State of Louisiana
Department of Natural Resources
Coastal Restoration Division

2004 Operations, Maintenance and Monitoring Report

For

DELTA WIDE CREVASSES

State Project Number MR-09
Priority Project List 6

May 2007
Plaquemines Parish

Prepared by:
Jonathan Barmore, Biological Monitoring Section

LDNR/Coastal Restoration Division
New Orleans Field Office
CERM, Suite 309
2045 Lakeshore Dr.
New Orleans, La 70122

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For
Delta Wide Crevasses (MR-09)

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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

The project area is located in Plaquemines Parish to the southeast of Venice, Louisiana on the active Mississippi River Delta (figure 1). This project utilizes the major process that forms subaerial land in the lower Mississippi River Delta, the formation of crevasses. 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 crevasse-splays, the construction of new crevasse-splays, and future maintenance of selected crevasse-splays 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.

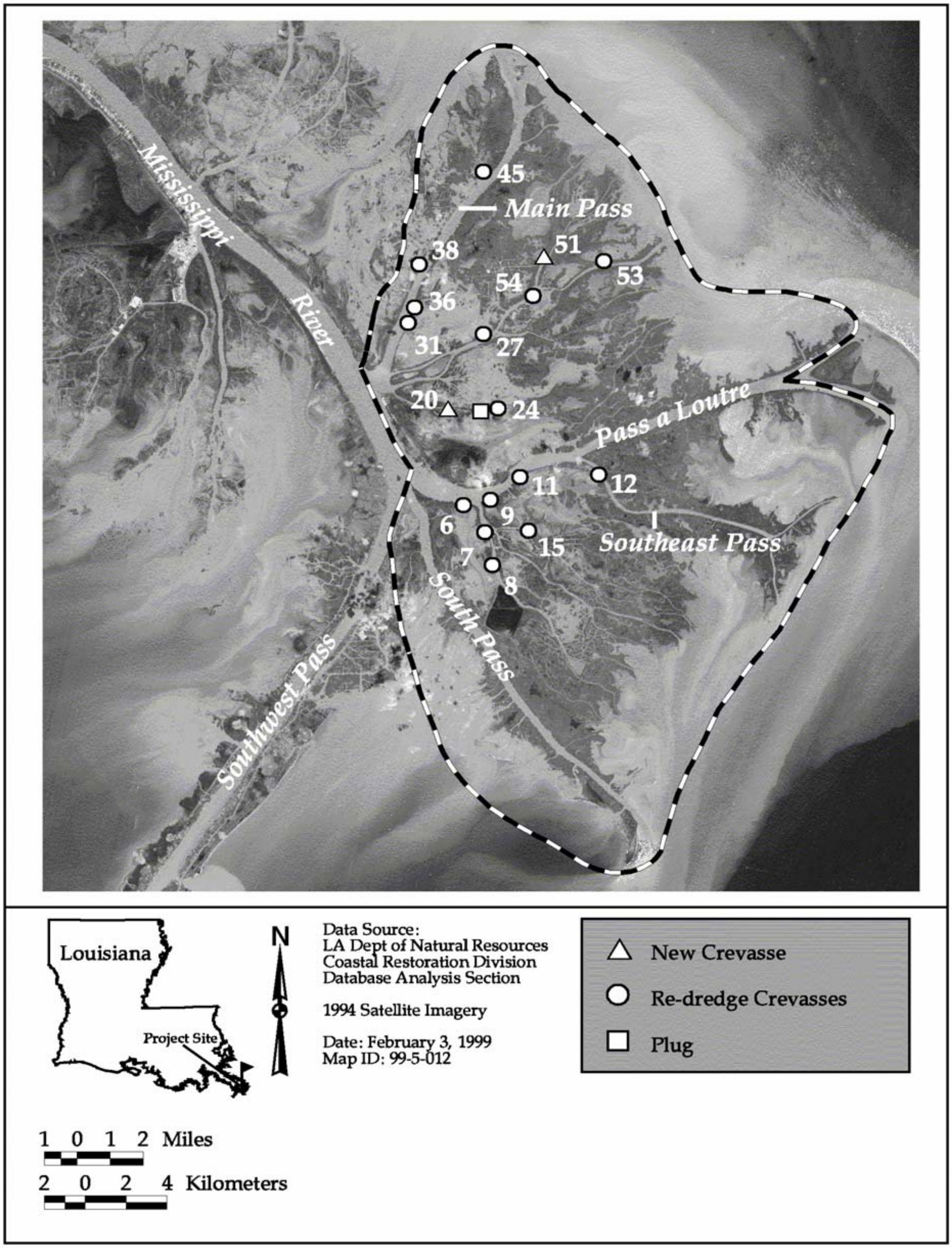


Figure 1. Delta Wide Crevasses (MR-09) project boundary and features.

The colonization of an emergent mudflat as produced by a crevasse has been well documented (Neill and Deegan 1986). The general pattern of habitat change on the deltaic plain is as follows: fresh marshes colonize newly created mudflats of low salinity. Fresh marsh, intermediate marsh, and swamp increase as the delta grows, and brackish marsh occurs away from the river mouth. As a lobe is abandoned and salinity increases, brackish and salt marshes increase near the coast at the expense of less saline marshes, which concurrently retreat inland. 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. The first phase of mobilization features for this project included:

- Creating two new crevasse-splays 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 crevasse-splays 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.

<u>Project Objective</u>

1. 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.

Construction Dates

Initial Construction (Phase I) :	May 1999
Construction (Phase II) :	Mid-Late 2004

II. Maintenance Activity

There is no current maintenance on this project.

III. Operations Activity

There are currently no structures to operate on this project.

IV. Monitoring Activity

This is a comprehensive report and includes all data collected from the pre-construction period and the post-construction period through December 2003.

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

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 will be obtained in 2007, 2012, and 2017 postconstruction.

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 2 and 3). 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 samples were conducted in the late summer (mid-July to August) in 1999 (as-built) and in the postconstruction years designated for aerial photography, years 2002, 2007, 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 Linscombe 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 2 and 3). 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 during years 2002, and will be conducted in 2007, 2012, and 2017 postconstruction. 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).

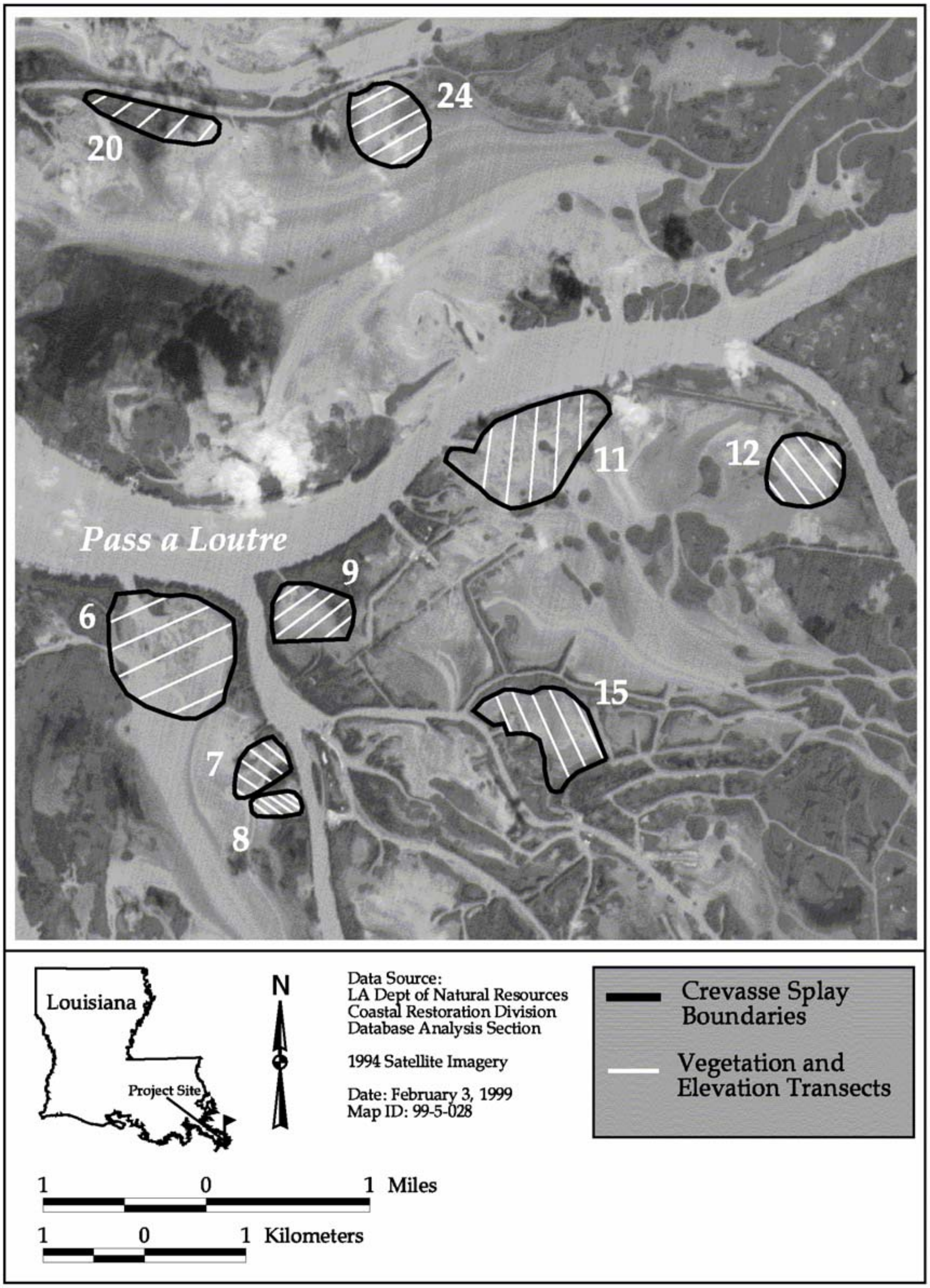


Figure 2. Crevasses in the southern project area of MR-09 (Delta Wide Crevasses).

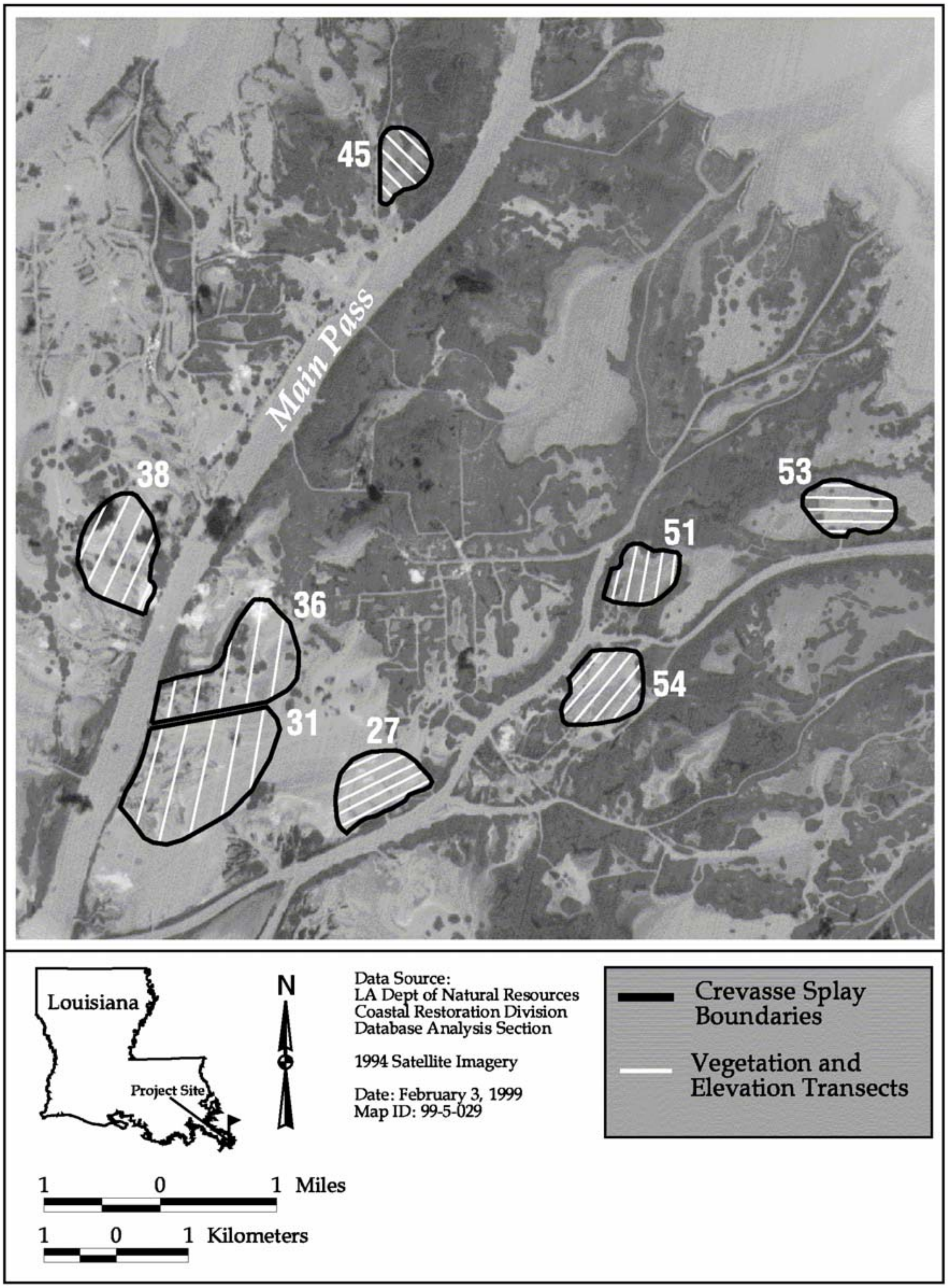


Figure 3. Crevasses in the northern project area of MR-09 (Delta Wide Crevasses).

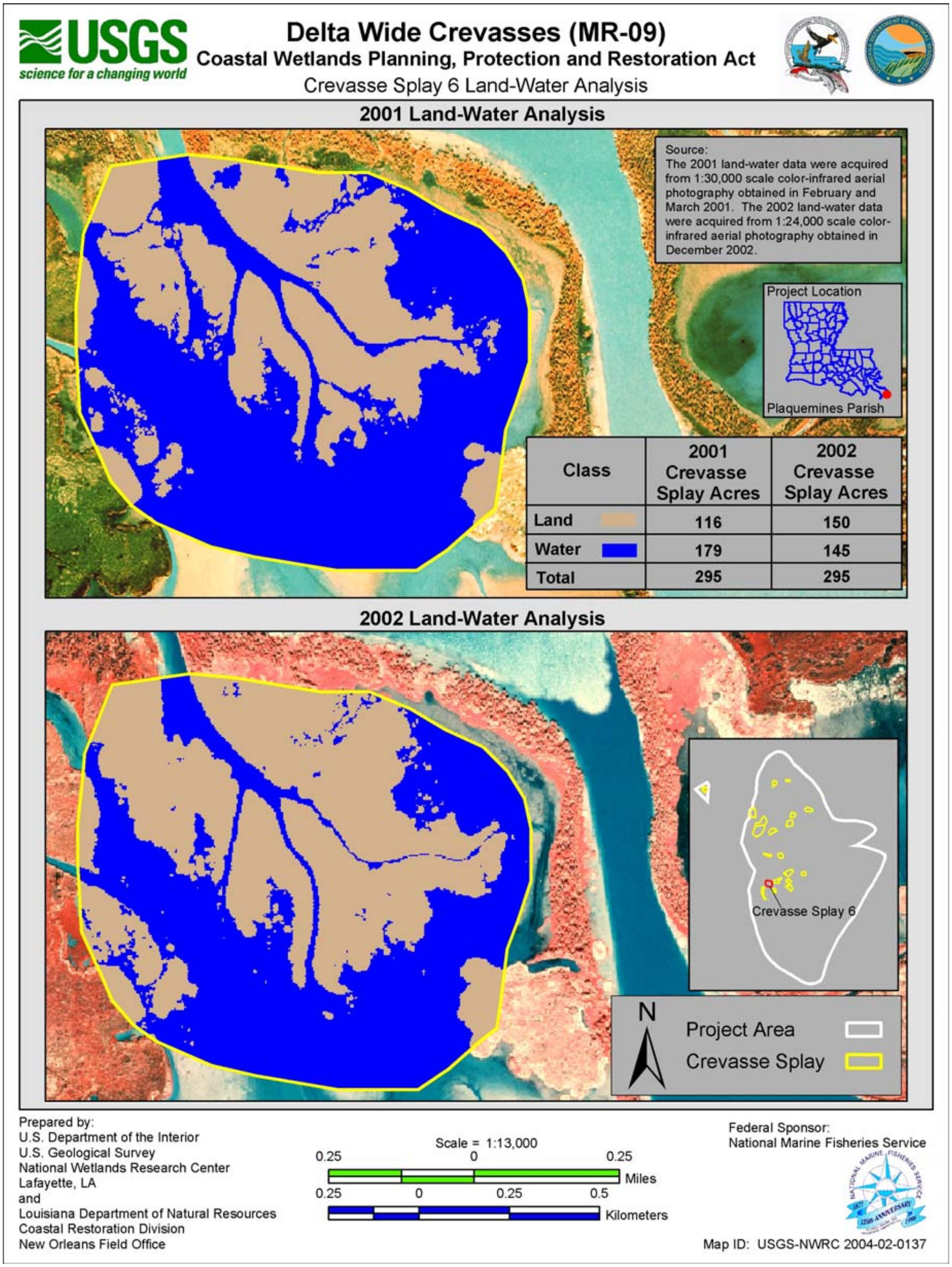
c. Preliminary Monitoring Results and Discussion

Aerial Photography

Color infrared aerial photography obtained in 2000 (as-built) and 2002 has been analyzed by the USGS and are presented as a land-water analysis. The dates listed on the graphics are for very early 2001 and very late 2002 resulting in almost two full years between data collection. There were a total of 21 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 the rate (per year). The total land gain recorded for the MR09 project area is 140 acres with an average gain of 7 acres per crevasse. That translates to a total land gain of 15.6% across the project area. The largest increase in a single crevasse was Crevasse 6 (Figure 4) with a land gain of 34 acres (25.6%). The highest relative gain was Crevasse CO-2 (Figure 5) with a gain of 5 acres (111.1%) The only crevasse to not see land gain was Crevasse 38 (Figure 6) with a land loss of 3 acres (only 3%). The confounding factors involved in this crevasse's biological and geophysical growth are probably related to its age and will be discussed in more detail later.

Crevasse	2001	2002	Change	Relative	Rate (acres/year)
6	116	150	34	25.6%	17.0
7	24	28	4	15.4%	2.0
8	5	8	3	46.2%	1.5
9	39	45	6	14.3%	3.0
11	116	131	15	12.1%	7.5
12	21	28	7	28.6%	3.5
15	19	26	7	31.1%	3.5
20	28	28	0	0.0%	0.0
24	3	4	1	28.6%	0.5
27	7	10	3	35.3%	1.5
31	67	90	23	29.3%	11.5
36	125	136	11	8.4%	5.5
38	102	99	-3	3.0%	-1.5
45	47	51	4	8.2%	2.0
47	3	5	2	50.0%	1.0
51	21	24	3	13.3%	1.5
53	33	36	3	8.7%	1.5
54	41	47	6	13.6%	3.0
CO-2	2	7	5	111.1%	2.5
NC-1	5	6	1	18.2%	0.5
NC-3	6	11	5	58.8%	2.5
Totals	830	970	140	15.6%	70.0
Average	40	46	7	15.6%	3.3

Table 1. Land-Water change in acres for Delta Wide Crevasses (MR09).



Class	2001 Crevasse Splay Acres	2002 Crevasse Splay Acres
Land	116	150
Water	179	145
Total	295	295

Figure 4. Land-Water analysis for Crevasse 6, MR09 Delta Wide Crevasses.

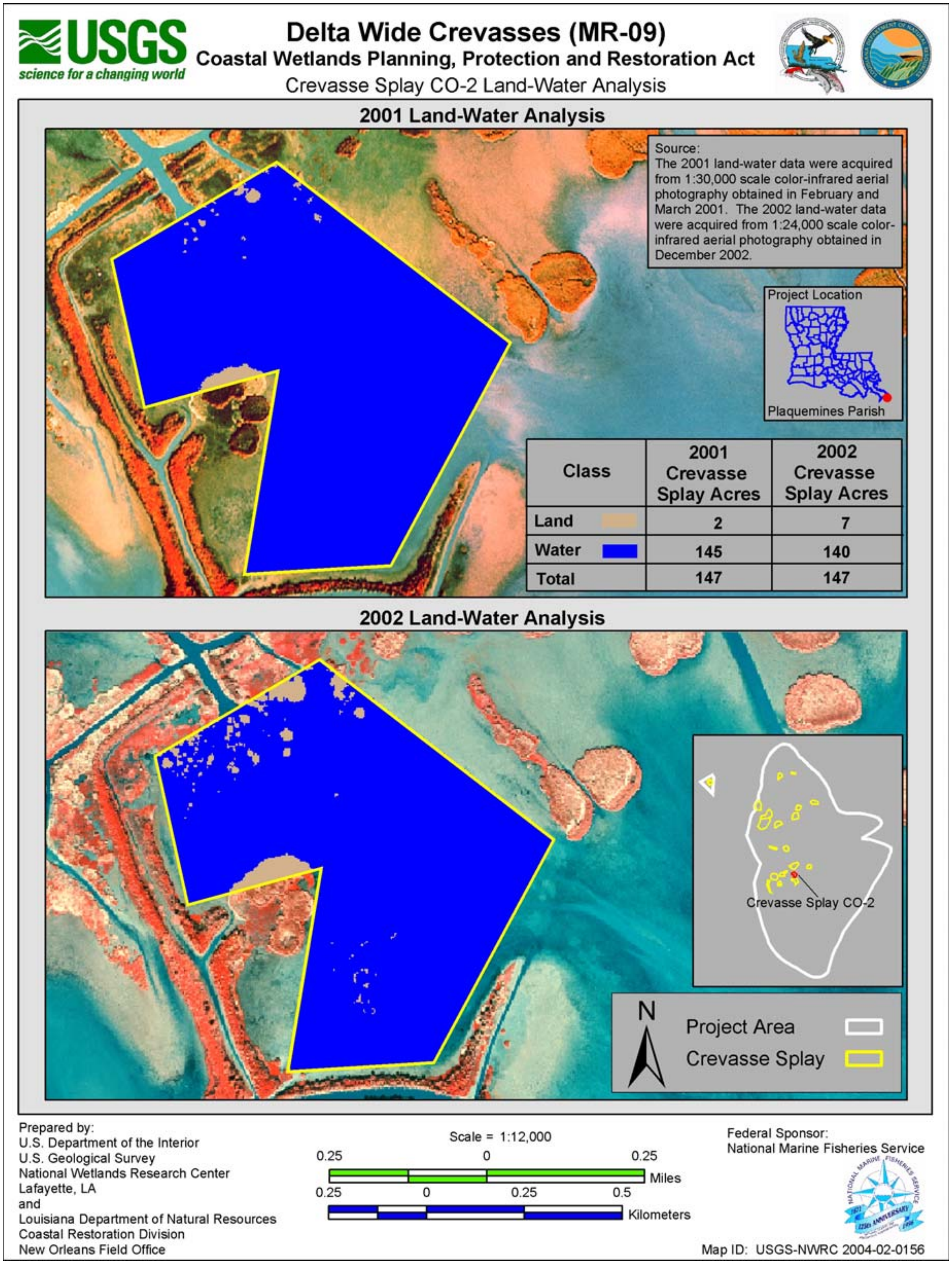
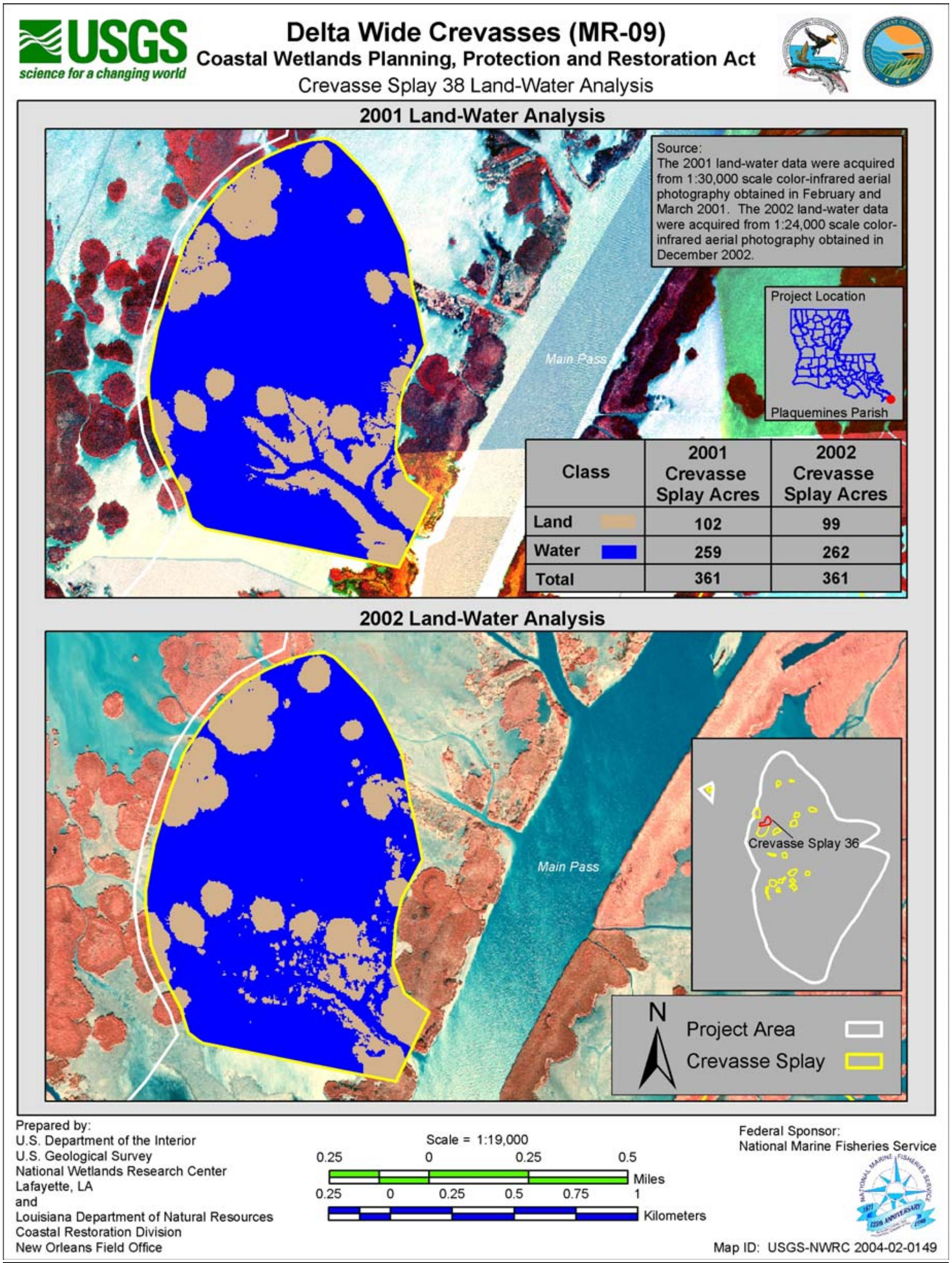


Figure 5. Land-Water analysis for Crevasse CO-2, MR09 Delta Wide Crevasses.



Class	2001 Crevasse Splay Acres	2002 Crevasse Splay Acres
Land	102	99
Water	259	262
Total	361	361

Figure 6. Land-Water analysis for Crevasse 38, MR09 Delta Wide Crevasses.

Vegetation

Vegetation surveys were conducted in August 1999 (N=46) and August 2002 (N=48) during the post-construction period. *Panicum dichotomiflorum* was the dominant species in both 1999 and 2002 (Figure 7). As of yet, there are no significant differences in mean percent cover across all plots. A comparison of diversity shows that diversity increased from 1999 to 2002 across all crevasses except Crevasse 38 (Figure 8). This may have been due to the plant community being further along in succession than other plant communities in this study.

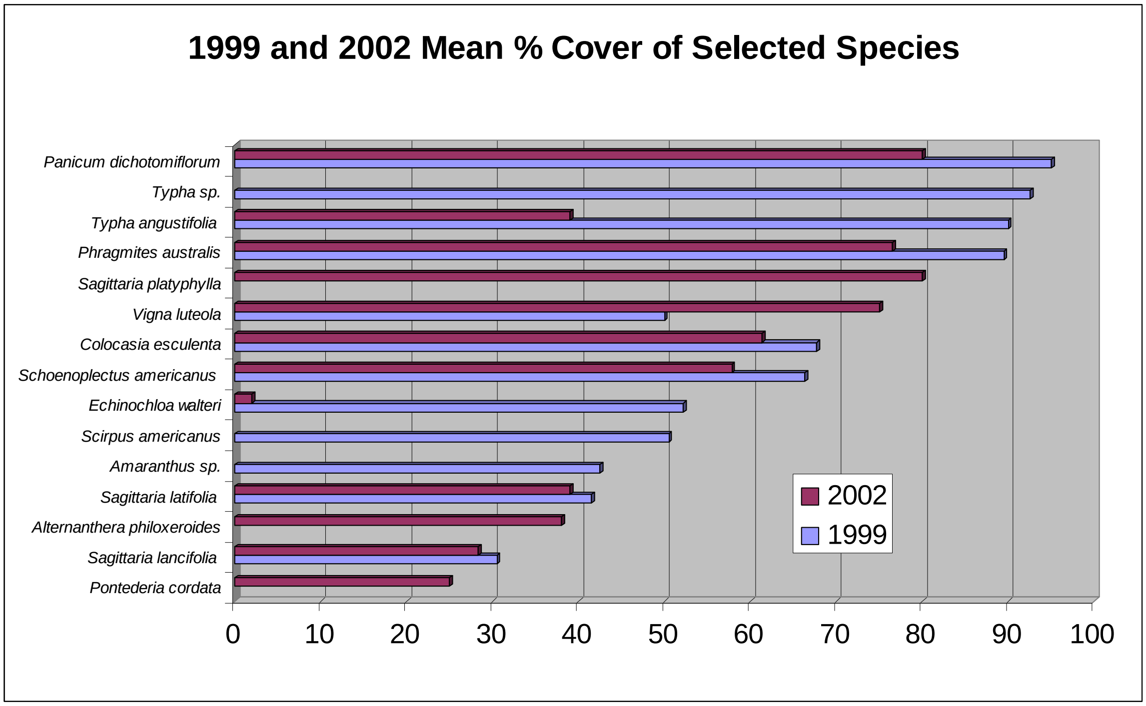


Figure 7. Mean % cover of selected species across all 4-m^2 plots within the MR-09 project area during August 1999 (N=46 plots) and August 2002 (N=48 plots). Vegetation was sampled using the Braun-Blanquet method.

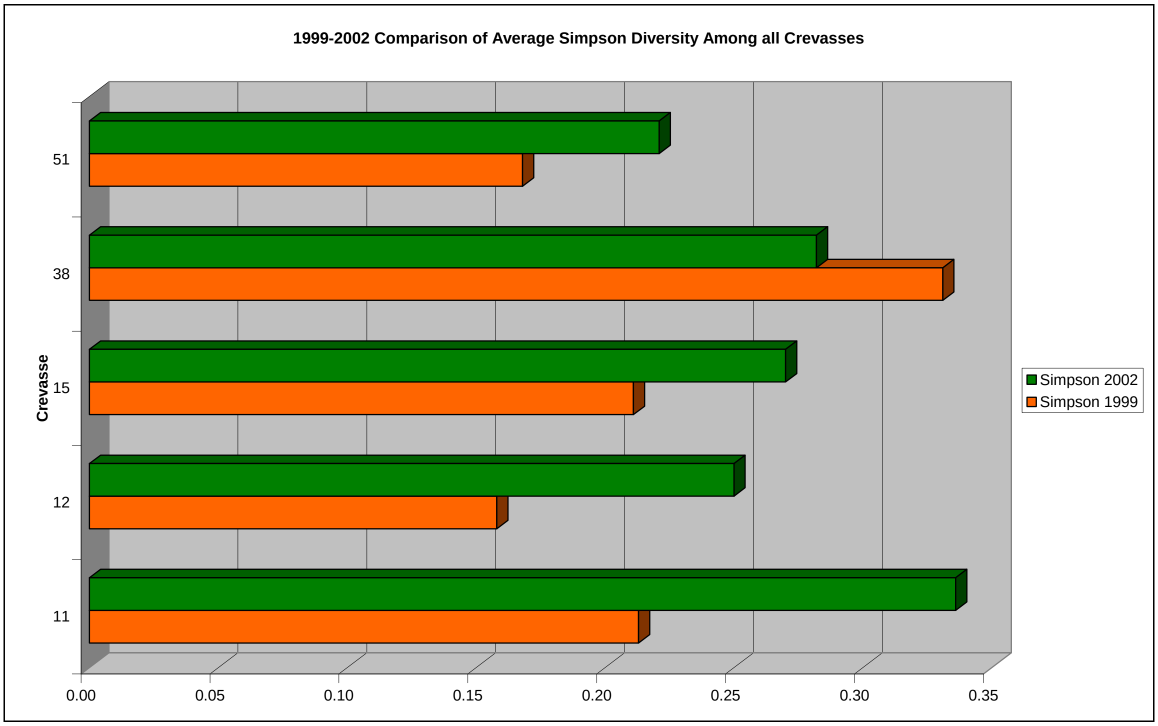


Figure 8. Comparison of diversity between sampling years 1999 (N=46 plots) and 2002 (N=48 plots) across each crevasse using the Simpson index of diversity. Note: diversity index values have no unit values and are used for comparative purposes only.

Elevation

Elevation surveys were conducted in 2000 (as-built) and 2003 (post-construction) on 12 crevasses in the MR-09 project area (Figure 9). Elevation gradient models (TIN models) were created for the 2000 data set and are currently being developed for the 2003 elevation survey. Preliminary analysis of the elevation data shows a strong trend in land gain across all crevasses except 12, 20, and 51 (Figures 10 and 11). The trends of land gain show an average increase in elevation of 0.5 m in the project area after only 3 years.

Crevasse 20 may have suffered land loss due to its relative newness. While all other crevasses were pre-existing to some degree, crevasse 20 was newly constructed. This may lead to a beginning period of substrate scouring and therefore lower readings for elevation. Also, all three of the anomalous crevasses were located in tertiary distributaries (rather than primary or secondary distributaries) that were narrower than average. This may have created some minor alteration in hydrology in the area.

One last option to consider is that if a hurricane or tropical storm (2000: TS Helene, 2001: TS Allison, 2002: TS Bertha/Hanna, H Isidore/Lili, 2003: TS Bill) scoured 'X' amount of soil from the top layer of all crevasses, some crevasses may have been measured as a loss. Any crevasse with a large gain would have had their gain reduced, but still seen a gain. Other sites with very small gains may have not only lost any gain in soil, but lost some of the starting soil. Therefore, some sites may appear to gain land while some appear to lose land while in reality all site lost some land.

Using a comparison of elevation survey cross-sections from the 2000 (as-built) and the 2003 (post-construction), I analyzed the depth of the first transect (closest to the mouth of the crevasse) for a loss of depth. The original planned depth for each crevasse was set at -6 feet NAVD. The following figures (12-17) compare the depth of each crevasse. The discrepancy in the number of points on the X-axis is due to the precision of the elevation survey. The next currently planned dredging is set to open each crevasse to a depth of -8 ft NAVD.

Vigilance needs to be kept when dealing with crevasse openings during splay formation and new land growth. Early in splay formation, soon after the initial dredging of crevasse, sediment will begin to drop out of the water column and begin increasing local elevations. With no interference, this new substrate will become compacted and continue increasing in elevation until it is seeded by the local plant community. The new soil is kept in place by a combination of compacted soil pressure, plant roots, and a lack of hydrologic scouring found in the slow moving water of a splay. If a crevasse were to fill in before a new round of dredging were performed, the splay would halt growth and may begin to subside or wash away. Tidal waters would slowly erode the newly formed land, thus negating any beneficial effect already achieved.

Examining the crevasses that are used in the vegetation monitoring (11, 12, 15, 20, 38, and 51), we note that crevasse splays 11, 12, 38, and 51 have filled in the most severe (Figures 12-17). A cursory glance shows us that the crevasse splays that have had the most land gain were those whose crevasse openings remained open. So there is the possibility that crevasses that close off too early in the splay formation do not allow enough sediment to be deposited, leading to a lack of consolidation and loss of soil retention. These traits will be monitored and compared before the next round of dredging occurs (after this year's) to determine how much crevasse depth may affect splay lifetimes.

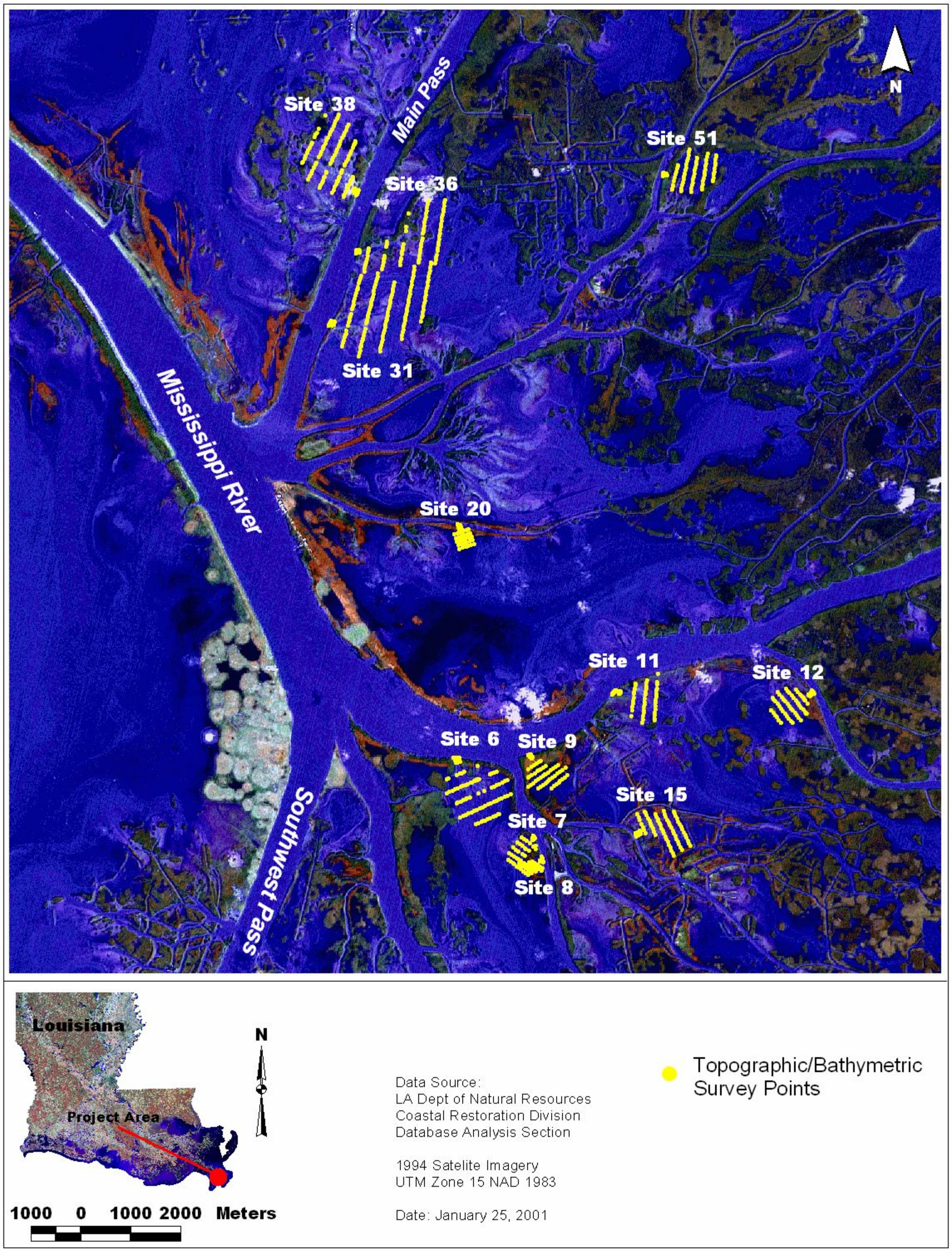


Figure 9. Location of Elevation surveys for Delta Wide Crevasses (MR-09).

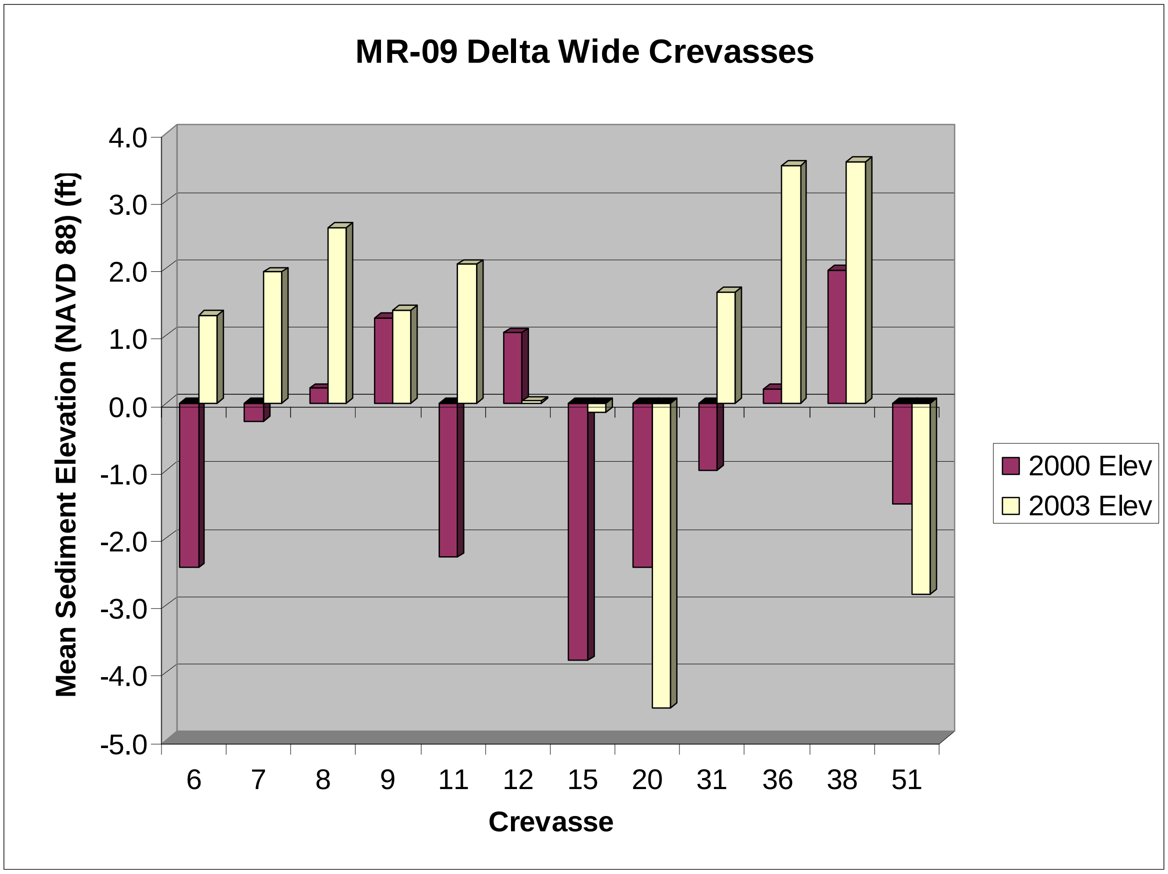


Figure 10. Mean sediment elevation (NAVD 88) in the project area (by crevasse) in 2000 (as-built) and 2003 (post-construction) for the twelve crevasses of Phase I of Delta Wide Crevasses (MR-09).

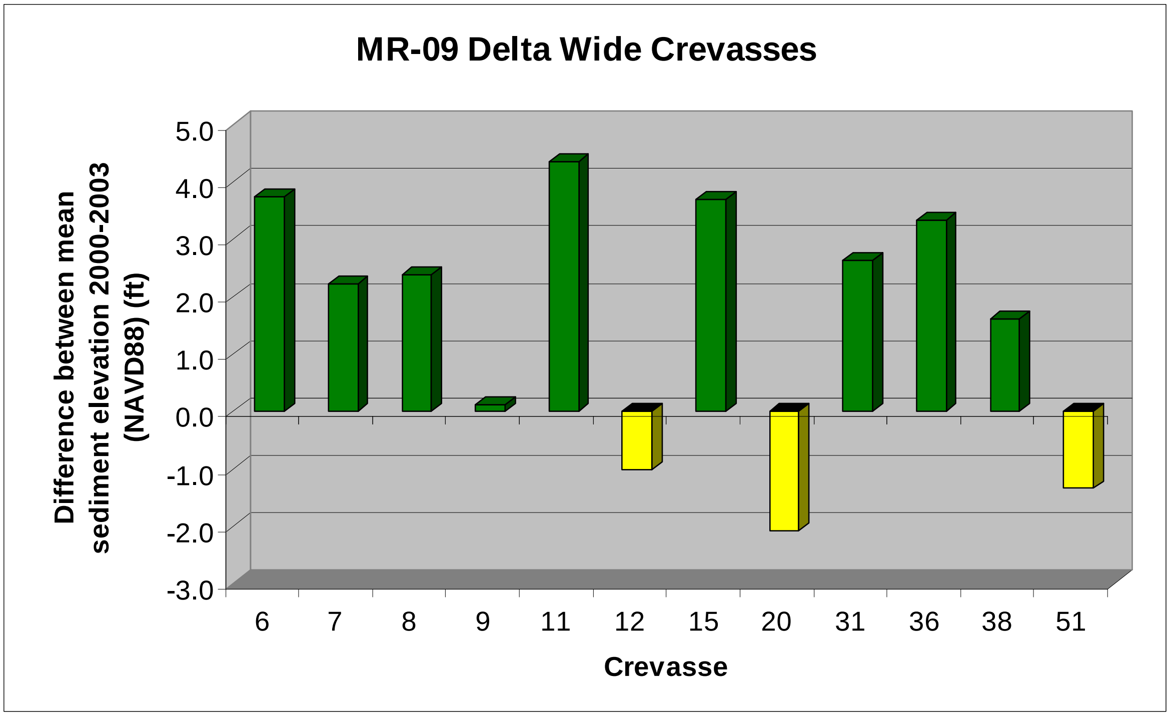
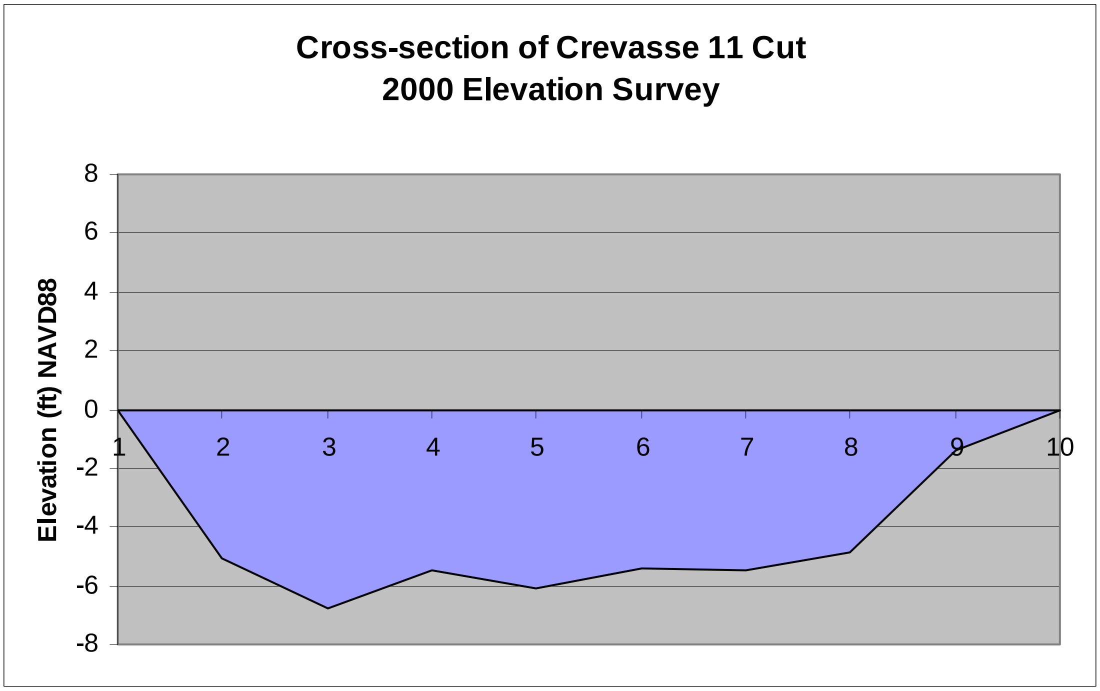


Figure 11. Difference between mean elevations (2000 – 2003) for each of the twelve crevasses in Phase I of Delta Wide Crevasses (MR-09). Bars marked in green represent an overall increase in mean elevation while bars marked in yellow represent those crevasses with an overall decrease in mean elevation.



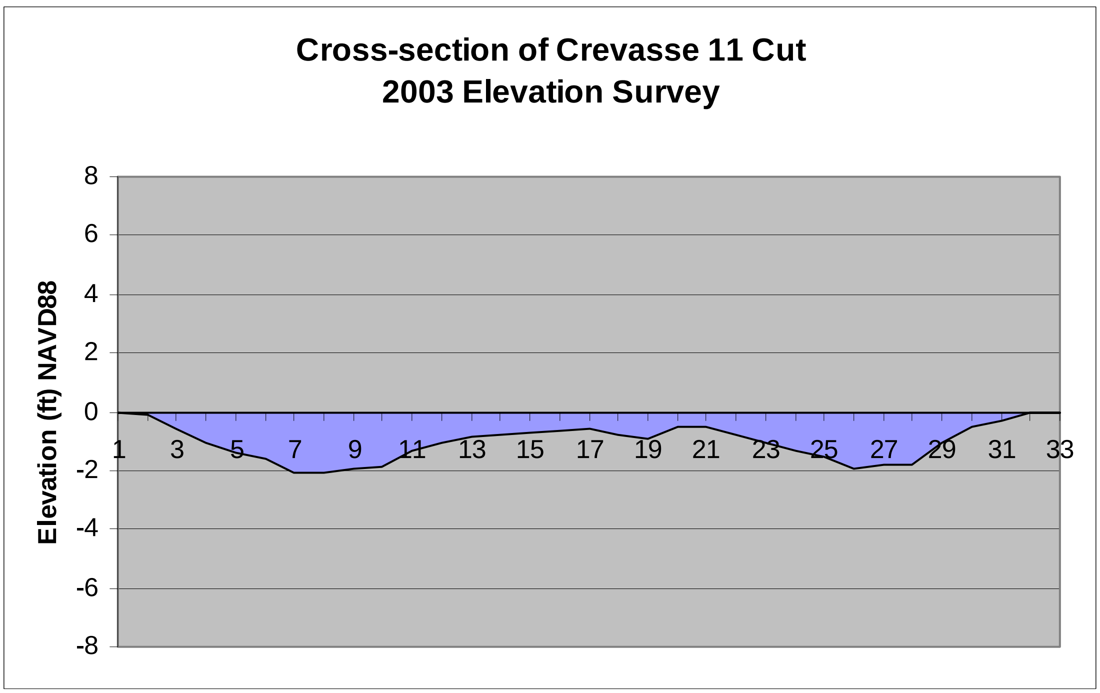
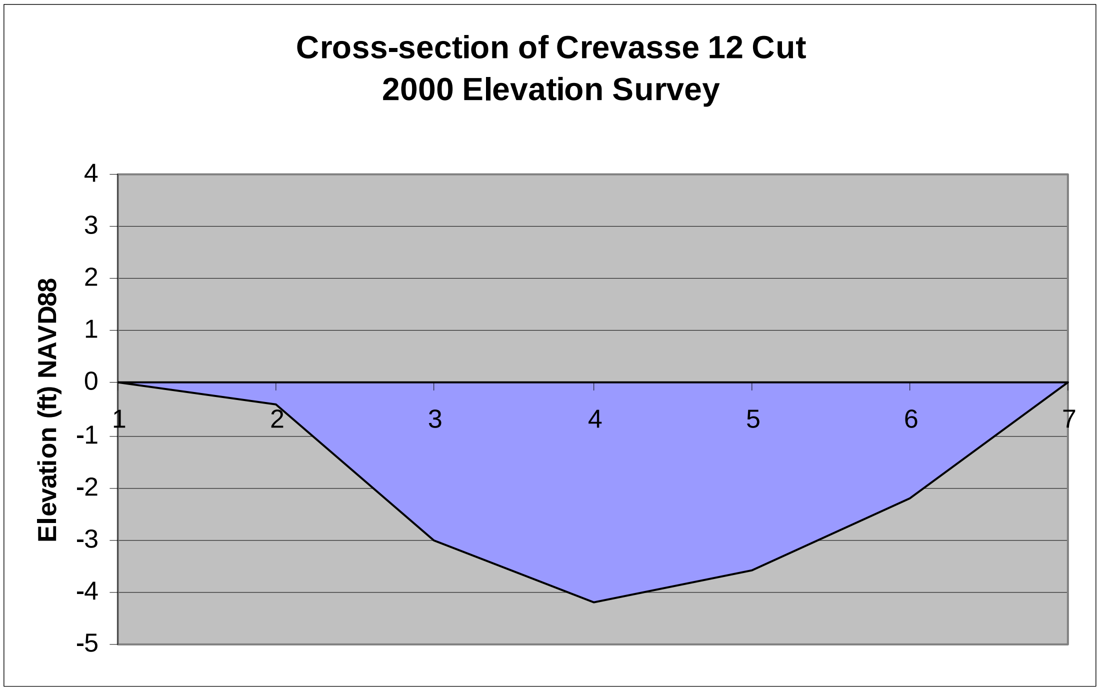


Figure 12. Comparison of cross-section elevation for 2000 (as-built) and 2003 (post-construction) in Crevasse 11 (MR-09 Delta Wide Crevasses).



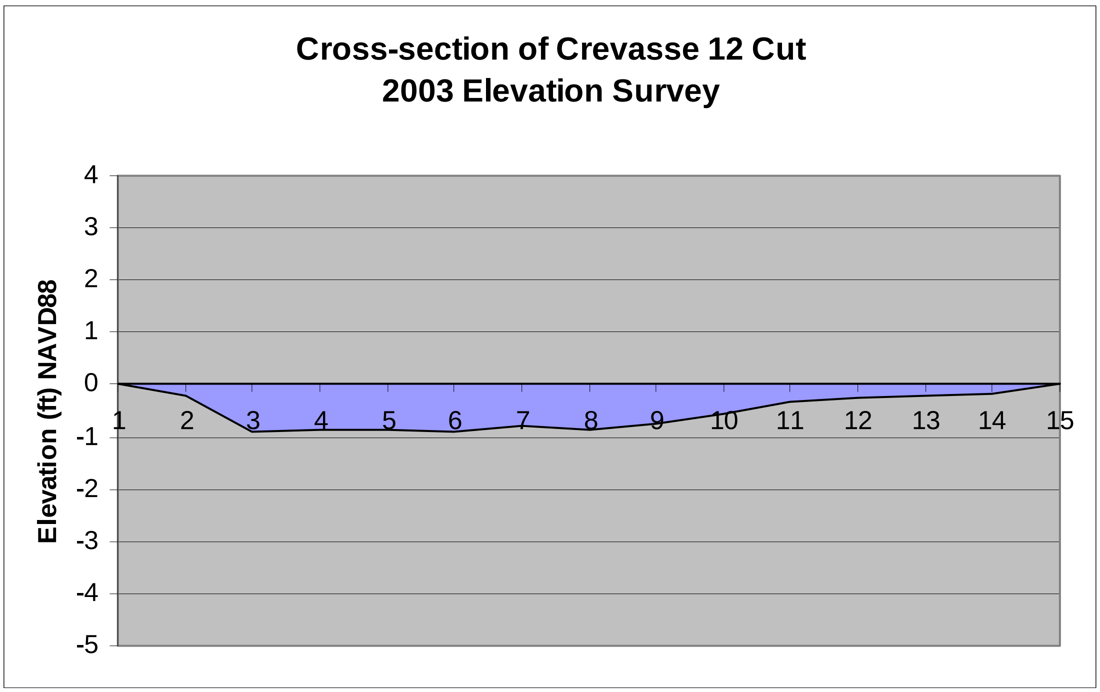
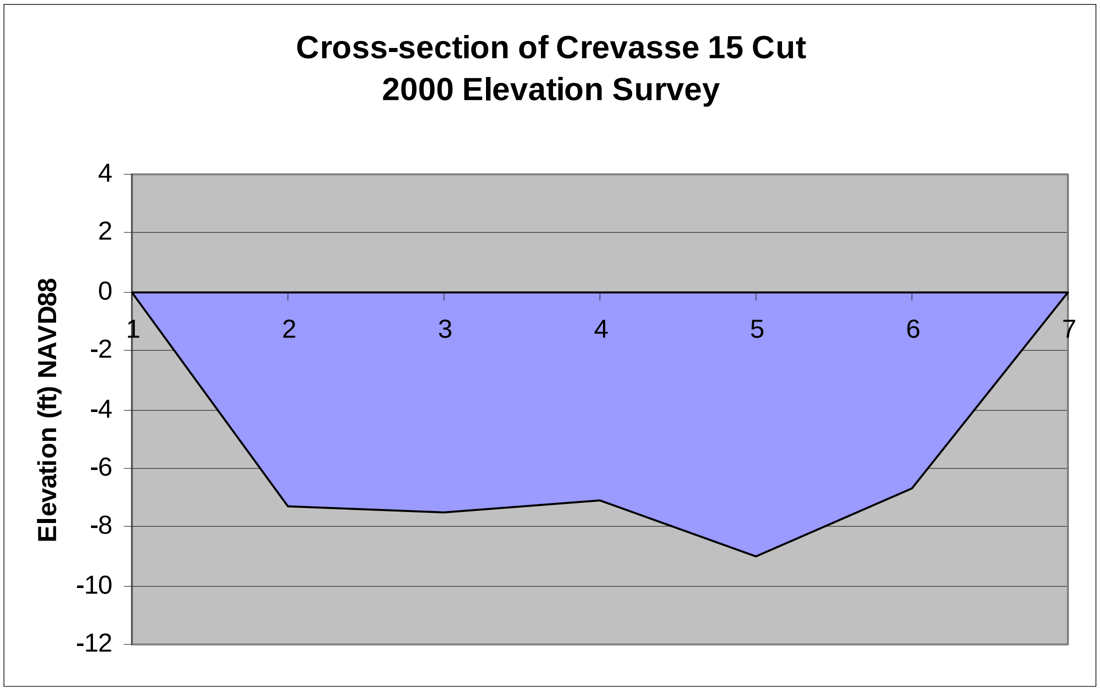


Figure 13. Comparison of cross-section elevation for 2000 (as-built) and 2003 (post-construction) in Crevasse 12 (MR-09 Delta Wide Crevasses).



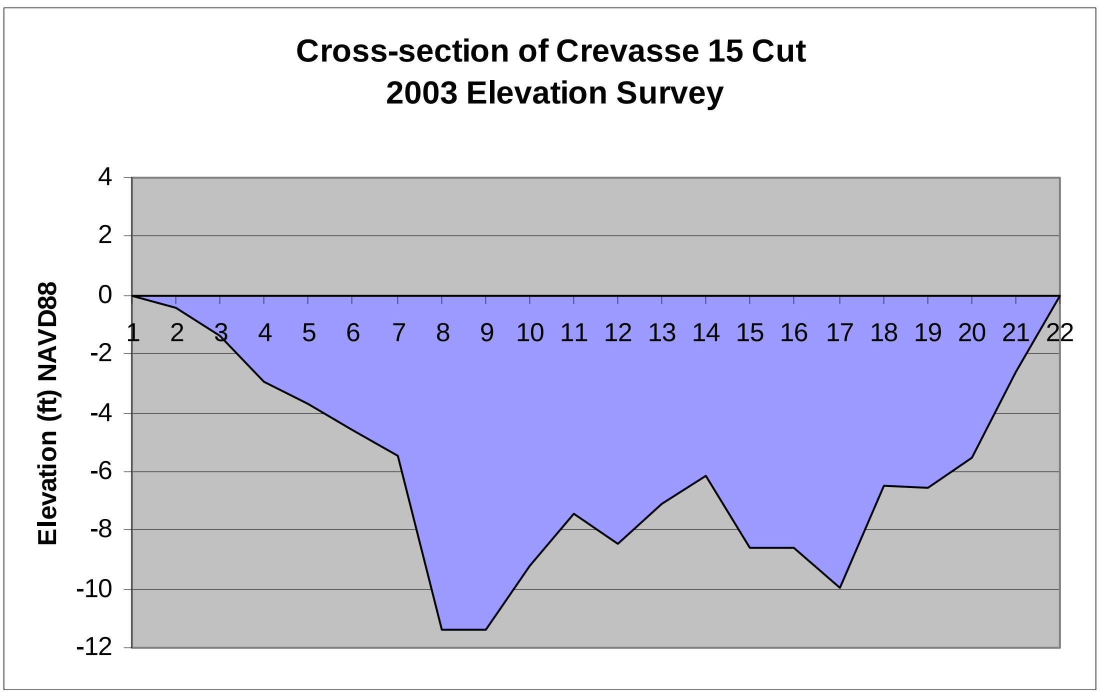
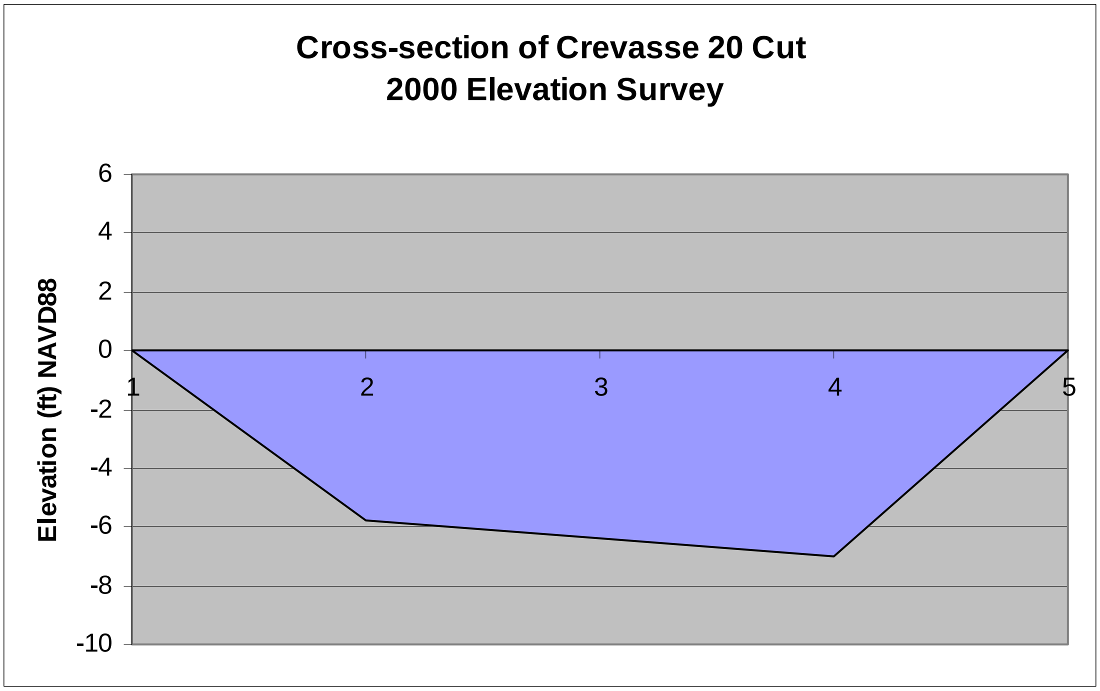


Figure 14. Comparison of cross-section elevation for 2000 (as-built) and 2003 (post-construction) in Crevasse 15 (MR-09 Delta Wide Crevasses).



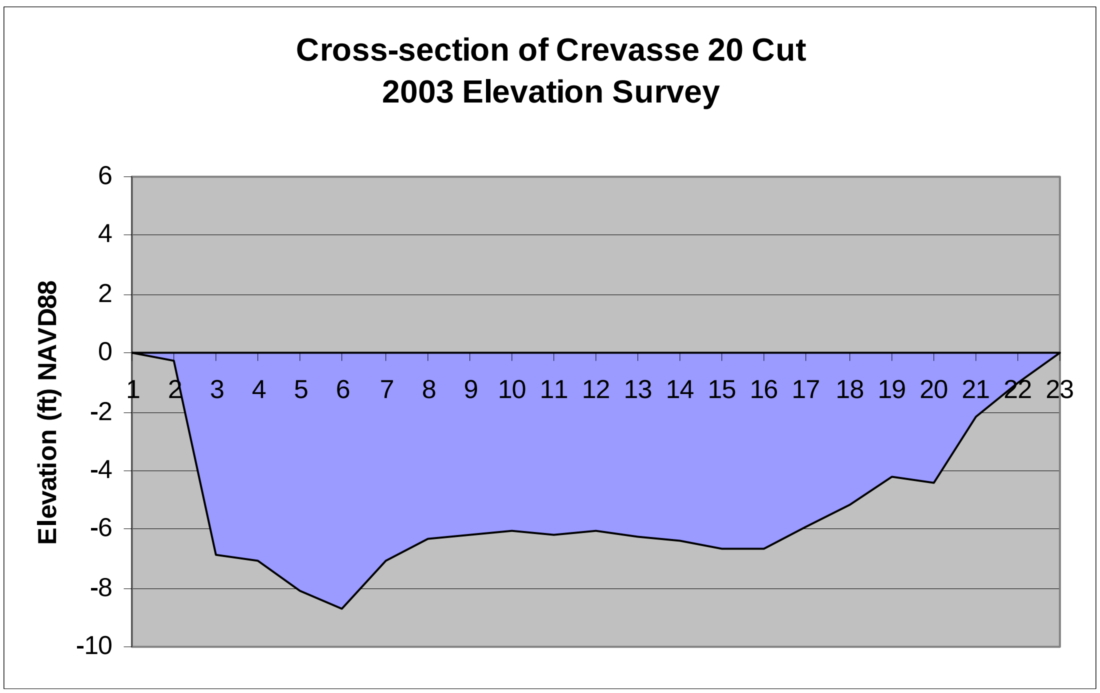


Figure 15. Comparison of cross-section elevation for 2000 (as-built) and 2003 (post-construction) in Crevasse 20 (MR-09 Delta Wide Crevasses).

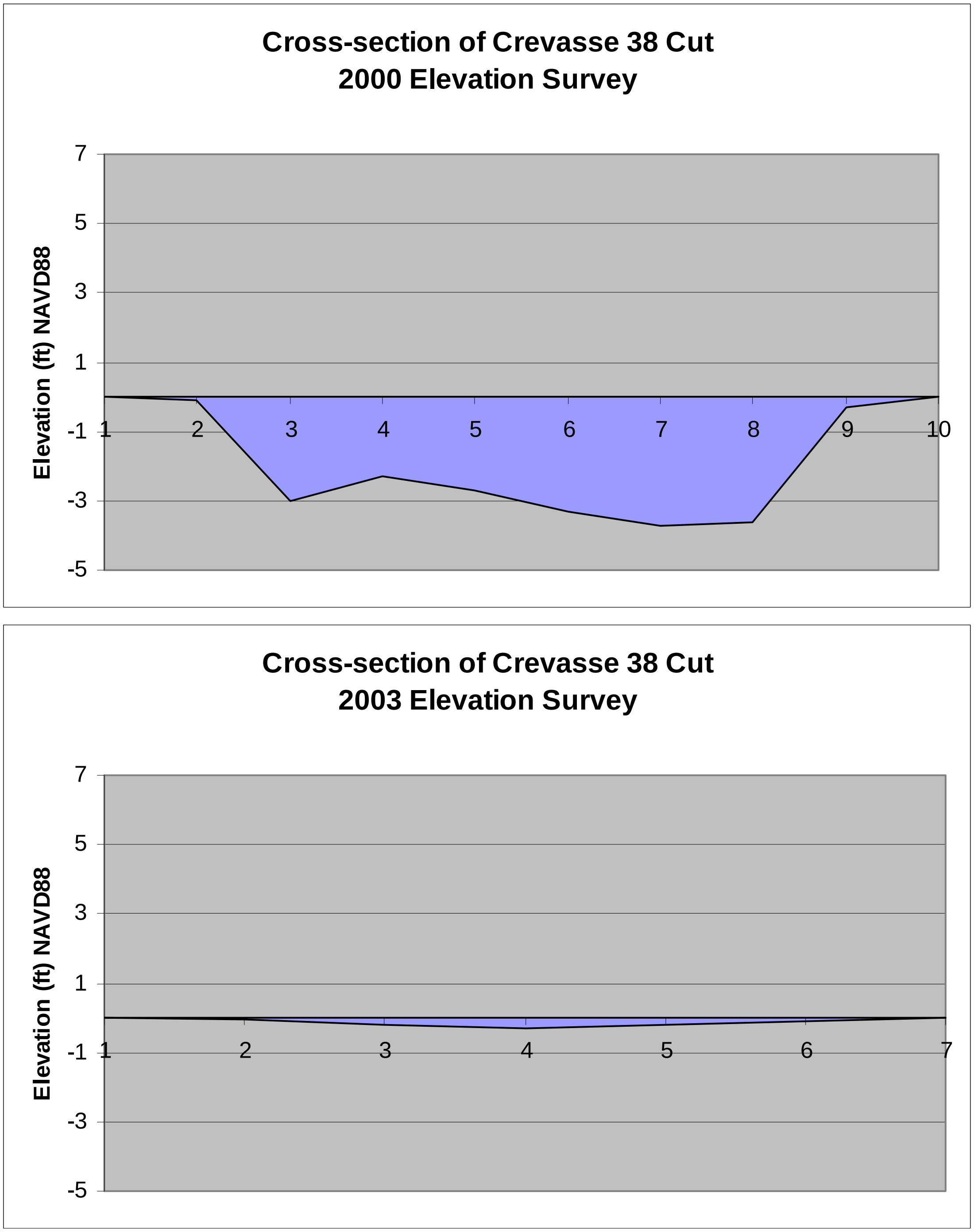


Figure 16. Comparison of cross-section elevation for 2000 (as-built) and 2003 (post-construction) in Crevasse 38 (MR-09 Delta Wide Crevasses).

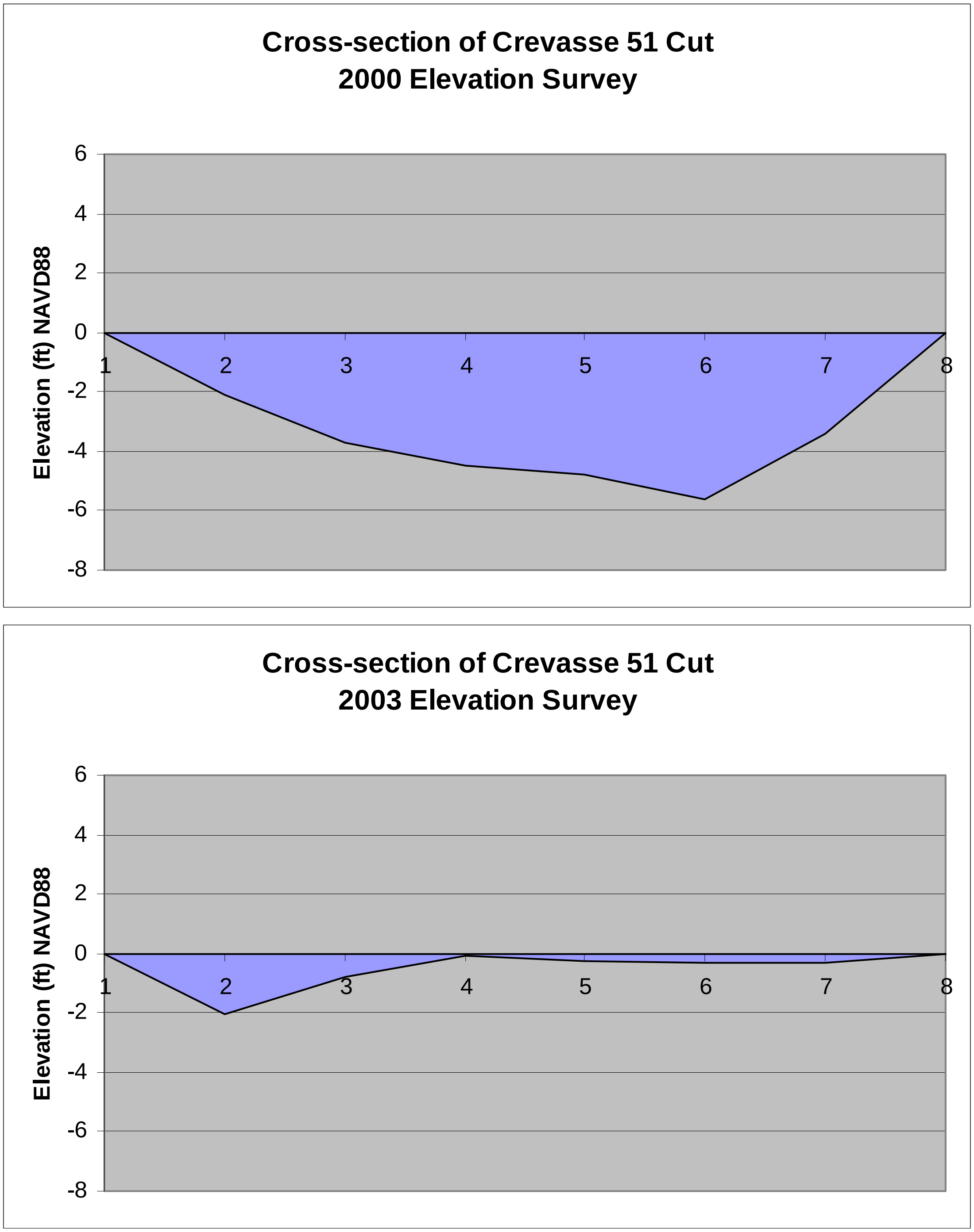


Figure 17. Comparison of cross-section elevation for 2000 (as-built) and 2003 (post-construction) in Crevasse 51 (MR-09 Delta Wide Crevasses).

V. Conclusions

a. Project Effectiveness

Monitoring
A combination of elevation data and vegetation data seem to strongly support the conclusion that the project is working. Most of the crevasses have experienced land growth and will continue to do so unless their channels fill in. Project wide plant diversity has increased from 1999 to 2002.

Elevation data indicates that new land is being created in the crevasse receiving areas. Individual crevasses had increases of as much as 1.326 m in land elevation (crevasse 11). This is very promising growth when compared with the simultaneous increase in plant diversity at these locations. The unexplained loss of land elevation at crevasses 12, 20, and 51 will be monitored in the next elevation survey in 2007.

Vegetation analysis also supports the conclusion that new land is being formed and colonized by emergent vegetation. 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 will significantly help in strengthening the new land and increasing new land deposition. The addition of two new plots in newly vegetated areas also confirms the presence of new land (new for 2002). Further comparison of vegetation data in 2007, 2012, and 2017 will support or refute the hypothesis of primary succession on newly formed crevasse land.

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

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.

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