**State of Louisiana**
**Coastal Protection and Restoration Authority of Louisiana (CPRA)**

# 2013 Operations, Maintenance, and Monitoring Report

for

# Holly Beach Sand Management

State Project Number CS-31
Priority Project List 11

June 2013
Cameron Parish

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2013 Operations, Maintenance, and Monitoring Report
For
Holly Beach Sand Management Project (CS-31)

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## Preface

This report includes monitoring data collected through December 2012, and annual Maintenance Inspections through May 2013.

The 2013 report is the 5th report in a series of reports. For additional information on lessons learned, recommendations and project effectiveness please refer to the 2004, 2005, 2007, and 2010 Operations, Maintenance, and Monitoring Reports on the LDNR web site (http://sonris-www.dnr.state.la.us/sundown/cart_prod/cart_bms_avail_documents_f).

## I. Introduction

The Holly Beach Sand Management (CS-31) project was proposed on the 11th priority list of the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) and is co-sponsored by the Natural Resources Conservation Service (NRCS) and the Coastal Protection and Restoration Authority (CPRA). The project area is located between the communities of Holly Beach and Constance Beach on the Gulf of Mexico shoreline of southwestern Louisiana, west of Calcasieu Pass in Cameron Parish (figure 1) and is comprised of approximately 10,849 acres (4,426 ha), of which 8,900 acres (3,603 ha) are classified as wetlands (U.S. Geological Service, National Wetland Research Center [USGS-NWRC] 2001). The project area is divided into two areas separated by the Louisiana Highway 82 embankment, which is built on a chenier ridge. Area A includes approximately 8,600 acres (3,481 ha) of brackish and intermediate marsh located along the north side of the highway. Area B includes approximately 300 acres (121 ha) of beach dune and coastal chenier habitat located south of the highway along 8.0 miles (12.9 km) of beach between Holly Beach and Ocean View Beach.

Chronic erosion in this area is caused by a deficit of sand and sediment in the littoral transport system due to stabilization of the Mississippi River and regulation of the Atchafalaya River to the east (U.S. Department of Agriculture, Natural Resources Conservation Service and Louisiana Department of Natural Resources [USDA-NRCS and LDNR] 2001). In addition, the Calcasieu and Mermentau rivers are not supplying coarse grained sediment (sand) to the area, and the Cameron jetties associated with the Calcasieu Ship Channel deflect what little material that exists away from the project area (Byrnes et al. 1995, Byrnes and McBride 1995).

Today, this ridge is the only remaining hydrologic barrier separating thousands of acres of low energy, intermediate and brackish marsh along the southern boundary of Sabine National Wildlife Refuge (SNWR) from the high energy, saline waters of the Gulf of Mexico. The highway revetment has already been undermined and repaired in some sections, and the underlying chenier is in danger of being breached. A breach of this ridge would lead to direct wave erosion and saltwater intrusion into fragile, low energy wetlands in Area A to the north.

In Area B, the intent of the project is to modify the design of 18 existing breakwaters on the west end of the breakwater field and remove 6 experimental breakwaters located landward of existing breakwaters 35 through 40, to enhance their sediment trapping capability. In addition, utilizing the beneficial placement of sand dredged from offshore, the beach will be widened and a sub-aerial beach profile will be re-established that will reduce the occurrence of wave over-wash of the chenier-beach ridge.


**Figure 1.** Holly Beach Sand Management (CS-31) project area boundaries.

The breakwater modifications, which were funded by the state of Louisiana, were completed on June 19, 2002. The removal of the experimental breakwaters was completed on September 5, 2002. Approximately 1,750,000 cubic yards (1,600,200 cu meters) of coarse grained sand were pumped from a distance of 5 miles offshore between Holly Beach and OceanView Beach. Construction of the sand-pumping portion of the project was initiated in July 2002 and was expected to be completed in November 2002. Inclement weather and equipment problems delayed completion until March 2003. Construction of 18,797 linear feet of sand fencing on the eastern end of the project parallel to LA Hwy 82 was completed in March, 2003, and installation of 18,400 gallons of *Panicum amarum* (Bitter Panicum) was completed in August 2003. Shortly thereafter, another 11,000 linear feet of sand fencing was installed on the western portion of the project.

Hurricane Rita struck the coast of Louisiana on September 24, 2005 with maximum storm surge of 14-15 ft (4.3 – 4.6m) in the CS-31 project area. USGS calculated the amount of land that changed to water resulting from the storm to be 98 square miles in southwestern Louisiana, 22 square miles of land lost in the Cal/Sab basin (Barras, 2006). This land loss can be attributed to several patterns. Shearing, which is ripping and removal of marsh vegetation in historically healthy marshes was observed north of Johnson's Bayou and south of the Sabine National Wildlife Refuge. The removal of remnant marsh from areas with historical land loss from the surge was observed in the marsh just north of Johnson's Bayou and north of Mud Lake.

Hurricane Ike struck near Galveston, Texas on September 13, 2008. A maximum storm surge of 15 – 16 ft (4.6 – 4.9m) was reported for the CS-31 project area (East et al. 2008). The surge caused additional scour and expansion of open water areas south of Sabine Refuge formed by Hurricane Rita.

## II. Maintenance Activity

### a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Holly Beach Sand Management Project (CS-31) is to evaluate the constructed project features to identify any deficiencies and prepare a report detailing the condition of project features and recommended corrective actions needed. Should it be determined that corrective actions are needed, CPRA shall provide, in the report, a detailed cost estimate for engineering, design, supervision, inspection, and construction contingencies, and an assessment of the urgency of such repairs (O&M Plan, 2003). The annual inspection report also contains a summary of maintenance projects, if any, which were completed since completion of constructed project features and an estimated projected budget for the upcoming three (3) years for operation, maintenance and rehabilitation. The three (3) year projected operation and maintenance budget is shown in Appendix B.

An inspection of the Holly Beach Sand Management Project (CS-31) was held on October 31, 2012 under sunny skies and cool temperatures. In attendance were Dion Broussard and Jody White of CPRA; Dale Garber and Brandon Samson of NRCS; Daryl Clark of USFWS for other inspections. The annual inspection began at approximately 11:00 a.m. on the western boundary of the project area.

The field inspection included a complete visual inspection of all features. Staff gauge readings where available were used to determine approximate elevations of water, sand dunes, and sand fencing. Photographs were taken at each project feature (see Appendix A) and Field Inspection notes were completed in the field to record measurements and deficiencies (see Appendix C).

### b. Inspection Results

**Beach Nourishment**

There has been substantial loss of beach head. The sand fence alignment (September 2011) had to be adjusted from the preconstruction survey (November 2010) alignment, as the alignment would have placed the fence in the surf. Additionally, during construction, the fence alignment had to be moved north several times due to encroachment of gulf waters. An existing dune is in place and barring a hurricane a new dune should be created in a few years with the installation of the new sand fence. The vegetation included in the sand fence project of 2011 is flourishing in areas of the beach where there is less impact from wave energy. (Photos: Appendix B, Photos 1 – 5).

**Sand Fence**

The sand fence has suffered extensive damage due to tidal action. There were many sections of considerable length where the fence fabric was completely removed from the posts. We did not

generally see many broken sections of fence material lying on the beach. There are many bare posts remaining.

There are areas of fencing still intact on higher ground that are showing good dune formation, as well as healthy plant growth. (Photos: Appendix B, Photos 1 - 5).

## II. Maintenance Activity (continued)

### c. Maintenance Recommendations

#### i. Immediate/ Emergency Repairs

There are no immediate repairs required at this time.

#### ii. Programmatic/ Routine Repairs

There are fence posts left standing where the beach has washed significantly and the fence is no longer present. It was decided at this time not to repair the fence in the section of beach where there is now high wave activity. The remaining posts will be removed in a future contract if it is seen that they pose a safety hazard.

### d. Maintenance History

**General Maintenance:** Below is a summary of completed maintenance projects and operation tasks performed since April 2003, the construction completion date of the Holly Beach Sand Management Project (CS-31).

**April 2005** - The LA Dept. of Agriculture along with the Cameron Parish Police Jury installed approximately an additional 10,000 linear feet of sand fencing along with approximately 4,000 plants in April 2005.

**July 2006** – The LA Dept. of Agriculture installed approximately 5,550 plants along the entire length of the beach project.

**October 2006 – Sand Fence Replacement (FEMA Project)** – A maintenance event was performed to replace 46,000 linear feet of sand fence destroyed by Hurricane RITA. The contractor was Landscape Management Services from Lake Charles, LA. Work began on October 9, 2006 and the contract was completed on November 27, 2006. The cost associated with the engineering, design and construction of the Holly Beach Sand Fence Maintenance Project is as follows:

| | |
|---|---|
| Construction: | $ 218,473.50 |
| Engineering & Design: | $ 10,000.00 |
| Construction Admin./Oversight: | $ 10,000.00 |
| As builts: | $ 8,797.50 |

**TOTAL CONSTRUCTION COST:** **$ 247,271.00**
(Note: FEMA reimbursed $222,843)

**September 2011 – Sand Fence Replacement –** A maintenance event was performed to replace 46,000 linear feet of sand fence destroyed by storm surge from Hurricane Ike. The primary contractor was Petron L.L.C. Subcontractors were Lohmann Fencing and Landscape Management Services. Work began on September 9, 2011 and the contract was completed on December 22, 2011. There were 45,434 feet of sand fence constructed and approximately 30,000 bitter panicum plants planted. The cost associated with the engineering, design and construction of the Holly Beach Sand Management Sand Fence Project (Post Hurricane Ike – 2010) is as follows:

| | |
|---|---|
| Construction: | $290,989.60 |
| Engineering and Design: | $10,000.00 |
| Construction Admin./Oversight: | $16,312.00 |
| As builts: | $11,309.00 |
| **TOTAL CONSTRUCTION COST:** | **$328,610.60** |

## 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

### a. Monitoring Goals

The objective of the Holly Beach Sand Management Project is to protect approximately 8,600 acres (3,481 ha) of existing low energy, intermediate and brackish wetlands north of the chenier/beach ridge between Holly Beach and Constance Beach and to protect approximately 300 acres (121 ha) of beach dune and coastal chenier habitat along the shoreline from erosion and degradation caused by high energy wave action from the Gulf of Mexico.

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

1. Evaluate the beach response to sand nourishment and modification of 18 existing breakwaters after 2 years to facilitate re-evaluation of the existing breakwater

design and the ability of the constructed beach profile to reduce predicted over-wash events (Note: Downdrift of the 18 existing breakwaters to be modified, it will not be possible to determine if changes in beach response are the result of the beach nourishment or the breakwater modifications, or both.).

2. Determine shoreline position to assess project-effectiveness at maintaining the shoreline (high water/rack line along beach ridge) seaward of its pre-nourishment position for the first 5 years (for breakwaters 10 thru 72).

3. Determine shoreline position to assess project-effectiveness at maintaining shoreline (high water/rack line along beach ridge) seaward of its pre-nourishment position for an additional 5 years should the beach need re-nourishment.

4. Evaluate water salinity in the project area north of the beach/ridge, Area A, for effects of over-wash occurrences.

5. Evaluate maintenance of existing intermediate and brackish marsh vegetation in Area A, the project area north of chenier/beach ridge.

6. Evaluate condition of the *Panicum amarum* plantings along the project area shoreline.

### b. Monitoring Elements

**Aerial Photography:**

To measure marsh and open water areas (in Areas A and B), near-vertical color-infrared aerial photography (1:12,000) was acquired pre-construction in December 2001, December 2002 (since project completion was delayed), October 2005 and December 2009. The original photography was checked for flight accuracy, color correctness, and clarity and was subsequently archived. Aerial photography was scanned, mosaicked, and georectified by USGS personnel according to standard procedures (Steyer et al.1995, revised 2000). Additional photography may be obtained in response to storm events.

Aerial photography and satellite imagery will be collected for the entire coast through CRMS-*Wetlands*. The satellite imagery will be subset and used to qualitatively evaluate changes in land and water areas within the CS-31 project area at a coarse (30m) resolution. Photography and satellite imagery for the Calcasieu/Sabine basin was collected and analyzed in 2005, 2008, and 2012, analyzed in 2005 and 2008, and will be collected in 2015 and 2018.

Percent land trends were calculated using Landsat Thematic Mapper (TM) data for 1985 -2010. Linear regressions were calculated for the period of record. The variability in percent land data points around the slope illustrates 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., 2011).

**Bathymetry/Topography:**

To document both horizontal and vertical change along the project area shoreline, transect lines used to measure elevation were established parallel and perpendicular to the breakwaters, and tied in to a known elevation datum by professional surveyors. These transect lines were surveyed incrementally pre-construction in 2002-2003, and immediately post-construction in March 2003 and were surveyed in August 2005, post-hurricane Rita in January 2006 and post-hurricane Ike in January 2009.

**Vegetation Plantings:**

The general condition of the *Panicum amarum* (Bitter Panicum) plantings in Area B was documented using a generally accepted methodology similar to Mendelssohn and Hester (1988), Coastal Vegetation Project, Timbalier Island. Plots were chosen by randomly selecting numbers based on the coordinates within the project area to represent a 10 percent sample of the plantings. The GPS coordinates were used to mark one corner of a plot of 16 plants to determine % survival by counting live plants within each plot, dividing by the total number of plants, and multiplying by 100. Ocular estimates of percent canopy cover were recorded for each plot. The percent cover for each plot was broken down into the percent cover provided by the *P. amarum* plantings, by other wetland species and by upland species. These criteria were documented in the fall of 2003 and in the spring and fall of 2004. The possibility of herbivore damage is recognized and was recorded if observed.

**Shoreline Change:**

To document shoreline movement between Holly Beach and Constance Beach, differential global positioning system (DGPS) surveys of unobstructed sections of the shoreline were conducted using the high water/rack line as the vegetative edge. DGPS shoreline positions were mapped and used to measure shoreline erosion/growth rates. Shoreline change rates were used to calculate the average ft/yr gained/lost along the project area shoreline. Surveys were conducted immediately post-construction in 2003, the fall and spring of 2003, 2004, 2005, the fall of 2006, and the fall and spring of 2007, 2009, and 2011. No monitoring was scheduled for 2006, but a survey was conducted to evaluate the effects of Hurricane Rita

**Water Salinity:**

To assist in determining the frequency that high salinity water enters the interior marsh in Area A from wave over-wash, three continuous recorders were installed to collect hourly salinity data, one at the southern end of Cowboy Ditch, one adjacent to the low section of La. Hwy 82 with concrete block revetment between Peveto Beach and Holly Beach, and one in a marsh pond on the east side of the project area (figure 1). Hourly salinity data were collected at these three stations preconstruction, from September 2002 to February 2003, and 3 years post-construction from March 2003 to March 2006. Data collected from these stations were compared to hourly salinity data collected from the Sabine Refuge Structure Replacement (CS-23) project and the USGS realtime data recorder in Calcasieu Lake near Cameron, Louisiana to aid in determining the origin of high salinity water entering the project area. The CS-23-01R data have been collected by personnel from Sabine National Wildlife Refuge and provided to CPRA since March 2004.

Salinity is currently monitored hourly utilizing one CRMS-*Wetlands* station (680) within the project area and a selected reference site (2219). Continuous data were used to characterize average annual salinities throughout the project and reference areas.

**Emergent Vegetation:**

To document the condition of the emergent vegetation in the project area over the life of the project, vegetation was monitored at 30 sampling stations established along 3 transect lines within Area A. Using the Braun-Blanquet methodology outlined in Steyer et al. (1995), percent cover, species composition, and dominant plant height were documented in replicate 2 m by 2 m sampling plots established at each station. A pole installed in one corner of each plot allows for locating and reevaluating established plots over time. Descriptive observations of SAV was noted during monitoring of emergent vegetation. Vegetation was monitored once pre-construction in 2002 and postconstruction in the fall of 2003, 2004, 2005 and 2009. Subsets of the vegetation transects were also collected in the fall of 2006, 2007, 2008 to document the effects of Hurricane Rita.

Vegetation composition and cover were also estimated from 10 permanent 2m x 2m plots that are randomly distributed along a transect in the emergent marsh within each of the 1 $km^2$ CRMS-*Wetlands* sites. Data were collected in the late summer to early fall of 2006 - 2012 using the Braun Blanquet method.

Individual species' cover data were summarized according to the Floristic Quality Index (FQI) method (Cretini and Steyer 2011). The FQI assigns a low score to invasive species indicative of disturbance and a high score to native species indicative of stability. CRMS sites inside (608) and outside (2219) the project area were used for this report.

**Porewater Salinity:**

At each project-specific emergent vegetation station, we attempted to obtain soil porewater salinity data, utilizing the sipper method, down to 10 cm below the soil surface. Data were collected pre-construction in 2002 and postconstruction in the fall of 2003, 2004, 2005 and 2009. Subsets of the data were also collected in the fall of 2006, 2007, 2008 to document the effects of Hurricanes Rita and Ike.

At each servicing of the CRMS-*Wetlands* station recorders, a measurement of the interstitial water salinity is collected adjacent to the boardwalk. Interstitial water salinity is also determined at 5 of the vegetation plots, when vegetation is surveyed.

**CRMS Supplemental**

In addition to the project specific monitoring elements listed above, a variety of other data are collected at CRMS-*Wetlands* stations which can be used as supporting or contextual information. Data types collected at CRMS sites include hydrologic from continuous recorder (mentioned above), vegetative, physical soil characteristics, discrete porewater, surface elevation, and land:water analysis of 1 $km^2$ area encompassing the station (Folse et al., 2012). For this report, data from CRMS 680 within the project area was compared to data from CRMS 2219 outside the project area in a traditional project versus reference manner. Data collected from the CRMS network are used to develop integrated data indices at different spatial scales (local, basin, coastal) from which we can assess project performance.

Soil cores were collected one time (within a year of site establishment) to describe soil properties (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 the site. The soil was processed by the Department of Agronomy and Environmental Management at Louisiana State University.

Average annual salinity and percent time flooded are used to develop a Hydrologic Index (HI) score (Snedden and Swenson 2012) based on the suitability of the site in maximizing vegetation productivity according to its specific marsh class (swamp, fresh, intermediate, brackish, and saline). The HI score (between 0 and 100) corresponds to the percent of maximum vegetation productivity expected to occur if the separate effects of salinity and inundation interact in a multiplicative fashion on vegetation productivity.

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) so it can be directly compared to other elevation variables such as water level. The submergence vulnerability index (SVI) determines a sites vulnerability to future sea level rise by comparing cumulative elevation change at the site to the site's calculated relative sea level rise (RSLR). A site is considered vulnerable if the elevation change rate is too low to offset the RSLR.

## IV. Monitoring Activity (continued)

### c. Preliminary Monitoring Results and Discussion

**Aerial Photography:**

Land to water analysis was completed for the pre-construction photography acquired in November 2001 and December 2002 and post-construction acquired in October 2005 and December 2009 (figures 2 - 6). Results are presented in Table 1. The difference between the 2001 and 2002 analyses was due to the partial construction of the beach at the time of the 2002 photography. The 2005 analysis followed Hurricane Rita and showed approximately 40 acres of land lost, mostly along the shoreline. The 2009 analysis, which would have covered the period of Hurricane Ike, showed another 48 acres lost since the 2005 analysis.

The general land change trend within the project area prior to construction was slightly positive (0.19% per year) from 1985 – 2002 (figure 7). Incorporating the 2002 to 2010 data, which includes the post-construction satellite imagery, causes the general trend to increase slightly (0.26% per year), even though the project area saw land loss following the hurricanes.

Table 1. Land:Water acreages from 2001, 2002 (pre-construction), 2005 and 2009 (post-construction) in the project area.

| Year | | Project Acres | Hectares | % |
|---|---|---|---|---|
| 2001 | Land | 8812 | 3566 | 82 |
| 2001 | Water | 1989 | 805 | 18 |
| 2002 | Land | 8938 | 3617 | 83 |
| 2002 | Water | 1863 | 754 | 17 |
| 2005 | Land | 8897 | 3601 | 82 |
| 2005 | Water | 1894 | 767 | 18 |
| 2009 | Land | 8849 | 3581 | 82 |
| 2009 | Water | 1946 | 788 | 18 |

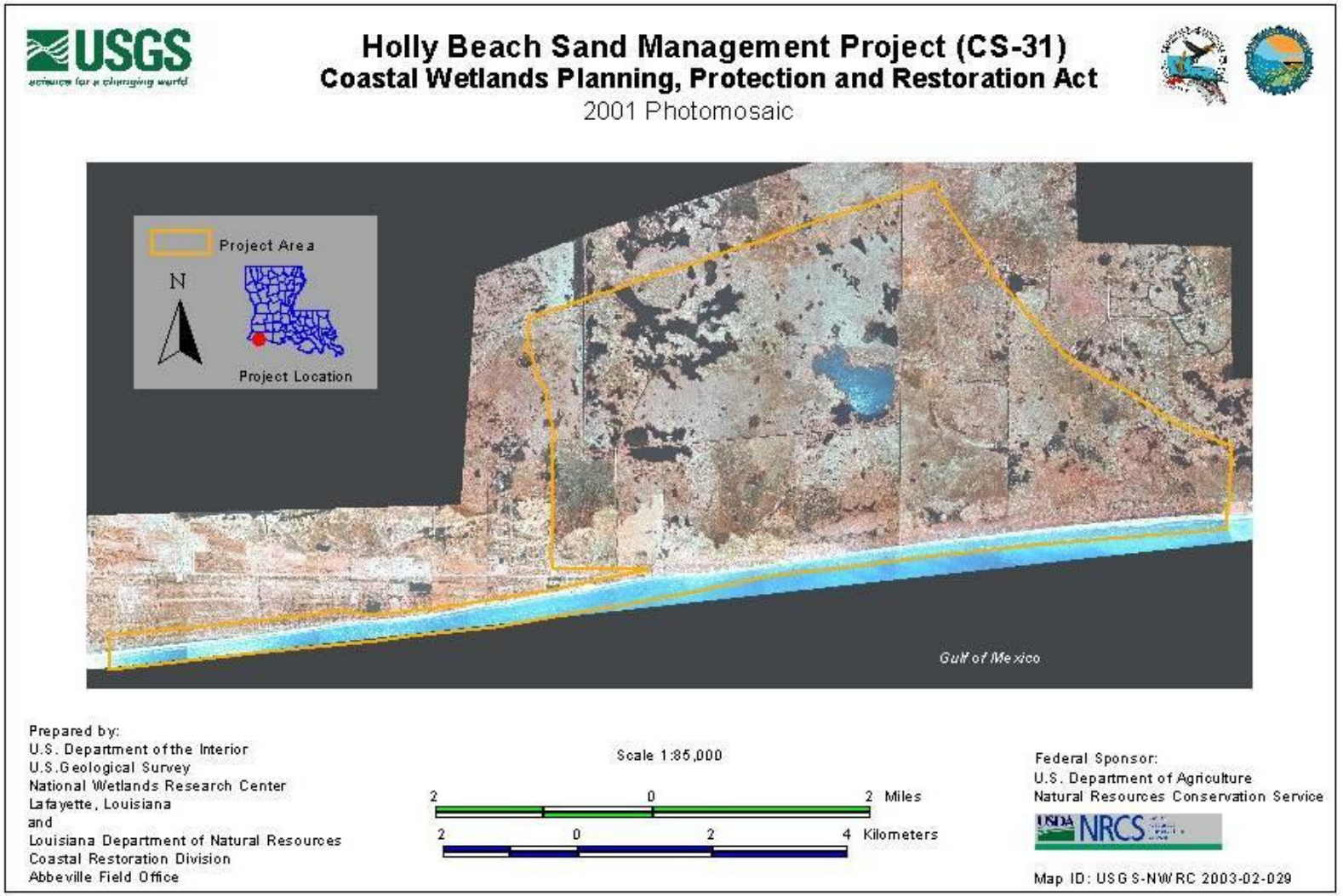



**Figure 2.** Photomosaic of the Holly Beach Sand Management (CS-31) project area from photography obtained November 17, 2001.

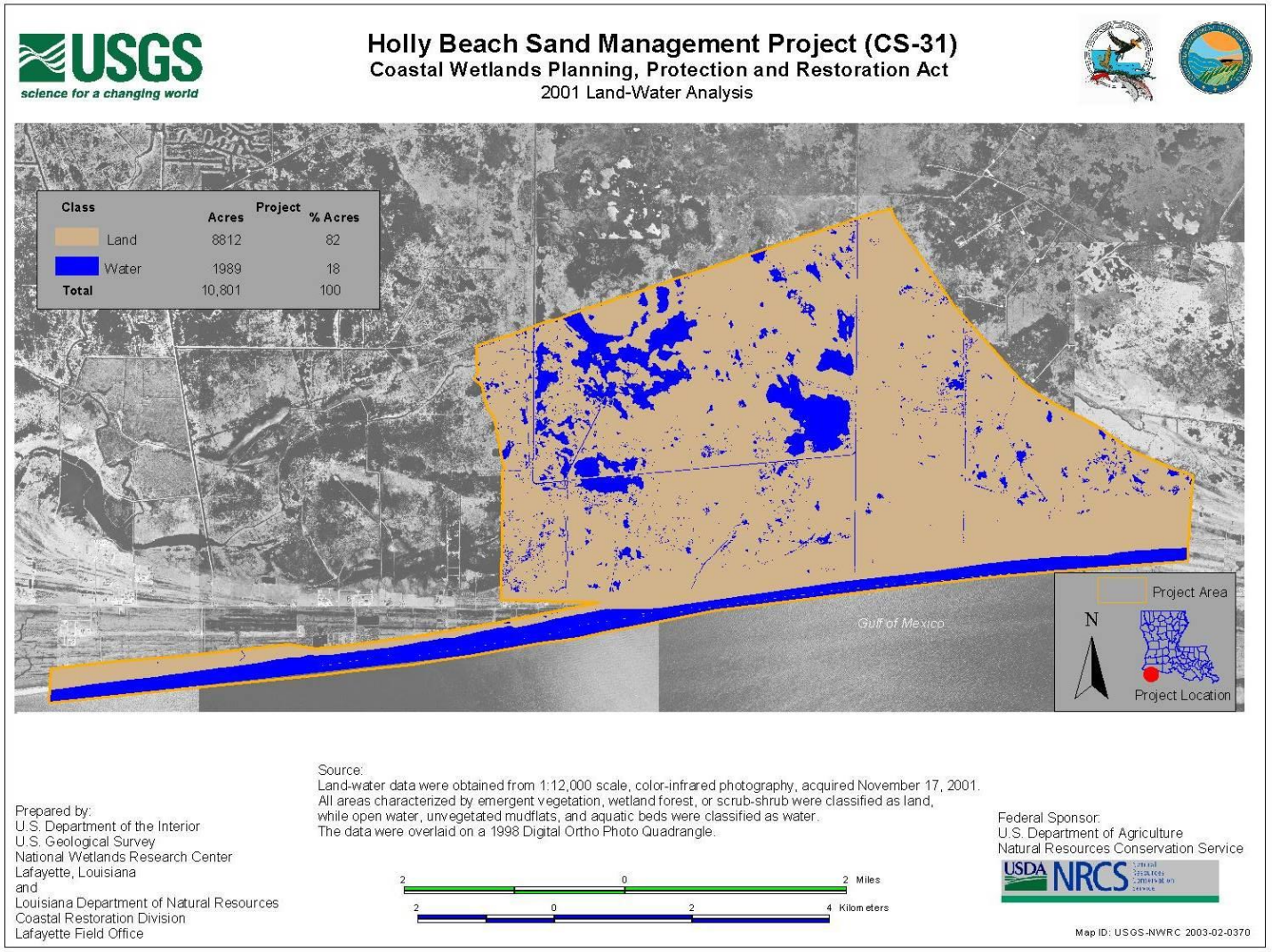



**Figure 3.** Land/Water analysis of the Holly Beach Sand Management (CS-31) project area from photography obtained November 17, 2001.

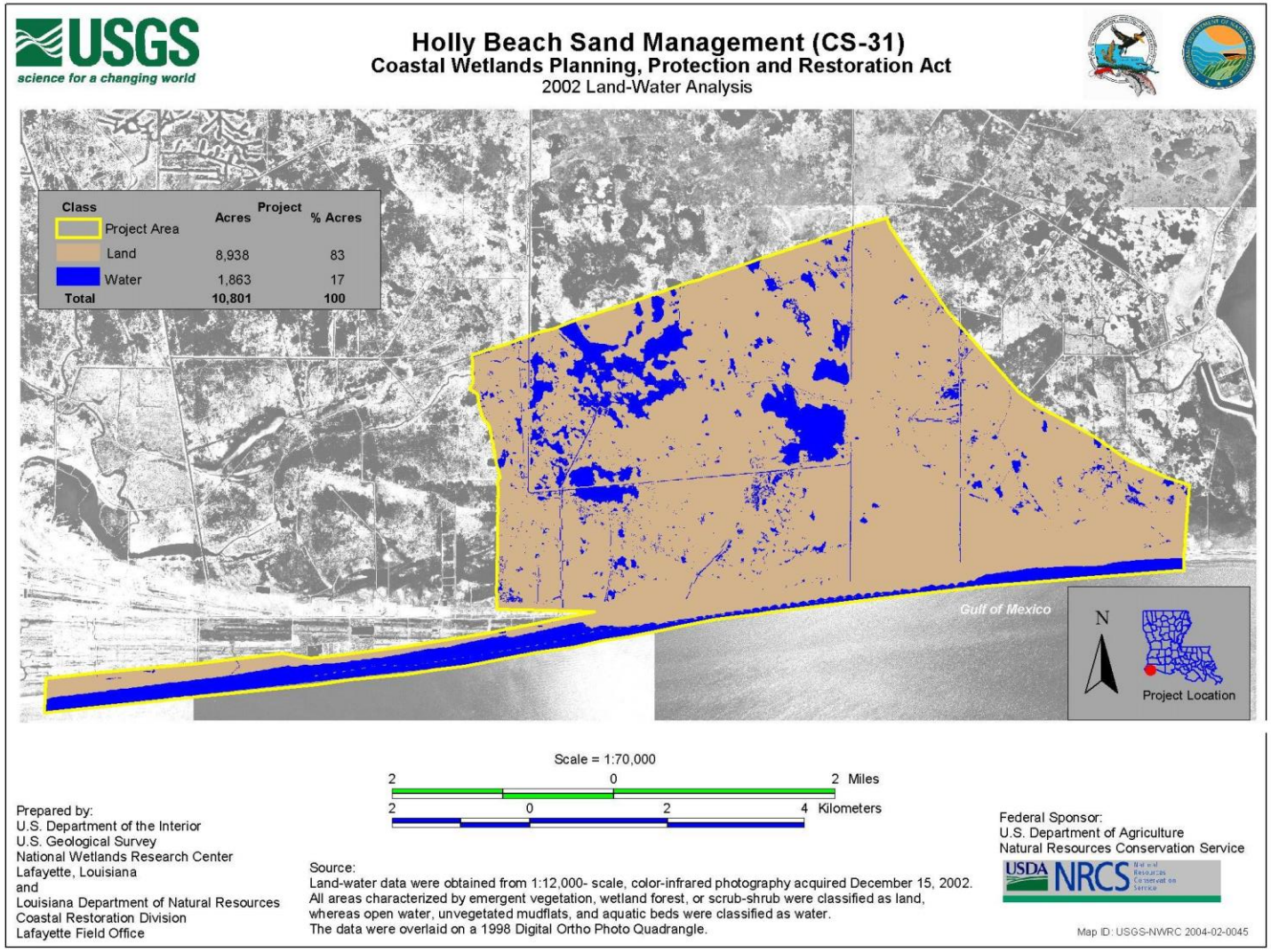



**Figure 4.** Land/Water analysis of the Holly Beach Sand Management (CS-31) project area from photography obtained December 15, 2002.

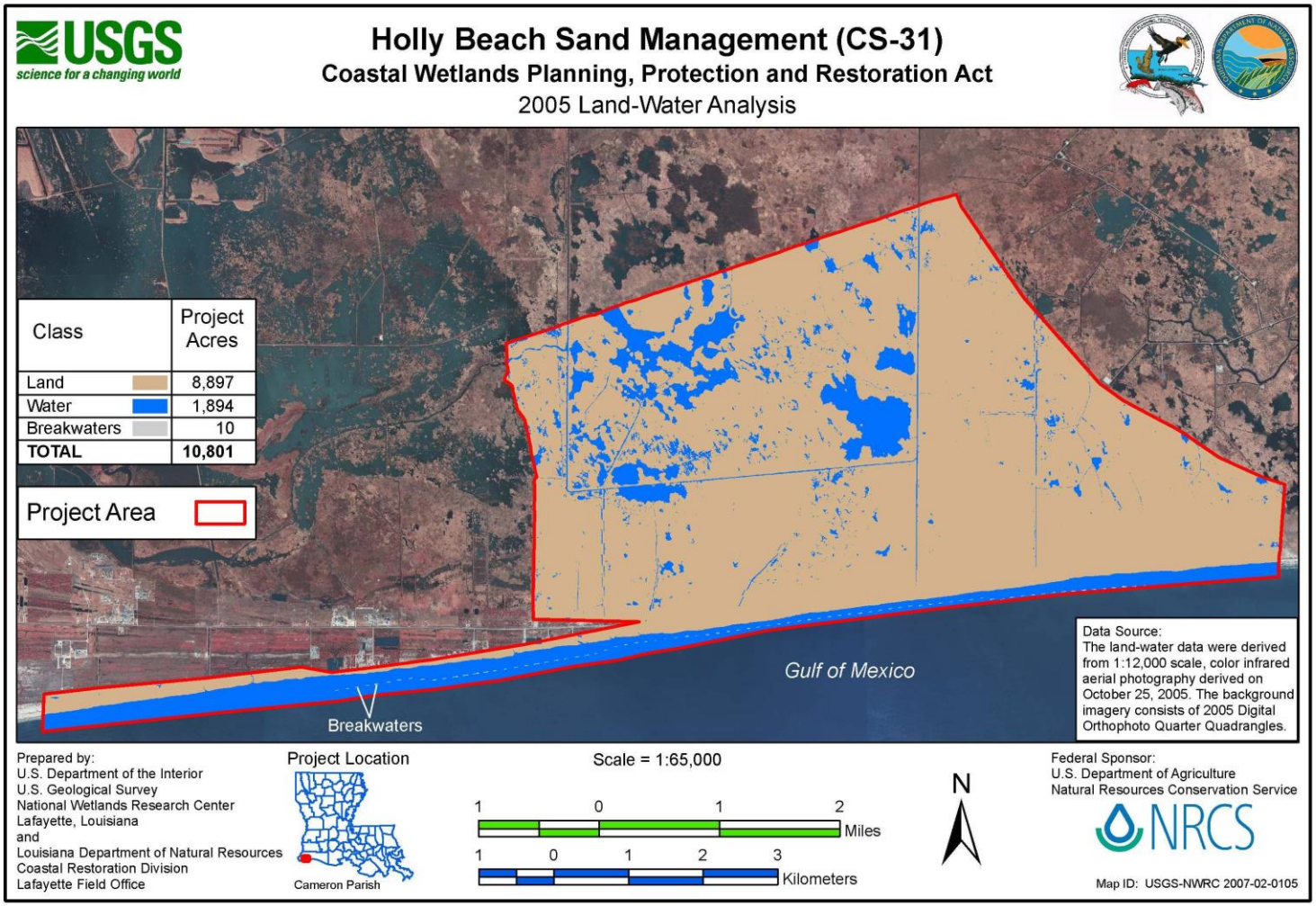



**Figure 5.** Land/Water analysis of the Holly Beach Sand Management (CS-31) project area from photography obtained October 25, 2005.

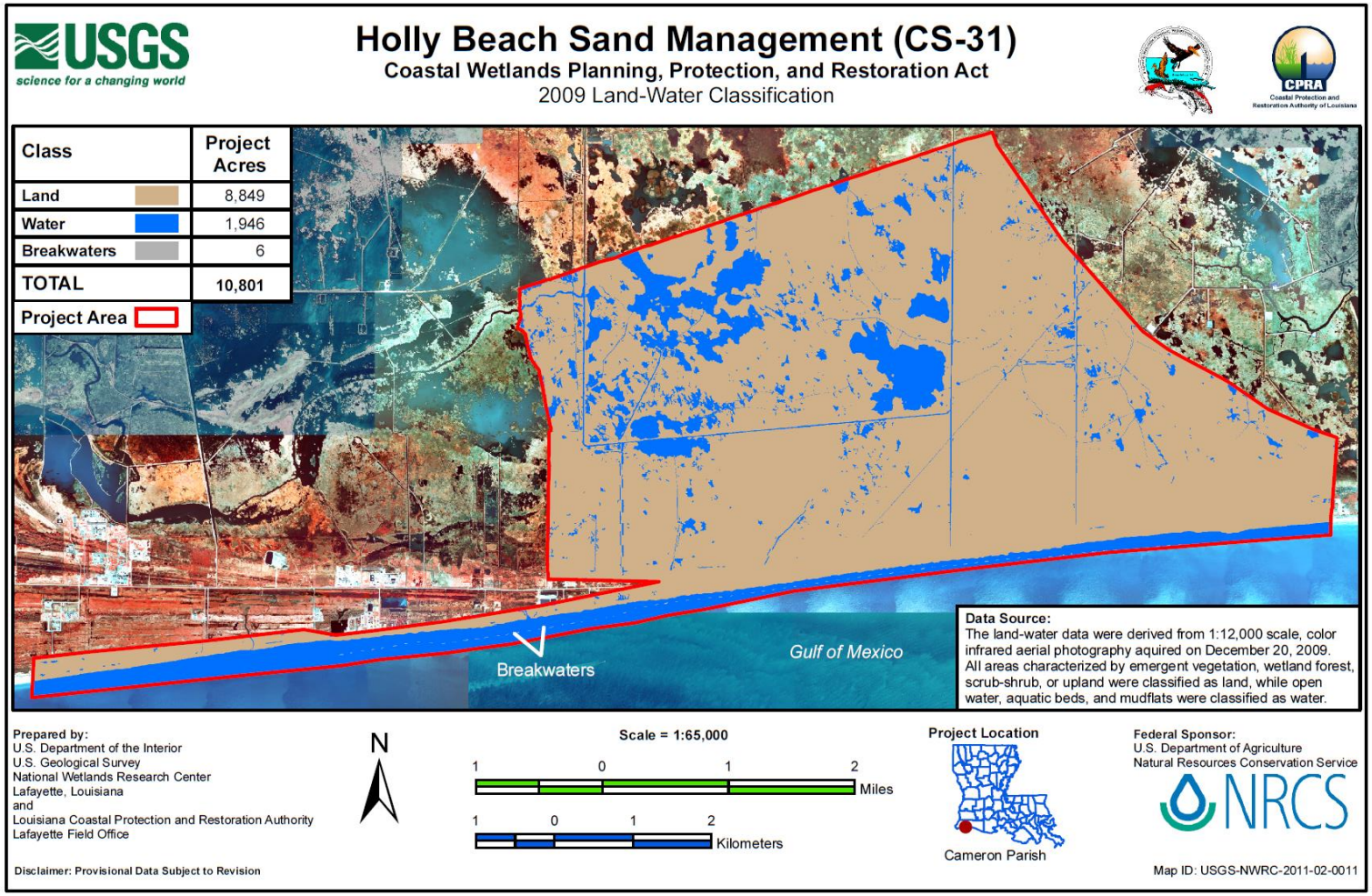



**Figure 6.** Land/Water analysis of the Holly Beach Sand Management (CS-31) project area from photography obtained December 20, 2009.

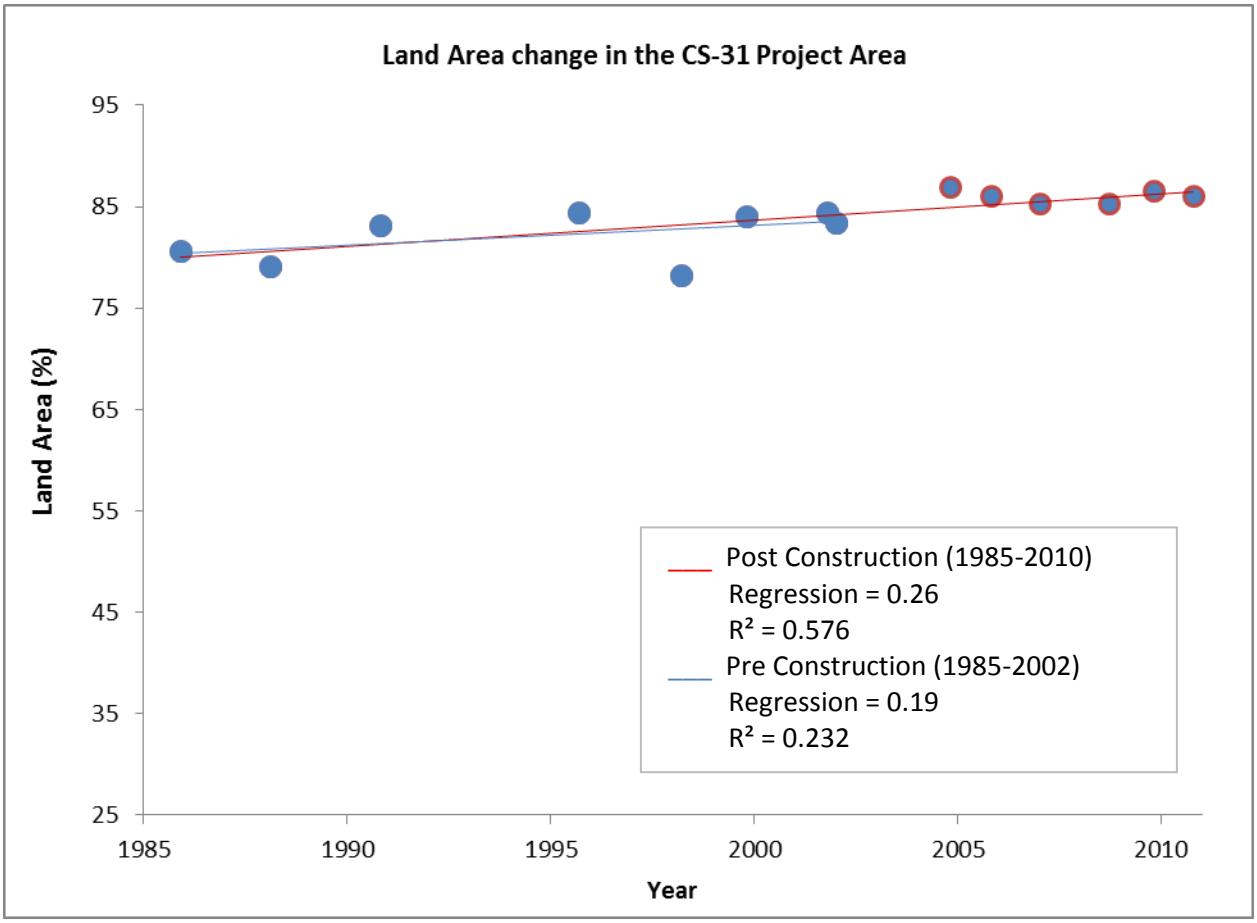



**Figure 7.** Project scale percent land change for CS-31. Percent land values are displayed for all cloud free TM images available for 1985-2010. The red line depicts the percent land trend for the entire period of record. The blue line depicts the percent land trend for the pre-construction time period only. Percent land calculated as percent land of total project area. See Couvillion et al. 2011.

**Bathymetry/Topography:**

A Geographic Information System (GIS) database was developed to facilitate the data processing and analysis phase of this investigation. Substantial data processing was required to prepare survey coordinate data for beach profile analysis. Survey data were imported to ArcGIS and reprojected to a Universal Transverse Mercator (UTM) coordinate system for surface interpolation. A triangulation-based (TIN) digital terrain model was then generated from each survey in order to produce two interpolated surfaces for comparison.

Shoreline position change rates were calculated using the Digital Shoreline Analysis System (DSAS Ver. 3.2). Shoreline position was defined as the location of the 2.55 foot contour along the beach. Inspection of the beach profiles indicated that the 2.55 foot contour tended to coincide with a distinct break in slope along the upper beach (figures 8a and 8b). This position is an interpretation of the upper limit of wave activity at high tide; relative to geomorphology, this position is generally recognized as the berm crest or a scarp at the toe of the dune (see Byrnes and Hiland 1995). Transect start points were generated using a baseline created by drawing a

straight line north of the beach, running parallel to the beach (for breakwaters 10 thru 72). Transects were placed perpendicular to the baseline, spaced 20 m apart, and measured from the baseline to the shoreline position at the 2.55 ft contour within each survey. Shoreline change was calculated by subtracting the August 2005 shoreline position from the January 2006 shoreline position and then the January 2006 shoreline position from the January 2009 shoreline position. The 2006 data indicate that the shoreline retreated at an average of 21 ft/yr during the time period that included Hurricane Rita. By comparing the 2009 data to the 2006 data, the data indicated that 11 ft/yr was lost during the time period that included Hurricane Ike.

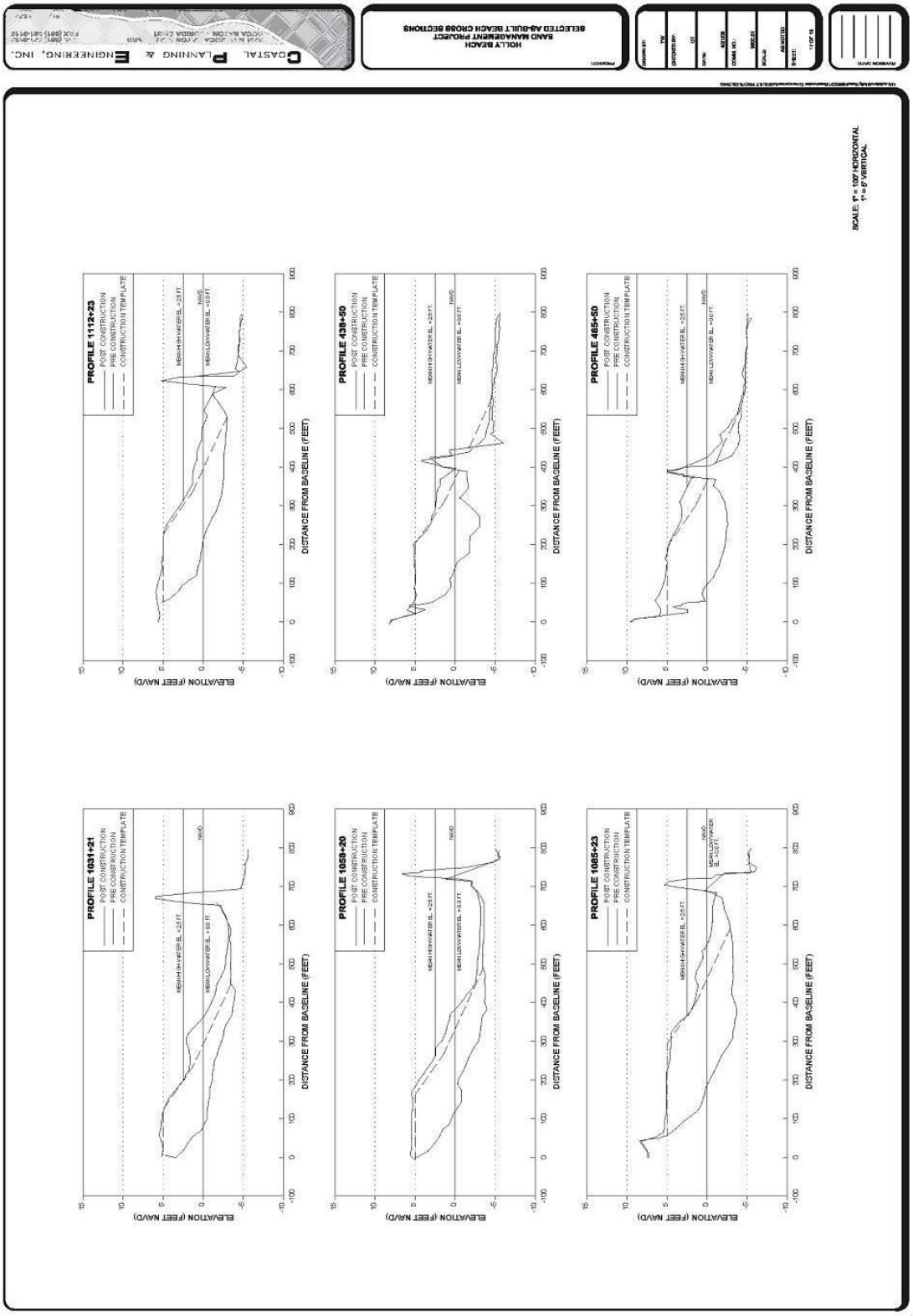



**Figure 8a.** Holly Beach Sand Management selected pre-construction and as-built cross-sections.

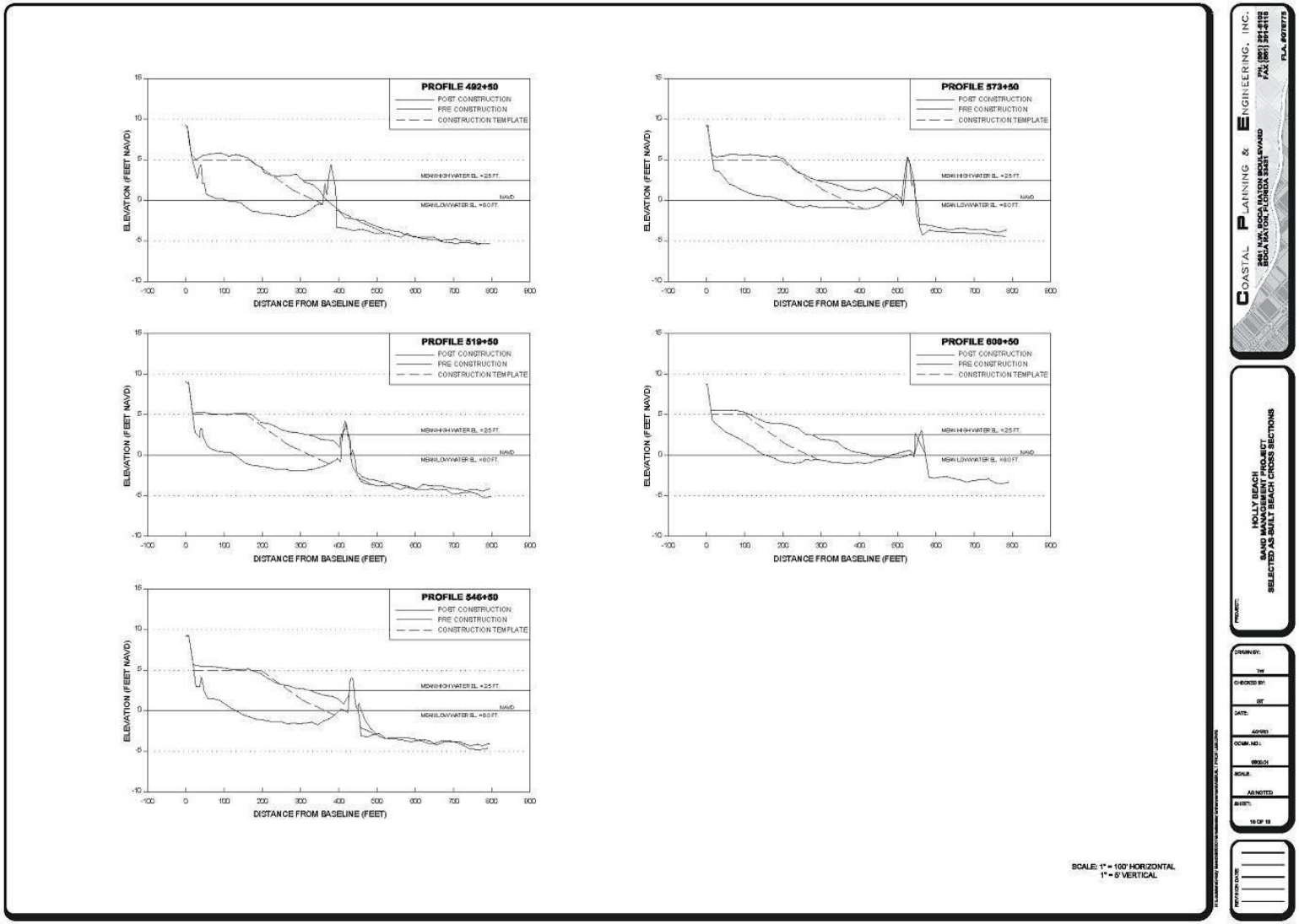



**Figure 8b.** Holly Beach Sand Management (CS-31) selected pre-construction and as-built cross-sections.

**Vegetation Plantings:**

Data were collected on October 6, 2003, April 20, 2004 and October 12, 2004 (Table 2, figure 9). Mean percent survival and mean percent cover in the fall of 2003 were 82.5% and 13.07%, respectively. In the spring of 2004 mean percent survival was 81.1% and mean percent cover was 26.7%. Mean percent survival dropped to 76.7% in the fall of 2004, while mean percent cover increased to 46.4% (figure 10). Many of the original plants were actually covered by the dune that formed behind the fences. The dunes were becoming colonized by both *Panicum amarum* and other species as well. The last scheduled monitoring of the vegetation plantings occurred in the fall of 2004. As documented in the inspection report, though, the plantings were severely impacted by Hurricane Rita and were replanted by the La Dept. of Agriculture and Forestry. These plantings were again severely impacted by Hurricane Ike and were replanted in the fall of 2011. During the 2012 O&M survey, good survival was noted among the plantings that were not affected by direct wave action.

**Figure 9a.** View of the sand fencing and Vegetation Plantings at Station CS31-108 taken in April 2004. Note the dune formation almost covering the fences. The photograph is facing east.

**Figure 9b.** View of the Sand Fencing and Vegetation Plantings at Station CS31-150 taken in October 2004. The photograph is facing east.

**Figure 9c.** View of a section of the sand fencing and vegetation plantings taken October 2005, following Huricane Rita. The photograph is facing west.

## Holly Beach Sand Management (CS-31)
## Vegetation Plantings

**Table 2.** Vegetative species observed during the 2002, 2003, and 2004 Vegetation plantings survey.

| Scientific Name | Common Name |
|---|---|
| *Cakile geniculata* | gulf searocket |
| *Chrysopsis mariana* | Maryland goldenaster |
| *Pluchea odorata* | sweetscent |
| *Symphyotrichum subulatum* | eastern annual saltmarsh aster |
| *Spartina patens* | marshhay cordgrass |
| *Solidago sempervirens* | seaside goldenrod |
| *Amaranthus rudis* | tall amaranth |
| *Amaranthus australis* | southern amaranth |
| *Eclipta prostrata* | false daisy |
| *Alternanthera philoxeroides* | alligatorweed |
| *Ipomoea pes-caprae* | bayhops |
| *Vigna luteola* | hairypod cowpea |
| *Cyperus odoratus* | fragrant flatsedge |
| *Ipomoea imperati* | beach morningglory |

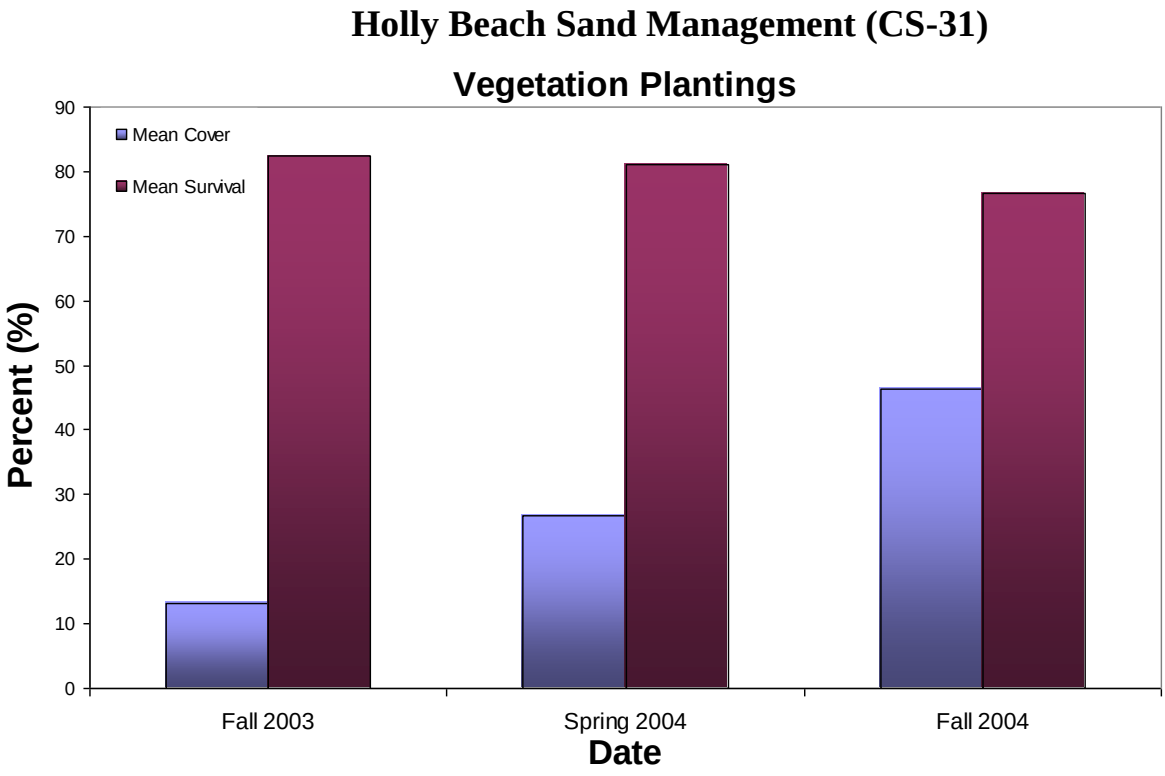



**Figure 10.** Mean percent cover and survival of the *Panicum amarum* plantings on the 2003 and 2004 surveys.

**Shoreline Change:**

The data indicate an average loss of -6.12 ft/yr between the spring 2003 and spring 2004 surveys (table 3). This period would be considered the initial adjustment period after construction when the beach was taking shape. The beach was expected to quickly degrade during this time period due to an overfill of sand by the contractors. The pre-Hurricane Rita data (spring 2003 to spring 2005) indicate an average loss rate of -17.72 ft/yr. The post-hurricane Rita survey (comparing spring 2005 to fall 2005) showed an average of -46.33 ft/yr was lost during the storm (figure 12). Comparing the fall 2005 to spring 2006, which would be considered the recovery period after the impact, indicated an average loss rate of -41.47 ft/yr. The post-hurricane Ike survey (comparing spring 2007 – fall 2009) showed an average of -5.27 ft/yr was lost during the storm (figure 13). The post-Hurricane Ike recovery period (comparing fall 2009 to spring 2011) showed an average loss of -15.52 ft/yr. The final survey (comparing spring 2011 to fall 2011) showed a gain of +8.79 ft/yr. Average loss across all surveys (spring 2003 to fall 2011) was -8.76 ft/yr (figure 11). These should not be taken individually as an actual indication of loss rates along the beach, but rather an indication of the processes occurring along the beach. Unlike the bathymetric/topographic surveys, these shoreline surveys can be influenced by tide levels considering the gentle slope of the beach (1:40 during construction) and the fact that elevation is not taken into account during data collection. For instance, tide levels were 1.66 ft higher during the spring 2006 survey compared to the fall 2005 survey which may have exaggerated loss rates. Tide levels during the surveys are presented in Table 3. Loss rates appeared to be fairly uniform across the project area in most surveys prior to Hurricane Rita. However, the post-Hurricane Rita and post-Hurricane Ike data indicate greater loss rates along the eastern side of the beach and some gain along the western end (figure 12). The hurricanes appear to have shifted large amounts of sand to the western side.

**Table 3.** Shoreline survey results and tide levels during shoreline surveys. Tide data were collected at Sabine Pass in ft Mean Sea Level.

| Date of Survey | Tide level (Ft MSL) | Survey Results (ft/yr) | Survey Description |
|---|---|---|---|
| Spring 2003 | 0.51 | -6.12 | Initial Adjustment |
| Fall 2003 | 0.47 | | |
| Spring 2004 | 0.18 | -17.72 | Pre-Rita |
| Fall 2004 | -0.17 | | |
| Spring 2005 | 0.17 | | |
| Fall 2005 | -0.89 | -46.33 | Rita Effects |
| Spring 2006 | 0.77 | -41.47 | Rita Recovery |
| Spring 2007 | -0.7 | -8.76 | Average across all |
| Fall 2007 | 0.71 | -5.27 | Ike Effects |
| Spring 2009 | -0.42 | | |
| Fall 2009 | 0.78 | | |
| Spring 2011 | 0.34 | -15.52 | Ike Recovery |
| Fall 2011 | -0.32 | +8.79 | Final Survey |

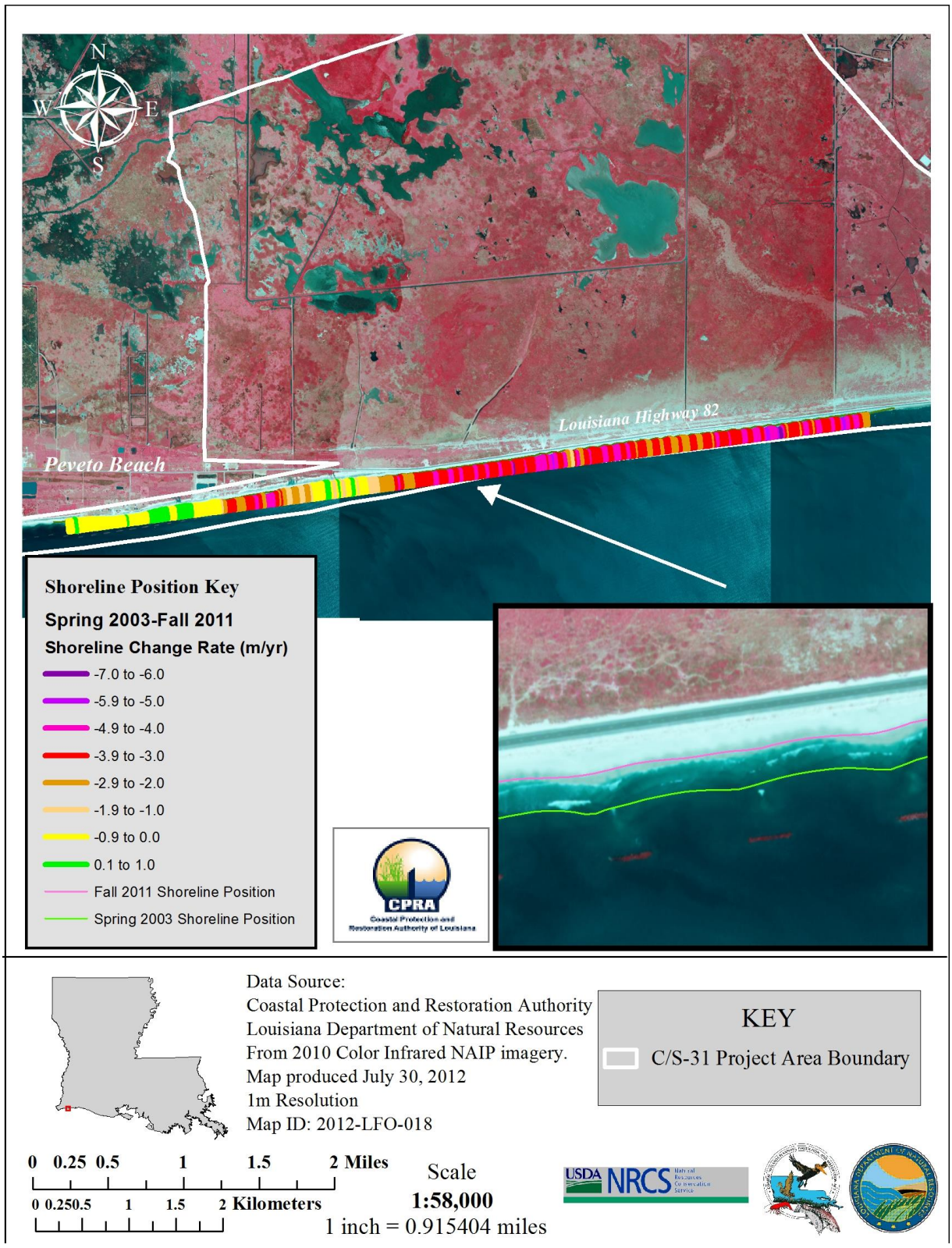



**Figure 11.** Shoreline Change Rates across all surveys from Spring 2003 to Fall 2011.

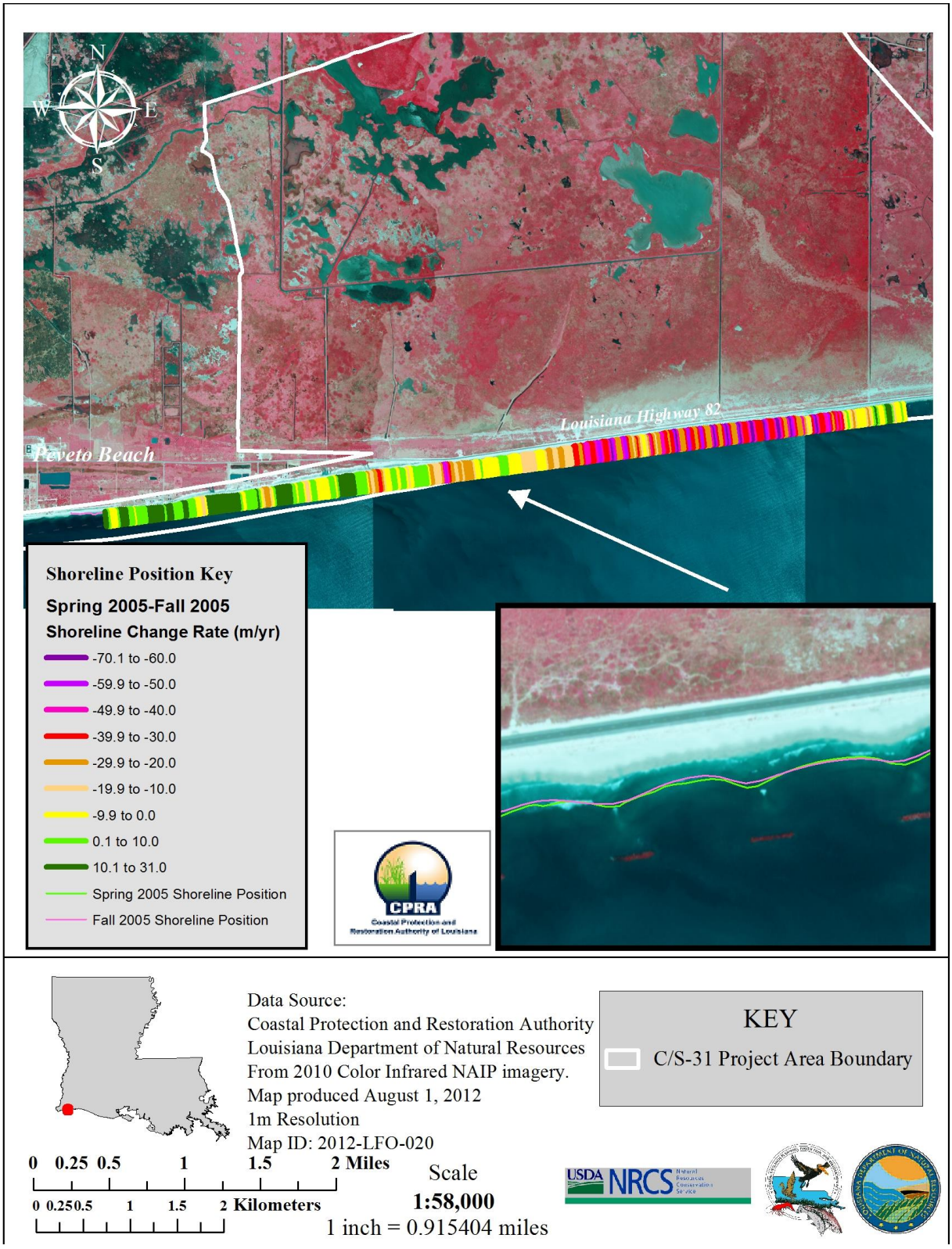



**Figure 12.** Shoreline change rates comparing pre- and post- Hurricane Rita surveys.

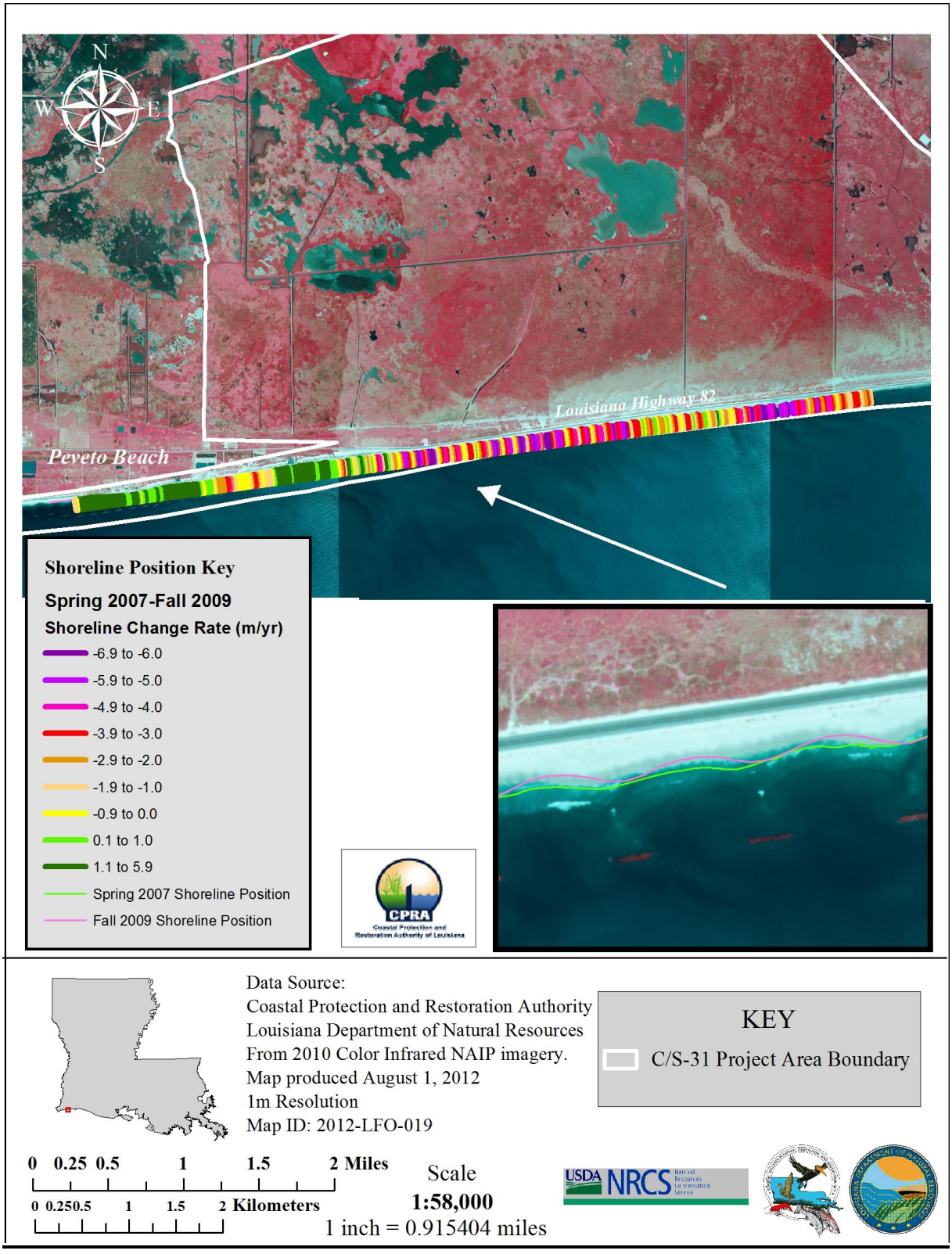



**Figure 13.** Shoreline change rates comparing pre- and post- Hurricane Ike surveys

**Water Salinity:**

Hourly salinity data have been collected at the following continuous recorder stations (figures 14 and 15a-c).

| Station | Data collection period |
|---|---|
| CS31-01 | 9/10/02 – 6/11/07 |
| CS31-02 | 2/18/03 – 6/11/07 |
| CS31-03 | 2/18/03 – 5/1/07 |
| CS20-15R | 1/1/95 – 12/31/12 |
| CRMS0680 | 7/30/07 – 12/31/12 |
| CRMS2219 | 12/12/07 – 12/31/12 |

The project goals for salinity were to maintain levels within the intermediate to brackish range of 3-12 ppt . Yearly means of all project area recorders were less than 3 ppt through 2004 (figure 15a). Monthly means at all project area stations stayed within the target range until Hurricane Rita struck in September. CS31-02 was the only recorder that continued to log through the Hurricane where salinities reached 24 ppt. Monthly salinity means remained above 20 ppt at stations CS31-01 and CS31-02 until December 2005 (figures 15b – 15c). CS31-03 was not redeployed until March 2006. In July 2006, monthly salinities returned to normal and remained below 7 ppt until April 2007. Data from station CS20-15R in the East Mud Lake Marsh Management (CS-20) reference area, which reflects conditions in Calcasieu Lake, are presented for comparison. The data from this recorder was used since the recorder at CS23-01R did not collect data for much of 2005 and 2006. Yearly mean salinities at this recorder were below 12 ppt for the years preceding Hurricane Rita. However, following Rita, monthly mean salinities remained around 15 ppt through the end of 2006 as salinities in the project area had returned to normal. In May and June of 2007, salinities spiked at CS20-15R to near 20 ppt. An increase was also detected at CS31-01 and CS31-02 indicating some influence from the Calcasieu Ship Channel may have occurred in the project area.

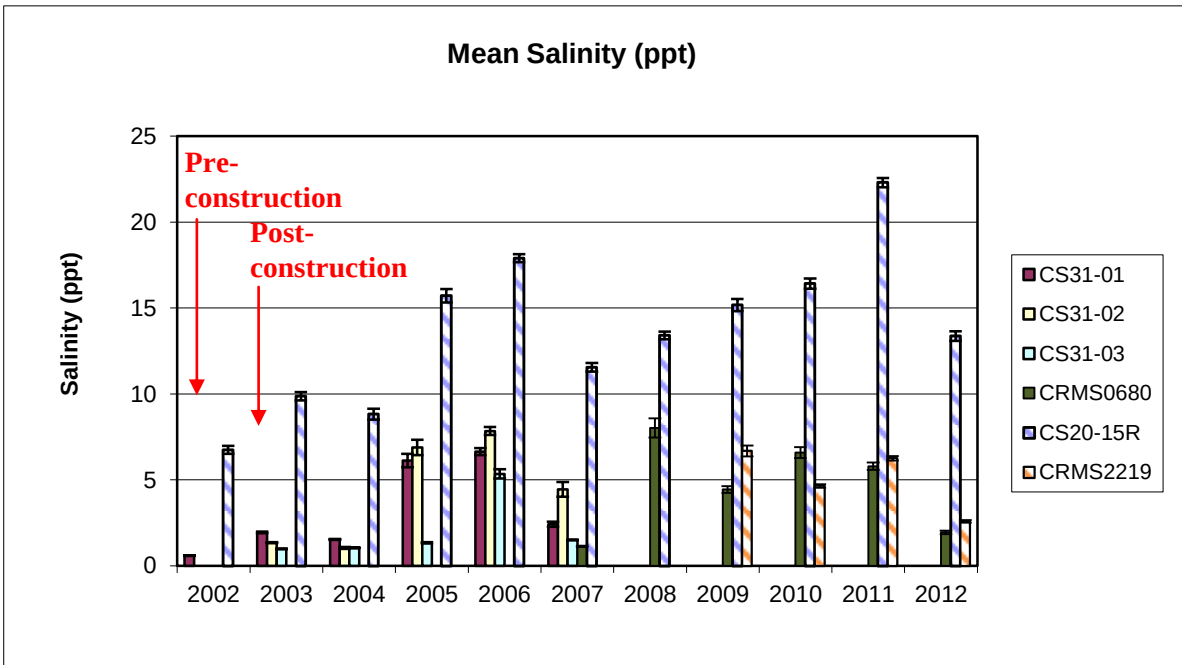
The recorder at CRMS0680 is located in the same canal as CS31-03. Salinities at this station were below 5 ppt until Hurricane Ike made landfall in September 2008. During this event, the salinity reached 26 ppt. Monthly salinities dropped below the target level of 12 ppt in December of 2008 and remained below that level until the end of 2010, where salinities exceeded 15 ppt due to low rainfall. Salinities at the site have remained below the target range since then, even though salinities exceeded 25 ppt at CS20-15R in the latter part of 2011. Reference station CRMS2219 had similar salinities as CRMS0680 throughout most of the sampling period. However, salinities at 2219 didn't reach the levels recorded at 680 in late 2010/early 2011.

Project area yearly salinities were within the target range of 3-12 ppt 94% of the time in years 2003 – 2012 (Figure 15d). In contrast, yearly salinities at reference station CS20-15R were within this range only 40% of the time.

Water level data did not indicate any overwash events other than the surges from Hurricanes Rita and Ike. There was a maximum storm surge in the project area of 14-15 ft for Hurricane Rita (Barras, 2006) and 15-16 ft for Hurricane Ike (East et al. 2008).


**Figure 14.** Location of continuous recorder stations at Holly Beach Sand Management (CS-31) project.

# Holly Beach Sand Management (CS-31)
## Salinity Data




*Project area sites are displayed as solid bars

**Figure 15a.** Yearly salinity means at all CS-31 project area stations, CS20-15R, CRMS0680 and CRMS2219 for years 2002-2012.

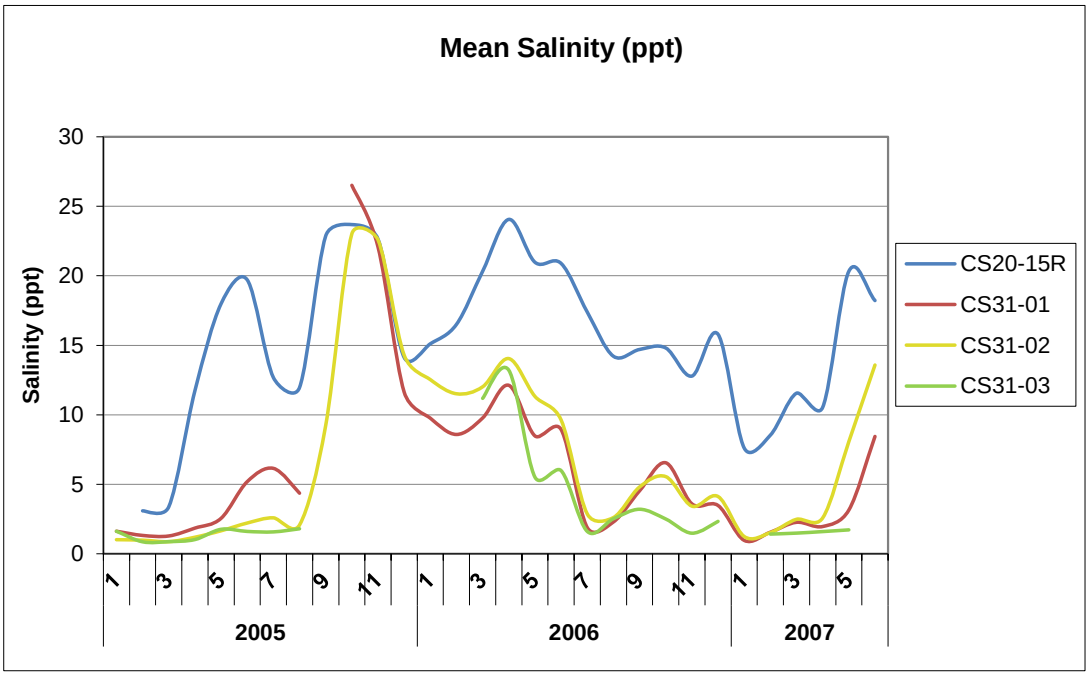



**Figure 15b.** Monthly means at CS-31 project area stations and CS20-15R for years 2005 - 2007.

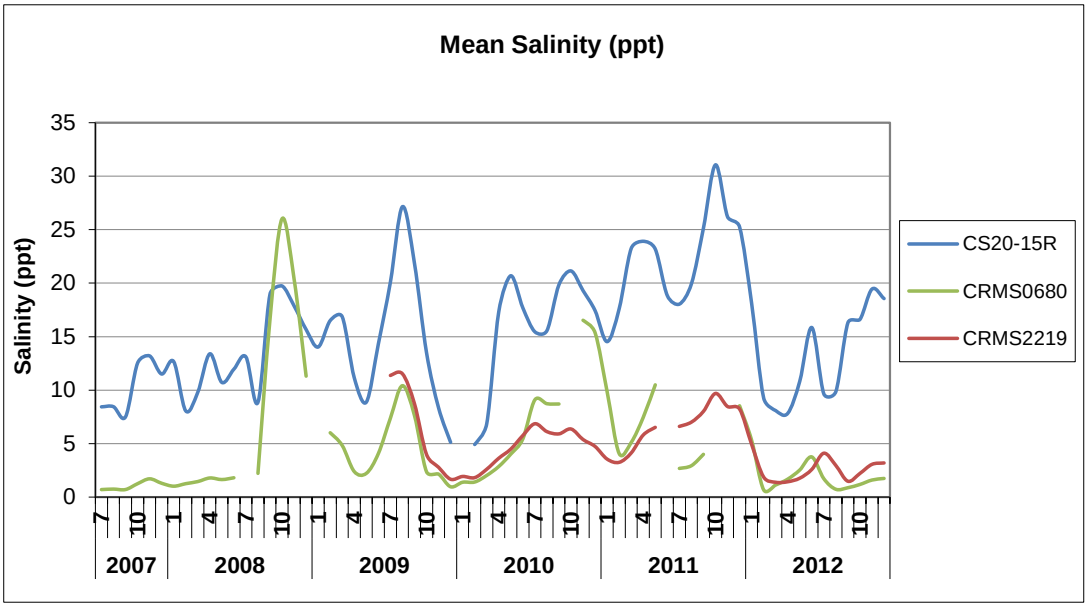



**Figure 15c.** Monthly means at CS20-15R, CRMS0680 and CRMS2219 for years 2007 – 2012.


*Represents the first 6 months of the year

**Figure 15d.** Percentage of year salinities were inside and outside of target range post-construction for project and reference stations.

**Emergent Vegetation:**

The project goal was to maintain the existing intermediate and brackish marsh vegetation community in project Area A north of the chenier/beach ridge. The dominant species in all surveys were *Spartina patens*, *Schoenoplectus americanus* and *Distichlis spicata.* Other frequently occurring species were *Paspalum vaginatum*, *Schoenoplectus robustus*, and *Paspalum distichum*. These are all species that typically inhabit brackish marshes (Table 4, figures 16a-c).

Total percent cover for the pre-construction survey in 2002 was over 100% with an FQI score of 76. The FQI score dropped in 2003 and 2004 but still remained above 60. Following Hurricane Rita, cover and FQI (6.4) dropped dramatically within the project area, but showed a good

recovery in 2006. Percent cover, as well as the quality of vegetation rebounded in 2007 to the 2002 level but dropped in 2008 following Hurricane Ike. A slight decrease in FQI score occurred again in 2009 (43 versus 47 FQI score), but cover remained the same as in the 2008 survey (Figure 16b).

CMRS site 680 showed the same trend as the project-specific sites; however the 2008 CRMS survey showed an increase in FQI score and cover (figure 16b). The 2009 values showed the same decline in quality and cover as the project-specific sites. Low rainfall and extensive cattle herbivory in 2011 cause another sharp decrease in cover and quality of vegetation at the CRMS station. The site did not show full recovery until 2012, where cover (~105%) and FQI (~76) rebounded sharply. Reference site CRMS2219 showed a mild increase in cover and FQI from 2006 to2007 (figure 16c). Cover dropped in 2008 following Hurricane Ike, but, unlike the sites in the CS-31 project area, cover and FQI score increased in 2009 and continued to increase through 2012. The reference site was not subjected to herbivory.

# Holly Beach Sand Management (CS-31)
# Emergent Vegetation

**Table 4.** Plant species observed during the 2002, 2003, 2004, 2005, 2006, 2007, 2008 and 2009 vegetation surveys of the CS-31 project area.

| Scientific Name | Common Name |
|---|---|
| *Amaranthus australis* | southern amaranth |
| *Baccharis halimifolia* | eastern baccharis |
| *Batis maritima* | turtleweed |
| *Borrichia frutescens* | bushy seaoxeye |
| *Cyperus odoratus* | fragrant flatsedge |
| *Distichlis spicata* | seashore saltgrass |
| *Echinochloa walteri* | coast cockspur |
| *Eclipta prostrata* | false daisy |
| *Iva annua* | annual marshelder |
| *Iva frutescens* | bigleaf sumpweed |
| *Lycium carolinianum* | Carolina desert-thorn |
| *Mikania scandens* | climbing hempvine |
| *Paspalum distichum* | knotgrass |
| *Paspalum vaginatum* | seashore paspalum |
| *Pluchea camphorate* | camphor pluchea |
| *Rumex crispus* | curly dock |
| *Salicornia bigelovii* | dwarf saltwort |
| *Schoenoplectus americanus* | chairmaker's bulrush |
| *Schoenoplectus californicus* | california bulrush |
| *Schoenoplectus maritimus* | cosmopolitan bulrush |
| *Schoenoplectus pungens* | common threesquare |
| *Schoenoplectus robustus* | sturdy bullrush |
| *Sesbania herbacea* | bigpod sesbania |
| *Solidago sempervirens* | seaside goldenrod |
| *Spartina patens* | saltmeadow cordgrass |
| *Spartina spartinae* | gulf cordgrass |
| *Suaeda linearis* | annual seepweed |
| *Symphyotrichum subulatum* | eastern annual saltmarsh aster |
| *Symphyotrichum tenuifolium* | perennial saltmarsh aster |
| *Typha* | cattail |
| *Vigna luteola* | hairypod cowpea |

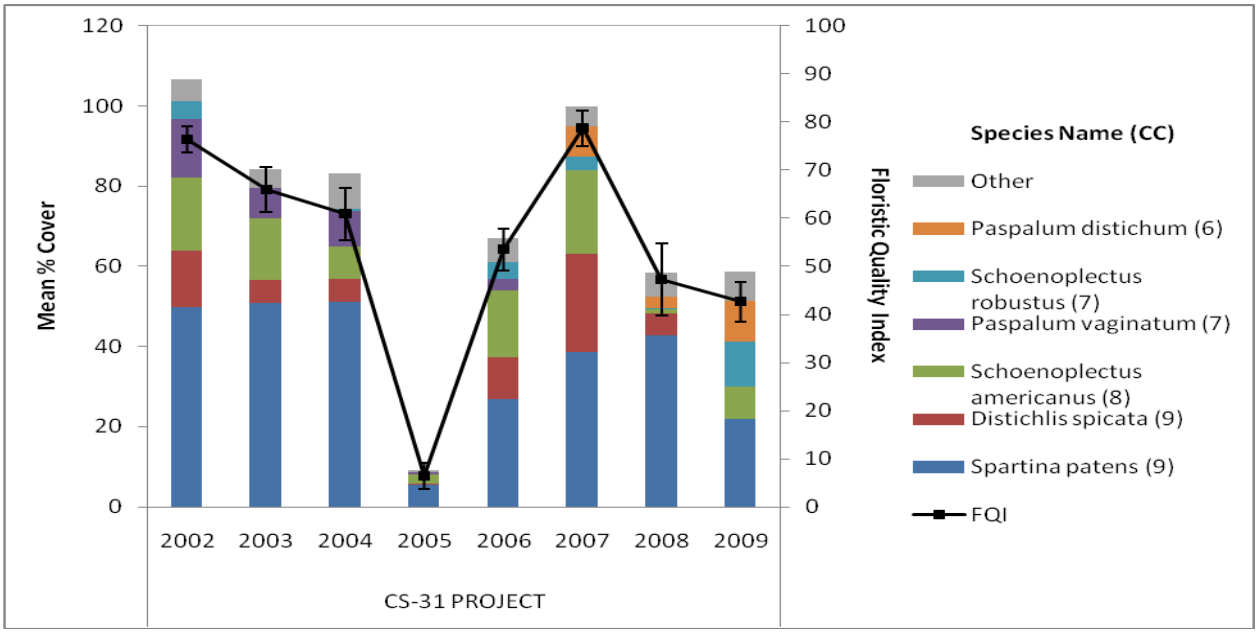



**Figure 16a.** Percent coverage and floristic quality index of species collected from the CS-31 project area in years 2002 – 2009. Values are means of 30 stations within the project area; therefore, the sum of % coverage of individual species can be greater than 100%.

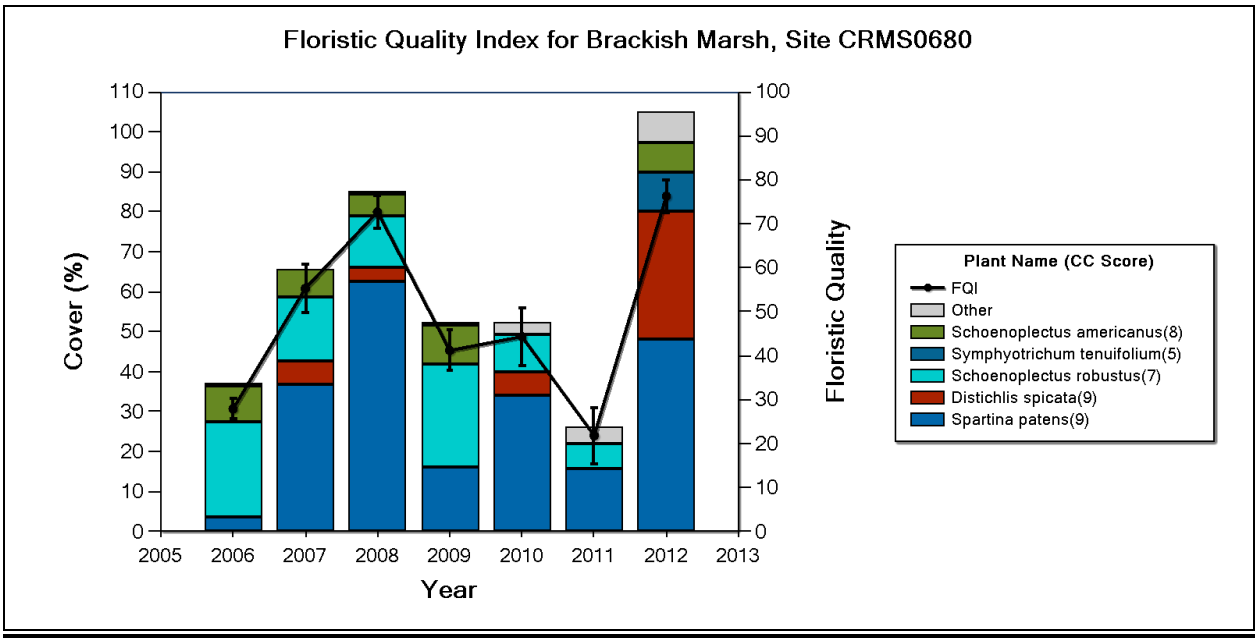



**Figure 16b.** Percent coverage and floristic quality index of species collected from CRMS site 680 within the project area in years 2006 – 2012. Values are means of 10 stations within the site; therefore, the sum of % coverage of individual species can be greater than 100%.

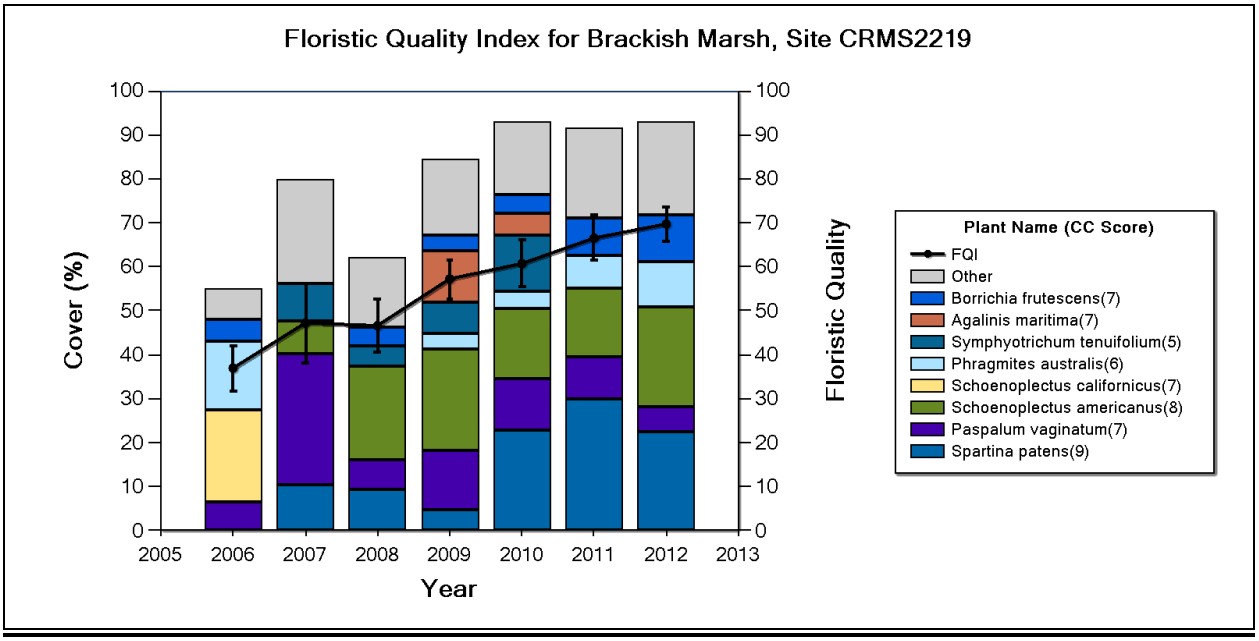



**Figure 16c.** Percent coverage and floristic quality index of species collected from CRMS reference site 2219 in years 2006 – 2012. Values are means of 10 stations within the site; therefore, the sum of % coverage of individual species can be greater than 100%.

**Porewater Salinity:**

In the 2002 and 2004 surveys, mean interstitial water salinity data was nearly identical inside the project area at just over 3 ppt. Due to the hardness of the ground in 2003, data wasn't collected. Mean salinity in 2005 following Hurricane Rita rose to approximately 16.5 ppt. We could only obtain data at 2 stations in 2006. These stations had a mean of 13.2 ppt. Salinities in 2007 dropped to around 8.5 ppt. Following Hurricane Ike, salinities again rose to 16.5 ppt but dropped to 8.5 ppt by 2009 (figure 17a).

Means by month of interstitial water salinity for CRMS stations 680 and 2219 are presented in figures 17b and 17c. Salinities at both stations rose to around 20 ppt following Hurricane Ike but slowly dropped to near pre-hurricane levels at the 10 cm level in 2010. The project station saw an increase in salinity at the beginning of 2012, but has generally remained below 10 ppt through the end of the data collection period. The 30 cm salinities at both project and reference stations remained around 15 ppt through 2010. Data was not available for the project station through 2011 and 2012, but the reference station showed a decrease in salinity through the spring of 2012 to near 10 ppt. These data show that the effects of a large overwash event linger in the soil for several years following the event and translate to an impact to the vegetation as well. In the subsequent year following the overwash event, vegetation showed a decrease in cover, followed by a shift to more salt tolerant species in later years.

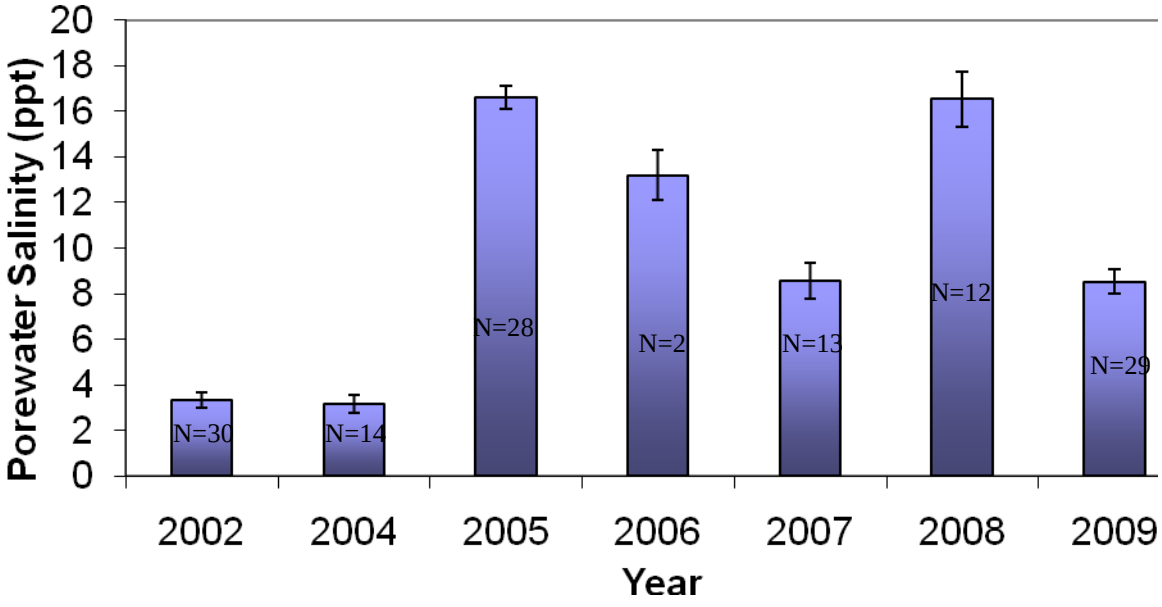



**Figure 17a.** Interstitial salinities collected at project emergent vegetation stations on 2002, 2004, 2005, 2006, 2007, 2008 and 2009 surveys. Error bars represent the mean of stations for that month ± 1 Std. Err.

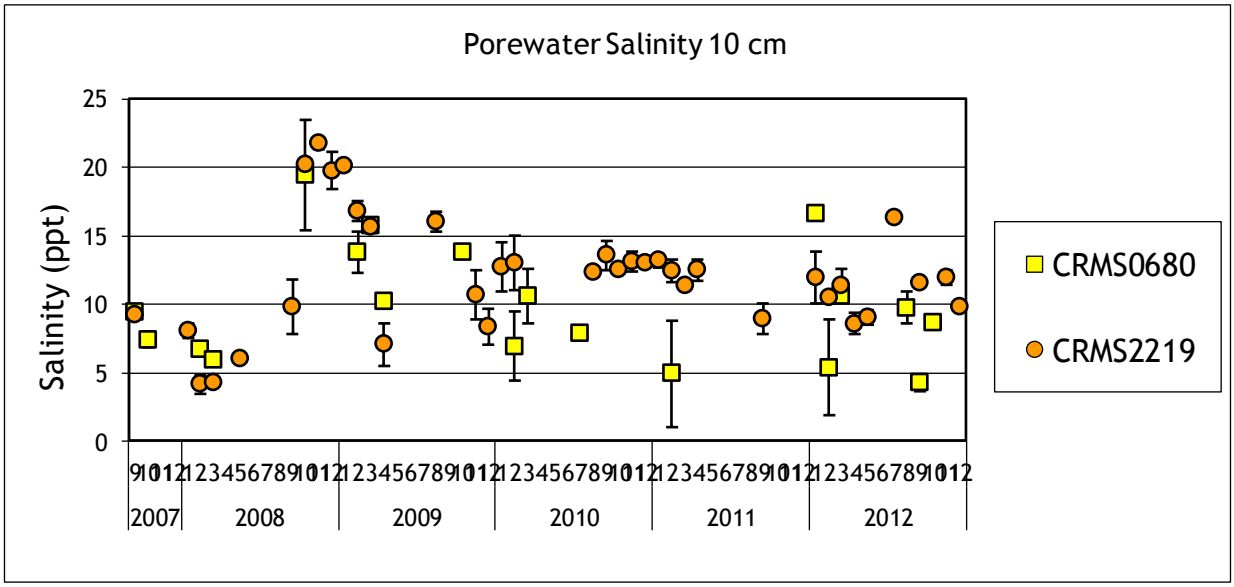



**Figure 17b.** Interstitial water salinity at 10 cm below the soil surface for CRMS project station 680 and reference station 2219. Error bars, where present, represent the mean of stations for that month ± 1 Std Err.

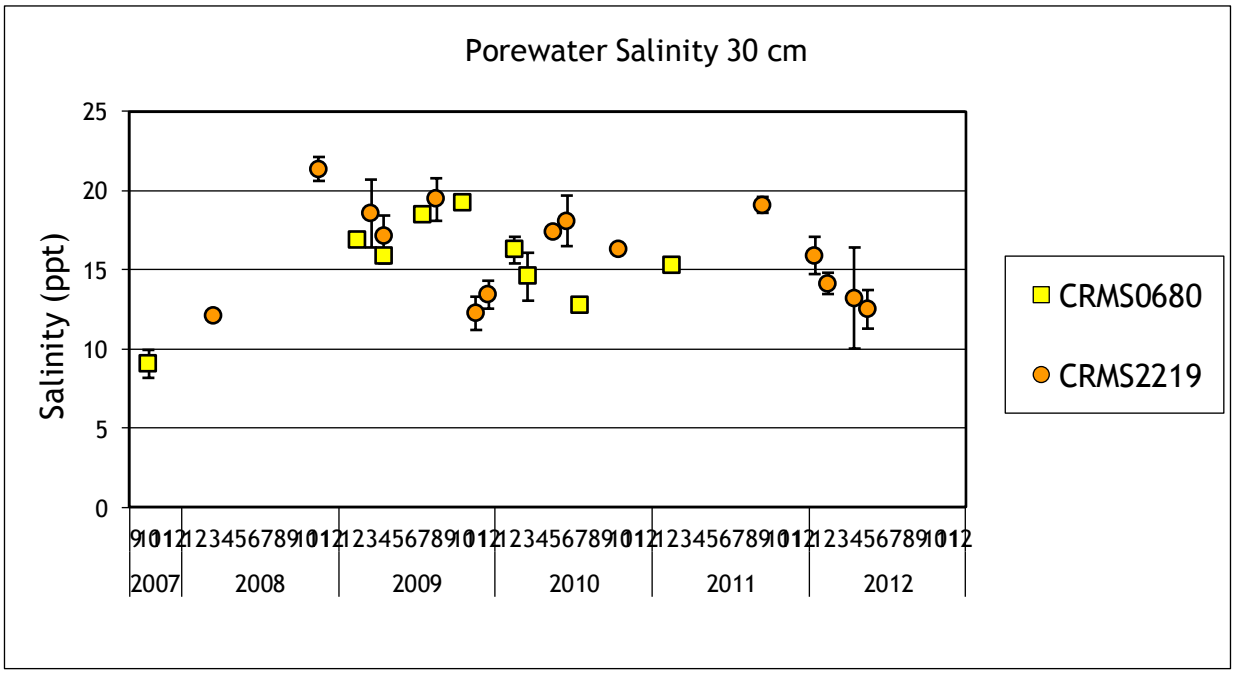



**Figure 17c.** Interstitial water salinity at 30 cm below the soil surface for CRMS stations 680 and 2219. Error bars, where present, represent the mean of stations for that month ± 1 Std. Err.

## CRMS Supplemental:

### Soils:

Soil samples were collected in 2007 at CRMS0680 in the project area and in 2009 at CRMS2219 in the reference area. The soil properties data were sampled in 4 cm increments at CRMS2219. Since the soil at CRMS0680 was too fluid to be sliced, three 16cm cores were analyzed for the site. Figures for mean bulk density and organic matter are presented in figures 18a and 178. The project area station had a higher mean bulk density (~0.8 g/cm$^3$) than the reference area station (<0.6 g/cm$^3$ throughout the core). Percent organic matter was also very low at the project area station (~10%).

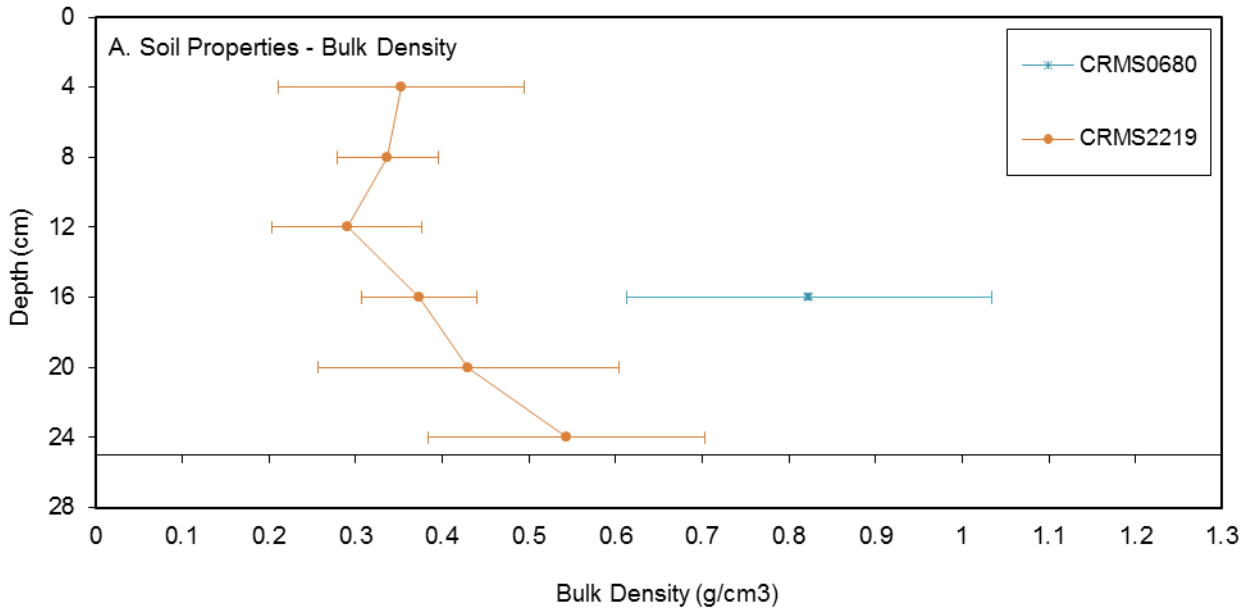



**Figure 18a.** Mean ± 1 Standard error of soil bulk density collected at CRMS 0680 and CRMS2219.

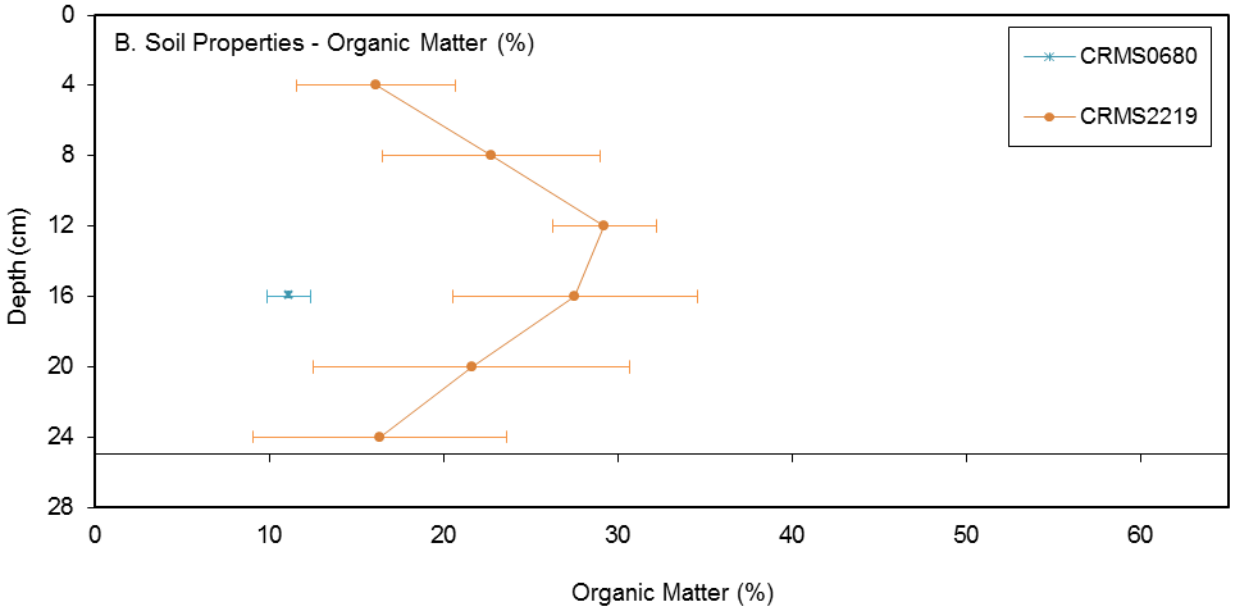



**Figure 18b.** Mean ± 1 Standard error of soil organic matter content collected at CRMS 0680 and CRMS2219.

**Vegetation:**

The FQI scores of CRMS0680, within the project area, were slightly below average in 2006 and 2007, when compared to other brackish CRMS sites coastwide, but by 2008, the site had recovered from the effects of Hurricane Rita and scored above average. In years 2009-2011, the

lingering effects of Hurricane Ike, along with low rainfall and cattle herbivory caused the sites FQI scores to be way below average. Abundant rainfall enabled the site to score higher than average in 2012 (figure 19).

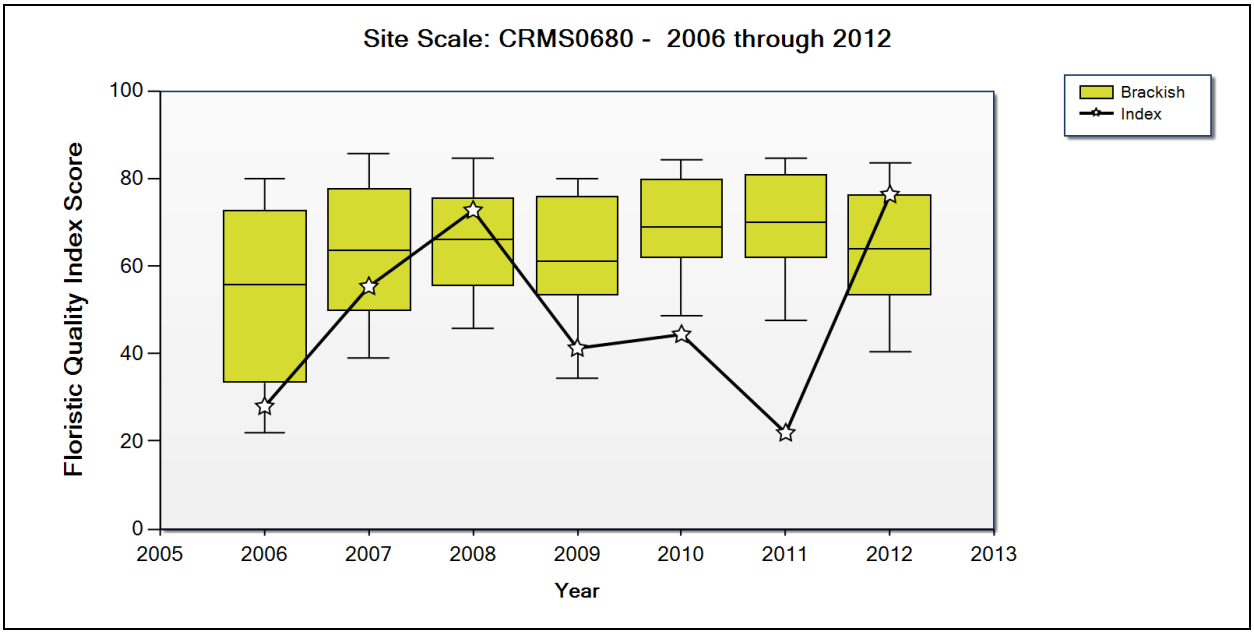



**Figure 19.** A time series of FQI Scores for CRMS0680 relative to the distribution of scores for all the CRMS sites within the same marsh type each year.

**Soil Surface Elevation Change:**

Project station CRMS0680 (Figure 21) showed a negative elevation change of over -1 cm/yr in the 5 years that it has been sampled. The elevation at the site appeared to be increasing prior to 2011. The introduction of cattle to the area likely caused compaction and possibly erosion as a result of the grazing activity. The site had a very low SVI score of 7.48 and given the current trend, would be submerged within 5 years. The SVI score at CRMS0680 was also well below average when compared to other brackish CRMS sites coastwide in 2012. Reference station CRMS2219 has not had enough measurements to calculate viable elevation change rates at this time.

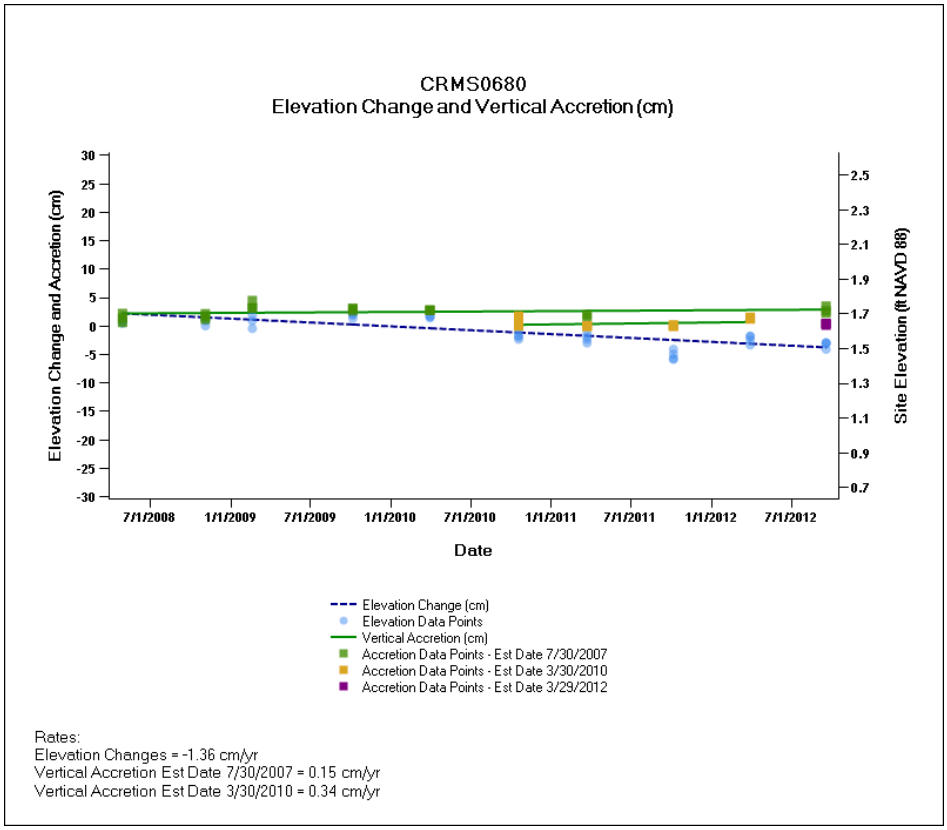



**Figure 21.** Accretion and Elevation change for project station CRMS0680 over 10 samplings for the period July 2007 to September 2012.

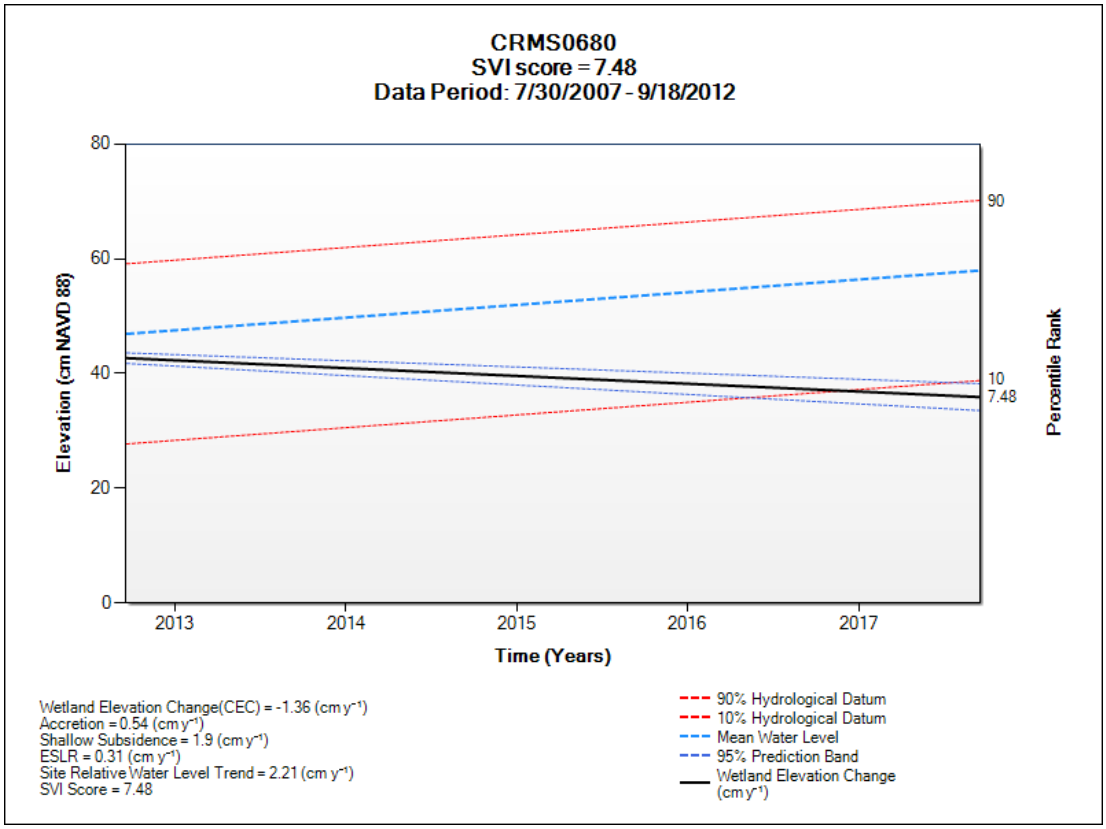



**Figure 22.** Submergence Vulnerability Index for CRMS0680.

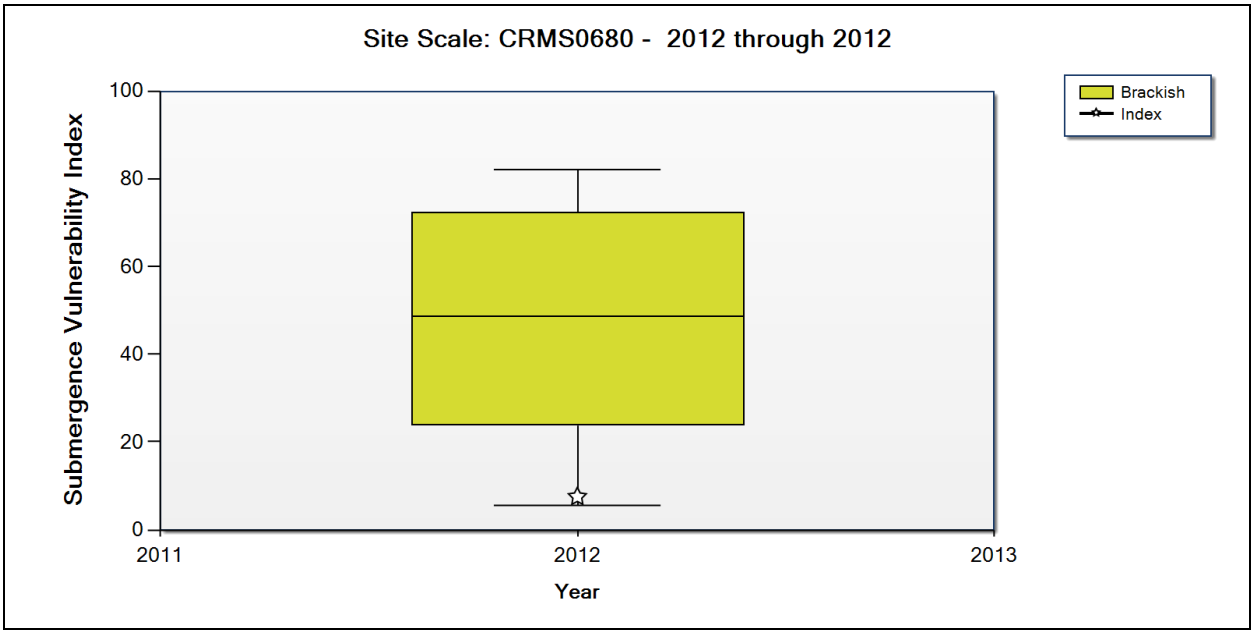



**Figure 23.** Submergence Vulnerability Index score for CRMS0680 in 2012 compared to the distribution of scores for all the CRMS sites coastwide within the brackish marsh type.

# V. Conclusions

## a. Project Effectiveness

The Land:Water analyses completed in 2005 and 2009 have shown that less than 1% of the project area's land was lost since construction, occurring mostly along the shoreline as a result of Hurricanes Rita and Ike. The percent land change analysis shows an increase in percent land through time since construction of the project, even with the land loss from these storms.

Topographic/Bathymetric surveys completed in the project area indicated much higher erosion rates than the rates found by Byrnes et al. (1995) in their study of historical shoreline dynamics along Louisiana's Gulf of Mexico shoreline (-3.9 ft/yr average with a maximum retreat of -8.2 ft/yr). However, the topo/bathy surveys were only done following Hurricanes Rita and Ike. Shoreline surveys completed by CPRA showed an overall retreat rate very near the maximum found by Byrnes et al, but did not collect vertical data and thus the accuracy was influenced by tidal variations. Both the topo/bathy and CPRA surveys indicated large amounts of sand were shifted to the western side of the project area during the hurricanes.

The vegetation plantings along the beach nourishment area were severely impacted by Hurricane Rita. They were replanted by the La Dept of Agriculture and Forestry and again were severely impacted by Hurricane Ike. Bitter Panicum were planted by CPRA in 2011. No monitoring is scheduled for the new plantings; however, during the 2013 O &M Annual inspection it was noted that the vegetation was flourishing in areas along the beach front which were not impacted by beach retreat and direct wave action. There was minimal to no vegetation remaining where the beach was severely eroded and experiencing constant wave energy.

The fencing has proven to be effective in creating dunes where there is ample beach head present, but becomes easily damaged or destroyed where it is routinely subjected to wave energy.

The project has been effective in maintaining salinities within the intermediate to brackish range. Yearly salinities at project stations were within the target range 94% of the time as opposed to 40% at the reference station. Interstitial salinities rose to around 20 ppt following hurricane Ike but dropped to within the target range at the 10 cm level by 2010.

The marsh vegetation is meeting the goal of maintaining intermediate to brackish vegetation. All surveys have been classified as brackish based on the species observed. Vegetation in the project area was severely impacted by Hurricanes Rita and Ike. Recovery from Hurricane Rita took place by 2007, but was slower following Ike, due to low rainfall and cattle herbivory. Full recovery appears to have taken place by 2012. The reference site showed a quicker recovery from Hurricane Ike than the project sites, increasing in both cover and FQI every year since 2009. The difference appears to be a larger occurrence of salt-tolerant species at the reference site, such as *Borrichia frutescens* and *Agalinis maritima*, as well as a lack of grazing pressure. The project area has seen a shift toward more salt tolerant species, with a decrease in *Schoenoplectus robustus* and an increase in *Distichlis spicata*.

Overall elevation change at the project area CRMS site has been negative, due largely to disturbance from cattle. The site appeared to have a slight gain in elevation prior to 2011, but given current rates, would not be sustainable into the future.

b. Recommended Improvements

Additional beach nourishment should be considered in the near future as wind and wave action are scouring sections of the beach and encroaching on LA Highway 82.

The fence posts left from damaged or destroyed sand fence may need to be removed should they become a safety hazard.

c. Lessons Learned

Future monitoring efforts on similar projects should focus more on topographic/bathymetric surveys for shoreline monitoring. This would allow a more accurate determination of loss or gain in ft/yr.

## Literature Cited


Barras, John A., 2006, Land area change in coastal Louisiana after the 2005 hurricanes-a series of three maps: U.S. Geological Survey Open-File Report 06-1274.

Byrnes, M. R., and M. W. Hiland 1995. Large-scale sediment transport patterns on the continental shelf and influence on shoreline response: St. Andrew Sound, Georgia to Nassau Sound, Florida, U.S.A. In: J. H. J. Terwindt (editors), Large-Scale Coastal Behavior, Special Issue in Marine Geology.

Byrnes, M. R., and R. A. McBride. 1995. Preliminary assessment of beach response to a segmented breakwater system: Constance Beach and vicinity, 1990-1994: Final Report to Louisiana Department of Natural Resources, Coastal Restoration Division, Baton Rouge, LA. 102 p.

Byrnes, M. R., R. A. McBride, Q. Tao, and L. Duvic. 1995. Historical dynamics along the Chenier Plain of southwestern Louisiana. Gulf Coast Association of Geological Societies Transactions 45:113-122.

Couvillion, B.R., Barras, J.A., Steyer, G.D., Sleavin, William, Fischer, Michelle, Beck, Holly, Trahan, Nadine, Griffin, Brad, and Heckman, David, 2011, Land area change in coastal Louisiana from 1932 to 2010: U.S. Geological Survey Scientific Investigations Map 3164, scale 1:265,000, 12 p. pamphlet.

Cretini, K.F., and Steyer, G.D. 2011, Floristic Quality Index-An assessment tool for restoration project and monitoring sites in coastal Louisiana: U.S. Geological Survey Fact Sheet 2011-3044, 4p.

East, J. W., M. J. Turco, and R. R. Mason, Jr. 2008. Monitoring inland storm surge and flooding from Hurricane Ike in Texas and Louisiana. U.S. Geological Survey Open-File Report 2008-1365. 38 pp.

Folse, T. M., J. L. West, M. K. Hymel, J. Pl. Troutman, L. A. Sharp, D. Weifenbach, T. McGinnis and L. B. Rodrigue. 2012. A Standard Operating Procedures Manual for the Coast-wide Reference Monitoring System-*Wetlands*: Methods for Site Establishment, Data Collection, and Quality Assurance/Quality Control. Louisiana Coastal Protection and Restoration Authority. Office of Coastal Protection and Restoration. Baton Rouge, LA. 207 pp.

McBride, R. A. and M.. R. Byrnes. 1995. A megascale approach for shoreline change analysis and coastal management along the northern Gulf of Mexico. Gulf Coast Association of Geological Societies Transactions 65: 405-414.

Mendelssohn, I.A., and M. W. Hester 1988. Coastal Vegetation Project: Timbalier Island Final Report submitted to Texaco, USA, New Orleans Division, New Orleans, LA. Agreement No. RC-84-01. 244pp.

Snedden, G.A., and Swenson, E.M., 2012, Hydrologic index development and application to selected Coastwide Reference Monitoring System sites and Coastal Wetlands Planning, Protection and Restoration Act projects: U.S. Geological Survey Open-File Report 2012–1122, 25 p.

Steyer, G. D., R. C. Raynie, D. L. Steller, D. Fuller, and E. Swenson. 1995, revised 2000. Quality Management Plan for Coastal Wetlands Planning, Protection, and Restoration Act Monitoring Program. Open-file report no. 95-01. Department of Natural Resources, Coastal Restoration Division, Baton Rouge, LA. 97 pp.

U.S. Department of Agriculture, Natural Resources Conservation Service and Louisiana Department of Natural Resources. 2001. Holly Beach to Constance Beach Sand Management Project (CS-01): Project Fact and Information Sheet for Wetland Value Assessment. Baton Rouge: LDNR-CRD. 21 pp.

U.S. Geological Survey National Wetlands Research Center 2001. CS-01 Holly Beach habitat analysis report. USGS/NWRC, Coastal Restoration Field Station, Baton Rouge, La. Unpublished report. 2 pp.

# APPENDIX A
# (Inspection Photographs)

**Photo No. 1**, Typical sand fence section on westernmost end of project

**Photo No. 2**, Double fence section with plantings thriving

**Photo No. 3**, Good dune formation on fence section not affected by tidal waters

**Photo No. 4**, Long section of damaged fence

**Photo No. 5**, More damaged fence

# APPENDIX B
# (Three Year Budget Projection)

## HOLLY BEACH SAND MANAGEMENT/ CS-31 / PPL 11

### Three-Year Operations & Maintenance Budgets 07/01/2013 - 06/30/2016

| Project Manager | O & M Manager | Federal Sponsor | Prepared By |
|---|---|---|---|
| *Pat Landry* | *Dion Broussard* | *NRCS* | *Dion Broussard* |

| | 2013/2014 (-11) | 2014/2015 (-12) | 2015/2016 (-13) |
|---|---|---|---|
| ***Maintenance Inspection*** | $ 6,457.00 | $ 6,651.00 | $ 6,851.00 |
| ***Structure Operation*** | | | |
| ***State Administration*** | | | $ - |
| ***Federal Administration*** | | | $ - |
| ***Maintenance/Rehabilitation*** | | | |

13/14 Description:

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

14/15 Description:

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

15/16 Description:

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

| | 2013/2014 (-11) | 2014/2015 (-12) | 2015/2016 (-13) |
|---|---|---|---|
| ***Total O&M Budgets*** | **$ 6,457.00** | **$ 6,651.00** | **$ 6,851.00** |

| | |
|---|---|
| **O &M Budget (3 yr Total)** | **$ 19,959.00** |
| **Unexpended O & M Budget** | **$ 170,990.00** |
| **Remaining O & M Budget (Projected)** | **$ 151,031.00** |

## OPERATION AND MAINTENANCE BUDGET WORKSHEET

HOLLY BEACH SAND MANAGEMENT / PROJECT NO. CS-31 / PPL NO. 11 / 2013/2014 (-11)

| DESCRIPTION | UNIT | EST. QTY. | UNIT PRICE | ESTIMATED TOTAL |
|---|---|---|---|---|
| O&M Inspection and Report | EACH | 1 | $6,457.00 | **$6,457.00** |
| 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**

| | | | | |
|---|---|---|---|---|
| LDNR / CRD Admin. | LUMP | 0 | $0.00 | $0.00 |
| FEDERAL SPONSOR Admin. | LUMP | 0 | $0.00 | $0.00 |
| SURVEY Admin. | LUMP | 0 | $0.00 | $0.00 |
| OTHER | | | | $0.00 |
| | | | **TOTAL ADMINISTRATION COSTS:** | **$0.00** |

**MAINTENANCE / CONSTRUCTION**

***SURVEY***

| SURVEY DESCRIPTION: | | | | | |
|---|---|---|---|---|---|
| Secondary Monument | EACH | 0 | $0.00 | $0.00 |
| Staff Gauge / Recorders | EACH | 0 | $0.00 | $0.00 |
| Marsh Elevation / Topography | LUMP | 0 | $0.00 | $0.00 |
| TBM Installation | EACH | 0 | $0.00 | $0.00 |
| OTHER | | | | $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 | |
| | 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 | $12.00 | $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 | | LUMP | 0 | $0.00 | $0.00 |
| General Structure Maintenance | | LUMP | 0 | $0.00 | $0.00 |
| OTHER | | | | $0.00 | $0.00 |
| OTHER | | | | $0.00 | $0.00 |
| OTHER | | | | $0.00 | $0.00 |
| | | | | **TOTAL CONSTRUCTION COSTS:** | **$0.00** |

**TOTAL OPERATIONS AND MAINTENANCE BUDGET: $6,457.00**

## OPERATION AND MAINTENANCE BUDGET WORKSHEET

HOLLY BEACH SAND MANAGEMENT / PROJECT NO. CS-31 / PPL NO. 11 / 2014/2015 (-12)

| DESCRIPTION | UNIT | EST. QTY. | UNIT PRICE | ESTIMATED TOTAL |
|---|---|---|---|---|
| O&M Inspection and Report | EACH | 1 | $6,651.00 | **$6,651.00** |
| 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**

| | | | | |
|---|---|---|---|---|
| LDNR / CRD Admin. | LUMP | 0 | $0.00 | $0.00 |
| FEDERAL SPONSOR Admin. | LUMP | 0 | $0.00 | $0.00 |
| SURVEY Admin. | LUMP | 0 | $0.00 | $0.00 |
| OTHER | | | | $0.00 |
| | | | **TOTAL ADMINISTRATION COSTS:** | **$0.00** |

**MAINTENANCE / CONSTRUCTION**

***SURVEY***

| SURVEY DESCRIPTION: | | | | | |
|---|---|---|---|---|---|
| Secondary Monument | EACH | 0 | $0.00 | $0.00 |
| Staff Gauge / Recorders | EACH | 0 | $0.00 | $0.00 |
| Marsh Elevation / Topography | LUMP | 0 | $0.00 | $0.00 |
| TBM Installation | EACH | 0 | $0.00 | $0.00 |
| OTHER | | | | $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 | |
| | 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 | $12.00 | $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 | | LUMP | 0 | $0.00 | $0.00 |
| General Structure Maintenance | | LUMP | 0 | $0.00 | $0.00 |
| OTHER | | | | $0.00 | $0.00 |
| OTHER | | | | $0.00 | $0.00 |
| OTHER | | | | $0.00 | $0.00 |
| | | | | **TOTAL CONSTRUCTION COSTS:** | **$0.00** |

**TOTAL OPERATIONS AND MAINTENANCE BUDGET:** **$6,651.00**

## OPERATION AND MAINTENANCE BUDGET WORKSHEET

HOLLY BEACH SAND MANAGEMENT / PROJECT NO. CS-31 / PPL NO. 11 / 2015/2016 (-13)

| DESCRIPTION | UNIT | EST. QTY. | UNIT PRICE | ESTIMATED TOTAL |
|---|---|---|---|---|
| O&M Inspection and Report | EACH | 1 | $6,851.00 | **$6,851.00** |
| 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**

| | | | | |
|---|---|---|---|---|
| LDNR / CRD Admin. | LUMP | 0 | $0.00 | $0.00 |
| FEDERAL SPONSOR Admin. | LUMP | 0 | $0.00 | $0.00 |
| SURVEY Admin. | LUMP | 0 | $0.00 | $0.00 |
| OTHER | | | | $0.00 |
| | | | **TOTAL ADMINISTRATION COSTS:** | **$0.00** |

**MAINTENANCE / CONSTRUCTION**

***SURVEY***

| SURVEY DESCRIPTION: | | | | | |
|---|---|---|---|---|---|
| Secondary Monument | | EACH | 0 | $0.00 | $0.00 |
| Staff Gauge / Recorders | | EACH | 0 | $0.00 | $0.00 |
| Marsh Elevation / Topography | | LUMP | 0 | $0.00 | $0.00 |
| TBM Installation | | EACH | 0 | $0.00 | $0.00 |
| OTHER | | | | | $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 | |
| | 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 | $12.00 | $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 | | LUMP | 0 | $0.00 | $0.00 |
| General Structure Maintenance | | LUMP | 0 | $0.00 | $0.00 |
| OTHER | | | | $0.00 | $0.00 |
| OTHER | | | | $0.00 | $0.00 |
| OTHER | | | | $0.00 | $0.00 |
| | | | | **TOTAL CONSTRUCTION COSTS:** | **$0.00** |

**TOTAL OPERATIONS AND MAINTENANCE BUDGET:** **$6,851.00**

**APPENDIX C**
**(Field Inspection Notes)**

**MAINTENANCE INSPECTION REPORT CHECK SHEET**

Project No. / Name: CS-31 Holly Beach

Date of Inspection: October 31, 2012 Time: 11:00 am

Structure No.

Inspector(s): Dion Broussard, Jody White (CPRA)
Dale Garber, Brandon Samson (NRCS)
Daryl Clark (USFWS) for other inspections

Structure Description: Sand fencing and beach fill.

Type of Inspection: Annual

Weather Conditions: sunny & cool

| Item | Condition | Physical Damage | Corrosion | Photo # | Observations and Remarks |
|---|---|---|---|---|---|
| Steel Bulkhead / Caps | N/A | | | | |
| Steel Grating | N/A | | | | |
| Stop Logs | N/A | | | | |
| Hardware | N/A | | | | |
| Timber Piles | N/A | | | | |
| Timber Wales | N/A | | | | |
| Vegetation | Good | | | 1-5 | Many plants were lost to high water. In places of higher elevation, the plants are flourishing. |
| Sand Fencing | Good | | | 1-5 | Many sections of fence damaged due to high water. |
| Signage /Supports | N/A | | | | |
| Sand (fill) | Fair | | | 1-5 | Beach fill in fair condition, but retreating. |
| Earthen Embankment | N/A | | | | |

What are the conditions of the existing levees?
Are there any noticeable breaches?
Settlement of rock plugs and rock weirs?
Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?