State of Louisiana
Department of Natural Resources
Coastal Restoration Division

2004 Operations, Maintenance, and Monitoring Report

for

Channel Armor Gap Crevasse

State Project Number MR-06
Project Priority List 3

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Plaquemines Parish

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Table of Contents

Preface

The 2004 OM&M Report format is a streamlined approach which combines the Operations and Maintenance annual project inspection information with the Monitoring data and analyses on a project-specific basis. This new reporting format for 2004 includes monitoring data collected through December 2003, and annual Maintenance Inspections through June 2004. Monitoring data collected in 2004 and maintenance inspections conducted between July 2004 and June 2005 will be presented in the 2005 OM&M Report.

I. Introduction

Human alterations to the Mississippi River (MR) have had negative impacts on the hydrography of the river and its wetland-building processes. Prolonged maintenance of the river in its present course through artificial levees has caused rapid sedimentation onto the continental shelf and seaward progradation of the river mouth at rates up to 328 ft/yr (100 m/yr) within the past several decades. In addition, an abundance of small, bifurcating distributaries throughout the Mississippi River Delta (MRD) has caused a loss in stream gradient, which is critical to efficient sediment transport. Growth of the MRD has therefore not been limited by the size of the receiving basin, but by inefficient sediment delivery. Moreover, the MR currently delivers 50 to 60 percent less sediment to the delta than it did in the early 1900's (Wells and Coleman 1987). Much of this sediment loss has been due to trapping of coarse sediment material, which is essential in building subaerial land, by upstream dams and reservoirs, and better conservation measures by farmers in the Arkansas, Missouri, and Ohio River basins.

Rapid wetland deterioration in the MRD is likely due to a combination of the above factors in conjunction with eustatic sea-level rise, which is estimated to be 0.37 in/yr (0.94 cm/yr) (Penland and Ramsey 1990). In addition, the subsidence rate for the entire MRD is approximately 0.43 in/yr (1.1 cm/yr) (Day and Templet 1989). The most recent land loss rate estimate for the MRD is 0.6 mi^2/yr (Barras et al. 2003).

The natural MR levee south of Venice, Louisiana, was reinforced with stone over the last few decades, but a few shallow gaps were left in this river-bank armor to allow overflow of freshwater into adjacent marshes and to promote levee breaches (crevasses) during periods of high river stages. Crevasses promote infilling of shallow interdistributary ponds with sediment-laden river water and eventually create subaerial land (or deltaic splays) that becomes colonized with marsh vegetation. A natural crevasse splay typically has a life of 20 to 175 years, depending on the size of the crevasse and adjacent parent pass, water discharge, sediment volume, and wind and tidal influences (Wells and Coleman 1987). Between 1750 and 1927, regularly occurring crevasse splays were responsible for building more than 80% of the MRD wetlands (Davis 1993).

Since the early 1980s, artificial crevasses have been used as a management tool to combat wetland loss in the MRD. By breeching natural levees and digging crevasses, the natural processes of crevasse splay formation are enhanced. The Louisiana Department of Natural

Resources, Coastal Restoration Division (LDNR/CRD) constructed three crevasses within the Pass-a-Loutre Wildlife Management Area in 1986 that produced over 657 acres (266 hectares) of emergent marsh from 1986 to 1991, and four crevasses in 1990 that produced over 400 acres (162 hectares) of emergent marsh in three years (LDNR 1993; Trepagnier 1994). Results from the LDNR Small Sediment Diversions project show that land gains from 1986 to 1993 from thirteen artificial crevasses ranged from 28 to 103 acres (11.3 to 41.7 hectares) for older crevasses (4 to 10 years old) and 0.5 to 12 acres (0.2 to 4.9 hectares) for younger crevasses (0 to 2 years old) (LDNR 1996).

Crevasse construction is recognized as both cost-effective and highly successful at creating new wetlands. The average cost per crevasse constructed by LDNR in 1990 was approximately $48,800, or $433/acre of wetland created. Boyer et al. (1997) reported that the average cost per area of land gain for 24 constructed crevasses in Delta National Wildlife Refuge declines with age as new land builds and may be only $19/acre if all the receiving bays revert to marsh.

The Channel Armor Gap Crevasse project area is located in the MRD, south of Venice in Plaquemines Parish, Louisiana, and is within the boundary of the Delta National Wildlife Refuge between the main stem Mississippi River and Main Pass (figure 1). The crevasse is located on the left descending bank of the MR at mile 4.7 above Head of Passes. Based on the 1996 land/water analysis, the project receiving bay (Mary Bowers Pond) comprises 70% of the total 1,567 acres (634 hectares) in the project area.

The natural gap in the Mississippi River channel bank armor was enlarged to a length of 3,400 ft (1,036 m), a bottom width of 80 ft (24 m), a top width of 130 ft (40 m), and a minimum depth of –4.0 ft (-1.2 m) NGVD. The crevasse channel is estimated to allow an average flow of 2,400 cfs (68 cms) to enter the outfall area. Approximately 70,000 yd^3 (53,522 m^3) of material was excavated from the outfall channel. The dredged material was deposited in a non-continuous fashion adjacent to the channel at an elevation not exceeding +4.0 ft (1.2 m) above existing surface elevations with several 50 ft wide gaps. Construction of the crevasse was completed in October 1997.

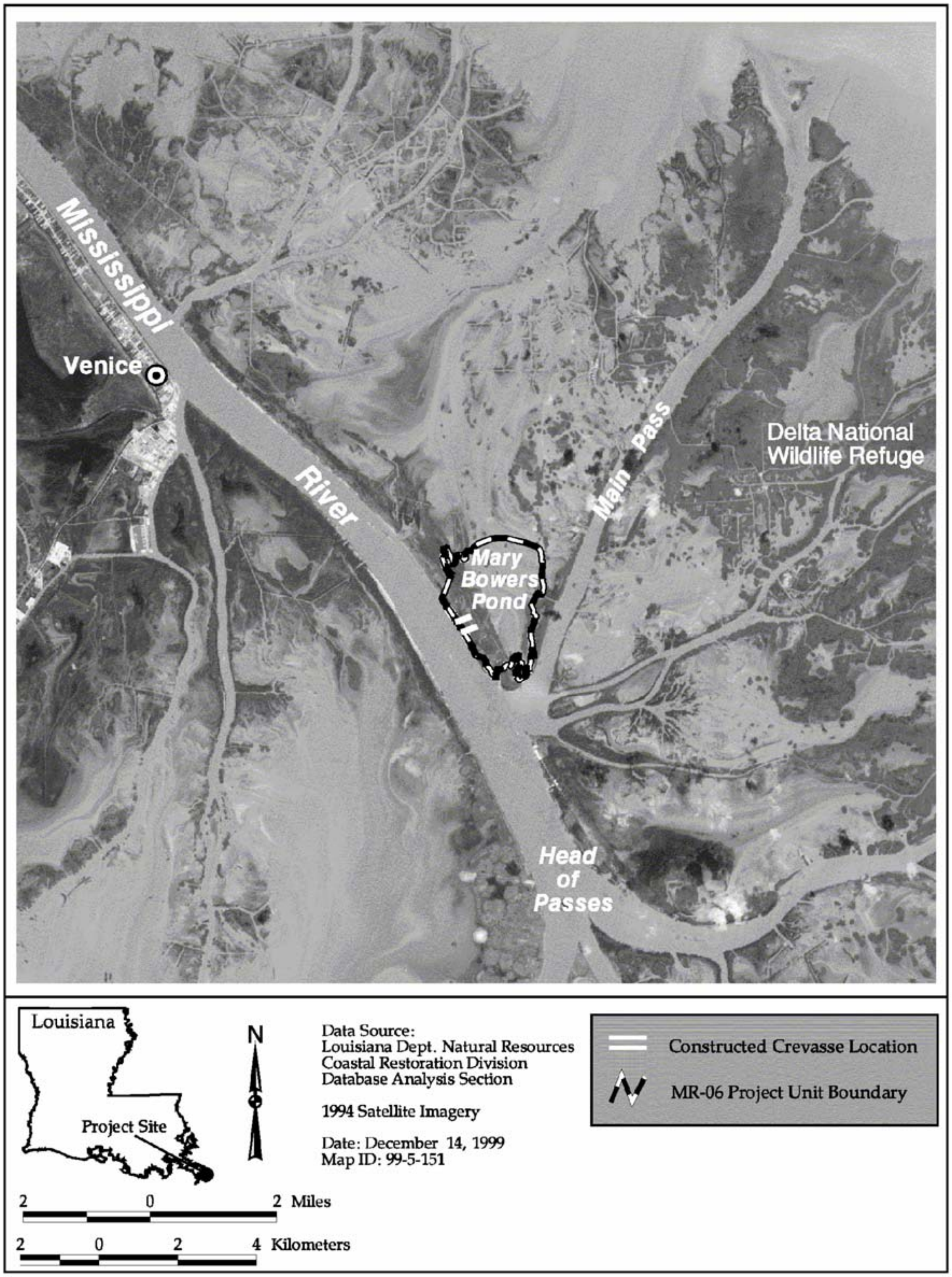

Figure 1. Channel Armor Gap Crevasse (MR-06) project location.

II. & III. Maintenance and Operation Activity

No maintenance or operations were planned or budgeted for this project.

IV. Monitoring Activity

a. Monitoring Goals

The objective is to promote formation of emergent freshwater marsh in place of the shallow, open water area of Mary Bowers Pond by increasing the flow of sediment-laden river water into the receiving bay.

The specific goals are to increase sediment elevation and cover of emergent wetland vegetation in the project area. Over it's 20-yr life, the project is expected to create approximately 1,000 acres (405 hectares) of emergent marsh.

b. Monitoring Elements

Water Discharge and Suspended Sediments
Based on a CWPPRA Task Force decision, monitoring of suspended sediment and discharge was discontinued after 1998. Results of discharge and suspended sediment monitoring can be found in the first progress report for this project (Troutman 1999), and will not be reported here.

Sediment Elevation
Elevation, reported in North American Vertical Datum of 1988 (NAVD), was surveyed in the receiving bay on November 25, 1997 to determine preconstruction elevation in the project area, and a postconstruction survey was conducted on October 16, 2001**.** In the 1997 survey, eleven transect lines were established perpendicular to the crevasse channel, 500 ft (152 m) apart, and extended the entire length of the open water areas in the receiving bay (figure 2). Land elevations were not measured during this survey. Elevations were recorded at 500-ft intervals along each transect and at any significant change in elevation within those intervals. In the 2001 survey, the same transect lines were used, but elevations were recorded at 200-ft intervals and at any significant change in elevation within those intervals (figure 2). Elevations of the entire project area (open water and land) were collected during the 2001 survey. A t-test was utilized to compare mean elevation between years. Only overlapping 1997 and 2001 survey data points were used for that analysis.

Land/Water Analysis and Habitat Mapping
Distribution of habitat types and the land to open water ratio were determined from aerial photography (infrared, 1:12,000 scale) that was taken of the project area on January 9, 1996 (preconstruction) and December 19, 2001 (postconstruction). At the U.S. Geological Survey's National Wetlands Research Center (NWRC), the aerial

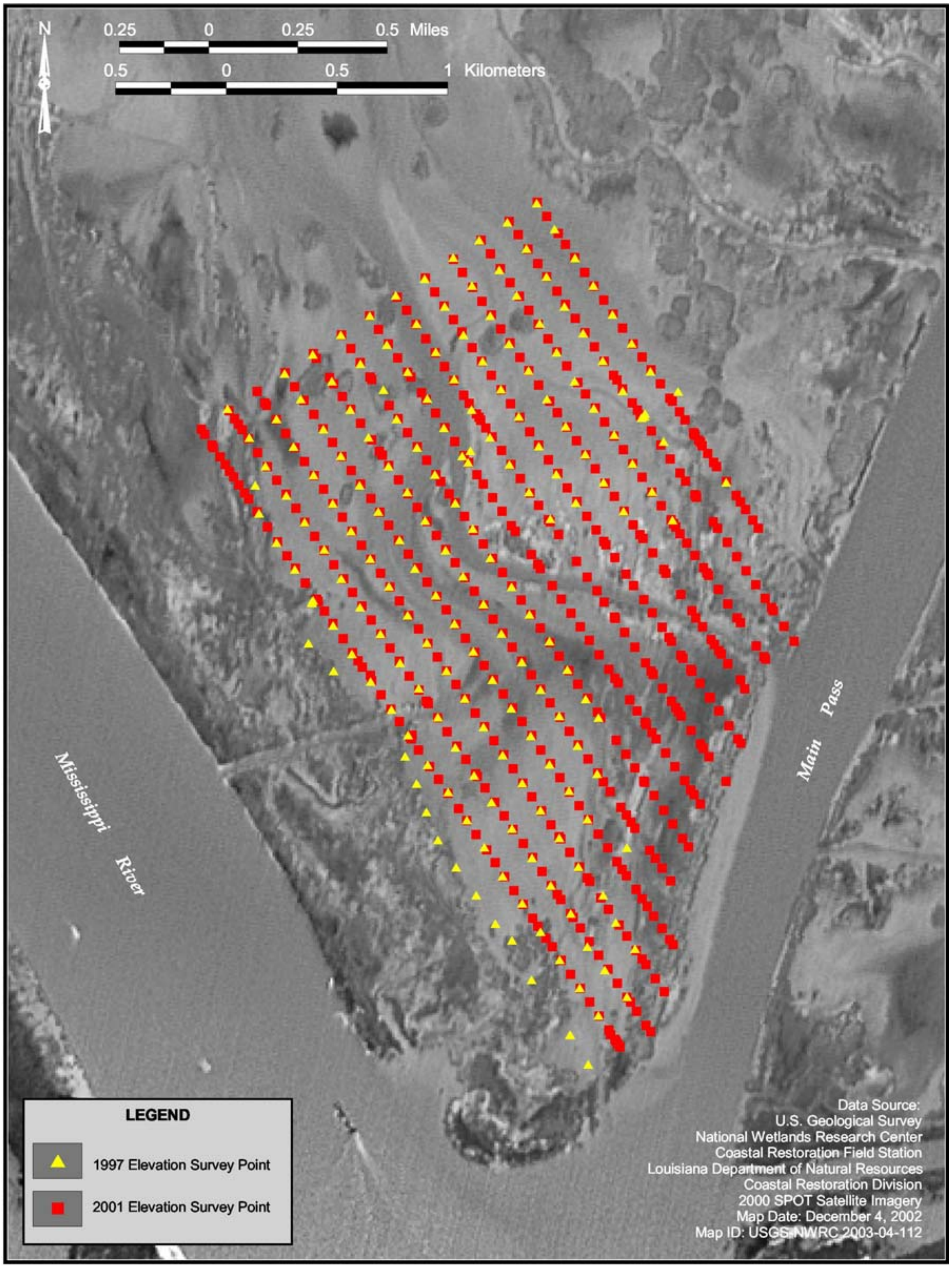

Figure 2. Schematic diagram of elevation sampling station locations in 1997 (yellow triangles) and 2001 (red squares) in the Channel Armor Gap Crevasse (MR-06) project area.

photographs were scanned at 300 pixels per inch and georectified with ground control data collected with a differential global positioning system (DGPS) capable of sub-meter accuracy. Individual georectified frames were then mosaicked to produce a single image of the project area. To determine habitat types and their distributions, the photomosaic was photointerpreted by NWRC personnel and classified to the subclass level using the National Wetlands Inventory (NWI) classification system (Anderson et al. 1976). Habitat classifications were then transferred to 1:12,000 scale Mylar base maps, digitized, and checked for quality and accuracy. In addition, the photomosaic was classified according to pixel value and analyzed to calculate the land to water ratio of the project area. All areas characterized by emergent vegetation, wetland forest, or scrub-shrub were classified as land, while open water, aquatic beds, and nonvegetated mud flats were classified as water.

Vegetation

Plant species composition, percent cover, and relative abundance will be evaluated to document vegetation succession on the newly created crevasse splay and to ground-truth aerial photograph interpretations. Vegetation surveys will follow the Braun-Blanquet method. Data will be collected at the same sample stations established for elevation measurements whenever possible. Transects will be established once the splay islands become subaerial, at locations where all major plant communities will be intersected. Sample stations along each transect will be established to represent the major plant communities of interest (*S. nigra*, *S. deltarum*, mixed marsh, pioneer marsh, and *Sagittaria* spp.), with at least five plots in each community. Additional transects and sample stations will be established over time as new land is created. Annual vegetation surveys began on October 16, 2001, after the first subaerial crevasse splay formed, and will continue through 2011.

c. Preliminary Monitoring Results and Discussion

Sediment Elevation

Average elevation of the receiving bay in 1997 (preconstruction) was -3.48 ft NAVD 88 (figure 3 and figure 4). The average elevation of the receiving bay for the 2001 (postconstruction) survey was –0.37 ft NAVD 88 (figure 3 and figure 5). Sediment elevations increased in most of the receiving bay between 1.64 ft and 4.92 ft (figure 6). Little change occurred near the center of the receiving bay, where channels appear to be forming. T-test results indicated that elevation of the receiving bay sediments was significantly higher in 2001 than in 1997 (table 1).

Land/Water Analysis and Habitat Mapping

Results from the 1996 land/water analysis indicated that 474 acres (191.8 hectares) of the project area were land, and 1,091.8 acres (442 hectares) were open water, a ratio of 30% land : 70% open water (figure 7). In the 2001 analysis, 526.4 acres (213 hectares) were land and 1,039.8 acres (420.8 hectares) were open water, increasing the ratio to 34 % land : 66 % open water (figure 8).

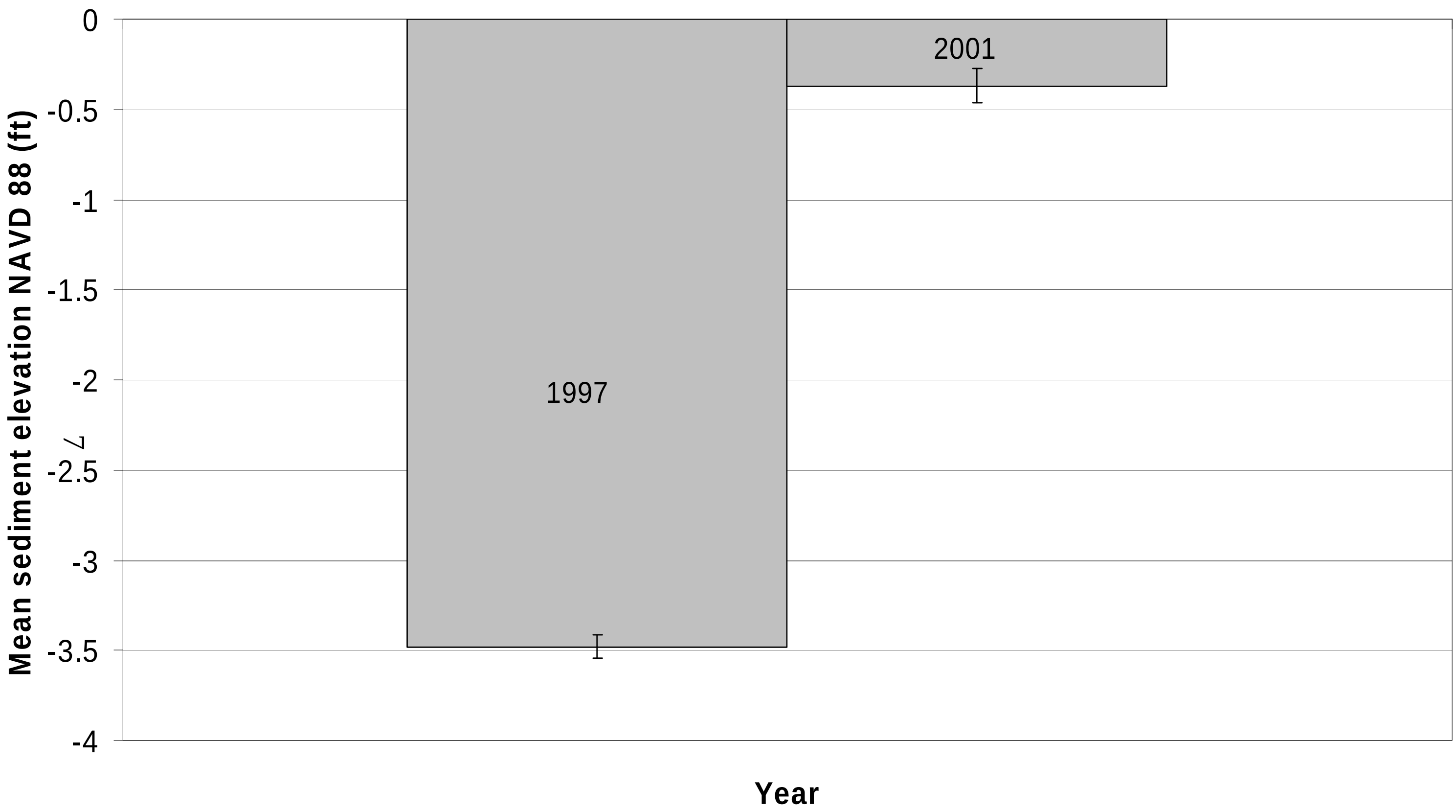

Figure 3. Mean sediment elevation (NAVD 88) (ft) in the project area in 1997 (preconstruction) and 2001 (postconstruction) stations that overlapped 1997 stations for the Channel Armor Gap Crevasse (MR-06) project.

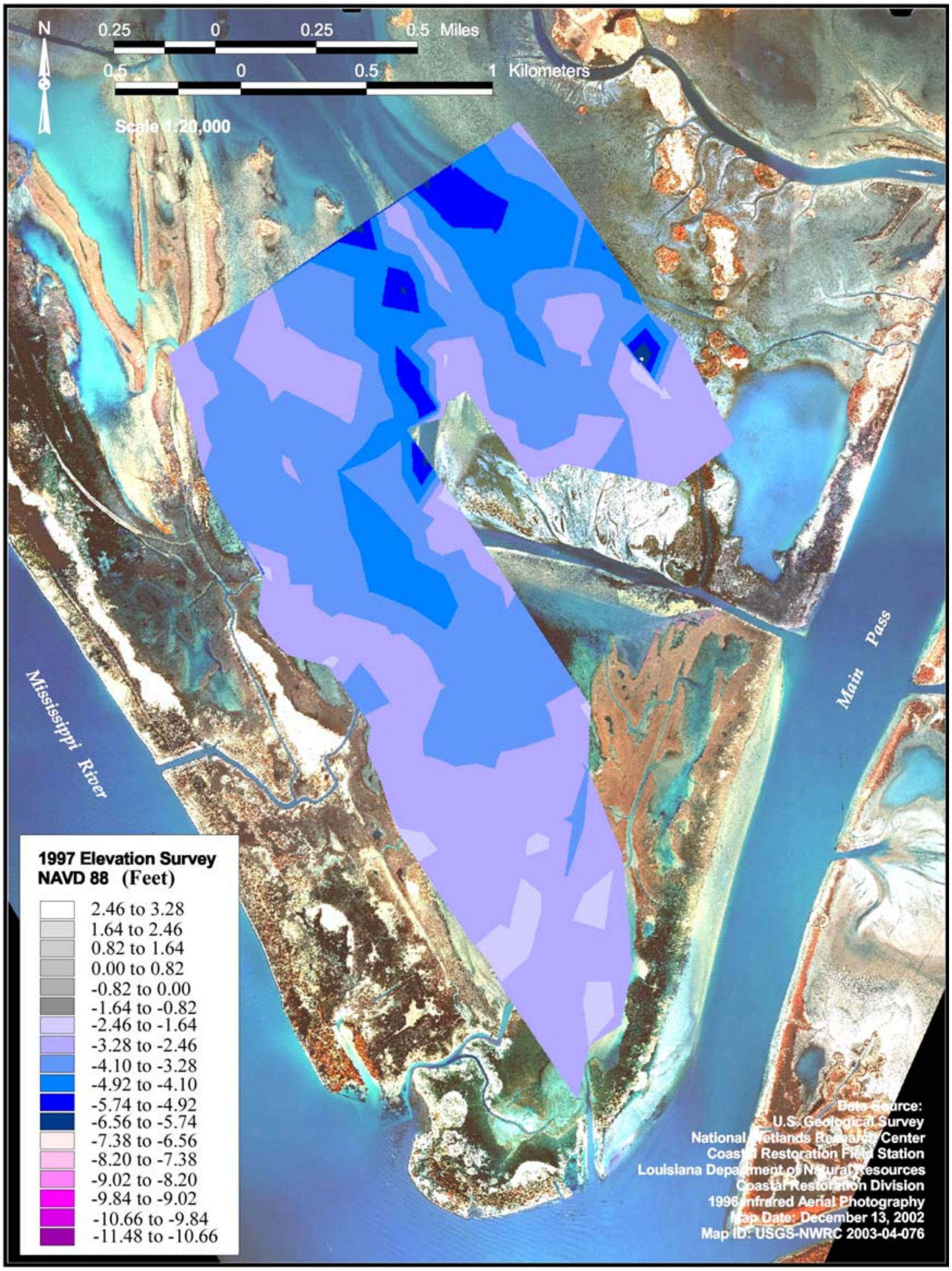

Figure 4. Preconstruction elevation (ft) within the receiving bay (Mary Bowers Pond) of the Channel Armor Gap Crevasse (MR-06) project area. Survey was conducted on November 25, 1997.

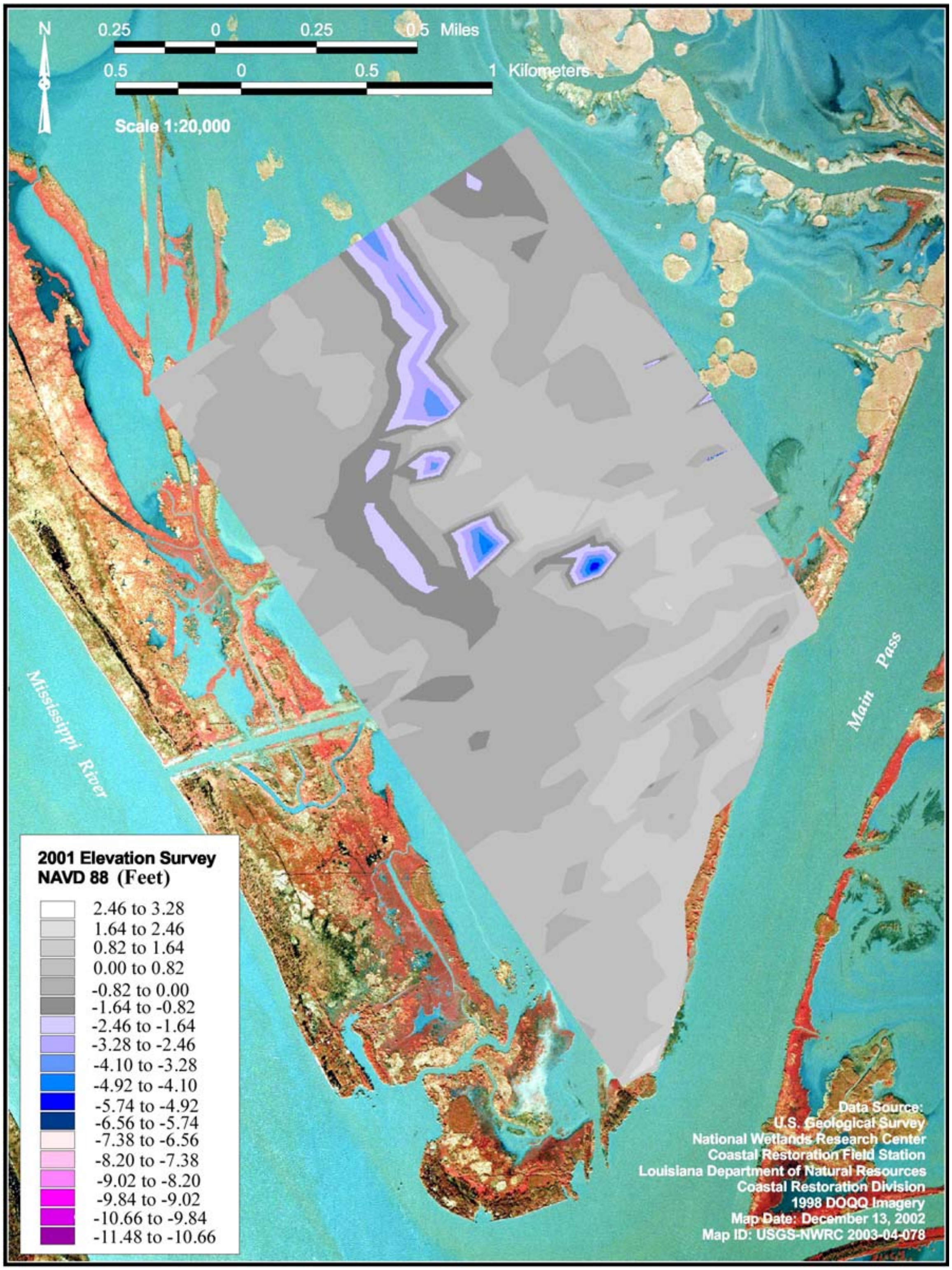

Figure 5. Postconstruction elevation (ft) within the receiving bay (Mary Bowers Pond) of the Channel Armor Gap Crevasse (MR-06) project area. Survey was conducted on October 16, 2001.

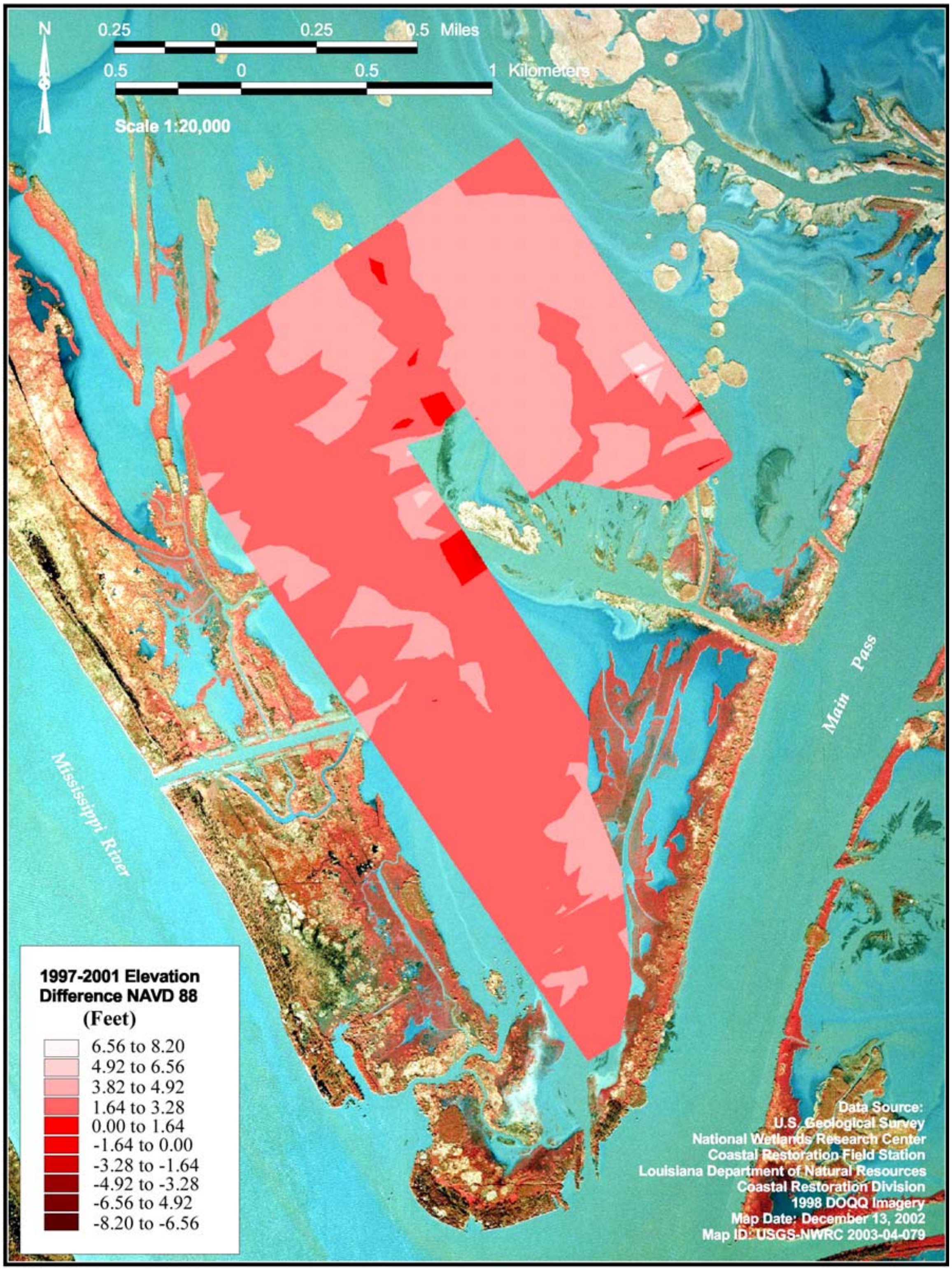

Figure 6. Sediment elevation change (ft) within the receiving basin between 1997 and 2001 in the Channel Armor Gap Crevasse (MR-06) project area.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
1997 Sediment Elevation (ft)	195	-6.76	-1.84	-3.48	0.9
2001 Sediment Elevation (ft)	382	-11.81	1.12	-0.37	1.24

Paired Samples Test								
	Paired Differences							
	Mean Elevation (ft)	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
1997 - 2001	-3.220	1.610	0.120	-3.440	-2.990	-27.9	194	< 0.001

Table 1. T-test comparing overlapping 1997 and 2001 sediment elevations (ft).

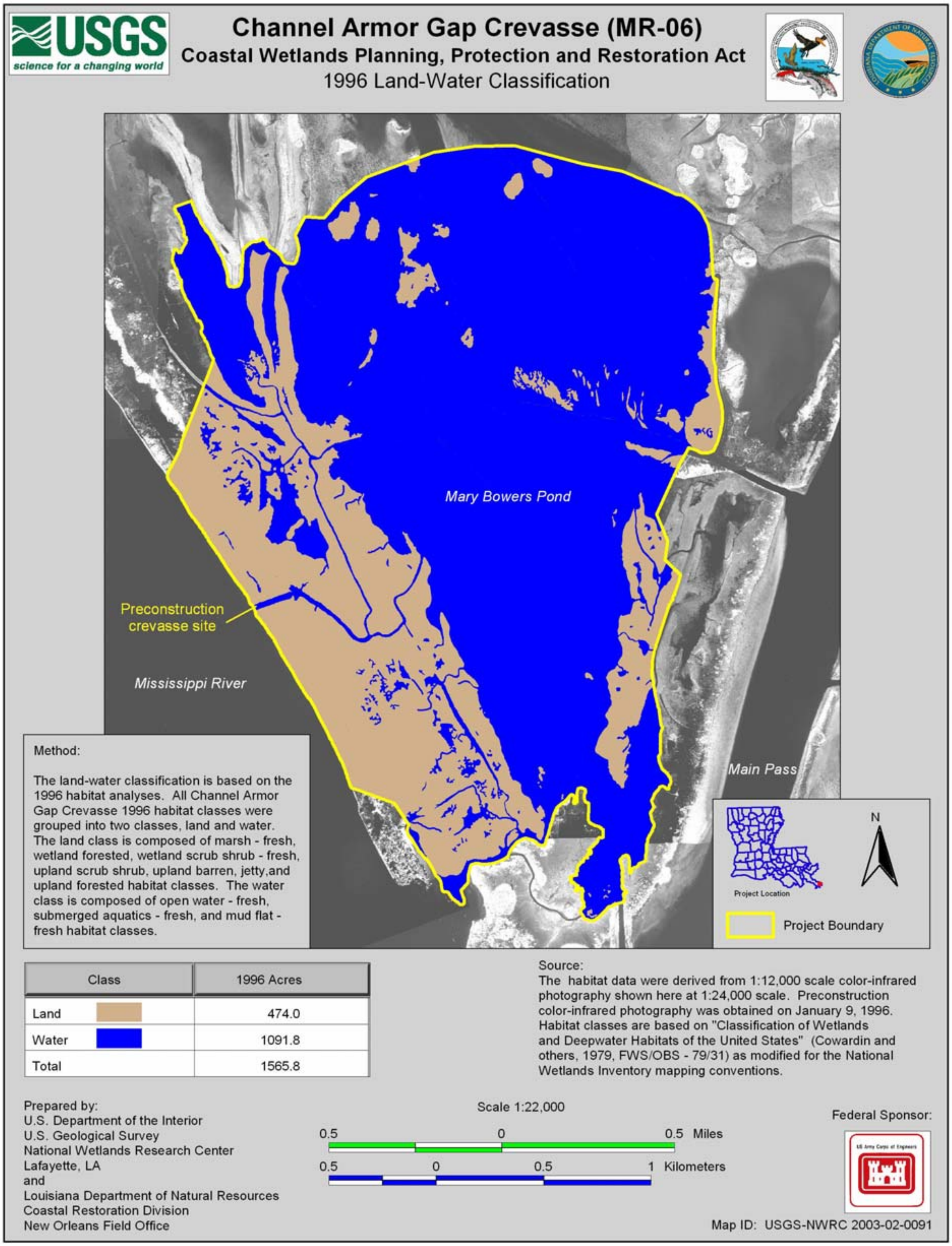

Figure 7. 1996 (preconstruction) land/water analysis of the Channel Armor Gap Crevass (MR-06) project area.

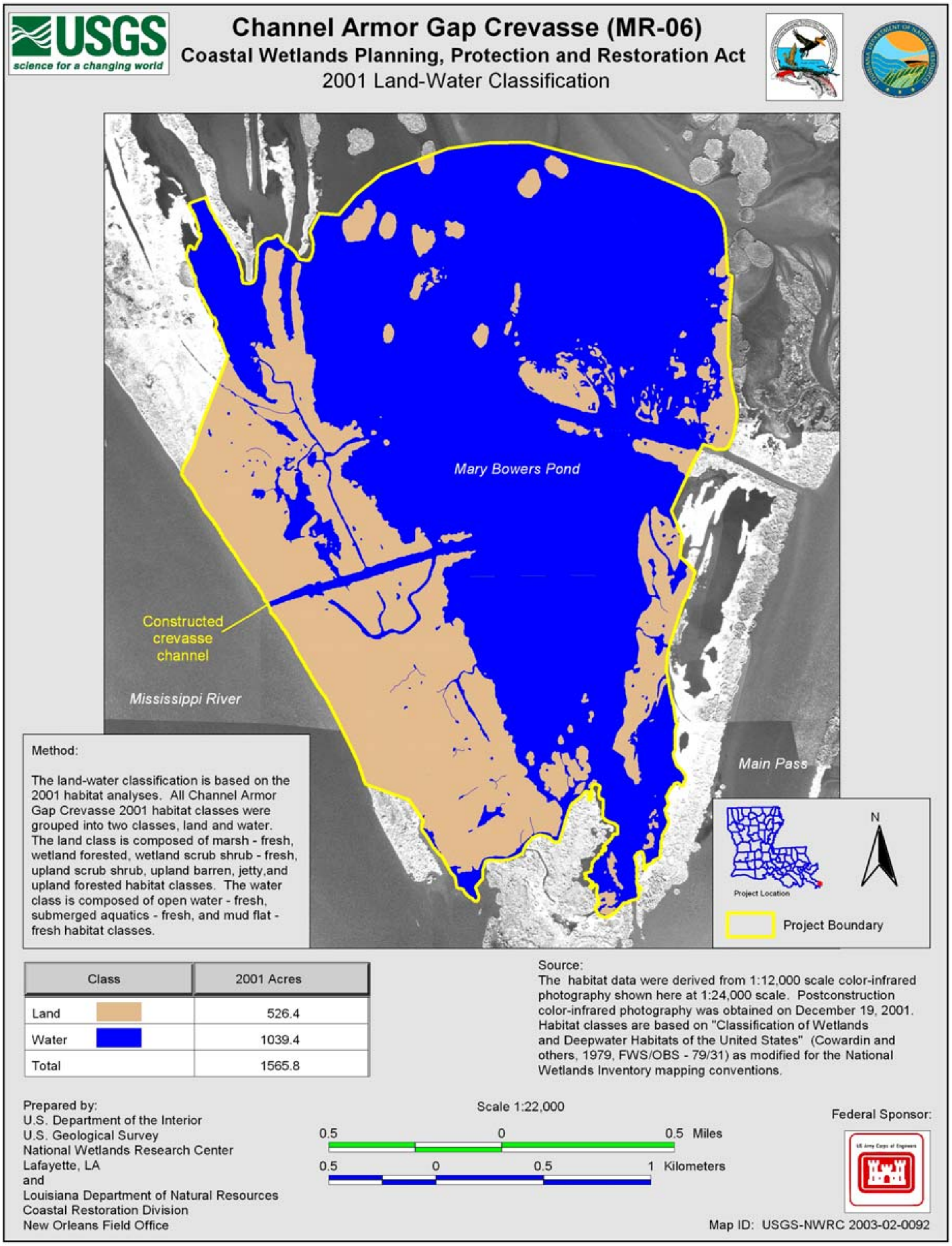

Figure 8. 2001 (postconstruction) land/water analysis of the Channel Armor Gap Crevasse (MR-06) project area.

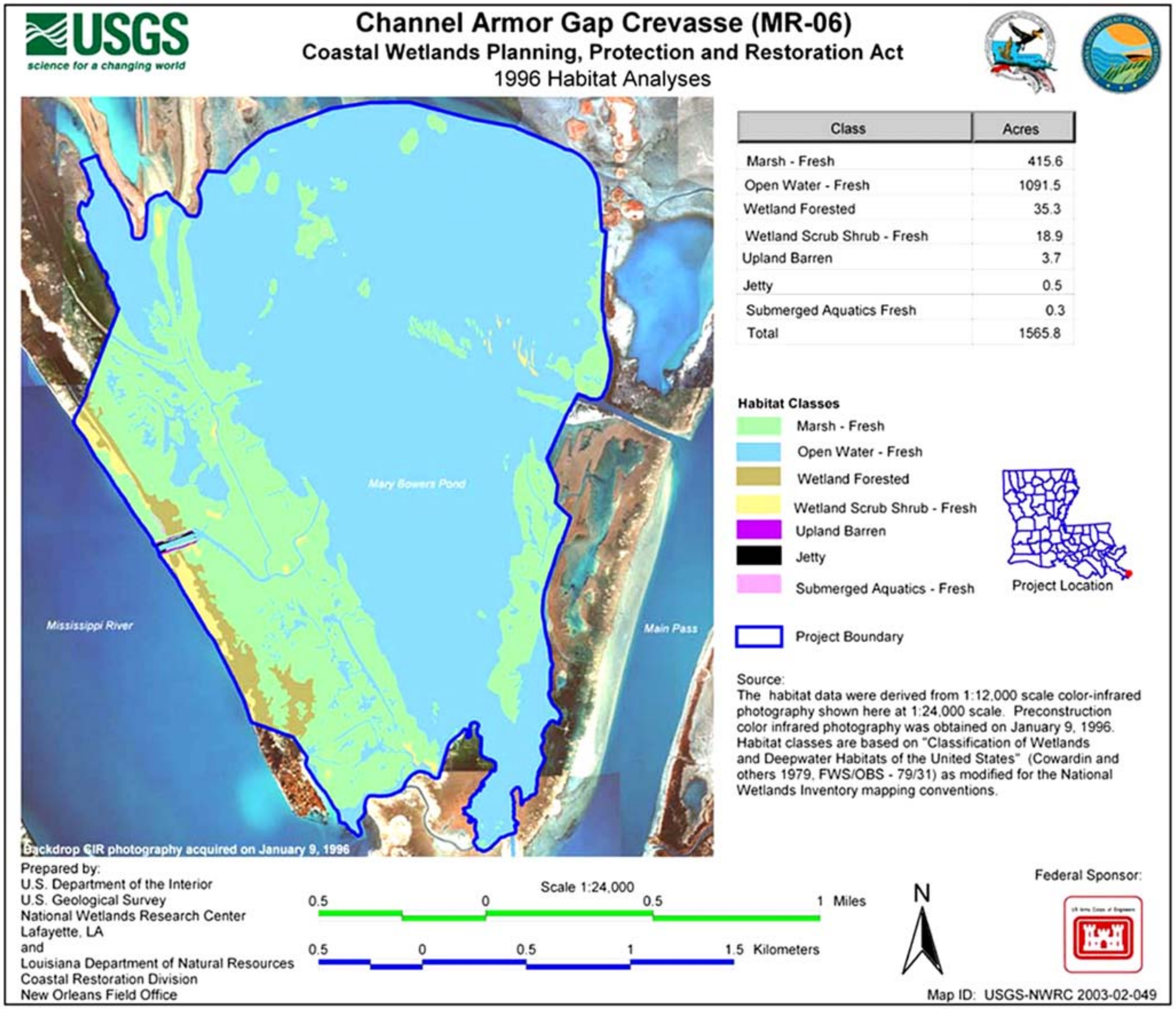

Figure 9. Preconstruction habitat analysis of the Channel Armor Gap (MR-06) project area.

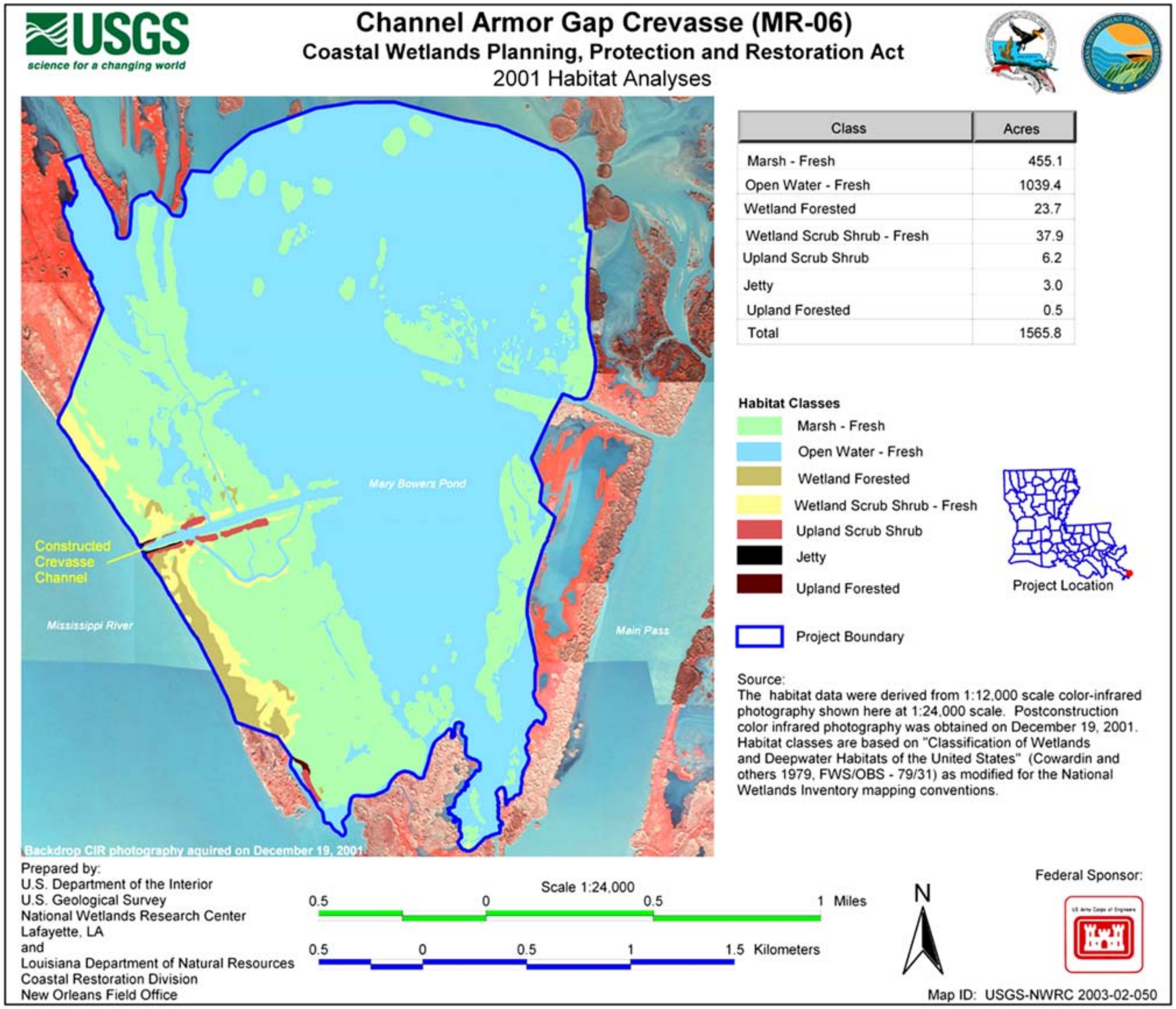

Figure 10. Postconstruction habitat analysis of the Channel Armor Gap (MR-06) project area.

Habitat analysis of the 1996 aerial photographs yielded seven habitat classes (figure 9). Approximately two thirds of the project area consisted of fresh open water, including 0.3 acres of submerged aquatic vegetation. Fresh marsh made up the majority of the remaining acreage. Most fresh marsh was located on the western side of the project area, as were nearly all of the wetland forest and scrub-shrub habitats. Upland barren and jetty made up the remaining 4.2 acres (1.7 hectares). Habitat analysis of the 2001 aerial photographs yielded seven habitat classes (figure 10). Most of the fresh marsh increase was adjacent to two, previously constructed, crevasses on the eastern and southern fringes of the project area and at the mouth of a small natural bayou off of the MR at the southwestern boundary. Forested wetlands decreased from 35.3 acres (14.3 hectares) to 23.7 acres (9.6 hectares), and fresh wetland scrub shrub increased from 18.9 acres (7.6 hectares) to 37.9 acres (15.3 hectares). Upland scrub shrub, jetty, and forested uplands made up the remaining 9.7 acres (3.9 hectares), and were mostly located on spoil banks adjacent to the constructed crevasse channel, which were created during construction by placement of dredge material from the channel.

Vegetation

During 2001, subaerial land was first observed adjacent to the end of the crevasse channel. Thus, the first two vegetation stations were established on October 17, 2001. Station MR06-0101, located on the southeast side of the crevasse channel, had 75 % coverage of *Sagittaria lancifolia* (bull tongue) that had an average height of 1.0 ft (30.5 cm). Station MR06-0102, located on the northwest side of the crevasse channel, had 60 % coverage of *Sagittaria lancifolia* that had an average height of 1.0 ft (30.5 cm). These stations were placed in transect number one. Figure 11 shows the mean percent cover of species by year.

During the 2002 survey, no subaerial land or emergent vegetation was observed in the area adjacent to the crevasse channel where we previously established vegetation stations. Mississippi River water level was higher than in the 2001 survey, therefore the plots were submerged and the vegetation may have been obscured from view. However, two tropical systems, tropical storm Isidore and hurricane Lili, passed through southern Louisiana in late September and early October of 2002. High wind and wave energy from the storms may have eroded vegetation and sediment away from the previously established stations. Another explanation is that the salinity incursions associated with hurricane Lili and tropical storm Isidore caused the observed *Sagittaria lancifolia* losses (Holm and Sasser 2001).

Five new vegetation stations, and a second transect were established during the 2003 survey due to an increase in emergent vegetation near the mouth of the crevasse channel. Most of the observed vegetation was *Sagittaria lancifolia*, but *Phragmites australis* and *Colocasia esculenta* were also present. Neither tropical storms nor other major weather events occurred between the 2002 and 2003 surveys. This left the crevasse system relatively undisturbed, allowing sediment accretion and vegetative colonization to occur.

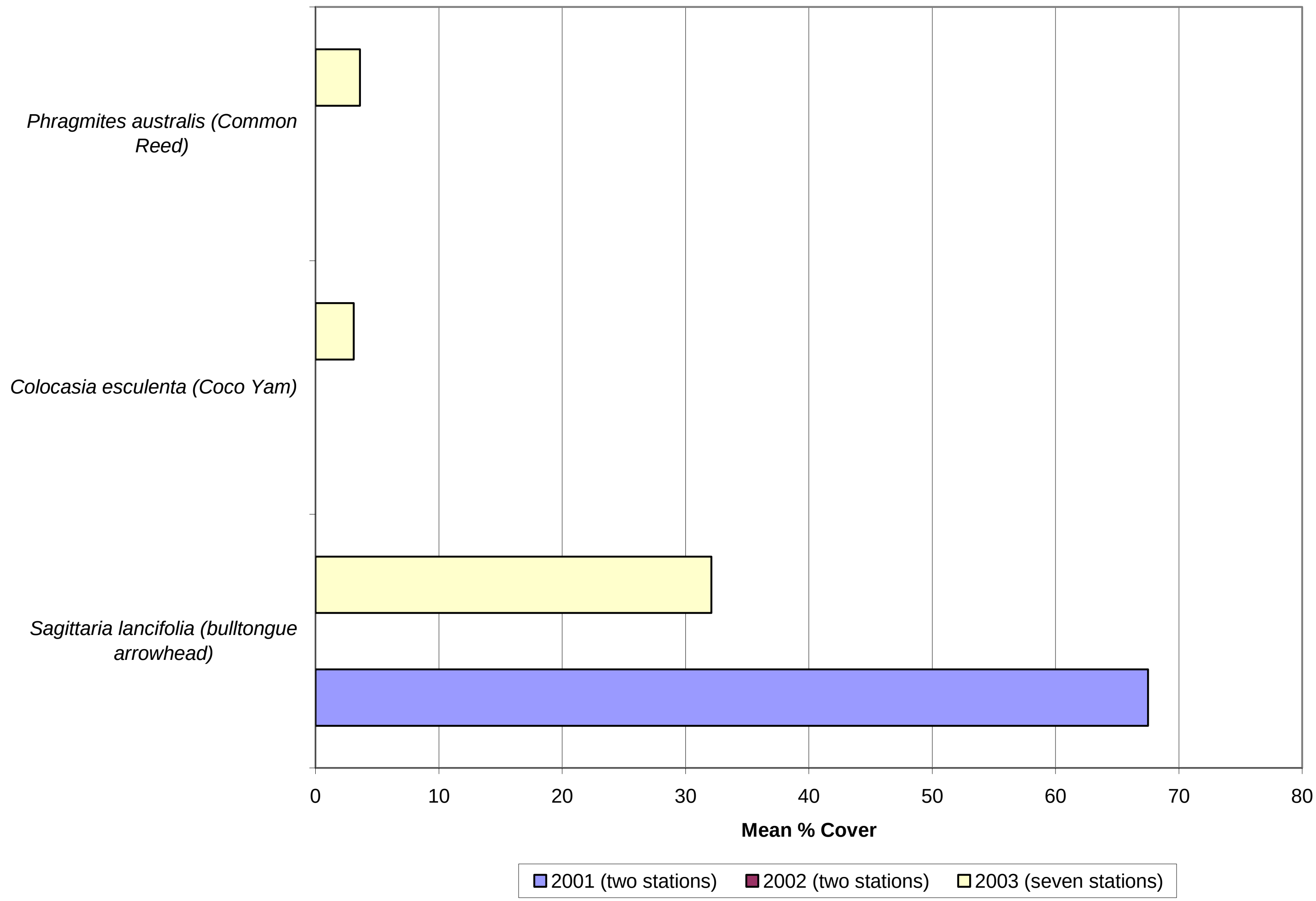

Figure 11. Mean percent cover of emergent vegetation species from 2001 to 2003.

V. Conclusions

a. Project Effectiveness

Sediment elevation has significantly increased within the entire project area since project construction was completed in 1997. However, most of the land gains were in the vicinity of older crevasses in the southern and eastern areas of the project and a natural bayou at southwestern boundary. Nonetheless, we have seen a dramatic accumulation of sediment of which some was likely contributed by the project crevasse. For example, two small, vegetated subaerial land formations appeared near the constructed crevasse mouth in 2001, but 2002 tropical storm systems eliminated them by redistributing sediment. In 2003, more vegetation was observed. The goals of increasing sediment elevation, land expression, and emergent wetland vegetation cover in the MR-06 project area are successfully being met, however based on the spatial distribution of the subaerial land in the vicinity of the older crevasses and the natural bayou at southern boundary, it is not clear how much of this is a direct result of the MR-06 crevasse.

b. Recommended Improvements

Suspended sediment and discharge measurements were dropped because their sampling frequency was not sufficient to give us accurate and reliable data. However, we suggest that funding for these variables be provided for future projects. The quantity and quality of sediment being transported into the project area can be combined with land gain data, and used to model, and increase predictive capabilities of crevasse splay development.

c. Lessons Learned

For this project, more time was required for subaerial land to develop than in previously-studied crevasses. Mary Bower's Pond was a relatively deep receiving area, averaging nearly 3.5 ft deep prior to construction. Thus, subaerial expression of the crevasse splay may have been delayed, because more sediment was needed to fill in the project area. Furthermore, the frequent tropical systems that passed through the region during the study period may have delayed land development by redistributing (i.e., removing) sediments in the area. Another lesson learned was that measuring and modeling sediment elevation was a good short-term indicator that the project is working. For instance, in the early phase of splay development before any subaerial land is expressed, sediment elevation data verified that the receiving basin was infilling and that the project area was on a positive trajectory toward subaerial land expression. Although the endpoint for determining project success is land gain measured from aerial photography, the elevation data show project benefits earlier than photography and also show additional benefits (i.e., subaqueous infilling).

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