CALCASIEU-SABINE

COOPERATIVE RIVER BASIN STUDY REPORT
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
LOUISIANA

In Cooperation with

Gulf Coast Soil and Water Conservation District

United States Fish and Wildlife Service

Louisiana Department of Natural Resources

Louisiana Department of Wildlife and Fisheries

Louisiana Department of Agriculture and Forestry

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CALCASIEU-SABINE COOPERATIVE RIVER BASIN STUDY
(FROM PLANNING TO IMPLEMENTATION-A TRUE PARTNERSHIP SUCCESS STORY)

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ABSTRACT

Coastal wetlands in Louisiana are being lost at a rate of about 25 square miles per year. Louisiana contains 40 percent of the nations coastal wetlands, but has 80 percent of the national loss of these habitats annually. Coastal wetlands produce an abundance of diverse wildlife and fisheries species, many of which are commercially and industrially valuable to man-kind.

People living and working in western Cameron Parish, Louisiana witnessed a progressive loss of coastal wetlands because of natural and man-made problems. During the 50 year period from 1933 to 1983, the area lost about 124 square miles to erosion, that is, the area was converted from land or vegetated marsh to open water. The loss rate in 1983 was about two square miles per year.

In May, 1989 personnel from the Sabine National Wildlife Refuge (SNWR) met with Soil Conservation Service (SCS) personnel to discuss a strategy for involving the SNWR in a basin-wide approach to resolving the water quality and habitat loss problems that threatened the refuge and adjacent wetlands. The group determined that an overall plan was needed for the entire area in order to avoid a piece-meal approach in attempting to provide protection for the coastal wetlands.

The plan was intended to be a "program neutral" plan and was not developed to meet the requirements of a specific implementation program or funding source. The plan serves as a guide for landowners or local, state, and federal agencies to select conservation measures for implementation with funds under their control.

Many of the conservation practices and conservation management systems proposed in the study report have been implemented as envisioned. Private landowners have installed measures with their own funds. Several measures were installed as mitigation for damage caused to wetlands by development elsewhere. Projects have been installed through the Wetland Conservation Act in support of the North American Waterfowl Management Plan, and numerous projects have been approved for funding and installed through PL-101-646 Coastal Wetlands Planning, Protection, and Restoration Act. One project has been proposed for implementation under PL-83-566 Small Watershed Program.

The objective of this poster is to provide an example of achieving results from a cooperative planning effort among landowners, land users, volunteers, local units of government and local, state, and federal agencies. This group developed and is implementing a comprehensive resource plan that addressed environmental concerns in a 475,000-acre coastal wetland eco-system.

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Note: This will be presented as a poster presentation

IMPLEMENTATION SUCCESS

Probably the best indication of the value of this planning effort is to review success in implementing elements proposed in the recommended plan. Some of the conservation practices were implemented prior to release of the final report. Practices that were identified during the CRBS planning process and installed since 1991 are:

Mgt Unit	Element	Project Description
NO-1	4	The US Army Corps of Engineers in cooperation with LDNR and Amoco Corp. created approximately 350 acres of marshland, by placing confined spoil on an area of highly deteriorated marshland in the vicinity of Brown Lake.
NO-1	9	Brown Lake vegetative project was a DNR/SCS/SWCD project that allowed the planting of approximately 16,000 feet of Smooth Cordgrass along the Brown Lake shoreline. Amoco's lessee also planted an additional 20,200 feet of Smooth Cordgrass along the Alkali ditch and adjacent oil production canals..
NO-2	13	Approximately 6,000' of Black Lake levee was repaired and planted with Smooth Cordgrass with SCS assistance.
NO-2	14	The Amoco lessee has installed one 48" diameter variable crest weir inlet structure for water control.
NO-2	16	Armor-plating 2,000 feet of the levee was done Sept 98 as an Amoco mitigation project. Amoco lessee installs 1,000 feet of wave break fence.
NO-2A	21	Approximately 2,000' of Smooth Cordgrass was planted adjacent to the eastern boundary of NO-4 as part of an Amoco/Shell western mitigation project.
NO-3	22	Approximately 2,000' of wave stilling/sediment fence was constructed in 1990 by DNR/CRD. 1,500' of fence was constructed by DNR/SWCD. Approximately 2,000' Smooth Cordgrass was planted behind these fences. 4,000 feet of Smooth Cordgrass was planted along GIWW in 1997 by NRCS/SWCD/DNR.
NO-3	23	Amoco's lessee installed one fixed crest box structure for water control along the southern boundary of NO-3. 2-48" variable crest structures installed in 1996.

NO-3	24	Amoco's lessee repaired approximately 500 ft. of exterior levee along the Alkalie Ditch, and planted canal bank with Smooth Cordgrass.
NO-4	25	Approximately 10,000 feet of smooth Cordgrass was planted along the base of the levee that forms the eastern boundary of the unit. This was a 1993 DNR/SCS/SWCD planting project to provide shoreline protection along the Black Lake levee.
NO-4	26	10,000 of California Bulrush was planted in interior marsh in 1994. This was a landowner project designed to demonstrate the effectiveness of California Bulrush planted on sites having deeper (24") water.
NO-5	31	2,000 of wave stilling/sediment fence was installed by DNR/Cameron Parish Policy Jury. 1,000 ft Smooth Cordgrass planted, 1999, by NRCS/SWCS/DNR.
NO-5	Unnum.	Four 48" variable crest weir inlet structures have been installed and one variable crest flapgated sheetpile weir was installed as part of the DNR Rycade Canal coastal restoration project.
NO-8	34	Approximately 6,000 ft of wave stilling/sediment fence was constructed and approximately 28,000 ft of California Bulrush was planted as part of the SCS sponsored West Hackberry PL-646 project.
NO-8	35	Approximately 30,000 ft of California Bulrush was planted as part of a mitigation project.
SA-1A	77	Approximately 10,000 ft of California Bulrush was planted on the northern boundary of this unit in 1994 as part of a mitigation project.
SA-1A	77	Approximately 21,000 ft of California Bulrush were planted as wave stilling/sediment trapping measures in shallow open water areas of this unit, as a mitigation project.
SA-1A	79	Approximately 1,800 of breached levee was repaired along the northern boundary of this unit, as part of a mitigation project.

SA-1B	Unnum.	Install pilings and rock revetment along the Sabine NWR nature trail as part of a mitigation project.
SA-3	84 & 86	Approximately 42,000 ft. of natural meandering channels were opened to improve interior water exchange. 480 wildlife islands were created utilizing the spoil. These islands were hay mulched and the island perimeters planted with California Bulrush. These projects were constructed as part of mitigation projects.
SA-3	86	Approximately 42,000 ft of California Bulrush were planted as wave stilling/sediment measures in shallow open water areas of this unit, as mitigation.
SA-5	93	Approximately 27,000 ft of levee was repaired and rock lined along the western boundary of Pool 3, three water control structure sites were protected with rock revetment, and matted alligator crossings were constructed as part of US F&WS sponsored PL-646 project.
SA-6	100	Approximately 26,000 ft of California Bulrush was planted to serve as windbreak/wave break structures in shallow open water areas. As part of a mitigation project.
SA-6	100 & 106	Three 300 ft wave stilling/sediment trapping terraces were constructed utilizing round haybales, as part of a mitigation project.
SA-7	Unnum.	Install pilings and rock revetment along the outfall channel of the West Cove Canal structure as part of a mitigation project.
SA-9	112	Approximately 100 acres of open shallow water has been converted to marsh by the construction of wave stilling/sediment trapping earthen terraces, which were constructed as part of a DNR coastal restoration project.
SA-9	Unnum.	Install pilings and rock revetment along the outfall channel of the Hog Island Gully structure as part of a mitigation project.

SA-10	117	Approximately 450 acres of marsh was created and additional 400 acres of marsh enhanced by the beneficial use of spoil material from a 1993 US Army Corps of Engineers maintenance dredging project.
SO-5	131	Water control structure modified by installation of variable crest inlets to stabilize excessive water level fluctuations, by Cameron Parish Gravity Drainage District #7.
SO-6	135	Approximately 20,000 ft of Smooth Cordgrass planted in 1993 and 1994 as part of DNR/SCS/SWCD planting program.
SO-8	Unnum.	Approximately 3,000 ft of Smooth Cordgrass planted in 1994 as part of a mitigation project.
NO-1	5-8, 11,12	CWPPRA Brown Lake Project, 1999.
NO-6	Unnum.	1,000 ft levee repair by landowner.
NO-7	Unnum.	Dugas Landing Bank Stabilization. 10,000 ft of Rock Revetment installed by COE.
NO-12	Unnum.	One 48" VC structure installed.
NO-13	Unnum.	80,000 ft plowed terraces and 160,000 ft Smooth Cordgrass planted, CWWPRA 1999.
NO-13	44	10,000 ft California Bulrush planted in 1996 by NRCS/SWCD/DNR.
NO-13	44	2,000 ft, Smooth Cordgrass planted for mitigation, 1997
NO-13	Unnum.	1,000 ft levee repair by landowner for mitigation.
NO-15	52	2,000 ft Smooth Cordgrass planted in 1996 by NRCS/SWCD/DNR.
NO-15	50	2-200 ft Rock Plugs installed for mitigation by landowner in 1997.
NO-17	56	3,000 ft California Bulrush, 1 acre Smooth Cordgrass by NRCS/SWCD/DNR in 1996

NO-18	60	2,000 ft California Bulrush planted by NRCS/SWCD/DNR in 1997.
NO-19	Unnum.	3,000 ft Smooth Cordgrass along GIWW Bank planted by NRCS/SWCD/DNR in 1996.
SA-7	101	1,000 ft Smooth Cordgrass planted for mitigation
SA-8	108	Replace West Cove Structure, by CWPPRA/USFWS, in 1999.
SA-8	109	Replace Headquarters canal structure by CWPPRA/USFWS in 1999
SA-10	114	Replace Hog Island Gully structure By CWPPRA/USFWS in 1999.
SO-1	Unnum.	Clean 25,000 ft of canal, installed 3 VC structures Cameron Parish GDD #6, and Global Industries in 1998
SO-5	132	Two-48" VC structures for mitigation by Fina in 1998.
SO-5	131	Three-48" VC structures by Cameron Parish GDD #7 in 1994.
SO-8A	143	25,000 ft Rock Breakwater installed along Gulf shore by DNR in 1994.
SO-6	133	CWPPRA/NRCS Mud Lake Project in 1996
SO-7	137	2,000 Smooth Cordgrass planted by NRCS/SWCD/DNR in 1997.

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EXECUTIVE SUMMARY

Coastal Wetlands in Louisiana are being lost at the rate of about 25 square miles per year. Louisiana contains forty percent of the nations coastal wetlands and has eighty percent of the total loss to these habitats annually. Wetlands are not only an important linkage for wildlife and fisheries productivity, but also the productivity of man. Wetlands produce an abundance of diverse wildlife and fisheries species, many of which are commercially and industrially valuable to man-kind.

The Calcasieu-Sabine River Basin study area is losing one and one-half square miles per year of these fragile habitats. Without efforts to reduce these loses, the quality of life for the area residents will be impaired. Therefore the Gulf Coast Soil and Water Conservation District requested the investigation and documentation of the area problems along with alternative solutions. The focus of this study is on the conservation, restoration, and enhancement of wetland resources.

The Calcasieu-Sabine Cooperative River Basin Study is authorized under Section 6 of Public Law 83-566, as amended. The Soil Conservation Service, representing the United States Department of Agriculture, worked with State, Federal, and local agencies and private citizens in compiling the information and preparing this document. Participants include the Gulf Coast Soil and Water Conservation District, Louisiana Department of Agriculture and Forestry, United States Fish and Wildlife Service, Louisiana Department of Wildlife and Fisheries, United States Army Corps of Engineers, Louisiana Department of Natural Resources, Louisiana Department of Environmental Quality, Louisiana Geological Survey, Cameron Parish Gravity Drainage Districts No. 7 (Johnsons Bayou) and No. 9 (Hackberry), Imperial Calcasieu Planning Commission, Amoco Oil Company, and John Walthers (USFWS-retired) of Sabine National Wildlife Refuge.

Cooperating agencies include the United States Environmental Protection Agency, National Marine Fisheries, Louisiana Department of Transportation and Development, Louisiana State University-Department of Agricultural Economics and Agricultural Business, McNeese State University, Sabine River Authority, Sulphur Gravity Drainage District No. 5, and Vinton Gravity Drainage District.

The study analyzed four alternatives: 1) No Action; 2) Basin Wide Control Structures; 3) Hydrologic Unit Treatment; and 4) Extended Hydrologic Unit Treatment. The study does not include an extended economic evaluation of the impacts of each alternative. It contains information relative to location of potential structures and costs for each alternative on nominal dollar construction cost.

The study results indicate that an individual Hydrologic Unit Treatment approach would be less costly ($36,7000,000), provide for greater opportunities to restore habitats in smaller areas, and allow for individual landowners to implement a plan on their property. The No Action alternative did not seem to be beneficial because it does not improve the long-term problems associated with wetland loss. The Basin Wide Control Structures Alternative provides for increased control of wetland loss at a basin level but construction costs were estimated to be $500,000,000. The Extended Hydrologic Unit Treatment alternative provides for the greater opportunities

than the Hydrologic Unit Treatment alternative, but would be costly, $22,100,000, for additional wetland improvement features.

Arresting wetland habitat loss in the study area will require a concentrated and concerted effort by landowners, Federal and State agencies, local governments, and industry. Local organizations must initiate request for assistance when possible, but also take a personal initiative to protect, conserve, and enhance our coastal wetlands.

INTRODUCTION

The introductory section of the report discusses the evolution of the river basin study. The background subsection discusses the need and initiation of the study. The authority subsection discusses the legislation that allows the Soil Conservation Service to provide leadership and guidance in the formulation of a river basin study. The sponsors and participants subsection lists the public and private organizations involved in the study process. The use of the report subsection will detail the structure of the report and the use of informational maps and appendices.

BACKGROUND

For several years, people living and working in the area between the Calcasieu and Sabine Rivers below the Intracoastal Waterway have witnessed the increased progression of the marsh erosion problem in the area. During the 50 year period from 1933 to 1983, the area lost about 124 square miles to erosion, that is, the area was converted from land or marsh to open water. The loss rate in 1983 was about 2.0 square miles per year[1].

In May, 1989 personnel from the U.S. Fish and Wildlife Service - Sabine National Wildlife Refuge (SNWR) met with Soil Conservation Service (SCS) personnel to discuss a strategy for involving the SNWR in a basin-wide approach to resolving the water quality and habitat loss problems that are threatening the entire area. The group determined that an overall plan was needed for the entire area (about 475,000 acres) in order to avoid a piece-meal approach in attempting to provide protection for the marsh. The area is so large and complex that it will require input and assistance, both financial and technical, from many different agencies, groups, private companies, individual landowners, and other individuals.

The SNWR-SCS group agreed to ask the Gulf Coast Soil and Water Conservation District to request a River Basin Study that would be geographically defined as the Sabine River on the west, Intracoastal Waterway on the North, the east shore of Calcasieu Lake on the east, and the Gulf of Mexico on the south. The request was made and a study start was granted for the Calcasieu-Sabine area to begin in October, 1990.

AUTHORITY

The Calcasieu-Sabine Cooperative River Basin Study (CRBS) is authorized under Section 6 of Public Law 566 (PL-566), as amended. Public Law - 566 was passed by the 83rd Congress in August, 1954. It authorizes the United States Department of Agriculture (USDA) to cooperate with other federal, state, and local agencies in making surveys and investigations of the watersheds of rivers and other waterways. Such surveys form the basis for planning coordinated water and related land resource development programs. Planning procedures are based on the Principals and Guidelines that were signed by the President on February 3, 1983, and became effective on July 8, 1983.

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[1]Land Loss Rates, Report 2, Louisiana Chenier Plain, Joseph P. Dunbar, Louis D. Britsch, and E. Burton Kemp III, United States Army Corps of Engineers, New Orleans, LA, November, 1990.

INTRODUCTION

SPONSORS, PARTICIPANTS, AND COOPERATING AGENCIES

Sponsors for the study are the Gulf Coast Soil and Water Conservation District, Louisiana Department of Agriculture and Forestry, United States Fish and Wildlife Service, Louisiana Department of Wildlife and Fisheries, and Cameron Parish Police Jury. The Soil Conservation Service has overall responsibility for the study.

Other participants in the study are the United States Army Corps of Engineers, Louisiana Department of Natural Resources, Louisiana Department of Environmental Quality, Louisiana Geological Survey, Cameron Parish Gravity Drainage Districts No. 7 (Johnsons Bayou) and No. 9 (Hackberry), Imperial-Calcasieu Planning Commission, Amoco Oil Company, and John Walthers (USFWS-retired) of the Sabine National Wildlife Refuge.

Cooperating agencies include the United States Environmental Protection Agency, National Marine Fisheries, Louisiana Department of Transportation and Development, Louisiana State University-Department of Agricultural Economics and Agricultural Business, McNeese State University, Sabine River Authority, Sulphur Gravity Drainage District No. 5, and Vinton Gravity Drainage District.

USE OF THE REPORT

An overall plan was developed for the entire study area with forty-seven management (hydrologic) units designated within the area. The objective of the overall plan is to provide a method wherein plans for each of the forty-seven hydrologic units may be installed independently of one another and still fit into the overall plan. Federal, state, and local government agencies, private companies, or individuals can install structural or vegetative measures in hydrologic units in accordance with the overall plan.

The report is designed with the goal of easier use and readability by separating hydrologic units. Each hydrologic unit will have a description of its physical setting, problems, alternatives, and analysis of "with" and "without project" conditions. The format allows one to look at one section of the report and find a particular hydrologic unit and get the needed information.

Maps

The report has a special map folder in the back cover that holds the maps to be used in the description of each hydrologic unit. The maps should be removed from the folder for referral while reading about a particular unit.

Hydrologic Units. The map containing the hydrologic unit boundaries, Map 1, will be referred to when describing a hydrologic unit. The map shows the basin study area to be divided into three areas: 1) North of the Sabine National Wildlife Refuge (NO's); 2) Sabine National Wildlife Refuge (SA's); and South of Sabine National Wildlife Refuge (SO's). These areas are further sub-divided by a red dashed line to delineate hydrologic unit boundaries and will be useful as a location map. The map also shows element numbers for the location of proposed structural and non-structural components for wetland conservation.

General Soil Map. The map containing the general soils information, Map 2, will be referred to in discussing the soils located in each hydrologic unit. This information is important in planning for engineering structures and associated cost estimates.

Important Biological Areas. The map containing the important biological areas, Map 3, shows locations of environmentally sensitive bird species and oystering grounds. Nesting and roosting areas of herons, egrets, cormorants, and seabirds are depicted, as are areas normally harvested for oysters. Two Christmas Bird Counts are included within the basin, these counts are conducted annually and not only identify species found within a 24-hour time period, but include the numbers of individual birds observed.

Oil and Gas Fields and Pipelines. The map containing oil and gas fields and pipelines, Map 4, will be used to help locate structures for planning purposes.

Marsh Land Water 1956-1978. The map containing the marsh land water changes between the time period of 1956 to 1978 is useful in estimating future rates of change in those resources. The map has a legend on the left-hand-side for interpretation of changes within the area wetlands. The results can be compared to Map 6, 1984 Classified Landsat Thematic Mapper Satellite Data. However, the satellite image data is calculated differently than the Map 5 data. Therefore, the maps are roughly comparable for general planning purposes only.

1984 Classified Landsat Thematic Mapper Satellite Data. The map containing the landsat data, Map 6, is useful to see the changes in land, marsh, and water from 1956-1978 Marsh Land Water Change Map. The map has a legend on the left hand side to explain classification of the colors. Landsat data has a classification scheme different from the comparative map of 1956-1978. The reasons are that satellite information makes it difficult to discern one marsh type from another, and the other map has only changes from one time period to another. The broken marsh category can be interpreted as a half marsh and half water ratio.

1931 Vegetative Map. This vegetative map, Map 7, contains the numbers and boundaries of hydrologic units, and the marsh types and predominant vegetative cover on the Sabine National Wildlife Refuge and some surrounding units. The right-hand-side of the map contains a legend for vegetative species acronyms used on the map. The information is useful to compare across all the vegetative maps, Map 7 to 11, to measure the change of the marsh environment over time.

1949 Vegetative Map. This vegetative map, Map 8, contains information regarding the marsh types and predominant marsh species in the river basin. The map is outlined with the hydrologic unit boundaries and numbers for reference purposes. The right-hand-side of the map contains a legend showing the different vegetative categories. The information is useful to compare across all the vegetative maps, Map 7 to 11, to measure the change of the marsh environment over time.

1968 Vegetative Map. This vegetative map, Map 9, contains information regarding the marsh types and predominant marsh species in the river basin.

The right-hand-side categorizes the vegetative communities according to marsh categories and a non-marsh category. It differs from the 1949 marsh categories, but is still useful for some comparative purposes. The information is useful to compare across all the vegetative maps, Map 7 to 11, to measure the change of the marsh environment over time. The vegetative map data was compiled by Robert Chabreck.

1978 Vegetative Map. This vegetative map, Map 10, contains information regarding the marsh types and predominant marsh species in the river basin. The right-hand-side categorizes the vegetative communities according marsh categories and a non-marsh category. The information is useful to compare across all the vegetative maps, Map 7 to 11, to measure the change of the marsh environment over time. The vegetative map data was compiled by Robert Chabreck and Greg Linscombe.

1988 Vegetative Map. This vegetative map, Map 11, contains information regarding the marsh types and predominant marsh species in the river basin. The right-hand-side categorizes the vegetative communities according marsh categories and a non-marsh category. The information is useful to compare across all the vegetative maps, Map 7 to 11, to measure the change of the marsh environment over time. The vegetative map data was compiled by Robert Chabreck and Greg Linscombe.

Landuse Map. The landuse map, Map 12, contains a color coding system that delineates areas by the predominant landuse. The categories are urban/indrustry, agriculture, forest, non-forested wetlands, and other.

Land Ownership Map. The land ownership map, Map 13, contains a color coding system that delineates areas by the predominant land owner or land owner size tract. The categories are federal land, Cameron Parish School Board (Section 16 of every township), private lands predominantly held by landowners with more than 500 acres, and private lands predominantly held by land owners with less than 500 acres.

Appendices

The report has several appendices that contain information that may be useful when detailed planning is initiated on a hydrologic unit. These sections will also provide more detailed information that participants and readers will find helpful in understanding the report or for further research on the river basin.

Appendix A: Plant Species Found in Basin Area. Taxonomic listing of the plants and there relative abundance found within the river basin project area. This appendix provides information for plant species listed in the document by common name only.

Appendix B: Animals that Inhabit Basin Area. Taxonomic listing of the animal species that are found with the river basin project area. This appendix provides information for animal species listed in the document by common name only. The appendix list includes marine invertebrates, fish, amphibians, reptiles, birds, and mammals.

Appendix C: Summary of Coastal Marsh Inventory. An inventory of the marsh resources was made in 1984-1986. The basin inventory information was collected on a grid format, however is presented as a summation by hydrologic unit. Each point in the grid had a sample of vegetation, soil type, and elevation taken. The information is useful for general planning purposes.

Appendix D: Sabine Christmas Bird Count. Summary of the species and individuals observed during the day of the count for years conducted.

Appendix E: Johnsons Bayou Christmas Bird Count. Summary of the species and individuals observed during the day of the count for years conducted.

Appendix F: Range Report for the Calcasieu-Sabine River Basin Area. The report details the impact of range landuse and livestock production within the basin. It includes utilization of livestock on specific soil and wetland types, management practices, and economic and cultural impacts of ranching in the basin.

Appendix G: Summary of Project Costs. The appendix itemizes the construction components and costs for each hydrologic unit for Alternatives 3 and 4.

PHYSICAL SETTING

LOCATION AND SIZE

The Calcasieu-Sabine River Basin study area is located in southwest Louisiana in Calcasieu and Cameron Parishes. The study area consists of approximately 475,000 acres with 7,000 acres in Calcasieu Parish and 468,000 acres is Cameron Parish. The study area boundaries are the Louisiana-Texas border(Sabine Lake) on the west, the Intracoastal Waterway on the north, the east bank of Calcasieu Lake on the east, and the Gulf of Mexico on the south. The area includes all of Calcasieu Lake and about one-half of Sabine Lake. The Sabine National Wildlife Refuge covers a large part of the study area, 126,000 acres, and is located approximately in the middle of the study area. Three towns or communities are in the area; Hackberry, Holly Beach, and Johnsons Bayou.

TOPOGRAPHY

Most of the study area is flat and consists of coastal marsh which is one to one and one-half feet above mean low gulf. The topography ranges from level to nearly level with elevations ranging from at or below sea-level in the southern part of the study area to about 16 feet above sea-level west of Hackberry Louisiana. Most of the area is comprised of marsh of varying salinity rates.

Rising slightly above the surrounding marshes are several long, narrow, sandy ridges that run roughly parallel to the gulf coast. They are sharply localized, well drained, fertile and support naturally luxuriant vegetational cover and are called "cheniers" by the local inhabitants.

Cheniers (oak ridges) are believed to be formed from debris blown inland by hurricane and later covered by shell, and finally by sand. They are generally five to nine feet above sea-level and can range from a few hundred feet to nearly a mile in width and generally are covered with live oak trees. One of the most complex sets of cheniers known along the Gulf coast begins near Peveto Beach and radiates like an elongated feathered fan to the west. The oldest distinct chenier in this area is known as the Smith Ridge. Smith Ridge extends from Hamilton Lake to Johnsons Bayou. Blue Buck Ridge, the second main chenier, starts at Peveto Beach and extends about eighteen miles to the west.

CLIMATE

The study area's climate is humid, subtropical with a strong maritime character. The climate is influenced to a large degree by the amount of water surface in the immediate area and the proximity to the Gulf of Mexico. Prevailing winds from the Gulf reduce extreme summer heat, shorten the duration of infrequent winter polar air masses and provide abundant rain in all seasons.

Records of temperatures are available from "Climatological Data" for Louisiana published by the National Climate Center. The study area can be described by using the temperature data observed at Lake Charles, Louisiana. The annual normal temperature based on the period 1951-1980 is 68^{0} Fahrenheit (F) with monthly normal temperatures varying from 82.3^{0}F in July to 51.5^{0}F in January.

The maximum temperature recorded over the period was 102°F in July 1980. The overall maximum temperature record was 106°F during June 1930. The lowest temperature during the period was 18°F and occurred in January 1977. The record low was 3°F and occurred in February 1899. The average winter and summer temperatures are 55.5°F and 80.8°F, respectively.

The average annual precipitation based on records taken at Hackberry for the period 1951-1980 is 54.7 inches. Hackberry's monthly extremes were a maximum of 20.81 in June 1989 and a minimum of 0.00 inches occurring during several different months. These extremes cover the period 1942-1989. The greatest 24-hour rainfall measured 9.63 inches for 10 November 1940 at Hackberry. The heaviest rainfall usually occurs in the summer (July-September) with July being the wettest month having an average monthly normal of 6.3 inches. The driest month for the normal period is March with an average normal of 3.2 inches.

Wind records are available from the Lake Charles Airport. Prevailing winds are southerly during most of the year and average 8.7 mph based on the period 1973-1989.

SOILS

The total study area within the basin is about 475,000 acres with 215,000 (45.26%) acres of water and 260,000 (54.74%) acres of land and marsh. The coastal marsh within the study area totals approximately 230,000 acres. The soils of the marsh are fragile, that is they are easily broken or dispersed and subsequently washed away. They developed in Holocene deposits. The source of these deposits are pulses of Mississippi and Red River alluvial sediments transported westward along the coastline via littorial drift. The intermittent reworking of these sediments produced the sequence of mud flats; and sand or shell ridges known as cheniers.

The soils of the marsh (Table 1) are composed of fluid or firm mineral, and organic materials. For classification purposes, the two broad soil classes, organic and mineral, are subdivided into three groups - saline, brackish and fresh (non-brackish). Soils of the cheniers are composed of mineral soil materials and shell fragments.

The fluid, mineral soils of the marsh are the Scatlake series (saline); and Bancker, Gentilly and Creole series (brackish). The Ged series is a firm mineral marsh soil (fresh). The fluid organic soils of the marsh are the Clovelly series (brackish) and the Allemands series (fresh).

The firm, mineral soils of the chenier are the Hackberry series and the depressional areas between the cheniers are the Mermentau series.

As long as sedimentation is taking place, the marsh will remain static or grow, depending on the amount of sediment delivered. The nutrients in the sediment are very important to plant growth. Vigorous plant growth contributes to the organic fraction of the soil and helps build the marsh. However, when sediment delivery ceases, the combined forces of subsidence, rapid salinity changes and erosion cause marsh deterioration.

PHYSICAL SETTING

Table 1. Distribution of River Basin Soil Associations

	Acreage	Percent
Coastal Prairie Ridge		
Loamy Terrace Lowlands	9,360	3.60
Mowata		
Morey		
Loamy Terrace Upland	4,680	1.80
Crowley		
Vidrine		
Clayey Terrace Lowland		
Midland	1,560	0.60
Fresh Marsh		
Mineral		
Ged	16,302	6.27
Organic		
Allemands	12,298	4.73
Brackish Marsh		
Firm Mineral		
Gentilly	25,012	9.62
Mermentau	5,772	2.22
Creole	44,252	17.02
Fluid Mineral		
Bancker	90,428	34.78
Organic		
Clovelly	26,936	10.36
Salt Marsh		
Scatlake	10,400	4.00
Chenier and Beach Ridges		
Hackberry	4,940	1.90
Peveto	260	0.10
Spoil Banks		
Udifluvents	4,056	1.56
Aquents	3,744	1.44

The fragile soils of the marsh are held in place primarily by profuse vegetative root systems. When the vegetative community is altered, the soil is easily displaced. Saltwater is an agent which contributes to severe alteration of the plant community and displacement of soil materials. As plant species die, they lose their "grip" on the soil. Also, saltwater tends to disperse the organic and soft, semifluid, mineral soil material. This loss of binding forces within the soil profile further contributes to soil displacement. Organic soils are more susceptible to the forces of erosion than are the mineral soils.

GEOLOGY

The study area is in the Quaternary Period of the Cenozoic Era. Most of it is in the Holocene (Recent) Series with small remnants of the Pleistocene Series. The Holocene Series include the Cheniers, the saline marsh of the Chenier

Plain, and the fresh marsh of the Chenier Plain. The Cheniers are a series of long narrow sandy ridges running roughly parallel to the Gulf coast. They range in elevation from four to nine feet above sea-level; no more than a few hundred yards wide; and up to eighteen miles long. The saline marsh of the Chenier Plain is generally adjacent to the cheniers. They consist of gray to black clays and silts of moderate organic matter content with varying salinity contents. The fresh marsh of the Chenier Plain is more inland and is fed by freshwater sources. They consist also of gray to black clays but generally have high organic matter contents.

The Pleistocene Series of the Quaternary period consist of remnants of the northern Prairie Terraces. They are in the northern part of the study area around Hackberry Island; in the central part around Gum Cove Ridge; and a small area to the western part known as Pine Ridge and Perry Ridge. Hackberry Island is believed to be part of the Pleistocene Mississippi Delta while the other Ridges are thought to be part of the Pleistocene delta of the Sabine River.

EXISTING CONDITIONS

Calcasieu and Sabine Lakes are the dominant water bodies within the basin. Beaches and cheniers along the Gulf Coast support residential, commercial/industrial, and agricultural uses. The prairies north of the coastal wetlands support similar landuses. The Gum Cove ridge and north of Hackberry are isolated portions of coastal prairie. The primary landuses in these areas are residential and agricultural. Other small outcroppings of prairie occur within the coastal marshes which contain forest land, covered with prairie, shrub/scrub, or marsh vegetation.

Major oil and gas fields exist at Cameron Meadows, Black Bayou, East and West Hackberry, Black Lake, Second Bayou, and near Broussard Lake. A number of access canals, and board roads are due to the natural resource extraction facilities located within the basin. Numerous small access canals have been dredged through marshes between Calcasieu and Sabine Lakes.

Navigation channels dominate the hydrology of the basin. The 40-foot-deep by 400-foot-wide Calcasieu Ship Channel extends from the Gulf of Mexico to Lake Charles along the eastern edge of the basin. The Gulf Intracoastal Waterway (GIWW) is maintained at 12-foot-deep by 125-foot-wide across the northern portion of the basin. The reach between the Sabine River and the Calcasieu Ship Channel was dredged to 30-feet-deep during 1927. Along the western side of Sabine Lake is the Sabine-Neches Waterway. The channel is 40-foot-deep by 400-foot-wide between the Gulf and Port Arthur, Texas. Between Port Arthur and Orange, Texas, the channel is 30-foot-deep by 200-foot-wide. Both the Sabine-Neches Waterway and the Calcasieu Ship channel have long jetties that extend into the Gulf on both sides of the channel.

Marshes within the basin generally drain into Sabine and Calcasieu Lakes. Those lakes exchange water with the Gulf via the channelized outlets. Freshwater inflow into the coastal basin occurs primarily through the Calcasieu and Sabine Rivers. The Vinton Drainage Canal, Choupique Bayou, and several other small drainage canals also drain uplands into the northern portion of the basin.

The Sabine River is a much larger river than the Calcasieu, hence Sabine Lake tends to be fresher than Calcasieu Lake. The timing of freshwater input into the Sabine Estuary has been altered by operation of the Toledo Bend Dam, for the generation of electricity, on the Sabine River, and the Sam Rayburn Reservoir Dam on the Neches River. In order to generate electricity during the peak demand summer months, more water is discharged than normally. This tends to reduce summer salinities in Sabine Lake and may adversely impact recruitment of white shrimp in June and July.

The hydrology of marshes between Sabine and Calcasieu Lakes has been altered by several relatively small access canals which run east to west and north to south. The GIWW and this network of small access canals has established hydrologic connections between the Sabine and Calcasieu estuaries. Additionally, bayous which once drained adjacent marshes into either Sabine or Calcasieu Lakes have been connected to one another. Consequently, marshes between Sabine and Calcasieu Lakes have become large interlinked system with water draining to the north, east, and west.

EXISTING CONDITIONS

Because of saltwater intrusion and associated marsh loss, a number of water control structures have been installed along the edges of Calcasieu Lake to retard saltwater intrusion and protect deteriorating marshes. Several water control structures exist to regulate water exchange between Calcasieu Lake and marshes west of the lake. The largest of those structures are located on Hog Island Gully Canal and West Cove Canal. Those structures in combination with the smaller Headquarters Canal culvert are used to reduce penetration of saltwater into interior marshes via man-made canals. Water control structures and spoil banks are also used in other areas to preserve and restore deteriorated marshes north and west of Black Lake. Marsh areas have also been leveed for cattle grazing adjacent to the cheniers in Johnsons Bayou, and westward to Sabine Lake. Some wetlands adjacent to the prairies are also leveed and under various forms of agriculture.

Marshes between Sabine and Calcasieu Lake range from saline to fresh. Saline marshes are primarily located adjacent to Calcasieu Lake and Sabine Pass. Brackish marshes are located adjacent to both Sabine and Calcasieu Lakes and extend inland where they grade into intermediate and low-salinity marshes. The once vast interior fresh marshes south of the GIWW have been reduced to that within three fresh marsh impoundments. Although totally impounded, excess freshwater is discharged into adjacent low-salinity marshes.

Because of severe marsh deterioration and loss during the 1960's, and 1970's, large areas of turbid shallow open water and broken marsh exist. The most extensive of such areas are adjacent to Black Lake, south and southwest of Hackberry, and in the vicinity of Black Bayou, Greens Lake, and Willow Bayou. Marshes adjacent to these large open water areas experience erosion due to wave action. Wind action across these areas may also produce tides that exacerbate the export of eroded soils.

Excessive rainfall during the last several years has reduced the frequency and magnitude of saltwater intrusion events. In some interior broken marsh areas, cattails, California bulrush, and seashore paspalum have expanded into shallow open water areas and begun to rebuild deteriorated areas. In these and other more brackish areas, marshhay cordgrass appears to be stressed by excessive water levels. Vegetation in other areas appears to be healthy. In some saline areas, smooth cordgrass appears to also be expanding gradually into shallow open water.

Wetlands within the basin provide extensive nursery habitat for estuarine-dependent species such as brown shrimp, white shrimp, blue crab, Gulf menhaden, Atlantic croaker, striped mullet, spotted seatrout, red drum, black drum, southern flounder, and many other species of fish and shellfish. Low-salinity tidally-influenced marshes, such as those midway between Sabine and Calcasieu Lakes, support both freshwater and estuarine-dependent fish and shellfish. Such areas also provide high quality habitat for resident and migratory waterfowl, furbearers, white-tailed deer, American alligator, and numerous species of reptiles and amphibians (Appendix B). Brackish marshes having abundant widgeongrass and three-cornered grass may also provide high quality habitat for waterfowl and furbearers. Wetlands throughout the basin provide habitat for herons, egrets, ibises, bitterns, and rails. Saline and brackish marshes may also provide habitat for numerous species of shorebirds.

EXISTING CONDITIONS

The Gulf of Mexico shoreline is retreating across the basin. Losses appear to be greatest west of the jetties at the Calcasieu Ship Channel. Losses are also high east of the jetties at Sabine Pass. Segmented breakwaters have been installed along the shore at Constance Beach to reduce beach erosion. Several times a year, during periods of strong southerly winds, Gulf waters are pushed over the beach and into interior marshes. During hurricanes and tropical storms, beach erosion and Gulf overwash is most severe.

EXISTING RESOURCES

This section contains information on many of the basic commercial and recreational resources in the river basin study area. The commercial resources include: 1) Shipping and navigation; 2) Fisheries; 3) Alligator and Fur harvests; and 4) Mineral extraction and oil storage facilities. The recreational resources include: 1) Fisheries; 2) Hunting; 3) Visual utilization, and 4) Water quality of the basin water bodies and watercourses.

COMMERCIAL RESOURCES

Shipping and Navigation

Shipping and navigation has an important influence on the economic and environmental welfare of the Calcasieu-Sabine river basin study area. The entire study area is encapsulated by three federal navigation projects and water bodies: 1) Sabine Lake with the Sabine-Neches Waterway; 2) Gulf Intracoastal Waterway; and 3) Calcasieu Lake with the Calcasieu Ship Channel.

The Sabine-Neches Waterway provides for commerce with ports in Southeast Texas. The waterway was initially constructed in the 1870's and today provides for deep draft navigation with a depth of 40 feet. The Gulf Intracoastal Waterway is a portion of the Inland Waterway system authorized by Congress in 1910. It provides for shipping of goods and commodities on boats that do not have a deep draft. The waterway is maintained with a bottom depth of 12 feet and primarily utilized for barge traffic. The Calcasieu Ship Channel was initially began in 1874 and today has a depth of 40 feet. It is used for deep draft navigation to the Lake Charles Deep Water Port. These navigation projects will be addressed in more detailed in the Historical Events and Impacts of Historical Events subsections.

Fisheries

This subsection contains information on important marine and estuarine species that utilize the inland marshes during their life cycles. The discussion will include landings data and limiting factors of productivity.

Tidally-influenced marshes throughout the study area serve as nursery habitat for many estuarine-dependent fish and shellfish. Estuarine-dependent species typically spawn in the Gulf of Mexico and migrate into the marsh as post-larvae or juveniles. Upon becoming sub-adult, they typically migrate to the Gulf to complete their life cycle (Table 2). Because of the many different species and differing life cycle requirements, migration occurs throughout the year.

Many of the commercially important species harvested within the study area include blue crab, white and brown shrimp, red drum, black drum, spotted and sand seatrout, sheepshead, southern flounder, Atlantic croaker, striped mullet and Gulf menhaden. Calcasieu Lake supports a large, viable shrimping industry (Table 3). Sabine Lake serves as an estuary for much of the year, however, due to freshwater discharge from the Toledo Bend and Sam Rayburn Reservoirs, during summer for hydroelectric power, white shrimp recruitment and harvest may be adversely affected (Table 2).

Table 2. Ingress and Egress of Commercial and Recreational Important Estuarine Organisms[1].

Species	Ingress	Egress
Gulf Menhaden	Feb. and March	Oct. to Jan.
Red Drum	Sept. and Oct.	Dec. and Jan
Spotted Seatrout	Aug. and Sept.	Nov. and Dec.
Sand Seatrout	April, May, and Sept.	June and July
Atlantic Croaker	Dec. to Feb.	Sep. to Nov.
Striped Mullet	Jan. and Feb.	?
Southern Flounder	Jan., Feb., and March	Oct. to Dec.
Brown Shrimp	February to May	June and July
White Shrimp	August and Sept.	Oct. to Dec.
Small Blue Crab	Jan., July to Sept.	?

Limiting factors to the productivity of estuarine-dependent organisms may include the food and cover accessibility, and salinity ranges. The impact of salinity ranges can be seen in Table 3 where freshwater discharge (Sabine Lake) affected the salinity regime needed for optimal productivity during an organisms life cycle. Food and cover needs are met by emergent and submergent wetland vegetation. Submerged aquatic vegetation and emergent vegetation provide cover and food, while deterioration of emergent marsh and submerged aquatic vegetation provides the detrital material that drives the food chain in a nursery system. Upon the depletion of the resource base, erosion of marsh substrate, the food and cover will disappear. However, detrital material stay in the system for several years. Submerged aquatic vegetation, will be impacted by increased turbidity which limits photosynthesis for plant survival.

Table 3. Brown and White Shrimp Landings for Calcasieu and Sabine Lakes from 1980 to 1989[2].

	Calcasieu Lake		Sabine Lake	
Year	Brown Shrimp	White Shrimp	Brown Shrimp	White Shrimp
1980	-	-	1,099	49,900
1981	6,245	341	60,856	47,042
1982	-	-	-	173,568
1983	483	-	-	582
1984	3,507	1,470	8,923	9,592
1985	-	2,980	-	-
1986	1,297,157	1,606,906	-	-
1987	936,251	479,922	-	-
1988	1,131,978	1,409,657	-	-
1989	395,027	228,316	-	-

[1]Roger and Herke, 1985, Temporal Patterns and Size Characteristics of Migrating Juvenile Fishes and Crustaceans in a Louisiana Marsh.

[2]Data is from Leryes Usie of National Marine Fisheries Service, New Orleans, Louisiana. Data is heads-on landings in pounds.

EXISTING RESOURCES

Brown Shrimp

The brown shrimp is the major species of in the Gulf shrimp industry, which is the most valuable fishery in the United States. Shrimping begins in May, peaks in June and July during seaward migration and continues offshore through November. Spawning is reported to occur in offshore waters deeper than 60 feet and possibly as deep as 450 feet. The major spawning occurs from September to December, with a minor peak from March to May. Eggs hatch into planktonic larvae which grow by molting through nauplius, protozoea, mysis to the post-larval stage in ten to twenty-five days. Larval development takes place in Gulf waters.

The portion of the brown shrimp's life cycle spent in estuaries is critical. Peak recruitment of post-larvae may occur months after the peak of spawning. Overwintering brown shrimp post-larvae may burrow into the bottom and wait for warmer temperatures before entering the estuary. February through May are normally the peak months for ingress (Table 2), however this may vary year to year. Post-larvae are most often found in the upper portions of the water column and may modify their position according to light. As they grow and move to shallow, soft-bottom areas of the estuary, they become randomly distributed throughout the nursery areas. During this phase of their life cycle they are opportunistic omnivores, feeding on a variety of organic matter. Brown shrimp are significantly more dense in vegetated habitat than in non-vegetated water bottoms.

Their greatest abundance generally occurs in salinities of 10 to 30 parts per thousand (ppt), however they have been collected from fresh areas to over 60 ppt. Peak ingress is in most cases associated with increased salinities, while egress is associated with declining salinities. June and July are normally the peak months of brown shrimp emigration, and is correlated with full moon and outgoing tide at twilight and on into the night.

White Shrimp

White shrimp compose about forty percent of the Gulf shrimp fishery. The offshore commercial fishery begins in late August and September when the shrimp leave the estuaries, and is generally concentrated with the thirty foot contour. Adult white shrimp spawn in shallow offshore Louisiana waters from the latter part of March or early April through September with a peak in June or July. The same shrimp may spawn as many as four times in one season. Growth is similar to the brown shrimp with larval development in offshore waters and movements largely governed by currents. Post-larval white shrimp begin entering the passes in small numbers in late May, but peak in August and September in Louisiana (Table 2). Often post-larvae appear in waves, depending upon environmental conditions of temperature and salinity.

Within the estuary the juveniles disperse rapidly and are associated with the marsh-water interface, but generally in the non-vegetated areas with no seasonal difference between vegetated and non-vegetated bottoms. Juvenile white shrimp are found in lower salinity waters than brown shrimp and have been collected from freshwater to over 30 ppt, however they are more abundant in salinities ranging from 0.05 to 10 ppt. White shrimp are a warmer water species than brown shrimp. As the weather cools they begin to migrate to higher salinities and deeper waters. The magnitude of migration is dependent

on total amount and abruptness of the temperature drop. White shrimp like brown shrimp are omnivorous, ingesting amphipods, polychaetes and organic detritus.

Atlantic Croaker

The Atlantic croaker ranges from the Gulf of Maine to Argentina, and is one of the most abundant inshore fishes of the Gulf of Mexico. They are the prime target species of the groundfish industry, as a protein source, in the Gulf. Sport fisherman also harvest this fish even though it is less preferred than spotted seatrout and red drum.

Spawning has not been observed but is believed to take place in the open Gulf near the mouths of various passes that lead into shallow bays. Spawning occurs from September to late March with a distinct peak in October. Eggs hatch in less than a week and the larvae are planktonic. By late November post-larvae croaker begin migrating into estuaries and peak in December and January (Table 2). Young-of-the-year croaker remain in estuarine nursery areas, especially deeper low salinity areas, through spring and early summer.

Emigration may begin as early as June in Louisiana (Table 2). Gulfward migration peaks from September to November and is correlated with decreasing temperatures. Very young croaker feed on zooplankton while larger croaker are omnivorous, feeding on micro and macro benthic animals, small fishes and organic detritus. Adults feed on small fishes, shrimp, crabs, and mollusks. The largest catches of post-larvae and juveniles are in salinities of 15 to 19 ppt. Sudden and prolonged cold snaps can cause mass mortalities when they are in shallower estuarine waters. Croaker rarely live longer than four or five years.

Spotted Seatrout

Spotted seatrout (commonly called "speckled trout") are probably the most popular and sought after fish by the greatest number of people along the Gulf coast. The estimated sport catch is substantially greater than the commercial catch. Adults start appearing along the shoreline, especially at tidal passes, in March and early April (Table 2).

Spawning occurs throughout the summer in both estuaries and the Gulf. Spawning is dependent upon salinity and temperature with optimum at 28 ppt and 28^{o}C, respectively. The first minor peak of post-larvae ingress occurs in April (Table 1) and is associated with submergent vegetation such as widgeongrass and marsh edge. As they grow seatrout move and feed throughout the estuary during summer, gradually moving to lower bays as they finally migrate to the Gulf in the fall and winter.

Spotted seatrout change their feeding preference from nearly all invertebrates such as shrimp and worms to mostly fish such as anchovies, menhaden, mullet, sheepshead minnow, and silversides as they become adults. Sexual dimorphism exists in this species. As the size of the fish increases there are proportionally fewer males. By the eighth year all spotted seatrout are females, the female grows faster than the male and lives as long as ten years.

EXISTING RESOURCES

Red Drum

The red drum or redfish is a highly valued estuarine-dependent sport and food fish. Large schools of adult red drum often occur along the Gulf shoreline, especially near the tidal passes, from August to November. Along the Louisiana coast "Bull" red drum begin spawning in August. Peak spawning occurs in September and October and tapers off in November. Larva drum have been captured in the passes as early as September. Post-larvae and young juveniles immigrate to sheltered coves and bayous where they rest among shallow water grassbeds. They forage in clumps of grass, oyster beds, and muddy bottoms for small invertebrates. As they mature, during their first winter, young red drum move farther into the estuary and deeper waters.

Some migrate to the open Gulf by spring, however, the main emigration occurs with the cooling of waters in the fall (Table 2). By the time they reach the Gulf their diet has changed to crabs, penaeid shrimp, and polychaetes. They reach sexual maturity in four to five years and about thirty-five inches in length. Most captures of older juvenile and adult drum are from salinities greater than 20 ppt. The red drum is susceptible to sudden cold shocks and massive fish kills have been reported after sudden freezes.

Southern Flounder

The southern flounder is common to the Gulf coastal waters and is a valuable food and sport fish. Adult flounder are most often found on soft muddy bottoms of shallow bays and lagoons, but frequently occur on sandy beach areas. Large flounder have been captured as far inland as freshwater which suggests that the species moves extensively within the estuary. Adult southern flounder apparently migrate from estuaries to nearshore Gulf waters from October to December (Table 2) to spawn, with the peak emigration of males occurring prior to that of females. Males over three years old are not usually caught in the estuary and either may spend the latter part of their life in the Gulf or die after their third year. Growth studies indicate that males grow slower than females.

Post-larvae and juveniles have been captured from the beach near Barataria Bay and in the Caminada Pass area from December through April. Tidal stages rather than day-night cycles appear to be the more important factor affecting migration. Post-larvae and juveniles appear to concentrate in quieter waters of tidal channels during ebb tides and disperse during flood tides.

Recruitment of young flounder into inland waters occur mainly from December through April with peak ingress during February and March. Marshes of either low to high salinity may serve as nurseries. Ninety-five percent of the food items found in the stomachs of small flounder are invertebrates, while larger flounders feed mainly on fish.

Gulf Menhaden

Gulf menhaden (commonly called pogies) range along the coastline of the Gulf from Florida to Veracruz, Mexico. They support the largest single fishery by weight in the United States. Menhaden are a schooling species throughout their life which accounts for the success of the purse seine fishery. The bony, mealy fleshed, oily fish is not a food fish, but is processed for fishmeal and

oil. The Gulf fishery, which occurs from April to October, is dependent on age-1 and age-2 fish.

Spawning has not been observed, but is reported to occur in the open Gulf from October through March in waters 6 to 420 foot deep. Menhaden may spawn four or five times during a spawning season, releasing spherical eggs that float near the surface. Larvae may spend three to five weeks in offshore waters prior to moving through the passes into the estuaries. Peak movements may vary year to year, and generally occur from December through March or April (Table 2).

Juveniles remain in low salinities, where they travel in dense schools often near the surface. The length of time they spend in the estuary is variable, ranging from six to twelve months after hatching. Emigration of adults and maturing juveniles has been reported to occur from midsummer through winter, with peak movement from October to January (Table 2). Movement back into inshore waters by surviving members of all age groups following overwintering in the Gulf occurs early the following spring in March or April. Gulf menhaden live to a maximum of four years, therefore, this cycle may be repeated several times.

Menhaden have two distinct feeding stages - larvae feed on individual zooplankton, while juveniles and adults are omnivorous filter-feeders. Research on the closely related Atlantic menhaden indicate that algal production in an estuary is insufficient to sustain even the juveniles. Juvenile Atlantic menhaden ingest significant quantities of vascular plant material and are able to digest cellulose with 75 percent efficiency. This demonstrates an efficient direct link from marsh primary production to fishery utilization.

Trapping

Fur trade was an integral part of Louisiana's coastal economy in the early 1900's. The productivity of Louisiana's marshes for fur production is the highest in the North American Continent for nutria. This is noted in Linscombe and Kinler 1985.

Stanley Arthur wrote in 1931, Louisiana produced more pelts of fur animals than any other state in the union, or providence and territory in Canada. He further stated that the peak period of the late 1920's, Louisiana produced more pelts of fur animals than all of the Dominion of Canada with Alaska's harvest thrown in for good measure. Between the 1913-14 season and the 1929-30 season average statewide production was over five million pelts. During the 1922-23 season estimates from fur trade indicated that ten to fifteen million muskrats were shipped from the state. Louisiana has continued to hold this prominent position in fur production. Harvest data from the 1981-82 season indicated that Louisiana was the number one state in fur production. However, the average fur harvest during the past twenty years was two and a quarter million pelts, only 45 percent of the early 1900's production.

Louisiana produced 97 percent of the North American nutria harvested during 1970-71 season through 1980-81 season. Coastal area of the state accounted for 97 percent of the harvest. The Chenier Plain parishes, comprising 36 percent of the coastal marshes (excluding salt marsh), accounted for 19 percent of the nutria harvest during this period.

EXISTING RESOURCES

The market for furs has drastically declined in recent years and overpopulation of some species have had a detrimental effect in some marsh areas.

Muskrat and Nutria

Fresh marshes have the lowest muskrat populations and the highest nutria population. Muskrat numbers generally increase as salinities increase and are most abundant in brackish areas. These two animals can occupy the same area without significant conflict. Their selection of food overlaps on some plant species, but generally nutria feed on coarser vegetation above the ground and the muskrat takes more of its food below the surface in the form of roots, tubers, and rhizomes.

The muskrat is widespread throughout the coastal marshes of south Louisiana. In areas near sea level it builds houses from readily available vegetation. These houses are three to five feet in diameter at the base and two to four feet in height. The main food source for muskrats is vegetation, but small quantities of fish, snails, mussels, insects, crabs and crawfish are also eaten. The preferred vegetation eaten by muskrat include Olney and saltmarsh bulrush, cattail, alligatorweed, roseau shoots, and pickerelweed.

Nutria, a native of South America, was introduced into Louisiana in 1938. By 1943 the species was widespread in the southern parishes, and today the distribution is statewide. In marsh areas nutria feed largely on bulrushes, cattail, alligatorweed, and many other plants. Often a feeding platform of vegetation is erected which is a resting area used during feeding.

Linscombe and Kinler (1985), calculated the differential rates of productivity for nutria and muskrat on fresh, intermediate, and brackish marshes (Table 4). These estimates are in acres of marsh needed to support one furbearer. Nutria were found to be the most productive furbearer with a 3.4 acre to animal unit in the Chenier Plain fresh marsh. Muskrat was found to most productive in the brackish marshes with 8.5 acres per animal unit. This rate is still less than nutria in the brackish marsh with a 7.3 acre per animal unit productivity rate (Table 4). The value per acre for nutria is $1.94, $1.18, and $.90 per acre for fresh, intermediate, and brackish marshes (Table 5) with a total value to the study area of $192,846 per year.. Muskrat value per acre was $.15, $.05, and $.63 per acre for the marsh types with a total value to the basin of $71,725 per year.

Raccoon

Raccoons are found statewide in a wide variety of habitats. They are omnivorous, eating berries, shoots and buds of many different plant species, and consuming crawfish, crabs, snails, clams, frogs, earthworms, and insects.

Raccoon was found to be most productive in the brackish marshes (Linscombe and Kinler 1985). This furbearer needs 68 acres of marsh per animal unit (Table 4) for a value of $.02 per acre (Table 5). The total value of raccoon productivity is estimated at $3,558 per year to the basin.

Mink

Mink live in areas always adjacent to a water source. The largest populations occur in the coastal marsh. They often live in dens abandoned by other animals, such as nutria and muskrat. These nests are lined with soft materials, such as feathers, fur and grass. The diet of the mink is dependent upon the availability of food items. In the coastal area they feed largely on fish, crabs, crawfish and frogs.

Mink was found to be most productive in the fresh marshes (Linscombe and Kinler 1985). This furbearer needs 223 acres of marsh per animal unit (Table 4) for a value of $.02 per acre (Table 5). The total value of mink productivity is estimated at $1,943 per year to the basin.

Otter

Otter occur throughout the state wherever water is abundant. The largest populations occur in the Atchafalaya Basin and coastal marshes. Although they usually dig their own den on the banks of stream, with the entrance hole under water, they have been known to utilize abandoned nutria or muskrat dens. Their diet consists largely of frogs, snakes, fish, turtles, crawfish and crabs, however they will also eat birds, rats and mice.

Otter was found to be most productive in the brackish marshes (Linscombe and Kinler 1985). This furbearer needs 752 acres of marsh per animal unit (Table 4) for a value of $.02 per acre (Table 5). The total value of otter productivity is estimated at $2,834 per year to the basin.

Linscombe and Kinler (1985) examined the fur harvest in the eastern and western zones of Louisiana's coastal marshes. They looked at each of the furbearing species within these zones and determined the amount of acreage necessary for the various marsh types to produce a single individual of these species. These rates according to species and marsh type within the Chenier Plain are depicted in Table 4.

Table 4. Fur Harvest Rates (acres yielding one animal) for Chenier Plain by Vegetative Type[3].

Species	Fresh	Intermediate	Brackish
Nutria	3.4	5.6	7.3
Muskrat	36.0	99.0	8.5
Raccoon	86.0	73.0	68.0
Mink	223.0	329.0	466.0
Otter	2,036.0	1,258.0	752.0

Linscombe and Kinler using fur harvest data placed a dollar value obtainable for each species by acre according to marsh type. Table 5 examines these figures according to species and marsh type within the Chenier Plain.

[3]Data from Linscombe and Kinler 1985, Fur Harvest and Distribution in Coastal Louisiana.

Table 5. Fur Harvest Value (dollars per acre) for Chenier Plain by Vegetative Type[4].

Species	Fresh	Intermediate	Brackish
Nutria	$1.94	$1.18	$0.90
Muskrat	$0.15	$0.05	$0.63
Raccoon	$0.02	$0.02	$0.02
Mink	$0.02	$0.01	$0.01
Otter	$0.01	$0.01	$0.02
TOTAL	$2.14	$1.27	$1.58

Using the value figures developed by Linscombe and Kinler and the acreages of these marsh types (16,400 acres of fresh marsh; 56,000 acres of intermediate; and 105,500 acres of brackish marsh) within the project area, an annual value estimate of $272,906 was obtained for the basin. Table 6 shows this estimate of annual value according to species and marsh type within the project area.

Table 6. Annual Value Estimates of Fur Harvest by Vegetative Type for Calcasieu-Sabine River Basin.

Species	Fresh	Intermediate	Brackish	Total
Nutria	$31,816	$66,080	$ 94,950	$192,846
Muskrat	$ 2,460	$ 2,800	$ 66,465	$ 71,725
Raccoon	$ 328	$ 1,120	$ 2,110	$ 3,558
Mink	$ 328	$ 560	$ 1,055	$ 1,943
Otter	$ 164	$ 560	$ 2,110	$ 2,834
TOTAL	$35,096	$71,120	$166,690	$272,906

Agriculture

Agriculture is a major landuse in the river basin. The 1987 Census of Agriculture shows that 256,000 acres of the river basin's 475,000 acres is in agricultural production of one type or another. Out of the approximately 1200 households in the basin, 442 are involved in agricultural production. Table 7 displays information from the 1982 and 1987 Census of Agriculture:

Table 7. Agricultural Information for Basin in 1982 and 1987.

	1982	1987
Farm Numbers	446	442
Land in Farms	260,012	255,447
Average Size	583	578
Cropland (Farms)	328	295
Cropland (Acres)	67,811	63,048
Woodland (Farms)	21	34
Woodland (Acres)	10,656	6,464
Pasture (Farms)	345	345
Pasture (Acres)	210,981	207,343
Expenses (Avg)	7,921	13,594
Revenue (Avg)	16,175	17,025
Net Returns	8,254	3,431

[4]Data from Linscombe and Kinler 1985, Fur Harvest and Distribution in Coastal Louisiana.

EXISTING RESOURCES

The information indicates that farm number, size, and landuse in the river basin has remained relatively unchanged. The basin contains 63,000 acres of cropland which produce a variety of products. These include corn, rice, soybeans, and forages. The list of forages include alfalfa, grass silage, and other types of haylage. These products are sold as commodities and used on the farm for farm animal production such as cattle, hogs, and poultry. The basin does produce some truck crops which include sweet corn, green cowpeas, green southern peas, and Irish potatoes.

The remaining agricultural land in the river basin is used for forestry and livestock production. The forest land dropped from 10,700 acres to 6,500 acres between the two census's. The forest land is also used for some cattle grazing the basin. The predominant use of agricultural lands in the basin is for cattle grazing. In fact, 207,000 acres or 81 percent of the agricultural lands are for cattle production. A further detailed discussion of rangeland and cattle production is presented in Appendix F.

Mineral Extraction

The importance of oil and gas production can be seen by the number of production fields and infrastructure for transport of these resources (Map 4). The basin contains the following production fields (East to West on Map 4): 1) East Hackberry Oil and Gas Fields; 2) East Mud Lake Oil and Gas Fields; 3) East Holly Beach Gas Field; 4) Second Bayou Gas Field; 5) Mud Lake Gas Field; 6) South Black Bayou Oil and Gas Fields; 7) Southeast Black Bayou Gas Fields; 8) Black Bayou Oil Fields; 9) East Cameron Meadows Gas Field; 10) Cameron Meadows Oil and Gas Fields; 11) Deep Bayou Oil and Gas Fields; 12) Northwest Johnsons Bayou Gas Field; 13) Johnsons Bayou Oil and Gas Field; 14) West Johnsons Bayou Gas Field; and 15) Blue Buck Point Gas Field. The basin is innervated with hundreds of miles of oil, gas, and product pipelines (Map 4).

The number of oil and gas fields and the pipelines display the tremendous investment in extractive industries for the river basin. It also shows the relative importance of this industry to the economy of the basin.

NON-COMMERCIAL

Recreation

The Calcasieu-Sabine study area offers many recreational opportunities, including fishing for both saltwater and freshwater species. The basins hunting resources offer an abundance of migratory and non-migratory waterfowl and various small (rabbits, quail, etc.) and large (deer) game. The basin also offers non-consumptive use of recreation for bird watchers and campers who visit and enjoy the abundance and diversity of the basin's coastal marshes.

Fisheries

The basin's residents and many visitors purchase both saltwater and freshwater fishing licenses to pursue the various species of fish that abound. The marine and estuarine-dependent species include the species listed in the Commercial Fisheries subsection and: 1) Spanish mackerel, 2) blue fish, and 3)

grey snapper. These recreationally important species spend some of their life cycle in Calcasieu Lake and surrounding marshes.

Low-salinity marshes within the study area support an abundance of freshwater sport fishes such as largemouth bass, yellow bass, bluegill, redear sunfish, crappie, freshwater drum, blue catfish, and channel catfish. Trawl samples on the Sabine National Wildlife Refuge have routinely demonstrated that freshwater fishes and estuarine-dependent species simultaneously occupy the same habit. Depending upon the season bay anchovies, naked gobies, hogchoker, Atlantic croaker, Gulf menhaden, blue crab, and white shrimp were frequently caught in trawl samples containing freshwater fishes. These samples were taken in waters with salinities of up to four ppt.

The geographic distribution of freshwater fisheries in tidally-influenced areas is largely dependent upon isohalines (ridges of constant salinity). During high rainfall years, red swamp crawfish are occasionally abundant within the tidally-influenced low-salinity marshes.

During 1991, an estimated 58,000 anglers fished the interior marshes on Sabine National Wildlife Refuge for freshwater game species. This occurred during the 26-week long period in which public fishing is allowed in the refuge (SNWR 1991).

Hunting

The Calcasieu-Sabine study area is blessed with vast and diverse hunting resources. This section will concentrate on waterfowl, and selected small and large game species.

Waterfowl

The study area is part of the Mississippi River and Flyway Flyway and winters millions of migratory waterfowl every year. The basin also contains the non-migratory duck, mottled duck, which makes its home in the Louisiana coastal marshes (Table 8).

Ducks. Ducks actually favor the fresh and intermediate marsh areas, but if the food supply and water conditions are suitable, the brackish marshes may also be utilized.

Most marsh management for ducks involves puddle ducks rather than diver ducks, which prefer deeper lakes and bays (Table 8). Water depth is a critical factor to consider in management for ducks. If a marsh is dry, or if the water is too deep, puddle ducks will not utilize the area. Normally fifteen inches of water cover is the maximum feeding depth for puddle ducks.

The earlier successional stages of plant species furnish the greatest abundance of duck food. Saltgrass and tender shoots of marshhay cordgrass are good food items. Excellent food plants are Olney bulrush, saltmarsh bulrush, and widgeongrass. A program of prescribed burns in selected areas favors the growth of larger stands of the bulrushes and tender leaf growth in marshhay stands.

Table 8. Common Species of Waterfowl in the Calcasieu-Sabine Basin[5].

Common Name	Scientific Name	Migratory	Type	Chenier Plain (%)
Gadwall	Anas strepera	Yes	Puddle	23.0
Green-winged Teal	Anas crecca	Yes	Puddle	21.2
American Wigeon	Anas americana	Yes	Puddle	18.5
Northern Pintail	Anas acuta	Yes	Puddle	19.5
Mallard	Anas platyrhynchos	Yes	Puddle	10.7
Northern Shovler	Anas clypeata	Yes	Puddle	4.5
Mottled Duck	Anas fulvigula	No	Puddle	1.5
Blue-winged Teal	Anas discors	Yes	Puddle	0.9
Lesser Scaup	Aythya affinis	Yes	Diver	
Greater Scaup	Aythya marila	Yes	Diver	
Ring-billed Duck	Aythya collaris	Yes	Diver	
Redhead	Aythya americana	Yes	Diver	
Canvasback	Aythya valisneria	Yes	Diver	
Bufflehead	Bucephala albeola	Yes	Diver	
Common Goldeneye	Bucephala clangula	Yes	Diver	
White-fronted Goose	Anser albifrons	Yes		
Snow Goose	Chen caerulescens	Yes		
Ross' Goose	Chen rossii	Yes		
Canada Goose	Branta canadensis	Yes		

Geese. Southwestern Louisiana is a primary wintering area for geese, and is of special importance for Snow Geese. All geese that winter in Louisiana (Table 8) are primarily grazers. Favorite food types are rice, rice sprouts, Olney bulrush, saltmarsh bulrush and the leaves of freshly burned marshhay cordgrass. The brackish marsh is the favorite zone for geese since Olney and saltmarsh bulrushes are common there.

A fair food plant for geese is smooth cordgrass. The burning of brackish areas from September to February favors the production of tender young shoots and clears the ground of heavy roughage so the geese can get to the roots and tubers of marsh plants. Burning encourages the growth of the bulrushes and results in the production of tender leaves of marshhay cordgrass.

A good management practice for geese is the initiation of a prescribed burn two or three weeks before the arrival of geese into the area. A series of these burns two or three weeks apart can be spread over the winter months to assure the continuing production of young and tender vegetation.

Other

The marsh provides food and cover for many important hunting species. These include large game such as whitetail deer, small game such as rabbits and birds such as quail and dove. This section will concentrate on whitetail deer and swamp rabbit.

Whitetail Deer. The whitetail deer is found in all areas of Louisiana where suitable habitat is present. The extent of the home range of the animal varies seasonally. During most of the year, the range varies from 300 to 600

[5]Puddle ducks percentages are from A.W. Palmisano 1972.

acres. With the advent of the breeding season, males will move further in search of receptive females.

Deer are completely herbaceous in their food habits and the number of plant species they are known to consume is over one hundred. In the marshes, their diet consists of tender marsh vegetation and browse from bushy canal spoil banks and natural levees and bayous.

Deer living in marsh areas are normally found in greater numbers in fresh and intermediate locations. Their numbers diminish in brackish areas and they are seldom found in saline marshes. Like many other species, deer utilize bushy cover found on spoil areas. Deer in these areas usually feed in the marsh and retreat to the bushy cover to escape enemies or to find shaded resting places. Care should be taken to avoid the burning of these areas during prescribed burning procedures.

Swamp Rabbit. The swamp rabbit differs from the eastern cottontail in that it is larger and has a darker coat color. The species is found in all parts of Louisiana. It tends to thrive best in coastal marshes and areas that are heavily wooded. In marshes, the swamp rabbit populations are heaviest in areas where canal banks and wooded ridges provide good cover, but it will also live in a cover of roseau cane, paille fine, or Olney bulrush. Nests are constructed in shallow depressions on the ground and are made of a mixture of grass and rabbit hair.

This species is herbivorous and will utilize food types such as grasses, sedges, cane and aquatic emergents. They usually feed at night, but at particular times, like after a rainfall, the swamp rabbit may be seen feeding in the daylight hours.

Visual Utilization (Non-Consumptive Use)

The basin study area has a diverse ecosystem and culture that offers opportunities to see historical land marks and natural habitat. The beauty of wildlife can be seen along nature trails and tours. One can see alligator, various species of migratory and non-migratory birds, and other wildlife species foraging in the basin marshes. A listing of known animals that occur in the basin is in Appendix B.

The National Register of Historic Places lists Sabine Pass Lighthouse (C81000290) located on Light House Bayou along Sabine Pass in the southwestern corner of the study area. It was used in the Civil War. The basin has many archaeological sites ranging from burial mounds to shell middens. Johnsons Bayou has three known burial mounds that have been excavated and contained bones, pottery, and projectile points.

The basin area has legends of several treasure burial sites that have been found by residents, some in their back yards[6]. The basin also offers several campsites along the beaches and around the town of Hackberry.

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[6]Cameron Parish Rural Development Committee, 1970. Appraisal of Potential for Outdoor Recreation for Cameron Parish.

EXISTING RESOURCES

Nature trails offer a unique opportunity to observe wildlife in their native habitat. Nature photography and bird watching are just two of the many opportunities offered along these trails.

Bird watching is a major attraction in the area bringing visitors from many states. During migration periods species congregate in the area prior to crossing the Gulf, and on their return gather reserves to continue northward. The Louisiana Ornithological Society holds annual meetings in the parish, and many unusual western species are recorded by these avid birders. The coastal wetlands of Louisiana provide habitat for some of the largest concentrations of nesting egrets, herons and ibises in North America. These species along with shore birds and marine species add interest to those enjoying this sport.

Christmas Bird Counts (CBCs) were started in the northeastern states in 1901 with 25 counts conducted by 27 participants. In 1916 a 15 mile diameter circle was designated as the standard count area. Since then the counts have increased to include all states within the United States, Canada, Mexico, and Central America. In 1992 a total of 1,646 counts were conducted and published in American Birds. The basin area contains two CBCs. The Sabine count was first held in 1943 (Appendix D), and the Johnsons Bayou count was begun in 1976 (Appendix E). These appendices contain the species found on these counts each year.

Table 9. Threatened and Endangered Species Potentially in Basin Area[7].

Common Name	Scientific Name	Class
Loggerhead sea turtle	Caretta caretta	T
Atlantic (Kemp's) Ridley's turtle	Lepidochelys kempii	E
Hawksbill sea turtle	Eretmochelys imbricata	E
Green turtle	Chelonia mydas	T
Leatherback turtle	Dermochelys coriacea	E
Southern Bald Eagle	Haliaeetus leucocephalus	E
Arctic Peregrine Falcon	Falco peregrinus tundrius	E
American Brown Pelican	Pelecanus occidentalis	E
Eskimo Curlew	Numenius borealis	E
Least Tern	Sterna antillarum	E
Piping Plover	Charadrius melodus	T
Red wolf	Canis rufus	E
Finback whale	Balaenoptera physalus	E
Humpback whale	Megaptera novaeangliae	E
Sei whale	Balaenoptera borealis	E
Sperm whale	Physeter catodon	E
Right whale	Eubalaena glacialis	E

The possibility exists that some endangered or threatened species may be found within or adjacent to the basin area. Table 9 provides a listing of theses species. The large turtles occur in tropical seas and may turn up at beaches or in bays. No nests of the Southern Bald Eagle have been found in the southwestern part of Louisiana, however, since they feed on both live and dead fish the habitat is suitable and could be part of their nesting range. Like the Bald Eagle, the Peregrine Falcon has not been reported as nesting, but

[7]Endangered and Threatened Species of the Southeastern United State (The Red Book), 1992. "T" stands for a threatened species classification and "E" stands for an endangered species classification.

they are likely to be observed along the Gulf shores attempting to catch gulls, terns, sandpipers, or plovers. Nesting colonies of the American Brown Pelican have been reestablished in the southeastern part of Louisiana, and sightings are possible along the shore. The Eskimo Curlew migrates from Argentina to Alaska, with the eastern edge of its spring migration path just touching Louisiana, therefore it is possible that it might be observed within the basin area. The Piping Plover has been declining since the 1950's with the inland nesting habitat greatly threatened. The Least Tern is still fairly common in the coastal areas, however the interior population is endangered. The range of the Red Wolf has drastically decreased with the study area encompassing the remaining possible range as of 1970. The whales might be sighted just offshore, or perhaps accidently moving into the deeper lakes or bays.

WATER QUALITY

The Calcasieu-Sabine River Basin study area is surrounded by water bodies and watercourses and is innervated with bayous and canals. Investigation of Louisiana Department of Environmental Quality (LDEQ) report on water quality inventory for 1992 shows that all water bodies and watercourses are fully supporting designated uses for primary and secondary contact. This information is for LDEQ sampling stations within the basin study area.

A problem does exist in the basin interior marshes with turbidity. The suspended soil particles in the water column due to soil transport of eroded particles reduces water clarity. The effect of reduced water clarity impacts light penetration into the water column and thus decreases submerged aquatic vegetative productivity. This reduced productivity leads to additional open water in the marshes and decreased habitat for waterfowl and estuarine-dependent organisms.

SOCIAL, CULTURAL, AND ECONOMIC

The Calcasieu-Sabine Cooperative River Basin study area includes two political districts: 1) District 1 - Johnsons Bayou; and 2) District 2 - Hackberry. These districts contain close to half of the land resources of Cameron Parish and one-third of the population. The area population, education level and employments statistics are below:

Table IO. Population and Education Estimates from 1990 Census.

	Population	above 25 Years of Age	25+ with High-school Education	25+ with College Education
State Average			68.3%	16.1%
Dist. I	1,147	622	64.8%	6.4%
Dist. 2	1,730	1,067	67.9%	10.2%

Table 10, above, reflects that people of the basin are similar to the state average as far as adults with High-school educations. However, the percent of college educated residents is below the state average. This may be a result of the types of industries within the basin study area. Table 11 below, shows that the percent of residents in some work status similar to the state average, but that the rate of employment and overall income is above the state

average. The summation of these results would indicate a predominantly highly skilled, well paid blue collar work force.

Table 11. Labor and Median Income Estimates from 1990 Census.

	Labor Force	Percent in Labor Force	Percent Unemployment	Median Income
State Average		59.3%	9.6%	$21,949
Dist. 1	768	58.7%	8.2%	$20,735
Dist. 2	1,301	57.8%	5.5%	$25,677

The marsh is extremely valuable to the local economy, the parish, the state, and the nation. Louisiana has 40 percent of the nations coastal marshes and is experiencing 80 percent of the nation's annual loss of coastal marshlands. The economy is basically extractive with oil and gas extraction, and export of farm raw products. The basin also has tremendous amounts of wildlife and fisheries of commercial and recreational value.

Oil and Gas Resource

Oil and gas extraction are the major direct sources of income through tax revenues as well as corporate and personal income. In 1985, 16 percent of the nation's oil and 29 percent of natural gas production came from the Louisiana coastal marsh. This volume of hydrocarbon extraction translated into $27.1 billion (United States Army Corps of Engineers, no date).

In assessing the importance of hydrocarbon revenues to energy companies, corporate, individual, and parishes, that the best interest of these entities is to keep the marsh intact (Van Beek et al., 198x),

> Under present state laws, oil and gas royalties are derived by the parish from production under parish-owned lands. Ownership of lands is determined by present shoreline positions where water bodies are involved, unless a fixed boundary has been established under Act 839 of 1984. Accordingly, the continued value of oil and gas resources with regard to income to the parish may in some cases be dependent on the present distribution of wetlands and associated shoreline locations (1986:2-57).

What this means is that if marshland converts to open water, ownership can revert to the state government. This decreases parish tax revenues and results in a loss of land rights to previous owners of the marshlands. Shoreline modifications can change who receives tax revenues and well ownership.

The state owns all in-shore water bottoms, while, the federal government owns all water bottoms beyond the three mile limit of the Gulf coast to international waters. The state has a set three mile limit which means regardless of the shoreline retreat that state water bottoms will not be lost to the federal government.

The change in the shoreline results in a major reduction in revenues to the parishes and thus, local communities. The monetary, social, and political effects of the marsh's erosion would cause massive changes in the fabric of social relationships within the area. Unemployment and

underemployment would likely rise, and with it, federal expenditures would need to increase on programs such as welfare, food stamps, housing subsidies, etc.

Fisheries

Louisiana provides 36 percent of the nation's volume of commercial fisheries with value of $680 million annually, and 40 percent of the wild fur and hide harvest with an annual value of $17 million (Corps of Engineers, Crisis on Louisiana's Coast. America's Loss). The marsh provides a nursery ground for estuarine species such as, white and brown shrimp, red drum, blue crab, speckled trout, spot, and menhaden.

The basin has several fisheries processing plants for shell fish and fin fish. The Port of Hackberry serves as the primary shrimp dock for shrimp boats under thirty feet in length which fish mainly in inland water of Calcasieu Lake, Black Lake, and the Calcasieu Ship Channel. Both white and brown shrimp are important to the inland shrimp industry. Holly Beach has a menhaden processing plant for processing these fish into meal and oil.

The oyster industry is another important commercial fishery which seasonally provides an important source of income to many parish fishermen. Oysters are primarily harvested from reefs located in Calcasieu Lake, and are processed at three of the five parish oyster shucking plants located in Hackberry. Hackberry also has three volume buyers of live crabs where the majority of commercially caught blue crabs are sold.

Wildlife

The importance of the marsh for its diversity in fish and wildlife also provides opportunities for consumptive and non-consumptive recreation. The marshes of southwest Louisiana are a resting place along the Mississippi Flyway for many waterfowl. Hunters may spend up to $3,000 to lease a duck blind for a hunting season. Many residents in and around the river basin purchase hunting and fishing licenses for consumptive recreation. Also, some residents will go visit the marsh for non-consumptive recreation such as sightseeing or bird watching. These hunters, anglers, and wildlife observers purchase many goods and services which provide revenue to both vendor and taxing authorities.

Agriculture

The area also contains agricultural resources which generates revenue and provides for a culturally rewarding way of life. The basin has several thousands of acres of forest and agricultural land. The lands produce row crops such as corn, soybeans, rice and haylage. A large percent of agricultural land is being used for cattle production.

The agricultural acreage (Table 3) for the basin is 260,000 acres in 1982 and 256,000 acres in 1987. The total farm sales for 1982 and 1987 were $7,214,000 and $7,508,000, respectively. Most of the land is in pasture land, hence the importance of livestock production within the basin's agricultural community.

EXISTING RESOURCES

In 1991, the Louisiana beef cattle industry had a gross farm value of about $287 million. Cameron Parish has the second highest number of beef cattle in the state with over 36,000 head. The cattle industry in Cameron Parish had a $14 million gross farm value in 1991. About half of the livestock in Cameron Parish are headquartered or spend a portion of the year grazing in the basin. In addition, a large number of cattle headquartered in Calcasieu Parish spend a portion of the year grazing in the CSRB area. The gross farm value for these cattle is attributed to Calcasieu Parish.

Almost all of the cattle in the river basin are in the cow-calf phase of the industry. Weaned calves are sold as rodeo roping calves or as weaning calves. Very few calves are kept in the stocker calf phase. Therefore, most of the value added economic returns from livestock are derived outside the river basin area.

Agriculture influences the culture as well as the economy of the basin. It is estimated that 1200 households reside in the study area with 442 of these associated with agriculture. This influence extends from the home to school activities.

The family unit is evident in the livestock operations in the basin. Often one family member is responsible for the day to day management of the livestock enterprise while actual ownership is distributed between various family members. Its not unusual to find 5 or 6 ownership brands in one herd of cattle. Family members and neighbors pool their labor and resources to carry out the major management endeavors such as moving, working, and marketing livestock.

Youth activities in the basin are highly influenced by the agriculture and livestock industry. Participation in 4-H, FFA, and High School Rodeos are major activities for a large percentage of the area youth.

PROBLEMS

The objective of this section is to list the problems of the study area, then discuss historical events that lead to the present conditions, and describe the impacts of the historical events. The subsections will be Problems, Historical Events, and Impacts of Historical Events.

PROBLEMS

The problems associated with the Calcasieu-Sabine River Basin are both natural and man-made. The natural occurrences are apparent sea level rise, saltwater intrusion, increased water level fluctuations, and shoreline erosion. The man-made events are saltwater intrusion, increased water level fluctuations, rapid freshwater removal, ponding, and erosion of interior marsh. Some of the man-made problems are the same as natural occurrences because they are aggravated by man-induced changes to hydrology.

Natural Occurrences

Several factors that cause marsh loss occur naturally. These include relative sea level rise, subsidence, tides, saltwater intrusion, and shoreline erosion.

Relative sea level rise

The described as the net sum of subsidence and global sea level rise. Relative sea level rise impacts the design, construction, and operation of water resource projects and the regulation of natural resources in Louisiana, both in water control operations and permit authority.

In 1929, Mean Sea Level (MSL) at Biloxi, Mississippi, was used to determine the zero elevation for the North American Sea Level Datum (in 1978 this was renamed National Geodetic Vertical Datum (NGVD), of 1929). Thus in 1929, zero NGVD was equal to MSL at Biloxi and was used to establish the vertical control for the North American Continent. In recent years, as a result of subsidence, global sea level rise, and possibly other geologic factors, the mean elevation of local sea level has increased with respect to NGVD.

A report entitled Relative Sea Level and Subsidence in Louisiana and the Gulf of Mexico by the Louisiana Geological Survey (LGS), dated 1989, establishes the disparity between local Mean Sea Level and NGVD in terms of relative sea level rise. Tide data collected by the National Oceanic Service (NOS) and the United States Army Corps of Engineers, New Orleans District, are the basis for the LGS study. The study showed the relative sea level rise in Galveston, Texas (approximately 100 miles from the study area) had a rate of .62 centimeters per year.

Subsidence

The term is defined as the net effect of numerous processes that result in the downward displacement of land relative to a fixed datum. These processes include but are not limited to, sediment compaction; regional downwarping of the Gulf Coast Geosyncline; and local sources of subsidence which may be associated with the environments of deposition, faulting, salt extraction, and man-induced processes related to subsurface fluid withdrawal and drainage. The LGS study, discussed above, showed the subsidence rate for Cameron and

Hackberry to be .42 and .32 centimeters per year after correction for the Gulf of Mexico Sea Level Rise.

Tides

Along the coast of Louisiana, the range, timing, and extent vary with the meteorological conditions, plan form of the shoreline, and seasonal freshwater runoff. Astrological tides are generally semi-diurnal along the Chenier Plain, thus the study area.

Tides and storm surge resulting from the wind blowing over the waters of the Gulf, bays, and lakes. Generally the term wind-tide is used to describe set-up of the water surface in a lake or on the open coast of the Gulf or a bay. On the open coast, an onshore wind of 10 miles per hour can increase the tide by one foot. Usually tidal currents are 1/2 foot to one foot per second or less.

Saltwater intrusion

Saltwater intrusion is the result of an insufficient freshwater hydraulic head (flow) to push higher saline waters gulfward. It has been exacerbated by navigation channels and resulted in local salinity peaks that enter interior marshes via canals which increase vegetative loss. The result of saltwater intrusion into a marsh can cause stress or death of an emergent vegetative community. If plant death results, then the plant roots will detach from the soil substrate and leave the exposed soil vulnerable to erosive conditions. The eroded soil then becomes suspended in the water column which increases turbidity and decreases light penetration necessary for productivity of submerged aquatic vegetation. Thus, eroded areas have a lower probability of becoming productive waterfowl and fisheries habitat due to lowered light penetration and thus become open water.

Shoreline erosion

This erosion is the result of several factors combined to produce erosion along the coastline and waterbody and waterway boundaries. Much of the erosion can be prevented and controlled. Currents and waves can be prevented from eroding banks and shorelines by using hardened structures such as bulkheads and revetments. In low energy areas, banks, levees and lake rims can be strengthened by levee refurbishment, vegetative plantings, and wave dampening devices.

Reduced Organic Production

This is one of the problems which causes a marsh to not keep pace with subsidence. Organic production is the build-up of a marsh via its own vegetative production in fresh and low salinity marshes. As the natural process of soil subsidence occurs, organic material or introduced sediments must be deposited to maintain proper elevation for wetland plant survival. The inability of marsh vegetation to keep up with subsidence can be a factor in the loss of fresh and low salinity marsh.

PROBLEMS

Herbivores

These plant eating animals, are a cause of marsh denuding and marsh loss to open water in coastal Louisiana. Scientific evidence indicates that, under certain conditions, grazing of marsh and cypress/tupelo swamp by nutria (Myocaster coypus) and muskrat (Ondatra ziberthicus) 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 in 1938. Many people believe that nutria are causing much greater damage than muskrats because they are more numerous, they occur in 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 and muskrat is considered a very serious threat to marshes. 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. However, due to the worldwide downturn in the fur industry they now have a very reduced economic value and the populations are expanding rapidly.

Hurricanes

These storms strike the Louisiana Gulf Coast on the average of once in 4 years, though locations and frequencies at any one location are longer. High winds, waves and water levels (often exceeding 10 feet) are detrimental to beaches.

Major storms can cause direct losses to wetlands, especially to areas that are vulnerable or in the process of deterioration. In addition, hurricanes can force large volumes of saltwater into interior marshes, where they can cause acute stress to fresh and intermediate vegetation (Coleman et al., 1986). However, hurricane-borne sediments are an important resource in some areas, such as the Calcasieu/Sabine basin. The value of wetlands in protecting resources and reducing economic impacts from hurricane damage is often apparent when storm surge energy is blunted by marshes. Between 1917 and 1979, about 7 hurricanes made land fall at Cameron Parish. The most sever being Hurricane Audrey which was a category 4 storm carrying wind speeds up to 144 miles per hour when it landed on June 25, 1957.

Man Induced Problems

Several problems associated with marsh loss are the result of man's activities or natural problems which are magnified due to man's activities. The problems that are exacerbated by man's activities are saltwater intrusion and interior

marsh erosion. The problems which are more of result of man's activities are increased water level fluctuations, rapid freshwater removal, and ponding.

Saltwater intrusion

This is the result of an insufficient freshwater hydraulic head to push higher saline waters Gulfward. However, the result of deepening connections to the Gulf of Mexico for navigation and the dredging of access canals for natural resource extraction has exacerbated the problem. The deep channels dredged for navigation allow for entrance of the saline waters throughout the year. This is due to the fact that higher saline water have greater densities than fresher water and thus travel lower in the water column. Therefore, deep draft navigation has provided avenues for saltwater intrusion higher in the basin than would naturally occur.

Dredging of access canals for natural resource extraction purposes has created more connections between the water bodies and waterways that carry more saline water to inland marsh areas. These canals have helped to exacerbate interior marsh erosion by providing direct avenues for saltwater into these interior marshes.

Increase water fluctuation

This is defined as the increased tidal exchange and range within a hydrologic unit than would naturally occur. This is a result of excessive openings, exchange points, into a marsh area which allow for greater tidal influence than would normally occur. The greater tidal range increases the erosive force of water movements in the marsh area and thus detach soil particles and wash away vegetation. The problem is most noticeable during frontal passages when strong winds resuspend/erode soils and outgoing tides flush material out of the marsh.

Rapid freshwater removal

This result of rapid freshwater removal is a reduction the hydraulic head, flow, necessary to keep saltwater from entering an area. This is the result of increased openings into a hydrologic unit that would not occur naturally. These excessive openings allow for an increased rate of discharge of freshwater from a marsh system, thus greater chance of saltwater intrusion.

Ponding

This term is defined as excessive water levels in an marsh environment. The excessive water levels stress and eventually kill marsh vegetation which increases the opportunity of soil detachment thus erosion.

Erosion of interior marsh

This is the result of several factors, saltwater intrusion; increased water level fluctuations; and ponding of marsh. These factors can work independently or in a cumulative fashion. Saltwater intrusion can stress or kill lower salinity tolerant communities. Increased water level fluctuations can provide greater erosive force due to tides or wave fetch. Ponding can

stress or kill vegetative communities and eventually convert emergent vegetative communities to aquatic communities or open water.

HISTORICAL EVENTS

The history of the study area had been dominated by the implementation of three federal navigation projects. Two of the projects, the Sabine-Neches Waterway and the Calcasieu Ship Channel, were begun during the 1870's. In 1910 Congress authorized the construction of the Inland Waterway, which created the Gulf Intracoastal Waterway. Besides navigation, The area has also been developed for mineral extraction.

A chronological listing has been prepared for each of the navigation projects. Another chronological listing of activities has been developed for other historical events in the basin that have had a major influence on the basin ecosystem. Each of these events have led to changes in basin hydrology either basin wide or for large land areas within the basin.

Calcasieu Ship Channel

Prior to navigation improvement projects, a series of natural 3 to 5-foot-deep bars and shell reefs located in Calcasieu Lake at the head of Calcasieu Pass, hindered commercial commerce on the Calcasieu River system (Cameron Parish Pilot 1988, United States Army corps of Engineers 1891 and 1912). A 80-foot-wide by 5-foot-deep channel was dredged through those bars in 1874. Because of resilting, that channel was redredged 3 times during the 1880's (United States Army corps of Engineers 1891 and 1912). In 1893, an 8-foot-deep channel was dredged through the lake bars at the head of Calcasieu Pass. To facilitate maintenance of that channel, a revetment on either side of that channel was also constructed (United States Army Corps of Engineers 1912). That channel was redredged in 1894, 1898, and 1902. During 1906 and 1907, that channel was enlarged to 100-foot-wide, 7-foot-deep, and 4.5 miles long. The revetment was also rebuilt (United States Army Corps of Engineers 1912).

Table 12. Calcasieu Ship Channel

Year	Activity
1874	Dredged channel to 80 ft. wide and 5 ft. deep (COE 1891 and 1912).
1880's	Redredged channel five times because of siltation (COE 1891 and 1912).
1893	Dredged lake bars at head of Calcasieu Pass to 8 ft. deep and constructed a revetment on either side of channel (COE 1912).
1894-1902	Dredged channel three times (COE 1912).
1900	Jetties 1.5 miles in length were placed at the mouth of Calcasieu Pass (COE 1923).
1903	Dredged a channel 12 ft. deep and 200 ft. wide between the jetties at the mouth of Calcasieu Pass (COE 1923).
1906-1907	Channel was enlarged to 100 ft. wide, 7.5 ft. deep and 4.5 miles long. The revetment was reconstructed (COE 1912).
1941	Calcasieu Ship Channel was complete. It was 30 ft. deep and 250 ft. wide. The Channel ran from Lake Charles through portions of Calcasieu Lake through Long Point Lake, and into the Gulf of Mexico to the 32 ft. depth contour (COE 1951).

1951	Channel was enlarged to 35 ft. deep and the jetties were extended into the Gulf of Mexico to the 10 ft. depth contour. The jetties were 8,050 and 8,620 ft long respectively (COE 1951).
1968	Channel was enlarged to a depth of 40 ft. and a bottom width of 400 ft. (COE 1985).

A series of 5 to 6-foot deep bars in the Gulf at the mouth of Calcasieu Pass also hindered commercial navigation (United States Army Corps of Engineers 1912). To overcome that hinderence, a pair of converging 1.5-mile-long jetties were constructed into the Gulf from the mouth of Calcasieu Pass and were completed in 1900. Excavation of a 12-foot-deep by 200-foot-wide channel from the Gulf, between the jetties, and to the foot of the pass was also completed in 1903 (United States Army Corps of Engineers 1923).

Shallow bars at the north end of Calcasieu Lake, at the mouth of the Calcasieu River, also hindered commercial navigation. By 1893, an 8-foot-deep channel was excavated through those bars and revetments were constructed on either side (United States Army Corps of Engineers 1923).

During 1941, the Lake Charles Ship Channel (Calcasieu Ship Channel) was completed (United States Army Corps of Engineers 1951). This 30-foot-deep, 250-foot-wide (bottom width) channel extended from Lake Charles, Louisiana, through portions of Calcasieu Lake through Long Point Lake, and into the Gulf, to the 32-foot-depth contour. During 1951, the channel was enlarged to a depth of 35 feet and jetties were extended into the Gulf to the 10-foot-depth contour. The west jetty was 8,050-foot-long. The east jetty was 8,620-foot-long (United States Army Corps of Engineers 1951). The channel was again enlarged in 1968 to a depth of 40 feet and bottom width of 400 feet (United States Army Corps of Engineers 1985).

Sabine-Neches Waterway

Federal projects to improve navigation through Sabine Pass and Sabine Lake were begun during the late 1800's. Prior to those projects, it was determined that the river mouth bars of soft mud, 5 to 6-foot-deep, hindered passage of vessels between the Gulf and Sabine Pass. Consequently, during the late 1870's, several dredging projects were implemented in an attempt to improve navigation across the river mouth bars. Because of equipment breakdowns and resilting, those projects were of little success (United States Army Corps of Engineers 1977). Subsequently, army engineers recommended that jetties be constructed in lieu of additional channel dredging projects. Construction of the east jetty was completed in 1920 and the west jetty in 1929. As a result of jetty construction, a 25-foot-deep channel was scoured through the river mouth bars between the jetties (United States Army Corps of Engineers 1977).

Table 13. Sabine-Neches Waterway

Year	Activity
1870's	Several dredging projects were implemented, but were of little success due to equipment breakdown and resilting (COE 1977).
1890's	Rice farming became a thriving business along Taylor's Bayou.
1897-1899	Kansas City Railroad, Gulf Railroad, and the Port Arthur Channel and Dock Company dredged a 75 ft. wide by 25 ft. deep canal from the north end of Sabine Pass to Taylor's Bayou (COE 1977).

PROBLEMS

1901	Rice growers along Taylor's Bayou suffered saline contamination to their irrigation water. The water contamination was due to a combination of a drought, increased drain on the freshwater supply, and modifications to the Port Arthur Canal. Later that year saltwater contaminated irrigation water was found in the Neches River above Beaumont (COE 1977).
1901	Oil was discovered south of Beaumont at what is now known as the Spindle Top Oil Field. The Sabine and Neches Rivers, which are in close proximity to one another, had a increasing demand for navigational use due to industrial demands and associated demands (COE 1977).
1906	The Federal government acquired, free of charge, the privately dug Port Arthur Canal (COE 1977).
1908	The Sabine-Neches waterway excavation was complete to a 9 ft. depth by 100 ft. wide channel. The channel extended north from Port Arthur Canal to the west side of Sabine Lake, up the Neches River to Beaumont, and up the Sabine River to Orange, TX (COE 1977).
1912	The Port Arthur Canal became part of the Sabine-Neches Waterway (COE 1977).
1916	A project to deepen the Sabine-Neches Waterway to 25 ft. was complete. A saltwater barrier was installed 6 miles north of Port Arthur to reduce problems of saltwater contamination to freshwater supplies (COE 1977).
1920-1929	Construction of the east and west jetties were completed in lieu of dredging. As a result of jetty construction, a 25 ft. deep channel was scoured through the river mouth bars between the jetties (COE 1977).
1922	Legislation was authorized to modify the existing Port Arthur Canal and the Sabine-Neches Waterway to 30 ft. deep and 150 ft wide (COE 1947 & 1989).
1922	Sabine-Neches Canal was widened from 100 ft. to 125 ft. (COE 1977)
1923	After a salinity study, the Corps of Engineers concluded that the lock should be removed. Subsequently, a bypass channel was constructed around the lock (COE 1977).
1927	Widening of the Port Arthur Canal to 200 ft. and the Sabine-Neches Waterway, below the mouth of the Neches River, to 150 ft. was authorized.
1935	Port Arthur Canal was authorized for a width of 250 ft. and a depth of 34 ft. The Sabine-Neches Waterway was also authorized for a width of 250 ft. and a depth of 32 ft. (COE 1947).
1938	Congress authorized the enlargement of the Port Arthur Canal to 400 ft. and Sabine-Neches to 350 ft. (COE 1947).
1946	Legislation was passed authorizing the deepening of the Sabine Pass outer bar channel to 37 ft., the deepening of the Port Arthur Canal and Sabine-Neches Waterway to 36 ft., the widening of the Sabine-Neches Waterway to 400 ft., and widening that segment of the Sabine-Neches Waterway between the Sabine and Neches Rivers to 150 ft. (COE 1982).
1972	Authorized improvements were completed that provided a 500 ft. wide by 40 ft. deep channel from the Gulf of Mexico to Port Arthur, a 400 ft. wide by 40 ft. deep channel from Port Arthur, up the Neches River to Beaumont, and a 200 ft. wide by 30 ft. deep

channel from the mouth of the Neches River up the Sabine River to Orange (COE 1982).

During the period 1897 through 1899, Kansas City Railroad, Gulf Railroad, and the Port Arthur Channel and Dock Company dredged a 75-foot-wide, 25-foot-deep canal from the north end of Sabine Pass to Taylor's Bayou. This canal, the Port Arthur Canal, was dredged several hundred feet inland from the edge of Sabine Lake, along the southwest bank of Sabine Lake (United States Army Corps of Engineers (1977). During the mid to late 1890's, rice farming along Taylor's Bayou had became a "booming business." A drought in 1901, together with increased drain on the freshwater supply and modifications due to the Port Arthur Canal, caused rice growers along Taylor's Bayou to suffer saline contamination of their irrigation water for the first time. Later that same year, saltwater contaminated irrigation water in the Neches River above Beaumont, Texas (United States Army Corps of Engineers 1977). Thereafter, area rice farmers began to oppose future navigation projects and began calling for a saltwater protection structure in either Taylors Bayou or the Port Arthur Canal (United States Army Corps of Engineers 1977).

In 1901, oil was discovered south of Beaumont, Texas. Because the Sabine and Neches Rivers were located near the newly discovered Spindletop Oil Field, industrial development and associated demands for navigation grew rapidly. Consequently, the Sabine-Neches Waterway, a 9-foot-deep, 100-foot-wide channel, was completed in 1908 (United States Army Corps of Engineers 1977). This channel extended northward from the end of the Port Arthur Canal, along the west side of Sabine Lake, up the Neches River to Beaumont, Texas, and up the Sabine River to Orange, Texas. In 1906 the federal government acquired, free of charge, the privately dug Port Arthur Canal. Maintenance of the Port Arthur Canal became a responsibility of the Army Corps of Engineers and that canal became part of the Sabine-Neches Waterway in 1912 (United States Army Corps of Engineers 1977).

Because of the area's rapid commercial growth, interests along the Sabine-Neches Waterway were soon requesting that the channel be deepened to 25 feet. Fearful that the deepened channel would cause further saltwater contamination of their freshwater supplies, area rice farmers were successful in including in the proposed project, a saltwater barrier (saltwater guard lock), to be located 6 miles north of Port Arthur, Texas (United States Army Corps of Engineers 1977). During 1916, the deepening of the Sabine-Neches Waterway and construction of the guard lock was completed. The guard lock was not successful in halting all saltwater intrusion up the Sabine-Neches Waterway. Additionally, it created a navigation problem on the busy waterway. After a salinity study, the Corps concluded in 1923 that the lock should be removed. A bypass channel was constructed around the guard lock, and the lock was removed during 1952 and 1953 (United States Army corps of Engineers 1977).

In 1922, the Sabine-Neches Canal was widened from 100 to 125-foot-wide (United States Army Corps of Engineers 1977). During 1922, legislation was authorized to deepen to 30 feet, and widen to 150 feet, the existing Port Arthur Canal and the Sabine-Neches Waterway (United States Army Corps of Engineers 1947 and 1989). In 1927, the widening of the Port Arthur Canal to 200 feet and the Sabine-Neches Waterway, below the mouth of the Neches River, to 150 feet was authorized. In 1935, the Port Arthur Canal was authorized for a width of 250 feet and a depth of 34 feet. The Sabine-Neches Waterway was also authorized

for a width of 250 feet and a depth of 32 feet. In 1938, Congress authorized the enlargement of the Port Arthur Canal to 400 feet, and the Sabine-Neches Waterway to 350 feet (United States Army Corps of Engineers 1947). In 1946, legislation was passed authorizing the deepening of the Sabine Pass outer bar channel to 37 feet, the deepening of the Port Arthur Canal and Sabine-Neches Waterway to 36 feet, the widening of the Sabine-Neches Waterway, to 400 feet, and widening that segment of the Sabine-Neches Waterway between the Sabine and Neches Rivers to 150 feet (United States Army Corps of Engineers 1982).

In 1922, the Sabine-Neches Canal was widened from 100 to 125-foot-wide (United States Army Corps of Engineers 1977). Legislation was authorized to deepen to 30 feet, and widen to 150 feet, the existing Port Arthur Canal and the Sabine-Neches Waterway (United States Army Corps of Engineers 1947 and 1989). In 1927, the widening of the Port Arthur Canal to 200 feet and the Sabine-Neches Waterway, below the mouth of the Neches River, to 150 feet was authorized. In 1935, the Port Arthur Canal was authorized for a width of 250 feet and a depth of 34 feet. The Sabine-Neches Waterway was also authorized for a width of 250 feet and a depth of 32 feet.

In 1938, Congress authorized the enlargement of the Port Arthur Canal to 400 feet, and the Sabine-Neches Waterway to 350 feet (United States Army Corps of Engineers 1947). In 1946, legislation was passed authorizing the deepening of the Sabine Pass outer bar channel to 37 feet, the deepening of the Port Arthur Canal and Sabine-Neches Waterway to 36 feet, the widening of the Sabine-Neches Waterway, to 400 feet, and widening that segment of the Sabine-Neches Waterway between the Sabine and Neches Rivers to 150 feet (United States Army Corps of Engineers 1947 and 1989).

During 1972, additional authorized improvements to the channel system were complete. Those improvements provided a 500-foot-wide, 40-foot-deep channel from the Gulf to Port Arthur, Texas, a 400-foot-wide by 40-foot-deep channel from Port Arthur, Texas, up the Neches River to Beaumont, Texas, and a 200-foot-wide, 30-foot-deep channel from the mouth of the Neches River up the Sabine River to Orange, Texas (United States Army Corps of Engineers 1982).

Gulf Intracoastal Waterway

In 1910, Congress authorized construction of an inland waterway, 5-foot-deep by 40-foot-wide, from the Sabine River to the Mermentau River. The Sabine River to Calcasieu River section was constructed during the period 1913 to 1915 (United States Army Corps of Engineers 1914). By 1925, the government owned a continuous inland waterway between the Mississippi River and the Sabine River to Orange, Texas (United States Army Corps of Engineers 1978).

Table 14. Gulf Intracoastal Waterway

Year	Activity
1910	Congress authorized construction of an inland waterway, 5 ft. deep by 40 ft. wide, from the Sabine River to the Mermentau River (COE 1978)
1913-1915	Construction of a waterway between the Sabine and Calcasieu Rivers was complete (COE 1978).
1925	The government, by this time, owned a continuous inland waterway between the Mississippi and Sabine Rivers to Orange (COE 1978).

PROBLEMS

1925	Congress authorized the enlargement of the inland waterway, Gulf Intracoastal Waterway (GIWW), to 100 ft. wide by 9 ft. deep.
1927	An enlargement from the GIWW from Sabine River to Calcasieu River of 125 ft. wide by 30 ft. deep was completed (COE 1928). This portion of the GIWW is known as the Lake Charles Deep Water Channel. It was authorized for the period 1935-41 (COE 1978 & 1983).
1941	Calcasieu Ship Channel was completed. Federal maintenance of the Lake Charles Deep Water Channel was deauthorized and the channel was thereafter maintained as part of the GIWW (COE 1978 & 1983).
1942-1949	The GIWW was deepened to 12 ft. and remains so today (COE 1978 & 1983).

During that same year, Congress authorized the enlargement of the inland waterway, the Gulf Intracoastal Waterway, to 100-foot-wide by 9-foot-deep. Eager to attract ocean-going commerce from the Sabine-Neches Waterway to Lake Charles, the Calcasieu Parish Police Jury received permission from the Corps to enlarge the Sabine River to Calcasieu River portion of the inland waterway to 125-foot-wide by 30-foot-deep. This enlargement was completed in 1927 (United States Army Corps of Engineers 1928). This enlarged portion of the Gulf Intracoastal Waterway became known as the Lake Charles Deep Water Channel, and was authorized for the period 1935-41.

In 1941, construction of the Calcasieu Ship Channel was completed. Because the latter channel provided a more direct deep-water route to the Gulf than did the Lake Charles Deep Water Channel, federal maintenance of the Lake Charles Deep Water Channel was deauthorized and the channel was thereafter maintained as part of the Gulf Intracoastal Waterway (GIWW). During the period 1942 to 1949, the GIWW was deepened to 12 feet and remains so today (United States Army Corps of Engineers 1978 and 1983).

Other Historical Events Within the Project Area

Historically several events, other than major navigation projects, have impacted the marsh system within the river basin. These items include small federal and private navigation projects, oil and gas exploration, water quality degradation, and natural occurrences such as hurricanes.

During 1899, the Corps of Engineers dredged a 6-foot-deep channel through the 2.5-foot-deep bar at the mouth of Johnsons Bayou (United States Army Corps of Engineers 1901).

Landowners within the study area dredged numerous small access canals such as Burton Canal, Starks Canal, South Line Canal, Beach Canal, and Willow Bayou Canal during the period 1900 to 1917 (1990 John Walther, personal communication). Roadside Canal was constructed by a barge mounted dredge during 1917 (1991 John Walther, personal communication). To access the construction site, the dredge dug a channel from West Cove (Calcasieu Lake) which is now the West Cove Canal. Shell Canal was dug later to barge in shell for road construction material. Upon completion of the highway embankment, the dredge dug a canal to leave the marsh and return to West Cove. That canal enters West Cove at its western extremity and is locally known as West Cove Canal.

PROBLEMS

Grays Ditch was dredged in the early 1920's (1991 John Walther, personal communication). Spoil was placed on the canal's west bank to create a continuous embankment. That canal and embankment, in combination with several bridges, was constructed to provide a cattle walkway between Johnsons Bayou and The Pines ridge.

Oil exploration activities began occurring in the project area in 1902. In that year, several wells were drilled into the Hackberry Saltdome (now the West Hackberry Oil and Gas Field). Between 1902 and 1920, at least 8 wells were drilled. Between 1920 and 1935, 134 wells were drilled. The first oil-producing well was completed in 1928 at a depth of 3,152 feet. Subsequent oil production occurred between depths of 3,100 to 3,400 feet (Howe et al 1935).

Table 15. Other Historical Events Within the Project Area

Year	Activity
1899	The Corps of Engineers dredged a 6 ft. deep channel through a 2.5 ft. deep bar at the mouth of Johnsons Bayou Canal (COE 1901).
1900-1917	Landowners within the study area dredged numerous small access canals such as, Burton Canal. Starks Canal, South Line Canal, Beach Canal, Roadside Canal, and Willow Bayou Canal (SNWR 1990 & 1991).
1900's	Shell Canal was dug to barge in shell for road construction. Another canal was dredged to leave the marsh and return to West Cove. It is locally known as the West Cove Canal (SNWR 1991).
1920's	Gary's Ditch was dredged. Spoil was placed on the canal's west bank to create a continuous embankment. The canal and embankment, in combination with several bridges, was constructed to provide a cattle walkway between Johnsons Bayou and the Pines Ridge.
1902	Oil exploration began in the project area and several wells were drilled in the Hackberry Saltdome. The area is now known as the West Hackberry Oil and Gas Field (Howe et al. 1935).
1920-1935	The West Hackberry Oil and Gas Field produced 134 wells (Howe et al 1935).
1920's	Seismic crews worked the Hackberry Saltdome and discovered the East Hackberry Saltdome. The area is now known as the East Hackberry Oil and Gas Field (Howe et al. 1935).
1927-1935	The East Hackberry Oil and Gas Field produced 160 wells (Howe et al 1935).
1927-1935	The Black Bayou Saltdome was discovered. The area is now known as the Black Bayou Oil and Gas Field (Howe et al. 1935).
1928-1935	The Black Bayou Oil and Gas Field had over 40 wells drilled (Howe et al. 1935).
1926	The Cameron Meadow Saltdome was discovered by trappers when they noticed gas seepage from marshes along Old North Bayou. The area became known as the Cameron Meadow Oil and Gas Field (Howe et al. 1935).
1930-1935	The Cameron Meadow Oil and Gas Field had 18 wells drilled (Howe et al. 1935).
1937	Bureau of Fish and Wildlife purchased 139,308 acres (124,160 acres in the river basin) of marsh on the east and west sides of Calcasieu Lake. The area, Sabine National Wildlife Refuge, was established to provide a sanctuary for wintering waterfowl.

PROBLEMS

1951	Construction of a 26,400 acre marsh impoundment (Pool 3) was completed on the SNWR for waterfowl habitat enhancement.
1957	Hurricane Audrey struck Cameron, Louisiana and the associated tidal surge virtually flooded all of the Cameron Parish marshes.
1959	Two additional impoundments were constructed, 5,180 acre and 1,800 acre on the SNWR for waterfowl habitat enhancement.
1961	Hurricane Carla struck Cameron, Louisiana and the associated tidal surge virtually flooded all of the Cameron Parish marshes.
1965	Construction of Sam Rayburn Reservoir was completed for freshwater and hydroelectric power supply to nearby communities and industries.
1966	Toledo Bend Reservoir was completed for freshwater and hydroelectric power supply to nearby communities and industries.
1979-1980	SNWR personnel redredged several canals to six-foot-deep by sixteen-foot-wide.
1981	Water control structures were installed on SNWR at Hog Island and West Cove Canal. Another structure was installed between Headquarters Canal and Shell Canal. The structures were designed to reduce saltwater intrusion by limiting the amount of high salinity waters entering the area from the Calcasieu Ship Channel.
1988	The entire Calcasieu estuary was found to be contaminated with hexachlorobenzene and hexachlorobutadiene.

During the late 1920's, seismic crews working the perimeter of the Hackberry Saltdome discovered another saltdome, the East Hackberry Saltdome (now the East Hackberry Oil and Gas Field). In 1927 the first well was drilled. The first oil-producing well was also completed in 1927. Between 1927 and 1935, at least 160 wells were drilled in that field. Those wells produced both oil and gas. Oil production occurred at depths from 2,600 feet to 7,400 feet (Howe et al. 1935).

Because of natural gas seepages and other surface expressions, the Black Bayou Saltdome was discovered in 1927 (Black Bayou Oil and Gas Field). The first well was drilled in 1927. The first oil producing well was completed in 1929. Between 1928 and 1935, 40 wells were drilled. Fifteen of those wells produced oil. Oil production occurred at depths of 3,900 to 5,200 feet. Because of its remote location, access was by boat or vessel. Consequently, canals were dredged to provide access for exploration and production equipment to prospective drill sites (Howe et al. 1935).

Reports from trappers of gas seepages from marshes along Old North Bayou in south central Cameron Parish resulted in the discovery of the Cameron Meadows Saltdome in 1926 (now the Cameron Meadows Oil and Gas Field). The first well was drilled in 1930 and the first oil-producing well was completed in 1931. Through mid 1935, 18 wells were drilled, 12 of which produced oil. Oil production occurred at depths ranging from 3,300 to 5,200 feet. Because of North Bayou, canals, and Sabine Lake. Consequently, canals were dredged to provide access by exploration and production equipment to drill sites (Howe et al. 1935).

Sabine National Wildlife Refuge was established in 1937 when the Bureau of Fish and Wildlife purchased 139,308 acres of marsh on the east and west side of Calcasieu Lake (124,160 acres of refuge marsh are within the study area). At that time, the marshes of Sabine Refuge supported large concentrations of

wintering waterfowl and the area was considered a "jewel". The refuge was established for the purpose of providing a sanctuary for wintering waterfowl.

Construction of a 26,400 acre marsh impoundment (Pool 3) on Sabine National Wildlife Refuge was completed in 1951. During 1959, two small marsh impoundments (5,180 acre Unit 1A and 1,800 acre Unit 1B) were constructed on Sabine National Wildlife Refuge. Backridge Canal was created by the construction of the impoundments. Those impoundments were constructed to maintain high water levels and open up otherwise solid unbroken marsh for the purpose of improving waterfowl habitat.

Hurricane Audrey struck Cameron, Louisiana, on June 27, 1957. The tidal surge associated with that storm flooded virtually all of Cameron Parish's marshes. In several places the tidal surge damaged levees surrounding Sabine Refuge's Unit 3. Hundreds of acres of marsh in the five lakes area (Unit 3) were peeled from the substrate and rolled back (1990 John Walther, personal communication). In tidally-influenced areas, ponds and open water areas were enlarged by wave action. After the storm, the tidal surge drained off quickly (Sabine Refuge 1957a). In some areas "shallow marsh and ridge terrain" was "completely denuded" by storm effects (Sabine Refuge 1957b). Over subsequent years, some of those barren areas increased in size and large areas of sawgrass throughout the refuge began to die (Sabine Refuge 1959b and 1959c).

Aided by a series of adverse conditions, deterioration of area sawgrass marshes continued (Map 8). A severe drought occurred in 1960 during which many ponds on the refuge dried up. Valentine (1988) observed that in 1960, sawgrass was dead and dying throughout the refuge. By the end of 1960, refuge personnel observed that sawgrass was "almost nonexistent" on the refuge (Sabine Refuge 1960c). Then in September 1961, Hurricane Carla struck Cameron Parish and the project area was again inundated. Unlike Hurricane Audrey, Carla's tidal surge lingered 3 weeks before water levels returned to normal. Because little rain fell during the storm, and for a month and a half afterward, area marshes were not flushed with freshwater as they had been after Hurricane Audrey (Sabine Refuge 1961b and 1961c).

During January 1962, a hard freeze (15 degrees Fahrenheit) was reported to have killed seashore paspalum on Sabine Refuge. Later that year, a severe drought occurred during the growing season. Again, many ponds on the refuge dried and the bottom sediments cracked (Sabine 1962a and 1962b). The resulting high soil salinities and severe nutria depredation resulted in the loss of California bullrush, roseau cane, hogcane, and Cyperus spp. that had formerly grown in association with the sawgrass (Valentine 1967 and Valentine 1988) attributed some of the die-offs to nutria. During the summer of 1963, a severe drought once again dried and cracked pond bottom throughout the refuge. Refuge personnel reported that refuge canals contained "Gulf Water" (Sabine Refuge 1963a and 1963b).

Following the die-offs of sawgrass and associated plant species, 12,000 acres on Sabine Refuge's Unit 1 were left as "large mucky mudflats or water areas" (Valentine 1988). Some mudflat areas were colonized by annual grasses, sedges, and dwarf spikerush (Sabine Refuge 1960b and 1961b). Bulltongue and even some sawgrass re-established itself in parts of Sabine Refuge's Unit 1 and Unit 5. However, droughts, canal-induced saltwater intrusion, and unknown

causes killed those plants (Sabine Refuge 1962b, 1967, 1968, and Valentine 1988).

Gradually over a number of years, saltmeadow had been colonized by annual vegetation (Valentine 1988). Many of the mudflat areas would support no vegetation, except occasional large strands of dwarf spikerush (Sabine Refuge 1962c, 1963b, and 1966). Unvegetated organic soils of the sawgrass die-off areas were lost to oxidation and erosion (Valentine 1988 and 1976). Valentine (1988) noted that "immense" amounts of organic material were suspended by wave action and carried about by currents. Subsequently, organic material filled portions of North Line Canal and Black Ridge Canal and some piled up against remaining saltmeadow cordgrass island allowing those islands to "expand slightly" in size. Valentine (1988) observed however, "that most water areas have become deeper (8 to 16 inches)." Presently, the sawgrass die-off areas identified by Valentine are characterized by large relatively deep bodies of turbid open water and adjacent eroding and deteriorating marsh.

During 1965, construction of Sam Rayburn reservoir was completed. Located on the Neches River, that project was constructed to supply freshwater to nearby communities and to generate hydroelectric power. During 1966, Toledo Bend Reservoir was completed. Toledo Bend is located on the Sabine River and was also built to supply freshwater and hydroelectric power to nearby communities and industries. To meet peak electricity demands during the summer months, Toledo Bend and Sam Rayburn release large volumes of freshwater. This has resulted in a considerable freshening of Sabine Lake during those months, virtually eliminating the commercial harvest of white shrimp in Sabine Lake (Texas Department of Water Resources 1981).

During 1979 and 1980, refuge personnel used a low-pressure hydraulic dredge to clean-out Roadside Canal, South Line Canal, Grays Ditch, Three Mile Canal, Marceaux Ditch, Beach Canal, and portions of Central Canal. Those canals were redredged 6-foot-deep and 16-foot-wide. The spoil slurry was discharged into the adjacent marsh (Sabine Refuge 1979 and 1980).

Water control structures on Sabine National Wildlife Refuge at Hog Island Gully Canal, West Cove Canal, and Headquarters Canal were completed during 1981. The Hog Island Gully structure consists of a fixed-crest weir (crest elevation +1.5′ mean sea level) with an 11-foot-wide, tainter gate (bottom depth -8.0′ mean sea level). The West Cove Canal structure also included a fixed-crest weir (crest elevation +1.5′ mean sea level) with a 7-foot-wide tainter gate (bottom depth -8.0′ mean sea level). A 48-inch-diameter flapgated culvert was also installed in Headquarters Canal to regulate water exchange between Headquarters Canal and Shell Canal (West Cove). Those structures were installed to reduce the rapid deterioration of refuge marshes caused by the intrusion of high-salinity water into refuge marshes from the Calcasieu Ship Channel.

Upon completion of those water control structures, the tainter gates at both structures were maintained in the open position until approximately 1988. At that time, refuge personnel began conducting short-term closures of the tainter gates to reduce saltwater intrusion. Presently, the tainter gates and the Headquarters Canal culvert are actively operated by refuge personnel to reduce saltwater intrusion, introduce freshwater, sediment, and nutrients,

retard export of suspended marsh soil, and provide for ingress and egress of estuarine-dependent fish and shellfish.

During 1988, the entire Calcasieu estuary was found to be contaminated with hexachlorobenzene and hexachlorobutadiene. Consequently, the Louisiana Department of Environmental Quality and the Louisiana Department of Health and Hospitals issued a joint advisory on February 24, 1989, warning against the "sale and consumption of speckled trout and white trout from anywhere in the entire Calcasieu River Estuary system from the saltwater barrier to the Gulf of Mexico". That advisory was an expansion of a January 1987 advisory against eating fish and shellfish or other seafood from Bayou d'Inde, Prien Lake, and the Calcasieu River from just north of the I-210 bridge to just north of Moss Lake.

IMPACTS OF HISTORICAL EVENTS

This subsection links the problems of the basin with many of the historical events. The information is discussed in a chronological fashion for problems.

Prior to canalization, study area marshes consisted primarily of vast unbroken stands of fresh and low-salinity marshes. Brackish marshes occurred primarily around the border of Calcasieu and Sabine Lakes. Small meandering bayous such as Black Bayou, Willow Bayou, Johnsons Bayou, Deep Bayou, Black Lake Bayou (Kelso Bayou), and Old North Bayou provided drainage and water exchange for the vast unbroken interior marshes. Given the lack of watercourses throughout much of the interior marshes, the hydrology of those areas must have been dominated by sheetflow with extremely little tidal influence. In those areas, the fresh and low-salinity conditions prevailed, and over time, organic matter accumulated, giving rise to soil types such as Allemands, which are characterized by a shallow surface layer (1 to 4 feet) of organic material overlying a clay substrate. The soils of marshes located near the Gulf and adjacent to Calcasieu and Sabine Lakes were characterized by a greater mineral content than interior marsh soils.

Prior to canal dredging and other man-made alterations, physical and biological processes functioned naturally within study area marshes. Disturbances, such as storms, fires, freezes, droughts, and animal eat-outs have occurred. However, because the physical and biological processes were in harmony, the marsh was often able to repair itself and thus maintain its virtually unbroken character. Even the dredging of numerous small access canals by landowners in the early 1900's did not seem to adversely affect project-area marshes as those marshes remained virtually unbroken until the 1940's and 1950's.

These canals and their associated spoil banks disrupted the regional hydrology by dividing the marsh into units which were hydrologically independent of each other. Canal spoil banks may have partially impounded some marshes and diverted sheetflow of excess freshwater away from other marsh areas. Those canals also served to increase water exchange rates, consequently reducing retention of freshwater with the region.

Unfortunately, little ecological information is available regarding study-area marshes prior to 1930's. Prior to construction of the Calcasieu Ship Channel, Calcasieu Lake was used as a source of irrigation water for rice fields

located on the east side of Calcasieu Lake (personal communication, Tommy Wright 1992). Prior to construction of the Calcasieu Ship Channel, Black Lake was also used as a source of irrigation water for rice agriculture in the vicinity of Hackberry (James Lowery, personal communication 1992). These facts are significant because rice is adversely affected by salinities in excess of 2.0 ppt (1982 United States Department of Agriculture). Consequently, for a water body to serve as a source for rice irrigation water, the water has to be essentially fresh from April through June (1992 Ron Marcantel, Soil Conservation Service District Conservationist, Cameron and Calcasieu Parishes).

While conducting a survey for the proposed Gulf Intracoastal Waterway during 1874, Mr. H.C. Ripley recorded characteristics of some portion of the study area (United States Army Corps of Engineers 1874-1876). Mr. Ripley noted that along the banks of Black Bayou "a few willow and cypress trees are to be found here and there." Mr. Ripley also noted the presence of numerous shell middens throughout adjacent marshes. Regarding hydrology of Black Bayou, Mr. Ripley stated that the current "rounds in and out as the tide rises and falls in the lake. The water is generally fresh, but brackish water has been known to reach up the bayou as far as Smith's, 13.5 miles from its mouth."

Mr. Ripley described Black Lake as being "everywhere over 6 feet deep 800 feet from shore. The banks are about 2 feet under water, and covered with a thick growth of sea-cane. West from the lake, the swamp is filled with a thick growth of broad-bladed, three edged grass, about 5 feet high, the roots of which form a matting over the soft mud beneath. This characteristic of land is known as TERRE TREMLANTE, or trembling prairie, and it may be well to mention....that all of the swamp, in this portion of the survey, is of this character." The vegetation described by Ripley as "sea cane," was probably Roseau cane. Similarly, the broad-bladed, three-edged grass was likely Jamaica sawgrass. Marshes adjacent to Black Lake were dominated by sawgrass until the 1950's.

The most significant environmental problem affecting project-area marshes has been deterioration and conversion to open water of those marshes. Prior to the mid 1950's, study area marshes were relatively stable. An analysis of land loss during the period 1934 to 1951 revealed that those areas (covered by USGS 15-minute quadrangles for Cameron and Johnsons Bayou) were densely vegetated and were not deteriorating (Gagliano and van Beek 1970). However, recent land loss mapping studies indicate that marshes within the central and northern portions of the study area have suffered extremely rapid and extensive marsh loss beginning in the mid 1950's (Map 5).

Adams et al. (1978) determined that the marshes in the area of Black Lake (south of the Gulf Intracoastal Waterway, west of the Alkali Ditch, and east of the Cameron Farms ridge) experienced an 81 percent loss during the period of 1952 to 1974. That loss rate was greater than that of any other area examined throughout the Louisiana coastal zone and area "may well have the highest intensity of marsh loss for any area of comparable size over a similar time period in coastal Louisiana" (Adams et al. 1978). The deterioration and loss of study area marshes has also been documented through other reports (Valentine 1967 and Valentine 1988)

PROBLEMS

Study area marsh deterioration may have involved numerous factors. Nutrients and suspended sediments from the Calcasieu River are now largely contained within the spoil banks of the Calcasieu Ship Channel and the GIWW. Only during major floods does appreciable riverine sediment and nutrients enter project-area marshes. The Sabine-Neches Waterway may have had a similar affect on nutrient and sediment distribution within marshes adjacent to Sabine Lake. Additionally, the Louisiana Highway 27 embankment, the Grays Ditch cattle walkway, and spoil banks of the GIWW and other canals may also restrict movement of suspended sediments and nutrients and deposition of suspended sediments, marshes may become weakened and over time, deteriorate.

Prior to man-made hydrologic alterations, interior marshes probably received little or no riverine sediment and nutrients because of their hydrologic isolation from sediment sources. The highly organic nature of surface substrates in those areas bears out this fact. Therefore, reductions in suspended sediment input and the anticipated accretion deficit may not have contributed significantly to the deterioration of interior project-area marshes. Additionally, if an accretion deficit was the primary factor responsible for marsh loss, marsh loss rates would likely exhibit a gradual acceleration over time. Marsh loss studies have indicated however, that marsh loss rates have decreased after peaking 20 to 30 years ago. Consequently, reduced sediment deposition does not appear to be a primary cause of study area marsh loss. However, introduction of additional nutrients or suspended sediment would likely reduce the rate of current marsh deterioration and loss. Sediment/nutrient introduction should be implemented when and wherever feasible.

Construction of the Calcasieu Ship Channel appears to be the most environmentally damaging event to impact marshes within the study area. Van Sickle (unpublished manuscript) noted that during the early 1900's, salinities in Calcasieu Lake were reported to range from fresh to brackish and that freshwater conditions were frequent and relatively long-lasting. Brackish conditions prevailed most frequently during the summer months. The frequency of freshwater and/or low-salinity events was also reported to adversely impact oyster reefs in Calcasieu Pass making that area "marginal" habitat for oysters (Crassostrea virginica). The above-mentioned conditions prevailed after construction of jetties, dredging of a channel through the bars at the head of Calcasieu Pass and between the jetties. The fact that oysters now inhabit much of the lake suggest that the salinity regime within Calcasieu lake has been further increased, compared to that of the early 1900's (Van Sickle unpublished manuscript).

Construction of the ship channel greatly increased the efficiency of water exchange through Calcasieu Pass. Freshwater retention within the Calcasieu Basin was consequently reduced and saline water was able to enter in greater quantities and penetrate further north than ever before. The salinity regime within Calcasieu Lake therefore became much more variable and peak salinities were probably higher than ever before. Similar alterations of salinity regimes have been documented at Lafitte, Louisiana, after enlargements of the Barataria Waterway[1] (Taylor and Day 1988).

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[1]The Barataria Waterway was enlarged in 1963 from a five feet deep by fifty feet wide channel to a twelve feet deep by 125 feet wide channel.

PROBLEMS

As part of the study, the influence of canals on the hydrology of marshes at Jean Lafitte Historic Park was investigated. It was determined that canal salinities were extremely variable and responded rapidly to "outside environmental factors such as tides and rains."

Residents of Hackberry, Louisiana, recall that in 1960, Black Lake was much different compared to its present condition (James Lowery 1992 personal communication). Recreational angling for largemouth bass was good and a commercial fishery existed for freshwater catfish. Living beds of Ranqia occurred in Black Lake and water lilies were found along the lake's north shore. These living resources vanished after enlargement of the Calcasieu Ship Channel in 1968 (James Lowery 1992 personal communication).

Additional evidence regarding a salinity increase within Calcasieu Lake is available through examination of vegetative type maps. According to the 1931 refuge vegetation map (Map 7), the refuge was dominated by fresh and intermediate plant communities. The 1968 and 19867 vegetative maps (Maps 9 and 10) as compared to the 1874 vegetative observations from the Black Lake area (United States Corps of Engineers 1874-1876), show a definite salinity increase has occurred in that area.

The 1931, 1968, and 1978 (Maps 7, 9, and 10) vegetation maps also indicate that the Sabine Lake estuary has experienced a substantial salinity increase. John Walther, former manager of Sabine National Wildlife Refuge (1990 personal communication) recalls that cypress trees along Black Bayou appeared to have been dead for 10 or more years prior to his being stationed at the refuge in the mid 1950's. Today, only a few stumps and snags can be found. The nearest viable stand of cypress trees occurs much further north in the vicinity of Orange, Texas. Since the mid-1960's, marshes adjacent to Sabine Lake, have experienced increased discharges of freshwater from reservoirs on the Neches and Sabine Rivers during the peak of the growing season. Fortunately for those marshes, this has served to counteract salinity increases and partially restore the former low-salinity regime of the Sabine Lake estuary.

Salinity increases in the Sabine and Calcasieu estuaries are likely a result of the Port Arthur Canal/Sabine-Neches Waterway and the Calcasieu Ship Channel. Similar deep-draft navigation channels have been shown to reduce freshwater retention, increase saltwater intrusion, and increase the magnitude of salinity fluctuations (Turner and Cahoon 1987, and Taylor and Day 1988). Using a water level model of Calcasieu Lake and Ship Channel, Suhayda et al. 1988, compared water level effects of a 15-foot-deep channel versus a 40-foot-deep channel. They found greater duration of tidal flooding and tides having twice the amplitude with the 40-foot-deep channel. Coupled with canal-induced saltwater intrusion such channel-induced hydrologic alterations would be extremely damaging to affected fresh and low-salinity marshes.

Project-area navigation channels are hydrologically connected to interior marshes via a network of small canals and bayous such as West Cove Canal, Hog Island Gully, Black Lake Bayou, Alkali Ditch, Black Bayou, Black Bayou Cutoff, Backridge Canal, Beach Canal, Central Canal, North Line Canal, South Line Canal, Rycade Canal, Burton Canal, and others. Because this canal network is hydrologically connected to the Calcasieu Ship Channel and the Gulf Intracoastal Waterway, virtually all project-area marshes have experienced

increased tidal exchange, saltwater intrusion, and reduced freshwater retention.

Because of its location on the western side of Sabine Lake, the Sabine-Neches Waterway was not directly connected to project-area canals or bayous. Consequently, project-area marshes bordering Sabine Lake were not as severely impacted as those marshes directly linked to the Calcasieu Ship Channel. Nevertheless, substantial impacts did occur resulting in conversion to open water of former fresh and low-salinity marshes.

Adverse impacts to project-area marshes resulting from construction of the Calcasieu Ship Channel and the Port Arthur Canal/Sabine Neches Waterway did not begin immediately after channel completion. Affected plant communities may not have been too severely affected by the initially small channel sizes. However, after enlargement to the present size, the hydrologic alterations were substantial (Suhayda et al. 1988). Weakened by resulting saltwater intrusion, the fresher plant communities (sawgrass) began dying.

During the severe 1954 drought, refuge personnel observed that saltwater intrusion brought sargassum into interior refuge canals (Sabine Refuge 1954a). On Sabine Refuge, deterioration of sawgrass was noted during the mid 1950's prior to Hurricane Audrey (1990 John Walther, 1992 Allen Ensminger personal communications). Natural disturbances such as Hurricane Audrey, Hurricane Carla, and the severe droughts of the early 1960's served to convert the marsh into open water and mudflats by stressing the sawgrass and fresh marsh vegetation. Fresh and intermediate vegetation was unable to revegetate because of the greater salinity levels throughout the entire region. Because of the low substrate elevation (typical of interior fresh marshes), the unstable and semi-fluid nature of the organic substrate, and the slow rate of saltmeadow cordgrass colonization, those marshes were never able to recover from the storms as they might have done had the biological and physical processes been unaltered.

In portions of the Mermentau Basin not adversely impacted by the Sabine-Neches and Calcasieu Ship Channels sawgrass marshes were converted to open water following Hurricane Audrey (Valentine 1967). However, within 16 years, fresh marsh emergent vegetation recolonized the open water areas and a healthy marsh ecosystem (93 percent emergent vegetation) was restored (Valentine 1967).

After the die-off of study-area sawgrass marshes, the unvegetated organic substrate was affected by increased tidal exchange due to interior canals and nearby navigation channels. Immense quantities of the organic substrate were washed away (Valentine 1988), and thousands of acres of former sawgrass marsh became unvegetated open water. The sawgrass areas experiencing the most extensive conversion to open water (northeast portion of the study area) were those areas having direct or near direct hydrological connection to the Calcasieu Ship Channel and areas having the most organic, semi-fluid soils.

The former sawgrass communities now consist of saline marsh, brackish marsh, intermediate marsh, and shallow open water. In highly organic areas, emergent brackish marsh appears to be slowly deteriorating. Although slower, the process is very similar to that described by Valentine (1988). The open water areas are extremely turbid and devoid of submergent vegetation. Those open

water areas continue to expand as adjacent organic soils are eroded by wave action and tidal exchange.

Frequent heavy rain events and closure of refuge water control structures during saltwater intrusion events and resulted in low salinity conditions during most of 1990 and 1991. In some interior broken marsh areas, fresh marsh emergent species invaded and expanded into shallow open water areas. A reversal of marsh deterioration has been observed in these areas. Such observations reveal that salinity has a pronounced effect upon marsh loss.

Considering the above-described events, the construction of deep-draft navigation channels and subsequent saltwater intrusion appear to be most responsible for the rapid deterioration of project-area marshes during the 1960's and 1970's.

Localized marsh deterioration may have been caused by the discharge of brine water from mineral exploration activities and saltdome leaching prior to the regulation of such discharges. The extent to which brine discharges may have adversely affected project-area marshes is not known. Because changes in vegetative composition and marsh deterioration occurred throughout the entire project area, brine discharge was probably not a major cause for the widespread deterioration of project-area marshes.

Nutria populations peaked during the late 1950's and early 1960's. During December 1959, refuge trappers were catching 30 to 50 nutria per day without moving their traps (Sabine Refuge 1959b). During the summer of 1960, refuge personnel observed that nutria were extremely abundant. Dead nutria were observed floating in the water. Some living nutria were observed having paralysis of the hind quarters. In Miami Corporation marshes east of Calcasieu Lake, nutria were observed "acting crazy", such as biting their tails, swimming in Calcasieu Lake, and trying to get into boats (Sabine Refuge 1960b). As sawgrass and other fresh marsh plants were dying, nutria were also digging up California bullrush and other plants in order to eat their roots and tubers (Sabine Refuge 1960a). Valentine (1988) attributed some of the vegetation die-offs to severe nutria depredation. During 1963 and 1964, a downward trend in nutria harvest on Sabine Refuge was noted (Sabine Refuge 1963a and 1964).

Because nutria populations peaked simultaneously with the die-off of sawgrass and fresh marsh plants, one could speculate that nutria were the cause. Unfortunately the extent to which nutria adversely affected project-area marshes is unknown. Given the existing information, it appears that the nutria's preferred habitat (fresh and low-salinity marshes) collapsed during a period of high and increasing nutria populations. Consequently, nutria assisted in the devastation begun earlier as a result canal-induced saltwater intrusion.

As demonstrated by the historical events and impacts of historical events, the basin marshes have been affected by various natural and man-made problems. Nature can adapt and heal itself from natural occurences, however, the additional affect of many man-made hydrologic modifications have exacerbated the problems and caused potentially irreversible damage to the fragile wetland ecosystem.

PROBLEMS

SALINITY SOURCES

All water bodies surrounding the project-area serve as salinity sources to varying degrees, especially during droughts. At times, some of those surrounding water bodies may also serve as freshwater sources. Salinities may vary daily depending upon rainfall, wind direction, precipitation, and stage of the Calcasieu and Sabine Rivers. Salinity fluxes are usually greatest in project-area marshes adjacent to the Calcasieu Ship Channel. Salinities of interior marshes are relatively stable. Under ordinary conditions, several generalizations may be made.

1. Calcasieu Lake is usually more saline than Sabine Lake.

2. Incoming water at the Hog Island Gully water control structure is usually more saline and salinity fluxes greater than that of incoming water at the West Cove Canal water control structure.

FRESHWATER SOURCES

Precipitation is the most significant source of freshwater for project-area marshes. Consequently, lowest salinities generally occur within interior project-area marshes. Although Sabine Lake, Calcasieu Lake, and the Gulf Intracoastal Waterway usually serve as saltwater sources, they may occasionally serve as freshwater sources, especially during floods. The Sabine Refuge's Impoundment 3 may also serve as an important freshwater source for adjacent tidally-influenced marshes during flood events.

WATER FLOW REGIME

Except for the three fresh marsh impoundments on Sabine National Wildlife Refuge, and several privately-owned fresh marsh impoundments in the northeast portion the project-area, the remaining marsh is tidally-influenced. Water level and flow direction may vary daily depending upon tide, wind, precipitation, river stage, barometric pressure, and water control structure operations. Wind is often the primary force determining water flow patterns. Strong winds stack water on the windward side of large open water bodies. Such conditions often result in localized flow patterns that overpower the effects of lunar tides. Described below are the most predominant wind-induced water flow patterns.

1. Strong prolonged southeast, and south winds push large volumes of Gulf water into Calcasieu Lake causing a rise in lake water levels. Such conditions often occur prior to a frontal passage and result in continuous or near-continuous incoming tides at water exchange points bordering Calcasieu Lake . Strong prolonged south winds may also push large volumes of Gulf water into Sabine Lake, resulting in continuous or near-continuous incoming tides at water exchange points bordering Sabine Lake.

2. Strong prolonged northwest, north, and northeast winds lower water levels in the nearshore Gulf of Mexico and push large volumes of Calcasieu Lake and Sabine Lake water southward into the Gulf. Such conditions occur after frontal passages and often result in continuous

tidal outflow at water exchange points bordering Calcasieu Lake and Sabine Lake.

3. The large expanse of deteriorated marsh and shallow open water extending northward from Sabine Refuge's Impoundment 1A to Hackberry and the Gum Cove ridge (sawgrass die-out area) is also subject to wind-induced water stacking. Prior to a frontal passage, strong prolonged southeast and south winds push water northward. Consequently, water levels at the southern end of the open water area are lowered while water levels at the northern end are elevated. The low water level condition produced at the southern end of the open water area facilities flow into that area from several sources. The dominant source of inflow is from Calcasieu Lake via Hog Island Gully, and Kayo Bayou. Because lake water levels are elevated under such conditions (see #1 above), a large head differential occurs. Consequently, large volumes of lake water are subsequently imported. Additionally, Roadside Canal (from the West Cove Canal water control structure to North Line Canal) also flows strongly toward the southern end of the open water area. The Roadside Canal flow also serves to import Calcasieu Lake water via the Headquarters Canal water control structure and the West Cove Canal water control structure. Under such winds, Backridge Canal also flows northward toward the southern end of the open water area.

   At the northern end of the open water area, wind-induced high tides discharge through several canals. Rycade Canal drains water toward Black Lake. Because those winds also lower water levels in the southern end of Black Lake, a substantial head differential may be created, and the flow through Rycade Canal is often very strong. North Line Canal also serves to discharge large volumes of water from the wind-induced high tide area toward Sabine Lake, via Black Bayou. Typically, waters draining from the wind-induced high tide area (sawgrass die-out area) are extremely turbid due to resuspended and eroded organic material.

4. The large expanse of deteriorated marsh and shallow open water discussed above (from Sabine Refuge's Impoundment 1A northward toward Hackberry and the Gum Cove ridge) is also affected by strong northwest and north winds following a frontal passage. Under those conditions, water levels are elevated at the southern end of the open water area. Because water levels in Calcasieu Lake are also lowered, strong flows toward Calcasieu Lake are produced. Backridge Canal and Roadside Canal also serve to discharge large volumes of water from the wind-induced high tide area toward Calcasieu Lake via the Headquarters Canal and West Cove Canal water control structures. Typically, waters draining from the wind-induced high tide area (sawgrass die-out area) are extremely turbid due to resuspended and eroded organic material.

   At the northern end of the open water area, water flows patterns in Rycade Canal may vary. Following a frontal passage, flow through North Line Canal is usually toward the west to Sabine Lake.

Lunar tides often determine flow pattern during the summer months when winds are typically light and variable. Normal flow pattern during outgoing tides are very similar to outflows associated with frontal passages (see number 4 above). Additionally, normal flow patterns associated with incoming tides are

very similar to that during inflows associated with strong southerly winds preceding a frontal passage (see number 3 above). Flow velocities associated with lunar tides are often less than velocities associated with tides induced by strong winds.

The Gulf Intracoastal Waterway, South Line Canal, Central Canal, and North Line Canal provide hydrologic connections between Sabine Lake and Calcasieu Lake. During ebb tide, project-area marshes adjacent to those canals may drain simultaneously into both Sabine and Calcasieu Lakes. This creates zones of divergent flow. East of the zone, water flows east toward Calcasieu Lake. West of the zone, water flows west toward Sabine Lake. In other cases, canals allow project-area marshes to drain into Sabine Lake via two watersheds. This also creates a zone of divergent flow. The location of the divergent flow zone varies depending upon wind, water levels, river stage (Calcasieu and Sabine Rivers), and the degree to which refuge water control structures are open. These observations were made by refuge personnel during 1990 and 1991.

Because of insufficient data, the location of the divergent flow zone on the GIWW is not known. It does appear however, that a zone usually exists under normal circumstances. Available data suggest that salintiesat the old Gum Cove Ferry crossing, reflect salinities within the upper portion of Sabine Lake. The divergent flow zone may therefore be located east of the old ferry crossing. During the I988 Sabine River flood, tugboat captains reported that eastward flows in the GIWW were so strong that some vessels could barely make headway. This however, was a unusual condition resulting from excessive water in the Sabine River and normal water levels in the Calcasieu River.

Monitoring has revealed that a divergent flow zone is often seen on the upper portion of Black Bayou. West of the zone, water drains normally down Black Bayou toward Sabine Lake. East of the zone, water flows "backwards" up Black Bayou toward the GIWW. On several occasions refuge personnel determined that the zone was located at the intersection of Right Prong and Black Bayou. The fact that water flows backward up Black Bayou illustrates the degree to which the GIWW has altered water circulation in the area.

Two zones of divergent flow have been observed in Central Canal. East of its intersection with Beach Canal, flow during outgoing tide is usually to the east. The zone of divergent flow is often oberved on Central Canal between Burton and Bush Canals. The location of this zone may occasionally move a mile or two westward depending upon weather and hydrologic conditions. This zone marks the separation between the Calcasieu and Sabine drainages.

The second zone of divergent flow on Central Canal delineates the boundary of the Willow Bayou/Canal and Right Prong/Burton Canal watersheds. This zone is wide and has often been observed in the vicinity of the intersection of Three Mile Canal and Central Canal. Organic material carried from open water areas south of Central Canal have a tendency to settle out in the divergent flow zone. During the summer of I990, mudflats and emergents vegetation closed the canal in this area. Frequent maintenance dredging is needed to maintain small boat navigation through this reach of Central Canal.

In interior marsh areas, flow in South Line Canal is extremely sluggish. Flow data is theses areas have not been collected. Refuge personnel believe that flows in South Line Canal mirror those observed to the north in Central Canal.

PROBLEMS

SEDIMENT SOURCES AND DISTRIBUTION

Suspended sediment available to project-area marshes from off site sources, originate from either riverine sources, lake bottom sources or from Gulf sediments, carried in by storm surges. Suspended sediments from the Calcasieu and Sabine Rivers enter project-area marshes primarily during flood events. During periods of strong southerly winds, resuspended lake bottom sediments enter project-area marshes as a result of the predominantly incoming tides. Flow patterns of water entering the project area are described in the section on Water Flow Regime. Sediments carried by such flows must then enter the marsh though canal spoil bank breaks or small tidal channels along natural bayous.

Rates of sediment deposition in project area marshes have not been measured. However, visual observations of water turbidity indicate that little suspended sediment is carried into interior areas from the source canals or bayous. In such areas, the only significant source of resuspended sediment may be that from hurricane storm surges. Otherwise maintenance of viable marsh elevations must apparently depend upon accumulation of organic materials.

In highly deteriorated or fragmented marshes large interior open water areas often serve as sources of sediment. During periods of high velocity winds, bottom sediments of such open water areas are resuspended. Provided that water levels are high enough, those sediments may then be deposited on the marsh surface. Generally, sediments from such interior sources are composed largely of organic materials whereas sediments from outside sources are of higher mineral content.

Water discharge from Sabine Refuge's 26,000 acre Unit 3 (fresh marsh impoundment) can often be a source of suspended organic material. High concentration of suspended materials may be discharged from the unit's east water control structure, particularly during periods of high velocity winds.

ALTERNATIVES AND ANALYSIS

The goals of this section will be to present alternatives and display the analysis of these alternatives for conservation, restoration, and enhancement of fragile wetlands. In addition to a "No Action" alternative, three other alternatives are evaluated. Alternative 2 relies on the use of perimeter structures to treat many of the wetland loss problems. Alternatives 3 and 4 are based on treatment for individual hydrologic units to correct marsh loss problems on an individual unit basis.

ALTERNATIVES

The Calcasieu-Sabine River Basin Study area is a large, diverse coastal section of Louisiana and with many problems of varying degrees. Conversely, solutions to these problems will vary depending upon effectiveness of the measure, landowner desires, environmental acceptability, access to the area, management capability, cost, transportation, drainage needs of local residents, and others. The alternatives were developed with the consideration of these conditions.

Alternative 1

The first alternative is the no action or status quo alternative. Under this alternative the basin will be left in its present condition and coastal wetlands will continue to deteriorate.

Alternative 2

The second alternative is the perimeter structure alternative. Installation of this alternative will require structures along major waterways for protection of the entire basin. The project components are:

a. Locks and/or floodgates at Calcasieu Pass above Cameron. See number 1 on the project map (Map 1).
b. Locks and/or floodgates at Sabine Pass. See number 2 on the project map (Map 1).
c. Locks and/or floodgates on the Gulf Intracoastal Waterway (GIWW) between the Calcasieu and Sabine Rivers. See number 3 on the project map (Map 1).

The purpose of these structures would be to restrict saltwater flow to the interior portion of the area and to partially restore hydrologic conditions to pre-ship channel conditions. The installation of these structures would eliminate the need for many of the project components to be discussed in alternatives 3 and 4.

The costs of these structures is estimated at a total of $500,000,000[1] which is as follows:

GIWW Structure	$150 million
Calcasieu Channel Structure	$250 million
Sabine Channel Structure	$350 million

[1]Construction cost on these locks are on a nominal basis.

ALTERNATIVES AND ANALYSIS

Alternative 2 components would provide the structural measures on the perimeter of the basin to reduce saltwater intrusion, but would impact navigation. The use of locks would require ship and barges to stop for short periods of time to allow for opening and closing of the locks. The time would add to the cost of operation for ships and barges. Also, locks require personnel to operate and maintain these facilities. The proposed Houma Navigation Canal lock (which is based on the Leland-Bowman Lock in the Mermentau Basin) requires almost a $1 million a year for operation and maintenance. These three locks would then add a $3 million a year cost of operation and maintenance to the construction cost.

Alternative 3

The third alternative is for the installation of conservation practices on a hydrologic unit basis. Each hydrologic unit has specified treatments for reducing the effects of most natural and man-made problems affecting the unit.

The study area is divided into forty-seven hydrologic units. Twenty-four hydrologic units are located north of the Sabine National Wildlife Refuge (SNWR), and are designated as NO-1 through NO-21. Twelve hydrologic units are located on the Sabine SNWR, and are designated as SA-1 through SA-10. The remaining 11 hydrologic units are south of the Sabine National Widllife Refuge, and are designated as SO-1 through SO-9.

Alternative 4

The fourth alternative is for the installation of the conservation practices on the hydrologic units with additional components for specified units. The additional components will provide greater protection and enhancement of the wetland resources as compared to Alternative 3. The specific components usually added are additional vegetative plantings and wave stilling/sediment trapping devices. These help to reduce turbidity, reduce erosion, and improve vegetative productivity.

COMPONENT GROUPS FOR HYDROLOGIC UNITS

The components proposed for alternatives 3 and 4 are grouped according the action item proposed and list as Group A through Group K below.

Group A - Placing dredge material in wetlands for marsh creation.
Group B - Vegetative plantings to reduce erosion rates along levees and shoreline and provide improved genetic vegetative stock for inner marshes.
Group C - Wave stilling/sediment trapping devices - Theses devices are recommended in open water areas, water depth 1.5 feet or less, 500 acres or greater open water with at least 0.5 miles of fetch. Terraces or fences could be installed in areas with mineral soils; fences only should be installed in organic soil areas. Generally, these wave stilling devices are planned for installation in a 500 to 1,000 foot spacing.
Group D - Hydrologic boundary - streambanks, levee maintenance or reconstruction.
Group E - New hydrologic boundaries.

Group F - Passive management structures - rock weirs, fixed crest weirs, open culverts with or without flapgates.
Group G - Active management structures - variable crest weirs, culverts with screw gates and/or manipulated gates.
Group H - Plugs in man-made canals.
Group I - Gaps in spoil banks to marsh level or slightly below.
Group J - Boat wake reduction.
Group K - Gulf shoreline protection.

HYDROLOGIC UNITS

Each hydrologic unit will be discussed as to the present conditions and with or without project components for Alternatives 3 and 4. The hydrologic units will be discussed in order from north of Sabine National Wildlife Refuge, Sabine National Wildlife Refuge, and south of Sabine National Wildlife Refuge (Map 1). Map 1 also contains the component numbers and locations within each hydrologic unit.

DESCRIPTION OF HYDROLOGIC UNITS

North Unit 1 (NO - 1)

The hydrologic unit is a 2,800 acre area located in the northeast portion of the study area (Map 1). It contains equal portions of Gentilly-Ged and Clovelly soil associations (Map 2). The land is non-forested wetland (Map 12) dominated by landowners that have 500 acres or more (Map 13). The unit has an oil pipeline that runs along the southeastern edge of the hydrologic unit (Map 4).

The unit was historically a solid emergent, low salinity marsh. Open water areas included the 200 acre Browns Lake and a small, unnamed bayou that provided a drainage outlet into Kelso Bayou. In the 1940's it was almost solid emergent with little open water, presently it is 15 percent marsh with 85 percent open water (Map 5). The only emergent marsh left is in a narrow band parallel to Louisiana Highway 27 on the east and the GIWW on the north (Map 6). The marsh vegetation has been representative of an intermediate to brackish marsh since 1949 (Maps 8-11).

The problems include wave erosion in Brown's Lake, salinity, and sediment deprivation. Louisiana Highway 27 will be exposed to direct wave action if erosion rates continue. The salinity rates should be stabilized in order to promote vegetative growth and reduce the erosive energies of waves. Most open water areas are too deep to manage for emergent vegetation and should be managed for aquatics. Therefore, the goals should be to reduce wave fetch and energy, moderate salinity, and increase sediment into the system.

ALTERNATIVES AND ANALYSIS

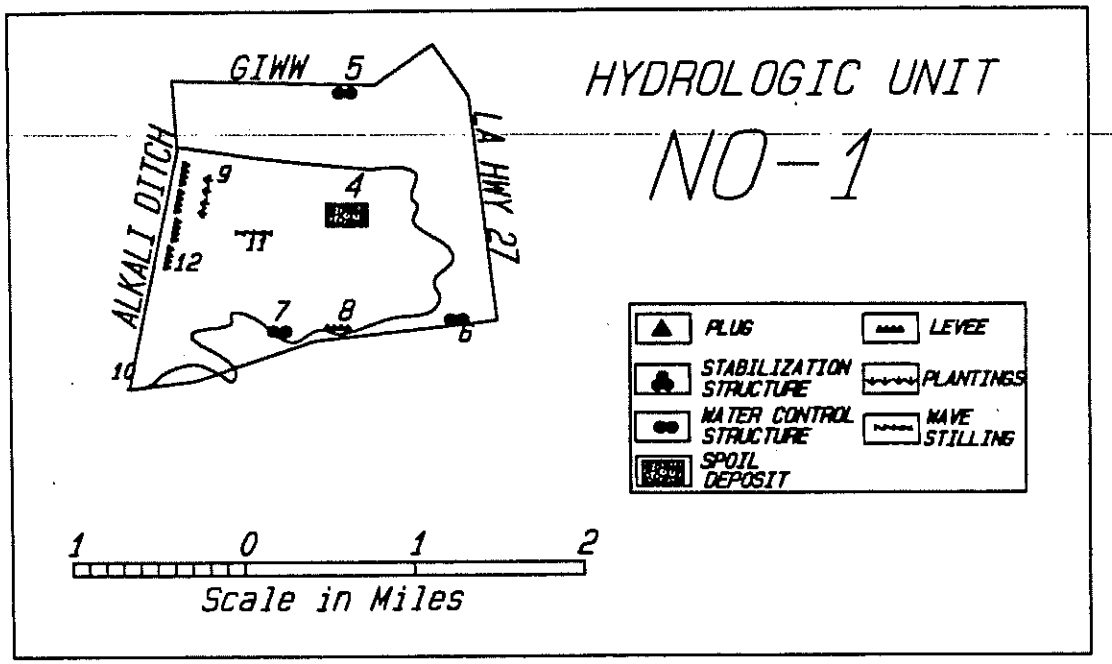

Figure 1. Hydrologic Unit NO-1.

Alternative 3

The plan objective for the hydrologic unit is to actively manage for brackish marsh, stabilize salinities and water level fluctuations. The water salinity levels in the surrounding area makes managing for lower salinity marsh types impractical. The objective will be accomplished by installing two water control structures, maintaining existing and constructing new perimeter levees, and installing a freshwater/sediment introduction structure from the GIWW.

Element 6 calls for installation of five-48 inch culverts with flapgates to stabilize the south boundary by placing them in oil field canals. Element 7 calls for the installation of a variable crest weir with a boat bay in the south boundary levee. The plan also calls for four-48 inch pipes with flapgates to be placed through the levee spoil for freshwater introduction (element 5). The plan includes rebuilding 20,000 linear feet of the south bound levee (element 8) and 12,000 feet of the east levee of Alkali Ditch (element 12).

Additional measures include dredge spoil disposal, wave stilling/sediment trapping structures in open water areas and vegetation plantings throughout the unit. The plan for marsh creation via dredge spoil disposal includes 100,000 cubic yards of spoil. The wave stilling devices (element 11), 50,000 linear feet, will be installed to capture suspended sediments for marsh accretion. The alternative utilizes 12,000 linear feet of vegetation along Alkali Ditch and interior areas (element 9). The Department of Energy plant operator will be asked to use a smaller boat on trips through the GIWW and Alkali Ditch. The smaller boat will reduce wave energy and thus, wave erosion along the banks and levees.

The planned components for Alternative 3 will cost a total of $1,803,000. Specific structure design has not been determined, but should incorporate design or operation features that allow opportunities to stabilize water and salinity levels and provide access for marine organisms.

Table 16. Hydrologic Unit NO-1. Components for Alternative 3. 2,800 Acres - Plan Objective: Stabilize salinities and water level fluctuations; will be actively managed.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
4	A	cubic yards of Spoil	$3.00	100,000	$300,000
5	G	48" Pipe w/gates	$26,250	4	$105,000
6	G	48" culvert w/gates	$14,000	5	$70,000
7	G	VC Weir w/boat bay	$80,000	1	$80,000
8	D	South Levee Repair (Ft)	$15.00	20,000	$300,000
9	B	Vegetation (Ft)	$1.50	12,000	$18,000
10	J	Request of DOE			$0
11	C	Wave stilling Device (Ft)	$15.00	50,000	$750,000
12	D	East Levee Repair (Ft)	$15.00	12,000	$180,000
Total Alternative Cost					$1,803,000

Alternative 4

The alternative includes an additional 8,000 linear feet of vegetative plantings (element 9) for a total of 20,000 linear feet of plantings and an extra 84,000 linear feet of wave stilling devices be planned over alternative 3. The wave stilling devices will be installed for additional opportunities to reduce emergent marsh erosion and capture suspended sediments in the water column for marsh accretion. The total construction cost of Alternative 4 is $3,075,000 which is $1,272,000 more than alternative 3.

Table 16a. Hydrologic Unit NO-1. Additional Components for Alternative 4.
Unit Acreage 2,800

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
9	B	Vegetation (Ft)	$1.50	8,000	$12,000
11	C	Wave Still Device (Ft)	$15.00	84,000	$1,260,000
Sub Total Alternative					$1,272,000
Total Alternative Cost					$3,075,000

North Unit 2 (NO - 2)

The hydrologic unit is a 1,300 acre intermediate/brackish marsh area located in the northeast quadrant of the study area (Map 1). The unit soils are predominantly Clovelly association, however the northwestern part of the unit contains Gentilly-Ged associated soils (Map 2). The unit acreage is non-forested wetlands (Map 12) and land ownership is by landowners with 500 or more (Map 13). The unit contains a product pipeline that intersects the northeastern fringe area (Map 4).

ALTERNATIVES AND ANALYSIS

The unit historically was mapped as brackish marsh on the eastern half and intermediate marsh on the western half of the unit (Map 8). The unit was mapped as brackish in 1968 (Map 9) and 1978 (Map 10). The 1988 vegetative map showed the unit to be intermediate in the northern half and brackish in the southern half (Map 11).

According to 1940 aerial photography the area was almost solid emergent marsh. The 1983 photography shows that the area had changed to an open water pond. The 1956-1978 Marsh Land Water Change Map (Map 5) showed that the unit marsh had predominantly converted to open water. By 1984, only the northeast corner of the unit contained marsh and broken marsh (Map 6).

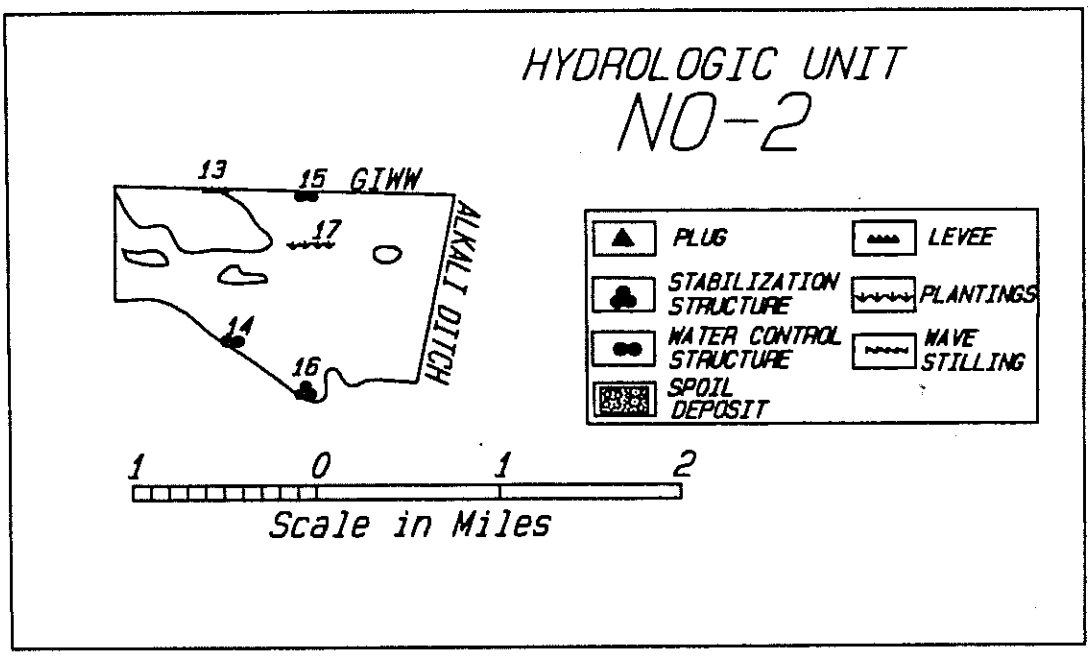

Figure 2. Hydrologic Unit NO-2.

Alternative 3

The hydrologic unit will be under an active management plan and operated according to the permitted plan. The objectives are to stabilize salinity and water level fluctuation, and stimulate emergent vegetation growth. The water salinity levels in the surrounding area makes managing for the historical marsh type impractical. This area will be managed for brackish/intermediate marsh by manipulating the water control structures to control salinity and water levels. Special operation provisions will insure fisheries access. The operation schedule also contains provisions to periodically lower water levels to encourage natural revegetation of adapted emergent species in shallow water areas.

The plan components, Table 17, includes maintaining the existing perimeter levee system (element 13 and 16), installing a freshwater introduction structure in the north boundary (element 15), replacing two existing water control structures in the south boundary with variable crest, flapgated

structures and installing a 18" flapgated culvert for fisheries access (element 14). The final component, vegetation, will be used for shoreline protection and to help improve the vegetative productivity of shallow open water areas (element 17). The system of components proposed for the hydrologic unit will cost $691,000 to construct.

Table 17. Hydrologic Unit NO-2. Components for Alternative 3.
1,300 Acres - Plan Objective: Stabilize salinity and water level fluctuation, stimulate emergent vegetation growth. Actively managed.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
13	D	Levee Repair (ft.)	$8.00	6,000	$48,000
14	G	Water Control Structures	$50,000	3	$150,000
15	G	North Side Pump	$150,000	1	$150,000
16	D	Armor-Plate (ft.)	$65.00	5,000	$325,000
17	B	Vegetation (ft.)	$1.50	12,000	$18,000
Total Alternative Cost					$691,000

Alternative 4

The alternative, Table 17a, includes an additional 4,000 feet of armor plated levee, element 16, for a total of 9,000 feet of armor plated levee work in the hydrologic unit. The construction cost of the additional levee work will be $260,000 and bring the total cost of the alternative to $951,000.

Table 17a. Hydrologic Unit NO-2. Additional Components for Alternative 4.
Unit Acreage 1,300

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
16	D	Armor-Plate (ft.)	$65.00	4,000	$260,0000
Sub Total Alternative					$260,0000
Total Alternative Cost					$951,0000

North Unit 2A (NO - 2A)

The hydrologic unit is a 800 acre area located in the northeast quadrant of the study area (Map 1). The unit soils are mapped as Clovelly association (Map 2). The landuse is non-forested wetlands (Map 12) and land ownership is by landowners of 500 acres or more (Map 13). The southwestern portion of the unit is traversed by an oil pipeline (Map 4).

The unit was historically mapped as intermediate marsh with some sawgrass marsh in the northwest corner (Map 8). The 1968 and 1978 vegetative maps have the unit as a brackish marsh (Maps 9-10). The 1988 vegetative map has the unit mapped as intermediate marsh on the northern two-thirds and brackish on the southern one-third (Map 11).

The area was historically a solid fresh/intermediate emergent marsh. In 1940, the area contained approximately only small isolated areas of open water. The area is now basically open water with small isolated areas of emergent marsh and classified as intermediate to brackish marsh. The 1956-1978 Marsh Land Water Change Map (Map 5) shows that most of the unit has converted from marsh

to water. The 1984 data shows the unit as predominantly water with small areas of marsh and broken marsh (Map 6).

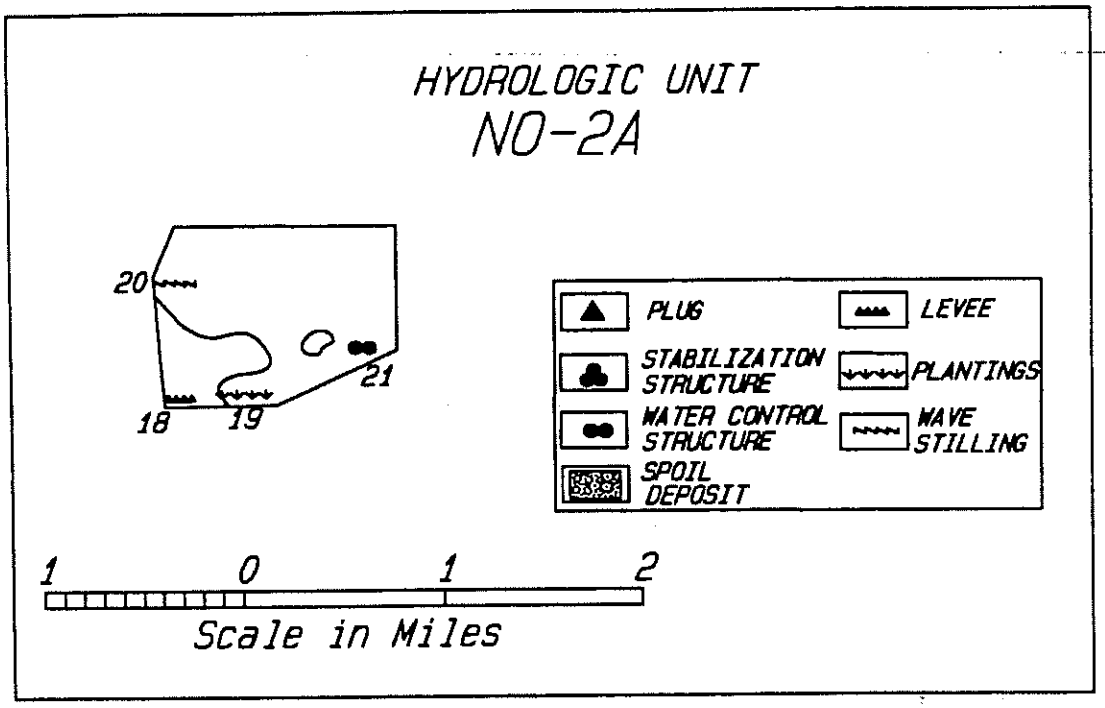

Figure 3. Hydrologic Unit NO-2A.

Alternative 3

The water salinity levels in the surrounding area makes managing for the historical marsh type impractical. The proposal for this area is to stabilize water level fluctuation, reduce turbidity, and passively manage for brackish/intermediate marsh. Features, listed in Table 18, of the proposal include re-establishing the historic Black Lake shoreline (element 18), maintaining the existing freshwater introduction structure in the north boundary, and installing one water control structure in the south boundary (element 19). Specific structure design has not been determined, but should incorporate design or operation features that allow for opportunities to stabilize water and salinity levels and provide access for marine organisms.

The addition of wave stilling devices (element 20) and vegetation (element 21) will allow for an improvement in the turbidity of the unit's waters and provide an opportunity to accrete marsh near the wave stilling devices and vegetation. The vegetation will reduce erosion in the project area and help to increase vegetative productivity in the unit.

Table 18. Hydrologic Unit NO-2A. Components of Alternative 3.
800 acres - Plan Objective: Stabilize water level fluctuation, reduce turbidity, and passively manage.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
18	D	Armor-Plate Levee (ft.)	$65.00	8,000	$520,000
19	G	VC Weir (slotted) (ft.)	$80,000	1	$80,000
20	C	Wave Still Device (ft.)	$15.00	10,000	$150,000
21	B	Vegetation (ft.)	$1.50	15,000	$22,500
Total Alternative Cost					$772,500

Alternative 4

The alternative, Table 18a, includes additional wave stilling devices (element 20) for additional protection of the area and a greater opportunity to captured suspended sediments in the water column for accretion of emergent marsh habitat. The wave stilling devices cost a total of $600,000 for the additional 40,000 feet of protection. The total cost of alternative 4 will be $1,372,500 to construct.

Table 18a. Hydrologic Unit NO-2A. Additional Components of Alternative 4. Unit Acreage 800

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
20	C	Wave Still Device (ft.)	$15.00	40,000	$600,000
Sub Total Alternative					$600,000
Total Alternative Cost					$1,372,500

North Unit 3 (NO - 3)

The hydrologic unit is a 4,100 acre area located in the northeast quadrant of the study area bordering the Gulf Intracoastal Waterway (Map 1). The unit soils are predominantly Gentilly-Ged association with some Clovelly association in the southern one-quarter (Map 2). The landuse for the area is non-forested wetlands (Map 12) with ownership by landowners with 500 acres or more (Map 13). The unit has an oil pipeline in the southeast portion and contains oil, gas, and product pipelines latitudinally crossing the unit (Map 4).

The unit was historically mapped as fresh marsh (Map 8). The area was mapped with the eastern three-fifths as brackish and the western two-fifths as intermediate in 1968 (Map 9). Vegetative mapping done in 1978 showed the area to be brackish (Map 10). Recent vegetative mapping, completed in 1988, shows the area to be predominantly intermediate marsh (Map 11).

The unit had a small amount of conversion from land and marsh to water between 1956 and 1978 (Map 5). The 1984 classified satellite data shows the unit is interspersed with solid marsh, some agricultural and pasture land, and broken marsh (Map 6).

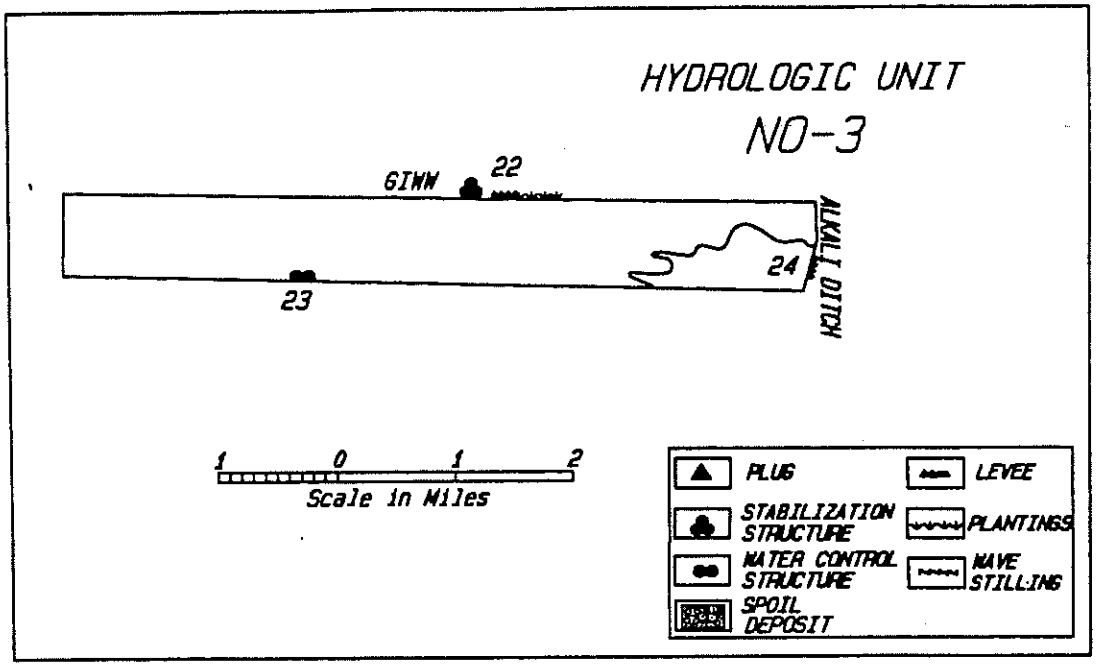

Figure 4. Hydrologic Unit NO-3.

Alternative 3

The plan objective for the unit is to maintain fresh and intermediate marsh in a passively managed approach. The area was managed as an agricultural pump-off between the 1960's and early 1980's. Water levels were artificially lowered to improve cattle grazing. The area experienced moderate oxidation of the soil surface during this time period. The area is now being managed as fresh to intermediate marsh for waterfowl and freshwater fisheries habitat.

Features, Table 19, of the proposal is to maintain the existing perimeter levee system (elements 22 and 24) and provide outlets for excess water (element 23) from this unit into adjacent wetlands. Levee maintenance will require 1,000 feet of armor plated levee and 4,500 feet of levee repair to maintain the present impoundment conditions. The addition of the two water control structures will provide the water manipulation capabilities needed to control water level conditions for enhancement of emergent and submergent aquatic species desirable for waterfowl and freshwater fisheries. The components of the alternative will cost $252,500 for construction.

Table 19. Hydrologic Unit NO-3. Components for Alternative 3.
4,100 Acres - Plan Objective: Maintain freshwater marsh, passively managed unit.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
22	D	Armor-Plate (ft.)	$65.00	1,000	$65,000
23	F	Water Control Structures	$60,000	2	$120,000
24	A	Levee Repair (ft.)	$15.00	4,500	$67,500
Total Alternative Cost					$252,500

Alternative 4

Alternative 4, Table 19a, will require an additional 2,000 linear feet of armor-plating (element 22) for the present levees. The additional work will provide for long-term protection of the levee and reduce the need for levee maintenance. The additional cost of the added levee armor-plating will be $132,000 for a total construction cost of $382,500.

Table 19a. Hydrologic Unit NO-3. Additional Components for Alternative 4. Unit Acreage 4,100

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
22	D	Armor-Plate (ft.)	$65.00	2,000	$130,000
Sub Total Alternative					$130,000
Total Alternative Cost					$382,500

North Unit 4 (NO - 4)

The hydrologic unit is a 6,600 acre area located northeast quadrant of the study area, south of Unit NO-3 (Map 1). The unit is predominantly mapped as Clovelly association soils with some Gentilly-Ged association in the southwest portion (Map 2). The unit landuse is predominantly non-forested wetlands with agricultural lands in the southwest corner (Map 12). Land ownership is dominated by landowners with 500 acres are more (Map 13).

The unit was historically mapped as sawgrass marsh on the eastern half and intermediate marsh on the western half of the marsh (Map 8). The 1968 vegetative mapping showed an increase in salinities in the unit with the eastern half as brackish marsh and the western half as intermediate marsh (Map 9). The salinity migration increase by 1978 with only the unit's northwest corner being intermediate and the remaining area being brackish (Map 10). The 1988 mapping showed an increase in freshwater with the unit's northwest corner being freshwater marsh and the remaining marsh being brackish (Map 11).

The unit has had conversion of most of the marsh to water between 1956 and 1978 (Map 5). This is also shown by comparison of the 1953 and 1985 aerial photography of the area. The 1953 aerial photography shows the area to be almost solid emergent marsh. The 1985 photography shows that the area the area had changed to open water with small isolated spots of broken marsh. The 1984 classification shows the area has mostly water with broken marsh in the southeastern portion of the unit (Map 6).

Alternative 3

The hydrologic unit will be actively managed for intermediate emergent vegetation. The water salinity levels in the surrounding area makes managing for the historical marsh type impractical. The area will be managed for intermediate marsh by manipulating the water control structures to control salinity and water levels. The proposed features, Table 20, for this area include maintaining the existing perimeter levee system (element 25), maintaining existing water control structures, installing shoreline protection measures on the east boundary adjacent to Black Lake, and planting adapted

emergent plant species in the marsh interior (element 26). The construction cost for these components total $368,000.

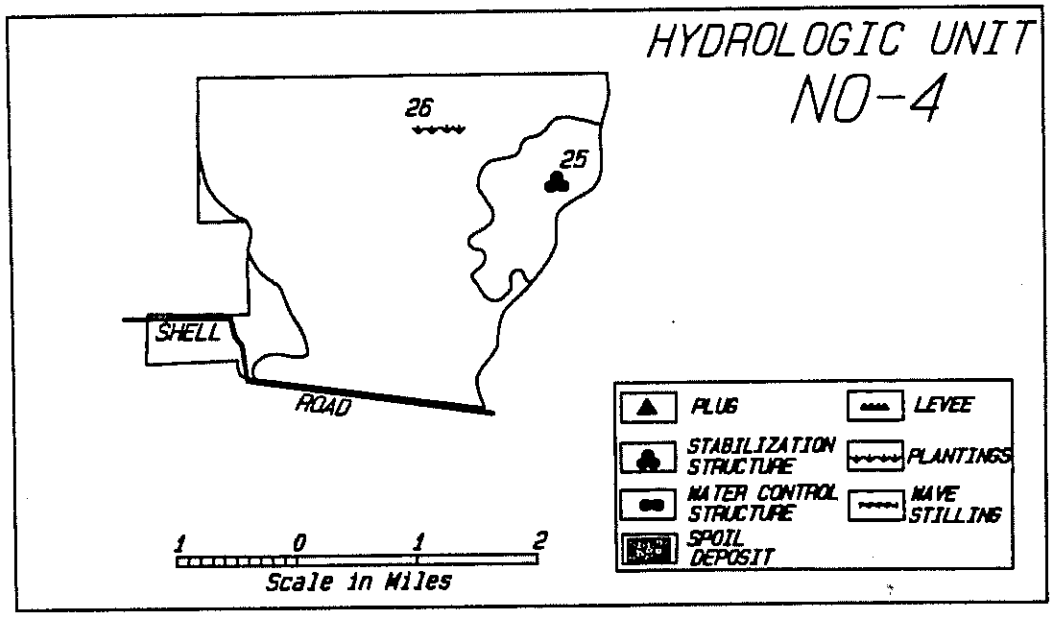

Figure 5. Hydrologic Unit NO-4.

Special operation provisions will insure maintaining fisheries access. The operation schedule also contains provisions to periodically lower water levels to encourage natural revegetation of adapted emergent species in shallow water areas.

Table 20. Hydrologic Unit NO-4. Components for Alternative 3. 6,600 Acres - Plan Objective: Manage for emergent vegetation for fresh-intermediate marsh. Unit is actively managed.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
25	D	Armor-Plate (ft.)	$65.00	5,200	$338,000
26	B	Vegetation Demo (Ac.)	$1,500	20	$30,000
Total Alternative Cost					$368,000

Alternative 4

Additional protection and vegetative enhancement can be afforded by increasing the acreage of vegetative plantings in the unit. The addition of 30 acres of vegetation (Table 20a, element 26) could be added to the project area at an additional cost of $45,000 for a total alternative construction cost of $413,000.

Table 20a. Hydrologic Unit NO-4. Additional Components for Alternative 4. Unit Acreage 6,600

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
26	B	Vegetation Demo (Ac.)	$1,500	30	$45,000
Sub Total Alternative					$45,000
Total Alternative Cost					$413,000

North Unit 5 (NO - 5)

The hydrologic unit is a 11,700 acre unit located in the northeast corner of the study area below Unit NO-1 (Map 1). The unit soils east of Highway 27 are mapped primarily as the Mowata-Vidrine-Crowley association. The area east of Alkali Ditch and west of Highway 27 are mapped as Clovelly association in the western portion of this area. The eastern portion contains Gentilly-Ged association. The southern portion contains soils in the Scatlake association. The remaining portion of the unit east of Alkali Ditch is mapped as Clovelly association with some Scatlake associated soils in the lower area next to Alkali Ditch (Map 2). The unit landuse is predominantly non-forested wetlands with some urban/industrial lands in the southwest portion of the unit (Map 12). The land is predominantly owned by landowners with 500 acres or more in the unit (Map 13). The unit has part of the East Hackberry Oil and Gas fields and has oil and product pipelines crossing the area (Map 4).

The unit was historically mapped as a brackish three-corner grass marsh (map 8). The vegetative mappings of 1968, 1978, and 1988 have the unit as brackish marsh (Maps 9-11). The 1956-1978 change maps show the unit having some conversion from land and marsh in the northern portion to water (Map 5). The 1984 classified satellite data shows the northern portion to be broken marsh and the southern portion to be an intermingling of land and solid marsh (Map 6).

Alternative 3

The objective for this hydrologic unit is to maintain and enhance the vegetation. The unit consists of Black Lake, brackish marsh areas, and spoil disposal areas along the Calcasieu Ship Channel. Brackish marsh occupies approximately 60 percent of the area. Much of this area is in the East Hackberry Oil and Gas Field. Historically, Kelso Bayou was the only water exchange point for Black Lake and the surrounding marshes. Construction of the Alkali Ditch, GIWW, and Calcasieu Ship Channel increased the number of water exchange points for Black Lake and has resulted in; 1) Increased salinities 2) Increased water fluctuations 3) increased opportunities for saltwater intrusion 4) Increased tidal scouring and erosion. This area experienced the same marsh type change and marsh loss discussed in Units No-1, 2A, 2, and 4.

The project components, Table 21, for the alternative include dredge spoil placement, water control structures, plugging abandoned canals, gapping spoil banks on abandon canals, wave stilling devices, and vegetation. The concept for the water control structure, element 25, is to reduce water fluctuations and salinities by controlling water at either Kelso Bayou or the Alkali Ditch. The reason for proposing Kelso Bayou is that it is closer to the Ship Channel (source of tidal influence). Commercial boat traffic will still be provided for through the Alkali Ditch. No decision has been made, as of yet, to put in a boat bay, but the design should provide provisions for fisheries access.

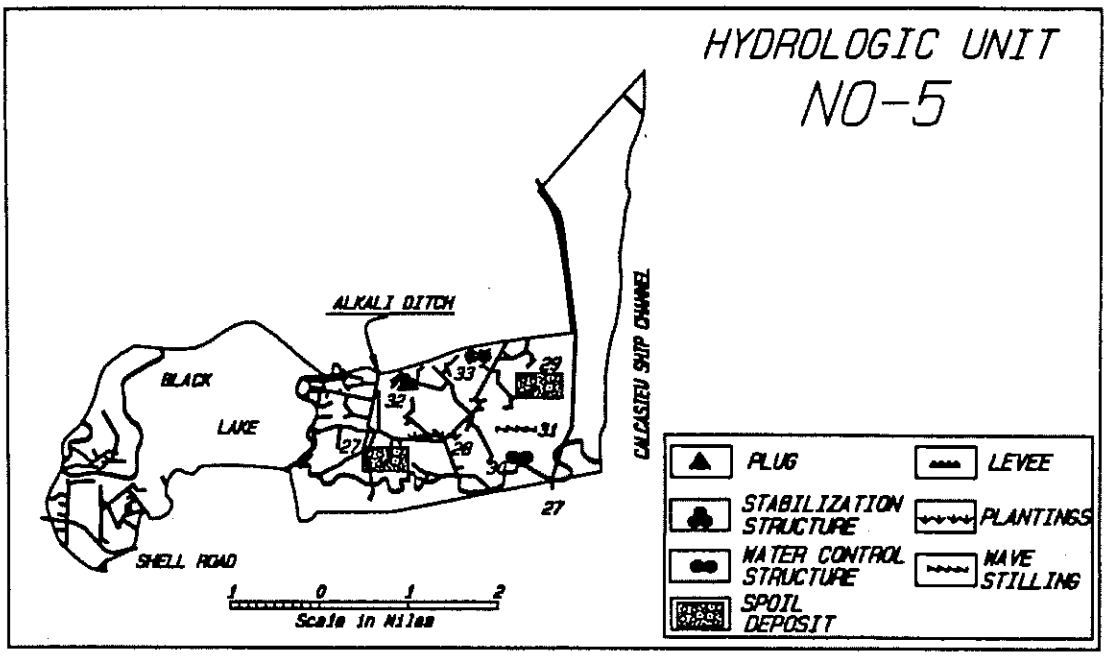

Figure 6. Hydrologic Unit NO-5.

Dredge material from Alkali Ditch (element 27) and the Calcasieu Ship Channel can be used (element 29) for marsh creation. The dredge material will provide for more emergent marsh and thus, a greater edge effect for wildlife and fisheries habitat. Plugging inactive oil field canals (element 32) will provide for greater hydrologic control of the unit and allow for potential spoil bank gapping of these plugged canals (element 33). The wave stilling devices (element 31) will provide protection from wave energy by reducing wave fetch and allowing for suspended sediments to drop out of the water column for marsh accretion. The vegetation (element 28) will provide for increased vegetative cover and reduced wave fetch in the marsh area. Implementation of any of the proposed elements should be coordinated with oil exploration activities. The construction cost of this alternative is $3,165,000.

Table 21. Hydrologic Unit NO-5. Components of Alternative 3.
11,700 Acres - Plan Objective: Maintain and/or enhance internal vegetation.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
27	A	cubic yards of Spoil	$3.00	80,000	$240,000
28	B	Vegetation (Ac.)	$15,00	50	$75,000
29	A	cubic yards of Spoil	$3.00	170,000	$510,000
30	F	Water Control Structure	$1,500,00	1	$1,500,000
31	C	Wave Stilling Devices (ft.)	$15.00	50,000	$750,000
32	H	Plug Canal	$70,000	1	$70,000
33	I	Gap Spoil Banks	$20,000	1	$20,000
Total Alternative Cost					$3,165,000

Alternative 4

The alternative, Table 21a, would provide for additional protection of the unit from erosion due to wave fetch. The vegetation (element 28) and wave stilling devices (element 31) will provide the additional protection. The added vegetation and wave stilling devices will cost $1,335,000 over the cost of Alternative 3 for a total construction cost of $4,500,000.

Table 21a. Hydrologic Unit NO-5. Additional Components of Alternative 4. Unit Acreage 11,700

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
28	B	Vegetation (Ac.)	$1,500	50	$75,000
31	C	Wave Stilling Device (ft.)	$15.00	84,000	$1,260,000
Sub Total Alternative					$1,335,000
Total Alternative Cost					$4,500,000

North Unit 6 (NO - 6)

The hydrologic unit is a 6,700 acre area that is predominantly the inhabited area of Hackberry and is located in the northeast quadrant of the study area below Unit NO-5 (Map 1). The unit soils are predominantly Mowata-Vidrine-Crowley association (Map 2). The primary landuse is agriculture with some small areas of forest land and urban/industrial lands (Map 12). The lands are mostly owned by landowners with 500 acres or more, except the northwest portion is owned by the federal government (Map 13). The unit contains a portion of the East Hackberry Oil and Gas Fields (Map 4).

The southeastern portion of the unit was historically mapped as brackish three-corner grass and southwest portion was mapped as intermediate marsh (Map 8). By 1968 only a small portion of the southern boundary was mapped as brackish marsh (Map 9). The 1978 vegetative mapping showed that the southeast boundary was mapped as saline marsh (Map 10). The 1988 vegetative mapping showed most of the unit to be non-marsh with a small portion of the southeast being brackish (Map 11). The 1956-1978 change map showed the unit to have only small conversions from land to marsh (Map 5). The 1984 classified satellite data shows the area to be an intermixing of agricultural land and marsh with pockets of broken marsh (Map 6).

The major objective of the local residents for this unit is to maintain adequate flood control and drainage facilities in the area. Also, insure that wetland practices installed in adjacent hydrologic units do not increase flooding of the inhabited areas and that any future drainage discharge is utilized to benefit wetlands. All wetland conservation and restoration elements installed in adjacent hydrologic units will be compatible with this objective. Therefore, no specific elements are proposed for the hydrologic unit.

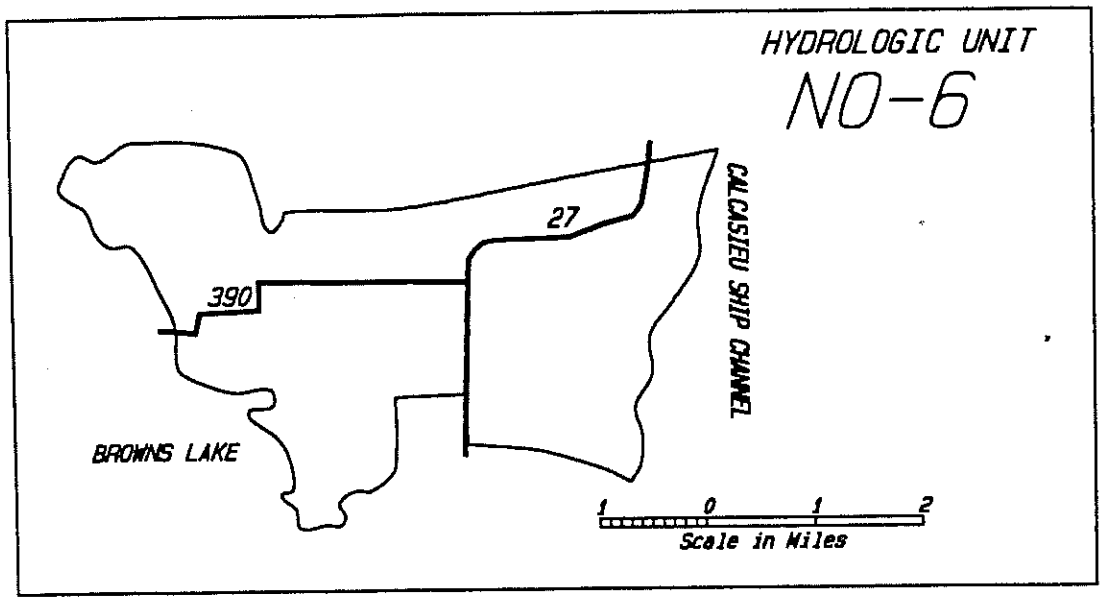

Figure 7. Hydrologic Unit NO-6.

North Unit 7 (NO - 7)

The hydrologic unit is a 1,660 acre area located in the northeast quadrant of the study area below the intersection of Units NO-4 and NO-5 (Map 1). The unit soils are mapped as Mowata-Vidrine-Crowley association on the eastern fringe with the remaining area is Gentilly-Ged association (Map 2). The unit landuse is predominantly non-forested wetlands with the northeast corner having some urban/industry lands (Map 12). The land is predominantly owned by landowners with 500 acres or more (Map 13). The unit northeast portion is part of the East Hackberry Oil and Gas Fields and has oil and product pipelines traversing the area (map 4).

The unit was historically a sawgrass marsh with the western fringe containing fresh marsh (Maps 7-8). The 1968 vegetative mapping showed the eastern and northwestern portion as brackish and the southwestern portion as intermediate marsh (Map 9). The 1978 and 1988 vegetative maps show the area as brackish marsh. The 1956-1978 change maps showed only small pockets of conversion from marsh to water (Map 5). The 1984 classified satellite data show the area as marsh and agricultural lands with some broken marsh in the northern portion of the unit (Map 6).

The plan objective for the unit is to maintain the present system of levees and water control structures of the actively managed freshwater marsh. The system is functioning well under the present management scheme, therefore, no additional elements proposed for this unit.

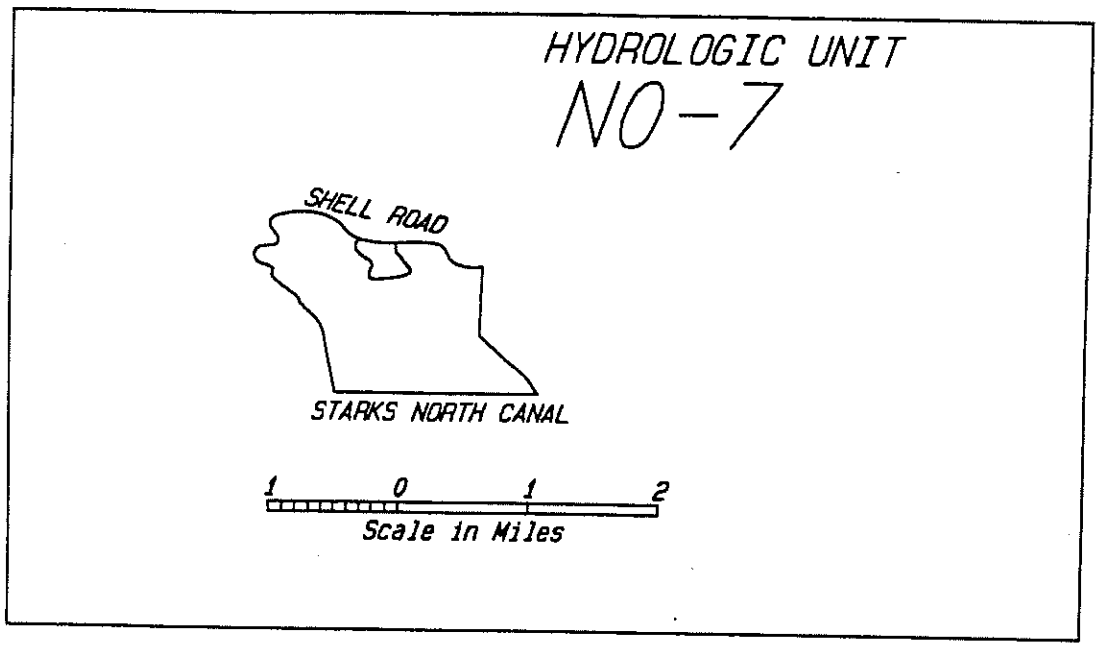

Figure 8. Hydrologic Unit NO-7.

North Unit 8 (NO - 8)

The hydrologic unit is a 4600 acre area located in the northeast quadrant below Unit NO-4 (Map 4). The unit soils are Clovelly association (Map 2). The landuse is mostly non-forested wetlands with the western one-quarter being used for agricultural purposes (Map 12) and the land ownership is dominated by landowners with 500 acres or more (Map 13). The unit is traversed by a product pipeline and an oil pipeline (Map 4). The unit does have an important biological area where a heron rookery (601015) is located (Map 3).

The unit was historically mapped as freshwater marsh on the eastern portion (Map 8). The 1968 vegetative mapping has the northern portion as predominantly brackish marsh and the southern portion as intermediate marsh. The 1978 vegetative mapping showed the unit as brackish marsh with the western edge containing intermediate marsh (Map 10). The 1988 vegetative maps has the area as brackish marsh.

The 1956-1978 change map shows that the unit converted from marsh to water during this period with a few small pockets of marsh left in the southeast section (Map 5). The 1984 classified satellite data showed the area to be almost all water with a few small pockets of broken marsh in the southeast portion (Map 6).

Alternative 3

The plan objective for the hydrologic unit is to stabilize salinity and water level fluctuations passively manage for a fresh to intermediate marsh. Presently no submerged aquatic vegetation is present in the open water areas.

By stabilizing the salinity and water level fluctuations, the problem of turbidity can be reduced and submerged aquatic productivity can be improved.

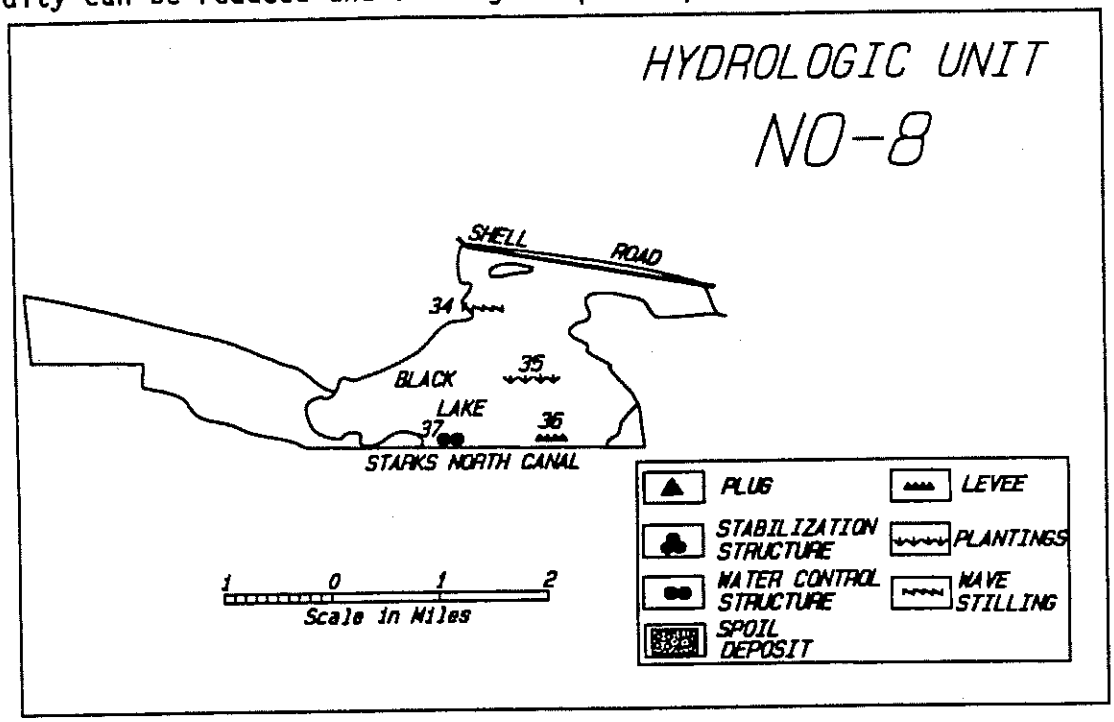

Figure 9. Hydrologic Unit NO-8.

The proposed elements, Table 22, include maintaining a perimeter levee system (element 36), installing passively managed water control structures (element 37), installing wave stilling/sediment trapping devices (element 34) in open water areas and planting adapted species of emergent vegetation (element 35) throughout the marsh interior. The construction cost for this alternative is $1,957,400.

Table 22. Hydrologic Unit NO-8. Components of Alternative 3.
4,600 Acres - Plan Objective: Stabilize salinity and water level fluctuation.
Passively managed for fresh/intermediate marsh.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
34	C	Wave Stilling Devices (ft.)	$15.00	100,000	$1,500,000
35	B	Vegetation (Ac.)	$1,500	50	$75,000
36	D	Levee Maintenance (ft.)	$8.00	22,800	$182,400
37	F	VC Weirs	$50,000	4	$200,000
Total Alternative Cost					$1,957,400

Alternative 4

The additional work for alternative 4 involves more wave stilling devices and vegetation. The plan calls for an additional 168,000 linear feet of wave stilling devices (element 34), and 50 additional acres of vegetative plantings (element 35). The extra work items cost $2,959,000 over alternative 3 for a total construction cost of $4,552,400.

Table 22a. Hydrologic Unit NO-8. Additional Components of Alternative 4. Unit Acreage 4,600

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
34	C	Wave Stilling Devices (ft.)	$15.00	168,000	$2,520,000
35	B	Vegetation (Ac.)	$1,500	50	$75,000
Sub Total Alternative					$2,595,000
Total Alternative Cost					$4,552,400

North Unit 8A (NO - 8A)

The hydrologic unit is a 1,110 acre area located in the north central portion of the study area west of Unit NO-8 (Map 1). The soils are mapped as Clovelly association on the southern half and predominantly Gentilly-Ged association in the northern half (Map 2). The landuse is non-forested wetlands (Map 12) with the lands being owned by landowners with 500 acres are more (Map 13). The western portion of the unit contains part of the South Black Bayou Oil and Gas Fields and is traversed by a product pipeline (Map 4).

The area was historically mapped as fresh marsh (Map 8). The 1968 vegetative map shows the southeastern portion of the unit as intermediate marsh and the remaining area as fresh marsh (Map 9). The 1978 and 1988 vegetative maps show the area as intermediate marsh (Map 10-11). The 1956-1978 change map has had a marsh conversion to land in the western fringe and predominantly marsh conversion to water in the southeastern portion of the hydrologic unit (Map 5). The 1984 classified satellite data shows the southern and western portions of the unit to contain broken marsh (Map 6).

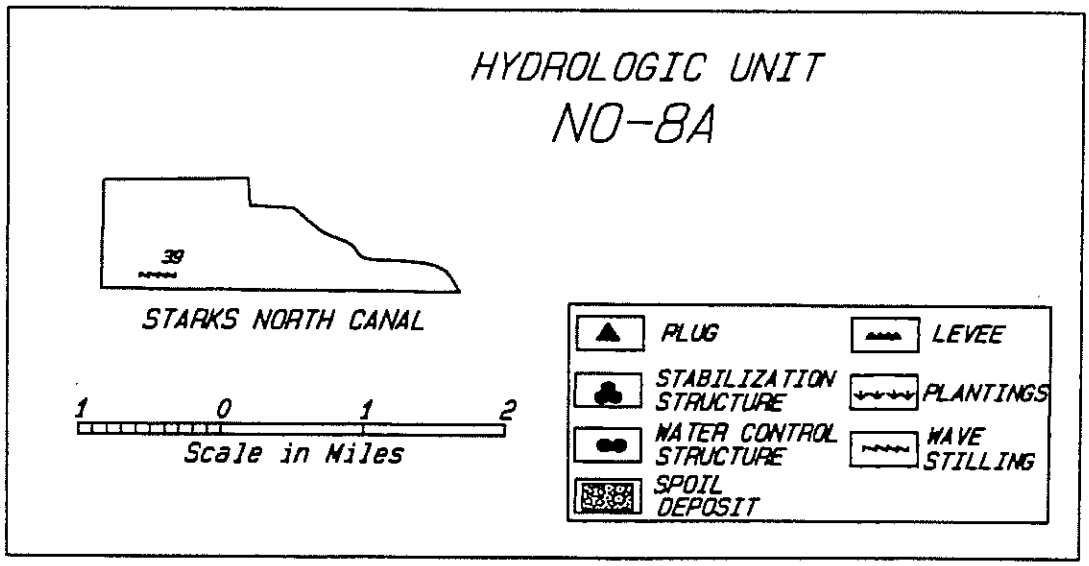

Figure 10. Hydrologic Unit 8A.

Alternative 3

The plan objective for the hydrologic unit is to enhance existing vegetation via a passive management scheme. The planned component, Table 23, is to install wave stilling/sediment trapping devices (element 38) across open water areas. The component will reduce wave fetch and thus, wave erosion within the unit. The devices will also enhance marsh accretion by capturing suspended sediment in the water column. The alternative will cost $90,000.

Table 23. Hydrologic Unit NO-8A. Components of Alternative 3.
1,110 Ac. - Plan Objective: Enhance existing vegetation. Passive management.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
38	C	Wave Still Device (ft.)	$15.00	6,000	$90,000
Total Alternative Cost					$90,000

Alternative 4

The alternative calls for an additional 14,000 linear feet of wave stilling devices (Table 23a, element 38). The additional work will cost $210,000 for a total cost of $300,000.

Table 23a. Hydrologic Unit NO-8A. Additional Components of Alternative 4.
Unit Acreage 1,100

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
38	C	Wave Still Device (Ft)	$15.00	14,000	$210,000
Sub Total Alternative					$210,000
Total Alternative Cost					$300,000

North Unit 9 (NO - 9)

The hydrologic unit is a 310 acre area located in the north central portion of the study area west of Unit NO-4 (Map 1). The soils map shows the unit to contain Clovelly association (Map 2). The landuse is predominantly non-forested wetlands with the southwest eighth used for agriculture (Map 12). The land is owned by the Cameron Parish School Board (Section 16).

The unit was historically mapped as a fresh marsh (Map 8). The 1968 vegetative map has the area mapped as intermediate marsh (Map 9). The 1978 vegetative map shows the unit as intermediate with the southeastern portion being brackish (Map 10). The 1988 vegetative map shows the area as predominantly brackish marsh with the northwest corner as fresh marsh (Map 11). The 1956-1978 change map shows the unit as solid marsh with only the extreme southern fringe converted to open water (Map 5). The 1984 classified satellite data shows the area as broken marsh and marsh (Map 6).

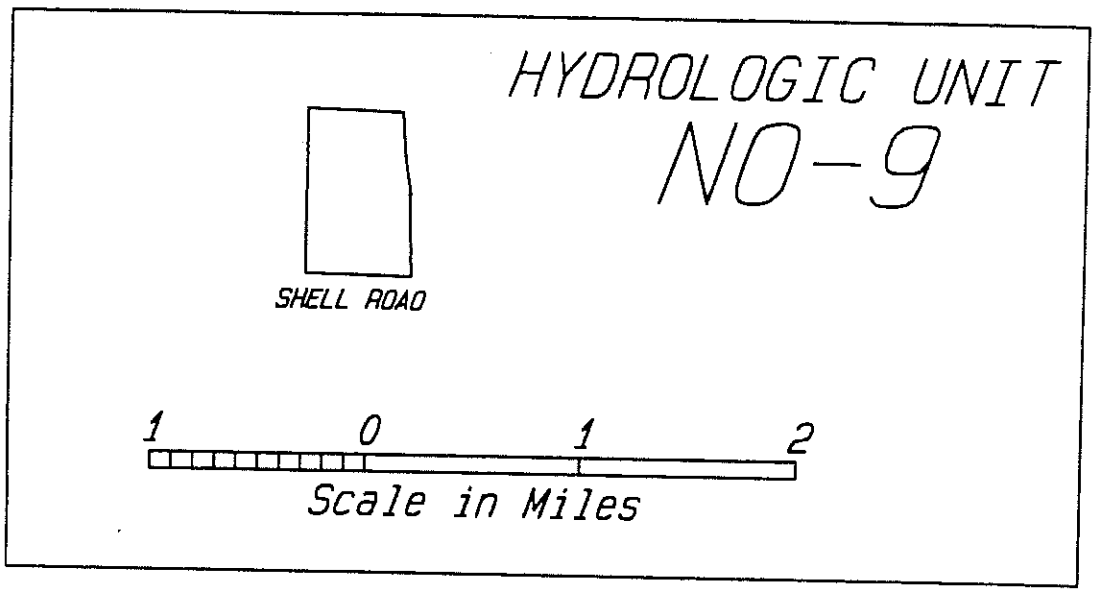

Figure 11. Hydrologic Unit NO-9.

The unit is surrounded by a continuous levee with no water exchange with adjacent units. The unit has no specific work items for implementation.

North Unit 10 (NO - 10)

The hydrologic unit is a 800 acre area located north central portion of the study area west of Unit NO-9 (Map 1). The soils were mapped as Clovelly association on the eastern portion, Gentilly-Ged association on the west portion, and Morey-Mowata-Midland associated soils in the northwest (Map 2). The landuse is primarily non-forested wetlands with pockets of agricultural lands (Map 12). The southeast one-fourth of the unit lands belong to the Cameron Parish School Board (Section 16) with the remaining land belonging to landowners with 500 acres or less (Map 13).

The area was historically mapped as a fresh marsh (Map 8). The 1968 and 1978 vegetative maps show the unit to be intermediate marsh (Maps 9-10). The 1988 vegetative map shows the unit to be mostly fresh marsh with the southern one-fourth being brackish marsh (Map 11). The 1956-1978 change maps show that the area had some marsh to land conversion (Map 5). The 1984 classified satellite data showed the unit to be land (ag/pasture), marsh, and some broken marsh in the middle of the unit (Map 6).

Alternative 3

The hydrologic unit is in the Water Bank Program and will be maintained in its current condition. The area was converted to an agriculture pump off and was in crop production until approximately 1980. The unit is now being managed as

fresh marsh for waterfowl habitat. Drainage is facilitated by a pump on the east boundary of the unit.

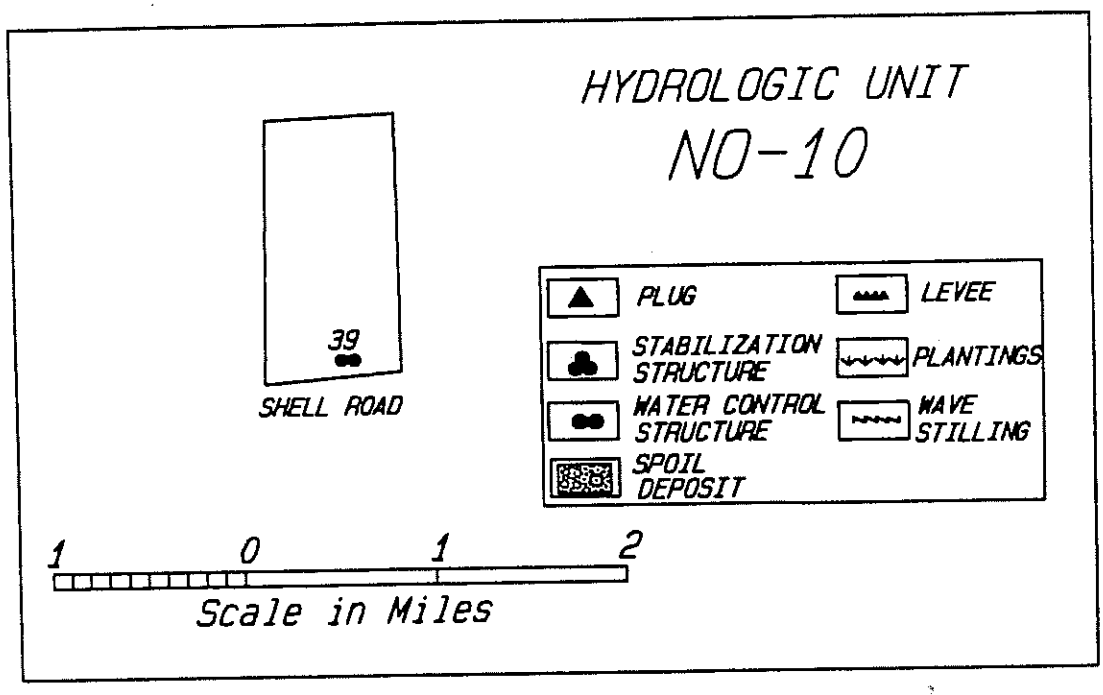

Figure 12. Hydrologic Unit NO-10.

The proposed structural component, Table 24, for the unit is to move the present pump (element 39). The pump will be relocated to the southeast corner of the area. Routing the discharge to the south would enhance water control capabilities in Unit NO-4 and provide freshwater introduction into Unit NO-8. The cost of the pump moval is estimated at $180,000. No additional work was proposed for the unit, so Alternative 4 is not presented.

Table 24. Hydrologic Unit NO-10. Components for Alternative 3.
800 AC. - Plan Objective: Maintain the area. It is in the water bank program.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
39	G	Move Pump	$180,000	1	$180,000
Total Alternative Cost					$180,000

North Unit 11 (NO - 11)

The hydrologic unit is a 12,800 acre area located in the north central portion of the study area bordering the Gulf Intracoastal Waterway (Map 1). The unit's soil are mapped predominantly as Morey-Mowata-Midland association, Gentilly-Ged association on the eastern and northwestern fringes, and Mowata-Vidrine-Crowley association on the southern portion (Map 2). The area is predominantly agricultural land with forest land in the southwest corner (Map 12). Land ownership in the unit has predominantly landowners with 500 acres or

more with the lower west central area having landowners with 500 acres or less (Map 13). The area also contains an important biological area with a heron rookery (588001) in the center of the unit (Map 3).

The area was historically mapped as a sawgrass marsh with a band of fresh marsh is the western part of the unit (Map 8). The 1968 vegetative maps shows the eastern one-third as intermediate marsh with the a small area in southern fringe as fresh marsh (Map 9). The 1978 vegetative map has the eastern one-third and western fringe mapped as intermediate marsh, the extreme southwest as brackish marsh, and northwest as fresh marsh (Map 10). The 1988 vegetative map shows the northeast and northwest as fresh marsh, the southeast as brackish marsh, and the remaining area as non-marsh (Map 11).

The 1956-1978 change maps showed that the western fringe area had some conversion from marsh to land (Map 5). The 1984 classified satellite data shows the area to be interspersed with agricultural land, marsh and broken marsh (Map 6).

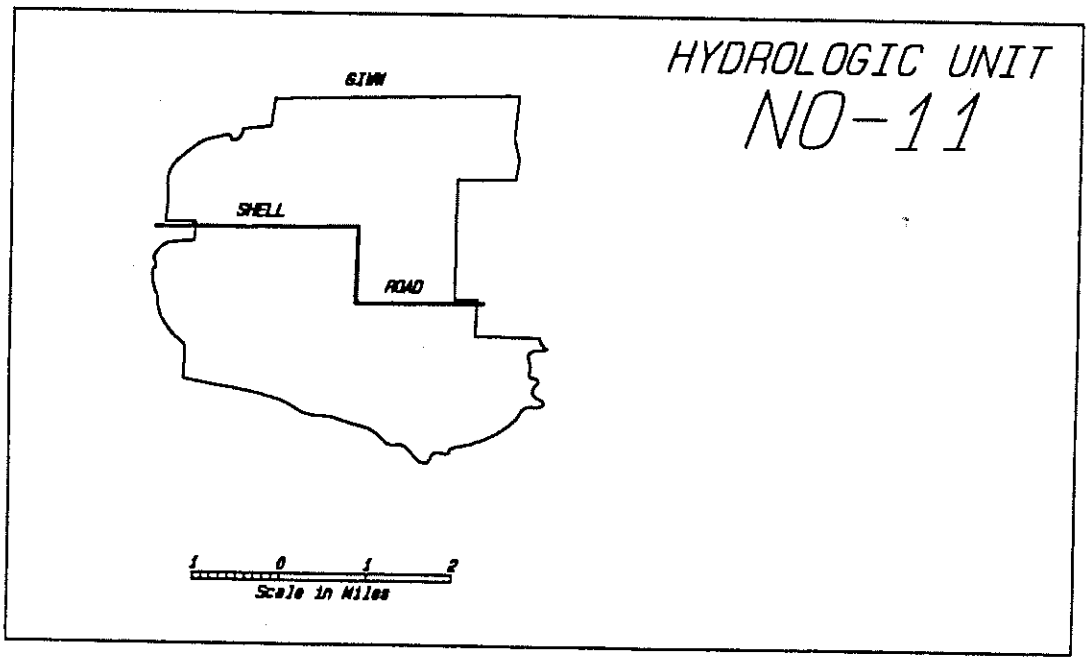

Figure 13. Hydrologic Unit NO-11.

The objective of the unit will be to maintain in the present condition. The unit includes all of Gum Cove Ridge and is composed of prairie (non-marsh) soils and small areas of wetland marsh soils. A water control structure has been permitted and planned for installation in the northeast corner of this unit. The structure will provide water level control and a drainage outlet. No other elements are proposed for this unit.

North Unit 12 (NO - 12)

The hydrologic unit is a 2,870 acre area located in the north central portion of the study area, west of Units NO-8 and NO-8A (Map 1). The unit soils are broken down as Mowata-Vidrine-Crowley association in northeast portion, northwest and central portions contain Morey-Mowata-Midland association, and Gentilly-Ged association on the southern portion (Map 2). The landuse is predominantly non-forested wetland except for the northern one-sixth of the unit which is used for agriculture (Map 12). The land in the unit is predominantly owned by land owners with 500 acres or more (Map 13). South Black Bayou Oil and Gas Fields and a portion of the Southeast Black Bayou Gas Fields are within the unit.

The 1931 vegetative map showed the area to be grazing land (Map 7). The 1949 vegetative map shows that the western one-fifth contained sawgrass marsh with the remaining land as predominantly fresh marsh (Map 8). The 1968, 1978, and 1988 vegetative maps show that the unit is predominantly intermediate marsh (Map 9-11). The 1956-1978 change maps show that the unit has remained unchanged (Map 5). The 1984 classified satellite data shows that the unit is mostly marsh, with some broken marsh and agricultural land (Map 6).

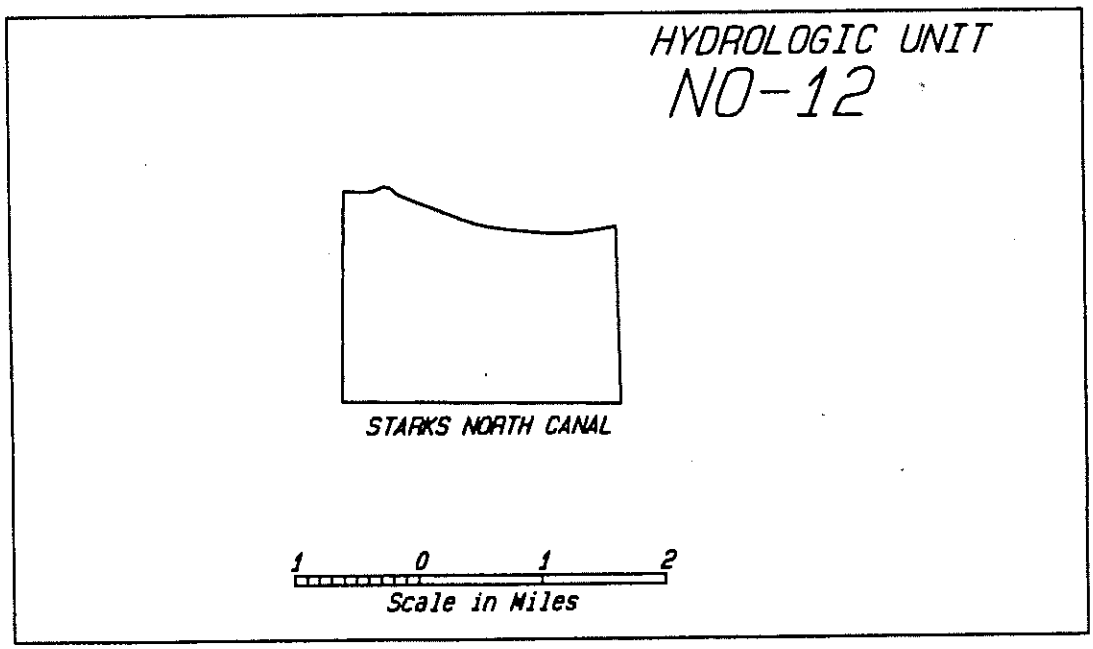

Figure 14. Hydrologic Unit NO-12.

The objective for this unit is to maintain in its current condition. Elements proposed for adjacent units address the hydrologic needs of this unit.

North Unit 13 (NO - 13)

The hydrologic unit is a 4600 acre area located in the north central portion of the study area. The unit soils are mainly Clovelly association with the

northern one-third containing Gentilly-Ged associated soils (Map 2). The area landuse is mapped as non-forested wetlands (Map 12). The unit is dominated by landowners owning 500 acres or more except the southwest portion which has landowners with 500 acres or less (Map 13). The southwest portion contains part of Black Bayou Oil Fields and also has several oil, gas, and product pipelines traversing the area (Map 4).

The area was mapped as sawgrass marsh with the northern one-third being fresh marsh (Map 8). Between 1968 and 1988 the unit made a conversion to freshwater and intermediate marsh (Maps 9-11). The marsh had converted from marsh to mostly water except for some marsh and land located in the northern and central portions of the unit (Map 5). The 1984 classified satellite data shows that most of the area is open water with marsh and agricultural land in the northern portion and broken marsh and marsh in central portion of the unit (Map 6).

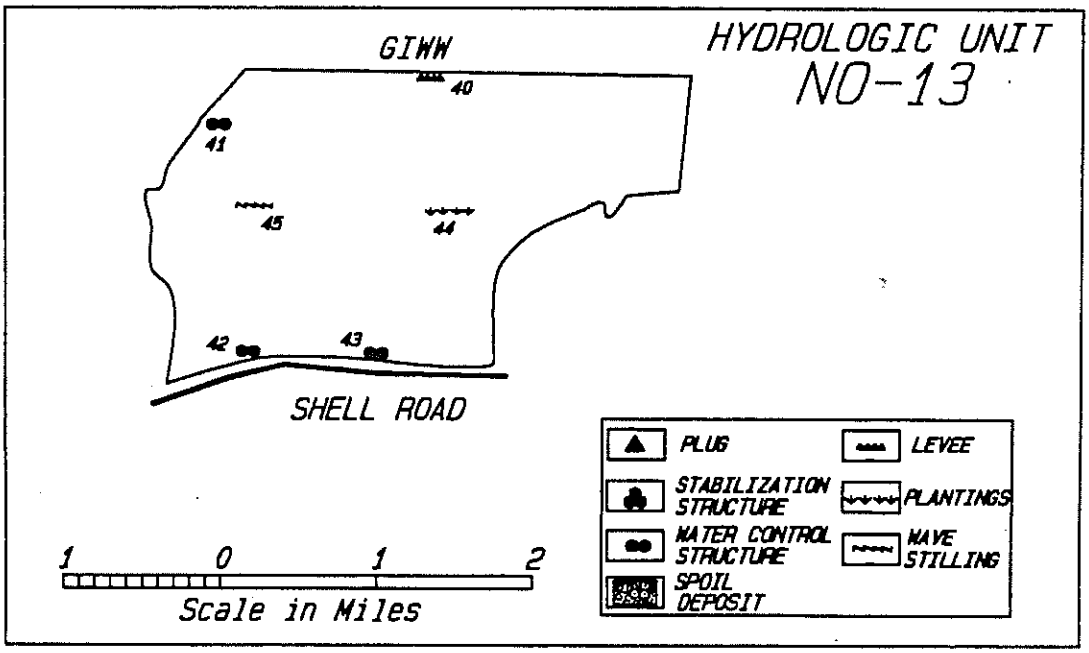

Figure 15. Hydrologic Unit NO-13.

Alternative 3

The objective for this unit is to manage for fresh marsh habitat. The unit is now a fresh/intermediate marsh with large open water areas. Open water is now estimated to compose over 85 percent of the unit. Chabreck's 1988 Vegetative Type Map shows this unit to contain the only remaining area of fresh marsh west of the Gum Cove Ridge north of the Sabine National Wildlife Refuge.

The proposed components for the for the unit are listed in Table 25. These elements include closing breaches in the GIWW spoil bank (element 40), replacing the existing structure on the west boundary (element 41), replacing the three structures on the south boundary (elements 42 and 43), vegetative

plantings (element 44), and installing wave stilling/sediment trapping devices (element 45).

Closing the breaches on the GIWW will allow for more control of water level fluctuations within the unit. The replacement of the three failed structures in the south boundary levee will provide for water and salinity control needed to reduce the fluctuating conditions in these water parameters. By reducing water and salinity fluctuations, the area will have an opportunity to remain in a fresh condition and decrease the soil erosive forces prevalent in an unnaturally fluctuating environment. The wave stilling devices will reduce wave fetch and allow for suspended sediments to be trapped and accrete marsh. The vegetative plantings will provide necessary plant materials to increase vegetative productivity within the system and capture sediments in the water column. The reduction of suspended sediments in the water column will reduce turbidity, increase light penetration, and enhance conditions to improve productivity of submerged aquatic vegetation.

Specific structure designs have not been determined, but should incorporate design and operation features that allow opportunities to stabilize water and salinity levels, allow management for freshwater/sediment introduction on the west boundary, and freshwater flow-through into Unit NO-14 at the south boundary. The total construction cost of the components will be $1,200,000 for the alternative.

Table 25. Hydrologic Unit NO-13. Components of Alternative 3.
4,600 Ac. - Plan Objective: Manage for fresh marsh, actively managed

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
40	D	Repair Spoil Bank (ft.)	$65.00	2,000	$130,000
41	G	Replace Water Control Str.	$100,000	2	$200,000
42	G	Replace Str. S Boundary	$15,000	2	$30,000
43	G	Replace Str. S Boundary	$15,000	1	$15,000
44	B	Vegetation (Ac.)	$1,500	50	$75,000
45	C	Wave Stilling Device (ft.)	$15.00	50,000	$750,000
Total Alternative Cost					$1,200,000

Alternative 4

The additions to alternative 4 over alternative 3 will provide for a greater opportunity to capture suspended sediments and increase emergent and submergent vegetative productivity. The components, Table 25a, include an additional 50 acres of interior marsh vegetative plantings (element 44) and 100,000 linear feet of wave stilling devices (element 45). The cost of the extra work would be $1,575,000 over alternative 3 for a total construction cost of $2,775,000 for alternative 4.

Table 25a. Hydrologic Unit NO-13. Additional Components for Alternative 4. Unit Acreage 4,600

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
44	B	Vegetation (Ac.)	$1,500	50	$75,000
45	C	Wave Stilling Device (ft.)	$15.00	100,000	$1,500,000
Sub Total Alternative					$1,575,000
Total Alternative Cost					$2,775,000

North Unit 14 (NO - 14)

The hydrologic unit is a 4,200 acre area located in north central part of the study area below Unit NO-13 (Map 1). The soils are mapped as Gentilly-Ged association, with some Morey-Mowata-Midland association in the south central fringe and Clovelly association in the northwest part of the unit (Map 2). The landuse is mostly non-forested wetlands except for the southeast part of the unit which is agricultural lands (Map 12). The Cameron Parish School Board owns a section of land within the unit (Section I6), and the remaining land is owned by landowners holding 500 acres or more (Map 13). The southeastern part of the unit contains the Southeast Black Bayou Gas Field (Map 4).

The area was historically a Sawgrass marsh (Map 8). The area made a slow conversion to fresh marsh and non-marsh lands (Map 9-11). The 1956-1978 change map shows that the central one-third of the area had marsh convert to water, the northeast part converted from land to marsh, while the area remained intact (Map 5). The 1984 classified satellite data showed the central one-third of the unit to be open water and broken marsh and the remaining area to be intermixed with marsh and agricultural lands (Map 6).

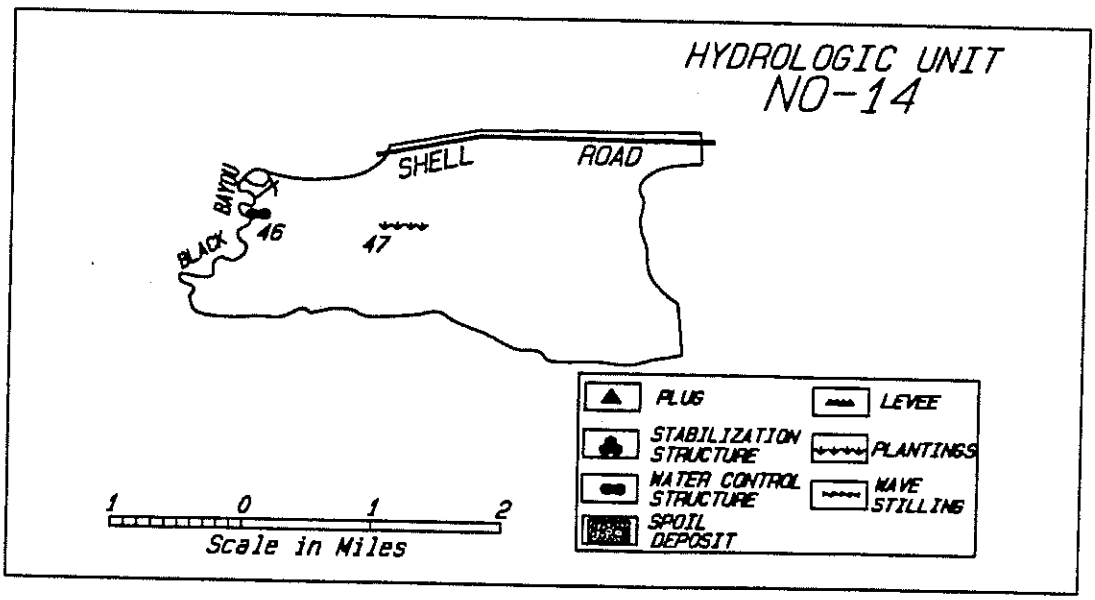

Figure 16. Hydrologic Unit NO-14.

Alternative 3

The plan objective for the hydrologic unit is to passively manage for a fresh to intermediate marsh. Marsh is estimated to occupy approximately 90 percent of the unit. The prairie areas occur as islands, some of which are connected by cattle walkways. The south boundary of the unit is a hydrologic boundary formed by prairie and cattle walkways. The north boundary is Bancroft Canal. Drainage of this unit is now to the north, through Bancroft Canal, then into Black Bayou.

Elements proposed include installing rock weirs (element 46) in openings through the Black Bayou natural levee and a water control structure (element 46) under the cattle walkway in the southwest part of the unit. The structures along Black Bayou should be designed to reduce water fluctuation and saltwater intrusion. The structure under the cattle walkway should be designed for one-way flow toward Black Bayou. Additionally, 5,000 linear feet of vegetation (element 47) is planned for the unit. The total construction cost of the alternative is $407,500. No additional components are recommended for extra protection of the wetland resources, therefore Alternative 4 will not be discussed.

Table 26. Hydrologic Unit NO-14. Components of Alternative 3. 4,200 Ac. - Plan Objective: Maintain as a fresh/intermediate marsh, passively managed.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
46	F	Rock Weirs at Black Bayou	$50,000	8	$400,000
47	B	Vegetation (ft.)	$1.50	5,000	$7,500
Total Alternative Cost					$407,500

North Unit 14A (NO - 14A)

The hydrologic unit is a 3500 acre area located in the north central part of the study area below Unit NO-14 (Map 1). The unit is bound on the east by a levee, on the north by non-marsh soils, on the west by Black Bayou and Right Prong of Black Bayou and on the south by the spoil bank of Starks North Canal. The unit is characterized by Clovelly associated soils with the eastern edge containing Gentilly-Ged and the south and central western portion containing Bancker associated soils (Map 2). The landuse is mostly non-forested wetlands (Map 12) and most of the land is owned by landowners with 500 acres or more.

The 1931 vegetative map showed the southwest portion of the unit contained some timberland (Map 7). The 1949 vegetative maps showed that the eastern half of the unit was sawgrass marsh and the western half was intermediate marsh (Map 8). By 1968 the eastern half had converted to a fresh marsh and the western half had converted to a brackish marsh (Map 9). The 1978 and 1988 vegetative maps show that the unit converted to predominantly intermediate marsh with only the western one-third being brackish marsh (Map 10-11).

The 1956-1978 change map showed only a small amount of marsh to open water conversion in the central part of the unit (Map 5). The 1984 classified

satellite data shows the central part of the unit is water and broken marsh and the remaining area to be marsh (Map 6).

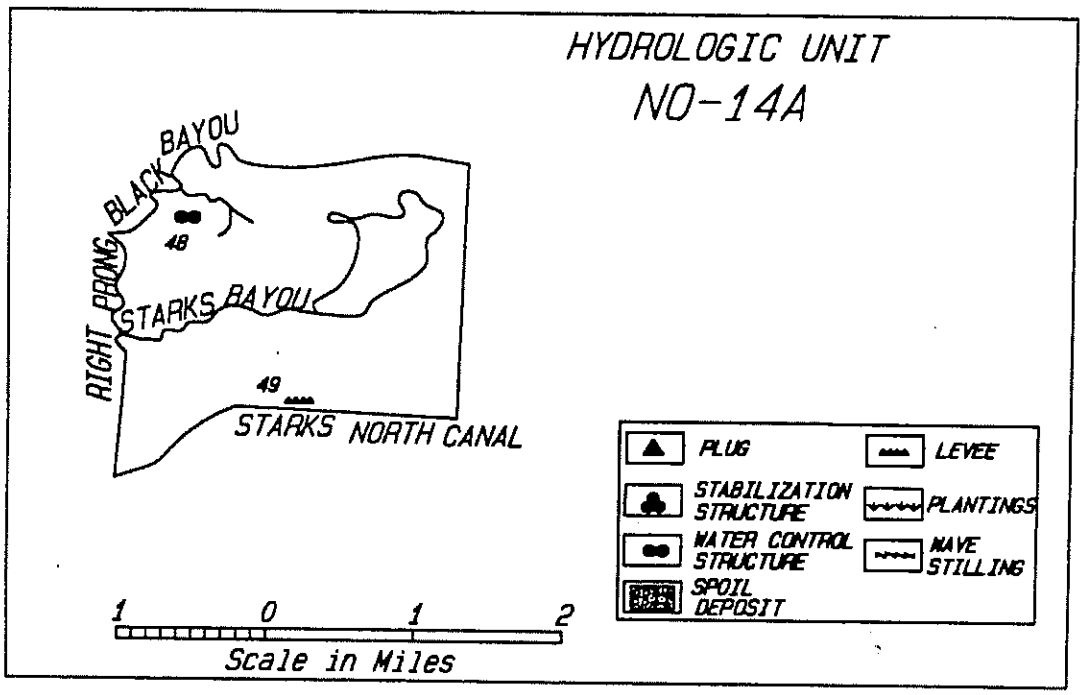

Figure 17. Hydrologic Unit 14A.

Alternative 3

The objective for the unit is to passively manage for a fresh to intermediate marsh condition. The components, Table 27, installing rock weirs (element 48) along Black Bayou to reduce water level fluctuations and to maintain the south hydrologic boundary with 13,000 linear feet of levee repair (element 49). The components will ensure the needed hydrologic control to create and maintain the fresh and intermediate condition as planned. The construction cost of this alternative is $395,000. No additional components are recommended for extra protection of the wetland resources, therefore Alternative 4 will not be discussed.

Table 27. Hydrologic Unit NO-14A. Components of Alternative 3.
3,500 Ac. - Plan Objective: Maintain fresh/intermediate marsh, passively managed

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
48	F	Rock Weirs at Black Bayou	$50,000	4	$200,000
49	D	Levee Repair (ft.)	$15.00	13,000	$195,000
Total Alternative Cost					$395,000

North Unit 15 (NO - 15)

The hydrologic unit is a 900 acre area located in the north central part of the study area west of Unit NO-13 (Map 1). The unit soils are predominantly Gentilly-Ged association except for the northeast and southwest one-half which are Clovelly associated soils. The landuse is non-forested wetlands (Map 12) with land ownership being landowners with 500 acres or more (Map 13). The unit is traversed by several oil, gas, and product pipelines (Map 4).

The area is historically a fresh marsh with the southern one-fifth being sawgrass (Map 8). The area converted to intermediate marsh by 1968 and was mapped as intermediate marsh in 1978 and 1988 (Map 9-11). The 1956-1978 change map showed that the northern one-third of the unit converted from marsh to water (Map 5). In 1956 this area was 84 percent fresh marsh 9 percent open water and remaining was forest and scrub shrub. The 1984 classified satellite data showed that the northern one-third to still be open water and the remaining area to be marsh and broken marsh (Map 6). Field work shows the unit to be composed of fresh and intermediate marsh, approximately 20 percent of which is open water, 42 percent broken marsh and the remaining 38 percent is vegetated marsh.

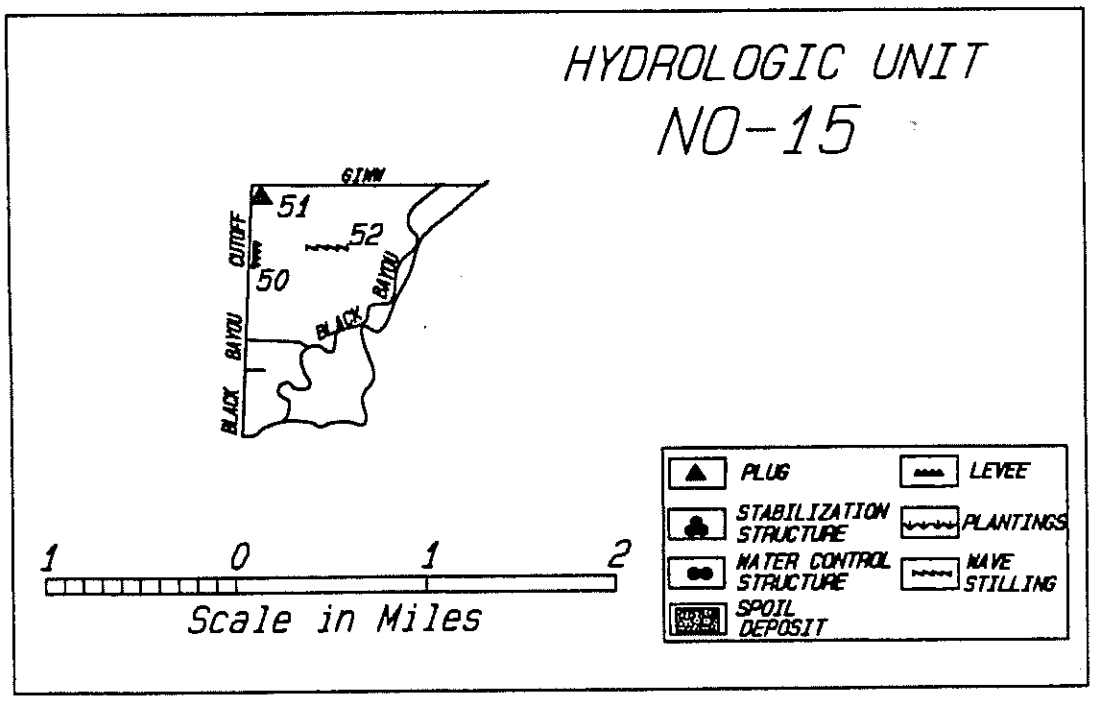

Figure 18. Hydrologic Unit NO-15.

Alternative 3

The objective for the hydrologic unit is to reduce excessive water exchange which results in unnatural water level fluctuations and thus erosion and potential drowning of emergent vegetation. The components, Table 28, include repairing the spoil bank along the Black Bayou Cutoff Canal (element 50) and reducing or closing the Vinton drainage ditch (element 51) and/or old Black

Bayou at the GIWW to reduce excess water exchange. Wave stilling and sediment trapping devices (element 52) are proposed in open water areas to encourage emergent and aquatic vegetation. The construction cost of the alternative is $529,000.

Table 28. Hydrologic Unit NO-15. Components for Alternative 3.
900 Acres - Plan Objective: Reduce excess water exchange and fluctuation.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
50	D	Levee Repair (Ft)	$65.00	600	$39,000
51	H	Plugs	$200,000	2	$400,000
52	C	Wave Still Device (Ft)	$15.00	6,000	$90,000
Total Alternative Cost					$529,000

Alternative 4

The extra work associated with this alternative would be an additional 14,000 linear feet of wave stilling devices (element 52) to encourage emergent and aquatic vegetation. The work will cost an additional $210,000 for a total construction cost of $739,000.

Table 28a. Hydrologic Unit NO-15. Additional Components for Alternative 4.
Unit Acreage 900

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
52	C	Wave Still Device (Ft)	$15.00	14,000	$210,000
Sub Total Alternative					$210,000
Total Alternative Cost					$739,000

North Unit 16 (NO - 16)

The hydrologic unit is a 1,500 acre area located in the northwestern part of the study area below Unit NO-15 (Map 1). The unit is predominantly mapped as Clovelly associated soils with Gentilly-Ged associated soils in the northwest portion (Map 2). The landuse is predominantly non-forested wetlands with the eastern half containing Urban/Industrial lands (Map 12). The land is owned by landowners with 500 acres or more (Map 13). The unit contains part of the Black Bayou Oil Field and has a gas pipeline traversing the northwest portion of the unit (Map 4).

The area was historically mapped as sawgrass marsh (Map 8). The 1968 vegetative map showed the unit to be mostly intermediate marsh with the northeast one-fifth being fresh marsh (Map 9). The 1978 and 1988 vegetative maps show the area to be intermediate marsh (Map 10-11). The 1956-1978 change map showed that the area had stayed as marsh except for the fringe areas of the unit which had some conversion from marsh to land (Map 5). The 1984 classified satellite data showed the area to be marsh with broken marsh on the western fringe (Map 6).

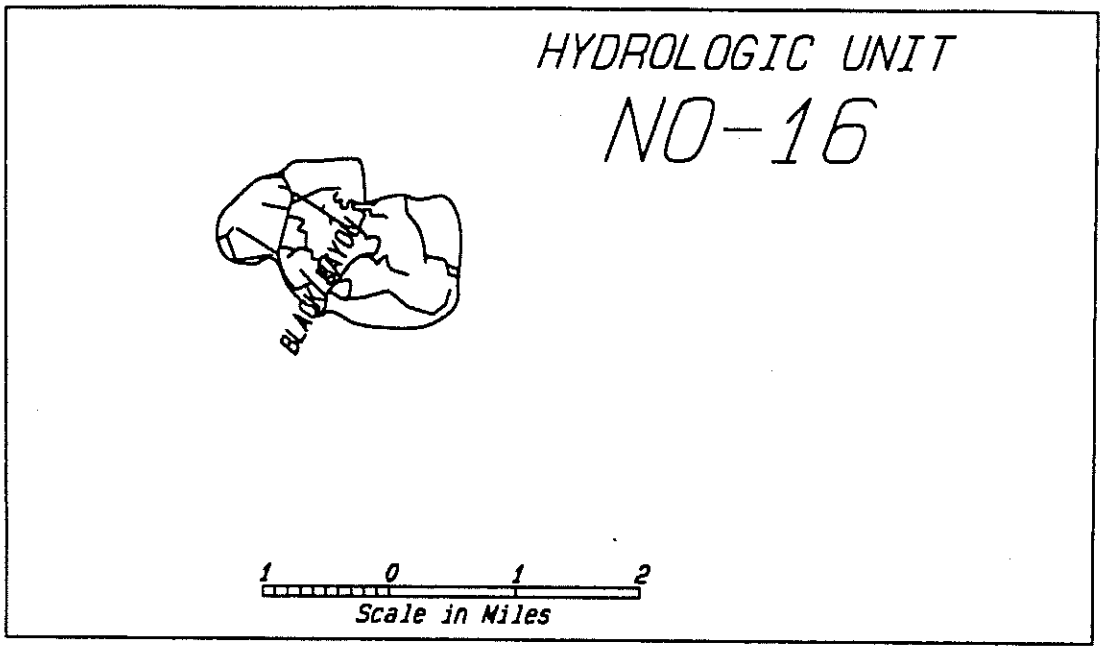

Figure 19. Hydrologic Unit NO-16.

The unit is an active oil field and is to be maintained in its present condition. The only request for this unit is that brine discharge, produced water, be disposed of properly in order to minimize impacts to the unit's marshlands.

A system of components will be used for Units 17, 18, 19, 20, and 21 where the concepts are:

1) to control flow of water from the north (GIWW) as much as possible and still allow freshwater to flow from Black Bayou Cutoff Canal through Units NO-17 and NO-18
2) to leave Black Bayou Cutoff Canal open,
3) to reduce overall water movement and prevent ponding,
4) to maintain as a fresh/intermediate marsh and
5) install wave stilling/sediment trapping devices in open water areas of all units to encourage emergent and aquatic vegetation.

North Unit 17 (NO - 17)

The hydrologic unit is a 2,950 acre area located in the northwestern part of the study area (Map 1). The unit predominantly mapped as Gentilly-Ged associated soils with the western one-eighth containing Morey-Mowata-Midland associated soils (Map 4). The landuse for the unit is predominantly non-forested wetlands (Map 12) with most of the area being owned by landowners with 500 acres or more (Map 13). The unit is traversed by oil, gas, and product pipelines (Map 4).

ALTERNATIVES AND ANALYSIS

The area was historically sawgrass marsh with fresh marsh in the northeast and central part of the unit (Map 8). The unit converted to intermediate marsh by 1968 and was recorded as intermediate marsh in the 1978 and 1988 vegetative maps (Maps 9-11). The 1956-1978 change map showed the unit has primarily converted from marsh to open water (Map 5) and was basically open water with broken marsh in the southeastern part of the unit in 1984 (Map 6).

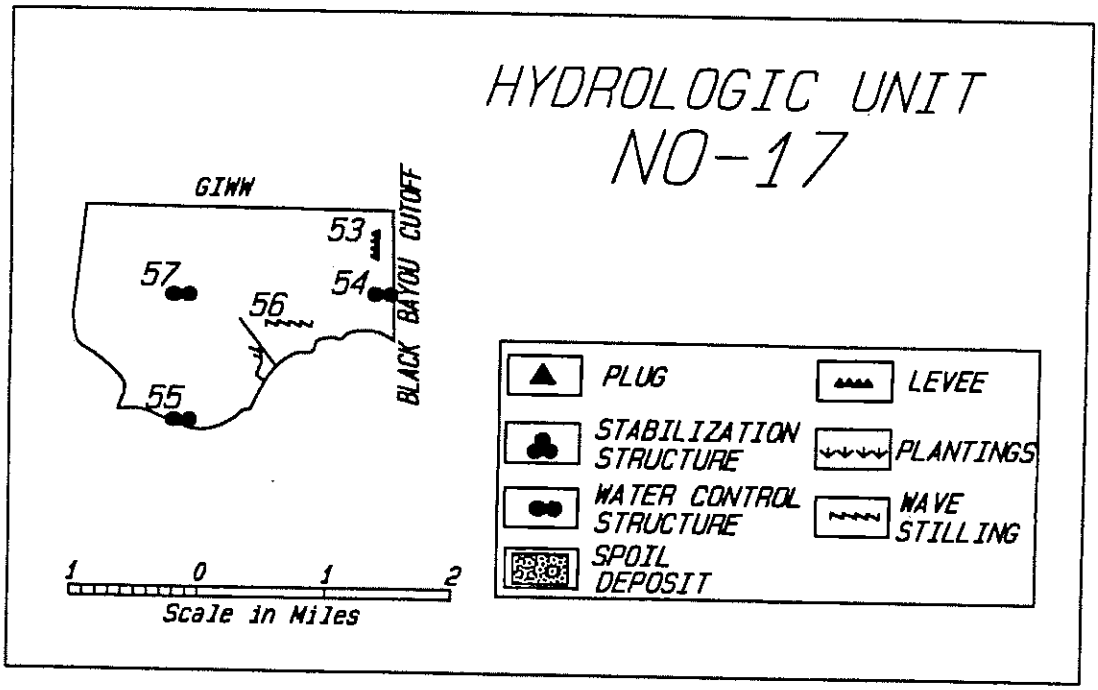

Figure 20. Hydrologic Unit NO-17.

Alternative 3

The objective for the unit is to passively manage the unit as a fresh/intermediate marsh and allow flow through this unit to Unit NO-18. It requires control of inflows from the GIWW and allow freshwater input from Black Bayou Cut-Off Canal to enter the marsh system. The components, Table 29, include 8,500 feet of spoil bank repair (element 53) along Black Bayou Cut-Off Canal to increase water control capabilities. Place two rock weirs (element 54) in openings along Black Bayou Cut-Off Canal, structure height will be set to prevent ponding of excess water, to reduce water flux yet allow marine organism access. A flapgated structure (element 55) will be placed under the road at the southern-most part of the hydrologic unit to prevent northward flow from Unit NO-18. Install about 22,000 feet of sediment trapping/wave stilling devices (element 56) in order to capture suspended sediments and reduce wave fetch within the unit. The result should be improved productivity of emergent and submerged aquatic vegetation. The last component is to gap some of the interior spoil banks (element 57) within the unit. The gapping of existing oil field canal spoil banks in the interior will enhance the flow through of freshwater. The total cost of the alternative set of components is $867,500.

Table 29. Hydrologic Unit NO-17. Components of Alternative 3.
Unit Acreage 2,950

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
53	D	Repair Spoil Bank (ft.)	$15.00	8,500	$127,500
54	F	Rock Weirs	$150,000	2	$300,000
55	F	Flapgated Structure	$80,000	1	$80,000
56	C	Wave Still Device (Ft)	$15.00	22,000	$330,000
57	I	Gap Spoil Banks	$30,000.00	1	$30,000
Total Alternative Cost					$867,500

Alternative 4

The scheme for this alternative includes all of the above components for Alternative 3 plus 45,000 feet of additional sediment trapping/wave stilling devices (element 56). The additional sediment trapping/wave stilling devices will provide for additional opportunities to capture suspended sediment in the water column and reduce wave fetch, thus erosion potential, within the hydrologic unit. The results will be greater productivity of emergent and submergent aquatic vegetation within the unit. The cost of this alternative will be an additional $675,000 for a total construction cost of $1,542,500 (Table 29a).

Table 29a. Hydrologic Unit NO-17. Additional Components for Alternative 4.
Unit Acreage 2,950.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
56	C	Wave Still Device (Ft)	$15.00	45,000	$675,000
Sub Total Alternative					$675,000
Total Alternative Cost					$1,542,500

North Unit 18 (NO - 18)

The hydrologic unit is a 4800 acre area located in the northwestern portion of the study area below Unit NO-17 (Map 1). The unit soils are predominantly Clovelly association with central part being Gentilly-Ged association (Map 2). The landuse in the unit is mostly non-forested wetlands with the lower central portion containing some forest land. (Map 12). The landowners in the unit have 500 or more acres in the unit (Map 13). The eastern half of the unit contains some gas pipelines (Map 4).

The unit was historically mapped as intermediate marsh on the southern half and sawgrass marsh on the northern half (Map 8). In 1954 the area was over 50 percent fresh marsh. The 1968, 1978, and 1988 maps show the area to be predominantly intermediate marsh with varying amounts of brackish marsh (Maps 9-11). The 1956-1978 change map showed that only the central portion of the unit converted from marsh to open water (Map 5). The 1984 classified satellite data shows that the central part of the unit has open water and broken marsh (Map 6). At present the unit is composed of 13 percent open water, 66 percent intermediate marsh (approximate 50 percent broken marsh), 11 percent brackish marsh, and 10 percent prairie.

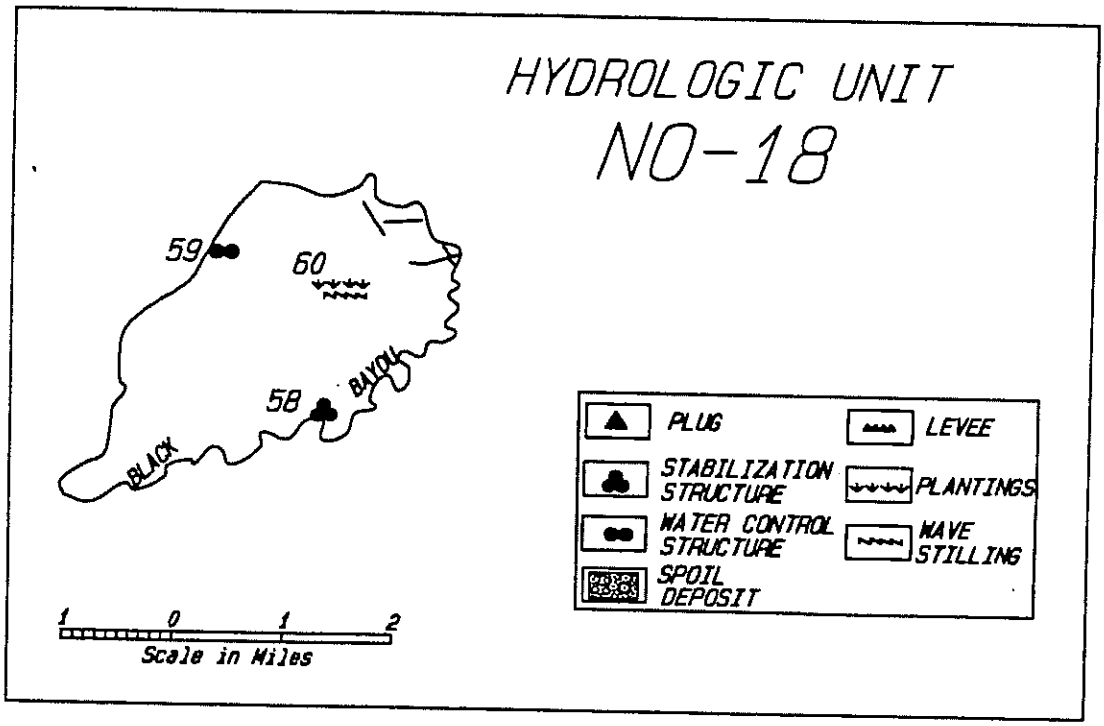

Figure 21. Hydrologic Unit NO-18.

Alternative 3

The proposal is to passively manage this unit as fresh/intermediate marsh and allow water to flow through this unit to Black Bayou and into Unit NO-19. The components, Table 30, include installation of 22 rock liners (element 58) in openings along Black Bayou and installation of a culvert (element 59) through an existing cattle walkway between Units NO-18 and NO-19 to allow for flow through to Unit NO-19. Lastly, installation of 18,000 feet of wave stilling/sediment trapping devices and vegetation (element 60) will allow for the enhanced production of emergent and submergent aquatic vegetation within the unit. The total construction cost of the alternative is $786,000.

Table 30. Hydrologic Unit NO-18. Components of Alternative 3.
Unit Acreage 4,800

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
58	F	Rock Liners	$20,000	22	$440,000
59	F	Control Structure	$40,000	1	$40,000
60	C	Wave Still Device/vegetation (ft.)	$17.00	18,000	$306,000
Total Alternative Cost					$786,000

Alternative 4

The scheme for this alternative includes all of the above components for alternative 3 plus 29,000 feet of additional sediment trapping/wave stilling devices and vegetation (element 60). The additional sediment trapping/wave

stilling devices will provide for additional opportunities to capture suspended sediment in the water column and reduce wave fetch, thus erosion potential, within the hydrologic unit. The results will be greater productivity of emergent and submergent aquatic vegetation within the unit. The cost of this alternative will be an additional $493,000 for a total cost of $1,279,000 (Table 30a).

Table 30a. Hydrologic Unit NO-18. Additional Components for Alternative 4. Unit Acreage 4,800

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
60	C	Wave Still Device/vegetation (ft.)	$17.00	29,000	$493,000
Sub Total Alternative					$493,000
Total Alternative Cost					$1,279,000

North Unit 19 (NO - 19)

The hydrologic unit is a 10,920 acre area located in the northwestern part of the study area west of Units NO-17 and NO-18 (Map 1). The soils of the unit are predominantly a mixture of Gentilly-Ged and Bancker associated soils with Morey-Mowata-Midland soils in the northeastern part and Clovelly soils in the southwestern part of the unit (Map 2). The landuse in the unit is non-forested wetlands (Map 12). The center of the unit contains Cameron Parish School Board Land (Section 16) and the remaining lands are mostly landowners with 500 acres or more (Map 13). The unit is traversed by several oil, gas, and product pipelines (Map 4).

The unit was historically mapped as sawgrass marsh with some intermediate marsh in the southeast and brackish marsh on the edge (Map 8). In 1956 this unit was 58 percent fresh marsh. The 1968 vegetative map had the area mapped with intermediate marsh in the northern and lower central portion and brackish marsh in the western and southern fringe. The 1978 vegetative map showed the area as brackish marsh (Map 10), and the 1988 map showed the marsh conversion to a lower salinity intermediate marsh (Map 11).

The eastern part of the unit converted from marsh to open water between 1956 and 1978 (Map 5). The 1984 classified satellite data shows that the area is solid marsh except for the center of the unit which has open water and broken marsh (Map 6). The unit is presently composed of 13 percent open water, 62 percent intermediate marsh (approximate 50 percent broken marsh), and 25 percent brackish marsh.

Alternative 3

The objective is to passively manage this unit as fresh/intermediate marsh. The components, Table 21, include rock liners, vegetation, and wave stilling devices. Element 61 is seven rock liners to be installed in openings along Black Bayou. Approximately 60,000 linear feet of interior vegetative plantings (element 62) will be used to enhance sediment capture and increase vegetative productivity within the unit. Element 63 calls for 60,000 linear feet of wave stilling/sediment trapping devices to be installed along with the vegetation in order to improve sediment capture and wave stilling

capabilities. A canal plug (element 64) will be placed at the junction of Units NO-19 and NO-20 along the Sabine River. A rock plug (element 65) will be installed in the bayou at Units NO-19 and NO-20 and Black Bayou junction. The installation of rock liners in the openings along Black Bayou, a plug in the canal at the junction of unit 19 and 20 at the Sabine River and a plug in the opening at the junction of unit 19, 20 and Black Bayou will allow freshwater introduction from the Sabine River at northwest corner of unit through the existing man-made canal. The total construction cost of this alternative is $1,310,000.

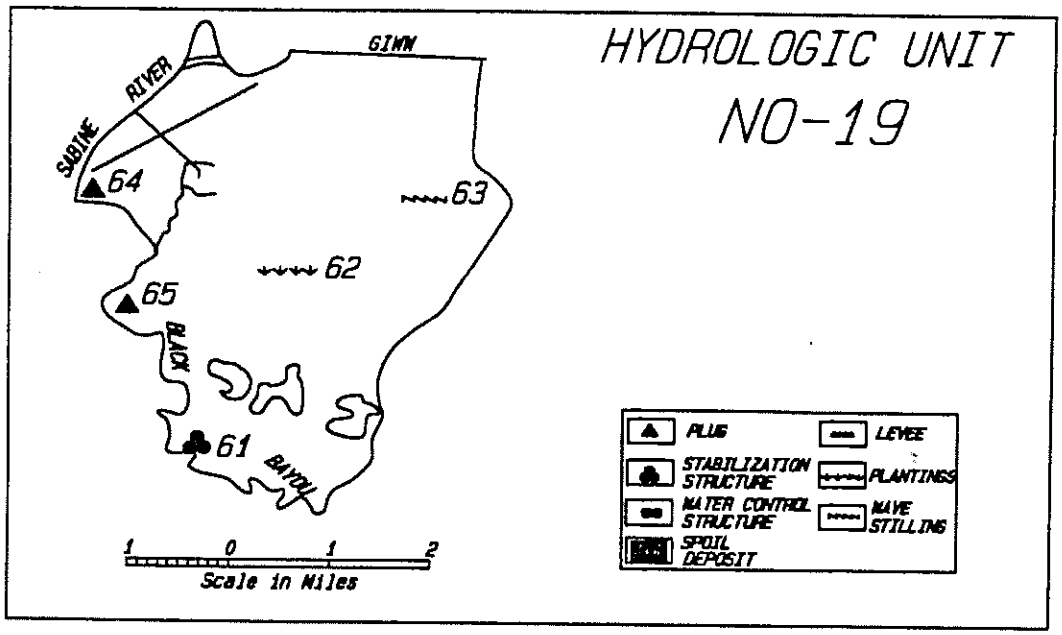

Figure 22. Hydrologic Unit NO-19.

Table 31. Hydrologic Unit NO-19. Components of Alternative 3.
Unit Acreage 10,920

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
61	F	Rock Liners	$20,000	7	$140,000
62	F	Vegetation (Ft)	$1.50	60,000	$90,000
63	C	Wave Still Device (Ft)	$15.00	60,000	$900,000
64	H	Canal Plug	$80,000	1	$80,000
65	F	Rock Plug	$100,000	1	$100,000
Total Alternative Cost					$1,310,000

Alternative 4

This alternative requires the addition of 140,000 linear feet of sediment trapping/wave stilling devices (element 63) and vegetation (element 62). The

additional sediment trapping/wave stilling devices and vegetation will provide for additional opportunities to capture suspended sediment in the water column and reduce wave fetch, thus erosion potential, within the hydrologic unit. The results will be greater productivity of emergent and submergent aquatic vegetation within the unit. The cost of this alternative will be an additional $2,310,000 for a total cost of $3,620,000 (Table 31a).

Table 31a. Hydrologic Unit NO-19. Additional Components for Alternative 4. Unit Acreage 10,920

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
62	F	Vegetation (Ft)	$1.50	140,000	$210,000
63	C	Wave Still Device (Ft)	$15.00	140,000	$2,100,000
Sub Total Alternative					$2,310,000
Total Alternative Cost					$3,620,000

North Unit 20 (NO - 20)

The hydrologic unit is a 1,680 acre area located in the northwest corner of the study area west of Unit NO-19 (Map 1). The unit soils Bancker association with the eastern one-third being Clovelly association. The landuse in the unit is non-forested wetland (Map 12). The northwest part of the unit contains landowners of 500 acres or less and the remainder of the unit lands are owned by landowners own 500 acre or more (Map 13). The area unit is traversed by several oil, gas, and product pipelines (Map 4).

The unit was historically a brackish three-corner grass marsh (Map 8). The unit remained brackish until the 1988 vegetative mapping when the unit vegetation indicated an intermediate marsh environment (Maps 9-11). The area has remained a solid marsh (Map 5) until 1984 when the south central portion began to show a broken marsh condition (Map 6). The unit is presently composed of 50 percent of intermediate marsh (approximate 30 percent broken marsh), 50 percent brackish marsh, and very little open water.

Alternative 3

The objective for the unit is to passively manage for fresh/intermediate marsh. This will be accomplished by installing five rock liners (element 66) in openings along Black Bayou to allow water exchange while reducing overall water movement (Table 32). Element 64, in Unit NO-19 is on the border between Units NO-19 and NO-20, is proposed to plug a canal going into the Sabine River which will improve freshwater retention in the unit. The total construction cost of alternative 3, rock liners only, will be $100,000.

Table 32. Hydrologic Unit NO-20. Components of Alternative 3. Unit Acreage 1,680

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
66	F	Rock Liners	$20,000	5	$100,000
Total Alternative Cost					$100,000

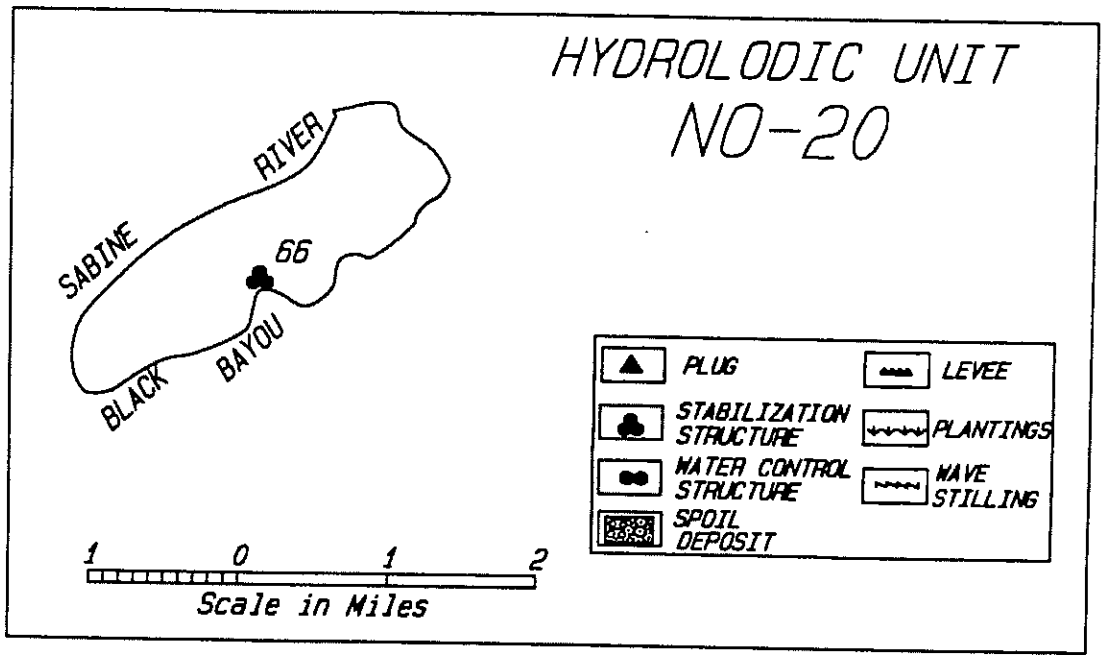

Figure 23. Hydrologic Unit NO-20.

North Unit 21 (NO - 21)

The hydrologic unit is a 6,650 acre area located in the northwest part of the study area below Unit NO-20 (Map 1). The unit soils are mapped as mostly Bancker association with Gentilly-Ged in the southwest and some Clovelly association in the north and east portion of the unit (Map 2). The landuse is non-forested wetlands (Map 12). The northern part of the unit is split between landowners owning 500 or more and 500 or less acres, while the southern unit acreage is federal land.

The unit was historically mapped as grazing land on the southern one-third and the other areas contained Saw grass, Delta patato, cane, and needle grass (Map 7). The other vegetative maps show the unit to be brackish marsh (Maps 8-11). The central part of the unit had some marsh to water conversion by 1978 (Map 5). The 1984 classified satellite data show the area to be marsh except in the center of the unit which is broken marsh and water (Map 6)

Alternative 3

The objective of the unit is to passively manage the area as a fresh / intermediate / brackish marsh. It will be accomplished by installing rock liners, wave stilling/sediment trapping devices, and vegetation (Table 33). Element 67 requires twelve rock liners be installed along Black Bayou to allow water exchange while reducing overall water movement. An additional rock liner (element 68) will be placed in the opening between the marsh and Sabine

Lake at the Units NO-21 and SA-5 boundary. The interior marsh area will contain 10,000 linear feet of vegetation and wave stilling/sediment trapping devices (element 69) for improved productivity of emergent and submergent aquatic vegetation. The total construction cost of the alternative is $430,000.

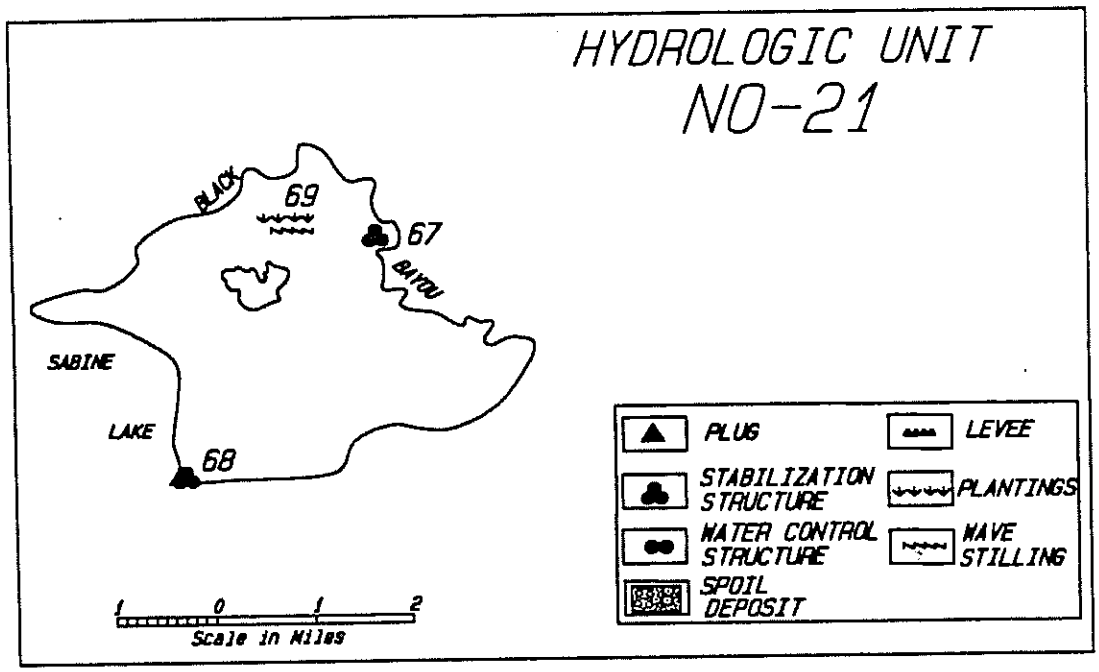

Figure 24. Hydrologic Unit NO-21.

Table 33. Hydrologic Unit NO-21. Components of Alternative 3.
Unit Acreage 6,650

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
67	F	Rock Liners	$20,000	12	$240,000
68	F	Rock Liners	$20,000	1	$20,000
69	C	Wave Still Device/vegetation (ft.)	$17.00	10,000	$170,000
Total Alternative Cost					$430,000

Alternative 4

This alternative requires the addition of 23,000 linear feet of sediment trapping/wave stilling devices (element 69). The additional sediment trapping/wave stilling devices and vegetation will provide for greater opportunities to capture suspended sediment in the water column and reduce wave fetch, thus erosion potential, within the hydrologic unit. The results will be greater productivity of emergent and submergent aquatic vegetation.

The cost of this alternative will be an additional $170,000 for a total construction cost of $600,000 (Table 33a).

Table 33a. Hydrologic Unit NO-21. Additional Components for Alternative 4. Unit Acreage 6,650

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
69	C	Wave Still Device/vegetation (ft.)	$17.00	10,000	$170,000
Sub Total Alternative					$170,000
Total Alternative cost					$600,000

ALTERNATIVES AND ANALYSIS

Sabine National Wildlife Refuge Unit 1 (SA-1)

The hydrologic unit is a 28,500 acre area located in the central part of the study area below Unit NO-8 (Map 1). Small access canals which delineate the unit boundaries were dredged prior to 1920. Canals were never dredged through the area nor do any major bayous innervate the area. The southeast side of the unit is bordered by Backridge and Backridge Canal. Backridge extends from Lost Ridge southwestward into Unit SA-2. It ranges from 150 to 300 feet wide and consists of low prairie-like brackish marsh. During the late 1950's, Backridge Canal was dredged adjacent to and in several places, through Backridge. Dredged material was used to construct levees around units SA-1A and SA-1B.

The project area contains mostly Gentilly-Ged and Bancker associated soils with the remaining soils being Clovelly, Scatlake, and Mowata-Vidrine-Crowley associated soils (Map 2). The land is predominantly non-forested wetlands (Map 12). The predominant land owner of the hydrologic unit is the Federal government which is the land in the Sabine National Wildlife Refuge. The remaining land contains Cameron Parish School Board Land (Section 16), and acreages for landowners above and below 500 acres (Map 13). The area was included in the Sabine Christmas Bird Count and found to contain Green Back Heron nesting sites in the northeast corner of the hydrologic unit (Map 3).

The land was mapped in 1931 and was found to be a fresh and intermediate wetland (Map 7). The 1949 vegetative map shows the central eastern part of the unit to be sawgrass marsh, and the remaining area is an intermixing of fresh and intermediate marsh (Map 8). According to the 1955 quadrangle map and 1953 aerial photography, an area of deteriorated marsh existed in the southwest corner of Unit SA-1. The 1983 aerial photography revealed that the area had recovered. During the mid 1950's through the 1960's large areas of sawgrass and associated low-salinity emergent vegetation (bulltongue, cattail, and bullwhip) died. Some of the die-off areas converted to marshhay cordgrass, however, hundreds of acres changed to unvegetated open water. These changes have been attributed primarily to saltwater intrusion associated with construction and enlargement of the Calcasieu Ship Channel.

The 1968, 1978, and 1988 vegetative maps document a slow conversion from an intermediate to brackish marsh environment (Maps 9-11). By 1978 about one-third to one-half of the unit had converted from marsh to open water (Map 5). Examination of 1983 and 1988/89 color infrared aerial photography indicates that broken marsh throughout the northern and eastern (adjacent to Backridge Canal) portions of SA-1 experienced a marsh gain. Those gains occurred primarily as clusters of small islands welded together. This appears to be a reversal of the previous deterioration trend. Despite this trend erosion of marsh edges continues in some areas. The remainder of the unit appeared to be relatively unchanged over the same period of time. The 1984 classified satellite data show the area to have open water on the eastern one-half, broken marsh on the southern and central portions, and the remaining areas to be solid marsh in the unit (Map 6).

This reversal of marsh deterioration might be due to the construction of the water control structure at Hog Island Gully in 1981, the construction of board road (approximately 1985) extending westward from Louisiana Highway 27 then northward from near the western side of Brown's Lake, and to the accelerating

colonization of shallow water areas by smooth cordgrass, Spartina alterniflora. The Hog Island Gully structure and the board road reduced saltwater intrusion and tidal exchange. Lower salinities allowed seashore paspalum, Paspalum vaginatum, to colonize pond edges and encroach outward as it trapped suspended organic material. Adjacent to Backridge Canal, marsh expansion is attributed primarily to reduced tidal scour and expansion of smooth cordgrass into shallow water areas.

Currently, Unit SA-1 consists of intermediate, brackish, and saline marsh. Since 1989, water control structures at Hog Island Gully, West Cove Canal, and Headquarters Canal have been actively managed to reduce canal-induced saltwater intrusion. Abundant rainfall has also served to moderate salinities. In many formerly brackish interior areas, bullwhip, cattail, sawgrass, and white water lily have colonized pond bottoms. Some small ponds, 1 to 2 acres in size, have been completely filled in by cattail. In many of those areas however, Spartina patens appears to be waterlogged and is gradually dying. Erosion of marsh edges adjacent to large open water areas continues in northern portions of the study area.

The primary threat to marshes within the area is the waterlogging and break-up of interior brackish marsh. This coupled with salinities that preclude vigorous growth of cattail, bullwhip, sawgrass, and other intermediate marsh plants would result in accelerated marsh deterioration and loss. Proposed elements address these problems by establishing more effective salinity control capabilities and by providing for additional water discharge capabilities to avoid ponding of excess water following floods or storm tidal surges. Wave stilling and sediment trapping devices are proposed in large open water areas to reduce wind-induced erosion of marshes. Other features serve to correct small scale hydrologic problems within Unit SA-1.

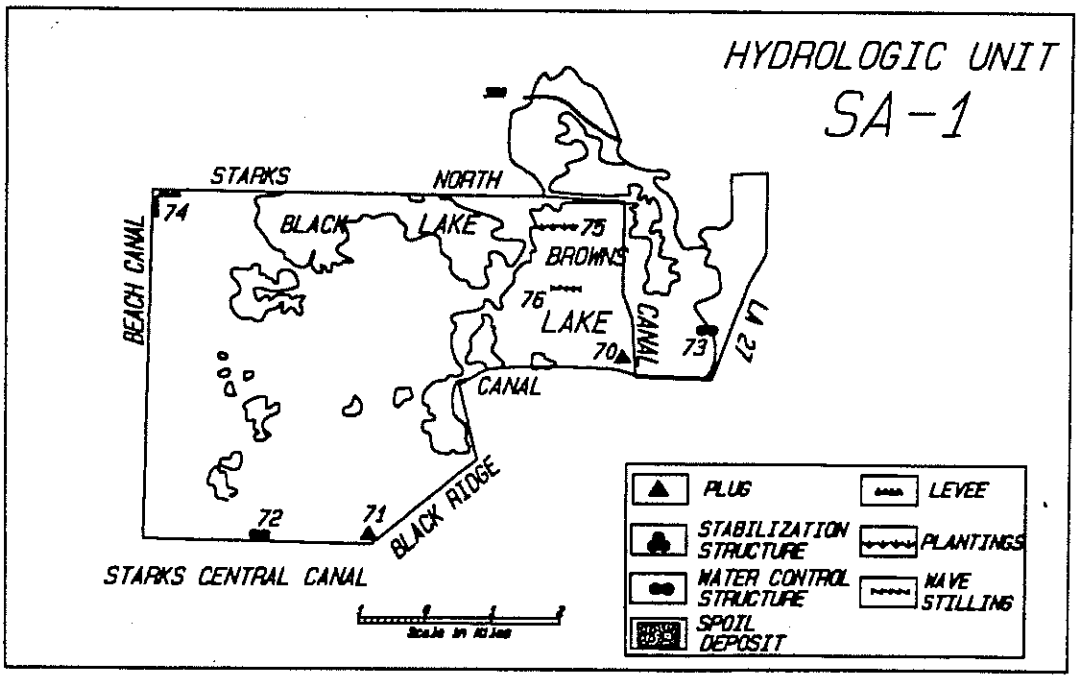

Figure 25. Hydrologic Unit SA-1.

Alternative 3

The objective for the hydrologic unit is to reduce excess water ponding by improving water discharge capacity and to preclude excessive saltwater intrusion (Table 34). Salinity control would be more effective by replacement or modifications to the Hog Island Gully and West Cove water control structures (elements 114 and 108 in Units SA-10 and SA-8), construction of additional structures (element 73), and plugging of West Cove Canal near its junction with the Calcasieu Ship Channel (element 113 in Unit SA-10). Construction of a water control structure on North Line Canal (element 85) would conserve freshwater by restoring the hydrologic barrier breached by North Line Canal. Conserved freshwater would reduce adverse affects of canal-induced saltwater on marshes within units SA-1, SA-2, and SA-4.

Ponding impacts would be reduced through construction of additional water control structures at Headquarters Canal and Long Point Bayou (elements 109 and 73). Canal plugs (elements 70 and 71), would reduce the wind-induced sloshing of water through Backridge Canal, conserve freshwater discharged into the canal from Units SA-1A and SA-1B, and reduce loss of eroded and resuspended sediment. Introduced freshwater would drain northward benefiting Unit SA-1 marshes. Element 72, a rock weir, would reduce saltwater intrusion into interior marshes via an existing board-road borrow ditch. Spoil bank reconstruction adjacent to open water areas (element 74) would reduce export of eroded and resuspended organic material into adjacent canals and would promote increased growth of submerged vegetation. The total construction cost of the alternative is $959,000.

Table 34. Hydrologic Unit SA-1. Components for Alternative 3.
28,800 Ac. - Plan Objective: Reduce ponding and preclude excessive saltwater Intrusion.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
70	H	Earthen Canal Plug	$20,000	1	$20,000
71	H	Rock Plug	$75,000	1	$75,000
72	F	Rock Weir	$90,000	1	$90,000
73	G	Culverts and Water Str.	$68,000	3	$204,000
73	G	Levee	$25.00	300	$7,500
74	D	Rebuild Levee (ft.)	$15.00	12,500	$187,500
75	B	Vegetation (Ac.)	$1,500	50	$75,000
76	C	Wave Still Device (Ft)	$15.00	20,000	$300,000
Total Alternative Cost					$959,000

Alternative 4

The additional components of this alternative include vegetation and wave stilling/sediment trapping devices (Table 34a). The plan calls for an additional fifty acres of vegetation (element 75) and 17,000 linear feet of wave stilling/sediment trapping devices (element 76). The work will improve emergent and submergent vegetative productivity and reduce erosion potential. The added cost of these components are $330,000 for a total construction cost of $1,289,000

Table 34a. Hydrologic Unit SA-1. Additional Components for Alternative 4, 28,800 Acres - Plan Objective: Reduce ponding and preclude excessive saltwater Intrusion.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
75	B	Vegetation (Ac.)	$1,500	50	$75,000
76	C	Wave Still Device (Ft)	$15.00	17,000	$255,000
Sub Total Alternative					$330,000
Total Alternative					$1,289,000

Sabine National Wildlife Refuge Unit 1A (SA-1A)

The hydrologic unit is a 5,138 acre area located in the eastern central portion of the study area southeast of Unit SA-1. The southeastern portion is Gentilly-Ged association, southwestern is Bancker association, and the remaining area is Scatlake association. The landuse is non-forested wetlands (Map 12) and the land is part of the Sabine National Wildlife Refuge (Map 13). The unit was part of the Christmas Bird Count and was found to contain a Black-Crowned Night Heron nesting area.

The unit was historically vegetated by fhresh and intermediate marsh plants (Map 7). The unit was in transition from predominantly brackish marsh to intermediate marsh between 1949 and 1988 (Maps 8-11). By 1978 the northern half of the unit had converted from marsh to open water (Map 5). The 1984 classified data showed that the northern one-third of the unit was open water and the remainder of the unit was marsh and broken marsh (Map 6).

The impoundment was constructed during the late 1950's in fresh and intermediate marshes. Water levels within the unit are maintained using a large variable-crest weir located in the southeast corner. Aerial photography dated 1953 shows that the area consisted of solid marsh. Hurricanes Audrey and Carla flooded the unit with saltwater. Extensive stands of sawgrass located in the northern portion of the unit subsequently died. Those areas have converted to relatively deep open water. A pumping station was recently constructed to augment water level control within the unit.

Currently, marshes adjacent to those large open water areas experience wind-induced erosion. High water levels stress vegetation and may also contribute to marsh loss. Comparison of 1983 and 1989 aerial photography indicated that there has been net loss of marsh within the unit. Additionally, the northern levee is threatened by wind-induced erosion. A levee breach in that location would expose much of the enclosed marshes to severe saltwater intrusion impacts.

Alternative 3

The objective for the hydrologic unit is to maintain the area as an impoundment. Vegetative plantings, element 77, along the eroding northern levee, would protect against levee breaching, saltwater intrusion, and subsequent marsh loss. The construction of an additional drainage structure, element 78, would improve water level control, especially the ability to reduce water levels and encourage the colonization of shallow open water areas

by emergent species. The structure would also benefit brackish marshes within Unit SA-1 by redirecting freshwater discharge into those marshes. The unit needs some canal and levee maintenance (element 79) work in order to ensure the unit can be maintained in its current impounded condition. The total construction cost of the alternative is $393,500.

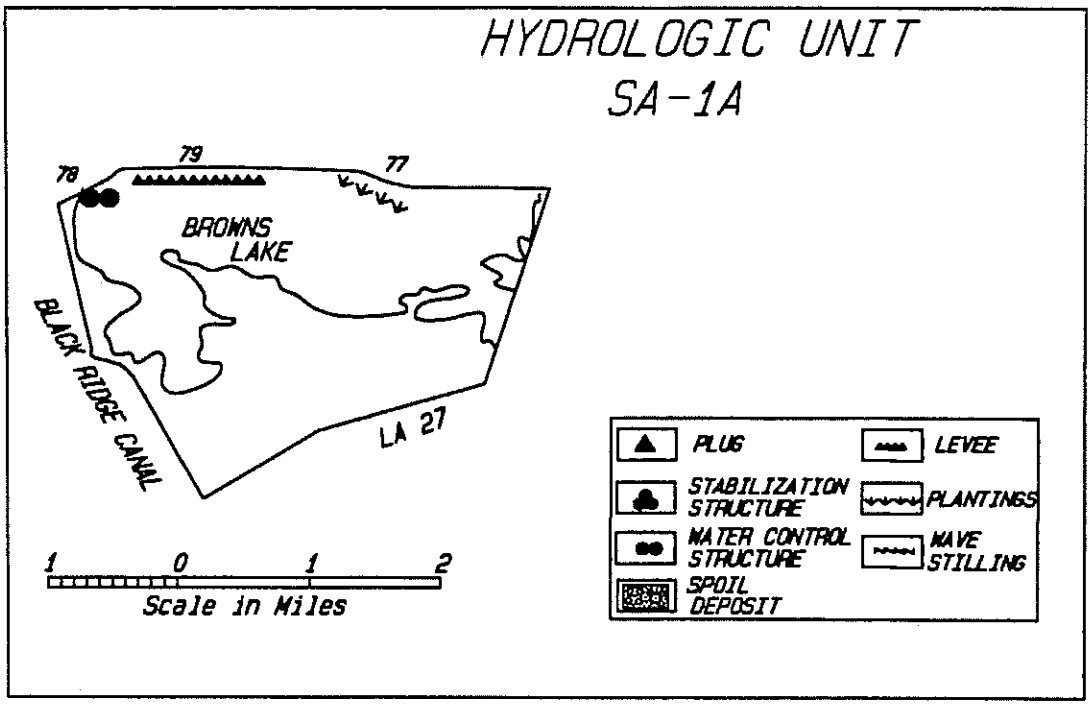

Figure 26. Hydrologic Unit SA-1A.

Table 35. Hydrologic Unit SA-1A. Components of Alternative 3.
Unit Acreage 5,000 - Plan Objective: Maintain as an impoundment.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
77	B	Vegetation (Ft)	$1.50	9,000	$13,500
78	F	Drainage Structure	$110,000	1	$110,000
79	D	Levee Maint. (ft.)	$15.00	18,000	$270,000
Total Alternative Cost					$393,500

Sabine National Wildlife Refuge Unit 1B (SA-1B)

The hydrologic unit is a 1,961 acre area located in the east central portion of the study area (Map 1). The unit contains Bancker soils in the southwest to eastern central and Creole soils on the remaining fringe of the unit (Map 2). The unit was included in the Sabine Christmas Bird Count and was found to contain Black-Crowned Night Heron nesting area (Map 3). The landuse is non-forested wetlands (Map 12) and is federally owned as part of the Sabine National Wildlife Refuge (Map 13).

The unit was historically a fresh to intermediate marsh (Map 7). The 1949, 1968, 1978, and 1988 vegetative maps show a slow conversion from brackish marsh to fresh marsh (Maps 8-11). The 1956-1978 change map showed the unit was remaining stable (Map 5). However, by 1984 the central area contained broken marsh and open water while the remaining area stayed in marsh (Map 6).

Aerial photography dated 1953 shows that the area consisted of solid marsh. The impoundment was constructed during the late 1950's and contained fresh and intermediate marshes. Water levels within the unit are maintained using a large variable-crest weir located in the eastern corner. Following construction, high water levels have been maintained to open up the marsh for improving fish and wildlife habitat. A pumping station was recently constructed to augment water level control within the unit.

Ground truthing and a comparison of 1983 and 1989 color infrared aerial photography revealed that expanding stands of California bulrush have converted substantial portions of shallow open water to emergent marsh.

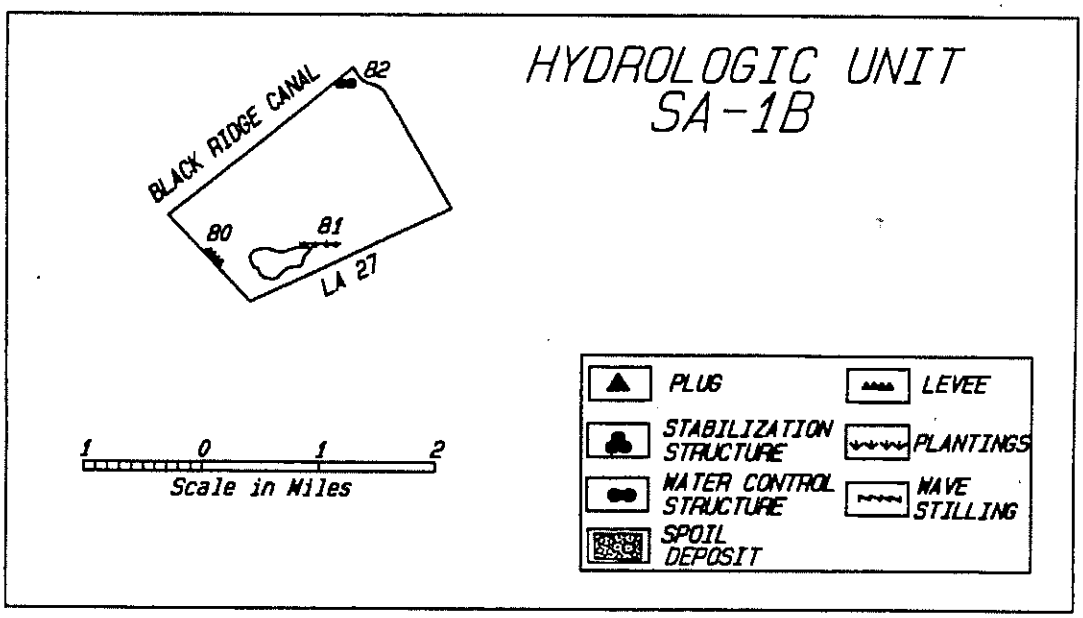

Figure 27. Hydrologic Unit SA-1B.

Alternative 3

The objective for the hydrologic unit is to ensure long-term maintenance of the area as an impoundment. An additional water control structure, element 82, is proposed for this unit (Table 36). Although this element could be used to improve water level manipulations, its primary purpose is to redirect freshwater discharge into Unit SA-1 brackish marshes. The unit will need levee maintenance (element 80) in order to maintain the present impoundment condition. Vegetative plantings (element 81) within the unit will provide for

opportunities to reduce wave energies and capture suspended sediment within the impoundment. The total construction cost of the alternative is $265,000.

Table 36. Hydrologic Unit SA-1B. Components of Alternative 3. 1,800 Acres - Plan Objective: Maintain as an impoundment.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
80	D	Levee Maint. (ft.)	$8.00	20,000	$160,000
81	B	Vegetation (Ft)	$1.50	10,000	$15,000
82	F	Drainage Structure	$90,000	1	$90,000
Total Alternative Cost					$265,000

Sabine National Wildlife Refuge Unit 2 (SA-2)

The hydrologic unit is a 7,552 acres area located in the eastern central portion of the study area below SA-1 (Map 1). The unit soils are distributed with Creole association located in a portion of the southeast, northeast, and eastern fringe. The northwest portion of the unit contains Clovelly association and the remaining area is Bancker association (Map 2). The eastern two-thirds of the unit were included in the Sabine Christmas Bird Count Area (Map 3). The unit also has a gas pipeline traversing the area (Map 4). The landuse is non-forested wetlands (Map 12). The unit land is mostly federal owned by the Sabine National Wildlife Refuge with the southeast corner of the unit containing Cameron Parish School Board (Section 16) land (Map 13).

The unit was historically a fresh and intermediate marsh according to the vegetation recorded in the 1931 vegetation maps (Map 7). The 1949, 1968, 1978, and 1988 vegetative maps showed a gradual increase in intermediate marsh and decrease in brackish marsh between the 1949 and 1988 time frame. The 1949 map showed the unit to have half brackish and half intermediate marsh and the 1988 map shows one-eighth of the unit to be brackish marsh and remaining area to be intermediate marsh (Maps 8-11).

The marsh change map from 1956-1978 shows the unit to remain a stable marsh (Map 5). However, the 1984 classified satellite data shows that the central part of the unit shows the marsh breaking up (Map 6).

Alternative 3

Historically this area consisted primarily of fresh and intermediate marsh and contained very few ponds. Access canals which delineate the unit's boundaries were dredged prior to 1920. One small canal has been dredged across the southwest tip of the unit. No bayous or other watercourses innervate the area. Backridge extends from the western tip of Unit SA-1B into the center of Unit SA-2. This low ridge, 150-300 feet wide, consists of brackish prairie marsh.

Despite the conversion from fresh/intermediate to intermediate/brackish vegetation, the marsh has remained very stable. Currently, the most brackish areas are found in the northeast portion of the unit. The western portion of unit supports the freshest plant communities. In some of those areas, the top 12 inches of substrate consists of poorly consolidated semi-fluid organic material. Soils throughout most of the eastern portion of the unit or generally much firmer.

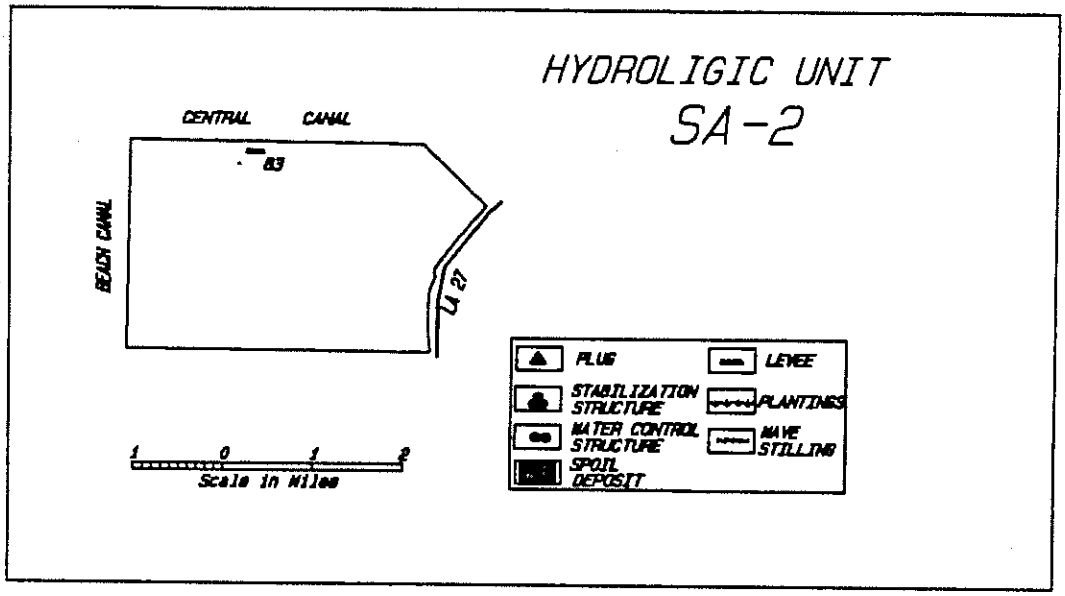

Figure 28. Hydrologic Unit SA-2.

Examination of 1983 and 1988 color infrared aerial photography indicates that there may have been slight closure of ponds in western and central portions of the unit. Otherwise, little or no change was noted. In recent years however, vegetation in western portions of the unit have occasionally been impacted by canal-induced saltwater intrusion. Marsh loss might accelerate if spoil banks along the north side of the unit erode and allow saltwater to enter fragile organic soil areas. Ponding of flood water or saline storm surges might also cause marsh loss within the unit.

Saltwater intrusion damage would be prevented or greatly reduced by replacement or modifications of the Hog Island Gully and West Cove water control structures (elements 114 and 108 in Units SA-10 and SA-8). Maintenance of the Central Canal south spoil bank (element 83) would prevent additional saltwater entry points, thus protecting low-salinity fragile marsh areas. The water control structure on North Line Canal (element 85 in Unit SA-3) would conserve freshwater by restoring the hydrologic barrier breached by North Line Canal. Conserved freshwater would reduce adverse affects of canal-induced saltwater on marshes within Unit SA-1, SA-2, and SA-4. Potential ponding impacts would be reduced through additional water control structures at Headquarters Canal and Long Point Bayou (elements 109 and 73 in Units SA-8 and SA-1).

Table 37. Hydrologic Unit SA-2. Components of Alternative 3.
6,800 Acres - Plan Objective: Maintain in present condition.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
83	D	Levee Maint. (ft.)	$15.00	18,000	$270,000
Total Alternative Cost					$270,000

Sabine National Wildlife Refuge Unit 3 (SA-3)

The hydrologic unit is a 26,356 acre area located in the center of the study area (Map 1). The unit is predominantly Allemands soils in the center with small areas of Bancker, Gentilly-Ged, and Clovelly soils in the remaining area (Map 2). The unit contains some important bird areas. The southeast portion contains a Black-Crowned Night Heron nesting areas and the eastern central and western fringe areas contain 7 sites for winter Olivaceous Cormorant nesting and spring heron rookeries (Map 3). The unit has a product pipeline that runs along the Sutton-Burton Canal (Map 4). The landuse is non-forested wetlands (Map 12). Land ownership is predominantly federal for the Sabine National Wildlife Refuge with two sections of land belonging to the Cameron Parish School Board (Section 16) in the east central and west central portion of the unit (Map 13).

The unit was historically a fresh marsh as indicated by the vegetation mapped in 1931 (Map 7). The 1949 vegetative map showed the northeast corner to be fresh marsh, the southern half as intermediate marsh, and the remaining area as a sawgrass marsh (Map 8). The 1968, 1978, and 1988 vegetative maps have the area mapped as a fresh marsh (Map 9-11).

The unit had a conversion in the eastern and southern central marsh to water along with the western fringe marsh areas (Map 5). By 1984, the unit marsh had mostly converted to open water and brackish marsh with solid marsh being located in the northeast part of the unit (Map 6). This was due to a three-year waterlevel drawdown during 1979-81 was conducted to promote revegetation of open water areas. Through this effort, emergent vegetation was restored to portions of theformer open water area.

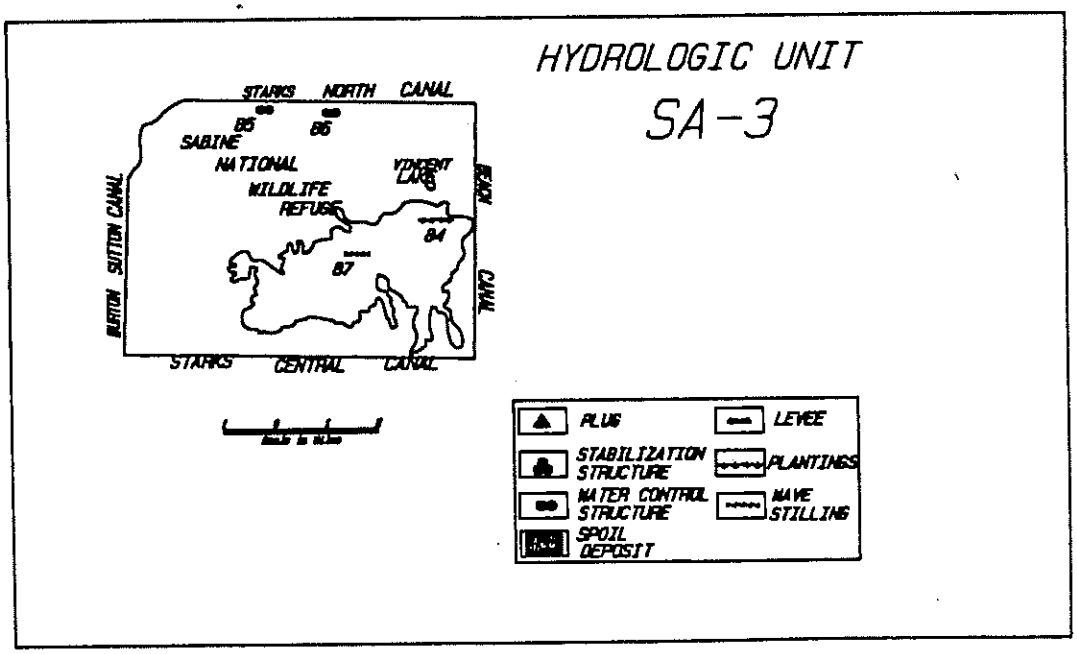

Figure 29. Hydrologic Unit SA-3.

Alternative 3

The construction of this freshwater impoundment was completed during 1951. Except for a small area of broken marsh in the southeast corner and several small lakes in the east central area, fresh marshes within the impoundment were very solid at that time. The north central portion of the impoundment includes some high prairie-like fresh marsh. This is the southern most extension of the Gum Cove ridge. When construction of the impoundment was complete, water levels within the area were maintained above marsh level to improve habitat for freshwater game fishes and migratory waterfowl. Three large variable-crest weirs are used to regulate impoundment water levels.

In 1957, the tidal surge of Hurricane Audrey breached impoundment levees and caused mechanical damage to organic marshes in the east central portion of the impoundment. The tidal surge of Hurricane Carla also breached impoundment levees in 1961. Following Hurricane Audrey, damaged marshes continued to deteriorate. By the late 1970's, much of the marsh located in the southeast quadrant had converted to shallow, turbid open water. A three-year-long drawdown period during the early 1980's served to restore several perimeter areas of the large open water area. The central open water area remained turbid despite water level lowering, but open water areas along the western side of the unit are full of aquatic vegetation.

Examination of 1981/1983 and 1989 color infrared aerial photography reveals that noticeable closure of marsh occurred during that period. Additionally, floating-leaved and aquatic vegetation appeared to be more abundant within interior ponds. These trends are likely the result of low water levels during one or more growing seasons.

The primary threat to emergent marshes within Unit SA-3 are wind-induced erosion and stresses associated with high water levels. The plan objective for the unit is to keep it in a freshwater impoundment condition. Element 87 (Table 38) would allow for installation of additional flapgate/stoplog assemblies to improve water level reduction capabilities. A water control structure with a boat bay (element 85) will be placed in the North Line Canal for greater water control capabilities. Wave stilling devices and vegetation, elements 84 and 86, would serve to reduce wind induced-deterioration of marshes adjacent to large open water areas and improve vegetative productivity. The total construction cost of these components is estimated at $1,064,000.

Table 38. Hydrologic Unit SA-3. Components of Alternative 3.
26,800 Acres - Plan Objective: Manage as fresh marsh and pool.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
84	B	Vegetation (ft.)	$1.50	26,000	$39,000
85	F	Water Ctr. Str.(w/boat bay)	$250,000	1	$250,000
86	C	Wave Stilling Device(ft.)	$15.00	45,000	$675,000
87	F	Drainage Structure	$100,000	1	$100,000
Total Alternative Cost					$1,064,000

Alternative 4

The additional components of this alternative include vegetation and wave stilling/sediment trapping devices (Table 38a). The plan calls for 24,000 linear feet of vegetation (element 84) and 225,000 linear feet of wave stilling/sediment trapping devices (element 86). The result of the additional work will improve emergent and submergent vegetative productivity and reduce erosion potential within the unit. The added cost of these components are $3,411,000 for a total construction cost of $4,475,000

Table 38a. Hydrologic Unit SA-3. Additional Components of Alternative 4. Unit Acreage 26,800

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
84	B	Vegetation (ft.)	$1.50	24,000	$36,000
86	C	Wave Stilling Device (ft.)	$15.00	225,000	$3,375,000
Sub Total Alternative					$3,411,000
Total Alternative Cost					$4,475,000

Sabine National Wildlife Refuge Unit 4 (SA-4)

The hydrologic unit is a 13,614 acre area located in south central part of the study area below SA-3 (Map 1). The unit's soils are predominantly Bancker association, with Allemands in the north central, Clovelly in the northeast, and Creole in the southeast parts of the unit (Map 2). The unit contains some important bird sites with Black and Turkey Vulture winter roost (300 bird average between November and January) in the northeast corner. The west southwest part of the unit was included in the Johnsons Bayou Christmas Bird Count (Map 3). There are product and oil pipelines running along the west side and a gas pipeline crossing the southeast portion of the unit (Map 4). Landuse is predominantly non-forested wetlands (Map 12). The land is owned by the Federal government for the Sabine National Wildlife Refuge with two sections of land for the Cameron Parish School Board (Section 16) in the southwestern edge and south central portions of the unit (Map 13).

The area was historically mapped as a fresh to intermediate marsh according to the 1931 vegetative map (Map 7). The 1949, 1968, 1978, and 1988 basically show the unit being intermediate marsh (Map 8-11). The 1956-1978 change map shows the unit to have some conversion from marsh to water in the north central part of the unit (Map 5). The 1984 classified satellite data show that the eastern center of the unit to have converted to open water and broken marsh (Map 6).

Alternative 3

Historically little open water existed and the area was dominated by fresh marsh. Prior to 1920, access canals were dredged through the marsh around the perimeter of the unit.

Following construction and enlargement of the Calcasieu Ship Channel, canal-induced saltwater intrusion impacted sawgrass and associated low-salinity vegetation in the northern part of the unit. The increased salinity regime

resulted in a conversion to more saline vegetative types and a conversion of some marsh to open water. Marshes in the southeast portion of the unit have remained very solid despite hydrologic changes. Due to abundant rainfall and subsequent low salinity conditions since 1990, cattail, bullwhip, three-corner grass, and seashore paspalum have colonized some of the shallow open water areas in the northern broken marsh areas. Despite this healing, Spartina patens appear to be severely stressed and dying in some areas. Consequently, preservation of marshes will depend heavily upon the presence and growth of cattails and other low-salinity emergent marsh species. Preservation features must avoid causing increased water levels since that would likely result in accelerated rates of Spartina loss.

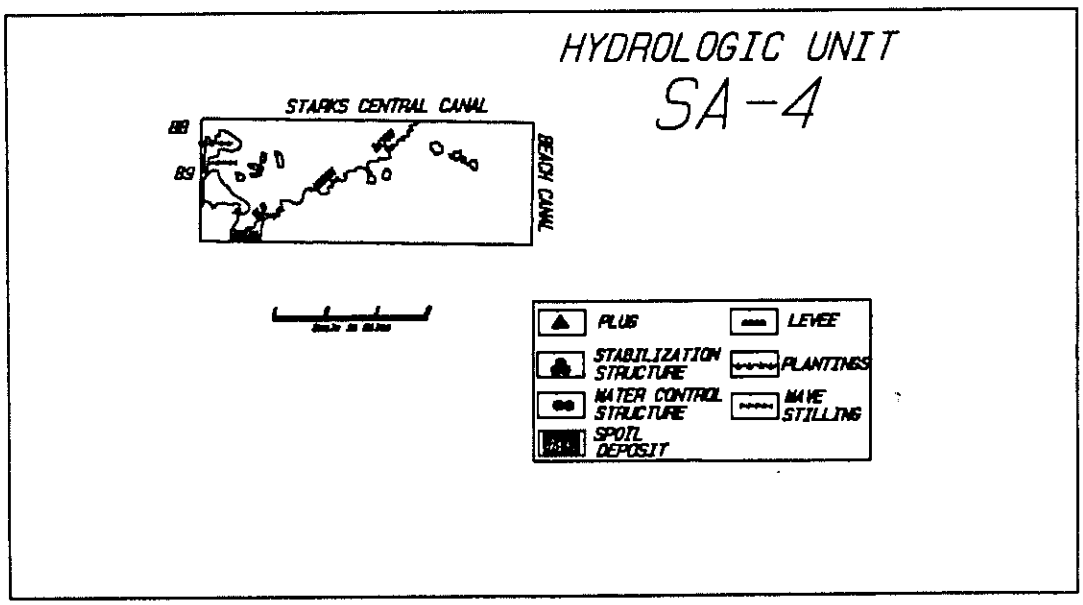

Figure 30. Hydrologic Unit SA-4.

Examination of 1981/1983 and 1989 color infrared aerial photography indicated that a very slight loss of marsh occurred. Visual inspection of marshes within Unit SA-4 suggest that those marshes have begun to heal as cattail and other intermediate marsh species colonize shallow open water areas. This trend is likely due to heavy rainfall and subsequent low-salinity conditions over the past two years. Increased Sabine Lake or Calcasieu Lake salinities entering area marshes through spoil bank breaks along Burton Canal and Central Canal could threaten marshes within Unit SA-4. Marshes might also be damaged through slow drainage and ponding of saline storms surges.

Element 85, a water control structure on North Line Canal, would improve freshwater retention (Table 38, Unit SA-3). Consequently, additional freshwater would be available around the northeast portion of the unit and would buffer against canal-induced saltwater intrusion from the east via Central Canal and from the west via Burton and Central Canals. Replacement or modification of the structures at Hog Island Gully and West Cove (elements 114

and 108 in Units SA-10 and SA-8) would increase the ability to prevent saltwater intrusion from Calcasieu Lake. The additional structures planned on Headquarters Canal (Elements 109 and 73 in Units SA-8 and SA-1) would also improve the capability to drain excess water or saline surges off the marsh.

The objective of the unit is to maintain as a fresh/intermediate marsh, but reduce interior erosion and improve vegetative productivity (Table 39). The unit plan will require the use of vegetation (element 88) and wave stilling/sediment trapping devices (element 89). These components will reduce the erosion potential by reducing wave fetch and improve submerged aquatic productivity by reducing the suspended sediment in the water column. The total construction cost of the alternative is $249.000.

Table 39. Hydrologic Unit SA-4. Components of Alternative 3.
12,200 Acres - Plan Objective: Maintain as fresh/intermediate marsh.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
88	8	Vegetation (ft.)	$1.50	16,000	$24,000
89	C	Wave Stilling Device(ft.)	$15.00	15,000	$225,000
Total Alternative					$249,000

Alternative 4

The additional components of this alternative include vegetation and wave stilling/sediment trapping devices (Table 39a). The plan calls for an additional 10,000 linear feet of vegetation (element 84) and 7,000 linear feet of wave stilling/sediment trapping devices (element 86). The result of the additional work will improve emergent and submergent vegetative productivity and reduce erosion potential within the unit. The added cost of these components are $120,000 for a total construction cost of $369,000

Table 39a. Hydrologic Unit SA-4. Additional Components of Alternative 4.
12,200 Acres - Plan Objective: Maintain as fresh/intermediate marsh.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
88	B	Vegetation (ft.)	$1.50	10,000	$15,000
89	C	Wave Stilling Device(ft.)	$15.00	7,000	$105,000
Sub Total Alternative					$120,000
Total Alternative Cost					$369,000

Sabine National Wildlife Refuge Unit 5 (SA-5)

The hydrologic unit is a 26,378 acre area in the western central portion of the study area (Map 1). The soils in the unit are distributed with Gentilly-Ged association in the northern one-third, some Clovelly association around Greens Lake and Willow Bayou, and the remaining unit area is Bancker association (Map 2). The northwest portion of the unit contains a year round heron roost site (Map 3). Some product and gas pipelines cross the unit (Map 4). The landuse map shows the northwest portion to contain some agricultural land along the pleistocene island known as "The Pines" with the remaining area being non-forested wetlands (Map 12). The land ownership map shows the

agricultural land to be owned by landowners with 500 acres or more and the remaining area to be mostly Federal land for the Sabine National Wildlife Refuge (Map 13).

The unit was historically mapped as containing fresh, intermediate, and some brackish marsh vegetation according to the 1931 vegetative map (Map 7). The 1949 vegetative map showed the unit to contain fresh marsh, intermediate, and sawgrass marsh (Map 8). The 1968, 1978, and 1988 maps show a slow conversion from a mixed intermediate and brackish marsh to a brackish marsh (Maps 9-11).

The 1956-1978 change map shows that the central north central portion had a conversion from marsh to open water. The remaining unit has pockets of marsh with a few small pockets of conversion from marsh to water (Map 5). The 1984 classified satellite data shows that the south central part of the marsh had deteriorated to broken marsh and open water (Map 6).

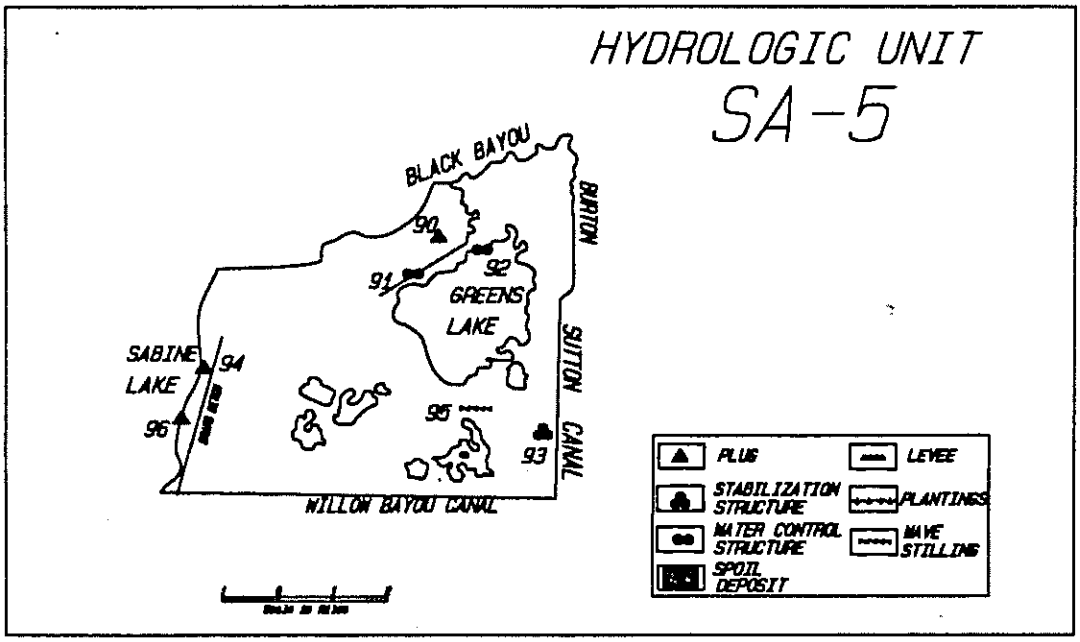

Figure 31. Hydrologic Unit SA-5.

Alternative 3

The unit currently consists of brackish and intermediate marsh. A small area of relatively high prairie-like marsh known as the Marceaux Tract, is located along the lower west side of the unit. Near Sabine Lake, marshes are higher and underlain by soils having greater mineral content than compared to interior areas.

Historically, the unit consisted of fresh and intermediate marsh. According to 1953 aerial photography, marshes within the unit were very solid. Greens Lake was the largest body of open water. Greens Bayou and Three Bayous innervated the northeast and west central marshes respectively. Willow Bayou

and associated unnamed tributaries innervated marshes along the southern boundary. Prior to 1920, access canals were dredged through the marsh around the eastern and southern perimeter of the unit. Grays Ditch was dredged during the early 1920's in order to construct an earthen embankment for moving cattle from Johnsons Bayou to The Pines. The embankment was constructed on the west side of the ditch. To facilitate cattle access, bridges were built over Willow Bayou and Three Bayous.

Sawgrass and associated low-salinity vegetation adjacent to Greens Lake and throughout the interior marshes experienced rapid deterioration and loss during the mid 1950's through the 1960's. These changes occurred throughout the study area suggesting that a basin-wide salinity increase had occurred. The timing of marsh loss within Unit SA-5 and throughout the entire study area coincides very well with the 1951 enlargement of the Calcasieu Ship Channel (Table 12) and the enlargements of the Port Arthur Canal and Sabine-Neches Waterway authorized in 1946 (Table 13).

In recent years, the marsh has been relatively stable. However, numerous small isolated marsh islands have been lost to erosion over the past ten years. Recent aerial inspection suggests that in response to low salinities during 1990-1992, cattail has spread throughout much of the interior marsh. If salinities remain favorable, these and other low-salinity plant species might be able to colonize shallow open water areas and heal broken marsh areas. Despite this healing, Spartina patens appears to be severely stressed and dying in many areas. Consequently, preservation of marshes within the area will depend heavily upon the expansion of cattails and other aggressive low-salinity emergent marsh species. Preservation features must avoid causing increased water levels since that would likely promote accelerated rates of Spartina loss.

The plan objective of this unit is to enhance vegetative productivity and density (Table 40). In order to facilitate the healing process, some of the proposed project elements would serve to reduce saltwater intrusion. Element 92, a water control structure on Greens Bayou, could be operated to reduce or prevent high salinity water from entering Unit SA-5. Passive salinity reduction would be achieved by plugging Three Bayous (element 96) at the Grays Ditch cattlewalk embankment. This would increase the length of Three Bayous and make it a tributary of Willow Bayou. Element 94 would plug a small bayou which connects Grays Ditch with Sabine Lake. This plug would make element 96 much more effective.

The remaining elements would address issues other than salinity. Element 93 would use rip-rap to prevent additional enlargement of spoil bank breaches along Burton Canal. Wave stilling/sediment trapping devices, element 95, would be installed in large open water areas to reduce wind-induced erosion of adjacent marshes. Elements 90 and 91 would block off an abandoned access canals and re-establish hydrologic connections between it and adjacent marsh. The total construction cost for this alternative is $1,938,500.

Table 40. Hydrologic Unit SA-5. Components of Alternative 3. 26,700 Acre - Plan Objective: Enhance vegetation.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
90	H	Plug North End of Canal	$80,000	1	$80,000
91	F	Culverts from canal to marsh	$9,500	3	$28,500
92	F	VC Weir	$250,000	1	$250,000
93	F	Rock Liners	$20,000	1	$20,000
94	F	Plug in Bayou	$40,000	1	$40,000
95	C	Wave Stilling Devices ft.)	$15.00	100,000	$1,500,000
96	H	Plug in Canal	$20,000	1	$20,000
Total Alternative Cost					$1,938,500

Alternative 4

The additional component of this alternative is wave stilling/sediment trapping devices (Table 40a). The plan calls for an extra 235,000 linear feet of wave stilling/sediment trapping devices (element 95). The result of the work will improve emergent and submergent vegetative productivity and reduce erosion potential within the unit. The added cost of this component is $3,525,000 for a total construction cost of $5,463,000

Table 40a. Hydrologic Unit SA-5. Additional Components of Alternative 4. Unit Acreage 26,700

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
95	C	Wave Stilling Devices (ft.)	$15.00	235,000	$3,525,000
Sub Total Alternative					$3,525,000
Total Alternative Cost					$5,463,500

Sabine National Wildlife Refuge Unit 6 (SA-6)

The hydrologic unit is a 7,418 acre area in the west central part of the study area below Unit SA-5 (Map 1). The area contains Bancker associated soils (Map 2). The unit was part of Johnsons Bayou Christmas Bird Count area and the southwest portion of the unit contains a winter Olivaceous Cormorant nesting and spring heron rookery area (Map 3). The eastern portion of the unit has product and gas pipelines (Map 4). Land in the unit is categorized as non-forested wetlands (Map 12) and owned by the Federal government for the Sabine National Wildlife Refuge (Map 13).

The unit was historically a fresh marsh as indicated by the 1931 vegetative map (Map 7). The 1949, 1968, 1978, and 1988 vegetative maps document a shift from predominantly intermediate marsh to predominantly brackish marsh (Maps 8-11).

The 1956-1978 change map shows that the northwest and north central areas of the unit have large amounts of open water that was previously marsh (Map 5). By 1984, the northwest and north central was still predominantly open water, but small areas of broken marsh were beginning in other areas of the unit (Map 6).

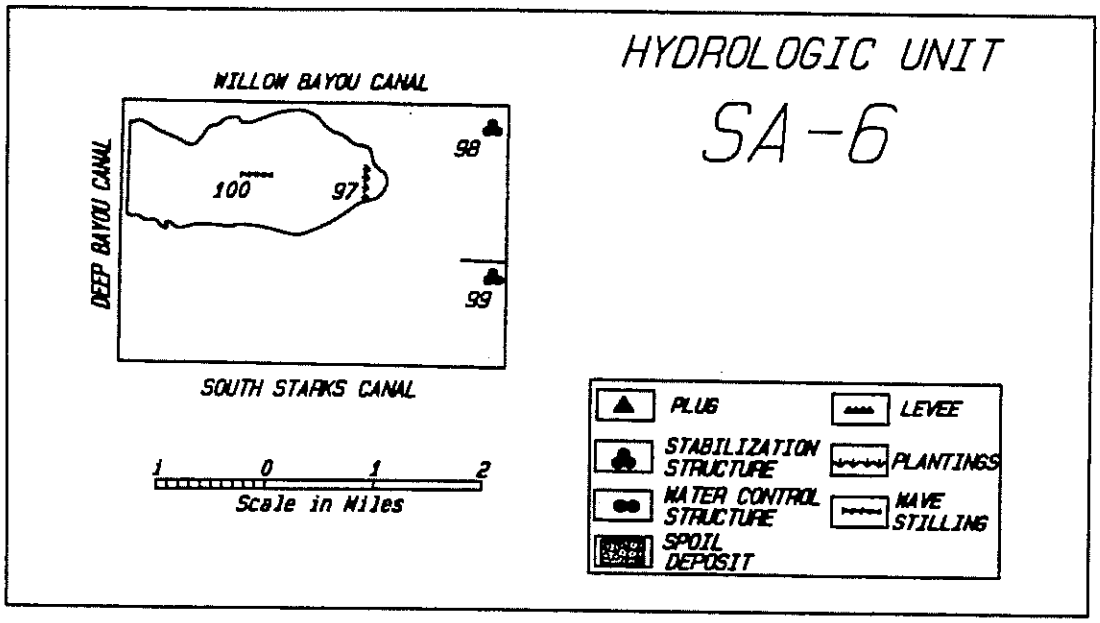

Figure 32. Hydrologic Unit SA-6.

Alternative 3

Prior to 1920, access canals were dredged through the marsh around the perimeter of the unit. During the mid 1950's, the northwest portion of the unit consisted of a deep fresh marsh characterized by sawgrass and bullwhip. The north boundary of this deep fresh marsh consisted of what appears to be a natural ridge or stranded lakeshore berm. The remainder of Unit SA-5 was characterized by solid emergent marsh with few open water areas.

Sawgrass and associated low-salinity vegetation located in the deep fresh marsh area experienced rapid deterioration and loss during the mid 1950's through the 1960's. These changes occurred throughout the study area suggesting that a basin-wide salinity increase had occurred. The timing of marsh loss within Unit SA-6 and throughout the entire study area coincides very well with the 1951 enlargement of the Calcasieu Ship Channel (Table 12) and the enlargements of the Port Arthur Canal and Sabine-Neches Waterway authorized in 1946 (Table 13).

Examination of 1981 and 1989 color infrared aerial photography reveals that substantial marsh recovery has occurred along of the southern shore of the large open water area. In 1983, that shoreline was very broken and appeared to be a deteriorating condition. The 1988 photo shows that the shoreline had become much more uniform (less broken) and had encroached outward across the mouths of small bays and indentations. Additionally, many island clusters welded together to form one or more larger islands. Many small isolated islands did disappear, presumably due to erosion. Most interior areas showed little change over that period.

Currently the area consists primarily of intermediate marsh. The former deep fresh marsh area in now mostly turbid open water with a few deteriorating marsh islands. As a result of oil and gas exploration activities, board roads and earthen wave-stilling levees have been constructed (during 1992) in the western portion of the open water area. The northeast portion of the unit consists of broken marsh with a few medium-sized lakes scattered throughout. Marshes in the southern half of the area are relatively isolated from tidal influences, characterized by fresh marsh vegetation, and appear to have experienced minimal change.

Recent aerial inspection revealed that cattail occurs with fair to moderate frequency throughout much of the interior broken marsh. If salinities remain favorable, these and other low-salinity plant species might be able to colonize shallow open water areas and heal broken marsh areas. Despite the colonization by cattails, Spartina patens appears to be stressed and dying in some areas. Consequently, preservation of marshes within the area will depend heavily upon the expansion of cattails and other aggressive low-salinity emergent marsh species. Preservation features must avoid causing increased water levels since that would likely promote accelerated rates of Spartina loss.

The major factor causing marsh loss within Unit SA-6 is wind-induced erosion of marshes adjacent to large open water areas and continued loss of broken marsh areas. Eroded and suspended marsh soils are being exported out of the unit through several breaks in the Willow Bayou Canal spoil bank. Because flows in the canal are very weak, sediments immediately settle out in the canal. Every several years, Willow Bayou Canal becomes plugged with sediment and emergent vegetation making boat access through that portion of the canal difficult or impossible.

The plan objective of this hydrologic unit is to enhance the present vegetation. Measures proposed to reduce saltwater intrusion into surrounding units are anticipated to provide protection against intrusion of saltwater into Unit SA-6. This may stimulate increased colonization of intermediate marsh species resulting in restoration of broken marsh areas. Wave stilling devices and vegetation, elements 100 and 97 (Table 41), in the open water areas would reduce erosion of marsh edges, reduce turbidity, and increase the abundance of submergent vegetation. Elements 98 and 99, rock liners, would serve to maintain the desired amount of water exchange between area marshes and Willow Bayou and Burton Canals. The total construction cost of this alternative is estimated to be $238,000.

Table 41. Hydrologic Unit SA-6. Components of Alternative 3.
7,400 Acre - Plan Objective: Enhance vegetation.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
97	B	Vegetation (Ft)	$1.50	12,000	$18,000
98	F	Rock Liner	$20,000	1	$20,000
99	F	Rock Liner	$20,000	1	$20,000
100	C	Wave Still Device (Ft)	$15.00	12,000	$180,000
Total Alternative Cost					$238,000

Alternative 4

The additional component of this alternative is wave stilling/sediment trapping devices and vegetation (Table 41a). The plan calls for an extra 5,000 linear feet of wave stilling/sediment trapping devices and vegetation (elements 100 and 97). The result of the work will improve emergent and submergent vegetative productivity and reduce erosion potential within the unit. The added cost of this component is $82,500 for a total construction cost of $320,500

Table 41a. Hydrologic Unit SA-6. Additional Components of Alternative 4. Unit Acreage 7,400

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
97	B	Vegetation (Ft)	$1.50	5,000	$7,500
100	C	Wave Still Device (Ft)	$15.00	5,000	$75,000
Sub Total Alternative					$82,500
Total Alternative Cost					$320,500

Sabine National Wildlife Refuge Unit 7 (SA-7)

The hydrologic unit is a 6,286 acre area in the west central part of the study area below Unit SA-5 (Map 1). The unit is predominantly Bancker associated soils with some Creole and Clovelly associated soils (Map 2). The unit is part of the Johnsons Bayou Christmas Bird Count area and was found to contain winter Olivaceous Cormorant nesting and spring heron rookery (Map 3). The land is non-forested wetlands (Map 12) and is predominantly owned by the federal government for the Sabine National Wildlife Refuge (Map 13).

The unit was historically mapped as an intermediate to brackish marsh according to the 1931 vegetative map (Map 7). The 1949, 1968, 1978, and 1988 vegetative map shows the unit has been converting to brackish marsh (Maps 8-11).

The 1956-1978 change map shows that the northeast portion of the unit converted from marsh to open water (Map 5). By 1984, additional acreage had converted to broken marsh in the north central part of the unit (Map 6).

Alternative 3

Adjacent to Sabine Lake, marshes are higher and underlain by soils having greater mineral content than interior marshes. A natural ridge or stranded lakeshore rim exists in the northeast portion of the unit. This rim forms the northern boundary of a former deep fresh marsh area. Willow Bayou and its tributaries drain most of the unit into Sabine Lake. Double Island Gully is a major tributary which used to provide water exchange for marshes in the southwest and central portions of the unit. Prior to 1920, access canals were dredged through the marsh around the perimeter of the unit.

Sawgrass and associated low-salinity vegetation located in the deep fresh marsh area experienced rapid deterioration and loss during the mid 1950's through the 1960's. These changes occurred throughout the study area

suggesting that a basin-wide salinity increase had occurred. The timing of marsh loss within Unit SA-7 and throughout the entire study area coincides very well with the 1951 enlargement of the Calcasieu Ship Channel (Table 12) and the enlargements of the Port Arthur Canal and Sabine-Neches Waterway authorized in 1946 (Table 13).

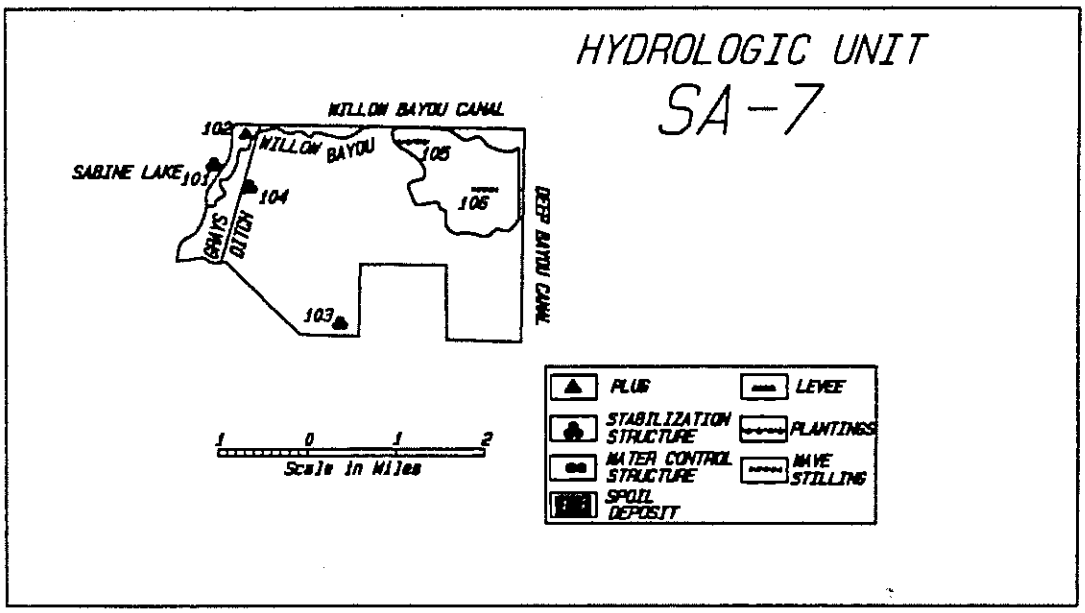

Figure 33. Hydrologic Unit SA-7.

Examination of 1981 and 1989 color infrared aerial photography reveals that within the large open water area, clusters of nearby islands welded together to form larger islands. In marshes adjacent to the open water areas, some ponds and small lakes closed in. Throughout most to the interior marsh there was little net change.

Currently the are consists of brackish and intermediate marsh. The brackish areas are located near Sabine Lake. The former deep fresh marsh is now mostly turbid open water. A large break in the southern Willow Bayou Canal spoil bank currently allows very rapid water exchange between the large open water area and Willow Bayou. By providing a shorter more direct water exchange route, Willow Bayou Canal has captured the flow of the middle and upper reaches of Willow Bayou.

Cattails occur with low to medium frequency throughout much of the unit's interior. Inspection and ground truthing of 1989 and 1991 aerial photography indicates that cattail and other low-salinity species have recently colonized some shallow open water areas. Recent aerial inspection revealed that deterioration of Spartina patens is occurring in the Double Island Gully watershed. As elsewhere throughout the study area, waterlogging appears to be the primary cause of this deterioration. Consequently, proposed project

elements have been planned to avoid increases in water level and associated waterlogging stresses.

The plan objective of this hydrologic unit is to enhance vegetation. Many proposed project elements serve to reduce or mitigate adverse affects of canals. Element 102 (Table 42) consists of five plugs in Willow Bayou Canal. Those plugs would restore flow through Willow Bayou and its tributaries. Elements 103 and 104 would maintain the desired amount of water exchange between Grays Ditch and marshes along the southern portion of the unit. Element 101 would armor the Sabine Lake shore at a point where further retreat threatens to connect the lake with an upstream section of Willow Bayou. Elements 106 and 105 involve construction of wave stilling/sediment trapping devices and planting of vegetation in the large open water areas and along unit shorelines. The total construction cost of this plan is $618,000.

Table 42. Hydrologic Unit SA-7. Components of Alternative 3.
6,400 Acre - Plan Objective: Enhance vegetation

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
101	D	Shoreline Protection (ft.)	$65.00	1,500	$97,500
102	H	Plugs in Canal	$40,000	4	$160,000
103	F	Rock Liners (along Sec.16)	$20,000	2	$40,000
104	F	Rock Liners (Grays Ditch)	$20,000	2	$40,000
105	D	Vegetation (Ft)	$1.50	17,000	$25,500
106	C	Wave Still Device (Ft)	$15.00	17,000	$255,000
Total Alternative Cost					$618,000

Alternative 4

The additional component of this alternative is wave stilling/sediment trapping devices and vegetation (Table 42a). The plan calls for an extra 11,000 linear feet of wave stilling/sediment trapping devices and vegetation (elements 106 and 105). The result of the work will improve emergent and submergent vegetative productivity and reduce erosion potential within the unit. The added cost of these component is $181,500 for a total construction cost of $799,500

Table 42a. Hydrologic Unit SA-7. Additional Components of Alternative 4.
Unit Acreage 6,400

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
105	D	Vegetation (Ft)	$1.50	11,000	$16,500
106	C	Wave Still Device (Ft)	$15.00	11,000	$165,000
Sub Total Alternative					$181,500
Total Alternative Cost					$799,500

Sabine National Wildlife Refuge Unit 8 (SA-8)

The hydrologic unit is a 718 acre area located in the eastern central portion of the study area below Unit SA-1A (Map 1). It contains some Scatlake

associated soils on the eastern half of the unit and the remaining area is Creole association (Map 2). The unit was included in the Sabine Christmas Bird Count Area (Map 3). The land is Federally owned for the Sabine National Wildlife Refuge (Map 13) and its use is non-forested wetlands (Map 12).

The area was historically mapped as brackish marsh according to the 1931 vegetative map (Map 7). The 1949, 1968, 1978, and 1988 vegetative maps show the area to be brackish marsh (Maps 8-11). The 1956-1978 change map showed that the marsh was fairly stable with only the northeast portion where some marsh converted to water (Map 5). The 1984 classified satellite data showed the marsh to still be a stable condition (Map 6).

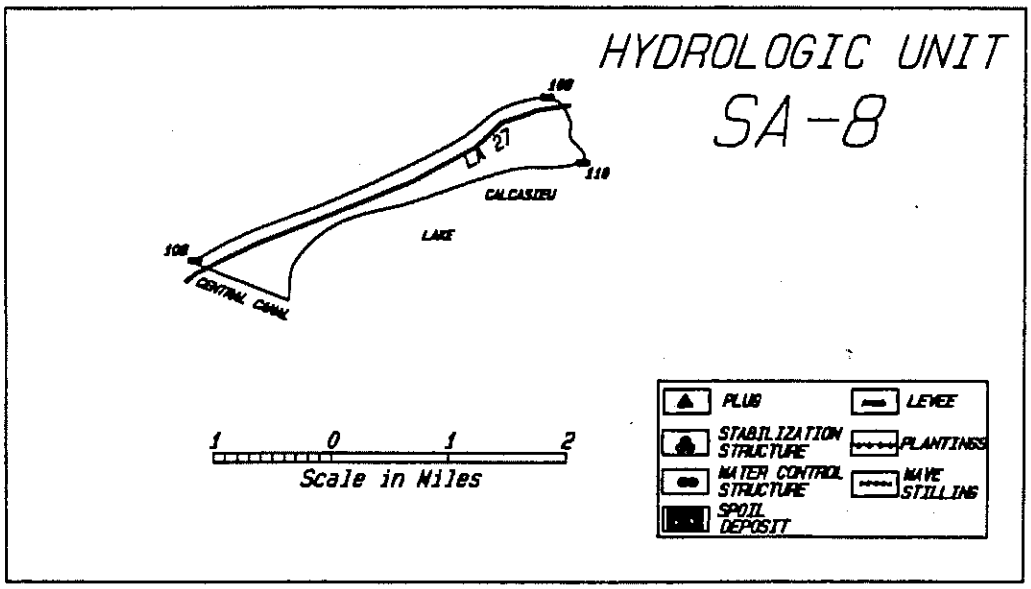

Figure 34. Hydrologic Unit SA-8.

Alternative 3

The western half of the unit drains through several spoil bank breaks into the extension of Central Canal (section connecting West Cove and Roadside Canal). Historically this area was brackish marsh, however, it now is a saline marsh. The eastern half of the unit contains some broken marsh. The majority of this area is dominated by brackish vegetation, however, saline marsh vegetation is becoming more abundant. The eastern portion of the unit drains through several spoil bank breaks into Headquarters Canal near its junction with Roadside Canal.

Lakeshore retreat constitutes the greatest threat for marshes within this unit. Interior marshes within the western portion of the unit are very stable. Examination of 1983 and 1988 color infrared photography indicated that interior marshes experienced no net change. During high water periods, lake water tops the lakeshore rim and enters the broken marsh area. Once

there, it flows into Headquarters Canal and thence, to Roadside Canal. This flow circumvents the water control structures at Hog Island Gully, Headquarters Canal, and West Cove. Continued lakeshore retreat will only make this problem worse and uncontrolled saltwater intrusion might become a problem.

The objective for this hydrologic unit is to maintain and enhance the current vegetative community (Table 43). Element 107, Units SO-7 and SA-8 boundary, will be rebuilt to maintain greater hydrologic control between each unit. Element 110 would plug the breaks in the Headquarters Canal spoil bank. A new water exchange point would be established by constructing a water control structure (element 110) along the western spoil bank of Shell Canal. Element 108 proposes the modification of an existing structure in order improve flow regulation and reduce saltwater intrusion.

Table 43. Hydrologic Unit SA-8. Components of Alternative 3.
720 Acre - Plan Objective: Maintain and enhance vegetation

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
108	G	Modify Structure	$500,000	1	$500,000
109	G	48" Culv. flap & screw gates	$33,000	2	$66,000
110	G	Plug Canal	$20,000	1	$20,000
110	G	24" Culv. screw gates	$7,800	3	$23,400
Total Alternative Cost					$616,900

Sabine National Wildlife Refuge Unit 9 (SA-9)

The hydrologic unit is a 1,787 acre area located in the east central part of the study area and east of Unit SA-8 (Map 1). The soils are Creole association on the southern rim with the remaining being Scatlake association (Map 2). The area was part of the Sabine Christmas Bird Count Area (Map 3). It is Federal land used for the Sabine National Wildlife Refuge (Map 13) with a landuse classification of non-forested wetlands (Map 12).

The historical vegetation, as mapped in 1931, indicate an intermediate to brackish marsh with cane, bulrush, wiregrass, and three square grass (Map 7). The 1949, 1968, 1978, and 1988 vegetative maps document the influence of Calcasieu Lake as the marsh went from a brackish to predominantly saline condition. (Maps 8-11). The 1956-1978 change map shows the north central and south central parts of the marsh had converted from marsh to open water (Map 5). The 1984 classified satellite data shows the unit had further deterioration to open water and broken marsh with only the western fringe areas contain solid marsh (Map 6).

Alternative 3

Hog Island Gully Bayou historically drained area marshes into West Cove. West Cove Canal and Shell Canal were dredged around 1917. Saltwater flooding over a marsh burn contributed to some of the marsh break-up adjacent to West Cove Canal (1991 John Walther personal communication). Interior marshes have converted to brackish and saline marshes. Those areas have also experienced moderate to severe deterioration.

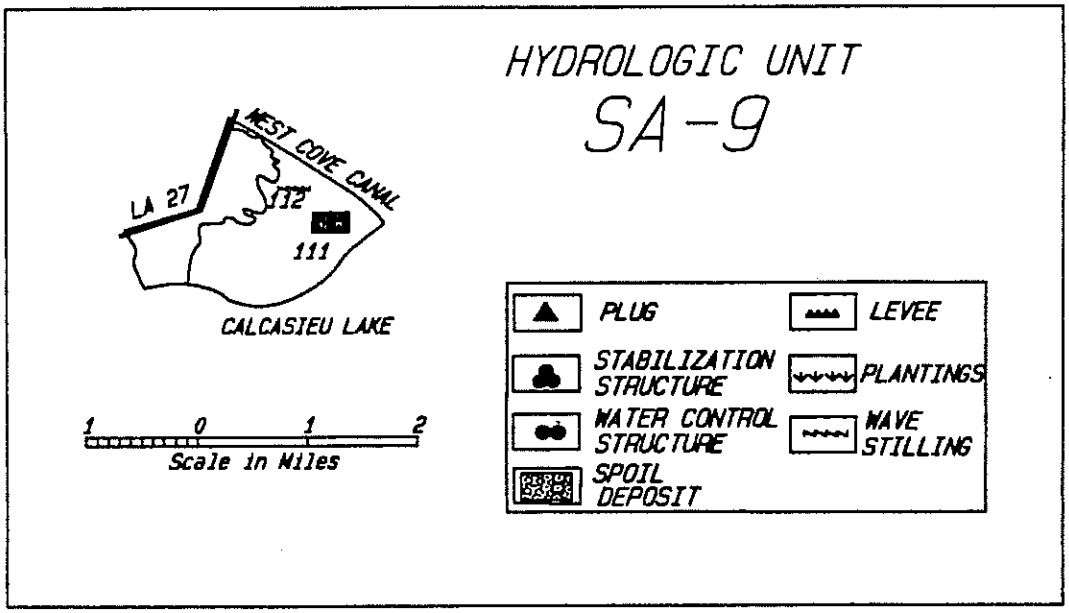

Figure 35. Hydrologic Unit SA-9.

West Cove Canal appears to have captured the flow of the old Hog Island Gully Bayou. Consequently, the bayou has filled in considerably. As a result, the natural sediment delivery and deposition mechanisms to a large portion of interior marshes have been reduced and altered. Examination of 1983 and 1988 color infrared aerial photography reveals that their has been no net change in marsh area. Recent field observations reveal that some areas of marshhay cordgrass and saltgrass adjacent to old Hog Island Gully Bayou appear to be dying. In 1990, the Louisiana Coastal Restoration Division constructed a terracing project in the southern part of the unit. That project appears to be successful in creating new marshes and promoting accretion of nearby natural marshes.

The plan objective of the hydrologic unit is to maintain and enhance existing vegetation. Installation of similar wave stilling/sediment trapping devices (element 112) is proposed to create marsh and restore marsh functions in large open water areas. Element 111 would provide additional money necessary to have the Corps of Engineers deposit dredged spoil in open water areas to create marsh. The Corps of Engineers is required to have local cost-share or payment for the incremental cost of dredging operations when not using the Federal Standard. Construction of a plug across West Cove Canal (element 113 in Unit SA-10) would revive flow through Hog Island Gully Bayou, increase accretion rates of marshes in the western portion of the unit, and reduce excessive canal-induced water exchange and salinity fluxes. This element might also provide benefits to Unit SA-1 by reducing salinities entering via the Hog Island Gully water control structure. The total construction cost of this alternative is $390,000.

Table 44. Hydrologic Unit SA-9 Components of Alternative 3.
1,800 Acre - Plan Objective: Maintain & enhance vegetation.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
111	A	Cubic yards of Spoil	$3.00	80,000	$240,000
112	C	Wave Stilling Devices (ft.)	$15.00	10,000	$150,000
Total Alternative Cost					$390,000

Alternative 4

The additional component of this alternative is wave stilling/sediment trapping devices (Table 44a). The plan calls for an extra 10,000 linear feet of wave stilling/sediment trapping devices (element 112). The result of the work will improve emergent and submergent vegetative productivity and reduce erosion potential within the unit. The added cost of this component is $150,000 for a total construction cost of $540,000.

Table 44a. Hydrologic Unit SA-9. Additional Components of Alternative 4.
Unit Acreage 1,800

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
112	C	Wave Stilling Device (ft.)	$15.00	10,000	$150,000
Sub Total Alternative					$150,000
Total Alternative Cost					$540,000

Sabine National Wildlife Refuge Unit 10 (SA-10)

The hydrologic unit is a 4,600 acre area located in the east central part of the study area below Unit NO-6 (Map 1). The unit soils are Gentilly-Ged association on the northern part and Scatlake on the southern part of the unit (Map 2). The area was part of the Sabine Christmas Bird Count area (Map 3). The landownership is split with southern land being owned by the Federal government for the Sabine National Wildlife Refuge, and the northern part of the unit being owned by small and large land owners (Map 13) The northern fringe area is used for agricultural purposes, the eastern and central parts of the unit are used for other purposes and the southern lands are non-forested wetlands (Map 12).

The unit historically had bulrush and sawgrass in the northern part, a small forested island in the center, and submerged vegetation along with wiregrass, cane, and three square grass in the southern part of the unit (Map 7). The 1949, 1968, 1978, and 1988 vegetative maps document the unit converting from brackish to a part brackish and part saline condition (Maps 8-11). The 1956-1978 change map shows the central and southern areas had large areas of marsh converted to water equal to about one-third of the unit (Map 5). The 1984 classified satellite data shows the further deterioration of marsh as only the northern one-fifth of the unit was still solid marsh and the remaining unit was water and broken marsh (Map 6).

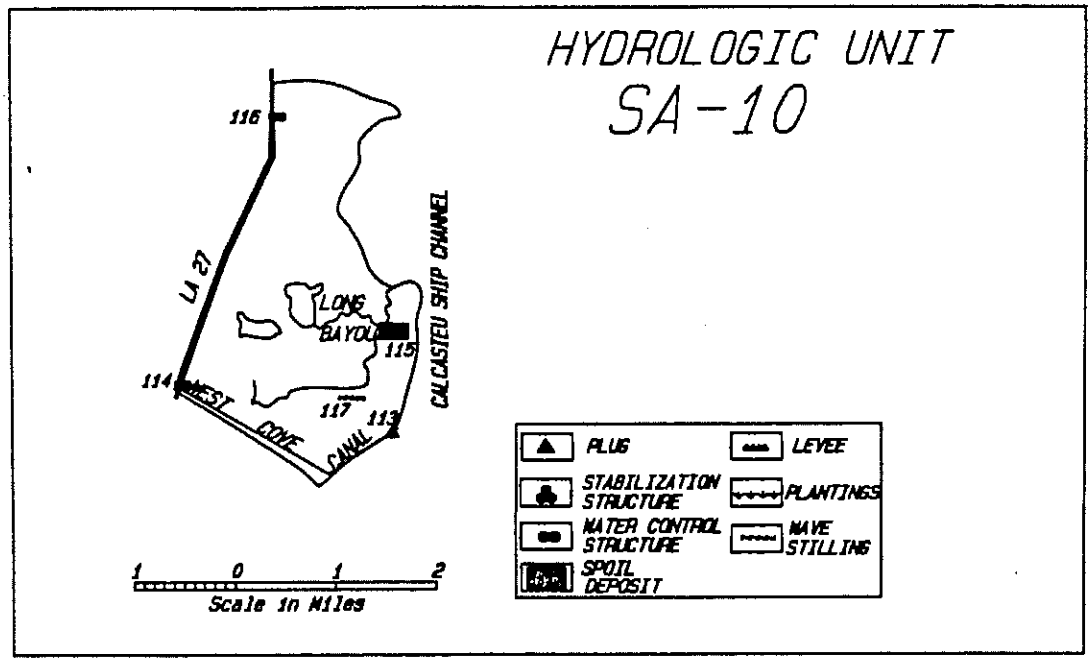

Figure 36. Hydrologic Unit SA-10.

Alternative 3

The unit consists of brackish and saline marsh and open water. Interior marshes have experienced moderate deterioration. In existing open water areas, physical erosion of adjacent marshes could be reduced by the construction of wave-break devices.

The objective of the hydrologic unit is to maintain the present physical condition and enhance vegetative productivity (Table 45). West Cove Canal currently has an outlet into West Cove and the Calcasieu Ship Channel. The purpose of element 113 is to reduce the amount of flow directly into the ship channel and insure that major water exchange occurs at the West Cove outlet by installing a plug across the outlet at the channel.

The purpose of element 114, modification of existing structure, is to increase its capability to regulate flow and reduce saltwater intrusion from the Calcasieu Ship Channel into the marshes west of Louisiana Highway 27 by adding flapgates and/or stoplogs to the existing Sabine NWR structure. This is a major fisheries access site and any modification will address this issue. This structure would be actively managed by the Sabine NWR.

Element 116 is proposed to replace flapgates on the two culverts under Louisiana Highway 27. These culverts were initially equipped with flapgates on the east side of Louisiana Highway 27 to prevent westward flow of tidal waters. These flapgates have since deteriorated and no longer exist.

Element 117 proposes the use of wave stilling/sediment trapping devices. Those devices would reduce erosion, serve to trap suspended sediment and

promote growth of submerged vegetation. It is also proposed to utilize dredge material (element 115) from the Calcasieu Ship Channel to fill in the deeper ponds and establish emergent vegetation. The total construction cost of this plan is $1,195,000.

Table 45. Hydrologic Unit SA-10. Components of Alternative 3.
4,600 Acre - Plan Objective: Maintain & enhance vegetation.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
113	H	Plug with Armor Plating	$80,000	1	$80,000
114	G	Modify Existing Structure	$500,000	1	$500,000
115	A	Cubic yards of Spoil	$3.00	100,000	$300,000
116	F	Replace Culv. w/flap gates	$30,000	3	$90,000
117	C	Wave Still Device (Ft)	$15.00	15,000	$225,000
Total Alternative Cost					$1,195,000

Alternative 4

The additional component of this alternative is wave stilling/sediment trapping devices (Table 45a). The plan calls for an extra 4,000 linear feet of wave stilling/sediment trapping devices (element 117). The result of the work will be improvement in emergent and submergent vegetative productivity and reduce erosion potential within the unit. The added cost of this component is $60,000 for a total construction cost of $1,255,000.

Table 45a. Hydrologic Unit SA-10. Additional Components of Alternative 4.
Unit Acreage 4,600

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
117	C	Wave Still Device (Ft.)	$15.00	4,000	$75,000
Sub Total Alternative					$75,000
Total Alternative Cost					$1,270,000

South Unit 1 (SO - 1)

The hydrologic unit is a 42,650 acre area located in the southwestern part of the unit above Unit SO-2 (Map 1). The unit has several soil types with Mermentau-Hackberry association located in the southeast and south central fringe areas, Scatlake association on the western edge, a band of Creole association running from the south central to north central part of the unit, and the remaining association being Bancker (Map 2). The unit was part of Johnsons Bayou Christmas Bird Count Area (Map 3). The unit contains several oil and gas fields running from the east to west it contains Cameron Meadows Oil and Gas Field, Deep Bayou Oil and Gas Fields, Northwest Johnsons Bayou Gas Field, and Blue Buck Point Gas Field. The unit also traversed by several oil, gas, and product pipelines (Map 4). Landuse is urban/industrial lands in the northeast corner, agricultural land in the south central and southeast, and remaining land being non-forested wetlands (Map 12). The unit lands are privately owned with small landowners in the agricultural lands of the south central and southeast, and large landowners in the remaining parts of the unit (Map 13).

The unit was historically mapped as intermediate marsh in the north central and northwest part of the unit, sea rim and excessively drained salt marsh on the west central part of the unit and the central area contained a band of sea rim (map 8). The 1968 vegetative map showed the area to be predominantly intermediate marsh with brackish and saline marsh on the western one third of the unit (Map 9). The unit was mapped as predominantly intermediate marsh with brackish marshes on the western part of the unit (Maps 10-11).

The 1956-1978 change map showed the marsh to stay in stable condition (Map 5). The 1984 classified satellite data showed the unit to have small spots of open water and broken marsh throughout the unit (Map 6). Water exchange occurs between the marsh and Sabine Lake at four natural bayous. The area presently is predominantly emergent marsh with less that 10 percent open water.

Alternative 3

The proposal for this unit is to reduce excessive water exchange and maintain present marsh types. The objective requires several components (Table 46) which are rock liners and plugs. Element 118 calls for sixteen rock liners along natural openings of Johnsons, M. Johnsons, Greens, and B. Forge Bayous. Fourteen plugs (element 119) will be required to close man-made openings in the bayous. Two shell dredging sites exists in the unit at Sabine Lake. Elements 120 and 121 will use plugs to close these openings and re-establish the historic lake shoreline. A man-made channel was constructed from Sabine Lake to Greens Bayou. This channel increased removal of freshwater from the bayou system and provided potential for circulation of water through the channel & bayou from Sabine Lake. A plug (element 122) is proposed for installation in the man-made channel to prevent water circulation problems in the Greens Bayou system and to improve freshwater retention. The total construction cost of the elements are $920,000.

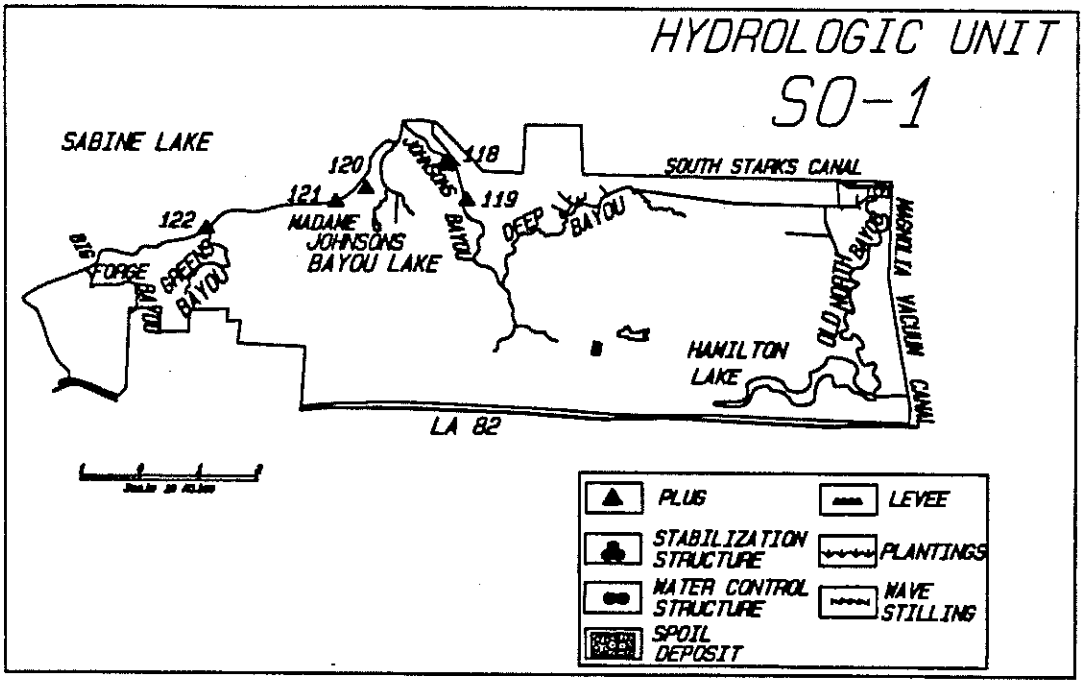

Figure 37. Hydrologic Unit SO-1.

Table 46. Hydrologic Unit SO-1. Components of Alternative 3: 42,650 Acre - Plan Objective: Reduce excessive water exchange Install structures in openings.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
118	F	Rock Liners	$20,000	16	$320,000
119	H	Plugs	$20,000	14	$280,000
120	H	Plug Shell Oredge Site	$150,000	1	$150,000
121	H	Plug shoreline opening	$90,000	1	$90,000
122	H	Plug cut at Greens Bayou	$80,000	1	$80,000
Total Alternative Cost					$920,000

South Unit 1A (SO - 1A)

The hydrologic unit is a 3,950 acre area located southwest part of the study area below Unit SO-1 (Map 1). The unit has a bank of Bancker soils running from the north central to northwest part of the unit with the remaining area being Creole soils (Map 2). The unit was included in the Johnsons Bayou Christmas Bird Count Area (Map 3). The unit is traversed by gas and product pipelines (Map 4). The lands in the northeast to north central part of the unit are used for agricultural while the remaining area is non-forested wetlands (Map 12). The unit lands are mostly owned by large landowners with 500 acres or more (Map 13).

The unit was historically mapped as a brackish marsh with sea rim in the central part of the unit (Map 8). The 1968, 1978, and 1988 vegetative maps show a conversion from brackish marsh to a combination of brackish and

intermediate marsh (Maps 9-11). The 1956-1978 change map showed the unit marsh to remain in a stable condition (Map 5). The 1984 classified satellite data showed the unit to contain a small amount of water and broken marsh (Map 6).

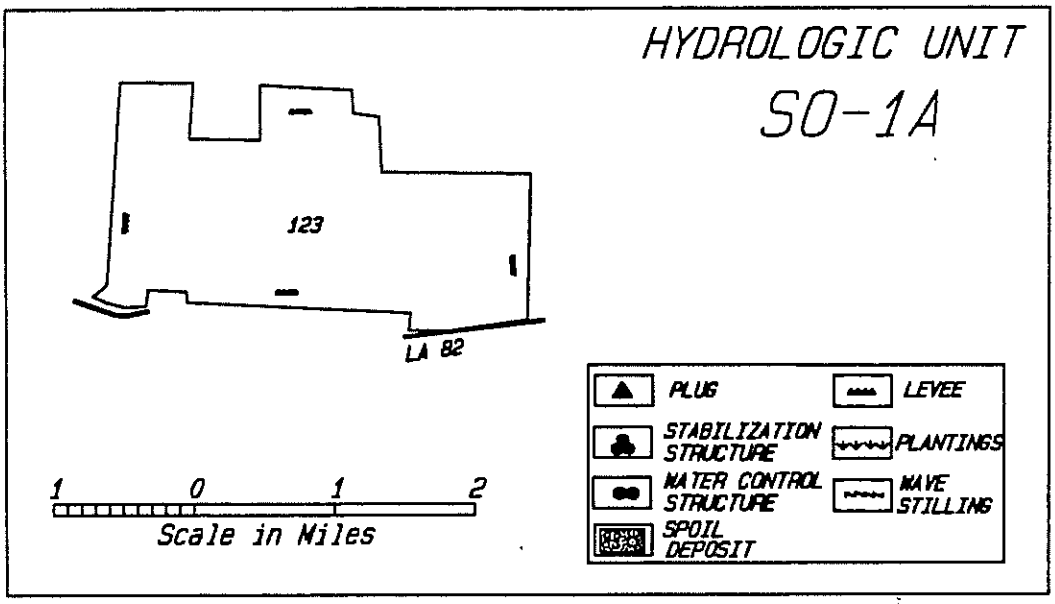

Figure 38. Hydrologic Unit SO-1A.

Alternative 3

The objective of this unit is to manage the area as a fresh/intermediate marsh. This will be accomplished by maintaining the levees and may need the installation of new water control structures with variable crest headers and flapgates. The levee maintenance requires 48,000 linear feet of levee work for a total construction cost of $240,000. The water control structures element has not been finalized and thus, are not priced or on the unit map.

Table 47. Hydrologic Unit SO-1A. Components of Alterative 3.
3,950 acre - Plan Objective: Maintain as a freshwater impoundment.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
123	A	Levee Maintenance (ft.)	$5.00	48,000	$240,000
Total Alternative Cost					$240,000

South Unit 2 (SO - 2)

The hydrologic unit is a 22,200 acre area located in the southwest part of the study area (Map 1). This unit is bounded on the west by Sabine River, the north by Louisiana Highway 82, the south by the Gulf of Mexico and extends eastward just pass Johnsons Bayou. The unit contains several soil associations with Mermentau-Hackberry in the southeast part of the unit, small

bands of Scatlake in the middle of the unit, Udifluvnets-Aquents (dredge material) on the western fringe, and remaining area Creole soils (Map 2). The unit was part of the Johnsons Bayou Christmas Bird Count area and contains a heron rookery/sea bird colony (601011) on the coastal south central part of the unit (Map 3). The unit contains the Johnsons Bayou Oil and Gas Field, West Johnsons Bayou Gas Field, and oil and gas pipelines. The land in the north central and eastern part of the unit is used for agriculture while the remaining lands are predominantly non-forested wetlands (Map 12). The lands are owned by a mixture of small and large landowners and two sections are owned by the Cameron Parish School Board (Section 16) (Map 13).

The historical vegetative mapping shows the eastern and southern area and west central to northwest fringe as sea rim, the southwest as excessively drained salt marsh, and remaining area as Brackish marsh (Map 8). The 1968, 1978, and 1988 maps show the unit converting from a salt and brackish marsh condition to a salinity gradient with intermediate, brackish, and saline marshes within the unit (Maps 9-11).

The 1956-1978 change map shows the unit marshes to basically remain in a stable condition (Map 5). The 1984 classified satellite data show the marsh beginning to deteriorate in the central and west central part of the unit (Map 6).

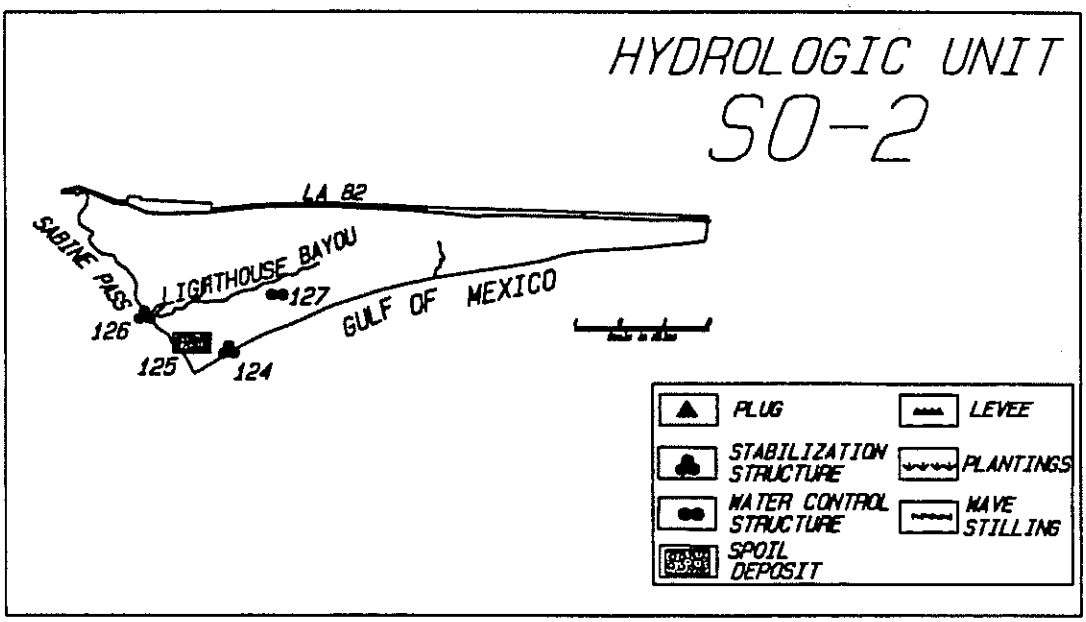

Figure 39. Hydrologic Unit SO-2.

Alternative 3

The objective for the unit is to maintain the present marsh types and control shoreline erosion. The alternative (Table 48) will call for breakwaters, use of dredge material, rock liners and water control structures. Element 124

calls for the installation of breakwaters on the east side of the Sabine River at the Gulf where there is no beach. The erosion rate is estimated at 7 feet per year. Element 124, wave breaking structures, should be similar to the Louisiana Department of Natural Resources structures west of Holly Beach. Dredge material (element 125) from Sabine Pass could be deposited to reclaim land already lost to shoreline erosion in order to maintain a beach rim. A rock liner (element 126) should be installed in Lighthouse Bayou to protect the exiting channel cross-section from further erosion. A structure should be installed in the North-South Canal to also protect the intermediate marsh area from saltwater intrusion. The total construction cost of the project components is $2,020,000.

Table 48. Hydrologic Unit SO-2. Components of Alternative 3. 22,200 Acre - Plan Objective: Protect eroding shoreline.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
124	K	Breakwaters (ft.)	$70.00	15,000	$1,050,000
125	A	Cubic yards of Spoil	$3.00	250,000	$750,000
126	F	Rock Liner	$160,000	1	$160,000
127	H	Water Control Structures	$30,000	2	$60,000
Total Alternative Cost					$2,020,000

South Unit 3 (SO - 3)

The hydrologic unit is a 13,200 acre area located in the south central part of the study area below Unit SA-4 (Map 1). The unit is bound on the north by the Starks South Canal, the east by Unit SO-4, the west by the Magnolia Vacuum Canal and the south by Unit SO-2. The unit contains Creole associated soils in the southern part of the unit and predominantly Bancker associated soils in the northern part of the unit (Map 2). The western part of the unit was

HUSO3.SPL;6";4";HPGL

Figure 40. Hydrologic Unit SO-3.

included in the Johnsons Bayou Christmas Bird Count (Map 3). The unit has the East Cameron Meadows Gas Field in the southwest part of the unit and contains several oil and gas pipelines (Map 4). The northwest corner of the unit contains urban/industrial lands and the remaining area is non-forested wetlands (Map 12). The unit is privately owned by both small and large landowners (Map 13).

The unit historically contained wiregrass, bulrush, and cane in the northern fringe. The eastern fringe contains wiregrass, bulrush, cane, cattail and aquatic. The southeast part of the unit has three square grass and bulrush (Map 7). The 1949, 1968, 1978, and 1988 vegetative maps show the unit's conversion from a predominantly brackish marsh to an intermediate marsh (Maps 8-11). The 1956-1978 change map showed the center of the unit had some conversion from marsh to water (Map 5). The 1984 classified satellite data shows some deterioration of the southern and western part of the unit (Map 6). The unit has no elements proposed at this time.

South Unit 4 (SO - 4)

The hydrologic unit is a 6,800 acre area located in the south central portion of the study area below Unit SA-4 (Map 1). The unit is bound on the north by the Starks South Canal, the south by the Gulf, the east by the Beach Canal and the west by Unit SO-3. The area contains some Creole associated soils in the northern part of the unit, but is mainly Bancker association (Map 2). The unit contains several gas pipelines (Map 4). It is owned by large landowners with 500 or more acres (Map 13) and has a use classification of non-forested wetlands (map 12).

The unit historically contained cane, wiregrass, cattail, burush, three square grass, and aquatics (Map 7). The 1949, 1968, 1978, and 1988 vegetative maps document the marsh's conversion from a predominantly brackish marsh to an intermediate marsh (Maps 8-11). The 1956-1978 change map shows a small amount of conversion from marsh to water in the unit (Map 5). The 1984 classified satellite data shows that the fringe marshes have been converted to open water and broken marsh while the remaining marsh has remained stable (Map 6).

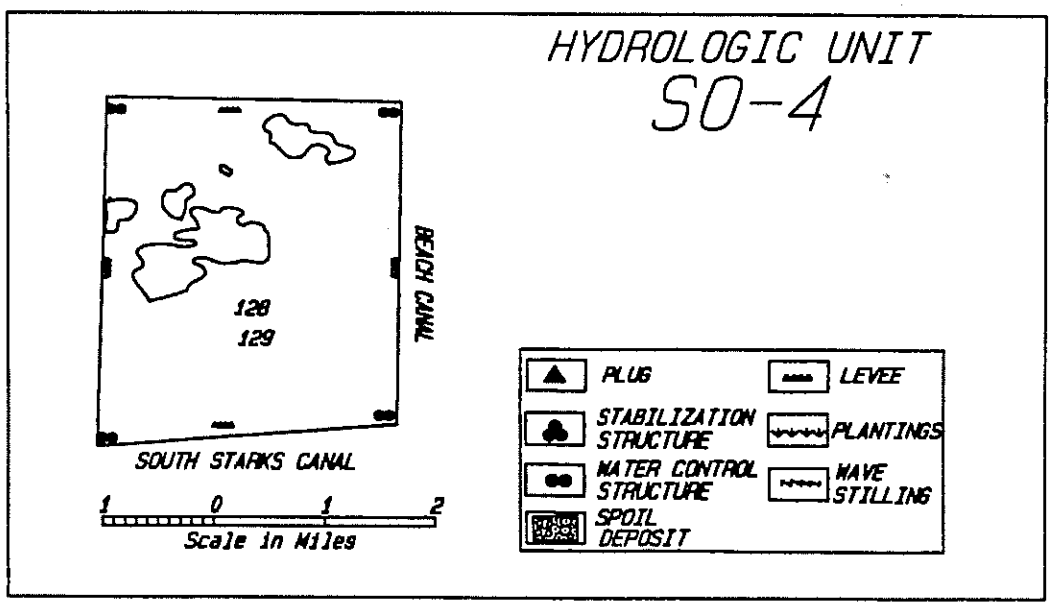

Figure 41. Hydrologic Unit SO-4.

Alternative 3

The objective for this unit is to manage for fresh to intermediate marsh. The components (Table 49) to accomplish the objective include perimeter levee repair and water control structures. Approximately 20,000 linear feet of levee repair (element 128) on the perimeter of the unit will maintain hydrologic control. Element 129 calls for installing and actively managing four water control structures. No specific structure design and marsh plan

has been developed. The total construction cost of the components are $420,000.

Table 49. Hydrologic Unit SO-4. Components of Alternative 3. 6,800 Acre - Plan Objective: Manage for fresh-intermediate marsh, actively managed.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
128	D	Perimeter Levee Repair (Ft)	$15.00	20,000	$300,000
129	G	Water Control Structures	$30,000	4	$120,000
Total Alternative Cost					$420,000

South Unit 5 (SO - 5)

The hydrologic unit is a 9,800 acre area located in the south central portion of the study area below Unit SA-2 (Map 1). The unit's soils are Creole association in the southern and eastern part of the unit and remaining area is Bancker association (Map 2). The eastern part of the unit was included in the Sabine Christmas Bird Count (Map 3). The unit has some petroleum activity with the northeast portion containing Second Bayou Gas Field, the southeast and central portions containing the Mud Lake Gas Field, and having several gas pipelines running through the unit (Map 4). The unit's landuse classification is non-forested wetlands (Map 12) and is owned by large landowners with 500 acre or more (Map 13).

The unit historically contained wiregrass, cane, cattail, and some submerged aquatics in the northern one-third, several small communities of three square grass in the area, and cane, wiregrass, cattail, bulrush, sawgrass, and submerged aquatics in the remaining portions of the unit (Map 7). The 1949 vegetative map showed the southern fringe area to contain sea rim, the southeast portion to contain leafy three corner grass or coco grass, the northwest portion to contain intermediate marsh, and the remainder as brackish (Map 8). The 1968, 1978, and 1988 vegetative maps show the area to be fluctuating between intermediate and brackish marsh (Maps 9-11).

The 1956 to 1978 change map shows the eastern one-half of the unit experienced pockets of conversion from marsh to open water (Map 5). The 1984 classified satellite data shows the west central and southeastern portion of the unit contains broken marsh and water while the remaining area is solid marsh (Map 6).

Alternative 3

The objective of the hydrologic unit is to passively manage to maintain the existing marsh types. The alternative components (Table 50) include culvert maintenance, variable crest weir and the addition of double flapgated culverts. Interior water movement can be improved by lowering existing culverts and adding additional culverts (element 130) under oil field roads. A variable crest header can be added to an existing structure (element 131) under Louisiana Highway 27 in the southeast corner of the unit. The only structure manipulation would be to remove stoplogs during high water events to remove excess water from west of Louisiana Highway 27. Installation of double flapgated culverts (element 132) under oil field roads will also improve

interior water circulation and thus, improve emergent and submergent aquatic productivity. The total construction cost of this alternative is $290,000.

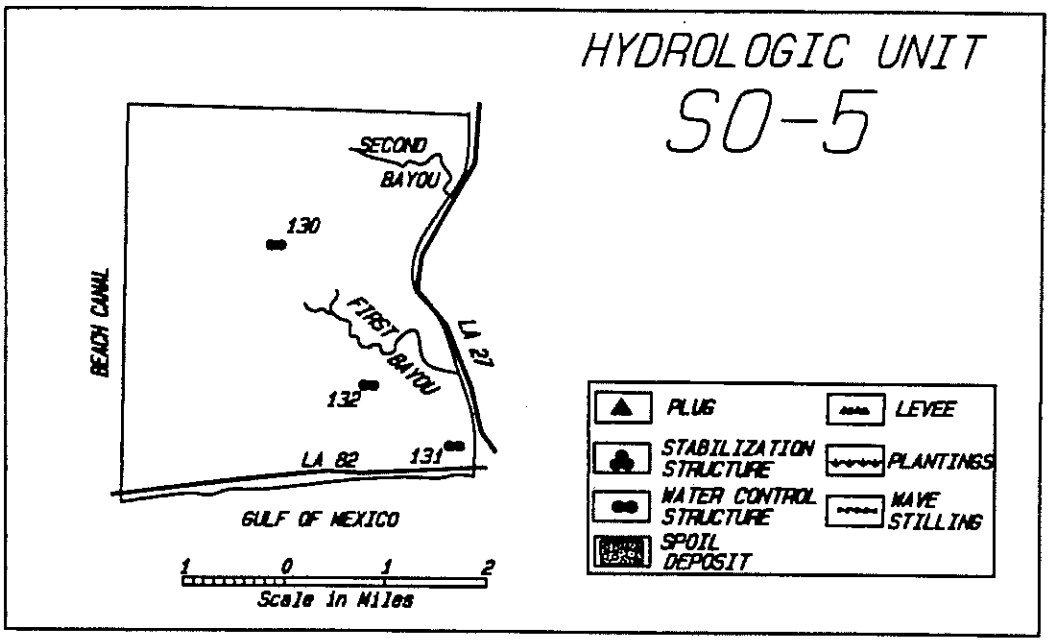

Figure 42. Hydrologic Unit SO-5.

Table 50. Hydrologic Unit SO-5. Components of Alternative 3. 8,100 Acre - Plan Objective: Maintain for fresh-intermediate, passively managed.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
130	F	Culverts maint. & additional	$6,000	5	$30,000
131	G	VC Weir	$180,000	1	$180,000
132	G	Culvert double flap gates	$40,000	2	$80,000
Total Alternative Cost					$290,000

South Unit 6 (SO - 6)

The hydrologic unit is an 8,100 acre area located in the southeastern portion of the study area and east of Unit SO-5 (Map 1). The area is bounded on the north by Unit SO-7 on the east by Unit SO-8, on the south by Louisiana Highway 82 and on the west by Louisiana Highway 27. The unit contains mostly Creole associated soils, except for some Bancker associated soils in the central portion of the unit (Map 2). The area was included in the Sabine Christmas Bird Count but had no known nesting sites found (Map 3). Part of the East Mud Lake Oil and Gas Field and several gas pipelines are in this unit (Map 4). The land is owned by landowners with 500 acres or more (Map 13) and the landuse is classified as non-forested wetlands (Map 12).

ALTERNATIVES AND ANALYSIS

The area historically contained cane, wiregrass, bulrush, and submerged aquatics with several plots of three square grass within the unit (Map 7). The 1949, 1968, 1978, 1988 vegetative maps show the unit to be brackish marsh (Maps 8-11). The 1956-1978 change map show the north central part of the unit contained some marsh to water conversion (Map 5). The 1984 classified satellite data shows the open water in Mud Lake and the remaining unit lands to be broken marsh (Map 6).

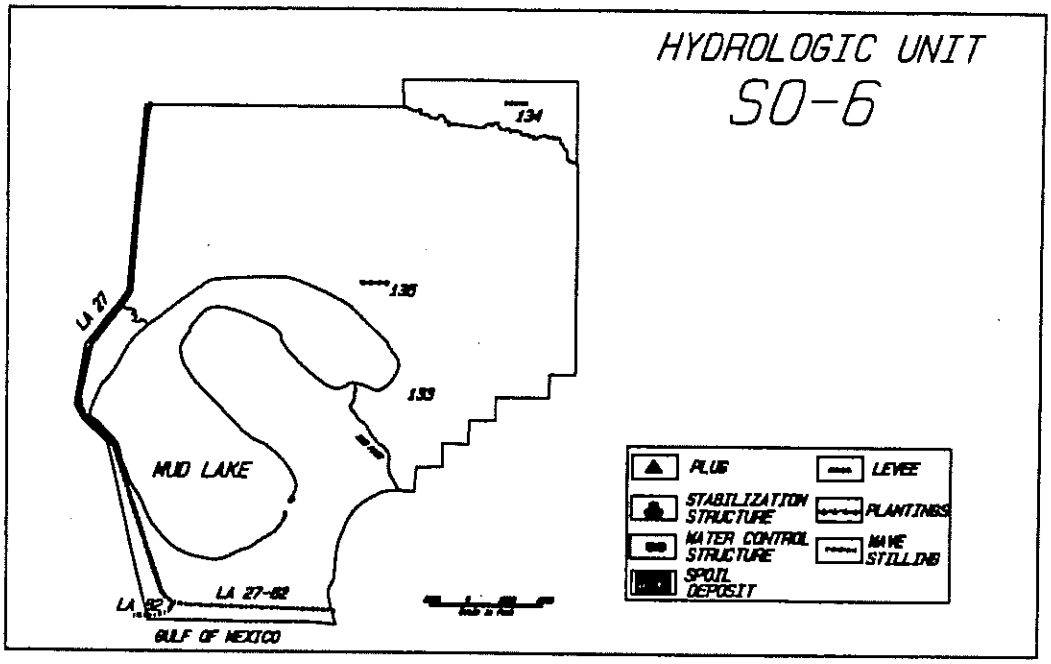

Figure 43. Hydrologic Unit SO-6.

Alternative 3.

The objective of this hydrologic unit are to manage the area according to the permitted marsh plan. The project was approved for construction under the Coastal Wetlands Planning, Protection, and Restoration Act (Public Law 101-646) It is proposed to install all the permitted features. The area will be actively managed as permitted. The cost of the alternative is $1,920,000.

Table 51. Hydrologic Unit SO-6. Components of Alternative 3.
Unit Acreage 8,100

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
133		Fina Plan Elements	$945,000	1	$945,000
134	C	Wave Still Device (Ft)	$15.00	50,000	$750,000
135	B	Vegetation (Ft)	$1.50	150,000	$225,000
Total Alternative Cost					$1,920,000

Alternative 4

The productivity of the marsh could be improved through the addition of extra wave stilling/sediment trapping devices (Table 51a). This alternative calls for an extra 84,000 linear feet of wave stilling/sediment trapping devices (element 134) be installed to improve sediment trapping capabilities and reduce wave fetch. The work would cost an extra $1,260,000 and have a total construction cost of $3,180,000.

Table 51a. Hydrologic Unit SO-6. Additional Components of Alternative 4. Unit Acreage 8,100

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
134	C	Wave Still Device (Ft)	$15.00	84,000	$1,260,000
Sub Total Alternative					$1,260,000
Total Alternative Cost					$3,180,000

South Unit 7 (SO - 7)

The hydrologic unit is a 2,400 acre area located in the southeast portion of the study area above Unit SO-6 (Map 1). The unit is bounded on the south by SO-6, on the north by West Cove and West Cove Canal, on the west by Louisiana Highway 27 and on the east by West Cove. Organic soils make up approximately 70 percent of the unit which are Creole associated soils (Map 2). The unit was included in the Sabine Christmas Bird count, but was found to contain no significant nesting sites (Map 3). Portion of East Mud Lake Oil and Gas Field and several gas pipelines are in the unit (Map 4). The unit landuse is non-forested wetlands (Map 12) and is owned mostly by the Federal government (Map 13).

The area historically contained wiregrass, bulrush, and cane according to the 1931 vegetative map (Map 7). The 1949, 1968, 1978, and 1988 vegetative maps show the are to be brackish marsh (Maps 8-11). The 1956-1978 change map shows that the southern fringe marshes had some conversion from marsh to water (Map 5). The 1984 classified satellite data show the western and southeastern fringe to be broken marsh and the remaining as marsh (Map 6). Approximately 50 percent of the emergent marsh on the organic soils have eroded to shallow open water areas. The severe marsh breakup on the organic soil types is due to high salinities and excessive water fluctuations and high water levels.

Marshes adjacent to West Cove are relatively high and stable. The center of the unit is an area of deeper organic marshes. Construction of the canal between the western tip of West Cove and Roadside Canal, and the subsequent breaks in its southern spoil bank breached the hydrologic barrier of the high lake rim marshes and allowed water exchange to occur between West Cove and the interior deep organic marshes. The eastern boundary of the unit consists of a canal which also cuts through the high like rim marsh and connects West Cove with interior marshes. Interior marshes in the vicinity of that canal have experienced some deterioration and loss but not as much as in the area of deep organic marsh.

Construction and enlargement of the Calcasieu Ship Channel increased salinities and tidal exchange and promoted the deterioration and loss of marshes in the deep marsh area. Adjacent to the canal spoil bank breaks and southward for approximately one-half mile, the central deep marsh area appears to be in transition from a deteriorating brackish marsh to a building/expanding saline marsh. Open water area and mud flats here are being closed in by Spartina alterniflora.

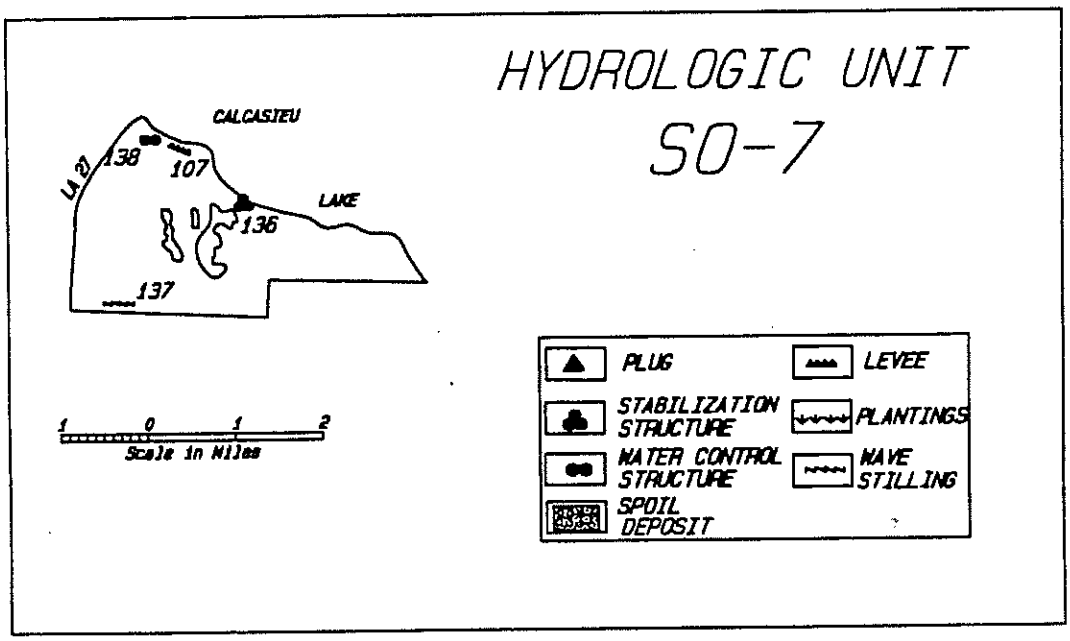

Figure 44. Hydrologic Unit SO-7.

Alternative 3

The objective of the hydrologic unit is to maintain the unit as a brackish marsh by reducing canal-induced water exchange between the lake and interior marshes. The components (Table 52) include spoil bank maintenance, a rock liner, wave stilling/sediment trapping devices and a water control structure. The boundary spoil bank between Units SA-8 and SO-7 will be rebuilt. The installation of a rock liner (element 136) in the canal that leads into West Cove would protect the existing channel crossOsection from further erosion. The installation of a water control structure (element 138), in the spoil breaks, at the marsh opening into West Cove Canal will reduce water level fluctuation, salinities and tidal scouring for Units SO-7 and SO-6. The wave stilling/sediment trapping devices will improve vegetative productivity in the unit by placement in open water areas to reduce erosion of marshes adjacent to open water areas. Installing these elements would reduce the need to install or actively manage some of the elements in the permitted plan for Unit SO-6.

Table 52. Hydrologic Unit SO-7. Components of Alternative 3.
2,400 Acre - Plan Objective: Maintain as a brackish marsh.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
107	A	Rebuild Spoil Bank (ft.)	$15.00	500	$7,500
136	F	Rock Liner	$50,000	1	$50,000
137	C	Wave Still Device (Ft)	$15.00	10,000	$150,000
138	F	Water Control Structure	$80,000	1	$80,000
Total Alternative Cost					$287,500

Alternative 4

Installation of 5,000 linear feet of additional wave stilling/sediment trapping devices (element 137) will provide additional protection to the inner marshes from erosion (Table 52a). The construction cost of additional wave stilling/sediment trapping devices is $75,000 for a total construction cost of $362,500 for this alternative.

Table 52a. Hydrologic Unit SO-7. Additional Components of Alternative 4.
Unit Acreage 2,400

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
137	C	Wave Still Device (Ft.)	$15.00	5,000	$75,000
Sub Total Alternative					$75,000
Total Alternative Cost					$362,500

South Unit 8 (SO - 8)

The hydrologic unit is a 12,600 acre area located in the southeastern portion of the study area east of Unit SO-6 (Map 1). The unit is bounded on the south by Louisiana Highway 82, on the north by West Cove, on the west by Unit SO-6 and on the east by the Calcasieu Ship Channel. Organic soils make up approximately 60 percent of the unit. The unit contains Bancker associated soils in the central part of unit and the remaining area is Creole associated soils (Map 2). The area was included in the Sabine Christmas Bird Count (Map 3). The East Holly Beach Gas Field and several gas pipelines are located within the unit (Map 4). The unit land is classified as non-forested wetlands (Map 12) and the acreage is owned by both large and small land owners (Map 13).

The area historically contained wiregrass, bulrush, and sawgrass according to the 1931 vegetative map (Map 7). The 1949 vegetative map shows the eastern central area as excessively drained salt marsh, the southern rim as sea rim, and the remaining area as three corner grass brackish marsh (Map 8). The 1968, 1978, and 1988 show the area to basically be a brackish marsh (Maps 9-11).

The 1956-1978 change maps show the area to have a few small pockets of marsh to water conversion with the remaining area being marsh and land (Map 5). The 1984 classified satellite data show the central and western portions of the unit to be broken marsh and the remaining area as marsh and land (Map 6).

ALTERNATIVES AND ANALYSIS

Approximately 50 percent of the emergent marsh on the organic soils has eroded to shallow open water areas. The area is experiencing very severe marsh breakup on the organic soil types due to high salinities and excessive water level fluctuations and high water levels.

The area has two openings directly into the West Fork of the old Calcasieu River. The openings provide access for tidal scouring, Gulf strength water salinities and tidal fluctuations without any source of freshwater dilution other than rainfall. Any freshwater head that could be achieved by rainfall is quickly removed due to the tidal fluctuations.

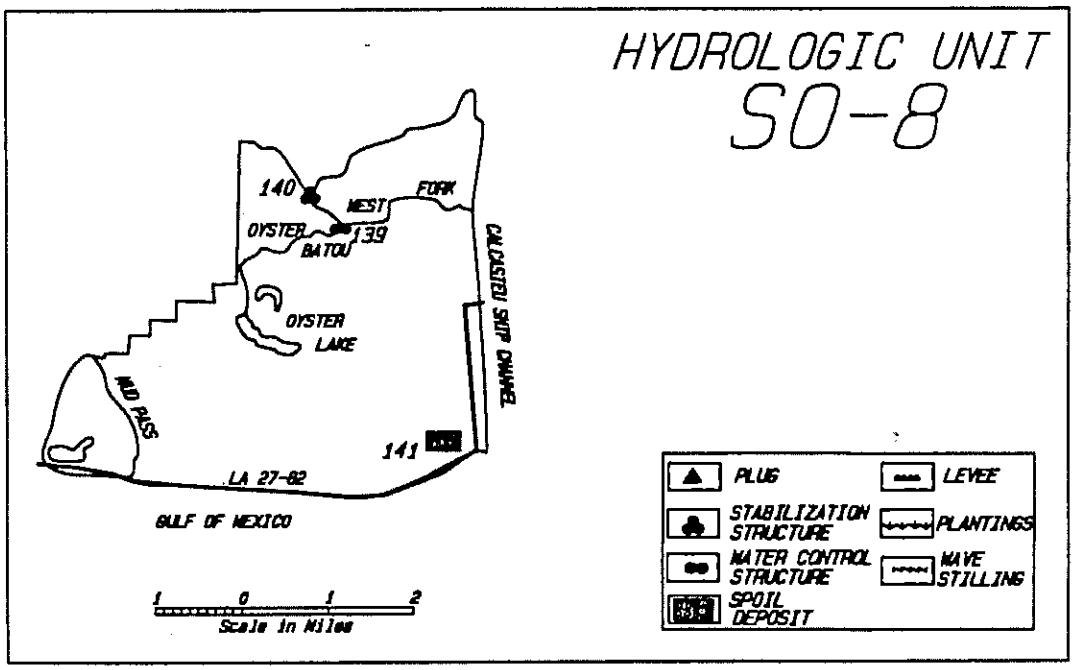

Figure 45. Hydrologic Unit SO-8.

Alternative 3

The objective of the hydrologic unit is to reduce water level fluctuations. This will be accomplished with the installation of rock liners and addition of dredged spoil for marsh creation (Table 53). The proposal calls for rock lining Mud Bayou (element 140) to maintain the present size of the opening going into West Fork. Dredge spoil (element 141) from the Gulf and the Calcasieu Ship Channel would benefit the building of pond bottoms and help restore emergent marsh vegetation. The total cost of construction for this alternative is $650,000.

Table 53. Hydrologic Unit SO-8. Components of Alternative 3.
12,600 Acre - Plan Objective: Reduce water level fluctuation.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
139		Water Control Structure	$1,000	1	$1,000,000
140	F	Rock Liner	$50,000	1	$50,000
141	A	Cubic yards of Spoil	$3.00	200,000	$600,000
Total Alternative Cost					$1,650,000

Alternative 4

This alternative requires the installation of a large structure (Table 53a). The large water control structure (element 139) will be installed in Oyster Bayou near the opening into West Fork. The structure needs to be designed for fisheries access because the marshes are a very important nursery area for nursery depended marine organisms. The additional component will cost $1,000,000 for construction for a total construction cost of $1,650,000.

Table 53a. Hydrologic Unit SO-8. Additional Components of Alternative 4.
Unit Acreage 12,600 Alternative 3A Additions

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
139	G	Oyster Bayou Structure	$1,000,000	1	$1,000,000
Sub Total Alternative					$1,000,000
Total Alternative Cost					$1,650,000

South Unit 8A (SO - 8A)

The hydrologic unit is an 1,100 acre area located in the southeast portion of the study area below Unit SO-8 (Map 1). The unit is bounded on the south by the Gulf, on the north by Louisiana Highway 82, on the west by Louisiana Highways 27 and 82, and on the east by the Calcasieu Ship Channel. The unit soils are Mermentau-Hackberry association (Map 2). The unit was included in the Sabine Christmas Bird count and contains a sea bird colony (601012) (Map 3). The landuse is predominantly non-forested wetlands (Map 12) and is owned by both large and small landowners (Map 13).

The unit was first vegetatively mapped as sea rim in 1949 (Map 8) and mapped as non-marsh in 1968 (Map 9). The 1978 and 1988 maps show the southeastern portion of the unit as saline marsh and the remaining unit as non-marsh (Maps 10-11). The 1956-1978 change map shows the southeastern corner to have converted from marsh to water and the remaining area stayed as land and marsh (Map 5). The 1984 classified satellite data shows the southeastern portion of the unit as broken marsh (Map 6).

Alternative 3

The objective of the hydrologic unit is to maintain the unit in its present condition. The objectives require the use of dredge material and rock breakwaters (Table 54). The dredge material (element 142) could be used for beach nourishment in order to protect the present shoreline. The rock

breakwaters (element 143) will afford shoreline protection by reducing wave energies near the beach line. Shoreline erosion on the Gulf is being addressed by the State's Coastal Wetlands Conservation and Restoration Plan. The total construction cost of these components is $5,350,000.

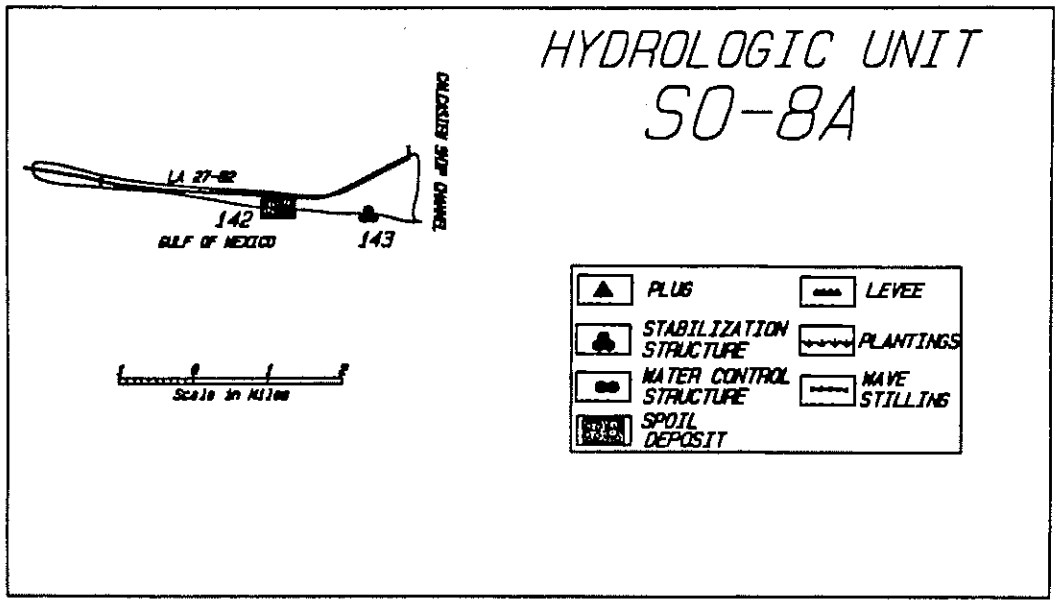

Figure 46. Hydrologic Unit SO-8A.

Table 54. Hydrologic Unit SO-8A. Components of Alternative 3. 1,100 Acre - Plan Objective: Maintain as is.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
142	A	Cubic yards of Spoil	$3.00	200,000	$600,000
143	K	Breakwaters (ft.)	$190	25,000	$4,750,000
Total Alternative Cost					$5,350,000

South Unit 9 (SO -9)

The hydrologic unit is a 300 acre area located in the eastern central portion of the study area above Unit SO-8 (Map 1) and is composed of all of Rabbit Island. The unit soils are Creole association (Map 2). The unit was included in the Sabine Christmas Bird Count area and was found to contain a heron rookery site (601002) (Map 3). The unit is a very important nesting area for several species of shorebirds and wading birds.

The area was not vegetatively mapped until 1978 and was found to be brackish (Map 10). The 1988 vegetative map showed the area as not mapped (Map 11). The 1956 to 1978 change map showed the area to have several small pockets of marsh to water conversion (Map 5). The 1984 classified satellite data shows the area to be broken marsh (Map 6).

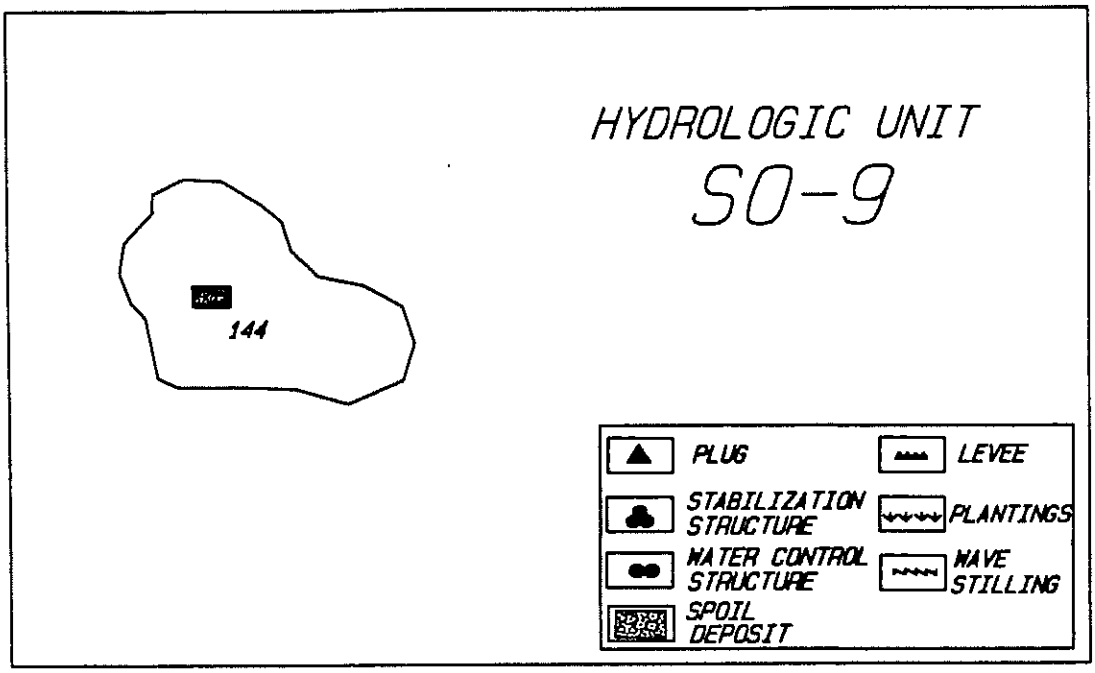

Figure 47. Hydrologic Unit SO-9.

Alternative 3

The objective is to create emergent marsh where the marsh has eroded into shallow water areas. The component (Table 55) calls for use of dredge material (element 144) from the Calcasieu Ship Channel which would be used to restore the open water areas into emergent marsh. The alternative has a total construction cost of $78,000.

Table 55. Hydrologic Unit SO-9. Components of Alternative 3.
300 Acre - Plan Objective: Maintain as a nesting habitat for water birds.

Element Number	Mgt. Opt.	Units	Unit Cost	Units Required	Element Cost
144	A	Cubic yards of Spoil	$3.00	26,000	$78,000
Total Alternative Cost					$78,000

RECOMMENDED PLAN

The Calcasieu-Sabine River Basin Study area is a large, diverse coastal section of Louisiana with many problems of varying degrees. Several alternatives were presented in the previous section of this document, each with its merits and short comings.

Alternative one, the no action alternative, will not require expenditure of public and private funds. However, the costs associated with further wetland loss and deterioration will not only have a local but a national impact. Further marsh deterioration will have a long-term impact on the culture and economy of the basin residents.

This loss will reduce the income generated through vendor sales of goods and services to commercial and recreational users of the basin wetlands. This loss will also impact the tax collections at the local, state, and Federal levels. As the coastal marsh is lost and the coast line recedes from its present locale, millions of dollars worth of infrastructure will be damaged and require greater maintenance or be lost.

Alternative two, perimeter structure alternative, will provide for greater control of the problems associated with saltwater intrusion. However, it will not completely solve many of the problems associated with increased water level fluctuations and marsh erosion in the interior marsh areas. The locks will also increase the operation cost of shipping by increasing travel time through these locks. The cost of this alternative could be as high as $750 million.

Alternative three, hydrologic unit treatment, will help solve the problems for interior marsh areas and allows for implementation by both public and private interests. It does not completely solve the problem of saltwater intrusion from navigation projects. However, it will provide ample protection to interior marsh areas from saltwater intrusion. This alternative has a total construction cost of $36.7 million.

Alternative four, extended hydrologic unit treatment, is similar to alternative 3, except it provides for additional marsh protection and opportunity for emergent and submergent vegetative productivity. This additional productivity increase would further enhance the recovery of coastal wetlands within the basin. However the total construction cost of this alternative is $58.8 million which is $22.1 million greater than alternative three.

The criteria for selecting the best alternative is multi-faceted and requires the analysis of each issue. These issues include cost, ease of installation for both public and private interests, and solve many of the problems associated with wetland deterioration and loss. Under these conditions alternative three provides the best opportunity to protect and enhance the basin wetlands and has a benefit to cost ratio above unity. Also, alternative four is an extension of alternative three which allows project implementors to choose ahigher level of protection if current conditions warrent.

IMPLEMENTATION

INTRODUCTION

Implementation of his river basin plan can be accomplished by government agencies, corperations, or individuals who could potentially institute certain portions of a conceptual plan. It is not designed to say that a certain group or individual will perform tasks to fulfill the plan requirements. The groups discussed in this section will be both private and public. The public groups will be local, state, and Federal government.

PRIVATE

The Selected Plan is designed so that individual landowners and landusers can implement the proposed components to arrest or reduce wetland loss within particular hydrologic units. Some of the unit proposals may be too costly and require funding sources or technical expertise beyond individual capabilities. However, other financial and technical sources can be sought at the local, state, and federal level.

STATE AND LOCAL

Louisiana Department of Natural Resources Coastal Restoration Division (LDNR/CRD)

The primary function of LDNR/CRD is to conserve and restore vegetated wetlands in coastal Louisiana. A statutorily dedicated trust fund was created by Act 6 of the Second Extraordinary Session of the 1989 Louisiana Legislature to provide a long-term funding source for coastal wetlands projects. The agency prepares a Coastal Wetlands Conservation and Restoration Plan for each fiscal year and evaluates all submitted projects for funding and implementation.

State Soil and Water Conservation Committee (SSWCC)

The primary function of the SSWCC is to provide program, administrative, and financial support to Louisiana's 40 soil and water conservation districts. As the leading soil and water conservation agency in Louisiana, this committee is responsible for planning and implementing all soil and water conservation programs in the state. Recognizing the need to provide direction for future soil and water conservation programs, as well as guidance for funding activities, the SSWCC developed, in concert with others, the Louisiana Statewide Resource Conservation Program. This plan represents proposals for program needs, priorities, operational funding levels, and a schedule for implementation.

State Soil and Water Conservation District (SWCD)

In Louisiana, SWCD's have been charged with the responsibility of conserving Louisiana's soil and water resources since 1938 when the Louisiana Legislature passes the Soil Conservation District Law, Act no. 370. The objectives, as stated in the law, are to provide for conservation of the State's soil and water resources, control and prevent soil erosion, preserve wildlife, protect public lands, and promote the health, safety, and general welfare of the people of the state. The Act recognized Louisiana's farm, grazing, and

forestlands as assets basic to survival of mankind. The Gulf Coast Soil and Water Conservation District covers the entire study area.

FEDERAL GOVERNMENT

United States Department Of Agriculture Programs

Soil and Water Conservation

The Soil Conservation and Domestic Allotment Act, Public Law 74-46, approved April 27, 1935, is the authorizing legislation that created the Soil Conservation Service. The objectives of the legislation was to plan and carry out a national soil and water conservation program, and to provide leadership in conservation, development, and productive use of the nations soil, water, and related resources.

The Soil Conservation Service provides technical assistance to individuals and groups in planning and applying soil and water conservation practices, and furnishing technical soil and water conservation information to units of government.

The SCS in Louisiana has 10 field offices that provide technical assistance to marsh landowners. This is not a new concept, because assistance has been provided since the 1940's. Over the years, SCS personnel have provided essential interdisciplinary input into preparing complex coastal wetland restoration plans.

Currently, there are 946 cooperating landowners that control 2,191,000 acres of coastal wetlands. During the period of 1981-1984, 185 resource management plans were developed, covering 663,600 acres.

Watershed Protection and Flood Prevention

This program was authorized under the Watershed Protection and Flood Prevention Act, Public Law 83-566, as amended. The objectives are to provide financial and technical assistance in planning and carrying out works of improvement to protect, develop and utilize the land water resources in small watersheds.

Assistance is provided in planning, designing, and installing watershed works of improvement; in sharing costs of flood prevention, irrigation, drainage, watershed protection, sedimentation control, and public water based fish and wildlife and recreation; and in extending long-term credit to help local interests with their share of the costs.

Public Law 566 funds have been used in Louisiana to provide protection for marsh areas in two watersheds. About 26 miles of levees and several structures for water control have been installed.

River Basin Surveys and Investigations

The program was authorized under the Watershed Protection and Flood Prevention Act, Public Law 83-566, as amended, Section 6. The objectives are to assist Federal, State, and local agencies in collecting decision making information

regarding water and related land resources with specific objectives of improving national economic development and environmental quality. Studies are carried out in cooperation with State, Federal and local agencies. Special priority is given to solving non-point pollution problems including erosion and salinity; protecting and improving important farmlands, wetlands, flood plains, and other special resources; improving irrigation efficiencies; and identifying flood hazards and other flood plains resources to assist local governments develop a local flood plain management program.

Parts of Louisiana's coastal area have been included in six river basin studies since 1967 as follows:

Name	Type	Completion Date
Sabine	B[1]	1967
Coastal & Independent Streams	CRBS[2]	1971
Lower Mississippi River	1[3]	1974
Southwest Louisiana Basin	CRBS	1974
Louisiana Statewide	CRBS	1974
Lafourche-Terrebonne	CRBS	1986
East Central Barataria	CRBS	1989

The major objectives of each study are to identify water and related land resource problems. Each study further identifies those USDA project-types and related programs which can be used effectively to meet the needs for water related goods and services in the study area and to ensure that agricultural interests are identified and protected in any overall water and related land development program.

River basin studies have provided input for the State water plan, coastal zone management plan, and Section 208 planning process. The State Soil and Water Conservation Districts have based parts of their long-range programs on information provided by river basin studies.

Inventory and Monitoring

The program was authorized under the Soil Conservation and Domestic Allotment Act, Public Law 74-76, April 27, 1935; Rural Development Act, Public Law 92-419, Section 302, Title III, August 30, 1982; and Resources Conservation Act, Public Law 95-192, November 18, 1977. The objectives are to provide for field collection, interpretation, and publication of natural and related resource data. These data and interpretations serve many agency and department needs as well as those of individuals, groups, and units of government. They permit users to examine the relations and interaction of natural and related resources to determine how they are used, how they are managed, to define resource problems, and to identify resource potential.

Inventories will provide data on prime, unique, and other important farmland that are used to carry out surface mining regulations, prepare environmental impact statements, and appraise the rural lands that produce food, feed, forage, fiber,

[1]Comprehensive Detailed Study
[2]Cooperative River Basin Study
[3]Framework Study

and oilseed crops for domestic use and export. Other inventories made on the status and condition of natural and related resources furnish data for resource analyses and evaluation, programming, and planning at the State and National levels.

The "Coastal Marsh Inventory," a three-year inventory of Louisiana's Coastal Marsh, was completed in 1986. The inventory was designed to consider all program and agency resource data needs; and data collected permits an in-depth evaluation of the coastal marshland and its degradation. Although the 1982 National Resources Inventory (NRI) did not inventory marshland erosion, data is being collected on the 1982 Primary Sample Units (PSU's) so that erosion trends can be established from future monitoring of the PSU's.

Plant Materials for Conservation

The program was authorized under the Soil Conservation and Domestic Allotment Act, Public Law 74-76, approved April 27, 1935. The objectives are to assemble, evaluate, select, release, and introduce into commerce new and improved plant materials for soil, water, wildlife conservation, and environmental improvement.

Plant materials are used in all phases of the soil and water conservation program. Plant material centers produce only enough of any variety for field testing to prove value in conservation on cooperator's properties and to provide commercial producers with breeder and foundation quality seed or propagules. Large-scale production is conducted by cooperating commercial producers in conjunction with Soil Conservation Districts, State Agricultural Experiment Stations, State Crop Improvement Associations, and other Federal and State agencies.

Other Federal Programs

Coastal Wetlands Planning, Protection, and Restoration Act (PL 101-646)

The act was enacted by the 101st Congress as House Bill No. 646 to provide for the long-term protection, restoration, and enhancement of Louisiana coastal wetlands. A Restoration Plan will be prepared fiscal years 1992 to 1996. The projects that go into the annual plan are evaluated as to need and cost-effectiveness for implementation purposes. The Act calls for a monitoring plan for each project in order to evaluate the effectiveness of the project in protecting and restoring vegetated coastal wetlands.

PROJECT COORDINATION AND REGULATION

Hydrologic unit treatment will require coordination with natural resource conservation agencies at the State and Federal level. The coordination can be in the form of consultation over water control structural operation with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, USEPA, and the Louisiana Department of Wildlife and Fisheries. This coordination can also be required permits from the Corps of Engineers, Louisiana Department of Natural Resources Coastal Management Division, and the Louisiana Department of Environmental Quality, and possibly the Louisiana Department of Health and Hospitals. Coordination will expedite issue resolution by allowing the early exchange of information to allow for project installation and conservation of wildlife and fisheries resources.

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APPENDICES

APPENDIX A

LIST VEGETATION IN THE CALCASIEU-SABINE RIVER BASIN

The vegetation that could occur within the Calcasieu-Sabine River Basin was taken from Allen (1975), Dutton (1985), Montz (1979) and Thieret (1980), and follows the format of USDA-SCS's National List of Scientific Plant Names (1984). This taxonomic listing provides the family (using family number according to USDA-SCS National List of Scientific Plant Names), common name, scientific name, and abundance.

Abundance is shown by the following codes: A = abundant,
F = frequent, VC = very common, C = common, U = uncommon,
O = occasional, R = rare, E = escaped from cultivation, and
X = shown to occur however abundance not recorded.

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Fam #	Common Name	Scientific Name	Abn.
001	Scouringrush Horsetail	*Equisetum hyemale*	U
005	Blackfoot Quillwort	*Isoetes melanopoda*	R
008	Ebony Spleenwort	*Aspelenium platyneuron*	O
008	Japanese Holly-fern	*Cyrtomium falcatum*	R
008	Ressurrection Fern	*Polypodium polypodioides*	O
008	Widespread Maiden Fern	*Thelypteris kunthii*	U
008	Southern Marsh Fern	*Thelypteris thelypteroides*	U
009	American Waterfern	*Ceratopteris pteridoides*	R
012	Japanese Climbing Fern	*Lygodium japonicum*	O
013	Royal Fern	*Osmunda regalis*	x
014	Mosquito-fern	*Azolla caroliniana*	C
014	Salvinia	*Salvinia minima*	x
017	Bulbous Adders-tongue	*Ophioglossum crotalophoroides*	U
017	Limestone Adders-tongue	*Ophioglossum engelmannii*	U
017	Long-stemmed Adders-tongue	*Ophioglossum petiolatum*	O
023	Eastern Redcedar	*Juniperus virginiana*	O
023	Slash Pine	*Pinus elliottii*	O
023	Longleaf Pine	*Pinus palustris*	U
023	Loblolly Pine	*Pinus taeda*	O
023	Baldcypress	*Taxodium distichum*	C
023	Northern White Cedar	*Thuga orientalis*	U
025	Southern Cattail	*Typha domingensis*	O
025	Common Cattail	*Typha latifolia*	C
028	Curly Pondweed	*Potamogeton crispus*	x
028	Waterthread Pondweed	*Potamogeton diversifolius*	U
028	Long-leaved Pondweed	*Potamogeton nodosus*	O
028	Sago Pondweed	*Potamogeton pectinatus*	R
028	Small Pondweed	*Potamogeton pusillus*	O
028		*Potamogeton tenuissimus*	x
028	Wigeongrass	*Ruppia maritima*	C
029	Southern Naiad	*Najas guadalupensis*	C
032	Creeping Burhead	*Echinodorus cordifolius*	U
032	Upright Burhead	*Echinodorus rostratus*	R
032	Coastal Arrowhead	*Sagittaria falcata*	VC
032	Grassy Arrowhead	*Sagittaria graminea*	O
032	Broadleaf Arrowhead	*Sagittaria latifolia*	U
032	Hooded Arrowhead	*Sagittaria montevidensis*	U
032	Nipplebract Arrowhead	*Sagittaria papillosa*	x
032	Delta Arrowhead	*Sagittaria platyphylla*	C
034	Blyxa	*Blyxa aubertii*	x
034	Elodea	*Egeria densa*	U
034	Hydrilla	*Hydrilla verticillata*	O
034	American Frog's-bit	*Limnobium spongia*	C
034	Ducklettuce	*Ottelia alismoides*	O
034	Wildcelery	*Vallisneria americana*	O
036	Elliot Bentgrass	*Agrostis elliottiana*	x
036	Ticklegrass	*Agrostis hyemalis*	O
036	Carolina Foxtail	*Alopecurus carolinianus*	O
036	Bushy Bluestem	*Andropogon glomeratus*	O
036	Broomsedge	*Andropogon virginicus*	U
036	Purple Silkyscale	*Anthaenantia rufa*	U
036	Slimspike Threeawn	*Aristida longespica*	x
036	Oldfield Threeawn	*Aristida oligantha*	U

Fam#	Common Name	Scientific Name	Abn.
036	Fringed Arthraxon	*Arthraxon hispidus*	U
036	Giant Reed	*Arundo donax*	U
036	Common Oats	*Avena sativa*	U
036	Carpetgrass	*Axonopus affinis*	C
036	Big Carpetgrass	*Axonopus furcatus*	U
036	Awnless Bluestem	*Bothriochloa exaristata*	U
036	King Ranch Bluestem	*Bothriochloa ischaemum*	O
036	Silver Bluestem	*Bothriochloa saccharoides*	O
036	Broadleaf Signalgrass	*Brachiaria platyphylla*	O
036	Sprawling Panicum	*Brachiaria reptans*	R
036	Little Quakinggrass	*Briza minor*	O
036	Rescuegrass	*Bromus unioloides*	O
036	Southern Sandbur	*Cenchrus echinatus*	C
036	Coast Sandbur	*Cenchrus incertus*	C
036	Dune Sandbur	*Cenchrus tribuloides*	R
036	Longleaf Uniola	*Chasmanthium sessiliflorum*	U
036	Rhodesgrass	*Chloris gayana*	x
036	Pampasgrass	*Cortaderia selloana*	U
036	Bermudagrass	*Cynodon dactylon*	C
036	Durban Crowfootgrass	*Dactyloctenium aegyptium*	O
036	Needle Panicum	*Dichanthelium aciculare*	O
036	Woolly Panicum	*Dichanthelium acuminatum*	O
036	Variable Dichanthelium	*Dichanthelium commutatum*	O
036	Clute Panic	*Dichanthelium dichotomum*	O
036	Scribner Panicum	*Dichanthelium oligosanther*	O
036	Velvet Panicum	*Dichanthelium scoparium*	O
036	Roundseed Panicum	*Dichanthelium sphaerocarpon*	O
036	Southern Crabgrass	*Digitaria ciliaris*	x
036	Hairy Crabgrass	*Digitaria sanguinalis*	C
036	Seashore Saltgrass	*Distichlis spicata*	C
036	Junglerice	*Echinochloa colonum*	C
036	Barnyardgrass	*Echinochloa crusgalli*	O
036	Walter's Millet	*Echinochloa walteri*	O
036	Goosegrass	*Eleusine indica*	C
036	Virgina Wildrye	*Elymus virginicus*	O
036	Bahia Lovegrass	*Eragrostis bahiensis*	U
036	Gummy Lovegrass	*Eragrostis curtipedicellata*	R
036	Elliott Lovegrass	*Eragrostis elliottii*	U
036	Teal Lovegrass	*Eragrostis hypnoides*	U
036	Carolina Lovegrass	*Eragrostis pectinacea*	U
036	Red Lovegrass	*Eragrostis secundiflora*	C
036	Purple Lovegrass	*Eragrostis spectabilis*	O
036	Centipedegrass	*Eremochloa ophiuroides*	U
036	Sugarcane Plumegrass	*Erianthus giganteus*	U
036	Prairie Cupgrass	*Eriochloa contracta*	U
036	Louisiana Cupgrass	*Eriochloa punctata*	O
036	Stiffleaf Chloris	*Eustachys petraea*	C
036	Meadow Fescue	*Festuca pratensis*	U
036	African Jointgrass	*Hemarthria altissima*	x
036	Little Barley	*Hordeum pusillum*	O
036	Watergrass	*Hydrochloa caroliniensis*	O
036	Clubhead Cutgrass	*Leersia hexandra*	O
036	Rice Cutgrass	*Leersia oryzoides*	x
036	Whitegrass	*Leersia virginica*	O

Fam#	Common Name	Scientific Name	Abn.
036	Bearded Sprangletop	*Leptochloa fascicularis*	O
036	Neally Sprangletop	*Leptochloa nealleyi*	U
036	Amazon Sprangletop	*Leptochloa panicoides*	U
036	Mexican Sprangletop	*Leptochloa uninervia*	O
036	Ozarkgrass	*Limnodea arkansana*	O
036	Perennial Ryegrass	*Lolium perenne*	C
036		*Manisuris exaltata*	U
036	Shoregrass	*Monanthochloa littoralis*	U
036	Thintail	*Monerma cylindrica*	R
036	Hairawn Muhly	*Muhlenbergia capillaris*	U
036	Nimblewill	*Muhlenbergia schreberi*	O
036	Common Basketgrass	*Oplismenus hirtellus*	O
036	Rice	*Oryza sative*	O
036	Bitter Panicum	*Panicum amarulum*	O
036	Beaked Panicum	*Panicum anceps*	O
036	Witchgrass	*Panicum capillare*	U
036		*Panicum dichatum*	O
036	Fall Panicum	*Panicum dichotomiflorum*	O
036	Paille Fine	*Panicum hemitomon*	C
036		*Panicum ramosum*	U
036	Torpedograss	*Panicum repens*	C
036	Redtop Panicum	*Panicum rigidulum*	O
036	Switchgrass	*Panicum virgatum*	O
036	Sicklegrass	*Parapholis incurva*	R
036	Water Panicum	*Paspalidium geminatum*	U
036	Combs Paspalum	*Paspalum almum*	U
036	Fringeleaf Paspalum	*Paspalum ciliatifolium*	U
036	Dallasgrass	*Paspalum dilatatum*	O
036	Mudbank Paspalum	*Paspalum dissectum*	x
036	Knotgrass	*Paspalum distichum*	O
036	Florida Paspalum	*Paspalum floridanum*	O
036	Water Paspalum	*Paspalum hydropilum*	O
036	Field Paspalum	*Paspalum laeve*	x
036	Rustyseed Paspalum	*Paspalum langei*	O
036	Longtom	*Paspalum lividum*	C
036	Mat Paspalum	*Paspalum minus*	U
036	Gulfdune Paspalum	*Paspalum monostachyum*	x
036	Bahiagrass	*Paspalum notatum*	O
036	Brownseed Paspalum	*Paspalum plicatulum*	C
036	Early Paspalum	*Paspalum pracox*	x
036	Fringeleaf Paspalum	*Paspalum setaceum*	O
036	Sand Paspalum	*Paspalum stramineum*	U
036	Vaseygrass	*Paspalum urvillei*	C
036	Seashore Paspalum	*Paspalum vaginatum*	C
036	Pearl Millet	*Pennisetum typhoides*	x
036	Timothy Canarygrass	*Phalaris angusta*	O
036	Carolina Canarygrass	*Phalaris caroliniana*	O
036	Savannah Panic	*Phanopyrum gymnocarpon*	U
036	Common Reed	*Phragmites australis*	C
036		*Phyllostachys aurea*	U
036	Annual Bluegrass	*Poa annua*	C
036	Rabbitfootgrass	*Polypogon monspeliensis*	C
036	American Cupscale	*Sacciolepis striata*	C
036	Brown Beardgrass	*Schizachyrium scoparium*	O

Fam#	Common Name	Scientific Name	Abn.
036	Slender Bluestem	*Schizachyrium tenerum*	U
036	Knotroot Bristlegrass	*Setaria geniculata*	C
036	Giant Bristlegrass	*Setaria magna*	O
036		*Setaria pallide-fusca*	U
036	Indiangrass	*Sorghastrum avenaceum*	U
036		*Sorghum almum*	U
036	Sorghum	*Sorghum bicolor*	U
036	Johnsongrass	*Sorghum halapense*	O
036	Smooth Cordgrass	*Spartina alterniflora*	O
036	Big Cordgrass	*Spartina cynosuroides*	C
036	Marshhay Cordgrass	*Spartina patens*	C
036	Gulf Cordgrass	*Spartina spartinae*	C
036	Prairie Wedgescale	*Sphenopholis obtusa*	C
036	Tall Dropseed	*Sporobolus asper*	x
036	Smutgrass	*Sporobolus indicus*	C
036	Whorled Dropseed	*Sporobolus pyramidatus*	U
036	Seashore Dropseed	*Sporobolus virginicus*	O
036	Gaping Panicum	*Steinchisma hians*	C
036	St. Augustinegrass	*Stenotaphrum secundatum*	C
036	Texas Needlegrass	*Stipa leucotricha*	R
036	Purpletop	*Tridens flavus*	U
036	Longspike Tridens	*Tridens strictus*	O
036	Eastern Gammagrass	*Tripsacum dactyloides*	O
036	Seaoats	*Uniola paniculata*	R
036	Sixweeks Fescue	*Vulpia octoflora*	O
036	Giant Cutgrass	*Zizaniopsis miliacea*	C
037	Greenish-white Sedge	*Carex albolutescens*	C
037	Atlantic Sedge	*Carex atlantica*	U
037	Carolina Sedge	*Carex caroliniana*	U
037	Woodbank Sedge	*Carex cephalophora*	O
037	Cherokee Sedge	*Carex cherokeensis*	U
037	Blue Sedge	*Carex complanata*	O
037	Crowfoot Sedge	*Carex crus-corvi*	U
037	Fescue Sedge	*Carex festucacea*	O
037	Thinfruit Sedge	*Carex flaccosperma*	O
037	Frank's Sedge	*Carex frankii*	O
037	Pale Sedge	*Carex glaucescens*	O
037	Meadow Sedge	*Carex granularis*	U
037	Thinscale Sedge	*Carex hyalinolepis*	U
037	Bristlestalk Sedge	*Carex leptalea*	x
037	Louisiana Sedge	*Carex louisianica*	U
037	Hop Sedge	*Carex lupulina*	U
037	Cedar Sedge	*Carex reniformis*	C
037	Reflexed Sedge	*Carex retroflexa*	O
037	Bristlebract Sedge	*Carex tribuloides*	U
037	Warty Sedge	*Carex verrucosa*	x
037	Fox Sedge	*Carex vulpinoidea*	O
037	Jamaica Sawgrass	*Cladium jamaicensis*	C
037	Taperleaf Flatsedge	*Cyperus acuminatus*	O
037	Jointed Flatsedge	*Cyperus articulatus*	C
037	Shortleaved Flatsedge	*Cyperus brevifolius*	O
037	Poorland Flatsedge	*Cyperus compressus*	O
037		*Cyperus digitatus*	O
037	Sticky Flatsedge	*Cyperus elegans*	O

Fam#	Common Name	Scientific Name	Abn.
037	Redroot Flatsedge	*Cyperus erythrorhizos*	C
037	Chufa	*Cyperus esculentus*	C
037	Nerved Flatsedge	*Cyperus filicimus*	U
037	Baldwin Flatsedge	*Cyperus globulosus*	C
037	Sheathed Flatsedge	*Cyperus haspan*	O
037	Southcentral Flatsedge	*Cyperus hermaphroditus*	O
037		*Cyperus huarmensis*	R
037	Ricefield Flatsedge	*Cyperus iria*	C
037		*Cyperus ochraceus*	U
037	Fragrant Flatsedge	*Cyperus odoratus*	C
037	Globe Flatsedge	*Cyperus ovularis*	C
037	Sharpscale Flatsedge	*Cyperus oxylepis*	C
037	Manyspiked Flatsedge	*Cyperus polystachyos*	C
037	Green Flatsedge	*Cyperus pseudovegetus*	C
037	Nutgrass	*Cyperus rotundus*	C
037	Strawcolored Nutsedge	*Cyperus strigosus*	C
037	Thinleaved Flatsedge	*Cyperus tenuifolius*	U
037	Green Flatsedge	*Cyperus virens*	C
037	Starrush Whitetop-Sedge	*Dichromena colorata*	C
037	Sandswamp Whitetop-Sedge	*Dichromena latifolia*	U
037	Needle Spikesedge	*Eleocharis acicularis*	O
037	Saltmarsh Spikesedge	*Eleocharis albida*	C
037	Purple Spikesedge	*Eleocharis atropurpea*	x
037	Baldwin's Spikesedge	*Eleocharis baldwinii*	U
037	Gulfcoast Spikesedge	*Eleocharis cellulosa*	U
037	Water Spikesedge	*Eleocharis elongata*	U
037	Northern Jointed Spikesedge	*Eleocharis equisetoides*	O
037	Crowned Spikesedge	*Eleocharis fallax*	U
037	Yellow Spikesedge	*Eleocharis flavascens*	U
037	Capitate Spikesedge	*Eleocharis geniculata*	x
037	Creeping Spikesedge	*Eleocharis macrostachya*	U
037	Torrey's Spikesedge	*Eleocharis microcarpa*	U
037	Mountain Spikesedge	*Eleocharis montana*	O
037	Sand Spikesedge	*Eleocharis montevidensis*	C
037	Blunt Spikesedge	*Eleocharis obtusa*	C
037	Bright-green Spikesedge	*Eleocharis olivacea*	O
037	Dwarf Spikesedge	*Eleocharis parvula*	O
037	Squarestem Spikesedge	*Eleocharis quadrangulata*	C
037	Weak Fimbry	*Fimbristylis annua*	U
037	Slender Fimbry	*Fimbristylis autumnalis*	U
037	Hairy Fimbristylis	*Fimbristylis caroliniana*	U
037	Corm Fimbry	*Fimbristylis castanea*	C
037	Twoleaf Fimbristylis	*Fimbristylis dichotoma*	O
037	Globe Fimbry	*Fimbristylis miliacea*	O
037	Hairy Fimbry	*Fimbristylis puberula*	C
037		*Fimbristylis spadicea*	x
037		*Fimbristylis tomentosa*	O
037	Saltmarsh Umbrellasedge	*Fuirena breviseta*	U
037	Umbrellagrass	*Fuirena squarrosa*	x
037	Shortbeak Baldrush	*Psilocarya nitens*	O
037	Baldwin's Beakrush	*Rhynchospora baldwinii*	U
037	Falling Beakrush	*Rhynchospora caduca*	C
037	Horned Beakrush	*Rhynchospora corniculata*	O
037	Elliott's Beakrush	*Rhynchospora elliottii*	O

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037	Fasciculate Beakrush	*Rhynchospora fascicularis*	U
037	Grasslike Beakrush	*Rhynchospora globularis*	C
037	Clustered Beakrush	*Rhynchospora glomerata*	U
037	Nodding Beakrush	*Rhynchospora inexpansa*	O
037	Tall Beakrush	*Rhynchospora macrostachya*	x
037	Littleseed Beakrush	*Rhynchospora microcarpa*	O
037	Millet Beakrush	*Rhynchospora miliacea*	x
037		*Rhynchospora perplexa*	O
037	Thread Beakrush	*Rhynchospora rariflora*	U
037	Hardstem Bulrush	*Scirpus acutus*	x
037	American Bulrush	*Scirpus americanus*	O
037	California Bulrush	*Scirpus californicus*	C
037	Swamp Bulrush	*Scirpus etuberculatus*	x
037	Keeled Bulrush	*Scirpus koilolepsis*	C
037	Salt-marsh Bulrush	*Scirpus maritimus*	C
037	Olney Bulrush	*Scirpus olneyi*	O
037	Saltmarsh Bulrush	*Scirpus robustus*	R
037	Softstem Bulrush	*Scirpus validus*	x
037		*Websteria submersa*	U
038	Dwarf Palmetto	*Sabal minor*	C
040	Taro	*Colocasia antiquorum*	O
040	Goldenclub	*Orontium aquaticum*	C
040	Arrow-Arum	*Peltandra virginica*	C
040	Waterlettuce	*Pistia stratiotes*	O
041	Lesser Duckweed	*Lemna minor*	C
041	Minute Duckweed	*Lemna persusilla*	O
041	Pale Duckweed	*Lemna valdiviana*	U
041	Common Ducksmeat	*Spirodela polyrhiza*	O
041		*Spirodela punctata*	U
041	Florida Mudmidget	*Wolffiella floridana*	O
041	Tongue Mudmidget	*Wolffiella lingulata*	x
046	Southern Yellow-eye-grass	*Xyris difformis*	x
046	Irisleaf Yellow-eye-grass	*Xyris iridifolia*	O
046		*Xyris jupicai*	O
049	Small Ballmoss	*Tillandsia recurva*	R
049	Spanishmoss	*Tillandsia usneoides*	C
050		*Commelina caroliniana*	U
050	Spreading Dayflower	*Commelina diffusa*	O
050	Narrowleaf Dayflower	*Commelina erecta*	C
050		*Rhoeo spathacea*	U
050	Hairystem Spiderwort	*Tradescantia hirsutiflora*	O
050	Prairie Spiderwort	*Tradescantia occidentalis*	U
050	Ohio Spiderwort	*Tradescantia ohioensis*	U
051	Waterhyacinth	*Eichhornia crassipes*	C
051	Longleaf Mudplantain	*Heteranthera limosa*	O
051	Pickerelweed	*Pontederia cordata*	C
051	Lance Pickerelweed	*Pontederia cordata lanceolata*	O
051	Waterstargrass	*Zosterella dubia*	x
053	Tapertip Rush	*Juncus acuminatus*	C
053		*Juncus biflorus*	C
053	Short-fruited Rush	*Juncus brachycarpus*	C
053	Toad Rush	*Juncus bufonius*	C
053	Forked Rush	*Juncus dichotomus*	C
053	Diffuse Rush	*Juncus diffusissmus*	U

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053	Soft Rush	*Juncus effusus*	O
053	Bog Rush	*Juncus elliottii*	U
053	Inland Rush	*Juncus interior*	O
053	Shore Rush	*Juncus marginatus*	U
053	Stout Rush	*Juncus nodatus*	C
053	Manyheaded Rush	*Juncus polycephalus*	x
053	Creeping Rush	*Juncus repens*	U
053	Black Needlerush	*Juncus roemerianus*	O
053	Slender Rush	*Juncus tenuis*	C
053	Torrey Rush	*Juncus torreyi*	U
053	Roundhead Rush	*Juncus validus*	U
055	False Garlic	*Allium bivalve*	C
055	Canada Garlic	*Allium canadense*	O
055	Tawny Daylily	*Hemerocallis fulva*	U
055	Saw Greenbrier	*Smilax bona-nox*	C
055	Cat Greenbrier	*Smilax glauca*	U
055	Bristly Greenbrier	*Smilax hispida*	O
055	Small's Greenbrier	*Smilax smallii*	O
055	Aloe Yucca	*Yucca aloefolia*	O
057	Swamp Lily	*Crinum americanum*	O
057		*Habranthus tubispathus*	O
057	Carolina Spiderlily	*Hymenocallis caroliniana*	O
057	Eula Spiderlily	*Hymenocallis eulae*	x
057		*Hymenocallis liriosome*	x
057	Bristleseed Goldstar	*Hypoxis micrantha*	O
057		*Narcissus tazetta*	O
057	Autumn Zephyrlily	*Zepranthes canida*	R
061	Herbertia	*Alophia drummondii*	U
061	Lamance Iris	*Iris brevicaulis*	x
061	Giantblue Iris	*Iris giganticaerulea*	x
061	Yellow Iris	*Iris pseudacorus*	U
061	Southern Blue-Flag	*Iris virginica*	O
061	Stout Blue-eye-grass	*Sisyrinchium angustifolium*	U
061	Eastern Blue-eye-grass	*Sisyrinchium atlanticum*	O
061	Yellow Blue-eye-grass	*Sisyrinchium exile*	O
061	Pale Blue-eye-grass	*Sisyrinchium langloisii*	O
061	Least Blue-eye-grass	*Sisyrinchium minus*	U
061	Annual Blue-eye-grass	*Sisyrinchium rosulatum*	O
061	Spearbract Blue-eye-grass	*Sisyrinchium sagittiferum*	C
062	Common Banana	*Musa x paradisiaca*	R
064	Golden Canna	*Canna flaccida*	O
064	Common Garden Canna	*Canna generalis*	O
064	Louisiana Canna	*Canna glauca*	O
064	Indian Canna	*Canna indica*	x
065	Powdered Thalia	*Thalia dealbata*	U
067	Waterspider Orchid	*Habenaria repens*	O
067	Grassleaf Ladies'-tresses	*Spiranthes preacox*	U
067	Spring Ladies'-tresses	*Spiranthes vernalis*	O
069	Lizard's-tail	*Saururus cernuus*	O
073	White Poplar	*Populus alba*	U
073	Eastern Cottonwood	*Populus deltoides*	U
073	Weeping Willow	*Salix babylonica*	E
073	Black Willow	*Salix nigra*	C
074	Southern Waxmyrtle	*Myrica cerifera*	O

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077	Bitter Pecan	*Carya aquatica*	O
077	Common Pecan	*Carya illinoiensis*	O
077	Black Walnut	*Juglans nigra*	R
079	Cherrybark Oak	*Quercus falcata leucophylla*	R
079	Cherrybark Oak	*Quercus falcata pagodaefolia*	R
079	Laurel Oak	*Quercus laurifolia*	O
079	Overcup Oak	*Quercus lyrata*	U
079	Swamp Chestnut Oak	*Quercus michauxii*	R
079	Water Oak	*Quercus nigra*	O
079	Nuttall's Oak	*Quercus nuttallii*	R
079	Willow Oak	*Quercus phellos*	R
079	Delta Post Oak	*Quercus stellata paludosa*	R
079	Live Oak	*Quercus virginiana*	C
080	Sugarberry	*Celtis laevigata*	C
080	Hackberry	*Celtis reticulata*	x
080	Water Elm	*Planera aquatica*	R
080	Winged Elm	*Ulmus alata*	R
080	American Elm	*Ulmus americana*	U
080	Chinese Elm	*Ulmus parvifolia*	E
080	Slippery Elm	*Ulmus rubra*	O
081	Paper Mulberry	*Broussonetia paprifera*	U
081	Common Fig	*Ficus carica*	E
081	Osage Orange	*Maclura pomifera*	O
081	White Mulberry	*Morus alba*	O
081	Black Mulberry	*Morus nigra*	E
081	Red Mulberry	*Morus rubra*	O
082	False Nettle	*Boehmeria cylindrica*	O
082	Pennsylvania Pellitory	*Parietaria pensylvanica*	C
082	Stinging Nettle	*Urtica chamaedryoides*	O
094	Buckwheat Vine	*Brunnichia cirrhosa*	O
094	Prostrate Knotweed	*Polygonum aviculare*	O
094	Pink Smartweed	*Polygonum bicorne*	U
094		*Polygonum brasiliense*	x
094	Cepitose Knotweed	*Polygonum cespitosum*	U
094	Stout Smartweed	*Polygonum densiflorum*	O
094	Mild Water Pepper	*Polygonum hydropiperoides*	C
094	Willow Weed	*Polygonum lapthifolium*	C
094	Water Smartweed	*Polygonum punctatum*	C
094	Bristly Smartweed	*Polygonum setaceum*	O
094	Jumpseed	*Polygonum virginianum*	U
094	Amamastla	*Rumex chrysocarpus*	C
094	Curly Dock	*Rumex crispus*	C
094	Mexican Dock	*Rumex mexicanus*	U
094		*Rumex obovatus*	U
094		*Rumex paraguayensis*	O
094	Fiddle Dock	*Rumex pulcher*	C
094	Swamp Dock	*Rumex verticillatus*	C
095	Seabeach Orach	*Atriplex arenaria*	C
095	Fathen Saltbush	*Atriplex patula*	O
095	Lamb's-Quarters	*Chenopodium album*	O
095	Wormseed	*Chenopodium ambrosioides*	C
095	Goosefoot	*Chenopodium berlandieri*	C
095	Bigelow Glasswort	*Salicornia bigelovii*	C
095	Glasswort	*Salicornia europaea*	R

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095	Woody Glasswort	*Salicornia virginica*	O
095	Annual Seepweed	*Suaeda linearia*	C
097	Alligatorweed	*Alternanthera philoxeroides*	C
097	Chaff-flower	*Alternathera paronychioides*	U
097	Amaranth Tumbleweed	*Amaranthus albus*	R
097	Gulf Coast Water-hemp	*Amaranthus australis*	C
097	Seaside Amaranth	*Amaranthus greggii*	C
097	Pigweed	*Amaranthus hybridis*	U
097	Redroot Pigweed	*Amaranthus retroflexus*	U
097	Nuttall's Water-hemp	*Amaranthus rudis*	O
097	Sticky Careless	*Amaranthus spinosus*	C
097	Pigweed	*Amaranthus viridis*	C
097	Bloodleaf	*Iresine rhizomatosa*	U
097	Tidestroemia	*Tidestroemia lanuginosa*	R
098	Scarlet Spiderling	*Boerhaavia diffusa*	O
098	Upright Spiderling	*Boerhaavia erecta*	O
098	Common Four-O'Clock	*Mirabilis jalapa*	O
099	Maritime Saltwort	*Batis maritima*	C
101	Poke	*Phytolacca americana*	O
101	Pigeon-Berry	*Rivina humilis*	O
102	Carpetweed	*Mollugo verticillata*	O
102	Seaside Purslane	*Sesuvium maritimum*	C
102	Coast Purslane	*Sesuvium portulacastrum*	O
103	Spring Beauty	*Claytonia virginica*	U
103	Common Purslane	*Portulaca oleracea*	O
103	Hairy Purslane	*Portulaca pilosa*	O
105	Sandwort	*Arenaria seryllifoloa*	U
105	Mouse-ear Chickweed	*Cerastium glomeratum*	C
105	Trailing Pearlwort	*Sagina decumbens*	C
105	Sleepy Catch-fly	*Silene antirrhina*	O
105	Bristleseed Sand-Spurry	*Spergularia echinosperma*	O
105	Marine Sand-Spurry	*Spergularia mariana*	O
105	Common Chickweed	*Stellaria media*	C
105	Chickweed	*Stellaria prostrata*	U
106	Watershield	*Brasenia schreberi*	C
106	Carolina Fanwort	*Cabomba caroliniana*	C
106	American Lotus	*Nelumbo lutea*	C
106	Spadderdock	*Nuphar luteum*	O
106	Blue Waterlily	*Nymphaea elegans*	O
106	White Waterlily	*Nymphaea odorata*	C
107	Coontail	*Ceratophyllum demersum*	C
107	Pimpled Hornwort	*Ceratophyllum muricatum*	O
109	Windflower	*Anemone caroliniana*	U
109	Blue Jasmine	*Clematis crispa*	O
109	Sweet Autumn Clematis	*Clematis ternifolia*	U
109	Tiny Mousetail	*Myosurus minimus*	U
109	Spearwort	*Ranunculus laxicaulis*	U
109	Roughseed Buttercup	*Ranunculus muricatus*	C
109	Sticktight Buttercup	*Ranunculus parviflorus*	O
109		*Ranunculus platensis*	U
109	Low Spearwort	*Ranunculus pusillus*	O
109	Hairy Buttercup	*Ranunculus sardous*	O
109	Celeryleaf Buttercup	*Ranunculus sceleratus*	C
109	Threelobed Buttercup	*Ranunculus trilobus*	O

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112	Red-berried Moonseed	*Cocculus carolinus*	O
113	Southern Magnolia	*Magnolia grandiflora*	U
121	Camphor Tree	*Cinnamomum camphora*	O
121	Sassafras	*Sassafras albidum*	O
123	White Prickly Poppy	*Argemone albiflora*	x
123	Scrambled Eggs	*Corydalis micrantha*	O
124	Leaf Mustard	*Brassica juncea*	E
124	Turnip	*Brassica rapa*	E
124	American Sea-Rockets	*Cakile edentula*	O
124	Gulf Sea-Rockets	*Cakile geniculata*	U
124	Hairy Bitter Cress	*Cardamine hirsuta*	O
124	Small-flowered Bitter Cress	*Cardamine parviflora*	C
124	Pennsylvania Bitter Cress	*Cardamine pensylvanica*	C
124	Swine Cress	*Coronopus didymus*	O
124	Whitlow-Grass	*Draba brachycarpa*	U
124	Pepperwort	*Lepidium ruderale*	U
124	Virginia Pepperweed	*Lepidium virginicum*	C
124	Sessile-flowered Yellow Cress	*Rorippa sessiliflora*	O
124	Marsh Cress	*Rorippa teres*	C
124	Mustard	*Sinapis arvensis*	O
124	Hedge-Mustard	*Sisymbrium officinale*	U
131	Dwarf Sundew	*Drosera brevifolia*	U
134	Common Pigmy-Weed	*Crassula aquatica*	U
136	Little People	*Lepurapetalon spathulatum*	R
136	Ditch Stonecrop	*Penthorum sedoides*	x
142	Sweetgum	*Liquidambar styracifera*	O
143	American Sycamore	*Platanus occidentalis*	O
145	Green Hawthorn	*Crataegus viridis*	C
145	Loquat	*Eriobotyra japonica*	E
145	White Avens	*Geum canadense*	U
145	Chickasaw Plum	*Prunus angustifolia*	U
145	Cherry Laurel	*Prunus caroliniana*	U
145	Big-tree Plum	*Prunus mexicana*	U
145	Peach	*Prunus persica*	U
145	Wild Black Cherry	*Prunus serotina*	C
145	Firethorn	*Pyracantha coccinea*	E
145	Common Pear	*Pyrus communis*	E
145	Yeddo Hawthorn	*Raphiolepis umbellata*	E
145	McCartney Rose	*Rosa bracteata*	C
145	Cherokee Rose	*Rosa laevigata*	U
145	Multiflora Rose	*Rosa multiflora*	U
145	Champney Rose	*Rosa noisettiana*	E
145	Louisiana Blackberry	*Rubus louisianus*	O
145	Southern Dewberry	*Rubus trivialis*	O
147	Sweet Acacia	*Acacia smallii*	C
147	American Joint-Vetch	*Aeschynomene americana*	x
147	Joint Vetch	*Aeschynomene indica*	C
147	Mimosa	*Albizzia julibrissin*	E
147	False Monkeywort	*Alysicarpus vaginalis*	R
147	Dull-leaf Indigo	*Amorpha fruticosa*	O
147	American Potatobean	*Apios americana*	U
147	Slimpod Milkvetch	*Astragalus leptocarpus*	x
147	Nuttal Milkvetch	*Astragalus nuttalianus*	O
147	Cream Wild Indigo	*Baptisia bracteata glabrescens*	U

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147	Plains Wild Indigo	*Baptisia bracteata laevicaulis*	U
147	Round Wild Indigo	*Baptisia sphaerocarpa*	O
147	Ringworm Senna	*Cassia alata*	U
147	Partridge Pea	*Cassia fasciculata*	O
147		*Cassia fasciculata puberula*	O
147	Maryland Senna	*Cassia marilandica*	O
147	Sicklepod	*Cassia obtusifolia*	O
147	Coffee Senna	*Cassia occidentalis*	O
147	Butterfly Pea	*Centrosema virginianum*	C
147	Redbud	*Cercis canadensis*	E
147	Prairie Clover	*Dalea emarginatum*	U
147	Bunchflower	*Desmanthes brevipes*	R
147	Illinois Bunchflower	*Desmanthes illinoensis*	C
147	Canada Tickclover	*Desmodium canescens*	U
147	Littleleaf Tickclover	*Desmodium ciliare*	O
147	Dillen Tickclover	*Desmodium dillenii*	O
147	Cherokee Tickclover	*Desmodium tortuosum*	O
147	Coral-Bean	*Erythrina herbacea*	O
147	Milkpea	*Galactia macreei*	O
147	Downy Milkpea	*Galactia volubilis*	O
147	Honey Locust	*Gleditsia tricanthos*	O
147	Anil Indigo	*Indigofera suffruticosa*	O
147	Australian Pea	*Lathyrus aphaca*	E
147	Japanese Bush Clover	*Lespedeza striata*	O
147	Black Medic	*Medicago lupulina*	C
147	Bur Clover	*Medicago polymorpha*	C
147	Sour Clover	*Melilotus indica*	C
147	Yellow Sweet Clover	*Melilotus officinalis*	x
147	Herbaceous Mimosa	*Mimosa strigillosa*	O
147	Tropical Neptunia	*Neptunia pubescens*	O
147	Jerusalem Thorn	*Parkinsonia aculeata*	O
147	Scurf-Pea	*Psoralea rhombifolia*	O
147	Snoutbean	*Rhynchosia minima*	O
147	Black Locust	*Robinia pseudo-acacia*	U
147	Sensitive Briar	*Schrankia hystericina*	O
147	Sensitive Briar	*Schrankia microphylla*	x
147	Drummond's Rattlebush	*Sesbania drummondii*	C
147	Colorado River-Hemp	*Sesbania exalta*	O
147	Bladderpod	*Sesbania vesicarium*	O
147	Trailing Wildbean	*Strophostyles helvola*	C
147	Slick-seed Bean	*Strophostyles leiosperma*	C
147	Pink Wildbean	*Strophostyles umbellata*	x
147	Pencil Flower	*Stylosanthes biflora*	U
147	Hoary Pea	*Tephrosia onobrychoides*	U
147	Big Hop Clover	*Trifolium campestre*	U
147	Carolina Clover	*Trifolium carolinianum*	U
147	Red Clover	*Trifolium pratense*	U
147	Dutch White Clover	*Trifolium repens*	C
147	Persian Clover	*Trifolium resupinatum*	O
147	Deerpea Vetch	*Vicia ludoviciana*	C
147	Deerpea	*Vigna luteola*	C
147	Kentucky Wisteria	*Wisteria macrostachya*	O
149	Wild Geranium	*Geranium sphaerospermum*	C
150	Creeping Lady Sorrel	*Oxalis corniculata*	O

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150	Yellow Lady Sorrel	*Oxalis dillenii*	C
150		*Oxalis rubra*	O
150	Yellow Wood Sorrel	*Oxalis stricta*	x
150	Violet Wood Sorrel	*Oxalis violacea*	U
157	Satsuma Orange	*Citrus reticulata*	E
157	Trifoliate Orange	*Poncirus trifoliata*	U
157	Prickly Ash	*Zanthoxylum clava-herculis*	C
160	Chinaberry	*Melia azedarach*	O
165	Pink Milkwort	*Polygala incarnata*	U
165	Swamp Milkwort	*Polygala leptocaulis*	O
165	Maryland Milkwort	*Polygala mariana*	O
165	Whorled Milkwort	*Polygala verticillata*	U
167	Slender Copperleaf	*Acalypha gracilens*	O
167	Hophornbeam Copperleaf	*Acalypha ostryaefolia*	C
167	Caperonia	*Caperonia palustris*	O
167	Goatweed	*Croton capitatus*	C
167	Tropic Croton	*Croton glandulosus*	O
167	Prairie-Tea	*Croton monanthogynus*	O
167	Beach-Tea	*Croton punctatus*	C
167		*Euphorbia ammannioides*	R
167	Heartleaf Euphorbia	*Euphorbia cordifolia*	O
167		*Euphorbia dentata*	O
167		*Euphorbia glyptosperma*	C
167		*Euphorbia heterophylla*	O
167	Spotted Spurge	*Euphorbia maculata*	C
167	Large Spotted Spurge	*Euphorbia nutans*	O
167		*Euphorbia prostrata*	U
167		*Euphorbia serpens*	C
167		*Euphorbia spathulata*	O
167		*Phyllanthus caroliniensis*	U
167		*Phyllanthus urinaria*	O
167	Chinese Tallow Tree	*Sapium sebiferum*	C
167	Queen's-Delight	*Stillingia sylvatica*	O
168	Larger Water-Starwort	*Callitriche heterophylla*	O
168	Mat Water-Starwort	*Callitriche peploides*	O
169	Small-leaf Boxwood	*Buxus microphylla*	E
173	Winged Sumac	*Rhus copallina*	U
173	Smooth Sumac	*Rhus glabra*	U
173	Poison Ivy	*Toxicodendron radicans*	O
177	Deciduous Holly	*Ilex decidua*	C
177	American Holly	*Ilex opaca*	O
177	Yaupon	*Ilex vomitoria*	O
183	Drummond Red Maple	*Acer rubrum drummondii*	O
185	Balloon-vine Heartseed	*Cardiospermum halicacabum*	O
185	Golden Rain-Tree	*Koelreuteria paniculata*	R
185	Western Soapberry	*Sapindus saponaria drummondii*	O
189	Rattanvine	*Berchemia scandens*	O
189	Carolina Buckthorn	*Rhamnus caroliniana*	O
190	Peppervine	*Ampelopsis arborea*	O
190	Raccoon Grape	*Ampelopsis cordata*	U
190	Ivy Treebine	*Cissus incisa*	C
190	Virginia Creeper	*Parthenocissus quinquefolia*	O
190	Summer Grape	*Vitis aestivalis*	O
190	Pigeon Grape	*Vitis cinerea*	O

Fam#	Common Name	Scientific Name	Abn.
190	Mustang Grape	*Vitis mustangensis*	C
190	Muscadine	*Vitis rotundifolia*	U
194	Orinoco Jute	*Corchorus hirtus*	U
195	Rough Rose-Mallow	*Hibiscus aculeatus*	U
195	Large-flowered Rose-Mallow	*Hibiscus grandiflorus*	U
195	Halberd-leaved Rose-Mallow	*Hibiscus laevis*	U
195	Swamp Rose-Mallow	*Hibiscus moschuetos*	x
195	Wooly Rose-Mallow	*Hibiscus moschuetos lasiocarpus*	O
195	Virginia Saltmarsh-Mallow	*Kosteletzkya virginica*	C
195	Malva-De-Caballo	*Malachra capitata*	x
195	False Mallow	*Malvastrum coromandelianum*	C
195	Texas Mallow	*Malviscus arboreus*	E
195	Carolina Bristly-Mallow	*Modiola caroliniana*	C
195	Showy Sida	*Sida lindheimeri*	O
195	Broomjute Sida	*Sida rhombifolia*	C
195	Prickly Teaweed	*Sida spinosa*	O
198	Chocolate Weed	*Melochia corchorifolia*	O
198	Broom-wood	*Melochia pyramidata*	R
207	St. Andrew's Cross	*Ascyrum hypericoides*	O
207	St. Peter's Wort	*Ascyrum stans*	U
207	Shrubby St. John's Wort	*Hypericum densiflorum*	O
207	Nits-and-Lice	*Hypericum drummondii*	O
207	Bedstraw St. John's Wort	*Hypericum galioides*	U
207	Clasping-leaved St. John's Wort	*Hypericum gymnanthum*	O
207	Dwarf St. John's Wort	*Hypericum mutilum*	x
207	Purple St. John's Wort	*Triadenum virginicum*	U
209		*Elatine triandra*	x
211	Salt Cedar	*Tamarix gallica*	O
213		*Lechea tenuifolia*	U
218	Stemless Blue Violet	*Viola esculenta*	x
218	Lance-leaved Violet	*Viola lanceolata*	R
218	Bayou Violet	*Viola langloisii*	U
223	Yellow Liliko'i	*Passiflora edulis*	C
230	Prickly Pear	*Opunthia vulgaris*	U
230	Texas Prickly Pear	*Opuntia lindheimeri lehmanni*	O
230	Prickly Pear	*Opuntia stricta*	U
236	Purple Ammannia	*Ammannia coccinea*	O
236	Tarweed Cuphea	*Cuphea carthagensis*	O
236	Water-Willow	*Decodon verticillatus*	O
236	Crape Myrtle	*Lagerstroemia indica*	E
236	Winged Lythrum	*Lythrum alatum*	C
236	Linear-leaved Loosestrife	*Lythrum lineare*	x
236	Toothcup	*Rotala ramosior*	x
244	Maryland Meadow-Beauty	*Rhexia mariana*	O
245	White Gaura	*Gaura lindheimeri*	C
245	Bigflower Gaura	*Gaura longiflora*	C
245	Velvetleaf Gaura	*Gaura parviflora*	C
245	Primrose-Willow	*Ludwigia decurrens*	O
245	Cylindric-fruited Water Primrose	*Ludwigia glandulosa*	O
245	Anglestem Water-Primrose	*Ludwigia leptocarpa*	O
245	Narrowleaf Water Primrose	*Ludwigia linearis*	O
245	Shrubby Water-Primrose	*Ludwigia octovalvis*	x
245	Marsh Purslane	*Ludwigia palustris*	C
245	Perennial Water-Primrose	*Ludwigia peploides*	C

Fam#	Common Name	Scientific Name	Abn.
245	Hairy Ludwigia	*Ludwigia pilosa*	x
245	Globe Ludwigia	*Ludwigia sphaerocarpa*	x
245	Uraguay Water-Primrose	*Ludwigia uraguayensis*	C
245	Beach Evening Primrose	*Oenothera drummondii*	C
245		*Oenothera grandis*	x
245	Cutleaf Evening Primrose	*Oenothera laciniata*	C
245	Showy Evening Primrose	*Oenothera speciosa*	O
247	Parrotfeather	*Myriophyllum brasiliense*	O
247	Variable Water-Milfoil	*Myriophyllum heterophyllum*	O
247	Pinnate Water-Milfoil	*Myriophyllum pinnatum*	O
247	Eurasian Water-Milfoil	*Myriophyllum spicatum*	O
247	Marsh Mermaidweed	*Proserpinaca palustris*	U
251	Bowlesia	*Bowlesia incana*	O
251	Spadeleaf	*Centella asiatica*	C
251	Wild Chervil	*Chaerophyllum tainturieri*	C
251	Marsh Parsley	*Ciclospermum leptophyllum*	C
251	Spotted Water Hemlock	*Cicuta maculata*	C
251	Mexican Water Hemlock	*Cicuta mexicana*	R
251	Dwarf Wild Carrot	*Daucus pusillus*	U
251	Creeping Eryngo	*Eryngium prostratum*	C
251	Rattlesnakemaster	*Eryngium yuccifolium*	U
251	Large-leaf Pennywort	*Hydrocotyle bonariensis*	C
251	Floating Pennywort	*Hydrocotyle ranunculoides*	O
251	Umbrella Pennywort	*Hydrocotyle umbellata*	C
251	Whorled Pennywort	*Hydrocotyle verticillata*	O
251	Carolina Lilaeopsis	*Lilaeopsis attenuata*	R
251	Eastern Lilaeopsis	*Lilaeopsis chinensis*	x
251	Pinnate Cynosciadium	*Limnosciadium pinnatum*	O
251	Dog-sunshade	*Limnosciadium pumilum*	C
251	Parsley	*Petroselinum crispum*	E
251	Mock Bishop's-weed	*Ptilimnium capillaceum*	C
251	Nuttall Mock Bishop's-weed	*Ptilimnium nuttallii*	x
251	Black Snakeroot	*Sanicula canadensis*	O
251	Spiny Scale Seed	*Spermolepis echinata*	U
251	Aethusa-like Trepocarpus	*Trepocarpus aethusae*	O
252	Rough-leaf Dogwood	*Cornus drummondii*	O
252	Swamp Dogwood	*Cornus foemina*	O
252	Tupelogum	*Nyssa aquatica*	U
252	Blackgum	*Nyssa sylvatica*	U
256	Farkleberry	*Vaccinium arboreum*	U
261	Scarlet Pimpernel	*Anagallis arvensis*	O
261	Chaffweed	*Centunculus minimus*	O
261	Bractless Brookweed	*Samolus ebracteatus*	x
261	Water Pimpernel	*Samolus parviflorus*	O
262	Carolina Sea-Lavender	*Limonium carolinianum*	C
263	Gum Bumelia	*Bumelia lanuginosa*	C
263	Buckthorn Bumelia	*Bumila lycioides*	R
264	Persimmon	*Diospyros virginiana*	O
265	Two-winged Silverbell	*Halesia diptera*	?
265	Small Snowbell	*Styrax americana*	R
267	White Ash	*Fraxinus americana*	U
267	Green Ash	*Fraxinus pensylvanica*	U
267	Jasmine	*Jasminium ovalifolium*	E
267	California Privit	*Ligustrum ovalifolium*	U

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267	Chinese Privit	*Ligustrum sinense*	C
269	Lax Hornpod	*Cynoctonum mitreola*	O
269	Wand Hornpod	*Cynoctonum sessilifolium*	U
269	Yellow Jasmine	*Gelsemium sempervirens*	U
269	Juniperweed	*Polypremum procumbens*	O
270	Lady Bird's Centaury	*Centaurium texense*	O
270	Catch-fly Gentian	*Eustoma exaltatum*	C
270	Big Floating-Heart	*Nymphoides aquatica*	C
270	Prairie Rose-Gentain	*Sabatia campestris*	C
271	Blue-star	*Amsonia glaberrima*	O
271	Willow Amsonia	*Amsonia tabernaemontana*	O
271	Indian-Hemp Dogbane	*Apocynum cannabinum*	U
271	Oleander	*Nerium oleander*	E
271	Climbing Dogbane	*Trachelospermum difforme*	O
272	Pacific Milkweed	*Asclepias lanceolata*	U
272	Longleaf Milkweed	*Asclepias longifolia*	U
272	Savannah Milkweed	*Asclepias obvata*	O
272	Whorled Milkweed	*Asclepias verticillata*	O
272	Antelope-Horn	*Asclepias viridis*	C
272	Marsh Shallow-wort	*Cynanchum angustifolium*	O
272	Anglepod	*Matelea gonocarpa*	O
273	Hedge Bindweed	*Calystegia sepium*	C
273	Field Bindweed	*Convolvulus arvensis*	x
273		*Cuscuta campestris*	C
273		*Cuscuta compacta*	x
273	Lovevine	*Cuscuta cuspidata*	O
273		*Cuscuta glabrior*	x
273	Gonovius Dodder	*Cuscuta gronovii*	x
273	Showy Dodder	*Cuscuta indecora*	O
273	False Pennywort	*Dichondra carolinensis*	O
273	Evolvulus	*Evolvulus sericeus*	x
273	Red Morningglory	*Ipomocea coccinea*	U
273	Ivyleaf Morningglory	*Ipomoea hederacea*	U
273	Railroad Vine	*Ipomoea pes-caprae*	O
273	Common Morningglory	*Ipomoea purpurea*	U
273	Marsh Morningglory	*Ipomoea sagittata*	C
273	Beach Morningglory	*Ipomoea stolonifera*	C
273	Small-flowered Pink Morningglory	*Ipomoea trichocarpa*	C
273	Pitted Morningglory	*Ipomoea x leucantha*	O
273	Tie Vine	*Jacquemontia tamnifolia*	O
275	Hairy Waterleaf	*Hydrolea ovata*	U
275	Waterpod	*Hydrolea quadrivalvis*	x
275	Small-flowered Nemophila	*Nemophila aphylla*	U
275	Phacelia	*Phacelia hirsuta*	U
276	Seaside Heliotrope	*Heliotropium curvassicum*	C
276	Indian Heliotrope	*Heliotropium indicum*	O
276	Fourspike Heliotrope	*Heliotropium procumbens*	U
276	Gromwell	*Lithospermum incisum*	U
276	White Forget-Me-Not	*Myosotis macrosperma*	C
276	Hairy False Gromwell	*Onosmodium molle hispidissimum*	U
277	French Mulberry	*Callicarpa americana*	O
277	Glorybower	*Clerodendron bungei*	E
277	West Indian Lantana	*Lantana camara*	C
277		*Lantana urticoides*	U

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277	Northern Frog-fruit	*Phyla lanceolata*	R
277	Common Frog-fruit	*Phyla nodiflora*	C
277	Frog-fruit	*Phyla x intermedia*	C
277	South American Vervain	*Verbena bonariensis*	O
277	Brasilian Vervain	*Verbena brasiliensis*	C
277	Rose Vervain	*Verbena canadensis*	U
277	Texas Vervain	*Verbena halei*	C
277		*Verbena montevidensis*	U
277	Sandpaper Vervain	*Verbena scabra*	O
277	Gulf Vervain	*Verbena xutha*	O
277	Chaste-Tree	*Vitex agnus-castus*	E
278	Rough Pennyroyal	*Hedeoma hispidum*	U
278	Cluster Bushmint	*Hyptis alata*	O
278	Henbit	*Lamium amplexicaule*	O
278	Dead Nettle	*Lamium purpureum*	U
278	Lion's Ears	*Leonotis nepetaefolia*	U
278	Stalked Water-Hoarhound	*Lycopus rubellus*	U
278	Applemint	*Mentha rotundifolia*	x
278	Spearmint	*Mentha spicata*	U
278	Spotted Beebalm	*Monarda punctata*	C
278	Beefsteak Plant	*Perilla frutescens*	O
278	Correll's Dragonhead	*Physostegia correllii*	x
278	False Dragonhead	*Physostegia virginiana*	U
278	Self-Heal	*Prunella vulgaris*	U
278	White-leaved Mountain-Mint	*Pycnanthemum albescens*	U
278	Slender Mountain-Mint	*Pycnanthemum tenuifolium*	O
278	Blue Sage	*Salvia azurea*	O
278	Scarlet Sage	*Salvia coccinea*	O
278	Lyre-leaf Sage	*Salvia lyrata*	O
278	Skullcap	*Scutellaria drummondii*	O
278	Hyssop Skullcap	*Scutellaria integrifolia*	U
278	Heart-leaved Skullcap	*Scutellaria ovata*	U
278		*Scutellaria parvula*	O
278	Shade Betony	*Stachys agraria*	C
278	Chinese Artichoke	*Stachys floridana*	O
278	Smooth Hedge-Nettle	*Stachys tenuifolia*	O
278	Canada Germander	*Teucrium canadense*	C
278	Germander	*Teucrium cubense*	O
278	Forked Blue Curls	*Trichostema dichotomum*	U
280	Bird Pepper	*Capsicum annuum*	O
280	Carolina Wolf-Berry	*Lycium carolinianum*	C
280	Tomato	*Lycoperscon esculentum*	E
280	Seaside Petunia	*Petunia parviflora*	U
280	Cutleaf Ground-Cherry	*Physalis angulata*	C
280		*Physalis cordata*	U
280	Downy Ground-Cherry	*Physalis pubescens*	C
280	Prairie Ground-Cherry	*Physalis pumila*	O
280	Beach Ground-Cherry	*Physalis viscosa maritima*	x
280	Nightshade	*Solanum americanum*	C
280	Carolina Horsenettle	*Solanum carolinense*	O
280	Silver-leaf Nightshade	*Solanum elaeagnifolium*	U
280	Jerusalem-Cherry	*Solanum pseudocapsicum*	O
280	Jerusalem-Cherry	*Solanum pseudogracile*	x
281	Fascicled False-Foxglove	*Agalinis fasciculata*	O

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281	Prairie False-Foxglove	*Agalinis heterophylla*	U
281	Seaside Purple False-Foxglove	*Agalinis maritima*	R
281	Blue Water-Hyssop	*Bacopa caroliniana*	O
281	Coast Bacopa	*Bacopa monnieri*	C
281	Roundleaf Bacopa	*Bacopa rotundifolia*	O
281	Florida Bluehearts	*Buchera floridana*	O
281	Sticky Hedge-Hyssop	*Gratiola brevifolia*	R
281	Clammy Hedge-Hyssop	*Gratiola neglecta*	U
281	Hairy Hedge-Hyssop	*Gratiola pilosa*	U
281	Round-fruited Hedge-Hyssop	*Gratiola virginiana*	O
281	Limnophila	*Limnophila indica*	R
281	Blue Toad-Flax	*Linaria canadensis*	R
281	Texas Toad-Flax	*Linaria texana*	O
281	Linaria (int. between L. can. & L. tex.)		O
281	Clasping False Pimpernel	*Lindernia anagallidea*	U
281	Mazus	*Mazus pumilus*	O
281	Purple Mecardonia	*Mecardonia acuminata*	U
281	Sweet Broomwort	*Scoparia dulcis*	O
281	Common Mullein	*Verbascum thaspus*	O
281	Common Sppedwell	*Veronica arvensis*	O
281	Purslane Speedwell	*Veronica peregrina*	C
282	Trumpet Creeper	*Campsis radicans*	C
282	Catalpa	*Catalpa bignonioides*	U
288	Two-flowered Bladderwort	*Utricularia biflora*	O
288	Horned Bladderwort	*Utricularia cornuta*	x
288	Fibrous Bladderwort	*Utricularia fibriosa*	x
288	Giant Bladderwort	*Utricularia foliosa*	O
288	Humped Bladderwort	*Utricularia gibba*	O
288	Floating Bladderwort	*Utricularia inflata*	C
288	Common Bladderwort	*Utricularia macrorhiza*	O
288	Purple Bladderwort	*Utricularia purpurea*	U
288	Little Floating Bladderwort	*Utricularia radiata*	x
290	Lake Acanthus	*Hygrophila lacustris*	U
290	Lance-leaf Water-Willow	*Justicia ovata lanceolata*	U
290	Prairie Petunia	*Ruellia humilis*	C
293	Buckhorn	*Plantago aristata*	U
293	Variable-leaf Plantain	*Plantago heterophylla*	O
293	Common Plantain	*Plantago major*	O
293	Dwarf Plantain	*Plantago virginica*	O
294	Buttonbush	*Cephalanthus occidentalis*	O
294	Rough Buttonweed	*Diodia teres*	O
294	Virginia Buttonweed	*Diodia virginiana*	C
294	Cleavers	*Galium aparine*	O
294	Hairy Bedstraw	*Galium pilosum*	U
294	Dye Bedstraw	*Galium tinctorium*	C
294	Fragrant Bedstraw	*Galium triflorum*	U
294	Small Bluets	*Houstonia minima*	O
294		*Houstonia nigricans*	U
294		*Olenlandia boscii*	U
294		*Olenlandia fasciculata*	O
294	Prairie Buttonweed	*Richardia tricocca*	x
295	Japanese Honeysuckle	*Lonicera japonica*	C
295	Elderberry	*Sambucus canadensis*	O
295	Southern Arrowwood	*Viburnum dentatum*	O

Fam#	Common Name	Scientific Name	Abn.
295	Viburnum	*Viburnum suspensum*	U
297	Corn-Salad	*Valerianella radiata*	C
299	Watermelon	*Citrullus lanatus*	O
299	Stinkmelon	*Cucumis melo*	C
299	Sponge Gourd	*Lagenaria siceraria*	U
299	Creeping Cucumber	*Melothria pendula*	C
300	Pale Lobelia	*Lobelia appendiculata*	x
300	Downy Lobelia	*Lobelia puberula*	O
300	Chicken Spike	*Sphenoclea zeylandica*	U
300	Venus' Lookingglass	*Triodanis biflora*	O
300	Venus' Lookingglass	*Triodanis perfoliata*	C
304	Creeping Spotflower	*Acmella oppositifolia*	x
304	Common Ragweed	*Ambrosia artisiifolia*	C
304	Western Ragweed	*Ambrosia psilostachya*	C
304	Giant Ragweed	*Ambrosia trifida*	O
304	Mayweed Dogfennel	*Anthemis cotula*	R
304	Lazy Daisy	*Aphanostephus skirrhobasis*	C
304	Western Mugwort	*Artemisia ludoviciana*	U
304	Bushy Aster	*Aster dumosus*	x
304	Calico Aster	*Aster lateriflorus*	O
304	Devilweed Aster	*Aster spinosus*	C
304	Annual Saltmarsh Aster	*Aster subulatus*	C
304	Hierba-del-Marrano	*Aster subulatus ligulatus*	C
304	Saline Aster	*Aster tenuifolius*	x
304	Sea Myrtle	*Baccharis angustifolia*	x
304	Eastern Baccharis	*Baccharis halimifolia*	C
304	Fouchet	*Bidens laevis*	U
304	Marsh Boltonia	*Boltonia asteroides*	O
304	Doll's Daisy	*Boltonia diffusa*	O
304	Bushy Sea-oxeye	*Borrichia frutescens*	C
304	Prostrate Lawnflower	*Calyptocarpus vialis*	U
304	Boneset	*Chromolaena ivifolia*	U
304	Bull Thistle	*Cirsium horridulum*	C
304	Mist Flower	*Conoclinium coelestinum*	C
304		*Conyza bonariensis*	C
304	Canada Horseweed	*Conyza canadensis*	C
304		*Conyza canadensis pusillus*	O
304	Goldmane Coreopsis	*Coreopsis basalis*	C
304	Thickleaf Coreopsis	*Coreopsis lanceolata*	x
304	Painted Tickseed	*Coreopsistinctoria*	C
304	Spanish-Needles	*Cosmos bipennata*	U
304	Clasping Coneflower	*Dracopis amplexicaulis*	R
304	Pale Purple Coneflower	*Echinacea pallid*	x
304	Yerba-del-Tago	*Eclipta alba*	C
304	Leafy Elephant's-Foot	*Elephantopus carolinianus*	O
304	Fireweed	*Erechtites hieracifolia*	C
304	Philadelphia Fleabane	*Erigeron philadelphicus*	O
304	Blue Fleabane	*Erigeron tenuis*	O
304	Cypressweed	*Eupatorium capillifolium*	C
304	Yankeeweed	*Eupatorium compositifolium*	O
304	Hyssop-leved Boneset	*Eupatorium hyssopifolium*	O
304	Lanceleaf Eupatorium	*Eupatorium lancifolium*	U
304	Thoroughwort	*Eupatorium perfoliatum*	U
304	Boneset	*Eupatorium pinnatifidum*	x

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304	Small-flowered Thoroughwort	*Eupatorium semiserratum*	U
304	Late Eupatorium	*Eupatorium serotinum*	C
304	Euthamia	*Euthamia gymnospermoides*	O
304	Slimhead Goldenrod	*Euthamia leptocephala*	O
304	Facelis	*Facelis retusa*	U
304	Pink Boneset	*Fleischmannia incarnata*	x
304	Winkler Gaillardia	*Gaillardia aestivalis*	x
304	Indian Blanket	*Gaillardia pulchella*	C
304		*Gamochaeta calviceps*	C
304	Wandering Cudweed	*Gamochaeta pensylvanicum*	C
304	Purple Cudweed	*Gamochaeta purpurea*	C
304	Fragrant Cudweed	*Gnaphalium obtusifolium*	O
304	Bitterweed	*Helenium amarum*	C
304	Sneezeweed	*Helenium drummondii*	x
304	Purple-headed Sneezeweed	*Helenium flexuosum*	C
304	Narrowleaf Sunflower	*Helianthus angustifolius*	O
304	Ashy Sunflower	*Helianthus mollis*	U
304	Jerusalem Artichoke	*Helianthus tuberosus*	U
304	Sunflower Everlasting	*Heliopsis helianthoides*	x
304	Camphorweed	*Heterotheca subaxillaris*	C
304	Cat's-Ears	*Hypochoeris microcephala*	O
304	Narrow-leaf Sumpweed	*Iva angustifolia*	C
304	Rough Sumpweed	*Iva annua*	C
304	Big-leaf Sumpweed	*Iva frutescens*	C
304	Dune Sumpweed	*Iva imbricata*	R
304	Dwarf Dandelion	*Krigia cespitosa*	C
304	Potato Dandelion	*Krigia dandelion*	O
304	Canada Lettuce	*Lactuca canadensis*	O
304	Florida Lettuce	*Lactuca floridana*	O
304	Prickly Lettuce	*Lactuca serriola*	U
304	Ox-eye Daisy	*Leucanthemum vulgare*	x
304	Slender Gayfeather	*Liatris acidota*	U
304	Pinkscale Gayfeather	*Liatris elegans*	x
304	Camphor Daisy	*Machaeranthera phyllocephola*	C
304		*Machaeranthera spinulosus*	x
304	Climbing Hempvine	*Mikania scandens*	C
304	False Ragweed	*Parthenium hysterophorus*	C
304	Camphorweed	*Pluchea camphorata*	U
304	Stinking Fleabane	*Pluchea foetida*	U
304	Seaside Stinking Fleabane	*Pluchea odorata*	C
304	Stinkweed	*Pluchea rosea*	C
304	Wand Blackroot	*Pterocaulon virgatum*	R
304	Carolina False Dandelion	*Pyrrhopappus carolinianus*	C
304	Upright Prairie-Coneflower	*Ratibida columnifera*	x
304	Naked Prairie-Coneflower	*Ratibida peduncularis*	C
304	Narrowleaf Black-eyed Susan	*Rudbeckia hirta angustifolia*	x
304	Late Brown-eyed Sysan	*Rudbeckia hirta pulcherrima*	C
304	Sweet Coneflower	*Rudbeckia subtomentosa*	x
304	Butterweed	*Senecio glabellus*	C
304	Threadleaf Groundsel	*Senecio imparipinnatus*	U
304	Yellowtop	*Senecio tampicanus*	x
304	Slender Rosin-weed	*Silphium gracile*	O
304		*Silphium radula*	U
304		*Silphium simpsonii*	x

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304	Bear's-Foot	*Smallanthus uvedalia*	U
304	Canada Goldenrod	*Solidago canadensis*	C
304	Shiny Goldenrod	*Solidago nitida*	U
304	Hackberry-leaved Rough Goldenrod	*Solidago rugosa celtidifolia*	C
304	Seaside Goldenrod	*Solidago sempervirens*	C
304	Noble Goldenrod	*Solidago speciosa*	R
304	Elmleaf Goldenrod	*Solidago ulmifolia*	U
304		*Soliva mutisii*	O
304		*Soliva pterosperma*	O
304	Prickly Sow Thistle	*Sonchus asper*	C
304	Common Sow Thistle	*Sonchus oleraceus*	C
304	Creeping Spot Flower	*Spilanthes americana*	O
304	Common Dandelion	*Taraxacum officinale*	O
304	Frostweed	*Verbesina virginica*	O
304	Tall Ironweed	*Vernonia gigantea*	O
304	Missouri Ironweed	*Vernonia missourica*	O
304	Cocklebur	*Xanthium strumarium*	O
304	Oriental Hawkbeard	*Youngia japonica*	O
304	Zinnia	*Zinnia elegans*	E

Plant list collected from:

Soil Conservation Service. 1984. National List of Scientific Plant Names, 2 vols.

Dutton, Bryan Eugene. 1985. A Preliminary Survey of the Vascular Flora of Cameron Parish, LA. Northeast. La. Univ., MS Thesis, 141pp

Allen, Charles M. 1975. Grasses of Louisiana, Univ. Southwest. La., 358pp

Thieret, John W. 1980. Louisiana Ferns and Fern Allies, Laf. Nat. Hist. Mus., Lafayette, 123pp

Montz, Glen N. 1979. Distribution of Selected Aquatic Species in Lousiana, US-CE, 33pp

Abundance Codes:

A = Abundant
F = Frequent
VC = Very Common
C = Common
U = Uncommon
O = Occassional
R = Rare
E = Escaped from Cultivation
x = Abundance not listed

Appendix B

MARINE INVERTEBRATES OBSERVED WITHIN RIVER BASIN[1]

Common Name	Scientific Name
Portugese man-of-war	*Physalia physalis*
Sea nettle	*Chrysaora quinquecirrha*
Cabbagehead jellyfish	*Stomolophus meleagris*
Phosphorus jellyfish	*Mnemiopsis mccradyi*
Blood worm	*Glycera americana*
Periscope tube worm	*Oiopatra cuprea*
Oyster blister worm	*Polydora websteri*
Marsh periwinkle	*Lettorina irrorata*
Common mud snail	*Nassarius vibex*
White slipper shell	*Crepidula plana*
Atlantic slipper shell	*Crepidula fornicata*
Common marsh snail	*Melampus bidentatus*
Southern oyster drill	*Thais haemostoma*
Ribbed mussel	*Geukensea demissa*
Hooked mussel	*Ishadium recurvum*
Eastern oyster	*Crassostrea virginica*
Road shell clam	*Rangia cuneata*
Small macoma	*Macoma mitchelli*
Constricted macoma	*Macoma constricta*
Stout razor clam	*Tagelus plebeis*
Southern quahog	*Mercenaria campechiensis*
Bean clam	*Donax variabillis*
Squid	*Loligo pealei*
Acorn barnacles	*Chelonibia* spp.
Speckled crab	*Arenaeus cribrarius*
Blue crab	*Callinectes sapidus*
Blue crab	*Callinectes similis*
Flat mud crab	*Eurypanoplus depressus*
Stone crab	*Menippe mercenaria*
Common mud crab	*Panopeus herbstii*
Harris mud crab	*Rithropanopeus harrisii*
Red-jointed fiddler crab	*Uca minax*
Sand fiddler	*Uca picgillator*
Mud fiddler	*Uca pugnax*
-	*Uca rapax*
-	*Uca spinicarpa*
Wharf crab	*Sesarma cinereum*
Purple marsh crab	*Sesarma reticulatum*
Shore crab	*Pachygrapsus gracilis*
-	*Pachygrapsus transversus*
-	*Petrolisthes armatus*
-	*Porcellana sigsbeiana*
Mussel crab	*Pinnotheres maculatus*
Oyster crab	*Pinnotheres ostreum*
Spider crab	*Libinia dubia*
Striped hermit crab	*Clibanarius vittatus*
-	*Isocheles wurdemanni*
Long-armed hermit crab	*Pagurus longicarpus*
White River crayfish	*Procambarus acutus*

[1] from Wildlife of the Sabine National Wildlife Refuge

Marine Invertebrates (continued)

Common Name	Scientific Name
Red Swamp crayfish	*Procambarus clarkii*
Flat-browed mud shrimp	*Upogebia affinis*
Brown shrimp	*Penaeus aztecus*
White shrimp	*Penaeus setiferus*
Pink shrimp	*Penaeus duorarum*
Sea bob	*Xiphopeneus kroyeri*
-	*Solenocerinae* spp.
-	*Acetes americanus*
Freshwater shrimp	*Macrobrachium ohione*
Freshwater shrimp	*Macrobrachium acanthurus*
Grass shrimp	*Palaemonetes pugio*
Grass shrimp	*Palaemonetes vulgaris*
Big-clawed snapping shrimp	*Alpheus heterochaelis*
Mantis shrimp	*Squilla empusa*
Wood-boring isopod	*Limnoria tripunctata*
Rock louse	*Ligia exotica*
-	*Bopyrissa wolffi*
Smooth-backed sphaeroma	*Sphaeroma quadridentatum*
Fish louse	*Cymothous* sp.
Wharf roach	*Ligia* sp.
Beach flea	*Orchestia grillus*
-	*Gammarus mucronatus*
Marsh hopper	*Talorchestia* sp.

FISH OBSERVED WITHIN RIVER BASIN[1]

Common Name	Scientific Name
Atlantic stingray	*Dasyatis sabina*
Spotted gar	*Lepisosteus oculatus*
Longnose gar	*Lepisosteus osseus*
Alligator gar	*Atractosteus spatula*
Bowfin	*Amia calva*
Ladyfish	*Elops saurus*
American eel	*Anguilla rostrata*
Speckled worm eel	*Myrophis punctatus*
Shrimp eel	*Ophichthus gomesi*
Skipjack herring	*Alosa chrysochloris*
Gulf menhaden	*Brevoortia patronus*
Gizzard shad	*Dorosoma cepedianum*
Threadfin shad	*Dorosoma petenense*
Scaled sardines	*Harengula jaguana*
Atlantic thread herring	*Opisthonema oglinum*
Striped anchovy	*Anchoa hepsetus*
Bay anchovy	*Anchoa mitchilli*
Largescale lizardfish	*Saurida brasiliensis*
Inshore lizardfish	*Synodus foetens*
Common carp	*Cyprinus carpio*
Golden shiner	*Notemigonus crysoleucas*
Bigmouth buffalo	*Ictiobus cyprinellus*
Blue catfish	*Ictalurus furcatus*
Black bullhead	*Ictalurus melas*

Fish (continued)

Common Name	Scientific Name
Yellow bullhead	*Ictalurus natalis*
Channel catfish	*Ictalurus punctatus*
Hardhead catfish	*Ariopsis felis*
Gafftopsail catfish	*Bagre marinus*
Pirate perch	*Aphredoderus sayanus*
Gulf toadfish	*Opsanus beta*
Atlantic midshipman	*Porichthys plectrodon*
Skilletfish	*Gobiesox strumosus*
Southern hake	*Urophycis floridana*
Bearded brotula	*Brotula barbata*
Bank cusk-eel	*Ophidion holbrooki*
Atlantic needlefish	*Strongylura marina*
Diamond killifish	*Adinia xenica*
Sheepshead minnow	*Cyprinodon variegatus*
Golden topminnow	*Fundulus chrysotus*
Gulf killifish	*Fundulus grandis*
Saltmarsh topminnow	*Fundulus jenkinsi*
Starhead topminnow	*Fundulus blairae*
Bayou killifish	*Fundulus pulvereus*
Longnose killifish	*Fundulus similis*
Rainwater killifish	*Lucania parva*
Mosquitofish	*Gambusia affinis*
Least killifish	*Heterandria formosa*
Sailfin molly	*Poecilia latipinna*
Brook silversides	*Labidesthes sicculus*
Rough silversides	*Membras martinica*
Inland silversides	*Menidia beryllina*
Dusky pipefish	*Syngnathus floridae*
Chain pipefish	*Syngnathus louisianae*
Gulf pipefish	*Syngnathus scovelli*
Lined seahorse	*Hippocampus erectus*
Striped bass	*Morone saxatilis*
White bass	*Morone chrysops*
Yellow bass	*Morone mississippiensis*
Flier	*Centrarchus macropterus*
Banded pygmy sunfish	*Elassoma zonatum*
Warmouth	*Lepomis gulosus*
Bluegill	*Lepomis macrochirus*
Redear sunfish	*Lepomis punctatus*
Bantam sunfish	*Lepomis symmetricus*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Bluefish	*Pomatomus saltatrix*
Cobia	*Rachycentron canadum*
Crevalle jack	*Caranx hippos*
Atlantic bumper	*Chloroscombrus chrysurus*
Bluntnose jack	*Hemicaranx amblyrhynchus*
Leatherjack	*Oligoplites saurus*
Atlantic moonfish	*Selene setapinnis*
Lookdown	*Selene vomer*
Florida pompano	*Trachinotus carolinus*

Fish (continued)

Common Name	Scientific Name
Bigeye scad	*Selar crumenophthalmus*
Gray snapper	*Lutjanus griseus*
Tripletail	*Lobotes surinamensis*
Spotfin mojarra	*Eucinostomus argenteus*
Mottled mojarra	*Eucinostomus lefroyi*
Pigfish	*Orthopristis chrysoptera*
Sheepshead	*Archosargus probatocephalus*
Pinfish	*Lagondon rhomboides*
Freshwater drum	*Aplodinotus grunniens*
Silver perch	*Bairdiella chrysoura*
Sand seatrout	*Cynoscion arenarius*
Spotted seatrout	*Cynoscion nebulosus*
Silver seatrout	*Cynoscion nothus*
Banded drum	*Larimus fasciatus*
Spot	*Leiostomus xanthurus*
Southern kingfish	*Menticirrhus americanus*
Atlantic croaker	*Micropogonias undulatus*
Black drum	*Pogonias cromis*
Red drum	*Sciaenops ocellatus*
Star drum	*Stellifer lanceolatus*
Atlantic spadefish	*Chaetodipterus faber*
Striped mullet	*Mugil cephalus*
White mullet	*Mugil curema*
Guaguanche	*Sphyraena guachancho*
Atlantic threadfin	*Polyactylus octonemus*
Southern stargazer	*Astroscopus y-graecum*
Striped blenny	*Chasmodes boquianus*
Freckled blenny	*Hypsoblennius ionthas*
Fat sleeper	*Dormitator maculatus*
Emerald sleeper	*Erotelis smargdus*
Spinycheek sleeper	*Eleotris pisonis*
Lyre goby	*Evorthodus lyricus*
Violet goby	*Gobioides broussoneti*
Darter goby	*Gobionellus boleosoma*
Sharptail goby	*Gobionellus shufeldti*
Freshwater goby	*Gobionellus shufeldti*
Naked goby	*Gobiosoma bosci*
Code goby	*Gobiosoma robustum*
Clown goby	*Microbius gulosus*
Green goby	*Microbius thalassinus*
Pink wormfish	*Microgobius longipinnis*
Atlantic cutlassfish	*Trichiurus lepturus*
Spanish mackerel	*Scomberomorus maculatus*
Harvestfish	*Peprilus alepidotus*
Gulf butterfish	*Peprilus burti*
Bighead searobin	*Prionotus tribulus*
Ocellated flounder	*Ancylopsetta quadrocellata*
Bay whiff	*Citharichthys spilopterus*
Fringe flounder	*Etropus crossotus*
Gulf flounder	*Paralichthys albigutta*
Southern flounder	*Paralichthys lethostigma*
Lined sole	*Achirus lineatus*
Hogchoker	*Trinectes maculatus*
Blackcheek tonguefish	*Symphurus plagiusa*
Pygmy filefish	*Monacanthus setifer*

Fish (continued)

Common Name	Scientific Name
Southern puffer	*Sphoeroides nephelus*
Least puffer	*Sphoeroides parvus*

AMPHIBIANS OBSERVED WITHIN RIVER BASIN[1]

Common Name	Scientific Name
Three-toed amphiuma	*Amphiuma tridactylum*
Gulf coast toad	*Bufo valliceps*
Northern cricket frog	*Acris crepitans*
Green treefrog	*Hyla cinerea*
Eastern narrow-mouthed toad	*Gastrophryne carolinensis*
Bullfrog	*Rana catesbeiana*
Pig frog	*Rana grylio*
Green frog	*Rana clamitans*
Southern leopard frog	*Rana sphenocephala*

REPTILES OBSERVED WITHIN RIVER BASIN[1]

Common Name	Scientific Name
American alligator	*Alligator mississippiensis*
Green anole	*Anolis carolinensis*
Broad-headed skink	*Eumeces laticeps*
Ground skink	*Scincella lateralis*
Common snapping turtle	*Chelydra serpentina*
Alligator snapping turtle	*Macroclemys temminckii*
Common mud turtle	*Kinosternon subrubrum*
Gulf coast box turtle	*Terrapene carolina*
Mississippi diamond-backed terrapin	*Malaclemys terrapin*
Common slider	*Trachemys scripta*
Spiny softshell turtle	*Apalone spinifer*
Southern water snake	*Nerodia fasciata*
Green water snake	*Nerodia cyclopion*
Diamondback water snake	*Nerodia rhombifera*
Brown snake	*Storeria dekayi*
Western ribbon snake	*Thamnophis proximus*
Rainbow snake	*Farancia erytrogramma*
Glossy crayfish snake	*Regina rigida*
Eastern hognose snake	*Heterdon platyrhinos*
Mud snake	*Farancia abacura*
Blue racer	*Coluber constrictor*
Rat snake	*Elaphe obsoleta*
Common kingsnake	*Lampropeltis getulus*
Copperhead	*Agkistrodon contortrix*
Cottonmouth	*Agkistrodon piscivorus*
Pigmy rattlesnake	*Sistrurus miliarius*

BIRDS OBSERVED WITHIN RIVER BASIN[2]

Common Name	Scientific Name
Common Loon	*Gavia immer*
Pied-billed Grebe	*Podilymbus podiceps*
Horned Grebe	*Podiceps auritus*
Red-necked Grebe	*Podiceps grisegena*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmophorus occidentalis*
Northern Gannet	*Morus bassanus*
American White Pelican	*Pelecanus erythrorhynchos*
Brown Pelican	*Pelecanus occidentalis*
Double-crested Cormorant	*Phalacrocorax auritus*
Olivaceous Cormorant	*Phalacrocorax olivaceus*
Anhinga	*Anhinga anhinga*
Magnificent Frigatebird	*Fregata magnificens*
American Bittern	*Botaurus lentiginosus*
Least Bittern	*Ixobrychus exilis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Casmerodius albus*
Snowy Egret	*Egretta thula*
Little Blue Heron	*Egretta caerulea*
Tricolored Heron	*Egretta tricolor*
Reddish Egret	*Egretta rufescens*
Cattle Egret	*Bubulcus ibis*
Green-backed Heron	*Butorides striatus*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Yellow-crowned Night-Heron	*Nyctanassa violaceus*
White Ibis	*Eudocimus albus*
Glossy Ibis	*Plegadis falcinellus*
White-faced Ibis	*Plegadis chihi*
Roseate Spoonbill	*Ajaia ajaja*
Wood Stork	*Mycteria americana*
Fulvous Whistling-Duck	*Dendrocygna bicolr*
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*
Greater White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen caerulescens*
Ross' Goose	*Chen rossii*
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Green-winged Teal	*Anas crecca*
American Black Duck	*Anas rubripes*
Mottled Duck	*Anas fulvigula*
Mallard	*Anas platyrhynchos*
Northern Pintail	*Anas acuta*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
Canvasback	*Aythya valisneria*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*

[2] from Sabine National Wildlife Reguge-Birds, and Sabine and Johnsons Bayou Christmas Bird Count data

Common Name	Scientific Name
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Oldsquaw	*Clangula hyemalis*
Black Scoter	*Melanitta nigra*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Common Goldeneye	*Bucephala clangula*
Bufflehead	*Bucephala albeola*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Ruddy Duck	*Oxyura jamaicensis*
Black Vulture	*Coragyps atratus*
Turkey Vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Black-shouldered Kite	*Elanus caeruleus*
Bald Eagle	*Haliaetus leucocephalus*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*
Broad-winged Hawk	*Buteo platypterus*
Swainson's Hawk	*Buteo swainsoni*
Red-tailed Hawk	*Buteo jamaicensis*
Rough-legged Hawk	*Buteo lagopus*
Golden Eagle	*Aquila chrysaetos*
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Northern Bobwhite	*Colinus virginianus*
Yellow Rail	*Coturnicops noveboracensis*
Black Rail	*Laterallus jamaicensis*
Clapper Rail	*Rallus longirostris*
King Rail	*Rallus elegans*
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
Purple Gallinule	*Porphyrula martinica*
Common Moorhean	*Gallinula chloropus*
American Coot	*Fulica americana*
Black-bellied Plover	*Pluvialis squatarola*
Lesser Golden-Plover	*Pluvialis dominica*
Snowy Plovr	*Charadrius alexandrinus*
Wilson's Plover	*Charadrius wilsonia*
Semipalmated Plover	*Charadrius semipalmatus*
Piping Plover	*Charadrius melodus*
Killdeer	*Charadrius vociferus*
Black-necked Stilt	*Himantopus mexicanus*
American Avocet	*Recurvirostra americana*
Greater Yellowlegs	*Trnga melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Solitary Sandpiper	*Tringa solitaria*
Willet	*Catoptrophorus sempalmatus*
Spotted Sandpiper	*Actitis macularia*
Upland Sandpiper	*Bartramia longicauda*
Whimbrel	*Numenius phaeopus*
Long-billed Curlew	*Numenius americanus*

Birds (continued)

Common Name	Scientific Name
Marbled Godwit	*Limosa fedoa*
Ruddy Turnstone	*Arenaria interpres*
Red Knot	*Calidris canutus*
Sanderling	*Calidris alba*
Semipalmated Sandpiper	*Calidris pusilla*
Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
White-rumped Sandpiper	*Calidris fuscicollis*
Pectoral Sandpiper	*Calidris melanotos*
Purple Sandpiper	*Calidris maritima*
Dunlin	*Calidris alpina*
Stilt Sandpiper	*Calidris himantopus*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Common Snipe	*Gallinago gallinago*
American Woodcock	*Scolopax minor*
Wilson's Phalarope	*Phalaropus tricolor*
Red-necked Phalarope	*Phalaropus lobatus*
Pomarine Jaeger	*Stercorarius pomarinus*
Parasitic Jaeger	*Stercorarius parasiticus*
Laughing Gull	*Larus atricilla*
Franklin's Gull	*Larus pipixcan*
Bonaparte's Gull	*Larus philadelphia*
Ring-billed Gull	*Larus delawarensis*
Herrng Gull	*Larus argentatus*
Lesser Black-backed Gull	*Larus fuscus*
Glaucous Gull	*Larus hyperboreus*
Great Black-backed Gull	*Larus marinus*
Black-legged Kittiwake	*Rissa tridactyla*
Gull-billed Tern	*Sterna nilotica*
Caspian Tern	*Sterna caspia*
Royal Tern	*Sterna maxima*
Sandwich Trn	*Sterna sandvicensis*
Common Tern	*Sterna hirundo*
Forster's Tern	*Sterna forsteri*
Least Tern	*Sterna antillarum*
Black Tern	*Chlidonias niger*
Black Skimmer	*Rynchops niger*
Rock Dove	*Columba livia*
White-winged Dove	*Zenaida asiatica*
Mourning Dove	*Zenaida macroura*
Inca Dove	*Columbina inca*
Common Ground-Dove	*Columbia passerina*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Yellow-billed Cuckoo	*Coccyzus americanus*
Groove-billed Ani	*Crotophaga sulcirostris*
Barn-Owl	*Tyto alba*
Eastern Screech-Owl	*Otus asio*
Great Horned Owl	*Bubo virginianus*
Burrowing Owl	*Athene cunicularia*
Barred Owl	*Strix varia*
Long-eared Owl	*Asio otus*
Short-eared Owl	*Asio flammeus*
Northern Saw-whet Owl	*Aegolius acadicus*
Lesser Nighthawk	*Chordeiles acutipennis*

Birds (continued)

Common Name	Scientific Name
Common Nighthawk	*Chordeiles minor*
Chuck-will's-willow	*Caprimulgus carolinensis*
Whip-poor-will	*Caprimulgus vociferus*
Chimney Swift	*Chaetura pelagica*
Buff-bellied Hummingbird	*Amazilia yucatanensis*
Ruby-throated Hummingbird	*Archilochus colubris*
Black-chinned Hummingbird	*Archilochus alexandri*
Anna's Hummingbird	*Calypte anna*
Rufous Hummingbird	*Selasphorus rufus*
Belted Kingfisher	*Ceryle alcyon*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Olive-sided Flycatcher	*Contopus borealis*
Eastern Wood-Pewee	*Contopus virens*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Acadian Flycatcher	*Empidonax virescens*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Say's Phoebe	*Sayornis saya*
Vermilion Flycatcher	*Pyrocephalus rubinus*
Ash-throated Flycatcher	*Myiarchus cinerascens*
Great Crested Flycatcher	*Myiarchus crinitus*
Brown-crested Flycatcher	*Myiarchus tyrannulus*
Couch's Kingbird	*Tyrannus couchii*
Western Kingbird	*Tyrannus verticalis*
Eastern Kingbird	*Tyrannus tyrannus*
Scissor-tailed Flycatcher	*Tyrannus forficatus*
Horned Lark	*Eremophila alpestris*
Purple Martin	*Progne subis*
Tree Swallow	*Tachycineta bicolor*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Cliff Swallow	*Hirundo pyrrhonota*
Barn Swallow	*Hirundo rustica*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Fish Crow	*Corvus ossifragus*
Carolina Chickadee	*Parus carolinensis*
Tufted Titmouse	*Parus bicolor*
Red-breasted Nuthatch	*Sitta canadensis*
Brown Creeper	*Certhia americana*
Carolina Wren	*Thryothorus ludovicianus*
Bewick's Wren	*Thryomanes bewickii*
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Sedge Wren	*Cistothorus platensis*
Marsh Wren	*Cistothorus palustris*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Blue-gray Gnatcatcher	*Polioptila caerulea*

Birds (continued)

Common Name	Scientific Name
Eastern Bluebird	*Sialia sialis*
Veery	*Catharus fusescens*
Gray-cheeked Thrush	*Catharus minimus*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
Varied Thrush	*Ixoreus naevius*
Wood Thrush	*Hylocichla mustelina*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Northern Mockingbird	*Mimus polyglottos*
Sage Thrasher	*Oreoscoptes montanus*
Brown Thrasher	*Toxostoma rufum*
Curve-billed Thrasher	*Toxostoma curvirostre*
American Pipit	*Anthus rubescens*
Sprague's Pipit	*Anthus spragueii*
Cedar Waxwing	*Bombycilla cedorum*
Loggerhead Shrike	*Lanius ludovicianus*
European Starling	*Sturnus vulgaris*
White-eyed Vireo	*Vireo griseus*
Bell's Vireo	*Vireo bellii*
Solitary Vireo	*Vireo solitarius*
Yellow-throated Vireo	*Vireo flavifrons*
Warbling Vireo	*Vireo gilvus*
Philadelphia Vireo	*Vireo philadelphicus*
Red-eyed Vireo	*Vireo olivaceus*
Blue-winged Warbler	*Vermivora pinus*
Golden-winged Warbler	*Vermivora chrysoptera*
Tennessee Warbler	*Vermivora peregrina*
Orange-crowned Warbler	*Vermivora celata*
Nashville Warbler	*Vermivora ruficapilla*
Virginia's Warbler	*Vermivora virginiae*
Northern Parula	*Parula americana*
Tropical Parula	*Parula pitiayumi*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Magnolia Warbler	*Dendroica magnolia*
Cape May Warbler	*Dendroica tigrina*
Black-throated Blue Warbler	*Dendroica caerulescens*
Yellow-rumped Warbler	*Dendroica coronata*
Black-throated Gray Warbler	*Dendroica nigriscens*
Townsend's Warbler	*Dendroica townsendi*
Black-throated Green Warbler	*Dendroica virens*
Blackburnian Warbler	*Dendroica fusca*
Yellow-throated Warbler	*Dendroica dominica*
Pine Warbler	*Dendroica pinus*
Prairie Warbler	*Dendroica discolor*
Palm Warbler	*Dendroica palmarum*
Bay-breasted Warbler	*Dendroica castanea*
Blackpoll Warbler	*Dendroica striata*
Cerulean Warbler	*Dendroica cerulea*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Prothonotary Warbler	*Prothonotaria citrea*
Worm-eating Warbler	*Helmitheros vermivorus*
Ovenbird	*Seiurus aurocapillus*

Birds (continued)

Common Name	Scientific Name
Northern Waterthrush	*Seiurus noveboracensis*
Louisiana Waterthrush	*Seiurus motacilla*
Kentucky Warbler	*Oporornis formosus*
Mourning Warbler	*Oporornis philadelphia*
MacGillivray's Warbler	*Oporornis tolmiei*
Common Yellowthroat	*Geothlypis trichas*
Hooded Warbler	*Wilsonia citrina*
Wilson's Warbler	*Wilsonia pusilla*
Canada Warbler	*Wilsonia canadensis*
Yellow-breasted Chat	*Icteria virens*
Summer Tanager	*Piranga rubra*
Scarlet Tanager	*Piranga olivacea*
Western Tanager	*Piranga ludoviciana*
Northern Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Blue Bunting	*Cyanocompsa parellina*
Blue Grosbeak	*Guiraca caerulea*
Indigo Bunting	*Passerina cyanea*
Painted Bunting	*Passerina ciris*
Dickcissel	*Spiza americana*
Green-tailed Towhee	*Pipilo chlorurus*
Rufous-sided Towhee	*Pipilo erythrophthalmus*
Chipping Sparrow	*Spizella passerina*
Clay-colored Sparrow	*Spizella pallida*
Field Sparrow	*Spizella pusilla*
Vesper Sparrow	*Pooectes gramineus*
Lark Sparrow	*Chondestes grammacus*
Savannah Sparrow	*Passerculus sandwichensis*
Grasshopper Sparrow	*Ammodramus savannarum*
Henslow's Sparrow	*Ammodramus henslowii*
LeConte's Sparrow	*Ammodramus leconteii*
Sharp-tailed Sparrow	*Ammodramus caudacutus*
Seaside Sparrow	*Ammodramus maritimus*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
White-crowned Sparrow	*Zonotrichia leucophrys*
Harris' Sparrow	*Zonotrichia querula*
Dark-eyed Junco	*Junco hyemalis*
Lapland Longspur	*Calcarius lapponicus*
Red-winged Blackbird	*Agelaius phoeniceus*
Eastern Meadowlark	*Sturnella magna*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Rusty Blackbird	*Euphagus carolinus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Great-tailed Grackle	*Quiscalus mexicanus*
Boat-tailed Grackle	*Quiscalus major*
Common Grackle	*Quiscalus quiscalus*
Bronzed Cowbird	*Molothrus aeneus*
Brown-headed Cowbird	*Molothrus ater*
Orchard Oriole	*Icterus spurius*

Birds (continued)

Common Name	Scientific Name
Northern Oriole	*Icterus galbula*
Purple Finch	*Carpodacus purpureus*
Pine Siskin	*Carduelis pinus*
American Goldfinch	*Carduelis tristis*
House Sparrow	*Passer domesticus*

MAMMALS OBSERVED WITHIN RIVER BASIN[1]

Common Name	Scientific Name
Vrginia opossum	*Didelphis virginiana*
Nine-banded armadillo	*Dasypus novemcinctus*
Least shrew	*Cryptotis parva*
Red bat	*Lasiurus borealis*
Seminole bat	*Lasiurus seminolus*
Eastern pipistrelle	*Pipistrellus subflavus*
Evening bat	*Nycticeius humeralis*
Brazilian free-tailed bat	*Tadarida brasiliensis*
Coyote	*Canis latrans*
Gray fox	*Urocyon cinereoargenteus*
Red fox	*Vulpes vulpes*
Raccoon	*Procyon lotor*
Mink	*Mustela vison*
Striped skunk	*Mephitis mephitis*
Spotted skunk	*Spilogale putorius*
River otter	*Lutra canadensis*
Bobcat	*Lynx felis*
White-tailed deer	*Odocoileus virginianus*
Marsh rice rat	*Oryzomys palustris*
Fulvous harvest mouse	*Reithrodontomys fulvescens*
Hispid cotton rat	*Sigmodon hispidus*
Muskrat	*Ondatra zibethicus*
House mouse	*Mus musculus*
Black rat	*Rattus rattus*
Norway rat	*Rattus norvegicus*
Nutria	*Myocaster coypus*
Swamp rabbit	*Sylvilagus aquaticus*
Eastern cottontail	*Sylvilagus floridanus*

APPENDIX C

SUMMARY OF COASTAL MARSH INVENTORY FOR THE CALCASIEU-SABINE RIVER BASIN

The Coastal Marsh Inventory (CMI) was conducted by USDA-SCS in Louisiana to expand on coastal marsh data collected during the 1982 National Resource Inventory. The CMI was initiated as a result of the perceived need for sampling the marshland resource. The following is a summary of the vegetation data collected for the CMI data each Conservation Treatment Unit according to the three areas within the Calcasieu-Sabine River Basin.

CALCASIEU-SABINE RIVER BASIN - CTU VEGETATION

(NORTH)

SPECIES	SYMB.	1	2	3	4	5	6	7	8	9	10
Marshhay Cordgrass	SPPA	75	70	19	40	62	11	50		85	-
California Bulrush	SCCA	-	-	-	-	-	-	-		-	-
Roseau	PHAU7	4	-	3	-	-	-	-		-	-
Seashore Paspalum	PAVI6	-	-	10	-	-	-	-		-	-
Cattail	TYPHA	-	-	2	-	-	-	-		-	-
Seashore Saltgrass	DISP	-	-	2	-	3	-	8		-	-
Black Needlerush	JURO	11	-	2	2	18	6	36		-	-
Carex Sedge	CAREX	-	-	-	-	-	-	-		-	-
Common Rush	JUEF	-	-	-	-	3	-	-		-	-
Jamaica Sawgrass	CLJA	-	-	14	-	1	-	-		-	-
Rattlebox	DATE8	-	-	-	-	-	-	-		-	-
Coast Bacopa	BAMO	-	-	9	-	-	-	-		-	-
Smartweed	POLYG4	-	-	2	-	-	-	-		-	-
Va. Saltmarsh-Mallow	KOVI	-	-	5	-	-	-	-		-	-
Torpedograss	PARE3	-	-	5	-	4	-	-		-	-
St. Augustinegrass	STSE	-	-	-	-	18	-	-		-	-
Walter's Millet	ECWA	-	-	-	-	-	2	-		-	-
Giant Cutgrass	ZIMI	-	-	-	-	10	-	-		-	-
Wigeongrass	RUMA5	-	-	-	-	-	2	-		-	-
Smooth Cordgrass	SPAL	-	20	-	-	6	-	-		-	-
Bulltongue	SALA	-	-	-	-	-	-	-		12	-
Saltmarsh Bulrush	SCRO	-	-	1		-	-	-		-	-
Olney Bulrush	SCOL	-	-	7	-	-	-	-		-	-
Flatsedge	CYPER	-	-	-	-	-	35	-		-	-
Pennywort	HYDRO2	-	-	-	-	-	-	-		-	-
American Lotus	NELU	-	-	-	-	-	-	-		-	-
Paille Fine	PAHE2	-	-	-	-	-	-	-		-	-
Alligatorweed	ALPH	-	-	-	-	-	-	-		-	-
Bushy Bluestem	ANGL2	-	-	-	5	-	-	-		-	-
Eastern Baccharis	BAHA	-	-	-	-	-	5	-		-	-
Chinese Tallowtree	SASE5	-	10	-	-	3	4	-		-	-
Dwarf Spikesedge	ELPA5	-	8	3	20	-	-	16		-	-
Square-stem Spikesedge	ELQU	-	-	-	-	-	-	-		-	-
Water Paspalum	PAHY2	-	-	3	-	-	-	-		-	-
Longtom	PALI7	1	-	9	-	-	-	-		-	-
Sprangletop	LEFA	-	-	-	-	-	-	-		-	-

CALCASIEU-SABINE RIVER BASIN - CTU VEGETATION

(NORTH)

SPECIES	SYMB.	11	12	13	14	15	16	17	18	19	20
Marshhay Cordgrass	SPPA	28	11	46	27				15	74	30.
California Bulrush	SCCA	-	16	2	11				-	-	-.
Roseau	PHAU7	-	-	1	-				-	-	-.
Seashore Paspalum	PAVI6	-	-	-	11				-	4	-.
Cattail	TYPHA	4	2	1	2				-	-	-.
Seashore Saltgrass	DISP	-	-	4	22				-	5	-.
Black Needlerush	JURO	13	10	12	-				7	1	-.
Carex Sedge	CAREX	-	4	-	-				-	-	-.
Common Rush	JUEF	-	-	8	-				-	1	-.
Jamaica Sawgrass	CLJA	-	-	-	1				-	-	-.
Rattlebox	DATE8	2	-	-	-				-	-	-.
Coast Bacopa	BAMO	-	-	-	-				-	-	-.
Smartweed	POLYG4	-	1	-	-				-	-	-.
Va. Saltmarsh-Mallow	KOVI	-	-	-	-				-	-	-.
Torpedograss	PARE3	-	1	-	-				-	-	-.
St. Augustinegrass	STSE	-	-	-	-				-	-	-.
Walter's Millet	ECWA	-	-	-	-				-	-	-.
Giant Cutgrass	ZIMI	-	-	-	-				-	-	-.
Wigeongrass	RUMA5	-	-	-	-				-	-	-.
Smooth Cordgrass	SCRO	3	-	3	3				-	-	3.
Bulltongue	SALA	-	7	6	18				-	4	47.
Saltmarsh Bulrush	SCRO	-	-	-	-				5	-	-.
Olney Bulrush	SCOL	-	-	8	2				-	4	7.
Flatsedge	CYPER	-	-	-	-				-	-	-.
Pennywort	HYDRO2	4	-	-	-				-	-	-.
American Lotus	NELU	31	-	-	-				-	-	-.
Paille Fine	PAHE2	4	21	-	-				-	-	-.
Alligatorweed	ALPH	8	-	-	-				-	-	-.
Bushy Bluestem	ANGL2	-	-	-	-				-	-	-.
Eastern Baccharis	BAHA	-	-	-	-				-	-	-.
Chinese Tallowtree	SASE5	-	-	-	-				-	-	-.
Dwarf Spikesedge	ELPA5	-	-	-	-				-	-	-.
Square-stem Spikesedge	ELQU	6	17	-	-				-	-	3.
Water Paspalum	PAHY2	-	-	-	-				-	-	-.
Longtom	PALI7	-	-	-	-				-	-	-.
Sprangletop	LEFA	-	1	-	-				-	-	-.
Softstem Bulrush	SCVA	-	-	1	-				-	1	-.
Bigleaf Sumpweed	IVFR	-	-	1	-				-	-	-.
Marsh Horninglory	IPSA	-	-	1	-				-	-	-.
Deerpea	VILU3	-	-	-	-				-	4	-.
Sesbania	SEEX	-	-	-	-				-	1	-.
White Waterlily	NYOO	-	-	-	6				-	-	-.
Bush Sea-oxeye	BOFR	-	-	-	2				-	-	-.
Maritime Saltwort	BAMI7	-	-	-	7				-	-	-.
Woody Glasswort	SAVI	-	-	-	3				-	-	-.
Gulf Cordgrass	SPSP	-	-	-	-				7	-	-.

CALCASIEU-SABINE RIVER BASIN -CTU VEGETATION

SABINE

SPECIES	1	1A	1B	2	3	4	5	6 & 7	8	9	10
Marshhay Cordgrass	60	32	27	47	4	57	72	68	72	74	31.
California Bulrush	2	-	3	9	16	20	-	3	3	-	-.
Roseau	2	33	2	13	-	4	1	4	-	2	-.
Seashore Paspalum	3	1	7	9	11	-	1	-	7	1	-.
Cattail	-	-	-	1	2	2	1	-	17	10	25.
Seashore Saltgrass	13	4	-	3	1	-	-	-	-	-	16.
Black Needlerush	-	-	-	-	2	-	5	-	-	-	-.
Carex Sedge	2	-	-	13	1	-	-	-	-	-	-.
Deerpea	4	-	-	-	-	-	4	6	-	-	-.
Marsh Morningglory	1	5	-	-	-	1	3	4	-	-	-.
Common Rush	-	5	-	-	-	-	-	-	-	-	-.
Jamaica Sawgrass	-	-	-	-	1	-	-	-	-	-	-.
Rattlebox	-	-	13	-	-	-	-	-	-	-	-.
Coast Bacopa	-	6	-	-	-	-	-	1	-	-	-.
Smartweed	-	-	-	9	-	-	-	-	-	-	-.
Ludwiga	-	--	-	-	6	-	-	-	-	-	-.
Va. Saltmarsh-Mallow	-	-	-	-	-	-	-	1	-	-	-.
Wooly Rose-Mallow		-	-	-	2	-	-	-	-	-	-.
Torpedograss	-	4	3	-	-	-	-	-	-	10	-.
Walter's Millet	-	-	-	3	-	-	-	1	-	-	-.
Giant Cutgrass	-	-	-	-	2	-	-	-	-	-	-.
Buttonbush	-	-	-	-	1	-	-	-	-	-	-.
Purple Pluchea	-	-	7	-	-	-	-	-	-	-	-.
Wigeongrass	1	-	-	-	2	-	-	1	-	-	-.
Smooth Corgrass	-	-	-	-	-	-	-	-	-	3	20.
Bulltongue	-	-	-	-	23	-	1	-	-	-	-.
Saltmarsh Bulrush	-	-	-	-	-	-	1	1	-	-	-.
Olney Bulrush	-	-	-	-	-	-	5	-	-	-	-.
Flatsedge	-	-	-	-	-	-	1	-	-	-	-.
Pennywort	-	-	27	-	-	-	-	-	-	-	-.
White Waterlily	-	-	2	-	3	-	-	-	-	-	-.
American Lotus	-	-	-	-	7	-	-	-	-	-	-.
Paille Fine	-	-	-	-	5	-	-	-	-	-	-.
Alligatorweed	-	-	-	-	3	-	-	-	-	-	-.

CALCASIEU-SABINE RIVER BASIN - CTU VEGETATION

SOUTH

SPECIES	SYMB.	1	2	3	4	5	6	7	8	9
Marshhay Cordgrass	SPPA	46	15	37	66	49	54	57	62	70.
California Bulrush	SCCA	10	1	16	4	6	1	-	-	-.
Roseau	PHAU7	4	-	12	2	11	-	-	-	-.
Seashore Paspalum	PAVI6	3	-	5	-	13	15	9	3	10.
Cattail	TYPHA	1	-	2	-	-	-	-	-	-.
Seashore Saltgrass	DISP	-	-	3	4	3	11	21	18	-.
Black Needlerush	JURO	-	7	-	-	-	-	-	-	3.
Carex Sedge	CAREX	1	-	-	-	-	-	-	-	-.
Marsh Morningglory	IPSA	-	3	-	-	-	2	-	-	-.
Rattlebox	DATE8	1	2	3	-	-	-	-	-	-.
Coast Bacopa	BAMO	-	-	-	-	-	2	1	-	-.
Smooth Cordgrass	SPAL	-	-	-	-	-	-	-	-	20.
Saltmarsh Bulrush	SCRO	2	5	5	1	-	-	4	-	-.
Olney Bulrush	SCOL	9	3	3	-	2	-	-	7	-.
Pennywort	HYDRO2	-	-	1	-	-	-	-	-	-.
White Waterlily	NYOO	-	-	-	-	1	-	-		-.
Bigleaf Sumpweed	IVFR	-	3	-	-	-	-	2	-	-.
Eastern Baccharis	BAHA	-	-	-	4	-	-	2	-	-.
Gulf Cordgrass	SPSP	6	7	-	-	4	1	-	3	-.
Bushy Bluestem	ANGL2	-	-	-	-	-	12	-	-	-.
Duckweed	LEMI2	-	-	-	-	2	-	-	-	-.
Knotgrass	PADI6	-	-	-	16	-	-	-	-	-.
Fibristylis	FICA4	-	-	1	-	-	-	-	-	-.
Sesbania	SEEX	1	-	2	-	-	-	-	-	-.
Goldenrod	SOLID	-	-	-	-	-	-	-	3	-.
Softem Bulrush	SCVA	1	3	-	-	-	-	-	-	-.

APPENDIX D

COMPILATION OF JOHNSONS BAYOU CHRISTMAS BIRD COUNTS CALCASIEU-SABINE RIVER BASIN

Christmas Bird Counts were begun in 1901 in the northeastern United States and are currently conducted nationwide. Each count encompasses an area no greater than 15 miles in diameter. Counts are conducted annually and are held within a 24 hour period (from midnight to midnight) within a three week slot, determined nationally. The counts are published in American Birds. The following is a summary of species and numbers observed on all the counts in the Johnsons Bayou circle from its inception in 1976 until the last published results in 1991.

Additional information included in the counts are the date of the count, number of participants and parties, party-hours and party-miles according to transportation mode, and weather conditions.

	12/26	12/18	12/17	12/16	12/21	12/20	12/19	12/18	12/16	12/22	12/21	12/20	12/18	12/17	12/16	12/15
Species	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Common Loon		5	4		2	1	1	3	4	1	1	14	3	1	6	8
Pied–billed Grebe	104	65	46	21	266	46	41	71	24	110	129	41	153	148	24	80
Horned Grebe								12		1						
Eared Grebe			3				2	58	1	20	3	2	2	1		1
WESTERN GREBE										1						
NORTHERN GANNET											25	5			5	
Am. White Pelican	132	49	476	157	1		307	124	1192	164	817	547	288	395	45	364
BROWN PELICAN											1	8	1		16	1
D.–cr. Cormorant	14	1	6	12		8	35	43	83	287	320	224	584	142	24	339
Olivaceous Cormorant	91	49	508	11	9	568	208	280	166	71	411	147	174	1877	309	89
cormorant sp.					13	3	29	59	10		14					
Anhinga		1			2	1	6	4	2		4	2	2	2		1
American Bittern	4	1	1	1							2	1	2			
LEAST BITTERN	4	1									4				2	
Great Blue Heron	45	76	43	25	26	46	95	67	123	58	73	84	105	89	62	76
Great Egret	100	102		21	15	24	92	87	222	76	227	339	99	941	72	82
Snowy Egret	114	185		46	27	63	86	135	281	58	154	243	40	1079	54	111
Little Blue Heron	45	29	31	5	26		15	37	23	28	52	10	12	17	1	8
Reddish Egret			3				5				1					1
Tricolored Heron	63	33	59	15	7	23	45	25	82	41	96	45	31	39	25	41
Cattle Egret	50	26	21	28	57	56	10	57	27	19	75	71	4	12	7	13
Green–backed Heron	4	12	3	6		1	1	3	1	2	3	3	3	1		4
Blk.–cr. Night–Heron	12	24	9	2		16	13	8	156	29	5	65	8	4	13	2
YEL.–CR. NIGHT–HERON				1												
White Ibis	13	4	57	22	13	70	95	26	113	135	560	249	307	1677	137	141
Glossy Ibis		1									1	4	1			3
White–faced Ibis	43	1635		6		40	2	21		2	755	247	974	2888	20	699
Plegadis sp.			513	300	297		158	51	118	4409		74			35	50
Roseate Spoonbill	161		190			15	68	1	42	28	71	79	73	1750	18	110
Gr. Wh.–fronted Goose	63	106	280	281	96	12	243	259	178	864	755	161	259	100	107	458
Snow Goose	1218	4561	3807	1710	8255	368	4784	10507	7165	7259	16702					1574
Snow Goose (white form)							7461	4995	185	12974	584	1515	3576	2160	215	
Snow Goose (blue form)	605		2777	2457	8760	245	4764	8089	110	3789	597	494	562	356	30	
ROSS' GOOSE							1	1					1	1		2
Canada Goose	10	2						22		3	1	17	27			2
Canada Goose (small form)													3			
Wood Duck							2	2	6	2	1	1	15	5		9
Green–winged Teal	1186	721	5510	52	173	3770	506	376	1178	1308	5476	893	890	1523	2077	303
Mottled Duck	52	10	47	37	7	32	74	58	144	44	495	82	90	59	79	94
Mallard	66	315	55	26	24	57	161	175	60	20	458	24	47	175	52	66
Northern Pintail	182	313	5500	168	190	374	247	325	1179	1234	1666	253	253	398	382	3
Blue–winged Teal	141	268	2162	67	100	348	205	216	251	78	521	256	134	724	294	176
CINNAMON TEAL									1							
Northern Shoveler	229	365	901	73	156	430	174	202	844	1362	444	311	756	1453	1382	459
Gadwall	360	235	104	472	1296	561	619	770	1951	3052	4675	1483	522	2650	1492	568
American Wigeon	18	416	200	570	308	134	26	278	863	1254	299	247	105	1044	803	177
Canvasback	15	8	1062	7		1	5	1	24		5	40		1	3	
Redhead	2		22			14	1	2	2		2			2	1	
Ring–necked Duck	7	1	50		100	3		17	5		20	87	8	3	19	199
Greater Scaup		4	3			117		1	2		2					2
Lesser Scaup	2600	958	196	1		1135	30	220	3734	878	1212	33815	1993	826	2284	1266
scaup sp.			4000	80	605	567	1530	895	385	522				250		
BLACK SCOTER			2								2		2			
SURF SCOTER			1	2	7		1								1	
WHITE–WINGED SCOTER				3			1		3							

	12/26	12/18	12/17	12/16	12/21	12/20	12/19	12/18	12/16	12/22	12/21	12/20	12/18	12/17	12/16	12/15
Species	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
scoter sp.	15									2			3			
Common Goldeneye								1	1					6	26	2
Bufflehead							1		1	8				3		
Hooded Merganser			5		3		5	3	8	6	1	2		1	10	1
COMMON MERGANSER									1							
Red–breasted Merganser	40	17	27	18		3	16	23	9	18	91	9	13	39	1	20
merganser sp.							2									
Ruddy Duck	1500	7	382	8	30		61	87	6	32	2	6	31	34	105	10
duck sp.							540	500		2235				1565		
Black Vulture	1		2					1		1	7		10	20	4	28
Turkey Vulture	8	5	19	6			11	3	5	15	59	20	35	12		42
Osprey	2		1										1			
Black–shouldered Kite													1			
Northern Harrier	50	36	39	37	18	22	23	28	64	41	55	44	83	28	40	62
Sharp–shinned Hawk	1	1	1	6		2	12	6	3	6	8	6	5	1	7	9
Cooper's Hawk						1	1	2			6	2	3	1	3	3
Accipiter sp.									1	2		1	1	1		1
Red–shouldered Hawk	1		1	3	1			2	12	8	5	10	13	1	2	3
BROAD–WINGED HAWK											1					
SWAINSON'S HAWK							1	1								
Red–tailed Hawk	32	23	43	58	30	20	28	56	59	70	61	54	118	44	50	88
Red–tail. (Harlan's) Hawk			1		1											
ROUGH–LEGGED HAWK	2		1												1	
Buteo sp.							2	2								
GOLDEN EAGLE			1a													
American Kestrel	33	50	46	55	18	38	25	17	51	39	43	55	55	18	36	33
Merlin		1	2	2	2	1	2	5	6	6	4	4	5	1	5	9
Peregrine Falcon			1		1	1	1	1		2	6	3	1	2	1	2
Northern Bobwhite										1						
BLACK RAIL											1					
Clapper Rail	3	1	27	7		2	6	8	28	83	7	17	2	2	3	1
King Rail	6	1	1	1		2	21	27	8	57	107	15	3	6	23	25
Virginia Rail	3	1	2	2		1	4	9	3	8	11	1	8	1	2	8
Sora		3		10	1	5	19	12	36	90	137	54	35	9	24	16
rail sp.									4				7			
PURPLE GALLINULE		3		1												
Common Moorhen	414	134	93	327	249	260	1259	414	174	648	1217	685	619	319	751	709
American Coot	873	1430	842	777	12351	325	456	1357	4181	1981	6335	1453	1138	880	516	1359
Black–bellied Plover	50	116	815	51	8	15	96	100	456	317	107	153	163	70	86	46
Snowy Plover			6	8	3		2	15		24	23	11	1	19	14	
Wilson's Plover			1	2			1		4			3				
Semipalmated Plover			3	1	2		3					2	14	4		
Piping Plover		12	17	6		15	4	10	12	9	6	27	4	18	10	
Killdeer	172	231	369	610	155	105	168	182	573	388	159	306	406	757	98	81
Black–necked Stilt	10	62	98	28	71	148	163	133	282	431	537	94	41	125	83	296
American Avocet	19	218	57	3			316	63	285	950	527	74	120	40		40
Greater Yellowlegs	7	16	42	32	6	1	52	28	42	43	27	30	3	2	14	13
Lesser Yellowlegs	8	17	14	67	3	7	30	31	31	20	10	8	16	9	26	18
SOLITARY SANDPIPER								1								
Willet	15	149		65	79	39	74	41	97	255	31	142	58	16	38	14
Spotted Sandpiper			5	1	3		1	4	2		1	2	5	4	2	
Whimbrel			3	6			2			4			1			
Long–billed Curlew		26	21	4	1		216	3	45	596	29	21	9	191	40	2
Marbled Godwit			1			6	2		18	35			2	2	39	
Ruddy Turnstone			5	2	3	7	28	5	2	1		4	2			

Species	12/26 1976	12/18 1977	12/17 1978	12/16 1979	12/21 1980	12/20 1981	12/19 1982	12/18 1983	12/16 1984	12/22 1985	12/21 1986	12/20 1987	12/18 1988	12/17 1989	12/16 1990	12/15 1991
Red Knot	3		2				126		65		3		8		6	
Sanderling	85	462	280	110	29	45	105	176	614	149	135	177	93	322	41	55
Western Sandpiper		12	150	2	8	17	846	43	230	765	41	300	197	15	16	
Least Sandpiper	25		80	1	1		79	28	180	42	32	150	71	16	23	12
Dunlin		40	2504	275	154	6	587	52	900	2781	74	778	75	26	70	
peep sp.								105						8		
STILT SANDPIPER				1					18	11	8					
Short–billed Dowitcher			11				80		602	27		28	180	24	45	
Long–billed Dowitcher	8	5	5		8	1	85	19	54	28		4	257	12	11	16
dowitcher sp.				201	13	90	800			244		104		16	3	
Common Snipe	41	55	12	126	27	56	49	85	66	50	41	3	86	27	45	41
American Woodcock		1	8	2	19	3		2			3		8	1		4
WILSON'S PHALAROPE											1					
RED–NECKED PHALAROPE										1						
PARASITIC JAEGER														130		
jaeger sp.								1		1	3					4
Laughing Gull	6	42	35	58	79	47	1447	998	1957	6493	3427	849	793		576	733
Bonaparte's Gull	1	37	80	3	2	6	6	137	538	456	172	80	19	7	96	115
Ring–billed Gull	517	1310	1289	222	106	406	1761	525	3381	5407	994	2110	1283	210	1421	689
Herring Gull	48	157	6	22	9	117	138	76	613	75	102	193	84	5	58	14
LESSER BLACK–BACKED GULL									1							
gull sp.							200	45								
Gull–billed Tern			1				2			1		1	2			
Caspian Tern	14	48	49	5	14	12	50	59	81	115	68	32	16	10	25	23
Royal Tern	9	77	22	12	26	29	23	6	70	467	21	133	56	1	47	53
SANDWICH TERN			1				1									
Common Tern			1			4	2	6	3	2		15				
Forster's Tern	27	55	38	2	3	10	194	97	386	602	582	211	446	9	66	107
BLACK TERN							1									
Black Skimmer	8		2				147		180	55	201	130	85			
Rock Dove		9		12		18	2	3	17	57	58	54	63	20	18	7
White–winged Dove				1				1			1		1		1	
Mourning Dove	13	28	59	19	53	20	46	21	20	35	43	96	56	41	168	71
INCA DOVE			2													
COMMON GROUND–DOVE				1		2				2					2	
small dove sp.								1								
Groove–billed Ani		2	cw	17	2	2	5	12		7	4	18				
Common Barn–Owl				1	1		1	3		1	3	1	5		1	
Eastern Screech–Owl								2	1				1	2		
Great Horned Owl				1	1			1	3	3	2	1		3	3	3
Burrowing Owl							2		1	2	1		1			
CHUCK–WILL'S–WIDOW			1			3	2		2	2	1			2	1	1
WHIP–POOR–WILL				1											1	1
Caprimulgus sp.													1			
Archilochos sp.				1					3			1				
ANNA'S HUMMINGBIRD				1												
Selasphorus sp.							3		1							
hummingbird sp.							1									
Belted Kingfisher	40	46	32	47	10	28	43	47	34	31	34	34	67	83	38	45
RED–HEADED WOODPECKER									1			1				
Red–bellied Woodpecker					2	1	1			1		14				
Yellow–bellied Sapsucker	3	11	5	11	17	2	16	15	17	20	18	20	19	14	12	19
Downy Woodpecker					4		1		3		4	33	4		3	
Hairy Woodpecker	1				1											
Northern Flicker	45	22	1	86	46	52	75	56	83	88	93	225	52	53	47	82

	12/26	12/18	12/17	12/16	12/21	12/20	12/19	12/18	12/16	12/22	12/21	12/20	12/18	12/17	12/16	12/15
pecies	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
. (RED–SHAFT.) FLICKER												1				
AST FLYCATCHER				1		1			2			1	1			
mpidonax sp.							1	1			1					
stern Phoebe	6	3	10	50	13	32	45	48	77	58	75	67	148	77	62	92
rmilion Flycatcher	1	1		2		2		1		3	3	3	6	3	1	
H–THROATED FLYCATCHER										1	1	1	1			
ESTERN KINGBIRD			1						1							1
ellow–bellied kingbird sp.																1
ISSOR–TAILED FLYCATCHER				1												
RNED LARK			3													
RN SWALLOW											1					
e Swallow	53	73	634	145	14	108	208	489	5219	1260		506	2553	3	41	727
. ROUGH–WINGED SWALLOW	4															
wallow sp.							4									
ue Jay	4	3	5	41	17	17	28	28	52	43	49	65	25	37	37	48
MERICAN CROW					1		1					1	1		1	
h Crow	351	325	40	415	187	505	137	25	267	463	303	1008	570	397	256	370
row sp.							115									
rolina Chickadee													1			
FTED TITMOUSE									10							
d–breasted Nuthatch					2											
own Creeper					3				2	1		1	1			1
rolina Wren						1	3	2	1	2	2	7	2	1	7	6
WICK'S WREN				1							2				1	
use Wren	1	13	2	92	20	6	82	128	168	151	114	179	181	54	126	116
nter Wren	1			2		1	1	1	1		3	3	1		3	2
dge Wren	2	6	28	10	4	27	169	90	167	239	154	420	168	22	67	35
rsh Wren	2	3	8	18	4	3	49	32	94	166	60	129	77	13	63	42
lden–crowned Kinglet				3	65	2	14	10	44	72	74	57	237	18	69	9
by–crowned Kinglet	126	43	59	283	204	56	345	283	294	259	379	224	480	146	340	180
ue–gray Gnatcatcher	39	72	34	319	65	70	130	197	125	50	97	133	159	65	65	75
STERN BLUEBIRD	1											20	1			4
ERY								1								
rmit Thrush	8	2	1	32	39	1	22	13	51	36	8	51	3	34	50	91
OOD THRUSH		3	1	1	1											
nerican Robin	128	29	19	81	285	5	88	89	23	198	2012	1045	55	672	463	100
ay Catbird	1	2		4			6	9	6	3	9	6	4	6	4	2
rthern Mockingbird	29	25	11	91	22	41	63	35	90	116	139	116	96	71	89	125
own Thrasher	32	17	18	41	110	65	67	80	272	85	58	170	113	50	41	55
ter Pipit		6	6	96		17	306	28	66	25	4	16	15	91	2	13
rague's Pipit				2			3	2					1			
dar Waxwing	7	19		30	16		222	60	1	2	146	16		73		38
ggerhead Shrike	81	113	118	73	42	84	72	56	91	92	124	102	133	51	63	102
ropean Starling	51	579	52	771	8	1269	136	251	710	263	535	1329	597	439	814	290
ite–eyed Vireo	16						2	1	3	4	6	1	1	1		
litary Vireo	7		1	15	1	3	10	7	13	11	12	18	20	9	18	18
NNESSEE WARBLER			1	1												
ange–crowned Warbler	4	3	6	66	32	64	117	139	70	68	74	80	194	94	120	132
SHVILLE WARBLER				1					1							
lash. Warb./Oporonis sp.										1						
RGINIA WARBLER														cw		
CY'S WARBLER														cw		
ermivora sp.															1	
RTHERN PARULA								1			1					
LLOW WARBLER												1		1		

	12/26	12/18	12/17	12/16	12/21	12/20	12/19	12/18	12/16	12/22	12/21	12/20	12/18	12/17	12/16	12/15
Species	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CHESTNUT–SIDED WARBLER													2			
MAGNOLIA WARBLER		1														1
Yellow–rumped Warbler	194	49	119	240	239	425	884	111	110	314	2276	940	497	610	918	717
Yel.–rump. (Audubon's) W.						1										
BLACK–THROATED GRAY WARBLER							1	1							1	
TOWNSEND'S WARBLER								1								
BLACK–THROATED GREEN WARBLER								2	2				1			
BLACKBURNIAN WARBLER				1												
Pine Warbler		3			3	1	3	5	4	3	12	46	38	2	6	14
PRAIRIE WARBLER									1							
Palm Warbler	2	6	1	21	2	8	30	11	17	30	12	2	22	7	13	7
Palm Warbler (yellow race)									1							
BAY–BREASTED WARBLER			2				1									
BLACK–AND–WHITE WARBLER			1	2	5	2		3	1	1			1			
AMERICAN REDSTART			1	1									1			2
PROTHONOTARY WARBLER								1								
WORM–EATING WARBLER					1											
OVENBIRD								1	1		1		1	1		
Northern Waterthrush							1	1		1	1	2				4
KENTUCKY WARBLER		1														
Common Yellowthroat	2	8	1	28	13	18	67	53	103	104	154	120	183	48	130	84
HOODED WARBLER													1			
Wilson's Warbler		1	1	2	6		3	3	9	2	3	5	3		1	2
YELLOW–BREASTED CHAT				1								2		2	1	
SUMMER TANAGER																1
WESTERN TANAGER			1	1												1
Northern Cardinal	78	71	29		120	75	243	248	303	299	288	219	244	173	179	195
BLUE GROSBEAK													cw		1	
BLUE BUNTING				1												
INDIGO BUNTING				2			3	1	10	4	3				2	2
PAINTED BUNTING									1							
GREEN–TAILED TOWHEE				1								1				
RUF.–SIDED (SPOTTED) TOWHEE													1			
Rufous–sided Towhee					2		4		2	2	1	21		1	3	
Chipping Sparrow								3	17	2	2	18	1			1
Field Sparrow	9				33	1		6	8	2	4	38	1	10		3
Spizella sp.				1												
Vesper Sparrow					3	2		1				4				
Savannah Sparrow	72	123	103	67	60	41	366	190	338	773	148	936	310	52	108	51
Grasshopper Sparrow				8	1		3			2	1	1				2
HENSLOW'S SPARROW	1											1				
LeConte's Sparrow			11	6		7	40	6	97	12	25	25	6		1	9
Sharp–tailed Sparrow	8		7	5	1	18	4	4	84	49	43	129	63	3	1	
Seaside Sparrow	5	2	161	45	40	61	65	20	578	400	116	685	252	53	15	
Fox Sparrow	8	1				3	2			2		5		2		
Song Sparrow	21	16	1	11	87	7	93	86	135	54	59	443	171	70	197	229
Lincoln's Sparrow	4	25	1	27	15	5	66	65	114	37	1	42	24		51	193
Swamp Sparrow	5	86	54	311	155	27	867	585	1740	1277	768	1378	703	300	578	676
White–throated Sparrow	16	15	31	42	127	49	78	117	513	61	115	615	157	183	245	397
White–crowned Sparrow	8	6	6	33	15	4	9			8	2	2	1	1	55	9
HARRIS' SPARROW														1		1
Dark–eyed Junco	4	1	3		1	1	1	1	1		3	12	7	2	4	23
sparrow sp.							3									
LAPLAND LONGSPUR								1				3				
longspur sp.							4									

	12/26	12/18	12/17	12/16	12/21	12/20	12/19	12/18	12/16	12/22	12/21	12/20	12/18	12/17	12/16	12/15
Species	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Red–winged Blackbird	1812	2606	1715	2405	3670	5592	3636	5630	8730	6720	10741	8989	3937	6297	6139	2074
Eastern Meadowlark	116	188	233	284	183	84	267	232	418	504	381	618	214	80	150	139
WESTERN MEADOWLARK				1			2					1	-			
Rusty Blackbird	1				2							11				
Brewer's Blackbird						2		2				36				
Great–tailed Grackle	30	40	13	29	1	1	2	45	38	67	27	209	10	10	62	141
Boat–tailed Grackle	500	1092	1337	240	191	580	950	979	2165	2614	3497	840	1251	1321	2026	743
Common Grackle	105	101	35	16	1	340	3	5			57	87	13	1		
Brown–headed Cowbird	52	400	26	157	113	258	165	16	7	109	179	186	62	15	41	
Northern Oriole		1					1		1		1	1				
PURPLE FINCH							1				2					4
HOUSE FINCH																1
Pine Siskin		12								1	4	9				
American Goldfinch	9	25	3	726	28		602	138	21	399	68	69	67	62	186	185
House Sparrow	2	35	25	3	19	13	32	10	4	67	64	131	34	15	2	
TOTAL SPECIES	123	125	147	155	125	126	166	163	160	156	168	170	164	144	145	144
OBSERVERS	18	29	15	25	17	24	36	33	48	47	45	37	37	28	25	24
PARTIES	8	12	9	9	9	11	10–12	10–11	13–15	13–17	14–18	16–20	12–16	10–14	10–12	10–11
PARTY–HOURS:																
FOOT	28	37	22	40	29.25	40	61	65.5	89	89.5	106	62.5	84.25	57.5	47.75	45.25
CAR	25	38	29	35	21	29	4	4	12.5	9.5	23	21	11.5	12.5	11	11.5
BOAT	19	12	10			8	6	5.5	10	5	4	8	5	3.5	5.25	2.5
PARTY–MILES:																
FOOT	20	54	16	36	39.75	36	38	43	60	59	97	47	56.25	36.5	35	30.5
CAR	142	236	139	182	153	225	50	54	69	92	102	125.5	99	92	52	48
BOAT	64	67	45			60	15	12	27	27	33	23	25	30	8	23
OWLING: HRS				1.5	0.75			2	0.5	0.5	1			1		
MILES								5	0.5	0.25	0.5			35		
TEMP. (F)	36–55		40–60	48–65	30–40	35–50	49–72	45–58	64–74	40–66	45–56	54–63	32–53	29–34	50–60	35–55
WIND: (MPH)	5–15		10–30	0–10	10–30	10–35	5–10	8–15	0–10	0–3	2–10	7–14	10–15	12–15	10	5–15
DIRECTION	NNW		NE	NW	NE	E	N	N–NW	E	E	NE	N	N	NW	SE	NW

APPENDIX E

COMPILATION OF SABINE CHRISTMAS BIRD COUNTS
CALCASIEU-SABINE RIVER BASIN

Christmas Bird Counts were begun in 1901 in the northeastern United States and are currently conducted nationwide. Each count encompasses an area no greater than 15 miles in diameter. Counts are conducted annually and are held within a 24 hour period (from midnight to midnight) within a three week slot, determined nationally. The counts are published in American Birds. The following is a summary of species and numbers observed on all the counts in the Sabine circle from its inception in 1942 until the last published results in 1991.

Additional information included in the counts are the date of the count, number of participants and parties, party-hours and party-miles according to transportation mode, and weather conditions.

	12/23	1/1	12/23	12/29	12/28	1/2	1/1	12/31	12/30	12/28	12/27	12/27	1/1
Species	1942	1950	1950	1951	1952	1954	1955	1955	1956	1957	1958	1959	1961
Common Loon			1	2	2	2		3	2	1		7	7
Pied–billed Grebe	12	5	3	23	21	9	24	38	11	49	131	11	99
Horned Grebe				2		4	3	14	3	11		1	2
RED–NECKED GREBE													
Eared Grebe						1	cp	16	3	1			
WESTERN GREBE													
NORTHERN GANNET													
Am. White Pelican		cw	196	51	208	104	99	476	202	98	426	240	146
BROWN PELICAN		26	176	96	147	90	110	978	90	19			
D.–cr. Cormorant	23	13	6	6	53	27	36	39	2	35	923	136	251
Olivaceous Cormorant			17	5	10	2	13	19	2	109	70	252	94
cormorant sp.							1350	474	27	180			
Anhinga	16					1				3		1	
American Bittern	3		4	7	4	2	19	16	8	6	6	4	14
LEAST BITTERN					1	1		2					
Great Blue Heron		10	74	79	108	70	71	107	60	177	131	66	87
Great Egret	7	32	9	42	46	65	167	96	28	114	277	139	335
Snowy Egret	4	36	108	44	63	88	123	186	18	438	226	247	238
Little Blue Heron		16	1	10	3	7		12	3	28	139	60	127
Reddish Egret							1					2	1
Tricolored Heron	3	2	5	17	44	24	3	210	14	105	212	142	254
Cattle Egret								2					1
Green–backed Heron									2	1		3	
Blk.–cr. Night–Heron		1	8	12	11	25	34	4	91	16	7	128	115
Yel.–cr. Night–Heron	20		2	1		1					4	4	5
White Ibis			80	10	1	22	27	cp	200	56		357	65
Glossy Ibis		cw											
White–faced Ibis			131	68	4	1259	2036	881	250	279	358	5627	2103
Plegadis sp.													
Roseate Spoonbill										250		32	133
FULVOUS WHISTLING DUCK													
BLACK–BELLIED WHISTLING DUCK													
Gr. Wh.–fronted Goose			300	50	15	16	210	6	400	500	1500	30	30
Snow Goose													
Snow Goose (white form)	670	2942	35000	32000	17000	4271	8000	25085	20000	7000	6000	5000	2450
Snow Goose (blue form)	360	9829	20000	32000	24000	12992	22000	70538	30000	35000	28000	12000	45500
ROSS' GOOSE													
Canada Goose	460	31	21	315	137	105	1457	3316	400	3300	862	404	92
Canada Goose (small form)				15			2						
Wood Duck	7		2		3		2	4	2		4		
Green–winged Teal	50	4	193	500	64	2400	2140	7566	11	19	282	55	274
AMERICAN BLACK DUCK		66	28	100	5	5	4	6	10	4	23	6	20
Mottled Duck	5			50		6	4	2	25	52	8	24	18
Black or Mottled Duck						6	10	97					
Mallard	1080	81	55	20000	1193	1045	445	1084	275	121	1316	2040	661
Northern Pintail	50	46	137	10500	233	3652	151	1200	123	308	233	3762	2973
Blue–winged Teal			48	2500		6	10	206	25	14	156	695	638
CINNAMON TEAL													
Northern Shoveler		7	84	1000	266	1018	22	660	416	124	104	980	3554

	12/23	1/1	12/23	12/29	12/28	1/2	1/1	12/31	12/30	12/28	12/27	12/27	1/1
Species	1942	1950	1950	1951	1952	1954	1955	1955	1956	1957	1958	1959	1961
Gadwall	186	86	29	2000	517	5520	113	602	210	102	65	215	2100
American Wigeon		76	15	1000	26	1572	325	326	180	136	147	1220	2773
Canvasback	2		12		10	52	38	313	12	2			
Redhead			34			2	cp	cp	24	2			9
Ring–necked Duck	11		10	4		2	30	2		4		1502	9
Greater Scaup						1		9		1	6		2
Lesser Scaup	15	60		100		61	1	24	61	58	513	990	350
scaup sp.			81		4	3056	134	522		171			1
OLDSQUAW													
BLACK SCOTER													
SURF SCOTER													
WHITE–WINGED SCOTER			2										
scoter sp.					13	23							
Common Goldeneye	1	1			1		13	5		9	25	5	10
Bufflehead					1	2	3	12		2	4		32
Hooded Merganser						7	13	30	9		4	5	38
COMMON MERGANSER								1					
Red–breasted Merganser			45		3	3	cp	64	5	6	14		29
merganser sp.													
Ruddy Duck		1	115		13	13	8	2	2		7	4	11
duck sp.							3000						
Black Vulture	15	7	14	43	15	4	10	12	4	19	1	5	2
Turkey Vulture	3	4	13	21	28	8	11	32	5	9	26	7	18
Osprey													
Black–shouldered Kite									1				
BALD EAGLE													
Northern Harrier	10	40	56	134	58	79	33	136	61	44	45	25	79
Sharp–shinned Hawk			1		1	1	1	1	1		1	1	
Cooper's Hawk			2		5	1	1	cp				1	
Accipiter sp.													
Red–shouldered Hawk			5	3	2	2	5	cp	4	3	2	1	2
BROAD–WINGED HAWK												1	
SWAINSON'S HAWK													
Red–tailed Hawk	4	1	17	6	26	21	19	15	10	4	18	18	52
Red–tail. (Harlan's) Hawk												1	
ROUGH–LEGGED HAWK				1				1					2
GOLDEN EAGLE													
American Kestrel	1	2	23	120	26	41	23	20	62	24	72	32	35
Merlin				1		1	1	1	4	1	5	4	1
Peregrine Falcon		cw		1	1	1	2	1	1	1	2	4	5
Northern Bobwhite			20	4	19	20	7	4	24	5	11	25	37
SANDHILL CRANE			2										
Yellow Rail													
BLACK RAIL								1					
Clapper Rail		21	34	3	11	26	3	8	2	1	60	36	27
King Rail	1		8	10	2	100	10	5	16	19	14	25	19
Virginia Rail		1	1			cw	4	4	1	1	6	3	1
Sora		15	2		2	16	12	16		5	13	9	1
rail sp.													

	12/23	1/1	12/23	12/29	12/28	1/2	1/1	12/31	12/30	12/28	12/27	12/27	1/1
Species	1942	1950	1950	1951	1952	1954	1955	1955	1956	1957	1958	1959	1961
PURPLE GALLINULE											1	2	
Common Moorhen	5	5	2	1		14	2	6		3	30	47	398
American Coot	732	90	715	100	5	22	5	210	155	2580	10917	3500	4782
Black–bellied Plover		5	145	30	126	205	72	75	14	113	105	74	158
Snowy Plover			9		4	4	6	4	2	3			
Wilson's Plover			4		1								
Semipalmated Plover				3	9	3	10	10	1	7	22	8	10
Piping Plover			2		5	1		10			2	3	6
Killdeer		166	210	151	147	475	231	444	830	164	347	176	406
Black–necked Stilt													4
American Avocet			13	9	14	68			55	49	7	195	151
Greater Yellowlegs		59	32	25	11	73	85	50	517	23	29	16	58
Lesser Yellowlegs		4	42	32		54	22	41	46	78	14	64	244
SOLITARY SANDPIPER													
Willet			60	55	98	9	28	43	27	35	5	31	131
Spotted Sandpiper		1	1		1		1	3	3	3	3	1	5
Whimbrel												2	
Long–billed Curlew			3	3	2		15	19	5		2	7	113
Marbled Godwit									2	1	2		
Ruddy Turnstone			20	2	26	36	25	46	39	10	13	54	33
Red Knot													
Semipalmated Sandpiper		1	176	3	4	3	109	203	17	40	310	100	8
Sanderling		8	67	34	47	49	66	56	34	60	38	86	
Western Sandpiper		150	365	415	210	57	45	20	27	129	93	103	255
Least Sandpiper			178	22	111	134	64	316	80	110	4	75	176
PECTORAL SANDPIPER			3										
PURPLE SANDPIPER													
Dunlin		350	263	13	853	270	419	149	37	73	431	141	473
Ereuntes sp.													
peep sp.							1000	450					
STILT SANDPIPER													
sandpiper sp.													
Short–billed Dowitcher			6					x			4	1	8
Long–billed Dowitcher			17				17	x				2	20
dowitcher sp.		450	223	13	25	304	211	854	124	250			
Common Snipe		4	29	178	13	149	179	102	34	25	152	56	76
American Woodcock			4	1	3	2	1				3	7	
phalarope sp.													
POMARINE JAEGER													
PARASITIC JAEGER													
Laughing Gull		42	54	441	263	195	73	2581	485	34	621	284	195
FRANKLIN'S GULL													
Bonaparte's Gull		1	135	240	36	8	91	511	78	21	16	42	26
GRAY GULL													
Ring–billed Gull		102	252	728	419	359	484	1278	500	360	493	270	427
CALIFORNIA GULL													
Herring Gull	2	82	94	295	104	103	73	311	224	63	133	243	189
THAYER'S GULL													
GLAUCOUS GULL													

Species	12/23 1942	1/1 1950	12/23 1950	12/29 1951	12/28 1952	1/2 1954	1/1 1955	12/31 1955	12/30 1956	12/28 1957	12/27 1958	12/27 1959	1/1 1961
GREAT BLACK–BACKED GULL													
BLACK–LEGGED KITTIWAKE						1							
gull sp.													
Gull–billed Tern			6	19	32	14	10	6	17	10	13	7	34
Caspian Tern		16	23	5	10	6	50	27	7	9	34	14	36
Royal Tern		40	52	65	71	228	105	98	71	34	106	15	43
Sandwich Tern			4										
Common Tern			4	4	9	17	4	4	2	2	10	5	3
Forster's Tern		17	32	68	91	95	108	111	83	143	70	71	152
LEAST TERN			1										
BLACK TERN													
Black Skimmer				77	551	154	67	1100	170	450	650	470	340
Rock Dove												3	
White–winged Dove													
Mourning Dove		cw	24	79	31	27	68	94	49	2	29	8	7
INCA DOVE													
Common Ground–Dove			3		1	1	3		2		5		
MONK PARAKEET													
YELLOW–BILLED CUCKOO												6	
Groove–billed Ani													
Common Barn–Owl			1		5	14	3			1	3	12	11
Eastern Screech–Owl			2		1	3	6	3		1	6	7	5
Great Horned Owl						1				1	2	1	
Burrowing Owl					2	1	2	cp			3	1	1
BARRED OWL			1		2		1	1	2			1	
LONG–EARED OWL													
SHORT–EARED OWL					1	2	3				2		4
SAW–WHET OWL													
owl sp.													
Lesser Nighthawk													
nighthawk sp.													
CHUCK–WILL'S–WIDOW													
WHIP–POOR–WILL													
Caprimulgus sp.													
BUFF–BELLIED HUMMINGBIRD													
RUBY–THROATED HUMMINGBIRD													
BLACK–CHINNED HUMMINGBIRD													
Archilochos sp.													
ANNA'S HUMMINGBIRD													
RUFOUS HUMMINGBIRD													
Selasphorus sp.													
hummingbird sp.													
Belted Kingfisher		20	31	36	23	28	29	152	28	41	67	86	58
RED–HEADED WOODPECKER							5		2		5		2
Red–bellied Woodpecker					3	3	4	12	17	4	9	8	3
Yellow–bellied Sapsucker			2	1	3	1	7	28	10	16	14	14	8
Downy Woodpecker			2	1	1		4		6		2	6	3
Hairy Woodpecker											2	1	1
Northern Flicker		1	17	17	52	34	108	59	57	35	29	35	18

Species	12/23 1942	1/1 1950	12/23 1950	12/29 1951	12/28 1952	1/2 1954	1/1 1955	12/31 1955	12/30 1956	12/28 1957	12/27 1958	12/27 1959	1/1 1961
LEAST FLYCATCHER													
Empidonax sp.													
Eastern Phoebe	2	5	43	8	17	11	20	22	22	12	15	14	4
SAY'S PHOEBE													
VERMILION FLYCATCHER	2		3				1	2	2	1		2	2
ASH–THROATED FLYCATCHER													
BROWN–CRESTED FLYCATCHER													
COUCH'S KINGBIRD													
WESTERN KINGBIRD													
EASTERN KINGBIRD													
yellow–bellied kingbird sp.													
SCISSOR–TAILED FLYCATCHER													
HORNED LARK												8	
BARN SWALLOW													
Tree Swallow		65	29	2			253	12	850	696	384	1048	952
NO. ROUGH–WINGED SWALLOW										20	1		
swallow sp.													
Blue Jay		8	57	39	49	54	61	33	38	12	47	22	9
AMERICAN CROW									1		6		
Fish Crow	8	22	13	53	31	12	29	136	11	25	228	176	19
crow sp.													
Carolina Chickadee		1	2	1	1	4	2				2		3
Tufted Titmouse												1	
RED–BREASTED NUTHATCH							1						
nuthatch sp.													
Brown Creeper					4	6	6		6		2	1	
Carolina Wren			1	7	5	4	14	3	3		1	3	
BEWICK'S WREN			1						1				
House Wren			29	1	30	22	35	18	4	20	20	32	8
Winter Wren				2	2	3	8	3		1		6	4
Sedge Wren		28	3	51	10	57	120	5		8	70	90	13
Marsh Wren	3	12	40	2	42	45	98	4		3	21	17	10
Golden–crowned Kinglet				22	1	13	33	4				18	1
Ruby–crowned Kinglet	1	10	93	23	39	114	126	62	47	56	60	113	111
Blue–gray Gnatcatcher		10	198	48	39	49	47	48	57	106	117	129	77
Eastern Bluebird													
Hermit Thrush			2	1	6	6	15	22	4	4	1	9	1
WOOD THRUSH													
American Robin		2	331	18	218	181	175	278	9	108	19	127	419
VARIED THRUSH													
Gray Catbird						1				3		4	4
Northern Mockingbird	1	4	185	88	138	46	133	121	72	69	48	65	15
Brown Thrasher		3	45	39	74	36	119	26	77	16	68	56	28
SAGE THRASHER													
CURVED–BILLED THRASHER													
Water Pipit		16	424	167	319	741	598	463	507	45	246	324	334
Sprague's Pipit			1	4	10	4	65	3	12	3	2	9	91
Cedar Waxwing			122		4	20	14	39	2	35	118	21	
Loggerhead Shrike	8	32	72	324	70	72	94	102	97	54	85	92	60

	12/23	1/1	12/23	12/29	12/28	1/2	1/1	12/31	12/30	12/28	12/27	12/27	1/1
Species	1942	1950	1950	1951	1952	1954	1955	1955	1956	1957	1958	1959	1961
European Starling		1150	1011	10000	889	1144	1692	1604	1500	349	506	620	3045
White–eyed Vireo								2	1		1	2	4
BELL'S VIREO													
Solitary Vireo		1	11	2		6	4	6		1	4	3	3
PHILADELPHIA VIREO													
RED–EYED VIREO													
Vermivora sp.													
TENNESSEE WARBLER													
Orange–crowned Warbler		1	35	12	21	17	38	15	11	10	33	43	24
NASHVILLE WARBLER													
VIRGINIA'S WARBLER													
NORTHERN PARULA											1		
TROPICAL PARULA													
YELLOW WARBLER						2							
MAGNOLIA WARBLER													
Dendroica sp.													
Yellow–rumped Warbler		23	150	48	39	33	61	644	5	211	48	8	7
Yel.–rump. (Audubon's) W.													
BLACK–THROATED GRAY WARBLER					2	2	1						
BLACK–THROATED GREEN WARBLER													
YELLOW–THROATED WARBLER									1				
Pine Warbler		1	1		1		11	1	18			4	
PRAIRIE WARBLER													
Palm Warbler			1	12	5	5	4	9	11	2	3	2	1
BAY–BREASTED WARBLER													
BLACK–AND–WHITE WARBLER		1	1					1				3	
OVENBIRD													
Northern Waterthrush													
Opornis sp.													
MacGILLIVRAY'S WARBLER													
Common Yellowthroat		1	24	44	37	63	83	21	8	9	42	38	29
Wilson's Warbler					3	5	1		8	3	1	2	
American Redstart								1	1				
YELLOW–BREASTED CHAT											1		1
SUMMER TANAGER													
WESTERN TANAGER													
Northern Cardinal		6	135	102	109	84	126	122	93	47	54	59	33
ROSE–BREASTED GROSBEAK													
BLACK–HEADED GROSBEAK													
Pheucticus sp.													
BLUE GROSBEAK													
INDIGO BUNTING													
PAINTED BUNTING													
Passerina sp.													
Rufous–sided Towhee			6	4	4	3	17	5	7	4	8	4	2
Ruf.–s. (SPOTTED) Towhee			1		8	1	1						
AMERICAN TREE SPARROW											4		
Chipping Sparrow											2		
CLAY–COLORED SPARROW													

	12/23	1/1	12/23	12/29	12/28	1/2	1/1	12/31	12/30	12/28	12/27	12/27	1/1
Species	1942	1950	1950	1951	1952	1954	1955	1955	1956	1957	1958	1959	1961
Field Sparrow						2	8	13	8		5		
Vesper Sparrow					19	1	3	1	30	1	9	4	1
LARK SPARROW							cp				1		
Savannah Sparrow	5	45	87	97	94	284	270	91	51	26	105	207	205
Grasshopper Sparrow						1	26	3					1
LeConte's Sparrow			2	16		1	2	4				3	2
Sharp–tailed Sparrow			22	15	20	25	21	28	1	8	29	14	18
Seaside Sparrow			157	68	56	190	216	162	45	2	117	42	44
Fox Sparrow						cw	1	1	1		7		1
Song Sparrow			18	8	36	71	273	72	46	37	23	34	15
Lincoln's Sparrow			2	3		1	7	1		1	14	37	3
Swamp Sparrow	6	68	34	47	66	74	61	99	13	65	174	89	64
White–throated Sparrow			13	47	44	22	268	46	136	15	372	111	92
White–crowned Sparrow			1	44	12	1	15	7	2		3	24	
HARRIS' SPARROW				1	1						3		1
sparrow sp.													
Dark–eyed Junco					2	cw	cp	1		1		1	2
Dark–eyed (OREGON) Junco													
Lapland Longspur													
longspur sp.													
Red–winged Blackbird	155	950	1090	5000	859	3101	3012	4315	2500	1760	5308	1725	2905
Eastern Meadowlark	5	277	152	142	152	190	347	754	1675	103	237	236	324
WESTERN MEADOWLARK			2	5		9	3	1	1		6	9	1
YELLOW–HEADED BLACKBIRD													
Rusty Blackbird											5		
Brewer's Blackbird				5	7		6	4		150	12	1	8
Great–tailed Grackle							x	x	x	x	x	x	
Boat–tailed Grackle	21						x	x	x	x	x	x	3114
Cassidix sp.		416	411	2000	1232	827	222	5668	1360	1280	1046	824	
Common Grackle		2	2		18	3	12	10	160		85	2	10
BRONZED COWBIRD													
Brown–headed Cowbird		7		4	2	6	72	23	409	46	16	51	25
blackbird sp.												1	
Northern Oriole												1	
No. (BULLOCK'S) Oriole						cw		1					
SCOTT'S ORIOLE											1		
oriole sp.							1						
Purple Finch							16	10					
HOUSE FINCH													
Pine Siskin					2				1	2		1	
American Goldfinch		1	19	5	47	5	132	50	17		10	60	31
House Sparrow		35	34		32	60	171	78	125	37	131	140	132
TOTAL SPECIES	46	83	142	124	142	153	156	153	143	138	155	163	153
OBSERVERS	2	1	10	5	11	7	23	18	19	10	22	11	24
PARTIES	1	1	6	4	7	11	12	10	7	8	6	6	9

	12/23	1/1	12/23	12/29	12/28	1/2	1/1	12/31	12/30	12/28	12/27	12/27	1/1
Species	1942	1950	1950	1951	1952	1954	1955	1955	1956	1957	1958	1959	1961
PARTY–HOURS:	6												
FOOT		4	42	22	52	84	79.5	56.5	37	35	47	43	44
CAR		3	14	14	11	9.5	14	17.5	30	12	16	13	24
BOAT		4	9	8	9	4	11.5	23	4	17	8	7	10
AIRBOAT													
MARSH BUGGY								4					
WEASEL							1						
HELICOPTER								3					
PLANE						0.5							
PARTY–MILES:													
FOOT	1	5	51	15	40	78	64.5	46	29	32	51	37	50
CAR	31	65	97	104	163	102	133	227	404	209	154	270	205
BOAT		10	15	28	20	34	47	62	15	50	66	75	38
AIRBOAT													
MARSH BUGGY								3					
WEASEL							4						
HELICOPTER								100					
PLANE						75							
OWLING: HRS.		1				12	4.5					3	3.5
MILES						52	41.5					75	60
FEEDER: #													
HRS.													
TEMP. (F)	50–64	50–65	52–70	65–60	46–64	53–66	55–70	33–55	47–71	45–60	48–62	47–70	38–50
WIND: (mph)	light	5–20	4–18	4–12	0–7	4–12–0	0–7	0–10	5–12	3–16	3–18	8–28	8–15
DIRECTION	NE	N	E–NE	SW	N	SW	S–SW	NNE–NE	W–SW	N–NNW	SW–N–E	SE–NW	NW

	12/29	12/27	12/27	12/27	12/18	12/30	12/15	12/28	12/20	12/18	12/17	12/16	12/15
Species	1962	1964	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Common Loon	2	5	4	3	1		6	1	1	1	1		3
Pied–billed Grebe	104	68	113		86	171	124	52	153	136	63	1159	438
Horned Grebe	1	5	6	6	24	3	54		9	10	9		2
RED–NECKED GREBE									1	1	1		
Eared Grebe	3	6	11	20	27	1	42	4	56	13	66	23	12
WESTERN GREBE													
NORTHERN GANNET													
Am. White Pelican	293	318	57	343	1393	138	158	121	244	471	274	1103	372
BROWN PELICAN													
D.–cr. Cormorant	57	46	28		5	46	5	5		4	47	17	11
Olivaceous Cormorant	68	178	235	62	109	194	248	77	64	655	122	84	519
cormorant sp.			21		43		18	18	3	15		2	18
Anhinga													
American Bittern	32	9	7	2	33	15	3	2		12	2	9	1
LEAST BITTERN							1						
Great Blue Heron	131	93	88	123	164	128	110	70	123	360	281	214	217
Great Egret	137	145	330	187	244	653	546	140	367	361	650	241	2384
Snowy Egret	131	229	210	147	491	492	1091	167	1029	474	516	211	894
Little Blue Heron	23	10	32	19	29	16	82	24	82	77	28	24	82
Reddish Egret									4	4		2	
Tricolored Heron	117	51	68	73	107	134	587	51	389	54	82	34	68
Cattle Egret	2	4		1	13	6	21	1	23	12	76	45	5
Green–backed Heron	1		5	3		2	19	1	4	2	7	1	4
Blk.–cr. Night–Heron	60	36	6	11	9	76	9	46	2	84	40	115	5
Yel.–cr. Night–Heron	3			1						3			
White Ibis	33	43	57	11	9	448	95	15	707	175	151	108	5033
Glossy Ibis								cw				1	
White–faced Ibis	263	2736	654	420	5400	2692	4789	41		182	19	3	13
Plegadis sp.									5507	65	984	1525	8982
Roseate Spoonbill	2	1	800	4	66	252	350	76	491	169	57	229	25
FULVOUS WHISTLING DUCK						4							
BLACK–BELLIED WHISTLING DUCK													
Gr. Wh.–fronted Goose	45	61	1090	17	218	40	22	19	13	218	90	50	11
Snow Goose							6039			7960	2648	3350	135
Snow Goose (white form)	6000	2000	1600	4000	10200	6289		173	1597		1481	3996	7707
Snow Goose (blue form)	12000	13000	6300	6000	17000	9509		342	2460		825	4198	6553
ROSS' GOOSE				2		1							
Canada Goose	7	202	24								5		1
Canada Goose (small form)													
Wood Duck									2	2		2	
Green–winged Teal	495	16011	6660	3300	340	6902	1932	61	1574	7384	5109	8217	5902
AMERICAN BLACK DUCK	6	12											
Mottled Duck	22	43	121	38	158	41	59	10	24	65	80	63	33
Black or Mottled Duck	138	202											
Mallard	841	117	240	58	17	57	19	26	54	68	35	19	53
Northern Pintail	3672	22825	1880	3200	471	2129	1841	21	3842	618	1812	806	752
Blue–winged Teal	879	332	33	54	100	204	733	59	258	137	160	988	402
CINNAMON TEAL						2	1		2				
Northern Shoveler	1869	4105	1020	975	1000	580	950	119	590	1593	782	2230	1263

	12/29	12/27	12/27	12/27	12/18	12/30	12/15	12/28	12/20	12/18	12/17	12/16	12/15
Species	1962	1964	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Gadwall	1726	2696	2260	2800	1600	1708	1660	262	394	2374	2793	2480	7439
American Wigeon	3613	3007	4830	1200	1670	1883	5626	552	786	917	914	397	2866
Canvasback		27		108	39	155	256	36	140	294	75	3917	2213
Redhead	6	8		5		8	97		25	3	7	2	
Ring–necked Duck	2	52	4	1	16	3	1		20	15	13	47	
Greater Scaup				2			38		1	2	14		
Lesser Scaup	1736	4413	103	36	323	196	2608	152	180	1294	218	1050	61
scaup sp.			200	40			7		352	674	3498	11000	526
OLDSQUAW													
BLACK SCOTER										2			
SURF SCOTER										20			16
WHITE–WINGED SCOTER				5									4
scoter sp.									1				8
Common Goldeneye	3	12	cw		1			2					1
Bufflehead	3	21	8	13		3	8	4	8	2	8	2	2
Hooded Merganser	27	183	86	85	43	2	22		10	22	15	70	10
COMMON MERGANSER	2		1		1	1	1						
Red–breasted Merganser	7	14	cw		186	298	1129	6	102	117	99	96	46
merganser sp.													
Ruddy Duck	71	247	830	600	543		442	494	480	639	1389	7080	2844
duck sp.												12000	8000
Black Vulture	55	4	6		6		8		cw	1		15	2
Turkey Vulture	12	17	2		4	cw	23	1	13	14	15	14	3
Osprey													
Black–shouldered Kite													
BALD EAGLE													
Northern Harrier	81	72	44	67	23	25	17	9	21	46	61	59	44
Sharp–shinned Hawk	1		1	1					1	2	1	4	2
Cooper's Hawk	1									1			
Accipiter sp.													
Red–shouldered Hawk	1			1		1					3		2
BROAD–WINGED HAWK													
SWAINSON'S HAWK													
Red–tailed Hawk	36	24	16	13	14	12	16	3	16	42	23	29	44
Red–tail. (Harlan's) Hawk							1						
ROUGH–LEGGED HAWK		1											
GOLDEN EAGLE													
American Kestrel	31	57	13	11	11	7	9	10	19	50	51	30	29
Merlin		4	1	1	2	cw	2		1	2	1	3	1
Peregrine Falcon	1	5	1	1	4		1		1	1		1	4
Northern Bobwhite	14	12	2	6	12	1			18	35		30	2
SANDHILL CRANE													
Yellow Rail				1					1				
BLACK RAIL				2		1				1			
Clapper Rail	19	6	1	16	4	57	27	12	28	40	2	73	72
King Rail	9	12	26	14	33	24	22	12	9	20	38	4	3
Virginia Rail	1		2	3	16	27	5	2	3	7	2	6	7
Sora	cw	1	3	2	11	15	1	1	9	4	4	3	2
rail sp.													

	12/29	12/27	12/27	12/27	12/18	12/30	12/15	12/28	12/20	12/18	12/17	12/16	12/15
Species	1962	1964	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
PURPLE GALLINULE	2		1					2				1	
Common Moorhen	11	32	139	390	95	339	409	130	161	185	465	259	39
American Coot	4768	5418	2650	13500	8500	6120	1825	1568	7015	1230	16210	12218	10684
Black–bellied Plover	120	163	31	208	75	82	65	72	73	118	273	27	274
Snowy Plover		5	5	cw	2		1		1	1			1
Wilson's Plover		1				1	1			1			2
Semipalmated Plover	15	3	5	18	3	15	2	9	14	13	4	5	2
Piping Plover	15			cw	5	6	7	2	6	18	19	8	19
Killdeer	526	335	214	160	329	274	409	137	622	479	1054	322	918
Black–necked Stilt				6		3	71	65	25	35	43	106	221
American Avocet	236	149	111	311	283	358	551	340	619	668	457	1547	2003
Greater Yellowlegs	28	24	21	26	49	28	15	10	57	23	87	61	53
Lesser Yellowlegs	33	37	13	21	22	25	82	32	59	20	42	83	59
SOLITARY SANDPIPER							1						
Willet	53	55	6	338	293	108	292	57	63	174	332	173	357
Spotted Sandpiper	5	4	5	2	2	3	4	3	7	9	9	9	4
Whimbrel			2	5	5	2			2	24	4		3
Long–billed Curlew	84	107	16	119	79	33	5	6	15	156	49	85	188
Marbled Godwit	1	1		12					6	1	1	2	3
Ruddy Turnstone	54	7	4	11	23	52	46	9	121	300	112	26	65
Red Knot			1	cw		1			2		2		27
Semipalmated Sandpiper	32	12	310	14	15	2		35	9				
Sanderling	75	30	54	136	73	58	68	58	310	829	254	213	131
Western Sandpiper	68	48		300	83	31	56	3	712	102	25	151	912
Least Sandpiper	611	91	15	14	59	97	19	166	167	1089	143	77	736
PECTORAL SANDPIPER													
PURPLE SANDPIPER													
Dunlin	372	1263	106	395	195	60	1256	262	620	727	367	982	1879
Ereuntes sp.			50	500									
peep sp.							30				200		2296
STILT SANDPIPER						cw					6		2
sandpiper sp.							5					8000	
Short–billed Dowitcher				8	5	4	7	85	135	40	5	7	10
Long–billed Dowitcher	95			3		2	60	1	635	65	2	66	448
dowitcher sp.		77	4	350		24	1298	7	510	8	18	701	435
Common Snipe	99	37	25	35	87	67	20	16	61	558	174	136	384
American Woodcock	6	3	2	7	2	4	5		2	32	2	18	10
phalarope sp.										cw			
POMARINE JAEGER													
PARASITIC JAEGER													
Laughing Gull	926	1172	473	775	2200	850	2931	621	3143	1434	2889	2285	1928
FRANKLIN'S GULL													
Bonaparte's Gull	285	50	37	42	160	52	2	3	153	18	69	84	28
GRAY GULL													
Ring–billed Gull	1002	851	528	700	3600	622	959	168	1733	1456	906	395	563
CALIFORNIA GULL													
Herring Gull	243	62	102	130	319	235	95	156	162	354	204	50	176
THAYER'S GULL													
GLAUCOUS GULL									1				

	12/29	12/27	12/27	12/27	12/18	12/30	12/15	12/28	12/20	12/18	12/17	12/16	12/15
Species	1962	1964	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
GREAT BLACK–BACKED GULL													
BLACK–LEGGED KITTIWAKE					1								
gull sp.					1								
Gull–billed Tern	1	1		1		4			2	3	2	4	2
Caspian Tern	24	23	15	47	23	41	27	3	13	16	66	66	73
Royal Tern	14	16	34	26	84	160	13	54	182	143	44	36	45
Sandwich Tern					2		1						
Common Tern	4	19	33	8	40	37	8	6	54	64	9	7	5
Forster's Tern	95	273	73	99	730	183	302	165	686	1321	477	334	248
LEAST TERN													
BLACK TERN						1			1				
Black Skimmer	112	173	178	273	915	275	1815	953	1136	600	261	250	598
Rock Dove				*	*	*	*		5	41	53	10	
White–winged Dove		1					1		1			2	3
Mourning Dove	77	31	22	17	21	5	9	5	25	109	113	53	27
INCA DOVE													
Common Ground–Dove											2		
MONK PARAKEET													
YELLOW–BILLED CUCKOO													
Groove–billed Ani		6	6	19	31	7	46	28	5	16	15	13	4
Common Barn–Owl	6	5	2	4	5	4		3	2	7	4	12	1
Eastern Screech–Owl	1	3	2	1	1	3			9	16	8	2	4
Great Horned Owl	1	1		1		1		1		3	3		1
Burrowing Owl				1	1	1			1	2	1	1	1
BARRED OWL		2						1					
LONG–EARED OWL													
SHORT–EARED OWL		1		1						cw			
SAW–WHET OWL	1												
owl sp.											1		
Lesser Nighthawk												cw	
nighthawk sp.		1											
CHUCK–WILL'S–WIDOW	1					1				1			
WHIP–POOR–WILL						1				1			
Caprimulgus sp.											1		
BUFF–BELLIED HUMMINGBIRD							1						
RUBY–THROATED HUMMINGBIRD													
BLACK–CHINNED HUMMINGBIRD													
Archilochos sp.													1
ANNA'S HUMMINGBIRD													
RUFOUS HUMMINGBIRD								1					
Selasphorus sp.									1				1
hummingbird sp.		cw	1		2		1						
Belted Kingfisher	55	59	36	56	35	51	43	25	75	55	99	54	71
RED–HEADED WOODPECKER	2		1			10							
Red–bellied Woodpecker	10		3		1	7	1	1	2	5			
Yellow–bellied Sapsucker	18	15	5	11	11	21	3	5	17	35	11	10	11
Downy Woodpecker	1	4	4	2				1	2	1			5
Hairy Woodpecker			2			2	1			1		1	6
Northern Flicker	56	60	64	72	52	129	61	58	85	149	108	66	104

	12/29	12/27	12/27	12/27	12/18	12/30	12/15	12/28	12/20	12/18	12/17	12/16	12/15
Species	1962	1964	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
LEAST FLYCATCHER													
Empidonax sp.										1			
Eastern Phoebe	15	20	11	7	7	9		2	9	8	9	6	39
SAY'S PHOEBE													1
VERMILION FLYCATCHER		3		1					1				
ASH–THROATED FLYCATCHER													1
BROWN–CRESTED FLYCATCHER													
COUCH'S KINGBIRD													
WESTERN KINGBIRD													
EASTERN KINGBIRD													1
yellow–bellied kingbird sp.													
SCISSOR–TAILED FLYCATCHER					2								
HORNED LARK										cw		2	
BARN SWALLOW					1						4		
Tree Swallow	491	2	530	2280	565	2800	2038	281	792	801	106	271	471
NO. ROUGH–WINGED SWALLOW													
swallow sp.													
Blue Jay	45	30	47	48	62	88	49	18	78	44	86	67	114
AMERICAN CROW													
Fish Crow	4	5	1	1	60	1		1	1	94	10	59	1
crow sp.										6			
Carolina Chickadee			2										
Tufted Titmouse													
RED–BREASTED NUTHATCH								1				3	
nuthatch sp.													
Brown Creeper	6	4	1	1		1							
Carolina Wren	7		6	3	5	6		3	3	2	1		1
BEWICK'S WREN													
House Wren	19	31	41	41	30	29	11	7	43	24	36	61	65
Winter Wren	9	8	4	1	6	1	1	1		2	1	1	2
Sedge Wren	60	34	36	46	50	82	8	7	93	19	156	158	5
Marsh Wren	3		5	15	21	9	1	7	24	64	23	15	23
Golden–crowned Kinglet	4		29	4	2	6			10	3			
Ruby–crowned Kinglet	216	182	89	170	134	148	140	187	252	446	86	64	194
Blue–gray Gnatcatcher	58	99	48	82	106	51	54	99	115	69	55	37	83
Eastern Bluebird	cw							1		cw			2
Hermit Thrush	22	21	4	13	12	14	5	5	12	23	8	4	17
WOOD THRUSH					2	1			1	1			
American Robin	183	78	174	323	1200	429	311	127	351	853	15	174	277
VARIED THRUSH													
Gray Catbird	2			2	2		6	2	3	5	6	8	3
Northern Mockingbird	44	43	37	53	53	107	35	71	107	156	91	74	115
Brown Thrasher	74	28	40	62	43	94	35	26	58	61	18	29	52
SAGE THRASHER	1												
CURVED–BILLED THRASHER						1							1
Water Pipit	541	152	43	33	45	39	12	28	518	158	128	84	458
Sprague's Pipit	9		5	2	6	1			2	1	8	2	23
Cedar Waxwing	61	17	35	12	82	34	cw	1	383	528		2	7
Loggerhead Shrike	85	102	49	58	41	55	44	47	219	159	194	99	80

	12/29	12/27	12/27	12/27	12/18	12/30	12/15	12/28	12/20	12/18	12/17	12/16	12/15
Species	1962	1964	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
European Starling	1868	718	790	770	235	1664	830	228	680	1653	2038	1374	2334
White–eyed Vireo				2	3	2	2	2	4	2			
BELL'S VIREO						1							
Solitary Vireo	6		4	13	7	5		2	4	6	3	10	16
PHILADELPHIA VIREO											1		
RED–EYED VIREO													
Vermivora sp.										1			
TENNESSEE WARBLER													
Orange–crowned Warbler	19		49	60	68	36	22	31	109	63	35	37	52
NASHVILLE WARBLER													
VIRGINIA'S WARBLER													
NORTHERN PARULA					1								
TROPICAL PARULA													
YELLOW WARBLER													
MAGNOLIA WARBLER													
Dendroica sp.													
Yellow–rumped Warbler	638	56	33	81	700	225	208	112	302	905	2438	1020	869
Yel.–rump. (Audubon's) W.													
BLACK–THROATED GRAY WARBLER													
BLACK–THROATED GREEN WARBLER					1								
YELLOW–THROATED WARBLER	1	3									1		
Pine Warbler	2			1	1	2		1	2	1			cw
PRAIRIE WARBLER													
Palm Warbler		1	2	2	1			1	5	13	4	4	2
BAY–BREASTED WARBLER								1					
BLACK–AND–WHITE WARBLER		1											3
OVENBIRD					1								
Northern Waterthrush							1						
Opornis sp.													
MacGILLIVRAY'S WARBLER													
Common Yellowthroat	41	13	22	15	46	23	3	4	49	24	43	42	36
Wilson's Warbler	1	3	1	4		2			1	1	1		1
American Redstart						1					1		
YELLOW–BREASTED CHAT	1		1	2								1	
SUMMER TANAGER													
WESTERN TANAGER												1	
Northern Cardinal	111	81	55	68	63	71	114	100	113	82	43	45	98
ROSE–BREASTED GROSBEAK													1
BLACK–HEADED GROSBEAK													1
Pheucticus sp.												1	
BLUE GROSBEAK											1		
INDIGO BUNTING												2	2
PAINTED BUNTING													
Passerina sp.													
Rufous–sided Towhee	55	11	13	12	2	95	1	7	2	8		1	7
Ruf.–s. (SPOTTED) Towhee													
AMERICAN TREE SPARROW													
Chipping Sparrow											5	12	1
CLAY–COLORED SPARROW													

	12/29	12/27	12/27	12/27	12/18	12/30	12/15	12/28	12/20	12/18	12/17	12/16	12/15
Species	1962	1964	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Field Sparrow						1	2		1	3		3	
Vesper Sparrow		11		6					1	8			2
LARK SPARROW				2									
Savannah Sparrow	328	577	114	129	140	42	58	46	254	314	450	295	279
Grasshopper Sparrow										cw	2	2	
LeConte's Sparrow	1			3	1				8	1	2	3	
Sharp–tailed Sparrow	24	11	21	2	1	56	10	32	15	94	6	25	355
Seaside Sparrow	38	118	70	102	92	116	40	52	174	280	40	64	443
Fox Sparrow	4	3		2	3	32	1		3	2	6		
Song Sparrow	57	114	14	44	31	30	9	12	76	155	42	25	48
Lincoln's Sparrow	45	47	2	13	3	1		3	20	2	8	8	28
Swamp Sparrow	176	274	100	170	133	224	68	203	663	163	360	305	352
White–throated Sparrow	241	246	123	124	91	191	46	18	247	117	48	109	206
White–crowned Sparrow	38	2	8	80	27	12			5	19	1	4	12
HARRIS' SPARROW		2										1	
sparrow sp.													
Dark–eyed Junco	cw				9		6		4	13		cw	2
Dark–eyed (OREGON) Junco													
Lapland Longspur													
longspur sp.													
Red–winged Blackbird	5100+	2421	2100	4900	1800	3162	2716	1520	3796	5262	3084	4762	7710
Eastern Meadowlark	113	599	160	270	220	151	179	128	269	346	350	320	451
WESTERN MEADOWLARK	cw	5							2	2			1
YELLOW–HEADED BLACKBIRD													
Rusty Blackbird	6					10	6	22	1	64	9	5	50
Brewer's Blackbird	5		3			4	6		22	8	3	2	3
Great–tailed Grackle								1	63	20	196	16	520
Boat–tailed Grackle	930	1168	880	1350	450	1176	1166	1199	807	1886	1844	1763	1259
Cassidix sp.													
Common Grackle	29	1	1		15	20		250	463	69	21	196	128
BRONZED COWBIRD													
Brown–headed Cowbird	27	34	95	84	53	84	285	72	477	407	160	715	178
blackbird sp.													
Northern Oriole				1		1			1		1		
No. (BULLOCK'S) Oriole		5					1						
SCOTT'S ORIOLE													
oriole sp.													
Purple Finch	1		3		22	1			1	6	6		
HOUSE FINCH													
Pine Siskin			2		3						30		
American Goldfinch	155	20	14	55	166	7	22		41	71	380	85	37
House Sparrow	86	363	159	124	115	49	47	75	193	131	379	83	146
TOTAL SPECIES	155	147	144	154	151	159	138	132	165	171	155	152	165
OBSERVERS	18	24	13	14	17	15	12	10	23	31	29	26	23
PARTIES	7	8	7	6–7	6–7	7	6	6	9	12	11	11	13

	12/29	12/27	12/27	12/27	12/18	12/30	12/15	12/28	12/20	12/18	12/17	12/16	12/15
Species	1962	1964	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
PARTY–HOURS:													
FOOT	41	48	48	38	42	44	29	25	67.5	77	45	52.5	67.5
CAR	18	30	19	22	25	23	25	9	22.5	32	34	32.5	31
BOAT	9	8	7	4	5	4	5	5	7.5	8	12.5	6	4
AIRBOAT													
MARSH BUGGY				3	2	2							
WEASEL													
HELICOPTER													
PLANE													
PARTY–MILES:													
FOOT	39	43	38	36	35	31	27	19	60	44	44.5	44	56.5
CAR	154	292	208	152	173	261	283	185	296	342	378	306	211.5
BOAT	65	75	45	26	33	38	25	19	50	40	45	38	25
AIRBOAT													
MARSH BUGGY				3	5	2							
WEASEL													
HELICOPTER													
PLANE													
OWLING: HRS.						5						6.5	4.5
MILES						70							
FEEDER: #													
HRS.													
TEMP. (F)	50–57	39–69	46–64	50–59	50–63	55–68	43–65	60–64	35–57	45–55	45–69	50–65	39–50
WIND: (mph)	8–18	35–5	3–15	2–12	11–23	10–15	0–15	0–6	5–20	5–10	12–16	5–6	5–15
DIRECTION	N	N–E	SE	E–SE	NE	E	N	E	SW	Var.	NW	N	NW

	12/20	12/19	12/18	12/17	12/15	12/21	12/20	12/19	12/17	12/16	12/15	12/14
Species	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Common Loon	1	3	4	7	6	5	13	63	1	4	13	13
Pied–billed Grebe	291	231	90	161	164	265	233	454	267	173	66	102
Horned Grebe	1	7	11	2	48	24	21	1	26	4	1	10
RED–NECKED GREBE			1									
Eared Grebe	4	25	3	198	64	445	2	1	7	1	10	2
WESTERN GREBE						2	1	1				
NORTHERN GANNET							1	3			35	2
Am. White Pelican	719	1170	1765	2866	5055	1947	1505	3514	4760	2796	1488	1924
BROWN PELICAN							1	3	2	2	119	
D.–cr. Cormorant	59	74	225	333	322	2044	1089	1686	813	452	1053	758
Olivaceous Cormorant	356	197	470	5906	3613	2409	2304	5224	660	2267	762	830
cormorant sp.	2	130	433	248	428	241	64		85		30	
Anhinga		1		8	5	1		1	1	3		1
American Bittern	3	2	9	8	14	5	14	20	6	6	6	2
LEAST BITTERN	1		1	2	1	1	1		3			
Great Blue Heron	178	387	509	313	694	586	567	378	812	336	521	297
Great Egret	239	438	480	775	1635	762	920	959	1670	874	593	267
Snowy Egret	269	562	728	1315	2015	736	666	805	1275	439	767	413
Little Blue Heron	26	169	124	202	145	92	66	40	459	162	28	36
Reddish Egret	14	12	8		4	14	6	1			4	1
Tricolored Heron	29	164	163	226	248	146	172	158	215	155	126	88
Cattle Egret	7	48	28	78	22	59	12	48	9	18	14	53
Green–backed Heron	1	7	9	9	20	16	26	12	6	4	3	5
Blk.–cr. Night–Heron	17	68	173	240	424	395	580	195	1666	70	166	95
Yel.–cr. Night–Heron		1	6	2	1	2	3		2	1	1	
White Ibis	74	460	626	1136	983	4234	2258	703	3852	4523	414	227
Glossy Ibis		1	3	6	3	9	1	1	4		1	1
White–faced Ibis	385	387	84	8246	158	3017	571	63	228	3773	131	2387
Plegadis sp.	769	3917	2349	4035	6076	6863	1613	2867	7941	61	769	925
Roseate Spoonbill	253	88	724	555	400	527	1535	422	597	241	208	342
FULVOUS WHISTLING DUCK												
BLACK–BELLIED WHISTLING DUCK					7							
Gr. Wh.–fronted Goose	104	475	212	549	932	2314	815	982	2784	699	1681	4851
Snow Goose	7151	19752	7325	26414	16432	25881	17460					37833
Snow Goose (white form)	1731	3231	2904	1322	302	10237	2035	5252	26392	17596	7532	
Snow Goose (blue form)	4924	3328	4224	2383	411	2080	2171	831	3373	6738	8098	
ROSS' GOOSE			cw				2		15	4	1	2
Canada Goose	1	6	34	8	17	8	2	10	352	158	91	
Canada Goose (small form)												
Wood Duck	6	6	4		14	7	54	47	66	11	6	2
Green–winged Teal	8992	4376	1486	4372	3557	6170	9725	4735	11639	4790	7673	9881
AMERICAN BLACK DUCK	2					1						
Mottled Duck	31	138	247	252	228	285	122	176	318	224	398	196
Black or Mottled Duck												
Mallard	52	82	387	100	109	222	168	432	7663	304	91	99
Northern Pintail	1928	1281	5187	1475	3636	5700	294	622	6451	1216	3337	150
Blue–winged Teal	719	3811	1127	3357	771	1112	3074	2494	2079	697	2896	814
CINNAMON TEAL						2			1	1		
Northern Shoveler	1650	2945	1693	3349	1313	2456	5091	1845	9746	2230	3876	3042

	12/20	12/19	12/18	12/17	12/15	12/21	12/20	12/19	12/17	12/16	12/15	12/14
Species	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Gadwall	3993	1959	4808	3704	5621	4963	5487	2411	6890	1419	3189	8290
American Wigeon	1286	1359	2880	6536	1815	2244	3035	509	5263	394	2135	5054
Canvasback	257	1314	612	102	1092	177	1215	498	618	1995	1601	348
Redhead	1	18	13	7	2	9	2	4	4	9	1	
Ring–necked Duck	2	2215	25	18	41	16	27	5	143	602	2	65
Greater Scaup		1	1	4		5	8	5	1			2
Lesser Scaup	4	4295	1505	324	834	153275	2991	4263	2083	8436	10172	599
scaup sp.	405	4145	415	4051	256	281	228				1001	
OLDSQUAW						7						
BLACK SCOTER			3	1		2	3				5	
SURF SCOTER				1								
WHITE–WINGED SCOTER	2		1						2			
scoter sp.		3			15			3			2	
Common Goldeneye	7	11		8	3	27	15	8	15	6	3	2
Bufflehead	53	22	19	33	17	50	39	25	137	21	80	95
Hooded Merganser	27	8	51	33	36	100	72	34	53	12	32	19
COMMON MERGANSER			1		6					1		1
Red–breasted Merganser	74	27	317	162	49	141	264	161	218	31	41	628
merganser sp.										8		
Ruddy Duck	207	6021	1558	2135	748	3879	4483	964	4324	521	1901	1039
duck sp.	85	8343	3836	5931	3768	12959			5550	15262	1780	
Black Vulture	1	17	2	8	2	82	42		54	82	3	82
Turkey Vulture	32	37	37	62	26	81	120	9	128	109	23	86
Osprey			1	4	3	1	1		1	1		2
Black–shouldered Kite						1		2	3		1	1
BALD EAGLE												
Northern Harrier	118	116	123	157	221	133	90	102	206	110	128	129
Sharp–shinned Hawk	1	6	8	9	12	10	12	8	17	14	9	13
Cooper's Hawk	2	2	5	4	1	4	3	2	10	3	6	4
Accipiter sp.				1				1		2	1	1
Red–shouldered Hawk	1	1	3	5	7	4	8	12	12	4	8	4
BROAD–WINGED HAWK							2					
SWAINSON'S HAWK			cw									
Red–tailed Hawk	106	86	57	95	114	117	81	86	240	95	112	115
Red–tail. (Harlan's) Hawk				2	1		1					
ROUGH–LEGGED HAWK											1	
GOLDEN EAGLE		1l										
American Kestrel	38	41	46	48	42	33	55	41	73	41	47	37
Merlin	4	2	7	6	6	6	5	6	8	3	7	6
Peregrine Falcon	2		1	4	3	3	3	2	3	6	8	3
Northern Bobwhite		3	1	48	46	23	33	9	24	21	7	
SANDHILL CRANE												
Yellow Rail		1	1		1							
BLACK RAIL		1					1			1		
Clapper Rail	7	42	77	43	69	74	101	43	104	17	59	61
King Rail	9	12	128	44	64	107	43	72	38	12	128	53
Virginia Rail	8	3	15	14	5	11	17	19	6	7	13	6
Sora	6	9	13	13	18	37	28	21	27	10	20	4
rail sp.												

	12/20	12/19	12/18	12/17	12/15	12/21	12/20	12/19	12/17	12/16	12/15	12/14
Species	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
PURPLE GALLINULE		1		cw				1	2			1
Common Moorhen	412	492	625	5352	1645	1361	2975	1565	3264	279	728	592
American Coot	5968	2993	6054	13422	14369	10876	11519	10170	10575	2246	4265	3778
Black–bellied Plover	238	352	671	650	914	283	369	394	561	400	432	118
Snowy Plover	17	1	6	8	3	5	7	13	4	13	2	3
Wilson's Plover	1	1	12	2	2	4	11	1			2	
Semipalmated Plover	8	9	85	177	99	51	75	20	76	7	68	38
Piping Plover	11	2	30	1	25	43	12	17	8	21	15	3
Killdeer	924	1563	792	946	994	836	335	553	1621	1450	254	212
Black–necked Stilt	449	468	305	514	480	504	468	495	819	672	497	605
American Avocet	502	763	524	1679	1587	842	763	763	1066	2151	1587	195
Greater Yellowlegs	136	129	110	98	191	127	137	34	346	105	87	29
Lesser Yellowlegs	167	242	53	90	97	75	41	34	254	233	235	8
SOLITARY SANDPIPER		1				1						
Willet	143	49	701	350	475	383	346	386	497	601	417	116
Spotted Sandpiper	4	4	9	5	6	5	11	7	11	6	19	12
Whimbrel	2	1	2	3	4	1		2	4		7	3
Long–billed Curlew	72	26	161	364	285	203	68	71	164	7	46	14
Marbled Godwit			7	10	14	3		1	23	6	11	
Ruddy Turnstone	68	18	160	85	209	169	97	191	65	58	154	66
Red Knot			72		4	9		2	37		9	
Semipalmated Sandpiper												
Sanderling	247	489	762	264	823	329	173	262	303	773	766	146
Western Sandpiper	929	1302	4326	3108	1726	1286	824	1975	16506	1487	4813	87
Least Sandpiper	273	219	927	1683	372	336	813	317	273	2065	15	92
PECTORAL SANDPIPER												
PURPLE SANDPIPER												
Dunlin	1819	1046	7261	3524	2638	1788	609	698	2037	2588	4416	472
Ereuntes sp.												
peep sp.	260	15	69	688	60	308	25	20	2400	120	66	421
STILT SANDPIPER									1	3		
sandpiper sp.												
Short–billed Dowitcher	4	125	80	12	319	35	50	177	1561	317	920	
Long–billed Dowitcher	604	147	155	231	135	232	1	15	3668	140	65	300
dowitcher sp.	130	476	742	360	199	661	330	12	57	2640	459	89
Common Snipe	106	211	239	240	529	368	384	267	233	211	214	168
American Woodcock	21	16	23	31	17	14	37	19	10	18	11	15
phalarope sp.												
POMARINE JAEGER							1	1	1		1	2
PARASITIC JAEGER						1	3	1			5	
Laughing Gull	4871	6268	3631	6755	7051	9546	8155	6491	11077	8093	14841	7930
FRANKLIN'S GULL				2		1						
Bonaparte's Gull	861	526	357	317	267	669	134	880	635	1046	409	165
GRAY GULL								1				
Ring–billed Gull	1824	2833	1916	1551	4757	4736	1302	2519	4348	2524	3221	905
CALIFORNIA GULL							1					
Herring Gull	147	124	277	103	495	352	157	442	302	181	535	93
THAYER'S GULL										1		
GLAUCOUS GULL												

	12/20	12/19	12/18	12/17	12/15	12/21	12/20	12/19	12/17	12/16	12/15	12/14
Species	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
GREAT BLACK–BACKED GULL			1					1				
BLACK–LEGGED KITTIWAKE												1
gull sp.												
Gull–billed Tern		5	1	10	14	3	2	6	25	3		8
Caspian Tern	66	99	155	209	351	366	218	164	147	201	125	195
Royal Tern	185	64	77	47	149	333	168	269	190	43	240	144
Sandwich Tern		1	1			3	2	1	2			
Common Tern	14	20	39	20	33	7	11	50	11	3	17	43
Forster's Tern	458	800	1144	802	1789	2433	931	1160	3476	6767	2135	3088
LEAST TERN												
BLACK TERN					1							
Black Skimmer	320	520	816	450	207	184	1072	930	993	522	1164	261
Rock Dove	11	64	34	30	31	3	17	43	20	4	27	4
White–winged Dove		5	9	2		3	1			cw	9	27
Mourning Dove	107	83	156	248	255	192	190	176	136	75	124	93
INCA DOVE						1			1	3		
Common Ground–Dove	1	2		1								4
MONK PARAKEET						1						
YELLOW–BILLED CUCKOO				1								
Groove–billed Ani	6	13	22	24	1	18	13	17		2		5
Common Barn–Owl	1	7	4	18	4	3	6	5	7	5	9	1
Eastern Screech–Owl	2	14	11	18	6	6	18	13	7	4	3	1
Great Horned Owl	1	3	5	3	7	9	14	7	8	5	8	
Burrowing Owl	1	1	2		1				1		3	2
BARRED OWL	1			1					1			
LONG–EARED OWL		1	1	1								
SHORT–EARED OWL		2			2			1				
SAW–WHET OWL												
owl sp.												
Lesser Nighthawk												
nighthawk sp.									1			
CHUCK–WILL'S–WIDOW		2	3			1		2	2	1	1	
WHIP–POOR–WILL	1	1	1	1			1	1		1		1
Caprimulgus sp.									1			
BUFF–BELLIED HUMMINGBIRD				1				3		cw	1	1
RUBY–THROATED HUMMINGBIRD									1	1		1
BLACK–CHINNED HUMMINGBIRD				1	2	1	1			2		
Archilochos sp.								1				
ANNA'S HUMMINGBIRD								2				
RUFOUS HUMMINGBIRD									1			3
Selasphorus sp.	1	1						2		1	2	
hummingbird sp.		2	1				1					
Belted Kingfisher	49	89	80	118	109	2	99	83	160	83	95	68
RED–HEADED WOODPECKER	1	1	1					3				
Red–bellied Woodpecker	6	2	1	2	1	2		20	3	1	2	
Yellow–bellied Sapsucker	29	22	24	17	11	31	21	32	37	16	36	4
Downy Woodpecker	9	6	3	4	2	3	14	33	15	4	13	4
Hairy Woodpecker	2	2	5	4	1	4	6	3	7	2	6	5
Northern Flicker	276	164	338	189	168	111	161	224	99	121	197	133

	12/20	12/19	12/18	12/17	12/15	12/21	12/20	12/19	12/17	12/16	12/15	12/14
Species	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
LEAST FLYCATCHER				2					1			
Empidonax sp.	1		1						1			
Eastern Phoebe	26	38	45	30	26	39	54	61	78	46	134	66
SAY'S PHOEBE												
VERMILION FLYCATCHER				2	1		1		1	1		
ASH–THROATED FLYCATCHER												
BROWN–CRESTED FLYCATCHER				1								
COUCH'S KINGBIRD							1					
WESTERN KINGBIRD					1							
EASTERN KINGBIRD												
yellow–bellied kingbird sp.									1			
SCISSOR–TAILED FLYCATCHER					2							
HORNED LARK												
BARN SWALLOW			1									
Tree Swallow	68	264	2079	660	994	1565	5358	1289	15560	6	541	259
NO. ROUGH–WINGED SWALLOW	1			1	3	1	8		1		1	
swallow sp.		1										
Blue Jay	97	141	205	189	176	285	247	205	230	149	130	125
AMERICAN CROW									1			
Fish Crow	7	402	238	21	8	183	22	16	663	36	70	38
crow sp.		2	54			40						
Carolina Chickadee	6		4	4	6	7	11	3	4	3	5	6
Tufted Titmouse			cw	2	10	5	4	1				
RED–BREASTED NUTHATCH	6		1	1		8				2		
nuthatch sp.							1					
Brown Creeper		2	2	2	13	4	1	3	4		5	
Carolina Wren			2	4	3	5	6	2	6		7	
BEWICK'S WREN	1	1		1	1			3			1	
House Wren	19	114	126	132	145	136	145	105	257	42	226	110
Winter Wren	2	2	2	7	2	4	1	8	8		6	
Sedge Wren	6	69	156	117	124	124	130	197	367	42	159	99
Marsh Wren	8	40	72	116	88	133	274	192	192	20	97	38
Golden–crowned Kinglet	32	2	1	30	35	55	124	49	244	12	191	1
Ruby–crowned Kinglet	188	218	320	554	433	409	499	203	705	191	443	141
Blue–gray Gnatcatcher	93	83	185	233	116	41	98	83	165	55	129	40
Eastern Bluebird			1		cw	cw		15	1	4	6	14
Hermit Thrush	22	9	40	15	31	54	68	105	16	34	200	59
WOOD THRUSH					1		1					1
American Robin	1121	145	2183	264	586	750	1471	1381	126	5127	1431	175
VARIED THRUSH					1				1			
Gray Catbird	3	9	7	25	12	5	17	11	26	10	37	8
Northern Mockingbird	88	170	210	133	200	256	282	172	180	108	180	107
Brown Thrasher	122	168	145	82	289	96	61	128	153	29	96	52
SAGE THRASHER												
CURVED–BILLED THRASHER												
Water Pipit	59	742	149	394	292	289	47	29	73	332	11	16
Sprague's Pipit	6	9	6	3	14	2	1		1	2		
Cedar Waxwing	19	2	126	29	19	36	212	52	2	708	24	85
Loggerhead Shrike	67	142	196	126	200	167	208	146	240	98	161	93

	12/20	12/19	12/18	12/17	12/15	12/21	12/20	12/19	12/17	12/16	12/15	12/14
Species	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
European Starling	2489	1709	3291	2084	1939	2047	5589	8276	1641	3372	3618	859
White–eyed Vireo		3	2	3	7	3	5		1	1	2	2
BELL'S VIREO											1	
Solitary Vireo		14	8	17	18	24	23	20	55	17	36	11
PHILADELPHIA VIREO												
RED–EYED VIREO				1			1					
Vermivora sp.												
TENNESSEE WARBLER					3	1	1					
Orange–crowned Warbler	67	241	155	206	180	139	162	66	297	133	326	166
NASHVILLE WARBLER	1		1	1	1		1					
VIRGINIA'S WARBLER									1			
NORTHERN PARULA				1			1		1	1		
TROPICAL PARULA				1								
YELLOW WARBLER				1								
MAGNOLIA WARBLER							1					
Dendroica sp.						1						
Yellow–rumped Warbler	983	958	5062	874	945	2583	8464	1104	1539	4396	3453	1465
Yel.–rump. (Audubon's) W.								1				
BLACK–THROATED GRAY WARBLER												
BLACK–THROATED GREEN WARBLER			1	1		1	1					1
YELLOW–THROATED WARBLER												
Pine Warbler	4	4	16	15	46	52	51	69	67	17	66	13
PRAIRIE WARBLER		1			1			1				
Palm Warbler	13	15	17	9	20	7	27	6	17	21	4	2
BAY–BREASTED WARBLER				1			1			1		
BLACK–AND–WHITE WARBLER		2		1				1				
OVENBIRD					1		1		1			
Northern Waterthrush					1	1				cw		
Opornis sp.						1						
MacGILLIVRAY'S WARBLER							1					
Common Yellowthroat	14	49	94	229	94	134	246	119	220	90	134	86
Wilson's Warbler	2	3	3	6	8	2	1	4			1	2
American Redstart												
YELLOW–BREASTED CHAT												
SUMMER TANAGER				1	1							
WESTERN TANAGER			1				1			1		
Northern Cardinal	104	139	303	257	278	196	209	196	221	124	262	163
ROSE–BREASTED GROSBEAK		1			1							
BLACK–HEADED GROSBEAK						1						
Pheucticus sp.												1
BLUE GROSBEAK												
INDIGO BUNTING		1		3	8	6		3				4
PAINTED BUNTING				1	1							
Passerina sp.			2									
Rufous–sided Towhee	6	5	4	5	5	3	3	27	1	5	13	1
Ruf.–s. (SPOTTED) Towhee											1	
AMERICAN TREE SPARROW												
Chipping Sparrow	7	2	11	6	5	6	9	2		13		12
CLAY–COLORED SPARROW		2									1	

	12/20	12/19	12/18	12/17	12/15	12/21	12/20	12/19	12/17	12/16	12/15	12/14
Species	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Field Sparrow	43	23	4	10	2	2	1	18	2		5	15
Vesper Sparrow	2	1		1	3	2	4	1	1	1	1	
LARK SPARROW			2	3								
Savannah Sparrow	292	450	719	498	713	585	488	757	1376	386	917	716
Grasshopper Sparrow	1	1		1	5	1	2		4	1	3	1
LeConte's Sparrow	3	8	13	10	23	3	7	27	48	8	20	15
Sharp–tailed Sparrow	49	131	110	148	65	99	117	100	341	355	121	21
Seaside Sparrow	258	143	360	564	280	199	248	277	577	542	228	97
Fox Sparrow		4	8	1		3		4	1	5		2
Song Sparrow	56	65	166	85	133	113	91	605	344	128	451	238
Lincoln's Sparrow	1	50	10	26	44	10	4	17	16	7	127	67
Swamp Sparrow	244	255	985	1070	1273	1198	1284	2000	1927	685	1417	1090
White–throated Sparrow	243	180	150	219	642	179	146	657	291	257	971	623
White–crowned Sparrow	24	30	8	7	7	2	3	42	11	23	69	30
HARRIS' SPARROW	2	1										
sparrow sp.		10										
Dark–eyed Junco	41	2	35	19		4	28	31	36	12	4	24
Dark–eyed (OREGON) Junco												1
Lapland Longspur					4	2						
longspur sp.							1					
Red–winged Blackbird	5026	15606	13417	12351	9938	14321	13766	12597	9701	6664	11400	7659
Eastern Meadowlark	560	822	862	656	500	606	385	541	552	297	447	165
WESTERN MEADOWLARK		1				1						
YELLOW–HEADED BLACKBIRD							1					
Rusty Blackbird	12	196	36	4	28	27	4	41		2		75
Brewer's Blackbird			19	13	6	6	4	64	5		3	5
Great–tailed Grackle	15	89	162	364	975	556	546	820	474	451	1686	367
Boat–tailed Grackle	1333	6880	2060	7003	3043	3693	6194	2216	3014	1540	4850	3268
Cassidix sp.					434		500	47		40		
Common Grackle	251	70	215	162	2018	490	1816	4304	1393	2201	2645	1811
BRONZED COWBIRD							1	2				
Brown–headed Cowbird	681	393	894	408	697	555	1285	1208	104	231	172	200
blackbird sp.					465	1004						
Northern Oriole						1					1	
No. (BULLOCK'S) Oriole	cw					1	1					
SCOTT'S ORIOLE												
oriole sp.												
Purple Finch			6	3	2	8	41	1				3
HOUSE FINCH											6	2
Pine Siskin		1				1	18	7		50	8	
American Goldfinch	73	57	195	92	170	149	269	93	153	712	377	92
House Sparrow	81	233	175	217	239	325	277	188	198	267	92	71
TOTAL SPECIES	169	188	190	198	194	199	200	191	193	177	182	175
OBSERVERS	28	59	94	71	83	81	80	56	60	38	39	36
PARTIES	12	17	31	26	24–28	24–48	23–40	20–24	21–32	18–26	17–20	15–17

	12/20	12/19	12/18	12/17	12/15	12/21	12/20	12/19	12/17	12/16	12/15	12/14
Species	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
PARTY–HOURS:												
FOOT	69	132.75	206	187	269.5	225.5	210.75	135	225.5	122.25	139.75	90.5
CAR	44	48.25	55	53	42.25	44.75	51.75	40.5	57.75	40	29.25	47.25
BOAT	4	19.5	34	18	21.75	26.5	26.5	19.5	23.75	12.5	20	20
AIRBOAT					?	2	3	2.5				
MARSH BUGGY												
WEASEL												
HELICOPTER												
PLANE												
PARTY–MILES:												
FOOT	72	122	146	140	153.5	143	127.5	126.5	132.75	81.75	97	66
CAR	238	330.5	245	282	332.5	366	409.5	320	311.75	267	283	225
BOAT	26	40	63	43	77	109	119	57	160.5	62	77	57
AIRBOAT					12.5	12		12				
MARSH BUGGY												
WEASEL												
HELICOPTER												
PLANE												
OWLING: HRS.	5	5.25	5	2.5	12	7.5	4.75	8	4	4.5	3.25	0.75
MILES					83.7	25.8	10.5	37.5	11.2	51.5	6.25	0.25
FEEDER: #				0–2		0–1		2	4	1		
HRS.				5		2		8	8	4		
TEMP. (F)	35–38	25–44	48–75	34–46	64–77	31–57	47–59	53–70	28–48	22–29	55–75	45–55
WIND: (mph)	5–15	8–12	7–21	5–15	11–30	8–12	5–10	15–25	5–10	15–20	5–10	10–20
DIRECTION	NNW	NNE	S–SE	NE	NE	NE–SSW	N	S	N	N	S	NW

APPENDIX F

RANGELAND OF CALCASIEU-SABINE RIVER BASIN

CALCASIEU-SABINE RIVER BASIN STUDY

RANGELAND SECTION

Rangeland is land on which the native vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs, or shrubs suitable for grazing or browsing use. Rangelands include natural grasslands, savannahs, most deserts, tundra, alpine plant communities, coastal marshes, wet meadows, and introduced plant communities managed like rangeland.

RANGE SITES / SOILS

The Calcasieu-Sabine River Basin (CSRB) area consists of seventeen different soil types and 5 different range sites. Each soil type has properties and characteristics that determine which dominant plant community will be present and which type of herbivore will be able to utilize the existing plant cover. Range sites are developed based on the kinds, amounts, and proportions of vegetation capable of being produced on the soils present. Factors such as soil-plant-water interactions are considered in determining range sites. In coastal marshes, salinity is a major determinant in what plant cover a soil is capable of producing. The climax plant community is used as the benchmark and any deviation from the climax indicates the ecological condition of the vegetation present at a given time. Therefore, range sites are established in conjunction with soil types.

Soil salinity and N-value, the relative softness or firmness of soil layers are the two major soil properties that determine type of plant cover, plant utilization, and consequently range site.

All five range sites, recognized in Louisiana are found within this river basin. The basin is approximately 6 percent Coastal Prairie range site, 11 percent Fresh Marsh range site, 74 percent Brackish Marsh range site, 4 percent Salt Marsh range site, 2 percent Chenier and Beach Ridge range site, and 3 percent spoil banks.

Coastal Prairie Range Site

The Coastal Prairie range site is divided into three subgroups. Loamy Terrace Lowlands, where Mowata soils and Morey soils occur, which make up about 60 percent of this range site. Loamy Terrace Ridges, where Crowley soils and Vidrine soils occur, which make up about 30 percent of this range site. Clayey Terrace Lowlands, where Midland soils occur, which make up about 10 percent of this range site. All of these soils are firm/consolidated soils that have a low concentration of available salts. These areas are dominated by bluestems (Andropogon sp.), swithchgrass (Panicum virgatum), and gulf cordgrass (Spartina spartinae). These soils have excellent trafficability, and can support the weight of domestic livestock throughout the year. Considerable forage is utilized in this area by whitetail deer, nutria, and other upland wildlife. These soil types are present as unsubsided prairie remnants or islands, in the northern portion of the basin. These areas include Pines Ridge, Perry Ridge, Gum Cove, and Hackberry.

Fresh Marsh Range Site

The fresh marsh range site occurs in areas of fresh firm mineral marsh, where areas of Ged soils occur; and fresh organic marsh sites, where areas of Allemands soils occur. These soils have low concentrations of available salts.

The Ged soils make up about 57 percent of the fresh marsh range site. These soils are immediately adjacent to Coastal Prairie soils and exist where Coastal Prairie soils have subsided below present marsh level. These soils are covered with a thin deposit of recent fluid alluvium. These soils have a surface layer of very fluid mucky clay and clay ranging in thickness from about four to eighteen inches. Subsoil layers consist of firm/consolidated clay. Vegetation is dominated by cattail (Typha sp.), maidencane (Panicum hemitomon), giant cutgrass (Zizianopsis miliaceae), bulltongue (Saggitaria lancifolia) and common reed (Phragmites australis). The surface layers of this soil will not support the weight of domestic livestock, but the subsoil layers will, thus these areas have fair trafficability. Grazing distribution is limited by the thickness of the surface layers. Considerable forage is utilized by whitetail deer, nutria, and other wetland wildlife in this area.

Allemands soils make up about 43 percent of the fresh marsh range site. Within this basin, these soils occur exclusively in Pool #3, on Sabine National Wildlife Refuge. This soil occurs in areas where the Prairie Terrace has subsided to depths ranging from about 16 inches to 20 feet. This soil has a very fluid muck (organic) surface layer ranging in thickness from 16 inches to 40 inches. The underlying mineral soil layers are dominantly very fluid clay. These areas are dominated by Maidencane, giant cutgrass, bulltongue, and cattail. These areas have poor trafficability, and cannot support the weight of domestic livestock. Most forage is utilized by nutria, muskrat, and other wetland wildlife.

Brackish Marsh Range Site

The Brackish Marsh range site is the dominant range type in the basin. This range site represents the southern 74 percent of the basin area. Brackish marsh refers to a general marsh type; however, due to soil properties and hydrologic differences, this range type is divided into three different range sites which have slightly different climax vegetative communities. This range type is 39 percent Brackish Firm Mineral Marsh; where Gentilly, Creole, and Mermentau soils occur; 47 percent Brackish Fluid Mineral Marsh; where Bancker soils occur; and 14 percent Brackish Organic Marsh; where Clovelly soils occur. These soils all have moderate concentrations of available salts. A complete range site description is available for the five recognized range sites in coastal Louisiana. These range site descriptions include a description of the relative composition of the climax plant community for each of these range sites. Further investigations are necessary to separate the brackish marsh into three different range sites. Until such time that enough information is assimilated to make these distinctions the brackish marsh will be considered one range site. The following information can be used for making management decisions in these areas until such time that these three separate sites are officially recognized.

Brackish Firm Mineral Marsh

Gentilly soils make up about 13 percent of the brackish marsh range site. These soils are adjacent to Ged soils and occur where the Prairie Terrace has subsided to depths ranging from 20 to 40 inches. Gentilly soils have a surface layer of very fluid muck ranging in thickness from about 4 to 16 inches. The next layer is slightly fluid clay. The underlying firm/consolidated clay is at depths ranging from 20 to 40 inches. Vegetation is dominated by marshhay cordgrass (Spartina patens), Olney bulrush (Scirpus olneyi), seashore paspalum (Paspalum vaginatum), and seashore saltgrass (Distichlis spicata). These soils have fair trafficability, and can support the weight of domestic livestock. Grazing distribution is determined by the depth to firm underlying clay layers.

Mermentau soils make up about 3 percent of the brackish marsh range site. These soils are adjacent to beach ridges (cheniers). This soil occurs where clay deposition has buried low beach ridges and the lower edges of beach ridges. This soil has firm clay surface layers ranging in thickness from 10 to 30 inches. The underlying soil layers are firm/consolidated very fine sandy loam. These soils are dominantly vegetated with gulf cordgrass, marshhay cordgrass, seashore paspalum, and seashore saltgrass. These soils have excellent trafficability, and can support the weight of domestic livestock throughout the year.

Creole soils make up 23 percent of the brackish marsh range site. These soils are adjacent to, and slightly lower than Mermentau soils. This soil occurs where the elevation of the marsh surface allows seasonal ponding of surface water for long periods during the wet season. These soils have slightly fluid clay surface layers and very fluid clay underlying layers. These soils are dominantly vegetated with marshhay cordgrass, seashore paspalum, and seashore saltgrass. These soils have good trafficability and can support the weight of domestic livestock throughout the year. The surface layer of this soil may become boggy during the wet season if cattle utilization is heavy.

Brackish Fluid Mineral Marsh

The marsh type is made up of Bancker soils which form the broad expanse of marsh in the middle portion of this basin. This soil makes up 47 percent of the brackish marsh range site. Bancker soil has a very fluid muck (organic) surface layer about 6 inches thick with underlying layers of very fluid clay. This soil is dominantly vegetated with marshhay cordgrass, and California bulrush (Scirpus californicus). The soil has poor trafficability, and cannot support the weight of domestic livestock. Most forage is utilized by nutria, muskrat, and other wetland wildlife.

Brackish Organic Marsh

The marsh type is made up of Clovelly soils which make up 14 percent of the brackish marsh range site and occur in abandoned stream channels and lake beds. A large area of these soils occur in the vicinity of Black Lake, but some occur along Black Bayou and on Sabine National Wildlife Refuge along Double Island Gully and adjacent to the southeast corner of Pool #3. The soil has a very fluid muck (organic) surface layer ranging from 16 to 40 inches thick with underlying layers of very fluid clay. It is predominantly

vegetated with marshhay cordgrass and black needlerush (Juncus roemerianus) and has poor trafficability, and cannot support the weight of domestic livestock. Most forage is utilized by nutria, muskrat, and other wetland wildlife.

Salt Marsh Range Site

The range site is exclusively made up of Scatlake soils which occur in the vicinity of Big Forge Bayou and Lighthouse Bayou, where tidal salinities are highest. Scatlake soils have a surface layer of very fluid mucky clay about 10 inches thick with underlying layers of very fluid clay. The soil has high concentrations of available salts and is predominantly vegetated with smooth cordgrass (Spartina alterniflora) and seashore saltgrass. The soil has poor trafficability, and cannot support the weight of domestic livestock. Most forage is utilized by nutria, muskrat, and other wetland wildlife.

Chenier and Beach Ridges Range Site

Approximately 95 percent of this range site is made up of Hackberry soils, the remaining 5 percent is made up of Peveto soils. These soils occur along the coast parallel to beach ridges in the southernmost portion of the basin. These soils are sandy throughout and have a high percentage of shell and shell fragments. They have low concentrations of available salts, even when oriented adjacent to the gulf because of their low capacity to hold salts in high rainfall areas. These areas are predominantly vegetated with gulf cordgrass, common bermudagrass (Cynodon dactylon), and hackberry trees (Celtis laevigata). The soils have excellent trafficability throughout the year and are used intensively as bedding and resting areas.

Spoil Banks

Spoil banks constitute 3 percent of the basin area. Most spoil banks are adjacent to the Calcasieu River ship channel and Sabine River ship channel. Spoil banks also found along the numerous small navigational canals in this area. These spoil banks are made up of general soil types known as Udifluvents and Aquents. Udifluvents make up 52 percent and Aquents make up 48 percent of the unti spoil banks.

Udifluvents are the higher areas of spoil that support numerous types of trees, shrubs, and grasses. The soils in these areas have low to high concentrations of available salts. Udifluvents are firm and consolidated soils unless altered by recent dredging activities. Udifluvents soil type has good to excellent trafficability. Domestic livestock utilize these areas as bedding and resting areas, and for refuge from storm tides and other flood periods. These areas have high populations of whitetail deer and swamp rabbits. Many of these areas have been stocked with domestic goat populations.

Aquents soils are the lower spoil areas and are vegetated with grasses and forbs. These soils consist of slightly fluid and very fluid soil layers. These soils have low to high concentrations of available salts. Trafficability is fair to poor. Whitetail deer, swamp rabbits, domestic goats, nutria, and muskrat utilize most of the forage in these areas.

VEGETATION

In the first half of the 20th century, marsh ecotypes were more stratified than they are today. Formerly, this area was characterized by a progression from fresh marshes in the center of the basin, grading into a broad expanse of intermediate marsh to the west of Calcasieu Lake and the south central part of the basin.

Intermediate marshes serve as a buffer zone between the brackish marsh and fresh marshes. Historically, intermediate marshes were represented predominantly by Creole and Bancker soils. Hydrologic modifications such as oilfield and transportation canals expanded the number of avenues for saltwater intrusion into these zones of intermediate marsh. By increasing the area for saltwater intrusion, the effects of tidal fluctuation were also expanded. Previously the less salt tolerant plant communities of the intermediate marsh were affected gradually throughout the day by the tides. With more avenues, the effects of the tides and the duration of saltwater on the plant communities were increased. Prolonged durations of saltwater gradually transformed intermediate marsh plant communities to a more brackish plant community.

Historically, the dominant vegetation of the intermediate marshes consisted of Jamaica sawgrass (Cladium jamaicense), interspersed with marshhay cordgrass. The vegetation was altered due to saltwater intrusion during droughts and 'trapped' saltwater from hurricanes Audrey in 1957 and Carla in 1961. Conditions of higher salinity in the upper soil strata permitted more salt tolerant plants such as marshhay cordgrass the opportunity to encroach on these areas.
The resulting plant community, while growing in an intermediate setting, now more resembles a brackish vegetative community.

The basin is built upon marine sediments which have salinity concentrations ranging from saline to brackish. The plant community which ultimately inhabits the different marsh types is relative to the salinity of the water in the upper soil strata, which includes the root zone. Even though the soil in the root mat may be of intermediate concentration, the substrate is brackish; marsh communities such as these will be referred to as brackish marsh in this report.

Plant communities in areas which were historically delineated as brackish marsh; which are composed of Hackberry, Mermentau, and most Bancker soils, are also subject to the saltwater concentrations and water levels in which they evolved. The highest percentage of emergent vegetation in the brackish marsh is comprised of marshhay cordgrass along with associated grasslike vegetation. These plants make up the majority of the grazeable vegetation as well as providing wildlife habitat.

Plant communities in the marsh overlie soils with varying degrees of load bearing capacity. The organic and mineral components of the soil as well as the hydrology of the area impact the strengths of these marshes concerning livestock trafficibility.

While trafficibility is related to the inherent ability of the soil to hold up under the weight of animals, areas holding water can contribute to poor

trafficibilty. Much of the lower lying marsh is now holding water at levels and durations that most grass plants such as marshhay cordgrass cannot tolerate. Vegetative communities in these areas are being altered, with California bulrush as the dominant plant. While this plant provides foliar cover and habitat for wildlife it does not provide as much basal coverage as a grass dominated marsh, therefore trafficibility suffers as well as access for livestock in some instances. Other areas of the same soil type, in which the hydrology has not been significantly altered, exhibit a much higher proportion of marshhay cordgrass. Evidence of better drainage in areas such as these is supported by a reduction in density of California bulrush.

In marshes with better water exchange and drainage, plants such as alligatorweed (Alternathera philoxeroides), seashore paspalum, and various sedges (Carex sp.) become established. Marshhay cordgrass, Olney bulrush, and leafy threesquare (Scirpus robustus) tend to out-compete these plants and push them into isolated communities as water levels stabilize.

The majority of the brackish marsh is intermittently flooded and dominated by marshhay cordgrass in higher successional stages. These areas produce the highest amount of biomass and grazeable forage. Long growing seasons facilitated by a subtropical climate, coupled with the enormous growth potential of marsh vegetation necessitate removal of annual growth. In the absence of plant removal either by grazing animals or prescribed burning, a thatch of old growth can quickly develop. Under these conditions, new growth is restricted due to competition for sunlight with the canopy of the previous year's growth. Total annual vegetative production on a dry matter basis can range from 6,000 pounds per acre on an underused site with no burning program, to upwards of 24,000 pounds per acre on a properly managed site.

Gently undulating complexes associated with Hackberry and Mermentau soils exhibit the highest diversity of vegetation in the brackish marsh. These areas support a large amount of marshhay cordgrass that is associated with seashore saltgrass in the swales and on lower positions, and gulf cordgrass on low ridges. Individual communities of seashore paspalum, sedges, and annuals occupy natural drains; while the backslopes grading toward the gulf become dominated by gulf cordgrass and seashore saltgrass with smooth cordgrass in the intertidal zone.

Fresh sandy cheniers composed of Hackberry and Peveto soils provide excellent trafficibility. These soils are well drained and support a community dominated by gulf cordgrass and marshhay cordgrass. Cattle tend to concentrate on these ridges due to their proximity to prevailing gulf winds and better footing. Under intense grazing gulf cordgrass will dominate along with torpedoegrass (Panicum repens) and marshhay cordgrass to a lesser extent. Traditional upland species such as common bermudagrass, windmillgrass (Chloris sp.), and bristlegrass (Setaria sp.) invade this site under further heavy use.

Pockets of coastal prairie are scattered across the northern part of the basin. These areas are represented by the community of Hackberry, and the Gum Cove, Perry and Pine Ridges. Initially these areas supported cordgrasses (Spartina sp.) in the lows and bluestems (Andropogon sp.), switchgrass, and indiangrass (Sorghastrum nutans) on the better drained sites. Intense grazing of these areas has reduced most of the true prairie vegetation to a sod forming, prostate plant community characterized by carpetgrass (Axonopis

affinis) and common bermudagrass. Wetter sites of the coastal prairie are still dominated by gulf cordgrass.

NUTRITIONAL VALUES OF MARSH PLANTS

The nutritional value of forage plants in the Southeastern U.S. are noted for having a low nutritional value after they mature or enter dormancy. However, many plants are an exception to this rule. Some examples are:

PLANT	CRUDE PROTEIN % (YOUNG GROWING)	CRUDE PROTEIN % (MATURE OR DORMANT)
Smooth Cordgrass	8 - 13	8 - 10
Marshhay Cordgrass (unburned)	3.5 - 7	3.5 - 8
Marshhay Cordgrass (burned)	12 - 20	5 - 8
Gulf Cordgrass	7 - 8.5	6 - 7
Longtom	10 - 13	6.5 - 8
Giant Cutgrass	14 - 16	6 - 12

Marsh forages typically supply the cow with needed calcium and phosphorus for fetal development and lactation. Furthermore, cattle will select those plants and plant parts that approximate their nutritional demands. Normally the only supplemental feeding needs are to supply additional energy during periods of cold, wet weather, typically "Blue Northerns" during January and February.

GRAZING MANAGEMENT PRACTICES

Due to the seasonal possibility of tropical storms, many producers move cattle to upland areas between June and October of each year. This provides a rest - rotation grazing system for much of the marsh range. Other producers move cattle from the 'front marshes', those nearest to the Gulf of Mexico, to the 'back marshes', or those farthest inland. This movement is primarily to avoid high concentrations of insects, mainly mosquitoes in the brackish marshes. Ridges and relic coastal dunes provide land areas of higher elevation. These areas provide some relief from the insect problems.

Many grazing operations rely on lands that are leased for grazing. These same lands are often leased for activities centered around wildlife resources such as hunting and trapping. Coordination between resource use is needed to attain multiple use management. Sabine National Wildlife Refuge is a good example of multi-use management. There were over 800 head of cattle grazing the refuge during the October through April allotment period in 1989. The refuge does play a major role in the basin, both as a forage resource and as a model for multiple use management.

Prescribed Burning

Prescribed burns do several things to benefit wildlife and beef cattle in marsh areas. The most important of which is to reduce foliar cover and excessive rough allowing ecologically lower plants to compete with higher order plants. As the foliar cover of the dominant plants increases and competes for space and sunlight, they will once again reduce the number and amount of secondary plants. The dense cover of mature marsh vegetation is

burned to stimulate new, succulent vegetative growth for both wildlife and cattle and to increase the availability of forage. This is best illustrated by a marsh dominated by marshhay cordgrass which, when dominant, produces very little wildlife food. The burn will remove the accumulated rough and allow desirable secondary plants such Olney bulrush to grow. Under controlled water conditions, a burn will also encourage growth of desirable duck foods such as duckmillets (Echinochloa spp.), sprangletop (Leptochloa spp.), coastal waterhyssop (Bacopa monnieri) and saltmarsh bulrush (Scirpus robustus).

Other benefits of burns include the increase of nutrients necessary for plant growth, and the blackened soils warm up more quickly and enhance the growth of plants. Burns provide landing areas for geese and ducks in otherwise unbroken stands of tall stands of marshhay cordgrass.

Cattle Walkways

Walkways are earthen levees constructed from cheniers into marsh areas to improve accessibility and encourage uniform use of the marsh vegetation. The walkways benefit cattle by serving as trails, bedgrounds, calving locations, and places for young calves to rest while their mothers graze.

Walkways provide refuge for wildlife and cattle during periods of high water. They provide resting, nesting, and den sites for several types of birds and mammals as well as providing different species of food plants.

Borrow pits from which soil is excavated to build the walkways are staggered on each side of the levee at intervals of several hundred feet. The allows cattle to graze from either side of the walkways. Staggered pits also prevent the flow of water off the range while providing permanent fresh water and small ponds for waterfowl and other wildlife.

Range Proper Use

Range proper use means grazing at an intensity that will maintain or improve the quality and the quantity of the desirable vegetation. This is normally 50 percent by weight of the current growth of the key plant or plants.

Range Deferred Grazing

Deferred grazing involves resting the range from cattle grazing during the major growth period of the key plants to encourage improvement through increased plant vigor, vegetative increase through rhizomes and stolons, and from seed production. This practice also provides to have cattle off of marsh range during periods when insects, especially mosquitoes, become intolerable during the late spring and summer months.

Fencing

Fencing is needed to distribute grazing and facilitate livestock and forage management. Fencing (property line fences, cross fences, and blind fences) will keep livestock out of areas which are being deferred from grazing, as well as in areas designated for grazing. For example, fences can prevent livestock from entering areas that have been over-utilized or grazed out by waterfowl or furbearers such as nutria and muskrats.

Brush Management

Control of competitive shrubs such as Cherokee rose, Eastern Baccharis (Baccharis halimifolia), Rattlebox (Sesbania drummondii) and Chinese Tallow trees is needed to provide for favorable food plants. When controlling brush consideration should be given to leaving some trees and shrubs such as oaks and yaupons, which can provide shade for livestock and food and cover for wildlife. Management which favors the better forage plants is the best overall weed control.

Brush management methods include mowing, burning, and chemical control. Follow all directions and heed all precautions on the container's label when chemical treatment is needed.

NON - LIVESTOCK USE OF MARSH RANGES

Marsh ranges in the Calcasieu-Sabine River Basin study area are utilized by a number of herbivores. The major non-domestic livestock users include migratory waterfowl, furbearers, rabbits, and deer (Existing Resources).

Management practices that enhance marsh vegetation for livestock can also benefit wildlife. Prescribed burning is an example. Geese prefer sites that have lower vegetation which will not impede them when landing. The tender shoots provide excellent quality food. Nutria, rabbit, and deer also thrive on freshly greened up marsh. In addition, burning opens the marsh so the less dominant plants can increase. This is especially true for the grasslike and annual plants which are noted for their wildlife food value.

Overpopulation of any herbivore can cause problems in maintaining the marsh vegetation. "Eat-outs" caused by nutria, muskrat, or geese can cause severe damage to the plant community, often leading to the area being converted to open water. "Eat-outs" occur when the population density of the herbivores exceeds the carrying capacity of the plant community. Typically, nutria or geese will graze the plants to the ground surface and uproot the plants to forage on the rootstock. When this happens the plants loose the capacity to vegetatively reproduce. In the case of nutria the lack of sufficient predator or trapping pressure can lead to overpopulations. Geese concentrate on fresh burns and if the burned areas are limited, especially on the marsh sites with higher elevations, the herbivore population will be out of balance with the food source.

Planned burning rotations need to consider past use of the area by migratory waterfowl, resident herbivore populations, and domestic livestock. Burns should be rotated so that adjacent marshes that have been burned or heavily utilized in the past growing season do not get excessive use due to proximate of the current years burns. Several areas exist in the basin where high nutria concentrations have occurred. Additional "eat-outs" can be expected to occur unless the nutria populations are controlled.

SOCIAL AND CULTURAL ASPECTS

The livestock industry in the Calcasieu Sabine River Basin Study area is the dominant agricultural enterprise. About 100 operating units are headquartered

in the basin area. Other producers are headquartered outside the basin but utilize the grazing resources for part of the year by moving cattle from upland areas to the marsh as part of a planned grazing system.

The family unit is evident in the livestock operations in the basin. Often one family member is responsible for the day to day management of the livestock enterprise while actual ownership is distributed between various family members. Its not unusual to find 5 or 6 ownership brands in one herd of cattle. Family members and neighbors pool their labor and resources to carry out the major management endeavors such as moving, working, and marketing livestock.

Youth activities in the basin are highly influenced by the livestock industry. Participation in 4-H, FFA, and High School Rodeo activities are major activities for a large percentage of the area youth.

ECONOMICS

In 1991, the Louisiana beef cattle industry had a gross farm value of about $287 million. Cameron Parish has the second highest number of beef cattle in the state with over 36,000 head. The cattle industry in Cameron Parish had a $14 million gross farm value in 1991. About half of the livestock in Cameron Parish are headquartered or spend a portion of the year grazing in the basin.

In addition, a large number of cattle headquartered in Calcasieu Parish spend a portion of the year grazing in the Calcasieu-Sabine River Basin area. The gross farm value for these cattle is attributed to Calcasieu Parish.

Almost all of the cattle in the river basin are in the cow-calf phase of the industry. Weaned calves are sold as rodeo roping calves or as weaning calves. Very few calves are kept in the stocker calf phase. Therefore, most of the value added economic returns from livestock are derived outside the river basin area.

APPENDIX G

ALTERNATIVES 3 AND 4 UNIT COSTS
CALCASIEU-SABINE RIVER BASIN

CALCASIEU-SABINE RIVER BASIN STUDY
Alternatives 3 and 4
Description of Elements

Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
NO-1	2800 Acres - Mgt. Objective: Stabilize salinities and water level fluctuations; will be actively managed							
	Any spoil from ship channel should be placed in this area	4	A	$3.00 cu. yd.	100,000 cu. yd.		300,000	
	Fresh water introduction structure through proposed West Levee Spoil	5	G	$26,250 each	4-48" pipes w/gates		105,000	
	Stabilize south boundary by installing structures in oil field canals	*6	G	$14,000 each	5-48" culverts w/gates		70,000	
	Install variable crest weir with boat bay in south boundary levee	*7	G	$80,000	Weir with boat bay		80,000	
	Rebuild south boundary levee	*8	D	$15/ft.	20,000 ft.		300,000	
	Interior vegetative plantings and plantings along Alkali Ditch Levee	9	B	$1.50/ft.	12,000 ft.	20,000 ft.	18,000	12,000
	Request that DOE plant operator use a smaller boat on GIWW and Alkali ditch trips	10	J		Written Request		0	

Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Install wave stilling devices in open water areas. Terraces or fences.	11	C	$15/ft.	50,000 feet	134,000 feet	750,000	1,260,000
	Rebuild levee on east bank of Alkali ditch	12	D	$15/ft.	12,000 feet		180,000	
	TOTAL COST ALT 3						1,803,000	3,075,000
	TOTAL COST ALT 4							
NO-2	1300 Acres - Mgt. Objective: Stabilize salinity and water level fluctuation, stimulate emergent vegetation growth. Actively managed.							
	Maintain exterior levees	*13	D	$8/ft.	6,000 feet		48,000	
	Install structures for water control.	*14	G	$50,000 each	3		150,000	
	The structure on the north side may need to be a pump. Fresh water introduction.	15	G	$150,000	1 w/pump		150,000	
	Armor-plate part of south levee along Black Lake	16	D	$65/ft.	5000 feet	9000 feet	325,000	260,000
	Interior Vegetative Plantings	17	B	$1.50/ ft.	12,000 feet		18,000	

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	TOTAL COST ALT 3						691,000	
	TOTAL COST ALT 4							951,000
NO-2A	800 acres - Mgt. Objective: Stabilize water level fluctuation, reduce turbidity, and passively manage.							
	Rebuild south levee and armor-plate	*18	D	$65/ft.	8000 feet		520,000	
	Install structure for water control (slottted, variable crest flapgated structure)	*19	G	$80,000	1		80,000	
	Install wave stilling/sediment trapping devices	20	C	$15/ft.	10,000 feet	40,000 feet	150,000	450,000
	Interior vegetative plantings	21	B	$1.50/ft	15,000 ft.		22,500	
	TOTAL COST ALT 3						772,500	
	TOTAL COST ALT 4							1,222,500
NO-3	4100 Acres - Mgt. Objective: Maintain fresh water marsh, passively managed unit							
	Repair levee along GIWW and provide protection with vegetation or armor plate.	22	D	$65/ft.	1,000 feet	3,000 feet	65,000	130,000

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Structures for water control on south side	23	F	$60,000 each	2		120,000	
	Repair levee along Alkali ditch	24	A	$15/ft.	4,500 feet		67,500	
	TOTAL COST ALT 3						252,500	
	TOTAL COST ALT 4							382,500
NO-4	6600 Acres - Mgt. Objective: Manage for emergent vegetation for fresh-intermediate marsh. Unit is actively managed.							
	Shoreline protection on east side, along Black Lake	25	D	$65/ft.		5,200 feet	338,000	
	Demonstration - Try for vegetative stand in deeper water, gallon containers of Bull Whip etc.	26	B	$1,500/ ac.	20 acres	50 acres	30,000	45,000
	TOTAL COST ALT 3						368,000	
	TOTAL COST ALT 4							413,000
NO-5	11,700 Acres - Mgt. Objective: Maintain and/or enhance internal vegetation							

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Utilize any future dredge material from Alkali ditch for marsh rebuilding	27	A	$3/cu. yd.	80,000 cu. yd		240,000	
	Interior marsh vegetative planting	28	B	$1,500/ ac.	50 ac.	100 ac.	75,000	75,000
	Utilize spoil from Calcasieu ship channel for marsh rebuilding	29	A	$3/cu. yd.	170,000 cu. yd.		510,000	
	Install a water control structure in Kelso Bayou near Hwy. 27 bridge. A boat bay may need to be included in the structure.	30	F	$1,500,000		1		1,500,000
	Install sediment trapping/wave stilling devices	31	C	$15/ft.	50,000 feet	134,000 feet	750,000	1,260,000
	Plug existing inactive oil field canal.	32	H	$70,000	1 plug		70,000	
	Gap spoil banks of inactive plugged oil field canals.	33	I	$20,000 for job	Various gaps		20,000	
	TOTAL COST ALT 3						1,665,000	
	TOTAL COST ALT 4							4,500,000

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
NO-6	6700 Acres - Mgt. Objective: Maintain adequate flood control facilities in the area and insure that wetland management practices installed in adjacent management units do not increase flooding of inhabited areas and any future pump discharge is utilizaed to benefit wetlands. No specific elements are proposed.							
NO-7	1660 Acres - Mgt. Objective: Maintain present system of levees and water control structures, existing actively managed area.							
NO-8	4600 Acres - Mgt. Objective: Stabilize salinity and water level fluctuation. Passively managed for fresh/intermediate marsh.							
	Install wave breaks across open water areas	34	C	$15/ft.	100,000 feet	268,000 feet	1,500,000	2,520,000
	Install vegetative plantings in open water areas and on south levee	35	B	$1500/ ac.	50 ac.	100 ac.	75,000	75,000

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Maintain south canal levee	*36	D	$8/ft.	22,800 feet		182,400	
	Install fixed crest weirs	*37	F each	$50,000	4 weirs		200,000	
	TOTAL COST ALT 3						1,957,400	
	TOTAL COST ALT 4							4,552,400
NO-8A	1110 Ac. - Mgt. Objective: Enhance existing vegetation. Passive management							
	Install wave stilling/sediment trapping devices	38	C	$15/ft.	6000 ft.	20,000 ft	90,000	210,000
	TOTAL COST ALT 3						90,000	
	TOTAL COST ALT 4							300,000
NO-9	310 Ac. - Mgt. Objective: Maintain in present condition							
NO-10	800 AC. - Mgt. Objective: Maintain the area. It is in the water bank program.							

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	The pump that is in the middle of the east boundary may need to be moved to the southeast corner of the area.	39	G	$180,000	1		180,000	
	TOTAL COST ALT 3						180,000	
NO-11	12,800 Ac. - Mgt. Objective: Maintain present conditions							
NO-12	2870 Ac. - Mgt. Objective: Maintain as is							
NO-13	4600 Ac. - Mgt. Objective: Manage for fresh marsh, actively managed							
	Repair spoil bank along GIWW	*40	D	$65/ft.	2,000 feet		130,000	
	Introduce water from GIWW. Replace breached water control structure on the west boundary. A structure with flapgates will be considered in order to allow one-way flow from GIWW.	*41	G	$100,000 each	2		200,000	

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Replace failed structures along south boundary	*42	G	$15,000 each	2		30,000	
	Replace failed structure along south boundary	*43	G	$15,000	1		15,000	
	Interior vegetative plantings	44	B	$1500/ ac.	50 ac.	100 ac.	75,000	75,000
	Install wave stilling/sediment trapping devices	45	C	$15/ft.	50,000 ft.	150,000 ft.	750,000	1,500,000
	TOTAL COST ALT 3						1,200,000	
	TOTAL COST ALT 4							2,775,000
NO-14	4200 Ac. - Mgt. Objective: Maintain as a fresh/intermediate marsh, passively managed							
	Install water control structures in openings along Black Bayou (rock weirs)	46	F	$50,000 each	8		400,000	
	Interior vegetative plantings	47	B	$1.50/ ft.	5000 ft.		7,500	
	TOTAL COST ALT 3						407,500	

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
NO-14A	3500 Ac. - Mgt. Objective: Maintain fresh/intermediate marsh, passively managed							
	Install water control structures in openings along Black Bayou (rock weirs)	48	F	$50,000 each	4		200,000	
	Maintain hydrologic barrier on south boundary	49	D	$8/ft.	13,000 feet		104,000	
	TOTAL COST ALT 3						304,000	
NO-15	900 Ac. - Mgt. Objective: Reduce excess water exchange & fluctuation							
	Repair spoil bank along boundary cut-off canal (west of Mgt. Unit)	50	D	$65/ft.	600 ft.		39,000	
	Reduce or close openings along GIWW with plugs. (Black Bayou & Vinton Drainage Canal)	51	H	$200,000 each	2		400,000	
	Install wave stilling/sediment trapping devices	52	C	$15/ft.	6,000 feet	20,000 feet	90,000	210,000
	TOTAL COST ALT 3						529,000	
	TOTAL COST ALT 4							739,000

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
NO-16	1500 Ac. - Mgt. Objective: Oil field area, maintain as is and insure that brine discharge is controlled.							
Note:	Management concept for Unit 17, 18, 19, 20, & 21 - Block flow from the north (GIWW) as much as possible and still allow flow from Black Bayou Cut-off Canal through Units 17 and 18 - Leave Black Bayou Cut-off open - Try to utilize the one way in, one way out concept for water from the Sabine River side - Maintain as a fresh/intermediate marsh							
NO-17	2950 Ac.							
	Rebuild spoil bank along Black Bayou Cut-off Canal	*53	D	$15/ft.	8,500 ft		127,500	
	Install rock weirs in openings along Black Bayou Cut-off Canal. Ensure that height of structures prevent ponding of excess water.	*54	F	$150,000 each	2		300,000	
	Install flap-gated structure to south under road at southern-most part of Mgt. Unit	*55	F	$80,000	1		80,000	
	Install sediment trapping/wave stilling devices	56	C	$15/ft.	22,000 feet	67,000 feet	330,000	675,000

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Gap spoil in interior of unit	57	I	$30,000	Various Gaps		30,000	
	TOTAL COST ALT 3						867,500	
	TOTAL COST ALT 4							1,542,500
NO-18	4800 Ac.							
	Install rock liners in openings along Black Bayou	58	F	$20,000 each	22		440,000	
	Install structure under cattle walkway along Units 18-19 boundary	59	F	$40,000	1		40,000	
	Install wave stilling/sediment trapping devices and interior vegetative plantings	60	C	$17/ft.	18,000 feet	47,000 feet	306,000	493,000
	TOTAL COST ALT 3						786,000	
	TOTAL COST ALT 4							1,279,000
NO-19	10,920 Ac.							
	Install rock liners in openings along Black Bayou	61	F	$20,000 each	7		140,000	

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Interior vegetative plantings	62	F	$1.50/ft	60,000 feet	200,00 feet	90,000	210,000
	Install wave stilling/sediment trapping devices	63	C	$15/ft.	60,000 feet	200,000 feet	900,000	2,100,000
	Plug canal at Units 19-20 and Sabine River junction	64	H	$80,000	1		80,000	
	Install rock plug in bayou at Units 19-20 and Black Bayou junction	65	F	$100,000	1		100,000	
	TOTAL COST ALT 3						1,310,000	
	TOTAL COST ALT 4							3,620,000
NO-20	1680 Ac.							
	Install rock liners along Black Bayou	66	F	$20,000 each	5		100,000	
	TOTAL COST ALT 3						100,000	
	TOTAL COST ALT 4							0
NO-21	6650 Ac.							
	Install rock liners along Black Bayou	67	F	$20,000 each	12		240,000	

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Install rock liner in marsh near southern boundary of Mgt. Unit and Sabine NWR boundary	68	F	$20,000	1		20,000	
	Install wave stilling/sediment trapping devices and interior vegetative plantings	69	C	$17/ft.	10,000 feet	33,000 feet	170,000	391,000
	TOTAL COST ALT 3						430,000	
	TOTAL COST ALT 4							821,000
SA-1	28,800 Ac. - Mgt. Objective: Reduce salinity levels							
	Plug Canal (earthen plug)	70	H	$20,000	1		20,000	
	Plug Canal (rock)	71	H	$75,000	1		75,000	
	Install rock weir in canal near junction with Central Canal	72	F	$90,000	1		90,000	

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Install overflow culverts in levee just west of Long Point Bridge. Culverts flapped out with screw gates on the inside. Culverts would be for emergency use. 1. Install 6000 ft. of levee. 2. Install water control structure at Sabine NWR boundary. 3. Install overflow culverts at north end of levee adjacent to Long Point Bayou bridge.	73	G	$68,000 each $25/ft.	3 300 ft. of levee		204,000	
	Rebuild levees in northwest corner of Mgt. Unit. (Also see Mgt. Unit NO-8)	74	D	$15/ft.	12,500 feet		187,500	
	Interior vegetative plantings	75	B	$1500/ ac.	50 ac.	100 ac.	75,000	75,000
	Install wave stilling/sediment trapping devices in open water areas	76	C	$15/ft.	20,000 feet	37,000 feet	300,000	255,000
	TOTAL COST ALT 3						959,000	
	TOTAL COST ALT 4							1,289,000

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
SA-1A	5,000 Ac. - Mgt. Objective: Maintain as an impoundment							
	Vegetative plantings	77	B	$1.50/ft.	9,000 feet		13,500	
	Install drainage structure	78	F	$110,000	1		110,000	
	Maintain north boundary canal	79	D	$15/ft.	18,000 feet		270,000	
	TOTAL COST ALT 3						393,500	
SA-1B	1,800 Ac. - Mgt. Objective: Maintain as an impoundment							
	Maintain boundary levees	80	D	$8/ft.	20,000		160,000	
	Demonstration vegetative plantings	81	B	$1.50/ft	10,000 ft.		15,000	
	Install drainage structure	82	F	$90,000	1		90,000	
	TOTAL COST ALT 3						265,000	

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
SA-2	6,800 Ac. - Mgt. Objective: Maintain in present condition							
	Maintain north boundary canal	83	D	$15/ft.	18,000 ft.	270,000		
	TOTAL COST ALT 3						270,000	
SA-3	26,800 Ac. - Mgt. Objective: Manage as fresh water marsh and pool							
	Interior vegetative plantings	84	B	$1.50/ft	26,000 ft.	50,000 ft.	39,000	36,000
	Install water control structure w/boat bay in north boundary canal	85	F	$250,000	1		250,000	
	Install wave stilling/sediment trapping devices.	86	C	$15/ft.	45,000 feet	270,000 feet	675,000	3,375,000
	Install drainage structure	87	F	$100,000	1		100,000	
	TOTAL COST ALT 3						1,064,000	
	TOTAL COST ALT 4							4,475,000
SA-4	12,200 Ac. - Mgt. Objective: Maintain as fresh/intermediate marsh							

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Interior vegetative plantings	88	B	$1.50/ft	16,000 ft.	26,000 ft.	24,000	15,000
	Install wave stilling/sediment trapping devices	89	C	$15/ft.	15,000 feet	22,000 feet	225,000	105,000
	TOTAL COST ALT 3						249,000	
	TOTAL COST ALT 4							369,000
SA-5	26,700 Ac. - Mgt. Objective: Enhance vegetation							
	Plug north end of canal	90	H	$80,000	1		80,000	
	Install open culverts from canal into marsh	91	F	$9,500 each	3		28,500	
	Install variable crest structure in Greens Bayou	92	F	$250,000	1		250,000	
	Install rock liners in east boundary canal (Burton-Sutton Canal)	93	F	$20,000 each	1		20,000	
	Install plug in bayou near cattle walkway	94	F	$40,000	1		40,000	
	Install wave stilling/sediment trapping devices	95	C	$15/ft.	I00,000 feet	335,000 feet	1,500,000	3,525,000

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Install plug in canal on west side of cattle walkway	96	H	$20,000	1		20,000	
	TOTAL COST ALT 3						1,938,500	
	TOTAL COST ALT 4							5,163,500
SA-6	7,400 Ac. - Mgt. Objective: Enhance vegetation							
	Interior vegetative plantings	97	B	$1.50/ft ft.	12,000 ft.	17,000	18,000	7,500
	Install rock liner in marsh along east boundary canal	98	F	$20,000	1		20,000	
	Install rock liner in marsh along the east boundary canal	99	F	$20,000 each	1		20,000	
	Install wave breaks in open water area	100	C	$15/ft.	12,000 feet	17,000 feet	180,000	75,000
	TOTAL COST ALT 3						238,000	
	TOTAL COST ALT 4							320,500
SA-7	6,400 Ac. - Mgt. Objective: Enhance vegetation							

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Sabine Lake shoreline protection on critical area just west of Willow Bayou	101	D	$65/ft.	1500 ft.		97,500	
	Install plugs in Willow Bayou Canal to help re-establish flow pattern in Willow Bayou	102	H	$40,000 each	4 plugs		160,000	
	Install rock liners in breaks along school board section	103	F	$20,000 each	2		40,000	
	Install rock liners along Grays Ditch	104	F	$20,000	2		40,000	
	Interior vegetative plantings	105	D	$1.50/ft.	17,000	28,000	25,500	16,500
	Install wave stilling/sediment trapping devices in open water areas	106	C	$15/ft.	17,000 feet	28,000 feet	25	165,000
	TOTAL COST ALT 3						618,000	
	TOTAL COST ALT 4							799,500
SA-8	720 Ac. - Mgt. Objective: Maintain and enhance vegetation							
	Modify existing structure in order to regulate flow and reduce salt water intrusion	108	G	$500,000	1		500,000	

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Install culverts with flap and screw gates in Hdq. Canal and under LA 27 into Shell Canal	109	F	$33,000 each	5 - 60"		165,000	
	Plug Hdq. Canal cuts & install screw gated culverts into Shell Canal	110	H G	$20,000 each $7800 each	1 3 - 24"		20,000 23,400	
	TOTAL COST ALT 3						708,400	
SA-9	1,800 Ac. - Mgt. Objective: Maintain & enhance vegetation							
	Utilize dredge material from ship channel in this unit when possible	111	A	$3/cu. yd.	80,000 cu. yd.		240,000	
	Install wave stilling/sediment trapping devices	112	C	$15/ft.	11,000 ft.	15,000 ft.	150,000	
	TOTAL COST ALT 3						390,000	
	TOTAL COST ALT 4							465,000

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
SA-10	4,600 Ac. - Mgt. Objective: Maintain & enhance vegetation							
	Install plug w/armor plate in West Cove Canal outlet into ship channel to reduce flow	113	H	$80,000			80,000	
	Modify existing structure in order to regulate flow and reduce salt water intrusion	114	G	$500,000	1		500,000	
	Utilize dredge material from ship channel to refurbish marsh	115	A	$3/cu. yd.	100,000 cu. yd.		300,00	
	Remove existing culverts under Hwy. 27 and replace with flapgates	116	F	$30,000 each	3		90,000	
	Install wave stilling/sediment trapping devices	117	C	$15/ft.	15,000 feet	20,000 feet	225,000	75,000
	TOTAL COST ALT 3						1,195,000	
	TOTAL COST ALT 4							1,270,000
SO-1	42,650 Ac. - Mgt. Objective Reduce excessive water exchange Install structures in openings							

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Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Element Cost 4 $
	Install rock liners structures in natural openings along Johnsons Bayou, M. Johnsons Bayou, Greens Bayou & B. Forge Bayou	118	F	$20,000 each	16		320,000	
	Install plugs in man made openings along Johnsons Bayou, M. Johnsons Bayou, Greens Bayou, & B. Forge Bayou	119	H	$20,000 each	14 plugs		280,000	
	Plug shell dredge site	120	H	$150,000	1		150,000	
	Plug opening as close to shoreline as feasible	121	H	$90,000	1		90,000	
	Plug cut to Greens Bayou	122	H	$80,000	1		80,000	
	TOTAL COST ALT 3						920,000	
SO-1A	3950 ac. - Mgt. Objective: Maintain as a fresh water impoundment							
	Maintain boundary levees	123		$5/ft.	48,000 ft		240,000	
	TOTAL COST ALT 3						240,000	

* This element is one component of a management system for this unit. All elements denoted with an asterisk must be installed at the same time for the management unit to function properly.

Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
SO-2	22,200 Ac. - Mgt. Objective: Protect eroding shoreline							
	Install breakwater on east side of Sabine River at the Gulf where there is no beach	124	K	$70/ft.	15,000 ft.		1,050,000	
	Utilize dredge material for beach nourishment	125	A	$3/cu. yd.	250,000 cu. yd.		750,000	
	Install rock liner in Lighthouse Bayou	126	F	$160,000	1		160,000	
	Install structures in North-South Canal	127	H	$30,000	2		60,000	
	TOTAL COST ALT 3						2,020,000	
SO-3	13,200 Ac. - No specific elements proposed.							
SO-4	6,800 Ac. - Mgt. Objective: Manage for fresh-intermediate marsh, actively managed							
	Repair perimeter levees	*128	D	$15/ft.	20,000 feet		300,000	
	Install water control structures	*129	G	$30,000 each	4		120,00	

* This element is one component of a management system for this unit. All elements denoted with an asterisk must be installed at the same time for the management unit to function properly.

Mgt. Unit	Description	Element Number	* Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	TOTAL COST ALT 3						420,000	
SO-5	8,100 Ac. - Mgt. Objective: Maintain for fresh-intermediate, passively managed							
	Lower existing and install additional culverts under oil field roads to improve interior water exchange.	130	F	$6,000 each	5		30,000	
	Modify drainage structure in S.E. corner (under LA 27) by installing VC weir on west side of highway	131	G	$180,000	1		180,000	
	Install double flap-gated culvert under oil field road	132	G	$40,000 each	2		80,000	
	TOTAL COST ALT 3						290,000	
SO-6	8,100 Ac.							
	Install practices as outlined in Fina permitted marsh plan	133		$945,000 structure & install	Structural Plan	945,000		
	Install wave stilling/sediment trapping devices	134	C	$15/ft.	50,000 ft.	134,000 ft.	750,000	1,260,000

* This element is one component of a management system for this unit. All elements denoted with an asterisk must be installed at the same time for the management unit to function properly.

Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Interior vegetative plantings	135	B	$1.50/ft.	150,000 ft.		225,000	
	TOTAL COST ALT 3						1,920,000	
	TOTAL COST ALT 4							3,180,000
SO-7	2,400 Ac. - Mgt. Objective: Maintain as a brackish marsh							
	Rebuild Spoil Bank (ft.)	107	A	$15.00	500		7,500	
	Install rock liner in canal near outlet into West Cove	136	F	$50,000	1		50,000	
	Install wave stilling/sediment trapping devices	137	C	$15/ft.	10,000 feet	15,000 feet	150,000	75,000
	Install water control structure in south spoil bank	138	F	$80,000	1		80,000	
	TOTAL COST ALT 3						287,500	
	TOTAL COST ALT 4							362,500
SO-8	12,600 Ac. - Mgt. Objective: Reduce water level fluctuation							

* This element is one component of a management system for this unit. All elements denoted with an asterisk must be installed at the same time for the management unit to function properly.

Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
	Install structure in Oyster Bayou before the entrance to West Fork to reduce water level fluctuation and salinity levels	139	G	1,000,000	1			1,000,000
	Install rock liner in Mud Bayou north of Oyster Bayou in order to maintain present opening.	140	F	$50,000		1	50,000	
	Utilize dredge spoil from the Gulf of Mexico and/or ship channel for marsh building	141	A	$3 per cu. yd.	200,000 cu. yds		600,000	
	TOTAL COST ALT 3						650,000	
	TOTAL COST ALT 4							1,650,000
SO-8A	1,100 Ac. - Mgt. Objective: Maintain as is							
	Utilize dredge material from Gulf for beach nourishment	142	A	$3/cu.yd.	200,000 cu. yd.		600,000	
	Install breakwaters along Gulf shore	143	K	$190/ft.	25,000 ft.		4,750,000	
	TOTAL COST ALT 3						5,350,000	

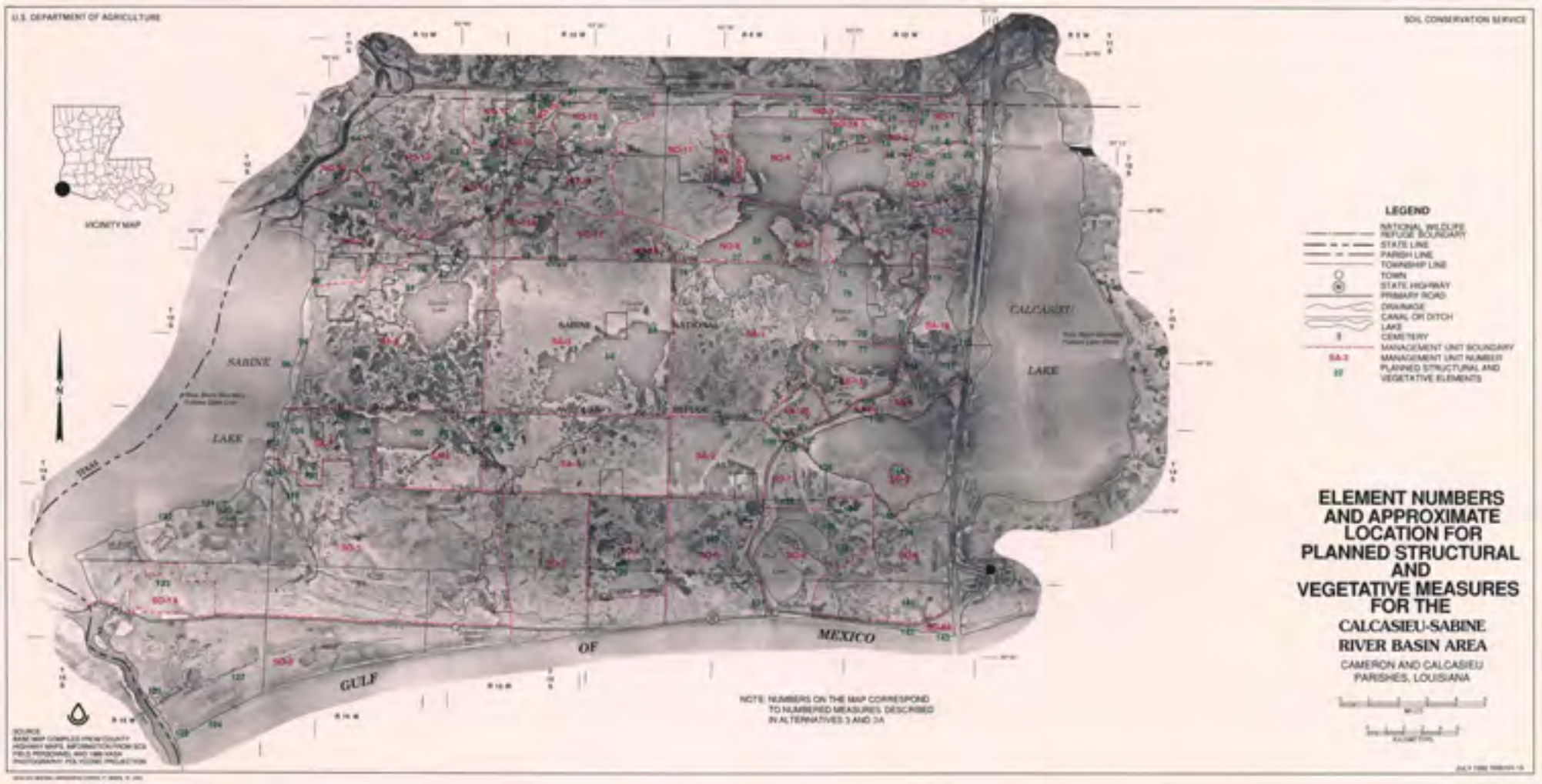
* This element is one component of a management system for this unit. All elements denoted with an asterisk must be installed at the same time for the management unit to function properly.

Mgt. Unit	Description	Element Number	Mgt. Opt.	Unit Cost	Alt. #3	Alt. #4	Element Cost 3 $	Added Element Cost 4 $
SO-9	300 Ac. - Mgt. Objective: Maintain as a nesting habitat for water birds							
	Utilize dredge spoil from Calcasieu Ship Channel to rebuild emergent marsh areas that have converted to open water	144	A	$3 per cu. yd.	26,000		78,000	
	TOTAL COST ALT 3						78,000	

* This element is one component of a management system for this unit. All elements denoted with an asterisk must be installed at the same time for the management unit to function properly.

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

VICINITY MAP

LEGEND

SOILS OF THE GULF COAST PRAIRIES

MORATIA-VERNIE-CROWLEY association: Level and gently sloping, poorly drained and somewhat poorly drained soils that have a loamy surface layer and a loamy and clayey or clayey subsoil

MERRY-MOWATA-METLAND association: Level, poorly drained soils that have a loamy surface layer and a loamy and clayey subsoil

MINERAL SOILS OF THE GULF COAST MARSH (FRAGILE SOILS)

GENTILLY-CED association: Level, very poorly drained soils that have a very fluid mucky surface layer and a slightly fluid and firm underlying material on a firm clayey subsoil, in brackish and freshwater marshes

CREOLE association: Level, very poorly drained soils that have a very fluid mucky surface layer and a slightly fluid and very fluid clayey, sandy, and loamy underlying material, in brackish marshes

BANCKER association: Level, very poorly drained soils that have a very fluid mucky surface layer and a very fluid, clayey underlying material, in brackish marshes

SCATLAKE association: Level, very poorly drained soils that have a very fluid mucky surface layer and a very fluid clayey underlying material, in saline marshes

ORGANIC SOILS OF THE GULF COAST MARSH (FRAGILE SOILS)

ALLEMANDE association: Level, very poorly drained soils that have a very fluid mucky surface layer and a very fluid mucky, clayey, and sandy underlying material, in freshwater marshes

CLOVELLY association: Level, very poorly drained soils that have a very fluid mucky surface layer and a very fluid mucky and clayey underlying material, in brackish marshes

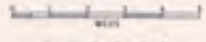
SOILS ON LOW RIDGES AND IN DEPRESSIONAL AREAS BETWEEN RIDGES

MERMENTAU-HACKBERRY association: Level and gently undulating, poorly drained and somewhat poorly drained soils that have a clayey, loamy, or sandy surface layer and a clayey and loamy or loamy, sandy, and clayey subsoil and underlying material

SOILS ON SPOIL BANKS

UDIFLUVENTS-AQUENTS association: Level to moderately steep soils that are stratified and sandy to clayey throughout

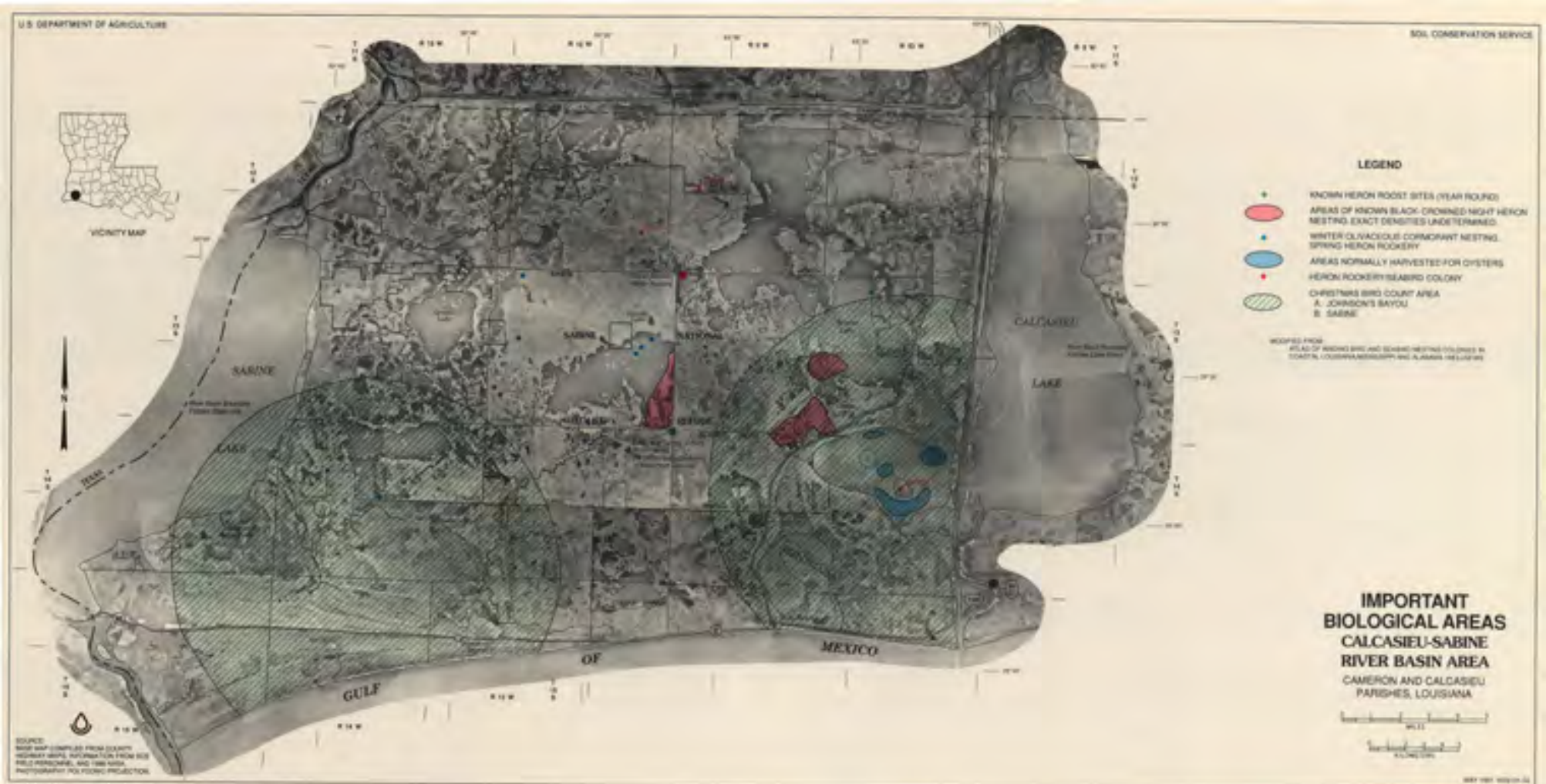
GENERAL SOIL MAP
CALCASIEU-SABINE RIVER BASIN AREA
CAMERON AND CALCASIEU PARISHES, LOUISIANA



SOURCE:
BASE MAP COMPILED FROM COUNTY HIGHWAY MAPS, INFORMATION FROM SCS FIELD PERSONNEL AND 1968 NASA PHOTOGRAPHY. POLYCONIC PROJECTION.

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



IMPORTANT BIOLOGICAL AREAS

CALCASIEU-SABINE RIVER BASIN AREA

CAMERON AND CALCASIEU PARISHES, LOUISIANA

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

VICINITY MAP

LEGEND

- NATIONAL WILDLIFE REFUGE BOUNDARY
- STATE LINE
- PARISH LINE
- TOWNSHIP LINE
- TOWN
- STATE HIGHWAY
- PRIMARY ROAD
- DRAINAGE
- CANAL OR DITCH
- LAKE
- CEMETERY
- OIL FIELD
- OIL PIPELINE
- GAS PIPELINE
- PRODUCT PIPELINE

OIL AND GAS FIELDS AND PIPELINES

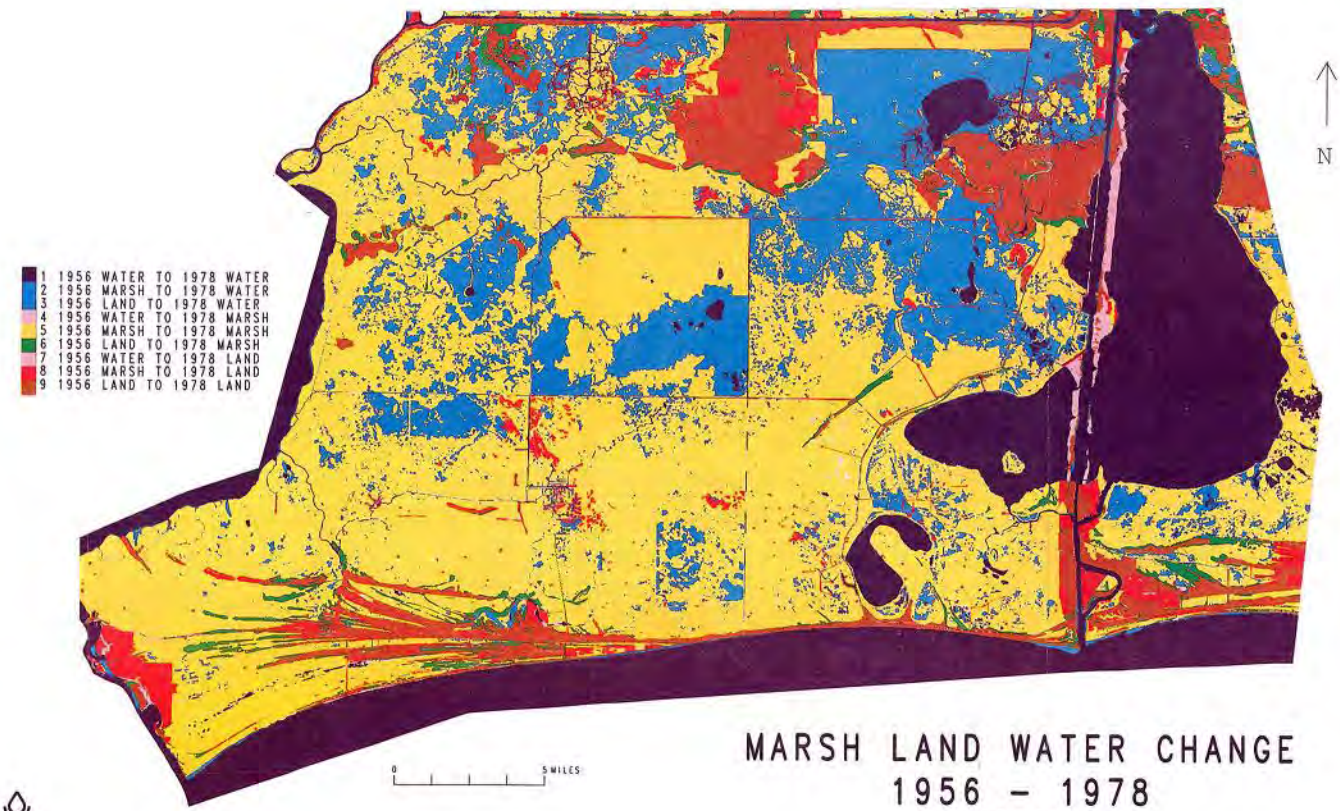
CALCASIEU-SABINE RIVER BASIN AREA

CAMERON AND CALCASIEU PARISHES, LOUISIANA

SOURCE:
BASE MAP COMPILED FROM COUNTY HIGHWAY MAPS, INFORMATION FROM SCS FIELD PERSONNEL AND 1988 NASA PHOTOGRAPHY. POLYCONIC PROJECTION.

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



MARSH LAND WATER CHANGE
1956 - 1978
LOUISIANA

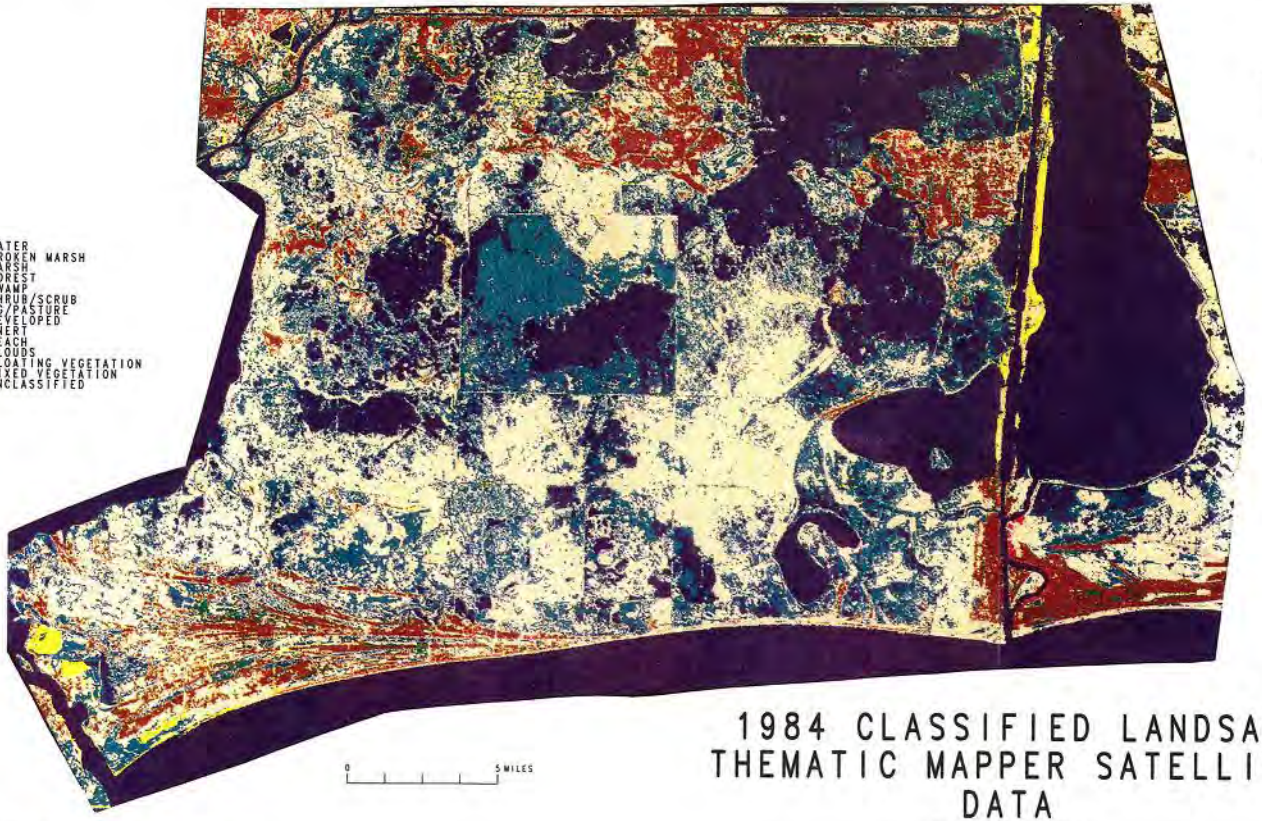
SOURCE: DATA AND INFORMATION SUPPLIED BY LOUISIANA DEPARTMENT OF NATURAL RESOURCES CWD ENERGY GIS LAB 1991
FINAL MAP FINISHING BY SOIL CONSERVATION SERVICE
NATIONAL CARTOGRAPHIC CENTER, FORT WORTH, TEXAS

USDA SCS NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX. 1991

JULY 1991 1005101-06

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



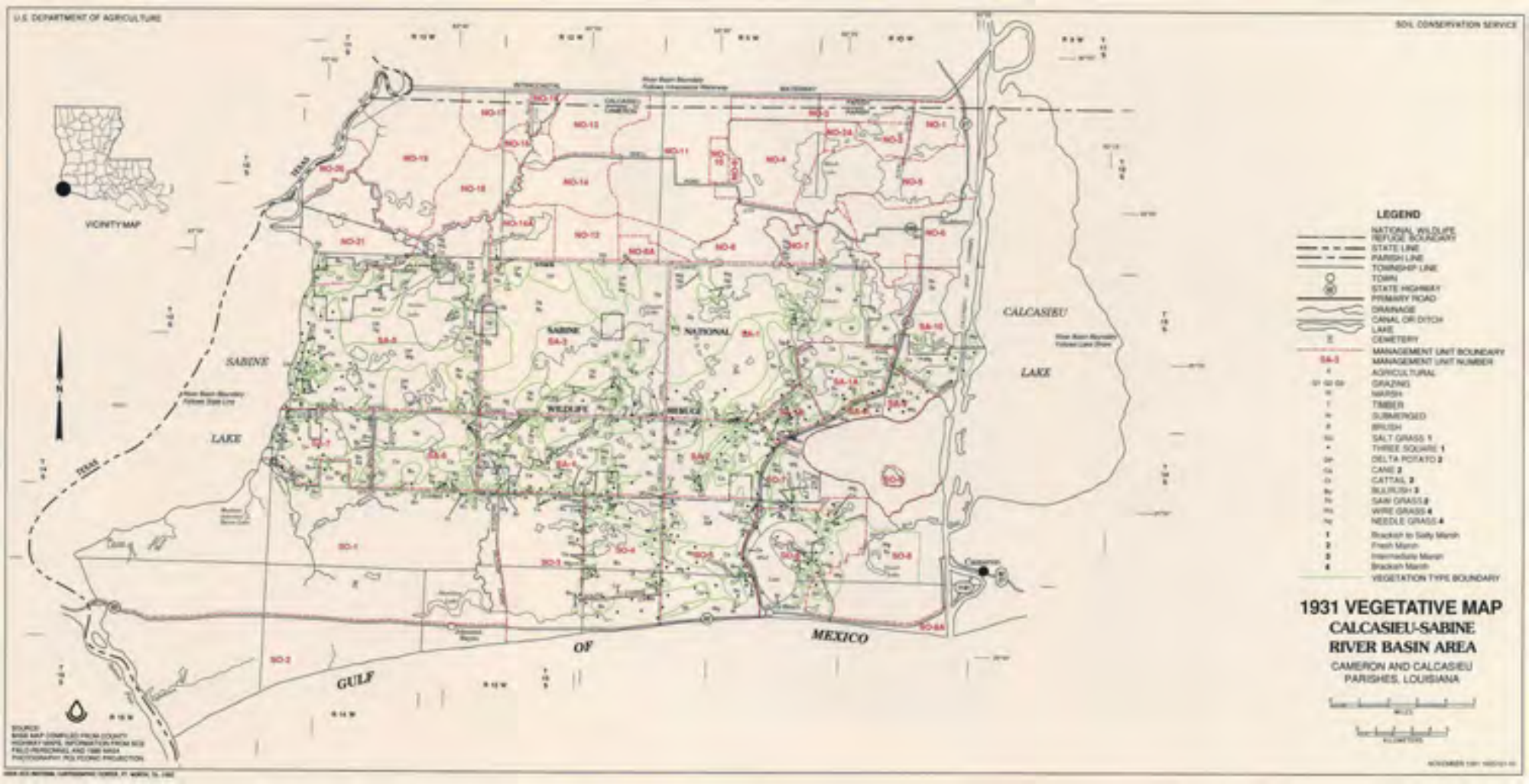
1984 CLASSIFIED LANDSAT THEMATIC MAPPER SATELLITE DATA

LOUISIANA

SOURCE: DATA AND INFORMATION SUPPLIED BY LOUISIANA DEPARTMENT OF NATURAL RESOURCES CMD ENERGY GIS LAB 1991
FINAL MAP FINISHING BY SOIL CONSERVATION SERVICE
NATIONAL CARTOGRAPHIC CENTER, FORT WORTH, TEXAS

USDA SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX-1991

JULY 1991 1005101-05



LEGEND

- NATIONAL WILDLIFE REFUGE BOUNDARY
- STATE LINE
- PARISH LINE
- TOWNSHIP LINE
- TOWN
- STATE HIGHWAY
- PRIMARY ROAD
- DRAINAGE
- CANAL OR DITCH
- LAKE
- CEMETERY
- MANAGEMENT UNIT BOUNDARY
- SA-3 MANAGEMENT UNIT NUMBER
- A AGRICULTURAL
- G1 G2 G3 GRAZING
- M MARSH
- T TIMBER
- W SUBMERGED
- B BRUSH
- SG SALT GRASS 1
- TS THREE SQUARE 1
- DP DELTA POTATO 2
- CA CANE 2
- CT CATTAIL 2
- BU BULRUSH 2
- SG SAW GRASS 2
- WG WIRE GRASS 4
- NG NEEDLE GRASS 4
- 1 Brackish to Salty Marsh
- 2 Fresh Marsh
- 3 Intermediate Marsh
- 4 Brackish Marsh
- VEGETATION TYPE BOUNDARY

1931 VEGETATIVE MAP
CALCASIEU-SABINE RIVER BASIN AREA
CAMERON AND CALCASIEU PARISHES, LOUISIANA

MILES

KILOMETERS

SOURCE:
BASE MAP COMPILED FROM COUNTY HIGHWAY MAPS. INFORMATION FROM SCS FIELD PERSONNEL AND 1980 NASA PHOTOGRAPHY. POLYCONIC PROJECTION.

NOVEMBER 1981

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

VICINITY MAP

VEGETATIVE LEGEND

FRESH WATER MARSH

The fresh water marshes primarily support fresh water vegetation. It is comparatively poor muskrat habitat, but more important for nutria, raccoon, and wintering waterfowl. The recently introduced nutria (coypu) have chosen this type of marsh as their most desirable habitat. The vegetative species on the Mississippi Delta are as follows: cattail (Typha spp.), maiden cane (Panicgrass hemitomon), fresh marsh three-cornered grass (Scirpus americanus), bog marsh grass (Panicum repens), yellow cutgrass (Zizaniopsis miliacea), oyster grass (Spartina alterniflora), adapted to both fresh and salt water marsh, and delta duck potato (Sagittaria latifolia). At present the Delta is completely dominated by alligator grass (Alligantherra philoxeroides), and water hyacinth (Eichornia crassipes), two exotics that are rapidly making a place for themselves in the coastal marshes.

Fresh marshes north and west of Lake Sabastier in the Atchafalaya River area are dominated by cocosicha (Panicum hemitomon). Other important species present are as follows: cattail, bulrush (Scirpus californicus), sow grass (Cladium jamaicensis), arrowleaf (Sagittaria platyphylla), alligator grass, and water hyacinth.

The fresh prairie type marshes of the western part of the State are made up of cocosicha, cattail, bull tongue, spike rush (Eleocharis quadrangulata, palustris, and cellulosa), yellow cutgrass, saw grass, mosquito cane, and bulrush (Scirpus californicus and validus).

EXCESSIVELY DRAINED SALT MARSHES

Marshes occasionally drained by many tidal inlets/ give rise to cupid-like flats/points and marine deposits which elevate the marsh floor two to six inches above that found in producing area. Such marshes are practically without value as muskrat habitat. They produce some low quality raccoon and mink, but are the least important habitat in the coastal marshes. Outstanding vegetation: black rush (Juncus roemerianus), smoothcord (Spartina patens), oyster grass, and occasional clumps or stalks of saw grass. Salinities range from extremely saline to brackish.

BRACKISH THREE-CORNERED GRASS MARSH

At near normal high tide feed the brackish three-cornered grass (and marshes produce approximately 80% of the Gross. muskrat crop. The vegetation is predominately three-cornered grass (Scirpus olneyi), but it will revert to its dwarf species, emergrass, if not properly burned at least every other year. Such marshes are also an producers of mink and raccoon, they are also average waterfowl habitat. The three-cornered grass marsh extending from the east end of Marsh Island to Sabine Pass is the most important wintering range for blue geese.

INTERMEDIATE MARSH (BETWEEN BRACKISH AND FRESH)

Marshes at a balance between brackish and fresh support a wide variety of vegetative species. The outstanding species are tidal grass, mosquito cane, cattail, and bulrush. From a distance this marsh appears to contain only three other species, however, upon close examination one finds three-cornered grass, emergrass, bull tongue, and hogcane. Occasionally when advancing three-cornered grass marshes are heavily associated with moderate fresh areas are very productive, but only for a short period.

LEAFY THREE-CORNERED GRASS OR COCO MARSH

A rare (Scirpus robustus) marsh is second to a brackish three-cornered grass marsh in muskrat productivity. Coco is also a subdominant species and difficult to produce. Wiregrass generally overpowers this valuable muskrat, waterfowl, and grazing food plant. Hogcane is also an associate in this type marsh, generally dominating the higher bayou banks and ridges.

SAW GRASS MARSH

Other species appearing in this marsh are cattail, bulrush, mosquito cane, bull tongue, hogcane, and spike rush are yellow cutgrass near the ridges. This is considered deep marsh. Water levels range from plus 4" to plus 10". Where water control is possible and salt or brackish water is avoidable, this type marsh can be converted to a three cornered grass marsh. This once produces the greatest portion of mink in the wettest part of the State.

SEA ISM

This is made up of sand and shell deposits. Note the stranded sea rim of Pecan Island and Grand Chenière. There are many bar or completely submerged sea rims throughout the marshes of Cameron and Vermilion Parishes.

1949 VEGETATIVE MAP
CALCASIEU-SABINE RIVER BASIN AREA
CAMERON AND CALCASIEU PARISHES, LOUISIANA

SOURCE:
BASE MAP COMPILED FROM COUNTY HIGHWAY MAPS. INFORMATION FROM SCS FIELD PERSONNEL AND 1948 NASA PHOTOGRAPHY. POLYCONIC PROJECTION.

NOVEMBER 1961

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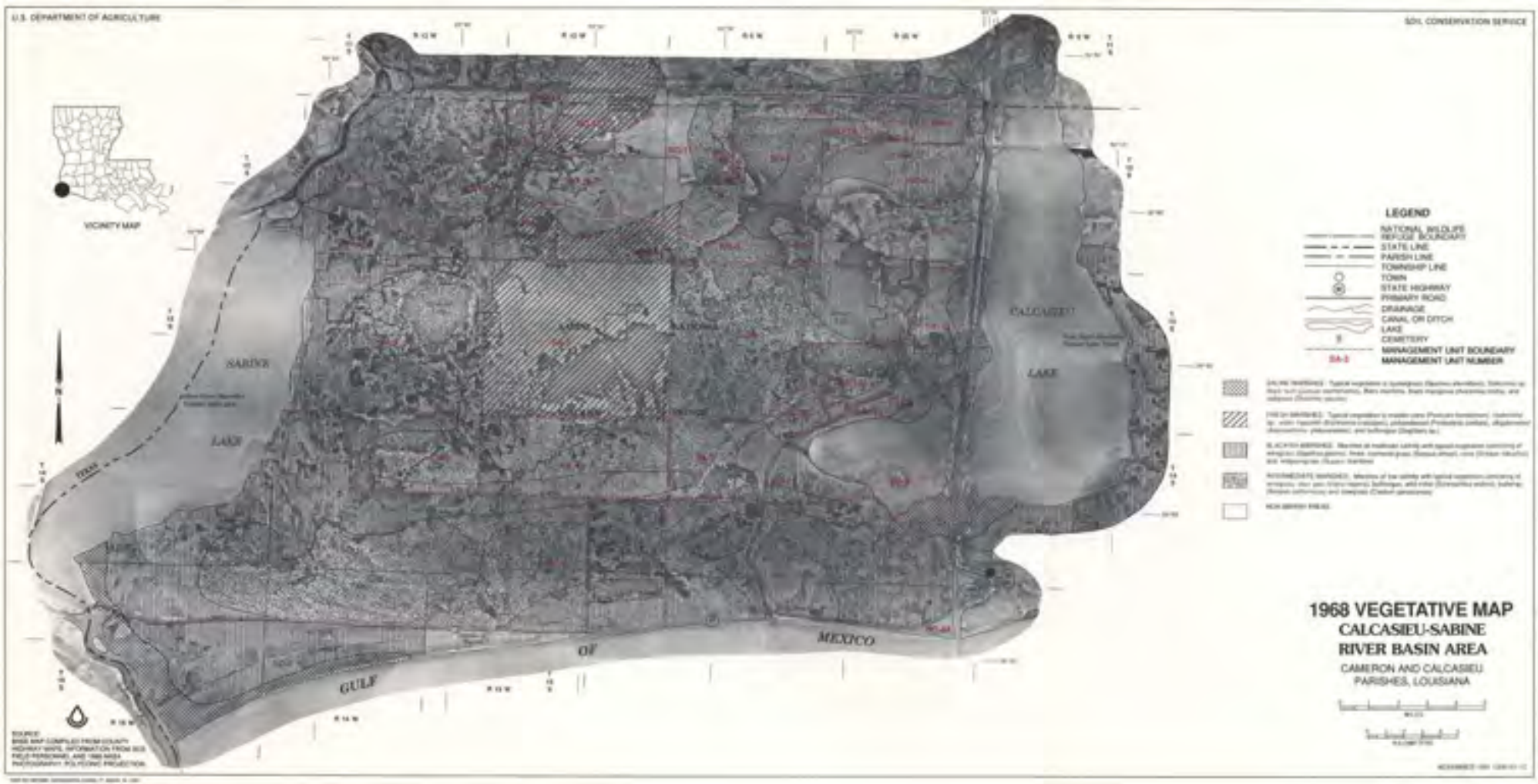


1968 VEGETATIVE MAP
CALCASIEU-SABINE RIVER BASIN AREA
CAMERON AND CALCASIEU PARISHES, LOUISIANA

SOURCE:
BASE MAP COMPILED FROM COUNTY HIGHWAY MAPS, INFORMATION FROM SCS FIELD PERSONNEL, AND 1968 AREA PHOTOGRAPHY. POLYCONIC PROJECTION.

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

VICINITY MAP

LEGEND

- NATIONAL WILDLIFE REFUGE BOUNDARY
- STATE LINE
- PARISH LINE
- TOWNSHIP LINE
- TOWN
- STATE HIGHWAY
- PRIMARY ROAD
- DRAINAGE
- CANAL OR DITCH
- LAKE
- CEMETERY
- MANAGEMENT UNIT BOUNDARY
- SA-3 MANAGEMENT UNIT NUMBER

SALINE MARSHES - Typical vegetation is cordgrass (*Spartina alterniflora*, *Spartina* sp., *Distichlis spicata*), needlegrass, *Scirpus maritimus*, *Scirpus robustus*, and *Salicornia* spp.

FRESH MARSHES - Typical vegetation is maidencane (*Panicum hemitomon*), *Hydrocotyle* sp., water hyacinth (*Eichhornia crassipes*), pickerelweed (*Pontederia cordata*), arrowhead (*Sagittaria falcata*), paspalum (*Paspalum* sp.), and bulltongue (*Sagittaria lancifolia*).

BLACKISH MARSHES - Marshes of moderate salinity with typical vegetation consisting of wiregrass (*Spartina patens*), three-cornered grass (*Scirpus olneyi*), olney (*Scirpus robustus*), and needlegrass (*Fimbristylis*).

INTERMEDIATE MARSHES - Marshes of low salinity with typical vegetation consisting of wiregrass, olney, giant bulrush (*Scirpus californicus*), bulltongue, and millet (*Echinochloa walteri*), bulrushes (*Scirpus californicus*), and cordgrass (*Sagittaria falcata*).

NON-MARSH AREAS

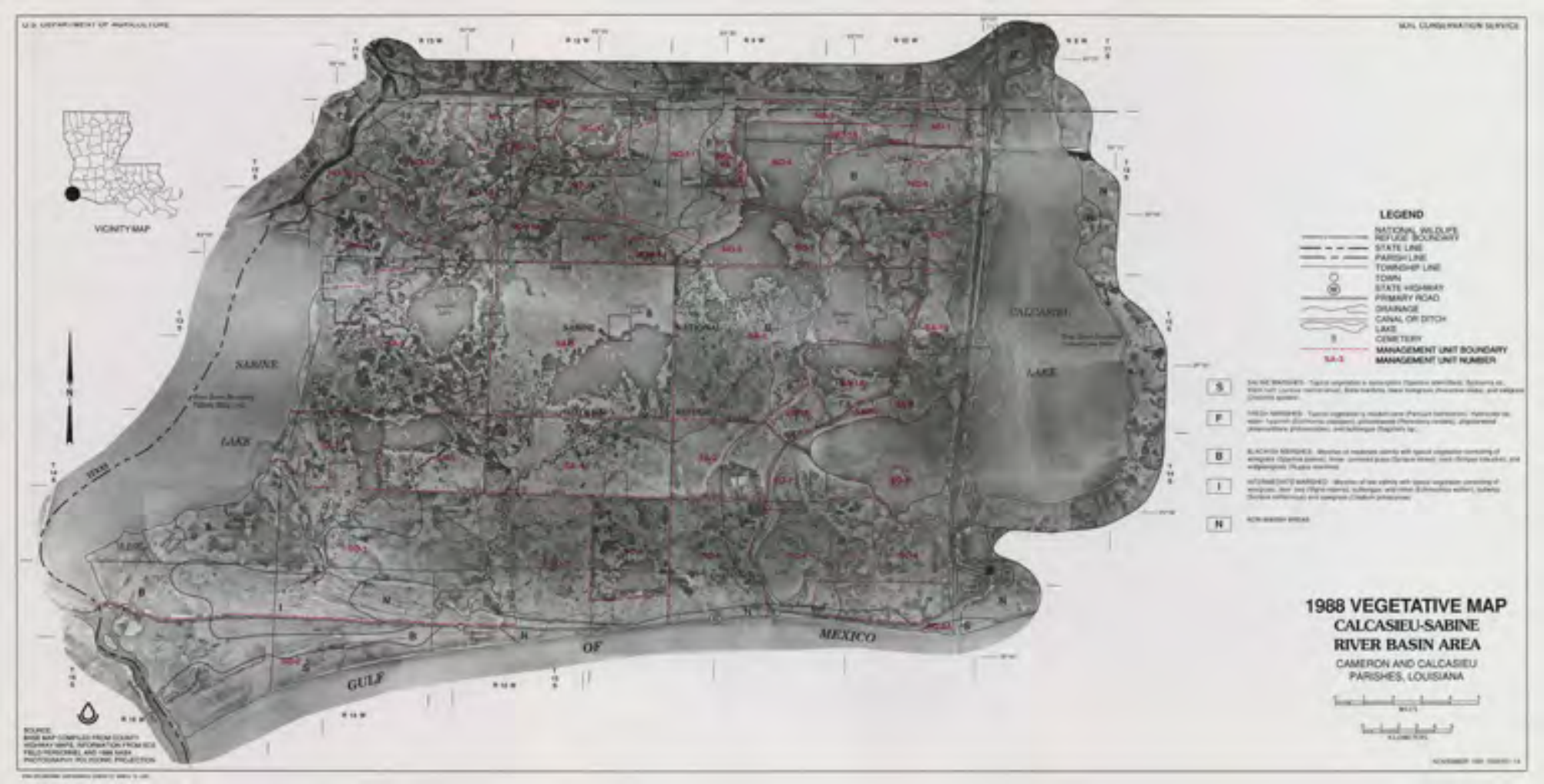
1978 VEGETATIVE MAP
CALCASIEU-SABINE RIVER BASIN AREA

CAMERON AND CALCASIEU PARISHES, LOUISIANA

MILES

KILOMETERS

SOURCE:
BASE MAP COMPILED FROM COUNTY HIGHWAY MAPS, INFORMATION FROM SCS FIELD PERSONNEL AND 1986 NHOI PHOTOGRAPHY. POLYCONIC PROJECTION


U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
VICINITY MAP
SABINE
LAKE
CALCASIEU
LAKE
GULF
OF
MEXICO
LEGEND
NATIONAL WILDLIFE REFUGE BOUNDARY
STATE LINE
PARISH LINE
TOWNSHIP LINE
TOWN
STATE HIGHWAY
PRIMARY ROAD
DRAINAGE
CANAL OR DITCH
LAKE
CEMETERY
MANAGEMENT UNIT BOUNDARY
MANAGEMENT UNIT NUMBER
S
F
B
I
N
1988 VEGETATIVE MAP
CALCASIEU-SABINE
RIVER BASIN AREA
CAMERON AND CALCASIEU
PARISHES, LOUISIANA
MILES
KILOMETERS
SOURCE:
BASE MAP COMPILED FROM COUNTY
HIGHWAY MAPS, INFORMATION FROM SCS
FIELD PERSONNEL AND 1988 NASA
PHOTOGRAPHY. POLYCONIC PROJECTION

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

VICINITY MAP

LEGEND

- NATIONAL WILDLIFE REFUGE BOUNDARY
- STATE LINE
- PARISH LINE
- TOWNSHIP LINE
- TOWN
- STATE HIGHWAY
- PRIMARY ROAD
- DRAINAGE
- CANAL OR DITCH
- LAKE
- CEMETERY
- MANAGEMENT UNIT BOUNDARY
- SA-3 MANAGEMENT UNIT NUMBER
- URBAN/INDUSTRY
- AGRICULTURE
- FOREST
- NON-FOREST WETLAND
- OTHER

Modified from:
LA. Area of Forest Plains and Flooring Protocol, USE, 1980

LAND USE
CALCASIEU-SABINE RIVER BASIN AREA
CAMERON AND CALCASIEU PARISHES, LOUISIANA

SOURCE:
BASE MAP COMPILED FROM COUNTY HIGHWAY MAPS. INFORMATION FROM SCS FIELD PERSONNEL AND 1980 NASA PHOTOGRAPHY. POLYCONIC PROJECTION

SEPTEMBER 1981 - CEN 51-59

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

VICINITY MAP

LEGEND

- NATIONAL WILDLIFE REFUGE BOUNDARY
- STATE LINE
- PARISH LINE
- TOWNSHIP LINE
- TOWN
- STATE HIGHWAY
- PRIMARY ROAD
- DRAINAGE
- CANAL OR DITCH
- LAKE
- CEMETERY
- MANAGEMENT UNIT BOUNDARY
- SA-3 MANAGEMENT UNIT NUMBER
- FEDERAL LAND
- CAMERON PARISH SCHOOL BOARD (SEC.16)
- LESS THAN 500.0 AC.
- MORE THAN 500.0 AC.

LAND OWNERSHIP
CALCASIEU-SABINE RIVER BASIN AREA
CAMERON AND CALCASIEU PARISHES, LOUISIANA

SOURCE:
BASE MAP COMPILED FROM COUNTY HIGHWAY MAPS, INFORMATION FROM SCS FIELD PERSONNEL AND 1980 NASA PHOTOGRAPHY. POLYCONIC PROJECTION.

SEPTEMBER 1981 1205101-SB