State of Louisiana
Coastal Protection and Restoration Authority

2015 Operations, Maintenance, and Monitoring Report

for

East Sabine Lake Hydrologic Restoration (CS-32)

State Project Number CS-32
Priority Project List 10

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Cameron Parish

Prepared by:

Mike Miller and
Jody White
CPRA Operations Division
Lafayette Regional Office

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Preface

The East Sabine Lake Hydrologic Restoration Project (CS-32) 2015 Operations, Maintenance, and Monitoring (OM&M) report includes monitoring data collected through December 2014. Annual inspections were conducted by CPRA, USFWS and NRCS staff in 2014 and 2015 for the terrace field and structure components, respectively. The Maintenance History is also included.

This report is the 3rd report in a series of OM&M reports. For additional information on environmental assessments, ecological reviews, and annual inspection reports (2009/2010, 2010/2011 and 2012/2013) please refer to the CPRA web site ((http://lacoast.gov/new/Projects/Info.aspx?num=CS-32).

I. Introduction

The CS-32 project area is parceled throughout the Sabine National Wildlife Refuge (NWR) in western Cameron Parish, Louisiana. The area is bounded on the west by the east shoreline of Sabine Lake, on the north by the approximate northern boundary of Sabine NWR, on the east by the Burton-Sutton Canal, and on the south by Starks South Canal (Figure 1). The project area is comprised of approximately 8,248 acres (3,338 ha) of intermediate and brackish marsh (Sasser et al. 2008), the latter generally located along the shoreline of Sabine Lake and extending inland for 1 to 2 miles (1.6 to 3.2 km). In 2004, approximately 66% of the project area was shallow open water habitat (Balkum et al. 2003; Clark and Mazourek 2004).

Land loss within the project area has been attributed to saltwater intrusion from Sabine Lake and Calcasieu Ship Channel via Black Bayou, Green's Bayou, Willow Bayou, the Gulf Intracoastal Waterway (GIWW), and the construction of oilfield and boundary/drainage canals (Louisiana Coastal Wetlands Conservation and Restoration Task Force 2002). The average land loss rate for the project area from 1983 to 1990 was estimated at 0.2% per year (Dunbar et al. 1992). Coast 2050 analysis predicted continued land loss within the project area and identified Sabine Lake shoreline erosion, interior marsh loss along the edges of open water areas, and altered hydrologic regimes as the primary causes (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority [LCWCRTF & WCRA] 1998).

The East Sabine Lake Hydrologic Restoration project (CS-32) is designed to address these causes of land loss by controlling channel-induced saltwater intrusion and water level fluctuations, by creating marsh in shallow open water areas, and by reducing and/or stopping erosion at a critical reach along the eastern Sabine Lake shoreline. These proposed approaches are consistent with the Coast-wide Common Strategies and Regional Ecosystem Strategies identified in Coast 2050 (LCWCRTF & WCRA 1998). The CS-32 project is from Project Priority List 10 of the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) and is federally co-sponsored by the US Fish and Wildlife Service and USDA – Natural Resource Conservation Service.

Project Goals and Strategies

1. Reduce salinity and water level variability by constructing a rock weir at 1 ft below average water elevation (or 0.0 ft NAVD 88) in Pines Ridge Bayou at the intersection of an east-west oil and gas canal that connects Pines Ridge Bayou to Sabine Lake.

2. Reduce salinity and water level variability through the construction of a rock weir at 1 ft below average water elevation (or 0.0 feet NAVD 88) at Double Island Gully intersection with Starks South Canal.

3. Stop Sabine Lake shoreline erosion by constructing a 3,000 linear ft, foreshore, rock dike (3 ft NAVD 88 in elevation) north of the mouth of Willow Bayou at Sabine Lake.

4. Create 127 acres (51.3 ha) of emergent marsh and reduce area salinity through the construction of approximately 229,000 linear feet (69,062 m) of vegetated earthen terraces in open water areas north and south of Greens Lake.

5. Increase opportunity for fisheries and estuarine organism access into the western portion of Sabine NWR and restore Bridge Bayou's hydrologic integrity through the installation of three 24-inch diameter culverts with stop logs and flapgates at the intersection of Bridge Bayou, the cattle walkway, and Grays Ditch.

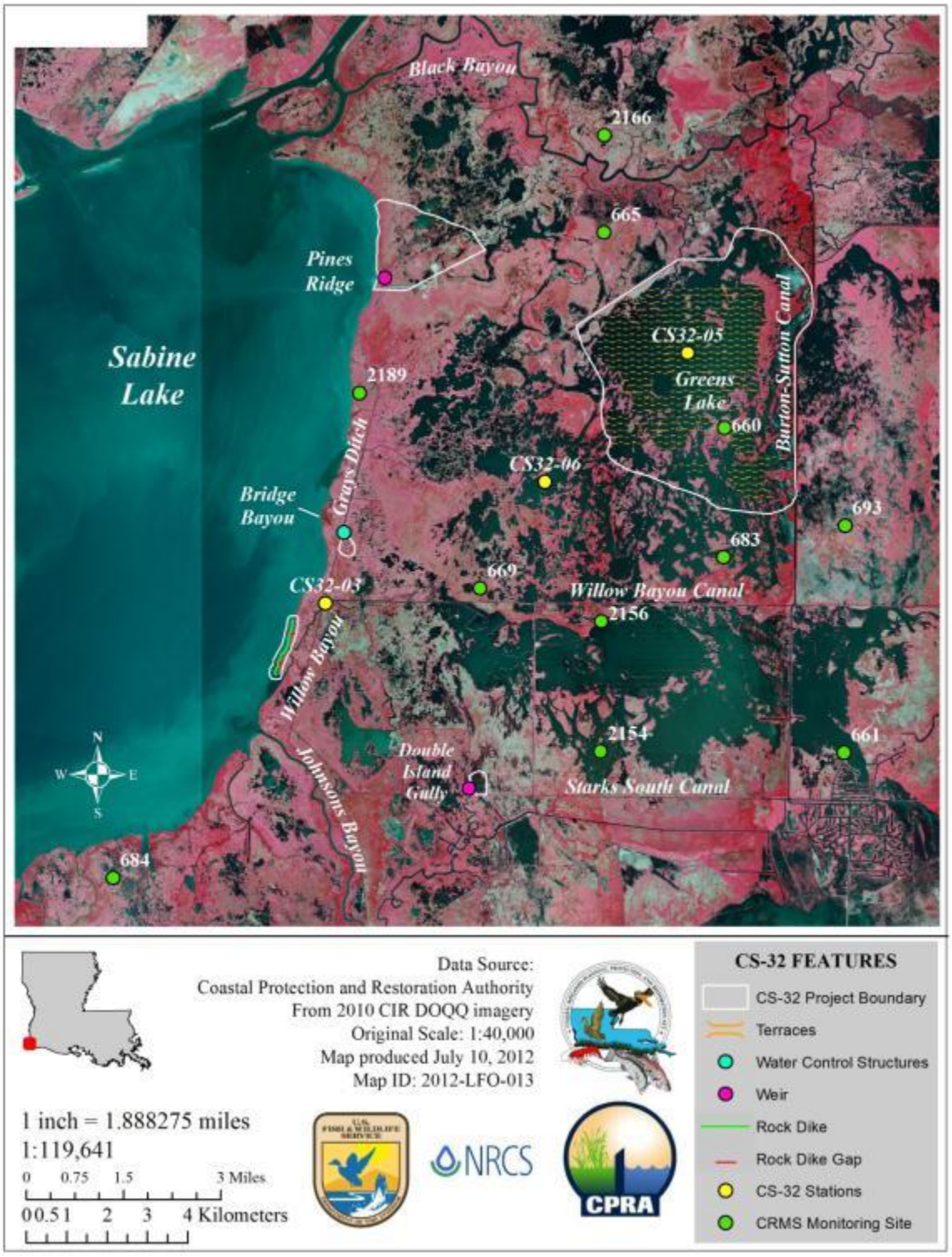


Figure 1. East Sabine Hydrologic Restoration (CS-32) project area showing project boundaries, project features, and monitoring (CS-32 and CRMS) stations in or near the project area.

II. Maintenance Activity

a. Inspection Purpose and Procedures

The purpose of the annual inspection of the East Sabine Lake Hydrologic Restoration Project (CS-32) 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. As noted in Appendices A, B, and C, initial project goals included documenting inspections with photographs, creating a three-year budget projection, and taking field inspection notes.

Typically, an inspection team consisting of two representatives of CPRA and one representative of the Natural Resources Conservation Service (NRCS) and US Fish and Wildlife Service (USFWS) perform annual visual inspections. If damage is apparent, CPRA, NRCS, and USFWS assign a team to perform a detailed inspection and report on the findings. The team documents the condition of the project features and may employ a survey party to make detailed measurements. An annual inspection of all project features was not performed in the 2011-2012 cycle; however, a brief reconnaissance trip to view the vegetation on the terraces was conducted on November 1, 2011 and September 29, 2014 by CPRA, NRCS and USFWS personnel.

Primary Project Features:

1. A 40-ft wide, low-level (0.0 ft, NAVD88) rock weir in Pines Ridge Bayou was constructed in 2005 to attenuate water fluctuations from Sabine Lake.

2. 3000 linear feet, rock, dike along Sabine Lake shoreline north of the mouth of Willow Bayou was constructed in 2005 to prevent erosion and was segmented to allow for fish and wildlife access in 2007.

3. A low-level (0.0 ft, NAVD88) rock weir at the Double Island Gully and Starks South Canal intersection was constructed in 2005; however, it was removed by the Cameron Parish Drainage District in 2010 and was reconstructed in 2015.

4. Approximately 229,000 linear feet of vegetated earthen terraces in large, shallow, open-water areas north and south of Greens Lake were constructed from 2005-2009 to increase marsh acreage, disrupt wind fetch waves, improve water quality, and reduce erosion of surrounding shorelines. Two phases of terraces were constructed as a result of a reallocation of funds within the project features. The originally planned terraces, (CU-1) constructed from 2005-2006, had a 15 foot-wide crown width and 4:1 side slopes; the additional section of terraces (CU-1A), constructed from 2008-2009, were constructed with a 9 foot-wide crown width and 3:1 side slope. Both construction phases were interrupted by hurricanes.

CU-1 2005 Installation of 171,000 LF of terraces and 142,500 vegetative transplants was 54 % complete when interrupted by Hurricanes Katrina and Rita.

CU-1 2006 Resumed work post Hurricane Rita to complete the remaining 13,722 feet of terraces and to replant damaged terraces with an additional 42,500 transplants.

CU-1A 2008 An additional 50,000 LF of terraces with 41,000 transplants was nearly complete when interrupted by Hurricane Ike; the northern most row was not completed.

CU-1A 2009 Replanted damaged CU-1A terraces with 32,200 transplants.

5. Three, 24-inch diameter culverts with sluice gates in Bridge Bayou at Grays Ditch were constructed in 2005 to improve fish access.

b. Summary of Past Operations and Maintenance Projects

Earthen Terraces (CU1 & CU1A)

An annual field inspection of the rock dike, weirs and culverts was conducted by CPRA and Federal sponsor staff on September 29, 2014. Findings of the plant condition were better in 2014 with more expansion into the water by smooth cordgrass. The percent cover for the total length of terraces was estimated at appx. 90%. The inspection began on the north end of the terrace field and proceeded south. Each air boat took a row of terraces meeting up along the way to discuss what was seen. The northern section of terraces (CU1) had a variety of vegetation, i.e. smooth cordgrass, roseau cane, baccharis, iva, and a few cattails. The terraces narrowed heading south (CU1A), but there was still good cordgrass spread out beyond the terrace width. There were skips in vegetation coverage noted, averaging 5%-7% bare areas. (See Appendix A, Photos 1-5)

The salinity was also recorded at three locations as follows:

CU - Row # - Terrace #	Salinity - ppt
CU1 - R1 - 1	8.1 ppt
CU1 - R14A - 1	7.4 ppt
CU1A - R6	6.2 ppt

Foreshore Rock Dike

The water level was approximately a foot higher than normal. Although there were low areas of the rock dike noted between the south warning sign up to just south of the bend in Willow Bayou, the foreshore rock dike was in good condition and performing as intended. The higher water was contributing to the low appearance of the rock dike and there were no signs of damage to the original marsh behind the rock dike. This area will continue to be monitored.

The vegetation has filled in nicely behind several segments of the rock dike. Willow Bayou however has broken through to the dike. There is a segment of rock dike in the vicinity of Willow Bayou that has settled and warrants installing signs. Temporary signs were installed the

summer of 2015. The existing warning signs along the rock dike were in place and intact. The salinity in Sabine Lake was 0.3ppt. (See Appendix A, Photos No. 6-13)

Rock Weir at Pines Ridge

The Pines Ridge Weir is still functioning as intended. The water level on the staff gauge adjacent to the outside of the weir was at 2.3ft. Due to the higher than normal water levels, there was little rock visible above the water. Probing the area revealed rock approximately 3.5 ft below the water at center and the weir appeared to be intact. The warning sign was struck by something but was still intact. The salinity at Pines Ridge Weir was also 0.3ppt. (See Appendix A, Photos No. 14-15)

Double Island Gully Plug

The Cameron Parish Gravity Drainage District No. 7 removed the weir in 2010 for drainage after Hurricane Ike, and placed the rock on the spoil bank adjacent to the plug location. From probing during the 2013 site visit, it was found that the center of the plug was approximately the same water depth as the Southline Canal, and therefore no longer functioning as a weir. There doesn't appear to be a significant impact on the project area. The drainage district replaced the rock in the summer of 2015 and it appears to be about 2 feet above water level. We expect it to subside and compact to water level or below in the near future.

Bridge Bayou Culverts

The culverts were not visited during this inspection. Although the water levels were high, there would not have been enough depth in Grey's ditch to accommodate the boat. The culverts were intact during the 2013 inspection.

c. Inspection Results

i. Immediate/ Emergency Repairs

No maintenance is recommended at this time.

ii. Programmatic/ Routine Repairs

No maintenance is recommended.

General Maintenance: Below is a summary of completed maintenance projects and operation tasks performed on the constructed project features since completion of the East Sabine Lake Hydrologic Restoration Project (CS-32).

2007 - Hurricane Rita Repairs to Pines Ridge Bayou Weir and Willow Bayou Rock Realignment – F. Miller Construction - This maintenance project included placing 146 tons of R-300 rock rip-rap along with 794 LF of PVC sheet pile wall at Pines Ridge Bayou Weir. Rock realignment was performed at each end of the dike and rock gaps were placed in two other locations along the shoreline. This maintenance project was a result of damages sustained from Hurricane Rita in 2005 and other maintenance work required.

The costs associated with the engineering, design and construction of the Pines Ridge Bayou and Willow Bayou Maintenance Project are as follows:

Construction (CWPPRA)	$ 74,700.00
Construction (FEMA: Pines Ridge Weir repair)	$143,032.00
E & D, construction oversight, as-builts	$ 35,026.65
Project Total	**$252,758.65**

III. Operation Activity

a. Operation Plan

There are no active operations associated with this project**.**

b. Actual Operations

There are no active operations associated with this project.

IV. Monitoring Activity

The CWPPRA projects authorized for construction after August 14, 2003 are monitored with Coastwide Reference Monitoring System - *Wetlands* (CRMS) stations, other existing data collection, and any additional data collection specifically added to the project and funded separately from the standard CRMS monitoring. One CRMS site (CRMS0660) is located within the Greens Lake terrace area, and seven sites (CRMS0665, 0665, 0669, 0683, 0684, 2154, 2156, and 2189) located in the surrounding marsh serve as suitable references (Figure 1). No CRMS sites are within the small area of impact area around the weirs; therefore, project-specific sondes were deployed from (October 2012 – February 2014) at the Pines Ridge structure to monitor salinity and water level variability differences inside and outside of the affected area.

a. Monitoring Goals

The East Sabine Lake (CS-32) project is classified as a marsh restoration, hydrologic restoration, and shoreline protection project. Land area is expected to increase with the addition of terraces north and south of Greens Lake. Through the use of passive water control structures and terraces, a more beneficial hydrology is expected in the vicinity of Pines Ridge and Greens Lake. In the Pines Ridge area, the low-level weir is expected to attenuate rapid water fluctuations and salt water intrusion from Sabine Lake caused by artificial channel connections that increase hydrologic exchange. The rock dike along Sabine Lake is expected to stop erosion.

The specific measurable goals established to evaluate the effectiveness of the project are:

1. Evaluate land area changes in the project area, especially the terraced areas around Greens Lake.
2. Evaluate water level variability within Pines Ridge and Greens Lake area.

3. Evaluate water salinity within Pines Ridge area and Greens Lake.
4. Evaluate shoreline change along Sabine Lake behind the gapped, foreshore, rock dike.

b. Monitoring Elements

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

Land Change

To evaluate land area changes in the project area, land/water ratio will be estimated for each project area (Greens Lake terraces, foreshore dike along Sabine Lake, and water control structures at Pines Ridge, Double Island Gully, and Bridge Bayou) from available aerial photography minimum of 1 m^2 resolution collected around years 1 (2008), 5, 10, and 20 post construction. The photography will be processed by National Wetlands Research Center (NWRC) personnel using standard operating procedures through GIS analysis (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, and inferences will be drawn from project area (CS-32) and basin (Calcasieu/Sabine) comparisons.

CS-32 Hydrology

To assess the effectiveness of Greens Lake terraces on decreasing water level variability and salinity, hourly water level and salinity recordings were collected from hydrologic sondes near the Sabine Lake rim (Lake), interior marsh ponds (Reference), and a large, interior open water area around Greens Lake where the CS-32 terrace field was constructed (Terraces). The hydrologic data were grouped over time by a preconstruction time period and four post construction periods (one before Hurricanes Rita and Ike and three after Hurricane Ike); each time period covered one year except the first post construction/pre Hurricane Ike period which was seven months. Time periods were used that had sufficient data from all three locations. The preconstruction time period was collected from project specific sondes that were used for project planning purposes, and the post construction periods were collected from CRMS sites in similar hydrologic settings (Table 1, Figure 1). Reconstruction of CRMS sites following Hurricane Ike was not complete until the summer of 2009. Data were summarized on a daily basis; water level range was calculated for each day, and salinity was averaged for each day; days without 24 hours of data at each site were omitted. The daily data were analyzed with a full-factorial (location × time period) Analysis of Variance (ANOVA). Differences within significant effects were determined with a Tukey's Honest Significant Difference (HSD) post-test.

Table 1. Water level and salinity data were collected hourly from different sets of hydrologic sondes within similar hydrologic settings during preconstruction (project-specific planning stations) and post construction (CRMS stations).

Location	Preconstruction	Post Construction
Sabine Lake Rim (Lake)	CS32-03	CRMS0684
Marsh Reference (Reference)	CS32-06	CRMS0683
CS-32 Terrace Area (Terraces)	CS32-05	CRMS0660
Pines Ridge Weir		PR1R & PR2

To assess the effectiveness of the Pines Ridge weir on decreasing water level variability and salinity, hourly water level and salinity recordings were collected from a pair of sondes (PR1R and PR2) positioned on either side of the weir from September 2012 through January 2014. Hourly water level range and hourly salinity will be compared.

Terrace Condition and Vegetation

The conditions of the natural and planted vegetation on the terraces have been qualitatively assessed by NRCS and USFWS staff during O&M inspections. Field trip reports by Cindy Steyer detailing post Hurricane Rita assessments (October 27, 2005 and April 03, 2006), post Hurricane Ike assessment (February 06, 2009); replacement planting assessment (March 18, 2010), and a terrace assessment (October 06, 2010, October 11, 2012 and September 29, 2014) are summarized, and the full reports are included as Appendix D.

CRMS Supplemental

Additional data are collected at CRMS-*Wetlands* stations which can be used as supporting or contextual information for this project. In addition to project/reference comparisons within the vicinity of project, comparisons to CRMS sites at hydrologic basin and marsh type scales coastwide can also be made. Spatial, vegetative, and hydrologic (surface and porewater) data representing the 1 km^2 area encompassing the CRMS stations were used in this report (Folse et al. 2014).

c. Monitoring Results and Discussion

i. Land Change

Prior to construction, the CS-32 project area lost land at a rate of -0.97% per year from 1932, when the project area was 98.4 % land, through 2004, when the project area was 39.6% land. Most of this historical loss occurred between 1956 and 1973 (Figure 2) and was stimulated by damage from Hurricane Audrey in 1957 (Barras 2009). The land loss was further exacerbated by increased tidal influence (higher water level and salinity fluctuations) into the interior marshes via the installation of interior canals that created hydraulic connectivity with perimeter water bodies including Sabine Lake to the west, the Calcasieu Ship Channel to the east, and Black Bayou to the north (Figure 1). Land change trends over the past 25 years show that CS-32 project area was slowly losing land prior to construction from 1985-2004 (Figure 3). The construction of 127 acres of terraces around Greens Lake resulted in small land gains for CS-32 from 1985-2010 despite hurricanes Rita in 2005 and Ike in 2008 as land change increased by

0.08%/y (Figure 3). During the same periods, the Calcasieu/Sabine (CS) basin was slowly gaining land prior to the hurricanes but lost land from 1985-2010 because of the hurricanes, and the land change rate changed by -0.15% per year (data modified with permission from Couvillion et al. 2011). Although the land loss trend in the time period following the hurricanes (2005-2010) is greater in the project area than in the CS basin, the addition of the terraces buffered the CS-32 project area against net land loss post-construction (Figure 3). A stronger recovery CS basin wide than in the CS-32 project area from 2009-2010 resulted in the difference between loss rates since 2005. Additional time will be helpful for assessing hurricane impacts and recovery.

Land area of the five CS-32 project areas is assessed from a minimum of 1 m2 resolution aerial photography. Land and water was classified by USGS-NWRC from photography acquired in 2008 following construction of project features. The CS-32 project was 33.5 % (2764 acres) land in 2008 (Figure 4). Land change in the project areas will be assessed over time.

Land expansion in the Sabine Lake Rock Dike area (Area 5) will be limited by the rock dike. Much of the area had converted from open water to land between construction in 2005 and the 2015 site inspection. Mud flats have formed and vegetation has been established in fifty percent of the area behind the rock dike except for areas behind the gaps in the rock dike (both ends and two in the middle) which allow for fish and estuarine organisms access to the shoreline (Figure 5). The rock dike did not prevent the breaching of Sabine Lake and Willow Bayou; however, subsequent mud flat formation and vegetation in the vicinity of the breach behind the rock dike is expected to diminish hydrologic exchange between the two water bodies.

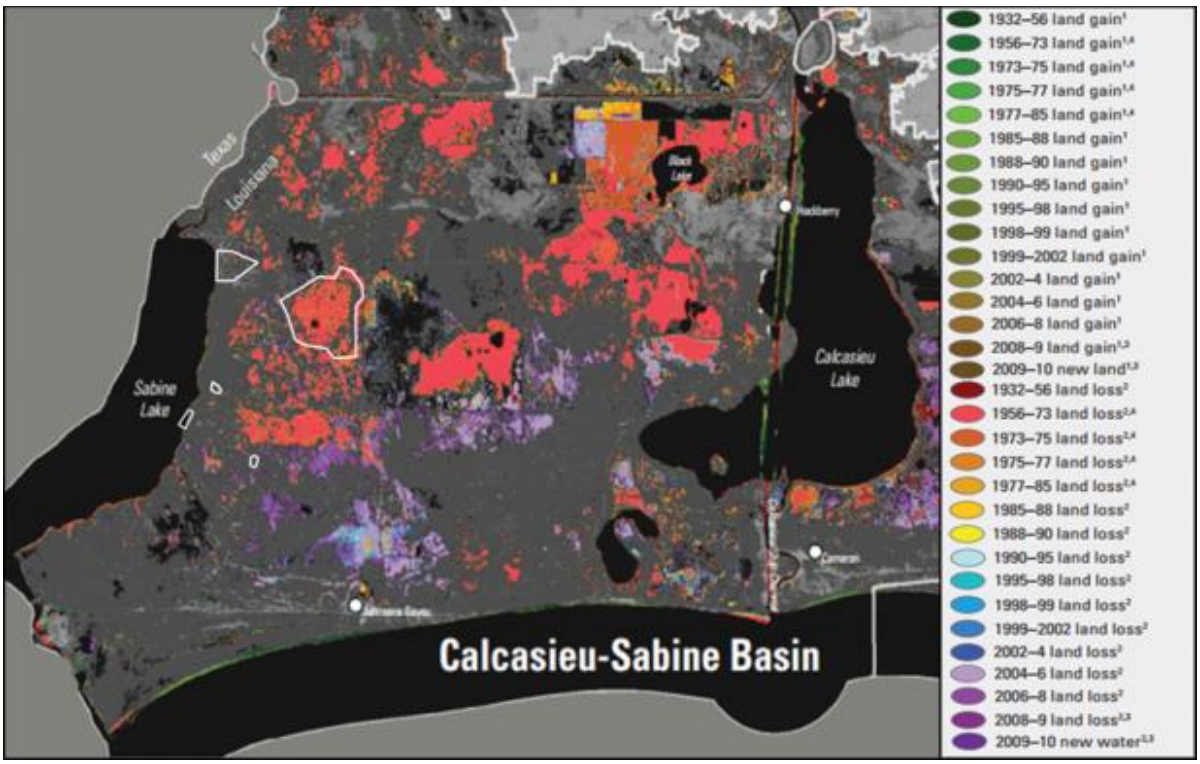


Figure 2. Land change in the Calcasieu/Sabine basin 1932-2010 (adapted from Barras 2009).

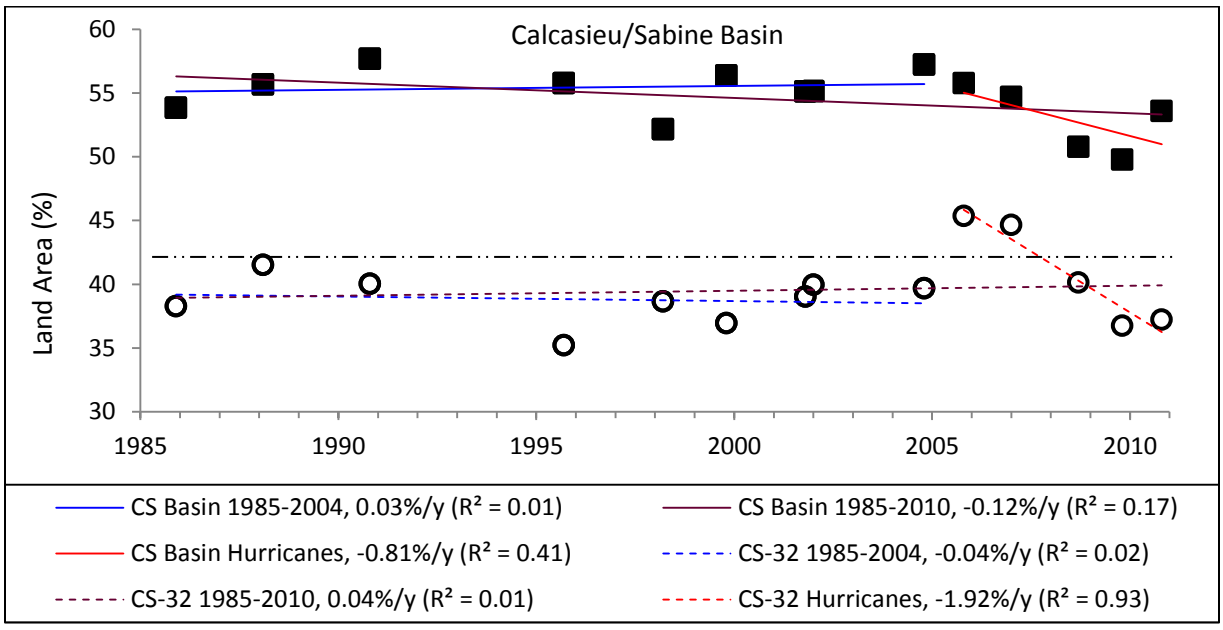


Figure 3. Land area (%) was analyzed over 25 years (1985-2010) from satellite imagery for the Calcasieu/Sabine (CS) basin (solid lines) and the CS-32 project area (dashed lines). The trend lines represent the linear rate of land change (% land/y) prior to CS-32 construction and the hurricanes (1985-2004; blue lines), including CS-32 construction and hurricanes Rita in 2005 and Ike in 2008 (1985-2010; purple lines), and effects of the hurricanes (2005-2010; red lines). Positive land change rates indicate land gain whereas negative rates indicate land loss. The CS basin data was modified with permission from Couvillion et al. 2011.

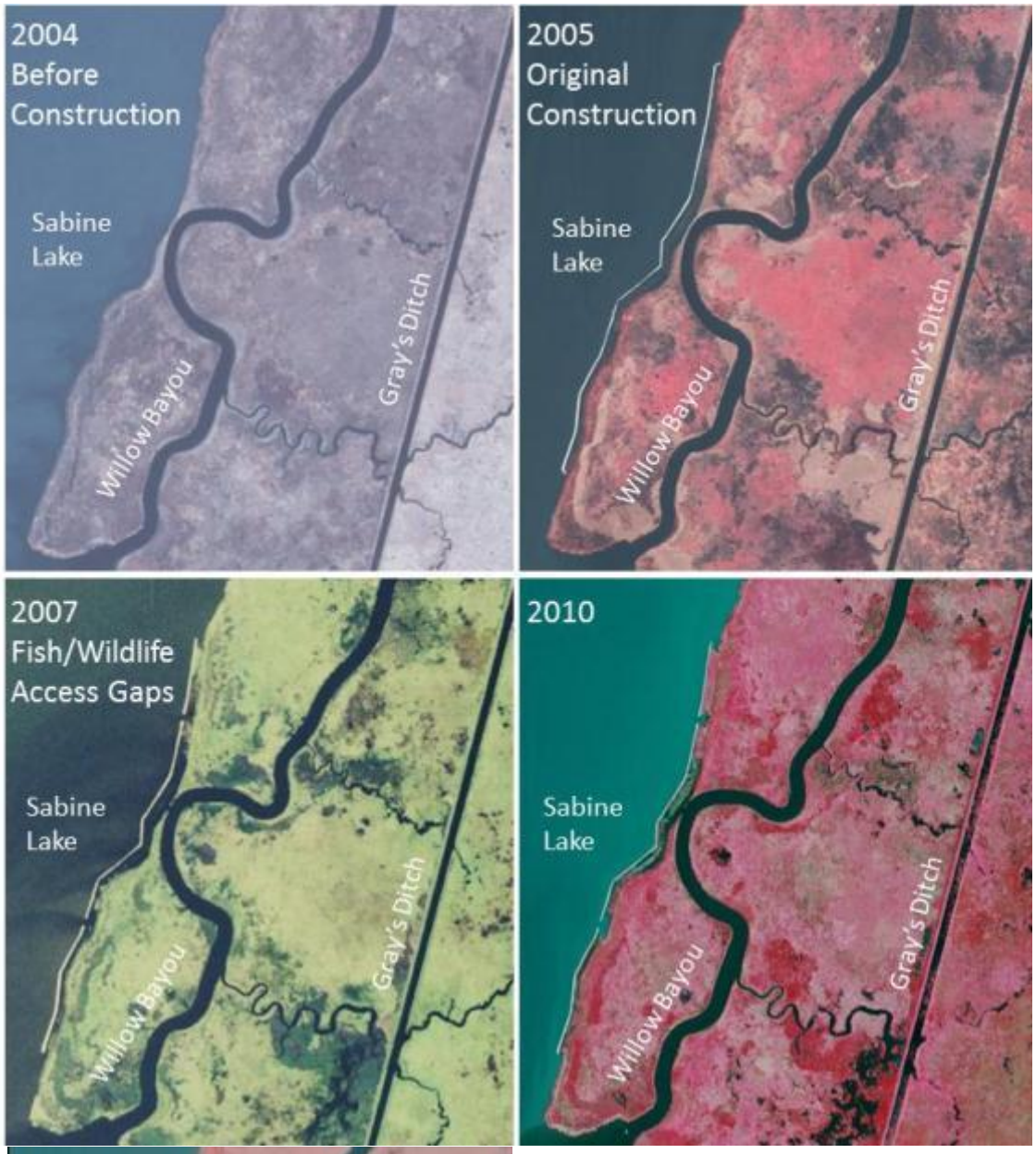


Figure 5. Sabine Lake rock dike near Willow Bayou before construction in 2004 and after construction in 2005 (full rock dike), 2007 (gapped rock dike), and 2010 (vegetation and mud flat expansion). Note thin strip of land between Sabine Lake and Willow Bayou in 2004 and 2005 and subsequent breach in 2007, 2010 and 2012. Also note the conversion of open water to land over time and vegetation growth behind rocks in 2012.

Hydrology

Water level variability decreased in the Greens Lake area after construction of the terrace field. The statistical model was robust (adjusted $R^2 = 0.73$) and significant ($F_{1,4} = 887$; $p < 0.0001$), and the location × time period interaction was significantly different ($F_8 = 31$; $p < 0.0001$). Water level ranges around Greens Lake decreased by -0.38 ft following construction of the terraces (Figure 6). During the preconstruction period, the water level range in the area around Greens Lake was 2.5 times more variable than the reference interior marsh area. Water level variability (standard deviation) decreased by 221% after the terraces were constructed. Water level ranges in the reference interior marsh site were similar over all the time periods and were typically about -0.6 ft less than Sabine Lake. Post construction water level variability in the Greens Lake area was similar to the interior marsh reference area.

The terraces in open water surrounding Greens Lake did not substantially affect mean salinity relative to other locations. The statistical model was robust (adjusted $R^2 = 0.74$) and significant ($F_{1,4} = 887$; $p < 0.0001$), and the location × time period interaction was significantly different (F8 = 32; $p < 0.001$). At all locations, salinity increased over the time periods and was highest during the drought in 2010/2011(Postconstruction 3 09/2010-08/2011). Salinity decreased during Postconstruction 4 (09-2013 – 08/2014) which was a rainy period. Salinity was consistently highest in the lake and about the same in the reference and terrace areas (Figure 7).

The Pines Ridge weir was effective in decreasing water level variability by slowing and decreasing the tidal amplitude behind the weirs at station PR2. The tidal amplitude was affected the most when water levels were below -0.5 (ft) due to the raised elevation of the rocks and the depth of water at PR2 being shallower than at PR1R (Figure 8). The rock weir had little effect on salinities but did slightly decrease salinities for short periods when salinities were greater than 12 ppt near Sabine Lake (Figure 9).

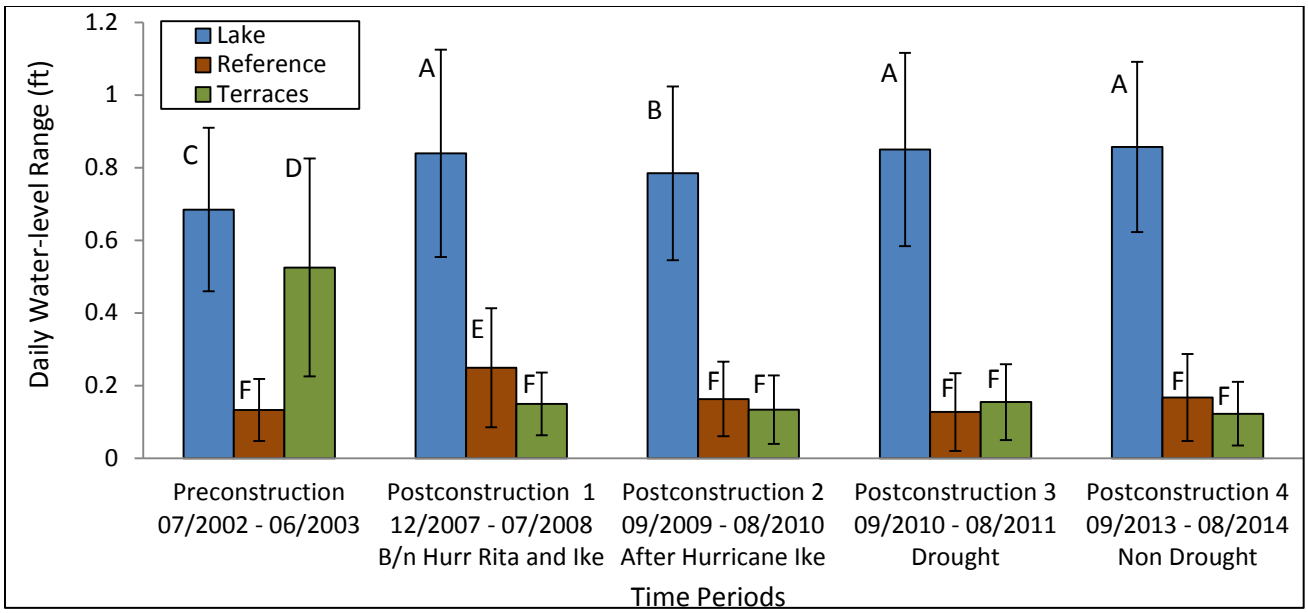


Figure 6. Water level ranges were collected from the west Sabine Lake rim (Lake), a reference interior marsh (Reference), and the CS-32 terrace field around Greens Lake (Terraces) over different time periods (one preconstruction and three postconstruction time periods). The values are mean + 1 standard deviation of daily water level range for each location and time period combination. The columns with separate letters are significantly different as determined by a Tukey's Honest Significant Difference post-test of least square means and standard errors.

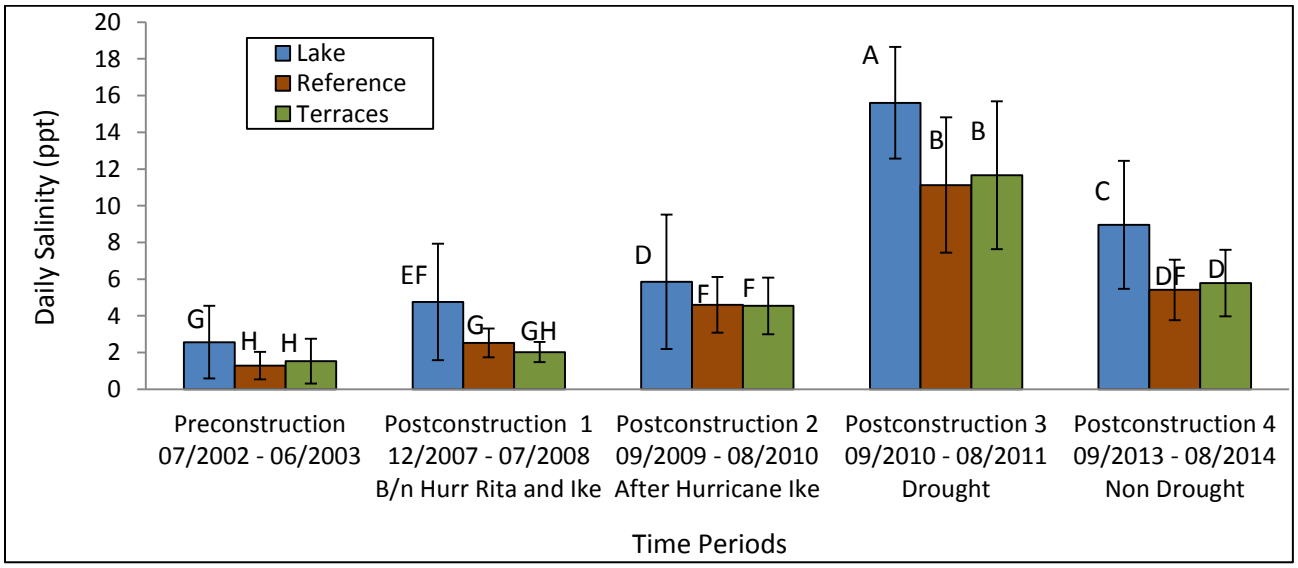


Figure 7. Salinity was collected from the west Sabine Lake rim (Lake), a reference interior marsh (Reference), and the CS-32 terrace field around Greens Lake (Terraces) over different time periods (one preconstruction and three postconstruction time periods). The values are mean + 1 standard deviation of daily salinity for each location and time period combination; columns with a different letter are significantly different as determined by a Tukey's Honest Significant Difference post-test of least square means and standard errors.

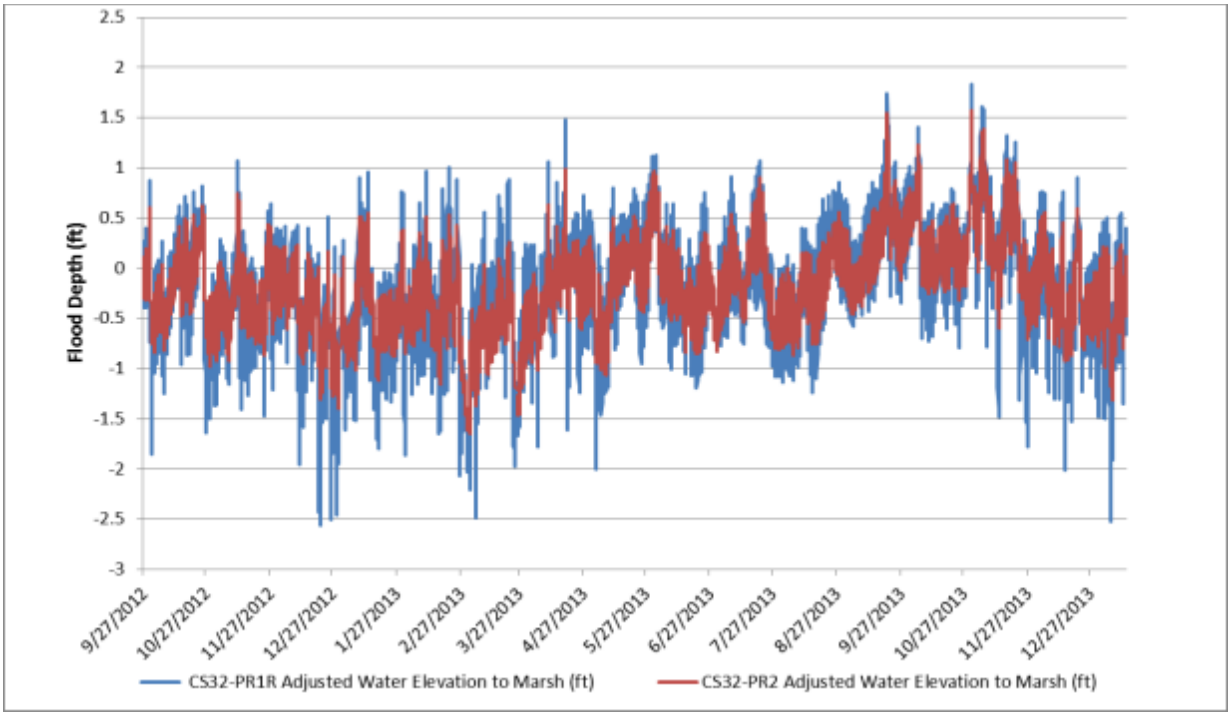


Figure 8. Hourly Adjusted water level data collected from September 2012 to January 2014 showing water level variability at the Pines Ridge weir. (Station PR1R is located outside of the weir near Sabine Lake and station PR2 is located behind the rock weir.)

Figure 9. Hourly adjusted salinity data collected from September 2012 to January 2014 showing salinity variability at the Pines Ridge weir. (Station PR1R is located outside of the weir near Sabine Lake and station PR2 is located behind the rock weir.)

ii. Terrace Condition and Vegetation

The terraces were constructed in two phases; the originally planned terraces (CU-1) were constructed from 2005-2006, and an additional section of terraces (CU-1A) were constructed from 2008-2009. Construction progressed from the south to north for each group (CU-1 and CU-1A). 'Vermilion' smooth cordgrass was planted along the toe of all sides within fifteen days after construction of each 1,000 linear feet of terrace. Construction was interrupted by hurricanes during both phases of construction. Monitoring of the terraces was performed during annual inspections in 2005, 2006, 2009, 2010, 2011, 2012 and 2014.

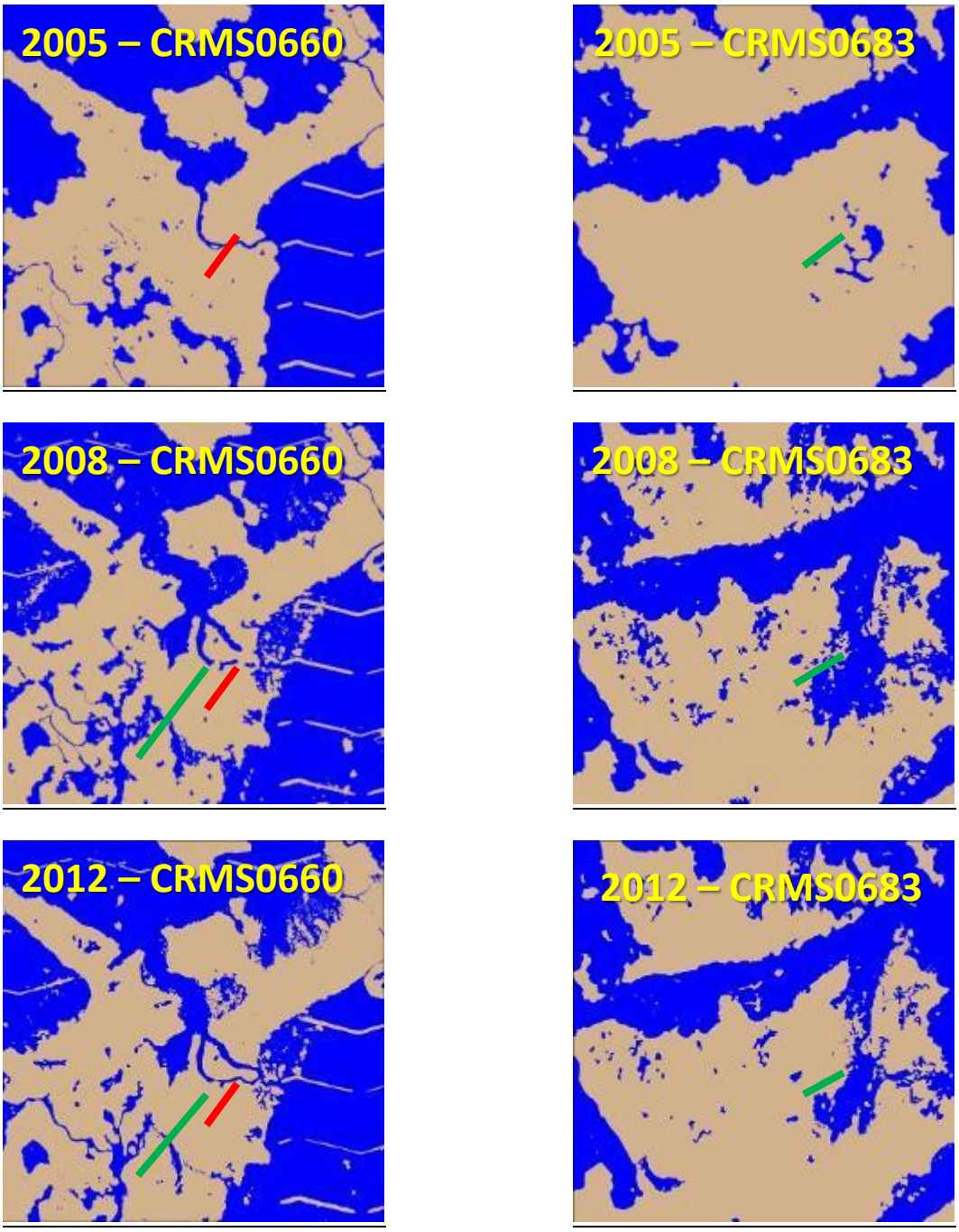
After Hurricane Rita the newer northernmost terraces in CU-1 experienced severe loss of the vegetative plantings and the plantings were replaced in 2007. Hurricane Ike then caused a vegetative planting loss of 77% in the CU-1A area. The CU-1A plantings were replaced in 2009. The replacement plantings in both CTU's were brown and thinning in 2010 due to drought conditions in early 2009 followed by an unusually cold winter in 2009/2010. When weather and water conditions returned to normal in 2011/2012 the vegetative plantings began to recover and were in good condition. In 2014 the vegetative plantings began to spread out from the terraces and were considered healthy and in good condition although the hurricane damage was evident at many points along the terraces where segments were significantly more narrow and/or lower in elevation than the constructed dimensions. (see Appendix D for complete field trip reports).

iii. CRMS Supplemental

The Coastwide Reference Monitoring System – Wetlands (CRMS) is a large repository of monitoring information at the CRMS site and CWPPRA project levels covering a variety of spatial scales. The following data and graphics are all available through the CRMS website (http://lacoast.gov/crms_viewer/).

Spatial

Land and water classifications of 2005, 2008 and 2012 aerial photography (1:40,000 resolution) were performed on the 1 km^2 (247 acre) area encompassing CRMS sites by the USGS-National Wetlands Research Center. CRMS0660 is within the CS-32 terrace field; the broader CU-1 terraces, constructed in 2005, are in the southeast corner of both frames, and the narrower CU-1A terraces, constructed in 2008, are along the north and northeast of the 2008 and 2012 frames (Figure 10). Hurricane Ike had a marked effect on the sites; marsh was displaced by the storm surge and either removed from the area, deposited elsewhere on previously existing marsh, or deposited in the open water. CRMS0660 (project site), which added land from 2005 to 2008 and again from 2008 to 2012, had more open water for marsh to be displaced into than CRMS0683 (reference site), which lost land from 2005 to 2008. CRMS0683 had a 9% land increase from 2008 to 2012 due to the shallow interior ponds becoming filled with vegetation. Also, the terraces may have created a lower energy environment that allowed the displaced marsh to settle and establish in the shallow open water.



Land	2005 % (ac)	2008 % (ac)	2012 % (ac)	2005-2012 % (ac)
CRMS0660	47 (117)	48 (120)	52 (129)	+5.4 (+12.3)
CRMS0683	72 (177)	60 (147)	69 (158)	-3.4 (-19.6)

Figure 10. Land and water were classified from 2005, 2008 and 2012 aerial photography (1:40,000 resolution) by the USGS-National Wetlands Research Center for CRMS0660 (project) and CRMS0683 (reference). The aerial photography was collected post hurricane in 2005 (Hurricane Rita), 2008 (Hurricane Ike) and 2012 post construction.. The original transect at CRMS0660 (red line) was scoured by Hurricane Ike in 2008 relocated to its current location (green line). Sufficient land remained at CRMS0683 to continue using the vegetation transect

Vegetation

The vegetative community composition within the CS-32 project area has vacillated between being predominantly intermediate and brackish from 1949-2007 (Table 3) as has the western Calcasieu-Sabine (CS) basin. Since 2006, vegetation composition and cover has been estimated at CRMS sites from 10 stations (4 m^2) randomly distributed along a vegetated transect. Individual species' cover data and quality were summarized according to the Floristic Quality Index (FQI) method (Cretini and Steyer 2011); the quality score is based on whether the species is typical for a disturbed area (low score) or of mature vegetation (higher score) for a vegetation type. Averaged CRMS sites within the vicinity of the CS-32 project area have had lower floristic quality than other CWPPRA project sites and reference sites within intermediate and brackish marsh of the CS Basin, but they have an average distribution (between the 25th and 75th percentile) relative to sites coastwide (figure 11). Sites in the vicinity of the CS-32 project area were recovering from Hurricane Rita in 2005 when Hurricane Ike impacted them in 2008. Although the vegetation was negatively impacted by Hurricane Ike and a subsequent drought in the first half of 2009, vegetation at the CRMS sites recovered by 2011 (Figures 12 and 13). The hurricane effect was especially evident at CRMS0660, the only site within project boundaries (CS-32 terraces), as the FQI dropped to 0 in 2009 because the plots were completely scoured away; a new vegetation transect was established in adjacent marsh in 2011 (Figures 12, 13, and 10). CRMS0660 is classified as an intermediate marsh; the shift in vegetative composition and percent coverage (Figure 14) resulted from recovery since Hurricane Ike (as occurred at the other sites) and/or changing the sampling location (Figure 10). CRMS0683 and CRMS2189 are intermediate and brackish marsh sites, respectively, outside of the CS-32 project boundaries. The intermediate reference shifted species composition to more salt tolerant vegetation in 2011 as *Spartina patens* (marsh hay) and *Distichlis spicata* (salt grass) increased in coverage (Figure 13).

Table 3. Vegetation classifications of the East Sabine Lake Hydrologic Restoration (CS-32) project area from historical surveys. Vegetation Class "Other" includes water, swamp, and developed land. The data was obtained from the Coastwide Reference Monitoring System (CRMS) website (http://www.lacoast.gov/crms_viewer/) on August 04, 2013.

	Vegetation Classification - % area (acres)			
Year	Fresh	Intermediate	Brackish	Source
1949	---	86.6 (7142)	13.4 (1106)	O'Neil 1949
1968	---	46.7 (3851)	53.3 (4397)	Chabreck et al. 1968
1978	0.1 (6)	75.3 (6210)	24.6 (2032)	Chabreck and Linscombe 1978
1988	0.3 (27)	---	99.7 (8221)	Chabreck and Linscombe 1988
1997	---	99.1 (8175)	0.9 (73)	Chabreck and Linscombe 1997
2001	---	94.5 (7798)	5.5 (450)	Linscombe and Chabreck n.d.
2007	---	88.7 (7315)	11.3 (933)	Sasser et al. 2008
2013		83.9 (6833)	16.1 (1307)	Sasser et al. 2014

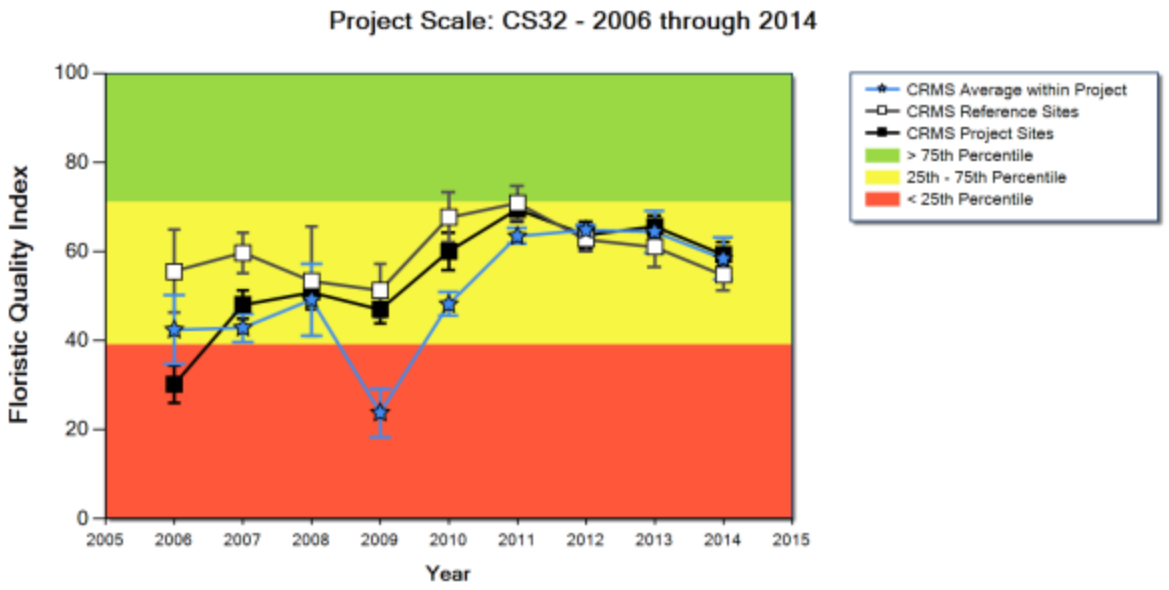


Figure 11. Floristic Quality Index scores of CRMS sites averaged within the vicinity of CS-32 are shown over time relative to all other CRMS sites (Reference and CWPPPA Projects) within intermediate and brackish marsh of the Calcasieu/Sabine hydrologic basin. The green, yellow, and red background represents the coastwide distribution of all CRMS site since 2006.

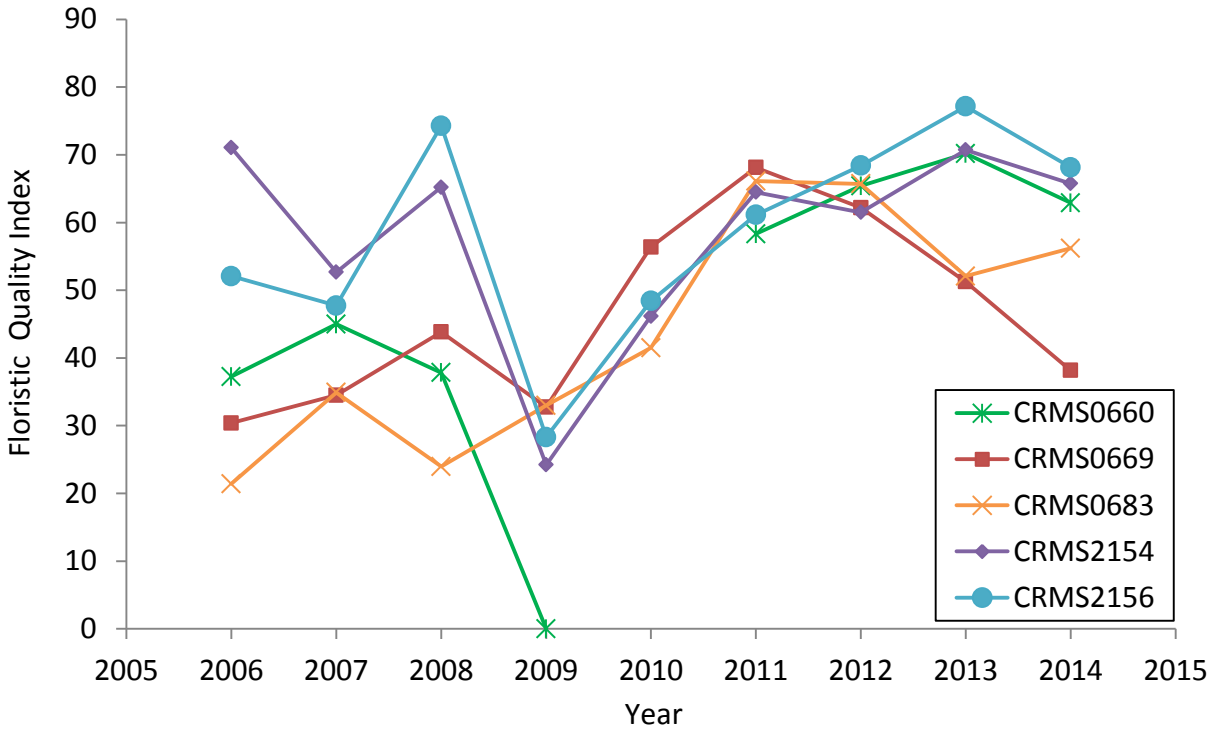


Figure 12. Floristic Quality Index scores for the CRMS sites within the vicinity of the CS-32 project area are shown over time. The CRMS0660 vegetation stations, the only stations within the project area (terraces), were scoured away during Hurricane Ike after the 2008 sampling (note 0 for 2009); new stations were established in 2011 after giving time for potential recovery.

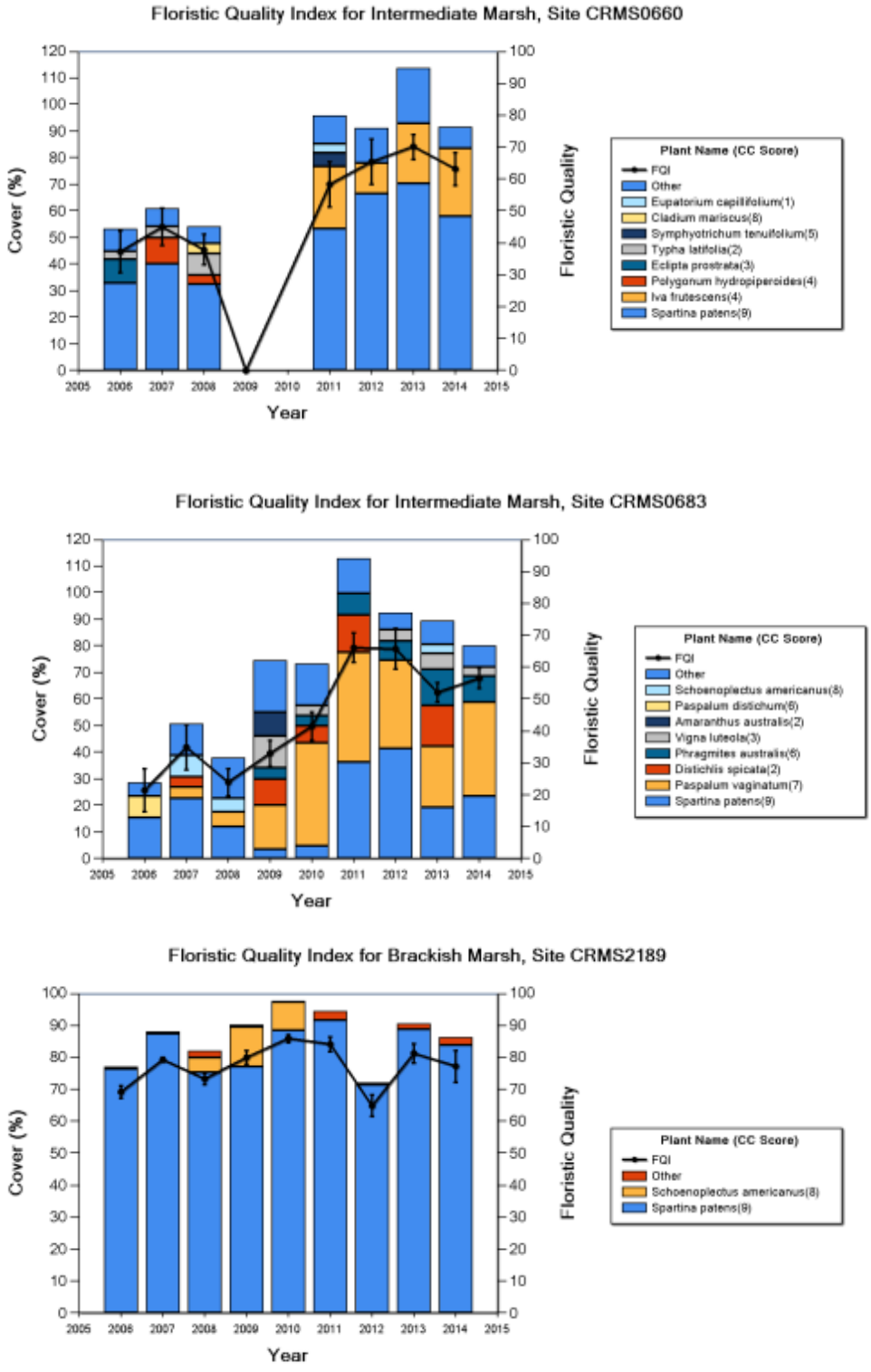


Figure13. Species composition, total percent cover, and the floristic quality index (FQI) of vegetation observed at CRMS0660 (CS-32 terrace, intermediate marsh), CRMS0683 (intermediate marsh reference), and CRMS2189 (brackish marsh reference). The original CRMS0660 vegetation stations were scoured away during Hurricane Ike prior to the 2009 sampling, and new stations were established in 2011 after giving time for potential recovery.

Hydrology

Hydrologic data has been collected on an hourly basis at CRMS sites in the vicinity of the CS-32 project area since November 2006 During this time, the hydrology of the area in western Calcasieu/Sabine hydrologic basin (CS basin) has been largely affected by climatological events, Hurricane Ike and drought (Figure 14). After settling into seasonal water level patterns and lower salinities following Hurricane Rita in 2005, Hurricane Ike ushered in another large storm surge with the associated inundation of salty water in September 2008. After salinities returned to pre Hurricane Ike concentrations (< 5 ppt) aided by a large rain event in September 2009 that increased water levels while decreasing salinity, a drought lasting over 1.5 years lowered water levels and increased salinities to beyond 20 ppt during the summer of 2011 at most of the CRMS stations. The drought lasted from 5/22/2010 to 01/07/2012; based on the Palmer Drought Severity Index, the drought typically fluctuated between moderate and severe and reached extreme drought conditions during most of the summer of 2011 (5/7/2011 to 8/27/2011) (NOAA-NWS Climate Prediction Center n.d.). In 2013 (1/12/13 to 3/6/13) rainfall accumulations contributed to moist to very moist indexes which ended the drought conditions. The 2012 and 2014 indexes were near normal throughout the year.

As with many areas in the CS basin, Hurricane Ike and the drought drove the hydrology at CRMS0660. Along with hourly water level and salinity data collected from surface water, porewater salinity at 10 cm is collected when continuous sondes are serviced which is approximately monthly. Surface water and soil porewater salinity decrease (~6 ppt to ~3 ppt) over the 2.5 years before Hurricane Ike following the Hurricane Rita storm surge (Figure 15 a). Following Hurricane Ike, elevated soil porewater salinity was less likely to change than surface water as porewater salinity only slightly decreased following the September 2009 rain event and did not increase as much during the drought (Figure 15 b). The prolonged period of elevated porewater salinity may have caused the shift to more salt tolerant plant species at CRMS0660 and CRMS0683 in 2011(Figure 13). A return to near normal and moist indexes from 2012 to 2014 have allowed for the salinities and water levels to return to normal conditions and also allowed the porewater salinities to remain below 10 ppt (Figure 14 and 15).

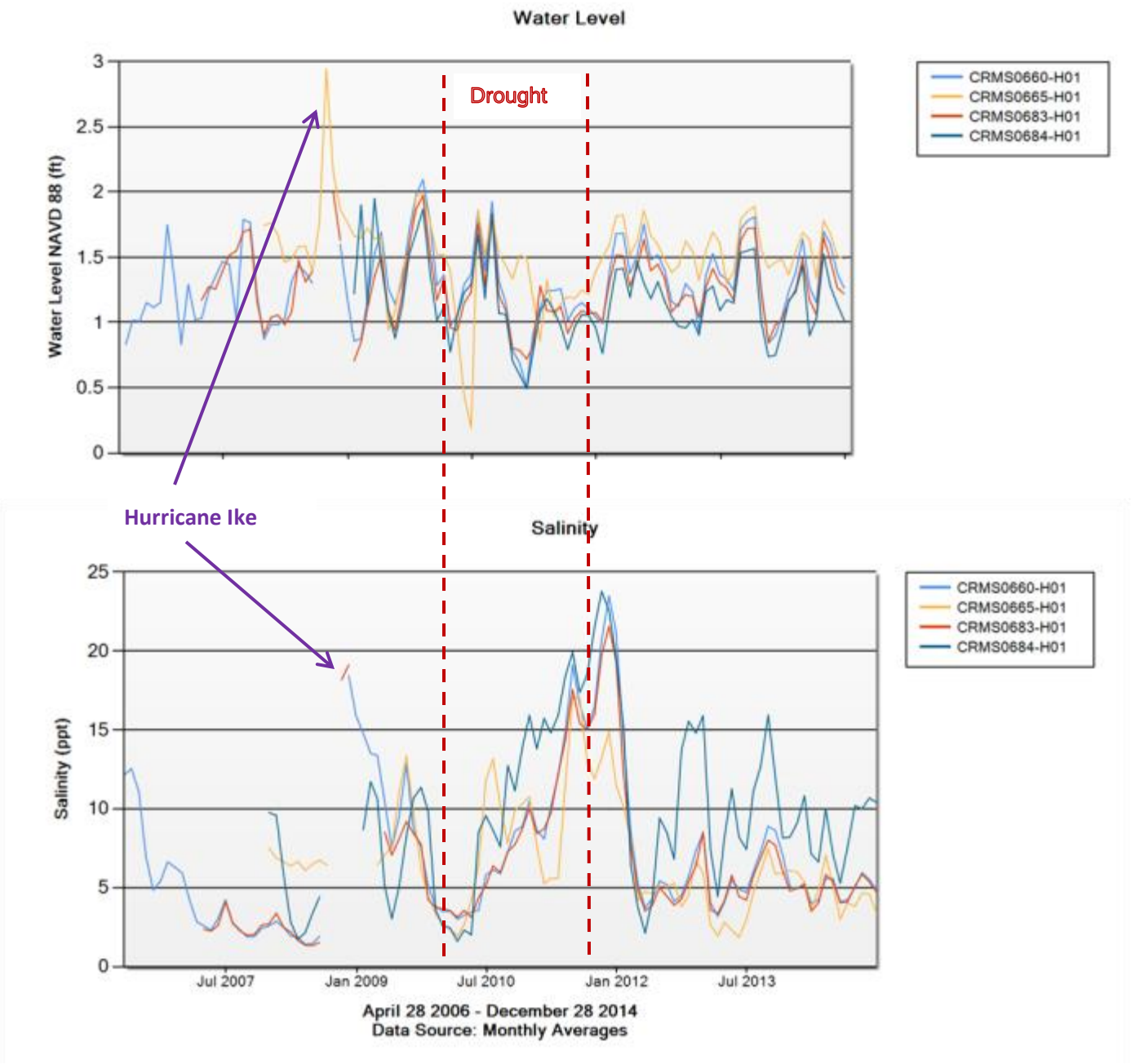


Figure 14. Surface water level (top) and salinity (bottom) data collected at CRMS sites within the vicinity of CS-32; CRMS0660 is within the CS-32 terrace area whereas all other CRMS sites are outside. The average marsh elevation from the CRMS sites (1.1 ft, NAVD88) is represented by the green, level line in the water level graph. Hurricane Ike made landfall on September 13, 2008. A continuous drought spanned from May 2010 – January 2011. http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml

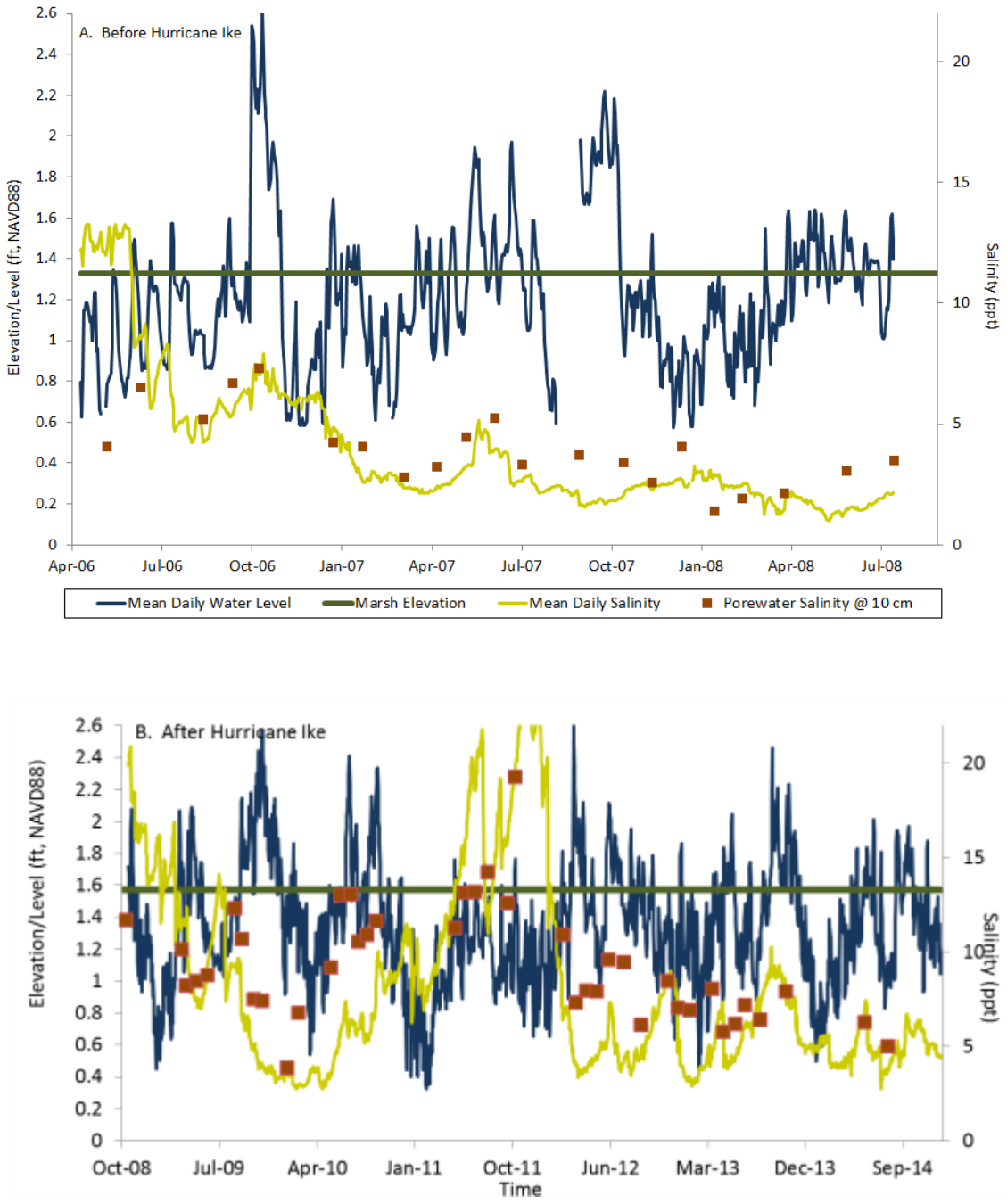


Figure 15. Hydrologic data (surface water level and salinity) and porewater salinity was collected from the CS-32 terrace area (CRMS0660) from April 26, 2006 through September 30, 2014. Note that marsh elevation was adjusted when the marsh sampling stations were re-established following Hurricane Ike.

V. Conclusions

a. Project Effectiveness

The CS-32 project has progressed towards most project goals.

The terraces in and around Greens Lake effectively reduced water level variability but had no effect on salinity. The Pines Ridge weir effectively decreased water level variability but not salinity.

The 3,000 ft rock dike along the Sabine Lake shoreline west of Willow Bayou effectively stopped erosion and allowed for land building.

The terraces installed around Greens Lake added approximately 127 acres (47.3 ha) of emergent marsh in shallow open water areas. The addition of terraces has slightly increased land gains around the terrace field from 2005 through 2012; however, the project area, along with the rest of the CS basin, has been significantly losing land since Hurricanes Rita and Ike which occurred during the project construction.

b. Maintenance Recommendations

Direct measurements from the rock dike to the vegetated shoreline would be useful to track vegetation growth behind the rock dike.

Adding additional vegetative plantings and/or terraces to the scoured areas south/southwest of the existing terrace field would be helpful in repairing these areas more rapidly.

c. Lessons Learned

The addition of terraces to open water areas can reduce water level variability within the terraced area.

The timing of vegetative planting on terraces is critical. Successive high salinity events and long periods of inundation and drought are stressful to newly planted vegetation.

Plantings will recover over time and will flourish when conditions become favorable.

VI. References

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Appendix A
Inspection Photographs

Photo No.1 –Northern Section of Terraces – Variety of Vegetation

Photo No. 2 –Northern Section of Terraces - Expansion

Photo No. 3 – Some Narrowing of Terraces Going South

Photo No. 4 – Southern Terraces

Photo No. 5 – Southern Terraces

Photo No. 6 – South End of Sabine Lake Foreshore Rock Dike

Photo No. 7 – Sabine Lake Foreshore Rock Dike, South of Southern Warning Sign

Photo No. 8– Sabine Lake Foreshore Rock Dike, Low area of Rock

Photo No. 9– Sabine Lake Foreshore Rock Dike, Low area of Rock

Photo No. 10– Sabine Lake Foreshore Rock Dike, Low area at Willow Bayou bend (looking south)

Photo No. 11– Sabine Lake Foreshore Rock Dike, Low area at Willow Bayou bend (Same Location as Photo 10)

Photo No. 12– Sabine Lake Foreshore Rock Dike, near North Warning Sign

Photo No. 13– Sabine Lake Foreshore Rock Dike, North End

Photo No. 14– Pines Ridge Weir, From outside

Photo No. 15– Pines Ridge Weir, East bank of weir

Appendix B
Three Year Budget Projection

EAST SABINE LAKE HR/ CS-32 / PPL 10

Three-Year Operations & Maintenance Budgets 07/01/2014 - 06/30/2017

Project Manager	O & M Manager	Federal Sponsor	Prepared By
Pat Landry	*Jody White*	*USFWS*	*Jody White*

	2015/2016 (-6)	2016/2017 (-7)	2017/2018 (-8)
Maintenance Inspection	$ 6,851.00	$ 7,057.00	$ 7,269.00
Structure Operation			
State Administration		$ -	$ -
Federal Administration		$ -	$ -
Maintenance/Rehabilitation			

15/16 Description:

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

16/17 Description

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

17/18 Description:

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

	2015/2016 (-6)	2016/2017 (-7)	2017/2018 (-8)
Total O&M Budgets	**$ 6,851.00**	**$ 7,057.00**	**$ 7,269.00**

O &M Budget (3 yr Total)	**$ 21,177.00**
Unexpended O & M Budget	**$ 230,129.00**
Remaining O & M Budget (Projected)	**$ 208,952.00**

OPERATION AND MAINTENANCE BUDGET WORKSHEET

EAST SABINE HYDROLOGIC RESTORATION PROJECT / PROJECT NO. CS-32 / PPL NO. 10 / 2015/2016

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/ Navigational Aid Inspec.	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:	Add staff gage.				
	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	
Rock Rip rap	0	0.0	0	$0.00	$0.00
Aggregate Surface Course	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		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**

OPERATION AND MAINTENANCE BUDGET WORKSHEET

EAST SABINE HYDROLOGIC RESTORATION PROJECT / PROJECT NO. CS-32 / PPL NO. 10 / 2016-2017

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$7,057.00	**$7,057.00**
General Structure Maintenance	LUMP	0	$0.00	**$0.00**
Engineering and Design	LUMP	0	$0.00	**$0.00**
Operations Contract/ Navigational Aid Inspec.	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	
Rock Rip rap	0	0.0	0	$0.00	$0.00
Aggregate Surface Course	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		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: **$7,057.00**

OPERATION AND MAINTENANCE BUDGET WORKSHEET

EAST SABINE HYDROLOGIC RESTORATION PROJECT / PROJECT NO. CS-32 / PPL NO. 10 / 2017-2018

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$7,269.00	**$7,269.00**
General Structure Maintenance	LUMP	0	$0.00	**$0.00**
Engineering and Design	LUMP	0	$0.00	**$0.00**
Operations Contract/ Navigational Aid Inspec.	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	
Rock Rip rap	0	0.0	0	$0.00	$0.00
Aggregate Surface Course	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		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: **$7,269.00**

Appendix C
Field Inspection Notes

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name:CS-32 East Sabine Lake HR

Date of Inspection: 05-19-2015 Structures Time: 11:00 am

Inspector(s): Jody White and Mike Miller (CPRA)
Dale Garber and Brandon Samson (NRCS)
Darryl Clark and Billy Leonard (USFWS)

Structure No.

Structure Description: Rock Dike, Culverts, Rock Weir, & Rock Plug

Water Level Inside: Outside: 2.3ft
Salinity: 0.3ppt

Type of Inspection: Annual

Weather Conditions: Cloudy and Mild

Item	Condition	Physical Damage	Corrosion	Photo #	Observations and Remarks
Foreshore Rock Dike	Good			6-13	The rock dike is functioning as intended. There are low areas identified along the dike between the south warning sign and the Willow Bayou Bend which will continue to be monitored. Temporary refuge signs will be installed in the vicinity of Willow Bayou to mark the low area of rock.
Pines Ridge Weir/ Warning Sign	Good			14-15	The weir is in tact. The water elevation was approximately a foot above normal at the time of the inspection. Little rock was visible above the water line on the East Bank. Probing showed the center of the weir to be at approximately 3.5ft depth. The warning sign was struck by something but still in place.
Hardware					
Staff Gauge at Pine Ridge	Good				Still legible
Double Island Gully Plug	N/A				The plug location wasn't visited during this inspection. The Drainage District has requested to install a control structure at this location which they will operate.
Signage /Supports	Good				The warning signs along the foreshore rock dike in Sabine Lake were intact.
Bridge Bayou Culverts	N/A				The culverts were not visite during this inspection.

What are the conditions of the existing levees? N/A
Are there any noticeable breaches? N/A
Settlement of rock plugs and rock weirs? No
Position of stoplogs at the time of the inspection? N/A
Are there any signs of vandalism? No

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name:CS-32 East Sabine Lake HR

Structure No.

Structure Description: Terraces

Type of Inspection: Annual

Date of Inspection: 09-29-2014 Terrace Field Time: 11:20 am
Inspector(s): Jody White and Mike Miller (CPRA)
Dale Garber and Brandon Samson (NRCS)
Darryl Clark and Billy Leonard (USFWS)
Water Level Inside: Outside:
Salinity range: 6.2ppt South to 8.1ppt North
Weather Conditions: Partly Cloudy and Mild

Item	Condition	Physical Damage	Corrosion	Photo #	Observations and Remarks
Earthen Terraces	Good				Vegetation was well established on the northern terraces with a variety of smooth cordgrass, roseau cane, baccharis, iva, and cattails. The cordgrass spread out beyond the terrace width. There were approximately 5%-7% bare areas. The terraces widths narrowed as traveling south due to wave action.

What are the conditions of the existing levees? N/A
Are there any noticeable breaches? N/A
Settlement of rock plugs and rock weirs? N/A
Position of stoplogs at the time of the inspection? N/A
Are there any signs of vandalism? No

Appendix D
Field Inspection Notes

TRIP REPORT

To: Brad Sticker, CE, NRCS, Alexandria

From: Cindy Steyer, CVS, NRCS, Baton Rouge

Date: May 24, 2006

Subject: East Sabine Lake Hydrologic Restoration Project (CS-32)
Post-Hurricane Damage Assessment of Terrace Vegetation
October 27, 2005 and April 3, 2006

Attending Agencies: Louisiana Department of Natural Resources, CED and CRD
US Fish and Wildlife Service
USDA Natural Resources Conservation Service

The CS-32 East Sabine Hydrologic Restoration Project lies east of Sabine Lake in Cameron Parish, Louisiana. The project area lies within brackish marsh habitat where average monthly water salinity ranges from 3 to 8 ppt throughout the year. This report summarizes an investigation of hurricane damage to the vegetated terrace component of this project (Figure 1). In May 2005, terrace construction commenced at the southernmost row of terrace sections and proceeded to the north (Figure 2). The earthen terraces were planted with 'Vermilion' smooth cordgrass (*Spartina alterniflora* var. Vermilion), at the toe on all sides within fifteen days after construction of each 1,000 linear feet of terrace. Construction of this component was interrupted in August 2005 by Hurricanes Katrina and Rita that impacted Louisiana's coastal area. Due to the order of construction, the oldest and more well-established transplants were on the southern terraces, and the most recent transplants were on the northernmost terrace segments. Approximately 54% of the total contracted linear footage of terrace segments was constructed and planted by the contractor and was inspected and considered completed by the NRCS Contracting Officer's Technical Representative (COTR) . The project area was severely impacted by excessive flooding from the storm surge associated with Hurricane Rita which made landfall to the immediate east. Following the storm, the project area remained inundated with highly saline water for some period, and since the hurricane until present, there has been little rainfall resulting in highly saline soil conditions.

Vermilion' smooth cordgrass is very salt tolerant and naturally occurs in the intertidal zones (approx. between mean high and mean low water) of brackish and saline wetland habitats. Nevertheless, a significant abrupt increase in salinity and prolonged elevation of water levels can severely impact smooth cordgrass plants, causing die-back of plant portions or complete mortality. Specific effects are influenced by degree and duration of the increase in water salinity, depth and duration of flooding, temperature, season, and condition of the plants (for example, recently planted vs. established).

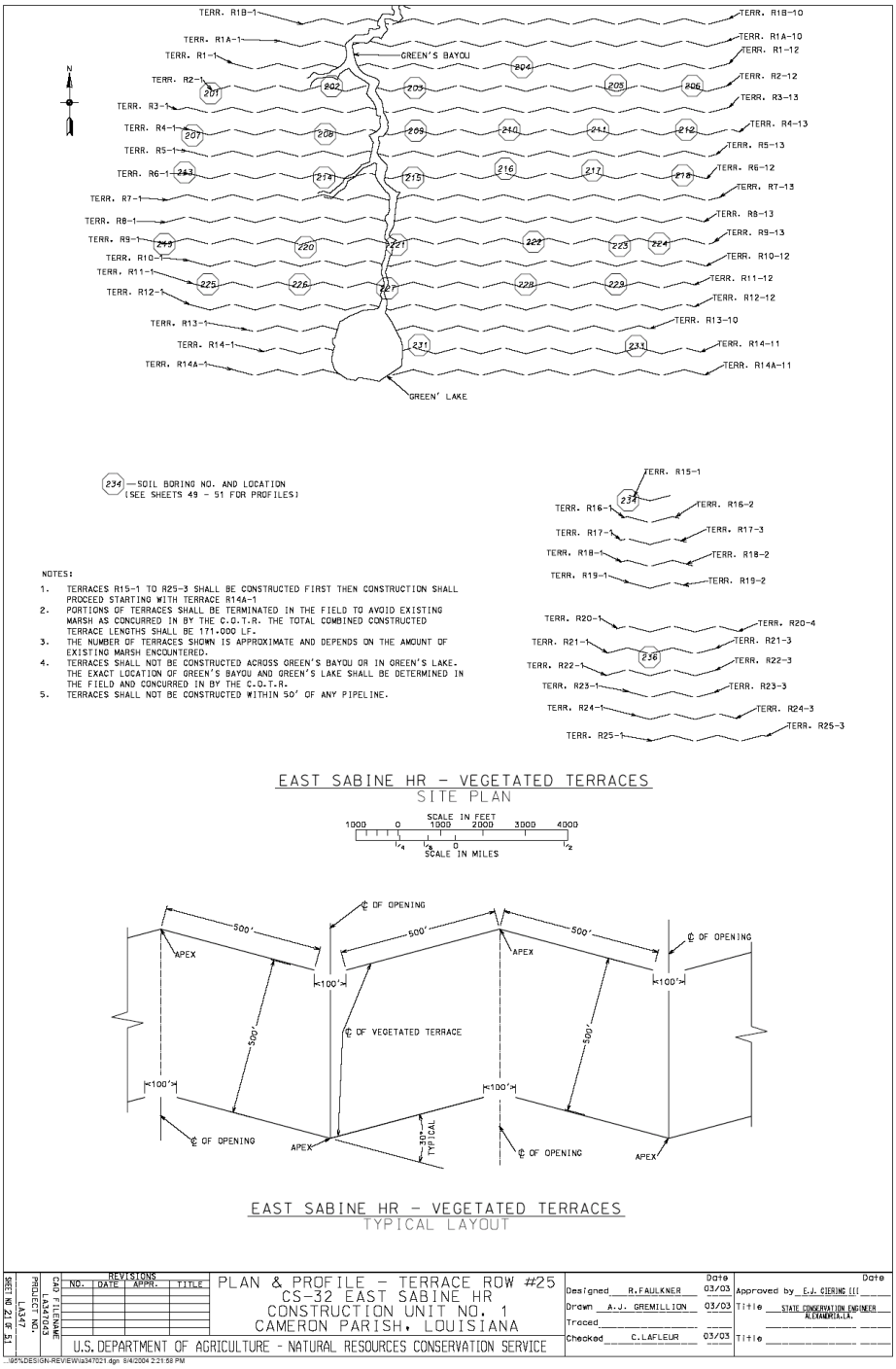


Figure 1. CS-32 East Sabine Project Earthen Terrace

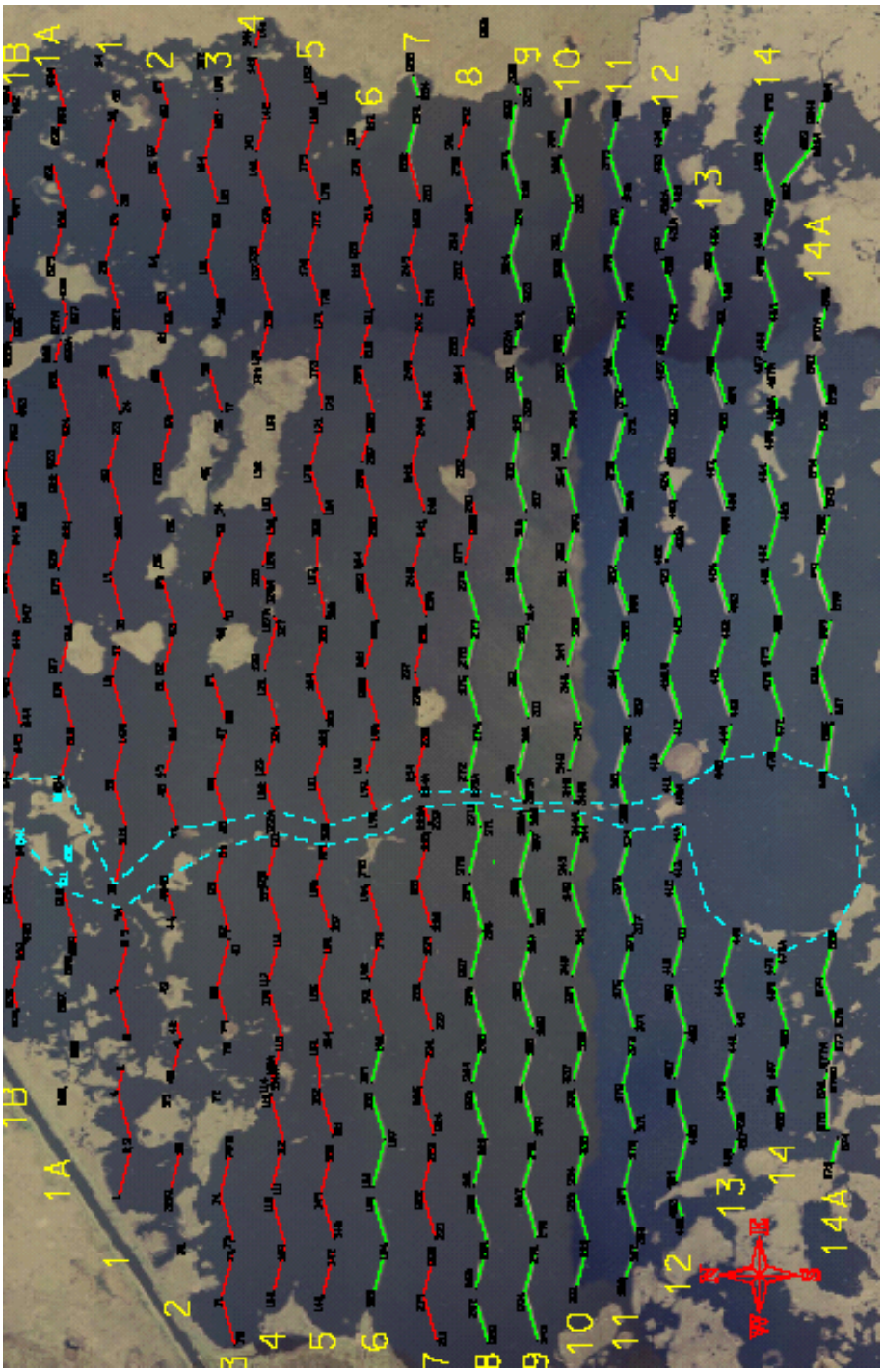


Figure 2. Layout of north unit terraces. Terrace segments shown in red were not constructed at the time of hurricane impact. Construction and planting was completed on all terrace segments shown in green on this map plus those in the southern unit.

On the October 2005 trip, the investigating party traveled west by airboat, from near USFWS Sabine Refuge Headquarters on Hwy 27, across Refuge marshes to the project area. Huge swaths of wrack, composed of vegetative and anthropogenic material (tanks, lumber, 18-wheeler trailers, etc.), had been deposited on top of the marshes. All emergent marsh vegetation that could be seen was completely brown and much of it was covered with what appeared to be fine-grained sediment and precipitated salt (below).

At the project area, although the plants on the southernmost terrace rows appeared to have produced significant growth and spread prior to the storm and the plants' physical structure was mostly intact, we found that all contract plantings on all of the terraces were considerably browned (below).

On the southern terraces, a few very young green stems were found emerging from the roots or stem tips of the plants, with the oldest transplants showing the most new growth.

Proceeding northward, we began to note gaps in the planted rows and the number of plants missing on each terrace segment progressively increased.

In addition, the younger a transplant was, the less old and new growth was present. From oldest to youngest, mortality increased, and the base of the plant stems ranged in color from pale yellow/green to brown/black and rotten at the base.

On the most recently built terrace segments, the number of live plants remaining appeared very low. Because I was unable to determine whether some plants were at the point of decline or

recovery, and the growing season was over and conditions had not yet returned to normal (water salinities were found to be 19 to 22 ppt in the terraced ponds), I recommended that another field investigation be conducted in the spring to more accurately determine the amount of plant mortality.

On April 3, 2006, we again traveled to the project area. The condition of the marshes between the launch site and the project area generally remained the same as in October 2005. However, as we approached the project area and a closer proximity to Sabine Lake, signs of green-up in the native vegetation increased. This may likely be the result of increased flushing from water exchange with the lake. Salinities were 8.5 to 10 ppt.

The oldest vegetative plantings on the southern terraces appeared to have recovered very well, having produced significant new growth and lateral spread (below).

However, moving northward, we found that as age of the plantings decreased, mortality increased, until the plantings no longer formed a continuous vegetative hedge at the toe of the terrace segments. On the newest terrace segments, remaining plants formed very sparsely

distributed live clumps, or single plants with a couple of stems each. There was no longer difficulty in calculating the plant mortality.

Plant mortality was estimated for each row of constructed terrace segments, and ranged from zero to 92%. All mortality was found to have occurred within the plantings on terrace rows 6 through 15. The plantings on rows 16 through 25 had 100% survival and were producing new growth. Based on the known constructed lengths of each terrace segment within the rows, the total linear footage of terrace edge that will require replanting was calculated by row and totals 103,022 linear feet. To replace the destroyed plantings on the 2.5 foot center spacing, per the contract specifications, will require 41,209 plants. To allow for changes in field conditions, a three percent allowance should be added for a total of 42,500 plants to be replaced. The original government cost estimate for the contract planting component was approximately three dollars per plant installed plus mobilization and demobilization. Based on recent successful bids for post-hurricane vegetative planting contracts, increases in local labor and fuel costs, and damages reported by Louisiana wetland plant nurseries, the government cost estimate for the replacement planting would be $3.50 per plant installed for a total of $148,750 plus mobilization and demobilization.

It is recommended that the destroyed plantings be replaced as soon as possible, in order to achieve the necessary stabilizing vegetative cover on the exposed tops and edges of the earthen terraces, particularly now that the start of hurricane season is days away. Please contact me and the LDNR and USFWS project and O&M managers to discuss how, and how soon, this can be accomplished.

Trip Attendees by Date:

October 27, 2005: Dewey Billodeau, O&M Manager, LDNR CED, Lafayette
Justin Price, Monitoring Manager, LDNR, CRD, Lafayette
Ralph Libersat, Project Manager, LDNR CRD, Baton Rouge
Wayne Melancon, CE, NRCS, Crowley
Cindy Steyer, NRCS, Baton Rouge

April 3, 2006: Dewey Billodeau, O&M Manager, LDNR CED, Lafayette
Darryl Clark, Project Mgr, USFWS, Lafayette
Dale Garber, CE, NRCS, Crowley
Donald Taffi, Jr., CET, NRCS, Crowley
Cindy S. Steyer, CVS, NRCS, Baton Rouge

cc: Dale Garber, CE, NRCS, Crowley
Britt Paul, ASTC/WR, NRCS, Alexandria
Quin Kinler, RC, NRCS, Baton Rouge
Darryl Clark, Biologist, USFWS, Lafayette
Dewey Billodeau, O&M Manager, LDNR CED, Lafayette

TRIP REPORT – via Electronic Mail

To: Brad Sticker, CE, NRCS, Alexandria

From: Cindy Steyer, CVS, NRCS, Baton Rouge

Date: March 16, 2009

Subject: East Sabine Lake Hydrologic Restoration Project (CS-32), CU-1A
Post-Hurricane Damage Assessment of TerraceVegetation
February 26, 2009

Attendees: Darryl Clark, USFWS, Lafayette
Dewey Billodeaux, O&M Manager, OCPR, Abbeville
Mark Mouledous, OCPR, Monitoring Manager, Abbeville
Dale Garber, CE, NRCS, Crowley
Cindy S. Steyer, CVS, NRCS, Baton Rouge

cc: Britt Paul, ASTC-WR, NRCS, Alexandria
Ronnie Faulkner, CE, NRCS, Alexandria
Attendees

Background: The CS-32 East Sabine Hydrologic Restoration Project lies east of Sabine Lake in Cameron Parish, Louisiana. The project area lies within brackish marsh habitat where average monthly water salinity normally ranges from 3 to 8 ppt throughout the year. This report summarizes an investigation of hurricane damage to the most recently constructed vegetated terrace component of this project, Construction Unit 1A (Figures 1 and 2). After the Notice to Proceed was issued in March 2008, terrace construction commenced at the southernmost row of terrace segments and proceeded to the north. Beginning in early June, the earthen terraces were planted with 'Vermilion' smooth cordgrass (*Spartina alterniflora* var. Vermilion) at approximately mean high water level on all sides of each segment on 2 ½-foot centers. Due to the order of construction, the oldest and more well-established transplants were on the southern terraces, and the most recently planted transplants were on the northernmost terrace segments. Construction of this component was suspended in late August 2008 due to the approach of Hurricane Ike. At that point, the terrace work was complete on all but Row 1 of the terrace segments. In Row 1, the two westernmost terrace segments were not yet completed, and the remaining segments lacked the final finishing work necessary to meet the specified lines & grades. Also, none of the Row 1 segments had been planted.

The Sabine Lake area lies within the swath of Louisiana-Texas coastal area most severely impacted by Hurricane Ike (Figure 3). The project area was inundated by the storm surge that exceeded 10 feet, and then remained submerged under unusually high water levels for over a month following landfall (Figures 4 and 5). In addition, elevated salinities well above normal have persisted in the project area to date. Vermilion' smooth cordgrass is very flood and salt tolerant, and naturally occurs in the intertidal zones (approx. between mean high and mean low water) of brackish and saline wetland habitats. Nevertheless, a significant abrupt increase in salinity and prolonged elevation of water levels can severely impact smooth cordgrass plants, causing die-back of plant portions or complete mortality. The specific effects of any particular event are influenced by the degree and duration of the increase in water and soil salinity, depth and duration of flooding, temperature, season, and condition of the plants (for example, recently transplanted vs. established).

Figure 1. CS-32 East Sabine Hydrologic Restoration Project Plan Map – CU-1A.

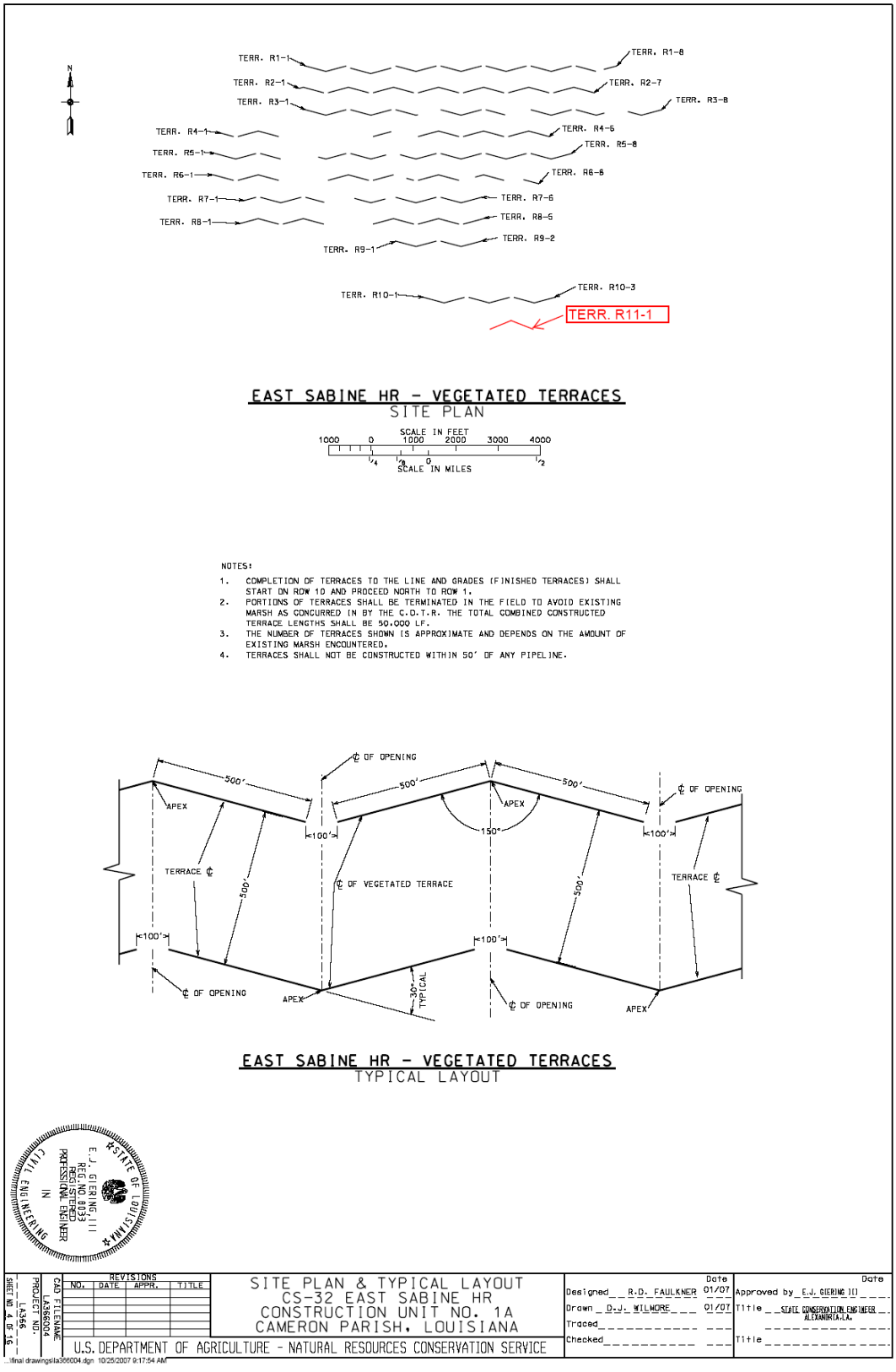


Figure 2. CS-32 East Sabine Hydrologic Restoration Project CU-1A Terrace Layout.

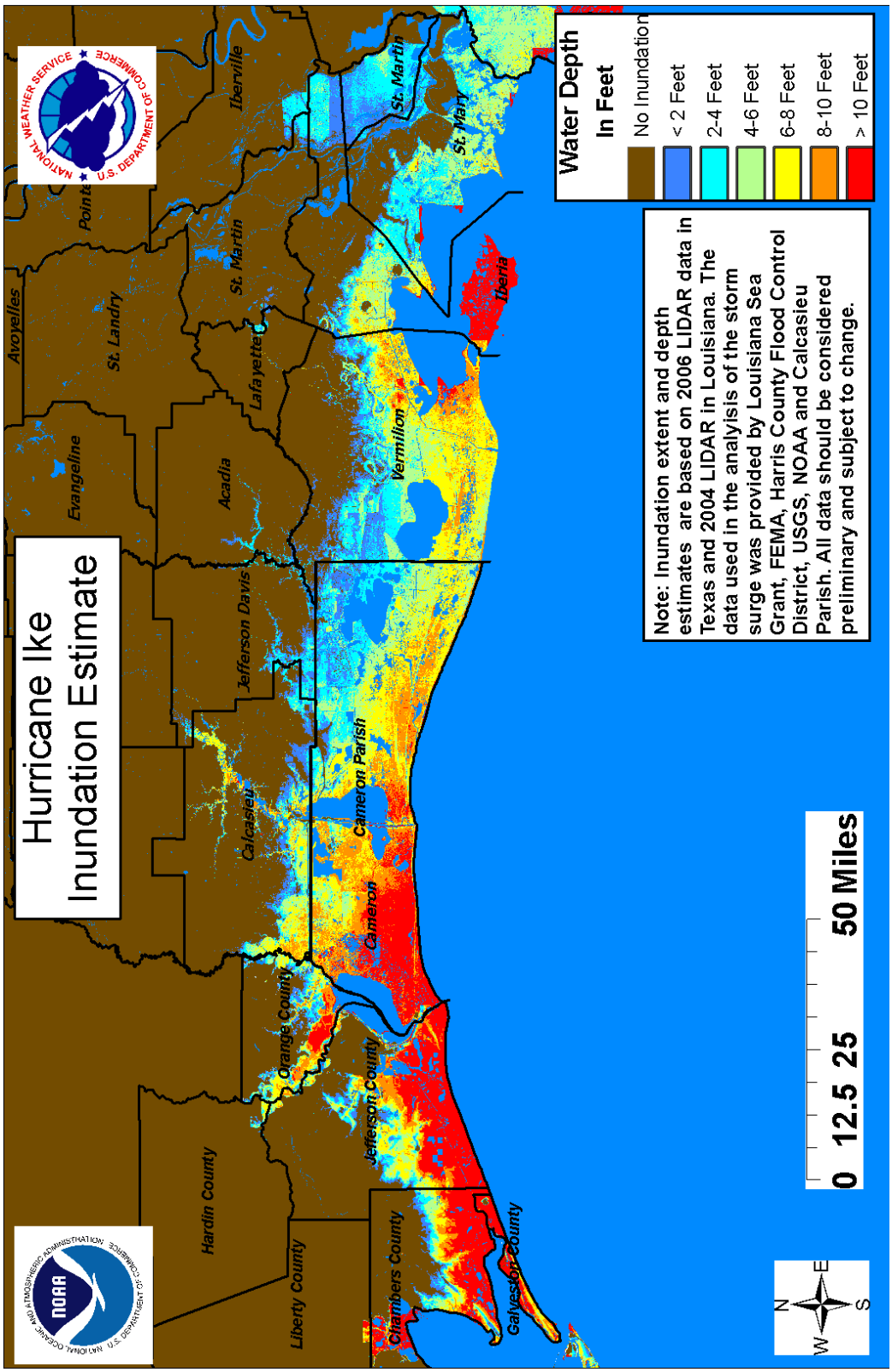


Figure 3. Provisional Estimate of the Extent of Hurricane Ike's surge.

Figure 4. Project terraces remained flooded one month following Hurricane Ike landfall.

Figure 5. Project terraces remained flooded one month following Hurricane Ike landfall.

Findings: To determine the extent of storm damage to the project area, the investigating team of above attendees traveled to the project site on February 26, 2009 to assay the condition of the terraces and plantings. While traveling to the project area from the Cameron-Meadows boat launch, significant damage was observed to the Sabine area marshes in the form of extensive, browning, breakup and reconfiguration of emergent areas. Salinities within the project area on that date ranged from 13 ppt to 15 ppt from south to north respectively. The condition of the newest CU-1A plantings was similar to that of the CU-1 plantings following hurricane Rita (see April 3, 2006 Trip Report, Subject: *CS-32 Post Hurricane Plant Damage Assessment of Terrace Vegetation*), but the overall mortality rate of the CU-1A plantings appeared to be more severe. All of the adjacent natural herbaceous marsh and all contract plantings that remained had been completely browned. Many contract plants were missing or appeared dead. The bases of some of the plants that were believed dead were black and rotten-looking and the root material did not appear to be viable (Figure 6). For many of the other contract plants that remained, a few stems of very new, tender growth were observed just emerging from the base (Figure 7).

Figure 6. Composite examples of dead plants.

Figure 7. Composite of typical examples of surviving plants.

Plant mortality and loss appeared to generally follow three patterns: One, over all rows, mortality or loss was the greatest on those terrace segments that were exposed to open water with longer fetch lengths, especially to the south (i.e., Row 10) (Figure 8). Plantings seemed to fare better when there was at least some emergent marsh adjacent to the terrace segment, even when the marsh consisted of very small fragments (Figure 9). Two, within each row, plantings on the north sides of the rows/segments fared better than on the south sides (Figure 10). Three, over all rows, mortality appears to increase as the age of the plantings decrease (Figure 11).

Figure 8. Greater mortality and loss seen where exposed to open water with longer fetch.

Figure 9. Survival tended to be greater on terrace segments where there was some adjacent fragmented marsh.

Figure 10. Comparison of mortality and loss on a terrace segment's south (left) side vs. the north (right) side.

Figure 11. Less evidence of recovery was seen from the most recently planted transplants.

The plants on the Construction Unit 1 terraces that were completed in 2007 were also significantly impacted. The vegetation had obviously spread and was forming fairly dense cover on those terrace segments prior to the storm, but all emergent stems that remained post storm were completely browned. Nevertheless, new plant growth emerging at sufficient density was observed on all the CU-1 terrace segments (Figures 12 through 14).

Figure 12. Post hurricane condition of vegetation on CU 1 terraces.

Figure 13. Post hurricane condition of vegetation on CU 1 terraces.

Figure 14. Post hurricane condition of vegetation on CU 1 terraces.

Project plant mortality/loss was estimated for each row of the CU-1A constructed terrace segments, and ranged from 40% to 95% as follows:

Row #	Mortality
Row 1 (segmts 1-7 only)	not planted
Row 2	95%
Row 3	95%
Row 4	75%
Row 5	90%
Row 6	60% (varied a lot – from 30% to 70%)
Row 7	60%
Row 8	60%
Row 9	40%
Row 10	70%
Row 11	70%

Recommendations: I do not recommend that any CU-1 terrace segments be replanted, since the density of the new growth we found there indicates that sufficient cover will likely be achieved from the remaining plant material. I do recommend that the dead and missing CU-1A plants be replaced as soon as possible, in order to achieve the necessary stabilizing vegetative cover on the exposed tops and edges of the earthen terraces. I also recommend that all Row 1 terrace segments that were built (segments 1 through 7) be planted, whether or not the construction work on this row was completed.

Based on known constructed dimensions of each CU-1A terrace segment within the rows, and the estimated mortality and loss, the linear footage of terrace edge that requires replanting was calculated by row and totals approximately 80,500 linear feet. To replace the destroyed plants on the 2.5-foot-center spacing, per the contract specifications, will require approximately 32,200 plants – about 77% of the original CU-1A contract plant total. I am not adding an allowance to this estimate because I believe this to be a conservative estimate. This field trip was very early in the growing season, so it's possible that some of the plants originally counted as dead were alive but the recovering growth hadn't emerged yet. In addition, it is not strictly necessary to replace a plant that was located in stretches where it is the only plant missing.

At this time, I recommend that the government cost estimate for the replacement planting be $3.50 per plant installed, for a total of $112,700, plus mobilization and demobilization cost of approximately $15,000. This does not include S & I or administration costs.

Follow Up: The OCPR and USFWS project sponsors have reviewed this report and concur with the recommendation to replace all dead or missing CS-32 CU-1A plants. Darryl Clark, USFWS, has recommended that NRCS begin the contracting process immediately to have the replacement plantings installed as soon as possible in the 2009 growing season. Please contact Dewey Billodeaux, OCPR project manager, Darryl Clark, USFWS project manager, Dale Garber and me to discuss how, and how soon, this can be accomplished.

TRIP REPORT – via Electronic Mail

To: Brad Sticker, CE, NRCS, Alexandria

From: Cindy Steyer, CVS, NRCS, Baton Rouge

Date: April 1, 2010

Subject: East Sabine Lake Hydrologic Restoration Project (CS-32), CU-1A
Field Check of Terrace Vegetation
March 18, 2010

Attendees: Dewey Billodeaux, PE, O&M Manager, OCPR, Lafayette
Darrell Pontiff, PE, Project Engineer, OCPR Lafayette
Mark Mouledous, OCPR, Monitoring Manager, Lafayette
Mike Miller, OCPR, Monitoring Manager, Lafayette
Dale Garber, CE, NRCS, Crowley
Cindy S. Steyer, CVS, NRCS, Baton Rouge

cc: Britt Paul, ASTC-WR, NRCS, Alexandria
Darryl Clark, Project Manager,USFWS, Lafayette
Attendees

Background: The CS-32 East Sabine Hydrologic Restoration Project lies east of Sabine Lake in Cameron Parish, Louisiana. The project area lies within brackish marsh habitat where the typical average monthly water salinity normally ranges from 3 to 8 ppt throughout the year. This report summarizes a field check of the vegetation component of this project, particularly of the most recent Construction Unit 1B planting installed in July 2009 to complete or replace the CU 1A terrace (Figures 1 and 2) vegetation damaged or destroyed by hurricane Ike (see Feb 2009 Trip Report, Subject: *CU-1A Post-Hurricane Damage Assessment of Terrace Vegetation*).

The Sabine Lake area was severely impacted by Hurricane Ike in September 2008. The project area was inundated by storm surge exceeding 10 feet, and then remained submerged under unusually high water levels for over a month following landfall. In addition, elevated salinities well above normal persisted in the project area until the fall of 2009. Smooth cordgrass, including the 'Vermilion' ecotype, is very flood and salt tolerant, and naturally occurs in the intertidal zones (approx. between mean high and mean low water) of brackish and saline wetland habitats. Nevertheless, the combination of a significant abrupt increase in salinity and prolonged elevation of water levels can severely impact smooth cordgrass plants,

causing die-back of plant portions or complete mortality. The specific effects of any particular event are influenced by the degree and duration of the increase in water and soil salinity, depth and duration of flooding, temperature, season, and condition of the plants (for example, recently transplanted vs. established).

Figure 1. CS-32 East Sabine Hydrologic Restoration Project Plan Map – CU-1A.

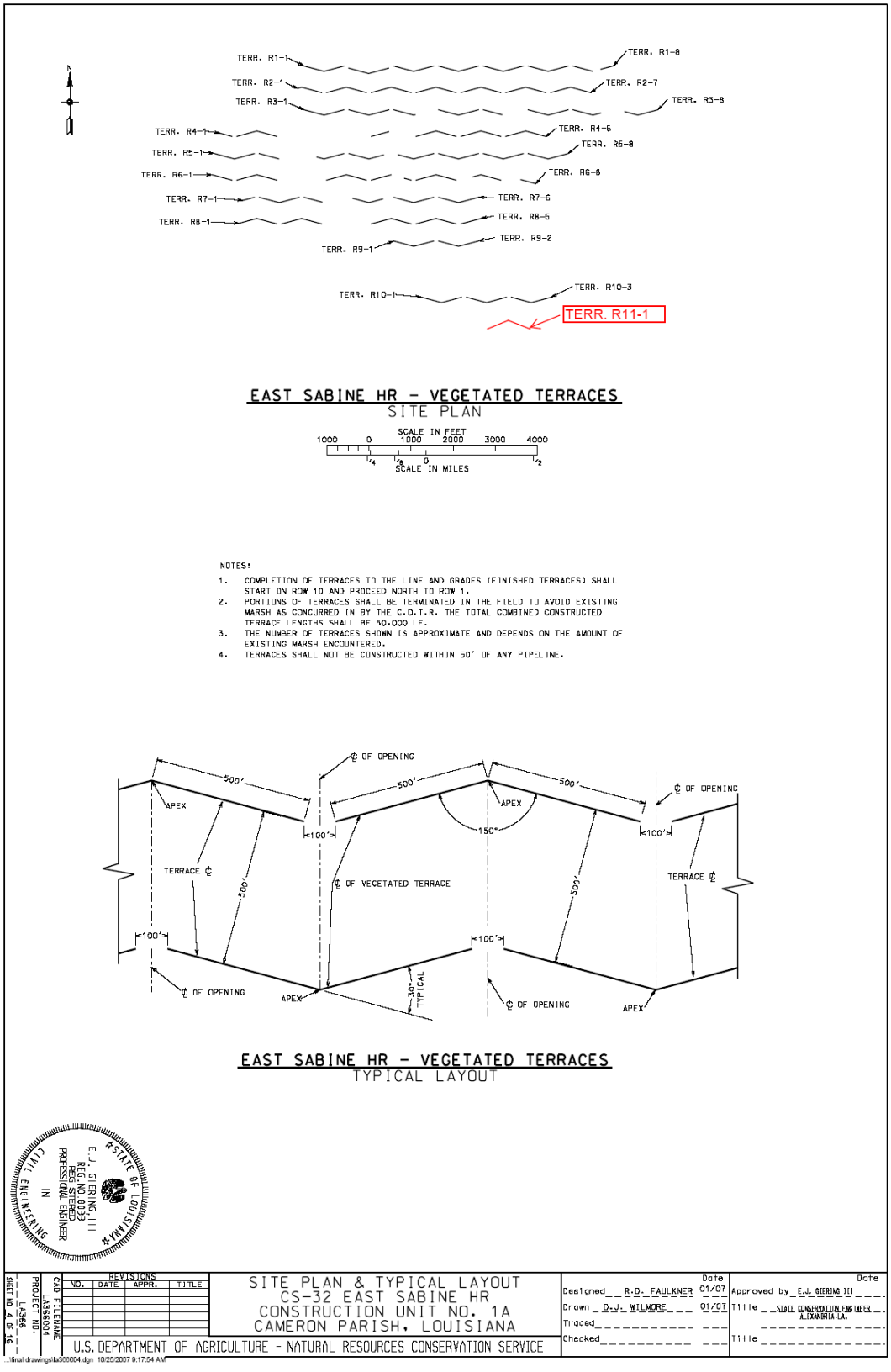


Figure 2. CS-32 East Sabine Hydrologic Restoration Project CU-1A Terrace Layout.

Findings: The team of above attendees traveled to the project site on March 18, 2010 to check the condition of the terraces and plantings. While traveling to the project area from the Cameron-Meadows boat launch, the area marshes were observed to be characteristic of very brown, late-winter vegetation, likely due to the especially severe winter season which was still persisting with frequent, unusually low minimum temperatures. Salinities within the project area on that date ranged from 2.9 ppt to 3.3 ppt from south to north respectively. The condition of the newest CU-1B plantings appeared very poor and severely browned – surprisingly similar to that of the CU-1 and CU-1A plantings following hurricanes Ike and Rita (see 2006 and 2008 Trip Reports). Many contract plants appeared missing or dead without having produced any new stems prior to winter. A very few stems of just emerging, tender growth were observed at the base of a small percentage of newest contract plants. But also, severe die-back of the above-ground plant tissue was evident throughout most of the earlier plantings that had previously recovered well and were spreading, as well as in the natural adjacent herbaceous marsh.

Condition of existing natural emergent marsh next to terraces:

Examples of condition of older plantings when appeared to be recovering well in August 2009:

Contrast above with the appearance of the condition of those older plantings in March 2010:

March 2010 condition of terrace segments with combination of older and recent plantings:

March 2010 condition of newest plantings:

For the newest CU-1B plantings, it is not likely that the source of the plants is a factor contributing to their current state, as the contract plants came from two different nurseries, one in Cameron Parish and one in Lafourche Parish, and all of the remaining plants from the other CU's generally appeared to be in the same condition on the date of this field trip.

Although mainly conjecture, weather could have played a causative role in the overall plant condition we observed. Installation of the CU-1B plantings was completed in July 2009 which turned out to be less than an ideal time for bare-root plant establishment. Following the extreme and prolonged saltwater inundation from hurricane Ike surge in September 2008, southwest LA experienced severe drought conditions in the first half of 2009, with a precipitation deficit persisting until October. In addition, discreet and continuous measurements during the summer revealed that salinities in the project area were significantly higher than normal - greater than 12ppt, and with water temperatures remaining around 85ºF until September (CRMS). This may have led to stagnant or phytotoxic soil conditions until precipitation levels returned to normal in October, but by that time it was already at the end of the growing season when plants are beginning to senesce. This period was then followed by an unusually cold winter pattern that began in late November and persisted throughout south Louisiana. Minimum temperatures frequently dropped into the 30's or below for at least half of Jan and Feb 2010 dates (NWS monthly summaries for the Lake Charles/Port Arthur area). It is possible that the newest plantings experienced higher mortality or dieback of aboveground tissue from the combination of elevated stress during initial acclimation and then additional impact by the ensuing cold temperatures to any new shoot growth that did occur. Further, following a typical winter season, robust new growth is not usually seen in smooth cordgrass until March when warmer spring temperatures become entrenched. So it is also possible that this year's new growth expected for all plants in the area may still be absent because it's been retarded by the persistent winter weather pattern and the late freeze in early March.

Because of the high uncertainty at this date of what below-ground tissue remains viable, a mortality rate or pattern cannot reasonably be determined for any of the plantings, regardless of age. I recommend returning to the project site in September near the end of this year's growing season when a much more accurate assessment of the extent of plant survival can be made. Collection and analysis of soil samples may also provide additional insight in discerning actual causes of the apparent poor performance of all the plants.

TRIP REPORT – via Electronic Mail

To: Brad Sticker, CE, NRCS, Alexandria

From: Cindy Steyer, CVS, NRCS, Baton Rouge

Date: October 6, 2010

Subject: East Sabine Lake Hydrologic Restoration Project (CS-32), CU-1A
Field Check of Terrace Vegetation
October 28, 2010

Attendees: Dewey Billodeaux, PE, O&M Manager, OCPR, Lafayette
Mark Mouledous, OCPR, Monitoring Manager, Lafayette
Mike Miller, OCPR, Monitoring Manager, Lafayette
Dale Garber, CE, NRCS, Crowley
Cindy S. Steyer, CVS, NRCS, Baton Rouge
Darryl Clark, Project Manager,USFWS, Lafayette

cc: Britt Paul, ASTC-WR, NRCS, Alexandria
Attendees

Background: The CS-32 East Sabine Hydrologic Restoration Project lies east of Sabine Lake in Cameron Parish, Louisiana. The project area lies within brackish marsh habitat where the typical average monthly water salinity normally ranges from 3 to 8 ppt throughout the year. This report summarizes a field check of the vegetation component of this project, particularly of the most recent Construction Unit 1B planting installed in July 2009.

This project's construction and plantings were implemented in multiple actions as a result of interruptions and impacts from hurricanes, and a surplus of project funds later allowed for construction of additional terraces. The following is a summary list of the actions to build, and plant or replant the project terraces:

CU-1	2005	Original contract work to install 171,000 LF of terraces and 142,500 transplants (Figure 1) was 54% complete when interrupted by hurricanes Katrina and Rita.
CU-1	2006	Resumed work Post-Rita to complete the remaining 46% of terraces, and the contract was modified to replant damaged terraces with an additional 42,500 transplants.
CU-1A	2008	Contract to install an additional 50,000 LF of terraces with 41,000 transplants (Figure 2) was nearly complete when interrupted by hurricane Ike (two Row 1 segments not constructed, remainder of Row 1 not finished to grade or planted).
CU-1B	2009	Contract to replant damaged CU-1A terraces with 32,200 transplants.

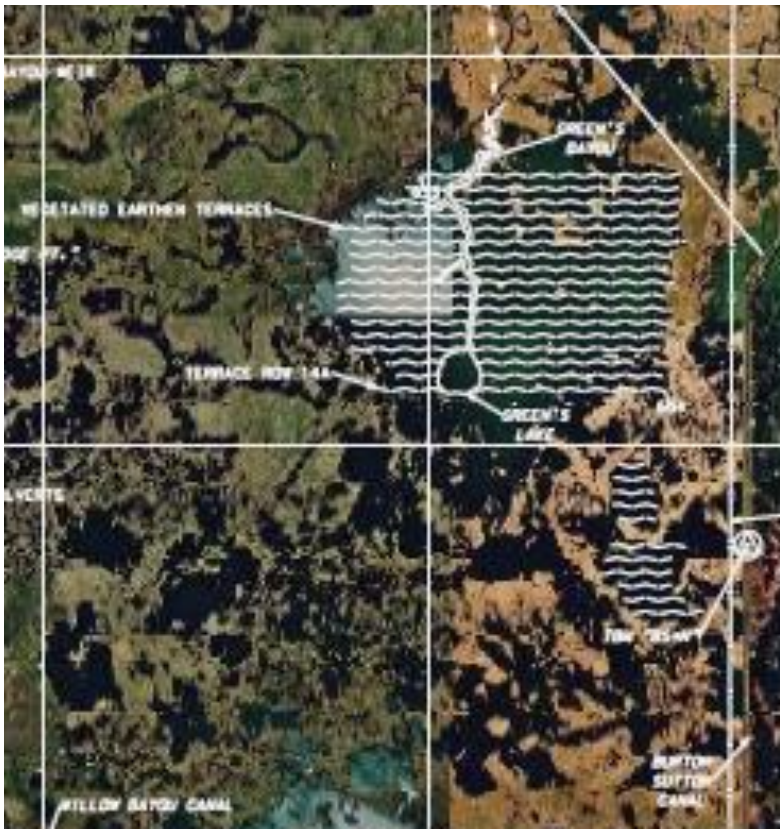


Figure 1. CU-1 contract plan for 171,000 LF terraces and vegetative plantings.

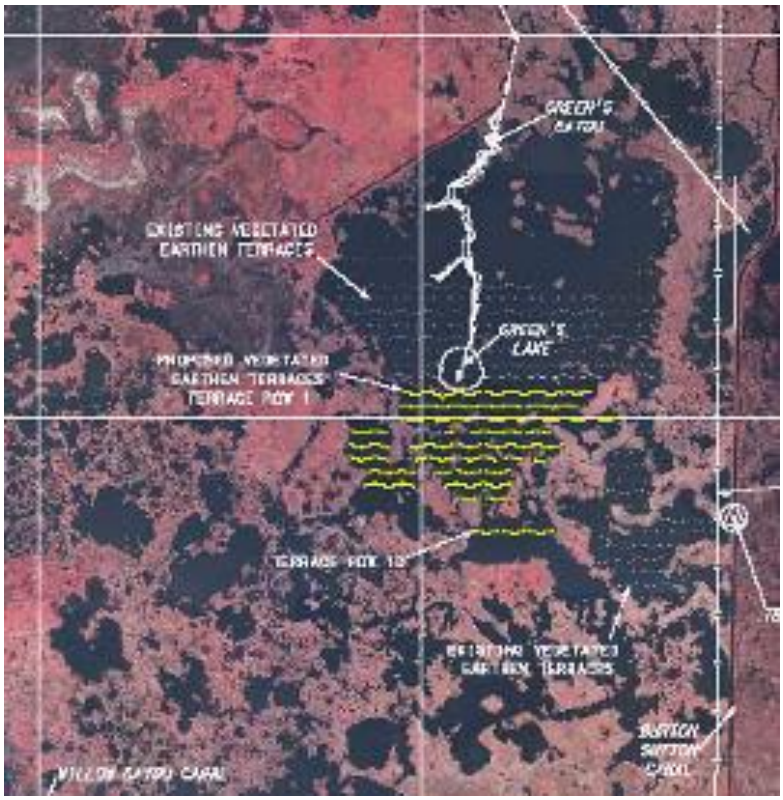


Figure 2. CU-1A contract plan for 50,000 LF terraces and vegetative plantings.

For details of hurricane damage and vegetative planting assessments, and recommendations throughout this project's construction phase to date, see May 2006 Trip Report - Subject: *East Sabine Lake Hydrologic Restoration Project (CS-32) Post-Hurricane Damage Assessment of Terrace Vegetation October 27, 2005 and April 3, 2005*; and February 2009 Trip Report - Subject: *CU-1A Post-Hurricane Damage Assessment of Terrace Vegetation*; and April 2010 Trip Report – Subject: *CU-1A Field Check of Terrace Vegetation March 18, 2010*.

Findings: On October 6, 2010, the team of above attendees traveled by two airboats from the Cameron Meadows boat landing to the project site to check the condition of the terraces and plantings. The field party generally moved from south to north through the entire project area– from CU-1 Rows 16 to 25, to CU-1A/B Rows 11 to 1, to CU-1 Rows 14A to 1B. Water salinity and soil EC was measured at sites along a north-south transect, and six soil samples from within the CU-1A/B terraces were collected for Mike Lindsay, NRCS soil scientist, to perform a lab check on EC using a saturated paste method of analysis. Water salinity within the project area on that date ranged from 7.5 ppt to 9.8 ppt.

The vegetative growth of smooth cordgrass on the oldest and southeasternmost CU-1 Rows 16 to 25 looked excellent, as did that on newer CU-1A/B Rows 11 to 8, and the coverage was nearly 100%. The few gaps that were occasionally present on a few segments were minor and some gaps were occupied by other species such as seashore paspalum (*Paspalum vaginatum*) where the terrace crown was above the water elevation on this date.

The estimated survival of the newer CU-1A/B plantings was very good in Rows 5 to 11 (greater than 80%), although the size of the gaps were more significant and narrowing of some terrace segments became more noticeable as we neared Row 5.

As the party continued north, the survival estimates for the rows dropped dramatically and ranged from fair to poor (5% to 50%) on the CU-1A/B Rows 4 to 2, but the vegetation that did remain appeared to be recovering well and for the most part looked very healthy.

There were a few exceptions however where some plants appeared to be struggling, but those were generally found where the terrace segments were severely impacted and were obviously narrowed with lower crown elevation.

The survival on CU-1A/B Row 1, south of Green's Lake, was about 75%. Here again, the surviving plants looked very healthy and provided nearly 100% cover across the crown in some spots, but there were also other stretches bare of vegetation more than 100 feet long on this row.

The older CU-1 Row 14A terraces continue to be in very good shape, and well covered with vegetation (below). Most of the crown cover however was from a variety of other pioneering species, mainly seashore paspalum and marshhay cordgrass (*Spartina patens*), but seashore elder (*Iva imbricata*), leafy three-square (*Schoenoplectus maritimus*), goldenrod (*Solidago* sp.) and sedges (*Cyperus* spp.) were also present, as well as saltmarsh aster (*aster tenuifolius*), cattail (*Typha* spp.), camphorweed (*Pluchea camphorata*) and marsh morningglory (*Ipomoea sagittata*), and walter's millet (*Echinochloa walteri*). The smooth cordgrass at the toe of this row's segments actually looked in poor shape, and the cover it provided was sparse along some edges.

Overall, the southern rows of CU-1 group looked stable though some had obviously narrowed. There were some areas of loss observed, but there was no discernable pattern that might explain the loss, or why the smooth cordgrass was not recovering well on some segments or in spots, but on others, though providing thin cover, the individual plants looked fairly robust.

Continuing north, the survival and cover on the CU-1 terraces was found to vary quite a lot. Many terrace segments were much narrower and had poor to no cover, but there were other segments where the cover was good and the terraces retained their width. Overall though, there were only a few sites found where individual smooth cordgrass plants looked as robust as those seen to the south. It almost appeared that some plantings were just beginning to re-emerge and expand the cover.

The water salinity and soil EC data, and the vegetative coverage estimates recorded by the field party are attached. A lot of photographs have been included in this report to fully illustrate just how widely

the condition of the terraces and plantings ranged over the 221,000 LF (nearly 42 miles) of terraces. Over the entire project, I would estimate that vegetative cover of the terraces is at approximately 50%. The impact of the combination of storms and repeated years of drought had been extreme, although the current soil and water salinity/EC conditions on this date were well within tolerable ranges for smooth cordgrass. A large portion of the remaining plantings still appear to be in a recovery mode and may just require more time to achieve desired vigor and expansion.

Recommendation: The project team discussed options and it is recommended that the construction phase of this project be closed out. The remaining plantings are expected to continue to recover and expand but where there are large stretches of missing plants, it is advisable to re-vegetate with additional plantings that can be conducted through O&M. I recommend that an O&M planting to target areas with poor to no cover be planned for TY1 or 2, and could probably be accomplished for less than $100,000 (not amortized $). To provide for adequate cover to be maintained throughout the 20-year project life, O&M funds should also be available for an additional O&M planting event if it becomes necessary later in the project life. Darryl Clark has confirmed that there currently is $254,428.04 in the project O&M budget, which is sufficient to fund a TY1 or 2 planting. OCPR typically implements the O&M activities, but if USFWS & OCPR agree, NRCS can design and implement the planting.

The condition of the terraces and plantings should be reassessed again by the end of October 2011 at which time a more accurate estimate of the replanting needs will be made.

U.S. FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
646 Cajundome Blvd. Suite 400
Lafayette, LA 70506
(337) 291-3111 (Clark), 3100 (Main)
FAX (337) 291-3139
E-mail: Darryl_Clark @fws.gov

October 26, 2010

TO: East Sabine Lake Project Team

RE: East Sabine Lake Hydrologic Restoration Project October 6, 2010, Terrace Field Trip

Over 45 miles (237,600 linear feet) of vegetated earthen terraces were constructed mostly in 2005 adjacent to the Green Lake area of Sabine National Wildlife Refuge. The second group of 50,000 linear feet of terraces were constructed and planted in 2008 with a lower elevation and smaller crown (9-feet wide) than the original terraces. CRMS station No. 660 water level and salinity data equaled 1.3 feet NAVD and 9.1 ppt respectively. The following are notes from the October 6, 2010 field trip.

Terrace Row	Percent Vegetated	Condition of Plantings	Salinity (ppt)
11	100%	Smooth cordgrass ins in good condition.	8.8
10		Some portions thinly vegetated	
7-4	> 80%	Narrow terrace some bare sections > 50 to 100 feet bare	7.9
7-3	> 80%		
7-2	> 80%		
7-1	> 80%		
5-1	> 70%		
5-2	50%		
5-3?	> 80%		
5-4	> 80%	Good re-vegetation	
5-5	> 80%	Some thin spots	
5-6	> 80%		
5-7	> 80%	Minor bare spots	
5-8	> 80%		
3-1	10%		
3-2	20%		9.3
3-3	25%		

3-4	50%		
3-5	50%		
3-6	10%		
3-7	5%		9.7
3-8	25%		
1-1 & 1-2	N/A	Terraces not constructed.	
1-3	75%	Bare spots > 100 feet long	
1-4	75%		
1-5	50%		
1-6	20%	1,000 unvegetated	
1-7	20%	1,000 unvegetated	
1-8		submerged	
Green Lake Terraces	50%	Most terraces were 15 – 20 feet wide with bare spots. Stubble remains of some vegetation. Some vegetation spread > 5 feet from the terrace platform.	8.4

Overall on some of the poorer terraces the vegetative cover was 20% or less, on others greater than 80%. The overall mean vegetative cover may be closer to about 50%. It is hopeful that in the near future terraces with poor vegetative cover will recover with natural re-vegetation.

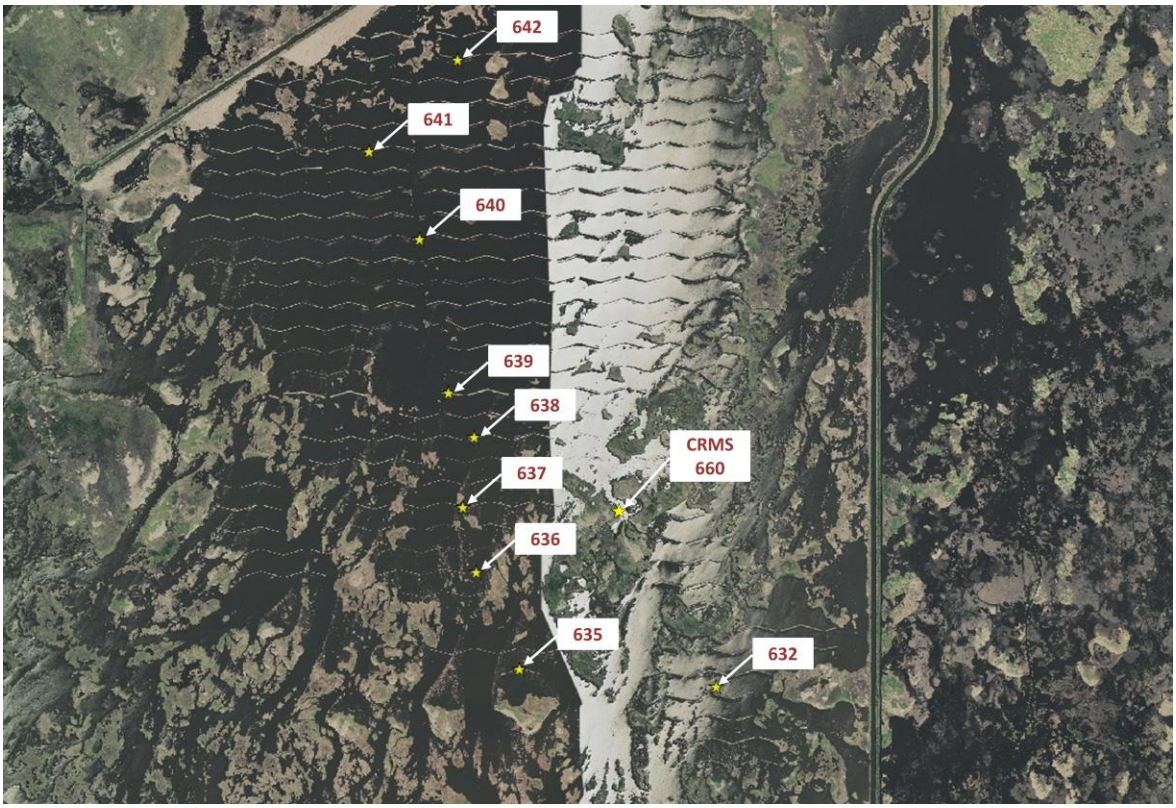
The project team decided not to do a third planting of the lasts 2008 constructed terraces. We will close out project first construction costs and E&D and begin the O&M phase. Some vegetative planting O&M may be added in the future to the O&M budget if necessary.

Darryl Clark
Project Manager/Senior Fish and Wildlife Biologist

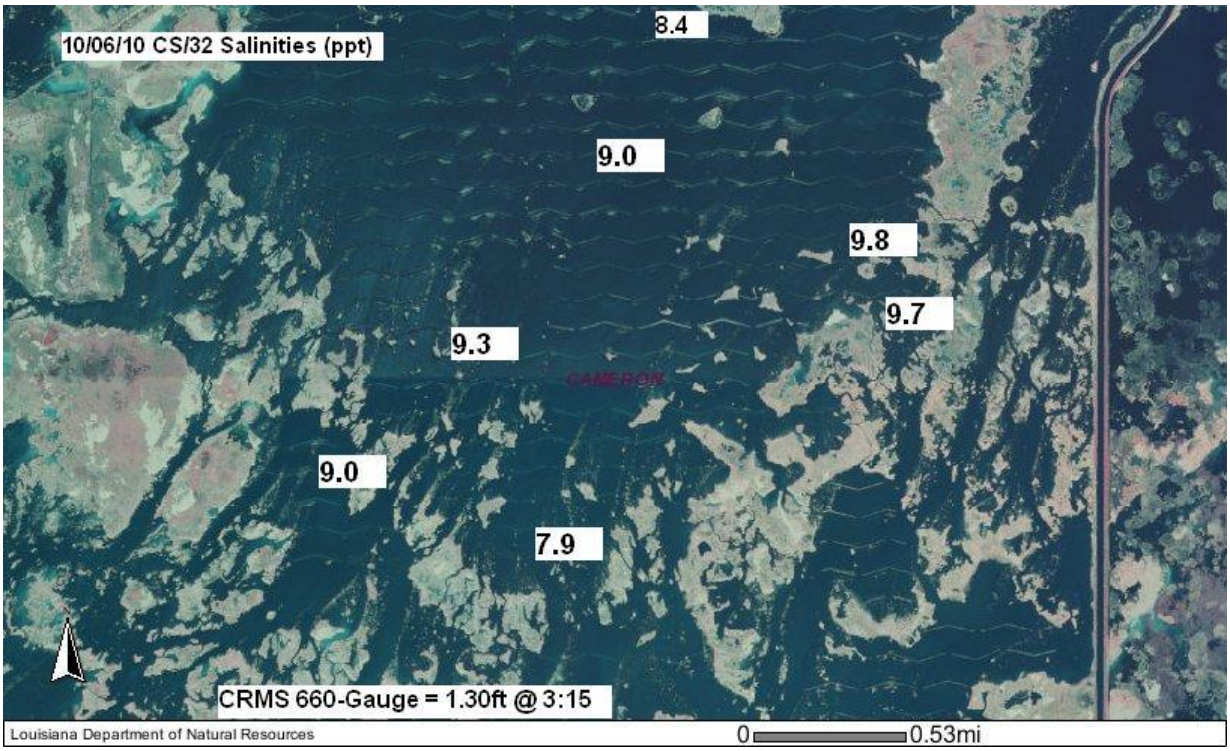
CS-32 East Sabine Terraces Field Trip October 6, 2010
Water & Soil Salinities & Notes

Table 1. Water & Soil Salinities, etc.

Way-point	Water Salinity (ppt)	Soil Depth (in)	Soil EC Field Probe (mS/cm^3)	Soil EC* Lab Sat Paste (mS/cm^3)	Temp (ºC)	Notes
N/A	8.3					At Cameron-Meadows boat landing
632	7.5					CU-1 row 22 segment 3(?); pre-Rita
635		4”	6.02		24.5	CU-1A row 11 segment 1 (south of Row 10); post-Rita, pre-Ike
		12”	6.95			
636		6”	5.55	6.85		CU-1A row 8 segment 5; post-Rita, pre-Ike; (soil sample labeled ‘row 8’)
		12”	5.35			
637	9.5	6”	6.78			CU-1A row 5 segment 5; post-Rita, pre-Ike
		12”	8.00			
638	8.3	6”	5.46	6.77	23.6	CU-1A row 2 segment 5; post-Rita, pre-Ike: Water EC 14.7 (soil sample labeled ‘row 2’)
		12”	4.27			
639	9.6	6”	4.57	4.41	24.0	CU-1 row 14(A) noted as segment 5 but segment 4; pre-Rita (soil sample labeled ‘row 14’)
		12”	6.54			
640	8.4	6”	6.21	7.68	23.5	CU-1 noted as row 7- but row 8 segmt 6; pre-Rita; water EC 14.9; (soil sample labeled ‘row 7’)
		12”	3.50			
641	8.6	6”	5.68	6.82	23.9	CU-1 noted as row 3- but row 4 segment 4; post-Rita, pre-Ike; (soil sample labeled ‘ row 3’)
		12”	5.66			
642	8.0	6”	3.55	6.98		CU-1 noted as row 1B- but row 1A segment 2; post-Rita, pre-Ike; (soil sample labeled ‘row 1B’)
		12”	3.65			
CRMS 660	9.1	*6”	13.5			WL 1.3’ @ 3:15 pm; *soil EC reading from native soil; site S of WP 632 & 635
		*12”	6.0			
643	7.4					Location in marsh area just west of Burton-Sutton Canal
644	7.9					At intersection of Burton-Sutton and Starks Canals
						*EC Lab reading is an average of two samples



Waypoint Map for October 6, 2010 Field Data from NRCS for Table 1



Map for October 6, 2010 Salinity Data from OCPR – Mike Miller, Monitoring Manager, OCPR Lafayette Field Office

VI. Conclusions and Recommendations

Overall, the Earthen Terrace Field portion of the East Sabine Lake Hydrologic Restoration Project is in good condition. The vegetation was in a much better condition than expected due to previous performance recorded in past site inspections. The plants have recovered well with significantly better coverage. No additional planting is anticipated at this time. Some sporadic bare locations remain without an obvious cause. Wave energy has impacted the southern rows of CU1A and washed away terrace segments in that area. Despite narrowing and settling in some areas, the terraces appear to be functioning as intended. The majority of these locations have well established vegetative cover.
A site inspection for the remaining project features is planned for fall of 2013.
Considering lessons learned for future projects, it is recommended that a 300 foot separation between terrace rows is considered to reduce wave action.

Annual Inspection Report
EAST SABINE LAKE HR
State Project No. CS-32

Earthen Terraces

Overall the vegetation is in good condition. (Appendix B: Photo No. 1) From discussion with the team members after the site inspection it was estimated that approximately 90% coverage was present. At this time it doesn't appear that additional planting is required. The terraces are in good condition with somewhat more significant narrowing or settling of the terraces seen in CU1 than in CU1A. During this inspection, salinity and soil samples were collected by NRCS at four locations noted on the Terrace Field Site Map in Appendix A.

CU1A:
Typically the terraces are in good condition with slight narrowing or settling. On CU1A Rows 1-3 & 5 there were a few gaps where the terraces were bare with good vegetation on either side. (Appendix B: Photo No. 2) CU1A Rows 3, 7, & 8 show signs of narrowing where Row 8 has a cut bank on the south side. (Appendix B: Photo No. 4) There are a couple of segments on the

west side of CU1A Row 10 that have been washed away by wave action. (Appendix B: Photo No. 5)

CU1:
The southern end of CU1 tended to have narrower widths than the northern end of the terrace field. On Row 1B – Row 6, the terrace width and vegetation were in very good condition. (Appendix B: Photos No. 6) Narrowing of the terrace width has occurred on Rows 10, 12, & 13. (Appendix B: Photos No. 7) There were small segments of terraces with bare spots on Row 10 – Row 14A. Some locations were bare with vegetation on either side where as some locations were bare on the terrace crown with vegetation growth expanding outward into the water. (Appendix B: Photos No. 8)

Conclusions and Recommendations

Overall, the Earthen Terrace Field portion of the East Sabine Lake Hydrologic Restoration Project is in good condition. The vegetation was in a much better condition than expected due to previous performance recorded in past site inspections. The plants have recovered well with significantly better coverage. No additional planting is anticipated at this time. Some sporadic bare locations remain without an obvious cause. Wave energy has impacted the southern rows of CU1A and washed away terrace segments in that area. Despite narrowing and settling in some areas, the terraces appear to be functioning as intended. The majority of these locations have well established vegetative cover.

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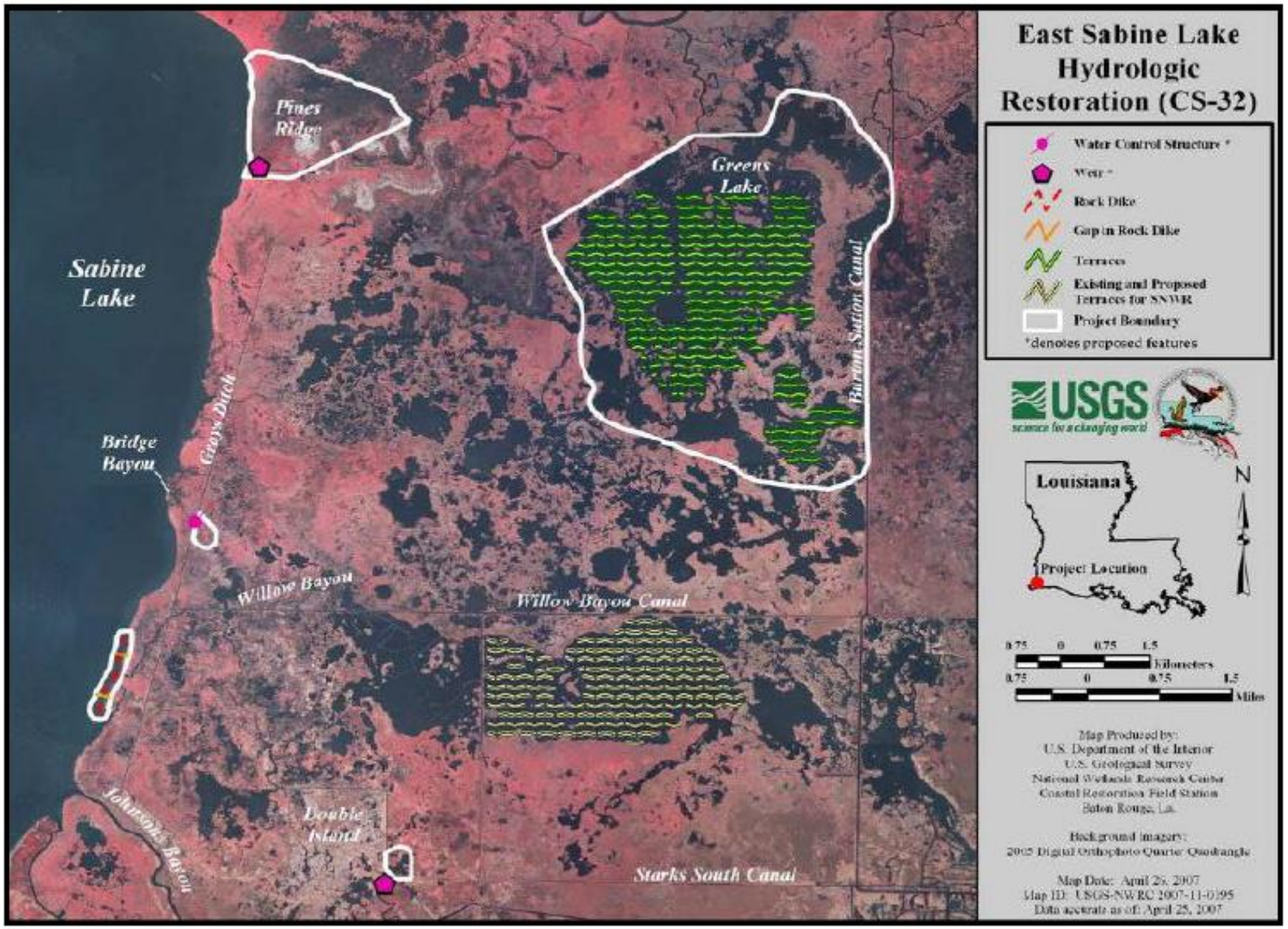
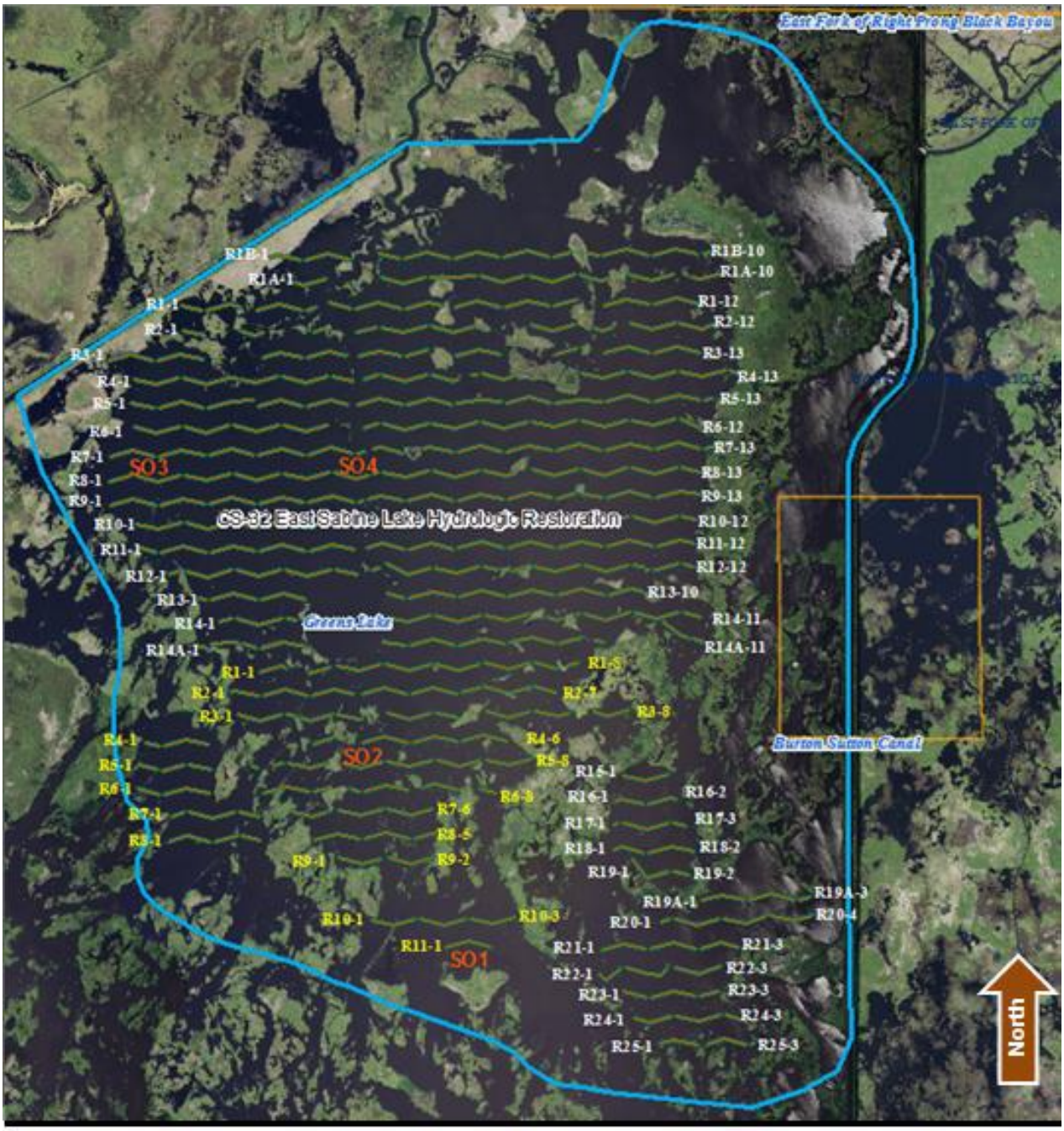

East Sabine Lake Hydrologic Restoration (CS-32)
Water Control Structure *
Weir *
Rock Dike
Gap in Rock Dike
Terraces
Existing and Proposed Terraces for SNWR
Project Boundary
*denotes proposed features
Pines Ridge
Greens Lake
Sabine Lake
Bridge Bayou
Greys Ditch
Willow Bayou
Willow Bayou Canal
Barron Station Canal
Double Island
Johnsons Bayou
Starks South Canal
USGS
science for a changing world
Louisiana
Project Location
N
0.75 0 0.75 1.5
Kilometers
0.75 0 0.75 1.5
Miles
Map Produced by:
U.S. Department of the Interior
U.S. Geological Survey
National Wetlands Research Center
Coastal Restoration Field Station
Baton Rouge, La.
Background imagery:
2005 Digital Orthophoto Quarter Quadrangle
Map Date: April 26, 2007
Map ID: USGS-NWRC 2007-11-0195
Data accurate as of: April 25, 2007



Label Legend

CU-1A

CU-1

Soil Samples

CS-32 East Sabine Lake Hydrologic Restoration

Earthen Terraces

Inspection Site Visit 10-11-2012

Photo No.1 –Typical Terrace in CU1A - Row 1 (Northern Most Row)

Photo No. 2 –CU1A Bare Segments

Photo No. 3 - CU1A Rows Slightly Narrowed with Good Vegetation

Photo No. 4 - CU1A Row 8 Cut Bank on South Side

Photo No. 5 - CU1A Row 10 (Southern End of CU1A Terraces – West Side of Row)

Photo No. 6 - CU1 - Typical Terrace in Row1B-Row 6

Photo No. 7 - CU1 – Narrowing Terrace Widths - Typical Terrace in Rows 10, 12, & 13

Photo No. 8 - CU1 – Typical Bare Spots in Row 10 - Row14A

U.S. FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
646 Cajundome Blvd. Suite 400
Lafayette, LA 70506
(337) 291-3111 (Clark), 3100 (Main)
FAX (337) 291-3139
E-mail: Darryl_Clark @fws.gov

July 27, 2015

East Sabine Lake (CS-32) O&M Field Trip Report –September 29, 2014

Terrace Rows

Row R1-1 – 8%

R1B-1 – (West to East) 2nd segment – smooth cord., Roseau (trace), Iva > 50%, baccharis 40-50%

1B – some thinner parts of terrace, less shrubs, smooth cord expanding into water

R 1 (from east to west) – smooth cord expanding into water column, terrace about 40 feet wide, terrace looks good, some thinner spots.

R3 (west to east) – 2 to 5% thinner sections, mottle ducks, cattail and Roseau on west end, > 1 o2 segments less to 0% shrubs, smooth cord 20 to 40 feet wide, terrace top only 3 feet wide after 1st natural marsh area, 3rd segment from east looks good, 2nd segment from E 40 to 50 feet wide, 5% shrubs; last segment to east 10 to 15% shrubs.

R5 (E-W) – 1st segment good; 2nd seg. Smooth cord expanding, 5-10% shrubs; Segment 3 – 50 feet wide trace shrubs; R-5 E-W center – thinner in middle on some segments west of Greens Bayou, smooth cord present but thinner, terrace top only 3 to 5 feet wide; 3rd segment from end – thin, 5-10% shrubs; 2nd from end – smooth cord expansion 40 to 50 feet; last segment – robust sm. cord expansion 50 to 60 feet wide.

R7 (W to East) – Seg. 1 – wide; 2 – some thinning but sm. cord expanding to 50 ft; 3 – lower 2-3 foot tops to none; 4 about the same as Seg. 3; 5 OK sm. cord expansion to > 50 feet; 6 – partial thinning; 7 – thin; 8 – thick expansion to > 50 feet, shrubs 5-10%; 9 – wide but thinning; 10 –

good wide 10% Iva; 11 – 10% shrubs, terrace tops 3 to 5 feet wide; 12 – equals to seg. 11 but even thinner; 13 - > 50 feet wide some shrubs

R 9 (E to W) – Segment 5 – wide 10% shrubs, 3to 5 ft top; 6 - > 50 ft wide; 5-10% shrubs; Segs. 8&9 equal to Seg. 7; Seg. 9 - 2 to 5 foot wide tops; Segs. 10, 11 and 12 – 50 ft wide; 13 – some thinning, trace shrubs.

R 11 (west to east) – Seg. 1 – 10-15% ?; 2 – wide, large shrubs, Roseau > 20%; 3 – trace shrubs, wide terrace, top 2 to 3 feet > water (not sure of meaning of this. doubt it means elevation); 4 – 0 to 3 ft tops, trace shrubs, > 50 ft wide; 5 – 50 ft wide, water over tops, 5% shrubs; 6 – thinner won west side, > 50 ft wide; 7 – 5 to 10% shrubs, > 50 feet wide; 8 – thinner trace shrubs; 9 – 50 ft wide, Roseau tract to 5%, shrubs 5%; 10- thinner, 30-40 ft wide, trace shrubs; 11 – 40 feet wide, 3 to 5 ft tops, 5% shrubs; 12 – 5 to 10 % Roseau, some thinner parts of segment.

R 13 (E to W) – Seg. 1 – 30 feet wide, 3 – 50 ft, 5 to 10% shrubs; 4 40 ft, 5% shrubs; 5 – 50 ft wide, tr to 5% shrubs; 6 > 50 ft wide, trace shrubs; 7 – 20 to 30 ft wide (East of Greens Lake); 8 – 100 ft missing (Seat of Greens Lake); 9 – 50 ft wide, trace shrubs.

R 14 A (7.4 ppt salinity); Seg. 1 – some thinning; 2 – 2-3 feet tops, open water,; 3 – 60-75 ft wide (East Green Lake), 10 to 15% shrubs; 4- 100 feet bare; 5 – 50 feet bare, > 60 ft wide, > 25 % shrubs; 6 > 60 ft wide, 50 feet bare on tops; 7 – 25 to 30% shrubs, 60 feet wide; 8 – small or thinning before natural marsh; 9 – after nat. marsh.

R 1 (south of Green Lake) – 1 – 30 to 40 ft wide; 2 – 50 ft wide; 3 40 ft wide and full; 4 – 20-30 ft wide, millet 5%-10%.

R 3 – Seg. 1 – OK but thinning; 2 - > 25% shrubs; 3 – 20-30 ft wide marsh; 4 & 5 – 30-50 ft wide; 6 – 30 ft wide; 7 > 50 ft wide, trace millet and shrubs; 8 – 50 ft wide, 30 to 40 ft marsh; 9 – 40 ft wide, 5% shrubs.

R 5 (E-W, South of Greens Lake) – Seg 1 – thinning, 2 – 20-30 ft, tract shrubs, trace millet; 3 – Roseau, hog cane trace; 4 – 30 to 40 ft wide; 5 – short segment; 6 – 40-50 ft wide, tr shrubs; 7 – 50 ft wide, tr shrubs.

R 7 (W to E) – Seg. 1 – 30 ft wide; 2 40-50 ft wide, cattail trace; 3 – 40-50 ft wide; 5 20-30 ft marsh; 6 – thinner, 10 to 40 ft wide, alternaflora?; 7 – 30 to 50 ft, 200 foot segment thinning before natural marsh.

R 11 (only 1 segment) Seg. 1 – 10-15 ft wide, foxtail, 3-square, segment looks OK.

Darryl Clark
Senior Fish and Wildlife Biologist