State of Louisiana

Coastal Protection and Restoration Authority (CPRA)

2022 Operations, Maintenance, and Monitoring Report

for

Sediment Trapping at the Jaws (TV-15)

State Project Number TV-15
Priority Project List 6

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Vermilion Parish

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Preface

This report includes monitoring data collected through December 2021, and the most recent site inspections through September 2021. Sediment Trapping at the Jaws (TV-15) project is a 20-year Coastal Wetlands, Planning, Protection, and Restoration Act (CWPPRA, Public Law 101-646, Title III, Priority List 6) project administered by the National Marine Fisheries Service (NMFS) and the Coastal Protection and Restoration Authority of Louisiana (CPRA).

The 2022 report is the 3rd and final in a series of reports. For additional information on lessons learned, recommendations and project effectiveness, please refer to the 2005 and 2012 Operations, Maintenance, and Monitoring Reports on the CPRA web site at http://coastal.Louisiana.gov/. These reports will be made available for download at the following website: http://cims.coastal.la.gov/.

I. Introduction

The Sediment Trapping at the Jaws (TV-15) project was part of CWPPRA PPL 6 and is sponsored by the National Marine Fisheries Service (NMFS) and comprises approximately 4,543 acres (1,838 ha). Ninety-one percent, 4,139 acres (1,675 ha), of the project is classified as open water, while the remaining 404 acres (163 ha) is classified as fresh and intermediate marsh (CRMS spatial viewer land/water 2021, Couvillion et al. 2017). The project is located near "The Jaws" in the northeast segment of West Cote Blanche Bay, approximately 10 miles southwest of Franklin, Louisiana in St. Mary Parish (Figure 1).

The area has experienced major hydrologic changes since the construction of the Gulf Intracoastal Waterway (GIWW) in the 1920's, which created a hydrologic connection between the project area and the sediment-laden Atchafalaya River. In addition, the volume of fresh water flowing from the Mississippi River to the Atchafalaya River has steadily increased since 1839 when logjams were removed to make the river more navigable and the construction of the Old River Control structure which diverted Mississippi River water into the Atchafalaya in 1963. (Adams and Bauman 1980). The United States Army Corps of Engineers (USACE) regulates flow into the Atchafalaya River at 30 percent of the Mississippi River, increasing the amount of sediment-laden water transported by the Atchafalaya River. During low rainfall periods which would allow saltwater intrusion inland, the Teche Vermilion Freshwater Diversion (constructed in 1982) pumps Atchafalaya River water into the Teche-Vermilion Basin which makes its way to Vermilion Bay via the Vermilion River and Bayou Teche & Fausse Point to the Charenton Canal then southwest and out of The Jaws. During southeast winds, sediment-laden water is also being delivered to the project area via West Cote Blanche Bay (Walker et al. 1997). Canal construction has greatly increased the tidal exchange between East and West Cote Blanche Bays and the interior marshes (Good et al. 1995).

These hydrologic alterations have changed the marsh type and water salinities accordingly. The area surrounding "The Jaws" supported vegetation typical of brackish marsh in 1949 (O'Neil 1949) and in 1968 (Chabreck et al. 1968). However, starting in 1978 the area was classified as fresh marsh (Chabreck and Linscombe 1978, 1988, and 1997). This conversion took place as fresh water from the Atchafalaya River began reaching Vermilion Bay. More recent investigations of the marsh in and around the project have classified the area as a fresh and intermediate marsh in 2001, 2007, and 2013 (Chabreck and Linscombe 2001 and Sasser

and Visser 2008, 2013). The current plant community consists mainly of *Vigna luteola* (hairy cowpea), *Sagittaria lancifolia* (bulltongue arrowhead), with lesser amounts of *Leersia oryzoides* (southern cut-grass), *Alternanthera philoxeroides*, (alligator weed), *Panicum hemitomon* (maidencane), *Polygonum punctatum* (dotted smartweed), *Schoenoplectus americanus* (chairmaker's bulrush), and *Spartina patens* (saltmeadow cordgrass) (CRMS 2021). Approximately 10% of the shallow open water areas prior to project implementation were dominated by submerged aquatic vegetation (SAV) such as *Vallisneria americana* (water celery), *Najas quadalupensis* (southern naiad), *Myriophyllum spicatum* (Eurasian watermilfoil), and *Heteranthera dubia* (star grass). Floating aquatic vegetation (FAV) *Eichhornia crassipes* (water hyacinth) is also prevalent, with large floating mats often developing in open water areas in the summer and autumn.

Marsh loss between 1957 and 1990 in the nearby Cote Blanche Hydrologic Restoration (TV-04) project area was calculated by USDA-NRCS personnel to be more than 2,400 acres (971.5 ha), approximately 73 acres (29.5 ha)/yr during the 33 year span. Shoreline erosion was calculated to be 15 ft/yr (4.5 m/yr), based on planimetric analyses of aerial photography for this period. The soils in and around most of the project area are Kenner muck, a semifluid organic soil, and Balize silt loam, a very fluid mineral soil, which are both frequently flooded (Soil Survey Staff NRCS).

The project features include earthen terraces, conveyance channels, and plantings designed to reduce shoreline erosion, enhance sediment deposition, and lock alluvial soils in position. The terraces were designed to slow down water leaving the GIWW so suspended sediment would be deposited in the shallow water adjacent to the terraces and along the shores of West Cote Blanche Bay. The construction of terraces was also intended to protect the existing marsh against shoreline erosion by reducing wave and wake energy and creating marsh by planting along the slopes of the constructed terraces. The construction of the terraces was intended to reduce fetch, current, and turbidity between terraces, while inducing sediment deposition which would result in the creation of mud flats and SAV beds in formally shallow open water areas. The dredging of distributary channels has increased freshwater and sediment flow into the project area. The high sediment availability makes the project area a good site for creating marsh by trapping sediments from the GIWW and West Cote Blanche Bay. Fisheries habitat has also been enhanced by the marsh edge created by the terraces and the propagation of SAV beds on the mud flats.

The construction of Sediment Trapping at the Jaws (TV-15) was completed in December 2004 and is functioning as intended to date. Approximately 40,100 linear ft (12,223 m) of terraces just southwest of the Jaws (Figure 2) were constructed to deter wave erosion and enhance sediment deposition. The terraces were arranged in a deltaic ridge alignment in the near shore open water area. The terraces were built to + 4.0 ft (+1.2 m) NAVD88 with a 6 ft wide crown and 4:1 ft side slopes. Post consolidation elevation of all terraces was expected to be greater than 2 ft NAVD88. The distributary channels are located on the landward side of the terraces and were constructed to a maximum width of 50 ft and maximum depth of 12 ft below the existing water bottom. In order to minimize erosive energies, the terrace slopes were planted with approximately 38,500 *Schoenoplectus californicus* (California bulrush) and *Zizaniopsis miliacea* (giant cutgrass) plants (Figures 3a-d).

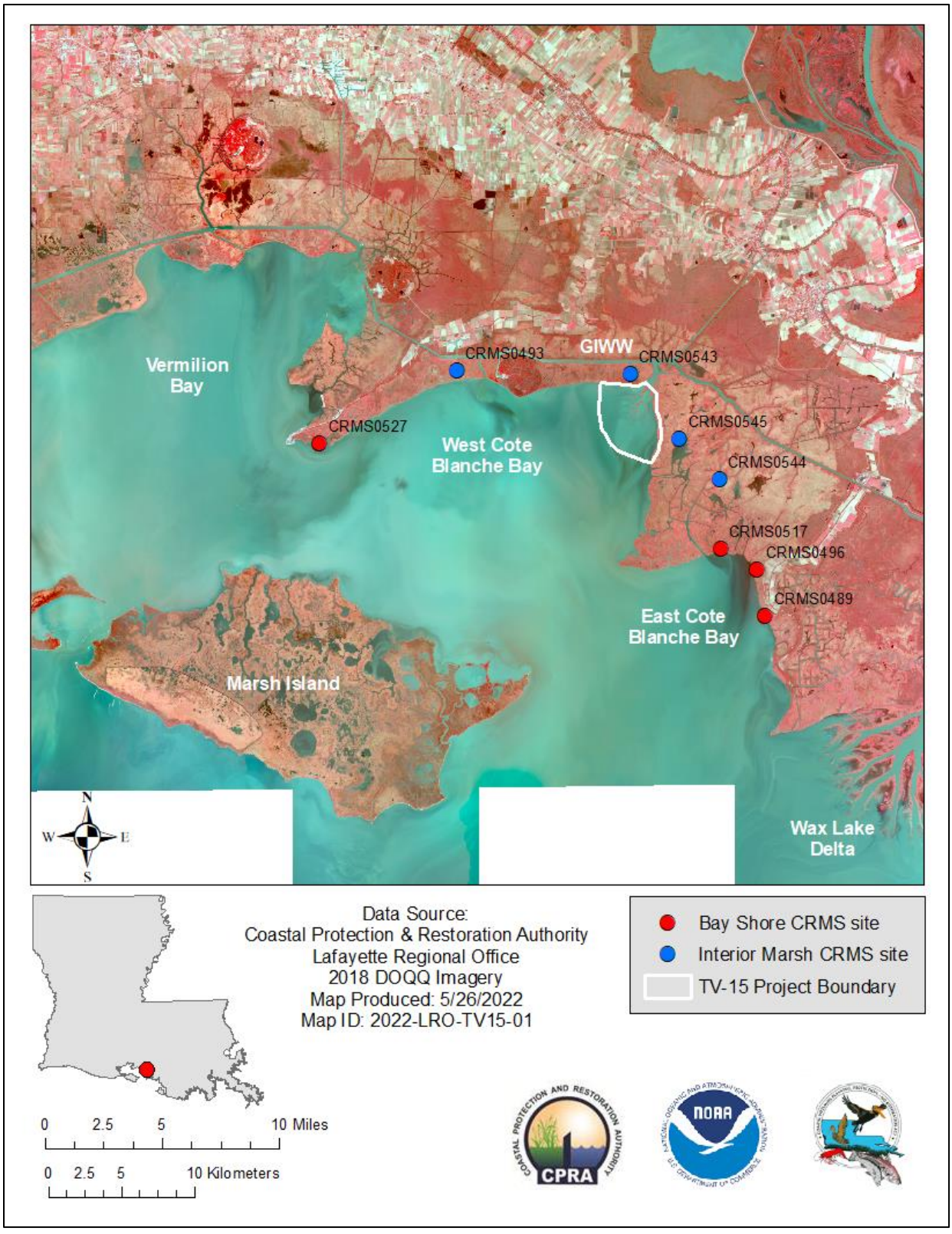

Figure 1. Sediment Trapping at the Jaws (TV-15) project area and surrounding Bay Shore and interior marsh CRMS-*Wetlands* sites.

Figure 2 Sediment Trapping at the Jaws (TV-15) under construction on 7-2004.

Figure 3a Sediment Trapping at the Jaws (TV-15) during planting in April 2005.

Figure 3b. Sediment Trapping at the Jaws (TV-15) the same location post construction on 4-2008.

Figure 3c. Sediment Trapping at the Jaws (TV-15) the same location post construction on 9-2012.

Figure 3d. Sediment Trapping at the Jaws (TV-15) the same location near the end of the projects 20 year economic life post 2020 hurricane season on 9-2021.

II. Maintenance Activity

a. Project Feature Inspection Procedures

While no formal inspection took place as part of this report, the condition of the terraces was indirectly inspected during a trip to another project on September 23, 2021 under clear skies and mild temperatures. In attendance were Stan Aucoin, Jody White, and Phillip Parker from CPRA Lafayette as well as representatives from NRCS and Aucoin & Associates. The inspection began at the northern most terrace.

The field inspection included a visual inspection of the terrace field from the main channel. Staff gauge readings were unavailable. Photographs taken are included in Appendix A. A three year projected operation and maintenance budget is shown in Appendix B.

b. Inspection Results

Terraces

Looking from the main channel, the terraces appear to be still in very good condition. Warning signs appeared to be in place and stable. (Photos: Appendix A, Photo 1-2)

Vegetative Plantings

Submerged and emergent aquatic vegetation between the terraces continues to expand. No apparent need for any maintenance at this time. (Photos: Appendix A, Photo 1-3).

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

None

ii. Programmatic/ Routine Repairs

Install a staff gage.

d. Maintenance History

General Maintenance: There has been no required maintenance on this project.

III. Operation Activity

a. Operation Plan

There are no water control structures associated with this project, therefore no Structural Operation Plan is required.

b. Actual Operations

There are no water control structures associated with this project, therefore no required structural operations.

IV. Monitoring Activity

Pursuant to a CWPPRA Task Force decision on August 14, 2003 to adopt the Coastwide Reference Monitoring System-*Wetlands* (CRMS) for CWPPRA, updates were made to the TV-15 Monitoring Plan 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 (Folse et al. 2020). There are eight CRMS sites located around the project area, four Bay Shore sites (CRMS0489, CRMS0496, CRMS0517, and CRMS0527) and four interior marshes sites (CRMS0493, CRMS0543, CRMS0544, and CRMS0545) which are used as reference locations and if necessary to address the project goals.

a. Monitoring Goals

The objective of the Sediment Trapping at the Jaws Project is to convert areas of open water to vegetated marsh through the construction of earthen terraces and vegetation plantings along with increasing SAV occurrence within the project area over the 20-year project life (Figure 4).

The following goals will contribute to the evaluation of the above objective:

1. Protect the banks of "the Jaws" and existing marshes from shoreline erosion.

2. Create 1,821 acres (735 ha) of marsh habitat.

3. Greatly increase the quantity of submerged aquatic vegetation habitat.

b. Monitoring Elements

Aerial Photography

For project specific data, near-vertical color-infrared aerial photography (1:35,000 scale) was used to measure land and water quantities for the project area. The photography was obtained during construction year 2004 and post-construction in 2008, 2015, and 2018. An estimate of the land water post hurricanes was assessed in 2020 via Google Earth. The original photography was checked for flight accuracy, color correctness and clarity and was subsequently archived. Aerial photography was scanned, mosaicked, and geo-rectified by USGS/NWRC personnel according to standard operating procedures (Steyer et al. 1995, revised 2000).

In addition, land change of the project area as a whole will be assessed from land/water data interpreted from TM satellite imagery (30 m^2 resolution) which is stored on the CRMS viewer website (http://www.lacoast.gov/crms_viewer/); pre- and post-construction comparisons will be made. Linear regressions were calculated for the period of record. The variability in percent land data points around the slope illustrate the influence of various sources of environmental variance or classification error. Positive slopes indicate increasing percent land or historical land gain and negative slopes indicate decreasing percent land or historical land loss (Couvillion et al., 2017). This data set is fairly course given the size and scope of the TV-15

project and is useful for trend analysis but not for exact acreage calculations or specific locations of loss or gain.

Submerged Aquatic Vegetation (SAV):

SAV was not monitored implicitly, but was observed on the final project specific monitoring effort and on multiple LA-39 monitoring trips in the project area, so information on occurrence and species can be ascertained from these observations. Emergent marsh sampling locations also had notes and photographs documenting SAV presents. Correspondingly the Sentinel-2 L2A satellite data using Normalized Difference Vegetation Index (NDVI) imagery on the Sentinel-Playground.com platform was used to validate on the ground SAV observations and extrapolate them to project scale SAV occurrence at the end of project life. The NDVI is a simple graphical indicator that can be used to analyze remote sensing measurements, often from a space platform, assessing whether or not the target being observed contains live green vegetation.

Emergent Vegetation:

Vegetation composition and cover is estimated from 10 permanent 2x2 m plots that are randomly distributed along a transect in the emergent marsh within each of the 1 km^2 CRMS-Wetlands sites. Data was collected in early fall of 2006 through 2021 using the Braun Blanquet method (Cretini et al. 2011). Four Bay Shore sites (CRMS0489, CRMS0496, CRMS0517, and CRMS0527) and four interior marshes sites (CRMS0493, CRMS0543, CRMS0544, and CRMS0545) were used for this report.

Salinity

Salinity is monitored hourly utilizing four Bay Shore sites (CRMS0489, CRMS0496, CRMS0517, and CRMS0527) and four interior marshes sites (CRMS0493, CRMS0543, CRMS0544, and CRMS0545) in close proximity to the project area. Continuous data will be used to characterize average monthly salinities throughout the project area. The salinity sondes are serviced on approximately a bimonthly basis. At each servicing, a measurement of interstitial water salinity is collected adjacent to each station. Interstitial water salinity is also determined at the 10 vegetation plots, when vegetation is surveyed. Salinity data will be used to characterize the spatial variation in salinity throughout the project area and to determine if project area salinity variability is affecting project effectiveness.

Water Level

Water level is monitored hourly utilizing four Bay Shore sites (CRMS0489, CRMS0496, CRMS0517, and CRMS0527) and four interior marshes sites (CRMS0493, CRMS0543, CRMS0544, and CRMS0545) in close proximity to the project area. The sondes are surveyed relative to North American Vertical Datum (NAVD 88 GEOID 12A), based on a 2014 coastwide CRMS survey effort. The water level sonde is serviced on approximately a bimonthly basis. Water level data is used to document variability in water level in the project and reference areas. Water level data will be used to characterize the spatial variation in water elevation throughout the project area and to determine if project area water level variability is effecting project effectiveness.

Soil Properties

Soil cores were collected to describe major soil properties such as bulk density and percent organic matter. Three, 4" (10.16-cm) diameter cores were collected to a depth of 24 cm and divided into 6, 4-cm sections at each site. The soil was processed by the Department of Agronomy and Environmental Management at Louisiana State University. Soil cores were collected at the project and reference CRMS sites during station establishment in 2005-2007 and again in 2018. Cores were collected at four Bay Shore sites (CRMS0489, CRMS0496, CRMS0517, and CRMS0527) and four interior marshes sites (CRMS0493, CRMS0543, CRMS0544, and CRMS0545) around the project area.

Elevation Change

Soil surface elevation change utilizing a combination of sediment elevation tables (RSET) and vertical accretion from feldspar horizon markers are being measured twice per year at each site. This data will be used to describe general components of elevation change and establish accretion/subsidence rates. The RSET was surveyed to a known elevation datum (ft, NAVD88 GEOID 12A) so it can be directly compared to other elevation variables such as water level at four Bay Shore sites (CRMS0489, CRMS0496, CRMS0517, and CRMS0527) and four interior marshes sites (CRMS0493, CRMS0543, CRMS0544, and CRMS0545) around the project area. Data collection has been ongoing from 2006-2020.

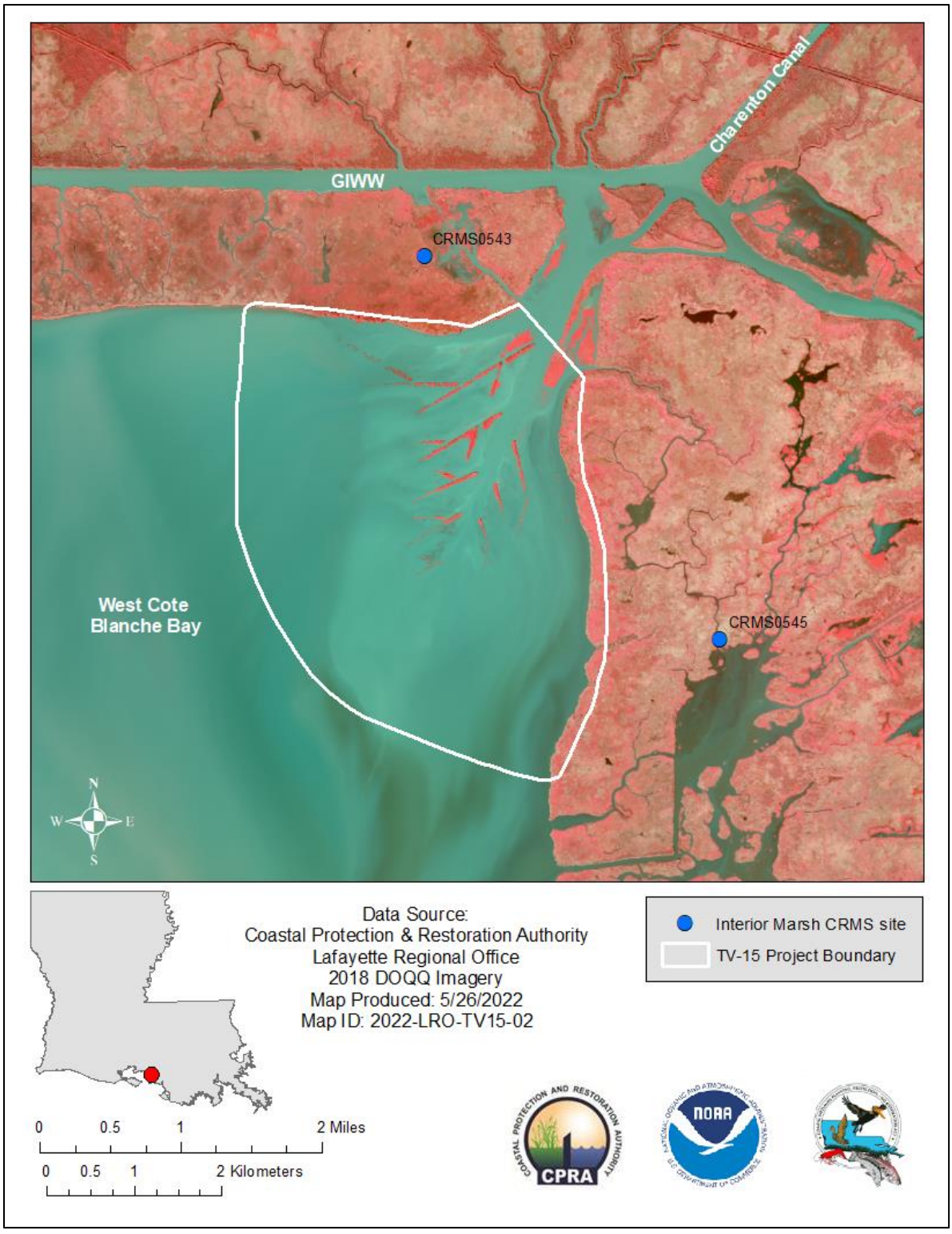

Figure 4. A closer view of the Sediment Trapping at the Jaws (TV-15) project area boundaries and project features.

c. Monitoring Results and Discussion

Aerial Photography

Aerial photography was collected during construction on March 9th, 2004 and post-construction on October 27th, 2008, December 5th, 2015 and December 5th, 2018 (Table 1, Figure 6-9). The project area increased in acreage as the terraces were constructed and planted; these plants then expanded into contiguous shallow open water habitats post construction. Gradually, due to terrace erosion and subsidence, the project began losing land as shown in 2015. This trend has continued as the inter terrace tidal mudflats have been slow to vegetate and offset perimeter shoreline and terrace erosion, especially from the 2019-2021 highly active hurricane seasons in the project area. The occasional TV-15 project land area percentage above 15% is likely due to floating aquatic vegetation and some ephemeral land under low water conditions. The Teche Vermilion basin as a whole has experienced general stability from 1985-2016 but will also undoubtedly show some negative consequences from three years of storm surge erosion and other forms of mechanical hurricane damage (Figure 5). As the terraces sustain damage, subsided, and eroded they offer reduced protect to the naturally existing shorelines to the north and east of the project features near the end of project life. Without the transition and expansion of mudflats into functional emergent marshes, the losses both to the terraces and the existing shoreline cannot be replaced or reduced; this directly effects the projects ability to meet its goals of increasing marsh area and protecting existing shorelines. This transition has shown to be difficult at multiple terrace locations in the TV basin, but when effective, can start a positive cascade event, retaining more sediment and becoming subaerial when conditions are conducive, such as in the TV-12 project area (Wood et al 2016). Another contributing factor to the difficulty in meeting project goals is the steadily increasing water levels in the project area and Gulf of Mexico (GOM) making the determination of land and water in a small project footprint more difficult along with emergent marsh being flooded more often. Consequently, the goal to protect the bay shoreline was achieved, while creating 1,800 acres of marsh was not, as the area did not vegetate between terraces at a rate greater than erosion and marsh loss mostly attributable to prevalent storm damage. The project area does however retain vast quantities of sediment within the deltaic framework which has functioned effectively as designed. This is evident in the bathometric data collect in the area in 2022 (Figure 10) which demonstrates a majority of the distribution channels along with the main conveyance channel into West Cote Blanche Bay are self-maintaining with depths between -10ft to -18ft NAVD. The majority of the rest of the project area, while technically classified as water, is intertidal mudflats rarely deeper that -1.5ft NAVD, supporting a vast network of SAV and FAV communities with sporadic emergent vegetation (Figure 11).

Table 1. Acreages and percentages for land water classifications from aerial photography collected in 2004, 2008, 2015 and 2018 (Figures 6-9).

Date	Year	Land Acres	Water Acres	Land %	Water %	Total
3/9	2004	301	4093	6.85	93.15	4394, 100%
10/27	2008	363	4182	7.98	92.02	4545, 100%
12/5	2015	332	4213	7.30	92.60	4545, 100%
12/5	2018	305	4240	6.71	93.29	4545, 100%

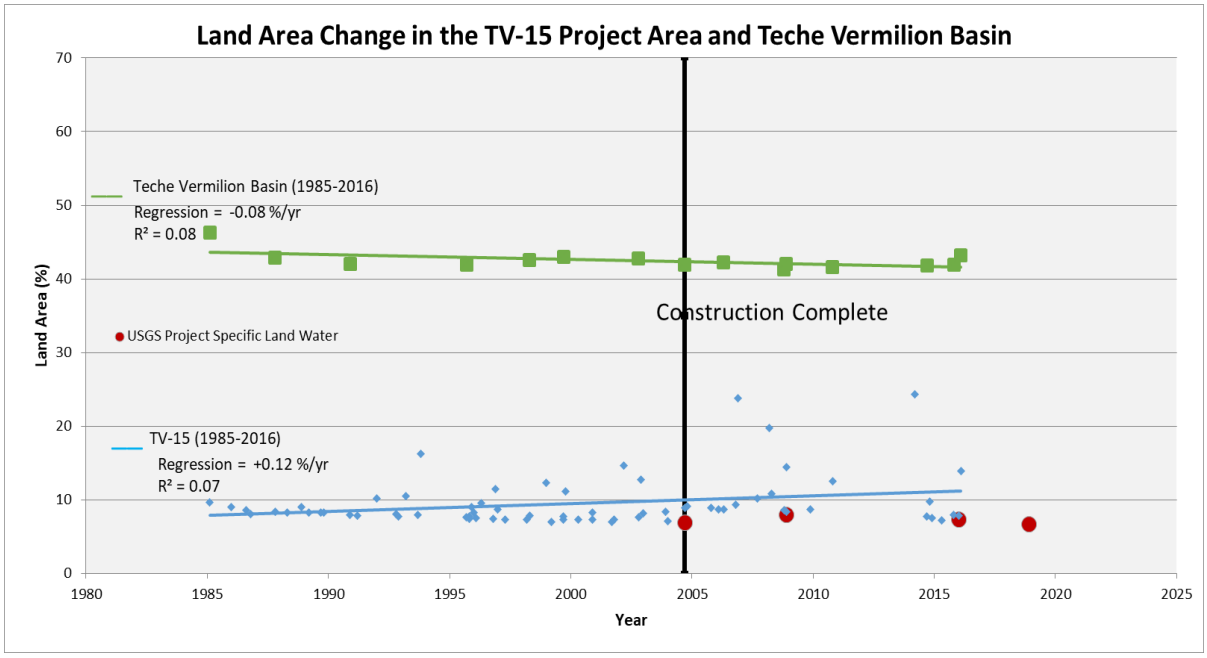

Figure 5. Project and basin scale percent land change for TV-15. Percent land values are displayed for all cloud free TM images available from 1985-2016. Percent land calculated as percent land of total project area. See Couvillion et al. 2017. Also the four project specific land water percentages at a higher resolution from figures 6-9 below are displayed in red.

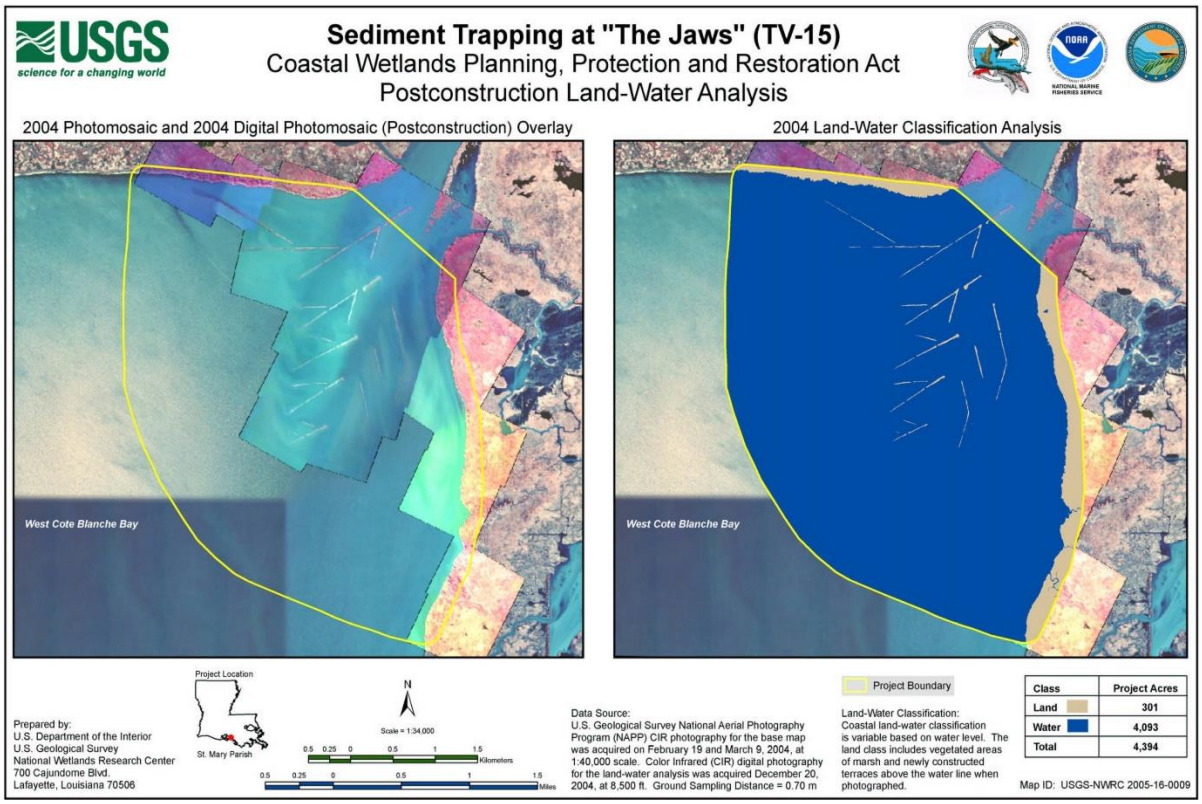

Figure 6. Sediment Trapping at the Jaws (TV-15) 2004 Land/Water analysis of the project area post construction.

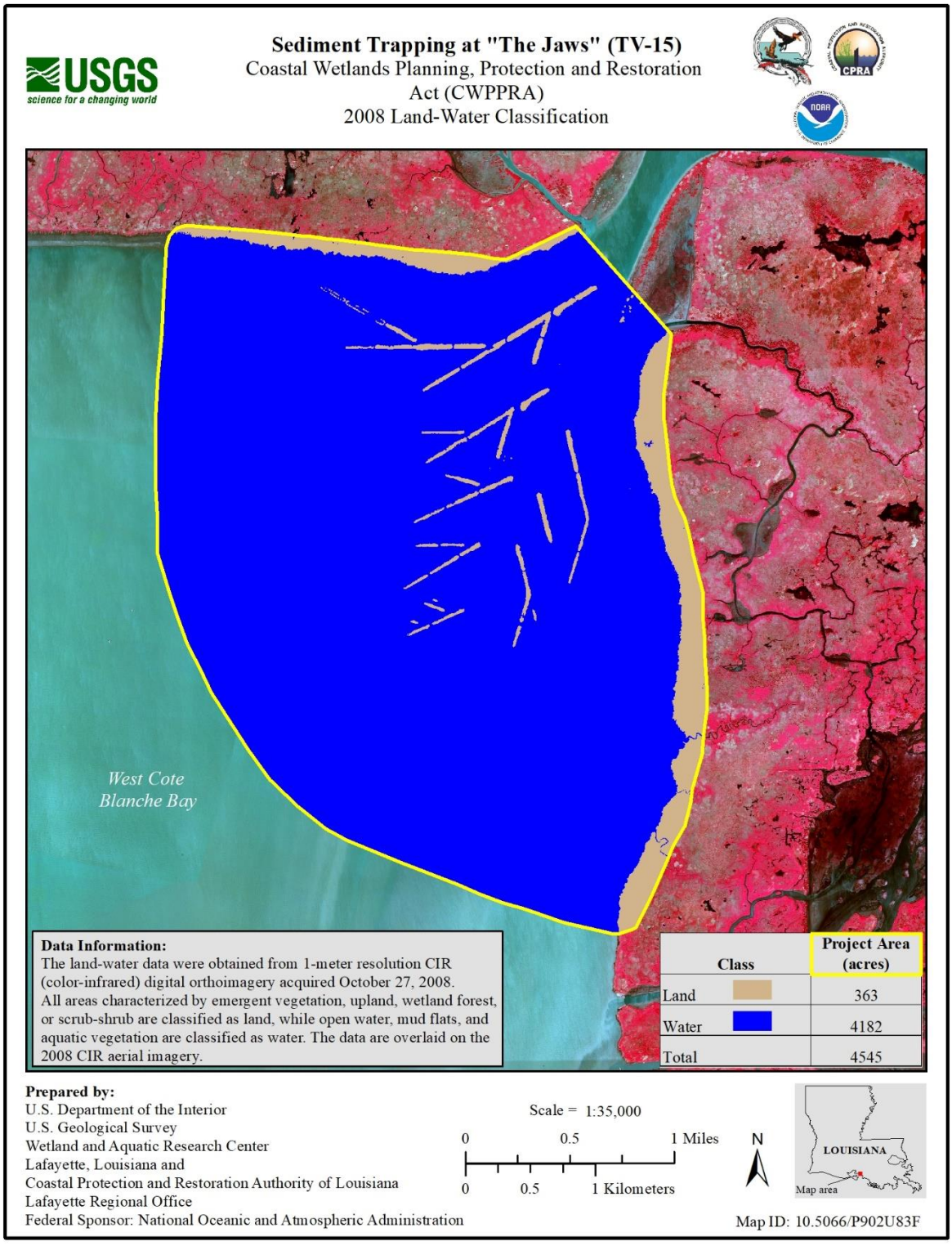

Figure 7 Sediment Trapping at the Jaws (TV-15) 2008 Land/Water analysis of the project area post construction.

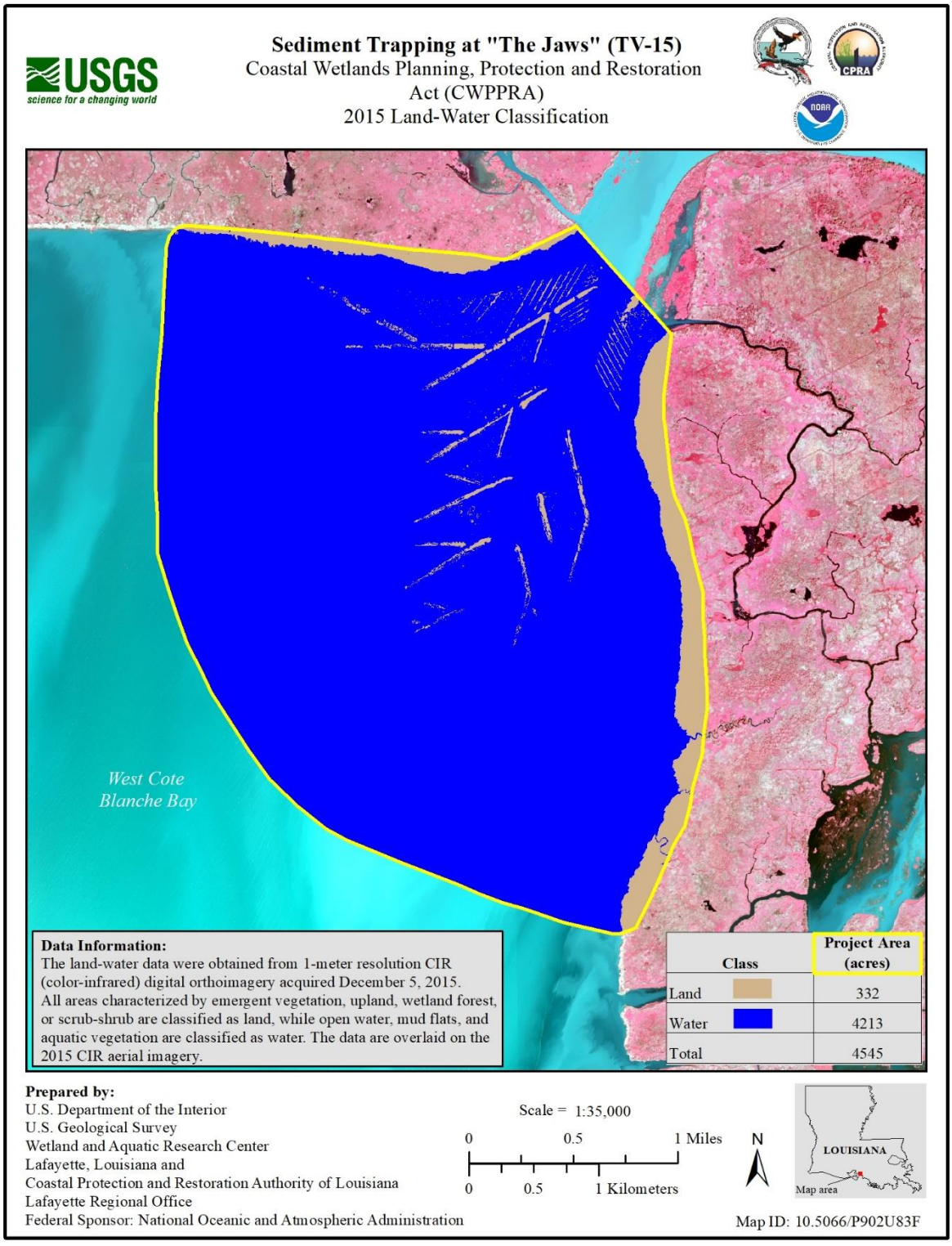

Figure 8 Sediment Trapping at the Jaws (TV-15) 2015 Land/Water analysis of the project area post construction.

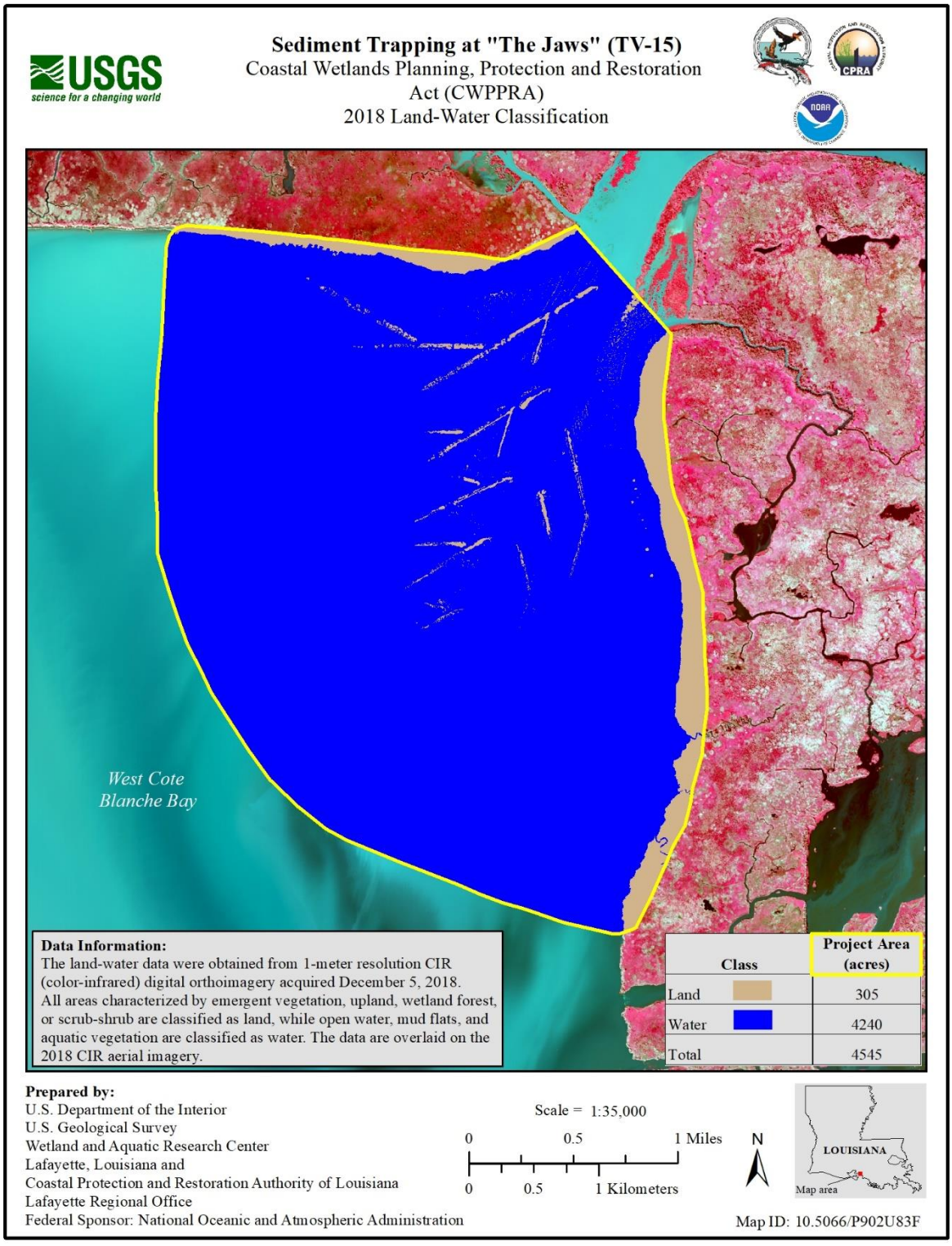

Figure 9. Sediment Trapping at the Jaws (TV-15) 2018 Land/Water analysis of the project area post construction.

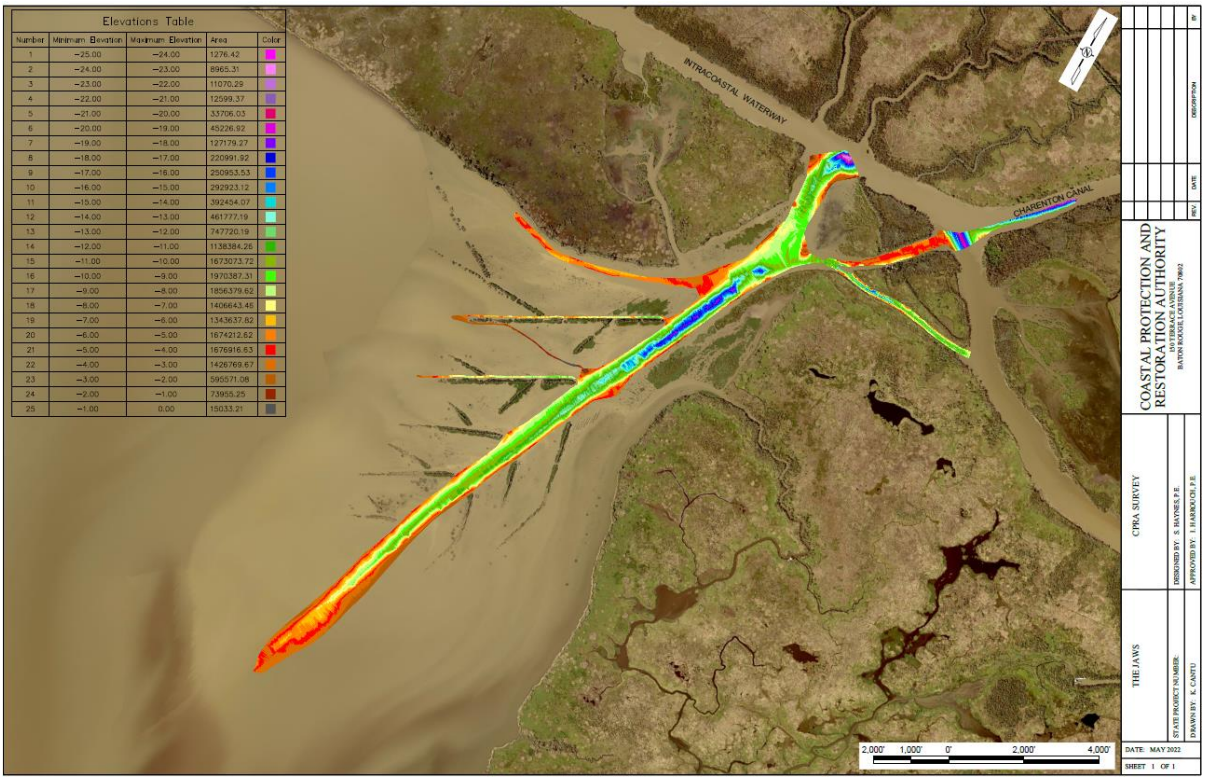

Figure 10. Sediment Trapping at the Jaws (TV-15) 2022 bathymetric survey data collected by CPRA LRO showing depths in one foot intervals.

Figure 11. Sediment Trapping at the Jaws (TV-15) 2012 aerial photo looking southwest showing large swaths of SAV, FAV, and some emergent marsh on inter-terrace mudflats.

Submerged Aquatic Vegetation (SAV)

Pre-construction, SAV was limited to the naturally occurring bank margins and the occasional shallow mudflats in the project area. SAV is highly variable depending on hydrologic conditions for both quantity and species present, this leads to some boom-bust dynamics as conditions vary. Post-construction the project area likely contained minimal SAV after Hurricane Rita and Ike in 2005 and 2007, as was widely seen in other locations along the Chenier plain (Mouledous et al 2020, Wood et al 2021). The drought conditions of 2010-2011 along with Hurricane Isaac in 2012 minimally increased salinity while reducing water level and turbidity creating an environment capable of supporting a variety of salt tolerant SAV species. Starting in 2014, the LA-39 plantings (McGinnis et. al. 2021) on the shallow project mudflats reduced fetch and turbidity which along with consistent fresh conditions from 2013-2021 started an period of increasing SAV in the project area as noted and observed during LA-39 and project specific data collection visits. During the initial LA-39 plantings *Ceratophyllum demersum* was seen growing sparsely but widespread in the project area in the fall 2014 (Figure 12). As the plantings thrived Floating Aquatic Vegetation (FAV) overwhelmed the project area, growing tightly packed in between the plantings and the project terraces on the mudflats. These dense FAV rafts slowed down and filtered the water coming through the Jaws. They also contained some interior open ponds harboring multiple species of SAV in thick colonies. After the winter of 2016 much of the LA-39 plantings had been smothered by the now receded FAV rafts leaving considerably more SAV species and coverage than in the previous years, such as *Vallisneria anericana*, *Ceratophyllum demersum*, *Potamogeton pusillus*, and *Potamogeton diversifolium* (Figure 13). These SAV beds continued to expand and shift between species as the second LA-39 planting took place in the project area early in 2018 (Figure 14). Post hurricanes Barry in 2019 and Laura and Delta in 2020, a shift in SAV occurred in the project area with the beginning and vast expansion of *Potamogeton diversifolium* and Najas guadalupensis dominated the SAV species present (Figure 15). Whether this was due to the elimination of competition from other SAV and FAV species, nutrient changes, or other factors is unknown; but a vast expansion of these species has occurred at the end of project like covering tens of acres typically oriented on elevated mudflats bordering channels. The Sentinel-2 L2A satellite NDVI image on 8-23-2021 showing extensive SAV beds of *Potamogeton diversifolium* and other species that are present just above the surface of the water in the blue colors growing in vast areas interspersed in the project area correspond quite well with field observations one month later (Figure 16). Overall the project area mudflats have provided an exceptional platform for SAV establishment and expansion when environmental conditions allow. While not imperially quantified the onsite observations and satellite imagery have shown a compelling response in the SAV community in the project area.

Figure 12. Sediment Trapping at the Jaws (TV-15) on 11-2014, with minimal occurrences of *Ceratophyllum demersum*, seen growing in the project area.

Figure 13. Sediment Trapping at the Jaws (TV-15) on 9-2017, with *Vallisneria americana, Ceratophyllum demersum, Potamogeton pusillus, Potamogeton diversifolium* seen growing in area.

Figure 14. Sediment Trapping at the Jaws (TV-15) on 11-2018, with significant quantities of *Vallisneria anericana* seen growing in area.

Figure 15. Sediment Trapping at the Jaws (TV-15) on 9-2021, with extensive beds of *Potamogeton diversifolium* and Najas guadalupensis seen growing in vast areas interspersed in the project area, covering multiple acres.

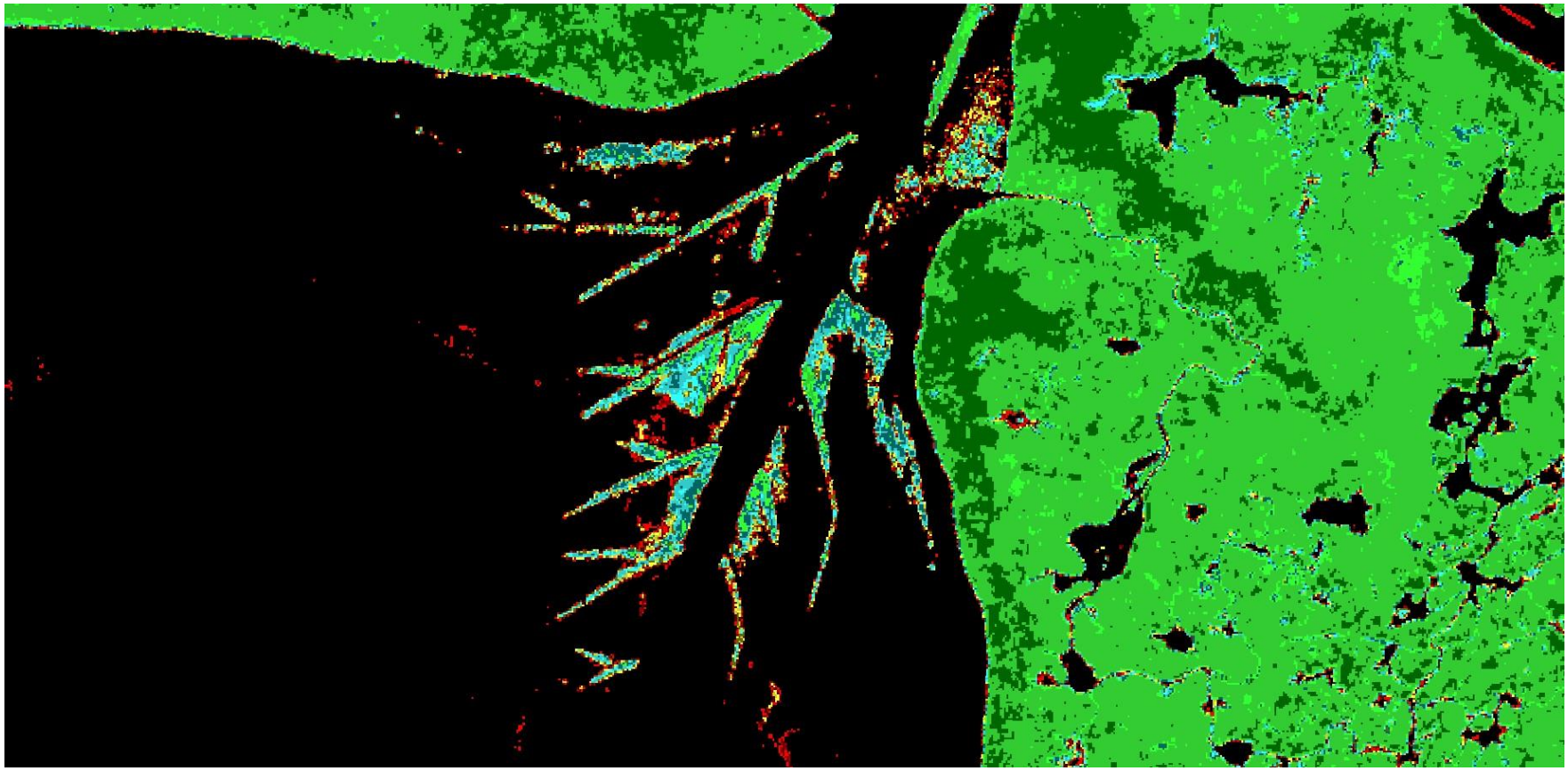

Figure 16. Sediment Trapping at the Jaws (TV-15), a Sentinel-2 L2A satellite NDVI image on 8-23-2021 showing extensive SAV beds of *Potamogeton diversifolium* and other species that are present just above the surface of the water in the blue colors growing in vast areas interspersed in the project area. These agreed with field observations taken on 9-23-2021.

Vegetation

Emergent vegetation data was collected on the terraces post construction in Sept 2021. The total cover of emergent vegetation at differing relative elevations was utilized to determine what elevation's effect of species composition and quantity was over the project life. Vegetation quickly became established on all elevations of the terraces including the planted *Schoenoplectus californicus* on the terrace edge. In general, terrace vegetation types have been stable over the project life with *Salix nigra* (23%) dominating the higher point bar terrace crowns and *Schoenoplectus californicus* (69%) consistently filling the land water interface niche and spreading into deeper waters (Figure 17). However, this does not indicate the succession that has taken place in the vegetative species present and their dominance. The middle elevation of the terraces or transitional area between the water and the crown contained the least cover during the 2021 survey likely due to three factors. First, the nature of this relative elevation is transitional and annual and seasonal variability could select for new species. During this recent survey, *Schoenoplectus californicus* (14%) was the dominant species, likely due to years of high water and recent storm events. Also this relative elevation on the terrace slope was generally in the wave break zone during average storm and frontal passages leading to both erosive damage and smothering via FAV's, mainly *Eichhornia crassipes* (Figure 18). In general the terrace's northern most portions were higher supporting woody vegetation which, as the terrace stretched out away from the main channel, transitioned into *Schoenoplectus californicus* monocultures in deep water, rarely appearing subaerial (Figure 19). These stands eventually gave way to isolated pockets of the vegetation before diminishing to open water where the terraces had either eroded, subsided too deeply beneath the water, or both. (Figure 20).

As expected, none of the terrace vegetation appeared closely related to the species assemblages in the nearby emergent Bay Shore sites (CRMS0489, CRMS0496, CRMS0517, and CRMS0527) or the interior marsh sites (CRMS0493, CRMS0543, CRMS0544, and CRMS0545), as measured between 2006 and 2021 (Figure 21). The reference CRMS sites were much more similar to one another and do not have the same elevation differences present over a short distance as is evident on the project features. The coverage of vegetation, overall, spread across all terraces post construction, planted or not, has helped to maintain the original project foot print and assist with meeting the project goals of reduced erosion and increased SAV occurrence. This was true even in the face of multiple negative climactic events. Project features have successfully maintained vegetation where elevation remains viable, though this is being reduced somewhat near the end of project life.

The Coastwide Vegetative Planting Project (LA-39) has done two plantings on the inter terrace mud flats in recent years, one in 2014 and another in 2017. The first consisted of linear hedge rows of *S. californicus* at four different locations throughout the project area where inter terrace elevation had increased over the project life to show some minimal growth of emergent vegetation. The plantings were initially very successful and became established quickly, slowing water flow and causing fine particles to drop out of suspension (Figure 22). In the interior of these plantings in 2015 there was clear water supporting lush SAV growth in this generally very turbid environment. The vegetative structure provided by the planted vegetation unfortunately also provided excellent conditions for the growth and proliferation of *E. crassipes* which in the winter of 2016 smothered most of the LA-39 plantings. With the initial impressive success of the plantings a different approach was applied in 2017, which more

closely resembled the natural emergent vegetation in both species and form. As noted in TV-15 project inspections and LA-39 site visits, the emergence and resiliency of circular clumps of *Zizaniopsis miliacea* was evident year in and year out. These were likely deposited as full clumps of intact vegetation with root systems present and local increased elevation was a result. There was minimal initial spreading of these pioneer individuals, which is what the second planting of LA-39 was designed to expedite. This consisted of four planting zones including two species, *S. californicus* and *Z. miliacea*, in five different spatial orientations. Among the different locations and species, the plantings' spatial orientation are one of the following: 3–plant clusters, 6–plant clusters, 9–plant clusters, 16–plant clusters, and a single row of *Z. miliacea* (Figure 23). These plantings again were initially very successful, but over time the *S. californicus* succumbed to the same outcome as the original plantings as was expected as it was used as a partial control. *S. californicus* can grow in deep permanently flooded conditions even when salinity is present at less that 5ppt. Those attributes make it a highly desirable species in restoration for both protecting newly constructed earthworks and filling in shallow open water. However one of the species shortcomings in these usages appears to be its lack of resiliency to mechanical damage and smothering especially during the winter months, as has been shown repeatedly by the LA-39 project. The *Z. miliacea* seems to be more resilient to the rafts of *E. crassipes* rafts during the winter months, which likely will lead to increased vegetation, SAV, and elevation on the inter terrace areas of the TV-15 project areas. These LA-39 plantings were facilitated by the TV-15 project area's success at trapping and retaining sediment to increase elevation in formerly open water, which synergistically helps the project meet its goals of increased SAV and protection of nearby marsh shorelines. This area has been battered by multiple hurricane storm surges from 2019 through present which has interfered with but not halted these project effects. Replanting the area in a targeted fashion can still enhance an already successful project, but challenges remain to creating a long lasting self-replicating emergent marsh on the expansive TV-15 mudflats.

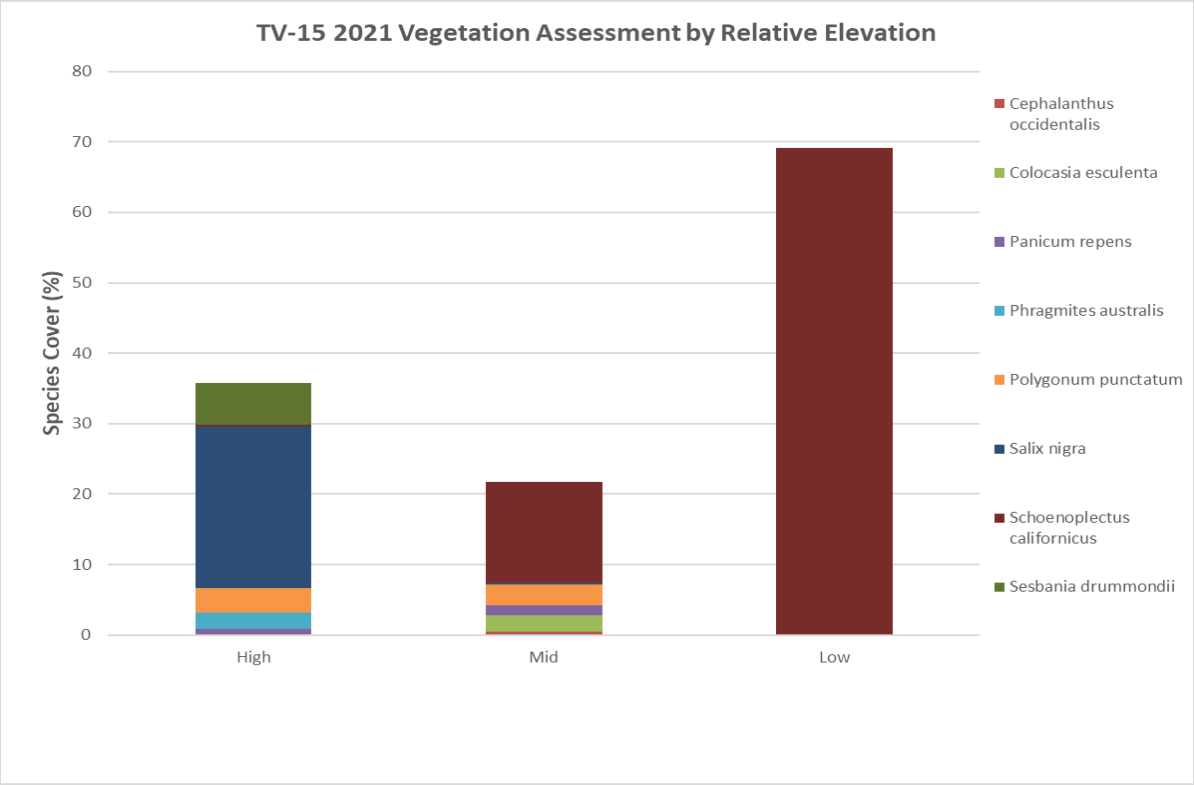

Figure 17. Sum of species percent cover across a relative elevation gradient from terrace crown to toe for TV-15; some of the higher elevations contained no vegetation due to 2020 storm damage and or rafting FAV's.

Figure 18. Sediment Trapping at the Jaws (TV-15) photo of a typical terrace as it transitions from higher to lower elevation, left to right. This generally occurs traveling southwest through the project area.

Figure 19 Sediment Trapping at the Jaws (TV-15) photo of a typical terrace as it transitions from higher to lower elevation, left to right. This generally occurs traveling southwest through the project area.

Figure 20. Sediment Trapping at the Jaws (TV-15) photo of a typical terrace as it transitions from higher to lower elevation, right to left. This generally occurs traveling southwest through the project area.

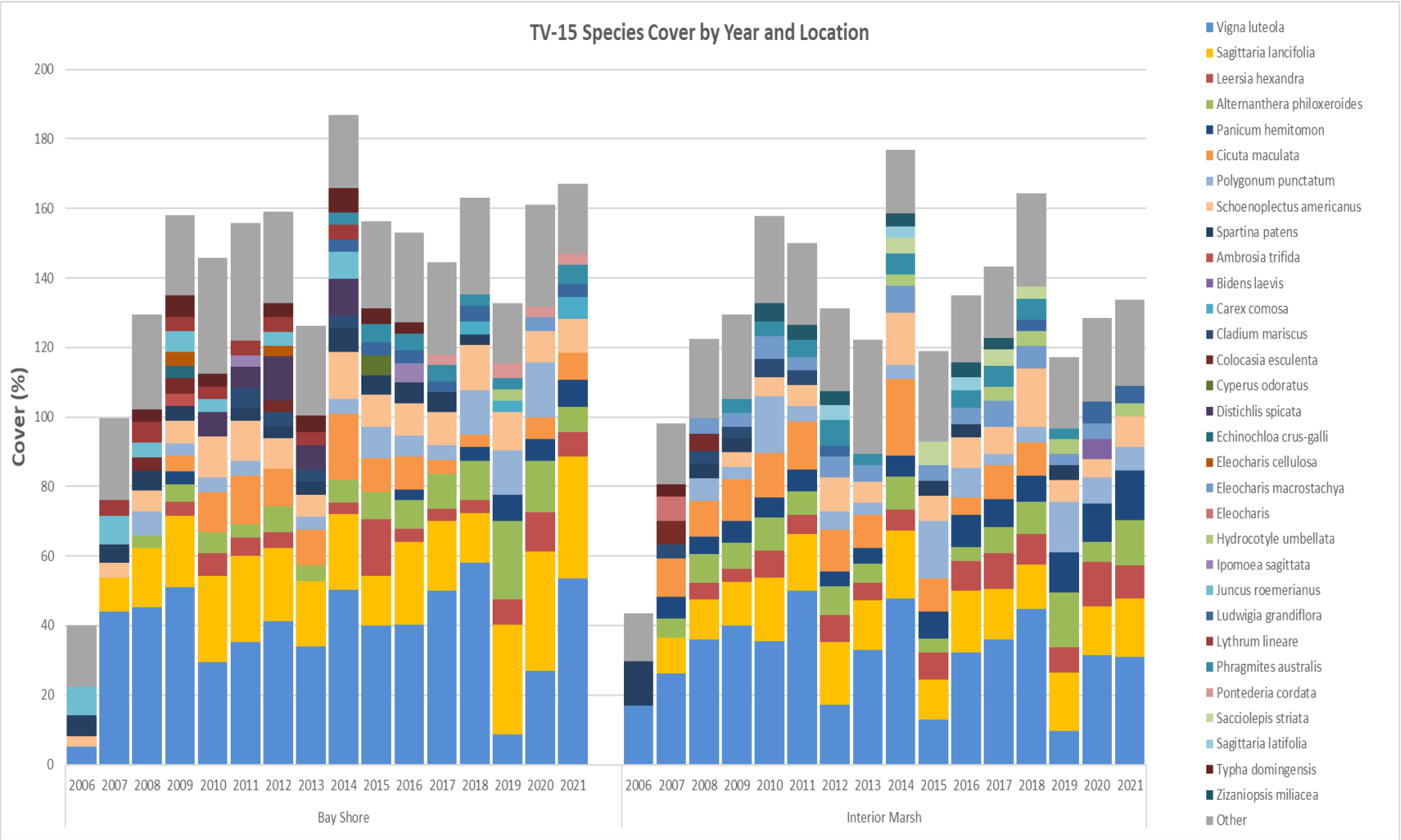

Figure 21. Percent coverage and floristic quality index of species collected at Bay Shore CRMS sites (4) and interior marsh CRMS sites (4), around the TV-15 project area in years 2006 – 2021, showing a large number of species consistent with fresh and intermediate marsh.

Figure 22. Typical view of a double row plantings at LA-39 Year 3 - The Jaws just prior to the September 2015 sampling. Note accumulation of *Eichhornia crassipes.* This was previously an unvegetated inter terrace mudflat with sediment accumulation as a result of the TV-15 project with minimal emergent vegetation present.

Figure 23. LA-39 Year 6 The Jaws 2, *Zianiopsis miliacea* 16-plant clumps were growing out away from the monitoring station and becoming contiguous with naturally occurring stands of the same species by October 2018.

Salinity

The project area surface water salinity as measured at eight CRMS sites from 2006-2021 has generally remained consistent with Bay Shore sites (CRMS0489, CRMS0496, CRMS0517, and CRMS0527) maintaining a more intermediate salinity regime while the interior marshes are notably fresher (CRMS0493, CRMS0543, CRMS0544, and CRMS0545) (Figure 24). This general increase in salinity in the late summer and early fall creates stressful conditions for many of the fresh FAVs, SAVs, and emergent marsh species that became established in the spring and early summer. This should not come as a surprise as the project area is in one of the more dynamic areas of the coast, influenced by the fresh water Atchafalaya Basin to the north and east via the GIWW and the waters of Atchafalaya bay. While the ever present saline GOM to the south can under low Atchafalaya River and low rainfall conditions funnel high saline waters into East and West Cote Blanche bays around Marsh Island under average water levels. Storm surge events carry saline water into the project area which does drain out efficiently and is somewhat self-mitigating as copious upland rainfall is typically associated with these surge events and effectively flushes the salinity back out of the tidal project area. This is reflected in the lack of major salinity spikes above 5ppt even in the face of multiple recent hurricane storm surges over the life of the project (Figure 18). The one notable exception was in 2012 when Hurricane Isaac blew much of the fresh water off shore which was replaced with higher saline water that coincided with a low Atchafalaya river stage and minimal rainfall causing salinity in the Bay Shore sites to spike above eight ppt for approximately one month. Overall, though, salinities have been by and large trending downward in the project area over the course of the data record. However, this pattern is not unique to the project as this trend has been on display coastwide during this timeframe. While the project has no goals related to reducing salinities in the area, salinity along with flooding play a large role in determining which species of emergent vegetation, FAV, and SAV are present and what is likely to remain long term.

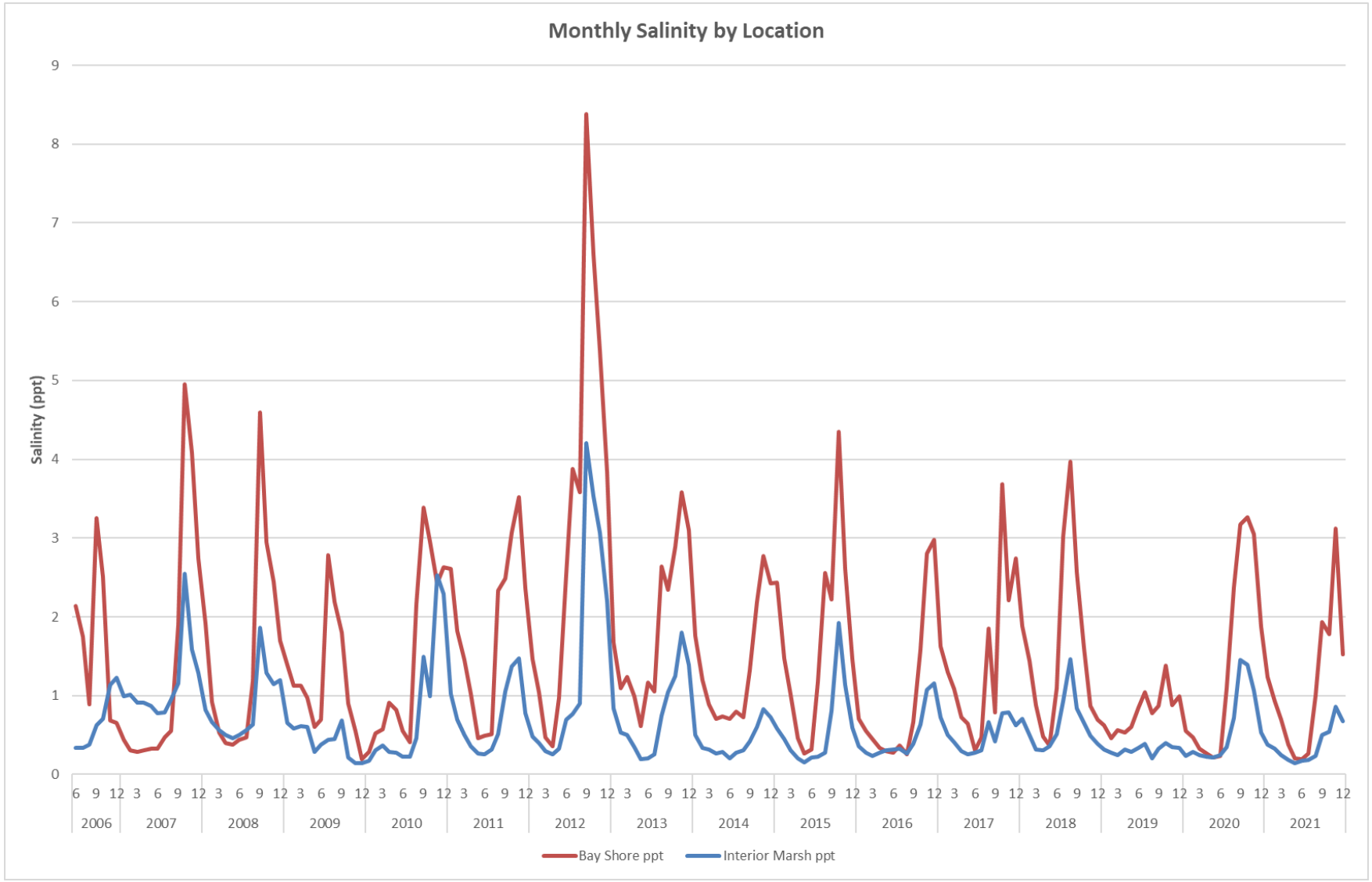

Figure 24. Monthly means of salinity data collected post-construction around the TV-15 project area, the project area is more similar to the Bay Shore sites, experiencing higher salinities more often than the interior marshes.

Water Level

Water levels from 2006-2021 were collected at eight CRMS sites located around the project area: Bay Shore sites (CRMS0489, CRMS0496, CRMS0517, and CRMS0527) and interior marshes sites (CRMS0493, CRMS0543, CRMS0544, and CRMS0545) (Figure 25). Post-construction, water levels have oscillated through time, seasonally, but persistent rainfall and higher than average GOM in recent years has increased water levels throughout the project and surrounding areas by approximately 0.5 ft. This persistent high water mixed with occasional mild salinity intrusions, may in part be responsible for the general lack of wide spread vegetation on the inter terrace mud flats. These mudflats are quite variable in elevation with higher elevation areas closer to channels and inland locations, generally losing elevation as they extend out into the bay (Figure 26). Some of the channel bar areas are probably close to +0.25 ft NAVD, GEOID 12A harboring sparse emergent marsh vegetation. Overall the mudflats average elevation is between -0.1 ft and -0.6 ft according to estimates from LA-39 plantings and Sentinel-2 L2A satellite data combined with CRMS water level data. Local water level increases coupled with terrace settling, local subsidence have created more flooding more often on many of the distal terraces, some near 100% flooded year round. This is not conducive to marsh vegetation survival or spread. Many of the marshes around the project area, both Bay Shore and interior marsh have some of the highest elevations coastwide, averaging 1.13 and 1.34 feet NAVD GEOID 12A respectively. While this has little bearing on a sinking deltaic splay terrace framework it is worth noting that local water levels are encroaching on even these high marshes and will likely lead to the loss of vegetation in low project areas that reach far out into West Cote Blanche Bay which now have negative surface elevation trajectories.

Second to this persistent high water levels was the episodic effects associated with five major hurricanes having impacted the project area through the monitoring period, temporarily flooding the project area with up to 8 feet of GOM water: Hurricanes Rita (2005), Ike (2008), 2020 Hurricanes Laura and Delta, and Ida in 2021 (McGee et al. 2006; East et al. 2008; NOAA Hurricane Laura's Storm Surge 2021). This does not include minor Hurricanes such as Barry which produced significant flooding and damages in the project area in 2019 but was limited in the size and scope of human and wetlands damage and was quickly forgotten in the face of the 2020 and 2021 hurricane seasons which produced two category four hurricane landfalls. No category five hurricanes and only two others category four storms have made land fall in Louisiana between 1852 and 2019, Isle Dernieres (Last Island) in 1856 and Audrey in 1957, (Ross et al. 2010).

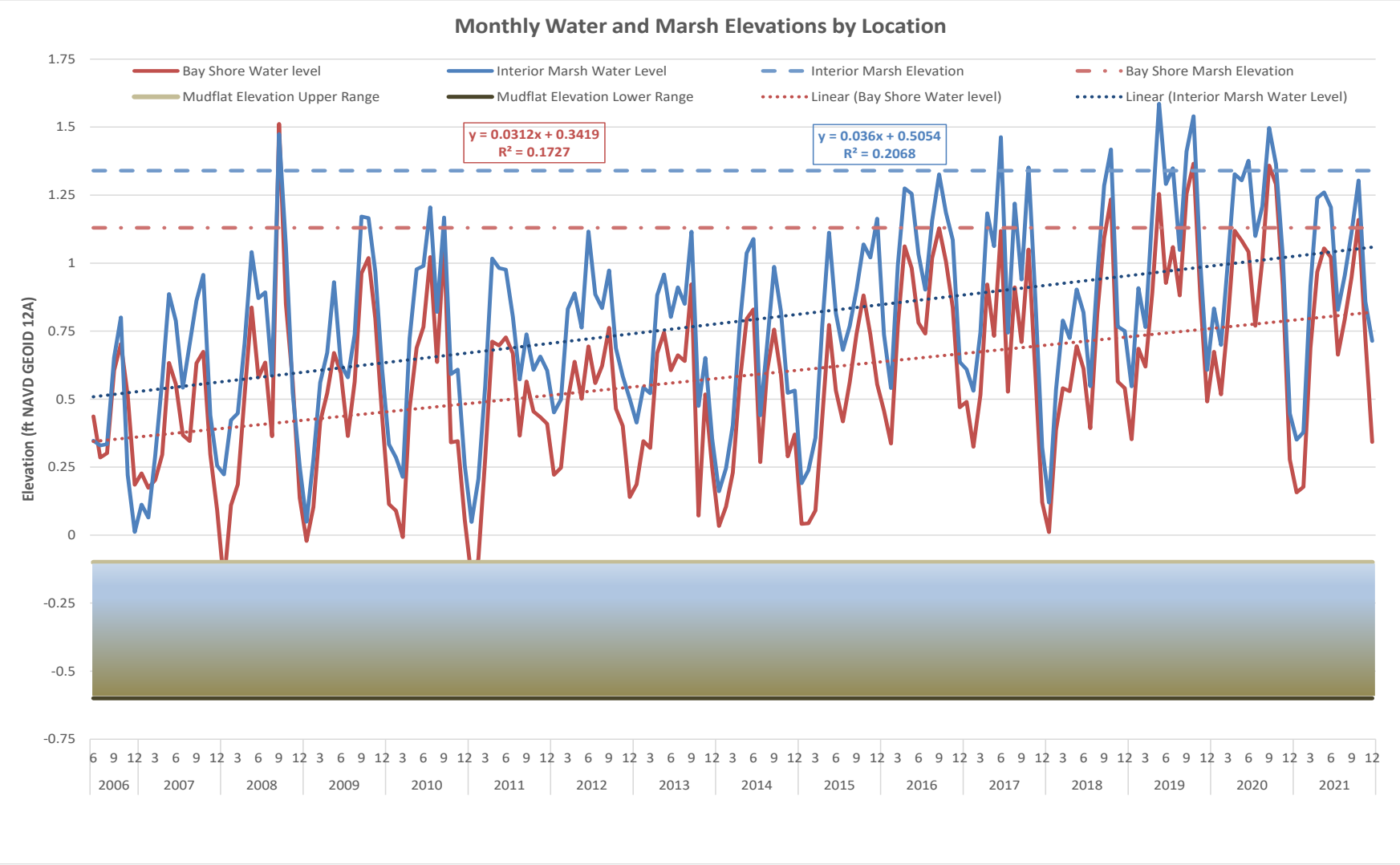

Figure 25. Monthly means of water level data collected post-construction around the TV-15 project area. The project area is more similar to the Bay Shore sites, experiencing lower water levels more often than the interior marshes. An average mudflat elevation estimate was developed from CRMS water level data, satellite data, and LA-39 data and is between -0.1 and -0.6 ft.

Figure 26. Sediment Trapping at the Jaws (TV-15), a Sentinel-2 L2A satellite color inferred image on 2-19-2021 showing extensive mudflats in the project area (-0.685 water elevation NAVD GEOID 12A). There is a general trend of higher elevation mudflats in the northeast project area and along channels, which gradually tapering downward toward the bay.

Soil Properties

Soil samples were collected around the TV-15 project area at eight CRMS sites located at Bay Shore sites (CRMS0489, CRMS0496, CRMS0517, and CRMS0527) and interior marshes sites (CRMS0493, CRMS0543, CRMS0544, and CRMS0545) during 2008 and again in 2018. The soil properties data were sampled in 4 cm increments. Higher bulk densities occurred at the Bay Shore sites as was expected because generally more heavy materials are associated with these locations, the less dense soils were found more interior (Figure 27). Bay Shore sites also had a lower organic matter percent in the 2008 and 2018 samples; though the 2018 data suggests some organic peat accumulation and reduced bulk densities as waters rise due to increased flooding, especially at the surface (Figure 28). Lower bulk densities and higher organic matter percent were found in the interior marsh sites, which also likely have more shrink swell potential. The TV-15 project area is more consistent with the Bay Shore soil properties due to several factors including the material used during construction had a high mineral content, water land interface allowing for mineral deposition during storm events, and existing in a high energy environment which would consistently remove organic matter during the winter months and under storm conditions.

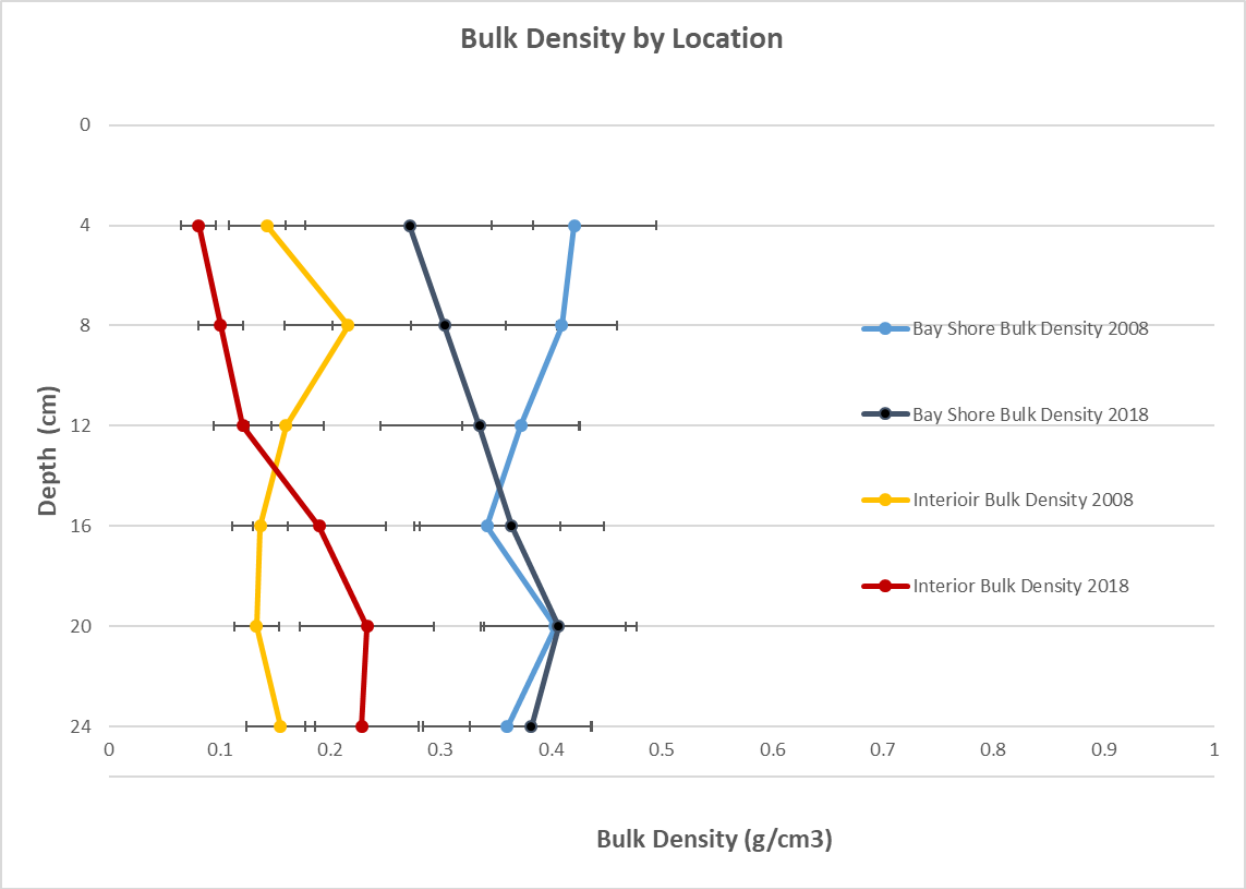

Figure 27. Mean ± Standard error of soil bulk density collected around the project area at CRMS Bay Shore and interior marsh sites.

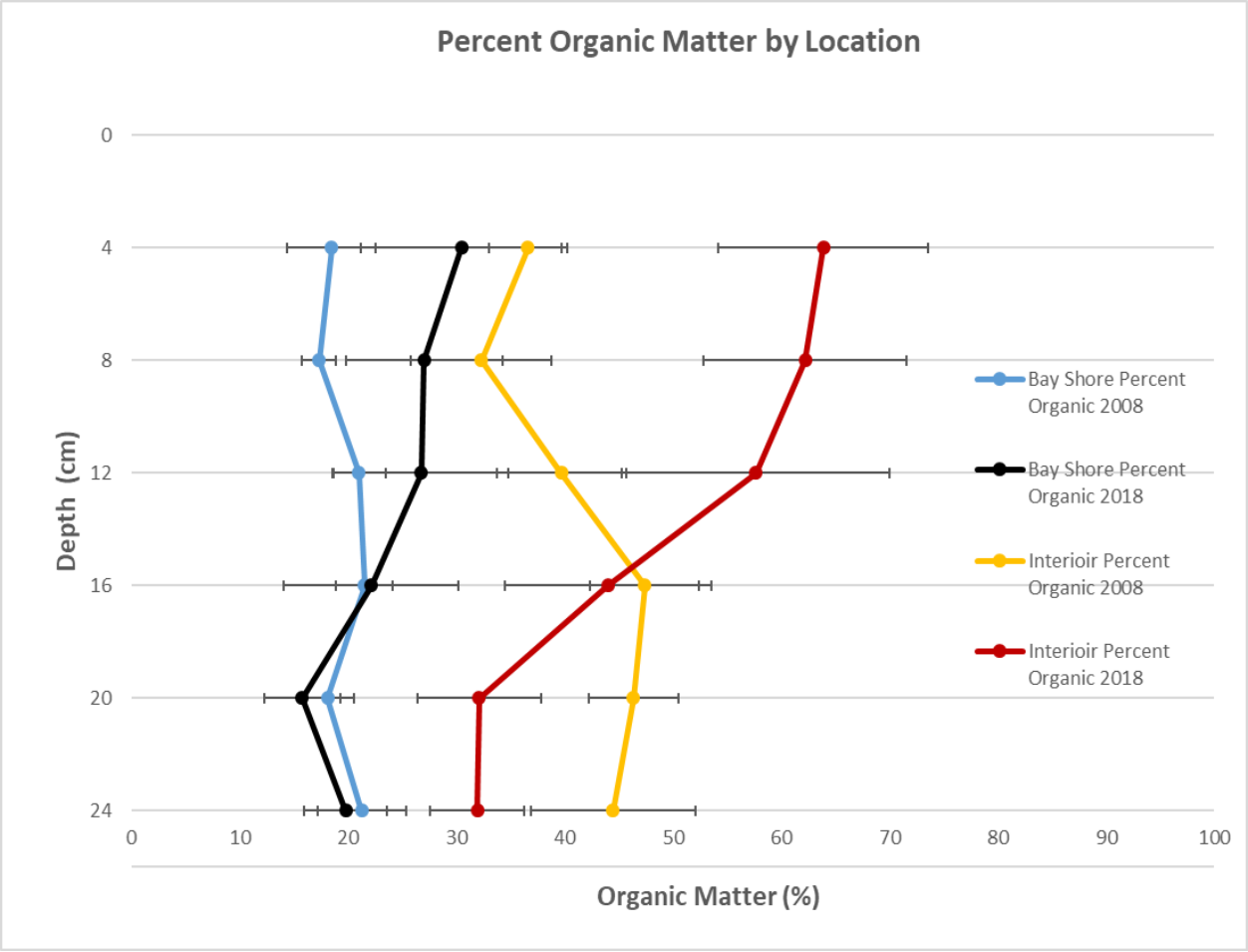

Figure 28. Mean ± Standard error of soil organic matter collected around the project area at CRMS Bay Shore and interior marsh sites.

Elevation Change

Elevation change data at the TV-15 project area's surrounding CRMS sites either located on the bay edge or in the interior marsh environment show that the surrounding area has generally gained elevation through time on pace with Relative Sea Level Rise (RSLR)(Figures 29). However, these positive gains in elevation occurred under the most persistent high water period in the CRMS hydrologic database and are a clear response to increased flooding (Figures 30-31). There is likely a vegetative and soil pore space response to increased water level driving this increasing in elevation. As water levels rise wetland plants adapt by growing adventitious roots essentially raising the elevation of the root zone and soils swell with increased hydration increasing pore space, inflating the soil volume much like a sponge. These sites are, however, maintaining elevation when compared to the Sabine Pass NOAA tide gauge sea level rise estimate of 0.7 cm/yr (Zervas 2009, 2013). CRMS sites 0489 and 0545 are exceptions to this trend; 0489 is located on the bay edge and is experiencing significant shoreline erosion while 0545 is an interior site that was heavily damaged by Hurricanes Barry, Laura, and Delta (Figures 32-33). These however are the outliers with the majority of sites continuing vigorous and healthy marsh functions (Figures 34-35).

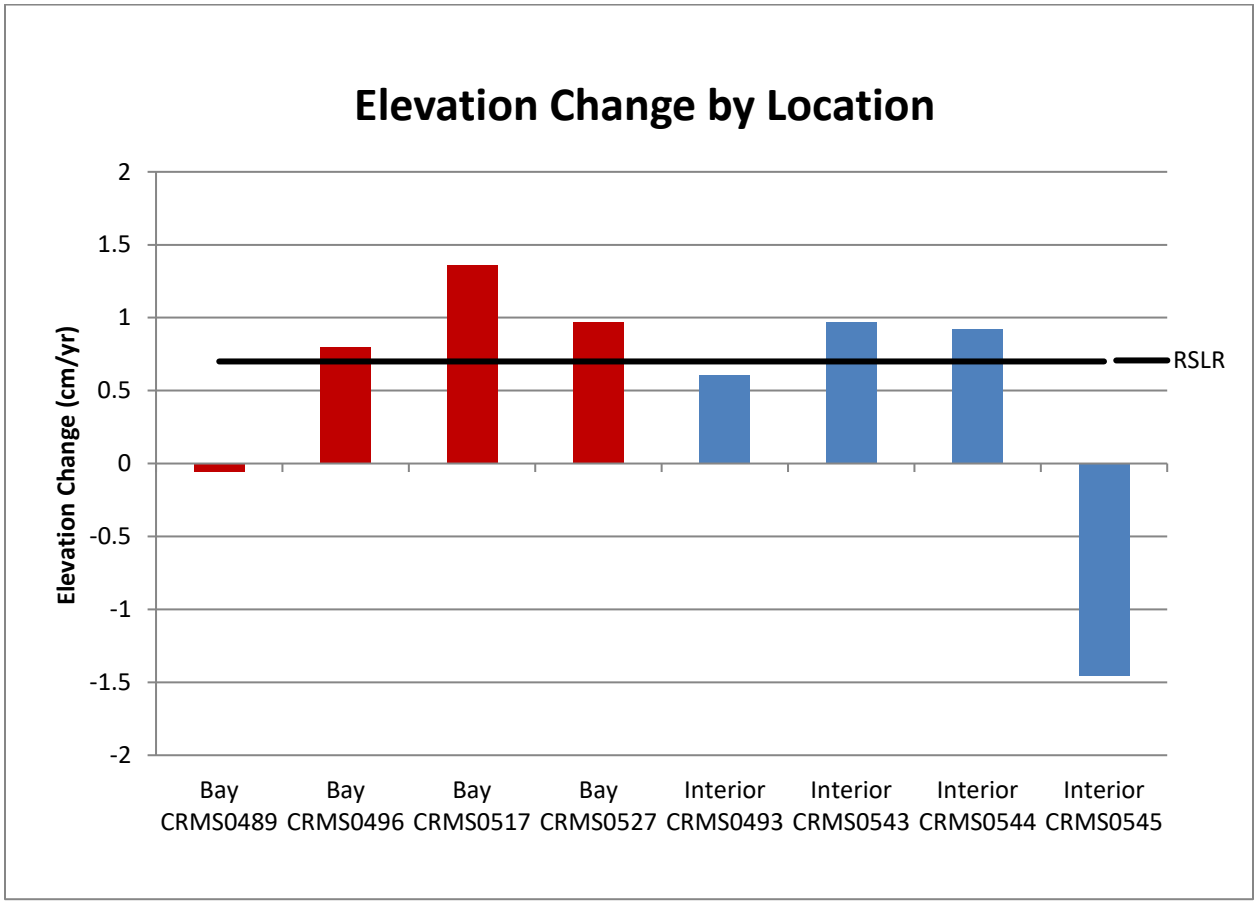

Figure 29. Elevation change per year experienced at the TV-15 surrounding CRMS sites located along the bay edge or in the interior marshes compared to an annual RSLR rate.

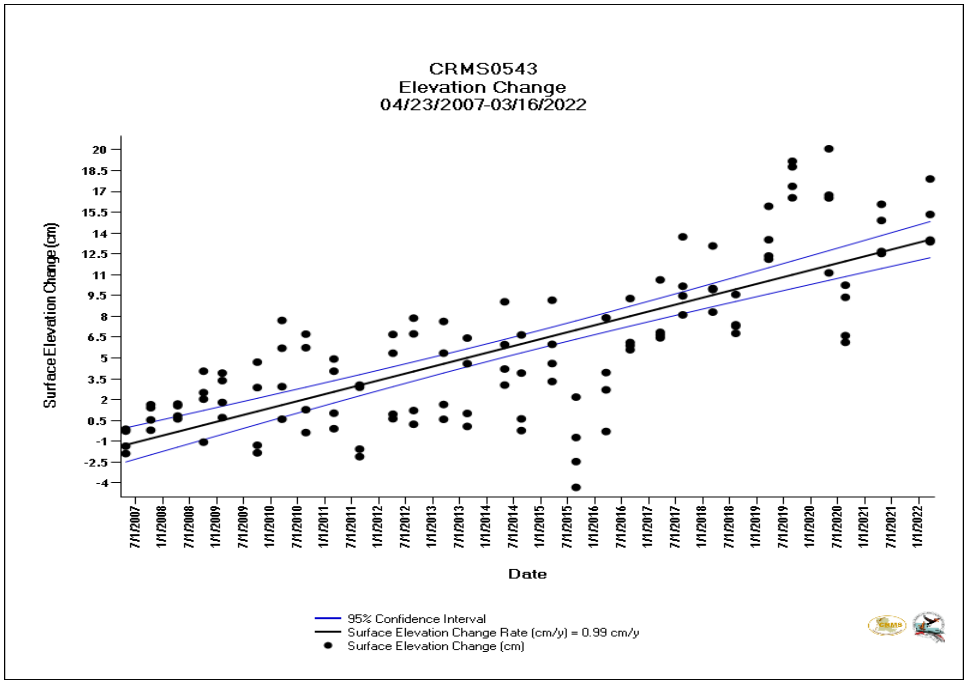

Figure 30. Elevation change per year at CRMS site CRMS0543 located in the interior marsh showing a clear response to elevated water levels starting in 2017 and continuing through the present.

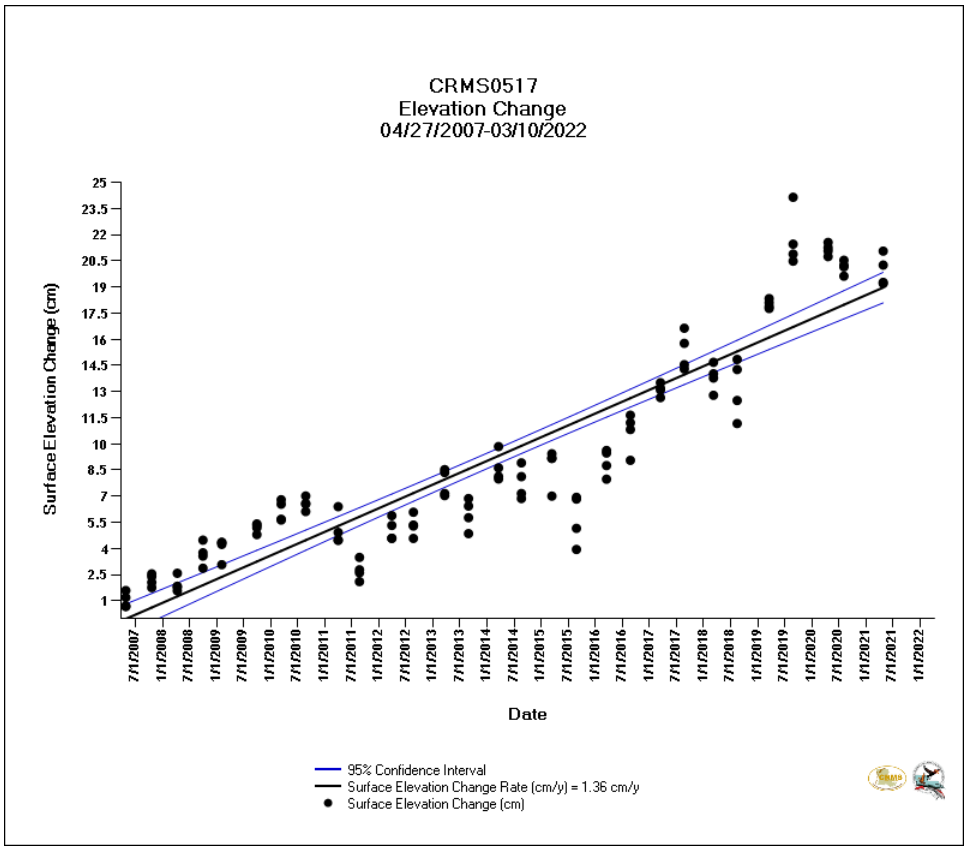

Figure 31. Elevation change per year at CRMS site CRMS0517 located on the Bay Shore showing a clear response to elevated water levels starting in 2017 and continuing through the present.

Figure 32. TV-15 interior marsh CRMS site CRMS0489 losing elevation as a result of shoreline erosion.

Figure 33. TV-15 interior marsh CRMS site CRMS0545 losing elevation as a result of hurricane damage likely exacerbated by prolonged flooding.

Figure 34. TV-15 Bay Shore CRMS site CRMS0517 demonstrating positive elevation as a result of increased water elevation.

Figure 35. TV-15 interior marsh CRMS site CRMS0543 increasing in elevation as water level increases.

V. Discussion

TV -15 has protected West Cote Blanche Bay Shore from extensive coastal erosion in the area of the Jaws as intended since the project was constructed in 2004. Additionally, the TV-15 project has provided ample water wetland interface (edge habitat) and produced expansive mudflat formation over its 20 year economic life, while also sustaining a healthy population of submerged aquatic vegetation in the inter terrace tidal flats. These areas of dampened wind and wave driven fetch provided the conditions necessary for SAV growth along with harboring the animals that use these resources. The project features have also maintained healthy emergent marsh vegetation on the terraces throughout the project's life, even in the face of some historic environmental extremes, namely Hurricanes Rita, Ike, Barry, Laura, and Delta, a significant drought in 2011 and high water over the last 5 years. These events all had impacts on the project features and the vegetative response they elicited, and generally these were negative, with hurricane storm surges heavily damaging SAV beds and emergent vegetation on the terraces, while also causing erosion and windthrow of trees in the project area. The emergent marsh response to the drought conditions of 2011 was likely positive or neutral as lower water levels could have allowed for broader expansion of vegetation into previously flooded areas. However, other than that event, salinity generally remained consistent allowing for SAV establishment and development, with rapid expansion later in project life as emergent vegetation expanded and fresher conditions were consistent. As such, the 2015-2021 prolonged high freshwater conditions within the project area and the coast as a whole likely provided some stability for the SAV community as was seen with large expanses of *Potamogeton sp.* present in the 2021 data collection visit. The project area has also seen vegetative expansion post construction as vegetation has thrived and expanded, though not to the extent or at the speed that was expected after early mudflat formation. This, however, has gained attention within the restoration community as a thriving location with the potential to grow emergent marsh species and has been planted with non-project funds twice with differing degrees of success. Planted vegetation, specifically *Schoenoplectus californicus* on the mudflats, had exponential growth and a subsequent population crash due to rafting of FAV's, specifically *Eichhornia crassipes* during the winter months. This was less evident in the planted *Zizaniopsis miliacea* which has naturally recruited to the intra-terrace mudflats. It is a prime candidate for additional dense area plantings in the highest elevation areas of the project mudflats, with the possibility of expansion if successful. The Jaws area is a highly energetic confluence of multiple waterways which provide nutrients and sediment, but also exacerbates storms surges like those of Barry, Laura, and Delta. As of the final monitoring event, much of the original project area terraces are either still flourishing with multiple species of vegetation or becoming monocultures of *S. californicus* as they lose elevation to erosion and subsidence. The majority of the most productive locations of emergent vegetation and SAV beds are along the project's most protected area as seen in figures 3C and 23. Overall the project has provided habitat, forage, and protection for SAV and marsh alike, while showing the potential for extensive emergent marsh expansion, though it has not been able to expand emergent marsh as anticipated through the end of project life.

VI. Conclusion

a. Project Effectiveness

Overall, the project has successfully increased and protected emergent marsh in the project area compared to preconstruction, with the creation of over 300 acres of terraces and natural marsh along with approximately 600 acres of intertidal mud flats and SAV beds. The pre project marsh shoreline has moved very little behind the project terraces essentially becoming static post construction adjacent to the terraces. However, the project boundaries do reach farther out into open water than do the project features which in turn mutes the project effectiveness as erosive forces in the form of hurricanes and wind born fetch reduced the total acreage. Ultimately with a consistent sediment source the project is generally expanding on emergent habitat in the north and west while losing land in the south and east. That stated the development of extensive mud flats between the terraces and on the landward sides of the created deltaic ridges have generated estuarine habitat and helped protect the back marshes from more extensive shoreline erosion as is common in the area.

Overall, the project has created an effective sediment trap and shoreline erosion protection complex that is expected to maintain its function into the near term. Some of the project features will likely remain long after the 20 year life and continue to function as designed, trapping sediments, harboring SAV, and protecting shorelines; although with a limited potential for emergent marsh growth. The initial project goal of creating up to 1,821 acres of project area marsh were in retrospect undoubtedly lofty. Just remaining stable in an ever increasingly erosive coastal era would be a lofty goal for most projects, especially given the highly energetic environment of the Jaws that is also prone to rafting by FAV.

Submerged aquatic vegetation was likely minimally present in the project area pre-project and has substantially increased following the flooded fresh conditions of 2014 through 2021. These interpretations are supported by ancillary field observations from CRMS data collection, storm damage assessments, LA-39, and project data collection in the project area, and satellite data. The shallow mudflats of the project area post project construction are at ideal depths for SAV growth. However, the generally turbid waters of the Jaws have limited the SAV growth potential on these flats. After the successful plantings funded through LA-39, extensive SAV and FAV growth occurred in 2015 and 2016 following a cycle seasonally. As of the 2021 project area vegetation data collection, there were very large SAV beds located throughout the project area generally dominated by *Potamogeton sp.*

b. Recommended Improvements

Armoring some of the more exposed terraces in the project area and increasing the number of overall terraces would have likely led to a longer functional project life and enhanced project performance over the life of the project. Both of these would have reduced the wind and wave energy inside of the project area. Another feature being incorporated into newer sediment retention project designs is the idea of a “backstop” or river mouth bar at the down current end of a project, slowing waters and stopping sediment from easily exiting the system. This could be an intriguing design feature in a similar project or during a redesign, but cannot exasperate upstream flooding.

c. Lessons Learned

Initial geo-technical reports indicated that this project would be difficult if not impossible to construct. Based on the apparent success of the TV-15 terraces, consideration should be given to build additional projects of this type in this area in the future. The deltaic terrace framework appears to be at capacity for creating more mud flats, additional terracing may be required if continued sediment trapping is desired. The conversion of intertidal mudflats to emergent wetland may require an extra step of repeated dedicated planting or backstop formation to slow water flow and stop sediment from escaping to the bay under high upland flow periods.

d. End of Project Life

The TV-15 project will likely continue to be effective at protecting local marshes and fostering SAV beds long after its 20 year economic planned effectiveness, which ends on May 19, 2025. Whether or not TV-15 can vegetate with large swaths of emergent marsh vegetation remains to be seen but at the end of project life it still possesses the potential for this to manifest with effective additional plantings, though as water levels rise this is becoming less likely. No maintenance is expected to be performed and the project features will be allowed to naturally progress through time, maintaining much of the originally intended project functions as this occurs.

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APPENDIX A
(Inspection Photographs)

Typical terrace and sign

Mud flats and vegetation between terraces

Emergent vegetation between Terraces

APPENDIX B
(Three Year Budget Projection)

SEDIMENT TRAPPING AT THE JAWS/ TV15 / PPL 6

Three-Year Operations & Maintenance Budgets 07/01/2022 - 06/30/2025

Project Manager	O & M Manager	Federal Sponsor	Prepared By
	Stan Aucoin	*NMFS*	*Stan Aucoin*

	2022/2023 (-17)	2023/2024 (-18)	2024/2025 (-19)
Inspection	$ -	$ 8,000.00	$ -
Structure Operation			
State Administration	$5,000.00	$ 5,000.00	$ 5,000.00
Federal Administration		$ -	$ -
Maintenance/Rehabilitation			

22/23 Description: OM&M report, Permit reviews

E&D	
Construction	
Construction Oversight	
Sub Total - Maint. And Rehab.	$ -

23/24 Description:

E&D	$ -
Construction	$ -
Construction Oversight	$ -
Sub Total - Maint. And Rehab.	$ -

24/25 Description: Closeout activities

E&D	$ -
Construction	$ -
Construction Oversight	$ -
Sub Total - Maint. And Rehab.	$ -

	2022/2023 (-17)	2023/2024 (-18)	2024/2025 (-19)
Total O&M Budgets	**$ 5,000.00**	**$ 13,000.00**	**$ 5,000.00**

O &M Budget (3 yr Total)	**$ 23,000.00**
Unexpended O & M Budget	**$ 202,096.50**
Remaining O & M Budget (Projected)	**$ 179,096.50**

OPERATION AND MAINTENANCE BUDGET WORKSHEET

SEDIMENT TRAPPING AT THE JAWS / PROJECT NO. TV-15 / PPL NO. 6 / 2022-2203

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	0	$0.00	**$0.00**
General Structure Maintenance	LUMP	0	$0.00	**$0.00**
Engineering and Design	LUMP	0	$0.00	**$0.00**
Operations Contract	LUMP	0	$0.00	**$0.00**
Construction Oversight	LUMP	0	$0.00	**$0.00**

ADMINISTRATION

CPRA Admin.	LUMP	1	$5,000.00	$5,000.00
FEDERAL SPONSOR Admin.	LUMP	0	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$5,000.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:					
	Secondary Monument	EACH	0	$0.00	$0.00
	Staff Gauge / Recorders	EACH	0	$0.00	$0.00
	Bathymetry / Topography	LUMP	0	$0.00	$0.00
	TBM Installation	EACH	0	$0.00	$0.00
	Other	LUMP	0	$0.00	$0.00
				TOTAL SURVEY COSTS:	**$0.00**

GEOTECHNICAL

GEOTECH DESCRIPTION:					
	Borings	EACH	0	$0.00	$0.00
	OTHER				$0.00
				TOTAL GEOTECHNICAL COSTS:	**$0.00**

CONSTRUCTION

CONSTRUCTION DESCRIPTION:						
	Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	Rip Rap	0	0.0	0	$0.00	$0.00
		0	0.0	0	$0.00	$0.00
		0	0.0	0	$0.00	$0.00
	Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
	Navigation Aid		EACH	0	$0.00	$0.00
	Signage		EACH	0	$0.00	$0.00
	General Excavation / Fill		CU YD	0	$0.00	$0.00
	Dredging		CU YD	0	$0.00	$0.00
	Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
	Timber Piles (each or lump sum)			0	$0.00	$0.00
	Timber Members (each or lump sum)			0	$0.00	$0.00
	Hardware		LUMP	0	$0.00	$0.00
	Materials		LUMP	0	$0.00	$0.00
	Mob / Demob		LUMP	0	$0.00	$0.00
	Contingency (25%) (1,795,650 x 0.25)		LUMP	0	$0.00	$0.00
	General Structure Maintenance		LUMP	0	$0.00	$0.00
				0	$0.00	$0.00
				0	$0.00	$0.00
				0	$0.00	$0.00
					TOTAL CONSTRUCTION COSTS:	**$0.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **$5,000.00**

OPERATION AND MAINTENANCE BUDGET WORKSHEET

SEDIMENT TRAPPING AT THE JAWS / PROJECT NO. TV-15 / PPL NO. 6 / 2023-2024

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$8,000.00	**$8,000.00**
General Structure Maintenance	LUMP	0	$0.00	**$0.00**
Engineering and Design	LUMP	0	$0.00	**$0.00**
Operations Contract	LUMP	0	$0.00	**$0.00**
Construction Oversight	LUMP	0	$0.00	**$0.00**

ADMINISTRATION

CPRA Admin.	LUMP	1	$5,000.00	$5,000.00
FEDERAL SPONSOR Admin.	LUMP	0	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$5,000.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:					
Secondary Monument	EACH	0	$0.00	$0.00
Staff Gauge / Recorders	EACH	0	$0.00	$0.00
Bathymetry / Topography	LUMP	0	$0.00	$0.00
TBM Installation	EACH	0	$0.00	$0.00
Other	LUMP	0	$0.00	$0.00
			TOTAL SURVEY COSTS:	**$0.00**

GEOTECHNICAL

GEOTECH DESCRIPTION:					
Borings	EACH	0	$0.00	$0.00
OTHER				$0.00
			TOTAL GEOTECHNICAL COSTS:	**$0.00**

CONSTRUCTION

CONSTRUCTION DESCRIPTION:					
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
Rip Rap	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
Navigation Aid		EACH	0	$0.00	$0.00
Signage		EACH	0	$0.00	$0.00
General Excavation / Fill		CU YD	0	$0.00	$0.00
Dredging		CU YD	0	$0.00	$0.00
Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
Timber Piles (each or lump sum)			0	$0.00	$0.00
Timber Members (each or lump sum)			0	$0.00	$0.00
Hardware		LUMP	0	$0.00	$0.00
Materials		LUMP	0	$0.00	$0.00
Mob / Demob		LUMP	0	$0.00	$0.00
Contingency (25%) (1,795,650 x 0.25)		LUMP	0	$0.00	$0.00
General Structure Maintenance		LUMP	0	$0.00	$0.00
			0	$0.00	$0.00
			0	$0.00	$0.00
			0	$0.00	$0.00
				TOTAL CONSTRUCTION COSTS:	**$0.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **$13,000.00**

OPERATION AND MAINTENANCE BUDGET WORKSHEET

SEDIMENT TRAPPING AT THE JAWS / PROJECT NO. TV-15 / PPL NO. 6 / 2024-2025

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	0	$0.00	**$0.00**
General Structure Maintenance	LUMP	0	$0.00	**$0.00**
Engineering and Design	LUMP	0	$0.00	**$0.00**
Operations Contract	LUMP	0	$0.00	**$0.00**
Construction Oversight	LUMP	0	$0.00	**$0.00**

ADMINISTRATION

CPRA Admin.	LUMP	1	$5,000.00	$5,000.00
FEDERAL SPONSOR Admin.	LUMP	0	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$5,000.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:					
Secondary Monument	EACH	0	$0.00	$0.00
Staff Gauge / Recorders	EACH	0	$0.00	$0.00
Bathymetry / Topography	LUMP	0	$0.00	$0.00
TBM Installation	EACH	0	$0.00	$0.00
Other	LUMP	0	$0.00	$0.00
			TOTAL SURVEY COSTS:	**$0.00**

GEOTECHNICAL

GEOTECH DESCRIPTION:					
Borings	EACH	0	$0.00	$0.00
OTHER				$0.00
			TOTAL GEOTECHNICAL COSTS:	**$0.00**

CONSTRUCTION

CONSTRUCTION DESCRIPTION:					
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
Rip Rap	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
Navigation Aid		EACH	0	$0.00	$0.00
Signage		EACH	0	$0.00	$0.00
General Excavation / Fill		CU YD	0	$0.00	$0.00
Dredging		CU YD	0	$0.00	$0.00
Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
Timber Piles (each or lump sum)			0	$0.00	$0.00
Timber Members (each or lump sum)			0	$0.00	$0.00
Hardware		LUMP	0	$0.00	$0.00
Materials		LUMP	0	$0.00	$0.00
Mob / Demob		LUMP	0	$0.00	$0.00
Contingency (25%) (1,795,650 x 0.25)		LUMP	0	$0.00	$0.00
General Structure Maintenance		LUMP	0	$0.00	$0.00
			0	$0.00	$0.00
			0	$0.00	$0.00
			0	$0.00	$0.00
			TOTAL CONSTRUCTION COSTS:		**$0.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **$5,000.00**