which if left unabated will have catastrophic consequences.
- Fourth is a review of the SOLUTIONS available to address these problems--the proven as well as the innovative techniques which can be used to create new wetlands and abate wetlands losses.
- Fifth is the PLAN itself, which fits the best short-term and long-term solutions to the varying problems in each of nine hydrologic subbasins across coastal Louisiana.
- Sixth is a specific outline of actions for the IMPLEMENTATION of the plan.

The result of the Task Force's investigations, developed through this combined effort, is the blueprint for coastal restoration presented in this report.

ENVIRONMENTAL SETTING

OVERVIEW

The coastal wetlands and estuaries of Louisiana are one of the world's great ecosystems. For millennia, the Mississippi River has supplied the coast with an immense resource of fresh water, nutrients, and sediment, building a vast expanse of marsh and swamp land. Natural erosional processes have continuously altered these lands. The dynamic interplay of land and water, where new lands are always being built and old lands changed and lost, has produced an environment rich in natural habitats, with an unsurpassed diversity in vegetation, wildlife, and fisheries, and an extraordinary biological productivity.

Encompassing four million acres, Louisiana's coastal marshes and swamps represent over 40 percent of the estuarine wetlands in the contiguous United States and provide 20 percent of the country's annual commercial harvest of fish and shellfish. Millions of people rely directly or indirectly on the marshes for their livelihood and for protection against hurricanes and storms. This land is the heart of the unique Cajun culture, an invaluable cultural heritage whose influence extends far beyond the boundaries of Louisiana. The area is also of enormous economic importance in ways not directly related to wetlands, especially because it produces some 15 percent of the nation's oil and over 20 percent of its natural gas, and because the Mississippi River ranks as the country's most important inland navigational waterway, as well as the access route to one of the largest deep-draft ports in the world.

In the last several decades, however, humans have impacted this ecosystem in many ways, especially by controlling rivers so natural floods no longer build wetlands in the quantities they once did, and by dredging channels that expose freshwater marshes to salt water at an unnatural rate.

As the twentieth century progressed, each year coastal Louisiana lost its wetlands at an increasing rate, reaching about 40 square miles per year in the 1970's. This represented 80 percent of all coastal wetland loss in the United States and constituted an economic cost of about one-half billion dollars per year. Recently the rate has slowed somewhat, but still it exceeds 25 square miles per year. Many signs indicate that if nothing is done, large rates of loss will continue--and in some areas perhaps increase--far into the future. The ultimate economic cost will be in the billions of dollars; beyond that, there will be immeasurable damage to cultural and environmental values.

Any plan to benefit Louisiana's coastal wetlands must include restoration and enhancement of the natural processes that first created this ecosystem. This cannot be achieved without an understanding of the geomorphological processes that have built and changed the coast and formed the resulting landscape, and of the ecological principles that govern its use by living organisms.

DELTA FORMATION AND DETERIORATION

Deltas and rivers, like all natural systems, are continually in a state of change, evolving toward a new set of conditions. Ecologists see the process reflected in plant and animal community succession. It is important to understand this natural

Key Terms

Natural Processes. The forces responsible for shaping our environment are dependent on geothermal energy, solar energy, and movement of air and water, including tides. These forces result in geological and geomorphological transformations, be they due to tectonic, erosional, subsidence, or sedimentary processes.

Sediment Accretion. Wetlands are built by the accumulation of sediment, or sediment accretion. Under natural conditions, rivers reaching the Louisiana coast have periodically overflowed their banks and carried sediment-laden water into areas between river channels. During a flood, the heaviest sediments are dropped on the river bank (at the natural levee), while the finer sediments are transported farther and build mudflats. The vegetation on the levees and mudflats grows, then decays, and much of the decaying organic material accumulates on the land, adding to the buildup of material. The fresh water and nutrients which accompany the sediment are also major resources which are vital to the wetlands.

Subsidence. The compaction of soft sediments deposited by the rivers and vegetation is the most important of many processes which cause the land surface to become lower over time. Additionally, crustal downwarping due to the thick sediment pile deposited by the Mississippi River over millennia is a near-constant land lowering process. Land lowering is termed subsidence. When subsidence (plus the added effect of sea level rise) exceeds sediment accretion, the land is said to experience a sediment deficit. Land with a sediment deficit will gradually become flooded.

Marine Forces. Winds, tides, and currents in the Gulf of Mexico are sources of energy and water which modify the land and which ultimately can turn subsiding wetlands into open lakes and estuaries. Important marine processes include: flooding of the land with salty water during high tides and storms; shore erosion by waves (especially during storm surges); and the transport and redeposition of eroded sediments. In active deltas where sediment accretion is large, marine forces mostly attack the margins. But in the areas where subsidence dominates, the marine forces increasingly penetrate into and change the interior marshes.

adaptability as we seek to manage wetland sustainability. The major sedimentation cycle, delta switching at about 1,000-year intervals, is an example of succession.

Figure 1 illustrates how a delta is built, then abandoned, by the Mississippi River. First, the river extends its channel into open water; when floods overflow the channel, sediment accretion builds land out of the sea as an "active" delta. This continues until the slope of the river is so flat that sediment is not moved efficiently. Then the river channel will shift to a new, more efficient course and build a new delta. These are known as lobes and actually contain many different sublobes and channels (or distributaries) of varying sizes. The delta-switching process has built up what we now know as coastal Louisiana (see Figure 1 of the Executive Summary). When the river switches, the previous delta lobe is considered "abandoned," and begins to degrade through erosional processes, even though some flow may continue down the old distributary.

Nature's Response to Changes in the Deltas.

Each stage in the cycle of delta building and abandonment is characterized by different natural processes and ecological conditions. The slow but continual transformation of coastal Louisiana depends on the balance between fluvial (river) and erosional processes, modified to some extent by the accumulation of organic sediments. These processes are listed in Table 1.

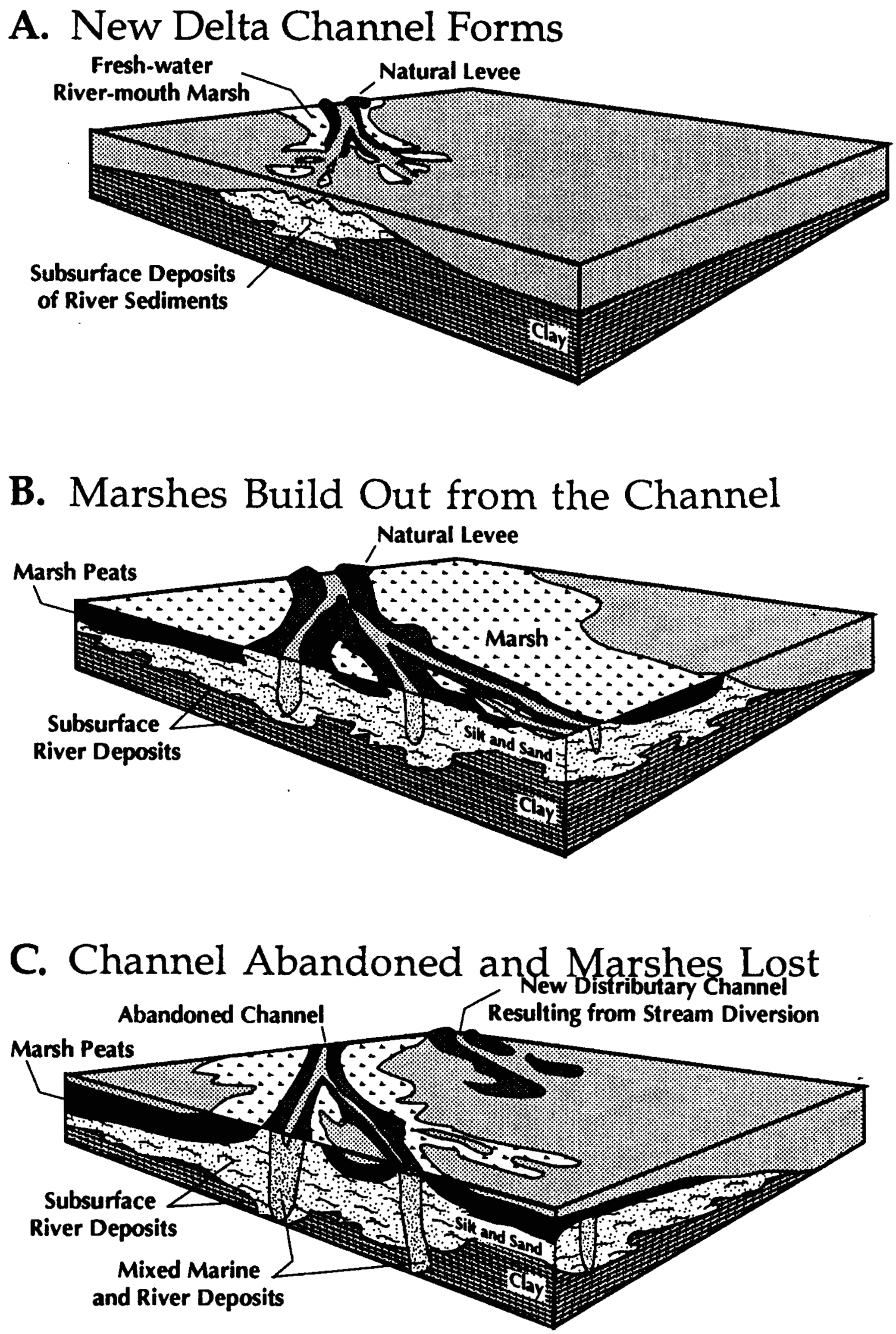


Figure 1. Delta Growth and Abandonment.

Table 1
Geomorphological Processes in the Coastal Zone

Erosional Processes (Land Loss)	Fluvial Processes (Land Building)
subsidence	sedimentation (inorganic)
tidal action	spring floods
storms	delta switching
wave action	freshwater introduction

Erosional processes generally lead to wetland loss, while natural fluvial systems lead to land gain. Each coastal basin is in a different state of succession and can be viewed as fitting on a continuum extending from predominantly erosion-dominated to fluvial-dominated processes. Those basins losing land the fastest primarily are affected by erosional processes. Those gaining land are controlled by fluvial events and are on the other end of the spectrum. A combination of erosional and fluvial processes governs the remainder of the basins.

Prior to European settlement along the Mississippi River, the deltaic plain not only sustained itself above sea level but also gradually increased in area and elevation. This was a product of dominance by various fluvial processes, such as overbank sedimentation during spring flood events, crevassing, channel bifurcation, and delta switching, which overcame the natural subsidence.

Human actions have tended to curb fluvial land-building processes and favor the dominance of erosional processes. They therefore tipped the balance in the direction of land loss.

Natural System Units and Dominant Processes.

Within coastal Louisiana we recognize three major natural system units: active delta, abandoned delta, and chenier plain. The deltaic plain, which makes up the eastern half of the coastal zone, consists of active and abandoned deltas units. The following sections will discuss the relationship between erosional and fluvial processes and the major ecological conditions within each. Human impacts on these physiographic units are disregarded in the following characterizations.

Deltaic Plain--Active Delta.

In an active delta, the key physical processes are those related to the input of fresh water and mineral-rich sediment. Thus, fluvial processes dominate and control the erosional processes of subsidence, wind-wave and ocean swell erosion, tidal scour, etc. The net result is expansion of the wetland surface over time and creation within the system of extensive freshwater habitats. Figure 2 is an idealized cross section showing the evolution of a delta distributary and adjoining marshes. With time, the delta and associated fluvial channels prograde and fill in the landscape's topographic lows to create vegetated wetlands.

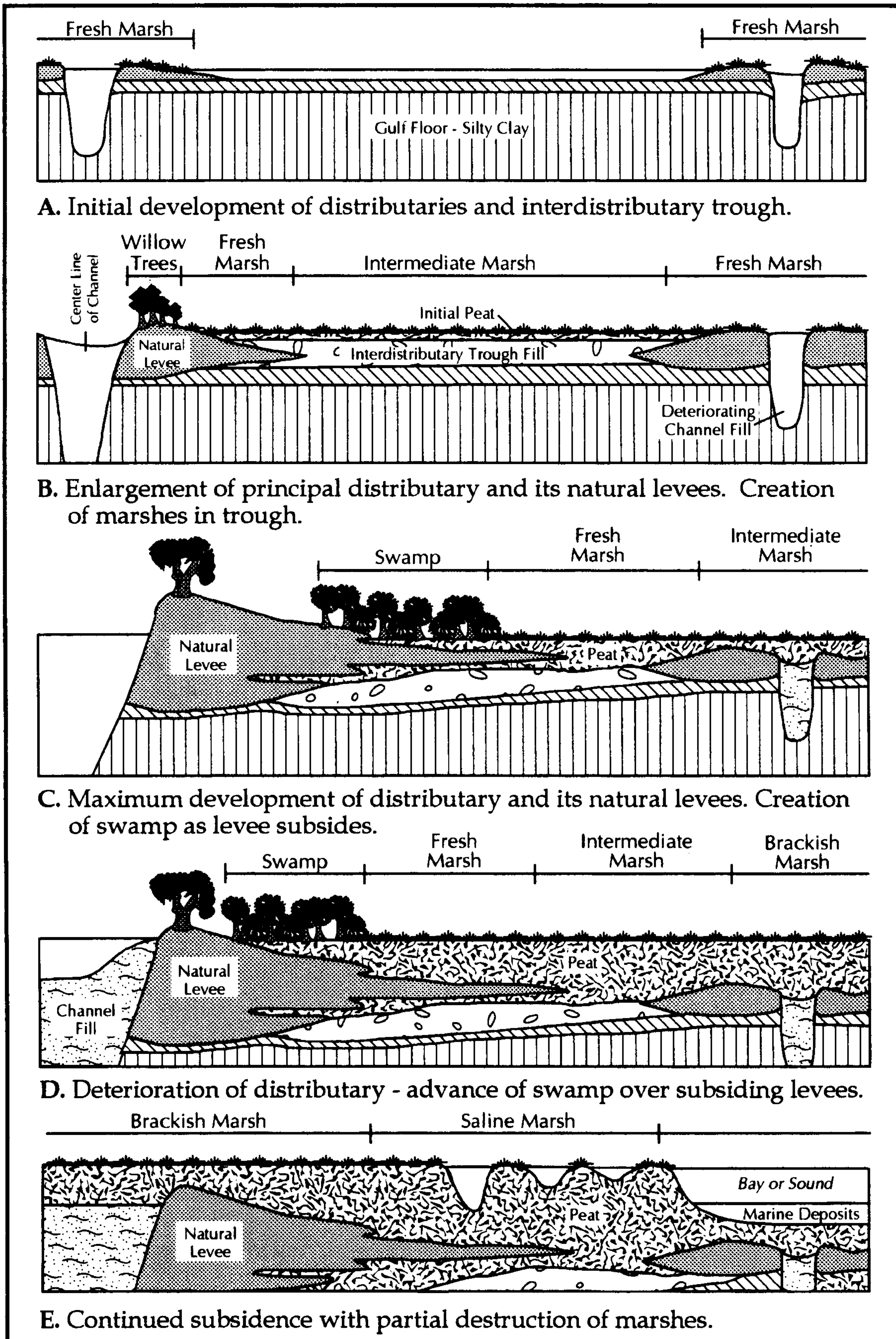


Figure 2. Stages in Growth of a Delta and Marshes.

During the building process, the highest land, the coarsest and most stable sediment, and the freshest water are found at the natural levees near the sediment source. Elevations decrease, sediment becomes finer and more organic, and salinities increase away from the stream. Marshes develop between channels on an organic-rich (peaty) soil, while the natural levees support flood-tolerant forests. Just before abandonment, the land is at its greatest extent, still dominated by river processes and fresh water.

Deltaic Plain--Abandoned Delta.

In the abandoned delta, erosion processes dominate fluvial. However, fluvial inputs of fresh water and nutrient-rich sediment, although reduced from when the system was an active delta, lead to the maintenance of large parts of the wetlands. Initially, this maintenance nearly balances the wetland loss processes.

In cases where the production of organic materials is prolific, marshes may maintain themselves above the sea for a long time after abandonment. But the combined effects of reduced fresh water and sediment plus subsidence eventually allow marine impacts to increase. A strong salinity gradient is established from fresh water at the landward end toward the salty water at the Gulf of Mexico end, and vegetation follows this pattern, with fresh marsh inland grading to salt marsh near the gulf. As the marine forces begin to dominate, the shoreline is reworked into sandy headlands and barrier islands, and tidal channels form. The marsh is increasingly eroded or flooded out, and the land opens to form shallow interior lakes and bays (estuaries) that are connected to the sea by the tidal channels. The barrier islands slowly move landward, generally at a lower rate than the outer shoreline of the marshes, so that the estuary is gradually enlarged. Ultimately, the outer coastal marshes are eroded into a series of islands, with the barrier islands separated from the marshes by large, open bays. The estuarine system is eventually replaced by a sound (e.g., Breton Sound). Moreover, the estuary is restricted to small bays within the marshes that have tidal connections to the sound.

Biological productivity is at its peak during the early stages of abandonment, when the landscape changes most rapidly and ecological conditions are particularly diverse. This explains why the most recently abandoned delta lobe, in the area of the Barataria and Terrebonne estuaries, is so productive for commercial fisheries. The fact that productivity can increase as wetlands decrease helps mask the fundamental problem that wetland destruction ultimately will cause a loss in biological and economic value.

Chenier Plain.

West of the complex of abandoned and active deltas is the chenier plain, an area formed by Mississippi River sediments that have been carried westward by currents along the coast and reworked by marine forces into low ridges and intervening wetland swales parallel to the coastline. The shoreline was built outward through mudflat accretion at times when the active delta was near the western edge of the deltaic plain and when fluvial processes dominated, and was eroded back when the delta was to the east and the process balance shifted to the erosion end. The chenier ridges are the remnants of the old, reworked shorelines, and the intervening swales are the old mudflats. The majority of the beach materials are shell and shell fragments. These are derived from the eroded mudflats and from shell organisms on the shallow inner shelf. Ocean swell processes rework the shells into the beach profile.

The interval when the dominant chenier processes change from erosional to fluvial, such as is occurring today, is marked by both progradation and rapid shoreline erosion. The onset of the fluvial phase increases the turbidity within the shallow inner shelf's water column. This affects the productivity of the region's clams and snails, which in turn reduces the quantity of shell material that can be incorporated in the beach.

The chenier plain also contains large inland lakes that were formed after the last glaciation, when the sea level rose and drowned old river valleys. The natural environments of the chenier plain are strongly affected by fresh water from rain and upland runoff. This water is impounded in the flat, low-energy zone behind the chenier ridges, and extensive freshwater marshes have developed on peaty materials around the lakes. Narrow passes connect these inland wetlands to the Gulf of Mexico, and, under natural conditions, tidal influence (and salt water) penetrated a relatively limited area around the passes. The ridges were historically forested, and salt marshes flourished on the seaward side of the cheniers.

BIOLOGICAL ABUNDANCE OF THE WETLANDS

The salinity gradient between inland fresh water and marine salt water is dynamic; it varies over time and space as, for example, winds and tides push salt water inland, or river floods push fresh water seaward. However, under natural conditions the gradient is sufficiently stable that it results in well-defined zones of vegetation roughly parallel to the coast, with salt marshes along the gulf and fresh marshes at the upper ends of the estuaries (Figure 3). Swamp forests occur on slightly higher ground farther inland.

Dominant species in different zones are depicted in Figure 4. Species diversity is greatest in fresh marsh and decreases seaward. Prior to major human impacts, Louisiana's coastal region contained nearly 1 million acres of swamp forest and about 3 million acres of marshes, of which 60 percent were in the deltaic plain and 40 percent were in the chenier plain.

Marshes are an abundant source of food for fish and wildlife--animals that inhabit the wetlands permanently, and an even larger spectrum of animals that use the wetlands seasonally. The food production rivals that of intensively cultivated farms, due in part to the warm and moist climate, the abundance of nutrients, and the substantial energy resulting from water movement. Upon the death of the plants, this production becomes the base of a detrital food chain. Organic debris washes into adjacent lakes and streams, where it supports intense biologic activity. It is here that the detritus accumulates, and where crawfish and oysters proliferate, juvenile fish find food and shelter, and carnivorous fish and birds find an abundant diet.

Figure 5 illustrates the energy and food flows among the inland areas, marshes, the estuaries, and the Gulf of Mexico. The marshes, old distributary channels, tidal channels, and shallow lakes are vital habitats because of their role as nursery grounds for virtually all commercial and sport fish species and wintering grounds at the southern end of the major duck and goose migration corridors. Additionally, the area is a major stopping-off point for migratory song birds and other birds en route from the northeastern United States to Central and South America and back.

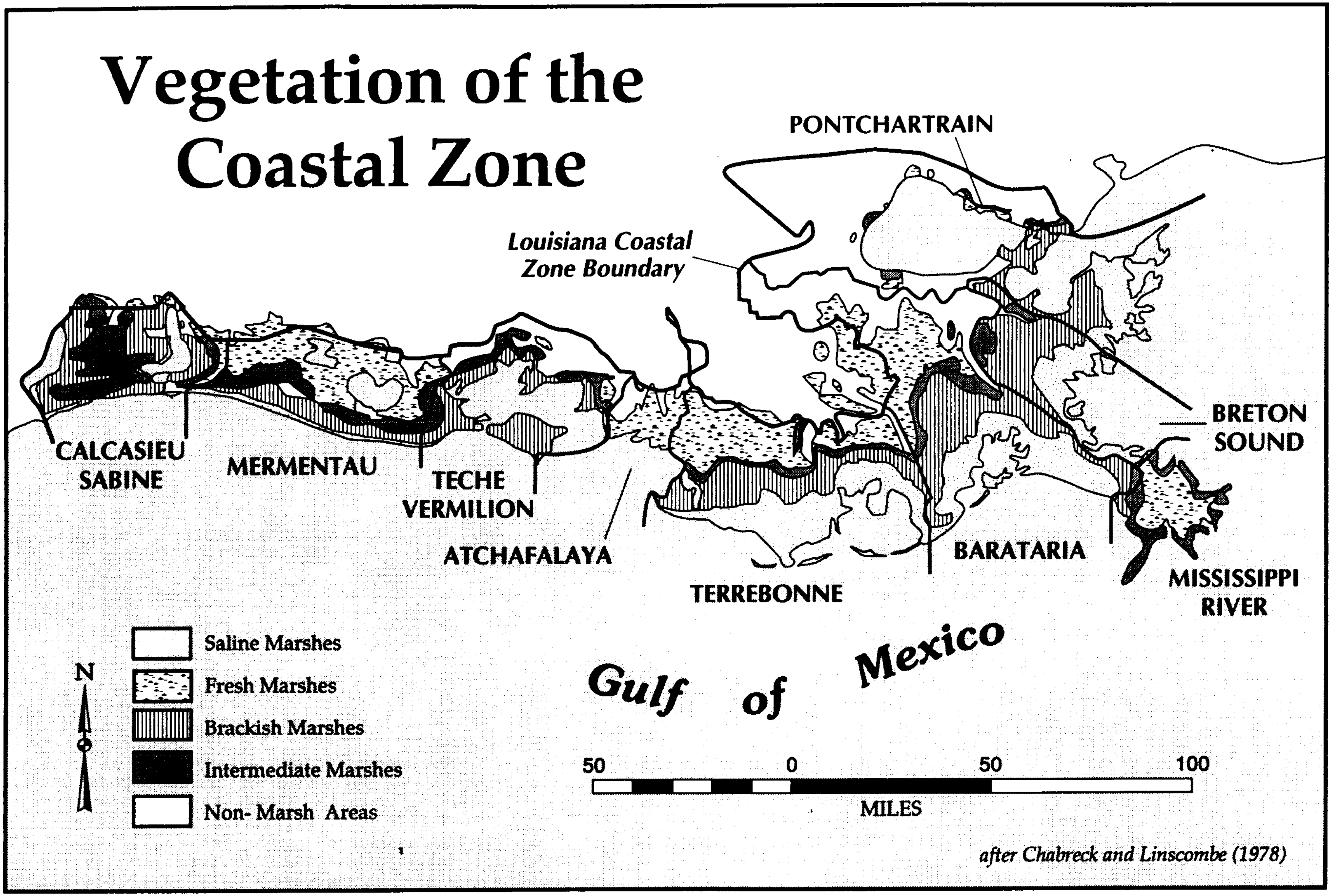


Figure 3. Marsh Types of the Coastal Zone.

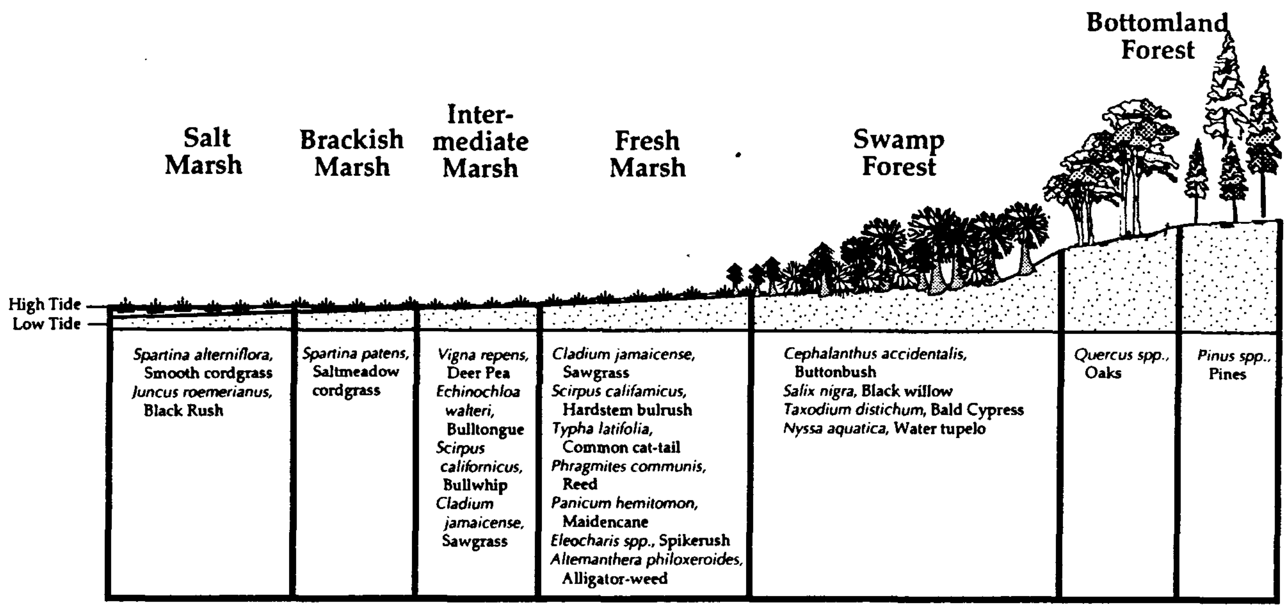


Figure 4. Dominant Plant Species in Different Wetland Types.

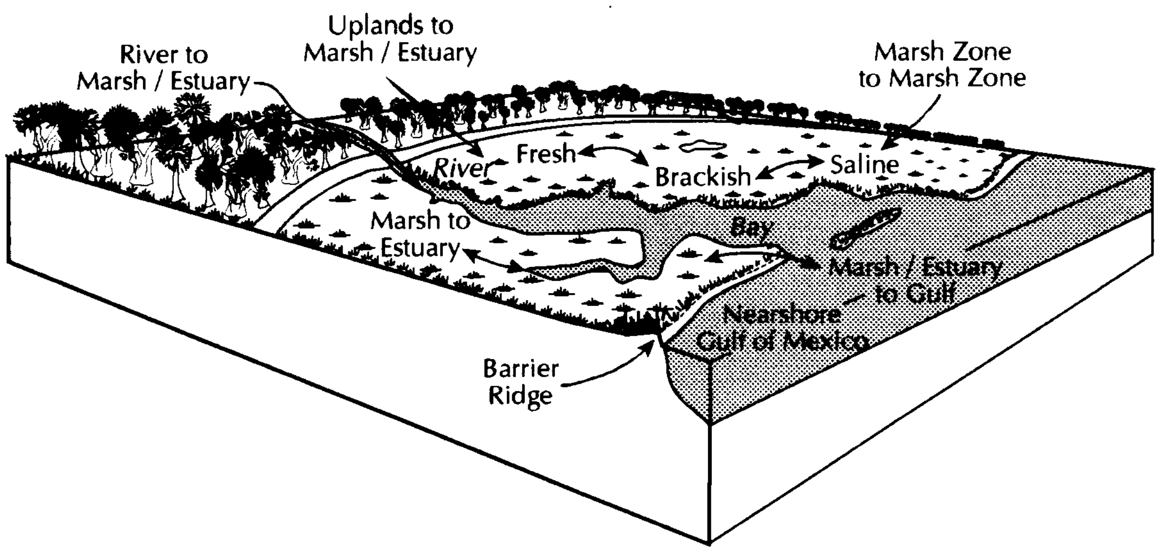


Figure 5. Energy Flow in the Coastal Zone.

Different marsh types support different species; moreover, the fish and wildlife species using the wetlands change substantially over the course of a year, further contributing to the overall complexity and value of the habitat.

THE VALUE OF COASTAL WETLANDS

The economy of southern Louisiana, today as in the past, is closely tied to its geography and geologic history. Following two centuries of sporadic visits by European explorers, settlement began in the early 18th century with the arrival of French colonists. Fertile delta soils deposited by ancient meanders of the Mississippi River eventually fostered a plantation-based agricultural economy that produced indigo, tobacco, sugar cane, cotton, and rice as primary crops. Heavily wooded regions and easy access to water transport also gave rise to timber exports. Economic activity expanded along with greater development and exploitation of the Mississippi River and the access it provided to domestic and foreign markets. Modern development has added manufacturing, service, and resource sectors featuring major ports, oil and gas exploration and refining, chemical production, ship and oil rig construction, tourism, and commercial and recreational fishing. Actions taken to enhance these enterprises, or to protect them from the high intrinsic flood risks of the coastal area and the delta, account for the chief human impacts on the wetlands.

The national wealth and infrastructure created over the nearly three centuries of economic activity in the project area form a context in which to view the relatively minor cost of remediation. More importantly, continuation of some of these activities and continued accrual of related wealth hinges on solution of the wetland loss problem.

The sections that follow describe the economic resources at stake in coastal Louisiana under three general categories: values directly dependent on the marshes and their output; values based on economic activities and infrastructure investments; and values arising from the unique coastal ecosystem and man's social and cultural adaptations to it.

FISH AND WILDLIFE VALUES

The wetlands within the Louisiana coastal area are a natural resource of immense regional and national economic importance. National Marine Fisheries Service statistics for the period 1984-91 show that the commercial fisheries dependent on this habitat contributed an average of 20 percent of the nation's harvest. These marshes also produce more wild furs and hides than any other state in the United States, valued at nearly $20 million annually.

Louisiana fishing ports, which include four of the country's ten largest, produce a catch comparable to that of the entire Atlantic seaboard, and double that of the remaining gulf states. These landings command an annual market value of nearly $1 billion. Important species include shrimp, oyster, blue crab, and menhaden. Combined, these four species account for 98 percent of the annual catch value. Data on shrimp and oyster harvests, when adjusted for unreported landings, indicate that the coastal fisheries supplied 35 to 40 percent of the nation's needs. These catch data, as presented in Table 2, reflect a pro rata assignment of the entire gulf harvest based on the percentage distribution of productive wetlands (see EIS).

Table 2
Gulf of Mexico and Louisiana Coastal Area Estuarine-Dependent Commercial Fisheries Harvest and Value

Species	1983-1990 Average Landings 1/ (Pounds)	Correction Factors for Unreported Landings 2/	1983-1990 Average Corrected Landing (Pounds)	1992 Normalized Price 3/ ($)	1992 Gross Exvessel Value 4/ ($)
Blue Crab	61,740,498	2.00	123,480,996	0.58	71,618,978
Shrimp	247,554,500	2.00	495,109,000	2.17	1,074,386,530
Oyster	21,614,731	1.90	41,067,989	2.61	107,187,451
Menhaden	1,739,444,500	1.00	1,739,444,500	0.05	86,972,225
Croaker	307,383	1.00	307,383	0.58	178,282
Black Drum	7,032,894	1.00	7,032,894	0.44	3,094,473
Red Drum	3,500,956	1.00	3,500,956	1.15	4,026,099
Catfish	5,754,891	1.00	5,754,891	0.60	3,452,935
Flounder	1,473,552	1.00	1,473,552	1.04	1,532,494
King Whiting	669,077	1.00	669,077	0.37	247,558
Mullet	25,011,536	1.00	25,011,536	0.41	10,254,730
Sea Catfish	135,484	1.00	135,484	0.21	28,452
Sea Trout Spot	2,704,407	1.00	2,704,407	1.16	3,137,112
Sea Trout White	516,460	1.00	516,460	0.54	278,888
Sheepshead	3,514,347	1.00	3,514,347	0.23	808,300
Spot	272,907	1.00	272,907	0.29	79,143
Finfish	6,773,194	1.00	6,773,194	0.23	1,557,835
Total Gulf of Mexico	2,128,021,317		2,456,769,573		1,368,841,485
La. Coastal Area 5/	1,361,933,643		1,572,332,527		876,058,551

1/ Source: U.S. Department of Commerce, National Marine Fisheries Service. Published and unpublished data for the years 1983 to 1990.

2/ Correction factors based on information provided by the Louisiana Department of Wildlife and Fisheries.

3/ 1992 Normalized Prices were calculated by escalating the exvessel values of the 1983-1990 catches to March 1992 price levels using the Consumer Price Index.

4/ Based on 1992 normalized prices and the 1983-1990 average corrected landings.

5/ Gulf of Mexico landings allocated to the Louisiana coastal area are based on the relative abundance of estuarine marsh habitat.

The fishery resource also supports a wide range of related businesses such as processing and canning, shipping, wholesale and retail operations, and restaurants. On-water operations are likewise dependent on boat building and repair yards, net and gear manufacturing, ice making, and commercial marinas. Employment data suggest that from 50,000 to 70,000 people are directly engaged in these fisheries and in subsequent processing, wholesaling, and other activities. Because a substantial portion of the fish caught in Louisiana's offshore waters are landed and processed elsewhere, numerous jobs in adjacent gulf states also depend on the continued productivity of this state's wetlands.

Also based in these coastal wetlands is a major recreation industry. Primary leisure activities include fishing, hunting, boating, picnicking, birding, and camping. A study completed in 1984 for the LSU Center for Wetland Resources estimates that the 180,000 licensed saltwater sports fishermen in the state annually spend $181 million on fishing and have nearly $1 billion invested in boats, gear, camps, and other equipment. The study estimates the total annual economic impact of sport fishing-related expenditures at over half a billion dollars. A later analysis produced by the Sport Fishing Institute put the total economic impact at nearly $900 million for the year 1985.

Located at the southern end of the Mississippi and Central Flyways, Louisiana marshes are the overwintering site for nearly 70 percent of the ducks and geese migrating along that route. The economic value of the hunting provided by the flyway exceeds $10 million annually. Waterfowl hunting and recreational fishing supported by Louisiana wetlands exceed 3 million annual user days.

Various methods have been proposed that attempt to capture all of the mentioned marketable outputs, as well as non-marketable but nonetheless valuable outputs, in a dollar-based expression of wetland value. Methods which include the value of the wetlands as a processor of urban and agricultural waste products, its storm buffering effects, surrogate values based on captured energy, and existence value to non-users produce per-acre values ranging from a few hundred dollars to $40,000 or more, in addition to the value of real estate and mineral rights. Using the upper end of this range, the current loss rate exceeds half a billion dollars a year. When confined to the more easily documented fish and wildlife outputs that make up most of the value at the low end of the range, the numbers are still impressive. If wetland losses are permitted to continue unabated, by the year 2040 wildlife and fishery harvests will decline by about $220 million annually compared to present levels. Most of these losses will be made up by foreign supplies. Real estate assets valued at $240 million also will be lost.

CAPITAL ASSETS AND INFRASTRUCTURE

Human alteration of the environment and the physical landscape in Louisiana began with the early French colonists, who settled along the natural levees of the Mississippi River and its tributaries. The site selected for the settlement of New Orleans was chosen for its strategic location near the Bayou St. John Portage, a primary trading route to Mobile. Because the site tended toward periodic flooding, settlers began constructing a levee system shortly after the founding of the town. From that time to this, the economic history of the region continues to be largely a story of enterprises carried on under the protection of public and private flood control works.

The French settlers who recognized potential in the site picked for New Orleans chose well. Located at the gateway to the entire Mississippi Valley, it today marks the center of the nation's largest deep-draft port complex. Facilities located between the mouth of the Mississippi River and Baton Rouge annually handle cargoes of over 230 million tons, valued in excess of $30 billion. These cargoes, which exceed in volume the traffic of the entire West Coast of the United States, include about 25 percent of this nation's exported commodities and 24 percent of its grain shipments. The ports along this deep-draft segment of the river serve as transshipment terminals for these cargoes and for other shallow-draft movements utilizing the vast network of inland waterways formed by the Mississippi River, its tributaries, and connecting streams. The value of the transfer service provided by these facilities is estimated at about $400 million a year.

Three other deep-draft ports are located in coastal Louisiana: Lake Charles, Morgan City, and Port Fourchon. The Port of Lake Charles serves an important chemical and refining center, handling about 30 million tons of high value cargoes annually. Morgan City and Port Fourchon primarily function as construction and service centers for the offshore oil and gas industry. Additionally, many commercial fishermen operate out of these ports.

The Gulf Intracoastal Waterway, a critical link in the country's shallow-draft transportation system, also traverses the project area wetlands. Freight carried on this waterway has averaged about 70 million tons annually in recent years. Total transportation savings to the nation generated by this system during the period 1940-90 are equivalent to $936 billion in today's terms. In addition to the national and international trade carried on over area waterways, these channels, along with numerous smaller feeder streams and canals, also serve as a vital transportation asset of the oil and gas activities centered in the state's coastal region and in the Gulf of Mexico. All told, the coastal navigation features threatened by wetland loss represent nearly 3,000 miles of deep- and shallow-draft channels built and maintained with billions of dollars of public investments.

Other transportation facilities in the project area include: mainline railroads; Federal interstate highways; numerous other U.S., state, and parish highways; an extensive oil and gas pipeline network; and commercial airports. The Southern Pacific, Illinois Central, and Amtrak lines provide service to most of the area. Service is extended via spur lines along the alluvial ridges as far south as the GIWW and along the Mississippi River below New Orleans. The primary east-west highway routes are Interstates 10 and 12 and U.S. Highways 90 and 190. Major north-south routes include Interstates 49, 55, and 59, and U.S. Highways 51, 61, and 165.

Pipelines are the primary carriers of petroleum products imported, produced, and refined in the coastal zone. Over 14,000 miles of onshore and 2,000 miles of offshore pipelines are located in the area. Also located in this vulnerable region is the Louisiana Offshore Oil Port, Inc., which began operations in 1981. This $700 million dollar offloading facility supplies 15 percent of the country's imported oil, moved from ships unloaded at a floating terminal 18 miles south of Grand Isle through pipelines to storage caverns in the Clovelly salt dome. Oil is then transferred from the salt caverns to a system of seven pipelines serving refineries along the gulf coast and in the Midwest. Other terminals in the area contribute another 5 percent to the supplies of imported crude oil, for a state total of about 20 percent of U.S. imports.

In addition to being a major importing center, Louisiana is a primary producer of energy resources. The state provides about 15 percent of the nation's crude petroleum and over 20 percent of its natural gas supplies. The combined value of these two products averaged $16 billion annually for the 1986-91 period. Nearly 90 percent of this output is extracted from the coastal area and adjacent offshore waters. Abundant supplies of crude petroleum and natural gas, fresh process water, and nearby water transportation account for the concentration of refining and petrochemical manufacturing facilities located in the project area, primarily along the Mississippi and Calcasieu rivers. These industries, which rank Louisiana as the nation's third largest chemical producer, ship commodities valued at nearly $50 billion annually. There were over 90,000 refining and refining-related jobs in the state during 1992.

Tied to these and other economic activities are major population centers and their related public and private infrastructure, valued at well over $100 billion. These are protected from the destructive river and tidal flood events characteristic of low-lying regions by an extensive system of levees and other protective works which, when completed, will represent an investment of nearly $12 billion. Estimates of storm and flood damage that would have occurred without this protection suggest the flood risk faced by the 2.1 million people living in the region's coastal communities: works already in place have prevented $111 billion in losses since 1927.

The marshes surrounding the economic landscape described above--the cities, towns, businesses, industries, transportation corridors, etc.--are an integral design consideration for the flood control features on which the entire region depends. Continued substantial loss of wetlands will require that levees and other structures be enlarged or relocated in order to maintain current levels of protection. Activities and features located outside of existing lines of protection will likewise be impacted. Highways, ports, waterways, railroads, pipelines, and other utilities will need to be relocated, or will experience major escalations in maintenance costs. Businesses, residences, camps, schools, and other structures in the coastal area will also need to be protected or relocated at great expense. To the extent that wetland loss can be offset, particularly in specific, critical locations, many or most of these economic losses can be avoided.

CULTURAL VALUES AND TOURISM

Coastal Louisiana can claim a rich mixture of cultural backgrounds and community histories. Initially settled by the French and later ceded to the Spanish, the region boasts a lengthy and diverse roll of ethnic groups who have made important contributions to Louisiana, both before and after its admission to the United States in 1812. Native Americans, Anglo-Americans, African-Americans, the Acadians, Italians, Irish, Germans, French, Spanish, Canary Islanders, Dalmatians, Chinese, Filipinos, and others are among the major ethnically distinct populations who now reside in the coastal zone. The earliest of these settlers made their livings, often in the face of adversity, as planters, farmers, fishermen, trappers, loggers, moss gatherers, and other occupations keyed to the rich natural environment. Out of this heritage arose the social and cultural systems that set the area apart from the rest of the nation. The languages, the customs, the cuisines, and a view of life unlike any other continue to distinguish the area.

Tourism, a major component of the local economy, is inextricably linked to the unique regional characteristics which evolved from past and present interactions of coastal Louisiana populations and their wetland environment. State tourism officials estimate the expenditures, payroll, and tax receipts in the 20-parish project area at slightly over $4 billion in 1991, producing about 61,000 jobs. Visitors to New Orleans alone number 11 to 12 million persons annually. The loss of these coastal societies and their cultural, culinary, and esthetic identities which will accompany continued wetland disappearance will clearly impact this sector of the regional economy. Beyond that, something of great value to the nation may be lost as well--the unique cultural heritage of south Louisiana.

SUMMARY

The economic assets and activities described in this section have been impacted for several decades by coastal processes set in motion by man and nature. Some of the effects, such as the gradual decline of fishery productivity and failure of related businesses, are subtle and difficult to detect in the short term. Others can be dramatic, such as failure of a levee overstressed because adjacent protective wetlands are lost. Without decisive action, however, current losses will accelerate and other losses will be felt as newly critical areas are affected. As the shoreline approaches mainline flood protection levees, communities will incur substantial costs for upgrading protection and for relocations. Unprotected features will require costly additional works. Some features will doubtless be lost altogether.

Local resources available to address the problem are limited. The 1980-90 decade was marked by substantial turmoil in one of the region's primary economic sectors, the oil and gas industry. Consolidations, down sizing, and transfer of operations to other states or foreign locations resulted in significant unemployment and out-migration. As detailed in the socioeconomic discussions contained in the EIS, the population is not projected to soon return to the levels generated during the peak of the oil and petrochemical industry expansions.

Maturation of these industries and lower regional birth rates also forecast long-term declining employment. As these industries and the payrolls they support decline, so will the Louisiana tax base.

As the cost of flood protection rises and overall economic activity declines, scarce local tax revenues will be diverted from other deserving community needs. Tax burdens in general will increase; business operations will grow more costly and less competitive. Average incomes will fall and quality of life will suffer. Most of the conditions characteristic of long-term regional decline will exist.

There are also serious implications from the national point of view. For example, the Federal government is the primary provider of navigation and flood control works. As land loss encroaches on channels and levees located in the coastal zone, Federally built facilities will grow more costly to maintain or will require additional investment to function properly. Long-term viability of some presently threatened communities is also an issue that carries wide ranging risks for disaster relief funding and other Federal emergency programs. Threats to the several large wildlife refuges in the project area will similarly strain the budgets of the natural resource agencies.

Indirect effects will also be felt at the national level. This region is a primary producer of energy and many other basic materials on which the U.S. economy depends. Economical supplies of these products and their efficient movement through coastal ports and waterways are matters that involve much more than Louisiana alone.

The problem will never be less expensive to solve than it is now; on the other hand, the cost of inaction will grow exponentially.

THE PROBLEM: LOSS OF COASTAL WETLANDS

INTRODUCTION

Recognizing that extremely valuable resources are at risk, it is important to determine what the problems impacting the resources are and to what extent they are human induced. The primary causes of wetland loss in coastal Louisiana have been understood for some time; they include subsidence, global sea level rise, sediment deprivation, and hydrologic alteration (Boesch 1982; Mendelssohn et al. 1983, Titus 1986, Turner and Cahoon 1987, Day and Templet 1989, Duffy and Clark 1989). Subsidence and global sea level rise have combined to subject wetland plant communities to relative sea level rise (RSLR) rates that exceed half an inch per year in parts of the Louisiana coast (Hatton et al. 1983, Baumann et al. 1984). Rapid submergence and local penetration of marine processes into the freshwater interior of Louisiana's coastal estuaries are secondary effects, resulting from the interplay of these factors, that impose stresses on these wetland plant communities (Mendelssohn and McKee 1989, Nyman et al. 1993).

These stresses reduce plant productivity and compromise the inherent ability of most wetland vegetation to withstand submergence by adding sufficient organic matter to the substrate to maintain surface elevation within the intertidal or intermittently flooded zone (Mitsch and Gosselink 1986). A variety of more local impacts, associated with canal dredging, faulting, ponding, hurricanes, herbivory, and erosion by waves and currents, affect stressed marshes--far more severely than healthy ones--and can act as the "last straw" that gives rise to dramatic "hot spots" of loss (Leibowitz and Hill 1987).

Coastal Louisiana has been extensively altered by human activity. Each of the primary causes of land loss has a natural and man-induced component. Subsidence, for example, occurs naturally in the wetlands built by the Mississippi River as a consequence of geologic downwarping and compaction of a sediment column with a high component of water, gas, and organic materials (Kolb and van Lopik 1958, McGinnis et al. 1991). However, subsidence also may be significantly affected by local drainage efforts that reduce the water content of the upper few feet of the soil profile (Harrison and Kollmorgen 1947), by placement of levees and other structures that load the surface (Kolb and van Lopik 1958), or by removal of minerals (e.g., oil, gas, or sulphur) from near-surface deposits.

Similarly, sediment deprivation in a marsh can be a natural consequence of the switching and change in dominance of the various distributaries of the Mississippi River (Coleman and Gagliano 1964), but it also is affected by development of continuous river levee systems that prevent overbank flooding and crevasse development (Kesel 1989) or promote loss of sediment into deep waters overlying the continental slope (Viosca 1928). Finally, hydrologic alterations can occur as a natural consequence of the breakup of barrier island systems at the mouths of estuaries (Penland and Boyd 1981), abandonment of distributary channels, or the development of tidal drainage networks (Tye and Costers 1986). However, the viability of coastal wetlands also is affected by thousands of miles of dredged channels and associated levees that alter hydrology, sedimentation, and salinity regimes (Scaife et al. 1983, Swenson and Turner 1987).

The basin plans included in the appendices of this report provide an overview of the complexity of this system. The remainder of this section is devoted to a review of the research findings critical to the restoration process.

HISTORICAL PERSPECTIVE

More than 4 million acres of the coastal wetlands built by the Mississippi River survived into the 20th Century. Nearly one million of these acres have been converted to open water in the last 60 years alone (Dunbar et al. 1992). It is critical to clearly identify the processes that have caused the most damage in the past to determine whether they are still causing destruction and to prioritize restoration efforts to stop or offset the most serious loss-producing processes.

Much coastal wetland loss in Louisiana, as in other maritime states, accompanied canal, railroad, and highway building, and development of drainage systems for agricultural, industrial, and residential purposes. In the first two decades of the 20th century over 200,000 acres were leveed and put under pump to create agricultural and suburban lands (Harrison and Kollmorgen 1947). Pumping of the organic soils caused rapid subsidence within the leveed areas and many areas, with the exception of some suburban districts adjacent to New Orleans, underwent conversion to open water once the pumps stopped or storms breached the levees.

Unique to Louisiana is the connection between current land loss and the evolution of a comprehensive levee system along the Mississippi River and the damming of distributaries like the Atchafalaya River, Bayou Plaquemine, Bayou Manchac, Bayou Lafourche, and several others south of New Orleans. The confining of the Mississippi River to a small part of its original flood plain and to a single course was initiated to provide flood control in the last century. Efforts to improve navigation resulted in the extension and stabilization of the mouth as a jettied channel to the edge of the continental shelf (Humphreys and Abbot 1861). Sediment supply to river flanking marshes was decreased, but continued to occur through crevasses or high-water levee breaks (Millis 1894).

The disastrous 1927 flood galvanized the Nation and provided impetus for a massive federal effort to raise and reinforce levees for comprehensive flood control (Elliott 1932). Crevassing was effectively stopped and control over the river tightened. Construction of the Old River Control Structure was completed in 1963 to stop the capture of the Mississippi by the Atchafalaya (Fisk 1952) and distribute the combined flows of the Red and Mississippi Rivers so that 70 percent flowed down the Mississippi and 30 percent flowed down the Atchafalaya. Revetments constructed along the Mississippi River and dams built on the Missouri and other large tributaries in the 1950's have affected the amount of sediment reaching the Gulf of Mexico (Meade and Parker 1985, Keown et al. 1986, Kesel 1987).

The suspended sediment load from the Mississippi River drainage system that helped build these wetlands apparently declined in the mid-1950's following a long-term drought and the construction mentioned above (Meade and Parker 1985). Measurements of bed materials also show a shift to finer grained sediment in the active delta during the 20th century (Keown et al. 1981). However, land clearing for agriculture and urban expansion has undoubtedly contributed to increased sediment loading in the river over the last 200 years. These changes, coupled with the elimination of direct input to the wetlands through crevasses, levee breaks, and delta lobe construction, have influenced sediment supply rates to the coastal wetlands.

Development of projects within the coastal basins themselves accelerated once river flooding was controlled. Large navigation channels were constructed and enlarged between 1920 and 1970. The Gulf Intracoastal Waterway joined and incorporated several smaller canals running parallel to, but considerably inland of, the coast. In addition, large channels perpendicular to the coast were built to connect inland ports located along the GIWW with the Gulf of Mexico. These connect the fresh interior marshes with the gulf and provide efficient conduits for freshwater drainage, and for sea water to move inland across natural subbasin boundaries (Wang 1987). Such channels have promoted the invasion of marine processes into freshwater areas previously isolated from them.

Pertinent information on the major navigation channels that transit the Louisiana coastal zone can be found in Exhibit 6 of this report. A high percentage of the banks of these waterways are unstable and were left unprotected during the construction process. As a result, bank erosion has caused many of the channels to grow far beyond the authorized width (Johnson and Gosselink 1982). The Mississippi River Gulf Outlet (MRGO), a channel completed east of New Orleans in 1968, is now as much as 2,000 feet wide, nearly three times its original width of 750 feet.

The dredging of smaller channels for drilling rig access and pipeline installation proliferated in the coastal wetlands of Louisiana during the oil and gas exploration and development boom of the 1950's, 1960's, and 1970's (Lindstedt et al. 1991). Where onshore fields were developed, the marsh was broken up by dense canal networks. Offshore fields also caused destruction as pipeline canals were dredged through the marshes and barrier islands to connect with onshore processing facilities. By 1978, more than six percent of Louisiana's coastal wetlands had been directly converted to open water or spoil through canal dredging alone (Baumann and Turner 1990). Indirect losses are estimated to be considerably greater than this (Cowan and Turner 1987).

Pursuant to the Coastal Zone Management Act of 1972 and subsequent State legislation, a state-administered Coastal Zone Management Program (CZMP) became operational in Louisiana in 1980. This began a new era of public interest and involvement in the way coastal wetland areas were managed and developed. Data presented in Table 3 reflect federal permitting in coastal Louisiana, of which CZMP permits are a subset. Over the period of this record, the number of public notices advertising work proposed in coastal wetlands declined and the acreage of wetlands permitted for dredging and filling decreased by approximately 50 percent.

The decline in public notices and permitted dredge and fill acreage resulted, in part, from a general economic downturn and increased use of general permits. However, these decreases also reflect the heightened public concern and enhanced regulatory efforts through federal and state permitting programs. An important regulatory development has been the increased use of directional drilling by the petroleum industry. This allows exploration of new sites from existing canals or reduced canal excavation to reach drill sites. The increased cooperation between the oil and gas industry and regulatory agencies and the eventual development of a state Conservation Plan will help to ensure that wetlands restored at public expense will not be destroyed later by permitted activities.

Table 3
Acreage Permitted for Development [1]

Year	Number of Public Notices	Area Permitted for Dredge and Fill (acres)
1982	1,645	1,476
1983	1,341	1,413
1984	1,517	962
1985	1,606	2,362
1986	1,138	925
1987	1,138	339
1988	974	402
1989	983	988
1990	1,271	721

[1] Hartman et al. 1993.

The potential for restoration has inspired a great deal of applied scientific study directed at quantifying and categorizing land loss processes. Much new insight has emerged in the past five years, largely as a consequence of research sponsored by the agencies that now make up the CWPPRA Task Force; some of that research is ongoing. The results of this work, together with project monitoring findings, form a credible basis for continued improvement in the design of coastal restoration projects.

CHARACTERIZATION OF WETLANDS LOSS

REGIONAL LAND LOSS

The rates at which different parts of the coastal plain are sinking have been related to the thickness of sediment deposited during the last 8,000 years, which varies across the coastal zone. This sediment has the potential to lose volume by dewatering, degassing, and compaction (Penland et al. 1991). During the last glaciation, about 20,000 years ago, when sea level was about 400 feet lower than it is today, the ancestral Mississippi eroded a deep valley into the underlying Pleistocene surface across what is now the coastal zone. When sea level began to rise, the valley was gradually filled with sediment, until about 5,000 years ago when sedimentation spilled out of the valley across the deltaic plain. Consequently, some parts of the deltaic plain are underlain by a massive thickness of Holocene sediment of more than 400 feet. The Holocene layer gradually thickens seaward (Frazier 1967). Slow seaward growth of the chenier plain on the western end of the state has resulted in a much thinner wedge (generally less than 40 feet) of recent deposits over the Pleistocene (Gould and McFarlan 1959).

The rate of sinking and compaction of organic soils and the varied history of sediment deposition across the coastal zone means that RSLR also varies. RSLR estimates include 0.09 inches per year for regional sea level rise in the Gulf of Mexico (Gornitz et al. 1982), and in Louisiana range from a high of 0.51 inches per year in the Atchafalaya and Mississippi deltas to 0.24 inches per year in the chenier plain (Ramsey and Moslow 1987). However, other factors can affect RSLR in local areas. Basin sediment can move downward along fault lines. There are hundreds of "growth faults" in coastal Louisiana, some of which cause displacement at the land surface. The downthrown side of these faults is seaward, and unless sediment deposition counteracts this displacement, land loss rates may increase on this side of the fault, which is thought to be true in the Barataria basin south of Empire.

The gulf shoreline of Louisiana retreats an average of 13.8 feet per year (U.S. Geological Survey 1988). However, some sections prograde as much as 11.2 feet per year on average, while other sections retreat at mean rates that are as high as 50.2 feet per year. Shoreline movement is not a steady process; accelerated erosion occurs during and after the passage of major cold fronts, tropical storms, and hurricanes (Dingler and Reiss 1991). Field measurements have documented 65 to 100 feet of coastal erosion during a single 3- to 4-day storm. These major storms produce a low-relief barrier landscape (Penland et al. 1988, 1990). Erosion along gulf and bay shorelines has resulted in a 55 percent decrease in the total area of Louisiana's barrier islands, and a great deal of lateral and inland migration, between 1880 and 1988. Isles Dernieres, in the Terrebonne basin, has the highest rate of coastal erosion of any Louisiana barrier system. Over the last 100 years the gulf shoreline of these islands has retreated northward a distance of 5,390 feet

Hurricane Andrew struck the Terrebonne and Barataria barrier islands in 1992, causing extensive erosion and breaching. Beaches were eroded more than 130 feet in two days, and some islands were reduced in area by 30 percent (Stone et al. 1993, van Heerden et al. 1993). The destabilized condition of the barrier islands, combined with the winter storms of 1992-1993, further accelerated the erosion problem (U.S. Geological Survey 1992).

Patterns of land loss between the 1930's and 1983 have been mapped coast wide (Britsch and May 1987), and these maps provide a clear indication that many other "hot spots" of loss exist. For most of these sites the cause of loss is so compounded that it defies any simple explanation (Leibowitz and Hill 1987). While land has been lost along gulf and bay shorelines, far more has disappeared in interior marshes many miles inland of the coast (Turner and Rao 1987), as ponds have formed, expanded, and coalesced into larger water bodies (Fisk et al. 1936, Reed 1991).

WETLAND LOSS AS A FUNCTION OF PLANT MORTALITY

It is important to identify the actual mechanisms through which processes such as submergence and the invasion of marine influences affect different plant communities. Effective measures to reverse coastal land loss must affect plant communities, in their root zone, in such a way as to promote healthy growth and reproduction, plant succession, or revegetation of denuded surfaces.

Sedimentation and the Accretion Deficit.

A positive difference between RSLR (Penland and Ramsey 1991) and the rate of marsh accretion (DeLaune et al. 1978, Baumann et al. 1984, Ritchie and McHenry 1990) implies that sedimentation is not keeping pace with submergence. Accretion deficits in excess of 0.1 inch per year result over time in a lowering of the elevation of affected wetland surfaces relative to a fixed datum (Baumann et al. 1984, Nyman et al. 1993). Even a minute accretion deficit could quickly influence flooding duration in Louisiana coastal marshes, which are seldom more than 1 foot above mean sea level (Chabreck 1970). Marsh water-level data from a deteriorating salt marsh near Cocodrie in the Terrebonne basin, for example, show that while high and low tides occurred daily, the marsh surface drained infrequently and for short periods such that it remained flooded for over 90 percent of an 11-day period of record (Cahoon 1992).

Vertical accretion of wetland soils depends on soil formation from sedimentary material of two types: mineral sand, silts, and clays brought in by flood waters or winds; and living and dead organic matter produced locally by the plants. In Louisiana (Nyman et al. 1990, 1991), organic matter accumulation is frequently more important than mineral sediment input to vertical accretion, except during initial phases of delta lobe building (van Heerden and Roberts 1988). Increased rates of root production, as opposed to above-ground shoot production, appear to be an adaptation to increased flooding in salt marsh cordgrass (*Spartina alterniflora*) and wiregrass (*S. patens*) that can increase the organic component of soil formation (Good et al. 1982). Another unique but poorly understood adaptation occurs when the living root mat of some fresh marshes actually detaches from the more mineral substrate and persists for long periods in a floating condition (Russell 1942). However, such adaptations can only occur if conditions are favorable for continued plant growth.

Pezeshki et al. (1992) showed that plants from all Louisiana coastal marsh types respond positively to experimental additions of mineral sediment and suggests that a certain minimal level of mineral sediment input may be required to maintain productivity. The minimal amount of mineral matter required each year by fresh marsh communities is about half of that necessary for brackish species and less than 20 percent of that needed by the salt marsh community (Nyman and DeLaune 1992). Because overbank flooding from the Mississippi has been eliminated, most of this material is derived from the limited return of Mississippi River discharge back into coastal estuaries via tidal passes, from the Atchafalaya sediment plume, and from bay bottom sediment reworked and distributed by tidal currents. Although the mineral matter may contribute from 50 to 90 percent of the dry weight of a Louisiana marsh soil, this denser material typically occupies from 2 to 7 percent of the soil volume, most of which is actually pore space within a matrix of living and dead plant roots (Nyman et al. 1990).

It is important to recognize that surface elevation in Louisiana marshes is controlled far more by soil volume than by its composition and that the formation of soil mass and structure is largely regulated in place by the plants themselves. Accretion deficits in Louisiana coastal marshes are caused primarily by inadequate organic matter accumulation (Nyman et al. 1993). The organic matter content of the soils supporting fresh, brackish, and salt marsh communities, in contrast to the mineral content, is similar. Inadequate organic matter accumulation results from a shift in the balance between plant production of organic mass, particularly below ground, that adds to the soil organic matter stock, and removal via conversion to carbon dioxide and other gases through decomposition. Any environmental change that lowers productivity or increases the rate of organic matter removal increases the vertical accretion deficit.

Decomposition is more vigorous in the fresh marsh than in the salt marsh and is slowest in the brackish marsh (Smith et al. 1983). As a result, to add enough organic matter to the marsh substrate to maintain position with respect to RSLR, fresh marsh plants must contribute about twice the amount of organic matter each year to the substrate than is true for brackish marshes, and the salt marshes fall in the middle (Nyman et al. 1990). Processes other than decomposition also can remove organic matter and may be locally important. These include lateral erosion of wetland margins due to waves and currents (Gagliano and Wicker 1989), deep burns of marshes during drought periods, and the direct consumption of below-ground root material by nutria, muskrats, and geese that can occur at times when population pressures are severe (O'Neill 1949).

An "eat-out" is a condition that occurs in the marsh when muskrats or nutria have populated an area to the extent of completely consuming the existing vegetation, including the root system which binds the organic soils (O'Neill 1949). Eatouts can be divided into 3 stages: initial, secondary, and final. Recovery of vegetation is dependent on the presence of other stressors, but is not well understood. During the 1970's and 1980's, much greater recognition of wetlands loss led some researchers to conclude that peak populations of muskrats during the 1940's and nutria during the 1960's likely played a major role in the breakup of some interior brackish marshes in coastal Louisiana.

At a Nutria and Muskrat Management Symposium held in October 1992, it was demonstrated that nutria and muskrat herbivory (particularly nutria) has produced substantial adverse economic and environmental impacts. Researchers with the Louisiana Department of Wildlife and Fisheries, United States Fish and Wildlife Service, and Louisiana State University (LSU) indicated that the impact of nutria herbivory is likely having a very significant detrimental effect on coastal vegetation (Conference Summary 1992. Proc. Nutria and Muskrat Management Symposium). These effects are thought to be particularly significant in marshes already stressed by submergence.

Submergence, Salinity, and Sulfide Effects on Plant Productivity.

While all wetland plants are adapted to grow in flooded soils, prolonged flooding negatively affects the productivity of many Louisiana swamp, brackish marsh, and salt marsh species to varying degrees. Plants must use more energy to obtain nutrients and respire toxins when the oxygen content of the soils drops because of prolonged flooding (Gosselink et al. 1977, DeLaune et al. 1979). Most existing information is available for salt (*Spartina alterniflora*) and brackish (*S. patens*) marsh species (Kirby and Gosselink 1976, Hopkinson et al. 1978, Mendelssohn et al. 1981, DeLaune et al. 1983, Mendelssohn and McKee 1988, Nyman et al. 1993) and swamp tree species (Kozlowski and Pallardy 1979, Pezeshki and Chambers 1985, 1986). Less information is available on fresh marsh species, but the negative response to flooding appears much less severe (Crawford and Tyler 1969, McKee and Mendelssohn 1989).

Sudden increases in salinity in waters flooding fresh marshes can result in vegetative die-back (Pezeshki et al. 1987). Brackish and salt marshes contain salt tolerant plant species with salt-excreting organs to make them better able to adjust to salinity increases (Mendelssohn and Marcellus 1976). Salt tolerant plant communities have encroached into historically fresh and intermediate marsh zones in many of the inland reaches of Louisiana's estuarine basins over the past 50 years (Chabreck and Linscombe 1982).

Increased salinity levels are often an important factor contributing to fresh marsh loss in areas adjacent to deep navigation channels or in impounded areas flooded by storm-driven seawater. It appears that sulfate, another constituent of seawater, may be at least as important as the salt itself in inducing toxicity in fresh marshes and reducing productivity in brackish and saline marshes when prolonged flooding results in oxygen-depleted soils. Such conditions can result in significant soil accumulation of free hydrogen sulfide (DeLaune et al. 1983) as well as root oxygen deficiencies (Mendelssohn et al. 1981). These factors can reduce nutrient uptake (Howes et al. 1986), growth, and productivity (Mendelssohn and McKee 1988). The iron associated with mineral sediment found in greater abundance in brackish and salt marsh soils can precipitate sulfides and reduce their concentrations below toxic levels for these marshes (Buresh et al. 1980).

When fresh marsh is killed by the toxic effects of salt or sulfide, it will be converted to open water if succession to salt marsh species is unsuccessful. This may happen if the soil surface elevation drops below the lower limit at which more salt- and sulfide-tolerant plants can live (Sasser 1977), if the mineral content of the soil is insufficient to support these species (Nyman and Delaune 1991), or if the soil is lost to erosion because of the lack of vegetation.

When the plants of any marsh type die, for any reason, the subsequent rapid decomposition of the root mass can result in a reduction in soil strength and a substantial collapse of the soil volume. Such collapses have been observed to result in a soil volume decrease that leads to a surface lowering of up to four inches. For marshes experiencing a RSLR about 0.5 inches per year, the amount of organic matter required to be returned to the soil each year just to maintain elevation begins to approach the limits for annual below-ground plant production (Nyman et al. 1993). Hydrologic changes by humans or nature that affect the sedimentation regime, freshwater supply or depth, and duration of flooding experienced by a marsh plant community influence its ability to flourish in a subsiding landscape (Stevenson et al. 1986, Reed 1991). Those effects may be manifested in the succession of one plant community to another or, alternatively, in the conversion of land to open water.

MAGNITUDE OF THE PROBLEM: LAND LOSS NUMBERS

Two parallel mapping efforts have been undertaken to characterize and quantify land loss on Louisiana's coastal plain by the USACE (Dunbar et al. 1992) and by the FWS and Louisiana Department of Natural Resources (FWS/LDNR). The USACE data set is complete for the entire coastal zone and provides land loss information for four time intervals (1931-33 to 1956-58, 1956-58 to 1974; 1974 to 1983; and 1983 to 1990). It is mapped at a resolution of 1:62,500, the scale of standard 15-minute topographic quadrangle maps. The results of this study are published in Dunbar et al. (1992). The FWS/LDNR effort has recently been completed, covering the time periods of 1956-1978 and 1978-1990. It provides habitat as well as land-to-water change information mapped at a resolution of 1:24,000, the scale of a standard 7.5-minute topographic quadrangle map. This mapping covers changes that have occurred since 1956, when the first comprehensive habitat map was prepared (Wicker et al. 1981).

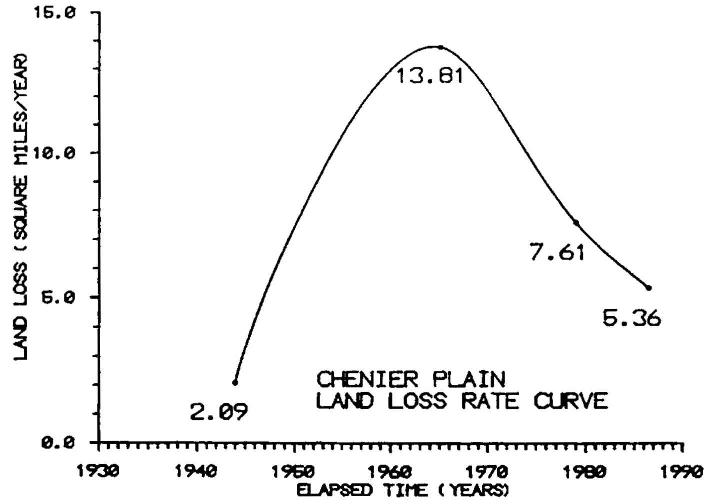
The USACE data set is used for the following discussion because it has been published for the entire coastal zone, dates back to 1932, and recently has been aggregated by the nine basins used to analyze the Louisiana coast (Dunbar et al. 1992). The USACE researchers looked for land loss in 8,511 square miles (5,447,000 acres) of lands identified in an 18,000-square-mile coastal project area, much of which is open water. About 70 percent of this land lies in the delta plain, while the remainder constitutes the chenier plain. It should be noted that a significant portion of the area mapped is not actually wetland but includes developed levee ridges and areas ringed by levees within forced drainage districts. In addition, it is important to note that the USACE methodology measures gross land loss rather than net change in any interval. Open water that is converted to land, as in the Atchafalaya Delta, is not registered as a gain, for example.

The Dunbar et al. (1992) study deserves careful scrutiny because it dates back far enough to tell us much about man's role in accelerating land loss. The 1932 imagery provides a bench mark of conditions prior to most of the major local alterations that humans have made within the coastal plain. Mean annual loss rates, based on an average value over the time period of each data set, are shown in Figure 6 for the coastal plain as a whole, and for the delta plain and chenier plains separately.

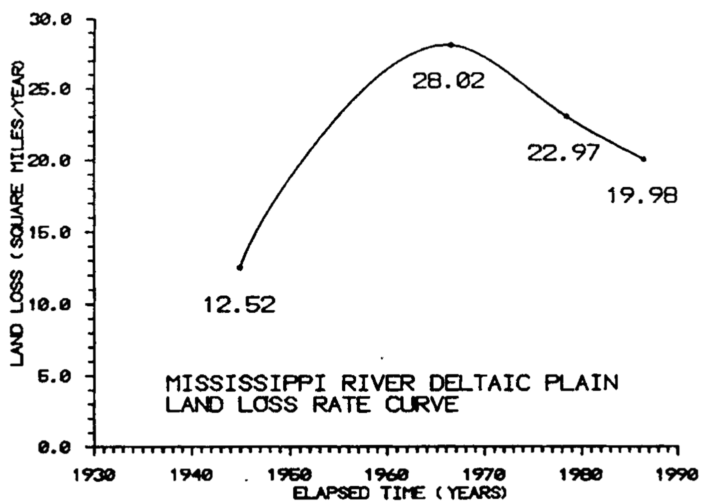
These curves show that land loss increased for the coastal plain during the period between the early 1930's and mid-1970's, rising from 14.6 square miles per year (9,000 ac/yr), prior to the late 1950's, to an extreme value of about 42 square miles per year (27,000 ac/yr). Annual loss had dropped by 1990 to 25 square miles (16,000 ac/yr). Five square miles of loss occur each year in the chenier plain, while the delta plain loses about 20 square miles annually. Aggregate land loss for the entire coastal plain totalled nearly a million acres during the 60 years of record, at an average loss rate of about 27 square miles per year (17,000 ac/yr). Two important points emerge from these data. First, it is apparent that the land loss rate has dropped coastwide over the past two decades. Second, earlier projections of accelerating land loss have not been realized (Gagliano et al. 1981).

Current land loss rates of approximately 25 square miles per year, though still very high, are far lower than earlier extrapolations projecting that annual losses would approach 60 square miles annually by the 1990's. This information challenges an earlier assumption implicit in those projections. That assumption is that land loss is self compounding and perpetuating. Rather, it can now be concluded that much land loss occurred relatively quickly in response to within-basin alterations occurring in the 1950's, 1960's, and 1970's, but the effect of these impacts has tapered off rather than grown over time.

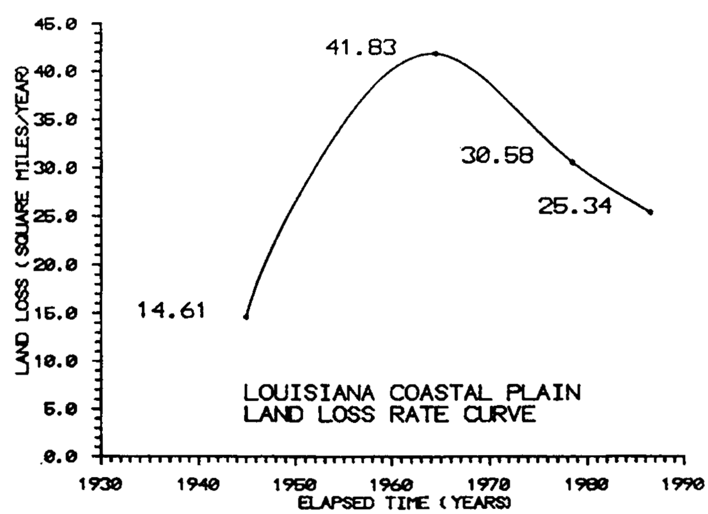
The USACE data set has been broken out along the natural hydrologic basin boundaries used by the Task Force for planning. Time histories of annual land loss for each of the basins are shown in Figure 7. It is apparent that some of the loss curves are more peaked than others. This is most pronounced in the Calcasieu-Sabine basin, where the peak can be taken to represent very rapid loss associated with the compounding impacts of a major navigation project and a devastating hurricane occurring within this time step. In the Breton Sound and Teche-Vermilion basins, a flatter curve may indicate the more gradual effects of shoreline erosion, sediment deprivation, increased marine influences, and subsidence.



a. Curve expressed in square miles per year



a. Curve expressed in square miles per year



a. Curve expressed in square miles per year

Figure 6. Louisiana Coastal Land Loss Rates by Region.

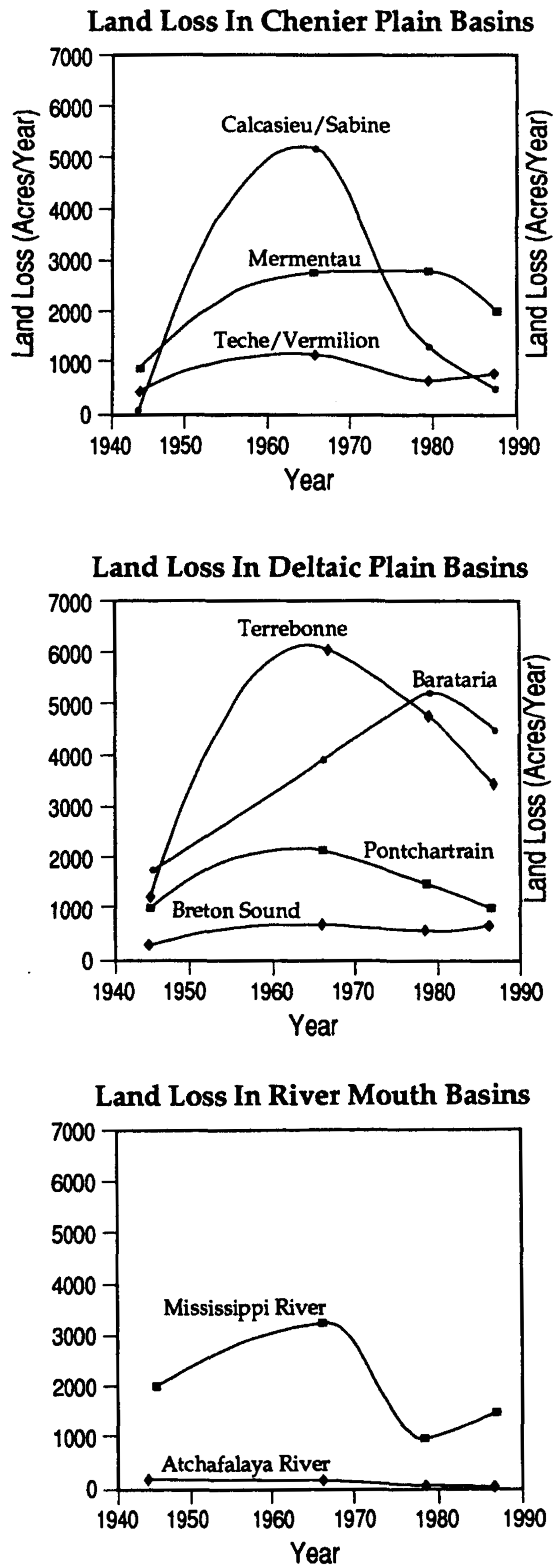


Figure 7. Louisiana Coastal Land Loss Rates by Basin.

From the planning perspective, such comparisons can be useful in allocating restoration resources. They provide at least a qualitative basis for partitioning the recorded and, more importantly, ongoing land loss between local, within-basin alterations and those of a more regional nature, associated with the underlying geology, subsidence, and sediment supply.

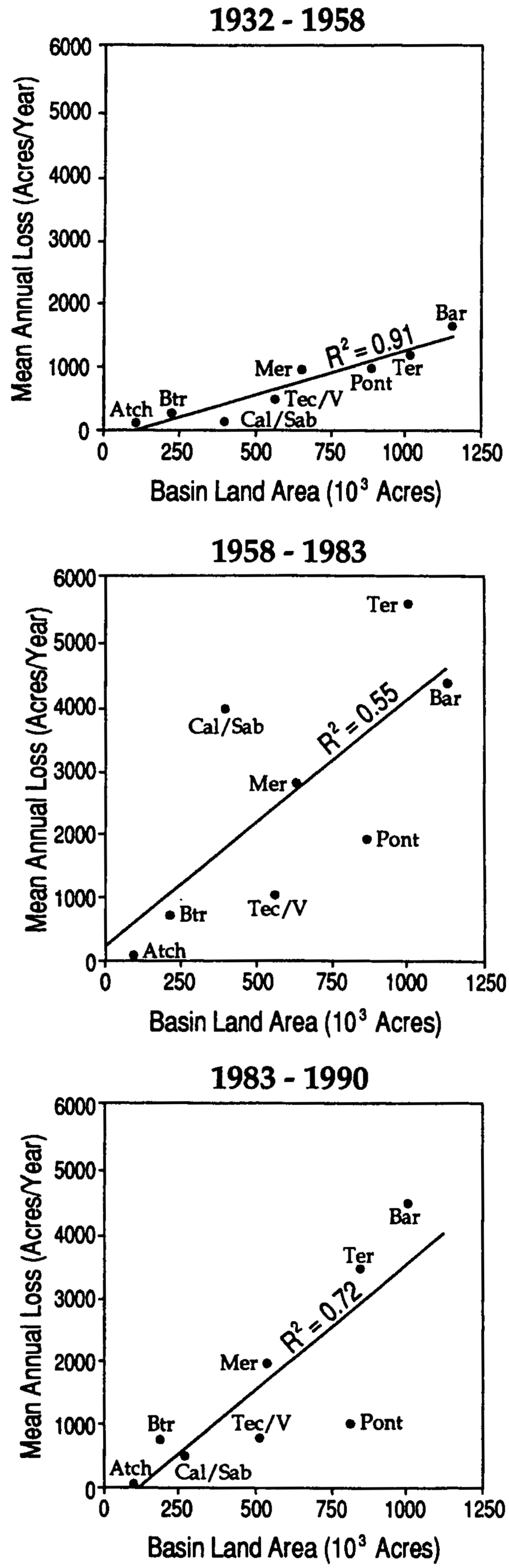
BACKGROUND LOSS

One way to separate out various factors affecting land loss rates is to use the loss data from the first interval (1932-58) as recommended by Dunbar et al. (1992) to provide an estimate of "background" loss. It is important to recognize that this background differs significantly from "natural" loss because it includes the regional impacts of management of the lower Mississippi River and its distributaries. This management began long before the 1930's, but was systematized with the authorization of the Mississippi River and Tributaries project in 1928, and evolved rapidly through the 1940's and 1950's. Canal dredging and road building, however, did far less damage to the interior hydrology of the basins prior to 1958. About 40 percent of the canals present in 1978 were dredged prior to 1958 (Turner and Cahoon 1987). Conversely, most of the disastrous land loss, associated with the wave of failed agricultural reclamations, was already complete by 1932 (Harrison and Kollmorgen 1947).

Background land loss, within the subsiding Louisiana coastal plain largely cut off from its fluvial supply of mineral sediments, is expected to be at least loosely correlated with the initial land area of each basin. Coastal basins with large initial land areas have more to lose. Sediment to maintain existing wetlands must be derived from the erosion of other lands within the system or generated in place by wetland organic production. A plot of mean annual loss rates against basin land area during the background period (Figure 8) shows a positive correlation between basin land area and mean annual background land loss. This analysis is continued for two additional periods. The 1958-74 and 1974-83 data are considered together, and the 1983-90 interval is evaluated separately. The 1958-83 period brackets the time during which most internal basin alterations occurred.

Projecting cumulative background loss rates to the present for each of the basins and comparing these projections with the actual record provides an estimate of "excess" loss for each basin for the 58-year record. The Mississippi and Atchafalaya river mouth basins have experienced cumulative losses within 10 percent of the loss predicted from the 1932-58 background rates. Excess loss for the other basins ranges from a low of 31 percent for the Pontchartrain Basin to a high of 93 percent for the Calcasieu-Sabine Basin. The Terrebonne and Mermentau Basins each experienced cumulative excess loss of about 60 percent, while the remainder of the basins are in the 40-50 percent range. Coastwide, of the approximately 1 million acres that have been lost over the past 60 years, 51 percent falls into the "excess" category. The chenier plain has experienced proportionally more excess loss (70 percent) than has the delta plain (42 percent).

Despite a geological history of dynamic land building and land loss, the magnitude of current land loss in the coastal zone of Louisiana is a relatively recent phenomenon. These high rates of loss are primarily confined to the past 60 years--the period during which the lower Mississippi River was under human control and land building was brought to a halt. It also is a time during which the hydraulic



Atch = Atchafalaya Basin Bar = Barataria Basin Btr = Breton Basin
Cal/Sab = Calcasieu/Sabine Basin Mer = Mermentau Basin Pont = Pontchartrain Basin
Tec/V = Teche/Vermilion Basin Ter = Terrebonne Basin

Figure 8. Land Loss vs. Basin Area by Time Period.

- There can be drawbacks to regional-scale projects which work with natural processes, because so much human activity is presently dependent on the modifications which man has made to the natural ecosystem. Thus, while natural sediment diversions are by far the lowest direct-cost technique for creating new marshes, such projects may incur significant secondary costs because of conflicts in the areas from which the river water is taken (e.g., navigation channels) and in the areas where the diversion would put the water and sediment (e.g., areas which may contain commercial shellfish beds). These are issues to be recognized and addressed in project implementation.

- Developing the important large-scale projects, while resolving potential conflicts, will require completion of detailed feasibility studies.

- The design of all types of projects, large and small, will be improved over time as reliable information is gained from three sources: the monitoring of restoration projects already in place or funded for construction; the use of CWPPRA projects to demonstrate new techniques for wetlands restoration; and research being conducted outside of the CWPPRA.

- There are situations in which the ability to apply ideal solutions is severely limited. An example is the Calcasieu/Sabine Basin, where the natural hydrologic system has limited sediment resources with which to overcome the problems created by the alterations to which it has been subjected.

This introduction to project types makes clear that there is no one "solution" to the wetlands loss problem in coastal Louisiana; the urgency of the coastwide problems requires that restoration work move forward on many tracks at once. The remainder of this section briefly describes the wetland restoration techniques which were given primary consideration in the CWPPRA planning process, including both proven methods (most of which are already being used within the first three priority lists) and some of the exciting new ideas which are conceptual at this time.

For the purposes of discussion, the various techniques have been subdivided into two groups: projects which result in the creation of new productive, sustainable wetlands; and projects which enhance or protect existing wetlands. A concluding discussion briefly reviews additional project types that address significant but unique natural problems.

ADVANTAGES OF PROMOTING NATURAL PROCESSES IN COASTAL LOUISIANA

An emphasis of CWPPRA projects is to increase natural wetlands-building processes by increased sedimentation, and by reestablishing the natural flows of water and sediment which sustain wetlands health. These are the processes which created the valuable resources which now need protection. This approach has a number of advantages.

1. The forces of nature will be used beneficially. This can result in large gains from a relatively small expenditure of effort, thus lower direct costs, especially for maintenance; refer to the text for a discussion of secondary costs.

2. The resulting environment will consist of landforms, ecosystems, and productivity which are determined and maintained by the natural flows of energy and materials, and which therefore approximate the environment which has provided such a natural bounty to the nation. Among other consequences, this means the ecosystem will support natural species diversity and thus, in time, the benefits of restoration will be determined by natural processes more than by human management decisions. (Note that species distributions may be different from those observed at present.)

3. The approach provides for substantial gain in new wetlands, and maintenance of existing wetlands, not simply a reduction in rates of loss. Indeed, this approach recognizes that some changes and losses are inevitable, and aims to work with such changes.

CREATION OF PRODUCTIVE, SUSTAINABLE WETLANDS

Creation and restoration projects are efforts which build new wetlands acres or which build up the land elevation of deteriorated wetlands. These are the projects which must be successful in order to offset wetlands losses and replace unavoidable losses with new coastal wetlands resources; consequently they are particularly critical to the long-term success of any restoration effort.

Two important examples of creation projects were identified at the beginning of this section: diversion of sediment-laden river water into shallow open water, and the beneficial disposal of dredged materials. These examples illustrate the components of a typical creation project.

- Creation projects begin with a source of sediment. Natural sediment can come from a river, a tidal channel, or longshore currents. Sediments can be produced by human action through dredging to cut or maintain navigation channels or through dredging specifically for the purpose of wetlands creation.

- The sediment must be moved to a location where it can build wetlands. In some cases, this is done entirely by nature (as by a longshore current), but commonly it is done by relocating a natural process, as by building a structure to divert river flows, or by gapping a spoil bank so that water in a channel can move into a marsh by overland flow. Where the sediment source is artificial, the transportation process usually requires an energy-intensive human action such as the pumping of dredged material through a pipeline.

- Finally, the sediment must accumulate in open water until the elevation of the solid bottom is raised at least several inches above the water level, or it must accrete on an already emergent area. Accumulation can result from natural processes, or from modifications to those processes; an example is building structures which slow flow so that more sediments drop out. Direct deposition by human activity is also possible, as by spraying of dredged material onto a wetland from a specially-equipped barge, a technique which can build up the marsh surface while enhancing the existing plants (Cahoon and Cowan 1988).

Combining the many sediment sources, transportation mechanisms, and accumulation processes leads to a wide array of creation project types. Describing each combination in detail is beyond the scope of this report; however, some additional information is provided below, to assist readers in understanding subsequent discussions (including those in the basin plans found in Appendices A through I).

SEDIMENT DIVERSIONS

Sediment diversions restore fluvial processes in the wetland environment. Most typically, a levee is cut (and sometimes stabilized) so that some portion of river flow can move into the wetlands on the opposite side of the levee. In contrast to freshwater diversions, which carry only a dilute load of clay material (see subsequent discussion), sediment diversions are focused on capturing flows which are laden with the inorganic sediments most effective in building new land. Consequently, they also divert large quantities of river water. While this fresh water can benefit wetlands by decreasing salinity in the area which receives the outflow, the primary purpose of a sediment diversion is to build new land by mimicking the natural delta-building and wetland maintenance processes.

To date, sediment diversion projects constructed in coastal Louisiana are on a small scale; most involve cutting of crevasses in the natural levees of the Mississippi Delta. One major project, the West Bay Sediment Diversion, was included on the CWPPRA first Priority Project List. It is clear that additional projects are needed, at least some of which must operate on an unprecedented scale. Recent calculations which suggest that the available sediment supply in the Mississippi and Atchafalaya rivers is potentially sufficient to maintain all existing wetlands in the Deltaic Plain (Templet and Meyer-Arendt 1988, Suhayda et al. 1992, Van Heerden 1993).

Because of the scale at which future sediment diversions may operate, and in recognition of possible constraints to such projects (as noted at the beginning of this section), it is evident that detailed feasibility studies will be needed to evaluate how best to rebuild the Mississippi Delta. Beyond issues associated with any particular project, these studies must determine the upper limit to the amount of water and sediment which can be diverted from the Mississippi River system without significantly affecting navigation channel maintenance, municipal and industrial water supplies, and other aspects of human activity, such as commercial and recreational fishing. They also must consider the relative cost-effectiveness of sediment diversions using the Mississippi River, the Atchafalaya River, Bayou

LaFourche, and other distributaries; and areas where sediment accumulation would produce the greatest benefit.

SEDIMENT DREDGING

The Corps of Engineers dredges more than 80 million cubic yards per year in coastal Louisiana during channel maintenance operations. In addition, petroleum and natural gas access canals are dredged periodically, and new canals continue to be excavated, although at a far lower rate than occurred in the past. The volume of material moved by this process each year is similar to what is thought to be required to maintain all of Louisiana's coastal wetlands on an annual basis (Suhayda et al. 1992). Thus, the potential exists for a large number of wetland creation and maintenance projects to make use of material routinely dredged.

Dedicated dredging is that which is done explicitly for the purpose of wetlands creation or restoration. Two CWPPRA priority list projects presently underway in Atchafalaya Bay involve mining material in existing disposal sites or river and bay bottoms and placing it in degraded wetlands. A constraint to dedicated dredging projects is the transportation cost if the point of sediment need is distant from a material borrow site. Demonstration projects can be considered to test techniques which would reduce costs of transportation (as well as dredging and placement costs).

Other concepts which are under active consideration include the use of high-density slurries, which substantially reduce capital and energy costs per unit of material moved (Suhayda et al. 1992), and the use of abandoned oil and gas pipelines. Conceptually, these innovations offer the potential for dedicated dredging to have regional-scale benefits. Recent proposals have expanded the concept of sediment dredging to include innovative sources, such as byproducts of human activities; one example now under study is the use of bauxite mill tailings ("red mud").

SEDIMENT CAPTURE PROJECTS

There are two recognized types of small-scale projects which capture natural sediments: terracing and trapping/inducing. These techniques can be most effective where a dominant one-directional current carries a high load of suspended sediment. Sediment inducers are capable of being applied in conditions where multi-directional currents are present. Structures are built to slow the current, or make the flow less turbulent, and thereby promote sediment deposition. Structure types include:

- terraces built by dredging a bay bottom, so that a network of emergent land is built in shallow open water (this also serves to protect the nearby marshes);

- fences, including those built with recycled Christmas trees, which work best in a low-energy environment; and

- inducers, subsurface features which reduce turbulence (not yet tried, and potentially including anything from artificial reefs to artificial submerged vegetation).

Monitoring of sediment capture projects is an important tool to determine the effectiveness of this technique, and to improve project designs.

ENHANCEMENT AND PROTECTION OF EXISTING WETLANDS

Projects in the "enhance and protect" category act to reduce existing or future losses of wetlands, especially where such losses have been accelerated because of human activity. Descriptions defining two such projects were given at the beginning of this section, one involving hydrologic restoration and the other erosion protection. Although many different enhancement and protection techniques are available, a broad distinction can be made between projects which are directed at natural landforms and those which deal with the human-influenced landscape.

Most natural landforms--such as barrier islands, natural levees, and shorelines--have a positive influence on wetlands. They may promote processes which are important to marsh nourishment, such as retention of sediment-laden fresh water; or they may provide natural protection against tidal forces, wave erosion, and other processes which are a common direct cause of wetlands loss. Loss of these landforms can result from the normal deterioration of an abandoned delta or from human activity; in either case, projects which restore the landform can prolong the life of adjacent wetlands. Such projects usually include some degree of protection to or rebuilding of the landform; this can involve as simple a project as revegetation, or an engineered solution using dredged or other materials.

Many human-built landforms--such as navigation channels, oil and gas canals, and flood control levees--have the potential to adversely impact wetlands by modifying natural processes, especially flows of fresh water, salt water, sediment, and nutrients. Projects typically are directed at restoring some attributes of the natural hydrology, or otherwise improving hydrologic conditions, as the following examples illustrate.

- The natural introduction of fresh water is important to maintenance of healthy wetlands systems, but is often blocked by flood control levees. Freshwater diversions and outfall management are project types which provide a positive response to this problem by restoring the fluvial processes which are important to the estuarine ecosystem.

- An adverse effect of some man-made structures (levees, roads, spoil banks) is to block natural flows, or to provide a direct pathway for freshwater drainage or saltwater intrusion. The term "hydrologic restoration" is used to refer to projects which promote a more natural hydrology by eliminating the unnatural blockages and blocking the unnatural drainages.

- Finally, situations exist where water is already impounded in a wetland, or where some degree of hydrologic management is considered beneficial. In these cases, either active or passive measures may be considered to control water levels, enhance vegetation, and achieve other objectives.

Additional information on the major types of enhancement and protection projects is provided here to assist readers in understanding subsequent discussions (including those in the basin plan appendices).

RESTORATION OF BARRIER ISLANDS

Louisiana's barrier islands form the outer edges of the estuarine system and provide important protection to the marshes of the Terrebonne and Barataria basins (and, to a lesser degree, those in the Breton and Pontchartrain basins). Their rapid loss (in some cases, disappearance is projected within 5 to 7 years) is considered a serious threat to the coastal ecosystem. A typical project to restore a barrier island involves dedicated dredging to increase island height and width; engineered structures which protect or enhance the island may also be considered. Projects to restore islands in the Isles Dernieres chain have been included on all three of the CWPPRA priority project lists submitted to date. Proposals have been advanced to restore the barrier islands on a comprehensive scale, using dredging sediment from Ship Shoal, an offshore sand body (Byrnes and Groat 1991). As with major sediment diversions, the scale of such a project would require a feasibility study.

FRESHWATER DIVERSIONS

Like sediment diversions, freshwater diversions bring natural fluvial processes into wetlands. Freshwater diversions usually take water from the upper part of a river's flow, using siphons or a levee cut fitted with gates. When water levels are high, some portion of the river flow moves through the structure and into wetlands on the other side of the levee, thereby mimicking on a small scale the historically widespread overbank flow process. Project benefits for these diversions primarily focus on the change effected on a salinity regime and the response of the existing biological resources to this change. However, because the fine silt and clay portions of riverine sediment loads are uniformly distributed throughout the flow, some accretion or wetland enhancement results as a secondary benefit of these projects.

Several freshwater diversions have already been built, and others are in the design or detailed planning stage under authorities other than the CWPPRA. Completed projects are prominent in the Breton Sound and Barataria basins and include the Whites Ditch, LaReussite, and West Point a la Hache siphons, and the recently completed, much larger gated structure at Caernarvon, with an 8,000 cfs capacity. Planned are the 30,000-cfs Bonnet Carré Diversion in the Pontchartrain Basin and the 10,650-cfs Davis Pond project in the Barataria Basin.

OUTFALL MANAGEMENT

Outfall management projects are used to realize the full benefits from existing or authorized freshwater diversions, including diversions such as pump station outfalls which normally are operated for water-level control rather than directly for wetlands benefit. The Caernarvon Outfall Management project, included on the 2nd Priority Project List, is an example of this project type. Management involves the control of water levels and direction of flow to increase dispersion and retention time of fresh water, nutrients, and some sediment in the marsh. Inducing overbank flow across the marsh surface, so that any sediments and nutrients present reach and are retained in the interior marsh areas, is also accomplished with this technique.

HYDROLOGIC RESTORATION

The term hydrologic restoration implies changing human-altered drainage patterns back toward natural drainage patterns. In the past, this approach has been directed largely at preventing saltwater intrusion, but increasingly it is seen as a way to correct marsh impoundment problems (Swenson and Turner 1987) in areas where soils become so waterlogged that vegetation becomes severely degraded (Mendelssohn and McKee 1988). The technique is especially appropriate in situations where the human impact on the drainage system is profound or where other types of solutions, such as regional sediment diversions, may not be practicable. The GIWW to Clovelly project from the first Priority Project List is an example of this technique applied over a large area.

At one end of the scale, specific hydrologic restoration projects can address the large navigation channels which connect the Gulf of Mexico with ports far inland, and which have allowed salt water to penetrate far into interior wetlands; major engineered structures (such as locks or gates) could rectify this problem, especially if benefits for hurricane protection can be incorporated to offset their high costs. At the other end of the spectrum, hydrologic restoration projects may simply involve small-scale measures to block off dredged channels, or the cutting of gaps in spoil banks created by dredging of canals.

HYDROLOGIC MANAGEMENT OF IMPOUNDMENTS

This technique involves active management of areas which have been impounded by levees or other structures. It is similar to the active marsh management techniques discussed below.

MARSH MANAGEMENT

This technique has been practiced in Louisiana for at least 50 years to manage primarily for waterfowl and furbearers, and more recently for wetland protection and restoration. A large number of marsh management projects have been permitted in the past ten years, and it has been estimated that nearly 500,000 acres are currently under management (Knudsen et al. 1985). The technique can result in the enclosure of areas of deteriorating marsh. Once contained, the water levels and hydrologic regime of the area are manipulated to promote the growth or restoration of desired vegetation and wildlife habitat. No matter how management is done, the exchange between the impounded area and the larger estuary becomes limited.

Passive management of water levels relies on weirs and other nonadjustable structures to maintain minimum water levels throughout the year. Active marsh management uses adjustable structures (such as variable crest weirs, gated culverts, and even pumps) and levees to alter water levels on a seasonal basis and to provide more overall control.

EROSION CONTROL

Some erosion control techniques are applied directly to a shore or bank, while others are in open water and aim to alter the waves and currents which cause erosion. Either way, consideration must be given to the natural forces which erode, transport, and deposit material. Among the project types which have been used in Louisiana are the following.

- Rock dikes, pile supported bulkheads, and earthen levees are the most common methods to protect fragile marsh soils from wave attack in coastal bays.

- A relatively new technique is to use a flexible concrete mat placed on top of an earth-fabric (geotextile); this approach is used on banks along relatively deep oil and gas canals where there is relatively high energy associated with vessel wakes. The approach illustrates how a project which reduces bank caving and associated wetland erosion can have additional benefits, in this case a reduced need for expensive channel maintenance.

- "Soft" protection to shorelines uses methods such as vegetative planting or the spraying of dredged materials to promote a root mat of healthy plants to stabilize the soil, decreasing loss due to wave erosion. The most commonly used species for erosion control in coastal Louisiana is saltmarsh cordgrass or oystergrass (*Spartina alterniflora*) which, once established, can withstand moderate wave energy and prolonged flooding. In some areas, temporary silt screens or wave dampening devices are used to protect the new plants until they become established, and protection of newly planted sprigs is sometimes necessary to prevent grazing by nutria. The Vegetative Plantings Demonstration Project from the first Priority Project List is an example of a project to determine which species of marsh grasses have such desirable characteristics as accelerated growth and resistance to prolonged flooding or high salinity.

- Segmented breakwaters have been constructed along the gulf shoreline of the western Chenier Plain, and more are proposed. These are intended to stabilize a shoreline by altering wave patterns and inducing deposition of coarse beach material behind the breakwater. Other types of structures (dikes, subsurface sills, or berms) have been suggested to achieve similar benefits.

OTHER MANAGEMENT TECHNIQUES

The toolbox of wetlands restoration techniques just discussed addresses most, but not all, of the causes of loss which were reviewed earlier in this report. Two examples illustrate other solutions available to the CWPPRA plan.

The first example is herbivore control. Grazing of marsh vegetation by nutria (an introduced species) and muskrat has contributed to the loss of Louisiana's coastal wetlands (Linscombe and Kinler 1984, Nyman et al. 1993). Pressure on these species from predators is light, and a decline in the worldwide fur market has eased pressure from trappers as well. Possible short-term control measures to be considered include fences, shooting, poisoning, and bounties. Longer-term solutions include actions which promote harvesting for food or fur. A second example is projects to enhance flotant marshes.

Finally, it is worth repeating that while construction of projects is the focus of the CWPPRA, it is not the only solution to problems of wetlands loss in coastal Louisiana. An important action is the development of appropriate regulatory controls, as part of the Louisiana Conservation Plan and as part of the environmental programs of federal, state, and local agencies.

SUMMARY

Louisiana's restoration ecologists and engineers have a wide range of restoration and enhancement techniques at their disposal, and as demonstration projects come on line this array of tools will increase. While some of the most promising tools--those which could achieve regional benefits--require detailed planning feasibility studies to delineate the best long-term, large-scale restoration projects for Louisiana's coastal wetlands, overall the prognosis is good that solutions exist, or will be found, to address the Louisiana coastal wetlands loss problem.

There are many issues involved in the implementation of any of these solutions; these issues are addressed in the Environmental Impact Statement.

THE RESTORATION PLAN

The CWPPRA Restoration Plan is based on a combined knowledge of the natural processes of the delta and chenier environments, the factors responsible for wetlands loss, and the techniques available for restoration, as summarized in previous sections of this report. Based on this knowledge, the CWPPRA Task Force formulated its planning goals and strategies and applied them to each of nine separable hydrologic basins along the Louisiana coast. The resulting basin plans not only provide a fit between established project techniques and the problems and resources of specific areas, but they also develop new management concepts--some using unprecedented regional solutions, others based on potential demonstration of innovative technologies. Because many new concepts are proposed, the plan adopts a phased approach in which projects that address specific problems continue to be built in the short term, while at the same time major steps are taken toward implementing the larger scale, higher cost restoration efforts which represent the long-term cornerstone of the plan.

PLANNING GOALS AND STRATEGIES

Formulation of the comprehensive wetlands restoration plan for coastal Louisiana was guided by two basic goals established by the Task Force early in the planning process. Those goals are:

- to sustain the ecological value and economic productivity of the Louisiana coastal wetlands; and
- to accomplish this by maintaining and improving critical wetland functions.

The primary strategy established by the Task Force for meeting those goals is to maintain and restore natural processes where feasible. The objective of that strategy is to work with, not against, natural processes to promote wetland sustainability. Implementation of this strategy will require large-scale projects, especially freshwater and sediment diversions, that produce regional wetland benefits; it will also require smaller projects aimed at hydrologic and vegetative restoration. A supporting strategy will also be implemented, especially in the short term. That strategy is to abate wetland losses in situations of critical need or significant opportunity, i.e., "keep what we have," and to offset or reverse the remaining losses by wetland creation or shoreline protection measures that would result in wetland accretion.

These goals and strategies recognize that numerous constraints make it infeasible to restore the Louisiana coast to the natural condition which existed many decades ago, and that the Louisiana coast is an extremely dynamic system. Several additional principles have guided the restoration planning process thus far, and will assume more importance as implementation progresses. Those principles are:

1. Restoration projects must benefit the communities of Louisiana's coastal zone and not reduce their long-term economic viability. Those projects must be designed to maintain at least the current level of flood protection and transportation infrastructure. Projects that will unavoidably result in displacement of facilities and harvest areas for living resources must, to the

extent practicable, be implemented gradually and include measures to minimize or offset unavoidable short-term economic dislocations.

2. Restoration projects must seek to maintain and enhance the long-term biological productivity and biodiversity of Louisiana's coastal systems, which provide the primary impetus for restoration. This principle can be achieved by use of natural processes, or by design of project-specific measures (such as provisions for estuarine access through water-control structures).

DEVELOPMENT OF PLANS FOR INDIVIDUAL HYDROLOGIC BASINS

The formulation of the comprehensive Restoration Plan utilized a basin-by-basin approach. That approach was needed to address the unique set of problems and restoration opportunities specific to each of the nine hydrologic basins in coastal Louisiana (Plate 1 depicts the nine basins).

The basin plans formulated during the restoration planning process are visions for building projects that establish hydrologic conditions to benefit wetlands on a regional scale. Each of the basin plans (which are summarized in the sections to follow) is responsive to the overall restoration goals outlined above, within the limitations imposed by factors unique to each basin. The typical plan identifies key strategies for protecting, creating, restoring, and enhancing wetlands in that basin. Those strategies lay the foundation on which wetland protection and restoration throughout the basin will be achieved.

INTEGRATION OF BASIN PLANS

REGIONAL CONSIDERATIONS

It was recognized early in the planning process that large-scale, regional restoration projects that potentially affect multiple coastal basins and the management of the Mississippi and Atchafalaya rivers are needed to counter the sediment deficit and achieve the goals of the plan. It also became apparent that the causes of wetland loss in the Deltaic Plain are different from those in the Chenier Plain. Perhaps even more importantly, the types of restoration opportunities available in those two regions are significantly different. Even within the Deltaic Plain, restoration opportunities within the active deltas of the Mississippi and Atchafalaya rivers are different from many of those in the abandoned delta basins.

As shown in Figure 3 of the Executive Summary, the comprehensive restoration strategy advocates a diversity of approaches tailored to problems and opportunities across the Louisiana coastal region. Where possible, those approaches make use of beneficial natural processes to achieve large-scale wetland creation, and to abate losses of existing wetlands by regional restoration of hydrology.

In the Deltaic Plain, all basin plans recommend strategies to make better use of the critically important fresh water and sediments transported by the Mississippi and Atchafalaya rivers. Within that region, improved sediment management is recommended to enhance wetland creation in the active deltas of those two major rivers. Large-scale restoration of hydrology to abate wetland loss is recommended in the Pontchartrain, Breton Sound, Barataria, and Terrebonne basins of that region; barrier island restoration is a major component of the hydrologic restoration strategy in the Barataria and Terrebonne basins.

Restoration opportunities in the Chenier Plain are primarily shoreline protection, hydrologic and salinity management, marsh creation with material removed during maintenance dredging, and some limited freshwater diversion. With the exception of possibly modifying the design or operation of the structures that control water levels in the Mermentau Basin, the recommended restoration strategies primarily address more local, symptomatic problems arising from the underlying problems of subsidence, saltwater intrusion, hydrologic modification, and scour erosion of fragile marsh soils. A possible sediment source for the Mermentau Basin is the coastal mud stream; however, for most of this region a long-term sediment source is not available. Therefore, the strategies for that region utilize protective projects and localized restoration projects.

Several smaller-scale approaches to abate wetland losses are common to both the Deltaic and Chenier Plain Regions. Examples of such approaches include marsh creation with dredged material, marsh management, and protection of natural shorelines and the banks of eroding navigation channels.

Creating marsh with dredged material removed during maintenance of navigation channels is recognized as an approach that has great potential for more widespread, coast-wide application. Increased use of this approach should be facilitated when a Louisiana Department of Natural Resources effort to develop a long-term management strategy for ten federally maintained navigation channels is completed in June 1994. That strategy will supplement prior interagency disposal planning efforts spearheaded by the USACE.

Table 4 shows the types of solutions utilized in the various basins. In short, the plan proposes the building of new wetlands wherever sediment is available, and the restoration, protection, and enhancement of existing wetlands wherever such actions are needed and practical.

The topic of interbasin restoration issues was addressed during the restoration planning process. The Task Force determined that restoration measures that potentially affected more than one basin primarily involved allocation of the freshwater and sediment resources of the Mississippi and Atchafalaya rivers among basins to achieve optimum wetland benefits. Such allocation will require detailed feasibility analysis to determine the amount of fresh water and sediment available for diversion, and to compare the merits and constraints associated with each potential diversion option. Rational interbasin decisions regarding large-scale application of these resources can be made once this information is developed.

PHASED ELEMENTS OF THE PLAN

The urgency of the wetland loss problem in coastal Louisiana mandates that restoration work move forward along many tracks at once. Recommended smaller-scale projects represent a critical first step in a *phased process* for implementing the solutions presented in this plan. Installation of high priority, smaller-scale projects (Table 4) will address the short-term strategy of abating losses in areas of critical need or opportunity, and offsetting losses via smaller-scale wetland creation measures

Table 4
Distribution of Solutions

Major Strategies	Active Delta		Abandoned Delta					Chenier Plain	
	MR	AT	PO	BS	BA	TE	TV	ME	CS
Use existing sediment	ST	ST							
Move sediment to more effective location	LT	LT							
Restore sediment			LT	LT	LT	LT	LT	LT	
Restore and manage fresh water			ST LT	ST	ST LT	ST LT	ST LT	ST	
Restore or construct barrier islands			LT	LT	ST	ST			
Preserve or build land bridges or natural ridges			ST	LT	LT	ST			
Reduce salinity and tidal scour with structures			ST		ST	ST LT		ST	ST
Reduce flooding in wetlands			ST			LT		ST	
Protect shorelines			ST	ST	ST	ST	ST	ST	ST
Small-scale, site-specific measures	ST	ST	ST	ST	ST	ST	ST	ST	ST

ST=short-term strategy
LT=long-term strategy

PO=Pontchartrain
BS=Breton Sound
MR=Mississippi River Delta
BA=Barataria
TE=Terrebonne

AT=Atchafalaya
TV=Teche/Vermilion
ME=Mermentau
CS=Calcasieu/Sabine

(e.g., small-scale sediment diversions and beneficial use of dredged material). The strategy for abatement of losses of existing wetlands places a high priority on building projects that will produce regional benefits, especially those that will restore natural hydrologic conditions. These initial phase projects will be implemented in a manner that does not preclude wetland benefits of planned large-scale projects, such as major freshwater and sediment diversions. As with the smaller-scale projects, implementation of small-scale demonstration projects to apply new technologies or materials can proceed now without the need for detailed feasibility studies.

As can be seen in Table 4, there are numerous strategies in the restoration plan which are intended to be executed on a long-term basis. The major freshwater and sediment diversion projects recommended for the Deltaic Plain would provide long-term solutions to the underlying problems of land loss, subsidence, the enlarging tidal prism, and erosion of organic soils. Development of a sediment budget for the lower Mississippi River will provide critically needed information for feasibility studies of large-scale sediment diversions. An important long-term measure, of which a feasibility study is called for in Section 307(b) of the CWPPRA, is the potential increase of Mississippi River flows and sediment down the Atchafalaya River for land building and wetlands nourishment. The enhanced management of sediments in the Atchafalaya Delta to optimize growth of deltaic wetlands is also a long-term measure. The extensive restoration of coastal barrier islands and measures to address the encroachment of marine processes, such as installing a salinity barrier on the Houma Navigation Canal, are also major long-term elements of the plan.

Detailed feasibility studies will be required to evaluate various diversion options. There is a limit to the number of diversions that can be constructed without adversely affecting navigation channel maintenance and the freshwater supplies of New Orleans and other communities. Similar evaluations will be needed for other large-scale restoration proposals. The required studies will address a wide range of economic, social, engineering, and environmental factors. Once these studies are completed the detailed design and construction of these projects can be phased into the restoration effort.

The State of Louisiana has made the following recommendations to the chairman of the Task Force concerning its priorities for feasibility studies:

- Increasing the share of Mississippi River-borne sediments carried down the Atchafalaya River;
- Re-establishment of the barrier island systems in the Barataria and Terrebonne basins;
- Modifications to major navigation channels to reduce or prevent saltwater intrusion into historically fresh or intermediate wetlands, and to reallocate flow and sediment for diversions into other areas; and
- Development of a comprehensive Mississippi River diversion plan, to include multiple diversions as appropriate.

The complete text of the recommendation is contained in Exhibit 8.

Feasibility studies of major restoration projects will be conducted concurrent with implementation of the short-term phase. In the meantime, smaller, critically needed projects recommended in the basin plans will be implemented to prolong the life of the most threatened wetlands until the larger projects are installed and more natural hydrologic and sedimentation regimes can be established.

RESTORATION PLAN BENEFITS

Current estimates are that another 868,000 acres of Louisiana's coastal wetlands will disappear by the year 2040 unless decisive action is taken. The areas where the most serious losses will occur are shown in Figure 2 of the Executive Summary. Clearly, the loss of such a vast amount of nationally important coastal wetlands would have devastating ecological and economic consequences. The restoration strategy proposed in this plan forcefully addresses that serious threat in a comprehensive manner. Implementation of the projects proposed in this plan would have major national benefits. Those benefits include:

- creating, restoring, and protecting nearly 203,000 acres of coastal wetlands over the next 20 years, thus reducing projected wetland losses by approximately 65 percent;
- helping to sustain a nationally important commercial fishery valued at $1 billion per year, supporting at least 50,000 jobs in Louisiana alone;

- helping to sustain the biodiversity and habitat values of a wetland complex that supports nationally important concentrations of wildlife; and

- helping to maintain the flood-control and storm-surge-reduction functions of the Louisiana coastal wetlands, which play an important role in protecting a capital investment of at least $100 billion in infrastructure (e.g., petrochemical production; ports and waterways; and commercial and residential development).

MONITORING AND EVALUATION OF THE PLAN

In accordance with the CWPPRA, the monitoring of projects that are constructed in pursuit of this restoration plan must provide:

1. an "evaluation of the effectiveness of each coastal wetlands restoration project in achieving long-term solutions to arresting coastal wetlands loss in Louisiana" [Sec. 303 (b)(4)(L)]; and

2. "a scientific evaluation of the effectiveness of the coastal wetlands restoration projects carried out under the plan in creating, restoring, protecting and enhancing coastal wetlands in Louisiana" [Sec. 303 (b)(7)].

Losses to Louisiana coastal wetlands have been the subject of extensive research by federal and state agencies, universities, and individual scientists and scholars. The CWPPRA Task Force has used information from that research to guide its planning and, in the process, became familiar with what is known--and not known--about the design and functioning of wetland restoration projects. Two facts became evident: (1) enough is known about the restoration of wetlands to enable the Task Force to select projects with a very high probability of achieving the anticipated short term benefits; and (2) much more needs to be learned about the optimum design of some projects, the efficacy of some large scale projects, and the appropriate mix of projects in various basins. In short, the appropriate immediate restorative measures can be clearly defined and applied, but, in the process, information needed to improve any subsequent efforts must be generated.

To achieve these requirements, the Monitoring Work Group of the Task Force developed a set of standardized monitoring procedures and established a monitoring program to implement the procedures. The monitoring plan is provided in Exhibit 5. It stimulates a continuous return of information at several levels by: (1) suggesting modifications to features or operations of already constructed CWPPRA projects to achieve better results, (2) guiding the selection of projects recommended for construction to achieve a project mix better suited for the conditions in each basin, and (3) stimulating research and studies on new technologies and approaches to wetlands restoration. This procedure provides the means to measure success on a project-by-project basis, and thus to ensure the overall success of the restoration plan.

KEY ISSUES

SOCIOECONOMIC

Although fisheries in south Louisiana will benefit overall, on a small-scale some parts of the fishery economy will be adversely impacted by certain projects such as freshwater and sediment diversions, marsh creation, hydrologic restoration, and marsh management.

Freshwater and sediment diversions from the Mississippi River will undoubtedly result in the forced relocation of some oyster resources, as oysters thrive only within a relatively narrow salinity range with an optimum near 15 ppt (parts per thousand) and cannot tolerate smothering from heavy sedimentation resulting from sediment diversion and wetland creation projects. Displacement of some oyster populations seaward is a possibility, rendering some existing oyster leases unworkable and forcing their relocation seaward. However, the overall effect of such restoration projects will be increased oyster fishery habitat. These impacts are expected to primarily affect the oyster industry in the Breton Sound, Barataria, and (possibly) Pontchartrain basins.

River diversions will impact other fisheries by reducing salinities in spawning and nursery grounds. These spawning and nursery grounds will not be lost, but will also be displaced seaward. The shrimp fishing industry will likely be affected the most by these changes, as travel farther south in the estuary to land the catch, or relocation of operational bases, will result. Similar effects will occur in the recreational spotted sea trout and red drum fisheries, as they relocate to areas where they existed historically prior to the saltwater intrusion and channelization in these estuaries.

Another socioeconomic consideration arises in the application of hydrologic restoration and marsh management projects. The nature of these projects sometimes demands that oilfield canals be plugged and structures installed in the marsh in an attempt to recreate the historic hydrologic regime interupted by these canals. The principal issues in these cases are the restriction of access for marine organisms and loss of navigable access for fishermen. Some restoration projects will reduce the present access by oil and gas and other commercial development; however, they will not totally eliminate access. Some restoration projects may result in continued access by longer routes. Development of hydrologic restoration and marsh management plans can provide fisheries and human access to the maximum extent possible without compromising the integrity of the plan. However, it is important to note that in a majority of cases, human and estuarine fisheries access to these marshes was not historically available.

REAL ESTATE AND LEGAL CONSIDERATIONS

Program Application on Private and Public Lands.

The implementation of an effective coastal wetlands restoration program in Louisiana requires working cooperatively with private landowners. Previous estimates indicate that approximately 80 percent of the state's coastal wetlands are privately owned, with the remaining areas being under ownership and management of State and Federal agencies. Historically, most of these areas have been devoted primarily to wildlife, fisheries, and recreational uses. However, mineral extraction and transportation are major interests throughout the coastal area, while beef production and grazing represent other examples of resource management consideration in selected coastal areas.

The authors of the enabling legislation, both Federal (P.L. 101-646) and State (R.S. 49:213.1-.22 and R.S. 49:214.1-.5), recognized the important need for working cooperatively with private landowners to address the needs for long-term wetland resource protection while minimizing infringements on private property interests and rights.

Historically, the expenditure of federal funding for resource conservation and protection programs has included numerous applications on private lands where public benefits and improvements have been identified. Such programs, like the CWPPRA, recognize the need to provide resource protection, conservation, and enhancement measures where they provide the most benefits. The collective application of such measures (a project) may be on private or public lands. Many of the project benefits may be off-site and contribute to public interests as previously discussed. However, the right of public access to private lands included in such projects is not a requirement for participation on behalf of cooperating private landowners.

Existing state law [R.S. 49:217.7(E)(2)] specifically addresses the issue of public access and provides for the protection of private property rights on private lands which may be affected as part of any wetland restoration project funded entirely or partially through the Louisiana Wetlands Conservation and Restoration Fund. Any decision to expend state funds for approved state restoration projects on private lands is based on the inherent general public benefits such projects provide (benefits to fish and wildlife, storm buffering, water quality, etc.). Since this fund is the major source of state matching funds for implementation of federally sponsored projects as well (CWPPRA), the entire restoration program effort must properly address private property interests and rights.

The Task Force recognized the need for addressing the sensitive issue of private property rights fairly early in the development of the initial priority project lists. This is evident in their decisions to require that project easements address only the rights necessary to meet the objective of long-term resource protection required in Section 303(e) of the act. The Secretary of the Army must ensure that designated lead federal agencies comply with this provision through appropriate land rights documentation prior to funding specific projects. The existing Task Force policy requires that easements provide sufficient language to provide protection for the projected life span of the specific project being implemented.

Public Domain Resources.

Natural, renewable resources in the public domain (i.e., fish and wildlife) are subject to the harvest regulations of the Louisiana Department of Wildlife and Fisheries (LDWF), the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service, and to the private property laws of the state of Louisiana. This does not mean, however, that the public has the inherent right to harvest fish or wildlife on private property without permission, nor do private property owners have the right to harvest indiscriminately on their property in violation of applicable wildlife and fisheries regulations.

All methods for the harvest of public domain fish and wildlife resources must be in accordance with LDWF (Louisiana R.S. 56) and federal regulations. The entrapment of a public domain resource (i.e., coastal migratory fisheries) on private land by techniques other than those allowed by the LDWF under normal harvest methods is considered illegal. State law also prohibits the placement of nets within 500 feet of any water control structure to harvest fisheries resources (Louisiana R.S. 56 subsection 329).

Public and Private Ownership.

Historic provisions of the Louisiana Civil Code (Articles 450 and 452) specifically address the rights of ownership, use, and access of certain waters, water bottoms, lakes, rivers, and streams within the state. A recent opinion (No. 92-472) rendered by the State Attorney General's Office addresses issues relative to the rights of public use and private ownership concerning such water and adjacent land areas as they may be affected by state-approved wetland conservation projects. This opinion clearly states that Act 451 of 1990 [R.S. 41:213.7(E)(1-2)] "creates no rights in the public for use, access or any vested interest in privately owned lands or waters which are the subject of wetlands conservation projects, nor does the Act alter or modify historic Civil Code law concerning accretion, erosion, dereliction and subsidence." With this in mind, it is essential that the participating CWPPRA agencies be thoroughly familiar with the applicable state property laws and civil codes.

INTRODUCTION TO THE BASIN PLAN SUMMARIES

TERMINOLOGY

The following sections of this report summarize the restoration plans formulated for each of the nine basins in coastal Louisiana. Several key terms used in those plans are defined below.

Objectives are the endpoints toward which efforts to address wetlands problems are directed. *Key objectives* are those considered essential because they address the most fundamental causes of wetland losses or have regional impacts.

Strategies are general approaches to achieve objectives. *Key strategies* address key objectives.

Alternatives are mutually exclusive courses of action to achieve the same objectives.

Critical projects directly implement a basin's key objectives and strategy. Some critical projects are very large (e.g., major diversions); implementation of such projects will generally require lengthy planning, along with funding that is beyond the current capability of the CWPPRA. Some critical projects are part of an integrated subset of smaller projects that collectively achieve a regional impact.

Supporting projects are those that address more-localized wetland protection and restoration needs and opportunities.

The CWPPRA also provides for *demonstration projects* to apply new techniques or materials for wetland restoration, and to utilize established technologies in new ways or different environments. The basin plans contain small demonstration projects and may assign priority to those that pave the way for a critical project.

PROJECT NOMENCLATURE

The projects evaluated during the planning process were derived from several sources, the principal one being the scoping meetings held in October and November 1991. Hundreds of problems and proposals came out of those meetings

(Exhibit 4). To track projects through the screening and evaluation process, each project received an identification number proceeded by a two-letter code to identify its basin; these codes are shown in Table 5.

Table 5
Project Nomenclature

Symbol	Basin	Symbol	Basin
PO	Pontchartrain	AT	Atchafalaya
BS	Breton Sound	TV	Teche/Vermilion
MR	Mississippi River Delta	ME	Mermentau
BA	Barataria	CS	Calcasieu/Sabine
TE	Terrebonne		

Projects which are a part of the State's Coastal Wetlands Conservation and Restoration Plan use these two letters followed by a number. Projects derived from the scoping meetings are identified by a "P" ("public") preceding the two-letter code (e.g., PPO-52, PTV-18).

The plan formulation meetings held from February through May 1992 were an additional source of projects. Projects proposed during and after those meetings are identified with an "X" (e.g., XTE-41). Many of the "X" projects were formulated by the basin teams as they prepared the restoration plans for the various basins.

Some projects proposed during the planning process are not in a basin plan because they are inconsistent with CWPPRA objectives, e.g., a project that would not directly benefit wetlands.

The nine basin plan summaries which follow represent an attempt to condense into a manageable form the large volume of material contained in Appendices A through I. They provide a very brief outline of the process by which each basin plan was developed, using a broad brush to paint a picture of the restoration plan for each basin.

PONTCHARTRAIN BASIN: SUMMARY OF BASIN PLAN

STUDY AREA

The 1,700,000-acre Pontchartrain Basin is an abandoned delta generally bounded by the Pleistocene Terrace on the north and west, by Chandeleur Sound on the east, and by the Mississippi River and the disposal area of the Mississippi River Gulf Outlet (MRGO) on the south. Portions of nine parishes lie within the basin: Ascension, St. James, St. John the Baptist, St. Charles, Jefferson, Orleans, St. Bernard, St. Tammany, and Livingston. The basin is divided into six distinct areas: the upper, middle, lower, and Pearl basins, and the Lake Maurepas/Pontchartrain and Lake Pontchartrain/Borgne land bridges (Figure PO-1). Approximately 17 percent of the land in the basin is in public ownership.

EXISTING CONDITIONS AND PROBLEMS

The three large lakes, Maurepas, Pontchartrain, and Borgne cover 55 percent of the basin. Lakes Maurepas and Pontchartrain are separated by land bridges of cypress swamp and fresh/intermediate marsh. A brackish marsh land bridge separates Lake Pontchartrain from Lake Borgne.

The basin contains 483,390 acres of wetlands, consisting of nearly 38,500 acres of fresh marsh, 28,600 acres of intermediate marsh, 116,800 acres of brackish marsh, 83,900 acres of saline marsh, and 215,600 acres of cypress swamp. Since 1932, more than 66,000 acres of marsh have converted to water in the Pontchartrain Basin--over 22 percent of the marsh that existed in 1932. The primary causes of wetland loss in the basin are the interrelated effects of human activities and the estuarine processes that began to predominate many hundreds of years ago, as the delta was abandoned.

The Mississippi River levees significantly limit the input of fresh water, sediment, and nutrients into the basin. This reduction in riverine input plays a part in the major critical problem in the Pontchartrain Basin--increased salinity. Construction of the MRGO, which breaches the natural barrier of the Bayou La Loutre ridge and the Pontchartrain/Borgne land bridge, allowed saline waters to push farther into the basin. Relative sea level rise of up to 0.96 feet per century gives saltier waters greater access to basin wetlands. Mean monthly salinities have increased since the construction of the MRGO and other canals. However, these mean increases are less than the overall variability in salinity. In recent years, salinities have stabilized. The heightened salinity, caused mainly by subsidence, stresses wetlands, especially fresh marsh and swamp.

A second critical problem, occurring in the lower basin, is the erosion along the MRGO caused by ship-induced waves. The channel's north bank continues to eroding at a rate of 15 feet per year. This mechanism has resulted in the direct loss of over 1,700 acres of marsh since 1968.

The third critical problem is the potential loss of the Pontchartrain/Borgne and the Pontchartrain/Maurepas land bridges where wetland soils are especially vulnerable to erosion. Since 1932, approximately 24 percent of the Pontchartrain/Borgne Land Bridge has been lost to estuarine processes such as severe shoreline retreat and rapid tidal fluctuations, and the loss rate is increasing. During the same time, 17 percent of the Pontchartrain/Maurepas Land Bridge marshes disappeared due to subsidence and spikes in lake salinity. In addition, from 1968 to 1988, 32 percent of the cypress swamp on this land bridge either converted to marsh or became open water. These land bridges prevent estuarine processes, such as increased salinities and tidal scour, from pushing further into the middle and upper basins. If these buffers are not preserved, the land loss rates around Lakes Pontchartrain and Maurepas will increase dramatically.

The fourth critical problem is that several marshes in the basin are vulnerable to rapid loss if adequate protection is not provided soon. Examples of theses areas are: marshes adjacent to lakes and bays where if the narrow rim of shore is lost, interior erosion will increase dramatically; the perched fresh marsh on the MRGO disposal area which will drain and revegetate with shrub unless the back levee dikes are repaired; and near Bayou St. Malo, where unless canals are plugged, rapid water level fluctuations and salinity intrusion into adjacent marshes will continue.

Site specific problems of shoreline erosion, poor drainage, salinity stress, and herbivory are apparent throughout the basin. Solving these problems is important, but less urgent than solving the four critical problems described above.

FUTURE WITHOUT-PROJECT CONDITIONS

If nothing is done, and marsh loss continues at the pace set from 1974-1990, another 62,400 acres, or 23 percent of the basin's existing marshes, would be lost by the year 2040, as displayed in Table PO-1. If no action is taken, 69,400 acres of swamp, 32 percent of the basin's existing swamp, would be converted to marsh or open water by 2040. This does not include the possible loss of the upper basin swamps. As the land bridges are lost, estuarine processes would push farther into the basin and erosion rates would increase. The middle basin would be a lake surrounded by shallow ponds where marshes once existed. The lower basin marshes would be a tattered remnant of what exists today. Fewer fish and shellfish would be available for commercial or recreational fishermen. Vast marshes for wintering ducks would no longer exist. The emerging ecotourism industry would be hindered, and storm surge protection would be lost as lakes and bays inched closer to levees and roads.

Table PO-1
Projected Marsh and Swamp Loss

Subbasin	Projected Loss in 20 years (Acres)	Projected Loss in 20 years (Percent)	Projected loss in 50 years (Acres)	Projected loss in 50 years (Percent)
Upper Basin				
Swamp	0	0	0	0
Pontchartrain/Maurepas Land Bridge				
Swamp	23,200	38	58,000	95
Marsh	1,320	6	3,300	15
Middle Basin				
Swamp	9,600	62	11,400	74
Marsh	3,800	12	9,500	30
Pontchartrain/Borgne Land Bridge				
Marsh	4,560	10	11,400	30
Lower Basin				
Marsh	14,580	9	36,450	24
Pearl River Basin				
Marsh	700	4	1,750	10
Total Swamp Loss	32,800	15	69,400	32
Total Marsh Loss	24,960	9	62,400	23

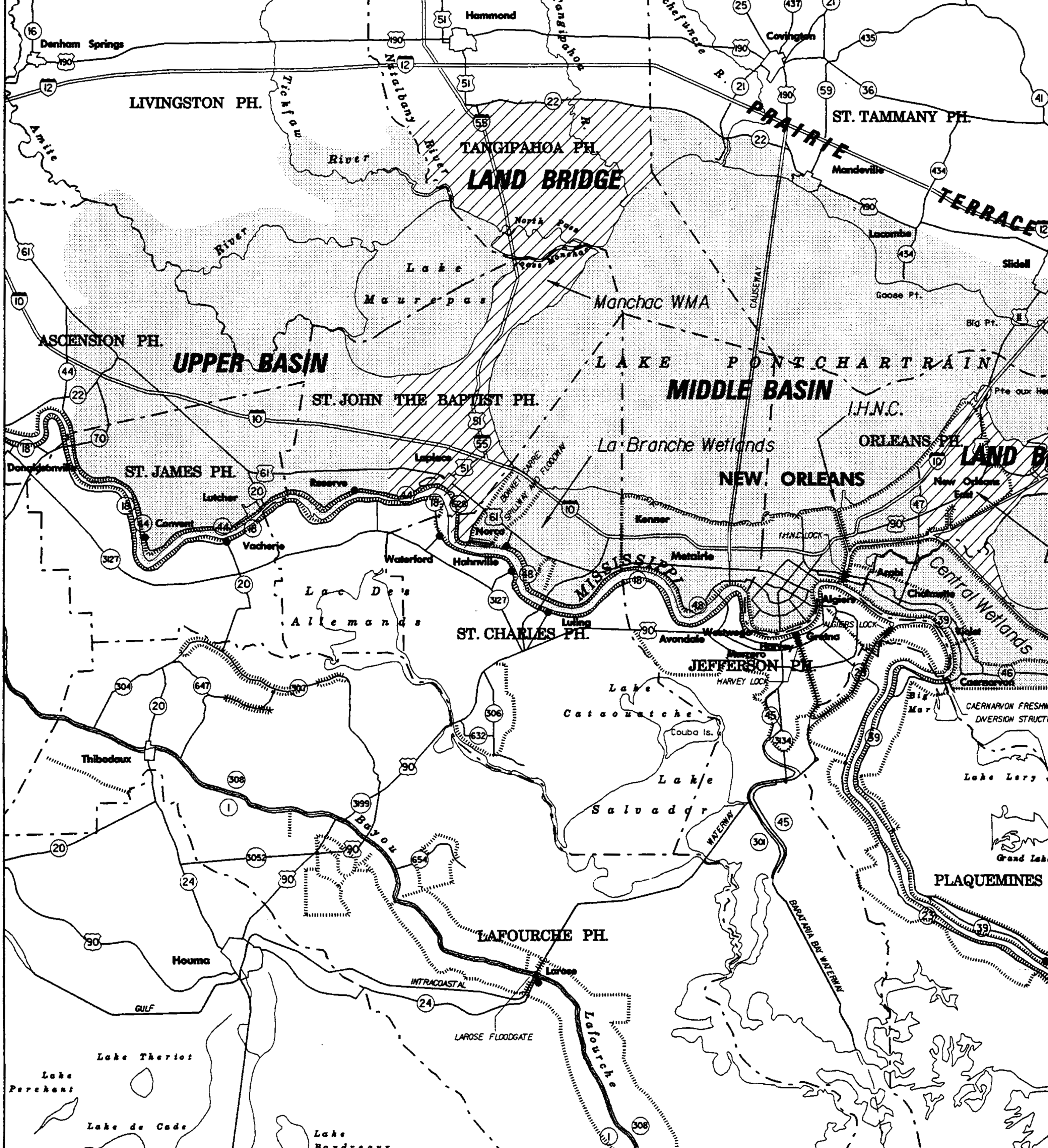
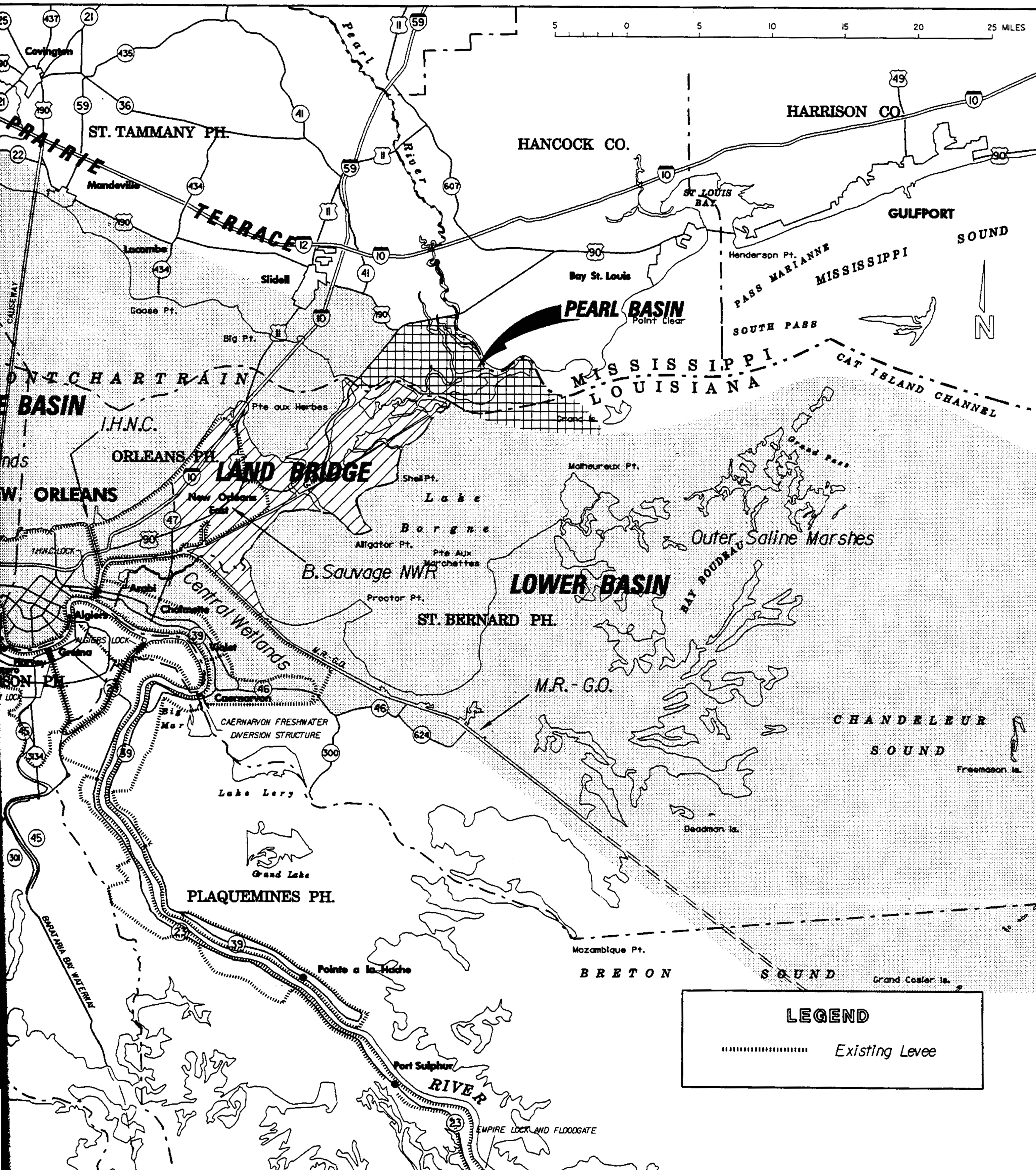


Figure PO-1. Pontchartrain Basin, Basin and Subbasin Boundaries.


25 MILES
HARRISON CO.
HANCOCK CO.
ST. TAMMANY PH.
Covington
Mandeville
Lacombe
Slidell
Goose Pt.
Big Pt.
PRAIRIE TERRACE
Pearl River
ST LOUIS BAY
GULFPORT
Henderson Pt.
Bay St. Louis
PASS MARIANNE
MISSISSIPPI SOUND
SOUTH PASS
PEARL BASIN
Point Clear
MISSISSIPPI
LOUISIANA
CAT ISLAND CHANNEL
PONTCHARTRAIN
BASIN
I.H.N.C.
Pte aux Herbes
ORLEANS PH.
LAND BRIDGE
NEW ORLEANS
New Orleans East
Shell Pt.
Lake Borgne
Malheureux Pt.
Grand Pass
Alligator Pt.
Pte Aux Marchettes
Outer Saline Marshes
B. Sauvage NWR
LOWER BASIN
BAY BOUDREAU
Proctor Pt.
ST. BERNARD PH.
I.H.N.C. LOCK
Arabi
Chalmette
Algiers
ALGIERS LOCK
Gretna
Harvey
Central Wetlands
Violet
M.R.-G.O.
Caernarvon
Big Mar
CAERNARVON FRESHWATER DIVERSION STRUCTURE
CHANDELEUR SOUND
Freemason Is.
Lake Lery
Deadman Is.
Grand Lake
PLAQUEMINES PH.
BARATARIA BAY WATERWAY
Mozambique Pt.
BRETON SOUND
Grand Cosier Is.
Pointe a la Hache
Port Sulphur
RIVER
EMPIRE LOCK AND FLOODGATE
LEGEND
Existing Levee

S.

BASIN PLAN

The main strategies of the basin plan are shown in Figure PO-2. Restoration of riverine input into the basin via freshwater diversion from the Mississippi River through the Bonnet Carré Spillway solves the first critical problem, salinity. This is preferred to the strategy of a navigable gate in the MRGO because the diversion has the added benefit of restoring fluvial input and is less costly overall and on a per-acre basis. The project is already authorized and need not be funded under the CWPPRA. An outfall management plan for the diversion is critical. Construction of a rock dike on the north bank of the MRGO and the beneficial use of all the material dredged for the MRGO would stop erosion, addressing the second critical problem, and create large amounts of marsh. The diversion at the Bonnet Carré Spillway and bank protection with marsh creation along the MRGO are critical projects.

Additional short-term projects include the following.

- Preservation of the land bridges through shoreline protection, hydrologic restoration, and marsh management solves the third critical problem. Various critical projects reduce future marsh loss rates and prevent estuarine processes from pushing farther into Lakes Pontchartrain and Maurepas.
- Preservation of the several marshes in the basin which are immediately vulnerable to loss is crucial to resolving the fourth critical problem. Projects which protect shorelines in several critical areas, preserve the fresh marshes on the MRGO disposal area, and retain the brackish marshes in the St. Malo area all require quick implementation.
- Several site specific areas of loss are scattered throughout the basin. Small-scale measures to preserve, restore, and enhance these marshes and swamps are important. These supporting projects should be considered once the more critical projects are in place.

In the long term, getting more fresh water and nutrients into the basin is critical. Five small-scale freshwater diversions into swamps and marshes of the basin are proposed. First, however, a study on the sediment and water budget for the Mississippi River must be completed.

Going beyond these diversions to achieve no net loss of wetlands in the long term depends on cost-effective importation of sediment either by diversions or by dedicated dredging with dispersal by barging or pipelines. This critical long-term strategy could significantly reduce wetland loss in the basin, but it is very costly at this time.

Creation of artificial barrier islands could preserve the outer saline marshes. Although expensive, it is defined as critical and retained in the selected plan for possible implementation in the long term. Studies are planned on methods to reduce the cost of construction and to better evaluate benefits to interior marshes. If costs can be reduced and benefits increased, priority for implementing this strategy will increase.

The selected plan uses a combination of measures to achieve basin objectives. Projects accounting for the majority of the acres preserved or created are distributed in the following manner: hydrologic restoration (27 percent), freshwater diversion/outfall management (28 percent), shoreline protection (24 percent), and marsh creation (18 percent).

In summary, the short-term portion of the basin plan consists of the freshwater diversion at the Bonnet Carré Spillway and bank protection and marsh creation along the MRGO complemented by the preservation of the land bridges, critical areas, and other wetlands using numerous hydrologic restoration, marsh creation, and shoreline protection projects. The long-term portion of the plan, necessary to achieve a no net loss of wetlands, consists of additional freshwater diversions, sediment import, and the creation of barrier islands.

Projects included in the Pontchartrain Basin Plan are listed in Table PO-2. The table provides the classification (e.g., critical, supportive, demonstration), estimated benefits and costs, and status of these projects. A complete listing of all the projects proposed for the Pontchartrain Basin can be found in Appendix A, Table 8. More detailed information on each project is also included in Appendix A.

COSTS AND BENEFITS

An expenditure of $132,738,000 on short-term projects and $72,000,000 on construction and 20 years of maintenance of the Bonnet Carré Freshwater Diversion will create or preserve 17,320 acres of marsh and 3,600 acres of swamp and thus prevent 69 percent of the marsh loss and 7 percent of the swamp loss in the Pontchartrain Basin (see Table PO-3).

As shown in the table, short-term projects prevent 83 to 92 percent of the future marsh loss on the land bridges and achieve no net loss of marsh in the middle basin. However the plan prevents only 44 percent of the marsh loss in the lower basin. Clearly, additional long-term efforts are needed to preserve these eroding marshes. Construction of the artificial barrier islands prevents the loss of an additional 33 percent of the lower basin. However, the cost of barrier island creation, using present technology, is an additional $600 million. Long-term sediment import projects are essential in achieving no net loss in the lower basin. Sediment import into the upper basin is necessary to begin to preserve its cypress swamps. The cost of these sediment import projects is unknown. Thus, complete restoration of the upper and lower basins requires investigation of cost effective techniques to build barrier islands and import sediment.

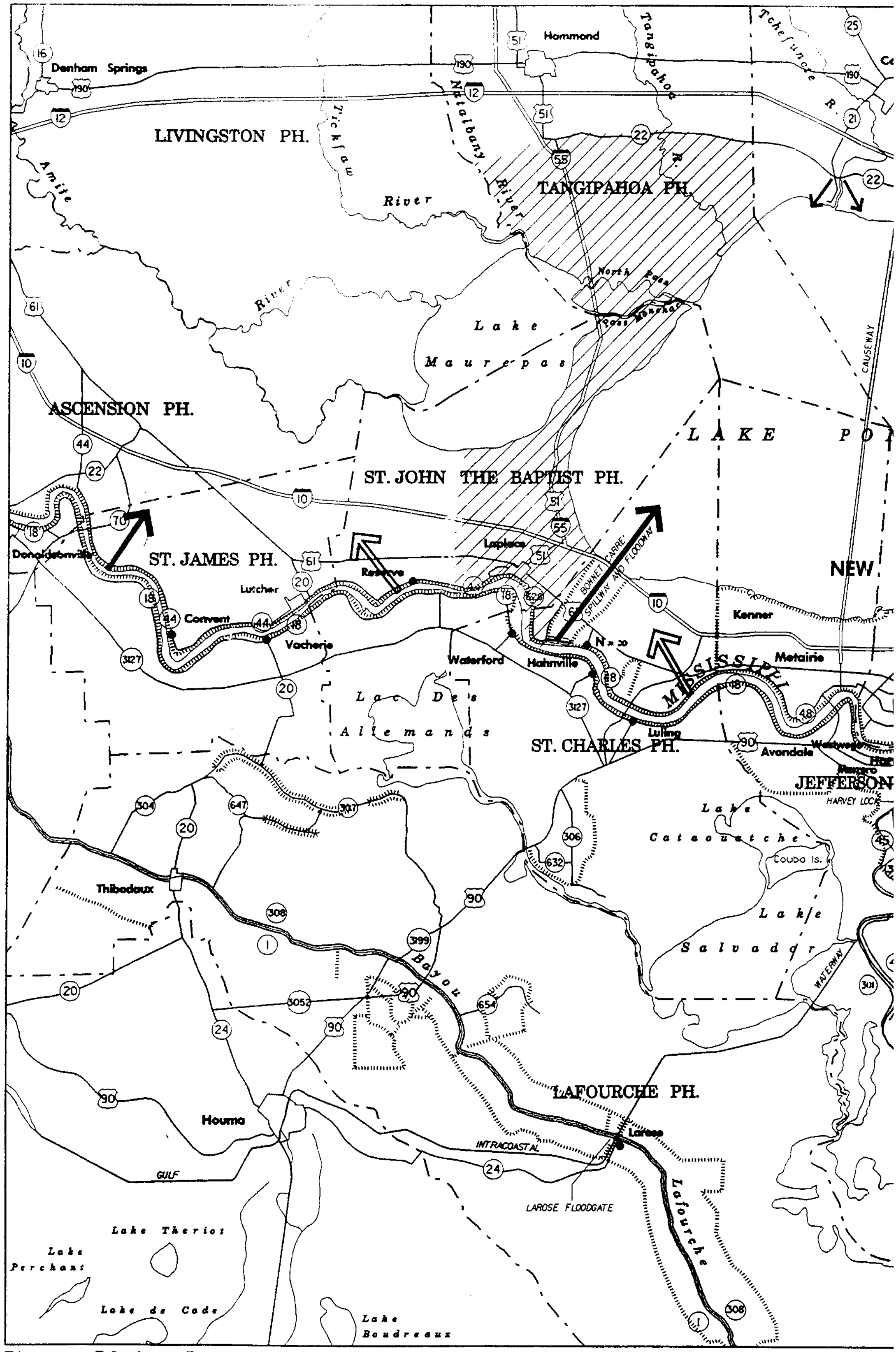


Figure PO-2. Pontchartrain Basin, Strategy Map.

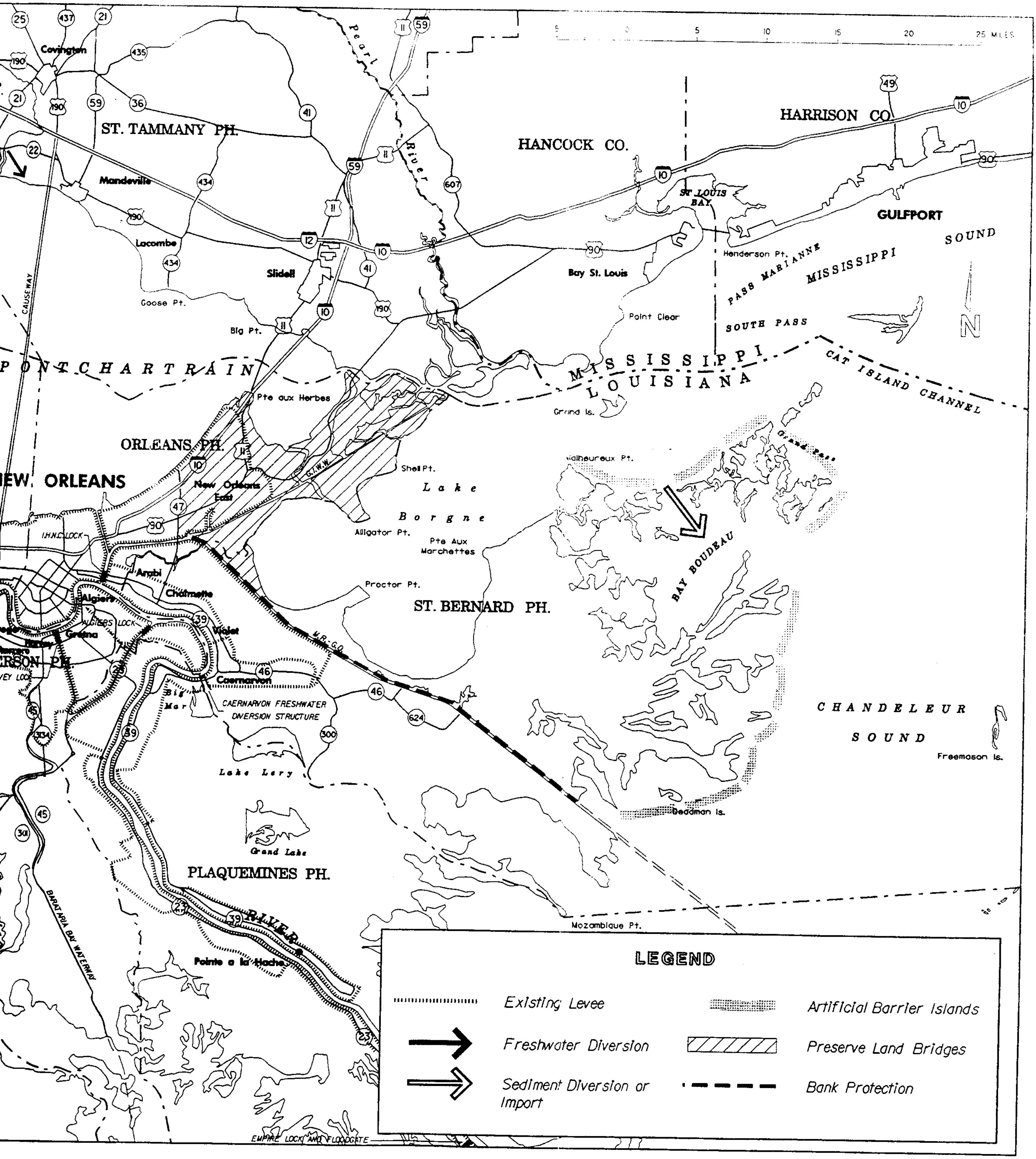

ST. TAMMANY PH.
HANCOCK CO.
HARRISON CO.
Covington
Mandeville
Lacombe
Slidell
Goose Pt.
Big Pt.
Bay St. Louis
ST LOUIS BAY
GULFPORT
Henderson Pt.
PASS MARIANNE
MISSISSIPPI SOUND
SOUTH PASS
Point Clear
PONTCHARTRAIN
MISSISSIPPI
LOUISIANA
CAT ISLAND CHANNEL
Grand Is.
Pte aux Herbes
ORLEANS PH.
NEW ORLEANS
New Orleans East
Shell Pt.
Lake Borgne
Malheureux Pt.
Alligator Pt.
Pte Aux Marchettes
Proctor Pt.
BAY BOUDEAU
ST. BERNARD PH.
I.H.N.C. LOCK
Arabi
Chalmette
Algiers
ALGIERS LOCK
Gretna
Harvey
Violet
Caernarvon
CAERNARVON FRESHWATER DIVERSION STRUCTURE
Big Mar
Lake Lery
M.R.-G.O.
G.I.W.W.
CAUSEWAY
Pearl River
CHANDELEUR SOUND
Freemason Is.
Grand Lake
PLAQUEMINES PH.
Beadman Is.
Mozambique Pt.
RIVER
Pointe a la Hache
BARATARIA BAY WATERWAY
EMPIRE LOCK AND FLOODGATE
5 0 5 10 15 20 25 MILES
N
LEGEND
Existing Levee
Freshwater Diversion
Sediment Diversion or Import
Artificial Barrier Islands
Preserve Land Bridges
Bank Protection

Table PO-2

Summary of Pontchartrain Basin Projects

Project No.	Project Name	Project Type	Priority List Project	Marsh Acres Created, Protected, or Restored	Swamp Acres Created, Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comment
Critical Projects, Short-Term									
PO-6	Fritchie Wetland Hydrologic Restortation	HR, FD	PPL 2	1,040		1,686	2,297,000	1,400	
PO-11	Cutoff Bayou Hydrologic Restoration	HR		103		503	722,000	1,400	
PO-13	Tangipahoa/Pontchartrain Shore Protect	SP		142		627	4,850,000	7,700	
PO-14	Green Point/Goose Point Marsh Rest	SP		249		1,026	3,252,000	3,200	
PO-15	Alligator Point Marsh Restortation	HR		139		1,489	1,575,000	1,100	
PPO-2a	Lk Borgne SP, Rigolets to Chef	SP		84		94	1,421,000	15,100	
PPO-2b	Lk Borgne SP, South of Bienvenue	SP		41		91	578,000	6,400	
PPO-2g	Lk Borgne SP, Chef to GIWW Bypass	SP		81		96	1,708,000	17,800	
PPO-7	La Branche Shore Protection, East	SP		524		1,083	1,309,000	1,200	
PPO-10	La Branche Marsh Creation, West	MC	PPL 1	205		266	4,087,000	15,400	
PPO-19	Highway 51/Railroad Culverts	HR			73	283	342,000	1,200	
PPO-38	MRGO Bank Stabilization and MC	MC, SP		4,220		6,745	54,500,000	8,100	
XPO-50a	Lk Maurepas SP, Blayhut Canal	SP		162		631	1,728,000	2,700	
XPO-50b	Lk Maurepas SP, W Jones Island	SP		118		164	2,044,000	12,500	
XPO-51	Manchac WMA Marsh Management	MM		454	32	1,195	1,021,000	900	
XPO-52a	B Sauvage NWR HR, Hwy 90 to GIWW	HM	PPL 1	1,550		1,953	1,448,000	700	
XPO-52b	B Sauvage NWR HR, Hwy 90 to I-10	HM	PPL 2	1,280		2,077	1,114,000	500	
XPO-54	Bonnet Carre, Outfall Management	OM		1,000	300	1,300	8,500,000	6,500	
XPO-55	Bonnet Carre Diversion, 30,000 cfs	FD		1,560	2,450	4,010	72,000,000	18,000	Authorized USACE project
XPO-58	Pass Manchac Shore Protection	SP		72		107	1,745,000	16,300	
XPO-69	B Sauvage NWR, B Chevee SP	SP		468		1,367	2,672,000	2,000	
XPO-70	Lk Pontchartrain SP, Bon Car to Ruddock	SP		25	124	188	1,867,000	9,900	
XPO-71	MRGO Disposal Area Marsh Protection	HR	PPL 3	755		775	434,000	600	
XPO-81	Pt au Herbes Shore Protection	SP		42		49	590,000	12,000	
XPO-83	Lk Athanasio Spit Marsh Creation	MC		99		1,713	895,000	500	
XPO-84	St. Malo Hydrologic Restoration	HR		2		122	658,000	5,400	
XPO-91	La Branche SP, Walker Canal to Blowhole	SP		19		37	351,000	9,500	
Subtotal: Critical Projects, Short-Term				12,870	530	25,670	101,708,000		Total does not include Bonnet Carre FWD

Table PO-2 (Continued)
Summary of Pontchartrain Basin Projects

Project No.	Project Name	Project Type	Priority List Project	Marsh Acres Created, Protected, or Restored	Swamp Acres Created, Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comment
Critical Projects, Long-Term									
PPO-27	Tchefuncte Freshwater Diversion, West	FD							
PPO-28	Tchefuncte Freshwater Diversion, East	FD							
XPO-45	Upper/Middle Basin Sediment Pumping	SD							Feasibility study of water and sediment first
XPO-46	Tickfaw Freshwater Diversion	FD							
XPO-66	Artificial Barrier Is on Saline Marsh Fringe	BI							
XPO-85	Bayou Manchac Diversion	FD							
XPO-89	Blind River Freshwater Diversion	FD							
XPO-90	Sediment Input Lower Basin	MC							
Supporting Projects, Short-Term									
PO-7	North Shore Wetlands	ST		22		1,213	488,000	400	
PO-9a	Violet Outfall Management	HR	PPL3	247		1,124	1,364,000	1,200	
PPO-2c	Lk Borgne SP, Proctor Point	SP		99		143	651,000	4,600	
PPO-2d	Lk Borgne SP, East of Shell Beach	SP		246		383	1,664,000	4,300	
PPO-2e	Lk Borgne SP, Point au Marchettes	SP		106		121	1,056,000	8,700	
PPO-2f	Lk Borgne SP, South of Malheureaux Pt	SP		49		52	651,000	12,500	
PPO-4	Eden Isles East Marsh Restoration	HM, MC		1,092		1,494	8,856,000	5,900	Cost does not include land purchase
PPO-9	La Branche Marsh Creation, East	MC		733		830	9,937,000	12,000	
PPO-12	Tchefuncte Marsh Shore Protection	SP		81		152	854,000	5,600	
PPO-13	B Chinchuba Marsh Shore Protection	SP		42		63	752,000	11,900	
PPO-31	Indian Beach Marsh Creation	MC		11		34	464,000	13,600	
XPO-47	Amite River Diversion Canal Bank Mod	SP			340	596	533,000	900	
XPO-48a	Tennessee Williams Canal Bank Mod	HR			70	122	269,000	2,200	
XPO-48b	Hope Canal Bank Modification	HR			160	281	290,000	1,000	
XPO-63	Lk Maurepas SP, Mouth of Blind River	SP		14	48	73	1,096,000	15,000	
XPO-72	MRGO MC, (Material From 9-23 to Jetties)	MC							
XPO-74	Bienvenue Marsh	OM, MC							
XPO-80a	Lower Pearl Basin Sediment Trapping	ST		55		2,940	660,000	200	
XPO-82	Fontainbleau Shore Protection	SP		16		28	246,000	8,800	
XPO-88	Point Platt Sediment Trapping	ST		74		1,138	1,199,000	1,100	
XPO-94	Lake Pontchartrain Grassbeds	ST							
Subtotal: Supporting Projects, Short-Term				2,890	620	10,790	31,030,000		

Table PO-2 (Continued)
Summary of Pontchartrain Basin Projects

Project No.	Project Name	Project Type	Priority List Project	Marsh Acres Created, Protected, or Restored	Swamp Acres Created, Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comment
Supporting Projects, Long-Term									
PPO-17	Amite/Petite Amite Swamp Restoration	HR							
PPO-36	GIWW Bank Stab, Rigolets to MRGO	SP							
XPO-59	North Shore Marsh Rest w/ Dredged Mat	MC							
XPO-60	Ascension Parish Swamp Restoration	HR							
XPO-61	St. James/St. John Swamp Restoration	HR							
XPO-64	B Sauvage NWR Hyd Rest, I-10 to Lake	HM							
XPO-73	MRGO Bar Wetland Creation	MC							
XPO-75	St. Bernard Brackish Marsh	HR							
XPO-76	Pontchatoula Marsh	HR							
XPO-77	GIWW Northern Marsh, Chief to Rigolets	HR							
XPO-78	Tangipahoa/Bedico Marsh	HR							
XPO-79	Jones Island Marsh	HR							
XPO-80	Pearl River Marsh	FD, HR							
Demonstration Projects									
PPO-21	N.O. East, Marsh Creation for Stormwater	MC							
PPO-25	Bayou St. John Grassbeds	VP							
PPO-34	Bonnabel Canal, Marsh Creation Stormwater	MC							
XPO-47	Amite R Div Canal Bank Modification	HR							
XPO-92	Shoreline Protection Demonstration Methods	SP							
XPO-93	N.O. East Marsh Creation W/ Biosolids	MC							
Defferred Projects									
PO-1b	Violet Siphon Enlargement	FD							Consider after PO-9a
PO-5	SE Lake Maurepas Wetlands	HR							Defer until cost & Benefits are known
PO-12	La Branch Wetland Management, West	HR							Defer until cost & Benefits are known
PPO-20	Port Louis Hydrologic Restoration	HR ,MC							Landowner not interesed
PPO-35	Duncan Canal, Marsh Creation Stormwater	MC							Defer until other stormwater demo's done
XPO-49	Tangipahoa Swamp Hydrologic Rest	HR							Defer until Bonnet Carre benefits are realized
XPO-56b	Seabrook Sill	HR							
XPO-65	Artificial Oyster Reefs	SP							Defer until results of similar demo's known
Total Pontchartrain Basin *				15,760	1,150	36,460	132,738,000		Includes Short-Term Projects Only
Total Pontchartrain Basin with Bonnet Carre Freshwater Diversion **				17,320	3,600	40,470	204,738,000		Includes Short-Term Projects and Bonnet Carre

BI Barrier Island Restoration
FD Freshwater Divesion
HM Hydrologic Management of Impoundments
HR Hydrologic Restoration
MC Marsh Creation
MM Marsh Management
OM Outfall Management
SD Sediment Diversion
SP Shoreline or Bank Protection
ST Sediment Trapping
VP Vegetative Planting

* Total cost and benefits for the basin plan include only Critical Short-Term Projects and Supporting Short-Term Projects.

** Total cost and benefits include only Critical Short-Term, Supporting Short-Term, and the Bonnet Carre Freshwater Diversion project.

Table PO-3. Results of Short Term Projects and Bonnet Carre Diversion

Area	CWPPRA Net Acres Marsh Created/ Preserved	CWPPRA Net Acres Swamp Created/ Preserved	CWPPRA Estimated Cost x $(1000)	Bon. Carre Net Acres Marsh Created/ Preserved	Bon. Carre Net Acres Swamp Created/ Preserved	Bon. Carre Estimated Cost x $(1000)	Total plan Net Acres Marsh Created/ Preserved	Total plan Net Acres Swamp Created/ Preserved	Total plan Percent Marsh Loss Prevented	Total plan Percent Swamp Loss Prevented
Upper Basin	10	620	2,188	0	0	0	0	620	0	3
Pontch/Maur Land Bridge	970	230	13,597	130	1960	37,520	1100	2,190	83	9
Middle Basin	5,110	300	42,592	420	490	16,500	5530	790	145	8
Pontch/Borgne Land Bridge	3,790	0	11,828	420	0	7,480	4210	0	92	0
Lower Basin	5,830	0	61,873	600	0	10,500	6430	0	44	0
Pearl Basin	60	0	660	0	0	0	60	0	9	0
Total	15,770	1,150	132,738	1,570	2,450	72,000	17,330	3,600	69	7

* Bonnet Carre Diversion benefits and costs were estimated for 20 years to be comparable to CWPPRA acres and costs.
The 4,000 acres and $72,000,000 were distributed to the land bridges, the middle basin, and the lower basin.

BRETON SOUND BASIN: SUMMARY OF BASIN PLAN

STUDY AREA

The Breton Sound Basin encompasses approximately 676,400 acres, of which 184,100 acres are wetlands. It is bounded on the west by the Mississippi River, on the north by Bayou La Loutre, on the east by the south bank of the Mississippi River Gulf Outlet (MRGO), and on the south by Baptiste Collette Bayou and Breton Island (Figure BS-1). The basin includes portions of Plaquemine and St. Bernard parishes. It consists of approximately 51,300 acres of public land, equaling 28 percent of the total lands within the basin.

EXISTING CONDITIONS AND PROBLEMS

The Breton Sound Basin is the remnant of a Mississippi River delta lobe, the abandoned St. Bernard Delta. The principal hydrologic features of the Breton Sound Basin include the Mississippi River and its natural levee ridges; the flood protection levee; the MRGO south disposal bank; Bayou Terre aux Boeufs and River aux Chenes (abandoned delta distributaries); and the freshwater diversions at Caernarvon, White's Ditch, Bohemia, and Bayou Lamoque.

The natural processes of subsidence, saltwater intrusion, and erosion of wetlands, and the human effects of river levee construction and the oil and gas industry, have caused major impacts to the Breton Sound Basin in recent decades. The two major wetland problems resulting from the natural processes and human intervention in this basin are sediment deprivation and saltwater intrusion.

Historically, the basin was flushed with large quantities of fresh water and sediments annually during the spring. Marine waters would then rise and enter the basin during the late summer and early fall months and would be flushed out the following spring. In the early 1930's, flood protection levees were raised along the Mississippi River as far south as Bohemia in the Breton Sound Basin. This prevented the annual input of fresh water, nutrients, and sediment that nourished the wetlands and combatted saltwater intrusion.

Between 1940 and 1970, 12.9 square miles (8,256 acres) of canals were dredged across and between the abandoned distributary ridges that run from the river to the outer fringes of the marsh (Gagliano et al., 1970). This has allowed channelized outflow of fresh water and increased tidal flux.

The combination of natural processes and human intervention has allowed salt water to enter close to the head of the basin. Much of the fresh and intermediate marsh that occurred in the upper basin earlier in this century has either converted to more saline habitats or has become open water as a result of sediment and nutrient deprivation brought about by the construction of flood protection levees and saltwater intrusion caused by the dredging of oil and gas access canals through and between the natural distributary ridges.

Subsidence combined with sediment and nutrient deprivation has contributed greatly to the marsh loss in the upper and middle basin and even more greatly in the Bohemia Subbasin. The subsidence rate ranges from 0.6 feet per century in the upper portion of the basin to 4 feet per century in the lower portion. The effect of subsidence is very apparent in the area south of Bohemia, which was created by alluvial deposits of the Mississippi River less than 1,000 years ago. Large areas of wetlands flanking the Mississippi River in this area have subsided and are continuing to subside and convert to open water. Periodic overbank flows from the

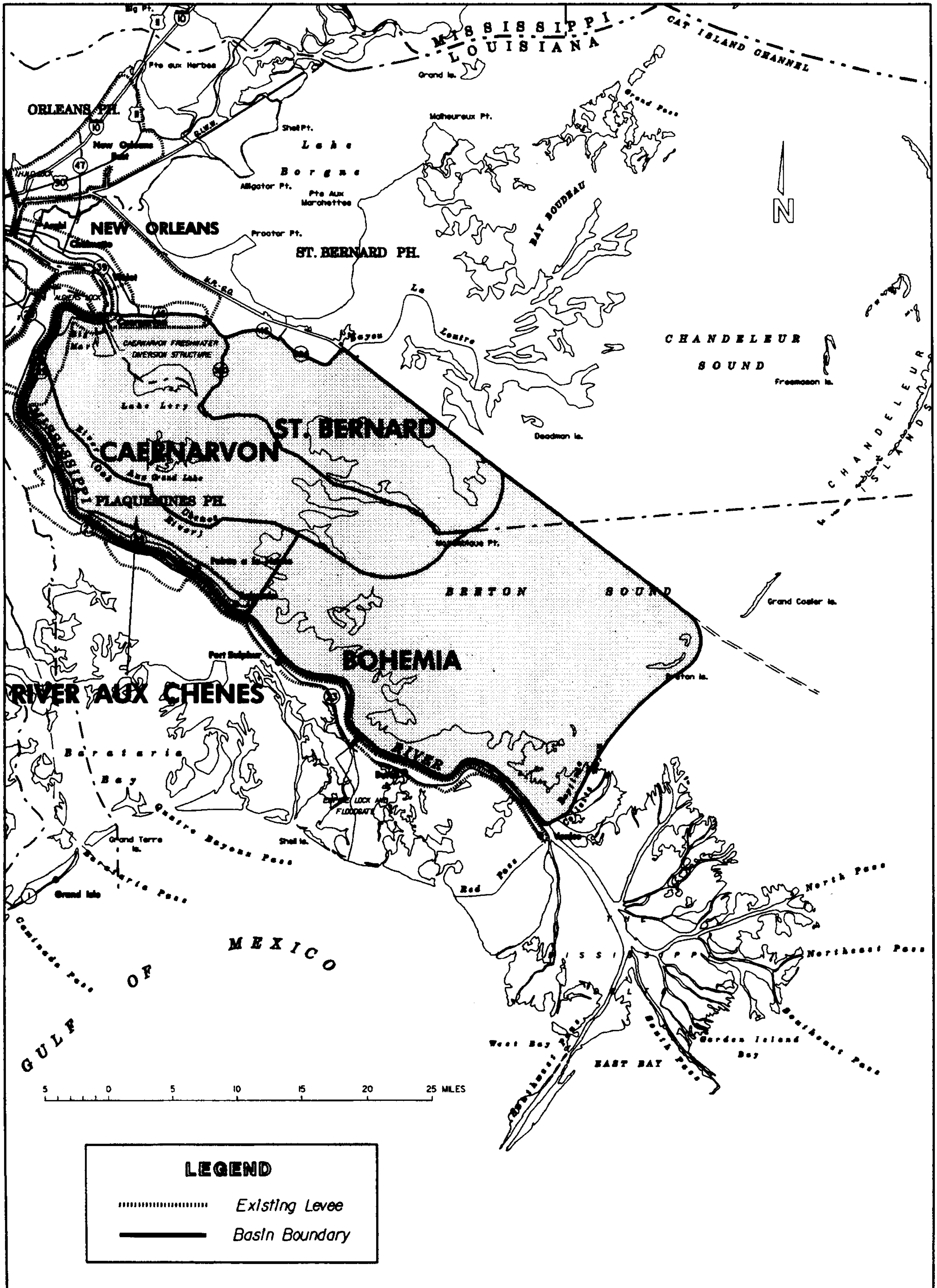


Figure BS-1. Breton Sound Basin, Basin and Subbasin Boundaries.

Mississippi River occur in this area, and some wetlands immediately adjacent to the river are being maintained by this input of sediments and fresh water.

A significant cause of wetland loss in the Breton Sound Basin is erosion of shorelines by wind-wave action. Along the shoreline of the outer marshes and around the perimeter of the larger bays, erosion rates of 5 to 10 feet per year are common. These high rates occur in the fringe marshes because the Breton barrier islands are so far offshore that they offer little protection to the estuary behind them.

FUTURE WITHOUT-PROJECT CONDITIONS

Table BS-1 shows the losses estimated over the next 20 and 50 years based on 1974-1990 loss rates from Table 2.

Table BS-1
Projected Marsh Loss

	Projected Loss in 20 years		Projected Loss in 50 years	
Subbasin	(Acres)	(Percent)	(Acres)	(Percent)
River aux Chenes	500	2	1,230	4
Caernarvon	5,100	7	12,760	16
St. Bernard	2,300	6	5,760	14
Bohemia	5,480	16	13,720	41
Total	13,380	7.3	33,470	18.2

The effects of the Caernarvon Freshwater Diversion Structure, which is expected to preserve 320 acres per year for 50 years or 16,000 acres, are reflected in the projected losses for the Breton Sound Basin.

Marsh loss will continue in the upper and middle parts of the basin where sediments from the Caernarvon structure are insufficient to offset impoundment and sediment deprivation. The marshes in the lower basin will continue to deteriorate from wind-generated wave action and tidal scour, following the general abandoned delta break-up process. Marshes south of Bohemia will continue to subside, erode, and convert to open water except for those areas nearest the river, which will be maintained by periodic overbank flow.

The economies of communities in the basin are largely based upon oil and gas and renewable biological resources. Fishery harvests have increased, largely due to increased numbers of harvesters, each of which is harvesting less per man-hour than was harvested ten years ago.

BASIN PLAN

The selected plan (Figure BS-2) provides a balanced approach to create, restore, protect, and enhance wetlands through the optimization of the available resources afforded the basin. Management and restoration of fluvial input form the foundation of the selected plan. In the short term, management of the Caernarvon Freshwater Diversion Structure's outfall along with outfall management of White's Ditch, Bohemia, and Bayou Lamoque Freshwater Diversions is vital to the restoration of this basin because such projects will help to maintain and restore the hydrology of the basin. Also, in the short term, construction of a small-scale controlled sediment diversion at Grand Bay and the restoration of overbank flow at Olga will create and nourish marsh through sediment transport.

Restoration of fluvial input to the basin through the construction of a 20,000-cfs sediment diversion, tentatively at Bohemia, is the core of the long-term strategy to restore the basin. A feasibility study is necessary to determine the optimum location for such a diversion. In support of the long-term strategies, construction of interior barriers and the restoration of natural ridges will help to restore the natural compartmentalized hydrology within the basin.

Projects selected for inclusion in the Breton Sound Basin plan are listed in Table BS-2. The table indicates project type; classification (i.e., critical, supporting); project status; acres created, restored, or protected; net benefited acres; cost per benefited acre; and the estimated project cost.

COSTS AND BENEFITS

The proposed projects, short- and long-term critical and short-term supporting, will create, restore, or protect approximately 5,200 acres, 39 percent of the predicted loss at an estimated cost of $11,367,000. Including submerged aquatic vegetation and enhancement of existing marsh, an additional 4,400 acres will benefit from plan implementation.

The selected plan provides a balanced approach to improving conditions in the basin. Hydrologic restoration measures such as outfall management and sediment diversion account for the majority of the acres created, restored, and protected.

If cost-effective construction techniques are developed, the Fiddler Point Barrier Island project could be implemented. This project would protect an additional 1,190 acres, preventing 10 percent of the projected loss. The cost of constructing this barrier island system using present technology is estimated to be $55,115,000. The cost per acre is $118,000 and is nearly 30 times the average cost per acre of the other proposed projects. Thus, the recommendation is to proceed with the rest of the plan and postpone barrier island construction until techniques are developed to decrease their cost.

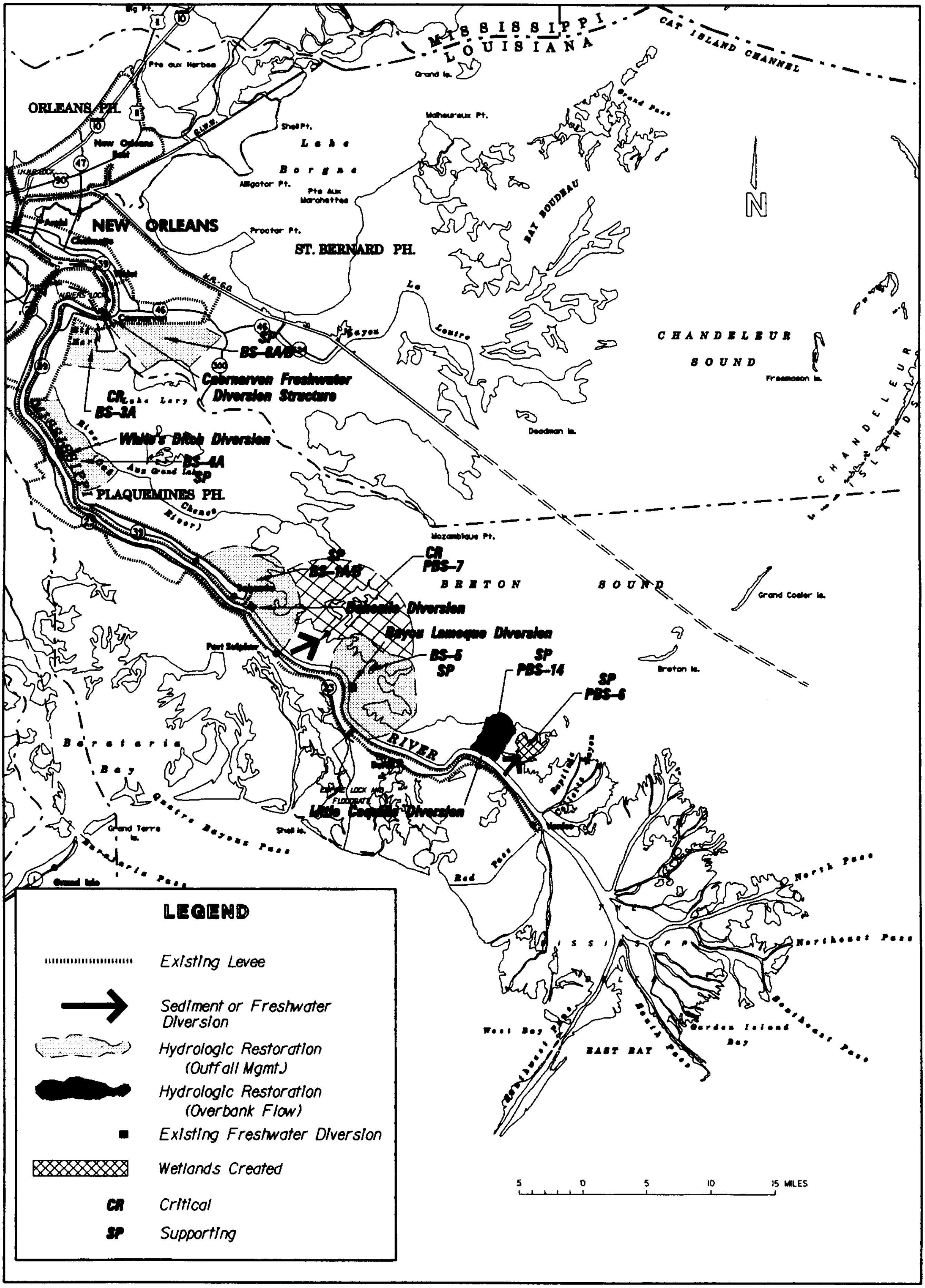


Figure BS-2. Breton Sound Basin, Selected Plan.

Table BS-2
Summary of the Breton Sound Basin Projects

Project No.	Project Name	Project Type	Priority List Project	Acres Created, Restored, or Protected	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comments
<u>Critical Project, Short-Term</u>								
BS-3a	Caernarvon Diversion Outfall Mgmt S. of Big Mar	OM	PPL2	812	1,758	1,885,000	1,100	Interacts w/ BS-4a
<u>Critical Project, Long-Term</u>								
PBS-7	Bohemia Sediment Diversion (large scale diversion)	SD		* 3,350	4,760	3,118,000	700	Compatible with PBS-4
<u>Supporting Projects, Short-Term</u>								
BS-1a/b	Restoration of Bohemia Diversion and O/F Mgmt	OM		124	658	1,642,000	2,500	Interacts w/ PBS-7 and BS-1a/b
BS-4a	White's Ditch Outfall Management	OM	PPL3	37	305	601,000	2,000	Interacts w/ BS-3a
BS-5	Bayou Lamoque Diversion Outfall Management	OM		350	555	317,000	600	Interacts w/ PBS-7 and BS-1a/b, Can PPL 3
BS-6a/b	Pump Outfall Management N. of Lake Lery	OM		169	746	2,241,000	3,000	Interacts w/ BS-3a, Candidate PPL 3
PBS-6	Grand Bay Crevasse	SD		364	800	1,563,000	2,000	Interacts w/ PBS-14, Candidate PPL 2, 3
PBS-14	Foreshore Dike Restoration at Olga	HR						Interacts w/ PBS-6
Subtotal:	Supporting Projects, Short-Term			1,040	3,060	6,364,000		
<u>Supporting Projects, Long-Term</u>								
PBS-4	Diversion of the Mississippi River into Breton Sound	SD						Compatible with PBS-7
PBS-5	Fiddler Point Barrier Island	BI						Not to be built unless cost are reduced
PBS-8	Interior Barrier	HR		* 1,875	12,480	32,000,000	2,600	To be tied into outfall mgmt plans
PBS-9	Interior Ridge Restoration and Enhancement	HR						To be built if PBS-7 is not
<u>Demonstration Project</u>								
PBS-13	Oyster Reef Demonstration	SP						Candidate PPL 2
Total Breton Sound Basin **				1,850	4,820	8,249,000		Includes only Short-Term Projects
Total Breton Sound Basin Including Long-Term Critical Projects ***				5,200	9,600	11,367,000		

BI Barrier Island Restoration — HR Hydrologic Restoration — SP Shore or Bank Protection
FD Freshwater Diversion — SD Sediment Diversion — OM Outfall Management

* Benefits not varified by the WVA work group
** Cost and benefits include only Critical Short-Term and Supporting Short-Term project
*** Cost and benefits include Critical Short and Long-Term and Supporting Short-Term projects

MISSISSIPPI RIVER DELTA BASIN: SUMMARY OF BASIN PLAN

STUDY AREA

The Mississippi River Delta Basin is defined as all of the land and shallow estuarine area between the two northernmost passes of the Mississippi River and the Gulf of Mexico. The basin is located in Plaquemines Parish, Louisiana, south of the city of Venice. Baptiste Collette Bayou, on the east side of the river, and Red Pass, on the west side, form the basin's northern boundary. This area is also referred to as the Plaquemines-Balize or "bird's foot" delta. The basin encompasses approximately 521,000 acres and is shown in Figure MR-1. Approximately 129,000 acres of land and water in this basin are in public ownership. This includes approximately 14,000 acres of the river's channel and passes which are navigable waterways of the United States.

EXISTING CONDITIONS AND PROBLEMS

The Mississippi River has had a profound effect on the landforms of coastal Louisiana. The entire area is the product of sediment deposition following the latest rise in sea level about 5,000 years ago. Each Mississippi River deltaic cycle was initiated by a gradual capture of the Mississippi River by a distributary which offered a shorter route to the Gulf of Mexico. After abandonment of an older delta lobe, which would cut off the primary supply of fresh water and sediment, an area would undergo compaction, subsidence, and erosion. The old delta lobe would begin to retreat as the gulf advanced, forming lakes, bays, and sounds. Concurrently, a new delta lobe would begin its advance gulfward. This deltaic process has, over the past 5,000 years, caused the coastline of south Louisiana to advance gulfward from 15 to 50 miles, forming the present-day coastal plain.

For the last 1,200 years, sediment deposition has occurred primarily at the mouth of the Mississippi River's Plaquemines-Balize delta, in the area defined as the Mississippi River Delta Basin. This delta is located on the edge of the continental shelf of the Gulf of Mexico. Its "bird's foot" configuration is characteristic of alluvial deposition in deep water. In this configuration large volumes of sediment are required to create land area; consequently, land is being lost in this delta more rapidly than it is being created.

The Mississippi River Delta Basin comprises approximately 521,000 acres of land and shallow estuarine water area in the active Mississippi River delta. Approximately 83 percent of this area, or 420,000 acres, is open water. The 101,100 acres of land in the basin are characterized by low relief, with the most prominent features being natural channel banks and dredged material disposal areas along the Mississippi River, its passes, and man-made channels. Coastal marshes make up approximately 61,650 acres or about 61 percent of the total land area in the Mississippi River Delta Basin. Eighty-one percent of this marsh is fresh, 17 percent is intermediate, and 2 percent is brackish-saline.

The Mississippi River discharges the headwater flows from about 41 percent of the contiguous 48 states. On a long-term daily basis, discharges in the Mississippi River average 470,000 cubic feet per second (cfs). A peak discharge of approximately 1,250,000 cfs occurs on the average of once every 16 years downstream of New Orleans.

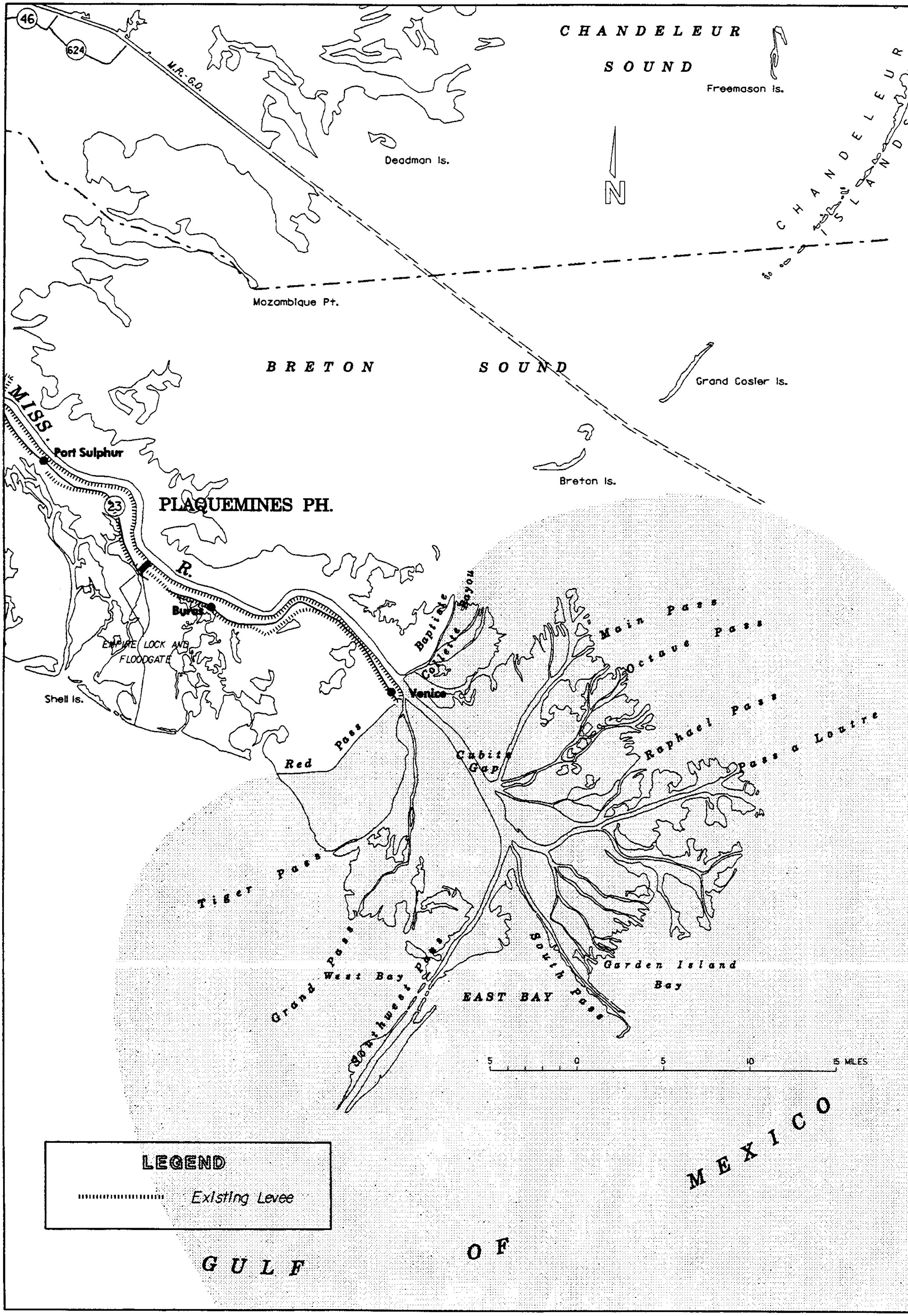


Figure MR-1. Mississippi River Delta Basin, Basin Boundaries.

Suspended sediment concentrations in the river decreased markedly between 1950 and 1966. Since that time the observed decrease in the suspended sediment load has been minimal. Long-term suspended sediment loads in the river average 436,000 tons per day; they have ranged from an average of 1,576,000 tons per day in 1951 to a still considerable average of 219,000 tons per day in 1988.

Between 1974 and 1990 the land loss rate in the Mississippi River Delta Basin averaged 1,072 acres per year, or 1.69 percent of existing land area (Dunbar, Britsch, and Kemp 1992). Between the mid-1950's and 1974, the estimated land loss rate for the basin was 2,890 acres per year. This loss is the result of compaction, subsidence, hurricanes, tidal erosion, sea level rise, and human activities. The loss has been aggravated by maintenance of navigation channels and construction of canals for mineral exploration. The total land area lost in this basin over the last 60 years has been approximately 113,300 acres.

The primary wetlands loss problem facing the Mississippi River Delta Basin is that of subsidence and compaction. Unlike other areas of coastal Louisiana, the Mississippi River delta is blessed with a relative abundance of inflowing fresh water and sediments. Despite the availability of these resources, the overall growth of emergent delta has been truncated in recent history. In its present position the Mississippi River deposits sediments into much deeper water than has been the case historically. This is evidenced by the thick stratum of Holocene deltaic sediments found in the active river delta. These unconsolidated sediments are highly susceptible to compaction, reducing the life span of emergent wetlands. While the rapid emergence of wetlands can occur over large areas in the delta, these areas deteriorate in an equally rapid manner.

Human activities have aggravated land loss rates in the Plaquemines-Balize delta. The stabilization of the Mississippi River's channel has cut off seasonal sediment-laden overbank flow that once nourished adjacent wetland areas. The Mississippi River levees to the north, and associated erosion control and channel stabilization measures extending to its mouth, also preclude the possibility of a naturally occurring crevasse or change in the river's course.

Many areas of the Louisiana coast suffer from a lack of the abundant fresh water and sediment found in the Mississippi River. Since the river is no longer free to alter its course and leave its banks to inundate vast coastal areas, the effects of human and natural forces which promote wetland deterioration are compounded. In this respect the relationship between the Mississippi River and the problems facing coastal wetlands is not limited to the river's delta, but extends across the entire Louisiana coast. The lack of growth in the Mississippi River delta, on a large scale, is as much a coast-wide problem as a basin problem. This source of ample fresh water and sediment, which shaped the Louisiana coast as we know it, is no longer producing a net gain in coastal wetlands, placing the entire Louisiana coast at risk.

FUTURE WITHOUT-PROJECT CONDITIONS

Since 1932, the Mississippi River Delta Basin has lost approximately 70 percent of its total land area. The composite of recent loss rates presented above was used to predict future wetlands losses. The total projected wetland losses over 20- and 50-year time spans represent, respectively, 35 and 87 percent of the existing wetlands in the basin and are shown in Table MR-1. Based on this loss of wetlands, only 5 percent of the original 1932 land area in this basin would remain intact in 50 years.

Table MR-1
Projected Wetland Losses

Projected Time (years)	Acres Lost	Percent Loss
20	21,440	35
50	53,600	87

BASIN PLAN

The unique opportunity present in this basin is the tremendous volume of sediment transported by the Mississippi River. The need which must be addressed with this resource is not limited to only this basin. The needs of the entire coast of Louisiana are linked, inseparably, to the unique opportunity that the Mississippi River presents.

Two alternative strategies were developed for this basin. Strategy One involves the study and development of a major uncontrolled diversion of the Mississippi River for the creation of a new delta, while maintaining the navigation route in its present location and managing the retreat of the existing delta. Strategy Two would maintain the course of the river in its present location and optimize the growth of the existing delta through redistribution of the available flows and sediments throughout this location.

The crucial point for the selection of the diversion plan, Strategy One, over Strategy Two, maintenance of the existing delta, is the extent of the benefits which can be achieved and the long-term optimization of available resources. Diversion of the river's main flow translates into large gains in newly emergent wetlands over potentially hundreds of years. It should also be recognized that the existing delta, if left to natural processes, would ultimately be abandoned and its wetlands lost.

It is also important to note that the same short-term strategy can be implemented under either major strategy. Many of the measures which can be taken to enhance the current delta configuration under Strategy Two will, in some scaled form, be used in preparing the existing delta for a diversion of the river and in managing its retreat under Strategy One. This allows the execution of the plan to proceed in the short term regardless of which major diversions may ultimately prove feasible.

Under the selected course of action, Strategy One, the proposed study would look into all viable options for undertaking the relocation of the river's primary delta. The restoration plans in both Breton Sound and Barataria basins are compatible with some form of large scale diversion as outlined in this basin. At this time the principal site for consideration is Breton Sound, although others will be evaluated.

In managing the retreat of the existing delta a number of small to moderate wetland creation projects will be undertaken in the short term. These projects will utilize available flow and sediment resources to expand and stabilize the existing wetlands in the delta prior to the onset of its retreat. In addition, a coordinated program of dredged material disposal, both from maintenance and dedicated dredging projects, will help to establish a line of barrier development throughout the existing delta. The major strategic points of the selected strategy are presented in Figure MR-2.

The concept of a major sediment diversion has been previously investigated at a reconnaissance level in the Louisiana Coastal Area, Mississippi River Delta Study completed by the U. S. Army Corps of Engineers, New Orleans District, in February 1990. This information should provide the basis for the next study level, a detailed feasibility study.

The significance of the available resources and the present lack of net delta growth is magnified in view of the extent of the larger wetlands loss problem in coastal Louisiana. This is apparent in a present day context and historically as well. In consideration of this fact, the selected strategy adopts an aggressive approach that would initiate the growth of a new delta. The basis for this selection is that the resource available in the Mississippi River cannot be under-utilized in the rebuilding and maintaining of the Louisiana coast. To achieve the goal of maintaining the current level of wetland functions and offset the high rates of wetland loss, measures which net large gains in coastal wetlands must be pursued. With this alternative, the transition from a posture of status quo to one of aggressive rebuilding is achievable.

COSTS AND BENEFITS

The benefits for the major project in this plan, the Uncontrolled Mississippi River Diversion, will be accrued in some other coastal basin. For the purpose of comparison with short-term projects (20 years), the cost and benefits of this project are estimated to be $428,720,000 and 61,290 acres. The project costs $910,000,000 and creates 89,300 acres over 50 years. Once constructed this project will continue to function well beyond 50 years, resulting in additional benefits and requiring continued maintenance. These benefits represent a significant reduction of wetlands loss from a coastal standpoint; however, they cannot be applied directly to the prevention of wetlands loss in this basin.

The direct costs and benefits of the selected plan in this basin are $23,910,000 and 24,600 acres, respectively. Based on these benefits, implementation of the selected plan will eliminate all projected loss and produce a net gain of 3,160 acres of wetlands over 20 years. The specific costs and benefits for known projects can be found in Table MR-2, which includes all projects in the selected plan.

The costs and benefits for the selected plan include only those projects with established designs. These include the long and short-term critical projects and all short-term supporting projects with the exception of any vegetative planting projects. Costs and benefits are shown for the long-term Bohemia Sediment Diversion project; however, this project would serve as a precursor or alternative to the critical Uncontrolled Mississippi River Diversion project. Because of this overlap, the costs and benefits of the larger, more crucial project have been included in the totals. Additional costs and benefits may be forthcoming as the details of additional supporting projects become known.

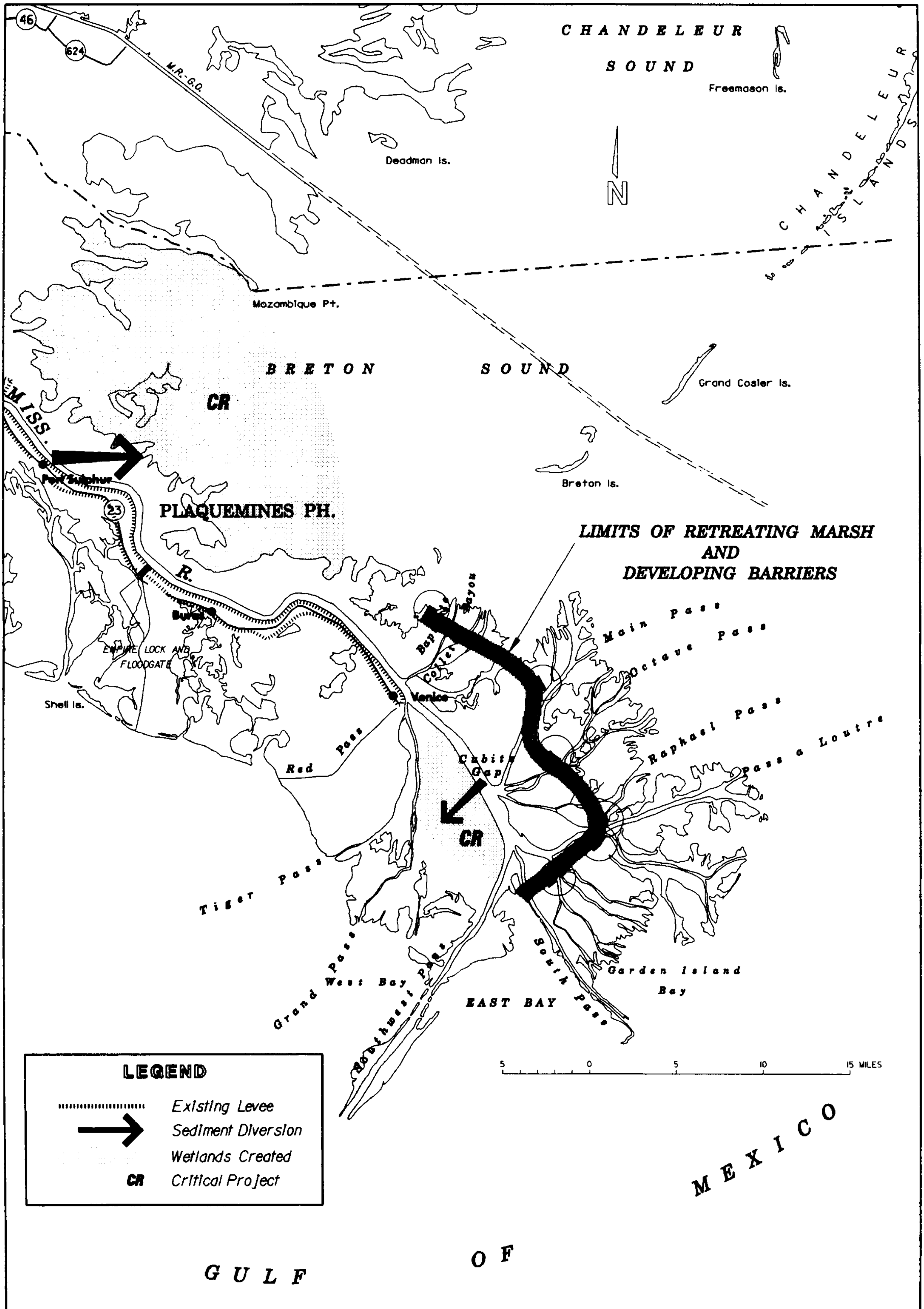


Figure MR-2. Mississippi River Delta Basin, Strategy Map.

Table MR-2
Summary of the Mississippi River Delta Basin Projects

Project No.	Project Name	Project Type	Priority List Project	Acres Created, Restored or Protected	Net Benefited Acres	Estimated Cost ($)	Cost per Benefited Acre ($/Ac)	Comments
Critical Projects, Short-Term								
FMR-3	West Bay Large Scale Sediment Diversion	SD	PPL1	9,831	10,722	6,328,000	600	
Critical Projects, Long-Term								
PMR-6	Mississippi River Channel Relocation	SD		89,300	89,300 *	910,000,000	10,200	50 Year Cost
				61,290	61,290	428,720,000	7,000	20 Year Cost
Supporting Projects, Short-Term								
MR-2	Pass A Loutre Sediment Fencing	ST		1,500	1,817	2,666,000	1,500	
FMR-4	Tiger Pass Dredged Material	MC		415	457	4,434,000	9,700	Deferred from PPL 1
PMR-5	Benny's Bay Sediment Diversion	SD		10,761	12,125	6,328,000	500	
PMR-8	Pass A Loutre Sediment Mining	MC		118	252	1,247,000	4,900	Deferred from PPL 2
PMR-8/9a	Pass a Loutre Crevasse	SD	PPL3	1,043	1,287	2,242,000	1,700	
XMR-10	Main Channel Armour Gaps	SD	PPL3	936	1,219	665,000	500	
XMR-11	Vegetative Plantings	VP						
Subtotal Supporting Projects, Short-Term				14,770	17,160	17,582,000		
Supporting Projects, Long-Term								
PMR-7	Mississippi River Passes Flow Redistribution	HR						
XMR-12	Beneficial Use of Hopper Dredge Material	MC						
XMR-13	Bohemia Sediment Diversion	SD		3,350	3,350 *	3,118,000	900	
XMR-14	Mississippi River Dredged Material Disposal Plan	MC						
Total Mississippi River Delta Basin **				24,600	27,880	23,910,000		
Total Mississippi River Delta Basin ***				85,890	89,170	452,630,000		

HR	Hydrologic Restoration	SD	Sediment Diversion	ST	Sediment/Nutrient Trapping
MC	Marsh Creation w/Dredged Material	SP	Shoreline Protection	VP	Vegetative Plantings

Net Benefitted Acres include aquatic vegetation & enhanced wetlands

* Denotes benefits not varified by the Wetland Value Assessment Work Group.

** Total includes only Short-Term Critical and Short-Term Supportin Projects.

*** Total includes Short-Term Supporting, Short-Term Critical, and Long-Term Critical (20 year) Projects.

KEY ISSUES

In the development of major strategies for this basin, measures to accommodate deep-draft navigation access between the Mississippi River and the Gulf of Mexico were of major concern. With a significant portion of national commerce dependent upon this deep-draft navigation route, it is essential that access between the river and the gulf be maintained without significant disruption. Any major reduction in the flow of the Mississippi River will result in a reduction of the naturally maintained channel. This would in turn result in increased dredging requirements.

Other important areas of impact exist under Strategy One. One would be the deterioration and retreat of the existing delta. The presence of the Delta National Wildlife Refuge and the Pass a Loutre Wildlife Management Area in the existing delta makes this an area of major concern for both State and Federal wildlife and fisheries authorities. Achieving a smooth transition, and a long-term net gain in acreage, from one delta area to the other is a specific concern and requires verification. The effects of the diversion in the receiving area also require study and verification. In Breton Sound, for example, a large number of oyster grounds and the Breton National Wildlife Refuge at its gulfward extent would be affected by the influx of fresh water.

Beyond these concerns a key issue to be addressed in this basin has ramifications for all of coastal Louisiana; a change in the basic philosophy for the selection and execution of environmental projects is needed. The Mississippi River, as the fifth largest drainage on earth, provides a resource of a global proportion. With a sediment output of millions of tons annually, the Mississippi River is responsible for the geology of the Louisiana coastal zone from Vermilion Bay to the Mississippi Sound. The present day utilization of this resource exhibits the manner in which the management of a significant resource to support one set of goals may lead to critical deficiencies and needs in meeting alternative goals.

Significant impacts to wetlands can be traced to existing projects intended for the protection or enhancement of long-term economic investment, both private and public. The decision to invest public funds in these projects has historically been based on the ability of the project to provide a positive level of benefit, measured in economic terms, within a relatively short project life span, traditionally 50 years. The cycles associated with natural processes and the life spans of the geologic and environmental features they produce are quite often much larger. An adjustment must be made in this basic analytic philosophy in order to select and execute environmental projects and to undertake the large measures necessary to overcome present wetland trends.

The perceived disparity between the initially analyzed, and the actual long-term, effects of existing water resources projects emphasizes the need to re-establish the essence of historically occurring natural processes. To accomplish this, a more foresighted philosophy for the recommendation, development, and execution of environmentally oriented projects is needed. Simply stated, the philosophy for successfully undertaking environmental restoration is to look beyond traditional short-term analyses of costs and benefits. The true benefits of these restoration efforts lie well beyond their immediate effects, in the long-term gains which ultimately provide the equilibrium necessary for the long-term conservation of coastal Louisiana.

BARATARIA BASIN: SUMMARY OF BASIN PLAN

STUDY AREA

The Barataria Basin (Figure BA-1) is located immediately south and west of New Orleans, Louisiana. The basin is bounded on the north and east by the Mississippi River from Donaldsonville to Venice, on the south by the Gulf of Mexico, and on the west by Bayou Lafourche. The basin contains approximately 1,565,000 acres. Portions of nine parishes are found in the basin: Assumption, Ascension, St. James, Lafourche, St. John the Baptist, St. Charles, Jefferson, Plaquemines, and Orleans. The basin is divided into nine subbasins: Fastlands, Des Allemands, Salvador, Central Marsh, Grande Cheniere, L'Ours, North Bay, Bay, and Empire.

EXISTING CONDITIONS AND PROBLEMS

The Barataria Basin is an irregularly shaped area bounded on each side by a distributary ridge formed by the present and a former channel of the Mississippi River. A chain of barrier islands separates the basin from the Gulf of Mexico. In the northern half of the basin, which is segregated by the Gulf Intracoastal Waterway (GIWW), several large lakes occupy the sump position approximately half-way between the ridges. The southern half of the basin consists of tidally influenced marshes connected to a large bay system behind the barrier islands. The basin contains 152,120 acres of swamp, 173,320 acres of fresh marsh, 59,490 acres of intermediate marsh, 102,720 acres of brackish marsh, and 133,600 acres of saline marsh.

Within the Barataria Basin, wetland loss rates averaged nearly 5,700 acres per year between 1974 and 1990. During this period, the highest rates of loss occurred in the Grande Cheniere and Bay Regions. Wetland loss within the Barataria Basin is attributed to the combination of natural erosional processes of sea-level rise, subsidence, winds, tides, currents, and herbivory, and the human activities of channelization, levee construction, and development.

Freshwater and sediment input to the Barataria Basin was virtually eliminated by the erection of flood protection levees along the Mississippi River and the closure of Bayou Lafourche at Donaldsonville; therefore, the only significant source of fresh water for the basin is rainfall. Only a small amount of riverine input, designed to mimic a natural crevasse, is introduced into the basin's wetlands through the recently completed siphons at Naomi and West Pointe a la Hache. This lack of fresh water, and the loss of the accompanying sediments, nutrients, and hydrologic influence, forms the most critical problem of the Barataria Basin.

The second critical problem is the erosion of the barrier island chain. As individual islands are reshaped or breached, or succumb to the forces of the Gulf of Mexico, passes widen and deepen with the result that a greater volume of water is exchanged during each tide.

Four islands--West Grand Terre, East Grand Terre, Grand Pierre, and Cheniere Ronquille--had a combined area of just over 1,800 acres in 1990. By 2015, the islands will be reduced to a total of approximately 1,000 acres. East Grand Terre and Grand Pierre are predicted to disappear by 2045, and the remaining islands will consist of only 400 acres.

The result of the problems described above is an increase in tidal amplitude in the marshes in the central basin. This cumulative effect is exemplified by increased salinities in the lower half of the basin, increased land loss rates, and change in vegetation.

Site-specific problems of shoreline erosion, especially in areas with organic soils, poor drainage, salinity stress, and herbivory, are apparent throughout the basin. Solving these problems is important, but less urgent than solving the critical problems described above.

FUTURE WITHOUT-PROJECT CONDITIONS

Projected wetland loss over the next 20 and 50 years within Barataria Basin, by the subbasins, is shown in Table BA-1. Without actions to correct the problems mentioned above, another fifth of the basin's wetlands would be lost to open water by 2045. Roughly 65 percent of the projected wetland loss, or more than 100,000 acres, would occur in the North Bay, L'Ours, Bay, and Empire subbasins. As wetlands bordering Barataria Bay erode and as its connection with the gulf becomes substantially larger because of the disappearance of the barrier islands, the bay would enlarge, absorbing adjacent waterbodies. With no action, moderate wetland losses (about 20 percent) would occur in the middle of the basin (Central Marsh and Salvador subbasins), and relatively minor losses (about 8 percent) would occur in the upper basin (Des Allemands) over the next 50 years. The disappearance of wetlands throughout Barataria Basin would mean the loss of critical breeding, nesting, nursery, foraging, or overwintering habitat for economically important fish, shellfish, furbearers, migratory waterfowl, alligator, and several endangered species. Loss of wetland habitat and the accompanying trend toward higher salinities would lead to lower biodiversity and productivity.

Table BA-1
Projected Marsh Loss in the Barataria Basin.

Subbasin	Projected Loss in 20 years (Acres)	(Percent)	Projected Loss in 50 years (Acres)	(Percent)
Des Allemands	1,010	3	2,520	7
Salvador	4,610	4	11,540	11
Central	7,380	10	18,440	26
L'Ours	6,240	21	15,590	53
North Bay	10,160	12	25,390	31
Grand Chenier	6,510	44	14,660	100
Empire	17,460	58	30,110	100
Bay	22,790	28	56,980	70
Total	76,160	17	175,230	38

Projected losses are based on Geographic Information System data compiled by the U.S. Army Corps of Engineers. Loss rates also are based on a projection of the 1974 to 1990 rates.

The disappearance of wetlands and the wildlife and fishery resources dependent on them would affect the economic structure of numerous communities in the lower and middle basin areas as supporting businesses (marinas, boat manufacturers, seafood processors, retailers, etc.) decline. In addition, the storm

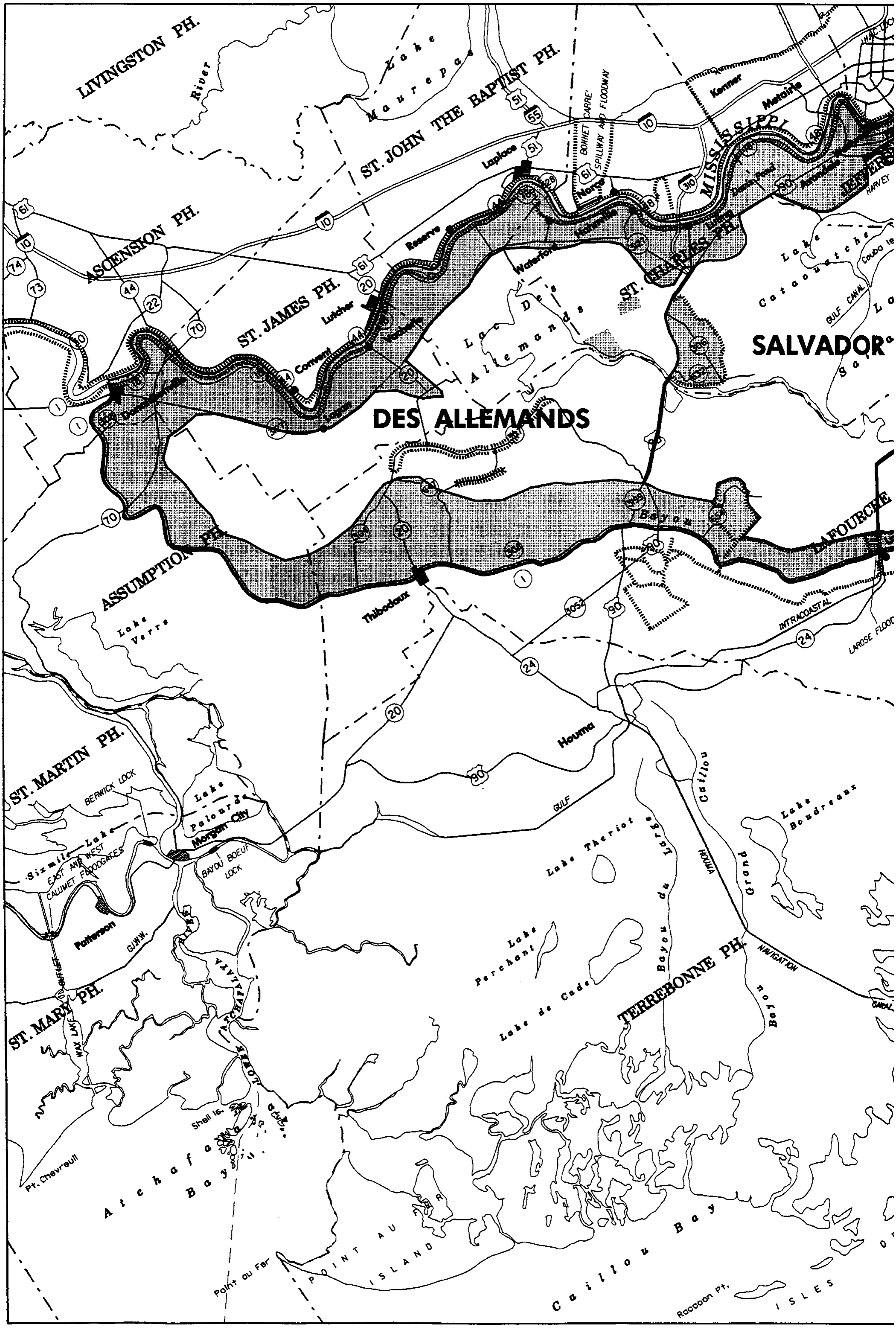
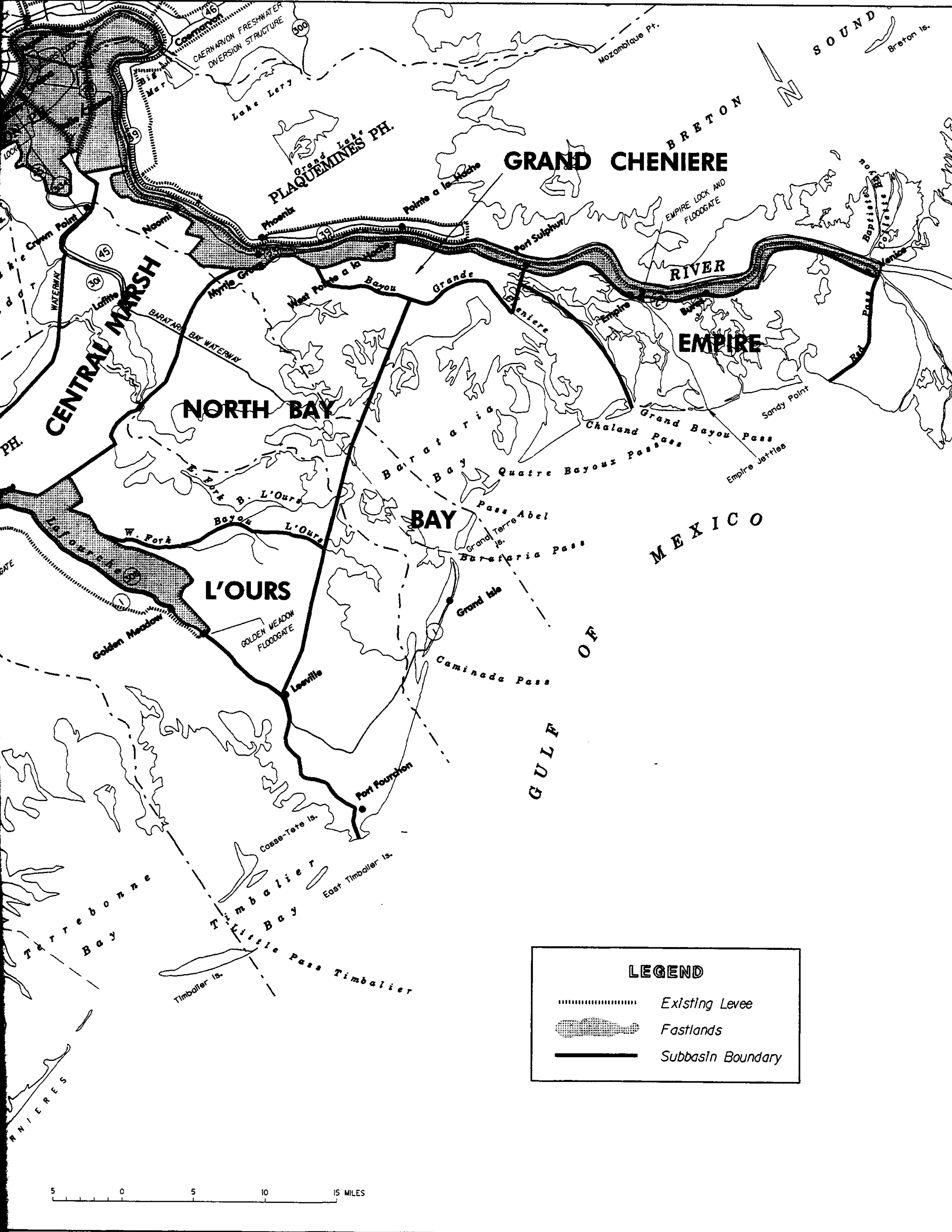


Figure BA-1. Barataria Basin, Basin and Subbasin Boundaries.


GRAND CHENIERE
CENTRAL MARSH
NORTH BAY
BAY
L'OURS
EMPIRE
PLAQUEMINES PH.
CAERNARVON FRESHWATER DIVERSION STRUCTURE
Caernarvon
Lake Lery
Grand Lake
Big Mar
Mozambique Pt.
BRETON SOUND
Breton Is.
RIVER
Phoenix
Pointe a la Hache
Port Sulphur
EMPIRE LOCK AND FLOODGATE
Empire
Buras
Venice
Naomi
Myrtle Grove
West Pointe a la Hache
Bayou Grande
Cheniere
Lafitte
BARATARIA BAY WATERWAY
Barataria Bay
E. Fork B. L'Ours
W. Fork Bayou L'Ours
Lafourche
Golden Meadow
GOLDEN MEADOW FLOODGATE
Leeville
Port Fourchon
Grand Isle
Grand Terre Is.
Barataria Pass
Pass Abel
Quatre Bayoux Pass
Chaland Pass
Grand Bayou Pass
Sandy Point
Empire Jetties
Red Pass
Caminada Pass
GULF OF MEXICO
Cosse-Tete Is.
East Timbalier Is.
Timbalier Bay
Little Pass Timbalier
Timbalier Is.
Terrebonne Bay
LEGEND
Existing Levee
Fastlands
Subbasin Boundary
5 0 5 10 15 MILES

buffering benefits the barrier islands and lower basin wetlands provide these communities, would be reduced as wetland loss continues. This loss would force relocations or require the expansion of flood protection and drainage facilities for many basin communities, and maintenance costs would increase for existing facilities.

BASIN PLAN

The selected plan focuses on the key strategies of freshwater and sediment diversion, combined with outfall and hydrologic management to reduce tidal exchange. Two additional mutually exclusive strategies were considered to offset the increase in tidal amplitude: sediment replenishment of the existing barrier islands or construction of a set of interior barrier islands. The former has been included in the selected plan because it supports the natural system, and would maintain the marshes located between the proposed interior barrier and the existing barrier islands. Supporting strategies of marsh creation with dredged material and shoreline protection address localized areas of marsh loss. A detailed description of the plan formulation process is contained in Appendix D. Strategies of the selected basin plan are shown in Figure BA-2, and projects are listed in Table BA-2.

Restoration of riverine input into the basin via freshwater diversion from the Mississippi River through the authorized Davis Pond Freshwater Diversion project helps in solving the first critical problem of freshwater and sediment deprivation. This diversion is vital to the health of the upper part of the basin because fresh water and nutrients slow the loss of marsh and swamp. Additional diversions from the Mississippi River on the eastern side of the basin, and the reconnection of Bayou Lafourche and subsequent construction of small diversions on the western side, are long-term solutions to the first critical problem. However, a study of the sediment and water budget for the Mississippi River must be completed first.

Sediment replenishment and marsh creation on the bay side of the barrier islands will strengthen the buffering capabilities of the barrier chain. Longshore sediment drift studies will determine the efficacy of installing segmented breakwaters or jetties to trap sediments that are, at present, transported from the system. Studies are planned on methods to reduce the cost of construction and to better evaluate the benefits of barrier islands to interior marshes. However, sediment replenishment of critical barrier islands (located adjacent to major tidal passes) needs to be implemented in the short term.

Hydrologic management to decrease tidal flux through the critical area of the central marshes and L'Ours Ridge will preserve the marshes in this area and slow the inland progression of the marine influence. Methods to reduce marsh loss rates and shoreline erosion, while providing access to the estuarine-dependent marine organisms so important to the economy of this basin, should be developed and implemented as soon as possible.

Several site-specific areas of loss are scattered throughout the basin. Small-scale measures to preserve, restore, and enhance these marshes and swamps are important. Implementation of these projects will maintain these areas until the critical long-term projects are in place.

The selected plan uses a mix of measures to achieve short-term basin objectives. Hydrologic restoration (77 percent), outfall management (8 percent), and barrier island nourishment (6 percent) account for the majority of the acres preserved, created, or enhanced. Marsh creation with dredged material, shoreline protection, and marsh management complete the short-term restoration process. The long-term portion of the plan, necessary to achieve no net loss of wetlands, consists of additional freshwater and sediment diversions, and continued barrier island replenishment.

COSTS AND BENEFITS

Table BA-3 summarizes the wetland benefits and costs over the next 20 years for the short-term projects proposed in the Barataria Basin selected plan and for the Davis Pond Freshwater Diversion project. The Davis Pond Freshwater Diversion project will preserve 83,000 acres over 50 years at a cost of $68.8 million. However, to be comparable to the CWPPRA projects, benefits and costs for 20 years (32,220 acres and $26,696,000) were used.

In the Des Allemands Subbasin, no direct benefits are achieved because there are no selected plan short-term projects and Davis Pond Freshwater Diversion is located south of the subbasin. However, this area will indirectly benefit from plan implementation because significant portions of the seaward subbasins will be restored or maintained, thus providing a continued barrier to the inland progression of marine influence.

Implementation of the short-term projects in the Salvador Subbasin would prevent 28 percent of the predicted loss. In the Central Marsh Subbasin, implementation of already funded projects BA-2, PBA-35, and XBA-65A, plus the deferred project BA-6, would result in predicted marsh enhancement of 177 percent. When estimated Davis Pond Freshwater Diversion benefits are added to the Salvador and Central Marsh Subbasins, marsh enhancement increases to 337 and 281 percent, respectively. The CWPPRA costs are $39,889,000.

Plan implementation would prevent 12, 13 and 55 percent of the predicted loss in the L'Ours, North Bay and Grande Cheniere Subbasins. The projects located in this mid-basin area are designed to protect wetlands against tidal and erosive forces. Adding the Davis Pond Freshwater Diversion benefits to the North Bay Subbasin prevents 75 percent of the predicted loss. The CWPPRA costs for this area are $8,344,000.

The lower basin marshes and barrier islands which make up the Empire and Bay Subbasins are projected to undergo the greatest losses. Plan implementation would only reduce the losses in these areas by 5 and 8 percent, respectively. The Davis Pond Freshwater Diversion project would prevent the loss of an additional 17 percent of wetlands in the Bay Subbasin. The CWPPRA costs are $66,425,000.

For a total expenditure of $114,658,000 on the selected plan projects, 23,050 acres of wetlands will be created, restored or protected. Over the next 20 years, 30 percent of predicted loss in the entire Barataria Basin would be prevented. Benefits from the Davis Pond Freshwater Diversion project increases the predicted amount of marsh saved to 73 percent, including gains in two subbasins.

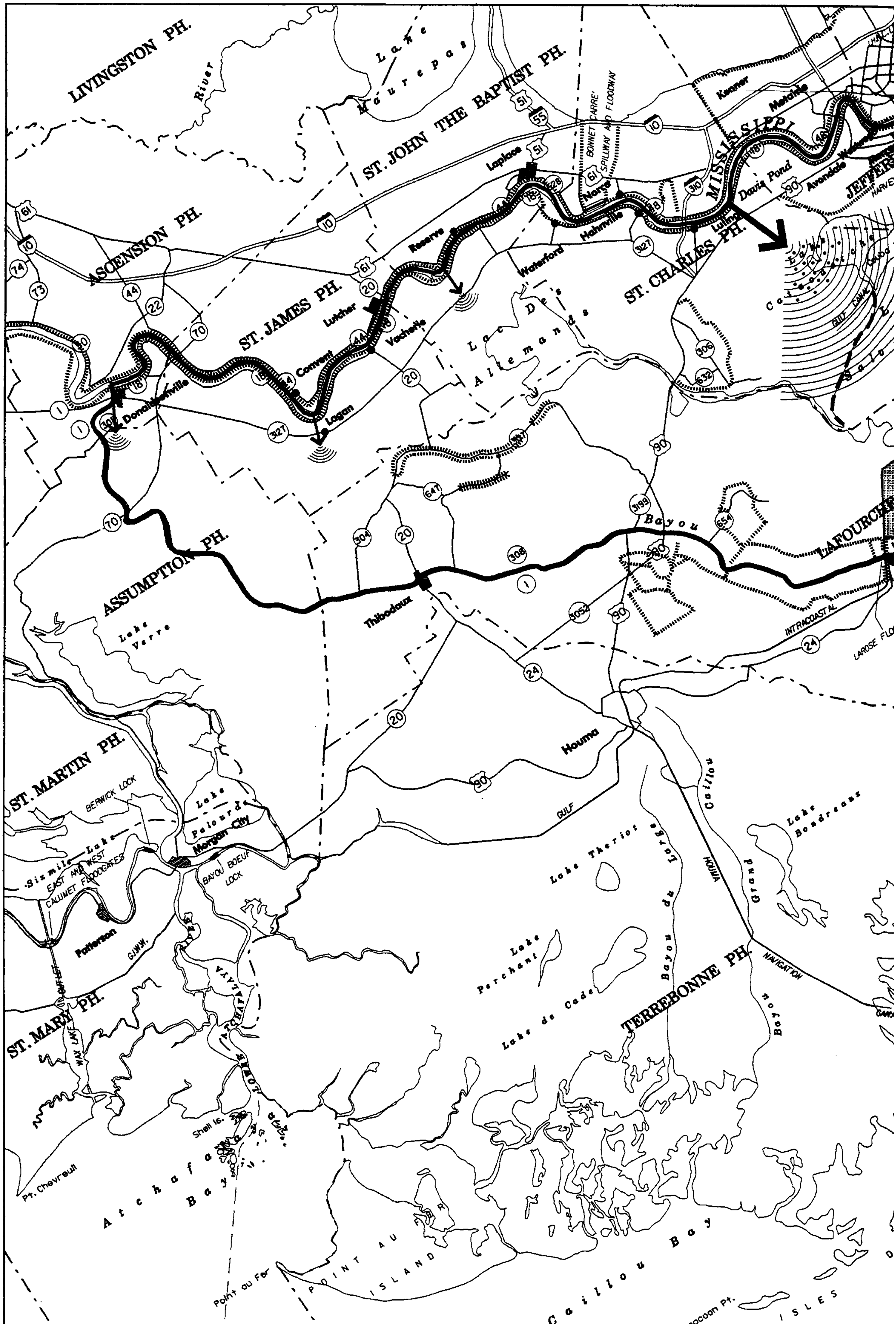
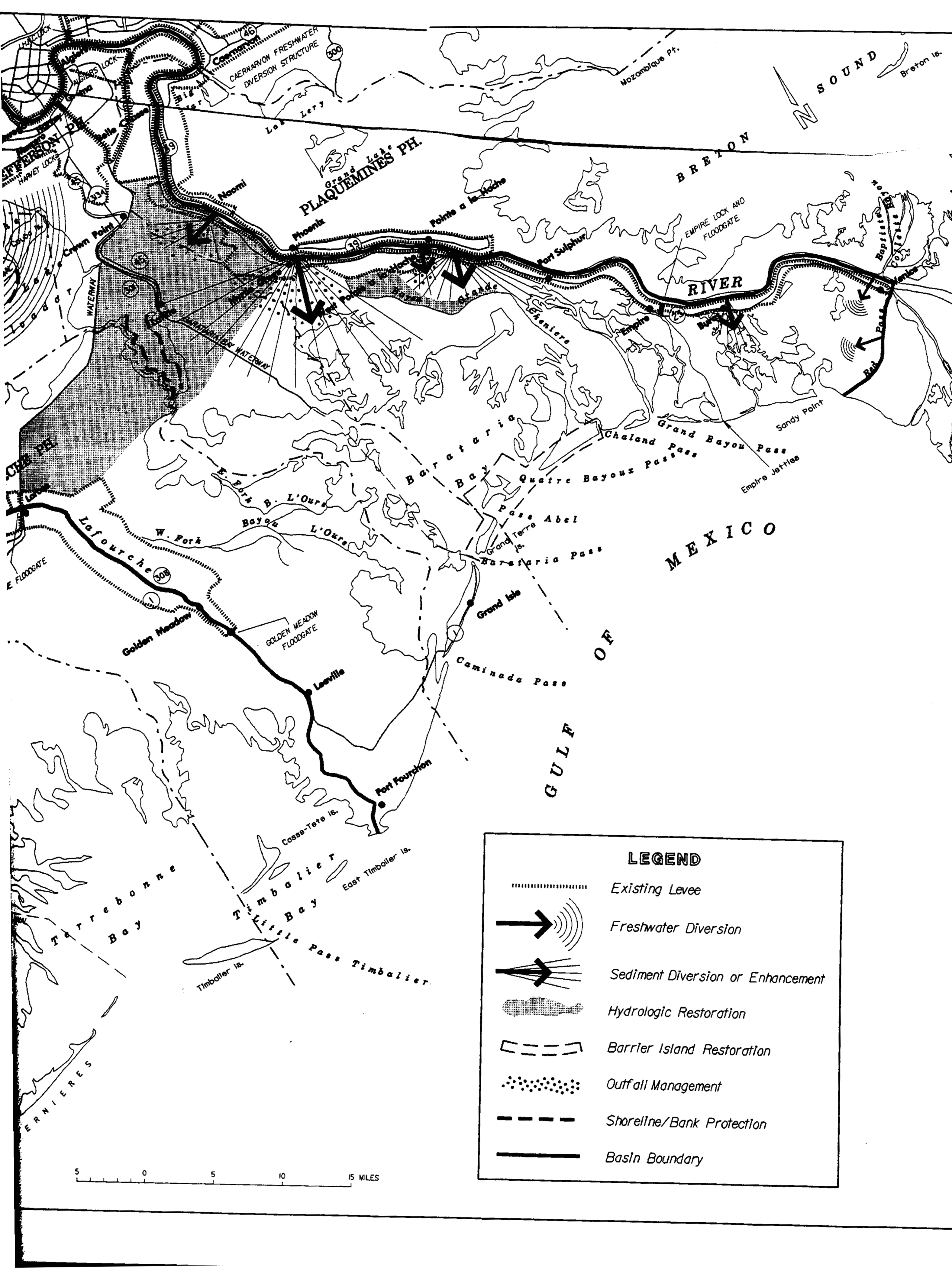


Figure BA-2. Barataria Basin, Strategy Map.



CAERNARVON FRESHWATER DIVERSION STRUCTURE
PLAQUEMINES PH.
BRETON SOUND
Breton Is.
Mozambique Pt.
Naomi
Phoenix
Pointe a la Hache
Port Sulphur
EMPIRE LOCK AND FLOODGATE
Empire
RIVER
Venice
Baptiste Collette
Red Pass
Sandy Point
Grand Bayou Pass
Chaland Pass
Empire Jetties
Quatre Bayoux Pass
Barataria Bay
Pass Abel
Grand Terre Is.
Barataria Pass
GULF OF MEXICO
Grand Isle
Caminada Pass
E. Fork B. L'Ours
W. Fork Bayou L'Ours
Lafourche
Golden Meadow
GOLDEN MEADOW FLOODGATE
Leeville
Port Fourchon
Casse-Tete Is.
East Timbalier Is.
Timbalier Bay
Terrebonne Bay
Little Pass Timbalier
Timbalier Is.
HARVEY LOCKS
ALGIERS LOCK
Belle Chasse
Lake Cataouatche
Crown Point
Lafitte
Grand Lake
LEGEND
Existing Levee
Freshwater Diversion
Sediment Diversion or Enhancement
Hydrologic Restoration
Barrier Island Restoration
Outfall Management
Shoreline/Bank Protection
Basin Boundary
5 0 5 10 15 MILES

Table BA-2
Summary of the Barataria Basin Projects

Project No.	Project Name	Project Type	Priority List Project	Acres Created, Restored, or Protected	Net Benefited Acres	Estimated Cost ($)	Cost per Benefited Acre ($/Ac)	Comments
Critical Projects, Short-Term								
BA-1a	Davis Pond Freshwater Diversion	FD	*	32,220	32,220	26,696,000	800	Authorized USACE project (20 yr cost & benefits)
BA-3c	Naomi (La Reussite) Diversion Outfall Management	OM		840	1,640	1,428,000	900 ✓	
BA-4c	West Pointe a la Hache Diversion Outfall Management	OM	PPL3	1,090	2,450	677,000	300 ✓	
XBA-1a	West Grand Terre Sediment Replenishment	BI		440	450	7,934,000	17,600	
XBA-1b	East Grand Terre Sediment Replenishment	BI		380	400	7,441,000	18,600	
XBA-1c	Grand Pierre Island Sediment Replenishment	BI		80	180	3,300,000	18,300	See XBA-53
XBA-1d	Cheniere Ronquille Sediment Replenishment	BI		180	190	2,368,000	12,500	
XBA-54	Bayou Grande Cheniere Subbasin Hydrological Restoration	HR		2,480	7,750	1,344,000	200 ✓	
Subtotal: Critical Projects, Short-Term				5,490	13,060	24,492,000		Costs & benefits do not include Davis Pond
Critical Projects, Long-Term								
BA-1b	Davis Pond Diversion Outfall Management, Phase 1	OM						Implement after diversion construction
BA-3b	Naomi (La Reussite) Diversion Siphon Enlargement	FD						On hold
BA-4b	West Pointe a la Hache Diversion Siphon Enlargement	FD						On hold
BA-10	Davis Pond Diversion Outfall Management, Phase II	OM		580	1,610	6,525,000	4,100	
BA-11	Tiger/Red Pass Diversion and Outfall Management	OM		800	1,360	5,321,000	3,900	
BA-12	Grand/Spanish Pass Diversion	FD						
BA-13	Hero Canal Freshwater Diversion	FD		350	350	9,510,000	27,200	
BA-17a	City Price Freshwater Diversion (Happy Jack)	FD		50	150	1,806,000	12,000	Probably will be two diversions
BA-17b	City Price Freshwater Diversion (Homeplace)	FD		1,130	1,270	3,094,000	2,400	Probably will be two diversions
PBA-18	Sediment Diversion at Hero Canal	SD						Supports BA-13
PBA-20	Freshwater Diversion to Bayou Lafourche	FD			300,000	1,500,000,000	5,000	
PBA-21	Route Diversion Outfalls to Area N. of The Pen	OM						
PBA-32	Hydrologic Restoration of Marshes Southeast of Leeville	HR						
PBA-36	Lagan Diversion	FD						
PBA-37	Bayou Des Allemands Diversion	FD						
PBA-44	Sediment Diversion at Buras	SD						
PBA-48a	Myrtle Grove Sediment Diversion Facility	SD						
PBA-48b	Myrtle Grove Outfall Management, Areas 1 thru 5	OM						
XBA-63	Central Basin Tidal Drag Enhancement	HR		24,130	74,470	16,782,000	200 ✓	
XBA-67b	Siphoned Sediment Enrichment of Davis Pond Diversion	SD						
XBA-67c	Siphoned Sediment Enrichment of Naomi Diversion	SD						
XBA-67d	Siphoned Sediment Enrichment of W Pointe a la Hache Diversion	SD						

Table BA-2

Summary of the Barataria Basin Projects (Continued)

Project No.	Project Name	Project Type	Priority List Project	Acres Created, Restored, or Protected	Net Benefited Acres	Estimated Cost ($)	Cost per Benefited Acre ($/Ac)	Comments
Supporting Projects, Short-Term								
BA-2	GIWW to Clovelly Hydrologic Restoration	HR	PPL 1	8,630	16,980	6,285,000	400	Permitted, active
BA-6	U.S. Highway 90 to GIWW Hydrologic Restoration	HR		1,620	6,360	4,583,000	700	Deferred from PPL 1
BA-7	Couba Island Shoreline Protection	SP		250	300	752,000	2,500	
BA-8	Lake Cataouatche Shoreline Protection	SP		20	70	376,000	5,400	
BA-9	Salvador WMA Gulf Canal Shoreline Protection	SP		40	60	844,000	12,060	
BA-14	Little Lake Marsh Management	MM		270	670	1,112,000	1,700	
BA-16	Bayou Segnette Wetland Protection	HR		90	90	1,106,000	12,300	
BA-18	Fourchon Wetland Restoration	HM	PPL 1	160	380	187,000	500	Partially completed by port
BA-19	Barataria Bay Waterway Marsh Building	MC	PPL 1	450	470	1,125,000	2,400	
PBA-11	Shoreline Protection on Grand Bayou with Tire Breakwater	SP		10	10	576,000	57,600	
PBA-12	BBW Shoreline Protection Below Bayou Rigolettes	SP		140	190	1,762,000	9,300	
PBA-16	The Pen Shoreline Protection	SP		60	110	2,324,000	21,100	
PBA-34	Hydrologic Restoration of Bayou L'Ours Ridge	HR		780	2,780	2,327,000	800	
PBA-35	Jonathan Davis Wetland Restoration	HR	PPL 2	510	1,580	2,796,000	1,800	
PBA-38	Shell Island Sediment Replenishment	BI		** 510	640	22,060,000	34,500	Included in XBA-1e, river sediments, not in total
PBA-39	Sandy Point Barrier Island Sediment Replenishment	BI		600	620	17,264,000	27,800	River sediments
PBA-58	Little Lake Oil and Gas Field Canal Closures	HR		580	1,130	1,193,000	1,100	
PBA-60	Barataria Drainage Pump Outfall Management	OM		20	90	97,000	1,100	Part of PBA-35 and XBA-63
PBA-61	Southeast Lake Salvador Hydrologic Restoration	HR		690	1,660	10,690,000	6,400	
PBA-66	Bara Bar Channel Maintenance Disposal on West Grand Terre	BI		160	160	3,027,000	18,900	
XBA-1e	Shell Island to Empire Jetties Sediment Replenishment	BI		510	530	15,296,000	28,900	Overlaps PBA-38, bay sediments
XBA-1f	Bay Champagne Gulf Shore Sediment Replenishment	SP		290	290	1,798,000	6,200	
XBA-51	Marsh Creation in Canals Between Passes La Mer and Chaland	MC		230	260	7,800,000	30,000	
XBA-65a	Restore Perot Peninsula Marsh, Spray Dredge	MC	PPL 3	1,070	1,480	1,658,000	1,100	
XBA-70	Dupre Cut & Bayou Dupont Shoreline Protection	SP		200	710	3,930,000	5,500	
Subtotal: Supporting Projects, Short-Term				17,380	36,980	88,908,000		

Table BA-2

Summary of the Barataria Basin Projects (Continued)

Project No.	Project Name	Project Type	Priority List Project	Acres Created, Restored, or Protected	Net Benefited Acres	Estimated Cost ($)	Cost per Benefited Acre ($/Ac)	Comments
Supporting Projects, Long-Term								
PBA-42	U.S. Highway 90 Drainage Improvements	HR						
PBA-45	Hydrologic Management of Grand Bayou	HR						
XBA-1a1	West Grand Terre Detached Breakwaters	SP			90	5,121,000	56,900	
XBA-1b1	East Grand Terre Detached Breakwaters	SP			600	4,481,000	7,500	
XBA-1c1	Grand Pierre Island Detached Breakwaters	SP			110	1,440,000	13,100	
XBA-1d1	Cheniere Ronquille Detached Breakwaters	SP			80	2,881,000	36,000	
XBA-1e1	Shell Island to Sandy Point Detached Breakwaters	SP			110	18,252,000	165,900	
XBA-49	Hydrologic Restoration of Marshes South of Clovelly	HR						
XBA-52	Grand Isle Jetty or Detached Breakwaters	BI						
XBA-53	Grand Pierre Jetty	BI		10	30	576,000	19,200	See XBA-1c
XBA-55	Jetty Modifications at Empire Waterway	SP		80	130	4,315,000	33,200	
XBA-56	Jetty Modifications at Belle Pass	SP		10	30	4,315,000	143,800	
XBA-62a	Northern Perot Peninsula Shoreline Protection	SP		480	480	9,367,000	19,500	
XBA-62b	Southern Perot Peninsula Shoreline Protection	SP		270	270	11,439,000	42,400	
Demonstration Projects								
BA-15	Lake Salvador Shoreline Protection	SP	PPL 3	180	1,190	1,258,000	1,100	
PBA-50	Oyster Reef Demonstration in Rambo Bay	SP		5	5	374,000	74,800	
XBA-50	Nairn Wetland Creation	MC		220	280	13,629,000	48,700	
XBA-67a	Dredged Sediment Enrichment of Davis Pond Diversion	SD						
Total Barataria Basin ***				23,050	51,230	114,658,000		
Total Barataria Basin with Davis Pond Freshwater Diversion ***				55,270	83,450	141,354,000		

BI Barrier Island Restoration
FD Freshwater Divesion
HM Hydrologic Managment of Impoundments
HR Hydrologic Restoration
MC Marsh Creation
MM Marsh Management
OM Outfall Management
SD Sediment Diversion
SP Shoreline or Bank Protection

* Cost and benefits for BA-1a, Davis Pond Freshwater Diversion, reflect a 20 year project life.

** Project PBA-38 overlaps with project XBA-1e, however, different construction techniques are used. PBA-38 is not included in the totals.

*** Total cost and benefits for the basin plan include only those for Critical Short-Term Projects and Supporting Short-Term Projects (BA-15 Demonstration included).

Table BA-3.
Estimated Benefits and Costs of Barataria Basin Selected Plan Projects

	CWPPRA			Davis Pond		Total	
Subbasin	Net Acres Protected, Created, or Restored	Cost x 1000 ($)	Percent Loss Prevented	Net Acres Protected, Created, or Restored	Cost x 1000 ($)	Net Acres Protected, Created, or Restored	Percent Loss Prevented
Des Allemands	0	0	0	0		0	0
Salvador	1,270	15,026	28	14,280		15,550	337
Central Marshes	13,090	24,863	177	7,640		20,730	281
L'Ours	780	2,327	12	0		780	12
North Bay	1,300	3,430	13	6,310		7,610	75
Grande Cheniere	3,580	2,587	55	0		3,580	55
Empire	1,110	32,560	5	0		1,110	7
Bay	1,920	33,865	8	3,990		5,910	23
Total	23,050	114,658	30	32,220	26,696	55,270	73

TERREBONNE BASIN: SUMMARY OF BASIN PLAN

STUDY AREA

The Terrebonne Basin is bordered by Bayou Lafourche on the east, the Atchafalaya Basin floodway on the west, and the Gulf of Mexico on the south. The Terrebonne Basin is divided into four subbasins--Timbalier, Penchant, Verret, and Fields, as shown in Figure TE-1. The basin includes all of Terrebonne Parish, and parts of Lafourche, Assumption, St. Martin, St. Mary, Iberville, and Ascension parishes.

EXISTING CONDITIONS AND PROBLEMS

The Terrebonne Basin is an abandoned delta complex, characterized by a thick section of unconsolidated sediments that are undergoing dewatering and compaction, contributing to high subsidence, and a network of old distributary ridges extending southward from Houma. The southern end of the basin is defined by a series of narrow, low-lying barrier islands (the Isles Dernieres and Timbalier chains), separated from the mainland marshes by a series of wide, shallow lakes and bays (e.g., Lake Pelto, Terrebonne Bay, Timbalier Bay).

The Verret and Penchant Subbasins receive fresh water from the Atchafalaya River and Bay, while the Fields Subbasin gets fresh water primarily from rainfall. The Timbalier Subbasin gets fresh water from rainfall and from Atchafalaya River inflow to the GIWW via the Houma Navigation Canal (HNC) and Grand Bayou Canal; it has the most limited fresh water resources in the entire Deltaic Plain.

The Terrebonne Basin supports about 155,000 acres of swamp and almost 574,000 acres of marsh, grading from fresh marsh inland to brackish and saline marsh near the bays and the gulf. The Verret Subbasin contains most of the cypress swamp (118,000 acres) in the Terrebonne Basin. The northern Penchant Subbasin supports extensive fresh marsh (about 166,000 acres), including a predominance of flotant marsh, with 98,000 acres of intermediate and brackish marsh in the Lost Lake-Jug Lake area and about 17,000 acres of saline marsh to the south. Fresh marsh is also dominant in the Fields Subbasin (approximately 23,000 acres). The Timbalier Subbasin grades from fresh marsh in the northern part of the subbasin to saline marsh near the bays, but is dominated by brackish (71,000 acres) and saline (153,000 acres) marsh types.

Of the four subbasins, only the Fields Subbasin experiences problems which are local and relatively minor. The Timbalier Subbasin experiences substantial subsidence and is essentially isolated from major freshwater and sediment inputs. Marsh loss rates are high due to the resulting sediment deficit, saltwater intrusion along the Houma Navigation Canal and other canals, historic oil and gas activity, and natural deterioration of barrier islands, which contributes to the inland invasion of marine tidal processes (including erosion, scour, and saltwater intrusion). The subbasin is rapidly converting to an open estuary.

In recent years, the Penchant and Verret Subbasins have experienced significant freshwater impacts from the Atchafalaya River. Historic wetlands loss resulting from subsidence, saltwater intrusion, and oil and gas activity appears to have moderated, but areas of cypress swamp (Verret) and flotant marsh (Penchant) are experiencing stress from high water levels in the Penchant Subbasin, the use of freshwater and sediment resources is not being maximized.

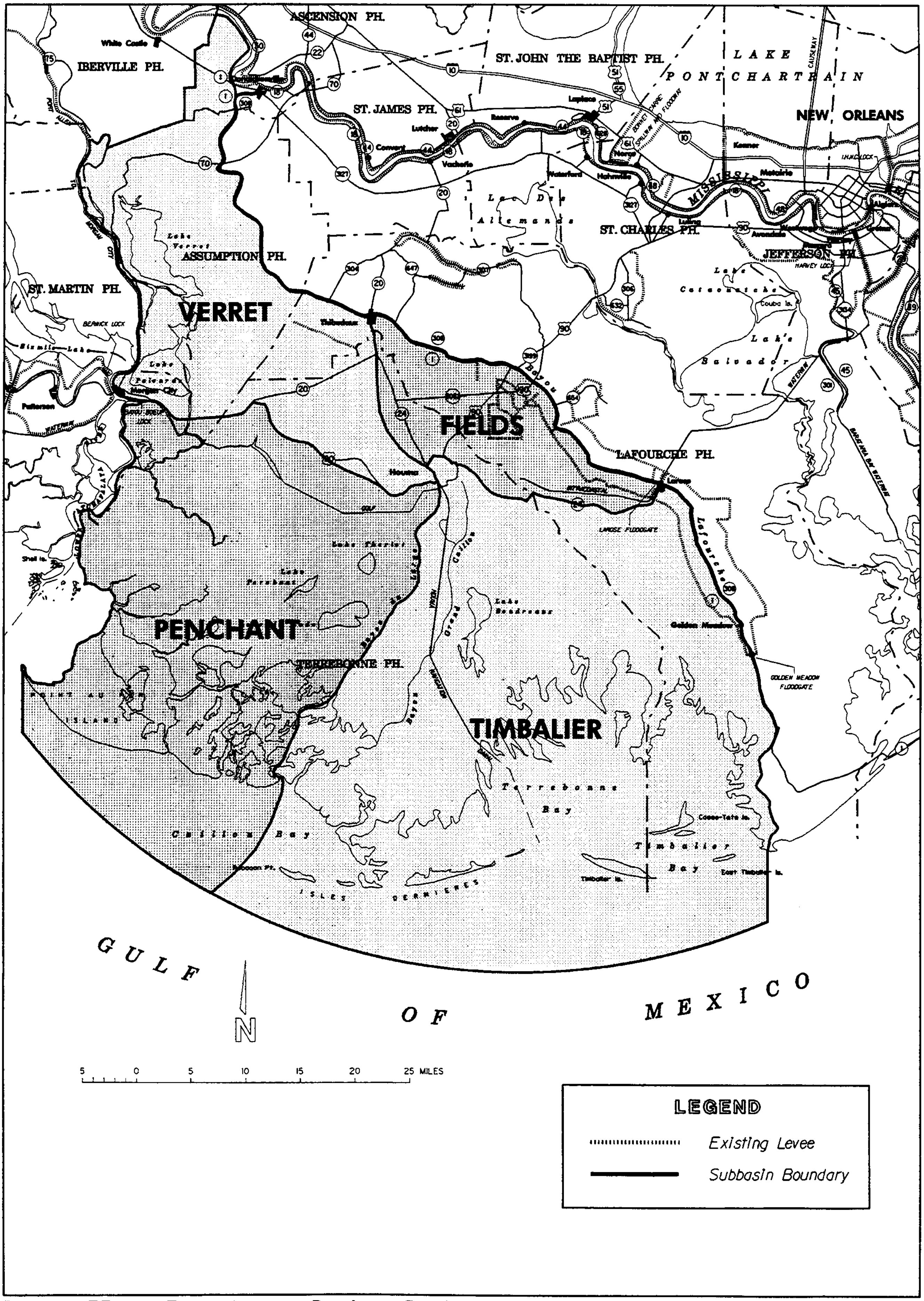


Figure TE-1. Terrebonne Basin, Basin and Subbasin Boundaries.

FUTURE WITHOUT-PROJECT CONDITIONS

Under a no action alternative, and assuming continued losses at the 1974-1990 rate, existing wetlands would be lost in the magnitude outlined in Table TE-1. The projected loss of more than half the Timbalier marshes in 50 years could be exceeded, because of the expectation that protection by existing barrier islands will cease within a few years to a few decades. The actual loss of Penchant marshes may be less than shown, because of benefits from Atchafalaya fresh water and sediment that have been increasing.

With no action, the Timbalier Subbasin will become 75 percent (or more) open water, with the shore reaching as far north as the suburbs of Houma. In the Penchant Subbasin, losses will likely be concentrated in the northern and central sectors, further exposing areas of open water and broken marsh. The inefficient use of Atchafalaya fresh water and sediments will continue to squander this significant resource. With continued high marsh losses, biological productivity and diversity will decrease. With loss of critical habitat for commercially and recreationally important fish, shellfish, and furbearers, as well as for endangered species, fish and wildlife dependent economic activities will decline. Flooding problems will increasingly impact economic activities throughout the Terrebonne Basin, leading to grave consequences for the oil and gas industry and for other human infrastructure.

Table TE-1.
Projected Marsh Loss

	Projected Loss in 20 years		Projected Loss in 50 years	
Subbasin	(Acres)	(Percent)	(Acres)	(Percent)
Timbalier	60,100	22	150,250	56
Penchant	24,900	8	62,250	20
Verret	Not Available		Not Available	
Fields	2,800	11	7,000	29
Total	87,800	14	219,500	36

BASIN PLAN

In the Timbalier Subbasin, protection and restoration of the barrier islands (Isles Dernieres and Timbalier Islands) requires immediate and extensive action, because these landforms provide protection for mainland marshes, and destruction of many of the islands is imminent. Interior marshes will also be protected through a hydrologic restoration zone which will be developed in the vicinity of the independently proposed Terrebonne Parish Comprehensive Hurricane Protection system. In this zone, fresh water and sediment will be used along with marsh protection and passive hydrologic restoration structures to enhance and restore overland and sinuous channel flow. A related action in the Timbalier Subbasin is a proposed barrier to saltwater intrusion in the Houma Navigation Canal.

In the Penchant Subbasin, Atchafalaya River fresh water, sediment, and nutrients will be better utilized through hydrologic restoration to protect marshes and reduce loss rates. To the extent possible, actions will restore historic flow

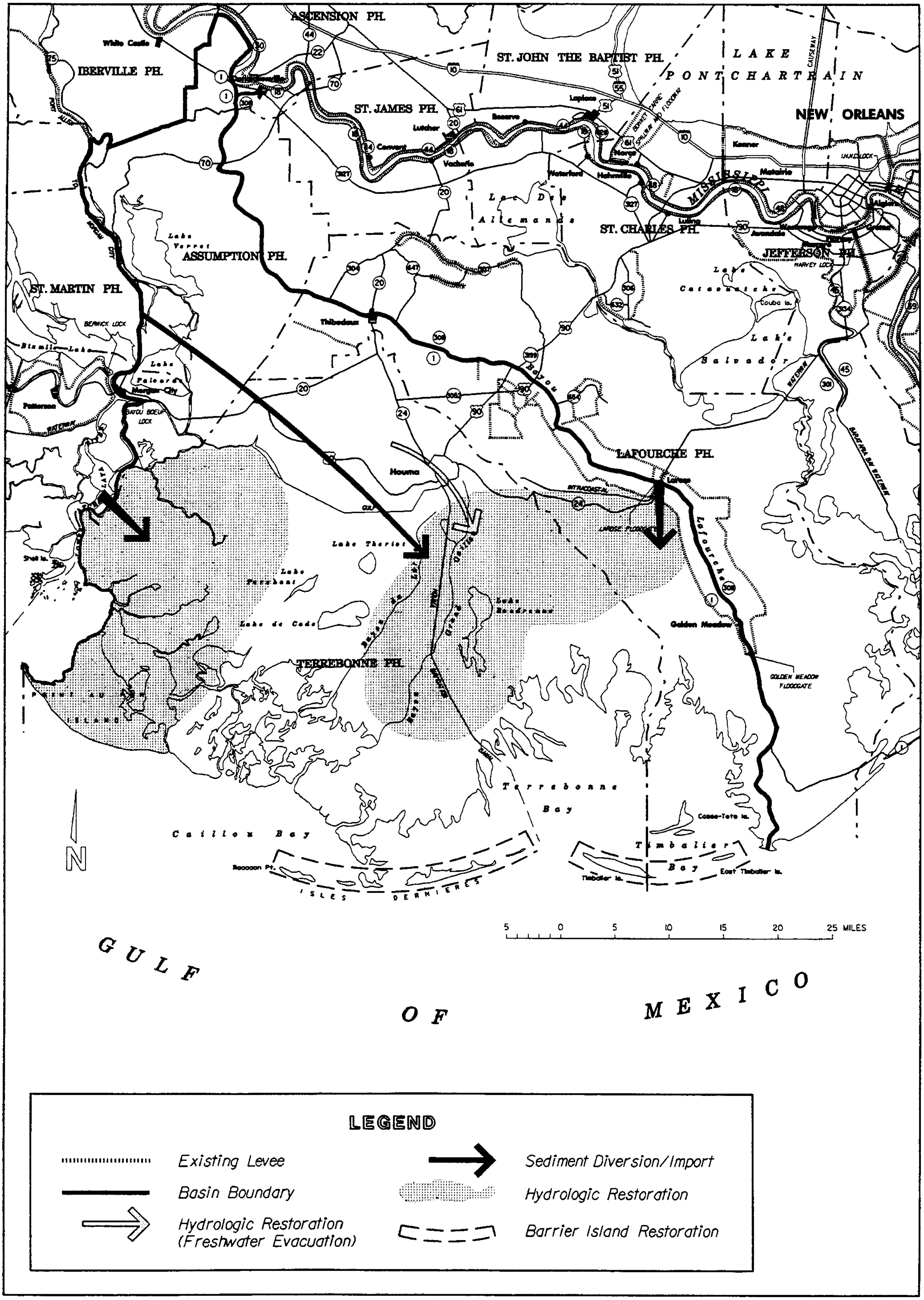


Figure TE-2. Terrebonne Basin, Strategy Map.

patterns and conveyance channels and improve the distribution of sediment-laden water. These actions in Timbalier and Penchant are considered critical for short-term implementation.

In the Penchant Subbasin, at least one major diversion would be built from the Atchafalaya River to bring fresh water and sediment into the subbasin. This is contingent upon adequate addressing of flood problems in the subbasin.

Because these actions will not cover all areas of concern, a supporting short-term strategy is to consider site-specific, small-scale projects in all subbasins where there is a critical need for wetlands protection or restoration, or a significant opportunity for wetlands creation. In the short term, demonstration and pilot projects must also be conducted to develop or test methods and approaches needed for implementing long-term strategies.

In the Timbalier Subbasin, long-term restoration depends on cost-effective importation of sediment by diversions or dedicated dredging, which makes demonstration of sediment extraction, transport, and placement technologies a priority. In addition, the possibility of diverting Mississippi River water and sediment into Bayou Lafourche as a conduit to the Timbalier Subbasin (as well as to the Barataria Basin) must be evaluated, and will be part of a larger study. The establishment of a Mississippi River sediment budget and distribution options, to be initiated by the Task Force immediately, will greatly aid in this effort.

In the Verret Subbasin, pumping to lower water levels is required to protect the swamp forests. This is a long-term strategy, because significant planning activities must precede its implementation. In addition, this action cannot occur until provisions are made for managing outfalls in ways which will not exacerbate flooding in the Penchant Subbasin.

In summary, the Terrebonne Basin Plan includes both a short-term and a long-term phase. The short-term phase focuses on immediate actions needed to protect vulnerable marshes from the proximal causes of loss in the Terrebonne Basin (saltwater intrusion, erosion, and other consequences of significant hydrologic modifications) using a combination of restoration techniques (especially hydrologic restoration and small-scale marsh creation) in the most critical areas or key locations, and barrier island protection. Successful implementation of short-term strategies will reduce rates of wetlands loss, and will provide the foundation for longer-term strategies. The long-term phase focuses on wetlands gains through sediment diversion and import, with the intent of encouraging development of a sustainable wetland ecosystem. Long-term strategies are critical to addressing the primary problem of sediment starvation associated with high subsidence and loss of fluvial inputs, and to achieving no net loss of wetlands in the basin.

Projects included in the Terrebonne Basin Plan are listed in Table TE-2. Table TE-2 indicates the classification (e.g., critical, supportive, demonstration), estimated benefits and costs, and status of these projects. The main elements of the Terrebonne Basin strategy are displayed in Figure TE-2.

A description of the Terrebonne Basin plan formulation process is contained in Appendix E. A complete listing of projects that have been proposed for the Terrebonne Basin can be found in Appendix E, Table 5, including those that were combined with other projects, or were not included in the plan for reasons stated in the appendix. More detailed information on each selected project also is provided in Appendix E.

Table TE-2
Summary of the Terrebonne Basin Projects

Project No.	Project Name	Project Type	Priority List Project	Acres Created, Restored, or Protected	Net Benefited Acres	Estimated Cost ($)	Cost per Benefited Acre ($/Ac)	Comments
Critical Projects, Short-Term								
Penchant Subbasin								
PTE-26	Upper Bayou Penchant	HR		[10,600]	[49,153]	50,000,000	1,000	
PTE-26b	Brady Canal Hydrologic Rest	HR	PPL 3	297	1,968	3,609,000	1,900	
PTE-23 /XTE-33	Lake Chapeau Hydr Rest/Sed	HR/MC	PPL 3	509	2,136	3,663,000	1,700	Includes XTE-33.
Subtotal				11,406	53,257	57,272,000		
Timbalier Subbasin, Barrier Island Restoration								
TE-11a	Is Derneriers New Cut Closures	BI		3	73	6,400,000	81,000	Complements PTE-15.
TE-20	Eastern Isles Dernieres	BI	PPL 1	9	79	5,714,000	72,300	
PTE-15	Restore Isles Dernieres	BI		1,050	1,864	33,188,000	17,800	Interacts w/ TE-20, XTE-41, XTE-45, XTE-40, XTE-67.
PTE-15b	Restore Is Dernieres Phase 2	BI						Interacts w/ TE-20,XTE-41, XTE-45, XTE-40, XTE-67.
PTE-15bi	Whiskey Island Restroration	BI	PPL 3	1,239	1,386	4,524,000	3,300	
PTE-15bii	Raccoon Island Restoration	BI						
XTE-41	Isles Dernieres Phase 1	BI	PPL 2	109	276	6,426,000	23,300	Cost & acreage included in PTE-15 for totals, active.
XTE-45	Timbalier Restoration	BI						
XTE-67	Creation/East Timbalier Island	BI	PPL 3	1,013	2,745	1,870,000	700	
Subtotal				3,423	6,423	58,122,000		
Timbalier Subbasin, Hydrologic Restoration								
TE-7a	Lake Boudreaux Watershed	MM/HR		63	796	2,665,000	3,300	2/
TE-7d	Lake Boudreaux Watershed	MM/HR		[1,492]	[5,888]	9,364,000	6,400	2/
TE-9	Bully Camp Marsh	MM		43	235	638,000	2,700	2/
TE-10/ XTE-49	Grand Bayou-GIWW Diversion Cutoff Canal Plug	FD/HR		[1,825]	[4,929]	5,515,000	1,100	2/, Interacts w/ XTE-47/48, XTE-49,51, See XTE-49.
TE-19	Lower B LaCache Wetlands	HR	PPL 1	86	292	1,388,000	4,800	2/, Active.
TE-21	Falgout Canal South	MC		104	118	5,792,000	49,000	3/, Interacts w/ XTE-43, XTE-55.
PTE-3	HNC Bank Stabilization	SP		311	1,059	1,600,000	1,500	
PTE-19	Stromwater Runoff Management	HR						2/
PTE-25	Bayou Blue water Management	HR		1,089	2,431	[4,400,000]	1,800	2/, Interacts w/ TE-10/XTE-49, TE-9, XTE-47/48.
XTE-29	Wonder Lake Restoration	MM		613	1,196	[2,200,000]	1,800	
XTE-35	HNC Sill							
XTE-42	HNC Lock	HR		2,891	2,891	122,545,000	42,400	Interacts w/ XTE-35.
XTE-47/48	Grand B Blue/Bully Camp Rest	MM/HR		247	1,829	[3,300,000]	1,800	2/
XTE-55	South Falgout Hydrologic Rest	HR		472	1,948	2,128,000	1,100	2/
XTE-56	South Bay Pelton Hydrologic Rest	HR		26	328	833,000	2,500	2/
XTE-57	South Pt au Chien Hydr Rest	HR		610	1,285	805,000	600	2/
XTE-58	South Bully Camp Hydr Rest	HR		1,401	3,109	1,879,000	600	2/
XTE-59	South Fina LaTerre Hydr Rest	HR		18	387	499,000	1,300	2/
XTE-60	South Wonder Lake Hydr Rest	HR		1,635	3,088	2,060,000	700	2/
Subtotal				12,926	31,809	167,611,000		
Subtotal Critical Projects, Short-Term				27,760	91,490	283,005,000		

Table TE-2
Summary of the Terrebonne Basin Projects (continued)

Project No.	Project Name	Project Type	Priority List Project	Acres Created, Restored, or Protected	Net Benefited Acres	Estimated Cost ($)	Cost per Benefited Acre ($/Ac)	Comments
Critical Projects, Long-Term								
Penchant Subbasin, Sediment Diversion								
PTE-5	Atchafalaya River Diversion	SD		[6,000]	[6000]			Interacts w/ PTE-13, PTE-26.
Timbalier Subbasin, Sediment Import from the Mississippi or Atchafalaya Rivers								
XTE-52	Miss R/B Lafouche Diversion	FD		[14,000]	[14,000]	[1,500,000,000]	107,100	Interacts w/ PTE-17.
XTE-63	Sediment Distribution/30" Pipe	SD						
Timbalier Subbasin, Sediment Import Dedicated Dredging								
XTE-44	Large Creat/Line of Defense (LOD)	MC		[86,311]	[86,311]			
Verret Subbasin, Hydrologic Restoration								
XTE-32	B Boeuf Pump Station/Barrier	HR						Interacts w/ XTE-50/51.
XTE-50	Verret Drainage of B Lafouche	HR/FD						4/, Interacts w/ XTE-32, XTE-51.
XTE-51	Disch Channel Verret-Houma	HR						4/, Interacts w/ XTE-32, XTE-50.
Supporting Projects, Short-Term								
Timbalier Subbasin								
TE-5	Grand Bayou Wetland	MM		823	7,043	2,500,000	400 ✓	1/, TE-5a mostly constructed.
TE-6	Point au Chien Wetland	MM		589	1,696	3,800,000	2,200	1/
TE-8	Bayou Pelton Wetland	MM		137	795	1,720,000	2,200	1/
TE-12	Bird Island Restoration	MC		10	15	2,117,000	141,100	
TE-17	Falgout Canal Vegetative Planting	VP	PPL 1	49	53	161,000	3,000	
TE-18	Timbalier Island Planting	VP	PPL 1	178	497	390,000	800	
PTE-27	W Belle Pass Headland Rest	MC/SP	PPL 2	474	639	4,424,000	6,900	
XTE-40	Timbalier Sediment Trapping	ST		4	93	1,359,000	14,600	Interacts w/ XTE-45.
XTE-62	Creation at Wine Island Shoals	BI		5	13	[500,000]	38,500	
Subtotal				2,269	10,844	16,971,000		
Penchant Subbasin								
PTE-22/24	Pt au Fer Canal Closure	HR	PPL 2	375	804	978,000	1,200	
XTE-38(d-i)	GIWW Bank Restoration	SP		130	684	3,800,000	5,600	
XTE-64	Avoca Island Sediment Div	SD		413	1,030	922,000	900 ✓	
XTE-65	Spray Dredging W Locust Bayou	MC		[1,300]	[1,300]	3,318,000	2,600	
Subtotal				2,248	3,978	9,018,000		
Fields Subbasin								
TE-16	St. Louis Wetlands Rest	MC		31	82	500,000	6,100	
XTE-38(a-c)	GIWW Bank Restoration	SP		30	160	315,000	2,000	
Subtotal				61	242	815,000		
Subtotal Supporting Projects, Short-Term				4,550	14,900	26,804,000		

Table TE-2
Summary of the Terrebonne Basin Projects (continued)

Project No.	Project Name	Project Type	Priority List Project	Acres Created, Restored, or Protected	Net Benefited Acres	Estimated Cost ($)	Cost per Benefited Acre ($/Ac)	Comments
Supporting Projects, Long-Term								
Timbalier Subbasin								
PTE-1	Bayou Terrebonne Dredging	MC		[291]	[291]	1,500,000	5,200	
PTE-14	Creation W Bayou Lafouche	MC						Interacts w/ PTE-27, XTE-52.
PTE-17	Bayou Lafourche Dredging	MC						Interacts w/ PTE-2, PTE-27, XTE-52.
PTE-21	B Terrebonne/Lafouche Channel	HR						
XTE-28	Parish Line of Defense	MM						2/
Penchant Subbasin								
PTE-8	MC W Houma N GIWW	MC		[115]	[115]	6,000,000	52,200	
PTE-13	B Chene, Boeuf, & Black WL	MC						Interacts w/ PTE-5, PTE-26.
Verret Subbasin								
XTE-31	Sediment Diversion, Verret	SD						Interacts w/ XTE-32.
XTE-34	Savanne Basin Restoration	HR				375,000		
Fields Subbasin								
TE-15	GIWW Levee Planting	VP		[24]	[24]	194,000	8,000	Interacts w/ XTE-38c.
Demonstration Projects								
PTE-10	Pt au Fer Restoration	HR		6	75	78,000	1,000	
PTE-20	Bayou Lafouche Salinity Barrier	HR						Interacts w/ XTE-52.
XTE-39	Lake Barre Oyster Reef	SP			41	301,000	7,300	
XTE-43	Red Mud Coastal Rest Demo	MC	PPL 3	3	3	529,000	58,800	
XTE-53	Pt au Fer Rest w/ Spray Dredge	MC						
XTE-54a	Flotant Creation/Enhancement	ST					674,000	Abandoned canals.
XTE-54b	Flotant Creation/Enhancement	ST					813,000	Fencing levee breaks.
XTE-61	Sediment Cypress Swamp	SD						
XTE-66	Sediment Conveyance Demo	MC		[550]	[1,080]	1,228,000	1,100	
TOTAL	TERREBONNE BASIN			32,310	106,390	309,809,000		5/

BI Barrier Island Restoration
FD Freshwater Diversion
HR Hydrologic Restoration
MC Marsh Creation with Dredged Material
MM Marsh Management
SD Sediment Diversion
SP Shoreline Protection with Structures
ST Sediment/Nutrient Trapping
VP Vegetative Plantings
1/ The project is part of Alternative G, northern portion of the zone in the vicinity of the proposed hurricane protection system.
2/ The project is part of Alternative G, southern portion of the zone in the vicinity of the proposed hurricane protection system.
3/ Deferred from PPL1
4/ Projects also serve as diversion to Timbalier subbasin
5/ Total cost and benefits for the basin plan include only those for Critical Short-Term and Supporting Short-Term Projects.
[ ] Denotes acreage not reviewed by Wetlands Value Assessment Workgroup or cost estimate order of magnitude only.

COSTS AND BENEFITS

An expenditure of approximately $310,000,000 will directly create, protect, or restore more than 32,000 acres of wetlands in the Terrebonne Basin (Table TE-3), with additional wetlands enhancement increasing the benefit to more than 100,000 acres (see Table TE-2). In the Timbalier Subbasin, implementation of critical and supporting projects which compose the short-term phase of the selected plan will offset almost one third (31 percent) of the predicted marsh loss by direct protection, restoration, or marsh creation. Additional efforts will be needed to achieve a sustainable wetlands environment in the Timbalier Subbasin, making the long-term phase of the plan--sediment import projects--and associated demonstrations necessary.

Table TE-3
Estimated Benefits and Costs of the Selected Plan 1/2/

	Acres Created, Protected, or Restored	Percent Loss Prevented	Cost ($)
Critical Short-Term			
Timbalier Subbasin	16,349	27	225,733,000
Penchant Subbasin	11,406	46	57,272,000
Fields Subbasin	na	na	na
Subtotal	27,755	32	283,005,000
Supporting Short-Term			
Timbalier Subbasin	2,269	4	16,971,000
Penchant Subbasin	2,218	9	9,018,000
Fields Subbasin	61	2	815,000
Subtotal	4,548	5	26,804,000
Total	32,303	37	309,809,000

1/ Only projects with estimates of both benefited acres and cost were included in the summary.
2/ Neither costs nor benefits are now known for the key strategies in the Verret Subbasin.
na--not applicable (no critical projects in the Fields Subbasin).

In the Penchant Subbasin, implementation of the short-term phase of the selected plan, including both critical and supporting projects, will avert or offset approximately 55 percent of the predicted loss. After hydrologic restoration is in place and flood control problems are addressed, the long-term strategy of diverting substantial amounts of Atchafalaya River water and sediment into the subbasin can be implemented, conceivably leading to no net loss of wetlands.

Although the costs and benefits for the key strategies in the Verret Subbasin are not currently known, the scale of the strategy in Verret is appropriate to the scale of stress on the cypress swamps and addresses the major portion of the problem. Only site-specific, small-scale projects are currently planned for the Fields Subbasin.

ATCHAFALAYA BASIN: SUMMARY OF BASIN PLAN

STUDY AREA

The Atchafalaya Basin is located in the central part of the coastal zone, west of the Terrebonne Basin (Figure AT-1). It encompasses 58,400 acres of wetlands in St. Mary Parish. The basin boundaries are the Mississippi River and Tributaries (MR&T) system levees below Berwick and Calumet to the north, Bayou Shaffer southward along the bank of the Lower Atchafalaya River to its mouth then following the shoreline around Atchafalaya Bay to Point Au Fer to the east, and a north-south line extending through Point Chevreuil to the west.

EXISTING CONDITIONS AND PROBLEMS

Major features in the basin include the Lower Atchafalaya River, Wax Lake Outlet, Atchafalaya Bay, and the Atchafalaya River and Bayous Chene, Boeuf, and Black navigation channel. Features of the Mississippi River and Tributaries (MR&T) flood control system, including the Old River complex and the Atchafalaya Basin Floodway system, define the flow and sediment resources entering the basin and influence the basin's evolution.

Previous Mississippi River delta complexes, including the Sale-Cypremort and the Teche deltas, formed the majority of the land within the Atchafalaya Basin. Delta growth in Atchafalaya Bay is a recent occurrence, with subaqueous delta, or land underwater, forming in the decade from 1952 to 1962 and subaerial delta, or land above the water, forming during the 1973 flood. About 16,000 acres of subaerial land exist today in the Lower Atchafalaya River and Wax Lake Outlet deltas in Atchafalaya Bay.

The Atchafalaya Basin is unique among the basins because it has a growing delta system with nearly stable wetlands. Wetland loss is minor in the areas north of Atchafalaya Bay when compared to the other basins. The total wetland loss in the area is approximately 3,760 acres between 1932 and 1990. The average loss from 1974 through 1990 is 87 acres per year. Wetland loss in this area is site dependent; loss is primarily due to erosion, human activities, and natural conversion. Storms and hurricanes cause shoreline erosion between Wax Lake Outlet and Point Chevreuil. Oil and gas pipelines disrupt the natural movement of flow and sediment within the wetlands. The development of the Lower Atchafalaya River, from a tidal to a riverine system, has created natural levees along the banks of the river, disrupting the movement of flow and sediment into the wetlands.

In Atchafalaya Bay, wetland gain, rather than loss, is taking place. However, natural processes and human activity are limiting the effectiveness of flow and sediment resources in creating new wetlands by affecting sediment delivery, deposition, and retention. Winter storm fronts, waves, and currents refine and reshape the deltas in the bay by eroding and reworking sediments. MR&T project features such as the Wax Lake Outlet Control Structure affect the location and quantity of flow and sediment entering the bay. Sediments available for delta building in the Lower Atchafalaya River delta deposit in the channel above Atchafalaya Bay. These sediments reach the delta only during significant high water events. The Chene, Boeuf, and Black navigation channel affects deposition and retention of sediments within the Lower Atchafalaya River delta. The majority of sediments conveyed by the Lower Atchafalaya River do not reach the delta; sands fall out in the navigation channel where they are dredged to maintain navigation;

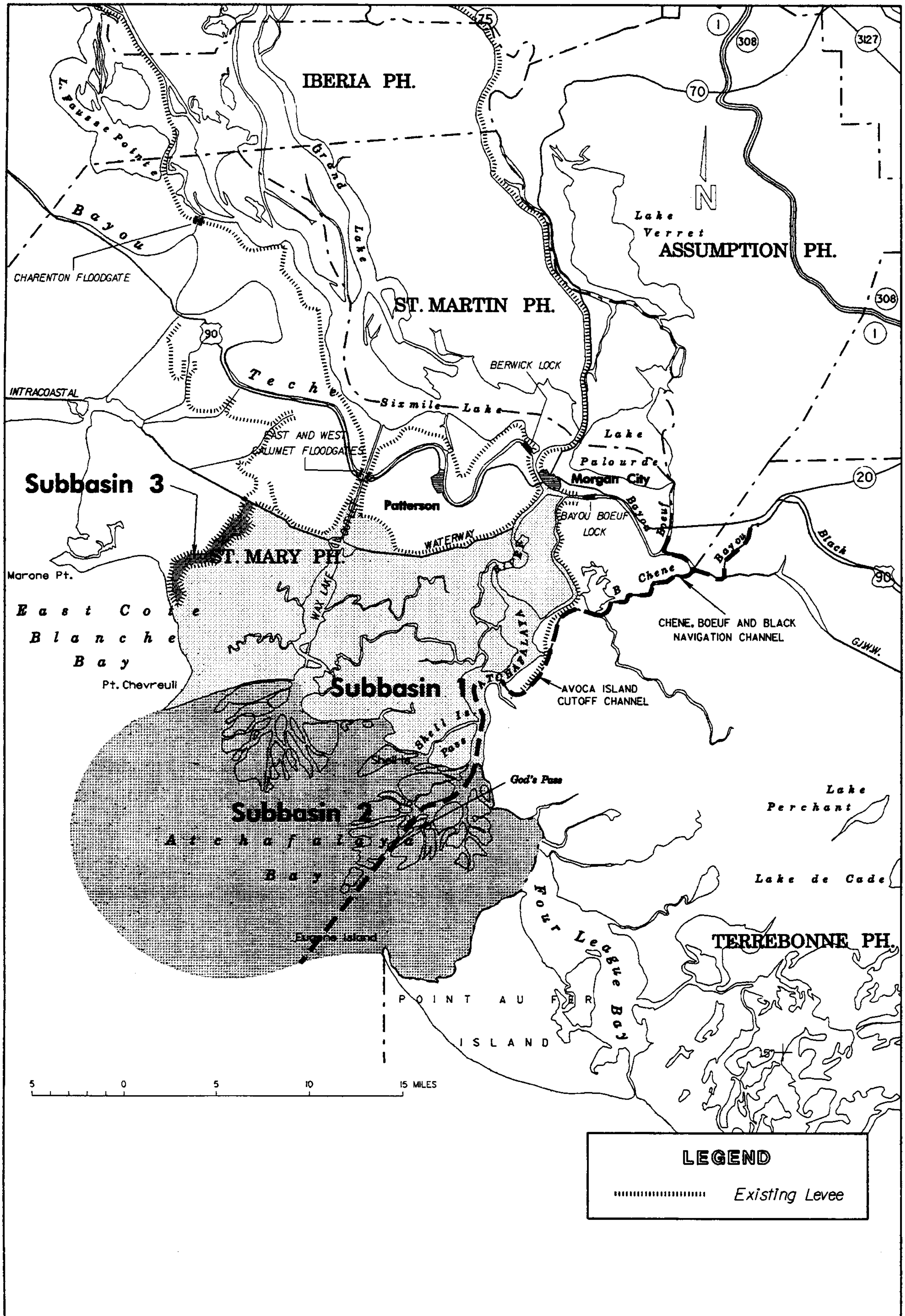


Figure AT-1. Atchafalaya Basin, Basin and Subbasin Boundaries.

silts and clays are conveyed out of the bay. The lack of sediments available for delta growth in the Lower Atchafalaya River delta is evident when the growth rate of this delta is compared to that of the Wax Lake Outlet delta. The Wax Lake Outlet delta receives approximately one- third the amount of flow and sediment of the Lower Atchafalaya River delta, and yet grows at a rate three times as great.

FUTURE WITHOUT-PROJECT CONDITIONS

Wetland loss in the area north of Atchafalaya Bay will generally continue at historical rates, resulting in 4,350 acres lost in this area in 50 years, or 8 percent of the existing acreage. Periodic overflow from the Atchafalaya system will continue to augment the wetlands, contributing to their overall stability. However, as the Lower Atchafalaya River and the Wax Lake Outlet evolve into riverine systems, natural levees will continue to form along the channel, disrupting the flow of sediment into the wetlands.

The deltas in Atchafalaya Bay will continue to grow. In 50 years, approximately 67,000 acres of subaerial delta will be present in both the Lower Atchafalaya River and the Wax Lake Outlet deltas. Of this subaerial land, approximately 27,550 acres will be vegetated wetlands--9,760 acres in the Lower Atchafalaya River delta and 17,790 acres in the Wax Lake Outlet delta, representing a gain in excess of 600 percent over the existing acreage.

As the deltas continue to grow, Atchafalaya Bay will change toward a riverine environment. Changes in salinity, water temperature, and turbidity will reduce shrimp, oyster, and marine fisheries production and increase furbearing, waterfowl and freshwater species production.

Table AT-1 shows projected wetland gain in the Atchafalaya Basin.

Table AT-1
Projected Wetlands in the Atchafalaya Basin

Measured Loss 1932-1990		Projected Gain in 20 years		Projected Gain in 50 years	
(Acres)	(Percent)	(Acres)	(Percent)	(Acres)	(Percent)
3,760	6.4	6,790	11.6	19,060	32.6

BASIN PLAN

Three strategies are available to increase the quantity of sediment delivered to Atchafalaya Bay: realign the entrance to Wax Lake Outlet, modify the Lower Atchafalaya River to increase its efficiency, and dredge sediments. Realigning the entrance to the Wax Lake Outlet is the preferred strategy. It creates more wetlands at a lower cost than the other two strategies.

Three strategies are available to reduce the quantity of sediment bypassing the Lower Atchafalaya River delta: relocate the navigation channel; relocate the flow and sediment to Wax Lake Outlet; and manage the growth of the Lower Atchafalaya River delta (delta management). Relocating the navigation channel is the preferred strategy because it solves a major problem of limited growth of the Lower Atchafalaya River delta without creating flood problems in the Teche/Vermilion

Basin or significantly reducing flow and sediment to the Terrebonne Basin. However, it has the potential for significant environmental and engineering problems. Delta management, on the other hand, can be initiated now and continue over the long term until these issues are resolved.

Delta management, relocating the navigation channel, and realigning the entrance to Wax Lake Outlet are the selected large scale measures to reduce the impact of human activity on the growth and development of wetlands in the Atchafalaya Basin. Priority projects to reopen Natal Channel and Radcliffe Pass and reduce the height of the Big Island in Atchafalaya Bay also reduce the impact of human activity in the short-term. These projects work toward the long-term goal of overall delta management. Other short-term measures support the overall basin plan. Management in the established wetlands north of Atchafalaya Bay by closing oil and gas pipelines and reopening closed distributaries, restores fluvial input disrupted by human activity and natural processes. Shoreline protection reduces erosion. Dredging sediments creates wetlands that offset loss from human activity and natural processes.

Delta management is the critical component of the plan for the basin because of its significant impact on delta growth. Reopening Natal Channel and Radcliffe Pass and reducing the height of Big Island are critical to the success of the restoration plan because they will shape the direction of future delta management activities in the Lower Atchafalaya River delta. Results of delta management will be enhanced in the long term with the relocation of the navigation channel. This long-term effort will require engineering and environmental studies to ensure a feasible plan.

The short-term portion of the plan contains projects that can be implemented under the CWPPRA with minimum effort. Small scale projects such as shoreline protection measures are effective in solving small, site dependent problems of wetland loss and erosion and creating small areas of wetlands.

In summary, the selected plan uses sediment diversion, marsh creation, and shoreline protection measures to achieve the basin objectives. The predominant feature is sediment diversion. The selected plan emphasizes management of existing resources until these resources can be increased in the future.

Nine individual projects are part of the selected plan for the Atchafalaya Basin. Table AT-2 summarizes these projects, indicating project type, cost, acres created, whether the project is critical or supporting, and if it is to be implemented in the short term or long term. Appendix F contains a detailed description of each project.

Appendix F contains a description of the plan formulation process. Figure AT-2 shows the main elements of the plan.

COSTS AND BENEFITS

The selected plan creates, protects, and restores approximately 11,090 acres of wetlands over 20 years and a total of 28,150 acres in 50 years. The three critical projects create, protect, or restore 8,110 acres of wetlands over a 20 year period at a cost of $15,981,000. In addition, these projects benefit an additional 5,960 acres. The critical long-term project, delta management, creates an additional 4,070 acres of wetlands in 50 years. Short-term supporting projects create, protect, or restore 350 acres of wetlands in 20 years at a cost of $3,407,000 and benefit an additional 2,110 acres. Long-term supporting projects create 15,630 acres in 50 years at a cost of $110,590,000.

Table AT-2
Summary of the Atchafalaya Basin Projects

Project No.	Project Name	Project Type	Priority List Projects	Acres Created, Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost per Benefited Acres ($/Ac)
Critical Projects, Short-Term							
PAT-2	Atchafalaya Sediment Delivery	SD, MC	PPL 2	2,230	2,790	810,000	300
XAT-7	Big Island Mining	SD, MC	PPL 2	1,560	2,020	3,821,000	1,900
Subtotal				3,790	4,810	4,631,000	
Critical Projects, Long-Term							
XAT-5	Delta Management	SD, MC		4,320	9,260	11,350,000	1,200
Supporting Projects, Short-Term							
XAT-3	Shoreline Erosion	SP		230	280	900,000	3,200
XAT-6	Booster Pump	MC		80	110	977,000	8,900
XAT-8	Dredge Sediments into Wax Lake Outlet	SD		40	2,070	1,530,000	700 ✓
Subtotal				350	2,460	3,407,000	
Supporting Projects, Long-Term							
XAT-4	Establish Wetland Management	SD, MC		800		300,000	
XAT-9	Relocate Navigation to Shell Island Pass	SD		* 9,040		90,000,000	
XAT-10	Realign Wax Lake Outlet	SD		1,840		20,290,000	
Total Atchafalaya Basin **				4,140	7,270	8,038,000	
Total Atchafalaya Basin ***				8,460	16,530	19,388,000	

MC Marsh Creation
SD Sediment Diversion
SP Shoreline Protection
* Denotes project to be implemented after 20 years. Acres shown are protected by year 50.
** Total include only Critical Short-Term Projects and Supporting Short-Term Projects.
*** Total includes Critical Short and Long-Term and Supporting Short-Term Projects.

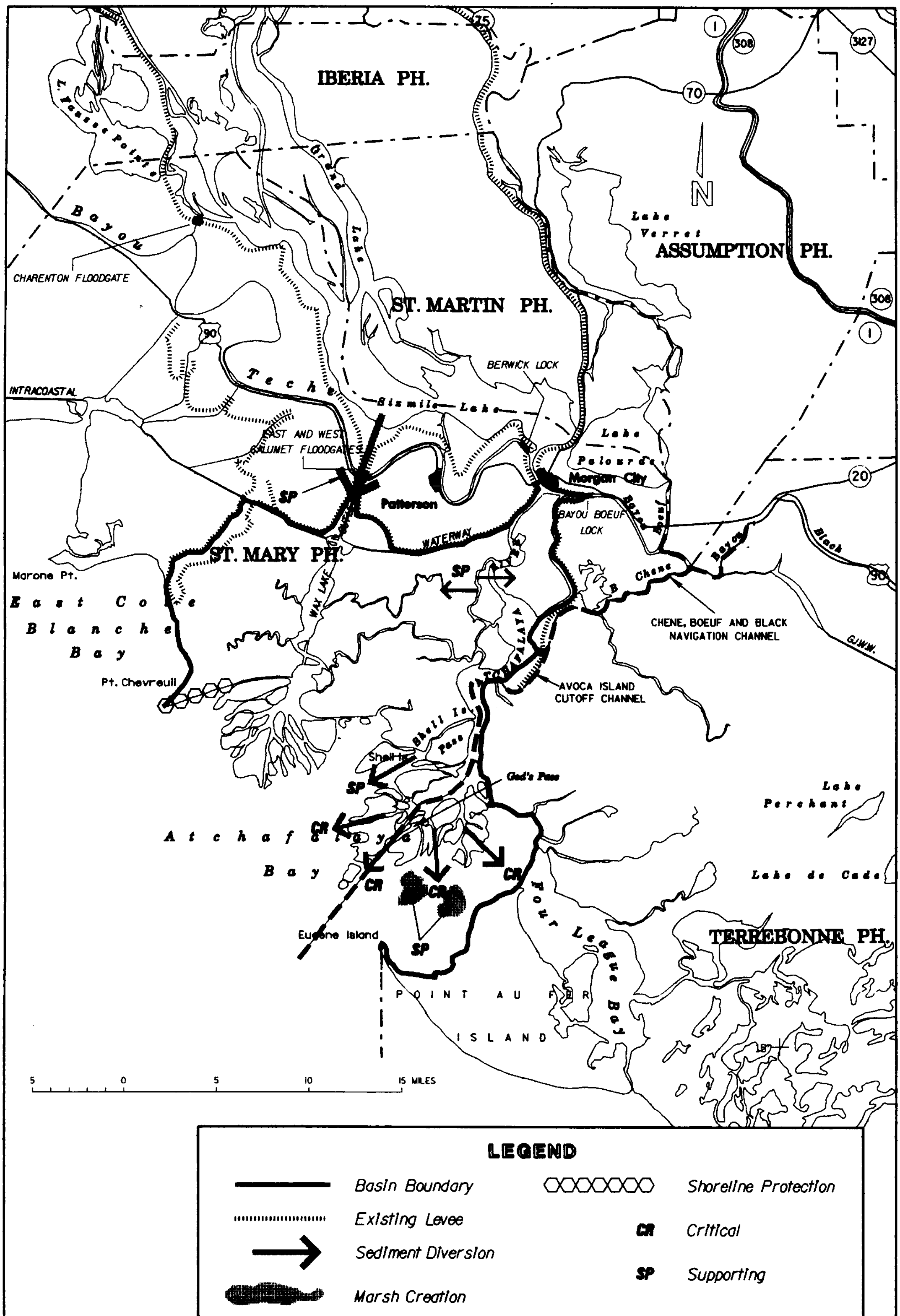


Figure AT-2. Atchafalaya Basin, Strategy Map.

TECHE/VERMILION BASIN: SUMMARY OF THE BASIN PLAN

STUDY AREA

The Teche/Vermilion Basin contains roughly 243,000 acres of wetlands in Vermilion, Iberia, and St. Mary parishes. The basin extends westward from Point Chevreuil through East and West Cote Blanche Bays, and includes Marsh Island and Vermilion Bay. The basin is bordered on the east by the West Atchafalaya Basin Protection Levee, on the west by Freshwater Bayou Canal and Louisiana Highway 82, on the north by the Lafayette/Vermilion and St. Martin/Iberia parish lines, and on the south by the Gulf of Mexico (Figure TV-1).

EXISTING CONDITIONS AND PROBLEMS

Much of the basin is occupied by three large bays: East Cote Blanche Bay, West Cote Blanche Bay, and Vermilion Bay. Marsh Island is an important hydrologic feature because it separates these bays from saltier water in the Gulf of Mexico. Therefore, marshes in this basin are primarily fresh, intermediate, and brackish with relatively few salt marshes. The Teche/Vermilion Basin lost 42,293 acres (14.8 percent) of marsh since 1932, nearly half of which was lost between 1951 and 1974, which is a relatively low rate compared to rates in other basins. Marsh loss is relatively slow because the basin is in the later stages of the delta lobe cycle; the more delicate wetlands deteriorated centuries ago. In fact, the delta lobe cycle has proceeded to the point that the basin should be experiencing rapid wetland creation in association with the emerging Atchafalaya River delta, but wetlands are not being built at maximum rates because the flow of fresh water and sediments down the Atchafalaya River is controlled at the Old River Control Structure. Fresh water and sediments from the Atchafalaya River benefit the basin nonetheless. Furthermore, numerous live and relic oyster reefs southeast of Marsh Island buffer water exchange between the big bays and the Gulf of Mexico, which also contributes stability.

Although the basin is geologically stable and benefits from the emerging Atchafalaya River delta, geomorphologic and hydrologic conditions have been altered by the dredging of navigation and petroleum access canals and the construction of spoil banks and levees. The effects of these alterations vary greatly from place to place, but generally they have created artificial barriers between wetlands and wetland maintenance processes, or removed natural barriers between wetlands and wetland decay processes. Interior marshes, traditionally maintained by annual flooding with fresh water in the spring, may deteriorate when exposed to increasing marine conditions, particularly in marshes where the soils have low mineral content. However, marshes near the Gulf of Mexico benefit from linkage with the gulf because winter storms deliver sediments to those marshes. Many landowners have responded to changing conditions caused by large-scale alterations by managing hydrologic conditions on a small scale using marsh management techniques. It is possible that some of these management efforts may not preserve marsh, particularly older ones. However, marsh management is an actively evolving field.

Some wetland loss might also be related to herbivory. Moderate herbivory alone is not believed to cause wetland loss, but it may be the "final straw" in marshes experiencing additional stresses such as flooding or saltwater intrusion.

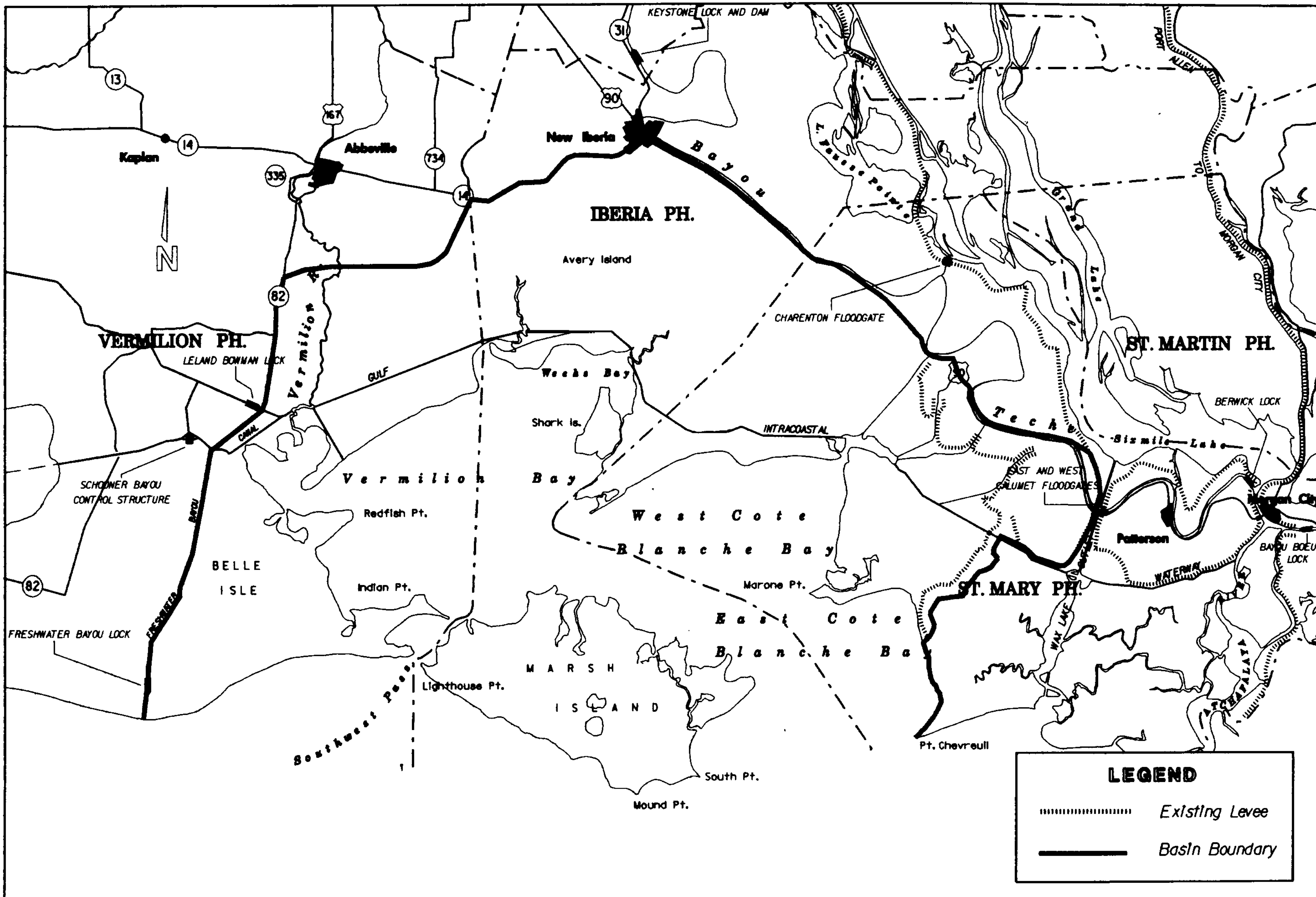


Figure TV-1. Teche/Vermilion Basin, Basin Boundaries.

Most wetland loss in the basin occurs either as shoreline erosion or in isolated hot spots. Areas are classified as hot spots when they experience rapid loss relative to other marshes within this basin. Hot spots in this basin are smaller than in other basins; they presumably originate from hydrologic changes that alter the balance between the marsh maintenance and deterioration processes, but the specific causes vary from place to place. Canals and spoil banks have impounded some areas and increased tidal energy in other areas. Thus, some areas have become isolated from sediment input, whereas water exchange removes more sediments than are introduced in other areas. Inadvertent impoundment also causes some areas to flood excessively.

Shoreline erosion on the large bays is caused primarily by natural wave energy. Wave energy has gradually increased over the centuries because the bays are naturally getting deeper due to the very slight but constant subsidence and global sea-level rise. Wave energy is also believed to have been increased because humans reduced the size of the oyster reefs between Marsh Island and Point Au Fer that shielded the large bays from wave and tidal energy in the Gulf of Mexico. Severe shoreline erosion occurs on Marone and Redfish Points, Shark Island, and the shore of Weeks Bay.

Shoreline erosion can dramatically affect wetland loss when it causes relatively isolated marsh drainage systems to become hydraulically connected with dynamic water bodies such as navigation canals and the large bays. In other areas, shoreline erosion is particularly rapid and causes the direct loss of significant wetland acreage. These may be classified as hot spots of erosion. Erosion caused by boat wakes and water surges associated with the passage of large vessels also causes wetland loss along the GIWW and other navigation canals.

FUTURE WITHOUT-PROJECT CONDITIONS

Over the next 20 years, 14,700 acres or 6.1 percent of the marsh (based on 1988 marsh acres) will be lost unless preventative measures are taken (Table TV-1). Within the next 50 years, 36,750 acres or 15.1 percent percent of the marsh will be lost. Cumulative losses since 1932 will approach 28 percent by 2040. In 50 years, shoreline erosion will reduce Marone Point, Redfish Point, and Shark Island, and Weeks Bay will be larger. The interior marshes on Marone Point, those north and south of the GIWW between the Vermilion River Cutoff and Tigre Lagoon, the south central marshes on Marsh Island, and marshes on State and Rainey refuges will become shallow ponds. This will reduce fisheries available for harvest by commercial and recreational fishermen and wintering habitat for millions of waterfowl. The growing ecotourism industry will be negatively affected, and storm surge protection will be reduced.

Table TV-1
Wetland Loss in the Teche/Vermilion Basin.

Measured Loss	Projected Loss in 20 years		Projected Loss in 50 years	
1932-1990 (Acres)	(Acres)	(Percent)	(Acres)	(Percent)
42,293	14,700	6.1	36,750	15.1

BASIN PLAN

Several objectives were developed to guide protection, restoration, and creation of wetlands within the Teche/Vermilion Basin. These objectives were based on prevailing conditions in the basin. A description of the plan formulation process is contained in Appendix G.

The short-term portion of the plan is dominated by projects that protect critical shorelines, restore more natural hydrological conditions, and determine the causes of marsh loss in hot spots so that site specific counter-measures can be designed. Locations of major areas of activity are noted in Figure TV-2. The long-term goal of the plan is to maximize spring flooding of wetlands, which will require feasibility studies and coordination with adjacent basins.

Shoreline erosion will ultimately slow because the bays are gradually filling with Atchafalaya River sediments. But this may take centuries without additional flow from the Mississippi River into the Atchafalaya River. Nonetheless, it may be possible to accelerate this process in some areas, and high priority is given to projects that speed this beneficial process, such as sediment trapping in Little Vermilion Bay.

There are substantial benefits to protecting some current shorelines that shield relatively isolated marsh ponds and bayous. It is preferred that these projects use beach nourishment, dredged material, and sediment trapping, but it may be necessary to use hard structures to protect some fragile but critical shorelines. Such projects are cost effective because they prevent rapid hydrological changes from occurring throughout large areas. This is the primary focus of critical short-term projects in many areas such as Lake Sand at Marsh Island.

Several critical projects restore more natural hydrological conditions on a small scale. For example, the Cote Blanche Hydrologic Restoration project slows shoreline erosion, restores hydrologic barriers between interior marshes and the bays, and controls water exchange between the GIWW and the project area, but does not include complete enclosure by levees. The net result is that this marsh is protected from artificial water exchange and shoreline erosion, but can still flood with fresh, sediment-rich water from the Atchafalaya River that is available in the adjacent GIWW and bays each spring.

Reducing loss in "hot spots" requires various measures such as sediment trapping, hydrologic restoration, and freshwater diversion. Addressing hot spots requires site-specific techniques in different areas because causes of wetland loss and the availability of counter measures vary throughout the basin. Restoring spring flooding with fresh, sediment-rich waters may someday stop marsh loss in hot spots, but it is important to protect these areas from loss now because if they convert to ponds, they will have to be restored--a much more expensive process. Thus, these projects are also classified as critical short-term even though specific causes of wetland loss must first be determined in each hot spot. Once site specific causes of marsh loss have been determined, then appropriate techniques, e.g., sediment trapping, hydrologic restoration, and freshwater diversions, can be implemented.

Restoring spring flooding to interior marshes provides optimum salinity levels and introduces mineral sediments, which promote plant growth. Restoring spring flooding on a regional scale is an important long-term goal, but it requires increased sediment delivery to the Wax Lake Delta; managing diversions into the Vermilion

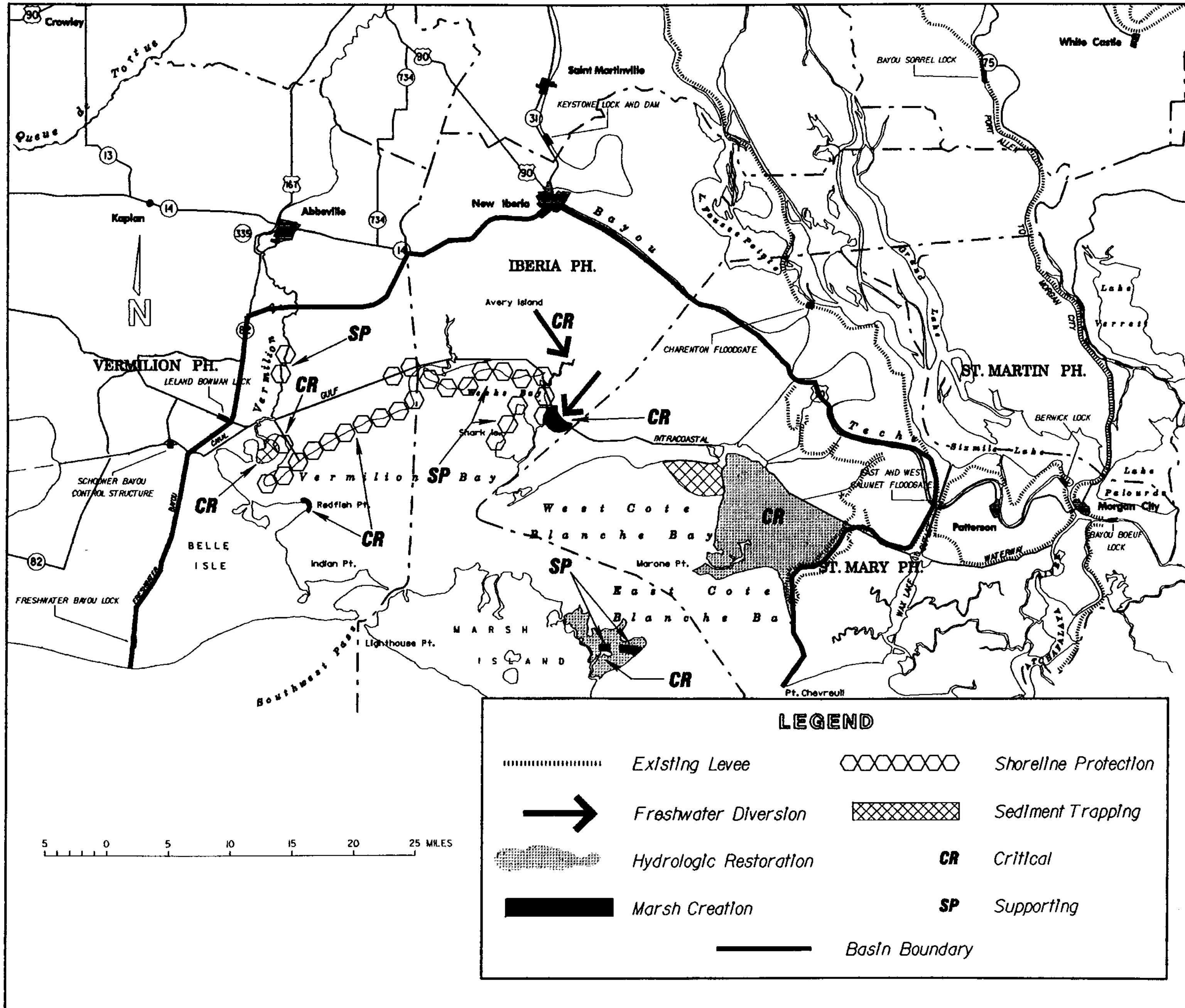


Figure TV-2. Teche/Vermilion Basin, Strategy Map.

River, Bayou Teche, and the GIWW during the spring flood; or increasing discharge of the Atchafalaya River. Increasing fresh water and sediments available from the Atchafalaya will also speed bay filling, which will slow shoreline erosion and initiate wetland creation in Vermilion Bay, West Cote Blanche Bay, and East Cote Blanche Bay. Detailed study and planning are necessary to determine if these concepts are feasible. Thus, no projects are proposed at this time even though restoring spring flooding on a regional scale is a critical long-term strategy.

Projects in the Teche/Vermilion Plan are listed in Table TV-2, which displays the project type and classification. A detailed description of all projects proposed in the Teche/Vermilion Basin can be found in Appendix G, Table 9.

COSTS AND BENEFITS

The short-term projects proposed in the selected plan will protect or create 4,770 acres of marsh and prevent 30 percent of the predicted loss at a cost of $34,039,000 (Table TV-3). In addition, 5,010 acres of marsh and submerged aquatic vegetation will be enhanced. Costs and benefits of the other three short-term critical projects cannot be determined until the site-specific causes of marsh loss can be determined in each hot spot.

Table TV-3
Costs and Benefits of the Selected Plan

Project Classification	Acres Created, Protected, or Restored	Percent Loss Prevented	Total Benefited Acres	Cost ($)
Critical Short-Term	3,840	26	8,720	22,149,000
Supporting Short-Term	930	4	1,060	11,890,000
Total	4,770	30	9,780	34,039,000

Less than half of the marsh loss predicted to occur in this basin can be countered with the projects listed in the plan. Additional efforts will therefore be needed to achieve no net loss of wetlands. Substantial gains may be possible by addressing marsh loss in the hot spots. However, the most beneficial action is likely to be maximizing spring flooding on a regional scale. In addition to slowing marsh loss processes of saltwater intrusion and sediment starvation, this would likely promote creation of new wetlands. This is one of the few basins with substantial potential for wetlands creation, and every avenue to maximize spring flooding should be explored.

Table TV-2

Summary of the Teche/Vermilion Basin Projects

Project No.	Project Name	Project Type	Priority List	Acres Created Restored, or Protected	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)
Critical Projects, Short-Term							
TV-1	Shark Island Shoreline Protect/Hyd. Restoration	SP/HR		457	591	7,559,000	12,800
TV-3	Vermilion River Cutoff Erosion Protection	SP	PPL 1	65	107	1,342,000	12,500
TV-4	Cote Blanche Hyd. Restoration	SP/HR	PPL 3	2,231	4,744	4,359,000	900
TV-5/7a	Marsh Island Canal Fill/Shore Stab./Hyd. Res.	SP/HR		512	1,090	2,328,000	2,100
TV-8	Redfish Point Shore. Prot./ Hyd. Res.	SP/HR		58	95	530,000	5,600
TV-10	Weeks Bay/GIWW Shore. Prot. /Hyd. Res.	SP/HR		406	1,422	4,993,000	3,500
PTV-19	Cote Blanche (Jaws)/Little Vermilion Bay Sed.	ST		27	505	600,000	1,200
XTV-26	Two Mouth Bayou Freshwater Diversion	FD		87	162	438,000	2,700
Subtotal: Critical Projects, Short-Term				3,840	8,720	22,149,000	
Critical Projects, Long-Term							
PTV-9	GIWW Shoreline Protection	SP					
PTV-10	Avery Canal Shoreline Protection	SP					
PTV-11	Restore Pipeline Plugs in Vermilion Bay	HR					
PTV-13	Marshes S. of GIWW, Vermilion River to Weeks Island	UK					
PTV-14	Marshes N. of GIWW, Vermilion River to Comm. Canal	UK					
PTV-17	Cote Blanche Outfall Management	HR					
PTV-21	Forested Area East of Weeks Island	UK					

Table TV-2

Summary of the Teche/Vermilion Basin Projects (Continued)

Project No.	Project Name	Project Type	Priority List	Acres Created Restored, or Protected	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)
Supporting Projects, Short-Term							
PTV-4	Vermilion River Shore. Prot., Live Oak	SP		7	70	300,000	4,300
PTV-8	Avery Canal/Weeks Isl. Veg. Plantings	VP		128	173	242,000	1,400
PTV-18/TV-9	Vermilion Bay/Boston Canal Shore. Protection	SP/ST/VP	PPL 2	378	397	829,000	2,100
XTV-11	Freshwater Bayou Bank Stab	SP		63	63	2,012,000	31,900
XTV-25	Oaks Canal Shoreline Protection	SP		120	125	1,069,000	8,600
XTV-27	Freshwater Bayou Bank Stab	SP		61	61	1,925,000	31,600
XTV-28	Freshwater Bayou Bank Stab	SP		91	91	2,888,000	31,700
XTV-29	Freshwater Bayou Bank Stab	SP		83	83	2,625,000	31,600
Subtotal: Supporting Projects, Short-Term				930	1,060	11,890,000	
Supporting Projects, Long-Term							
PTV-6	Bayou Carlin Bank Protection	SP					
PTV-7	Little Vermilion Lake Shoreline Protection	SP					
PTV-12	East/West Cote Blanche Bays Vegetative Plantings	VP					
Demonstration							
PTV-5	Cheniere au Tigre Shoreline Protection	SP					
Total Teche/Vermilion Basin *				4,770	9,780	34,039,000	

FD Freshwater Diversion
HR Hydrologic Restoration
SP Shore or Bank Projection
ST Sediment Trapping
VP Vegetative Planting
UK Unknown

* Total cost and benefits for the selected plan include only Critical Short-Term and Supporting Short-Term projects.

MERMENTAU BASIN: SUMMARY OF THE BASIN PLAN

STUDY AREA

The Mermentau Basin lies in the eastern portion of the Chenier Plain in Cameron and Vermilion Parishes. The 734,000-acre basin is bounded on the east by Freshwater Bayou Canal, on the South by the Gulf of Mexico, on the west by Louisiana State Highway 27, and on the north by the coastal prairie. The Grand Chenier and Pecan Island ridge systems are linked by Louisiana Highway 82 and divide the basin into two distinct subbasins: the Lakes Subbasin north of the highway and the Chenier Subbasin south of the highway (Figure ME-1). About 18 percent (128,200 acres) of the basin lands are publicly owned as Federal refuges and State wildlife management areas.

EXISTING CONDITIONS AND PROBLEMS

The basin contains about 450,000 acres of wetlands, consisting of 190,000 acres of fresh marsh, 135,000 acres of intermediate marsh, and 101,000 acres of brackish marsh. A total of 104,380 acres of marsh has converted to open water since 1932, a loss of 19 percent of the historical wetlands in the basin.

Prior to human alterations, delta-building processes associated with the Mississippi River resulted in periodic building of marsh along the gulf coast of the Mermentau Basin. Construction of flood control and navigation projects on the Mississippi and Atchafalaya rivers restricted those natural processes to relatively small portions of the coast. Consequently, marsh-building now occurs on only the eastern-most portion of the Mermentau Basin's coastline. This condition is further aggravated by continuing subsidence and sea level rise. In the Mermentau Basin, relative sea level rise results in an average water level rise of 0.25 inches per year. Although natural wetland building processes only occur along the eastern shore, natural marsh maintenance processes (e.g., plant deterioration and regeneration) can be fairly effective at keeping wetland loss rates low. However, these processes have been altered or interrupted and the ability of the system to maintain the marsh is jeopardized.

The two subbasins suffer from distinctly different hydrologic problems. The most critical wetland problem in the Lakes Subbasin is excessive flooding. A 5-mile-long segment of Louisiana Highway 27 almost totally blocks drainage from the western portion of the Lakes Subbasin into adjacent wetlands of the Calcasieu/Sabine Basin. Similarly, along the southern boundary of the Lakes Subbasin, Louisiana Highway 82 blocks drainage across 17 miles of marsh. The Freshwater Bayou navigation channel has altered the historic drainage pattern in the eastern portion of the Lakes Subbasin. These numerous blockages of drainage outlets significantly increase ponding in the subbasin.

The Catfish Point Control Structure, built to reduce saltwater intrusion into Grand Lake via the Mermentau River, controls the major drainage outlet from the Lakes Subbasin. High water levels in the gulf frequently prevent the drainage of the subbasin through the structure. Farther upstream, development and channelization of the Mermentau River watershed have increased the rate of run-off into the Lakes Subbasin. These factors, in combination with the loss of historic drainage outlets, result in periods of prolonged high water levels following heavy basin-wide precipitation. Because upland drainage improvements are continuing

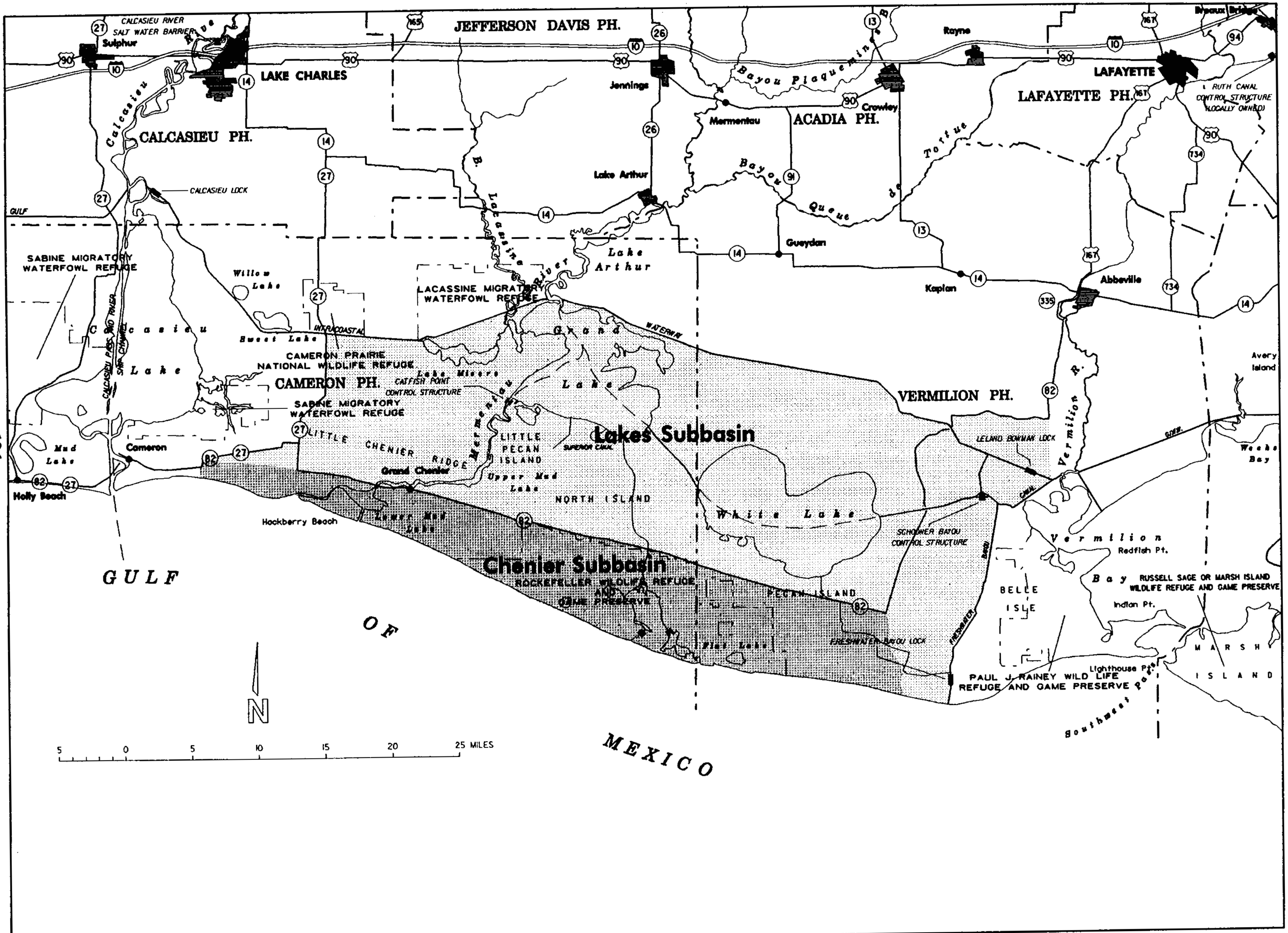


Figure ME-1. Mermentau Basin, Basin and Subbasin Boundaries.

throughout the Mermentau River watershed, high water levels in the Lakes Subbasin will remain a problem.

Natural freshwater inputs from the Lakes Subbasin into the marshes of the Chenier Subbasin are reduced by the same highway embankments that impound water in the northern subbasin. The loss of those freshwater inputs is compounded by waterways and canals that create additional connections between the gulf and area marshes, facilitating saltwater intrusion.

FUTURE WITHOUT-PROJECT CONDITIONS

If nothing is done to solve the problem of wetland loss in this basin, current estimates project a continuing loss rate of 1,980 ares per year. Table ME-1 shows projected losses for 20- and 50-year periods for each subbasin.

In absence of remedial action, about 18 percent, or 62,900 acres, of the land in the Lakes Subbasin would be lost over 50 years. This loss would occur in wetlands adjacent to the shorelines of White and Grand Lakes and the banks of the GIWW and Freshwater Bayou Canal. Interior losses would continue in the Deep Lake area, the Freshwater Bayou wetlands, and the vicinity of Little Pecan Bayou.

Chenier Subbasin wetland losses are projected to be 32 percent, or 36,100 acres, over the next 50 years. Interior wetland losses would continue to occur south of Pecan Island and Grand Chenier. Erosion along the gulf shoreline would continue at the present rate of 20 to 40 feet per year.

Table ME-1
Projected Marsh Loss

	Projected Loss at 20 yrs.		Projected Loss at 50 yrs.	
Subbasin	(Acres)	(Percent)	(Acres)	(Percent)
Lakes	25,160	7.3	62,900	18.3
Chenier	14,440	12.6	36,100	31.5
Totals	39,600	8.6	99,000	21.4

BASIN PLAN

The short-term portion of the Mermentau Basin plan depends on modifying existing structures and creating additional outlets to reduce ponding in the Lakes Subbasin and reducing salinity intrusion in the Chenier Subbasin. In addition, the plan utilizes shoreline protection, hydrologic restoration, marsh creation with dredged material, marsh management, terracing, and vegetative plantings. The long-term portion of the plan relies on hydrologic restoration and vegetative plantings. Figure ME-2 indicates the strategy for the basin. A detailed discussion of the plan formulation and evaluation process is in the Mermentau Basin Plan, Appendix H.

In the Lakes Subbasin, the short-term critical projects use two methods to move water out of the subbasin for the purpose of reducing flooding stress on vegetated wetlands: modifying the Vermilion Lock (which is no longer operational) and the

Figure ME-2. Mermentau Basin, Strategy Map

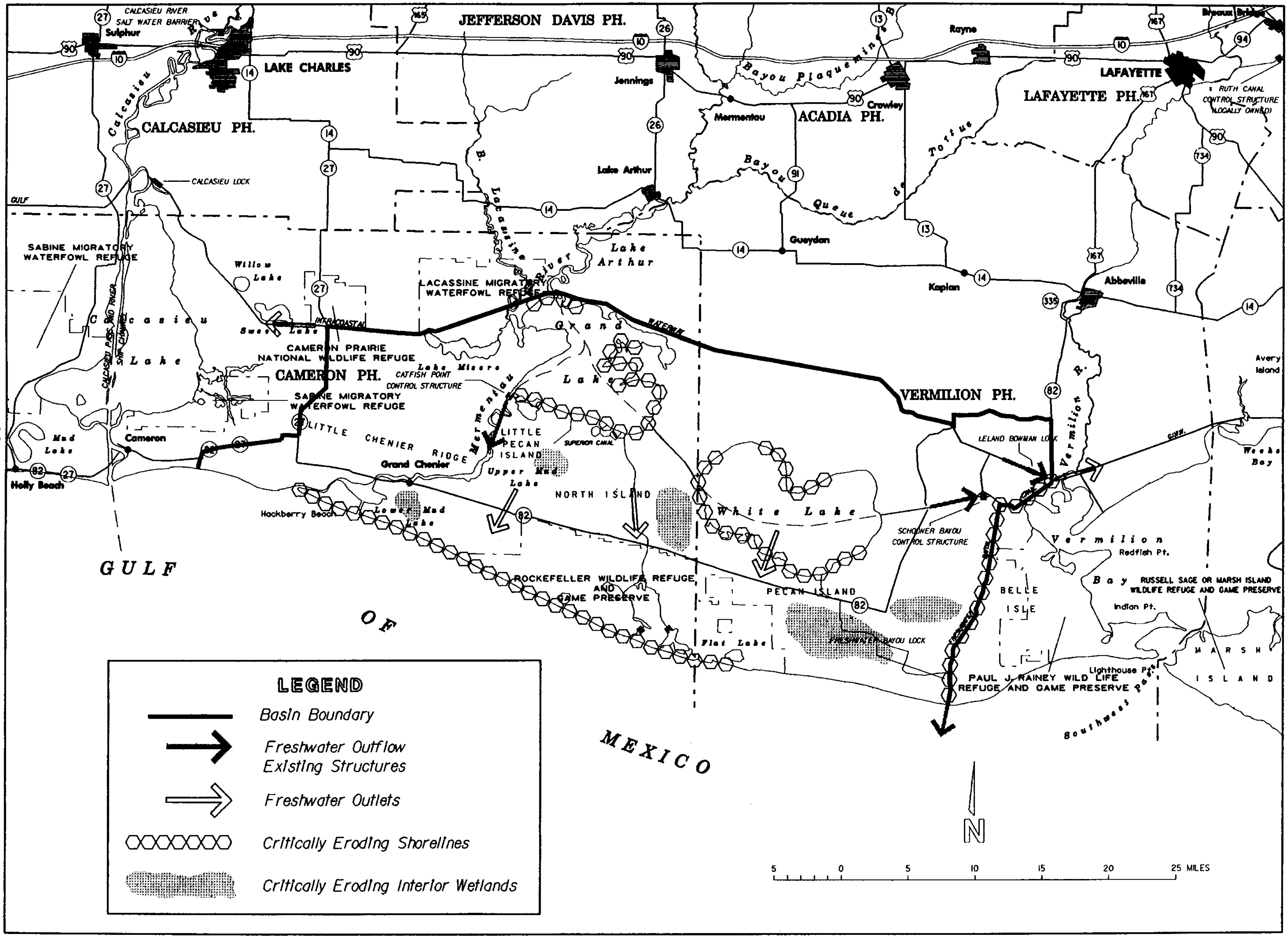


Figure ME-2. Mermentau Basin, Strategy Map.

operation of the Schooner Bayou Control Structure and Freshwater Bayou Lock, and creating additional outlets such as a structure at Black Bayou.

The short-term supporting projects within the Lakes Subbasin protect interior wetlands by hydrologic restoration (Sawmill and Humble Canals), rebuild open water areas (Big Burn and Deep Lake), and protect shorelines and banks (White Lake, Freshwater Bayou, and the GIWW).

The long-term supporting projects within the Lakes Subbasin treat critical loss areas by hydrologic restoration (Miami South Levee and Coteau Plateau Marsh) and vegetative plantings (Little Pecan Island and along the GIWW).

For the Chenier Subbasin, the short-term critical projects use water evacuated from the Lakes Subbasin to treat the saltwater intrusion problem (White Lake Diversion, Grand/White Lake Diversion, and Hog Bayou Freshwater Introduction).

The short-term supporting projects within the Chenier Subbasin protect the gulf shoreline from the Mermentau River to the eastern boundary of the Rockefeller Refuge, restore hydrology (Rollover Bayou Structure), create wetlands (Pecan Island Terracing), and plant vegetation along the gulf shoreline.

Table ME-2 lists all the projects in the selected plan. A detailed description of all projects in the selected plan is contained in Appendix H.

COSTS AND BENEFITS

Lakes Subbasin.

Implementation of the 30 evaluated projects in the selected plan (critical and supporting short-term projects) will protect, create, or restore 6,710 acres of wetlands and decrease marsh losses over a period of twenty years by an estimated 27 percent at a cost of approximately $53,358,000. Three critical hydrologic restoration projects in the subbasin were not evaluated for cost or habitat benefits and will require further study and evaluation. The benefits for these projects will depend on their ability to reduce the water levels in the subbasin. Additional projects will need to be evaluated for the subbasin for protection of acreage not covered under the present plan.

Chenier Subbasin.

The selected plan is expected to create, protect, or restore 3,150 acres of wetlands and reduce marsh loss over a period of twenty years by 22 percent at a cost of approximately $19,571,000. One project was not evaluated for cost or habitat benefits and will require further study and evaluation. There is a need to develop and evaluate other projects to achieve no net loss of wetlands. If dredging technology becomes more cost-effective, the option of pumping sediments from the gulf into shallow open water or deteriorating marshes will need to be investigated. This can only be used in the more saline subbasin marshes. It should only be done during the spring floods when the gulf salinities are the lowest in order to avoid placing sediments with higher salinities into marsh environments.

Table ME-2

Table 4. Summary of the Mermentau Basin Projects

Project No.	Project Name	Project Type	Priority List Projects	Acres Created Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comments
Critical Projects, Short-Term: Lakes Subbasin								
CS-16	Black Bayou Bypass	FD		115	1,661	4,600,000	2,800	Interacts w/ PME-7, in C/S Basin
XME-19	Old Vermilion Lock	FD		na	na	na	na	Interacts w/ PME-7
XME-20	Schooner Bayou Bypass	FD		na	na	na	na	Interacts w/ PME-7
XME-23	Freshwater Bayou Structure	FD		na	na	na	na	Interacts w/ PME-7
Subtotal: Critical Projects, Short-Term, Lakes Subbasin				120	1,660	4,600,000		
Critical Projects, Short-Term: Chenier Subbasin								
PME-04	White Lake Diversion	FD		126	1,133	2,000,000	1,800	Interacts w/ PME-7 & ME-1
PME-07	Grand/White Lake Diversion	FD		na	na	na		
XME-42	Hog Bayou F.W. Introduction	FD		1,274	2,264	2,000,000	900	✓
Subtotal: Critical Projects, Short-Term, Chenier Subbasin				1,400	3,400	4,000,000		
Supporting Projects, Short-Term: Lakes Subbasin								
ME-02	Hog Bayou Wetland	MM		20	55	6,419,000	116,700	
ME-04	Freshwater Bayou	SP	PPL2	1,593	4,513	2,032,000	500	Interacts w/ XME-29 & XME-30
ME-05	White Lake Shore Protection	SP		39	143	3,237,000	22,600	
ME-5 /XME-38	White Lake Shore Protection	SP		975	1,279	5,038,000	3,900	
ME-06	Big Burn Marsh Creation	MC		24	223	647,000	2,900	
ME-07	Deep Lake Marsh Protection	MC		127	526	1,187,000	2,300	
ME-09	Cameron Prairie Refuge	SP	PPL1	247	460	1,109,000	2,400	
PME-01	GIWW Bank Protection	SP		178	178	3,160,000	17,800	Interacts w/ XME-44
PME-03	Old GIWW Shore Protection	SP		20	20	750,000	37,500	
PME-05	Grand Lake South Shore	SP		74	86	980,000	11,400	
PME-14	Sawmill Canal	HR		229	486	1,100,000	2,300	

Table ME-2

Table 4. Summary of the Mermentau Basin Projects (Continued)

Project No.	Project Name	Project Type	Priority List Projects	Acres Created Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comments
Supporting Projects, Short-Term: Lakes Subbasin (Continued)								
PME-15	Humble Canal	HR		1,392	2,034	700,000	300	
XME-17	North Canal to Mermentau R.	SP		221	241	6,300,000	26,100	
XME-18	Lake Shore Rims	MC		92	92	370,000	4,000	
XME-26	Warren Canal Structure	HR		na	na	[150,000]	na	
XME-27	Seventh Ward Canal Structure	HR		na	na	[150,000]	na	
XME-28	GIWW/Freshwater Bayou	SP		60	60	700,000	11,700	
XME-29	Freshwater Bayou Phase 3	SP		118	118	3,763,000	31,900	
XME-30	Freshwater Bayou Phase 4	SP		36	36	1,138,000	31,600	
XME-31	Freshwater Bayou Phase 5	SP		36	36	1,138,000	31,600	
XME-32	Freshwater Bayou Phase 6	SP		31	31	1,000,000	32,300	
XME-33	Freshwater Bayou Phase 7	SP		25	25	788,000	31,500	
XME-35a	Umbrella Bay	SP		74	78	1,100,000	14,100	
XME-35b	Mallard Bay	SP		74	78	900,000	11,500	
XME-36	Tebo point	VP		9	11	200,000	18,200	
XME-37	Chenier DuFond	VP		15	18	840,000	46,700	
XME-38	Grand Volle Lake to Bear Lake	SP		204	242	1,000,000	4,100	
XME-40	N. Little Pecan Bayou	HR, SP		117	767	1,400,000	1,800	
XME-43	Florence Canal	HR		500	500	350,000	700	
XME-44	GIWW Bank Stabilization	SP		20	23	620,000	27,000	
XME-45	Pumpkin Ridge Structure	HR		15	136	700,000	5,100	
Subtotal Supporting Projects, Short-Term, Lakes Subbasin				6,570	12,500	48,666,000		Does not include Demo PME-06

Table ME-2

Table 4. Summary of the Mermentau Basin Projects (Continued)

Project No.	Project Name	Project Type	Priority List Projects	Acres Created Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comments
Supporting Projects, Short-Term: Chenier Subbasin								
PME-02	Rockefeller Gulf Shoreline	SP		850	913	9,000,000	9,900	
PME-09	Mermentau R. to Rockefeller	SP		418	450	4,200,000	9,300	
XME-22	Pecan Island Terracing	T		23	1,017	1,700,000	1,700	
XME-46	Rollover Bayou Structure	HR		150	601	400,000	700	
Subtotal Supporting Project, Short-Term, Chenier Subbasin				1,440	2,980	15,300,000		Does not include Demo ME-08
Supporting Projects, Long-Term: Lakes Subbasin								
PME-08	Miami South levee	HR				[2,380,000]		
PME-10	Little Pecan Is. Veg. Plantings	VP				[300,000]		
PME-11	GIWW Veg. Plantings	VP				[800,000]		
PME-16	Coteau Plateau Marsh	MM				[900,000]		
XME-34	Oak Grove Canal	FD				[572,000]		
XME-39	Mud Lake Levee Repair	HR				[750,000]		
XME-41	Grand Chenier Levee	HR				[900,000]		
Demonstration Project: Lakes Subbasin								
PME-06	White Lake South Shore	SP	PPL3	16	18	92,000	5,100	Supporting, short-term
Demonstration Projects: Chenier Subbasin								
ME-08	Dewitt Rollover, Veg Planting	VP	PPL1	310	331	271,000	800	Critical, short-term
Total Mermentau Basin **				9,860	20,890	72,929,000		

na Information not available
MC Marsh Creation
SP Shoreline or Bank Protection
FD Freshwater Diversion
MM Marsh Management
VP Vegetative Planting
HR Hydrologic Restoration
T Terrecing

[#] Not included in totals.

* Benefits not verified by the WVA work goup.

**Total cost and benefits for the basin plan include only those for Critical Short-Term Projects, Supporting Short-Term Projects, and Demonstration Projects.

CALCASIEU/SABINE BASIN: SUMMARY OF THE BASIN PLAN

STUDY AREA

The Calcasieu/Sabine Basin is located in southwest Louisiana in Cameron and Calcasieu parishes and consists of approximately 630,000 acres. The northern boundary of the basin is defined by the Gulf Intracoastal Waterway (GIWW). The eastern boundary follows the eastern leg of State Highway 27; the western boundary is the Sabine River and Sabine Lake; and the southern boundary is the Gulf of Mexico (Figure CS-1). About 24 percent (148,600 acres) of the basin lands is publicly owned as Federal refuges.

EXISTING CONDITIONS AND PROBLEMS

The basin contains about 312,500 acres of wetlands, consisting of 32,800 acres of fresh marsh, 112,000 acres of intermediate marsh, 158,200 of brackish marsh, and 9,500 acres of saline marsh. A total of 122,000 acres have been lost since 1932, 28 percent of the marsh that existed in 1932.

Marshes within the Calcasieu/Sabine Basin began forming about 3,500 years ago. Whenever the Mississippi River established a westerly course, large quantities of reworked riverine sediment were deposited along the gulf shore, resulting in southerly growth of the shoreline. When the Mississippi River shifted to an easterly course, the sediment supply decreased and erosive forces were greater than sediment deposition due to littoral drift. As a result, the shoreline converted to a more typical beach-like nature and gradually retreated. The repetitive occurrence of these pulses of sediment due to change in the Mississippi River's course helped to build the systems of cheniers (oak ridges) in the basin.

The progradation process served to establish an undulating land form along the gulf coast. The areas between the cheniers were collecting points for water and, over time, built up by decomposition and regeneration of plant materials to form low salinity marshes. These interior marsh areas would occasionally receive pulses of mineral sediment input due to storm tides.

Calcasieu and Sabine lakes are the major water bodies within the basin. Freshwater inflow to the basin occurs primarily through these lakes via the Calcasieu and Sabine rivers. Marshes within the basin historically drained into these two large lakes. This process was altered by the construction of channels to enhance navigation and mineral extraction activities. Navigation channels now dominate the hydrology of the basin. The Calcasieu Ship Channel is maintained at 40 feet deep by 400 feet wide and extends from the Gulf of Mexico to Lake Charles, Louisiana. The GIWW is maintained at 12 feet deep by 125 feet wide. The reach of the GIWW between the Sabine River and the Calcasieu Ship Channel was dredged to a depth of 30 feet in 1927. The Sabine-Neches Waterway, between the Gulf of Mexico and Port Arthur, Texas, is 40 feet deep by 400 feet wide.

The hydrology of the marshes between Sabine and Calcasieu lakes has also been altered by numerous relatively small access canals. The GIWW and this network of canals have established a hydrologic connections between the Sabine and Calcasieu Estuaries. Additionally, a number of bayous which once drained adjacent marshes into either of the estuaries have been connected to one another. Consequently, marshes between Sabine and Calcasieu Lakes have become a large interlinked system with water draining and circulating to the northern, eastern, and western portions of the basin.

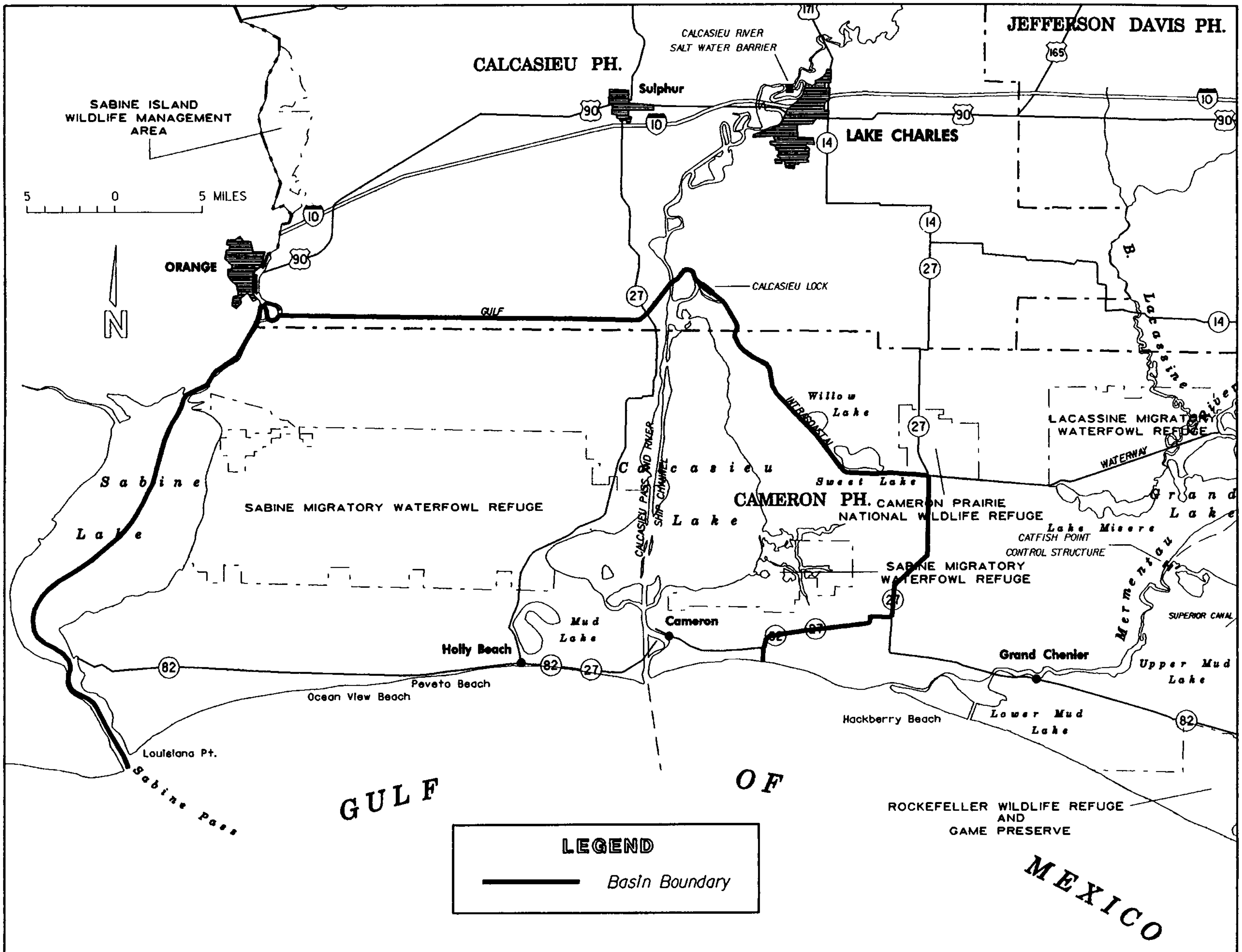


Figure CS-1. Calcasieu/Sabine Basin, Basin Boundaries.

The water circulation patterns allow for higher salinity water to enter the interior marshes (saltwater intrusion). The basin soils, which are 87 percent organic and support lower salinity marsh vegetation, are infiltrated by the more saline waters. This leads to increased stress and loss of the plant communities, and eventually erosion and sediment transport out of the inner marsh areas.

Subsidence and sea level rise are natural processes that contribute to wetland deterioration and loss. Under pristine conditions, natural marsh building and maintenance processes are effective in maintaining coastal marshes despite subsidence and sea level rise; however, human alterations have disrupted the hydrologic processes which contributed to wetland building and maintenance, while subsidence and sea level rise continues. In the Calcasieu/Sabine Basin, subsidence and sea level rise result in an average water level rise of 0.25 inches per year. Although natural wetland building processes no longer occur, natural marsh maintenance processes can be fairly effective at keeping wetland loss rates low.

Erosion is a problem along the shores of Calcasieu and Sabine lakes and the banks of the GIWW. Erosion related breaching of the lakes' shores threatens adjacent marshes because of the vulnerability of their typically weaker soils to increased water exchange and saltwater intrusion. Along the Gulf of Mexico, shoreline retreat is causing the loss of back-beach marshes and is threatening to alter the hydrology of interior marshes. Flood control projects on the Mississippi and Atchafalaya rivers, and construction of jetties on the Mermentau River, Calcasieu Ship Channel, and at Sabine Pass, have altered long shore sediment transport and sediment availability.

In summary, wetland loss within the basin is largely the result of extensive hydrologic alterations to wetland building and maintenance processes. Recent observations regarding marsh recovery indicate that in some areas, reducing salinities may protect and restore wetlands.

FUTURE WITHOUT-PROJECT CONDITIONS.

Land loss data for the period 1933 to 1990 reveals that 122,000 acres of wetlands have been lost in the basin. The current wetland loss rate of 1,100 acres per year is based on composite data for the period of 1974 to 1990. Table CS-1 shows the projected wetland loss over 20- and 50-year periods under the no action alternative.

Table CS-1
Projected Marsh Loss

	Projected Loss at 20 yrs.		Projected Loss at 50 yrs.	
Subbasin	(Acres)	(Percent)	(Acres)	(Percent)
Calcasieu	9,400	9.5	23,400	23.7
Sabine	12,500	8.4	31,200	20.9
Totals	21,900	8.9	54,600	22.0

BASIN PLAN

The Calcasieu/Sabine Basin Plan (Figure CS-2) has two possible strategies to reduce the effects of saltwater intrusion and tidal scour: locks in the major waterways or structures in the many canals where saltwater enters interior marshes.

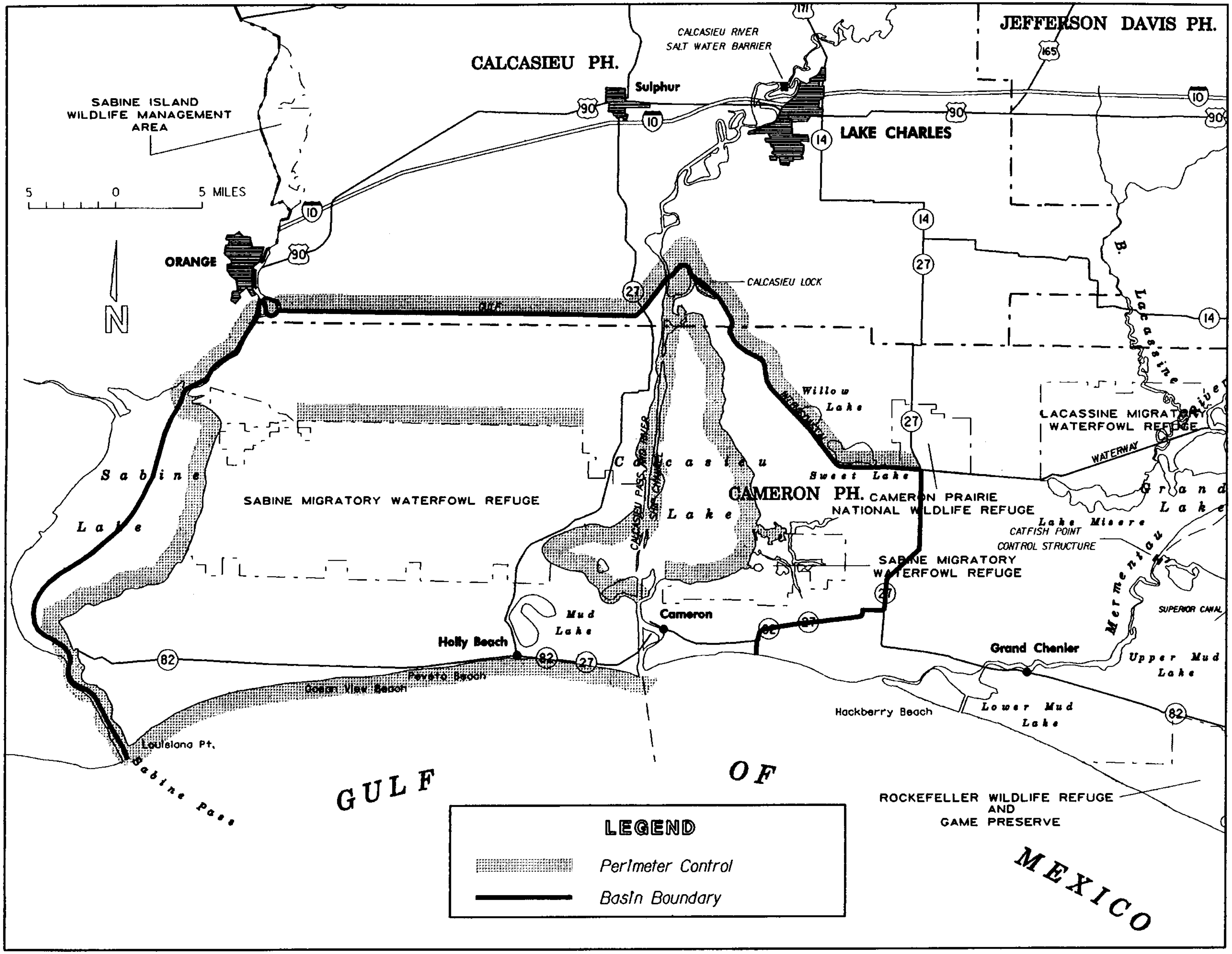


Figure CS-2. Calcasieu/Sabine Basin, Strategies 2 and 3 - Perimeter Control and Maintain Geologic Framework.

The latter is more cost effective and can be completed in a shorter time. The short-term projects in the plan include shoreline and bank protection, hydrologic restoration, freshwater introduction, marsh management, marsh creation with dredged material, and terracing. An additional freshwater introduction project is a long-term project in the basin plan. A detailed description of the plan formulation and evaluation is contained in Appendix I.

The core of the plan is structures at points where saltwater enters smaller canals that lead to interior marshes: the perimeters of Calcasieu and Sabine lakes, the Gulf of Mexico, and major waterways. This treats the adverse effects of basin-wide hydrologic alterations. Hydrologic restoration projects at Black Lake, Rycade Canal and twelve other areas, and marsh management in the Cameron-Creole area and at Brown Lake, are critical in preserving marshes. Shoreline protection projects at Sweet and Willow Lakes, from Constance Beach to Ocean View, and at five others sites, are also critical in preserving marsh. Freshwater introduction from the Toledo Bend Reservoir and marsh creation with dredged material from the Calcasieu Ship Channel are other critical projects. All these projects meet the key objectives of preserving marsh by restoring hydrology and maintaining the geological framework of the basin.

The availability of suspended sediment is limited throughout most of the basin. Freshwater diversions have been incorporated into projects where nutrient and sediment introduction may benefit wetlands. To the degree possible, actively managed perimeter structures will be opened during periods when nutrients and sediments can be introduced into wetlands.

Supporting projects are located in interior large open water areas and other severely eroding areas where perimeter projects alone would not provide a sufficient degree of protection or restoration. Bank protection at Johnsons Bayou; hydrologic restoration at Oyster and Mud Bayous and other sites; marsh management in Tripod Bayou, East Mud Lake, and Black Lake; marsh creation at Hog Island Gulley; beach nourishment with dredged material; freshwater introduction from the GIWW; sediment and nutrient trapping in Deep Lake and Browns Lake-Starks Canal area; and terracing are all supporting projects. These short-term projects help preserve the wetlands of the basin

Table CS-2 lists all the projects in the selected plan. A detailed description of projects in the selected plan can be found in Appendix I.

COSTS AND BENEFITS

The selected plan projects will protect, restore, or preserve 24,810 acres of wetlands at a cost of $136,460,000. The plan will prevent all of the marsh loss expected to occur over the next twenty years, producing a net gain of 2,910 acres of wetlands over this same period.

Table CS-2
Summary of the Calcasieu/Sabine Basin Projects

Project No.	Project Name	Project Type	Priority List Projects	Acres Created, Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comments
Critical Projects, Short-Term								
XCS-48(NO-13)	N.W. Gum cove Area	FD		200	1,171	3,013,000	2,600	Related to XCS-48a, 48b, CS-5a, 5a/12, 5b & 5b/12.
CS-5a/12	Black Bayou FW Diver. & Hydro Rest	FD/HR		376	4,311	4,263,000	1,000	Contains CS-5a &12; related to XCS-48 (NO-15,17,18,19,20, 21), PCS-10, XCS-48c & 48d.
CS-12	Black Bayopu Hydrologic Restoration	FD		[215]	[3,413]	[4,263,000]	1,200	
CS-2	Rycade Canal Structure	HR		* [3,000]	[10,000]	[650,000]		Relates to XCS-48 (NO-8), (SA-1), (SA-1a), and (SA-1b), completed by La. CRD
PCS-17	Camerol-Creole Plugs	HR	PPL1	600	1,741	534,000	300	Same as CS-17.
PCS-10	Rock Weirs	HR		23	259	1,607,000	6,200	Contained w/n CS-5a/12 & CS-12, rel. to XCS-48 (NO-17 to NO-21).
PCS-11	Sabine Lake Canal Closures	HR		12	58	2,090,000	36,000	Related to XCS-48 (NO-21), (SA-5), (SA-7), (SO-1), & (SO-2); XCS-48g.
PCS-14	Kelso Bayou Structure	HR		34	319	1,587,000	5,000	Contained w/n XCS-48 (NO-5); adj. to CS-9, XCS-48 (NO-1), XCS-53
PCS-25	Highway 384 Area	HR	PPL2	150	283	521,000	1,800	
PCS-31	Saltwater Barrier in Brannon Ditch	HR		na	na	686,000	na	Related to PCS-1
XCS-44	West Cove Canal Plug	HR		[52]	[985]	[253,000]	300	Related to XCS-48 (SA-10), contained w/n XCS-51/44.
XCS-46	North Line Canal Structure	HR		461	4,315	607,000	100	Benefits XCS-48 (SA-1),(Sa-5), (NO-14a).
XCS-47,48i,j,k&p	Replace Sabine NWR HQ Structures	HR/MM	PPL3	953	6,490	3,841,000	600	Same as XCS-48i,j,k, & p combined; will benefit XCS-48 (SA-1),(SA-2),(SA-4),(NO-8a).
XCS-48d(NO-17)	Black B. Cutoff Spoil Rep. & Rock Weir	HR		[88]	[613]	[977,000]	1,600	Contained w/n CS-5a/12, CS-5b/12, related to XCS-48 (NO-17).
XCS-48f	Structure near Long Point Bridge	HR		52	3,672	526,000	100	XCS-48 (SA-10), PCS-4.
XCS-48(NO-3)	N. Black Lake Freshwater Impound	HR		* 238	800	1,314,000	1,600	Related to PCS-1
XCS-48(NO-17)	N.W. Black Bayou Area	HR		88	613	2,322,000	3,800	Relates to CS-5a/12,5b/12, PCS-10, XCS-48b, 48d.
XCS-48(NO-18)	SE Black Bayou Area	HR		[144]	[607]	[2,153,000]	3,500	Contained w/n CS-5a/12, CS-12, related to PCS-10.
XCS-48(NO-19)	Black Bayou Area	HR		126	1,110	3,243,000	2,900	Related to CS-5a/12, CS-12, PCS-10.
XCS-48(SA-10)	W. Cove Canal Unit	HR		76	599	2,573,000	4,300	Related to XCS-47/48ijkp, XCS-44, XCS-51/44, XCS-48o, PCS-4.
XCS-52	Plug Canal near B. Peconi	HR		77	165	443,000	2,700	Related to CS-4a.
XCS-53	Alkali Ditch Structure	HR		17	303	1,587,000	5,200	Related to CS-9, PCS-14, XCS-48 (NO-1).
XCS-54	Goose Lake Restoration Project	HR		34	105	1,718,000	16,400	Related to PCS-1
XCS-51/44	Mine Calc. SC Spoil & Plug W. Cove Canal	MC/HR		235	1,056	1,929,000	1,800	Contains XCS-44, related to XCS-48 (SA-10).
CS-04a/PCS7	Cameron-Creole O&M	MM	PPL3	2,602	10,682	2,895,000	300	Contains PCS-22
CS-09	Brown Lake Hydrologic Restoration	MM	PPL2	282	1,020	2,532,000	2,500	Same as XCS-48 (NO-1) & relates to (NO-5), PCS-14, and XCS-53
CS-01a	Peveto to Holly Beach S. Protection	SP		2,723	3,890	7,280,000	1,900	Relates to XCS-48n and XCS-48 (SO-5)
CS-01c	Constance Beach to Ocean View S. Pro	SP		55	99	5,900,000	59,600	Relates to XCS-48n and XCS-48 (SO-3), part of XCS-48r
CS-11b	Sweet & Willow Lake-GIWW Bank Stab.	SP/HR		294	4,477	2,626,000	600	Contains CS-11, CS-11a, XCS-41
PCS-18	Sabine Pool 3 Levee Repair	SP	PPL1	5,542	8,985	4,484,000	500	
PCS-01	Erosion Protection along GIWW	SP		1,542	1,613	20,000,000	12,400	Related to PCS-26, PCS-27, XCS-48 (NO-19).
PCS-26	Perry Ridge, Shoreline Protection	SP		109	657	3,886,000	5,900	Part of PCS-1
PCS-27	Clear Marais	SP	PPL2	1,067	2,966	1,521,000	500	Part of PCS-1
XCS-42	GIWW Spoil Bank Maintenance	SP		814	1,517	295,000	200	Relates to CS-4a, contains CS-11, 11a, &11b.
XCS-48a	Spoil bank rep.-GIWW at Vinton Canal	SP		7	73	357,000	4,900	Part of CS-5a, CS-5a/12, XCS-48 (NO-13) & (NO-15).
Subtotal: Critcal Projects, Short-Term				18,790	63,350	86,180,000		

Table CS-2
Summary of the Calcasieu/Sabine Basin Projects (Continued)

Project No.	Project Name	Project Type	Priority List Projects	Acres Created, Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comments
Supporting Projects, Short-Term								
CS-04b	Freshwater Introduction & Outfall Mgt.	FD		132	400	1,018,000	2,500	Related to CS-4a.
CS-05a	Sabine Freshwater Introduction	FD		[376]	[4,311]	[2,228,000]	2,100	Contained w/n CS-5a/12 & 5b/12, relates to XCS-48 (NO-13,14, 14a &15).
CS-13	Back Ridge Freshwater Introduction	FD		2	27	1,425,000	52,800	Related to CS-4a, CS-4b, CS-14.
XCS-48b	Intro. Freshwater from GIWW	FD		[21]	[67]	[778,000]	11,600	Same as CS-5a, CS-5a/12, part of XCS-48 (NO13), (NO15).
PCS-12/18	Oyster Bayou & Mud Bayou Structures	HR		631	1,348	2,271,000	1,700	Contains XCS-48 (SO-8), XCS-48q, PCS-12, PCS-18.
PCS-21	Moss Lake Hydrologic Restoration	HR		19	92	1,245,000	13,500	
XCS-48(NO-05)	South Brown lake Hyd. Rest.	HR		500	1,387	3,683,000	2,700	Related to PCS-14, CS-9, XCS-48 (NO-1).
XCS-48(NO-15)	Black Bayou Cutoff Canal Area	HR		[16]	[122]	[1,617,000]	13,300	Contained w/n CS-5a/12, CS-5b/12, related to XCS-48b, XCS-48c.
XCS-48(NO-20)	W. Black Bayou Area	HR		[82]	[173]	[3,243,000]	200	Contained w/n CS-5a/12, CS-5b/12, related to PCS-10, PCS-11, PCS-17b.
XCS-48(NO-21)	SW Black Bayou Area	HR		[276]	[687]	[1,411,000]	2,100	Contained w/n CS-5a/12, CS-5b/12, related to PCS-10, PCS-11, PCS-17b.
XCS-48(SA-05)	Greens Lake Unit	HR		216	3,226	2,456,000	800	Contains part of PCS-11, related to PCS-17b.
XCS-48(SA-07)	S. Willow Bayou Unit	HR		46	777	1,707,000	2,200	Contains part of PCS-11, related to PCS-17b.
XCS-48(SA-08)	NW West Cove Unit	HR			25	332,000	13,300	Contains part of XCS-48h, related to XCS-47/48ijkp.
XCS-48(SO-01)	Johnsons Bayou Unit	HR		[1,147]	[3,854]	[2,430,000]	600	Related to PCS-11, PCS-17 b & XCS-48g.
XCS-48(SO-05)	W. Mud Lake Area	HR		300	1,281	1,017,000	800	Related to CS-1a, XCS-48l, XCS-48n.
XCS-48(SO-08)	Oyster Bayou/Lake Unit	HR		[2,080]	[7,000]	[4,989,000]	700	Major structures w/n PCS-12/18, XCS-48q, PCS-18.
XCS-48c	GIWW Canal Closures	HR		[21]	[119]	[918,000]	7,700	Related to XCS-48 (NO-15) & (NO-17).
XCS-48o	Rock Liner in Canal-SW portion of W. Cove	HR		[25]	[53]	[147,000]	2,800	Related to PCS-24, contained w/n XCS-48 (SO-7).
XCS-48m	Utilize Dredge Material-Beach Nourishment	MC		70	88	1,647,000	18,700	Related to PCS-2, benefits XCS-48 (SO-2).
XCS-48(SA-09)	Hog island Gulley Area	MC		16	644	1,329,000	2,100	Related to XCS-47/48ijkp.
XCS-50	St. Johns Island	MC		137	295	1,934,000	6,600	Related to XCS-48 (SO-8).
CS-8/ XCS-48 & (NO-2a)	Black Lake North Area	MM		14	298	1,144,000	3,800	Same as CS-8, related to PCS-23.
CS-10	Grand Lake Ridge Area	MM		662	832	1,117,000	1,300	
CS-14	Tripod Bayou	MM		51	190	1,127,000	5,900	Related to CS-4a, CS-4b, CS-13.

Table CS-2
Summary of the Calcasieu/Sabine Basin Projects (Continued)

Project No.	Project Name	Project Type	Priority List Projects	Acres Created, Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comments
Supporting Projects, Short-Term (Continued)								
PCS-24	East Mud Lake	MM	PPL2	1,520	3,121	2,268,000	700	Related to CS-1b, XCS-48 (SO6).
XCS-48n	Structure at LA Hwy. 27 W. of Holly Beach	MM	*	[na]	[500]	[224,000]	400	Related to PCS-24, contained w/n XCS-48 (SO-5).
XCS-48(NO-02)	Black Lake NE Area	MM		10	386	1,954,000	5,100	Contains part of PCS-23.
CS-01b	Holly Beach to Cal. Pass	SP		90	301	5,734,000	19,000	Relates to XCS-48 (SO-8 & 8a) and PCS-24
CS-07	West Black Lake Shore Protection	SP		120	640	743,000	1,200	Relates to XCS-48 (NO-4) and PCS-23
PCS-02(SO-02)	Breakwater at LA Point	SP		[73]	[93]	[2,227,000]	23,900	Related to XCS-48n, contained w/n XCS-48 (SO-2).
PCS-04	Long Point Lake Shore Protection	SP		25	25	710,000	28,400	Related to XCS-48 (SA-10).
PCS-29	Hebert-Precht Rip-rap	SP	*	75	250	126,000	500	Related to CS-4a
PCS-32	Bayou Choupique	SP		[30]	[30]	[667,000]	22,200	Contained w/n PCS-1.
XCS-34	Spoil along West Side CSC	SP		na	na	na		Related to XCS-48 (SA-10).
XCS-37	Rock Dike	SP		50	58	2,087,000	36,000	Located from mile 5 to 9.5 on E. side of channel.
XCS-39	Turners Bay Rock Revetment	SP		30	61	1,087,000	17,800	
XCS-48(NO-04)	West Black Lake Area	SP		[242]	[1,763]	[1,282,000]	700	Contained w/n CS-7 and PCS-23.
XCS-48(SO-02)	SW Johnsons Bayou Unit	SP		891	2,994	4,719,000	1,600	Related to PCS-11, PCS-2, XCS-48m.
XCS-36	Compost Demo Project	ST	*	10	10	250,000	25,000	Within XCS-48(NO-5) area.
XCS-48(NO-08)	S.W. Black Lake Area	ST		29	1,583	2,474,000	1,600	Related to CS-2, PCS-34.
XCS-48(NO-08a)	S. Gum Cove Area	ST		101	264	230,000	900	Related to XCS-46.
XCS-48(SA-01)	Browns Lake-Starks Canal Area	ST		87	6,583	1,619,000	200	Related to XCS-47/48lkp.
XCS-48(SA-06)	Deep Lake Bayou Unit	ST		5	789	1,185,000	1,500	
CS-15	Boudreaux-Broussard Marsh Protect	T		68	369	1,127,000	3,100	Related to CS-4a, CS-4b.
FCS-19	W. Hackberry Plantings	VP	PPL1	96	96	100,000	1,000	
PCS-34	Plantings to build bottom elevation	VP	*	2	5	128,000	25,600	w/n XCS-48 (NO-8) area.
XCS-49	Turners Bay Vegetative Planting	VP		18	18	287,000	15,900	
Subtotal: Supporting Projects, Short-Term				6,020	28,460	50,280,000		

Table CS-2
Summary of the Calcasieu/Sabine Basin Projects (Continued)

Project No.	Project Name	Project Type	Priority List Projects	Acres Created, Protected, or Restored	Net Benefited Acres	Estimated Cost ($)	Cost Per Benefited Acre ($/Ac)	Comments
Supporting, Long-Term Projects								
CS-05b/12	Sabine Freshwater Inro. & Hydro. Rest.	FD/HR		[376]	[4,311]	[8,119,000]	500	Contained w/n CS-5b &12, related to CS-5a/12, XCS-48 (NO-13, 14, 14a, &15).
XCS-33	Toledo Bend Water Mgt.	FD		920	10,770	na	na	Further study required. Benefits CS-5a/12, XCS-48 (NO-19 & 20), (SA-5 & 7) & (SO-1).
XCS-48(NO-14a)	Starks Bayou Unit	HR	*	[16]	[122]	[1,617,000]	2,000	Contained w/n CS-5a/12 and CS-12.
XCS-48(SA-01a)	S. Browns Lake-E. Hog Is. Gulley	HR	*	445	1,500	994,000	700	Related to XCS-47/48ijkp.
XCS-48(SA-01b)	E. Back Ridge Canal Area	HR	*	238	800	913,000	1,100	Related to XCS-47/48ijkp.
XCS-48(SA-02)	S. Back Ridge Canal Area	HR	*	[356]	[1,200]	[605,000]	500	Contained w/n XCS-47/48ijkp.
XCS-48(SO-04)	Four Mile Square Unit	HR	*	594	2,000	1,288,000	600	Related to XCS-47/48ijkp.
XCS-48(SO-09)	Rabbit Island	MC	*	239	300	249,000	800	Benefitted by PCS-17a.
XCS-48h(SA-08)	Rebuild spoil-S. side	MM	*	[59]	[200]	[30,000]	200	Related to XCS-47/48ijkp and XCS-48 (SA-08).
XCS-48l	Hwy. 27 culverts	MM	*	[59]	[200]	[180,000]	900	Related to XCS-48 (SA-1) & (SA-10).
XCS-48(NO-14)	W. Gum Cove-Black Bayou Area	MM	*	[120]	[400]	[994,000]	3,000	Same as CS-5a/12, CS-5b/12, & CS-12.
CS-06	Black Lake Shore Protection	SP		2	2	107,000	53,500	Relates to PCS-23
PCS-05	Calcasieu Ship Channel Erosion	SP	*	30	100	1,500,000	15,000	
XCS-38	Rock Revetment at Dugas Landing	SP	*	40	50	1,083,000	21,700	
XCS-48(SO-08a)	W. Calcasieu River Chenier	SP	*	327	1,100	11,171,000	10,200	Related to CS-1b.
XCS-48(SA-03)	Pool 3 Unit	ST	*	1,160	4,000	2,085,000	500	Related to CS-18 PPL 1 project.
XCS-48(SA-04)	Old North Bayou Unit	ST	*	356	1,200	1,036,000	900	Related to XCS-47/48ijkp.
XCS-48(SO-07)	SW West Cove Unit	ST	*	238	800	944,000	1,200	Related to XCS-48o.
XCS-48(NO-10)	E. Gum Cove Area	VP	*	[240]	[800]	[684,000]	900	Adjacent to XCS-48 (NO-4) & (NO-9).
Total Calcasieu/Sabine Basin **				24,810	91,810	136,460,000		Only Critical Short-Term and Supporting Short-Term projects included in total

FD Freshwater Diversion
HR Hydrologic Restoration
MC Marsh Creation
MM Marsh Management
SD Sediment Diversion
SP Shoreline Protection
ST Sediment/Nutrient Trapping
T Terracing
VP Vegetative Plantings
Net Benefited Acres include aquatic vegetation enhanced wetlands.
[#] Indicates cost and benefits are dulicates of other projects; values are not contained in the totals.
* Denotes benefits were not verified by the Wetland Value Assessment Work Group.
** Total cost and benefits include only Critical Short-Term and Supporting Short-Term projects
Projects in the Black Bayou region (i. e. XCS-48 (NO-13 through NO-21)) are part of an SCS Watershed Program under the authority of PL-566.

IMPLEMENTATION

In the CWPPRA, Congress did not ask the Task Force for recommendations on restoring the Louisiana Coast--it demanded real world action. The Task Force's response is to implement this Restoration Plan by building specific projects identified in the basin plan, in priority order. There will be two major tracks for this effort: 1) continued work on Priority Project Lists; and 2) new long-term efforts to build large-scale projects and to otherwise accomplish the plan objectives. The Task Force action agenda is outlined in this section.

RESPONSIBILITIES FOR IMPLEMENTATION

Putting the restoration plan into effect will require major commitments from the governments of the United States and Louisiana, and from the affected public. For its part, the Task Force will continue the existing, effective structure in which overall planning and analysis is conducted by interagency committees and work groups, and individual agencies are assigned the lead in implementation of projects and studies.

Input from the public and from the academic community has been an invaluable part of the planning process, but more needs to be done. In early 1994, the Task Force will develop and adopt a strategy to improve involvement of the public in the ongoing CWPPRA effort. Elements of the strategy are expected to include: designation of a central contact to be responsible for coordinating all public participation; use of a periodic newsletter to report on the status of projects and studies; periodic public meetings, including the annual meetings associated with development of the Priority Project List, in order to receive public input; and other activities involving both outreach and input. The revised public involvement program will be developed in conjunction with the Citizen Participation Group. An outline of a draft public involvement strategy is included in Exhibit 2.

In 1994, the Task Force will establish and fund a mechanism for securing scientific input. This input will help ensure that the evaluation, selection, and design of priority projects will be based on the best scientific information available, and that the Task Force is kept apprised of newly emerging predictive tools.

BUILDING PRIORITY PROJECTS

The Task Force will continue to select and build projects under the existing CWPPRA authorization. Key elements of this work include: submitting annual Priority Project Lists; improving procedures for selecting projects; performing project monitoring; addressing issues and conflicts which could affect project implementation; and ensuring compliance with the National Environmental Policy Act and other laws.

SUBMITTING ANNUAL PRIORITY PROJECT LISTS

The Task Force will continue to submit its annual Priority Project List to Congress as a continuation of the current authorization. Inclusive of cost-shared funds from the State of Louisiana, the total annual construction, operation, and monitoring budget is about $40 million per year. Selected projects will generally be small scale and generally will cost less than $5 million for construction, operation, and maintenance. Demonstration projects to enhance restoration science will be included in these lists.

IMPROVING PROCEDURE FOR SELECTING PROJECTS

In 1994, the Task Force will revise the procedure for selecting priority projects in order to ensure that the projects submitted to Congress make the most efficient use of the available funding, consistent with the plan. Critical projects will have a high priority, but consideration also will be given to short-term measures that can be built quickly and that contribute to the implementation of comprehensive regional strategies. The Task Force will also consider the idea of implementing important priority projects in multi-year phases. Revisions may also include modification of the evaluation process, such as the calculation of wetland values, to ensure that these procedures reflect the most current scientific information.

Now that the restoration plan is completed, time will be available to increase the level of design work done in conjunction with project evaluation; this will increase the amount of information available on each project prior to selections and rankings. Further, as noted above, the new procedures and reduced constraints on time will provide for a greater level of participation by the public and academic community.

PERFORMING PROJECT MONITORING

Detailed monitoring will be conducted on all CWPPRA-funded restoration projects, including demonstration projects, to objectively determine the degree to which programmatic and project-specific goals are achieved and to provide a basis for improved project design and operation. Monitoring will adhere to rigorous protocols that were developed by the Task Force's Monitoring Work Group, with input from the academic community (see Exhibit 5). Any revisions in those protocols will be developed with interagency participation and with collaborative input by the academic research community.

Monitoring results will provide an excellent basis for modifying existing projects to enhance their effectiveness, and for improving the selection and design of future small-scale and large-scale restoration projects. Monitoring results and associated evaluations for CWPPRA-funded projects will be provided to Congress every three years, in accordance with Section 303 (b)(7) of the CWPPRA. The State of Louisiana has been designated to develop an integrated, digitized monitoring data base. A readily accessible data base will encourage the publication of monitoring results, so that the ecosystem management techniques developed in Louisiana can be made available to, and be peer-reviewed by, a national and international audience.

ADDRESSING ISSUES AND CONFLICTS

In the process of building projects and preparing this plan, the Task Force has identified issues and conflicts which could constrain the restoration effort. These issues and conflicts arise because of the complex and dynamic nature of the wetlands loss problem, the extensive human interest (including private property interests) in the coastal zone, and the fact that projects are designed to have potentially far-reaching impacts. This situation is certain to continue as ever more ambitious projects are implemented.

As an ongoing component of project-building and other planning, the Task Force will address these issues and conflicts, recognizing that the resolution of certain issues will require authority beyond that which it has been granted. For the Task Force's part, issue resolution will be done in the context of specific projects, where designs, mitigation efforts, or other measures may be able to minimize the most severe effects on existing economic and property interests. Issues common to many projects may also be addressed in coordination with the State of Louisiana, or in the CWPPRA Conservation Plan.

ENSURING ENVIRONMENTAL COMPLIANCE

All projects must and will comply with federal, state and local statues, including but not limited to the National Environmental Policy Act (NEPA), Section 404 dredge and fill requirements of the Clean Water Act, the Endangered Species Act, and the Louisiana Coastal Zone Management Program. The Task Force will ensure that an appropriate level of environmental review and documentation will be completed for every project which is authorized for construction. The programmatic EIS for the restoration plan, which is part of this report, will support NEPA compliance, but does not substitute for the requirement that project-specific NEPA documents be prepared.

LONG-TERM EFFORTS

Two important principles are the basis for the long-range restoration goals in this plan. The first is the recognition that large, complex, innovative long-term projects are essential to ultimate restoration of Louisiana's coastal wetlands. The completion of feasibility studies is the first essential step toward the implementation of these projects. The second is that the restoration plan must be a living document, subject to modification with the finding of new facts through monitoring, the resolution of issues, and the conclusions arrived at in completing the needed feasibility studies.

FEASIBILITY STUDIES

The Task Force will immediately begin preparation of detailed feasibility studies on the large-scale projects which are the cornerstone of the plan. These studies will be funded from the $5 million allocated each year for planning purposes in the current CWPPRA funding stream. As these individual studies are completed, large-scale projects will be recommended for implementation. The costs to construct these regional scale projects will almost certainly exceed the level of funding currently provided through the CWPPRA. To build these essential projects will require authorization and adequate funding. Two means are available to pursue the construction of these measures. Following one course of action the Task Force will designate an appropriate lead federal agency for each project, and this agency will present the project, through its normal channels, to the Congress for construction authorization and funding. The second option available would be to seek an increase in the current CWPPRA allocation and execute the projects under the existing authorization.

In 1994, it is expected that priority will be given to studies investigating the feasibility of diversion of Mississippi River sediments into the basins of the deltaic plain. The specific area of the study will be developed in consultation with the State of Louisiana (Exhibit 8 consists of a letter from the Governor of Louisiana with the State's recommendations concerning feasibility studies). A study involving the enhanced management of sediments in the Atchafalaya River deltas, to optimize growth of deltaic wetlands, is currently being developed. This study, while being undertaken independently, is a direct result of the development of this plan.

As soon as possible, additional studies will be conducted, including: the evaluation of increasing diversions into the Atchafalaya River (see discussion of Section 307 (b) of CWPPRA in the introduction to this report); evaluation of sediment and flow diversions from the Mississippi and Atchafalaya rivers; regional-scale barrier island restoration or construction; and large salinity-control structures on major navigation channels.

Each feasibility study will be sharply focused to identify implementable projects that will provide regional wetland benefits through restoration of beneficial natural processes. Every effort will be made to fully utilize information gathered from previous feasibility investigations and other studies. The studies will address a wide range of economic, social, engineering, and environmental factors which impact proper project design, and will consider matters such as alternative designs and locations, cost-effectiveness, and mitigation. Development of a sediment budget for the lower Mississippi River will provide critically needed information for feasibility studies of large-scale sediment diversions. Where appropriate, hydraulic and ecological models will be used to help predict the effects of proposed large-scale restoration measures.

MAINTAINING THE PLAN AS A LIVING DOCUMENT

Just as the Louisiana coast is a dynamic environment, this Restoration Plan must be a dynamic document. The Task Force will continue to evolve the strategies presented here in light of the new information it will gather over time. The monitoring of constructed priority list projects will provide new working knowledge of wetland restoration. The resolution of significant issues may at times fall outside the authority of the Task Force, forcing changes in the execution of this plan. The completion of the needed feasibility studies will provide clearer direction for this restoration effort, and implementation of larger projects, because of their expected regional benefits, may eliminate the need for some smaller protection-oriented projects.

This evolving approach must be embraced by the member agencies of the Task Force through their commitments to coastal restoration in the execution of their overall missions. The growth of this plan will also incorporate the execution of non-CWPPRA projects and the long-term development and application of regulatory authorities. The implementation of the plan presented here will provide a road map for restoration of Louisiana's coastal wetlands.

SUMMARY

The Task Force has presented in this plan an action oriented program to respond to the Congressional mandate. The plan provides for immediate short-term actions to reduce coastal wetlands loss and prescribes long-term measures to overcome and neutralize this threat. The plan is submitted with the knowledge that the support of the citizens of the State of Louisiana, the academic community, and the Congress is necessary for its full and successful implementation. The Task

Force agencies are firmly committed to execution of the plan and will make every effort to bring long-term benefits to Louisiana and the Nation.

GLOSSARY

Accretion Deficit. That lowering of ground surface elevation due to subsidence which is not compensated by the rise in ground surface elevation due to accretion.

Average Corrected Landing. The average fishery landing (in this report from 1983 to 1990), corrected to include estimates of unreported landings, expressed in pounds per year.

Background Loss. Land loss attributable to both natural forces and manmade alterations of the land and river systems prior to 1958. For this report the annual rate of background loss was extrapolated from the 1932-1958 data set.

Batture. The alluvial land between a river at low-water stage and a levee.

Bird's Foot Delta. The modern Mississippi River delta, which resembles a bird's foot, unlike the fan-shaped deltas generally formed in shallow water.

Brackish Marsh. Wetland habitat dominated by any or several of the following plant species: Smooth Cordgrass, Black Rush, Glasswort, and Saltwort. Salinity ranges from 10 to 19 ppt.

Conservation Plan. The coastal wetlands conservation plan developed by the State of Louisiana in accordance with Public Law 101-646, Sec. 304.

Crevasse. A breach in the levee of a river.

Dedicated Dredging. The excavating of material from a water bottom for the express purpose of utilizing the material as fill in a project area.

Excess Loss. Land loss that exceeds that which is attributable to background loss.

Exvessel Price. Price received by the harvester for fish, shellfish, and other aquatic animals.

Fastlands. Lands which are separated from a coastal estuary system by levees.

Forested Wetland. Wetland habitat dominated by any or several of the following tree species: Bald Cypress, Buttonbush, Black Willow, and Water Tupelo. Salinity is 0 ppt.

Fresh Marsh. Wetland habitat dominated by any or several of the following plant species: Sawgrass, Bullwhip, Common Cattail, Roseau, Maidencane, Spikerush, and Alligator-weed. Salinity ranges from 0 to 5 ppt.

Geotextile. Man-made fabric used in the foundation of levees to minimize the size of the berms required and under stone or concrete bank armoring to retain soils.

Gross Exvessel Value. The value of a fishery calculated by applying the 1992 normalized price to the 1983-1990 average corrected landing.

Intermediate Marsh. Wetland habitat dominated by any or several of the following plant species: Deerpea, Walter's Millet, Bulltongue, Bullwhip, Sawgrass, and Saltmeadow cordgrass. Salinity ranges from 5 to 9 ppt.

Louisiana Coastal Wetlands Conservation and Restoration Task Force. A task force required by Public Law 101-646, Title III, sec. 303(a), consisting of the Secretary of the Army, the Administrator of the Environmental Protection Agency, the Governor of the State of Louisiana, and the Secretaries of the Departments of the Interior, Agriculture, and Commerce.

Louisiana Coastal Wetlands Restoration Plan. The plan required by Public Law 101-646, Title III, sec. 303(b), to restore and prevent the loss of coastal wetlands in Louisiana.

Marine Processes. Processes which originate offshore that affect coastal marshes, such as, tides, currents, littoral drift and storm surges.

National Geodetic Vertical Datum (NGVD). The datum to which all elevations in this report are referenced. Zero NGVD roughly correlates to mean sea level along the Louisiana coast.

Natural Loss. Land loss due to subsidence, global sea level rise, sediment deprivation, and hydraulic alteration which is attributable to natural forces such as geological downwarping, compaction of the sediment column, and natural river distributary switching and levee building.

Normalized Price. The price of a fishery calculated by applying (for this report) the 1992 Consumer Price Index to the exvessel prices of (for this report) 1983 1990 catches.

Relative Sea Level Rise (RSLR). The increase in the difference between ground elevations and mean sea level elevations.

Restoration Plan. The Louisiana Coastal Wetlands Restoration Plan.

Saline Marsh. Wetland habitat dominated by any or several of the following plant species: Smooth Cordgrass, Black Rush, Glasswort, and Saltwort. Salinity ranges above 20 ppt.

Sea Level Rise. The increase of mean sea level elevations as referenced to a fixed datum.

Sediment Accretion. A rise in the ground surface elevation due to the deposition of sands, silts and clays brought by floodwaters or an accumulation of organic matter from living and dead plants.

Spoil Banks. Elevated areas along the banks of water bodies created by the deposition of dredged material.

Subsidence. The lowering of the absolute surface elevation of the land caused by geological downwarping and compaction of the sediment column by various processes both natural and man-made.

Task Force. The Louisiana Coastal Wetlands Conservation and Restoration Task Force.

Tidal Drag. The cumulative frictional force, supplied by the marshes and geomorphic features of an estuary, which resists the movement of the tide and thus decreases its amplitude.

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LOUISIANA COASTAL WETLANDS RESTORATION PLAN

Summary and Complete Text of the CWPPRA

Exhibit 1

COASTAL WETLANDS PLANNING, PROTECTION, & RESTORATION ACT
(Public Law 101-646, Title III)

SECTION 303. Priority Louisiana Coastal Wetlands Restoration Projects.

- Section 303a. Priority Project List.
  - NLT 13 Jan 91, Sec. of the Army (Secretary) will convene a Task Force.
    - •Secretary
    - •Administrator, EPA
    - •Governor, Louisiana
    - •Secretary, Interior
    - •Secretary, Agriculture
    - •Secretary, Commerce
  - NLT 28 Nov 91, Task Force will prepare and transmit to Congress a Priority List of wetland restoration projects based on cost effectiveness and wetland quality.
  - Priority List is revised and submitted annually as part of President's budget.
- Section 303b. Federal and State Project Planning.
  - NLT 28 Nov 93, Task Force will prepare a comprehensive coastal wetlands Restoration Plan for Louisiana.
  - Restoration Plan will consist of a list of wetland projects, ranked by cost effectiveness and wetland quality.
  - Completed Restoration Plan will become Priority List.
  - Secretary will ensure that navigation and flood control projects are consistent with the purpose of the Restoration Plan.
  - Upon submission of the Restoration Plan to Congress, the Task Force will conduct a scientific evaluation of the completed wetland restoration projects every 3 years and report the findings to Congress.

SECTION 304. Louisiana Coastal Wetlands Conservation Planning.

- Secretary; Administrator, EPA; and Director, USFWS will:
  - Sign an agreement with the Governor specifying how Louisiana will develop and implement the Conservation Plan.
  - Approve the Conservation Plan.
  - Provide Congress with periodic status reports on Plan implementation.
- NLT 3 years after agreement is signed, Louisiana will develop a Wetland Conservation Plan to achieve no net loss of wetlands resulting from development.

SECTION 305. National Coastal Wetlands Conservation Grants.

- Director, USFWS, will make matching grants to any coastal state to implement Wetland Conservation Projects (projects to acquire, restore, manage, and enhance real property interest in coastal lands and waters).
- Cost sharing is 50% Federal / 50% State *

SECTION 306. Distribution of Appropriations.

- 70% of annual appropriations not to exceed (NTE) $70 million used as follows:
  - NTE $5 million annually to fund Task Force preparation of Priority List and Restoration Plan -- Secretary disburses funds.
  - NTE $10 million to fund 75% of Louisiana's cost to complete Conservation Plan -- Administrator disburses funds.
  - Balance to fund wetland restoration projects at 75% Federal/ 25% Louisiana ** -- Secretary disburses funds.
- 15% of annual appropriations, NTE $15 million for Wetland Conservation Grants - Director, USFWS disburses funds.
- 15% of annual appropriations, NTE $15 million for projects authorized by the North American Wetlands Conservation Act - Secretary, Interior disburses funds.

SECTION 307. Additional Authority for the Corps of Engineers.

- Section 307a. Secretary authorized to:
  - Carry out projects to protect, restore, and enhance wetlands and aquatic/coastal ecosystems.
- Section 307b. Secretary authorized and directed to study feasibility of modifying the MR&T to increase flows and sediment to the Atchafalaya River for land building and wetland nourishment.

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* 25% if the state has dedicated trust fund from which principal is not spent.

** 15% when Louisiana's Conservation Plan is approved.

activities, where appropriate, that would contribute to the restoration or improvement of one or more fish stocks of the Great Lakes Basin; and

"(2) activities undertaken to accomplish the goals stated in section 2006.

16 USC 941g.

"SEC. 2009. AUTHORIZATION OF APPROPRIATIONS.

"(a) There are authorized to be appropriated to the Director—

"(1) for conducting a study under section 2005 not more than $4,000,000 for each of fiscal years 1991 through 1994;

"(2) to establish and operate the Great Lakes Coordination Office under section 2008(a) and Upper Great Lakes Fishery Resources Offices under section 2008(c), not more than $4,000,000 for each of fiscal years 1991 through 1995; and

"(3) to establish and operate the Lower Great Lakes Fishery Resources Offices under section 2008(b), not more than $2,000,000 for each of fiscal years 1991 through 1995.

"(b) There are authorized to be appropriated to the Secretary to carry out this Act, not more than $1,500,000 for each of fiscal years 1991 through 1995.".

Coastal Wetlands Planning, Protection and Restoration Act.

TITLE III—WETLANDS

16 USC 3951 note.

SEC. 301. SHORT TITLE.

This title may be cited as the "Coastal Wetlands Planning, Protection and Restoration Act".

16 USC 3951.

SEC. 302. DEFINITIONS.

As used in this title, the term—

(1) "Secretary" means the Secretary of the Army;

(2) "Administrator" means the Administrator of the Environmental Protection Agency;

(3) "development activities" means any activity, including the discharge of dredged or fill material, which results directly in a more than de minimus change in the hydrologic regime, bottom contour, or the type, distribution or diversity of hydrophytic vegetation, or which impairs the flow, reach, or circulation of surface water within wetlands or other waters;

(4) "State" means the State of Louisiana;

(5) "coastal State" means a State of the United States in, or bordering on, the Atlantic, Pacific, or Arctic Ocean, the Gulf of Mexico, Long Island Sound, or one or more of the Great Lakes; for the purposes of this title, the term also includes Puerto Rico, the Virgin Islands, Guam, the Commonwealth of the Northern Mariana Islands, and the Trust Territories of the Pacific Islands, and American Samoa;

(6) "coastal wetlands restoration project" means any technically feasible activity to create, restore, protect, or enhance coastal wetlands through sediment and freshwater diversion, water management, or other measures that the Task Force finds will significantly contribute to the long-term restoration or protection of the physical, chemical and biological integrity of coastal wetlands in the State of Louisiana, and includes any such activity authorized under this title or under any other provision of law, including, but not limited to, new projects, completion or expansion of existing or on-going projects, individ-

ual phases, portions, or components of projects and operation, maintanence and rehabilitation of completed projects; the primary purpose of a "coastal wetlands restoration project" shall not be to provide navigation, irrigation or flood control benefits;

(7) "coastal wetlands conservation project" means—

(A) the obtaining of a real property interest in coastal lands or waters, if the obtaining of such interest is subject to terms and conditions that will ensure that the real property will be administered for the long-term conservation of such lands and waters and the hydrology, water quality and fish and wildlife dependent thereon; and

(B) the restoration, management, or enhancement of coastal wetlands ecosystems if such restoration, management, or enhancement is conducted on coastal lands and waters that are administered for the long-term conservation of such lands and waters and the hydrology, water quality and fish and wildlife dependent thereon;

(8) "Governor" means the Governor of Louisiana;

(9) "Task Force" means the Louisiana Coastal Wetlands Conservation and Restoration Task Force which shall consist of the Secretary, who shall serve as chairman, the Administrator, the Governor, the Secretary of the Interior, the Secretary of Agriculture and the Secretary of Commerce; and

(10) "Director" means the Director of the United States Fish and Wildlife Service.

SEC. 303. PRIORITY LOUISIANA COASTAL WETLANDS RESTORATION PROJECTS. 16 USC 3952.

(a) PRIORITY PROJECT LIST.—

(1) PREPARATION OF LIST.—Within forty-five days after the date of enactment of this title, the Secretary shall convene the Task Force to initiate a process to identify and prepare a list of coastal wetlands restoration projects in Louisiana to provide for the long-term conservation of such wetlands and dependent fish and wildlife populations in order of priority, based on the cost-effectiveness of such projects in creating, restoring, protecting, or enhancing coastal wetlands, taking into account the quality of such coastal wetlands, with due allowance for small-scale projects necessary to demonstrate the use of new techniques or materials for coastal wetlands restoration.

(2) TASK FORCE PROCEDURES.—The Secretary shall convene meetings of the Task Force as appropriate to ensure that the list is produced and transmitted annually to the Congress as required by this subsection. If necessary to ensure transmittal of the list on a timely basis, the Task Force shall produce the list by a majority vote of those Task Force members who are present and voting; except that no coastal wetlands restoration project shall be placed on the list without the concurrence of the lead Task Force member that the project is cost effective and sound from an engineering perspective. Those projects which potentially impact navigation or flood control on the lower Mississippi River System shall be constructed consistent with section 304 of this Act.

(3) TRANSMITTAL OF LIST.—No later than one year after the date of enactment of this title, the Secretary shall transmit to the Congress the list of priority coastal wetlands restoration projects required by paragraph (1) of this subsection. Thereafter,

Reports.

the list shall be updated annually by the Task Force members and transmitted by the Secretary to the Congress as part of the President's annual budget submission. Annual transmittals of the list to the Congress shall include a status report on each project and a statement from the Secretary of the Treasury indicating the amounts available for expenditure to carry out this title.

(4) LIST OF CONTENTS.—

(A) AREA IDENTIFICATION; PROJECT DESCRIPTION.—The list of priority coastal wetlands restoration projects shall include, but not be limited to—

(i) identification, by map or other means, of the coastal area to be covered by the coastal wetlands restoration project; and

(ii) a detailed description of each proposed coastal wetlands restoration project including a justification for including such project on the list, the proposed activities to be carried out pursuant to each coastal wetlands restoration project, the benefits to be realized by such project, the identification of the lead Task Force member to undertake each proposed coastal wetlands restoration project and the responsibilities of each other participating Task Force member, an estimated timetable for the completion of each coastal wetlands restoration project, and the estimated cost of each project.

(B) PRE-PLAN.—Prior to the date on which the plan required by subsection (b) of this section becomes effective, such list shall include only those coastal wetlands restoration projects that can be substantially completed during a five-year period commencing on the date the project is placed on the list.

(C) Subsequent to the date on which the plan required by subsection (b) of this section becomes effective, such list shall include only those coastal wetlands restoration projects that have been identified in such plan.

(5) FUNDING.—The Secretary shall, with the funds made available in accordance with section 306 of this title, allocate funds among the members of the Task Force based on the need for such funds and such other factors as the Task Force deems appropriate to carry out the purposes of this subsection.

(b) FEDERAL AND STATE PROJECT PLANNING.—

(1) PLAN PREPARATION.—The Task Force shall prepare a plan to identify coastal wetlands restoration projects, in order of priority, based on the cost-effectiveness of such projects in creating, restoring, protecting, or enhancing the long-term conservation of coastal wetlands, taking into account the quality of such coastal wetlands, with due allowance for small-scale projects necessary to demonstrate the use of new techniques or materials for coastal wetlands restoration. Such restoration plan shall be completed within three years from the date of enactment of this title.

(2) PURPOSE OF THE PLAN.—The purpose of the restoration plan is to develop a comprehensive approach to restore and prevent the loss of, coastal wetlands in Louisiana. Such plan shall coordinate and integrate coastal wetlands restoration

projects in a manner that will ensure the long-term conservation of the coastal wetlands of Louisiana.

(3) INTEGRATION OF EXISTING PLANS.—In developing the restoration plan, the Task Force shall seek to integrate the "Louisiana Comprehensive Coastal Wetlands Feasibility Study" conducted by the Secretary of the Army and the "Coastal Wetlands Conservation and Restoration Plan" prepared by the State of Louisiana's Wetlands Conservation and Restoration Task Force.

(4) ELEMENTS OF THE PLAN.—The restoration plan developed pursuant to this subsection shall include—

(A) identification of the entire area in the State that contains coastal wetlands;

(B) identification, by map or other means, of coastal areas in Louisiana in need of coastal wetlands restoration projects;

(C) identification of high priority coastal wetlands restoration projects in Louisiana needed to address the areas identified in subparagraph (B) and that would provide for the long-term conservation of restored wetlands and dependent fish and wildlife populations;

(D) a listing of such coastal wetlands restoration projects, in order of priority, to be submitted annually, incorporating any project identified previously in lists produced and submitted under subsection (a) of this section;

(E) a detailed description of each proposed coastal wetlands restoration project, including a justification for including such project on the list;

(F) the proposed activities to be carried out pursuant to each coastal wetlands restoration project;

(G) the benefits to be realized by each such project;

(H) an estimated timetable for completion of each coastal wetlands restoration project;

(I) an estimate of the cost of each coastal wetlands restoration project;

(J) identification of a lead Task Force member to undertake each proposed coastal wetlands restoration project listed in the plan;

(K) consultation with the public and provision for public review during development of the plan; and

(L) evaluation of the effectiveness of each coastal wetlands restoration project in achieving long-term solutions to arresting coastal wetlands loss in Louisiana.

(5) PLAN MODIFICATION.—The Task Force may modify the restoration plan from time to time as necessary to carry out the purposes of this section.

(6) PLAN SUBMISSION.—Upon completion of the restoration plan, the Secretary shall submit the plan to the Congress. The restoration plan shall become effective ninety days after the date of its submission to the Congress.

(7) PLAN EVALUATION.—Not less than three years after the completion and submission of the restoration plan required by this subsection and at least every three years thereafter, the Task Force shall provide a report to the Congress containing a scientific evaluation of the effectiveness of the coastal wetlands restoration projects carried out under the plan in crea- Reports.

ting, restoring, protecting and enhancing coastal wetlands in Louisiana.

(c) COASTAL WETLANDS RESTORATION PROJECT BENEFITS.—Where such a determination is required under applicable law, the net ecological, aesthetic, and cultural benefits, together with the economic benefits, shall be deemed to exceed the costs of any coastal wetlands restoration project within the State which the Task Force finds to contribute significantly to wetlands restoration.

(d) CONSISTENCY.—(1) In implementing, maintaining, modifying, or rehabilitating navigation, flood control or irrigation projects, other than emergency actions, under other authorities, the Secretary, in consultation with the Director and the Administrator, shall ensure that such actions are consistent with the purposes of the restoration plan submitted pursuant to this section.

(2) At the request of the Governor of the State of Louisiana, the Secretary of Commerce shall approve the plan as an amendment to the State's coastal zone management program approved under section 306 of the Coastal Zone Management Act of 1972 (16 U.S.C. 1455).

(e) FUNDING OF WETLANDS RESTORATION PROJECTS.—The Secretary shall, with the funds made available in accordance with this title, allocate such funds among the members of the Task Force to carry out coastal wetlands restoration projects in accordance with the priorities set forth in the list transmitted in accordance with this section. The Secretary shall not fund a coastal wetlands restoration project unless that project is subject to such terms and conditions as necessary to ensure that wetlands restored, enhanced or managed through that project will be administered for the long-term conservation of such lands and waters and dependent fish and wildlife populations.

(f) COST-SHARING.—

(1) FEDERAL SHARE.—Amounts made available in accordance with section 306 of this title to carry out coastal wetlands restoration projects under this title shall provide 75 percent of the cost of such projects.

(2) FEDERAL SHARE UPON CONSERVATION PLAN APPROVAL.—Notwithstanding the previous paragraph, if the State develops a Coastal Wetlands Conservation Plan pursuant to this title, and such conservation plan is approved pursuant to section 304 of this title, amounts made available in accordance with section 306 of this title for any coastal wetlands restoration project under this section shall be 85 percent of the cost of the project. In the event that the Secretary, the Director, and the Administrator jointly determine that the State is not taking reasonable steps to implement and administer a conservation plan developed and approved pursuant to this title, amounts made available in accordance with section 306 of this title for any coastal wetlands restoration project shall revert to 75 percent of the cost of the project: *Provided, however*, that such reversion to the lower cost share level shall not occur until the Governor has been provided notice of, and opportunity for hearing on, any such determination by the Secretary, the Director, and Administrator, and the State has been given ninety days from such notice or hearing to take corrective action.

(3) FORM OF STATE SHARE.—The share of the cost required of the State shall be from a non-Federal source. Such State share shall consist of a cash contribution of not less than 5 percent of

the cost of the project. The balance of such State share may take the form of lands, easements, or right-of-way, or any other form of in-kind contribution determined to be appropriate by the lead Task Force member.

(4) Paragraphs (1), (2), and (3) of this subsection shall not affect the existing cost-sharing agreements for the following projects: Caernarvon Freshwater Diversion, Davis Pond Freshwater Diversion, and Bonnet Carre Freshwater Diversion.

SEC. 304. LOUISIANA COASTAL WETLANDS CONSERVATION PLANNING. 16 USC 3953

(a) DEVELOPMENT OF CONSERVATION PLAN.—

(1) AGREEMENT.—The Secretary, the Director, and the Administrator are directed to enter into an agreement with the Governor, as set forth in paragraph (2) of this subsection, upon notification of the Governor's willingness to enter into such agreement.

(2) TERMS OF AGREEMENT.—

(A) Upon receiving notification pursuant to paragraph (1) of this subsection, the Secretary, the Director, and the Administrator shall promptly enter into an agreement (hereafter in this section referred to as the "agreement") with the State under the terms set forth in subparagraph (B) of this paragraph.

(B) The agreement shall—

(i) set forth a process by which the State agrees to develop, in accordance with this section, a coastal wetlands conservation plan (hereafter in this section referred to as the "conservation plan");

(ii) designate a single agency of the State to develop the conservation plan;

(iii) assure an opportunity for participation in the development of the conservation plan, during the planning period, by the public and by Federal and State agencies;

(iv) obligate the State, not later than three years after the date of signing the agreement, unless extended by the parties thereto, to submit the conservation plan to the Secretary, the Director, and the Administrator for their approval; and

(v) upon approval of the conservation plan, obligate the State to implement the conservation plan.

(3) GRANTS AND ASSISTANCE.—Upon the date of signing the agreement—

(A) the Administrator shall, in consultation with the Director, with the funds made available in accordance with section 306 of this title, make grants during the development of the conservation plan to assist the designated State agency in developing such plan. Such grants shall not exceed 75 percent of the cost of developing the plan; and

(B) the Secretary, the Director, and the Administrator shall provide technical assistance to the State to assist it in the development of the plan.

(b) CONSERVATION PLAN GOAL.—If a conservation plan is developed pursuant to this section, it shall have a goal of achieving no net loss of wetlands in the coastal areas of Louisiana as a result of development activities initiated subsequent to approval of the plan, exclusive of any wetlands gains achieved through implementation of the preceding section of this title.

(c) ELEMENTS OF CONSERVATION PLAN.—The conservation plan authorized by this section shall include—

(1) identification of the entire coastal area in the State that contains coastal wetlands;

(2) designation of a single State agency with the responsibility for implementing and enforcing the plan;

(3) identification of measures that the State shall take in addition to existing Federal authority to achieve a goal of no net loss of wetlands as a result of development activities, exclusive of any wetlands gains achieved through implementation of the preceding section of this title;

(4) a system that the State shall implement to account for gains and losses of coastal wetlands within coastal areas for purposes of evaluating the degree to which the goal of no net loss of wetlands as a result of development activities in such wetlands or other waters has been attained;

(5) satisfactory assurances that the State will have adequate personnel, funding, and authority to implement the plan;

(6) a program to be carried out by the State for the purpose of educating the public concerning the necessity to conserve wetlands;

(7) a program to encourage the use of technology by persons engaged in development activities that will result in negligible impact on wetlands; and

(8) a program for the review, evaluation, and identification of regulatory and nonregulatory options that will be adopted by the State to encourage and assist private owners of wetlands to continue to maintain those lands as wetlands.

(d) APPROVAL OF CONSERVATION PLAN.—

(1) IN GENERAL.—If the Governor submits a conservation plan to the Secretary, the Director, and the Administrator for their approval, the Secretary, the Director, and the Administrator shall, within one hundred and eighty days following receipt of such plan, approve or disapprove it.

(2) APPROVAL CRITERIA.—The Secretary, the Director, and the Administrator shall approve a conservation plan submitted by the Governor, if they determine that—

(A) the State has adequate authority to fully implement all provisions of such a plan;

(B) such a plan is adequate to attain the goal of no net loss of coastal wetlands as a result of development activities and complies with the other requirements of this section; and

(C) the plan was developed in accordance with terms of the agreement set forth in subsection (a) of this section.

(e) MODIFICATION OF CONSERVATION PLAN.—

(1) NONCOMPLIANCE.—If the Secretary, the Director, and the Administrator determine that a conservation plan submitted by the Governor does not comply with the requirements of subsection (d) of this section, they shall submit to the Governor a statement explaining why the plan is not in compliance and how the plan should be changed to be in compliance.

(2) RECONSIDERATION.—If the Governor submits a modified conservation plan to the Secretary, the Director, and the Administrator for their reconsideration, the Secretary, the

Director, and Administrator shall have ninety days to determine whether the modifications are sufficient to bring the plan into compliance with requirements of subsection (d) of this section.

(3) APPROVAL OF MODIFIED PLAN.—If the Secretary, the Director, and the Administrator fail to approve or disapprove the conservation plan, as modified, within the ninety-day period following the date on which it was submitted to them by the Governor, such plan, as modified, shall be deemed to be approved effective upon the expiration of such ninety-day period.

(f) AMENDMENTS TO CONSERVATION PLAN.—If the Governor amends the conservation plan approved under this section, any such amended plan shall be considered a new plan and shall be subject to the requirements of this section; except that minor changes to such plan shall not be subject to the requirements of this section.

(g) IMPLEMENTATION OF CONSERVATION PLAN.—A conservation plan approved under this section shall be implemented as provided therein.

(h) FEDERAL OVERSIGHT.—

(1) INITIAL REPORT TO CONGRESS.—Within one hundred and eighty days after entering into the agreement required under subsection (a) of this section, the Secretary, the Director, and the Administrator shall report to the Congress as to the status of a conservation plan approved under this section and the progress of the State in carrying out such a plan, including and accounting, as required under subsection (c) of this section, of the gains and losses of coastal wetlands as a result of development activities.

(2) REPORT TO CONGRESS.—Twenty-four months after the initial one hundred and eighty day period set forth in paragraph (1), and at the end of each twenty-four-month period thereafter, the Secretary, the Director, and the Administrator shall, report to the Congress on the status of the conservation plan and provide an evaluation of the effectiveness of the plan in meeting the goal of this section.

SEC. 305 NATIONAL COASTAL WETLANDS CONSERVATION GRANTS. 16 USC 3954.

(a) MATCHING GRANTS.—The Director shall, with the funds made available in accordance with the next following section of this title, make matching grants to any coastal State to carry out coastal wetlands conservation projects from funds made available for that purpose.

(b) PRIORITY.—Subject to the cost-sharing requirements of this section, the Director may grant or otherwise provide any matching moneys to any coastal State which submits a proposal substantial in character and design to carry out a coastal wetlands conservation project. In awarding such matching grants, the Director shall give priority to coastal wetlands conservation projects that are—

(1) consistent with the National Wetlands Priority Conservation Plan developed under section 301 of the Emergency Wetlands Resources Act (16 U.S.C. 3921); and

(2) in coastal States that have established dedicated funding for programs to acquire coastal wetlands, natural areas and open spaces. In addition, priority consideration shall be given to coastal wetlands conservation projects in maritime forests on coastal barrier islands.

(c) CONDITIONS.—The Director may only grant or otherwise provide matching moneys to a coastal State for purposes of carrying out a coastal wetlands conservation project if the grant or provision is subject to terms and conditions that will ensure that any real property interest acquired in whole or in part, or enhanced, managed, or restored with such moneys will be administered for the long-term conservation of such lands and waters and the fish and wildlife dependent thereon.

(d) COST-SHARING.—

(1) FEDERAL SHARE.—Grants to coastal States of matching moneys by the Director for any fiscal year to carry out coastal wetlands conservation projects shall be used for the payment of not to exceed 50 percent of the total costs of such projects: except that such matching moneys may be used for payment of not to exceed 75 percent of the costs of such projects if a coastal State has established a trust fund, from which the principal is not spent, for the purpose of acquiring coastal wetlands, other natural area or open spaces.

(2) FORM OF STATE SHARE.—The matching moneys required of a coastal State to carry out a coastal wetlands conservation project shall be derived from a non-Federal source.

(3) IN-KIND CONTRIBUTIONS.—In addition to cash outlays and payments, in-kind contributions of property or personnel services by non-Federal interests for activities under this section may be used for the non-Federal share of the cost of those activities.

(e) PARTIAL PAYMENTS.—

(1) The Director may from time to time make matching payments to carry out coastal wetlands conservation projects as such projects progress, but such payments, including previous payments, if any, shall not be more than the Federal pro rata share of any such project in conformity with subsection (d) of this section.

(2) The Director may enter into agreements to make matching payments on an initial portion of a coastal wetlands conservation project and to agree to make payments on the remaining Federal share of the costs of such project from subsequent moneys if and when they become available. The liability of the United States under such an agreement is contingent upon the continued availability of funds for the purpose of this section.

Texas

(f) WETLANDS ASSESSMENT.—The Director shall, with the funds made available in accordance with the next following section of this title, direct the U.S. Fish and Wildlife Service's National Wetland Inventory to update and digitize wetlands maps in the State of Texas and to conduct an assessment of the status, condition, and trends of wetlands in that State.

16 USC 3955

SEC. 306. DISTRIBUTION OF APPROPRIATIONS.

(a) PRIORITY PROJECT AND CONSERVATION PLANNING EXPENDITURES.—Of the total amount appropriated during a given fiscal year to carry out this title, 70 percent, not to exceed $70,000,000, shall be available, and shall remain available until expended, for the purposes of making expenditures—

(1) not to exceed the aggregate amount of $5,000,000 annually to assist the Task Force in the preparation of the list required under this title and the plan required under this title, including preparation of—

(A) preliminary assessments;
(B) general or site-specific inventories;
(C) reconnaissance, engineering or other studies;
(D) preliminary design work; and
(E) such other studies as may be necessary to identify and evaluate the feasibility of coastal wetland restoration projects;

(2) to carry out coastal wetlands restoration projects in accordance with the priorities set forth on the list prepared under this title;

(3) to carry out wetlands restoration projects in accordance with the priorities set forth in the restoration plan prepared under this title;

(4) to make grants not to exceed $2,500,000 annually or $10,000,000 in total, to assist the agency designated by the State in development of the Coastal Wetlands Conservation Plan pursuant to this title.

(b) COASTAL WETLANDS CONSERVATION GRANTS.—Of the total amount appropriated during a given fiscal year to carry out this title, 15 percent, not to exceed $15,000,000 shall be available, and shall remain available to the Director, for purposes of making grants—

(1) to any coastal State, except States eligible to receive funding under section 306(a), to carry out coastal wetlands conservation projects in accordance with section 305 of this title; and

(2) in the amount of $2,500,000 in total for an assessment of the status, condition, and trends of wetlands in the State of Texas.

(c) NORTH AMERICAN WETLANDS CONSERVATION.—Of the total amount appropriated during a given fiscal year to carry out this title, 15 percent, not to exceed $15,000,000, shall be available to, and shall remain available until expended by, the Secretary of the Interior for allocation to carry out wetlands conservation projects in any coastal State under section 8 of the North American Wetlands Conservation Act (Public Law 101-233, 103 Stat. 1968, December 13, 1989).

SEC. 307. GENERAL PROVISIONS. 16 USC 3956.

(a) ADDITIONAL AUTHORITY FOR THE CORPS OF ENGINEERS.—The Secretary is authorized to carry out projects for the protection, restoration, or enhancement of aquatic and associated ecosystems, including projects for the protection, restoration, or creation of wetlands and coastal ecosystems. In carrying out such projects, the Secretary shall give such projects equal consideration with projects relating to irrigation, navigation, or flood control.

Irrigation.
Navigation.
Flood control.

(b) STUDY.—The Secretary is hereby authorized and directed to study the feasibility of modifying the operation of existing navigation and flood control projects to allow for an increase in the share of the Mississippi River flows and sediment sent down the Atchafalaya River for purposes of land building and wetlands nourishment.

SEC. 308. CONFORMING AMENDMENT.

16 U.S.C. 777c is amended by adding the following after the first sentence: "The Secretary shall distribute 18 per centum of each annual appropriation made in accordance with the provisions of

section 777b of this title as provided in the Coastal Wetlands Planning, Protection and Restoration Act: *Provided*, That, notwithstanding the provisions of section 777b, such sums shall remain available to carry out such Act through fiscal year 1999.".

Great Lakes Oil Pollution Research and Development Act.

"TITLE IV—GREAT LAKES OIL POLLUTION RESEARCH AND DEVELOPMENT

33 USC 2701 note.

"SEC. 4001. SHORT TITLE.

"This title may be cited as the "Great Lakes Oil Pollution Research and Development Act".

"SEC. 4002. GREAT LAKES OIL POLLUTION RESEARCH AND DEVELOPMENT.

Ante, p. 559.

"Section 7001 of the Oil Pollution Act of 1990 (Public Law 101-380) is amended as follows:

"(1) GREAT LAKES DEMONSTRATION PROJECT.—In subsection (c)(6), strike "3" and insert "4", strike "and" after "California,", and insert "and (D) ports on the Great Lakes," after "Louisiana,".

"(2) FUNDING.—In subsection (f) strike "21,250,000" and insert "22,000,000" and in subsection (f)(2) strike "2,250,000" and insert "3,000,000".".

Approved November 29, 1990.

LEGISLATIVE HISTORY—H.R. 5390 (S. 2244):

SENATE REPORTS: No. 101-523 accompanying S. 2244 (Comm. on Environment and Public Works).
CONGRESSIONAL RECORD, Vol. 136 (1990):
Oct. 1, considered and passed House.
Oct. 26, considered and passed Senate, amended, in lieu of S. 2244.
Oct. 27, House concurred in Senate amendment.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 26 (1990):
Nov. 29, Presidential statement.

Statement on Signing the Bill on Wetland and Coastal Inland Waters Protection and Restoration Programs

November 29, 1990

Today I am signing H.R. 5390, "An Act to prevent and control infestation of the coastal inland waters of the United States by the zebra mussel and other nonindigenous aquatic nuisance species, to reauthorize the National Sea Grant College Program, and for other purposes." This Act is designed to minimize, monitor, and control nonindigenous species that become established in the United States, particularly the zebra mussel; establish wetlands protection and restoration programs in Louisiana and nationally; and promote fish and wildlife conservation in the Great Lakes.

Title III of this Act designates a State official not subject to executive control as a member of the Louisiana Coastal Wetlands Conservation and Restoration Task Force. This official would be the only member of the Task Force whose appointment would not conform to the Appointments Clause of the Constitution.

The Task Force will set priorities for wetlands restoration and formulate Federal conservation and restoration plans. Certain of its duties, which ultimately determine funding levels for particular restoration projects, are an exercise of significant authority that must be undertaken by an officer of the United States, appointed in accordance with the Appointments Clause, Article II, sec. 2, cl. 2, of the Constitution.

In order to constitutionally enforce this program, I instruct the Task Force to promulgate its priorities list under section 303(a)(2) "by a majority vote of those Task Force members who are present and voting," and to consider the State official to be a nonvoting member of the Task Force for this purpose. Moreover, the Secretary of the Army should construe "lead Task Force member" to include only those members appointed in conformity with the Appointments Clause.

George Bush

The White House,
November 29, 1990.

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

Summary of the Public Involvement Program

Exhibit 2

PUBLIC INVOLVEMENT

THE CITIZEN PARTICIPATION GROUP

The Task Force also established a Citizen Participation Group to provide general input from the diverse interests across the coastal zone: local officials, landowners, farmers, sportsmen, commercial fisherman, oil and gas developers, navigation interests, and environmental organizations. The Citizen Participation Group was formed to promote citizen participation and involvement in formulating Priority Project Lists and the restoration plan. The group meets at its own discretion, but may at times meet in conjunction with other CWPPRA elements, such as the Technical Committee. The purpose of the Citizen Participation Group is to maintain consistent public review and input into the plans and projects being considered by the Task Force and to assist and participate in the public involvement program. The membership of the Citizen Participation Group is shown in Table 1.

Table 1
Membership of the Citizen Participation Group

Gulf Coast Conservation Association	Concerned Shrimpers of America
Coalition to Restore Coastal Louisiana	Gulf Intracoastal Canal Association
Lake Pontchartrain Basin Foundation	Louisiana Association of Soil and Water Conservation Districts
Louisiana Farm Bureau Federation, Inc.	Louisiana Landowners Association
Louisiana League of Women Voters	Louisiana Nature Conservancy
Louisiana Oyster Growers and Dealers Association	Louisiana Wildlife Federation, Inc.
Midcontinent Oil and Gas Association	New Orleans Steamship Association
Oil and Gas Task Force (Regional Economic Development Council)	Police Jury Association of Louisiana
Organization of Louisiana Fishermen	

INVOLVEMENT OF THE SCIENTIFIC COMMUNITY

While the agencies sitting on the Task Force possess considerable expertise regarding Louisiana's coastal wetlands problems, the Task Force recognized the need to incorporate another invaluable resource: the state's scientific community. The Task Force therefore retained the services of a scientific advisor, who selected a team of scientists to work with the basin teams in the preparation of the 2nd Priority Project List.

In 1994, the Task Force will establish and fund a formally constituted group representing the academic community. This group will help ensure that the evaluation, selection, and design of priority projects is based on the best scientific information available, and that the Task Force is kept apprised of newly emerging predictive tools.

INVOLVEMENT OF THE PUBLIC AT LARGE

Even with its widespread membership, the Citizen Participation Group cannot represent all of the diverse interests affected by Louisiana's coastal wetlands. The CWPPRA public involvement program provides an opportunity for all interested parties to express their concerns and opinions and to submit their ideas concerning the problems facing Louisiana's wetlands.

The first step in the program comprised two series of scoping meetings held by the Task Force in October and November 1991--one series for coastal zone parish officials and another series for the general public. The purpose of these scoping meetings was to identify wetland loss problems throughout the coastal zone and potential solutions to those problems. Literally hundreds of ideas were submitted to the Task Force through the scoping meetings. (Exhibit 3 is a compendium of those proposals.) All of the ideas presented in those meetings have been evaluated during the planning process; many of them have been incorporated into the Restoration Plan. The schedule of scoping meetings is shown in Table 2 (for the general public) and Table 3 (for parish officials).

The public involvement program has continued with a series of public meetings held each summer, since 1992, to aid in the development of the basin plans and the Priority Project List to be submitted in that year. Meetings for the 2nd PPL were held in June of 1992. At these meetings, the conceptual plans which had been developed for each basin were presented to the public, along with the candidate projects for the 2nd Priority Project List. This series of meetings provided the first opportunity for review of the conceptual plans and were held as shown in Table 4.

In 1993 meetings were held in late July through mid-August, as shown in Table 5. These meetings were held in conjunction with the state of Louisiana's Wetlands Conservation and Restoration Authority, providing an additional level for public input. The purpose of the meetings was to present the candidate projects for the 3rd Priority Project List and to accept comments and recommendations. The meetings also provided a preview of the Draft Restoration Plan, which was released for NEPA public review on July 16, 1993. The formal public hearing for the draft plan was held in New Orleans on August 11, 1993. However, comments on the Draft Restoration Plan were accepted at all the meetings.

Table 2
Public Scoping Meetings

Date	Location
October 21, 1991	Lake Charles, La.
October 22, 1991	Abbeville, La.
October 24, 1991	Houma, La.
October 28, 1991	Mandeville, La.
November 6, 1991	Belle Chasse, La.
November 7, 1991	New Orleans, La.

Table 3
Parish Scoping Meetings
(for Parish Officials)

Date	Location	Parishes
October 8, 1991	Crowley, La.	Calcasieu Parish Cameron Parish Iberia Parish Vermilion Parish
October 16, 1991	New Orleans, La.	Jefferson Parish Orleans Parish Plaquemines Parish St. Bernard Parish St. Charles Parish
October 16, 1991	New Orleans, La.	Livingston Parish St. James Parish St. John the Baptist Parish St. Tammany Parish Tangipahoa Parish
October 17, 1991	Thibodaux, La.	Ascension Parish Assumption Parish Lafourche Parish St. Martin Parish St. Mary Parish Terrebonne Parish

Table 4
Public Meetings
(2nd Priority Project List and Conceptual Basin Plan)

Date	Location	Hydrologic Basins
June 16, 1992	Morgan City	Atchafalaya, Teche/Vermilion
June 18, 1992	Belle Chasse	Barataria, Breton Sound, Mississippi River Delta
June 23, 1992	Houma	Terrebonne
June 25, 1992	Lake Charles	Mermentau, Calcasieu/Sabine
June 30, 1992	New Orleans	Pontchartrain

Table 5
Public Meetings
(3rd Priority Project List and Draft Restoration Plan)

Date	Location	Hydrologic Basins
July 27, 1993	Larose	Barataria
July 28, 1993	Belle Chasse	Breton Sound, Mississippi River Delta
July 29, 1993	New Orleans	Pontchartrain
August 9, 1993	Houma	Terrebonne
August 10, 1993	Morgan City	Atchafalaya and Teche/Vermilion
August 11, 1993	New Orleans	Formal Public Hearing on the Draft Restoration Plan and EIS
August 12, 1993	Cameron	Calcasieu/Sabine and Mermentau

DEVELOPING THE PLANS

The October-November 1991 scoping meetings were the first stage in the process identifying coastal wetlands problems and developing basin-by-basin solutions . The process continued with a series of basin plan formulation meetings, held in February through May 1992. These meetings were attended by representatives of the Task Force agencies, members of the scientific community, representatives of the Citizen Participation Group, parish officials, private consultants, and members of the general public.

These meetings were intense planning sessions, consisting of four three-day meetings with a two-day follow up for each. Each set of meetings began with a description of the geology, hydrology, and biological resources of the basins followed by projections for the future. Finally, the coastal wetlands problems and their causes were discussed in detail, and strategies were developed for dealing with those problems on a basin-by-basin basis. These strategies were molded into conceptual plans that would serve as a guide in selecting and evaluating projects both for Priority Project Lists and for the Restoration Plan.

During these meetings, many of the ideas submitted in the 1991 scoping meetings were integrated into the conceptual plans. The basin teams refined the conceptual plans over the next year to produce the comprehensive restoration plan presented in this report. The meetings followed the schedule shown in Table 6.

Table 6
Plan Formulation Meetings

Date	Location	Hydrologic Basins
February 4-6, 1992	Baton Rouge	Pontchartrain
February 12-13, 1992 (follow up)	New Orleans	
March 17-19, 1992	St. Francisville	Barataria, Breton Sound, Mississippi R. Delta
March 25-26, 1992 (follow up)	New Orleans	
April 7-9, 1992	Baton Rouge	Terrebonne, Atchafalaya, Teche/Vermilion
April 15-16, 1992 (follow up)	New Orleans	
April 28-30, 1992	Abbeville	Mermentau, Calcasieu/Sabine
May 6-7, 1992 (follow up)	New Orleans	

CONTINUING EVOLUTION OF THE PUBLIC INVOLVEMENT PROGRAM

The Task Force recognizes the need to increase the outflow of information and input from the public as it proceeds with implementation of the CWPPRA. To meet this need, the Task Force is developing a public outreach strategy. An outline of this strategy, which has not yet been approved by the Task Force, is presented below.

1. Improve dissemination of information on CWPPRA activities to the public.

- Establish a mailing list of elected officials and participating Federal, State, and local agencies; interested citizens (people who have attended past CWPPRA pubic meetings); local, state, and national environmental organizations; libraries; and news media.
- Publish a periodic four- or eight-page newsletter containing:
  Reports on the status of priority list projects form lead agencies
  Status of basin plans from basin captains
  Financial report (funds spent on planning vs. funds spent on projects)
  (The newsletter could be published by contract services.)

2. Publicize individual CWPPRA projects.

- Invite media to groundbreakings and project completion ceremonies. Also hold media tours of projects under construction.
- Prepare project maps and graphics that are usable by print and electronic media.

3. Mark annual progress.

- Hold briefings for news media in New Orleans, Baton Rouge, Houma/Morgan City, Lafayette, and Lake Charles for news media when each year's priority project list is finalized.
- Prepare and update annually a traveling exhibit to depict CWPPRA activities and work in progress.
- Prepare annual briefings for higher authorities of all Task Force agencies and the congressional delegation.
- In later years, publish a color brochure showing completed projects.

4. Hold annual public meetings on Priority Project Lists and Long-term Plan status.

- Involve Public Affairs in early planning for public meetings to ensure effective public involvement.
- Prepare public notices and news releases well in advance of public meetings.
- Train all Task Force members participating in public meetings in public involvement and facilitation skills.

5. Conduct a Speakers' Bureau Program.

- Identify groups and organizations as potential audiences for CWPPRA speakers.
- Solicit and coordinate speaking engagement invitations.
- Maintain a current slide show so Task Force speakers can make presentations with minimal preparation.

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

Summary and Status of the Priority Project Lists

Exhibit 3

DEVELOPMENT OF PRIORITY PROJECT LISTS

Section 303(a) of the CWPPRA directs the Task Force to submit to Congress annually a Priority Project List "of coastal wetlands restoration projects in Louisiana . . . that can be substantially completed during a five-year period commencing on the date the project is placed on the list." To date, the Task Force has submitted three such lists to Congress.

THE FIRST PRIORITY PROJECT LIST

In accordance with the CWPPRA, the first Priority Project List was due to Congress on 29 November 1991--ten months after the first meeting of the Task Force. As a consequence of this restrictive time frame, the list was composed of projects for which most of the planning had already been done by one of the Task Force agencies. Thirty-five of these "off-the-shelf" projects were considered. The Task Force selected 14 for the priority list based on the procedures outlined below.

Because the act requires a ranking of projects in order of cost-effectiveness, the Task Force established a consistent means of assessing project costs and benefits. The lead agency for each project prepared a cost estimate and submitted it to the Engineering Work Group of the Task Force. The work group reviewed the estimates for accuracy and consistency by reviewing quantity estimates and unit prices for project features. In addition, the work group reviewed the design of the projects to ensure that the method of construction was appropriate and the design was feasible.

The cost component of the cost-effectiveness criterion was based on the following procedures and assumptions:

a. Average annual costs represent the sum of direct and known indirect construction and operating costs, discounted over time.

b. Construction or first costs include engineering and design, inspection, contingencies, real estate (land, easements, rights-of-way, and relocations), and administration, as well as direct building costs.

c. Operating costs for a project include monitoring, replacement or closure, and induced dredging, as well as direct operation and maintenance costs. (However, operating costs are not counted if they are part of an existing program which is not expanded because of the project.) Operating costs extend through 20 years from the base, which is also the time when first costs are considered fully amortized. Costs (and benefits) beyond 20 years are not considered.

d. The discount rate used to account for the time value of money was $8\frac{1}{2}$ percent.

e. The funding requirements for each project were based on the current dollar value of the construction and operating costs, except that costs paid by sources other than the CWPPRA were not included. Whereas average annual costs assume no inflation over time, the calculation of funding requirements does include an inflation adjustment of 3.5 percent to 4.7 percent per year.

Ensuring a consistent benefit evaluation was less straightforward. To this end, the Task Force adapted the U.S. Fish and Wildlife Service's Habitat Evaluation Procedure (HEP), a standard means of evaluating habitat quality to determine mitigation requirements. The Environmental Work Group modified the HEP to produce a methodology applicable strictly to wetland habitats--the Wetland Value Assessment (WVA). The Task Force used the WVA to calculate project benefits in terms of Average Annual Habitat Units (AAHU's). AAHU's provide a measure of the amount and quality of habitat which on the average would be found in a project area during the project life. When compared to the annual cost of a project, they give a means of determining the relative effectiveness of various projects in creating, protecting, restoring, or enhancing wetlands.

The stream of economic costs for each project was brought to present value and annualized at the current discount rate, based on a 20-year project life. Beneficial environmental outputs were annualized at a zero discount rate and expressed as AAHU's. These data were then used to rank each plan based on cost per AAHU produced. Where appropriate, individual plans were scaled and optimized to minimize cost per AAHU.

The lead agency for each project developed a fact sheet for that project. The fact sheet contained a description of the wetlands problems in the study area, a description of the proposed project and its purpose, a cost estimate, and a summary of the WVA analysis.

The final selection of projects for the first Priority Project List was based primarily on the criterion of cost-effectiveness, with consideration given to secondary criteria such as strong public support, addressing of critical needs, and the potential for providing new information regarding construction techniques or project impacts. The projects inculded on the first Priority Project list are summarized in Table 1.

THE 2ND PRIORITY PROJECT LIST.

The 2nd Priority Project List was submitted to Congress in November 1992. The expanded time frame allowed the Task Force to consider projects which had been proposed during the scoping meetings of October and November 1991 and the plan formulation meetings in February-May 1992. As a result of public input during these meetings, there were hundreds of potential projects available for consideration, some of which were little more than indistinct concepts.

The interagency basin teams that were established to develop the restoration plan were called upon to evaluate project proposals, flesh out those which were too sketchy but merited further work, and screen the scores of projects in each basin down to a few candidates. To give some form to the screening process, the Planning and Evaluation Subcommittee developed two tools: a Preliminary Evaluation Sheet (PES) and a Screening Information Sheet (SIS).

The PES constituted the first level of screening, and was designed to evaluate a proposal's fitness for the CWPPRA overall and the 2nd Priority Project List in particular. If the purpose of the project was not for the long-term benefit of coastal wetlands, or the project did not meet the objectives set for its particular basin at the plan formulation meetings, the project was dropped from consideration. The PES also screened out projects which could not be constructed within the five-year time frame prescribed by the CWPPRA for priority list projects. Any project which was judged capable of meeting the timing criterion was evaluated according to whether it: possessed local support; served as a critical project in the overall restoration strategy for its basin; provided a significant opportunity to preserve, improve, or build coastal wetlands; and had regional impacts or was a small demonstration project. Projects which met at least three of these criteria were elevated to the next level of evaluation.

The SIS was used as the next step in the screening process. Each Task Force agency made a rough estimate of the cost of the projects for which it was responsible and acres to be created, protected, or enhanced. A weight was assigned to these acres according to their value. The cost per weighted acre, served as the main criterion used by each basin team to select four to six projects for further evaluation.

The Planning and Evaluation Subcommittee reviewed the recommendations of the basin teams and selected a list of 36 candidate projects for detailed evaluation. These candidate projects were presented during the June 1992 public meetings, following which some revisions were made to the candidate list in response to the views of the public. Thirty seven candidate projects were evaluated in detail in a process similar to that which was done for the first Priority Project List. Again, selection of the 2nd Priority Project List was based largely on cost-effectiveness, with due consideration given to secondary criteria such as public support. Table 2 summarizes the projects selected for the second Priority Project List.

THE 3RD PRIORITY PROJECT LIST

The 3rd Priority Project List was developed in a parallel effort to this restoration plan report. Its development followed a procedure similar to that used for the second list: screening by the basin teams using the PES and SIS, nomination of candidates by the basin teams, selection of a draft candidate list by the Planning and Evaluation Subcommittee, presentation of the draft candidate list to the public, revision of the candidate list if appropriate, detailed analysis of the candidate projects, and final selection of the list through review and evaluation of the candidates by the Technical Committee and the Task Force.

The PES constituted the first level of screening, and was designed to evaluate a proposal's fitness for the CWPPRA and a Priority Project List. If the purpose of the project was not long term protection, restoration, enhancement, or creation of coastal wetlands, or the project did not meet the objectives set for its particular basin as outlined in the Draft Restoration Plan, the project was dropped from consideration. The PES also screened out projects which could not be constructed within the five year time frame prescribed by the CWPPRA for priority list projects. In addition, because of the time constraints involved with developing the Restoration Plan and the 3rd list, projects that were not in the preliminary draft of the Restoration Plan as of February 17, 1993 or was not sufficiently developed to perform a Wetland Value Assessment by July, 1993, were not considered for the 3rd list. Any project which was judged capable of meeting the timing criterion was evaluated according to whether it: possessed local support; was a critical project in the overall restoration plan; did not present a cost over $10,000,000; provided a significant opportunity to preserve, improve, or build coastal wetlands; and had regional impacts or was a small demonstration project. Projects which met the criteria were elevated to the next level of screening.

The SIS was again used as the next step in the screening process. Each Task Force agency made a rough estimate of the cost of the projects for which it was responsible. An estimate was also made of the acres to be created, protected, or enhanced by a project. The cost per acre was used to compare projects, serving as the main criterion each basin team used to select approximately four projects in each basin for further evaluation. The basin teams were responsible for doing preliminary evaluations of all projects submitted and making a recommendation to the Planning and Evaluation Subcommittee for candidate projects to be considered for the 3rd Priority Project List.

The Planning and Evaluation Subcommittee met on May 11, 1993, to hear the recommendations of the basin teams and develop the list of candidate projects for the 3rd Priority Project List. Each basin captain presented the results of his or her team's screening, recommending four projects (in most cases) for inclusion on the candidate list. The subcommittee decided to evaluate demonstration projects separately. Each agency was directed to develop fact sheets on their proposed demonstration projects and submit them for consideration at a later date.

The Planning and Evaluation Subcommittee met again on July 13, 1993, to evaluate the proposed demonstration projects. Each agency presented its projects to the subcommittee, outlining the critical project information, including what information would be learned by performing the demonstration and the need for such a project. A total of 12 projects were presented, but because of the time constraints in evaluating projects and a previous Task Force decision to limit spending on demonstration projects to approximately $2,000,000 per priority list, the subcommittee limited the number of projects to 5. Each agency ranked the projects, assigning a value of 5 to the most favored project and 1 to the least preferred. The subcommittee then put together a combined list of 41 candidate projects to be evaluated for the third list. These candidates were presented in the public meetings which took place in July and August of 1993.

On October 1, 1993 the Task Force met and selected the third Priority Project List. The list included 19 projects with 3 demonstration projects and 2 deferred projects. Table 3 summarizes these projects.

FUTURE PRIORITY PROJECT LISTS

The CWPPRA calls for two additional lists. Those lists and future lists that may result from a reauthorization of the CWPPRA will be drawn directly from--or, as a minimum, guided by--the Restoration Plan. The implementation section of the main report details the future use of the priority project procedure for the execution of the restoration plan. The priority list process will be a key tool for the phase one-short term implementation of the plan.

The Restoration Plan has already established its value in that regard. During development of the second priority list, the Task Force used basin conceptual plans as an important screening criterion for projects being considered for the list.

PROJECT IMPLEMENTATION

The 1st, 2nd and 3rd Priority Project Lists consist of 48 projects with an estimated fully funded cost of $123,280,000. The 48 projects encompass over 421,100 acres of coastal wetlands in Louisiana. If protective measures were not taken, some 41,780 acres of these wetlands would have been lost over the next 20 years. More significantly, it is estimated that these 29 projects will turn this anticipated loss into a net gain of approximately 13,800 acres.

On April 17, 1993, the lead Task Force agencies signed cost sharing agreements with the Louisiana Department of Natural Resources for 11 priority list projects: BA-2 (GIWW to Clovelly) Unit 1, Vegetative Planting (West Hackberry and Dewitt-Rollover), Cameron-Creole Watershed Hydrologic Restoration, Bayou Sauvage Refuge, Cameron Prairie Refuge Shoreline Erosion Control, Sabine Wildlife Refuge Shoreline Erosion Control, Lower Bayou La Cache, Bayou La Branche Marsh Creation, Vermilion River Cutoff, and Isles Dernieres Barrier Island Restoration (Demonstration and Phase I). These cost share agreements will serve as models for future agreements between the State and the Federal Government, facilitating the implementation of additional projects.

Four projects have been given approval by the Task Force to proceed to construction: BA-2 (GIWW to Clovelly) Unit 1, Vegetative Planting (West Hackberry and Dewitt-Rollover), Cameron-Creole Watershed Hydrologic Restoration, and Cameron Prairie Refuge Shoreline Erosion Control. It is anticipated that construction will begin on these projects by the summer of 1993. The remaining projects are expected to be constructed within the five year limitation set forth in the CWPPRA.

As of November 28, 1993 contracts have been awarded for two CWPPRA projects. The first contract to be awarded was the West Hackberry Vegetative Planting project. The USDA, Soil Conservation Service is the lead agency for this project and work is expected to begin in December 1993. The second contract was awarded for the LaBranche Wetland Creation project sponsored by the U. S. Army Corps of Engineers. Construction is scheduled to begin in January 1994.

Table 1

Coastal Wetlands Planning, Protection and Restoration Act

1st Priority Project List

Project No.	Project	Basin	Lead Agency	Average Annual Acres	Affected Area (Acres)	Acres Created, Protected, and Restored	Area Loss w/o Project (Acres)	Avg Annual Cost/AAHU ($/AAHU)	Fully Funded Cost ($)[1]
XBA-68	Fourchon	Barataria	NMFS	146	2,020	160	100	21	252,000
BA-2	(GIWW to Clovelly)	Barataria	SCS	3,102	60,000	8,629	8,946	68	8,142,000
FCS-17	Cameron Creole Watershed	Calc/Sabine	USFWS	440	10,500	600	0	128	660,000
XPO-52a	Bayou Sauvage Refuge	Pontchartrain	USFWS	1,313	3,800	1,550	475	180	1,658,000
FCS-18	Sabine Refuge	Calc/Sabine	USFWS	2,207	13,000	5,542	7,008	253	4,895,000
TE-18, TE-17, FCS-19, ME-8	Vegetative Plantings (Demo)	Ter,Mer, C/S	SCS	385	2,575	633	752	282	922,000
FMR-3	West Bay Sediment Diversion	Miss Delta	USACE	5,329	12,910	9,831	0	305	8,517,000
BA-19	Barataria Bay Waterway	Barataria	USACE	219	510	445	0	449	1,759,000
TE-19	Lower Bayou La Cache	Terrebonne	NMFS	45	4,200	86	244	837	1,695,000
PPO-10	Bayou La Branche	Pontchartrain	USACE	205	487	203	0	2,369	4,461,000
ME-9	Cameron Prairie Refuge	Mermentau	USFWS	131	640	247	250	3,171	1,178,000
FTV-3	Vermilion River Cutoff	Teche/Verm	USACE	37	202	65	51	6,196	1,526,000
TE-20	Isle Dernieres (Demo)	Terrebonne	EPA	61	449	9	117	13,949	6,345,000
	Total			13,620	111,293	28,000	17,943		42,010,000

[1] Fully funded costs from the 1st priority list have been adjusted to include monitoring costs.

EPA Environmental Protection Agency
NMFS National Marine Fisheries Service
SCS Soil Conservation Service
USACE U.S. Army Corps of Engineers
USFWS U.S. Fish and Wildlife Service
AAHU Average Annual Habitat Unit

Table 2

Coastal Wetlands Planning, Protection and Restoration Act

2nd Priority Project List

Project No.	Project	Basin	Lead Agency	Average Annual Acres	Affected Area (Acres)	Acres Created, Protected, and Restored	Area Loss w/o Project (Acres)	Avg Annual Cost/AAHU ($/AAHU)	Fully Funded Cost ($)
PAT-2	Atchafalaya Sediment Del	Atchafalaya	NMFS	1,267	4,248	2,232	30	113	908,000
ME-4/XME-21	Freshwater Bayou	Mermentau	SCS	523	14,381	1,593	1,679	128	2,770,000
XPO-52a	Bayou Sauvage	Pontchartrain	USFWS	841	5,475	1,280	503	185	1,452,000
PCS-27	Clear Marais	Calc/Sabine	USACE	677	4,637	1,067	1,029	193	1,741,000
BS-3a	Caernarvon Outfall Mgmt	Breton Sound	SCS	448	15,556	812	0	422	2,522,000
PCS-24	Mud Lake	Calc/Sabine	SCS	798	8,054	1,520	1,444	479	2,904,000
PBA-35	Jonathan Davis Wetland	Barataria	SCS	255	7,199	510	639	657	3,399,000
PTE-22/24	Point Au Fer	Terrebonne	NMFS	196	5,230	375	428	696	1,070,000
XAT-7	Big Island Mining	Atchafalaya	NMFS	944	3,400	1,560	342	933	4,136,000
PCS-25	Hwy 384	Calc/Sabine	SCS	79	650	150	142	1,023	701,000
PO-6	Fritchie Marsh	Pontchartrain	SCS	546	5,924	1,040	1,312	1,176	3,048,000
PTV-18/TV-9	Boston Canal/Vermilion	Teche/Verm	SCS	199	466	378	359	1,233	1,009,000
CS-9	Brown Lake	Calc/Sabine	SCS	152	2,794	282	85	2,223	3,223,000
PTE-27	West Belle Pass	Terrebonne	USACE	336	2,459	472	452	2,325	4,854,000
XTE-41	Isle Dernieres (Phase I)	Terrebonne	EPA	133	776	109	179	6,195	6,908,000
	Total			7,394	81,249	13,380	8,623		40,645,000

EPA Environmental Protection Agency
NMFS National Marine Fisheries Service
SCS Soil Conservation Service
USACE U.S. Army Corps of Engineers
USFWS U.S. Fish and Wildlife Service,
AAHU Average Annual Habitat Unit

Table 3

Coastal Wetlands Planning, Protection and Restoration Act

3rd Priority Project List

Project No.	Project	Basin	Lead Agency	Average Annual Acres	Affected Area (Acres)	Acres Created, Protected, and Restored	Area Loss w/o Project (Acres)	Avg Annual Cost/AAHU ($/AAHU)	Fully Funded Cost ($)
XPO-71	MRGO Back Dike Marsh Pro	Pontchartrain	USACE	661	855	755	755	99	512,000
BA-4c	West Pt.-a-la-Hache Outfall Mgmt	Barataria	SCS	581	16,612	1,087	1,206	140	881,000
XMR-10	Channel Armor Gap Crevasse	Miss Delta	USACE	497	2,097	936	325	286	808,000
TV-4	Cote Blanche Hydro Rest	Teche/Verm	SCS	1,167	30,000	2,223	3,442	371	5,173,000
CS-4a	Cameron-Creole Maintenance	Calc/Sabine	SCS	716	54,076	2,602	1,462	378	3,720,000
XBA-65a	B. Perot/B. Rigolettes Marsh	Barataria	NMFS	642	4,255	1,065	1,644	380	1,835,000
MR-8/9a	Pass-a-Loutre Crevasse	Miss Dellta	USACE	636	1,869	1,043	101	439	2,858,000
XTE-67	E. Timbalier Restoration	Terrebonne	NMFS	664	23,621	1,013	2,745	686	2,047,000
XCS-47,48i, 48j, 48p	Replace Hog Island etc. Control Structures	Calc/Sabine	USFWS	495	42,247	953	1,320	753	4,582,000
BS-4a	White's Ditch Outfall Mgmt	Breton Sound	SCS	20	5,249	37	75	781	756,000
PTE-23	L. Chapeau Mrsh Crtn and HR	Terrebonne	NMFS	391	13,024	509	423	876	4,149,000
PTE-15bi	Whiskey Island Restoration	Terrebonne	EPA	837	4,926	1,239	909	921	4,844,000
PTE-26b	Brady Canal Hydro Rest	Terrebonne	SCS	156	7,653	297	380	1,017	4,718,000
PO-9a	Violet Freshwater Distribution	Pontchartrain	SCS	130	17,980	247	207	3,305	1,821,000
BA-15	L. Salvador Shore Prote Demo	Barataria	NMFS	88	4,070	176	196	586	1,445,000
PME-6	SW Shore White Lake Demo	Mermentau	SCS	9	25	16	22	1,850	126,000
XTE-43	Red Mud Demo	Terrebonne	EPA	----	3	3	0	----	350,000
	Total			7,690	228,562	14,201	15,212		40,625,000

EPA Environmental Protection Agency
NMFS National Marine Fisheries Service
SCS Soil Conservation Service
USACE U.S. Army Corps of Engineers
USFWS U.S. Fish and Wildlife Service
AAHU Average Annual Habitat Unit

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

List of Publicly Proposed Projects

Exhibit 4

Record#	BASIN	CATEGORY	DESCRIPT
1	ATCH	FRSHWTR DIV	AVOCA ISLAND EXTENSION WITH FRESHWATER DIVERSION AND SEDIMENT DIVERSION (12)
2	ATCH	HYDRO REST	PLACE A LOCK IN BAYOU CHENE (11)
3	ATCH	SED DIV	DIVERSION STRUCTURE IN BAYOU SCHAFFER WITH AUX. STRUCTURE THRU LEVEE AT AVOCA I. TO DIVERT FRESH WATER INTO TERREBONNE PARISH
4	BARA	BARR ISL REST	BARRIER ISLANDS ARE MORE IMPORTANT TO INTERIOR WETLANDS THAN TO THE WETLANDS ON THE ISLAND (1)
5	BARA	BARR ISL REST	BARRIER ISLAND AND SHORELINE RESTORATION NEEDED BETWEEN BELLE PASS AND SANDY POINT (5)
6	BARA	BARR ISL REST	NOURISH GRAND ISLE AND GRAND TERRE ISLAND WITH SEDIMENTS DREDGED FROM NEARBY WATERWAYS & WATER BOTTOMS (10)
7	BARA	BARR ISL REST	IT IS ESSENTIAL TO PRESERVE GRAND ISLE FOR THE MANY FUNCTIONS IT SERVES (2A)
8	BARA	DREDGED MAT	FUND MITIGATION REQUIRED BY HIS PERMIT (MARSH CREATION WITH DREDGED MATERIAL) WITH CWPPRA FUNDS
9	BARA	DREDGED MAT	MARSH CAN BE CREATED WITH SEDIMENTS FROM A COMMERCIAL BOAT HARBOR ON GRAND ISLE (PERMIT- CARINADA BAY 52) (6)
10	BARA	DREDGED MAT	USE MATERIAL DREDGED FROM BAYOU DUPONT TO BUILD MARSH (11)
11	BARA	DREDGED MAT	PUMP DREDGED MATERIAL BEHIND FORT LIVINGSTON TO CREATE MARSH AND CREATE SHOREBIRD FEEDING HABITAT
12	BARA	DREDGED MAT	USE DREDGED MATERIAL FROM THE BARATARIA BAY WATERWAY TO BUILD AND PRTECT MARSH ON GRAND TERRE ISLAND
13	BARA	EROSION CONTR	EROSION CONTROL NEEDED ALONG LAKE SALVADOR SHORELINE FROM BAIE DU CABANAGE TO BAYOU DES ALLEMANDS
14	BARA	EROSION CONTR	SHORELINE EROSION CONTROL NEEDED ALONG EASTERN SHORE OF LAKE SALVADOR ESPECIALLY NEAR BAYOU SEGNETTE
15	BARA	EROSION CONTR	BANK STABLIZATION ALONG BAYOU LAFOURCHE AND AT THE INTERSECTION OF BAYOU LAFOURCHE AND THE GIWW (2)
16	BARA	EROSION CONTR	BANK STABLIZATION NEEDED ALONG BAYOU LAFOURCHE FROM SOUTH OF LAROSE TO SOUTH OF LEEVILLE (5)
17	BARA	EROSION CONTR	STABILIZE THE LAKE SALVADOR SHORELINE FROM BAIE CHACTAS SHELL BANK TO BAYOU DES ALLEMANDS WITH ROCK OR GABION
18	BARA	EROSION CONTR	CONSTRUCT A DEMONSTRATION BREAKWATER OF TIRES TO SLOW EROSION ON THE BANKS OF GRAND BAYOU
19	BARA	EROSION CONTR	USE TIRE STRUCTURE TO STABLIZE BANKS OF GRAND BAYOU BETWEEN WEST POINT A LA HACHE & PORT SULPHUR (2)
20	BARA	EROSION CONTR	EROSION IS OCCURRING ALL ALONG THE BARATARIA BAY WATERWAY (1)
21	BARA	EROSION CONTR	EROSION IS OCCURRING ALONG THE GIWW IN THE CROWN POINT AREA (2)
22	BARA	EROSION CONTR	SHORELINE STABILIZATION OF GRAND ISLE ESPECIALLY IN AREAS WHERE MARSH DESTRUCTION IS EVIDENT
23	BARA	EROSION CONTR	THE GIWW BANKS ARE ERODING FROM FLEMING CANAL WEST TO THE PARISH LINE. BANK PROTECTION IS NEEDED
24	BARA	EROSION CONTR	THE NORTHEASTERN SHORELINE OF THE PEN NEEDS A BARRIER TO ABSORB WAVE ENERGY TO PREVENT FURTHER EROSION AND TRAP SEDIMENTS
25	BARA	EROSION CONTR	THE WEST BANK OF THE BARATARIA WW. AT LAFITTE HAS SEVERE BANK EROSION. NEED TO PROTECT HOMES, DOCKS, ROAD, CEMETERY, CULTURAL SITES, ETC...
26	BARA	FRSHWTR DIV	SEDIMENT DIVERSION INTO THE UPPER BARATARIA BASIN, POSSIBLY HERO CANAL (8)
27	BARA	FRSHWTR DIV	STORM WATER RUNOFF TREATMENT FOR THE LAKE CATOUATCHE PUMPING STATION (16)
28	BARA	FRSHWTR DIV	DIVERT WATER FROM THE MISSISSIPPI RIVER DOWN BAYOU LAFOURCHE (1)
29	BARA	HYDRO REST	MARSH MANAGEMENT FOR THE AREA NORTH OF "THE PEN" NEAR LAFITTE. TIE IN WITH LAREUSSITE OR HERO CANAL DIVERSION PROJECTS (11)
30	BARA	HYDRO REST	REDUCE TIDAL FLUSHING ACTION IN THE BARATARIA BASIN BY CLOSING MAN-MADE CANALS, RE-ESTABLISHING N. TO S. FLOW (17)
31	BARA	HYDRO REST	LAFOURCHE PARISH SUPPORTS NMFS PROPOSED SPOIL IMPOUNDMENT RESTORATION FOURCHON (15)
32	BARA	HYDRO REST	WIDEN AND DEEPEN BAYOU LAFOURCHE AND CONSTRUCT LOCKS TO STOP SALT WATER INTRUSION (1A)
33	BARA	HYDRO REST	MANAGE WATER AND SEDIMENT OUTFLOW FROM DAVIS POND FRESHWATER DIVERSION TO MAXIMIZE BENEFITS
34	BARA	HYDRO REST	LAKE SALVADOR WATERSHED PROJECT - LARGE SCALE PROJECT TO MANAGE AN ENTIRE WATERSHED
35	BARA	HYDRO REST	CONSTRUCT A LOCK ON THE BARATARIA BAY WATERWAY AND FLOODGATES ON CARINADA PASS TO PREVENT SALTWATER INTRUSION, TIDAL SCOUR, ETC... (8)
36	BARA	HYDRO REST	RESTORE A CANAL PLUG OFF OF SCOFIELD BAYOU TO PREVENT TIDAL SCOUR. (5)
37	BARA	HYDRO REST	CONSTRUCT "LOW" LEVEES ALONG CANALS RUNNING BETWEEN PROTECTION LEVEES TO REDUCE SEDIMENT LOSS AND SALTWATER INTRUSION IN THE BARA. BASIN
38	BARA	MARSH MNGMNT	MANAGE THE AREA BETWEEN THE PEN AND HERO CANAL TO TRAP SEDIMENTS AND MAINTAIN THE INTEGRITY OF THE MARSH
39	BARA	MARSH MNGMNT	WATER MANAGEMENT AND FRESHWATER DIV. FOR THE AREA BETWEEN THE BARATARIA RIDGE AND THE MISS. RIVER AND NORTH OF BAYOUS DUPONT AND TRAVERSE
40	BARA	OTHER	ELEVATED WATER LEVELS ARE A PROBLEM IN THE VACHERIE AREA (3)
41	BARA	WETLAND LOSS	EAST OF GOOSE BAYOU IN LAFITTE AROUND BAYOU DUPONT IS ERODING. CONSIDER USING DREDGED MATERIAL
42	BARA	WETLAND LOSS	THE MARSH SOUTHEAST OF LEEVILLE IS BEING LOST TO SALTWATER INTRUSION AND SOIL COMPACTION (4)
43	BARA/MISS	EROSION CONTR	SEE MR. PETROVICH'S PROJECTS THAT WERE PREPARED BY BROWN AND ROOT; THE TIRE SEDIMENT TRAP AND THE BREAKWATER ALONG GRAND BAYOU
44	BARA/MISS	FRSHWTR DIV	PROVIDE FOR ENRICHED SEDIMENT DIVERSION INTO GRAND PASS, TIGER PASS, AND BAPTISTE COLLETTE (9)
45	BRET	FRSHWTR DIV	INTRODUCE FRESHWATER TO PREVENT SALTWATER INTRUSION AT FLOODGATES AT BAYOU BIENVENUE & BAYOU DUPRE (3A)
46	BRET	FRSHWTR DIV	RESTORE RIVER FLOW THROUGH OAK RIVER (15)
47	BRET	FRSHWTR DIV	FRESHWATER INTRODUCTION AND DISTRIBUTION SYSTEM TO DISTRIBUTE WATER FROM THE VIOLET SIPHON INTO THE CENTRAL WETLANDS AND LAKE LERY WETLAND
48	BRET	HYDRO REST	BUILD DOUBLE LOCKS AT BAYOU BIENVENUE & BAYOU DUPRE FLOODGATES TO REDUCE SALTWATER INTRUSION IN CENTRAL WETLANDS (3)
49	BRET	HYDRO REST	CONSTRUCT A LOW-LEVEL BARRIER BETWEEN POINT A LA HACHE AND THE MRGO TO REDUCE SALTWATER INTRUSION AND TIDAL SCOUR (7)
50	BRET	HYDRO REST	STABILIZE AND RESTORE THE MARSHES NORTH OF LAKE LERY (17)
51	BRET	HYDRO REST	BUILD A LOCK AT BAYOU BIENVENUE AND BAYOU DUPRE USING EXISTING FLOODGATES TO STOP SALTWATER FROM AFFECTING THE CENTRAL WETLANDS
52	BRET	SED DIV	BUILD LARGE-SCALE DIVERSIONS AT MYRTLE GROVE AND BOHEMIA TO REPLENISH MARSHES. ALSO, INCLUDE HYDROELECTRIC FACILITIES TO PAY FOR PROJECT
53	BRETON	OTHER	ISLAND CREATION ALONG THE EXISTING MARSH SHORELINE TO ACT AS BARRIERS TO MARSH EROSION AND PROVIDE WILDLIFE HABITAT
54	CALC	EROSION CONTR	CONSTRUCT "SOMETHING" TO PREVENT EROSION ALONG GIWW FROM CALCASIEU TO THE SABINE RIVER
55	CALC	EROSION CONTR	BREAKWATER OR ARTIFICAL REEF TO SLOW SHORELINE EROSION AT LOUISIANA POINT (12)
56	CALC	EROSION CONTR	EROSION OF A REMNANT DREDGED MATERIAL BANK WOULD ALLOW AN INCREASE OF EROSION ALONG MOSS LAKE. SUGGEST DREDGED MATERIAL OR ROCK DIKE (14)
57	CALC	EROSION CONTR	SHORELINE PROTECTION ALONG THE WEST SIDE OF THE CALCASIEU SHIP CHANNEL IN LONG POINT LAKE (2)
58	CALC	EROSION CONTR	EROSION IS OCCURRING ALONG THE CALCASIEU SHIP CHANNEL, ESPECIALLY BETWEEN CALCASIEU LAKE AND THE GIWW (6)
59	CALC	EROSION CONTR	EROSION IS OCCURRING ALONG THE GIWW FROM CALCASIEU TO SABINE RIVER, MOSTLY ON THE NORTH SIDE (5A)
60	CALC	EROSION CONTR	EROSION IS OCCURRING ALONG THE GIWW W. OF THE SALT (ALKALI) DITCH (5)
61	CALC	EROSION CONTR	EROSION IS OCCURRING ALONG THE MERMENTAU RIVER NORTH OF THE GIWW (15)
62	CALC	EROSION CONTR	MAKE HOLES IN CALCASIEU JETTIES OR BAFFLES TO THE WEST OF THE JETTIES TO REDUCE EROSION ALONG THE LA COAST (8)
63	CALC	EROSION CONTR	PLACE AN EARTHEN LEVEE OR NON-ERODABLE BREAKWATER AND VEGETATIVE PLANTINGS ALONG PRIORITIZED SECTIONS OF THE NORTH GIWW BANK
64	CALC	EROSION CONTR	PLACE EARTHEN LEVEE OR NON-ERODABLE BREAKWATER AND VEGETATIVE PLANTINGS ALONG CALCASIEU SHIP CHANNEL TO PREVENT EROSION
65	CALC	EROSION CONTR	RIP-RAP EXISTING STRUCTURES ON HEBERT-PRECHT CANAL AND AT WELFARE BRIDGE TO PROTECT STRUCTURES
66	CALC	EROSION CONTR	RIP-RAP EXISTING WATER CONTROL STRUCTURES FOR THE CAMERON-CREOLE WATERSHED PROJECT TO PREVENT UNDERMINING
67	CALC	FRSHWTR DIV	REROUTE PUMPED STORM WATER INTO THE CAMERON CREOLE WATERSHED PROJECT(1A)
68	CALC	FRSHWTR DIV	DIVERT WATER FROM THE SABINE RIVER INTO BLACK BAYOU
69	CALC	HYDRO REST	PLACE ROCK WEIRS ACROSS EXCHANGE POINTS ALONG BLACK BAYOU BETWEEN GIWW AND SABINE RIVER
70	CALC	HYDRO REST	CLOSURE OF PETROLEUM ACCESS CANALS ALONG SABINE LAKE AND IN ADJACENT MARSHES TO REESTABLISH HISTORIC HYDROLOGY AND REDUCE WETLAND LOSS (2
71	CALC	HYDRO REST	DECREASE TIDAL FLUCTUATIONS AND SCOUR BY DECREASING THE CROSS SECTION OF OYSTER BAYOU (15)
72	CALC	HYDRO REST	REDUCE CROSS SECTION OF CALCASIEU PASS TO AUTHORIZED WIDTH TO REDUCE TIDAL EXCHANGE AND SALTWATER INTRUSION
73	CALC	HYDRO REST	REDUCE THE CROSS-SECTION OF KELSO BAYOU TO PREVENT TIDAL SCOUR AND SALT WATER INTRUSION (3)
74	CALC	HYDRO REST	SALT WATER BARRIER WEST OF HWY 27 AND EAST OF ALKALI (SALT) DITCH TO REDUCE SALT WATER INTRUSION AND TIDAL SCOUR (22)
75	CALC	HYDRO REST	SALTWATER INTRUSION UNDER HWY 384 IS THREATENING FRESH MARSH. PLUGS OR WATER CONTROL STRUCTURES NEEDED (22)

Record#	BASIN	CATEGORY	DESCRIPT
76	CALC	HYDRO REST	A LOCK IS NEEDED ON THE GIWW, EAST OF THE HWY 27 BRIDGE AND WEST OF THE CALCASIEU RIVER TO PREVENT SALTWATER INRUSION (58)
77	CALC	HYDRO REST	INSTALL A LOCK AT THE MOUTH OF THE CALCASIEU SHIP CHANNEL TO REDUCE SALTWATER INTRUSION, ETC... (1)
78	CALC	HYDRO REST	MARSH MANAGEMENT IS NEEDED IN THE MUD LAKE AREA PERMIT; CAMERON PARISH WETLANDS 923 (12)
79	CALC	HYDRO REST	MARSH MANAGEMENT IS NEEDED IN THE OYSTER BAYOU AREA (11)
80	CALC	HYDRO REST	ROCK WEIRS SHOULD BE CONSTRUCTED ACROSS GAPS ALONG BLACK BAYOU FORM THE SABINE RIVER TO THE GIWW (22)
81	CALC	HYDRO REST	SALTWATER INTRUSION IS OCCURRING IN THE WETLANDS EAST OF HWY 384 (3)
82	CALC	HYDRO REST	STOP MAINTAINING THE CALCASIEU CHANNEL TO SAVE THE WETLANDS (2)
83	CALC	HYDRO REST	THERE IS A LACK OF WATER FLOW ALONG HWY 27 AT LITTLE CHENIER (4)
84	CALC	HYDRO REST	WATER MANAGEMENT IS NEEDED NORTH OF MOSS LAKE (10)
85	CALC	HYDRO REST	PLACE A SALT WATER BARRIER THAT ALLOWS NAVIGATION IN CALCASIEU PASS THAT A HIGH RISE BRIDGE COULD BE BUILT ON.
86	CALC	HYDRO REST	PLACE A SALTWATER BARRIER AT THE MOUTH OF BRANNON DITCH TO ALLOW RAINFALL RUNOFF FROM THE N. AND PREVENT SALTWATER FROM THE S.
87	CALC	HYDRO REST	CONSTRUCT A WATER CONTROL STRUCTURE IN BLACK BAYOU ADJACENT TO CALCASIEU LOCKS TO HELP RELIEVE MERMENTAU BASIN FLOOD FLOWS
88	CALC	HYDRO REST	CONSTRUCT LOCKS ON THE GIWW IN THE VICINITY OF ALKALI DITCH TO PREVENT SALTWATER CIRCULATION
89	CALC	HYDRO REST	BUILD LEVEE ON SOUTH SIDE OF MIAMI CORP. LAND TO ALLOW MARSH TO RECEIVE OVERBANK FLOW FROM THE NORTH AND PROTECT RESIDENTS
90	CALC	OTHER	ASSUMPTION OF O&M COSTS OF CAMERON-CREOLE WATERSHED PROJECT (17)
91	CALC	OTHER	DEAUTHORIZE THE LAKE CHARLES DEEPWATER CHANNEL SO THAT SALT WATER BARRIER OR FRESH WATER DIVERSION COULD BE BUILT INTO CHANNEL (23A,
92	CALC	OTHER	FLOODING OCCURS IN HACKBERRY AS A RESULT OF HYDROLOGIC RESTORATION (1)
93	CALC	OTHER	RESTORE BLACK LAKE'S SHORELINE TO PROTECT ADJACENT MARSHES AND RESTORE HYDROLOGY (4)
94	CALC	OTHER	USE HAY BALES AND ROLLS TO ENCOURAGE VEGETATION COLONIZATION OF AREA AND ACT AS WAVE DAMPENING DEVICES IN LAKE BOUDREAUX (27)
95	CALC	OTHER	FLOODING IS OCCURRING IN HACKBERRY AREA. REASONS SUGGESTED IN MARSH MANAGEMENT PROJECT (14)
96	CALC	WETLAND LOSS	RESTORE HYDROLOGY IN MUD LAKE MARSH TO REDUCE WETLAND LOSS (13)
97	CALC/MERM	EROSION CONTR	PLACE AN EARTHEN LEVEE OR NON-ERODABLE BREAKWATER AND VEGETATIVE PLANTINGS ALONG THE GIWW IN CALCASIEU, CAMERON, AND VERMILION PARISHES
98	CALC/MERM	MARSH MNGMNT	MARSH MANAGEMENT WITH STRUCTURES FOR THE COTEAU PLATEAU MARSH BETWEEN EAST CREOLE AND LITTLE CHENIER CHENIERS
99	CALC/MERM	OTHER	REINTRODUCE PRAIRIE BISON AND RED WOLVES TO BENEFIT THE ENTIRE PLANETARY ECOSYSTEM
100	CALC/MERM	WETLAND LOSS	EROSION IS OCCURRING ALONG THE GIWW FROM THE CALCASIEU RIVER TO LELAND-BOWMAN LOCK
101	MERM	EROSION CONTR	BREAKWATER OR ARTIFICAL REEF TO SLOW EROSION OF SHORELINE AT ROCKEFELLER WILDLIFE REFUGE (12A)
102	MERM	EROSION CONTR	EROSION OF GIWW DREDGED MATERIAL BANKS IS ALLOWING INCREASED WAVE ENERGY ON ADJACENT MARSHES (5)
103	MERM	EROSION CONTR	FRESHWATER BAYOU NEEDS BANK STABILIZATION FROM FRESHWATER BAYOU LOCK TO INTRACOASTAL CITY. AREAS HAVE BEEN PRIORITIZED & PERMIT ISSUED (1C
104	MERM	EROSION CONTR	INLAND WATERWAY'S (OLD GIWW) SHORELINE IS ERODING THREATENING ADJACENT MARSHES (9)
105	MERM	EROSION CONTR	LOWERING OF WATER LEVELS WOULD REDUCE WAVE INDUCED EROSION ALONG GRAND LAKE (6)
106	MERM	EROSION CONTR	LOWERING WATER LEVELS IN GRAND LAKE WOULD REDUCE SHORELINE EROSION (6A)
107	MERM	EROSION CONTR	REDUCE WATER LEVELS IN WHITE LAKE BY DIVERTING WATER UNDER HWY 82. WILL REDUCE EROSION AROUND WHITE LAKE & BENEFIT RECEIVING AREA
108	MERM	EROSION CONTR	LIMESTONE RIP-RAP ENTIRE SOUTH BANK OF GRAND LAKE AND PLANT WITH SMOOTH CORDGRASS
109	MERM	EROSION CONTR	LIMESTONE RIP-RAP ENTIRE SOUTH BANK OF WHITE LAKE AND PLANT WITH SMOOTH CORDGRASS
110	MERM	EROSION CONTR	EROSION IS OCCURRING ALONG THE OLD GIWW BETWEEN GRAND AND WHITE LAKES (13)
111	MERM	EROSION CONTR	SHORELINE OF WHITE LAKE IS ERODING (12)
112	MERM	EROSION CONTR	BUILD ROCK AND PILING EMBANKMENTS ALONG THE GULF SHORE TO TRAP SILT AND SAND TO PROTECT ROCKEFELLER REFUGE
113	MERM	EROSION CONTR	PLACE EARTHEN LEVEE OR NON-ERODABLE BREAKWATERS AND VEGETATIVE PLANTINGS ALONG CRITICAL SHORELINES OF GRAND AND WHITE LAKES
114	MERM	FRSHWTR DIV	FRESHWATER DIVERSION FROM GRAND AND WHITE LAKE BASINS UNDER HWY 82 TO DECREASE SALT WATER INTRUSION TO MARSHES S. AND E. OF HWY 82 (7)
115	MERM	HYDRO REST	THE HOG BAYOU AREA NEEDS A MANAGEMENT PLAN (28)
116	MERM	HYDRO REST	BUILD A LEVEE ON SOUTH BORDER OF MIAMI CORP. LAND TO ALLOW OVERBANK FLOODING TO ENTER BIG BURN MARSH AND PROTECT NEARBY RESIDENTS
117	MERM	HYDRO REST	CONSOLIDATE SAWMILL CANAL WATER CONTROL STRUCTURES INTO ONE UNIT AT INTERSECTION OF SAWMILL CANAL AND LITTLE PECAN BAYOU TO MAINTAIN MARSH
118	MERM	HYDRO REST	REPLACE EXISTING FLOODWATER CONTROL STRUCTURE ON HUMBLE CANAL TO MANAGE WATER LEVELS IN THE AREA OF BIG BURN
119	MERM	MARSH MNGMNT	A COMPREHENSIVE HYDROLOGIC PLAN TO PRESERVE AND RESTORE MARSH BETWEEN THE MERMENTAU RIVER AND ROCKEFELLER REFUGE
120	MERM	VEG PLANTINGS	PLANT SMOOTH CORDGRASS ALONG ENTIRE BANKS AND MARSH EDGE OF LITTLE PECAN BAYOU WATER SHED TO PREVENT EROSION FROM SALTWATER INTRUSION
121	MERM	VEG PLANTINGS	PLANT BALD CYPRESS SEEDLINGS ALONG THE GIWW FROM CALCASIEU LOCKS TO GRAND LAKE
122	MERM	WETLAND LOSS	EROSION IS OCCURRING IN THE GRAND & WHITE LAKE AREA (16)
123	MERM/VERM	EROSION CONTR	PLACE AN EARTHEN LEVEE AND/OR NON-ERODABLE BREAKWATER AND VEGETATIVE PLANTINGS ALONG FRESHWATER BAYOU TO PREVENT EROSION
124	MERM/VERM	OTHER	HERBICIDE USE IN GRAND & WHITE LAKE BASIN MAY BE HARMING WETLAND VEGETATION (9)
125	MERM/VERM	WETLAND LOSS	EROSION ALONG FRESHWATER BAYOU IS CRITICAL WHERE IT COMES CLOSEST TO VERMILION BAY (19)
126	MERM/VERM	WETLAND LOSS	MARSHES BETWEEN FRESHWATER BAYOU AND WHITE LAKE ARE BEING LOST (7)
127	MISS	DREDGED MAT	CREATE MARSH ISLANDS USING MATERIAL DREDGED FORM THE MISS. RIVER AND S.R.E.D.'S CONSTRUCTED WITH TIRES
128	MISS	EROSION CONTR	USE OLD TIRES TO CONTROL EROSION ALONG GRAND BAYOU (13)
129	MISS	FRSHWTR DIV	INVESTIGATE WAYS TO LET NATURE MOVE HEAVY SEDIMENTS INTO THE WEST DELTA (4)
130	MISS	FRSHWTR DIV	DIVERT HEAVY SEDIMENTS FROM SOUTHWEST PASS INTO WEST DELTA (14)
131	MISS	OTHER	USE OLD TIRES TO TRAP AND RETAIN DISPOSED DREDGED MATERIAL FROM THE MISSISSIPPI RIVER & COMPLEMENT THE WEST BAY SEDIMENT DIVERSION (COE)(1
132	MISS	OTHER	USE OLD TIRES TO TRAP SEDIMENTS IN THE RIVERSIDE BAY AREA OF THE WEST DELTA (12)
133	OTHER	WETLAND ACQ	BUY AND PROTECT A WET BATTURE AREA ALONG THE MISSISSIPPI RIVER IN THE VICINITY OF HARAHAN, LA
134	PONT	DREDGED MAT	STABILIZE AND REBUILD THE BANKS OF THE GIWW BYPASS BY USING MATERIAL BORROWED FROM THE CHANNEL
135	PONT	DREDGED MAT	MARSH CREATION WITH DREDGED MATERIAL NORTH OF INTERSTATE 10 IN ST. CHARLES PARISH (5)
136	PONT	DREDGED MAT	PROPOSAL SIMILAR TO THE LABRANCHE WETLANDS PROJECT ON THE FIRST PROJECT LIST
137	PONT	DREDGED MAT	USE MATERIAL DREDGED FROM LAKE PONTCHARTRAIN TO BUILD MARSH IN LABRANCHE WETLANDS IN ADDITION TO THE FIRST PRIORITY PROJECT LIST
138	PONT	EROSION CONTR	BANK STABILIZATION ALONG THE LAKE PONTCHARTRAIN SHORELINE IN ST. CHARLES PARISH (4)
139	PONT	EROSION CONTR	PROTECT LAKE PONTCHARTRAIN SHORELINE WITH ROCK OR GABION IN AREA OF LABRANCHE WETLANDS
140	PONT	EROSION CONTR	BEACH EROSION IS OCCURRING E. AND W. OF THE MOUTH OF THE TCHEFUNCTE RIVER (4)
141	PONT	EROSION CONTR	NEED TO PROTECT CHENIER NEAR BAYOU CHINCHUBA TO PREVENT LAKE PONTCHARTRAIN FROM BREAKING THROUGH INTO FRESHER MARSH (1)
142	PONT	EROSION CONTR	PROTECT THE SHORELINE OF LAKE BORGNE FROM EROSION (18)
143	PONT	EROSION CONTR	SHORELINE PROTECTION NEEDED NEAR THE MOUTH OF THE TCHEFUNCTE RIVER
144	PONT	EROSION CONTR	PLACE STRUCTURES ALONG THE SOUTH SHORE OF LAKE PONT. TO REDUCE WAVE ENERGY TO ALLOW FOR SEDIMENTS TO ACCUMULATE AND BUILD MARSH
145	PONT	HYDRO REST *	RESTORE EASTERN PART OF EDEN ISLES TO WETLANDS
146	PONT	HYDRO REST	RESTORE THE UNDEVELOPED 2,700 ACRES ON THE EASTERN SIDE OF EDEN ISLES ON THE NORTH SHORE OF LAKE PONTCHARTRAIN
147	PONT	HYDRO REST	MARSH MANAGEMENT OF AREA BOUND BY LAKE BORGNE, LAKE ST. CATHERINE, CHEF MENTEUR PASS, AND ST. CATHERINE PASS, USING ROCK WEIRS, PLUGS, E
148	PONT	HYDRO REST	CULVERTS UNDER HWY 51 & POSSIBLY THE RAILROAD ARE PREVENT WATER EXCHANGE BETWEEN LAPLACE AND PONCHATOULA (1)
149	PONT	HYDRO REST	THE WEIR AT THE WHITE RIVER DIVERSION CHANNEL NEEDS TO BE MAINTAINED (2)
150	PONT	HYDRO REST	DEAD END CANALS AT PORT LOUIS AREA CAUSING PROBLEMS. THE PORT IS NEARLY DEFUNCT AND NO MAINTENANCE IS BEING DONE. (2)

Record#	BASIN	CATEGORY	DESCRIPT
151	PONT	HYDRO REST	FORMULATE AND IMPLEMENT A COMPREHENSIVE HYDROLOGIC PLAN TO PRESERVE AND RETURN HYDROLOGIC FLOW TO THE LOWER MAUREPAS BASIN
152	PONT	MARSH MGMNT	CREATE MARSH SYSTEMS AND BARRIER ISLANDS TO RETAIN AND TREAT STORM WATER RUNOFF
153	PONT	OTHER	LOOK AT ACQUIRING AND PRESERVING EDEN ISLE PROPERTY EAST OF INTERSTATE HIGHWAY 10 (3)
154	PONT	OTHER	MARSH CREATION FOR TREATMENT OF STORM WATER RUNOFF IN EAST JEFFERSON (15)
155	PONT	OTHER	FUND PROJECT SWALLOW WITH CWPPRA FUNDS (7)
156	PONT	OTHER	PRESERVE MARSHES SURROUNDING LAKE PONTCHARTRAIN, POSSIBLY PURCHASE OF LAND. (6)
157	PONT	OTHER	RE-ESTABLISH GRASS BEDS IN LAKE PONTCHARTRAIN (5)
158	PONT	OTHER	RELOCATE HUMANS LIVING SOUTH OF LAKE PONTCHARTRAIN TO THE NORTH SHORE THEN OPEN UP LEVEES ALONG THE RIVER TO REPLENISH MARSH
159	PONT	OTHER	RESTORE THE AREA OF EDEN ISLES TO THE EAST OF INTERSTATE 10 (10)
160	PONT	OTHER	ANALYZE THE BONNABEL CANAL CREATED WETLANDS TO DETERMINE THEIR EFFECTIVENESS IN TREATING STORMWATER RUNOFF
161	PONT	OTHER	ANALYZE THE EFFECTIVENESS OF THE DUNCAN CANAL CREATED WETLANDS IN TREATING STORMWATER RUNOFF
162	PONT	WETLAND LOSS	WETLAND LOSS AREAS: A.GOOSE POINT MARSH, B.FRITCHIE MARSH C.BETWEEN MADISONVILLE AND MANDEVILLE, D.E&W OF TCHEFUNCTE RIVER (SHORELINE)(4)
163	PONT	WETLAND LOSS	EROSION OF SWAMP AND MARSH BETWEEN BAYOU CHINCHUBA AND TCHEFUNCTE RIVER
164	PONT	WETLAND LOSS	INTERIOR EROSION OF NORTH SHORE AND FRITCHIE MARSHES
165	PONT	WETLAND LOSS	INTERIOR MARSH LOSS BETWEEN CANE BAYOU AND BAYOU LACOMBE
166	PONT/BARA	WETLAND LOSS	BANK STABILIZATION AND HYDROLOGIC RESTORATION IS NEEDED ALONG THE GIWW IN ORLEANS AND JEFFERSON PARISH (2)
167	PONT/BRET	EROSION CONTR	PROTECT THE SHORELINE OF LAKE BORGNE FROM EROSION (23)
168	PONT/BRET	EROSION CONTR	BANK STABILIZATION ALONG MRGO (1)
169	PONT/BRET	HYDRO REST	CLOSE THE MRGO AND USE CWPPRA FUNDS TO RELOCATE CONTAINER CARGO FACILITIES TO THE MISSISSIPPI RIVER
170	PONT/BRET	HYDRO REST	INSTALL A GATE OR LOCK ON THE MRGO TO REDUCE SALTWATER INTRUSION
171	PONT/BRET	HYDRO REST	NAVIGABLE WEIR OR GATE ON THE MRGO TO REDUCE SALTWATER INTRUSION (17)
172	PONT/BRET	HYDRO REST	PUT A NAVIGABLE LOCK ON THE MRGO (19)
173	PONT/BRET	HYDRO REST	RESTORE MARSHES IN CENTRAL WETLAND UNITS OF ST. BERNARD PARISH (16)
174	STATE	BARR ISL REST	HE SUBMITTED A LENGHTY DISCOURSE ON HOW TO USE OLD TIRES, BOUND TOGETHER WITH NYLON CORD, FOR EROSION CONTROL AND CAPTURING SEDIMENTS
175	STATE	BARR ISL REST	FAILURE TO PRESERVE BARRIER ISLANDS WILL MAKE EFFORTS TO SAVE INTERIOR WETLANDS FUTILE (3)
176	STATE	DREDGED MAT	USE DREDGED MATERIAL WHEN & WHERE EVER POSSIBLE (19)
177	STATE	DREDGED MAT	USE DREDGED MATERIAL BENEFICALLY WHEN AND WHERE EVER POSSIBLE (10)
178	STATE	EROSION CONTR	THIS MAN'S COMPANY HAS A PRODUCT CALLED "BEACH BLOCKS" THAT THEY MARKET FOR EROSION CONTROL
179	STATE	EROSION CONTR	EROSION ALONG TYHE GIWW IS AFFECTING WETLANDS OUTSIDE OF THE PROJECT RIGHT-OF-WAYS (6)
180	STATE	FRSHWTR DIV	PUMP RIVER SEDIMENTS INTO THE INFLOW CHANNELS OF THE FRESHWATER DIVERSION PROJECTS (9)
181	STATE	HYDRO REST	RECONVERT MARGINAL AGRICULTURAL LANDS TO WET-PRAIRIE (MARSH). HE ALSO SUBMITTED THIS PROPOSAL FOR THE STATE PLAN
182	STATE	HYDRO REST	REDUCE TIDAL FLUSHING AND SCOUR BY FILLING OR PLUGGING UNUSED CANALS (20)
183	STATE	HYDRO REST	CONSIDER PLUGGING AND BACKFILLING CUTS INTO MARSHES MADE BY OIL COMPANIES, THEY SHOULD BEAR THIS COST
184	STATE	HYDRO REST	REDUCE THE SIZE OF TIDAL PASSES ALON THE GULF SHORELINE TO REDUCE SALTWATER INTRUSION AND TIDAL SCOUR (7)
185	STATE	OTHER	CONSTRUCTION AND VEGETATION OF BERMS ALONG NAVIGATION CHANNELS TO PREVENT BANKLINE EROSION (24)
186	STATE	OTHER	WAVE DAMPENING AND VEGETATIVE PLANTINGS IN OPEN WATER AREAS (20). ALSO OTHER WETLAND PROTECTION/RESTORATION TYPE PROJECTS (21)
187	STATE	OTHER	ALLOCATE OR DEDICATE WATER IN THE MISS. RIVER FOR USE IN LA. (22)
188	STATE	OTHER	EXAMINE ALL NAVIGATION CHANNELS FOR SALTWATER INTRUSION AND EROSION PROBLEMS (12)
189	STATE	OTHER	SUBSIDENCE AND MARSH DETERIORATION HAS OCCURRED FROM PETROLEUM EXTRACTION. EXAMINE REINTRODUCTION OF PRODUCED WATER (13)
190	STATE	OTHER	USE YARD WASTE TO CREATE A BASE FOR WETLAND GROWTH IN FRESHWATER CANALS (21)
191	STATE	OTHER	SUPPORT PROJECTS LIKE EPA'S FALGOUT CANAL SOUTH WETLAND CREATION DEMONSTRATION (7)
192	STATE	OTHER	CONSIDER SEA LEVEL RISE WHEN PLANNING PROJECTS ALONG THE COAST (9)
193	STATE	OTHER	PERMITTING PROCESS IS TO LONG AND COMPLICATED (10)
194	STATE	OTHER	GIVE MARSH OWNERS THE RIGHT AND PERMITS TO LEVEE THEIR LANDS WITH FIVE FOOT LEVEES
195	STATE	OTHER	USE PRODUCTS DEVELOPED FROM DISCARDED TIRES TO PROTECT AND REBUILD MARSHES AND BARRIER ISLANDS
196	STATE	OTHER	STOP ALL DREDGING AND ENCOURAGE LAND AND OIL COMPANIES TO RESTORE LAND
197	STATE	OTHER	A PROJECT TO DETERMINE THE FEASIBILITY OF USING BEACH CONES SHOULD BE FUNDED (3)
198	STATE	OTHER	PLAN RESTORATION BY HYDROLOGIC BASINS INSTEAD OF BY UNASSOCIATED INDIVIDUAL PROJECTS (4)
199	STATE	TIDAL EXCHANG	DEMOLISH CATTLE WALKWAYS THAT INTERRUPT SHEET FLOW USING MILITARY EQUIPMENT TO BLOW THEM UP
200	STATE	VEG PLANTINGS	PLANTING OF DEEPWATER AQUATICS TO REDUCE EROSION AND WAVE FETCH (26)
201	STATE	VEG PLANTINGS	VEGETATIVE PLANTING EFFORTS SHOULD BE EXPANDED
202	STATE	VEG PLANTINGS	PLANT NATUAL VEGETATION ALONG THE COASTLINE TO RESTORE AND MAINTAIN BEACHES & SAND BANKS, ie TURTLE GRASS, MANGROVES, WILDFLOWERES, COCONU
203	TERR	BARR ISL REST	COMPLETE BARRIER ISLAND RESTORATION PLAN FOR TERREBONNE PARISH (1)
204	TERR	BARR ISL REST	REBUILD BARRIER ISLANDS, PLANT VEGETATION, INSTALL ROCK JETTIES, AND STABILIZE NATURAL PASSES
205	TERR	BARR ISL REST	RESTORE ISLE DERNIERES CHAIN WITH MATERIAL FROM BAY SIDE, STRUCTURES TO SEDIMENTS ON GULF SIDE, AND REPAIRS TO BREAKS IN ISLANDS
206	TERR	DREDGED MAT	DREDGE BAYOU TERREBONNE AND USE DREDGED MATERIAL TO CREATE WETLANDS (8)
207	TERR	EROSION CONTR	MARSH CREATION AND BANK STABILIZATION ON THE WEST SIDE OF BAYOU LAFOURCHE AND AT BELLE PASS (4)
208	TERR	EROSION CONTR	STABILIZATION OF HOUMA NAVIGATION CANAL BANKS (4)
209	TERR	EROSION CONTR	CONSTRUCT ARTIFICAL REEF IN GULF OF MEXICO TO SLOW WAVE ACTION USING OLD CARS
210	TERR	EROSION CONTR	CONSTRUCTION OF LEVEES ALONG BAYOU PETIT CALLIOU & BAYOU TERREBONNE & UPGRADE ROAD SIDE ALONG HWY 56 S. OF BOUDREAUX CANAL
211	TERR	EROSION CONTR	PARISH WANTS BARRIER ISLAND PROJECTS
212	TERR	EROSION CONTRO	A LARGE BREACH HAS OCCURRED IN THE BANK OF THE GIWW ABOUT 3 MILES WEST OF BAYOU LAFOURCHE AND IS CAUSING WIDESPREAD LOSS OF FRESH MARSH
213	TERR	FRSHWTR DIV	DIVERT SEDIMENT AND FRESHWATER FROM THE ATCHAFALAYA RIVER AND OFFER FLOOD PROTECTION TO TERREBONNE PARISH (3)
214	TERR	HYDRO REST	ON POINT AU FER ISLAND, CLOSE AN EXISTING CANAL SYSTEM WITH PLUGS, AND FILL WITH DREDGED MATERIAL TO KEEP THE GULF FROM BREAKING THROUGH
215	TERR	HYDRO REST	ON POINT AU FER ISLAND, INSTALL THREE BULKHEADS IN ABANDONED ACCESS CANALS, SPECIFICALLY, IN THE AREA OF LOCUST BAYOU AND LAKE CHAPEAU
216	TERR	HYDRO REST	ON POINT AU FER ISLAND, REINSTALL TWO BULKHEADS THE HAVE FAILED IN A CANAL SYSTEM CONNECTING MOSQUITO BAY AND BAY CASTAGNIER
217	TERR	HYDRO REST	PLACE A LOCK IN THE HOUMA NAVIGATION CANAL TO REDUCE HYDROLOGIC EXCHANGE AND PREVENT SALTWATER INTRUSION (12)
218	TERR	HYDRO REST	RESTORE LAKE HOUMA TO CYPRESS SWAMP (3)
219	TERR	HYDRO REST	CLOSE HOUMA NAVIGATION CANAL OR INSTALL LOCKS JUST NORTH OF FALGOUT CANAL
220	TERR	HYDRO REST	INSTALL TWO SALINITY REDUCTION CELLS IN HOUMA NAVIGATION CANAL JUST N. OF COCODRIE AND IN DULAC AREA
221	TERR	MRSH CREATION	MARSH CREATION WEST OF HOUMA AND NORTH OF GIWW (8)
222	TERR	OTHER	RE-ROUTE GIWW SOUTH OF HOUMA AND USE DREDGED MATERIAL TO BUILD A HURRICANE PROTECTION LEVEE (7)
223	TERR	OTHER	RELOCATE THE GIWW SOUTH OF COCODRIE
224	TERR	WETLAND LOSS	RESTORE MARSH ON POINT AU FER ISLAND. LAND OWNERS HAVE DIFFICULTY GETTING PERMITS AND FINANCING PROJECTS (8)
225	TERR/ATCH	EROSION CONTR	STABILIZE BANKS OF AVOCA ISLAND CUTOFF BAYOU DRAINAGE CANAL AND THE GIWW IN TERREBONNE PARISH

Record#	BASIN	CATEGORY	DESCRIPT
226	TERR/ATCH	HYDRO REST	CLOSE OFF THE NORTHERN SEGMENT OF BAYOU CHENE (2)
227	TERR/ATCH	OTHER	INVESTIGATE BOTH WETLAND RESTORATION AND PROTECTION, AND FLOOD PROTECTION. (BARRIER PLAN - BAYOUS CHENE, BOEUF, AND BLACK) (10)
228	TERR/BARA	BARR ISL REST	RESTORE AREAS WEST OF BAYOU LAFOURCHE AND EAST OF TIMBALIER (9)
229	TERR/BARA	BARR ISL REST	RESTORE BARRIER ISLANDS IN BOTH TERREBONNE AND BARATARIA BASINS (6)
230	TERR/BARA	BARR ISL REST	PLACE MAN-MADE REEFS NEAR OR OUTSIDE BARRIER ISLANDS TO REDUCE WAVE ENERGY AND PREVENT EROSION (13)
231	TERR/BARA	BARR ISL REST	PLACE ROCKS IN BREACHES OF BARRIER ISLANDS TO PREVENT FURTHER EROSION (9)
232	TERR/BARA	BARR ISL REST	USE OYSTER SHELL AND SAND TO NOURISH BEACH AND BUILD STRUCTURES ON THE GULFSIDE OF THE ISLANDS FOR PROTECTION
233	TERR/BARA	DREDGED MAT	DREDGE ALL OF BAYOU LAFOURCHE AND USE DREDGED MATERIAL TO CREATE MARSH
234	TERR/BARA	EROSION CONTR	STUDY USE OF BEACH CONES TO SLOW EROSION OF BARRIER ISLANDS (1A)
235	TERR/BARA	FRSHWTR DIV	DIVERT WATER FROM BAYOU LAFOURCHE INTO WESTERN LAFOURCHE AND TERREBONNE BASIN
236	TERR/BARA	FRSHWTR DIV	REROUTE PUMPED OUTFALL WATER THROUGH ADJACENT MARSHES
237	TERR/BARA	HYDRO REST	PLACE 3-4 SILLS IN BAYOU LAFOURCHE TO REDUCE SALINITY
238	TERR/BARA	OTHER	CONNECT BAYOU TERREBONNE AND BAYOU LAFOURCHE WITH A CHANNEL (8A)
239	VERM	EROSION CONTR	STABILIZE EASTERN END OF MARSH ISLAND WITH SEDIMENT RETENTION DIKES AND DREDGED MATERIAL
240	VERM	EROSION CONTR	BREAKWATER, ARTIFICAL REEF, OR VEGETATIVE PLANTINGS BETWEN MUD POINT AND POINT CHAMPLAIN IN VERMILION BAY (16)
241	VERM	EROSION CONTR	EROSION OF VERMILION RIVER SHORELINE AT LIVE OAK PLANTATION IS THREATENING ADJACENT WETLANDS (19)
242	VERM	EROSION CONTR	POSSIBLE BREAKWATER &/OR ARTIFICAL REEF TO SLOW COASTLINE EROSION (11)
243	VERM	EROSION CONTR	BANKS OF BAYOU CARLIN ARE ERODING. POSSIBLE WAVE STILLING FENCES OR VEGETATIVE PLANTING (19)
244	VERM	EROSION CONTR	BANKS OF BAYOU PETIT ANSE ERODING FROM VERMILION BAY TO AVERY ISLAND POSSIBLE VEGETATIVE PLANTINGS AND WAVE STILLING FENCES (18)
245	VERM	EROSION CONTR	BANKS OF FRESHWATER BAYOU ARE ERODING (1)
246	VERM	EROSION CONTR	EROSION IS OCCURRING ALONG THE GULF SHORELINE FORM SOUTHWEST PASS TO THE WEST (16)
247	VERM	EROSION CONTR	EROSION IS OCCURRING NORTH OF LITTLE VERMILION LAKE IN THE AREA AROUND OLD BAYOU CHENE (14)
248	VERM	EROSION CONTR	FOUR-MILE CUT NEEDS EROSION CONTROL ON THE WEST SIDE (2)
249	VERM	EROSION CONTR	VERMILION BAY- MUD POINT TO CYPREMONT POINT NEEDS EROSION PROTECTION POSSIBLE VEGETATIVE PLANTINGS (3)
250	VERM	EROSION CONTR	MM WITH STRUCTURES, LEVEE REPAIRS, AND PLANTINGS. AREA IS S. OF GIWW, N. OF VERMILION BAY, E. OF 4 MILE CUT & W. OF BOSTON BAYOU
251	VERM	EROSION CONTR	EROSION ALONG GIWW IN VERMILION AND IBERIA PARISHES (40)
252	VERM	EROSION CONTR	EROSION IS OCCURRING ALONG AVERY CANAL (5)
253	VERM	EROSION CONTR	ISOLATE FRESHWATER BAYOU FROM VERMILION BAY WITH AN EARTHEN LEVEE AND ROCK BREAKWATERS
254	VERM	HYDRO REST	RESTORE PIPELINE PLUGS AROUND VERMILION BAY TO PREVENT WETLAND LOSS (15)
255	VERM	VEG PLANTINGS	VEGETATIVE PLANTINGS ALONG SHORELINE OF EAST AND WEST COTE BLANCHE BAYS (11)
256	VERM	WETLAND LOSS	FROM VERMILION RIVER EAST TO IBERIA PARISH LINE MARSHES ARE BEING LOST (11)
257	VERM	WETLAND LOSS	WETLAND LOSS BETWEEN VERM. PAR. LINE ON THE W., NEW IBERIA DRAINAGE CANAL ON THE E., TRUNKLINE PIPELINE ON THE N., AND GIWW ON THE S.
258	VERM	WETLAND LOSS	WETLANDS BEING LOST BETWEEN PECAN ISLAND AND GULF. POSSIBLE FRESHWATER INTRODUCTION FROM ATCHAFALAYA RIVER (A)
259	VERM	WETLAND LOSS	MARSH IS BEING LOST BECAUSE OF SALTWATER INTRUSION NORTH OF GIWW IN THE VICINITY OF THE LELAND-BOWMAN LOCK (8)
260	VERM/ATCH	FRSHWTR DIV	REROUTE OUTFALL WATER THROUGH ADJACENT MARSHES TO ENHANCE MARSHES AND IMPROVE WATER QUALITY IN EAST AND WEST COTE BLANCHE BAYS (10)

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

CWPPRA Monitoring Program and Protocols

Exhibit 5

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EXECUTIVE SUMMARY

Louisiana's coastal wetland loss, estimated at 79.5 km^2/year, has drawn national attention. In response, the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) was created to provide the guidance and means to develop and implement a project-oriented program to combat this coastal wetland loss. The CWPPRA requires a monitoring program be established to evaluate the effectiveness of these projects.

Projects developed under this program range from massive freshwater and sediment introduction to small scale vegetative plantings. Currently, there is no available standardized method for monitoring variables that can determine success or failure of wetland restoration projects. Consequently, data collected by Federal, State, and local entities within the coastal zone of Louisiana have not been comparable, and thus of limited use. The committee charged with the development of this monitoring program felt it was imperative to develop standardized protocols that could be used to judge project success or failure. Over 100 Federal and State restoration projects are currently being planned, and with standardized protocols, usable and comparable information will be generated, aiding in resource management and future planning and design.

These monitoring protocols were developed in response to the mandate for procedures that would evaluate the effectiveness of each coastal wetlands restoration project in achieving long-term solutions to arresting coastal wetlands loss in Louisiana. Specifically, this mandate requires that a scientific evaluation be conducted to test the effectiveness of these projects in creating, restoring, protecting, and enhancing coastal wetlands in Louisiana.

These monitoring protocols broadly categorize project types, goals, and biological variables, and standardize data collection methodologies using a matrix design. This organization provides accessibility to three levels of information: project type, category of variable, and variable. These three levels are cross-referenced and ranked to guide personnel in the development of appropriate monitoring plans.

The goal of the monitoring protocols is to provide a guidance document that can be used to develop project-specific and basin-wide monitoring plans and monitoring cost estimates. In addition, the protocol should help determine the minimum monitoring standards necessary to provide sufficient information to determine whether project-specific goals are met.

Monitoring protocols were developed by subgroups of technical experts for seven categories of monitoring variables: water quality, hydrology, soils and sediments, vegetative health, habitat mapping, wildlife, and fisheries. Some variables were identified as a monitoring priority by more than one subgroup, but only one subgroup will describe specific methodologies and costs (Table 1). The results of each subgroup are represented in the following sections of this document. Each section described protocol design, cost estimates, priority rankings, and existing data bases. Following is a general overview of the monitoring protocols each monitoring subgroup developed.

Table 1. Monitoring subgroup responsibilities based on project type and variables measured. VEG=vegetative health; WQ=water quality; HYD=hydrology; FISH=fisheries; SED=soil/sediments; HAB=habitat mapping.

Project type	Freshwater diversion	Sediment diversion	Marsh management	Hydrologic restoration	Dredge material	Shoreline protection	Barrier island restor.	Vegetative planting	Sediment/ nutrient trapping
Salinity temperature	WQ		WQ	WQ				WQ	
Physical variables	WQ		WQ	WQ					
Nutrients	WQ		WQ	WQ					WQ
Trace metals				WQ					
Synthetic organics				WQ					
Species composition	VEG	VEG	VEG	VEG	VEG		VEG	VEG	VEG
Relative abundance	VEG	VEG	VEG	VEG	VEG		VEG	VEG	VEG
Above-ground biomass	VEG		VEG	VEG				VEG	
Herbivory								VEG	
Precipitation	HYD		HYD	HYD				HYD	
Soil salinity					HYD				
Wind speed direction	HYD		HYD			HYD	HYD		
Water level	HYD	HYD	HYD	HYD					
Bathymetry		HYD	HYD	HYD	HYD	HYD	HYD		HYD
Topography		HYD	HYD	HYD	HYD	HYD	HYD		HYD
Discharge	HYD	HYD	HYD	HYD					
Suspended sediments	HYD	HYD, WQ			WQ		WQ	WQ	WQ
Oyster growth, recruitment, and survival	FISH		FISH	FISH					
Fish density, size, biomass, and species richness	FISH		FISH	FISH					
Accretion	SED	SED	SED	SED	SED	SED	SED	SED	SED
Subsidence	SED	SED	SED	SED	SED				SED
Organic matter	SED	SED	SED	SED	SED			SED	SED
Bulk density	SED	SED	SED	SED	SED			SED	SED
Water content	SED	SED	SED	SED	SED			SED	SED
Grain size		SED					SED		SED
Soil redox	SED	SED	SED	SED	SED			SED	
Habitat mapping	HAB	HAB	HAB	HAB	HAB	HAB	HAB	HAB	HAB

Water Quality

The water quality monitoring subgroup identified physical variables, salinity, temperature, nutrients, and priority pollutants as essential in designing a water quality monitoring plan for CWPPRA projects. Sampling methodologies vary widely in degree of sophistication as well as frequency (instantaneous, continuous recorder, realtime). The water quality monitoring subgroup feels that specification of sampling frequency is premature at this time and that sampling frequency will vary according to the availability of preexisting data, size of the project area, type of restoration project, and cost. Costs were estimated on a per sample basis and are illustrated by project type in Table 2.

Hydrology

The hydrologic monitoring subgroup identified variables to be monitored that would assist in determining project success as well as design of future projects. The variables are precipitation, evaporation, wind speed and direction, water level, bathymetry, topography, salinity, discharge, suspended sediment, ground water, and soil salinity. A majority of these variables can be monitored on a single data collection platform to provide realtime data, reduce maintenance costs, and minimize data loss. Cost estimates will vary according to frequency of data collection and number of sampling stations (Table 2).

Soil and Sediments

The soil and sediments monitoring subgroup identified variables that can be measured in the field to evaluate the success of CWPPRA projects in promoting soil development. The variables are organic matter content, bulk density, water content, grain size, soil redox, soil nutrients, soil contaminants, vertical accretion, subsidence, and soil erosion or creation. Vertical accretion and subsidence measurements can use three different methodologies depending on monitoring intensity: feldspar markers, sediment erosion table or radionuclide dating for accretion and carbon-14 dating, global positioning systems (GPS), and extensometers for subsidence. Estimates of total will vary tremendously depending on monitoring intensity and frequency as illustrated in Table 2.

Vegetative Health

The vegetative health monitoring subgroup determined that the following four variables were essential in evaluating vegetative health responses to CWPPRA projects: species composition, relative abundance, aboveground biomass, and herbivory. It was recommended that the Braun-Blanquet method be used for quantifying shifts in community compositions and abundances; that the clip-plot method be used for quantifying aboveground biomass; and that exclusion techniques be used to estimate the impacts of herbivory. Project-specific goals and available resources will dictate what and how frequently vegetative health variables will be monitored. Cost estimates by project type are illustrated in Table 2.

Habitat Mapping

The habitat mapping subgroup developed a two-phased monitoring approach. At the first level, basin-wide mapping at a scale of 1:100,000 is proposed. Data at this level could provide a quick

Table 2. Cost estimates based on priority (ranking 1 and 2) variables to be monitored.

Project type	Costs per project (annual)				Costs per sample		
	Hydrology[a]	Vegetative health[b]	Habitat mapping[c]	Wildlife[d]	Water quality[e]	Soil and sediments[f]	Fisheries[g]
Freshwater diversion	$39,200-235,200	$2,250-9,000	$12,250-18,600	$0	$50-400	$2,575-15,325	$150-200
Sediment diversion	$46,200-92,400	$2,000-4,000	$12,250-18,600	$0	$222-260	$2,675-15,425	$0
Marsh management	$23,600-96,400	$2,250-6,750	$12,250-18,600	$0	$50	$2,575-15,325	$150-200
Hydrologic restoration	$23,600-96,400	$2,250-6,750	$12,250-18,600	$0	$250-850	$2,575-15,325	$150-200
Dredge material	$10,500-21,000	$2,000	$12,250-18,600	$0	$222-660	$2,575-15,325	$0
Shoreline protection	$6,000-11,000	$0	$12,250-18,600	$0	$0	$250-1,000	$0
Barrier island restoration	$11,000-21,000	$2,000-4,000	$12,250-18,600	$0	$222-260	$350-1,000	$0
Vegetative planting	$2,500-8,000	$2,250-4,500	$12,250-18,600	$0	$208	$575-1,325	$0
Sediment/nutrient trapping	$6,000-33,100	$2,000	$12,250-18,600	$0	$222-296	$2,600-14,600	$0

[a]Hydrology cost estimates will vary depending on the number of data collection platforms (DCP's) in the project area.
[b]Vegetative health cost estimates will vary depending on the number of field days to conduct monitoring and the number of samples taken.
[c]Habitat mapping cost estimates will vary depending on the size of the project area.
[d]Wildlife monitoring will use existing data bases, therefore, no additional cost.
[e]Water quality cost estimates are only for discrete samples. Continuous samples for many variables could be obtained by using DCP's installed by the hydrologic monitoring subgroup.
[f]Soil and sediment cost estimates vary tremendously depending on whether an extensometer is used ($14,000).
[g]Fisheries cost estimates are only for the use of throw traps.

land and water classification to assess wetland trends for large restoration projects and entire hydrologic basins. The second level mapping is at scales ranging from 1:6,000 to 1:12,000. The Cowardin et al. classification is used for those restoration projects that require a greater level of detail. Habitat mapping will be conducted on all projects and will be prioritized based on project implementation timetables. Cost estimates by project type are illustrated in Table 2.

Wildlife

The wildlife monitoring subgroup recognized that wildlife populations are secondary to full recovery and conservation of coastal wetlands. The subgroup further recognized that wildlife populations are influenced by a broad range of factors, many of which are external and unrelated to basin-wide habitat conditions. For these reasons, the subgroup felt strongly that project evaluation should be based on monitoring variables that are expected to respond directly to restoration projects, namely water quality, hydrological, and vegetative variables. The subgroup agreed that, over the long term, recovery of coastal wetlands would benefit wildlife populations in the region. Wildlife populations or the effects of herbivores on vegetation will have to be monitored in case of herbivore demonstration projects.

Fisheries

The fishery monitoring subgroup determined that monitoring should target juvenile fish and crustaceans with emphasis placed on the collection of quantitative samples using high catch-efficiency gear. In addition to measuring animal density as an indicator of project area or habitat value, information on animal size, biomass, and species richness should also be collected. For oysters, measurements of growth, survival, and spat settlement should be collected. The gear type selected for sampling is throw traps. Sampling intensity and frequency depend on size of project area, number of different habitats present, and cost. Cost estimates by project type are illustrated in Table 2.

The standardized monitoring protocols developed in this document will provide statistically defensible, scientific procedures for monitoring those variables critical for determining project success or failure. It provides the framework and flexibility to develop basin-wide and project-specific monitoring plans while at the same time identifies the degree of effort and resources needed to accomplish this monitoring.

I. INTRODUCTION

Wetland loss in Louisiana has been caused in part by subsidence and natural delta senescence (Boesch et al. 1983), channelization of the Mississippi River (Frazier 1967), saltwater intrusion (van Beek and Meyer-Arendt 1982), and canal dredging along with other mineral exploration and extraction activities (U.S. Environmental Protection Agency 1987; Craig et al. 1979). Reductions in freshwater and sediment inputs caused by changes in wetland hydrologies have been key to this substantial loss.

Louisiana is experiencing the most critical coastal wetland erosion and land loss problem in the United States, accounting for nearly 80% of the nation's coastal marsh loss (U.S. Army Corps of Engineers 1987a). Shoreline erosion rates exceed 6 m/year in more than 80% of the Louisiana coastal zone and can reach up to 50 m/year in areas impacted by hurricanes (Suter et al. 1989). Continually impacted by a combination of natural forces and human activity, Louisiana coastal marshes lose an estimated 79.5 km^2/year (Dunbar et al. 1990).

The need for comprehensive, large-scale restoration action has been documented by state and federal agencies in several reports (U.S. Army Corps of Engineers 1987b; U.S. Environmental Protection Agency 1987; State of Louisiana 1988—Appendix A). In Louisiana, efforts of State and Federal agencies are currently underway to develop a comprehensive wetland conservation and restoration plan. This and other restoration efforts require that informed decisions be made in order to implement successful projects. In their action agenda, the National Wetlands Policy Forum (1988) specifically stated that "the ability to evaluate restoration efforts is severely limited because readily usable, accurate techniques for measuring or monitoring functions do not exist."

In response to accelerated wetland loss in Louisiana, Act 6 of the 2nd Extraordinary Session of the Louisiana State Legislature in 1989 and the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) of 1990 were created to conserve, restore, create, and enhance Louisiana coastal wetlands. The agencies responsible for designing and implementing coastal conservation and restoration projects include the Louisiana Department of Natural Resources, U.S. Department of Commerce, U.S. Department of Agriculture, U.S. Department of the Interior, U.S. Department of the Army, and the U.S. Environmental Protection Agency. The restoration plans developed pursuant to these acts specifically require an evaluation of the effectiveness of each coastal wetlands restoration project in achieving long-term solutions to arresting coastal wetlands loss in Louisiana. They necessitated the development of a monitoring program to adequately assess the success or failure of coastal restoration projects. The above agencies have a responsibility to the State of Louisiana, and to the nation, to develop a monitoring program that will effectively ensure the best use of State and Federal funds for the restoration and conservation of wetlands.

The CWPPRA created an interagency task force and charged it with the development and implementation of a comprehensive approach to the long-term conservation and restoration of coastal wetlands. Because in a broader context, the mission of the CWPPRA is to provide appropriate management plans for the Louisiana coastal zone over the next 50-100 years, monitoring protocols could be applied on a regional scale across the coastal zone to provide the data necessary for effective management planning at that scale. The CWPPRA requires that not less than 3 years after the completion and submission of the restoration plan, and at least every 3 years thereafter, a report shall be made to Congress containing a scientific evaluation of the effectiveness of the coastal wetlands restoration projects in creating, restoring, protecting, and enhancing coastal wetlands in Louisiana. Consequently, the purpose of this monitoring protocol is to evaluate the effectiveness of the projects selected for inclusion in the plan in achieving their stated goals. To address these monitoring requirements, a monitoring work group was established under the Planning and Evaluation Subcommittee of the CWPPRA Technical Committee (Figure 1). This report represents the efforts of the monitoring work group.

II. OBJECTIVE

The monitoring work group consisted of representatives from Federal and State agencies, as well as academia. The specific responsibilities of the monitoring work group were 1) to develop a monitoring program to evaluate the effectiveness of each coastal wetland restoration project in achieving long-term solutions to arresting coastal wetland loss in Louisiana, 2) to document the effectiveness in reports to the U.S. Congress and Louisiana legislature, and 3) to make recommendations to the CWPPRA Task Force for the allocation of monitoring funds properly.

To accomplish these responsibilities, the following goals were established: 1) to develop standardized protocols for monitoring variables, 2) to develop statistical review procedures, and 3) to develop quality assurance and quality control procedures. All three goals will lead to detecting change between the pre-project condition and the post-project condition in Louisiana wetlands. This will help determine if the project is working and whether midcourse corrections are necessary.

In pursuit of these goals, group members envisioned a monitoring program that would consider

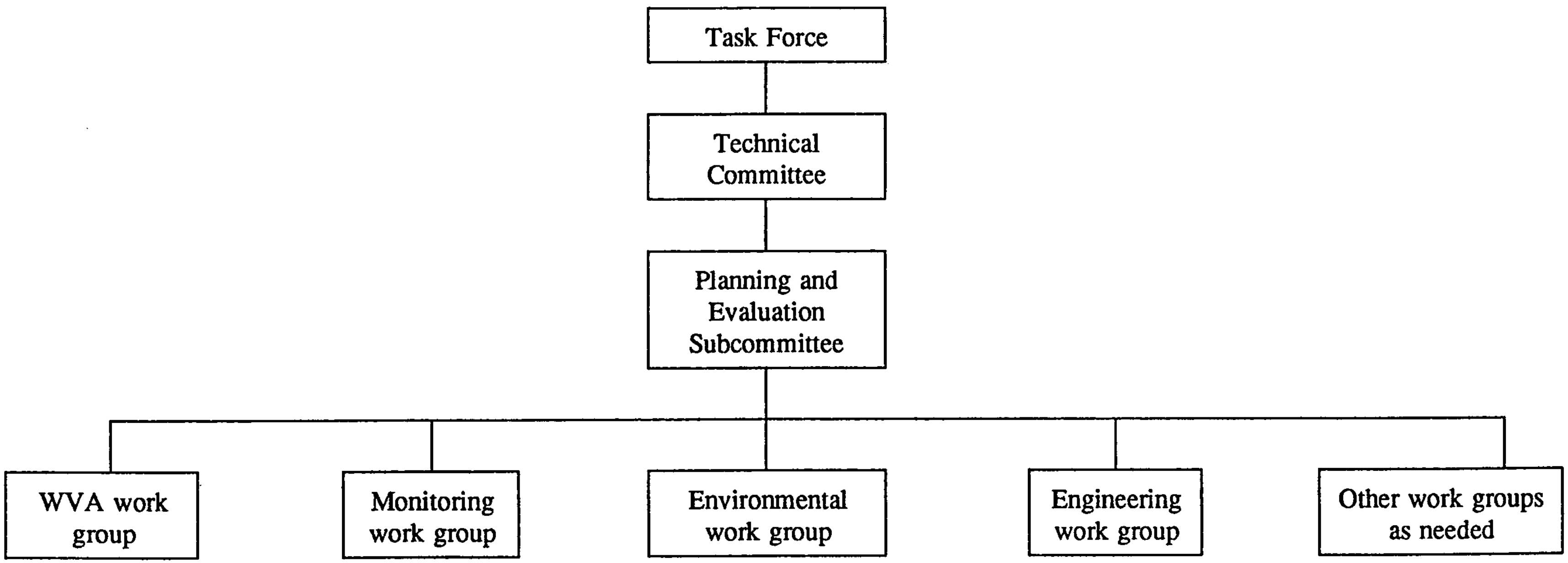
1) Nine types of restoration projects;
2) Project-specific goals (hypotheses);
3) Wetland values as determined by a wetland value assessment (WVA) procedure;
4) Site-specific as well as basin-level effects of projects; and
5) Existing monitoring activities occurring in coastal Louisiana.

Similar monitoring needs exist within and between each type of restoration project, and the development of standard protocols for these similarities are the backbone of the monitoring program. Monitoring methods and protocols for restoration projects were developed by technical experts for seven categories as follows:

1) Water quality
2) Hydrology
3) Soil and sediments
4) Vegetative health
5) Habitat mapping
6) Wildlife
7) Fisheries

The protocol design was developed to broadly categorize project types, goals, ecological variables, and data collection methodologies.

Figure 1. A hierarchial chart of the Coastal Wetlands Planning, Protection, and Restoration Act.



III. DESIGN

Restoration Project Types

Under Act 6 and the CWPPRA, all projects were categorized into nine types: freshwater introduction and diversions, sediment diversions, marsh management, hydrologic restoration, beneficial use of dredged material, shoreline protection, barrier island restoration, vegetative planting, and sediment and nutrient trapping.

Freshwater introduction and diversion

Freshwater introduction and diversion projects are designed to introduce fresh water and alluvial material from available sources to shallow marsh estuaries. Areas targeted for freshwater diversion projects are characterized by saltwater intrusion, sediment subsidence, and shoreline erosion. The primary goal of these projects is to enhance wetlands by increasing the use of fresh water, nutrients, and sediments that will be provided by the freshwater diversions. Management of the outfall will route the fresh water through the wetlands and provide greater deposition of sediments in the marsh to offset subsidence, greater availability of nutrients to vegetation, and a more gradual release of fresh water to the benefit of wildlife, fish, and shellfish. Monitoring freshwater diversions will help to determine if any changes or modifications are needed in the operation.

Sediment diversion

Sediment diversions are projects that increase deposition of river-borne sediment in shallow bay areas that cannot keep pace with subsidence through sediment accretion. A small-scale sediment diversion project is designed around the concept of natural crevasse splay development, where a breach occurs in the bank of a river, sediment infilling begins within the surrounding distributary bays, and crevasse splay sediments eventually become subaerial and established with marsh vegetation. Large-scale sediment diversions on the Mississippi River are designed to be similar to the large natural crevasses such as the one at Baptiste Collette, LA. The primary goal of the project is to create and manage crevasses through the natural levee ridges of rivers and major distributary channels so that the natural land-building process can create emergent and submergent aquatic communities critical to the overall productivity of the deltaic systems. Monitoring of sediment diversions will help to determine the management of the crevasses.

Marsh management

In marsh management projects, structures actively manipulate local hydrology to control water levels and salinity and while at the same time allowing ingress and egress of marine organisms. Marsh management plans generally incorporate existing canal spoil banks, the construction of short levees to connect these spoil banks, the installation of water control structures, and/or the construction of pump and other control structures to introduce fresh water into the managed area and keep out saline water. The main goals of marsh management are to minimize the loss of emergent and submergent plant communities by reducing salinities, stabilizing water levels, and restricting tidal exchange. Monitoring of marsh management projects will help determine operation schedules for pumps and structures.

Hydrologic restoration

Hydrologic restoration projects typically try to reestablish former hydrologic pathways and flow regimes, with the goal of redistributing fresh water to influence water levels and salinity. These manipulations of the local hydrology will aid in the reestablishment of emergent and submergent plant communities. Monitoring will help determine hydrologic effects on vegetative growth.

Beneficial use of dredged material

Open water bodies and navigational channels are often sources of dredged sediment material that could be beneficially used to create vegetated wetlands or to restore areas of deteriorating marsh. Sediments can be pumped into confined or unconfined areas to a height conducive to marsh development. Once the dredged material settles, growth of emergent vegetation can be promoted. Monitoring will help determine the applicability of this technique for marsh creation.

Shoreline protection

Shoreline protection projects use structural and nonstructural measures such as breakwaters, bulkheads, revetments, longyard tubes, wave-dampening fences, and levees to reduce wave energies and erosive action. Critical shoreline areas threatened with hydrological breaches could be protected to prevent wave erosion and water exchange from jeopardizing the physical integrity of the shoreline and adjacent marshes. Vegetation could also be incorporated into the shoreline protection design to create habitat as well as an additional erosion buffer. Monitoring will help determine the effectiveness of different shoreline protection techniques in reducing wave erosion and in creating wetland habitat.

Barrier island restoration

Barrier islands provide protection to back-barrier bays, estuaries, and marshes. This protection includes reduction of erosional effects and wind and wave energies, dissipation of storm surges, and prevention of saltwater intrusion. Over the last century, Louisiana's barrier islands have been reduced by approximately 40 percent, resulting in loss of habitat and protection for the coastal mainland. Barrier island restoration projects are needed to reestablish this natural protective zone. Barrier island restoration projects include creation of barrier islands or augmentation of existing islands. The objectives of these projects are to increase the height and width of the barrier island and close any shoreline breaches by using dredged materials and vegetation. Monitoring will help determine the effectiveness of restoration and creation techniques.

Vegetative planting

Vegetative planting projects are designed to introduce suitable plant species into deteriorating marsh areas and along eroding shorelines to provide a buffer against erosive wave action. Vegetative plantings also provide many other functions such as sediment stabilization, sediment trapping, and habitat value. Monitoring will help determine the success and effectiveness of different vegetative planting techniques in reducing wetland erosional loss and in creating wetland habitat.

Sediment and nutrient trapping

Sediment and nutrient trapping projects use structural devices such as brush fences or earthen berms to reduce wave energies, promote the deposition of suspended sediments, and increase water clarity. The goals are to reduce erosion of windward marsh edges, promote the growth of emergent vegetation, and increase the overall productivity of the area. Monitoring will help determine the effectiveness of different sediment and nutrient trapping techniques.

Project-Specific Goals

A critical step in establishing a successful monitoring program is to define the goals of conducting the monitoring. If the goals are poorly defined, there will be no guidance in the establishment of protocols. The CWPPRA requires an evaluation of the effectiveness of each project in achieving its specific goals directed towards creating, restoring, protecting, or enhancing coastal wetlands. For example, a project using dredged material may be built to reduce wave energies and consequent physical erosion or develop a new soil and sediment base at a proper elevation to restore or maintain vegetated marsh. Each of these projects begin with a hypothesis or set of hypotheses related to the expected change in physical, biological, or chemical variables of the project area. These hypotheses then guide the monitoring program as to which variables will be monitored and how frequently.

Control Areas

The importance of using appropriate control areas cannot be over emphasized. Monitoring on both project and control areas provides a means to achieve statistically valid comparisons, and is, therefore, the most effective means of evaluating project success.

Selection of a control area should ideally be done before project initiation. Controls should be ecologically similar to the project area yet located far enough away so as to not be influenced by the project. Potential control areas can be selected by use of WVA methods or through more basic comparisons of structural and functional attributes. To ensure the selection of appropriate controls, an interagency team of experts should be convened. If there is any question concerning the similarity of the control and project areas, more than one control area should be selected.

It is recognized that in many areas of Louisiana, appropriate controls cannot be identified. In addition, the extent of wetland modification (both planned and unplanned) occurring in this region often results in the loss of control areas before monitoring efforts are completed. We also recognize that occasionally, especially in the case of very large projects (e.g., sediment diversions and freshwater diversions from the Mississippi River or watershed projects) it may be difficult to select control areas that adequately reflect the same marsh type and function as those being affected by the project. In these cases, two strategies could be adopted:

(1) Monitoring before and after project implementation. The disadvantages of this strategy include delay in project implementation, temporal variability, and the inability to clearly identify cumulative impacts of the project in comparison to unaffected areas. In addition, before and after monitoring cannot ensure that the same events are being monitored for comparison; therefore, interpretation of the results will be difficult. However, such monitoring would provide some indication of project performance and impact.

(2) Baseline data collection. This may be especially important in areas where controls cannot be selected for monitoring. As a "once only" data collection program, it would not delay project implementation as much as full-scale monitoring before implementation (as in (1) above). It would provide a datum against which changing biological variables could be compared. In some cases, existing data bases might be considered appropriate as baseline data. If this were to occur, an interagency team of experts or their scientific advisors should be convened to evaluate the suitability of the existing data bases for this purpose.

Although before and after monitoring and baseline data collection provide valuable information, they do not necessarily provide a statistically valid evaluation of projects.

Statistical Design

The size of the project area, the number of different habitats present, and the heterogeneity within those habitats should define the number of statistical strata necessary for an analysis.

Before sampling is initiated, it is important to determine the desired statistical power for the analysis (Fairweather 1991). This procedure involves using a variance estimate to calculate the number of samples required to detect a percentage difference between two means. Initially, the sample size required to achieve this power can be estimated from sample variances reported in the literature, and these estimates can be refined by using data collected in the control area selection process. It should be recognized that this power will often improve with the use of data transformations and more complex analysis of variance (ANOVA) designs.

Data analysis for a project may include a two-way ANOVA with area and habitat as main effects. In the most basic design, the null hypothesis to be tested is whether the mean value for some variable is equal between the project area and the control area(s) or between the pre-project and post-project condition. The alternate hypothesis should be whether the mean value for that variable at the project area is greater or less than in control areas or whether the pre-project condition is greater or less than the post-project condition. It is important to determine whether the mean value for the variable increased or decreased because of the project, taking into consideration other outside influences. If the alternate hypothesis is limited to only whether the variable increased, negative effects will be indistinguishable from no effects.

Wetland Value Assessment Methodology

The Wetland Value Assessment (WVA) methodology was developed as a uniform and quantitative habitat-based assessment methodology for use in prioritizing project proposals submitted for funding under the CWPPRA. The WVA quantifies changes in wetlands quality and quantity that are expected from a proposed project.

The WVA was developed by the environmental work group assembled under the Planning and Evaluation Subcommittee of the CWPPRA Technical Committee. It is strictly designed for use in ranking proposed CWPPRA projects, and it is not intended to provide a detailed, comprehensive methodology for establishing baseline conditions within a project area. In addition, it was developed for application to the following coastal Louisiana wetland types: fresh marsh (including intermediate marsh), brackish marsh, saline marsh, and cypress-tupelo swamp.

The WVA operates under the assumptions that optimal conditions for a coastal wetland can be characterized, and that any existing or predicted condition can be compared to that optimum to provide an index of wetland quality. The quality component of a wetland is estimated or expressed through the use of a mathematical model developed specifically for each wetland type. Each model consists of 1) a set of variables that are considered important in characterizing the particular wetland type, 2) a suitability index graph for each variable, which defines the assumed relationship between wetland quality and the variable, and 3) a mathematical formula that combines the quality value (habitat suitability index or HSI) for each variable into a single value for overall wetland quality.

The variables chosen to describe wetland quality in each of the marsh types are

- V_1 - Percent of wetland covered by persistent emergent vegetation;
- V_2 - Percent of open water area dominated by aquatic vegetation;
- V_3 - Marsh edge and interspersion;
- V_4 - Water duration in relation to marsh surface;
- V_5 - Open water depth in relation to marsh surface;
- V_6 - Mean high salinity during the growing season; and
- V_7 - Aquatic organism access.

Predictions are then made as to how these model variables will change through time under two scenarios: with the proposed project in place and without the proposed project. A numerical representation of habitat quantity and quality is derived and compared between the two scenarios. Net benefits attributable to the project can then be compared to the net benefits from other projects in order to rank all proposed projects.

In most instances, variables measured in the monitoring program will provide data that can be used in the WVA models. Post-project WVA analyses utilizing these data can be compared with the results of WVA scores derived during priority project rankings in order to verify or refine the WVA. Such comparisons should not be used to judge project success or failure in achieving goals.

The monitoring work group recognizes the WVA as a planning tool and is therefore looking beyond the WVA in terms of monitoring variables. However, the WVA process can provide invaluable baseline information that may aid in the development of project-specific monitoring plans and/or the selection of appropriate control areas.

IV. APPROACH

The monitoring work group developed a broad-based, standardized approach for monitoring different variables. Each technical expert was asked to assemble a subgroup in order to

1) identify variables
2) develop a standard method or protocol for measuring each variable;
3) develop options for accurately and reliably measuring that variable over time;
4) develop options for accurately and reliably measuring that variable over space;
5) determine how the protocol, time, or space sampling might differ for each of the nine types of projects;
6) address a plan for statistical review;
7) address quality assurances;

8) develop generalized costs of monitoring option; and
9) determine existing monitoring efforts.

In addition to the above tasks, each monitoring subgroup was requested to complete a priority ranking for all variables to be sampled within their monitoring protocol. Each variable was assigned a numerical value of 1 for the highest priority through 4 for the lowest priority. This prioritization is according to the suitability of each variable in evaluating the various types of CWPPRA projects. For example, the highest ranking of 1 corresponds to the importance of a variable in determining if the primary objectives of a project are met. These rankings will provide a mechanism for selecting variables to be monitored according to the availability of funds.

The monitoring categories that comprise the following sections of this document are water quality, hydrology, soil and sediments, vegetative health, habitat mapping, wildlife, and fisheries. Each section establishes procedures that can guide personnel in the development of appropriate monitoring protocols.

I. TITLE: WATER QUALITY MONITORING IN COASTAL LOUISIANA

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IV. INTRODUCTION

The charge to the water quality monitoring subgroup was to develop a protocol documenting the approach the monitoring work group should use in establishing a water quality monitoring design. This design will provide data for the assessment of the different types of restoration projects on area water quality, and yet be consistent enough to allow for comparison of data between projects. The monitoring design must consider possible water quality effects on waters receiving discharge from restoration projects. The subgroup also felt that the protocol should be flexible in design to allow for successful monitoring of the many different types of restoration projects that will likely be attempted. It should be emphasized that many of the topics addressed by the water quality subgroup are directly related to the charges assigned to the hydrology, vegetative, and soil and sediment subgroups. Our subgroup recognizes the potential of fecal bacterial contamination by some CWPPRA projects; however, active monitoring programs by the Louisiana Departments of Health and Hospitals and Environmental Quality already address this issue. Frequency and intensity of collection of data for monitoring water quality are directly related to or influenced by the needs of these other subgroups.

V. GENERAL DISCUSSION

Pre-project Selection Considerations

The first recommendations of the water quality subgroup are that prior to actual selection of projects, the CWPPRA Planning and Evaluation Subcommittee must consider and perform the following tasks for each possible project:

1. Identify all superfund sites and sites proposed for superfund activities and landfills.

2. Identify all active and past oil and gas activities.

3. Identify any water quality problems existing in the basin.

4. Identify current and historical sources of water quality information.

5. Identify potential sources of water and bottom material to be used for restoration. Also, perform chemical analyses of these sources.

6. Evaluation of hazardous toxic radioactive waste by the U.S. Army Corps of Engineers (USACE).

If the above tasks are not considered for proposed restoration projects, then the potential monitoring costs may be quite high, and the possibilities for incursion of other nonrestoration- related costs could be extremely high. For example, if contaminated dredge material is used to reestablish a wetland, then the agency that performed the work may be responsible for clean-up of the site. Further, recent studies by Demas and Demcheck (1989) and Johnson and Leenheer (1992) have demonstrated remobilization of synthetic organic compounds from bottom material in saltwater environments on exposure to freshwater. Also, trace metals are known to be released from sediments under reducing conditions. Given these potential chemical reactions, it is quite possible that contaminants could be further dispersed within a project area unless the proper documentation of chemical concentrations within a restoration area has been made. Clean-up, in many cases, may be several times more costly than the actual cost of the project or the value of the area restored.

If no current data exist for a proposed restoration project, then it is recommended that the Planning and Evaluation Subcommittee consider that the following tasks may need to be accomplished prior to final selection of the project for restoration:

1. Randomly collect water and bottom material throughout the project area for analyses of priority pollutants. Stratify sampling such that potential contaminant sources are visited.

2. Depending on project objectives, document current conditions that the project is designed to mitigate, including such variables as specific conductance and salinity, suspended sediment, dissolved oxygen, pH, nutrients, total organic carbon, etc.

Variable Selection

Our subgroup recommends that the matrix in Table 3 be used in determining the water quality design variables that need to be monitored for those projects for which tasks 1-6 have already been performed. The variables to be monitored are listed in the priority of sampling necessary for the successful monitoring of potential changes in water quality, achievement of project goals, and the availability of funds.

The water quality monitoring subgroup feels that specification of sampling frequency is premature at this time, and that sampling frequency will vary according to the availability of preexisting data, size of project area, and the type of restoration project attempted. The subgroup feels quite strongly that the other protocols are all interrelated and that monitoring programs designed for specific projects consider these interrelationships in their design.

Table 3. Recommended prioritization of water quality variables for CWPPRA.

Project type	Salinity/ temperature	Physical, dissolved oxygen, pH, specific conductance	Nutrients, nitrogen, phosphorus	Trace metals	Synthetic organic compounds	Soil/suspended sediment: Nutrients	Soil/suspended sediment: Trace metals	Soil/suspended sediment: Synthetic organics	Soil/suspended sediment: Size fraction analyses
Freshwater introduction and diversion	1[a]	2	2	4,2[b]	4,2	4,2	4,2	4,2	3,N
Sediment diversion	4	4	3	4	4	2	3	3	2,N
Marsh management	1	2	2	4,2	4,2	3	4	4	4,N
Hydrologic restoration	1	2	2	2,4	2,4	3	4	4	4,N
Beneficial use of dredged material	4	4	4,1	4,1	4,1	2	3,1	3,1	2,N
Shoreline protection	4	4	4	4	4	4	4	4	N
Barrier island restoration	4	4	4,1	4,1	4,1	2	3,1	3,1	2,N
Vegetative plantings	1	3	3	4	4	2	3,2	3,2	3,N
Sediment and nutrient trapping	3	3	1	4,1	4,1	2	3,2	3,2	3,N

[a]Priorities:

1 = Primary objective
2 = Secondary objective
3 = Tertiary objective - long term evaluation
4 = Lower priority - long term evaluation
N = As needed, unique to a specific project

[b]For columns that have two numbers listed, the first number indicates the priority of that variable(s) for projects where information for tasks 1-6 are available. The second number indicates the priority of the monitoring task for projects lacking information for tasks 1-6.

VI. METHODOLOGY

The above grouping of variables can be implemented by using a variety of methods varying widely in degree of sophistication, frequency of collection, and cost. The methods selected for use in monitoring water quality and the frequency of collection is dependent upon the goals of the project (that is, the type of restoration project), the variability of the aquatic environment to be monitored, and the funds available.

Methods available for the collection of data for the grouping of variables, their relative costs, and the environments for which they are best suited are listed below. It should be noted that the costs for installation of a data collection platform (DCP) are based on the assumption that the other monitoring subgroups have not already installed one. If, on the other hand, a DCP already exists for other monitoring variables (e.g., directional velocity meter), then cost of additional probes to measure desired water quality variables is greatly reduced.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Salinity/ temperature	Data collection platform	$20k instrumentation, $6-8k maintenance, $2k installation[a]	5-30 min	Highly variable, tidal situation
	Fixed monitors paper punch or digital recorder (hydrolab, mini monitor)	$4-6k maintenance	5-30 min	Highly variable, tidal situation
	Non-fixed data sonde (hydrolab)	$4-6k	5-30 min	Highly variable, tidal situations, remote areas
	Fixed bottle collector (ISCO)	$4-5 instrumentation	30 min-24 hr	Highly variable to stable
	Daily observer	$840 collection, $2k analysis	Daily	Stable(Mississippi River)

[a]Installation cost if platform and transmitter are already installed.

Salinity and temperature data need quality control and assurance information in the form of duplicate samples, calibration checks, standards, and field checks.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Other physical measurements-pH, dissolved oxygen, specific conductance, ORP (oxidation reduction potential), turbidity	Data collection platform	$20k instrumentation, $2-4k installation[a], $6-8k maintenance	5-30 min	Highly variable, tidal areas
	Fixed recorder paper punch or digital recorder	$4-8 maintenance	5-30 min	Highly variable, tidal areas
	Non-fixed data sonde (Hydrolab)	$4-6k	5 min-2 hr	Highly variable, tidal situations, remote areas

[a]Installation cost if platform and transmitter are already installed.

These methods need quality control and assurance information in the form of duplicate samples, calibration checks, standards, and field checks. Dissolved oxygen probes may need frequent servicing during certain seasons to prevent biofouling.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Nutrients: total and dissolved nitrogen spp, phosphorus spp, (ortho P, NH_4, NO_2, NO_3, Organic)	Fixed sampler requires chilling to 4°C	$20k instrumentation, $10-35k including analysis	1 hr - daily	Highly variable, tidal situations
	Fixed probes for NH_4, NO_3	$8-20k instrumentation, $2-3k installation[a], $3-4k maintenance, including analysis	5-15 min	Highly variable, tidal situations, nutrient-sensitive areas
	Daily observer	$8k-collection and analysis	Daily	Stable areas

[a]Installation cost if platform and transmitter already installed.

Samples need to be chilled to 4°C upon collection and treated upon collection and analyzed within 7 days of collection according to accepted methods (the current edition of the U.S. Geological Survey, U.S. Environmental Protection Agency or Standard Methods for the examination of water and wastewater). This grouping of variables needs quality control and assurance information in the form of duplicate samples, calibration checks, standards, and field blanks.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Trace metals As, Be, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Pb, Zn, Ag, Ni, Se	Fixed sampler	$240k (instrumentation and analysis)	Daily	Highly variable and sensitive areas
	Daily observer	$220k collection and analysis	Daily	Highly variable and sensitive areas
	Instantaneous	$200-800 variable dependent	NA	Unknown basin

Samples need to be fixed at time of collection. Holding times are less critical; however, possibility for sample contamination is much greater. Analyses should be done according to accepted methods. This grouping of variables needs quality control and assurance information in the form of duplicate samples, calibration checks and blanks from laboratory, standards, and field blanks.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Synthetic organic (VOC's, pesticides-herbicides, insecticides, triazines, carbamates, semi-volatile priority pollutants, PCB's, dioxins)	Fixed sampler	$560k (instrumentation and analysis)	Daily	Highly variable and sensitive areas
	Daily observer	$550k collection and analysis	Daily	Highly variable and sensitive areas
	Instantaneous	$200-1,500 variable and analytical technique dependent	NA	Unknown basin

Costs of monitoring can be greatly decreased by employing gas chromatograph-flame ionization scans for those compounds extractable with methylene chloride, and by using portable gas chromatographs for volatile organic compounds and immuno-assay kits for triazine herbicides. Confirmation of detections by any of these methods must be performed by using quantitative gas chromatograph-mass spectrometer.

Samples need to be chilled or fixed and chilled at time of collection. Holding times are critical, depending upon class of compounds to be analyzed. The possibility of sample contamination is a concern. Analyses should be done according to accepted methods. This grouping of variables needs quality control and assurance information in the form of duplicate samples, surrogate recovery, blanks from laboratory, field spikes, and field blanks. Data should be reported with percent recoveries for the compounds analyzed.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Soils/sediment nutrients	Instantaneous, includes collection and analysis	$200	NA	NA

All samples should be chilled to 4°C immediately upon collection. Samples should be analyzed according to accepted methods. Quality control and assurance information need to be collected including duplicate analyses and laboratory standard and blank information.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Soils/sediment trace metals	Instantaneous, includes collection and analysis	$400-1,400[a]	NA	NA

[a] Cost is per sample. Cost of sample analysis is dependent upon the number and kinds of elements requested and the amount of ancillary data (TOC, grain size, surface area, etc.) needed.

Samples need to be chilled at the time of collection. Holding times are less critical; however, possibility for sample contamination is much greater. Analyses should be done according to accepted methods. This grouping of variables needs quality control and assurance information in the form of duplicate samples, and spikes and blanks from the laboratory.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Soils and sediment synthetic organic compounds, insecticides, PCB's, semi-volatile priority polluntants	Instantaneous, includes collection and analysis	$440-3,000 sample-compound class dependent	NA	NA

Samples need to be chilled at the time of collection. Holding times may be critical depending upon class of compounds to be analyzed. Possibility for sample contamination is a concern. Analyses should be done according to accepted methods. This grouping of variables needs quality control and assurance information in the form of duplicate samples, surrogate recovery and blanks from laboratory, and field spikes. Data should be reported with percent recoveries for the compounds analyzed.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Soil and sediment grain size	Instantaneous, analyses only	$22-60	NA	NA

Table 4 lists sampling frequency and priority of variables based on the perceived needs of the different kinds of restoration projects and the variable priorities listed in Table 3.

The water quality monitoring subgroup has the following equipment and sampling comments on each type of restoration project in addition to the above matrix:

Freshwater Diversion

The type of recorder installed and readout will be determined by whether the structure is "managed" or simply stage activated. Managed projects should have DCP's installed. Further, sampling of nutrients, trace metals, synthetic organic compounds, and turbidity is project dependent and greatly influenced by the availability of historical and recent data. Secondary objectives of projects, such as enhancement of fishery resources may require monitoring of turbidity on a realtime basis. Initially, the water quality monitoring subgroup recommends instantaneous (that is, only one initial sample) samples for the chemical variables listed for both water and sediments. If, however, abnormal concentrations of any compounds are detected, then sampling frequency will need to be increased to account for potential water quality effects on the project area and any areas impacted by waters exiting the project area.

Table 4. Sampling frequency and priority of variables.

Project type	Salinity/ temperature	Physical, dissolved oxygen, pH, specific conductance	Nutrients, nitrogen, phosphorus	Trace metals	Synthetic organic compounds	Soil/suspended sediment			
						Nutrients	Trace metals	Synthetic organics	Size fraction analyses
Freshwater introduction and diversion	R[a]	R2[b]	I2N	I4,2N	I4,2N	I4,2	I4,2N	I4,2N	I3N
Sediment diversion	4N	4N	I3N	I4,2N	I4,2N	I2N	I3N	I3N	I2N
Marsh management	R	R2N	I2N	I4,2N	I4,2N	I3N	I4N	I4N	I4N
Hydrologic restoration	R	R2N	I2N	I2,4N	I2,4N	I3N	I4N	I4N	I4N
Beneficial use of dredged material	I4	I4	I4,1N	I4,1N	I4,1N	I2N	I3,1N	I3,1N	I2N
Shoreline protection	I4N	I4N	I4N	I4N	I4N	I4N	I4N	I4N	N
Barrier island restoration	I4N	I4N	I4N	I4N	I4N	I2N	I3N	I3N	I2
Vegetative plantings	I1	I3N	I3	I4	I4	I2	I3,2	I3,2	I3
Sediment and nutrient trapping	I3	I3	I1	I4,1	I4,1	I2	I3,2	I3,2	I3

[a]Frequency of collection
I = Instantaneous
R = Realtime

[b]*Priorities:*
1 = Primary objective
2 = Secondary objective
3 = Tertiary objective - long term evaluation
4 = Lower priority - long term evaluation
N = As needed, unique to a specific project

Sediment Diversion

Because sediment diversion projects do not require active management, realtime data are not required except for specific projects (should match up with the flow monitoring requirements identified by the hydrology monitoring subgroup). The water quality monitoring subgroup recommends one initial set of samples for the chemical variables listed for both water and sediments be collected from the source water body and the receiving water body if recent chemical data are unavailable.
If, however, abnormal concentrations of any compounds are detected, then sampling frequency will need to be increased to account for potential water quality effects on the project area and any areas impacted by waters exiting the project area.

Marsh Management

Salinity and temperature data need to be collected on a continuous basis for these kinds of projects. DCPs need to be installed for control structures, but digital recorders can suffice for areas out in the marsh. Collection of dissolved oxygen and other physical variables on a realtime basis is dependent upon secondary objectives of the project; otherwise it should be collected whenever any site visits are made. For example, enhancement of fisheries resources would require monitoring of dissolved oxygen on a continual basis.

Frequency of water and soil and sediment chemistry sampling will be project dependent. Soil chemistry should be sampled at least once annually to provide information on factors that might affect plant growth.

Hydrologic Restoration

Salinity and temperature data need to be collected on a continuous basis for these kinds of projects. Installation of DCP's depend on the specifications of the hydrologic monitoring subgroup. Collection of dissolved oxygen and other physical variables on a realtime basis is dependent upon secondary objectives of the project; otherwise data should be collected whenever any site visits are made. For example, enhancement of fisheries resources would require monitoring of dissolved oxygen on a continual basis.

Frequency of water and soil and sediment chemistry sampling will be project dependent and based on availability of historical data. If, however, abnormal concentrations of any compounds are detected, then sampling frequency will need to be increased to account for potential water quality effects on the project area and any areas impacted by waters exiting the project area.

Beneficial Use of Dredged Material

The water quality monitoring subgroup recommends that standard elutriate tests be performed on source material prior to its dredging and dispersal. If the source material has been recently tested, then elutriate tests do not need to be performed; however, some chemical testing at the outfall pipe is advised.

Shoreline Protection

These kinds of projects are not expected to have any impacts on water quality; however, specific projects may require chemical samples from water and sediments before and after the project is completed.

Barrier Islands

These kinds of projects are not expected to have any impacts on water quality; however, specific projects may require chemical samples from water and sediments before and after the project is completed.

Vegetative Plantings

The water quality monitoring subgroup recommends that an initial synoptic sampling of the project area be completed (unless recent historical data exists) prior to initiation of the project. Sampling, especially soil and sediments, is recommended if problems are observed in the growth of the targeted plant species. Areas receiving agricultural runoff, especially herbicides, may need seasonally targeted sampling to determine factors effecting the success of the project.

Sediment and Nutrient Trapping

The water quality monitoring subgroup recommends that an initial synoptic sampling of the project area be completed (unless recent historical data exists) prior to initiation of the project. Additional yearly samples may be required to determine the effectiveness of an individual project. It should be noted that only those compounds identified during the initial synoptic sampling need to be reanalyzed.

VII. HISTORICAL DATA

Inventory of Existing Data

Maps and an inventory of current and historical U.S. Geological Survey (USGS) chemical and monitoring sites are on file with the monitoring work group. Nutrients, trace metals, pesticides, PCB's, and major ions in water and nutrients, trace metals, pesticides, and PCB's in sediments have been collected at most of the sites plotted on the map. Many of the current sites have suspended sediment and discharge collected on routine basis. Volatile organic compounds (VOCs), triazine herbicides, and semi-volatile priority pollutant data have not been collected at any USGS sites with the exception of the Mississippi, Calcasieu, and Mermentau Rivers.

A listing of the Louisiana Department of Environmental Quality (LDEQ) water quality stations also is on file with the monitoring work group. The LDEQ does not analyze for synthetic organic compounds on a routine basis at any of their sites with the exception of VOC's on the Mississippi River. The LDEQ does have synthetic organic compound data for the Calcasieu River system.

A listing of all stations in the U.S. Environmental Protection Agency STORET system also is on file with the monitoring work group. A total of 2,922 stations are listed for the Louisiana coast and inland to Interstate 10.

A listing of all USACE water quality sites is available from the water quality monitoring subgroup.

Also on file with the monitoring work group is a listing of all current RCRA and CERCLA sites in Louisiana. As previously stated, location of these sites should be considered by the CWPPRA Planning and Evaluation Work Group prior to project selection.

Potential Upgrading of Existing Sites

All federal agencies should be willing to increase the variables at existing sites to meet the needs of specific restoration projects if funds are provided to cover the additional costs of collection and analyses.

VIII. DATA STORAGE

The water quality monitoring subgroup recommends that all agencies that collect water quality data store that data electronically, review it for quality control prior to entry into data storage systems, enter data in a timely fashion, and have the capability of transferring data to the appropriate agencies.

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IV. INTRODUCTION

The primary purpose of hydrologic monitoring is to collect data required for the scientific evaluation of completed projects. In this evaluation, the success of a completed project will be measured by the number of acres of wetlands saved or created. This effort is intended by all involved—Federal, State, and local governments and private citizens alike—to be successful and have a positive, lasting effect in coastal Louisiana and to either preserve or create a measurable impact on our marshes and coastline. To measure the degree to which these activities and projects are being successful, physical variables must be quantified in the beginning, during construction, after completion, and for posterity. These variables will define the problem, define human impact, measure progress, suggest midcourse changes, improve design and performance of future projects, and ultimately justify our efforts and direction.

The second purpose of monitoring is to determine changes in hydrologic variables to assist in the design of future projects. The third purpose of monitoring is to determine how the selected design criteria and wetland values used for assessment interact to define the degree of success for each project type. The fourth ranking purpose is to develop a coastal network of hydrologic monitoring stations. The four purposes make up a ranking system against which the need for hydrologic data collection can be assessed.

V. GENERAL DISCUSSION

Precipitation

In the evaluation of many of the CWPPRA projects, the duration and volume of water in a wetland area are important variables for determining the quality of the wetland. Precipitation augments the volume and duration of water. For example, retention of local rainfall because of poor drainage contributes to long duration flooding and increases the quantity of shallow open water. The quality of the wetland is decreased. Because precipitation is a source of fresh water, it influences the quantity of fresh water needed to improve circulation, reduces salinity levels, and promotes growth of vegetation. Precipitation is a source of water contributing to overland and channel flow and will affect any flow measurements in the wetland and adjacent channels. Drought, the absence of precipitation, dries up the wetland and lowers water levels, which in turn increases the likelihood of saltwater intrusion. Precipitation is also a source of groundwater recharge.

Evaporation

Evaporation and transpiration reduce the quantity of water actually reaching the soil surface. They are indicative of changes in the moisture deficiency of a basin and affect the volume and duration of water. In areas of high evaporation, a larger volume of water is needed to maintain open water areas. Rates of evaporation vary depending on meteorological factors and the nature of the evaporating surface.

Wind Speed and Direction

Winds affect water levels, drive tides, and push large quantities of gulf waters into or out of the marshes. Such wind tides can increase salinity levels and depths. Winds affect wave height and cause erosion of lake and bay shoreline and barrier islands. Winds can cause set up in open water bodies, increasing volume of water entering adjacent wetlands. Wind speed and direction data indicate the presence and timing of frontal passages, tropical disturbances, and other weather types. Wind data can be used to develop wind fields, and make estimates of evaporation rate, flows, and surface currents.

Water Level

The volume and duration of water in a wetland area are important variables in determining the quality of the wetland. Excessive volume and duration of water can have an adverse effect on a wetland by stressing and drowning vegetation, increasing breakup of floating marsh, and increasing the vertical load forces on the wetland, which in turn increases settlement. Insufficient water can deprive a wetland of nutrients and foster growth of nonwetland vegetation. Water-level data are the primary indicators of hydrologic conditions in a wetland, of seasonal flooding, and of extreme events such as floods and hurricanes. They are indicators of tidal exchanges and sea-level change. Water-level data are important in interpreting aerial photography and converting bathymetric and topographic data to a common datum. Additionally, the data are used in making decisions on regulating inflow and outflow in a water control project such as a marsh management project.

Bathymetry

Bathymetry can be used in conjunction with aerial photography in quantifying increases and decreases in open water areas in determining the success of a project. Bathymetry can be used to measure sediment deposition, subaqueous delta development, and scour. Bathymetry can also provide valuable information on water depths, location of channels and crevasses, and overall marsh bottom configuration that will affect different hydrologic measurement and management practices.

Topography

Topography can be used in conjunction with aerial photography in quantifying increases and decreases in wetland areas and barrier islands. The elevation of the ground in a wetland affects the type of vegetation present and the depth and duration of water. Topography can be used to measure sediment deposition, subaerial deltaic development, and subsidence. Topography can also provide valuable information on channel obstructions, natural and artificial banks and levees, and points of ingress and egress.

Salinity

It is important to quantify the salinity in a project area because of its influence on wetland habitat. Wetland habitats are characterized by salinity levels, i.e., fresh marsh and saline marsh. Saltwater intrusion is a major cause of loss of freshwater wetland habitat in areas such as the Mississippi River delta because of its adverse impact on freshwater vegetation. Project types such as marsh management, freshwater diversion, and hydrologic restoration are geared toward regulation of salinity levels in a project area to reduce wetland loss.

The main body of information on this variable can be found in the report on water quality monitoring.

Discharge, Velocity, and Direction

Discharge, velocity, and direction data are important in defining circulation patterns and tidal characteristics within a project area. Circulation affects the presence and variability of nutrients in a wetland; estuarine organisms; and turbidity, salinity, and other water quality variables. Water exchange is an important variable in the quality of cypress-tupelo swamps. Discharge can be correlated with suspended sediment to quantify the amount of sediment available for deposition. Discharge measurements can be used to "rate" a structure to determine the volume of flow entering or exiting a water control structure, such as freshwater diversion or hydrologic restoration structures given certain headwater and tailwater conditions. Velocity and direction data can assist refuge managers in determining when to open or close a structure and for how long.

Suspended Sediment

Sediment is the building block of a wetland creation project. Too much sediment can change a wetland into upland; not enough sediment to counteract subsidence and erosion can result in open-water areas. Sediment replenishes the existing soil, providing nutrients to the vegetation. The quantity of sediment entering a wetland area is important to maintain a diverse habitat and a healthy wetland. Suspended sediment data can be used to determine the quantity and gradation of sediment available for deposition into the coastal zone. Suspended sediment data can also be used with other data to determine where scour and deposition will occur and why aggradation or degradation has taken place in an area.

Groundwater

Groundwater level and duration may affect the health of a wetland through waterlogging or drainage. Waterlogging may be evidenced by groundwater levels even when surface water levels are down. Some project types, such as marsh management and hydrological restoration, are intended in part to reduce water levels at certain times, e.g., by draw downs or by increasing drainage to decrease waterlogging. In these circumstances, measurement of groundwater levels would augment information obtained from surface water-level measurements and would support evaluation of the effectiveness of water management techniques.

Soil Salinity

Changes in hydrology that allow regular or intermittent saltwater intrusion can increase soil salinity (the salinity of interstitial water trapped within the sediment). Limited by a relatively low rate of exchange between interstitial water and overlying surface water, soil salinities can persist beyond the time when surface water salinities are apparent, even when saltwater intrusion is intermittent. Soil salinities can affect marsh vegetation and can thus affect wetland health. For projects in which salinity mitigation is an objective, principally freshwater diversions but perhaps also marsh management projects, the measurement of soil salinities would contribute to interpreting expected responses of vegetation. While soil salinities are not currently proposed for monitoring by the soils and sediments monitoring subgroup, it would be efficient to link measurement of soil salinity with that effort because the soils monitoring subgroup will already be equipped to collect soil cores.

Common Datum

Semi-permanent bench marks should be set at each project location. Many of these projects will require a common datum be established by ordinary leveling, global positioning system (GPS), or as a last resort, water level ties. Technical experts will provide information on an acceptable bench mark (e.g., a 35-foot brass rod) at each project location.

The datum of a gauge may be a recognized datum, such as NGVD, a local datum related to project or research activities, or an arbitrary datum selected for expediency or convenience. Normal practice is to select a recognized datum; however, cost may be a determining factor.

A permanent datum must be maintained so that only one datum for gauge height record is used for the life of a data collection station. To maintain a permanent datum at each gauging station requires at least two or three reference marks that are independent of the gauge structure. Reference marks are independent auxiliary datum references used to verify or reestablish the gauge datum. All gauges should be periodically checked by running levels or GPS and by using the reference marks to maintain a fixed datum.

A common datum for all the gauges in the coastal zone would be beneficial. A common datum allows for the comparison of data within the project area and throughout the coastal zone. However, this may prove to be cost prohibitive or infeasible. Reference marks may use a common datum such as NGVD but will contain different adjustments to the datum.

The costs to establish a datum for a water-level gauge has not been included in the cost of the gauge presented in this report. Costs will vary depending on the location of the gauge. A baseline of levels has been established by the U.S. Army Corps of Engineers (USACE) along the Mississippi River into Southwest Pass. Levels have also been run for the Lower Atchafalaya River. To tie into these baselines may be expensive; the cost of the Mississippi River levels was $40,000 for 20 miles of levels. GPS has been used in the Lake Verret-Atchafalaya area very successfully. The field work and post processing costs were approximately $26,000. More than 10 gauge datums were verified with the GPS method; the cost per gauge is therefore reasonable. In using GPS, consideration should be given to grouping gauges in a geographical area to reduce costs.

Ongoing Programs

The USACE has a gauging program to evaluate the effectiveness of their projects. The gauges are located predominantly along rivers, channels, and bayous. The networks, type of gauge, and parameters measured were designed for projects such as navigation, flood control, and water supply. Because many of the gauges are continuous recording or realtime, they can provide valuable information for the CWPPRA projects in the vicinity. Use of USACE gauges can minimize the cost o the CWPPRA monitoring program.

The USACE also installs gauges for data collection during the design phase of their projects. Although the data collection is short term and often uses an arbitrary datum, it can provide information on pre-project conditions in the coastal zone.

The USACE and U.S. Geological Survey (USGS) have a cooperative stream-gauging program with many gauges in the coastal zone. Again, the gauges are located predominantly along rivers, channels, and bayous and were installed mainly for flood control purposes.

The USGS and the Louisiana Department of Natural Resources have a cooperative program to monitor state wetland restoration projects in the coastal zone. The collection of stage, precipitation, salinity, wind speed and direction, and velocity data are primarily in realtime.

The U.S. Fish and Wildlife Service has installed some gauges in several of their refuge areas to monitor water levels, salinity, and tidal characteristics. The gauges collect realtime data.

The National Ocean Survey and the National Geodetic Survey have placed tide recorders and related equipment in the coastal zone. Data from these equipment are available to establish base conditions in some projects locations.

Data protocols are usually in ASCII format or are convertible to ASCII. The use of these data will minimize costs to establish base conditions and monitor project hydrology.

VI. METHODOLOGY

Precipitation

Precipitation is measured on the basis of the vertical depth of water that would accumulate on a level surface if the precipitation remained where it fell. Recording precipitation gauges are recommended when continuous records of precipitation are required. The tipping bucket continuous recording gauge is used with Handar equipment for realtime transmission. Other recording gauges include the weighing type gauge and the float type gauge. Precipitation is accrued on an hourly or more frequent basis until the gauge is reset. Standard rain gauges are used when continuous records are not required. These gauges need to be read daily and emptied. Precipitation is reported on a daily basis. The units of measure for precipitation data are generally inches.

Precipitation measurements are subject to various errors. Individually, the errors are small but cumulatively they could be significant. Errors are smaller for standard rain gauges than recording gauges. In rainfall of 5-6 inches per hour, the bucket of a tipping bucket gauge tips every 6-7 seconds. About 0.3 seconds is required to complete the tip, during which some water is still pouring into the already filled compartment. The resulting recorded rate may be 5 percent too low; however, the water is all caught in the gauge reservoir and can be measured independently of the recorder. The difference can be prorated through the period of excessive rainfall. The most serious error is the deficiency of measurements caused by wind; consequently, wind shields are recommended to reduce the error.

Methodology recommended for a project will depend on the uses for which the precipitation data are intended and the site at which the gauge will be located. Where accumulated volume of overland flow is of interest, the depth of rainfall measured by standard rain gauges should be adequate if the site is accessible on a daily basis. Recording precipitation gauges reduce the need for daily visits and can be serviced during the project site visits. Recording gauges also provide hourly or more frequent data. The use of tipping bucket gauges takes advantage of the Handar equipment used to transmit other hydrologic variables in realtime. For high priority projects, the standard protocol recommended is the use of tipping bucket gauges at water level or water quality sampling sites. This practice allows for continuous data collection and realtime transmission. The cost of a Handar 444a tipping bucket rain gauge is low, about $800. Installation costs are included in the cost of installing the other equipment. Data of good quality can be obtained by establishing a system of quality control that includes not only periodic inspection of stations and maintenance or repair of equipment, but preliminary checking of data by internal consistency checks. Maintenance costs should be no more than $500 per year, including analysis of the data for quality control.

Precipitation should be recorded continuously by using the same recording periods as the National Weather Service. Hourly incremental precipitation data can be determined from the data collected. Monthly and annual totals can be computed from the data with adjustments for periods of high intensity.

The uses for which the precipitation data are intended should determine network density. A relatively sparse network of stations would suffice for determining annual averages over large areas. In general, sampling errors, in terms of depth, tend to increase with increasing areal mean precipitation and decrease with increasing network density, duration of precipitation, and size of area. Average errors tend to be greater for summer than for winter precipitation because of the greater spatial variability. The minimum density of precipitation network recommended for general hydrometeorological purposes for flat regions of tropical zones is 230-350 mi^2 per station.

For lower priority projects, records from nearby precipitation stations may be sufficient. Gauges should be added, if necessary, to achieve a good spatial density. The cost to purchase and install a recording rain gauge is approximately $1,400 with maintenance costs around $1,000. Tipping bucket gauges can also be installed at existing realtime stage recording sites; the cost to purchase and install this equipment is approximately $800 for the gauge and $1,000 to install. Maintenance costs should be no more than $500 per year but will include some analysis of the data for quality control.

Evaporation

The pan is the most widely used evaporation instrument. The operation of a pan station is relatively inexpensive and should provide good estimates of annual evaporation. Water levels in the pan are measured, and the evaporation, in inches, is computed as the difference between observed levels, adjusted for any precipitation recorded. Three types of exposures are employed for pan installation: sunken, floating, and surface. Burying the pan tends to eliminate boundary effects such as radiation on the side walls and heat exchange between the atmosphere and the pan, but causes observational problems.

In the coastal zone, there are currently no evaporation pans from which evaporation rates can be determined. For projects where precipitation and evaporation are high priorities, one evaporation pan should be installed in the hydrologic basin along with a precipitation gauge for continuous data collection and realtime transmission. Purchase costs will be approximately $800 for the pan. Installation and maintenance costs will be included in the cost of the precipitation gauge.

Evaporation should be recorded continuously by using the same recording periods as the National Weather Service. Annual, seasonal, and monthly evaporation rates can be determined from the data collected. One evaporation pan per hydrologic basin should be sufficient spatial density.

Wind Speed and Direction

Wind speed is measured with anemometers. Both cup and propeller anemometers are commonly used. A wind vane measures the direction from which the wind is blowing. Surface winds are generally reported in miles per hour, meters per second, or knots. Surface wind directions are generally reported in degrees to the nearest 10 degrees.

Reported wind speed above 3 kn is nominally accurate to plus or minus 1.5 kn under steady-state conditions. Wind vanes are constructed to indicate direction within plus or minus 5 degrees.

Ideally, surface-wind sensing equipment should be placed 20 ft above the ground on a freely exposed tower over terrain that is relatively level and free from obstructions to wind flow.

For high-priority projects, the standard protocol recommended is to use automatic wind-speed and direction equipment linked to the Handar communication equipment for realtime data collection. Wind-speed and direction equipment would be installed at each water level and water quality data collection station with a data collection platform. The advantages are continuous realtime collection of data and reduced maintenance costs of on-site equipment. This protocol is really the only effective way to measure data of this type. Cost to purchase the equipment is about $600. Installation costs are included in the cost for a water-level or water-quality gauge. Maintenance of wind equipment should be performed at specified intervals to ensure continuity of data to prevent malfunctions. Maintenance costs should be no more than $500 per year. Maintenance costs include some analysis of the data for quality control.

The recommended frequency for wind-speed and direction data collection is continuous. In many cases, the dynamics of the wind data may be more important than the actual data. The same reporting periods at the National Weather Service--hourly, daily and monthly summations--should be adopted.

Spatial distribution of wind-speed and direction equipment will be dependent on the use of the data collected and the complexity of the project area. As data collection efforts move east across the coastal zone, wind data become more important. Wind gauges are important in the Barataria Bay, Breton Sound, Atchafalaya floodway, and Lake Pontchartrain hydrologic basins. Wind gauges should be distributed closer than a 50-mi radius in these basins because large-scale wind cells and circulation patterns develop in them. Wind gauges become less important in the Terrebonne and Teche-Vermilion river basins, and are generally not important in the Mermentau and Calcasieu-Sabine river basins. Because land breezes are different from sea breezes, data at airports should be only cautiously used in the coastal zone. Fewer wind gauges are needed if the data are to be used in conjunction with a wind-field model.

Where data collection is a lower priority, continuous records from a second site within a 40-mi radius are sufficient if this second site has similar hydrologic and hydraulic characteristics. Wind-speed and direction gauges should be installed at existing realtime stage recording sites to achieve a good spatial distribution. The purchase and installation costs at each site are approximately $600 to purchase and $500 to install, but installation costs will be lower where precipitation gauges are also installed. Maintenance costs should be no more than $500 per year, including analysis of the data for quality control. Purchase and installation of recording wind gauges without realtime capabilities should cost approximately $3,600. Maintenance costs should be no more than $1,000 per year.

Water Level

Stage is a measure of water-level surface in a body of water. Stage can be measured discretely or continuously over a period of time. Depending on the measurement device, accuracy limitations will range from 0.01 to 0.1 ft.

Stage measurements can be made by using several different devices. A staff gauge is the simplest of stage measurement devices. Water-level measurements are made by visual inspection of a vertical graduated staff. Water-level measurements can also be measured with a continuous stage recorder. The water levels are determined by using a tape-float system or pressure transducer. Readings are recorded on a regular time interval on digital recorders, graphic recorders, or electronic data recorders. Electronic data recorders are devices such as basic data recorders where the stage values are stored in memory and downloaded into a computer during field inspections or into data collection platforms that transmit the data via satellite, radio, or telephone on a realtime basis.

Stage recorders can be temporary or built to last over a long period of time and under various environmental and climatological conditions. Cost can range from $200 for a staff gauge to $20,000 for some data collection platforms. Some of this equipment can be rented.

Where cost is not a major issue and where water-level data are a high priority variable data collection platforms are recommended as the standard protocol. Data collection platforms have a high equipment and installation cost for the stage recorders but reduce the cost of collecting other variables such as water temperature, dissolved oxygen, and precipitation because the equipment that measures the other variables can also use the data collection platform. Data collection platforms reduce maintenance costs; maintenance personnel can see when a gauge is not functioning properly and can perform maintenance on a less frequent basis than without the data collection platform. Because maintenance is performed immediately rather than on a scheduled basis, periods of bad or missing data are reduced. Equipment costs will be $5,000 and installation costs $3,000. Maintenance costs will range from $3,000 to $6,000 per year ($5,000 will be used for estimating purposes), including analysis of the data for quality control.
The measurement of stage over time can be from one reading at a site to whatever interval is required, such as daily, hourly, or less over a determined period.

Measurement of stage at one location can be compared to other water levels within a certain range of the gauge in common hydrologic areas. Spatial distribution of water level gauges will depend on the project type and the hydrologic characteristics of the project area.

At many project areas, existing stage recorders or realtime data collection platforms in the vicinity will suffice. At some locations, an observer may be hired to daily record stage from a staff gauge; a paid observer usually receives about $365 per year. Purchase and installation of the staff gauge would be about $1,100, with annual maintenance costs about $500 per year. Some sites can be monitored continuously for a short time, i.e., 30 to 180 days to determine the relationship of stage at the project to a nearby permanent location. Other sites can have a staff gauge installed, which would be read during the site visits. Purchase and installation would be approximately $1,100. These protocols are best suited for projects where collection of water-level data is a low priority.

There will be some projects where the level of the water is not as important as the forces of the waves and littoral transport. Directional wave gauges may be necessary to determine these forces. Wave gauges are placed in deep and shallow water near the area of interest. Data are gathered for a 2-3 year period and used to develop a wave model. The wave model predicts the near-shore wave climate based on the deep water wave gauge data. The model then replaces the shallow water gauges. Wave gauges cost about $20,000 each. Installation and maintenance costs are similar to the realtime data collection platforms.

The National Oceanic and Atmospheric Administration (NOAA) has several wave gauging stations in the Gulf of Mexico as do many of the oil companies. Use of these gauging stations may be more reliable and less expensive than installing additional deep water gauges.

Bathymetry

Bathymetric surveying is the measurement of depths of water bodies. Bathymetry is generally measured from a boat by using positioning equipment and a fathometer. Range lines are laid out to be surveyed on a routine basis. Positioning is usually recorded in x-y coordinates; depth is recorded in feet. Data can be recorded electronically and even transmitted over telephone hookups.

Costs for bathymetry data collection will vary according to the size of the area to be surveyed and the depth of water. Some shallower water bodies may have to be surveyed by using topographic land surveying techniques. Costs will also depend on desired survey accuracy. Costs for a bathymetric survey have been included in the costs for a topographic survey because most of the project sites will probably require a combination of the two types.

For projects where this variable is a high priority, bathymetry should be measured once before project implementation and at least once during each 3-year reporting period. Frequency, methodology, and survey coverage will be project and priority dependent. Spot elevations should be taken annually in conjunction with aerial photography to provide supplemental information.

Topography

Topographic surveying is the measurement of the elevation of land. Topographic surveys can be taken by using three different methods. (1) A surveyor can "walk" an area, recording horizontal location and vertical elevation. A survey that uses the water surface as a base and measures elevations with a rod is less expensive than a survey that uses positioning equipment and a fathometer. The accuracy of such a survey is about 0.5-1.0 ft. (2) Surveying with GPS equipment should be used when some error in measurement is acceptable. With GPS equipment, the use of range lines to determine location is unnecessary. Data can be recorded electronically. (3) Conventional equipment is used when horizontal and vertical accuracy is critical. Range lines are laid out to be surveyed on a routine basis. Positioning is usually recorded in x-y coordinates; depth is recorded in feet.

Costs for topographic surveying will vary according to the size of the area to be surveyed, its accessibility, and the ground conditions. Survey costs can range from $5,000-$10,000 per square mile for a "rod" survey or GPS type survey, to $30,000-$60,000 per square mile for a conventional survey. Depending on the project area characteristics and the presence of permanent bench marks, these costs could be double or higher.

For projects where the magnitude of yearly accretion on an existing wetland is measured in millimeters, traditional topographic surveying techniques are not suitable. Three different methods can be used to measure accretion of this type. First of all, soil cores can be taken to determine mineral contents. Generally, the presence of minerals in an organic layer indicate accretion. Second, direct measurement can be made by using feldspar marker horizons at intervals from the edge of streambanks. Soil cores are taken to measure accretion. Problems can arise with this method if the existing surface is porous and spongy; the feldspar can diffuse through a zone for several centimeters. A third method is the use of experimental sediment trapping devices. Problems can arise with animals digging in the vicinity of the traps and throwing additional sediment into the traps. All three methods were used in a recently completed monitoring program for a small-scale freshwater diversion project on the Mississippi River. This type of topographic monitoring would also be suitable for a vegetative planting, marsh management, sediment trapping, and hydrologic restoration projects. Costs for the materials and evaluation of the cores should be less than $1,000 per year. During the site visits, cores could be taken and sediment traps emptied.

For projects such as sediment diversion, barrier island restoration, dredged material, and shoreline protection, where this variable is a high priority, topographic surveys should be taken once before project implementation and at least once during the 3-year reporting period. Frequency, methodology, and survey coverage will be project and priority dependent. Spot elevations should be taken annually in conjunction with aerial photography to provide supplemental information. For the other project types, measuring accretion by using soil cores, feldspar marker horizons, and sediment trapping devices is recommended.

Salinity

Salinity is a measure of dissolved mineral in sea water in units of parts per thousand. Salinity is typically measured by using electric resistance meters.

Water samples can be collected on a regular basis and analyzed for some projects. Recording salinity or conductivity meters can be installed on those projects needing frequent salinity data.

There are water-level gauges such as the Endeco 1159 that also measure temperature and salinity in addition to stage. Hydrolab H_2O equipment is another gauge that measures all three variables. Both can be used with data collection platforms. Costs for the equipment vary between $8,700 and $10,500. Maintenance costs should be around $2,000 per year. Where water level, salinity, and water temperature are high priorities, this is the recommended standard protocol. The advantages are the ability to acquire realtime data in hourly increments. The disadvantage is mainly in the cost of the equipment. In fresh and intermediate marshes, salinity levels in the growing season, from March through November, are important. In the interests of cost, monitoring could be realtime during the growing season and monthly for the remainder of the year.

Where salinity is a lower priority, monthly collection is recommended in conjunction with site visits. Salinity can be measured during the site visits by using a field instrument such as a YSI 3800, which measures water temperature, salinity, and dissolved oxygen, among other things. The cost of this equipment is about $5,000. Existing data collection platform equipment can also be upgraded to measure and record salinity. Purchase and installation costs will be about $3,100. Maintenance costs should be no more than $500. Further information on methodology, recommended protocol, cost, and frequency of data collection can be found in the water quality monitoring subgroup report.

Discharge, Velocity, and Direction

Discharge is the measurement of volume of water passing a given point within a given period of time. Units of measurement for discharge are typically cubic feet per second.

To determine discharge, a measurement of velocity and cross-sectional area is necessary. Velocities are usually measured with mechanical velocity meters, electromagnetic velocity meters, and acoustical velocity meters. Some of these meters can measure only in one direction, while some can measure bi-direction, and others in any direction. The measurement of area is made with physical sounding of depth or by using electronic depth finders.

Discharge measurements are instantaneous measurements, that is, measured at one point in time. Some projects require that the discharge rate be known over a period of time. Typically, discharge over a period of time is determined by using a stage-discharge relationship. A series of discharge measurements is made at different stage elevations and a relationship between stage and discharge is determined. Unfortunately, this stage-discharge relationship does not apply to tide-affected areas.

Another method to determine continuous discharge is to measure continuous velocity and to develop a relationship between velocity and discharge.

Discharge measurements are typically made from bridges, boats, or even by wading the channel. Discharge measurements typically cost around $800 for 20 measurements in small channels. Costs will vary depending on site location and hydrologic conditions.

Some projects need only velocity and direction measurements to determine the movement of water instead of the volume of water moved. Velocity and direction measurements can also be used to monitor the tidal inflow and outflow through gaps and openings in the barrier islands. Tides can transport sediments into and out of the barrier island area. Velocity and direction recorders that interface with the data collection platforms are available. This equipment costs around $5,100. Installation costs are around $500. Maintenance costs are approximately $4,000. Maintenance costs include the cost to compute discharge.

The standard protocol for data collection will vary with project type and location. For example, large scale uncontrolled diversions will require discharge measurements to be taken from a boat on a routine basis. Conventional measurements should be taken where cross-sectional geometry fluctuates and where the relation between velocity and discharge will vary over time. Velocity and direction measurements can be taken where the cross section does not appreciably change over time and where the direction of flow is more important than the volume of flow. Frequency and spatial distribution of discharge measurements will also be project dependent. Discharge measurements could be taken during the project visits.

Suspended Sediment

Sediment is solid material that originates mostly from disintegrated rocks and is transported by, suspended in, or deposited from water. It includes chemical and biochemical precipitates and decomposed organic material such as humus. Suspended sediment is the sediment that at any time is maintained in suspension by the upward components of turbulent currents or that exists in suspension as colloid. Suspended sediment is expressed in parts per million (ppm) or milligrams of dry sediment per liter of water sediment mixture (mg/L).

Suspended sediment samples can be collected in several ways. In moving water, samples can be collected by using a number of different types of point samplers. Samples are collected at different points in a vertical profile and combined for analysis or analyzed individually. Suspended sediment samples can be collected in low velocities with wide-mouth samplers. Suspended sediment samples can also be collected by using a pump system to collect the sample. Automatic samplers are also available to provide unattended sampling at the frequency desired. Sediment sample costs will vary depending on the number of samples taken. A typical sampling program would cost about $1,800 for data collection and lab analysis of around 20 stations on small channels. A DH59 sampler costs about $500. Additional information is provided in the water quality monitoring subgroup report.

Where sediment sampling is a high priority, channel measurements taken with a point sampler should be made or an automatic sampler should be installed. Channel measurements generally require a discharge or velocity measurement for correlation. Automatic samplers require implementation of a good quality control system that includes routine visits for maintenance. The frequency of measurements will be project and site dependent. Sampling should be performed a minimum of six times per year. Sampling could be done during the site visits.

Groundwater

Probably the easiest technique to measure groundwater is to install a shallow piezometer at the same time soil cores are initially taken. The piezometer would be slotted PVC and would need some type of fine-gravel pack to minimize siltation, an upper casing, and a protective cap. Height of groundwater could be measured by using a simple ruler from the top of the casing during site visits, or any other data collection event.

Piezometers to monitor groundwater are relatively inexpensive; they cost a few hundred dollars each. Piezometer monitoring could be done during site visits or when personnel are in the field for other monitoring.

Piezometers can probably be installed at a cost of a $200 to $400 each. Actual monitoring costs will be minimal since the monitoring will occur during other visits to the project area and take only a few minutes. Data collation and analysis will also be minimal. Estimated costs are $5 for collection and $10 for collation, quality control, and analysis per piezometer.

Soil Salinity

Soil salinities can be measured by extracting interstitial water from a surface sediment sample by centrifuge. In many cases, freezing and defrosting a segment of sediment will disrupt sediment particle structure and allow settling. Separation of interstitial water can then be measured by a conductivity probe. Titration is accurate, but time consuming and therefore expensive in terms of labor. A refractometer is quick and inexpensive, but measurements are only accurate to approximately 1 ppt.

Soil salinities change slowly, and variation will be dampened compared to variation in salinity of the overlying water, which will change with tidal cycle as well as wind direction, seasonal changes to freshwater input, and climatic cycles. Thus soil salinities can be measured monthly for projects that rank this data collection a high priority, at least within the season when projects are most likely to affect salinity. For example, freshwater diversions are typically operated seasonally when fresh water is available and when biota are most sensitive to high salinity. When soil salinity monitoring is a medium priority, monitoring should be done monthly during times when projects are most likely to affect soil salinity. With those project types where soil salinity monitoring is a low priority, monitoring may be done infrequently or not at all.

Soil salinity samples can be collected with the soil-sediment sampling equipment and therefore will have no costs for initial sampling. Costs for analysis are unknown at this time. If annual soil samples are not collected, annual surface samples to determine soil salinity will cost about $10 to collect, assuming they are collected during some other monitoring event or a project visit.

If soil salinity sampling is coordinated with soil-sediment sampling, no additional equipment expense should be incurred. Cost of a conductivity probe for measuring salinity (e.g., a YSI 3800) is about $5,000.

VII. HYDROLOGIC DATA COLLECTION

Types of Projects Needing Hydrologic Monitoring

The monitoring work group has identified nine types of projects for which we are to develop hydrologic monitoring requirements. The types of projects are listed in Table 5 along with the priority of need for hydrologic monitoring. The priorities correspond to the four purposes of hydrologic monitoring discussed in the introduction of this report.

Table 5. Priority consensus of hydrologic monitoring projects.

Project type	Priority consensus
Freshwater diversion	1
Sediment diversion	1
Marsh management	1
Hydrologic restoration	1
Dredged material	4
Shoreline protection	4
Barrier island restoration	3
Vegetative plantings	2
Sediment and nutrient trapping	2

The hydrologic monitoring subgroup has further prioritized monitoring of variables within each project. Priorities agreed upon by subgroup members along with estimated costs are shown in Table 6.

Table 6. Monitoring matrix by priority[a] for hydrologic monitoring projects.

Project type	Precip.	Evap.	Wind speed direction	Water level	Bathymetry	Topography	Salinity	Discharge	Suspended sediment	Ground water	Soil salinity	Annual cost[b]
Freshwater diversion	1	3	1	1	3	3	1	1	1	4	4	$39,200
Sediment diversion	3	3	3	1	1	1	3	1	1	4	4	$46,200
Marsh management	1	3	1-3	1	2	2	1	2	3	4	2-3	$23,600
Hydrologic restoration	1	3	2-3	1	2	2	1	2	3	4	2-3	$24,100
Dredged material	4	4	4	3	1	1	4	4	4	4	1	$10,500
Shoreline protection	4	4	2[c]	3[d]	1	1	4	3	4	4	4	$6,000
Barrier island restoration	4	4	2[c]	3[d]	1	1	4	3	4	4	4	$11,000
Vegetative plantings	2	3	4	2-3	3	3	1	4	3	4	2-3	$8,000
Sediment and nutrient trapping	4	4	3	2-3	1	2	3	4	2-3	4	2-3	$33,100

[a]Key:
1 = Primary objective
2 = Secondary objective
3 = Tertiary objective (long term evaluation)
4 = Lowest objective (long term evaluation)

[b]Estimates include average annual equipment maintenance cost for one gauging station.

[c]Wind vectors may have a higher priority if needed to hindcast wave height and period.

[d]A directional wave gauge to determine the forces and littoral transport may have a high priority in determining failures.

VIII. HISTORICAL DATA

A table showing inventory of current and discontinued hydrologic data collection stations in Louisiana is on file with the monitoring work group. Equipment type varies, depending on location and the frequency of collection. Generally, realtime gauges use Handar GOES equipment. Water-level gauges may be electronic continuous recorders, strip charts, or bubbler gauges. Daily water levels are usually read from a staff gauge. Daily temperature and chloride data are from paid observers. Discharge measurements and sediment samples are taken 3-4 times per week to monthly from a boat; daily discharge and sediment loads are computed from rating curves. Lark rain gauges are used for hourly and daily rainfall records; standard rain gauges are used for daily records.

Maps showing the network of current hydrologic data collection stations in the Louisiana coastal zone, which can be incorporated into the hydrologic monitoring program are available from USACE.

Some of the realtime water-level stations can be upgraded with precipitation, salinity, water quality, velocity, and wind gauges. The cost to add a rain gauge is about $800 for the equipment, $1,000 for installation, and $500 per year for maintenance. Adding a wind-speed and direction gauge will cost around $600 for equipment, $1,000 for installation, and $500 per year for maintenance. A salinity upgrade will cost about $2,600 for equipment, $1,000 for installation, and $2,000 per year for maintenance. Temperature will also be measured with this equipment. The cost to add a velocity and direction gauge is about $5,000 for equipment, $1,000 for installation, and $1,000 per year for maintenance. Computing discharge from the velocity gauge will add about $3,000 per year to the annual maintenance costs for periodic discharge measurements and the computation of discharge. Adding water-quality probes, to determine aspects such as dissolved oxygen, would cost at least $5,000 for equipment, $1,000 for installation, and $3,000-$10,000 per year maintenance. All maintenance costs include analysis of data for quality control. Costs will vary on location and accessibility. Costs do not include replacement costs in the event of vandalism or theft.

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I. TITLE: MONITORING PROTOCOL FOR EXAMINATION OF THE IMPACTS OF CWPPRA PROJECTS ON SOIL DEVELOPMENT, SUBSIDENCE, AND MARSH ACCRETION

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IV. INTRODUCTION

Continued vertical development of marsh soils is critical to their survival in coastal Louisiana. Subsidence is recognized as one of the major processes causing coastal erosion and wetland loss. Subsidence of Mississippi deltaic plain and chenier plain sediments, combined with eustatic sea-level rise, has resulted in relative sea-level rise rates of over 1 cm/year in the delta plain and approximately 0.6 cm/year in the chenier plain (Penland and Ramsey 1990). If coastal marshes cannot increase surface elevation at the same rate as relative sea-level rise, marsh soils will become increasingly waterlogged. Chemical changes in the marsh soil resulting from such waterlogging can cause reduced growth and even die-back in wetland vegetation in both saline and fresh Louisiana coastal marshes (Koch et al. 1990). Insufficient accretion of the marsh surface to keep pace with relative sea-level rise is frequently termed a "sedimentation deficit."

The processes that contribute to accretion of the marsh surface can be summarized as follows:

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NVA = [Deposition on the marsh surface + belowground plant production] -
[erosion from the marsh surface + belowground decomposition].
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where NVA is net vertical accretion of the marsh surface. The processes that contribute to subsidence include geosynclinal downwarping, compaction of Pleistocene and Tertiary sediments, compaction of Holocene deposits, localized consolidation, tectonic activity, and fluid withdrawals. Consequently, the impact of projects implemented under the Coastal Wetlands Planning, Protection, and Restoration Act on marsh accretion and soil development can be dramatic in terms of their effect on depositional and erosional processes at the marsh surface and the production and decomposition of organic material within the soil, but rarely will the projects be able to impact the underlying causes of subsidence. However, the type of sediments composing the marsh soils, their grain size, and their chemical characteristics affect long-term stability, and these factors might also be impacted by projects aimed at marsh restoration. Therefore, we propose a monitoring plan that includes a broad spectrum of soil variables.

It is important to recognize that even if the stated goals of a particular project are achieved, there may be unintentional or indirect alterations to marsh ecosystem function that can have detrimental cumulative impacts on the ecosystem. Consequently, to fully evaluate the project it is necessary to monitor marsh soil variables other than those directly impacted by the project. Because of the delicate balance between marsh accretion and relative sea-level rise, it is important to monitor accretion in areas where accretionary processes are directly or indirectly impacted by the project, even if enhanced accretion is only a secondary goal for the project. For example, the stated goal of a marsh management project might be to increase vegetation growth, and this increased productivity may either increase or decrease net vertical accretion via its effect on organic accumulation, depending upon concomitant alterations in decomposition (see mass balance equation above). Monitoring of changes in soil type can also indicate the impact of vegetative or hydrologic changes on the stability and fertility of the soil substrate.

Some projects proposed for funding by CWPPRA do not involve the manipulation of marsh processes but seek instead to create marsh in areas where it does not now exist (e.g., projects on the beneficial use of dredged spoil or the back barrier marsh component of barrier island restoration). These projects aim to create marsh that functions naturally and can become self-sustaining in the long term. Given that these projects are developed in a subsiding coastal environment, natural accretionary processes (involving the accumulation of both organic and inorganic material) must occur or the marshes will be gradually submerged and the vegetation subjected to waterlogging. In addition, an important aspect of marsh creation is the development of soil properties. The newly created marsh soil must attain adequate hydrologic function to prevent waterlogging and/or the accumulation of toxics while providing the necessary nutrients for vegetative growth.

In those projects that aim to stimulate accretionary processes or recreate natural marsh development processes, e.g., sediment diversions, monitoring of marsh vertical accretion and changing soil properties is essential to assessing the success of the project. On the basis of this assessment of the need for monitoring of soil development and accretionary processes in a variety of types of project, the proposed CWPPRA projects can be classified as follows:

> Class A. Those that aim to create new marsh by artificial means (e.g., use of dredged spoil) but do not manipulate marsh processes, and where subsequent accretion and soil development are essential for the longevity of the project.
>
> Class B. Those in which the manipulation of accretionary processes is a minor or secondary aim of the project, but where indirect affects on accretion and changes in soil type might occur (e.g., freshwater diversion, marsh management).
>
> Class C. Those that specifically aim to enhance accretionary processes in existing marsh or to create new viable marsh by the manipulation of existing processes (e.g., sediment diversion, crevasse splays).

In addition, the variables to be measured during monitoring have been ranked according to project type and their importance in assessing project goals.

V. GENERAL DISCUSSION

Rationale of Variables

The marsh soil is a result of the cumulative effect of marsh building processes that include the production, transport, and decomposition of organic matter and net influx of inorganic sediments. Depending upon the rate of soil development or marsh accretion, the soil can represent the cumulative impacts of these processes over years or decades. Consequently, monitoring changes in soil variables after project implementation can provide two types of information regarding the success of CWPPRA restoration projects:

(1) documentation of changes in soil composition, stability, structure or development that occur as a direct or indirect result of the project.

Variables:
- Organic matter
- Bulk density
- Water content
- Grain size
- Soil redox
- Soil nutrients
- Soil contaminants (trace metals, synthetic organics, etc.)

(2) documentation of continued development or accretion of the marsh soil that allow for the long-term survival of the marsh in the face of subsidence, sea-level rise, physical erosion, etc.

Variables: Soil vertical accretion
Subsidence
Soil erosion and creation (change in spatial extent)

Relationship to Ongoing Programs

1. The U.S. Soil Conservation Service has produced soil surveys of all coastal Louisiana parishes. These surveys can provide data about specific soil types and their distribution. General information is available concerning such soil variables as percentage of clay, percentage of organic matter, permeability, and moist bulk density. This information can provide a regional context for soil evaluations and may be of value to those responsible for the design and implementation of projects (e.g., levee construction for marsh management projects). The data bases used for soil characterization include specific measurements of soil physical variables and also pH, exchangeable cations, exchangeable aluminum, phosphorous, and particle size, and are available through Wayne Hudnall, Agronomy Department, Louisiana State University, for all Louisiana parishes for which soil surveys have been conducted since 1975.

2. Much of the existing data collection and monitoring efforts that concern soils and sediments are project specific. They include monitoring of individual marsh management plans and scientific research projects designed to either resolve particular management issues or increase understanding of marsh system function. The U.S. Geological Survey is presently participating in two such initiatives. The first involves detailed examination of the physical processes of wetland loss and includes measures of marsh soil bulk density, organic matter content and accretion, as well as field and modeling studies of the movements of freshwater and sediments through marsh areas. The second examines the impact of marsh management on marsh accretion and sedimentation and is being conducted in cooperation with the U.S. Fish and Wildlife Service. The project uses various approaches to the measurement of sediment deposition and marsh accretion and compares experimental marsh management areas, which are being actively managed, with control areas.

   Such studies, and the sampling strategies they develop, can provide data to be used as part of a plan to evaluate the success of CWPPRA projects, especially where they provide information on regional patterns or the character of various marsh types. An example of this use of existing information is in the evaluation of subsidence. The framework geology of an area is particularly important in determining its subsidence potential, and existing studies have identified broad differences in subsidence between the chenier plain and the deltaic plain, as well as more localized variations within hydrologic basins. Because of the purpose for which the data was originally collected, it may not be sufficiently specific to be used in the evaluation of individual projects. Other sources that can indicate subsidence potential (e.g., fault maps) may be available in a more detailed form. Such issues are reflected in the priority that individual variables are assigned in the monitoring matrix (Table 7).

Table 7. Monitoring matrix.

	Class	Accretion	Subsidence	Organic matter	Bulk density	Water content	Grain size	Soil redox	Erosion/ creation large scale (mapping)	Erosion/ creation small scale
Freshwater diversion	B[a]	2, 1a[bc]	2	1	1	1	3	2	3	N/A
Sediment diversion	C	1	1	1	1	1	1	2	1	N/A
Marsh Management	B	1	2	1	1	1	4	1	3	N/A
Dredged material	A	1	2	1	1	1	3	2	N/A	1D, 4M[d]
Barrier island restoration	A	1	3	3	3	3	2	4	N/A	1
Shoreline protection	B	2, 3c	4	3	3	3	3c	4	N/A	1
Vegetative plantings	B	2	4	2	2	2	3	2	N/A	1
Sediment and nutrient trapping	C	1	1 Basin	1	1	1	2	3	N/A	1
Hydrologic restoration	B	1	2	2	2	2	3, 2d	2	3	2 e

[a]A - Create new marsh by artificial means, not manipulate processes.
B - Manipulation of soil processes is a minor aim of project but impact on soil occurs.
C - Project aims to enhance accretionary processes or create new marsh using natural processes.

[b]1 - Primary objective
2 - Secondary objective
3 - Tertiary objective - long term evaluation
4 - Lowest priority - long term evaluation

[c]a - depending on the scale of monitoring for vegetative vigor/growth
b - higher priority of no previous information on soil quality available
c - higher priority if marsh creation is expected
d - if riverine sediment transport paths are affected
e - small scale monitoring required if marsh creation is expected

[d]D - importance at design stage
M - importance for monitoring
Basin - basin scale subsidence information only

3. The cost effectiveness of CWPPRA monitoring versus the use of existing data collection programs depends upon a variety of factors. If certain State or Federal agencies presently have personnel involved in data collection in the coastal zone, it may be appropriate, and cost effective, to incorporate them into a CWPPRA monitoring plan. However, the specific variables and the experimental design for CWPPRA monitoring should be determined independently of these programs in order to provide data that can be used in a statistically valid evaluation of the CWPPRA projects. Where these data collection efforts coincide with ongoing efforts, interagency cooperation is encouraged to increase cost effectiveness. If outside contractors are to be solicited to conduct monitoring efforts, they should be expected to make use of existing efforts and/or logistic support from agencies where appropriate.

VI. METHODOLOGY

Variables

The sediment and soil variables to be included in monitoring plans have been prioritized according to their suitability for evaluating the various types of CWPPRA projects (Table 7). The matrix in Table 7 distinguishes between large-scale and small-scale marsh erosion and creation variables. Large-scale monitoring variables are those that can be undertaken by mapping from aerial imagery, while small-scale monitoring variables are required where changes at a scale of meters are important to the project and must be determined on the ground.

Selection of Sampling Sites

Subsidence is a rapid, highly variable process throughout the Louisiana coastal zone, and all of the proposed CWPPRA projects will be constructed within environments experiencing subsidence. The rate of subsidence can have a dramatic effect on the success of a project. In projects designed to manipulate water and sediments for wetland restoration, the chances of success are greater in areas with lower subsidence rates. It is possible that in some areas subsidence rates are so high that the likelihood of project success is diminished. Because subsidence is an underlying problem for all projects, it is appropriate that it be addressed both at the basin and project specific levels to successfully plan for the management of the coastal zone, and for effective evaluation of project success.

To scientifically evaluate the success of projects, effective comparisons must be made between control and project areas. Certain criteria should be followed in control area selection:

* In projects that impact significant areas of existing vegetated marsh there will probably be gradients in marsh topography, soils and accretion between streamside areas, and back-marsh areas. Where this is the case, sampling sites should be selected consistently in either or both of these zones so that similar environments are being monitored.

* Differences in soil composition and the relative importance of organic and inorganic accretionary processes are also well established between marsh habitat (as defined by salinity and vegetation zones). If the project area includes sizeable areas of more than one marsh habitat comparisons between control and project areas should be made for each marsh habitat. This is necessary to ensure that comparisons are made between like environments.

* Control and project areas should be comparable in their vegetation (within marsh habitat), hydrology, and proximity to sediment sources. The amount of acceptable variability varies according to the number of control areas selected (see Experimental Design section).

* Control and project areas should be comparable in the thickness of the marsh soil. This provides the substrate for marsh growth and is the zone where changes resulting from project implementation will be identified. Previous studies by the U.S. Soil Conservation Service and Louisiana Geological Survey have noted some variations in the depth to the "clay horizon." In order to make effective comparisons between control and project areas, variations in the thickness of marsh soil must be examined before sampling sites are selected.

The validity of the comparisons made between project and control areas will depend upon the number of replicate samples that are taken. The project and control areas should be divided into marsh habitats and at least five replicate sample sites selected randomly within the areas. For instance, if the project area includes both brackish and saline marsh habitats and the study is to consider only back marsh locations, then five brackish-backmarsh-control, five brackish-backmarsh-project, five saline-backmarsh-control, and five saline-backmarsh-project sampling sites should be selected. It is necessary to ensure that control and project areas are comparable. If the project area is large, then sample size should be increased. It is essential that sampling sites are not chosen for logistic reasons but to represent the marsh area being studied. Boardwalks may be necessary to prevent unnecessary disturbance in areas where frequent access is necessary. In all cases, sampling on all areas should be conducted during as short a period as possible to prevent the confounding effects of unpredictable extreme events.

Marsh accretion and soil development are mediated by marsh hydrology and vegetative growth. If monitoring is to be conducted regarding hydrology and vegetation, the understanding of marsh function and the impact of the project will be greatly enhanced by coordination of sampling sites and frequencies. Indeed, the monitoring of marsh-water levels and vegetation productivity (aboveground and belowground), in particular, will enhance the understanding of project impacts gained from the monitoring of marsh accretion and soil development. Consequently, the overall monitoring strategy should allow for coordination between monitoring protocols. Preferably, the same agency or contractor should be responsible for these aspects of the monitoring, or a mechanism for cooperation should be established.

Sampling Design

The sampling matrix (Table 8) shows three strategies for sampling the different types of projects according to the frequency of sampling. The basic monitoring is for Class A projects; more detailed monitoring is proposed for Class B projects; and Class C projects require the most intensive monitoring as soils and sediments are included in the primary objectives of the projects. In addition, for projects where no control sites are available, pre-project monitoring of certain variables is proposed to provide baseline data. These are believed to be the minimum requirements necessary to meet the mandate of CWPPRA for scientific evaluation of project success.

Table 8. Sampling matrix.

	Basic class A	Better class B	Best class C	No control any class
Accretion				
Feldspar markers	A[a]	S	S	
Sediment-erosion table		A	S	
Radionuclide dating			Once only	Once only
Subsidence				
Carbon-14 dating	Once only			
GPS		C		
Extensometers			C	
Organic matter content	A	S	S	Pre-project
Bulk density	A	S	S	Pre-project
Water content	A	S	S	
Grain size	A			Pre-project
Soil redox	A	S	S	Pre-project
Erosion/creation large scale	A			
Erosion/creation small scale	A			
Nutrients	Once only	A		Pre-project
Pollutants	Once only	A		Pre-project

[a] A = Annual
S = Seasonal
C = Continuous

Methods

Soil properties - organic matter content, dry bulk density, water content, grain size

Core samples should be taken from the marsh for the evaluation of these variables.[1] The technique used for coring the marsh is important because inappropriate techniques can cause compaction of marsh sediments and particularly inaccurate measurements of dry bulk density and water content. The best method, which works in all marsh habitats (saline through fresh) and with minimum disturbance to the marsh surface, is cryogenic coring. This involves the freezing of the marsh onto a copper tube and the extraction of a small diameter (5 cm) core without compaction (Knaus and Cahoon 1990). The cores can be sliced into 1 cm or larger segments while still frozen. This method is more field intensive than other methods involving coring devices, but the frozen cores allow easier laboratory analysis for bulk density than other standard practices (e.g., Procedure 4A in U.S. Department of Agriculture, Soil Conservation Service 1984). Alternative coring methods usually involve some compaction of sediments, which can be critical in the evaluation of soil bulk density. A large-diameter (15 cm) core tube can be used to minimize compaction but it usually has to be dug from the substrate causing considerable disturbance. Such disturbance is not appropriate in areas that are being monitored, i.e., where repeated sampling is required. The core segments should be weighed while wet and then oven dried before reweighing. The difference in weights indicates the water content of the soil and the weight of the dried segment which, when standardized for the segment volume, provides the dry bulk density. Organic matter content can be similarly determined by loss to ignition at 375°C for 16 h in a laboratory muffle furnace (or see Procedure 8F in U.S. Department of Agriculture, Soil Conservation Service 1984). Size determination of the ashed sediment samples by using a combination of sieving and pipette/Coulter Analyzer techniques will provide soil grain size data.

Cost per sample[2]:	Organic matter content	$100
	Dry bulk density	$100
	Water content	$50
	Grain size	$100

Accretion (Feldspar)

Feldspar marker horizons should be established at each sampling site. Areas should be at least 50 cm x 50 cm and the layer of feldspar should be at least 3 mm thick. The increment of soil deposited and accumulated above marker horizons should be monitored seasonally. The cryogenic coring technique should be used to sample the surface soil layers at randomly selected locations and

[1] The depth to which these variables are measured within the soil and the number of samples taken from each core (e.g., 5 cm, 10 cm , 15 cm, etc.) will depend upon the nature of the project, but will be consistent between sampling within the project and control areas.

[2] Costs are very approximate and depend upon who is conducting the sampling and sample processing. Estimates were made based upon one agency or contractor conducting the monitoring and taking samples for all analyses during the same field trips. Project access costs (for example, if an airboat is required) could increase costs. Estimates were based on $100 per day for boat access to project areas. For airboats this would increase to $450.

the increment of accumulation measured to 0.5 mm. Alternative techniques for sampling feldspar marker horizons, including the use of thin-walled aluminum-core tubes, which are then frozen and split to reveal the feldspar horizon, are not effective in all wetland types. Highly organic soils, such as those in fresh to intermediate marshes, are very readily compacted by this technique. Cryogenic coring is the optimum, and it provides data in the field rather than requiring additional laboratory work.

Cost per measurement[3]: $250

Accretion (SET)

The sedimentation erosion table (SET) technique was originally used for measuring small changes in elevation on tidal flats in the Netherlands (van Erdt 1985) and is presently being used in marsh surface studies in Louisiana and Georgia. A 7.5-cm diameter aluminum pipe is inserted into the marsh surface using a vibracore until it will penetrate no further and then trimmed to within 30 cm of the marsh surface. The base of this pipe represents a datum against which marsh surface elevation is measured. A smaller notched pipe is cemented into the top of the aluminum pipe and this becomes the base for the sedimentation table. Bases are permanently located at sites where NVA (net vertical accretion) is to be measured. The sedimentation table is placed on the notched pipe during measurement. The distance between the table and the marsh surface is measured by using nine thin aluminum rods. Small discs at the end of the rods prevent penetration of the sediment surface. Changes in the distance between the marsh and the table represent changes in the elevation of the marsh surface. For each base the table can be placed in four positions, coinciding with the points of the compass, to give a total of 36 measures of marsh elevation for each manipulative plot.

Cost of set-up: $450 per site
Cost of measurements: $250

Accretion (radionuclide dating)

^{210}Pb dating of marsh soils can indicate the long-term (> 100 years) accretion rate of the marsh (DeLaune et al. 1989). The procedure involves coring the marsh surface and partitioning the core into vertical segments. The activity of the radionuclides in each segment can be plotted against depth to reveal the vertical profile. The slope of the activity profile is proportional to the rate of marsh accretion (DeLaune et al. 1989). These analyses should be handled by workers with suitable equipment and experience.

Cost of analysis: $1,000

Subsidence - basin scale

Historical tide-gauge trends can be determined by using data from existing long-term gauges operated by the National Ocean Service and the U.S. Army Corps of Engineers. In addition, within each basin, a systematic vibracore survey should be conducted to determine long-term subsidence by using radiocarbon analysis of buried horizons. In addition, GPS benchmarks and extensometers can be used to monitor subsidence. Their location should be based on an understanding of the framework geology

[3] Includes costs for establishing feldspar plots.

of each basin. Vertical extensometers are used to monitor aquifer compaction caused by withdrawal of groundwater. They consist of a well with a casing installed to a chosen depth. A pipe is placed inside the casing and anchored to the bottom of the casing. If the formation above the base of the casing compacts, the pipe appears to rise above the ground because it is free to move. Nests of three extensometers completed at different depths can be used to determine the amount of shallow compaction (or subsidence) and how it is vertically distributed.

Cost per vibracore:	$2,000
Cost per extensometer:	$14,000

Subsidence - project scale

Tide gauges established within each project (by the hydrology group) should be tied into the existing regional network of long-term gauges. Analysis of annual trends in tide-gauge data for long-term stations should be continued, with additional establishment of GPS benchmarks and extensometers (see above) at each project, which are tied to the basin-scale network.

Costs:	See above.

Soil redox potential

Soil redox potential should be measured *in situ* at 5-cm intervals below the marsh surface by using brightened platinum electrodes (Mendelssohn and McKee 1988). The depth to which measurements need to be made will depend on the particular project but should be at least 20 cm to coincide with samples taken for chemical analyses.

Cost of profile measurement: $75

Marsh erosion and creation - large scale

The methodologies and costs for this type of monitoring fall under the auspices of the habitat mapping group. Those types of projects that require this evaluation are indicated in Table 1, and we defer to the recommendations of the habitat mapping group regarding the acquisition of these data.

Marsh erosion and creation - small scale

Small-scale changes in the position of the marsh edge can be determined by one of two techniques:

(1) Repeated surveys of marker stakes (standard beach survey technique).
(2) Repeated measures of the position of the marsh margin in relation to a fixed point within the marsh (Letzsch and Frey 1980).

Which technique is most appropriate will depend upon the individual projects, substrate conditions, and the rate of expected erosion and progradation. The survey technique provides information on marsh morphology and is more accurate but requires experienced personnel for surveying. The Letzsch and Frey technique requires the insertion of posts at fixed positions in relation to each other and the original marsh edge. Subsequent measurements are made with a tape measure and do not require experienced personnel. Costs vary accordingly.

Cost of measurement: $150-$300

Soil nutrients and contaminants

The soil and sediments subgroup identified soil nutrients and contaminants as important variables to be monitored. The methodologies and costs for these variables fall under the auspices of the water quality subgroup and will not be addressed in this report.

VII. HISTORICAL DATA

Very little historical data on soils and sediments issues exist in established data bases. The data sources and programs described in the *Relationship to Ongoing Programs* section all provide some degree of historical data. The published scientific literature also contains vast bodies of knowledge concerning soils, subsidence, and marsh accretion in Louisiana. This protocol has been developed in awareness of these previous studies and builds upon that information. A review of this literature was considered beyond the purview of this subgroup.

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I. TITLE: VEGETATIVE HEALTH MONITORING ON CWPPRA PROJECTS IN COASTAL LOUISIANA

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IV. INTRODUCTION

The vegetative health monitoring subgroup of the CWPPRA Monitoring Work Group was tasked to develop vegetative protocols and analyses required to determine the degree of success of the various types of projects built under the CWPPRA. The act specifically asks for the development of projects that significantly contribute to the long-term restoration or protection of the physical, chemical, and biological integrity of coastal vegetated wetlands. The major goal of protection projects is to slow or reverse coastal erosion rates, while the major goals of restoration projects are to preserve, enhance, and/or promote the growth of emergent and submergent vegetation. These goals will be evaluated through the determination of acres of wetlands saved or created. Vegetative health monitoring allows us to determine to what degree the predicted response is occurring other than by the mere presence or absence of vegetative communities.

V. GENERAL DISCUSSION

This section provides information on why certain vegetative health variables were chosen and others were not, what additional issues need to be addressed, and how vegetative health monitoring ties in to other monitoring initiatives.

Rationale

The following variables were chosen because they are proven measures of vegetative health.

Species composition

This variable is a basic structural measure for determining what plant species are present. Plant species have specific tolerances to salinities and water levels, as well as varying levels of wildlife habitat use; therefore, they can be used as an indicator of change.

Relative abundance

This variable goes hand in hand with species composition. Relative abundance more accurately documents the degree of change by providing a measure of dominance and evenness of species. It is not just a measure of percent cover, but also indicates what species dominate the area and whether that species has a high value relative to project objectives (wildlife, cover, bank stabilization, etc.).

Aboveground biomass

This variable provides an indication of the overall vigor and health of the marsh and can be used as a conservative estimate of productivity.

Herbivory

This variable can be an important factor in determining success. Herbivory can be locally intense, very destructive, and costly relative to replanting vegetative projects.

Belowground Biomass and Productivity

It is well established that belowground productivity provides a significant contribution to the overall productivity of ecological systems (Vogt et al. 1986). However, accurate measurements of belowground biomass and productivity are difficult and expensive to obtain (Symbula and Day 1988). These measurements are beyond the realm of this monitoring initiative and would be more appropriately investigated by the scientific community.

Ongoing Programs

Currently, there are no ongoing programs that are providing vegetative health monitoring throughout coastal Louisiana. There are, however, a large number of projects and studies that have collected vegetative health data, and they would be useful in a historical context.

VI. METHODOLOGY

This section defines those variables chosen to monitor vegetative health. A recommended protocol for quantitative sampling of each of the variables is identified, with a discussion of its advantages and disadvantages. In addition, qualitative measures have been identified for use if a quantitative approach is not feasible.

Species Composition

This variable provides an inventory of plant resources by determining what plant species, vegetation types, and communities are present. It requires compiling a list of all species encountered within an area that best represents the community. Although this type of survey indicates what new species occur and existing species disappear with time, it cannot indicate change in vegetational importance unless a measure of abundance or dominance is provided. Therefore, it is recommended that species composition and relative abundance be measured at the same time by using the protocols discussed under relative abundance.

Relative Abundance

Relative abundance provides an estimate of the number of individuals per species in a given sample area. It can be measured by cover estimates or stem counts, depending on whether the measurement needs to be relative or absolute. It is limited by the preciseness of measure, with the potential for introducing bias from one individual to the next. Therefore it is recommended that the same individual(s) conduct the monitoring every sampling trip, if at all possible.

The Braun-Blanquet method (Mueller-Dombois and Ellenberg 1974) should be used to identify species compositions and abundances. It requires compiling a species-area curve, which will determine the minimal sample area size. These samples should fulfill the following requirements: the cumulative plot area should be large enough to contain all species, and the habitat should be as uniform and representative as possible. The Braun-Blanquet Cover-Abundance Scale provides absolute values in relation to fixed plot sizes. Scale values that are chosen should not be deviated from for reasons of comparability.

The advantage of this method is that it is simple, comparable, and accepted by ecological investigators. It is also a semi-quantifiable approach that is less time and labor intensive than stem count methods. The disadvantages include subjectiveness in the cover estimates as well as decreasing accuracies with increasing plot sizes. Additionally, care must be taken in selecting the size, shape, and numbers of plots.

Ocular estimates and low-level aerial photography are qualitative techniques that could be used to measure relative abundances. Another quantitative technique that could be used is stem counts.

Aboveground Biomass

This variable provides a measure of growth, health, and vigor of plants by obtaining the weight of vegetation per unit area. The limitations of this measure include its difficulty in being used in large plots and in woody vegetation.

The clip-plot method (Mueller-Dombois and Ellenberg 1974) should initially be used to obtain aboveground biomass. It would require the clipping of all aboveground matter in established plots, drying it in an oven, and weighing it. Plot size and shape are just as important for obtaining accurate estimates of biomass as they are for the other measures.

The advantages of this method are that it is quantifiable, comparable, and accepted by ecological investigators. The disadvantages include it being a destructive technique and time-intensive. It is recommended that clip-plots be used until a regression line between size and biomass can be developed. This regression could be obtained by counting stems and measuring heights.

Another method that could be used is airborne remote sensors that use Landsat Thematic Mapper and SPOT satellite images to quantify and map the distribution of live aerial biomass in monospecific marshes.

Herbivory

Herbivory is the consumption of all or part of a plant by a consumer. It can be calculated directly by a measurement of the plants themselves or indirectly by measuring the intensity of the herbivores in relation to a unit area. The limitations include the ability to determine cause and effect in terms of survival and stress.

A permanent plot method will be used to evaluate the effects of herbivory. All measurements and techniques described above will be evaluated in caged versus uncaged permanent plots in problem or potential problem areas.

The advantage of this method is that it will provide a structural estimate of potential herbivore impacts without too much additional effort. A disadvantage would be that it would not provide any measure of functional impacts.

It is suggested that during the project development stage, the evidence of herbivory should be evaluated to determine whether a qualitative or quantitative monitoring approach is necessary. For areas with intensive herbivory, a qualitative approach of looking at the presence or absence of vegetation by ocular estimates and/or low-level photography would suffice if historical vegetative composition is known.

General Recommendations

It is recommended that the Braun-Blanquet method be used when applicable because it has the broadest application for quantifying shifts in community composition and abundance. All other measurements can be incorporated into the sampling design required for this method in order to be cost and labor efficient.

Sample designs will be specific for each project. Random selection of permanent transects or plots would be preferred, and distribution and frequency depend on project area and heterogeneity.

The minimum sampling frequency for all variables is annually. Within highly diverse fresh marshes, minimum sampling should occur in the spring and fall because of seasonal species changes, which do not occur extensively in brackish and saline marshes.

The cost estimate for each field visit to the project area is $2,000. Aboveground biomass can be analyzed for $10.00 per sample. These costs will vary depending on size and heterogeneity of the project area and mode of transportation (i.e., airboats).

Resources and project-specific goals will dictate what and how frequently vegetative health variables will be monitored. However, our recommendation is to use resources on habitat mapping first because it provides the baseline for monitoring habitat health.

The broad goals and methods of vegetative monitoring will be more specifically developed on the project level. Each project type may vary somewhat in methodology and frequency of sampling depending on the size and scope of the projects as well as on project-specific objectives.

VII. PROJECT TYPES REQUIRING MONITORING

The monitoring work group has identified nine types of projects for which vegetative health monitoring requirements are to be developed. The types of projects listed in Table 9 have been prioritized regarding their need for vegetative health monitoring. In addition, a determination of whether this monitoring should emphasize qualitative, quantitative, or mixed approaches is identified. Qualitative approaches are used on projects whose response is to create new marsh. These approaches are concerned with identifying the presence or absence of vegetation. Quantitative approaches are used on projects whose response is to shift community types. The emphasis is on determining how much of a difference there is between areas with and without project conditions. These approaches are not only concerned with identifying the presence or absence of vegetation, but also how the vegetation structurally and functionally responds to the projects. Mixed approaches may be used on projects that require some qualitative and some quantitative analyses.

Table 9. The nine types of projects for which vegetative health monitoring requirements are to be developed and their priorities.

Project type	Ranking	Monitoring emphasis
Freshwater diversion (FD)	1	quantitative
Sediment diversion (SD)	3	qualitative
Marsh management (MM)	1	quantitative
Hydrologic restoration (HR)	1	quantitative
Beneficial use of dredge material (DM)	3	qualitative
Shoreline protection (SP)	4	qualitative
Barrier island restoration (BI)	3	qualitative
Vegetative plantings (VP)	2	mixed
Sediment and nutrient trapping (S/NT)	2	mixed

The specific monitoring variables and their ranking for each project type are listed in Table 10. Rankings of 1 or 2 indicate the importance of these variables in determining if the primary and secondary objectives of a project are being met.

The vegetative health subgroup also identified water level, salinity, temperature, pH, dissolved oxygen, turbidity, and macronutrients (N, P, K) as important variables relative to vegetative health monitoring. The methodologies and costs for these variables fall under the auspices of the hydrology and water quality subgroups and will not be addressed in this report.

Table 10. Monitoring matrix for vegetative health projects.[a]

Project type	Species composition	Relative abundance	Aboveground biomass	Herbivory
FD	2	1	2	4
SD	2	2	3	3
MM	2	1	2	4
HR	2	1	2	4
DM	2	2	3	3
SP	4	3	4	4
BI	2	2	3	3
VP	2	1	1	2
S/NT	2	2	3	3

[a]Key: 1) primary objective
2) secondary objective
3) tertiary objective - long term evaluation
4) lowest priority - long term evaluation

Note: Species composition is a qualitative measure.
Relative abundance is a quantitative measure.

VIII. HISTORICAL DATA

Vegetative surveys have been conducted in coastal Louisiana every 10 years since 1968 by the Louisiana Department of Wildlife and Fisheries and Louisiana State University. Descriptive analyses have been compiled on vegetation, water, and soil characteristics; however, these variables have not been correlated (Chabreck 1972). Vegetative type maps have been completed for the years 1968, 1978, and 1988. These maps illustrate fresh, intermediate, brackish, and saline marsh areas as well as nonmarsh areas. The associated data base can provide historical information and may be used as a baseline for some projects.

The Coastal Restoration Division of the Louisiana Department of Natural Resources is in the second year of cooperative agreements with the State Soil and Water Conservation Committee and the Coastal Soil and Water Conservation Districts to implement over 50 vegetative restoration projects. Monitoring of these projects includes percent survival, number of new shoots, lateral spread, height, basal cover, vigor, seed head formation, insect damage, and herbivore damage. The herbivore monitoring in particular can provide some useful information.

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IV. INTRODUCTION

Selected wetland areas throughout coastal Louisiana have been designated by the CWPPRA as potential restoration projects. Habitat mapping can provide a useful tool in the monitoring of restoration projects. The previous wetland mapping was based on aerial photography acquired at a scale of 1:63,500 and mapped at a scale of 1:24,000. The resulting maps have not proven feasible for marsh restoration and management use.

The U.S. Fish and Wildlife Service (USFWS), National Wetlands Research Center (NWRC) is presently producing 330 wetland and upland habitat maps for coastal Louisiana using 1988, 1:63,500 scale color infrared photography. Two hundred and twenty-three of these maps will be comparable to the previous mapping efforts of 1956 and 1978. In fact, many of the completed maps and the digital data available from them are being used in the planning process for the CWPPRA. Although this habitat mapping is providing data for basin-wide planning such as measuring wetland change, land loss, and marsh loss, the detail is insufficient for providing similar comparisons for each restoration project type. The regional mapping projects of NWRC and U.S. Army Corps of Engineers (USACE) are based upon 1:63,500 scale aerial photography or base maps; this scale precludes the ability to photointerpret and map consistently or economically those parcels of marsh or open water that are less than one acre in size. Consequently, studying the processes or documenting the change in the habitats in restoration project areas is difficult.

The objectives of habitat mapping are:

* To provide a data base from which basin-wide wetland trends can be measured and to update the 1988 data base with 1993 thematic mapper data
* To provide baseline maps for a historical time period for the vegetation within each of the restoration sites prior to the restoration project being implemented
* To acquire aerial photography for each restoration site for successive years and provide that photography to other monitoring subgroups
* To develop large-scale, detailed habitat maps (and assess the classification accuracy of these maps) for successive years that can be used by the other monitoring subgroups
* To coordinate with the vegetative health subgroup in fieldwork, data collected, and maps generated
* To assess the impacts or changes brought on by the restoration activity
* To develop digital data for selected restoration projects on an as needed basis.

V. GENERAL DISCUSSION

Data Availability

Wetland and upland habitat maps and digital data are available from USFWS for the whole Louisiana coastal zone for 1956, 1978, and 1988 at a scale of 1:24,000.

The Louisiana Department of Natural Resources (LDNR) Coastal Management Division has classified satellite thematic mapper (TM) data for the whole coastal zone for winter 1984-85. Geocoded (Louisiana State Plane-South Zone) TM data are available for winter 1990-91 for the whole coastal zone. Partial January 1988 geocoded TM data are also available for the eastern half of the coastal zone.

Unclassified advanced very high resolution radiometer (AVHRR) digital data are available through the Louisiana State University on a daily basis at a course resolution of 1 km.

Land and water change data and maps are available from the USACE for the Mississippi Deltaic Plain for the 1930's, 1950's, 1970's, 1980's, and 1990's at a scale of 1:62,500.

Digital line graph (DLG) data are available from the USFWS for transportation, hydrology, and public land survey for all 1:100,000 scale maps.

Digitized 1:24,000 data for portions of the coastal zone (non-U.S. Geological Survey [USGS] source) are available from LDNR in DXF format. LDNR is in the process of entering a contract with the USGS to complete all 1:24,000 DLG's south of 30 degrees latitude within Louisiana. Expected completion date is early 1994.

Transportation and boundary digital data are available from the Louisiana Department of Transportation for the whole coastal zone.

Scale

1) Basin-wide

Minimum mapping scale should be 1:100,000.

Use the existing USACE, USFWS, and LDNR digital data available.

Acquire and classify five geocoded scenes (180 x 180 km/scene) in the fall and winter 1993-94 to cover coastal Louisiana and update the 1988 habitat data base. The comparison of the USFWS habitat data to classified TM data has several inherent problems that will affect the resultant acreages of habitat change.

2) Project specific

Minimum mapping scale should be 1:24,000 with the following recommendations for each project area:

Acreage	Scale	Minimum Mapping Unit
Under 200 acres	1:6,000	0.05 acre
200 acres to 20,000 acres	1:12,000	0.1 acre
Over 20,000 acres	1:24,000	1 acre

Color infrared aerial photography must be collected as the primary mapping medium.

The period from September to early December is the optimum window for obtaining the aerial photography.

High water conditions should be avoided by acquiring the photography during normal to low water conditions (flat tides).

The aerial photography should be collected by basin to avoid the changing water and vegetation conditions that can often vary from one basin to another.

The aerial photography should be collected each year for the first 3 years then every third year thereafter. However, this should be considered on a case by case basis after the first year because some of the projects may have changes that necessitate the acquisition of aerial photography more or less frequently than every third year.

3) Historical

Use the existing USFWS aerial photography from 1978 and enlarge to 1:24,000 scale, photointerpret the habitats, and map each unit to provide baseline data to measure changes against. For areas that are to be mapped at 1:24,000 scale, the 1988 USFWS habitat maps can be used as an additional time period since those data are readily available. For areas to be mapped at the 1:12,000 scale, the 1978 photography will be enlarged to 1:12,000 scale and photointerpreted. For areas to be mapped from present and future photography at 1:6,000, the 1978 photography cannot be enlarged to 1:6,000 and maintain sufficient clarity and resolution. Therefore these areas will be mapped at 1:12,000 for 1978.

Classification

The basic goal of the habitat mapping program is to provide a consistency of products through the use of the USFWS wetland classification system (Cowardin et al. 1979) and upland habitat delineation (as modified by Anderson et al. 1976).

1) Basin level

The 1993-94 TM imagery should be classified to Level I (modified by Perwitt Braud after Anderson et al. 1976) consisting of approximately 14 land cover categories following LDNR procedures used for the 1984-85 imagery.

2) Project specific

Use the Cowardin et al. (1979) classification to the subclass level. As per the wishes of other monitoring subgroups, water regime, salinity, and species modifiers may be added to the mapping classification if sufficient fieldwork is funded and/or data from other monitoring subgroups are available. Additional modifiers, e.g., for flotant and managed areas may be added.

3) Historical

Use the Cowardin et al. (1979) classification for the historical mapping to the subclass level, with the use of water regime and special modifiers.

Fieldwork

Amount of fieldwork depends upon the specific level of the classification desired; the greater the level of classification the more fieldwork and time will be required.

The fieldwork performed in the mapping of projects will be separate from the field data collected by or for other monitoring subgroups. If the mapping field data are deemed usable by other monitoring subgroups, it will be made available to them.

1) Basin level

   Determining basin level habitat acreage depends on the availability of existing ancillary data sets. Complete coverage of the entire Louisiana coastal zone is not available for all years. Some groundtruthing may be necessary to correctly classify newly acquired TM imagery.

2) The fieldwork criteria necessary for the project-specific mapping include

   * location by longitude and latitude and a vicinity requires the use of a global positioning system for location of the following vegetative characteristics:

     predominant species in cover
     other species present
     canopy height
     vegetative vigor
     percent cover

   * water level at time of fieldwork
   * annual fluctuations of water level
   * schedule for groundtruthing
     prior to photointerpretation--all sites
     after photointerpretation--all sites
     review of draft maps--only areas over 20,000 acres
   * salinity from actual measurements managed (if the area is impounded, water level managed, ditched, etc.)

3) Horizontal control (mapping accuracy)

   In the mapping at detailed scales of 1:12,000 and 1:6,000, the placement of targets prior to each aerial photographic flight is necessary to provide control markers that will be seen on the aerial photography. Global positioning systems (GPS) should be used to locate targets and compare positions with the GPS readings recorded during acquisition of the aerial photography.

   Required especially for areas that do not have adequate natural and cultural features to maintain horizontal control for registering aerial photography to base maps.

Products

- * Aerial photographs
- * Final habitat maps
- * Digital data for selected restoration sites
- * Field notes
- * Classified TM data (including digital and hard copy products) for basin level mapping
- * Regional trend maps from basin-level mapping

Dissemination

The products should be made available to researchers and monitoring groups, State and Federal agencies, parishes, and universities; however, all products should be made available to everyone. Reproduction of maps should be made simple. Photograph reproduction will be a problem of photography, maps, and digital data. One agency should be responsible for archiving and distribution of photography, maps, and digital data, but this will be costly.

Review

1) Basin level

   Series of demonstrations for task force and subgroup chairs

2) Project specific

   Internal review

   Regional review

   Draft map review - maps would be available to the public for comments from those interested in reviewing the maps. Schedule, though, may negate this if rushed for time.

Statistical Review

While there are no statistical criteria or standards for mapping, classification and positional accuracy will be assessed in order to estimate the overall accuracy of the data.

VI. METHODOLOGY

Basin-level Mapping

The wetland cover and trend work currently being completed for the CWPPRA task force is establishing historical regional trends on either a basin or coastwide basis. There is no need to repeat this process except to update the coastal trend data sets by including the 1988 habitat data set when completed.

Basin-level mapping for a more recent vintage should use coastwide, level-one classification of geocoded TM imagery. Hybrid image classification techniques should be used to classify the geocoded TM data for major habitat categories. Resulting landcover and wetland trend maps, digital data, and reporting data (acreage by habitat category) generated by GIS analysis of the classified TM data should be made available for each basin in reproducible form.

Project-Specific Mapping

The color infrared aerial photography should be acquired at scales of 1:12,000 or 1:24,000 for each of the restoration projects. Acquisition should be accomplished through a contract with an aerial photographic that uses a 9 inch by 9 inch format camera to provide stereo coverage of each restoration site. The contractor should simultaneously acquire vertical airborne video tape for each site. The photography and video tape should be acquired within a late September to December window for each year from 1992 to 1994, and every third year thereafter. The aerial photography should be acquired for all projects within a basin for each flight. Each flight should avoid high water or high tide conditions.

The aerial photography should be interpreted for wetlands according to the Cowardin et al. (1979) classification system. Uplands within each project should be classified according to the Anderson et al. (1976) upland classification system as modified by L.R. Handley. The photointerpretation process involves the stereoscopic identification of various wetland and upland signatures. These signatures should be delineated by using a 6 x 0-size technical drafting pen and labeled according to the applicable classification system and mapping conventions. Where necessary, the classification system should be modified to fit the needs of these specific restoration projects. For example, because of the large scale of photography being interpreted (1:12,000) for some of the projects, the minimum mapping unit should be decreased to 0.1 acre. The modified mapping unit may also describe additional factors (e.g., salinity, species, density of coverage) if the information is available from the other monitoring subgroups.

Once the photointerpretation process has been completed, the interpreted photographs should be groundtruthed and any corrections should be made. The photographs should then be reviewed for quality control. Here the delineations and interpretations should be checked for positional and thematic accuracy and consistency. The delineations should then be transferred to an overlay placed on a 1:12,000 or 1:24,000 topographic base map. The 1:12,000 scale base maps should be prepared by either photographically enlarging a quarter of a USGS topographic base map or by manipulating the digital data for USGS topographic maps that may be available for some of the quadrangles to the desired scale. Each new 1:12,000 base map will then represent 1/4 of a 1:24,000 USGS topographic quadrangle. The delineations made on the 1:12,000 scale or 1:24,000 scale photography should then be transferred to the base maps by using a zoom transfer scope. The drafted map should be taken to the field for review, and copies distributed for review and comment. Final map production would come after all review comments were incorporated. A large-scale review should follow. In this step the final quality control is performed. All interpretation and mapping should follow the reporting and documentation process developed by NWI.

Deliverables of the mapping project should be paper copies of the maps drafted at 1:6,000, 1:12,000, and 1:24,000 scales. The aerial photography should be available for viewing and for copying on a cost reimbursable basis.

Final habitat maps should be digitized for selected restoration projects. It may not be feasible to digitize each project for each year. The restoration projects to be digitized should be determined on reviewing the draft maps to evaluate the extent of change that has taken place. Digitization should be done using the Analytical Mapping System (AMS) on a UNIX workstation. The AMS digital data should be available in DLG-3 format for use on ArcInfo, Integraph, Infocad, etc. Deliverables will be the digital data on standard tape format and acreage summaries for each quad.

GIS should be used to analyze the digitized habitat maps for the purpose of developing wetland trend maps to identify areas of wetland loss and gain occurring within restoration plans over time. Digital data, wetland trend maps, and reporting data (landcover and wetland trend acreage tables) should be available for use on a cost reimbursable basis.

VII. PROJECT TYPES

Project Ranking

Because the mapping program is providing a supporting role, projects are not ranked by the habitat mapping subgroup but should follow the consensus ranking of the other subgroups to do the project-specific mapping.

Proposed Mapping Scale for Each Project Type

Project	Acreage	Scale
Fourchon	2,300 acres	1:12,000
Gulf Intracoastal waterway to Clovelly wetland	60,000 acres	1:24,000
Cameron-Creole watershed	64,000 acres	1:24,000
Bayou Sauvage National Wildlife Refuge	6,000 acres	1:12,000
Turtle Cove shoreline	1,000 acres	1:12,000
Sabine National Wildlife Refuge	13,000 acres	1:12,000
Vegetative plantings		
West Hackberry	> 100 acres	1:6,000
Dewitt-Rollover Gulf	< 100 acres	1:6,000
Falgout Canal shoreline	> 100 acres	1:6,000
Timbalier Island	> 100 acres	1:6,000
West Bay sediment diversion	9,800 acres	1:12,000
Barataria Bay waterway	1,000 acres	1:12,000
Lower Bayou LaCache	4,200 acres	1:12,000
LaBranche wetlands	300 acres	1:12,000
Cameron Prairie	640 acres	1:12,000
Vermilion River cutoff	200 acres	1:12,000
Eastern Isles Dernieres	100 acres	1:6,000
GIWW to U.S. 90	40,000 acres	1:24,000
Tiger Pass marsh	415 acres	1:12,000
Falgout Canal South wetland	220 acres	1:6,000
Lake Salvador shoreline	> 100 acres	1:6,000

1) Projects added in future years should be mapped at scales according to the following guidelines:

Average	Scale
Under 200 acres	1:6,000
200 acres to 20,000 acres	1:12,000
Over 20,000 acres	1:24,000

2) Although the general procedure proposed is to obtain aerial photography for each project for each of the first 3 years and then every third year thereafter, it is the general consensus of the mapping subgroup that this be considered on a case-by-case basis because projects may show significant changes that should be monitored frequently.

Estimated Project Cost	1993	1994	1995
Project-Specific Mapping			
Photointerpreter(s)	$39,000	$79,000	$82,000
Cartographic technician(s)	$55,000	$58,000	$61,000
Geographer	$20,000	$20,000	$20,000
	$114,000	$157,000	$163,000
Photography	$24,000	$30,000	$35,000
Historical photography	$9,000	$4,000	$0
Supplies	$18,000	$12,000	$10,000
Materials (horizontal control)	$8,000	$4,000	$4,000
Travel	$2,000	$4,000	$4,000
Equipment	$106,000	$7,000	$0
	$167,000	$61,000	$53,000
Total cost	$281,000	$218,000	$216,000
Basin-level mapping			
TM scenes	$16,000	$20,000	$0
Geographer (classification)	$10,000	$36,000	$36,000
Total cost	$26,000	$56,000	$36,000
Digitizing selected project-specific maps	$18,000	$38,000	$38,000
GIS analysis of digital data from project-specific maps	$16,000	$36,000	$38,000

VIII. PEER REVIEWERS

Pat O'Neil	U.S. Geological Survey
Melvin Fuhrmann	U.S. Fish and Wildlife Service
James Gosselink	Louisiana State University
Carol Clark	Louisiana Department of Natural Resources
Nancy Powell	U.S. Army Corps of Engineers
Paul Kemp	Coalition to Restore Coastal Louisiana
Edward Hickey	U.S. Soil Conservation Service
James Johnston	U.S. Fish and Wildlife Service
John Barras	U.S. Fish and Wildlife Service

I. TITLE: WILDLIFE MONITORING ON COASTAL WETLANDS PLANNING, PROTECTION, AND RESTORATION ACT PROJECTS IN COASTAL LOUISIANA

II. AUTHORS:

Prepared by: Gerry Bodin and Carroll L. Cordes
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III. ACKNOWLEDGMENTS:

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IV. INTRODUCTION

The wildlife monitoring subgroup of the CWPPRA Monitoring Work Group examined the feasibility of developing wildlife monitoring protocols and analyses to determine the success of a wide range of wetland restoration projects planned for coastal Louisiana. The CWPPRA defines a restoration project as a technically feasible activity to create, restore, protect, or enhance coastal wetlands.

V. GENERAL DISCUSSION

The wildlife monitoring subgroup supports a monitoring program to evaluate the success of prescribed restoration projects in maintaining long-term wetland protection and conservation. The subgroup stressed the importance of selecting monitoring variables that are expected to show a direct (cause and effect) response to project design and actions. The subgroup determined that, since wildlife populations are influenced and controlled not only by local or basin-wide wetland conditions, but also by external factors, monitoring wildlife would be neither biologically sound nor cost-effective in evaluating project success. Several subgroup members pointed out that wildlife populations fluctuate greatly over time and space, and establishing statistically valid relationships between project features, wetland responses, and wildlife populations would be very difficult. For these reasons the wildlife monitoring subgroup recommends not developing a detailed, project-specific wildlife monitoring program.

The wildlife monitoring subgroup recognized that populations of herbivorous species such as the nutria (*Myocastor coypus*) and muskrat (*Ondatra zibethicus*) may have a significant effect on the rate of recovery of coastal wetland plant communities. The subgroup felt, however, the herbivory issue could best be addressed by the vegetative health monitoring subgroup.

The wildlife monitoring subgroup identified wildlife surveys conducted by the Louisiana Department of Wildlife and Fisheries (LDWF) and the U.S. Fish and Wildlife Service (USFWS) as having limited value for use in evaluating the success of specific coastal wetland creation and restoration projects. Both agencies collect annual records of waterfowl abundance and distribution within the Louisiana coastal zone, and the LDWF conducts inventories of fishery abundance and American alligator (*Alligator mississippiensis*) populations. The LDWF also periodically surveys colonial waterbird populations in Louisiana's coastal zone. The subgroup felt that some of these wildlife data bases, especially that for the alligator, may provide a valuable general index of the status and trends of wildlife populations across the Louisiana coast where wetland creation and restoration projects are underway. These data sets are, however, not considered to be adequate for use in evaluating the success of specific projects in achieving long-term wetland conservation.

VI. METHODOLOGY

The wildlife monitoring subgroup recommends that current and ongoing LDWF and USFWS surveys be used, where needed, as secondary data sets for examining correlations between wetland changes, wildlife abundance, and distribution problems. When used in conjunction with more quantitative monitoring data for water quality, vegetation, etc., these wildlife data bases may have value in confirming over a broad scale (i.e., entire Louisiana coast) what basin-specific monitoring data show for more localized areas.

Methodologies used by the LDWF and by the USFWS for wildlife surveys are either transect-based or are based on observations made on known wildlife concentration areas.

I. TITLE: ASSESSMENT OF CWPPRA PROJECT IMPACTS ON FISHERY RESOURCES

II. AUTHORS:

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We would like to thank Greg Steyer, Barton Rogers, Anna Shaughnessy, Geoffrey Matthews, Rick Hartman, Warren Stuntz, Jeanene Peckham, and Sammy Ray for their assistance in the development of this plan.

IV. INTRODUCTION

Most coastal habitats being lost in Louisiana are valuable in sustaining fishery productivity. Inherent in the goals of the CWPPRA is the idea that projects will be beneficial to coastal fisheries. However, this objective must be considered within the context of the entire program; some projects may benefit fisheries at the expense of other natural resources, and some benefits to fishery resources may not be realized for many years. Determining whether CWPPRA projects have benefited fishery resources will require assessments of impacts after these projects are initiated. The objective of this monitoring plan, therefore, is to provide scientifically defensible data for determining whether CWPPRA projects have had major impacts (either positive or negative) on fishery resources in coastal Louisiana.

All CWPPRA projects have the potential for impacts on fishery resources. Decisions as to the types of projects that should be monitored, however, should be based on the likelihood of these impacts, the time frame of expected impacts, and the difficulty in assessment of impacts.

V. GENERAL DISCUSSION

Variables to be Measured

Ideally, impacts of CWPPRA projects should be assessed by measuring fishery production from a project area. Realistically, however, the effort required to measure productivity is prohibitive, and measures of standing stock must be used as an indicator of fishery value in an area. Each project is likely to have a different assemblage of ecologically important species. These will include the following species of commercial, recreational, and food-chain importance: white shrimp, brown shrimp, grass shrimp, blue crab, stone crab, spotted seatrout, southern flounder, gulf menhaden, spot, Atlantic croaker, red drum, oysters, striped mullet, bay anchovy, and black drum. Other resident forage species may also be abundant, and certain freshwater species may be important in some projects. Most of these species can be sampled with similar gears and sampling designs. Because oysters are sedentary, however, different sampling techniques will be required for this species; monitoring for oysters can also include measures of recruitment, growth, and survival.

Juveniles and small adults (generally less than 100-mm total length [TL]) of the fishes and crustaceans should be targeted for sampling. Because the habitats being modified are usually nursery grounds for the young, juvenile stages are more abundant, making population sizes easier to estimate. Moreover, the best methods have been developed to quantitatively sample these small animals. Large juveniles and adults of these target species, if they are present in the area, will be extremely difficult to sample quantitatively. In addition, abundance measures for older juveniles and adults are subject to greater variances and may not reflect habitat value if populations are reduced by local fishing pressure.

The primary variables to be measured for juvenile fishes and crustaceans should be density (number of animals per area of bottom), size, and biomass. The number of species (species richness) collected within some standardized area should also be recorded. In certain instances, catch in standard gear (such as trawls and seines) may be measured rather than animal density. Catch per standard unit of effort can be useful in assessing relative abundance and species composition, but these data must be interpreted with caution because of the instability in catch efficiency (see Gear Selection).

Important Fishery Habitats

Different coastal habitats support different numbers and species of fishery organisms, and sampling efforts should be stratified within a project area by habitat. Examples of habitats include unvegetated sand or mud bottom, submerged aquatic vegetation, emergent vegetation, organic detrital bottom (coffee grounds), oyster reefs, and channels.

An assessment of relative area for each of these habitats will be necessary to determine sampling strata. Shallow unvegetated bottom is expected to be most common and must be sampled. Submerged aquatic vegetation and emergent shoreline vegetation are known to support high densities of juvenile fishery species and will also need to be sampled if present. Emergent vegetation may be omitted from the sampling program only if sampling can be conducted at low water levels (see section on water level). Sampling crustaceans will probably not be practical on bottoms with large amounts of organic detrital matter (coffee grounds) or on oyster reefs because quantitative sampling of these habitats is prohibitively labor and cost intensive. Combining solid-walled throw traps with the use of rotenone, however, could allow sampling of fishes in these habitats. Although deepwater channel habitats may be important for some animals, most juvenile fishery species are likely to be more abundant in shallow-water habitats. Shallow channels such as marsh creeks may be important habitats to sample.

In some situations, sampling of zones within habitats may be appropriate. For example, high-elevation intertidal wetlands have been shown to support different animal densities and species than low-elevation wetlands. Also, open-water habitats near access structures probably differ from areas further from these structures.

Gear Selection

Gear catch efficiency is a major problem that must be addressed in the selection of sampling gear for CWPPRA projects. Commonly used gear such as trawls and seines, which use the area-sweep method to estimate animal densities, usually have low catch efficiencies. If these efficiencies were stable, appropriate corrections could be made to estimate animal density. Unfortunately, these efficiencies also appear to be highly variable. For example, otter trawls are generally recognized as being selective in the sizes and species of animals caught. This gear catches some unknown percentage (the gear catch efficiency) of the animals present in any given area swept. Catch efficiency varies with net mesh size and with the species and size of the target animals. For small brown shrimp, catch efficiencies of 17.5-52.9% (Loesch 1976), 17% (Zimmerman et al. 1986), and 49% (Minello et al. 1991) have been measured. Catch efficiencies for spot (6%), Atlantic croaker (26%), and anchovies (7%) have also been reported (Loesch 1976; Minello et al. 1991).

A related and more insidious problem is that catch efficiency probably varies with habitat and environmental characteristics, and often these characteristics are related to the treatments being measured in a sampling design. Unless this bias is corrected, site differences attributed to a project may simply be a reflection of a systematic shift in gear efficiency. It has been shown that differences in turbidity affect the catch efficiency of trawls for small fish (Nielson 1983). Vegetation, unconsolidated bottom (coffee grounds), uneven bottom topography, sediment texture, and even temperature are also likely to affect this catch efficiency. Juvenile shrimp often avoid capture in nets because they are burrowed into the substrate, thus all the environmental factors that affect shrimp burrowing (incident light, turbidity, substrate type, predators, hunger level) are candidates for affecting catch efficiency of shrimp. Thus, to make legitimate comparisons among sampling sites and habitats by using catch from sampling gear with low catch efficiencies, researchers must adjust abundance estimates to correct for site-related differences in gear catch efficiency. These corrections could be made for each sampling site and habitat combination by making limited comparisons with gear known to have a high catch efficiency in that habitat.

The confounding problem of variables affecting both animal density and gear efficiency can be avoided if the catch efficiency of the sampling gear is very high. Enclosure devices, such as throw traps or drop samplers (Kushlan 1981; Zimmerman et al. 1984), appear to have high catch efficiencies that do not vary substantially in the presence of vegetation (Zimmerman et al. 1986). In addition, recovery efficiency (a major component of catch efficiency) can be easily measured for these samplers through simple tagging procedures after the sampler has been deployed. The area sampled with throw traps is generally smaller than the area sampled with other types of gear such as seines and trawls, but increasing the sample number can generally compensate for this limitation. Drop enclosures are also limited to water depths less than 4-6 ft, but water depth will probably be shallow for most habitats to be sampled in CWPPRA projects.

In some limited situations, trawls and seines may be useful in monitoring fishery abundance at CWPPRA project areas. These gear can be deployed in deeper water, sample larger areas, and provide data that is more comparable with historical data bases. Trawls and seines also have the advantage of being relatively easy to use, and they are more familiar to people conducting monitoring; they are often preferred by state research agencies. In general use, however, these gear are often only appropriate for measuring the presence or absence of species in an area. Abundances cannot be accurately measured in habitats where emergent or submerged vegetation is present; thus comparisons among habitats are not possible. Trawls and seines can provide semi-quantitative (moderately stable catch efficiency) abundance samples of non-burrowing animals in nonvegetated habitats. These data can be useful in making comparisons among nonvegetated areas if environmental factors that affect catch efficiency (such as turbidity and bottom type) are examined as potential causes of bias.

Monitoring Costs

The fishery monitoring subgroup has attempted to address the problem of limited monitoring funds in several ways:

1) By restricting the types of projects that require fishery monitoring.

2) By emphasizing monitoring mainly of juvenile fishes and crustacea that occur in greater numbers and are more readily sampled.

3) By limiting assessment of impacts to more easily measured variables such as standing crop, size, and species richness rather than attempting to measure productivity. Productivity estimates (growth, survival, recruitment) are only recommended for oysters.

4) By limiting the recommended temporal replication of sampling efforts.

The following prioritized list (one being most important) of sampling procedures should be used to reduce sampling effort and cost:

1. Collect high quality samples to accurately measure animal density.
2. Select appropriate controls.
3. Collect sufficient sample numbers at any one time for rigorous hypothesis testing.
4. Sample all dominant habitats.
5. Collect samples during biologically different times of year (early spring, late spring, fall).
6. Collect samples in successive years following project implementation.
7. Collect samples every 2 months during a year.

Procedures 1-3 in this list are mandatory, and procedures 1-5 are probably necessary to provide a scientifically sound assessment of project impacts.

The projected cost of assessing impacts on fishery resources depends upon the size of the project areas, the number of important fishery habitats present, and the variability of the measured variables (this determines sample size). Following the procedures outlined in this document, a cost of approximately $150-$200 per throw-trap sample might be expected.

The Water Level Problem

The effect of water-level fluctuations must be considered in estimating the abundance of fishery organisms (see Figure 2). Most fishery species require water and are associated with the bottom in some manner. Changing of water levels at a site, either from tidal fluctuations, water-level control structures, or alterations in freshwater inflow can drastically alter density estimates of animals. As an example, the rising tide in many coastal areas can easily cause a two-fold difference in the amount of bottom area flooded in a basin. This doubles the area of bottom available for animals, and if the animals are distributed evenly over the bottom, this tidal flooding will reduce the density of animals by half. If water level is not considered in comparing density estimates among sites or over time, spatial and temporal differences in animal abundance will be indistinguishable from density changes caused by this water-level effect. This concentrating factor at low water levels is often ignored in sampling designs. To further complicate this situation, many animals such as brown shrimp, blue crab, and spotted seatrout are attracted to shoreline emergent vegetation when it is available at high water levels (Zimmerman and Minello 1984). If sampling efforts are concentrated in the adjacent open-water habitats, density estimates for these organisms will increase dramatically as water levels drop and animals are forced out of the shoreline vegetation.

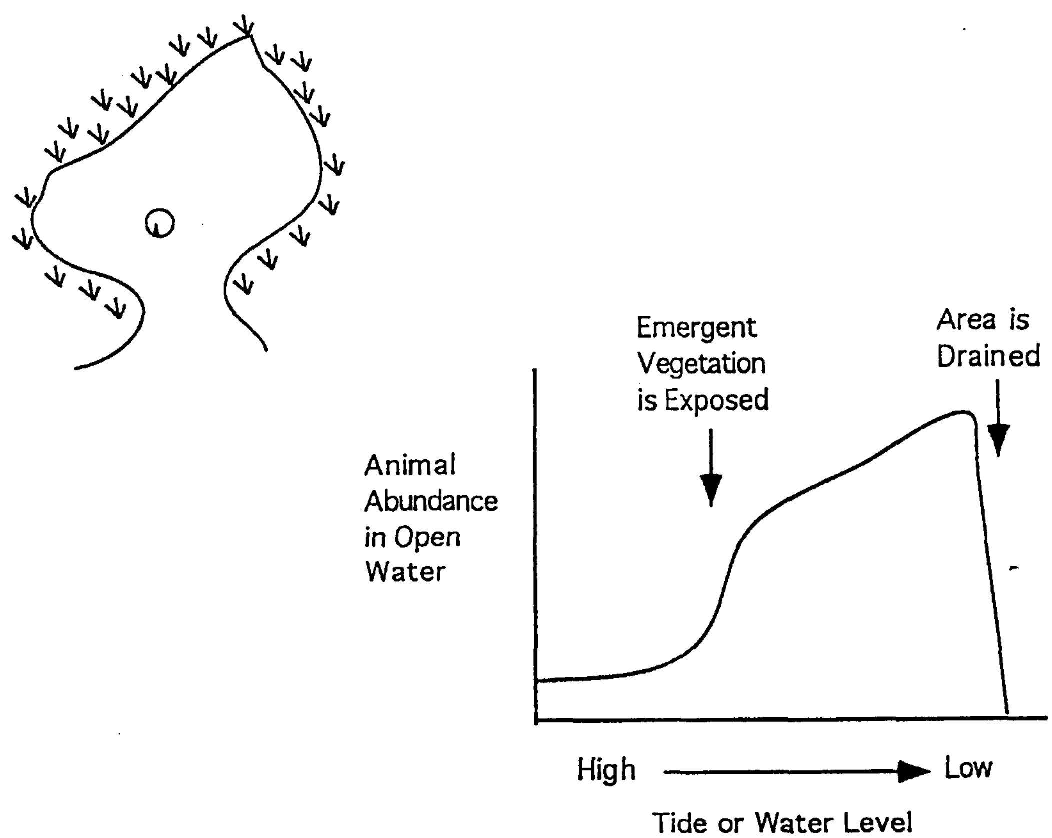

Figure 2. Hypothetical relationship between water level and abundance estimates in a marsh pond.

The most realistic picture of habitat use at a site would require sampling at all water levels in proportion to the time these water levels occur in the sampling area. This approach, however, would increase sample variances and result in unrealistic effort required to detect project impacts. The practical solution to this sampling problem is to sample both the control and project areas at similar water levels. Low-water sampling may be most desirable because it can eliminate the need to sample shoreline habitats (flooded vegetation) and will result in higher open-water densities. However, many locations are inaccessible at low tide except with air boats. In situations where water levels are being controlled as part of the project, sampling study and control areas at similar water levels should still be possible by carefully selecting sampling periods. If water level differences between project and control areas are persistent, all flooded habitats must be sampled, and differences in water levels and area flooded must be considered in interpreting the data.

Common Data

Availability of comprehensive water-quality data (temperature, salinity, dissolved oxygen, turbidity, water level) at the project and control areas will be essential in interpreting sampling results. These variables should also be measured every time a fishery sample is collected. In addition, estimates of coverage for different fishery habitats within project and control areas will be essential for fishery monitoring.

Ongoing Programs

The Marine Fisheries Division of the Louisiana Department of Wildlife and Fisheries monitors fishery species using a variety of equipment at stations in six coastal study areas of Louisiana. Samples are collected with plankton nets, 16-ft trawls, 6-ft trawls, seines, gill nets, and trammel nets. Oysters are sampled with Butler plates, a square-meter frame, and with an oyster dredge. The frequency of sampling and sampling locations are identified in a draft manual of their field procedures on file with the monitoring work group.

VI. METHODOLOGY

Sampling

Density of abundant juvenile and small adult fishes and crustaceans

1) Juveniles and small adults (generally less than 100-mm TL) should be targeted, and the density of animals per square meter of bottom area should be measured. In conjunction with this variable, the size of the organisms, the biomass of dominant species, and the number of species (species richness) collected within some standardized area should also be measured.

2) Throw traps similar to those described by Kushlan (1981) are recommended as sampling gear. The advantages are high catch efficiency in most shallow-water habitats; area sampled is fixed and known; easy and inexpensive to construct; easily deployed from an air boat; and recovery efficiency is measurable. The disadvantages are the area sampled is small, and large and highly motile organisms may avoid the sampler, especially in very clear water. A rough cost estimate that includes all overhead, personnel, and equipment costs would be approximately $150-$200 per sample.

3) Measuring density over time - density should optimally be measured every 2 months following project implementation. Minimally, samples should be collected in early spring, late spring, and fall.

4) Measuring density over space - spatial coverage and number of samples should be determined by the number of sampling zones identified and the variance among samples.

5) Other prioritized protocol (gear and procedures)

   a) Use of small-meshed seine to completely encircle a known area of shoreline habitat. This technique would have the advantage of sampling a larger area, thus reducing between-sample variability and providing a better estimate of abundance for low-density organisms. The technique could be used in deeper water and on all types of nonvegetated bottom, and recovery of enclosed animals could be measured with simple marking techniques. This seining technique, however, will not work well in vegetation, and sampling is restricted to areas where a suitable bank is present to "haul up" the catch and there are few obstructions (such as oysters, rocks, tires, etc.). Additional disadvantages include the possible enclosure of heterogenous bottom and the severe under-sampling of burrowed and bottom-hiding organisms. The cost per sample for this technique will be substantially higher than for throw traps, but the number of samples required for statistically valid comparisons will be significantly lower. Thus, overall project costs between these two gear types might be similar. The major reason this technique is not generally recommended is that sampling would have to be restricted to only certain nonvegetated habitats.

   b) Use of a beam-trawl. This gear is often used to collect small shrimp and fishes and has a relatively high catch efficiency for shrimp on nonvegetated bottom (Zimmerman et al. 1986). As with a seine, the beam trawl can be used in deeper water and samples can cover larger areas of bottom, thus reducing between-sample variability. This gear, however, is not restricted by access to the shoreline; samples can therefore be randomly distributed within an area. Disadvantages include restriction to sampling on nonvegetated bottom, and even here variability in catch efficiency may be related to environmental factors. The cost of a beam-trawl sample will probably be similar to a throw-trap sample, but the number of samples required in the sampling program will probably be reduced.

Oyster growth and survival

1) A standard set of small oysters will be used to measure growth and survival.

2) Nestier trays containing 20-25 oysters will be placed at selected sites within the study and control areas for the measurement of growth and survival. The advantage of this technique is that the initial size and number of oysters is known, commercial harvesting will not affect measurements, and permission to sample private leases is not required. Disadvantages include problems with vandalism of trays, and measurements of survival and growth in these trays may not exactly reflect survival and growth on reefs. Nestier trays are available for a negligible cost from biological supply houses. The trays are easy to deploy and retrieve, and two people could deploy or "read" dozens of trays in one day. Thus, the major expense will be salaries of personnel.

3) Measurements over time - trays will be monitored quarterly for oyster growth and survival. Trays and oysters will be replaced annually in January.

4) Measurements over space - spatial coverage and number of samples will be determined by the number of sampling zones identified and the variance among samples. Sampling zones will be different for oysters than for fish and crustaceans.

Oyster settlement and early survival

1) The number of oyster spat settling and surviving on a defined area will be used as an indicator of recruitment success.

2) Butler plates will be deployed in conjunction with the Nestier trays.

3) Measurements over time - plates will be replaced quarterly when Nestier trays are surveyed, and the number of spat will be recorded in the laboratory.

4) Measurements over space - spatial coverage and number of samples will be the same as for Nestier trays.

VII. PROJECT TYPES REQUIRING MONITORING

All CWPPRA projects have the potential for positive or negative impacts on fishery resources. Decisions as to the types of projects that should be monitored, however, should be based on the likelihood of these impacts, the time frame of expected impacts, and the difficulty in assessment of impacts. Project types have been grouped into the following categories:

Projects that definitely require impact assessment:
- Hydrological restoration
- Freshwater diversion
- Marsh management

Projects that require limited assessment (selected projects):
- Sediment diversion
- Beneficial uses of dredged material (including terracing)
- Sediment and nutrient trapping

Projects where assessment is unlikely to provide valuable information:
- Vegetative plantings
- Barrier island restoration
- Shoreline protection

VIII. HISTORICAL DATA

The Louisiana Department of Wildlife and Fisheries (LDWF) collects fishery samples at numerous stations throughout coastal Louisiana. The Field Procedures Manual, on file with the monitoring work group, identifies station locations and summarizes the variables being estimated, frequency of collection, and gear types in use.

Data collected in the LDWF fishery monitoring program are valuable in determining long-term trends and general abundance patterns of fishery species. In a broad-scale sampling program, variability in gear catch efficiency is more likely to simply increase variability among samples rather than cause biased estimates. In addition, the wide variety of gear types in use (each with its own specific catch efficiency characteristics), makes it unlikely that all samples will be biased in the same direction. In contrast to the large-scale sampling program of LDWF, sampling for CWPPRA projects must be designed on a smaller scale with specific hypotheses to be tested, and samples must be comparable in a variety of shallow-water habitats.

Therefore, the LDWF data base will be most useful in determining long-term fishery trends and assessing the comparability of control and project areas. In addition, these data should be valuable in assessing whether the overall abundance of fishery species for one specific year is abnormally high or low. This information will be important in comparisons of project area results before and after project implementation.

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LOUISIANA COASTAL WETLANDS RESTORATION PLAN

Studies, Plans, Programs and Existing Projects

Exhibit 6

Louisiana Coastal Wetlands Restoration Plan

EXHIBIT 6

Studies, Plans, Programs, and Existing Projects

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STUDIES, PLANS, PROGRAMS, AND EXISTING PROJECTS

A number of studies and reports on water resources development in coastal Louisiana have been prepared by the U. S. Army Corps of Engineers (USACE), the Environmental Protection Agency (EPA), the U. S. Fish and Wildlife Service (USFWS), the Soil Conservation Service (SCS), the National Marine Fisheries Service (NMFS), other federal agencies, the state of Louisiana (Louisiana Department of Natural Resources, LDNR), and local agencies, research institutes, and individuals. The information was used to identify historical trends and existing conditions in the Louisiana coastal zone, to obtain insight for projecting future conditions, and to assist in identifying problems. The more relevant studies, reports, and projects are summarized in the following paragraphs.

STUDIES, PLANS AND PROGRAMS

Department of the Army, U.S. Army Corps of Engineers.

A USACE report entitled *Flood Control, Mississippi River and Tributaries,* published as House Document No. 90, 70th Congress, 1st Session, submitted December 8, 1927, resulted in authorization of a project by the Flood Control Act of May 15, 1928. The project provides comprehensive flood control for the lower Mississippi Valley below Cairo, Illinois, and has had a significant impact on water and land resources in the Louisiana coastal zone. Presently the Mississippi River and Tributaries (MRT) projects includes a combination of features: levees along the main stem of the Mississippi River and its tributaries in the alluvial plain to confine floodflows; reservoirs on the tributaries to store excess flood flows; floodways; and channel improvements to increase channel capacity. Other features include control structures, cutoffs, pumping plants, floodwalls, and floodgates.

Under this authority the Mississippi River levees, which extend to Bohemia, Louisiana, on the east bank and Venice, Louisiana, on the west bank, were constructed. The levee system is essentially complete except in locations where additional work is necessary to bring the levees up to project grade.

Also under this authority, the Atchafalaya Basin Floodway system was developed. An inventory of authorized features in the basin is described herein. The Old River Complex (authorized by the Flood Control Act of September 1954) consists of a low sill structure, an auxiliary structure, an overbank structure and a navigation lock. The complex is designed to pass normal and flood flows from the Mississippi River system and the Red River system through the Atchafalaya Basin. The complex is managed to divert 30 percent of the total latitude flow (the sum of the flows of the Mississippi River at Tarbert Landing and the Atchafalaya River at Simmesport) into the Atchafalaya River. The remaining project features are the Morganza Floodway, the Atchafalaya River, the West Atchafalaya Floodway, and the Lower Atchafalaya Basin Floodway.

A USACE report entitled *Louisiana-Texas Intracoastal Waterway, New Orleans, La. to Corpus Christi, Texas,* was published as House Document No. 230, 76th Congress, lst Session. The report and prior River and Harbor Acts provide for the construction of a 12- by 125-foot channel 384 miles long from the mouth of the Rigolets to the Sabine River. The project was authorized by the River and Harbor Act of 23 July 1942. The main stem of the project was completed in 1944. The River and Harbor Act of 23 October 1962 authorized enlargement of the channel between the Sabine River and Atchafalaya River to 16 feet by 200 feet and between the Atchafalaya River and Mississippi River to 16 feet by 150 feet; however, this modification has never been implemented and the study was terminated and placed on an inactive status in May 1991.

The USACE is currently conducting a feasibility study under the authority of the Gulf Intracoastal Waterway, Louisiana-Texas study which will address the replacement of the locks on the Gulf Intracoastal Waterway (GIWW) system west of the Mississippi River. The preliminary results of the reconnaissance study indicated that the most immediate needs for capacity increases are at Bayou Sorrel and Calcasieu Locks. Also, a future need for capacity increases at Port Allen and Algiers Locks was indicated. The feasibility phase study will be initiated upon approval of the reconnaissance study. The reconnaissance report was certified in February 1993.

The USACE prepared a reconnaissance report on the authority of the Louisiana Coastal Area Study entitled *Louisiana Comprehensive Coastal Wetlands Study* in June 1990. The report developed a detailed scope of study which was a blueprint for the development of a comprehensive wetlands plan to address Louisiana's coastal wetlands loss problem. The study blueprint called for the Corps of Engineers and the State of Louisiana to do the bulk of the work. An interagency planning team and four interagency technical working groups would assist and guide the Corps and the State in formulating alternatives, reviewing and analyzing information, and screening alternatives. The interagency participation and coordination would assure that a comprehensive plan would result from the study. The study was not funded and is currently inactive.

A USACE report entitled *New Orleans-Baton Rouge Metropolitan Area, Louisiana* was completed in 1981. The report contains a comprehensive plan for development and conservation of water and related land resources in a 21-parish area. The report includes 13 parishes in the current study area.

The USACE prepared an initial evaluation report, *Louisiana Coastal Area, Louisiana Water Supply* in September 1984. This study investigated the advisability of improvements or modification, in the interest of water supply, of existing improvements in the coastal area of Louisiana. The report recommended that 5 of the 6 problem areas found be further investigated in the cost-shared feasibility phase of the study. Currently the study is inactive due to lack of a local cost-sharing agreement.

The USACE prepared an initial evaluation report entitled *Louisiana Coastal Area, Louisiana, Shore and Barrier Island Erosion Study* in September 1984. The Shore and Barrier Island Feasibility Study investigated the causes and consequences of the reduction and loss of the barrier islands and adjacent shores to the combined forces of erosion and subsidence. This study found that the barrier islands and barrier beaches of coastal Louisiana are effective barriers against hurricane and storm surges at locations far inland of the barriers; however, no economically justified erosion abatement plans were identified. This study is currently inactive.

A USACE report entitled *Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana,* was published as House Document No 215, 76th Congress, lst Session. The report recommended a navigation channel 35 to 40 feet deep by 800 to 1,000 feet wide. Construction of the channel was completed in 1963. The General Design Memorandum Supplement No. 2, dated April 1984, provides for the restoration of deteriorated bank lines below Venice and Southwest Pass with rock foreshore dikes and hydraulic fill to reduce shoaling. Shoal material not needed for bank restoration would be used to create marsh.

A USACE report entitled *Deep-Draft Access to the Ports of New Orleans and Baton Rouge, Louisiana,* was completed in 1981. The report recommended deepening the Mississippi River to a project depth of 55 feet from the Gulf of Mexico to the Ports of New Orleans and Baton Rouge. Dredged material would be placed in subsiding areas east and west of the river below Venice to create 11,600 acres of marsh over a 50-year period. The project was authorized by the 1985 Supplemental Appropriations Act, dated 2 July 1985, and the Water Resources Development Act of 1986, dated 17 November 1986. Construction of Phase I of the project, a 45-foot channel to mile 181 Above Head of Passes (A.H.P.), was completed in December 1988.

A USACE report entitled *Mississippi River-Gulf Outlet,* was published as House Document No. 245, 82nd Congress, lst Session. The report recommended an additional outlet, a 36- by 500-foot channel 76 miles long from New Orleans to the Gulf of Mexico. The improvements were authorized by the River and Harbor Act of 29 March 1956. Construction was completed in July 1963.

The USACE published the reconnaissance report *Mississippi River-Gulf Outlet, St. Bernard Parish, Louisiana (Bank Erosion)* in February 1988. The report assessed navigation channel shoaling, marsh loss, and other erosion-related problems along the Mississippi River-Gulf Outlet. Initial evaluation determined that erosion abatement measures could not be economically justified. The report is currently being reevaluated to justify the erosion control methods based on the intangible value of the wetlands protected. The report is scheduled for completion in February 1994.

The USACE prepared an initial evaluation report *Louisiana Coastal Area, Louisiana, Land Loss and Marsh Creation* in November 1984. The report recommended proceeding into the feasibility phase. The feasibility phase of this study, which is underway now, is investigating methods of creating vegetated wetlands to protect and enhance existing wetland habitat, and to preserve, to the maximum extent practical, the inherent functions of wetlands in the coastal area of Louisiana in the interest of preventing land loss and creating marsh. The feasibility study is limited to St. Bernard, Plaquemines, and Jefferson Parishes.

The USACE conducted a reconnaissance study under the Louisiana-Coastal Authority entitled *Mississippi River Delta Study* in February 1990. The purpose of this study was to determine the feasibility of realigning the lower Mississippi River navigation channel to increase the river's marsh-building capacity. The general study finding was that there are no economically justified alternatives for realigning the Mississippi River navigation channel.

The USACE prepared a feasibility report, *Louisiana Coastal Area, Freshwater Diversion to Barataria and Breton Sound Basins,* in September 1984. The report recommended diverting water from the Mississippi River at two locations near the City of New Orleans to enhance habitat and improve fish and wildlife resources. Diversions were recommended near Caernarvon, Louisiana, into the Breton Sound Basin, and near Davis Pond, Louisiana, into the Barataria Basin. The report also recommended that the plan be implemented under the authorized Mississippi Delta Region Project, which is identical in purpose.

These diversions are predicted to prevent the loss of about 99,000 acres of marsh during the 50-year projects. The Caernarvon structure was completed in February 1991. The Davis Pond structure is currently in the detailed design phase. Construction of the Davis Pond structure is scheduled to begin in March 1994, and is scheduled for completion in August 2997.

A USACE feasibility report entitled *Mississippi and Louisiana Estuarine Areas* was completed in 1984. The report recommended the diversion of Mississippi River water into the Lake Pontchartrain Basin and Mississippi Sound to enhance habitat conditions and improve fish and wildlife resources. The project was authorized by the Water Resources Development Act of 1988. The Preconstruction Engineering and Design phase was initiated in fiscal year 1984. Construction could begin in March 1994, and is scheduled for completion by June 1998.

A USACE report entitled *Barataria Bay, Louisiana* was published as House Document No. 82, 85th Congress, lst Session. The project provides for a 12- by 125-foot channel approximately 37 miles long from the Gulf Intracoastal Waterway (GIWW) to Grand Isle, Louisiana. These improvements were authorized by the River and Harbor Act of 3 July 1958. All work was completed in December 1967.

The USACE prepared an reconnaissance report, *Louisiana Coastal Area, Hurricane Protection,* which investigated hurricane induced surges associated with the anticipated future losses of coastal wetlands and barrier islands in the coastal zone of Louisiana. The report recommended that the study proceed into the cost shared feasibility phase for an area of St. Charles Parish on the west bank of the Mississippi River. The report was certified in March 1989. The feasibility study was initiated in March 1990. The local sponsor notified the USACE that they would not continue to participate in the cost shared study in January 1991; consequently, the study was terminated.

A USACE report entitled *Lake Pontchartrain, Louisiana and Vicinity* authorized, under the Flood Control Act of 1965 and by the Water Resources Development Act of 1974, hurricane protection for a portion of the metropolitan New Orleans area on the east bank of the Mississippi River. The plan called for construction of barriers at the entrance to Lake Pontchartrain. In December 1977, a Federal court injunction stopped construction of portions of the authorized project until a new Environmental Impact Statement could be prepared. A reevaluation study, dated July 1984, recommended construction of the Lake Pontchartrain High Level Plan and the Chalmette Area Plan. The plans consist of raising existing levees and constructing new levees, with no barriers at the entrance to Lake Pontchartrain. Construction of the project is ongoing.

A USACE report entitled *New Orleans to Venice, Louisiana, Hurricane Protection* was published as House Document No. 550, 87th Congress, 2nd Session. The project provides hurricane protection to developed areas in Plaquemines Parish along the Mississippi River. The locally constructed back levee from City Price to Venice on the west bank would be enlarged and the existing levee from Phoenix to Bohemia on the east bank would be brought up to grade. The General Design Memorandum Supplement No. 5, dated October 1983, provides for the creation of 297 acres of marsh in the Delta-Breton National Wildlife Refuge as mitigation for marsh loss caused by the levees. The project is approximately 53 percent complete and construction along all five reaches is scheduled to be completed in September 2013.

The USACE published the *Grand Isle and Vicinity (Larose to Vicinity of Golden Meadow), General Design Memorandum* in May 1972. The Larose to Golden Meadow Hurricane Protection Project was authorized by Public Law 298, 89th Congress, 1st Session, approved October 27, 1965. The project provides protection against hurricane surge flooding with a levee loop approximately 43 miles in length along both banks of Bayou Lafourche at Larose and Golden Meadow. The project includes floodgates in Bayou Lafourche at Larose and Golden Meadow. Construction of the project is continuing.

A USACE report published as House Document 112, Eighty-sixth Congress, first session, titled *Bayou Lafourche and Lafourche-Jump Waterway, Louisiana,* recommended modification of the existing project. The report recommended an auxiliary channel 12-by 125-feet from the Intracoastal Waterway (mile 37.2) generally parallel to and west of Bayou Lafourche along Grand Bayou Blue to Bayou Lafourche below the highway bridge at Leeville, and thence in the bayou to the 12-foot depth contour in the Gulf of Mexico; a channel 9 by 100 feet in Bayou Lafourche from Leeville to the lower limits of Golden Meadow restoring and extending the existing jetties at Belle Pass from the 6- to 12-foot depth if found advisable to reduce maintenance; and dredging a 12- by 125-foot channel from Bayou Lafourche at Leeville through the Southwestern Louisiana Canal to and through Bayou Rigaud (Grand Isle). The dredging between mile -0.3 and mile 13.2 on Bayou Lafourche has been completed; dredging Bayou Lafourche from Leeville to Golden Meadow (9 feet by 100 feet) has been completed, and dredging of Bayou Lafourche Auxiliary Channel will be initiated contingent upon availability of right-of-way and funds.

A USACE report published as House Document 583, Eighty-seventh Congress, second session, titled *Bayous Terrebonne, Petit Caillou, DuLarge, and Connecting Channels, Louisiana, and the Atchafalaya River, Morgan City to the Gulf of Mexico,* contained an evaluation of a 9- by 80-foot channel in Bayou Grand Caillou from the Houma Navigation Canal to the Gulf of Mexico. The study was unfavorable, and no improvements were recommended for Bayou Grand Caillou or other streams under study. Federal maintenance of the Houma Navigation Canal, as constructed by the Terrebonne Parish Police Jury, was recommended in the report and was authorized by Congress in the River and Harbor Act of 1962.

The USACE prepared a feasibility report and EIS, *Atchafalaya Basin Floodway System, Louisiana,* in 1982. The report recommended a plan to satisfy the flood control needs of southern Louisiana and optimize the environmental protection of the Lower Atchafalaya Basin Floodway. In February 1983, the Chief of Engineers recommended further study of the Atchafalaya Bay-Terrebonne marsh complex. This study will analyze backwater flooding problems east of the floodway. The study results will be presented in a reevaluation report. In addition, a delta management study will analyze techniques for managing the developing delta in Atchafalaya Bay that are consistent with USACE navigation and flood control responsibilities. Study results will be included in a feasibility report entitled *Atchafalaya Basin Land and Water Resources, Louisiana.*

A USACE report published as Senate Document Number 93, Seventy-seventh Congress, titled *Bayou Teche, Teche-Vermilion Waterway, and Vermilion River, LA* recommended an 8- by 80-foot channel from Vermilion Bay to the Gulf Intracoastal Waterway; a navigable 9- by 100-foot channel from the Gulf Intracoastal Waterway to the head of navigation at Lafayette for navigation and flood control improvement of the non-navigable channels of Vermilion River and Bayou Fusilier from Lafayette, Louisiana to Bayou Teche; channel enlargement in Bayou Teche from 2 miles below Arnaudville to Port Barre, Louisiana; an increase in pool elevation above Keystone Dam; and construction of suitable control works in Ruth Canal by local interests. All work has been completed. The project was reclassified as an "Operation and Maintenance, General" project under the category "Navigation" in 1956.

A USACE report on the Mermentau River and Tributaries and Gulf Intracoastal Waterway, which was published as Senate Document Number 231 Seventy-ninth Congress, recommended improvement or modifications to existing improvements in the coastal area of Louisiana. The report recommended the construction of a saltwater guard lock (Calcasieu Lock) in the Gulf Intracoastal Waterway; channel enlargement of the Mermentau River below Grand Lake and the construction of a sector gated control structure in the Mermentau River at Catfish Point; channel enlargement and realignment of the Inland Waterway from Vermilion Bay to Grand Lake; construction of a sector gated control structure in the enlarged channel near Schooner Bayou; and enlargement of the North Prong of Schooner Bayou and Schooner Bayou Cut-Off. All work was completed as of 1952.

A USACE report entitled *Calcasieu River and Pass, Louisiana,* was published as House Document No. 436, 86th Congress, 2nd Session. The report and prior River and Harbor Acts authorized a 35- by 250-foot channel 36 miles long from the Lake Charles Harbor and Terminal District (including the Clooney Island Loop) to the Gulf of Mexico. The project was authorized by the River and Harbor Act of 14 July 1960. Work was completed in October 1968.

A USACE report published as House Document 582, Eighty-seventh Congress, second session, titled *Calcasieu River Salt Water Barrier, Louisiana* recommended a salt water barrier structure with five 40-foot tainter gates in a new channel; a parallel channel with a navigation structure and single sector type gate; an earthen closure dam and a woven lumber type revetment. The project modification has been completed.

The USACE, under Section 1135 of the Water Resources Development Act (WRDA) of 1986 and as modified under Section 304 of the WRDA of 1990, is authorized to conduct studies on the operation of USACE water resources projects to determine the need for modification of the project for the purpose of improving the quality of the environment in the public interest. Proposed projects must be feasible, must be consistent with the authorized project purpose, and must emphasize fish and wildlife restoration. Project cost are cost shared 75 percent Federal and 25 percent non-federal. The total Federal cost to any particular project is limited to $3.75 million.

The USACE regulates construction and other work in navigable waterways under Section 10 of the Rivers and Harbors Act of 1899, and has authority over the discharge of dredged or fill material into the "waters of the United States"--a term which includes wetlands and all other aquatic areas--under Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500, the "Clean Water Act"). The Section 404 program is the principal way by which the Federal Government protects wetlands and other aquatic environments. The program's goal is to ensure protection of the aquatic environment while allowing for necessary economic development.

In an effort to ensure adequate disposal areas for dredged material removed during maintenance of Federal navigation projects, the USACE, New Orleans District, develops a Long Term Disposal Plan. As part of this effort, the District evaluates the existing disposal plan and possible alternatives with the objective of developing a more environmentally desirable plan at a reduced, comparable, or justifiably increased cost. The goal is a long-term disposal plan incorporating beneficial use of the dredged material to the maximum extent practicable.

U.S. Department of the Interior (U.S. Fish and Wildlife Service, U.S. Geological Survey, Minerals Management Service, and National Park Service).

The USFWS administers six National Wildlife Refuges encompassing over 264,000 acres; the majority of those lands are coastal wetlands. The USFWS carries out an active program to protect, restore, and enhance those wetlands. Funding for wetland conservation activities is derived from the USFWS's budget; the Sate of Louisiana's Wetland Conservation and Restoration Fund; the North American Wetlands Conservation Act (NAWCA) grants, matched with State and other non-Federal contributions; and private contributions matched by National Fish and Wildlife Foundation grants. An example of wetland restoration on refuge lands with multiple funding sources is the recent and ongoing construction of numerous small scale sediment diversions (crevasses) on the Delta National Wildlife Refuge. The USFWS also requires private and public entities to mitigate the impacts of their activities on refuge lands, including coastal wetlands.

The USFWS also provides leadership in the implementation of the North American Waterfowl Management Plan (NAWMP), a strategy for restoring continental waterfowl populations to levels observed in the 1970's. Joint ventures have been established to help implement the NAWMP in key geographic regions. Coastal Louisiana is a key component of the Gulf Coast Joint Venture. In support of the NAWMP, the USFWS and key public and private entities have management strategies to benefit waterfowl and other wetland dependent wildlife in coastal Louisiana. To help implement those strategies, the Service assists other entities in the preparation of applications for North American Wetlands Conservation Act grants, and advocates other means of achieving habitat conservation goals (*e.g.*, modifying USACE projects to benefit wetlands, implementation of selected State funded coastal wetland restoration projects, *etc.*)

The USFWS has a major consultation, reporting, and advocacy role under provisions of the Fish and Wildlife Coordination Act. Under the Act, the Service provides its findings and recommendations to Federal construction and permitting agencies regarding impacts to, and conservation of , important fish and wildlife resources. In coastal Louisiana, the USFWS participates in the planning and evaluation of proposed water resource development projects carried out by the USACE and the SCS, and advocates measures to reduce the loss of wetlands and to benefit wetland habitats whenever possible. The Service also has consultation responsibility under the Coastal Barrier Improvement Act and Section 7 of the Endangered Species Act of 1973, as amended; consultation with other Federal agencies under those authorities can ultimately result in reduced losses of coastal wetlands. The USFWS also participates in interagency wetland conservation planning efforts such as the Barataria-Terrebonne National Estuary Program.

The USFWS provides technical assistance to LDNR and private landowners in the planning and design of coastal wetland conservation and restoration projects. Limited cost share funding for coastal wetland restoration on private lands is available through the USFWS's Partners for Wildlife Program.

The USFWS's National Wetlands Research Center has produced numerous reports, habitat maps and other data sources dealing with Louisiana's coastal wetlands. Examples of their products which are useful in coastal restoration planning include ecological characterizations of the Chenier Plain and Mississippi Deltaic Plain ecosystems, a community profile of the delta marshes of coastal Louisiana, and habitat maps and associated trend analyses of coastal Louisiana for various time periods. The National Wetlands Research Center is conducting research on the effects of marsh management on coastal wetlands in Louisiana.

The Partners for Wildlife program promotes the restoration, enhancement and protection of fish and wildlife habitat on private lands through alliances between the USFWS, other organizations and individuals. Both technical and financial assistance can be provided to eligible landowners.

The Partners for Waterfowl Tomorrow program promotes the development and management of wetlands and waterfowl habitat on private lands. Landowners agree to operate and maintain development projects for 10 or more years. Landowners are provided water control structures, but must install, maintain and operate the structures for 10 years. The USFWS administers this program.

The U.S. Geological Survey (USGS) is involved in a variety of coastal geoscience research, topographic mapping, and data inventory activities in coastal Louisiana. The USGS investigates geological processes and monitors various water quality and contaminant parameters in that area, and their published findings provide a source of scientific information utilized in the planning, design, monitoring and evaluation of coastal wetland restoration projects. The USGS, in cooperation with Louisiana State University and other Federal agencies, has also produced maps, atlases and reports documenting the results of investigations of Louisiana's barrier islands, sand sources for possible maintenance and restoration of those islands, and critical wetland processes. The USGS is also incorporating major data bases in a computerized geographic information system network for coastal Louisiana. The agency is also involved in marsh management research being conducted jointly with the National Wetlands Research Center.

The Minerals Management Service (MMS) regulates mineral (primarily oil and gas) leasing, exploration, and production on the Outer Continental Shelf (OCS). MMS has funded several studies addressing OCS related impacts to sensitive habitats in the Gulf of Mexico coastal region, including impacts on Louisiana's coastal wetlands. MMS has provided financial support for a 1987 report which quantified wetland losses associated with various human activities, including but not limited to OCS related activities, in the central Gulf of Mexico coastal region. MMS also published a report in 1990 on marsh management practices in coastal Louisiana.

The National Park Service administers the Jean Lafitte National Historical Park and Preserve, authorized by Congress in 1978. The park was established to protect significant cultural and natural resources of Louisiana's Mississippi Delta Region and to interpret the area as it related to development of cultural diversity in the delta.

Environmental Protection Agency.

The National Estuary Program is a five-year, multi-agency planning effort that works toward the development of a Comprehensive Coastal Management Plan for specific estuarine systems. The Barataria-Terrebonne Estuary system is enrolled in this program. The Louisiana Department of Environmental Quality is the lead agency.

The Environmental Monitoring and Assessment Program (EMAP), includes the Louisiana Province within the estuaries section. Coastal monitoring includes the EMAP-Estuaries suite of benthic indicators, water quality and fish. The 1993 field samples are being processed at four province Laboratories.

The EPA has overview responsibility in the Clean Water Act, Section 404 program, which deals with the permitting of discharges of dredge and fill material into waters of the United States, including wetlands. This includes the responsibility to prohibit or restrict a fill that may have unacceptable impacts on these waters.

The EPA has responsibility to review and comment on environmental impacts and compliance with the National Environmental Policy Act for federal projects that may have significant impacts on the environment.

With CWA, Section 404 "extramural funds", EPA Region 6 and Headquarters has provided studies and small wetland related projects including the following:

Feasibility of Using Pipelines and Dredged Sediments to Restore Wetlands in Terrebonne Parish, September, 1991.

Demonstration Project for Revegetation and Wetland Restoration (Hammock Lake and the Gulf Intracoastal Waterway), November, 1993.

Gulf Intracoastal Waterway Spoil Bank Herbivory Study, April, 1993.

Sedimentation Processes of Natural and Dredged Material in the Atchafalaya Delta, scheduled completion date January, 1994.

Vegetational Analysis of the Avoca Island Marsh Management Plan in the Lower Atchafalaya Basin, Louisiana, May, 1991.

Field Monitoring of Marsh Management Activities at Rockefeller Wildlife Refuge and Fina-LaTerre. Accretion and flux studies reported in 1993, including vegetation stress and simulated drawdown studies now in progress.

Spoil Bank Management Study in Terrebonne Parish, in process.

Study of Ecological Effects of Mariculture on an Estuarine Marsh System Under Management (Preliminary Investigation), September, 1989.

A Project to Monitor the Effectiveness of Sediment Fences Constructed Near Leeville, Louisiana, 1992.

Development and Application of Spatial Simulation Model for Predication of Impacts from Marsh Management Practices in Coastal Louisiana, July, 1992.

Analysis of marsh loss and gain on sixteen marsh management sites and sixteen unmanaged (control sites in coastal Louisiana (1988).

Additional EPA programs have provided demonstration projects for the restoration of oil and gas canals with vegetation and sediment fencing, and for the development of vegetation in open water areas using submerged berms.

U.S. Department of Agriculture, (Soil Conservation Service, Agricultural Stabilization and Conservation Service).

The primary objective of the Soil Conservation Service Plant Material Program center located in Golden Meadow, Louisiana, is the development and introduction of plant species to be used to reduce coastal erosion.

The Swampbuster Provisions of the 1985 Food Security Act prohibits farm program payments to farmers who convert wetlands into croplands or transform wetlands into a condition that will allow crops to be planted.

Under the Conservation Reserve Program (CRP), the Agricultural Stabilization and Conservation Service (ASCS) will cost-share with landowners to implement an approved soil conservation plan and pay landowners annual rental payments for 10 years to maintain these practices. Specific land eligibility requirements must be met.

Under the Agricultural Conservation Program (ACP), ASCS provides up to 75 percent cost-share for certain practices designed to reduce sedimentation and pollution or provide wildlife habitat (permanent cover and shallow water) on land presently in agricultural production. Specific land eligibility requirements must also be met.

Under the Wetland Reserve Program (WRP), landowners are paid by ASCS for long-term or permanent easements on prior converted cropland that is restored both vegetatively and hydrologically into its natural wetland state. ASCS will also cost-share up to 75 percent of the restoration costs.

In Louisiana, the Water Bank Program is used primarily to protect existing wood duck nesting habitat. In coastal parishes, however, the program has been used to restore and protect mottled duck nesting habitat in former marsh pump-outs and abandoned rice fields. Contracts consist of 10-year agreements which require landowners to follow a conservation plan. Participating landowners receive rental payments from the U.S. Department of Agriculture.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service.

The National Sea Grant Program seeks to increase understanding, assessment, development, utilization and conservation of the Nation's ocean and coastal resources by promoting a strong educational base, responsive research and training activities and broad dissemination of knowledge and techniques. To accomplish this, the program has developed an infrastructure of marine research and technology transfer at its educational institutions, including Louisiana State University. Within this general framework, the National Sea Grant Program is structured to focus on NOAA-wide interests such as the Coastal Ocean Program and the Climate and Global Change Program.

Fishery Management Councils have the major responsibility for developing fishery management plans (FMP) for domestic and foreign fisheries in the U.S. Exclusive Economic Zone. The councils also evaluate estuarine and freshwater issues affecting managed species under their purview. NOAA provides the councils with technical and administrative assistance and financial support to develop, monitor, implement and amend the FMP's. Councils conduct public hearings, review applications from foreign countries, estimate yields and determine the total allowable level of foreign fishing for each fishery under their management jurisdiction. NOAA reviews management plans developed by the council to ensure their compliance with the Magnuson Fishery Conservation and Management Act. In the Gulf of Mexico, FMPs have been implemented for red drum, shrimp, mackerel, and other living marine resources.

NOAA's Habitat Restoration Center was established in 1991 to provide in-house expertise and coordination for restoration and habitat research. The NMFS is the lead office for the center and works with other NOAA components to develop appropriate restoration methodologies. The center leads the planning, implementation and monitoring of case specific programs to restore NOAA trust resources after successful settlement of natural resource damage claims. NOAA also has a ready response capability (utilized during oil spills in Louisiana) to provide critical information regarding oil spill trajectory, chemical hazard analyses and assessments of the sensitivity of marine and estuarine habitats. To fulfill the responsibility of the Secretary of Commerce under the Superfund and Clean Water Acts, NOAA, as Federal trustee for living natural resources in coastal and marine areas, conducts comprehensive assessments of damages to NOAA trust resources from discharge of oil or releases of other hazardous substances.

The NMFS, under the Fish and Wildlife Coordination Act, has a major role in the review process for applications regarding wetlands alterations and possible degradation, NMFS Habitat Conservation Division (HCD) provides substantive comments to Federal and state permitting agencies on the impacts of projects involving habitat which supports marine fishery resources and recomments appropriate and practicable measures to mitigate those impacts. The HCD also participates in numerous interagency wetland conservation planning efforts in Louisiana such as the Barataria-Terrebonne National Estuary Program and Coastal America.

NOAA, through its Coastal Ocean Program, has initiated a cooperative Federal and state interagency effort (C-CAP) to map coastal wetlands and adjacent upland cover and change in coastal regions of the U.S. every 2 to 5 years and to annually monitor areas of significant change.

The Fisheries Statistics Division collects, compiles and publishes data on U.S. commercial and recreational landings, foreign catches, employment, vessels, prices, production of processed fishery products and per capita consumption. Statistics for fish and shellfish landed in Louisiana are available by species in pounds and dollars, port landed, and harvest zone.

State of Louisiana.

The Louisiana Department of Wildlife and Fisheries (LDWF) Land Acquisition Program is administered by the LDWF and is funded primarily by duck stamp and hunting license revenues. Wetlands are given high priority. Revenue allocations for this program include $1.5 million to acquire waterfowl habitat, $800,000 from hunting licenses for general land acquisition, and $18,000,000 in one-time funding.

The LDWF Fur and Refuge Program, Refuge Division includes almost 200,000 acres of coastal wetlands in four separate refuges. Providing waterfowl habitat is the primary purpose of these wetlands.

The LDWF Natural Heritage Program's primary mission is the identification and indexing of unique natural habitats in Louisiana (including many wetlands).

The Louisiana Natural and Scenic Rivers Program is administered by the LDWF and provides for a system to protect certain rivers and streams from certain forms of destruction.

The Statewide Environmental Investigation Program is administered by the LDWF and allows for mitigating fish and wildlife habitat loss caused by local, state or federal development projects.

The Coastal Management Division Coastal Use Permitting Program is administered by the Louisiana Department of Natural Resources-Coastal Management Division (DNR-CMD). This program provides guidelines for the permitting of coastal zone developmental activities in the least environmentally damaging manner. Coastal Use Permits (CUP) are required for any activity in the coastal zone except those specifically exempted by the Louisiana State Legislature.

The Coastal Management Division Consistency Program is administered by DNR-CMD and involves the review of all federal activities in the coastal zone to ensure consistency with the Louisiana Coastal Management Program.

The Coastal Management Division Local Coastal Programs interfaces with local parish governments and provides for the development and implementation of local coastal management plans consistent with the state program for management of activities of local concern. Parishes with an approved local program can permit coastal activities of local concern.

The Louisiana Coastal Wetlands Conservation and Restoration Program is an action program administered by the Governor's Office of Coastal Activities that establishes specific coastal restoration or conservation projects through an annual updated priority plan approved by the Louisiana State Legislature. The program is funded from a portion of the state oil and gas severance taxes placed in a Wetlands Trust Fund.

The Forestry Stewardship Program is administered by the Louisiana Department of Forestry and Agriculture Office of Forestry. It provides financial incentives and/or technical support for farmers to improve habitat, including forested wetlands. Improvements include erosion control, water quality management, *etc.*

Louisiana Land & Exploration Company (LL&E) is the largest private owner of coastal wetlands in the U.S., with holdings in excess of 600,000 acres. Since the mid-1950's the company has conducted an aggressive wetlands management and conservation program. LL&E's efforts are continuing.

The Fina LaTerre Mitigation Bank program includes a comprehensive management effort to maintain and enhance vegetated wetlands to accrue credits used to mitigate for development projects within the same hydrologic basin.

The Mud Lake Marsh Conservation Plan involves two separate areas. Management techniques are oriented toward fisheries interests.

The Fina LaTerre Marsh Management Program manages extensive coastal wetlands to make a profit. The surface-leasing program includes leases for fur, alligator, deer, ducks, and campsites.

The Nutria Control Program was established by Act 552 and provides up to $50,000 to encourage trapping of nutria on private wetlands being destroyed by nutria.

The Louisiana Nature Conservancy program is designed to preserve plants and animals in natural communities that represent the diversity of life in unique and threatened habitats (including coastal and inland wetlands) by protecting the land

and water. This program is carried out by the acquisition of land that includes the habitats in question.

Act 1040 of the 1990 Louisiana Legislature requires LDNR to adopt regulations to require mitigation for the ecological values lost as a result of activities permitted in the Louisiana Coastal Zone. LDNR is in the process of developing those regulations with input from Federal and state agencies, landowners, development interests, local governments, and the environmental community. An initial draft of the regulations was distributed for review on November 18, 1992. The draft is presently undergoing significant revisions. LDNR intends to proceed with formal rulemaking procedures during Summer 1993, with a goal of adopting the regulations by the late Summer or Fall 1993.

The Short-Term Dredged Material Survey program is administered by the LDNR and provides for the development of short-term plans for the beneficial disposal of materials dredged in the Atchafalaya River, Barataria Bay Waterway, Houma Navigation Canal, Mississippi River Gulf Outlet, Calcasieu Ship Channel, and Freshwater Bayou. The dredged material disposal plans identify feasible disposal options which restore, create, conserve, and enhance vegetated wetlands.

The Long-Term Management Strategies Plan for Coastal Navigation Channels is administered by the LDNR and provides for the development of ten-year beneficial dredged material disposal plans for coastal zone portions of the following navigation channels in Louisiana: Gulf Intracoastal Waterway, Calcasieu River, Mermentau River, Freshwater Bayou, Atchafalaya River, Houma Navigation Canal, Bayou LaFourche, Barataria Bay Waterway, Mississippi River, and Mississippi River Gulf Outlet.

The LDNR has completed feasibility studies on a number of potential wetland benefiting projects. The purpose of the studies was to identify the causes for coastal degradation in the project area and submit alternatives for protecting the project area. Feasibility studies have been prepared for the following projects:

White's Ditch Outfall
Grand/Spanish Pass Diversion
Violet Siphon Enlargement
Tiger/Red Pass Diversion
Shark Island/Weeks Bay
Davis Pond Diversion Outfall
Caernarvon Outfall Big Mar
Lake Salvador Shoreprotection
Caernarvon Outfall Lake Lery
White Lake
West Point a la Hache Outfall
Black Bayou Marsh Management
LaReussite Outfall Management
Deep Lake Marsh Protection
Grand Bayou Wetland
Boudreaux/Broussard Marsh Protection
Bohemia Diversion Outfall
Sweet Lake/GIWW Bank Restoration
White's Ditch Enlargement
Redfish Point
Cameron Creole Freshwater GIWW
Back Ridge Freshwater Introduction
Violet Siphon Diversion Outfall

Weeks Bay Shore Restoration
North Shore Wetland
Black Lake South Shore Protection
Holly Beach to Calcasieu
Constance Beach to Ocean View

EXISTING PROJECTS (INTERBASIN)

Numerous projects have been constructed within the Louisiana coastal zone by Federal, State, and local agencies. Listed in this section are the relevant projects and their corresponding basin. The effects these projects have on a particular basin are discussed in the individual basin plans appended to this report.

Department of the Army, U.S. Army Corps of Engineers.

Project	Basin
Bayous Chene, Boeuf, and Black Navigation Project	Atchafalaya-Terrebonne
Gulf Intracoastal Waterway	All Basins
Larose to Golden Meadow, LA, Hurricane Protection	Terrebonne-Barataria
Mississippi River, Baton Rouge to the Gulf of Mexico, LA	Bar-Pontch-Bret-Delta
Mississippi River Ship Channel, Gulf to Baton Rouge, LA	Bar-Pontch-Bret-Delta
Mississippi River Channel Improvements (Dredging, Foreshore Protection, Levees, and Revetments)	Bar-Pontch-Bret-Delta
New Orleans to Venice, LA, Hurricane Protection	Breton-Barataria
Old River Control Structure	Atch-Bar-Pontch-Bret-Delta

State of Lousiana.

Project	Basin
Christmas tree Projects - 23 Projects	All Basins
Vegetative Plantings - 70 Projects	All Basins

EXISTING PROJECTS (INTRABASIN)

Department of the Army, U.S. Army Corps of Engineers.

River and Harbor Projects

Project	Basin
Amite River and Bayou Manchac, LA	Pontchartrain
Atchafalaya River, Morgan City to the Gulf of Mexico, LA	Atchafalaya
Barataria Bay Waterway, LA	Barataria
Queen Bess Island Habitat Restoration	Barataria
Wine Island Restoration	Terrebonne
Bayou Dupre, LA	Pontchartrain
Bayou Grand Caillou and Le Carpe, LA	Terrebonne
Bayou Lacombe, LA	Pontchartrain
Bayou Lafourche and Lafourche Jump Waterway, LA	Terrebonne
Bayous La Loutre, St. Malo and Yscloskey, LA	Breton Sound
Bayou Segnette Waterway, LA	Barataria
Bayou Teche, LA	Atchafalaya
Bayou Teche and Vermilion River,LA	Teche/Vermilion
Bayou Terrebonne, LA	Terrebonne
Bayou Vermilion, LA	Teche/Vermilion
Calcasieu River at Coon Island, LA	Calcasieu/Sabine
Calcasieu River at Devil's Elbow, LA	Calcasieu/Sabine
Calcasieu River and Pass, LA	Calcasieu/Sabine
Calcasieu River Saltwater Barrier, LA	Calcasieu/Sabine
Freshwater Bayou, LA	Teche/Vermilion
Grand Bayou Pass, LA	Barataria
Gulf Intracoastal Waterway	All Basins
Algiers Lock	Pontchartrain
Bayou Boeuf Lock (MRT)	Atchafalaya
Calcasieu Lock	Calcasieu/Sabine
Harvey Lock	Barataria
Inner Harbor Navigation Lock	Pontchartrain
Leland Bowman Lock	Mermentau
Houma Navigation Canal, LA	Terrebonne
Inland Waterway from Franklin to the Mermentau River, LA	Teche/Vermilion
Mississippi River to Bayou Tech, LA	Atchafalaya
Lake Charles Deep Water Channel, LA	Calcasieu/Sabine
Little Caillou Bayou, LA	Terrebonne
Mermentau River, LA	Mermentau
Catfish Point Control Structure	Mermentau
Scooner Bayou Control Structure	Mermentau
Mississippi River Gulf Outlet, LA	Pontchartrain
Mississippi River Outlets, Venice, LA	Miss River Delta
Michoud Canal, LA	Pontchartrain
Waterway from Empire, LA to the Gulf of Mexico, LA	Breton-Barataria
Waterway from the GIWW to Bayou Dulac, LA	Terrebonne

Flood Control, Mississippi River and Tributaries

Project	Basin
Atchafalaya Basin Floodway System, LA	Atchafalaya
Atchafalaya River Navigation	Atchafalaya
Bonnet Carre Spillway	Pontchartrain
Teche-Vermilion Basin, LA	Atchafalaya

Flood Control Projects

Project	Basin
Amite River and Tributaries, LA	Pontchartrain
Grand Isle, LA and Vicinity-Hurricane Protection	Barataria
Harvey Canal Bayou Barataria Levee, LA	Barataria
Lake Pontchartrain, LA and Vicinty-Hurricane Protection	Pontchartrain
Morgan City, LA and Vicinity-Hurricane Protection	Atchafalaya
Westwego to Harvey Canal	Barataria

Freshwater Diversions

Project	Basin
Bonnet Carre Freshwater Diversion Stucture (authorized, not constructed)	Pontchartrain
Caernarvon Freshwater Diversion Structure	Breton Sound
Davis Pond Freshwater Diversion Structure (authorized, not constructed)	Barataria

Department of the Interior, USFWS.

Projects on National Wildlife Refuges (NWR)

Project	Basin
Crevasses (Wetland Establishements) Delta NWR	Miss River Delta
Operation and Maintenance of 16,000 acre Lacassine Pool, Lacassine NWR	Mermentau
Wetland Management Projects Cameron Prairie NWR	Mermentau
Operation and Monitoring of Cameron-Creole Watershed Sabine NWR	Calcasieu
Operation of Water Control Sturctures Sabine NWR	Calcasieu
Operation and Maintenance of 30,000 acre Pool Sabine NWR	Calcasieu

State of Louisiana.

Projects	Basin
Three crevasse splays cut at Pass-a-Loutre	Mississippi
Pass Fourchon Closure and Beach Protection	Barataria
LaBranche Shoreline Stabilization and Canal Closure	Pontchartrain
Blind Lake Shoreline Stabilization (rocks)	Calcasieu/Sabine
Six Crevasse Splays Cut at Pass-a-Loutre	Mississippi
Baie de Chactas Shoreline Protection	Barataria
Brannon Ditch	Calcasieu/Sabine
Sabine Terraces	Calcasieu/Sabine
Sabine Shell bank Stabilization	Calcasieu/Sabine
Pecan Island Outfall Management	Mermentau
Three crevasse splays cut at theDelta Wildlife Refuge	Mississippi
Falgout Canal Protection and Enhancement	Terrebonne
Central Wetlands Pump Outfall	Pontchartrain
West Point-a-Hache Diversion	Barataria
Violet Siphon	Pontchartrain
Pecan Island Freshwater Introduction	Mermentau
Hammock Lake	Teche/Vermilion
Queen Bess Island Revegetation	Barataria
Naomi (LaReussite) Diversion	Baratatia
Montegut Levee	Terrebonne
Beachcones at Fourchon	Terrebonne
Yellow Bayou	Teche/Vermilion
Pass-a-Loutre Sediment Fencing	Mississippi
Constance Beach to Ocean View Breakwaters	Calcasieu/Sabine
Bayou Lamoque Freshwater Diversion	Breton Sound
White's Ditch Freshwater Diversion	Breton Sound
Bohemia Freshwater Diversion	Breton Sound
Teche/Vermilion Freshwater Diversion	Atchafalaya
Beach Nourishment at Grand Isle	Barataria
Beach Jetties at Grand Isle	Barataria
Canals, Marsh Management and Habitat Restoration at Rockefeller Wildlife Management Area	Mermentau
Little Pecan Island Habit Restoration	Mermentau

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

U. S. Fish and Wildlife Service Coordination Act Letter

Exhibit 7

United States Department of the Interior

FISH AND WILDLIFE SERVICE
825 Kaliste Saloom Road
Brandywine Bldg. II, Suite 102
Lafayette, Louisiana 70508

October 1, 1993

Colonel Michael Diffley
District Engineer
U.S. Army Corps of Engineers
P.O. Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Diffley:

The Fish and Wildlife Service (Service) has reviewed the June 1993 Draft Louisiana Coastal Wetlands Restoration Plan (Restoration Plan). The Restoration Plan was prepared by the Louisiana Coastal Wetlands Conservation and Restoration Task Force (Task Force), pursuant to Section 303(b) of the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA).

The purposes of this letter report are to underscore the importance of the Restoration Plan to nationally significant fish and wildlife resources, to document the involvement of the Service in the development of the Restoration Plan, to acknowledge how the plan will benefit fish and wildlife resources, and to outline the future involvement of the Service in the implementation, evaluation, and refinement of that plan. The following comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), but do not fulfill our total planning and reporting responsibilities under Section 2(b) of that Act for the specific projects recommended in the Restoration Plan.

FISH AND WILDLIFE RESOURCES

The Service has determined that the marshes, forested wetlands, and associated habitats of coastal Louisiana are truly of national importance to fish and wildlife resources. Coastal Louisiana contains an estimated 40 percent of the vegetated estuarine wetlands in the conterminous United States. Those wetlands provide essential habitat to diverse and abundant fish and wildlife resources.

The vast wetlands of coastal Louisiana produce the greatest tonnage of commercial fish and shellfish landings of the lower 48 States. As noted in the Restoration Plan, the market value of the commercial fish and shellfish harvest supported by Louisiana's coastal wetlands averages almost $1 billion annually. Coastal Louisiana also supports an important recreational fishery. In 1986, recreational fishermen made over 3.1 million saltwater fishing trips in Louisiana; the majority of their catch was comprised of species that rely on the coastal marshes and estuaries as nursery habitat. The swamps and freshwater marshes of coastal Louisiana provide important habitat for numerous freshwater sport fishes. Sport fishing for freshwater species is also an important recreational activity in that area.

The Louisiana coastal marshes provide winter habitat to more than two-thirds of the waterfowl population of the Mississippi Flyway, an estimated 20 to 25 percent of North America's puddle duck population, and large concentrations of diving ducks. Those wetlands are a vital component of the Gulf Coast Joint Venture, established to help achieve the goals of the North American Waterfowl Management Plan. The fresh and intermediate marshes support the greatest concentrations of wintering waterfowl in coastal Louisiana.

Coastal Louisiana's marshes, swamps, and associated habitats also support many other migratory birds, such as rails, gallinules, shorebirds, seabirds, wading birds, and numerous songbirds. Over 150 nesting colonies of wading birds, shorebirds, and seabirds (representing 25 species and hundreds of thousands of nesting adults) were observed in coastal Louisiana during a 1990 survey conducted by the Louisiana Department of Wildlife and Fisheries. The cheniers and natural levee forests of coastal Louisiana provide essential stop-over habitat to numerous neotropical migratory passerine birds.

Federally listed threatened and endangered species found in coastal Louisiana wetlands and associated habitats include, but are not limited to: bald eagle, brown pelican, Arctic peregrine falcon, piping plover, and Louisiana black bear. The bald eagle and brown pelican both nest extensively in that area.

Coastal Louisiana has long been a leading fur-producing area in North America. Common fur-bearers in that area include nutria, mink, muskrat, raccoon, and river otter. The coastal marshes and swamps also support game mammals such as white-tailed deer and swamp rabbit. That area also supports more than 500,000 alligators, and closely regulated sport and commercial hunting for that species.

The Service administers seven National Wildlife Refuges in coastal Louisiana, encompassing over 257,000 acres. Those refuges include Sabine, Cameron Prairie, Lacassine, Shell Keys, Delta, Breton, and Bayou Sauvage National Wildlife Refuges. The Louisiana Department of Wildlife and Fisheries operates nine refuges and wildlife management areas in that area, comprising over 481,000 acres. Coastal wetlands make up the majority of those Federal and State wildlife areas.

SERVICE INVOLVEMENT IN RESTORATION PLAN DEVELOPMENT

The Service has been involved throughout the Restoration Plan formulation process. Service personnel have represented the Department of the Interior on the Task Force and its Technical Committee, Planning and Evaluation Subcommittee, Environmental Work Group, and Monitoring Work Group. As members of the interagency planning teams for each of the nine coastal basins, we participated actively and extensively in the formulation of comprehensive restoration strategies for each basin. Service biologists actively participated in the identification and preliminary evaluation of numerous restoration projects proposed for those basins. We also helped to develop monitoring protocols to guide the future evaluation of completed restoration projects, also required by Section 303(b) of CWPPRA.

The Service has played a leadership role in the development, refinement, and application of the Wetland Value Assessment methodology, a habitat-based system used to quantify the benefits associated with proposed restoration projects. That methodology, along with cost data, was used to rank proposed restoration projects considered for the first three Priority Project Lists approved by the Task Force. Projects were ranked on the basis of their cost effectiveness, measured as cost per average annual habitat unit.

On May 19, 1993, the Service provided extensive review comments on the preliminary draft Restoration Plan. We also provided intensive editorial assistance to the Task Force in the preparation of the draft Restoration Plan. Service comments on the Draft Restoration Plan were incorporated in the Department of the Interior's September 3, 1993, response to that draft plan and the associated Draft Programmatic Environmental Impact Statement.

IMPACTS TO FISH AND WILDLIFE RESOURCES

Implementation of the proposed Restoration Plan will have major benefits to nationally important fish and wildlife resources. Key plan features include:

1. sediment and freshwater introduction to establish additional wetlands, reduce the loss of existing wetlands, and restore more favorable salinities in those wetlands and adjacent waters;

2. improved management of fresh water in the receiving (outfall) areas of freshwater diversion structures;

3. management to facilitate the growth of the emerging delta in Atchafalaya Bay;

4. use of dredged material to create wetlands or nourish deteriorated wetlands;

5. reduction of shoreline erosion along navigation channels, lakes, and bays;

6. restoration and protection of barrier islands; and

7. hydrologic restoration and marsh management to reduce the loss of wetlands and restore deteriorated wetlands.

The primary source of those benefits is the anticipated net reduction in wetland losses. With full implementation of the Restoration Plan, wetland losses would be reduced by an estimated 202,800 acres over the next 20 years; that reduction represents 70 percent of the wetland losses that would occur without plan implementation. In addition, an estimated 330,000 acres of wetlands will benefit by introduction of additional nutrients and restoration of more favorable salinity patterns.

The anticipated reduction in wetland losses with implementation of the Restoration Plan will benefit the full spectrum of fish and wildlife resources found in coastal Louisiana. Coastal Louisiana's estuarine fish and shellfish production is largely dependent on the nursery habitat provided by that area's extensive marshes and associated shallow waters. Therefore, the Restoration Plan-associated reduction in wetland loss will have major benefits to the sport and commercial harvest of estuarine-dependent species. Those species include spotted seatrout, sand seatrout, Atlantic croaker, spot, red drum, black drum, southern flounder, blue crab, white shrimp and brown shrimp. The plan will also reduce and reverse saltwater intrusion and its associated adverse effects on sport and commercial freshwater fishes, including largemouth bass, crappie, warmouth, bluegill, and catfishes.

Because much of the net wetland savings will be in fresh and low salinity marshes, migratory waterfowl, especially puddle ducks, will greatly benefit. Those wetland types provide the highest-value habitat to puddle ducks. The accelerated growth of the Atchafalaya Delta will also be highly beneficial to the large numbers of waterfowl that winter in that area. Numerous species of shorebirds and wading birds that feed on the tidal flats in that expanding delta will also benefit. The reduction in losses of forested wetlands will benefit a variety of non-game birds, including hawks, owls, and numerous migratory songbirds. Fur animals will also benefit from wetland loss reduction, as will American alligators and numerous other species of reptiles and amphibians.

Several measures recommended in the Restoration Plan would benefit Sabine, Cameron Prairie, Lacassine, Bayou Sauvage, and Delta National Wildlife Refuges, all of which are managed by the Service. That plan also identifies five projects on the first two Priority Project Lists, which were approved by the Task Force and are being implemented by the Service on and adjacent to Sabine, Cameron Prairie, and Bayou Sauvage National Wildlife Refuges. Implementation of the Restoration Plan will also benefit several refuges and wildlife management areas managed by the Louisiana Department of Wildlife and Fisheries.

In the Service's March 19, 1993, comments on a preliminary draft of the Mississippi River Delta Basin Restoration Plan, we expressed concern over the proposed full-scale diversion of Mississippi River flows into Breton Sound. Our concern focused on the anticipated adverse impacts of that proposal on Delta National Wildlife Refuge and the adjacent State-owned Pass a Loutre Wildlife Management Area. To address those concerns, the Service recommended that a detailed assessment be conducted, as part of the required feasibility study, to determine whether the full-scale diversion can create enough marsh to offset the accelerated loss of existing deltaic wetlands. We also recommended that the feasibility study evaluate alternative designs involving phased implementation of the full-scale diversion, resulting in a phased reduction of Mississippi River flows into the active delta. Such a phased approach could reduce potential negative impacts, both in the existing delta and in Breton Sound. A related Service recommendation was that the feasibility study compare the effects of smaller diversions of varying sizes to the effects of the full-scale diversion; the smaller diversions would be evaluated under the assumption that the supporting projects (recommended in the Restoration Plan) would be also be implemented.

The draft Restoration Plan acknowledges that a detailed feasibility study of the full-scale diversion will be conducted. The Service continues to recommend that the issue and alternatives identified above be fully addressed in that feasibility study, to include the use of predictive models to ensure the greatest possible reliability of impact predictions. The position of the Service on the proposed full-scale diversion will be presented upon completion of that study, and will be based on a careful analysis of the net fish and wildlife resource impacts of the various alternatives considered.

FUTURE SERVICE INVOLVEMENT

The Service intends to be actively involved in implementation and periodic revision of the Restoration Plan. That involvement will include:

1. participation in selection of future Priority Project Lists;

2. participation in feasibility analyses of proposed wetland restoration projects;

3. evaluation of project designs to ensure that projects achieve optimal benefits to fish and wildlife resources;

4. construction, operation, and maintenance of projects for which the Service is the designated lead agency;

5. evaluation of the effectiveness of completed restoration projects, as required by CWPPRA; and

6. active participation in the periodic revision of the Restoration Plan by the Task Force.

Under provisions of Section 7 of the Endangered Species Act of 1973, as amended, the Service will also assist the agencies responsible for implementation of projects proposed in the Restoration Plan to ensure that those projects do not jeopardize the continued existence of threatened and endangered species, or adversely modify any designated critical habitat. The required consultations will be accomplished on a project-by-project basis.

SUMMARY AND SERVICE POSITION

The Service has actively participated in the formulation of the Restoration Plan. We support the overall restoration strategies recommended for each of the nine basins along the Louisiana coast, and believe that implementation of those strategies will result in major benefits to nationally significant fish and wildlife resources. Those resources are threatened by the continuing, severe loss of Louisiana's coastal wetlands. To help ensure that optimum fish and wildlife resource benefits are achieved, the Service plans to remain actively involved throughout the implementation process. Our findings and recommendations on individual projects recommended in that plan will be provided under the authority of the Fish and Wildlife Coordination Act during required feasibility studies and following review of applications for required Department of the Army permits.

We compliment you for your exemplary leadership as Task Force chairman throughout the formulation of the Restoration Plan. Please contact me if you have any questions regarding the preceding comments.

Sincerely,

David W. Frugé
Field Supervisor

cc: FWS, Atlanta, GA (AES)
LA Dept. of Wildlife and Fisheries, Baton Rouge, LA
LA Dept. of Natural Resources, Baton Rouge, LA
Governor's Office of Coastal Activities, Baton Rouge, LA
EPA, Dallas, TX
NMFS, Baton Rouge, LA
SCS, Alexandria, LA

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

Recommendations of the State of Louisiana for CWPPRA Planning Studies

Exhibit 8

EDWIN W. EDWARDS
GOVERNOR

State of Louisiana
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December 2, 1993

Colonel Michael Diffley
District Engineer
U.S. Army Corps of Engineers
New Orleans District
P.O. Box 60267
New Orleans, LA 70160

Dear Col. Diffley:

The Louisiana Coastal Wetlands Conservation and Restoration Task Force has reviewed the comprehensive plan developed under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) during a two day technical workshop that included input from the academic community and the private sector. In addition, the state Task Force considered the relative urgency of the specific long term concepts identified in my letter of September 13.

The consensus adopted by the state Task Force as a result of the workshop was that re-establishing large scale sedimentation processes is the principal long term solution to Louisiana's coastal wetlands loss. With that overall goal in mind, it is clearly in the best interest of Louisiana to initiate feasibility studies of several of the major project concepts immediately, using the $800,000 of CWPPRA planning monies that have been set-aside for this process.

Specific recommendations resulting from the technical workshop are shown in the attached memorandum from the chairman of the state Task Force. These recommendations constitute the official state request for the initiation of feasibility studies, as discussed at the CWPPRA Task Force meeting on October 1, 1993.

I ask that the CWPPRA Task Force, at its next meeting, develop an official response to this request by proposing schedules and estimated budgets, as well as any requested modifications of the prioritization outlined here.

If additional information or assistance is needed, please call Dr. Len Bahr at 504-922-3244.

Sincerely,

Edwin W. Edwards

Attachment

c: Senator John Breaux
Senator J. Bennett Johnston

EDWIN W. EDWARDS
GOVERNOR

State of Louisiana
OFFICE OF THE GOVERNOR
Baton Rouge
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December 1, 1993

MEMORANDUM

TO: Col. Michael Diffley, Chairman
Coastal Wetlands Planning Protection and Restoration Act Task Force

FROM: LB Len Bahr, Chairman
Louisiana Coastal Wetlands Conservation and Restoration Task Force

SUBJECT: Recommendations for Initiating CWPPRA Feasibility Studies

Re-establishing large scale sedimentation processes and hydrologic "buffers" are the principal long term solutions to Louisiana's coastal wetlands loss. A strategy to reverse the loss calls for initiating feasibility studies on the following four major project concepts[1]. This list reflects the state's desired order of initiation and does not imply their relative importance:

1) Increasing the share of Mississippi River borne sediments sent down the Atchafalaya River in accordance with P.L. 101-646, Section 307(b) to maximize delta development;

2) The re-establishment of the barrier island systems in the Barataria and Terrebonne Basins, to an extent sufficient to ameliorate the trend of increasing tidal prism amplitudes;

3) Modifications to major navigation channels sufficient to offset marine transgressions of historically fresh and intermediate coastal wetlands and to reallocate flow and sediment for diversions and sub-delta building in other areas. Channels to be studied, at a minimum, include the MRGO, Barataria Waterway, Houma, Calcasieu, GIWW, Sabine, lower Atchafalya, and the lower Mississippi;

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[1] These feasibility studies will require the development of an onshore sediment budget for the Mississippi/Atchafalaya river system and an offshore sediment budget for the barrier islands.

4) A Mississippi River diversion plan[2] including: upper basin diversions, Bayou LaFourche corridor diversion, lower Mississippi diversions below New Orleans, and lower Atchafalaya diversions; in order to maximize the wetland conservation and creation potential of the water and sediment resources of the lower Mississippi River system.

To ensure that appropriate large scale projects are implemented within a reasonable time, the feasibility studies should begin immediately (January 1994) and should have achieved most major objectives by 1996. This date coincides with the three year statutory deadline for the evaluation of the comprehensive plan called for in P.L. 101-646 (Section 303, b, 7).

In order to save time and reduce cost, the feasibility studies should, to the maximum extent possible, incorporate existing data that have been published in scientific papers and technical reports. The studies should also take advantage of the technical expertise available in state agencies, academic institutions and the private sector.

Please initiate the appropriate procedures to commence these studies and keep the state Task Force agencies involved.

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[2]The initiation of small upper basin freshwater diversions would not be precluded by the development of the overall Mississippi River diversion plan.

FINAL PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
LOUISIANA COASTAL WETLANDS RESTORATION PLAN

DECEMBER 1993

Lead Agency: U.S. Army Corps of Engineers, New Orleans District.
Cooperating Agencies: Environmental Protection Agency; U.S. Department of the Interior, U.S. Fish and Wildlife Service, U.S. Minerals Management Service, and U.S. Geological Survey; U.S. Department of Agriculture, Soil Conservation Service; U.S. Department of Commerce, National Marine Fisheries Service; and the State of Louisiana, Governor's Office of Coastal Activities and Department of Natural Resources.

ABSTRACT: The coastal wetlands of Louisiana are disappearing at the rate of about 25 square miles per year. Since the 1930's, approximately 1,500 square miles of land has been lost to open water in coastal Louisiana. Congress, realizing this tremendous loss, passed the Coastal Wetlands Planning, Protection, and Restoration Act of 1990 (CWPPRA). The CWPPRA directs the Secretary of the Army to convene a Task Force to prepare a Restoration Plan consisting of projects that provide a comprehensive approach to restoring and preventing the loss of coastal wetlands in Louisiana. The Task Force consists of the Secretary of the Army, the Administrator of the Environmental Protection Agency, the Governor of Louisiana, the Secretary of the Interior, the Secretary of Agriculture, and the Secretary of Commerce. In practice, the Task Force members have delegated their responsibilities to other members of their organizations. The Task Force has developed a comprehensive Restoration Plan for the coastal wetlands of Louisiana. In order to accomplish this task, the wetlands were divided into nine hydrologic basins. The CWPPRA also provides funding for implementation of annual priority project lists containing priority coastal wetlands restoration projects. Three such lists have been prepared and projects included on those lists are in the process of being implemented. All projects included on the lists are also components of the Restoration Plan. The Restoration Plan contains a variety of projects that are grouped under thirteen categories: marsh management, hydrologic restoration, hydrologic management of impoundments, sediment diversion, freshwater diversion, outfall management, marsh creation (with dredged material), barrier island restoration, shoreline erosion control with structures, vegetative plantings, terracing, sediment trapping, and herbivore control. This Programmatic EIS discusses the effects expected from the various types of projects proposed for the Restoration Plan and provides an overview of the plans developed for each hydrologic basin, but does not address the effects of specific project proposals. Additional National Environmental Policy Act compliance, along with compliance with other environmental statutes, will be necessary for each project to be implemented with CWPPRA funding prior to project construction.

Date: ______________________

Please send your comments to Colonel Michael Diffley, New Orleans District Engineer, by the date stamped above. For additional information concerning this statement, please contact Mr. Richard Boe, Planning Division, U.S. Army Engineer District, P.O. Box 60267, New Orleans, Louisiana 70160-0267. Commercial telephone: (504) 862-1505.

Note: Displays, maps, figures, and other information discussed in the main report for the Restoration Plan are incorporated by reference in this Final EIS.

SUMMARY

Introduction.

The coastal wetlands of Louisiana are of National significance because of the products and values they provide to our society. Congress, recognizing this significance and the tremendous coastal wetland loss that has, and is occurring in Louisiana, passed the Coastal Wetlands Planning, Protection, and Restoration Act (CWWPRA) in 1990. A major feature of this legislation was the establishment of a Task Force, made up of five Federal agencies and the State of Louisiana, to plan and implement a comprehensive coastal wetlands Restoration Plan. The Restoration Plan is the subject of this Programmatic Environmental Impact Statement (EIS).

The CWPPRA also provides for annual priority project lists. Prior to the date on which the Restoration Plan becomes effective, the lists are to include only restoration projects that can be substantially completed during a five year period after the project is placed on the list. The first two priority project lists, submitted in November 1991 and 1992, respectively, consist of relatively small-scale projects that are in various stages of implementation. The third list will be transmitted to Congress in late 1993. All of the projects included on the first three priority project lists are also included as components of the Restoration Plan. After the completion of the Restoration Plan, subsequent annual priority lists will also be developed from the projects contained in the Restoration Plan. Funding is authorized to implement priority project lists at an annual rate of about $40 million (including the 25 percent State share) through fiscal year 1999.

The purpose of this EIS is to provide the public and decision makers with an overview of the effects to be expected from the kinds projects proposed for the Restoration Plan. The overall impacts of the Restoration Plan and its component projects cannot be determined at this time because they will depend on the specific actions that the CWPPRA ultimately funds. This Programmatic EIS does not provide National Environmental Policy Act (NEPA) compliance nor other necessary environmental compliance for any specific project. NEPA documents either have been or are being prepared separately for each of the projects contained on the first three lists and compliance will be necessary for all projects included on future annual priority lists prior to project construction.

The Planning Process.

Committees, work groups, and basin study teams, made up of Federal and State agency personnel, contractors, local governmental interests, and the academic community, were formed by the Task Force to develop the Restoration Plan. Also, a Citizen Participation Group was formed to maintain consistent public review and provide input to the plans and projects being considered, and to assist and participate in the public involvement program. Two series of scoping meetings were held in October and November 1991 - one series for coastal zone parish (county) representatives and another series for the general public. The purpose of these meetings was to identify wetland loss problems throughout the coastal zone and potential solutions to those problems. Literally hundreds of ideas were submitted to the Task Force through these scoping meetings and most of the suggestions have been included in the Restoration Plan as potential projects.

A series of plan formulation meetings were held from February to May 1992. These meetings were attended by Task Force agency representatives, members of the scientific and academic community, representatives of the Citizen Participation Group, private consultants, parish representatives, and members of the general public. Plan formulation revolved around a hydrologic basin approach to restoration. The term "basin" refers to any of Louisiana's nine major estuarine areas. During June 1992, another series of pubic meetings was held to present to the public the conceptual plans which had been developed for each basin.

During the latter half of 1992 and the first half of 1993, the Task Force's efforts were focused primarily on integrating all of the information gathered through the planning and public comment process into a comprehensive Restoration Plan. The draft version of the Restoration Plan, and accompanying EIS, was distributed to the public in mid-July 1993 and the notice of EIS availability was published in the Federal Register on July 16, 1993. The Task Force held a series of public meetings in coastal Louisiana during July and August 1993. These meetings were designed to solicit comments from the public on candidate projects being evaluated for the 3rd Priority Project List and to present the draft Restoration Plan and specific plans for restoring each basin. The formal public hearing for comments on the EIS was held on August 11, 1993 at the New Orleans District office of the U.S. Army Corps of Engineers (USACE).

Planning Considerations.

"Basin Captains" from the Federal Task Force agencies were assigned by the Task Force to act as study managers for each of Louisiana's nine coastal hydrologic basins. The Basin Captains had the responsibility for coordinating efforts of a multi-disciplined basin team to develop a restoration plan for their respective basins. Basin Captains and teams were instructed by the Task Force to take the plan formulation strategies developed by agency consensus in February to May 1992 and use this information to determine the best overall strategy for wetland restoration in each basin. In addition, projects were to be categorized as either critical to, or supporting of, the restoration of the basins.

The Task Force instructed the Basin Captains to develop the best approach to wetland restoration regardless of the cost involved. This guidance made formulation of alternatives difficult. Unless there was more than one mutually exclusive approach to overall basin restoration, the restoration plan for the basin became a combination of all non-conflicting projects.

Planning Constraints.

This Restoration Plan was assembled under the constraints imposed by its authorizing legislation, the Coastal Wetlands Planning, Protection and Restoration Act. These constraints, whether explicitly expressed or implied, affect the character of the projects, their ultimate benefit, the time frame in which the projects must be identified and analyzed, and the level of funding available for the purpose of plan formulation and development. The most significant of these are the legislative mandates concerning deadlines for submission of priority project lists and the Restoration Plan and the restriction of funds for expenditure in planning.

In the adopted study process, an attempt has been made to consider all suggested means of creating, restoring, or preventing the further deterioration of any type of coastal wetland. Many specific suggestions which have been received during this process have been burdened by the need for further development of their biological and technical backgrounds. Due to the limited availability of time and manpower to undertake these analyses, the availability of sound, verifiable data regarding specific projects has become an important consideration in selecting and developing alternative plans and projects, especially for the priority project lists.

Additionally, there are several recognized issues which must be accepted as either limiting factors or economic burdens in the design of some projects. Prominent among these issues are those of the continued protection of existing development from induced damages and the compatibility of proposed initiatives with private sector economic objectives. Some projects have the potential for producing significant changes in socioeconomic characteristics of communities along the Louisiana coast by displacing or shifting locations of existing commercial and recreational fishing areas. While these items are not considered constraints to development or recommendation of plans or projects, they do, in many cases, pose a significant monetary burden in implementing those projects.

Alternatives.

Given the difficulty with designating alternatives for restoration of each hydrologic basin, the selection of alternatives for this EIS focused on the types of projects that have been proposed for wetland creation, restoration, preservation, and enhancement. For purposes of this EIS, the proposed projects have been grouped into thirteen types. The project types are: marsh management, hydrologic restoration, hydrologic management of impoundments, sediment diversion, freshwater diversion, outfall management, marsh creation (with dredged material), barrier island restoration, shoreline erosion control with structures, vegetative plantings, terracing, sediment trapping, and herbivore control.

Environmental Consequences.

This Programmatic EIS focuses on the impacts expected from implementation of the types of projects proposed for implementation and not on effects of any specific project. Thus, discussions will necessarily, be broad and generalized. The analysis will focus on anticipated changes to the physical, biological, and socioeconomic environment that would result from implementation of any of the thirteen types of projects considered. The anticipated environmental effects are summarized in Table 1, Summary of Comparative Impacts of Proposed Project Types, on the following eight pages.

TABLE 1
SUMMARY OF COMPARATIVE IMPACTS OF PROPOSED PROJECT TYPES

SIGNIFICANT RESOURCES	EFFECTS OF VARIOUS PROJECT TYPES		
	NO-ACTION	MARSH MANAGEMENT	HYDROLOGIC RESTORATION
COASTAL MARSH	The rate of coastal marsh loss would probably continue its gradual decline from the present rate of about 25 square miles per year, but would remain significant.	Passive mgt. can have mixed effects on marsh vegetation. Active mgt. using draw-downs may invigorate existing marsh and cause new vegetation to develop.	Rate of marsh loss would be lowered by reducing tidal scour and moderating salinity levels.
CYPRESS-TUPELO SWAMP	Swamps would continue to deteriorate from subsidence, prolonged flooding, and saltwater intrusion.	Marsh management techniques could be used to benefit chronically flooded swamps.	Projects could be designed to benefit swamps by reducing tidal fluctuation and saltwater intrusion.
SUBMERGED AQUATIC VEGETATION (SAV)	Continued marsh loss and saltwater intrusion would reduce shallow, protected areas necessary for most species of SAV.	SAV in managed areas would likely increase due mainly to reduced tidal circulation, lowered turbidity levels, and possibly from lowered salinity levels.	SAV in restored areas would likely increase due mainly to reduced tidal circulation, lowered turbidity levels, and possibly from lowered salinity levels.
WILDLIFE RESOURCES	Populations of wildlife directly dependent on marsh and swamp would continue to decline with loss of habitat.	Projects would help maintain and possibly increase habitat values for most wildlife species, especially migratory waterfowl and furbearers and other terrestrial animals.	Beneficial effects expected due to preservation of emergent vegetation and higher incidence of submerged aquatic vegetation.
FISHERIES RESOURCES	Fisheries populations and harvests are being maintained by marsh loss adding organic material and new estuarine habitats. Fisheries harvest would decline with continued loss of marsh.	Use of managed areas by migratory estuarine species would likely be reduced to varying degrees depending on specifics of sites. Populations of resident aquatic species could increase inside areas.	Decrease in use of restored areas by estuarine species possible in some cases. Long-term benefits to fish from preservation of marsh, swamp, and submerged aquatic vegetation.
THREATENED AND ENDANGERED SPECIES	Coastal wetlands provide habitat for several listed species, including bald eagles, Arctic peregrine falcons, brown pelicans, and piping plovers. Continued habitat loss could jeopardize their recovery.	Long-term benefits to some listed species possible from wetland preservation. The National Marine Fisheries Service has expressed concern over potential cumulative effects of management on sea turtles.	No direct adverse impacts expected to listed species. Long-term benefits to some listed species possible from wetland preservation.
OYSTER LEASES	Areas leased for oyster production continue to increase as marsh is lost and estuarine open water develops. Large areas under lease would remain closed to harvest because of pollution.	Highly unlikely that areas capable of supporting significant quantities of oysters would be proposed for management. Any leases in managed areas would likely be adversely affected.	Any oysters or oyster leases within areas proposed for hydrologic restoration could be either beneficially or adversely affected by reduced tidal flows depending on site-specific conditions.
WATER QUALITY	Previously authorized freshwater diversions will restore favorable salinity regimes in some areas. Otherwise, no significant changes expected.	Projects are expected to reduce turbidity levels within managed areas and can be used to moderate and lower average salinity levels within managed areas.	Average salinity and turbidity levels are expected to decrease in restored areas.

TABLE 1 (continued)
SUMMARY OF COMPARATIVE IMPACTS OF PROPOSED PROJECT TYPES

EFFECTS OF VARIOUS PROJECT TYPES			
HYDRO MANAGEMENT OF IMPOUNDMENTS	SEDIMENT DIVERSION	FRESHWATER DIVERSION	OUTFALL MANAGEMENT
Optimal hydrologic conditions for growth of marsh vegetation would be restored to existing impounded areas.	This type of project is potentially the only approach capable of building enough new marsh to substantially offset losses from other sources.	Marsh loss in outfall areas would be reduced by introduction of nutrients and suspended sediments and by a reduction in salinity levels.	Projects will invigorate and restore marsh by efficient flow of freshwater with suspended nutrients and sediments across marsh and shallow open water.
The habitat value of impounded swamps could increase from hydrologic management.	Sediment diversions could benefit swamps by counteracting subsidence.	Benefits would be expected from sediment and nutrient input and flushing action of freshwater.	Swamps could be benefitted by nutrients, freshwater flow, and sediment deposition.
Coverage of SAV would increase in most project areas. With a high level of water control, SAV could be increased or decreased as desired.	SAV expected to occur in still waters between passes and in shallow water areas formed in the outfall areas. Seagrass beds could be negatively affected.	SAV is expected to increase in outfall areas from nutrient input and reduced salinity levels.	SAV is expected to increase in outfall areas from nutrient input and reduction in salinity levels.
Projects would benefit wetland-dependent wildlife in impounded areas by optimizing water levels.	Wildlife, especially migratory waterfowl, wading birds, and terrestrial animals, would be directly benefitted by an increase in wetland habitat.	Wildlife resources would be benefitted by reduction in loss of wetland habitats. Diversions would also increase vegetative vigor in receiving areas.	Wildlife resources would be benefitted by reduction in loss of wetland habitats. Management would also increase vegetative vigor in receiving areas.
Usually, only freshwater fish species would be benefitted. If tidal exchange were reestablished, estuarine species would benefit.	Some diversions would cause significant shift of estuarine fisheries species resources and expand freshwater fisheries. Long-term benefits from increased amount of wetlands expected.	Both positive and negative impacts, but overall, fisheries resources would benefit from re-establishment of favorable salinity regimes and preservation of wetland habitats.	Freshwater fisheries would likely be enhanced from distribution of freshwater and nutrients. Use of outfall managed areas by migratory estuarine species could be reduced by restrictions to access.
No direct adverse impacts expected to listed species. Long-term benefits to some listed species possible from wetland restoration.	No direct adverse impacts expected to listed species but biological assessments would be appropriate for large-scale diversions. Long-term benefits to some listed species from wetland restoration.	No direct adverse impacts expected to listed species but biological assessments would be appropriate for large-scale diversions. Long-term benefits to some listed species from wetland restoration.	No direct adverse impacts expected to listed species. Long-term benefits to some listed species from wetland restoration.
Not applicable, no oyster leases or significant amount of oysters in existing impoundments.	Diversions, depending on their location, could significantly shift areas of oyster production. Existing oyster beds could be covered with silt or killed by over-freshening.	Projects may negatively affect leases closer to diversion but would benefit leases farther away from diversions; overall net benefits expected.	Normally, no oyster leases expected within areas of outfall management. Leases adjacent to managed areas could be either positively or negatively affected.
Changes in water quality inside of impoundments may occur. No significant adverse effects expected.	Projects outside of active deltas would significantly change water chemistry. Increased nutrients, suspended sediment and lowered salinity expected.	Significant changes expected in water chemistry in outfall areas. Increased nutrients, suspended sediments, and lowered salinity expected.	No significant change in water quality expected. Average salinity levels should be lower within management areas.

TABLE 1 (continued)
SUMMARY OF COMPARATIVE IMPACTS OF PROPOSED PROJECT TYPES

SIGNIFICANT RESOURCES	EFFECTS OF VARIOUS PROJECT TYPES		
	NO-ACTION	MARSH MANAGEMENT	HYDROLOGIC RESTORATION
WILDLIFE REFUGES, MANAGEMENT AREAS, AND NATIONAL PARKS	Areas would continue to be managed for public use and fish and wildlife resources. Normal maintenance funding is not sufficient to maintain and restore wetlands within these areas.	Many of the western areas are already under some form of management. Additional management and maintenance of existing projects is proposed on some of these areas.	Public areas in coastal Louisiana could benefit from this type of project which reduces tidal scour and saltwater intrusion in stressed marshes.
PROPERTY OWNERSHIP AND VALUES	Existing uses include grazing, hunting, trapping, fishing, non-consumptive recreation, and oil and gas production. Continued loss of wetlands is negatively affecting these uses.	Easements would be obtained for structure sites. Existing land uses would be preserved. Some projects could reduce public access by boat giving landowners increased control over access points.	Easements would be obtained for structures sites. Existing land uses would be preserved. Structures used for some projects may hinder public access.
FLOOD PROTECTION	The storm surge-buffering effect of coastal wetlands would be reduced by continued wetland loss thereby causing greater storm-related flooding.	Possible flood protection benefits from the cumulative preservation of wetlands that provide storm surge protection.	Projects would provide flood protection benefits by reducing channelized flows and encouraging more natural sheet flow across marsh surfaces.
NAVIGATION AND OTHER FORMS OF TRANSPORTATION	The numerous navigation channels would be maintained. Increased dredging would be necessary because of the loss of wetlands that provide protection to channels.	Projects would not affect major channels. Active mgt. structures would exclude boat traffic from some areas. Structures can be fitted with boat bays in areas of high boat usage.	Projects would not affect major channels. Projects could reduce boat access into some restored areas but structures are commonly fitted with boat bays in areas of high boat usage.
RECREATION OPPORTUNITIES	Fishing and hunting activities, the two primary recreation pursuits, would be diminished by marsh loss. Non-consumptive uses would decline as well.	Hunting and freshwater fishing opportunities would likely increase in managed areas. Overall recreational catch of migratory estuarine species may be reduced but structures concentrate fish and often provide prime fishing spots.	Hunting opportunities may be increased in restored areas. Affects on fishing opportunities are not expected to be significant, except for long-term benefits from prevention of marsh loss.
CULTURAL RESOURCES	Numerous historic and prehistoric archeological sites located in the coastal wetlands would continue to be eroded and lost to subsidence.	Structures and dredging and filling activities could impact cultural resources. Site specific actions may be necessary to avoid impacts.	Structures and dredging and filling activities could impact cultural resources. Site specific actions may be necessary to avoid impacts.
SOCIOECONOMIC ITEMS	The continued loss of coastal wetlands threatens the socioeconomic stability of south Louisiana, especially the smaller coastal communities dependent upon harvestable fish and wildlife.	Socioeconomic items would be positively affected to the extent that projects maintain and protect coastal wetlands. Production of economically important estuarine fisheries may decline due to reduced access of these species into managed marsh areas.	Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources.

TABLE 1 (continued)
SUMMARY OF COMPARATIVE IMPACTS OF PROPOSED PROJECT TYPES

EFFECTS OF VARIOUS PROJECT TYPES			
HYDRO MANAGEMENT OF IMPOUNDMENTS	SEDIMENT DIVERSION	FRESHWATER DIVERSION	OUTFALL MANAGEMENT
Public areas could be substantially benefitted, especially Bayou Sauvage NWR.	Depending on location, proposed projects could build wetlands on public areas in active Mississippi and Atchafalaya Deltas or cause areas to deteriorate from sediment deficit.	Diversions could benefit public areas by reducing saltwater intrusion and adding nutrients and some sediments.	Project proposed for the Salvador WMA. Likely benefits include nourishment of existing marsh with nutrients and sediment and beneficial aspects of fresh water.
Easements to manage water levels in privately owned impoundments would probably be necessary.	The state owns navigable coastal waters but ownership of water bottoms is often uncertain. Easements to be obtained on private areas that would be substantially altered.	Easements would be obtained for diversion sites but not for affected areas except where substantial alteration of conditions is expected. Existing land uses would be maintained.	Easements would be obtained for areas substantially altered by dredging, filling, structures or other activities and may be necessary over the entire managed area.
No effect on flood protection, existing protection systems would be preserved.	Diversions may create problems by raising water levels but created wetlands would help buffer flooding from storm surge.	Diversions would be constructed to maintain flood protection systems. Preserved wetlands would help buffer storms.	No adverse effect on flood protection. Indirect benefit from preservation of wetlands for storm buffering.
No effect on navigation.	Significant adverse impacts to navigation possible from large-scale diversions. Increased shoaling of river channels could result from reduction of river flows.	Major navigation channels not expected to be affected. Some reduction in use of outfall areas by small boat traffic possible.	Projects would not affect major channels. Structures and plugs may reduce boat access into management areas but traditional access routes would be maintained.
Increased recreation opportunities would occur from optimization of water levels for fish and wildlife resources.	Fishing for estuarine species would shift away from diversion site. Hunting and freshwater fishing would increase in emerging deltas. Overall net increase in recreational opportunities expected.	Fishing for estuarine species would shift away from diversion sites during high flows. Freshwater fishing and hunting would likely increase in outfall areas.	Freshwater fish and wildlife expected to be benefitted. Access by fishermen and hunters could be reduced unless structures are equipped with boat bays.
Project construction could affect cultural sites. Site specific actions may be necessary to avoid impacts.	Project construction could negatively affect cultural sites. Sites may be covered with sediments but effect would depend on site-specific conditions.	Project construction could affect cultural sites. Operations not expected to impact cultural resources.	Project construction could affect cultural sites. Site specific actions may be necessary to avoid impacts.
Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources.	Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands. Site-specific, negative effects could occur from displacement of estuarine fishery resources.	Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources. Site-specific negative effects could occur from displacement estuarine fishery resources.	Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources.

TABLE 1
SUMMARY OF COMPARATIVE IMPACTS OF PROPOSED PROJECT TYPES

SIGNIFICANT RESOURCES	EFFECTS OF VARIOUS PROJECT TYPES		
	CREATE MARSH WITH DREDGED MATERIAL	BARRIER ISLAND RESTORATION	EROSION CONTROL WITH STRUCTURES
COASTAL MARSH	Significant opportunities exist for creation of new marsh to offset other losses. Created marshes would function similar to natural ones.	Saline marsh would be increased on the islands. Protection can, in some cases, be provided to mainland marshes.	Structural materials would prevent marsh loss. Accretion can occur from breakwaters. Structures on coastlines can have mixed effects.
CYPRESS-TUPELO SWAMP	No projects proposed for development of cypress swamp on dredged material.	Projects would not effect swamps except to the extent that islands moderate salinity levels in interior areas.	Structural erosion control can be used to stop erosion of swamps to maintain swamp productivity.
SUBMERGED AQUATIC VEGETATION (SAV)	Existing SAV in marsh creation area would be replaced with emergent vegetation. Over time, SAV could establish in shallow ponds within created marsh.	No direct effects on SAV. Projects would help maintain estuarine system thereby possibly helping to maintain SAV in interior marshes.	Generally, no adverse effect on SAV. Structures can protect and enhance SAV occurring in ponds and lagoons behind eroding shorelines.
WILDLIFE RESOURCES	Direct benefits to wildlife species by a direct increase in emergent wetlands vegetation.	Restoration would provide habitat for a variety of species that use barrier islands, especially seabirds, pelicans, wading birds, and other colonial nesters.	Wildlife habitats would be preserved but structures could alter the marsh-water interface. Breakwaters in inland areas would have mainly beneficial effects.
FISHERIES RESOURCES	Fisheries usage of immediate project area may be reduced by displacement but overall benefits expected from organic production of created marsh.	Restoration of barrier islands would help to preserve the estuarine ecosystem behind the islands and the fisheries resources using the estuaries.	Fisheries habitat would be preserved but structures on shorelines would alter the marsh-water interface. Breakwaters in inland areas would have mainly beneficial effects.
THREATENED AND ENDANGERED SPECIES	No direct adverse impacts expected to listed species. Long-term benefits to some listed species possible from wetland restoration.	Brown pelicans and piping plovers, which use barrier islands, would benefit over long-term. Projects may need to be built during seasons when negative effects of construction would be minimized.	Projects would protect habitats that may be used by listed species. Long-term benefits to some listed species possible from wetland preservation.
OYSTER LEASES	Any oyster leases occurring in direct areas of marsh creation would be lost. Adjacent leases could be adversely impacted. Created marsh would provide food for oysters.	Projects would preserve estuarine areas where leases are located. Leases may be affected by dredging operations if they occur near islands or borrow areas.	Leases may be adversely affected by dredging for access to project sites, otherwise no effects.
WATER QUALITY	No significant change in water quality expected unless material contains pollutants. Temporary high turbidity and possible decreased oxygen during construction.	Dredging operations and runoff from disposal areas would temporarily increase turbidity levels. Otherwise, no long-term effects expected.	Short-term increases in turbidity expected during construction. Long-term reduction in turbidity possible from reduced erosion.

TABLE 1 (continued)
SUMMARY OF COMPARATIVE IMPACTS OF PROPOSED PROJECT TYPES

EFFECTS OF VARIOUS PROJECT TYPES			
VEGETATIVE PLANTINGS	TERRACING	SEDIMENT TRAPPING	HERBIVORE CONTROL
Planting of vegetation, especially smooth cordgrass, in selected areas would reduce erosion and protect marsh.	Marsh would be created in geometric patterns in open water areas. Nearby marsh would be protected by reduced wave energy.	Marsh would accrete or be developed by slowing sediment-carrying currents.	Reduction of high nutria and muskrat populations would have a beneficial effect on marsh.
Some projects are proposed to protect swamps. Cypress may be planted to slow erosion.	No projects proposed for swamps.	No projects proposed for swamps.	Reduction of high nutria populations would increase cypress regeneration.
No adverse effects. Beneficial effects when used to protect areas containing SAV.	Increased coverage of SAV would be expected in terraced areas from decreased turbidity and lower wave energy.	Sediment trapping can increase SAV by stilling wave energy and reducing water depths.	Reduction of high nutria populations would increase coverage of SAV.
No adverse impacts to wildlife. Benefits expected from preservation of habitat.	Marsh created by terracing would provide nesting, resting, and feeding areas for birds and terrestrial species.	Newly developed marsh would provide nesting, resting, and feeding areas for birds and terrestrial wildlife.	Controlling high herbivore populations would preserve wetlands habitats and its associated wildlife.
Beneficial effects from preservation of marsh-water interface and wetlands behind the shorelines.	Fish species would benefit from the large amount of marsh-water interface and shallow protected water areas developed with terracing.	Long-term benefits from protection of wetlands.	Long-term benefits to fisheries resources possible because reduced populations of animals that are contributing to wetland loss would preserve habitats that provide nursery areas for fish.
Projects would protect habitats that may be used by listed species.	No direct adverse impacts expected to listed species. Long-term benefits to some listed species possible from wetland restoration.	No direct adverse impacts expected to listed species. Long-term benefits to some listed species possible from wetland restoration.	No direct adverse impacts expected to listed species. Long-term benefits to some listed species possible from wetland restoration.
Temporary, wave-dampening devices sometimes used for plantings may negatively affect very small areas.	Highly unlikely that projects would be proposed in areas of existing oysters or oyster leases. If oysters were present, they would be negatively impacted.	Projects would not likely be proposed in areas of existing oysters or oyster leases.	Possible increase in the areas open to oyster harvest from reduction of waste from herbivores which may cause the closure of harvest areas.
A decrease in turbidity from reduced erosion may occur.	No significant change in water quality expected except for decrease in suspended sediments.	No noticeable change in water quality expected.	Controlling herbivores could reduce bacteria levels in nearby waters.

TABLE 1 (continued)
SUMMARY OF COMPARATIVE IMPACTS OF PROPOSED PROJECT TYPES

SIGNIFICANT RESOURCES	EFFECTS OF VARIOUS PROJECT TYPES		
	CREATE MARSH WITH DREDGED MATERIAL	BARRIER ISLAND RESTORATION	EROSION CONTROL WITH STRUCTURES
WILDLIFE REFUGES, MANAGEMENT AREAS, AND NATIONAL PARKS	Projects are proposed to build marsh on several refuges and management areas including Pass a Loutre Wildlife Management Area and Delta National Wildlife Refuge.	No projects proposed for Breton National Wildlife Refuge. Projects are proposed to restore the state-operated Terrebonne Barrier Island Refuge complex.	Projects are proposed for, and would benefit, many of the publicly owned and managed areas by reducing shoreline erosion and, sometimes more importantly, by maintaining existing managed areas.
PROPERTY OWNERSHIP AND VALUES	In some cases, ownership of newly created lands could become controversial. Dredged material disposal easements would be obtained for private lands.	Disposal easements would be obtained on privately owned properties. Existing land uses would be maintained.	Easements would be obtained on privately owned areas where structures would be placed. Existing land uses would be maintained.
FLOOD PROTECTION	Direct beneficial effect from addition of marsh capable of buffering storm surges.	Barrier islands moderate the effects of storm flooding by providing hydrologic barriers. Restoration could only help flood control efforts.	Preservation of wetlands would provide flood control benefits.
NAVIGATION AND OTHER FORMS OF TRANSPORTATION	Projects would not affect major channels. Projects would reduce small boat use in created marsh and possibly in adjacent areas.	Possible interference during construction but no long-term effects expected.	Potential interference with navigation if wetlands disappear and structures are left in open water.
RECREATION OPPORTUNITIES	Increased hunting opportunities in created marsh probable. Fishing in created marsh would be limited to open water areas within and along fringe of new marsh.	Projects would preserve high recreational use of islands and estuarine system.	Projects would preserve wetlands and their associated recreation values. Short-term interference during construction possible.
CULTURAL RESOURCES	Structures and dredging and filling activities could impact cultural resources. Site specific actions may be necessary to avoid impacts.	Cultural sites could be adversely impacted by dredging and disposal operations. Site-specific actions may be required to avoid impacts.	Cultural sites could be either adversely or beneficially impacted by structures. Site-specific actions may be required to avoid adverse impacts.
SOCIOECONOMIC ITEMS	Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources.	Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources.	Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources.

TABLE 1 (continued)
SUMMARY OF COMPARATIVE IMPACTS OF PROPOSED PROJECT TYPES

EFFECTS OF VARIOUS PROJECT TYPES			
VEGETATIVE PLANTINGS	TERRACING	SEDIMENT TRAPPING	HERBIVORE CONTROL
Vegetative plantings could be used to benefit many of the publicly owned and managed areas.	The only constructed project is on Sabine National Wildlife Refuge. Additional terracing projects possible on public areas, especially in the Chenier Plain.	Projects are proposed for Pass a Loutre Wildlife Management Area. This approach could be used to build wetlands on other public areas.	Herbivore control could benefit public areas by reducing marsh stress and marsh loss. Applicable mainly in the Deltaic Plain where herbivores are causing the most problem.
Easements would be obtained to plant vegetation on private properties. Existing land uses would be maintained.	Easements would be obtained to build terraces on private properties. Land uses not expected to change.	Easements would be obtained to place structures on private properties. No change in land use expected.	No easements necessary and no changes in land uses expected.
Preservation of wetlands would provide flood control benefits.	No adverse effect on flood protection. Created, restored, and preserved wetlands would serve to buffer storm flooding.	No adverse effect on flood protection. Created, restored, and preserved wetlands would serve to buffer storm flooding.	No adverse effect on flood protection. Indirect benefit from preservation of wetlands for storm buffering.
No effects on navigation.	No effects on navigation.	No effects on navigation.	No effects on navigation.
Projects would preserve wetland-related recreation. No adverse impacts expected.	Hunting and fishing opportunities would probably increase in terraced areas.	Developed wetlands would provide habitat for desirable wildlife species and would increase hunting potential of area.	Protection of wetlands from destruction by herbivores would preserve recreational opportunities.
Projects may prevent erosion of cultural resources, otherwise no effect expected.	Cultural sites within areas proposed for terracing unlikely. The necessity of a cultural resources survey would be determined on a case-by-case basis.	Cultural sites within areas proposed for trapping unlikely. The necessity of a cultural resources survey would be determined on a case-by-case basis.	No effects on cultural sites.
Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources.	Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources.	Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources.	Projects would positively affect socioeconomic items to the extent that they restore and protect coastal wetlands and associated fish and wildlife resources.

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ABBREVIATIONS USED

BLH	Bottomland Hardwood Forest
BEA	Bureau of Economic Analysis
CPG	Citizen Participation Group
CWPPRA	Coastal Wetlands Planning, Protection, & Restoration Act
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
GIWW	Gulf Intracoastal Waterway
HUD	Department of Housing and Urban Development
LDEQ	Louisiana Department of Environmental Quality
LDNR	Louisiana Department of Natural Resources
LDWF	Louisiana Department of Wildlife and Fisheries
LSU	Louisiana State University
MOA	Memorandum of Agreement
MRGO	Mississippi River Gulf Outlet
MSA	Metropolitan Statistical Area
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NWR	National Wildlife Refuge
OBERS	Office of Business Economics/Economic Research Service
OSHA	Occupational Safety and Health Administration
SAV	Submerged Aquatic Vegetation
SCS	Soil Conservation Service
SWR	State Wildlife Refuge
USACE	United States Army Corps of Engineers
USFWS	United States Fish & Wildlife Service
WMA	Wildlife Management Area

1. PURPOSE AND NEED

1.1. STUDY AUTHORITY

The Coastal Wetlands Planning, Protection, and Restoration Act of 1990 (CWPPRA) directs the Secretary of the Army to convene a Task Force to:

> ....initiate a process to identify and prepare a list of coastal wetlands restoration projects in Louisiana to provide for the long-term conservation of such wetlands and dependent fish and wildlife populations....

The CWPPRA provides that the Task Force shall consist of the Secretary of the Army, who serves as chairman, the Administrator of the Environmental Protection Agency, the Governor of Louisiana, the Secretary of the Interior, the Secretary of Agriculture, and the Secretary of Commerce. The Secretary of the Army is also directed by the CWPPRA to transmit a priority project list to Congress not later than one year following enactment of the CWPPRA and thereafter submit lists annually. Funding is authorized for developing annual priority project lists at the rate of about $40 million annually through fiscal year 1999. The First and Second Priority Project Lists have been submitted to Congress and funding is available for construction of projects on those lists. The Third Priority Project List will be transmitted to Congress in late 1993.

The CWPPRA directs the Task Force to:

> ....prepare a plan to identify coastal wetlands restoration projects, in order of priority, based on cost-effectiveness of such projects in creating, restoring, protecting, or enhancing the long-term conservation of coastal wetlands, taking into account the quality of such coastal wetlands.... Such restoration plan shall be completed within three years from the date of enactment of this title.

The title was enacted on November 28, 1990. Therefore, the Restoration Plan should have been submitted to Congress by November 28, 1993. Due to voluminous comments received on the draft report, requiring substantial revisions, the final Restoration Plan report will likely be submitted to Congress in late 1993, or possibly early 1994. The Restoration Plan, and its potential to significantly affect the environment, are the reasons for preparing this Programmatic EIS.

1.2. BACKGROUND ON COASTAL WETLAND LOSS IN LOUISIANA

Most of coastal Louisiana is the product of alluvial deposits by the meandering Mississippi River over geologic history and the reworking of the material by natural processes. Over approximately the last 7,000 to 8,000 years, the Mississippi River built and abandoned a series of seven delta lobes that formed what is now the Deltaic Plain between Vermilion Bay and the Chandeleur Islands (Figure 1 of the Exectutive Summary). Vast amounts of alluvial material were further transported westward by prevailing currents and developed the Chenier Plain of southwest Louisiana and southeast Texas. During this period of geologic time, abandoned deltas were undergoing deterioration while other delta lobes were developing but wetland gains outweighed wetland losses. Since the time when Europeans first began settling in the lower Mississippi Valley, the Mississippi River has followed essentially the same course, flowing into the gulf at the southeastern tip of Louisiana. In the past several hundred years, the delta has extended itself far out onto the continental shelf and much of the sediment transported by the river is being lost to the Gulf of Mexico. Levees constructed along the river and closures of historic distributaries for flood control prevent the natural process of overbank flooding and deposition of sediments in the wetlands bordering the river. The marsh creation and maintenance processes driven by spring flooding of the major rivers are no longer operating because of the Nation's energy, flood protection, and commerce needs. Furthermore, the natural marsh decaying processes of sediment starvation, subsidence, and saltwater intrusion, which are associated with abandoned deltas, continue and have been greatly accelerated by the same needs that prevent natural marsh creation. Despite the fact that great quantities of sediment continue to flow through the active Mississippi River Delta, this area has experienced massive wetland losses mainly because of high subsidence rates normally associated with compaction of the unconsolidated, underlying alluvial deposits in young deltaic formations. Also, the navigation channel through the Southwest Pass of the Mississippi River carries much of the heavier sediments transported by the river into areas of the Gulf of Mexico that are too deep for wetland development. Preventing further marsh loss, given such large-scale natural processes and human activity, will require an integrated series of large-scale and small-scale projects, such as those listed in the Restoration Plan, rather than continued piecemeal and weakly coordinated efforts.

Approximately 30 percent of the combined Red and Mississippi Rivers' average annual flow is directed to the Atchafalaya River at the Old River Control Structure. A new delta at the mouth of the Atchafalaya River has formed in Atchafalaya Bay since the flood of 1973. This relatively small area of wetland gain, created by sediment deposition, is the only appreciable area of wetland gain in coastal Louisiana. The rest of the coastal area is undergoing various rates of deterioration and loss.

The rate of coastal wetlands loss began accelerating above modern historic levels during the twentieth century. Between the 1930's and 1990, approximately 1,526 square miles of land was disappeared and became to open water in coastal Louisiana. Of that amount, about 74 percent was lost in the Deltaic Plain and 26 percent in the Chenier Plain. Nearly half of the total loss was during the time period between 1956/58 and 1974. This was a period of extensive canal and channel dredging for oil and gas activities and navigation. The land loss rate for coastal Louisiana has decreased from a high of approximately 42 square miles per year between 1956 and 1974 to approximately 25 square miles per year between 1983 and 1990. The highest land loss rates and percentage of loss are occurring in and near the active Mississippi River Delta and in the eastern and south-central portions of the Deltaic Plain (Dunbar et al., 1992). These figures include losses of both wetlands and non-wetlands but virtually all of the loss is in tidally-influenced wetlands. Average annual land loss rates are displayed graphically in Figures 6 and 7 of the main report.

The primary wetland habitat type being lost in coastal Louisiana is marsh. Sizable areas of coastal cypress swamps have also been lost but attention has been focused on marsh because of the magnitude of the problem. In some areas, such as in the Central Wetlands of St. Bernard Parish, cypress swamp killed by saltwater intrusion has successfully converted to functional brackish marsh. Many, if not all, of the reasons given for marsh loss also apply to the loss of swamp.

Detailed discussion of the factors contributing to marsh loss is presented in the Restoration Plan (main report). Since this EIS and the main report are bound in the same volume and will always be circulated together, duplication of the discussion is unnecessary. Please refer to the chapter of the main report entitled, The Problem. Two important items to consider when reading the discussions about marsh loss are that 1) the reasons for marsh loss are both natural and man-induced, and 2) multiple factors usually contribute to the loss of marsh.

1.3. GOALS OF THE PROGRAMMATIC EIS

The CWPPRA Restoration Plan, and its potential for significantly affecting the environment, is the reason for this Programmatic EIS. The first two annual priority project lists were transmitted to Congress without National Environmental Policy Act (NEPA) compliance. This was a necessity due to stringent time constraints imposed by the CWPPRA. The Task Force has directed that NEPA documents, EIS's and Environmental Assessments (EA's), be prepared for all individual projects included on those lists prior to approving them for construction. The projects contained in those lists are part of the overall Restoration Plan.

This EIS will identify the potential environmental effects of the projects and other actions proposed for the CWPPRA Restoration Plan. The effects of the individual proposed projects will not be quantified but rather the effects will be discussed in general terms with specific project examples used for illustration. Many of the projects contained in the Restoration Plan are little more than conceptual ideas and, in other cases, problem areas have been identified, but the manner by which to address the problems has not been determined. The overall impacts of the Restoration Plan and its component projects cannot be determined at this time because they will depend on the specific actions that the CWPPRA funds.

The Restoration Plan contains a variety of methods and measures for creating, restoring, and preserving coastal wetlands. Some of these proposals are small in scale and would have minimal effects outside of their geographical footprint. Other large-scale projects would affect the ecology of one or more hydrologic basins. Cumulatively, the projects proposed in the Restoration Plan would affect most of coastal Louisiana.

The projects proposed in the Restoration Plan far exceed funding provided by the CWPPRA. The CWPPRA provides annual Federal funding of approximately $30-35 million. Of this amount, $5 million is designated for planning efforts, while the funding available for construction, including the State's 25 percent cost share, is about $40 million. Funds were first made available in fiscal year 1992 and will continue to be available through 1999. The annual priority project lists that result from the Restoration Plan will contain those projects that maximize wetland benefits compared to costs, and are within annual funding limitations. Large-scale projects that exceed annual funding limitations are candidates for feasibility study with CWPPRA planning funds but may require construction funding under other agency programs. It is possible that large-scale projects that exceed annual funding limitations could be phased-in over multiple years.

Projects would produce both beneficial and negative effects and divergent segments of the public will view the effects differently. In this EIS, the potential effects of the different types of proposed projects on identified significant resources are discussed. A resource is considered significant if it has been identified as such during public meetings held for the CWPPRA; if it is identified as significant in the laws or regulations of a public agency; or if it is considered significant by the lead and cooperating agencies responsible for this report. Significant resources specifically addressed in this chapter include coastal marsh; cypress-tupelo swamp; submerged aquatic vegetation; wildlife resources; fisheries resources; threatened and endangered species; oyster leases; water quality; National wildlife refuges, state wildlife management areas and refuges, and National parks; property ownership and values; flood protection; navigation and other forms of transportation; recreation opportunities; cultural resources including National Register sites; and various socioeconomic resources.

The effects of individual projects will not be discussed due to the lack of detail available for the proposals and the programmatic nature of this EIS. Project descriptions along with some obvious effects and key issues are included in the Basin Reports' Chapters and appendices to the accompanying main report. This EIS will provide NEPA compliance for the CWPPRA Restoration Plan as a whole, but individual projects selected for implementation will each require specific compliance with NEPA and other environmental and regulatory laws, regulations, and policies.

One of the five Federal Task Force agencies must take a lead role in the planning and implementation of each project. Nearly all proposed projects would require an evaluation for compliance with Section 404(b) of the Clean Water Act since dredging or filling activities in wetlands would be involved. Some non-structural initiatives such as vegetative plantings may be covered under general or nationwide permits. The U.S. Army Corps of Engineers (USACE) administers the Section 404 permitting process with oversight provided by the Environmental Protection Agency (EPA); therefore, lead agencies would submit an application to the USACE to obtain a permit. The permitting process requires preparation of an EA to determine the effects of a proposed action. In the case of a project or group of related projects that could significantly affect the environment, an EIS may be necessary. The determination of whether an EIS is necessary would be made by the lead agency in consultation with the USACE and the EPA.

The USACE has served as author and coordinator of this EIS with cooperating agencies. This role does not obligate the USACE to issue applicable permits to other task force agencies that may be required to build CWPPRA projects or preclude the USACE from recommending modifications to CWPPRA projects sponsored by other agencies as necessary to achieve NEPA or regulatory compliance.

Lead Federal Task Force agencies would determine, through their own NEPA implementing procedures, whether to circulate EA's for their projects or whether to rely on the permitting process to accomplish required NEPA compliance. Any EIS's prepared for projects would be circulated for public comment. The public would also be given the opportunity to comment on proposed projects through widespread circulation of notices of permit application. In Louisiana, a Joint Public Notice is issued by the USACE, the Louisiana Department of Natural Resources (LDNR), and the Louisiana Department of Environmental Quality (LDEQ). The notice serves to advise the public that an application has been made for a permit issued in accordance with one or more of the following statutes: 1) the State and Local Coastal Resources Management Act of 1978, as amended (Coastal Use Permit) administered by the LDNR; 2) the Clean Water Act (Section 404 permit) administered by the USACE; 3) the Rivers and Harbors Act of 1899 (Section 10 permit) administered by the USACE; and 4) the Clean Water Act (Section 401, Water Quality Certification) administered by the LDEQ. The USACE District Engineer would be responsible for signing a Finding of No Significant Impact in the case of an EA or a Record of Decision for an EIS to conclude the NEPA compliance process.

NEPA compliance for projects with the USACE as the lead agency would be coordinated somewhat differently than those sponsored by other agencies. An EA or an EIS would be prepared by the USACE and widely circulated to elected officials, agencies, environmental groups, and other responsible and interested parties. A Section 404(b) evaluation would also be prepared by the New Orleans District, signed by the District Engineer, and circulated for public review and comment. The USACE would prepare a Consistency Determination for submittal to the LDNR in accordance with their Coastal Zone Management Program and an application would be made with the LDEQ for a Water Quality Certificate. A Coastal Use Permit and a Water Quality Certification would be necessary before construction could begin. The District Engineer would be responsible for signing the Finding of No Significant Impact upon completion of the public review process for an EA. For an EIS, the District Engineer or another responsible USACE official would sign a Record of Decision.

Individuals who wish receive notices of NEPA document availability or copies of NEPA documents prepared for CWPPRA projects should request to be included on the mailing list. Requests to be included on the mailing list should be directed to the EIS coordinator identified on the cover sheet of this EIS.

During feasibility study, design, and permitting stages, lead Task Force agencies will consult with the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the Louisiana Department of Wildlife and Fisheries (LDWF) as required by the Fish and Wildlife Coordination Act.

The individual projects selected for implementation under the Restoration Plan are expected to produce a net increase in emergent and/or submerged vegetation over those conditions that would occur without a project. There is some risk involved with these projects. Some of the proposed projects are unproven and actual results attained may not reach the level of success expected. Coastal wetland restoration projects do not have a long track record that can be analyzed to determine the best methods to use under various situations. To a large degree, the Restoration Plan will be implemented using the professional judgement of the scientists and engineers of the Task Force agencies, the academic community, and private contractors. Each of the projects will be monitored according to protocol developed by the Task Force. The results of this monitoring will be used to improve the planning of future projects.

Restoration of wetland habitats will not be realized without affecting the existing condition of the wetlands and possibly, developed areas. Even though the existing condition of the wetlands may not be the most productive or desirable, the users of these areas have grown accustomed to the present conditions and often oppose actions that would change the existing condition because they would be affected socially or economically. A prime example of this is saltwater intrusion in a historically fresh marsh area. The saltwater displaces or kills freshwater species but brings in desirable estuarine species like shrimp, crabs, and finfish. Converting such an area back to a fresher habitat to preserve and restore vegetation by means of a freshwater diversion project could reduce or displace populations of estuarine species and could be opposed by the users of these resources. The effects of projects on these user groups will have to be considered by agency decision makers.

2. ALTERNATIVES

2.1. NO ACTION/WITHOUT CWPPRA CONDITIONS

The CWPPRA provides for a comprehensive, coast-wide, interagency approach to wetland protection and restoration that is not provided for by other legislation or initiatives. With or without the CWPPRA, some funding will probably continue to be provided for research into the causes of wetland loss in Louisiana and for various, sometimes unrelated wetland projects. Some of the types of projects listed under Section 2.3, Alternatives Considered in Detail, would probably be implemented, but not in a timely fashion or at the funding level that the CWPPRA offers.

Prior to passage of the CWPPRA, the USACE and the other Federal agencies that comprise the Task Force, along with the State of Louisiana, had just completed a reconnaissance level report for the Louisiana Comprehensive Coastal Wetlands Study (Comprehensive Study). That study had been funded under the general Louisiana Coastal Area authority given to the USACE by Congressional resolutions passed in 1967. The Comprehensive Study was designed to determine the most cost-effective projects for preserving, restoring, and creating coastal wetlands. It was the predecessor to the CWPPRA. Cost sharing agreements between the USACE and the State of Louisiana for the second-phase, feasibility study process were being negotiated when the CWPPRA was passed. The State and USACE decided to discontinue work on the Comprehensive Study and concentrate efforts on implementation of the CWPPRA. If the CWPPRA had not been enacted, it is likely that the Comprehensive Study would have progressed. However, unlike the CWPPRA, the Comprehensive Study did not provide funding for construction of any projects. Specific Congressional authorization would have been required to implement any proposals under that authority. The Comprehensive Study could be reactivated if the State and USACE agree to resume the study process; however, the CWPPRA has eliminated the need for the Comprehensive Study at the present time.

The Comprehensive Study proposed the use of non-conventional benefit analyses like the Wetland Value Assessment developed later for the CWPPRA to prioritize projects. Normally, USACE's project proposals seeking Congressional approval for construction funding must be justified by producing excess economic benefits over costs. How the results of the Comprehensive Study would have been accepted by Congress and the Administration is obviously unknown. With funding for project implementation already approved and projects not having to compete with the myriad of other civil works projects submitted for funding, the CWPPRA offers an immediate response to the coastal wetland loss problem in Louisiana.

The Louisiana Coastal Wetlands Conservation and Restoration Program, established by Act 6 of the 1989 Louisiana Legislature, Second Extraordinary Session, provides for a trust fund to be used for planning and implementing coastal wetlands projects. This program has successfully implemented a variety of wetlands projects and has studied and identified numerous other projects to benefit coastal wetlands. The program is the State's counterpart to the CWPPRA and its funds are used to cost-share CWPPRA projects. Many of the projects contained in the First and Second Priority Projects Lists are also in the State's Coastal Wetlands Conservation and Restoration Plan and future lists will undoubtedly include other projects contained in the State program. Without the Federal funds provided by the CWPPRA, the State would bear an increased burden of funding coastal wetlands restoration projects, resulting in considerably less project implementation.

The Barataria-Terrebonne National Estuary Program, cost-shared between the EPA and the State of Louisiana, is identifying problems affecting these basins and developing potential solutions. The program deals with a variety of issues including point and non-point source pollution, waste-water treatment, development issues, and wetland issues. The program provides funding for studies and pilot projects.

The Lake Pontchartrain Basin Foundation, under a grant from the EPA, is developing a Comprehensive Management Plan for the Pontchartrain Basin. The draft Comprehensive Management Plan identifies the numerous problems in the basin, including wetland loss, and proposes solutions. However, no funding is provided to implement the solutions.

The Gulf of Mexico Program, also sponsored by the EPA, is a gulf-wide initiative with wide-ranging objectives. A database of information pertaining to the Gulf of Mexico and its coastal areas has been developed. Committees and sub-committees, composed of knowledgeable representatives from various government agencies, private industry, and the public meet to identify problems affecting the Gulf of Mexico and its coastal areas and propose solutions. Very limited funds are available for implementation of projects.

The Coastal America Program is a multi-agency initiative coordinated by the President's Council on Environmental Quality. Its purpose is join the forces of Federal agencies with state, local, and private alliances to collaboratively address environmental problems along our Nation's shorelines. In particular, Coastal America focuses on three widespread problems: loss and degradation of habitat, pollution from non-point sources, and contaminated sediments. Funding for projects identified through this program must be provided through other existing authorities.

Two large-scale, freshwater diversion projects designed to benefit fish and wildlife resources are authorized for construction. The local cost-sharing agreement between the USACE and the State of Louisiana has been signed for the Davis Pond Freshwater Diversion and construction is set to begin in 1994 or 1995, after about one year of real estate acquisition. The project will restore favorable salinity regimes and benefit fish and wildlife resources in the Barataria Basin. The Bonnet Carré Freshwater Diversion would divert freshwater into the Pontchartrain Basin. Negotiations on the local cost-sharing agreement for that project are on-going.

Various other studies and programs are being funded by Federal and State agencies to document items such as coastal wetland loss and barrier island deterioration. Federal agencies have many sources of funding through existing laws and regulations to address specific topics concerning wetlands. For example, the North American Wetlands Conservation Act, administered by the U.S. Fish and Wildlife Service, provides a source of matching Federal grant funds for projects that help fulfill the goals of the North American Waterfowl Management Plan. The primary focus is on acquisition, restoration, enhancement, and management of wetland ecosystems and other habitat for migratory birds and other fish and wildlife. The Small Watershed Act (PL 83-566), administered by the Soil Conservation Service, provides funding for the restoration and protection of small watersheds under 250,000 acres. Programs such as these provide funding for the restoration and protection of both coastal and non-coastal wetlands throughout the entire United States. The CWPPRA on the other hand, focuses public resources exclusively on restoration and protection of coastal wetlands.

2.2. ALTERNATIVES ELIMINATED FROM CONSIDERATION

2.2.1. Plan Formulation Alternatives. According to the CWPPRA, the Restoration Plan shall "coordinate and integrate coastal wetlands restoration projects in a manner that will ensure the long-term conservation of the coastal wetlands of Louisiana". Through scoping and interagency meetings among Federal, state, and local agency representatives and the public, hundreds of projects have been proposed to address the wetland loss problem.

The CWPPRA legislatively mandates the use of cost-effectiveness as the criteria for identifying and prioritizing coastal wetland restoration projects. Alternatives to this process were not considered. For instance, alternatives for the Restoration Plan that would have favored a certain project type, such as sediment diversion, could have been formulated, but this approach would have been contrary to the legislation and would not have been a logical approach to the overall coastal wetlands loss problem. Only those types of project proposals that were obviously in conflict with the intended purpose of the CWPPRA were eliminated.

Alternative methods for prioritizing proposed projects could have been formulated. Unfortunately, no standard system exists for evaluating the habitat quality of coastal wetlands although several methods have been used for specific purposes. Therefore, a method for evaluating the effectiveness of projects was developed specifically for the Restoration Plan. This Wetland Value Assessment methodology is a habitat-based system for quantifying projected changes in wetland habitat quality and quantity for dependent fish and wildlife resources resulting from a proposed coastal wetland restoration project. The CWPPRA Task Force voted to use this methodology to evaluate and prioritize projects proposed for the priority projects lists. An abbreviated variation of the Wetland Value Assessment was used to prioritize all projects proposed for the Restoration Plan having enough detail to allow proper evaluation. Approximately one-half of the proposed projects were evaluated for potential benefits.

2.2.2. Project Type Alternatives. The CWPPRA specifically defines coastal wetlands restoration projects separately from coastal wetlands conservation projects. Coastal wetlands restoration projects are defined as "any technically feasible activity to create, restore, protect, or enhance coastal wetlands through sediment and freshwater diversion, water management, or other measures ...". Coastal wetlands conservation projects are defined as "obtaining of a real property interest in coastal lands or waters, ... for the long-term conservation of such lands and waters and the hydrology, water quality and fish and wildlife dependent thereon...". (A copy of the CWPPRA is provided as Exhibit 1 to the main report.) In other words, coastal wetlands conservation projects would involve obtaining easements or purchasing coastal lands specifically for their protection and management. Coastal wetlands conservation projects are specifically covered under Section 305 of the CWPPRA, while the Restoration Plan and its associated restoration projects are covered under Section 303. There are no projects proposed for the Restoration Plan at this time that would fit the definition of a coastal wetlands conservation project and therefore, that type of project is not covered in this EIS.

Regulation of developmental activities, which includes discharge of dredge or fill material, is also addressed by the CWPPRA. Under Section 304, the CWPPRA provides for funding the State of Louisiana to develop a Conservation Plan when requested by the Governor. The Conservation Plan is to include measures that the State shall take to achieve a goal of no net loss of wetlands as a result of development activities; a system to account for gains and losses of coastal wetlands for evaluating the attainment of no net loss; a program for public education on the need to conserve wetlands; and a program to encourage development and use of technologies that have negligible environmental impact. When the plan is complete and approved, the cost-share required of the State for CWPPRA project implementation will be reduced from 25 percent to 15 percent. The required agreement between the designated State agency (which has the responsibility for implementing and enforcing the Plan), the EPA (who administers the grants), the USACE, and the USFWS is being developed. Since regulation of developmental activities in wetlands is specifically covered by another section of the CWPPRA, it will not be considered as an alternative in this EIS which deals only with Section 303.

Proposals to help individuals or corporations mitigate for environmental damage caused by their projects with CWPPRA funds were eliminated. Also, proposals to move people out of developed areas so that areas can be restored to wetlands were eliminated. Other proposals that did not provide for protection, restoration, or creation of coastal wetlands were eliminated. A discussion of all project proposals submitted during Restoration Plan development is included in the Basin Reports' chapters and appendices of the main report.

Even though Louisiana has lost many thousands of acres of coastal marsh, there remains some extensive areas of marsh with very little interspersed open water (ponds). The habitat quality of these areas for many desirable aquatic and wildlife species could be improved by increasing the amount of interspersed ponds in the marsh; however, emergent marsh vegetation would have to be destroyed. This type of action, even though it may increase the habitat quality for some species, is considered counter to the mandate of the CWPPRA to preserve coastal wetlands, and will, therefore, not be considered.

Marsh burning is a practice commonly utilized in Louisiana to remove dead mats of marsh vegetation, especially saltmeadow cordgrass (*Spartina patens*), and encourage vegetative diversity. Benefits of marsh burning include increasing the quality of the habitat for some species of wildlife, facilitating human access to the marsh, and reducing the potential for devastation by marsh wildfires. Marsh fires can be classified as either wet or dry burns. Wet burns are conducted when the marsh soils are completely saturated and other factors, such as wind speed and direction, are favorable. By removing the dead, matted vegetation, the ground surface is exposed allowing the germination of desirable species like three-cornered grass (*Scirpus olneyi*) and leafy three-square (*Scirpus maritimus*), along with regeneration of saltmeadow cordgrass from root mats. The tender shoots of these species provide ideal forage for ducks, geese, swamp rabbits, muskrats, and other animals. Dry burns, on the other hand, have a high risk of destroying the organic soil material along with matted vegetation. Dry burns, unlike wet burns, would normally not be used by a responsible manager but may occur as a result of lightning or from irresponsible human action. By destroying the root mat that binds the soil together, dry burns increase water depth and increase the potential for marsh loss. Despite the aforementioned positive effects of proper marsh burning, it is not included as a alternative to be considered in detail because there is no evidence available to indicate that burning reduces the loss rate of marsh vegetation or builds new marsh. This practice alone is viewed primarily as vegetative enhancement for certain species of wildlife. However, elimination of marsh burning as a project type does not preclude the recommendation and use of burning within areas affected by CWPPRA projects under proper conditions and situations.

2.3. ALTERNATIVES CONSIDERED IN DETAIL

2.3.1. Introduction. The CWPPRA specifically directs the development of priority project lists and a Restoration Plan to incorporate such lists. The Task Force could have chosen any of a myriad number of ways to approach development of the Restoration Plan. Due to the enormity and complexity of the coastal wetlands loss problem in Louisiana, a system had to be developed to divide the area into manageable units. A hydrologic basin approach was adopted whereby a comprehensive plan for addressing coastal wetland loss was developed for each of coastal Louisiana's nine hydrologic basins (Plate 1 of the main report). Representatives from Task Force agencies ("Basin Captains") were selected and formed basin teams with other Task Force personnel. Basin teams also included representatives of the scientific community, local governmental agencies, and consulting contractors, but decisions regarding the basin plans were made by the Task Force agency representatives.

Basin Captains and teams were given direction by the Task Force to include all reasonable proposals and projects in the Restoration Plan regardless of cost. This direction made designation of mutually exclusive alternatives difficult. The Basin teams took information on basin problems and solutions, developed during strategic planning meetings conducted in 1991, and formulated basin plans. Several proposals were eliminated in every basin because they were not appropriate for CWPPRA funding or they duplicated other proposals. Some basin plans include a project or set of projects that meet the key objective(s) in the basin by solving the most pressing wetland loss problem(s). These projects are defined as critical. Supporting projects are included in the plan to address less critical objectives. The Plan at this point is a sort of catalog, listing critical and supporting projects, from which the most beneficial projects will be chosen for implementation.

Recognizing a general lack of basin-level alternatives, the methods and measures (project types) that could be implemented to restore, create, or protect coastal wetlands were used to form the basis for the discussion of alternatives in the EIS. Proposed projects have been grouped under thirteen major types: marsh management, hydrologic restoration, hydrologic management of impoundments, sediment diversion, freshwater diversion, outfall management, marsh creation (with dredged material), barrier island restoration, shoreline erosion control with structures, vegetative plantings, terracing, sediment trapping, and herbivore control. Specific proposals often combine more than one project type. For example, a large-scale hydrologic restoration project may include hydrologic restoration, marsh management of some sub-areas, shoreline erosion control with vegetative plantings or structures, and sediment trapping. Projects to demonstrate new technologies have also been placed under one of the thirteen categories.

The restoration plans for each basin are summarized in the main report and described in detail in its appendices. A very brief summary of projects and approaches proposed for each basin is presented in Section 3.4, Cumulative Impacts of Alternatives. The following sections describe the thirteen types of projects that have been proposed for the CWPPRA Restoration Plan.

2.3.2. Marsh Management. No universally accepted definition of marsh management exists. Cahoon and Groat (1990) offered one definition, Clark and Lehto (1991) reviewed several definitions, and Good and Clark (1993) cite a Louisiana statute that defines marsh management [Title 43:I.721(L) La. Admin. Code]. Regardless of the definition, the primary focus of marsh management is on water manipulation. Salinity, sediment load, flow velocity, and water levels are the attributes of water that are targeted for modification. The kinds, numbers, and vigor of plants and animals that comprise wetlands are sensitive to those same attributes. By attempting to selectively modify attributes, individually or in combinations, managers try to induce the desired plant and animal community responses. Proposed marsh management projects would likely be implemented in hydrologically altered areas where sediment and freshwater introduction is not feasible. In such cases, management is an attempt to assist marshes in countering the detrimental effects of mainly human-induced hydrologic changes.

Managers attempt to change selected hydrologic attributes either passively or actively. Passive management relies upon the use of non-adjustable structures. In contrast, active marsh management relies upon water control structures that can be reconfigured on an as-needed basis to effect one or more hydrologic attributes.

In order to effectively manage water levels and water flows, it is necessary to ensure the integrity of managed areas. New tidal connections can develop by the scouring action of water running across the marsh surface whether or not an area is managed. Natural levees, ridges, and lake rims surrounding proposed management areas would be evaluated for compatibility with structures and management plans proposed, and may have to be augmented by constructing low-level embankments. Existing canal banks may be gapped, reinforced, or otherwise modified, depending on hydrologic needs and conditions within the managed area.

The marshes of coastal Louisiana and South Carolina have been managed for similar reasons and in somewhat similar ways for many years. Improving conditions for waterfowl, furbearers, and recreational opportunities, as well as agriculture and fisheries production (to a much greater degree in South Carolina than Louisiana), have been and remain reasons to manage coastal marshes. In Louisiana, there is more emphasis on the role that marsh management can play in preserving and restoring emergent wetland vegetation.

DeVoe and Baughman's (1986) report of comparative studies of some managed and unmanaged South Carolina marshes are not directly applicable to all managed South Carolina marshes and are not directly applicable to Louisiana's marshes, managed or unmanaged. However, the South Carolina studies do provide some insight into the possible differences that may be expected between managed and unmanaged marshes in Louisiana.

2.3.2.1. Passive Management. The principal reason for choosing to passively manage marshes would likely be to enhance some attributes of fairly stable marshes by reducing tidal erosion, stabilizing water conditions, and enhancing conditions for some marsh-dwelling species. Several structures are used for passive management in Louisiana. Fixed-crest weirs, slotted weirs, rock weirs, plugs, levees, and trenasses (ditches) are the most common. These structures have both beneficial and adverse effects that are discussed in Section 3.

The traditional concept of passive marsh management is evolving into a relatively new concept called hydrologic restoration, to be discussed later. In contrast to passive marsh management, hydrologic restoration does not prevent or severely restrict the lowering of water levels below a certain elevation. Also, hydrologic restoration projects differ considerably from passive management because they minimally disrupt natural channels and do not prevent the sheet flow of water (and organisms) across the marsh during normal tidal stages as can be the case for passive management. Hydrologic restoration projects often contain the same type of structures used for passive marsh management, but sufficient vertical clearance is left in major tidal streams to allow for water exchange during periods when tidal levels are below normal. Neither of the two project types would prevent storm-driven high tides from entering or exiting protected marshes.

A number of First and Second priority project list projects contain plugs and weirs that can also be used for passive marsh management. However, these structures, when used for hydrologic restoration, would not be used to manipulate water levels, but rather to reduce and redirect water flows to other major waterways that would be left open to tidal exchange. Therefore, these projects are referred to as hydrologic restoration.

There are no specific projects envisioned at the present time for CWPPRA funding that are considered to be passive marsh management. As projects are developed for priority projects lists, some may be designed as passive management. However it is unlikely that this type of project will play a significant role in implementation of the CWPPRA. Passive marsh management is included as a project type only because of the possibility that during more detailed project development, situations may arise where passive management is determined to be an appropriate response to a wetland problem. Descriptions of the various structure types used for passive management that follow are applicable to hydrologic restoration as well.

2.3.2.1.1. Fixed-crest weirs. A fixed-crest weir is a low-level dam having a crest permanently set at some elevation relative to the surrounding marsh surface, usually about 6 inches lower. Most fixed-crest weirs constructed in Louisiana are of similar design and vary mainly in the method of construction and the materials used. Pilings are used to support the weir which may consist of wood, metal, or concrete sheet piling. Fill material is often deposited at the points where the weir ties into the channel bank to stabilize the weirs ends and prevent washing out.

Fixed-crest weirs were first used in Louisiana during the early 1940's. Weirs were and are constructed so that during low water periods they hold enough water in the affected area to facilitate access by boat, which also protects any submerged aquatic vegetation from drying out and, subsequently, perishing.

Nowadays, proposals to use only fixed-crest weirs to manage areas are extremely rare. Fixed-crest weirs are more often used in combinations with other kinds of water control structures to compliment management goals and objectives.

2.3.2.1.2. Slotted Weirs. Developed in the late 1980's, a slotted weir is similar to a fixed-crest weir in that it usually has a crest set six to 12 inches below marsh surface level, but is different in that it has an opening running vertically from the top to (or very near) the bottom of the weir. The slotted weir began as an experiment designed to alleviate the reduced fisheries access problem related to the use of conventional fixed-crest weirs. It has proven itself to be an improvement in this regard (Rogers, Herke and Knudsen, 1992). A recent variation is to build a slotted weir with a closable slot to provide for increased management options. Slotted weirs have also been perceived to be beneficial in enhancing sediment, nutrient, and water exchange, compared to fixed-crest weirs. Thus, the use of slotted weirs has increased in recent years but costs of construction and maintenance have somewhat curtailed its wider use.

2.3.2.1.3. Rock Weirs. A rock weir is a low-level dam composed of graded or mixed rock or concrete rip-rap across a channel with a crest height typically one-foot or more below the marsh surface elevation. An advantage to this type of weir over the fixed-crest and slotted weir designs is that rock can be added or removed if necessary to vary the height of the weir. Use of rock weirs is limited to areas with soils capable of supporting these heavy structures.

2.3.2.1.4. Plugs. A plug is a permanent barrier constructed across a channel to obstruct all water flow. Unlike weirs, plugs extend above water level and do not permit normal tides to flow in or out of the managed system. Plugs are typically installed only on man-made channels, but could be installed on small tidal openings that have developed in recent times due to scour or erosion. They can also be used to shunt water to other areas. No projects are proposed for the Restoration Plan that would involve completely closing off an area to tidal influence with plugs, although plugs are proposed for some projects to reduce the numbers of tidal openings or to redirect water flows to other structures.

2.3.2.1.5. Trenasses. A trenasse, also known as a level ditch, is a shallow ditch dug in a marsh. Originally, their purpose was to facilitate access into isolated marsh areas for trapping and hunting. Today they are used in some marsh management plans to more efficiently move water to or away from water control structures, to direct fresh water into a management area, or to provide proper water distribution.

2.3.2.2. Active Management. The reasons for choosing to actively manage marshes under the CWPPRA are to induce and invigorate the growth of emergent marsh and submerged aquatic plant species. Significantly more management capability is acquired, relative to passive management, when the amount, timing, quality (salinity) of water and sediment moving into and out of managed areas, can be controlled by manipulating water control structures. Active management structures can be configured to halt all water exchange when appropriate. They can also be configured to allow unhindered water exchange through the structures. Usually, they are configured to dampen exchange rates and volumes.

Active management provides the manager with expanded potential to create conditions that are conducive to: 1) inducing emergent marsh plants to grow on substrates that would otherwise be covered by shallow water; 2) inducing or invigorating the growth of submerged aquatic vegetation in open water areas; and 3) invigorating the growth of existing emergent marsh plants. To achieve these responses, managers typically select to install combinations of fixed-crest weirs, variable-crest weirs, and flap-gated culverts. There are many variations of the above listed structure types. In recent years, permits for structural management have often required that flap-gated, variable-crest structures include a vertical slot in their variable crest portions. Clark and Hartman (1990) noted that active management structures can be used in various combinations which determine the degree of effectiveness as well as degree of impact.

Which structures are to be located where, and operated according to what schedule, is determined on a case-by-case basis. Pumps can also be used but their use is more appropriate for existing impoundments, something different than active management. In Louisiana, operation of water control structures associated with active marsh management projects can have as many as three phases (Clark and Lehto, 1991; Paille, 1993). Phase 1 is the draw-down phase. Phase 2 is the water level maintenance phase. Phase 3 is the fresh water and sediment input phase. Freshwater and sediment sources frequently are not available and therefore phase 3 operations have limited applicability and documentation.

Phase 1 typically occurs during the spring and early summer months of every third year, but can be conducted more frequently. During phase 1, water control structures are configured to discharge water and preclude the entry of all water except rainfall. The goal is to sustain water levels below normal tidal level. The desired responses are the growth of vegetation on exposed substrates (mudflats and water bottoms), invigorated growth of existing marsh plants (both of the root mats and shoots), and initiation or invigoration of submerged aquatic vegetation in any remaining open water areas. Under favorable meteorological and hydrological conditions, these responses can be achieved by: 1) setting the crests of variable structures from 1 to 2 feet below marsh level; and 2) setting some or all flap-gates to discharge water and allow only rainwater to enter the managed area. Water is, therefore, removed from the managed area by gravity flow whenever a favorable head differential exists. Frequently, the timing and amount of rainfall, combined with high water levels outside of the managed areas, can preclude drawdowns sufficient to expose shallow water bottoms.

Phase 2 immediately follows phase 1. Phase 2 is in effect for the remainder of the year or unless a phase 3 operation is undertaken. Phase 2 goals are to sustain water levels within a suitable range, to protect against stressful conditions (rising salinity and water levels), and to maintain as much exchange with the estuary as possible without compromising the management effort. The primary response is the continued growth of marsh and submerged aquatic plant species. Another desired response, partly dependent upon achieving the primary response, is to increase furbearer population densities and/or to encourage overwintering waterfowl to use the area. These responses can be attained, under favorable meteorological and hydrological conditions, by setting variable weir crest elevations to about six inches below marsh surface elevation and by locking flap-gated structures open. Tidal exchange may be discontinued when salinity or water levels approach stressful levels. During waterfowl and trapping seasons, weir crest elevations are usually raised again (typically up to at least marsh level) to insure that sufficient water depth is maintained for hunter and trapper access and to enhance habitat for overwintering waterfowl.

A recent innovation, implemented on a limited basis during the last several years, is the inclusion of a flow-through phase (phase 3). Phase 3 operations can range from simple freshwater introduction to more complicated flow-through operations. The goal of phase 3 is to get fresh water, nutrients, and/or sediments into the managed area. The desired responses are the invigorated growth of rooted marsh plant species and sediment retention. Fresh water, with suspended sediments and nutrients, when and where available, is encouraged to flow into a management area through one or more structures. Excess freshwater, less much of its nutrient and sediment loads, exits the managed area through structures on the downstream side. The fresh water flow-through helps to keep soil salt levels below stressful or toxic levels. Phase 3 can be employed from spring to early summer during years when draw-downs are not attempted.

2.3.3. Hydrologic Restoration. Hydrologic restoration differs from marsh management in one principal fashion. It is employed to reduce and redirect tidal water flows whereas marsh management is employed to control water levels and water flows. Hydrologic restoration is used to restore, to the extent practical, historic water flow patterns and water and salinity regimes in wetlands that have been subjected to increased tidal action from canal dredging, erosion, and channel widening, by reducing and redirecting water flows. Projects would somewhat dampen water level fluctuations within restoration areas, but tidal flows would not be manipulated or restricted from rising above or dropping below certain levels as in the case of active marsh management projects.

Hydrologic restoration projects consist of structures such as plugs and weirs used to reduce flows in canals dredged through or into a wetland area and redirect water flows to naturally occurring bayous and streams. In many proposals, natural waterways leading into a wetland area may also be reduced in size to lessen tidal scour and redirect water flow, especially if these waterways have eroded and increased in size during recent times. Occasionally, small tidal streams that have developed recently due to erosion or marsh deterioration may have to be closed with plugs, but larger, historically-active bayous would not be closed. Structures on major water routes would typically have sufficient vertical clearance below the water surface to provide access for both vessel traffic and migrating aquatic species. Additional project features may include degrading or gapping canal banks to restore sheet flow across wetlands or rebuilding natural levees and canal banks to control water flows. Projects may also include shoreline stabilization and vegetative plantings. Hydrologic restoration does not require construction of levees to isolate the restoration site from surrounding wetlands. Hydrologic restoration is passive; no manipulation of structures or other variables is involved. The Lower Bayou LaCache (TE-19) and Jonathan Davis Wetlands (PBA-35) projects from the First and Second Priority Project Lists, respectively, are good examples of hydrologic restoration projects.

Durable structures are required to reduce water flows in scoured and eroded channels. Structures must be able to withstand tidal forces and be constructible on the poor soil conditions common in coastal Louisiana. Rock weirs with boat bays appear to be the preferred structure type based on proposals submitted for the Restoration Plan. These structures are very similar to the rock weirs described for passive marsh management but differ in their top elevation. The entire width of the weir, except for where it ties into the channel bank, may be well below the average water surface and there is normally a lower section in the center of the weir (boat bay) for passage of boat traffic. Consequently, water flows are not restricted nearly as much as by a rock weir constructed for passive marsh management. Rock weirs, because of their weight, are limited to areas where the soil is capable of supporting them.

Hydrologic restoration projects can range in size from small areas of several hundred acres to large-scale projects that would alter the hydrology of major portions of hydrologic basins. For example, the Central Basin Tidal Drag Enhancement project for the Barataria Basin (XBA-63) would attempt to reduce tidal flows in the upper half of the entire basin.

Projects that would maximize the beneficial use of sediment-laden waters found in the GIWW in the Terrebonne, Atchafalaya, and Teche/Vermilion Basins are also considered to be hydrologic restoration although they typically contain features of freshwater diversion, shoreline protection, and hydrologic restoration projects. The turbid water would be allowed to flow into deteriorated marshes on either side of the GIWW and distribution of water in the marsh would be controlled using hydrologic restoration techniques. Areas to be benefitted from these projects may or may not have problems related to salt water intrusion but do have sediment deficit problems.

2.3.4. Hydrologic Management of Impoundments. This type of project would be used to restore and enhance wetland functions in areas that have been impounded by levees and have undergone either subsidence and deterioration to open water or draining and conversion to non-wetland habitat. Previously leveed areas that have lost either part or all of their wetland functions would be restored, as much as feasible, to a viable marsh system by improved hydrologic control. Such areas have typically been impounded for reasons other than wetland preservation or restoration. Some of these impounded areas have been drained and converted to non-wetlands while others suffer from chronic high water levels. Water control structures and their operational scheme would have to be custom designed for individual project areas and may include pumps and other water control structures typically used for active marsh management. The end product of such projects would indeed be a form of management and a valid argument could be made to include this type of project under the marsh management category. The major difference between these projects and more typical marsh management lies in the existing condition of the impounded areas. The arguments and controversy surrounding the effect of marsh management on estuarine fisheries access are not applicable to impoundments since estuarine species are currently excluded or severely restricted from using these areas. Therefore, even though there are only a limited number of these projects proposed, they should be distinguished from marsh management due to their lack of additional impact on estuarine fisheries resources.

In typical examples like the Bayou Sauvage Projects (XPO-52A and XPO-52B) from the First and Second Priority Project Lists, the project area has been enclosed within a hurricane protection levee system and existing water level control structures (flap-gated culverts) are not effective in maintaining desirable wetland habitat. Past land use practices have caused the area to subside. Re-connection of the area to the tidal system is not feasible because the soil surface elevation is too low to support emergent vegetation and the hurricane protection system would be compromised. A system of pumps and other water control structures would be used to regulate water levels and to optimize wetland functions.

2.3.5. Sediment Diversion. One of the major causes of coastal wetland loss, especially in the Louisiana Deltaic Plain, is the deprivation of riverine sediments as a result of levee systems constructed along the Mississippi River and its tributaries for flood control. The primary purpose of sediment diversions is to create wetlands by re-establishing natural sediment deposition. Sediment diversions have the potential to create, restore, and preserve large areas of marsh, however the total amount of water and sediments in Louisiana's river systems is limited. The location and size of both freshwater and sediment diversions must be optimized to achieve the greatest benefit and minimize adverse impacts. One of the priority planning studies to be undertaken for implementation of the Restoration Plan will determine the sediment and freshwater budget of the Mississippi River below the Old River Control Structure.

Sediment and freshwater diversions attempt to mimic the natural over-bank flows that occurred annually during high river stages, typically in the spring of the year, before humans harnessed the lower Mississippi and Atchafalaya Rivers. Sediment diversion is as close as we can get to reestablishing the natural process of riverbank overflow given the existing development in coastal Louisiana. The Mississippi River built most of the coastal wetlands in Louisiana and in it lies the best hope for restoring wetlands that have been lost in recent decades. Protective measures can, in many instances, reduce or stop the loss, but generally cannot restore large areas of wetlands.

Sediment diversion would involve breaching the natural bank or levee of the Mississippi or Atchafalaya River, or their passes, and allowing sediments and freshwater to flow into shallow open water or deteriorated wetlands. The only existing man-made sediment diversions are the small-scale crevasses located along the passes in the active Mississippi River Delta. They have been moderately to very successful in restoring marsh and scrub/shrub wetland habitats. These small-scale diversions have been nothing more than cuts dredged through the natural banks to allow sediment and water to flow into adjacent shallow ponds and lagoons. Large-scale diversions along the main stem of a river would require much more detailed engineering and design to determine the optimal site location, angle-of-cut, depth-of-cut, scour possibilities, and effects on a variety of socioeconomic uses and environmental resources.

The West Bay Sediment Diversion project (FMR-3) included on the First Priority Project List is a large-scale sediment diversion directly from the Mississippi River below Venice at approximately river mile 4.5 above Head of Passes. As proposed, the project would involve cutting a gap in the west bank of the river, below the terminus of the mainline Mississippi River levee system, to allow river water and sediment to flow into an area of largely shallow open water. This site was found to provide the greatest economic benefit out of a number of sediment diversion sites evaluated during a study conducted by the USACE and the LDNR. Additional large-scale sediment diversions are included in the Restoration Plan for sites on both sides of the Mississippi River below New Orleans including Myrtle Grove and Homeplace on the west side and Bohemia and Benny's Bay on the east side. The Mississippi River Channel Relocation project (PMR-6) would divert up to 70 percent of the Mississippi River's flow through a new channel into either the Breton Sound or Barataria Basin. Obviously, this project would require extensive engineering and design work along with a thorough evaluation of its environmental effects and socioeconomic impacts before it could be constructed.

Special features of this type of project may include sediment retention devices and various techniques to manage wetlands nourished and created in the area influenced by the diversion. Large-scale sediment diversions, which are designed to take a percentage of the river's sediment bedload, require a deep excavation and a gradually upward sloping channel to move the sediment into the wetland creation area. Periodic dredging of the distributary passes may be necessary in order to keep the diversions operating effectively.

The Atchafalaya River, a major distributary of the Mississippi River, and the Atchafalaya Basin Floodway system are a primary element of the Mississippi River and Tributaries flood control system for southeast Louisiana. The Atchafalaya, which is apportioned 30 percent of the combined Red and Mississippi Rivers' average annual flow through control structures at Old River, has filled in large parts of its interior basin since the 1950's and has developed an extensive active delta in Atchafalaya Bay since the early 1970's. Wetlands form in this area because of the relatively shallow waters of Atchafalaya Bay and the consolidated nature of underlying sediments as compared to the Mississippi River Delta. The Big Island Sediment Mining and Atchafalaya Sediment Delivery projects (XAT-7 and PAT-2) from the Second Priority Project List are examples of the types of sediment diversion projects possible in the active Atchafalaya Delta. They are similar to, but larger than, the small-scale sediment diversion projects that have been implemented in the Mississippi Delta.

Another type of sediment diversion, designed to enrich the flow of existing and planned freshwater diversions with sediments, has been proposed. Conceptually, sediment enrichment would be accomplished in either of two ways, but would only be applicable to freshwater diversions from the Mississippi River. First, a hydraulic cutterhead dredge operating in the Mississippi River in the vicinity of the freshwater diversion could discharge dredged material just upstream of the freshwater diversion inflow channel. In theory, heavy sands would quickly settle to the bottom while lighter silts and clays would be carried through the diversion structure and discharged into the estuarine system to combat subsidence. Another method that has been proposed for freshwater diversion siphons is to extend the diversion's inflow pipes so that they pull water from a lower depth which may have a higher concentration of suspended sediment. The Siphoned Sediment Enrichment of Freshwater Diversions (XBA-67) project for the Barataria Basin is an example of this type of sediment diversion.

In the western part of the state, and some other areas isolated from the major rivers, sediment is not available to implement projects of this type. In these areas, the growth and maintenance of marshes is more dependent on organic accumulations (Nyman et al., 1993; Gagliano and Roberts, 1987) and the use of other project types becomes more important.

2.3.6. Freshwater Diversion. Freshwater diversions and sediment diversions differ in their intended purpose and in the type of excavation or structure required for diversion. Several small-scale (100-2000 cubic feet per second) and two large-scale (8,000-12,000 cubic feet per second) freshwater diversion structures (Caernarvon and Bayou Lamoque structures) have been constructed along the Mississippi River south of New Orleans. The small-scale structures are siphons that run over the river levees. The large-scale structures are steel and concrete culverts with closure gates that pass through the river levees. These diversions were built mainly to benefit fish and wildlife resources and vegetated wetlands by restoring favorable salinity levels in the affected estuaries. In addition to these structures, overflow weirs have been constructed along the armored banks of the Mississippi River, below the terminus of the mainline levee system. These weirs were installed as mitigation for rock dikes placed along the river banks. All of these structures have the potential to reduce the loss of wetlands, especially marsh, by reducing saltwater intrusion and adding nutrients from the Mississippi River. Considerable volumes of suspended sediments would also be diverted along with fresh water. At Caernarvon, several hundred acres of marsh are expected to develop in a large, shallow area of open water near its outfall over the next 50 years. Any development of marsh from freshwater diversions would likely be very near the diversion outfall and would depend on the configuration of the outfall area and outfall management features.

Two more freshwater diversions, the Bonnet Carré and Davis Pond diversions, have been authorized for construction through other authorities and are in the advanced design stage. The potential exists for additional freshwater diversions along the Mississippi River and its distributaries, including the Atchafalaya River, Bayou Lafourche, and other rivers in the coastal plain. There is a point at which diversion of too much water from the Mississippi River will begin to seriously effect the ability of the USACE to maintain the navigation channel. This critical point has been estimated at 100,000 cubic feet per second (CFS) measured during average high river stage. The total possible discharge of all structures currently authorized for construction and those already constructed is about 65,000 cfs, however it is unlikely that all structures would ever be operated at design capacity simultaneously.

Nevertheless, new proposals for freshwater and sediment diversions will have to be evaluated for their effects on navigation. The study referred to previously under sediment diversion will determine the freshwater and sediment budget of lower Mississippi River.

Freshwater diversions can be operated to mimic the natural over-bank river flows normally associated with spring flooding. They work with the natural process of marsh maintenance by supplying fine grained suspended sediments to counter the natural subsidence and compaction of alluvial deposits. They also provide nutrients that cause invigorated plant growth. Increased organic deposition stemming from invigorated plant growth also contributes to the vertical accretion process. Freshwater diversions can maintain and invigorate existing wetlands, but generally would not restore wetlands in areas of existing open water to any significant degree. Suspended sediments that would drop out of the diverted waters near diversion sites would, over time, form some vegetated areas, but the only real hope for restoring significant areas of coastal marsh and swamp that have been lost to open water is sediment diversions which capture a portion of the river's bedload. Sizable areas of marsh could be developed through the use of dredged material, but that method is costly and very inefficient except when dredged sediments are available in close proximity to a potential marsh creation site.

A very different type of freshwater diversion is possible in Chenier Plain. Water levels in the upper Mermentau Basin (Lakes Subbasin) are normally held higher than mean sea level, mainly to conserve fresh water for agricultural and navigational uses. Effects of saltwater intrusion in the eastern part of the Calcasieu/Sabine Basin and the lower Mermentau Basin could be lessened by diversion of excess freshwater from the northern part of the Mermentau Basin. Additionally, reducing water levels in the Lakes Subbasin would help reduce shoreline erosion occurring around Grand and White Lakes and would also reduce the stress on vegetation from chronically high water levels. The total amount of water available for diversion must be balanced with agricultural, navigational, and other competing interests in the basin. An impediment to diversions from the Lakes Subbasin is the fact that water levels in potential outfall areas are sometimes higher than those within the subbasin. Some freshwater diversion projects have already been constructed by local interests and the State, and more are proposed. The Pecan Island Diversion (ME-1), already constructed by the State, is a prime example of this type of project.

Most freshwater diversions consist of a structure through which flows can be regulated depending on the existing salinity regime of the outfall area. During wet periods when ambient conditions in the target area are fresher than normal, flows can be restricted to prevent unacceptable adverse impacts to estuarine fish species or to prevent inundating the outflow area. The constructed and envisioned sediment diversions do not have a mechanism for regulating flows, except for filling or partially filling the diversion sites with dredged or fill material.

2.3.7. Outfall Management. Outfall management is a form of hydrologic restoration but it will be discussed separately because it is dependent upon a freshwater source and because its intended purpose is considerably different. The purpose of outfall management is to make optimum use of freshwater, nutrients, and sediments conveyed through a freshwater or sediment diversion by managing water flow through a specified outfall area. These projects reduce channelized flows and route the diverted flows across marshes or through shallow water areas instead of through larger channels so that suspended sediments are deposited and marshes are nourished and created. Outfall management has been proposed for all existing and proposed freshwater diversions from the Mississippi River, because outfall management was not provided when the projects were funded. Project features are very similar to those used for hydrologic restoration. These features may include degrading or rebuilding canal banks as appropriate, plugging or filling canals, reducing the cross-section of natural tidal waterways, and using hay bales, brush fences, or low-level dikes to direct water flow and trap sediment. No outfall management projects have yet been constructed. The Caernarvon Outfall Management project (BS-3b) included on the Second Priority Project List is a good example of an outfall management proposal.

2.3.8. Marsh Creation with Dredged Material. This type of project would utilize material dredged specifically for marsh creation or material dredged during maintenance of navigation channels to create marsh or nourish existing deteriorated marsh. The conventional method is for a hydraulic cutterhead dredge to remove material (sand, silt, and clay) from the bottom of a water body and pump the material through either a floating or submerged pipeline and discharge the material into either a shallow open water area or into a deteriorated marsh. A typical deteriorated marsh is an area of mostly shallow water with some interspersed emergent vegetation that is dying due to subsidence or erosion.

Care must be taken to deposit the dredged material so that after settling, the elevation is conducive to the growth of marsh plant species. Vegetative plantings are sometimes used to establish desirable wetland species on the newly deposited material, although rapid colonization and spread of vegetation usually occurs naturally on material of proper elevation.

Dredged material may be excavated specifically for marsh creation efforts from nearby water bottoms or may come from maintained navigation channels. When marsh creation is accomplished with material dredged from a navigation channel, the CWPPRA could provide funds for the incremental cost of creating marsh above the cost of disposing the material in the least costly, environmentally acceptable manner. The USACE, New Orleans District uses material dredged from navigation channels for wetland development when this method of disposal is appropriate and when the cost of doing so does not substantially increase the cost of maintenance dredging. In many cases, no suitable marsh creation or nourishment sites are located near the dredging sites and an additional source of funding is necessary to utilize the material in a beneficial manner.

Proposals have been made to use unconventional technologies and materials for marsh creation. Some of these proposals are controversial. There are proposals to use abandoned oil and gas pipelines for transporting material to distant sites, innovative spraying techniques to spread dredged material evenly over shallow water or deteriorated marsh, and spent bauxite (locally referred to as "red mud") for building substrate to an elevation suitable for colonization by marsh plant species. While red mud is mined, not dredged, the method by which it would be deposited for marsh creation would be similar to methods used for dredged material. These types of proposals would probably be designated as demonstration projects that are specifically addressed in the CWPPRA. The Red Mud Wetlands Restoration project (XTE-43) is a proposed demonstration project that would utilize red mud generated at a Kaiser aluminum plant near Gramercy, Louisiana to build marsh substrate. The project site is located on vacant land st the plant site. This demonstration is designed to determine if red mud would be suitable for larger-scale restoration efforts. There are many questions to be answered about the possible toxic effects of this foreign material on the wetland ecosystem. The Falgout Canal South project (TE-20) is a proposed demonstration of a prototype for a regional system to mine, deliver, and distribute river sediment via pipelines and spray nozzle application. The Sediment Conveyance Demonstration project (XTE-66) would attempt to use gravity flow and pipelines to distribute sediment into subsided marsh areas.

2.3.9. Barrier Island Restoration. This type of project is similar to marsh creation with dredged material, but differs in several ways. The main purpose of this type of proposal is to restore barrier islands, not only for the marsh and dune habitat on the islands, but also for the protection that they may provide to the marsh and estuarine ecosystem landward of the islands. The extent to which barrier islands protect mainland marsh varies according to the proximity of the islands to the mainland marsh and the depth and extent of intervening bays. The actual amount of protection that would be provided to interior marshes by specific barrier island restoration projects is largely unknown and is the subject of considerable debate among the Task Force agencies. Barrier island restoration involves the pumping of sand, from either offshore deposits or from deposits in the bays behind the islands, into previously constructed containment cells on deteriorated barrier islands. The habitat created is a combination of dune, back-dune scrub/shrub and mangrove, and marsh. The dune habitat is essential to the integrity of barrier islands because it protects the marsh areas on the inland side of the islands from direct wave attack during storm events as well as providing material for the natural landward migration typical of many barrier islands.

Proposals have also been made to protect the barrier islands of the Barataria Basin with hard structures such as detached breakwaters (XBA-1A1 through XBA-1E1).

These projects are addressed under the following category of projects; shoreline erosion control with structures.

2.3.10. Shoreline Erosion Control with Structures. Various types of materials and structures can be used for shoreline erosion protection. The material most commonly used in Louisiana is quarried rock of various sizes. Sometimes filter fabric, geotextile material, and shell or other lightweight aggregate is used as a base for the rock. Other materials that have been used are shell, used tires, and timbers. In some cases where wave energy is low to moderate, material dredged from water bottoms adjacent to the eroding shoreline is used to provide stability to the shoreline. In such a case, vegetative plantings may be used to stabilize the newly deposited material. Structures may be built on the existing shoreline to prevent further erosion or may be built out from the shoreline to break waves and trap sediments so that marsh can develop between the shoreline and the structure. Structures built out from the shoreline (i.e. breakwaters) are preferred over structures on the shoreline if soil conditions will support it and if the sediment supply is sufficient to cause deposition behind the structures.

The use of hard structures along the open gulf shoreline, including barrier islands, is controversial. Hard structures such as jetties and groins can interrupt the littoral drift of sand causing deposition and shoreline building in some areas while causing sediment starvation and erosion in other areas. Any proposal to use hard structures along the gulf shoreline would require prior site-specific study to determine if the proposed structures would be suitable for the situation. Offshore segmented breakwaters placed along the gulf shoreline at Holly Beach in southwest Louisiana by the State of Louisiana are apparently performing well. Structural shoreline protection along inland waterways, lakes, and bays is not nearly as controversial because there is generally no littoral drift process in these inland areas and there is minimal potential for negative effects associated with sediment starvation in nearby areas.

2.3.11. Vegetative Plantings. The most commonly used species for erosion control in coastal Louisiana is smooth cordgrass (*Spartina alterniflora*) also known as saltmarsh cordgrass or oystergrass. It is the dominant plant species of saline marshes in Louisiana. Saltmarsh cordgrass, once established, can withstand moderate wave energy and prolonged flooding. It works especially well when introduced in areas where saltwater has intruded into previously fresher areas and saltmarsh cordgrass has not yet established naturally. This plant can also grow fairly well in freshwater conditions due to its extremely broad salinity range. The preferred planting site for this species is the intertidal zone. This plant does not perform well on the deep organic soils common to most fresh and intermediate marshes, which also tend to have very low tidal ranges. Giant cutgrass (*Zizaniopsis miliacea*), seashore paspalum (*Paspalum vaginatum*), and California bulrush (*Scirpus californicus*) are desirable species commonly recommended for shoreline protection in fresh and intermediate marsh areas.

Giant cutgrass is tolerant of standing water and may also be introduced into areas of shallow water. This species can sometimes thrive in areas where the vegetation occurring previously was not able to cope with high water levels. In some areas, temporary silt screens or wave dampening devices would be used to protect the new plants until they become established and protection of newly planted sprigs is sometimes necessary to prevent grazing by nutria.

Both private enterprise and government agencies are working to develop strains of marsh grasses that have desirable characteristics such as accelerated growth, resistance to prolonged flooding, and resistance to high salinity. Other species such as black willow (*Salix nigra*) and common reed (*Phragmites australis*) are sometimes used when conditions are not suitable for saltmarsh cordgrass such as insufficient salinity levels or highly organic soils. Although no introduced or exotic species are presently being used for shoreline protection, it has been suggested that the use of the Asian grass species known as vetiver (*Vetiveria sp.*) be investigated.

The Soil Conservation Service (SCS), LDNR, and other agencies and local interests have had considerable success with vegetative plantings in Louisiana. Much has been learned about the conditions necessary for various plant species. The Vegetative Plantings Demonstration Project from the First Priority Project List is an example of this type of project.

2.3.12. Terracing. This method of wetland creation uses a barge-mounted crane or dragline to dredge material from the bottom of shallow open water areas and deposit the material in rows or terraces forming geometric patterns with gaps to allow water flow. Marsh vegetation is planted on the terraces and both the terraces and vegetation help reduce fetch thereby minimizing turbidity and shoreline erosion on windward sides of open water areas from wind-generated waves. Although the acreage of marsh created by this method is relatively low compared to some other project types, the shallow, calm water between the terraces provides an ideal area for the growth of aquatic vegetation and the terraces can reduce the erosive force of wave action on nearby natural marshes. A considerable increase in marsh edge or marsh-water interface, which is very desirable habitat for aquatic species and wading birds, also results from terracing.

Only one terracing project has been constructed to date. It was financed jointly by the EPA and the State of Louisiana and is located on the Sabine National Wildlife Refuge near West Cove in Calcasieu Lake. In this project, the terraces were arranged in an open checkerboard pattern. The project is functioning as designed, providing shallow marsh edge habitat for aquatic species, nesting and feeding sites for birds, and reducing turbidity levels to the benefit of submerged aquatic vegetation.

2.3.13. Sediment Trapping. A commonly used method of sediment trapping in south Louisiana employs discarded Christmas trees that are set in cribs made of timbers and screening material. These devices slow water currents and allow sediments to drop out of the water column. Often marsh species are planted in the protected areas formed by the cribs if water depth or soil elevation is suitable. Sediment deposition will build the substrate in and around the cribs to an elevation suitable for colonization of the area by marsh plant species. Other devices used for sediment trapping include fences made with timbers and any of a number of different screening materials, set perpendicular to water flows.

Sediment trapping works best in areas where there is an abundance of sediments being transported by flowing water. Sediments suspended in the water settle on the downstream side of the fences and marsh plant species colonize the mud flats that develop when suitable build-up has occurred. This type of sediment trap has been used successfully in shallow ponds of the active Mississippi River Delta and may also be beneficial in emerging deltas in Atchafalaya Bay. An example of a sediment trapping project is the Pass a Loutre Sediment Fencing project (MR-2) proposed for the Second Priority Project List. Although not specifically referred to as sediment trapping devices, the structures described under Shoreline Erosion Control with Structures can act as sediment traps when they are set out from the shoreline and constructed as a segmented breakwater.

These projects can restore marsh in shallow open water areas. Success hinges on a variety of factors that must be taken into consideration when designing a project. Important factors to be considered are; the amount of sediment being transported through the project area, the proper alignment of the structure to maximize sediment capture, the proper position of the project, the existing water depths, subsidence rates, and overall geography and geology of the area.

2.3.14. Herbivore Control. Scientific evidence indicates that, under certain conditions, grazing of marsh and cypress/tupelo swamp by nutria (*Myocaster coypus*) and muskrat (*Ondatra zibethicus*) is having a negative effect on these habitats. Muskrat "eatouts" are easy to identify by large numbers of muskrat dens and denuded areas of marsh, whereas effects of nutria grazing are less obvious. While effects are not as obvious, it appears that high concentrations of nutria cause a long-term stress on marsh by continuously grazing selected species, uprooting other species in search of preferred roots, and grazing the fresh shoots of other species. Nutria are non-native animals introduced into the United States from South America. Many people believe that nutria are causing a much greater problem than muskrats because they are much more numerous, they occur in a greater range of habitats, and their eating habits are less specific. Normally, high muskrat concentrations are found only in intermediate and brackish marshes containing abundant amounts of three-cornered grass (*Scirpus olneyi*). Geese have also been known to cause "eatouts" in marshes that have resulted in conversion to open water, however this problem appears to have declined in recent years and is not of serious concern. The problem of overgrazing by nutria especially and muskrat to a lesser degree, is considered a very serious threat to marshes and cypress swamp regeneration efforts. These furbearing animals were, until the early 1980's, a valuable resource, harvested in great quantities for their pelts. The commercial harvest of these animals helped keep their populations under control. The worldwide downturn in the fur industry has reduced the economic value of these animals, and the population of nutria, especially in the more susceptible Deltaic Plain, is apparently expanding rapidly.

The Louisiana Department of Wildlife and Fisheries (LDWF) has jurisdiction over resident fur and game animal harvest. The LDWF considers these species a resource and governs their taking by various laws on fur harvest. Changing the animal's status to a nuisance species is not being considered by the LDWF.

The LDWF and LDNR have developed a pilot trapping incentive program under the Louisiana Coastal Wetlands Conservation and Restoration Plan to encourage landowners and trappers to control overpopulation of nutria in selected target areas where damage to wetlands has been identified by LDWF. This program involves incentive payments to trappers harvesting animals from selected areas. The incentive payments are cost-shared between the State and landowners. CWPPRA funds could be utilized to supplement this effort and expand the potential to control overgrazing. There has been some discussion among the various agencies involved in the Restoration Plan effort concerning whether a trapping incentive program would be an appropriate use of CWPPRA funds. The proposal is actually a sort of a bounty and bounties often have not produced anticipated results. However, the problem with herbivores exists and no other methods of control have yet been offered as part of the CWPPRA Restoration Plan.

Herbivory control could be critical to the success of some vegetative planting efforts. Exclusion devices like fencing or screening has been shown to be effective in protecting newly planted grasses and cypress trees from predation by nutria. No specific projects are proposed for exclusion devices, however various methods of protection will probably be incorporated into many vegetative planting efforts, especially in known areas of high nutria populations.

3. AFFECTED ENVIRONMENT/ ENVIRONMENTAL EFFECTS

3.1. DESCRIPTION OF HABITATS

The study area for the Restoration Plan includes all of Louisiana's 20 coastal parishes (Plate 1 of the main report). Each of these parishes contain coastal wetlands as defined by the Task Force.

Chabreck (1972) presented what is probably the most comprehensive study of the vegetation of the Louisiana Coastal Region. The following description of habitats is adapted mainly from his publication. Also, please refer to the "Problems" and "Solutions" sections of the main report which contain discussions about the natural processes that built the wetlands of coastal Louisiana and that cause changes and deterioration of these wetland habitats.

The Louisiana coastal area originated mainly from alluvial deposits of the Mississippi River and its distributaries. Over many centuries, these deposits have accumulated to form a broad, flat plain. The coastal region has been divided into two segments on a basis of origin and physiography. The area east of Vermilion Bay, occupying two-thirds of the coastal region, is designated as the Deltaic Plain. The Deltaic Plain is the site of the various active and abandoned river delta systems. Over approximately the last 8,000 years the Mississippi River has altered its course periodically, forming new deltas with each move. The older deltas, having had more time for compaction, subsidence, and wave modification, show greater stability. The area west of Vermilion Bay has been named the Chenier Plain and was formed by river sediment swept westward by long-shore currents in the Gulf of Mexico.

Daily tidal fluctuations along the Louisiana coast range from a few inches to about 2.5 feet. Tidal levels are greatly influenced by winds, with north and west winds causing below normal water levels and east and south winds causing elevated water levels. High pressure systems with strong northerly winds during winter can push water levels in the coastal wetlands more than 2 feet below normal for several days. At such times, marshes openly connected to tidal channels become practically dry. Conversely, low pressure systems in the Gulf of Mexico that produce strong southeast winds can push tidal levels several feet above normal and cause extensive flooding of coastal wetlands.

The climate of the Louisiana coast is influenced greatly by the area's subtropical latitude and its proximity to the Gulf of Mexico. Prevailing southerly winds in the summer provide moist, semi-tropical weather with numerous afternoon thunderstorms. Whenever westerly or northerly winds interrupt the prevailing moist conditions during summer, hotter and dryer weather results. During the winter, the coastal area is subjected to alternating cold continental air and warmer tropical air, causing drastic variations in climatic conditions. Rainfall is plentiful in coastal Louisiana with the maximum average rainfall occurring in July and the lowest in October. Average annual rainfall for the New Orleans area is about 60 inches.

Tropical storms and hurricanes occasionally strike the Louisiana coast. These storms can cause tremendous destruction to the wetlands by physical force and by pushing saltwater far into freshwater zones which can cause vegetation to die off.

Natural marsh exists where plants grow and sustain themselves on properly elevated substrate. However, shallow, interspersed open water areas are typically included in the concept of a marsh. These interspersed open water areas are commonly referred to as ponds whether they are tidally drained or not. The interspersion of ponds and streams collectively within a given marsh area establishes the ratio of open water to marsh. This ratio greatly influences utilization by various aquatic and wildlife species. Since wetland vegetation provides the primary food substance and cover for most fauna, the conversion to total open water systems typically discourages biological diversity and long-term productivity. In many areas of coastal Louisiana, marsh loss (conversion of marsh to open water) is often accompanied by increased salinities.

The most notable relief features located in the Louisiana coastal area are forested areas located on natural levee ridges along abandoned distributaries, relic Indian mounds and middens, elevated salt domes, and artificial levees and canal banks.

Coastal marshes are subdivided into four vegetative types based on the classification first reported by Penfound and Hathaway (1938). The four marsh types are fresh, intermediate, brackish, and saline. The vegetation occurring in a particular coastal area is determined mainly by the salinity regime of the area, although soil elevation and soil type also help determine vegetation types. Salinity ranges and means in parts per thousand (ppt) found by Chabreck (1972) for the four coastal marsh types are as follows:

Marsh Type	Range (ppt)	Mean (ppt)
Fresh	0.1 - 6.7	<3.0
Intermediate	0.4 - 9.9	3.3
Brackish	0.4 - 28.1	8.0
Saline	0.6 - 51.9	16.0

The ranges shown illustrate the drastic salinity variation that occurs in the coastal marshes of Louisiana. It is for this reason that marsh types are classified by vegetative composition and not by salinity levels. The means shown are similar to those reported by other authors.

Chabreck (1972) recorded 118 species of vascular plants in all marsh types. The species found in the greatest amount overall was saltmeadow cordgrass (*Spartina patens*), making up about one-fourth of the vegetation in the coastal marshes. Other major species found were saltmarsh cordgrass (*Spartina alterniflora*), maidencane (*Panicum hemitomon*), and bulltongue (*Sagittaria lancifolia*). Species richness or biodiversity of the coastal marsh systems increases from salt to fresh marsh and dominance decreases.

The saline marsh is dominated by saltmarsh cordgrass along with saltgrass (*Distichlis spicata*), black rush (*Juncus roemerianus*), saltwort (*Batis maritima*), and saltmeadow cordgrass. Chabreck identified 12 additional species of emergent vegetation from this habitat type. Aquatic vegetation does not usually occur in saline waters along the Louisiana coast. However, widgeongrass (*Ruppia maritima*) may occur in saline marshes bordering on the brackish marsh zone and in saline areas where tidal flow has been decreased by structures or other changes in hydrology. Seagrass beds occur in waters behind some barrier islands, especially the Chandeleur Island chain. Seagrass species occurring in this area include shoalgrass (*Halodule beaudettei*), turtlegrass (*Thalassia testudium*), and manategrass (*Cymodocea filiformis*). Other wetland types associated with saline marsh include scrub/shrub wetlands, which are usually dominated by black mangrove (*Avicennia germinans*) or eastern false-willow (*Baccharis halimifolia*), shell reefs, tidal flats, streams, and ponds.

In the brackish marsh, saltmeadow cordgrass is dominant. Saltmarsh cordgrass, saltgrass, black rush, three-cornered grass (*Scirpus olneyi*), and leafy three-square (*Scirpus maritimus*) are also common in this zone. Other wetland types associated with brackish marsh are scrub/shrub wetlands, dominated by eastern false-willow, tidal flats, streams, and ponds. Notice that the species are practically the same as for saline marsh, only the order of dominance is changed. Often brackish marshes have a distinctive "hummocky" appearance associated with the clumped growth of saltmeadow cordgrass. Aquatic plants that commonly occur in brackish marsh waters include widgeongrass, Eurasian watermilfoil (*Myriophyllum spicatum*), muskgrass (*Chara vulgaris*), coontail (*Ceratophyllum demersum*), and dwarf spikerush (*Eleocharis parvula*). Forty species of plants were identified from brackish marsh by Chabreck.

The intermediate marsh type is the most difficult to identify. It lies in the transition zone between brackish and fresh marsh. Saltmeadow cordgrass is usually the dominant vegetation along with bulltongue, three-cornered grass, roseau or common reed (*Phragmites australis*), bullwhip (*Scirpus californicus*), sawgrass (*Cladium jamaicense*), Walter's millet (*Echinochloa walteri*), and deer pea (*Vigna luteola*). Aquatic plant species found in intermediate marsh waters include widgeongrass, dwarf spikerush, muskgrass, Eurasian watermilfoil, coastal waterhyssop (*Bacopa monnieri*), and southern naiad (*Najas guadalupensis*). Fifty-four species were identified from intermediate marsh by Chabreck.

In the fresh marsh, the dominant species are maidencane, bulltongue, spikerushes (*Eleocharis sp.*), pennywort (*Hydrocotyle sp.*), pickerelweed (*Pontederia cordata*), and alligatorweed (*Alternanthera philoxeroides*). Other common plants are bullwhip (*Scirpus californicus*) and cattail (*Typha sp.*). Fresh marshes are often very diverse with different species of grasses and broad-leaved annuals waxing and waning throughout the growing season. Some fresh marshes, on the other hand, consist of nearly pure stands of maidencane. Aquatic plants commonly found in fresh marsh waters are common duckweed (*Lemna minor*), coontail, Eurasian watermilfoil, southern naiad, muskgrass, water hyacinth (*Eichornia crassipes*), sago pondweed (*Potamogeton pectinatus*), white waterlily (*Nymphaea odorata*), *Elodea*, fanwort (*Cabomba caroliniana*), and American lotus (*Nelumbo lutea*). Other wetland types associated with both fresh and intermediate marshes are scrub/shrub wetlands dominated by eastern false-willow and wax myrtle (*Myrica cerifera*). Chabreck documented 93 species of plants occurring in the fresh marshes of coastal Louisiana.

Cypress-tupelo swamp contains a mixture of bald cypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*), and red maple (*Acer rubrum*) along with various understory plant species. Swamps with fairly open canopies sometimes support fresh marsh and scrub/shrub species as groundcover. Very often the water surface in cypress-tupelo swamps is covered by common duckweed, alligatorweed, and sometimes water hyacinth. Extensive coastal swamps are found in the Pontchartrain, Barataria, Terrebonne, and Atchafalaya Basins where there generally occupy the area between fresh marshes and developed areas of higher elevation. Healthy cypress swamps occur only in fresh water areas where the salinity range does not normally exceed two parts per thousand.

3.2. ITEMS NOT CONSIDERED SIGNIFICANT

Coastal Louisiana contains a wealth of natural, cultural, and human resources. Many of these resources, though important, would not be significantly affected by any of the projects proposed for the Restoration Plan. Some of these resources are listed as follows.

Louisiana has a Natural and Scenic Stream Program which provides protection to 47 streams, 25 of which are located in Louisiana's coastal parishes. Some of the projects listed in the Restoration Plan would occur in the vicinity of these streams, especially Bayous Penchant, Des Allemands, Trepagnier, La Branche, Dupre, and the Lake Borgne Canal. Certain projects could require a permit issued by the Louisiana Department of Wildlife and Fisheries pursuant to the Natural and Scenic Stream Program for work in or adjacent to these streams. The Louisiana Natural and Scenic Stream Program would afford protection to these streams sufficient to prevent significant adverse effects. Furthermore, it is highly unlikely that any project would be promoted that would diminish the natural and scenic attributes of a listed stream.

Farming operations are not expected to be significantly affected. There is, however, at least one proposal to restore an area that was once marsh, but is now used for pasture, back to marsh (East Eden Isles Restoration, PPO-4). Generally, no farm lands will be expropriated to implement the CWPPRA projects. Easements to build structures, deposit dredged material, and divert sediments into a privately owned area would have to be granted by willing landowners. In some cases, expropriation may be necessary to "cure" title such as when ownership is uncertain or when landowners cannot be located. See Section 3.3.11., Property Ownership and Values, for additional discussion.

Air quality would not be significantly affected by the proposed projects. During construction of many projects, heavy machinery and tugboats would be used to move materials. Exhaust gases would be emitted from this equipment but due to the remote nature of the areas where construction would occur, no adverse impacts to human health are expected. Air quality is considered to be good in coastal Louisiana except for the developed corridor along the Mississippi River and in the industrialized area around Lake Charles, Louisiana.

Isolated stands of bottomland hardwood forest (BLH) occur within areas affected by some proposed projects; however, these forests are generally not regarded as coastal wetlands. In coastal Louisiana this habitat type typically occurs along active and abandoned distributary channels in the Deltaic Plain and on the relic seashores (chenier ridges) of the Chenier Plain. The BLH found within project areas would normally not be directed disturbed. Marsh management and hydrologic restoration projects may affect BLH, if it occurred in the project area, by controlling water levels and saltwater intrusion but the effects would likely be minimal and for the most part, beneficial. Freshwater diversion and sediment diversion projects sometimes require removal of BLH in the path of outfall channels, however, normally the effects are relatively minor compared to benefits expected from such projects.

Shrub/scrub habitat is found in fresh to saline areas at elevations sometimes only slightly higher than marsh. Generally any area within or around a marsh with higher elevation supports either scrub/shrub or swamp habitat. Scrub/shrub is also found in association with some cypress-tupelo swamps where the canopy cover is open enough to support it as an understory. The impacts of projects on scrub/shrub would be similar to its effect on the marsh or swamp that the scrub/shrub is associated with.

3.3. SIGNIFICANT RESOURCES AND EFFECTS OF ALTERNATIVES

3.3.1. Introduction. A resource is considered significant if it is identified in the laws, regulations, guidelines, or other institutional standards of National, regional, and local public agencies; if it is specifically identified as a concern by local public interests; or if it is judged by responsible Federal agencies to be of sufficient importance to be designated as significant. This section discusses each significant resource found in the study area, listed previously in Table 1, Summary of Comparative Impacts of Proposed Projects. The significance of each resource and existing conditions are described, then the effects of no-action and the various alternatives are discussed. Effects of operation and maintenance activities are included under the effects of alternatives.

The long-term effects of most proposed project types is largely unknown. One reason is that most existing coastal restoration projects have only recently been constructed. Monitoring of many restoration projects is ongoing but the data have not been synthesized and published to any large degree. Monitoring of projects constructed through the CWPPRA will provide valuable information to be used to plan and refine future projects. Much of what is written in the following discussion of project impacts is the professional judgement of the preparers of this report and other professionals employed by the Task Force agencies.

The project type for which the most research data is available is marsh management. However, Cahoon and Groat (1990) pointed out that the existing scientific data base on the ecological effects of managing marshes is currently limited. Acquiring the needed information will likely be difficult, take time, and be expensive. Perhaps researchers have turned their attention to this project type because it is probably the most common form of coastal wetlands project constructed to date; because of the controversy surrounding its affect on aquatic resources; and because of its often inconclusive effects on emergent vegetation.

Project-specific effects of large freshwater diversion projects are contained in two EIS's prepared by the USACE, New Orleans District. These reports are entitled; 1) Mississippi and Louisiana Estuarine Areas, Mississippi and Louisiana (Bonnet Carré Freshwater Diversion), and 2) Louisiana Coastal Area, Louisiana, Freshwater Diversion to Breton Sound and Barataria Bay (Caernarvon and Davis Pond Freshwater Diversions). No EIS's have been prepared for the other project types, although a draft EIS is under preparation for the West Bay Sediment Diversion project (FMR-3) from the First Priority Project List.

Prior to passage of the CWPPRA, the USACE, New Orleans District announced its intention to prepare a Programmatic EIS for marsh management due to the large number of Section 404(b)(1) permit applications received that, cumulatively, have the potential to significantly affect the environment. The impetus for this effort arises from the District's Section 404 regulatory responsibilities. The EIS will evaluate and disclose the issues and impacts associated with marsh management and will examine the several definitions of marsh management. Work on this document is currently on hold due to lack of funds but will resume to a limited degree when funding from the EPA is made available to the USACE, New Orleans District in late 1993.

The U.S. Fish and Wildlife Service's National Wetlands Research Center is currently conducting a multi-year, comprehensive study of marsh management. They are collecting data from managed and unmanaged (control) marshes. The results of this designed experiment will likely greatly extend our current knowledge of active marsh management in Louisiana coastal marshes. The field work is expected to be completed sometime in 1996.

3.3.2. Coastal Marsh.

3.3.2.1. Existing Conditions. The main purpose of the CWPPRA is to address the problem of coastal wetland loss. The CWPPRA did not specifically mention vegetated wetlands, but the Task Force has interpreted the act to speak mainly to the protection and restoration of emergent wetland vegetation, especially coastal marsh. In the early 1930's there was approximately 8,511 square miles of land in an area that approximates the CWPPRA study area as defined by the Task Force. Since that time, over 1,500 square miles (960,000 acres) or about 18 percent of these coastal lands, the vast majority of which are marsh, have been lost to open water. The most current published estimate of land loss is 20.0 square miles per year in the Deltaic Plain and 5.4 square miles per year in the Chenier Plain for a total of 25.4 square miles per year for coastal Louisiana (Dunbar et al., 1992). The reasons for this tremendous loss rate are varied and numerous. The problems that appear to be causing the majority of the loss are: a high rate of compaction and subsidence of unconsolidated sediments; a lack of sediment and freshwater inputs caused by levee systems along major rivers; saltwater intrusion and associated tidal scour caused in part by canal and channel dredging; global sea level rise; erosion by wind-blown waves and vessel traffic; and a general, natural degradation of abandoned deltas of the Mississippi River aggravated by many of the previously mentioned problems.

3.3.2.2. No-action. Coastal wetland loss is expected to continue but the actual rate of future marsh losses cannot be predicted accurately. A conceptual presentation of how the coastline of Louisiana may look in the year 2040 is presented in Figure 2 of the Executive Summary. How all the factors controlling loss rates precisely interact is largely unknown and, thus, precludes predicting future loss rates with a high degree of accuracy. However, the more recent trend is a loss rate lower than the high rate of loss experienced in the 1958-1974 time period. In order to estimate a no-action scenario for each basin, a Task Force subcommittee determined that the 1974-1990 loss rate might best represent future losses. The basin-specific rate of loss was applied to the existing amount of marsh in each basin to roughly estimate how much wetland might be lost in the next 20 and 50 year time periods. Wetland loss projections are contained in the basin chapters of the main report and in the basin appendices.

Reduced losses are expected in the near future partly as a result of changing economic forces (reduced canal dredging in support of petroleum extraction operations) and the implementation of freshwater diversion projects that at least locally will help to restore historic salinity regimes and add sediments and nutrients to sediment-starved basins. Additionally, the SCS would, under their existing authorities, be expected to continue to work with landowners and surface lease holders to plan and implement small watershed management plans. The State of Louisiana would also continue to evaluate and implement projects that would tend to further diminish wetland loss rates, if only on a local scale.

Landowners and surface lease holders have had to contend largely on their own with the problem of marsh loss and diminished habitat quality. Many have pursued acquisition of the necessary Federal and state permits to install and operate the structures necessary to conduct marsh management despite the rather large financial commitment often associated with successfully implementing, operating, and maintaining permitted projects. Herke (1979) estimated that 250,000 acres of Louisiana coastal marshes were already under marsh management. Spicer et al. (1986) estimated that over 600,000 acres were under some form of management. Between 1981 and 1984 the SCS developed 86 marsh management plans that if implemented would affect about 664,000 acres of private and corporately owned properties (Spicer et al., 1986).

Private landowners and surface lease holders would likely continue to try and protect their properties with the limited funds available to them. Thus, private landowners, surface lease holders, the Louisiana's Coastal Wetlands Trust Fund and various, often uncoordinated Federal initiatives would continue to represent the bulk of the effort to bring coastal wetland loss under control. The CWPPRA is a significant factor in that it serves to prioritize candidate projects relative to the larger goal of wetlands restoration and provides a funding mechanism to achieve that goal. It provides a unique opportunity for a speedy and positive effort at coastal wetlands restoration. Proponents of projects that are not selected for immediate implementation pursuant to the CWPPRA can be expected to vigorously pursue implementation through all other available means.

3.3.2.3. Marsh Management. Passive management has been and, on a limited basis, is still applied where the desire is primarily to suppress environmental extremes. Passive management structures are fairly effective at reducing the erosive force of water flowing over the surface of marsh soils; creating conditions conducive to the growth of submerged aquatic vegetation by decreasing water turbidity (when wind fetch is not a problem); maintaining a minimum water level throughout a year; and, in some cases, dampening salinity extremes.

Passive management structures can, except under unusual storm conditions, affect how much sediment is transported into and out of managed areas and retained within managed areas. In some instances, passive management structures may be used to shunt sediments or nutrient-laden waters into marshes or open water areas. If structures are located on all water routes influencing a passively managed area, mineral sediment input and accretion can be diminished (Cahoon 1990a, Reed 1992). Retention of sediments (organic and mineral) already within the managed area is probably enhanced by passive structures.

The effect of passive management structures on controlling marsh loss rates is not definitive (Chabreck and Nyman, 1989) and the effects of fixed crest weirs on emergent marsh plant species are not always clear (Chabreck and Nyman, 1989; Craft and Kleinpeter, 1989; Meeder, 1989; Turner et al., 1989; Sweeney et al., 1990). Turner et al. (1989) reported that passive structures can stress marsh plants through their effect on marsh soils. Slotted weirs and rock weirs, because of their greater exchange capacities, are presumed to reduce the potential for adverse effects on marsh soil conditions and promote more sediment, nutrient, and fisheries exchange compared to fixed-crest weirs.

More control than that available through passive management must be exerted on the hydrology of marshes that are subject to higher and more variable salinity regimes or have eroded substrates, especially when the goal is to affect marsh loss rates. Active management provides managers with the capability to reduce water levels and impose salinity controls under favorable meteorological conditions. With these capabilities, they can attempt to: 1) establish or invigorate the growth of emergent marsh plant species on existing or eroding substrates or substrates that would otherwise be covered by water; and/or, 2) create soil and water level relationships that are conducive to establishing or invigorating the growth of submerged aquatic vegetation. The goals of most active management projects are to: 1) reduce erosion -- by stabilizing marsh substrates and reducing erosive wave and tide energies along pond and open water edges; and, 2) increase productivity -- by increasing the amount of plant matter produced in the area and creating habitat to support larger numbers of marsh-dwelling species.

Establishing and maintaining marsh vegetation on surfaces capable of being exposed favorably affects erosion rates by slowing or halting the rate that remaining marsh soils are lost to open water. An added favorable effect occurs when marsh vegetation actually reclaims eroded areas by reestablishing marsh substrate elevations. Both effects represent success in addressing erosion rates with active marsh management. The first is a goal of most active management efforts. The second is highly desirable, but extremely difficult to achieve even on a small scale and, thus, typically serves as the ultimately hoped-for management achievement.

Attempting to affect marsh erosion rates by aggressively applying methods traditionally used for somewhat different purposes represents an extension of technology. Typically, the consequences of such extensions must be presumed to some degree. Presumptions are often based on professional insight or inferences drawn from available documentation of approximately similar situations. Thus, accurately predicting the actual impacts can be the subject of debate between involved interests. Partially in recognition of the developing debate over the effects of marsh management, Cahoon and Groat (1990) edited a document that consisted of: 1) a general literature review of marsh management; 2) several papers on studies specifically designed and conducted to develop a field research-based comparison of selected attributes of managed and unmanaged Louisiana marshes; and, 3) a summary and synthesis of the Louisiana studies.

In their literature review, Hartman and Cahoon (1990) reviewed over 300 articles related to management of marshes, including articles from Louisiana, South Carolina, and Florida. They observed that only about 9 articles dealt specifically with the effect of management on marsh loss rates. However, their review also revealed a relatively recent comparative, system-wide study of managed (for waterfowl) and unmanaged marshes in South Carolina. With the Louisiana field studies reported in Cahoon and Groat (1990), the South Carolina study provides a frame of reference for discerning universal, as well as unique and possibly site-specific responses, between managed and unmanaged marshes.

The South Carolina study (DeVoe et al., 1986), integrated and interpreted the findings of several authors and reported: 1) the composition and dynamics of the plant and animal assemblages between managed and adjacent tidal areas were structurally, functionally, and temporally different; 2) seasonal indices of carbon and nutrient dynamics were measurably different; 3) the dynamics of some attributes of the managed areas were sometimes out of phase with the adjacent tidal areas; 4) overall levels of productivity were similar between managed and unmanaged areas but primary production in unmanaged marshes came mostly from emergent vegetation while in managed marshes it came mostly from submerged aquatic vegetation, benthic algae, and phytoplankton; and, 5) shorebirds and waterfowl used the managed areas much more than adjacent tidal areas. The authors commented that differences between the managed and unmanaged areas were correlated with water transfer and movement rates; that the basic ecological processes occurring in managed and unmanaged areas were similar; and, that managed areas, tidal creeks, open wetlands and small parcels of high ground that comprised the general vicinity (of which the study locations were a part) collectively formed an integrated and productive ecological system.

Some of the field studies conducted for the Cahoon and Groat report described differences observed between two managed and two unmanaged marshes in Louisiana. Boumans and Day (1990) reported that the flux of some materials between the managed and unmanaged marshes can be accentuated or moderated by meteorological conditions (rainfall, wind speed, and direction). Cahoon (1990a) reported that: 1) vertical accretion and organic matter accumulation rates were measurably less in the managed marshes; and, 2) bulk density and organic matter content of soils differed between the managed and unmanaged marshes. Flynn et al. (1990) suggested that the response of marsh vegetation to active management could be linked to chemical and physical attributes of soils in managed and unmanaged marshes. They concluded that plant growth and productivity in the same two managed and unmanaged marshes were stimulated when water levels were temporarily lowered to below the marsh soil surface (successful draw-down) but suppressed if the reverse was true (unsuccessful draw-down). The marsh soil changes associated with active management observed by Flynn et al. had been previously observed by others.

Sweeney et al. (1990), also presented in Cahoon and Groat (1990), compared marsh-to-water ratios from 16 managed areas located throughout coastal Louisiana with their respective control areas. They found that management (both passive and active) did not have an adverse affect but neither did management induce any overall positive changes. Proponents of management tend to discount this study. They maintain that the study was flawed because of shortcomings with control areas and other technical factors and that favorable differences in marsh-water ratios were underestimated. They also maintain that managed areas exhibit favorable differences in other desirable attributes not looked at by Sweeney et al. Opponents of marsh management maintain that design shortcomings in the study were not critical and tend to accept the Sweeney et al. study as evidence that management does not appreciably affect marsh to water ratios. Also, they feel that management's overall impact cannot be comprehensively determined until other important ecological attributes are considered.

In their summary and synthesis of Louisiana studies, Cahoon and Groat (1990) observed that differences in tidal influences, water-level patterns and the degree of water exchange between managed and unmanaged systems were primarily responsible for primary production differences in managed and unmanaged Louisiana marshes. Cahoon (1990b,c) came to the same conclusion. Clearly, many of the structural, functional and primarily shorter-term effects of marsh management in coastal Louisiana and South Carolina are at least coincidentally similar.

3.3.2.4. Hydrologic Restoration. Hydrologic restoration is expected to decrease the rate of marsh loss within the area of project influence by restoring historic, natural water flow patterns to the extent practicable. These projects are most appropriate in marshes being subjected to unnaturally high tidal fluctuations due to canal or channel dredging. Reducing the effect of tidal scour while continuing to allow a somewhat reduced level of tidal exchange would contribute to a reduction in tidal erosion rates within the project area. These projects are not expected to cause shifts to fresher marsh types, but rather reduce marsh loss rates in deteriorating areas. No significant amount of marsh would be created or restored strictly by hydrologic restoration, although some projects categorized as such contain other features such as marsh creation with dredged material which would cause new marsh to develop.

3.3.2.5. Hydrologic Management of Impoundments. This type of project would be used to restore wetland vegetation within areas that have previously been impounded by levee systems and the existing water control systems for these areas are inadequate. Pumps would normally be used for water level control but adjustable structures used for active marsh management may be utilized where conditions warrant. Pumps offer very precise water level control and should produce the optimal marsh to open water ratio available for a given area. For instance, if the project area is relatively flat with little relief, a very high percentage of marsh vegetation could be established. If, however, the area varies in elevation by more than a few inches, the lower areas may remain open water, while the majority of the area could become revegetated with marsh grasses. The primary goal of most of the proposed projects of this type would be to create optimal conditions for wildlife and freshwater fisheries resources. Tidal exchange through closable structures would likely be incorporated into the design of projects to allow some access and use of the impounded area by estuarine fisheries species if tidal exchange would not negatively affect wetland vegetation in the impounded area.

3.3.2.6. Sediment Diversion. The effect of sediment diversion projects would differ considerably, depending on the existing condition of their receiving areas. Sediment diversions in the active Mississippi and Atchafalaya River deltas would be expected to develop marsh and other wetland communities basically the same as that which currently occurs in these deltas, mainly fresh marsh. Sediment diversions that are proposed for the Barataria and Breton Basins would cause a significant shift in salinity regimes and changes in wetland types. At the proposed diversion sites in these basins, brackish to saline marsh is found up to the back levees protecting the developed strips of land along the Mississippi River from storm-induced tidal flooding. Large-scale sediment diversions, as proposed for these sites, would cause new delta lobes to develop, replacing the existing brackish to saline marsh near the diversion sites with fresh to intermediate marsh and establishing a more natural gradation of fresh to saline habitats.

Sediment diversion is the only type of project that is capable of restoring large areas of marsh in a natural manner. Marshes created by these projects would be similar to the marshes found in the active Mississippi and Atchafalaya River Deltas. These marshes are extremely productive, supporting vast populations of fish and wildlife resources. Sediment diversions, and freshwater diversions and marsh creation with dredged material projects to a lesser extent, are the types of projects that offer the best opportunities for building new marshes or restoring deteriorated marshes to offset the loss of marsh in other areas where prevention of marsh loss would be inordinately expensive. Also, these projects are the primary methods by which the massive quantities of sediments that are transported by the Mississippi River and now lost to the deep water of the Gulf of Mexico can be used to preserve, restore, and create coastal wetlands.

The Atchafalaya and Mississippi Rivers transport a finite amount of sediment. Diversion of sediment to a certain area would cause less sediment to be deposited downstream of the diversion site. Diversion of the majority of the Mississippi River into the Breton Sound or Barataria Basin, with maintenance of the existing navigation channel through Southwest Pass, would cause some of the existing active delta to undergo deterioration due to sediment deprivation. It would take many years for a new delta, the size of the existing one, to form in the Breton Sound or Barataria Basin.

3.3.2.7. Freshwater Diversion. Freshwater diversions benefit marsh by combatting saltwater intrusion and adding nutrients and fine-grained sediments into the estuarine systems. Freshwater diversions slow the rate of marsh loss in their receiving areas and, in the case of the larger diversions, develop marsh in the shallow open water areas near the diversion outfall. In some cases, such as for the Caernarvon Freshwater Diversion where brackish marsh extends nearly up to the structure, a shift in marsh type is anticipated in an area around the structure. In other cases, such as for the Bonnet Carré and Davis Pond diversions, no shift in marsh type is anticipated.

Water input through diversion structures is sometimes not possible when most needed in outfall areas because of low river stages. Conversely, when it is possible for diversions to provide large quantities of water, the areas that would receive it may not need additional water at that time.

Freshwater diversions are also proposed from the GIWW and from the upper Mermentau Basin where water stage is held artificially high by locks and control structures. These diversions are different from the river diversions in that they would generally carry less sediment and nutrients and would benefit marsh in their receiving areas mainly by reducing salinity levels. Diversion of sufficient quantities of water from the upper Mermentau Basin would also help decrease the high erosion rates occurring around Grand and White Lakes and would help wetland vegetation that is currently stressed from the elevated water levels.

3.3.2.8. Outfall Management. Benefits for outfall management projects usually include both marsh preservation and creation components above and beyond what would be expected from operation of freshwater diversion without outfall management. By routing outflow across and through deteriorated marsh and shallow open water, opportunities for sediments to settle out and reach an elevation suitable for the establishment of wetland vegetation are enhanced.

Outfall management would increase average water levels within the managed area during periods of moderate to high flow through diversion structures. Raising water levels is necessary to deliver sediment into the deteriorated marshes. The effect of the elevated water levels is unknown. Some would argue that existing vegetation would become stressed and begin to die back while others would argue that the high nutrient content and oxygen level of the diverted waters would cause increased vegetative vigor even under elevated water level conditions. Freshwater diversions from river systems could not be operated at moderate to high flows throughout the year due to varying river stages, therefore even if high water levels stressed vegetation, it would likely be able to recover during low-flow periods, and probably even increase in areal extent due to elevated substrate from sediment deposition.

There is some concern about the impact of Caernarvon Outfall Management project (BS-3A) on freshwater retention time and distribution of flows in the upper basin and how it will affect the diversion's ability to maintain target salinity levels in the middle and lower basin. The Caernarvon diversion was justified on its projected benefits to fish and wildlife resources by maintaining favorable salinity levels in the middle to lower areas of the Breton Sound Basin.

3.3.2.9. Marsh Creation with Dredged Material. In some cases, marsh would be created in shallow open-water areas, whereas other projects would nourish deteriorating marsh, which is undergoing conversion to open water, with a thin layer of dredged material. Dredging may be associated with normal maintenance of a navigation channel where the CWPPRA would provide funds for the incremental cost of using material beneficially, or dredging may be dedicated specifically for the purpose of marsh creation.

Minello et al. (1992) studied habitat utilization of natural and artificially created marshes in the Galveston Bay area. Their data collection was limited to the spring season, at time of heavy utilization of the marsh by aquatic species. The created marshes were 2-5 years old at the time of sampling. Stem density and above-ground biomass of smooth cordgrass was consistently higher in the created marshes but macro-organic matter in the upper soil layer was significantly lower. Densities of polychaetes (marine worms) and amphipods (small crustaceans) were positively correlated with levels of macro-organic matter. This suggests that newly created marshes, with less organic matter in the soil, support less benthic organisms. Natural marshes consistently had higher numbers of grass shrimp, brown shrimp, and other decapod crustaceans with blue crabs being the only exception. Densities of fish were found to be similar between natural and created marshes; however, species diversity was higher in natural marshes. It is important to note that these marshes were recently established. There is considerable evidence that created marshes become increasingly similar to natural marshes over time.

Unconventional materials such as red mud, shredded tires, and composted yard waste have been suggested for use in coastal wetlands restoration as a way to increase substrate elevations to the point which would support marsh vegetation. The effect of these materials on coastal wetlands vegetation and animal species is unknown. There are questions about the possible release of toxic substances that should be answered through testing or small-scale demonstration projects before widespread use of these materials is attempted.

3.3.2.10. Barrier Island Restoration. Barrier island restoration involves creation and restoration of marsh, dune, beach, and other habitats on barrier islands. Projects would use sand dredged from either back-bay or offshore sources to increase the vertical height of existing islands and extend their back-side mangrove wetlands and marshes. The marshes created on the back-side of the islands are highly utilized by high salinity estuarine aquatic species and avian species. These back-side marshes and mangroves also provide a platform for natural landward migration of some of the barrier islands. While some barrier islands are eroding and migrating, others, such as the Isles Dernieres are simply eroding landward.

Although marsh is created, the overall purpose of barrier island restoration is to maintain the barrier island ecosystems and the estuarine and marsh ecosystems behind the islands. Studies indicate that some barrier islands provide protection to mainland marsh areas by decreasing wave energies, by reducing tidal amplitude, and by moderating salinity levels. The ability of barrier islands to produce these effects is dependant on the distance the barriers are from the mainland, the condition of the mainland marsh, the configuration of the barriers, and other complex factors. The functions and values of barrier islands in Louisiana have not been clearly defined. One of the items proposed as a priority study under the CWPPRA is a comprehensive study of the role and functions of Louisiana's barrier islands and the best method for their restoration.

This type of project does not include structural protection of barrier islands. That type of project is covered under the following section.

3.3.2.11. Shoreline Erosion Control with Structures. Various materials may be used to provide structural stability to eroding shorelines. Some materials that have successfully been used are rock, concrete rip-rap, clam shells, oyster shells, crushed limestone, treated wooden timbers, used tires, and concrete and steel sheet piling. These materials can be placed either directly on or adjacent to the shoreline or in a segmented breakwater located out from the shoreline. Segmented breakwaters can act to trap sediment, creating marsh and other wetland habitat between the breakwater and the shoreline in sediment-rich areas. Erosion control structures placed adjacent to the shoreline are generally assumed to reduce existing shoreline erosion rates to zero. Some of these projects derive substantial marsh preservation benefits by protecting large areas of marsh and open water that would be captured by a bay, lake, or channel if the shoreline protecting them would erode.

Hard structures, especially those constructed with rock or concrete rip-rap have been used with various levels of success along the gulf shoreline, including the gulf shoreline of some barrier islands. Jetties constructed at the mouths of passes for navigation purposes often interrupt the littoral drift process and cause sediment deposition on one side of the structures while the shoreline on the other side of the structures suffers from sediment starvation and erosion. Jetties and groins are not normally proposed for shoreline erosion control along the gulf shoreline, although conceptual ideas are included for some of the barrier islands in the Barataria Basin. Certainly, proposals for these structures would require extensive study to determine their suitability to correct the erosion problem on these islands.

Segmented breakwaters constructed by the State of Louisiana at Holly Beach to control erosion are apparently working well. A area that had been experiencing severe erosion problems appears to be stabilized and sediments are accumulating behind the breakwater. Shoreline erosion rates to the east and west of the breakwater are apparently not increasing. This project appears to be a success, however it was carefully planned and designed for the site. Another effort at stabilizing the gulf shoreline on East Timbalier Island has not been as successful. The corporation that owns the island attempted to stop shoreline erosion by hardening the shoreline with rock. The shoreline continued to erode behind the rock and now the rocks are located in the Gulf of Mexico hundreds of yards out from the island's vegetated natural shoreline. Whether the rock has or continues to reduce the amount of erosion that would otherwise be occurring is unknown. These examples point out that the use of any hard structures along the gulf shoreline requires thorough evaluation before construction.

3.3.2.12. Vegetative Plantings. Planting of vegetation along eroding shorelines would typically involve introducing rhizomatous plant species capable of withstanding wave action and inundation. Existing marsh behind the planted vegetation would be protected from wave and tidal erosion. No adverse effect on existing marsh would be expected. The actual amount of protection provided to existing marsh would depend on several factors including density of plantings; survival and expansion rates of introduced plants; and wave energy at the site. Plantings may slow the rate of shoreline erosion in some areas while in other areas, the plantings may completely arrest shoreline erosion or even cause the shoreline to prograde out into shallow open water.

Vegetative plantings may also be used in broken marsh or shallow open water areas within marshes, not necessarily to prevent shoreline erosion, but to re-establish emergent vegetation. Native plant species that are adapted to standing water conditions, especially giant cutgrass, would be introduced into areas where they have not colonized naturally.

3.3.2.13. Terracing. Terracing would create geometric patterns of marsh in shallow open water areas. Although relatively small acreage of marsh would be created compared to other restoration efforts, the configuration of the marsh, with extensive marsh-water interface, would be very productive for a variety of fish and wildlife species. Normally little to no existing marsh would be directly impacted but erosion of existing marsh within and surrounding the terracing would be reduced due to lower wave energy.

3.3.2.14. Sediment Trapping. Sediment trapping projects would create marsh by slowing water currents and causing deposition of sediments. These projects normally rely on seed and plant fragments from nearby wetlands to colonize the sediments being deposited although vegetative plantings are sometimes an integral part of the project. Sediment trapping can be used to develop marsh adjacent to the trapping structure and along a marsh edge being protected by the structure. Sediment trapping projects, depending on their configuration, could also reduce erosion of existing marsh by reducing wave energy.

Wave dampening fences, such as hay bale fences, can be used to dampen wave energy in shallow, open water environs whether or not there is sufficient sediments being moved through the area. They can also be used to protect newly established plantings.

3.3.2.15. Herbivore Control. Additional trapping to reduce high concentrations of nutria and muskrat would certainly enhance vegetative growth, especially those species of vegetation preferred by the animals. As currently envisioned, herbivore control efforts would be concentrated in areas where there is ample evidence that high concentrations of animals are causing marsh stress and loss. The emerging deltas in Atchafalaya Bay have been proposed for herbivore control specifically because there is evidence that the animals are retarding the growth of the deltas and because the deltas are owned by the state. State ownership makes it easier to regulate harvests and obtain accurate harvest records than for private property.

3.3.3. Cypress-Tupelo Swamp.

3.3.3.1. Existing Conditions. Virtually all of the cypress-tupelo swamp in coastal Louisiana is second growth forest. Some relatively small areas of the second growth swamp are being harvested for timber and mulch products. In many areas, the swamps bear scars of past logging activities; logging canals, ditches, abandoned railroad spurs, and the stumps of felled trees. Large areas of cypress swamp have been killed during the latter part of this century by saltwater intrusion. Other swamps are showing signs of stress; no regeneration, stunting, and conversion to marsh and open water. Often, prolonged flooding is suggested as the cause of cypress swamp deterioration and lack of regeneration. Ideal conditions for cypress swamps include periodic drying of the swamp floor on the order of once every 1 to 3 years to allow for regeneration to occur. Some of the coastal swamps virtually never undergo drying of the swamp floor because they are connected directly with the tidal system and subsidence has lowered the soil elevation. Some areas containing cypress with open canopy with marsh vegetation as an understory are more functionally a marsh.

3.3.3.2. No-action. Coastal swamps would continue to slowly deteriorate from prolonged flooding, subsidence, saltwater stress, and lack of regeneration. Loss of cypress swamp is difficult to determine because the loss is usually a gradual deterioration of the cypress and tupelo trees and conversion of the area into marsh and open water. Cypress swamps in the Pontchartrain and Barataria Basins would be protected to a degree from saltwater intrusion by the freshwater diversions already authorized for those basins under separate authorities.

3.3.3.3. Marsh Management. Although the name of this project type does not include swamp, active water level management (which active marsh management really is) could significantly benefit areas of cypress swamp that are being affected by prolonged high water levels. Passive or active marsh management may be used to reduce saltwater intrusion and tidal scour in swamps. Active management may also be used to reduce water levels and salinities which would promote cypress regeneration. If water levels were successfully lowered to encourage cypress regeneration, nutria herbivory would have to be controlled to prevent destruction of seedlings.

Many of these stressed swamps are tidally influenced, and the only way to control water level is to block the tidal influence with low-level levees and utilize water control structures or pumps to draw down water levels. Such measures are rarely practical; however, it is being proposed for a portion of the Verret Subbasin of the Terrebonne Basin. The cypress swamps and fresh marshes in parts of the Verret Subbasin are deteriorating due to chronically high water levels. A system of floodgates and pumps is proposed along the southern boundary of the basin to relieve the high water problems (XTE-32). Although this project is listed as hydrologic restoration in the Terrebonne Basin report, it can be considered to be a management project since water levels would be actively managed.

3.3.3.4. Hydrologic Restoration. Some cypress swamps are suffering from high water and soil salinity levels because of increasing tidal influence. These swamps could benefit from reducing tidal exchange, however precautions would have to be taken to assure that projects would not cause an increase in average water levels that could also stress the swamps.

3.3.3.5. Hydrologic Restoration of Impoundments. There are areas of cypress swamp that appear to be deteriorating due to prolonged flooding caused by roads, railroad embankments, or levees. Hydrologic restoration of these areas by providing outlets through or under these barriers would likely relieve some of the flooding problem and increase viability of the swamp.

3.3.3.6. Sediment Diversion. Sediment diversion projects could be used to invigorate swamps where subsidence has reduced soil elevation. Cypress and tupelo trees that occur in areas where the water levels remain too high suffer stunting and can die-off. Getting significant amounts of sediments to flow through a swamp and settle-out in a thin layer would be an engineering challenge that has not yet been attempted. A possible negative impact that could occur would be increased flooding of the swamps and surrounding low, developed lands if hindrances to drainage exist. Most sediment diversion sites proposed in the Restoration Plan do not contain swamps in the outfall areas. Some cypress trees may eventually colonize the lands created by these diversions, but faster growing species would predominate. Cypress planting could be used to help establish cypress stands in the outfall areas, if desired.

3.3.3.7. Freshwater Diversion. Freshwater diversions could greatly benefit existing cypress swamps, especially in the Pontchartrain, Barataria, and Terrebonne Basins by retarding saltwater intrusion and introducing fine-grained sediments and nutrients. In the case of some proposed freshwater diversions, such as the Hero Canal Diversion (BA-13), some cypress swamp would need to be destroyed to provide for outflow channels.

3.3.3.8. Outfall Management. Wherever cypress swamp occurs in the outfall of a freshwater diversion project, outfall management could be used to direct freshwater flows through the swamp to nourish the system with nutrients and sediment. Additional sediments could help to establish desirable understory species and promote cypress regeneration.

3.3.3.9. Marsh Creation with Dredged Material. There are no proposals in the Restoration Plan to develop cypress swamp on dredged material although some cypress seedings may be planted or cypress may naturally colonize some of the marsh creation efforts in the freshwater areas. Cypress forest could be developed on dredged material placed at proper elevation in fresh water areas, but it would take many years for a viable cypress swamp to develop.

3.3.3.10. Barrier Island Restoration. Cypress swamps would not be affected except to the extent that barrier islands moderate salinity levels within estuaries, which in theory could benefit swamps stressed by high salinity levels.

3.3.3.11. Shoreline Erosion Control with Structures. Some of the shoreline erosion control projects would protect cypress swamp as well as marsh.

3.3.3.12. Vegetative Plantings. Some of the vegetative planting would protect cypress swamp as well as marsh. Some projects may use cypress trees in combination with other species to control erosion.

3.3.3.13. Terracing. Not applicable to cypress swamp.

3.3.3.14. Sediment Trapping. Sediment trapping could be used along with outfall management to encourage sedimentation in cypress swamps in the outfall area of freshwater diversions.

3.3.3.15. Herbivore Control. Scientific experiments in the Pontchartrain and Terrebonne Basins have proven that nutria are seriously affecting regeneration of cypress. Unprotected seedlings planted in these areas experienced virtually 100 percent mortality. Any reasonable method to reduce nutria populations in cypress swamps would likely have a positive effect on natural regeneration and planting efforts.

3.3.4. Submerged Aquatic Vegetation.

3.3.4.1. Existing Conditions. Submerged aquatic vegetation (SAV), like emergent marsh plant species, grows only where favorable water depth and soil elevation relationships exist or can be established, and then only if nothing else, including salinity, is prohibitive. SAV serves several important ecological functions. It removes toxic materials from the water, it is a food source for a number of both fish and wildlife species, it disperses wave energy, it helps retain sediment, it can remove toxic materials from the water, and it contributes organic material for wetland maintenance. SAV also fuels the food chain by providing a surface for growth of epiphitic algae and bacteria which are grazed upon by herbivorous invertebrates. They in turn are fed upon by organisms higher in the food chain. SAV also provides shelter and escape habitat for small forage fish and invertebrates. Included under the category of SAV, in this report, are floating aquatic plants like duckweed and water hyacinth and rooted floating plants like American lotus.

Submerged aquatic vegetation occurs mainly in the brackish to fresh marshes and in cypress-tupelo swamps with open canopies. The more saline areas seldom contain any significant amount of SAV, with the notable exception of the area behind the Chandeleur Island chain where extensive areas of seagrasses occur. The seagrasses found near the Chandeleur Islands are of different species than those found in the brackish and fresh areas of Louisiana and require clear, high salinity waters with a sandy substrate for their survival. Many areas of brackish marsh contain widgeon grass, a desirable native species, commonly used for food by waterfowl. Eurasian watermilfoil has become well established in some lower salinity brackish areas. It is an exotic species usually considered undesirable by recreational boaters and fishermen because it can become so dense that it can restrict boat usage. It is, however, used as a food item by several species of waterfowl.

The occurrence of SAV in specific areas is sometimes cyclic and otherwise difficult to predict. It would be especially difficult to predict the species that would become established as a result of a project in intermediate and fresh marshes because any one of a number of species, either desirable or undesirable, could colonize suitable habitat.

3.3.4.2. No-action. Increased tidal amplitude, tidal scour, and saltwater intrusion as a result of deteriorating marshes and barrier islands would decrease SAV coverage. High tidal energies in fresh and brackish areas causes increased turbidity levels from resuspension of bottom sediments and organic matter, creating a condition that is not conducive to SAV establishment and survival. Most species of SAV grow best in areas of little to no water movement, so the more open the coastal marsh system becomes, the less SAV is expected to occur.

3.3.4.3. Marsh Management. Marsh management, whether active or passive, is generally considered to increase an area's potential to support SAV (Larrick and Chabreck, 1976). The potential is related to management's ability to reduce tidal fluctuations, which can lead to reduced turbidity levels (Chabreck and Nyman, 1989). Production of SAV can be a primary, secondary, or unintended but desirable, consequence of marsh management. The benefits of increased SAV are largely related to improved waterfowl habitat, improved habitat for some fishery species, increased plant productivity, and reduced wave energy.

3.3.4.4. Hydrologic Restoration. Hydrologic restoration projects would increase the potential of an area to support SAV by decreasing tidal energy and turbidity levels. The amount of SAV and the species that would colonize a particular area would depend mainly on the salinity ranges that would occur after project implementation and on the substrate of the water bottom.

3.3.4.5. Hydrologic Management of Impoundments. These projects would very likely increase SAV coverage through optimization of water levels within project areas.

3.3.4.6. Sediment Diversion. High suspended sediment concentrations in diverted flows would prevent widespread establishment of SAV in the direct path of the diversions. Using the active deltas of the Mississippi and Atchafalaya Rivers as an example, SAV often becomes established in the calm, protected areas formed between bifurcations in a growing delta. Usually coverage of SAV begins to expand rapidly after rivers fall in the summer and water clarity increases. By early winter sizable areas of SAV can become established, providing food for wintering waterfowl, but the vegetation dies back during winter and spring.

While SAV commonly occurs in the brackish and lower salinity marshes of Louisiana, only the area behind the Chandeleur Islands supports seagrass beds. Uncontrolled Diversion of the Mississippi River into either the Barataria or Breton Sound Basin (PMR-6), the critical project for the Mississippi River Delta Basin, could potentially negatively affect these seagrass beds by increasing turbidity levels. This is a potential significant negative effect that would have to be evaluated before project implementation.

3.3.4.7. Freshwater Diversion. The effect of freshwater diversion projects from major river systems on SAV appears to be undocumented. The EIS written for the Bonnet Carré Freshwater Diversion stated that existing SAV in Lake Pontchartrain and behind the Chandeleur Islands would not be adversely affected. The Caernarvon and Davis Pond EIS did not address effects to SAV. Increased turbidity and nutrients from freshwater diversion projects would likely have negative effects on SAV. Nutrients would tend to increase plankton production which would tend to decrease light penetration through the water column and shade-out SAV. On the other hand, the fertilizing effect of the nutrients could increase the growth of aquatic plant species that can survive in somewhat turbid water. The net effect is not clear and would certainly depend on the existing conditions in an area of proposed freshwater diversion.

The freshwater diversions proposed from the Mermentau Basin would not carry as much suspended sediment as diversions from the major river systems and may have a greater potential to increase SAV in their receiving areas by lowering salinity levels.

3.3.4.8. Outfall Management. Very high turbidity levels are common in the Mississippi and Atchafalaya Rivers during high water periods in winter and spring. The high turbidity and cool temperatures during this time of year would prevent widespread coverage of SAV in outfall areas under management. However, the high nutrient and sediment load of these turbid waters would have a fertilizing effect and during the summer and fall, when river stages are low and water clarity increases greatly, SAV would likely be able to become established and expand within outfall areas.

3.3.4.9. Marsh Creation with Dredged Material. Marsh creation projects could either increase, decrease, or have no effect on coverage of SAV depending on specific project conditions. Projects implemented in areas of existing SAV would reduce its aerial extent by replacing SAV with emergent vegetation. After a period of several years, small ponds developing within the marsh creation areas may begin supporting SAV. Created marsh could be configured in such a way as to encourage the development of internal ponds that could support SAV.

3.3.4.10. Barrier Island Restoration. No direct effects to SAV. The Chandeleur Islands, where the only seagrasses in Louisiana are found, are not proposed for restoration since they are designated as a wilderness area under the National Refuge System. Indirect benefits would occur to the extent that barrier islands maintain the integrity of a basin's estuarine ecosystem.

3.3.4.11. <u>Shoreline Erosion Control with Structures</u>. Structures built on a shoreline would not directly affect SAV except when the structures prevent a wash-out occurring between a large water body or channel and an internal marsh pond behind the shoreline. In such case, SAV occurring in the marsh pond would be protected from loss by the shoreline erosion control structure. Erosion control structures constructed as a breakwater, out from the shoreline, can provide calm, protected areas sometimes suitable for SAV. Suitable conditions would include a fairly low sediment transport rate in the area and ample protection from wave energy.

3.3.4.12. <u>Vegetative Plantings</u>. No direct effect except when used to prevent washout of a shoreline protecting marsh ponds containing SAV.

3.3.4.13. <u>Terracing</u>. One the primary goals of terracing is to increase SAV. This is accomplished by reducing fetch across shallow open water areas. The small protected areas within the terraced area provides suitable conditions for establishment of SAV.

3.3.4.14. <u>Sediment Trapping</u>. Sediment trapping is not usually designed to increase SAV. Areas containing sufficient sediments to warrant sediment trapping are usually too turbid to support any significant amount of SAV. However, depending on site-specific conditions, sediment trapping may create shallow protected areas suitable for colonization by SAV.

3.3.4.15. <u>Herbivore Control</u>. Nutria are known to graze SAV. Reduction of high nutria populations could result in increased coverage of SAV.

3.3.5. Wildlife Resources.

3.3.5.1. <u>Existing Conditions</u>. The high vegetative productivity of Louisiana's coastal swamps, marshes, and barrier islands provides support for a wide variety of wildlife. The traditional economy of coastal Louisiana was based, to a large degree, on harvestable resources of which wildlife played a significant part. Harvestable wildlife continue to be very important to the region, both for commercial and recreational purposes. Populations of all wildlife species that use the wetlands of coastal Louisiana are being adversely affected by the continued loss of habitat. There are no species of wildlife that stand to gain from the continued loss of wetlands.

3.3.5.2. No-action. Wildlife populations are expected to diminish as coastal wetlands are lost. Species directly dependent on the marsh are expected to undergo the greatest losses.

3.3.5.3. Marsh Management. Active management has been shown to have the potential to be an economically plausible, logistically feasible, and technologically proven way to manage for waterfowl, furbearers, and alligators. Habitat can be improved by encouraging the growth of annual seed producing plants and increasing submerged aquatic vegetation.

The growth of submerged aquatic vegetation, especially when associated with a stable water level in the fall, is attractive to waterfowl. Diminished water level fluctuations improve furbearer habitat and stabilized water levels in the fall and winter provide reliable access by boat, thereby facilitating fur harvests. Thus, the sought-after benefits to wildlife resources arise as the biological consequences of actions designed to affect other specific components of the marsh system.

Marsh management projects implemented under the CWPPRA will focus on arresting marsh losses. However, with the potential to affect how much and what kind of marsh plant communities occur within managed areas, it follows that it is sometimes possible to affect the animal species dependent upon those same managed plant communities. Therefore, it is not at all unreasonable to expect, and certainly understand, why managers often favor actions to enhance economic or recreational interests through marsh management.

3.3.5.4. Hydrologic Restoration. Hydrologic restoration would benefit wildlife species to the extent that the projects preserve marsh or swamp habitat upon which wildlife species depend. No adverse impacts to any wildlife species are anticipated.

3.3.5.5. Hydrologic Management of Impoundments. This type of project would benefit wildlife by restoring optimal hydrology conditions within impounded areas. Chronically high water levels in some impounded areas limit the exposed land available for wildlife species while other impoundments have been subjected to forced draining which has lowered the habitat value of these areas for wetland-dependent wildlife.

3.3.5.6. Sediment Diversion. The large areas of marsh that could be restored by sediment diversion would provide habitat suitable for a variety of wildlife species. Wildlife species that would inhabit the wetlands restored by sediment diversions would be very similar to species assemblages currently found in the active Mississippi and Atchafalaya River deltas. Productivity of existing wetlands nourished by the sediments and nutrients introduced by the diversion would increase, further benefitting wildlife populations. Construction of projects would require removal of wildlife habitat but the areas impacted by construction would be minimal compared to the habitat developed by the projects.

3.3.5.7. Freshwater Diversion. Freshwater diversions help preserve wetland habitats that support wildlife species and in some cases cause a shift to fresher wetland communities near the diversion sites. Wildlife species that are suppressed by the lack of suitable fresh and intermediate marsh would expand in the area of the freshwater diversion structure's outfall. Construction of projects normally results in elimination of relatively minor amounts of wildlife habitat compared to the amounts benefitted by the projects.

3.3.5.8. Outfall Management. Most effects similar to hydrologic restoration projects. In addition to those effects, outfall management would tend to expand habitat for wildlife that require fresher conditions.

3.3.5.9. Marsh Creation with Dredged Material. Created marsh would provide valuable nesting, shelter, and forage habitat for a variety of wildlife species. Marsh creation efforts can be custom designed for specific areas to produce a settled soil elevation suitable for colonization by particular plant species and hence by wildlife species that utilize that type of habitat. For instance, dredged material could be placed in a series of circular islands with a slightly higher elevation in the center of each island to provide protected areas of scrub/shrub for wading bird nest sites and escape areas for terrestrial wildlife during high water events. Temporary negative effects to wildlife populations could occur during dredging operations from disturbance of existing marsh around or within marsh creation areas.

3.3.5.10. Barrier Island Restoration. In Louisiana, barrier islands provide critical nesting sites for a variety of shorebirds, wading birds, and other avian species. Terns, gulls, brown pelicans, black skimmers, egrets, and herons are some of the better known nesters. The islands also are home to resident birds. Relatively few species of amphibians, reptiles, and mammals use these islands. Barrier island restoration is expected to help ensure continued habitat for these species. Timing of restoration efforts in areas used by colonial nesting birds to avoid disturbance to these species during their nesting season would be necessary.

3.3.5.11. Shoreline Erosion Control with Structures. Projects would preserve wildlife habitat from erosion. Marsh edge, which is a primary feeding area for some avian species, would be considerably altered by structures placed directly adjacent to shorelines. Segmented breakwaters would have a less dramatic effect on the existing shoreline allowing continued use by wading birds.

3.3.5.12. Vegetative Plantings. Only beneficial effects on wildlife species are anticipated as a result of decreased erosion of their habitat.

3.3.5.13. Terracing. Terracing is expected to benefit wildlife species by providing feeding, nesting, resting, and escape cover. No adverse impacts to wildlife expected.

3.3.5.14. Sediment Trapping. Wetlands developed by sediment trapping would benefit wildlife with no adverse effects anticipated.

3.3.5.15. Herbivore Control. Reduction in the numbers of herbivores that are causing marsh and swamp degradation would preserve and enhance those habitats and their associated wildlife populations. In the long-term, even populations of the herbivores would be maintained by the preservation of their habitat.

3.3.6. Fisheries Resources.

3.3.6.1. Existing Conditions. Much has been written about the value of coastal wetlands to estuarine-dependent fisheries. The young of most economically important gulf coast species depend on shallow, protected areas of the estuaries for food and shelter. Access to and use of marsh vegetation has been shown to be especially important to the young juveniles of many species for both food and shelter Minello and Zimmerman, 1983; Zimmerman and Minello, 1984; and Zimmerman et al., 1984). Adults of many economically important finfish species, such as red and black drum, spotted seatrout, and southern flounder, also periodically use the marsh areas as feeding habitat.

Even though many thousands of acres of marsh have been lost in coastal Louisiana, commercial harvest and recreational catches of most important species have not diminished drastically. Catch reductions reflected in Louisiana landings statistics often result from commercial fishery closures, quotas, gear restrictions, or other limitations on specific species, and do not necessarily reflect a decrease in the quantity of fish available. Since the mid-1980's, many new laws and regulations have been enacted to limit the recreational and commercial harvests of economically important species including spotted seatrout, red drum, black drum, and mullet. Although regulations on shrimp harvest have remained essentially unchanged, little growth in the production of shrimp has occurred since the mid-1970's even though fishing effort peaked during the 1980's. Because loss of habitat and fishing pressure have caused, or are expected to cause fishery declines, the Gulf of Mexico Fishery Management Council has implemented Department of Commerce approved fishery management plans for shrimp and red drum in the Gulf of Mexico.

One hypothesis to explain continued high fisheries production is that, as the once vast, largely unbroken marshes have deteriorated from various causes, tremendous amounts of organic detritus were released into the estuarine system, driving high levels of primary productivity. Additionally, vast amounts of marsh-water interface and shallow, protected lagoons and ponds were formed which are prime areas for growth and development of estuarine species. At the same time, saltwater intrusion into previously lower-salinity areas was increasing the amount of estuarine open water area available to salinity-dependent estuarine species. All these factors have combined to produce very high and probably unsustainable levels of estuarine fishery productivity.

In addition to providing nursery habitat for estuarine-dependent fish and shellfish, fresh and low-salinity coastal wetlands also provide habitat for resident freshwater species. Common species include largemouth bass, crappie, bluegill, redear sunfish, warmouth, blue catfish, and channel catfish. Because these species are intolerant of brackish waters, they are either displaced or killed when fresh and low salinity coastal wetlands become saltier. Since 1956, over 50 percent of Louisiana's coastal fresh marshes have been lost to open water or have converted to more brackish environments. These losses have resulted in severe declines in associated freshwater fish populations.

3.3.6.2. No-action. If marsh and other coastal wetland loss is allowed to continue unchecked, overall fishery production is likely to drop substantially below current levels. Browder et al. (1988) reported on the relationship between brown shrimp catch and wetland interface. Based on their analysis, shrimp yields will decline when interface declines, possibly beginning about 1995.

Operation of the Caernarvon, Davis Pond, and Bonnet Carré Freshwater Diversions will restore some fresh and low salinity conditions in their associated outfall areas. Despite these positive results, fresh and low salinity marshes will continue to be lost throughout the rest of coastal Louisiana, although the rate of loss would not be as rapid as in the past. Fresh marsh losses will result in proportional reductions in freshwater fish populations.

3.3.6.3. Marsh Management. The effects of passive management structures on fishery resources has been and is the subject of much research and discussion. There are experimental and survey data sets that support the conclusion that resident fish species tend to be beneficially impacted. Beneficial effects result presumably from protecting or expanding the extent of submerged aquatic vegetation in managed areas and possibly from a reduction in the number of migratory-estuarine competitors and predators and altered salinity regimes. Many of those same data sets support the conclusion that some estuarine-dependent migratory species are adversely impacted.

Any passive structure can be a physical or behavioral impediment to fish movement. Some types of passive structures can restrict the movement of fish species more than other types of structures (Herke et al., 1984). If passively managed areas can be accessed by fisheries through routes without structures, usage of the area is likely not appreciably diminished. However, when passive structures are located in a fashion that precludes the unobstructed movement of organisms into managed areas, the impact can be significant (Herke, 1979).

Studies conducted on a brackish marsh system in the Calcasieu Basin controlled by a fixed-crest weir (Herke et al., 1984) showed that management can substantially reduce production of migratory estuarine species. Even though the average size of individual organisms emigrating from managed areas is generally larger than in open systems, the number of organisms is much lower. The Herke et al. study showed a reduction of more than 50 percent in the number of individuals of most species leaving an experimental marsh management area. The results reported in the study by Herke et al. are not unique to Louisiana. Similar findings have been reported from South Carolina (DeVoe and Baughman, 1986). There is also a suggestion that not all migratory estuarine species are favorably impacted when the extent of submerged aquatic vegetation is increased in managed areas.

Fixed crest weirs in general are not used as much as they once were. Slotted weirs, variable-crest weirs, rock weirs and flap-gated culverts, individually as well as in various combinations, are now used instead because of the greater management potential they provide. Although these structures also diminish aquatic species movements in and out of managed areas, the amount of reductions are less than what commonly occurs with a fixed-crest weir (Rogers et al., 1987; Rogers et al., 1992a). How much reduction occurs, one kind of structure relative to all others, has been quantified for some (Rogers et al., 1987 and 1992a; Herke et al., 1987) but not for all possible combinations.

Periodic water level reduction is a very controversial aspect of active marsh management, primarily because in many cases, access to managed areas is prohibited during drawdown periods and use of actively managed areas by migratory estuarine fish is therefore reduced. However, in the short-term, water level reduction is the mechanism by which habitat conditions can be stabilized, expanded, or qualitatively improved for some estuarine fisheries resources. In the long term, the expectation is that wetland habitat supportive of migratory fish can be maintained or increased through active management, whereas comparable unmanaged areas would disappear quicker and provide diminishing value.

Undertaking a water level draw-down (Phase 1), even if only once every three years (the current practice), could adversely and significantly affect migratory estuarine-dependent fishery resources. All movement into an area would be virtually eliminated for the duration of the draw-down. Fishery movements out of a managed area during a draw-down would occur only during those progressively more infrequent situations when water could be discharged from the area by gravity.

Given the differences in project locations and operational schemes, it is difficult to predict the effect of active management on freshwater and resident estuarine fishes.

Reduced frequency of stressful salinity events, more cover in the form of submerged aquatic vegetation, possibly more emergent vegetation, and reduced competition and predation from migratory estuarine species are some reasons how freshwater and resident estuarine species could be benefitted. Conversely, extensive drawdowns could result in stressful water quality conditions that would likely reduce resident fish populations.

Phase 2 operations can also affect fishery resources because ingress and egress can occur only on a limited basis during this phase. The restrictive effect may be more pronounced during the three to four months of winter. Some management plans provide for the retention of water levels to facilitate other activities during these months. During those several months, water level control structures are typically set at elevation equal to or slightly less than marsh level. Thus, movements of the relatively few migratory estuarine-dependent fishery species that use the marshes during these months are precluded to a large degree from accessing or leaving such managed areas except when storm tides occur.

Another possible effect of management that may occur is a different fish species assemblage inside a managed area than outside. Such a difference was recently documented for a managed area in coastal Louisiana (USFWS, 1991). This effect has also been observed and reported in managed South Carolina brackish marshes (Wilkinson, 1987; Wenner et al., 1986). DeVoe and Baughman (1986) concluded that the operational schedule of the water control structures is an isolating mechanism that gives rise to differences in fish populations between managed marshes and nearby creeks. Rogers et al. (1992b) advanced a similar explanation as to why different fish communities become established in actively managed brackish marshes in Louisiana.

Structural and functional fish community differences that arise as an often unintended consequence of installing the water control structures can be measurably and materially reversed. Physically removing structures, or undertaking actions that have the effect of removing the structure (permanently locking flap-gated culverts open), can be equally effective (DeVoe and Baughman, 1986). Hoese and Konikoff (unpublished manuscript) suggest that naturally-occurring, high water events that inundate managed areas tend to diminish or offset differences in fish community composition between managed and unmanaged areas.

Improved habitat conditions for estuarine organisms, stemming partly from the enhanced growth of SAV, is sometimes claimed as a benefit of marsh management. Habitat conditions for and the population sizes of resident fish species were reported to improve in one managed area (USFWS, 1991). However, improvement of fisheries habitat has not been a principal reason for electing to undertake marsh management. Some landowners are very interested in maintaining fisheries resources usage of managed areas but, historically, provisions to diminish the adverse impacts of water control structures on the ingress and egress of fisheries into and out of managed marshes are typically included as project components to the extent that they do not appreciably reduce or compromise other management objectives.

3.3.6.4. Hydrologic Restoration. These projects normally allow unimpeded fishery access through natural tidal channels although some natural channels which have enlarged due to erosion, tidal scour, or dredging would sometimes be constricted back to more historic dimensions. Tidal influence which is unnaturally high due to canals, eroded banks, and ditches would be brought back to natural levels. Depending on the types of structures used and their location, some projects could reduce the use of project areas by migratory, estuarine-dependent fishery species. Effects would vary, depending on site-specific conditions. Over the long-term, projects are expected to reduce marsh loss rates, resulting in higher fishery habitat values than for unprotected areas. Projects located in fresh and low salinity areas would likely improve water quality and foraging habitat for freshwater and resident estuarine fish through stabilization of the hydrologic regime and enhanced production of submerged aquatic vegetation.

3.3.6.5. Hydrologic Management of Impoundments. Depending upon the operation of structures and pumps to be installed for the project and the existing conditions of the site, project effects could range from minimal to significant. If a project would re-establish tidal connection with an existing impoundment, even if only periodically, migratory estuarine species would benefit from this increase in nursery habitat (assuming that the organisms would be allowed to exit the area). On the other hand, other projects would not allow any tidal exchange and would therefore not affect estuarine fisheries species. Fishery access would continue to be blocked from impounded areas. Effects on resident freshwater species within the impounded areas is difficult to generalize because of considerable differences in project sites and operational schemes possible. Projects would be expected to increase populations of resident fish species in areas that are currently being used for pasture, whereas fish populations could decrease in areas that are suffering from chronic high water problems.

3.3.6.6. Sediment Diversion. Depending on the area, sediment diversions may or may not greatly affect fishery resources. The diversions proposed in the active Mississippi River delta (below Venice on the west bank of the river and below Baptiste Collette Bayou on the east bank) would discharge into habitat that is already fresh. Although there would be some displacement of aquatic organisms, the effects would be much less than for diversions proposed upstream for the Barataria and Breton Sound Basins, which would discharge directly into brackish and saline marshes. These diversions would cause a significant shift of estuarine species away from the fresh conditions established by the diversions, at least during periods of high river flow. Harvest of some species that favor higher salinity estuaries, such as brown shrimp, could be reduced. Other species that prefer lower salinity estuaries for juvenile growth and development, such as blue crab, white shrimp, and menhaden, could provide increased harvests. In the fresh and low salinity areas in the outfall of diversions, freshwater fish populations would establish.

The purpose of sediment diversions is to build vegetated marsh which supports fishery resources. From an overall perspective, sediment diversions are expected to provide long-term benefits to fisheries resources by providing the vegetated wetland habitat that supports the estuarine ecosystem.

3.3.6.7. Outfall Management. Outfall management would shift flow patterns and salinity regimes near freshwater diversion structures. Freshwater species would be benefitted in the areas of freshwater flow from the exclusion of salt water. Structures used for outfall management could potentially hinder the immigration of estuarine species and thereby reduce usage of the managed area by these species.

3.3.6.8. Freshwater Diversion. Freshwater diversion from the Mississippi River would produce a net positive effect on coastal fisheries. As stated for sediment diversions, productive areas for some estuarine species would be shifted, at least during high flow periods, to a more seaward location. Populations of estuarine species favoring lower salinity environments, like blue crabs, menhaden, and white shrimp, would be expected to increase. Diversions would cause a general shift in estuarine species away from the diversion sites where freshwater species could become established if salinities do not reach high levels during low-flow periods.

3.3.6.9. Marsh Creation with Dredged Material. Marshes created or restored by use of dredged material would remove shallow water habitat. In some areas, especially the East Coast of the U.S., this would be considered a detrimental effect, but in Louisiana, with its massive wetlands loss problems, there is no shortage of shallow water habitats. The created marsh would provide organic detritus to the estuarine system and critical marsh edge habitat for aquatic species.

3.3.6.10. Barrier Island Restoration. Barrier islands separate the gulf from the bays and sounds. Without barrier islands these bays and sounds would become more like shallow near-shore gulf which has a different species assemblage. Many of the economically important species harvested in Louisiana are taken from the larger bays where they occur as sub-adults. Other species spend their adult life in the larger bays or in the near-shore gulf. Barrier islands moderate tidal energy and salinity regimes within the bay systems. Species adapted for living in the surf zone would benefit from barrier island restoration because their habitat would be preserved by these projects.

Where effective in moderating tidal exchange, barrier island projects could prolong the life of upper-basin fresh and low-salinity environments. In such cases, freshwater fish populations in those areas would likely be maintained for a longer period of time before these areas would convert to more brackish habitats.

3.3.6.11. Shoreline Erosion Control with Structures. A long-term positive impact on fisheries resources would be expected by a reduction in the marsh erosion rate, protection of interior marsh from washing out through shoreline breaks, and the habitat provided by the structures themselves. Short-term impacts would occur during construction by physical disturbance of the area.

3.3.6.12. Vegetative Plantings. A positive effect on fisheries is expected by the preservation of marsh edge habitat, a reduction in the marsh erosion rate, and protection of interior marsh from washing out through shoreline breaks.

3.3.6.13. Terracing. Projects are expected to benefit fisheries resources by creating marsh edge habitat and protected aquatic areas with increased coverage of submerged aquatic vegetation. Short-term, construction-related adverse impacts would normally be minor.

3.3.6.14. Sediment Trapping. Temporary, usually minor disturbances would occur to aquatic species during construction. Long-term positive effects anticipated from preservation and development of marsh.

3.3.6.15. Herbivore Control. No direct effect on any fishery species except oysters (see Section 3.3.8.15.). Indirectly, herbivore control would benefit fisheries by preserving marsh.

3.3.7. Threatened and Endangered Species.

3.3.7.1. Existing Conditions. The Endangered Species Act of 1973 (as amended) provides protection for species identified as threatened or endangered. The USFWS and the NMFS administer the Act. Federal agencies are required to consult with the USFWS and the NMFS to determine if proposals are likely to adversely affect protected species and, if so, develop plans to avoid, minimize, or otherwise address potential conflicts with threatened and endangered (listed) species. Table 2 provides a list of the threatened and endangered species known to occur in the coastal wetlands and waters of Louisiana. Although American alligator is listed, it is biologically neither endangered or threatened. It is classified as "threatened due to similarity of appearance" meaning that other reptiles of similar appearance are threatened and endangered. A regulated commercial harvest of wild alligators is allowed in Louisiana. Discussions that follow do not include effects to alligators. The red wolf, although listed in the table, is generally considered to be extirpated in the wild in Louisiana. Cameron and Calcasieu Parishes are the locations of the last known, naturally occurring, wild individuals of this species. No critical habitat for

TABLE 2
THREATENED AND ENDANGERED SPECIES
FOUND IN THE COASTAL WETLANDS OF LOUISIANA

(E=Endangered; T=Threatened; CH=Critical Habitat determined)

Mammals		
Panther, Florida (Felis concolor coryi)	E	Entire state
Whale, Right (Eubalaena glacialis)	E	Coastal waters
Whale, Finback (Balaenoptera physalus)	E	Coastal waters
Whale, Humpback (Megaptera novaeangliae)	E	Coastal waters
Whale, Sei (Balaenoptera borealis)	E	Coastal waters
Whale, Sperm (Physeter catodon)	E	Coastal waters
Wolf, Red (Canis rufus)	E	Cameron and Calcasieu Parishes[1/]
Bear, Louisiana Black (Ursus americanus luteolus)	T	Entire state
Birds		
Curlew, Eskimo (Numenius borealis)	E	Entire state
Eagle, Bald (Haliaeetus leucocephalus)	E	Entire state
Falcon, Arctic Peregrine (Falco peregrinus tundrius)	T	East, South
Pelican, Brown (Pelecanus occidentalis	E	Coast
Plover, Piping (Charadrius melodus)	T	Coast
Warbler, Bachman's (Vermivora bachmanii)	E	Entire state
Woodpecker, Ivory-billed (Campephilus principalis)	E	Entire state
Reptiles		
Alligator, American (Alligator mississippiensis)	T(S/A)[2/]	Entire state
Turtle, Kemp's (Atlantic) Ridley (Lepidochelys kempii)	E	Coastal waters
Turtle, Green (Chelonia mydas)	T	Coastal waters
Turtle, Hawksbill (Eretmochelys imbricata)	E	Coastal waters
Turtle, Leatherback (Dermochelys coriacea)	E	Coastal waters
Turtle, Loggerhead (Caretta caretta)	T	Coastal waters
Turtle, Ringed Sawback (Graptemys oculifera)	T	Pearl and Bogue Chitto Rivers
Fish		
Pallid Sturgeon, Scaphirhynchus albus	E	Mississippi River & tributaries
Gulf Sturgeon, Acipenser oxyrhynchus desotoi	T	Pearl River & Lake Pontchartrain tributaries

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1/ Red wolves are considered extirpated in the wild. Cameron and Calcasieu Parishes are the last known areas supporting a wild population.

2/ For law enforcement purposes the alligators in Louisiana are classified as "Threatened due to Similarity of Appearance". They are biologically neither endangered nor threatened. Regulated harvest is permitted under State law.

threatened or endangered species has been designated in Louisiana, although critical habitat has been proposed for the Louisiana black bear.

Louisiana has a relatively large nesting population of bald eagles. In the 1992-93 nesting season, 65 active nests were recorded, and the nesting population is continuing to expand. The center of the nesting activity is located in the area around Avoca Island in the general vicinity of Morgan City, Louisiana, but nests are scattered throughout the coastal cypress swamps and fresh to intermediate marshes in the coastal area.

The Louisiana Natural Heritage Program maintains a database of plant and animal species that are considered rare or in danger of extirpation within Louisiana. Many of these locally rare species are found in the coastal wetlands and depend on the wetlands for their survival. Although these species are not specifically protected by law, government agencies are urged to consider them when planning projects. Some of the proposed Restoration Plan projects would preserve habitats where some of these species are found.

3.3.7.2. No Action. Continued loss of coastal wetlands would cause habitat loss and a decrease in food supply for several listed species including bald eagles, Arctic peregrine falcons, brown pelicans, piping plovers, loggerhead sea turtles, and Kemp's ridley sea turtles. The other threatened and endangered species occurring in Louisiana's coastal wetlands and coastal waters are either transient or do not rely as heavily on coastal wetlands for habitat or food sources.

3.3.7.3. Marsh Management. Project construction sites would have to be checked for presence of bald eagle nests. Any potential effects to nesting eagles could most likely be avoided by scheduling construction during the non-nesting season. Other species would probably not be affected directly by individual projects; however, the cumulative effect of marsh management projects could be a decrease in the nursery habitat available for some migratory estuarine species which provide food for brown pelicans and sea turtles. The NMFS has expressed concern that marsh management projects, cumulatively, could affect sea turtles by reducing their food supply and by affecting their access to shallow, open-water portions of managed areas, especially those areas located along the rim of the Gulf of Mexico. Sea turtles, especially Kemp's ridleys and loggerheads, are known to enter Louisiana's estuaries, but apparently have never been abundant in this area and nowadays occur infrequently. Marsh management projects are typically not located in the saline and highly brackish areas where these turtles are more likely to be found.

3.3.7.4. Hydrologic Restoration. Project construction sites would have to be checked for presence of bald eagle nests. Any potential effects to nesting eagles could most likely be avoided by scheduling construction during the non-nesting season. Other species would probably not be adversely affected, however each project would have to be evaluated individually. Long-term beneficial effects to wetland-dependent threatened and endangered species would be expected from restoration and preservation of wetlands.

3.3.7.5. Hydrologic Management of Impoundments. Effects similar to hydrologic restoration.

3.3.7.6. Sediment Diversion. Project construction sites would have to be checked for the presence of bald eagle nests. Any potential effects to nesting eagles could most likely be avoided by scheduling construction during the non-nesting season. Projects would also have to be assessed for their potential to affect feeding areas of eagles and other listed species. If a brown pelican nesting colony is located in the outfall of the diversion, a biological assessment would likely be required to determine the effect on the breeding colony. Other species would probably not be adversely affected, however each project would have to be evaluated individually. Long-term beneficial effects to listed species would be expected from creation and preservation of wetlands.

3.3.7.7. Freshwater Diversion. Effects similar to sediment diversion.

3.3.7.8. Outfall Management. Effects similar to hydrologic restoration.

3.3.7.9. Marsh Creation with Dredged Material. Effects similar to hydrologic restoration. Additionally, effects of dredging on listed aquatic species would require evaluation. Restriction of dredging to a certain time of the year may be necessary to avoid potential negatives impacts to listed species.

3.3.7.10. Barrier Island Restoration. Several listed species are found on and near barrier islands. Brown pelicans use barrier islands for nesting and resting. Piping plovers feed on the tidal flats around barrier islands. Although not a major nesting area, a small number of loggerhead sea turtles nest on the Chandeleur Islands. The Chandeleurs comprise part of the Breton National Wildlife Refuge, a wilderness area that is not the subject of any CWPPRA project proposals. Barrier island restoration projects would require evaluation to determine if brown pelicans, piping plovers, or sea turtles would be affected. The potential for adverse effects can be often be minimized or eliminated by limiting construction to certain times of the year. Long-term beneficial effects would be expected from preservation of the islands and associated wetlands.

3.3.7.11. Shoreline Erosion Control with Structures. Bald eagle nests near specific project sites or other listed species in the area may require limiting of construction to certain times during the year. Projects along the gulf shoreline would have to be evaluated for their potential to effect sea turtles. Otherwise no adverse impacts to listed species is anticipated. Long-term beneficial effects would be expected from preservation of wetlands.

3.3.7.12. Vegetative Plantings. Effects similar to shoreline erosion control with structures.

3.3.7.13. Terracing. Effects similar to shoreline erosion control with structures.

3.3.7.14. Sediment Trapping. Effects similar to shoreline erosion control with structures.

3.3.7.15. Herbivore Control. No direct effect on listed species. A reduction in the numbers of herbivores (nutria and muskrat) that have become overpopulated would help preserve and enhance stressed wetlands and thereby have beneficial effects on the threatened and endangered species that depend on the wetlands for their life requisites.

3.3.8. Oyster Leases.

3.3.8.1. Existing Conditions. Louisiana is one of the Nation's top oyster producers. The average annual harvest from 1988 to 1992 was 10 million pounds of oyster meats (approximately 2 million sacks) within average annual value of $30 million. Oyster production in Louisiana is from both private leases and from State-maintained water bottoms. Approximately 357,000 acres of water bottoms are leased for oyster culture in Louisiana. Fishermen pay the State two dollars per acre per year for the leases which the fishermen are allowed to sell or otherwise transfer. Lease terms are for fifteen year periods. In order to maintain productive leases, fishermen sometimes spread cultch material for oyster larvae attachment and spread seed oysters taken from State maintained water bottoms.

Oyster leases cover nearly all water bottoms available for lease that are capable of producing oysters. In addition, many areas that have remained closed to harvest for pollution reasons and that are presently unsuitable for oyster production are leased. Fishermen are normally compensated for seismic and other oil and gas activities that affect their leases. They also have the right to sue for damages to their leases.

As Louisiana's marshes have deteriorated and reverted to open water, vast shallow, open water areas, much of which is located in areas suitable for oyster culture, have developed. Vast acreage of these subsided marsh areas have been leased to oyster fishermen. The area between Port Sulphur and Buras, in Plaquemines Parish, is the most obvious example.

Oyster fishermen and their representatives have expressed concern over CWPPRA projects affecting leases. They have raised the issue that oyster reefs provide desirable habitat for various important fishery species and that oyster leases should not be sacrificed for emergent vegetation. The Louisiana Department of Wildlife and Fisheries, the agency responsible for managing the oyster industry, has begun including statements in new and renewed leases that the State shall not be liable for damages to oyster leases resulting from implementation of wetlands restoration projects. The legality of this disclaimer statement has not been challenged. The issue of whether oyster fishermen would be compensated and how they would be compensated for losing their leases to the effects of CWPPRA projects is a major unresolved issue. Either during the design of projects or during any subsequent evaluations of required Federal permits, the LDWF will be consulted, either directly or indirectly through the Louisiana Department of Natural Resources, concerning the occurrence of oyster leases within areas proposed for restoration.

3.3.8.2. No-action. The amount of water bottoms capable of supporting oysters is continuing to increase as marshes are lost to open water and salinity regimes move farther inland. Also, the organic material released from the deteriorating marshes is contributing to high fertility rates in the estuaries and high production of planktonic organisms and organic detritus for oysters to feed upon. While the areas suitable for oysters are increasing, pollution problems limit the areas where they can be harvested. The net effect is that the harvestable oyster zone is being squeezed between polluted areas and areas too high in salinity. Oyster production is expected to increase substantially as a result of the Caernarvon, Davis Pond, and Bonnet Carré Freshwater Diversion projects.

3.3.8.3. Marsh Management. Normally, marsh management is only proposed for areas that are entirely under private ownership, even the water bottoms. It is unlikely, but possible there could be cases where oyster leases occur within areas proposed for marsh management.

Marsh management would be detrimental to any oysters within the managed area because of reductions in tidal flow. Oysters develop and grow best in areas of moderate to high tidal velocities and the lentic (still water) conditions created by marsh management would create a situation unsuitable for commercial oyster production.

3.3.8.4. Hydrologic Restoration. Hydrologic restoration projects could be either beneficial or detrimental to oyster production, depending on the conditions of the specific site. In areas where salinity is too high, causing disease and predator problems, hydrologic restoration could produce a more suitable situation for oysters. However, the potential for hydrologic restoration projects in the high salinity habitats is less likely than in brackish areas where canals have altered the natural hydrology. In these brackish areas, it is very difficult to generalize about the effects of hydrologic restoration. If existing salinity levels are in the high range for oyster production, hydrology restoration, which reduces salinity levels, would tend to benefit oysters. If existing salinity levels are in the optimal to low range for oysters, hydrologic restoration could negatively impact oyster production. Also, reduced tidal circulation could negatively impact oysters which depend on tidal currents for food.

3.3.8.5. Hydrologic Management of Impoundments. No oysters leases nor substantial amount of oysters would be located within existing impoundments therefore no effects on these items would be expected.

3.3.8.6. Sediment Diversion. Sediment diversions would cause a detrimental effect to any oyster leases occurring in their immediate outfall areas. Oysters beds are capable of withstanding only very small quantities of sediment and being completely non-mobile, oysters can be easily suffocated by siltation. The large-scale sediment diversions proposed as long-term supporting projects and critical projects for the Breton, Barataria, and Mississippi River Delta Basins are especially likely to produce significant adverse impacts to oyster leases and State reserved water bottoms. Saline areas on the periphery of the outfall from sediment diversions could become more conducive to oysters from reduced salinity levels and nutrient input from the diversions, however existing brackish areas along the periphery would likely become too fresh for oyster production. The overall impact of a sediment diversion on oyster production would depend on site-specific conditions. Sediment diversions in the Atchafalaya Delta would not significantly impact oysters or oyster leases.

3.3.8.7. Freshwater Diversion. Discussion under this section will be limited to diversion of water from the Mississippi River. The types of freshwater diversions proposed from the Mermentau Basin would not significantly affect oyster production because of the lack of suitable habitat in the receiving areas. Proposals for diversion of Atchafalaya River water into western and northern Terrebonne Basin could impact oysters in the middle and southern parts of the basin if the diversions were large enough. If this were the case, impacts would be similar to those discussed for Mississippi River diversions.

The three major freshwater diversions from the Mississippi River that were authorized for construction before passage of the CWPPRA were economically justified mainly by their benefits to oysters. Other freshwater diversions constructed by local interests in Plaquemines Parish were built with the specific intention of benefiting wetland habitat and its dependent fish and wildlife resources. The Caernarvon Freshwater Diversion became operational in the spring of 1991 but construction of the Bonnet Carré and Davis Pond Diversions has not been initiated. These projects would restore favorable salinity levels in the historic oyster producing areas where saltwater intrusion has caused increased salinity levels. As saltwater has encroached into the coastal wetlands of Louisiana, the oyster production zone has expanded into areas that were previously too fresh. These areas, although productive, are not as well suited for oyster production because of poor substrate and proximity to pollution sources. The problem is that some oyster fishermen have come to expect continued production from their leases in the areas closer to diversions. Fishermen who maintain leases on the outer (high salinity) fringe of the productive oyster zone and the fishermen who rely on harvest of oysters from water bottoms reserved by the State on the seaward side of the leased zone, would greatly benefit from freshwater diversion by restoration of favorable salinity regimes in these areas. Oyster leases closer to the diversions could be negatively impacted by reduced salinity levels. Effects would depend upon the operational scheme developed for each freshwater diversion project.

3.3.8.8. Outfall Management. Outfall management is usually proposed for the immediate outfall of freshwater diversion projects. As such, these areas are not generally well suited for oyster production due to existing low salinity levels. Therefore, adverse effects to oyster leases are normally not expected. In unusual cases, such as near the Bayou Lamoque diversion in Plaquemines Parish, oyster leases occurring adjacent to the main outflow channel are now bypassed because the banks of the outflow channel contain the fresh water until in reaches the open bay system. The conceptual plan for Bayou Lamoque Diversion outfall management would involve the distribution of outflow into marshes and lagoons adjacent to the outflow channel which could possibly cause negative effects to some of the oyster leases near the channel while potentially benefitting others located farther away.

3.3.8.9. Marsh Creation with Dredged Material. These type projects are very site specific and therefore impacts to oyster leases for individual projects would be much easier to determine as compared to a freshwater or sediment diversion. Obviously, any oyster leases or oyster beds located in an area of marsh creation would be destroyed by sediment deposition and conversion of the area to vegetated wetlands. In some cases, nearby leases could be affected by runoff of sediments from the marsh creation sites and by altered hydrology in bayous and other tidal streams. Silt screening devices and other features could be used to minimize adverse effects.

3.3.8.10. Barrier Island Restoration. Restoring barrier islands would not significantly impact oyster leases or productive oyster areas except when they occur in the borrow areas or if oyster leases occur immediately behind the islands where dredged material is to be placed. Productive oyster areas would not be expected in the immediate vicinity of eroding barrier islands because of shifting sands and high salinity conditions, but may be present in the bays behind the islands.

3.3.8.11. Shoreline Erosion Control with Structures. The only known potential for impacts to oyster leases from this type of project is from the excavation of flotation canals through open water areas that may be required for equipment access to shoreline sites. Excavation of access routes, disposal of the dredged material, and turbidity caused by dredging and vessel traffic would have the potential to adversely impact oyster leases and oyster beds that the access routes cross.

3.3.8.12. Vegetative Plantings. Little potential for impacts to oyster leases is expected from this type of project. Temporary wave-dampening devices proposed for some of these projects may have a minor, very localized negative effect if oysters were located very near to a shoreline erosion control site.

3.3.8.13. Terracing. No impacts to oyster leases are expected. No projects are proposed for oyster producing areas.

3.3.8.14. Sediment Trapping. Normally, sediment trapping devices would not be proposed in areas capable of supporting oysters. In order to be successful, sediment trapping devices need to be placed in areas of high turbidity and sediment transport.

3.3.8.15. Herbivore Control. Oyster harvest areas, whether they are private leases or State maintained water bottoms, are subject to pollution-related harvest restrictions. The LDWF and Louisiana Department of Health and Hospitals monitor the water quality in oyster producing areas across the coast. The concentration of bacteria, especially *Escherichia coli* which is associated with animal feces, in the water is the primary parameter used to determine whether or not areas should be opened or closed for oyster harvest. Circumstantial evidence suggests that the waste generated by high concentrations of nutria and muskrat can cause elevated bacteria counts. If this assumption is true, reducing their populations could benefit the oyster industry by allowing more areas to be opened for harvest. It should be noted that the bacteria do not harm the oysters or restrict their population, only the areas that they can be harvested. The bacteria can be harmful to humans only if the oysters are eaten raw.

3.3.9. Water Quality.

3.3.9.1. Existing Conditions. Water quality in Louisiana's wetlands ranges from highly turbid, nutrient-laden waters in some fresher marshes and swamps to clear, saline waters near the barrier islands. Generally, the estuarine waters of Louisiana are turbid from suspended sediments and high plankton densities associated with high nutrient levels. Urban and agricultural runoff causes high coliform bacteria in some areas. Very high suspended sediment concentrations are found in waters around the Mississippi and Atchafalaya River deltas except during low flow conditions when water clarity increases. Increased salinity levels, caused by a variety of factors including navigation channels and the loss of barrier islands, have contributed to the marsh and swamp loss in recent decades and continue to contribute to wetland loss. Toxic pollution is not considered to be a major problem in the coastal wetlands except for very isolated spots near major industrial centers.

3.3.9.2. No-action. The only significant changes expected in water quality would be from the two freshwater diversion projects to be implemented under separate authorities. The salinity regimes of the Pontchartrain and Barataria Basins will be altered by freshwater introduction in the upper parts of these basins. High suspended sediment concentrations in the diverted river water will increase turbidity levels in large parts of these basins. No increase in toxic pollution levels is expected although the projects will be extensively monitored for water quality parameters.

3.3.9.3. Marsh Management. The effect of the marsh management on water quality attributes are inconclusively documented. Management's effect on some water quality attributes, such as temperature and dissolved oxygen, have seldom if ever been reported. Childers and Day (1990) concluded that several the dynamics of several water quality attributes respond to a number of variables and successional stage.

The effect that management has on salinity has received attention because salinity affects the composition and health of marsh communities. Most of the information currently available is related to how management affects average salinity levels within managed marshes, but even the more rigorously administered data collections derived from recently implemented management plans are not definitive regarding the effects of active management on average salinity levels.

However, unlike passive management, active management provides the manager with some capability to control how salty the water gets inside the managed area. This is important because if the upper limits of salinity can be suppressed, then vegetation can be protected from the stressful or toxic conditions of the higher salinity events. Attempts to suppress salinity in managed areas involve reconfiguring water control structures to restrict or eliminate saltier-water inputs for as long as outside salinity levels remain a potential problem. This selective control of salinity is called a salinity safeguard. It is a feature of many active management plans and would be considered for any management projects constructed under the CWPPRA.

3.3.9.4. Hydrologic Restoration. No significant effects on water quality would be expected. Salinity levels in restored areas may be reduced and water clarity may be improved.

3.3.9.5. Hydrologic Management of Impoundments. No significant changes in water quality would be expected.

3.3.9.6. Sediment Diversion. Significant changes in water chemistry would be expected for sediment diversions from the Mississippi River discharging directly into existing brackish and saline areas. There would be a shift from the typical brackish and saline conditions to a freshwater condition similar to that found in the active river deltas.

3.3.9.7. Freshwater Diversion. Effects would be similar to sediment diversion.

3.3.9.8. Outfall Management. During periods of low flows and when freshwater diversion structures are not operated, the managed areas would likely have lower salinity levels than if no outfall management were in place. This is because outfall management would reduce the tidal exchange within the managed areas, in some cases, and therefore would conserve the fresh, diverted waters within the managed area.

3.3.9.9. Marsh Creation with Dredged Material. Construction of projects would cause temporary increases in turbidity levels. Runoff from unconsolidated dredged material may cause localized, elevated turbidity levels until the dredged material becomes vegetated.

Proposal to use material dredged from potentially contaminated waterways or use of unconventional materials, such as "red mud", would require that contaminant-related issues be addressed before projects are implementation. The degree of testing necessary would depend on site specific conditions and scope of the proposed projects.

3.3.9.10. Barrier Island Restoration. Effects would be similar to marsh creation with dredged material.

3.3.9.11. Shoreline Erosion Control with Structures. Increased turbidity levels during construction would be likely. Over the long-term, a decrease in turbidity from prevention of erosion may occur.

3.3.9.12. Vegetative Plantings. Decrease in turbidity from prevention of erosion may occur.

3.3.9.13. Terracing. Decrease in turbidity would be likely.

3.3.9.14. Sediment Trapping. No significant changes in water quality would be expected.

3.3.9.15. Herbivore Control. Controlling nutria and muskrat populations may reduce bacteria levels.

3.3.10. National Wildlife Refuges, State Wildlife Management Areas, and National Parks.

3.3.10.1. Existing Conditions. Twenty-one National wildlife refuges (NWR's), State wildlife management areas (WMA's), and State wildlife refuges (SWR's), and one

National park are located in Louisiana's coastal wetlands. Table 3 displays the names, location, size, and habitat type of each of these areas. Most of the National and State wildlife refuges are managed primarily for migratory waterfowl. Some of the more unique areas are as follows. The Breton National Wildlife Refuge, consisting of the Chandeleur and Breton Islands, is a wilderness area composed of a chain of barrier islands heavily used by colonial nesting birds. The recently acquired Bayou Sauvage National Urban Wildlife Refuge, which supports large numbers of migratory waterfowl and resident wading birds, alligators, and terrestrial animals, is located within the city limits of New Orleans and will likely experience large numbers of visitors once infrastructure is developed. The Shell Keys National Wildlife Refuge consists solely of shifting shell reefs in the Gulf of Mexico south of Marsh Island that are used by nesting birds.

Many of the NWR's, WMA's, and SWR's have existing features designed to maintain and optimize habitat conditions. Marsh management with structures and/or pumps is an important component of refuge operations in the Chenier Plain. Less intensive management is possible in most of the Deltaic Plain because of poor soil conditions and more open and remote setting of the refuges. Small-scale sediment diversions (crevasses) have been implemented on the refuges in the active Mississippi River delta.

Projects proposed for refuges, management areas, and the National park would compete for available CWPPRA funds on an equal basis with projects on private lands. The CWPPRA makes no distinction between public and private lands.

3.3.10.2. No-action. Refuges, management areas, and the National park would continue to be managed and maintained to the extent possible with funds available. Funding levels often fall far short of that necessary to manage areas optimally.

The Bonnet Carré Freshwater Diversion, previously authorized under another authority, would reduce saltwater intrusion problems in the Manchac and Joyce WMA. The tidally-influenced portion of the Bayou Sauvage NWR and the Biloxi WMA would be enhanced with nutrient and sediment-laden freshwater. The Davis Pond Freshwater Diversion, also already authorized, will benefit the Jean Lafitte National Park and Salvador WMA by providing nutrient and sediment-laden freshwater to increase vegetative vigor and combat saltwater intrusion.

3.3.10.3. Marsh Management. Most of the refuges in the Chenier Plain already have subunits under marsh management. Projects are proposed to fund specific maintenance requirements of these management systems and also to upgrade their management potential.

3.3.10.4. Hydrologic Restoration. Hydrologic restoration projects would be most appropriate for the management areas and refuges located in the Deltaic Plain. The

TABLE 3
NATIONAL WILDLIFE REFUGES, NATIONAL PARKS, AND STATE WILDLIFE MANAGEMENT AREAS AND REFUGES

BASIN	NAME OF AREA[1/]	ACRES[2/]	HABITAT TYPE
Pontchartrain	Bayou Sauvage NWR	18,397	Fresh marsh, brackish marsh
Pontchartrain	Manchac WMA	8,325	Fresh to intermediate marsh, cypress swamp
Pontchartrain	Joyce WMA	15,609	Fresh marsh, cypress swamp, scrub/shrub wetlands
Pontchartrain	Pearl River WMA	34,896	Fresh and intermediate marsh, cypress swamp
Pontchartrain	Biloxi WMA	39,583	Brackish and saline marsh
Pontchartrain and Breton	Breton NWR	6,923	Barrier islands, mangrove, saline marsh
Mississippi	Delta NWR	48,800	Fresh and intermediate marsh
Mississippi	Pass a Loutre WMA	66,000	Fresh and intermediate marsh
Barataria	Jean Lafitte National Park	10,000	Fresh and intermediate marsh, cypress swamp
Barataria	Salvador WMA	31,000	Fresh marsh
Barataria	Wisner WMA	21,621	Saline marsh
Terrebonne	Terrebonne Barrier Island Complex SWR	3,200	Barrier islands, saline marsh
Terrebonne	Point au Chien WMA	30,037	Fresh to brackish marsh
Atchafalaya	Atchafalaya Delta WMA	125,375	Fresh marsh, scrub/shrub
Teche/Vermilion	Shell Keys NWR	<100	Shell reefs south of Marsh Island
Teche/Vermilion	Marsh Island SWR	79,000	Mostly brackish marsh, some saline marsh
Teche/Vermilion	State SWR	15,000	Mostly brackish marsh, some saline marsh
Mermentau	Cameron Prairie NWR	9,621	Fresh marsh
Mermentau	Lacassine NWR	32,625	Fresh marsh
Mermentau	Rockefeller SWR	84,000	Fresh to saline marsh
Calcasieu/Sabine	East Cove Unit of Cameron Prairie NWR	15,000	Mostly brackish marsh, some intermediate marsh
Calcasieu/Sabine	Sabine NWR	125,000	Fresh to saline marsh

[1/] NWR=National Wildlife Refuge, WMA=Wildlife Management Area, SWR=State Wildlife Refuge
[2/] Acres refers to all lands and waters within refuge, park, or management area boundary

Biloxi, Point au Chien, and Wisner WMA could likely benefit from this type of project.

3.3.10.5. Hydrologic Management of Impoundments. Several of the refuges and management areas have existing impoundments that are being managed with various levels of intensity. The recently designated Bayou Sauvage Refuge could probably benefit most from this type of project. Years ago, much of what is now the refuge was enclosed within the hurricane protection levees for New Orleans. Inadequate control of water levels within this impounded area has caused the loss of the enclosed freshwater wetlands. Two projects which have already been approved through priority project lists, would involve installation of pumping facilities to optimally manage water levels.

3.3.10.6. Sediment Diversion. Sediment diversions could significantly affect Breton NWR, Delta NWR, and the Pass a Loutre WMA. Additional small-scale sediment diversions could be constructed in Delta NWR and Pass a Loutre WMA to develop fresh marsh. A large-scale diversion off the main stem of the Mississippi River is proposed for the Benny's Bay area of Delta NWR (PMR-5). This project would build thousands of acres of fresh marsh within the refuge. On the other hand, uncontrolled diversion of the Mississippi River into the Barataria or Breton Sound Basin (PMR-6) would result in rapid deterioration of the existing active delta including the Delta NWR and Pass a Loutre WMA due to a reduction in sediment input. Another delta would eventually form in the Barataria or Breton Sound Basin, depending on which basin is selected for the project, but it would take many years to develop. Diversion of the Mississippi River into the Breton Basin would also have to be assessed for its effect on seabird nesting colonies and seagrass beds in the Breton NWR.

3.3.10.7. Freshwater Diversion. Some of the freshwater diversions proposed for the Mermentau Basin could benefit refuges located there, especially the East Cove Unit of Cameron Prairie NWR.

3.3.10.8. Outfall Management. Only the Salvador WMA would be included in any proposed outfall management plan. The Davis Pond Diversion Outfall Management project (BA-10) would direct freshwater and sediment flows from the Davis Pond Freshwater Diversion into the Salvador WMA.

3.3.10.9. Marsh Creation with Dredged Material. Marsh creation with dredged material has been proposed for the Delta NWR (PMR-8). Material dredged from the Southwest Pass navigation channel would be deposited in a large area of subsided marsh north of Pass a Loutre. The Atchafalaya Delta WMA would benefit from the projects proposed to beneficially use dredged material in this area for wetland creation (XAT-6, 7, and 11C). Dredging for the specific purpose of creating marsh and plugging canals is an integral component of the Marsh Island project (TV-5/7) and would provide benefits to the Marsh Island SWR.

3.3.10.10. Barrier Island Restoration. No projects proposed for the Breton NWR, the only barrier islands that are publicly owned. Some of the islands in the Isles Dernieres chain are leased by the State of Louisiana to form the Terrebonne Barrier Islands Refuge complex. Several projects are proposed to restore these islands.

3.3.10.11. Shoreline Erosion Control with Structures. This type of project is proposed for many of the refuges, management areas, and also the Jean Lafitte National Park. It is especially appropriate to control erosion of shorelines, canal banks, or levees that protect large areas of marsh from saltwater intrusion.

3.3.10.12. Vegetative Plantings. Vegetative plantings alone and in combination with other types of projects could be successfully implemented on a number of publicly owned areas, wherever conditions are suitable.

3.3.10.13. Terracing. The only constructed terracing project is in the Sabine NWR. The soils found in the Chenier Plain are better suited to this type of project than the poorer soils of the Deltaic Plain. Terracing projects could be implemented on several NWR's and WMA's.

3.3.10.14. Sediment Trapping. Sediment trapping is proposed for the Pass a Loutre WMA (MR-2). Fencing would be erected in the shallow ponds between distributary channels perpendicular to current flows. Previously constructed pilot projects have been successful in establishing emergent vegetation. Sediment trapping could be implemented on other WMA's, NWR's, and SWR's where sediments are being transported, especially Delta NWR and Atchafalaya Delta WMA.

3.3.10.15. Herbivore Control. A herbivore control program, similar to that proposed for the CWPPRA, was implemented for a few years on the Jean Lafitte National Park. Trappers were paid a bonus for each nutria they trapped. The program has been discontinued due to lack of funds. The wetlands of the NWR's, WMA's, SWR's, and the Jean Lafitte State Park in the Deltaic Plain all have problems with high populations of nutria. If a herbivore program is implemented, an inventory of existing herbivore problem would probably be necessary to identify areas in most need of population reductions.

3.3.11. Property Ownership and Values.

3.3.11.1. Existing condition. Estimates show that approximately eighty percent of the State's coastal wetlands are privately owned, with the remaining areas owned and managed by local, State, and Federal agencies. This private property includes a large expanse of wetland which extends southward from the urbanized areas to the Gulf of Mexico. It has a relatively low market value as compared to the more urbanized areas, but it has been identified as valuable for its public purposes, primarily its use as fish and wildlife habitat. In the past, resource conservation and protection programs have included private lands where public benefits and improvements have been identified. Many of the program benefits may be off-site and contribute to public interests; however, the right of public access to private lands included in such projects has not been a requirement for participation on behalf of cooperating landowners.

Act 451 of the 1990 Louisiana Legislature [R.S. 41:213.7(E)(1-2)] addresses the use of public funds for coastal restoration projects on private lands. The Act states in part that it:

> ... creates no rights in the public for use, access or any vested interest in privately owned lands or waters which are the subject of wetlands conservation projects, nor does the Act alter or modify historic Civil Code law concerning accretion, erosion, dereliction and subsidence.

A Louisiana Attorney General's opinion (92-472) states that, "The jurisprudence of our state, even in the absence of this new statutory language, supports the exclusion of the public at large from private lands and waters affected by the expenditure of public funds for authorized purposes unless a private landowner agrees otherwise with respect to such use".

Any easements or other real estate documents acquired by the Federal government for CWPPRA projects will not change the legal rights of the landowner to deny public access. Neither will CWPPRA projects be forced upon unwilling landowners. The LDNR has stated that it will not participate in projects that are opposed by affected landowners. The LDNR has made specific reference to the Act 6 of the 1989 Louisiana Legislature (R.S. 49:213.6) that prohibits the use of Coastal Wetlands Trust Fund money from being used to build coastal restoration projects on unwilling landowners' properties. The Trust Fund is used to cost share CWPPRA projects. The State has conceded that condemnation would be considered for circumstances where the title to property is unclear or where landowners cannot be located.

Unrelated to the issue of public access the CWPPRA states that:

> ... The Secretary (of the Army) shall not fund a coastal wetlands restoration project unless that project is subject to such terms and conditions as necessary to insure that wetlands restored, enhanced, or managed through that project will be administered for the long-term conservation of such lands and waters and dependent fish and wildlife populations.

This statement has been interpreted by the USACE to require lead Task Force agencies to obtain easements on any private lands where structures would be built or where a significant change in potential land use would occur. Easements would be necessary to insure that projects remain functional throughout their expected lives. Depending on the type of project and its features, easements may be necessary for construction and maintenance of levees, channels, and structures, as well as for borrow and disposal of dredged material, and flowage of waters.

The issue of wetland and water bottom ownership in coastal Louisiana is very controversial and unsettled. The same Attorney General's opinion referenced earlier (92-472) contains some important information about lands created or restored by coastal restoration projects. The following discussion, excerpted from the opinion, is necessarily long so as not to leave out any important information. The opinion states that:

> First of all, it should be recognized that the waters, beds and bottoms of natural navigable waterbodies are public things owned by the state and subject to public use, such as the sea, the seashore, rivers, lakes and streams. The banks of navigable rivers or streams, however, are private things which are subject to a right of public use. The bank of a navigable river or stream is the land lying between the ordinary low and the ordinary high stage of water.
>
> Consequently, on navigable rivers and streams, public ownership rights extend only to ordinary low water, while the public right of use extends to the ordinary high water stage. Under well-settled Louisiana jurisprudence, the servitude of public use is not for the use of the public at large for all purposes, but merely for purposes that are incidental to the navigable character of the stream, which traditionally, has been limited to such purposes as landing on the shore, to fish, to shelter oneself, to moor ships, to dry nets and the like. Thus, private ownership of such riparian lands is burdened with the right of public use incidental to navigation purposes. The public at large does not have the right to hunt, to trap, to camp, to construct facilities, to erect pilings or other structures, or to conduct other activities on the banks of navigable rivers without permission of the riparian owner.
>
> As to lakes, bays, and arms of the sea, the state owns the beds and bottoms up to the ordinary high water mark of 1812, in contrast to rivers and streams, where the state owns only to the ordinary low water mark. Therefore, the shores of navigable lakes are public things to the high water mark and subject to public use.
>
> It should be noted, however, that since the time of state sovereignty, 1812, there have been enormous changes in the size, shape and configuration of land and water forms, land/water contacts and the characteristics and appearance of formerly natural navigable water bodies throughout the state. These changes have affected rivers and streams, as well as lakes, bays, and arms of the sea. Consequently, many land/water boundaries defining private/public

boundaries are now submerged and may be determined only by complex and technical analysis of land and water elevation data, including reference to current and historical tide gauge data. As a result of these changes, what appears as a river bank at the present time may be (have been) geographically located in the bed of a naturally navigable lake at the time of sovereignty and, thus, insusceptible of private ownership. Conversely, the banks of rivers and streams may have accreted substantially, extending private riparian ownership into a formally navigable bed.

In some areas, difficult factual and legal analysis will have to be undertaken to determine the relevant aspects of form, ownership and boundary in connection with proposed projects and otherwise. One potential problem area which may arise in connection with coastal restoration and vegetation projects is that of the rights to accretion, the ownership of which in Louisiana varies depending on the classification of a waterbody as either a navigable river or stream, or as a lake, bay, arm of the sea or seashore, as explained above.

Accretion formed as alluvion or dereliction on a navigable river or stream belongs to the owner of the bank, but subject to the right of public use as described above. However, accretion formed as alluvion or dereliction on the shore of the sea or lakes belongs to the state. Thus, should vegetation or restoration projects lead to the formation of alluvion, these historic rules of property law long followed by Louisiana courts will likely be deemed to apply in the event a controversy results in litigation.

It should also be mentioned that erosion on a navigable river, stream, lake or seashore belongs to the state. These rules of accretion and erosion apply even where the change is an indirect result of the artificial works of man. According to some decisions, the changes must be slow and imperceptible, as distinguished from sudden or instantaneous changes. Other cases lead to the conclusion that artificial works which result in rapid development of accretion may also result in application of the usual rules of property, as enunciated above.

Should accretion form as alluvion from a coastal restoration or vegetation project on a navigable river or stream, it would belong to the owner of the bank, subject to the right of public use defined by the Civil Code. Any accretion forming as alluvion or dereliction on lakes, bays, arms of the sea and the shore of the sea belongs to the state and is subject to public use up to the ordinary high water mark of 1812. Thus the public would have the right to use these areas, but go no further. Such accreted or exposed areas should not be regarded as points of entry or access to riparian lands in any regard.

Based on the above information, it is apparent that ownership of created and restored wetlands will depend on site-specific information and final determination may depend on legal proceedings.

Coastal wetlands can be used for various purposes. The traditional purposes include livestock grazing (especially cattle), fur trapping, alligator trapping, hunting, and fishing. More recent uses have been associated with oil, natural gas, and sulphur extraction. Pipeline, access canals, pumping and transfer facilities, roads, and other structures have been constructed throughout the coastal wetlands.

Property values are influenced by a wide variety of factors such as economic development potential, erosion rates, subsidence rates, urban amenities, access to transportation systems, proximity to recreational opportunities and scenic landscapes, and the level of flood protection. All other things being equal, the unit values of protected land tends to be higher than unprotected land. This is particularly significant in areas where a wide variety of interests compete for a limited amount of land. The potential for expansion of the urbanized areas in coastal Louisiana is limited by the surrounding wetlands.

3.3.11.2. No-action. Continued loss of wetlands would only increase the controversy over ownership of water bottoms and disappearing wetlands. Wetland-dependent uses would continue to decline as wetlands are lost. The value of properties susceptible to erosion, subsidence, and increased flooding would decline. Although scarcity of a resource increases its value, in this instance the offsetting loss of productive characteristics would be expected to predominate. In addition, as the harvest of fish and wildlife for commercial and recreational purposes declines, the value of properties associated with these activities would also decline.

3.3.11.3. All Action Alternatives. Easements for various project-induced changes to land values and uses would be obtained for projects prior to construction. The easements would be specific for each project type and for site-specific circumstances.

Property values, including the value of fish and wildlife habitat in restored wetland areas, could be maintained; or at least they would tend to decline at slower rates. Since a large percentage of the coastal wetlands are privately owned, it is quite possible that some conflict will arise between private property owners and the State of Louisiana regarding ownership of the newly created wetlands. The legal definition of navigable waterways must be addressed for individual cases to determine if blocking or restricting access through channels would unlawfully restrict public access through navigable channels into areas proposed for restoration or management.

3.3.11.4. Marsh Management. Easements would be obtained by the lead Task Force agency only on structure sites. Easements would not normally be obtained on the areas under management. Future land uses would be expected to remain similar to existing conditions within specific management areas.

Marsh management projects implemented under the CWPPRA will be designed and operated to provide the widest range of benefits and to afford access by migratory estuarine species and by the public when the public has a legal right to access the area through navigable waters.

3.3.11.5. Hydrologic Restoration. Easements would be obtained only for structure sites. Land use would not be expected to change significantly. Projects could give landowners increased control over public access into the restoration area by reducing the numbers of access points.

3.3.11.6. Hydrologic Management of Impoundments. Depending on the existing condition and the ownership of the impoundment, easements may or may not be necessary for the entire impoundment. If the impoundment is privately owned, a flowage easement would probably be necessary for the entire impoundment. The two projects of this type that have already been approved through priority project lists are on public property, a National wildlife refuge, and therefore would not require easements.

3.3.11.7. Sediment Diversion. Large-scale sediment diversions would cause changes in land and water use of the outflow areas. New areas of land would be formed by the emerging deltas. Easements would be obtained on privately held areas that are predicted to be substantially effected. Access canals could be silted-in requiring frequent dredging to maintain access to oil and gas wells and other installations. Open water would be converted into land and there could be controversy regarding ownership of the newly created lands. A vivid illustration of the uncertainty over land and water ownership is the outflow area of the West Bay sediment diversion project from the First Priority Project List. During title searches to determine ownership of the outflow area it was determined that taxes are still being paid by private individuals and corporations on lands that had turned to open water decades ago. The State also claims ownership of these water bottoms but does not have the resources to determine where the property line lies between State water bottoms and private property.

3.3.11.8. Freshwater Diversion. In the case of diversions from the Mississippi River, easements would normally be obtained only for the structure site and outflow channel, not for the entire area influenced.

The USACE operates a number of control structures to control saltwater intrusion in the Mermentau Basin. These structures prevent intrusion of salt water into the wetlands as well as into waters used for irrigation for agriculture (primarily White Lake), especially rice farming, an activity of considerable economic importance in southwest Louisiana. Because the Lakes Subbasin is virtually surrounded by natural ridges, highway embankments, and the above-mentioned structures, drainage from the area is a significant problem. The problem is exacerbated by the basin's hydrology. USACE records indicate that water levels within the subbasin exceeded gulf levels only 26 percent of the time for the period from 1987 to 1990. This small window of opportunity makes drainage from the subbasin very difficult. There are two consequences of this problem; high water levels in the Lakes Subbasin stress wetland vegetation and cause increased erosion, and inadequate freshwater input to the Chenier Subbasin permits saltwater intrusion.

3.3.11.9. Outfall Management. Access to oil and gas wells and other installations may be adversely affected by these projects. Provisions to allow access to active wells would probably have to be designed into projects. Easements would be obtained for any areas on private property substantially altered by CWPPRA projects. Outfall management projects may require flowage easements over the entire management area.

3.3.11.10. Marsh Creation with Dredged Material. Dredged material disposal easements would be obtained for areas of private property that would be substantially altered by the projects. Use of property could change considerably, with an increased possibility hunting, trapping, and grazing of livestock on newly created wetlands.

3.3.11.11. Barrier Island Restoration. Easements would be obtained to dispose of dredged material on private properties. Existing land uses would be preserved.

3.3.11.12. Shoreline Erosion Control with Structures. Easements would be obtained to place rock or other materials on private properties. Existing land uses would be preserved.

3.3.11.13. Vegetative Plantings. Easements would be obtained or agreement with the landowner would be signed to plant vegetation on private properties. Existing land uses would be preserved.

3.3.11.14. Terracing. Easements would be obtained to dredge and create terraces on private properties. Land use not expected to change significantly although more hunting and fishing opportunities may occur.

3.3.11.15. Sediment Trapping. Easements would be obtained to place structures on private properties. No change in land use would be expected.

3.3.11.16. Herbivore Control. No easements would be required. No change in land use would be expected.

3.3.12. Flood Protection.

3.3.12.1. Existing Conditions. Flooding problems in coastal Louisiana are caused by any combination of three factors: local rainfall, high river stages, and tidal flooding. Flooding from local rainfall is a problem restricted mainly to the developed metropolitan areas, especially New Orleans. Much of the city is below sea-level and is surrounded by a levee system that protects the developed areas not only from high water on the Mississippi River but also from normal, daily tidal levels. Large pumping stations, including the largest in the world, are used to remove local rainfall from the city and discharge into the lakes, swamps, and marshes surrounding the metropolitan area. Levee systems protect the more densely populated areas of the coast from river and tidal flooding, but many of the rural communities in the coastal area are not protected and rely on gravity drainage to remove excess rainfall.

There is widespread opinion among the general public and many professionals that coastal wetlands provide protection from storm surge and thereby lower stage increases experienced in communities inland from the coast. This seems logical based on gauge readings taken during hurricanes which in general show decreasing peak stages the farther distance from the gulf the gauges are located. The degree to which coastal wetlands can ameliorate tidal surge is probably dependent on the extent and configuration of the wetlands and the path and strength of particular storms.

3.3.12.2. No-action. Existing levee systems would be maintained and upgraded as needed to provide populated areas with protection from hurricane flooding. Additional hurricane protection levees would likely be constructed especially on the west bank of the Mississippi River in the vicinity of New Orleans and in Terrebonne and Plaquemines Parishes. Long-term effects of global sea level rise coupled with regional subsidence would make gravity drainage systems work less efficiently and would subject unprotected areas to greater chances of flooding.

3.3.12.3. All Action Alternatives. Coastal wetlands are assumed to provide a buffer against storm-generated tidal surges. All action alternatives have creation, protection, or restoration of coastal wetlands as a primary project purpose. The protection afforded from storm surge by individual projects (especially the smaller-scale projects) would be negligible, but cumulatively, all of the projects implemented by the CWPPRA would add to the tidal surge buffering capability of coastal wetlands.

3.3.12.4. Marsh Management. See All Action Alternatives (Section 3.3.12.3.). Also, Boumans and Day (1990) reported that the construction of canals and levees for marsh management or other purposes can cause water level amplification in adjacent areas. Levees can also hinder storm water runoff from within a watershed. Given that the vast majority of marsh management projects are protected with only low-level levees or natural ridges, it is not anticipated that these projects would contribute to flooding of higher, developed areas. In unusual situations, such as when marsh management areas are surrounded by levees that are higher than enclosed or adjacent developed areas, there could be a potential for flooding problems.

3.3.12.5. Hydrologic Restoration. See All Action Alternatives (Section 3.3.12.3.).

3.3.12.5. Hydrologic Management of Impoundments. See All Action Alternatives (Section 3.3.12.3.).

3.3.12.6. Sediment Diversion. Diversions would be constructed so as not to directly affect existing flood protection systems. Large-scale sediment diversions proposed for the Breton and Barataria Basins have the potential to increase the risk of flooding in unprotected communities of these basins. The higher up in the basin the diversions would be located, the higher the risk of potential flooding. This is due to the average stage increases expected in outfall areas. Diversions in lower parts of these basins or within the active deltas of the Mississippi and Atchafalaya Rivers would have much less potential to increase flooding because of the diversion's proximity to the gulf. Also see All Action Alternatives (Section 3.3.12.3.).

3.3.12.7. Freshwater Diversion. See All Action Alternatives (Section 3.3.12.3.).

3.3.12.8. Outfall Management. See All Action Alternatives (Section 3.3.12.3.).

3.3.12.9. Marsh Creation with Dredged Material. See All Action Alternatives (Section 3.3.12.3.).

3.3.12.10. Barrier Island Restoration. Barrier islands can provide some hurricane flood protection benefits by providing a hydrologic barrier to storm surge associated with these tropical weather systems. The degree of protection has not been determined for the barrier islands of Louisiana, but public opinion, especially in the Terrebonne and Barataria Basins, is that the barrier islands provide critical flood protection.

3.3.12.11. Shoreline Erosion Control with Structures. See All Action Alternatives (Section 3.3.12.3.).

3.3.12.12. Vegetative Plantings. See All Action Alternatives (Section 3.3.12.3.).

3.3.12.13. Terracing. See All Action Alternatives (Section 3.3.12.3.).

3.3.12.14. Sediment Trapping. See All Action Alternatives (Section 3.3.12.3.).

3.3.12.15. Herbivore Control. See All Action Alternatives (Section 3.3.12.3.).

3.3.13. Navigation and Other Forms of Transportation.

3.3.13.1. Existing Conditions. New Orleans, the largest metropolitan city in the coastal area, is located at the gateway to the entire Mississippi Valley. It marks the approximate center of the nation's largest deep-draft port complex. The three major deep-draft navigation channels within the coastal area are the Mississippi River which serves New Orleans and Baton Rouge, the Calcasieu River which serves Lake Charles, and the Mississippi River Gulf Outlet (MRGO) which also serves New Orleans.

The Mississippi River navigation channel provides a 45-foot channel from the gulf to a point between New Orleans and Donaldsonville, Louisiana at mile 181 above Head-of-Passes, and a 40-foot channel from this point through the Port of Baton Rouge (mile 236 above Head-of-Passes). The entire channel up to Baton Rouge is authorized to 55-feet, with designs for deepening to 45-feet between Donaldsonville and Baton Rouge being finalized. The Mississippi River from Baton Rouge to below New Orleans is easily the area of highest traffic density in the U.S. In 1990, this deep-draft channel handled 169 million tons of foreign traffic, more than two and one-half times the next closest channel or waterway. Grain exports represent the largest tonnages on the Mississippi River, accounting for nearly half of the U.S. total.

The Calcasieu River navigation channel provides for a 40-foot channel from the gulf to Lake Charles, a distance of approximately 34 miles. In 1990, Lake Charles ranked 11th for U.S. ports in foreign traffic (24 million tons). Crude oil imports dominate deep-draft traffic at Lake Charles accounting for 70 percent of total foreign traffic.

The MRGO provides New Orleans with a second deep-draft channel. This 36-foot channel handled 5.6 million deep-draft tons in 1990. The majority of the port's container facilities are located along the MRGO and the MRGO accounts for approximately 90 percent of all New Orleans container traffic.

There are numerous channels serving shallow-draft traffic in the coastal area representing hundreds of miles of navigable waterways. The most significant waterway, other than the Mississippi River, is the Gulf Intracoastal Waterway (GIWW). The GIWW, west of the Mississippi River, handled 68 million tons in 1990. The principle commodities are refined petroleum products, chemicals, and crude oil. Somewhat unique to the coastal area are the nine shallow to medium-draft coastal ports and channels which primarily serve the offshore oil industry and, to a lesser extent, the commercial fishing fleet. These facilities, while not necessarily producing impressive annual tonnage statistics, move numerous high-value cargoes to and from drilling and production platforms in the Gulf of Mexico. The timely delivery of these cargoes is vital to the petroleum industry.

Vessel wakes cause extensive erosion and loss of marsh and swamp along the banks of many Federally-maintained navigation channels in Louisiana. These channels have also contributed to loss of coastal wetlands by allowing salt water and tidal action to intrude farther into the fresher habitats. Some of the most notable examples of navigation channels with erosion problems are the Mississippi River Gulf Outlet, the Houma Navigation Canal, Freshwater Bayou, the Gulf Intracoastal Waterway, and the Calcasieu Ship Channel.

Pipelines are the primary carriers of petroleum products imported, produced, and refined in the coastal zone. Over 14,000 miles of onshore and 2,000 miles of offshore pipelines are located in the area. Also located in this vulnerable region is the Louisiana Offshore Oil Port, Inc., which began operations in 1981. This 700 million dollar offloading facility supplies 15 percent of the country's imported oil, moved from ships unloaded at a floating terminal 18 miles south of Grand Isle, through pipelines, to storage caverns in the Clovelly salt dome. Oil is then transferred from the salt caverns to a system of seven pipelines serving refineries along the Gulf Coast and in the Midwest. Other terminals in the area contribute another 15 percent to the supplies of imported crude oil, for a State total of about 30 percent of U.S. imports.

Other transportation facilities in the project area include main-line railroads, Federal interstate highways, and numerous other U.S., state, and local highways, an extensive oil and gas pipeline network, and commercial airports. The Southern Pacific, Illinois Central, and Amtrak lines traverse much of the area, and service is further extended via spur lines along the alluvial ridges as far south as the Gulf Intracoastal Waterway and along the Mississippi River below New Orleans. The primary east-west highway routes are Interstates 10 and 12, and U.S. Highways 90 and 190. Major north-south routes include Interstates 49, 55, and 59, and U.S. Highways 51, 61, and 165.

3.3.13.2. No-action. Unchecked subsidence and erosion of the coastal wetlands would increase the cost of maintaining channels, railroads, roadways, and other public facilities. Most of the maintained channels in coastal Louisiana were either cut through land or follow natural waterways instead of traversing open bays and lakes. These routes were chosen to avoid the high siltation rates that occur in channels going through shallow open water areas from movement of bay bottom sediments into the channels. As the marsh, swamp, and higher banks of these channels continue to subside and erode forming open water bodies, increased maintenance dredging of channels is likely to be necessary. Also, as wetlands erode and subside, the cost of maintaining Federal, State, and local highways will increase.

3.3.13.3. Marsh Management. Structures and levees built for management purposes restrict the shallow-draft boat traffic that could otherwise pass through unobstructed bayous and canals. While small boats can pass over structures used for passive management during average to high tidal conditions, structures used for active marsh management usually preclude boat traffic except that boat bays are normally provided in areas of high boat traffic. The dredged material embankments typically associated with navigation canals quite frequently serve as ready-made boundaries for delineating candidate management areas. In many cases the embankments are in good enough repair to be used as they exist, thereby cutting costs.

3.3.13.4. Hydrologic Restoration. These type projects would have the potential to restrict navigation usage of waterways leading into the managed areas. Normally, boat bays are included in the design of structures across the larger channels to allow small boat access; however, passage of larger vessels could be impeded.

3.3.13.5. Hydrologic Management of Impoundments. No effect on navigation would occur due to the existing isolation of impoundments from the tidal system.

3.3.13.6. Sediment Diversion. The smaller sediment diversions in the active deltas of the Mississippi and Atchafalaya Rivers would not individually remove enough water and sediment to adversely affect navigation in the river channels. Shallow-draft navigation in outfall areas could be adversely affected if active oil or gas wells requiring maintenance are present. The larger sediment diversions, such as the West Bay Diversion from the First Priority Project List, have the potential to significantly affect deep-draft navigation in the major river channels. As originally proposed, the West Bay Diversion would involve dredging a deep cut in the bank of the Mississippi River below the terminus of the mainline levee system. Subsequent studies have shown that soil conditions in the area present a possibility of the diversion cut enlarging during flood events. Enlargement of the diversion cut could result in a disproportionate amount of water removed from the river. The ability of the river channel to move sediments downstream would be diminished because of the reduced flow. Sediments would accumulate faster than normal at the major deposition points at Head of Passes and in Southwest Pass, the navigation channel. A worst-case scenario would be the temporary inability of dredges to maintain project depth in the navigation channel during a high water event, which could seriously impact deep-draft navigation using the Mississippi River. During high river stages, sedimentation is very rapid and dredging is difficult because of high flow velocity.

Additional sediment diversions are proposed as long-term critical or supporting projects for the Barataria, Breton Sound, and Mississippi River Delta Basins. The critical project for the Mississippi River Delta Basin involves rerouting the majority of the river's flow into the shallow waters to the Breton Sound or Barataria Basins. Extensive studies would be necessary before this proposal could be implemented.

3.3.13.7. Freshwater Diversion. The two concerns, applicable to diversions from the Mississippi and Atchafalaya Rivers, would be siltation in channels located in the receiving areas from river-borne sediments and also increased sediment deposition in the rivers from which diversion occurs. Freshwater diversions normally take a disproportionate share of the water to sediment ratio and therefore could cause sediments that would otherwise be carried along with the river current to settle at the bottom of the navigation channel. Freshwater diversions from the Lake Subbasin of the Mermentau Basin into other areas should not have a significant effect on navigation.

3.3.13.8. Outfall Management. These type projects, in their attempt to cause fresh water to flow through shallow, open water areas and across deteriorated marshes, normally require the closure or restriction of waterways, especially oil and gas access canals and pipeline canals and therefore could restrict small boat traffic. Projects would have to be designed to accommodate access to active wells and other oil and gas installations.

3.3.13.9. Marsh Creation with Dredged Material. This type of project would normally not impact navigation in dredged channels. Marsh creation is usually proposed for shallow open water or deteriorated marsh where only very shallow draft vessels can pass. Less commonly, marsh creation is proposed for abandoned oil well access canals and pipeline canals. Although many of these canals are located on private property, they are commonly used by fishermen and other commercial and recreational users for transiting through coastal wetlands. In some cases, created marsh could create a hinderance to small commercial and recreational vessels that normally use these canals.

3.3.13.10. Barrier Island Restoration. Possible interference with navigation during construction from long pipelines used to transport dredged material. No long-term effect on navigation.

3.3.13.11. Shoreline Erosion Control with Structures. The banks of most navigation channels in Louisiana are eroding and causing damage to marsh and swamp. The most effective, widely accepted method to stabilize the banks of these channels is to armor them with rock or other hard material. Several projects to protect these eroding banks have been proposed. Concern has been expressed by navigation interests that rock dikes can pose a navigation hazard if the land behind the dike erodes or otherwise is lost. If that were to occur the dike would be situated in what appears to be an open bay. If the dike is not maintained and it subsides, it could present an underwater hazard to navigation.

3.3.13.12. Vegetative Plantings. No effect on navigation.

3.3.13.13. Terracing. No effect on navigation.

3.3.13.14. Sediment Trapping. No effect on navigation.

3.3.13.15. Herbivore Control. No effect on navigation.

3.3.14. Recreation Opportunities.

3.3.14.1. Existing Conditions. The extensive vegetated wetlands, water bodies, and beaches of Louisiana's coastal area are ideally suited for outdoor recreational activities. The biological wealth and productivity of these natural resources support many species of native plants and animals, and provide for a variety of consumptive and non-consumptive recreational pursuits.

Major recreational activities occurring in the coastal areas include sport fishing (the most popular); waterfowl, big game, and small game hunting; recreational shrimping, crabbing, and crawfishing; boating; swimming; sailing; picnicking; camping; water-skiing; and observing wildlife.

There are limiting factors on the potential recreational use of these abundant resources. These limiting factors include private land ownership, lack of public access, competition with commercial activities such as commercial fishing and shrimping, and mineral exploration and extraction. The ever-increasing loss of the wetland resource itself is also a factor limiting potential recreational use.

Privately owned, and some public, boat launching facilities are found throughout the coastal area. Generally, these facilities are located along the developed ridges of land that extend into the marshes or along coastal highways. Jean Lafitte National Historical Park and Preserve, and Bayou Segnette and Grand Isle State Parks are heavily used public recreation areas located within the coastal wetlands. Additionally, numerous National wildlife refuges, and State wildlife refuges and management areas are located within the study area.

Freshwater fish species sought after by anglers include largemouth bass, crappie, blue catfish, channel catfish, bluegill sunfish, and redear sunfish. A large and steadily growing number of anglers fish for largemouth bass in the low salinity marshes where productivity rates are high and large numbers of bass are found. Inshore and near-shore saltwater anglers' preferred species include spotted seatrout, red drum, southern flounder, black drum, sheepshead, Atlantic croaker, and sand seatrout. Crabs, shrimp, and crawfish are also a significant part of the recreational fishery. Waterfowl hunting is very popular activity in the coastal wetlands. Reduced bag limits and below average fall flights of popular duck species in recent years has somewhat depressed participation in the sport. Goose hunting is a very popular sport, especially in the western part of the coast. Big and small game animal species, such as white-tailed deer, swamp rabbits, and gray and red squirrels, are pursued as well, but to a much lesser degree.

Numerous marsh camps, serving as seasonal or weekend bases of operation, are used by many local and out-of-state recreationists as a starting point for various outdoor activities. Many of these camps, which are only accessible by boat, serve as clubhouses for the coastal area's numerous fishing and hunting clubs. Other camps are privately owned and used almost exclusively for family oriented recreation. Several thousand such camps are located in the coastal area.

The primary users of the recreation resources of the study area are residents of southeastern Louisiana. Current estimates indicate that several million user-days of recreational activity occur in the coastal parishes annually. A study completed in 1984 for the Louisiana State University Center for Wetland Resources (Bertrand, 1984) estimates the 180,000 licensed saltwater sports fishermen in the State annually spend $181 million on fishing and have nearly a billion dollars invested in boats, gear, camps, and other equipment. The study estimates the total annual economic impact of fishing related expenditures at over half a billion dollars. A later analysis, produced by the Sport Fishing Institute, put the total economic impact at nearly $900 million for the year 1985 (Sport Fishing Institute, 1988). In recent years, the economic importance of this recreational group has come to play in the increasing competition between commercial and recreational fishermen. A prime example is the case of red drum, a species with both sport and commercial value. A ban on commercial harvest was implemented in the late 1980's and remains in effect although retention of red drum by recreational fishermen is allowed. Commercial quotas have been implemented on other economically important species.

Louisiana is located at the southern end of the Mississippi Flyway, a major waterfowl migratory route. Nearly 70 percent of the ducks and geese that use the flyway overwinter in Louisiana's marshes. The economic value of the hunting provided by the flyway exceeds $10 million annually. Waterfowl hunting, when combined with recreational fishing supported by Louisiana's wetlands exceeds 3 million annual user days.

Beach-related activities are limited in coastal Louisiana because of the lack of hard, sandy beaches. Grand Isle, Elmer's Island, and Fourchon Beach in southeast Louisiana and the Hackberry Beach to Constance Beach area of southwest Louisiana are the only gulf beaches in Louisiana accessible by vehicle. While these beaches may not be as aesthetically pleasing as the white sand beaches of other gulf coast states, they are nevertheless enjoyed by thousands of Louisiana residents. Beaches and barrier islands accessible only by boat are also very popular recreation areas especially for fishing.

3.3.14.2. No-action. The recreational potential of the coastal wetlands and barrier islands is in many ways directly proportional to the quantity of wetlands available. The potential for recreational use will therefore diminish as the wetlands are lost. This is certainly true of game species which are directly dependent upon the vegetated wetlands for their entire life cycles. Somewhat less distinct is the relationship between fishery resources and the wetlands. Even though many thousands of acres of coastal wetlands have been lost, recreational fishery harvest for most species remains high. This is at least partly due to the vast new areas of shallow estuarine waters that have developed as a result of marsh loss and tremendous quantities of organic plant material that has entered the estuarine system. The problem here is that eventually, a point will be reached where organic input will diminish and the remaining fragmented marshes will no longer be capable of supporting the quantities of estuarine species we have become accustomed to harvesting. As the resources decline, controversy and conflict over allocation of the limited resources would increase.

3.3.14.3. Marsh Management. The possibility that public access for recreational purposes into managed areas could be restricted and controlled by landowner or surface lease holders could become a public resource usage issue. It has been a concern in past marsh management activities. The basis for the concern is that waters subject to Federal jurisdiction (tidal waters and wetlands) are often encompassed within areas brought under management. Decisions regarding this issue will likely be reflected in the language of easements that are acquired for CWPPRA projects as well as conditions incorporated into any necessary Federal permits.

Data from a closely monitored active marsh management project suggest that after several years of management the fishery within the managed area shifts towards a species assemblage more tolerant of freshwater. No such comparable data is available for a passively managed area. How much of a shift can be induced through active management at this one site remains to be determined. Overall, recreationists would likely respond to any such shifts by fishing for different species.

The water control structures of managed areas, especially actively managed areas, have proven to be popular and predictably successful sites for fishing. The structures are typically easily accessible sites at which estuarine organisms can be caught in great quantities as they exit the managed area or feed upon organisms exiting the managed area. Recreational harvest around water control structures is likely to continue or possibly expand if more areas are brought under management.

We have acknowledged in Section 3.3.5.3. that marsh management can make an area more attractive to waterfowl. Increased opportunities for waterfowl harvest would therefore likely be expected. In addition, stabilized water levels during hunting seasons provide reliable access by boat, thereby facilitating recreational hunting activities.

3.3.14.4. Hydrologic Restoration. This action would restore natural water flow patterns to the degree practicable and therefore foster natural productivity. Access for recreational use of the restored area could possibly be reduced by construction of plugs and structures. Projects are expected to reduce tidal flows into the restored areas creating a more favorable condition for growth of submerged aquatic vegetation. Submerged aquatic vegetation would attract more waterfowl and increase the potential for hunting opportunities.

3.3.14.5. Hydrologic Management of Impoundments. These projects would offer increased recreational usage due to optimization of water levels within restored areas for fish and wildlife resources.

3.3.14.6. Sediment Diversion. Significant displacement and redistribution of recreational activities would occur from major sediment diversions. Probably the greatest perceived adverse impact by recreational fishermen would be the changes that would occur to their favorite fishing spots. Saltwater fishing would be displaced away from the sources of sediment diversion and would be at least partially replaced by a freshwater fishery. Long-term fishery production would be increased by the addition of new wetlands and preservation of existing wetlands with sediment input. Waterfowl are expected to be attracted to the deltas formed by these diversions to feed upon the desirable plant species that colonize these areas. Terrestrial game animals would colonize the newly formed deltas, providing hunting opportunities.

3.3.14.7. Freshwater Diversion. Affects would be similar to sediment diversion except that relatively little new land would be formed and displacement of fisheries would not be as great.

3.3.14.8. Outfall Management. This action would increase the natural productivity of the outfall area through sediment and nutrient input. Recreational access of the managed area may be somewhat reduced by construction of plugs in the major canals leading into the managed areas.

3.3.14.9. Marsh Creation with Dredged Material. This action would create wetlands that will proportionately increase the recreation potential for both aquatic and terrestrial habitats. Short-term adverse effects to recreational fishing opportunities in the immediate vicinity of dredging operations could occur from increased turbidity levels and construction activities.

3.3.14.10. Barrier Island Restoration. Barrier islands have a high rate of utilization for recreational activities, especially bird watching, camping, and fishing. Another popular form of recreation that these islands provide is spearing flounders at night by walking in the clear, shallow waters around these islands. The barrier islands also protect the estuarine ecosystems in the bays behind the islands and protect the fishermen in the bays from large gulf waves. Overall, barrier islands provide substantial direct and indirect benefits to recreational users and restoration of deteriorating islands would preserve and enhance recreational use. Short-term disruption of some recreational activities may occur during construction of projects.

3.3.14.11. Shoreline Erosion Control with Structures. Projects would preserve the wetland habitat that recreationally important species depend upon for their life functions. Adverse short-term, construction-related impacts could occur from construction activities and increased turbidity levels.

3.3.14.12. Vegetative Plantings. Projects would preserve the wetland habitat that recreationally important species depend upon for their life functions. There would be negligible adverse impacts expected from planting activities.

3.3.14.13. Terracing. This type of project would potentially increase harvestable wildlife and fishery resources by providing nesting areas for bird species and marsh edges critical to early life stages of fish species. Projects also would provide shallow, protected waters suitable for establishment of submerged aquatic vegetation which would attract waterfowl and thereby increase hunting opportunities.

3.3.14.14. Sediment Trapping. Restoration and expansion of wetlands in eroded and subsided areas would provide quality habitat for wildlife species. Developed wetlands would provide important marsh edge for survival and growth of fishery species.

3.3.14.15. Herbivore Control. Prevention of intense grazing would allow better nesting and foraging conditions for desirable wildlife. Protection of wetlands from overgrazing would maintain the recreational uses of the resource.

3.3.15. Cultural Resources Including National Register Sites.

3.3.15.1. Existing Conditions. The coastal wetlands are known to contain numerous historic and prehistoric archeological sites. These sites span the human occupation sequence of the State and represent Louisiana's long cultural heritage. Over three hundred archeological sites are known for the Breton Sound Basin alone.

The prehistoric sites in the area are predominantly Indian shell middens situated along the natural levees of rivers and bayous and the surrounding shorelines of the numerous coastal lakes. Archeological evidence indicates that these prehistoric Indians gathered both freshwater and brackish water shellfish available in the nearby waters. These sites were habitation areas as well as camp sites for shellfish processing.

Historic sites in the coastal zone tend to be located along the natural levees of bayous used as transportation routes. Types of historic sites include domestic buildings, boat landings, hunting and fishing camps, shipwrecks, military fortifications and so forth. Many of these properties have been determined eligible to or listed on the National

Register of Historic Places that was established in 1966 by the National Historic Preservation Act, as amended (NHPA).

The NHPA was enacted to ensure that the country's historic resources would be considered in any Federal project and Federally assisted or permitted projects. Section 106 of this act states that all Federal agencies "take into account" how their proposed actions would affect any historic or archeological property. A Federal undertaking includes a wide variety of actions such as construction activities, rehabilitation and repair projects, permits, and demolition to name a few. Federal agencies are required to consider alternatives to avoid, mitigate, or minimize adverse impacts on historic properties (any prehistoric or historic district, site, building, structure, or object eligible for inclusion in the National Register). The Federal agency involved in the proposed project is responsible for initiating and completing the Section 106 review process. The Federal agency confers with the State Historic Preservation Officer (an official appointed in each state to administer the National Historic Preservation Program) and the National Advisory Council on Historic Preservation (Advisory Council).

There are five basic steps in the Section 106 review process. These are:
1. Identify and Evaluate Properties;
2. Assess Effects;
3. Consultation;
4. Council Comment; and
5. Proceed

Step 1 Identify and Evaluate Properties. The lead Federal agency is responsible for reviewing all available documents, maps, and cultural resource databases to determine the level of cultural resource survey coverage as well as the presence or absence of prehistoric and/or historic resources in a project area. If survey coverage is non-existent or additional information is needed, the Federal agency may conduct additional work. All cultural resources located in a project area are then evaluated for significance using National Register of Historic Places criteria. The Federal agency and the State Historic Preservation Officer (SHPO) decide whether the properties are eligible for listing to the National Register.

Step 2 Assess Effects. Following identification and evaluation of cultural resources, the Federal agency is responsible for determining the effect of its proposed action/activity on significant cultural resources. This determination of effect is made in consultation with the SHPO.

There are three possible determinations:

a. No effect. This determination is made when the agency's proposed action will have no effect on cultural resources in the project area. The agency notifies the SHPO. If the SHPO does not object, the project may proceed.

b. No adverse effect. In this case there could be an effect to a cultural resource, but the effect is not harmful. The agency obtains SHPO concurrence and submits to the Advisory Council a determination of no adverse effect. The project may proceed.

c. Adverse effect. This is when it has been determined that the proposed action could have a harmful effect on a cultural resource. The agency is required to begin the consultation process.

Step 3. Consultation. The purpose of consultation is to find acceptable ways to reduce the harm to a cultural resource so the project may proceed. This may involve such measures as avoiding the cultural resource or mitigating the adverse effect. The Federal agency and the SHPO are the consulting parties. The Advisory Council determines their own level of involvement in this step. When the consulting parties agree upon steps to avoid or mitigate harm, they sign a Memorandum of Agreement (MOA). If an agreement cannot be reached, the Federal agency may submit documentation to the Advisory Council for comments.

Step 4. Council Comment. After consultation, the Federal agency submits the signed MOA to the Advisory Council for review. The Advisory Council has the option to sign the MOA, request changes, or chose to issue written comments on the proposed activity. If an agreement was not reached in consultation by the SHPO and the agency, the Advisory Council will submit written comments to the agency regarding the proposed action.

Step 5 Proceed. If agreement was reached and a MOA was signed then the agency can proceed with the project. If an MOA was not signed then the Federal agency must take into account the Advisory Council's written comments.

3.3.15.2. No-action. Land surfaces in the coastal zone would continue to erode and in some instances could cause loss of cultural resources. Many of these fragile archeological sites in the wetlands may be adversely impacted by destructive natural forces such as subsidence and erosion. Other destructive forces attributed to man such as wave action from passing vessels and construction activities would also continue to destroy cultural resources in these areas.

3.3.15.3. All Action Alternatives. The various proposed actions may or may not have an adverse impact on cultural resources. Each proposed action must be examined on a project by project basis. Cultural resources evaluations are made on site specific as well as project specific information and plans. Maps indicating the location of cultural resources and cultural resources survey coverage are checked against the location of the proposed wetlands restoration projects. Cultural resources investigations conducted for some of the projects on the First and Second Priority Project Lists have identified the location of archeological and historical sites. A cultural resources evaluation of each of the proposed wetlands restoration projects will need to be conducted as soon as plans and specifications are known and well in advance of actual construction to avoid project delays. In some cases project designs could destroy, damage, or obscure archeological sites by construction activities. These cultural resource investigations will identify any significant cultural resources which may be at risk and allow time for project designs changes to avoid adverse impacts. The site specific nature of these resources demand this type of action. In some instances the proposed action may actually help to preserve and protect cultural resources. Coastal lands are eroding rapidly and the protection of these lands by the various CWPPRA projects may protect sites in the long run by stopping or slowing down land erosion.

Three major types of actions predominate these proposed erosion measures. These are: 1). sediment diversion or re-deposition, 2). dredging of some type, and 3). building of structures. Sediment diversion may or may not have a adverse impact on historical and archaeological sites. Increased sediment flow may cause a direct impact on any site in the immediate area, while in some cases it could provide sediment around an area acting as a buffer to further erosion. Depositing sediment on top of a known site can change the environment in which a the site has survived. This may or may not be an adverse impact. An assessment will need to be on a case by case basis. Dredging a waterway could impact any prehistoric or historic shipwrecks in the area. Submerged cultural resources surveys are conducted in areas with a high probability of containing shipwrecks. Construction of erosion devices such as weirs or dikes, or the building or removal of canal banks can adversely impact any prehistoric or historic site in the immediate impact area. In all cases these actions need to be examined on a project by project basis.

Each year, projects will be selected for implementation through priority project lists. The CWPPRA Task Force recognizes their responsibility regarding cultural resources management and the Section 106 process. This process can be very lengthy and complicated. The Natural/Cultural Resources Section of the U.S. Army Corps of Engineers, New Orleans District has been coordinating with the State Historic Preservation Office regarding cultural resources investigations associated with CWPPRA projects and Section 106 requirements. As a result of this year-long coordination, the CWPPRA Task Force has entered into a agreement with the State Historic Preservation Office which establishes procedures to follow in meeting cultural resource compliance. A copy of the signed agreement is provided as Appendix A to this EIS.

3.3.15.4. Marsh Management. Dredging and filling and building of structures has a moderate potential to affect cultural sites. Also see Section 3.3.15.3.

3.3.15.5. Hydrologic Restoration. Effects similar to marsh management.

3.3.15.6. Hydrologic Management of Impoundments. Effects similar to marsh management.

3.3.15.6. Sediment Diversion. Dredging and filling and building of structures has a moderate potential to affect cultural sites. Effect of sediment deposition would have to be determined for each site.

3.3.15.7. Freshwater Diversion. Effects similar to marsh management.

3.3.15.8. Outfall Management. Effects similar to marsh management.

3.3.15.9. Marsh Creation with Dredged Material. Effects similar to marsh management.

3.3.15.10. Barrier Island Restoration. Effects similar to marsh management.

3.3.15.11. Shoreline Erosion Control with Structures. Effects similar to marsh management.

3.3.15.12. Vegetative Plantings. Negligible effects to cultural sites expected.

3.3.15.13. Terracing. Effects similar to marsh management.

3.3.15.14. Sediment Trapping. Little potential for impacts to cultural sites.

3.3.15.15. Herbivore Control. No effects to cultural sites.

3.3.16. Socioeconomic Items.

3.3.16.1. LAND USE.

3.3.16.1.1. Existing Conditions. The majority of the land within the 20-parish project area is wetland, and is subject to heavy rainfall, spring flooding, and periodic hurricanes. These conditions, along with continued land loss from erosion, subsidence, sea level rise, and other factors, have tended to limit many types of development. In contrast, the soil conditions, mild climate, water resources, and abundant natural resources of the Gulf Coast have attracted economic development such as agriculture, commercial fisheries, and petroleum related activities. This has led to population growth and consequent demands for housing, streets, roads, bridges, institutions, and all of the various land use requirements normally associated with the growth of communities and metropolitan areas. The unique drainage conditions of the area have required construction of an extensive network of levees and pumps to protect development. Table 4 displays estimated land use and land type by parish for the project area as of 1980. In view of the continued and ongoing loss of wetlands, the table is not intended to reflect the current wetland acreage, but the general land use conditions in the coastal region. In 1980, the State of Louisiana estimated that more than 4.8 million acres, or about 57 percent, of almost 8.5 million acres of the land in the project area were wetland. Almost 1.4 million acres, or about 65 percent, of the land area now considered the New Orleans Metropolitan Statistical Area (MSA) was wetland and 85 percent of the Houma MSA was classified as wetland. While the total land area of the Lake Charles MSA was estimated to be only 16 percent wetland, Cameron Parish, immediately south of Lake Charles was estimated to be 80 percent wetland.

Residents have depended upon the barrier islands along the Louisiana shoreline, the coastal wetlands, and an extensive network of levees and pumps for protection against the frequent threat of storm damage. The natural levees and cheniers and, to a lesser extent, reclaimed wetlands adjacent to the elevated ridges are intensely developed for either agricultural or urban purposes. Based on the 1980 estimate, about 5.5 percent was developed for residential, transportation, industrial, and other urban purposes. About 22.5 percent was agricultural land and 13.9 percent was forest land not including forested wetlands.

Table 5 shows the estimated number of wetland acres lost between 1932 and 1990 in the basins considered in this study. Valuing the lost acreage is difficult; considerable controversy exists as to the per acre value of wetlands. Estimates have been published that compute the value based on various wetland functions. The published figures range from a capitalized value of $9 per acre for the wave barrier function to $6480 per acre (1984 dollars) for archeological or historic use (Anderson and Rockel, 1991). It is more difficult to determine the marginal value of wetland acreage lost since not enough is known about the effects that these large losses imply for productivity, i.e., it is unknown if the lost acres were either more or less productive than those currently in existence.

Given that these limitations in knowledge exist, it is possible to arrive at a rough approximation of the value of lost acreage by capitalizing the forecasted future earnings per acre of wetlands currently in existence. In 1992, the Corps undertook an analysis of the earning power of wetlands as recreational, real estate, and commercial fish and wildlife resources for its unpublished Land Loss and Marsh Creation Study. If we capitalize the value of the 900,000 acres lost for all basins using the earning power per acre computed in that study, approximately $400, and the current Federal discount rate, the lost acreage would be valued at nearly $4 billion. As part of an ongoing CWPPRA effort, an input-output analysis will be undertaken in an attempt to quantify wetland functions and account for the flow of goods and services which are dependent on them. For example, the impact of the purchases that a commercial

TABLE 4
1980 ESTIMATES OF LAND USE IN THE LOUISIANA COASTAL AREA

PARISH/MSA[1]	TOTAL LAND AREA	RESIDENTIAL LAND	COMMERCIAL & SERVICE LAND	INDUS-TRIAL LAND	TRANS., COMM., & REL. SRVS.	MIXED URB. & BLT-UP LAND	AGRICULT. LAND	FOREST LAND	STRIP MINES & QUARRIES	TRANSI-TIONAL AREA	WETLANDS & BEACHES
Baton Rouge MSA[1]											
ASCENSION	187,689	13,204	1,359	3,413	2,149	62	73,961	40,586	232	772	51,351
LIVINGSTON	417,151	27,042	1,328	185	2,054	77	43,474	289,818	1,019	2,116	70,038
Houma MSA	1,504,729	24,030	5,127	2,362	1,869	3,398	175,904	1,730	15	1,313	1,288,981
LAFOURCHE	705,377	12,787	2,054	571	834	1,004	121,573	1,622	15	488	564,469
TERREBONNE	799,352	11,243	3,073	1,791	1,035	2,394	54,331	108	-	865	724,512
Lafayette MSA[1]											
ST. MARTIN	486,370	11,567	571	1,467	1,421	201	125,001	74,578	-	1,900	269,664
Lake Charles MSA	691,077	29,621	4,649	10,224	4,448	1,421	315,948	208,043	216	6,733	109,774
CALCASIEU	691,077	29,621	4,649	10,224	4,448	1,421	315,948	208,043[2]	216	6,733	109,774
New Orleans MSA	2,131,081	124,817	25,544	25,374	23,844	13,049	202,453	307,223	5,790	24,032	1,378,955
JEFFERSON	204,522	30,579	7,475	6,116	4,355	4,602	2,456	124	154[3]	1,220	147,441
ORLEANS	115,719	26,702	8,942	2,517	4,602	4,386	664	7,722	108	1,405	58,671
PLAQUEMINES	502,788	7,768	2,008	4,510	3,691	1,313	19,012	13,853	1,745[3]	5,591	443,297
ST. BERNARD	282,096	6,502	1,127	1,637	31	46	1,915	7,923	170	5,622	257,123
ST. CHARLES	176,444	4,849	1,127	4,386	1,405	865	20,865	571	77	1,869	140,430
ST. JAMES	151,472	5,035	402	3,382	1,189	61	52,601	1,560	77	541	86,624
ST. JOHN BAPTIST	141,031	5,220	571	2,363	2,224	278	23,505	726	46	664	105,434
ST. TAMMANY	557,009	38,162	3,892	463	6,347	1,498	81,435	274,744[2]	3,413	7,120	139,935
Non-MSA Parishes											
ASSUMPTION	218,745	5,143	463	649	587	155	74,299	2,069	-	124	135,256
CAMERON	799,786	2,069	386	5,529	293	201	139,581	2,873	1,112[3]	880	646,862
IBERIA	375,238	11,367	2,363	1,498	865	463	121,110	15,691	201	93	221,587
ST. MARY	399,098	7,104	1,189	2,425	1,761	4,093	96,693	1,745	-	278	283,810
TANGIPAHOA	508,732	25,729	3,351	942	5,791	479	158,778	231,425[2]	4,695	2,486	75,056
VERMILION	738,272	12,479	1,050	973	432	170	377,862	21,899	46	479	322,882
TOTAL STUDY AREA	8,457,968	294,172	47,380	55,041	46,114	23,769	1,905,064	1,177,680	13,326	41,206	4,854,216

[1] MSA- Metropolitan Statistical Area. Baton Rouge MSA also includes East and West Baton Rouge Parishes. Lafayette MSA also includes Acadia, Lafayette, and St. Landry Parishes.

[2] Includes Shrub and Brush Rangeland: Calcasieu, 5,884 acres; St. Tammany, 2,826 acres; and Tangipahoa, 170 acres.

[3] Includes Sandy Areas other than Beaches: Cameron, 1,112 acres; Jefferson, 154 acres; and Plaquemines, 618 acres.

SOURCE: State of Louisiana, Department of Transportation and Development; and Louisiana Office of State Planning. Preliminary and unpublished.

fisherman makes on boats, bait, ice, etc., can be traced throughout the economy using this type of analysis.

3.3.16.1.2. No-action. If no action is taken there will be continued loss of land along coastal Louisiana, including the shoreline and in areas further inland as well. As shown in Table 5, the forecast is for over 700,000 acres to be lost by the year 2040. Valuing these acres in the same manner as above yields a value of approximately $3 billion for these wetlands. As shown in the table, the loss varies from basin to basin. Only one basin actually gains acreage over the period. The total land area lost, 3.2 million acres, represents 38.2% of the total land area as shown in Table 4.

TABLE 5
HISTORIC AND PROJECTED WETLAND LOSSES

Basin	Historic Acres Lost[2/] 1932-1990	Without Project Forecast of Acres Lost[2/] 1990-2010	Without Project Forecast of Acres Lost[2/] 1990-2040	Value of Acreage Lost[1/] (in Thousands $) 1990-2010	Value of Acreage Lost[1/] (in Thousands $) 1990-2040
PONTCHARTRAIN	67,000	58,000	132,000	261,000	594,000
BRETON SOUND	45,000	13,000	33,000	59,000	149,000
MISS. RIVER DELTA	113,000	21,000	54,000	95,000	243,000
BARATARIA	198,000	76,000	175,000	342,000	788,000
TERREBONNE	202,000	88,000	220,000	396,000	990,000
ATCHAFALAYA	8,000	(7,000)	(19,000)	(32,000)	(86,000)
TECHE/VERMILION	42,000	15,000	37,000	68,000	167,000
MERMENTAU	104,000	40,000	99,000	180,000	446,000
CALCASIEU/SABINE	122,000	22,000	55,000	99,000	248,000
TOTAL	901,000	326,000	786,000	1,467,000	3,537,000
Average per Basin	100,000	36,000	87,000	163,000	393,000

1/ Value of marsh acres taken from Land Loss and Marsh Creation Feasibility Study, USACE, New Orleans District, Unpublished.
2/ Data from USACE GIS database,1993.

Direct and indirect economic impacts of wetland losses may further reduce the development potential of nearby non-wet areas. For instance, reduced employment following wetland loss makes surrounding areas less attractive not only for residential development, but also for retail businesses, since potential customer bases would be eroding over time (see section on Business and Industry). The increased incidence of flooding from the loss of protective marshes would also make the nearby non-wet areas less attractive for residential, commercial, and industrial development.

3.3.16.1.3. Future With CWPPRA Projects. If projects are implemented that reduce the current level of land loss, the nature of existing land use may be maintained, or at least sustained for longer periods of time as the pattern of subsidence, erosion, and effects of periodic storm damages continues. It is estimated that 65% of the forecasted wetlands losses can be prevented by implementation of the projects, reducing the expected losses discussed above by $2 billion.

3.3.16.2. BUSINESS AND INDUSTRY.

3.3.16.2.1 Existing Conditions. As stated in the prior section, the soil conditions, mild climate, water resources, and abundant natural resources of the Gulf Coast have attracted various types of economic development. These resources support diverse activities that are economically important to the State of Louisiana and the Nation. Historically, agriculture, commercial fisheries, and petroleum-related activities have played a major part in the economy and development of the area. From large-scale plantation-based agricultural enterprises to small-scale fishing and trapping operations, the early settlers took advantage of coastal Louisiana's natural resources and location. Indigo and sugar cane, followed by cotton and rice, were the primary crops cultivated. Timber export occurred as well. Later activities expanded to include greater development and exploitation of the transportation assets inherent in the Mississippi River and the access it provided to domestic and foreign markets. To this base, modern development has added service, manufacturing, and resource sectors featuring major ports, oil and gas exploration and refining, chemical and petro-chemical production, ship and oil rig construction, tourism, and commercial and recreational fishing. Economic stimulus is provided to the region by several industries directly dependent on wetlands. The jobs and income created by these businesses provide economic benefits to the area, including taxes to support infrastructure, and thus increase the well-being and quality of life for residents. Commercial and recreational fishing are discussed in more detail in separate sections of the EIS.

The most significant commercial center within the project area is New Orleans, well known for its port activities and tourism; however, smaller commercial centers including Houma, Lake Charles, and Morgan City have developed along other alluvial ridges. The latest (1987) Census of Manufactures, Wholesale Trade, Retail Trade, and Census of Service Industries indicated that the number of establishments, sales, receipts, employment, and/or value added by manufacture in the project area varied from 45 to 58 percent of the State total. Further inland, in the more protected areas, tourism, manufacturing, retail and wholesale trade, and the various services normally required by large urban centers are found.

Louisiana is also a primary producer of energy resources. The State provides about 15 percent of the Nation's crude petroleum and over 20 percent of its natural gas supplies. The combined value of these two products averaged $16 billion annually for the period 1986-1991. Nearly 90 percent of this output is extracted from the coastal area and adjacent offshore waters. Abundant supplies of crude petroleum and natural gas, fresh process water, and nearby water transportation account for the concentration of refining and petrochemical manufacturing facilities located in the project area, primarily along the Mississippi and Calcasieu Rivers. These industries, which rank Louisiana as the Nation's third largest chemical producer, ship commodities valued at nearly $50 billion to domestic markets annually. There were over 90,000 refining and refining-related jobs in the State during 1992. While the economic growth generated by development and expansion of energy related industries along the coastal zone has not continued during the 1980's, the area remains an important source of domestic production and industrial processing.

Tourism has also played a significant role in the regional and local economies. Ecotourism, especially swamp and bayou tours, is a new industry which capitalizes on Louisiana's abundant natural resources. According to Louisiana tourism officials, the expenditures, payroll, and tax receipts in the 20-parish project area were estimated at $4.1 billion in 1991. The tourism industry produces approximately 61,000 jobs, and visitors to New Orleans alone number 11-12 million persons annually.

3.3.16.2.2. No-action. Figure 2 of the Executive Summary presents an estimate of where the coastline of Louisiana may be in 50 years. Included within the area which would be lost according to the figure are numerous businesses and industries which would be impacted directly. Indirect impacts to business and industry would include the effects of wind and water damage to inland metropolitan areas currently protected by coastal wetlands. Areas directly impacted by land loss would include a large portion of the wetlands east of Atchafalaya Bay, essentially undeveloped and with limited industrial and commercial use, but in close proximity to the metropolitan areas of Houma and New Orleans. Portions of the Lafayette and Lake Charles metropolitan areas and other cities and towns west of Atchafalaya Bay would also be indirectly affected by wetland loss. By 2040 some 19 towns and villages with a combined population in 1990 of 23,000 people could require relocation.

Businesses and industries directly impacted (displaced) would include commercial seafood and fur dealers; light manufacturing and processing facilities; retail, wholesale, and service facilities; construction companies; port operations; trucking companies; and various enterprises supporting oil and gas production. If the coastal economy recovers from the downturn experienced during the 1980's, additional growth would probably occur in areas that are either directly or indirectly at risk, requiring additional relocations of businesses and industries which may either expand or establish between 1990 and 2040.

While all of the businesses and industries in the project area may not anticipate continued growth to the year 2040, they no doubt anticipate at least enough return on their investment to meet their opportunity costs. In addition to the difficulties in accurately measuring flood damage frequency rates under dramatically changing environmental conditions, a wide variety of factors make a precise quantification of impacts to business and industry (and population and socio-economic growth) highly speculative. These factors include fluctuating prices due to improvements in technology, the availability (or lack of availability) of natural resources worldwide, international market structures, and changing political policies, just to mention a few.

Commercial fisheries and wildlife operations, ecotourism, and related business activity dependent on the wetlands could become increasingly unstable as resources are depleted. In addition, economic activity related to mineral and energy production could continue to decline as more economically recoverable resources are found elsewhere and alternative sources of energy are developed. As drainage conditions also change and areas become more vulnerable to flooding, the cost of commercial activities in flood prone areas may increase, forcing marginally productive operations to relocate or close.

3.3.16.2.3. Future With CWPPRA Projects. Projects that reduce the rate of land loss which has been occurring over the past several decades, or that build new wetlands, would assist businesses and industries operating in coastal Louisiana in maintaining current levels of activity. This would be due in part to the prevention of increased costs associated with operating businesses in a deteriorating and more flood-prone environment.

3.3.16.3. COMMERCIAL FISHING AND TRAPPING.

3.3.16.3.1. Existing Conditions. The wetlands within the study area represent a natural resource of immense regional and National economic value. Louisiana's tidal marshes make up approximately 64 percent of the total along the Gulf of Mexico (U.S. portion) and nearly 40 percent of the coastal marshes in the continental United States. As shown in Table 6, Louisiana, on average, accounted for 20 percent of U.S. commercial fisheries landings for the period 1984-1991. The fishing ports in Louisiana include four of the country's ten largest. The State ranked second only to Alaska in total pounds landed and third to Alaska and Massachusetts in the value of total landings.

One of the difficulties in accurately measuring the significance of the commercial fishing industry has been its comparatively fragmented structure, in part due to the number of people who supplement their primary source of income as part-time fishermen, and whose sales are not always included in the NMFS statistics. Important species include shrimp, oyster, blue crab, and menhaden. Combined, these four species account for 98 percent of the annual catch value. The USACE, New Orleans District's 1984 study, Louisiana Coastal Area, Louisiana, estimated commercial fisheries influenced by Louisiana wetlands. It included both estimates by NMFS and estimates of unreported harvests of blue crab, shrimp, and oysters. Based on this evaluation, correction factors were applied to the preliminary NMFS estimates of the commercial harvests influenced by Louisiana wetlands. Table 7, on the following page, shows an updated estimate of the amount of marine fisheries which may be influenced by Louisiana's coastal wetlands. When adjusted for unreported landings, the value approaches one billion dollars.

TABLE 6
U.S. AND LOUISIANA COMMERCIAL LANDINGS
1984 - 1991
(Thousand Pounds)

YEAR	LOUISIANA	U.S.	% OF U.S.
1984	1,931,027	6,437,783	30
1985	1,704,498	6,257,642	27
1986	1,699,321	6,030,634	28
1987	1,803,944	6,895,726	26
1988	1,356,466	7,192,553	19
1989	1,227,941	8,463,080	15
1990	1,061,228	9,403,571	11
1991	1,192,539	9,484,194	13
TOTAL	11,976,964	60,165,183	20

Source: U.S. Department of Commerce, National Marine Fisheries Service, 1984-1991.

As discussed in one of the industry's major trade journals (National Fisherman Magazine, April 1991), professionals in the field indicate that the productivity of marine fisheries are significantly dependent on the quality and quantity of marine fishery habitat and that in some cases this habitat has been declining at an alarming rate. Dr. James Chambers of the NMFS indicates that degradation and habitat loss are contributing to fishery declines which, unlike overfishing, could "...lead to permanent population effects." In the same article, Dr. R.E. Turner of Louisiana State University indicates that the:

> "... productivity of the Gulf shrimp fishery is directly proportional to the total area of intertidal marsh habitat.... We haven't really seen a decline in catch yet, because there's been a tremendous increase in effort with several times more fishermen and larger and more efficient boats."

Although a decline in shrimp harvest has not been observed in Louisiana, a decline in total commercial landings in Louisiana has occurred. As seen in Table 6, Louisiana landings have dropped from 1.9 million pounds in 1984 to 1.2 million in 1991, while U.S. landings have increased from 6.4 million to 9.4 million pounds.

In addition to the problems associated with declining production, overfishing, and the adverse impacts of deteriorating estuaries, the Gulf commercial fishing industry

TABLE 7
ESTUARINE-DEPENDENT COMMERCIAL FISHERIES HARVEST AND VALUES GULF OF MEXICO AND LOUISIANA COASTAL AREA

Species	1983-1990 Average Landings Per Year[1/] (pounds)	Correction Factors for Unreported Landings[2/]	Average Corrected Landing (pounds)	1992 Normalized Price[3/] $	1992 Gross Exvessel Value[4/] $
Blue Crab	61,740,498	2.00	123,480,996	0.58	71,618,978
Shrimp	247,554,500	2.00	495,109,000	2.17	1,074,386,530
Oyster	21,614,731	1.90	41,067,989	2.61	107,187,451
Menhaden	1,739,444,500	1.00	1,739,444,500	0.05	86,972,225
Croaker	307,383	1.00	307,383	0.58	178,282
Black Drum	7,032,894	1.00	7,032,894	0.44	3,094,473
Red Drum	3,500,956	1.00	3,500,956	1.15	4,026,099
Catfish	5,754,891	1.00	5,754,891	0.60	3,452,935
Flounder	1,473,552	1.00	1,473,552	1.04	1,532,494
King Whiting	669,077	1.00	669,077	0.37	247,558
Mullet	25,011,536	1.00	25,011,536	0.41	10,254,730
Sea Crab	135,484	1.00	135,484	0.21	28,452
Sea Trout Spotted	2,704,407	1.00	2,704,407	1.16	3,137,112
Sea Trout White	516,460	1.00	516,460	0.54	278,888
Sheepshead	3,514,347	1.00	3,514,347	0.23	808,300
Spot	272,907	1.00	272,907	0.29	79,143
Finfish	6,773,194	1.00	6,773,194	0.23	1,557,835
Total					
Gulf of Mexico	2,128,021,317		2,456,769,573		1,368,841,485
LA Coastal Area[5/]	1,361,933,643		1,572,332,527		876,058,551

[1/] Published and unpublished data for the years 1983–1990 were provided by the U.S. Department of Commerce, National Marine Fisheries Service.

[2/] The Correction Factors are based on information provided by the LA Dept. of Wildlife and Fisheries.

[3/] The 1992 Normalized Prices are calculated by applying the 1992 CPI for food to the exvessel value of 1983–1990 catches.

[4/] The Gross Exvessel Value is based on 1992 normalized prices and the 1983–1990 average corrected landing.

[5/] Gulf of Mexico landings allocated to the LA Coastal Area are based on the relative abundance of estuarine marsh habitat.

has experienced the effects of growing competition from Alaska and imports from developing countries. Seafood harvests in Alaska increased from about 1.0 billion pounds in 1980 to more than 5.5 billion pounds in 1988. Increases in imports have also impacted the industry. Shrimp imports, for example, have increased from 319.6 million pounds (heads-off) in 1982 to 632.8 million pounds in 1991 (NMFS, 1992). About 70 percent of the Nation's shrimp landings have been at Gulf ports (not including unreported landings).

Other major species influenced by the productivity of the wetlands include oysters, blue crab, mullet, black and red drum, sea catfish, trout, flounder, and a variety of other finfish. According to a 1991 study prepared for the Louisiana Seafood Promotion and Marketing Board, oyster production in Louisiana ranges from nine to thirteen million pounds annually, with a dockside value of more than $30 million. This represents 25 to 40 percent of the U.S. total.

Approximately 80 percent of the annual oyster production in Louisiana is harvested from more than 300,000 acres of oyster reefs under commercial lease from the state to private operators. The amount of waterbottoms and oyster reefs leased to private operators has increased from 110,000 acres in 1970 to 230,000 acres in 1980, to more than 300,000 acres in 1989. Despite the increase in acres used in production, output has remained largely stable since the early 1970's, indicating a decrease in productivity per acre (Keithly, 1991). Increased prices for oysters during this time period are partially due to a significant decline in oyster production along the East Coast, especially in Chesapeake Bay.

Production of blue crab in Louisiana has increased from an annual harvest averaging 15 million pounds during the early 1970's to over 50 million pounds in the late 1980's. This harvest represents as much as 25 percent of the domestic supply in some years. A similar increase has also occurred in the value of blue crab. The availability and variety of seafood have been important to the regional economy, particularly the New Orleans restaurant and tourism industry.

The increasing popularity of recreational sport fishing has had a negative impact on commercial fishing. Competition and hostility has arisen between the recreational and commercial fishermen concerning the allocation of resources. The current commercial ban on redfish is a prime example. Overfishing by commercial and recreational fishermen in the Gulf of Mexico resulted in a ban on all harvest of red drum from Federal waters since 1986. Commercial fishing of the species in State waters is prohibited as well. While commercial fishermen are prohibited from harvesting red drum in State waters, recreational fishermen can harvest 5 red drum per day. Commercial fishermen have repeatedly voiced their resentment toward recreational fishermen at public hearings, resulting in heated confrontations between the two groups. In the fishing communities across coastal Louisiana little else can cause as much controversy as the subjects of limited entry, fishing bans, moratoriums, license limitation, and individual quotas. Despite the intense conflict that has arisen in the fishing industry, the fishing resources still support a wide range of related businesses such as processors and canners, shippers, wholesale and retail operations, restaurants, boat building and repair yards, net and gear builders, icehouses, and commercial marinas. According to a recent study, the commercial fishing industry in Louisiana creates 90,000 jobs and has a economic impact of $1.5 billion (Keithly, 1991).

Although much less important in terms of their economic significance, furbearers and alligators are also commercially harvested for pelts, hides, and meats. After years of closed seasons, alligator hunting is now legal, and production has increased. Louisiana produces more wild furs and hides than any other State in the U.S., valued at nearly $20 million annually. This represents 40 percent of the production in the U.S. From 1972 to 1992 the annual harvest of alligator skins increased from 1,350 to an estimated 24,036. The value of an average skin has increased from approximately $55 in 1972 to more than $405 in 1991. The total commercial value of the alligator harvest (including meat and skins) has increased from about $75,500 to more than $13.5 million (LDWF, unpublished data).

While the harvest and value of alligators have increased, the harvest of furbearers has declined. During the 1945-46 season, for example, an estimated 8.3 million muskrat pelts were taken in Louisiana. During the period 1978-1991 an average of 256,692 muskrat pelts were taken per year, significantly less than the 1945 season. Table 8 displays the average takes and value of commercial wildlife for the period 1978-1991. As reported by the LDWF, a variety of factors have caused the sharp decline in demand for fur; among them a doubling of worldwide production of ranch mink, several mild winters, market saturation, shifts to alternative products, general economic conditions, and other factors such as the animal rights movement. The decline in demand for furbearers has become an increasing concern not only to the fur industry but landowners who have experienced adverse effects from the overpopulation of certain furbearers. The overpopulation of nutria caused significant damage to rice and sugarcane crops during the 1950's and 1960's. Recently, the overpopulation of muskrat and nutria has been identified as an additional cause of damage to marsh vegetation and subsequent wetland loss (Cochran, 1991).

3.3.16.3.2. No-action. The traditional pattern of commercial fishing and trapping is likely to change as the productivity of the wetlands decline. Increasing government regulations and restrictions combined with a declining resource base could make it difficult for fishermen and trappers to continue to earn a living from these traditional occupations. As the fishing resources decline, controversy and conflict over allocating the limited resources will increase. Declines in commercially harvested wildlife would be expected from the loss of nearly 800,000 acres of coastal wetlands that would occur without intervention.

TABLE 7
COMMERCIAL WILDLIFE TAKES & VALUE
1992 NORMALIZED PRICE[1/]

Type	# of Pelts	Normalized Price to Trapper[1/] $	Average Gross Value $
Furbearer Pelts[2/]			
Nutria	804,392	5.15	4,142,620
Muskrat	256,692	3.54	908,690
Raccoon	158,851	11.08	1,760,070
Mink	31,805	13.99	444,950
Opossum	25,046	1.45	36,320
Otter	5,037	24.37	122,750
Skunk	154	1.73	270
Red Fox	861	30.50	26,260
Gray Fox	2,441	29.62	72,300
Bobcat	2,208	57.55	127,070
Beaver	1,258	6.13	7,710
Coyote	1,269	11.65	14,780
TOTAL Pelts	1,290,017		7,663,790
	Pounds	Price/Foot	
Furbearer Meats[2/]			
Nutria	472,843	0.067	31,680
Raccoon	642,949	0.594	381,910
Opossum	28,931	0.326	9,430
TOTAL Meat	1,144,723		423,020
TOTAL Furbearer Pelts & Meats			8,086,810
	# of Hides	Price/Foot	
Alligator[2/]			
Alligator Hides	22,298	41.67	6,643,480
Alligator Meat	213,700	11.48	2,453,280
TOTAL Hides & Meats			9,096,760
TOTAL Commercial Harvest (Furbearers & Alligators)			17,183,570

1/ The 1992 Normalized prices as calculated by NOD using historical data and the Producer Price Index for "Hides, skins, leather, and related products" (code 04) for the period 1978 through March 1992 (1982 = 100). Sources of price index: U.S. Dept. of Labor, Bureau of Labor Statistics, unpublished reports furnished by Office of Prices and Living Conditions; "Summary Data from the Producer Index News Release" April 1992; and "Producer Price Indexes" June 1992.

2/ Based on the estimated takes of furbearers for seasons 1978–79 through 1990–91 and the harvests of wild alligators 1984 through 1991, from unpublished data reported by the Louisiana Department of Wildlife and Fisheries.

Declines in commercial fishing and trapping would cause a reverse in the positive impacts that the industry currently has on the local and national economies. Spending by consumers on commercial fishing and trapping goods produces personal income for both commercial fisherman and trappers as well as workers in related industries. Losses of income from a reduced level of sales of commercial and trapping products, as with any other types of goods, would result in direct and indirect negative impacts on the economy.

Direct, or first-round impacts, are those which result from purchases of a particular product by the consumer. Indirect, or second-round impacts, are those which result when beneficiaries of first round payments spend their earnings. The secondary impacts could be widely disbursed geographically. Equipment and supplies are often obtained from producers far beyond wetland areas, and sales of the catch take place throughout the country. Consequently, if wetland losses occur as anticipated, jobs and income could be negatively impacted far from the local economy in which the original catch and sales take place.

3.3.16.3.3. Future With CWPPRA Projects. Commercial fishing and wildlife industries would benefit to the extent that restoration projects reduce wetland deterioration. As discussed under sections dealing with transportation impacts and displacement impacts, individual fishermen may suffer negative impacts as certain areas of oyster leases and shrimp grounds move seaward from freshwater and sediment diversions. Some fishermen may have to travel further or relocate their base of operation, while others will be positively impacted by decreased travel time.

Some restoration projects have the potential to reduce migratory, estuarine-dependent species' access and use of marshes. Marsh management projects probably have the greatest potential to reduce fisheries access, followed to a lesser degree by hydrologic restoration and outfall management. All projects implemented under the CWPPRA will maximize overall benefits to wetlands, including dependent fish and wildlife resources. Projects that would eliminate fisheries access would, in all likelihood, not be implemented. Even though these types of projects may reduce fisheries access and hence may reduce production of estuarine fisheries resources from managed areas, the projects are expected to maintain and possibly increase vegetative cover and habitat quality within the project boundaries. The projects are therefore expected to provide habitat usable by commercially important species over the long-term, compared to the deteriorating conditions that would continue to occur without such projects.

3.3.16.4. POPULATION AND EMPLOYMENT.

3.3.16.4.1. Existing Conditions. Although important for their natural resources, the wetland areas remain largely unpopulated. The population centers are predominantly within areas which are protected from hurricanes. Table 9 summarizes the population trends in the 20-parish study area during the past three decades. As shown in the table, the total population in the area increased only 0.8 percent to 2,103,243 between 1980 and 1990. The total population of Louisiana showed an increase of only 0.3 percent during the same period. Although the total population of the study area slightly increased, the population in some parishes decreased dramatically. For example, in Orleans parish the population dropped 16 percent from 1970 to 1990. The parishes of Jefferson, Plaquemines, St. James, and St. Mary experienced population losses from 1980 to 1990. Ascension and Livingston Parishes, which are part of the Baton Rouge MSA, were less affected by the softening of the economy in southeast Louisiana and enjoyed population increases of 16.3 percent and 19.9 percent, respectively. St. Tammany Parish, which is included in the New Orleans MSA, showed an increase of 30.3 percent during the 1980's. This growth is due to a shift in population from the more urban environment of Orleans and Jefferson parishes; St. Tammany parish is more rural, and has a reputation for good public schools, less crime, and affordable housing. Single-family residential construction dominates the growth which has occurred in this parish.

Although the unemployment rate in the 20-parish area has improved considerably since the trough of the mid-1980's, it continues to remain comparatively high. As of January 1993, the labor force in the area totaled 908,300, with an unemployment rate of 8.6 percent. The U.S. unemployment rate is currently about 7 percent. Although the port and related activities have remained a significant part of the local economy, employment opportunities in these segments declined somewhat. Total employment in the service industries, including tourism and convention trade, has increased in recent years. Commercial fishing is an important source of secondary employment and income for a large segment of the area work force. Keithly and Liebzeit (1987) report that the total number of full-time commercial fishermen in Louisiana increased from about 9,379 in 1960 to 15,039 in 1980. Table 10 provides a recent estimate of the total number of jobs in the study area covered under the Louisiana Employment Security Law and the general classifications of employment. The data presented in the table are based on total wages paid and reflect the majority of employment in the 20-parish area.

TABLE 9
TOTAL POPULATION FOR METROPOLITAN STATISTICAL AREAS (MSA) AND PARISHES IN THE PROJECT AREA

	1960	1970	1980	1990
Baton Rouge MSA[1/]				
Ascension	27,927	37,086	50,068	58,214
Livingston	26,974	36,511	58,806	70,526
Houma MSA				
Lafourche	55,381	68,941	82,483	85,860
Terrebonne	60,771	76,049	94,393	96,982
MSA total	116,152	144,990	176,876	182,842
Lafayette MSA[2/]				
St. Martin	29,063	32,453	40,214	44,097
Lake Charles MSA				
Calcasieu	145,475	145,415	167,223	168,134
New Orleans MSA				
Jefferson	208,679	338,229	454,592	448,306
Orleans	627,525	593,471	557,927	496,938
Plaquemines	22,545	25,225	26,049	25,575
St. Bernard	32,186	51,185	64,097	66,631
St. Charles	21,219	29,550	37,259	43,437
St. James	18,369	19,733	21,495	20,879
St. John	18,439	23,813	31,924	39,996
St. Tammany	38,643	63,585	110,869	144,508
MSA total	987,605	1,144,791	1,304,212	1,286,270
Non-MSA Parishes				
Assumption	17,991	19,654	22,084	22,753
Cameron	6,909	8,194	9,336	9,260
Iberia	51,657	57,397	63,752	68,297
St. Mary	48,833	60,752	64,253	58,086
Tangipahoa	59,434	65,875	80,698	85,709
Vermilion	38,855	43,071	48,458	50,055
TOTAL PROJECT AREA	1,556,965	1,796,189	2,085,980	2,103,243

1/ The current Baton Rouge MSA also includes East and West Baton Rouge Parishes.
2/ The current Lafayette MSA also includes Acadia, Lafayette, and St. Landry Parishes.

Source: U.S. Department of Commerce, Bureau of the Census.

TABLE 10
EMPLOYMENT BY INDUSTRIAL GROUPS IN THE TWENTY PARISH PROJECT AREA

INDUSTRIAL GROUPS	PERSONS EMPLOYED	PERCENT OF TOTAL
AGRICULTURE	6,336	0.8
MINING	28,493	3.5
CONSTRUCTION	50,517	6.2
MANUFACTURING	91,797	11.3
TRANSPORTATION	71,952	8.9
WHOLESALE TRADE	45,698	5.6
RETAIL TRADE	156,853	19.3
FINANCE	38,893	4.8
SERVICES	284,498	35.0
PUBLIC ADMINISTRATION	37,499	4.6
TOTAL	812,566	100.0

Source: Louisiana Department of Labor, Employment and Total Wages Paid by Employees Subject to Louisiana Employment Security Law, Third Quarter 1992.

3.3.16.4.2. No-action. While the high unemployment rate caused by the decline of the oil and gas industry is not expected to continue indefinitely, employment and population growth related to the oil and gas industry are not expected to soon return to their pre-recession levels. Recent data show that the population in the coastal region, as well as in other areas in the State and Nation, has grown more slowly than originally projected. As an example, the Bureau of Economic Analysis (BEA) Regional Projections to 2040, published in October 1990, estimates that the population in the New Orleans MSA will reach 1.24 million by the year 2000. This is a downward revision from the 1985 OBERS projection of 1.41 million. Tables 11 and 12 show the BEA population and employment projections in the project area for the period 2000 to 2040. The study area as a whole is projected to increase only one percent between 1990 and 2040. On the parish level, the BEA projects several of the parishes will decline in population by the year 2040 as compared to the 1990 population. Since the BEA estimates do not take into account a decline in economic activity related to loss of wetlands, the projected population and employment in the Louisiana coastal zone are not likely to increase as much as projected. Employment and population associated with the harvesting and processing of commercial fish and wildlife and recreational resources could decline as the wetlands which support these industries decline. As much as 23,000 people currently living in coastal Louisiana could be displaced due to relocation requirements resulting from wetland loss over the next 50 years. Also, as environmental conditions change, an additional number of residents may decide to move further inland to avoid the effects of periodic storms.

TABLE 11
PROJECTED POPULATION BY PARISH

Parish	2000	2010	2020	2040
Ascension	57,700	57,500	58,100	57,100
Assumption	22,200	22,000	22,200	21,800
Calcasieu	166,300	165,900	168,000	165,900
Cameron	9,200	9,300	9,500	9,400
Iberia	68,200	68,100	68,900	67,700
Jefferson	454,700	460,000	469,500	467,000
Lafourche	87,400	88,600	90,600	90,000
Livingston	70,700	70,800	71,900	71,100
Orleans	486,100	478,400	481,100	473,200
Plaquemines	24,600	24,300	24,500	24,100
St. Bernard	67,800	68,800	70,300	70,000
St. Charles	43,200	43,700	44,700	44,300
St. James	20,500	20,400	20,600	20,200
St. John	41,100	42,000	43,100	43,000
St. Mary	55,700	54,100	54,000	52,600
St. Martin	45,500	46,600	47,800	47,500
St. Tammany	150,400	156,300	161,800	162,400
Tangipahoa	86,600	87,800	89,700	89,000
Terrebonne	98,900	100,500	102,800	102,200
Vermilion	49,000	48,300	48,500	47,500
Total Study Area	2,105,800	2,113,400	2,147,600	2,125,900
Total Louisiana	4,224,300	4,241,400	4,313,000	4,270,000

Source: U.S. Department of Commerce, Bureau of Economic Analysis, BEA Regional Projections to 2040.

TABLE 12
PROJECTED EMPLOYMENT BY PARISH

Parish	2000	2010	2020	2040
Ascension	25,000	25,400	24,400	22,800
Assumption	5,900	5,900	5,600	5,200
Calcasieu	76,200	76,500	73,200	68,300
Cameron	5,100	5,100	4,800	4,500
Iberia	29,000	28,900	27,500	25,500
Jefferson	236,200	241,300	233,100	219,500
Lafourche	31,400	31,800	30,600	28,700
Livingston	15,000	15,400	14,900	14,000
Orleans	332,100	327,300	310,100	287,800
Plaquemines	18,400	17,800	16,800	15,400
St. Bernard	19,400	19,800	19,100	18,000
St. Charles	19,500	19,700	18,900	17,600
St. James	7,800	7,700	7,300	6,700
St. John	13,000	13,400	13,000	12,200
St. Mary	28,800	28,100	26,400	24,300
St. Martin	15,200	15,900	15,500	14,700
St. Tammany	50,700	53,300	52,300	49,700
Tangipahoa	31,600	31,800	30,500	28,400
Terrebonne	43,700	44,100	42,400	39,700
Vermilion	17,400	17,000	16,000	14,700
Total Project Area	1,021,400	1,026,200	982,400	917,700
EPR-Project Area[1/]	49%	49%	46%	43%
Total Louisiana	2,033,400	2,045,000	1,960,200	1,832,200
EPR-Louisiana[1/]	48%	48%	45%	43%

[1/] EPR = Employment Participation Rate (Total Employment divided by Total Population)
Source: U.S. Department of Commerce, Bureau of Economic Analysis, BEA Regional Projections to 2040.

3.3.16.4.3. Future With CWPPRA Projects. The implementation of wetland protection and restoration projects would have a positive impact on economic developments which are dependent on or related to wetlands. The projects would have a stabilizing effect on employment and associated population elements. Employment on project construction of otherwise unemployed or under-employed labor would also be realized.

3.3.16.5. PERSONAL INCOME.

3.3.16.5.1. Existing Conditions. In 1990, per capita personal income in the project area was $15,610, somewhat higher than per capita personal income for the State, which was $14,530. As in other areas of the State and Nation, incomes have generally been higher in the metropolitan areas than in non-metro and rural areas. An important source of income and employment, particularly in more rural communities, has been commercial and recreational fishing, along with the sales and service sectors which support these industries.

3.3.16.5.2. No-action. The BEA projects that per capita personal income in the study area will increase from $12,470 in the year 2000 to $14,820 by 2020, and $17,400 by 2040 (1982 price levels). Per capita personal income for the State is projected to increase from $12,142 in 2000 to $14,346 by 2020, and $16,948 by 2040, again at 1982 price levels. Although the BEA data projects the per capita income of the study area to exceed the State average, the data does not account for decreases in fish and wildlife resources associated with wetland losses. The prospects of income opportunities may decline in the rural areas experiencing continued depletion of natural resources.

3.3.16.5.3. Future With CWPPRA Projects. To the extent that proposed plans can help to maintain resources and activities otherwise depleted due to wetland losses, projects could help to maintain personal incomes and social well-being of the area. Since many of the economic conditions of the area are unrelated to changes in wetland resources, a quantitative analysis of exactly how any particular project feature or combination of features is likely to impact personal income is problematic.

3.3.16.6. INFRASTRUCTURE, TAX REVENUES, AND PUBLIC FACILITIES AND SERVICES.

3.3.16.6.1. Existing Conditions. The unique drainage conditions of the area have required construction of an elaborate network of levees and pumps to protect the infrastructure in the coastal area. Tax revenues collected in the project area provide funds needed to construct and maintain flood protection systems, as well as to fund roads, bridges, fire and police protection, port facilities, and other necessary public facilities and services.

The area's tax base is dependent on economic activity which includes oil and gas production, commercial and recreational fishing, and tourism. Smaller communities tend to be unincorporated, and are supported by various State, regional, or parish revenue authorities. The four largest sources of revenue for the State -- the sales tax, the individual income tax, the general severance tax, and the gasoline tax -- provide 75 percent of total State revenues. The study area provided $535 million in State sales tax revenues in fiscal year 1993. The State also depends on severance tax revenues generated by mineral production. The study area provided $297 million of severance tax revenues in Fiscal Year 1993, representing 67 percent of total statewide collections. Each parish's contribution to both state sales tax and severance tax revenues is detailed in Table 13.

TABLE 13
1992 LOCAL AND STATE TAX REVENUES GENERATED BY PARISHES IN THE STUDY AREA

Parish	Local Revenues		State Revenues	
	Property Taxes $	Sales Taxes $	Severance Taxes $	Sales Taxes $
ASCENSION	17,488,000	31,891,000	1,282,000	20,866,000
ASSUMPTION	4,614,000	4,553,000	2,088,000	1,190,000
CALCASIEU	61,395,000	75,770,000	7,993,000	43,824,000
CAMERON	12,816,000	0	24,271,000	537,000
IBERIA	11,472,000	21,544,000	19,520,000	10,637,000
JEFFERSON	123,998,000	202,995,000	10,609,000	154,444,000
LAFOURCHE	22,381,000	15,980,000	36,241,000	7,539,000
LIVINGSTON	8,112,000	13,983,000	3,284,000	5,387,000
ORLEANS[1/]	215,070,000	89,279,000	133,000	195,903,000
PLAQUEMINES	19,433,000	10,529,000	77,893,000	3,839,000
ST. BERNARD	11,498,000	21,756,000	7,027,000	6,135,000
ST. CHARLES	40,946,000	26,165,000	4,380,000	9,190,000
ST. JAMES	13,570,000	8,493,000	814,000	5,065,000
ST. JOHN	14,685,000	15,053,000	269,000	4,772,000
ST. MARTIN	9,231,000	5,708,000	11,047,000	2,720,000
ST. MARY	19,084,000	16,885,000	20,787,000	7,810,000
ST. TAMMANY	40,005,000	155,994,000	353,000	17,924,000
TANGIPAHOA	10,288,000	27,332,000	271,000	12,930,000
TERREBONNE	25,324,000	24,681,000	32,870,000	16,599,000
VERMILION	11,375,000	10,171,000	36,065,000	7,364,000
STUDY AREA TOTAL	692,785,000	778,761,000	297,197,000	534,675,000
STATE TOTAL	1,167,560,000	N/A	44,866,000	1,518,003,000

1/ 1993 property tax data used for Orleans Parish only

Sources: Louisiana Tax Commission, Louisiana Department of Revenue and Taxation, and local sales tax agencies

Two major sources of local revenues are also depicted in the table. The economies and tax bases of fishing villages scattered throughout the coastal area depend on activities related to commercial and recreational fishing, hunting, and trapping. As reported by the Louisiana Tax Commission, the total assessment of all property in the project area for Fiscal Year 1992 was $8.3 billion, which represents 53 percent of the State total of $15.6 billion. This translated to a fair market value of property in the study area of approximately $72 billion, yielding parish and local taxes of $693 million in 1992. Also shown in Table 13 are parish and local portions of sales tax collections which provided $779 million to governments in the study area in Fiscal Year 1993.

Income taxes contribute significant revenues to both state and Federal governments, but these revenues are not reported directly at the parish level. An estimate of Louisiana personal income tax revenues based on average taxes paid in three-digit zip codes in the study area is $373.5 million for 1990. Estimates of Federal tax revenues generated by the study area in 1990 and 1991 are $3.3 billion and $3.6 billion, respectively. Assuming that the study area provided at least half of the statewide gasoline tax revenues, they would have exceeded $186 million in Fiscal Year 1991.

Considerable infrastructure investment and real estate assets exist in the parishes of the study area. The Twenty-Fifth Biennial Report of the Louisiana Tax Commission shows that approximately $67 billion dollars of taxable real estate assets, personal property, and property of public service corporations are contained in these parishes. In addition, tax exempt property amounts to another $5.5 billion, and investment in flood control, hurricane protection, navigation, and transportation infrastructure totals $32.6 billion, bringing a total of approximately $105 billion in property in the twenty parish study area.

3.3.16.6.2. No-action. As the wetlands decline, private property and infrastructure will become more vulnerable to hurricane damage. In the near term, a further decline of the area's economic base and property values could cause continued deterioration of tax revenue, thereby reducing the ability of state and local governments to maintain public facilities and services. This would also hinder continued development of the State's fish and wildlife resources, the majority of which are currently located in the study area.

3.3.16.6.3. Future With CWPPRA Projects. Implementation of CWPPRA projects would help maintain a large portion of existing fisheries productivity and related employment opportunities, thereby contributing to the area tax base and public facilities and services. Effects would tend to be more significant for communities where commercial fishing and wildlife activities are a major source of employment and income. Although less significant, the tax base and public facilities in urbanized areas could also benefit by continued revenues at seafood markets and restaurants.

Since indirect economic impacts would be felt throughout the economy, the effect of the loss of wetlands would be magnified beyond the direct economic impacts on fishing, wildlife, and property values.

3.3.16.7. COMMUNITY COHESION.

3.3.16.7.1. Existing Conditions. Community cohesion generally refers to those forces which create a social bond within a community. It may be characterized through many forms, including religion, ethnic background, education, income, recreation, or other factors considered of mutual economic or social benefit. The availability of an abundant source of fish, shellfish, and wildlife, for both commercial and recreational purposes, has been important to a broad spectrum of groups throughout the coastal area. The history of the region has been heavily influenced by a wide variety of traditions ranging from those of native Americans, the earliest Spanish, French, and English settlers, African descendants, the French "Acadians" by way of Nova Scotia, and various other immigrants who have been drawn to U.S. port cities. The cooperative efforts of the citizens of local communities and regions within the project area during flood emergencies and hurricane evacuations have also contributed to the overall community cohesion of groups within the project area.

3.3.16.7.2. No-action. Under the no-action scenario, mutual interests and economic viability of the communities along the coast could decline. In many communities within the project area, the decline of the oil industry and resultant outmigration has reduced the number of families previously supporting schools, churches, and other social/cultural institutions that contribute to community cohesion. Commercial fishing and related businesses remain a major factor in many small villages. In extreme cases, some smaller communities are physically threatened by erosion directly or indirectly due to significant increases in the risk of tidal and storm flooding. There is a general consensus within the larger community of coastal Louisiana that the current rate of land loss needs to be controlled.

3.3.16.7.3. Future With CWPPRA Projects. To the extent marsh protection, creation, and restoration helps maintain commercial and recreational fish and wildlife resources, flood protection, and other factors important to communities along the project area, the various alternatives under consideration would help maintain community cohesion, particularly in small communities and in the rural areas. Plans and programs which protect the urbanized areas further inland will have positive impacts on community cohesion within the larger community as well.

3.3.16.8. DISPLACEMENT OF PEOPLE AND BUSINESSES.

3.3.16.8.1. Existing Conditions. People and businesses historically locate where resources are available to support them. Displacement occurs due to changing economic conditions, whether from depletion of natural resources, changing environmental conditions, or from changes in demand for a particular resource (e.g., conversion of farmland for use in residential development). During the 1980's, displacement of people and businesses occurred largely from the decline in oil activities and fluctuations in port activities. This resulted in a significant increase in outmigration.

3.3.16.8.2. No-action. The rate of outmigration of people and businesses is expected to decline as the area adjusts to changes in oil production and as port activities recover. However, the coastal area will begin to experience displacement of people, businesses, and farms as the impacts of land loss and subsidence continue apace. Drainage problems associated with land loss include changes in salinity levels affecting irrigation.

Persons displaced by land loss could include those in communities south of the anticipated 2040 shoreline, communities immediately adjacent to the 2040 shoreline, and communities where road service would no longer appear feasible. Total direct displacement could be as much as 23,000 people based on the 1990 census. Other, possibly greater displacement may occur as a result of the disruption of economic activities, including oil and petro-chemical industries, ports, commercial and recreational fishing, and commercial sales and services which have developed as a result of these basic industries. Loss of jobs in commercial fishing, for instance, could be in the range of 50-80,000 persons if the entire industry eventually collapses. Table 14 summarizes the estimated 1990 population of communities likely to experience population displacement by the year 2040 if no action is taken.

TABLE 14
ESTIMATED 1990 POPULATION OF COMMUNITIES WITH DIRECT POPULATION DISPLACEMENT BY 2040

Barataria	1,160		Johnson Bayou	150	(est.)
Boudreau	150	(est.)	Lacombe	6,523	
Chauvin	3,375		Lafitte	1,507	
Cocodrie	500	(est.)	Leeville	175	(est.)
Cypremont	150	(est.)	Montegut	1,784	
Delacroix	150	(est.)	Pilot Town	150	(est.)
Dulac	3,273		Point Barre	150	(est.)
Fourchon City	50	(est.)	Theriot	150	(est.)
Grand Isle	1,455		Yscloskey	2,000	(est.)
Holly Beach	150	(est.)	TOTAL	23,002	

Sources: U.S. Dept. of Commerce, Bureau of the Census, "1990 Census of Population and Housing, Louisiana" 1990 CPH-1-20; and USACE, NOD estimates of population in rural communities reported by the census as part of voting districts, but not reported as part of identifiable communities.

3.3.16.8.3. Future With CWPPRA Projects. The CWPPRA projects will create jobs and stimulate the economy in the coastal parishes while simultaneously protecting the natural resources upon which many of the local economies depend. The projects as a whole will decrease the rate of displacement through its positive impacts on the fishery economy and its related infrastructure. On a smaller scale, some parts of the fishery economy and individual fishermen may be negatively impacted as certain fish and shellfish producing areas are displaced seaward. Some fishermen may have to travel further to land their catch, and as a result could relocate their operational base as well as their place of residence.

3.3.16.9. DESIRABLE COMMUNITY AND REGIONAL GROWTH.

3.3.16.9.1. Existing Conditions. Historically, some of the activities which have driven regional and community growth have centered around oil and gas production, tourism, port operations, and fishing and hunting. Development of the area's energy resources during the 1950's and 1960's was instrumental in the expansion of industrial growth in surrounding communities. More recently, saltwater sport fishing has become an important stimulus to local and regional economies. In the last thirty years this activity has gained in popularity due to the advancements in affordable and reliable power sources for small boats and the advent of fiberglass boat hulls. As discussed in recreation opportunities, some estimate that recreational fishing has an annual economic impact of nearly one billion dollars.

Community and regional growth would not have been possible without construction of an extensive network of levees and floodgates along the Mississippi River for flood protection and maintenance dredging of the river sufficient to accommodate deep-draft navigation and waterborne commerce as far up river as New Orleans and Baton Rouge. Numerous lesser flood control, hurricane protection, and navigation projects have also been developed in response to public officials seeking support for continued desirable community and regional growth. The population, employment, and income developments discussed in previous sections are reflections of these past growth trends.

3.3.16.9.2. No-action. While public officials and other community leaders express many different views regarding future needs and opportunities for community and regional growth, all seem to indicate that desirable community and regional growth will depend, in part, on maintaining an adequate level of flood and hurricane protection. Future growth in the project area will depend on local and regional commitment to develop natural and human resources in the area. The socioeconomic projections referred to previously indicate that population and employment growth in the coastal region is not expected to reach National growth rates, indicating that a certain amount of outmigration is expected to continue.

3.3.16.9.3. Future With CWPPRA Projects. To the extent that the CWPPRA projects help to maintain employment and income stability sufficient to support the tax base and public facilities and services of the various communities of the region, projects would ultimately benefit community and regional growth.

3.3.16.10. NOISE.

3.3.16.10.1. Existing Conditions. Noise is essentially sound without value, intrusive, or otherwise objectionable. General standards for measuring noise have been developed and quantified by the U.S. Department of Housing and Urban Development (HUD). Average weighted sound levels are expressed in decibels (dbl). HUD has estimated that noise levels which are greater that 65 Ldn (noise level, day/night) are "normally unacceptable". It has estimated that any level greater than 75 Ldn is unacceptable without adequate protection. The U.S. Occupational Safety and Health Administration (OSHA) requires employers to assist their employees in protecting themselves against the effects of unacceptable noise levels. OSHA standards apply within areas where future projects might develop. Since the coastal wetlands are largely unpopulated, threats to human health in areas where projects might develop seems unlikely.

3.3.16.10.2. No-action. No significant adverse impacts from noise are anticipated.

3.3.16.10.3. Future With CWPPRA Projects. No significant adverse impacts from noise are anticipated due to the remote location of most project sites. Construction activities associated with project alternatives would be subject to OSHA regulations and any related State and local health standards.

3.3.16.11. AESTHETICS

3.3.16.11.1. Existing Conditions. Aesthetic characteristics of the 20-parish project area include the unique historical structures and urban and rural landscapes that reflect the lifestyles and traditions of different groups within communities along the coast; the vast expanse of wetlands largely unpopulated except by a wide variety of birds and other wildlife; the winding bends of the Mississippi River; and the extensive network of other rivers, bayous, canals, lakes, and bays which lead to the barrier islands and Gulf of Mexico.

3.3.16.11.2. No-action. Much of the wetlands and its resources considered aesthetically pleasing will continue to be adversely impacted by destructive natural forces such as subsidence and erosion. If the pattern of land loss continues and causes a growing threat to developments further inland, the cost of maintaining resources with aesthetic value which could not easily be moved further inland would tend to increase. As the cost of protection or relocating becomes prohibitive, the value of those aesthetic resources would tend to decline or be lost. An example of this impact might be the loss of the aesthetic qualities of an historic residence which could no longer be maintained due to the cost of protection against storm damages.

3.3.16.11.3. Future With CWPPRA Projects. The CWPPRA could help maintain the current level of aesthetic values of the coastal region in Louisiana to the degree that the projects help in maintaining the aesthetic qualities of the beaches, wildlife refuges, parks and recreational facilities, historic residences, commercial developments, and other properties within the study area.

3.4. CUMULATIVE IMPACTS OF ALTERNATIVES

3.4.1. Introduction. In contrast to the typical projects and plans that EIS's are written for, the Restoration Plan will not add to the cumulative adverse effect that human development has had on the natural environment. Rather the plan seeks to halt and reverse many of the cumulative effects that have occurred from human activities, but this cannot be accomplished without affecting established infrastructure.

The Restoration Plan will contribute to the cumulative beneficial effects of coastal wetlands restoration efforts that have previously been constructed and are being constructed under separate Federal authority and by State, local, and private interests. Nearly all of the projects that make up the State's Coastal Wetlands Conservation and Restoration Program are included in the Restoration Plan.

The Restoration Plan is composed of a multitude of individual projects. These projects may interact with or be dependent upon other projects, offer substitute approaches to restoring a specific area, or they may be independent of other projects. As stated earlier in this report, many of these projects are very conceptual and in some cases, are no more than a statement that something is needed in a certain area. Preliminary cost and benefit data have been developed for some projects in an attempt to satisfy the language of the CWPPRA; that projects in the Restoration Plan be ranked according to their cost-effectiveness at creating, restoring, protecting, and enhancing wetlands. Unfortunately there was not the time or manpower available to develop costs and benefits for all projects in the plan. Preliminary cost and benefit information have been developed for most short-term critical and supporting projects. Descriptions of the projects included in the Restoration Plan are summarized in the basin summary chapters of the main report and discussed in more detail in the appendices. At this point in the development of the plan we know that the proposed projects far exceed the funds available through the CWPPRA. Which projects will ultimately be funded and constructed is unknown. It is therefore, very difficult to discuss the overall effects of the Restoration Plan. The implementation of all projects in any basin is highly unlikely. The effects of projects, either individually or in groups, will be addressed in specific NEPA documentation for those projects before they are constructed.

Project proposals were divided into several categories; short-term and long-term projects considered critical to the restoration of the basin, short-term supporting projects capable of being implemented within five years, and long-term supporting projects that would take longer to implement or lacked sufficient detail for evaluation. Supporting projects contribute to the restoration of a basin but are not critical to the overall success of the restoration effort. Additionally some demonstration projects were proposed to test new technologies or research unknown aspects of marsh restoration. Basin teams considered various strategies for each hydrologic basin and chose projects critical to restoration of each basin. Critical projects were chosen for their ability to achieve the key objectives developed for each basin.

The eventual effects of basin plans will essentially be a compilation of the effects of the various projects that are constructed. The general effects of various projects types have already been discussed. The following sections include a general overview of the restoration plans developed for each of the hydrologic basins. Each basin section includes a table showing how many projects of each type are proposed. These tables are meant to give the reader an indication of the approach that will be taken towards restoration of each basin, based on the types of projects proposed. Refer to the basin summaries of the main report and its appendices for additional information about individual projects.

3.4.2. Pontchartrain Basin.

The plan selected for the Pontchartrain Basin includes incorporation of the previously authorized Bonnet Carré Freshwater Diversion project and implementation of bank stabilization and marsh creation along the Mississippi River Gulf Outlet as short-term critical projects. Also included in the critical, short-term portion of the plan are projects to preserve the land bridges between Lakes Borgne and Pontchartrain and between Lakes Maurepas and Pontchartrain through shoreline stabilization and hydrologic restoration. Other critical areas would be preserved through shoreline stabilization, hydrologic restoration, and marsh creation. A large number of other projects, mainly in the categories of shoreline stabilization and hydrologic restoration, are designated as supporting projects. Several small freshwater diversion projects are proposed in the long-term critical phase of the plan. Long-term projects awaiting studies to develop new and more cost effective technologies include creation of new barrier islands along the outer marsh fringe and introduction of large quantities of sediment into the basin upper and lower basin areas.

One-hundred and twenty projects have been proposed for the Pontchartrain Basin. Of these, 45 have been eliminated or deferred because they were either the same as another project, they would not benefit wetlands, their benefits could be accomplished by a less costly strategy, or there was simply not enough known about their potential costs and benefits. The 75 projects that comprise the basin restoration plan are classified as shown in Table 15.

Table 15
Number of Projects Proposed for the Pontchartrain Basin by Project Type and Designation

Project Type	Project Designation					
	Critical Short-term	Critical Long-term	Supporting Short-term	Supporting Long-term	Demo	TOTAL
Marsh Management (MM)	1					1
Hydrologic Restoration (HR)	5		3	8	1	17
Hydro. Mgmt. of Impoundments (HM)	2			1		3
Sediment Diversion (SD)		1				1
Freshwater Diversion (FD)	1	5				6
Outfall Management (OM)	1					1
Marsh Creat. w/ Dredged Material (MC)	2	1	3	2	3	11
Barrier Island Restoration (BI)		1				1
Shoreline Prot. w/ Structures (SP)	13		9	1	1	24
Vegetative Plantings (VP)					1	1
Sediment Trapping (ST)			4			4
Combination FD/HR	1			1		2
Combination SP/MC	1					1
Combination OM/MC			1			1
Combination HM/MC			1			1
TOTAL	27	8	21	13	6	75

3.4.3. Breton Sound Basin.

This basin contains a series of somewhat parallel abandoned distributary ridges separated by brackish and saline marshes, interspersed with numerous lakes, ponds, and lagoons. The marshes of the upper basin will benefit substantially from the recently constructed Caernarvon Freshwater Diversion project. Management of the outfall from existing freshwater diversions and the enhancement of over-bank flow from the Mississippi River below the terminus of the Mississippi River levee system form the basis of the basin restoration plan. Additionally, large scale hydrologic restoration projects are proposed to help reduce tidal flows. Eighteen projects were proposed for the basin. Five of the projects are not included in the plan because they were either not appropriate, not implementable, or duplicated another project. The remaining 14 projects are categorized as shown in Table 16.

Table 16
Number of Projects Proposed for the Breton Sound Basin by Project Type and Designation

Project Type	Project Designation					
	Critical Short-term	Critical Long-term	Supporting Short-term	Supporting Long-term	Demo	TOTAL
Hydrologic Restoration (HR)			1	2		3
Sediment Diversion (SD)		1	1	1		3
Outfall Management (OM)	1		4			5
Shoreline Prot. w/ Structures (SP)					1	1
Barrier Island (BI)				1		1
TOTAL	1	1	6	4		13

3.4.4. Mississippi River Delta Basin.

Planning for the Mississippi River Delta Basin concentrated on beneficial use of the tremendous volume of sediment transported by the Mississippi River while recognizing that the needs of the entire coast of Louisiana are linked to the sediments in the river. The plan selected for the basin involves large-scale uncontrolled diversion of the Mississippi River to distribute the majority of the river's sediment load into a shallow estuary (either the Barataria or Breton Sound Basin) for creation of a new delta while maintaining deep draft navigation in the river. This action would require a significant amount of study to determine its feasibility. Also, an orderly deterioration and retreat of the existing delta would have to be provided for. Acknowledging that this effort would take considerable time to implement, supporting projects are included in the basin plan to prevent further deterioration of the existing delta in the near term. The supporting projects would enhance wetland development in the existing delta and actively counter the impacts of encroaching marine processes following diversion of the river. The projects proposed for the basin are categorized as shown in Table 17.

Table 17
Number of Projects Proposed for the Mississippi River Delta Basin by Project Type and Designation

Project Type	Project Designation				
	Critical Short-term	Critical Long-term	Supporting Short-term	Supporting Long-term	TOTAL
Hydrologic Restoration (HR)				1	1
Sediment Diversion (SD)	1	1*	3	1	6
Marsh Creation with Dredged Material (MC)			2	2	4
Vegetative Plantings (VP)			1		1
Sediment Trapping (ST)			1		1
TOTAL	1	1	7	4	13

* This project is for uncontrolled diversion of the Mississippi River

3.4.5. Barataria Basin.

The selected plan for the Barataria Basin is somewhat complex compared to the other basins. The plan would make use of nearly all types of proposed projects but concentrate efforts towards a combined sediment and freshwater diversion with hydrologic restoration component and a barrier island restoration component. One-hundred and nine were proposed for the basin. Thirty-six projects have been eliminated from the plan mainly because they were duplicates of other projects. The numbers of projects remaining in the plan in each category are shown in Table 18.

Table 18
Number of Projects Proposed for the Barataria Basin by Project Type and Designation

Project Type	Project Designation					
	Critical Short-term	Critical Long-term	Supporting Short-term	Supporting Long-term	Demo	TOTAL
Marsh Management (MM)			1			1
Hydrologic Restoration (HR)	1	2	7	3		13
Hydro. Man. of Impoundments (HM)			1			1
Sediment Diversion (SD)		6			1	7
Freshwater Diversion (FD)	1	9				10
Outfall Management (OM)	2	5	1			8
Marsh Creat. w/Dredged Mat. (MC)			3		1	4
Barrier Island Restoration (BI)	4		4	2		10
Shoreline Prot. w/Structures (SP)			8	9	2	19
TOTAL	8	22	25	14	4	73

3.4.6. Terrebonne Basin.

The Terrebonne Basin has been divided into four subbasins. Restoration of the Timbalier Subbasin involves barrier island restoration and hydrologic restoration along the alignment of a proposed hurricane levee system. In the Penchant Subbasin, freshwater, sediment, and nutrients from the Atchafalaya River would be used in concert with a system of hydrologic restoration projects. Lowering chronically high water levels of the Verret Subbasin through a large-scale water level management project is proposed. In the last two basins, the plan must be implemented in concert with appropriate flood protection measures. The Fields Subbasin is relatively small and healthy. Any problems that would develop in this basin would likely be addressed through marsh management or hydrologic restoration.

Ninety-eight projects have been proposed for the basin. Of those, 27 were dropped from the plan because they were either not implementable, they duplicated other projects, or they have already been implemented. The projects currently proposed for the Terrebonne Basin are categorized as shown in Table 19.

Table 19
Number of Projects Proposed for the Terrebonne Basin by Project Type and Designation

Project Type	Project Designation					
	Critical Short-term	Critical Long-term	Supporting Short-term	Supporting Long-term	Demo	TOTAL
Marsh Management (MM)	2		3	1		6
Hydrologic Restoration (HR)	12	2	1	2	2	19
Sediment Diversion (SD)		2	1	1	1	5
Freshwater Diversion (FD)		1				1
Marsh Creat. w/Dredged Mat. (MC)	1	1	3	5	3	13
Barrier Island Restoration (BI)	9		1			10
Shoreline Prot. w/Structures (SP)	1		2		1	4
Vegetative Plantings (VP)			2	1		3
Sediment Trapping (ST)			1		2	3
Combination MM/HR	3					3
Combination FD/HR	1	1				2
Combination SP/MC			1			1
Combination HR/MC	1					1
TOTAL	30	7	15	10	9	71

3.4.7. Atchafalaya Basin.

Similar to the Mississippi River Delta Basin, restoration planning efforts for the Atchafalaya Basin concentrated on maximizing the beneficial use of river-borne sediments. The Atchafalaya Basin is the only basin where significant growth of new wetlands has occurred in recent years and also because its existing wetlands are relatively stable. Opportunities to maximize the beneficial use of sediments include manipulation of the river's flow between its two main outlets and its two active deltas and marsh creation with dredged material. Table 20 shows the distribution of project types and categories proposed for the basin.

Table 20
Number of Projects Proposed for the Atchafalaya Basin by Project Type and Designation

Project Type	Project Designation: Critical Short-term	Critical Long-term	Supporting Short-term	Supporting Long-term	TOTAL
Sediment Diversion (SD)			1	2	3
Marsh Creation with Dredged Material (MC)			1		1
Shoreline Protection with Structures (SP)			1		1
Combination SD/MC	2	1		1	4
TOTAL	2	1	3	3	9

3.4.8. Teche/Vermilion Basin.

The restoration plan for the Teche/Vermilion Basin is composed mainly of shoreline protection projects along with hydrologic restoration. A long-term strategy for this basin involves the capture of annual spring-time inputs (fresh water and sediment) from the adjacent Atchafalaya River; however, projects have not yet been developed to support this strategy. Twenty-seven projects have been proposed for the basin, of which none have been eliminated. The projects proposed for the basin are categorized as shown in Table 21. Three areas within the basin have been identified as having critical wetland loss problems. The best method for addressing the problems are not known at this time, but the basin plan calls for development of projects to deal with the problems. Efforts to address the three critical areas are listed in the table under the category of "unknown".

Table 21
Number of Projects Proposed for the Teche/Vermilion Basin by Project Type and Designation

Project Type	Project Designation					
	Critical Short-term	Critical Long-term	Supporting Short-term	Supporting Long-term	Demo	TOTAL
Hydrologic Restoration (HR)		2				2
Freshwater Diversion (FD)	1					1
Shoreline Prot. w/ Structures (SP)	1	2	6	2	1	12
Vegetative Plantings (VP)			1	1		2
Sediment Trapping (ST)	1					1
Combination SP/HR	5					5
Combination SP/ST/VP			1			1
Unknown	3					3
TOTAL	11	4	8	3	1	27

3.4.9. Mermentau Basin.

Two distinct subbasins make up the Mermentau Basin; the Lakes Subbasin in the north and the Chenier Subbasin in the south. The most critical wetland problem in the Lakes Subbasin is excessively high water levels. The restoration plan for the basin includes large scale measures to improve freshwater discharge from the Lakes Subbasin. These structures would also provide fresh water to relieve saltwater stress on interior wetlands of the Chenier Subbasin. Treatment of critical areas of loss with hydrologic restoration and shoreline protection projects is also proposed. Fifty-one projects are proposed for the basin. No projects have been eliminated. The numbers of project by type and category are shown in Table 22.

Table 22
Number of Projects Proposed for the Mermentau Basin by Project Type and Designation

Project Type	Project Designation					
	Critical Short-term	Critical Long-term	Supporting Short-term	Supporting Long-term	Demo	TOTAL
Marsh Management (MM)			1	1		2
Hydrologic Restoration (HR)			7	3		10
Freshwater Diversion (FD)	7			1		8
Marsh Creat. w/ Dredged Material (MC)			3			3
Shoreline Prot. w/ Structures (SP)			20		1	21
Vegetative Plantings (VP)			2	2	1	5
Terracing (T)			1			1
Combination SP/HR			1			1
TOTAL	7	0	35	7	2	51

3.4.10. Calcasieu/Sabine Basin.

The restoration plan for the Calcasieu/Sabine Basin provides for protection of wetlands by a perimeter protection plan which would protect the interior wetlands from the gross hydrologic alterations of the basin. Projects that target specific areas of interior wetlands will be used to enhance and restore deteriorated wetlands. Eroding shorelines of Sabine Lake, Calcasieu Lake, and the Gulf of Mexico would be protected from further erosion and hydrologic restoration would be used to maximize freshwater and sediment input and limit saltwater intrusion into interior wetlands.

One-hundred and twenty-seven projects were considered for the basin. Twenty-six projects were eliminated from the plan, mainly because they were essentially duplicates of other projects. Three of the projects eliminated made up one of the strategies considered for the basin which consisted of three locks to reduce tidal flows in the main channels that allow saltwater to enter the basin: the Sabine River, the GIWW (west of Calcasieu Lake), and the Calcasieu River. One-hundred and one projects remain on the basin's restoration plan. No demonstration or critical long-term projects are proposed. The projects are categorized as shown in Table 23.

Table 23
Number of Projects Proposed for the Calcasieu/Sabine Basin by Project Type and Designation

Project Type	Project Designation: Critical Short-term	Critical Long-term	Supporting Short-term	Supporting Long-term	TOTAL
Marsh Management (MM)	2		6	3	11
Hydrologic Restoration (HR)	18		15	5	38
Freshwater Diversion (FD)	1		5	1	7
Marsh Creation with Dredged Material (MC)			3	1	4
Shoreline Protection with Structures (SP)	8		11	4	23
Vegetative Plantings (VP)			3	1	4
Sediment Trapping (ST)			5	3	8
Terracing (T)			1		1
Combination FD/HR	1			1	2
Combination HR/MM	1				1
Combination MC/HR	1				1
Combination SP/HR	1				1
TOTAL	33	0	49	19	101

3.4.11. Coast-wide.

Approximately 433 projects are included in the Restoration Plan at the present time. The number is an approximation because some projects may duplicate other projects, some projects could be separated into several smaller projects, and some small projects could be combined into a larger, more comprehensive project. The number of projects of each type are displayed in Table 24. The table offers a somewhat oversimplified view of the Restoration Plan and is intended only to show the relative numbers of projects proposed for the plan. Please refer to the basin summary chapters of the main report and to the basin appendices for detailed information on individual projects.

Table 24
Total Number of Projects Proposed for the Restoration Plan by Project Type

Project Type	Number of Projects Proposed	Percent of Total
Marsh Management (MM)	21	4.8
Hydrologic Restoration (HR)	103	23.8
Hydrologic Management of Impoundments (HM)	4	1.0
Sediment Diversion (SD)	25	5.7
Freshwater Diversion (FD)	33	7.6
Outfall Management (OM)	14	3.2
Marsh Creation with Dredged Material (MC)	40	9.2
Barrier Island Restoration (BI)	22	5.1
Shoreline Erosion Control with Structures (SP)	105	24.2
Vegetative Plantings (VP)	16	3.7
Terracing (T)	2	0.5
Sediment Trapping (ST)	17	3.9
Herbivore Control (HC)	0	0.0
Combination MM/HR	4	1.0
Combination HR/FD	6	1.4
Combination HR/MC	2	0.5
Combination HR/SP	7	1.6
Combination SD/MC	4	1.0
Combination MC/SP	2	0.5
Combination OM/MC	1	0.2
Combination HM/MC	1	0.2
Combination SP/VP/ST	1	0.2
Unknown	3	0.7
Total	433	100.0

3.5. COMMITMENTS OF RESOURCES.

Section 102(C)V. of the National Environmental Policy Act requires that Environmental Impact Statements disclose any irretrievable and irreversible commitments of resources expected from implementation of a proposed action. This language is probably more pertinent for projects that would cause a detrimental effect to the environment. In the case of the CWPPRA, public funds will be expended on a large number of projects that vary in their degree and ease of reversibility. Most likely, public funds would not be retrievable in the sense that project features (structures) would not be marketable to the private sector.

Most of the projects that are proposed for the CWPPRA are reversible. Structures built for freshwater diversion, marsh management, hydrologic restoration, outfall management, shoreline erosion control, and sediment trapping could normally be removed or rendered inoperable for less cost than for project construction. The effects of these projects on the environment will also, for the most part, be reversible. This is important because there is always the unlikely case where a project may cause unanticipated adverse effects that outweigh benefits. In such case, a change or modification in project operation would likely be initiated rather than termination of the project. Other projects like marsh creation with dredged material, barrier island restoration, and terracing would be much more costly and difficult to reverse but the odds of constructing one of these projects that does not produce net environmental benefits is highly unlikely. Large-scale sediment diversion projects from the Mississippi River would require a commitment of resources that would not easily be reversible. Although such diversions may be relatively easy to close off and render inoperable during periods of low river flow, they would be not be closable during high water and flood stages. Upon closure, conditions and resources of the project area would begin reverting back to pre-project conditions.

3.6. MONITORING OF IMPLEMENTED PROJECTS.

Section 303(b) of the CWPPRA requires monitoring of implemented projects to evaluate the effectiveness of each project in achieving long-term solutions to arresting coastal wetlands loss. A scientific evaluation of the effectiveness of projects in creating, restoring protecting, and enhancing coastal wetlands is also required by the act.

Procedures for monitoring CWPPRA projects were developed by a work group composed of Task Force agency representatives. The Louisiana Department of Natural Resources will be responsible for managing the monitoring program. Procedures for determining variables to be monitored, standardizing monitoring procedures, and reporting of data have been tentatively determined. Refer to the Monitoring and Evaluation Section of the main report for a detailed description of the monitoring program.

4. LIST OF PREPARERS

NAME	EXPERTISE	RESPONSIBILITY
Richard Boe USACE, New Orleans District, Planning Division, Environmental Analysis Branch	Estuarine Fishery Biology	EIS Coordinator, Major Author
Robert Bosenberg USACE, New Orleans District, Planning Division, Environmental Analysis Branch	Regulatory Functions Management, Biology	Marsh Management, Description and Effects
Joan Exnicios USACE, New Orleans District, Planning Division, Environmental Analysis Branch	Historic Archeology	Cultural Resources
Robert Lacy USACE, New Orleans District, Planning Division, Economics and Social Analysis Branch	Economics	Socioeconomic Items
Lisa Leonard USACE, New Orleans District, Planning Division, Economics and Social Analysis Branch	Economics	Socioeconomic Items
Dave Carney USACE, New Orleans District, Planning Division, Environmental Analysis Branch	Wildlife Biology	Review and Comment

5. PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

5.1. PUBLIC INVOLVEMENT PROGRAM AND STUDY HISTORY.

The background for this study actually began before passage of the CWPPRA with the Louisiana Comprehensive Coastal Wetlands Study. That study, which proceeded to the end of the reconnaissance phase, set the stage for many of concepts embraced by the CWPPRA Restoration Plan. The Comprehensive Study, funded through regular USACE authorities, proposed the use of a non-standard benefit-cost ratio to be used to prioritize projects similar to that used for prioritizing CWPPRA projects. Also, the Comprehensive Study involved all of the same agencies involved with implementation of the CWPPRA Restoration Plan.

To assist in implementing the requirements of the CWPPRA, the Task Force established the Technical Committee and the Planning and Evaluation Subcommittee. Each of these bodies contains the same representation as the Task Force--one representative from each of the five Federal agencies and one from the State. The Planning and Evaluation Subcommittee is responsible for the actual planning of projects and preparation of this Restoration Plan, as well as the other details involved in the CWPPRA process (such as development of schedules, budgets, etc.); the subcommittee lays the groundwork for all decisions which will ultimately be made by the Task Force, and makes recommendations to the Technical Committee. The Technical Committee reviews all materials prepared by the subcommittee, making revisions as it deems appropriate. The Technical Committee then makes recommendations to the Task Force. The Technical Committee operates at an intermediate level between the planning details considered by the subcommittee and the policy matters dealt with by the Task Force, and often serves to formalize procedures or formulate policy for the Task Force.

The Planning and Evaluation Subcommittee established several working groups to assist in evaluating projects for priority project lists and the Restoration Plan. The Environmental Work Group was charged with estimating the benefits (in terms of wetlands created, protected, enhanced, or restored) associated with various projects. The Engineering Work Group reviewed project cost estimates for consistency. The Economic Work Group performed the economic analysis which permitted comparison of projects on the basis of their cost effectiveness. The Monitoring Work Group established a standard procedure for monitoring of CWPPRA projects and developed a monitoring cost estimating procedure based on project type.

The Planning and Evaluation Subcommittee also established a basin team for each of the nine hydrologic basins in the coastal area. The nucleus of each team consisted of representatives of the five Federal Task Force agencies and the State, and it was these six members who voted on team recommendations. However, team meetings frequently involved additional agency representatives, scientific advisors, consultants, and local interests. The basin teams helped crystallize the comprehensive restoration plans for the basins. They also serve as the first level of screening for proposed priority project list projects.

One of the earliest Task Force efforts at public participation was the establishment of the Citizen Participation Group (CPG) by the Task Force to coordinate the preparation of the First Priority Project List with the interested public. The stated purpose of the CPG is to maintain consistent public review and input into the plans and projects being considered by the Task Force and to assist and participate in the public involvement program. The CPG is composed of organizations that represent the interests of the environmental community, oil and gas industry, agriculture, commercial fishing, recreational fishing, navigation, landowners, and public advocacy groups, all of which are active in Louisiana. The CPG meets at its own discretion, but many times meets in conjunction with other CWPPRA committees and work groups. The membership of the CPG is shown below.

Membership of the Citizen Participation Group

Gulf Coast Conservation Association	Coalition to Restore Coastal Louisiana
Gulf Intracoastal Canal Association	Lake Pontchartrain Basin Foundation
Louisiana Association of Soil and Water Conservation Districts	Louisiana Farm Bureau Federation, Inc.
Louisiana League of Women Voters	Louisiana Landowners Association
Louisiana Oyster Growers and Dealers Association	Louisiana Nature Conservancy
New Orleans Steamship Association	Louisiana Wildlife Federation, Inc.
Police Jury Association of Louisiana	Midcontinent Oil and Gas Association
Organization of Louisiana Fishermen	Oil and Gas Task Force (Regional Economic Development Council)
	Ex Officio Member: U.S. Senator John Breaux

While the agencies represented by the Task Force possess a tremendous amount of expertise regarding Louisiana's coastal wetlands problems, the Planning and Evaluation Subcommittee was concerned that there was no mechanism for incorporating into the process a very valuable resource: the State's scientific and academic community. The subcommittee therefore retained the services of a scientific advisor, who selected a team of scientists to work with the basin teams in the preparation of the 2nd Priority Project List. A team of scientists from Louisiana universities was later retained to review the comprehensive Restoration Plan.

Even with its widespread membership, the Citizen Participation Group cannot represent all of the diverse interests affected by Louisiana's coastal wetlands. The CWPPRA public involvement program provided an opportunity for all interested parties to express their concerns and opinions and to submit their ideas concerning the problems facing Louisiana's wetlands.

The first step in the program comprised two series of scoping meetings held by the Task Force in October and November 1991--one series for coastal zone parish officials and another series for the general public. The purpose of these scoping meetings was to identify wetland loss problems throughout the coastal zone and potential solutions to those problems. Literally hundreds of ideas were submitted to the Task Force through the scoping meetings. Exhibit 2 of the main report is a compendium of those proposals. All of the ideas presented in those meetings have been evaluated during the planning process; most of them have been incorporated into the Restoration Plan. The schedule of scoping meetings was as follows.

Parish Scoping Meetings (for parish officials)

October 8, 1991	Crowley, La.	Calcasieu, Cameron, Iberia, and Vermilion Parishes
October 16, 1991	New Orleans, La.	Jefferson, Orleans, Plaquemines, St. Bernard, and St. Charles Parishes
October 16, 1991	New Orleans, La.	Livingston, St. James, St. John the Baptist, St. Tammany, and Tangipahoa Parishes
October 17, 1991	Thibodaux, La.	Ascension, Assumption, Lafourche, St. Martin, St. Mary, and Terrebonne Parish

Public Scoping Meetings

October 21, 1991	Lake Charles, La.
October 22, 1991	Abbeville, La.
October 24, 1991	Houma, La.
October 28, 1991	Mandeville, La.
November 6, 1991	Belle Chasse, La.
November 7, 1991	New Orleans, La.

The public involvement program continued with a series of public meetings held in June 1992. At these meetings, the conceptual plans which had been developed for the basins were presented to the public along with the candidate projects for the 2nd Priority Project List. These meetings provided the first opportunity for review of the conceptual plans. Public meetings were held as shown below.

Public Meetings for 2nd Priority Project List
and Conceptual Basin Restoration Plans

Date	Location	Hydrologic Basins
June 16, 1992	Morgan City, La.	Atchafalaya, Teche/Vermilion
June 18, 1992	Belle Chasse, La.	Barataria, Breton Sound, Mississippi River Delta
June 23, 1992	Houma	Terrebonne
June 25, 1992	Lake Charles	Mermentau, Calcasieu/Sabine
June 30, 1992	New Orleans	Pontchartrain

The October-November 1991 scoping meetings were the first stage in the process of plan formulation, the process by which the Task Force agencies identified coastal wetlands problems and developed solutions to those problems. The process continued with a series of basin plan formulation meetings, which began in February 1992 and ran through May 1992. These were not formal public meetings but they were attended by representatives of the Task Force agencies, members of the scientific community, representatives of the Citizen Participation Group, private consultants, parish officials, and members of the general public. These were very intense planning sessions, consisting of four three-day meetings with a two-day follow-up for each. Each set of meetings began with a description of the geologic and geomorphic features of the basins being considered, as well as the hydrology. Further background involved descriptions of vegetative types. Projections for the future of each basin were presented. Finally, the coastal wetlands problems and their causes were discussed in detail, and strategies were developed for dealing with those problems on a basin-by-basin basis. These strategies were molded into conceptual plans, plans which would serve as a guide in selecting and evaluating projects both for Priority Project Lists and for the Restoration Plan. Consistency with these conceptual plans became an important criterion by which projects were judged. During these meetings, many of the ideas submitted in the 1991 scoping meetings were integrated into the conceptual plans. The basin teams refined the conceptual plans over the next year to produce the comprehensive restoration plan presented in this report. Everyone present at the basin plan formulation meetings had the opportunity to participate in the process which ultimately led to development of the restoration plan. The meetings followed the schedule below.

Basin Plan Formulation Meetings

Date	Location	Hydrologic Basins
February 4-6, 1992	Baton Rouge, La.	Pontchartrain
February 12-13, 1992	New Orleans, La.	(follow-up)
March 17-19, 1992	St. Francisville, La.	Barataria, Breton Sound, Mississippi River Delta
March 25-26, 1992	New Orleans, La.	(follow-up)
April 7-9, 1992	Baton Rouge, La.	Terrebonne, Atchafalaya, Teche/Vermilion
April 15-16, 1992	New Orleans, La.	(follow-up)
April 28-30, 1992	Abbeville, La.	Mermentau, Calcasieu/Sabine
May 6-7, 1992	New Orleans, La.	(follow-up)

The public involvement program continued with a series of public meetings held in June 1992. At these meetings, conceptual plans which had been developed for the basins were presented to the public along with the candidate projects for the 2nd Priority Project List. These meetings provided the first opportunity for public review of the conceptual basin plans. Public meetings were held as shown below.

Public Meetings for 2nd Priority Project List
and Conceptual Basin Restoration Plans

Date	Location	Hydrologic Basins
June 16, 1992	Morgan City, La.	Atchafalaya, Teche/Vermilion
June 18, 1992	Belle Chasse, La.	Barataria, Breton Sound, Mississippi River Delta
June 23, 1992	Houma	Terrebonne
June 25, 1992	Lake Charles	Mermentau, Calcasieu/Sabine
June 30, 1992	New Orleans	Pontchartrain

During the latter half of 1992 and the first half of 1993, the Task Force's efforts were focused primarily on integrating all of the information gathered through the planning and public comment process into a comprehensive Restoration Plan. The draft version of the Restoration Plan and accompanying EIS was distributed to the public in mid-July 1993 and the notice of EIS availability was published in the Federal Register on July 16, 1993. The Task Force held a series of public meetings in coastal Louisiana during July and August 1993. These meetings were designed to solicit comments from the public on candidate projects being evaluated for the 3rd Priority Project List and to present the draft Restoration Plan and specific plans for restoring each basin.

Public Meetings for the 3rd Priority Project List
and for Presentation of the Draft Restoration Plan

Date	Location	Hydrologic Basins
July 27,1993	Larose, La.	Barataria Basin
July 28, 1993	Belle Chasse, La.	Breton Sound and Mississippi Delta Basins
July 29, 1993	New Orleans, La.	Pontchartrain Basin
August 9, 1993	Houma, La.	Terrebonne Basin
August 10, 1993	Morgan City, La.	Atchafalaya and Teche/Vermilion Basins
August 12, 1993	Cameron, La.	Mermentau and Calcasieu Basins

The formal public hearing for comments on the EIS was held on August 11, 1993 at the New Orleans District office of the USACE. Written comments were presented by the EPA and by Dr. Charles G. Groat, Ph.D. of Louisiana State University. Several others presented oral comments.

5.2. REQUIRED COORDINATION.

A Notice of Intent to prepare an EIS for the CWPPRA was published in the Federal Register on March 24, 1992. A preliminary draft version of the Restoration Plan and EIS was distributed to the Task Force agencies for their review and comment in April

1993. After intensive and extensive discussions and coordination among the Task Force agencies and others, the draft version of the Restoration Plan and EIS was distributed in July 1993 for public review and comment. The Notice of Availability of the draft EIS was published in the Federal register on July 16, 1993. The public hearing on the Draft EIS was held on August 11, 1993 at the New Orleans District office of the USACE.

5.3. STATEMENT RECIPIENTS.

The following elected officials, agencies, businesses, libraries, and interested parties were sent either a copy of the draft Restoration Plan or a notice of its availability. Those that were sent a notice of availability were sent a copy of the report upon request. Also, all that are listed below have either been sent a copy of the final Restoration Plan or a notice of its availability. The agencies, businesses, groups, and individuals listed in bold provided written responses or comments on the draft report. Comments and responses are contained in Appendix J.

CONGRESSIONAL DELEGATION
Honorable J. Bennett Johnston
Honorable John B. Breaux
Honorable William Jefferson
Honorable Jerry Huckaby
Honorable Bob Livingston
Honorable Richard H. Baker
Honorable Jimmy Hayes
Honorable Billy Tauzin
Honorable Jim McCrery
Honorable Clyde C. Holloway

STATE OFFICIALS
Honorable Edwin W. Edwards, Governor
Honorable Melinda Schwegmann, Lieutenant Governor
Honorable W. Fox McKeithen, Secretary of State
Honorable Bob Odum, Commissioner of Agriculture and Forestry
Honorable Richard Ieyoub, Attorney General

FEDERAL AGENCIES
Advisory Council on Historic Preservation, Washington, DC and Golden, CO
Department of Agriculture,
    Soil Conservation Service, Washington, DC
    Soil Conservation Service, State Conservationist, Alexandria, LA
    Soil Conservation Service, Field Offices in the Coastal Parishes
    Regional Research Center, New Orleans, LA
    Forest Service, Planning & Budget Staff Unit, Atlanta, GA
Department of Commerce,
    Office of Ecology and Conservation, Washington, DC
    National Marine Fisheries Service, Habitat Conservation Division, Field Office, Baton Rouge, LA

FEDERAL AGENCIES (Continued)

Department of Commerce (Continued),
- **National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, FL**
- National Marine Fisheries Service, Restoration Center, Silver Spring, MD

Department of Energy, Office of Environmental Compliance, Washington, DC

Department of Health and Human Services, Centers for Disease Control, Atlanta, GA

Department of Housing and Urban Development, Fort Worth, TX

Department of Interior,
- Cameron Prairie National Wildlife Refuge, Bell City, LA
- Geological Survey, Baton Rouge, LA and Reston, VA
- Honorable Bruce Babbitt, Secretary
- Fish and Wildlife Service, Gulf Coast Fisheries Coordinator, Ocean Springs, MS
- Fish and Wildlife Service, Division of Habitat Conservation, Arlington, VA
- Fish and Wildlife Service, Field Supervisor, Lafayette, LA
- Fish and Wildlife Service, Lower Mississippi Valley Joint Venture, Vicksburg, MS
- Fish and Wildlife Service, Regional Director, Atlanta, GA
- Lacassine National Wildlife Refuge, Lake Arthur, LA
- Minerals Management Service, New Orleans, LA
- National Park Service, Jean Lafitte Historical Park, New Orleans, LA
- **Office of Environmental Affairs, Washington, DC**
- Sabine National Wildlife Refuge, Hackberry, LA
- Southeast Louisiana Refuges, Slidell, LA
- National Wetlands Research Center, Lafayette, LA

Department of Transportation, Coast Guard, New Orleans, LA and Washington, DC

Environmental Protection Agency,
- Coastal America Program, Washington, DC
- Office of Federal Activities, Washington, DC
- **Region VI, Federal Activities Branch, Dallas, TX**

Federal Emergency Management Administration, Washington, DC and Denton, TX

Federal Highway Administration, Baton Rouge, LA

STATE AGENCIES

Department of Agriculture & Forestry,
- Office of Agriculture and Environmental Sciences
- Office of Forestry

Department of Culture, Recreation and Tourism,
- Division of Outdoor Recreation
- State Historic Preservation Officer

Department of Environmental Quality,
- Secretary
- Inactive and Abandoned Sites
- Solid and Hazardous Waste
- Office of Water Resources

Department of Health and Hospitals, Office of Health Services and Environmental Quality

Department of Natural Resources,
- **Office of Coastal Restoration and Management, Assistant Secretary**
- Coastal Restoration Division
- Coastal Management Division, Consistency Coordinator
- Louisiana Geological Survey

Department of Transportation and Development,
- **Chief Engineer**

STATE AGENCIES (Continued)

Department of Transportation and Development (Continued),
- Division of Flood Control and Water Management

Department of Wildlife and Fisheries,
- **Secretary**
- Habitat Conservation Division, Natural Heritage Program

Division of Administration, State Land Office
Louisiana Attorney General's Office, Assistant Attorney General
Louisiana Board of Commerce and Industry, Research Division
Louisiana Mosquito Control Board
Louisiana Sea Grant Legal Program
Louisiana State Planning Office
Louisiana State University,
- **Center for Coastal, Energy, and Environmental Resources, Dr. Ivor Van Heerden et al.**
- **Center for Coastal, Energy, and Environmental Resources, Dr. Charles G. Groat**
- Center for Wetland Resources
- Center for Wetland Resources, Ports and Waterways Institute
- Coastal Studies Institute
- Department of Geography and Anthropology

Louisiana Tech University, Dept. of Economics and Finance, Dr. J. H. Jones
Office of the Governor, Dr. Len Bahr, Technical Coordinator for Coastal Activities
Southeastern Louisiana University, Dept. of Biological Sciences, Mr. Gary Shaffer, Hammond, LA

PARISHES, CITIES, and TOWNS

Assumption Parish Government, C. J. Savoie, Napoleonville, LA
Calcasieu Parish Office of Planning and Development, Mr. Paul Rainwater, Lake Charles, LA
Cameron Parish Police Jury, Ms. Tina Horn, Cameron, LA
Honorable Emmett Hardaway, Mayor, Berwick, LA
Honorable Timothy Matte, Mayor, Morgan City, LA
Iberia Parish Government, Ms. Ruth Fontenot, New Iberia, LA
Jefferson Parish, Dr. Mary Curry
Jefferson Parish, Mrs. Marnie Winter
Jefferson Parish Environmental Impact Officer, Mr. Foster Voelker, Harahan, LA
Lafourche Parish Council, Mr. Roy P. Francis, Cut Off, LA
Lafourche Parish President, Mr. Steve Wilson, Thibodaux, LA
Livingston Parish, Theriot, Alex and Associates, Denham Springs, LA
New Orleans City Planning Council, Ms. Patricia Thompson, New Orleans, LA
Plaquemines Parish Government, Mr. Rodney Barthelemy, Port Sulphur, LA
Plaquemines Parish Land Department, Belle Chasse, LA
St. Bernard Parish Planning Commission, Mr. Chris Andry, Chalmette, LA
St. Charles Parish Council, Mr. Earl Matherne, Hahnville, LA
St. James Parish Council, Ms. Mary Ann Champton, Convent, LA
St. John the Baptist Parish, Mr. Patrick McTopy, Laplace, LA
St. Martin Parish Manager, Mr. Gerard Durand, Jr., St. Martinville, LA
St. Mary Parish Council, Mr. Derhyl Hebert, Franklin, LA
St. Tammany Department of Development, Gibb Farrish, Covington, LA
Tangipahoa Parish Government, Mr. Jeff Schneider, Loranger, LA
Terrebonne Parish Council, Waterways and Permit Committee, Houma, LA
Terrebonne Parish Planning Office, Mr. Dean Babin, Houma, LA
Vermilion Parish Police Jury, Mr. Michael Bertrand, Abbeville, LA

LIBRARIES

Louisiana State University Library
Tulane University Library
University of New Orleans Library
St. Mary Parish Library
Iberia Parish Library
New Orleans Public Library
Louisiana Office of Commerce and Industrial Research Library
Terrebonne Parish Library
Vermilion Parish Library

ENVIRONMENTAL

Alliance of Concerned Citizens of Louisiana, Matthews, LA
Association of Louisiana Bass Clubs, Thibodaux, LA
Barataria-Terrebonne National Estuary Program, Thibodaux, LA
Bonnet Carré Rod and Gun Club, Environmental Committee, Norco, LA
Bicycle Awareness Committee of New Orleans, New Orleans, LA
Cactus Clyde Productions, Baton Rouge, LA
Clio Sportsman's League, Harahan, LA
Coalition to Restore Coastal Louisiana, Baton Rouge, LA
Ducks Unlimited, Inc., Jackson, MS
Environmental Defense Fund, New York, NY
Friends of the Earth, Seattle, WA
Governor's Advisory Council on Bicycling, New Orleans, LA
Gulf Coast Conservation Association, New Orleans and Baton Rouge, LA
Gulf of Mexico Fisheries Management Council, Tampa, FL
Gulf States Marine Fisheries Commission, Ocean Springs, MS
Lafayette Natural History Museum and Planetarium, Lafayette, LA
Lake Pontchartrain Basin Foundation, Metairie, LA
League of Woman Voters, Baton Rouge, LA
Louisiana Audubon Council, Baton Rouge, LA
Louisiana Nature and Science Center, New Orleans, LA
Louisiana Wildlife Federation, Baton Rouge, LA
Orleans Audubon Society, New Orleans, LA
National Audubon Society, Austin, TX and Tavernier, FL
National Wildlife Federation, Washington, DC
Natural Resources Defense Council, New York, NY
North Shore Coast Watch, Covington, LA
Orleans Audubon Society, New Orleans, LA
Sierra Club Legal Defense, New Orleans, LA
Sierra Club, Delta Chapter, New Orleans, LA
Sierra Club, Honey Island Group, Lacombe, LA
Sierra Club, Mr. Tyronne Foreman, New Orleans, LA
South Louisiana Environmental Council, Houma, LA
Tickfaw River Basin Group, Springfield, LA
The Fund for Animals, Jefferson, LA

OTHER GROUPS, AGENCIES, AND INDIVIDUALS

Dr. Nick Accardo, Franklin, LA
Mr. Tim Allen, Houma, LA

OTHER GROUPS, AGENCIES, AND INDIVIDUALS (Continued)

Mr. Bob Ancelet, Louisiana Department of Wildlife and Fisheries, New Orleans, LA
Aries 27 Building and Landscaping, Mr. Tom Aicklen, Lacombe, LA
Mr. J. Paul Armentor, New Iberia, LA
Atchafalaya Basin Levee District, Port Allen, LA
Avoca, Inc, New Orleans, LA
Bayou Lafourche Freshwater District, Thibodaux, LA
H. J. Broussard, Jr., New Iberia, LA
Dr. Robert Chabreck, Baton Rouge, LA
CMS Environmental Services, Mr. Larry Campbell, New Orleans, LA
Coalition of Coastal Parishes, Mr. Steve Wilson, Thibodaux, LA
Coastal Environments, Inc., Dr. Sherwood M. Gagliano, Baton Rouge, LA
R. W. Collins, Houma, LA
Colorado State University Library, Mr. Fred C. Schmidt, Fort Collins, CO
Conrad Industries, Mr. J. Parker Conrad, Morgan City, LA
Continental Land and Fur Company, Mr. George A. Strain, New Orleans, LA
Mr. Herman Crawford, Gibson LA
Mr. Donald Doyle, New Orleans, LA
Environmental Science and Engineering, Inc., Mr. William J. Elzinga, St Louis, MO
Fina-LaTerre Oil Company, Houma, LA
Mr. Robert Fritchey, New Orleans, LA
Gibbens and Blackwell, Attorneys at Law, New Iberia, LA
Glen Canyon Environmental Studies, Mr. Dave Wegner, Flagstaff, AZ
Mr. Robert D. Gorman, Thibodaux, LA
Gulf Intracoastal Canal Association, Mr. Vernon Behrhorst, Lafayette, LA
Gulf South Engineers Inc., Houma, LA
Kemp and Associates, Inc, E. Burton Kemp III, P.G., Bay St. Louis, MS
Lake Pontchartrain Sanitary District, New Orleans, LA
Landau Associates, Mr. Dale Stirling, Edmonds, WA
Dr. Mary C. Landin, USACE-WES, Vicksburg, MS
Mr. Harvey Latiolas, New Iberia, LA
LBJ School of Public Affairs, University of Texas, Ms. Susan Hadden, Austin, TX
Lee Wilson and Associates, Mr. Lee Wilson, Santa Fe, NM
Mr. Benjamin W. Leigh, P.E., Baton Rouge, LA
Louisiana Farm Bureau Federation, Inc., Dr. Ron Harrell, Baton Rouge, LA
Louisiana Farm Bureau Federation, Inc., Ms. Linda Zaunbrecher, Gueydan, LA
Louisiana Land and Exploration Company, New Orleans, LA
Louisiana Landowners Association, Mr. Newman Trowbridge, Franklin, LA
Louisiana League of Women Voters, Ms. Charlotte Fremaux, Metairie, LA
Louisiana Nature Conservancy, Mr. David Pashley, Baton Rouge, LA
Louisiana Oyster Growers and Dealers Association, Mr. Mike Voisin, Houma, LA
Mr. Karl Mapes, Louisiana Department of Wildlife and Fisheries, Slidell, Louisiana
Captain O. T. Melvin, Larose, LA
Mid-Continent Oil and Gas Association, Baton Rouge, LA
Middle South Services, Inc., Environmental Affairs Section, New Orleans, LA
Mr. Gregory B. Miller, Metairie, LA
National Rifle Association, ILA, Allen R. Hodgkins, III, Washington, DC
Mr. Robert Ness, Morgan City, LA
New Orleans Steamship Association, Mr. Channing F. Hayden, New Orleans, LA
Phillips Petroleum Company, Houston, TX
Pivach Agency, Mr. George Pivach, Jr., Belle Chasse, LA

OTHER GROUPS, AGENCIES, AND INDIVIDUALS (Continued)
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Kerry Rodriquez, Plaquemine, LA
Mr. Roy Rogge, Metairie, LA
St. Bernard Sportsmen's League, Charles (Pete) Savoye, President, Chalmette, La
St. Mary Land and Exploration Company, Denver, CO
SAIC, Mr. Bob Wheeler, Falls Church, VA
South Central Planning and Development, Thibodaux, LA
State Times/Morning Advocate, Outdoor Editor, Baton Rouge, LA
STRA, Mr. Edward Satler, Arlington, VA
T. Baker Smith and Son, Inc, Houma, LA
Tennessee Gas Pipeline, Inc, Houston, TX
Terrebonne Fishermen's Association, Dulac, LA
The Times Picayune, Mr. Mark Schleifstein, New Orleans, LA
Thompson Marine Transportation, Morgan City, LA
Freddie Trosclair, Jr., Cutoff, LA
Tulane Law School, New Orleans, LA
Virginia DOT, Environmental Division, Mr. Bill Beuter, Richmond, VA
Waldemar S. Nelson and Company, Mr. Carl B. Hakenjos, New Orleans, LA
Walk Haydel Association, New Orleans, LA
Wetlands and Wildlife Management, Mr. Allan Ensminger, Deridder, LA
Dr. Mary White, Louisiana State University, Baton Rouge, LA
Ms. Patricia Willging, New Orleans, LA
Williams, Inc., Patterson, LA
Woodward-Clyde Associates, Baton Rouge, LA

Note: The persons, agencies, businesses, and groups listed in bold type provided comments on the draft report. Their comments are reproduced and responded to in Appendix J, Public Views and Responses.

5.4. PUBLIC VIEWS AND RESPONSES.

The public's view of the efforts of the Task Force in developing the Restoration Plan and of the Restoration Plan itself has been generally supportive. Various interest groups have advised caution before implementing certain projects or types of projects because of potential waste of funds or adverse impacts. Some of the major comments on the draft Restoration Plan (Plan) and EIS are listed as follows:

- The draft report lacks an implementation strategy for the Plan.
- Marsh management projects should not be implemented under the Plan.
- The Plan should emphasize long-term, comprehensive solutions.
- The Plan should take a more offensive strategy. It should not concentrate on defensive efforts.
- The Mississippi River Gulf Outlet should be modified or closed.
- There needs to be more public accountability for expenditure of funds.
- The Plan does not adequately consider the rights of public access.
- There should be increased involvement of non-agency scientists.

- Plan should concentrate on the natural processes of marsh building and maintenance.
- Projects should produce broad public benefits.
- EIS's should be written for each hydrologic basin.

Over 200 pages of comments on the draft report were received. By far, the largest volume of comments received was from cooperating agencies and their contractors. The main report and basin plans have been essentially rewritten as a result comments received both from the public and from Task Force agencies and their contractors. All Task Force agencies had input into the rewrite of the main report, basin plans, and executive summary. Meetings with Task Force agencies were held to discuss and resolve their comments on the EIS. EIS has not been substantially changed, although sections pertaining to marsh management have been revised considerably as a result of extensive comments on the treatment of that type of project.

All comments received on the draft report, along with responses, are provided in Appendix J, Public Views and Responses.

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EIS
APPENDIX A

Agreement Between the Task Force
and the State Historic Preservation Officer

Procedures Governing Cultural Resources Investigations
for Projects Constructed under the Authority
of the Coastal Wetlands Planning, Protection, and Restoration Act

Management of Cultural Resources for Coastal Wetlands Planning, Protection and Restoration Act Projects

This agreement entered into this 25 day, of June 1993 between the Louisiana Coastal Wetlands Conservation and Restoration Task Force and the State Historic Preservation Officer of the Department of Culture, Recreation and Tourism establishes procedures governing cultural resources investigations for projects constructed under the authority of the Coastal Wetlands Planning, Protection and Restoration Act (PL101-646, Title III).

I. Introduction

Federal agencies are responsible for protecting and preserving historic properties that are significant to the heritage of the United States. The National Historic Preservation Act requires a Federal agency with jurisdiction over a Federal, federally assisted, or federally licensed undertaking to take into account the effects of the undertaking on properties listed, or eligible for inclusion in the National Register of Historic Places. Federal agencies are required to consider alternatives to avoid, mitigate or minimize adverse impacts on historic properties (any prehistoric or historic district, site, building, structure or object eligible for inclusion in the National Register). Under Section 106 of the National Historic Preservation Act, Federal undertakings are subject to review by the Louisiana State Historic Preservation Officer (SHPO) within the Department of Culture, Recreation, and Tourism (CRT), and, if significant sites will be impacted, by the Advisory Council on Historic Preservation.

This agreement governs cultural resources investigations associated with all Coastal Wetlands Planning, Protection and Restoration Act projects (PL 101-646, Title III). The act establishes a Louisiana Coastal Wetlands Conservation and Restoration Task Force whose members are: the Secretary of the Army, the Administrator of the Environmental Protection Agency, the Secretary of the Interior, the Secretary of Commerce, the Secretary of Agriculture, and the Governor of the State of Louisiana. The act requires that for each project undertaken, one of the Federal agencies must be identified as the lead agency, with responsibility for implementation of that project.

On 20 May 1993 the Task Force met and considered adoption of the procedures. Colonel Diffley, Chairman of the Task Force, proposed that the Task Force adopt the procedures for management of cultural resources as recommended by the Planning and Evaluation Subcommittee and Technical Committee, and that the Chairman of the Task Force execute the agreement with the appropriate state agencies on behalf of the Task Force. Mr. Donald Gohmert, Soil Conservation Service, moved that the procedures be adopted. Mr. David Fruge, U.S. Fish and Wildlife Service, seconded the motion. The motion was adopted unanimously.

II. Guidance

Under this agreement state and federal agencies are responsible for compliance with the following historic preservation and cultural resources laws and regulations:

- National Historic Preservation Act of 1966 as amended;
- Archeological Resource Protection Act of 1979;
- Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation as published in the Federal Register on September 29, 1983;
- 36 CFR 79 "Curation of Federally-Owned and Administered Archeological Collections";
- Louisiana's Comprehensive Archeological Plan dated October 1, 1983;
- The Advisory Council on Historic Preservation's regulation 36 CFR Part 800 entitled, "Protection of Historic Properties";
- Native American Grave Protection and Repatriation Act;
- Cultural Resources Code of Louisiana; and
- Louisiana Unmarked Human Burial Sites Preservation Act.

III. Procedures

A. General

Procedures to accomplish cultural resources management and historic preservation responsibilities will depend on the inhouse professional archeological capabilities of each lead agency. Whenever possible, lead agencies will cooperate with other members of the Task Force to achieve compliance with historic preservation laws and regulations. Agencies without professional archeologists should use the professional archeological services of other Task Force agencies whenever possible. This will allow for the development of a consistent and cost effective method to meet Federal requirements and project schedules.

Projects will follow one of the following three procedures:

- Procedure A for lead agencies with professional archeologists on staff,
- Procedure B for lead agencies using the services of other Task Force member agencies with professional archeologists on staff, or
- Procedure C for lead agencies lacking professional archeologists on staff and not using the services of other Task Force members.

B. Procedure A: Agencies with archeologists on staff

(1) Responsibilities of the lead agency

- A lead agency with professional archeologists on staff will identify and evaluate historic properties and develop methods to minimize adverse impacts on these properties. The lead agency will recommend the level of investigation following accepted scientific procedures. This may require a variety of studies including but not limited to archeological survey and testing, architectural surveys, historical research, and underwater investigations. When no cultural resources investigations are recommended for a project, the SHPO will be notified in writing. Project maps and a description of the proposed project will be provided and the SHPO will comment on the recommendation.
- When the lead agency recommends cultural resources investigations, the agency will complete the necessary work and submit management summaries, and draft and final reports to the SHPO for review and comment. Reports will meet the standards of the Cultural Resources Code of Louisiana, Chapter 3. Final reports will be submitted to the SHPO within four months of receiving the review comments on the draft report.

(2) Responsibilities of the SHPO

- For these lead agencies, the SHPO will review and provide comments on all reports within ten working days. A management summary will be an adequate document for review by the SHPO. A management summary is an interim report based on a cultural resources investigation of a project area. It will summarize the methodology and results of the investigation and include either recommendations for additional work or a conclusion that no further work is necessary. Requirements for a management summary are in Appendix A.
- The SHPO will review all recommendations that historic properties are eligible for the National Register of Historic Places. Mitigation plans for National Register sites will be coordinated with the SHPO.

C. Procedure B: Lead agencies without archeologists utilizing archeological services of Task Force agencies

(1) General

- Lead agencies without archeologists on staff will insure that each project is in compliance with historic preservation laws and regulations. Section 106 compliance and required cultural resources investigations can most effectively be accomplished by entering into a cooperative agreement with a Task Force agency capable of offering professional archeological services.

- Identification and evaluation of historic properties may require a variety of studies including but not limited to archeological surveys, architectural surveys, historical research, and underwater archeology.

(2) Responsibilities of the lead agency

- The lead agency will be responsible for funding cultural resources investigations and Section 106 coordination with the SHPO and the Advisory Council on Historic Preservation. The lead agency will initiate coordination with a Task Force agency with inhouse archeological capabilities, oversee completion of archeological investigations, and provide current information on plan formulation, real estate requirements, and project scheduling.
- The lead agency will ensure that necessary cultural resources investigations are completed and will submit management summaries, and draft and final reports to the SHPO for review. Reports will meet the standards of the Cultural Resources Code of Louisiana, Chapter 3. Final reports will be submitted to the SHPO within four months of receiving the review comments on the draft report.
- When no cultural resources investigations are recommended for a project, the SHPO will be notified in writing. Project maps and a description of the proposed project will be provided, and the SHPO will comment on the recommendation.

(3) Responsibilities of the agency providing archeological services

- The Federal agency providing archeological services will identify, evaluate, and make recommendations for avoidance of adverse impacts on significant historic properties. This may require a variety of studies including but not limited to archeological surveys, architectural surveys, historical research, and underwater archeology. This agency will complete the necessary work and submit management summaries, and draft and final reports to the lead agency.
- The agency providing archeological services will provide technical assistance for each step of the cultural resources process (evaluate the need for cultural resources investigations, develop scopes of work, review proposals, review reports and recommendations). This agency will be responsible for administration of contracts, including development of cost estimates, negotiation with contractors, monitoring of contractor efforts in the field and production of the final report on each project.

(4) **Responsibilities of the SHPO**

- For these lead agencies, the SHPO will review and provide comments on all reports within ten working days. A management summary will be an adequate document for review by the SHPO.

The SHPO will review all recommendations that historic properties are eligible for the National Register of Historic Places. Mitigation plans for National Register sites will be coordinated with the SHPO.

D. Procedure C: Lead agencies without archeologists and not utilizing archeological services of Task Force agencies

(1) **General**

- Lead agencies without professional archeologists on staff generally lack the capability to provide adequate technical review before draft reports are submitted to the SHPO. Lead agencies will be required to identify a qualified individual or firm specializing in cultural resources investigations and enter into a contract to provide necessary services. The lead agency will contract with a firm either on the SHPO's list of Contracting Archaeologists or able to meet the National Park Service professional qualification standards in 36 CFR Part 61, Appendix A.
- For the SHPO to adequately review recommendations and findings of cultural resources investigations a full report will be required. Management summaries are not acceptable.

(2) **Responsibilities of the lead agency**

- All projects will be submitted to the SHPO for review as early in the planning process as possible. Project maps and a description of the proposed project will be provided and the SHPO will recommend whatever cultural resources investigations are necessary.
- The lead agency will be responsible for funding cultural resources investigations and Section 106 coordination with the SHPO.
- The lead agency will be responsible for administration of contracts including funding, development of cost estimates, negotiation with contractors, monitoring of contractor efforts in the field, curation of collections, and production of the final report on each project. The agency will be responsible for coordination with project planners and engineers.
- Upon determination of the need for cultural resources investigations, the lead agency will supervise the production and delivery of draft and final reports to the SHPO for review and comment. Reports are required to meet the standards of the

Cultural Resources Code of Louisiana, Chapter 3. Final reports will be submitted to the SHPO within four months of receiving the review comments.

(3) **Responsibilities of SHPO**

- For those lead agencies without a full-time professional archeologist and not utilizing the services of a Task Force member, the staff of the SHPO will provide technical assistance for each step of the cultural resources process (evaluate the need for cultural resources investigations, develop scopes of work, review proposals, review reports and recommendations).
- The SHPO will review all recommendations that historic properties are eligible for the National Register of Historic Places. Mitigation plans for National Register sites will be coordinated with the SHPO.

IV. Information Needs

- For lead agencies to effectively manage the historic resources under their jurisdiction, it is necessary to have a complete understanding of the resources that are present. This requires that archeologists have access to current data on the location of archeological sites, standing structures and areas previously surveyed.
- CRT will work with agencies to provide access to data necessary for planning purposes, including site forms, the Louisiana Computerized Archeological Database (L-CAD), archeological survey maps, site location maps, and standing structure survey data.
- Agencies will protect sensitive data on the location of the cultural resources of Louisiana. These data contain confidential information about the location and character of historic properties and could result in destruction of sites if disclosed to the public. This information will be restricted to professional archeologists within agencies and will not be released to others in the agency or outside the agency.
- Federal agencies will work with CRT to investigate methods to automate the information housed at CRT and federal agencies to more effectively manage historic properties.

This Agreement shall become effective upon the signature of all Parties.

For the Task Force

By: ____________________
Michael Diffley
COLONEL, U. S. Army
Chairman
Date: 28 May 93

For the Department of Culture, Recreation and Tourism

By: ____________________
Mark H. Hilzim
Secretary
Date: 6/28/93

By: ____________________
Gerri Hobdy
State Historic Preservation Officer
Date: 6/25/93

Appendix A
DIVISION OF ARCHAEOLOGY
MANAGEMENT SUMMARY GUIDELINES
FOR REVIEW AND COMPLIANCE PROJECTS

The topics listed below are to be included in each management summary. Each topic should be addressed briefly but in sufficient depth that a reader unfamiliar with the project could assess its impact on cultural resources. It is expected that a more detailed treatment of these topics will be made in a final report. These guidelines are to be regarded as minimum requirements. The management summary is not to be viewed as a substitute for a final report.

At the least, the management summary must include:

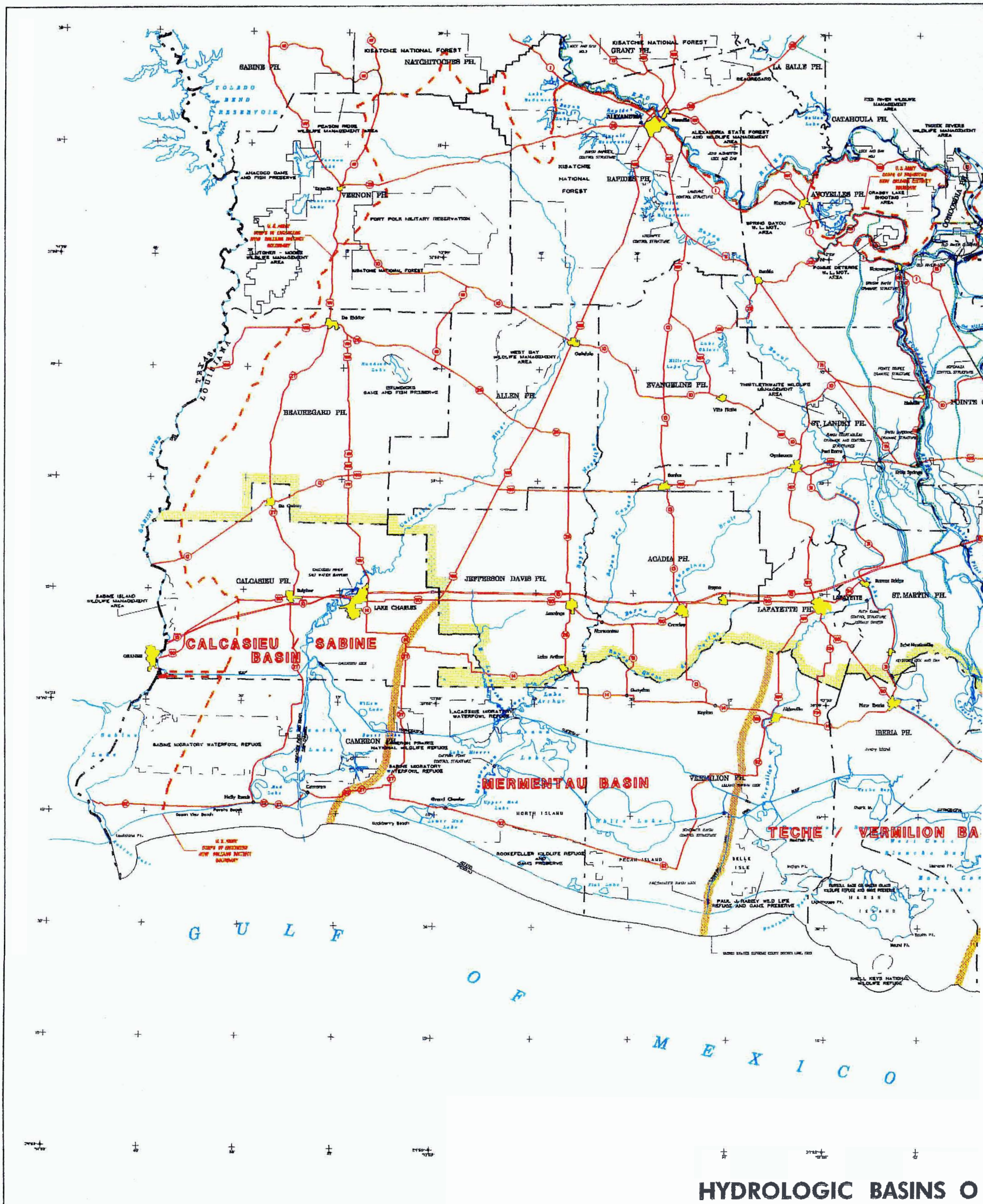
1) Project Description
   - type of project
   - map of project area
   - dates of fieldwork

2) Methodology
   - description of methodology
   - archival sources reviewed
   - archeological techniques used
   - sampling strategy employed

3) Results
   - number, size, and location of all sites and test units
   - brief description of each site and unit
   - at least one line drawing of a representative unit or a shovel test profile from each site
   - preliminary artifact analyses including counts and types of artifacts, for example, number of Coles Creek Incised sherds
   - preliminary assessment of cultural/temporal affiliation of each site
   - preliminary site interpretations

4) Direction of Research
   - description of analytical techniques to be used in the full analyses
   - location where the artifacts and associated records will be deposited upon completion of the final report
   - indication of when the final report will be completed

5) Recommendations
   - any recommendations for additional work will require detailed justifications



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