BENEFICIAL USE OF DREDGED MATERIAL MONITORING PROGRAM 1996 ANNUAL REPORT

(Base year through FY1996)

U.S. Army Corps of Engineers - New Orleans District
Louisiana State University - Coastal Studies Institute

Baton Rouge, Louisiana
1997

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers New Orleans District (USACE-NOD) maintains eleven major navigation channels in Louisiana that require regular maintenance dredging (Figure 1). More than 90 million cubic yards of sediment is 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 navigation channels. The USACE-NOD working in cooperation with Louisiana State University (LSU) - Coastal Studies Institute, implemented a large-scale monitoring program in 1994 to quantify the amount of new habitat created and to improve dredge disposal placement techniques to maximize beneficial use. This monitoring program is known as the USACE-NOD/LSU Beneficial Use of dredged material Monitoring Program (BUMP).

Vertical aerial photography was acquired in October/November 1995, and color mosaics were produced for all sites listed in table 2; monitoring and analysis was continued and updated for Baptiste Collette Bayou, the Lower Atchafalaya River Bay and Bar, and Mississippi River Gulf Outlet (MRGO) jetties and Breton Island; full field effort including ground-truthing, establishing profile benchmarks, and profile data acquisition was implemented for MRGO - Mile 50-60, Houma Navigation Canal - Bay Chaland and Lower Atchafalaya River - Horseshoe.

Vertical photography was acquired in November 1996, and digital color mosaics were produced for all sites listed in table 2. GIS habitat analysis was completed for MRGO - Mile 50-60, MRGO - Jetties, Baptiste Collette Bayou, Southwest Pass, Houma Navigation Canal - Bay Chaland, Atchafalaya River Bay and Bar, Lower Atchafalaya River - Horseshoe, with shoreline data for MRGO-Breton Island. Since the most recent aerial photography was flown in November 1996, most data and results of the 1996 Final Report reflected maintenance events that occurred through FY96.

The work products include habitat maps for the benchmark year and habitat maps for the selected monitoring years. Habitat change maps were produced for each time interval of comparison. From this analysis, coastal change data quantified the creation of new coastal lands and other habitats at selected navigation channel locations. The field program included ground truthing operations to verify and update the habitat maps and field surveys to collect information about vegetation, disposal elevations, and placement practices which maximize beneficial use.

The results of the 1996 Year 1 Beneficial Use of dredged material Monitoring Program (BUMP) are presented in a nine part report compiled in this binder:

- Part 1: Introduction and Methodology
- Part 2: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River Gulf Outlet, Louisiana - Mile 47-59
- Part 3: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River Gulf Outlet, Louisiana - Jetties
- Part 4: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River Gulf Outlet, Louisiana - Breton Island
- Part 5: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River Outlet, Venice, Louisiana - Baptiste Collette Bayou
- Part 6: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana - Southwest Pass
- Part 7: Results of Monitoring the Beneficial Use of Dredged Material at the Houma Navigation Channel, Louisiana - Bay Chaland
- Part 8: Results of Monitoring the Beneficial Use of Dredged Material at the Atchafalaya River and Bayous Chene, Boeuf, and Balck, Louisiana - Lower Atchafalaya River Horseshoe
- Part 9: Results of Monitoring the Beneficial Use of Dredged Material at the Atchafalaya River and Bayous Chene, Boeuf, and Black, Louisiana - Atchafalaya Bay/Delta and Bar Channel

In addition, the BUMP has generated a map series in support of the 1996 Final Report and these are listed below.

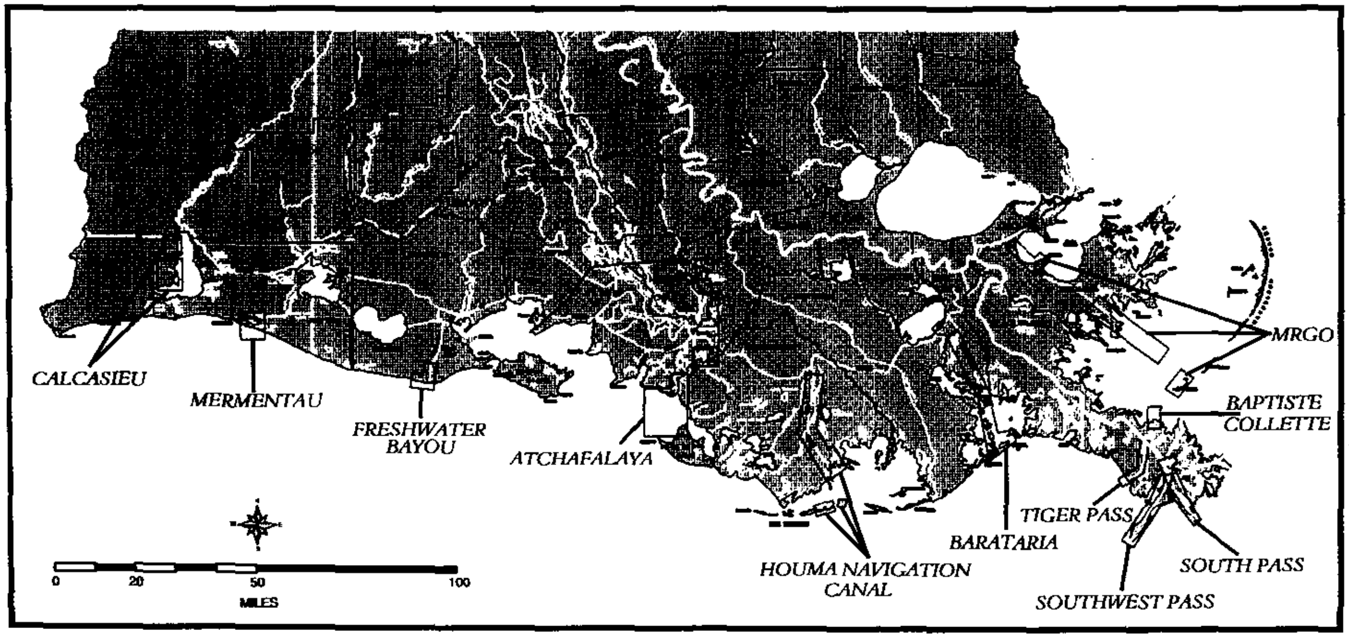
- Map Series #1: Habitat and Shoreline Changes of the Mississippi River Gulf Outlet, Louisiana - Mile 47-59: 1990 to 1996
- Map Series #2: Habitat and Shoreline Changes of the Mississippi River Gulf Outlet, Louisiana - Jetties: 1985 to 1996
- Map Series #3: Shoreline Changes of the Mississippi River Gulf Outlet, Louisiana - Breton Island: 1985 to 1996
- Map Series #4: Habitat and Shoreline Changes of the Mississippi River Outlet, Venice, Louisiana - Baptiste Collette Bayou: 1975 to 1996
- Map Series #5: Habitat Inventory of the Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana - Southwest Pass: 1985
- Map Series #6: Habitat Inventory of the Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana - Southwest Pass: February 1995
- Map Series #7: Habitat Inventory of the Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana - Southwest Pass: November 1995
- Map Series #8: Habitat Inventory of the Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana - Southwest Pass: 1996
- Map Series #9: Habitat and Shoreline Changes of the Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana - Southwest Pass: 1985 to 1996
- Map Series #10: Shoreline Changes of the Houma Navigation Canal, Louisiana - Bay Chaland: 1985 to 1996

U.S. Army Corps of Engineers - New Orleans District
Louisiana State University - Coastal Studies Institute

BENEFICIAL USE OF DREDGED MATERIAL MONITORING PROGRAM 1996 ANNUAL REPORT

(Base year through FY1996)

Part 1: Introduction and Methodology



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1997

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INTRODUCTION

Beneficial Use of Dredged Material Monitoring Program Description

The U.S. Army Corps of Engineers New Orleans District (USACE-NOD) maintains eleven major navigation channels in Louisiana that require regular maintenance dredging (Figure 1). More than 90 million cubic yards of sediment is 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 navigation channels. The USACE-NOD working in cooperation with Louisiana State University (LSU) - Coastal Studies Institute, implemented a large-scale monitoring program in 1994 to quantify the amount of new habitat created and to improve dredge disposal placement techniques to maximize beneficial use. This monitoring program is known as the USACE-NOD/LSU Beneficial Use of dredged material Monitoring Program (BUMP). The research staff for this program is listed in Table 1.

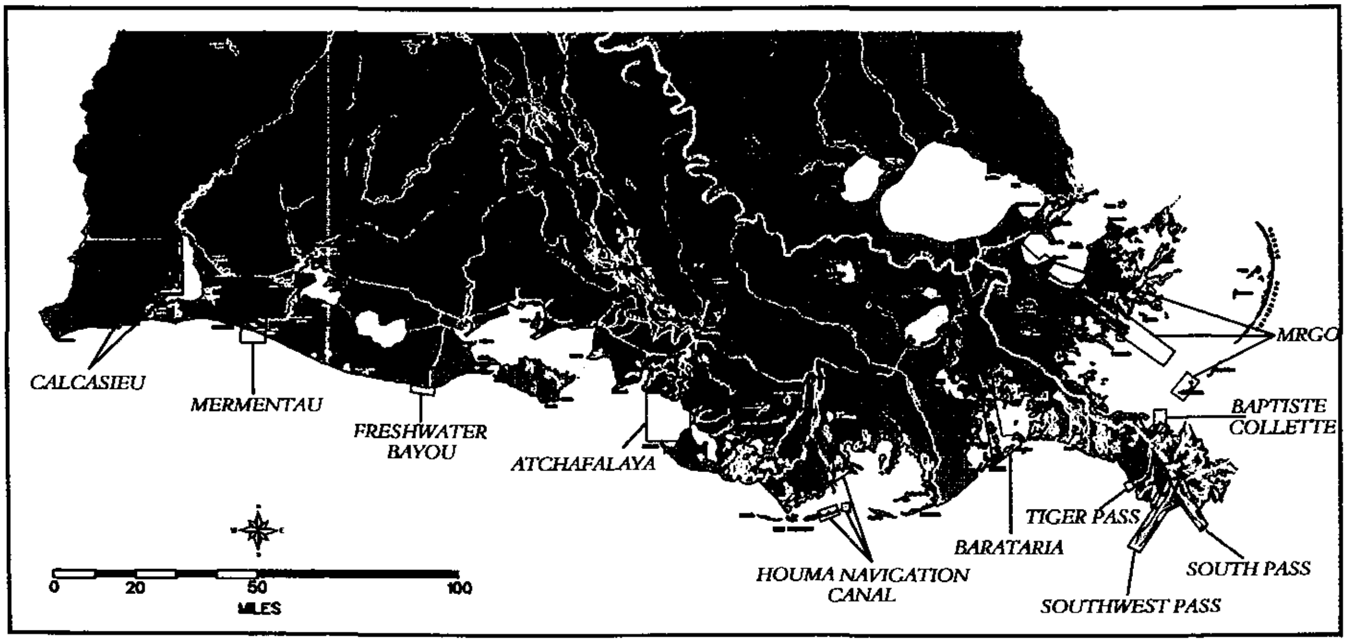

Figure 1. Locations of the beneficial use of dredged material monitoring areas.

TABLE 1
Beneficial Use of Dredged Materials Monitoring Program Research Staff

U.S. Army Corps of Engineers

- Dr. Linda Mathies - Environmental Resources Specialist
- Beth Nord - Environmental Resources Specialist
- Chris Accardo/Bill Caver - Project Engineer
- John Flanagan - Project Engineer
- Bob Gunn - Project Engineer
- Fred Schilling/Tim Roth - Project Engineer

Louisiana State University

- Dr. Shea Penland - Coastal Geologist
- Karen A. Westphal - Coastal Ecologist/Project Manager
- Lynda Wayne - GIS Specialist
- Qiang Tao - GIS Specialist
- Chris Zganjar - GIS Specialist
- Paul Connor - Geologist
- Jamie Phillippe - Geographer/photo-interpretation
- Robert Seal - Logistics Manager
- Elaine Evers - Coastal Ecologist/photo-interpretation
- Ashley Stokes - Coastal Ecologist/photo-interpretation
- Jenneke Vissar - Coastal Ecologist/field support
- Gary Peterson - Coastal Ecologist/Field support

LUMCON

- Dr. Denise Reed - Wetland Specialist

The Monitoring Program

The monitoring program uses remote sensing and field data acquisition strategies developed by the Baptiste Collette pilot study (Wayne et al., 1995) and refined in 1995. Table 2 lists the implementation schedule for the USACE-NOD beneficial use of dredged material monitoring program. This includes USACE-NOD and natural resources agency coordination, aerial photographic analysis, geographical information system (GIS) analysis, ground truthing, field monitoring, and the production of work products. Table 3 lists the data collection and analysis elements of the USACE-NOD monitoring program. The base year in Table 3 is the year chosen to begin GIS monitoring using aerial photography which ranges in date from 1976 for Baptiste Collette to 1992 for Calcasieu. Other dates are estimated for planning purposes and actual dates may vary due to weather or other unforeseen events. In 1997, the implementation of the large-scale monitoring program will be completed and will move from the implementation phase to the operation and maintenance phase.

TABLE 2
USACE-NOD Large-Scale Wetland Creation Monitoring Program Implementation Schedule

NAVIGATION CHANNEL	IMPLEMENTATION DATE	
	site specific aerial photography	field monitoring
1. Baptiste Collette Bayou	1993	1993
2. Lower Atchafalaya River		
Bay and Bar	fall 94	spring 95
Horseshoe Channel	fall 95	fall 96
Avoca Lake	fall 95	—
3. Mississippi River Gulf Outlet		
Mile 50-60	spring 95	fall 96
Jetties & Breton Island	spring 95	spring 95
4. Houma Navigation Canal		
Bay Chaland	spring 95	fall 96
Wine Island, East Island	spring 95	--
5. Southwest Pass	spring 95	summer 97
6. South Pass	spring 95	summer 95
7. Tiger Pass	spring 95	summer 97
8. Freshwater Bayou	spring 95	summer 97
9. Barataria Bay Waterway	spring 95	summer 97
10. Mermentau River - Mud Lake & Mermentau Beach	fall 95	summer 97
11. Calcasieu River - Brown Lake & Sabine	fall 95	summer 97

TABLE 3
Schedule for USACE-NOD Beneficial Use of Dredged Materials Monitoring Program

December 20, 1996

Navigation Channel	Engineer	Base Year	Disposal Since Base Year	Air Photo Acquisition	Air Photo Mosaic[3]	AP[4] Analysis[3]	Ground Truthing[3]	GIS Analysis[3,5]	Field Monitoring[3]	Dredging Conference[2]	Report
1. MRGO - Inside (Mi 50-60)	Bob Gunn	1990	1988 5Feb-26Jun 93 5Dec95-3Feb96	8Feb95 9Nov95 8Nov96	May 96 Feb 97	Jun 96 Feb 97	Nov 96	Jun 96 Mar 97	Nov 96	May 97	May 97
1. MRGO - Jetties (Mi 0-30)	Bob Gunn	1985	1993 1Jul-21Dec93 12Jul-29Aug94 18Jun-31Jul95 19Dec95-29Jan96 9May-17Jun96	8Feb95 9Nov95 8Nov96	Mar 95 May 96 Feb 97	Aug 95 Mar 96 Feb 97	May 95 Apr 96 Jun/Nov 96	Sep 95 Jun 96 Mar 97	May 95 Jun/Nov 96	May 96 May 97	May 96 May 97
1. MRGO - Breton Island (Mi -3 to -9)	Bob Gunn	1990	1984 4Oct91-9Mar92 Sep-Nov93 Sep-Nov94 22Aug-25Sep96	28Apr95 9Nov95 8Nov96 Pre/post 97	Mar 95 May 96 Feb 97	Feb 96 Feb 97	Feb 96	April 96 April 97	May 95 Aug 96	May 96 May 97	May 96 May 97
2. Baptiste Collette Bayou	Bob Gunn	1976	Jun-Oct 1994 2May-17May95 17May-21Sep95 31Aug-21Sep95 31Jul-16Sep96	11Nov94 9Nov95 8Nov96	Mar 95 May 96 Jan 97	May 95 May 96 Feb 97	Aug 95 Feb 96	Jun 95 May 96 Feb 97	Aug 95 Aug 96	June 95 May 96 May 97	Sept 94 June 95 May 96 May 97
3. South Pass	Fred Schilling	1985	Sep-Oct 1994	31Jan+28Apr95 9Nov95 9Nov96	May 95 May 96 Mar 97	Sep 95 Jun 96 Jun 97	Sep 95 Jun 96 Aug 97	Sep 95 Jun 96 Jun 97	Aug 95	May 96 May 98	May 96 May 98
4. Southwest Pass	Fred Schilling	1985	Mar-Oct 1994 4Sep95 Mar-Oct95 5Jun-4Sep95 24May-9Aug96	31Jan+28Apr95 12Nov 95 8Nov 96	May 95 May 96 Feb 97	Sep 95 Jun 96 Mar 97	Jun 95 Mar 97	Sep 95 Mar 97		May 97	May 96 May 97
5. Tiger Pass (Mi 6.2-9.5)	Bob Gunn	1985	7Dec93-26Jan94	8Feb 95 9Nov95 8Nov 96	Mar 95 May 96 Mar 97	Jun 96[5] Aug 97	Jul 96 Aug 97	July 96 Aug 97	Aug 97	May 98	May 98
6. Barataria Waterway - Queen Bess (Mi 2.6-12.1)	Bob Gunn	1985	1991 1Oct-3Dec96	8Feb 95 12Nov 95 9Nov 96	Mar 95 May 96 Mar 97	Aug 97	Aug 97	Aug 97	Aug 97	May 98	May 98
6. Barataria Waterway - Grand Terre Island	Bob Gunn	1985	19Aug-5Sep96	8Feb 95 12Nov 95 9Nov 96	Mar 95 May 96 Mar 97	Aug 97	Aug 97	Aug 97	Aug 97	May 98	May 98

(Table 4 continued on the next page)

TABLE 4 (cont'd)
Schedule for USACE-NOD Beneficial Use of Dredged Materials Monitoring Program

December 20, 1996

Navigation Channel	Engineer	Base Year	Disposal Since Base Year	Air Photo Acquisition[3]	Air Photo Mosaic[3]	AP[4] Analysis[3]	Ground Truthing[3]	GIS Analysis[3,5]	Field Monitoring[3]	Dredging Conference [2]	Annual Report
6. Barataria Waterway - Dupre Cut (Mi 32-27)	Bob Gunn	1985	none	8Feb 95 12Nov95 9Nov 96	Mar 95 May 96 Mar 97						
6. Barataria Waterway - Beauregard Is. to Bayou St. Denis	Bob Gunn	1985		8Feb 95 12Nov95 9Nov 96	Mar 95 May 96 Mar 97	Aug 97	Aug 97	Aug 97	Aug 97	May 98	May 98
7. Houma Nav. Canal Chaland Bay	Bob Gunn	1990	17Sep-7Nov93 29Sep-21Nov95 18Sep-19Nov95	8Feb+2Apr95 28Oct95 10Nov 96	Mar 95 May 96 Mar 97	Apr 96 Feb 97	19, 26Sep96	Jun 96 Feb 97	Sep 96	May 97	May 97
7. Houma Nav. Canal Cat Island Pass	Bob Gunn	1990	28Aug93-11Oct94 6May-10Jun95	8Feb+28Apr95 28Oct95 10Nov 96	Mar 95 May 96 Mar 97	Apr 96 Feb 97	Apr 97	Feb 97		May 98	May 98
8. Lower Atchafalaya River Bay and Bar	John Flanagan	1985	Jun-Oct 1994 28Aug-25Oct95 14Apr-11May95 24Jun-26Oct95 26Jul-28Aug95 16Apr-14Jul96 28Jul-16Dec96	11Nov 94 28Oct 95 10Nov 96	Jan 95 Mar 96 Feb 97	Apr 95 Jun 96 Feb 97	May 95 Sept 96	Jun 95 Jun 96 Mar 97	May 95 Aug/Oct 96 Aug 97	June 95 May 96 May 97	May 96 May 97
8. Lower Atchafalaya Channel (Horseshoe)	John Flanagan	1985	27May-16Oct94 12May-21Jun95 18Apr-16May96 17Aug-25Oct96 28Jul-16Dec96	28Oct 95 10Nov96+16Feb97	Mar 96 Feb 97	Jun 96 Feb 97	Oct 96	Jun 96 Mar 97	Oct 96	May 97	May 97
8. Atchafalaya Avoca Lake	John Flanagan	1985		28Oct 95 10Nov 96	Mar 96 Feb 97	Aug 97	Aug 97	Aug 97	Aug 97	May 98	May 98
9. Freshwater Bayou/Beach	Chris Accardo	1993 1990	30Jan-4Mar83 14Sep-17Oct90 27Mar-29Apr94	8Feb95 28Oct95 10Nov 96	Mar 95 May 96 Apr 97	Aug 97[s]	Sep 97	Sep 97[s]	Sep 97[s]	May 98	May 98
10. Mermentau River - Lake and Beach	Chris Accardo	1990	22Jun-16Jul 87 29Apr-10Jun 91 21Apr-22May96	28Oct 95 10Nov 96	May 96 Mar 97	Sep 97[s]	Sep 97	Sep 97[s]	Sep 97	May 98	May 98
11. Calcasieu River and Pass	Chris Accardo	1992	12Jun-20Oct 93 15Sep-10Oct93 1Jul96-17Jan97	28Oct 95 10Nov 96	May 96 Mar 97	Aug 97[s]	Aug 97	Aug 97	Aug 97	May 98	May 98

[s]Shoreline only, no habitats interpreted.

AD* To be done after dredging is completed, instead of or in addition to October. Check with project engineer.

[3]LSU is responsible for notification and performance.

[4]Aerial Photographic

[5]Geographic Information System Analysis

1996 Report and Products

Vertical aerial photography was acquired in October/November 1995, and color mosaics were produced for all sites listed in table 2; monitoring and analysis was continued and updated for Baptiste Collette Bayou, the Lower Atchafalaya River Bay and Bar, and Mississippi River Gulf Outlet (MRGO) jetties and Breton Island; full field effort including ground-truthing, establishing profile benchmarks, and profile data acquisition was implemented for MRGO - Mile 50-60, Houma Navigation Canal - Bay Chaland and Lower Atchafalaya River - Horseshoe.

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Map Series #13:	Habitat Inventory of the Atchafalaya River and Bayous Chene, Boeuf, and Black, Louisiana - Atchafalaya Bay/Delta and Bar Channel: 1996
Map Series #14:	Habitat and Shoreline Changes of the Atchafalaya River and Bayous Chene, Boeuf, and Black, Louisiana - Atchafalaya Bay/Delta and Bar Channel: 1985 to 1996

WORK PLAN

Aerial Photographic Analysis

The aerial photographic analysis involved five major steps, 1) photo acquisition, 2) photo mosaicing, 3) photo interpretation and digitization, 4) habitat classification, and 5) ground truthing.

1) Photo Acquisition

LSU's air photo contractor acquired photography of each BUMP site at the end of the USACOE-NOD maintenance year which corresponds to the end of the growing season to capture the maximum vegetation extent for that year. Color infrared photography was acquired at a scale of 1:24,000. There was a 60 percent forward overlap of the photography which allowed the use of stereo plotting techniques for better accuracy. Color infrared photography was used for mapping and photo-interpretation because it provided a better definition of vegetation types, habitats, and the land/water interface. LSU archived a copy of the color infrared photography at the Coastal Studies Institute in the Center for Coastal, Energy, and Environmental Resources (CCEER). A second set of color infrared photography was provided to the USACE-NOD.

2) Photo Mosaicing

The aerial photography acquired for each dredge disposal site was mosaiced for use by the USACE-NOD and LSU. The air photo mosaic was produced by scanning the photography into a digital database, rectifying to scale, and edge matching the photography to provide a complete image of the beneficial use disposal site. A color computer plot was made of the mosaiced image at a scale of 1:24:0006. The digital file can be used to overlay other USACE-NOD information as needed. The mosaics were delivered to the USACE-NOD as a hard copy plot and as a digital file on a CD ROM in Intergraph MGE format.

3) Photo Interpretation and Digitization

The study areas were interpreted and mapped from the base year photography and the color infrared aerial photography using a Bausch and Lomb Zoom Transfer Scope. 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'. The shoreline was 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. The work product is a map showing the location of the habitat types in each area.

4) Habitat Classification

The habitats are interpreted from the photography by discernible and recognizable differences in infrared color and texture, and specific areas were then ground truthed in the field for positive habitat identification and vegetative community composition.

The habitats will be broken into simple classes and sub-classes: water, wetlands (marsh and swamp), and land (beach, bare, dune, upland, shrub/scrub, and forest). These very general characterizations necessarily incorporate many other habitats and transition areas.

There are many areas that cannot easily be separated into one of these categories. The establishment of vegetation is a succession of gradual transitions as plant communities colonize, compete, adapt or die, and eventually dominate each habitat. Difficulties arise as an interpreter attempts to classify areas that are in transition from one class to another, either temporally, such as marsh newly colonizing a submerged area, or spatially, marsh grading to upland. At some point along the gradual and subtle changes in elevation, vegetative density, or vegetative composition, an interpreter must make a decision and draw a line, attempting to be consistent each time.

The habitat categories used are italicized 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 dredge 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 for our purpose, is any unforested, vegetated area normally subject to inundation or tidal action at any time, sufficient to support wetland-dependant, emergent vegetation. The type of marsh is further broken into classifications based on the salinity regime of the area which is indicated by the dominant vegetation in Louisiana. *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 uplands.

Saltmarsh, high salinity (20-40 parts per thousand), is dominated by Spartina alterniflora, Juncus roemerianus, and Distichlis spicata.

Brackish marsh, moderate salinity (0.5-16 parts per thousand), is dominated by Spartina patens and Distichlis spicata.

Intermediate marsh, low salinity (0.5-8 parts per thousand), is dominated by Spartina patens, Phragmites australis, Echinochloa walterii, or Scirpus sp.).

Freshmarsh, no salinity (less than 0.5 parts per thousand), is dominated by Sagittaria spp. and Panicum hemitomon.

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. Dominant tree species indicate more specific habitats; in the study area usually:

Cypress swamp, dominated by Taxodium distichum.

Willow swamp or *batture community*, dominated by Salix nigra. A batture community colonizes open areas along waterways, or on newly deposited or newly exposed areas near water.

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 fresh, 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, or some types of agricultural 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 as well as oak or pine woods.

5) Groundtruthing

The interpretations of habitat type are verified by taking the photography or interpreted map into the field to check against the actual landscape. Corrections are made where necessary to the map, and the revised map is then submitted for GIS digitization and final analysis. For each monitoring site, a base year was selected upon which the assessment of changes are based. The dates of the base years are listed in Table 2. The base year photography is acquired from sources such as National Aeronautics and Space Administration, U.S. Department of Agriculture, U.S. Geological Survey, USACE,and the U.S. Fish and Wildlife Service.

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, groundtruthing, verified the interpretation of habitat type, vegetative cover, and surface morphology from the aerial photographic analysis. The second field effort, field monitoring, recorded changes in elevation, vegetative cover, geomorphic character, and surface texture at selected beneficial use sites in order to assess the best disposal practices.

1) Ground Truthing

The interpretation of habitat type and vegetative cover within each beneficial use site were made from the color infrared aerial photography. These interpretations were made remotely by trained photo-interpreters. The work product is a map showing the location of the habitat types in each area. These interpretations were confirmed by site visits to each beneficial use disposal area. The photo-interpreted map was taken into the field and checked against the disposal area landscape. Corrections were made where necessary to the habitat map, and the revised map was then submitted for GIS data development and final analyses.

2) Field Monitoring

The objective of the field monitoring is to clarify the habitat types by identifying dominant vegetative communities, and to determine the best disposal elevation and placement configuration in order to produce the maximum habitat benefits. Monitoring changes in elevation, habitat type and surface morphology at a disposal site will identify the important processes that control change. Understanding the relationships between change and process and habitat and elevation will facilitate better predictions of the potential habitat benefits associated with different placement elevations and configurations.

Permanent benchmarks placed by the USACE-NOD or USACE-NOD contractors and temporary benchmarks placed on site by LSU to mark study profiles were established within each beneficial use dredged material disposal site to provide monitoring baseline. The elevation of these benchmarks was determined using either an existing datum, tide gage data combined with shoreline morphology, or a global positioning system (GPS). Where existing datums occur within range to the disposal site, a laser driven Total Station survey instrument will be used to level between the known datum and the new benchmark. This will allow the direct establishment of the elevation at the new benchmark.

Where there is no existing datum to use, an elevation can be inferred from tide gage data or measured directly by a GPS system. The inferred method uses a tide gage in close proximity to the site as a calibration for elevation. During the establishment of the benchmark, a measurement between the water level and the benchmark elevation was made. The tide gage record is then reviewed to determine the water level elevation at that moment in time. The elevational difference between the measured water level and benchmark height was then correlated back to the known datum for the tide gage to determine the actual benchmark elevation. This position was then referenced to the morphology of the high tide position on the shoreline. A direct measurement of the elevation of the new benchmark was also made using a global positioning system (GPS) survey system. Depending on the number of satellites available, two or three benchmarks was established per day. The new benchmarks were then used to survey other ones in close proximity.

Once the benchmark was established, a transect was surveyed to record elevation, habitat types, and vegetative cover for that beneficial use site. This data was compared to original dredge material stacking height information where available for initial performance evaluation of the newly created areas. Seasonal monitoring of this transect will record changes in elevation, habitat type, vegetative cover, and surface morphology. With repeated surveys, changes along the transect can be determined and interpreted. This information leads to an understanding of the relationship between disposal elevation and placement configuration in producing the maximum habitat benefits.

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, LSU proposes to develop a World Wide Web site for the dissemination of the beneficial use of dredged material monitoring data. A home page will be developed that will allow the user to click (hyperlink) through data on the beneficial use of dredged material. The user will be able to view scanned aerial photographic mosaics, habitat maps, habitat change maps, habitat data spread sheets, and the results of field investigations. The web site will be updated periodically and for the annual dredging conference.

WORK PRODUCTS

The work products for 1996 are 1) vertical, color, aerial photography, 2) color photo mosaics for October/November 1995 and color digital mosaics for November 1996, 3) habitat inventory maps, 4) shoreline change maps, 5) habitat change maps 6) change data matrices, 7) dredged material disposal history map 8) habitat creation and configuration monitoring results, 9) Coordination, 10) annual report, 11) BUMP archive, and 12) World Wide Web site.

1) Aerial Photography
   Color infrared aerial photography was acquired for areas selected by the USACE-NOD along each navigation channel (Appendix A). The scale of the photography was 1:24,000 in a 9" X 9" format.

2) Photo Mosaics
   For all of the beneficial use of dredged material areas delineated in Appendix A, a color infrared, aerial photographic mosaic was produced: photographically for the October/November 1995 photography and digitally for the November 1996 photography. The scale was approximately 1:24,000 within a 36" width.

3) Habitat Inventory Maps
   Habitat inventory maps were produced from the aerial photographic analysis for selected beneficial use areas on each navigation channel, for the base year and the selected monitoring years. Areas that could be determined to be created by BUMP were delineated. Habitat maps were produced at a scale to show appropriate resolution.

4) Shoreline Change Maps
   Shoreline change maps were produced where appropriate to show general trends in erosion and accretion of the study area.

5) Habitat Change Maps
   Habitat change maps were produced from the GIS analysis comparing the base year photography with subsequent monitoring year photography. These maps depict how the habitat evolved and changed through time to highlight areas created by BUMP. These maps were produced at the same scale and format as the habitat maps.

6) Change Data Matrices
   The data generated by the aerial photographic and GIS analyses was organized into data matrices for easy review and interpretation. Starting with the base year, information was generated to quantify, in acres, the amount of new wetlands and other habitats created. From the change analysis, data on how the habitats changed between each time period is provided. Sites previously monitored were updated.

7) Dredged Material Disposal History Map
From "As-Builts" provided by the USACE-NOD, historical photography and maps and any other information available, LSU compiled data into a map to illustrate the dredged materials placement history within the study area. This is only as accurate as the information that was located. This map is provided as a figure within the monitoring report.

8) Habitat Creation and Configuration Monitoring Results
For the beneficial use sites chosen, the results of the aerial photographic and GIS analysis combined with the field monitoring results document the performance of different disposal elevations and configurations to create wetlands and other valuable habitats. Using this new information, the USACE-NOD in cooperation with natural resource agencies can formulate new plans to improve disposal methods for the beneficial use of dredged material.

9) Coordination
LSU coordinated with USACE-NOD on a regular basis, participated in meetings with project engineers and natural resource agencies, and will present monitoring data at technical meeting and workshops. Semi-annual reports or memos were provided to document project milestones. Monthly work plans were developed with the USACE-NOD to coordinate changes in the LSU monitoring program in response to changes in USACE-NOD dredging activities, and to track monitoring program performances.

10) Annual Report
This is the annual report for the USACE-NOD Annual Dredging Conferences that has been prepared for distribution to the attendees. The annual report summarizes the status of sites being monitored for habitat inventories, wetland change statistics, recommendations concerning stacking elevations and placement configurations, and the total wetland and other habitat acreage created to date in the USACE-NOD.

11) BUMP Archive and LSU Facilities
LSU has established a data archive within the Howe-Russell Geoscience Complex for the USACE-NOD beneficial use of dredged materials monitoring program. Aerial photography, project mosaics, habitat maps, habitat change maps, and all digital data is being stored and maintained on the LSU campus. The archive contains two dedicated GIS workstations for viewing and analyzing wetland creation data. The archive also contains the data and results of the field monitoring program.

12) World Wide Web Site
LSU has established a World Wide Web Site for the distribution of BUMP data sets to natural resource trustees and other interested parties. The web site will be updated periodically as information is available. The BUMP Homepage may be accessed at http://beach.csi.lsu.edu/bump/

SUMMARY

The U.S. Army Corps of Engineers - New Orleans District in cooperation with Louisiana State University - Coastal Studies Institute established the Beneficial Use Monitoring Program (BUMP) to document the creation of new land through the placement of dredge material. The methodology used to quantify the creation or enhancement of new coastal lands through the beneficial use of dredge material is listed below.

1. Annual acquisition of color infrared photography of the eleven monitoring sites.

2. Creation of air photo mosaics of each monitoring site.

3. Photo-interpret the shoreline and habitat environments for each site and convert to digital data.

4. Import the digital shoreline and habitat data into Intergraph MGE for analysis.

5. Use Intergraph MGE to inventory each monitoring site for each time period and perform change detection analysis for each time period pairs.

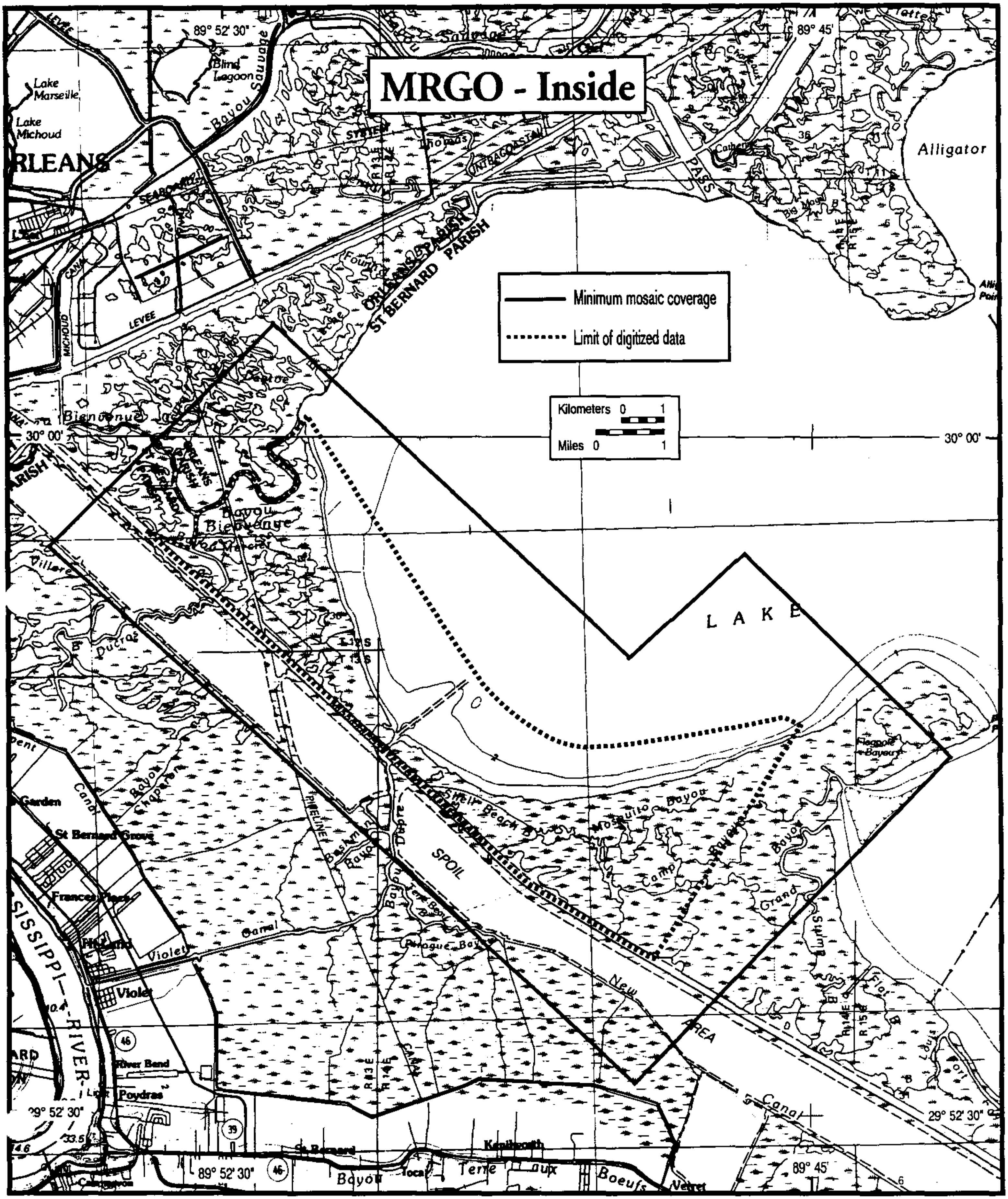
6. Ground truth the Intergraph MGE results.

7. Conduct field monitoring to determine the best stacking height and placement configuration strategies for each site.

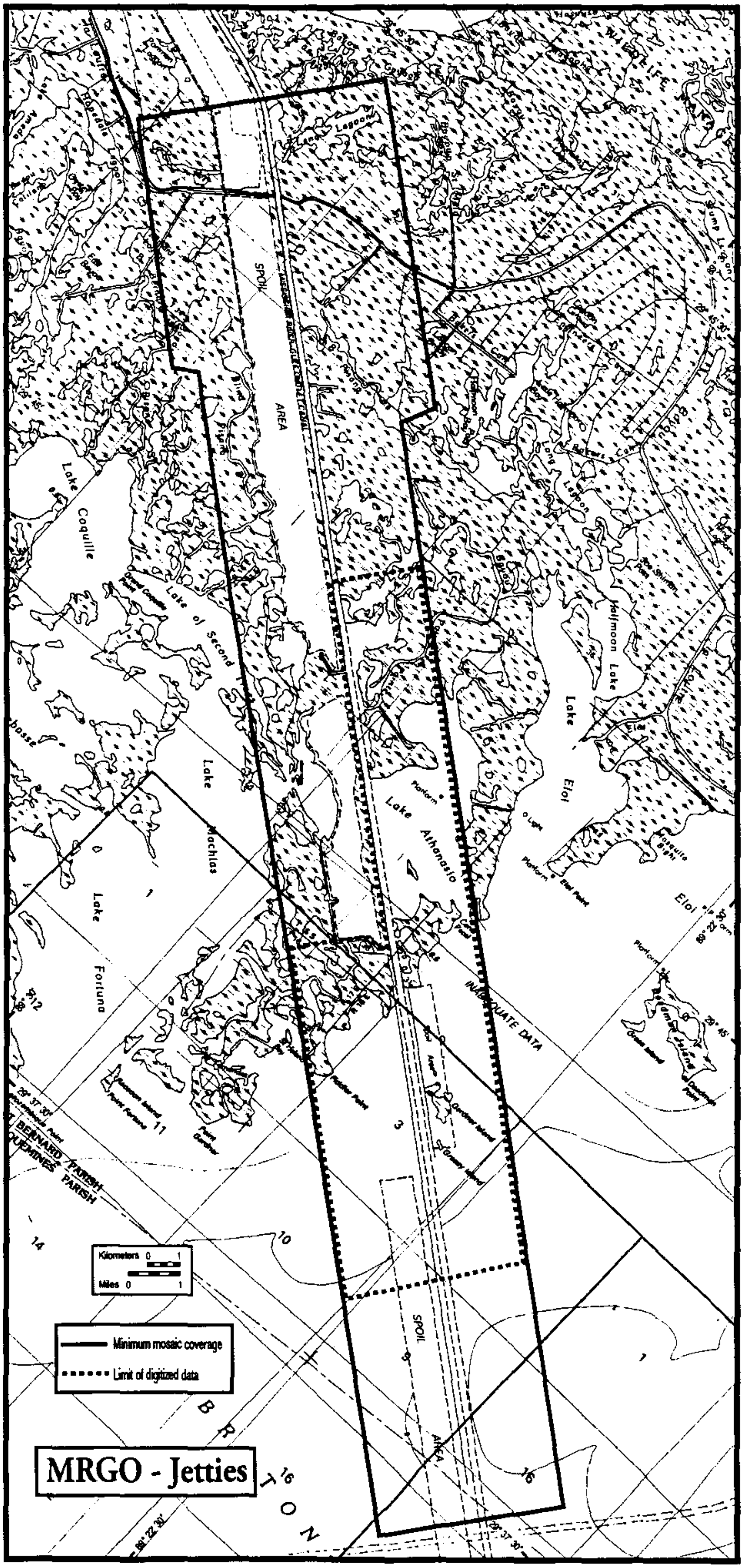
REFERENCES

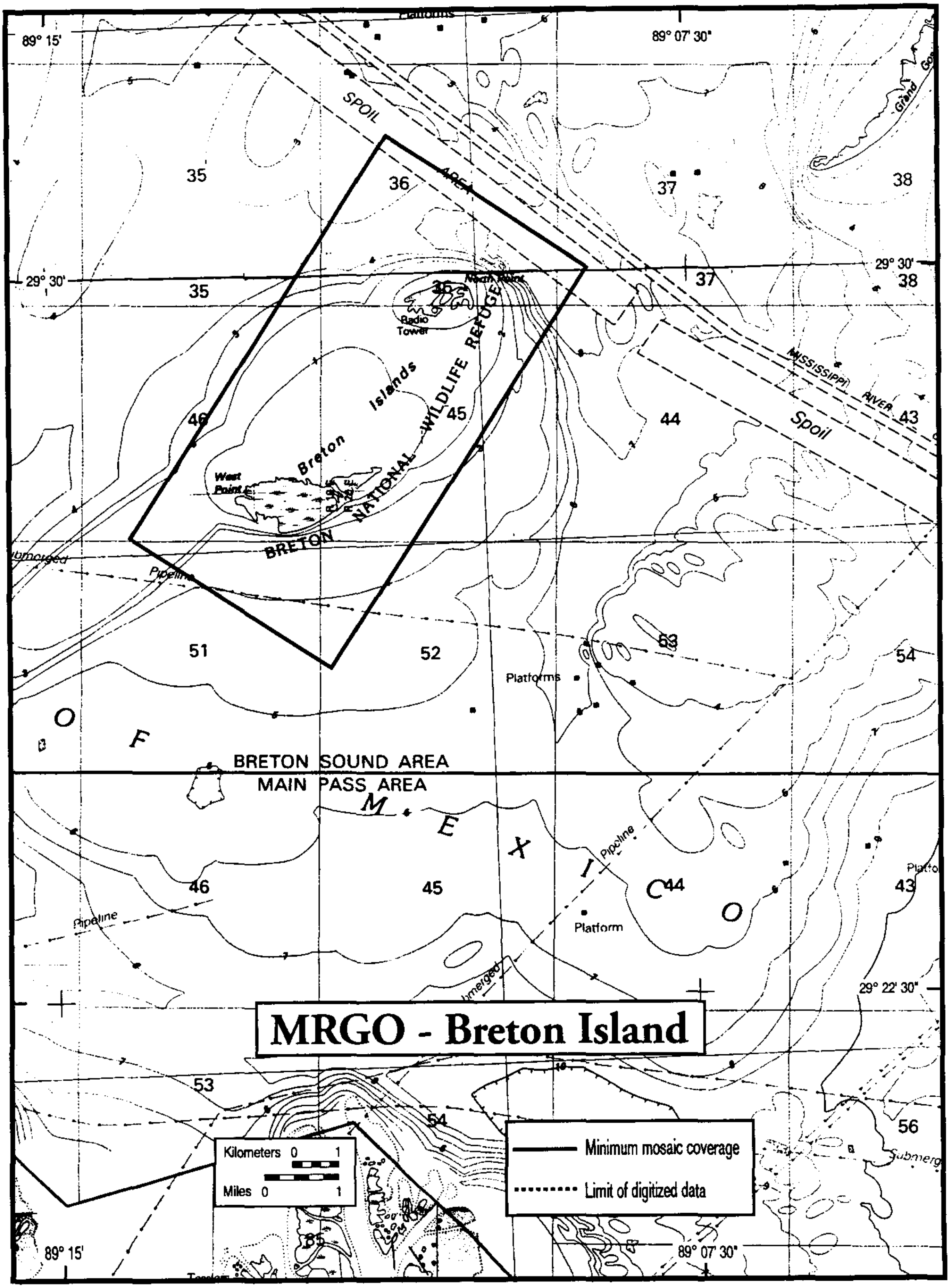
Wayne, L.D., Penland, S., Westphal, K.A., Hiland, M.W., Connor, P., and Zganjar, C.E., 1995. Development of a coastal monitoring program to document the beneficial use of navigation dredge materials in the U.S. Army Corps of Engineers - New Orleans District: Baptiste Collette Bayou Pilot Study. U.S Army Corps of Engineers, 34 pp.

APPENDIX 1A: BASE MAPS



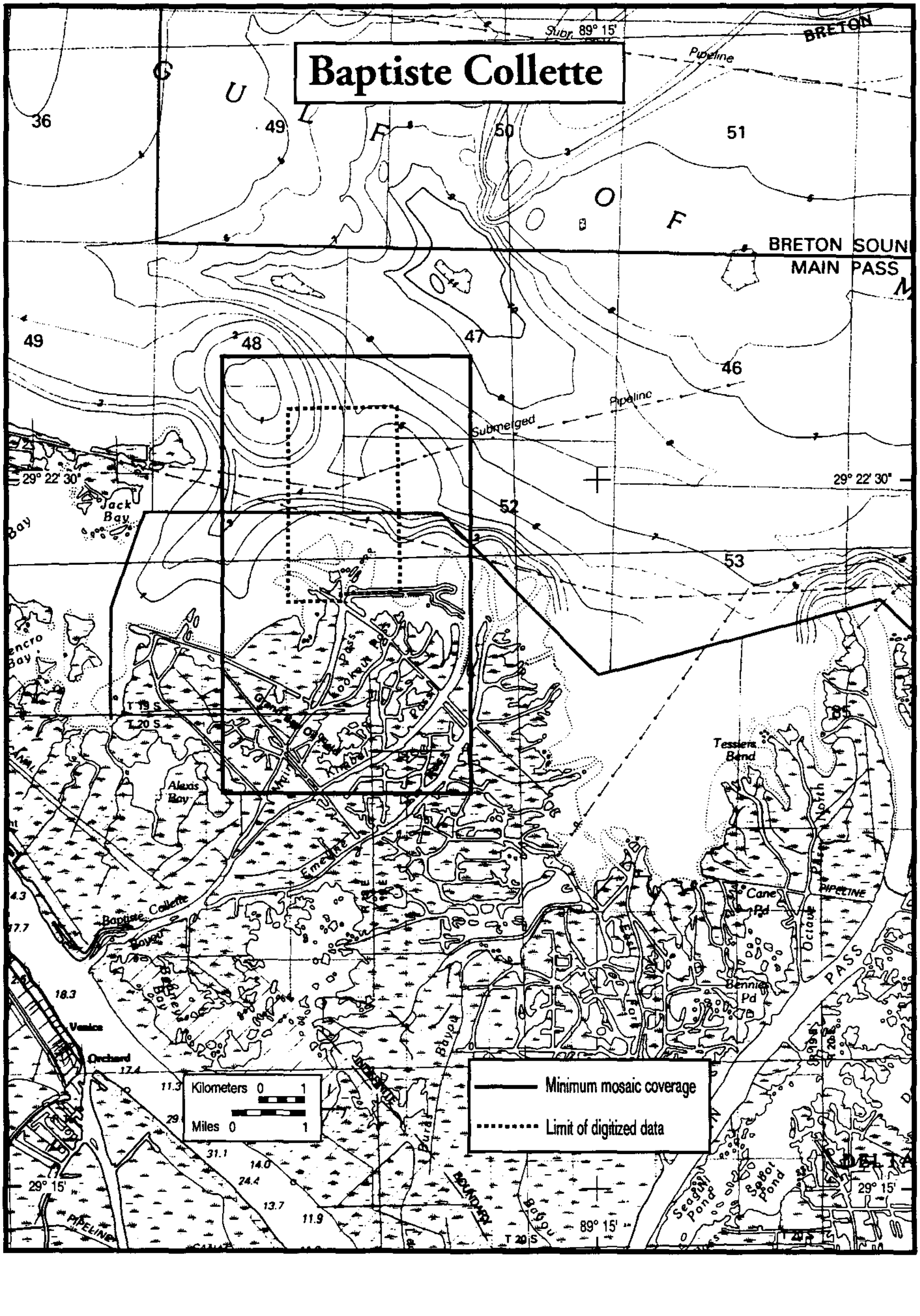
MRGO - Inside
Minimum mosaic coverage
Limit of digitized data
Kilometers 0 1
Miles 0 1
89° 52' 30"
89° 45'
30° 00'
29° 52' 30"
Lake Marseille
Lake Michoud
Blind Lagoon
Bayou Sauvage
ORLEANS
ST BERNARD PARISH
ORLEANS PARISH
Alligator
LAKE
PASS
INTRACOASTAL
LEVEE
Bayou Bienvenue
SPOIL
AREA
New
Canal
Violet
St Bernard Grove
Shell Beach
Mosquito Bayou
Bayou Dupre
Bayou Ducros
Villere
Bayou Chaperon
Bayou Terre aux Boeufs
St Bernard
Kenilworth
Poydras
River Bend
Toca
Verret
MISSISSIPPI—RIVER
Flagpole Bayou
Grand
Camp
Pirogue Bayou
T 12 S
T 13 S

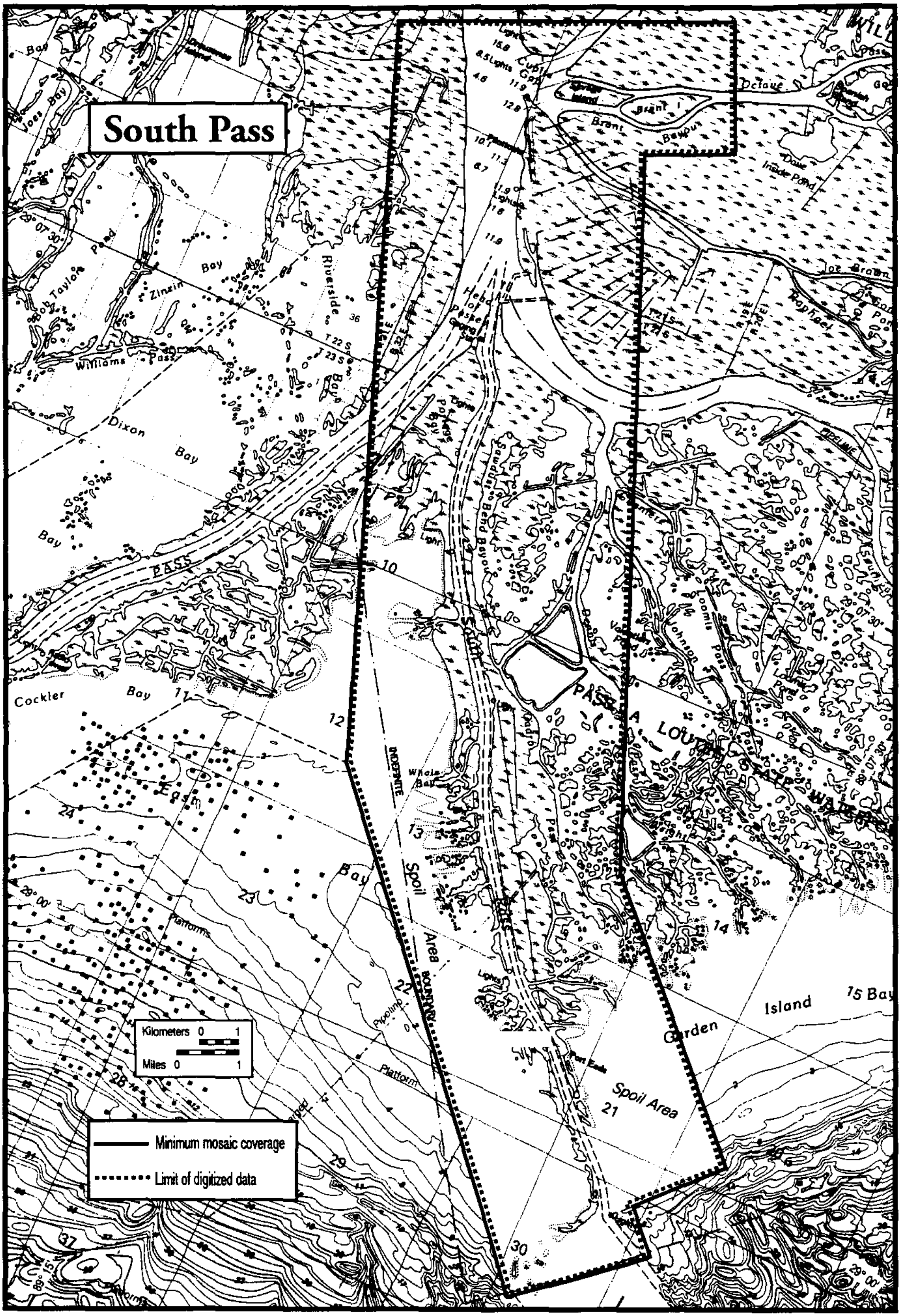

MRGO - Jetties
Minimum mosaic coverage
Limit of digitized data
Kilometers 0 1
Miles 0 1
SPOIL
AREA
Lake Coquille
Lake of Second
Lake Machias
Lake Fortuna
Lake Athanasio
Lake Eloi
Halfmoon Lake
Long Lagoon
INADEQUATE DATA
ST BERNARD PARISH
PLAQUEMINES PARISH
B R E T O N

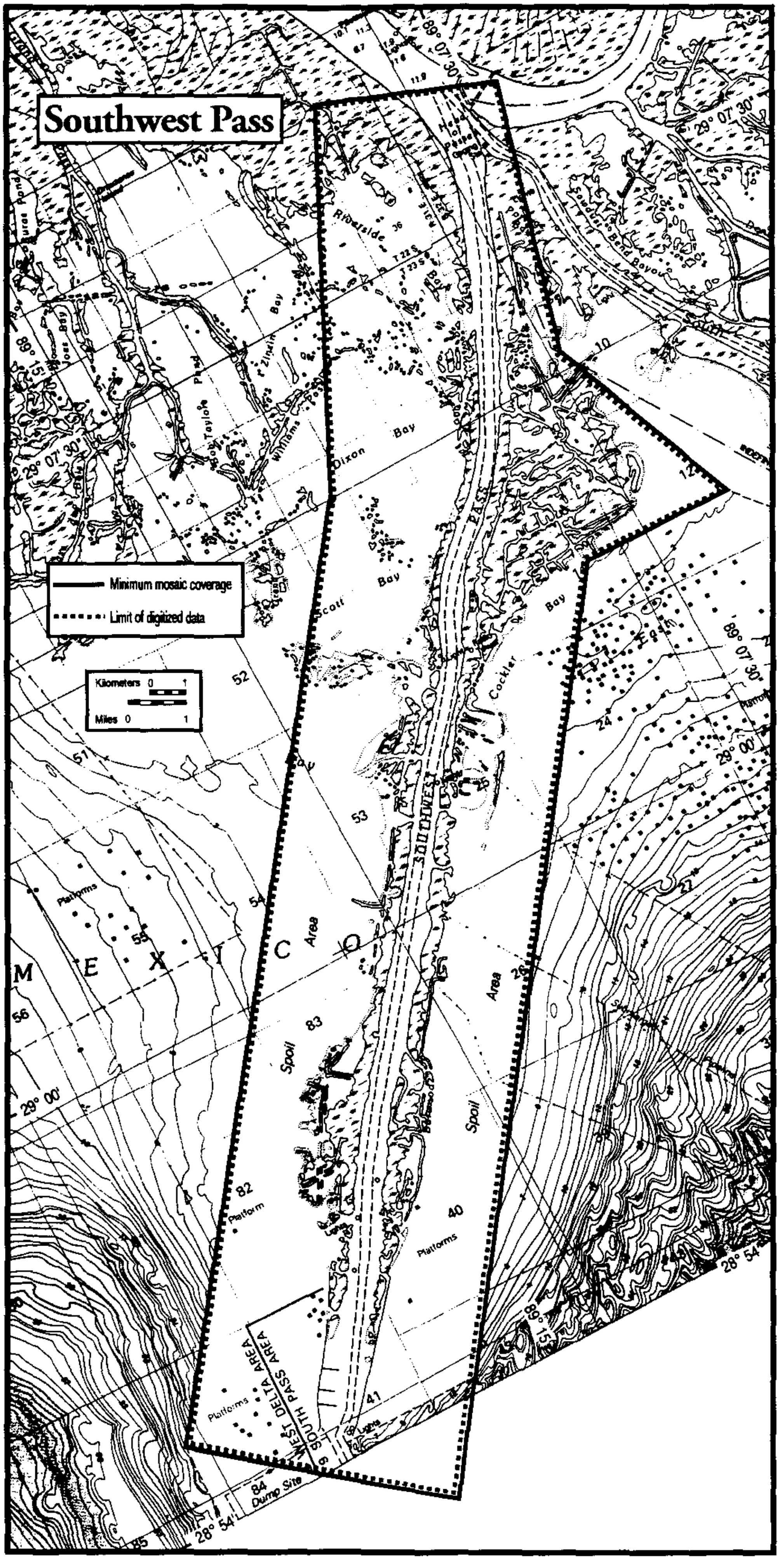


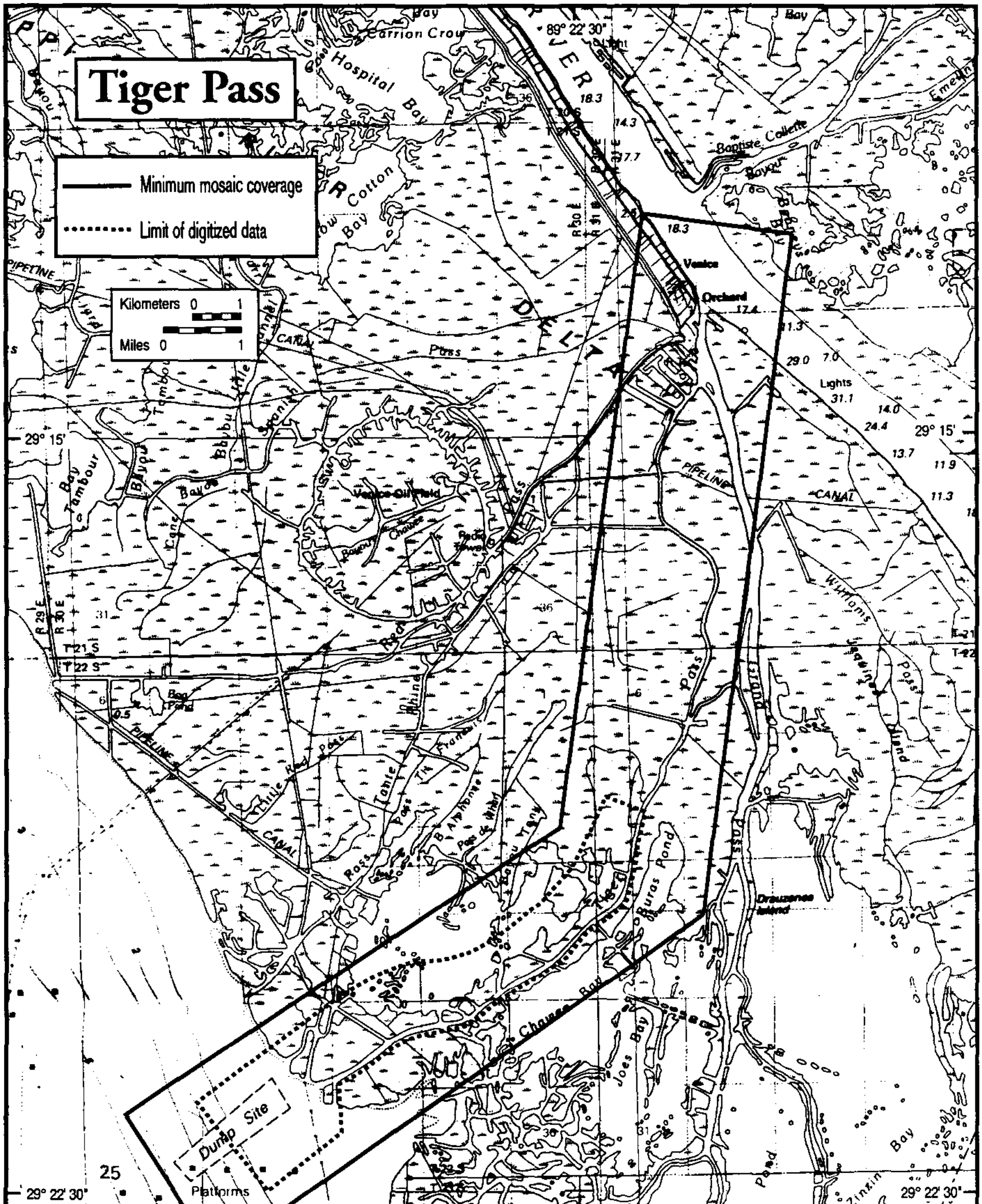
89° 15'
89° 07' 30"
Platforms
SPOIL AREA
35
36
37
38
29° 30'
Noah Point
Radio Tower
Breton Islands
BRETON NATIONAL WILDLIFE REFUGE
West Point
MISSISSIPPI RIVER
Spoil
46
45
44
43
Pipeline
51
52
53
54
O F M E X I C O
BRETON SOUND AREA
MAIN PASS AREA
Platform
29° 22' 30"
MRGO - Breton Island
56
Kilometers 0 1
Miles 0 1
Minimum mosaic coverage
Limit of digitized data

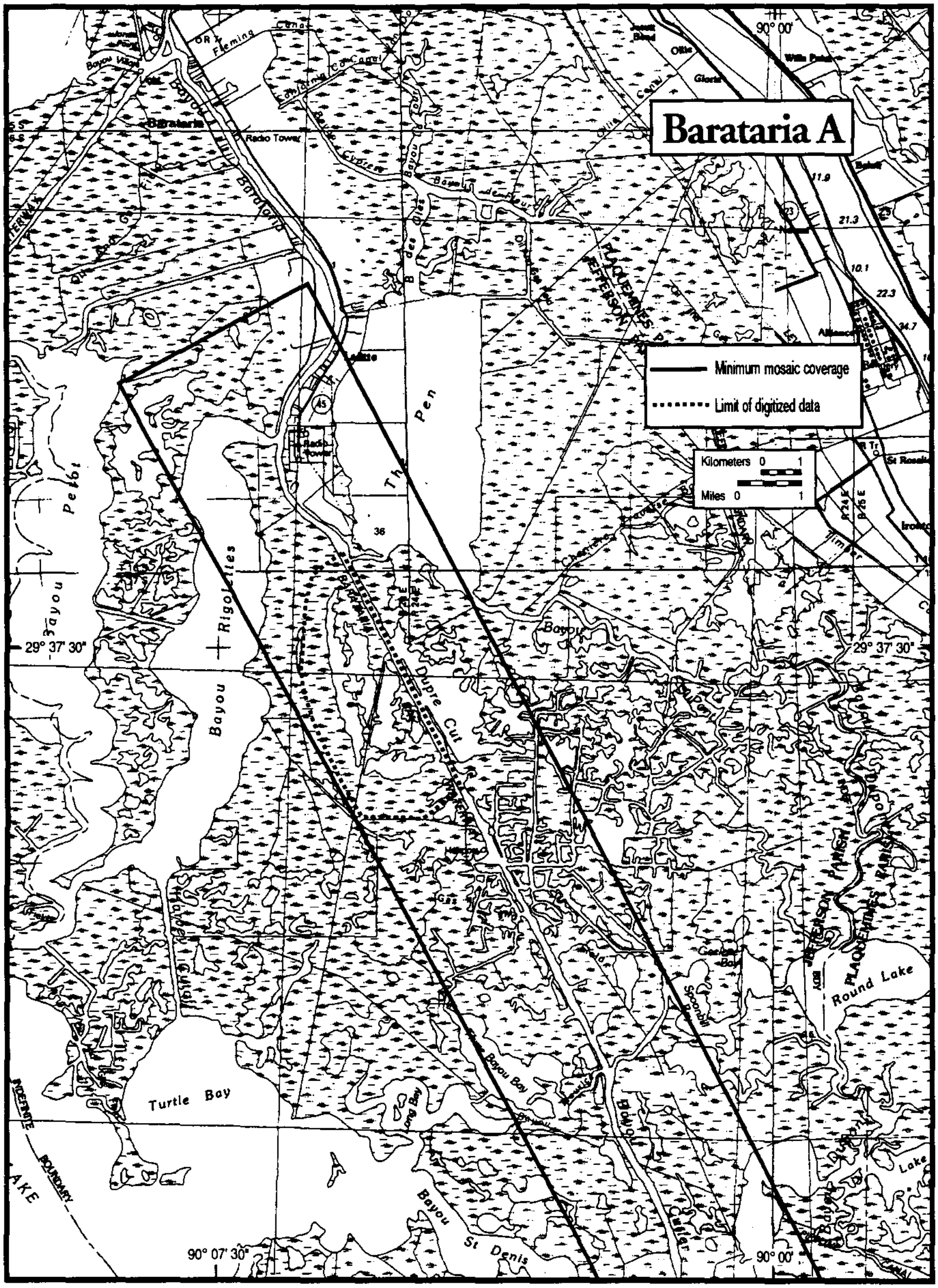
Baptiste Collette

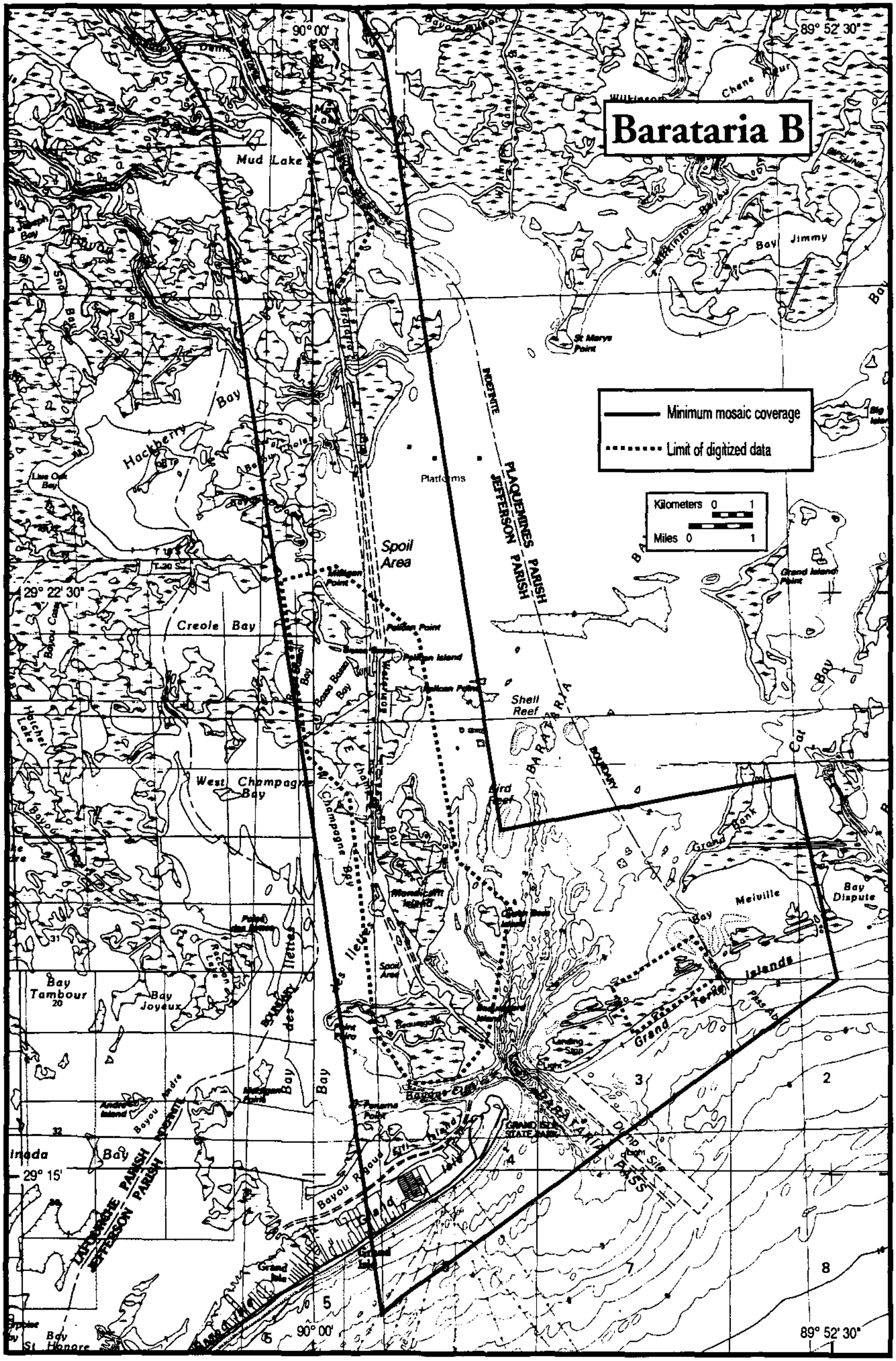


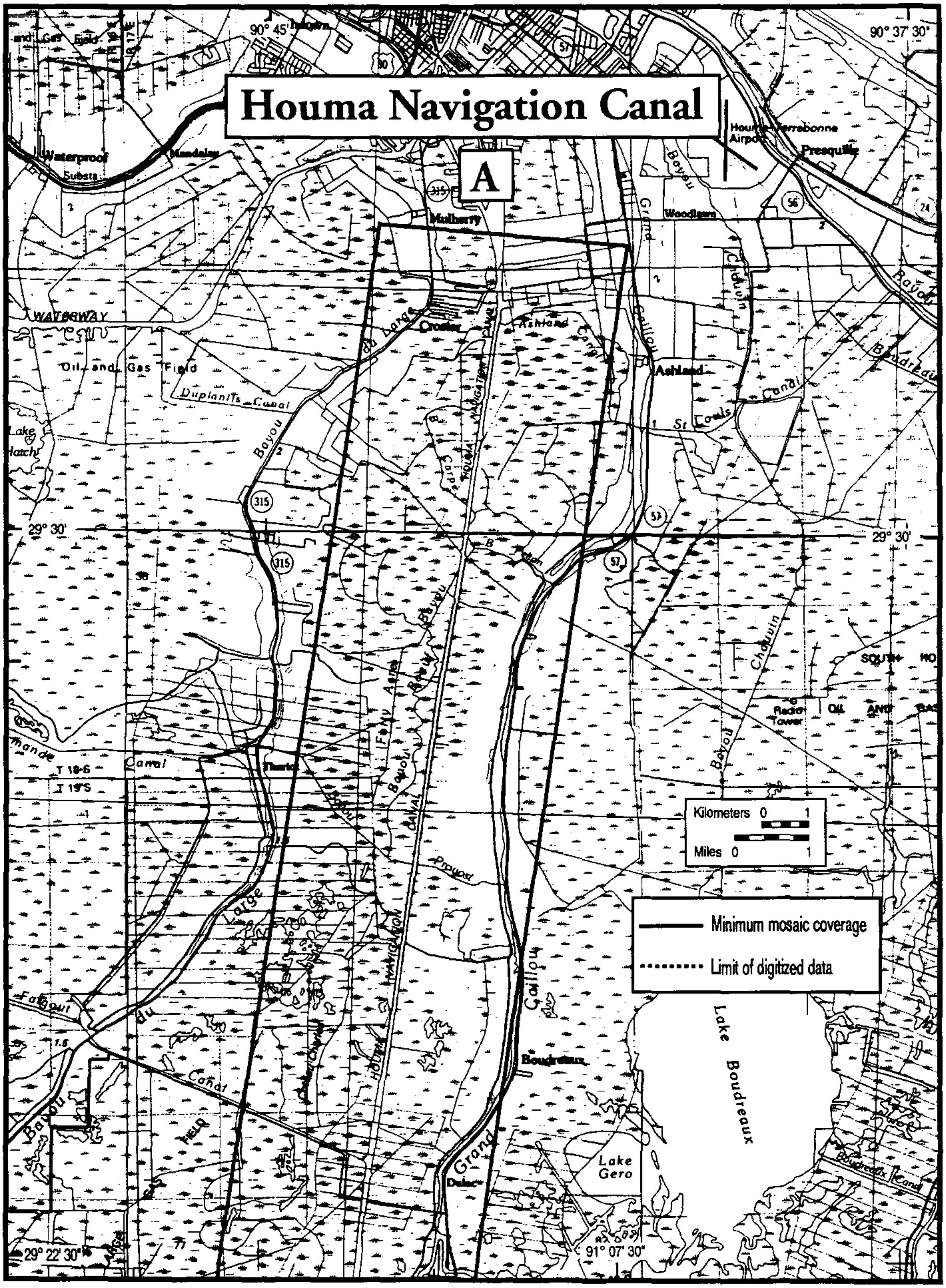

South Pass
Kilometers 0 1
Miles 0 1
Minimum mosaic coverage
Limit of digitized data
Cockler Bay
Dixon Bay
Zinzin Bay
Riverside Bay
Williams Pass
Bob Taylor Pond
Spoil Area
Garden Island
Johnson Pass
Loomis Pass
Platform
Platforms
Pipeline
Port Eads
PASS A LOUTRE STATE WATERFOWL

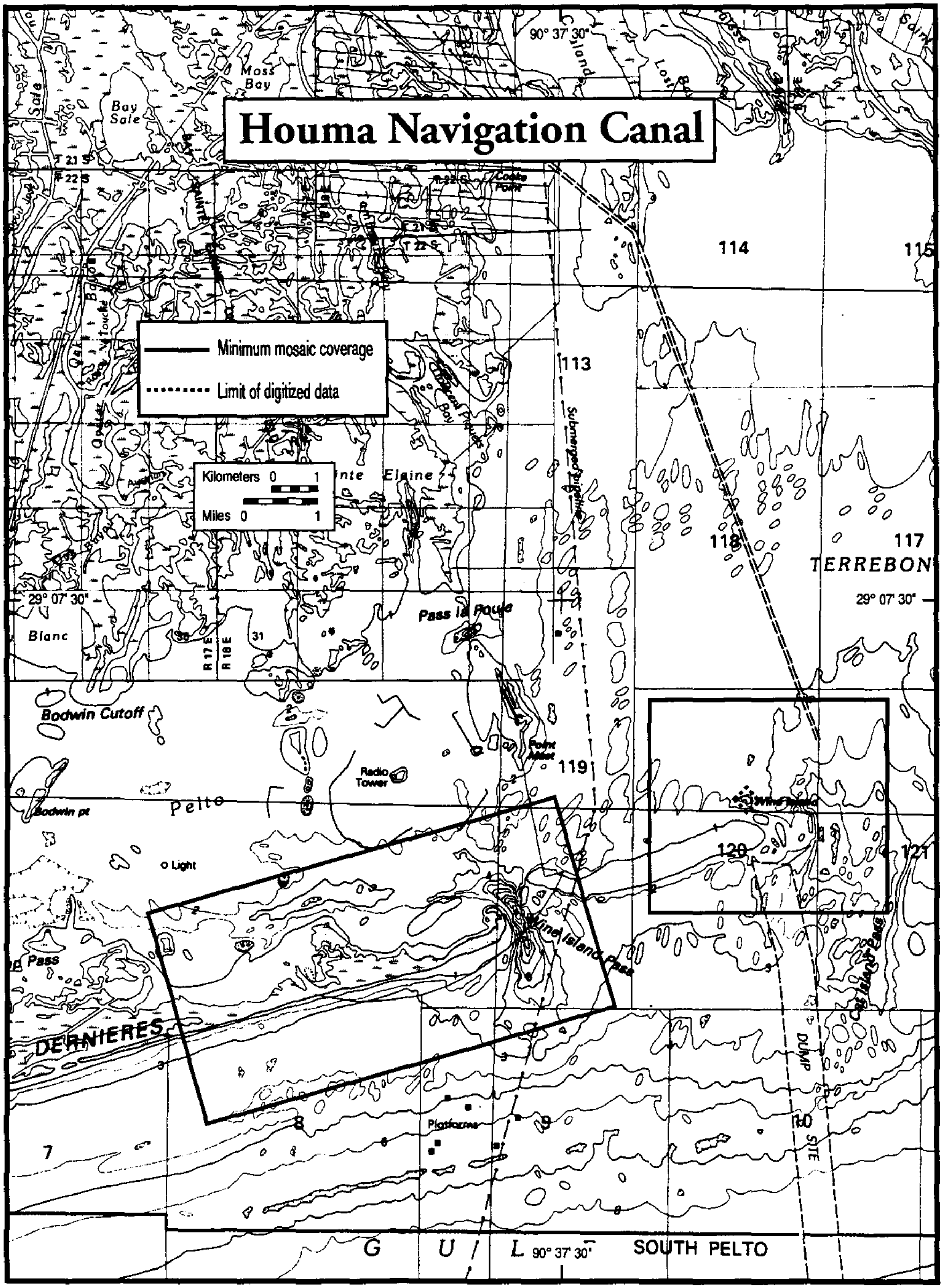

Southwest Pass
Minimum mosaic coverage
Limit of digitized data
Kilometers 0 1
Miles 0 1
Dixon Bay
Scott Bay
Cockler Bay
Riverside
SOUTHWEST PASS
Spoil Area
Spoil Area
M E X I C O
Platforms
Dump Site
SOUTH PASS AREA
WEST DELTA AREA
29° 07' 30"
29° 00'
28° 54'
89° 15'
89° 07' 30"


Tiger Pass
Minimum mosaic coverage
Limit of digitized data
Kilometers 0 1
Miles 0 1
Hospital Bay
Carrion Crow
Cotton Bay
Baptiste Collette Bayou
Venice
Orchard
Venice Oil Field
Pass
Lights
29° 15'
89° 22' 30"
29° 22' 30"
PIPELINE
CANAL
Bay Tambour
Bayou Cane
T 21 S
T 22 S
R 29 E
R 30 E
Red Pass
Little Red Pass
Grand Pass
Buras Pond
Dump Site
Platforms
Joes Bay
Drauzenes Island
Williams Pass
Zinzin Bay
Bob Taylor Pond
Chausse Bay
25

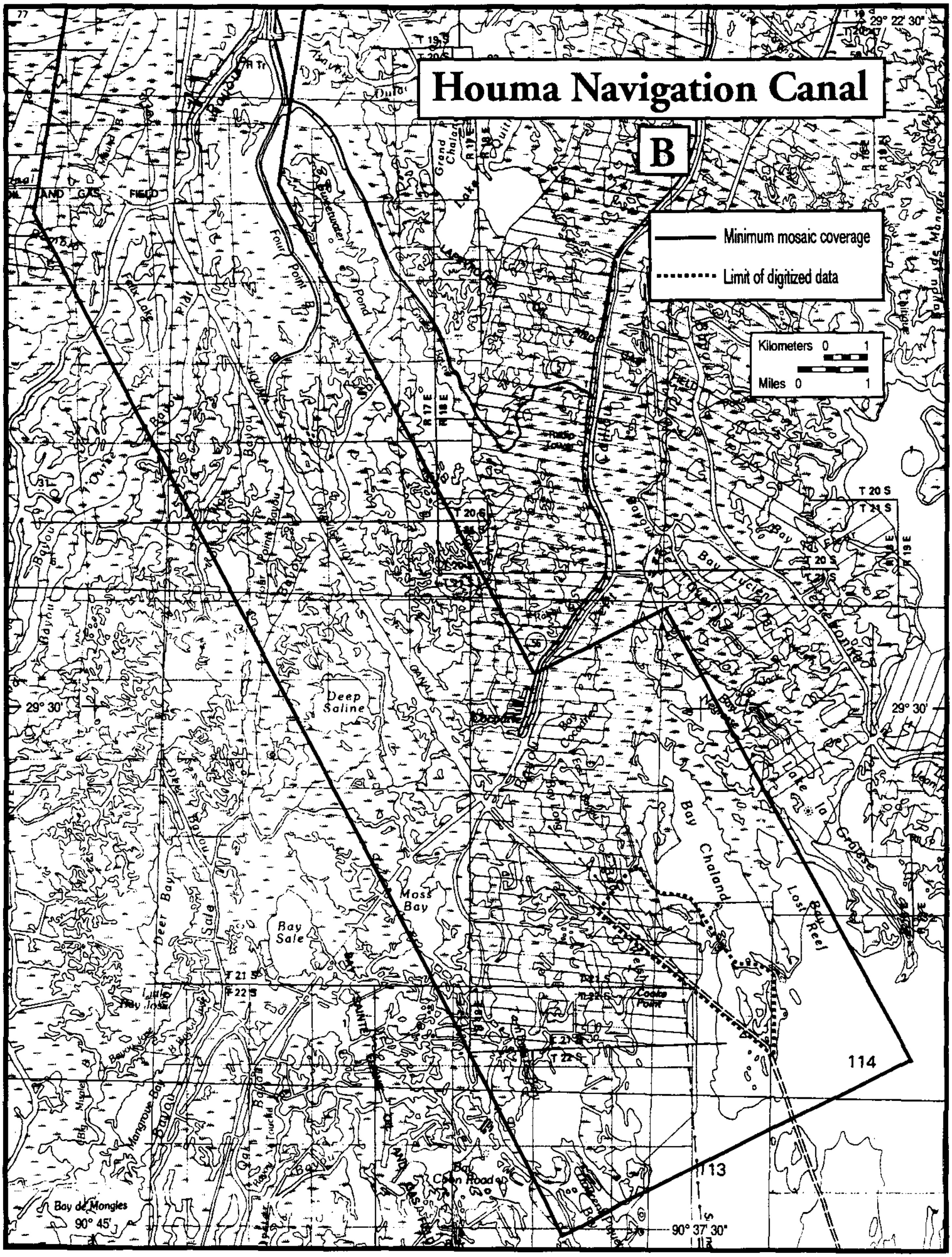

Barataria A
Minimum mosaic coverage
Limit of digitized data
Kilometers 0 1
Miles 0 1
90° 00'
29° 37' 30"
90° 07' 30"
Barataria
Radio Tower
The Pen
Bayou Dupre Cut
Bayou Rigolettes
Bayou Perot
Turtle Bay
Bayou St Denis
Round Lake
JEFFERSON PARISH
PLAQUEMINES PARISH

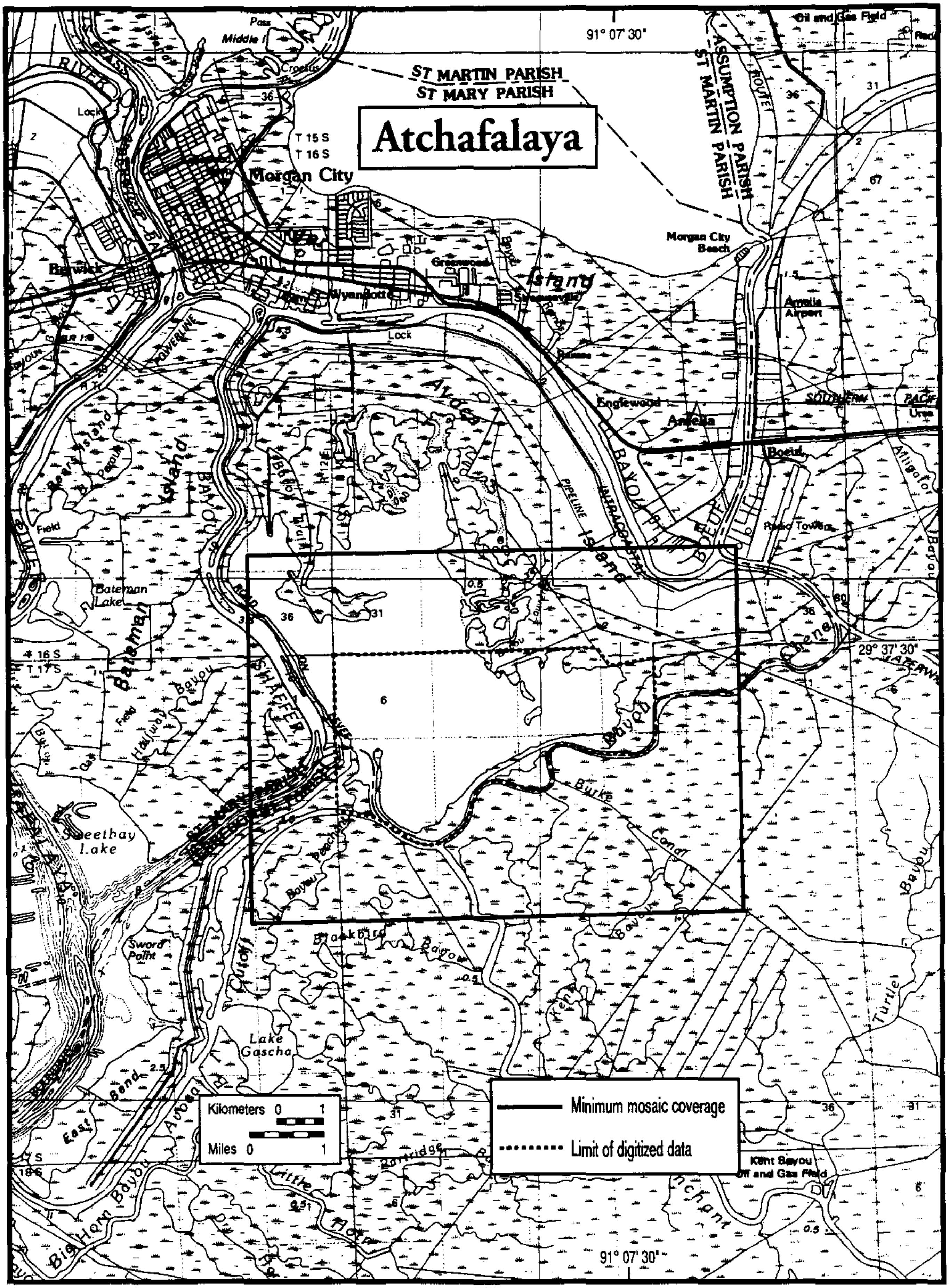

Barataria B
Minimum mosaic coverage
Limit of digitized data
Kilometers 0 1
Miles 0 1
90° 00'
89° 52' 30"
29° 22' 30"
29° 15'
Mud Lake
Hackberry Bay
Creole Bay
West Champagne Bay
Bay Tambour
Bay Joyeux
Spoil Area
Platforms
Shell Reef
Bird Reef
Bay Jimmy
Bay Melville
Bay Dispute
Grand Terre Islands
Grand Isle
PLAQUEMINES PARISH
JEFFERSON PARISH
LAFOURCHE PARISH
JEFFERSON PARISH
Grand Isle State Park


Houma Navigation Canal
A
Kilometers 0 1
Miles 0 1
Minimum mosaic coverage
Limit of digitized data
90° 45'
90° 37' 30"
29° 30'
29° 22' 30"
91° 07' 30"
Waterproof
Mandalay
Mulberry
Woodlawn
Presquille
Houma-Terrebonne Airport
WATERWAY
Oil and Gas Field
Duplantis Canal
Ashland
Ashland Canal
St Louis Canal
Crozier
Bayou Grand Caillou
Bayou Chauvin
Lake Hatch
Theriot
Lake Boudreaux
Lake Gero
Boudreaux
Dulac
Radio Tower
Boudreaux Canal

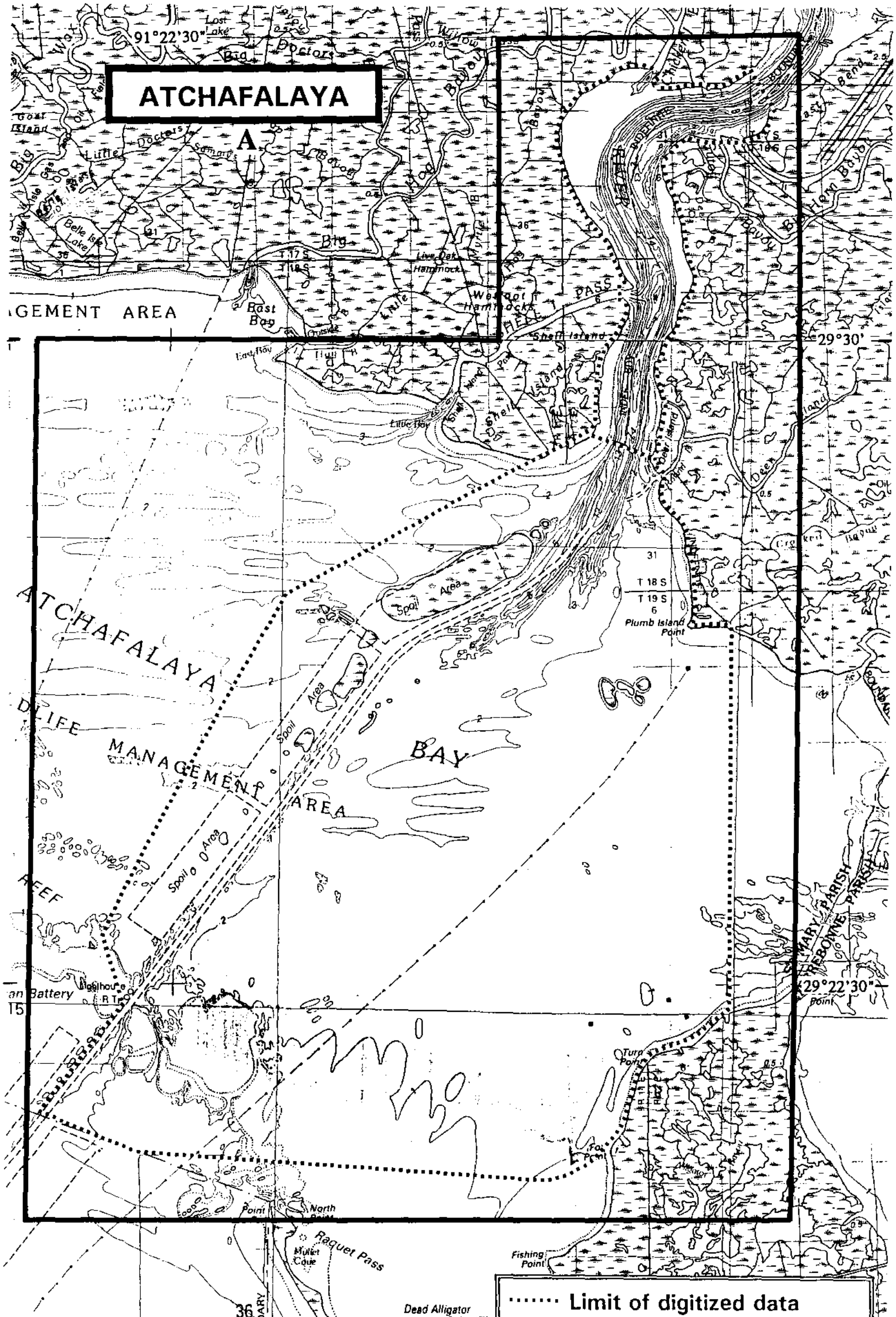


Houma Navigation Canal
Minimum mosaic coverage
Limit of digitized data
Kilometers 0 1
Miles 0 1
Moss Bay
Bay Sale
T 21 S
T 22 S
90° 37' 30"
29° 07' 30"
114
115
113
118
117
TERREBON
119
120
121
Blanc
Pass la Poule
Bodwin Cutoff
Radio Tower
Point Abbot
Pelto
Bodwin pt
Light
Wine Island Pass
Wine Island
Cat Island Pass
DERNIERES
Platforms
DUMP SITE
7
8
9
10
G U L
SOUTH PELTO
R 17 E
R 18 E
31
Submerged pipeline

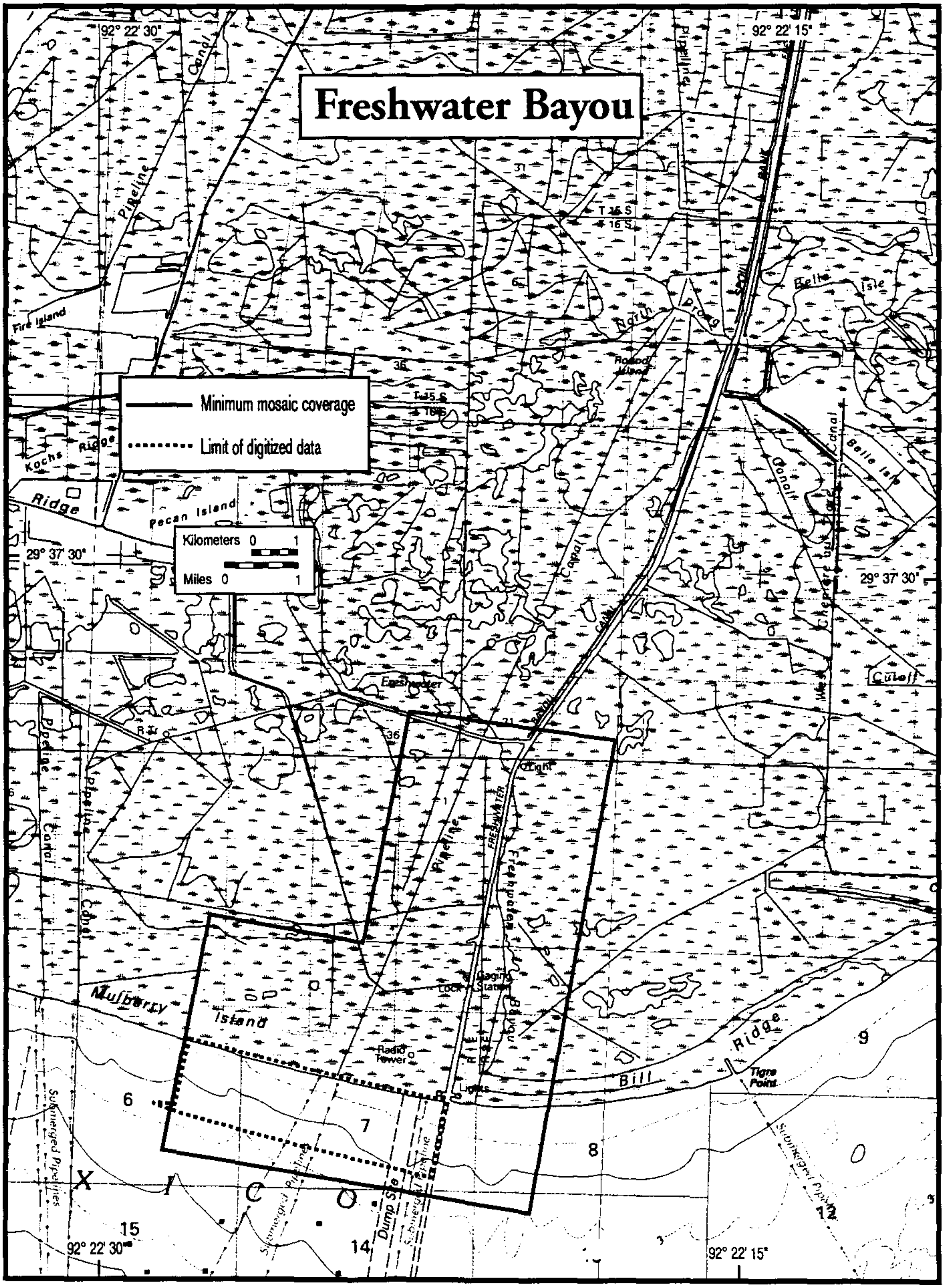

Houma Navigation Canal
B
Minimum mosaic coverage
Limit of digitized data
Kilometers 0 1
Miles 0 1
29° 22' 30"
29° 30'
29° 30'
90° 45'
90° 37' 30"
114
113
Deep Saline
Moss Bay
Bay Sale
Deer Bay
Bay Chaland
Lost Reel
Lake la Graisse
Four Point B
Bay Lucien
Bay de Mongles
Mangrove Bay
Little Bay Jose
Coate Point
T 20 S
T 21 S
T 22 S
R 17 E
R 18 E
R 19 E



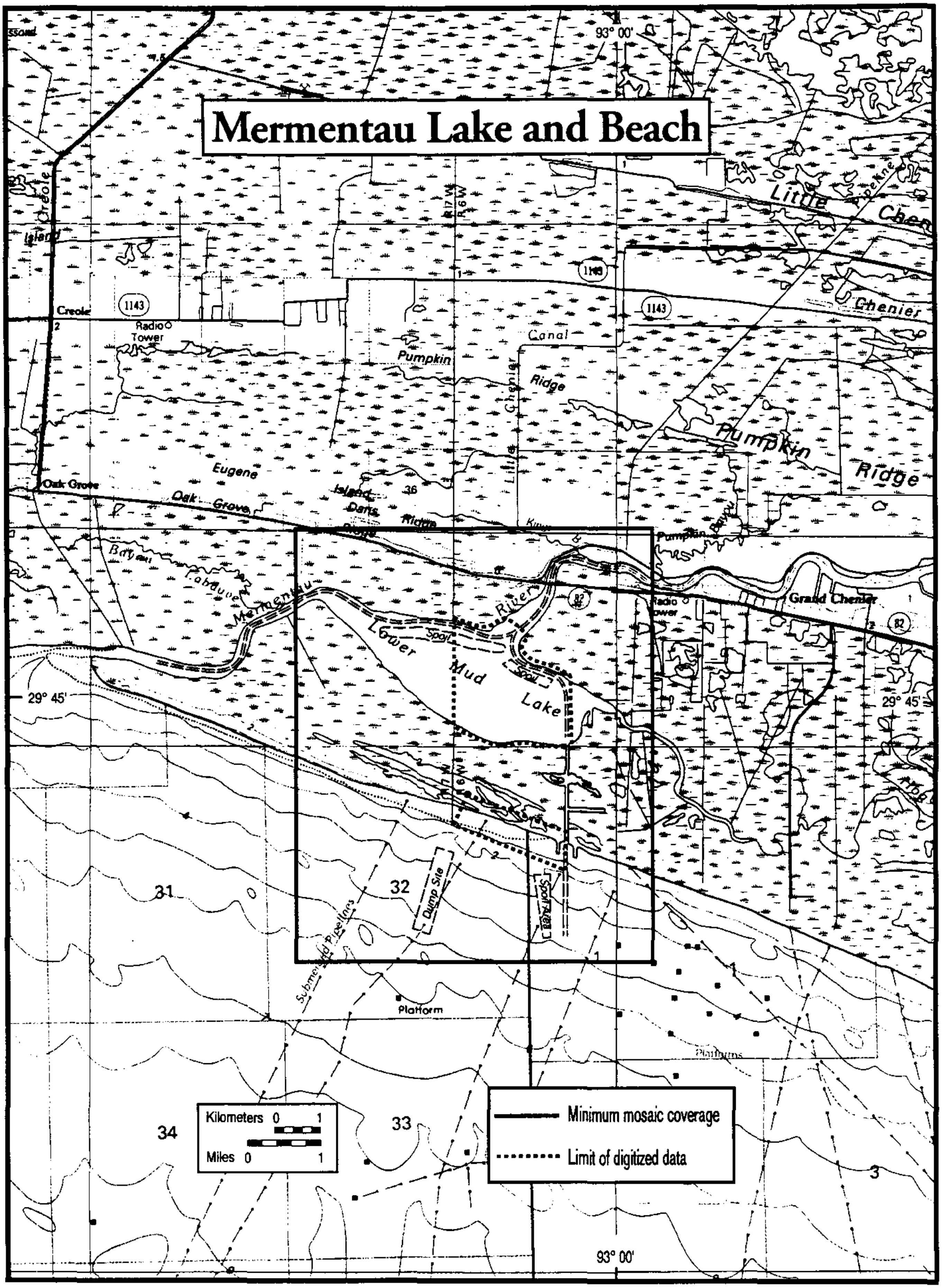
Atchafalaya
ST MARTIN PARISH
ST MARY PARISH
ASSUMPTION PARISH
ST MARTIN PARISH
91° 07' 30"
29° 37' 30"
Morgan City
Berwick
Wyandotte
Greenwood
Morgan City Beach
Amelia
Amelia Airport
Englewood
Lock
Bateman Lake
Sweetbay Lake
Sword Point
Lake Gascha
Burke Canal
Radio Towers
Kent Bayou Oil and Gas Field
T 15 S
T 16 S
T 17 S
Kilometers 0 1
Miles 0 1
Minimum mosaic coverage
Limit of digitized data



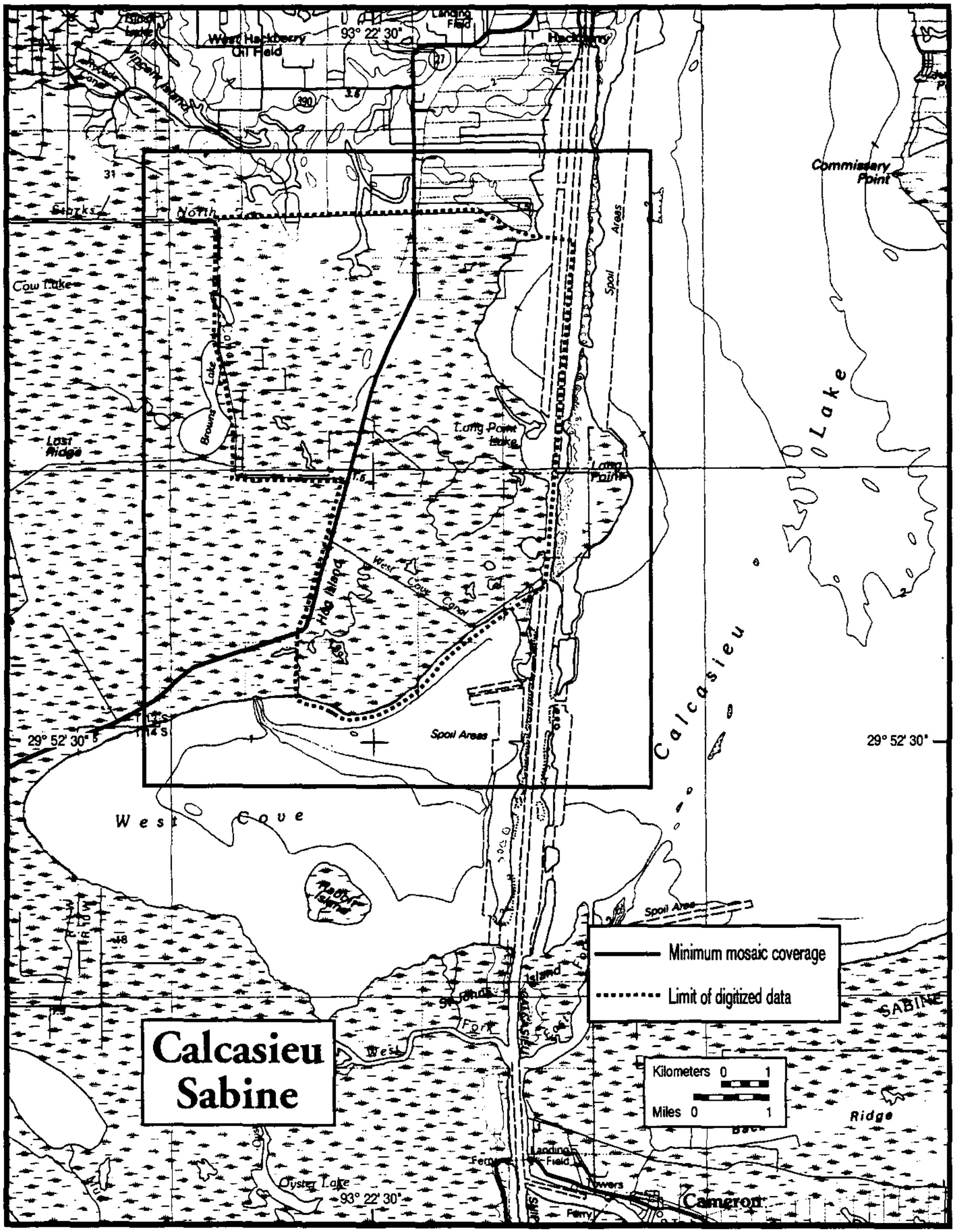
Original Scale 1:100,000
Reduced to 88%



Freshwater Bayou
Minimum mosaic coverage
Limit of digitized data
Kilometers 0 1
Miles 0 1
92° 22' 30"
92° 22' 15"
29° 37' 30"
Pecan Island
Kochs Ridge
Fire Island
Belle Isle
North Prong
Pipeline
Canal
Cutoff
Mulberry Island
Bill Ridge
Tigre Point
Gaging Station
Lock
Radio Tower
Lights
Light
Freshwater Bayou
Dump Site
Submerged Pipelines



Mermentau Lake and Beach
93° 00'
Little Chenier
Creole
Island
Creole
Radio Tower
1143
Canal
Pumpkin
Ridge
Little Chenier
Pumpkin Ridge
Eugene
Island
Oak Grove
Oak Grove
Dans Ridge
36
Pumpkin Bayou
Bayou Labauve
Mermentau
River
Lower Mud Lake
Spoil
Radio Tower
Grand Chenier
82
29° 45'
29° 45'
32
31
Dump Site
Spoil Area
Submerged Pipelines
Platform
33
34
Kilometers 0 1
Miles 0 1
Minimum mosaic coverage
Limit of digitized data
93° 00'



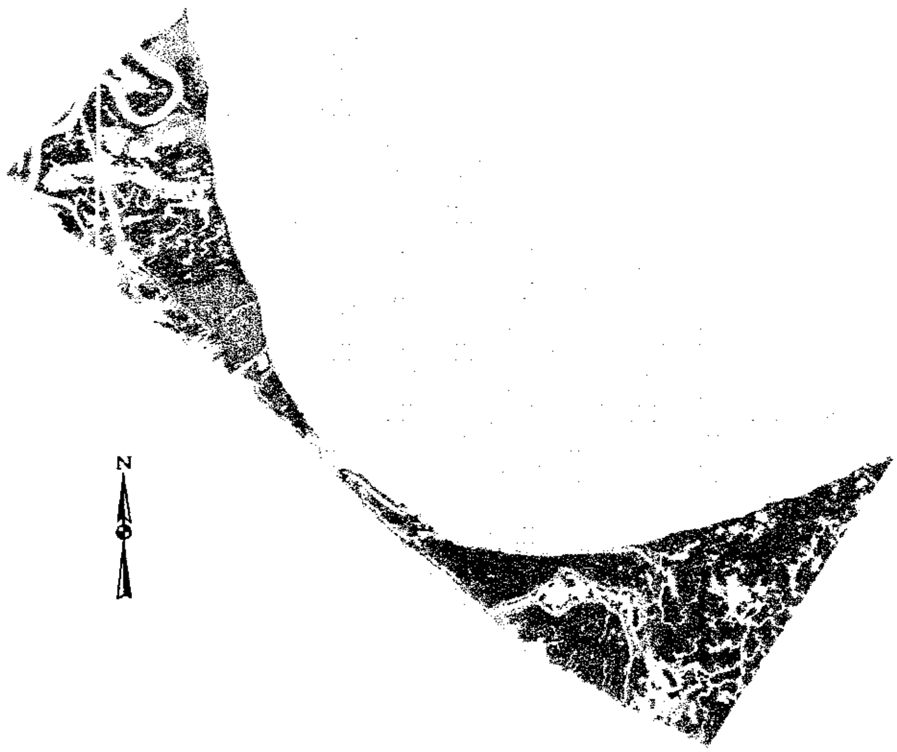
West Hackberry Oil Field
93° 22' 30"
Hackberry
Commissary Point
Cow Lake
Lost Ridge
Browns Lake
Long Point Lake
Long Point
Spoil Areas
Hog Island
West Cove Canal
29° 52' 30"
Calcasieu Lake
West Cove
Rabbit Island
Spoil Area
Minimum mosaic coverage
Limit of digitized data
Calcasieu
Sabine
Kilometers 0 1
Miles 0 1
Ridge
Oyster Lake
Cameron
SABINE

U.S. Army Corps of Engineers - New Orleans District
Louisiana State University - Coastal Studies Institute

BENEFICIAL USE OF DREDGED MATERIAL MONITORING PROGRAM 1996 ANNUAL REPORT

Part 2: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River Gulf Outlet, Louisiana - Inland Reach Vicinity Mile 60-50

Base Year 1990 through Fiscal Year 1996



Shea Penland, Karen A. Westphal, Qiang Tao, Jamie Phillippe, Chris Zganjar and Paul Connor
Louisiana State University - Coastal Studies Institute
Baton Rouge, LA 70803

and

Linda Mathies, Beth Nord, Ed Creef, and Robert Gunn
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U.S. Army Corps of Engineers - New Orleans District
New Orleans, LA 70160-0267

Baton Rouge, Louisiana
1997

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INTRODUCTION

The Mississippi River Gulf Outlet (MR-GO) navigation channel - Inland Reach Vicinity Mile 60-50 BUMP study area is located 10 miles southeast of New Orleans between MR-GO Mile 47 and Mile 59 (Figure 1). The U.S. Army Corps of Engineers - New Orleans District (USACE-NOD) maintains this navigation channel through the abandoned St. Bernard delta complex. Because the St. Bernard delta complex is abandoned by the Mississippi River, it is experiencing rapid coastal erosion and wetland loss.

The Beneficial Use of dredged material Monitoring Program (BUMP) at Louisiana State University - Coastal Studies Institute (LSU-CSI) is documenting the beneficial use of dredged material using aerial photography, geographical information system (GIS) analysis, and field surveys through the sponsorship of the USACE-NOD. BUMP results are provided in map series, annual reports, and scientific literature.

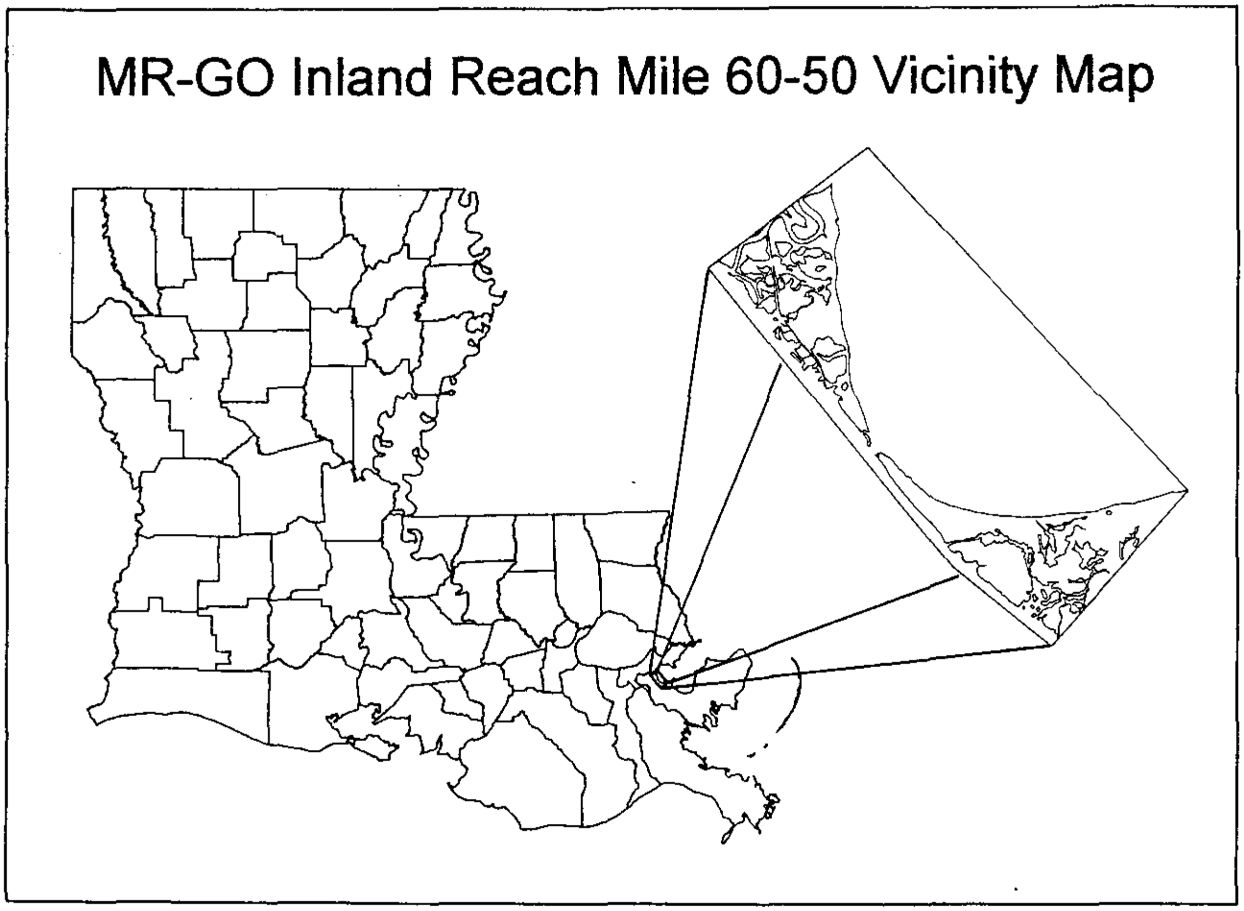


Figure 1. The location of the Mississippi River Gulf Outlet navigation channel - Inland Reach Vicinity Mile 60-50 BUMP study area in Louisiana.

In this report, LSU presents the first results of the BUMP analysis at the Mississippi River Gulf Outlet navigation channel - Inland Reach Vicinity Mile 60-50 study area, which represents monitoring results through the USACE-NOD 1996 Fiscal Year (FY). This is the second part of the nine part Beneficial Use of dredged material Monitoring Program (BUMP), 1996 Final Report. The nine parts are:

- Part 1: Introduction and Methodology
- Part 2: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River Gulf Outlet, Louisiana - Inland Reach Vicinity Mile 60-50
- Part 3: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River Gulf Outlet, Louisiana - Jetties Reach
- Part 4: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River Gulf Outlet, Louisiana - Breton Island
- Part 5: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River Outlet, Venice, Louisiana - Baptiste Collette Bayou
- Part 6: Results of Monitoring the Beneficial Use of Dredged Material at the Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana - Southwest Pass
- Part 7: Results of Monitoring the Beneficial Use of Dredged Material at the Houma Navigation Channel, Louisiana - Terrebonne Bay Reach
- Part 8: Results of Monitoring the Beneficial Use of Dredged Material at the Atchafalaya River and Bayous Chene, Boeuf, and Black, Louisiana - Lower Atchafalaya River Horseshoe
- Part 9: Results of Monitoring the Beneficial Use of Dredged Material at the Atchafalaya River and Bayous Chene, Boeuf, and Black, Louisiana - Atchafalaya Bay/Delta and Bar Channel

Using aerial photography LSU classified the natural and man-made habitats in the study area for December 1990, November 1995, and November 1996, including habitat created during the USACE-NOD FY 1995 maintenance event. Previous maintenance events occurred in FY 1988, FY 1993 and FY 1995. There was no maintenance dredging in the Vicinity of Mile 60-50 during FY 94 or FY 96. Through the GIS analysis, these areas were calculated and changes were documented between 1990, 1995 and 1996. Field surveys were conducted on the beneficial use area created during the FY 1993 and FY 1995 maintenance events. Habitats were ground truthed and survey transects established to document vegetation species, stacking elevations, and subsidence. Figure 2 shows the areas of minimum air photo mosaic coverage and the limit of the digitized area.

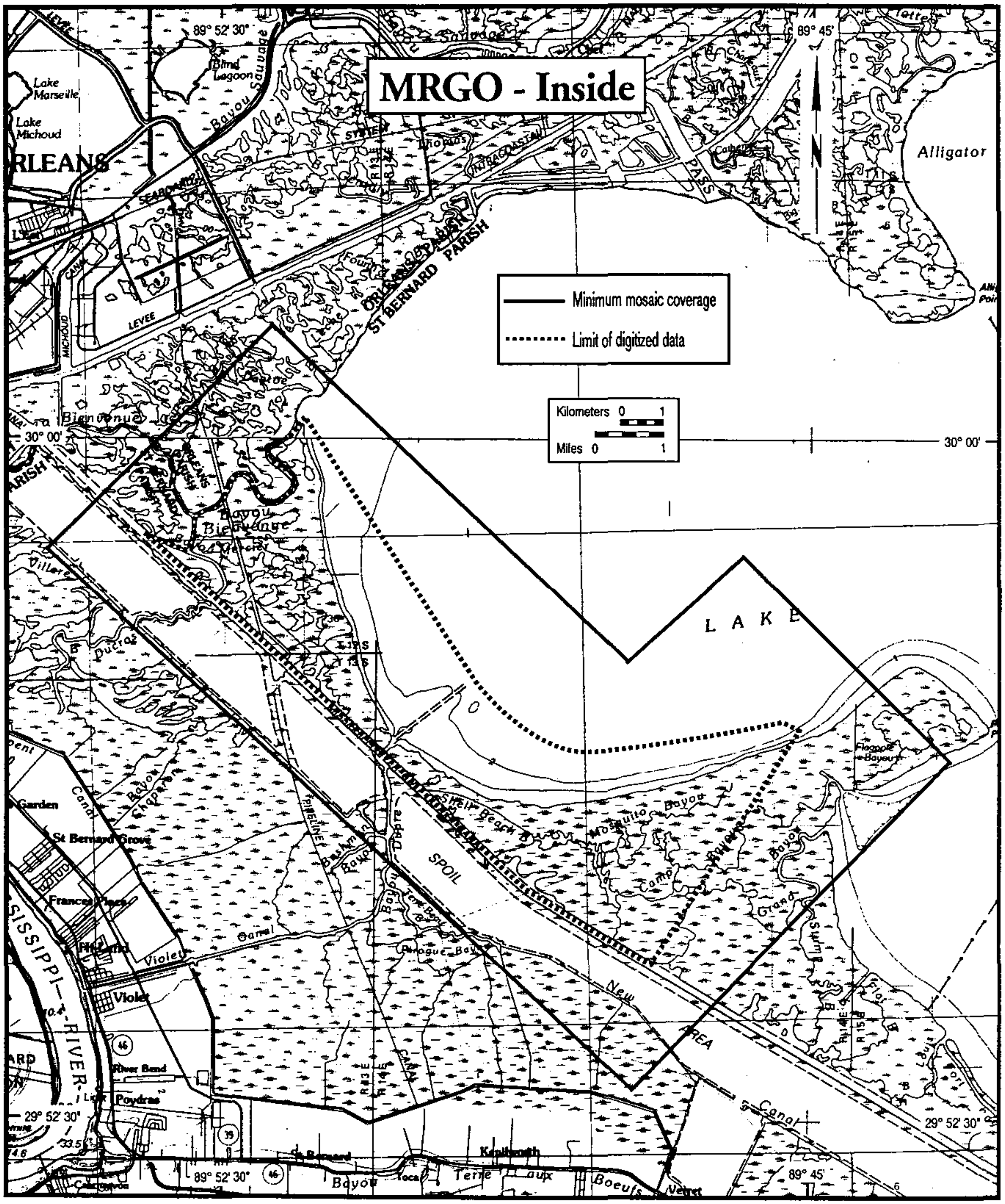


Figure 2. Location of the Mississippi River Gulf Outlet - Inland Reach Vicinity Mile 60-50 BUMP study area showing the minimum coverage of the aerial photo-mosaic and the limits of the area digitized.

DREDGED MATERIAL DISPOSAL HISTORY

The Rivers and Harbors Act of 1956 authorized the USACE-NOD to construct and maintain a deep draft navigation channel 36 feet deep by 500 feet wide from the Inner Harbor Navigation Canal in New Orleans to the Chandeleur Islands (Mile 66.0 to Mile 0) and a channel 38 feet deep by 600 feet wide from the islands to the 38 foot contour in the Gulf of Mexico (Mile 0 to Mile -9.0). Construction of the Mississippi River - Gulf Outlet (MR-GO), Louisiana, navigation channel was initiated in 1958 and enlargement to full project dimensions was completed in 1968. Maintenance of discontinuous reaches of the channel has been accomplished on an annual basis since construction was completed.

Figure 3 illustrates the dredged material disposal history for the MR-GO-Inland Reach Vicinity Mile 60-50 BUMP study area prior to November 1996. Prior to and including the USACE-NOD Fiscal Year 1988 maintenance event, dredged material removed from the Inland Reach vicinity Mile 50 to Mile 60 of the channel was placed into existing upland confined disposal facilities located on the south bank of the navigation channel.

For the FY 1993 maintenance event, dredged material removed from the Inland Reach vicinity of Mile 50 to Mile 60 was placed within confined wetlands development disposal areas A, B, C, D and F (Figure 3) located on the north bank of the navigation channel. The disposal areas are located between Lake Borgne and the MR-GO navigation channel. In general, the dredged material was pumped into shallow, open-water areas and ponds within the marsh and allowed to flow unrestricted within the confining dikes. The dikes were constructed along the perimeter of the disposal areas to prevent the dredged material from flowing into the navigation canal, Lake Borgne, Shell Beach Bayou and a no-work area. The maximum initial height of the dredged material placed for wetlands development/restoration was not to exceed +3.0 feet Mean Low Gulf (MLG) (+2.2 National Geodetic Vertical Datum (NGVD)).

During the FY 1995 maintenance events, dredged material removed from the Inland Reach vicinity of Mile 60 to Mile 50 and Michoud Canal was placed within confined wetlands development disposal areas B, D, E, and F. Dredged material was pumped into shallow open water areas within the disposal area and into the borrow canals that were excavated during retention dike construction and allowed to flow unrestricted into shallow ponds and broken marsh areas. At disposal area E earthen closures with a shell cap were constructed along Bayou Beinvenue bankline and plastic sheet pile closures were constructed along the Lake Borgne shoreline to prevent dredged material from flowing into Bayou Bienvenue and Lake Borgne. During FY 1995 the initial height of the dredged material placed in the disposal areas was not to exceed +3.5 feet MLG (+2.7 NGVD).

MISSISSIPPI RIVER GULF OUTLET DREDGING HISTORY

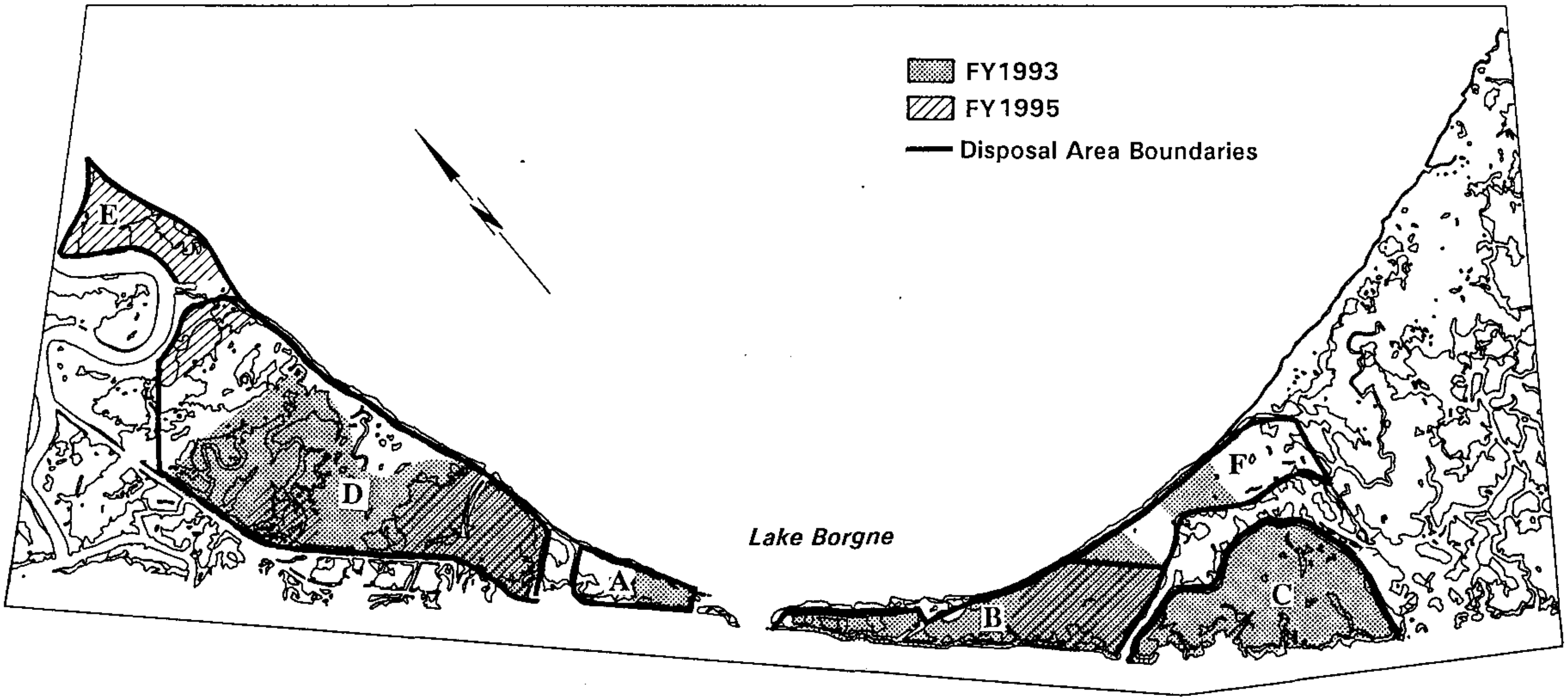


Figure 3. The dredged material disposal history for the Mississippi River Gulf Outlet - Inland Reach Vicinity Mile 60-50 BUMP study area before November 1996, and the USACE-NOD designated disposal areas.

FIELD SUMMARY RESULTS

Methodology

Elevation Profile Surveys

The MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area is located between Lake Borgne and the MR-GO navigation channel 10 miles southeast of New Orleans (Figure 2).

The collection of survey profiles was made in two phases. Phase-I involved assessing the characteristics of the study site to determine the most applicable position to setup a long-term monitoring program. This was accomplished using vertical aerial photography, reviewing dredging schedules and history, ground truthing the study area, defining varying vegetation and morphology, and assessing access possibilities. Based on these factors, one transect line was positioned at each of three widely spaced sites; one near Bayou Bienvenue to the northeast , one within an area designated by the USACE-NOD as "Area B", and a third site was established across Bayou Mercier within area "D" (Figure 4). At least one stake was permanently placed at each site to establish the profile transects. Permanent 1-inch diameter by 6-foot galvanized stakes were driven approximately 3.5 feet into the ground and secured with concrete. 8 ft. white, PVC pipes painted bright orange were placed over the stakes to help make relocation easier and to prevent damage from possible transportation through the area. The position of the stakes was determined using a Global Positioning System (GPS).

Phase-II involved the actual collection of profile datum. Two profile surveys were conducted in November 1996, and one profile survey was conducted in June of 1997, along the transects defined by the stakes during phase-I. One profile transect was collected from each site selected in the MR-GO- Inland Reach Vicinity Mile 60-50 area. Survey datum and profiles 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 $\pm$ 0.0125 ft., with a vertical accuracy of 0.45 ft $\pm$ 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, the position and exact orientation of each transect line, and the location of vegetation encountered along the transect lines. The transect datum collected were processed, referenced to local tide gages, and entered into a graphic software program to produce topographic profiles.

The topographic profiles for MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area were constructed in reference to the tide gage at Shell Beach, Lake Borgne, Louisiana (29°52' N / 89°41' W) and are corrected to Mean Sea Level (MSL). The mean diurnal tidal range for the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area is published as 1.4 ft. Profiles here ranged from 950 to 1200 feet in length. Maximum relief along profile A-A' at the Bayou Bienvenue site was 2.76 feet, with an average relief of 1.04 feet. Profile B-B' at the Area B site exhibited a maximum relief of 4.77 feet, with an average relief of 1.48 feet. Profile C-C' at the Bayou Mercier site exhibited a maximum relief of 2.85 feet , with an average relief of 1.45 feet. The area was characteristically defined as a low relief salt marsh throughout. The surficial sedimentology of the peninsula is composed of tidalite type sediments (silty clays, with very fine quartz sand).

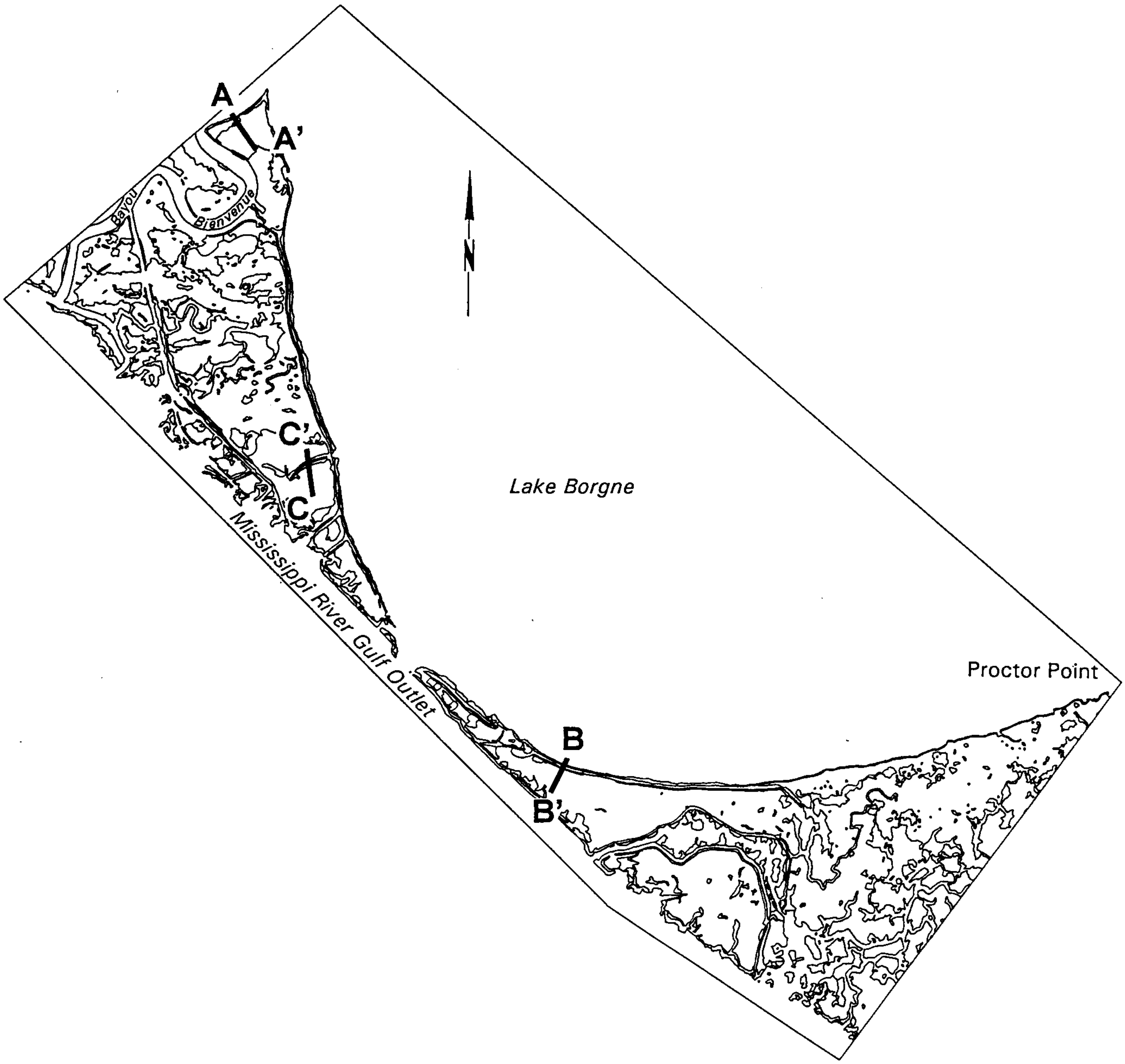


Figure 4. Location of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area profile transects.

Vegetation Surveys

Ground truthing for vegetative species composition and habitat verification was done in November 1996. Species composition was determined within an approximate six-foot swath along each transect. 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 author. 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 in Appendix 2A 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 time of the profile collection or ground truthing, and therefore can not be included in the list other than by a broad classification.

Profiles

The 1996 profiles were established with permanent 1-inch diameter by 6-foot galvanized stakes that were driven approximately 3.5 feet into the ground and secured with concrete. At least one stake was placed at each site to define each profile.

Bayou Bienvenue transect

The Bayou Bienvenue transect is located within the USACE-NOD Disposal Area "E" of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study site, to the south of where the bayou empties into Lake Borgne, and is generally defined by the shorelines of these waterbodies (Figure 4). The site was utilized during FY 1995. Construction activities at the site included the construction of an earthen retention dike encircling a deteriorating saltmarsh. In addition the dike was reinforced with a shell cap at two breaches located along the Bayou Bienvenue bankline and plastic sheet pile closures at two breaches located along the Lake Borgne shoreline. During the site inspection, several breaks were observed in the dike and it was noticed that the enclosed area was open to tidal action. This site included a vast amount of shallow, open water. The material within the disposal area was extremely fine grained, soft mud, sparsely colonized by widely spaced clumps of saltmarsh grass (Figure 5).

The transect was delineated by 1 permanent stake set in the north, shell and earth retaining dike along the southeast bank of Bayou Bienvenue, and one temporary stake set in the soft substrate of the old marsh at the southeast side of the site. It traversed the old deteriorating marsh, the shallow open water, and new colonizing marsh next to the retaining dike approximately parallel to the Lake Borgne shoreline (Figure 6).

The profile was 1200 feet in length. The maximum relief along the axis is 2.76 feet (MSL), with an average relief of 1.04 feet. The profile indicates that the disposal area is typically characterized as an intertidal mud flat colonized by saltmarsh (Figure 7).

Figure 5. Photograph of the MR-GO - Inland Reach Vicinity Mile 60-50 Bayou Bienvenue (Area E) BUMP study site taken on November 7, 1996 showing the shallow open water, sparsely colonized by widely spaced clumps of *Spartina alterniflora*. The view is from the back stake along the transect to the front stake that is just to the left of the marsh clump in the foreground.

Figure 6. Photograph of the MR-GO - Inland Reach Vicinity Mile 60-50 Bayou Bienvenue (Area E) BUMP study site taken on November 7, 1996 showing the existing saltmarsh protected by the earthen dike. View is from front stake toward the back stake which is placed in old marsh in the background.

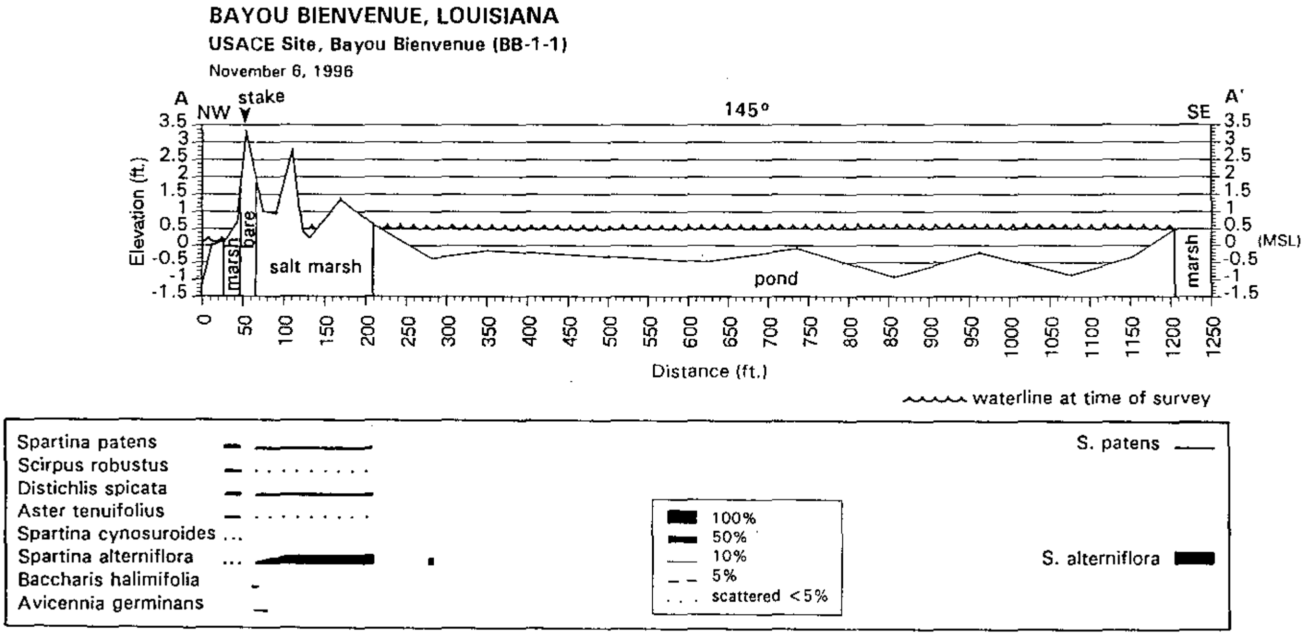


Figure 7. Elevation profile of the MR-GO Bayou Bienvenue (Area E) BUMP study site with vegetation data illustrated. Elevation is in reference to Mean Sea Level.

Bayou Dupre transect

The Bayou Dupre transect is located within the USACE-NOD Disposal Area "B" (Figure 3) toward the south portion of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area (Figure 4). An earthen levee was constructed around existing saltmarsh and material was filled in around the marsh during the FY 1993 and FY 1995 maintenance events (Figure 8). A shallow, water-filled borrow canal runs parallel to the levee on the inland side. The substrate was solid, compacted clay and silt and was well colonized by salt marsh (Figure 9). The nearshore was steep and of a sandy substrate.

The transect was delineated by one stake set in the top of the earthen levee on the northeast side of the site, near the shoreline of Lake Borgne and near the west end of the borrow canal east of the trees. The transect was set perpendicular to the Lake Borgne shoreline.

The profile was 950 feet in length. The maximum relief was 4.77 feet (MSL), with an average relief of 1.48 feet. The profiles indicate that the area is typically characterized as a low relief saltmarsh (Figure 10).

Figure 8. Photograph of the MR-GO - Inland Reach Vicinity Mile 60-50 Bayou Dupre (Area B) BUMP study site taken on November 7, 1996 of material added to the marsh as evidenced by mud cracks and the clumping appearance of the vegetation.

Figure 9. Photograph of the MR-GO - Inland Reach Vicinity Mile 60-50 Bayou Dupre (Area B) BUMP study site taken on November 7, 1996 showing the thick growth of *Spartina alterniflora* saltmarsh in the interior of Disposal Area "B".

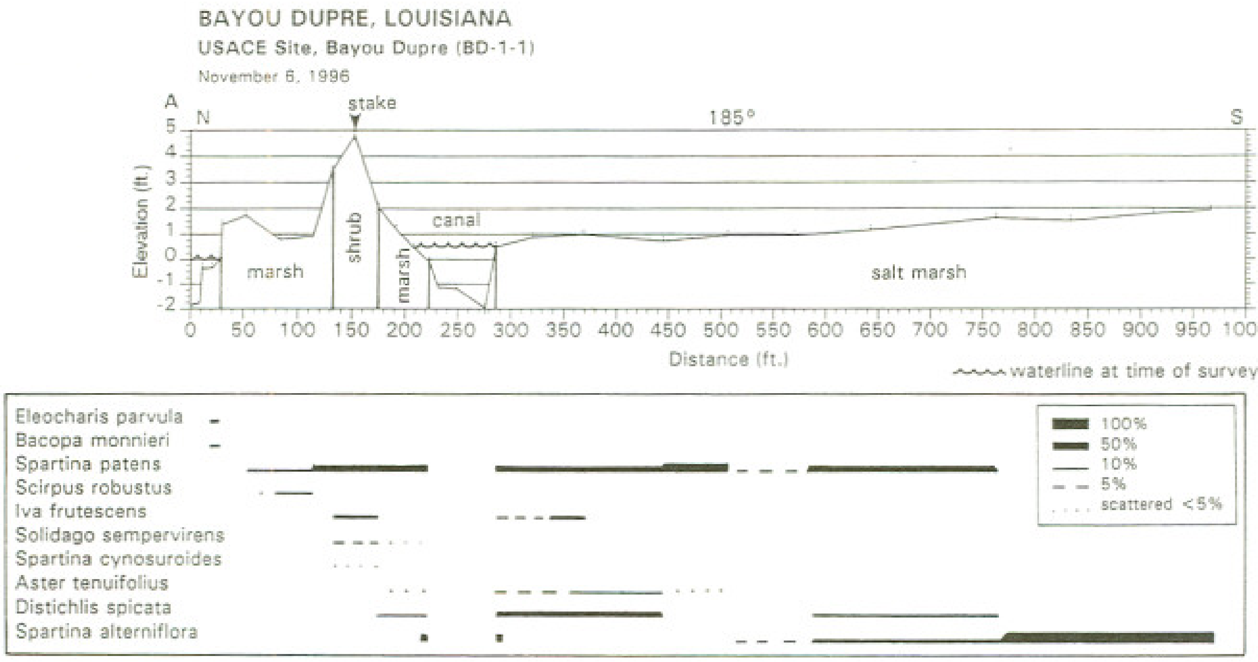


Figure 10. Elevation profile of the MR-GO - Inland Reach Vicinity Mile 60-50 Bayou Dupre (Area B) BUMP study site with vegetation data illustrated. Elevation data is in reference to Mean Sea Level.

Bayou Mercier transect

The Bayou Mercier transect is located within the USACE-NOD Disposal Area "D" (Figure 3) located at the north-central part of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area (Figure 4). The relict feature of Bayou Mercier lies east-west across the disposal area. An earthen levee was constructed around the east, south and west sides of the existing saltmarsh and material was filled in around the marsh during the FY 1993 and FY 1995 maintenance events. A shallow, mud-filled borrow canal runs along the inland side of the levee on the Lake Borgne shore. This soft-mud canal prevented access to the area in November 1996 for ground truthing and elevation determinations until later during a dry season. Subsequent ground truthing in June 1997 revealed that some of the areas that had appeared as water on the aerial photography were actually low-relief bare land that had been inundated by a high water event at the time of the photography. The substrate was soft, compacted clay and silt, and was beginning to be colonized by scattered intermediate marsh.

The transect was delineated by one stake set in the top of the former north bank of Bayou Mercier, about mid-way of its length, and a second stake set 266 feet away to the south in the mudflat. The transect was set perpendicular to the bayou and roughly parallel to the Lake Borgne shoreline (Figure 4).

The profile was 1075 feet in length. The maximum relief was 2.85 feet (MSL), with an average relief of 1.45 feet. The profile indicates that the area is typically characterized as a low relief mudflat (Figure 11).

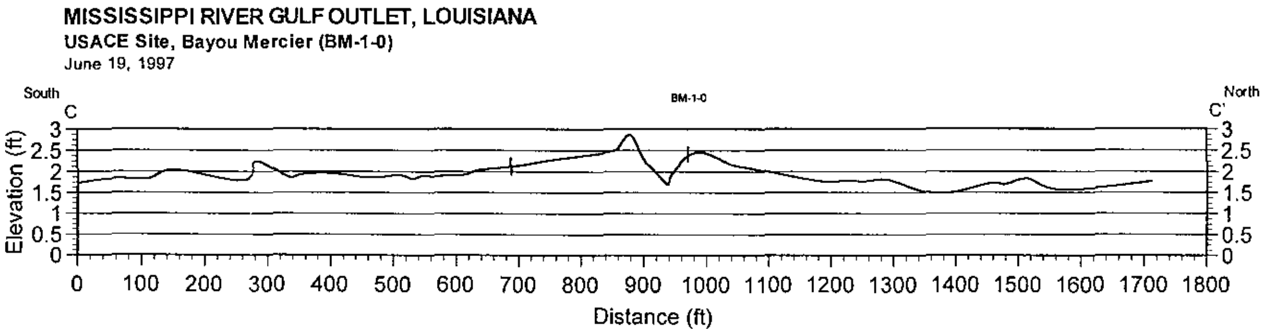


Figure 11. Elevation profile of the MR-GO - Inland Reach Vicinity Mile 60-50 Bayou Mercier (Area D) BUMP study site. Elevation data was referenced to Mean Sea Level.

Vegetative Character

General Description

The overall marsh type for this area would be classified as salt marsh. The only other vegetative habitat found at the site of each transect was a narrow shrub/scrub zone occupying the earthen ridge that was created to act as a retaining dike encircling each disposal area. The substrate was very soft, fine-grained silt and mud.

Vegetative Community Types

The salt marsh in the study area was represented by *Spartina alterniflora* and *Distichlis spicata*, with a variety of other species noticeable, such as *Aster tenuifolius*, *Spartina patens*, and *Scirpus sp.* growing thickly in older deposits and just beginning to colonize throughout the newly deposited mud flat.

Shrub communities usually indicate older, more stable, elevated areas. The narrow shrub zone occupying the earthen dike was primarily 5-6 foot *Iva frutescens* with some *Baccharis halimifolia* and an understory of *Spartina patens*, *Distichlis spicata*, and *Solidago sempervirens*.

GIS ANALYSIS RESULTS

Shoreline Changes: 1990-1996

Figure 12 graphs the spatial history of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area between December 1990 and November 1996 from the data in Table 1. In December 1990, the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area was measured at 3618.0 acres. The study area in November 1996 was measured at 3672.8 acres. This is a cumulative area increase of +54.8 acres or an increase in area of +1.5 percent for the 5.9 year period at an overall rate of +9.3 acres per year. There was an overall loss of -623.2 acres of natural habitats, offset by the creation of +663.5 acres due to the beneficial use of dredged materials. Without the contribution of the new habitats due to the beneficial placement of dredged material, the total coastal land loss in the study area would have exceeded -608.7 acres at a rate of -103.2 acres per year. Figure 13 illustrates the pattern of land loss and gain in the MR-GO - Inland Reach Vicinity Mile 60-50 study area.

Figure 14 depicts the coastal land loss/land gain history for the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area between December 1990 and November 1995. The total area of the MR-GO - Inland Reach Vicinity Mile 60-50 increased by +13.3 acres at a rate of +2.7 acres per year for this 4.9 year period. The primary land loss was in the form of edge erosion and natural marsh degradation, and direct loss of marsh when borrow canals were dug to build the retaining dikes. This was offset by an increase of +650.7 acres in direct and indirect BUMP-made habitats primarily as bare land, marsh colonization, and upland habitat development within USACE-NOD disposal areas.

Figure 15 depicts the coastal land loss/land gain history for the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area between November 1995 and November 1996. The total area of the MR-GO - Inland Reach Vicinity Mile 60-50 increased by +41.5 acres at a rate of +41.5 acres per year for this one year period. The primary areas of land loss took place as a result of edge erosion and interior pond development due to subsidence and natural marsh degradation. This was offset by an increase in area due to marsh colonization of shallow areas directly and indirectly created by BUMP dredged material disposal, and vegetative colonization of in-filled borrow canals within the USACE-NOD disposal areas.

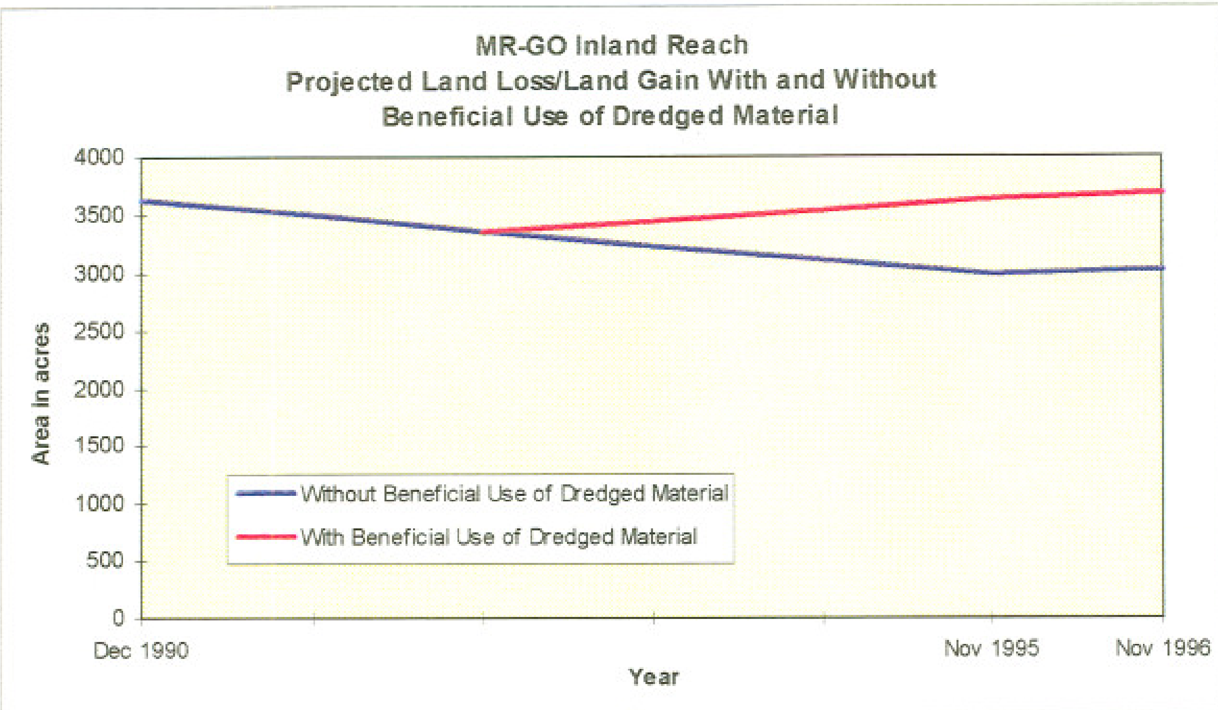


Figure 12. Graph of the area of the Mississippi River Gulf Outlet -Inland Reach Vicinity Mile 60-50 BUMP study area over time, with and without the placement of dredged material.

TABLE 1
MR-GO -Inland Reach Vicinity Mile 60-50 Area: 1990-1996

Area in acres	Dec 1990	Nov 1995	Nov 1996
Natural Areas	3548.7	2909.8	2925.5
Non-BUMP Man-made Areas	69.3	70.8	83.8
BUMP Man-made Areas	0	650.7	663.5
Total	3618.0	3631.3	3672.8

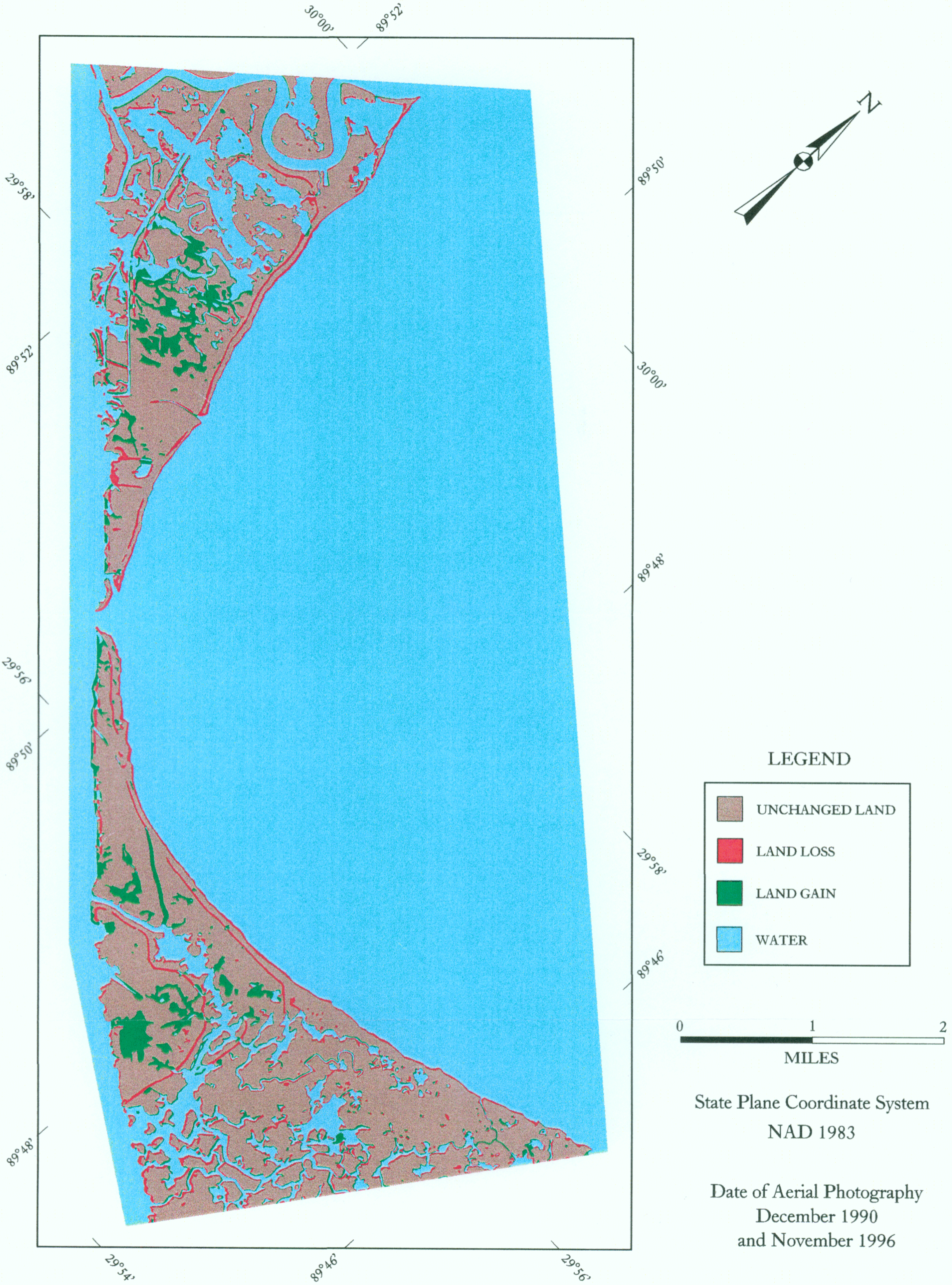


Figure 13. Land loss/land gain map of the Mississippi River Gulf Outlet - Inland Reach Vicinity Mile 60-50 BUMP study area comparing December 1990 and November 1996.

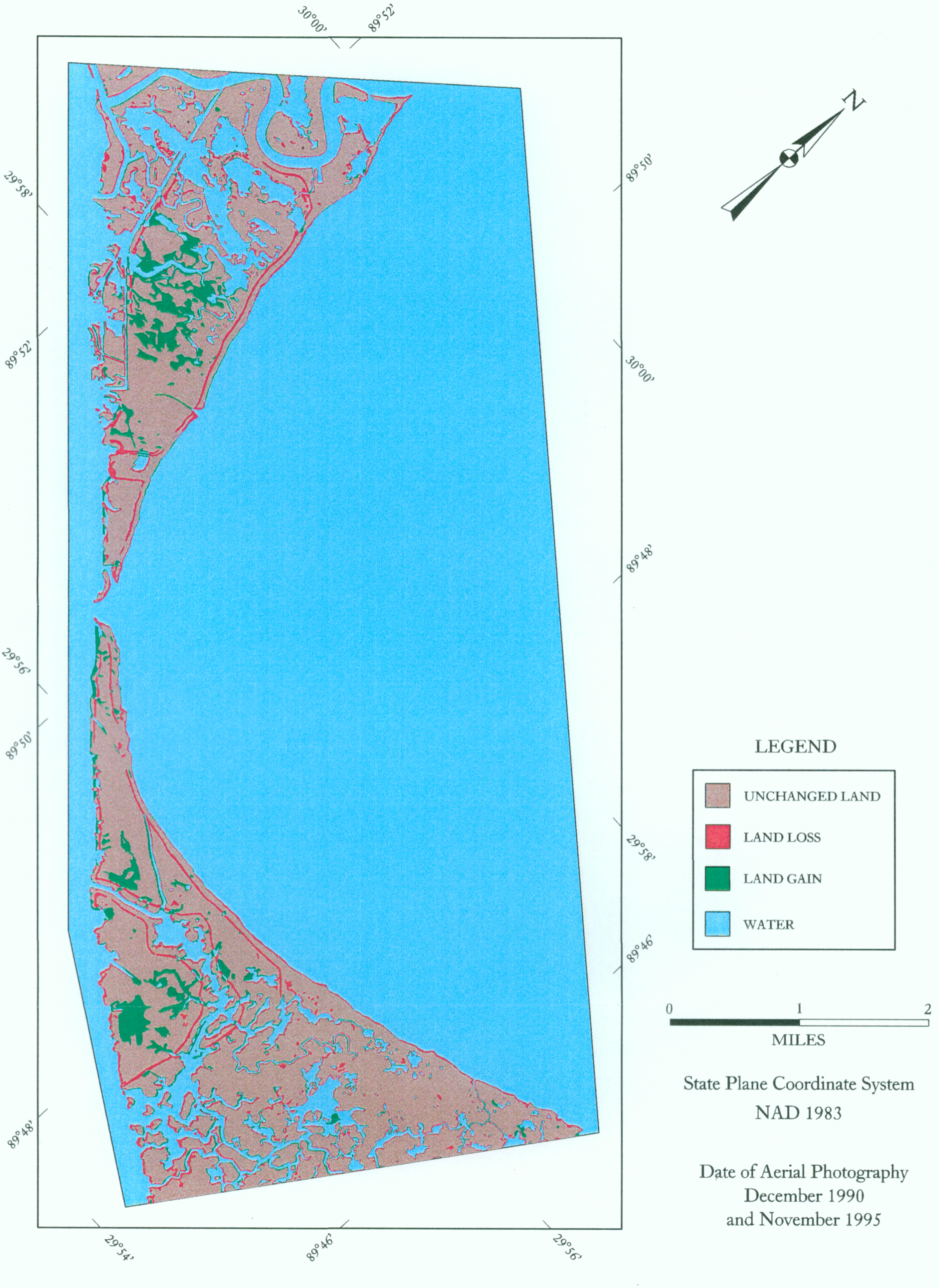


Figure 14. Land loss/land gain map of the Mississippi River Gulf Outlet - Inland Reach Vicinity Mile 60-50 BUMP study area comparing December 1990 and November 1995.

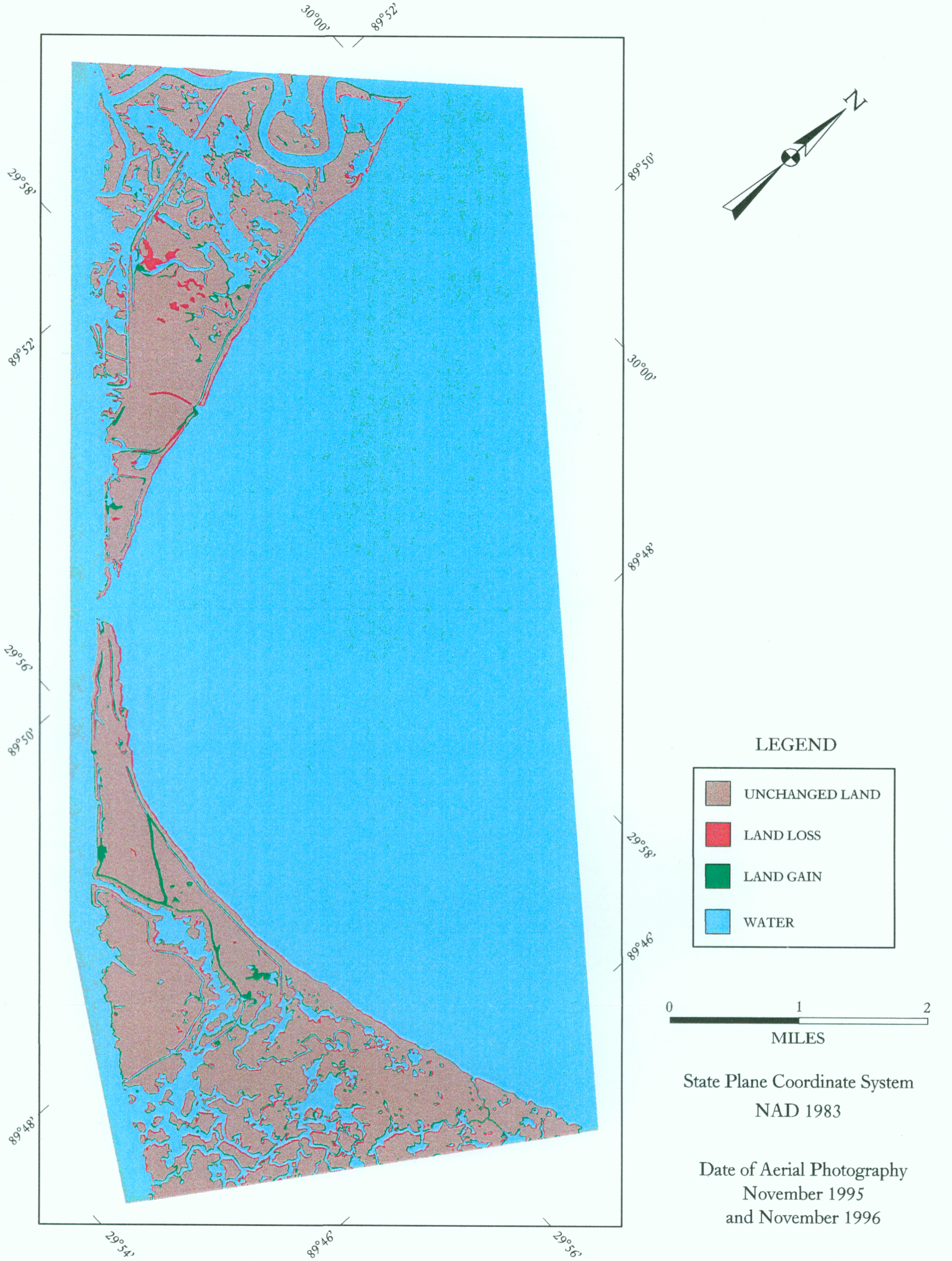


Figure 15. Land loss/land gain map of the Mississippi River Gulf Outlet - Inland Reach Vicinity Mile 60-50 BUMP study area comparing November 1995 and November 1996.

Habitat Inventory

The aerial photographic interpretation combined with field surveys identified six major habitat types in the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area. These habitats are further classified as natural, BUMP man-made, and non-BUMP man-made. The natural class identifies natural deltaic processes as responsible for habitat creation. The BUMP man-made (BUMP-made) class identifies the habitats created by the beneficial placement of dredged materials by the USACE-NOD. The non-BUMP man-made class (other-made) separates areas created that were not part of the BUMP effort, such as areas created in association with the oil industry access and pipeline canals. On the habitat maps presented in this report, an intertidal class is included to indicate nearshore 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 2 lists the areas of the six habitat types found in the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area in December 1990. The location and arrangement of these habitats is presented in figure 16. The total area of the MR-GO - Inland Reach Vicinity Mile 60-50 site was 3618.0 acres. Of this total, 3548.7 acres were natural and 69.3 acres were other-made habitats, or 98.1 percent were natural, and 1.9 percent were other-made. There were no BUMP-made habitats prior to 1993. In order of decreasing size and importance, the largest habitat found was natural marsh (3063.7 acres) followed by natural bare land (237.7 acres), natural upland (113.5 acres), natural shrub/scrub (68.9 acres), natural beach (64.9 acres), other-made upland (31.6 acres), other-made shrub/scrub (28.5 acres), other-made bare land (4.1 acres), other-made marsh (4.0 acres) and other-made trees (1.1 acres).

In terms of habitat totals, marsh (3067.7 acres or 85%) dominated the landscape.

TABLE 2
December 1990 Habitat Inventory of the MR-GO-Inland Reach Vicinity Mile 60-50 BUMP Study Area

HABITAT	TOTAL	NATURAL	OTHER-MADE	BUMP-MADE
Marsh	3067.7	3063.7	4.0	0
Upland	145.1	113.5	31.6	0
Shrub/Scrub	97.4	68.9	28.5	0
Trees	1.1	0	1.1	0
Bare Land	241.8	237.7	4.1	0
Beach	64.9	64.9	0	0
Habitat Total	3618.0	3548.7	69.3	0

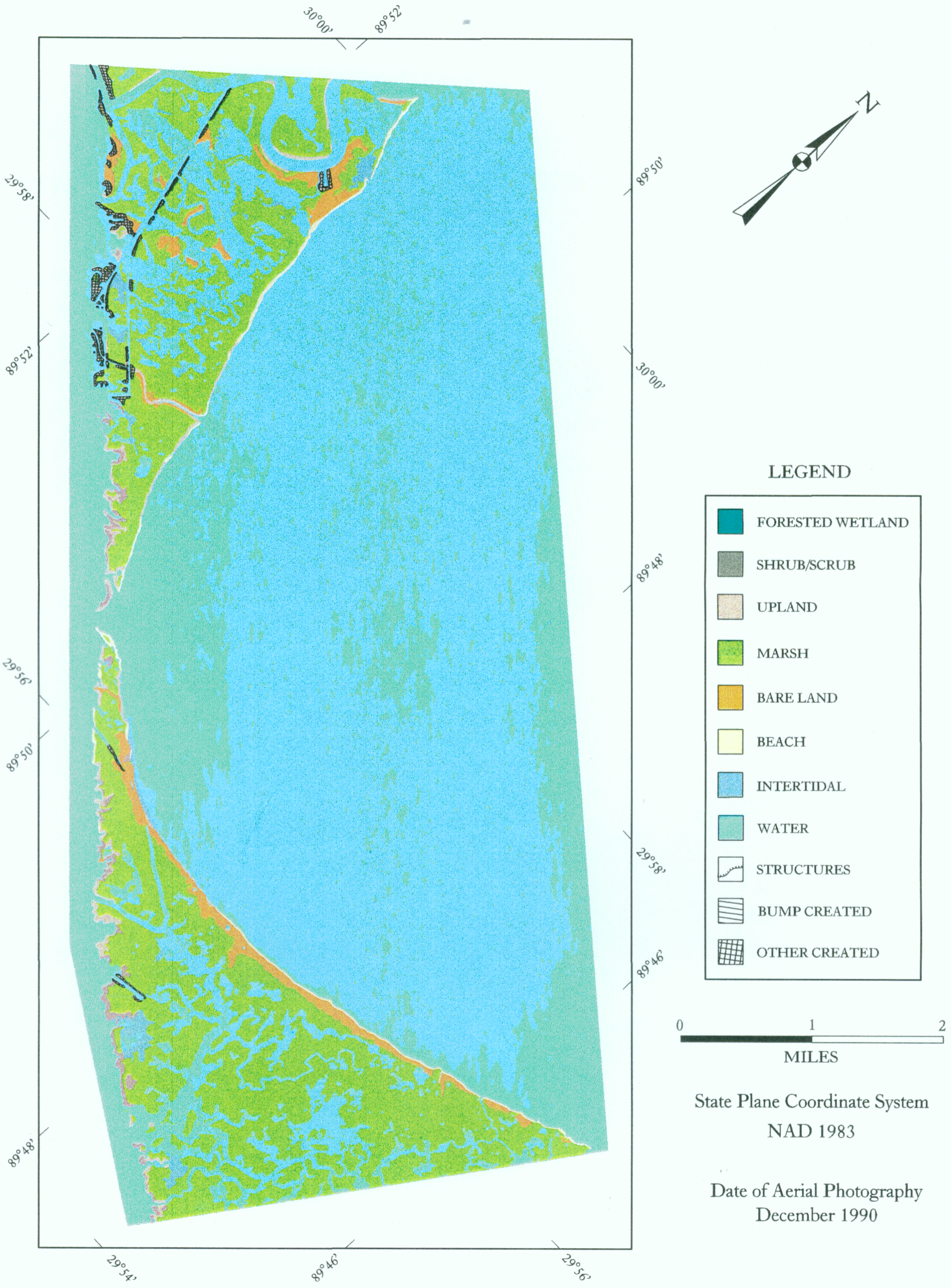


Figure 16. Habitat inventory map of the Mississippi River Gulf Outlet - Inland Reach Vicinity Mile 60-50 BUMP study area in December 1990.

Table 3 lists the areas of the six habitats found in the Mississippi River Gulf Outlet - Inland Reach Vicinity Mile 60-50 BUMP study area in November 1995. The location and arrangement of these habitats is presented in figure 17. In 1995, the total area of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area was calculated at 3631.3 acres. Of this total, 2909.8 acres were natural and 721.5 acres were man-made including 70.8 acres of other-made and 650.7 acres of BUMP-made, or 80.1 percent was natural, 1.9 percent was other-made, and 17.9 percent was BUMP-made. In order of decreasing size and importance, the largest habitat found is natural marsh (2704.8 acres) followed by BUMP-made marsh (221.5 acres), BUMP-made upland (187.4 acres), natural upland (64.5 acres), natural bare land (55.4 acres), natural beach (43.1 acres), natural shrub/scrub (42.0 acres), other-made shrub/scrub (38.0 acres), BUMP-made bare land (230.3 acres), other-made trees (19.1 acres), other-made upland (11.6 acres), BUMP-made shrub/scrub (11.5 acres), other-made marsh (1.2 acres), and other-made bare land (0.9 acres). The 1995 habitat inventory did not identify any natural trees, other-made beach or BUMP-made trees or beach.

In terms of total area, marsh (2927.5 acres or 80.6%) dominated the landscape of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area.

TABLE 3
November 1995 Habitat Inventory of the MR-GO-Inland Reach Vicinity Mile 60-50 BUMP Study Area

HABITAT	TOTAL	NATURAL	OTHER-MADE	BUMP-MADE
Marsh	2927.5	2704.8	1.2	221.5
Upland	263.5	64.5	11.6	187.4
Shrub/Scrub	91.5	42.0	38.0	11.5
Trees	19.1	0.0	19.1	0.0
Bare Land	286.6	55.4	0.9	230.3
Beach	43.1	43.1	0.0	0.0
Habitat Total	3631.3	2909.8	70.8	650.7

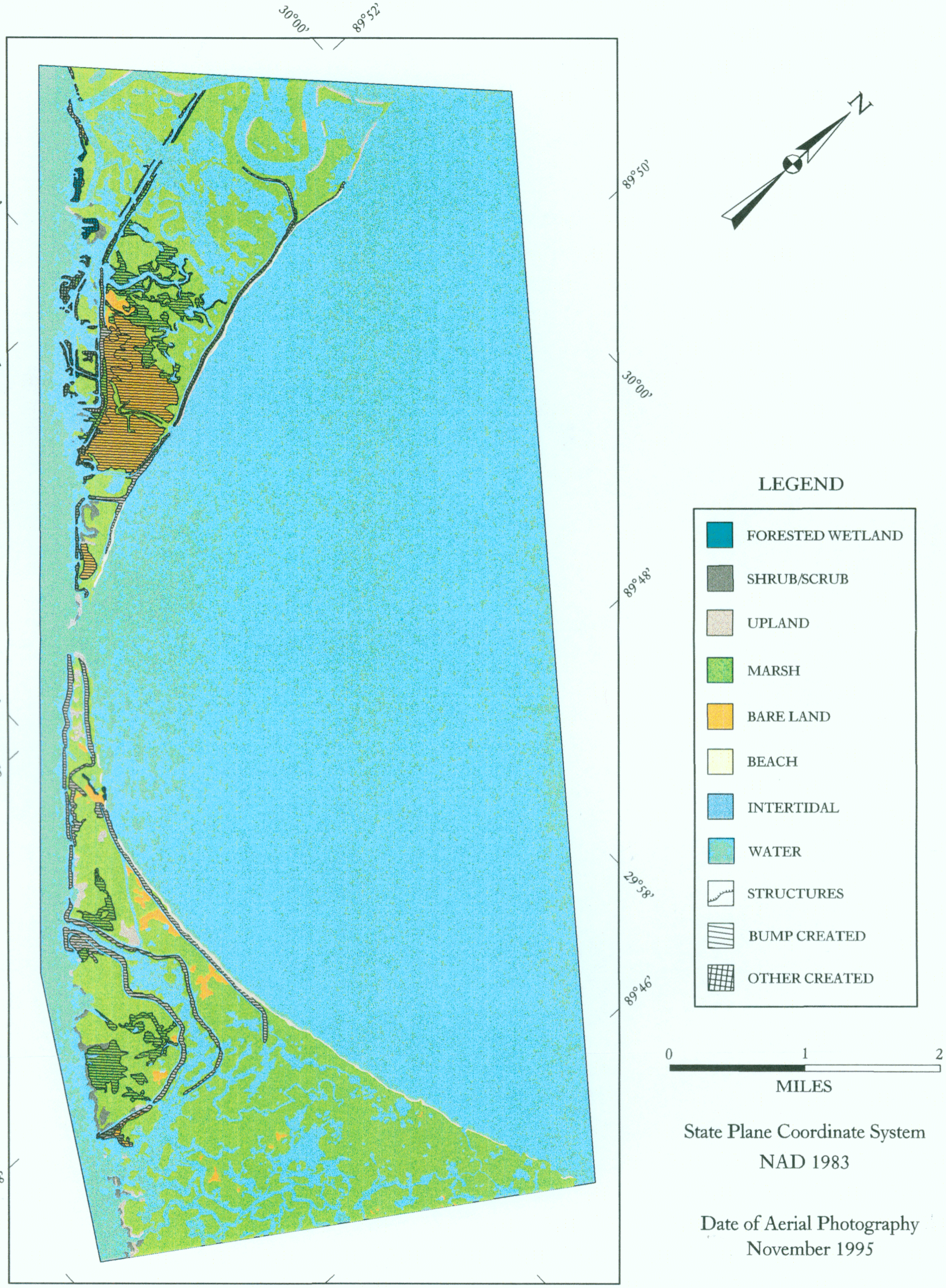


Figure 17. Habitat inventory map of the Mississippi River Gulf Outlet - Inland Reach Vicinity Mile 60-50 BUMP study area in November 1995.

Table 4 lists the areas of the six habitats found in the Mississippi River Gulf Outlet - Inland Reach Vicinity Mile 60-50 BUMP study area in November 1996. The location and arrangement of these habitats is presented in figure 18. In 1996, the total area of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area was calculated at 3672.8 acres. Of this total, 2925.5 acres were natural and 747.3 acres were man-made including 83.8 acres other-made and 663.5 BUMP-made, or 79.7 percent was natural, 2.3 percent was other-made and 18.0 percent was BUMP-made. In order of decreasing size and importance, the largest habitat found is natural marsh (2729.7 acres) followed by BUMP-made marsh (279.6 acres), BUMP-made bare land (201.6 acres), other-made upland (133.8 acres), natural shrub/scrub (67.7 acres), natural beach (63.9 acres), BUMP-made shrub/scrub (48.5 acres), natural upland (47.0 acres), other-made shrub/scrub (41.8 acres), other-made upland (28.2 acres), natural bare land (17.2 acres), other-made trees (6.6 acres), other-made bare land (5.2 acres), and other-made marsh (2.0 acres). The 1996 habitat inventory did not identify any natural or BUMP trees, other-made beach or BUMP-made beach.

In terms of total area, marsh (3011.3 acres or 82.0%) dominated the landscape of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area.

TABLE 4
November 1996 Habitat Inventory of the MR-GO-Inland Reach Vicinity Mile 60-50 BUMP Study Area

HABITAT	TOTAL	NATURAL	OTHER-MADE	BUMP-MADE
Marsh	3011.3	2729.7	2.0	279.6
Upland	209.0	47.0	28.2	133.8
Shrub/Scrub	158.0	67.7	41.8	48.5
Trees	6.6	0.0	6.6	0.0
Bare Land	224.0	17.2	5.2	201.6
Beach	63.9	63.9	0.0	0.0
Habitat Total	3672.8	2925.5	83.8	663.5

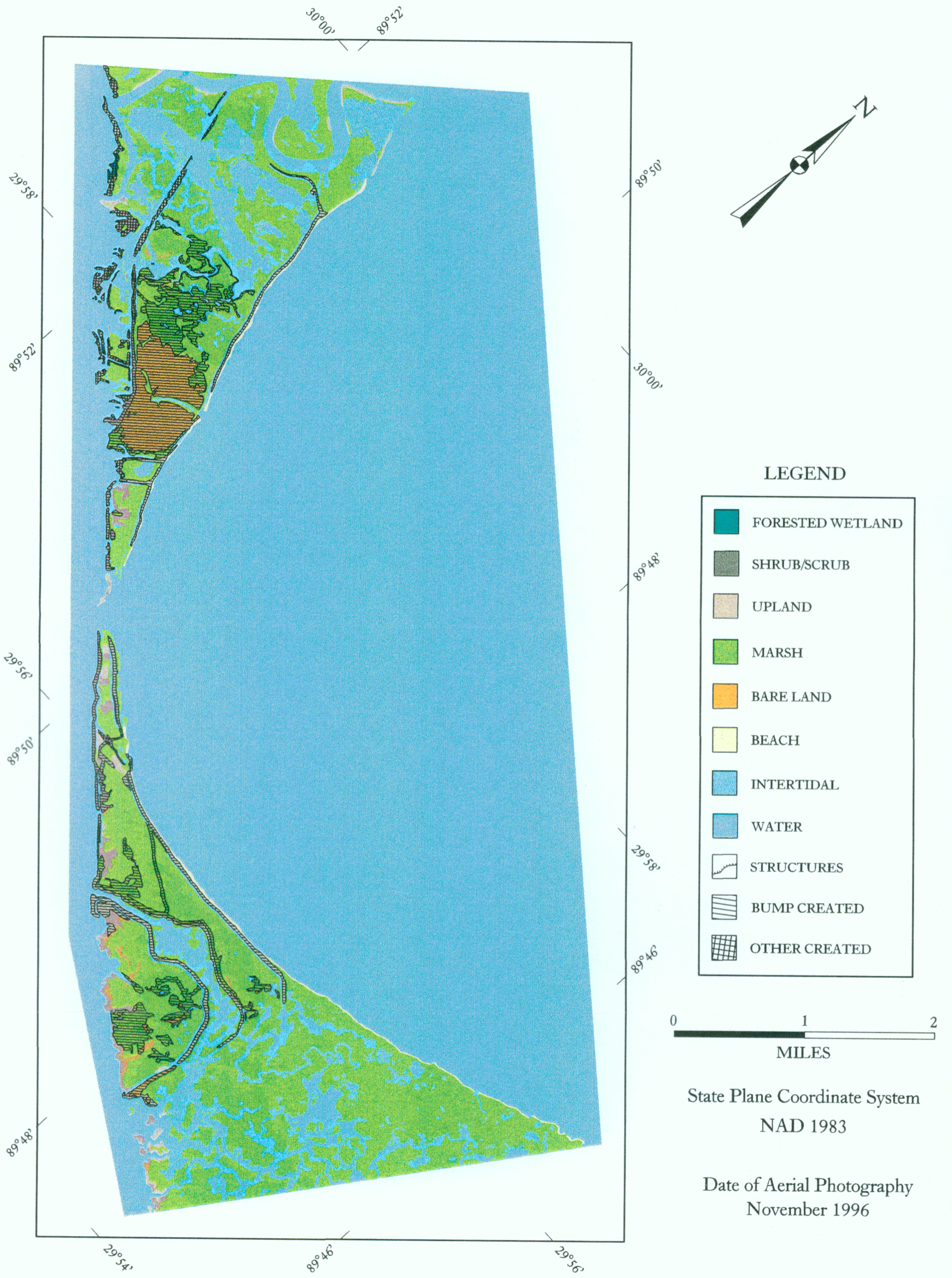


Figure 18. Habitat inventory map of the Mississippi River Gulf Outlet - Inland Reach Vicinity Mile 60-50 BUMP study area in November 1996.

Habitat Change

Land loss dominates the natural processes of this area, which is offset by land created directly or indirectly by the beneficial use of dredged disposal. The total area increased by +54.8 acres which represents a 1.5 percent increase in area between 1990 and 1996. There was an overall decrease of -623.2 acres of the natural habitats, offset by an overall 678.0 acres of increase in man-made habitats largely due to the placement of dredged materials. Table 5 lists the major habitat changes.

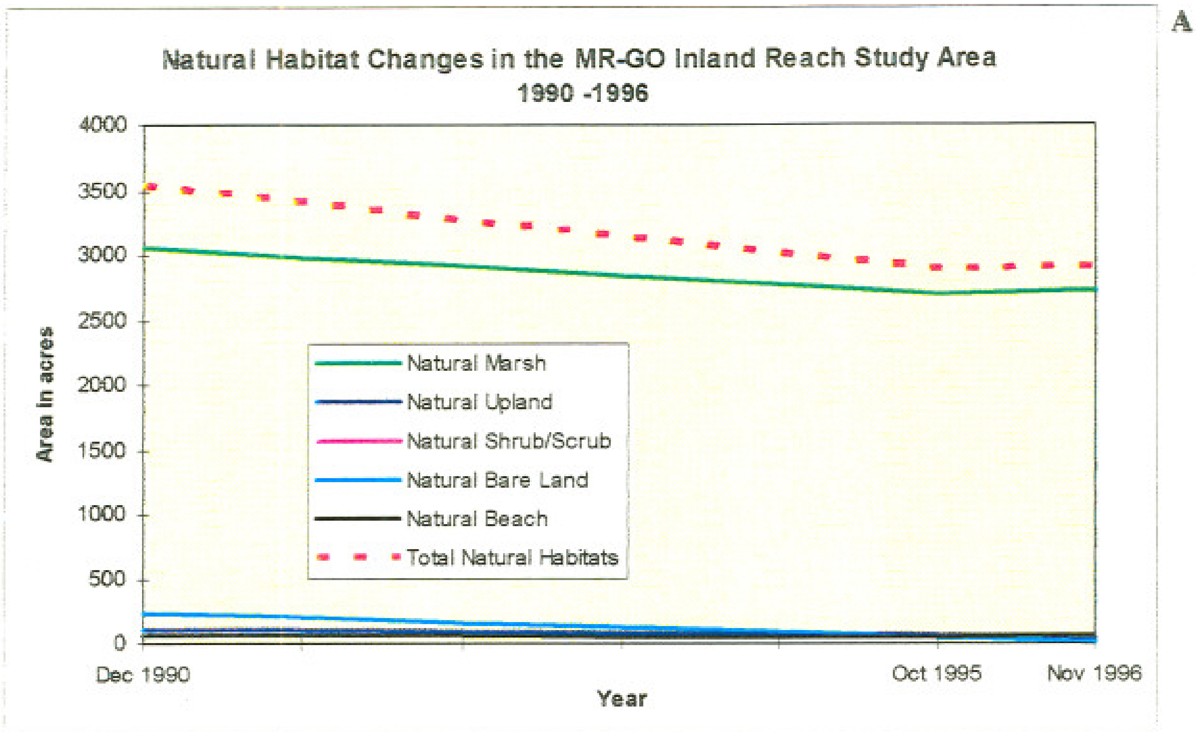
During the period measured between December 1990 and November 1996, the greatest habitat change was the decrease of natural marsh (-334.0 acres). Other large changes occurred in the BUMP-made marsh (+279.6 acres), natural bare land (-220.5 acres), BUMP-made bare land (+201.6 acres), BUMP-made upland (+133.8 acres), natural upland (-66.5 acres), and BUMP-made shrub/scrub (+48.5 acres). In terms of the beneficial use process, the greatest areas of new habitat creation include BUMP-made marsh (+276.9 acres), BUMP-made bare land (+197.5 acres), and BUMP-made upland (+105.0 acres).

Figure 19 shows a time series of habitat changes in the MR-GO Inland Reach Vicinity Mile 60-50 BUMP study area. Figure 19A graphs the natural habitat changes over time. Natural marsh degradation, erosion, and removal dominates the natural habitat class. Figure 19B graphs the man-made habitat changes. Land gain dominates the man-made habitat class with the most significant gains in the time period 1990-1995 when beneficial use of dredged material was initiated. Figure 20 documents the creation of habitats at the MR-GO-Inland Reach Vicinity Mile 60-50 BUMP study area from December 1990 and November 1996.

TABLE 5
Change in Total Acres of each Habitat
in the MR-GO-Inland Reach Vicinity Mile 60-50 BUMP Study Area
between 1990 and 1996

HABITAT	1990-1995[1]	1995-1996[1]	1990-1996[1]
Natural Marsh	-358.9	+24.9	-334.0
Natural Upland	-49.0	-17.5	-66.5
Natural Shrub/Scrub	-26.9	+25.7	-1.2
Natural Trees	--	--	--
Natural Bare Land	-182.3	-38.2	-220.5
Natural Beach	-21.8	+20.8	-1.0
Total Natural Habitats	-638.9	+15.7	-623.2
BUMP-made Marsh	+221.5	+58.1	+279.6
BUMP-made Upland	+187.4	-53.6	+133.8
BUMP-made Shrub/Scrub	+11.5	+37.0	+48.5
BUMP Man-made Trees	--	--	--
BUMP-made Bare Land	+230.3	-28.7	+201.6
BUMP-made Beach	--	--	--
Total BUMP-made Habitats	+650.7	+12.8	+663.5
Other-made Marsh	-2.8	+0.8	-2.0
Other-made Upland	-20.8	+16.6	-3.4
Other-made Shrub/Scrub	+9.5	+3.8	+13.3
Other-made Trees	+18.0	-12.5	+5.5
Other-made Bare Land	-3.2	+4.3	+1.1
Other-made Beach	--	--	--
Total Other-made Habitats	+1.5	+13.0	+14.5
HABITAT TOTAL	+13.3	+41.5	+54.8

[1] in acres



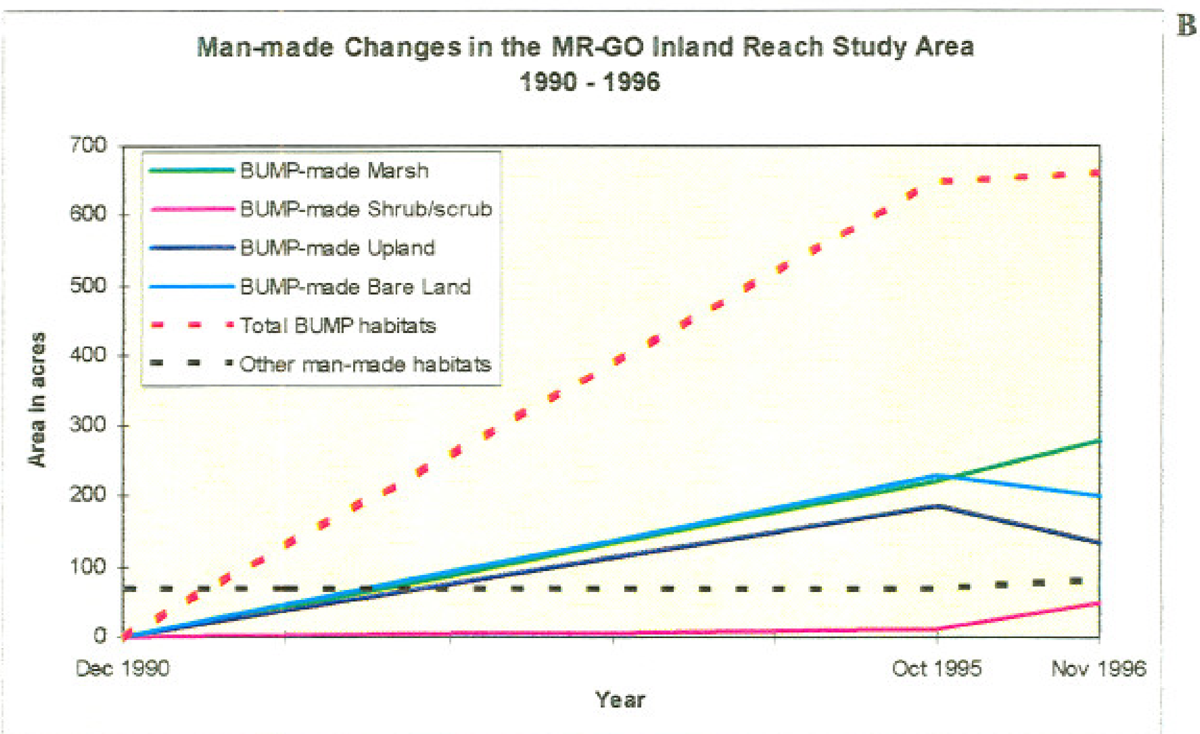


Figure 19. Time series showing the changes in total area of each habitat in the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area between December 1990 and November 1996. A) natural habitat changes. B) man-made habitat changes.

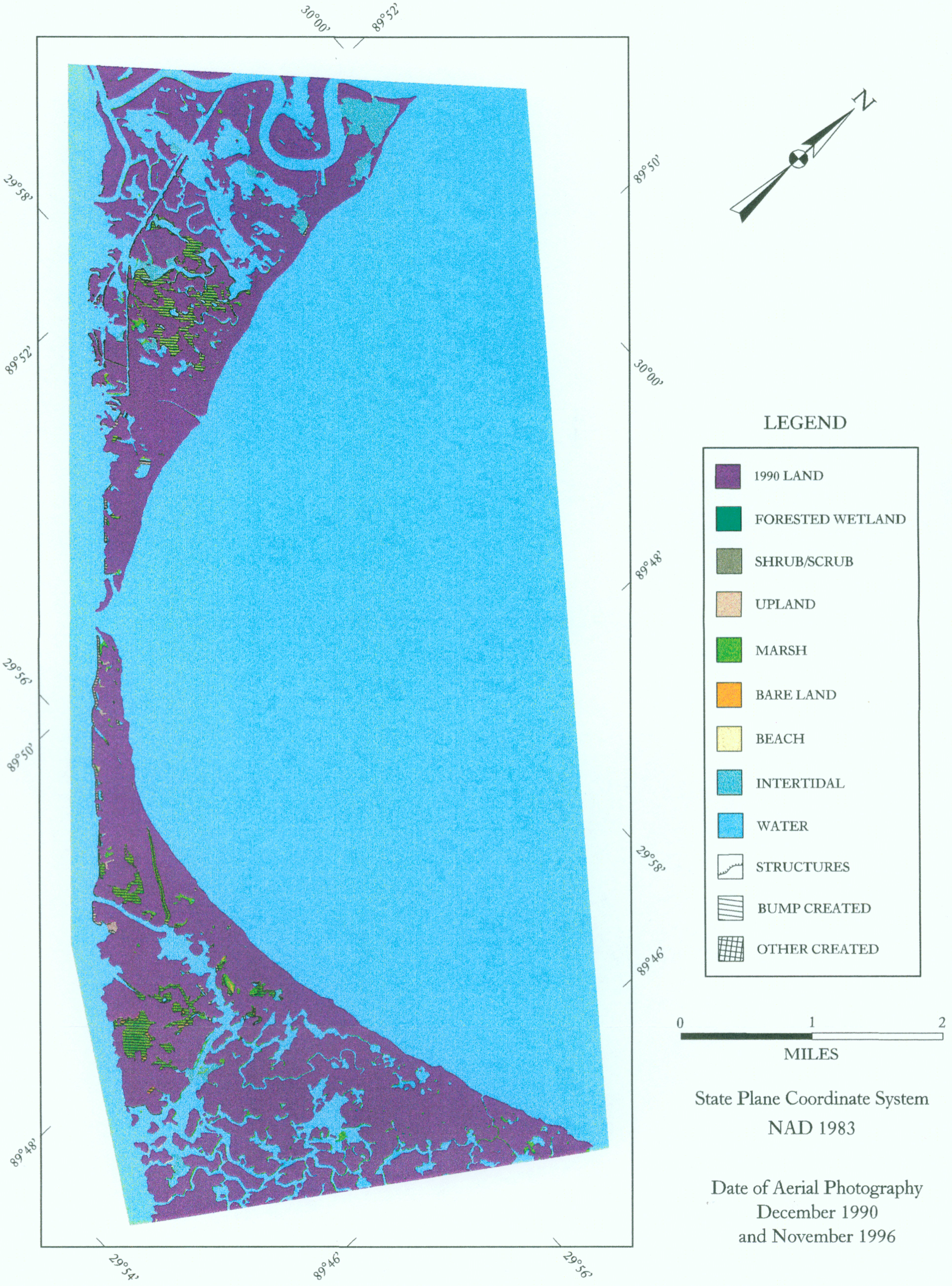


Figure 20. Map of the MR-GO-Inland Reach Vicinity Mile 60-50 BUMP study area showing the new habitats that developed between December 1990 and November 1996.

SUMMARY

1. A) The total area of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area in December 1990 was 3618.0 acres. Natural processes accounted for 3548.7 acres or 98 percent of the total area. Man-made processes not related to beneficial use of dredged material accounted for 69.3 acres or 1.9 percent of the total area.
   B) The total area of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area in November 1995 was 3631.3 acres. Natural processes accounted for 2909.8 acres or 80.1 percent of the total area. Man-made processes related to the beneficial use of dredged material accounted for 650.7 acres or 17.9 percent of the total area.
   C) The total area of the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area in November 1996 was 3672.8 acres. Natural processes accounted for 2925.5 acres or 79.7 percent of the total area. Man-made processes related to the beneficial use of dredged material accounted for 663.5 acres or 18.0 percent of the total area.

2. A) The MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area increased by 13.3 acres between December 1990 and November 1995. Natural processes were responsible for -638.9 acres of decrease and the beneficial use of dredged material was responsible for +650.7 acres of increase.
   B) The MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area increased by +41.5 acres between November 1995 and November 1996. Natural processes were responsible for +15.7 acres of increase and the beneficial use of dredged material was responsible for +12.8 acres of increase.
   C) The MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area increased by +54.8 acres between December 1990 and November 1996. Natural processes were responsible for -623.2 acres of decrease and the beneficial use of dredged material was responsible for +663.5 acres of increase.

CONCLUSIONS

1. The field surveys indicate the correct stacking heights are optimal for creating marsh and to a lesser extent shrub/scrub. The optimal elevation for marsh creation appears to be less than +2 feet MSL (+2.78 feet MLG). Initial stacking heights were reported to be +3.5 MLG from "As-builts" which resulted in appropriate height presently for healthy marsh growth.

2. Natural processes are responsible for eroding the marsh at a rate of -55.0 acres per year.

3. Beneficial use of dredged material appears to be effective in nourishing and restoring marsh habitats.

4. Within the MR-GO - Inland Reach Vicinity Mile 60-50 BUMP study area, the beneficial use of dredged material offset coastal land loss to cause a net land gain of 1.5 percent.

5. Retaining dikes need to be maintained in place until material within them has consolidated enough to withstand tidal movement.

APPENDIX 2A

LIST OF VEGETATIVE SPECIES IN THE MISSISSIPPI RIVER GULF OUTLET
Inland Reach Vicinity Mile 60-50

LIST OF VEGETATIVE SPECIES IN THE MISSISSIPPI RIVER GULF OUTLET - INLAND REACH VICINITY MILE 60-50

An alphabetical list of observed and collected plant species follows. This list is not complete, but is meant to establish vegetative character and indicate dominant species observed. 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 or The Smithsonian Guide to Seaside Plants of the Gulf and Atlantic Coasts.

Aster tenuifolius L. . . . . Salt marsh aster
Herbaceous perennial; brackish marshes

Avicennia germinans L. . . . . Black mangrove
evergreen shrub; sandy and silty shores in salt and brackish water, upper tidal zone of saline marshes (their presence at this site is due to artificial plantings)

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

Bacopa monnieri (L.) Pennell. . . . . Smooth water-hyssop
Succulent, creeping herb; sandy margins of fresh or brackish marshes, streams and ponds

Borrichia frutescens (L.) . . . . Sea ox-eye
rhizomatous shrub; brackish marsh or upper zones of salt marsh

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

Eleocharis parvula L. . . . . Spikerush
small dense, rhizomatous perennial; brackish marshes, rarely fresh-water marshes

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

Scirpus robustus L. . . . . Saltmarsh bulrush
coarse perennial; brackish marshes and ditches, higher parts of salt or brackish marshes

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

Spartina cynosuroides (L.) Roth . . . . Big cordgrass
coarse perennial; Brackish or freshwater tidal marshes, brackish sloughs

Spartina patens L. . . . . Marshhaycordgrass
rhizomatous perennial; brackish marshes, low dunes and backbarrier sand flats

Solidago sempervirens L. . . . . Seaside goldenrod
Herbaceous perennial; elevated sites in brackish or saline marshes, bay shores, swales, overwash areas, mini-dunes