State of Louisiana
Coastal Protection and Restoration Authority

2018 Operations, Maintenance, and Monitoring Report

for

Delta Wide Crevasses (MR-09)

State Project Number MR-09
Priority Project List 6

June 2019
Plaquemines Parish

Prepared by:

Bryan Gossman and
Jacinta Gisclair
CPRA Operations Division
New Orleans Regional Office

Suggested Citation:

Gossman, B., and J. Gisclair 2018. *2018 Operations, Maintenance, and Monitoring Report for Delta Wide Crevasses (MR-09),* Coastal Protection and Restoration Authority of Louisiana. New Orleans, Louisiana. 46pp.

2018 Operations, Maintenance, and Monitoring Report
for
Delta Wide Crevasses (MR-09)

Table of Contents

Preface

The Delta Wide Crevasses (MR-09) project is funded through the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) with the National Marine Fisheries Service (NMFS) as the federal sponsor and the Coastal Protection and Restoration Authority of Louisiana (CPRA) as the state sponsor. This project was included on the 6th Priority Project List (PPL 6). This report includes monitoring data collected through April 2018, and Annual Maintenance Inspections through October 2018. The 2018 Operations, Maintenance, & Monitoring (OM&M) Report is the fifth in a series of reports and includes monitoring data and analyses presented previously in the 2003, 2004, 2009, and 2013 OM&M reports, plus additional project-specific and CRMS data collected since the previous report. These reports, along with other documents and data pertaining to MR-09 can be accessed through CPRA's Coastal Information Management System (CIMS) website at http://cims.coastal.louisiana.gov/

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 included in the LDNR

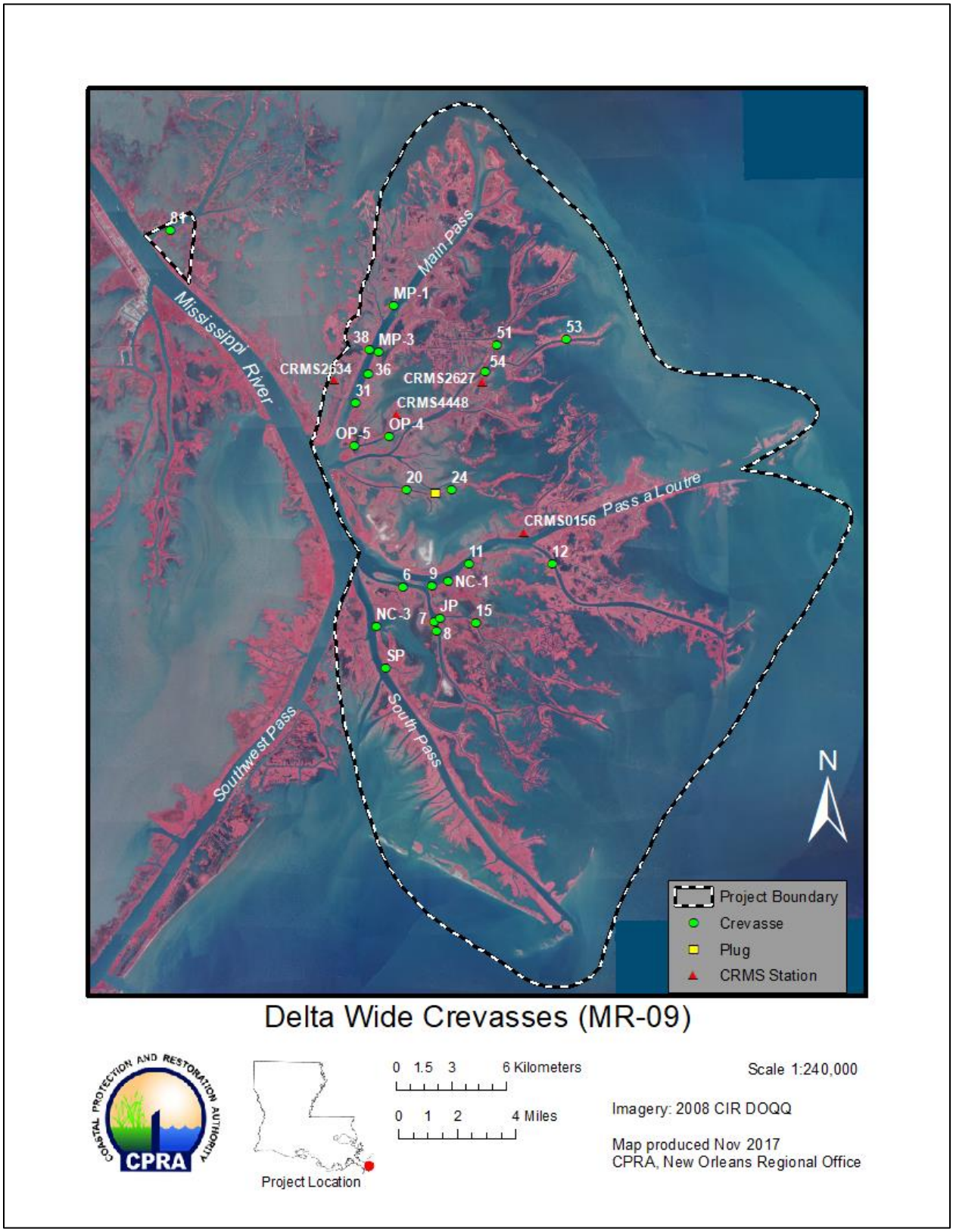

Figure 1. Delta Wide Crevasses (MR-09) project boundary and features.

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 Channel Armor Gap Crevasse (CWPPRA project MR-06), constructed in 1997, produced a total of 360 ac during the 20-yr project life; a rate of 18 ac/yr (Gossman 2018).

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 *Schoenoplectus deltarum* (delta bulrush) that develop downstream from the forested islands at intermediate elevations (between 4 inches [10 cm] and sea level), and (3) communities of *Colocasia esculenta* (coco yam) 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 was completed in Spring 2014 and included the following features:

- Creating 4 new crevasses in Main Pass and Octave Pass on DNWR
- Maintenance dredging of 1 Phase I crevasse and 2 other existing crevasses in PALWMA

Phase IV is planned for Fall 2019. The Phase IV features are under development by the project team.

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 (LDNR 2007). The annual inspection report also contains a summary of maintenance projects and a three (3) year projected budget for operation, maintenance, and rehabilitation. The projected operation and maintenance budget is shown in Appendix B.

This annual inspection of the Delta Wide Crevasse Project was held on October 29, 2018. Weather conditions were fair with winds varying from SW to NNW at 6 – 9 mph. At 0900 hours the Mississippi River Stage at Pilottown was +1.22 ft. The inspection team met at the Venice Marina and proceeded to the project area by Louisiana Department of Wildlife and Fisheries (LDWF) and U.S. Fish & Wildlife Services (USFWS) vessels. In attendance were Jacinta Gisclair, CPRA; Bryan Gossman, CPRA, Todd Baker, LDWF; Trebor Victorino, LDWF; Cornelius Williams, LDWF; Barret Fortier, USFWS; and Dawn Davis, NMFS.

b. Inspection Results

i. Crevasse MP-1 (dredged): (1,000 ft. X 100 ft. X -10.0 ft. NAVD 88 as constructed) This crevasse is located on Main Pass at N29 deg 15 min 40.9 sec; W089 deg 13 min 52.5 sec. The spoil areas on each bank were well vegetated. The channel, based on spot-checked sounding of 4’ appeared to retain some of its originally dredged depth and was adequate to continue carrying sediment to the receiving area.

ii. Crevasse MP-3 (dredged): (1,000 ft. X 100 ft. X -10.0 ft. NAVD 88 as constructed) This crevasse is located on Main Pass at N29 deg 14 min 29.8 sec;

W089 deg 14 min 19.6 sec. The spoil areas on each bank were well vegetated. The channel, based on spot-checked soundings of 6' to 7' near the mouth and 4' thereafter, appeared to retain most of its originally dredged depth and was adequate to carry sediment to the receiving area.

iii. Crevasse OP-4 (dredged): (400 ft. X 100 ft. X -8.0 ft. NAVD 88 as constructed) This crevasse is located on Octave Pass at N29 deg 12 min 18.7 sec; W089 deg 14 min 0.3 sec. The spoil areas on each bank were well vegetated. The channel, based on spot-checked soundings of 4', appeared to retain some of its originally dredged depth and was adequate to continue carrying sediment to the receiving area.

iv. Crevasse OP-5 (dredged): (840 ft. X 100 ft. X -8.0 ft. NAVD 88 as constructed) This crevasse is located on Octave Pass at N29 deg 12 min 4.4 sec; W089 deg 15 min 2.5 sec. The spoil areas on each bank were well vegetated. The channel, although not sounded, appeared to retain most of its originally dredged depth and was adequate to carry sediment to the receiving area.

v. Johnson Pass Crevasse (Maintenance Dredged): (1,200 ft. X 75 ft. X -8.0 ft. NAVD 88 as constructed) This existing crevasse is located on Johnson Pass at N29 deg 7 min 36.3 sec; W089 deg 12 min 30.1 sec. The spoil areas on each bank were well vegetated. The channel, based on spot-checked soundings of 8', appeared to retain most of its originally dredged depth and was adequate to carry sediment to the receiving area.

vi. Sawdust Bend Crevasse (i.e. Crevasse 6; Maintenance Dredged): (1,550 ft. X 75 ft. X -8.0 ft. NAVD 88 as constructed) This existing crevasse is located on Sawdust Bend at N29 deg 8 min 17.8 sec; W089 deg 13 min 33.3 sec. The spoil areas on each bank were well vegetated. The channel, based on spot-checked soundings of 5' near the mouth and 6' to 7' thereafter, appeared to retain most of its originally dredged depth and was adequate to carry sediment to the receiving area.

vii. South Pass Crevasse (Maintenance Dredged): (1,000 ft. X 100 ft. X -8.0 ft. NAVD 88 as constructed) This existing crevasse is located on South Pass at N29 deg 6 min 20.2 sec; W089 deg 14 min 5.9 sec. The spoil areas on each bank were well vegetated. The channel, based on spot-checked soundings of 5' to 7' near the mouth and 6' to 7' thereafter, appeared to retain most of its originally dredged depth and was adequate to carry sediment to the receiving area.

c. Maintenance Recommendations

i. Immediate/Emergency Repairs

As a result of the inspection, the team concluded that all project features are functioning and should continue to do so without any immediate maintenance.

ii. Programmatic/Routine Repairs

none

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 land-water analysis, vegetation, and elevation. Aerial photography for land-water analysis 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, 2012, and 2016 (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 2007 photography was acquired specifically for the MR-09 project at 1:24,000 scale with ground controls. The 2012 and 2016 photography was obtained using Coast-wide Reference Monitoring System-*Wetlands* (CRMS) aerial photography (Folse et al. 2017). The CRMS program utilizes digital imagery (Z/I imaging digital mapping camera) with 1-meter resolution.

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 whenever possible. Additional transects and sample stations were established over time as new land was created, with a maximum of 5 stations per transect and 15 stations per crevasse. Once stations were established, they were sampled in each subsequent survey, whether vegetation was present in the station or not. Vegetation surveys were conducted in the late summer (mid-July to August) in 1999 (as-built) and in post-construction years 2002, 2007, 2012, and 2017. These were 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, 2012, and 2017.

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. 2017). 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) (Figure 1) were selected for supplemental data. Land-water data from these 4 CRMS sites were used to assess project goals.

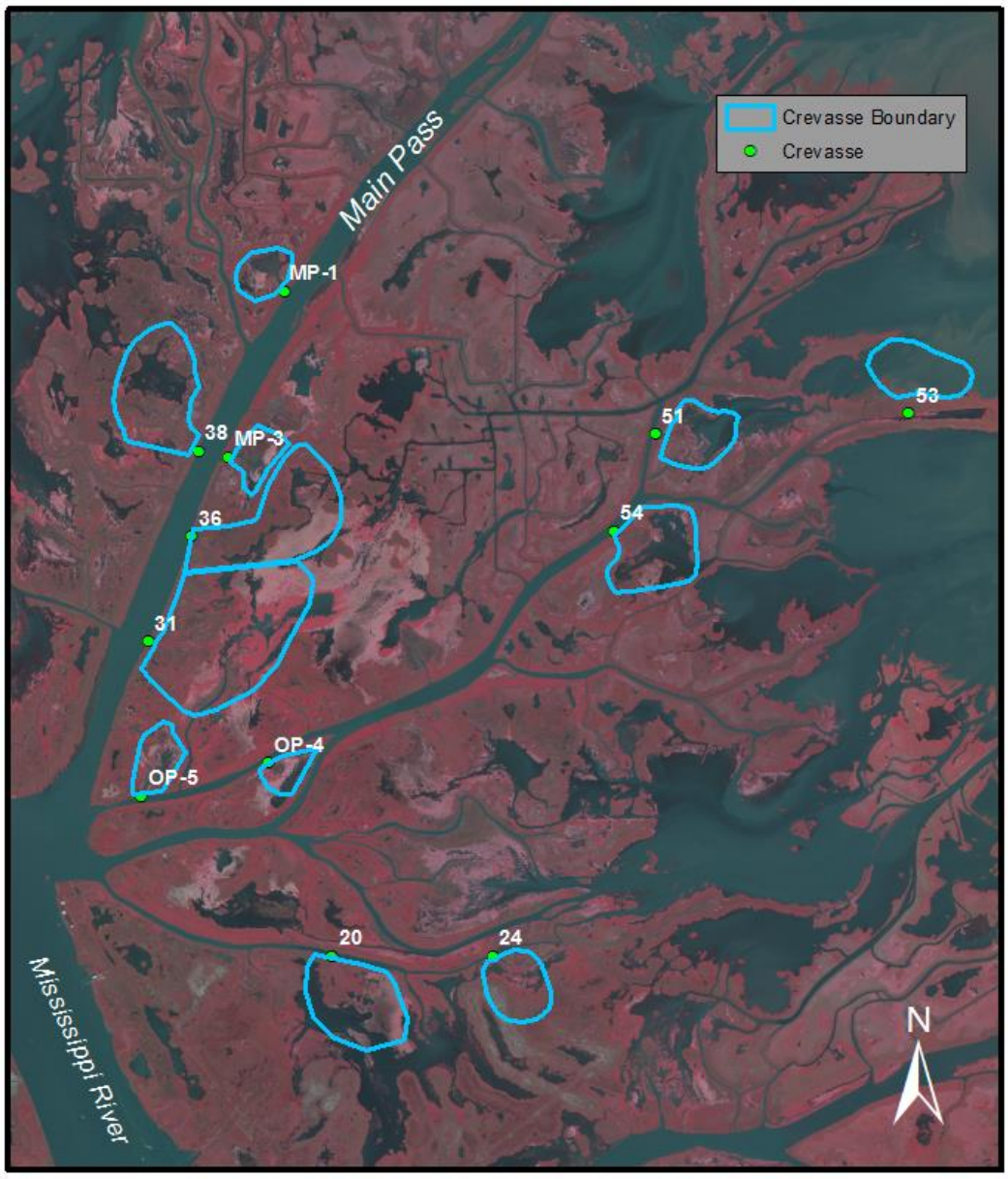

Figure 2. Crevasses and their associated receiving bays in the northern portion of the MR-09 project area

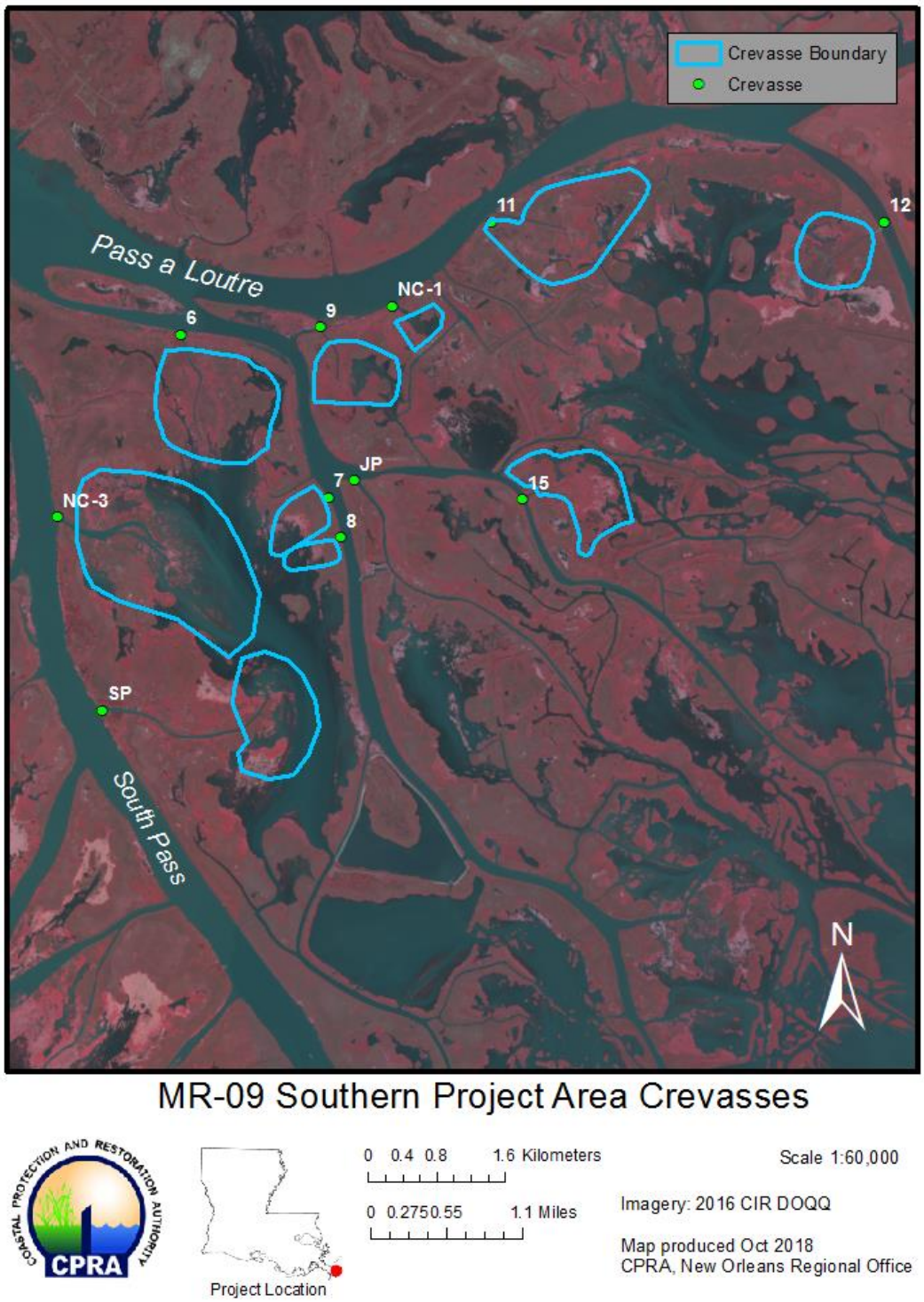

Figure 3. Crevasses and their associated receiving bays in the southern portion of the MR-09 project area

Disturbances to Monitoring Areas

The monitoring of the MR-09 crevasses is based upon the designation of a receiving bay, within which the various monitoring elements are measured. In order to accurately monitor the effects of a crevasse, it is important that, to the greatest extent possible, the crevasse being monitored is the only man-made alteration that affects that receiving bay during the monitoring period. Otherwise it will be difficult or impossible to determine whether changes within the receiving bay are due to the effects of the crevasse, or from other factors.

In the period following the 2013 OM&M Report, there have been man-made alterations of the receiving bays at multiple MR-09 crevasses. While these alterations are generally beneficial to the landscape (e.g. through the creation of land via the placement of dredge spoil), they complicate the monitoring effort for MR-09.

- A crevasse not associated with the MR-09 project was constructed immediately to the south of Crevasse 51 in approximately 2013. This new crevasse shares the receiving bay of Crevasse 51, so there are now multiple fresh water and sediment inputs. Additionally, a series of earthen terraces were constructed in the receiving bay. The 2016 land/water analysis, 2017 vegetation data, and 2017 elevation data are affected.
- Dredged material was placed within the receiving bay of Crevasse 24 at some point between 2013 and 2015. The 2016 land/water analysis was affected.
- Dredged material was placed within the receiving bays of Crevasses 6, 7, and 8 in early 2017. The 2017 elevation data are affected.

It was determined on a case-by-case basis whether data should be included or eliminated from analyses. Where data were excluded, results are based on data from the previous monitoring period. Where data were included, results are presented with the caveat that changes within the receiving bay may not be the result of the project.

c. Preliminary Monitoring Results and Discussion

Land/Water Analysis

Color infrared aerial photography obtained in 2000, 2002, 2007, 2012, and 2016 has been analyzed by the USGS to determine the acreages of land and water within each crevasse receiving area. There were a total of 23 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 739 ac. with an average land gain of 32 ac. per crevasse. The largest land gain for a single crevasse occurred at Crevasse 31 (Figures 4 and 5) with a land gain of 164 ac. (+244.8%). The largest relative gain occurred at Crevasse 81 (Figures 6 and 7) with an increase of 330% (33 ac). One crevasse experienced net land loss. Crevasse 53 (Figures 8 and 9) lost 21 ac of land between 2001 and 2016.

Table 1. Land area statistics for 23 crevasses in the MR-09 project area. All values are in acres unless otherwise noted. * indicates maintenance dredging during Phase II, ** indicates maintenance dredging during Phase III. Shaded cell indicates disturbance to analysis area; values not included in calculations.

	Crevasse	2001	2002	2007	2012	2016	Change (ac)	% Change	Gain/Loss Rate (ac/yr)
Phase I Crevasses	6**	116	150	171	163	179	63	54.3%	4.2
	7	24	28	30	26	28	4	16.7%	0.3
	8	5	8	10	7	9	4	80.0%	0.3
	9*	39	45	45	43	50	11	28.2%	0.7
	11*	116	131	157	178	191	75	64.7%	5.0
	12*	21	28	40	43	63	42	200.0%	2.8
	15	19	26	26	29	39	20	105.3%	1.3
	20	19	20	31	47	50	31	163.2%	2.1
	24	3	4	5	6	93	3	100.0%	0.3
	31	67	90	191	206	231	164	244.8%	10.9
	36	125	136	181	202	229	104	83.2%	6.9
	38	102	99	181	175	207	105	102.9%	7.0
	51	21	24	23	29	44	23	109.5%	1.5
	53	33	36	15	15	12	-21	-63.6%	-1.4
	54	41	47	57	63	75	34	82.9%	2.3
	Cumulative	751	872	1163	1232	1407	662		44.2
	Average	50	58	78	82	101	44	91.5%	2.9

	Crevasse	2001	2002	2007	2012	2016	Change (ac)	% Change	Gain/Loss Rate (ac/yr)
Phase II Crevasses	81	10		29	37	43	33	330.0%	2.2
	NC-1		6	11	15	8	2	33.3%	0.1
	NC-3		106	47	68	109	3	2.8%	0.2
	Cumulative	10	112	87	120	160	38		2.6
	Average	10	56	29	40	53	13	122.1%	0.9

	Crevasse	2001	2002	2007	2012	2016	Change (ac)	% Change	Gain/Loss Rate (ac/yr)
Phase III Crevasses	MP-1				20	32	12	60.0%	3.0
	MP-3				14	20	6	42.9%	1.5
	OP-4				4	9	5	125.0%	1.3
	OP-5				21	32	11	52.4%	2.8
	SP				13	18	5	38.5%	1.3
	Cumulative				72	111	39		9.8
	Average				14	22	8	63.7%	2.0

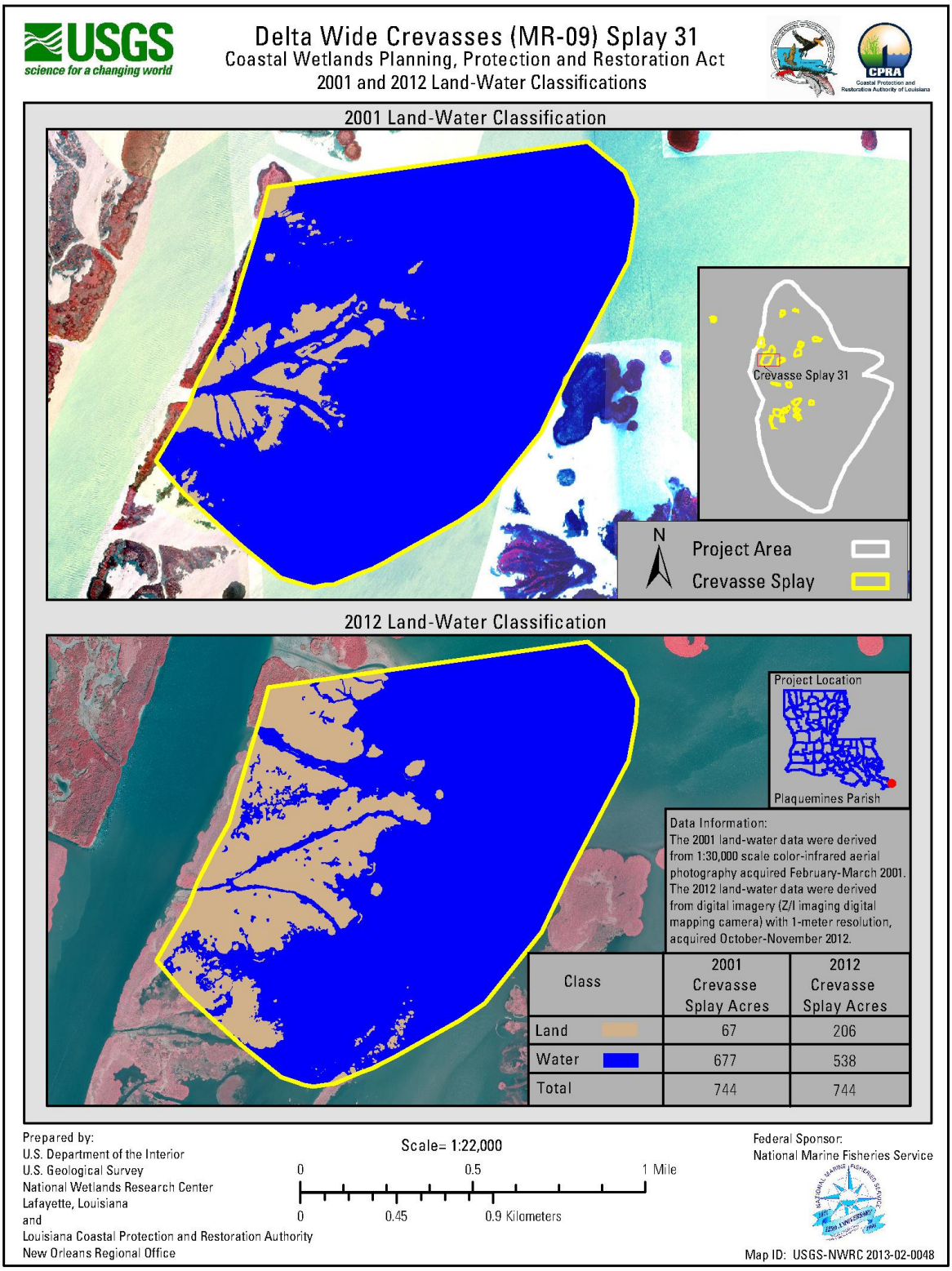

Figure 4. Land-water analysis for Crevasse 31 in 2001 and 2012.

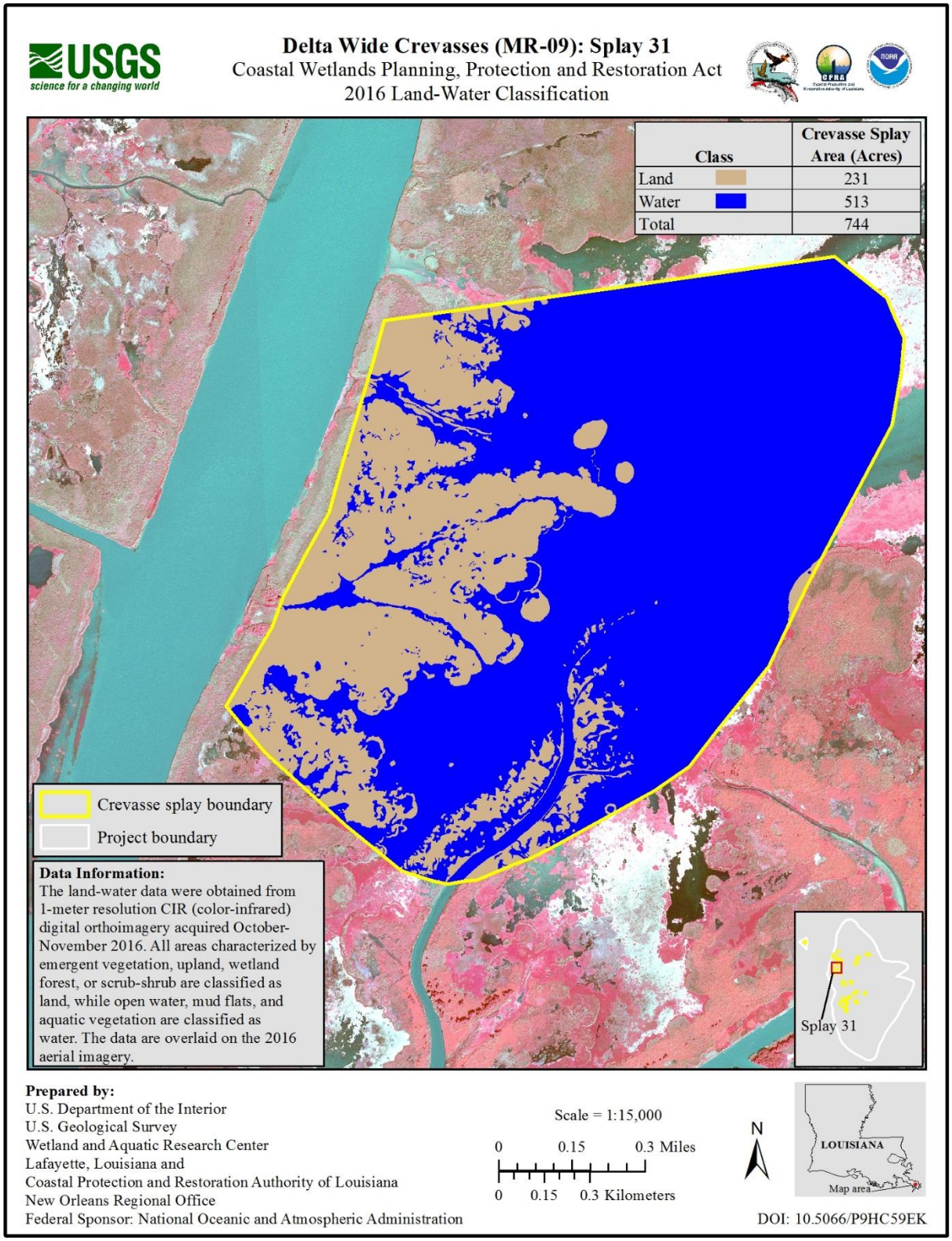

Figure 5. Land-water analysis for Crevasse 31 in 2016.

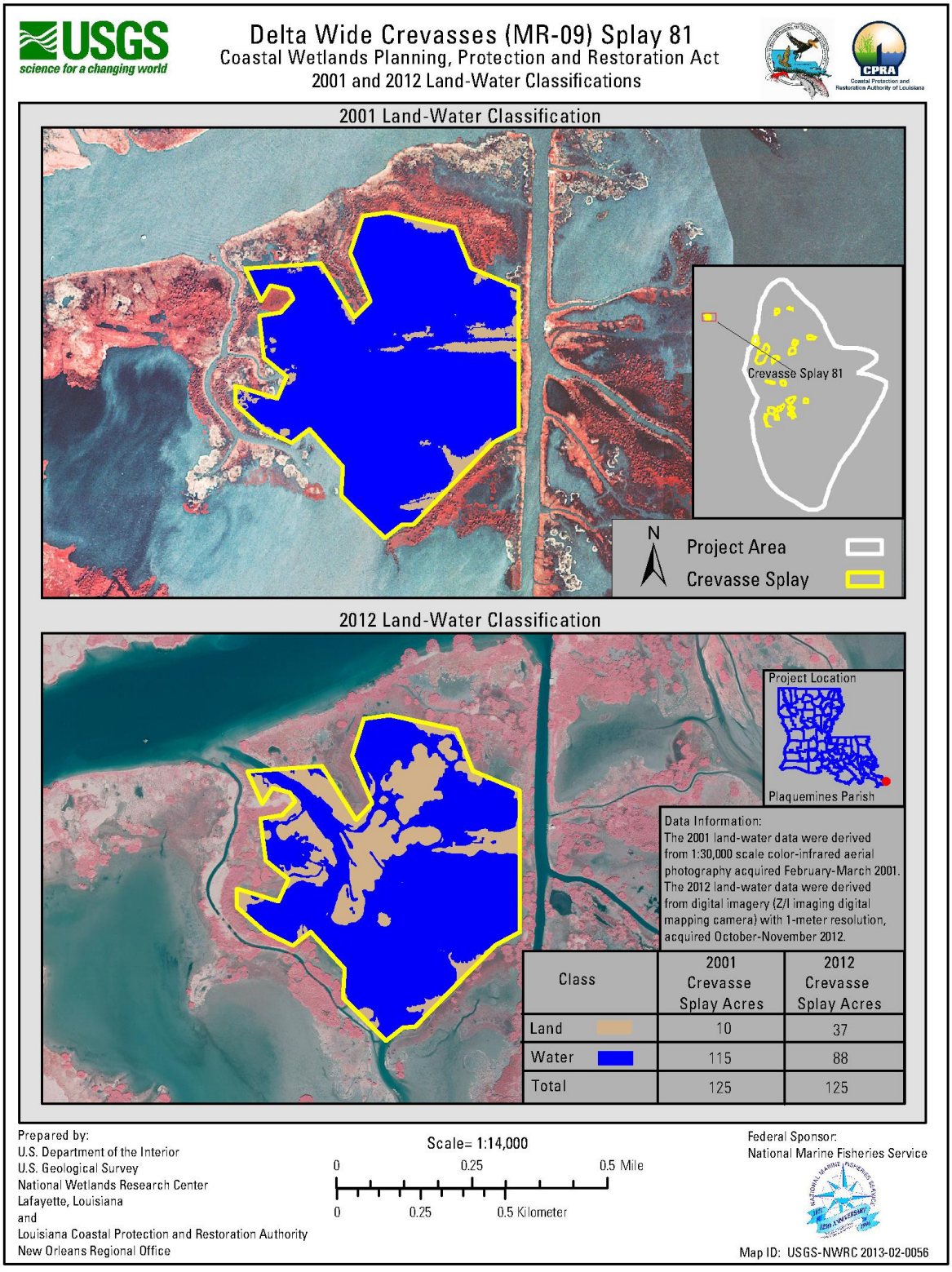

Figure 6. Land-water analysis for Crevasse 81 in 2001 and 2012.

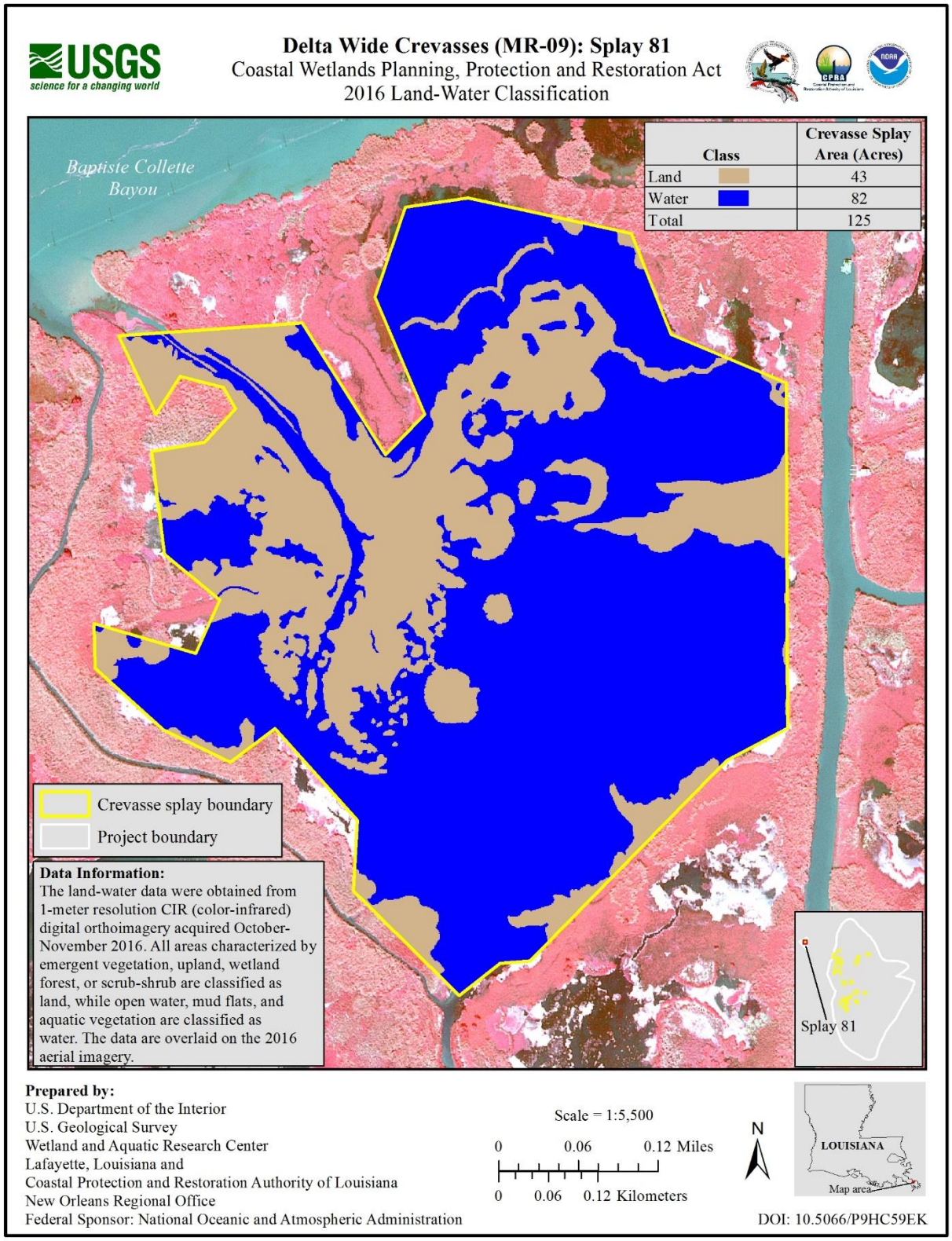

Figure 7. Land-water analysis for Crevasse 81 in 2016.

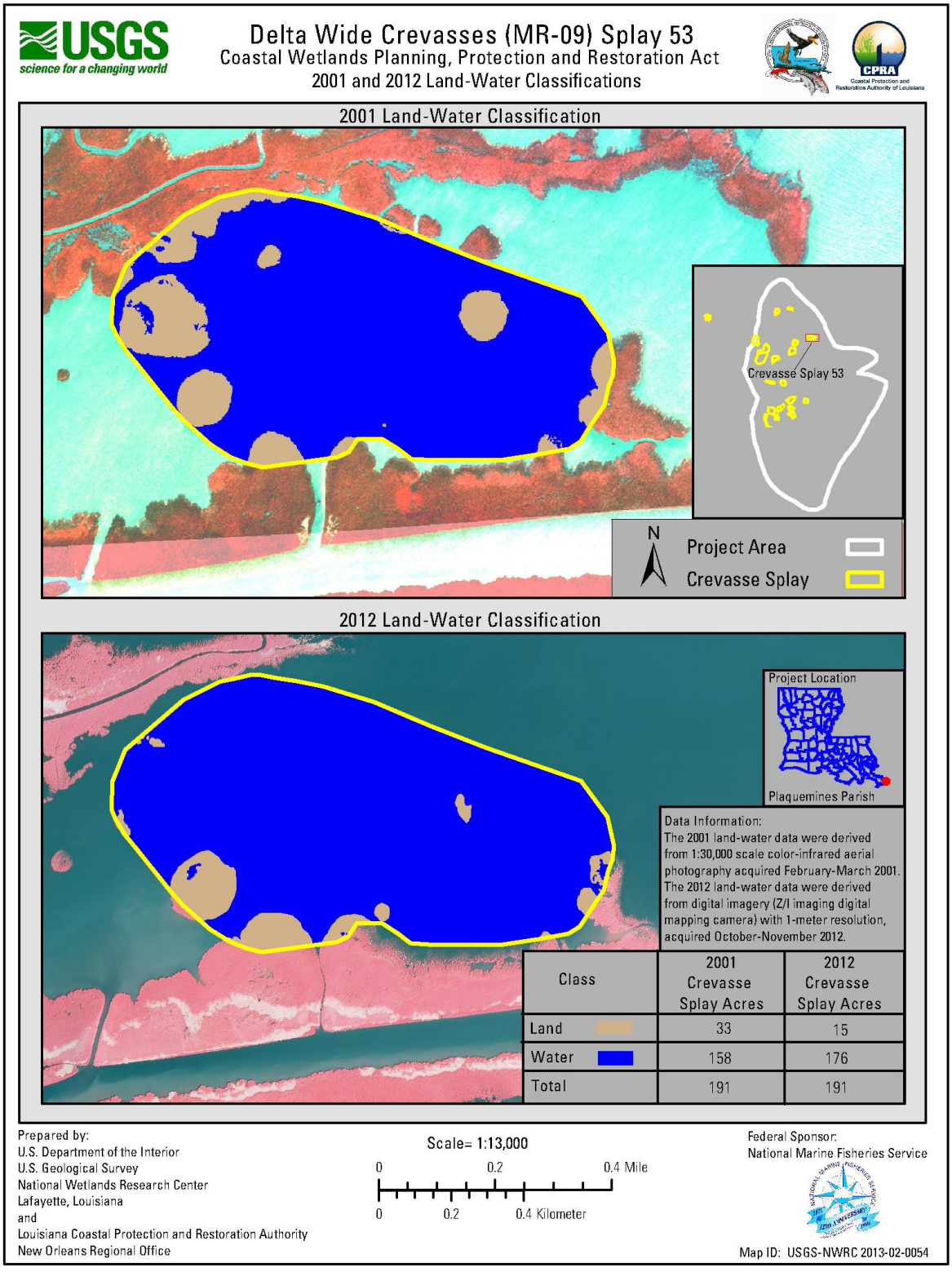

Figure 8. Land-water analysis for Crevasse 53 in 2001 and 2012.

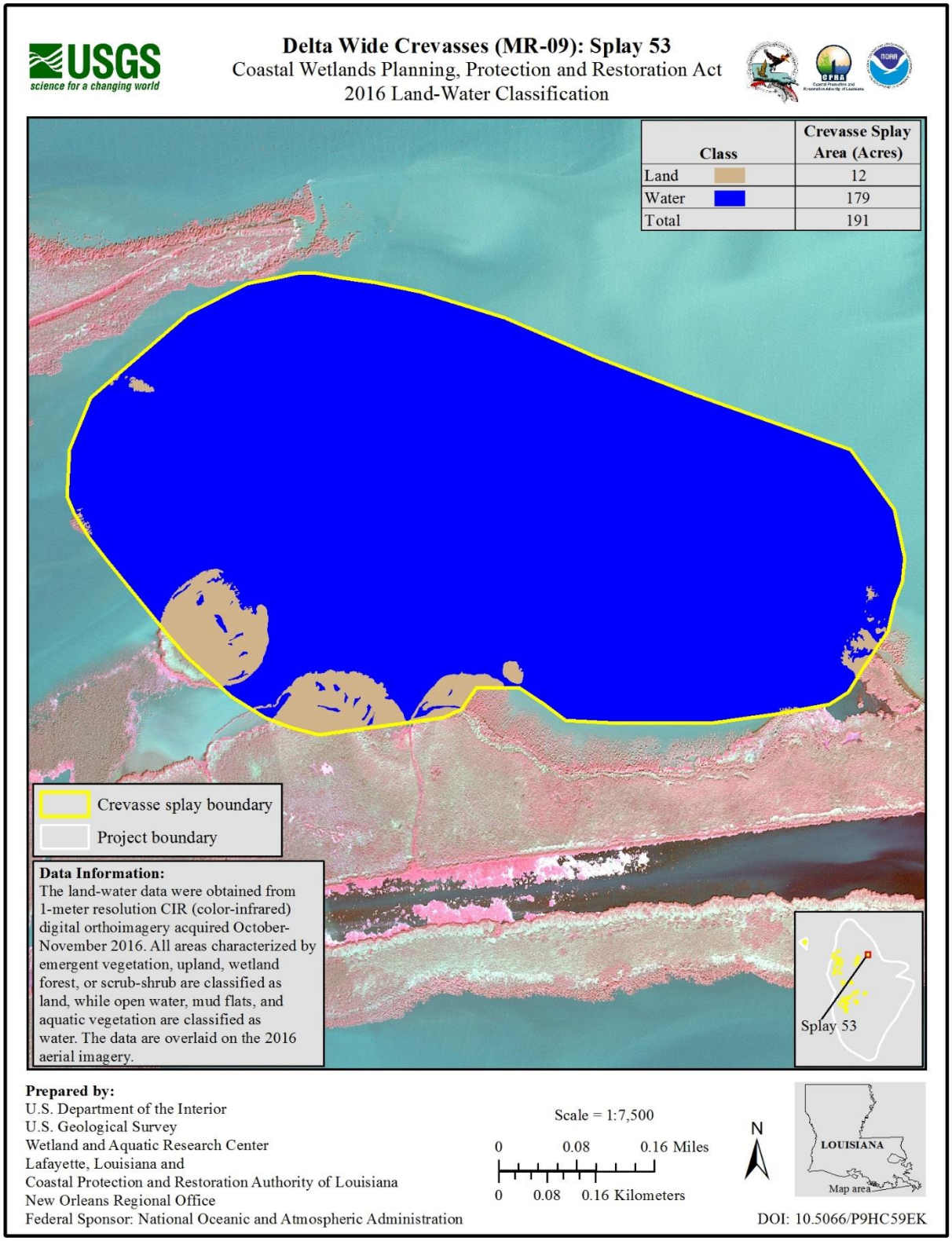

Figure 9. Land-water analysis for Crevasse 53 in 2016.

When examined by project phase, the largest gains were observed among Phase I crevasses, which experienced an average gain of 44 ac. per crevasse (91.5%). This is to be expected as these crevasses have existed longer than those from later project phases. Phase II crevasses experienced an average gain of 13 ac. per crevasse (122.1%). Crevasse NC-3, constructed during Phase II, is one of the better performing crevasses, although it only shows a net gain of 3 ac. from 2002 to 2016. This is due to a 59-ac. land loss between 2002 (pre-construction) and 2007 that can be attributed to the effects of Hurricane Katrina in 2005. In the period from 2007 to 2016, Crevasse NC-3 has gained 62 ac.; the highest among Phase II crevasses. Phase III crevasses experienced an average gain of 8 ac. per crevasse for the period from 2012 (pre-construction) to 2016.

For the 2012 – 2016 time period, 20 crevasses gained land acreage, 2 crevasses (Crevasses 53 and NC-1) lost land acreage, and one (Crevasse 24) was excluded from analysis. It was noted in the 2013 OM&M report (Gossman and Breaux, 2013) that 5 crevasses (Crevasses 6, 7, 8, 9, and 38) had lost land acreage between the 2007 and 2012 analyses. However, during the period from 2012 to 2016, all 5 of those crevasses experienced land gains, offsetting or reversing the earlier losses. Crevasse 6 was maintenance dredged during Phase III, and that may account for the 16-ac. land gain seen there. A closer analysis of the aerial photography for the other crevasses show that most of these crevasses have either narrowed significantly or closed completely. Although these crevasses are no longer delivering much sediment or fresh water to the receiving bays, conditions still exist there that allow for land creation through vegetative expansion of the existing marsh.

Vegetation

Vegetation surveys were conducted in August 1999 (N=46), August 2002 (N=49), August 2007 (N=50), October 2012 (N=65), and August 2017 (N=79) during the post-construction period. Total percent cover was higher in the 2017 survey than in 2012 at 5 of the 6 crevasses that are monitored for vegetation (Figure 10), reversing the generally downward trend in percent cover seen in previous surveys. Fourteen new sample plots were established during the 2017 survey at Crevasses 12 (5 plots), 20 (1 plot), and 51 (8 plots) as new land has formed along the vegetation transects.

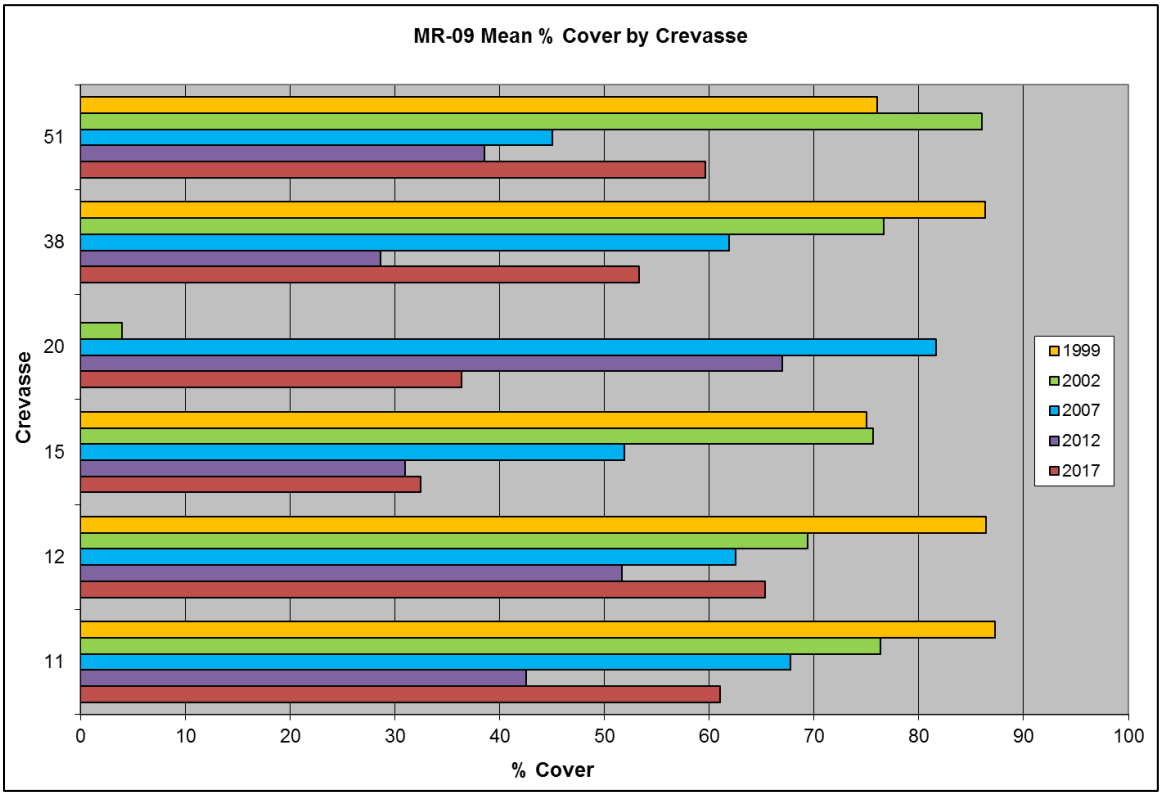

Figure 10. Mean percent cover of all 4-m^2 plots for six selected crevasses within the MR-09 project area Aug. 1999, Aug. 2002, Aug. 2007, Oct. 2012, and Aug. 2017. Vegetation was sampled using the Braun-Blanquet method.

Percent cover data of individual species across all plots in the MR-09 project area indicate a shift in species composition (Figure 11). A general trend can be observed in which, as the crevasse splays age, they come to be dominated by *Phragmites australis* (common reed). Coverage of *Phragmites australis* has increased steadily and dominated the 2007, 2012 and 2017 surveys. Percent cover of other species has increased as well. *Zizaniopsis miliacea* (giant cutgrass), which was present in only a few plots in the 1999 survey, had increased to the point that it had the second greatest coverage of any species in the 2012 survey, although this decreased slightly in the 2017 survey. Percent cover of species such as *Schoenoplectus americanus* (chairmakers bulrush) and *Colocasia esculenta* (coco-yam), which were abundant in the 1999 and 2002 surveys have decreased in the subsequent surveys. *Sagittaria sp*. (including *S. lancifolia, S. latifolia,* and *S. platyphylla*) which was the dominant species of the 1999 survey saw decreases in percent cover in the following 3

surveys. However, this trend was reversed in the 2017 survey, as *Sagittaria sp.* was the second most abundant species observed.

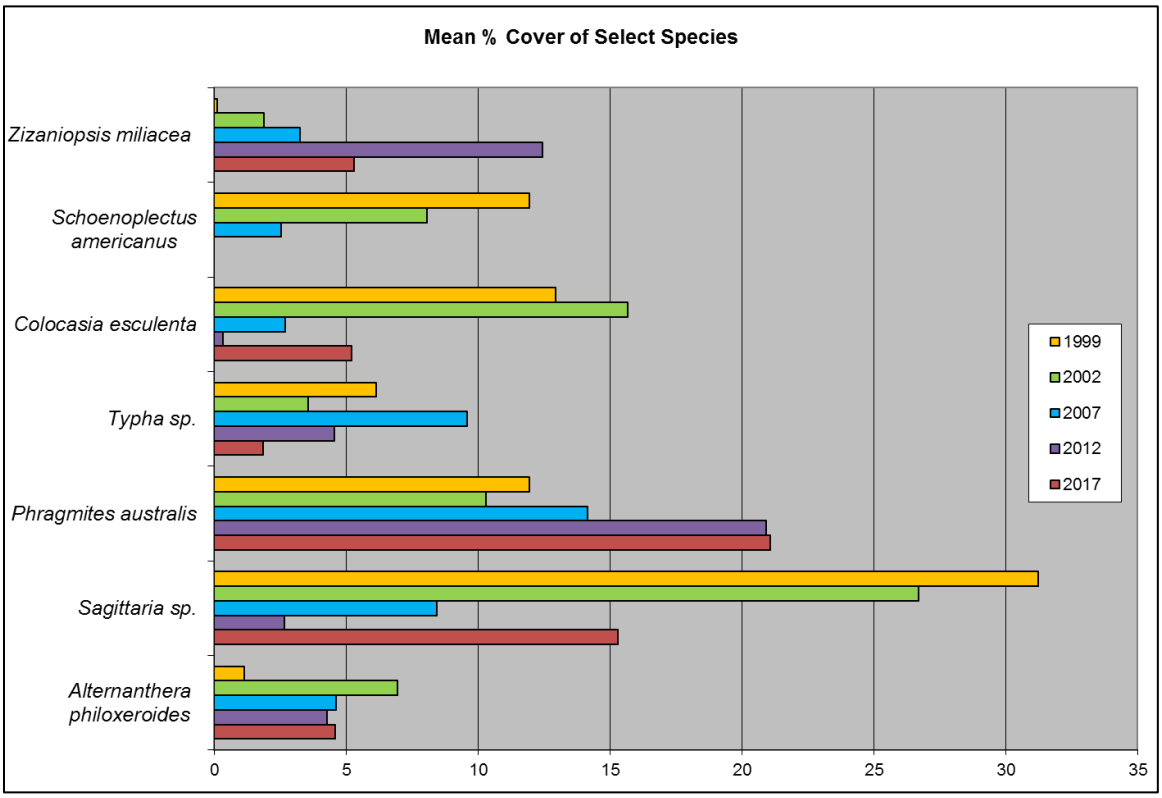

Figure 11. Mean % cover of selected species across all 4-m^2 plots within the MR-09 project area during August 1999 (N=46 plots), August 2002 (N=49 plots), August 2007 (N=50 plots), and October 2012 (N=65 plots). Vegetation was sampled using the Braun-Blanquet method.

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, 20, and 38) have become dominated by *Phragmites australis* (Figures 12 and 13). Crevasse 12, while still dominated by *Phragmites australis*, experienced an increase in *Sagittaria platyphylla* during the 2017 survey as new survey plots were established on newly formed land. In the case of Crevasse 51, *Phragmites australis* was the only species observed in vegetation plots during the 2012 survey. However, during the 2017 survey diversity increased greatly, with a shift to *Sagittaria platyphylla* as the dominant species. This sudden shift in species compostion, as well as the addition of new sample plots on newly formed land, is most likely attributable to the construction of a crevasse to the south which influences the receiving area of Crevasse 51.

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 12 and 13). 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 20) have increased, and 1 crevasse (Crevasse 15) has remained relatively stable. Similar to the trend seen in percent cover, FQI scores generally increased in 2017; rebounding from the lower values observed in 2012. FQI scores generally ranged from 25 to 50, which is below the ideal range of 55-70 for fresh marsh 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.

It was hypothesized in the 2013 OM&M report (Gossman and Breaux 2013) that the decrease in vegetative cover observed in the 2012 survey was at least partially associated with the effects of Hurricane Isaac, which passed over the project area in August 2012. The storm brought strong winds and high-salinity storm surge into the mostly fresh marsh area and delayed the survey, normally conducted in August, until October. The 2017 vegetation survey provides evidence to support this hypothesis as percent cover increased project-wide from 2012.

Another issue that may be affecting the vegetation in the project area is the effect of an invasive scale insect, *Nipponaclerda biwakeonsis*. The invasive scale has been responsible for the die-back of large stands of roseau cane across the lower Mississippi River Delta since at least 2016 (Knight et al. 2018). During the 2017 vegetation survey, the presence of scale insects was noted in many of the MR-09 survey plots where *Phragmites australis* was present, although it is not known whether the insects observed were the invasive *Nipponaclerda biwakeonsis* or the native *Aclerda holci*. Regardless, there was no measurable decline in *Phragmites australis* percent cover project-wide (Figure 11).

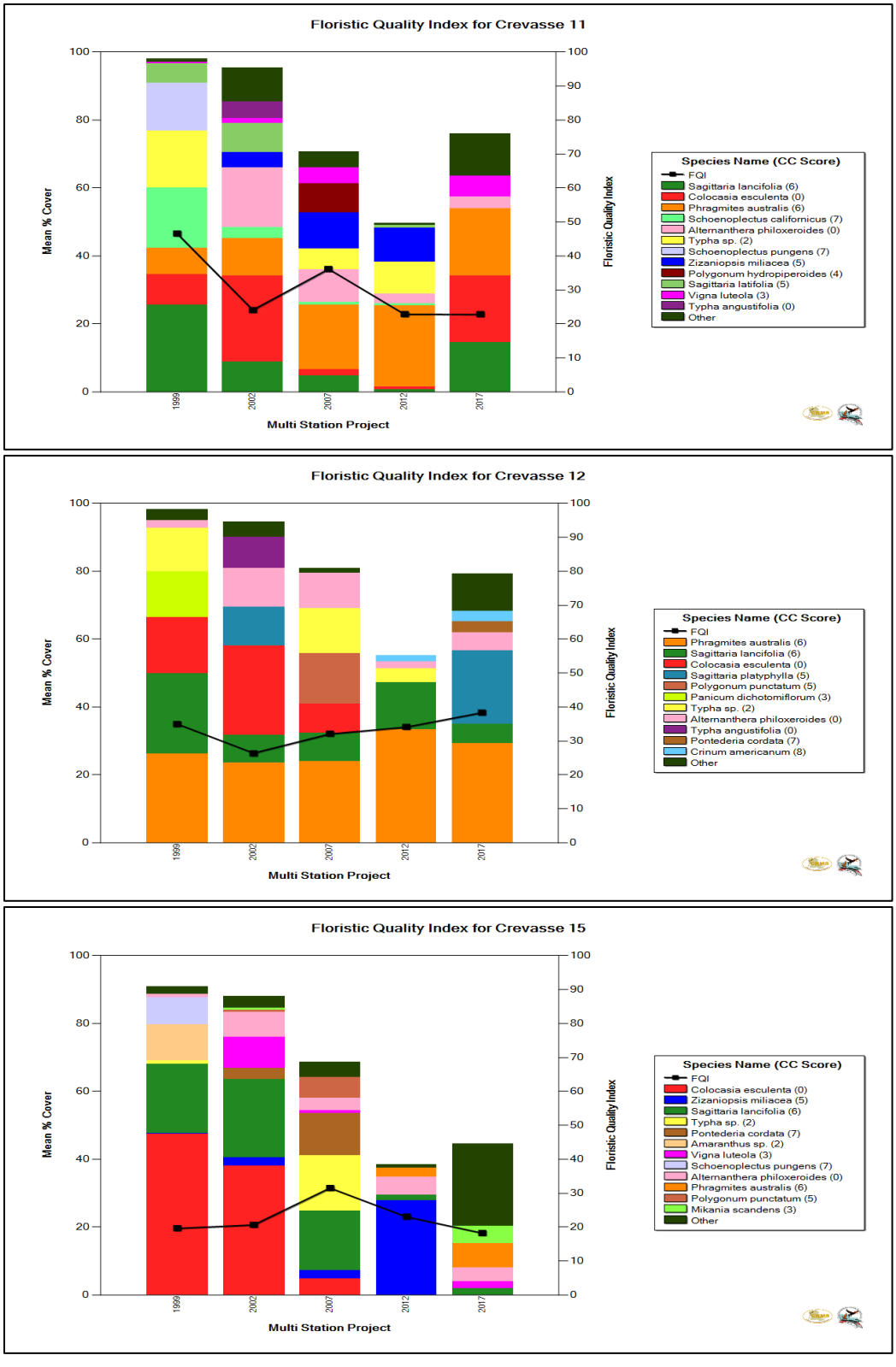

Figure 12. Mean percent cover and FQI for Crevasses 11 (top), 12 (middle), and 15 (bottom).

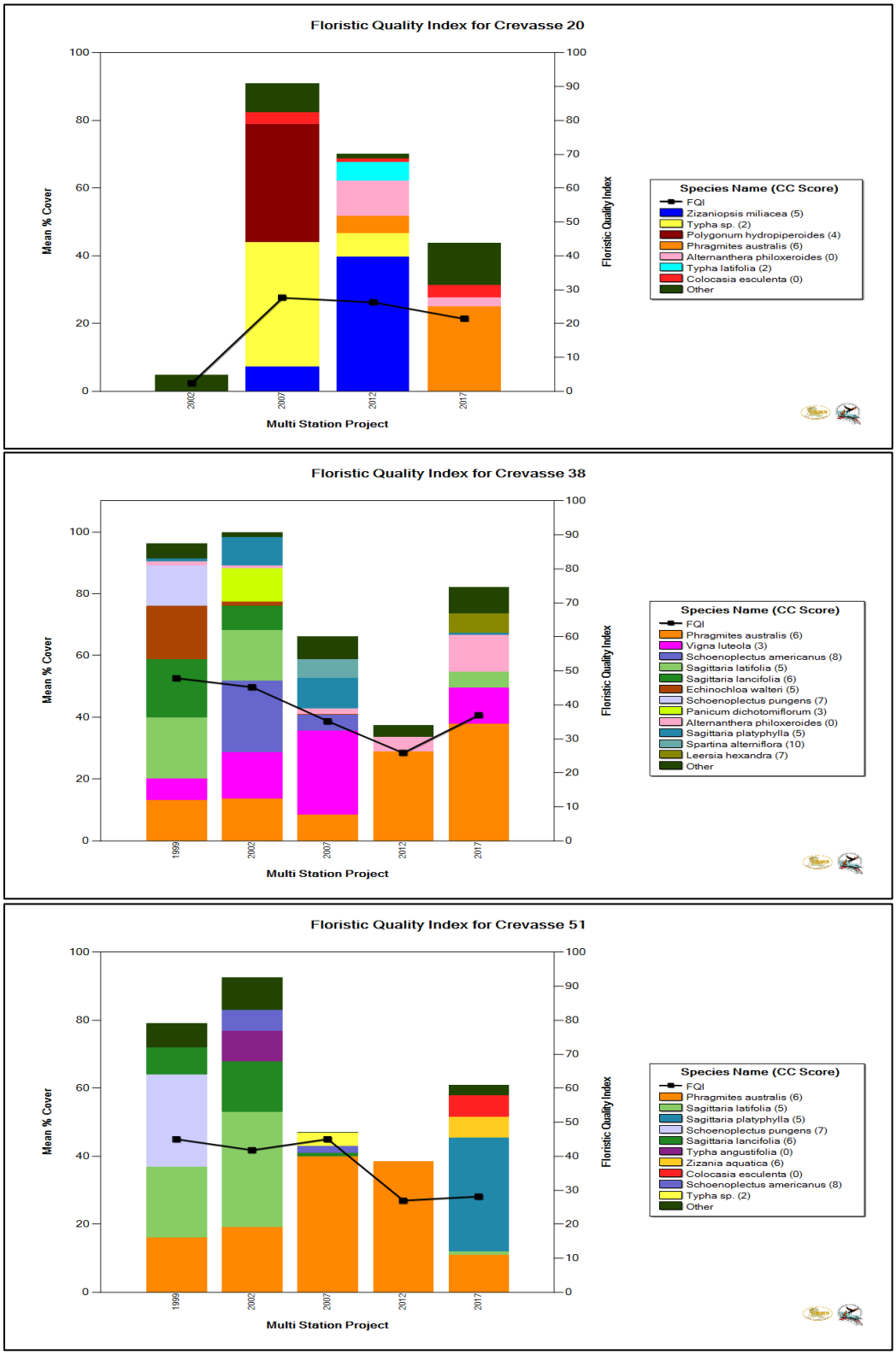

Figure 13. Percent cover and FQI for Crevasses 20 (top), 38 (middle), and 51 (bottom).

Elevation

Elevation surveys were conducted in 2000 (as-built), 2003, 2008, 2012, and 2017 (post-construction) on 12 of the MR-09 Phase I crevasses. The 2017 elevation survey was complicated by the fact that 4 of the crevasse receiving bays experienced disturbances that affected the elevation data. Dredged material was placed in the vicinity of Crevasses 6, 7, and 8. A crevasse unaffiliated with MR-09 was constructed immediately south of Crevasse 51 which brings freshwater and sediment into the receiving bay, and terraces were constructed in the receiving bay in concert with this new crevasse. The elevation data from these 4 crevasses are presented in Figures 14 and 15 below in order to illustrate current conditions. However, it should be noted that current elevations and changes in elevation between the 2012 and 2017 surveys cannot be attributed entirely to the MR-09 crevasses. Therefore, data from these 4 crevasses have been excluded from analyses and any trends associated with them will be based on the 2000-2012 surveys.

Analysis of the elevation data in the receiving areas shows a trend in elevation gain across all crevasses except Crevasse 51 (Table 2, Figures 14 and 15) since construction of the project. When analyzed across all 12 crevasses, there has been a mean gain in elevation of 1.64 ft in the project area from construction to 2012 (Table 2). Mean elevation gain from 2000 to 2003 was 0.76 ft., while mean elevation gains from 2003-2008, 2008-2012, and 2012-2017 were 0.15 ft., 0.23 ft., and 0.49 ft. respectively. The highest rate of elevation gain was observed in the first measurement period following construction. This may be explained by the fact that, at that time, the crevasses were at or near their constructed depth and moving higher volumes of water and sediment into the receiving bays. Rates of elevation gain then begin to slow as crevasse channels become narrower and shallower due to siltation. Elevation gain was impacted by crevasse angle of orientation and width. Mean elevation gain from 2000 to 2017 for crevasses oriented 60° from the parent channel was 1.72 ft, while crevasses oriented at 90° gained 1.22 ft. Similarly, wide crevasses (>150 ft. across) outgained narrow crevasses (<100 ft. across) 1.67 ft. to 1.27 ft. for the same time period. The greatest elevation gains were observed in wide, 60° crevasses (1.79 ft), while the least gains were observed in the narrow, 90° crevasses (0.89 ft).

The greatest elevation change occurred at Crevasse 20, where 2.96 ft of elevation was gained between 2000 and 2017. 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. * indicates that the crevasse was re-dredged in Phase II or ** Phase III.

Crevasse	Angle	Width	2000 Elevation	2003 Elevation	2008 Elevation	2012 Elevation	2017 Elevation	2000-2003 Change	2003-2008 Change	2008-2012 Change	2012-2017 Change	Total Change
6**	90°	wide	-0.74	0.34	0.42	0.46	.	1.09	0.07	0.04	.	.
7	60°	narrow	-0.08	0.74	1.16	1.26	.	0.82	0.42	0.10	.	.
8	60°	narrow	0.07	0.56	0.59	0.74	.	0.49	0.03	0.15	.	.
9*	90°	narrow	0.38	0.81	0.64	0.82	2.21	0.43	-0.17	0.18	1.38	1.83
11*	60°	wide	-0.70	0.89	1.25	1.38	1.68	1.59	0.36	0.13	0.30	2.38
12*	90°	narrow	0.32	0.35	0.63	0.98	1.42	0.03	0.28	0.35	0.44	1.10
15	90°	wide	-1.17	0.20	0.16	0.54	1.19	1.36	-0.04	0.38	0.65	2.36
20	60°	narrow	-0.75	0.59	1.01	1.76	2.21	1.34	0.42	0.75	0.45	2.96
31	60°	wide	-0.30	0.66	0.92	1.21	1.67	0.96	0.27	0.29	0.46	1.97
36	60°	wide	0.06	0.76	0.71	1.07	1.07	0.70	-0.05	0.36	0.00	1.01
38	90°	wide	0.60	1.10	1.29	1.46	1.71	0.50	0.19	0.17	0.25	1.11
51	90°	narrow	-0.46	-0.65	-0.62	-0.72	.	-0.19	0.03	-0.10	.	.
Average			-0.23	0.53	0.68	0.91	1.65	0.76	0.15	0.23	0.49	1.64

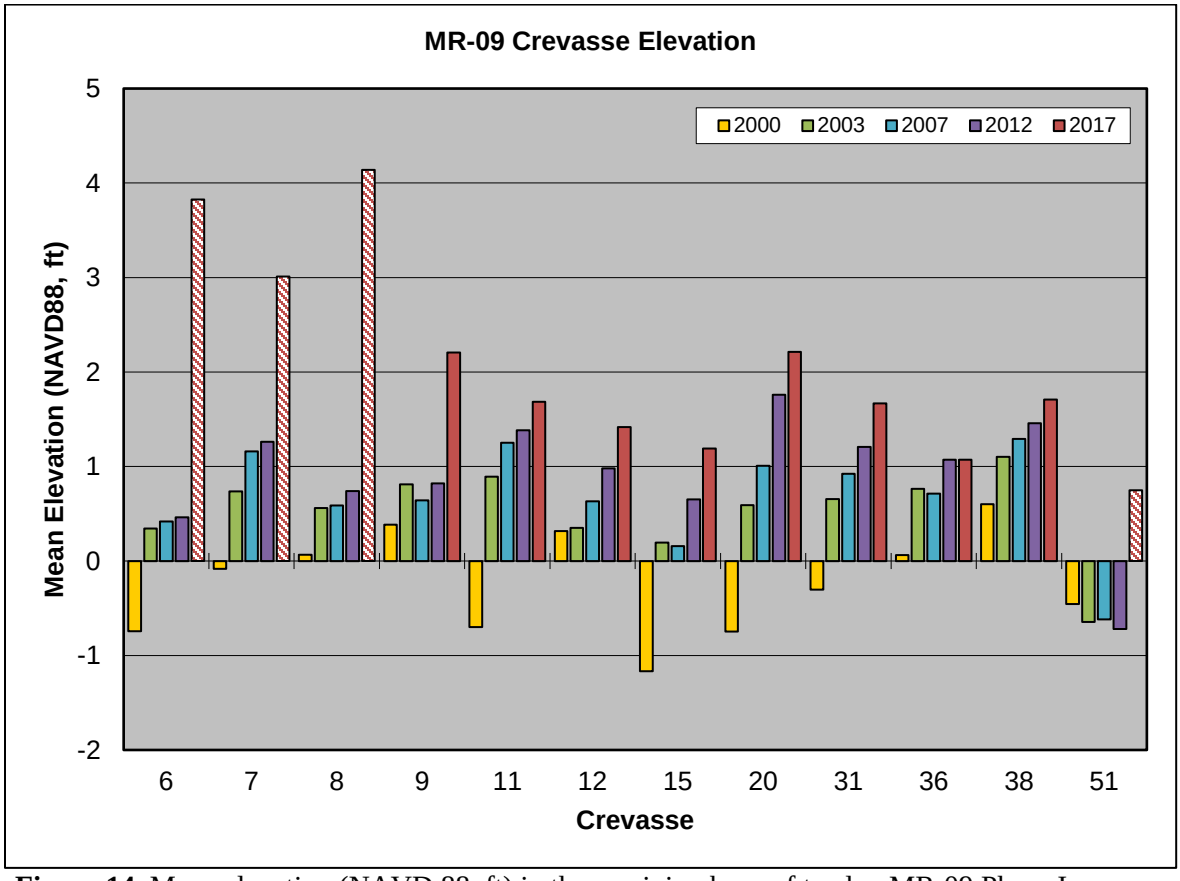

Figure 14. Mean elevation (NAVD 88, ft) in the receiving bays of twelve MR-09 Phase I crevasses in 2000 (as-built), 2003, 2008, 2012, and 2017 (post construction). Hatched bars indicate disturbance within the receiving bay.

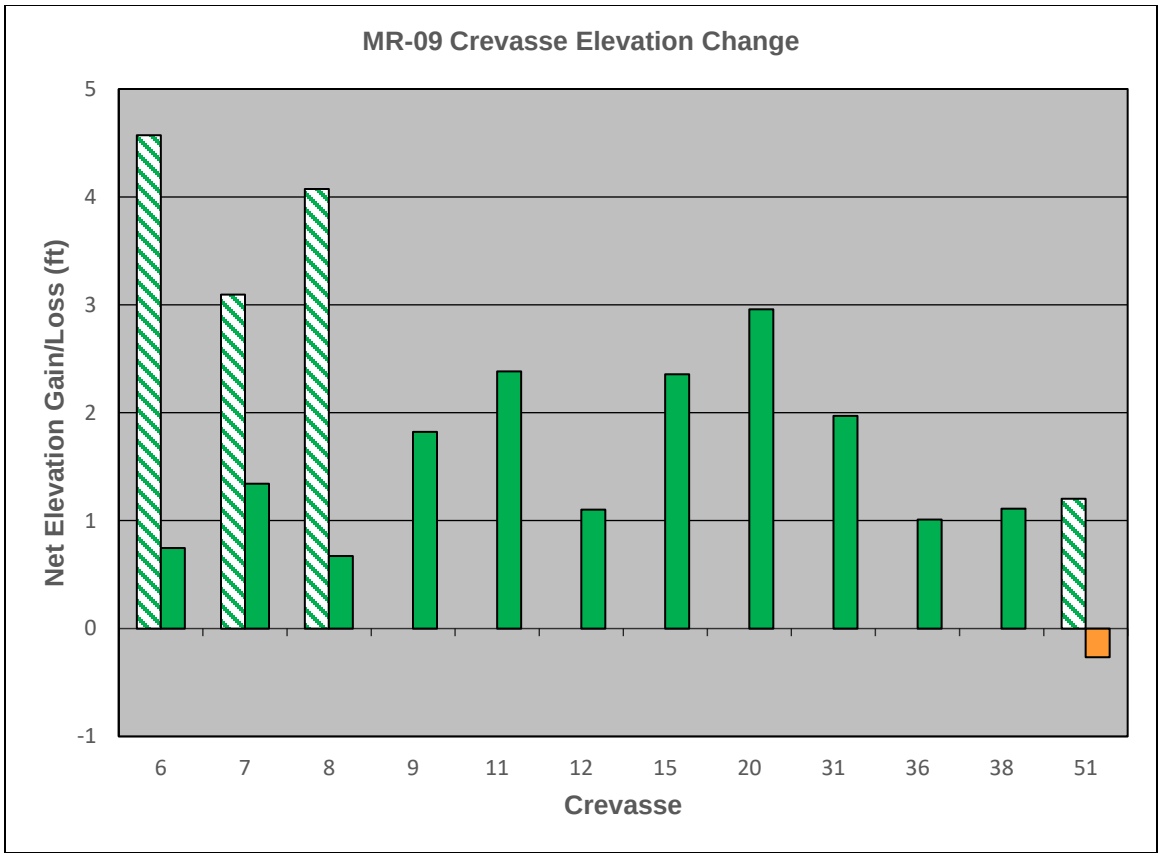

Figure 15. Elevation gain/loss between 2000 and 2017 for each of twelve MR-09 Phase I crevasses. Green bars represent an overall increase in mean elevation while orange bars represent an overall decrease in mean elevation. Hatched bars represent actual elevation change; solid bars represent change that can be attributed to MR-09.

The elevation loss in the Crevasse 51 receiving area prior to 2017 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, 2008, and 2012 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 (ac/yr) for each of the 4 CRMS sites evaluated. The total land gain recorded for the CRMS sites within the MR-09 project area for the 7-yr period from 2005 to 2012 is 139 ac. with an average land gain of 34.8 ac. per CRMS site. Rate of land gain ranged from 3.1 to 6.9 ac/yr with the highest rate occurring at CRMS4448 (Figure 16).

Table 3. Land area (ac.) for 4 CRMS sites within the MR-09 project area. See Figure 1 for CRMS site locations.

CRMS Site	2005	2008	2012	Change (ac)	% Change	Rate (ac/yr)
0156	102	117	124	22	21.6%	3.1
2627	110	125	140	30	27.3%	4.3
2634	67	94	106	39	58.2%	5.6
4448	88	120	136	48	54.5%	6.9
Cumulative	367	456	506	139		19.9
Average	91.8	114	126.5	34.8	37.9%	5.0

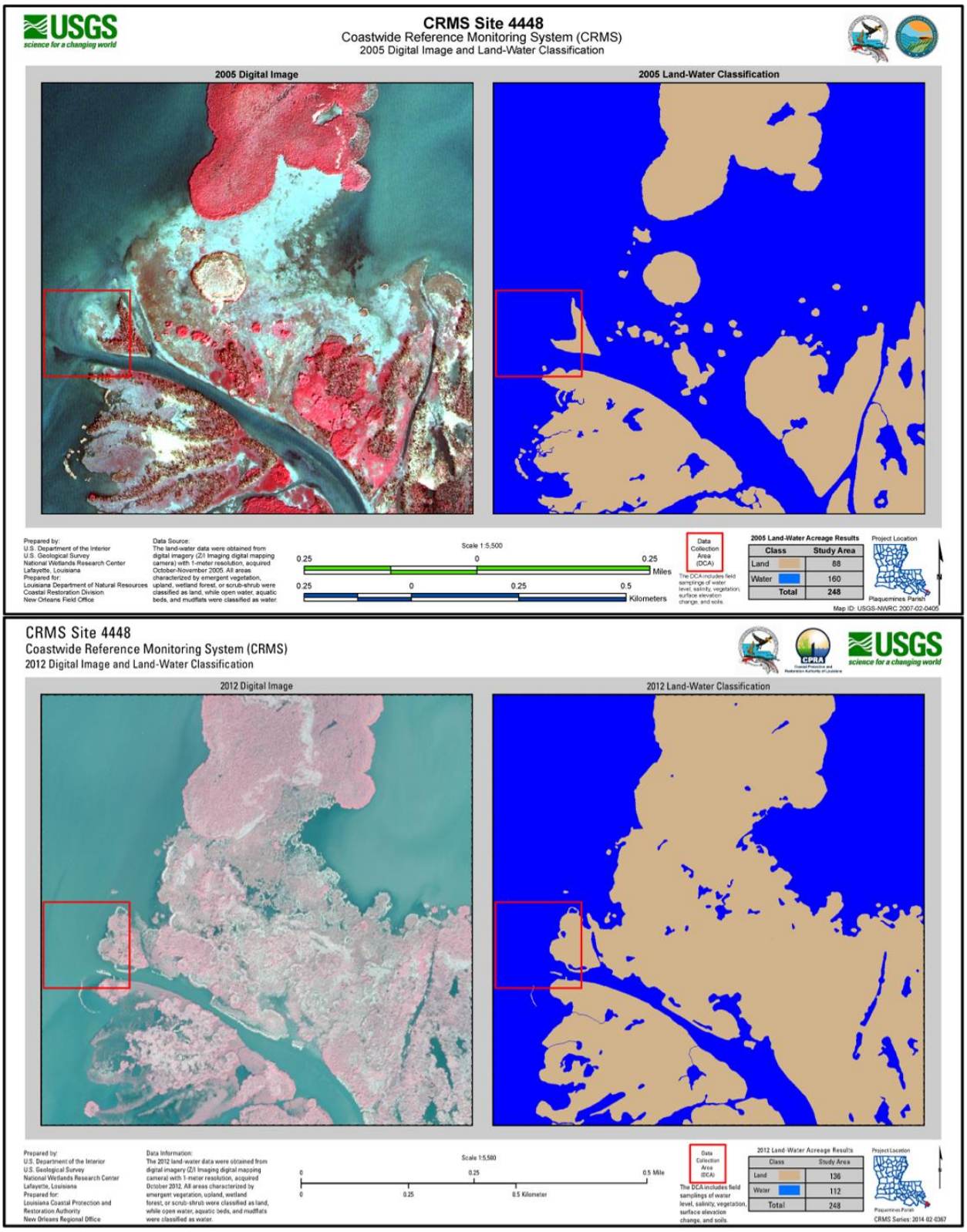

Figure 16. 2005 (top) and 2012 (bottom) land-water analysis for CRMS4448.

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 has achieved 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. Cumulatively, MR-09 crevasses have created 739 ac. of land. All of the crevasses except one have gained land in the receiving areas from the time of project construction to 2016. 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 2.5 ac/yr across all crevasses.

The project has also achieved the monitoring goal of increasing mean elevation of the receiving bays. Eleven of the 12 crevasses surveyed showed increases in elevation within the receiving bays. Individual crevasses had increases of as much as 2.96 ft in elevation (Crevasse 20). The greatest elevation gain was observed at Crevasse 20 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 decreased in the 2007 and 2012 surveys, and recovered in the 2017 survey, although not to levels seen in the early surveys following construction. Some of this decline is attributable to the survey methodology itself, in which stations without vegetation are still surveyed and included in the mean. Although percent cover has been variable, 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.

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

Long-term monitoring of crevasse splays in an environment as active and dynamic as the lower Mississippi River delta presents a unique set of challenges. Human alterations within the receiving bays such as the placement of dredge spoil, make it difficult to determine project effectiveness and may require adaptation of monitoring plans to reflect current conditions.

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.

VI. References

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.

Cretini, K. F., J. M. Visser, K. W. Krauss, and G. D. Steyer 2011. CRMS Vegetation Analytical Team framework—Methods for collection, development, and use of vegetation response variables. U.S. Geological Survey Open-File Report 2011-1097, 60 pp.

Folse T. M. , L. A. Sharp, J. L. West, M. K. Hymel, J. P. Troutman, T. E. McGinnis, D. Weifenbach, L. B. Rodrigue, W. M. Boshart, D. C. Richardi, W. B. Wood, and C. M. Miller. 2008, revised 2017. A Standard Operating Procedures Manual for the Coastwide Reference Monitoring System-*Wetlands*: Methods for Site Establishment, Data Collection, and Quality Assurance/Quality Control. Louisiana Coastal Protection and Restoration Authority. Baton Rouge, LA. 228 pp.

Gossman, B. 2018. *2017 Operations, Maintenance and Monitoring Report for Channel Armor Gap Crevasse, (MR-06),* Coastal Protection and Restoration Authority of Louisiana. 33pp. and Appendices

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.

Knight, I.A., B.E. Wilson, M. Gill, L. Aviles, J.T. Cronin, J.A. Nyman, S.A. Schneider, and R. Diaz. 2018. Invasion of *Nipponaclerda biwakoensis* (Hemiptera: Aclerdidae) and *Phragmites australis* die-back in southern Louisiana, USA. Biological Invasions, 20. pp. 2739-2744.

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.

Louisiana Department of Natural Resources (LDNR) 2007. Operation, Maintenance, and Rehabilitation Plan for Delta Wide Crevasses (MR-09). 7 pp. plus attachments

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, revised 2000. *Quality Management Plan for Coastal Wetlands Planning, Protection, and Restoration Act Monitoring Program*. Open-file report no. 95-01. Louisiana Department of Natural Resources, Coastal Restoration Division, Baton Rouge, LA. 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.

Appendix A
(Inspection Photographs)

Crevasse MP-1 (View 1)

Crevasse MP-1 (View 2)

Crevasse MP-3

Crevasse OP-4 (View 1)

Crevasse OP-4 (View 2)

Crevasse OP-5 (View 1)

Crevasse OP-5 (View 2)

Johnson Pass Crevasse (View 1)

Johnson Pass Crevasse (View 2)

Sawdust Bend Crevasse (View 1)

Sawdust Bend Crevasse (View 2)

South Pass Crevasse (View 1)

South Pass Crevasse (View 2)

Appendix B
(Three Year Budget Projection)

Delta Wide Crevasses (MR-09)

Federal Sponsor: NMFS

Construction Completed : 1999, 2005 (Maintenance Event 2014)

PPL 6

																			Project Estimate	CWPPRA Allocated Money
Current Approved O&M Budget June 2009	Year 0 FY06	Year - 1 FY07	Year -2 FY08	Year -3 FY09	Year -4 FY10	Year -5 FY11	Year -6 FY12	Year -7 FY13	Year -8 FY14	Year -9 FY15	Year -10 FY16	Year -11 FY17	Year -12 FY18	Year -13 FY19	***Year -14 FY20***	***Year -15 FY21***	***Year -16 FY22***	Year - 17 FY23	Year -18 FY24	Year -19 FY25	Project Life Budget	Currently Funded (Sum YR 0 to YR 19)
State O&M	$0	$5,530	$0	$5,821	$983,725	$6,128	$0	$6,451	$0	$1,123,693	$0	$7,148	$0	$7,525	$1,282,650	$7,921	$0	$8,338	$0	$8,777	$3,453,707	$3,453,707
Corps Admin																					$0	$0
Federal S&A																					$0	$0
Total																					$3,453,707	$3,453,707
																					Remaining Project Life	***Current 3 year Request (FY20, 21, 22)***
Projected O&M Expenditures																						
Maintenance Inspection		$5,530		$5,821		$6,128		$6,451		$6,790		$7,148		$7,525		$7,921		$8,338		$8,777	$25,036	$7,921
General Maintenance																					$0	$0
Structure Operation																					$0	$0
Federal S&A					$2,832					$3,220					$3,660						$3,660	$3,660
State S&A					$14,159					$16,098					$18,302						$18,302	$18,302
E&D					$81,031					$77,796					$88,449						$88,449	$88,449
Surveys					$14,581					$16,578					$18,848						$18,848	$18,848
Construction					$806,871					$930,162					$1,070,338						$1,070,338	$1,070,338
Construction Oversight					$64,251					$73,049					$83,052						$83,052	$83,052
Total	$0	$5,530	$0	$5,821	$983,725	$6,128	$0	$6,451	$0	$1,123,693	$0	$7,148	$0	$7,525	$1,282,650	$7,921	$0	$8,338	$0	$8,777	$1,307,686	$1,290,571

Total O&M Expenditures from COE Report (Inception to present)	$2,159,971.58	From July 2018 Lana	**Current O&M Budget less COE Admin**	$3,453,707		Current Project Life Budget less COE Admin	$3,453,707
State O&M Expenditures not submitted for in-kind credit	$0		*(State O&M Currently Funded + Fed S&A Currently Funded)*			*(State O&M Prorject Life Budget + Fed S&A Project Life Budg*	
Federal Sponsor MIPRs (if applicable) (REQUESTED MONEY)	$0		**Remaining Available O&M Budget**	$1,293,735		Total Projected Project Life Budget	$3,467,657
Total Estimated O&M Expenditures (as of May 2011)	**$2,159,971.58**		*(Current O&M - Total Est. O&M Expenditures)*			*(Remaining Project Life + Total Estimated O&M Expenditure*	
			Incremental Funding Request Amount FY20-FY22	**$ (3,164.62)**	Unexpended	**Project Life Budget Request Amount**	**$13,951**

Appendix C
(Field Inspection Check Sheet)

FIELD INSPECTION CHECK SHEET

Project No. / Name:	Delta Wide Crevasses MR-09		Date of Inspection:	October 29, 2018	Time: 9:00 AM
Crevasse No.	**See Report Section III**		Inspector(s):	CPRA: Jacinta Gisclair and Bryan Gossman; LDWF: Todd Baker, Trebor Victorino, and Cornelius Williams; USFWS: Barret Fortier; NMFS: Dawn Davis.	
Crev. / Terr. Specs.	See Report Section III		Water Level:	1.22 feet at Pilottown, La.	Time: 9:00 AM
Type of Inspection:	2018 Annual Inspection		Weather Conditions:	Fair, Wind SW to NNW @ 6-9 mph	

Item	Condition	Physical Damage	Dimensions	Photo	Observations and Remarks
Crevasse # MP-1	Good	None	1,000 ft X 100 ft by -10.0' NAVD 88	Appendix B	This crevasse is located on Main Pass at N29 deg 15 min 40.9 sec; W 089deg 13 sec 52.5 min. The spoil areas on each bank were well vegetated. The depth, based on spot-checked sounding of 4' appeared to retain some of its originally dredged depth and was adequate to carry sediment to the receiving area.
Crevasse # MP-3	Good	None	1,000 ft X 100 ft by -10.0' NAVD 88	Appendix B	This crevasse is located on Main Pass at N29 deg 14 min 29.8 sec; W 089 deg 14 sec 19.6 min. The spoil areas on each bank were well vegetated. The depth, based on spot-checked soundings of 6' to 7' near the mouth and 4' thereafter, appeared to retain most of its originally dredged depth and was adequate to carry sediment to the receiving area.
Crevasse # OP-4	Good	None	400 ft X 100 ft by -8.0' NAVD 88	Appendix B	This crevasse is located on Octave Pass at N29 deg 12 min 18.7 sec; W 089 deg 14 sec 0.3 min. The spoil areas on each bank were well vegetated. The depth, based on spot-checked soundings of 4', appeared to retain some of its originally dredged depth and was adequate to carry sediment to the receiving area.
Crevasse # OP-5	Good	None	840 ft X 100 ft by -8.0' NAVD 88	Appendix B	This crevasse is located on Octave Pass at N29 deg 12 min 4.4 sec; W 089 deg 15 sec 2.5 min. The spoil areas on each bank were well vegetated. The depth, although not sounded, appeared to retain most of its originally dredged depth and was adequate to carry sediment to the receiving area.
Johnson Pass Crevasse	Good	None	1,200 ft X 75 ft by -8.0' NAVD 88	Appendix B	This existing crevasse is located on Johnson Pass at N29 deg 7 min 36.3 sec; W 089 deg 12 sec 30.1 min. The spoil areas on each bank were well vegetated. The depth, based on spot-checked soundings of 8', appeared to retain most of its originally dredged depth and was adequate to carry sediment to the receiving area.
Sawdust Bend Crevasse	Good	None	1,550 ft X 75 ft by -8.0' NAVD 88	Appendix B	This existing crevasse is located on Sawdust Bend at N29 deg 8 min 17.8 sec; W 089 deg 13 sec 33.3 min. The spoil areas on each bank were well vegetated. The depth, based on spot-checked soundings of 5' near the mouth and 6' to 7' thereafter, appeared to retain most of its originally dredged depth and was adequate to carry sediment to the receiving area.
South Pass Crevasse	Good	None	1,000 ft X 100 ft by -8.0' NAVD 88	Appendix B	This existing crevasse is located on South Pass at N29 deg 6 min 20.2 sec; W 089 deg 14 sec 5.9 min. The spoil areas on each bank were well vegetated. The depth, based on spot-checked soundings of 5' to 7' near the mouth and 6' to 7' thereafter, appeared to retain most of its originally dredged depth and was adequate to carry sediment to the receiving area.

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