State of Louisiana
Coastal Protection and Restoration Authority (CPRA)

2023 Short Summary Report

for

Cameron-Creole Watershed Grand Bayou Marsh Creation

State Project Number CS-54
Priority Project List 20

April 2024
(Revised April 2025)

Cameron Parish

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Table of Contents

I. Preface

The Cameron-Creole Watershed Grand Bayou Marsh Creation (CS-54) 2023 short summary report includes monitoring data collected through August 2023.

This report is intended to update USFWS on the latest land/water, hydrographic, vegetation and elevation change data. Future summary reports are planned for 2029 and 2034, and comprehensive OM&M reports are planned for 2026, 2032, and 2038.

II. Monitoring Activity

Pursuant to a CWPPRA Task Force decision on August 14, 2003 to adopt the Coastwide Reference Monitoring System-*Wetlands* (CRMS) for CWPPRA, the CS-54 Monitoring Plan was written to merge it with CRMS and provide more useful information for modeling efforts and future project planning while maintaining the monitoring mandates of the Breaux Act. In this report, seven CRMS sites outside of the project area (CRMS 0644, 0645, 0650, 0648, 1738, 1743, and 2418) are to be used to assess the effectiveness of the project along with the project-specific monitoring.

A. Monitoring Goals

The Cameron-Creole Watershed Grand Bayou Marsh Creation project (CS-54) was designed to create sustainable emergent marsh through the use of dredged sediments from a disposal site within Calcasieu Lake (Figure 1). The benefits provided by the project include the re-creation of degraded wetlands that provide important wetland habitat for marine organisms and the enhancement of storm protection for inland areas. Additionally, the Cameron-Creole Watershed Grand Bayou Marsh Creation project will work in conjunction with other projects in the area to reduce salt water intrusion, tidal exchange, and erosion within the Cameron-Creole Watershed. Construction was conducted at each project area in the following order: Northern MCA (6/15/2018), Southern MCA (6/29/2019), LDNR MCA (9/15/2019), and Marsh Nourishment Area (10/24/2019).

The objectives of the Cameron-Creole Watershed Grand Bayou Marsh Creation project are:

1. Construct an emergent marsh that is 80% vegetated and contains 175 acres of land in the Northern cell and 318 acres in the Southern cell.
2. Construct a marsh that settles to the height predicted by the established settlement curves within the Southern and Northern Cells and maintains an elevation of 1.1 ft NAVD88 (Geoid 03) at the end of the project life. The Southern Cell is predicted to settle to 1.91 ft at FY1, 1.39 ft at FY3, 1.22 ft at FY5 and 1.13 ft at FY10. The northern Cell is predicted to settle to 1.80 ft at FY1, 1.37 ft at FY3, 1.24 ft at FY 5 and 1.15 ft at FY10. W
3. Construct a marsh that is flooded between 20% and 60% of the year and maintains water levels between 2” above and 6” below the marsh surface after settlement.

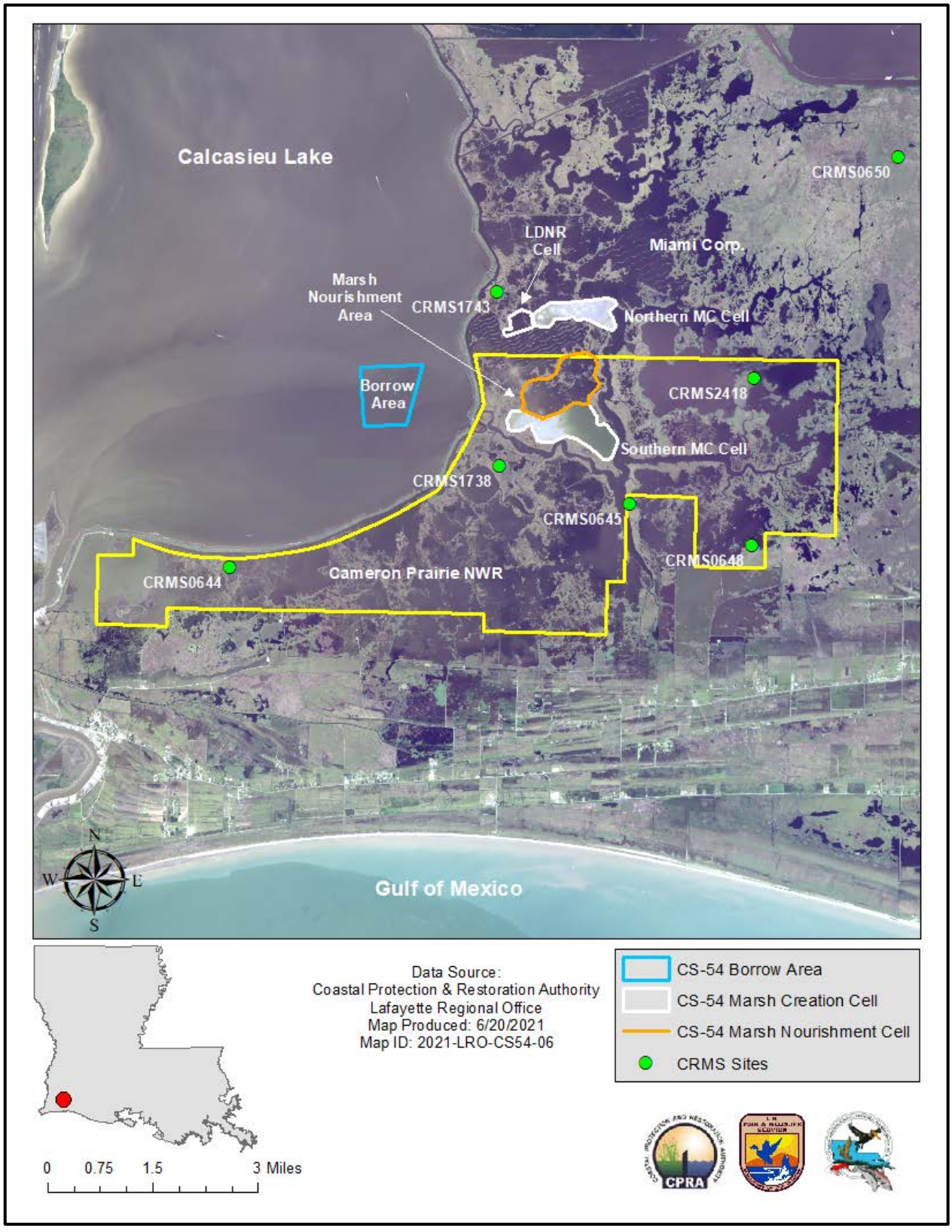

Figure 1: Cameron-Creole Watershed Grand Bayou Marsh Creation (CS-54) project features.

B. Monitoring Elements

Land Water Survey

Land/Water analysis of the CS-54 project will be obtained from digital imagery with 1-meter resolution. Aerial photography will be collected for the entire coast through CRMS and will be used to evaluate CS-54 along with project specific photography. The photography will be georectified and, using standard operating procedures described in Steyer et al. (1995, revised 2000), land/water ratios will be determined. Aerial Photography will be captured post-construction when CRMS coastwide imagery becomes available near 2025 and at a later date if deemed necessary.

Elevation Surveys

To monitor the settlement of the marsh surface, relative to target elevations, a cross sectional survey will be conducted across the unit. Survey transects will be spaced at 1000 feet intervals in the created marsh and will extend 200 feet into the open water and marsh adjacent to the marsh creation cells. Position, elevation, and ground elevation will be recorded every 50 feet along each transect. All bathymetric surveys must be corrected for tidal fluctuations and wave action to the NAVD88 vertical datum. All surveys shall be performed to CPRA standards. Fill area elevation surveys were completed post construction in November 2019 (as-built) and May 2022, and will be conducted in 2025, 2030 and at a later date if deemed necessary. To monitor the settlement of the underlying soils, six settlement plates were placed in the marsh creation areas during construction at locations where geotechnical soil borings were collected pre-construction. Settlement plates will be resurveyed in 2025 and at a later date if deemed necessary.

Water Level

Water level within the surrounding marsh is measured at seven CRMS sites every hour with a water-level gauge installed within an area that is hydrologically connected to the surrounding water body. The gauge is surveyed relative to the top of the RSET (NAVD 88). Water level data is used to document the variability in water levels and duration of inundation in project and reference areas.

Emergent Vegetation

Emergent vegetation parameters will be evaluated at 20 sampling stations established uniformly across the Nourishment Area, and the LDNR Marsh Creation Area (MCA), Northern MCA, and Southern MCA using techniques described in Folse et al. (2023) to quantify percent cover, height of dominant species, and species composition. Vegetation will be monitored in 2m x 2m sampling plots marked with 2 corner poles to allow for revisiting the sites over time. Vegetation data from the seven CRMS sites within the watershed will be used as reference stations to compare species composition over time. Vegetation monitoring began in 2023 and will be sampled again in 2025 and 2030.

Borrow Area Surveys

To determine fill rates within the borrow area, bathymetric and topographic surveys of the Calcasieu Lake borrow area will be performed along the same transects as the As-Built Surveys. Survey transects will be spaced 1000 feet apart and extend 250 feet beyond the boundaries of the borrow area. Position and bottom elevation will be recorded every 50 feet along each transect. All bathymetric surveys must be corrected for tidal fluctuations and wave action to the NAVD88 vertical datum. All surveys shall be performed to CPRA standards. Borrow area elevation surveys were completed in November 2019 and May 2022, and will be conducted in 2025 and at a later date if deemed necessary.

Dissolved Oxygen/ Hypoxia Monitoring

To identify potentially hypoxic conditions within the dredge borrow area, synoptic surveys recorded dissolved oxygen (DO), depth, salinity and temperature in the borrow area continuously from June through September. Measurements were taken in the deepest portion of the borrow area, approximately 2 feet off of the bottom, and in a reference location approximately 0.25 to 0.50 miles outside of the borrow area. The location of the reference area was based on results of the geophysical investigation (CB&I; BAMM 2013). Site visits were conducted once per month for data collection. During each deployment, maintenance event and retrieval, vertical profiles were taken for temperature, salinity and dissolved oxygen (DO) at each site. Vertical profile data were collected at one foot intervals. Dissolved oxygen monitoring was completed in 2021.

C. Monitoring Results and Discussion

Land/Water Survey

When available, aerial photography from CRMS coastwide imagery will be analyzed using standard Land/Water analysis methodology. This data will be used to assess the project goal of an 80% vegetated emergent marsh with 175 acres of land in the Northern Cell and 318 acres in the Southern Cell. Land/Water analysis is expected to become available in 2025, and will be used in subsequent reporting to assess project goals.

Elevation Survey

Unless otherwise noted, all elevations presented are in NAVD88 vertical datum, Geoid 12B. All design/target elevations were also adjusted from Geoid 03 using the latest CRMS elevation benchmark survey, by a factor of -0.23 ft. Using the updated survey benchmark, the goal of the project is a settled marsh elevation of 0.87 (Geoid 12B) ft at the end of the 20-year project life. In order to achieve this, a target construction elevation of 2.97 ft was determined for the Northern marsh creation area (MCA) and 3.17 ft for the Southern MCA. Due to prolonged pumping durations and analysis of highly concentrated dredge slurry, the target elevation of the Southern MCA was reduced to 2.27 ft (Figure 2). During construction additional funding became available for the construction of the LDNR MCA as well as the nourishment of a 391 acre area north of the Southern MCA. Based on the changes made for the Southern MCA during construction, the target elevation of the LDNR MCA was determined to be 2.27 ft and the Marsh Nourishment Area was 1.27 ft (Table 1). Dredging activities in the LDNR MCA (19 days) occurred much faster than the Northern (129 days) and Southern (364 days) MCAs. This resulted in the LDNR MCA having less

than half the volume per acre than the Southern MCA and significantly less time to dewater, resulting in more settlement after construction (Table 1). This is also shown in the remaining area of the Southern MCA after the construction elevation target was reduced (ST-7 and ST-8, Figure 2). Although ST-1 and ST-7 in the Southern MCA settled to approximately the same elevation (1.1 and 1.03 ft, respectively), ST-1 was constructed to an elevation 0.72 ft lower than ST-7, further highlighting the effects of dredge characteristics on settlement rates and their effect on meeting project elevation target (Figure 2; Table 1).

The Northern and Southern MCAs were pumped to an average elevation of 2.9 and 2.6 ft and were both measured to an average height of 1.6 ft in 2022 at year 3 (Figures 2-4). When compared to the settlement curves, both the Northern and Southern MCAs have remained at an elevation approximately 0.4 ft higher than the predicted elevation at year three (Figures 5-6). The Southern MCA has decreased in elevation at a rate of 0.58 ft/yr while the Northern MCA has decreased by 0.70 ft/yr. The Northern and Southern MCAs are expected to settle at or above the goal settled marsh elevation of 0.87 ft at the end of the 20 year project life.

Soil deposition from Hurricanes Laura and Delta in 2020 have affected elevation within the MCAs. Reference CRMS sites experienced increases in elevation change rates as a result of a 0.4 ft elevation gain on average at the sites between 2020 and 2021 (Figure 7). Elevation gains ranged from 0.13 to 0.55 ft. This soil deposition is still present at the reference sites as of surveys conducted in March 2022. Due to the close proximity of the marsh creation areas to these reference CRMS sites, it is believed that the CS-54 project also experienced hurricane driven soil deposition of up to 0.4 ft. When adjusted for this hurricane driven soil deposition, the surveyed elevation of the Northern and Southern MCA follows the predicted elevation depicted in the settlement curves in 2022 (Figures 5-6).

The LDNR MCA was pumped to an average elevation of 2.1 ft and was measured to an average height of 0.7 ft in 2022. Elevation in the LDNR MCA is decreasing at a rate of 0.85 ft/yr, which is a higher rate of settlement than the Northern and Southern MCA. The goal of a settled marsh elevation of 0.87 ft is not being met and the LDNR MCA is expected to decrease further in elevation as continued settlement of the dredged material occurs. The Marsh Nourishment Area was pumped to an average elevation of 0.3 ft and was measured to an average height of 0.2 ft in 2022 (Figures 2-4), which is significantly lower than the elevation target of 1.27 ft. Although the Marsh Nourishment Area was filled in two phases with time between dredging events to allow material to stack. As-built data show that only about 30% of the area reached the 1.5 ft target, and by a month after construction only 2 data points were above the 1.5 ft target.

At year 3 post construction the MCAs are expected to be at elevations much higher than the settled target to account for the negative effect of soil settlement on constructed marsh elevation and to achieve project goals. The Northern and Southern MCAs elevation are currently higher than predicted marsh elevation goals but are following the predicted settlement curves when adjusted for soil deposition from Hurricanes Laura and Delta. Based on the settlement curves the Northern and Southern MCAs are expected to meet marsh elevation goals set for the end of project life. Although the LDNR MCA and the Marsh Nourishment Area did not have settlement curves, their constructed marsh elevations were much lower than their as-built target and therefore are not expected to meet project goals for target water levels and land/water percentage.

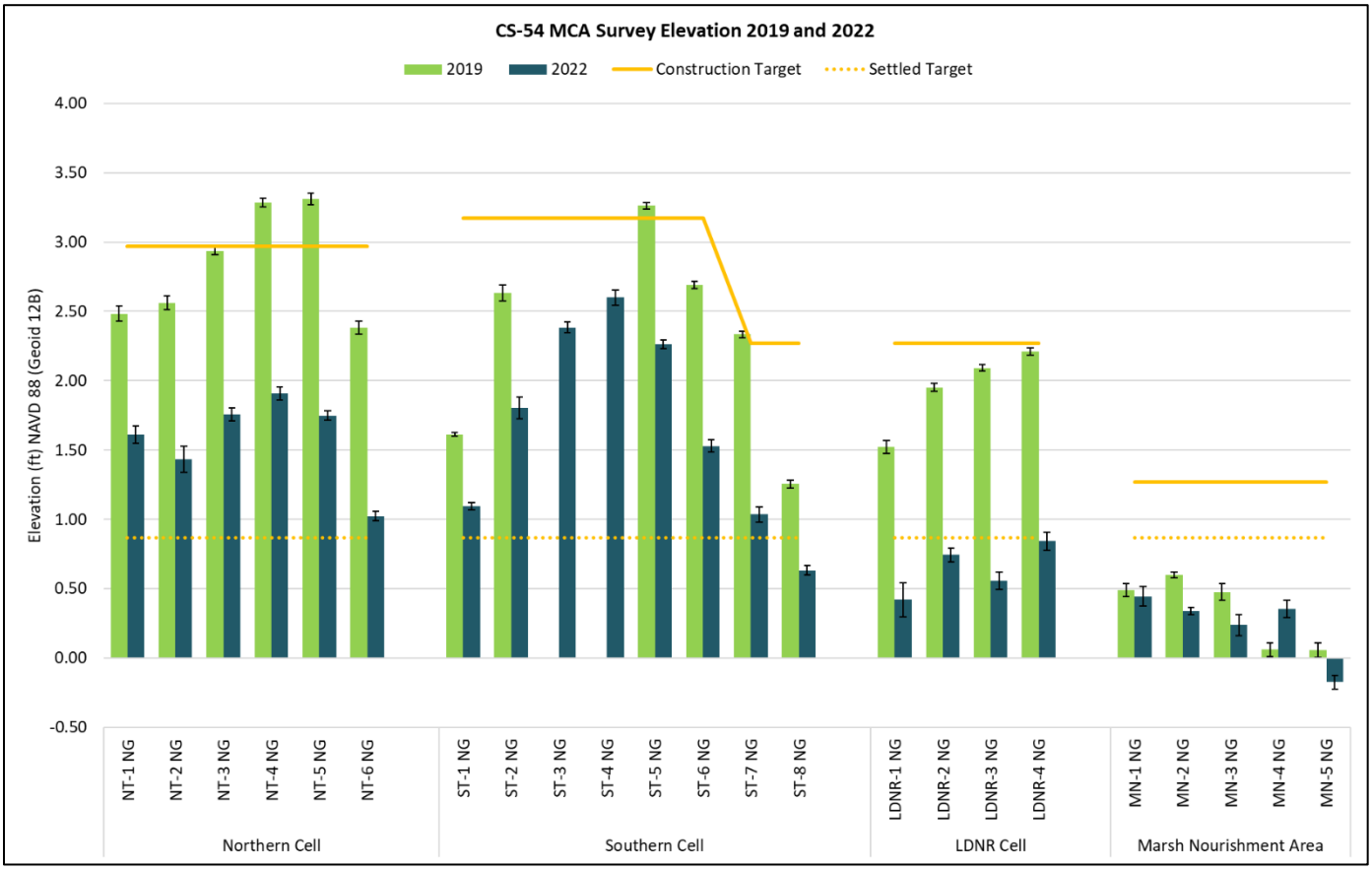

Figure 2: Survey elevation, target construction elevation and target settled elevation 2019 (as-built) and 2022 collected at the Northern, Southern, and LDNR Cells as well as the Marsh Nourishment Area.

Project Feature	Total Duration of Dredging Activities (days)	Target Constructed Marsh Elevations (ft; NAVD88, Geoid 12B)	Acres of Marsh Created/ Nourished (Ac)	Volume of Material Placed (CY)	Volume of Material by Total Acreage (CY/Ac)	Post-Construction Settlement Rate (ft/yr)
Northern MCA	129	2.97	211	998,758	4,733	0.7
Southern MCA	364	3.17 & 2.27*	386	2,272,504	5,887	0.58
LDNR MCA	19	2.27	60	171,199	2,853	0.85
Marsh Nourishment Area	66	1.27	378	536,081	1,418	-
*Constructed marsh elevation of the Southern MCA was reduced to +2.5 due to prolonged pumping durations and material availability. Subsequent target elevation for remainder of Southern MCA and all of LDNR MCA based on this modified target elevation.						

Table 1: Post-construction target elevation/dredge activity summary by project feature.

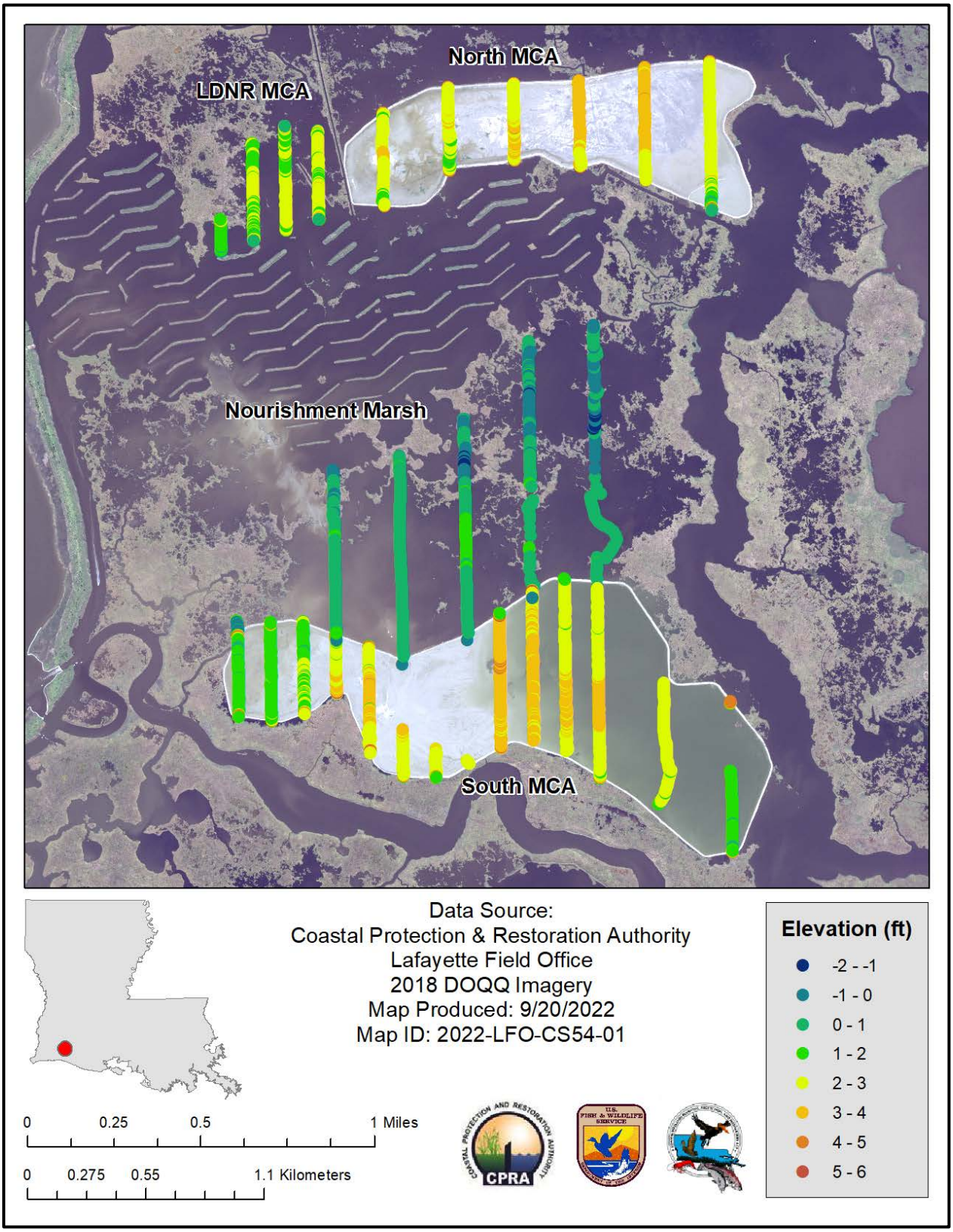

Figure 3: Survey transect elevation of the Northern, Southern, and LDNR Cells as well as the Marsh Nourishment Area in 2019 (as-built).

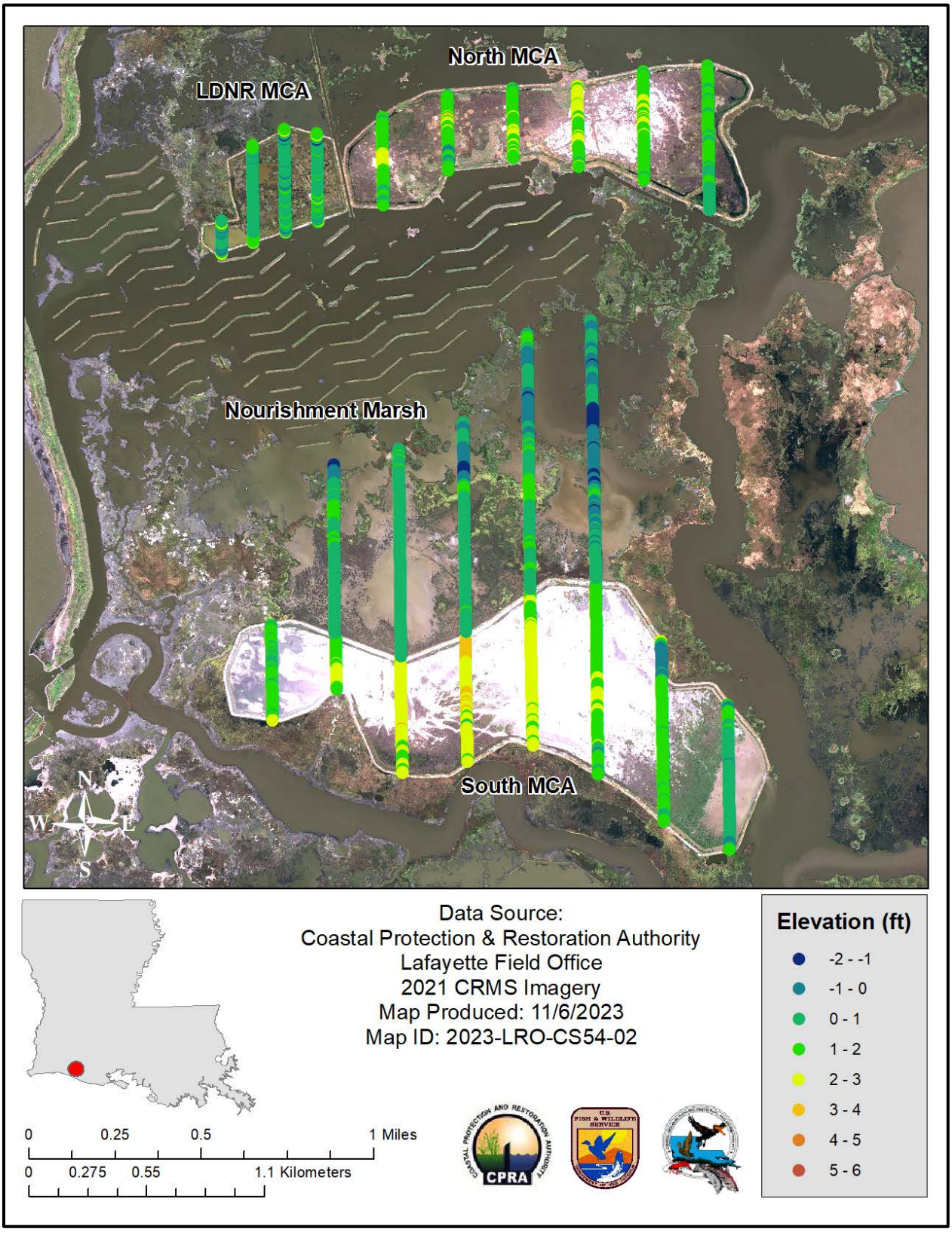

Figure 4: Survey transect elevation of the Northern, Southern, and LDNR Cells as well as the Marsh Nourishment Area in 2022.

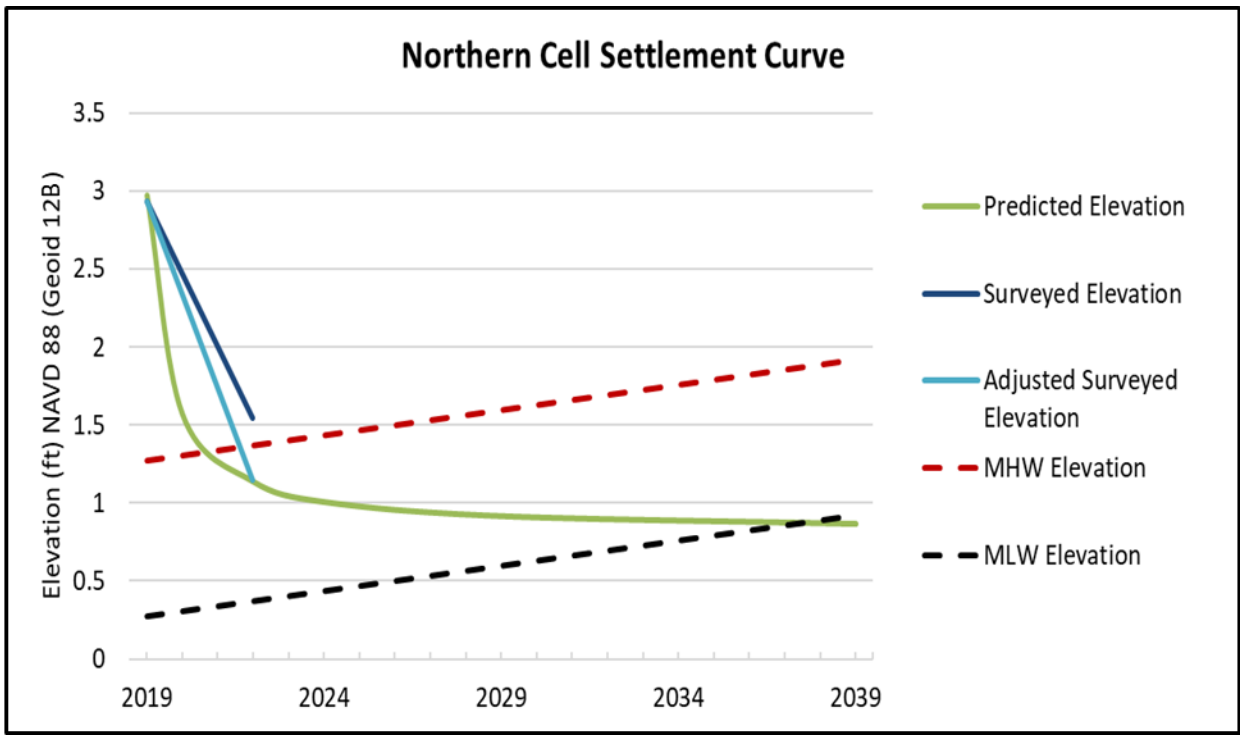

Figure 5: Predicted settlement curve and actual settlement for the CS-54 Northern Marsh Creation Cell. Adjusted surveyed elevation is adjusted for an estimated 0.4 ft of soil deposition due to Hurricanes Laura and Delta based on reference CRMS sites.

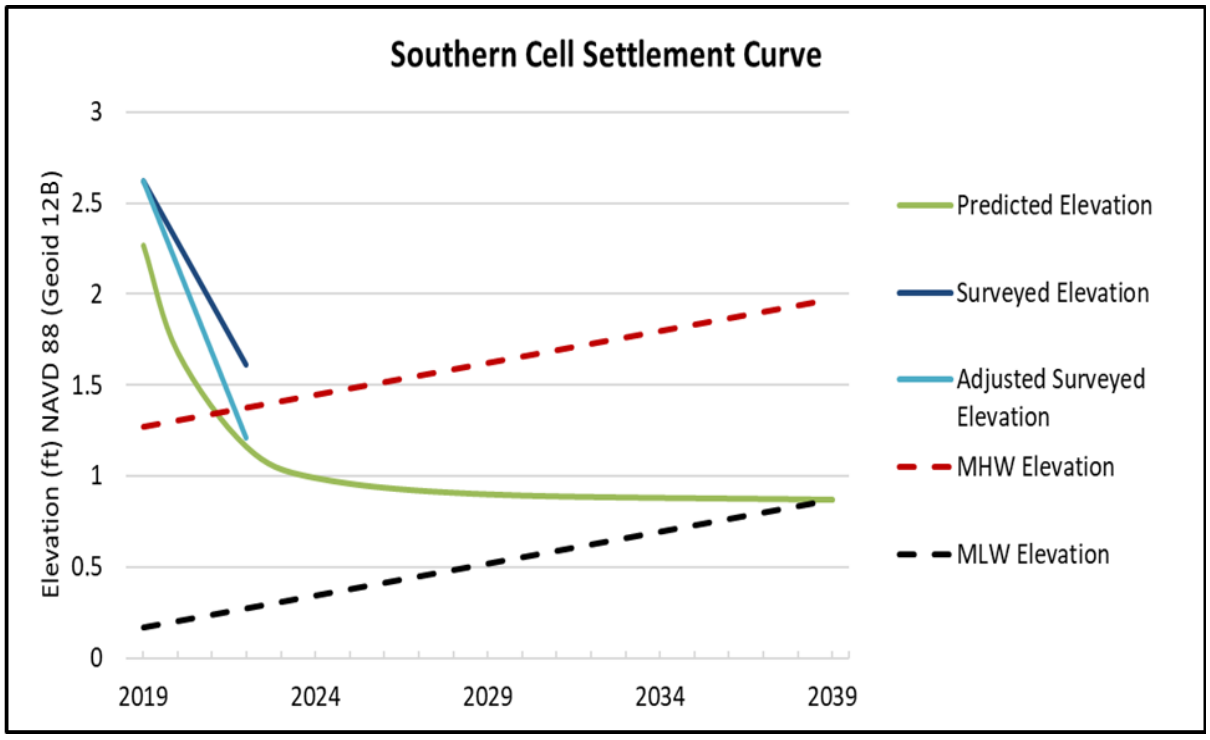

Figure 6: Predicted settlement curve and actual settlement for the CS-54 Southern Marsh Creation Cell. Adjusted surveyed elevation is adjusted for an estimated 0.4 ft of soil deposition due to Hurricanes Laura and Delta based on reference CRMS sites.

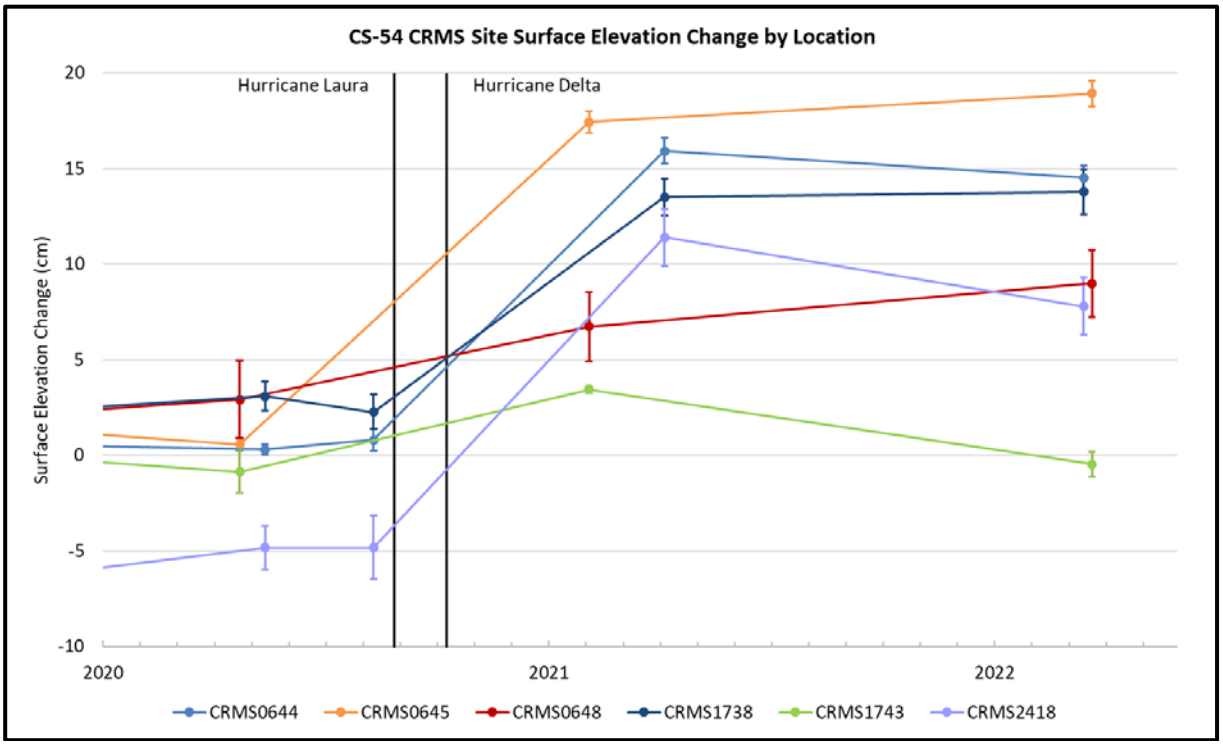

Figure 7: Yearly means and standard errors of surface elevation change (cm) collected at reference CRMS sites. Mean ± SE. CRMS 0650 was excluded from this analysis because it is a floating marsh.

Water Level

Water level data were collected hourly at the 7 reference CRMS sites surrounding the project area. Water levels have experienced fluctuations from 2019-2023 but are generally within a 1ft elevation range. The area experienced elevated water levels as an impact of Hurricanes Laura and Delta in August and October 2020. A reference CRMS site further inland of the project (CRMS0650) recorded a maximum water level of 4.3 ft. Water levels quickly receded by December 2020 (Figure 8). The peak water level in 2021 appears to be a results of a spring rain event: 12.49 inches of precipitation on 5/17/2021 (National Weather Service, 2023). It is also worth noting that 2022 and 2023 were drought years so those years had lower than normal water levels.

The project's goal for marsh inundation is to construct a marsh that is flooded between 20% and 60% of the year. Based on marsh elevation surveyed in May 2022, the Northern and Southern Marsh Creation Areas (MCAs) have maintained a marsh elevation higher than regional water levels, having been inundated 2% of the year on average from construction to June 2022 (Figure 9). The LDNR MCA and Marsh Nourishment Area elevations at year 3 post construction are below the elevations required to meet the inundation goals of the project. The LDNR MCA has experienced inundation 72% of the year on average and the Marsh Nourishment Area has been inundated 98% of the year on average.

The project's goal for water level is to maintain water levels between 2 inches above and 6 inches below the marsh surface after settlement. Water levels post construction have been generally below

target for the Northern and Southern MCAs, from 80% to 99% of the year on average, between 2020 and 2022 (Figure 9a). The LDNR MCA was constructed to an elevation lower than the Northern and Southern Cells and has settled lower as well, resulting in water levels being above the target water level range 21% and within the target range for 69% of the year on average. The Marsh Nourishment Area experiences water level above or within the target range 100% (77% and 23%, respectively) of the year due to low constructed and year 3 elevations. As the Northern and Southern MCA elevations continue to settle it is expected that they will settle within target water levels. The LDNR MCA and the Marsh Nourishment Area are at elevations insufficient to maintain the goal water level range, which will result in long periods of inundation in the LDNR MCA as well as continued constant inundation of the Marsh Nourishment Area.

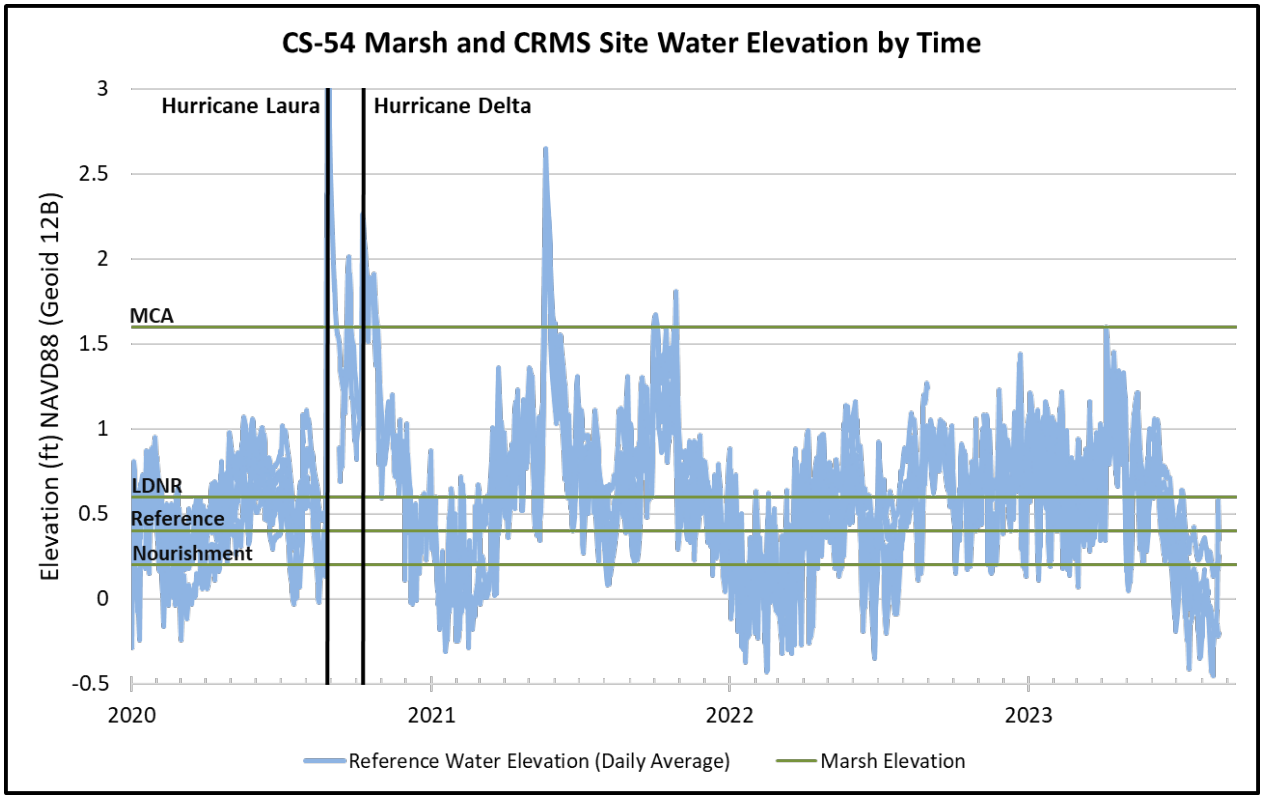

Figure 8: Daily means of surface water elevation (ft) collected at the reference CRMS sites from 1/1/2020-8/21/2023. Most recent mean elevations for North and South MCAs, LDNR MCA, Marsh Nourishment Area, and reference CRMS sites (excluding CRMS 0650).

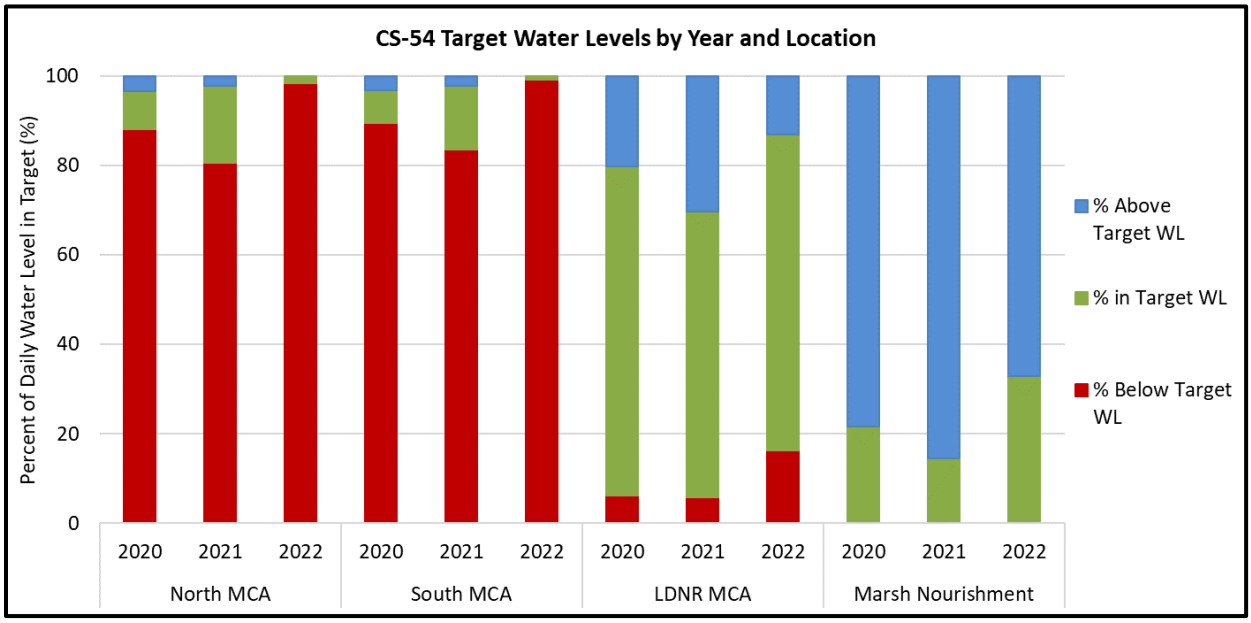

Figure 9a: Percentage of year water levels were inside target range at the project sites. Water levels based on daily averages. Average marsh elevation was used for each project area from the 2022 elevation survey.

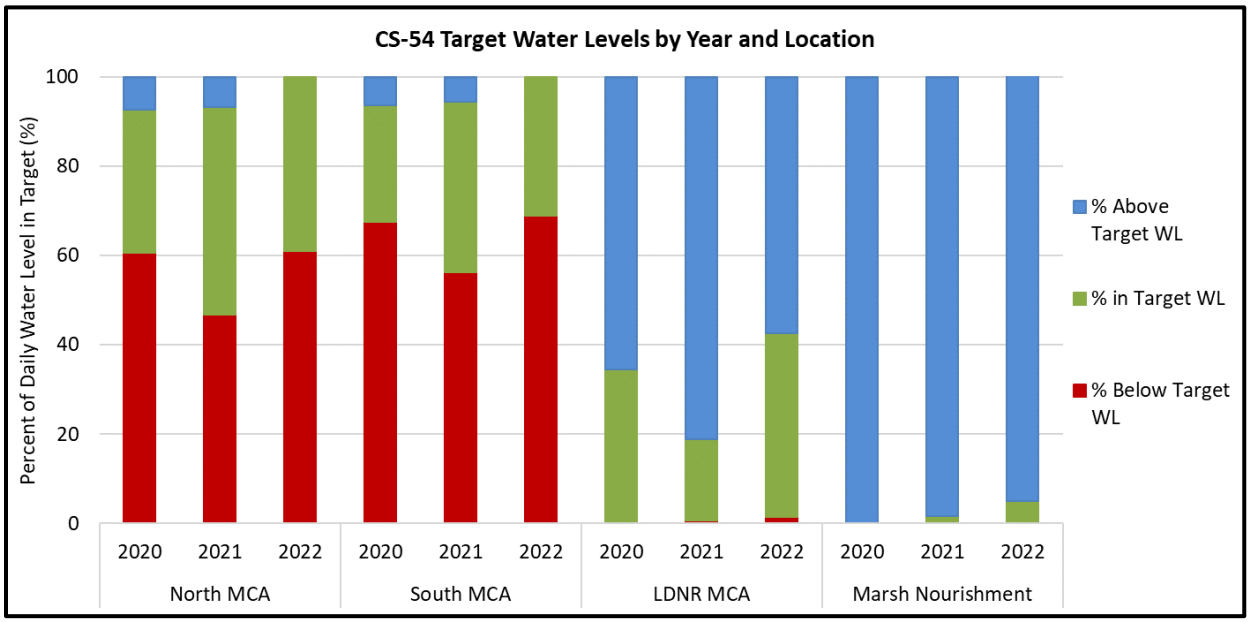

Figure 9b: Percentage of year water levels were inside target range at the project sites using Laura deposition corrected marsh elevation (-0.04 ft). Water levels based on daily averages. Average marsh elevation was used for each project area from the 2022 elevation survey.

Emergent Vegetation Survey

Emergent vegetation data was collected at 20 sampling locations across the project area in July 2023 (Figure 10). The dominant species observed across the project were *Spartina alterniflora*, *Paspalum vaginatum,* and *Spartina patens*, which is reflective of intermediate to saline marshes throughout coastal Louisiana. *Spartina alterniflora* was the only species present in all 4 project areas. The average species richness by vegetative sampling station was highest in the Northern (7.2) and Southern (5.6) MCAs, lowest in the LDNR MCA (2). Although the Marsh Nourishment Area had less species richness per station then the Northern and Southern MCAS, it had the highest percent of vegetative cover of all the project areas.

Dominant species in the Marsh Nourishment Area appeared to be tied to elevation, with the lower elevation northern areas being dominated by *Spartina patens* and the higher elevation southern area dominated by *Spartina alterniflora*. Species composition for reference CRMS sites was most comparable to the Marsh Nourishment Area, with most of the sites observed as *Spartina patens* dominated marsh (Figure 11a and 11b). The one CRMS site observed as *Spartina alterniflora* dominated marsh (CRMS 0644) is most similar to the NC2 data point, which is the lowest vegetative data point collected in that MCA (Figures 4, 10, 11a, and 11b). In the North and South MCAs, which are the highest elevations of the project area, typical high marsh/dune species commonly observed in early succession of marsh creations were recorded, including *Salicornia depressa*, *Amaranthus albus*, and *Batis maritima*. The LDNR MCA had the only 100% bare ground location sampled, in the lower elevation, southwest corner of the MCA (Figures 11a and 12a). The other vegetation data point collected in the LDNR MCA had the highest cover of *Paspalum vaginatum* in all the project areas (Figure 11a), which is expected as this plant is an early disturbance colonizer. It is also worth noting although the sampling event occurred during an extreme drought (when most marshes in the area had dried) the LDNR MCA was still flooded, further indicating a relatively low marsh elevation (Table 1).

Spartina alterniflora can often act as a pioneer species in the early stages of marsh creation in this region (CS-28-3 and CS-28-4-5; Mouledous 2022). This is due, at least in part, to the ubiquity of this plant species across the Louisiana coastal marshes, and its high rate of seed production/dispersal. As the created marsh elevation settles and continues to vegetate naturally, the species assemblage change over time depends greatly on the elevation, hydrology, and salinity of the surrounding landscape. For example, when marshes are created at a sufficiently high elevation, *Spartina alterniflora* may be gradually replaced by more drought tolerant species (Figure 12c). This was observed in the North MCA where *Spartina spartinae* was present only at the highest elevation locations, in the northern portion of the Cell (NC3 and NC 5; Figures 10 and 12d). It is worth noting these were the only observations of this plant species for the entire project, because the conditions present (high elevation, *Spartina spartinae* wetlands with sparse shrub vegetation) represent highly suitable habitat for the federally threatened Eastern Black Rail (*Laterallus jamaicensis jamaicensis*).

Reference CRMS continuous salinity stations for the project area (excluding CRMS 0650) recorded an average salinity of 24.4 ppt for the month of vegetative sampling (July 2023). Surface water readings in the Marsh Nourishment Area were consistent with these readings at 22.7 ppt. Porewater was not collected in any of the MCAs due to exceptional drought and high elevations of the marsh platform. These salinity readings represent abnormally high salinity readings for this area, when

compared with the average salinity (11.7 ppt) for the CRMS hydrology stations since 2020.

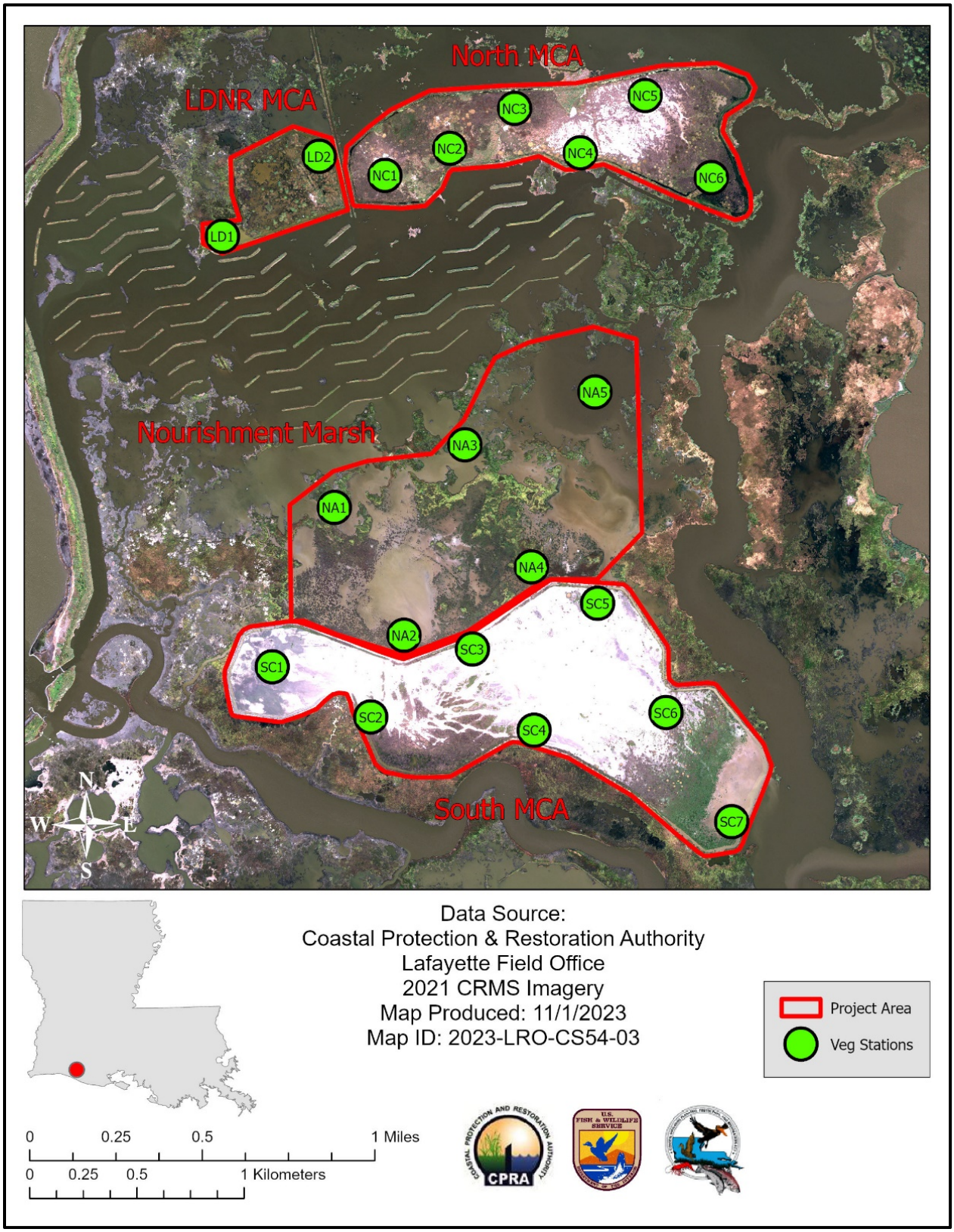

Figure 10: Map of vegetation monitoring stations in project area.

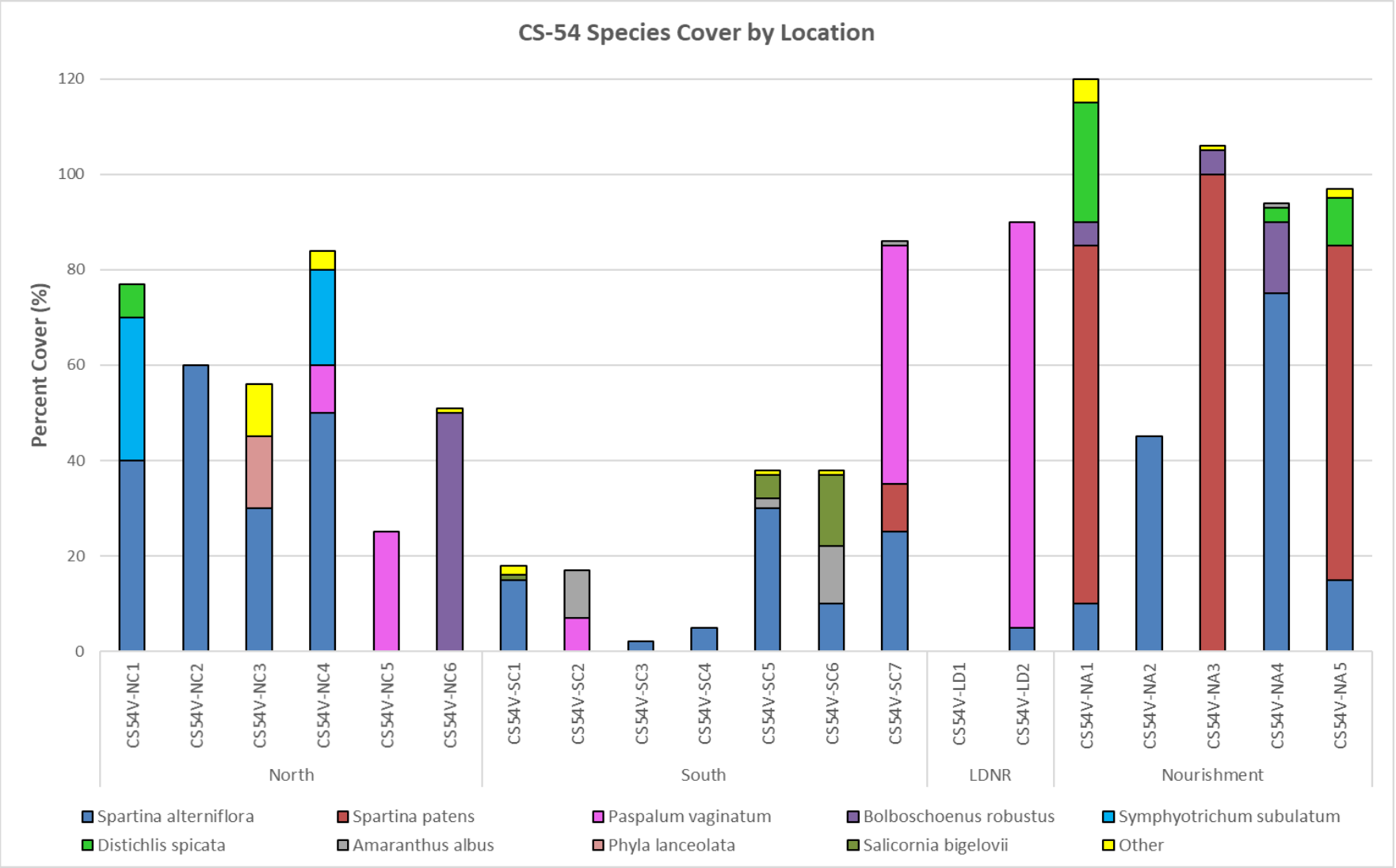

Figure 11a: Percent coverage of vegetative species collected from CS-54 in 2023. Species with less than 5% cover are classified as "Other." Cumulative vegetative cover over 100% indicates overlapping vegetative cover.

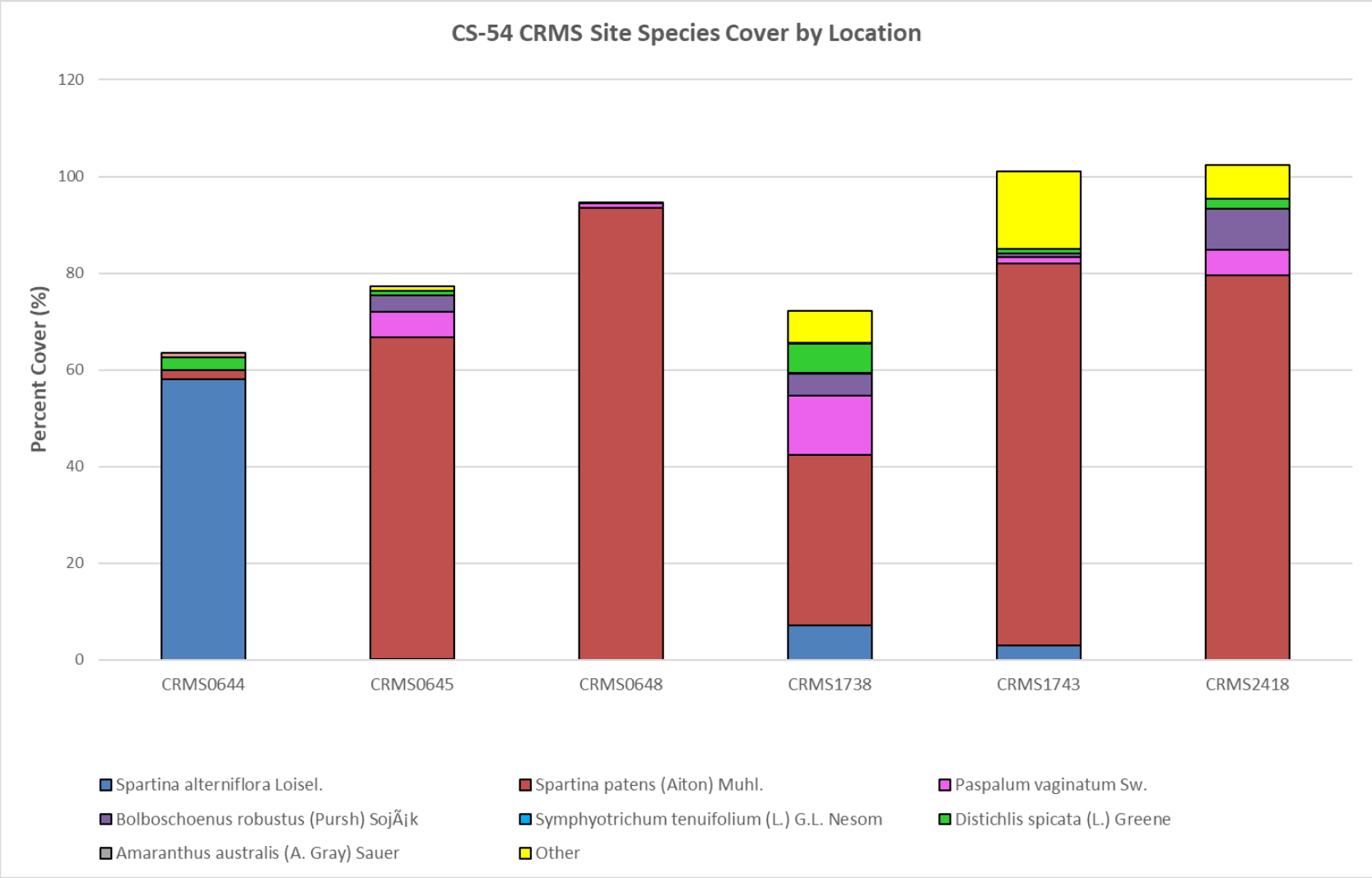

Figure 11b: Percent coverage of vegetative species collected from CS-54 CRMS reference sites in 2023. Cumulative vegetative cover over 100% indicates overlapping vegetative cover. CRMS 0650 was excluded from this analysis because it is a floating marsh.

Figure 12a: LD1 vegetation data point taken in the LDNR MCA.

Figure 12b: NA2 vegetation data point taken in the Marsh Nourishment Area.

Figure 12c: SC5 vegetation data point taken in the South MCA. High marsh/dune species cohabitating with drought stressed *Spartina alterniflora*.

Figure 12d: NC5 vegetation data point taken in the North MCA. *Paspalum vaginatum* dominated marsh with intermittent, densely vegetated stands of *Spartina spartinae* outside of plot.

Borrow Area Survey

The borrow area in Calcasieu Lake was surveyed post-construction in October 2019 and three years post-construction in May 2022. After construction in 2019 the borrow area had an average elevation of -11.9 ft. During the three years post-construction, infilling has occurred and average elevation increased by approximately 1.9 ft to -10.0 ft. Increases in elevation occurred at every survey transect, with the largest increases occurring at transects 1 and 5 on the northern and southern borders of the borrow area (Figures 13-15). The borrow area is expected to continue infilling throughout the project life.

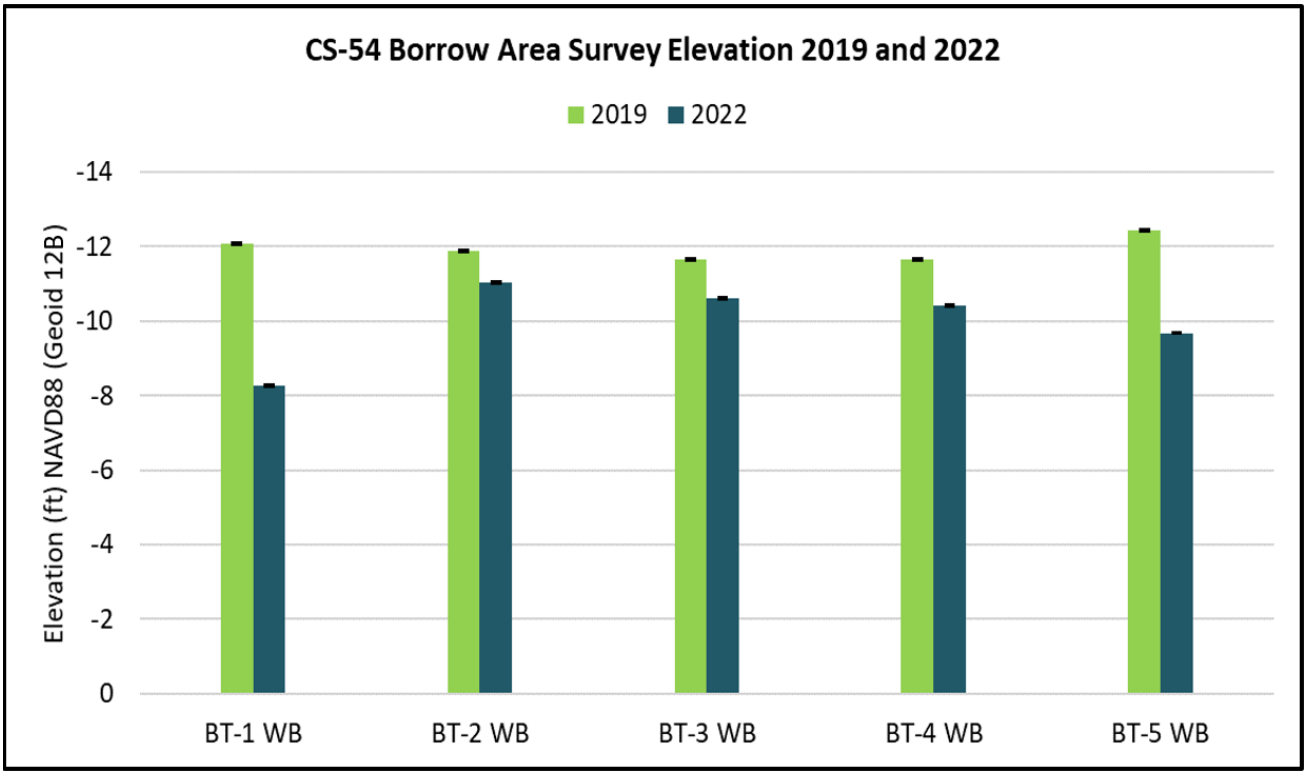

Figure 13: Survey elevation from 2019 and 2022 collected at the Borrow Area.

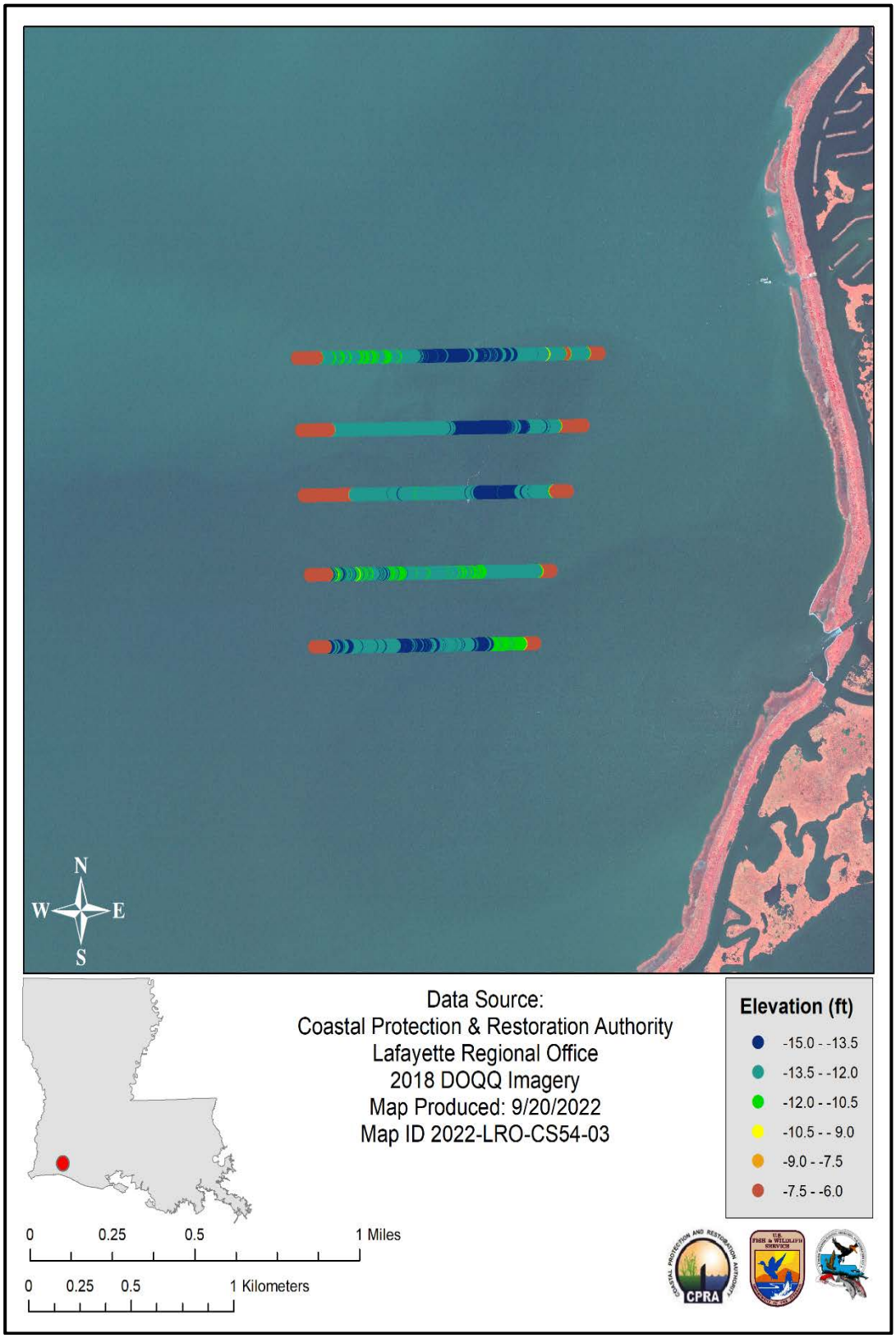

Figure 14: Survey transect elevations of the Borrow Area in 2019 (as-built).

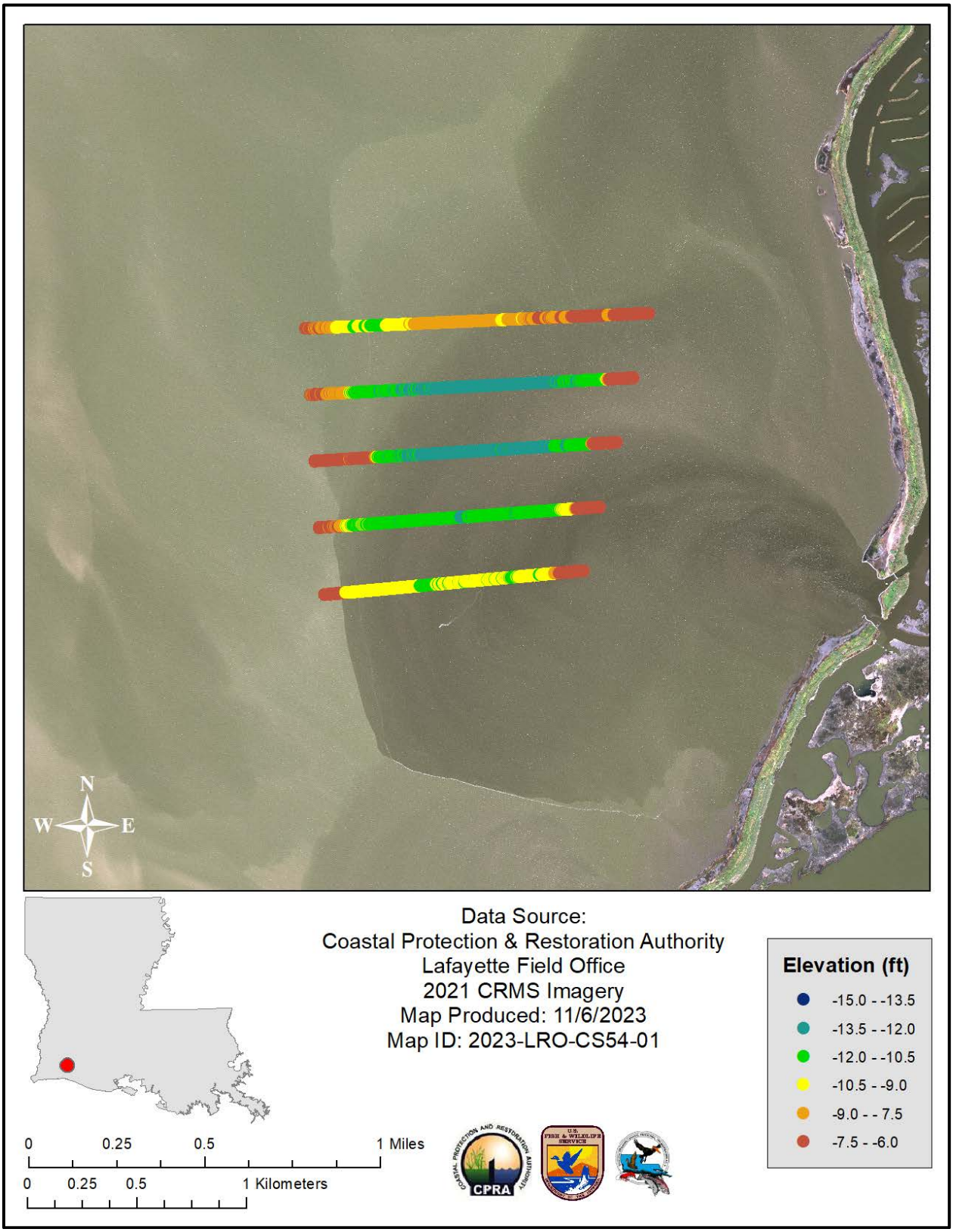

Figure 15: Survey transect elevations of the Borrow Area in 2022.

Dissolved Oxygen/ Hypoxia

Dissolved oxygen was monitored from July to October 2021 to determine if hypoxic conditions occur within the borrow area in Calcasieu Lake as a result of dredging activities. During this period dissolved oxygen was similar between the borrow area and the reference site from July through August (Figures 14-16). In September dissolved oxygen in the borrow area declined, remaining below the upper limit for hypoxic conditions from late September (9/25/21) to early October (10/04/21). Concentrations returned to levels similar to the reference site by mid-October. The reference area also experienced a reduction in dissolved oxygen but remained above hypoxic levels.

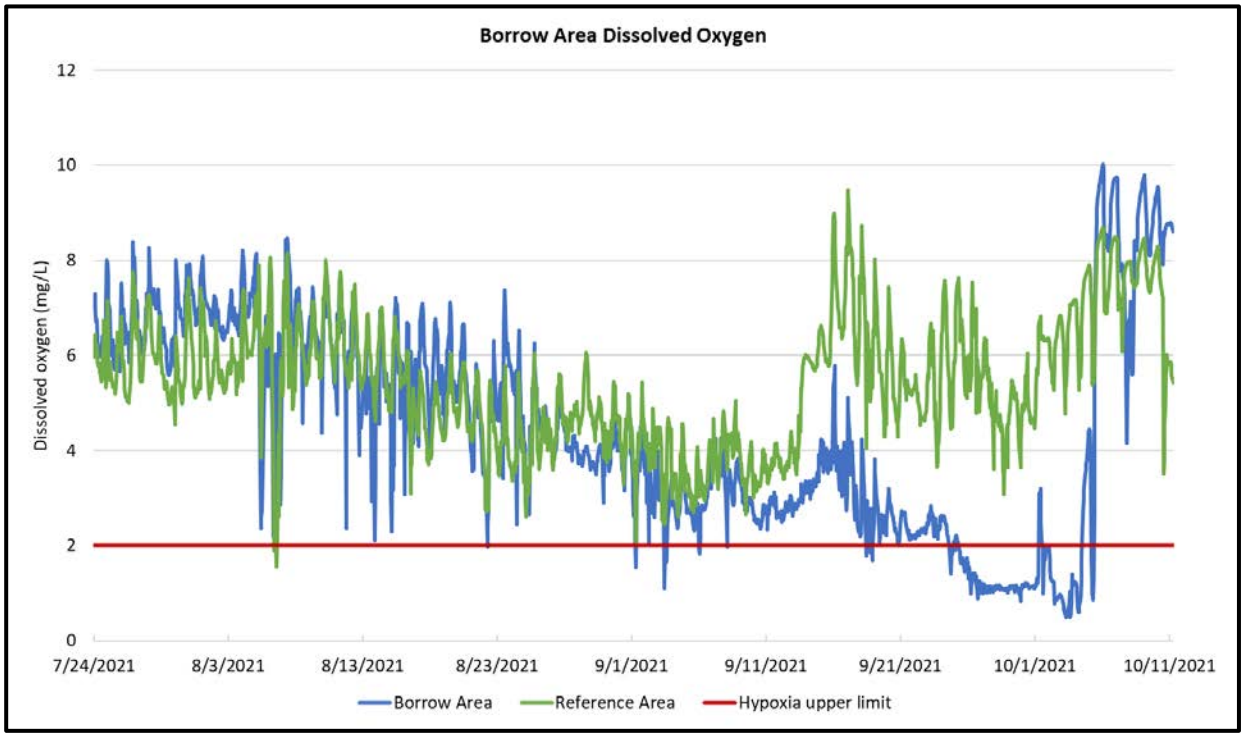

Figure 16: Dissolved oxygen (mg/L) within the Borrow Area and reference area from July-October 2021.

III. Conclusions

a. Project Effectiveness

The Northern and Southern MCAs are expected to maintain the goal for settled marsh elevation by the end of the project life. Because these are the only two project areas included in the project monitoring goals, the Northern and Southern MCAs are determined to be meeting expected metrics for success at this stage of the project life cycle. It is important to note the changing of constructed elevation targets based on observed conditions and geotechnical analysis of highly concentrated dredge slurry that entered the Southern MCA. Based on this change, the small portion of the remaining Southern MCA and all of the LDNR MCA were then constructed to a lower elevation than the original MCA construction target. Due to changes in dredge material and conditions, the LDNR MCA experienced increased settlement rates and a marsh elevation 3 years post construction that is below the settled marsh elevation goal. The LDNR MCA marsh elevation is below the settled marsh elevation goal by approximately 1 foot and experiences inundation over 95% of the year. The LDNR MCA will not meet the project goals by the end of the 20 year project life. Given that the reduction of the target construction elevation and dredge pumping below target for the LDNR MCA resulted in an MCA below the goal settled marsh elevation, future marsh creation areas should be constructed to the determined construction elevation. The Marsh Nourishment Area was also constructed lower than the goal construction elevation and was not successful due to low constructed elevations.

b. Recommended Improvements

The natural colonization of *Spartina spartinae* in the project area is particularly noteworthy with the increased interest in managing restoration projects to create habitat for the federally threatened Eastern Black Rail. The unique structure of *Spartina spartinae* (thin-leaved, clumping grass present at high elevations) makes it the preferred habitat for the threatened Eastern Black Rail in this area. As planners and managers explore potential solutions to create black rail habitat, increased elevation targets, along with specified management practices (grazing, prescribed burns, etc.) could support the establishment of suitable Eastern Black Rail habitat in new marsh creation projects.

c. Lessons Learned

Elevation data from the LDNR MCA demonstrated how decreasing the target elevation during construction, combined with factors increasing rates of elevation settlement, can result in marsh creation that will not meet the goal of settled elevation for a sustainable emergent marsh. Because dredge composition can be a dynamic component of construction, changes to elevation targets should not be based solely on dredge characteristics. Altered elevation targets for the additional MCA resulted in created marsh (some low areas in the Southern MCA and all of the LDNR MCA) with settled elevations below the parameters for success. In order to allow for more adaptive management practices during construction, alternative methods for defining elevation targets may provide a more favorable outcome under variable dredging conditions.

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