CPRA
Coastal Protection and Restoration Authority of Louisiana

State of Louisiana
Office of Coastal Protection and Restoration

2008 Operations, Maintenance, and Monitoring Report

for

Channel Armor Gap Crevasse

State Project Number MR-06
Project Priority List 3

June 2008
Plaquemines Parish

Prepared by:

Melissa Kaintz, Engineering and Operations

Office of Coastal Protection and Restoration
New Orleans Field Office
CERM, Suite 309
2045 Lakeshore Dr.
New Orleans, La. 70122

Suggested Citation:

Kaintz, M. 2008. *2008 Operations, Maintenance, and Monitoring Report for Channel Armor Gap Crevasse (MR-06), Office of Coastal Protection and Restoration, New Orleans, Louisiana.* 23*pp.*

2008 Operations, Maintenance, and Monitoring Report
for
Channel Armor Gap Crevasse (MR-06)

Table of Contents

I. Introduction

Channelization of the Mississippi River (MR) has had negative impacts on the hydrography of the river and its wetland-building processes. The prolonged existence of 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. 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 not been limited by the size of the receiving basin, but by insufficient sediment delivery. 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 the trapping of coarse sediment material, essential to building subaerial land, in upstream dams and reservoirs. Better conservation practices by farmers in the Arkansas, Missouri, and Ohio River basins have also decreased river sediment availability in the MRD.

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). The subsidence rate for the entire MRD, approximately 0.43 in/yr (1.1 cm/yr; Day and Templet 1989), is exacerbated by frequent canal dredging for navigation purposes and mining of mineral resources. The most recent land loss rate estimate for the MRD is 0.6 mi^2/yr (Barras et al. 2003).

The MR levee south of Venice, Louisiana has been reinforced with stone over the last few decades. Some shallow gaps were left in the river-bank armor to assist in crevasse development and the subsequent overflow of freshwater into adjacent marshes during periods of high water. Crevasses provide sediment-laden river water to shallow interdistributary ponds creating subaerial land (or deltaic splays) that become colonized with marsh vegetation over time. A natural crevasse splay has a life span 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. Artificial crevasses emulate the natural process of deltaic splay formation and marsh creation. 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 indicate 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 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.

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 of this project 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 the 20-yr life span of the project, it is expected to create approximately 1,000 acres (405 hectares) of emergent marsh.

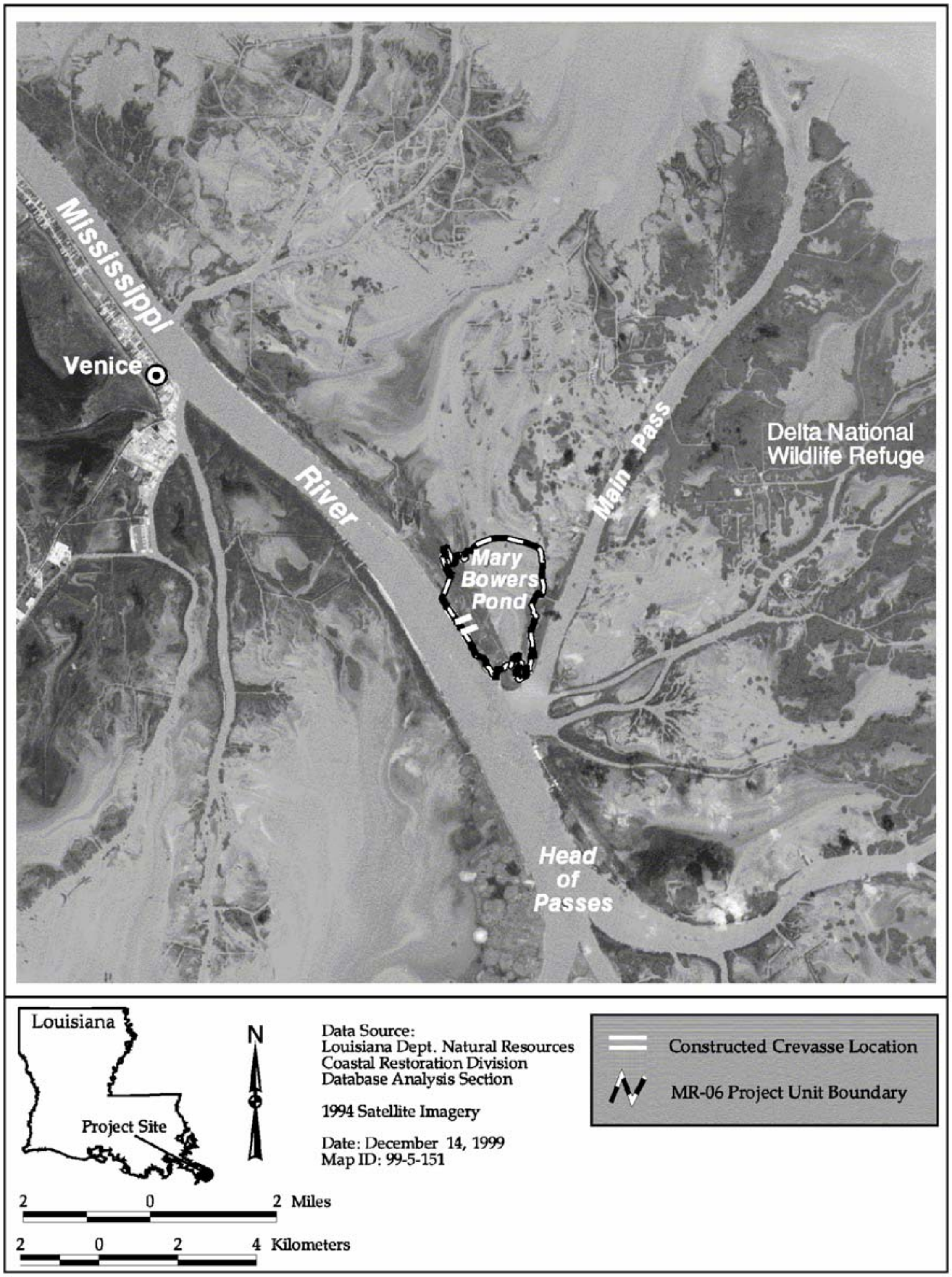


Figure 1. Channel Armor Gap Crevasse (MR-06) project location.

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. Another survey was conducted on March 11, 2008. According to the monitoring plan, this survey was scheduled for 2007; however, due to funding issues, it was postponed until the spring of 2008. It will be referred to as the 2007 elevation survey in this report.

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 and 2007 surveys, 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 and 2007 surveys. However, only the immediate receiving bay was used to compare the mean elevations among all three years.

This method differed from previous analyses and was done to avoid using any elevation data that could have been influenced by other channels and natural cuts. In addition, elevations from all three years could be compared using this smaller receiving area. ArcMap© Version 9.2 was used to draw the polygon in the immediate receiving bay, calculate mean elevations, and to create all elevation images. SAS© Version 9 was used to compare mean elevations among years.

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). Aerial photography was also taken in the Fall of 2007; however, the analysis was not available for this report. At the U.S. Geological Survey's National Wetlands Research Center (NWRC), the aerial 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.

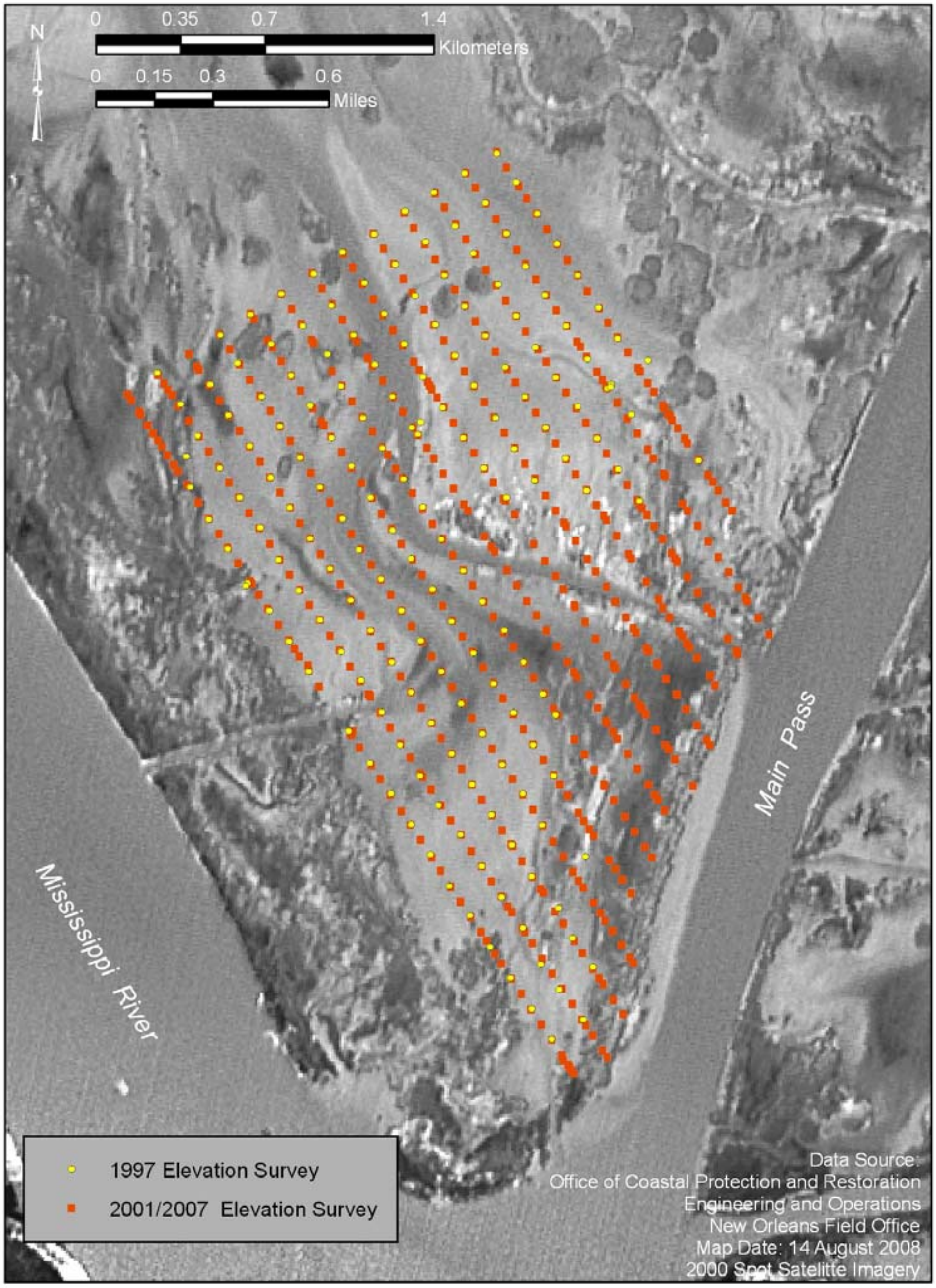


Figure 2. Schematic diagram of elevation sampling station locations in 1997 (yellow triangles) and 2001/2007 (red squares) in the Channel Armor Gap Crevasse (MR-06) project area.

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 (Folse and West 2008). 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 immediate receiving bay in 1997 (preconstruction) was - 3.39 NAVD 88 (ft; Figure 3 and 4). The average elevation of the receiving bay in the 2001 (post construction) elevation survey was - 0.41 NAVD 88 (ft; Figure 3 and 5) and 0.16 NAVD 88 (ft) in the 2007 elevation survey (Figure 3 and 6). There was a significant increase in elevation among all three years ($p < 0.0001$). Elevations ranged from -4.70 to -2.30 NAVD 88 (ft) in 1997, -2.10 to 0.50 NAVD 88 (ft) in 2001, and from 1.8 to 1.15 NAVD 88 (ft) in 2007. There was a greater increase in elevation from 1997 to 2001 than from 2001 to 2007, possibly a result of intense storm activity in 2005. Differences in elevation ranged from 1.2 to 4.0 NAVD 88 (ft) from 1997 to 2001 (Figure 7) and from -0.09 to 2.0 NAVD 88 (ft) from 2001 to 2007 (Figure 8). Sediment elevations increased in most of the receiving bay between 1.64 and 4.92 NAVD 88 (ft) from 1997 to 2007 (Figure 9). The channel that had been forming in the center of the receiving bay is still evident; however, it appears to be filling in. The change in elevation across the entire project area from 1997 to 2007 is shown in Figure 10. Differences in elevation ranged from -4 to 8 NAVD 88 (ft).

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 11). 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 12).

Habitat analysis of the 1996 aerial photographs yielded seven habitat classes (Figure 13). 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 14). Most of the fresh marsh increase was adjacent to two, previously constructed, crevasses on the eastern and southern fringes of the project area. 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.

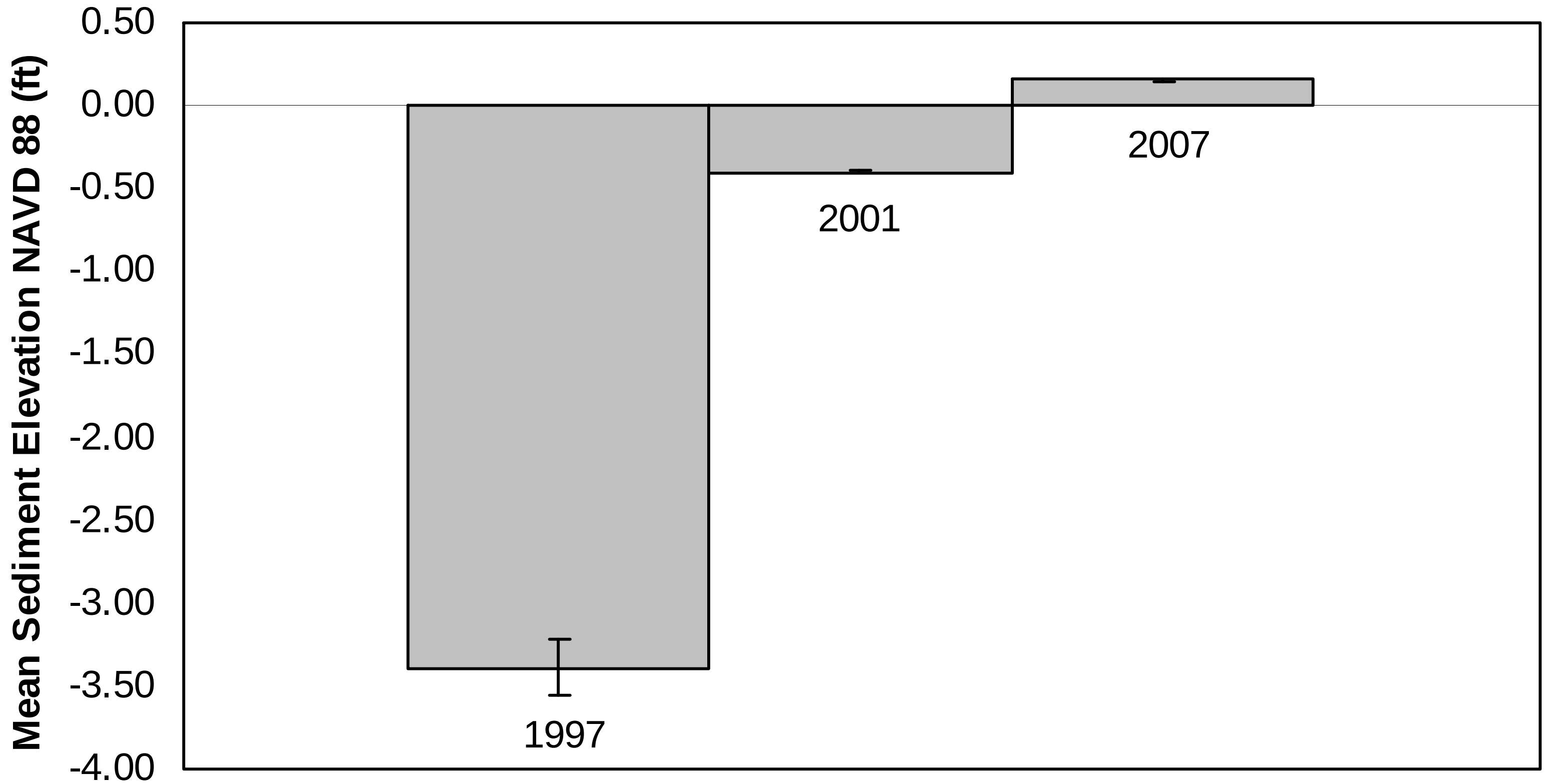


Figure 3. Mean sediment elevation (NAVD 88) (ft) in the immediate project area in 1997 (preconstruction), 2001 (post construction), and 2007 for the Channel Armor Gap Crevasse (MR-06) project.

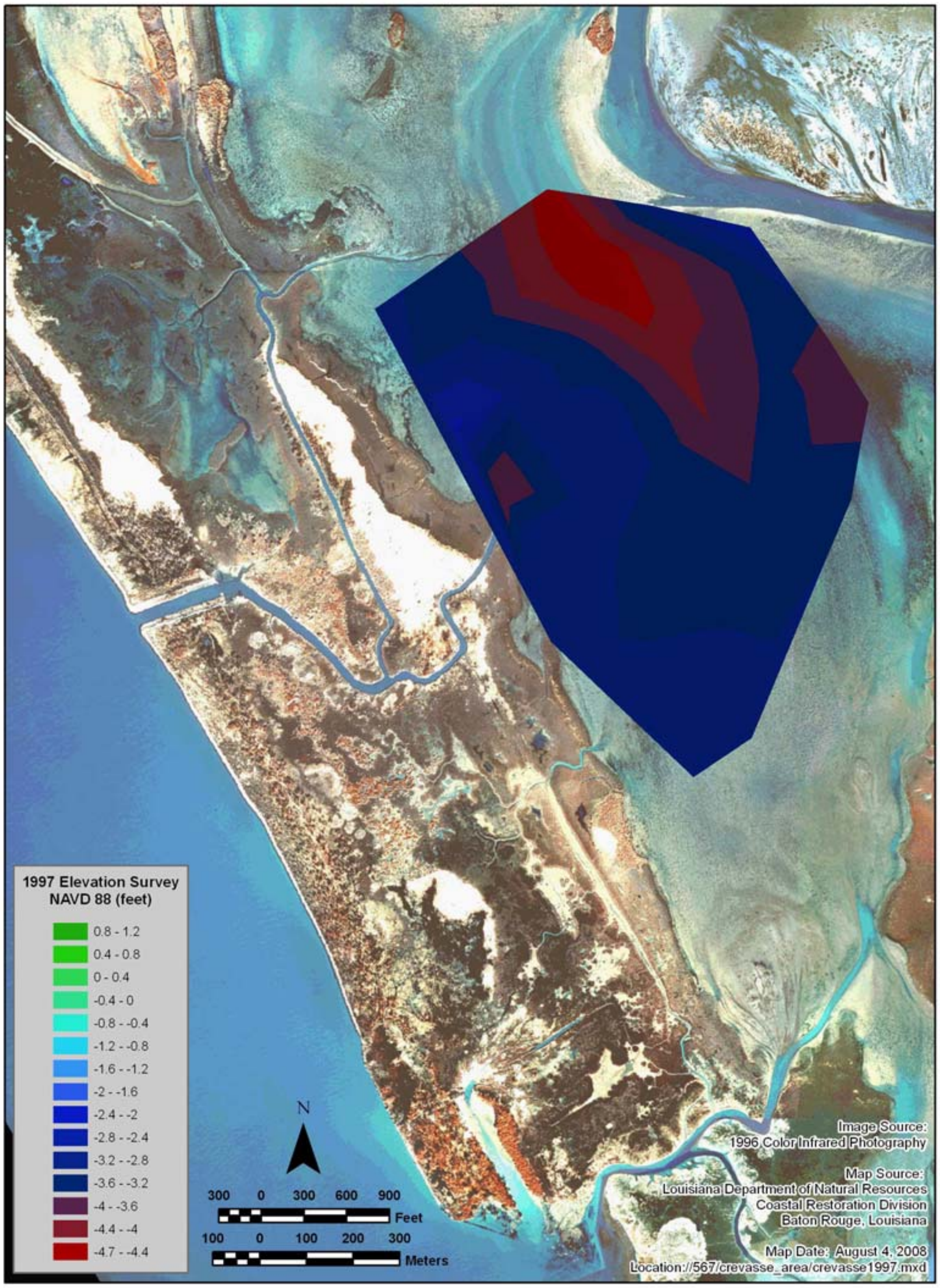


Figure 4. Preconstruction (1997) elevation (ft) within the receiving bay (Mary Bowers Pond) of the Channel Armor Gap Crevasse (MR-06) project area.

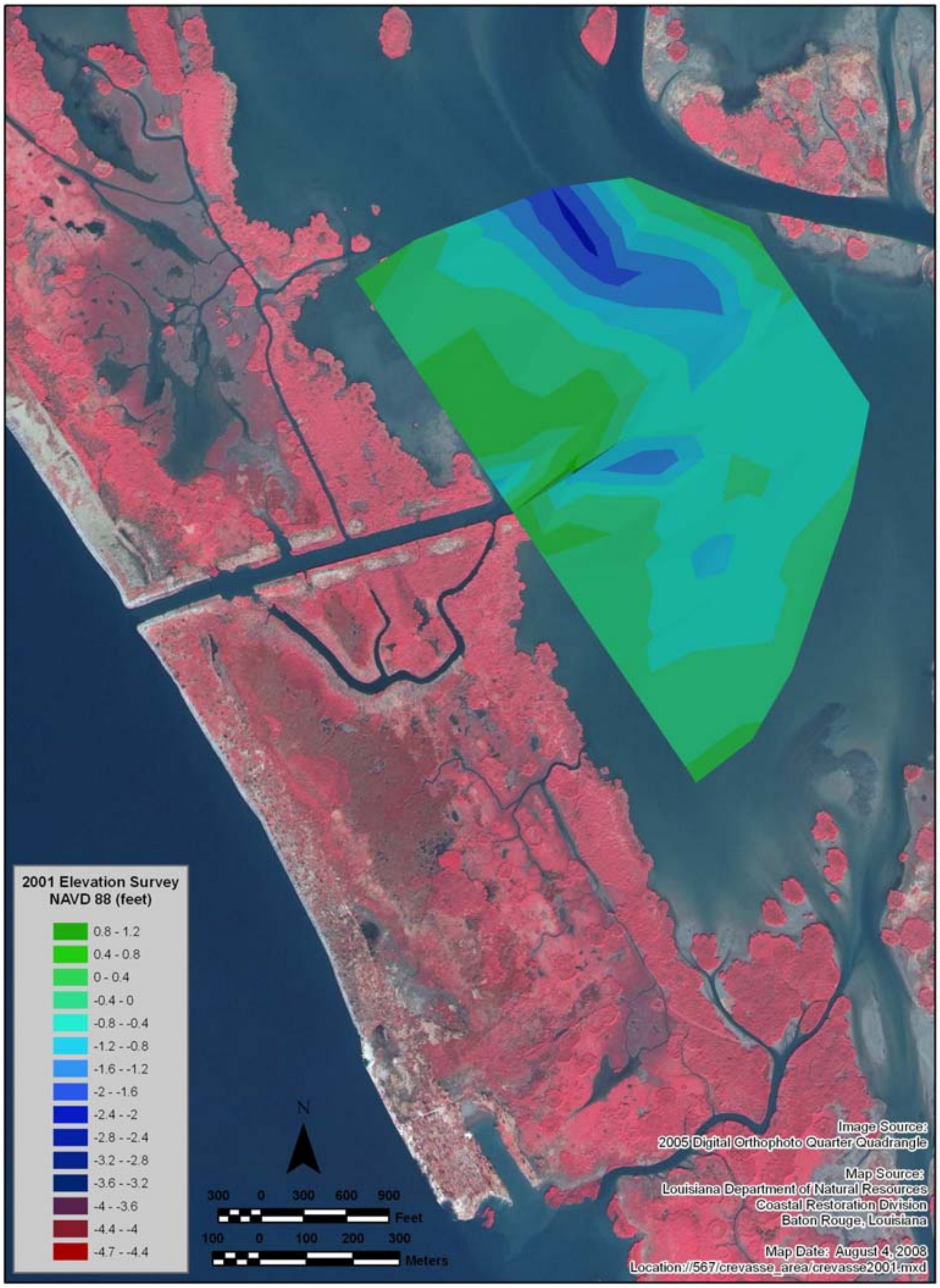


Figure 5. Post construction (2001) elevation (ft) within the receiving bay (Mary Bowers Pond) of the Channel Armor Gap Crevasse (MR-06) project area.

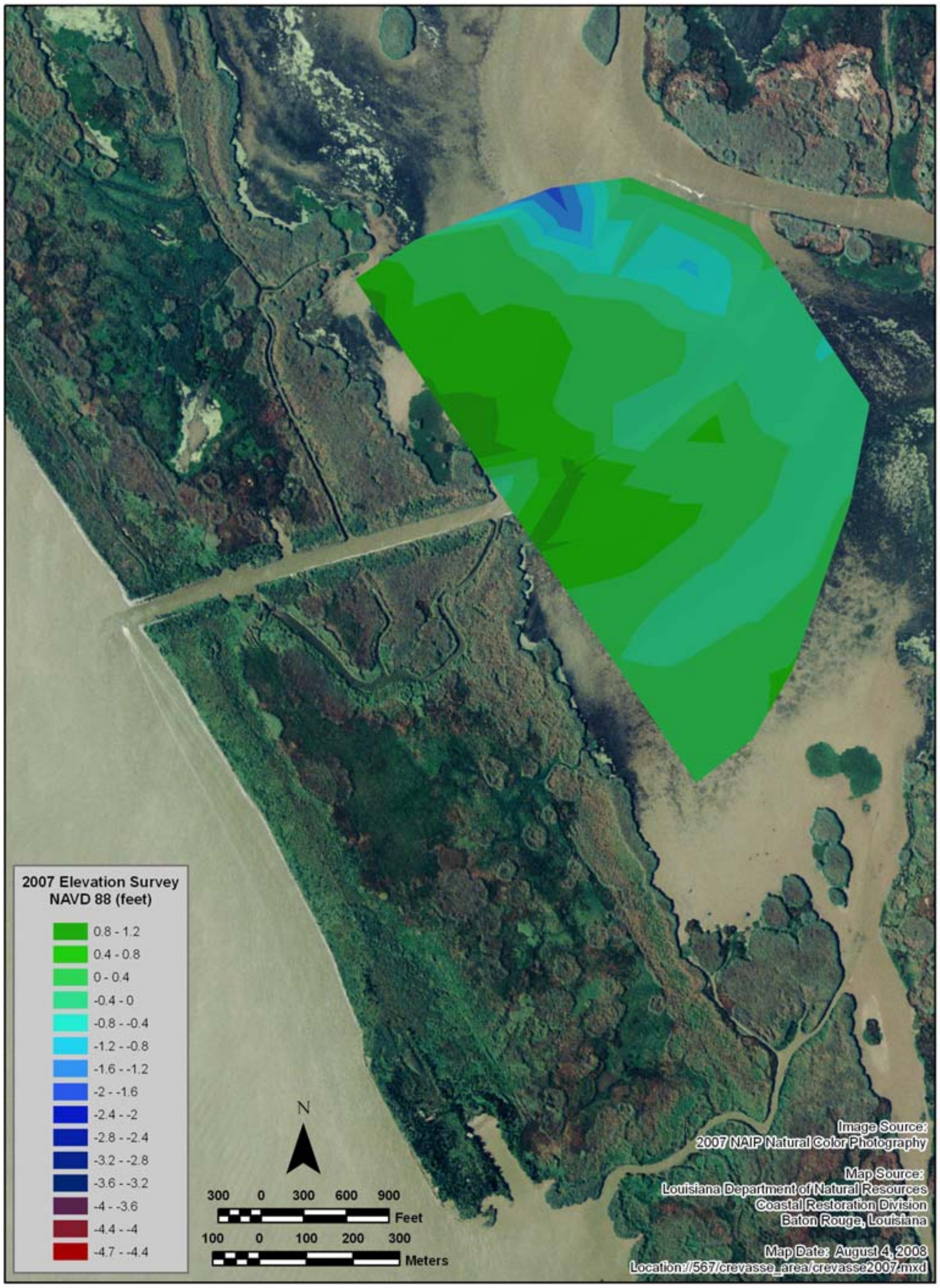


Figure 6. Post construction (2007) elevation (ft) within the receiving bay (Mary Bowers Pond) of the Channel Armor Gap Crevasse (MR-06) project area.

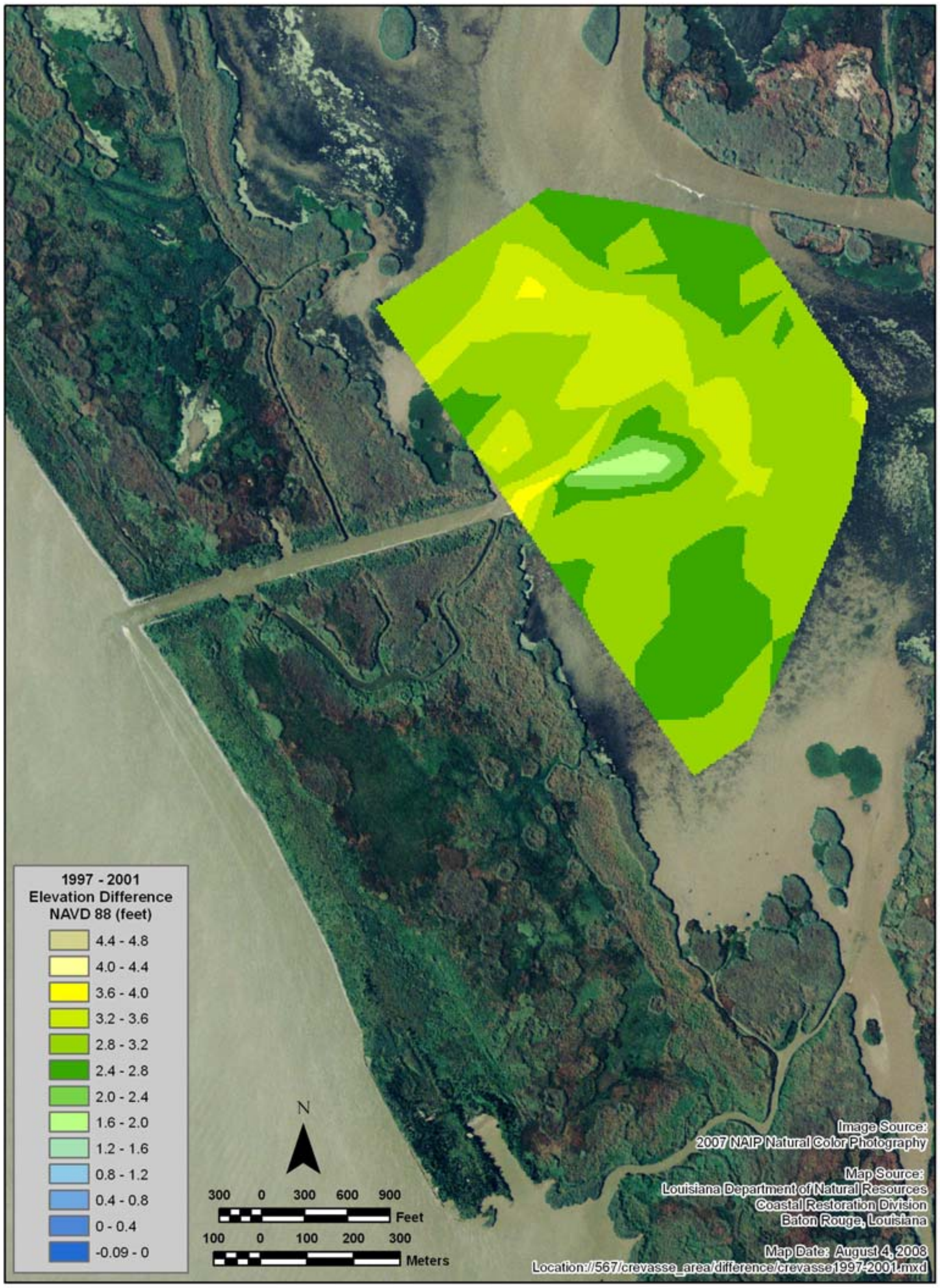


Figure 7. Sediment elevation change (ft) within the receiving basin between 1997 and 2001 in the Channel Armor Gap Crevasse (MR-06) project area.

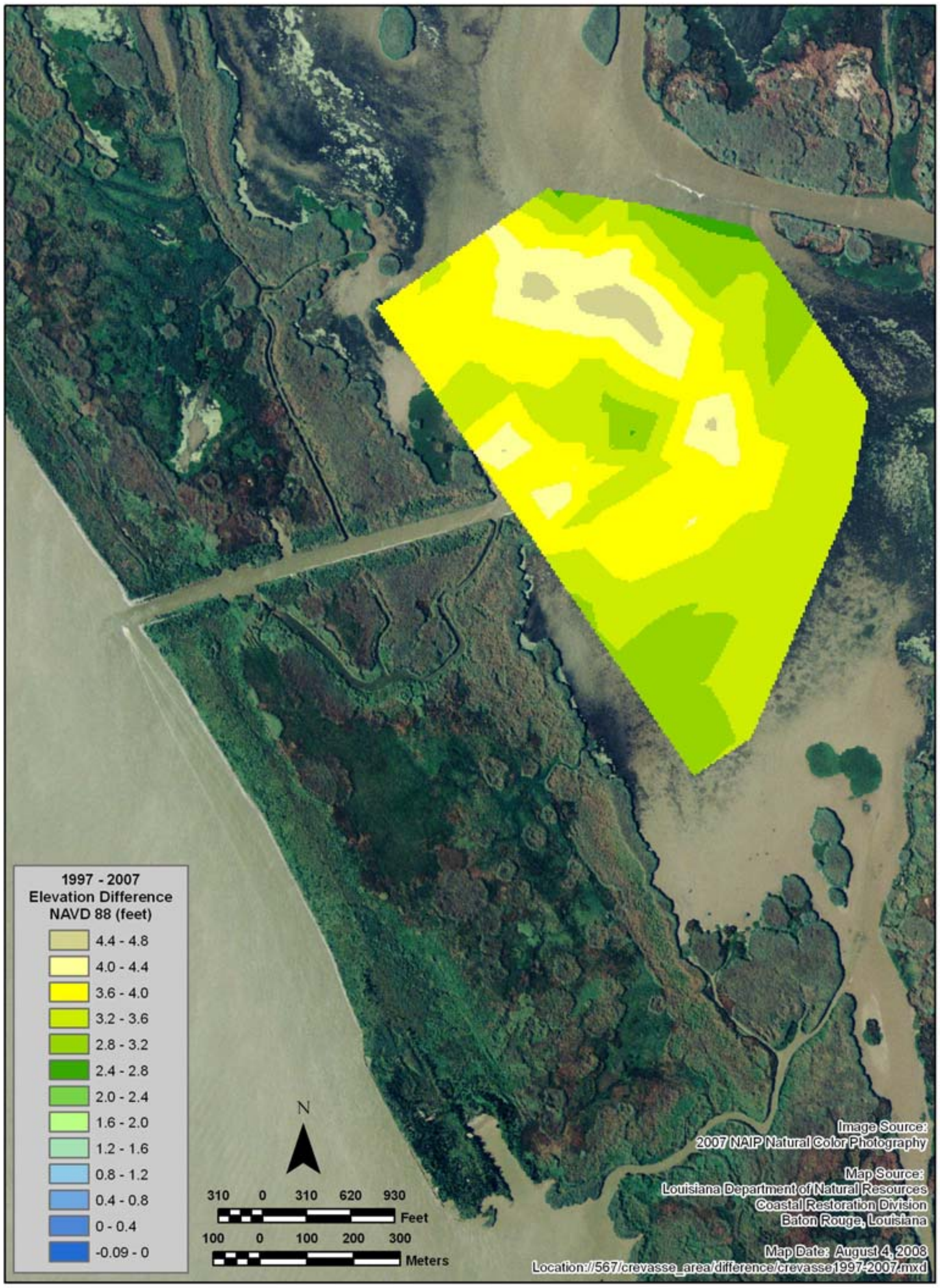


Figure 8. Sediment elevation change (ft) within the receiving basin between 1997 and 2007 in the Channel Armor Gap Crevasse (MR-06) project area.

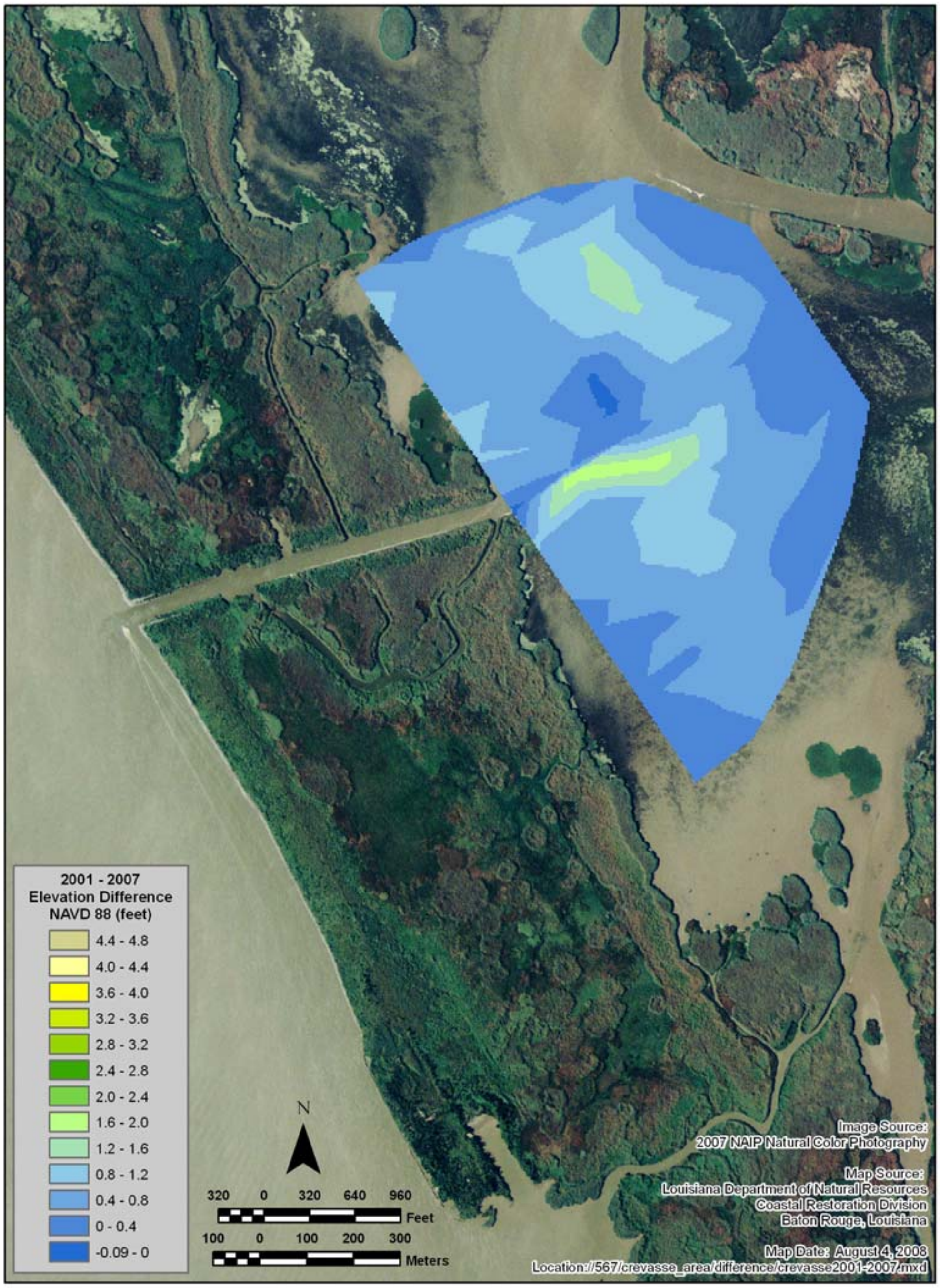


Figure 9. Sediment elevation change (ft) within the receiving basin between 2001 and 2007 in the Channel Armor Gap Crevasse (MR-06) project area.

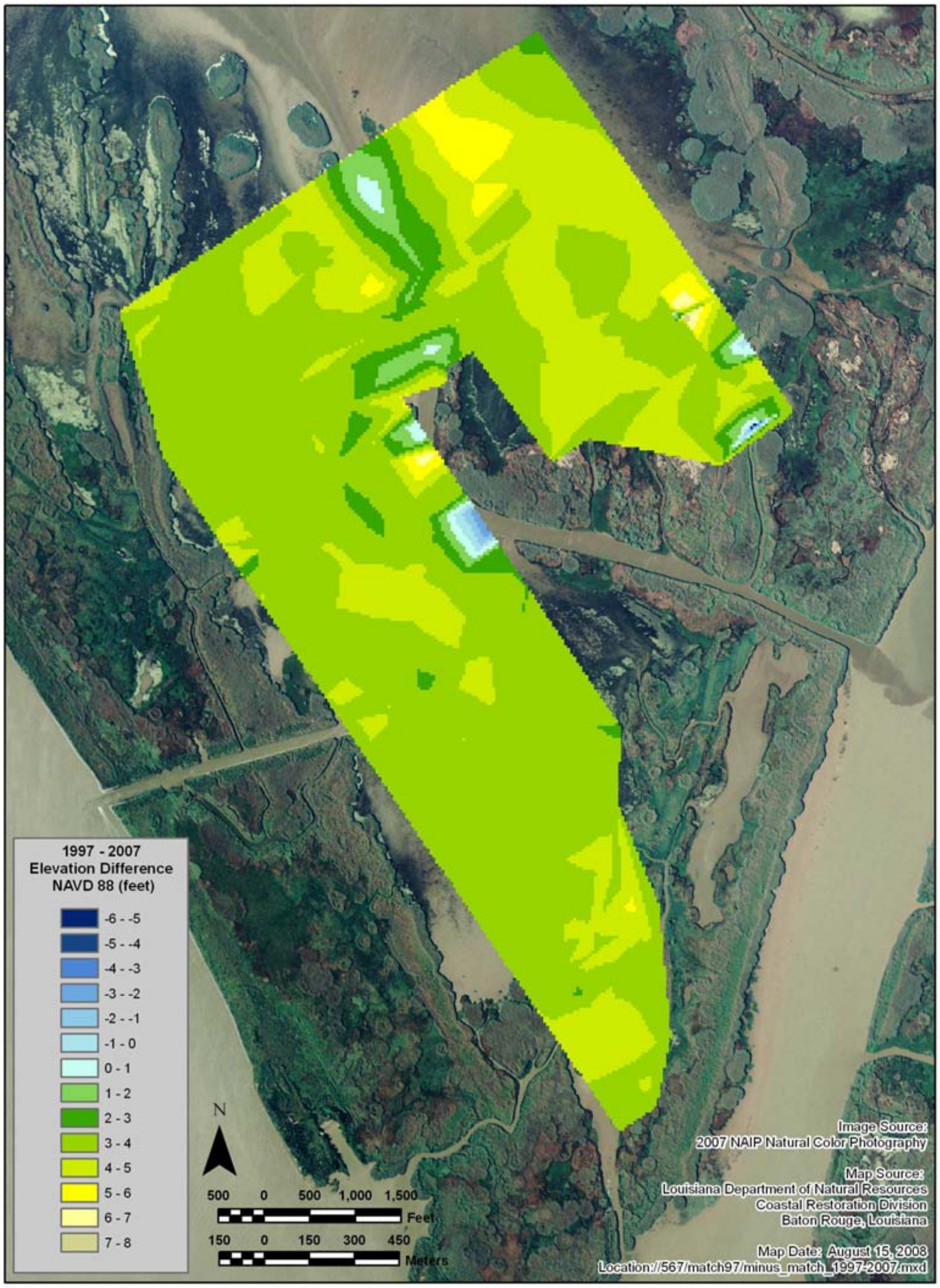


Figure 10. Sediment elevation change (ft) between 1997 and 2007 in the Channel Armor Gap Crevasse (MR-06) project area.

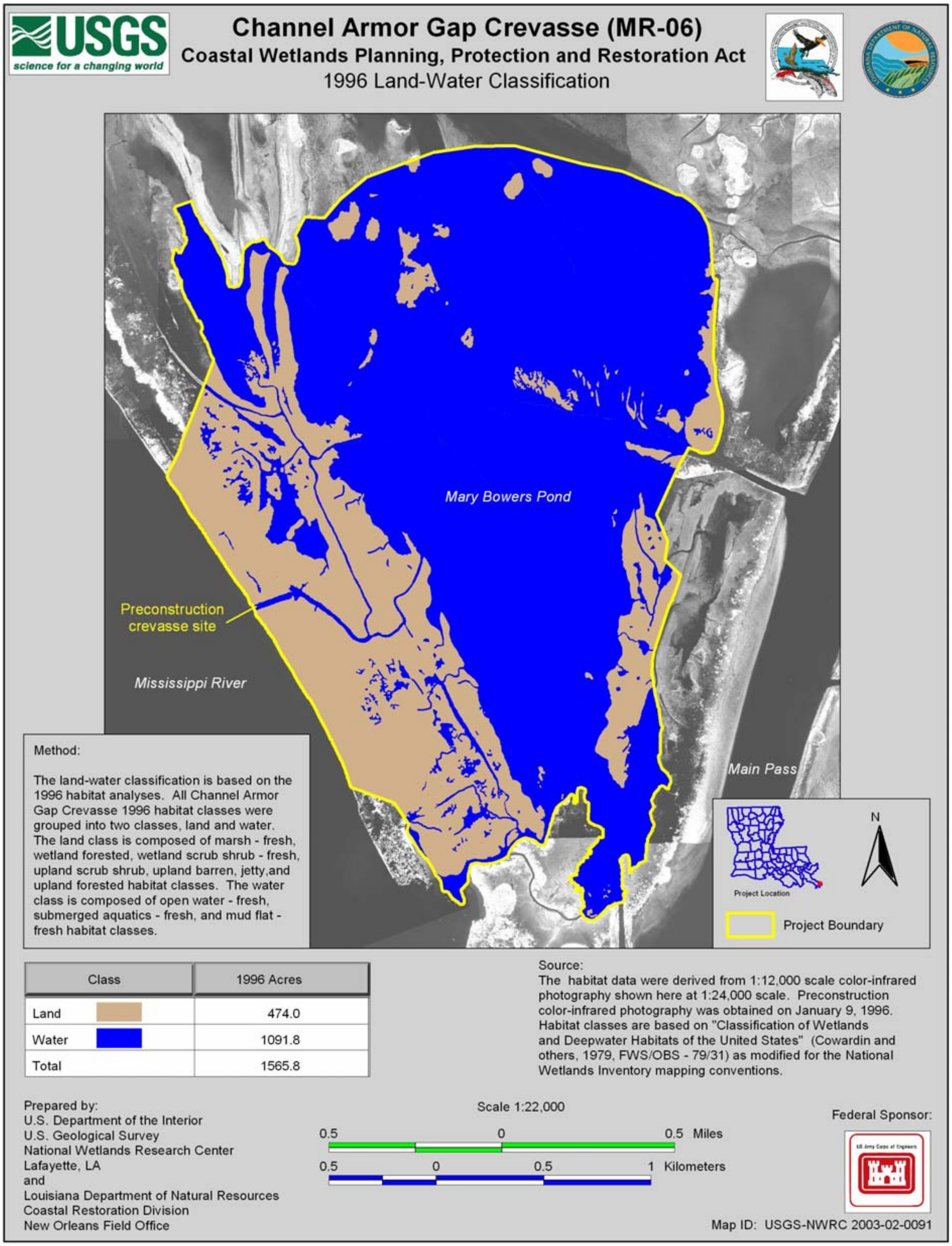
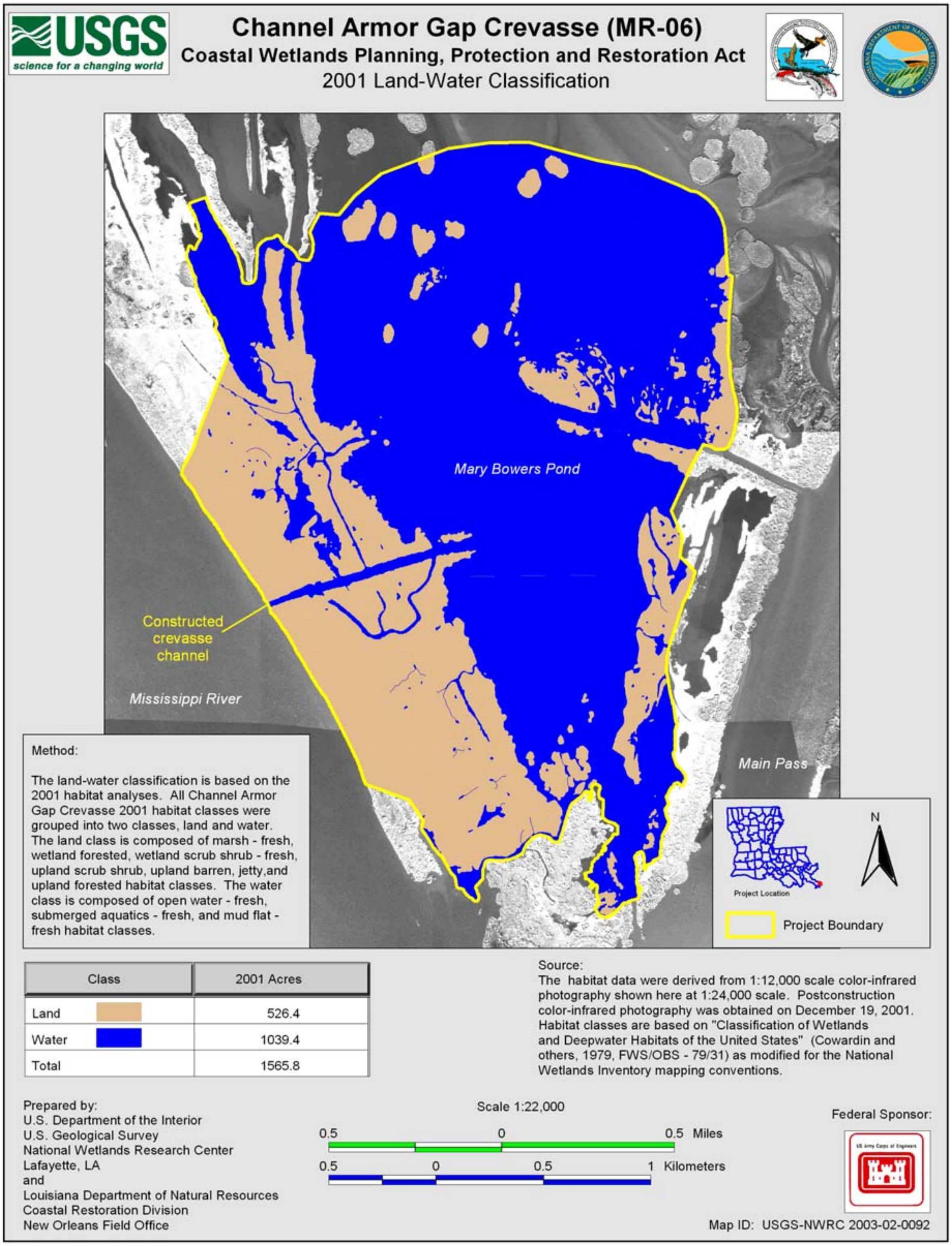


Figure 11. 1996 (preconstruction) land/water analysis of the Channel Armor Gap Crevass (MR-06) project area.



Class	2001 Acres
Land	526.4
Water	1039.4
Total	1565.8

Figure 12. 2001 (post construction) land/water analysis of the Channel Armor Gap Crevasse (MR-06) project area.

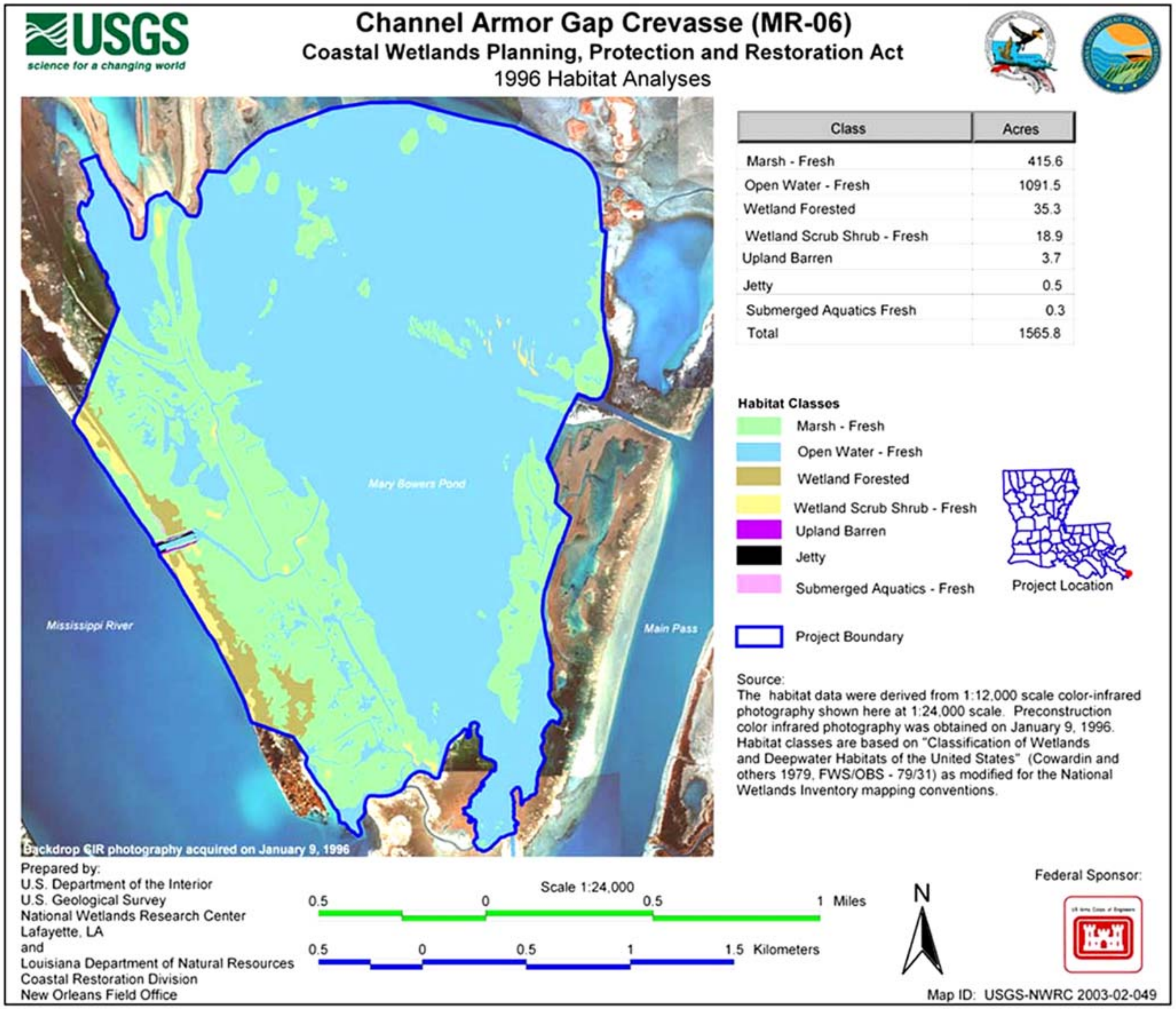


Figure 13. Preconstruction habitat analysis of the Channel Armor Gap (MR-06) project area.

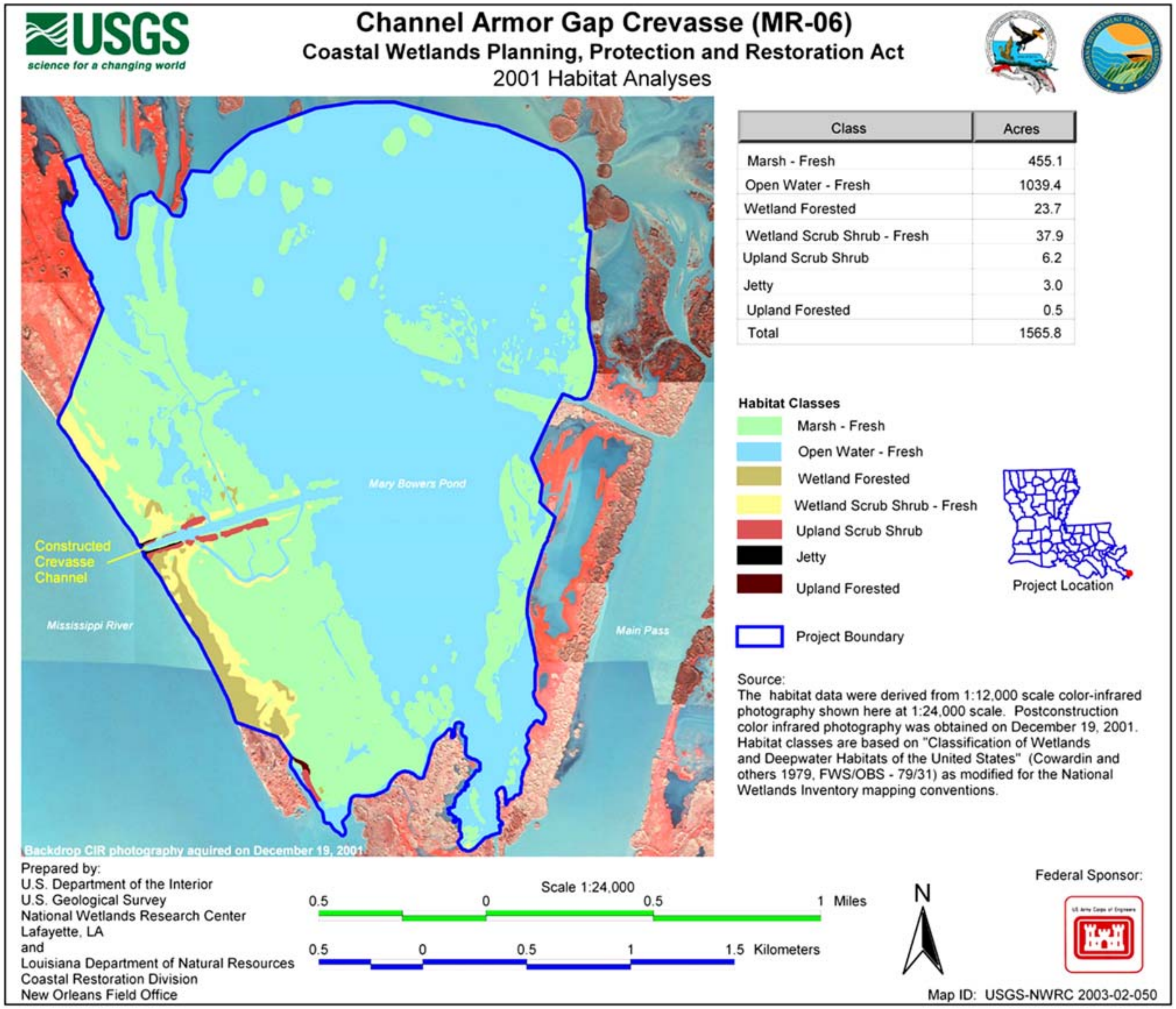


Figure 14. Post construction habitat analysis of the Channel Armor Gap (MR-06) project area.

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* sp. 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* sp. that had an average height of 1.0 ft (30.5 cm). These stations were placed in transect number one. The mean percent cover of species by year is shown in Figure 15.

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. The Mississippi River water level was higher at this time than in the 2001 survey and the plots were submerged; therefore, 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 Tropical Storm Isidore and Hurricane Lili caused the observed *Sagittaria* sp. 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* sp., but *Phragmites australis* and *Colocasia esculenta* were also present. No 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. Low vegetative coverage in 2004 was most likely caused by Hurricane Ivan.

No vegetation was observed in 2005 or 2006, a result of Hurricanes Katrina and Rita. Until the crevasse has sufficient time to generate a stable vegetative community; these storm events will destroy any forward progress. Newly established vegetation cannot survive the combination of wind, wave action, and, salt water intrusion from a significant storm without a well-developed root mass. In 2007, two years after Hurricanes Katrina and Rita, only a small patch of *Sagittaria* sp. was observed in the immediate receiving bay (Figure 15).

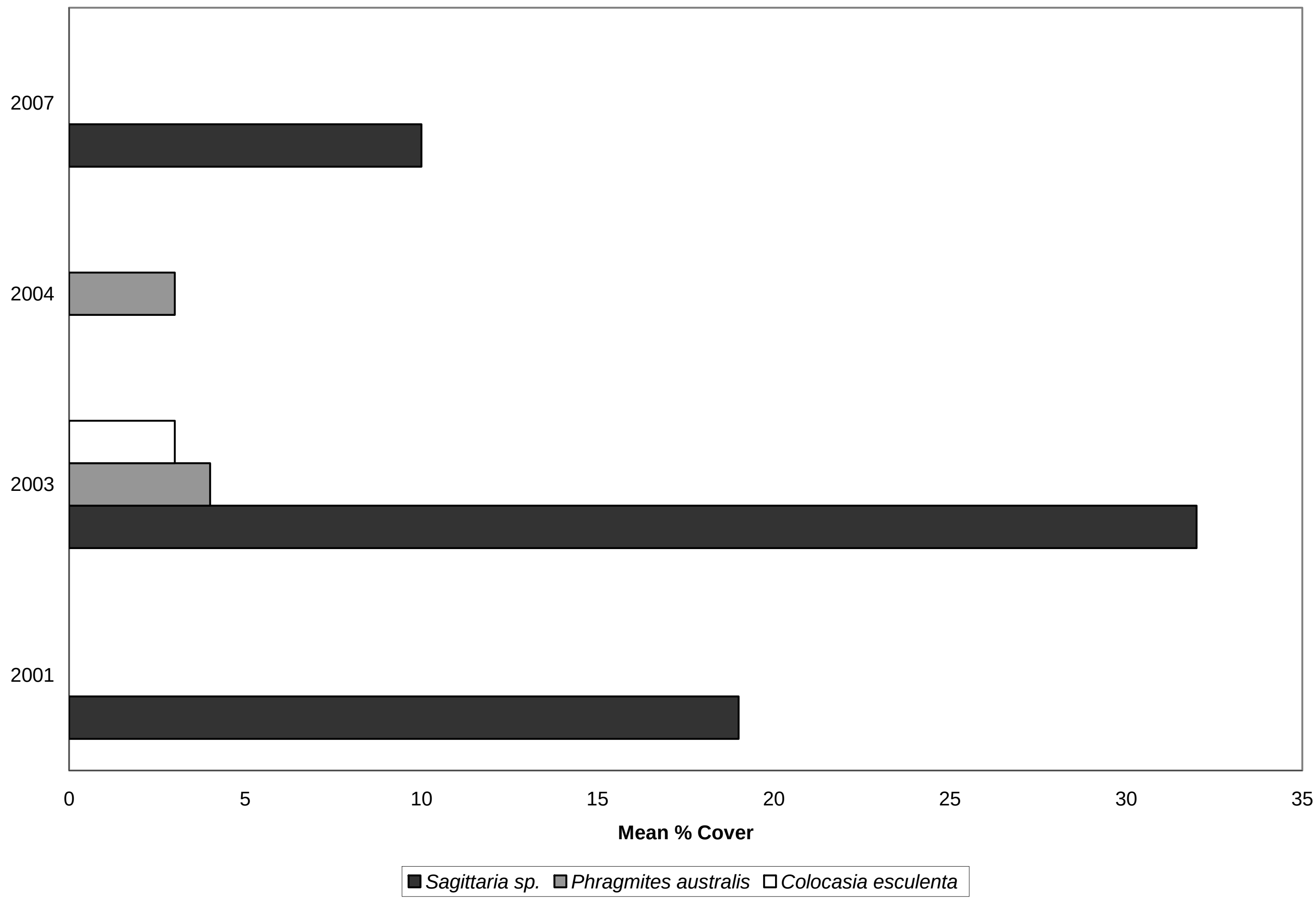


Figure 15. Mean percent cover of emergent vegetation species from 2001 to 2007. No vegetation was observed in 2002, 2005, and 2006.

V. Conclusions

a. Project Effectiveness

Sediment elevation has significantly increased within the entire project area since project construction was completed in 1997. It is clear that the goal of increasing sediment elevation is being met. Also, using only the immediate receiving bay for elevation analyses has eliminated concern regarding how much sediment was a direct result of the MR-06 project. Unfortunately, extensive storm disturbances have made it difficult to see progress in land expression and emergent wetland vegetation cover in the MR-06 project area.

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, modeled, and used to increase predictive capabilities of crevasse splay development.

c. Lessons Learned

In this project, more time was required for subaerial land to appear than in previously studied crevasses. Mary Bower's Pond was a relatively deep receiving area, averaging nearly 3.5 ft deep prior to construction. Subaerial expression of crevasse splays may be delayed with increasing pre-construction water depth. More sediment is required to fill a relatively deep receiving basin as opposed to shallower basins. Furthermore, many factors affect the rate of sediment retention and sediment distribution in receiving basins. Measuring and modeling sediment elevation is an effective short-term indicator of project success rather than relying solely on aerial photography to monitor visible land gain.

VI. Literature Cited

Anderson, J. E., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. U.S. Geological Survey Professional Paper No. 964. 28 pp.

Barras, J.A., S. Beville, D. Britsch, S. Hartley, S. Hawes, J. Johnston, P. Kemp, Q. Kinler, A. Martucci, J. Porthouse, D, Reed, K. Roy, S. Sapkota, and J. Suhayda 2003. Historical and projected coastal Louisiana land changes: 1978-2050:USGS Open File Report 03-xx (in press)

Boyer, M. E., J. O. Harris, and R. E. Turner 1997. Constructed crevasses and land gain in the Mississippi River Delta. Restoration Ecology 5: 85-92.

Davis, D. 1993. Crevasses on the lower course of the Mississippi River. pp. 360-378 *in* O. T. Magoon, W. S. Wilson, H. Converse, and L. T. Tobin, (eds), Coastal Zone '93, Proceedings of the Eighth Symposium on Coastal and Ocean Management. New York, New York: American Society of Civil Engineers.

Day, J. W. Jr., and P. H. Templet 1989. Consequences of sea level rise: implications from the Mississippi Delta. Unpublished report. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration and Management Division. 17 pp.

Folse, T. M. and J. L. West. 2005. A Standard Operating Procedures Manual for the Louisiana Department of Natural Resources' Coastal Restoration Division: Methods for Data Collection, Quality Assurance / Quality Control, Storage, and Products. Louisiana Department of Natural Resources, Baton Rouge, LA. 226 pp.

Holm, G.O. and C.E. Sasser 2001. Differential salinity response between two Mississippi River subdeltas: implications for changes in plant composition. Estuaries Vol. 24, No.1 p. 78-89.

Louisiana Department of Natural Resources 1993. Accretion and Hydrologic Analyses of Three Existing Crevasse Splay Marsh Creation Projects at the Mississippi Delta. Final Report to U.S. EPA, Region 6, Grant No. X-006587-01-0. Baton Rouge: Louisiana Department of Natural Resources. 28 pp.

Louisiana Department of Natural Resources 1996. Small Sediment Diversions (MR-01). Progress Report No. 2. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division. 12 pp.

Penland, S. and K. E. Ramsey 1990. Relative sea-level rise in Louisiana and the Gulf of Mexico: 1908-1988. Journal of Coastal Reasearch, 6: 323-342. Fort Lauderdale (Florida). ISSN 0749-0208.

Trepagnier, C. M. 1994. Near Coastal Waters Pilot Project, Crevasse Splay Portion. Final Report to U.S. EPA Region 6, Grant No. X-006518-01-2. Baton Rouge: Louisiana Department of Natural Resources. 37 pp.

Troutman, J. P. and A.D. MacInnes 1999. Channel Armor Gap Crevasse (MR-06) (XMR-10). Progress report No.1. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division. 14 pp.

Wells, J. T., and J. M. Coleman 1987. Wetland Loss and the Subdelta Life Cycle. Estuarine, Coastal and Shelf Science 25: 111-125.