Coastal Protection and Restoration Authority of Louisiana

State of Louisiana
Coastal Protection and Restoration Authority

2013 Operations, Maintenance, and Monitoring Report

for

Delta Wide Crevasses (MR-09)

State Project Number MR-09
Priority Project List 6

July 2013
Plaquemines Parish

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Suggested Citation:

Gossman, B., and K. Breaux 2013. *2013 Operations, Maintenance, and Monitoring Report for Delta Wide Crevasses (MR-09),* Coastal Protection and Restoration Authority of Louisiana, New Orleans, Louisiana. 39pp.

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Preface

This report includes annual maintenance inspections and monitoring data collected through December 2012.

The 2013 Operations, Maintenance, & Monitoring (OM&M) Report is the fourth in a series that includes monitoring data and analyses presented previously in the 2003, 2004 and 2009 OM&M reports (Barmore 2004, Barmore 2007, Gossman 2009), plus additional project-specific and CRMS data collected since the previous report. For additional information on lessons learned, recommendations and project effectiveness please refer to the 2003, 2004 and 2009 OM&M Reports at the following website:
http://sonris.com/direct.asp?path=/sundown/cart_prod/cart_bms_avail_documents_f

I. Introduction

The Delta-wide Crevasses (MR-09) project is a series of small, uncontrolled sediment diversions 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 3 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 4 crevasses in 1990 (2 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

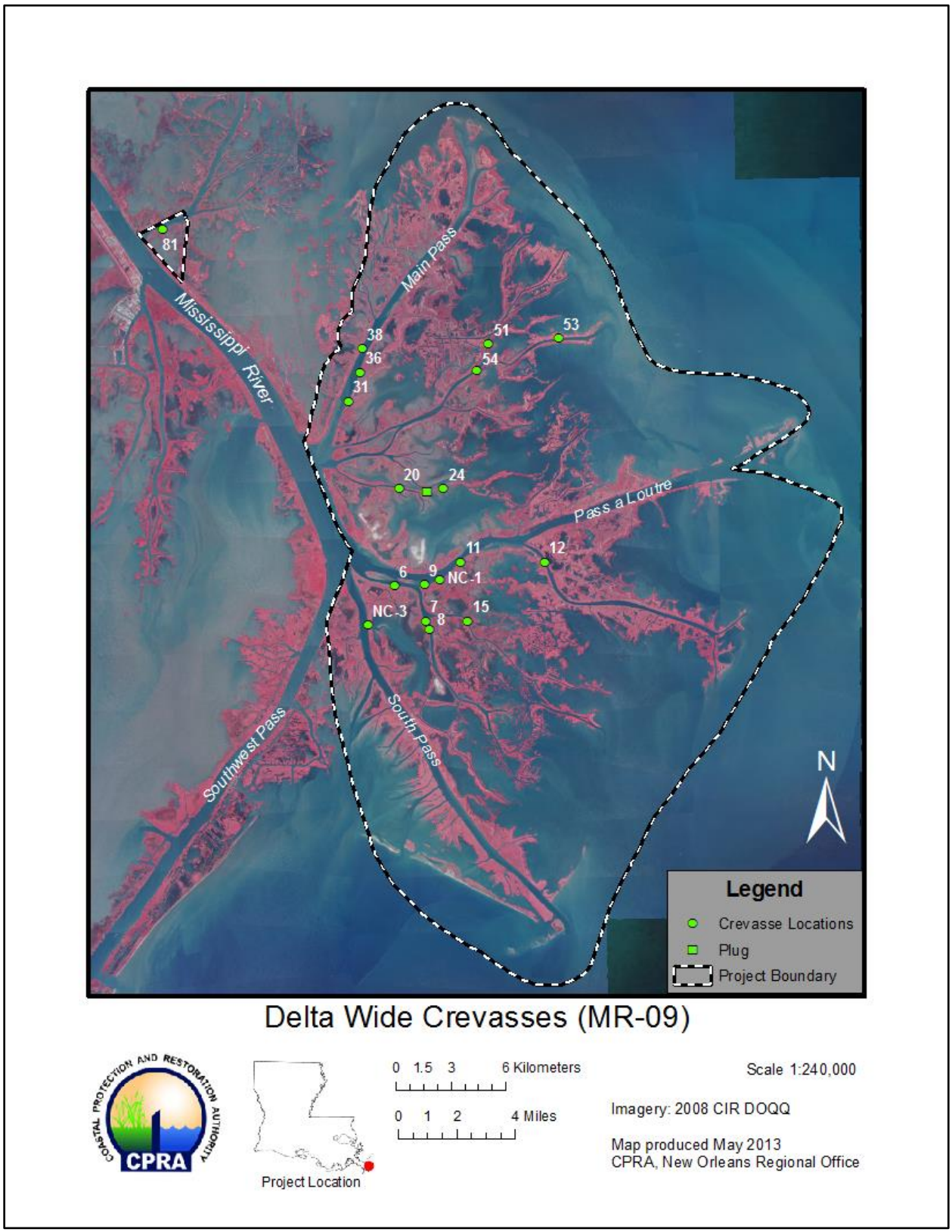

Figure 1. Delta Wide Crevasses (MR-09) project boundary and features.

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.

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 3 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 1 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 5 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 2 new crevasses in the Delta National Wildlife Refuge. To this end, crevasses were constructed to the dimensions of approximately 100 ft wide by 6 ft deep.
- Maintaining approximately 13 existing crevasses located in the DNWR (7) and in the PALWMA (6). 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 3 new crevasses; 2 in the PALWMA and 1 in DNWR.
- Maintaining 3 of the Phase I crevasses in the PALWMA whose crevasse channels had silted in and were not functioning as designed.

Phase III is planned for Fall 2013 and will include the following features:

- Construction of 4 new crevasses in Main Pass and Octave Pass (MP-1, MP-3, OP-4, OP-5)
- Cleanout of 3 existing crevasses in Pass-a-Loutre, Johnson Pass, and South Pass (JP, PAL Sawdust Bend, SP Campground)
- The total dredged volume is approximately 270,000 cubic yards

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

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Delta Wide Crevasses Project is to evaluate the constructed project features to identify any deficiencies and prepare a report detailing the condition of the project features and recommended corrective actions. Should it be determined that corrective actions are needed, CPRA shall provide a detailed cost estimate for the following: engineering, design, supervision, inspection, construction contingencies, and an assessment of the urgency of such repairs (O&M Plan August 1, 2007). The annual inspection report also contains a summary of maintenance projects and a 3-yr projected budget for operation, maintenance, and rehabilitation. The projected operation and maintenance budget is shown in Appendix C. A summary of past maintenance projects since completion of the Delta Wide Crevasses Project in 1999 is outlined in Section IV.

The most recent annual inspection of the Delta Wide Crevasse Project (MR-09) was held on August 24th, 2012 and included an inspection of the 6 Phase II crevasses. Weather conditions were partly cloudy with winds S/SE at 7-10 knots. At 0800 hours the Mississippi River Stage at Venice was +1.71 feet NAVD 88. The reading at the Head of Passes gage was +2.01 NAVD88. In attendance were Kyle Breaux, CPRA; Bryan Gossman, CPRA; Trebor Victorino, LDWF. The inspection team met with Louisiana Department of Wildlife and Fisheries (LDWF) personnel at the LDWF/ PALWMA Camp/Headquarters. LDWF vessels transported the team to each crevasse site. Soundings were taken through each cut.

b. Inspection Results

i. Crevasse NC-1 (2005): (1,000 ft. X 100 ft. X -8.0 ft. NAVD 88) This crevasse appears to be in good condition. Soundings indicate that it has retained slightly more than half of its originally constructed depth. The interior indicates that river water is flowing very well through the channel carrying large amounts of sediment, and the receiving bay is heavily vegetated. SAV's densely populate the spoil islands**.**

ii. Crevasse NC-3 (2005): (1,400 ft. X 100 ft. X -8.0 ft. NAVD 88) This is the second of the two new crevasses and the only one on South Pass. Our soundings show that the crevasse is maintaining its original depth throughout its channel length and the spoil from the crevasse dredging has completely vegetated. The crevasse channel has extended into the receiving bay, creating a visible, subaerial channel bank.

iii. Crevasse 9 (1999): (2,200 ft. X 75 ft. X -8.0 ft. NAVD 88) Dog-leg shaped crevasse. Soundings indicate that this crevasse is maintaining a 5'-6' depth. The spoil deposition from this cut is very heavily vegetated with cut grass and Roseau cane.

iv. Crevasse 11 (1999): (2,600 ft. X 100 ft. X -8.0 ft. NAVD 88) This re-dredged crevasse (1999) is maintaining a good flow throughout its length. Soundings indicate that it has maintained 5'-7' depth throughout the channel. The low water levels in the river have allowed more vegetation growth on sediment deposits. Wild rice (*Zizania aquatica)* is now growing in the interior receiving bay.

v. Crevasse 12 (1999): (2,000 ft. X 75 ft. X -8.0 ft. NAVD 88) This crevasse has silted in on the right bank and is forming a channel ranging from 4'-8' deep. Mudflats spread across the receiving bay indicating development of new land**.**

vi. Crevasse 81 (2005): (1,200 ft. X 100 ft. X -8.0 ft. NAVD 88) This crevasse was not visited by the inspection team. It is located off Baptiste Collette in the Delta Wildlife Management Area. Conditions from the 2011 inspection are presumed to be the same: "Despite soundings indicating that the mouth of this crevasse has silted up from the large amounts of sediments moving into the cut, [sediment continues flowing] into the interior marsh area. The 3.5' draft of the boat was too deep to travel into the crevasse."

c. Maintenance Recommendations

i. Immediate/Emergency Repairs

There are no immediate or emergency repairs needed at this time.

ii. Programmatic/Routine Repairs

Phase III will be the final construction maintenance event for the MR-09 project due to funding. Funds were budgeted for the remaining monitoring activities and inspection trips, which will continue to the end of project life.

III. Operations Activity

There are no operations associated with this project.

IV. Monitoring Activity

a. Monitoring Goals

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.

The specific measurable goals established to evaluate the effectiveness of the project are:

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.

Land-Water Analysis

To evaluate land to water ratios in the individual receiving bays, near vertical, color infrared aerial photography was obtained in January 2000 (as-built) and in 2002, 2007, and 2012 (post-construction) for all crevasses in the project area. The imagery was geo-rectified, photo-interpreted, and analyzed to determine land/water ratios using standard operating procedures documented in Steyer et al. (1995, revised 2000). The 2000, 2002, and 2012 photography was acquired specifically for the MR-09 project at 1:24,000 scale with ground controls. The 2012 photography was obtained using Coast-wide Reference Monitoring System-*Wetlands* (CRMS) aerial photography (Folse et al. 2012). The CRMS program utilizes digital imagery (Z/I imaging digital mapping camera) with 1-meter resolution. Photography will be acquired again in 2017 using CRMS aerial photography.

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, revised 2000). 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 surveys were conducted in the late summer (mid-July to August) in 1999 (as-built) and in the post-construction years designated for aerial photography, 2002, 2007, and 2012. An additional survey is scheduled for 2017. These surveys are to be limited to a subset of 6 of the 12 Phase I crevasses (11, 12, 15, 20, 38, and 51) monitored for elevation. Additional data from the CRMS-*Wetlands* sites in the Mississippi River Delta and Chabreck and Lindscombe 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. 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 2 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 3 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 post-construction during years 2002, 2007, and 2012. A final post-construction survey will be conducted in 2017.

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.

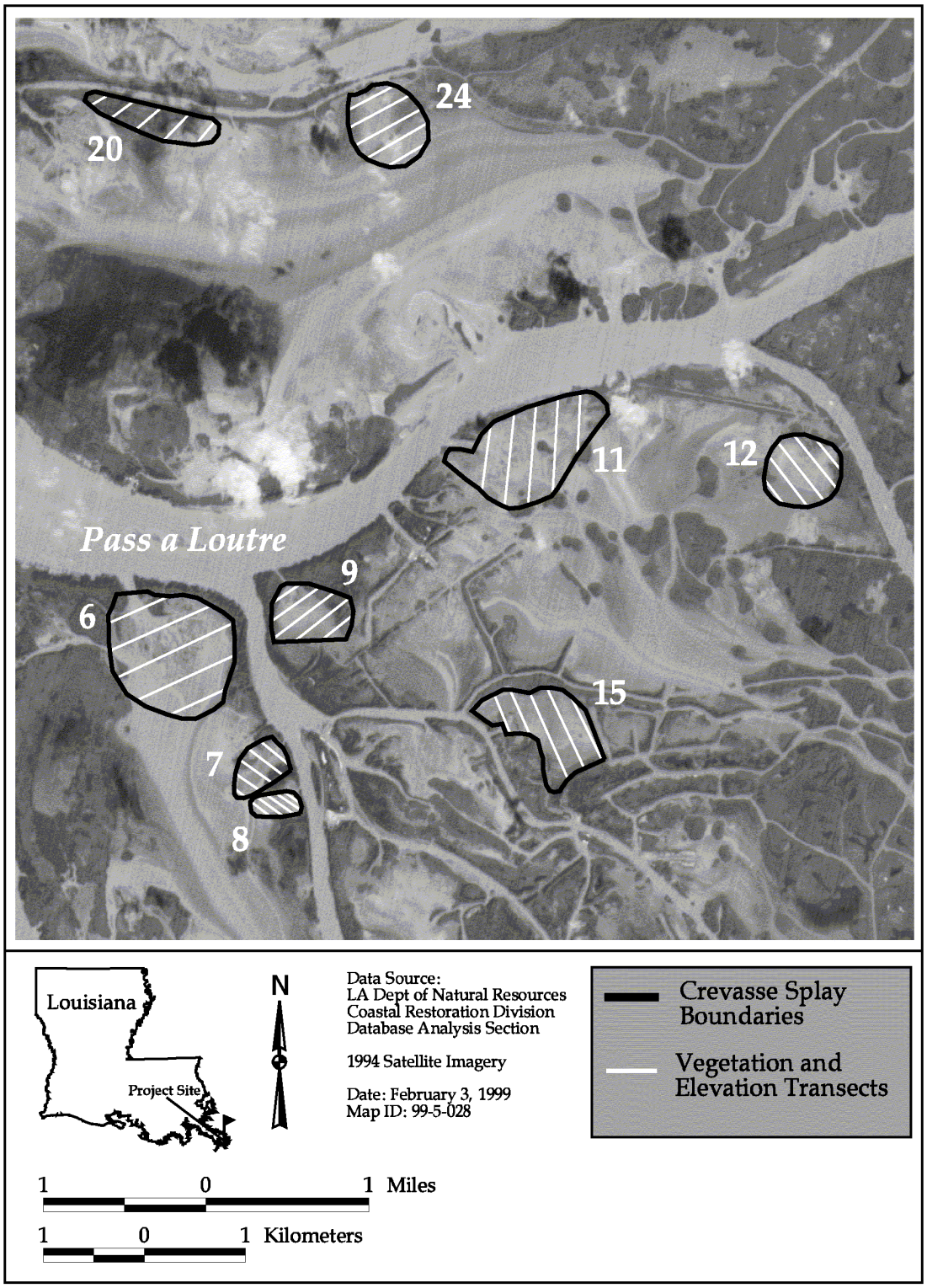

Figure 2. Phase I crevasses in the southern project area of MR-09 (Delta Wide Crevasses).

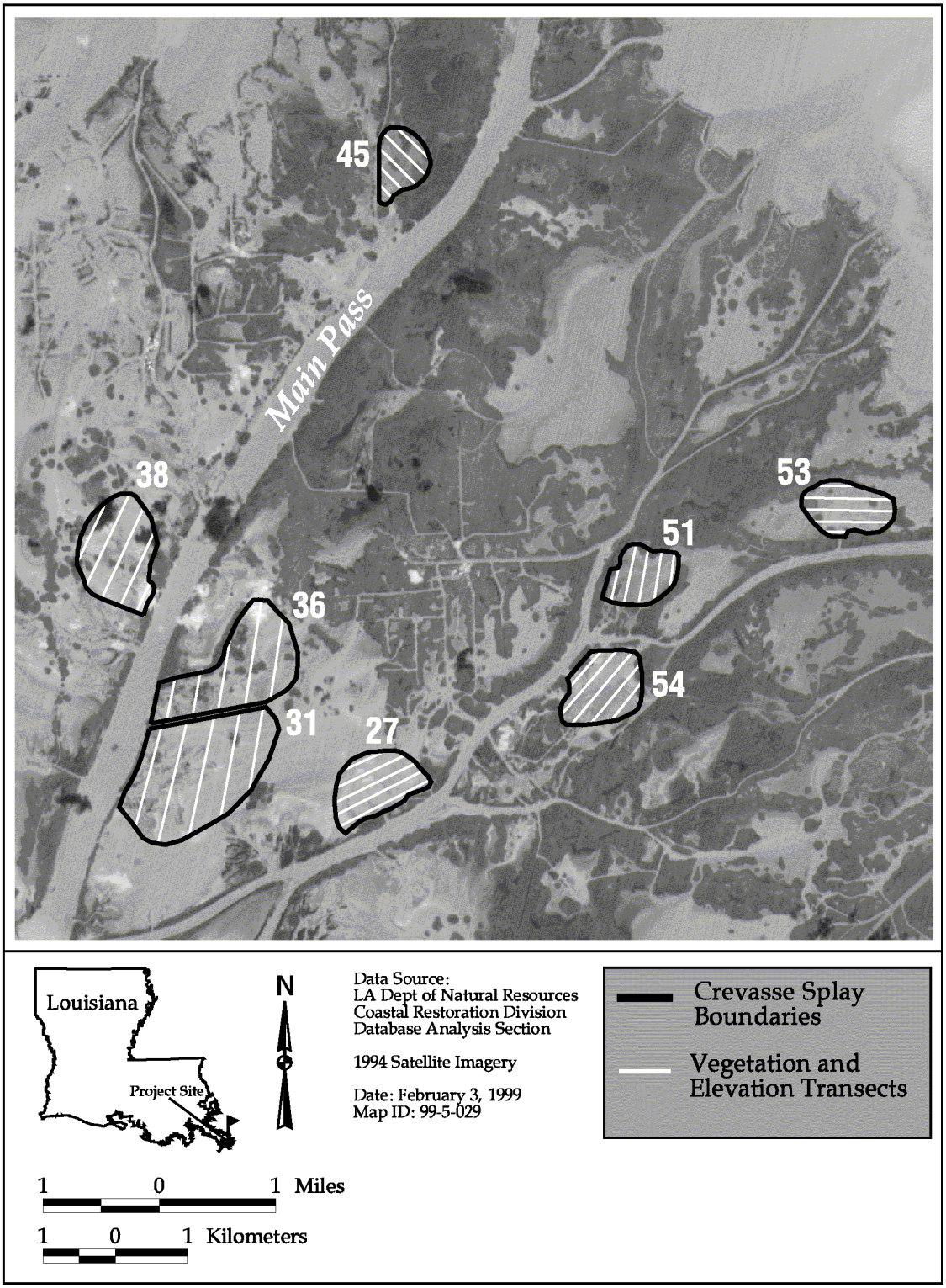

Figure 3. Phase I Crevasses in the northern project area of MR-09 (Delta Wide Crevasses).

CRMS Supplemental

Additional data were collected at CRMS-*Wetlands* sites, which can be used as supporting or contextual information for this project. Data types collected at CRMS sites include hydrologic, emergent vegetation, physical soil characteristics, discrete porewater salinity, marsh surface elevation change, vertical accretion, and land-water analysis of the 1-km^2 area encompassing the station (Folse et al. 2012). There are 11 CRMS sites located in the MR-09 project area. However, due to the extent of the project area, not all of these CRMS sites are located near a crevasse. For this report, four CRMS sites that are in the immediate vicinity of a crevasse or that experience similar hydrologic conditions (CRMS0156, CRMS2627, CRMS2634, and CRMS4448) were selected for supplemental data. Vegetation and land-water data from these 4 CRMS sites were used to assess project goals.

c. Preliminary Monitoring Results and Discussion

Land/Water Analysis

Color infrared aerial photography obtained in 2000 (as-built), 2002, 2007, and 2012 has been analyzed by the USGS and are presented as land-water analysis. There were a total of 18 crevasses analyzed including the 6 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 519 ac. with an average land gain of 29 ac. per crevasse. This translates to a total land gain of 66.5% across the project area. The largest land gain for a single crevasse occurred at Crevasse 31 (Figure 4) with a land gain of 139 ac. (+207.5%). The largest relative gain occurred at Crevasse 81 (Figure 5) with an increase of 270% (27 ac). One crevasse experienced net land loss. Crevasse 53 (Figure 6) lost 18 ac of land between 2001 and 2012.

While 17 of the 18 MR-09 crevasses have a net land gain over the entire length of the project, there were 5 crevasses (Crevasses 6, 7, 8, 9, and 38) that lost land acreage between the 2007 and 2012 analyses (Table 1). A closer analysis of the aerial photography for these sites show that most of these crevasses have either narrowed significantly or closed completely. It is likely that these crevasses have reached the end of their lifespan and would require maintenance dredging in order to effectively transport water and sediment into the receiving bays.

Table 1. Land area (ac) for 18 crevasses in the MR-09 project area.

Crevasse	2001	2002	2007	2012	2001-2012 Change	Relative gain/loss	Rate (ac/yr)
6	116	150	171	163	47	40.5%	4.3
7	24	28	30	26	2	8.3%	0.2
8	5	8	10	7	2	40.0%	0.2
9	39	45	45	43	4	10.3%	0.4
11	116	131	157	178	62	53.4%	5.6
12	21	28	40	43	22	104.8%	2.0
15	19	26	26	29	10	52.6%	0.9
20	28	28	39	42	14	50.0%	1.3
24	3	4	5	6	3	100.0%	0.3
31	67	90	191	206	139	207.5%	12.6
36	125	136	181	202	77	61.6%	7.0
38	102	99	181	175	73	71.6%	6.6
51	21	24	23	29	8	38.1%	0.7
53	33	36	15	15	-18	-54.5%	-1.6
54	41	47	57	63	22	53.7%	2.0
81	10		29	37	27	270.0%	2.5
NC-1	5	6	11	15	10	200.0%	0.9
NC-3	6	11	17	21	15	250.0%	1.4
Totals	781	897	1228	1300	519	66.5%	47.2
Average	43	53	68	72	29	66.5%	2.6

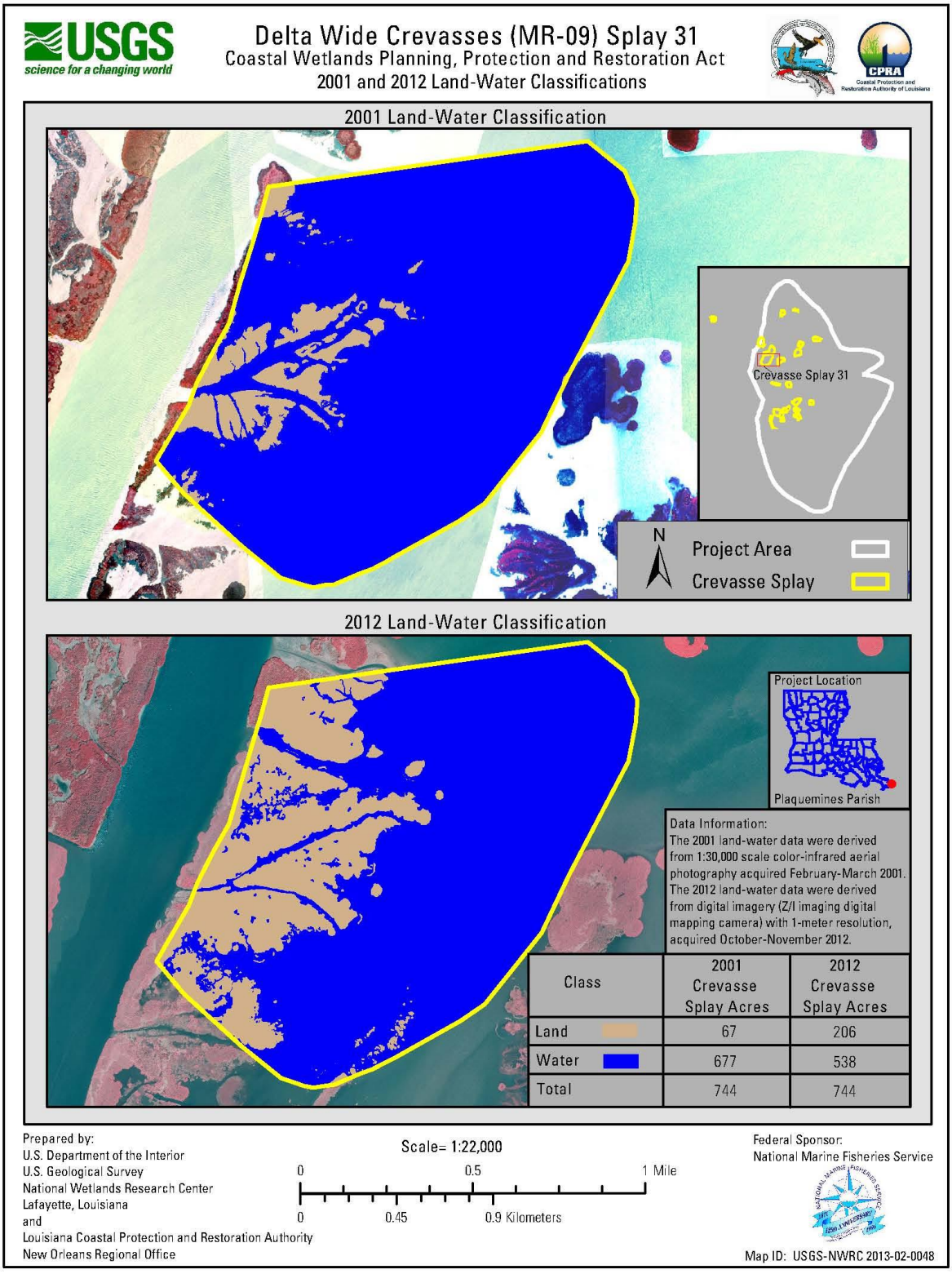

Figure 4. Land-water analysis for Crevasse 31 in 2001 and 2012.

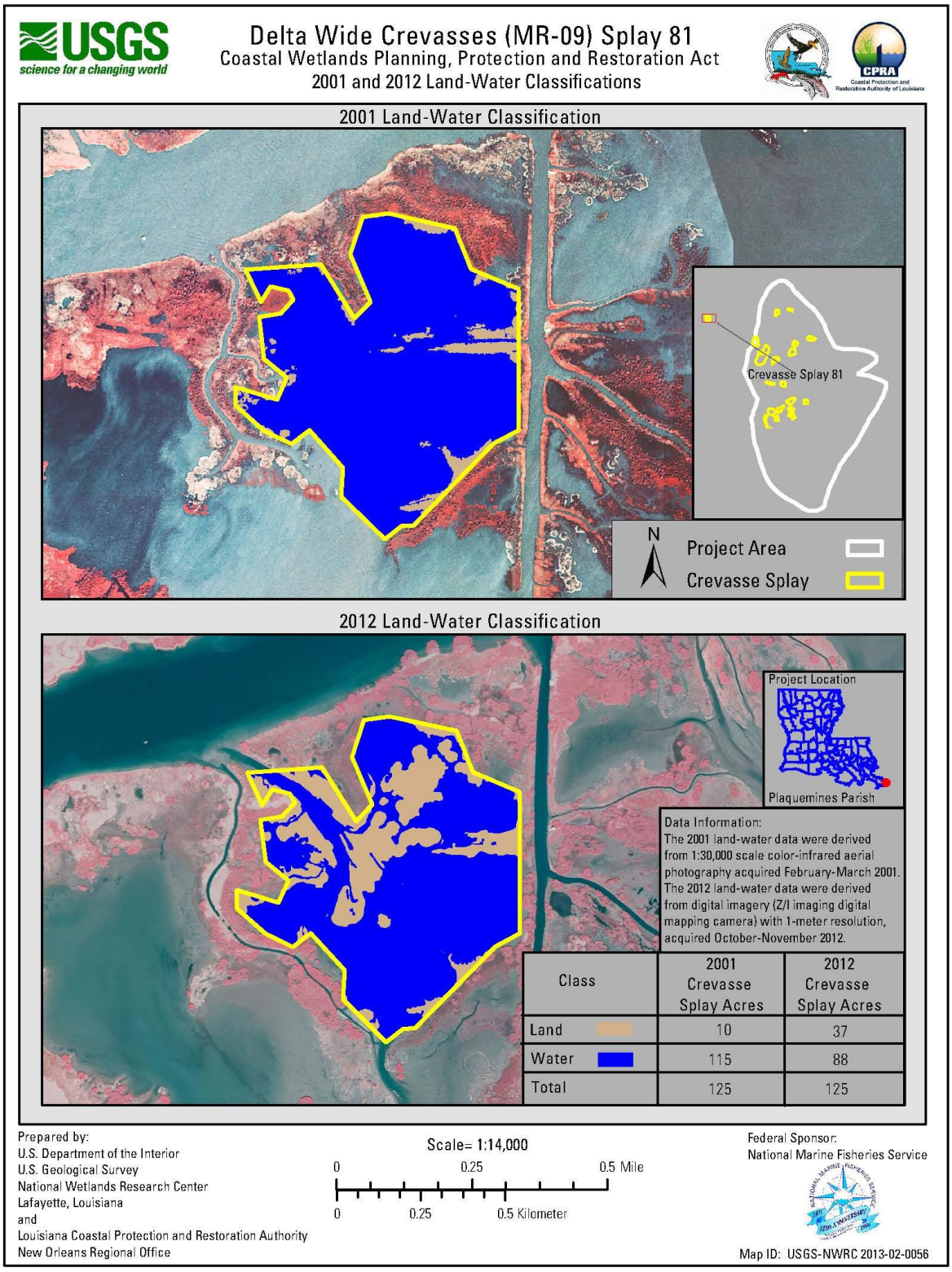

Figure 5. Land-water analysis for Crevasse 81 in 2001 and 2012.

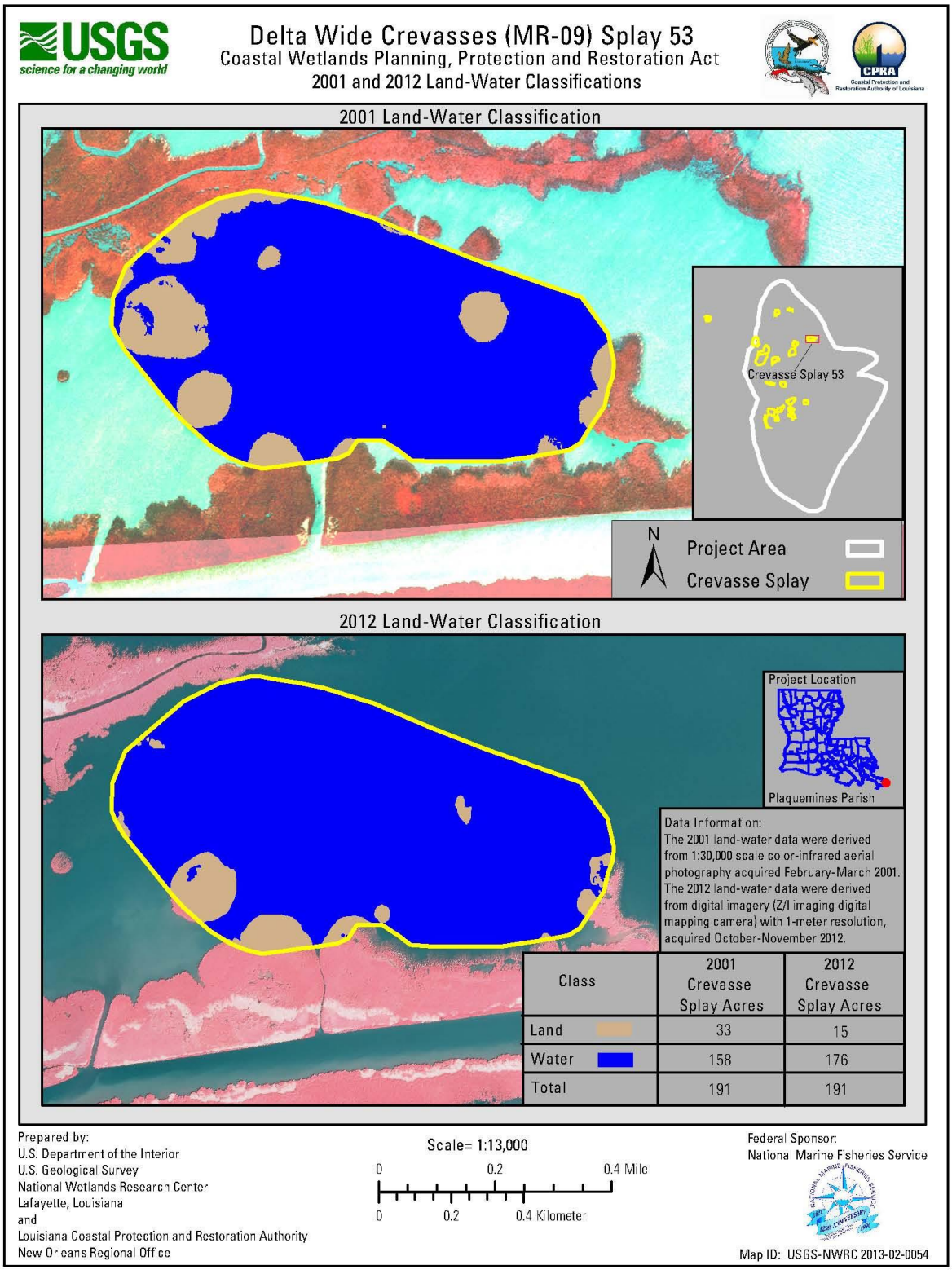

Figure 6. Land-water analysis for Crevasse 53 in 2001 and 2012.

Vegetation

Vegetation surveys were conducted in August 1999 (N=46), August 2002 (N=49), August 2007 (N=50), and October 2012 (N=65) during the post-construction period. Total percent cover was lower in the 2012 survey than in 2007 at all 6 of the crevasses that are monitored for vegetation (Figure 7), continuing the generally downward trend in percent cover seen in previous surveys. Crevasse 20 is the one exception that has shown a generally increasing trend. There was no vegetation present in the 1999 survey and percent cover increased greatly between 2002 and 2007. Although total percent cover decreased in the 2012 survey, 7 new sample plots were added as new land has formed.

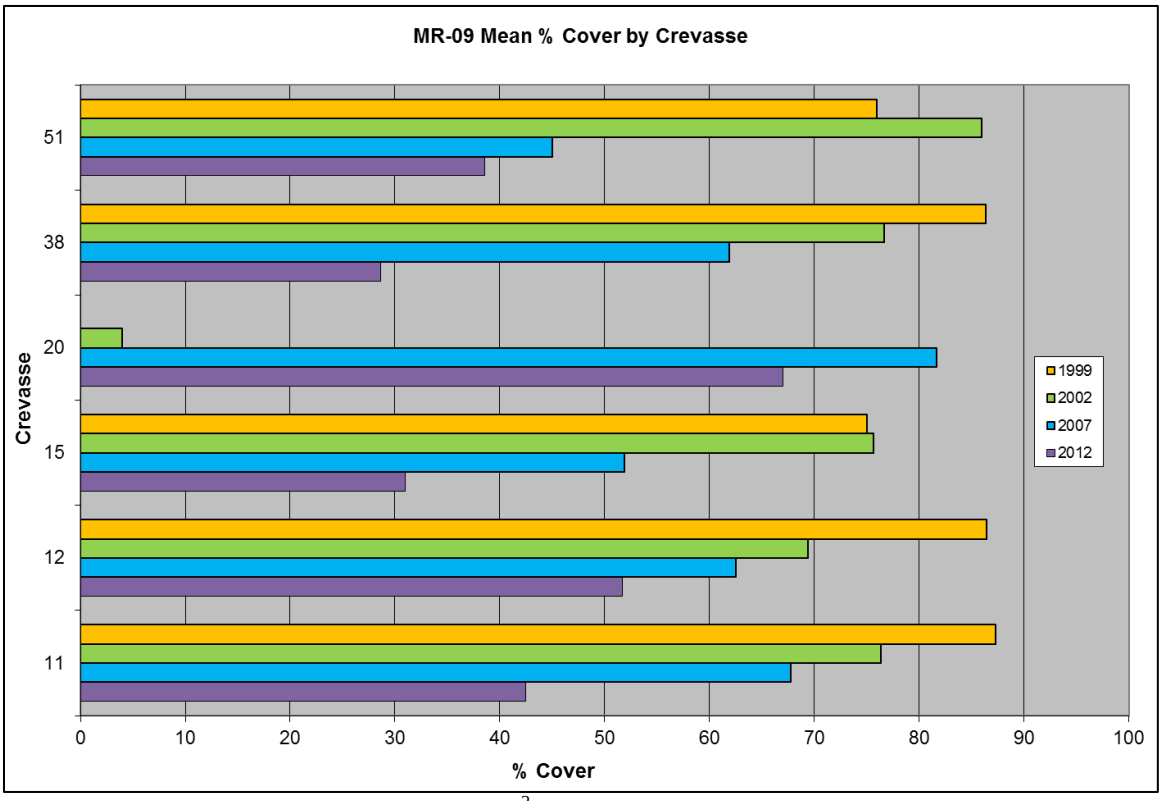

Figure 7. Mean percent cover of all 4-m^2 plots for six selected crevasses within the MR-09 project area August 1999, August 2002, August 2007, and October 2012. Vegetation was sampled using the Braun-Blanquet method.

Percent cover data of individual species across all plots in the MR-09 project area indicate a shift in species composition (Figure 8). Percent cover of species such as *Sagittaria lancifolia* (bulltongue), *Sagittaria latifolia* (broadleaf arrowhead), *Colocasia esculenta* (elephant ear), and *Schoenoplectus americanus* (chairmakers bullrush), which dominated the 1999 and 2002 surveys decreased in the 2007 and 2012 surveys. Meanwhile, percent cover of other species has increased. *Phragmites australis* (common reed) has increased steadily and dominated the 2007 and 2012 surveys. *Zizaniopsis miliacea* (giant cutgrass), which was present in only a few plots in the 1999 survey, has increased to the point that it had the second greatest coverage of any species in the 2012 survey.

When examined at the individual crevasse level, shifts in species composition can be observed in greater detail. Vegetation communities at 4 of the 6 crevasses studied (Crevasses 11, 12, 38, and 51) have come to be dominated by *Phragmites australis* (Figures 9 and 10). In the case of Crevasse 51, *Phragmites australis* was the only species observed in vegetation plots during the 2012 survey. The 2 remaining crevasses (Crevasses 15 and 20) have shifted to a community dominated by *Zizaniopsis miliacea*, particularly in the 2012 survey.

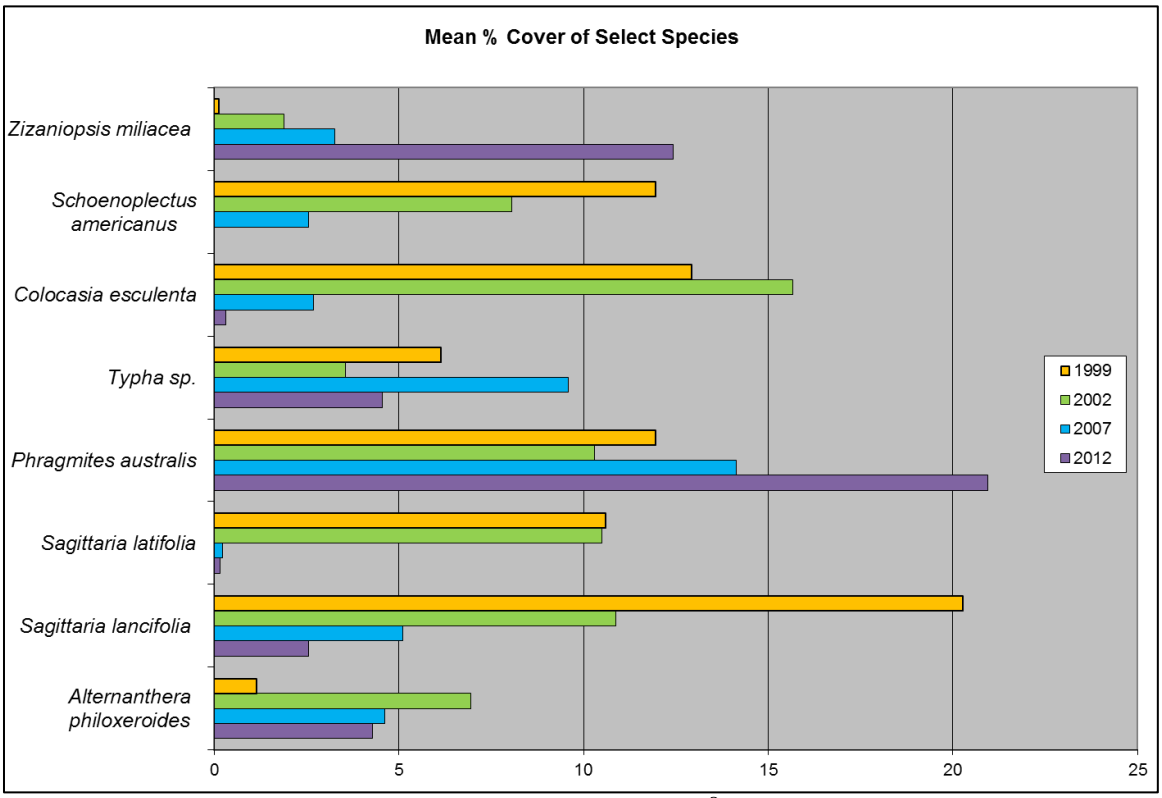

Figure 8. Mean % cover of selected species across all 4-m^2 plots within the MR-09 project area during August 1999 (N=46 plots), August 2002 (N=49 plots), August 2007 (N=50 plots), and October 2012 (N=65 plots). Vegetation was sampled using the Braun-Blanquet method.

Another metric that has been used to assess the quality of the vegetation community is the Floristic Quality Index (FQI) (Cretini et al. 2011). The FQI is calculated by assigning each species a CC score, or coefficient of conservatism, which is scaled from 1 to 10 and reflects a species' tolerance to disturbance and habitat specificity. A modified FQI was developed by the CRMS Vegetation Analytical Team, which assembled a team of experts to assign CC scores to Louisiana's wetland plant species. The modified FQI equation takes into account not only the CC scores, but also the percent covers of species at a site, and the resulting score is scaled from 0 to 100. Mean FQI scores were calculated for the 6 MR-09 project sites for each of the sampling years (Figures 9 and 10). Long term trends in FQI scores for the MR-09 crevasses have varied according to site. Scores at 3 crevasses (Crevasses 11, 38, and 51) have decreased, 2 crevasses (Crevasses 12 and 15) have remained relatively stable, and 1 crevasse (Crevasse 20) has increased. FQI scores generally ranged from 25 to 50, which is below the ideal range of 55-70 for fresh marsh

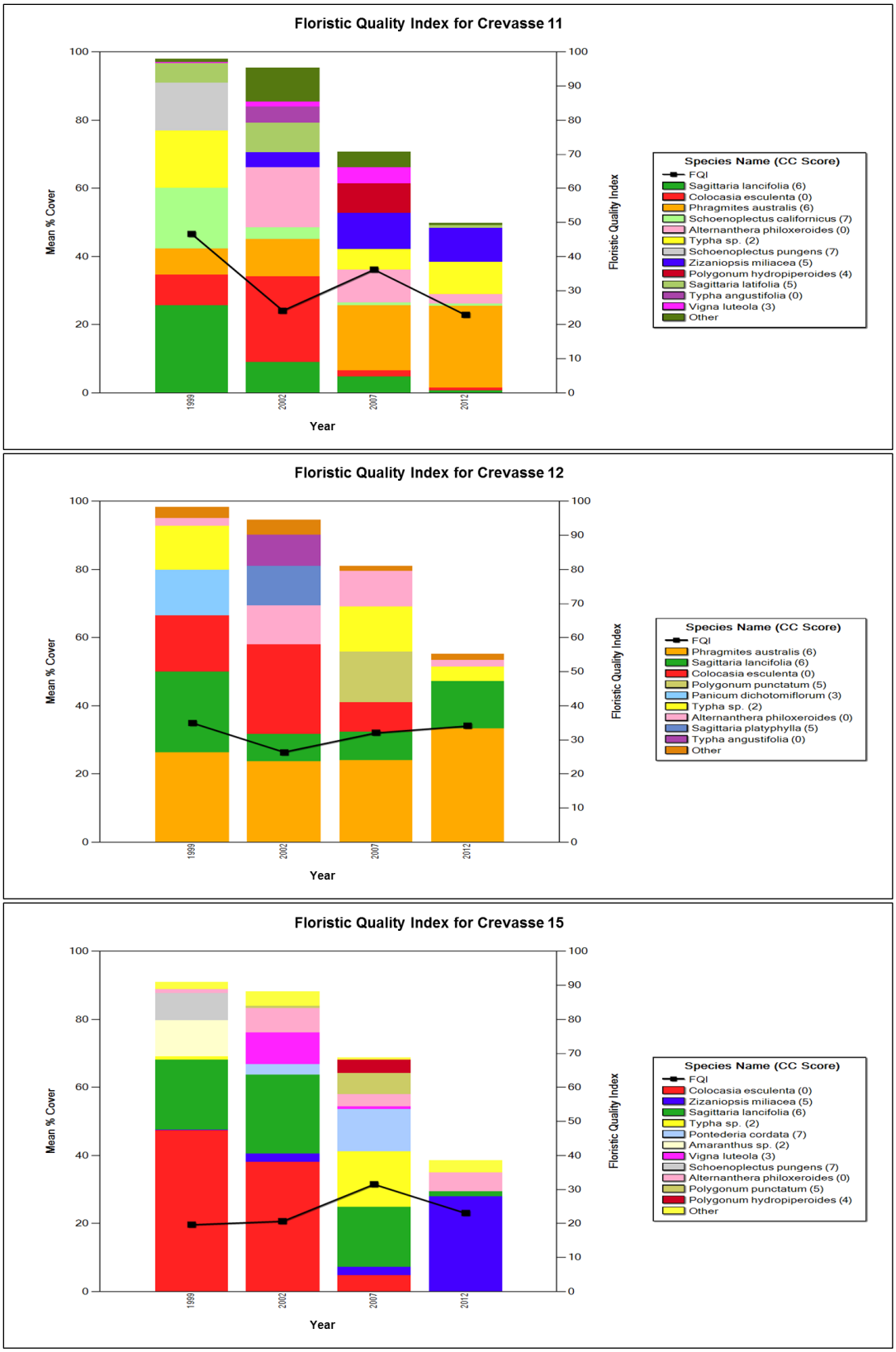

Figure 9. Mean percent cover and FQI for Crevasses 11 (top), 12 (middle), and 15 (bottom).

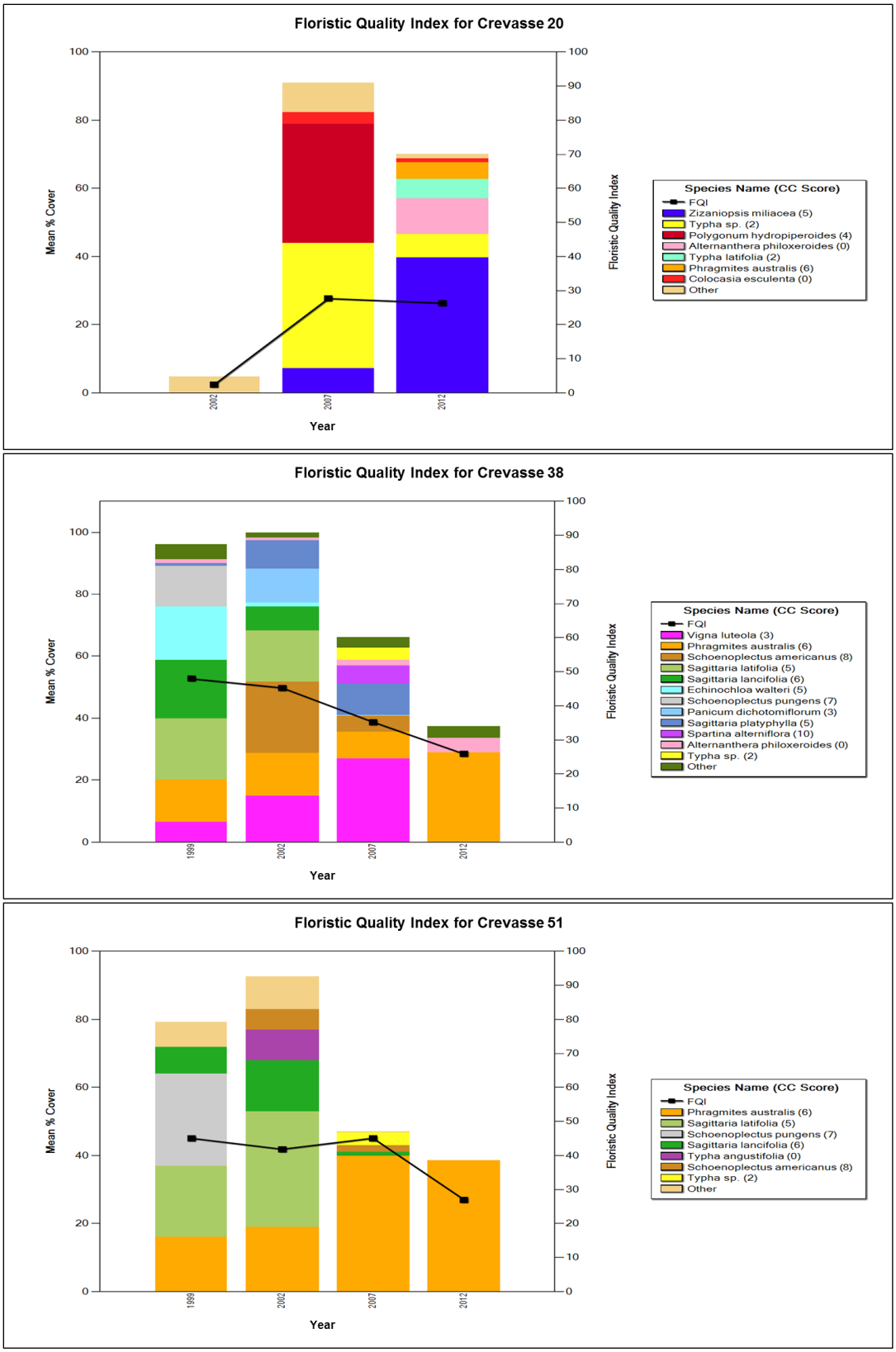

Figure 10. Percent cover and FQI for Crevasses 20 (top), 38 (middle), and 51 (bottom).

in an active delta plain, as estimated by the CRMS Vegetation Analytical Team (Cretini et al. 2011). The lower FQI scores throughout the project area are attributable to the higher abundance of fresh/intermediate species, which are often associated with disturbance and therefore have lower CC scores.

One factor that must be considered is the effect of Hurricane Isaac on the 2012 vegetation data. Hurricane Isaac passed over the MR-09 project area on August 28, 2012. There is little doubt that the hurricane had negative effects on the vegetation, both through the physical effects of wind and storm surge and the effects of salt water on the mostly fresh marsh vegetation in the area. Additionally, due to the passage of the storm, the vegetation survey was delayed until October while previous surveys were conducted in August. It is reasonable to conclude that the decrease in percent cover observed in 2012 was at least partially associated with Hurricane Isaac.

Elevation

Elevation surveys were conducted in 2000 (as-built), 2003, 2008 and 2012 (post-construction) on 12 crevasses in the MR-09 project area. Analysis of the elevation data in the receiving areas shows a trend in elevation gain across all crevasses except Crevasse 51 (Table 2, Figures 11 and 12) since construction of the project. When analyzed across all 12 crevasses, there has been a mean gain in elevation of 1.14 ft in the project area from construction to 2012 (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 mean elevation gains from 2003 to 2008 and 2008 to 2012 were 0.15 ft. and 0.23 ft. respectively. Elevation gain was impacted by crevasse angle of orientation and width. Mean elevation gain from 2000 to 2012 for crevasses oriented 60° from the parent channel was 1.52 ft, twice the elevation gain of crevasses oriented at 90°, 0.77 ft. Similarly, wide crevasses (>150 ft. across) outgained narrow crevasses (<100 ft. across) 1.40 ft. to 0.96 ft. for the same time period. The greatest elevation gains were observed in wide, 60° crevasses (1.54 ft), while the least gains were observed in the narrow, 90° crevasses (0.28 ft).

The greatest elevation change occurred at Crevasse 20, where 2.51 ft of elevation was gained between 2000 and 2012. Of the 12 crevasses that are monitored for elevation, Crevasse 20 is the only one that was newly constructed during Phase I of the project; the other 11 were existing crevasses that were re-dredged. This may explain the greater elevation gain at Crevasse 20. Since the other crevasses were already in place, sediments had already begun to accumulate in the receiving bays when the project began. Since Crevasse 20 was a new crevasse, it had a greater potential for elevation gain because it had not been receiving the sediment inputs that the other crevasses had been before the project began.

Table 2. Mean elevation (NAVD88 (ft)) and change in elevation (ft) 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	2012 Elevation	2000-2003 Change	2003-2008 Change	2008-2012 Change	Total Change
6	90°	wide	-0.74	0.34	0.42	0.46	1.09	0.07	0.04	1.20
7	60°	narrow	-0.08	0.74	1.16	1.26	0.82	0.42	0.10	1.34
8	60°	narrow	0.07	0.56	0.59	0.74	0.49	0.03	0.15	0.67
9*	90°	narrow	0.38	0.81	0.64	0.82	0.43	-0.17	0.18	0.44
11*	60°	wide	-0.70	0.89	1.25	1.38	1.59	0.36	0.13	2.08
12*	90°	narrow	0.32	0.35	0.63	0.98	0.03	0.28	0.35	0.66
15	90°	wide	-1.17	0.20	0.16	0.54	1.36	-0.04	0.38	1.71
20	60°	narrow	-0.75	0.59	1.01	1.76	1.34	0.42	0.75	2.51
31	60°	wide	-0.30	0.66	0.92	1.21	0.96	0.27	0.29	1.51
36	60°	wide	0.06	0.76	0.71	1.07	0.70	-0.05	0.36	1.01
38	90°	wide	0.60	1.10	1.29	1.46	0.50	0.19	0.17	0.86
51	90°	narrow	-0.46	-0.65	-0.62	-0.72	-0.19	0.03	-0.10	-0.26
Average			**-0.23**	**0.53**	**0.68**	**0.91**	**0.76**	**0.15**	**0.23**	**1.14**

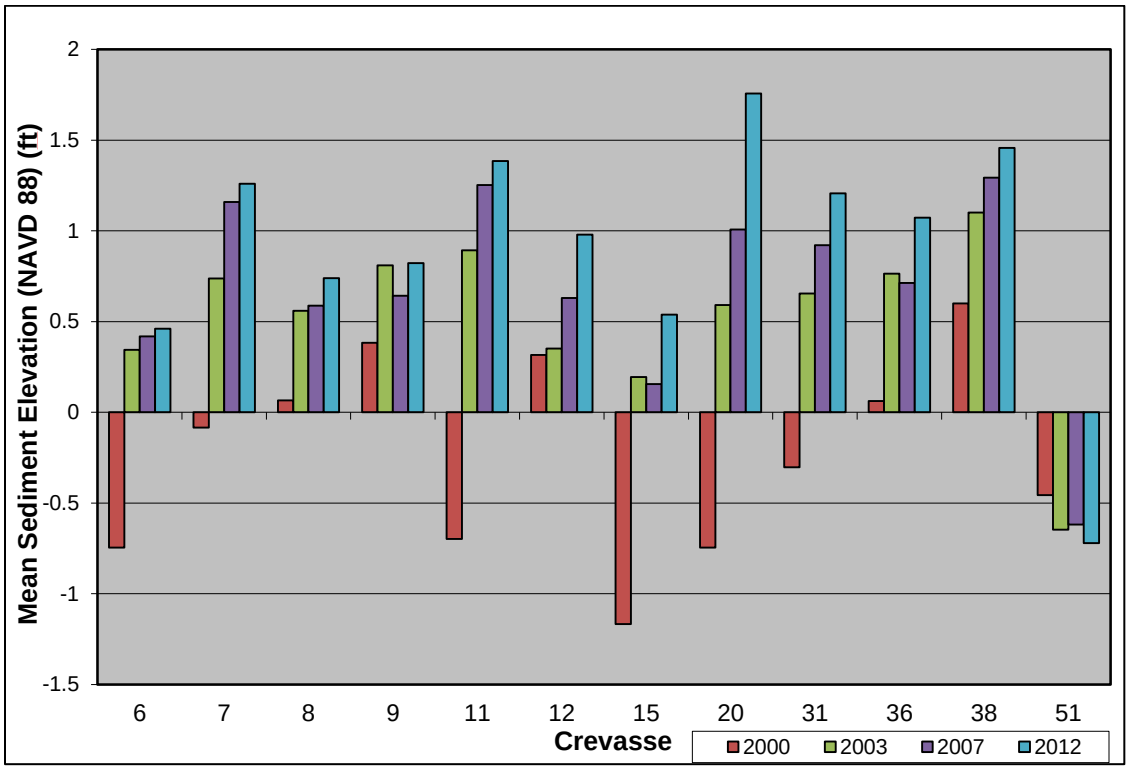

Figure 11. Mean sediment elevation (NAVD 88) in the receiving bays of twelve Phase I crevasses of Delta Wide Crevasses (MR-09) in 2000 (as-built), 2003, 2008, and 2012 (post construction).

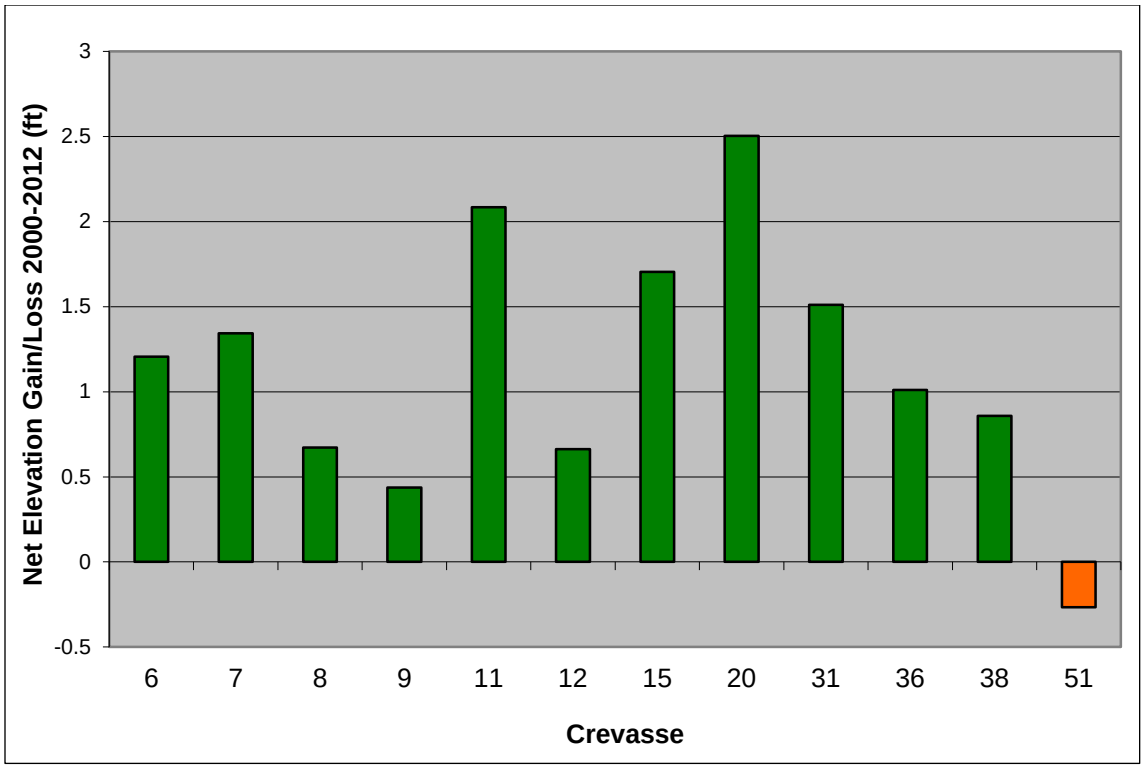

Figure 12. Elevation gain/loss between 2000 and 2012 for each of the twelve crevasses in Phase I of Delta Wide Crevasses (MR-09). Green bars represent an overall increase in mean elevation while orange bars represent an overall decrease in mean elevation.

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

CRMS Supplemental

Land-Water Analysis

CRMS land-water analysis is available from 2005 and 2008 coast-wide aerial photography. Land-water areas are calculated for a 1-km^2 (248 ac.) area at each CRMS site. Table 3 shows a summary of land gain/loss in acres including the relative change and rate (per year) for each of the 4 CRMS sites evaluated. The total land gain recorded for the CRMS sites within the MR-09 project area from 2005 to 2008 is 89 ac. with an average land gain of 22.3 ac. per CRMS station. Rate of land gain ranged from 5.0 to 10.7 ac/yr with the highest rate occurring at CRMS4448 (Figure 13).

Table 3. Land area (ac.) for 4 CRMS sites within the MR-09 project area.

CRMS Site	2005	2008	Change	Relative Gain/loss	Rate (ac/yr)
0156	102	117	15	14.7%	5.0
2627	110	125	15	13.6%	5.0
2634	67	94	27	40.3%	9.0
4448	88	120	32	36.4%	10.7
Totals	367	456	89	24.3%	29.7
Average	91.8	114	22.3	24.3%	7.4

Vegetation

Vegetation data from 3 CRMS sites was evaluated (CRMS4448 was eliminated due to a change in the CRMS methodology for sites dominated by *Phragmites australis*) to compare to MR-09 project specific data. Some of the same trends observed in the MR-09 vegetation data are visible in the CRMS data. CRMS vegetation data for the 3 sites were available for years 2007-2012. During that time frame, 2 sites (CRMS2627, CRMS4448) exhibited a downward trend in total percent cover while the other remained relatively stable (CRMS2634) (Figure 14). Similar trends can be seen when looking only at years 2007 and 2012, the years that coincide with the 2 most recent MR-09 project specific vegetative samplings. FQI values closely followed percent cover and were in the same range as those observed at MR-09 project sites. Also, similar to the MR-09 sites, 2 of the CRMS sites (CRMS2634, CRMS4448) had a shift in species composition between 2007 and 2012 with *Phragmites australis* as the dominant species.

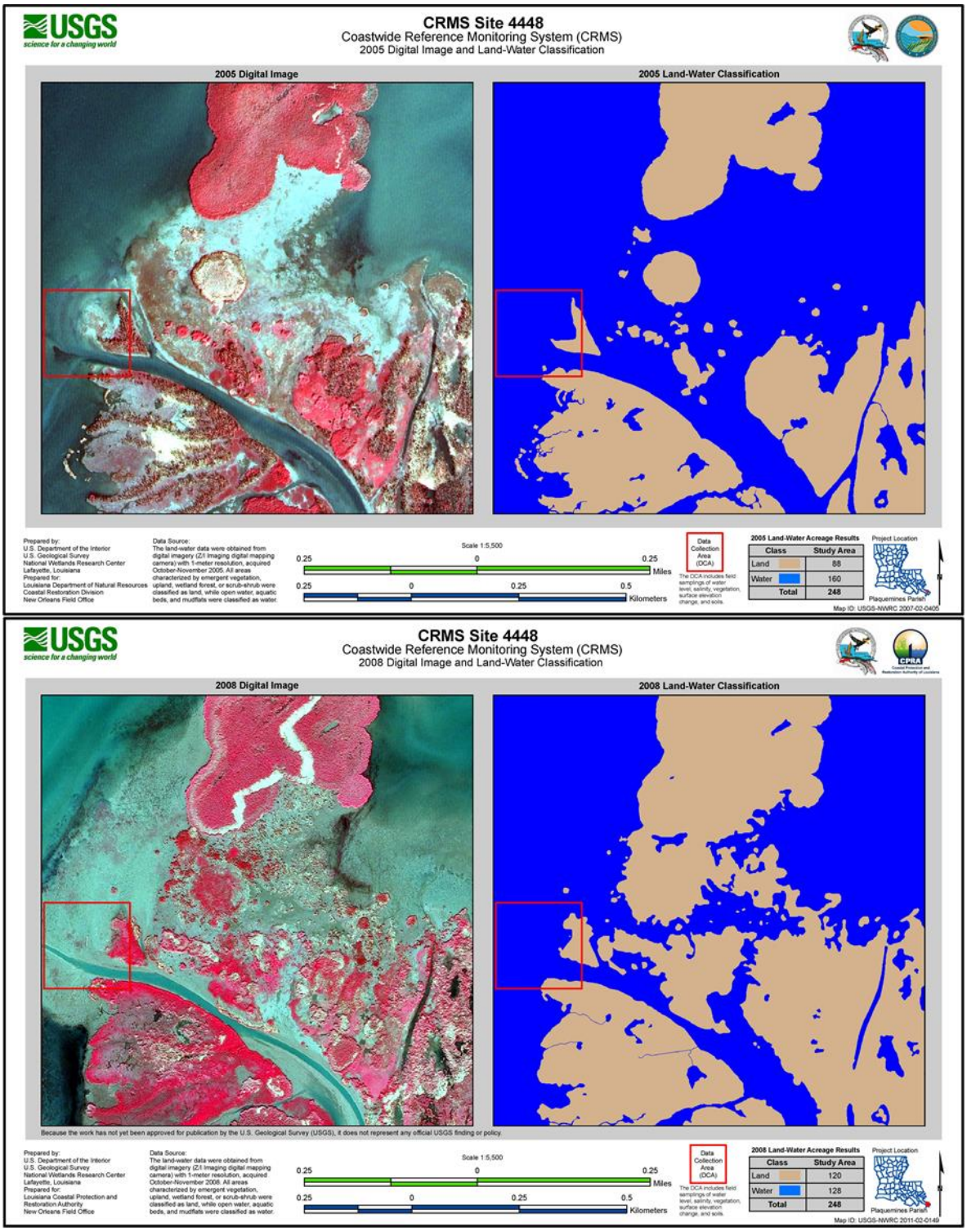

Figure 13. 2005 (top) and 2008 (bottom) land-water analysis for CRMS4448.

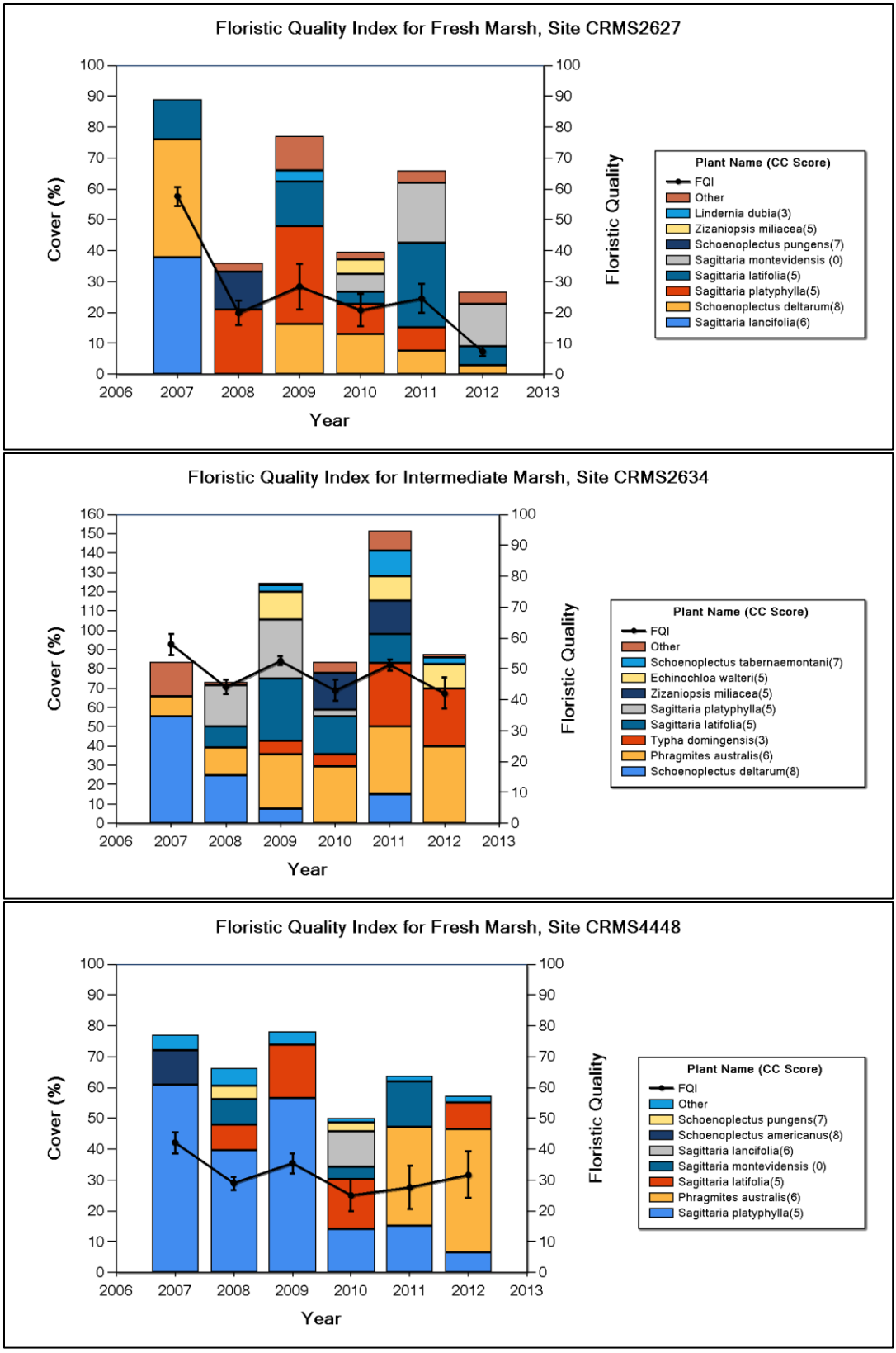

Figure 14. Percent cover and FQI for CRMS2627 (top), CRMS2634 (middle), and CRMS4448 (bottom).

V. Conclusions

a. Project Effectiveness

A combination of land-water analysis, elevation data and vegetation data support the conclusion that the project is functioning as designed.

The project is meeting the monitoring goal of maintaining or increasing land to open water ratios within the receiving bays. Land-water analyses indicate that new land is being created in the crevasse receiving bays. All of the crevasses except one have gained land in the receiving areas from the time of project construction to 2012. 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 2.6 ac/yr across all crevasses.

The project is also meeting the monitoring goal of increasing mean elevation of the receiving bays. All but one of the crevasses surveyed showed increases in elevation within the receiving bays. Individual crevasses had increases of as much as 2.51 ft in elevation (Crevasse 20). The greatest elevation gain was observed at a crevasse that was newly constructed as part of Phase I.

The results are less clear with respect to the monitoring goal of increasing the mean percent cover of emergent fresh and intermediate marsh type vegetation in the receiving bays. For the most part, vegetative percent cover at MR-09 crevasses has decreased in the 2007 and 2012 surveys. However, when compared to vegetation data from the CRMS sites, it appears likely that decreases in percent cover and FQI are part of a larger trend in the area rather than an effect of the project. Although percent cover has decreased in most cases, it should be taken into account that the total vegetated area has increased within the receiving bays, as evidenced by increases in land:water ratios and the addition of new vegetation plots along transects.

A final factor to consider when judging project effectiveness is the effect of hurricanes on the project area in 2005 and 2012. Hurricane Katrina passed just to the west of the project in 2005 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. There is little doubt that Hurricane Isaac affected the 2012 vegetation data, although the effects cannot be directly quantified.

b. Recommended Improvements

Channel cross sections on additional crevasses (other than crevasses that are currently surveyed) would document whether the crevasse channels are remaining open or filling in and 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° 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.

Land-water analysis and elevation data suggest that several crevasses have narrowed or closed completely, rendering them largely ineffective at delivering sediment to the receiving bays. This is not unexpected, as it is understood that crevasse-splay development is a temporary event that is rarely active for more than 10 to 15 years. However, it does present a challenge to managers with respect to strategy; i.e. whether to use available funding to create new crevasses or to attempt to extend the effective lifespans of existing crevasses through maintenance. Both approaches are valid and management decisions must be made according to project goals.

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Appendix A
(Inspection Photographs)

Crevasse No. 12 (View 1) Looking into crevasse from South East Pass.

Crevasse No. 12 (View 2) Looking west. Spoil area in center of view.

Crevasse No. 11. (View 1) Looking back to Pass a Loutre. Crevasse has maintained its constructed width throughout.

Crevasse No. 11. (View 2) Vegetated crevasse dredging spoil in bay area, foreground.

Crevasse No. NC-1. (View 1) Looking into Receiving Bay.

Crevasse No. NC-1. (View 2) Vegetated spoil deposition in inside bay area.

Crevasse No. 9. (View 1) From Pass-A-Loutre looking south into the crevasse.

Crevasse No. 9. (View 2) Crevasse end looking at spoil area vegetation sediment deposits from the recent high river.

Crevasse No. NC-3. (View 1) Looking into crevasse from South Pass showing heavy vegetation on both banks.

Crevasse No. NC-3. (View 2) Crevasse terminus looking east into open pond area. Notice shallow depth of water in center.

Crevasse No. 81. (2011 Stock Photo). This crevasse location was not visited by the crew.

Appendix B
(Three Year Budget Projection)

:revasses (MR-09)

:or: NMFS

Completed : 1999, 2005

Year 0 FY00	Year - 1 FY01	Year -2 FY02	Year -3 FY03	Year -4 FY04	Year -5 FY05	Year -6 FY06	Year -7 FY07	Year -8 FY08	Year -9 FY09	Year -10 FY10	Year -11 FY11	***Year -12 FY12***	***Year -13 FY13***	***Year -14 FY14***	Year -15 FY15	Year -16 FY16	Year - 17 FY17	Year -18 FY18	Year -19 FY19	OCPR Project Estimate Project Life Budget	CWPPRA Allocated Money Currently Funded (Sum YR 0 to YR 19)
$0	$5,530	$0	$5,821	$1,038,284	$6,128	$0	$6,451	$0	$1,217,164	$0	$7,148	$0	$7,525	$1,376,120	$7,921	$0	$8,338	$0	$8,777	$3,695,207	$3,695,207
																				$0	$0
																				$0	$0
																				$3,695,207	$3,695,207

M Expenditures																				Remaining Project Life	***Current 3 year Request (FY12, 13,***
Inspection												$7,525	$7,721	$7,921	$8,127	$8,339	$8,555	$8,778	$9,006	$65,973	$23,167
:enance													$0							$0	$0
ration													$0							$0	$0
													$10,258							$10,258	$10,258
													$15,387							$15,387	$15,387
													$76,935							$76,935	$76,935
													$126,000				$133,506			$259,506	$126,000
													$1,700,000							$1,700,000	$1,700,000
Oversight													$120,000							$120,000	$120,000
				$840,551	$0	$0	$0	$0	$0	$0	$0	$7,525	$2,056,301	$7,921	$8,127	$8,339	$142,061	$8,778	$9,006	$2,713,418	$2,071,747

penditures from COE Report (Ince	$1,014,506.26	Lana 2012	**Current O&M Budget less COE Admin**	$3,695,207	Current Project Life Budget less COE Admin
penditures not submitted for in-k	$0		*(State O&M Currently Funded + Fed S&A Currently Funded)*		*(State O&M Prorject Life Budget + Fed S&A Project Life Budge*
or MIPRs (if applicable) (REQUEST	$0		**Remaining Available O&M Budget**	$2,680,701	Total Projected Project Life Budget

$3,695,207
$3,727,924

Appendix C
(Field Inspection Notes)

FIELD INSPECTION CHECK SHEET

Project No. / Name:	Delta Wide Crevasses MR-09	Date of Inspection:	August 24, 2012 Time: 9:30 AM
Crevasse No.	**See Report Section III**	Inspector(s):	CPRA: Kyle Breaux, Bryan Gossman; LDWF: Trebor Victorino
Crev. / Terr. Specs.	See Report Section III	Water Level:	1.71 feet NAVD 88 at Venice, La. Time: 8:00 AM
Type of Inspection:	2012 Annual Inspection	Weather Conditions:	Cloudy, Breezy, Wind SSE @ 7-10 knots

Item	Condition	Physical Damage	Dimensions	Photo	Observations and Remarks
Crevasse # NC-1	Good	None	1,000 ft X 100 ft by -8.0' NAVD 88	Appendix B	This new crevasse (2005) appears to be in good condition. Soundings read 4' at the inlet and 4' at the terminus. The spoil from the dredging of the crevasse is heavily vegetated throughout the deposited bay area (roseau cane patches)
Crevasse # NC-3	Excellent	None	1,400 ft X 100 ft by -8.0' NAVD 88	Appendix B	This new crevasse (2005) off of South Pass is functioning very well, seems to be flowing swiftly. This crevasse maintains a -10'+ at inlet and 8.5' at the terminus. The interior bay is heavily silted and full of roseau cane.
Crevasse # 9	Very Good	None	2,200 ft X 75 ft by -8.0' NAVD 88	Appendix B	Good flow is being maintained by this dog-leg shaped crevasse. 6' at inlet, sloping to 8'. The water depth hovered between 5'-6' throughout the channel. Vegetation includes cut grass and roseau cane
Crevasse # 11	Very Good	None	2,600 ft X 100 ft by -8.0' NAVD 88	Appendix B	<4 ft at the inlet, which drops to 8 ft and rises to 5-6 ft about 100 yards in.. The crevasses was 3' at the terminus. The channel is forming on the left side with SAV present on the right side. Wild rice gtrowing throughout receiving bay.
Crevasse # 12	Very Good	None	2,000 ft X 75 ft by -8.0' NAVD 88	Appendix B	Currents are moderate to swift through this crevasse, despite it being located off of the main channel. Soundings read 8' at the inlet, 5'-6' halfway through, and <4' at the terminus. Right side of the crevasse is beginning to silt in..
Crevasse # 81	Poor	None	1,200 ft X 100 ft by -8.0' NAVD 88	Appendix B	This crevasse is located on the south bank of Baptiste Collette just off of the Miss. River. Due to its location, it is receiving strong current and heavy sediment loads. The dredge spoil has vegetated very nicely; however, it's location causes it to shoal at the inlet (3'-4' depth) during the first high river and renders it inefficient for the long term.

Appendix D
(Monitoring Budget)

Delta-Wide Crevasses (MR-09) - NMFS - Priority List 6

Infl. Rate	2.60%		**Monitoring Budget**	$ 288,052		KEEP L:W; KEEP 6 VEG SITES AND 6 ELEV SITES																		
Price Level	1998																							
	Round Trip Mileage	400																						
		Expended																						
	Rates	**Dollars**	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Daily Rate Items																								
Base Field Equipment	160.90			8			8					6					6					6		
14' Pirogue	11.37			8			8					6					6					6		
20' Aluminum	275.00			8	-	-	8	-	-	-	-	6	-	-	-	-	6	-	-	-	-	6	-	-
Three Man Crew	592.59			8			8					6					6					6		
3 Man Lodging	165.00			6			6					6					6					6		
3 Man Per Diem	78.00			8	-	-	8	-	-	-	-	6		-	-	-	6	-	-	-		6	-	-
Vehicle	0.29			400	-	-	400	-	-	-	-	400	-	-	-	-	6	-	-	-	-	6	-	-
Annual Rate Items																								
Misc. Supplies	800.00			1			1					1					1					1		
Computer Database	2,273.88			1		-	1			-	-	1				-	1					1		
Monitoring Progress Report	2,157.43				1																			
Comprehensive Monitoring Report	4,814.73							1					1					1						1	
TAG Meetings	1,468.74							1					1					1						1	
Quality Assurance	500.00			1	1		1	1				1	1				1	1				1	1	
***Aerial Photography**	20,380.48			1			1					1					1					1		
Monitoring Plan Dev.	12,833.00			1																				

		Expended																						
	Rates	**Dollars**	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Daily Rate Items																								
Base Field Equipment	160.90			1,320.66			1,426.37					1,216.27					1,382.82					1,572.18		
14' Pirogue	11.37			93.32			100.79					85.94					97.71					111.09		
20' Aluminum	275.00			2,257.20			2,437.88					2,078.79					2,363.45					2,687.10		
Three Man Crew	592.59			4,864.00			5,253.34					4,479.54					5,092.96					5,790.38		
3 Man Lodging	165.00			1,015.74			1,097.05					1,247.27					1,418.07					1,612.26		
3 Man Per Diem	78.00			640.22			691.47					589.62					670.36					762.16		
Vehicle	0.29			116.96																				
	-																							
Annual Rate Items	-																							
Misc. Supplies	800.00			820.80			886.50					1,007.90					1,145.92					1,302.84		
Computer Database	2,273.88			2,333.00			2,519.74					2,864.79					3,257.09					3,703.11		
Monitoring Progress Report	2,157.43				2,271.07																			
Comprehensive Monitoring Report	4,814.73							5,474.05					6,223.66					7,075.91					8,044.87	
TAG Meetings	1,468.74							1,669.87					1,898.54					2,158.52					2,454.10	
Quality Assurance	500.00			513.00	526.34		554.06	568.47				629.94	646.31				716.20	734.82				814.27	835.44	
***Aerial Photography**	20,380.48			20,910.37			22,584.16					25,676.79					29,192.91					33,190.54		
Monitoring Plan Dev.	12,833.00			13,166.66																				
DNR Expenditures To Date																								
***Other Federal Expenditures**																								
Total		0.00	0.00	48,168.89	2,797.41	0.00	37,677.68	7,712.39	0.00	0.00	0.00	40,020.47	8,768.51	0.00	0.00	0.00	45,339.95	9,969.25	0.00	0.00	0.00	51,548.72	11,334.42	0.00
Projected - Running Total			0.00	48,168.89	50,966.31	50,966.31	88,643.99	96,356.38	96,356.38	96,356.38	96,356.38	136,376.85	145,145.36	145,145.36	145,145.36	145,145.36	190,485.31	200,454.56	200,454.56	200,454.56	200,454.56	252,003.28	263,337.69	287,868.86