Coastal Protection and Restoration Authority of Louisiana

2022 Operations, Maintenance, and Monitoring Report

for

South Lake Lery Shoreline and Marsh Restoration (BS-0016)

State Project Number BS-0016
Priority Project List 17

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Preface

The South Lake Lery Shoreline and Marsh Restoration (BS-0016) project was funded through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) on the 17th Priority Project List with the U.S. Fish and Wildlife Service (USFWS) as the federal sponsor. The 2022 Operations, Maintenance, & Monitoring (OM&M) report for the BA-0016 project is the 1st in a series of reports to summarize monitoring and O&M activities conducted during the life of the project. This report includes monitoring data and site visit results available through 2022. Additional documents pertaining to the BS-0016 project may be accessed on the Coastal Protection and Restoration Authority (CPRA) website at https://cims.coastal.louisiana.gov/outreach/projects/ProjectView?projID=BS-0016 or on the CWPPRA website at https://www.lacoast.gov/new/Projects/Info.aspx?num=BS-16.

I. Introduction

The Lake Lery Shoreline Restoration and Marsh Creation project is located within the Breton Sound hydrologic basin in Plaquemines Parish, Louisiana, southeast of New Orleans and northwest of the community of Delacroix (**Figure 1**). Historically the greatest land loss (6,500 acres) occurred from 1956-1974 and coincided with Hurricane Betsy and extensive oil and gas canal construction. The project area has experienced changes in vegetative communities due to the construction and operation of the Caernarvon Freshwater Diversion which diverts as much as 8,000 cfs of Mississippi River water. Since the opening of that diversion in 1991, this area has converted from a brackish/saline marsh to an intermediate/fresh marsh (Chabreck and Linscombe 1988, Chabreck and Linscombe 1997, Sasser et al. 2008, Sasser et al. 2014, Nyman et al. 2022). More recently, a large amount of land loss has occurred as a result of Hurricanes Katrina and Rita in 2005. Land-water data indicate a 1984-2011 loss rate of –1.53% per year (USFWS 2012), with the primary causes of marsh loss being the 2005 hurricanes (**Figure 2**). However, since 2005, shoreline erosion in Lake Lery appears to be caused by wind generated waves.

To restore the shoreline and marshes around Lake Lery, approximately 35,723 linear feet of shoreline along the western and southern shores was restored using a bucket dredge, which dredged *in situ* material to construct an earthen embankment. Additionally, 491 acres of marsh were created/and or nourished within the containment area and another approximately 1,054 acres were nourished outside and south of the containment area, using hydraulically dredged material borrowed from Lake Lery (**Figure 1**). The area of nourishment outside of the containment area is an estimate as the sediment spread over a large area with some of the sediment flowing further than the estimated area. The original project plan included a marsh creation area behind the western shoreline feature, which was eliminated due to limited funding.

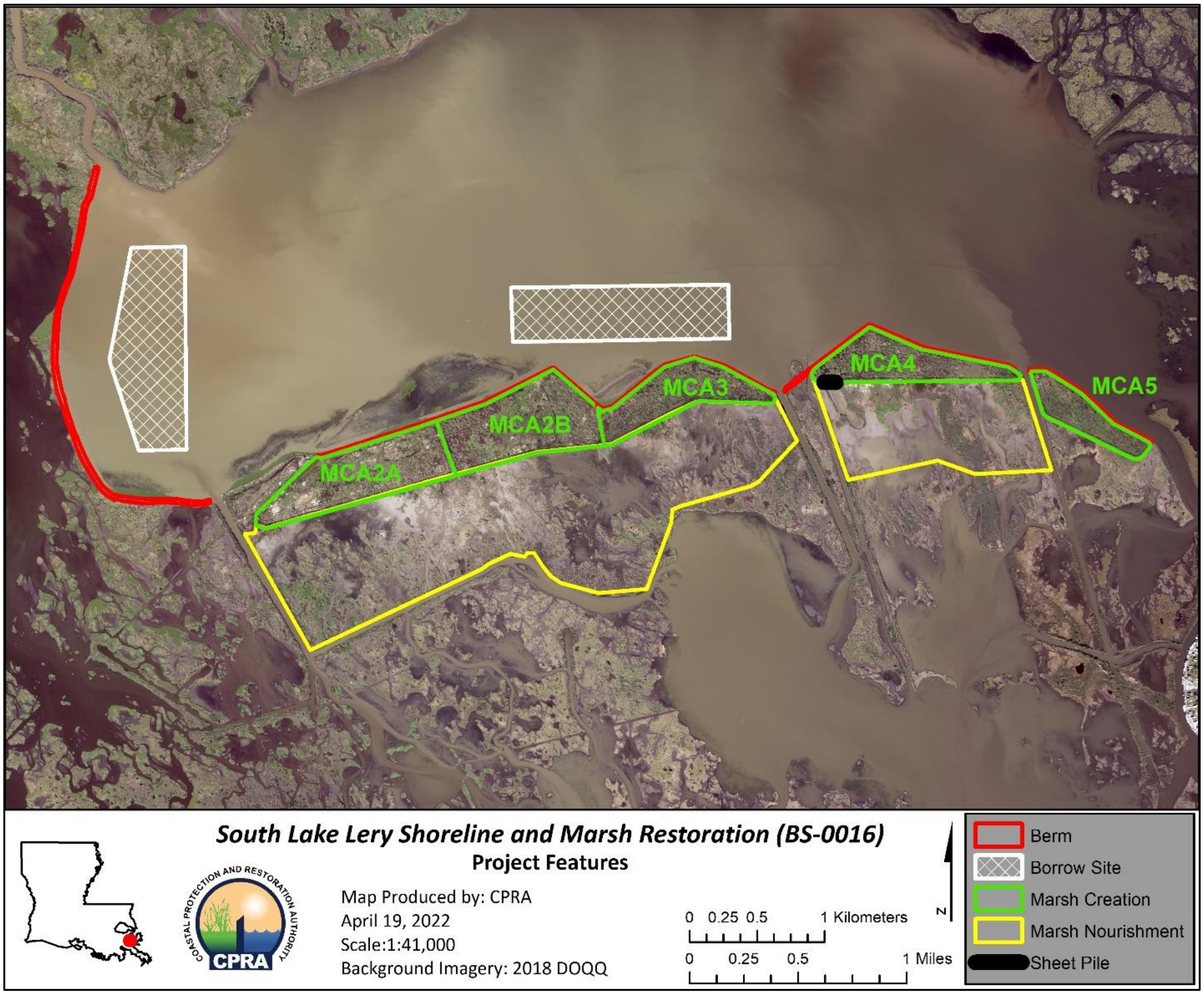


Figure 1: South Lake Lery Shoreline and Marsh Restoration (BS-0016) project features.

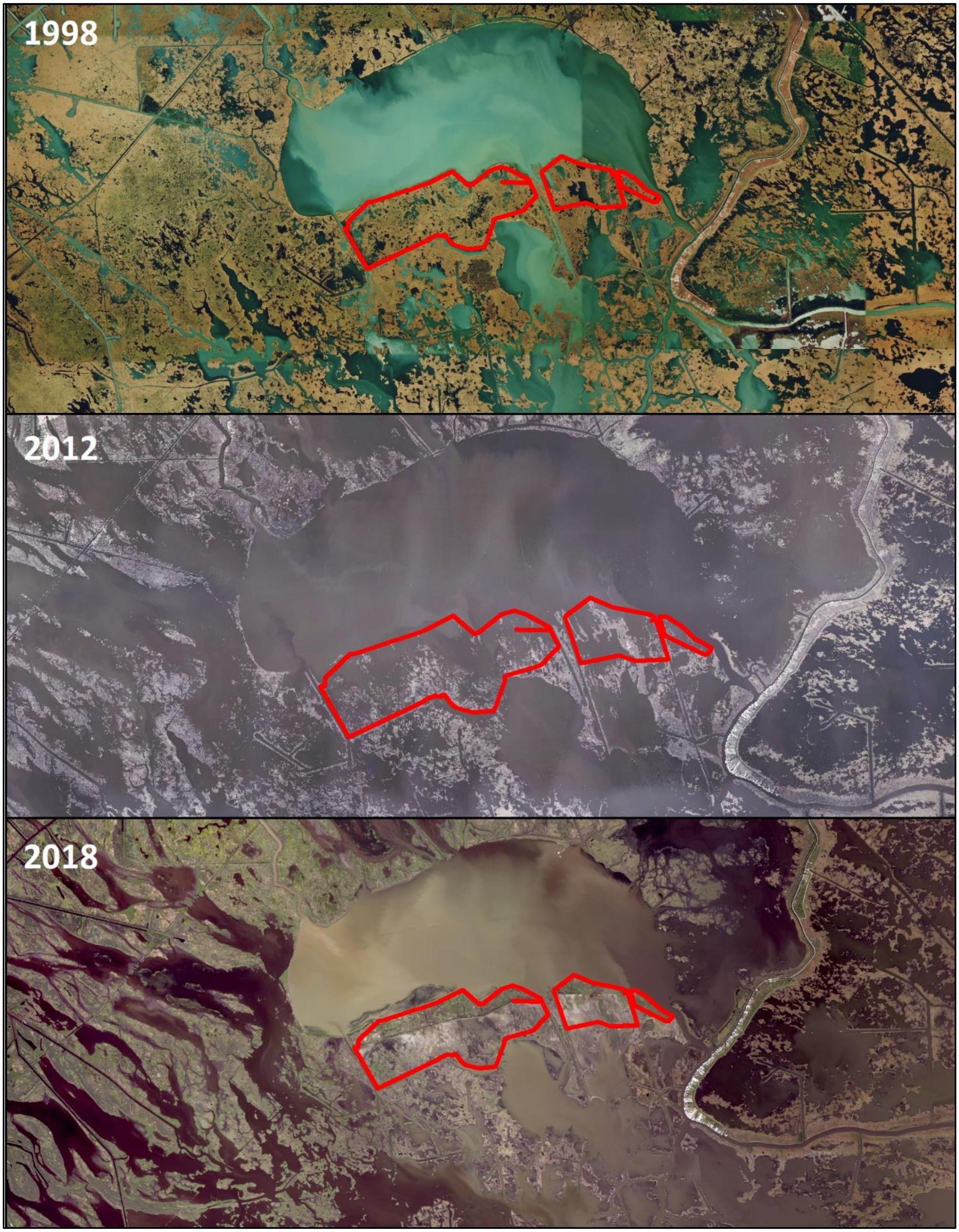


Figure 2: South Lake Lery Shoreline and Marsh Restoration (BS-0016) project marsh creation areas with 1998, 2012, and 2018 DOQQ imagery, showing land change trends over time in the region.

a. Goals and Objectives

The goals of the South Lake Lery Shoreline and Marsh Restoration Project are to restore the southern and western shoreline of Lake Lery and create marsh south of the newly constructed shoreline. The specific objectives of the project were to:

- Create and nourish approximately 496 acres of marsh by filling open-water areas and fragmented marsh with dredge material;
- Restore 35,831 linear feet (55 acres) of the southern and western shorelines.

b. Constructed Features

Construction of the BS-0016 project began in June 2015 and was completed in May 2017. The construction included the building of the lake berm on the eastern and southern shores of Lake Lery, containment dike for the five marsh creation cells, filling of the marsh creation cells with dredge material, nourishing the marsh south of the marsh creation cells and planting of the lake berm to prevent/slow erosion. A total of 3,732,762 cubic yards of material was dredged from the borrow areas during the construction of this project.

The borrow sites were located along the southern and western shorelines of Lake Lery and cover a combined 335 acres (western site = 175 acres, southern site = 351 acres, **Figure 1**). The borrow sites were chosen for their proximity to the shoreline and marsh fill sites and do not cross any pipelines. The maximum depth of cut was -20 feet NAVD88. The total volume of available sediment in the combined borrow areas was 8,712,000 cubic yards (yd^3). The total fill volume required was estimated to be 3,840,447 yd^3 (including refilling containment dike borrow sites).

The shoreline restoration feature consists of sediments mechanically dredged from Lake Lery and placed along the existing adjacent shorelines, basically forming a low levee along the lakeshore. There were 35,711 linear feet of lake rim constructed. The feature was designed to maintain its integrity against the design wave height (+2.2 feet NAVD88) based on the twenty year life of the project. Design parameters include a crown width of 50 feet (60 feet-wide along the western shoreline), a lakeside slope of 1 vertical (V):5 horizontal (H), and a marshside slope of 1(V):3(H). Design calculations indicated that the shoreline restoration feature should be constructed to an elevation of +2.5 to +3.0 feet to insure that the crown elevation is below +2.0 ft at target year (TY) 5 (i.e., five years after construction), while still maintaining a minimum crown elevation of approximately +1.4 feet at the end of the twenty year project life. In general, the lake berm was constructed higher and wider than the design. Data was not available to provide an average height and width of the constructed feature, but the as-built drawings show a larger feature than designed. Most canals and pipelines along the shoreline remained open during construction. The shoreline slope was planted with 2 rows (14,337 trade gallons) of smooth cordgrass (*Spartina alterniflora*) on 5.0-foot-long staggered centers, approximately parallel to the shoreline (**Figure 3**). One row was planted at an elevation of +0.6 feet NAVD 88 and the second row at elevation +0.1 feet NAVD 88. Also one row of California bullrush (*Schoeneoplectus californicus,* 7,166 trade gallons) was planted parallel to the shoreline on five foot centers staggered with the centers of the adjacent row of smooth cordgrass (**Figure 3**). This row was planted at an elevation of -0.4 feet NAVD 88 (USFWS 2012). Additionally, in an attempt to stabilize the lake berm more quickly, Bermuda grass (*Cynodon dactylon*) and seashore paspalum (*Paspalum vaginatum*) were seeded to the top of the berm shortly after construction.

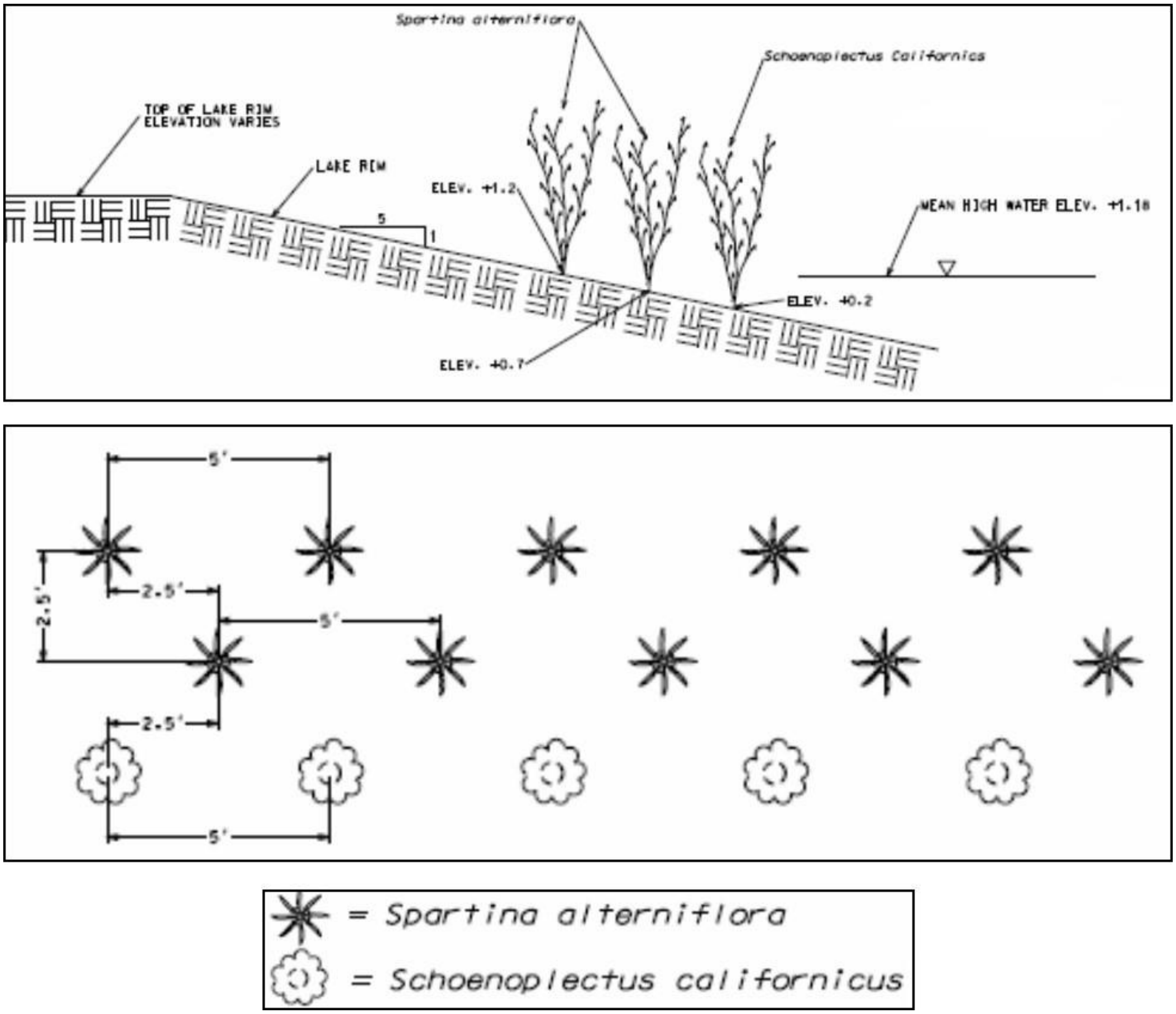


Figure 3: Plan view (top) and top view (bottom) of the lake berm plantings.

Five marsh creation cells were filled with hydraulically dredged material from Lake Lery. There were 549 acres of marsh created in the project area. To determine target elevations for the fill sites, marsh elevation surveys were performed by NRCS and USFWS. To achieve a sustainable marsh elevation throughout the project life, the marsh platform was initially pumped to a higher elevation during construction and allowed to settle to the desired target elevation over time. The target fill elevation of between +2.0 to +3.0 feet NAVD88 would ultimately settle to an elevation of +0.8 feet NAVD88 in 20 years.

There were 50,475 linear feet of containment dikes constructed. Marsh side or interior containment dikes were built to +3.5 to +4.5 feet NAVD88 with a 5-foot crown width and 1(V):3(H) side slopes. Containment dikes were constructed with a bucket dredge using *in situ* material and the borrow area was filled with hydraulically dredged material. A 200-ft long metal sheet pile structure was constructed along the southern boundary of Marsh Creation Area 4 (MCA 4) approximately 300 feet from the westernmost extent of the MCA (**Figure 1**). The purpose of the structure was to alleviate construction difficulties in building the containment dike at this location. Interior containment dikes were gapped within 3 years of the construction completion date. Twenty-five-foot wide gaps were constructed every 1,000 feet thus allowing for natural tidal connectivity and to prevent ponding. Lake side containment dikes were built on top of the inside edge of the shoreline embankment with materials dredged from the lake and placed during the construction of the shoreline embankment. These containment dikes matched the height of the interior dikes for that marsh cell and were constructed with a 5-foot crown and 1(V):3(H) side slope. These containment dikes were degraded by the end of construction to allow tidal connectivity.

An area south of the marsh creation areas received uncontained fill in an unknown amount. It is hard to predict the area influenced by this activity, but an area of 1,054 acres was included in the land/water analysis described below. Therefore, for this portion of the project, there were no containment dikes constructed and no target elevation for the area.

II. Maintenance Activity

a. Project Feature Inspection Procedures

Maintenance inspections are not required for this project and are not included in the Operations and Maintenance Plan (O&M Plan). The only O&M required for this project is the removal of the metal sheet pile structure described above.

b. Sheet Pile Removal

The metal sheet pile structure removal will consist of the removal and disposal of all of the components of the structure including the timber piles, walers, and hardware in addition to the sheet piles themselves. It is anticipated that this work will be completed prior to the next OM&M report due in 2027.

c. Maintenance Recommendations

1. Immediate/ Emergency Repairs

- No immediate repairs are necessary at this time.

2. Programmatic/ Routine Repairs

- None

d. Maintenance History

- Not applicable

III. Operation Activity

Operations are not required for this project.

IV. Monitoring Activity

a. Monitoring Goals

The following specific monitoring goals will be used to evaluate the success of the project, as specified in the BS-0016 Monitoring Plan (Gossman 2015):

1) Evaluate the success of project shoreline features;

2) Reduce the "future without project" projected land loss rate of -1.53% per year (USFWS 2012) within the project area.

3) Increase the percent cover and diversity of herbaceous plants.

b. Monitoring Elements

The following monitoring strategies will provide the information necessary to evaluate the specific goals listed above:

1. Land/Water Analyses

Analysis of aerial photography will be used to evaluate land to water ratios within the marsh creation and extended nourishment areas over the life of the project. Land to water ratios within the project area in 2012 and 2018 were analyzed by the USGS Wetland and Aquatic Research Center (WARC) using 1-m resolution aerial photography (Z/I Imaging digital mapping camera) collected through the CRMS program. The 2012 analysis will provide land:water before the project was constructed and the 2018 analysis will provide data from year 1 of the project. The analysis was conducted using standard operating procedures originally documented in Steyer et al. (1995, revised 2000) and further refined in Folse et. al 2020, in which all areas characterized by emergent vegetation, wetland forest, scrub-shrub, or upland are classified as land, while open water, aquatic beds, and non-vegetated mudflats are classified as water. Future aerial photography analyses are tentatively scheduled for 2027 (year 9) and 2036 (year 18).

2. Marsh Vegetation

Vegetation data were collected within the marsh creation areas and along the shoreline berm. Twenty-five 2m x 2m vegetation monitoring stations were established within the project area, with 15 stations along the shoreline berm and 10 stations within the marsh creation areas. Marsh vegetation was sampled in September 2018 and November 2021 using a modified Braun-Blanquet sampling method (Mueller-Dombois and Ellenberg 1974) as described in Folse et al. 2020 (**Figure 4**). In 2021, some plots had to be moved as existing lake rim plots had eroded away (**Figure 4**). Vegetation within all established plots were representative of the surrounding area. Data collected within each sample plot included an assessment of total cover, species present, percent cover of each species, average height of each vegetation layer, and the depth of water on the marsh surface. Future vegetation surveys on the marsh platform shall occur in 2026 (Year 9), 2031 (Year 14), and 2036 (Year 19).

Herbaceous marsh vegetation data were analyzed in a variety of ways. Percent cover (100% or less), percent shrub cover, percent total cover (sum of all individual species covers, can be more than 100%), and Floristic Quality Index (FQI) (Cretini et al. 2012) were all analyzed by year, location (berm vs marsh), and marsh creation cell using ANOVA in RStudio (RStudioTeam 2016). There were 6 marsh creation "cells" with Cell 1 being the western lake berm (where there was no marsh creation), and then moving west to east along the southern shore of Lake Lery, there are Cells 2A, 2B, 3, 4, and 5, respectively (**Figure 1**). The marsh and shoreline vegetation data were analyzed separately for trends over time and compared to each other. The marsh vegetation data from the BS-0016 project were compared to data from CRMS 0115, which is natural intermediate marsh, located approximately four miles west of the project area. There are no CRMS stations in the immediate vicinity of the project. The BS-0016 project data and CRMS site data from 2018 and 2021 were compared by using ANOVA on the factors listed above, by site. Lastly, in order to compare community composition, non-metric multidimensional scaling (NMDS) was performed using RStudio with the Vegan Package. The NMDS analysis was performed using Bray-Curtis distances and two axes. Analysis was conducted which compared the community composition of each plot for the two surveys at the project by berm vs marsh and by year. The mean of the marsh stations only for the BS-0016 project for each year was compared to the mean of CRMS 0115 for the same survey years (2018 and 2021). Lastly, all plots from the BS-0016 and CRMS 0115 were compared for differences by site (project vs CRMS).

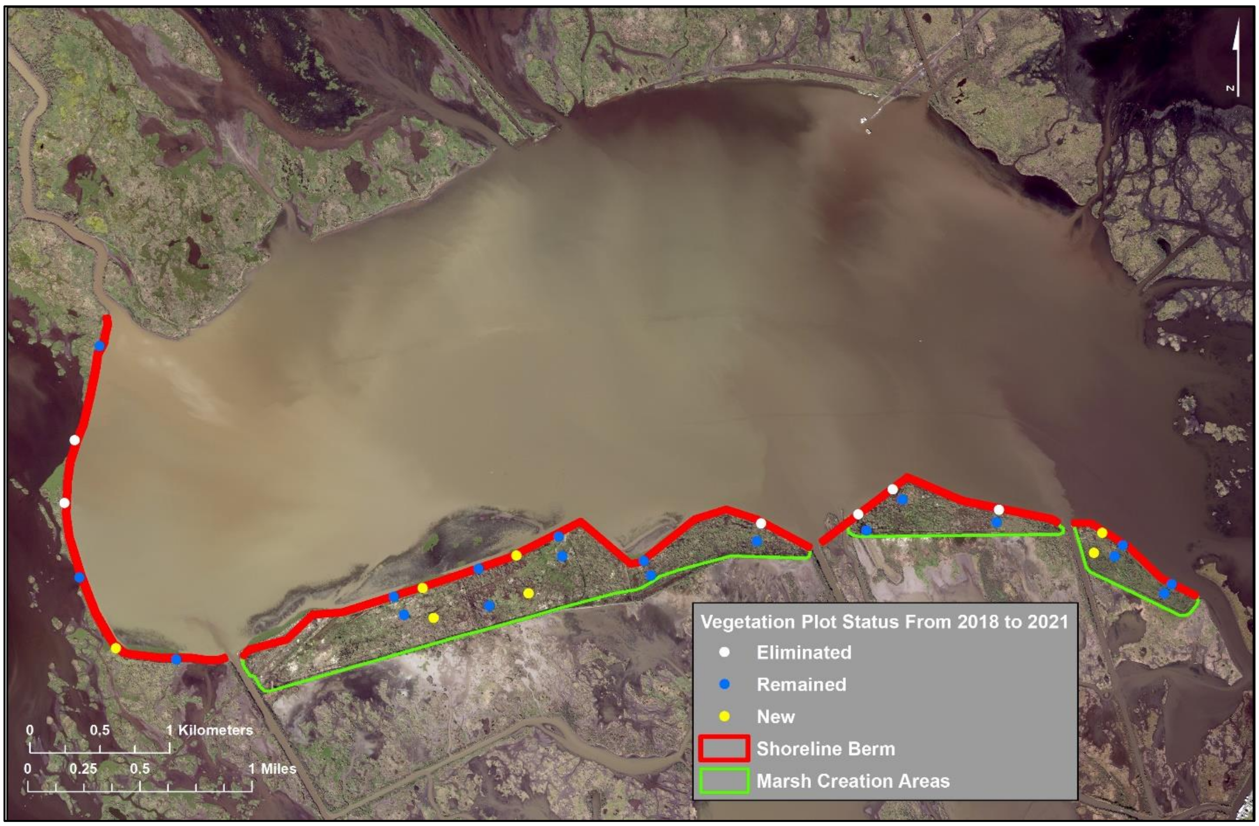


Figure 4: Location of the vegetation survey stations in the South Lake Lery Shoreline and Marsh Restoration (BS-0016) project area for 2018 and 2021. Some stations were eliminated when the shoreline berm eroded away in some locations. Stations were added in 2021 to replace the stations that were eliminated.

3. Shoreline Change Analysis

Shoreline position data will be used to assess the integrity of the shoreline berm and to track the movement of the shoreline over time. To evaluate change in shoreline position, a sub-meter Differential Global Positioning Satellite (DGPS) system was used to document the position of the vegetated marsh edge. Shoreline change rate analyses were conducted using the Digital Shoreline Analysis System (DSAS) provided by the USGS (Himmelstoss et al. 2018a). This analysis provides average shoreline change rates based on a series of transects that originate from a user defined baseline through the various shoreline surveys (**Figure 5** for example). In addition to average shoreline change rates, the DSAS also provides an estimate of how much of the change is statistically significant. For all analyses, transects were generated 25 meters apart (82 ft) and shoreline change was calculated for each transect and then averaged for the entire shoreline. For more details on the methods used in DSAS, see Himmelstoss et al. 2018b. Analysis was conducted on the entire shoreline and then also separated into two sections. One section is the western edge of Lake Lery where no marsh creation occurred behind the new shoreline, and the second section is the southern shore of Lake Lery, where marsh creation did occur. Shoreline surveys were conducted in 2017 (as-built condition), 2019 (year 2), and 2022 (year 5). Shoreline surveys will be conducted in 2026 (year 9), 2031 (year 14), and 2036 (year 19).

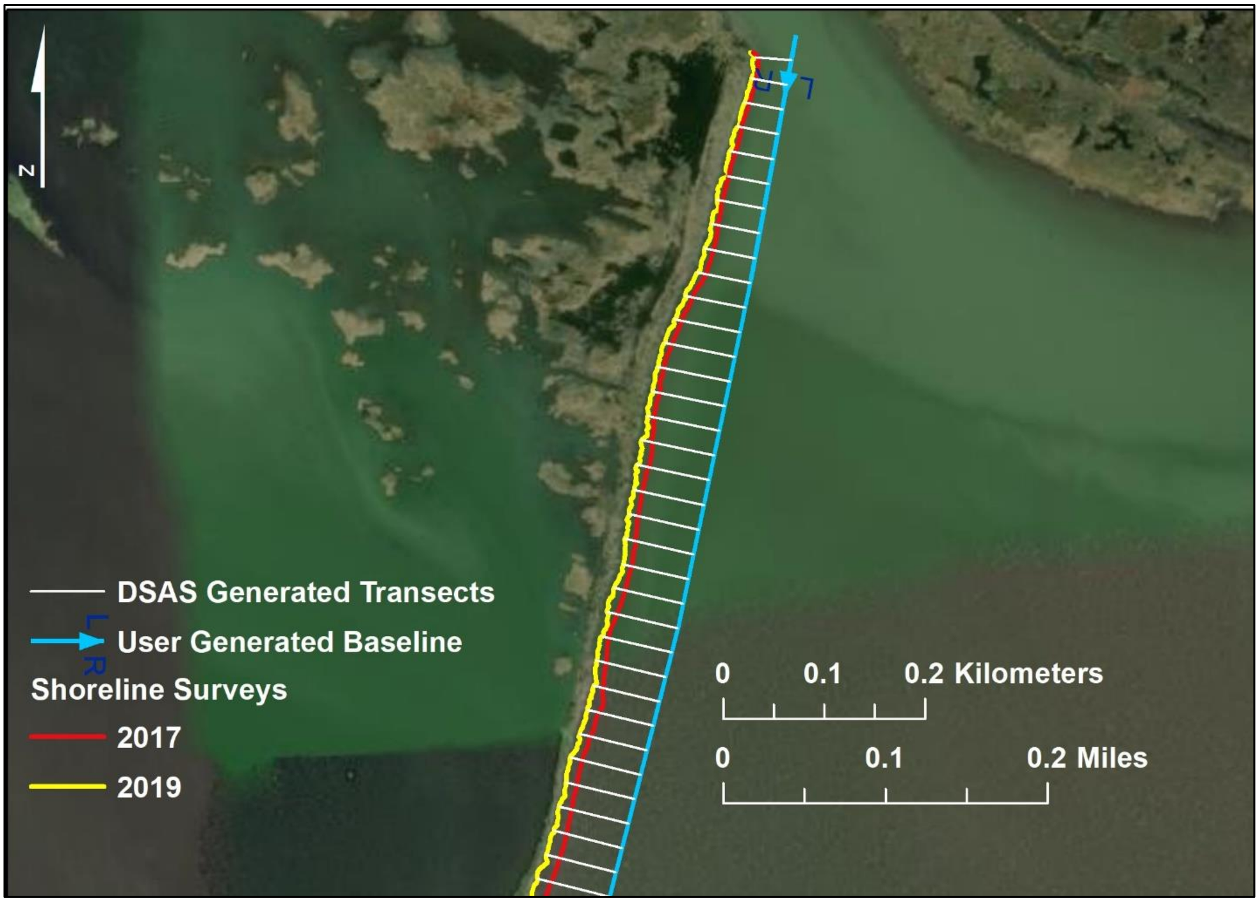
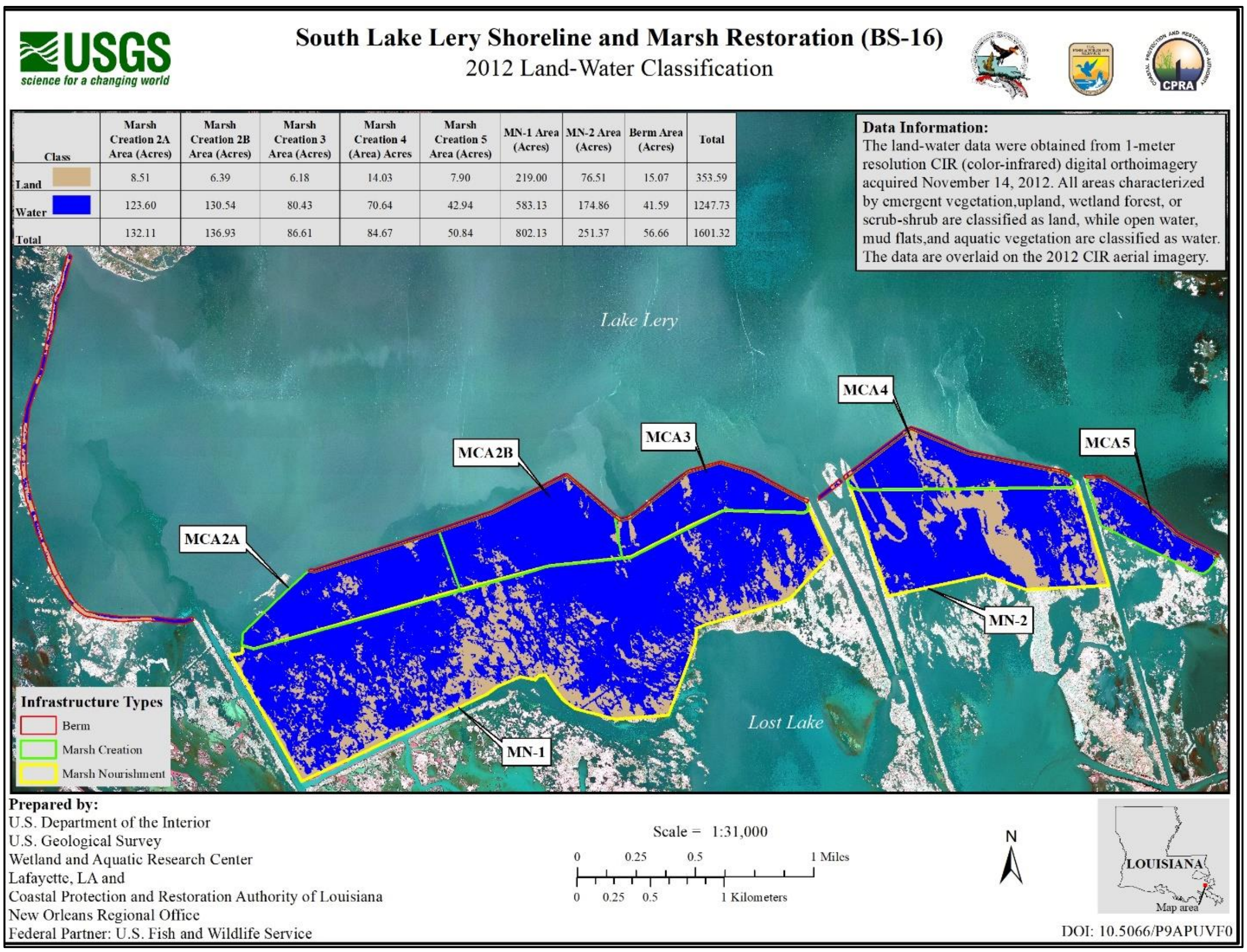


Figure 5: Example of transects generated by DSAS for shoreline change analysis. A shoreline change rate is calculated for each transect and then averaged for the entire shoreline length.

c. Monitoring Results and Discussion

1. Land/Water Analyses

The land/water analysis was conducted on 2012 (before the project) and 2018 imagery. Analysis was conducted on the marsh creation areas as well as the uncontained fill areas, in order to ascertain if the uncontained fill resulted in increased land. In 2012, there were 353.6 acres of land in the entire project area, or 28.3% of the area was land (**Figure 6**). In the marsh creation areas there were 58.1 acres or 10.6% land. In the uncontained fill area, there were 295.5 acres or 28% land. In 2018, there were 932.8 acres in the entire project area or 58.3% of the area was land (**Figure 7**). In the marsh creation areas there were 514.9 acres or 94% land. In the uncontained fill area there were 417.8 acres or 39.6% land. The marsh creation areas all had greater than 93% land area after project construction while the uncontained fill areas had less than 50% land (**Table 1**). The uncontained fill areas were constructed to use “extra” dredge material and therefore did not really cost any additional money in this case, and from that perspective was somewhat successful because it did result in additional land building without an increase in costs. However, this technique would not be recommended in general, since the resulting land building was not nearly as successful as in the traditionally constructed marsh creation areas. It will be interesting to track the land area in both the marsh creation and uncontained fill areas into the future to see if the there is a difference in long-term sustainability between the two areas.



Class	Marsh Creation 2A Area (Acres)	Marsh Creation 2B Area (Acres)	Marsh Creation 3 Area (Acres)	Marsh Creation 4 (Area) Acres	Marsh Creation 5 Area (Acres)	MN-1 Area (Acres)	MN-2 Area (Acres)	Berm Area (Acres)	Total
Land	8.51	6.39	6.18	14.03	7.90	219.00	76.51	15.07	353.59
Water	123.60	130.54	80.43	70.64	42.94	583.13	174.86	41.59	1247.73
Total	132.11	136.93	86.61	84.67	50.84	802.13	251.37	56.66	1601.32

Figure 6: Land/water analysis using 2012 imagery, before project construction.

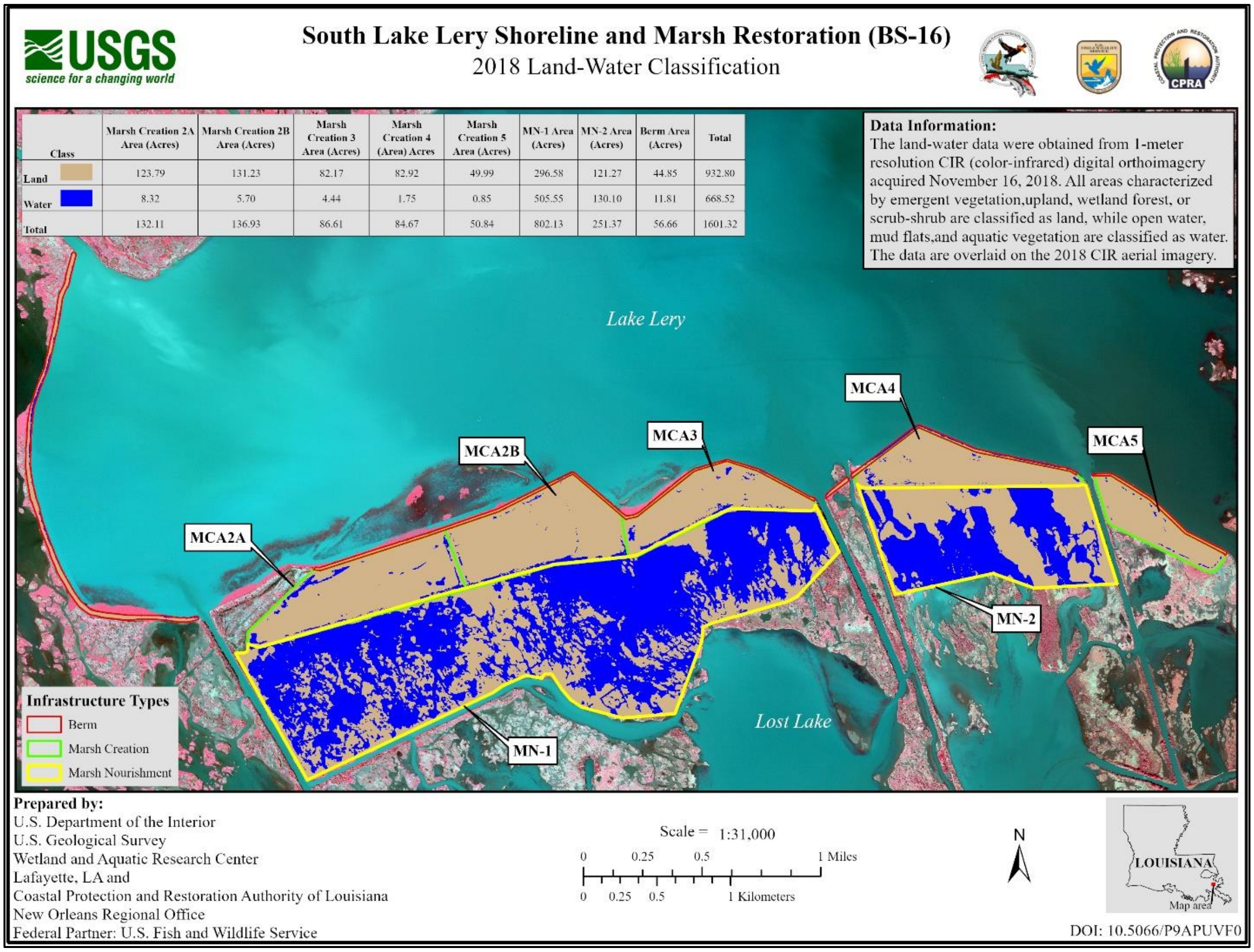


Figure 7: Land/water analysis using 2018 imagery, shortly after construction was complete. Analysis was conducted in both the marsh creation areas and the uncontained fill areas.

Table 1: Land area in acres and percent land in the marsh creation and uncontained fill areas in 2012 and 2018.

	MCA 2A		MCA 2B		MCA 3		MCA 4		MCA 5		MN 1		MN 2	
	Acres	% Land	Acres	% Land	Acres	% Land	Acres	% Land	Acres	% Land	Acres	% Land	Acres	% Land
2012	8.5	6.4%	6.4	4.7%	6.2	7.1%	14.0	19.9%	7.9	15.5%	219.0	27.3%	76.5	30.4%
2018	123.8	93.7%	131.2	95.8%	82.2	94.9%	82.9	97.9%	50.0	98.3%	296.6	37.0%	121.3	48.2%

2. Vegetation

Refer to **Appendix A** for a list of all species found in and around the BS-0016 vegetation plots in 2018 and 2021. In 2018, percent vegetation cover was 85.5% ± 21.5 in the marsh area and 81% ± 28.6 on the lake berm. By 2021, percent cover had reduced to 79.2% ± 10.8 in the marsh and 60% ± 27.9 on the lake berm. Percent cover was not significantly different by year, location (berm vs marsh) or their interaction. Percent cover was significantly different by cell (p=0.02) with "Cell 1" having significantly lower cover than cells 3 and 5. However, Cell 1 only had vegetation plots on the berm, which had lower percent cover then the marsh, while all of the other cells were pooled across the marsh and berm, therefore having a higher percent cover. There was no significant interaction of cell and location. Total percent cover (addition of individual species cover) was significantly different by year (p=0.04) but not by any other factor. Total cover was significantly lower in 2021 (86.2% ± 30) than in 2018 (105.4% ± 37.5). Since percent cover and total percent cover decreased in both the berm and the marsh from 2018 to 2021, there was most likely a regional event(s) that impacted the whole project area. This period was marked by active hurricane seasons, high, prolonged river flooding and high water, which could have impacted the project area. However, while cover decreased, species richness increased significantly from 2018 to 2021 (p<0.001). Species richness was not significantly different by any other factor. Species richness increased from 3.4 ± 1.6 to 6.1 ± 1.8 on the berm and from 4.7 ± 1.5 to 5.5 ± 1.9 in the marsh from 2018 to 2021. Overall, there were 28 species found in the vegetation plots in 2018 and 33 in 2021. During the vegetation surveys, the biologists also note species that are within 15 feet of each plot. When all of these species are taken into account, there were 40 species observed in 2018 and 49 in 2021. Percent shrub cover was not significantly different by any factor but cover did increase on the berm from 2018 to 2021 (8.2% ± 16.7 and 23.6% ± 21.8, respectively). The shrubs *Baccharis halimifolia* and *Iva frutescens* colonized the berm. There were multiple berm plots that had 65% shrub cover in 2021.

The Floristic Quality Index (FQI) is a tool used to determine habitat quality based on plant species composition, and a modified FQI (scaled from 0 to 100) was developed for coastal Louisiana to assess vegetation condition at the CRMS sites across various spatial and temporal scales (Cretini et al. 2012). The FQI was significantly different by location (p<0.001) with the berm having significantly lower FQI than the marsh, regardless of year (19.2 ± 16.1 and 45.8 ± 18.0, respectively). Between 2018 and 2021, the FQI decreased slightly on the berm and increased slightly in the marsh (**Figure 8**). The main reason for the low FQI on the berm was because Bermuda grass was seeded to help stabilize the berm. This species is not native and therefore receives a CC score of zero when calculating the FQI. Since this species dominated the berm, it resulted in a low FQI score. The species that were seeded into the berm decreased in cover over time. The *Paspalum vaginatum* cover was reduced from 18% to <1% from 2018 to 2021 and *Cynodon dactylon* was reduce from 48% to 22%. Overall, both the berm and the marsh had good percent cover (over 80%) just one year after project construction completion.

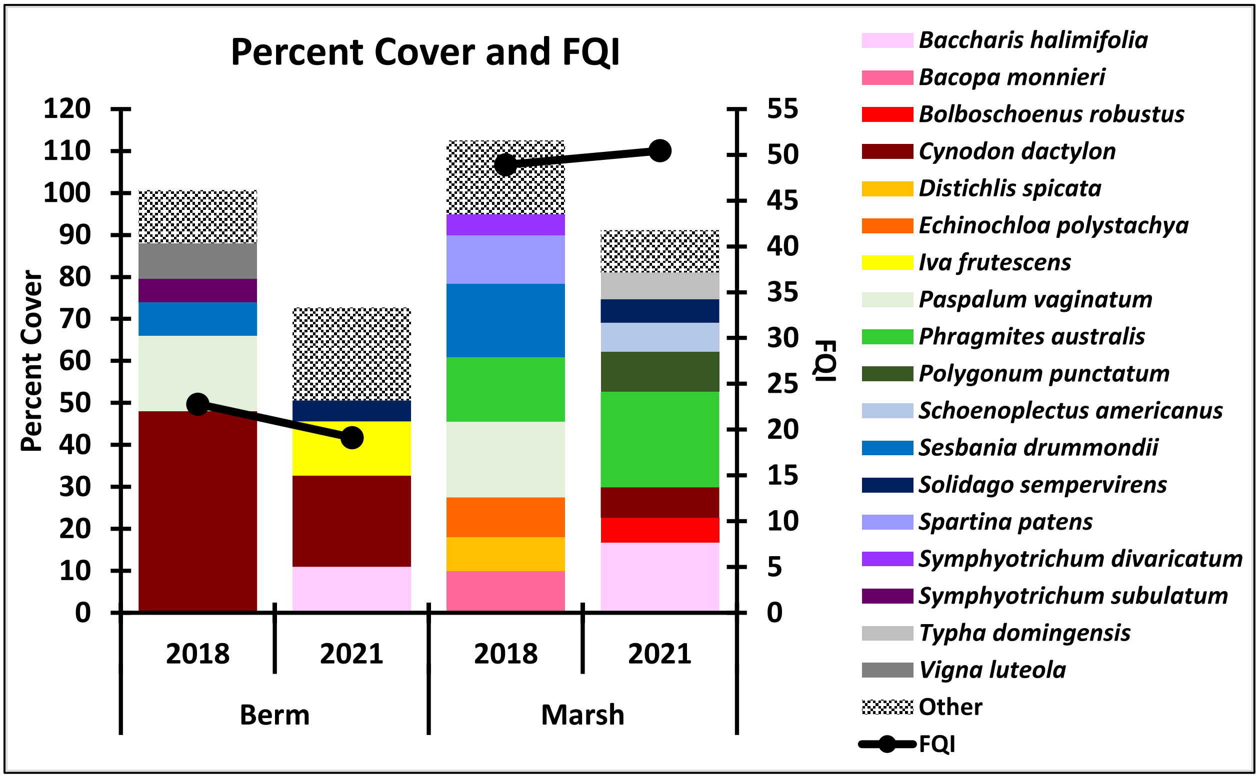


Figure 8: Percent cover and FQI at the BS-0016 project, separated by year and location (lake berm vs marsh).

The vegetation at the BS-0016 project marsh was compared to the vegetation at CRMS 0115 for the same survey years, 2018 and 2021 (lake berm plots at the BS-0016 project were excluded from this analysis) (**Figure 9**). Analysis was conducted analyzing percent cover, total percent cover, percent shrub cover, species richness, and FQI by year, type (CRMS vs project), and their interaction. Percent cover was significantly different by type (p=0.02) with CRMS having higher percent cover than the BS-0016 project. The CRMS 0115 station had a mean percent cover in 2018 of 91.8% ± 6.5 and in 2021 91.0% ± 8.1. The BS-0016 marsh stations had a percent cover in 2018 of 85.5% ± 21.5 and in 2021 79.2% ± 10.8. Therefore the CRMS station not only had a higher percent cover, but also less variability, as indicated be the standard deviation. Total cover was significantly different by type (p=0.006) and by year (p=0.008), but not by their interaction. Similar to percent cover, the CRMS site had higher cover than the BS-0016 project, but both sites experienced a reduction in total cover between 2018 and 2021 (**Figure 9**). Total cover at the BS-0016 project site in 2018 was 112.5% ± 36.3 and in 2021 was 99.8% ± 21.9. At the CRMS 0115 site, total cover in 2018 was 149.1% ± 35.9 and in 2021 was 112.1% ± 14.3. As mentioned above, it appears that regionally, vegetation cover was reduced between 2018 and 2021. Percent shrub cover was not significantly different by any factor. Both areas had similar shrub cover and both areas experienced a reduction in shrub cover from 2018 to 2021. Species richness at the CRMS site was significantly higher than at the BS-0016 project (p=0.002) with 7.2 ± 2.4 species at the CRMS site and 5.1 ± 1.8 at the BS-0016 project.

The FQI was not statistically different by type, year, or their interaction. In 2018, the FQI at CRMS 0115 and BS-0016 project were similar. In 2021, the FQI was similar to the prior survey at the BS-0016 project, but the CRMS site experienced a nine point reduction, most likely due to the expansion of *Alternanthera philoxeroides* (alligator weed; cc score = 0) and the reduction of *Spartina patens* (saltmeadow cordgrass;

cc score = 9). The BS-0016 project had a FQI lower than the mean of the FQI of all intermediate marshes across the coast, higher than the mean of all marshes in Breton Basin, and lower than the mean of all marshes coastwide (**Figure 10**). The CRMS 0115 FQI was lower than the 25 percentile when compared to other intermediate marshes and lower than the mean when compared to Breton Basin and coast-wide marshes.

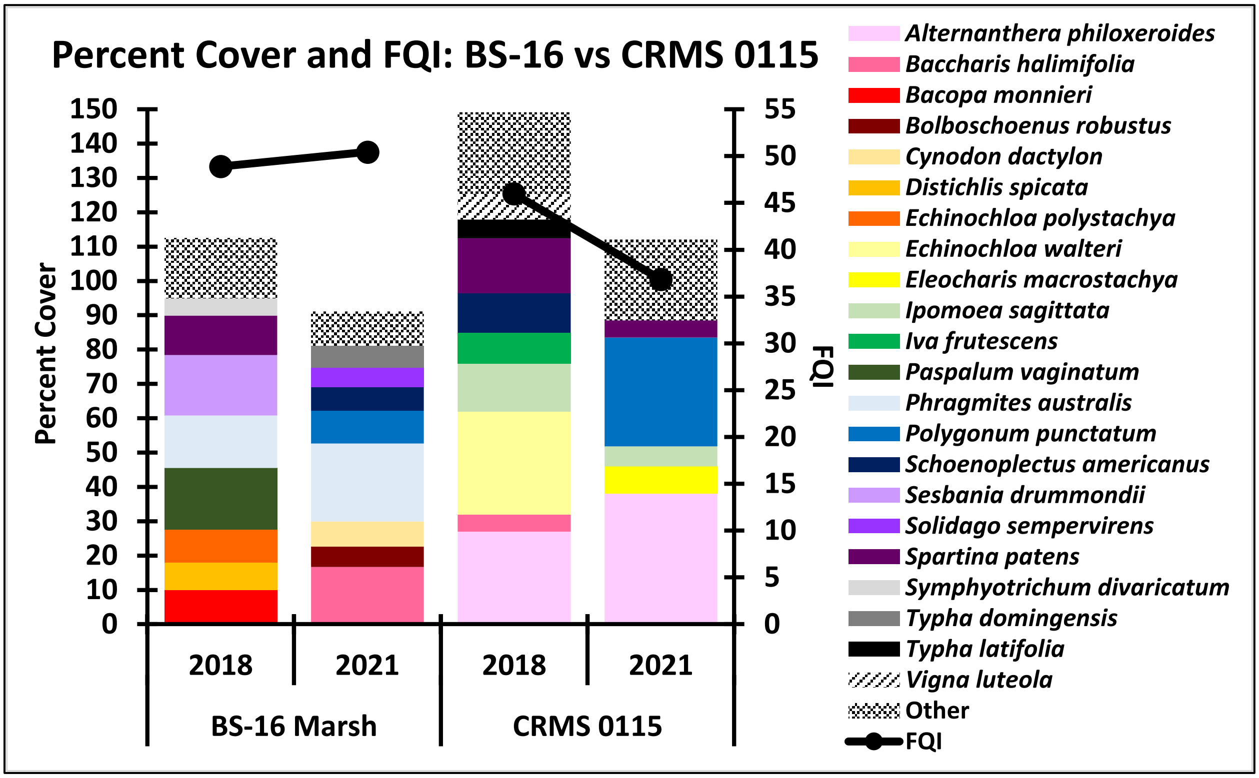


Figure 9: Percent cover and FQI at the BS-0016 project marsh and CRMS 0115 in 2018 and 2021. The lake berm vegetation plots were excluded from this analysis.

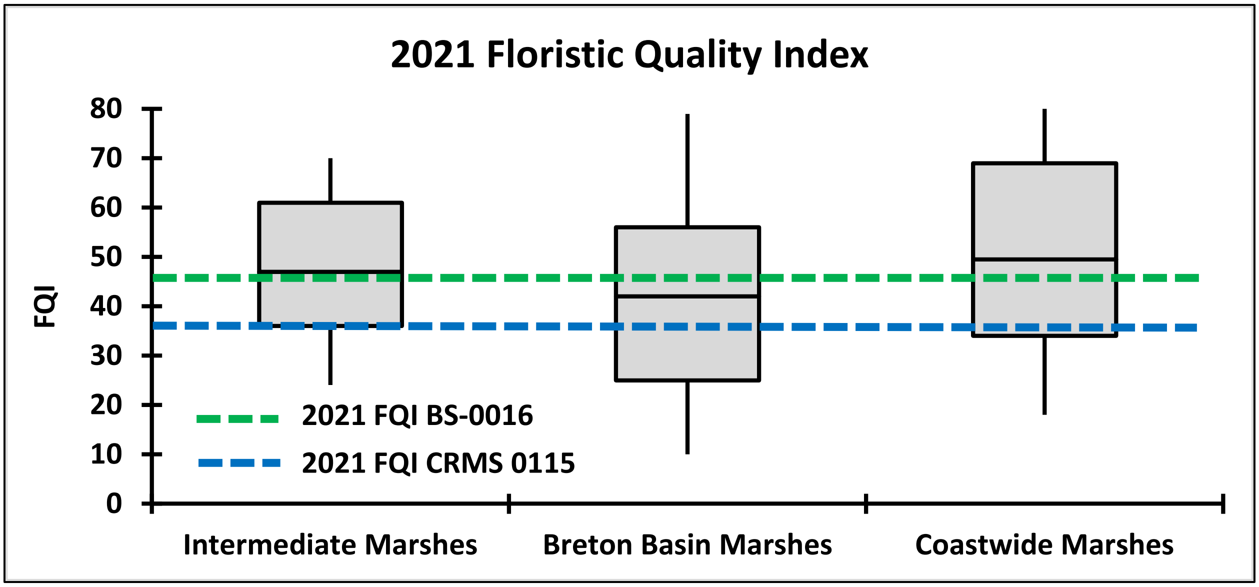


Figure 10: The 2021 FQI of the BS-0016 marsh plots and CRMS 0115 compared to other intermediate marshes across the state, marshes in Breton Sound and all marshes in the state.

Non-metric multidimensional scaling (NMDS) analysis was conducted on all of the BS-0016 plots from both years (51 plots total, 25 in 2018, 26 in 2021) in order to investigate if there were differences in community composition by year or by location (berm vs marsh). Analysis was conducted with all species included, and then re-analyzed with all species with less than 5% cover removed from the analysis. When all species were included, the NMDS analysis could not converge on a solution. When low-cover species were removed, the NMDS arrived at a convergent solution with a stress of 0.21. A convergent solution above 0.2 is a poor result that can result in false interpretation (Clarke and Warwick 2001). However, in this case, it seems that the NMDS convergence showed a significant difference in community composition by location (berm vs marsh, p=0.001). The species that were characteristic of the berm community were Bermuda grass, alligatorweed, and hairypod cowpea (*Vigna luteola*) (**Table 2 and Figure 11**). The species that was characteristic of the marsh habitat was the common reed (*Phragmites australis*). Because Bermuda grass was seeded on the berm, it is expected that this species is characteristic of the berm environment. Cover of this species on the berm did reduce over time. Also, there is one marsh plot mixed in with the berm plots in **Figure 11**, and this is because in 2021, this plot had 95% cover of Bermuda grass, most likely growing down from the berm. The other species planted on the berm (California bulrush and smooth cordgrass), were most likely not dominant in the berm data set because they were planted on the lake-side slope of the berm and the monitoring plots were located on the top of the berm.

Table 2: Species from the BS-0016 plots in 2018 and 2021 included in the NMDS analysis. No species that had under 5% cover were included. Species in bold were significant in driving the results of the analysis at the p=0.05 level or less.

Species	Species Code	NMDS1	NMDS2	r^2	P-Value
Alternanthera philoxeroides	**ALPH**	**-0.18989**	**0.9818**	**0.21**	**0.005**
Baccharis halimifolia	**BAHA**	**0.86131**	**0.50808**	**0.18**	**0.016**
Bacopa monnieri		0.62723	0.77883	0.08	0.104
Bolboschoenus robustus		0.43557	-0.90016	0.03	0.486
Cynodon dactylon	**CYDA**	**-1**	**0.00197**	**0.43**	**0.001**
Cyperus odoratus		0.11617	-0.99323	0.01	0.928
Distichlis spicata		-0.37324	-0.92773	0.06	0.139
Echinochloa polystachya		-0.56733	-0.82349	0.12	0.074
Eremochloa ophiuroides		0.25203	0.96772	0.01	0.866
Ipomoea sagittata		0.45751	-0.8892	0.07	0.203
Iva frutescens		-0.45479	0.8906	0.10	0.083
Panicum dichotomiflorum		-0.217	0.97617	0.08	0.122
Paspalum vaginatum	**PAVA**	**-0.04876**	**-0.99881**	**0.23**	**0.003**
Phragmites australis	**PHAU**	**0.80048**	**-0.59937**	**0.44**	**0.001**
Pluchea odorata		0.98963	-0.14365	0.07	0.167
Polygonum punctatum		0.40831	0.91285	0.08	0.176
Rorippa palustris		0.02556	0.99967	0.06	0.253
Sambucus sp.		0.55209	0.83379	0.03	0.638
Schoenoplectus americanus		0.89122	-0.45356	0.03	0.472
Schoenoplectus californicus		0.19256	-0.98129	0.04	0.398
Sesbania drummondii	**SEDR**	**-0.59769**	**-0.80172**	**0.28**	**0.003**
Solidago sempervirens	**SOSE**	**0.6866**	**0.72703**	**0.19**	**0.007**
Spartina patens		0	-1	0.09	0.098
Symphyotrichum divaricatum		0.99092	0.13447	0.09	0.078
Symphyotrichum subulatum		-0.9998	-0.01982	0.00	0.909
Typha domingensis		0.9602	0.27932	0.05	0.233
Typha latifolia		0.97518	-0.22139	0.08	0.086
Vigna luteola	**VILU**	**-0.95642**	**-0.29198**	**0.16**	**0.01**

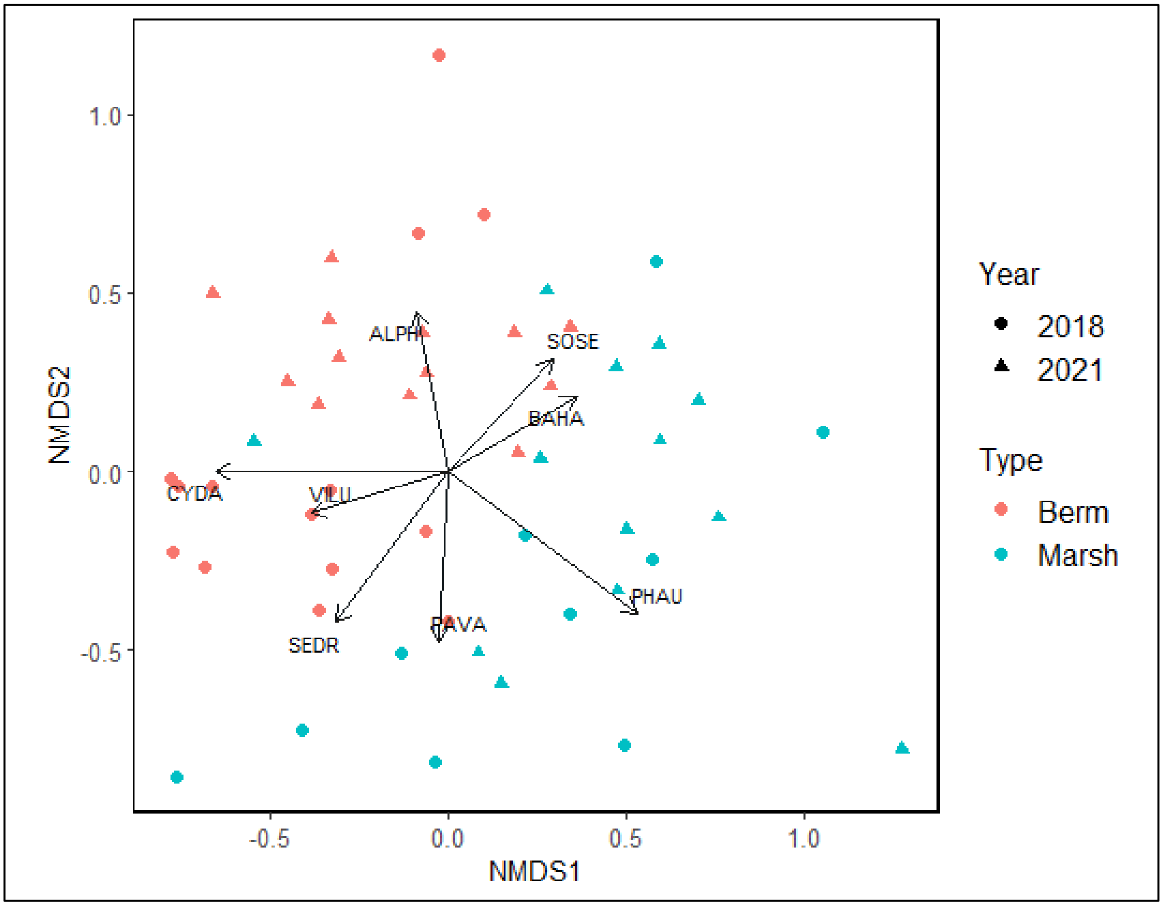


Figure 11: Results of the NMDS analysis of the BS-0016 plots by location and by year. Reference Table 2 to identify species by the code.

A similar analysis was conducted in order to compare the community composition of CRMS 0115 and the BS-0016 project sites. For all of these analyses, only the plots from the BS-0016 marsh were used and the berm plots were excluded. The first NMDS analysis compared the average species cover from CRMS and the project in 2018 and 2021. This analysis did not converge on a solution. Another analysis was conducted to compare CRMS 0115 and BS-0016 vegetation plot data for 2021. In 2021, the CRMS station had 10 plots and the project had 13 plots. For this analysis, species with less than 5% cover were removed. The analysis had a convergent solution with a stress of 0.19, which is a fair solution, better than the previous analysis (Clarke and Warwick 2001), with a significant difference in community composition between CRMS and BS-0016 vegetation (p=0.001). The BS-0016 community was characterized by seashore paspalum, sturdy bulrush (*Bolboschoenus robustus*), common reed, and the shrub eastern baccharis (*Baccharis halimifolia*) (**Table 3 and Figure 12**). The CRMS 0115 community was characterized by alligatorweed, hydrocotyle, fall panicgrass (*Panicum dichotomiflorum*), and softstem bulrush (*Schoenoplectus tabernaemontani*) (**Table 3 and Figure 12**). While both areas are classified as intermediate marsh, it appears that the BS-0016 community is not yet similar to the natural marsh at the CRMS station. It can take time for the vegetation community at a created marsh site to become similar to natural marsh, however, it is usually the quickest factor to become similar when compared to soil characteristics, etc. (Faulkner and Poach 1996, Edwards and Proffitt 2003). The created marsh is most likely at a higher elevation only four years after construction than the natural marsh, which may also drive differences in vegetation community composition (Edwards and Proffitt 2003). The BS-0016 marsh was built to between 2 and 3 ft. in elevation (which has decreased since, due to compaction and dewatering), and the CRMS 0115 marsh is at 1.5 ft. (NAVD88 for both).

Table 3: Species from the BS-0016 and CRMS 0115 plots in 2021 included in the NMDS analysis. No species that had under 5% cover were included. Species in bold were significant in driving the results of the analysis at the p=0.05 level or less.

Species	Species Code	NMDS1	NMDS2	r^2	P-Value
Alternanthera philoxeroides	**ALPH**	**-0.61836**	**-0.7859**	**0.46**	**0.001**
Baccharis halimifolia	**BAHA**	**0.63456**	**0.77287**	**0.26**	**0.041**
Bacopa monnieri		-0.11823	-0.99299	0.06	0.59
Bolboschoenus robustus	**BORO**	**-0.19737**	**0.98033**	**0.29**	**0.026**
Cynodon dactylon		-0.65118	0.75893	0.15	0.18
Cyperus odoratus		-0.93223	0.36186	0.11	0.333
Distichlis spicata		0.3269	0.94506	0.08	0.552
Eleocharis macrostachya		-0.36982	-0.9291	0.18	0.133
***Hydrocotyle* sp.**	**HYTL**	**-0.86062**	**-0.50924**	**0.30**	**0.027**
Ipomoea sagittata		-0.95526	-0.29577	0.08	0.438
Iva frutescens		-0.98642	0.16422	0.08	0.466
Panicum dichotomiflorum	**PADI**	**-0.58428**	**-0.81155**	**0.29**	**0.025**
Paspalum vaginatum	**PAVA**	**-0.27021**	**0.9628**	**0.39**	**0.004**
Phragmites australis	**PHAU**	**0.99359**	**-0.11304**	**0.58**	**0.001**
Polygonum punctatum		-0.61586	-0.78786	0.14	0.229
Schoenoplectus americanus		-0.28414	0.95878	0.07	0.545
Schoenoplectus californicus		-0.21033	0.97763	0.20	0.083
Schoenoplectus tabernaemontani	**SCTA**	**-0.15334**	**-0.98817**	**0.27**	**0.032**
Solidago sempervirens		0.64995	0.75997	0.23	0.054
Spartina patens		-0.59933	-0.8005	0.02	0.829
Symphyotrichum spp.		-0.61933	-0.78513	0.07	0.607
Typha domingensis		0.51634	-0.85638	0.10	0.282
Typha latifolia		0.35209	-0.93596	0.08	0.437
Vigna luteola		0.54213	0.8403	0.20	0.091

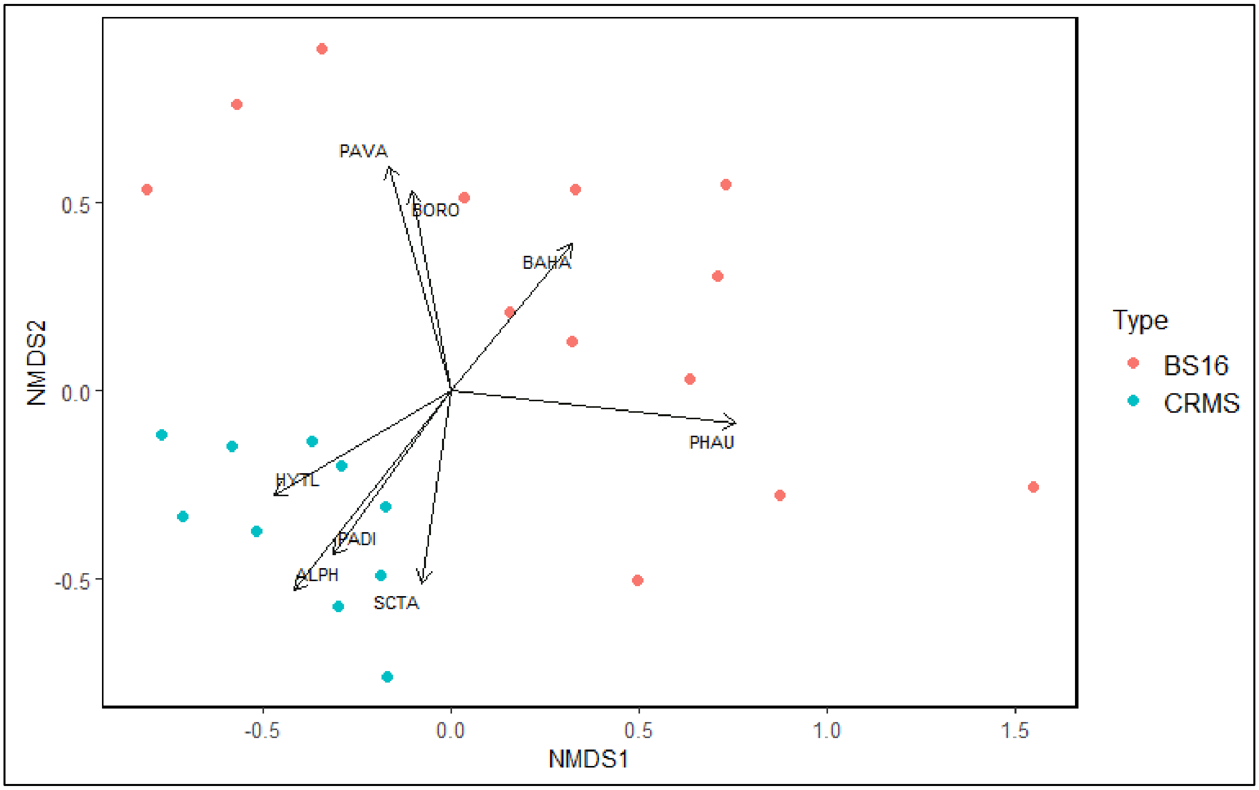


Figure 12: Results of the NMDS analysis of the BS-0016 and CRMS 0115 plots in 2021. Reference Table 3 to identify species by the code.

Overall, the vegetative community at the BS-0016 project seemed to suffer a similar regional decline from 2018 to 2021 as nearby natural marsh when compared to CRMS stations east and south of the project area (CRMS 0115 was included in the analysis above but CRMS 0114, 0146, 0131, and 0135 had similar declines). This decline in FQI also included a decline in shrub cover. The period of 2018 through 2021 was marked by Mississippi River flood and elevated water levels. Also the first half of 2021 (before the 2021 vegetation survey occurred) was marked by high rainfall, which included 50 inches of rain by the end of June, 10 inches in March, and 13 inches each in April and May. By the end of the year, the rain total was 86 inches, well above the annual average of 63 inches the region normally experiences. All of these events could have caused extended periods of inundation during the growing season, which can reduce vegetative cover, especially of species that are less tolerant of prolonged inundation.

The lake berm and marsh plant community at the BS-0016 project were different, which is to be expected due to the plantings and seeding that occurred on the berm as well as the elevation differences between the two. The berm was less diverse and had different species present than the marsh (there was some overlap in species). Three years after construction, the BS-0016 marsh was not similar to natural, nearby intermediate marsh. This is to be expected so soon after construction, as species colonize and then are eliminated, and given the higher elevation of the project in comparison to natural marsh. The project marsh is expected to subside over time and enter a tidal regime more similar to natural marsh. Future vegetation surveys will be analyzed to determine if the differences between the BS-0016 berm and marsh, and the differences between the project and natural marsh persist over time.

3. Shoreline Change Analysis

There were 443 transects drawn for the shoreline change analysis at a 25 m spacing. Over the two years between the 2017 and 2019 survey (essentially the as-built and project year 2 surveys) there was an average shoreline change rate of -11.2 ft/yr ± 4.9 (-3.4 m/yr ± 1.5) (**Table 4, Figures 13 and 14**). Of the 443 transects, 304 or 68.6% were erosional and 139 or 31.4% were accretional. The average rate of erosion at erosional transects was -18.1 ft/yr (-5.5 m/yr) with a maximum erosion of –39.6 ft/yr (-12.1 m/yr). This maximum erosion point was located on the south shore of Lake Lery, where the project polygon juts out into the lake in a triangle shape. A total of 55.5% of the transects had erosion rates that were statistically significant. The average rate of accretion at the accretional transects was 4.0 ft/yr (1.2 m/yr). The maximum rate of accretion was 12.4 ft/yr (3.9 m/yr) which was located on the south shore of the lake on the western side of the project area on a portion of the shore that is oriented toward the northwest. A total of 3.4% of the accretional transects were statistically significant.

The area along the western shore of Lake Lery, where no marsh creation was conducted, had 127 transects with an average shoreline change of -12.5 ft/yr ± 6.9 (-3.8 m/yr ± 2.1). Of the 127 transects, 113 or 89% were erosional with 75.6% of the transects having statistically significant erosion. The average erosion rate was -14.6 ft/yr (-4.5 m/yr) with the maximum erosion rate of -25.6 ft/yr (-7.8 m/yr). The maximum erosion was located at the southern end of this section of shoreline. There were 14 accretional transects in this section or 11.0% of the transects. The average accretion was 4.0 ft/yr (1.2 m/yr) with a maximum accretion of 5.8 ft/yr (1.8 m/yr). The highest rate of accretion occurred also near the southern end of the shoreline where it curves from eastern facing to northern facing.

The southern shoreline had 316 transects with an average shoreline change of -10.6 ft/yr ± 6.9 (-3.2 m/yr ± 2.1). Of these transects, 191 or 60.4% were erosional, with an average erosion rate of -20.1 ft/yr (-6.1 m/yr). There were 125 or 39.6% of the transects that were accretional with an average accretion rate of 4.0 ft/yr (1.2 m/yr). In this section 47.5% of the transects had statistically significant erosion and 4.7% of the transects had significant accretion. The maximum rates of erosion and accretion for this section were the same as listed for the entire shoreline above.

There were less transects drawn for analysis comparing the 2019 and 2022 shorelines. Twelve transects were eliminated because there was no longer shoreline present in 2022 at those locations. The majority of the complete shoreline loss occurred along the western shoreline. Along the southern shoreline there were two small areas where gaps developed. The common conditions for all areas that were missing shoreline was that there was no marsh creation behind the shoreline, leaving the shoreline vulnerable to gapping rather than retreat. Therefore, in the 2019/2022 analysis, there were 431 transects drawn rather than the 443 drawn previously. From 2019 to 2022 the average shoreline change rate was -5.8 ft/yr ± 3.0 (-1.8 m/yr ± 0.9) (**Table 4, Figures 13 and 14**). Of the 431 transects, 315 or 73.1% were erosional and 116 or 26.9% were accretional. The average rate of erosion at erosional transects was -9.7 ft/yr (-3.0 m/yr) with a maximum erosion of –26.6 ft/yr (-8.1 m/yr). This maximum erosion point was located on the south shore of Lake Lery, where the project polygon juts out into the lake in a triangle shape. A total of 57.3% of the transects had erosion rates that were statistically significant. The average rate of accretion was 5.0 ft/yr (1.5 m/yr). The maximum rate of accretion was 74.6 ft/yr (22.7 m/yr). A total of 12.1% of the accretional transects were statistically significant. The large maximum accretion rate is attributable to two transects that were located where a small island that was previously unconnected from the shoreline, became attached. This is an anomalous condition and not representative of the average shoreline condition. Therefore, analysis was conducted with these two transects removed. When the transects were removed, the average shoreline change rate increased to -6.1 ft/yr ± 3.0 (-1.9 m/yr ± 0.9). The average accretion rate decreased to 3.7 ft/y (1.1 m/yr) with a maximum value of accretion of 9.1 ft/yr (2.8 m/yr). The maximum value occurred towards the western end of the southshore where the shore is northwest facing.

The area along the western shore of Lake Lery, where no marsh creation was conducted, had 113 transects with an average shoreline change of -7.5 ft/yr ± 4.2 (-2.3 m/yr ± 1.3). Of the 113 transects, 102 or 90.2% were erosional with 79.6% of the transects having statistically significant erosion. The average erosional rate was -8.7 ft/yr (-2.6 m/yr) with the maximum erosion rate of -16.0 ft/yr (-4.9 m/yr). There were 11 accretional transects in this section or 9.8% of the transects with 1.8% of the transects demonstrating statistically significant accretion. The average accretion was 2.7 ft/yr (0.8 m/yr) with a maximum accretion of 6.0 ft/yr (1.8 m/yr). Accretion in this western section occurred near the southern end of the shoreline where it curves from eastern facing to northern facing.

The southern shoreline had 318 transects with an average shoreline change of -5.1 ft/yr ± 4.2 (-1.6 m/yr ± 1.3). Of these transects, 213 or 67% were erosional, with an average erosion rate of -10.2 ft/yr (-3.1 m/yr). There were 105 or 33% of the transects that were accretional with an average accretion rate of 5.2 ft/yr (1.6 m/yr). In this section 49.4% of the transects had statistically significant erosion and 15.7% of the transects had significant accretion. For the southern section, analysis was conducted leaving out the two outlier transects, as described above. When those two transects were removed, average shoreline change rate increased to -5.6 ft/yr ± 4.2 (-1.7 m/yr ± 1.3). The average accretion rate decreased to 3.9 ft/yr (1.2 m/yr). It is important to note that the average shoreline change rate from 2019 to 2022 is most likely a larger decrease than found in this analysis as all of the transects that were eliminated due to missing shoreline would have been erosional transects.

As with the previous analysis, there were less transects drawn when comparing the 2017 to the 2022 shoreline due to missing shoreline in 2022. In the 2017/2022 analysis, there were 424 transects drawn. From 2017 to 2022 the average shoreline change rate was -7.8 ft/yr ± 1.7 (-2.4 m/yr ± 0.5) (**Table 4, Figures 13 and 14**). Of the 424 transects, 293 or 69.1% were erosional and 131 or 30.9% were accretional. The average rate of erosion at erosional transects was -13.1 ft/yr (-4.0 m/yr) with a maximum erosion of –28.9 ft/yr (-8.8 m/yr). The maximum erosion rates were found on the south shore of Lake Lery, where project polygons jut out into the lake in a triangle shape. A total of 60.6% of the transects had erosion rates that were statistically significant. The average rate of accretion was 4.0 ft/yr (1.2 m/yr). The maximum rate of accretion was 44.3 ft/yr (13.5 m/yr). A total of 20.5% of the accretional transects were statistically significant. As above, the large maximum accretion rate is attributable to two transects that were located where a small island that was previously unconnected from the shoreline, became attached so analysis was conducted with these two transects removed. When the transects were removed, the average shoreline change rate increased to -8.1 ft/yr ± 1.7 (-2.5 m/yr ± 0.5). The average accretion rate decreased to 3.3 ft/yr (1.0 m/yr) with a maximum value of accretion of 6.9 ft/yr (2.1 m/yr).

The area along the western shore of Lake Lery, where no marsh creation was conducted, had 113 transects with an average shoreline change of -9.1 ft/yr ± 2.5 (-2.8 m/yr ± 0.8). Of the 113 transects, 99 or 87.6% were erosional with 83.2% of the transects having statistically significant erosion. The average erosional rate was -10.8 ft/yr (-3.3 m/yr) with the maximum erosion rate of -17.7 ft/yr (-5.4 m/yr). There were 14 accretional transects in this section or 12.4% of the transects with 5.3% of the transects demonstrating statistically significant accretion. The average accretion was 2.5 ft/yr (0.8 m/yr) with a maximum accretion of 5.5 ft/yr (1.7 m/yr). Accretion in this western section occurred near the southern end of the shoreline where it curves from eastern facing to northern facing.

The southern shoreline had 311 transects with an average shoreline change of -7.3 ft/yr ± 2.5 (-2.2 m/yr ± 0.8). Of these transects, 194 or 62.4% were erosional, with an average erosion rate of -14.3 ft/yr (-4.4 m/yr) and a maximum erosion rate of -28.9 ft/yr (-8.8 m/yr). There were 117 or 37.6% of the transects that were accretional with an average accretion rate of 4.1 ft/yr (1.3 m/yr). In this section 52.4% of the transects had statistically significant erosion and 26.1% of the transects had significant accretion. For the southern section, analysis was conducted leaving out the two outlier transects, as described above. When those two transects were removed, average shoreline change rate increased to -7.7 ft/yr ± 2.5 (-2.3 m/yr ± 0.8). The average accretion rate decreased to 3.4 ft/yr (1.1 m/yr). As with the 2019/2022 analysis, the average shoreline change rate from 2017 to 2022 is most likely a larger decrease than found in this analysis as all of the transects that were eliminated due to missing shoreline would have been erosional transects.

Table 4: Shoreline change rates over time at the BS-0016 project.

		2017 - 2019		2019 - 2022		2017 - 2022	
		ft/yr	m/yr	ft/yr	m/yr	ft/yr	m/yr
Project	**Shoreline Change Rate**	-11.2	-3.4	-6.1	-1.9	-8.1	-2.5
	Erosion Rate	-18.1	-5.5	-9.7	-2.3	-13.1	-4.0
	Accretion Rate	4.0	1.2	3.7	1.1	3.3	1.0
Western Shore	**Shoreline Change Rate**	-12.5	-3.8	-7.5	-2.3	-9.1	-2.8
	Erosion Rate	-14.6	-4.5	-8.7	-2.6	-10.8	-3.3
	Accretion Rate	4.0	1.2	2.7	0.8	2.5	0.8
Southern Shore	**Shoreline Change Rate**	-10.6	-3.2	-5.6	-1.7	-7.7	-2.3
	Erosion Rate	-20.1	-6.1	-10.2	-3.1	-14.3	-4.4
	Accretion Rate	4.0	1.2	3.9	1.2	3.4	1.1

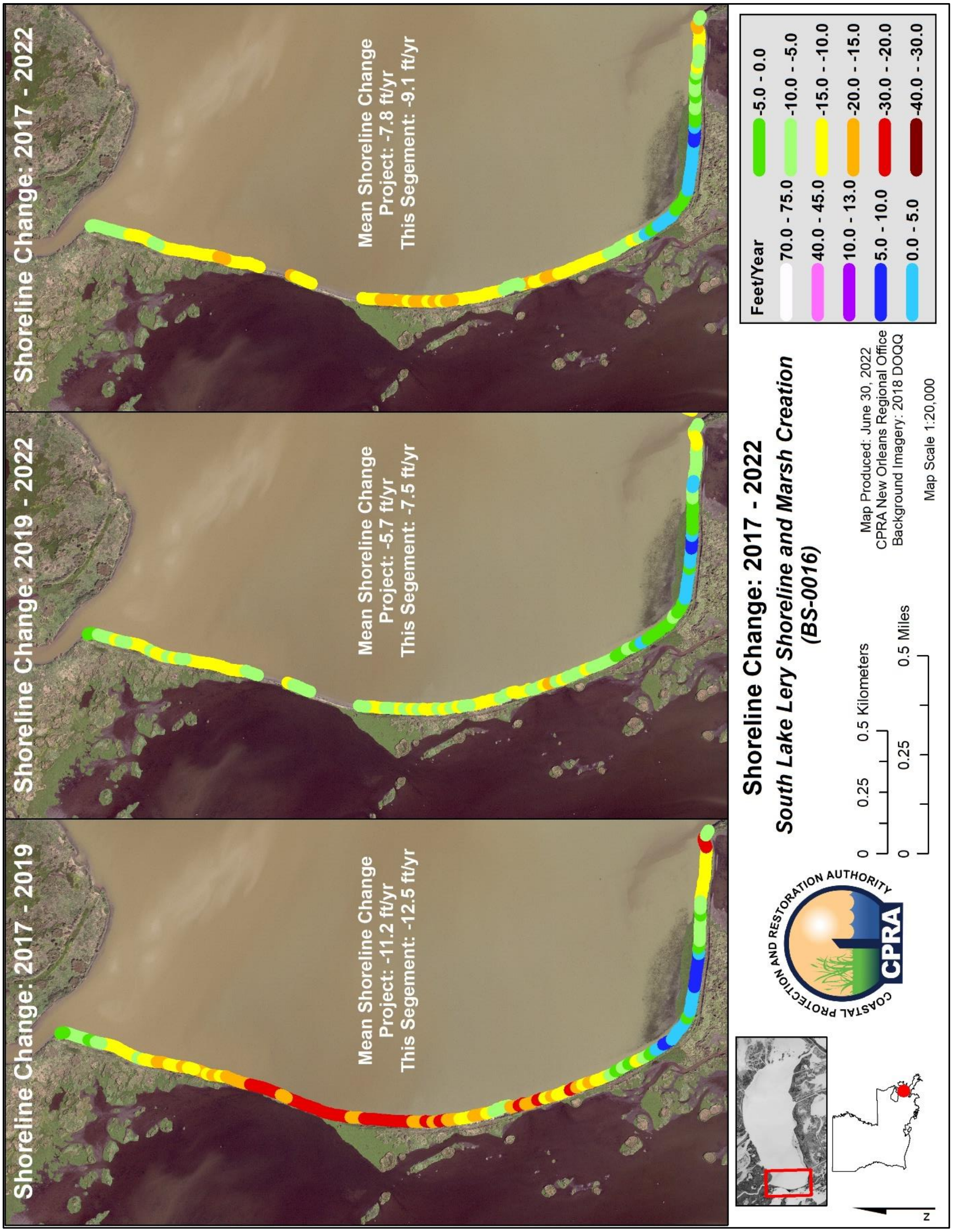


Figure 13: Shoreline change over time at the western shore of the South Lake Lery Shoreline and Marsh Creation project (BS-0016).

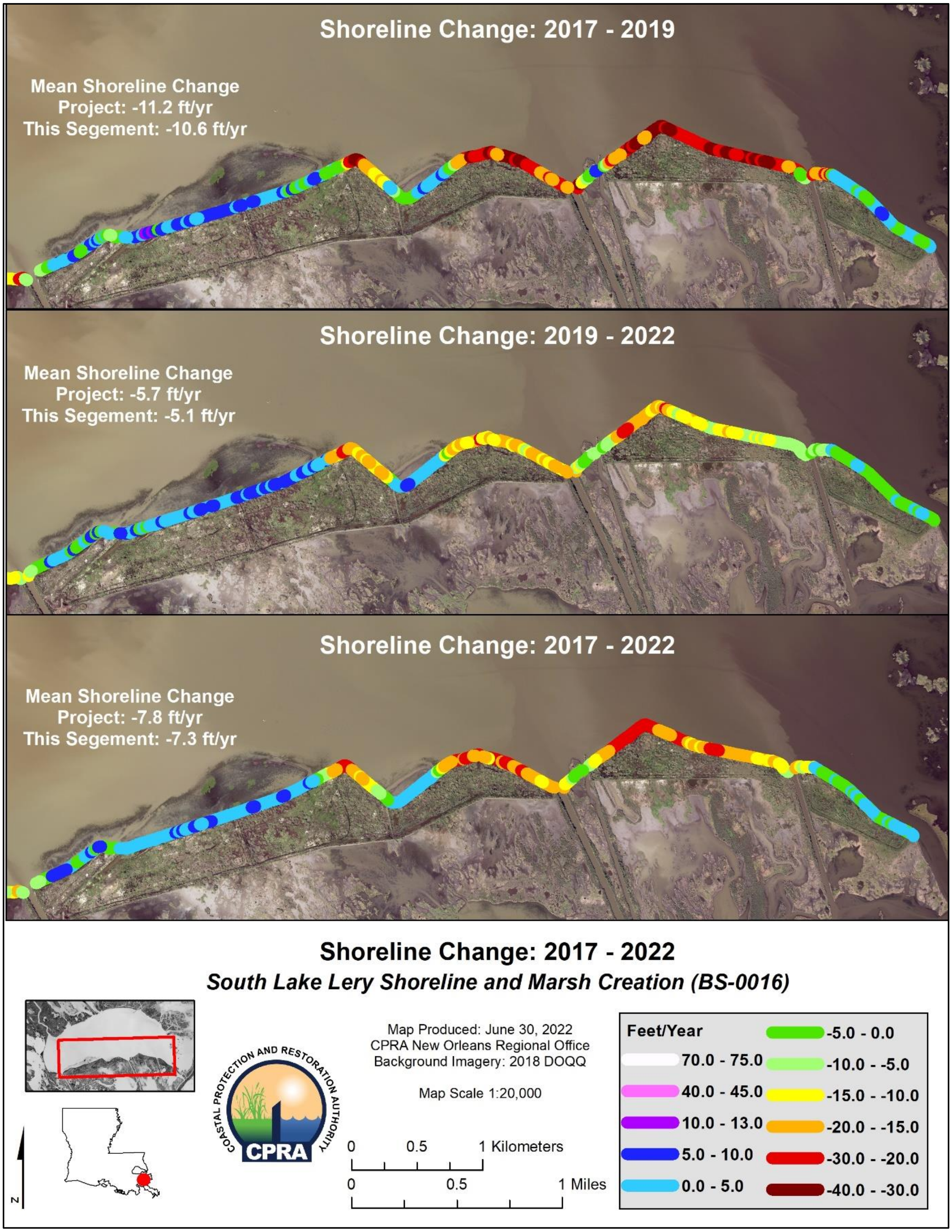


Figure 14: Shoreline change as along the southern shore of the South Lake Lery Shoreline and Marsh Creation project (BS-0016).

The shoreline at the South Lake Lery Shoreline and Marsh Creation project is an overall erosional environment (**Figure 15**). There are some small areas with low rates of accretion (mostly less than 5 ft/yr), with areas of erosion surpassing 30 ft/yr early on in the project and averaging 20 to 30 ft/yr of erosion over the five years since project construction. Erosion rates were highest along the western shoreline where there was no marsh creation behind the constructed shoreline feature and along the southern shore where project polygons jutted out into the lake (rather than a straighter lined shore). Erosion rates were highest between 2017 and 2019, and decreased during the 2019 – 2022 period. However, during the later increment, erosion rates still surpassed 30 ft/yr in some locations. Areas of accretion were concentrated in the southwest corner, extending along the western end of the south shore. In front of this area of shoreline there appears to a shallow area where submerged aquatic vegetation grows (perhaps ephemerally throughout the year), which may provide some wave energy dampening, allowing for expansion of the bulrush that was planted in front of the lake rim to help protect the lake berm feature. These shallows can be seen in figures 2, 13, and 14. Along the shoreline that is erosive, the bulrush is mostly not present. There is also a small length of low rate shoreline accretion at the far eastern end of the project shoreline. This stretch of shoreline is facing northeast and may be protected by land just to the north as the lake narrows on the eastern end. This decreases the fetch of direct wind driven wave action from northeastern winds. Shoreline erosions rates for the 2019 to 2022 and 2017 to 2022 periods represent a conservative shoreline rate because of the missing shoreline along the western edge. These areas would have a higher rate of erosion similar to the rest of this shoreline, if analysis was able to be conducted on these stretches. The western shoreline was especially vulnerable, both because no marsh creation was conducted behind this shoreline to help stabilize and slow erosion, and because the lake fetch is longest along this shoreline and would be impacted during east winds. The east/west fetch of Lake Lery is approximately 6 miles while the north/south fetch is approximately 2 miles. Strong northerly and easterly winds would affect the project area the most. The next shoreline survey is scheduled for 2026, which will be year 9 of the project.

Figure 15: Pictures of the erosional environment as the BS-0016 project: Clockwise from top right: Erosional western shoreline with gap developing; Long-view of the erosional western shoreline; erosional southern shoreline with planted *Schoenoplectus californicus* in front, which was originally planted right on the shoreline; Long-view of the erosional southern shoreline with planted species off of the shoreline.

V. Conclusions

a. Project Effectiveness

The BS-0016 project was effective in building land in the planned marsh creation areas, and building some land in the uncontained fill areas. The created marsh became naturally vegetated and seems to be thriving. The earthen berm on the lake edge has seen substantial erosion, especially in areas that jut out into the lake or where there is no marsh creation behind, where the berm was breached and eroded away. Lake Lery is a very high energy lake with a large fetch, where wave action is high during wind events. Therefore, the lake berm portion of the project was not as successful as planned.

b. Recommended Improvements

A repair of the western shoreline feature is recommend. The repair should be constructed in conjunction with marsh creation behind the shoreline as outlined in the 95% design for this project, or the repair should incorporate some harder material such rock, or another strategy such as articulated concrete mats, if they can be proven to be effective in a high energy environment. The entire western shoreline should be fortified, not only the areas where breaches have occurred. If shoreline erosion rates remain similar on the southern shore in future surveys, a fortification of the southern shoreline with harder material is also recommended.

c. Lessons Learned

A major lesson learned is to not construct an earthen shoreline feature without marsh creation behind it. The western shoreline was planned to have marsh creation behind the lake berm, but there was not enough construction funding to complete this project feature. Project managers decided to abandon the marsh creation portion and only construct the shoreline. The shoreline breached within a few years of construction and by 2022, approximately 0.25 miles were missing or 1/8 of the western shoreline. The erosion of this shoreline is expected to continue at a rapid rate, because the existing breaches will allow tidal flow in and out of the pond behind the shoreline, causing the shoreline to erode at a faster rate. In the future, these features should either be constructed with a non-erosive material that is resistant to erosion, like rock, or the feature should not be constructed until the accompanying marsh creation can be constructed as well.

Another lesson learned is that marsh creation polygons along an active shoreline should be designed with smooth edges to decrease erosion rates. This project had polygons where in three locations, the designed shape jutted out into Lake Lery and these were the areas of the project with the highest erosion rates. The shape of the marsh interior portion of the polygon does not seem to be of concern.

Lastly, uncontained fill, while it can provide some benefit, did not, in this case result in substantial land building. However, considering that this fill was provided at no extra cost to the project, the resulting land building is a net benefit in this case. This technique is not recommended as a primary method of marsh creation.

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Appendix A:
Master Plant Species List for 2018 and 2021 in the BS-0016 Project Area.

Scientific Name	Common Name	Status+	CC Score	Duration	Form	Family
Alternanthera philoxeroides	alligatorweed	I	0	Perennial	Herb	Amaranthaceae
Amaranthus australis	southern amaranth	N	2	Annual	Herb	Amaranthaceae
Ammannia latifolia	pink redstem	N	4	Annual	Herb	Lythraceae
Andropogon glomeratus	bushy bluestem	N	3	Perennial	Graminoid	Poaceae
Baccharis halimifolia	eastern baccharis	N	4	Perennial	Shrub	Asteraceae
Bacopa monnieri	herb of grace	N	5	Perennial	Herb	Scrophulariaceae
Bidens laevis	smooth beggartick	N	3	Annual	Herb	Asteraceae
Bolboschoenus robustus	sturdy bulrush	N	7	Perennial	Graminoid	Cyperaceae
Chamaesyce maculata	spotted sandmat	N	1	Annual	Herb	Euphorbiaceae
Colocasia esculenta	coco yam	I	0	Perennial	Herb	Araceae
Cynodon dactylon	Bermudagrass	I	0	Perennial	Graminoid	Poaceae
Cyperus odoratus	fragrant flatsedge	N	4	Annual	Graminoid	Cyperaceae
Cyperus virens	green flatsedge	N	4	Perennial	Graminoid	Cyperaceae
Digitaria ciliaris	southern crabgrass	N	4	Annual	Graminoid	Poaceae
Distichlis spicata	saltgrass	N	2,9*	Perennial	Graminoid	Poaceae
Echinochloa polystachya	creeping river grass	N	5	Perennial	Graminoid	Poaceae
Echinochloa walteri	coast cockspur grass	N	5	Annual	Graminoid	Poaceae
Eclipta prostrata	false daisy	N	3	Annual	Herb	Asteraceae
Eleocharis vivipara	viviparous spikerush	N	3	Annual	Graminoid	Cyperaceae
Eremochloa ophiuroides	centipede grass	I	0	Perennial	Graminoid	Poaceae
Fimbristylis castanea	Saltmarsh Fimbristylis	N	6	Perennial	Graminoid	Cyperaceae
Galium tinctorium	stiff marsh bedstraw	N	2	Perennial	Herb	Rubiaceae
Heliotropium curassavicum	salt heliotrope	N	4	Annual	Herb	Boraginaceae
Hydrocotyle	hydrocotyle	N	3	Perennial	Herb	Apiaceae
Ipomoea sagittata	saltmarsh morning-glory	N	8	Perennial	Vine	Convolvulaceae
Iva frutescens	Jesuit's bark	N	4	Perennial	Shrub	Asteraceae
Kosteletzkya virginica	Virginia saltmarsh mallow	N	7	Perennial	Herb	Malvaceae
Ludwigia leptocarpa	anglestem primrose-willow	N	4	Annual	Herb	Onagraceae
Lythrum lineare	wand lythrum	N	5	Perennial	Herb	Lythraceae
Panicum dichotomiflorum	fall panicgrass	N	3	Annual	Graminoid	Poaceae
Panicum hemitomon	maidencane	N	10	Perennial	Graminoid	Poaceae
Panicum repens L.	Torpedograss	N	3	Perennial	Graminoid	Poaceae
Paspalum vaginatum	seashore paspalum	N	7	Perennial	Herb	Araceae
Phragmites australis	common reed	N	6	Perennial	Graminoid	Poaceae
Pluchea odorata	sweetscent	N	2	Annual	Herb	Asteraceae
Polygonum punctatum	dotted smartweed	N	5	Annual	Herb	Polygonaceae
Rorippa palustris	bog yellowcress	N	2	Annual	Herb	Brassicaceae
Sacciolepis striata	American cupscale	N	6	Perennial	Graminoid	Poaceae
Sagittaria lancifolia	Bulltongue	N	6	Perennial	Herb	Alismataceae
Salix nigra	black willow	N	2	Perennial	Tree	Salicaceae
Sambucus	elderberry	N	2	Perennial	Shrub	Caprifoliaceae
Schoenoplectus americanus	chairmaker's bulrush	N	8	Perennial	Graminoid	Cyperaceae
Schoenoplectus californicus	California bulrush	N	7	Perennial	Graminoid	Cyperaceae
Schoenoplectus tabernaemontani	softstem bulrush	N	7	Perennial	Graminoid	Cyperaceae
Sesbania drummondii	poisonbean	N	2	Perennial	Shrub	Fabaceae
Sesbania herbacea	bigpod sesbania	N	2	Annual	Shrub	Fabaceae
Solanum	nightshade	N	3	Annual	Herb	Solanaceae
Solidago sempervirens	seaside goldenrod	N	4	Perennial	Herb	Asteraceae
Spartina patens	saltmeadow cordgrass	N	9	Perennial	Graminoid	Poaceae
Symphyotrichum divaricatum	southern annual saltmarsh aster	N	4	Annual	Herb	Asteraceae
Symphyotrichum subulatum	eastern annual saltmarsh aster	N	4	Annual	Herb	Asteraceae
Typha domingensis	southern cattail	N	3	Perennial	Graminoid	Typhaceae
Typha latifolia	broadleaf cattail	N	2	Perennial	Graminoid	Typhaceae
Vigna luteola	hairypod cowpea	N	3	Perennial	Vine	Fabaceae
Zizaniopsis miliacea	giant cutgrass	N	5	Perennial	Graminoid	Poaceae

+ N= Native; I= Introduced

* When species occurs in Fresh or Intermediate marsh it receives a CC score of 2, when it ocurrs in Brackish or Salt marsh, it receives a 9