Coastal Protection and Restoration Authority of Louisiana

Coastal Protection and Restoration Authority of Louisiana
Office of Coastal Protection and Restoration

2009 Operations, Maintenance and Monitoring Report

For

DELTA WIDE CREVASSES

State Project Number MR-09
Priority Project List 6

August 1, 2009
Plaquemines Parish

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2009 Operations, Maintenance and Monitoring Report
For
Delta Wide Crevasses (MR-09)

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I. Introduction

The Delta-wide Crevasses (MR-09) project is an uncontrolled sediment diversion located in Plaquemines Parish to the southeast of Venice, Louisiana on the active Mississippi River Delta (figure 1). Crevasses are breaks in the levee that allow overbank deposition of sediments to occur in adjacent interdistributary receiving bays. This deposition of sediments causes land formation that is controlled by the processes of distributary mouth-bar islands. Coleman and Gagliano (1964) ordered the mouth-bar island process into crevasse sub-delta and crevasse-splay based on relative size. Crevasse sub-deltas consist of relatively large receiving bays that have areal extents of 115-154 sq mi. (300-400 sq km) and depths of 32-49 ft (10-15 m). The process by which these sub-deltas are formed is referred to as "bay filling" (Coleman and Gagliano 1964). Crevasse-splays are a smaller sub-unit that are distinguished from sub-deltas in that their size, frequency, and expected life spans are smaller generally having a receiving bay extent of approximately 0.234 sq mi. (0.59 sq km) (Boyer 1996).

The project consists of maintaining presently existing crevasses, the construction of new crevasses, and future maintenance of selected crevasses in both the Pass-A-Loutre Wildlife Management Area (PALWMA) and the Delta National Wildlife Refuge (DNWR). The PALWMA covers 66,000 ac (26,709 ha) between Pass-A-Loutre and South Pass and is owned and managed by the Louisiana Department of Wildlife and Fisheries (LDWF). The DNWR covers 48,000 ac (19,425 ha) from just north of Main Pass southward to Pass-A-Loutre and is owned and managed by the U.S. Fish and Wildlife Service (USFWS). It is understood that the natural cycle of crevasse-splays is a temporary event that is rarely active for more than 10 to 15 years. This process of crevasse-splay deposition, building, and subsidence will all be considered in the evaluation of this project.

The usefulness of crevasses as a tool of wetland and coastal management on the Mississippi River Delta began to be realized in the early 1980's. The Louisiana Department of Natural Resources (LDNR) constructed three new crevasses in 1986 (on Pass-A-Loutre, South Pass, and Loomis Pass) that produced over 657 ac (266 ha) of emergent marsh from 1986 to 1991, and four crevasses in 1990 (two each on South Pass and Pass-A-Loutre) that produced over 400 ac (162 ha) of emergent marsh from 1990 to 1993 (LDNR 1993; Trepagnier 1994). Thirteen crevasses included in the LDNR Small Sediment Diversions Project cumulatively produced 313 ac (127 ha) of emergent marsh between 1986 and 1993; land growth rates ranged from 28 to 103 ac (11.3 to 41.7 ha) per crevasse for the older crevasses (4 to 10 years old) and 0.5 to 12 ac (0.2 to 4.9 ha) for the younger crevasses (0 to 2 years old) (LDNR 1996). Boyer et al. (1997) concluded that crevasses in the DNWR accumulated land at about 11.6 ac/yr (4.7 ha/yr), but subaerial growth did not occur for 2-3 years after the crevasses were constructed.

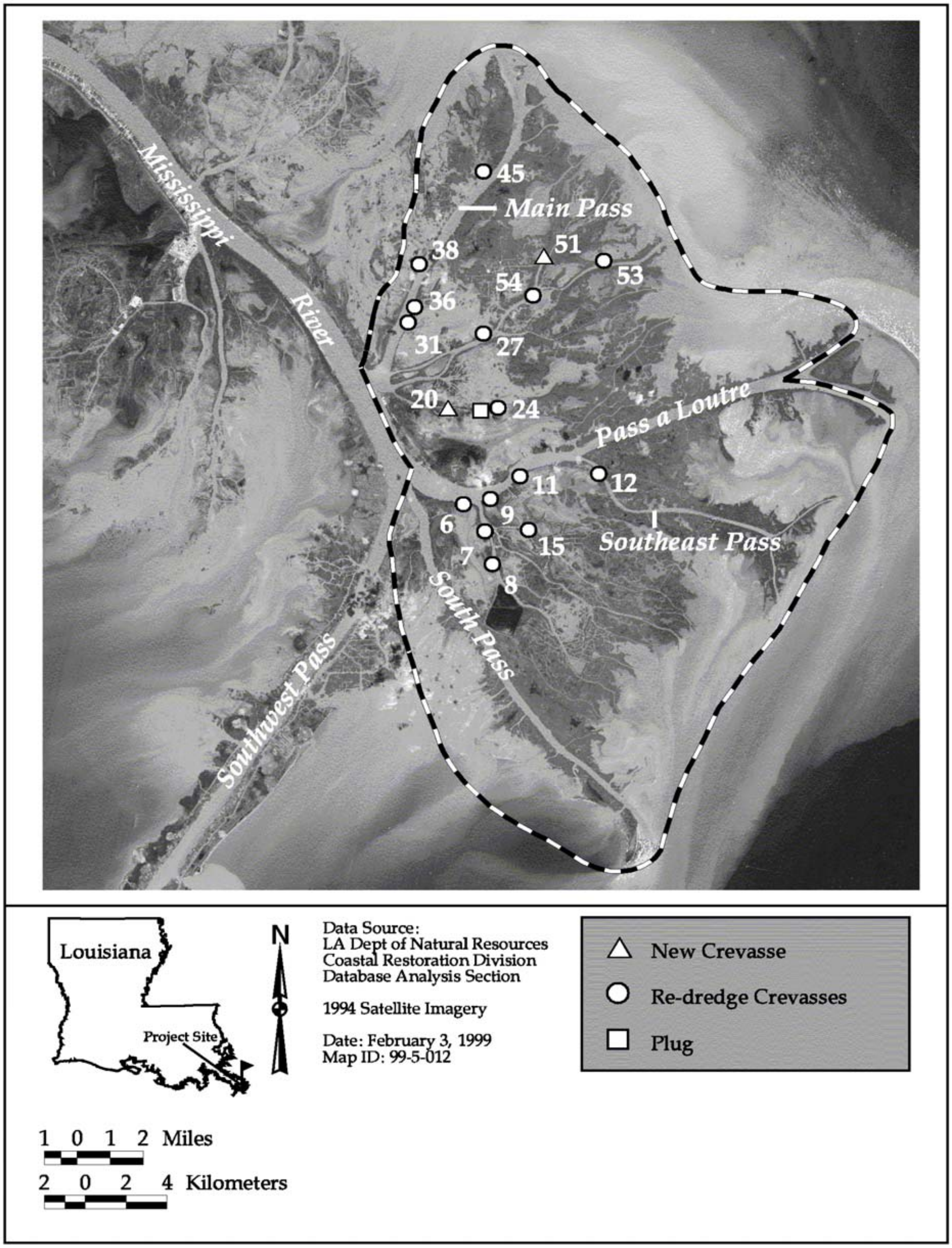


Figure 1. Delta Wide Crevasses (MR-09) project boundary and features (Phase I).

The colonization of an emergent mudflat as produced by a crevasse has been well documented (Neill and Deegan 1986). White (1993) delineated the vegetative ecological succession that occurs on newly emergent delta into three major plant communities: (1) forests of *Salix nigra* (black willow) establishing on upstream, high elevation islands that usually consist of the coarsest sediments, (2) stands of *Scirpus deltarum* (delta three square) that develop downstream from the forested islands at intermediate elevations (between 4 inches [10 cm] and sea level), and (3) communities of *Colocasia esculenta* (elephant ear) developing just downstream from the forested islands, where the finest sediments are deposited and land elevation is below Mean Sea Level (MSL).

The soils in this area are predominantly Balize and Larose types. These soils may be classified as continuously flooded deep, very poorly drained and very permeable mineral clays and mucky clays. They are distributed on the fringes of freshwater marshes, adjacent to the natural distributary levees of the Mississippi River, at an elevation less than 3 ft (0.9 m) and a slope of less than one percent. Since Larose soils are deposited underwater, never being air-dried or consolidated, they remain semifluid and highly unstable (Natural Resources Conservation Service, unpublished data).

The 20-yr project is to be implemented in a series of mobilizations every five years. At the close of each mobilization cycle the project will be re-evaluated to determine the success of existing crevasses, if maintenance is required, and the possible addition of new crevasses to the project area.

Phase I was completed in May, 1999 and included the following features:

- Creating two new crevasses in the Delta National Wildlife Refuge. To this end, crevasses were constructed to the dimensions of approximately 100 feet wide by six feet deep.

- Maintaining approximately 15 existing crevasses located in the DNWR (8) and in the PALWMA (7). The existing crevasses were re-dredged according to their needs, either by increasing their width, depth, or angle of opening.

- A plug was constructed in an existing crevasse north of Raphael Pass to increase flow to the crevasse-splay downstream.

Phase II was completed in March, 2005 and included the following features:

- Creating three new crevasses; 2 in the PALWMA and 1 in DNWR.

- Maintaining three of the Phase 1 crevasses in the PALWMA whose crevasse channels had silted in and were not functioning as originally constructed.

Project Objective

The objective of the Delta Wide Crevasses Project is to promote the formation of emergent freshwater and intermediate marsh in shallow open water areas through the construction of new and maintenance of new and existing crevasse-splays.

II. Maintenance Activity

There is no current maintenance on this project; however the project area is inspected annually by personnel from OCPR, LDWF, and NMFS. The 2008 and 2009 annual inspections examined the 6 crevasses constructed or maintained during Phase II. These inspection reports indicate that the project is functioning successfully. Aerial inspection during a high river phase in November, 2009 indicated high amounts of water and sediment flowing through the crevasse channels into the receiving areas (figs. 2 and 3). Depth soundings of the channel at crevasse 81 during the 2008 inspection suggest that the channel is silting in, although flow through the crevasse was still strong.

Figure 2. View of Crevasse 9 and receiving area during the 2009 annual inspection, November, 2009.

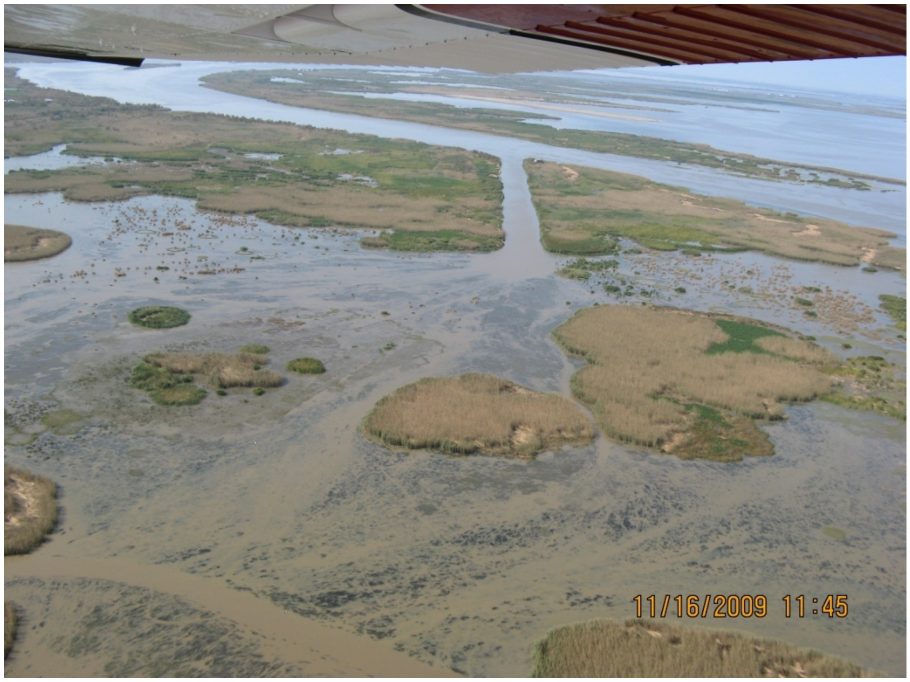


Figure 3. View of Crevasse 11 and receiving area during the 2009 annual inspection, November, 2009. Note the heavy sediment load.

III. Operations Activity

There are currently no structures to operate on this project.

IV. Monitoring Activity

a. Monitoring Goals

The following measurable goals were established to evaluate project effectiveness:

1. Maintain or increase land to open water ratio within the receiving bays.

2. Increase mean elevation of the receiving bays.

3. Increase the mean percent cover of emergent fresh and intermediate marsh type vegetation in the receiving bays.

b. Monitoring Elements

Monitoring includes aerial photography, vegetation, and elevation. Aerial photography is obtained for all crevasses within the project area. A set of 12 crevasses from Phase I was selected for elevation monitoring based on design characteristics. A sub-set of 6 of these crevasses is monitored for vegetation.

Aerial Photography

To evaluate land to water ratios in the individual receiving bays, near vertical, color infrared aerial photography (1:24,000 scale, with ground controls) was obtained in January 2000 (as-built) and in 2002 and 2007, and will be obtained in 2012, and 2017 postconstruction for all crevasses in the project area.

Vegetation

Plant species composition, percent cover, and relative abundance were evaluated to document vegetation succession on the receiving bays and to ground-truth aerial photograph interpretations. Vegetation surveys followed the Braun-Blanquet method as described in Steyer et al. (1995). Transects were established once the splay islands became subaerial and matched the transects laid out for the elevation surveys for those respective sites (see figures 4 and 5). Sample stations (duplicate 4 m^2 [2m x2m] plots) along each transect were established to represent the major plant communities of interest, with at least five stations in each community. Additional transects and sample stations may be established over time as new land is created. Vegetation surveys were conducted in the late summer (mid-July to August) in 1999 (as-built) and in the postconstruction years designated for aerial photography, 2002 and 2007. Future surveys are scheduled for 2012 and 2017. These surveys will be limited to Phase I construction and only a subset of 6 of the 12 Phase I crevasses (11, 12, 15, 20, 38, and 51). Additional data from the CRMS-*Wetlands* sites in the Mississippi River Delta and Chabreck and Lindscome vegetation transects will supplement the project data.

Elevation

To document changes in mean elevation within the receiving bays related to the creation of subaerial land, elevation transect lines were established across the receiving bays at 12 sites (see figures 4 and 5). The sites chosen consisted of 3 narrow (<100' across) crevasses at an angle of 90^o from the main channel (crevasses 12, 9, 51), 3 wide (>150' across) crevasses at an angle of 90^o (crevasses 6, 15, 38), 3 narrow crevasses at an angle of 60^o (crevasses 7, 8, 20), and 3 wide crevasses at an angle of 60^o (crevasses 36, 31, 11). Benchmarks were installed at the time of construction at the Mississippi River levee and tied to the North American Vertical Datum 1988 (NAVD88) using an established benchmark located at the USFWS Wildlife Headquarters lookout tower, north of Cubits Gap. Five elevation transect lines and one baseline, including at least two benchmarks, were established perpendicular to each crevasse channel, and distributed evenly across the receiving bay. Elevations were recorded at 500-ft intervals along each transect and at any significant change in elevation within those intervals. Elevation surveys also included three cross-sectional profiles of the crevasse-splay channel, with data recorded every 10 ft (3 m) across the channel. Elevation surveys were conducted as-built (2000) and postconstruction during years 2002 and 2007, and will be conducted in 2012 and 2017.

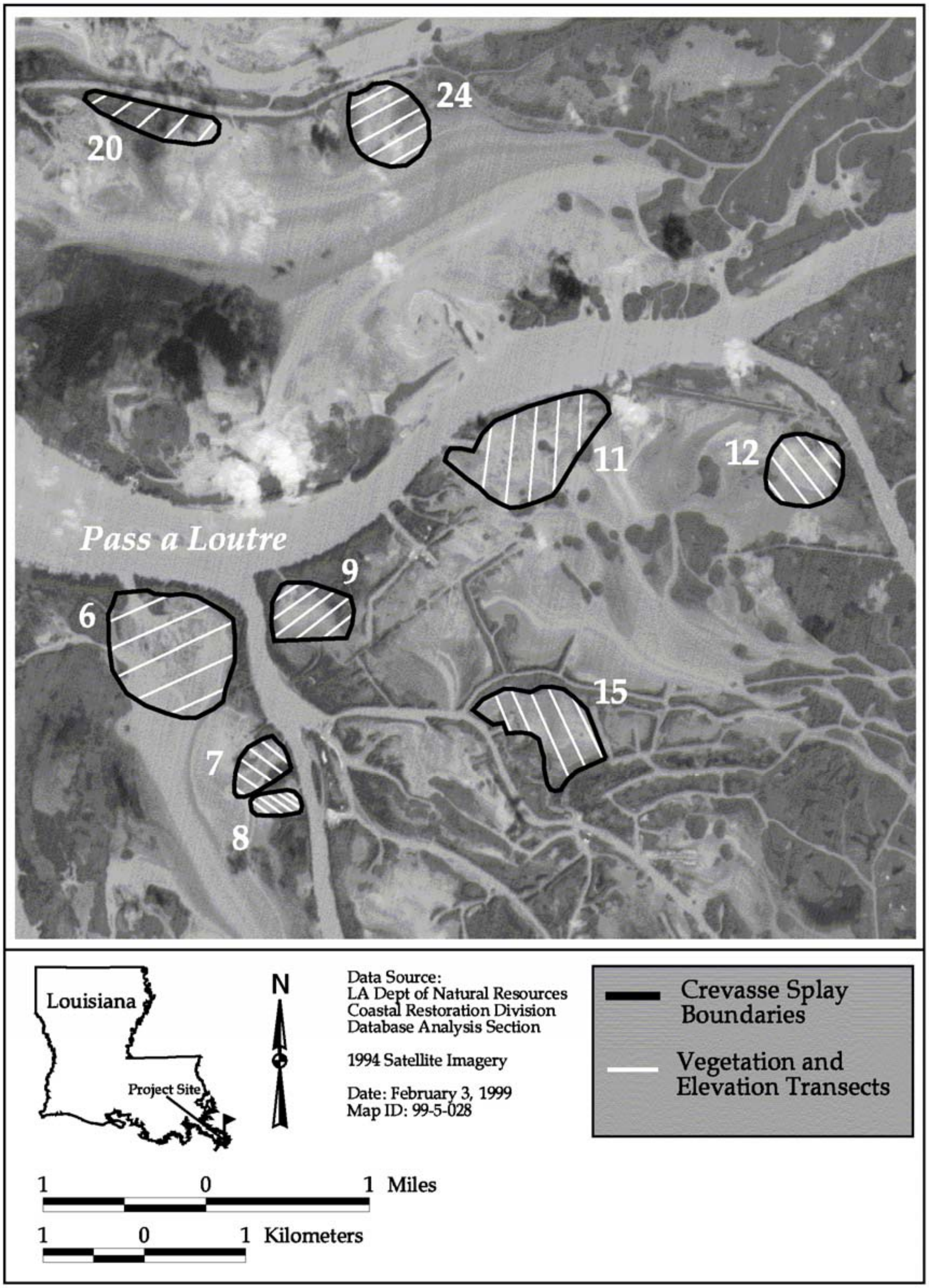


Figure 4. Phase I crevasses in the southern project area of MR-09 (Delta Wide Crevasses).

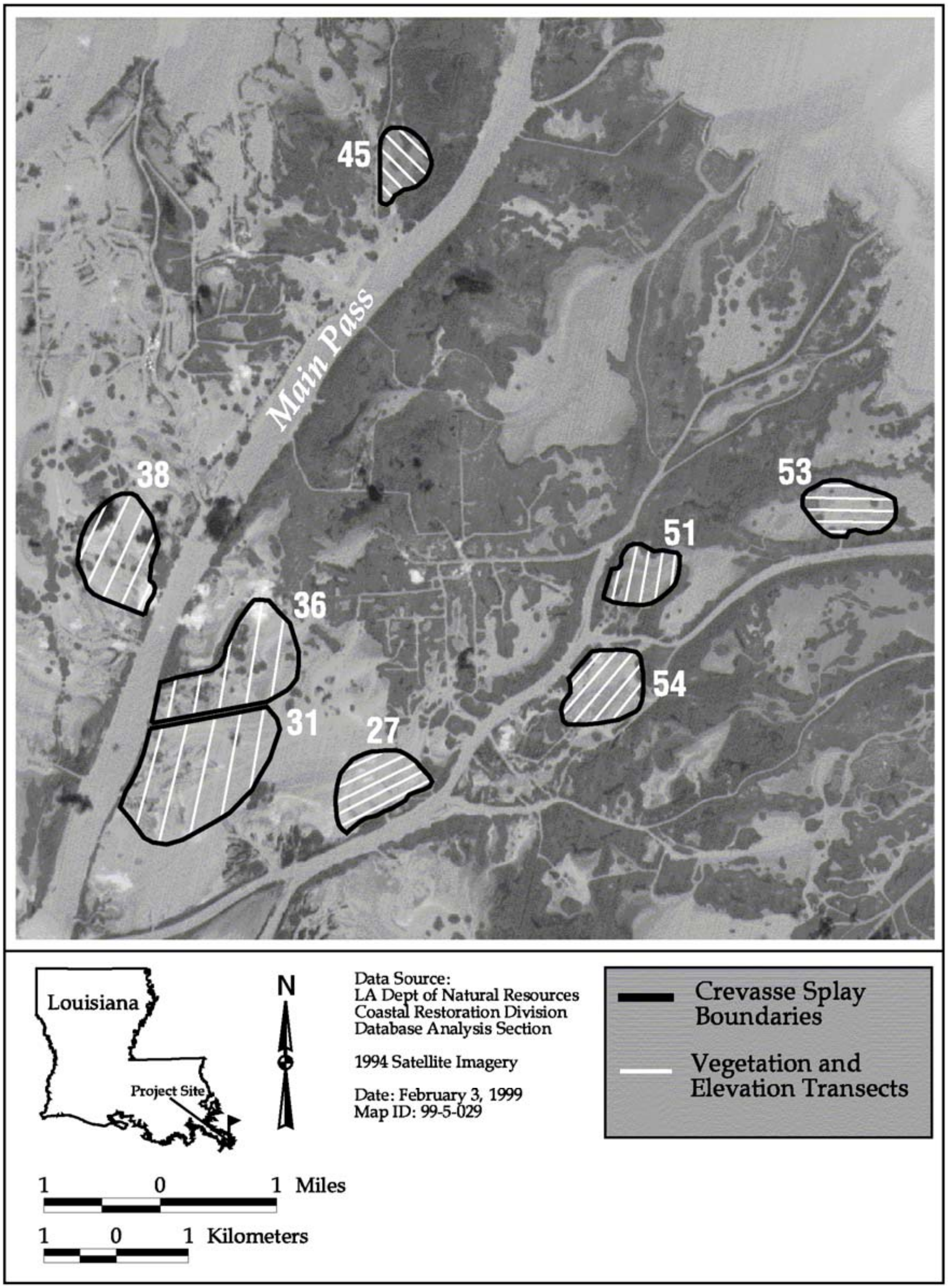


Figure 5. Phase I Crevasses in the northern project area of MR-09 (Delta Wide Crevasses).

Based on the CRMS review, the surveys conducted during 2007, 2012, and 2017 will be reduced in scope to include only the 6 crevasses that are being used in the vegetation survey (11, 12, 15, 20, 38, and 51). Monitoring funds are not available to support elevation surveys. As a result, all surveys will be paid through construction funds.

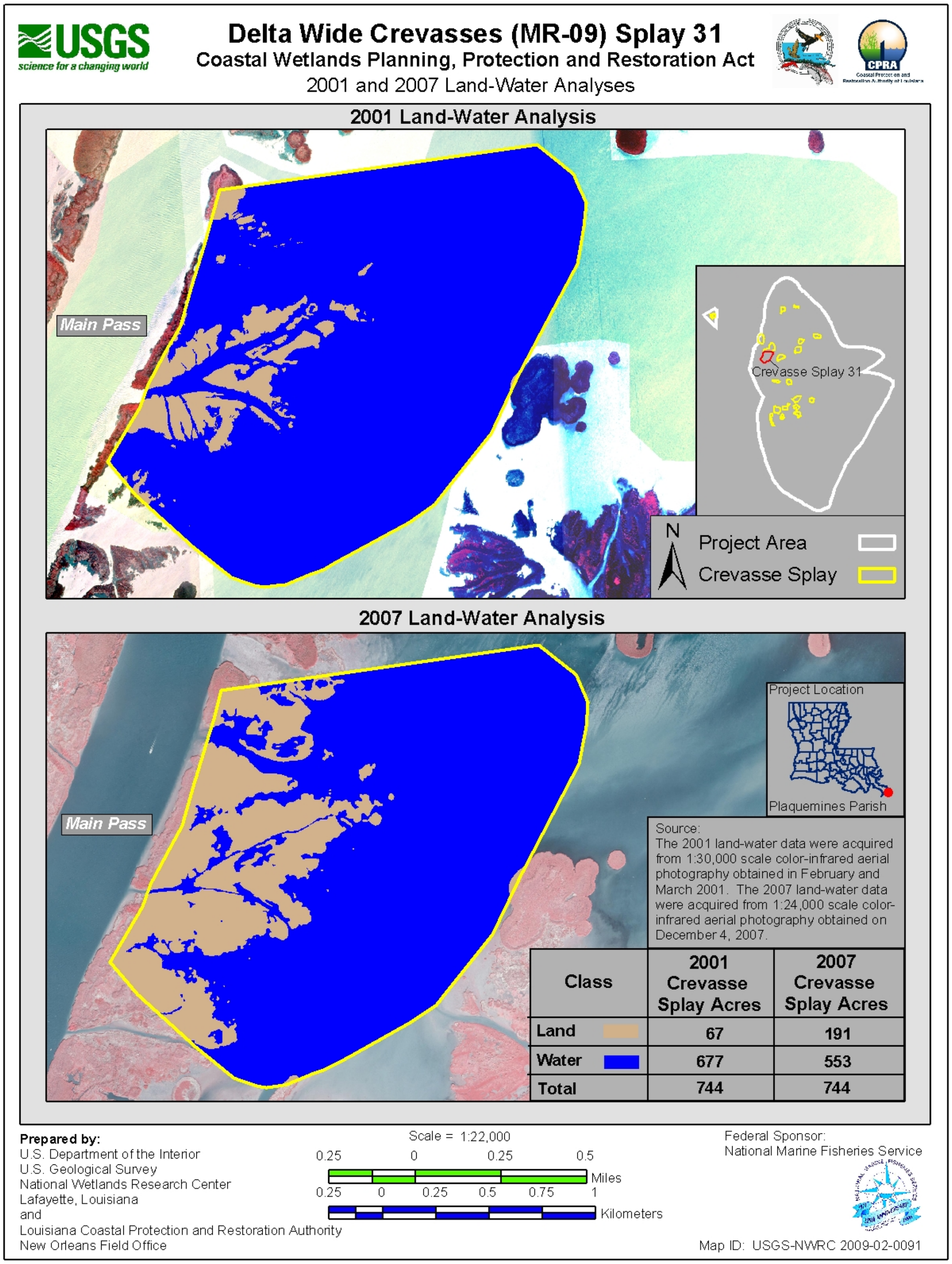
c. Preliminary Monitoring Results and Discussion

Aerial Photography

Color infrared aerial photography obtained in 2000 (as-built), 2002, and 2007 has been analyzed by the USGS and are presented as land-water analysis. There were a total of 22 crevasses analyzed including the six used for vegetation data. Table 1 shows a summary of land gain/loss in acres including the relative change and rate (per year). The total land gain recorded for the MR-09 project area since construction is 499 ac. with an average land gain of 23 ac. per crevasse. This translates to a total land gain of 59.4% across the project area. The largest land gain for a single crevasse occurred at Crevasse 31 (fig. 6) with a land gain of 124 ac. (185.1%). The largest relative gain occurred at Crevasse CO-2 (fig.7) with an increase of 850% (17 ac). One crevasse experienced land loss. Crevasse 53 (fig. 8) lost 18 ac of land between 2001 and 2007.

Table 1. Land area (ac) for 22 crevasses in the MR-09 project area.

Crevasse	2001	2002	2007	Change	Relative gain/loss	Rate (ac/year)
6	116	150	171	55	47.4%	7.9
7	24	28	30	6	25.0%	0.9
8	5	8	10	5	100.0%	0.7
9	39	45	45	6	15.4%	0.9
11	116	131	157	41	35.3%	5.9
12	21	28	40	19	90.5%	2.7
15	19	26	26	7	36.8%	1.0
20	28	28	39	11	39.3%	1.6
24	3	4	5	2	66.7%	0.3
27	7	10	29	22	314.3%	3.1
31	67	90	191	124	185.1%	17.7
36	125	136	181	56	44.8%	8.0
38	102	99	181	79	77.5%	11.3
45	47	51	54	7	14.9%	1.0
47	3	5	9	6	200.0%	0.9
51	21	24	23	2	9.5%	0.3
53	33	36	15	-18	-54.5%	-2.6
54	41	47	57	16	39.0%	2.3
81	10		29	19	190.0%	2.7
CO-2	2	7	19	17	850.0%	2.4
NC-1	5	6	11	6	120.0%	0.9
NC-3	6	11	17	11	183.3%	1.6
Totals	840	970	1339	499	59.4%	71.3
Average	38	46	61	23	59.4%	3.2



Class	2001 Crevasse Splay Acres	2007 Crevasse Splay Acres
Land	67	191
Water	677	553
Total	744	744

Figure 6. Land-water analysis for Crevasse 31 in 2001 and 2007.

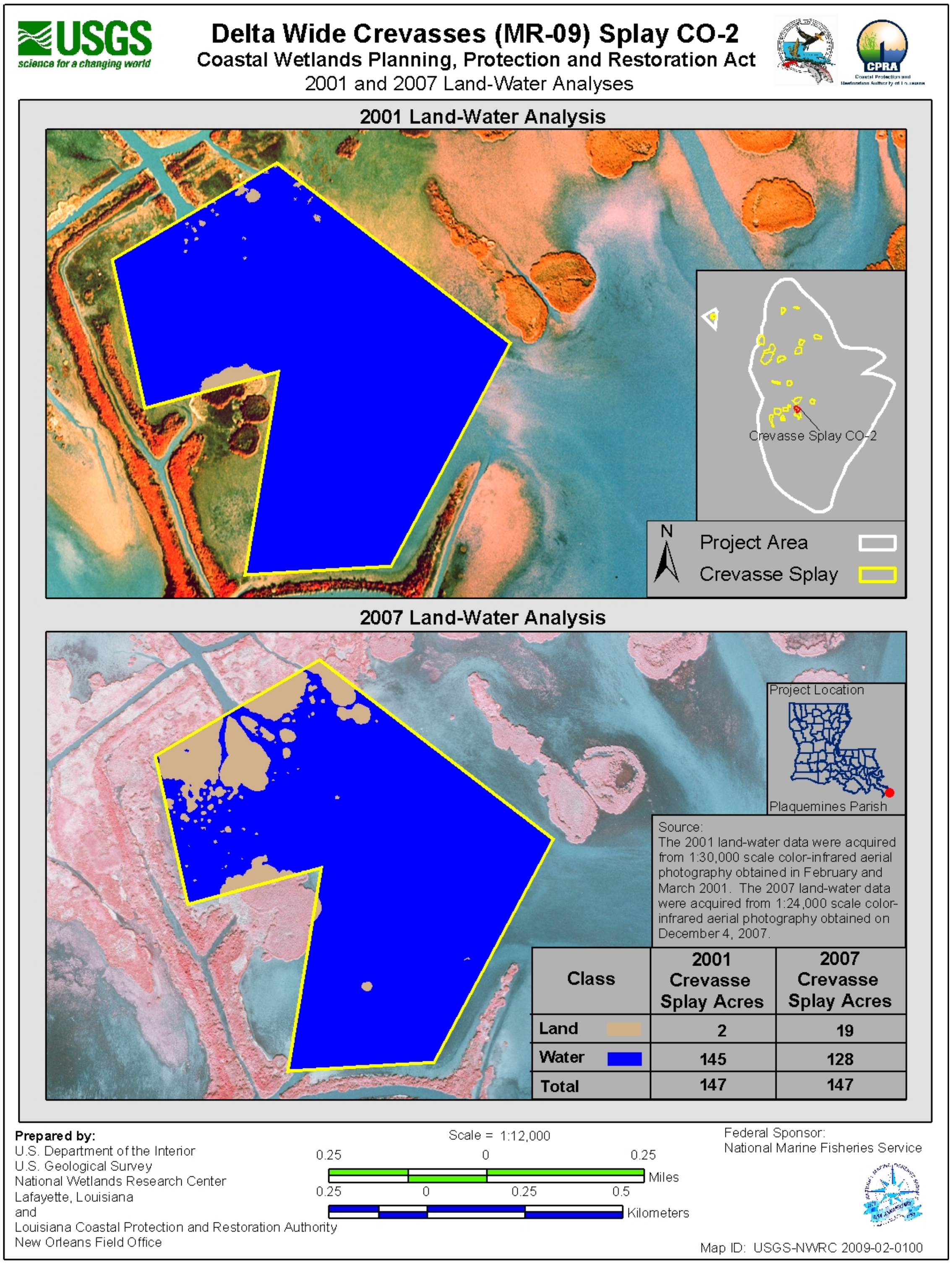


Figure 7. Land-water analysis for Crevasse CO-2 in 2001 and 2007.

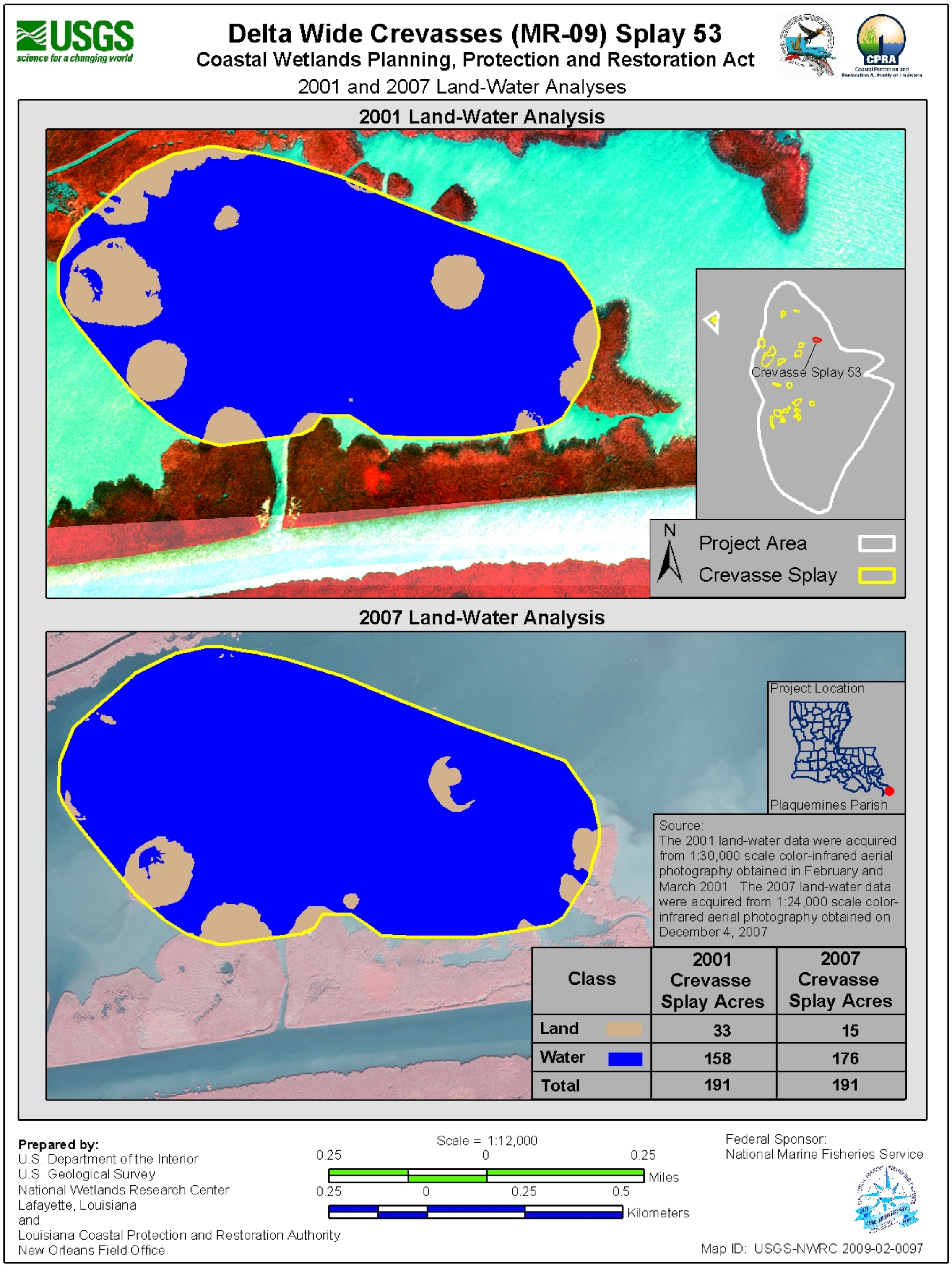


Figure 8. Land-water analysis for Crevasse 53 in 2001 and 2007.

Vegetation

Vegetation surveys were conducted in August 1999 (N=46), August 2002 (N=49), and August 2007 (N=50) during the post-construction period. Total percent cover was lower in 2007 than in previous years at 5 of the 6 crevasses surveyed (Fig. 9). The exception is Crevasse 20 where total percent cover increased from 4% in 2002 to 82% in 2007.

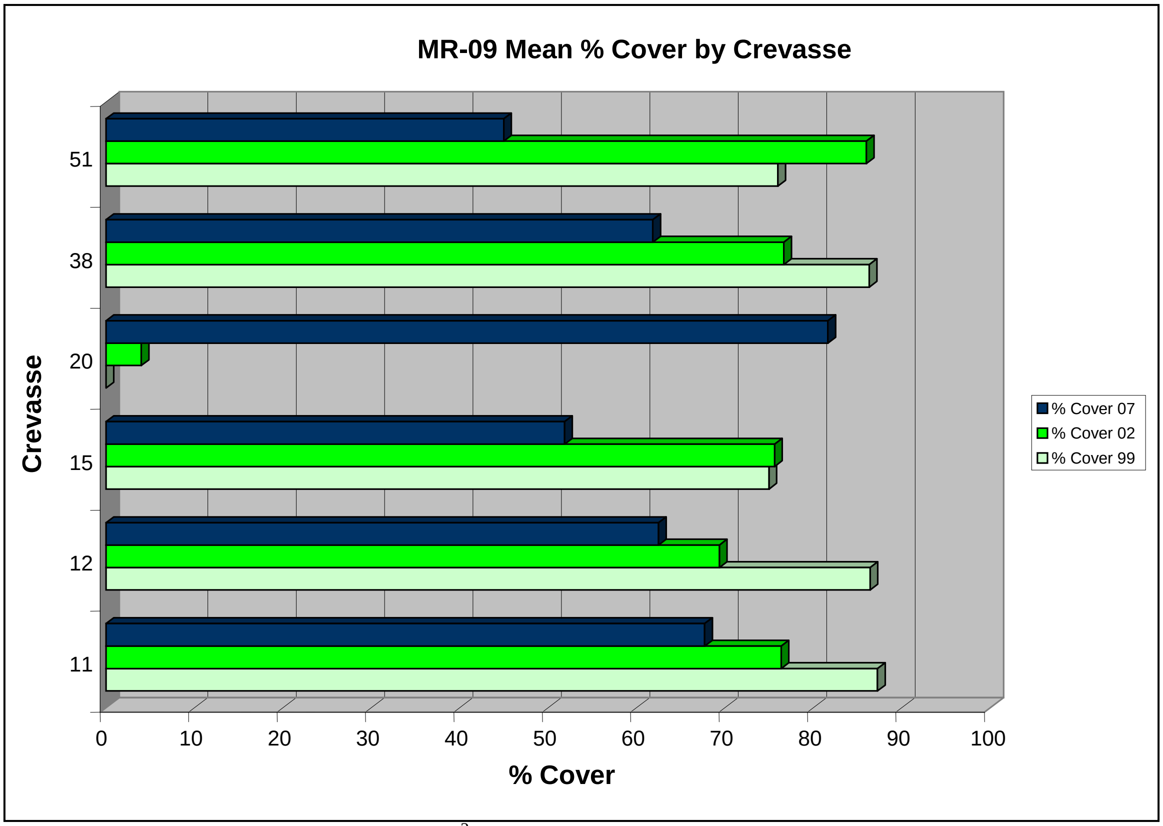


Figure 9. Mean percent cover of all 4-m^2 plots for six selected crevasses within the MR-09 project area August 1999, August 2002, and August 2007. Vegetation was sampled using the Braun-Blanquet method.

Percent cover data of individual species across all plots in the MR-09 project area suggest a shift in species composition (Fig. 10). Percent cover of species such as *Sagittaria lancifolia*, *Sagittaria latifolia*, *Colocasia esculenta*, and *Schoenoplectus americanus*, which dominated the 1999 and 2002 surveys decreased in the 2007 survey. Meanwhile, percent cover of other species has increased. *Phragmites australis*, *Vigna luteola*, and *Typha* sp. have all increased from 1999 to 2007.

Diversity, as measured by Simpson's Diversity Index, increased at 4 of the 6 crevasses surveyed from 1999 to 2007 (Fig. 11). Diversity decreased at crevasses 38 and 51.

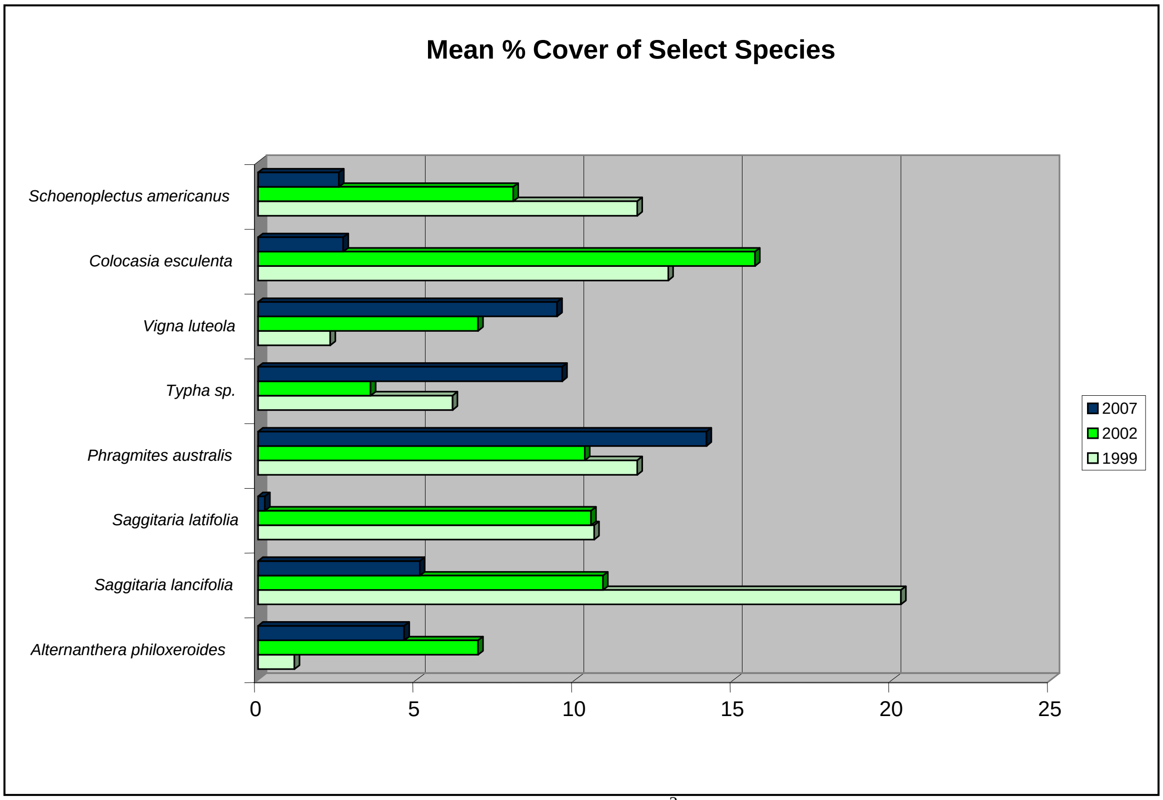


Figure 10. Mean % cover of selected species across all 4-m^2 plots within the MR-09 project area during August 1999 (N=46 plots), August 2002 (N=49 plots), and August 2007 (N=50 plots). Vegetation was sampled using the Braun-Blanquet method.

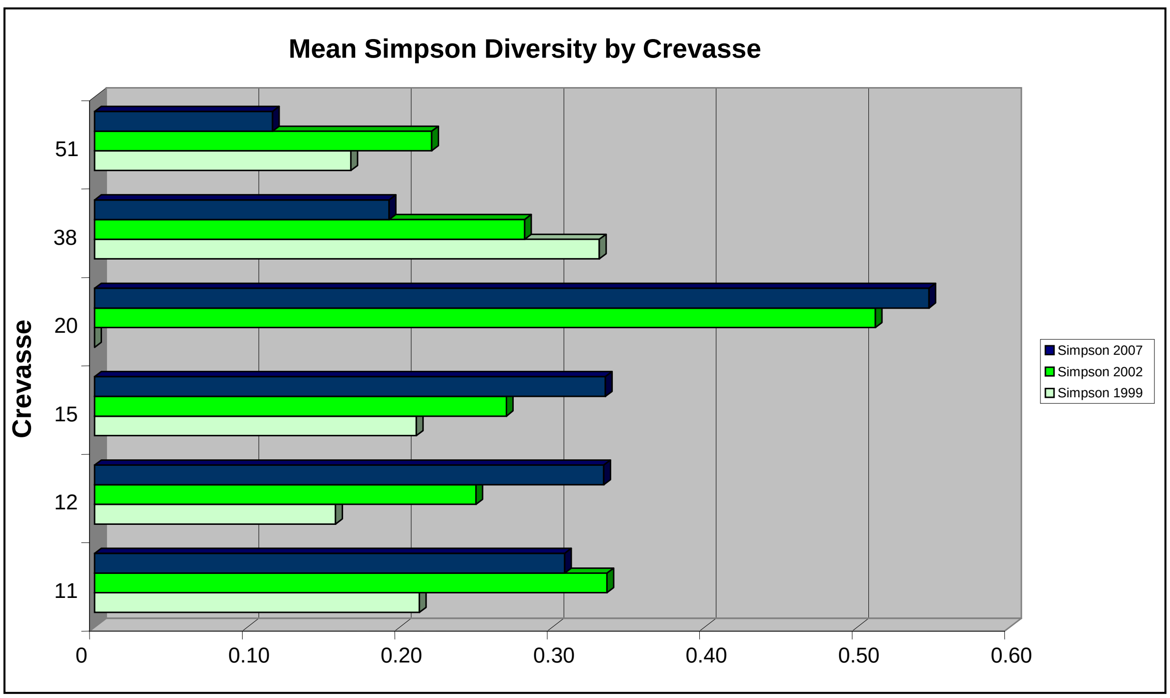


Figure 11. Comparison of diversity between sampling years 1999 (N=46 plots), 2002 (N=48 plots), and 2007 (N=50 plots) across each crevasse using the Simpson index of diversity. Note: diversity index values have no unit values and are used for comparative purposes only.

Elevation

Elevation surveys were conducted in 2000 (as-built), 2003 and 2008 (post-construction) on 12 crevasses in the MR-09 project area (Figure 12). Analysis of the elevation data in the receiving areas shows a trend in elevation gain across all crevasses except 51 (Figures 13 and 14) since construction of the project. When analyzed across all 12 crevasses, there has been a mean gain in elevation of 0.91 ft in the project area from construction to 2008 (Table 2). However it is worth noting that much of that elevation gain occurred in the first few years after construction. Mean elevation gain from 2000 to 2003 was 0.76 ft., while from 2003 to 2008 mean elevation gain was 0.15 ft. Elevation gain was impacted by crevasse angle of orientation and width. Mean elevation gain from 2000 to 2008 for crevasses oriented 60° from the parent channel was 1.22 ft, twice the elevation gain of crevasses oriented at 90°, 0.60 ft. Similarly, wide crevasses (>150 ft across) outgained narrow crevasses (<100 ft across) 1.17 ft to 0.65 ft for the same time period. The greatest elevation gains were observed in wide, 60° crevasses (1.28 ft), while the least gains were observed in the narrow, 90° crevasses (0.14 ft).

Table 2. Mean elevation (NAVD88 (ft)) and change in elevation for 12 crevasse receiving areas within the MR-09 project area. Asterisks (*) indicate that the crevasse was re-dredged in Phase II (2005).

Crevasse	Angle	Width	2000 Elevation	2003 Elevation	2008 Elevation	2000-2003 Change	2003-2008 Change	Total Change
6	90°	wide	-0.74	0.34	0.42	1.09	0.07	1.16
7	60°	narrow	-0.08	0.74	1.16	0.82	0.42	1.24
8	60°	narrow	0.07	0.56	0.59	0.49	0.03	0.52
9*	90°	narrow	0.38	0.81	0.64	0.43	-0.17	0.26
11*	60°	wide	-0.7	0.89	1.25	1.59	0.36	1.95
12*	90°	narrow	0.32	0.35	0.63	0.03	0.28	0.31
15	90°	wide	-1.17	0.2	0.16	1.36	-0.04	1.32
20	60°	narrow	-0.75	0.59	1.01	1.34	0.42	1.75
31	60°	wide	-0.3	0.66	0.92	0.96	0.27	1.23
36	60°	wide	0.06	0.76	0.71	0.7	-0.05	0.65
38	90°	wide	0.6	1.1	1.29	0.5	0.19	0.69
51	90°	narrow	-0.46	-0.65	-0.62	-0.19	0.03	-0.16
Average			-0.23	0.53	0.68	0.76	0.15	0.91

Elevation loss in the Crevasse 51 receiving area may be due to sedimentation of the crevasse channel (fig 15). The elevation survey of the crevasse channel and the land-water analysis of the aerial photography suggest that the channel may be filling in with sediment. Sedimentation in the crevasse channel prevents water and sediments from passing through the crevasse into the receiving area.

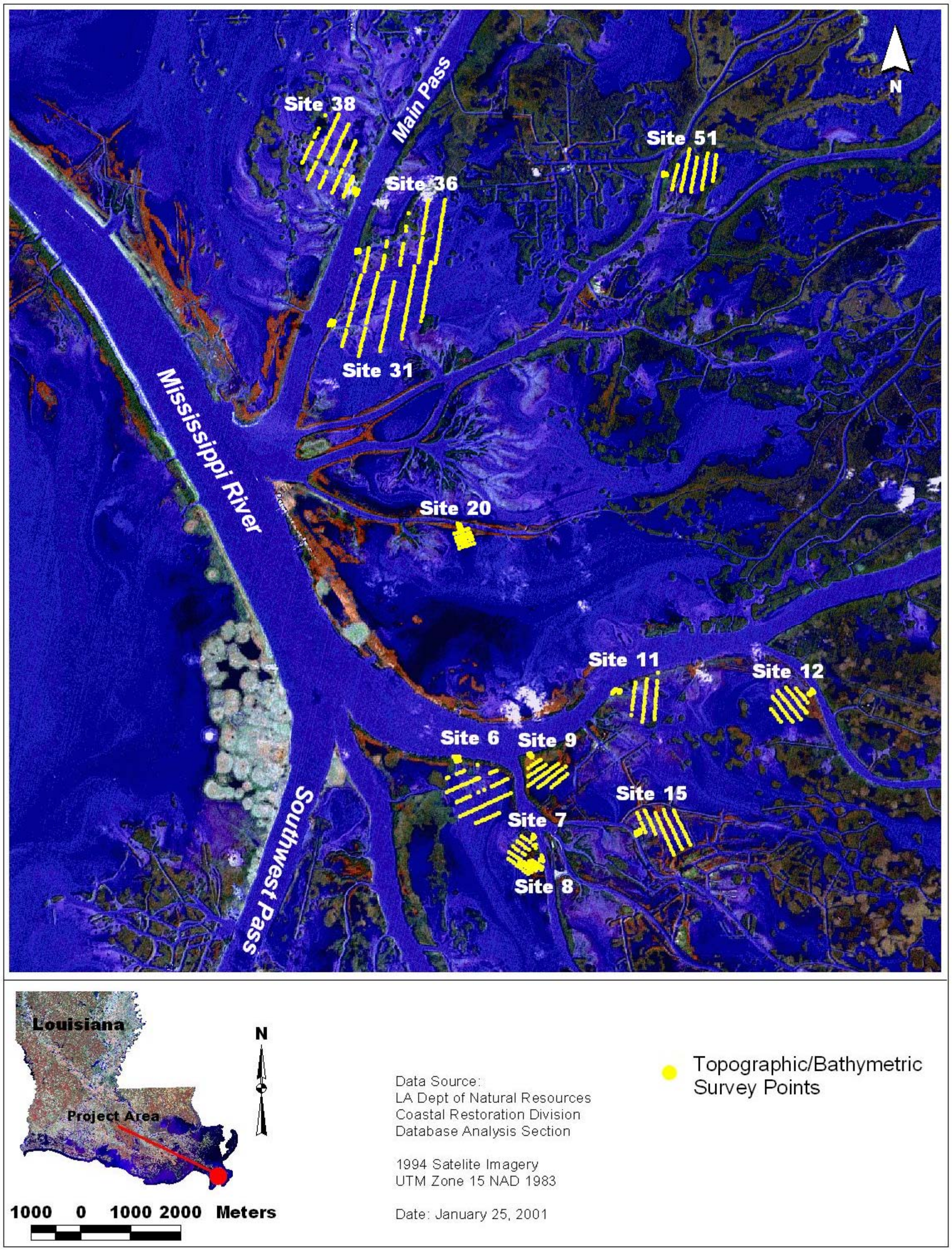


Figure 12. Location of Elevation surveys for Delta Wide Crevasses (MR-09).

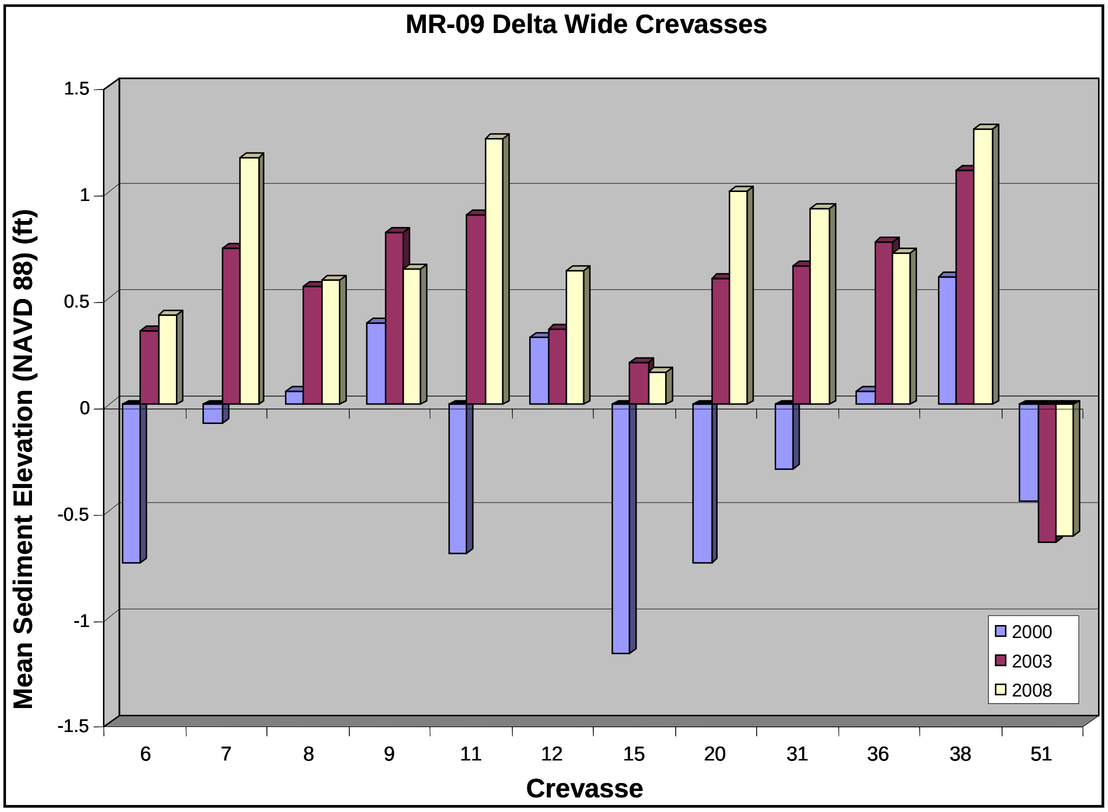


Figure 13. Mean sediment elevation (NAVD 88) in the project area (by crevasse) in 2000 (as-built), 2003 and 2008 (post-construction) for the twelve crevasses of Phase I of Delta Wide Crevasses (MR-09).

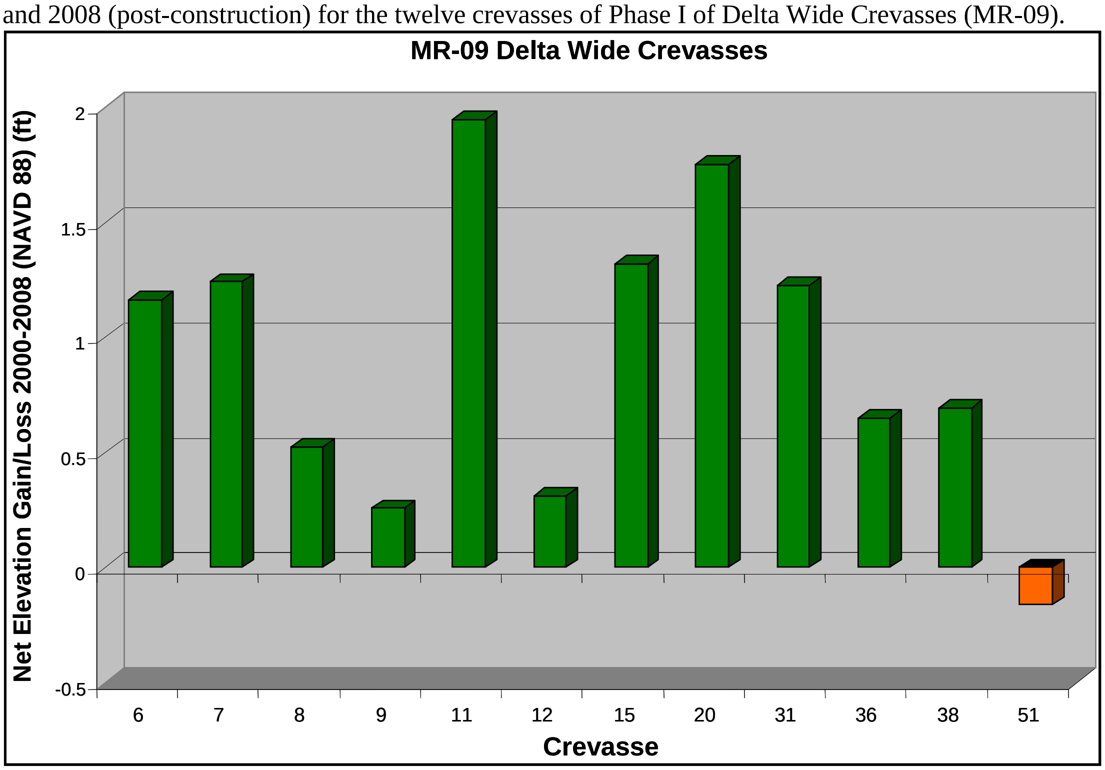


Figure 14. Elevation gain/loss between 2000 and 2008 for each of the twelve crevasses in Phase I of Delta Wide Crevasses (MR-09). Green bars represent an overall increase in mean elevation while orange bars represent an overall decrease in mean elevation.

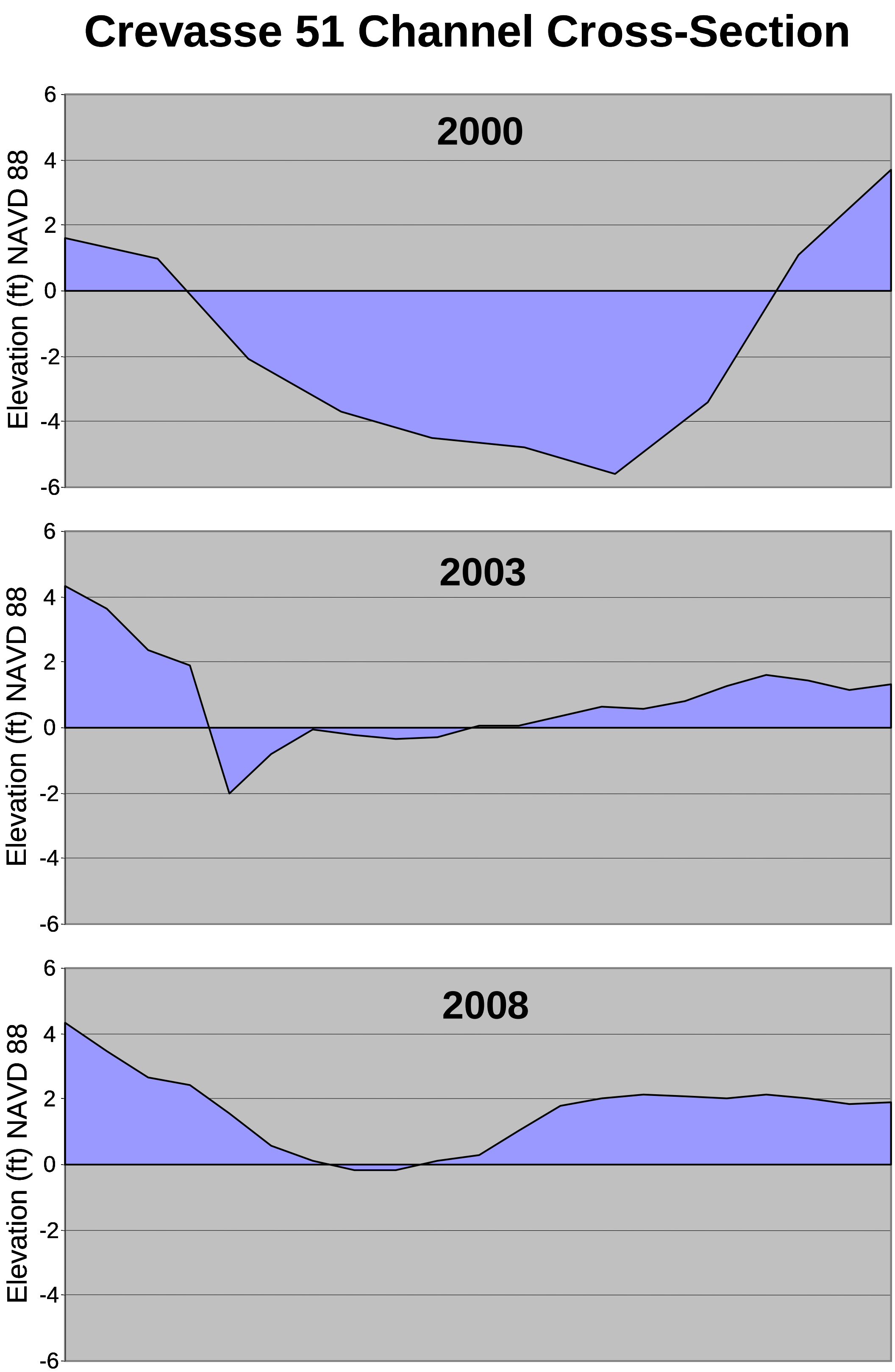


Figure 15. Elevation cross-section of crevasse channel for Crevasse 51 in 2000, 2003, and 2008.

V. Conclusions

a. Project Effectiveness

A combination of elevation data and vegetation data support the conclusion that the project is functioning as designed. All of the crevasses except one have experienced land growth and should continue to do so as long as their channels remain clear. Project wide plant diversity and expansion of plant communities support the claim that primary succession is occurring on the new land that was formed. These plant communities and their root masses should significantly help in strengthening the new land and increasing new sediment deposition.

Land-water analyses indicate that new land is being created in the crevasse receiving areas. All of the crevasses except one have gained land in the receiving areas from the time of project construction to 2007. Reported rates of land gain from a LDNR study of constructed crevasses (LDNR 1996) varied from a mean value of 2.5 ac/yr (crevasses 0 to 2 yrs. old) to 18.1 ac/yr (crevasses 4 to 10 yrs. old). Boyer et al. (1997) found that constructed crevasses in the DNWR created land at a rate of 11.6 ac/yr, but subaerial growth did not occur until 2-3 yrs after construction. Rates of land gain for the MR-09 project averaged 3.2 ac/yr across all crevasses.

Most of the crevasses surveyed showed increases in elevation within the receiving areas. Individual crevasses had increases of as much as 1.95 ft in land elevation (crevasse 11). This is very promising growth when coupled with the simultaneous increase in plant diversity at these locations.

Vegetation analysis also supports the conclusion that new land is being formed and colonized by emergent vegetation. Increases in diversity from 1999 to 2007 support the hypothesis of succession occurring in most crevasses. The addition of new plots in newly vegetated areas 2002 and 2007 also confirms the presence of new land. Further comparison of vegetation data in 2012, and 2017 will support or refute the hypothesis of primary succession on newly formed crevasse land.

A final factor to consider when judging project effectiveness is the effect of hurricane Katrina on the project area in 2005. Katrina passed just to the west of the project and heavily impacted a large area. Although they cannot directly be attributed to hurricane Katrina, there are several variables such as the slower rate of elevation gain between 2003 and 2008 and the slight decrease in vegetative percent cover across all crevasses that could possibly be explained as storm impacts.

b. Recommended Improvements

Channel cross sections are needed on other crevasses (other than crevasses that are currently surveyed) to document whether the crevasse channels are remaining open or whether they are filling in and are in need of maintenance. Operation and Maintenance project managers can use the increase or decrease of average elevation as the determining factor on when and where to dredge to re-open channels.

c. Lessons Learned

Results to this point suggest that width and orientation are important factors in the performance of crevasses. Wider crevasses and crevasses oriented at 60° angles from their parent channels gained elevation and created subaerial land at rates faster than crevasses that were narrower and oriented at 90° from their parent channels. The wider 60° crevasses can likely divert more flow through the crevasse, increasing the amount of fresh water and sediment delivered to the receiving areas and minimizing sedimentation in the crevasse channel.

Including an already vegetated crevasse (crevasse 38) in the vegetation comparisons slightly skews the data. Primary succession can be witnessed on all of the crevasses by combining the elevation data and the vegetation data. As land is created, new plant growth begins with a small, non-diverse community of pioneer plants (1999 as-built). Later, a more diverse community of highly competitive species begins to dominate (2002 post-construction). In the late stages of succession the most competitively stable species begin to dominate and bring about an overall lower diversity to the community (crevasse 38 and other studies). Perhaps in the future, older crevasses like these can be marked as reference plots and used as targets for comparative purposes only.

VI. Literature Cited

Boyer, M.E. 1996. Constructed crevasses as a techniques for land gain in the Mississippi River Delta. M.S. thesis, Louisiana State University. 110 pp.

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

Coleman, J.M and S.M. Gagliano 1964. Cyclic sedimentation in the Mississippi River deltaic plain. Gulf Coast Association of Geological Societies Transactions, 14. pp. 67-80.

Louisiana Department of Natural Resources (LDNR) 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. plus appendices.

Louisiana Department of Natural Resources (LDNR) 1996. Small Sediment Diversions (MR-01), Progress Report No. 2. 12 pp.

Neill, C. and L.A. Deegan 1986. The Effect of Mississippi River Delta Lobe Development on the Habitat Composition and Diversity of Louisiana Coastal Wetlands. The American Midland Naturalist, 116(2). pp. 296-303.

Steyer, G. D., R. C. Raynie, D. L. Steller, D. Fuller, and E. Swenson 1995. Quality Management Plan for Coastal Wetlands Planning, Protection, and Restoration Act Monitoring Program. Open-file report no. 95-01. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division. 97 pp. plus appendices.

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. plus appendices.

White, D. A. 1993. Vascular plant community development on mudflats in the Mississippi River delta, Louisiana, USA. Aquatic Botany, 45. pp. 171-194.