State of Louisiana
Department of Natural Resources
Coastal Restoration Division and
Coastal Engineering Division

2007 Operations, Maintenance, and Monitoring Report

for

Cameron Creole Plugs Project

State Project Number CS-17
Priority Project List 1

August 2007
Cameron Parish

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For
Cameron Creole Plugs Project (CS-17)

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I. Introduction

The Cameron Creole Watershed consists of 64,000 acres (25,900 ha) of brackish, intermediate, and fresh marsh located along the east side of Calcasieu Lake in the Calcasieu/Sabine Basin in Cameron Parish and is part of the Sabine National Wildlife Refuge. The Calcasieu Ship Channel has allowed salt water to flood the interior marshes surrounding Calcasieu Lake. As a result, approximately 63,000 acres (25,496 ha) of brackish, intermediate, and fresh marsh on the east side of Calcasieu Lake were lost between 1950 and 1970 (Delany 1991).

In 1989, a levee and five (5) water control structures were constructed by the Soil Conservation Service along the eastern shore of Calcasieu Lake. The structures were intended to reduce the movement of salt water into the watershed. A borrow canal was also constructed along the wetland side of the levee which may further prevent saltwater intrusion into the marsh. In order to increase control of water flow, isolate management areas, and prevent further saltwater intrusion in the Cameron-Creole Watershed, the CS-17 plug project placed two plugs in the borrow canal in 1997 (U.S. Fish and Wildlife Service [USFWS] 1991).

The CS-17 project is comprised of 14,471 acres (5,858 ha) of brackish marsh divided into three project areas and two reference areas (figure 1). The plug south of Mangrove Bayou, was intended to influence 6,082 acres (3,462 ha) in the northern project area (figure 2). In order to investigate the effect of the plug south of Mangrove Bayou on the surrounding marshes, water flow and the response of emergent vegetation were measured in the northern project area.

The plug south of Grand Bayou was intended to allow for separate operation of the Grand Bayou and Lambert Bayou structures and was expected to affect 6,606 acres (2,675 ha) of brackish marsh in the southern project area (figures 1 and 2). In order to determine if the borrow canal plugs reduced water level in the southern project area, duration of flooding was measured and emergent vegetation was sampled.

The plugs were also expected to affect 1,783 acres (720 ha) of broken marsh and shallow open water ponds from 0.5 ft to 2.0 ft (0.15-0.61 m) to the east of Grand Bayou (figures 1 and 2). The ponds support stands of submerged aquatic vegetation (SAV). The ponds in the eastern project area were monitored for affects of the plug project on submerged aquatic vegetation. Project construction was completed in February 1997.

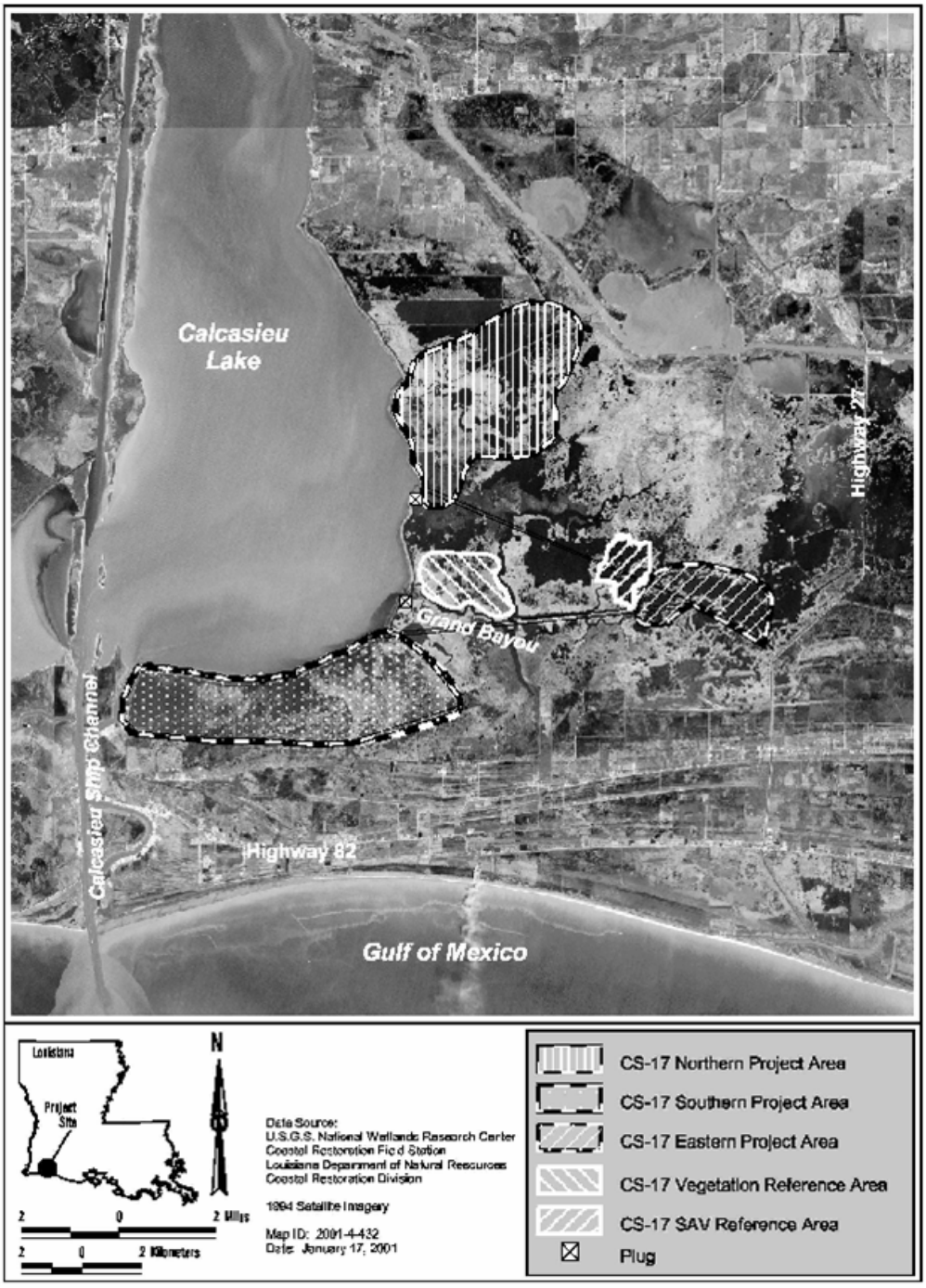

Figure 1. Cameron Creole Plugs (CS-17) project and reference areas.

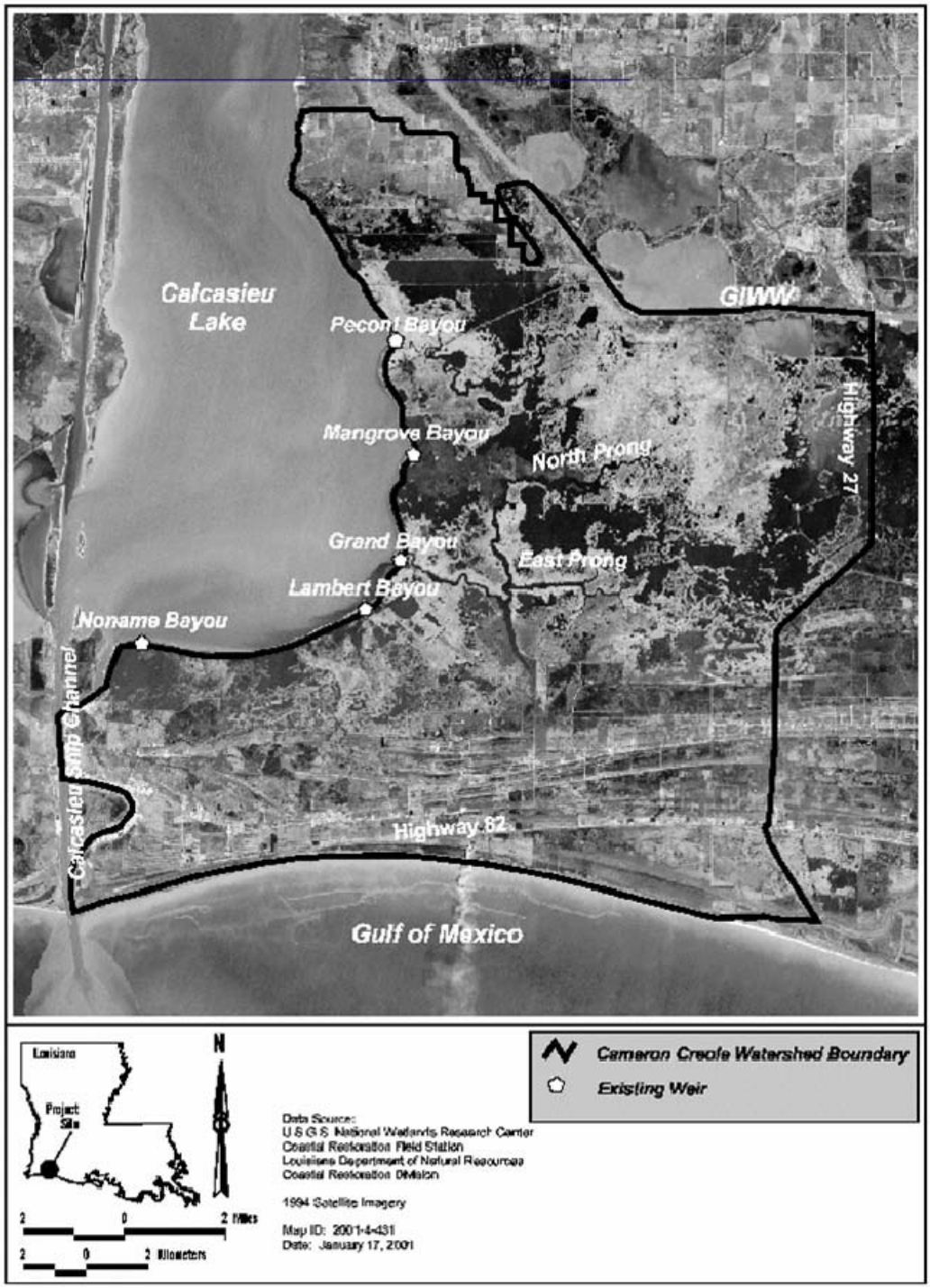

Figure 2. Cameron Creole Plugs (CS-17) project boundaries and structures.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Cameron Creole Plugs Project (CS-17) 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, Louisiana Department of Natural Resources (LDNR) 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. The annual inspection report also contains a summary of maintenance projects which were completed since completion of constructed project features and an estimated projected budget for the upcoming three (3) years for operation, maintenance and rehabilitation. The three (3) year projected operation and maintenance budget is shown in Appendix C.

An inspection of the Cameron Creole Plugs Project (CS-17) was held on April 17, 2007, under partly cloudy skies and mild temperatures. In attendance were Dewey Billodeau and Mel Guidry from LDNR, and Jim Ashfield with the U.S. Fish and Wildlife Service (USFWS). All parties met at the Cottonwell Road boat launch in Cameron Parish, La. The annual inspection began at approximately 11:00 a.m. at the Grand Bayou structure.

The field inspection included a complete visual inspection of the entire project site. Staff gauge readings and existing temporary benchmarks where available were used to determine approximate elevations of water, steel bulkhead structures, and other project features. Photographs were taken at each project feature (see Appendix B) and Field Inspection notes were completed in the field to record measurements and deficiencies (see Appendix D).

b. Inspection Results

Structure #2—Grand Bayou structure

The structure is in good condition since the maintenance repair project in 2005; however, there is bank erosion on both ends of the sheet pile wall which will need to be addressed with rock rip rap. (Photos: Appendix B, Photos 1 & 2).

Structure #1—Mangrove Bayou structure

This structure is also in good condition, but has been vandalized. Two (2) sections of 8” x 12” Seatimber Composite Marine Timber have been removed from the boat guide and need to be replaced along with the stainless steel hardware. There is bank erosion on both ends of the sheet pile wall which will need to be addressed with rock rip rap. (Photos: Appendix B, Photos 3 & 4).

II. Maintenance Activity (continued)

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

None at this time.

ii. Programmatic/ Routine Repairs

Repair bank erosion at each end of the sheet pile wall at both structures and replace boat guide timbers as described above.

d. Maintenance History

General Maintenance:
Below is a summary of completed maintenance projects and operation tasks performed since February 1997, the construction completion date of the Cameron Creole Plugs Project (CS-17).

2005 – Cameron Creole Maintenance Project – LDNR: (M & M Electric) This maintenance project included the removal and replacement of existing handrails with hot dipped galvanized handrails, and installation of a boat guide in the existing boat bay. Construction was completed in May 2006. The cost associated with the engineering, design, and construction of the Cameron Creole Watershed Maintenance Project is as follows:

Construction:	$ 67,777.00
Engineering & Design:	$ 4,292.40
Construction Administration:	$ 3,000.00
Construction Oversight/As builts:	$ 2,841.17
TOTAL CONSTRUCTION COST:	**$ 77,910.57**

III. Operation Activity

a. Operation Plan

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

b. Actual Operations

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

IV. Monitoring Activity

Pursuant to a 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-17 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. There are seven CRMS-*Wetlands* sites in the CS-17 project area.

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 sites in the CS-17 project area (Appendix A).

a. Monitoring Goals

The object of the Cameron Creole Plugs project is to enhance and improve marsh condition in the northern, southern, and eastern project areas, and to improve present structural management capabilities.

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

1. Reduce the duration of flooding in the southern project area.

2. Reduce water flow in the borrow canal in the northern project area.

3. Increase cover of marsh vegetation in the northern and southern project areas.

4. Increase the relative frequency of occurrence of SAV in the eastern project area.

b. Monitoring Elements

Aerial Photography:
To measure wetland to open water ratios and to map habitat types in the project area, 1:24,000 scale near-vertical color-infrared aerial photography was obtained pre-construction on November 1, 1993. The original photographs were checked for flight accuracy, color correctness, and clarity and were subsequently archived. The photography was photo interpreted and classified to the subclass habitat level. The habitat delineations were

transferred to 1:6,000 scale Mylar base maps, digitized according to standard operating procedures by United States Geological Survey/National Wetlands Research Center (USGS/NWRC) personnel (Steyer et al. 1995, revised 2000). No further flights are scheduled.

Salinity:

To monitor the effects of the plugs on salinity in the project and reference area, salinity was measured at four continuous stations. One recorder was placed in the northern project area, one in the southern project area, one in the vegetation reference area (in the borrow canal), and one outside of the levee surrounding the watershed in Calcasieu Lake (figure 3). These recorders were removed in July 2004 as recommended in the 2003 comprehensive report. Discrete salinity readings were taken by refuge personnel at 25 existing USFWS monitoring stations, 6 located inside the project areas and 19 located outside the project areas, every two weeks (bi-weekly) from January 1990 to December 1999. Maximum and minimum mean salinity were calculated for each station over the entire sampling period. Salinity will be monitored at seven CRMS-*Wetlands* stations beginning in fall of 2007.

Water Flow:

Flow was measured in four channels for four consecutive days in May 1996, pre-construction, and was not measured post-construction.

Water Level:

To monitor the effects of the plug project on inundation in the project and reference area, water level was recorded hourly at four continuous stations and at six staff gauges (three located within the project area and three located outside the project area). These recorders were removed in July 2004 as recommended in the 2003 comprehensive report (figure 3) surveyed to NAVD. Staff gauges were monitored bi-weekly by USFWS personnel. Water level will be monitored at seven CRMS-*Wetlands* stations beginning in fall of 2007.

Emergent Vegetation

Species composition, percent cover, and height of dominant plants in $2m^2$ vegetation plots (1.4 m x 1.4 m) were determined at 60 sampling points [25 in the northern portion, 25 in the southern portion, and 10 in the vegetation reference area (figure 4)] along transects, using the modified Braun-Blanquet method (Steyer et al. 1995). Emergent vegetation data were collected pre-construction in October 1996 and post-construction in October 1997, September 2000, and September 2002. Vegetation will be monitored at seven CRMS-*Wetlands* stations beginning in fall of 2007. A subset of the stations were sampled for post-Rita vegetation analysis (Appendix A).

Submerged Aquatic Vegetation (SAV):

Species composition and relative frequency of occurrence were determined for SAV in two ponds in the eastern project area and two ponds in a SAV reference area (figure 4). Presence or absence of SAV was recorded at no less than 25 random points along two transects in each pond, using the rake method (figure 4) (Chabreck and Hoffpauir 1962; Nyman and Chabreck

1996). SAV was monitored pre-construction in October 1996 and post-construction in

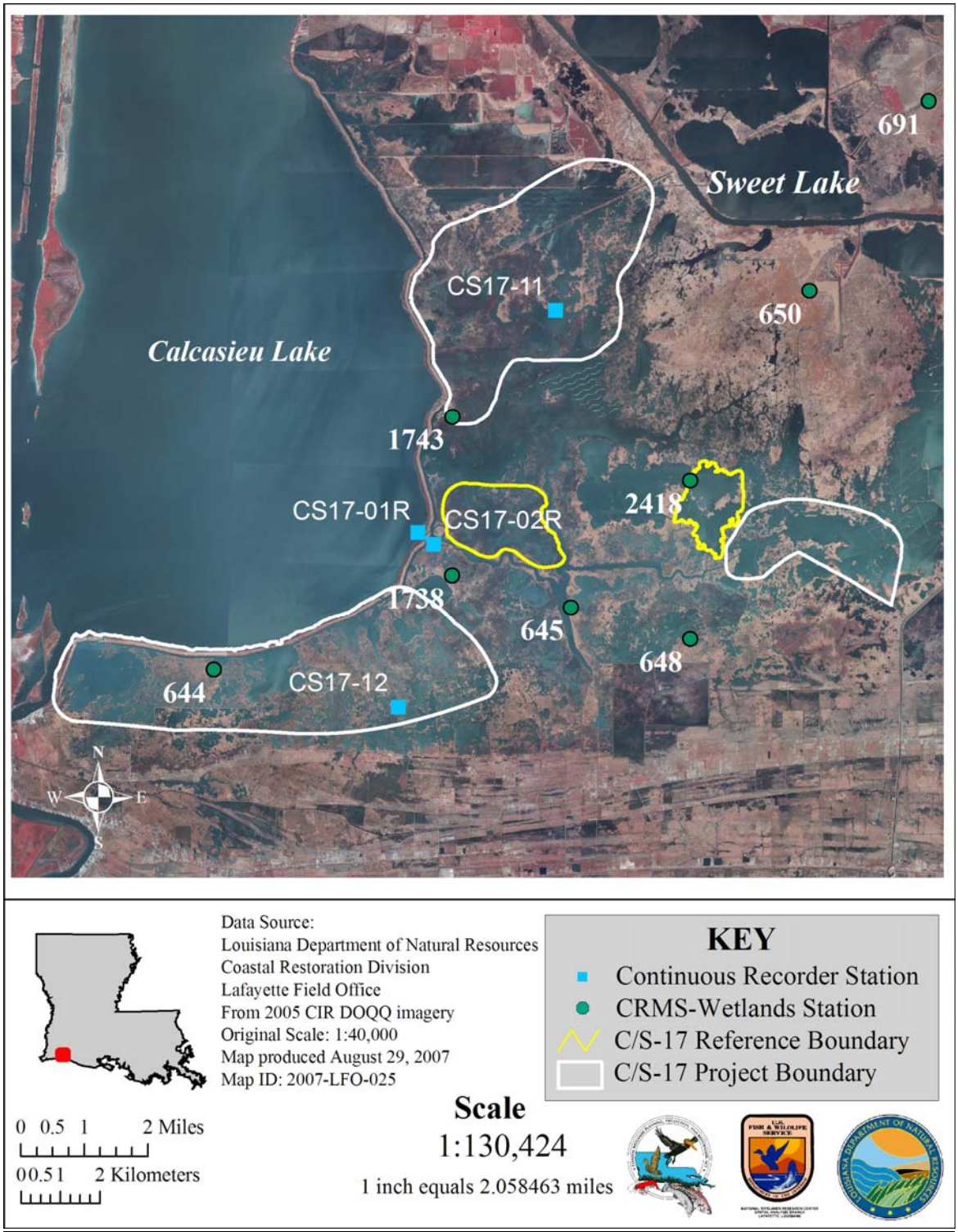

Figure 3. Cameron Creole Plugs (CS-17) hydrologic monitoring station locations and CRMS station locations on 2005 post-Hurricane Rita aerial photography.

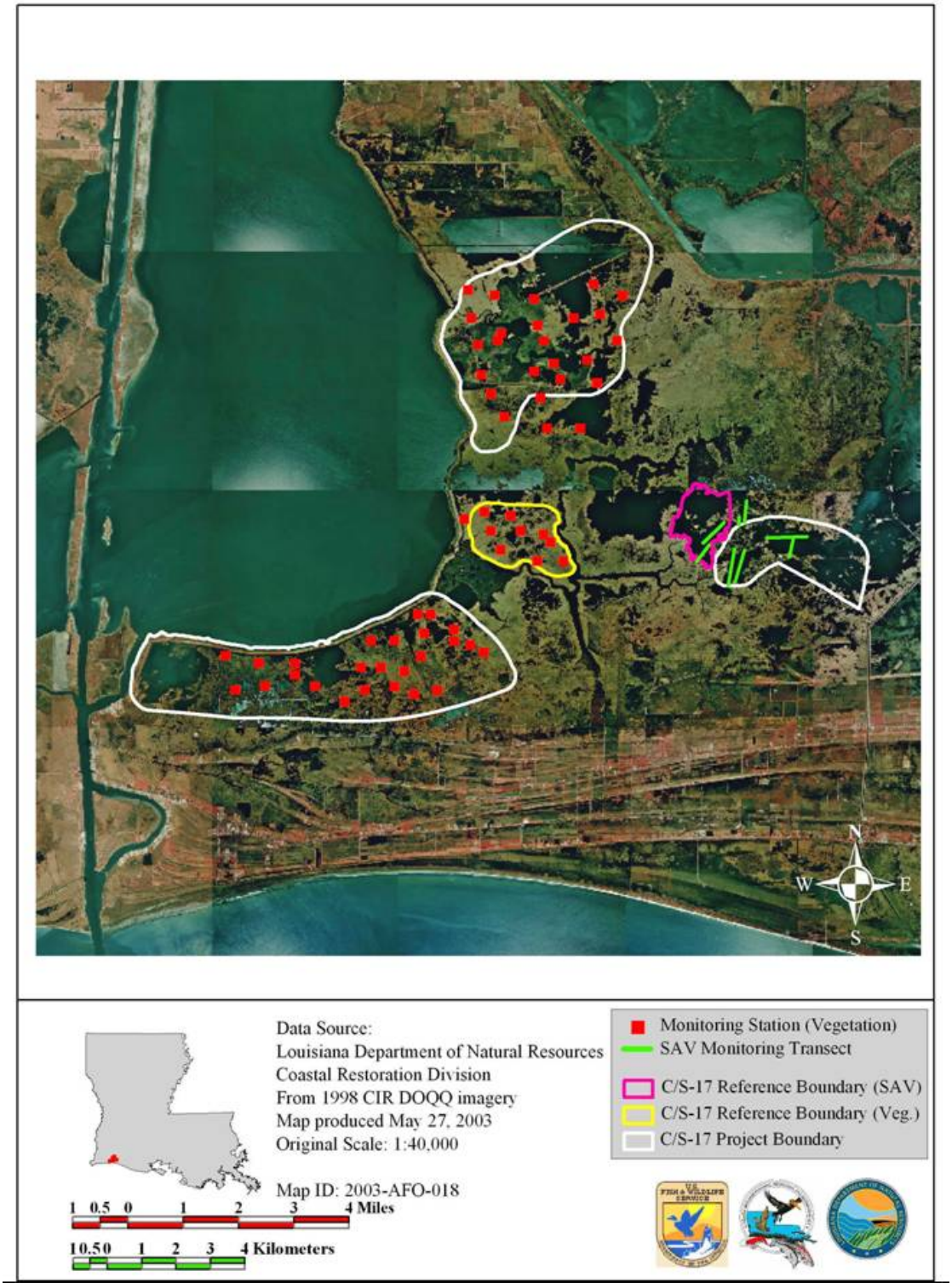

Figure 4. Cameron Creole Plugs (CS-17) vegetation and SAV sampling transects.

October 1997, September 2000, and September 2002. Means of relative frequency of occurrence of each species, species richness, and water depth and salinity were calculated and compared in the eastern project and SAV reference areas.

c. Preliminary Monitoring Results and Discussion

Habitat Mapping:
The marsh in all of the project and reference areas was dominated by salt marsh in 1993 when the pre-construction aerial photography was obtained (figure 5 and table 1). The project and reference areas used for vegetation monitoring were composed of about half land and half water and the vegetation reference area was over 70% land. The SAV Project and Reference areas were mostly water. Post-Hurricane Rita land to water ratios have not been calculated but it is apparent from post storm aerial photography (figure 3) that all of the areas have more open water and less land now than they did in 2003.

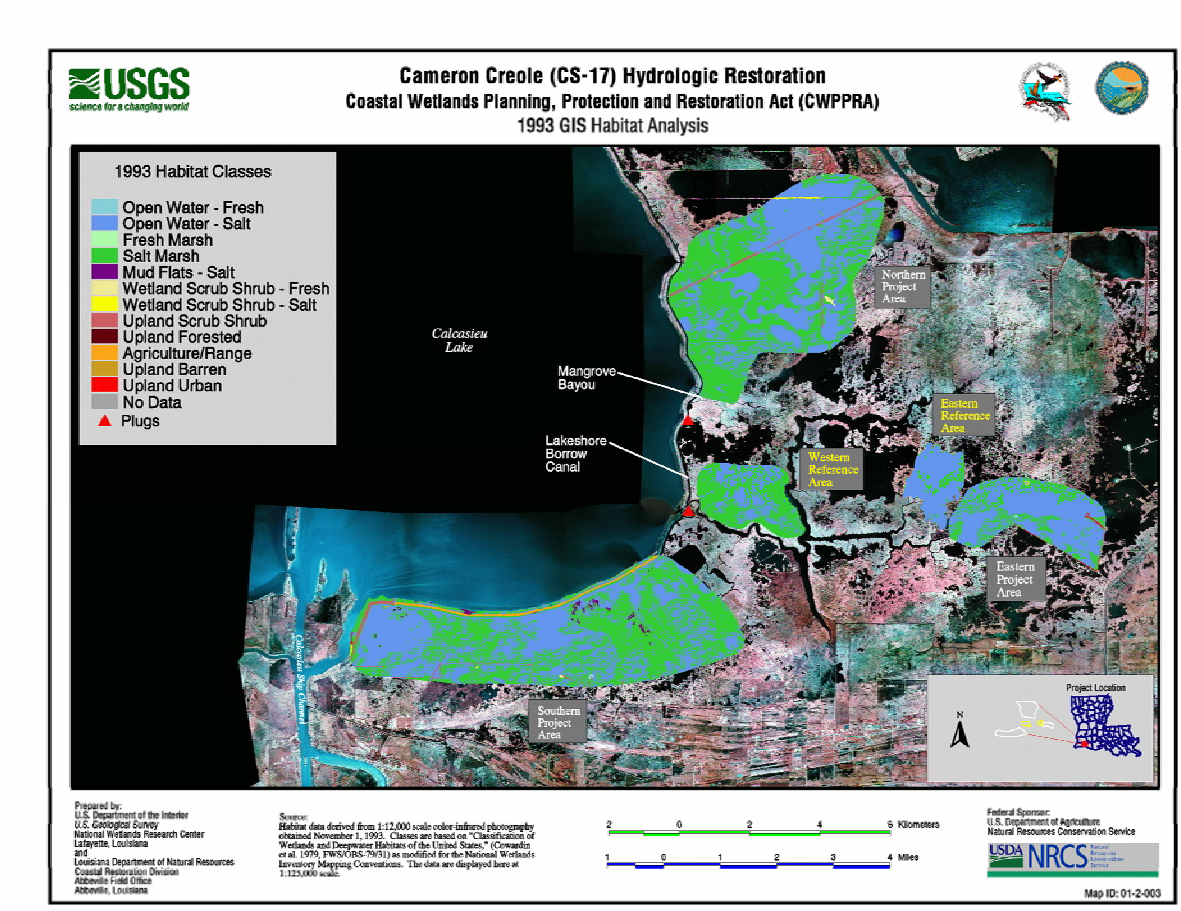

Figure 5. Habitat analysis in the Cameron Creole Plugs project (CS-17) and reference areas based on aerial photography obtained November 1, 1993.

Table 1. % Land and Open Water in each Area

	Project Area			Reference Area	
	Northern	Southern	Eastern	SAV	Vegetation
% Land	54.9	51.7	26.2	9.9	72.8
% Water	45.1	48.3	73.8	90.1	27.2

Soils:
Soil samples were to be collected in September 1996 and October 1997. Soil samples were not collected in September 1996 due to the fluidity of the soil but were collected in 1997 post-construction. Mean soil salinity, organic matter %, and bulk density from 1997 are presented in table 2.

Table 2. Mean ± Std Err of soil variables for data collected October 1997 in the Cameron Creole Plugs (CS-17) project.

Site	N	Soil Salinity (ppt)	Organic Matter %	Field Bulk Density (gm/cm^3)
Northern project area	25	5.0 ± 0.7	48.3 ± 3.7	0.13 ± 0.01
Southern project area	25	8.3 ± 0.6	59.3 ± 4.1	0.11 ± 0.01
Eastern reference area	10	2.8 ± 0.4	62.6 ± 4.7	0.11 ± 0.01

Salinity:
Hourly salinity and water level data were collected from 1994 to 2004 at four stations (figure 3). Salinity was consistently higher at CS17-01R, which was influenced by salinity in the lake (figure 6). Salinity measurements at CS17-02R (inside the plugs) and CS17-12 (southern project area) were similar throughout the course of monitoring, while salinity CS17-11 (northern project area) was consistently lower than other sondes.

Water Level:
Water level relative to the marsh surface throughout the course of the project was calculated (figure 7). It was not possible to separate the effects of the plugs in the water level data (LDNR 2003). The southern levee of Calcasieu Lake was breached by Hurricane Rita and there is no hydrologic control of the area at this time.

Water Flow:
Pre-construction water flow data were collected April 14-16, 1996, and presented in the 2003 comprehensive report. The data were collected in the middle of what became a severe

drought and did not reflect normal watershed conditions. No post-construction data are available for comparison. Therefore, whether or not the plugs altered water circulation in the northern project area cannot be determined from these data.

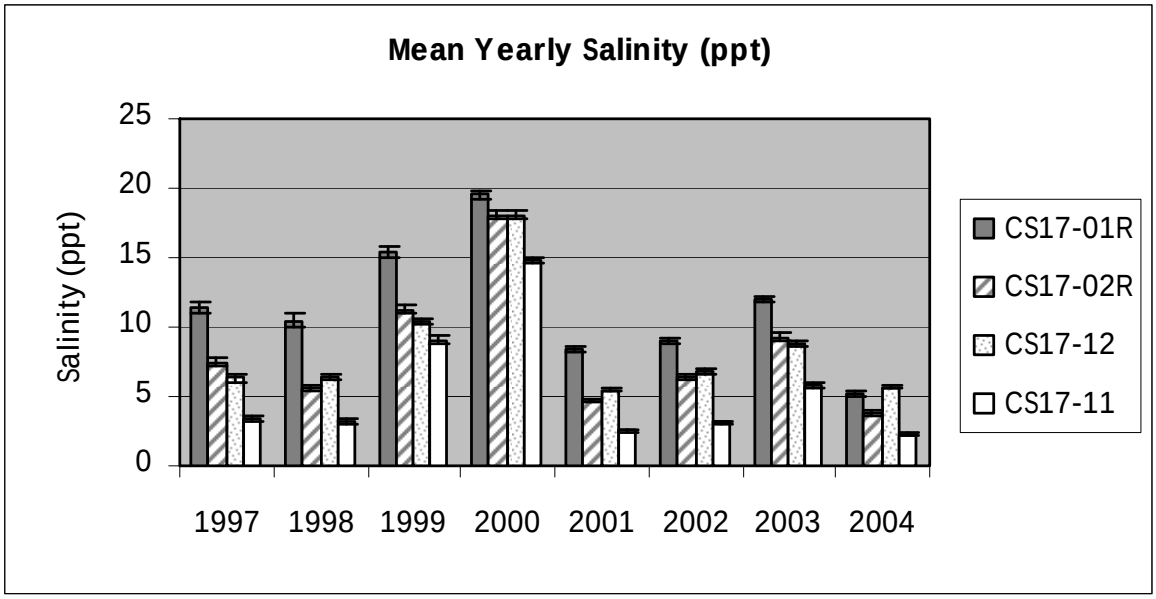

Figure 6. Yearly means of daily mean salinity at CS-17. Means ± SE.

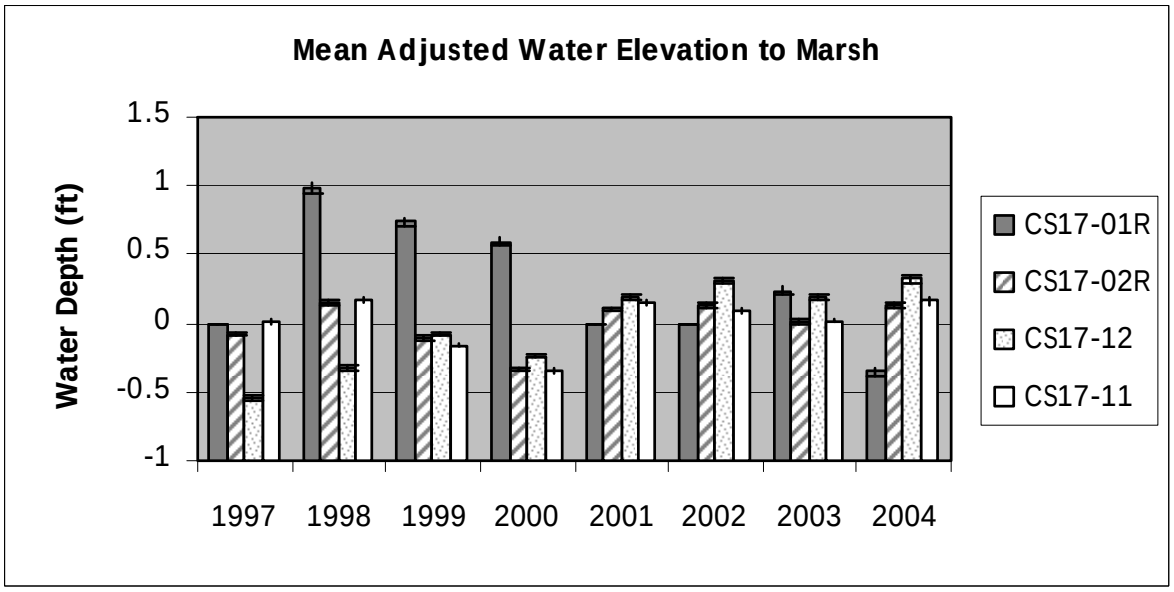

Figure 7. Yearly means of daily mean water depth relative to the marsh surface at CS-17. Means ± SE.

Emergent Vegetation:

Emergent vegetation surveys were conducted in 1996 pre-construction, and in 1997, 2000, and 2002 post-construction. Species found each year and the frequency each species occurred each year can be found in table 3. Analysis of Variance (ANOVA) of total percent cover over years in the project and reference areas revealed that cover was lower in both the project and reference areas in 2002 than in the other three years (figure 8). Cover decreased in both the project and reference areas, which suggests that the reason for the decline was not the CS-17 project but rather some other factor. The most likely cause of that decrease is water level but it could be a combination of factors. Note that total cover is skewed and does not meet the assumptions of ANOVA.

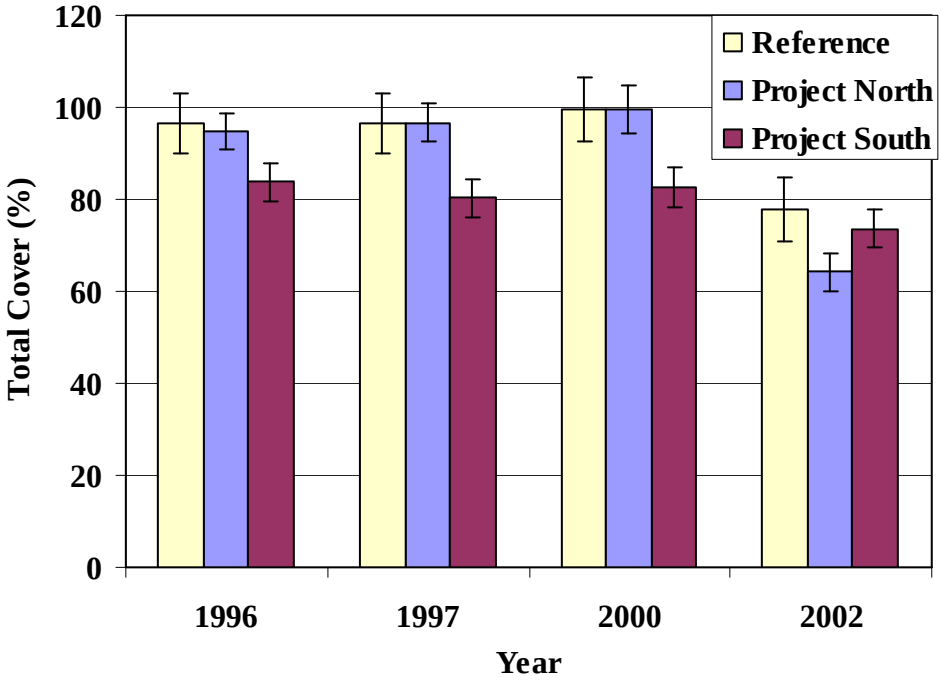

Figure 8. Total percent cover in the two project and reference areas for each sampling year for the CS-17 Cameron Creole Plugs project (LS Mean ± SE). Cover in 2002 was significantly lower than in the other sampling years ($p<0.0001$). There was also a significant interaction between project/reference areas and years ($p=0.0211$). Post-ANOVA contrasts showed that the southern project area was significantly lower than the reference area in both 1997 and 2000. The low cover values in 2002 could be due to increased frequency of inundation in 2001 and 2002.

Table 3. Frequency of occurrence (%) of each species found in the CS-17 project and reference area ((n plots species present in/total plots)*100).

	Reference Area				Northern Project Area				Southern Project Area			
Species	**1996**	**1997**	**2000**	**2002**	**1996**	**1997**	**2000**	**2002**	**1996**	**1997**	**2000**	**2002**
Spartina patens	100	100	100	100	100	96.0	86.7	95.8	100	92.0	95.2	100
Schoenoplectus pungens	70.0	80.0	88.9	77.8	32.0	44.0	53.3	45.8	12.0	4.0	14.3	16.0
Spartina alterniflora	.	.	.	.	.	.	.	.	16.0	20.0	33.3	28.0
Distichlis spicata	.	.	.	.	.	.	.	.	8.0	24.0	19.0	16.0
Amaranthus australis	.	10.0	.	.	8.0	16.0	.	.	16.0	24.0	.	.
Aster tenuifolius	.	.	.	11.1	.	.	.	4.2	.	.	.	.
Baccharis halimifolia	10.0	.	.	.	8.0	.	.	.	.	.	.	.
Bacopa monnieri	.	.	.	.	.	.	.	.	.	4.0	.	.
Cyperus odoratus	.	.	.	.	4.0	4.0	.	.	4.0	20.0	.	8.0
Erechtites hieraciifolia	.	.	22.2	.	.	.	.	.	.	.	.	.
Eupatorium capillifolium	10.0	.	.	.	4.0	.	.	.	.	.	.	.
Green algae	.	.	.	.	.	4.0	.	.	.	.	.	.
Ipomoea sagittata	.	.	.	11.1	8.0	8.0	6.7	12.5	.	.	.	.
Juncus roemerianus	.	.	.	.	.	.	6.7	.	.	.	.	.
Kosteletzkya virginica	.	.	.	.	4.0	.	.	.	.	4.0	.	.
Lythrum lineare	10.0	.	.	.	4.0	.	.	.	.	.	.	.
Mikania scandens	.	.	.	.	.	.	6.7	.	.	.	.	.
Paspalum vaginatum	.	.	.	.	.	4.0	.	.	.	.	.	.
Phytolacca americana	.	.	.	.	.	.	.	.	.	.	4.8	.
Pluchea camphorata	.	.	.	.	.	.	.	.	.	4.0	.	.
Schoenoplectus americanus	.	.	.	.	.	.	.	4.2	.	.	.	.
Schoenoplectus robustus	.	10.0	11.1	.	.	8.0	.	.	8.0	12.0	.	.
Sonchus	.	.	.	.	.	.	.	.	.	4.0	.	.
Symphyotrichum subulatum	.	.	.	.	.	.	.	.	8.0	8.0	.	.
Symphyotrichum tenuifolium	.	.	.	.	.	.	13.3	.	.	.	9.5	.
Typha	10.0	.	.	33.3	.	4.0	26.7	29.2	.	12.0	4.8	8.0
Vigna luteola	.	.	.	11.1	12.0	12.0	26.7	12.5	.	.	.	0.0

Submerged Aquatic Vegetation:
Submerged aquatic vegetation surveys were conducted in 1996 pre-construction, and in 1997, 2000, and 2002 post-construction. The frequency of occurrence of SAV species decreased in 2000 in both the project and reference areas, most likely due to drought (table 4). SAV cover had recovered in 2002. Species richness was the same in the project area and reference area over the years. Richness decreased in 2000 and recovered in 2002 to five species per plot.

Table 4. Frequency of occurrence of SAV species in the CS-17 project and reference areas for each sampling year.

	Project Area				Reference Area			
Species	**1996**	**1997**	**2000**	**2002**	**1996**	**1997**	**2000**	**2002**
Algae 1	36.50	53.50	7.25	40.41	63.25	12.50	9.75	48.04
Ceratophyllum demersum	.	7.50	.	17.26	.	8.00	.	9.62
Chara	.	.	.	10.75	.	.	.	11.31
Myriophyllum spicatum	2.50	1.00	.	69.74	.	1.50	.	70.18
Najas caroliniana	18.75	41.75	.	.	42.25	32.50	.	5.88
Potamogeton	.	.	.	11.75	.	.	.	5.79
Ruppia maritima	44.00	1.50	10.00	.	45.75	.	1.50	2.78
Vallisneria americana	14.75	23.25	0.50	56.30	23.00	69.50	.	75.97

POST-HURRICANE RITA EMERGENT VEGETATION:
In the CS-17 project area, 24 stations were randomly chosen from the available stations, 12 in the northern project area and 12 from the southern project area (figure 9). In the last sampling before Rita (2002), the vegetation was broken but was not highly stressed (figure 10). In 2005, 60% of the stations had either turned to open water or were severely stressed. By 2006, the area had recovered slightly but 60% of the stations remained open water or severely stressed; 20% of the stations recovered to only slightly stressed. Total cover dropped to below 20% in 2005 and remained below 20% in 2006 (figure 11). Species richness recovered to pre-storm levels (about 2 species per plot) (figure 12).

The vegetation in the area remains highly stressed and the marsh is becoming more and more broken. The entire area may convert to open water if restoration attempts are not made. The levee south of Calcasieu Lake needs to be repaired and elevation needs to be restored. The area would make a good candidate for spray dredge applications.

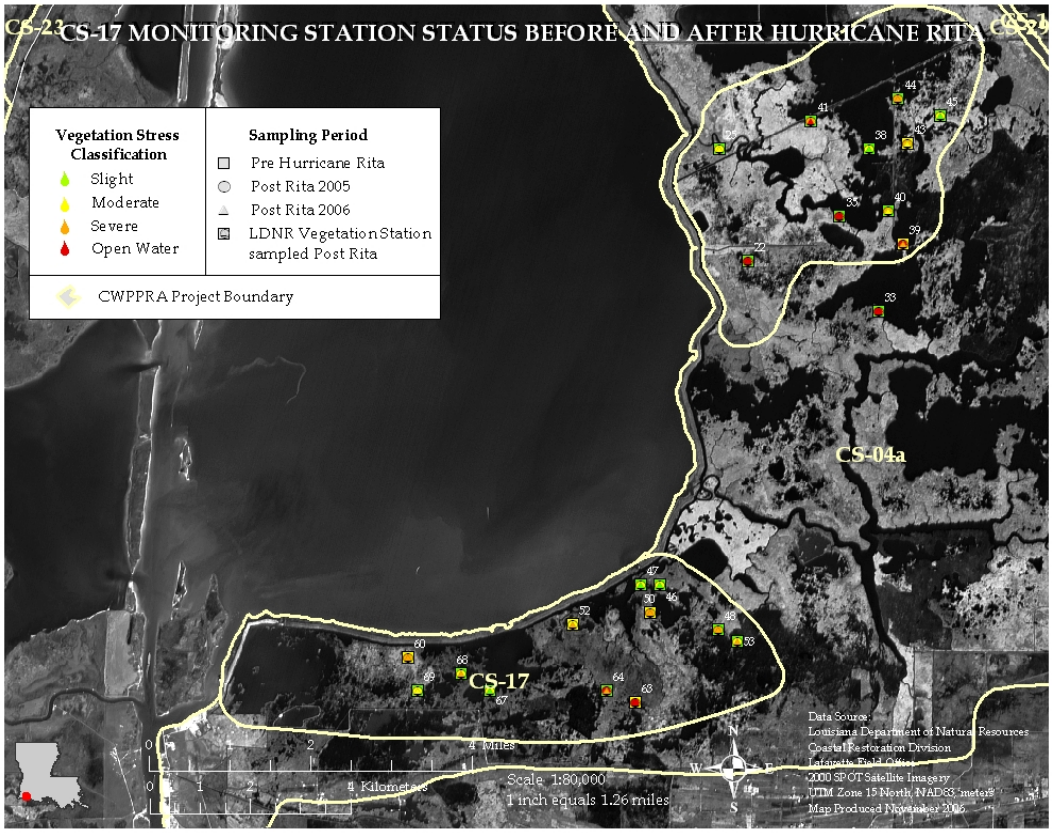

Figure 9. Location and status of CS-17 vegetation stations sampled after Hurricane Rita.

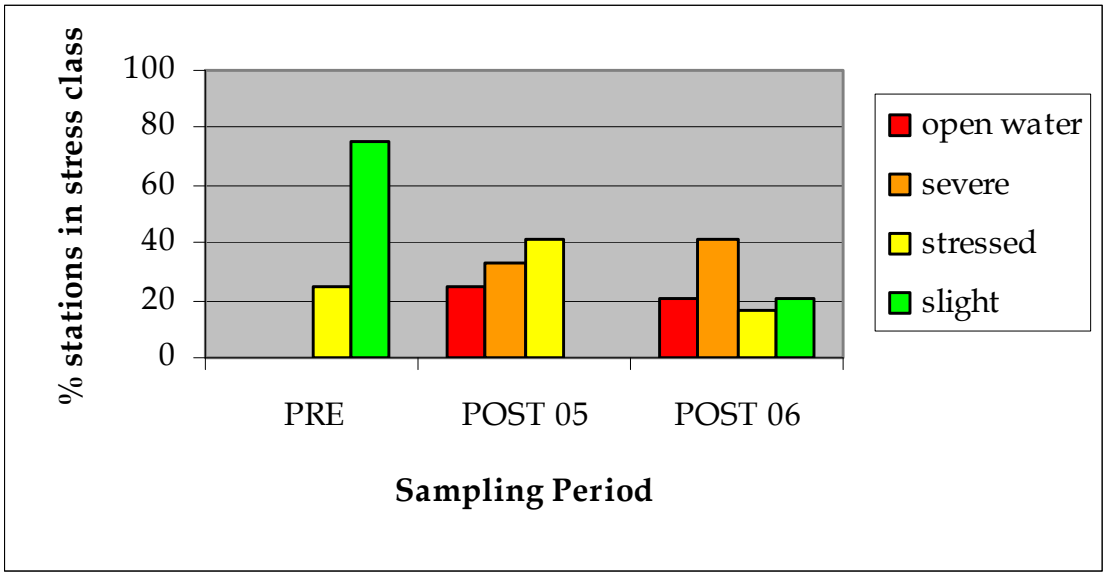

Figure 10. Percent of CS-17 vegetation stations in each stress class before and after Hurricane Rita (n=23).

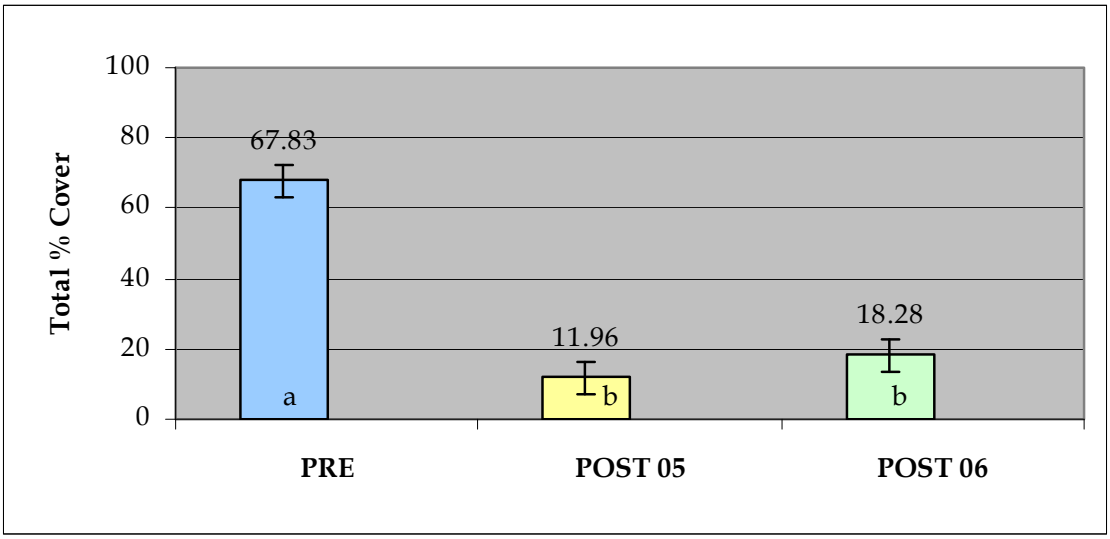

Figure 11. Total % cover of vegetation at CS-17 pre- and post-Hurricane Rita. LS Mean ± SE (n=23 stations), $F_{2, 68}$=45.28, p<0.0001. Levels connected by the same letter are not significantly different.

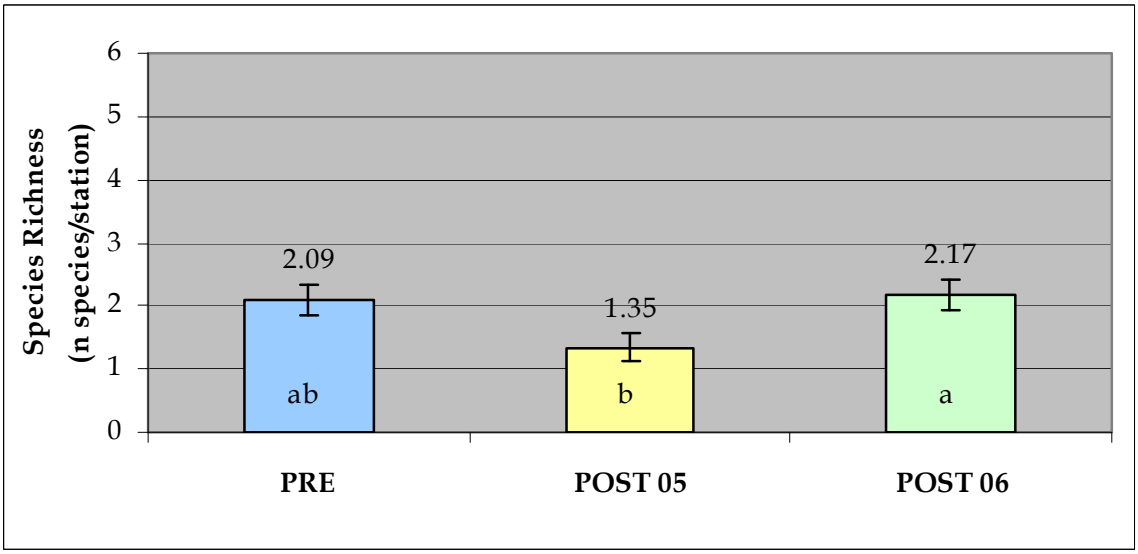

Figure 12. Species richness at CS-17 pre- and post-Hurricane Rita. LS Mean ± SE (n=23 stations), $F_{2, 68}$=3.89, p=0.0252. Levels connected by the same letter are not significantly different.

V. Conclusions

a. Project Effectiveness

The cover of emergent vegetation remained stable over the duration of the project in each of the northern and southern project areas, and in the vegetation reference area until Hurricane Rita struck in September 2005. Because both species richness and cover had been consistent over time and through seemingly adverse conditions, it appeared that the emergent vegetation had become preconditioned to the dynamics of salinity and water level fluctuations over time. The levee and structure system were constructed only 11 years ago, resulting in a reversal from eroding marsh to a thriving, more stable emergent community until the storm.

Results from the submerged aquatic vegetation community reveal how fast the SAV responded to stress factors such as salinity and water level. Species responded to rising salinity and dropping water levels. Although frequency of occurrence and species richness were low in 2000, field observations over the last few years have shown that SAV have recovered as the watershed returned to more optimal salinity and water levels.

It was not possible to differentiate ecological responses due to the project plugs and the pre-existing water control structures. Due to these complications, we have been unable to document significant ecological responses to the project design. The reference areas for vegetation and SAV have been deemed inappropriate for the project areas because they are not independent of any possible effects of the plugs on vegetation and hydrology.

The goals of the Cameron Creole Plugs (CS-17) project cannot be met due to the adjacent and non-functioning Cameron-Creole Maintenance Project (CS-04a), which sustained major damage from Hurricane Rita (four breaches in the levee system), allowing uncontrolled water exchange. Repairs to make the CS-04a project fully operational again should be complete in 2008.

The area has been losing land since Hurricane Rita. Improvements to the levee system should help reduce landloss but spray dredge applications may be needed to reverse current landloss rates and jumpstart recovery in the area.

b. Recommended Improvements

Overall, the Cameron Creole Plugs Project structural components are still in fair condition; however, some maintenance is required as listed below. Plans and specifications will be prepared to address these issues in 2007.

- Grand Bayou structure – repair bank erosion with rock rip rap.

- Mangrove Bayou structure – repair bank erosion with rock rip rap; replace boat guide marine timber.

c. Lessons Learned

No report at this time.

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), 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-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).

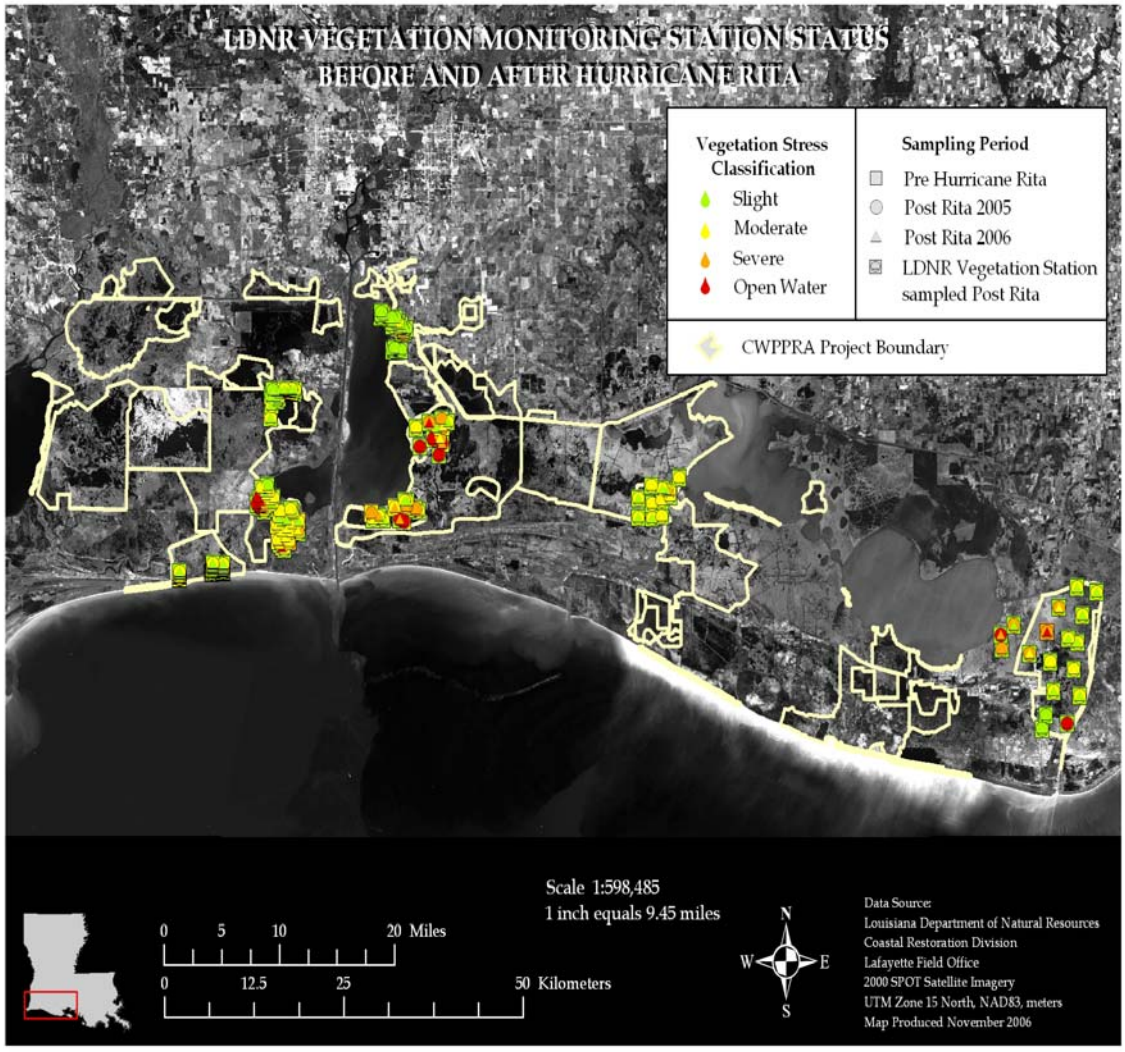

Figure 1. Location and status of LDNR vegetation stations sampled after Hurricane Rita. Stations were classified according to storm-induced stress as described in Table 1.

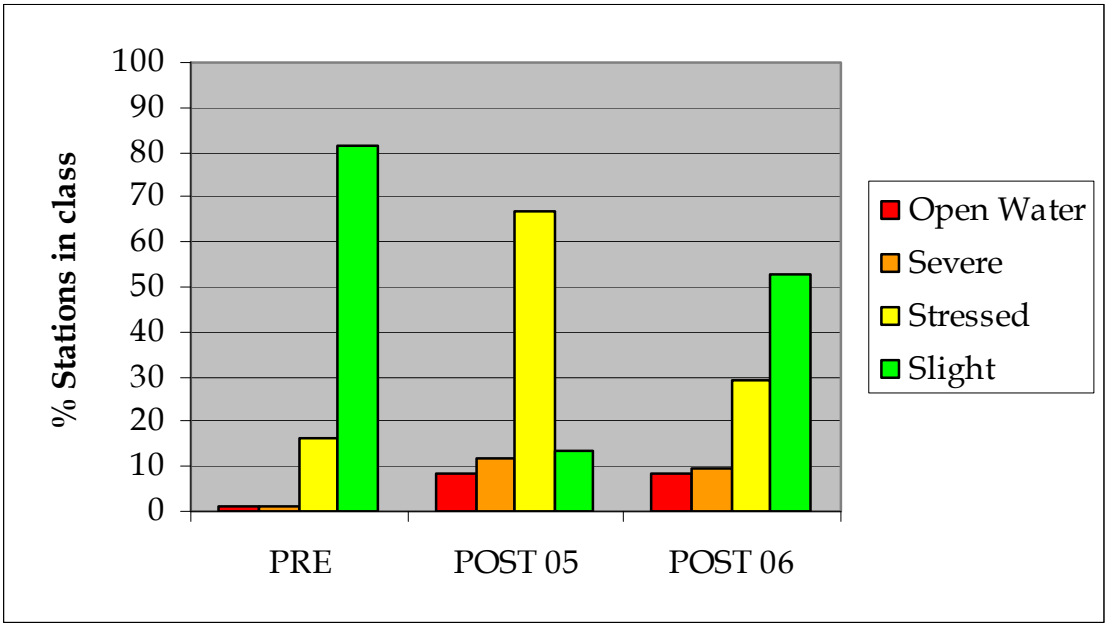

Figure 2. Percent of LDNR vegetation stations in each stress class before and after Hurricane Rita (n=163).

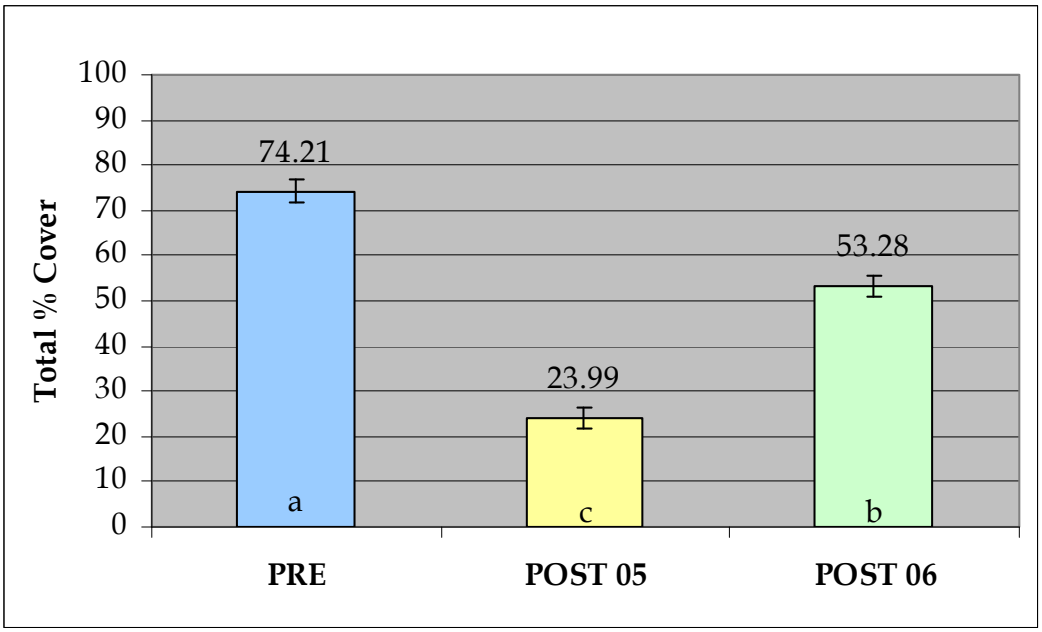

Figure 3. Total % Cover Pre- and Post-Hurricane Rita. LS Mean ± SE, n=163 stations, $F_{2, 488}$=109.7, p<0.0001. Levels not connected by same letter are significantly different.

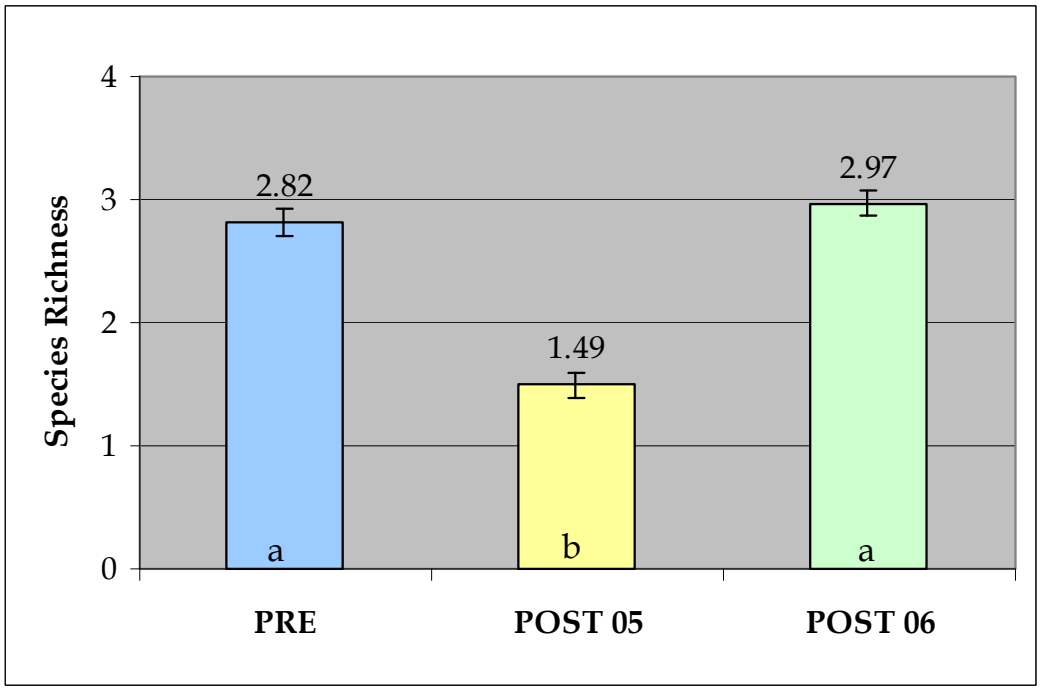

Figure 4. Species Richness Pre- and Post-Hurricane Rita. LS Mean ± SE, n=163 stations, $F_{2, 488}$=56.8, p<0.0001. Levels not connected by same letter are significantly different.

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-Hurricane Rita levels at most projects, many of the species present were disturbance species.

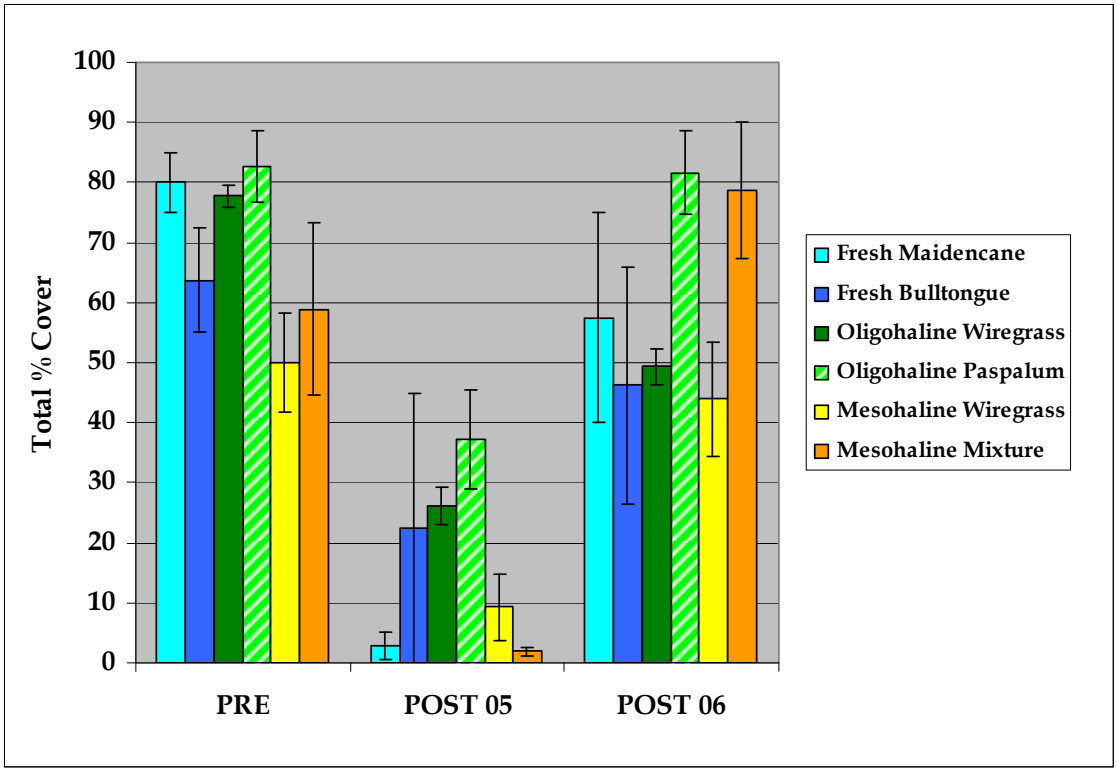

Figure 5. Total % Cover by Visser Vegetation Type. LS Mean ± SE, n=163 stations, $F_{17, 488}$=17.0, p<0.0001.

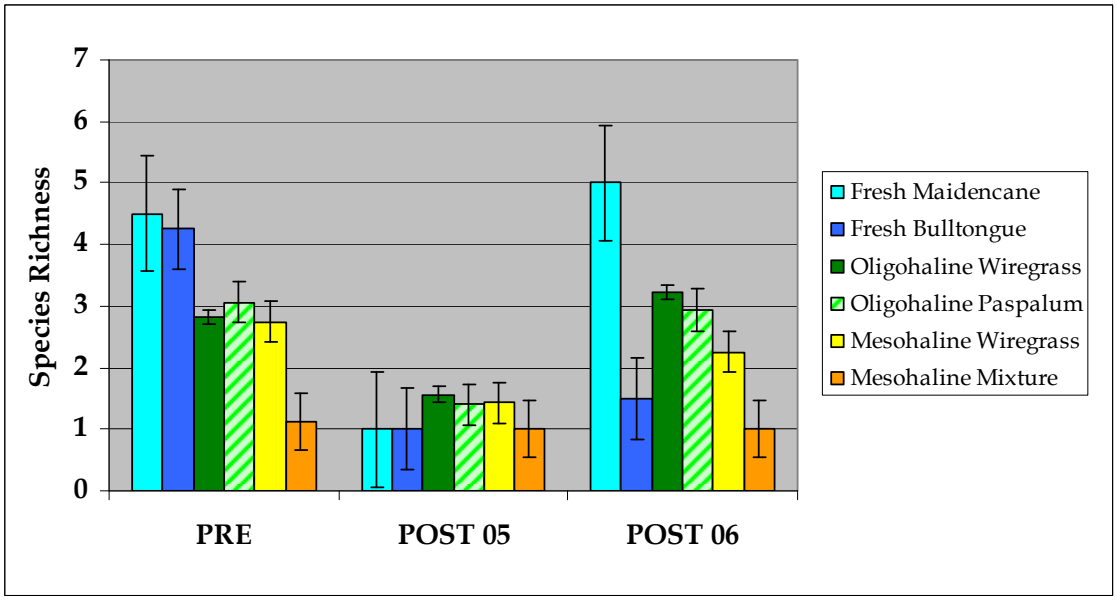

Figure 6. Species Richness by Visser Vegetation Type. LS Mean ± SE, n=163 stations, $F_{17, 488}$=10.9, p<0.0001.

Appendix B
(Inspection Photographs)

Photo 1, Partial view of boat bay and sheet pile wall at Grand Bayou Structure (April 17, 2007).

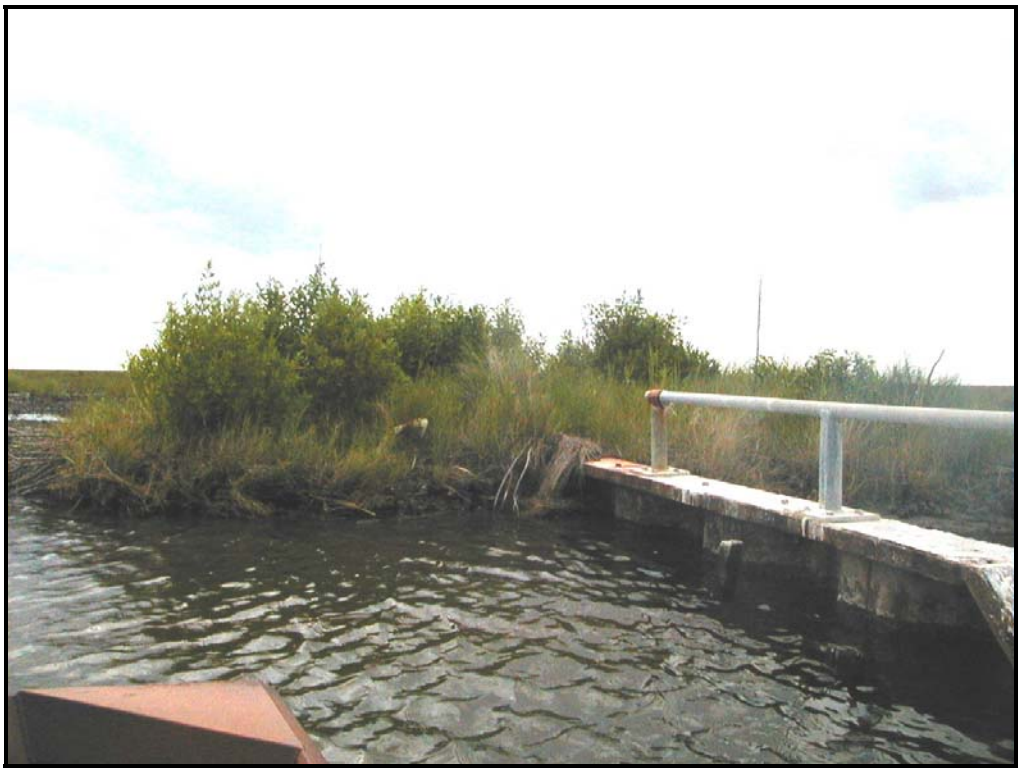

Photo 2, View of erosion occurring at each end of sheet pile wall at Grand Bayou Structure (April 17, 2007).

Photo 3, View showing missing composite timbers on boat guide at Mangrove Structure (April 17, 2007).

Photo 4, View of erosion at ends of sheet pile wall at Mangrove Structure (April 17, 2007).

Appendix C
(Three Year Budget Projection)
CAMERON-CREOLE/ CS-17/ PPL 1
Three-Year Operations & Maintenance Budgets 07/01/2007 - 06/30/2010

Project Manager	O & M Manager	Federal Sponsor	Prepared By
Pat Landry	*Dewey Billodeau*	*USFWS*	*Dewey Billodeau*

	2007/2008	2008/2009	2009/2010
Maintenance Inspection	$ 5,962.00	$ 6,106.00	$ 6,240.00
Structure Operation			
Administration	$ 3,000.00	$ -	$ -
Maintenance/Rehabilitation			

07/08 Description: Repair bank erosion (Grand Bayou & Mangrove), replace composite timbers (Mangrove).

E&D	$ 20,620.00
Construction	$ 105,625.00
Construction Oversight	$ 2,000.00
Sub Total - Maint. And Rehab.	$ 128,245.00

08/09 Description

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

09/10 Description:

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

	2007/2008	2008/2009	2009/2010
Total O&M Budgets	**$ 137,207.00**	**$ 6,106.00**	**$ 6,240.00**

O &M Budget (3 yr Total)	**$ 149,553.00**
Unexpended O & M Budget	**$ 101,656.00**
Remaining O & M Budget (Projected)	**$ (47,897.00)**

OPERATION AND MAINTENANCE BUDGET WORKSHEET

CAMERON-CREOLE / PROJECT NO. CS-17 / PPL NO. 1

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$5,962.00	**$5,962.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$20,620.00	**$20,620.00**
Operations Contract	LUMP	1	$0.00	**$0.00**
Construction Oversight	LUMP	1	$2,000.00	**$2,000.00**
ADMINISTRATION				
LDNR / CRD Admin.	LUMP	1	$2,000.00	$2,000.00
FEDERAL SPONSOR Admin.	LUMP	1	$1,000.00	$1,000.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$3,000.00**

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:	Repair bank erosion at Grand Bayou & Mangrove structures, replace composite marine timber at Mangrove boat guide.				
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
Bank Paving	0	0.0	600	$90.00	$54,000.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD		$12.00	$0.00
Navigation Aid		EACH		$0.00	$0.00
Signage		EACH		$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	1	$0.00	$0.00
Materials		LUMP	1	$0.00	$0.00
Mob / Demob		LUMP	1	$30,000.00	$30,000.00
Contingency		LUMP	1	$21,125.00	$21,125.00
General Structure Maintenance		LUMP	1	$500.00	$500.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
				TOTAL CONSTRUCTION COSTS:	**$105,625.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **$137,207.00**

OPERATION AND MAINTENANCE BUDGET 07/01/2008 - 06/30/2009

CAMERON CREOLE STRUCTURES / CS-17 / PPL NO.1

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$6,106.00	**$6,106.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$0.00	**$0.00**
Operations Contract	LUMP	1	$0.00	**$0.00**
Construction Oversight	LUMP	1	$0.00	**$0.00**

ADMINISTRATION

LDNR / CRD Admin.	LUMP	1	$0.00	$0.00
FEDERAL SPONSER Admin.	LUMP	1	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$0.00**

MAINTENANCE / CONSTRUCTION

SURVEY

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

GEOTECHNICAL

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

CONSTRUCTION

CONSTRUCTION DESCRIPTION:					
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
Navagation 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	1	$0.00	$0.00
Materials		LUMP	1	$0.00	$0.00
Mob / Demob		LUMP	1	$0.00	$0.00
Contingency		LUMP	1	$0.00	$0.00
General Structure Maintenance		LUMP	1	$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: **$6,106.00**

OPERATION AND MAINTENANCE BUDGET 07/01/2009 - 06/30/2010

CAMERON CREOLE STRUCTURES / CS-17 / PPL NO.1

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$6,240.00	**$6,240.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$0.00	**$0.00**
Operations Contract	LUMP	1	$0.00	**$0.00**
Construction Oversight	LUMP	1	$0.00	**$0.00**

ADMINISTRATION

LDNR / CRD Admin.	LUMP	1	$0.00	$0.00
FEDERAL SPONSER Admin.	LUMP	1	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$0.00**

MAINTENANCE / CONSTRUCTION

SURVEY

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

GEOTECHNICAL

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

CONSTRUCTION

CONSTRUCTION DESCRIPTION:					
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
Navagation 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	1	$0.00	$0.00
Materials		LUMP	1	$0.00	$0.00
Mob / Demob		LUMP	1	$0.00	$0.00
Contingency		LUMP	1	$0.00	$0.00
General Structure Maintenance		LUMP	1	$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: **$6,240.00**

Appendix D
(Field Inspection Notes)

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: CS-17 Cameron Creole

Date of Inspection: April 17, 2007 Time: 11:00 am

Structure No. 2

Inspector(s): Mel Guidry & Dewey Billodeau (LDNR)
James Ashfield (USFWS)

Structure Description: Fixed crest weir at Grand Bayou

Water Level

Type of Inspection: Annual

Weater Conditions: Partly cloudy and mild

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Steel Bulkhead / Caps	Good			1	
Steel Grating	N/A				
Stop Logs	N/A				
Hardware	Good				
Timber Piles	N/A				
Timber Wales	N/A				
Galv. Pile Caps	Good				
Cables	N/A				
Signage /Supports	Good			1	
Rip Rap (fill)	N/A				
Eathern Embankment	Poor			2	Erosion occuring on both ends of the sheet pile wall.

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

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: CS-17 Cameron Creole

Date of Inspection: April 17, 2007 Time: 11:30 am

Structure No. 1

Inspector(s): Mel Guidry & Dewey Billodeau (LDNR)
James Ashfield (USFWS)

Structure Description: Fixed crest weir at Mangrove Bayou

Water Level

Type of Inspection: Annual

Weater Conditions: partly cloudy and mild

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Steel Bulkhead / Caps	Good			3	
Steel Grating	N/A				
Stop Logs	N/A				
Hardware	Fair				
Timber Piles	N/A				
Timber Wales	N/A				
Galv. Pile Caps	Good				
Cables	N/A				
Signage /Supports	Good			3	
Rip Rap (fill)	N/A				
Eathern Embankment	Poor			4	Erosion occuring at both ends of sheetpile wall.

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