BENEFICIAL USE OF DREDGED MATERIAL MONITORING PROGRAM 2000 ANNUAL REPORT

Results of Monitoring the Beneficial Use of Dredged Material at the Calcasieu River and Pass, Louisiana

Base Year 1985 thru Fiscal Year 2000

Prepared for:

U.S. Army Corps of Engineers
New Orleans District
New Orleans, LA 70160-0267

Prepared by:

University of New Orleans
Department of Geology and Geophysics
New Orleans, LA 70148

Contract No. DACW29-98-D-0008

2001

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Beneficial Use of Dredged Material Monitoring Program (BUMP)

The U.S. Army Corps of Engineers New Orleans District (USACE-NOD) maintains eleven major navigational projects in Louisiana that require regular maintenance dredging (Figure 1). More than 90 million cubic yards of sediment are dredged annually and the USACE-NOD coordinates with state and federal natural resource agencies to determine the most appropriate methods for the disposal of dredged material and, where possible, to beneficially use this material to create or enhance wetlands and other habitats. The USACE-NOD has developed long-term disposal plans incorporating beneficial use for each of these navigational channels. In 1994, the USACE-NOD, working in cooperation with Louisiana State University - Center for Coastal, Energy and Environmental Resources (LSU), implemented a large-scale monitoring program to quantify the amount of new habitat created and to improve dredge disposal placement techniques to maximize beneficial use. A contract was awarded to the University of New Orleans in 2000 to continue the monitoring program that is known as the USACE-NOD Beneficial Use of dredged material Monitoring Program (BUMP).

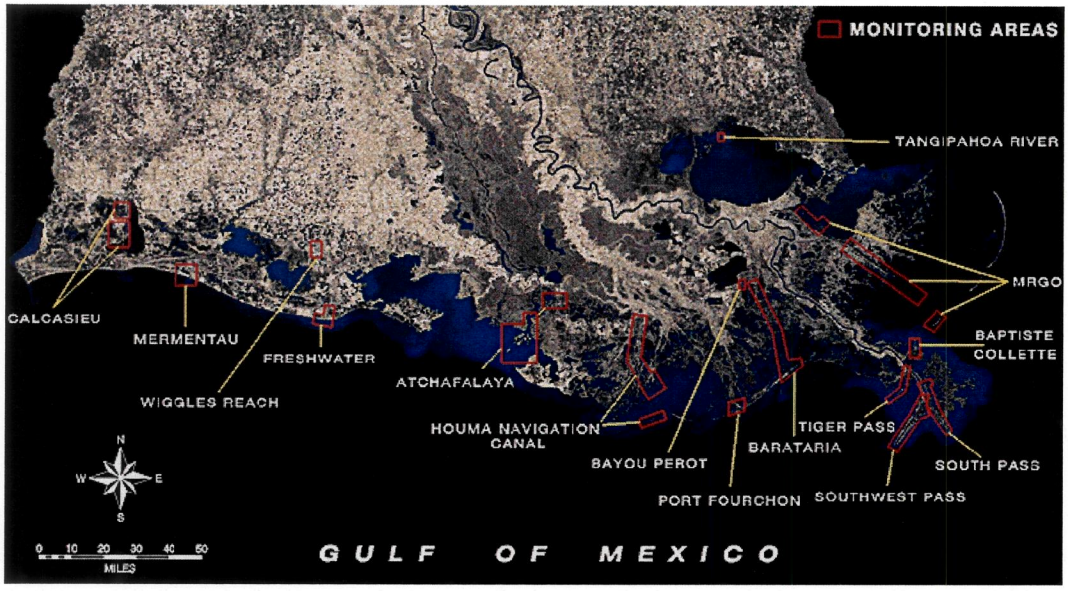

Figure 1. Locations of the beneficial use of dredged material monitoring areas.

Each year, vertical photography is acquired and digital mosaics are produced for each of the study sites listed on Figure 1. GIS habitat analysis and field surveys are conducted on only those sites specified by the USACE-NOD. The work products for the sites selected for full monitoring include dredging history maps, habitat maps for the base year, habitat maps for the selected monitoring years, and habitat change maps. From this analysis, coastal change data quantifies the creation of new coastal lands and other habitats at selected navigational channel locations. The field program includes ground truthing operations to verify and update the habitat maps and field surveys to collect information about vegetation, disposal elevations, and placement practices that maximize beneficial use.

This is the second part of the Beneficial Use of dredged material Monitoring Program (BUMP), 2000 Final Report. Part one was the beneficial use of dredged material at Southwest Pass, Mississippi River Baton Rouge to the Gulf of Mexico, Louisiana.

Calcasieu River and Pass Area

Calcasieu River, located in southeast Louisiana (Figure 2), drains approximately 4,316 square miles of Louisiana and flows over 190 miles from northern Vernon Parish, through Calcasieu Lake, to the Gulf of Mexico.

The deep-water port of Lake Charles is located on the Calcasieu River. A 34-mile channel is maintained by the US Army Corps of Engineers at 40-ft deep and 400-ft wide between Lake Charles, Louisiana and the Gulf (See Beneficial Use of Dredged Material Disposal History for details).

Hackberry, named for a tree prevalent in the area, is the site of the oldest, still- producing oil wells in the nation. Sweetlake Oilfield in Cameron Parish was the earliest oil field developed in south Louisiana, between 1902 and 1926 (LGS, 1991). Board roads were built to accommodate oxen and mud sleds for transportation of supplies. The marsh buggy was invented in the 1930s to assist drilling and oil-associated activities in the marsh. Canals were dredged for barge transportation and maintenance of drilling rigs and supplies. Today the area is crossed with oil canals, pipeline right-of-ways, old roads, and old canal dredge ridges. However, the once-extensive marshes are subsiding, degrading, and experiencing saltwater intrusion throughout, with a high rate of land loss.

BUMP at Calcasieu River and Pass

The USACE conducts a number of individual projects designed to improve navigation from the Gulf of Mexico to port facilities in and around Lake Charles, Louisiana, and to prevent salt-water intrusion in the river above Lake Charles. Approximately 4 million cubic yards of material are removed from the inland reach of the channel annually. Historically, most of this material was place in confined disposal facilities along the channel. The first beneficial use of dredged material from maintenance of the navigational channel took place in 1983 on the edge of the Sabine National Wildlife Refuge adjacent to the channel, in an attempt to stabilize the bank and restore eroded wetlands. In 1993, the USACE-NOD began placing dredged material further inland,

within confined cells in the shallow open water areas in the vicinity of Brown Lake and semi-confined in the Sabine National Wildlife Refuge, implicitly for wetlands restoration (See following section on disposal history for details). The LSU/UNO BUMP study sites are located to monitor these areas.

The Calcasieu - Sabine National Wildlife Refuge (SNWR) BUMP study site is located within the 142,846-acre Sabine National Wildlife Refuge, to the west of the south part of Calcasieu Lake (Figure 3A). The Brown Lake BUMP study site is located just north and slightly west of Hackberry (Figure 3B). The two sites will be monitored and evaluated separately.

In this report, UNO/LSU presents the first results of the monitoring along the Calcasieu navigational channel, Brown Lake and SNWR disposal areas through the USACE-NOD Fiscal Year (FY) 2000 maintenance event.

The natural and man-made habitats in the study area were classified using aerial photography acquired December 1985 and December 2000. Through GIS analysis, these areas were measured and changes calculated. Field surveys were conducted in June 2001 on the beneficial use areas created through FY00 at SNWR and Brown Lake study sites. Habitats were ground truthed; and survey transects established to document vegetation species and stacking elevations, and as a base for measuring compaction.

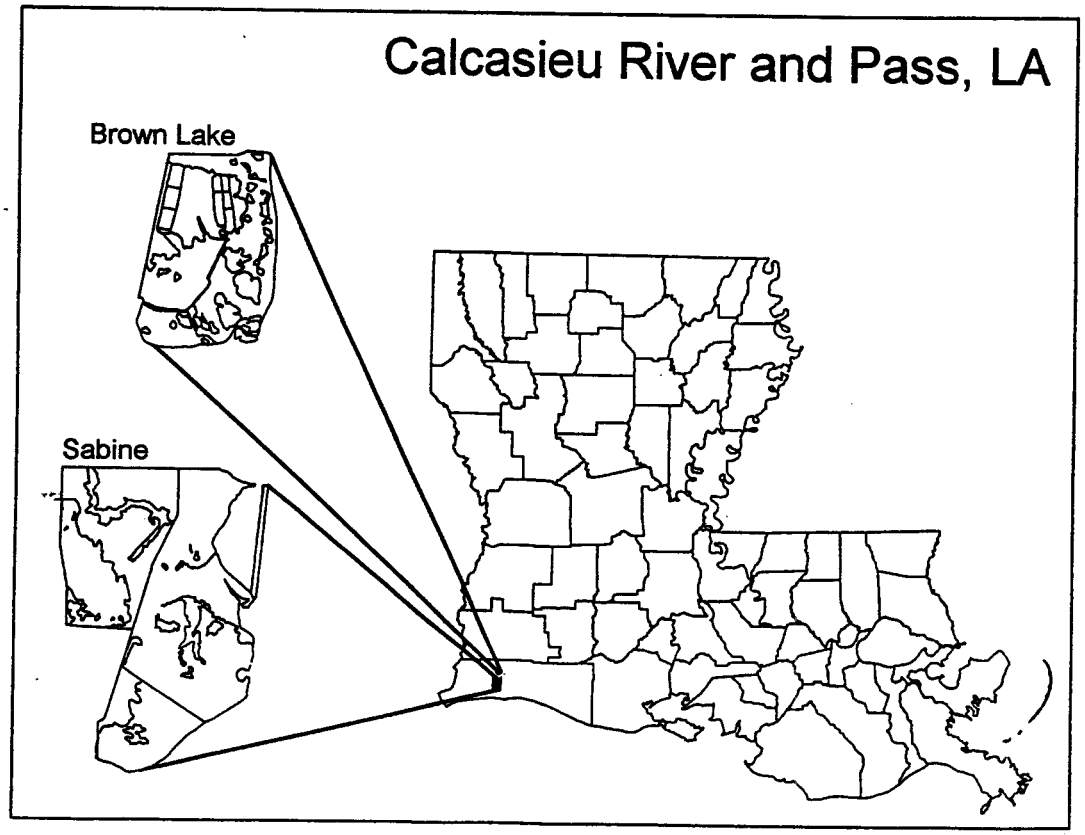

Figure 2. Location map of Calcasieu River and Pass, La. - SNWR and Brown Lake BUMP study areas.

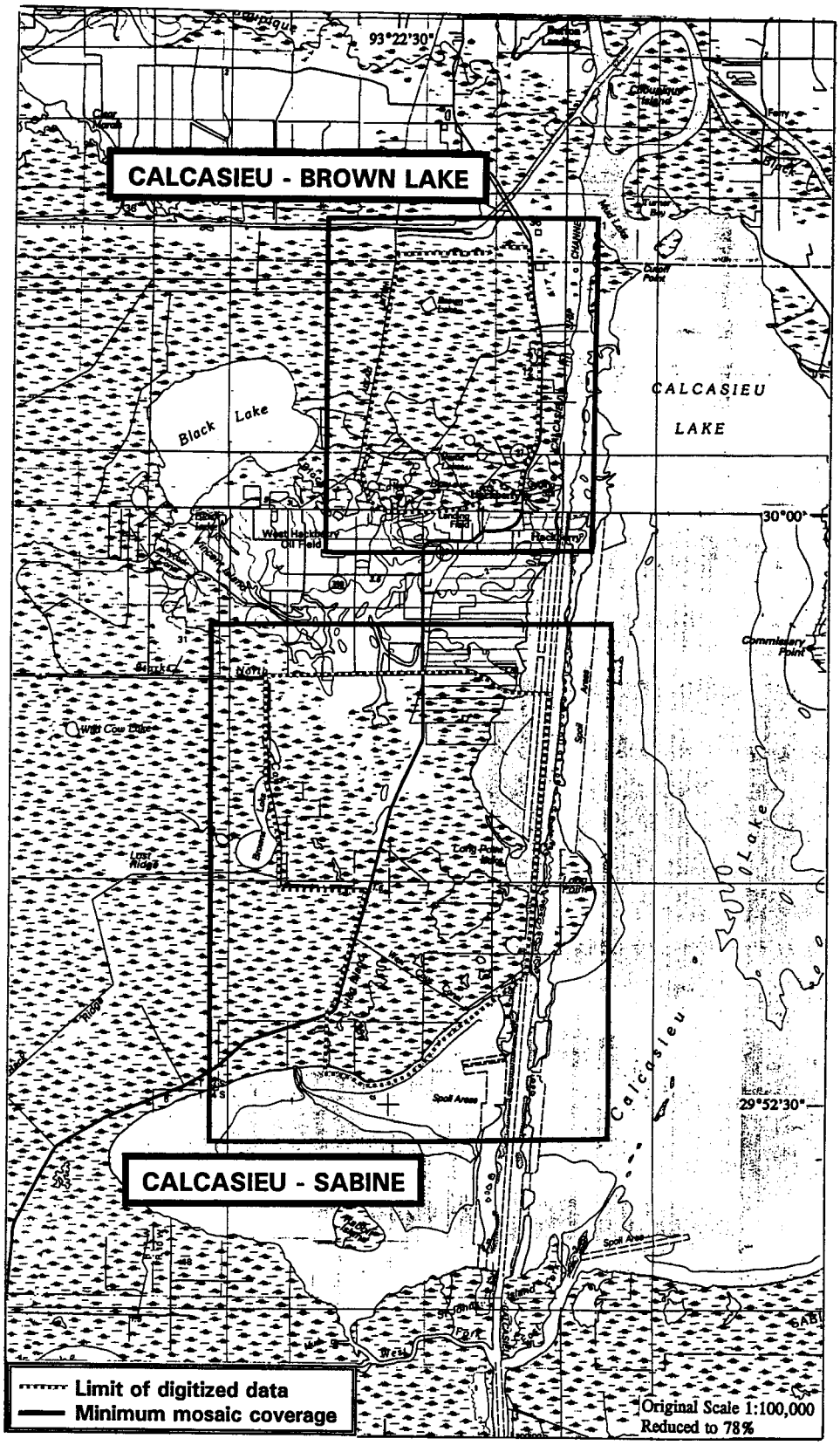

Figure 3. The Calcasieu River and Pass, La. - SNWR and Brown Lake BUMP study areas showing the minimum coverage of the aerial photo-mosaic and the limits of the area digitized.

BENEFICIAL USE OF DREDGED MATERIAL DISPOSAL HISTORY
CALCASIEU RIVER AND PASS, LA
Through FY 2000

The Calcasieu River and Pass, Louisiana, project consists of a number of individual projects designed to improve navigation from the Gulf of Mexico to port facilities in and around Lake Charles, Louisiana, and to prevent salt water intrusion in the river above Lake Charles.

The Rivers and Harbors Act of July 24, 1946, House Document 190, 79th Congress, 2nd Session and prior Rivers and Harbors acts authorized the USACE-NOD to construct and maintain a channel 35 feet deep and 250 feet wide from the wharves of the Lake Charles Harbor and Terminal District (including the Loop around Clooney Island) to the Gulf of Mexico, via Calcasieu Lake and through Calcasieu Pass; a channel 35-37 feet deep and 250 feet wide between the jetties; and an approach channel 37 feet deep and 400 feet wide seaward to the 37-foot depth contour in the Gulf of Mexico. This act also authorized reconstruction and extension of improvement of the river from Lake Charles to Phillips Bluff by removing logs, snags, overhanging trees and dredging. Construction of these channel improvements was completed in April, 1953.

The Rivers and Harbors Act of July 14, 1960, House Document 436, 86th Congress, 2nd Session authorized modification of the existing project to provide an approach channel having a depth of 42 feet below Mean Low Gulf (MLG) over a bottom width of 800 feet from the 42-foot depth in the Gulf of Mexico to the jettied channel; a channel between the jetties varying in depth from 42 to 40 feet at the seaward end and shoreline, respectively, over a bottom width of 400 feet; a channel 40 feet deep over a bottom width of 400 feet from the shoreline at Mile 0.0 to the wharves of the Port of Lake Charles at Mile 34.1; enlargement of the existing turning basin at Mile 29.6 to a depth of 40 feet; a mooring basin at about Mile 3.0 having a width of 350 feet, a length of 2000 feet, and a depth of 40 feet; extension of the ship channel at a depth of 35 feet below MLG over a bottom width of 250 feet from the wharves of the Port of Lake Charles, Mile 34.1, to the vicinity of the bridge on U.S. Highway 90, Mile 36.0; a turning basin of the same depth at the upper end having a width of 750 feet and a length of 1000 feet; and maintenance of the existing channel 12 feet deep and 200 feet wide from the ship channel to Cameron, Louisiana, via the old channel of the Calcasieu River. Construction under this modification was initiated in April, 1962, and completed in October, 1968.

The Rivers and Harbors Act of October 23, 1962, House Document 582, 87th Congress, 2nd Session authorized construction of a salt water barrier structure with five 40-foot tainter gates in a new bypass channel; a parallel channel with navigational structure and a single sector type gate; an earth closure dam; and a woven lumber type revetment. The salt water barrier was completed in January, 1968.

The Senate Public Works committee on December 27, 1970, and the House Public Works committee on December 15, 1970, adopted resolutions giving the USACE-NOD authority to construct and maintain the project at Devil's Elbow under the provisions of Section 201 of the Flood Control Act of 1965 (Public Law 89-298; S.D. 91-111). This

project involved enlarging 2.3 miles of the existing industrial channel to a 40-foot depth over a bottom width of 400 feet; a 0.5 mile eastward extension of the enlarged channel; and the construction of a 1200-foot by 1400-foot turning basin south of the extended channel at its landward end. Construction of the Devil's Elbow Industrial Channel was begun in 1976 and completed in 1978.

Construction and maintenance of the Calcasieu River at Coon Island, Louisiana, project was authorized under Section 107 of the Rivers and Harbors Act of 1960, as amended by Section 310 and Section 112 of the Rivers and Harbors Acts of 1965 and 1979, respectively. The project consists of deepening and widening to -40 feet by 200 feet for a distance of 6,943 feet, and the existing turning basin to -40 feet by 750 feet by 1000 feet. Construction of this project commenced in 1973 and was completed in 1974.

Dredging records dating back to 1949 indicate that maintenance of discontinuous reaches of the inland reach and bar channel of the 35-foot navigational project occurred on an annual basis from 1953 to 1962. Dredged material from construction and all maintenance events within the inland reach (Mile 34.1 to Mile 0.0) was placed in confined disposal facilities or placed unconfined in open water in Calcasieu Lake. Material from the bar channel was placed in open water off the right-descending bank of the navigational channel.

Maintenance of discontinuous reaches of the inland reach (Mile 36.0 to Mile 0.0) and/or the bar channel of the deep-draft/40-foot navigational project has occurred every year since project completion except for 1970, 1974, 1977 and 1982. Maintenance dredging of the inland reach is accomplished using hydraulic cutterhead pipeline dredges; hopper dredges are used for maintenance of the bar channel. Dredged material removed during construction of the inland reach and during all maintenance events until 1983 was placed into confined disposal facilities located on either side of the channel. Dredged material from maintenance of the deep-draft channel in the bar is placed in open water off the right-descending bank of the navigational channel.

The first beneficial use of dredged material from maintenance of the Calcasieu River and Pass, Louisiana, navigational channel took place in 1983 (April 5, 1983 - July 28, 1983) as part of the maintenance of the Mile 5.0 to Mile 22.7 reach. Approximately 20,000 cubic yards of dredged material was placed at two sites within the Sabine National Wildlife Refuge off the right-descending bank of the channel adjacent to the Mile 10 in an attempt to stabilize the bank and restore eroded wetlands (Figure 4A). Earthen dikes were constructed on the channel-side of these open water disposal areas to prevent the flow of dredged material back into the navigational channel; however, no other dikes were constructed. The maximum height of the dredged material placed in these disposal areas was +4.0 feet Mean Low Gulf (MLG).

During the 1985 maintenance of the Mile 5.0 to Mile 22.7 reach (August - December, 1985), the open water areas located between the 1983 sites on Sabine National Wildlife Refuge were used for the placement of dredged material. Earthen dikes were constructed on the channel-side of these areas and dredged material was placed in the same manner as in 1983 except that earthen dikes also were constructed perpendicular to the channel on the north and south sides of these sites to keep the dredged material off the 1983 sites.

In 1992, the USACE-NOD designated shallow open water areas in the vicinity of Brown Lake and in the Sabine National Wildlife Refuge pursuant to Section 404 of the Clean Water Act for the placement of dredged material from maintenance of the navigational channel for wetlands restoration. These areas had been identified as alternatives for the placement of dredged material for beneficial use during development of the Long Term Disposal Plan/Dredged Material Management Plan for the Calcasieu River and Pass, Louisiana, project; however, use of the sites required special authority and funding because placement of dredged material into these sites was beyond the Base Plan.

Prior to the 1993 maintenance of the Mile 5.0 to Mile 22.7 reach, Congress provided authorization and funding for the beneficial use of dredged material in association with maintenance of the navigational project in the Fiscal Year 1993 Energy and Water Appropriation Act. The USACE-NOD also sought and received authority and funding pursuant to Section 1135 of the Water Resources Development Act of 1986 for the beneficial use of dredged material at Sabine National Wildlife Refuge. The state of Louisiana was the non-Federal sponsor for the Section 1135 project. Detailed plans for the placement of dredged material at both Brown Lake and the Sabine National Wildlife Refuge were developed in coordination with state and Federal natural resources agencies, the Sabine National Wildlife Refuge manager, and private land owners.

During the 1993 maintenance event (February 26 - August 23, 1993), dredged material from Mile 5.0 to Mile 22.7 was placed at both Brown Lake and within the Sabine National Wildlife Refuge to restore wetlands. Five (5) contiguous containment cells were constructed on the eastern side of Brown Lake (Figure 4B). Containment dikes were constructed to a height sufficient to contain the dredged material to a maximum height of +5.5 feet MLG. The interior dikes were constructed to allow the containment cells to be filled in pairs; dredged material was placed directly into one cell and the effluent from that cell passed through the next adjacent cell. Dredged material discharge was into cell #1, #2, #3, and #5. Approximately 756,000 cubic yards of material removed from Mile 18.0 to Mile 19.3 were placed in the Brown Lake containment cells during this event.

At Sabine National Wildlife Refuge, containment dikes were constructed only along the navigational channel and along the north bank of West Cove Canal; no back dikes were required (Figure 4A). Approximately 1,840,243 cubic yards of dredged material removed from Mile 7.8 to Mile 12.2 of the navigational channel were placed in the refuge north of West Cove Canal. The maximum initial height of the dredged material was +4.0 feet MLG.

The USACE-NOD placed additional dredged material from maintenance of the Mile 5 to Mile 22.7 reach of the navigational channel in the Sabine National Wildlife Refuge pursuant to Section 204 of the Water Resources Development Act (WRDA) of 1992 during the 1996 maintenance event (May, 1996 - January 1997). The state of Louisiana was the non-federal sponsor for this project. The Sabine National Wildlife refuge staff and other state and Federal natural resources agencies participated in the development of the disposal plan. Containment dikes were constructed along the south bank of West Cove Canal and along the east bank of Hog Island Gully (Figure 4A). Approximately 1,291,236 cubic yards of material removed from Mile 7.0 to Mile 11.5 of the navigational channel were placed in the refuge south of West Cove Canal. The initial height of the

dredged material slurry was +5.0 feet MLG.

During the 1998 maintenance of the Mile 14.0 to Mile 26.0 reach of the navigational channel (October, 1998 - July, 1999), the USACE-NOD obtained authority and funding under Section 204 of WRDA 1992 to place dredged material removed from Mile 16.5 to Mile 21.0 at Brown Lake. The state of Louisiana was the non-federal sponsor for this project and the property manager and other state and Federal natural resources agencies participated in the development of the disposal plan. The primary disposal site for this event consisted of four (4) additional contiguous containment cells, "A", "B", "C", and "D", constructed on the western side of Brown Lake (Figure 4B). Four (4) of the cells constructed during the 1993 maintenance event, cells #2, #3, #4, and #5, were specified as a secondary disposal site to be used if the primary disposal site could not contain all of the material from the specified reach. Although the contract specified that the perimeter dikes be constructed to a height of +8.0 feet MLG, soil conditions at the primary disposal site precluded construction of dikes at cell "C" and "D" to this height. Perimeter dikes at cells "A" and "B" were constructed to +8.0 feet MLG; dikes at cells "C" and "D" were built to +6.5 feet and +6.8 feet MLG, respectively. Low-level internal dikes constructed to +5.0 feet MLG separated the cells in the primary disposal area and allowed effluent to flow from one cell to the next. The dredged material discharge was directed into cell "A". Approximately 1,233,539 cubic yards of dredged material were placed into the primary disposal site before the discharge was placed in cell #2 of the secondary disposal site. The elevations of the dredged material slurry in the cells at the primary disposal site at the time that discharge therein was halted were as follows: in "A" +6.2 feet MLG to +6.0 feet MLG; in "B" +6.0 feet MLG to +4.4 feet MLG; in "C" +4.1 feet MLG to +4.0 feet MLG; and in "D" +3.9 feet MLG. Approximately 727,100 cubic feet of material was placed in cell #2 of the secondary disposal site. The elevation of the dredged material slurry in cell #2 was limited to +6.0 feet MLG.

The USACE-NOD again received Section 204 authority and funding to place dredged material from the Mile 5.0 to Mile 14.2 reach of the navigational channel in Sabine National Wildlife Refuge during the 1999 maintenance event (July - November, 1999). The state of Louisiana was the non-Federal sponsor for this project, and the Sabine National Wildlife Refuge staff and other state and Federal natural resources agencies participated in the development of the disposal plan. Perimeter dikes were constructed to an elevation of +8.0 feet MLG along the north bank of West Cove Canal and on the east and west boundaries of the disposal site; a low level dike was constructed to an elevation of +4.5 feet MLG along the northern boundary of the disposal site (Figure 4A). Approximately 1,394,000 cubic yards of dredged material from the Mile 7.0 to Mile 11.5 reach of the navigational channel were placed into the disposal site. The elevation of the dredged material slurry was limited to +5.0 feet MLG. A booster pump was required to pump the dredged material from the navigational channel to this disposal site.

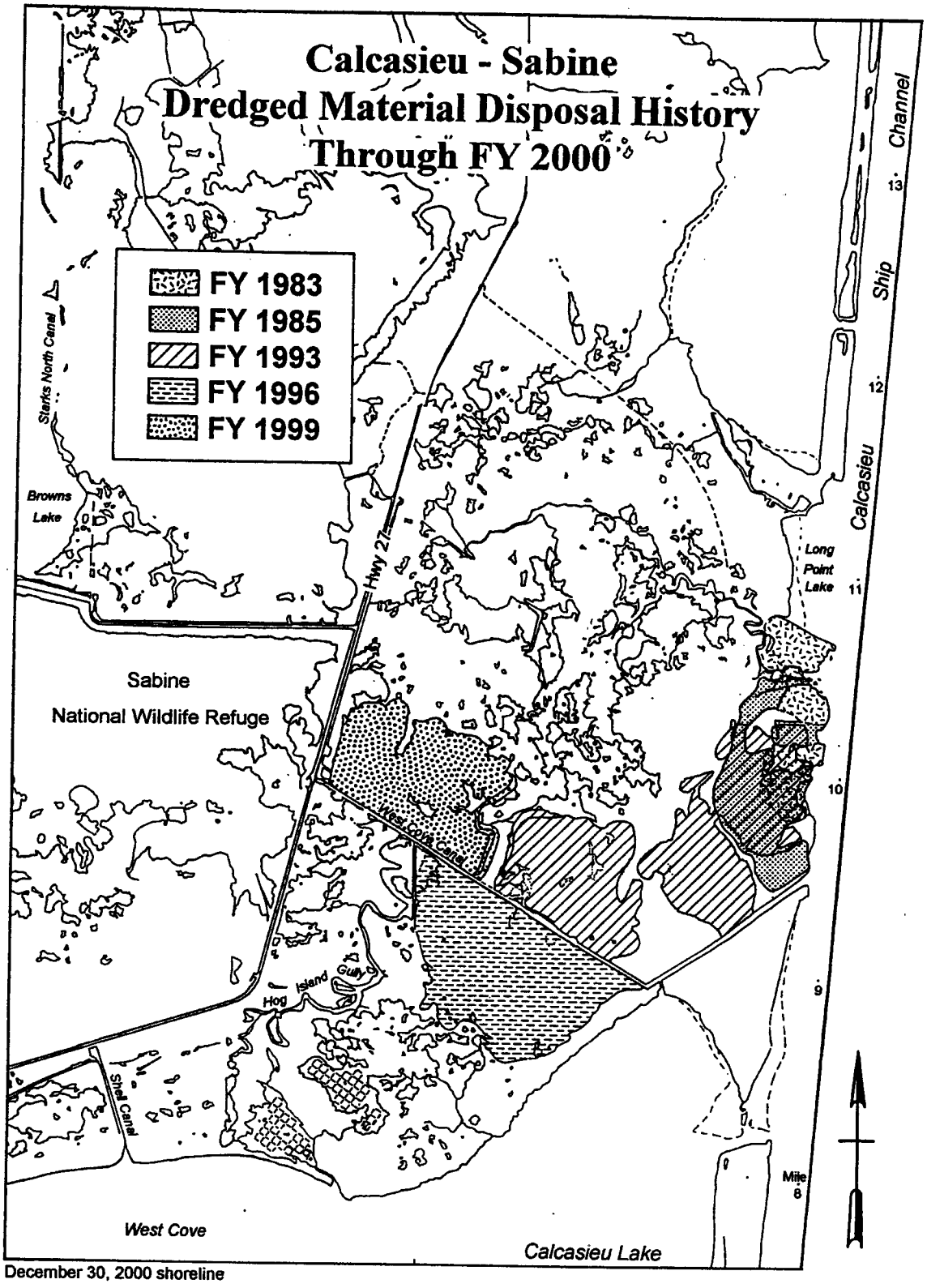

Figure 4A. The dredged material disposal history for the Calcasieu River and Pass, Louisiana - SNWR BUMP study area, showing disposal through FY 2000.

Calcasieu - Brown Lake Dredged Material Disposal History

Through FY 2000

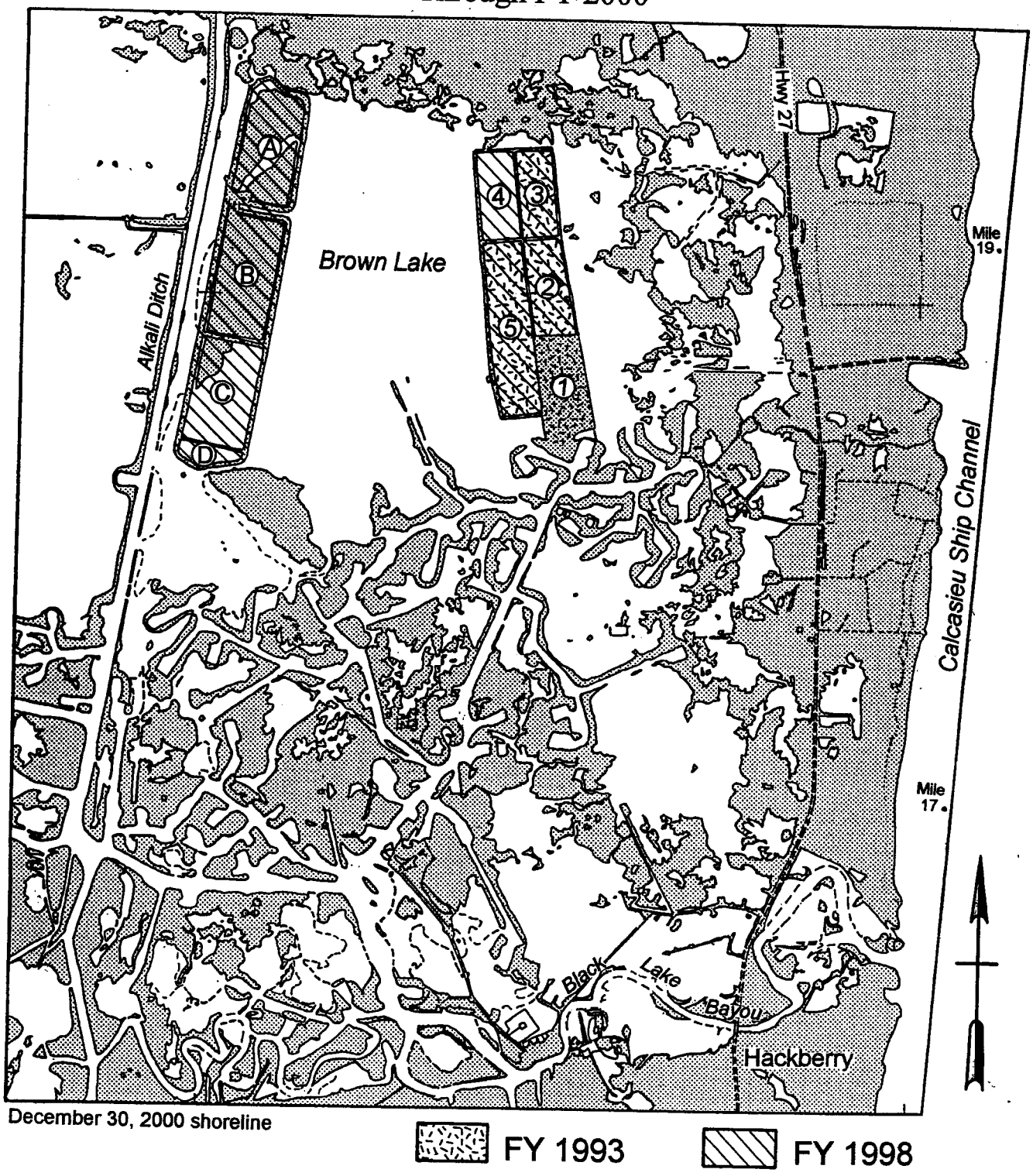

Figure 4B. The dredged material disposal history for the Calcasieu River and Pass, Louisiana - Brown Lake BUMP study area, showing disposal through FY 2000.

BASIC METHODOLOGY

Aerial Photographic Analysis and Habitat Determination

The aerial photographic analysis was the basis for all statistics and analyses. For each monitoring site, a base year was selected against which the assessment of changes is made. The base year for the Calcasieu River and Pass, Louisiana project was 1985 and the historical 1985 aerial photography was acquired from the U.S. Geological Survey Earth Resources Observation Systems (EROS) Data Center. Photography was acquired by UNO's air photo contractor during January 2001. Color infrared photography was acquired at a scale of 1:24,000. There was a 60 percent forward overlap of the photography that allowed the use of stereo plotting techniques for better accuracy. Color infrared photography was used for mapping and photo-interpretation because it provides a better definition of vegetation types, habitats, and the land/water interface. A copy of the color infrared photography was archived at UNO/LSU. A second set of color infrared photography was provided to the USACE-NOD.

From base year to FY1999, study areas were interpreted and mapped from the base year photography and the color infrared aerial photography using a Bausch and Lomb zoom transfer cope. USGS quadrangle maps were used for the initial ground control to set the interpretations in the state plane coordinate system. The absolute accuracy is $\pm$50' and the relative accuracy is $\pm$10'. Beginning in FY2000, habitats were interpreted using Erdas Imagine™ remote sensing software. The current FY photo-mosaic was interpreted by a supervised classification of spectral reflectance, texture and tone. Shorelines were interpreted according to the location of the wet/dry beach contact visible on aerial photographs, the outer edge of well-established marsh, or the outer edge of organic beaches. An accurate shoreline was important to area calculations and assessments of trends in erosion, accretion, or effects of dredged material disposal.

The interpretations of habitat type were verified by taking the photography or interpreted map into the field to check specific areas against the actual landscape for positive habitat identification and vegetative community composition. Corrections were made where necessary to the map, and the revised map was then submitted for GIS digitization and final analysis.

Habitat types were important to understanding the result of disposal practices. The Appendix of this report lists the species documented during the field visits, including scientific names, common names, habit and preferred habitat. This information verifies the habitat interpretations; helps to further characterize the habitat type; and provides further insight to the type of habitats created by the placement of dredged material. The habitats were broken into simple classes and sub-classes based on the types of vegetation present: water, wetlands (marsh and forested wetlands), and land (beach, bare, dune, upland, shrub/scrub, and forest). These very general characterizations necessarily incorporate many other habitats and transition areas.

The habitat categories used are in quotes below and were delineated using the definitions and criteria defined below:

Water (not included in statistics)
"***Open water***" is water not completely encircled by land, including some intertidal areas.

"***Intertidal***" is an indistinct, shallow area that indicates natural sediment deposits or dredged material deposits below normal high tide that does not support emergent vegetation. Some of these areas do support submerged aquatic vegetation or can become colonized by marsh vegetation.

Wetlands
"***Marsh***" is any unforested, vegetated area normally subject to inundation or tidal action at any time, sufficient to support wetland-dependant, emergent vegetation. *High marsh*, an area above normal high tides but inundated frequently by spring and storm tides or seasonally heavy rainfall, can occur in conjunction with any type of marsh, but is associated most commonly along the coast with saline marshes and is dominated there by *Spartina patens* and *Distichlis spicata*. High marsh associated with fresh or brackish marsh is often represented by grasslands and considered "upland".

"***Forested Wetlands***" is any forested area normally subject to inundation through part of the growing season, or with permanent or near-permanent standing water. This includes swamps, batture communities, bottomland forest, and riparian forest.

Land
"***Beach***" is an unvegetated area adjacent to open water that is subject to direct wave action at some time during the daily tidal cycle or during average storm surges. This can be sand, shell, organic, or a mixture of sediment types. This area is unlikely to permanently support vegetation because of frequent reworking by wave action. Most colonization occurs on the upper beach area less frequently affected by waves.

"***Dune***" is an area above the high water line formed by aeolian deposition of sand into ridges or hummocks.

"***Bare land***" encompasses the areas that are unvegetated and not normally subject to direct wave action. It may be adjacent to open water but in a more sheltered orientation not subject to active wave reworking. Usually it indicates areas of freshly deposited dredged material or recent natural sediment deposition. It may include areas of sparse plant colonizations that may become either upland or marsh.

"***Upland***" is a natural area or dredged material deposition area that is elevated and not subject to tidal action or inundation under normal circumstances so that upland species (non-marsh species) thrive. For this study, it includes barrier

island habitats as well as inland habitats, does not include significant shrub or tree coverage, and usually denotes a grassland, meadow, natural levee or elevated area within a marsh, or some types of agricultural or artificially altered land. Natural succession may lead to shrub/scrub in some areas.

"***Shrub/scrub***" is an area dominated by shrubs or small trees under 20 feet tall. This may be within an upland area or within a marsh area. Within a marsh, shrubs usually occupy elevated areas, marking natural levees or areas artificially elevated. Natural succession may eventually lead to forest or forested swamp in some areas.

"***Forest***" is any area dominated by trees that is not normally subject to inundation during the growing season or is only periodically influenced by flooding. For this study it includes bottomland hardwood areas, oak or pine woods, and trees on older ridges and elevated areas created by dredge placement.

Field Program

The field program supported the air photo-interpretation and GIS analysis tasks. The field program was comprised of two work efforts. The first field effort, ground-truthing, verified the interpretation of habitat type based on the density and types of vegetation present, and verified surface morphology from the aerial photographic analysis. The second field effort, field monitoring, recorded changes in elevation, vegetative species and cover, geomorphic character, and surface texture at selected beneficial use sites in order to assess the best disposal practices. Both ground-truthing and monitoring were done within the same time frame. The field program for Calcasieu was conducted June 19-21, 2001.

The objective of the field monitoring is to clarify the habitat types by identifying dominant vegetative communities, and to determine the results of disposal elevation and placement configuration to assist in the evaluation of the habitat benefits. Monitoring changes in elevation, habitat type and surface morphology at a disposal site identifies the important processes of the specific area. Understanding the relationships between change and process, and between habitat and elevation will facilitate better predictions of the potential habitat benefits associated with different placement elevations and configurations.

Geographic Information System (GIS) Analysis

Once the photography was acquired and interpreted for each site, the digital files were imported into the GIS, ground truthed, and referenced to its true geographic position. The line work was checked for gaps, overshoots and other digitizer errors and edited accordingly. A project schema was created to organize data attributes: area, habitat type, and perimeter. After corrected digital data sets were generated for each USACE-NOD beneficial placement site, two primary forms of GIS analysis were used to quantify and characterize wetland conditions at selected sites. The first form of analysis was the

extraction of area measures for each habitat type. Values were generated per type for each year and location. The second form of GIS analysis was the creation of change detection maps and tables for interim periods. These illustrated primary trends in geomorphic change by comparing shoreline configurations and total areas of habitat for the different time periods.

World Wide Web Site

To facilitate the transfer of information to the natural resource trustees and other interested parties, UNO has a World Wide Web site for the dissemination of the beneficial use of dredged material monitoring data. A home page allows the user to click (hyperlink) through data on the beneficial use of dredged material, including scanned aerial photographic mosaics, habitat maps, habitat change maps, habitat data spread sheets, and the results of field investigations. The web site is updated periodically after data has been checked and approved by the USACE-NOD. The site can be found at:

http://www.coastal.uno.edu/coastal/research/bump/

CALCASIEU – SABINE NATIONAL WILDLIFE REFUGE (SNWR) FIELD SURVEY RESULTS

The SNWR BUMP study site is located on the west side of Calcasieu Lake, between Highway 27 and the Calcasieu River Navigational Channel, north of West Cove. West Cove Canal cuts through the area (Figure 4A). It's of very low relief and low elevation, dominated by salt marsh and shrubs. The Calcasieu River and Pass, Louisiana - Brown Lake BUMP study site will be presented later and discussed separately.

Methodology

The collection of elevation and vegetation profile surveys was conducted in two phases. Phase-I involved assessing the characteristics of various beneficial use disposal areas to determine the most appropriate sites to document the beneficial use of dredged material and habitat development. This was accomplished in 2001 in discussion with the USACE-NOD reviewing vertical aerial photography, and reviewing dredging schedules and history. Four areas were selected, based on the dates of wetland creation: three on the north side of West Cove Canal, and one on the south side of the canal. Three transects from the sites created in FY 1993, FY 1996 and FY 1999 were planned to coincide roughly with previous elevation surveys taken by the USACE March 20-28, 2000. Two additional transects were selected in the site created in 1993 (Figure 5).

Phase-II involved the actual collection of profile data. Access was by boat from a boat launch on West Cove Canal, next to Highway 27. On June 19-21, 2001, one stake was placed on the top of the dike on the north shore of the canal to define each transect line, recording secondary features such as trees, tidal inlets or other features to assist in relocating the transects should the vegetation become taller or thicker, or should erosion or other action remove the stakes. Transects across the FY 1996 south area were on the same line with the FY 1993 north site and used those stake as the transect reference. Permanent 1-inch diameter by 6-foot galvanized stakes were buried approximately 1-foot in the sediment of the dike and secured with concrete.

Three transect profiles were collected from three of the sites and two from the fourth. Survey data were collected using a Topcon GTS-300_{DPG} Total-Station, tri-prism, and TDS48 Data Collection System. Horizontal accuracy of the GTS-300 is 0.25 ft Å 0.0125 ft., with a vertical accuracy of 0.45 ft Å 0.0125 ft. The maximum horizontal range with tri-prism is 3,525 ft. A Pathfinder Professional MC-5 global positioning system (GPS) device was used to record the horizontal positions of each stake, instrument location, and the position and exact orientation of each transect line. The transect data collected were processed, referenced to the local tide gage, and entered into a graphic software program to produce topographic profiles.

The topographic profiles for the study area were constructed in reference to Micronautics Tide Table – Calcasieu Pass. The mean diurnal tidal range for the Calcasieu River and Pass, Louisiana BUMP study area is published as 2.0 ft.

Field monitoring for vegetative species composition and habitat verification was done in June 2001. Species composition was determined within a six-foot swath along each profile, and major divisions between vegetative communities were entered as points on the elevation profile. No submerged aquatic species were considered for this report. Plants were identified in the field, with only representative specimens taken for confirmation by taxonomic keys and/or verification by the LSU Department of Plant Biology. The better specimens and uncommon specimens were entered into the LSU herbarium collection; all others were archived by the contractor. The percent composition of each species was visually estimated in order to determine the relative abundance and dominance of species for habitat determinations. These percentages were not intended to provide scientific ratios or statistics.

The species list included on the profiles and in the Appendix of this report is not complete; it reflects only those species that were readily observed during the profiling period. Some plants can only be identified during a short flowering period that may not have coincided with the ground truthing or the profile data collection, and therefore can not be included in the list other than by a broad classification.

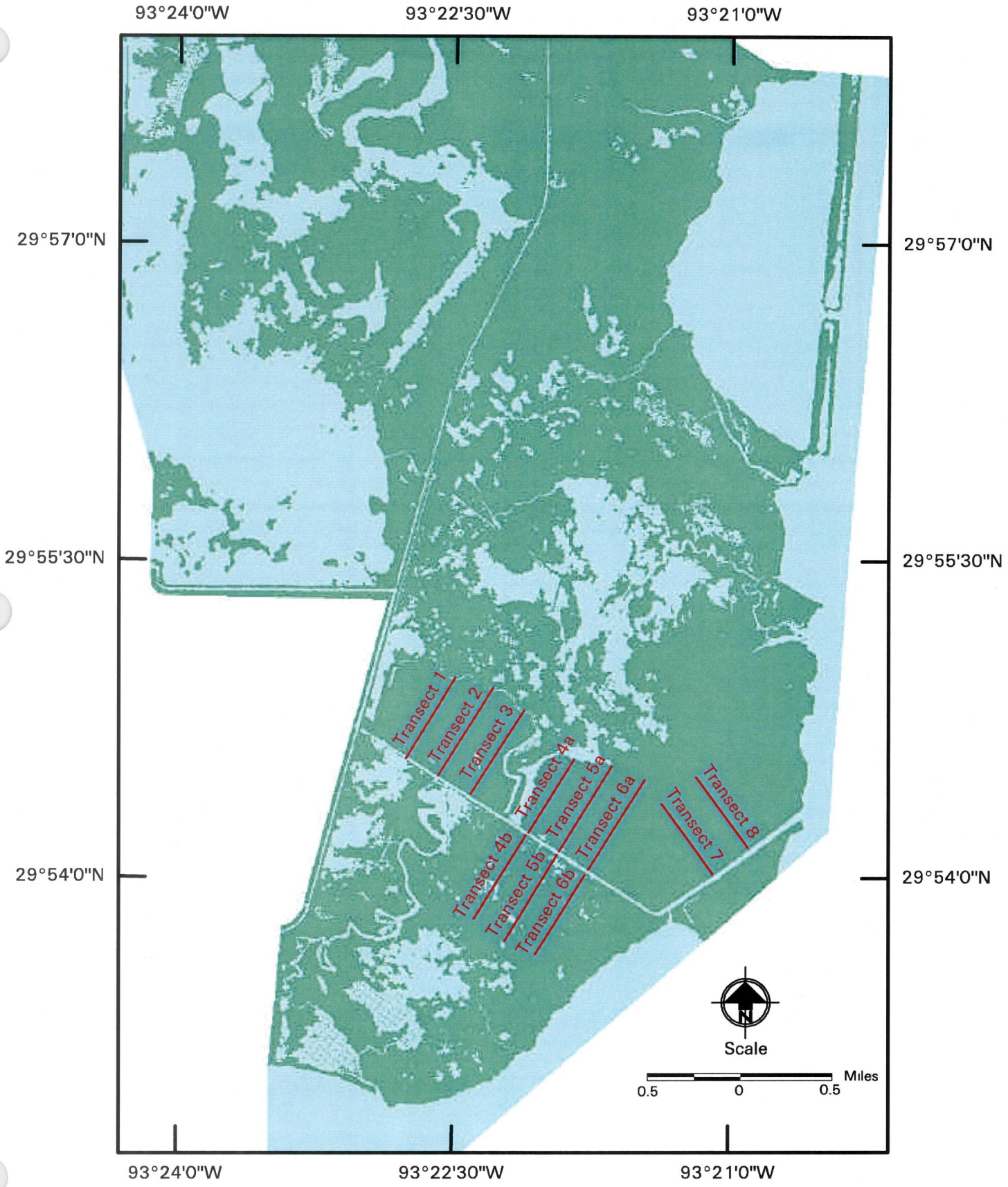

Figure 5 Location of the eleven elevation and vegetation transects at the Calcasieu -SNWR BUMP study area

Profiles at Calacasieu - SNWR

The 2001 profiles were established with one metal pole (stake) on the top of the dike on the north shore of West Cove Canal, partially buried and anchored with concrete, and extending 2-3 feet from the sediment surface. Transects were constructed perpendicular to the orientation of West Cove Canal. The south transects were continuations of the transects across the FY 1993 cell and shared the same stakes. A dike was constructed on both sides of West Cove Canal, leaving a borrow ditch within each cell that had to be crossed with varying degrees of difficulty. The transects are presented below grouped by cell and year of disposal.

Calcasieu - SNWR FY 1999

The Calcasieu - SNWR FY 1999 cell, is located on the north side of West Cove Canal, just east of Highway 27 (Figure 4A). An 8-foot MLG dike was constructed along the northern shore of the canal, and along the east and west boundaries of the site, a 4.5 ft dike was constructed along the perimeter of the marsh to the north of the site. The disposal within this area was during FY 1999, and was confined within these dikes (Figure 6). The US Army Corps of Engineers survey data acquired in March 2000 shows an initial average cell elevation of 2.7 ft MLG (Table 1). The FY 1999 cell settled to an average elevation of approximately 2.2 ft MLG by the time of the transects and remains predominantly bare land. It is being colonized by salt-flat and salt marsh vegetation, and will probably become salt marsh. The borrow ditch was extremely soft sediment and was difficult to traverse. Data for three transects were collected from this cell: #1, #2, and #3.

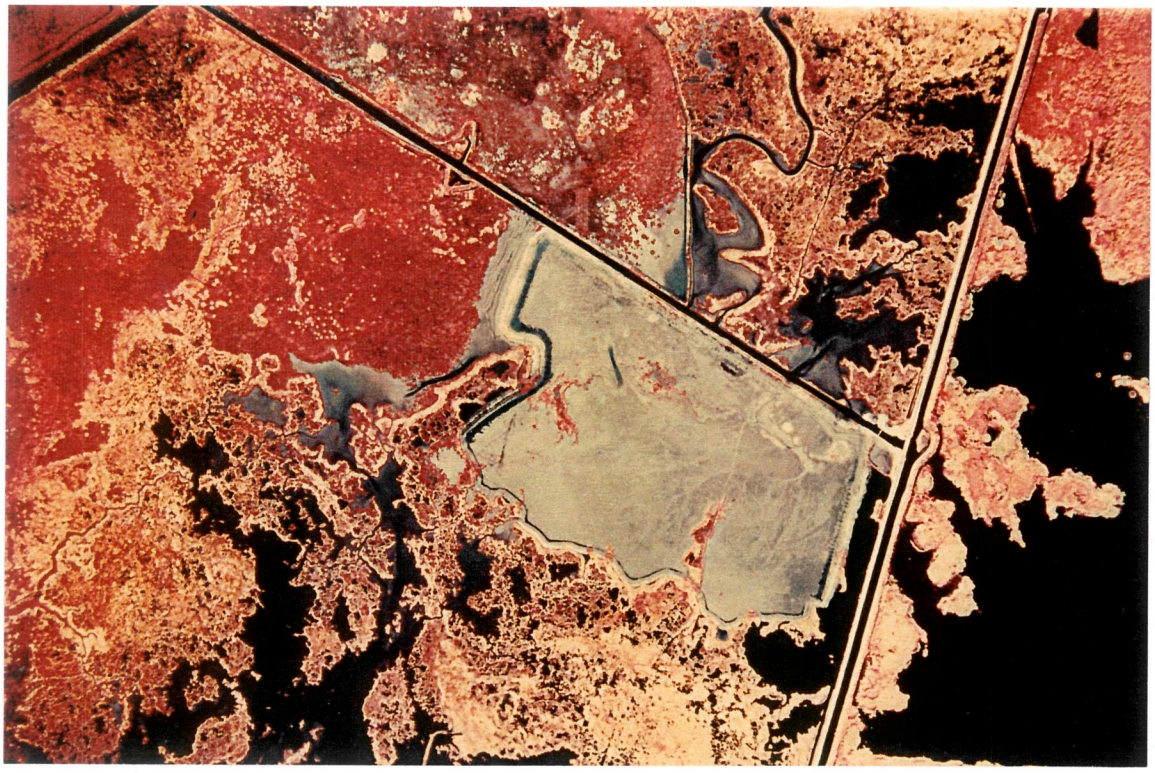

Figure 6. Infrared, vertical aerial photography taken on January 6, 2001 of the Calcasieu River and Pass - SNWR, FY 1999 cell BUMP study area showing the extent of newly created bare land for transects #1-3.

TABLE 1
Average Elevation of Transects and Disposal Cells for the Calcasieu - SNWR BUMP Study Area [1]

Transect/cell	USACE 2000 average elevation (ft MLG)	2001 Transect data (ft MLG)
Transect #1	2.87	2.05
Transect #2	2.65	2.32
Transect #3	2.47	2.25
Average for Cell FY 1999	2.66	2.21
Transect #4a	1.13	0.79
Transect #5a	1.85	1.67
Transect #6a	2.06	1.76
Average for Cell FY 1993	1.68	1.40
Transect #4b	1.98	1.64
Transect #5b	2.68	2.35
Transect #6b	2.78	2.51
Average for Cell FY 1996	2.48	2.17
Transect #7		1.72
Transect #8		0.38
Average for Cell FY 1993 east		1.05

[1] Averages calculated using data within dikes. Does not include elevation data for the dikes or margins outside of dikes.

Transect #1 - CS1

The Calcasieu - SNWR 1999 cell, transect #1 is located on the north side of West Cove Canal approximately 1,500 ft from the boat launch east of Highway 27 (Figure 5). The elevation and vegetation data were acquired June 19, 2001. The transect CS1 was oriented to cross recent disposal in the area and crossed the entire width of land between West Cove Canal and the borrow ditch to the north, just alongside a bit of natural, old marsh. The transect was delineated by 1 stake on the dike north of West Cove Canal (Figure 7). The dike has been well colonized by shrubs and grasses, but the disposal landscape was dominated by bare land (Figures 8 & 9), and included scattered clumps of colonizing saltmarsh at the north mudflats (Figure 10). The disposal material was made up of fine silty sand.

The profile had a length of 2701 ft (Figure 11). The maximum relief along the transect was 7.3 ft MLG (6.5 ft NGVD), at the location of the stake on the dike, with an average relief of 2.4 ft MLG (1.6 ft NGVD). The average relief of the cell (not including the dike) was 2.0 ft MLG (1.2 ft NGVD). The USACE March 2000 data showed an elevation of 2.9 ft MLG (2.1 ft NGVD), for a decrease in elevation of this area of 0.9 ft over the one-year period as the sediment compacts (Table 1). The published tidal range for Calcasieu River and Pass is 2.5 ft for June 19, 2001.

Figure 7. Photograph taken June 19, 2001 of the instrument placed over the stake at Calcasieu - SNWR FY 1999 cell, transect #1 on the dike just north of West Cove Canal. View is to the east.

Figure 8. Photograph taken June 19, 2001 along transect #1 at the Calcasieu -SNWR FY 1999 cell BUMP study site. View is along the transect from the instrument, showing the borrow ditch and the dense vegetation of the dike as opposed to the bare land of the dredged material placement area.

Figure 9. Photograph taken on June 19, 2001 along transect #1 at the Calcasieu - SNWR FY1999 cell BUMP study site showing the sparse, salt-flat vegetation colonizing some areas. *Spartina alterniflora* is in the foreground, and *Salicornia* forms clumps in the background.

Figure 10. Photograph taken on June 19, 2001 along transect #1 at the Calcasieu - SNWR FY1999 cell BUMP study site, showing the mudflat and occasional clumps of *Spartina alterniflora* at the end of the transect.

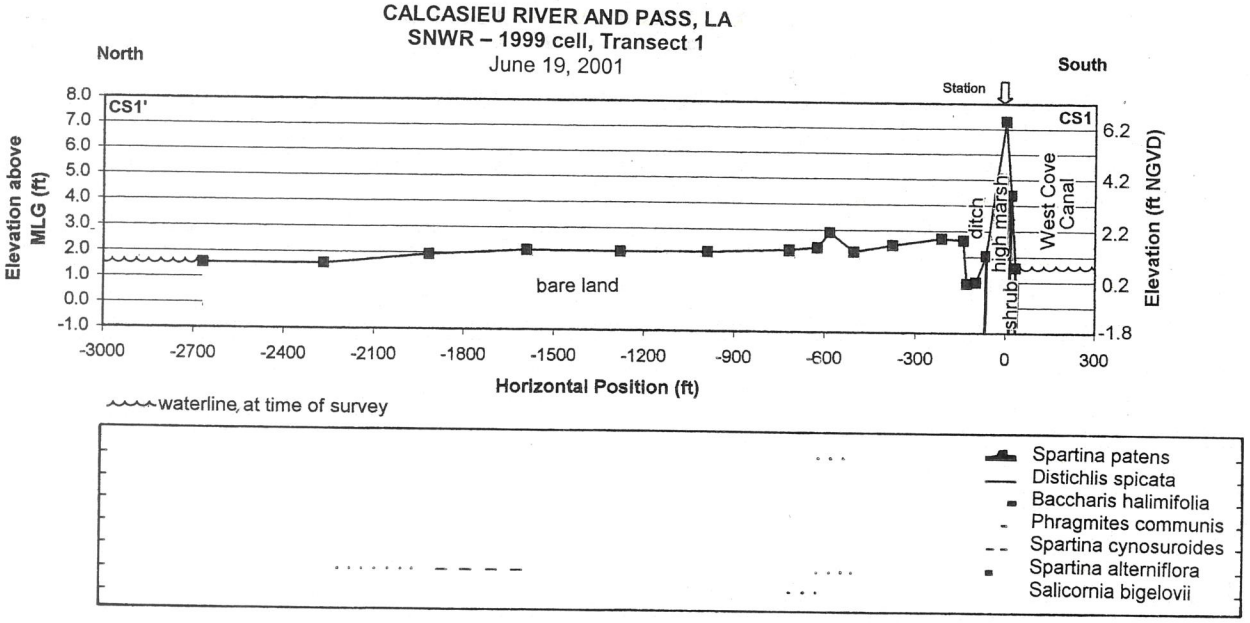

Figure 11. Elevation profile CS1 for transect #1 of the Calcasieu - SNWR FY 1999 cell BUMP study site with vegetation data illustrated.

Transect #2 - CS2

The Calcasieu - SNWR FY1999 cell, transect #2 is located on the north side of West Cove Canal approximately 2,500 ft from the boat launch east of Highway 27 and 1,000 ft east of transect #1 (Figure 5). The elevation and vegetation data were acquired June 19, 2001. Transect #2 was oriented to cross recent disposal in the area and crossed the entire width of land between West Cove Canal and the borrow ditch to the north (Figure 6). The transect was delineated by 1 stake on the dike north of West Cove Canal (Figure 12). The dike was recently rebuilt and had little vegetation, and the disposal landscape was dominated by bare land other than the older marsh areas it crossed (Figures 13 & 14), and included scattered clumps of colonizing saltmarsh at the north mudflats (Figure 15) . The disposal material was made up of fine silty sand.

The profile had a length of 2948 ft (Figure 16). The maximum relief along the transect was 6.9 ft MLG (6.1 ft NGVD), at the location of the stake on the dike, with an average relief of 2.6 ft MLG (1.8 ft NGVD). The average relief of the cell itself (not including the dike) was 2.3 ft MLG (1.5 ft NGVD). The USACE March 2000 survey data showed an average elevation for this site as 2.7 ft MLG (1.9 ft NGVD), for a decrease in average elevation of 0.4 ft over the one-year period as the sediment compacts. The published tidal range for Calcasieu River and Pass is 2.5 ft for June 19, 2001.

Figure 12. Photograph taken on June 19, 2001 along transect #2 at the Calcasieu - SNWR FY1999 cell BUMP study site showing the borrow ditch and the location of the instrument and stake on the dike north of West Cove Canal.

Figure 13. Photograph taken on June 19, 2001 along transect #2 at the Calcasieu - SNWR FY1999 cell BUMP study site showing the colonizing *Spartina alterniflora* marsh.

Figure 14. Photograph taken on June 19, 2001 along transect #2 at the Calcasieu - SNWR FY1999 cell BUMP study site showing the old, dense *Spartina alterniflora* marsh.

Figure 15. Photograph taken on June 19, 2001 along transect #2 at the Calcasieu - SNWR FY1999 cell BUMP study site, showing the mudflat and occasional clumps of *Spartina alterniflora* at the north end of the transect.

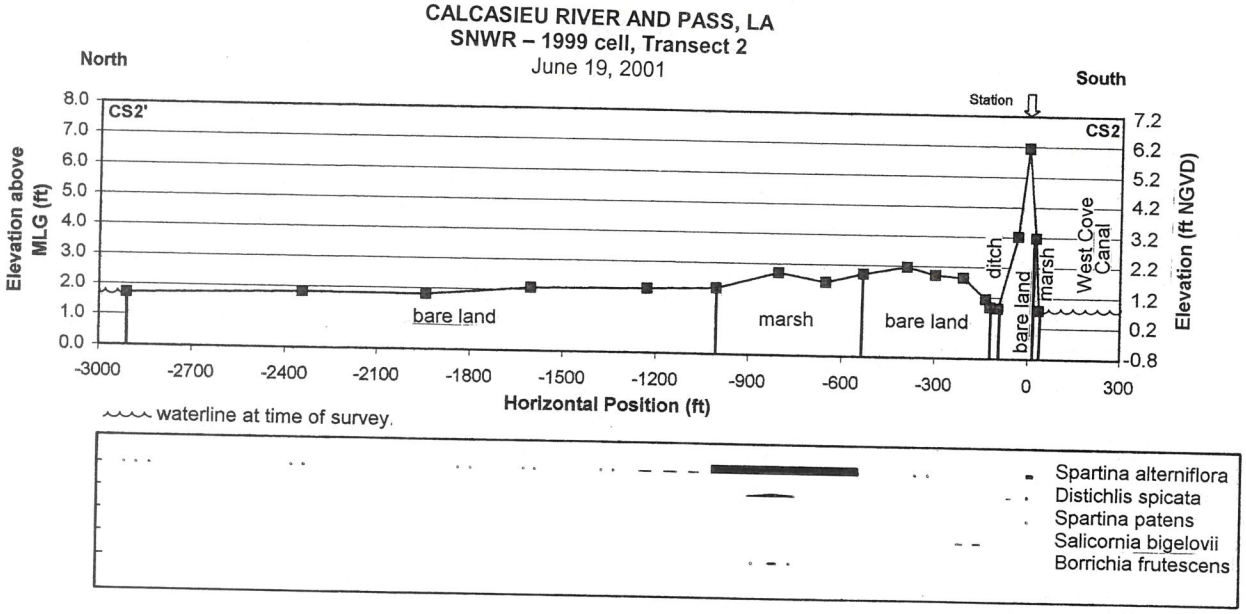

Figure 16. Elevation profile CS2 for transect #2 of the Calcasieu - SNWR FY1999 cell BUMP study site with vegetation data illustrated.

Transect #3 - CS3

The Calcasieu - SNWR FY1999 cell, transect #3 is located on the north side of West Cove Canal approximately 3,500 ft from the boat launch east of Highway 27 and 1,000 ft east of transect #2 (Figure 5). The elevation and vegetation data were acquired June 19, 2001. Transect #3 was oriented to cross recent disposal in the area and crossed the entire width of land between West Cove Canal and the borrow ditch to the north (Figure 6). The transect was delineated by 1 stake on the dike north of West Cove Canal (Figure 17). The dike was recently rebuilt and had little vegetation, and the disposal landscape was dominated by bare land (Figure 18) other than the older marsh areas it crossed (Figure 19), and included scattered clumps of colonizing saltmarsh at the north mudflats (Figure 20). The disposal material was made up of fine silty sand.

The profile had a length of 2382 ft (Figure 21). The maximum relief along the transect was 6.1 ft MLG (5.3 ft NGVD), at the location of the stake on the dike, with an average relief of 2.4 ft MLG (1.6 ft NGVD). The average relief of the cell itself (not including the dike) was 2.3 ft MLG (1.5 ft NGVD). The USACE March 2000 survey data showed an average elevation for this site as 2.5 ft MLG (1.7 ft NGVD), for a decrease in average elevation of 0.2 ft over the one-year period as the sediment compacts. The published tidal range for Calcasieu River and Pass is 2.5 ft for June 19, 2001.

Figure 17. Photograph taken on June 19, 2001 along transect #3 at the Calcasieu - SNWR FY1999 cell BUMP study site. View is to the south showing the location of the instrument and stake on the dike north of West Cove Canal.

Figure 18. Photograph taken on June 19, 2001 along transect #3 at the Calcasieu - SNWR FY1999 cell BUMP study site showing the extensive, low relief bare land that occurs over most of the transect.

Figure 19. Photograph taken on June 19, 2001 along transect #3 at the Calcasieu - SNWR FY1999 cell BUMP study site showing the old, dense *Spartina alterniflora* marsh.

Figure 20. Photograph taken on June 19, 2001 along transect #3 at the Calcasieu - SNWR FY1999 cell BUMP study site, showing the mudflat and occasional clumps of *Spartina alterniflora* at the end of the transect.

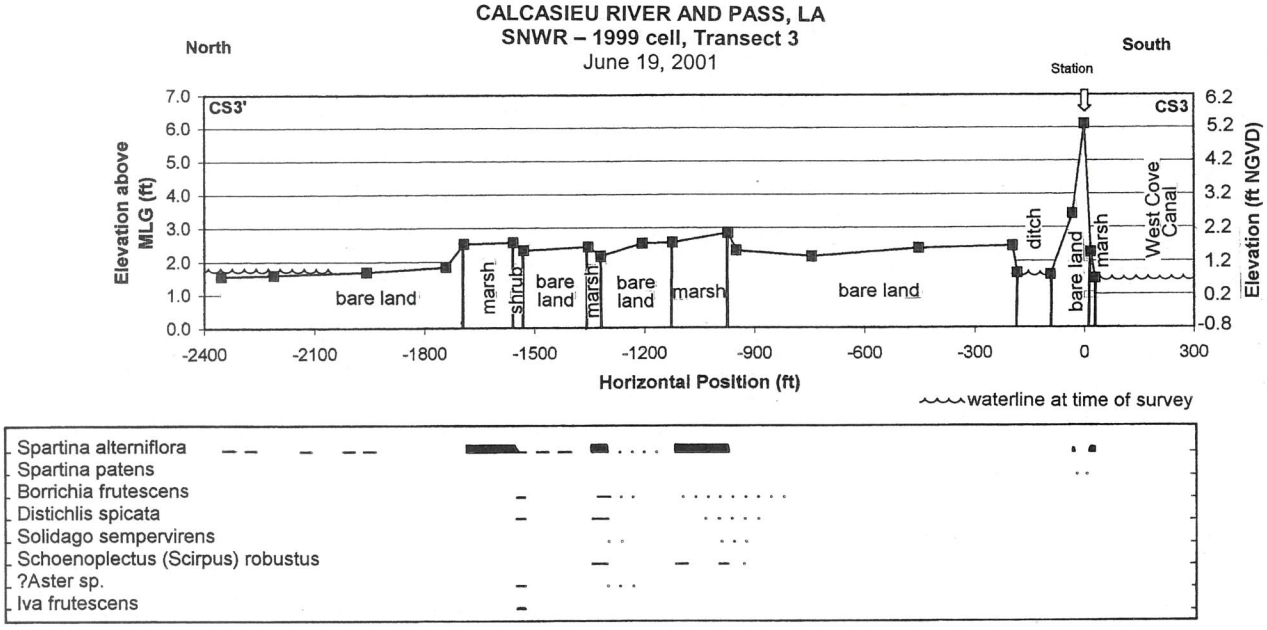

Figure 21. Elevation profile CS3 for transect #3 of the Calcasieu - SNWR FY1999 cell BUMP study site with vegetation data illustrated.

Calcasieu - SNWR FY 1993

The Calcasieu - SNWR FY1993 cell, is located on the north side of West Cove Canal, east of Highway 27 (Figure 4A). A dike was constructed along the northern shore of the canal, leaving a borrow ditch parallel and just to the north. The disposal within this area was during FY 1993, and was semi-confined and allowed to flow into the remaining saltmarsh (Figure 22). The maximum elevation allowed for placement was +4 ft MLG. The USACE survey data acquired in March 2000 showed an average elevation of the cell at1.7 ft MLG (Table 1). The cell settled to an average elevation of approximately 1.4 ft MLG by the time of the transects in June 2001. The area is densely colonized by *Spartina alterniflora* saltmarsh, with a few shrub areas indicating higher elevations. The bank of the borrow ditch is outlined by thick, tall saltmarsh, but the ditch itself is not vegetated and appears to hold tidal water. The transects were continued across the West Cove Canal to the 1996 cell, and so were labeled "a" within the 1993 cell and "b" within the 1996 cell (Figure 5). Three transects were placed across this cell: #4a, #5a, and #6a.

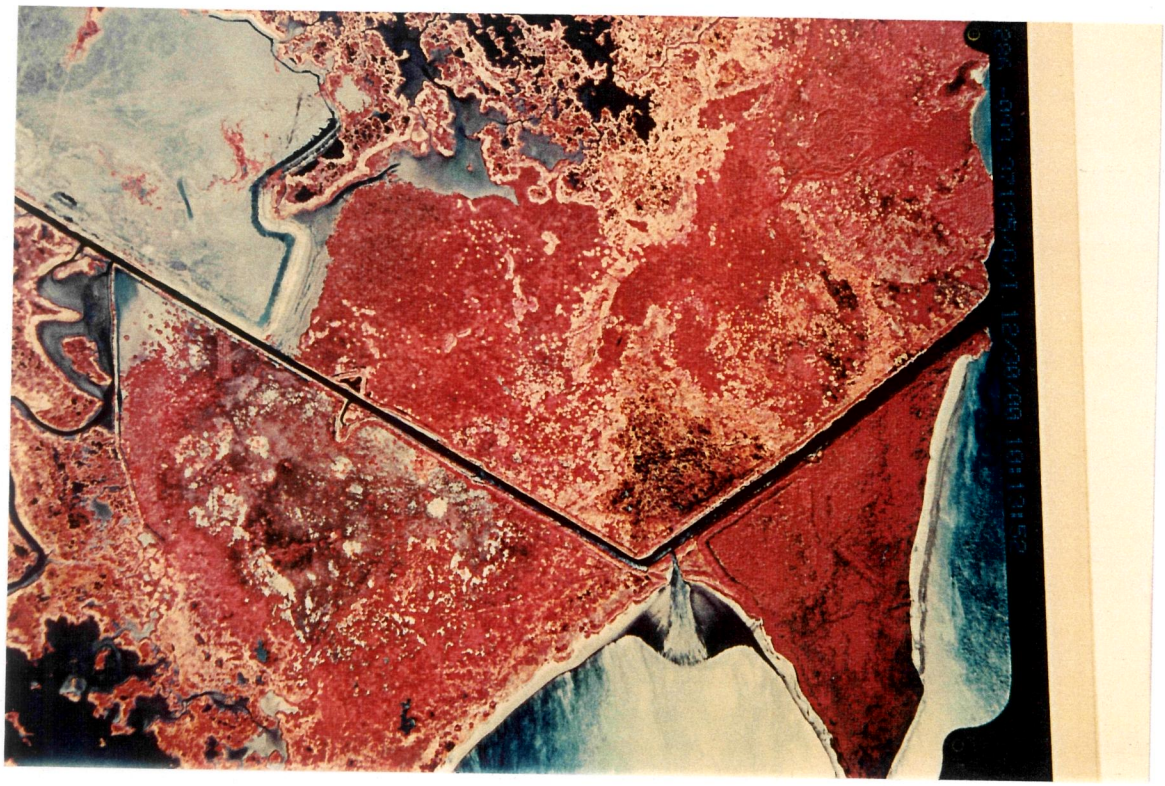

Figure 22. Infrared, vertical aerial photography taken on January 6, 2001 of the Calcasieu River and Pass - SNWR FY1993 cell BUMP study area showing the thick marsh and shrub habitats of transects #4a-6a.

Transect #4a

The Calcasieu - SNWR FY 1993 cell, transect #4a is located on the north side of West Cove Canal approximately 5,500 ft from the boat launch east of Highway 27, and 2,000 ft from transect #3 (Figure 5). The elevation and vegetation data were acquired June 19, 2001. Transect #4a was oriented to cross recent disposal in the area and crossed the entire width of land between West Cove Canal and the waterway to the north (Figure 22). The transect was delineated by 1 stake on the dike north of West Cove Canal. The dike had been well colonized by shrubs and high marsh grasses, and the disposal landscape was dominated by saltmarsh (Figure 23). The disposal material was made up of fine silt and sand.

The profile had a length of 2485 ft (Figure 24). The maximum relief along the axis was 1.6 ft MLG (0.8 ft NGVD), at the location of the stake on the dike, with an average relief of 0.82 ft MLG (0.04 ft NGVD). The average relief of the cell itself (not including the dike) was 0.79 ft MLG (0.01 ft NGVD). The USACE March 2000 survey data showed an average elevation for this line as 1.13 ft MLG (0.35 ft NGVD), for a decrease in average elevation of 0.34 ft over the one-year period as the sediment compacted. The published tidal range for Calcasieu River and Pass is 2.5 ft for June 19, 2001.

Figure 23. Photograph taken June 19, 2001 from the instrument placed over the stake at Transect #4a of the Calcasieu - SNWR FY 1993 cell BUMP study area on the dike just north of West Cove Canal, showing the extensive saltmarsh along the transect, and the crew trying to cross the borrow ditch.

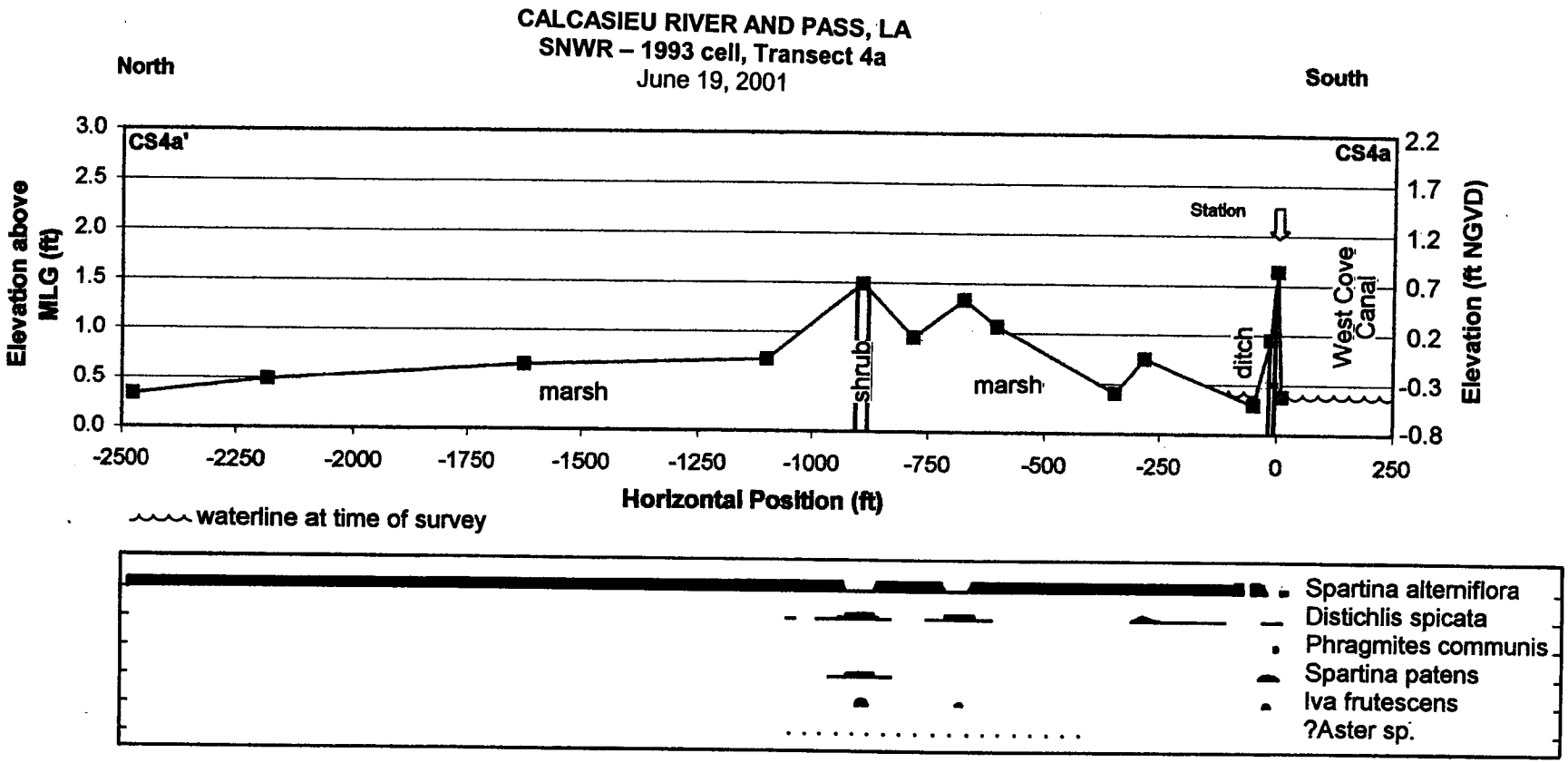

Figure 24. Elevation profile CS4a for transect #4a of the Calcasieu - SNWR FY 1993 cell BUMP study site with vegetation data illustrated.

Transect #5a

The Calcasieu - SNWR FY 1993 cell, transect #5a is located on the north side of West Cove Canal approximately 6,500 ft from the boat launch east of Highway 87 and 1,000 ft from transect 4a (Figure 5). The elevation and vegetation data were acquired June 19, 2001. The transect CS5a was oriented to cross recent disposal in the area and crossed an extent of land between West Cove Canal and the older marsh to the north (Figure 22). The transect was delineated by 1 stake on the dike north of West Cove Canal. The dike was well colonized by shrubs and high marsh grasses except for the top where the dike had been recently augmented (Figure 25). The disposal landscape was dominated by saltmarsh (Figures 26). The disposal material was made up of fine silt and sand.

The profile had a length of 2491 ft (Figure 27). The maximum relief along the axis was 7.3 ft MLG (6.5 ft NGVD), at the location of the stake on the dike, with an average relief of 1.8 ft MLG (1.0 ft NGVD). The average relief of the cell itself (not including the dike) was 1.7 ft MLG (0.9 ft NGVD). The USACE March 2000 survey data showed an average elevation for this line as 1.9 ft MLG (1.1 ft NGVD), for a decrease in average elevation of 0.2 ft over the one-year period as the sediment compacted. The published tidal range for Calcasieu River and Pass is 2.5 ft for June 19, 2001.

Figure 25. Photograph taken June 20, 2001 of the dike just north of West Cove Canal, from the instrument at Transect #5a. The view is to the west, showing the bare top of the dike, the fringing saltmarsh at the waterline of the canal on the left, and the shrubs on either side of the dike.

Figure 26. Photograph taken June 20, 2001 along transect #5a at the Calcasieu - SNWR FY1993 cell BUMP study site. View is north along the transect from the instrument, showing the dense saltmarsh of the dredged material placement area, and the borrow ditch that still holds water and soft sediment.

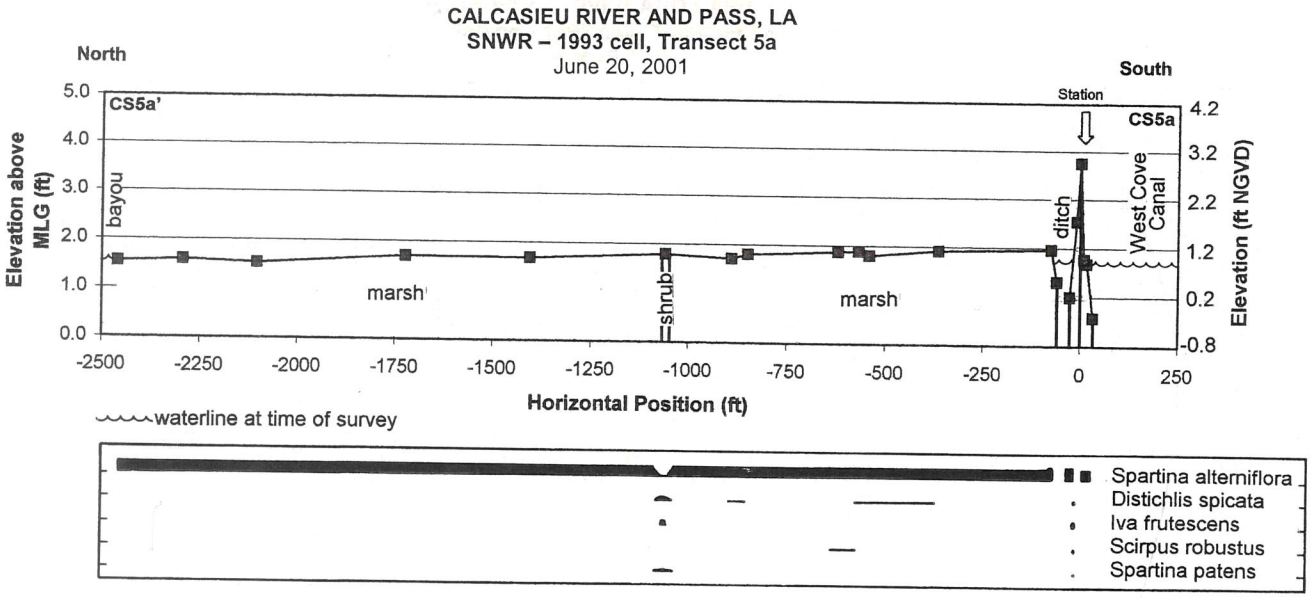

Figure 27. Elevation profile CS5a for transect #5a of the Calcasieu - SNWR FY1993 cell BUMP study site with vegetation data illustrated.

Transect #6a

The Calcasieu - SNWR FY 1993 cell, transect #6a is located on the north side of West Cove Canal approximately 7,500 ft from the boat launch east of Highway 27 and 1,000 ft from transect #5a (Figure 5). The elevation and vegetation data were acquired June 20, 2001. Transect #6a was oriented to cross recent disposal in the area and crossed a width of land between West Cove Canal and the older terrain to the north including shrub and scour holes (Figure 22). The transect was delineated by 1 stake on the dike north of West Cove Canal. The dike had been well colonized by shrubs and grasses, and the disposal landscape was dominated by *Spartina alterniflora* saltmarsh and *Iva frutescens* shrub habitats (Figures 28-30). The disposal material was made up of fine silt and sand.

The profile had a length of 2541 ft (Figure 31). The maximum relief along the transect was 5.1 ft MLG (4.3 ft NGVD), at the location of the stake on the dike, with an average relief of 1.81 ft MLG (1.0 ft NGVD). The average relief of the cell itself (not including the dike) was 1.76 ft MLG (0.98 ft NGVD). The USACE March 2000 survey data showed an average elevation for this line as 2.06 ft MLG (1.28 ft NGVD), for a decrease in average elevation of 0.3 ft over the one-year period as the sediment compacted. The published tidal range for Calcasieu River and Pass is 2.8 ft for June 20, 2001.

Figure 28. Photograph taken June 20, 2001 along transect #6a of the Calacasieu - SNWR FY 1993 cell BUMP study area from the dike just north of West Cove Canal. View is to the north, showing the interspersed shrub and saltmarsh habitats.

Figure 29. Photograph taken June 20, 2001 along transect #6a at the Calcasieu - SNWR FY1993 cell BUMP study site. View is along the transect to the north, showing a scour hole supporting brackish to fresh vegetation and wildlife (tadpoles).

Figure 30. Photograph taken on June 20, 2001 along transect #6a at the Calcasieu - SNWR FY1993 cell BUMP study site showing the dense, unbroken *Spartina alterniflora* saltmarsh to the north end of the transect.

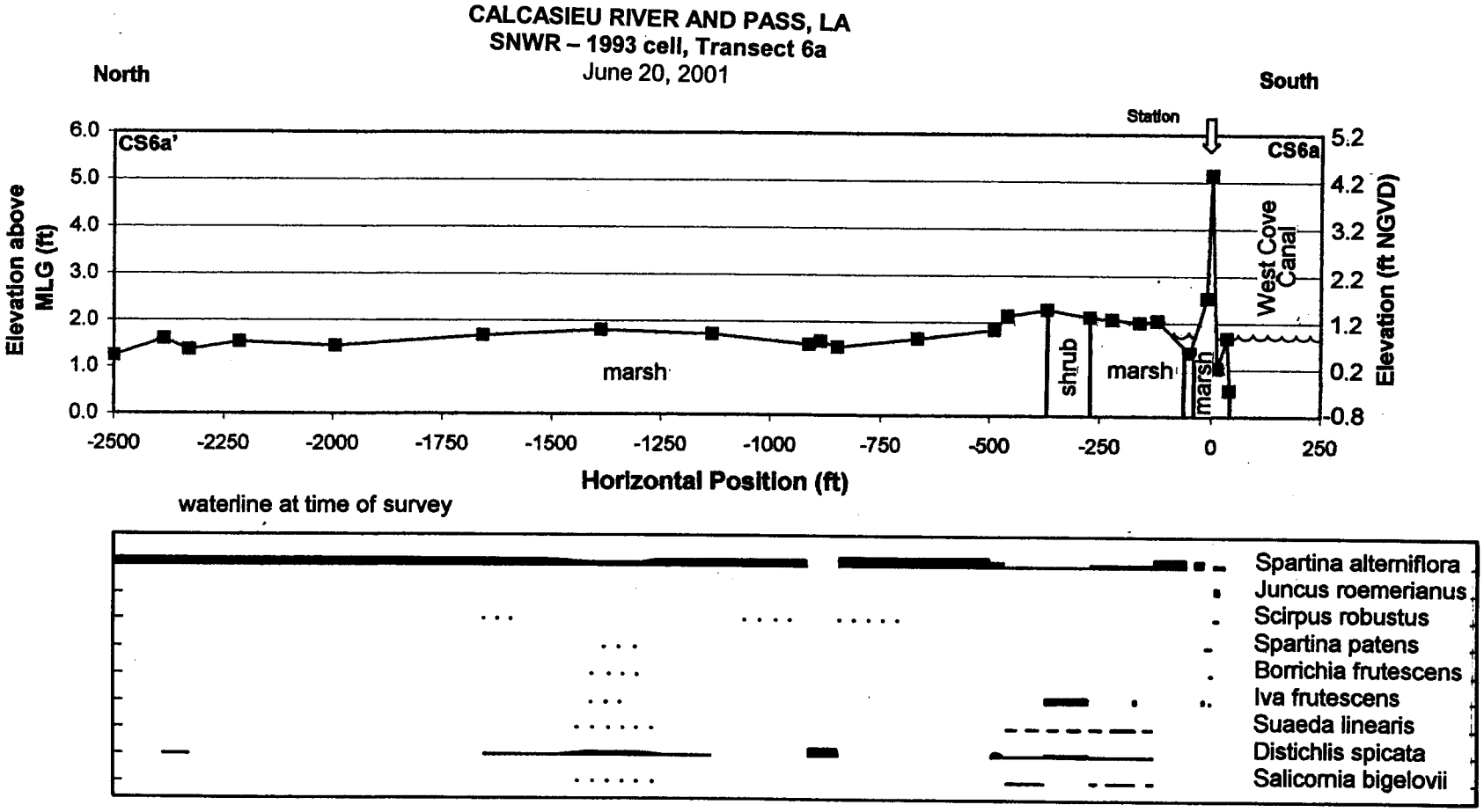

Figure 31. Elevation profile CS6a for transect #6a of the Calcasieu - SNWR FY1993 cell BUMP study site with vegetation data illustrated.

Calcasieu - SNWR FY 1996

The Calcasieu - SNWR FY 1996 cell is located on the south side of West Cove Canal, east of Highway 27 (Figure 4A). A dike was constructed along the southern shore of the canal, and along the western extent of the cell to prevent material from filling in the natural bayou Hog Island Gully. The disposal within this area was during FY 1996. The dredged material was placed semi-confined and allowed to flow into the remaining saltmarsh to the south (Figure 32). The maximum elevation allowed for the placement of material was 5 ft MLG. The USACE survey data acquired in March 2000 showed an average elevation of the cell at 2.5 ft MLG (1.7 ft NGVD). The cell had settled to an average elevation of approximately 2.2 ft MLG (1.4 ft NGVD) by the time of the transects in June 2001 (Table 1).

The area is lightly colonized by high marsh grasses and composites and salt-flat species along the north end of the transect and densely colonized by saltmarsh at the south end, with a few shrub areas indicating higher elevations. The borrow ditch was densely colonized by a tall stand of *Spartina alterniflora* saltmarsh with only occasional standing water. The transects were continued across the canal from the 1993 cell, and so were labeled "a" within the 1993 cell and "b" within the 1996 cell (Figure 5). The three transects here were #4b, #5b, and #6b.

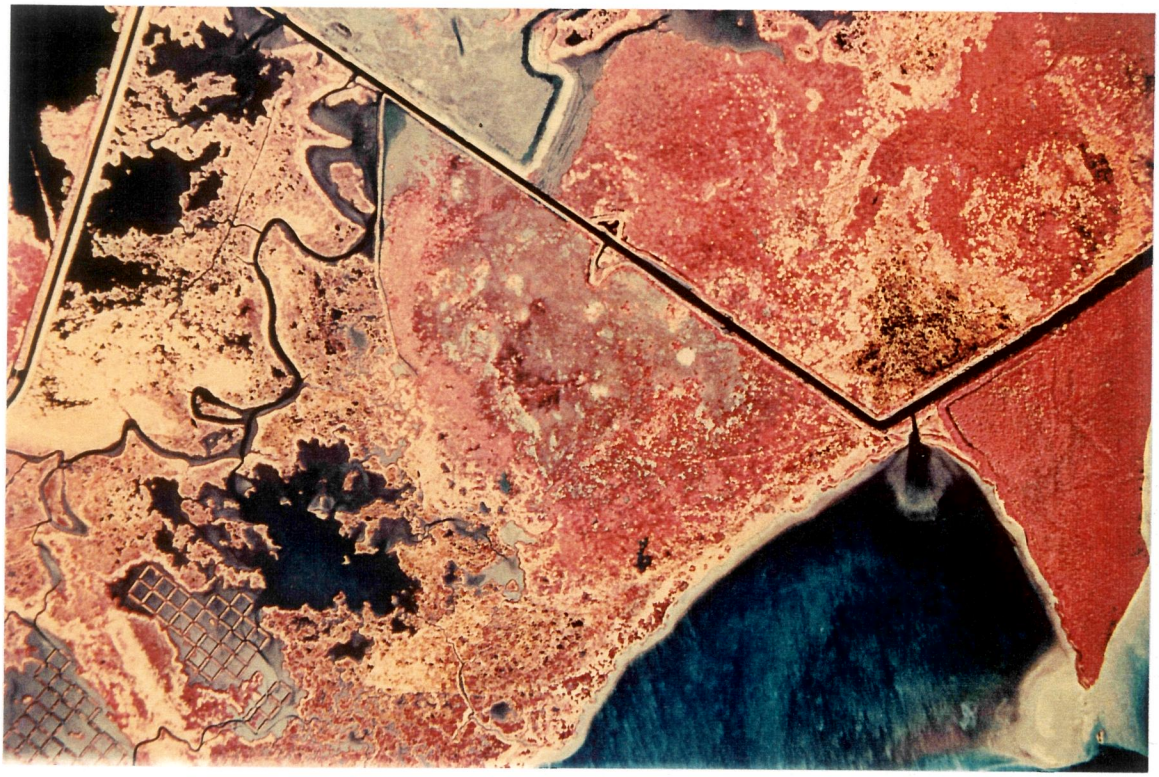

Figure 32. Infrared, vertical aerial photography taken on January 6, 2001 of the Calcasieu River and Pass - SNWR FY 1996 cell BUMP study area containing transects #4b-6b.

Transect #4b - CS4b

The Calcasieu - SNWR FY 1996 cell, transect #4b is located on the south side of West Cove Canal approximately 5,500 ft from the boat launch east of Highway 27 (Figure 5). The elevation and vegetation data were acquired June 19, 2001. The transect #4b was oriented to cross recent disposal in the area and crossed an extent of land between West Cove Canal and the older marsh to the south (Figure 32). The transect was delineated by 1 stake on the dike north of West Cove Canal (Figure 33). The dike south of the canal was recently augmented by new material and the top was bare, but the slopes were well colonized by shrubs and grasses. The disposal landscape was dominated by composites and salt-flat vegetation, but none of the species could be identified to be anything other than high marsh species (Figure 34). There were distinct differences on the profile between saltmarsh and highmarsh habitats. Toward the south end of the transect, Iva shrub areas were common before the extensive saltmarsh (Figure 35). The disposal material was made up of fine sand.

The profile had a length of 2468 ft (Figure 36). The maximum relief along the axis was 4.2 ft MLG (3.4 ft NGVD), at the top of the dike, with an average relief of 1.8 ft MLG (1.0 ft NGVD). The average relief of the cell itself (not including the dike) was 1.6 ft MLG (0.8 ft NGVD). The USACE March 2000 survey data showed an average elevation for this site as 2.0 ft MLG (1.2 ft NGVD), for a decrease in average elevation of 0.4 ft over the one-year period as the sediment compacted. The published tidal range for Calcasieu River and Pass is 2.5 ft for June 19, 2001.

Figure 33. Photograph taken June 19, 2001 from the Calcasieu - SNWR FY 1996 cell, transect #4b, of the instrument placed over the stake at Transect #4a on the dike across West Cove Canal. View is to the north.

Figure 34. Photograph taken June 19, 2001 along transect #4b at the Calcasieu - SNWR FY1996 cell BUMP study site. View is south along the transect, showing the low relief, composite vegetation of the dredged material placement area.

Figure 35. Photograph taken on June 19, 2001 along transect #4b at the Calcasieu - SNWR FY1996 cell BUMP study site showing the Iva shrub areas just before the dense saltmarsh at the south end of the transect.

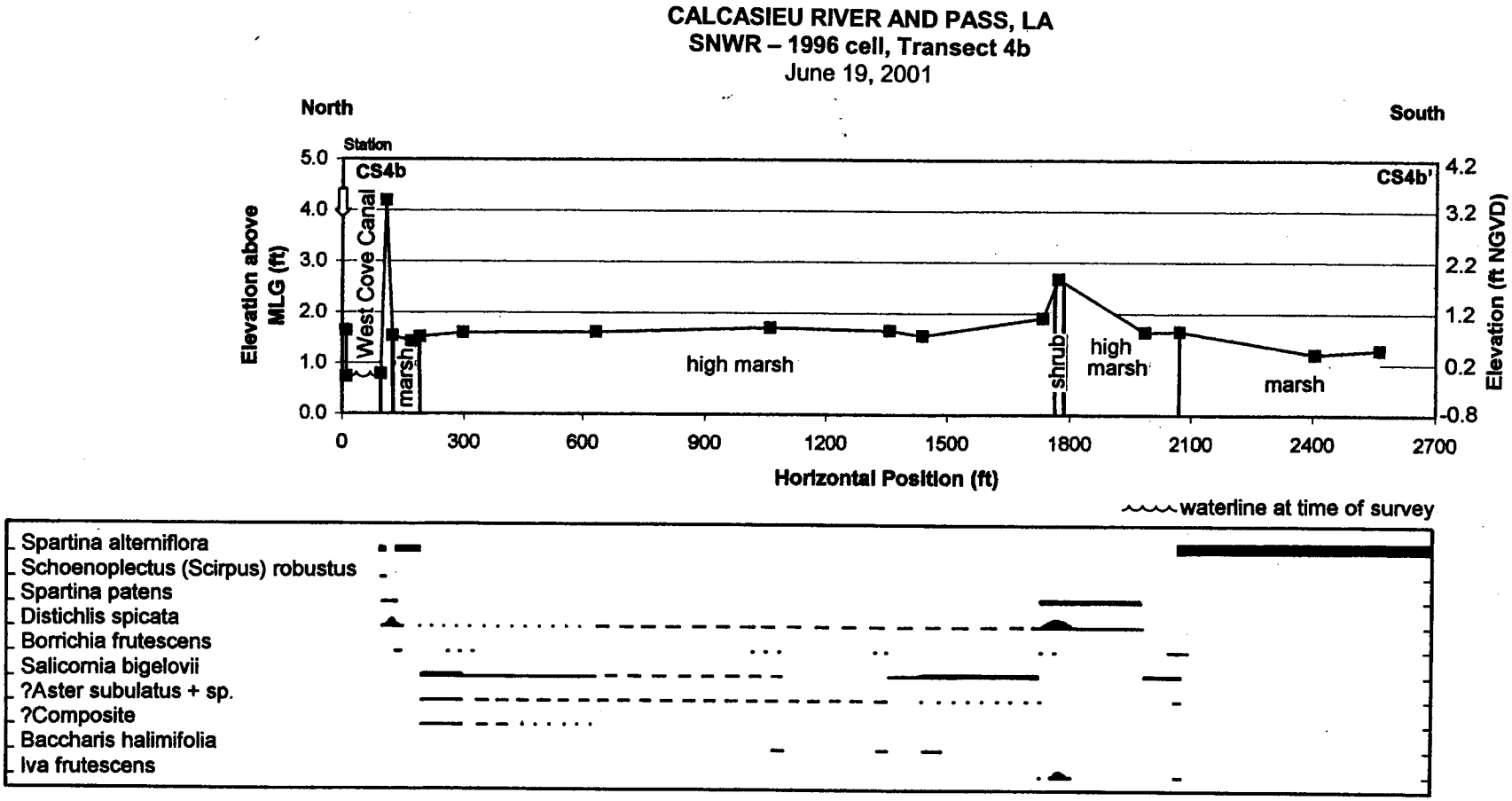

Figure 36. Elevation profile CS4b for transect #4b of the Calcasieu - SNWR FY 1996 cell BUMP study site with vegetation data illustrated.

Transect #5b - CS5b

The Calcasieu - SNWR FY 1996 cell, transect #5b is located on the south side of West Cove Canal approximately 6,500 ft from the boat launch east of Highway 27 and across from 1993 cell transect #5a (Figure 5). The elevation and vegetation data were acquired June 20, 2001. Transect #5b was oriented to cross recent disposal in the area and crossed an extent of land between West Cove Canal and the older marsh to the south (Figure 32). The transect was delineated by 1 stake on the dike north of West Cove Canal. The dike south of the canal was recently augmented by new material and the top was bare, but the slopes were well colonized by shrubs, composites and grasses. The borrow ditch was colonized by a dense stand of *Spartina alterniflora* (Figure 37). The disposal landscape was dominated by composites and salt-flat vegetation, but none of the species could be identified to be anything other than high marsh species (Figure 38). There were distinct differences on the profile between high marsh and saltmarsh habitats. *Iva* and *Baccharis* shrub areas were common scattered throughout the area before the extensive saltmarsh to the south (Figure 39). The disposal material was made up of fine sand.

The profile had a length of 2839 ft (Figure 40). The maximum relief along the transect was 5.0 ft MLG (4.2 ft NGVD), at the top of the dike, with an average relief of 2.4 ft MLG (1.6 ft NGVD). The average relief of the cell along the profile (not including the dike) was 2.4 ft MLG (1.6 ft NGVD). The USACE March 2000 survey data showed an average elevation for this site as 2.7 ft MLG (1.9 ft NGVD), for a decrease in average elevation of 0.3 ft over the one-year period as the sediment compacts. The published tidal range for Calcasieu River and Pass is 2.8 ft for June 20, 2001.

Figure 37. Photograph taken June 20, 2001 along transect #5b at the Calcasieu - SNWR FY 1996 cell. The view is south from the dike showing the band of dense saltmarsh occupying the borrow ditch.

Figure 38. Photograph taken June 20, 2001 along transect #5b at the Calcasieu - SNWR FY1996 cell BUMP study site. View is south along the transect, showing the low relief, composite vegetation of the dredged material placement area, and the scattered Iva shrubs.

Figure 39. Photograph taken on June209, 2001 along transect #5b at the Calcasieu - SNWR FY1996 cell BUMP study site showing the dense saltmarsh at the south end of the transect.

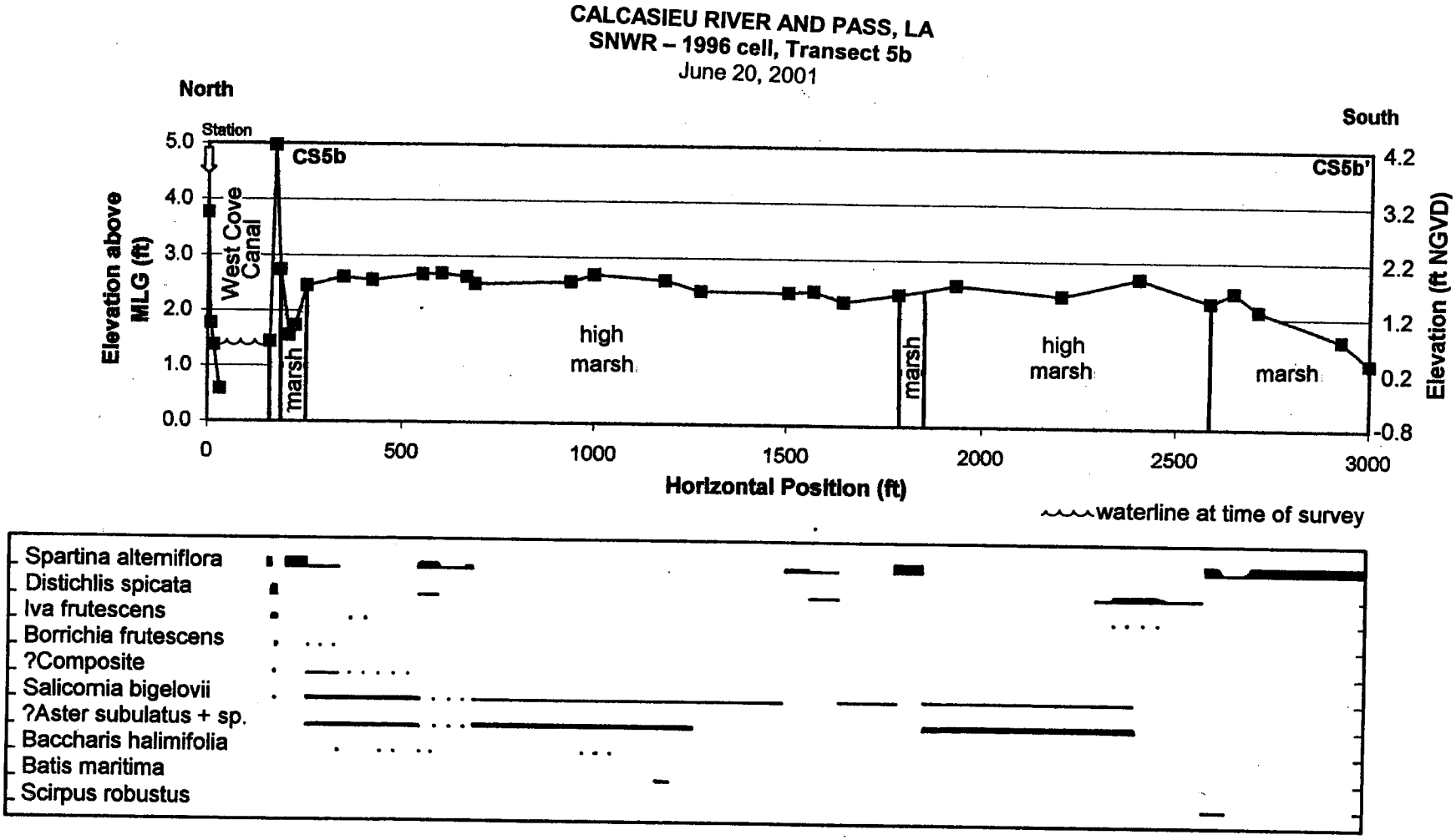

Figure 40. Elevation profile CS5b for transect #5b at the Calcasieu - SNWR FY 1996 cell BUMP study site with vegetation data illustrated.

Transect #6b - CS6b

The Calcasieu - SNWR FY 1996 cell, transect #6b is located on the south side of West Cove Canal approximately 7,500 ft from the boat launch east of Highway 27 and across the Canal from transect #6a (Figure 5). The elevation and vegetation data were acquired June 20, 2001. Transect #6b was oriented to cross recent disposal in the area and crossed an extent of land between West Cove Canal and the older marsh to the south (Figure 32). The transect was delineated by 1 stake on the dike north of West Cove Canal. The dike south of the canal was recently augmented by new material and the top was bare, but the slopes were well colonized by shrubs and grasses (Figure 41). The disposal landscape was dominated by composites and salt-flat vegetation, but none of the species could be identified to be anything other than high marsh species (Figure 42). Iva and Baccharis shrubs were more common along this transect and formed scattered thickets (Figure 43). Saltmarsh again took over at the south end of the transect. The disposal material was made up of fine sand.

The profile had a length of 2383 ft (Figure 36). The maximum relief along the axis was 5.4 ft MLG (4.6 ft NGVD), at the location of the dike, with an average relief of 2.6 ft MLG (1.8 ft NGVD). The average relief of the cell along the transect (not including the dike) was 2.5 ft MLG (1.7 ft NGVD). The USACE March 2000 survey data showed an average elevation for this line as 2.8 ft MLG (2.0 ft NGVD), for a decrease in average elevation of 0.3 ft over the one-year period as the sediment compacts. The published tidal range for Calcasieu River and Pass is 2.8 ft for June 20, 2001.

Figure 41. Photograph taken June 20, 2001 of the top of the dike at transect #6b, Calcasieu - SNWR FY 1996 cell, showing the marsh and composites colonizing both sides of the dike and a *Juncus* ridge at the south margin of West Cove Canal not on the transect. View is to the east.

Figure 42. Photograph taken June 20, 2001 along transect #6b at the Calcasieu - SNWR FY1996 cell BUMP study site. View is south along the transect, showing the low relief, composite vegetation and scattered shrubs of the dredged material placement area.

Figure 43. Photograph taken on June 20, 2001 along transect #6b at the Calcasieu - SNWR FY1996 cell BUMP study site showing the *Iva* and *Baccharis* shrub thickets.

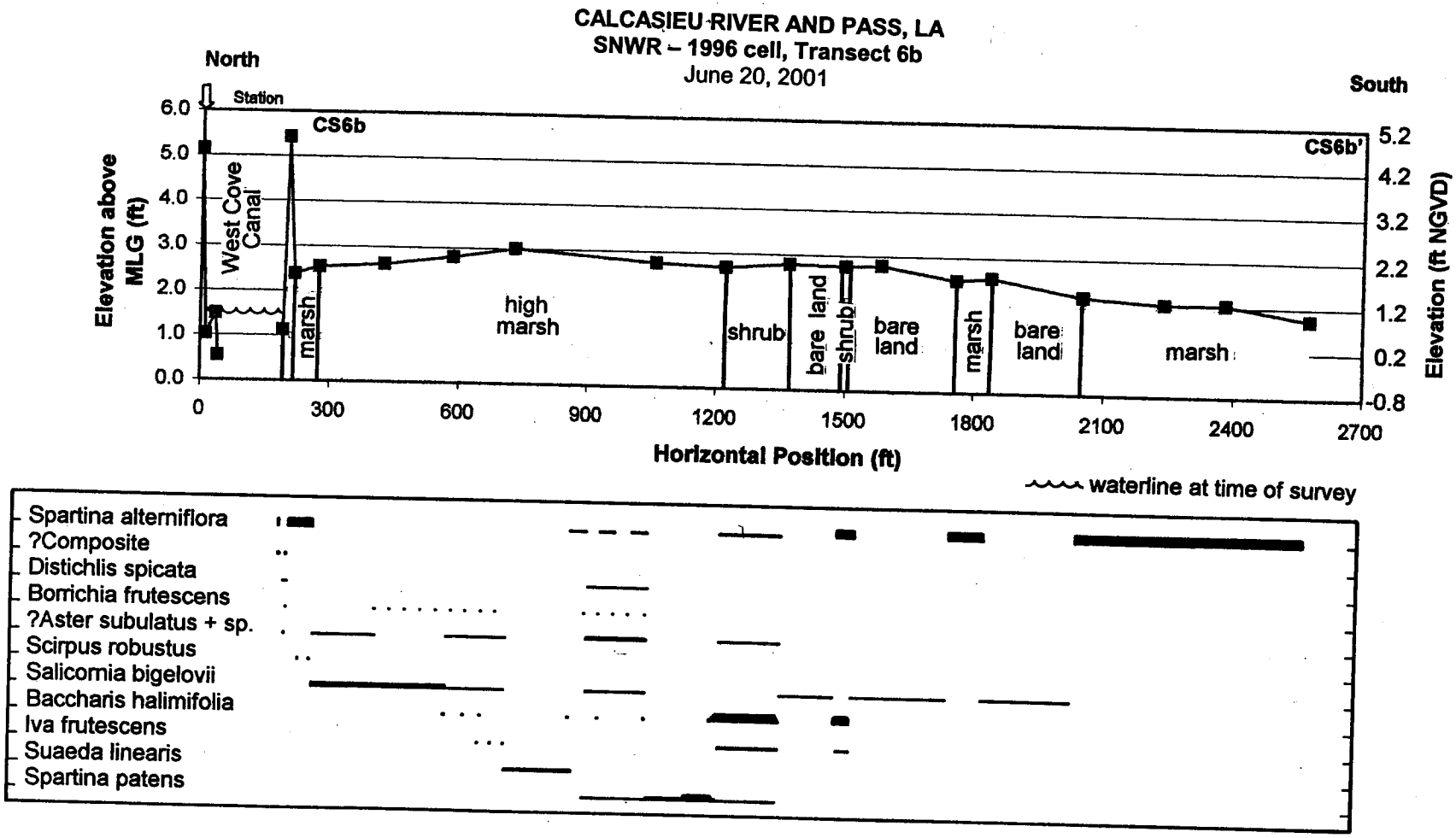

Figure 44. Elevation profile CS6b for transect #6b at the Calcasieu - SNWR FY 1996 cell BUMP study site with vegetation data illustrated.

Calcasieu - SNWR FY 1993 east

The Calcasieu - SNWR FY 1993 east cell is located on the northwest side of West Cove Canal after it turns toward the northwest, before it reaches the Calcasieu Shipping Channel (Figure 5). A dike was constructed along the northwestern shore of the canal. The disposal within this area was during FY 1993, and was semi-confined and allowed to flow into the existing saltmarsh and shrub habitats to the north and west (Figure 45). The dike at this site supported scattered trees and a dense assortment of grasses and upland species. The side of the dike on the West Cove Canal was experiencing erosion and exhibited a scarp of a foot or more, with overhanging shrubs. The base of the dike on the cell side was colonized by bulrush in a strip reminiscent of the borrow ditch conformation. Two transects were placed across this cell: #7 and #8.

The vegetation transects could be broken into three main zones across the disposal area. The area near the dike was densely colonized by *Spartina patens*, broken by a maze of ditches, ponds and waterways. The middle zone held *Scirpus, Distichlis* and *Iva* shrubs. The zone furthest away from the dike was densely colonized by *Spartina alterniflora* saltmarsh.

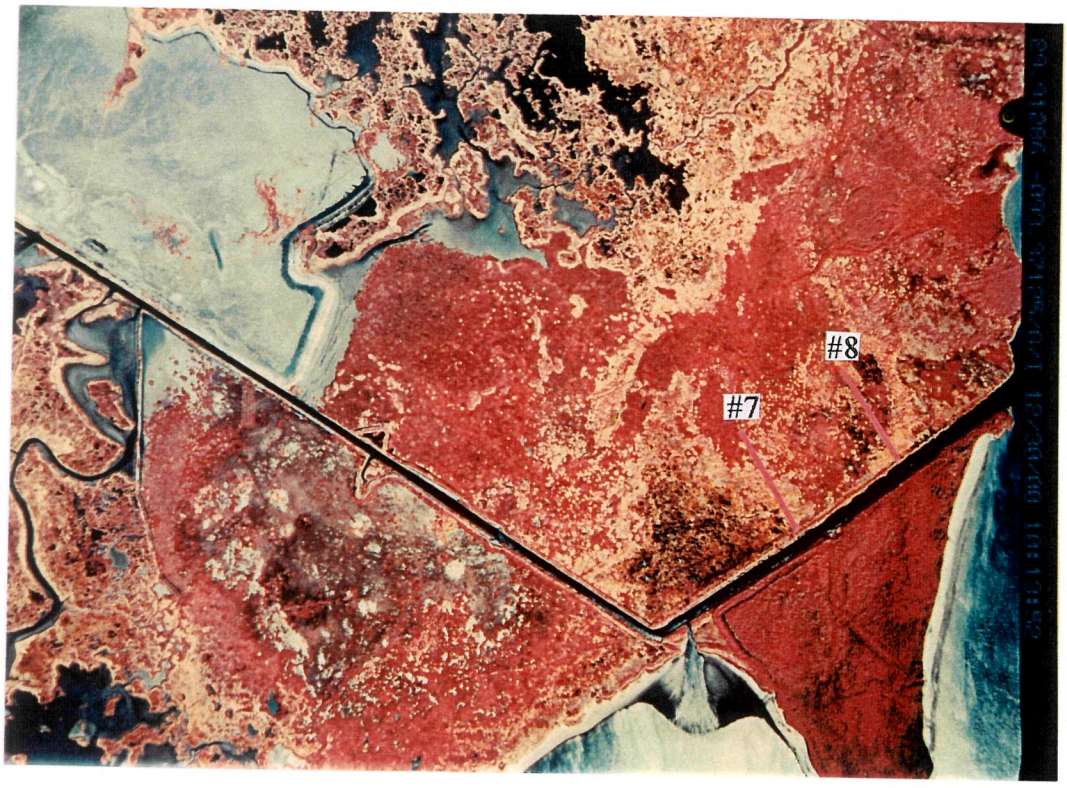

Figure 45. Infrared, vertical aerial photography taken on January 6, 2001 of the Calcasieu River and Pass - SNWR FY 1993 east cell BUMP study area showing the approximate locations of transects #7-8.

Transect #7 - CS7

The Calcasieu - SNWR 1993 east cell, transect #7 is located on the northwest side of West Cove Canal approximately 2,100 ft from the point where the Canal turns to the northeast (Figure 5). The elevation and vegetation data were acquired June 20, 2001. Transect #7 was oriented to cross recent disposal in the area (Figure 4a). The transect was delineated by 1 stake on the dike northwest of West Cove Canal near a rose bush. The waterline of the West Cove Canal had a fringe of *Spartina alterniflora* marsh, and *Borrichia* and *Iva* shrubs hung over the erosional scarp (Figure 46). The dike was well colonized by shrubs, vines and grasses, with an occasional tree. The disposal landscape was dominated by saltmarsh and brackish marsh vegetation, and marsh shrubs (Figures 47-50). The disposal material was made up of fine sand.

The profile had a length of 1935 ft (Figure 51). The maximum relief along the transect was 5.2 ft MLG (4.4 ft NGVD), at the top of the dike, with an average relief of 2.1 ft MLG (1.3 ft NGVD). The average relief of the cell along the transect (not including the dike) was 1.7 ft MLG (0.9 ft NGVD). The published tidal range for Calcasieu River and Pass is 2.8 ft for June 20, 2001.

Figure 46. Photograph taken June 20, 2001 of the waterline at Calcasieu - SNWR FY 1993 east cell, transect #7, along West Cove Canal showing the erosional scarp with overhanging vegetation and the fringing marsh. View is to the northeast.

Figure 47. Photograph taken June 20, 2001 along transect #7 at the Calcasieu - SNWR FY1993 east cell BUMP study site. View is northwest from the instrument, showing the grass and shrubs of the dike, and the Spartina patens marsh in the background.

Figure 48. Photograph taken on June 20, 2001 along transect #7 at the Calcasieu - SNWR FY1993 east cell BUMP study site showing the *Spartina patens* marsh at the dike end of the transect.

Figure 49. Photograph taken June 20, 2001 along transect #7 at the Calcasieu - SNWR FY1993 east cell BUMP study site showing the thick shrub habitat.

Figure 50. Photograph taken on June 20, 2001 along transect #7 at the Calcasieu - SNWR FY1993 east cell BUMP study site showing the *Spartina alterniflora* marsh at the end of the transect. View is to the southeast looking back to the instrument.

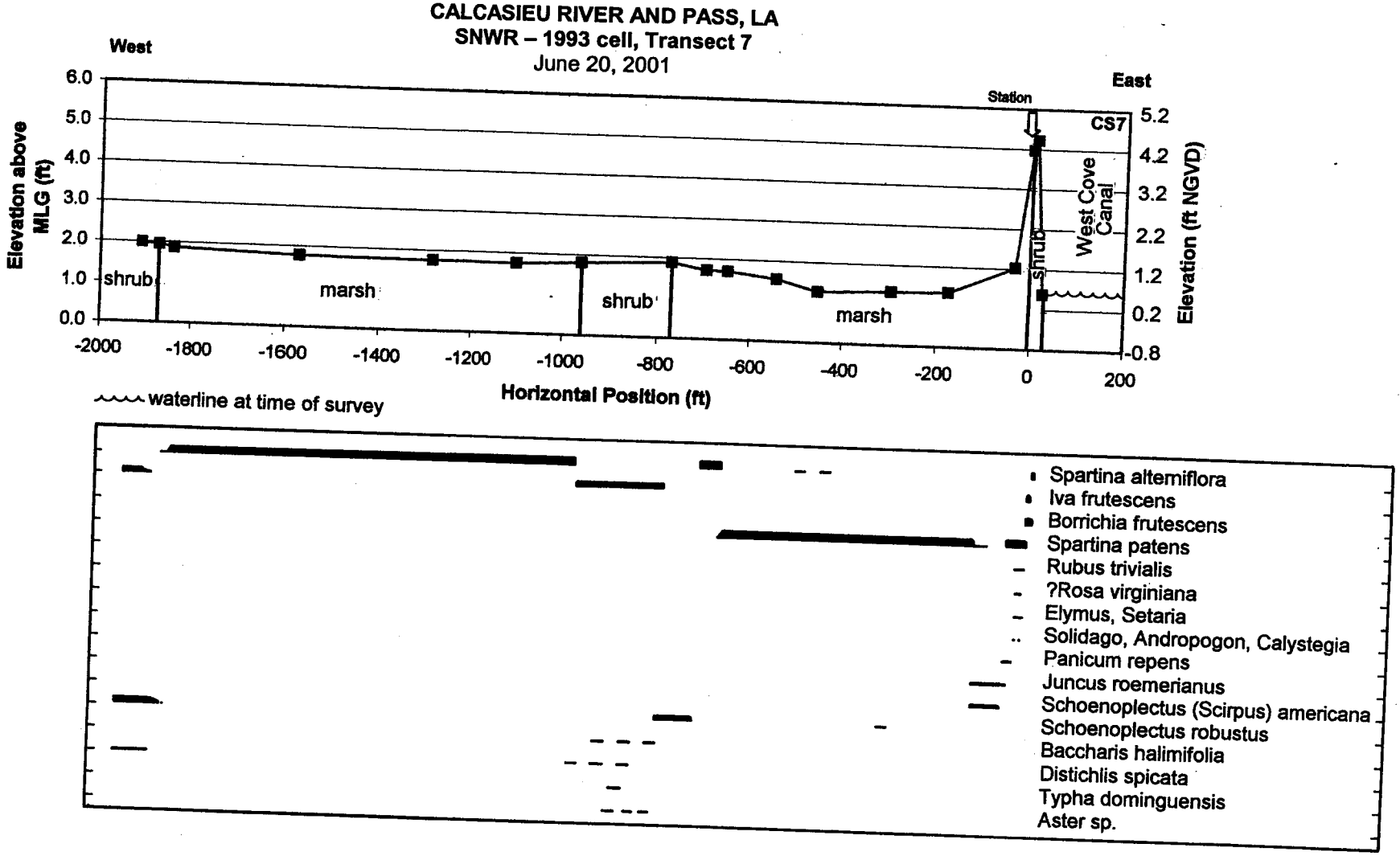

Figure 51. Elevation profile CS7 for transect #7 at the Calcasieu - SNWR FY 1993 east cell BUMP study site with vegetation data illustrated.

Transect #8 - CS8

The Calcasieu - SNWR FY 1993 east cell, transect #8 is located on the northwest side of West Cove Canal approximately 3,500 ft from the point where the Canal turns to the northeast (Figure 5). The elevation and vegetation data were acquired June 21, 2001. Transect #7 was oriented to cross recent disposal in the area (Figure 4a). The transect was delineated by 1 stake on the dike northwest of West Cove Canal just to the north of a toothache tree. The waterline of the West Cove Canal had a fringe of *Spartina alterniflora* marsh, and *Borrichia* and *Iva* shrubs hung over the erosional scarp (Figure 52). The dike was well colonized by shrubs, vines and grasses, with an occasional tree. The disposal landscape was dominated by saltmarsh and brackish marsh vegetation, and marsh shrubs (Figures 53-57). The disposal material was made up of fine sand.

The profile had a length of 2857 ft (Figure 58). The maximum relief along the axis was 4.5 ft MLG (3.7 ft NGVD), at the top of the dike, with an average relief of 0.6 ft MLG (-0.2 ft NGVD). The average relief of the cell along the transect (not including the dike) was 0.4 ft MLG (-0.4 ft NGVD) (Table 1). The published tidal range for Calcasieu River and Pass is 3.1 ft for June 21, 2001.

Figure 52. Photograph taken June 21, 2001 south along transect #8 at the Calcasieu - SNWR FY 1993 east cell, from the dike showing the erosional scarp and the fringing marsh. View is to the northeast.

Figure 53. Photograph taken June 21, 2001 along transect #8 at the Calcasieu - SNWR FY1993 east cell BUMP study site. View is northwest along the transect, showing the well vegetated dike area and a glimpse of the Spartina patens marsh past the shrubs.

Figure 54. Photograph taken on June 21, 2001 along transect #8 at the Calcasieu - SNWR FY1993 east cell BUMP study site showing the dense Spatina patens marsh at the dike end of the transect. View is to the southeast looking back at the instrument.

Figure 55. Photograph taken on June 21, 2001 along transect #8 at the Calcasieu - SNWR FY1993 east cell BUMP study site showing the dense *Iva* thicket along a large part of the transect.

Figure 56. Photograph taken on June 21, 2001 along transect #8 at the Calcasieu - SNWR FY1993 east cell BUMP study site showing the salt marsh with scattered shrubs at the northwest end of the transect.

Figure 57. Photograph taken on June 21, 2001 along transect #8 at the Calcasieu - SNWR FY1993 east cell BUMP study site showing the extensive saltmarsh at the northwest end of the transect.

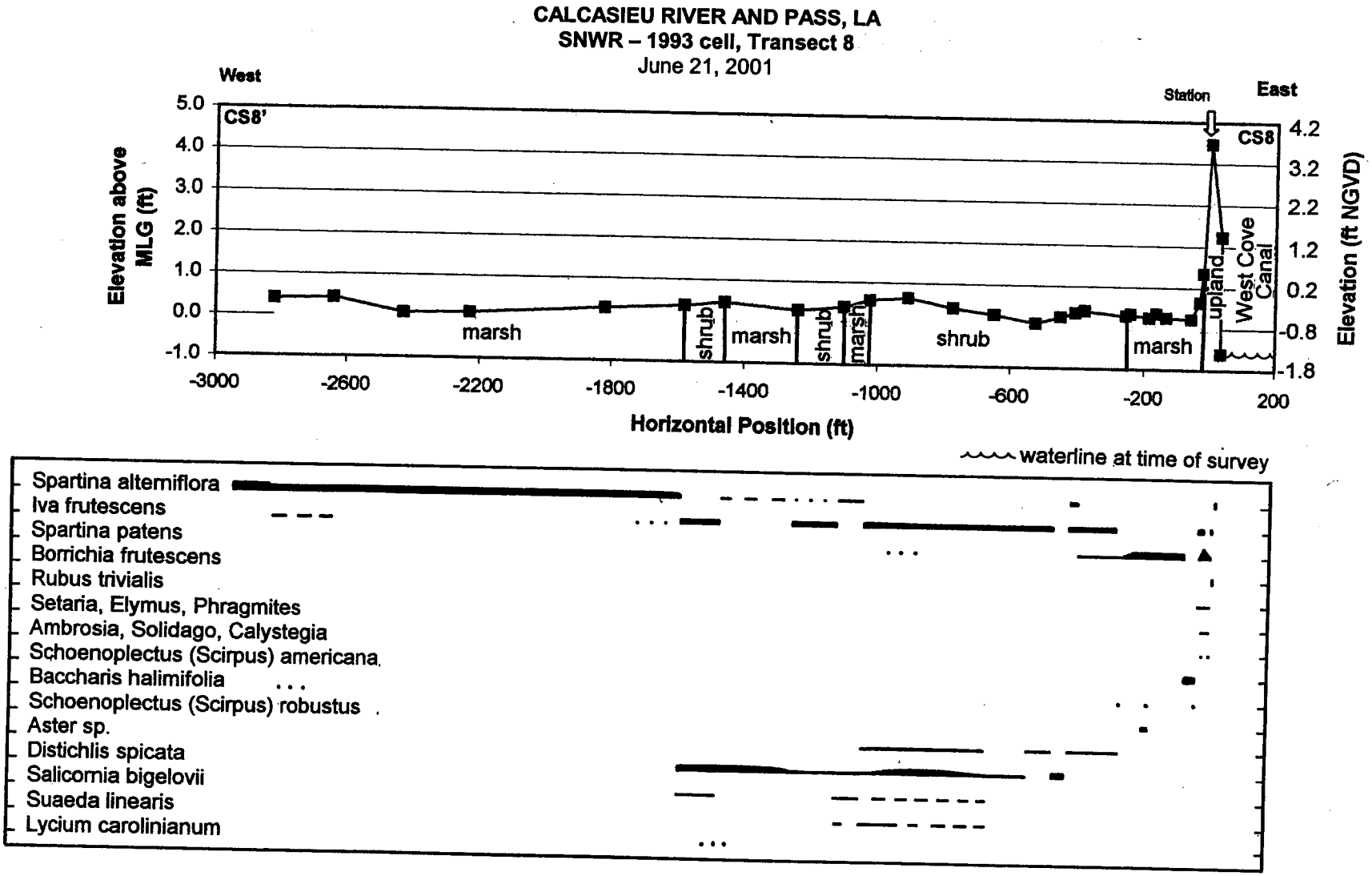

Figure 58. Elevation profile CS8 for transect #8 of the Calcasieu - SNWR FY 1993 east cell BUMP study site with vegetation data illustrated.

Vegetative Character of Calcasieu River and Pass - SNWR study area

General Description

Most of the Calcasieu River and Pass - SNWR topography is the result of extensive saltmarsh altered over time by hydrologic changes induced by oil-related canal dredging and activities, or maintenance of the shipping channel. Much of the saltmarsh has subsided or otherwise degraded. The BUMP study sites, being large areas altered by differing project designs over different time periods, provides an opportunity to compare disposal techniques and practices.

Calcasieu River and Pass is a tidal dominated system acted upon by the salt waters of the Gulf of Mexico, with some riverine influences from Calcasieu River and lacustrine influences from Calcasieu Lake. There is some interaction between the seasonal levels of fresh water of the river and the tidal forces of the Gulf of Mexico. The marshes tend to be brackish or saline.

Vegetative community types

The overall marsh type for this area is salt marsh typified by Oyster grass (*Spartina alterniflora*) and salt grass (*Distichlis spicata*). Stands of black rush *(Juncus roemerianus)* and leafy 3-square *(Scirpus robustus)* also commonly occur. The higher marsh areas typically are occupied by *Spartina patens* and the shrub *Iva frutescens*. These higher marsh areas are the most frequently seen habitats of the naturally occurring marsh in the area, as well as the habitats of the cell created in FY 1993.

The habitats of the cell created in FY 1996 are more complicated. The average elevation of the profile is three-quarters of a foot higher than in the FY 1993 cell (Table 1), and the vegetation is more of a high-marsh type, with composites and salt-flat species such as saltwort (*Salicornia bigelovii*), *Suaeda linearis* and sea ox-eye (*Borrichia frutescens)*. Most of the composites were not in flower at the time of the profiles and could not be identified, but there was no evidence that they were other than high marsh species. This indicates that although low in relief, the area currently is too dry for the *Spartina alterniflora* saltmarsh to develop and is too salt-influenced for expected upland plants to colonize. It is expected that the FY 1996 cell will continue to compact and dewater.

The cell created in FY 1999 is still, for the most part unvegetated. The vegetation that does occur alternates between *Spartina* saltmarsh and *Salicornia* salt-flat. By the average elevation, it is expected that the FY 1999 cell will become similar to the FY 1996 cell as the site compacts, with more high-marsh/salt-flat species toward the canal and saltmarsh along the lower areas to the north. Similar to the FY1996 cell, it is expected that the FY 1999 cell will continue to compact and dewater.

The dike along the FY 1993 east cell was the only area surveyed within the study area that contained trees and true upland species. The trees along the dike were toothache (*Xanthoxylum americana)* and Chinese tallow (*Sapium sebiferum*) trees. The upland shrubs were rose (*Rosa virginiana*) and dewberry (*Rubus trivialis*), and the grasses mixed with the *S. patens* were wild rye (*Elymus virginicus*) and bristle grass (*Setaria geniculata*).

Shoreline Changes of Calcasieu - SNWR: 1985-2000

Figure 59 graphs the spatial history of the Calcasieu - SNWR BUMP study area between December 1985 and December 2000. Table 2 documents the changes and Figure 60 illustrates the changes that took place at Calcasieu - SNWR between 1985 and 2000.

In December 1985, the Calcasieu - SNWR study area was measured at 5,533.4 acres. The study area in December 2000 measured 7,360.7 acres. This is a cumulative area increase of +1,827.3 acres at a rate of +121.8 acres per year for this 15-year period. The total area of the Calcasieu - SNWR BUMP study site increased by 33 percent between 1985 and 2000. There was an overall increase in the area of Calcasieu - SNWR of +997.1 acres in the natural areas. The contribution of BUMP related and other man-made areas accelerated the rate of growth by +830.2 acres. BUMP-made land totaled +973.3 acres in 2000, with +816.4 acres of increase between 1985 and 2000. Other man-made land totaled +13.8 acres, with +13.8 having been created between 1985 and 2000. The BUMP-made habitats accounted for 45 percent of the increase in area of the Calcasieu - SNWR Study area between 1985 and 2000.

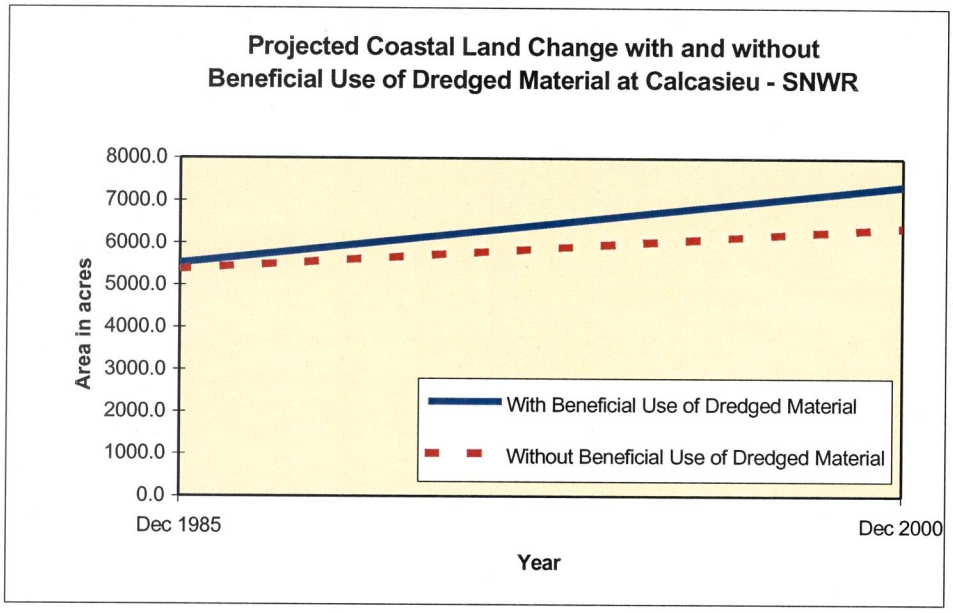

Figure 59. Graph of the area of the Calcasieu - SNWR study area over time, showing the contribution of the beneficial use of dredged material.

TABLE 2
Calcasieu – SNWR Area: 1985-2000

Area (acres)	Dec 1985	Dec 2000	Area Change 1992-2000	Change Rate 1992-2000
Natural Areas	5,376.5	6,373.6	997.1	66.5
Other-made Areas	0.0	13.8	13.8	0.9
BUMP-made Areas	156.9	973.3	816.4	54.4
Total	5,533.4	7,360.7	1,827.3	121.8

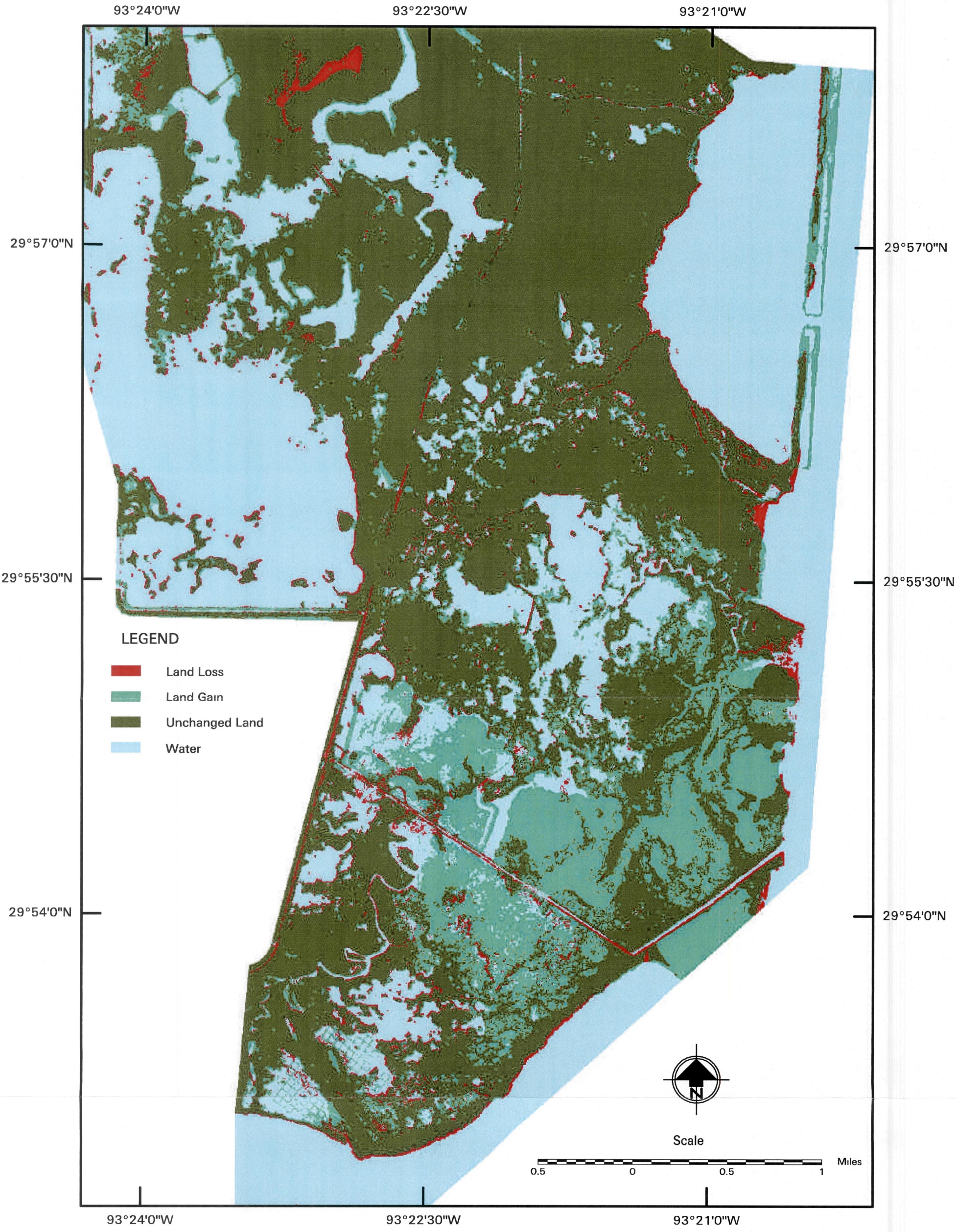

Figure 60 Shoreline changes of the Calcasieu - SNWR BUMP study area between December 1985 and December 2000

Habitat Inventory

The aerial photographic interpretation combined with field surveys identified seven major habitat types in the Calcasieu – SNWR BUMP study area. These habitats are further classified as natural and man-made. The natural class identifies natural processes as responsible for habitat creation. The BUMP man-made (BUMP-made) class identifies the habitats created by the beneficial- placement of dredged material. The non-BUMP man-made class (Other-made) separates areas created that were not related to the beneficial use of dredged material such as areas created in association with the oil industry access and pipeline canals. Disposal materials reworked by natural processes are most often classified as "natural" unless specifically identified by the USACE-NOD as "BUMP-created." On the habitat maps presented in this report, an intertidal class is included to indicate near shore topography. Because the seaward extent of these areas is not clearly defined, the area of this class is not calculated or included in the inventory.

Table 3 lists the areas of the seven habitat types found in the Calcasieu – SNWR BUMP study area in December 1985. The location and arrangement of these habitats is presented in figure 61. The total area of the Calcasieu – SNWR study site was 5,533.4 acres. Of this total, 5,376.5 acres were natural and 156.9 acres were man-made, all of which were BUMP-made and none other-made. Habitats within the BUMP study site were 97.1 percent natural, 2.9 percent BUMP-made and zero percent other-made.

In order of decreasing size and importance, the largest habitats found were natural marsh (4,839.3 acres), natural upland (256.4 acres), and natural bare land (194.1 acres). The largest BUMP-made habitat was marsh (145.2 acres).

In terms of habitat totals, marsh (4,984.5 acres or 90.1%) dominated the Calcasieu – SNWR landscape.

TABLE 3
December 1985 Habitat Inventory of the
Calcasieu – SNWR BUMP Study Area

HABITAT	TOTAL	NATURAL	OTHER-MADE	BUMP-MADE
Marsh	4,984.5	4,839.3	0.0	145.2
Wetland Forest	24.5	24.5	0.0	0.0
Beach	6.3	6.3	0.0	0.0
Bare Land	197.7	194.1	0.0	3.6
Upland	256.4	256.4	0.0	0.0
Shrub/Scrub	63.0	54.9	0.0	8.1
Upland Forest	1.0	1.0	0.0	0.0
Habitat Total	5,533.4	5,376.5	0.0	156.9

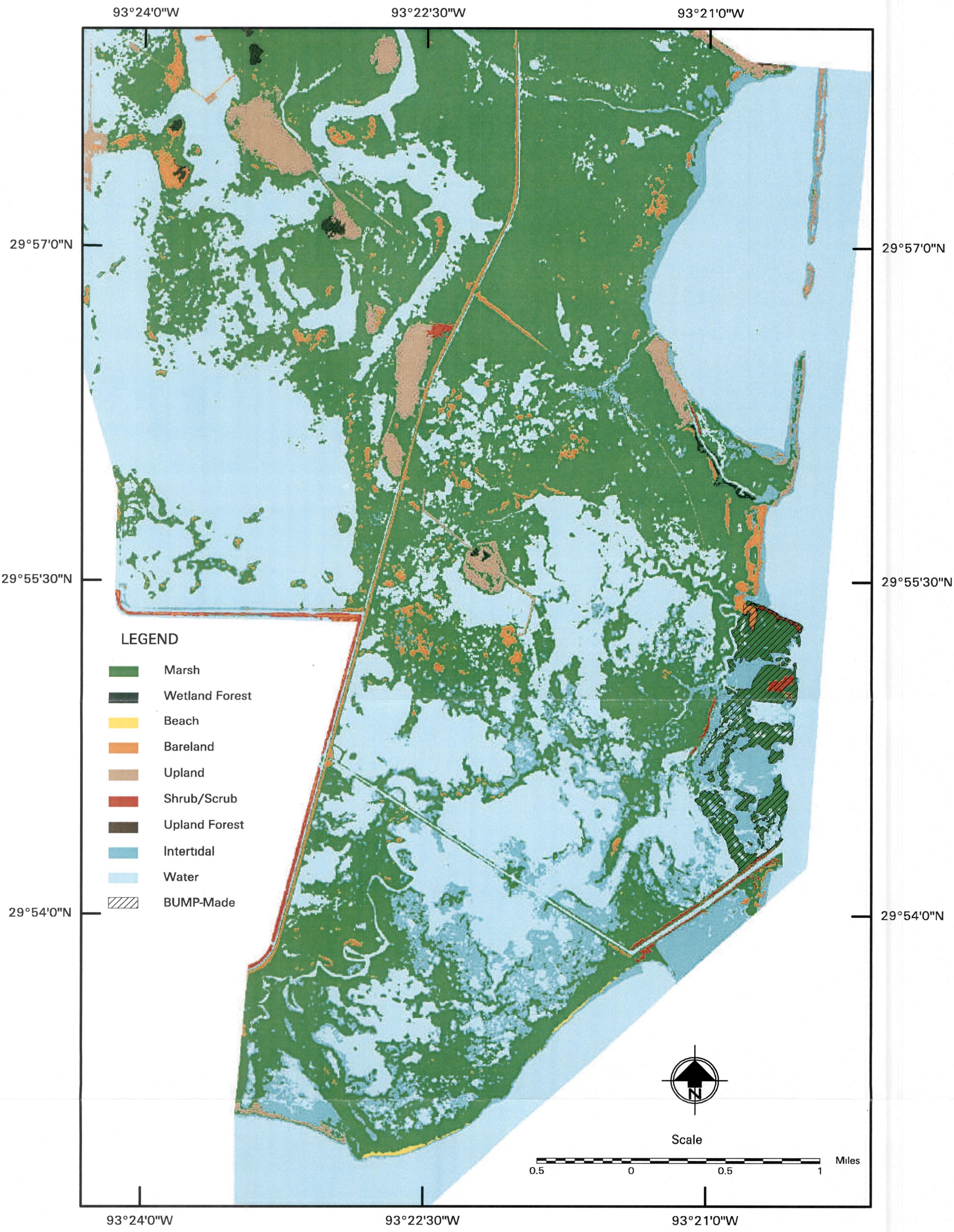

Figure 61 Habitat inventory of the Calcasieu - NWR BUMP study area in December 1985

Table 4 lists the areas of the seven habitats found in the Calcasieu – SNWR BUMP study area in December 2000. The location and arrangement of these habitats is presented in figure 62. In 2000, the total area of the Calcasieu – SNWR BUMP study area was calculated at 7,360.9 acres. Of this total, 6,373.7 acres were natural and 997.1 acres were man-made including 973.4 acres BUMP-made and 13.8 acres other-made. Habitats were 86.6 percent natural, 13.2 percent BUMP-made and less than 0.2 percent other-made.

In order of decreasing size and importance, the largest habitats found were natural marsh (5,673.9 acres) followed by BUMP-made marsh (665.4 acres), natural shrub/scrub (291.1 acres), natural upland (287.9 acres), and BUMP-made bare land (279.63 acres).

In terms of total area, marsh (6,353.1 acres or 86.3%) dominated the landscape of the Calcasieu – SNWR BUMP study area.

TABLE 4
December 2000 Habitat Inventory of the
Calcasieu - SNWR BUMP Study Area

HABITAT	TOTAL	NATURAL	OTHER-MADE	BUMP-MADE
Marsh	6,353.1	5,673.9	13.8	665.4
Wetland Forest	54.9	54.8	0.0	0.1
Beach	2.7	2.3	0.0	0.4
Bare Land	338.6	59.0	0.0	279.6
Upland	287.9	287.9	0.0	0.0
Shrub/Scrub	319.0	291.1	0.0	27.9
Upland Forest	4.7	4.7	0.0	0.0
Habitat Total	7,360.9	6,373.7	13.8	973.4

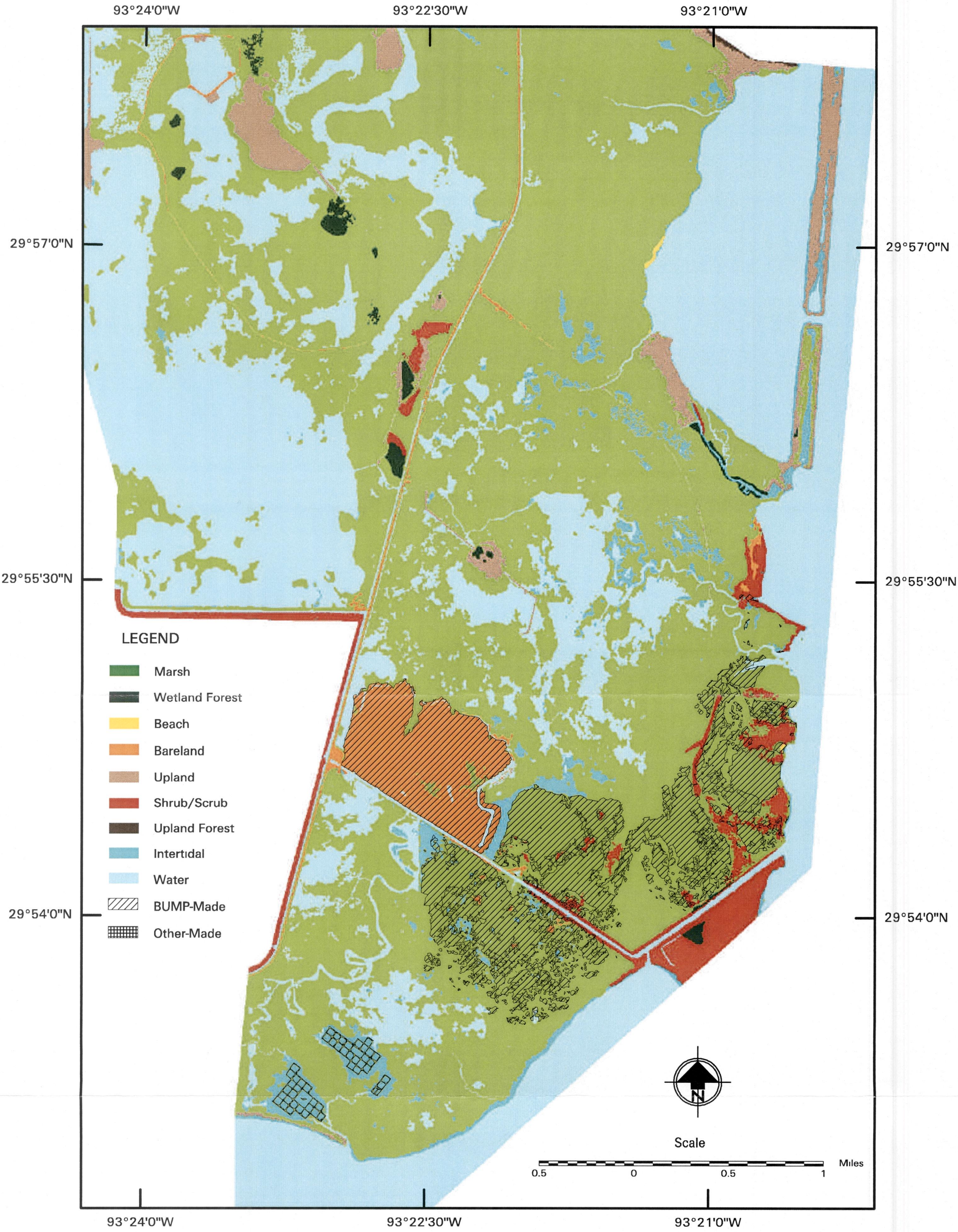

Figure 62 Habitiat inventory of the Calcasieu - SNWR BUMP study area in December 2000

Habitat Change

Figure 63 shows changes over time of the major habitat categories: natural, other-made and BUMP- made. Figure 64 shows the creation of new habitat along the Calcasieu – SNWR BUMP study area by comparing December 1985 and December 2000. Land gain due to natural processes and beneficial use of dredged materials dominates the processes of this area. The total area increased by +1,827.3 acres that represents a +33 percent increase in area between 1985 and 2000. There was an overall increase of +997.0 acres of the natural habitats, an increase of +13.8 acres in other-made habitats, and an increase of +816.5 acres of BUMP-made habitats. Table 5 lists the major habitat changes during the period between December 1985 and December 2000.

The greatest cumulative habitat changes between 1985 and 2000 were the increases of natural marsh (+834.4 acres) and BUMP-made marsh (+520.26 acres). Also, BUMP-made bare land gained 276.0 acres. The overall change in natural and man-made habitats was an increase of +1,827.3 acres.

Figure 65 shows a time series of habitat changes along the Calcasieu - SNWR BUMP study area. Figure 65A graphs the natural habitat changes over time. Natural land building and erosion dominates the processes affecting the natural habitat class. Figure 65B graphs the other-made habitat changes over time. Marsh and bare land creation by beneficial use of dredged material dominates the man-made class. Figure 65C graphs the BUMP-made changes over time.

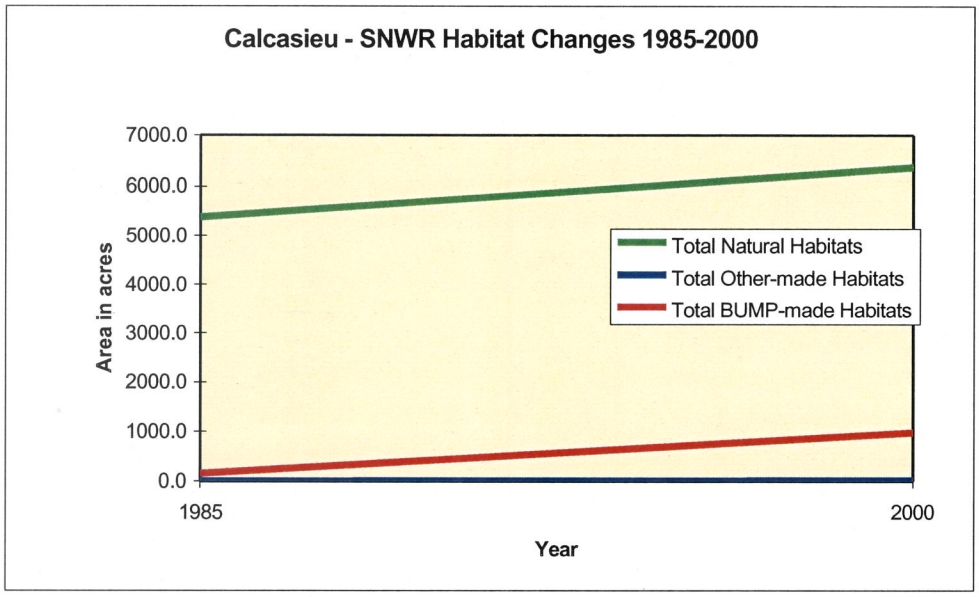

Figure 63. Graph showing the relative change in total area of the major habitat categories: natural, other-made, and BUMP-made, between 1985 and 2000.

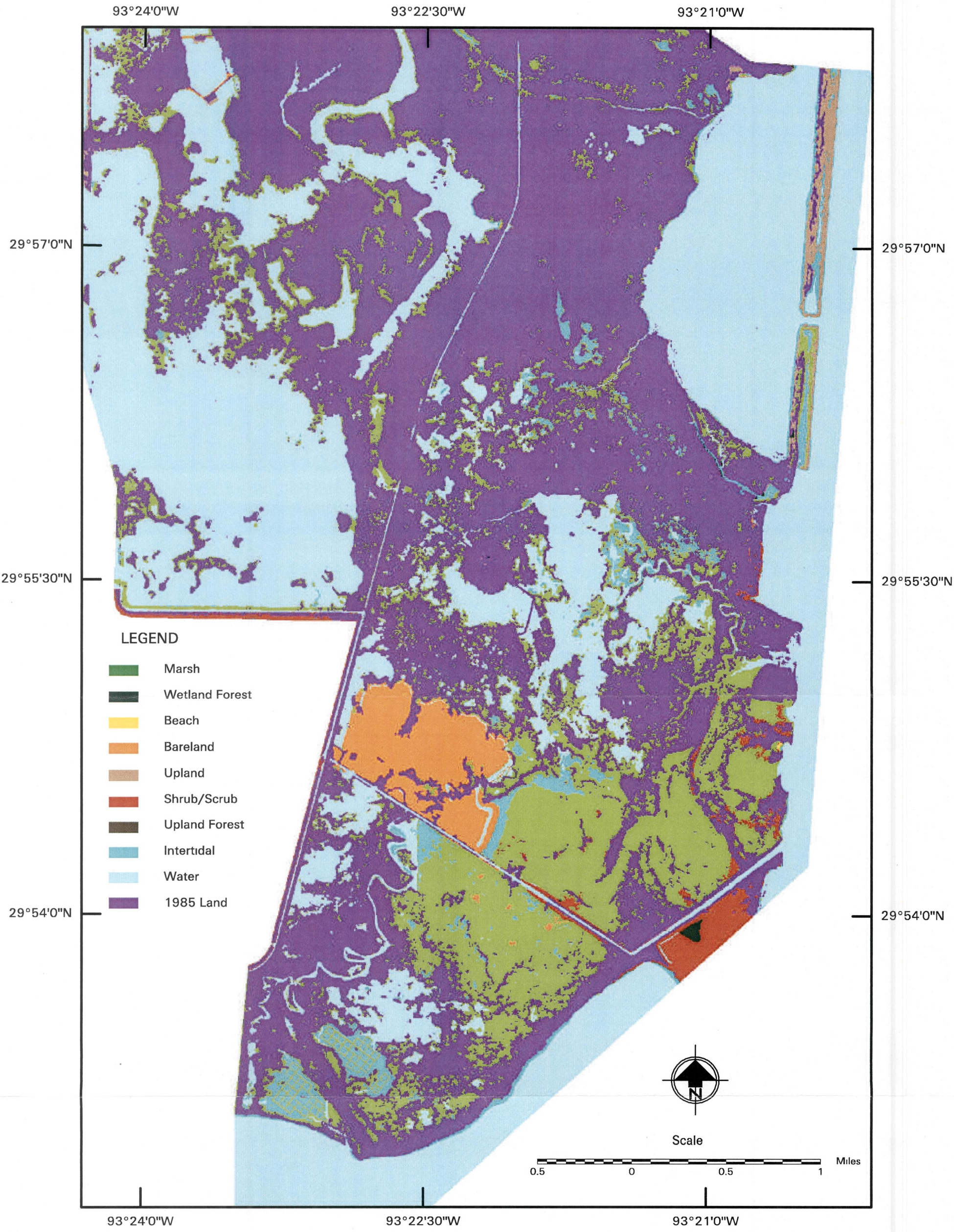

Figure 64 Map of the Calcasieu - Sabine BUMP study area showing the new habitats created between December 1985 and December 2000

TABLE 5
Cumulative Change in Total Area of each Habitat
in the Calcasieu - SNWR Study Area between 1985 and 2000[1]

HABITAT	Dec 1985	Dec 2000	AREA CHANGE
Natural Marsh	4,839.5	5,673.9	834.4
Natural Wetland Forest	24.5	54.8	30.3
Natural Beach	6.3	2.3	-4.0
Natural Bare Land	194.1	59.0	-135.1
Natural Upland	256.4	287.9	31.5
Natural Shrub/Scrub	54.9	291.1	236.2
Natural Upland Forest	1.0	4.7	3.7
Total Natural Habitats	5,376.5	6,373.7	997.0
Other-made Marsh	0.0	13.8	13.8
Other-made Wetland Forest	0.0	0.0	0.0
Other-made Beach	0.0	0.0	0.0
Other-made Bare Land	0.0	0.0	0.0
Other-made Upland	0.0	0.0	0.0
Other-made Shrub/Scrub	0.0	0.0	0.0
Other-made Upland Forest	0.0	0.0	0.0
Total Other-made Habitats	0.0	13.8	13.8
BUMP-made Marsh	145.2	665.4	520.2
BUMP-made Wetland Forest	0.0	0.1	0.1
BUMP-made Beach	0.0	0.4	0.4
BUMP-made Bare Land	3.6	279.6	276.0
BUMP-made Upland	0.0	0.0	0.0
BUMP-made Shrub/Scrub	8.1	27.9	19.8
BUMP-made Upland Forest	0.0	0.0	0.0
Total BUMP-made Habitats	156.9	973.4	816.5
HABITAT TOTAL	5,533.4	7,360.9	1,827.3

[1] in acres

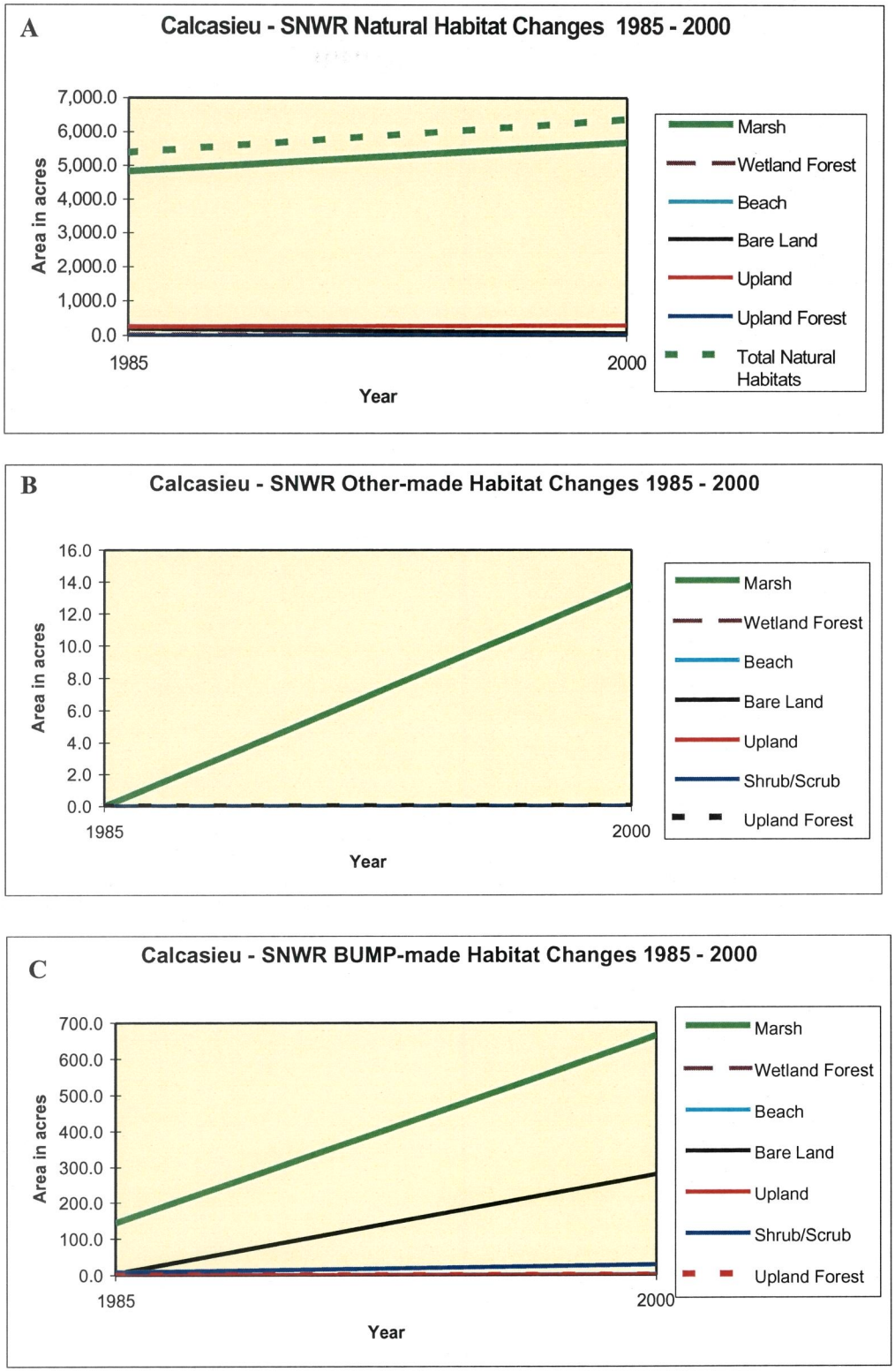

Figure 65 Time series showing the changes in total area of each habitat in the Calcasieu - SNWR BUMP study area between December 1985 and December 2000. A) natural habitat changes. B) Other-made habitat changes. C) BUMP-made habitat changes.

CALCASIEU RIVER AND PASS - BROWN LAKE FIELD SURVEY RESULTS

The Brown Lake BUMP study site is located on the west side of Calcasieu Lake, between highway 27 to the east and Alkali Canal to the west, just south of the Intracoastal Waterway (Figure 66). The area once was a small lake within an expanse of saltmarsh. The lake expanded over time as the saltmarsh degraded and disappeared to form a rather large expanse of shallow open water. The land that is left is of very low relief and low elevation, dominated by marsh and shrubs, and by a maze of canals and narrow ridges lined with trees and upland habitats with fringing marsh. The BUMP study sites are in the form of rectangular cells enclosed by dikes with interconnecting overflow channels. All material was placed confined, but allowed to flow between the interconnected cells as each was filled. There are two separate sets of these cells: the eastern one contains 5 cells labeled 1-5, and the western set contains 4 larger cells A-D (Figure 66).

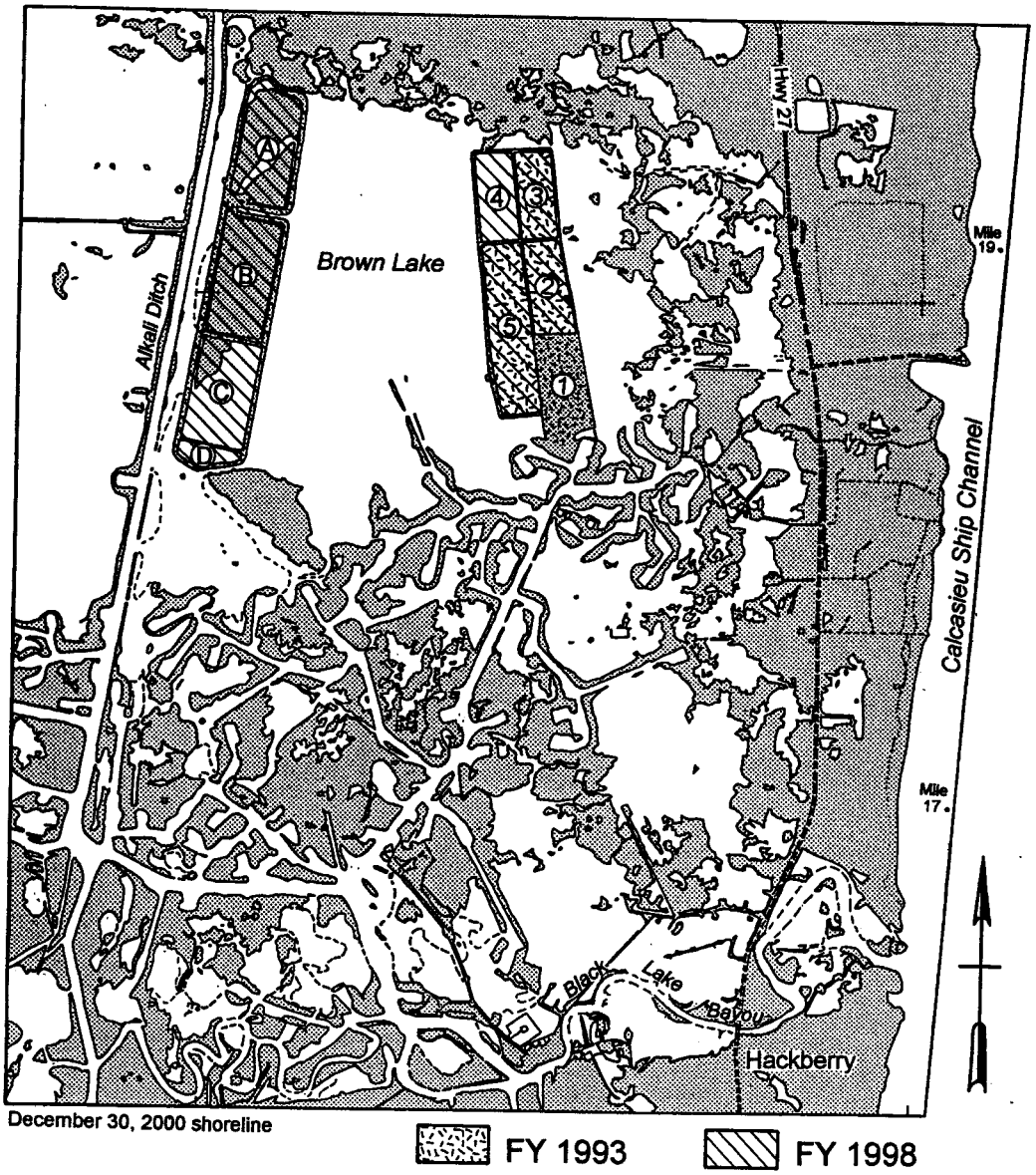

Figure 66. A location map and dredged material disposal history for the Calcasieu River and Pass, Louisiana - Brown Lake BUMP study area.

Methodology

The collection of elevation and vegetation profile surveys was conducted in two phases. Phase-I involved assessing the characteristics of various beneficial use disposal areas to determine the most appropriate sites to document the beneficial use of dredged material and habitat development. This was accomplished in 2001 by discussion with the USACE-NOD, reviewing vertical aerial photography, and reviewing dredging schedules and history. Based on these factors, transects across the lengths of each cell were selected (Figure 67).

Phase-II involved the actual collection of profile data. Access was by boat from a boat launch on the Intracoastal Waterway, next to Highway 87, and through a maze of oil field canals. On June 21, 2001, at the eastern Brown Lake site, one stake was placed centrally located on the top of the dike between cells 1 & 2 and between 4 & 5 to define the transect lines. On July 17, 2001, at the western Brown Lake site, one stake was placed centrally located on the top of the dike north of "Cell B" to define the transect lines. Permanent 1-inch diameter by 6-foot galvanized stakes were buried approximately 1-foot in the sediment and secured with concrete.

Survey data were collected using a Topcon GTS-300_{DPG} Total-Station, tri-prism, and TDS48 Data Collection System. Horizontal accuracy of the GTS-300 is 0.25 ft Å 0.0125 ft., with a vertical accuracy of 0.45 ft Å 0.0125 ft. The maximum horizontal range with tri-prism is 3,525 ft. A Pathfinder Professional MC-5 global positioning system (GPS) device was used to record the horizontal positions of each stake, instrument location, and the position and exact orientation of each transect line. The transect data collected were processed, referenced to the local tide gage, and entered into a graphic software program to produce topographic profiles.

The topographic profiles for the study area were constructed in reference to Micronautics Tide Table – Calcasieu Pass. The mean diurnal tidal range for the Calcasieu River and Pass BUMP study area is published as 2.0 ft.

Field monitoring for vegetative species composition and habitat verification was done in June, 2001. Species composition was determined within a six-foot swath along each profile, and major divisions between vegetative communities were entered as points on the elevation profile. No submerged aquatic species were considered for this report. Plants were identified in the field, with only representative specimens taken for confirmation by taxonomic keys and/or verification by the LSU Department of Plant Biology. The better specimens and uncommon specimens were entered into the LSU herbarium collection; all others were archived by the contractor. The percent composition of each species was visually estimated in order to determine the relative abundance and dominance of species for habitat determinations. These percentages were not intended to provide scientific ratios or statistics.

The species list included on the profiles and in the Appendix of this report is not complete; it reflects only those species that were readily observed during the profiling period. Some plants can only be identified during a short flowering period which may not have coincided with the ground truthing or the profile data collection, and therefore can not be included in the list other than by a broad classification.

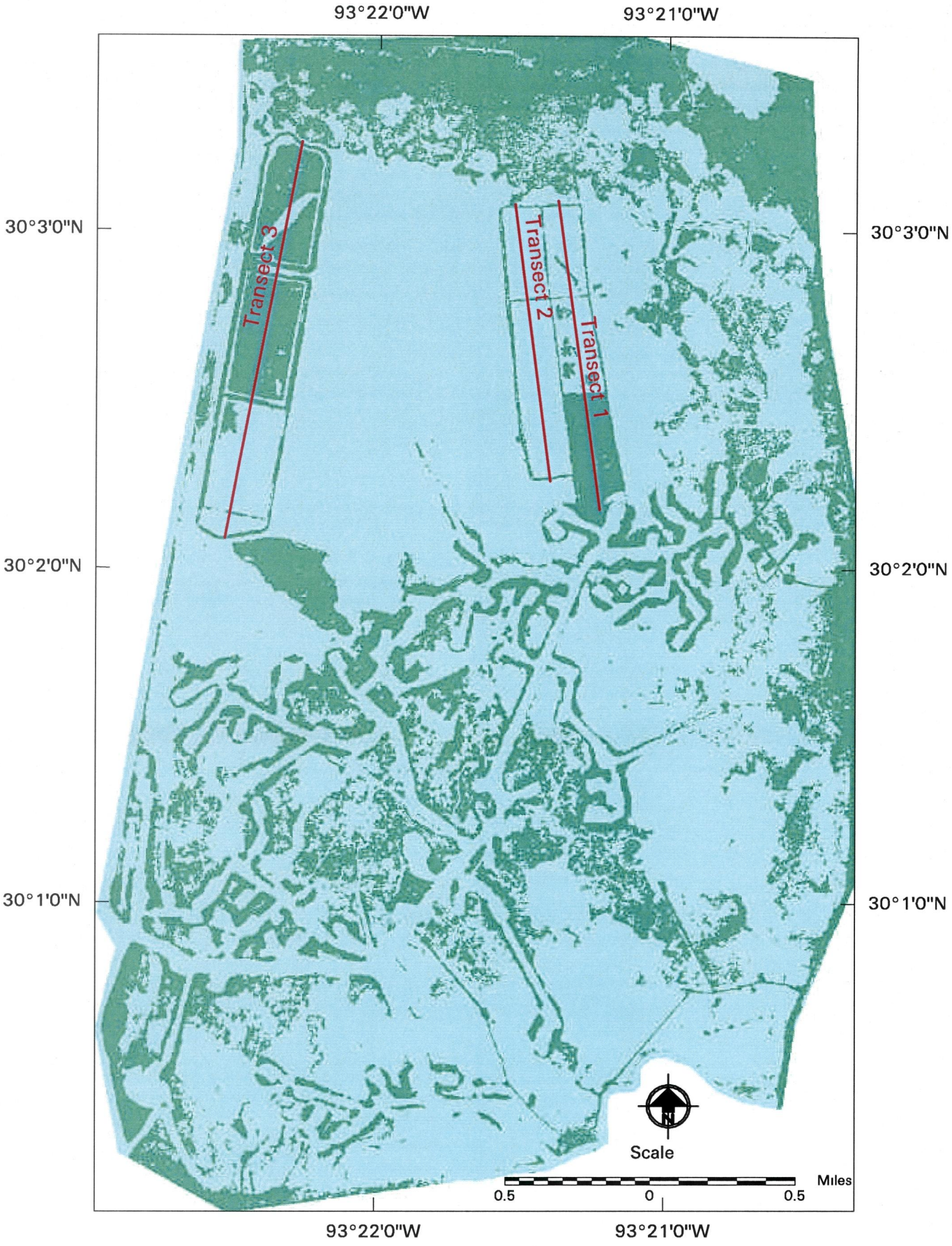

Figure 67 Location of the three elevation and vegetation transects at the Calcasieu -Brown Lake BUMP study area

Profiles at Calcasieu - Brown Lake

The 2001 profiles were established with one metal pole (stake) on the top of a dike between two of the cells, partially buried and anchored with concrete, and extending 2-3 feet from the sediment surface. Transects were constructed parallel to the orientation of long sides of the rectangular cells, approximately down the middle. Two transects were recorded at the eastern site and one at the western site (Figure 67). The dike around each cell was constructed leaving a borrow ditch within each cell that had to be crossed with varying degrees of difficulty (Figure 68). The sediment was extremely soft at the lower elevations of some of the cells and profile data could only be acquired where the "rod man" was not in danger.

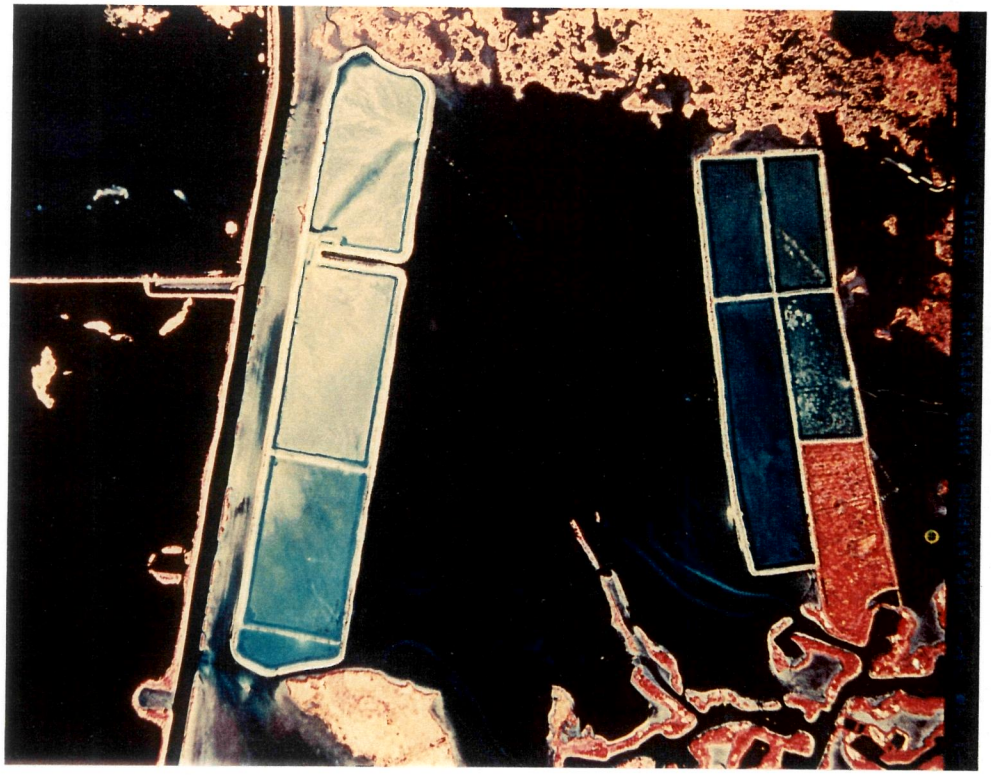

Figure 68. Infrared, vertical aerial photography taken on December 30, 2000 of the Calcasieu River and Pass - eastern Brown Lake BUMP study area.

Calcasieu - eastern Brown Lake - Transect #1 (Cells 1-3)

The Calcasieu - Brown Lake eastern site was the first site to be constructed, and the first beneficial use disposal was in FY 1993 (Figure 66). The stake was placed approximately midway along the dike between cells 1 and 2 (Figure 69), and the transect was oriented roughly north-south. The dike at the south end of the transect was attached to an older canal ridge and was colonized by toothache and tamarisk trees and a variety of upland and upper marsh species (Figure 70). The borrow ditch at the south end was 1.5 ft deep in water, had extremely soft sediment and was difficult to cross (Figure 71). Cell 1 was well vegetated by saltmarsh throughout (Figure 72). Dredged material was placed within cells 2 and 3 to the north of cell 1 in FY 1998 and were bare land at the time of the transect. Cells 2 and 3 are being colonized by salt-flat and saltmarsh vegetation, and will probably become salt marsh (Figure 73).

The profile had a length of 5677 ft (Figure 74). The maximum relief along the transect was 8.8 ft MLG (8.0 ft NGVD), at the location of the stake on the dike between cells 1 and 2, with an average relief of 3.3 ft MLG (2.5 ft NGVD) over the entire line. The average relief of the disposal material within the cells, not including the dikes or outside areas, is shown in Table 6. Cell 1 averaged 2.2 ft MLG, Cell 2 averaged 3.0 ft MLG and Cell 3 averaged 4.0 ft MLG; for an average substrate elevation of 3.1 ft MLG. The published tidal range for Calcasieu River and Pass is 3.1 ft for June 21, 2001.

Figure 69. Photograph taken June 21, 2001 at the Calcasieu - Brown Lake BUMP study site of the instrument placed on the dike between cells 1 and 2. View is to the east along the dike, showing the well vegetated Cell 1 on the right and the bare Cell 2 with borrow ditch on the left.

Figure 70. Photograph taken June 21, 2001 along transect #1 at the Calcasieu - Brown Lake BUMP study site. View is to the east along the older canal ridge that serves as the south dike of cell 1, showing upland species and trees.

Figure 71. Photograph taken June 21, 2001 along transect #1 at the Calcasieu - Brown Lake BUMP study site. View is to the north along the transect from the older canal ridge to the instrument on the far dike, showing the water-filled borrow ditch and saltmarsh.

Figure 72. Photograph taken June 21, 2001 along transect #1 at the Calcasieu - Brown Lake BUMP study site. View is from the instrument on the dike to the south along transect #1 showing the thick saltmarsh throughout cell 1.

Figure 73. Photograph taken June 21, 2001 along transect #1 at the Calcasieu - Brown Lake BUMP study site. View is to the north along the transect showing the bare land habitat of cells #2 and #3.

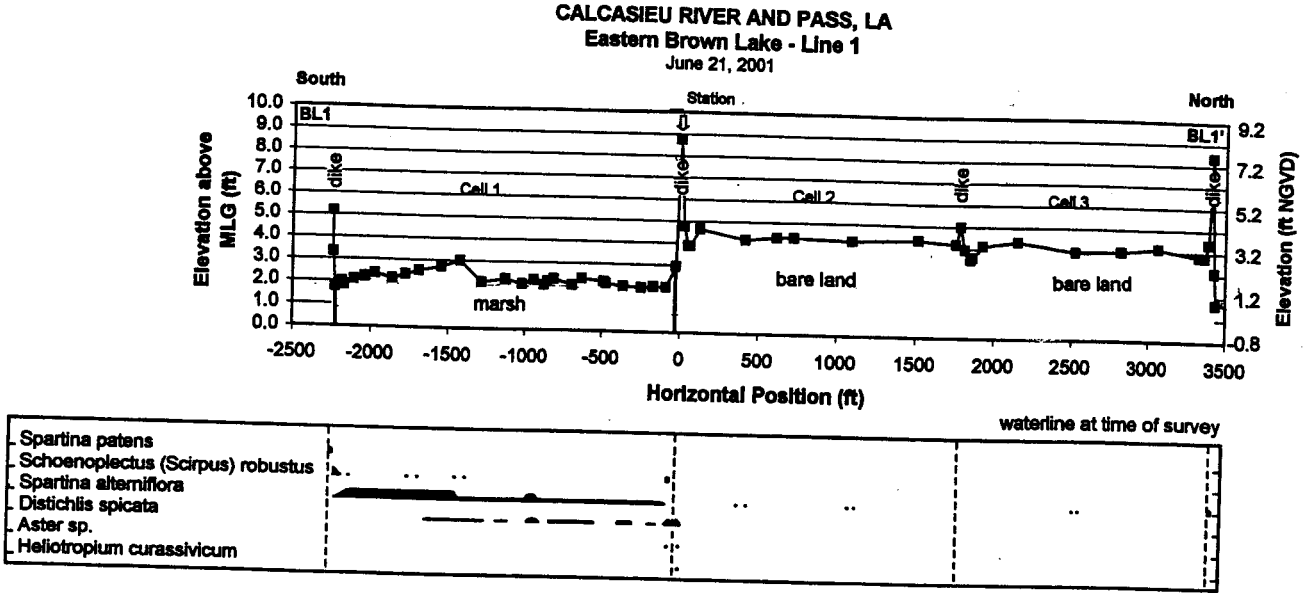

Figure 74. Elevation profile BL1 for transect #1 through cells 1-3 of the eastern Calcasieu - Brown Lake BUMP study site with vegetation data illustrated.

TABLE 6
Average elevation of Transects and Disposal Cells for the Calcasieu - Brown Lake BUMP Study Area (ft MLG)

Transect/Cell	Average Elevation of Cells including dikes	Average Elevation of Disposal Material (exc. dikes)
East Cell #1	2.56	2.24
East Cell #2	4.71	3.00
East Cell #3	4.11	3.95
East Cells; Transect Line 1	3.29	3.06
East Cell #4	4.19	3.57
East Cell #5	3.85	2.68
East Cells; Transect Line 2	3.82	3.13
West Cell A	3.98	3.41
West Cell B	3.04	2.55
West Cell C	2.32	2.04
West Cell D	2.97	1.81
West Cells; Line 3	3.09	2.45

Calcasieu - eastern Brown Lake - Transect #2 (Cells 4-5)

Cells 4 and 5 lie to the west and adjacent to cells 1-3. Dredged material was placed within cells 4 and 5 in FY 1998. The stake was placed approximately midway along the dike between cells 4 and 5 (Figure 75). The area remained predominantly bare land at the time of the transect, but was being colonized by salt-flat and saltmarsh vegetation, and will probably become salt marsh (Figures 76 & 77). The dikes were being colonized by shrubs and grasses. The southern extent of cell 5 was covered by a few inches of water at the time of the survey, and saltmarsh was observed to be colonizing in random patterns (Figure 78).

The profile had a length of 4988 ft (Figure 79). The maximum relief along the axis was 8.2 ft MLG (7.4 ft NGVD), at the location of the stake on the dike between cells 4 and 5, with an average relief of 3.8 ft MLG (3.0 ft NGVD) over the entire line. The average relief of the disposal material within the cells, not including the dikes or outside areas, is shown in Table 6. Cell 4 averaged 3.6 ft MLG and Cell 5 averaged 2.7 ft MLG; for an average disposal substrate elevation of 3.1 ft MLG. The published tidal range for Calcasieu River and Pass is 3.1 ft for June 21, 2001.

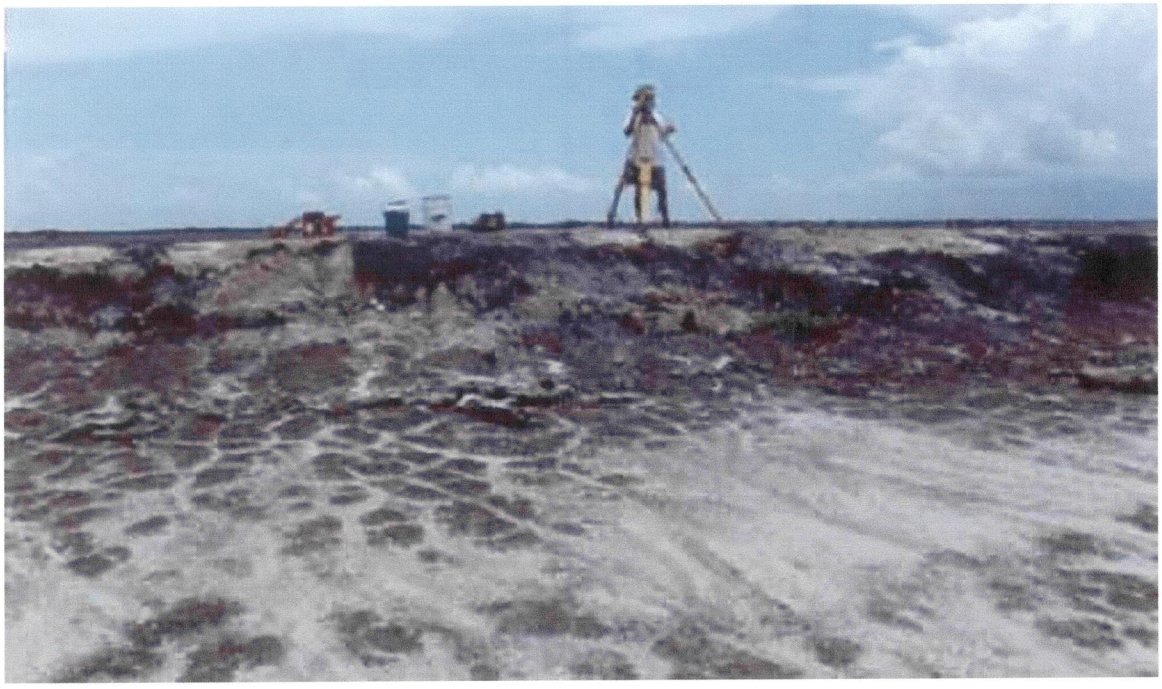

Figure 75. Photograph taken June 21, 2001 of the instrument on the dike between Cells 4 and 5 along transect #2 at the Calcasieu - Brown Lake BUMP study site. View is to the south.

Figure 76. Photograph taken June 21, 2001 along transect #2 at the Calcasieu - Brown Lake BUMP study site. View is to the north along the transect from the stake across cell 4, showing the extent and character of the bare land.

Figure 77. Photograph taken June 21, 2001 along transect #2 at the Calcasieu - Brown Lake BUMP study site. View is to the south along the transect from the stake across cell 5, showing the extent and character of the bare land.

Figure 78. Photograph taken June 21, 2001 of the southern part of cell 5 at the southern reach of transect #2 at the Calcasieu - Brown Lake BUMP study site. View is to the west across cell 5, showing the shallow water (notice wading birds) and colonizing saltmarsh.

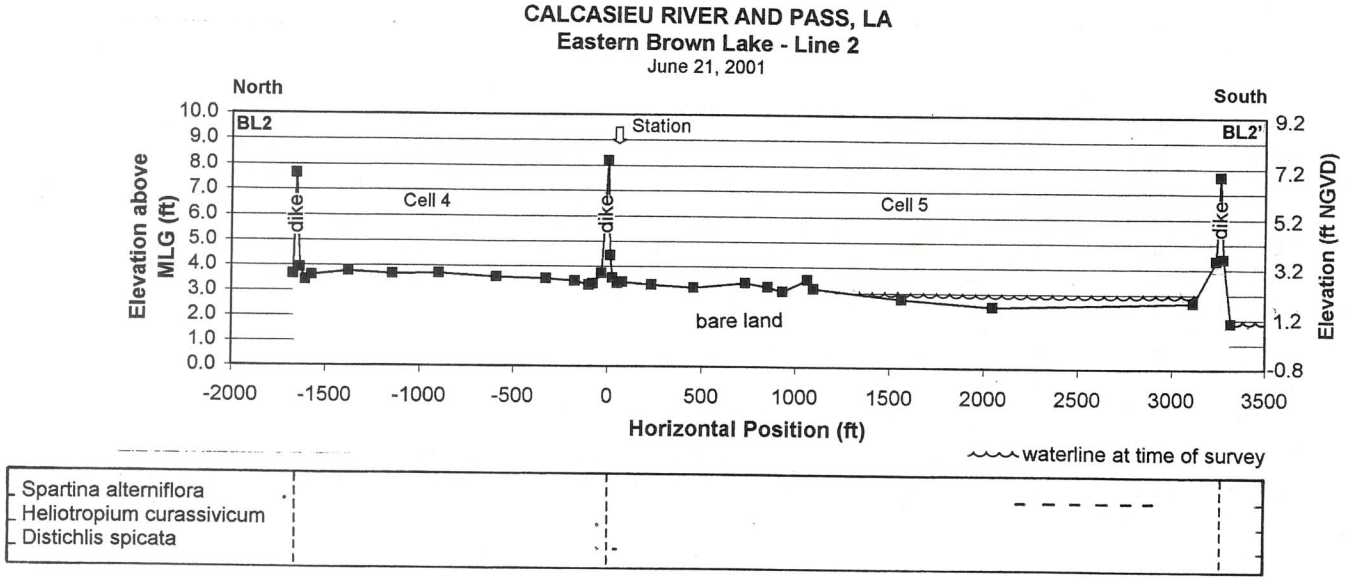

Figure 79. Elevation profile BL2 for transect #2 across cells 4-5 of the eastern Calcasieu - Brown Lake BUMP study site with vegetation data illustrated.

Calcasieu - western Brown Lake - Transect #3 (Cells A-D)

The Calcasieu - Brown Lake western site was the second site to be constructed, and the first beneficial use disposal was in FY 1998 (Figure 65). All disposal in the study site was confined but allowed to flow into adjacent cells (Figure 66). The stake was placed in on the dike north of cell B approximately centered across the cell, with Transect 3 oriented roughly north-south across the length of the disposal area. The area remains predominantly bare land, but is being colonized by salt-flat and saltmarsh vegetation, and will probably become salt marsh. The borrow ditch was extremely soft sediment and was difficult to cross.

The profile had a length of 7164 ft (Figure 80). The maximum relief along the axis was 8.7 ft MLG (7.9 ft NGVD), at the dike on the south end of the disposal area, with an average relief of 3.1 ft MLG (2.3 ft NGVD) over the entire line. The average relief of the disposal material within the cells, not including the dikes or outside areas, is shown in Table 6. Cell A averaged 3.4 ft MLG, Cell B averaged 2.6 ft MLG, Cell C averaged 2.0 ft MLG, and Cell D averaged 1.8 ft MLG; for an average disposal substrate elevation of 2.5 ft MLG. The published tidal range for Calcasieu River and Pass is 3.1 ft for July 17, 2001.

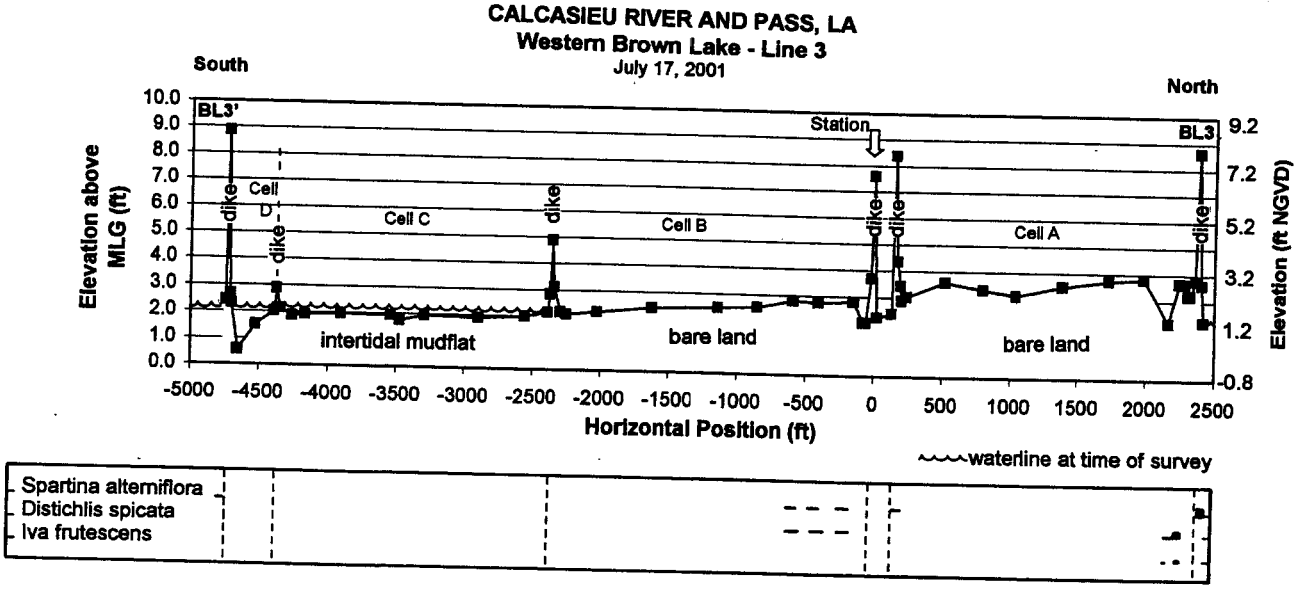

Figure 80. Elevation profile BL3 for transect #3 across cells A-D of the western Calcasieu - Brown Lake BUMP study site with vegetation data illustrated.

Vegetative Character of the Calcasieu - Brown Lake BUMP study area

General Description

The Calcasieu Brown Lake BUMP study area is a tidal dominated system that is subjected to flood and tidal forces. There is a some interaction between the seasonal levels of fresh water of the river and the tidal forces of the Gulf of Mexico. The marshes are saline. The area is within a producing oil field and is affected by oil industry activities and traffic. The study area once held small lake named Brown Lake within an expanse of saltmarsh. The lake expanded over time as the saltmarsh degraded and disappeared to form a rather large expanse of shallow open water. The current landscape is of very low relief and low elevation, dominated by marsh and shrubs, and by a maze of canals and narrow ridges lined with trees and upland habitats with fringing marsh.

The BUMP study sites are within the Brown Lake shallow water area and are in the form of rectangular cells enclosed by dikes with interconnecting overflow channels. All land and habitats within the dikes were created by BUMP. All material was placed confined, but allowed to flow between the interconnected cells as each was filled.

Vegetative community types

The overall marsh type for this area is salt marsh typified by oyster grass (*Spartina alterniflora*), salt grass (*Distichlis spicata*), bulrush (*Scirpus robustus*), and black rush (*Juncus roemerianus*).

The upland on the top of the dikes was represented mostly by Bermuda grass (*Cynodon dactylon*), with a few other grass and composite species present. The older ridge forming the south dike of the eastern site also held dewberry, honeysuckle, a multitude of grasses, goldenrod *(Solidago* sp.), and other composites.

The forest habitat occurred along the older ridge and was represented by toothache trees (*Xanthoxylum americana*), tamarisk trees (*Tamarix chiensis*), and yaupon (*Ilex vomitoria*).

Shrub/scrub habitats occurred along the dikes of the study area and were represented by small versions of the trees mentioned above plus the yellow rattlebox (*Sesbania drummondii*), groundsel bush (*Baccharis halimifolia*), lantana (*Lantana camara*), Elderberry (*Sambucus canadensis*), and marsh elder (*Iva frutescens*).

GIS ANALYSIS RESULTS FOR THE CALCASIEU - BROWN LAKE BUMP STUDY AREA

Shoreline Changes of Calcasieu – Brown Lake: 1992-2000

Figure 81 graphs the spatial history of the Calcasieu – Brown Lake BUMP study area between December 1992 and December 2000. Table 7 documents the changes and Figure 82 illustrates the changes that took place at Calcasieu – Brown Lake between 1992 and 2000.

In December 1992, the Calcasieu – Brown Lake BUMP study area was measured at 2,413.3 acres. The study area in December 2000 measured 1,769.5 acres. This is a cumulative area decrease of –643.7 acres at a rate of –80.5 acres per year for this 8 year period. The total area of the Calcasieu – Brown Lake BUMP study site decreased by –26.7 percent between 1992 and 2000. There was an overall decrease in the natural areas of Calcasieu – Brown Lake by –868.9 acres. The contribution of BUMP related and other man-made areas accelerated the rate of growth by +225.2 acres. BUMP-made land totaled 189.3 acres in 2000 and other man- made land totaled 35.9 acres.

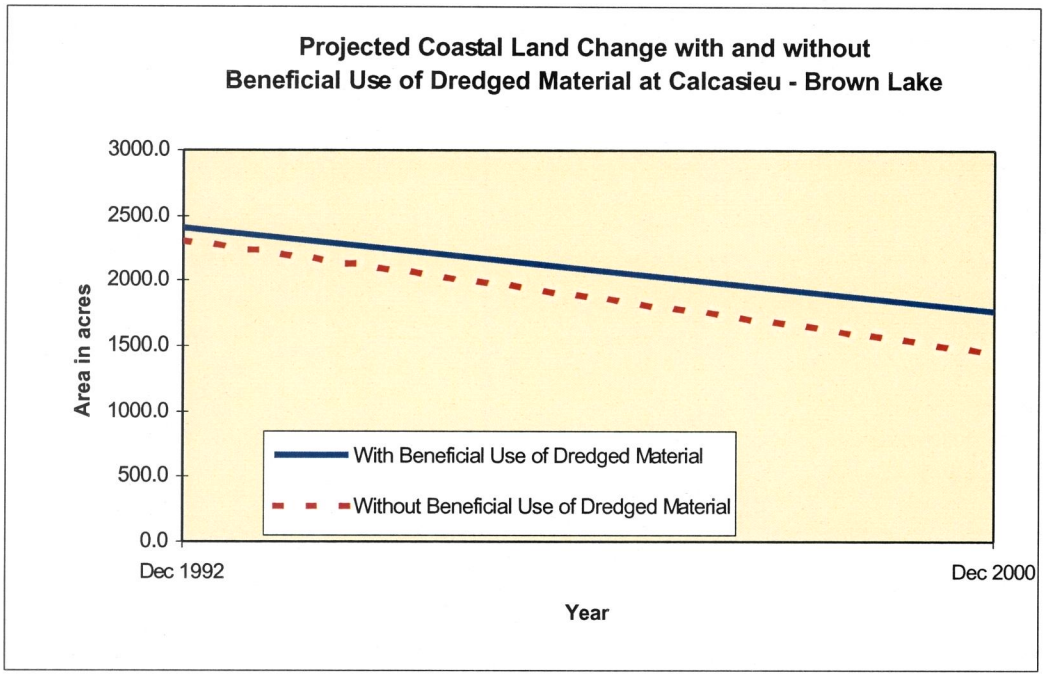

Figure 81. Graph of the area of the Calcasieu- Brown Lake BUMP study area over time, showing the contribution of the beneficial use of dredged material.

TABLE 7
Calcasieu – Brown Lake Area: 1992-2000

Area in acres	Dec 1985	Dec 2000	Area Change 1992-2000	Change Rate 1992-2000
Natural Areas	2,317.8	1,448.9	-868.9	-108.6
Other Man-made Areas	95.5	131.4	35.9	4.5
BUMP-made Areas	0.0	189.3	189.3	23.7
Total	2,413.3	1,769.6	-643.7	-80.5

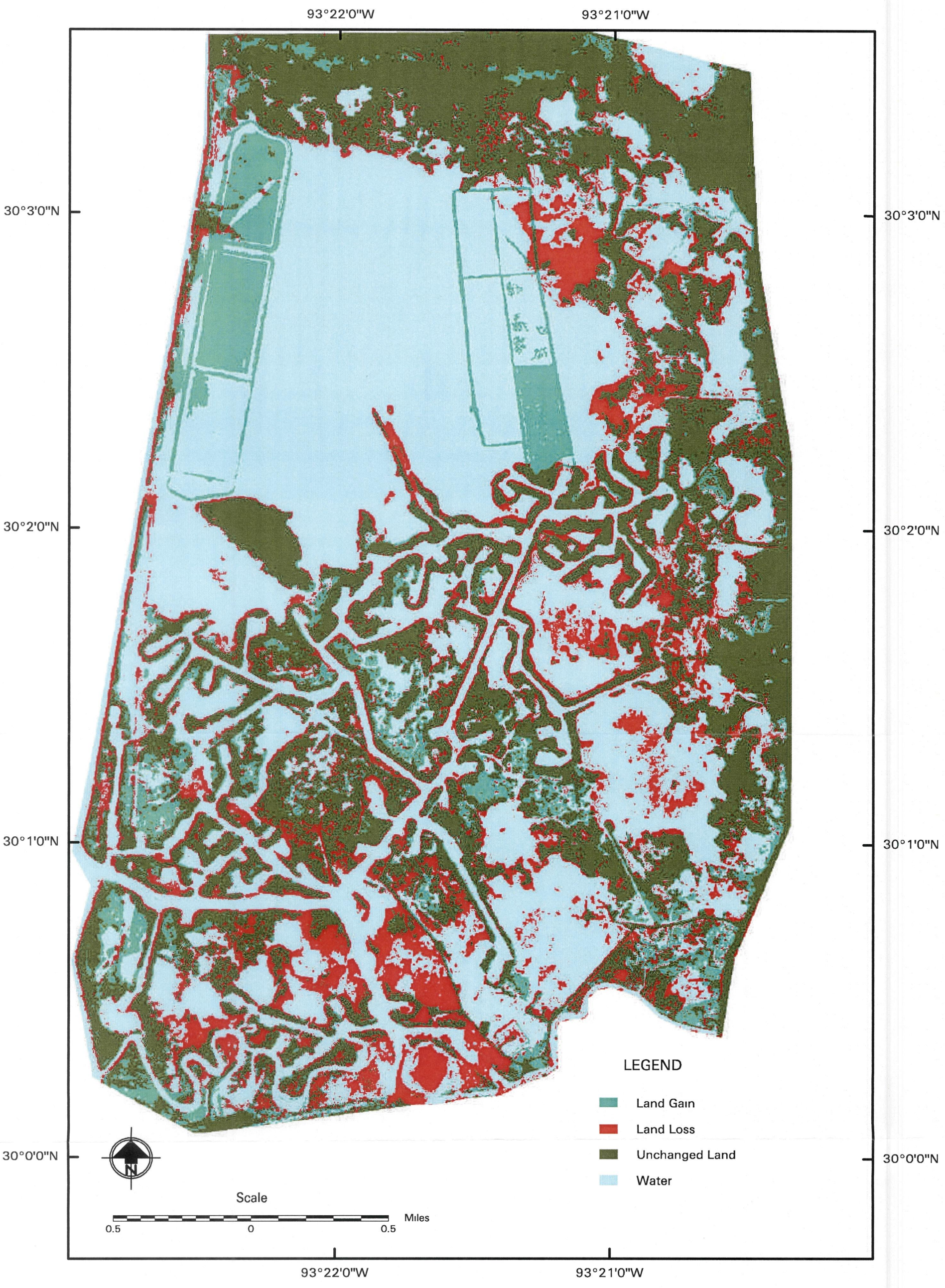

Figure 82 Shoreline changes of the Calcasieu - Brown Lake BUMP study area between December 1992 and December 2000

Habitat Inventory

The aerial photographic interpretation combined with field surveys identified five major habitat types in the Calcasieu – Brown Lake BUMP study area. These habitats are further classified as natural and man-made. The natural class identifies natural processes as responsible for habitat creation. The BUMP man-made (BUMP-made) class identifies the habitats created by the beneficial-placement of dredged material. The non-BUMP man-made class (other-made) identifies areas created as a result of activities other than BUMP, such as areas associated with the oil industry access and pipeline canals. Disposal materials reworked by natural processes are most often classified as "natural" unless specifically identified by the USACE-NOD as "BUMP-created." On the habitat maps presented in this report, an intertidal class is included to indicate near shore topography. Because the seaward extent of these areas is not clearly defined, the area of this class is not calculated or included in the inventory.

Table 8 lists the areas of the five habitat types found in the Calcasieu – Brown Lake BUMP study area in December 1992. The location and arrangement of these habitats is presented in figure 83. The total area of the Calcasieu – Brown Lake BUMP study site was 2,413.3 acres. Of this total, 2,317.8 acres were natural and 95.5 acres were man-made with zero acres of BUMP-made; or 96.0 percent were natural, zero percent were BUMP-made and 4.0 percent were other-made.

In order of decreasing size and importance, the largest habitats found were natural marsh (2,053.0 acres) and natural bare land (193.5 acres). In terms of habitat totals, marsh (2,123.0 acres or 88.0%) dominated the Calcasieu – Brown Lake 1992 landscape.

TABLE 8
December 1992 Habitat Inventory of the Calcasieu – Brown Lake BUMP Study Area

HABITAT	TOTAL	NATURAL	OTHER-MADE	BUMP-MADE
Marsh	2,123.0	2,053.0	70.0	0.0
Wetland Forest	33.3	32.3	1.0	0.0
Beach	0.0	0.0	0.0	0.0
Bare Land	214.7	193.5	21.2	0.0
Shrub/Scrub	42.3	39.0	3.3	0.0
Habitat Total	2,413.3	2,317.8	95.5	0.0

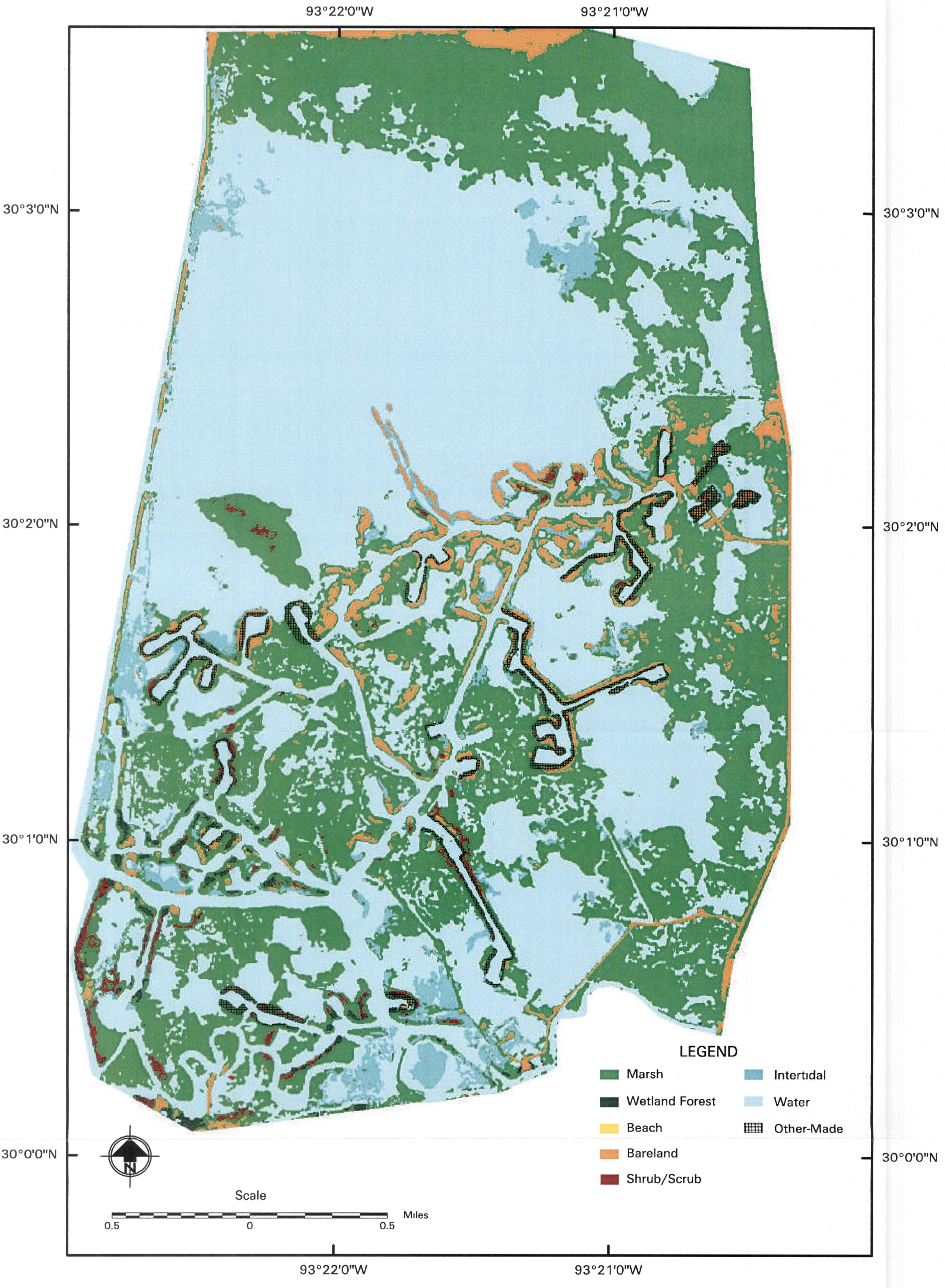

Figure 83 Habitat inventory map of the Calcasieu - Brown Lake BUMP study area in December 1992

Table 9 lists the areas of the five habitats found in the Calcasieu – Brown Lake BUMP study area in December 2000. The location and arrangement of these habitats is presented in figure 84. In 2000, the total area of the Calcasieu – Brown Lake BUMP study area was calculated as 1,769.6 acres. Of this total, 1,448.9 acres were natural and 320.7 acres were man-made including 189.3 acres BUMP-made and 131.4 acres other-made, or 81.9 percent was natural, 10.7 percent was BUMP-made and 7.4 percent was other-made.

In order of decreasing size and importance, the largest habitats found were natural marsh (1,212.6 acres), BUMP-made bare land (151.3 acres), and natural shrub/scrub (107.6 acres). In terms of total area, marsh (1,319.6 acres or 74.6%) dominated the landscape of the Calcasieu – Brown Lake BUMP study area in 2000.

TABLE 9
December 2000 Habitat Inventory of the
Calcasieu – Brown Lake BUMP Study Area

HABITAT	TOTAL	NATURAL	OTHER-MADE	BUMP-MADE
Marsh	1,319.6	1,212.6	69.0	38.0
Wetland Forest	62.7	49.3	13.4	0.0
Beach	1.6	1.6	0.0	0.0
Bare Land	232.3	77.8	3.2	151.3
Shrub/Scrub	153.4	107.6	45.8	0.0
Habitat Total	1,769.6	1,448.9	131.4	189.3

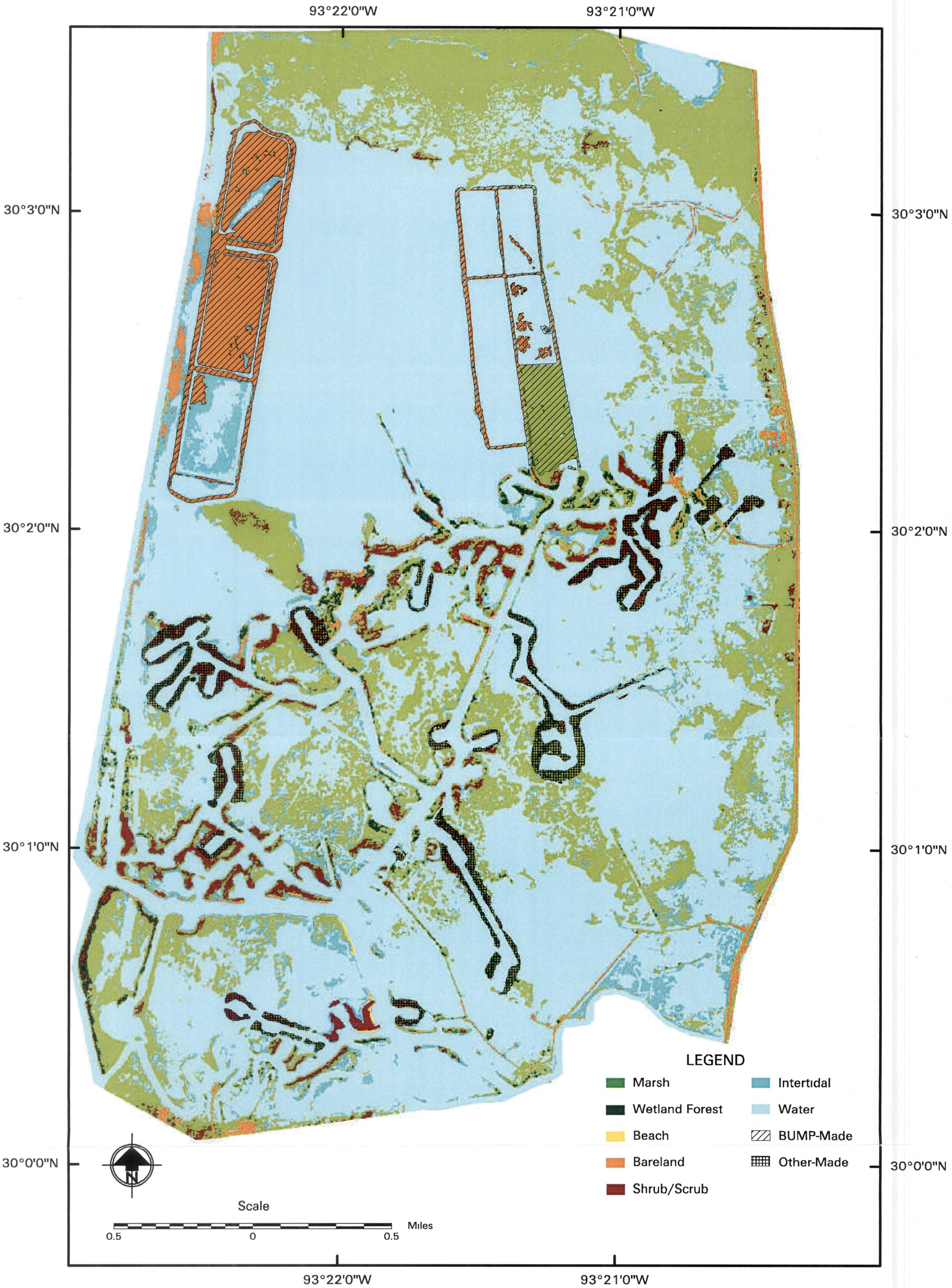

Figure 84 Habitat inventory map of the Calcasieu - Brown Lake BUMP study area in December 2000

Habitat Change

Figure 85 shows changes over time at the Calcasieu - Brown Lake BUMP study area of the major habitat categories: natural, other-made and BUMP-made. It clearly shows the dominance and decline of the natural habitats. Figure 86 shows the creation of new habitat, both natural and man-made, along the Calcasieu – Brown Lake BUMP study area by comparing December 1992 and December 2000. Land loss of natural habitats dominates the land-change processes of this area. The total area decreased by –643.7 acres which represents a 26.7 percent decrease in area between 1992 and 2000. There was an overall decrease of –868.9 acres of the natural habitats, a increase of +35.9 acres in other-made habitats, and an increase of +189.3 acres of BUMP-made habitats. Table 10 lists the major habitat changes during the period between December 1992 and December 2000.

The greatest cumulative habitat change between 1992 and 2000 was the decrease of natural marsh (-840.4 acres) and the decrease of natural bare land (-115.7 acres). There was an increase in BUMP-made bare land (151.3 acres) and BUMP-made marsh (38.0 acres). Also, there was an increase in other-made shrub/scrub (42.5 acre). The overall change in natural and man-made habitats was a decrease of –643.7 acres.

Figure 87 shows a time series of habitat changes along the Calcasieu - Brown Lake BUMP study area. Figure 87A graphs the natural habitat changes over time. Land loss dominates the processes affecting the natural habitat class. Figure 87B graphs the other-made habitat changes over time. Figure 87C graphs the BUMP-made changes over time. Bare land creation by beneficial use of dredged material dominates the man-made class.

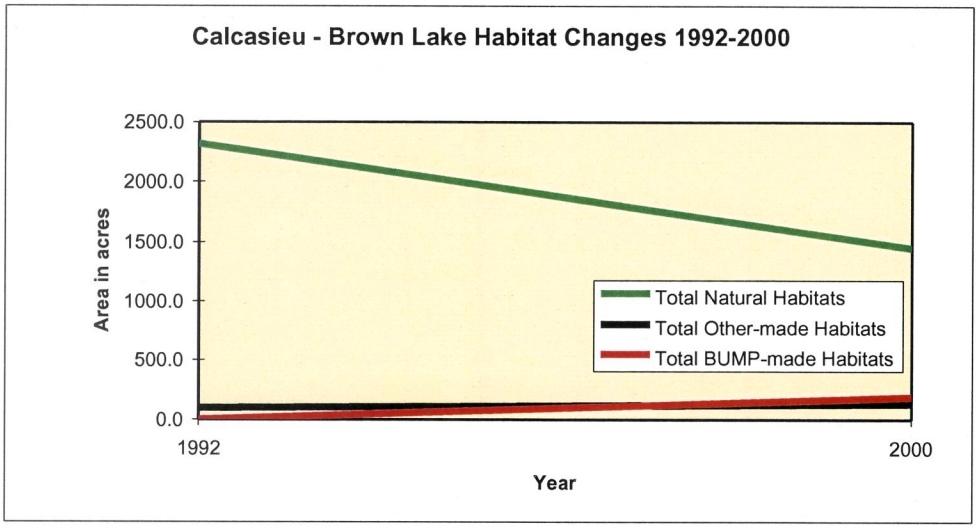

Figure 85. Graph showing the relative change in total area of the major habitat categories: natural, other-made, and BUMP-made, between 1992 and 2000.

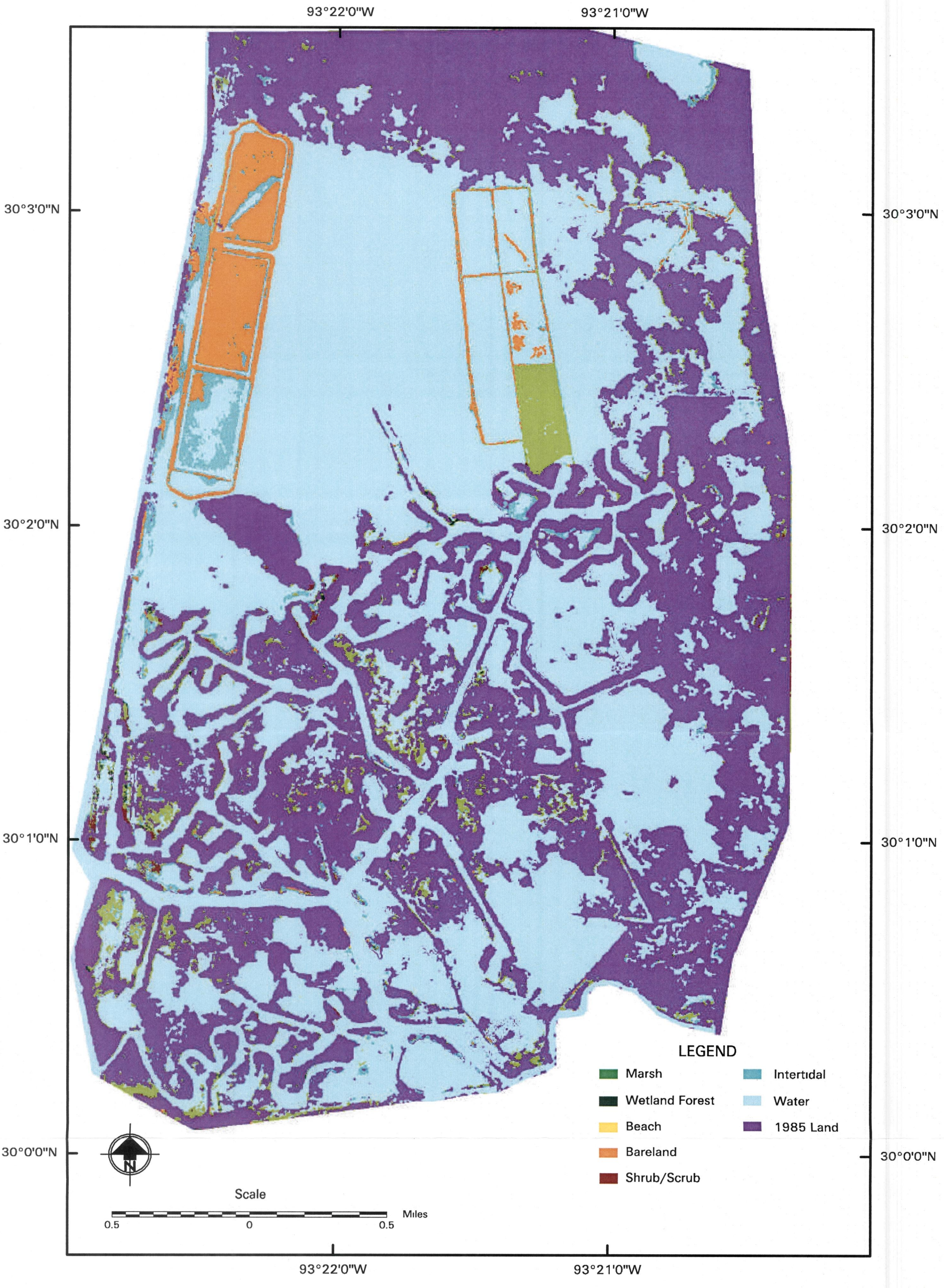

Figure 86 Map of the Calcasieu - Brown Lake BUMP study area showing the new habitats created between December 1992 and December 2000

TABLE 10
Cumulative Change in Total Area of each Habitat
in the Calcasieu – Brown Lake Study Area between 1992 and 2000[1]

HABITAT	Dec 1992	Dec 2000	AREA CHANGE	RATE OF CHANGE (acres/yr)
Natural Marsh	2,053.0	1,212.6	-840.4	-105.1
Natural Wetland Forest	32.3	49.3	17.0	2.1
Natural Beach	0.0	1.6	1.6	0.2
Natural Bare Land	193.5	77.8	-115.7	-14.5
Natural Shrub/Scrub	39.0	107.6	68.6	8.6
Total Natural Habitats	2,317.8	1,448.9	-868.9	-108.6
Other-made Marsh	70.0	69.0	-1.0	-0.1
Other-made Wetland Forest	1.0	13.4	12.4	1.6
Other-made Beach	0.0	0.0	0.0	0.0
Other-made Bare Land	21.2	3.2	-18.0	-2.3
Other-made Shrub/Scrub	3.3	45.8	42.5	5.3
Total Other-made Habitats	95.5	131.4	35.9	4.5
BUMP-made Marsh	0.0	38.0	38.0	4.8
BUMP-made Wetland Forest	0.0	0.0	0.0	0.0
BUMP-made Beach	0.0	0.0	0.0	0.0
BUMP-made Bare Land	0.0	151.3	151.3	18.9
BUMP-made Shrub/Scrub	0.0	0.0	0.0	0.0
Total BUMP-made Habitats	0.0	189.3	189.3	23.7
HABITAT TOTAL	2,413.3	1,769.6	-643.7	-80.5

[1] in acres

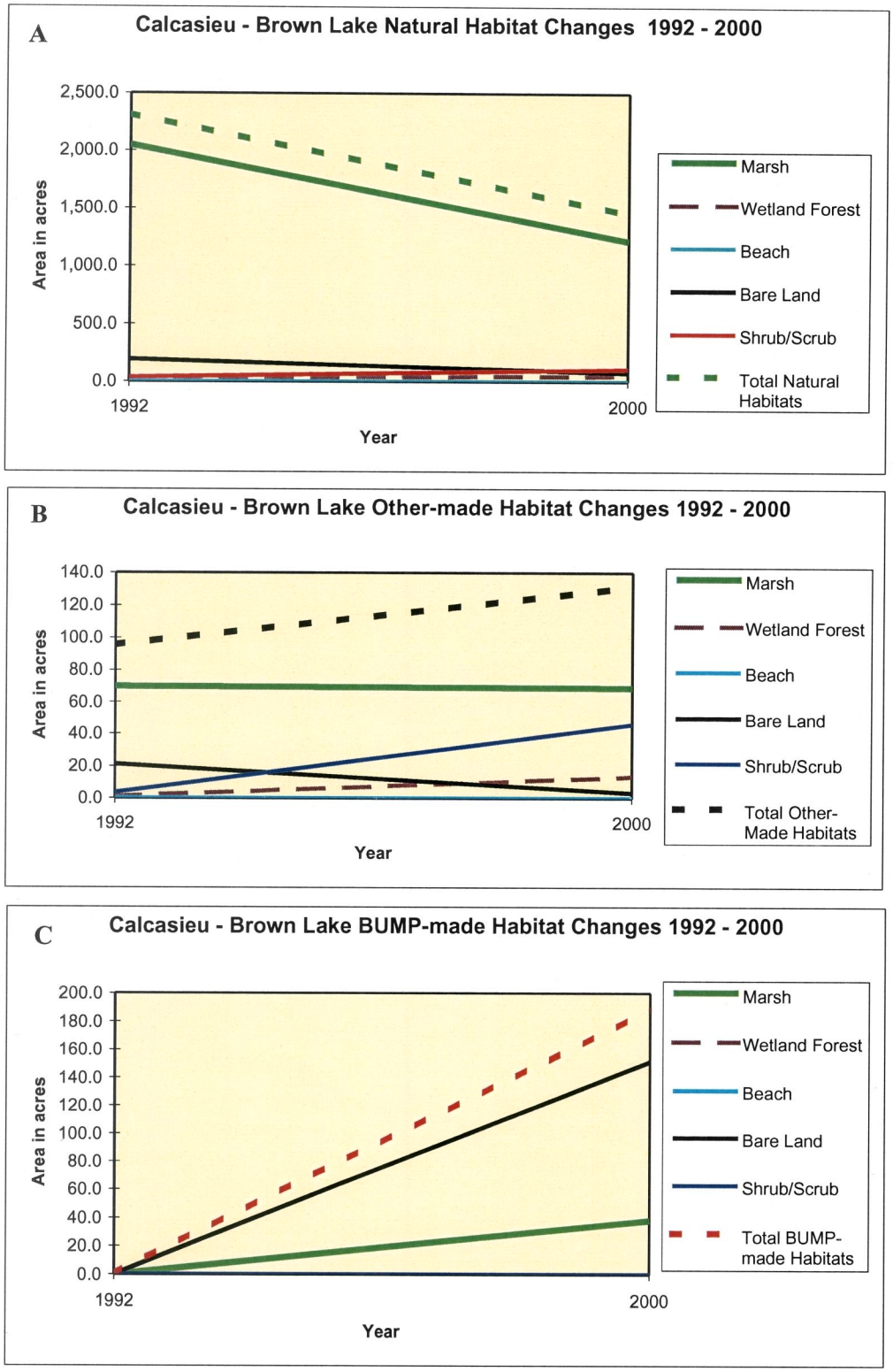

Figure 87. Time series showing the changes in total area of each habitat in the Calcasieu – Brown Lake BUMP study area between December 1992 and December 2000. A) natural habitat changes. B) Other-made habitat changes. C) BUMP-made habitat changes.

CONCLUSIONS

1. The study documented that both the study areas underwent significant area changes.

   A) Calcasieu – SNWR Area change 1985-2000: +1,827.3 acres
      a. Natural areas increased by +997.0 acres
      b. BUMP-made areas increased by +816.4 acres

   B) Calcasieu – Brown Lake Area change 1992-2000: -643.7 acres
      a. Natural areas decreased by –868.9 acres
      b. BUMP-made areas increased by +189.3 acres

2. The habitat inventory showed both study areas are dominated by natural salt marsh.

   A) Calcasieu – SNWR natural marsh increased by 834.6 acres
      a. BUMP-made marsh increased by +520.2 acres
      b. BUMP-made bare land increased by +276.0 acres

   B) Calcasieu – Brown Lake natural marsh decreased by –840.4 acres
      a. BUMP-made marsh increased by 38.0 acres
      b. BUMP-made bare land increased by 151.3 acres

3. The beneficial use of dredged material at the Calcasieu – SNWR and Calcasieu – Brown Lake disposal areas has been successful in creating new habitats.

   A) The rapid increase in area of Calcasieu – SNWR is a result of both natural processes and habitat creation as a result of the beneficial use of dredged material.

   B) While there is a dramatic loss of natural habitats in Calcasieu – Brown Lake, habitat creation as a result of the beneficial use of dredged material has slowed this process and created 189.3 acres of new land.

REFERENCES

Lindstedt, D.M., Nunn, L.N., Homes, J.C., Willis, E.E., 1991. History of Oil and Gas Development in Coastal Louisiana. Louisiana Geological Survey, Baton Rouge, Louisiana.

APPENDIX A
LIST OF VEGETATIVE SPECIES OF THE CALCASIEU RIVER AND PASS BUMP STUDY AREAS

Sesbania drummondii

LIST OF VEGETATIVE SPECIES IN THE CALCASIEU RIVER AND PASS - SNWR AND BROWN LAKE BUMP STUDY AREAS

An alphabetical list of observed and collected plant species follows. This list is not complete, but is meant to establish vegetative character and identify the habitat by the type of habitat the observed vegetation prefers. The list includes the species name, alternate scientific names, common names, and general habitat description for each plant. The habitat information was taken from the Manual of the Vascular Flora of the Carolinas, The Smithsonian Guide to Seaside Plants of the Gulf and Atlantic Coasts, or Common Vascular Plants of the Louisiana Marsh.

Species names are listed in bold type with new taxonomic name changes indicated in red. Probable but not verified species are listed preceded by a "?"

Ambrosia artemisiifolia L. ..... ragweed
annual; fields, pastures, roadsides and waste places

Andropogon glomeratus (Walter) BSP ..... broom-straw
tufted perennial; fields, roadsides, open woods, savannahs and bogs

Aster sp. ..... purple aster
perennial; marshes, sand-mud flats

?Aster subulatus Michx. ..... annual saltmarsh aster
annual herb; brackish marshes

Baccharis halimifolia L. ..... Groundselbush
shrub; elevated sites in fresh to saline marshes

Batis maritima L. ..... saltwort
succulent; open brackish marshes, frequently with Salicornia

Borrichia frutescens (L.) DC ..... sea ox-eye
low shrub or woody herb; brackish marshes

Calystegia sepium (L.) R.Brown ..... hedge bindweed, potato-vine
herbacious, perennial vine; fields, roadsides, and waste places

?Composite ..... unknown
erect, robust herbacious - unidentifiable; sandy flats with Salicornia and Suaeda

Cynodon dactylon (L.) Persoon ..... Bermuda grass
rhizomatous repent perennial grass; fields, roadsides, waste places; valuable as forage

Distichlis spicata (L.) Greene ..... seashore salt grass
rhizomatous perennial; brackish marshes and flats

Elymus virginicus L. ..... Virginia wild rye
tufted perennial grass; low woods, ditches and waste places

Erechtites hieraciifolia (L.) Raf. ex DC. ..... American burn
robust annual; old fields, woodlands, pastures and waste places, usually disturbed or burned

Euthamia (Solidago) graminifolia (L.) Nutt. ..... flat-top fragrant goldenrod
Erect perennial herb; sandy alluvium

Helioptropium curassavicum L. ..... seaside heliotrope
annual or short-lived perennial; seashores and borders of fresh or saline marshes

Ilex vomitoria Aiton ..... yaupon
large shrub/small tree; maritime forests, sandhills

Iva frutescens L. ..... marsh elder
shrub; brackish marshes, upper zones of salt marsh

Juncus roemerianus Scheele ..... black rush, needlerush
perennial; upper portions of salt and brackish marshes, often in solid stands

Lantana camara L. ..... lantana, ham & eggs
shrub; roadsides and waste places

Lonicera japonica Thunb ..... Japanese honeysuckle
evergreen, twining vine; woodlands, roadsides, fence rows and pastures

Lycium carolinianum Walt. ..... matrimony vine, Christmas berry
low, succulent shrub; sandy shell beaches and mounds, sandy ridges in salt marshes

Panicum repens L. ..... dogtooth grass, torpedo grass
creeping, rhizomatous perennial grass; fresh and intermediate marshes on slightly elevated sites; provides forage for rabbits, nutria and cattle

Phragmites communis Trinius ..... roseau cane
tall, rhizomatous, perennial reed; fresh marshes, elevated areas in brackish or salt marshes

Polypogon monspeliensis (L.) Desf. ..... rabbit-foot grass
annual grass; brackish marshes

?Rosa virginiana Mill ..... Pasture Rose
upright, thorny, rhizomatous shrub; along streams, ponds and swamp forests

Rubus trivialis Michaux ..... southern dewberry
trailing or arching, thorny shrub; roadsides, old fields and along railroads

Rumex obovatus Danser ..... dock
erect, robust perennial;

Salicornia bigelovii Torrey. ..... glasswort
annual succulent; brackish marshes, salt flats, low sand flats

Sapium sebiferum (L.) Roxb. ..... Chinese tallow tree
small tree; sandy soil, low swampy areas, waste places, stable dunes

Schoenoplectus (Scirpus) americanus Persoon. ..... bulrush, swordgrass
coarse rhizomatous perennial; fresh or brackish marshes, swales, shallow brackish water

Schoenoplectus (Scirpus) robustus Pursh ..... alkali bulrush
creeping perennial; marshes and rocky stream beds

Sesbania drummondii (Rydb.) Cory. ..... rattlebox
shrub; elevated areas in fresh to brackish marshes, backdunes, waste places

Setaria geniculata Beauv. ..... knot-root bristle grass
tufted pernnial; fields, roadsides and waste places

Solidago sempervirens L. ..... seaside goldenrod
perennial; brackish marsh or saline sand

Spartina alterniflora Loisel. ..... oyster grass
rhizomatous perennial; salt and brackish marshes

Spartina cynosuroides (L.) Roth ..... big cordgrass
coarse perennial; brackish marshes

Spartina patens (Aiton) Muhl. ..... marshhay cordgrass
tufted rhizomatous perennial; brackish marshes, low dunes and sand flats

Spartina spartinae (Trin.) Merr. ex A.S. Hitchc..... gulf cordgrass
clump-forming perennial; dunes, sandy beaches, roadsides, ditches, meadows, salt flats marshes

Suaeda linearis (Ell.) Moq..... annual seepweed
annual herb; moist sand dunes or brackish marshes

Tamarix chiensis Lour.....tamarisk, salt cedar
shrub or small tree; sandy roadsides and waste places, dunes, meadows, old fields, saline or brackish areas

Xanthoxylum americana Miller ..... toothache tree
thorny shrub or small tree; woodlands, neutral or basic soils, spoil ridges in brackish marshes

Tamarix chiensis