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Department of Natural Resources
Coastal Restoration Division and
Coastal Engineering Division

2007 Operations, Maintenance, and Monitoring Report

for

Sabine Refuge Marsh Creation

State Project Number CS-28
Priority Project List 8

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Cameron Parish

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2007 Operations, Maintenance, and Monitoring Report
For
Sabine Refuge Marsh Creation (CS-28)

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I. Introduction

The project area is composed of 5,776 acres (2337.5 ha) of wetlands located in the Calcasieu-Sabine Basin on the Chenier Plain. The area is within the Sabine National Wildlife Refuge and roughly bounded by Starks North Canal to the north and east, Back Ridge Canal to the south, and existing marsh to the west (figure 1). Hurricanes and canal building between 1956 and 1978 caused land loss in the area. Saltwater from the Calcasieu Ship Channel (CSC) is currently introduced from several sources including the Gulf Intracoastal Waterway (GIWW) through Alkali Ditch and probably more importantly through West Cove Canal via Back Ridge Canal (Miller 1997). Vegetation has shifted from intermediate sawgrass dominated marsh including *Cladium jamaicense* (sawgrass), *Schoenoplectus californicus* (giant bulrush), and *Phragmites australis* (Roseau cane), with some fresh marsh to more brackish species including *Spartina patens* (saltmeadow cordgrass), *Schoenoplectus americanus* (bulrush), and *Schoenoplectus robustus* (saltmarsh bulrush) since at least 1968 (Chabreck and Linscombe 1978, 1988). Most of the project is shallow open water with brackish marsh on the surrounding edges. The current land loss rate is approximately 0.5 square miles (1.3 km^2) per year.

The Sabine Refuge Marsh Creation Project (CS-28) is designed to create approximately 1,120 acres (450 ha) of emergent vegetated marsh and to nourish and protect existing broken marsh via five cycles of spoil placement. During the January 2001 maintenance dredging of the Calcasieu River by the Operations Division of the U.S. Army Corps of Engineers-New Orleans District, via Cycle I of the project, approximately 1,000,000 cubic yards of sediment were dredged from the Calcasieu Ship Channel between miles 8.3 to 10.4 (13.4 to 16.7 km) and placed in a confined area within the Sabine National Wildlife Refuge. The first cycle created approximately 200 acres of vegetated marsh. The plan called for 36,000 *Spartina alterniflora* plants to be planted along the edges of the perimeter and the constructed canals in the Cycle I dredge placement area. This effort was completed, but the interior of the newly created marsh creation revegetated quickly on its own. Four more cycles of marsh creation were scheduled to occur every year, beginning in 2005 (figure 2). Two cycles have been completed, Cycle I and Cycle III.

Construction of Cycle II has been slowed. The northern and eastern portions of the containment levees have been constructed for Cycle II but no material has been placed to date. Maintenance dredge material was pumped into Cycle III and was completed in March 2007. Like Cycle I, the goal for elevation of material pumped into Cycle III was 4.5 ft (1.4 m) MLG. However, actual elevation achieved was between 3.6 ft and 4.0 ft MLG in that area. Plantings will not be utilized in Cycle III, or in subsequent cycles, as the resulting spoil material in the Cycle I area appeared to have vegetated from the soil seedbank and windborne seed sources.

Hurricane Rita struck the coast of southwestern Louisiana on September 24, 2005, with maximum storm surge of approximately 9 ft (2.7 m) in the CS-28 project area. The U.S. Geological Survey (USGS) calculated the amount of land that changed to water resulting from the storm to be 98 square miles in southwestern Louisiana, with 22 square miles of land lost in the Calcasieu/Sabine basin (Barras 2006). This land loss can be attributed to several patterns. Shearing, which is ripping and removal of marsh vegetation in historically healthy marshes, was observed north of Johnson's Bayou and south of the Sabine National Wildlife Refuge. The removal of remnant marsh from areas with historical land loss from the surge was observed in the marsh just north of Johnson's Bayou and north of Mud Lake.

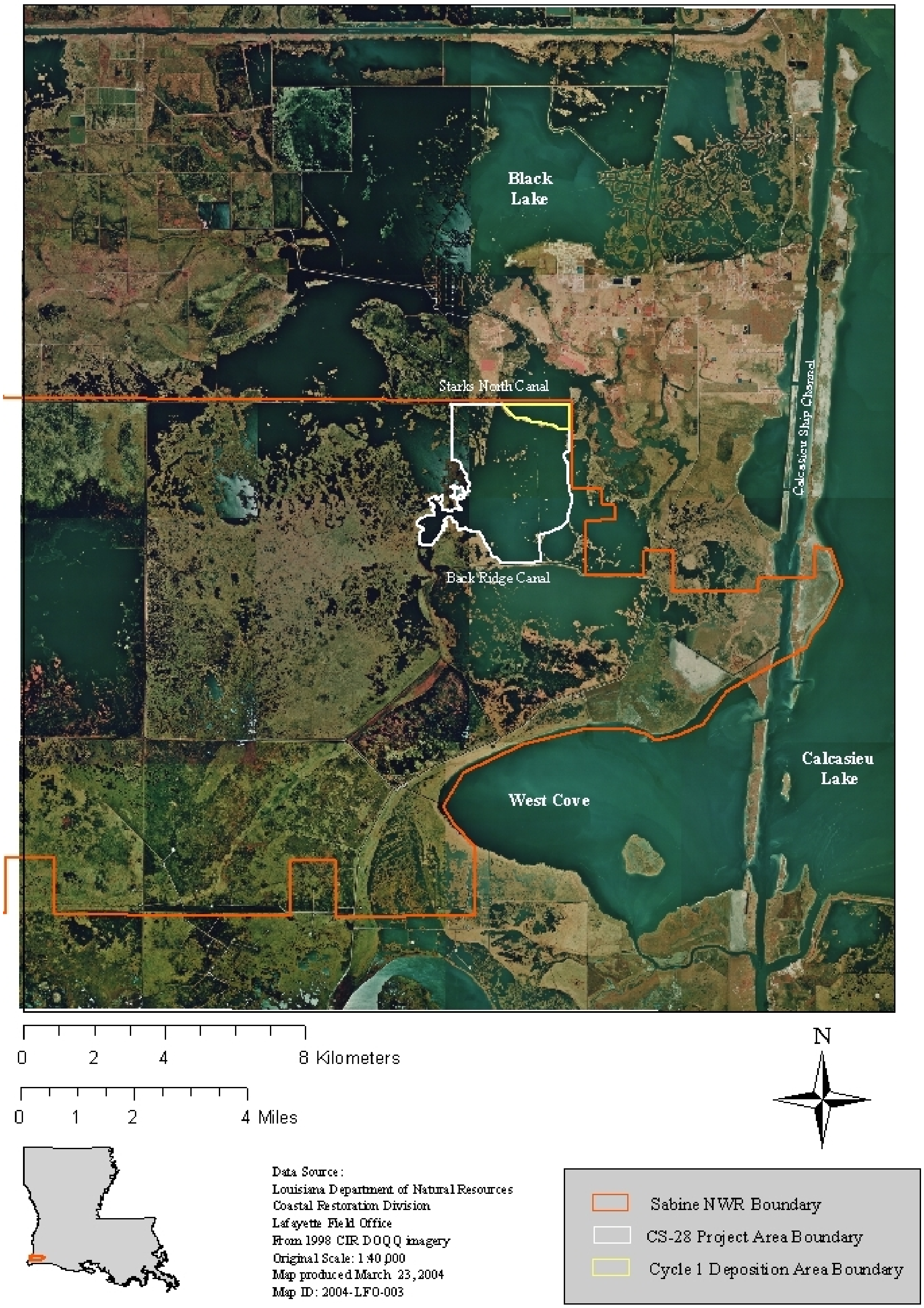

Figure 1: Sabine Refuge Marsh Creation (CS-28) project area boundary.

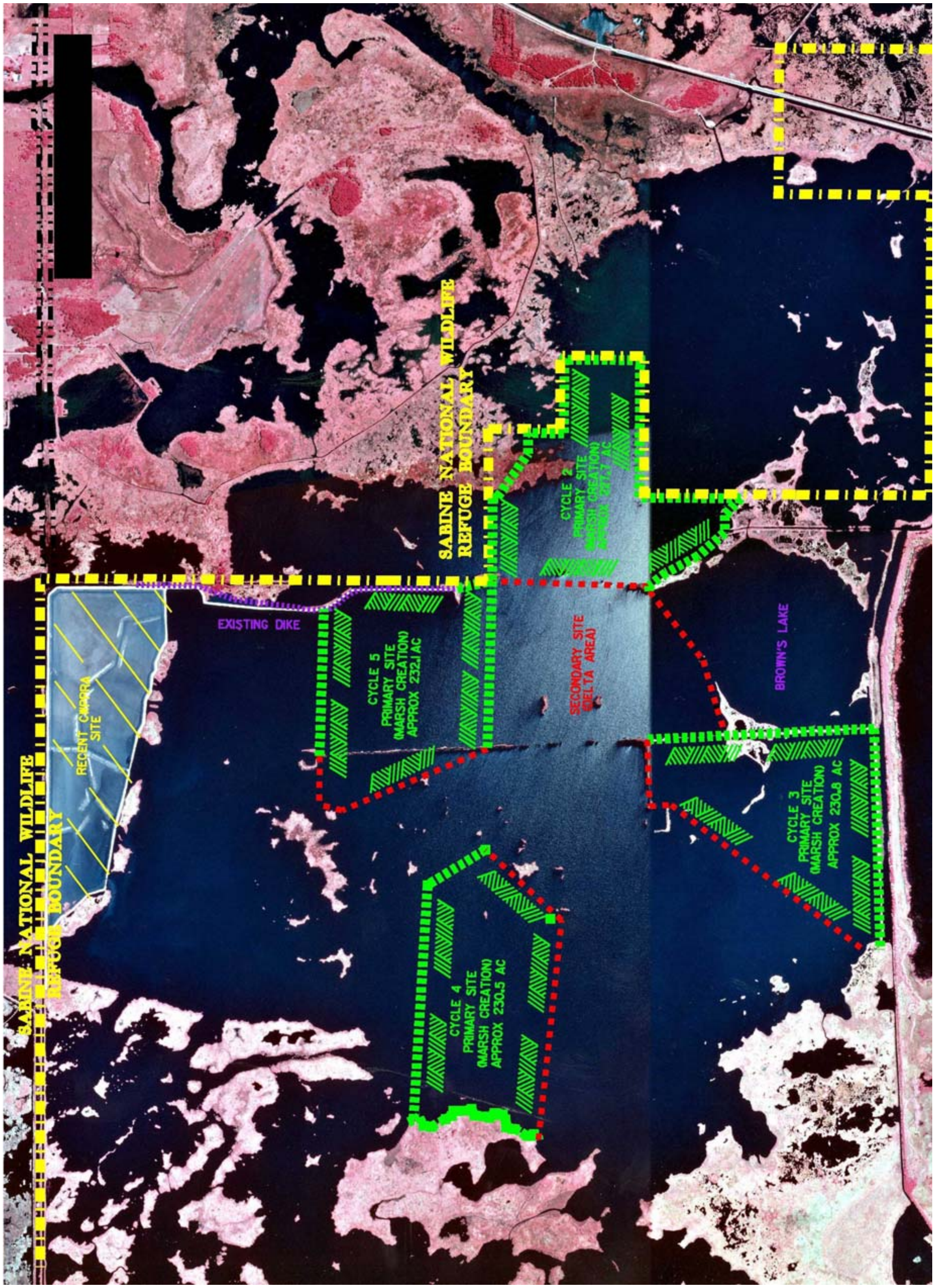

Figure 2. Location of Cycles 1 and 3 dredge placement area and the proposed location of Cycles 2, 4, and 5.

II. Maintenance Activity

There are no O&M monies for this project, therefore, no inspection, maintenance activity, operation, or plan applies.

III. Operation Activity

There are no O&M monies for this project, therefore, no inspection, maintenance activity, operation, or plan applies.

IV. Monitoring Activity

Pursuant to a Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Task Force decision on August 14, 2003, to adopt the Coastwide Reference Monitoring System-*Wetlands* (CRMS-*Wetlands*) for CWPPRA, updates were made to the CS-28 Monitoring Plan to merge it with CRMS-*Wetlands* and provide more useful information for modeling efforts and future project planning while maintaining the monitoring mandates of the Breaux Act. No CRMS-*Wetlands* sites are located within the CS-28 project area.

In response to Hurricane Rita in 2005, 163 Louisiana Department of Natural Resources (LDNR) emergent vegetation stations were sampled in the late summer/early fall of 2005 and 2006. The stations represented a subset of the LDNR vegetation stations established on the Chenier Plain to monitor CWPPRA projects including sites in the CS-21 project area (Appendix A).

a. Monitoring Goals

The objective of the Sabine Refuge Marsh Creation Project is to create new vegetated marsh and enhance and protect existing surrounding marsh vegetation.

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

1 Place dredge spoil slurry to a maximum height of 4.5 ft (1.4 m) MLG to settle to a height of 2.5 ft (0.8 m) MLG, after five years, for each of five dredging cycles.

2. Create 125 acres (50 ha) of vegetated wetlands in the first dredge placement cycle and 230 acres (93 ha) in each cycle for Cycles II through V.

3. Reduce loss of existing surrounding marshes within the project area.

b. Monitoring Elements

Aerial Photography:

Near-vertical color-infrared aerial photography (1:24,000 scale) was used to measure vegetated and non-vegetated areas for the project and reference areas. The photography was obtained in 2000 prior to project construction and on December 15, 2002, following construction. The original photography was checked for flight accuracy, color correctness, and clarity and was subsequently archived. Aerial photography was scanned, mosaicked, and georectified by USGS/National Wetlands Research Center (NWRC) personnel according to standard operating procedures (Steyer et al. 1995, revised 2000).

Emergent Vegetation:

To document changes in emergent vegetation due to the project, vegetation was monitored pre-construction in 2001 and post-construction in 2002 and 2004. Ten stations were established in the project area and vicinity in pre-existing marshes (figure 3). Eight stations were also established in the first cycle dredge deposition area after construction, but before vegetation was planted along the edges. Two 2 m^2 plots were sampled at each of the stations. Percent cover, height of dominant species, and species richness were quantified. Vegetation was to be sampled in late summer of 2006, 2008, 2010, and 2017. Vegetation was sampled in 2005 and 2006 in response to Hurricane Rita as part of a larger, separate post-hurricane vegetation survey conducted by LDNR (see Appendix A).

Elevation Survey:

The elevation of the initial placed dredge material was documented within placement sites for the first dredging cycle in 2002. Elevation measurements were to be recorded in 2003 for I and every year after each subsequent cycle is built (2004, 2006, 2008, 2010, and 2017).

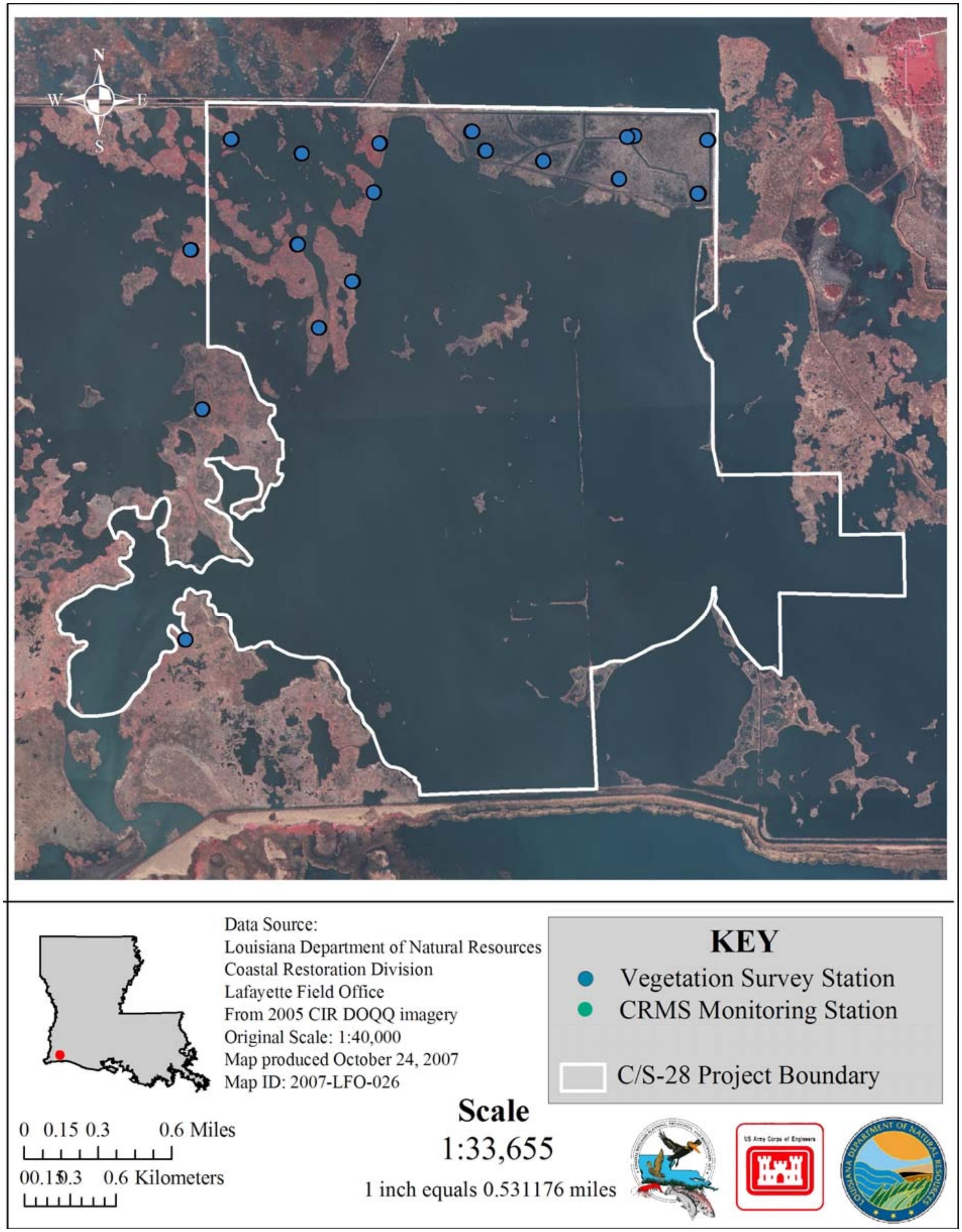

Figure 3. CS-28 project area and vegetation station locations.

IV. Monitoring Activity (continued)

c. Preliminary Monitoring Results and Discussion

Aerial Photography:

Land / Water analysis was completed for photography acquired in December 2002. The 2000 photography was collected for the adjacent Hog Island Gulley Project (CS-23) and was processed for CS-23, but has not been subset for the CS-28 project area. The 2002 acreages are presented in figure 4. At the time the photography was flown, the area was entirely mudflat.

Emergent Vegetation:

Vegetation stations were established in the dredge cell constructed in 2002 (Cycle I) after construction. At the time of station establishment, the area was still an un-vegetated mudflat (figure 5). The Cycle I stations were revisited in 2004 (figure 6) and again after Hurricane Rita in 2005 and 2006 (figures 7, 8 and 9) as part of a regional post-hurricane survey (see Appendix A for complete survey results). In 2004, two species were present in the dredge construction area, *Spartina alterniflora* and *Schoenoplectus robustus* (table 1). *Spartina alterniflora* had been planted along the edges post-construction in 2002. Total cover had increased from 0 to 52% in the constructed marsh by 2004 (figure 10). Comparisons to the vegetative assemblages in the adjacent, natural marsh revealed that cover in the constructed marsh was approaching levels in the natural marsh (figure 10), although the constructed marsh was a monoculture of *Spartina alterniflora* while the natural marsh was dominated by *Distichlis spicata* and *Spartina patens* and had 3 to 4 species per plot with a maximum of 6 (figure 11). Vegetation height in the constructed marsh was much higher than in the natural marsh due to differences in growth habit of dominant vegetation (figure 12). The dredge material contains mineral-rich clays that *Spartina alterniflora* was likely responding to (although there are no data to assess this assertion).

Hurricane Rita impacted cover, richness, and height of vegetation in both the project and reference areas. The effect of the storm surge in 2005 was more pronounced in the constructed marsh where most *S. alterniflora* stems died (figure 10). The natural marsh died back but was not as severely impacted as the constructed marsh (figures 7 and 9). There were a maximum of 2 live species in any one plot in the reference area in 2005 and up to 5 in 2006. Both areas had generally recovered to 2004 levels of cover, species richness, and height by 2006 (figures 10, 11, 12, 13, 14, 15, and 16). Several new species were found in the reference area after the hurricane, including *Borrichia frutescens*, *Iva frustescens*, *Pluchea camphorata*, and *Setaria magna* (table 1). Also, several species common prior to Hurricane Rita were not found in 2006, including *Iva annua*, *Juncus roemerianus*, *Schoenoplectus maritimus*, *Symphyotrichum tenuifolium*, and *Typha* sp. In 2006, *Salicornia bigelovii* was noted in the constructed marsh although it was not present in or around vegetation plots. It will be interesting to note the succession of species on the constructed marsh in years to come.

One of the suggested benefits of the project was nourishment of the adjacent natural marsh after construction by the suspended dredge sediments released when the southern levee was purposely degraded post-construction (small delta formation effect). There does not appear to have been a benefit as the pre-construction cover, height, and richness (2001) were virtually the same as the post-construction values (2002). Cover, height, and richness actually decreased in the adjacent marsh from 2002 to 2004, although this difference is not significant.

Elevation Survey:

An elevation survey was conducted “as built” following construction in 2002. The 2003 survey was conducted only in the area where Cycle II is to be built.

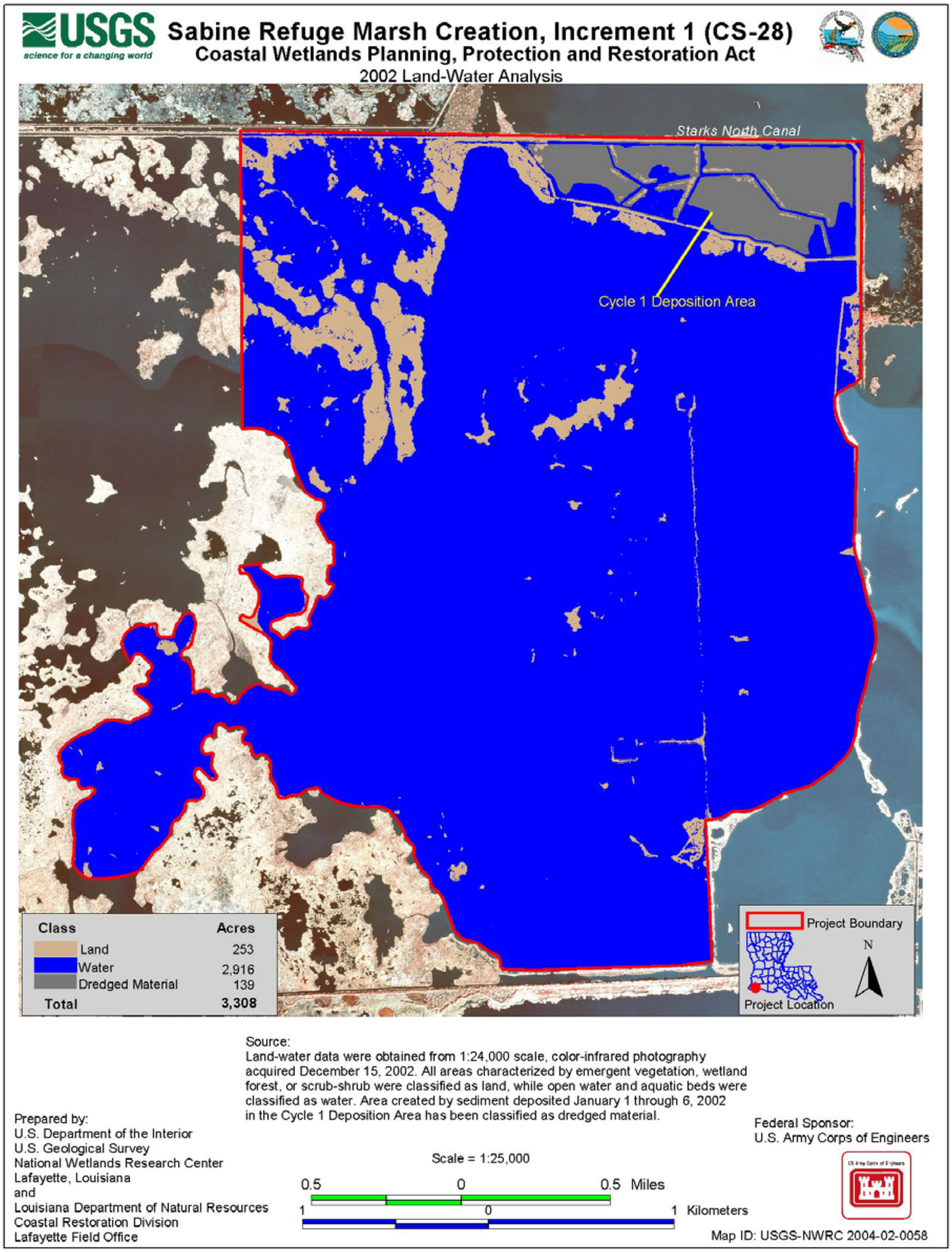

Figure 4. Land:Water analysis from photography obtained December 15, 2002, with project boundaries and land, water, and dredge material acreages. Most of the dredge material is now vegetated.

Figure 5. Photograph of vegetation station (CS28-205) in the Cycle I deposition area at time of establishment (September 2002). The plants in the background are *Salicornia bigelovii*.

Figure 6. Photograph of vegetation station (CS28-205) in the Cycle I deposition two years after construction (August 2004).

Figure 7. Photograph of vegetation station (CS28-200) in the Cycle I deposition area six weeks after Hurricane Rita and three years after construction (October 2005).

Figure 8. Photograph of vegetation station (CS28-206) in the Cycle I deposition area one year after Hurricane Rita and four years after construction (September 2006).

Figure 9. Photograph of vegetation station (CS28-150) in the reference area six weeks after Hurricane Rita and three years after construction (October 2005).

Table 1. Frequency of abundance or the % of stations species present and percent cover of species when present (in parentheses). Note that Bare Ground was not classified in the reference area until 2005.

Scientific Name	Reference Area 2001	2002	2004	2005	2006	Cycle I 2002	2004	2005	2006
Bare Ground	.	.		100 (38.8)	20 (100)	100 (100)	12.5 (46.5)	100 (97.9)	12.5 (21.3)
Amaranthus australis	10 (0.3)	10 (0.3)	.	.	30 (6.3)	.	.	.	.
Borrichia frutescens	.	.	.	.	10 (0.5)	.	.	.	.
Distichlis spicata	95 (72)	100 (62.4)	100 (54) *	.	10 (2)	.	.	.	.
Ipomoea sagittata	.	5 (0.5)	.	.	.	.	.	.	.
Iva annua	25 (6.2)	5 (0.5)	.	.	.	.	.	.	.
Iva frutescens	.	.	.	.	60 (27)	.	.	.	.
Juncus roemerianus	5 (2)	10 (0.5)	7.14 (0.5)	.	.	.	.	.	.
Kosteletzkya virginica	5 (0.1)	.	.	.	.	.	.	.	.
Paspalum vaginatum	70 (35)	80 (48.8)	*	90 (42.3)	70 (84.2)	.	.	.	.
Pluchea camphorata	.	.	.	.	30 (8.8)	.	.	.	.
Schoenoplectus americanus	10 (70)	10 (72.5)	21.4 (33.5)	.	10 (10)	.	.	.	.
Schoenoplectus maritimus	30 (4.4)	35 (3.4)	.	.	.	.	.	.	.
Schoenoplectus robustus	.	.	71.4 (3.9)	.	50 (11)	.	12.5 (2)	.	.
Setaria magna	.	.	.	.	10 (1)	.	.	.	.
Solidago sempervirens	.	.	7.1 (0.5)	.	.	.	.	.	.
Spartina alterniflora	5 (0.5)	15 (0.5)	.	.	.	.	87.5 (60)	87.5 (1.6)	87.5 (90)
Spartina patens	80 (41)	70 (55.9)	64.3 (30.7)	70 (10.6)	10 (80)	.	.	.	.
Symphyotrichum sp.	.	.	.	.	20 (13.5)	.	.	.	.
Symphyotrichum tenuifolium	10 (0.3)	.	14.3 (10.3)	.	.	.	.	.	.
Typha sp.	5 (0.5)	5 (10)	7.1 (10)	.	.	.	.	.	.
Vigna luteola	.	.	7.1 (0.5)	.	.	.	.	.	.

* *Paspalum vaginatum* most likely present in 2004. May have been confused with *Distichlis spicata*. Both species were most likely present in 2004.

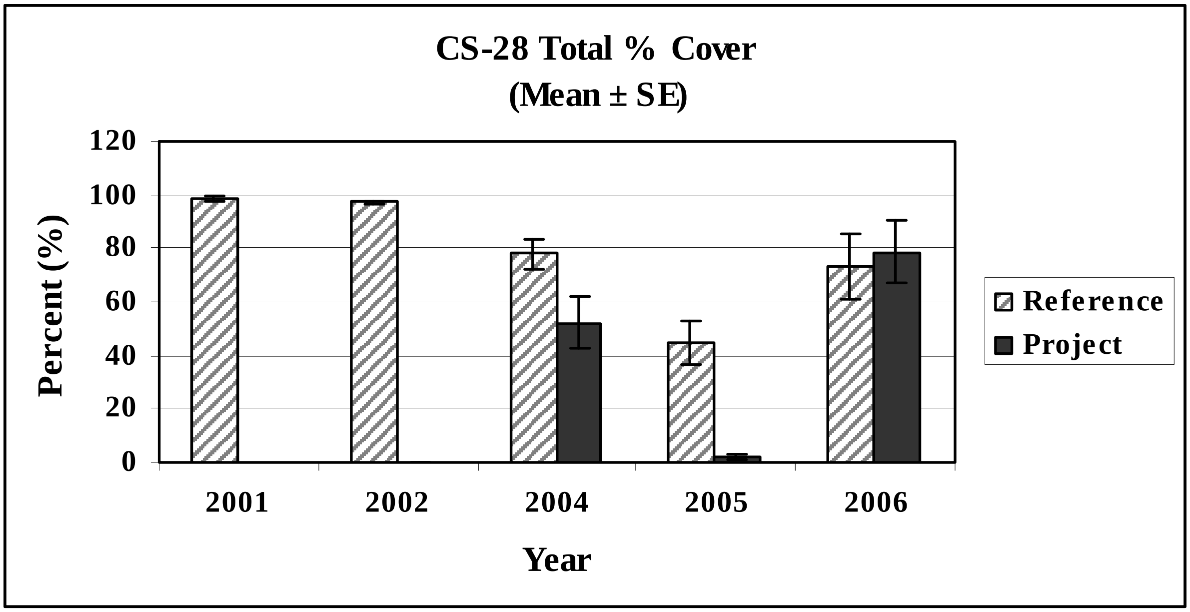

Figure 10. Total % Cover of emergent vegetation at sites in pre-existing marsh adjacent to and within the CS-28 Cycle I dredge deposition area.

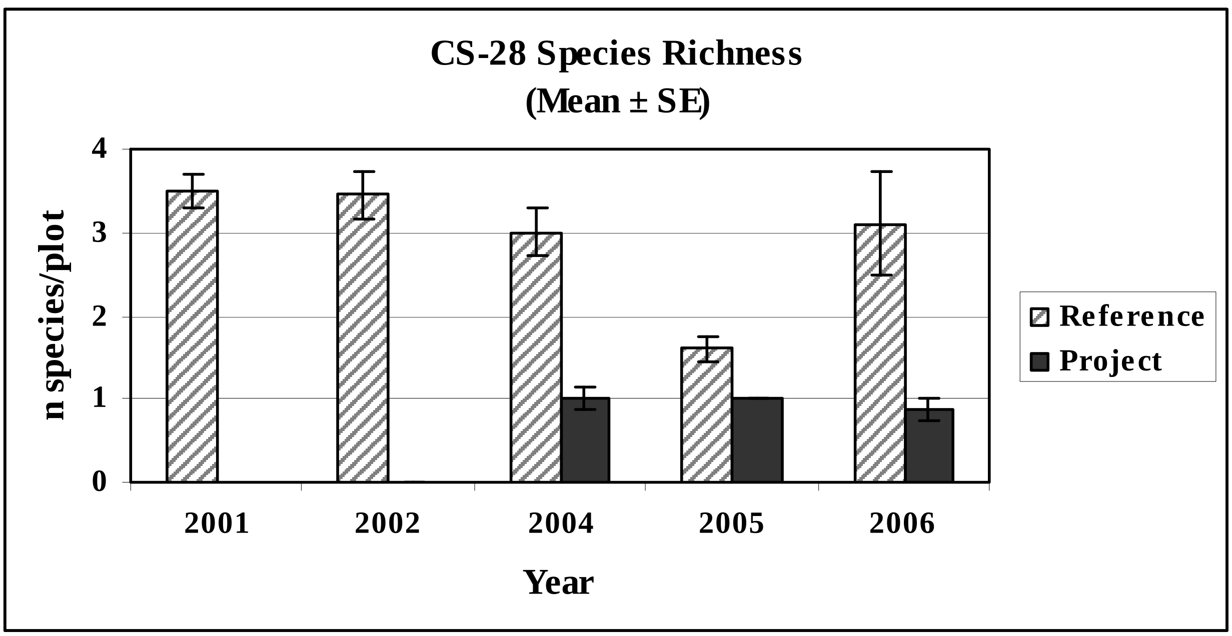

Figure 11. Species Richness at sites in pre-existing marsh adjacent to and within the CS-28 Cycle I dredge deposition area.

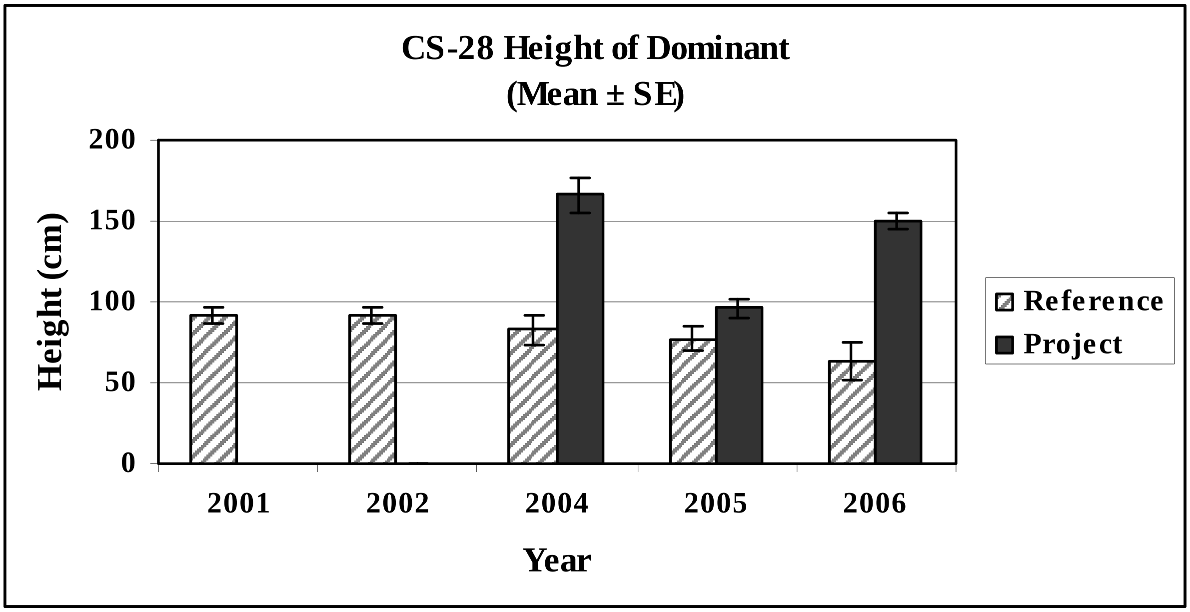

Figure 12. Height of dominant vegetation at sites in pre-existing marsh adjacent to and within the CS-28 Cycle I dredge deposition area.

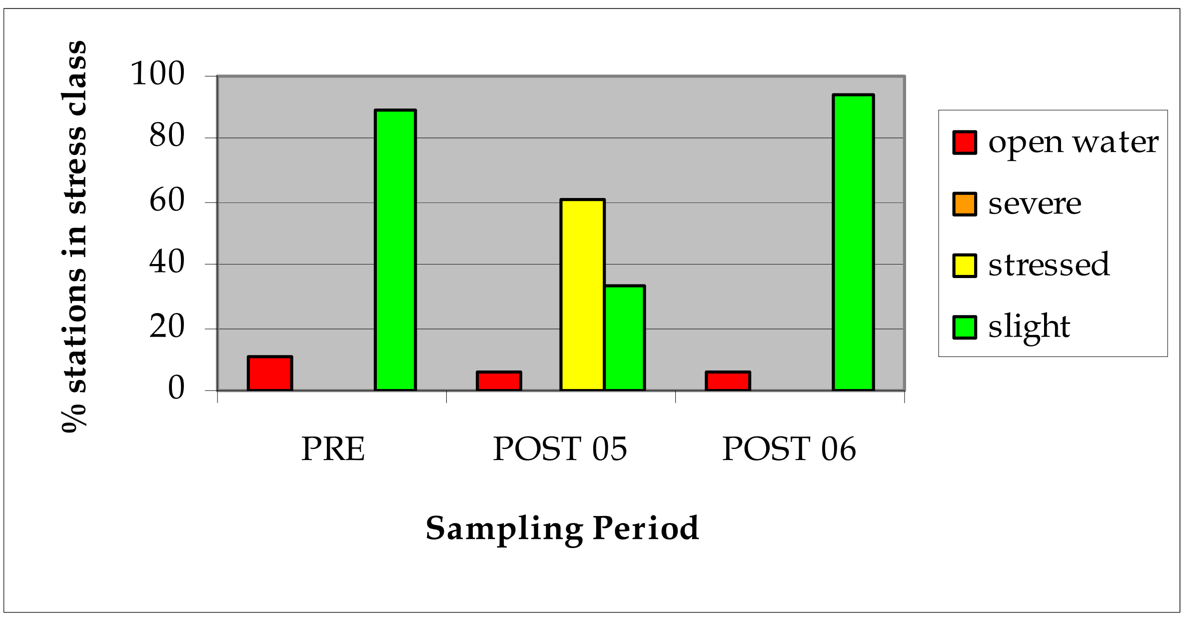

Figure 13. Percent of CS-28 vegetation stations in each stress class before and after Hurricane Rita (n=23).

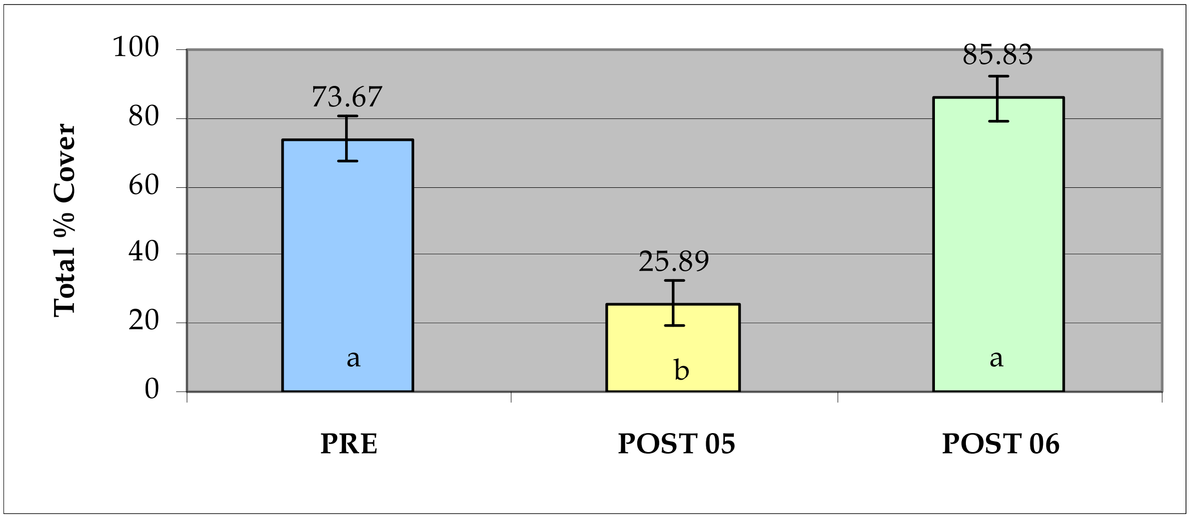

Figure 14. Total % Cover of vegetation at CS-28 Pre- and Post-Hurricane Rita. LS Mean ± SE (n=23 stations). $F_{2, 68}$=23.28, p<0.0001. Levels connected by the same letter are not significantly different.

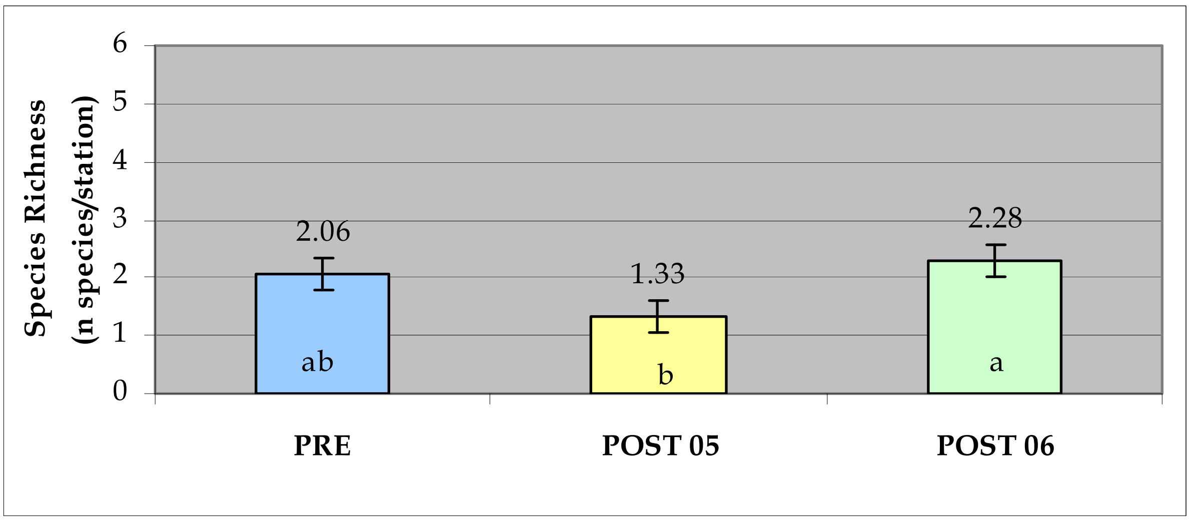

Figure 15. Species Richness at CS-28 Pre- and Post-Hurricane Rita. LS Mean ± SE (n=23 stations). $F_{2, 68}$=3.27, p=0.0463. Levels connected by the same letter are not significantly different.

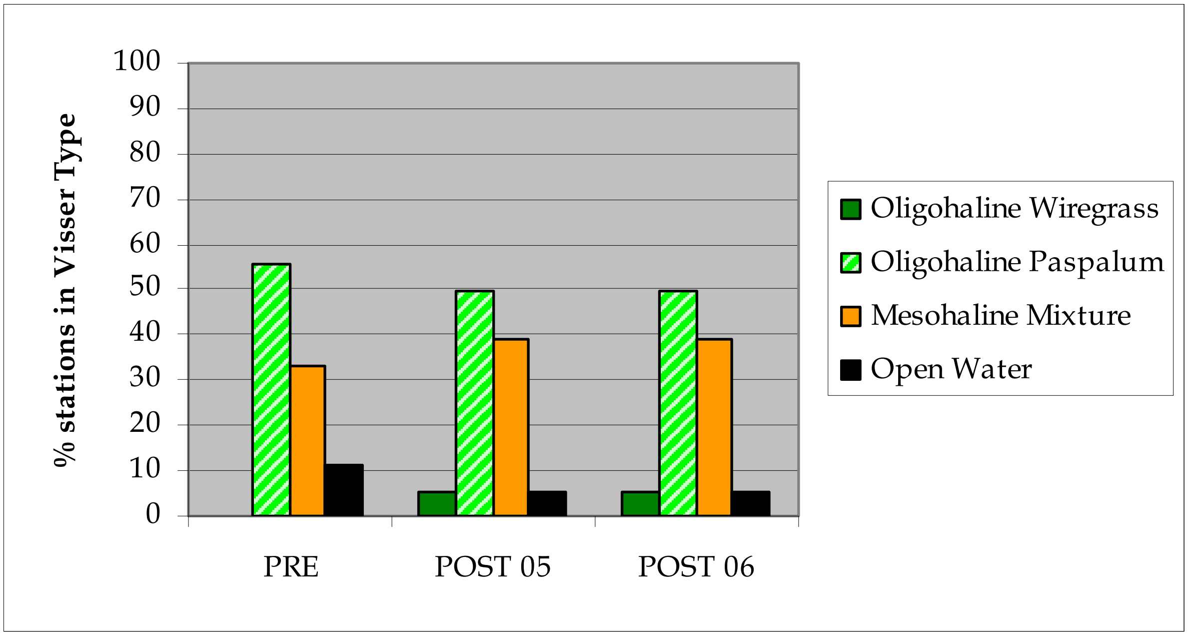

Figure 16. Percent of CS-28 vegetation stations in each Visser vegetation type before and after Hurricane Rita (n=23).

V. Conclusions

a. Project Effectiveness

The major objective of the Sabine Refuge Marsh Creation Project is to create new vegetated marsh and to enhance and protect existing surrounding marsh vegetation. Over 200 vegetated acres were created in Cycle I and another 230 acres are anticipated from each new Cycle. Cycle III should help protect the area from saltwater intrusion (figure 2). The specific goal of building marsh that settles to 2.5 ft MLG after five years cannot be evaluated at this time. The specific goal of reducing land loss within the project area has been achieved by creating land in Cycle I.

b. Recommended Improvements

There are no specific recommended improvements at this time.

c. Lessons Learned

Pre-dug trenasses were excavated and spoil resulting from same was distributed over 200 linear foot reaches alternately to each side of the trenasse excavations in the Cycle I Marsh Creation Area prior to the deposition of the spoil material. The pre-dug trenasses were excavated to elevation -5.0 MLG Datum with a 30 foot bottom width. The theory behind "pre-dug" trenasses was that, once the new spoil consolidated and dried, then depressed shallow channels would result at the excavated locations and trenasses or channels would then be present to serve as ingress/egress for tidal water and marine organism movement within the new marsh creation site. The theory and end product of the "pre-dug" trenasse effort proved very successful as at one year-post construction, very adequate trenasses were apparent and effective.

However the construction effort for the "pre-dug" trenasses was costly and the resulting spoil generated and placed within the marsh creation area created a problem that eventually hindered the placement of the dredge spoil to construct the marsh creation area. During that final work for the marsh creation, it required a constant effort, via marsh hoe/marsh buggy type equipment, to reduce the height of the spoil from the "pre-dug' trenasses to allow "flow" of the dredge spoil placed for the marsh creation work to the south and west portions of the site.

During February 2002, one year post-construction of Cycle I, personnel of the LDNR/ Lafayette Field Office conducted a test to create trenasses in the marsh creation area via tracking a marsh hoe/marsh buggy piece of equipment through the spoil material deposited one year earlier. These tests proved satisfactory with but one pass of the equipment developing trenasses that were deemed to be adequate by LDNR and U.S.

Fish and Wildlife Service (USFWS) personnel that observed the performance of the test.

Accordingly, the lesson learned was that the desirable post-construction trenasses can be created by a very cost effective procedure of simply tracking a marsh hoe/marsh buggy along desired routes to develop trenasses through marsh creation areas. The work effort should be performed approximately one year post-construction. Significant benefits of employing this lesson learned are (1) reduced costs and (2) more productive and efficient placement of spoil materials within the marsh creation area.

VI. Literature Cited

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Appendix A
Response of Emergent Vegetation to Hurricane Rita

METHODS

In response to Hurricane Rita in 2005, 163 LDNR emergent vegetation stations were sampled in the late summer/early fall of 2005 and 2006. The stations represented a subset of the LDNR vegetation stations established on the Chenier Plain to monitor CWPPRA projects including CS-20 (40 stations), CS-17 (24 stations), CS-31 (30 stations), CS-28 (18 stations), ME-04 (18 stations), and ME-11 (12 stations) (Figure 1).

After the 2005 data collection, the stations were classified according to the level of disturbance/stress they had experienced and the resulting vegetation response. Stations were classified as either Open Water, Severely Stressed, Moderately Stressed (also classified as "Stressed"), or Slightly Stressed (Table 1). Data collected in 2006 and the last CWPPRA data available from before Hurricane Rita were also classified by stress.

At each station, a marker had been previously established. A 2m x 2m square was placed on the marsh and Total % Cover, % Cover of each species present in the plot, and height of the dominant species were collected. Presence of other species that were not in the plot, depth of surface water, salinity, and sometimes porewater salinity were noted.

The compiled vegetation data from the three sampling periods were utilized to classify each site according to Visser's vegetation types of the Chenier Plain (Visser et al. 2000). The pre-storm types were determined with photographs and Visser Type definitions. The stations were reclassified after the 2005 and 2006 sampling. Stations that did not fit into any Visser Type after the storm maintained their pre-storm types. If the dominant species shifted to an identifiable Visser Type, the station was reclassified.

The data were analyzed to determine the impact of the storm on Total % Cover and Species Richness at three levels; overall by year (all 163 stations), by CWPPRA restoration project (7 projects), and with Visser vegetation type (6 types).

Table 1. Vegetation Stress Classifications used in this survey.

Vegetation Classification	Description
Open Water	Vegetation has been ripped out. 100% of plot is open water.
Severely Stressed	>50% of plot is open water. Vegetation is weak.
Stressed	Perennial grasses and herbs are mostly dead (>50%) or >25% open water. Often dominated by annual shrubs.
Slightly Stressed	Perennial grasses are healthy and vigorous.

RESULTS

COASTWIDE

Prior to Hurricane Rita, most of the vegetation stations utilized for this survey were healthy and intact (>80%). Following the hurricane in 2005, most of the stations were stressed (67%) or worse (20%). A year later in 2006, over 50% of the stations were back to pre-storm stress levels. Severely stressed stations either converted to open water or recovered to a less stressed state. Most stations that had been converted to open water in 2005 did not recover (figures 1 and 2).

ANOVA was utilized to test for differences in Total % Cover (% of plot covered by living vegetation) and Species Richness (n species per plot) over the three sampling periods, by CWPPRA Project, and with Visser vegetation type classifications.

Total % Cover was significantly different over time (figure 3). Post-ANOVA comparisons (Tukey's HSD) revealed that all three sampling periods were significantly different, meaning Total % Cover for 2006 is still significantly lower than Pre-Hurricane Rita levels. Species Richness was also significantly different over the three sampling periods (figure 4). The number of species present before Rita and in 2006 were statistically the same.

Most of the projects had significant differences over time for both Total % Cover and Species Richness, with trends similar to the overall model (figures 3 and 4). Post-ANOVA comparisons were utilized to determine whether the projects had recovered to pre-storm levels for both Cover and Richness (Table 2).

Visser Type was added to the overall model and the interaction between Visser Type and time was analyzed. Both models had significant differences in Visser Type over time (figures 5 and 6). Post-ANOVA contrasts of Cover and Richness Pre-Rita and Post 06 for each Visser Type revealed that all Visser Types were the same in Total Cover (had recovered to pre-storm levels) and in Richness except Fresh Bulltongue (mostly in the ME-04 project area), which had not recovered, and in Oligohaline Wiregrass, which had significantly more species per plot post-Rita than before (up from 2.83 to 3.22 species).

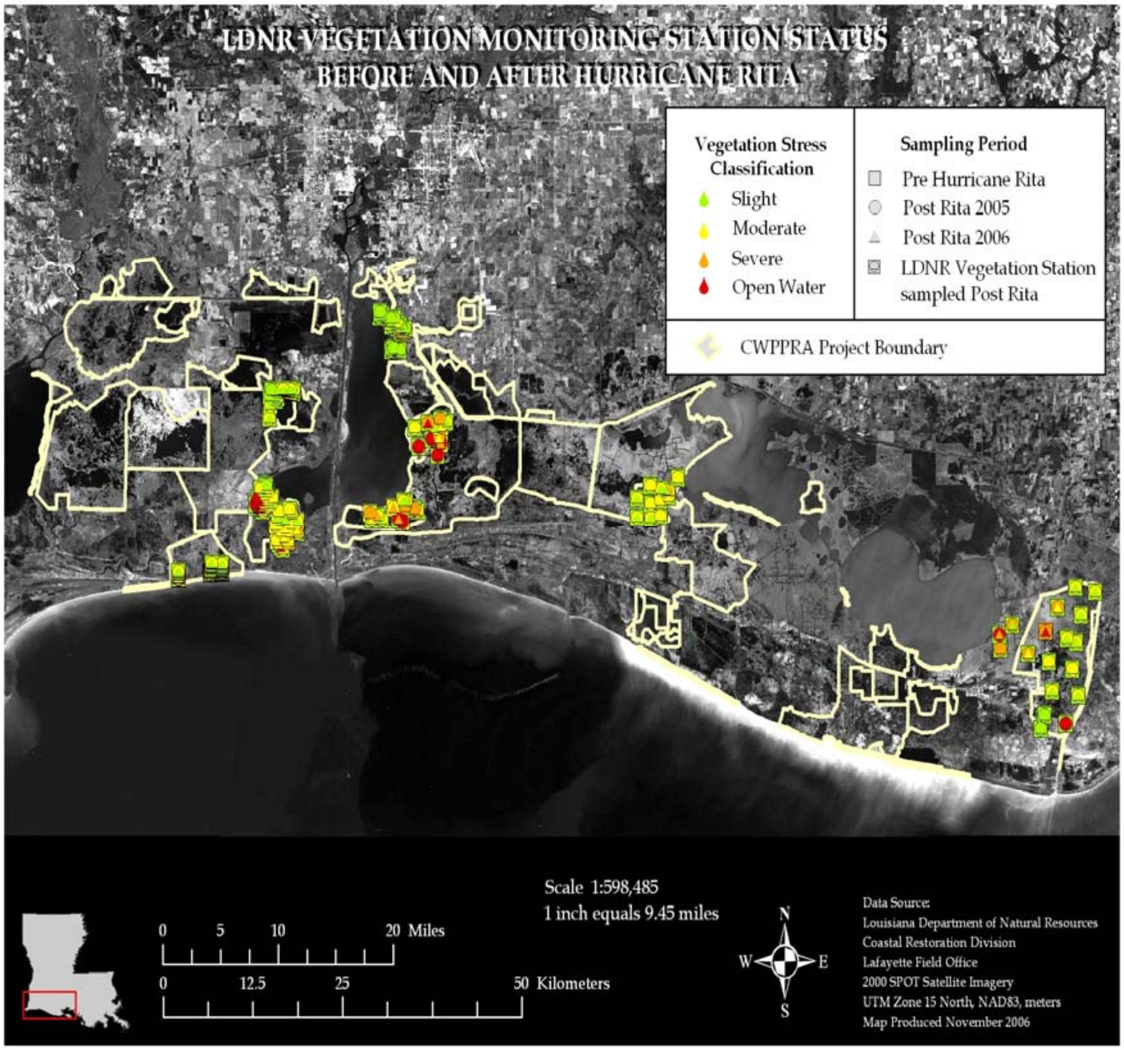

Figure 1. Location and status of LDNR vegetation stations sampled after Hurricane Rita. Stations were classified according to storm induced stress as described in Table 1.

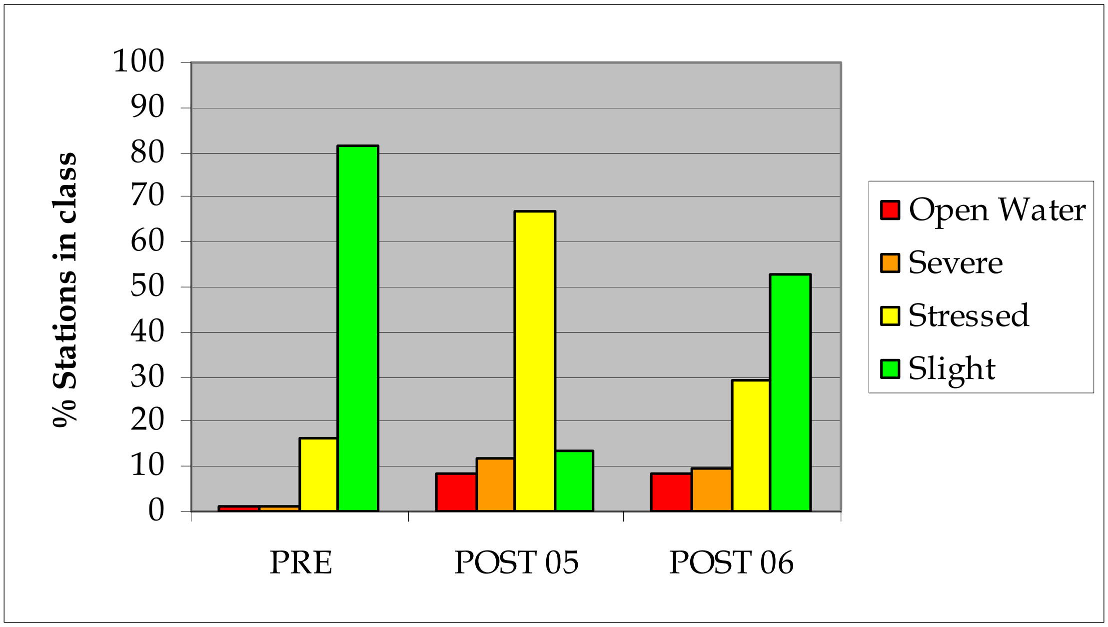

Figure 2. Percent of LDNR vegetation stations in each stress class before and after Hurricane Rita (n=163).

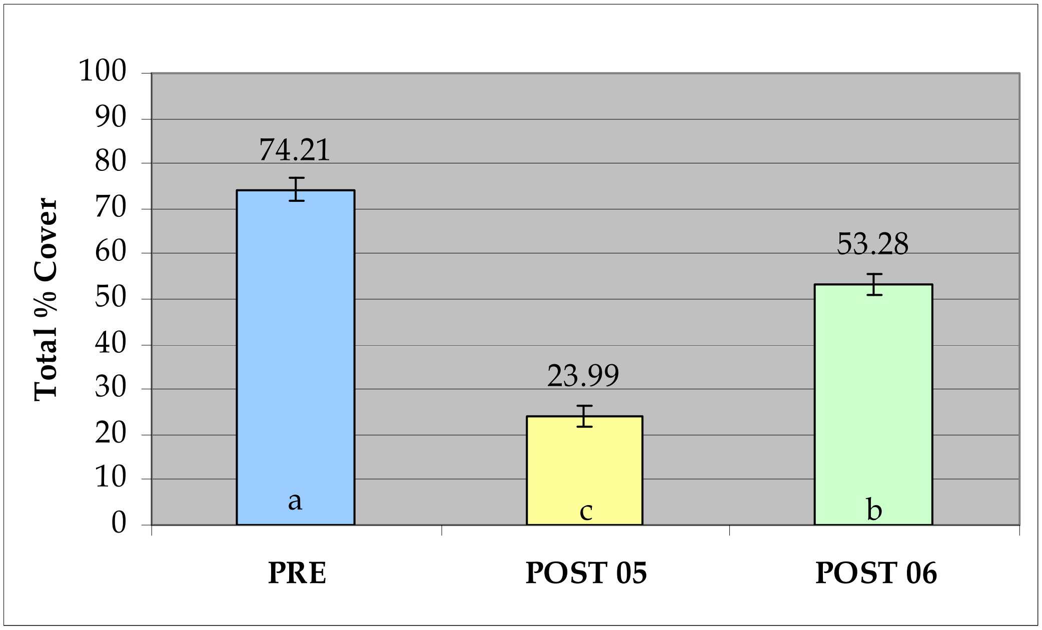

Figure 3. Total % Cover Pre- and Post-Hurricane Rita. LS Mean ± SE, n=163 stations, $F_{2,\ 488}$=109.7, p<0.0001. Levels not connected by same letter are significantly different.

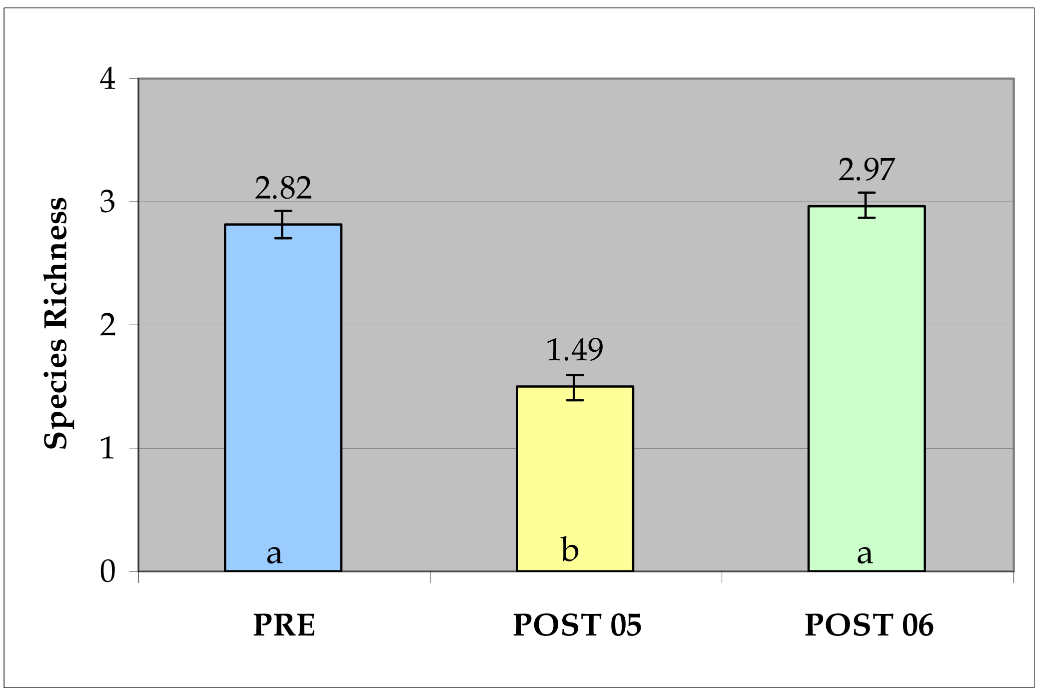

Figure 4. Species Richness Pre- and Post-Rita. LS Mean ± SE, n=163 stations, $F_{2,\ 488}$=56.8, p<0.0001. Levels not connected by same letter are significantly different.

Table 2. CWPPRA Project ANOVA Results

Results of Post-ANOVA comparisons by CWPPRA Project Summary of 2006 levels relative to Pre-Hurricane Rita and 2005		
Project	**Total Cover**	**Species Richness***
CS-17	Not Recovered	Recovered
CS-20	Not Recovered	Recovered
CS-21	Recovered	Recovered
CS-28	Recovered	No Rita Impact.
CS-31	Not Recovered	Recovered
ME-04	Not Recovered	Recovered
ME-11	No Rita Impact	Recovered

*****Although the number of species present returned to Pre-Rita levels at most projects, many of the species present were disturbance species.

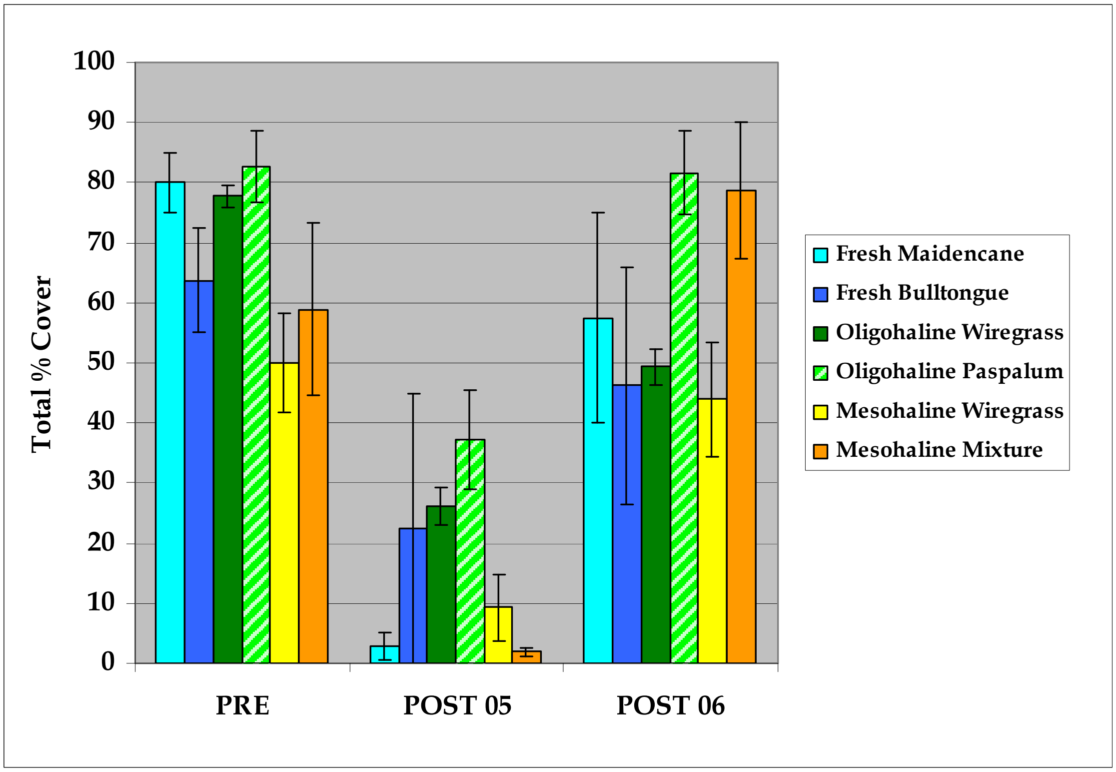

Figure 5. Total % Cover by Visser vegetation type. LS Mean ± SE, n=163 stations, $F_{17, 488}$=17.0, p<0.0001.

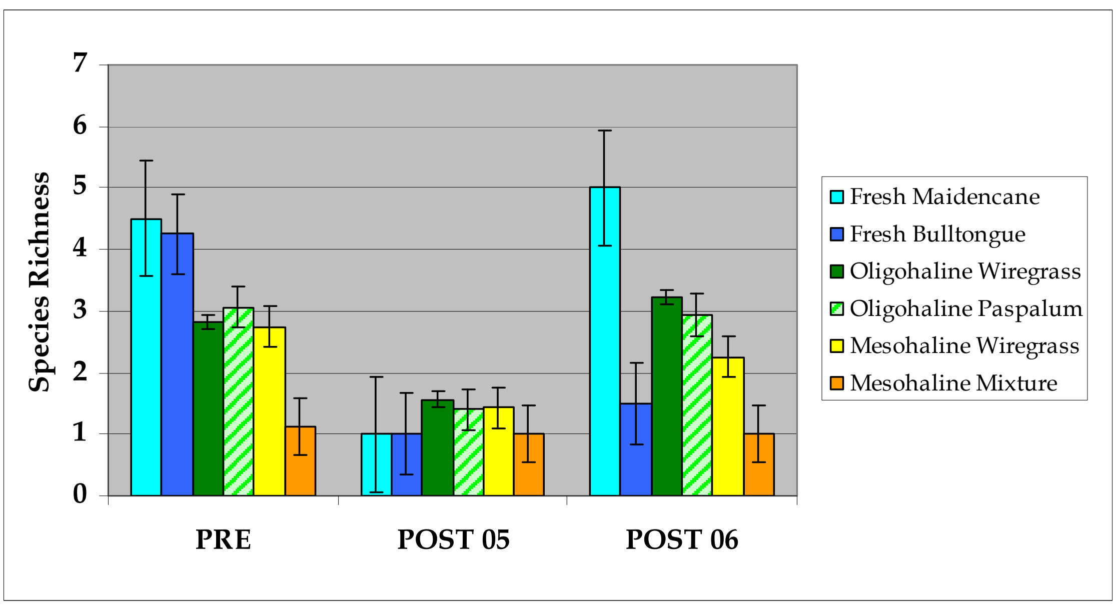

Figure 6. Species richness by Visser vegetation type. LS Mean ± SE, n=163 stations, $F_{17, 488}$=10.9, p<0.0001.

REFERENCES

Visser, J. M., C. E. Sasser, R. H. Chabreck, and R. G. Linscombe. 2000. Marsh vegetation types of the Chenier Plain, Louisiana, USA. Estuaries 23(3):318–327.