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

2007 Operations, Maintenance, and Monitoring Report

for

Highway 384
Hydrologic Restoration

State Project Number CS-21
Priority Project List 2

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Cameron Parish

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2007 Operations, Maintenance, and Monitoring Report
For
Highway 384 Hydrologic Restoration (CS-21)

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I. Introduction

The Highway 384 Hydrologic Restoration project area contains 935 ac (378 ha) of deteriorated wetlands located along the northeast shoreline of Calcasieu Lake in Cameron Parish. The project area is bounded by Calcasieu Lake to the west, the Gulf Intracoastal Waterway (GIWW) to the east, and higher elevation prairie formations to the north and south.

The project area (figure 1) is divided into three Conservation Treatment Units (CTUs). CTU 1 extends from Calcasieu Lake easterly to the La. Highway 384 embankment and includes 250 ac (101 ha) of open water and brackish marsh. A shell oilfield access road forms its northern boundary and prairie formations form its southern boundary. CTU 2 includes 226 ac (91 ha) of open water and intermediate marsh. This unit extends easterly from the La. Highway 384 embankment. The northern boundary of CTU 2 is the prairie formation on which the community of Grand Lake is located. A continuous oil field road embankment joins the prairie formations north and south of the project area and forms the remainder of the southern and eastern boundaries of CTU 2. CTU 3 lies between CTU 2 and the GIWW and includes 459 ac (186 ha) of intermediate marsh. Increased tidal volumes, enlargement of tidal exchange routes, and salt water intrusion resulting from human-induced changes to the area's hydrology are the primary causes of wetland loss in the project area.

Two small reference areas have been selected for monitoring this project. Reference Area 1 (R1) is comprised of 424 ac (172 ha) of deteriorated brackish marsh and open water located 2 mi (3.2 km) south of the community of Grand Lake along the east bank of Calcasieu Lake (figure 1). Reference Area 2 (R2) consists of approximately 106 ac (43 ha) of open water and deteriorated brackish marsh located along the north side of the shell road that forms the northern boundary of CTU 1.

Hurricane Rita struck the coast of southwestern Louisiana on September 24, 2005, with maximum storm surge of approximately 7 ft (2.1 m) in the CS-21 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, and 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.

The objective of the project is to protect and maintain approximately 935 ac (378 ha) of intermediate to brackish wetlands by reducing water level variability, thereby increasing the abundance of emergent vegetation. This will be achieved through structural modification of hydrologic conditions. Construction for the Highway 384

Hydrologic Restoration Project began on October 20, 1999, and was completed on January 4, 2000.

The principal project features include:

1. Set of 3 culverts (ES-1), each with a manual sluice gate on the exterior and a flap gate on the interior to provide controlled freshwater introduction from the GIWW (CTU 2/CTU 3 perimeter levee).

2. Approximately 95 ft (28 m) of armored plug (ES-8) to reduce hydrologic exchange with Calcasieu Lake and to decrease tidal scour and salinity in the project area (existing exchange point in CTU 1).

3. Set of 2 culverts (ES-12), each with a variable-crested weir inlet and flap gated outlet to reduce and stabilize tidal ranges and salinity in project area south of the central shell road in CTU 1 (existing shell road along north side of CTU 1).

4. Maintenance of approximately 10,000 ft (3 km) of existing road embankment to maintain the hydrologic barrier between CTU 2 and CTU 3 (existing southern and eastern perimeter embankment of CTU 2).

5. Maintenance of 1 flow-through culvert (ES-11) to maintain an existing storm water drainage point for the adjacent prairie formation (existing southern perimeter embankment of CTU 2).

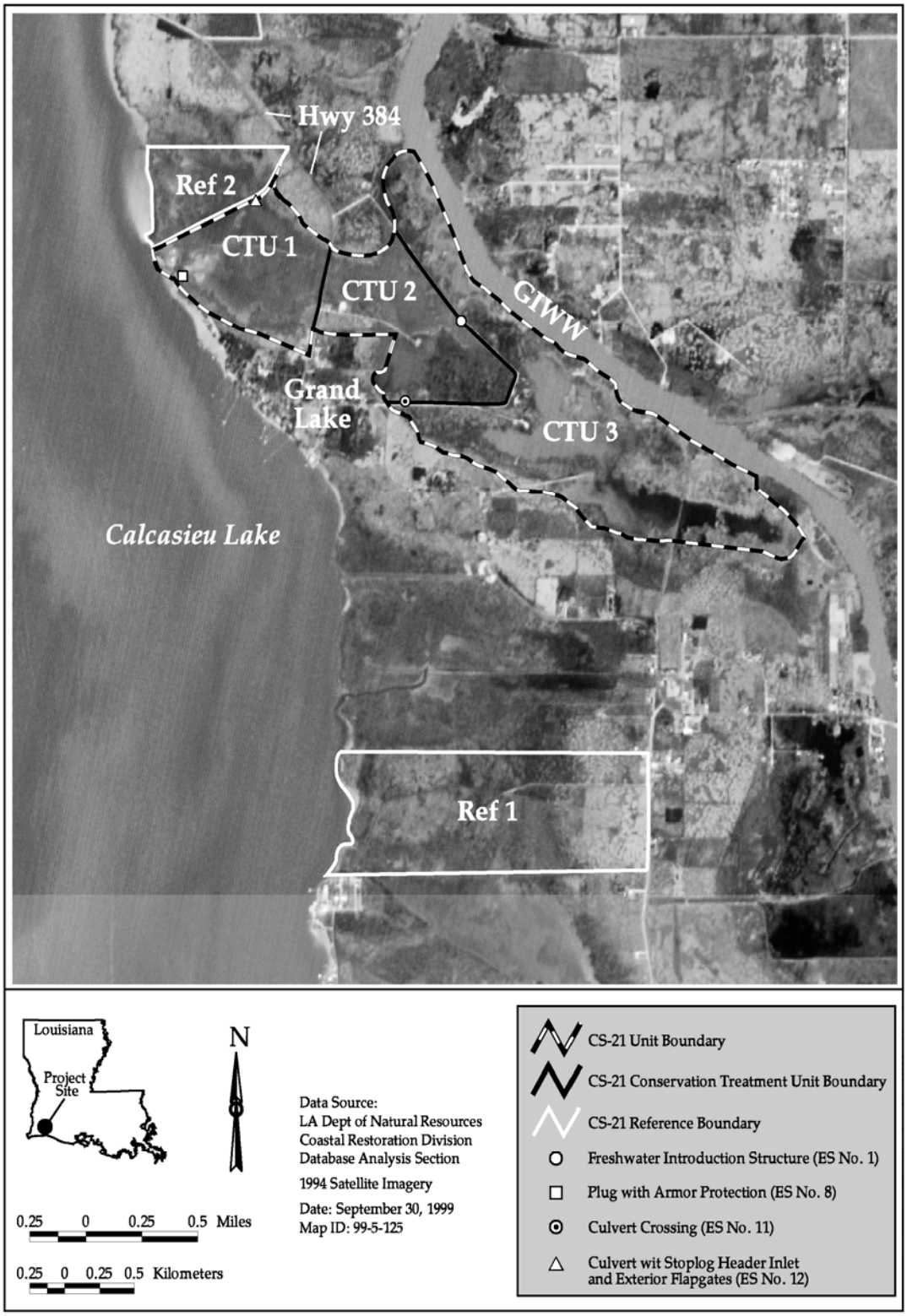

Figure 1. Highway 384 Hydrologic Restoration (CS-21) project and reference area boundaries and features.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Highway 384 Hydrologic Restoration Project (CS-21) 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, if any, which were completed since completion of constructed project features and an estimated projected budget for the upcoming three (3) years for operation, maintenance, and rehabilitation. The three (3) year projected operation and maintenance budget is shown in Appendix C. This project was previously inspected on March 18, 2004, and October 24, 2005.

An inspection of the Highway 384 Hydrologic Restoration Project (CS-21) was held on March 8, 2007, under sunny skies. The temperature was approximately 60 degrees. In attendance were Darrell Pontiff and Dewey Billodeau of LDNR, and Dale Garber, representative of the Natural Resources Conservation Service (NRCS). Parties left the Lafayette Field Office of CED, and proceeded to the CS-21 project area in the community of Grand Lake, La. The annual inspection began at approximately 10:30 a.m. at Structure #12.

The field inspection included a complete visual inspection of all features. Staff gauge readings where available were used to determine approximate elevations of water, rock weirs, earthen embankments, 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 #1

The structure is in good condition. Water level on the outside was elevation +0.9 and the level inside could not be determined because the staff gauge was not readable. The staff gauge was replaced on 7/8/2007. Rock placed on the bank during the maintenance event of June 2002 is stable and in no need of repair. The hyacinth fence is in good condition; however, there is trash from Hurricane Rita that is between the fence and the sluice gates which needs to be removed. The road/levee leading up to the structure is in good condition since it was repaired in June 2006. The recently installed Portable Multi-Parameter Water Quality Troll 9500 – 29r is in good

condition and operating properly. The solar panel should be cleaned and bird excluder devices installed. Sluice gates were in the open position and flap gates were partially open. (Photos: Appendix B, Photos 1-5)

Structure #12

The structure is in good shape. Water levels were +0.9 outside and +0.5 inside. Pile caps on the outlet side and the padlocks on the stop log locking devices have rusted and will eventually need to be replaced. Rock that was placed during the maintenance of Nov. 2000 is stable. The road/levee leading up to the structure is in good condition since it was repaired in June 2006. The recently installed Portable Multi-Parameter Water Quality Troll 9500 – 15r is in good condition and operating properly. The solar panel should be cleaned and bird excluder devices installed. The flap gates were in the closed position and the positions of the stoplogs were unknown. (Photos: Appendix B, Photos 6-9)

Structure#8

The rock plug is in good condition. Water levels could not be determined because the outside staff gauge is missing and the inside staff gauge was leaning and not readable. Both staff gauges will need to be replaced. The recently completed maintenance work in May 2005 to repair the plug from vandalism held up well under the high storm surge waters. The lakeside area of the rock plug is showing signs of shoaling. (Photos: Appendix B, Photo 10)

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

ii. Programmatic/ Routine Repairs

Install bird excluder device on the solar panel and replace the staff gauge at Structure #1. Replace the metal pile cap covers and install bird excluder device on the solar panel at Structure #12.

d. Maintenance History

General Maintenance: Below is a summary of completed maintenance projects and operation tasks performed since January 2000, the construction completion date of the Highway 384 Hydrologic Restoration Project (CS-21).

Nov. 2000- Glenn Lege Construction
Placed 40.32 cy. of #610 limestone on the road near Structure #12 due to some overtopping of the road during high tidal events.
Placed 12 cy. of man size rip rap on the inlet side of Structure #12 due to some scouring of the bankline around the structure.

TOTAL CONSTRUCTION COST- $3,461.14

June 2002- Glenn Lege Construction

Provided labor and materials to construct a "hyacinth fence" on the inlet side of Structure #1. The fence is constructed of galvanized woven wire and CCA treated timber piles and whalers.

Provided labor and materials to reinforce the existing levee around Structure #1 with graded crushed stone.

Provided labor and materials to repair an existing rock plug at Structure #8 that had been leaking and also had been vandalized. The plug was repaired by hauling in earth fill from an off-site location and pushing it over the existing rock plug with a bulldozer. The earthen plug was then planted under separate contract by the LDNR plantings group.

TOTAL CONSTRUCTION COST- $14,386.87

May 2005- Bertucci Construction

Provided labor, material, and equipment to repair 13 linear feet of the rock plug at structure #8. The rock was removed by vandals. 39.9 tons of 1200# rip rap stone was used to repair the thirteen foot gap. A four foot thick layer of 150# stone was applied to the marsh side slope of the plug to prevent water flow through the plug. This required 343.4 tons of rock. Completion and final acceptance was on May 15, 2005.

TOTAL CONSTRUCTION COST- $45,090.00

May 2006- F. Miller & Sons

Provided labor, material, and equipment to repair the existing access roads to permit elevations (+3.0 on Roadway No.1 west side of Highway 384, +2.5 on Roadway No. 2, east side of Highway 384). Approximately 3,225 tons of recycled concrete were used to elevate the roadways. Two Portable Multi-Parameter Water Quality Troll 9500 units were provided through this contract and installed by Simon & DeLany for operation of Structures #1 and #12. Completion and final acceptance was on June 28, 2006.

Engineering, Design ,Surveying, Construction Oversight & As-Builts	$ 26,705.00
Construction Cost	$150,000.00

TOTAL CONSTRUCTION COST $176,705.00

June 2006 – F. Miller & Sons

Provide labor, material and equipment to refurbish and install flap gate on west culvert of Structure #12. This flap gate was vandalized during spring of 2006. Completion and final acceptance was on June 28, 2006.

TOTAL CONSTRUCTION COST $1,600.00

March 2007 – Simon & Delany
Provide labor necessary to remove and dispose of trash and debris which has accumulated within the hyacinth fence and adjacent to the sluice gates at Structure #1

TOTAL CONSTRUCTION COST $900.00

III. Operation Activity

a. Operation Plan

HIGHWAY 384 HYDROLOGIC RESTORATION

CS-21

"WATER MANAGEMENT PLAN"

Revised 05-03-06

ES #1 Structure - 3-24" Aluminum culverts with Interior 24" Flapgates and Exterior 24" Sluice Gate

	Culvert # 1		Culvert #2		Culvert #3	
Salinity	Sluice	Flap	Sluice	Flap	Sluice	Flap
≥ 7 ppt	down	down	down	down	down	down
< 7 ppt	open	down	open	down	open	down

Average Marsh Level CTU 2 = 1.253 ft NAVD88

NOTE: When exterior salinities at ES #1 structure meet or exceed 7 ppt, the structure will be set according to the above chart. When exterior salinities fall below 7 ppt, the structure will be reset according to the above chart.

ES #12 Structure- 2-48" Aluminum Culverts, each with an Interior 10' Variable-Crested Weir Inlet with a 4" vertical slot and an Exterior 48" Flapgate.

	Culvert #1			Culvert #2		
Salinity	Flap	Stoplog	Slot	Flap	Stoplog	Slot
< 7 ppt	open	.88 ft NAVD88	open	open	none	open
7-10 ppt	down	.88 ft NAVD88	open	open	none	open
>10 ppt	down	.88 ft NAVD88	open	down	.38 ft NAVD88	open

Average Marsh Level CTU 1 = 1.38 ft NAVD88

"None" refers to removal of all stop logs.

Salinity will be monitored on the northern side of the shell road at ES #12

b. Actual Operations

In accordance with the operation schedule outlined in the Operation and Maintenance Plan and the U.S. Army Corps of Engineers (USACE) Permit, structures were manipulated as required by Simon & DeLany, Resource Management personnel who are under contract with LDNR. Copies of the quarterly reports that are provided as well as a copy of the operations contract between LDNR and Simon & DeLany are attached in the "Structure Operations" section of the CS-21 Highway 384 Operation & Maintenance Plan. No operation of the two structures was necessary during the first quarter of calendar year 2007.

The original operating procedures for Structure #1 was based on water level only; there was no provision for salinity control. Records for the structure showed salinities of 9+ ppt. The procedure was modified to close the Structure #1 sluice gates at 7 ppt. Operations for Structure #12 were not changed. To view the real time conditions at Structures #1 or #12 log on to www.romcomm.net and use ldnr for both the username and pass word. 15r is for Structure #12 and 29r for Structure #1.

IV. Monitoring Activity

The original monitoring plan was approved in December 1996 and was modified in 1998 when it was determined that water level and salinity would be monitored continuously from 1997 through 2002, and then evaluated to determine if the project goals were achieved. It was determined that the goals had been met and monitoring was discontinued in 2004.

Pursuant to a decision made on November 9, 1999, by the Natural Resources Conservation Service and the Louisiana Department of Natural Resources, the project area boundary was revised to exclude the northernmost third of CTU 1 and all associated structural measures due to landrights constraints. The monitoring plan was modified to reflect changes in reference areas and elimination of shoreline change monitoring.

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-21 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 no CRMS-*Wetlands* sites in the CS-21 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-21 project area (Appendix A).

a. Monitoring Goals

The objective of the Highway 384 Hydrologic Restoration Project is to protect and maintain 935 ac (378 ha) of intermediate and brackish wetlands by reducing water level variability, thereby increasing the abundance of emergent vegetation.

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

1. Decrease the rate of marsh loss in the project area.
2. Reduce water level variability within the project area.
3. Maintain salinity levels within CTU 1 at $\leq$ 10 ppt.
4. Maintain salinity levels in CTU 2 and CTU 3 within the 0-5 ppt target range for intermediate marsh vegetation.
5. Increase the coverage of emergent wetland vegetation and submersed aquatic vegetation (SAV) in shallow open water areas within the project area.

b. Monitoring Elements

Habitat Mapping

Near-vertical, color-infrared aerial photography (1:12,000 scale, with ground controls) was used to measure vegetated and non-vegetated areas for the project and reference areas. The photography was obtained pre-construction for the project area and Reference Area 2 in December 1996 and again in January 1997 due to overexposed frames. In March 1997, R1 was flown. Post-construction photography was obtained December 15, 2002. 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 the standard operating procedures (Steyer et al. 1995, revised 2000). No additional photography is scheduled.

Salinity

Water salinity was monitored monthly at 29 discrete sampling stations and 4 continuous recorder stations within the project and reference areas (figure 2). The recorders were deployed in May 1997 to log hourly salinity. Salinity data were collected at all four stations until July 2004.

Water Level

Water level was monitored monthly at the same discrete sampling stations as salinity and at staff gauges installed inside and outside of the project area near the two CS-21 project water control structures. Four continuous data recorders were deployed in May 1997 to record hourly water level in the three project areas and in R1. These data are available in raw and graphic formats. To document the frequency, magnitude, and duration of head differences conducive to freshwater introduction into the project from the GIWW, the data recorders in CTU 2 & 3 were deployed near the freshwater introduction structure, one on each side of the structure (figure 2). All four recorders were surveyed to NAVD 88. Water level data were collected until July 2004.

Emergent Vegetation

Vegetation was monitored at a maximum of 30 sampling stations established uniformly along transects in the project and reference areas (CTU 1, CTU 2, CTU 3, R1, and R2). At each sampling station, percent cover, species composition, and dominant plant height were documented in a 2m x 2m sampling plot marked with a pole in the southeast corner of the plot to allow for revisiting each site over time. Vegetation was evaluated at the sampling sites pre-construction in 1997, and post-construction in 2002. No additional vegetation sampling is scheduled.

A subset of the CS-21 established vegetation stations was monitored in 2005 and 2006 to determine the impacts of Hurricane Rita within the project and reference areas.

Submerged Aquatic Vegetation (SAV)

SAV was monitored using the modified rake method (Chabreck & Hoffpauir 1962, Nyman and Chabreck 1996). Within each study area (CTU 1, CTU 2, CTU 3, and R2), two ponds were sampled for presence or absence of SAV at 25 random points

within each pond. Species composition and frequency of occurrence [freq = (n occurrences SAV species / n total sampling points)*100] were determined. SAV was monitored once pre-construction in October 1996 and once post-construction in September 2002. No additional SAV sampling is scheduled.

Soil Characteristics

Soil samples were collected from the emergent vegetation sampling plots established in the project and reference areas and analyzed for bulk density, percent organic matter, and soil salinity. Soil samples collected pre-construction in 1997 were not collected post-construction.

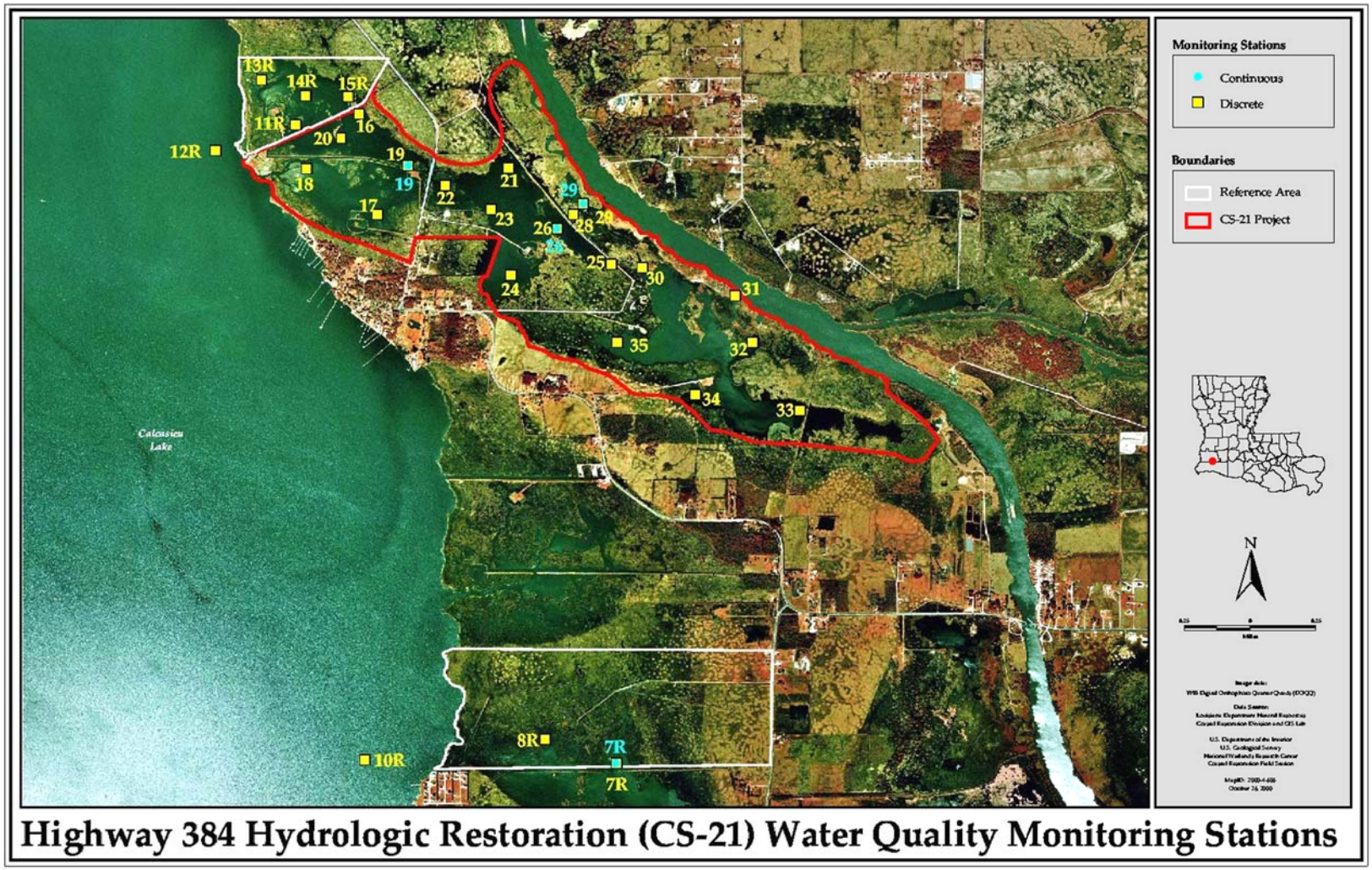

Figure 2. Location of continuous recorders and discrete water quality stations for La.Highway 384 Hydrologic Restoration (CS-21).

IV. Monitoring Activity (continued)

c. Preliminary Monitoring Results and Discussion

Habitat Mapping

Photography of the project area was obtained by USGS in 1997 and 2002 (figures 3 and 4). The two flights showed a modest increase in the percentage of each area that can be considered land (table 1, figure 5). The greatest increase in land was in CTU 3 (4.2%), which is not actively managed. The total increase for the project areas combined was 3.4% while the reference areas collectively increased by 1.7%. The increases were small in both the project and reference areas, although they were larger in the project areas.

Salinity and Water Level

Hourly salinity and water level data have been collected at the following continuous recorder stations:

Station	Period of data collection
CS21-19 (CTU 1)	January 1997 – July 2004
CS21-26 (CTU 2)	January 1997 – January 2002
CS21-98 (CTU 2)	January 2002 – July 2004
CS21-29 (CTU 3)	January 1997 – July 2004
CS21-07R (R1)	January 1997 – July 2004

Due to low water levels, the recorder at CS21-26 was no longer able to function properly and was replaced by CS21-98 and moved approximately 100 yards north.

The project goals for salinity were to maintain salinities in a target range of 0-10 ppt in CTU 1 and 0-5 ppt in CTU 2 and CTU 3. Comparison of the percentages of time salinities were within the target range before and after construction (by years) in CTU 1 and R1 showed that the reference area has been above 10 ppt at least 10% of the year (1999) and up to 80% of the year (2000) from 1997 to 2004 (figure 6). Before construction (which was completed in early January 2000), salinities in R1 and CTU 1 followed the same trend relative to the 10 ppt target level most of the time. In 2000 both units were inundated with salinities above the target range for CTU 1 over 80% of the time due to drought conditions. Following 2000, the project seems to have had an affect on salinities in CTU 1 as the amount of time water was above the target range has decreased in CTU 1 and the two units have ceased to follow the same trends. Closer management of the structure in accordance with a water management plan of closing the gates when salinities outside are more than 7 ppt will help bring the amount of time outside the target range in CTU 1 down even further which should help to achieve the overall project goal of protecting and maintaining intermediate and brackish marsh in the project area.

The project goals for salinity in CTU 2 and CTU 3 were to maintain salinities in a target range of 0-5 ppt. Comparisons of the percentage of time salinities were within the target range in those units showed a similar trend to CTU 1. Salinities in the

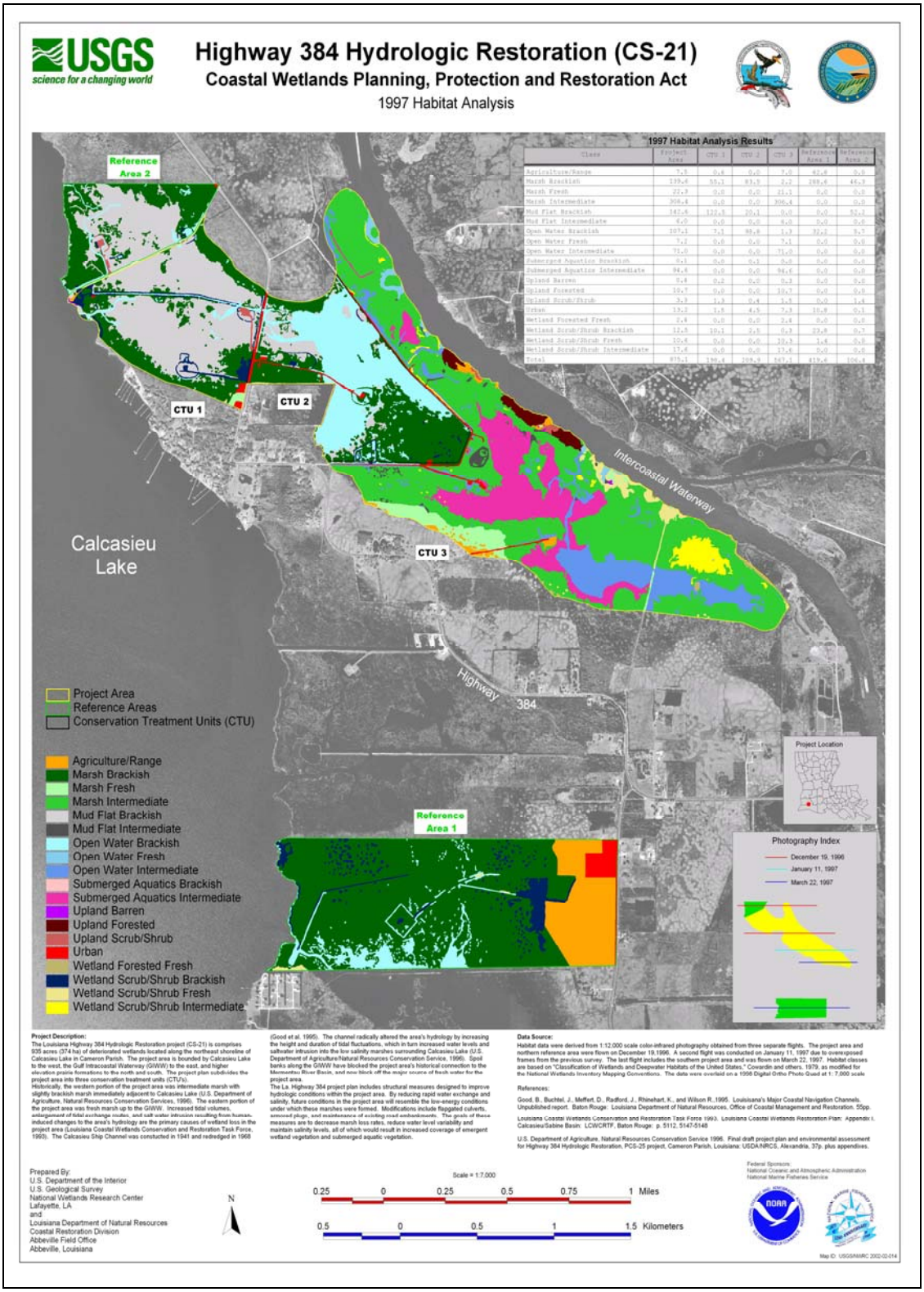

Figure 3. Habitat analysis from aerial photography flown January 11 and March 22, 1997.

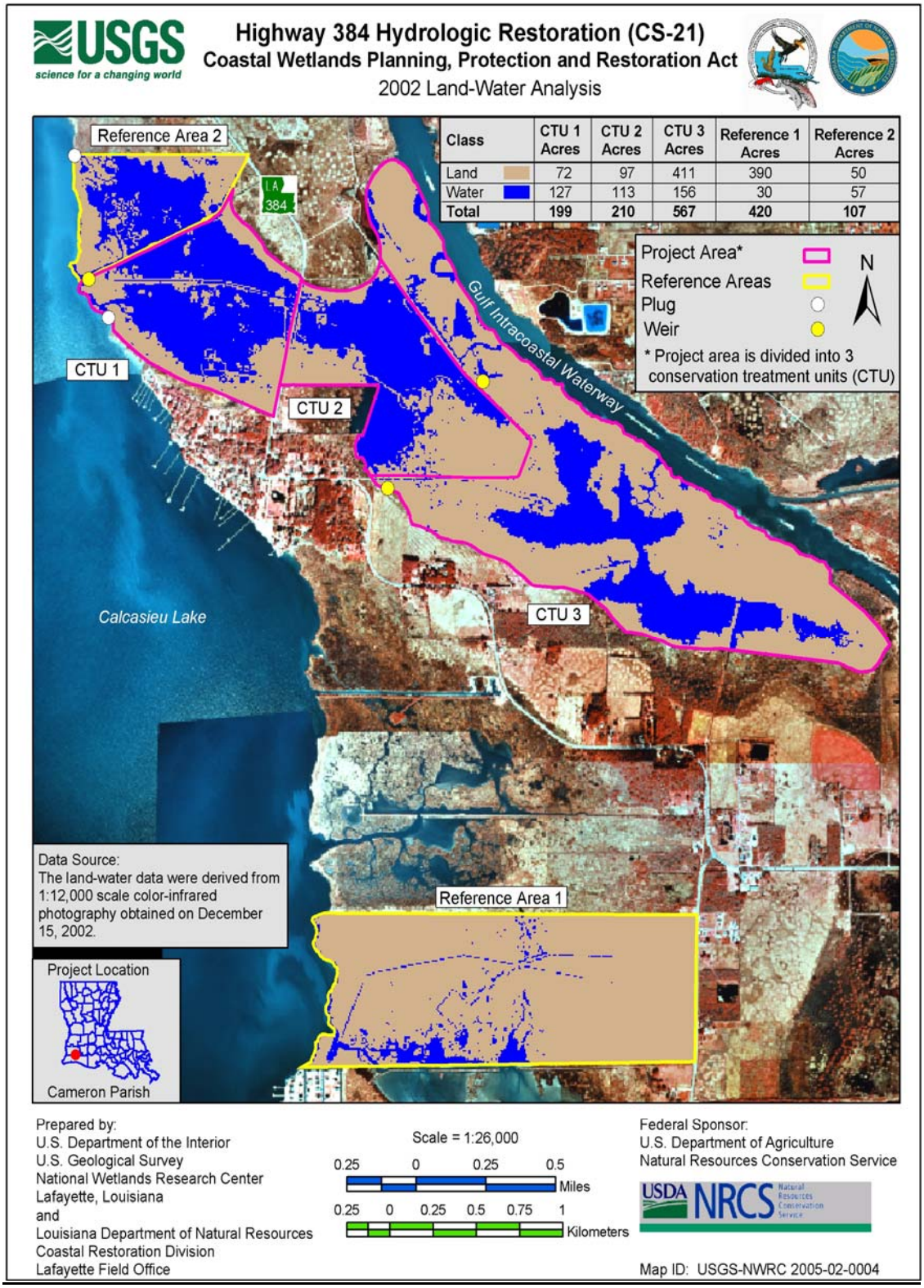

Figure 4. Land to water analysis from aerial photography flown December 15, 2002.

Table 1. Ratios of land and water for the Highway 384 Hydrologic Restoration (CS-21) project from aerial photography obtained pre-construction in 1997 and post-construction in 2002. The 1997 photography was classified by habitat (figure 2) while the 2002 photography was classified by land and water so acreages of land were summed. Mudflats were considered land, and upland habitats were included. Total acreages from the two years are not exactly the same, therefore percentages and differences in percentages should be used for comparison.

	Total Project		CTU 1		CTU 2		CTU 3		Total Reference		R 1		R 2	
	ac	ha	ac	ha	ac	ha	ac	ha	ac	ha	ac	ha	ac	ha
1997 Land	546.5	221.2	68.8	27.8	90.9	36.8	387.1	156.7	430.2	174.1	387.4	156.8	48.5	19.6
1997 Water	428.6	173.4	129.6	52.4	119.0	48.2	180.0	72.8	95.8	38.8	32.2	13.0	57.9	23.4
2002 Land	580.0	234.7	72.0	29.1	97.0	39.3	411.0	166.3	440.0	178.1	390.0	157.8	50.0	20.2
2002 Water	396.0	160.3	127.0	51.4	113.0	45.7	156.0	63.1	87.0	35.2	30.0	12.1	57.0	23.1
1997 Land %	56.0		34.7		43.3		68.3		81.8		92.3		45.6	
1997 Water %	44.0		65.3		56.7		31.7		18.2		7.7		54.4	
2002 Land %	59.4		36.2		46.2		72.5		83.5		92.9		46.7	
2002 Water %	40.6		63.8		53.8		27.5		16.5		7.1		53.3	
1997 TOTAL	975.1	394.6	198.4	80.3	209.9	84.9	567.1	229.5	526.0	212.9	419.6	169.8	106.4	43.1
2002 TOTAL	976.0	395.0	199.0	80.5	210.0	85.0	567.0	229.5	527.0	213.3	420.0	170.0	107.0	43.3
2002-1997 Land %	3.4		1.5		2.9		4.2		1.7		0.5		1.1	

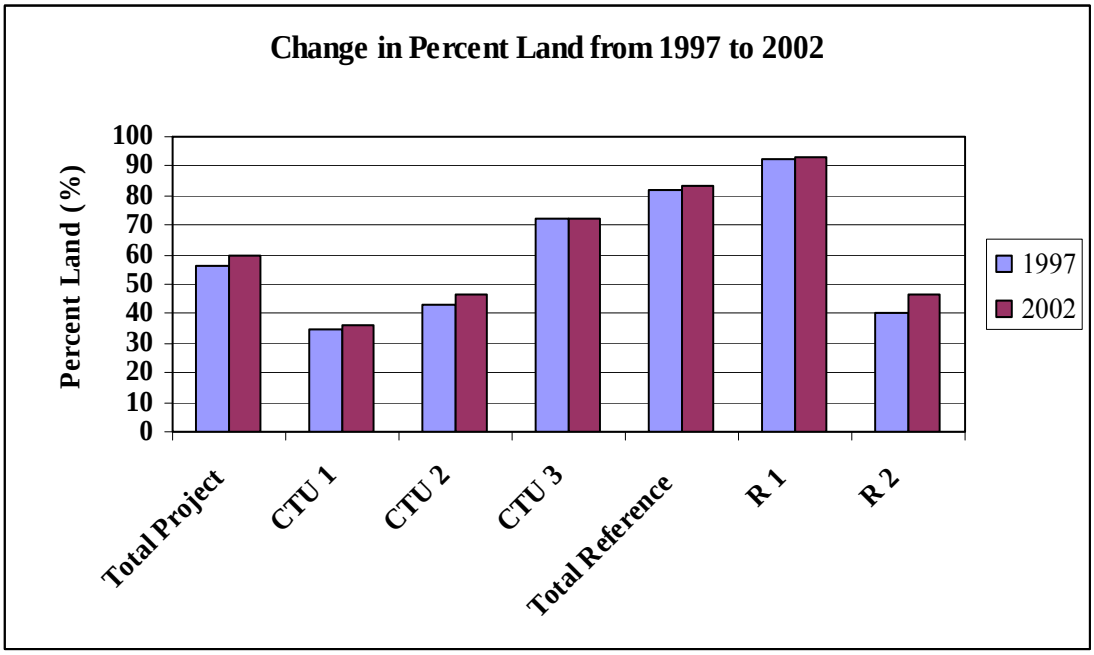

Figure 5. Percent of land area in 1997 and 2002 from aerial photography of each project CTU and the reference areas.

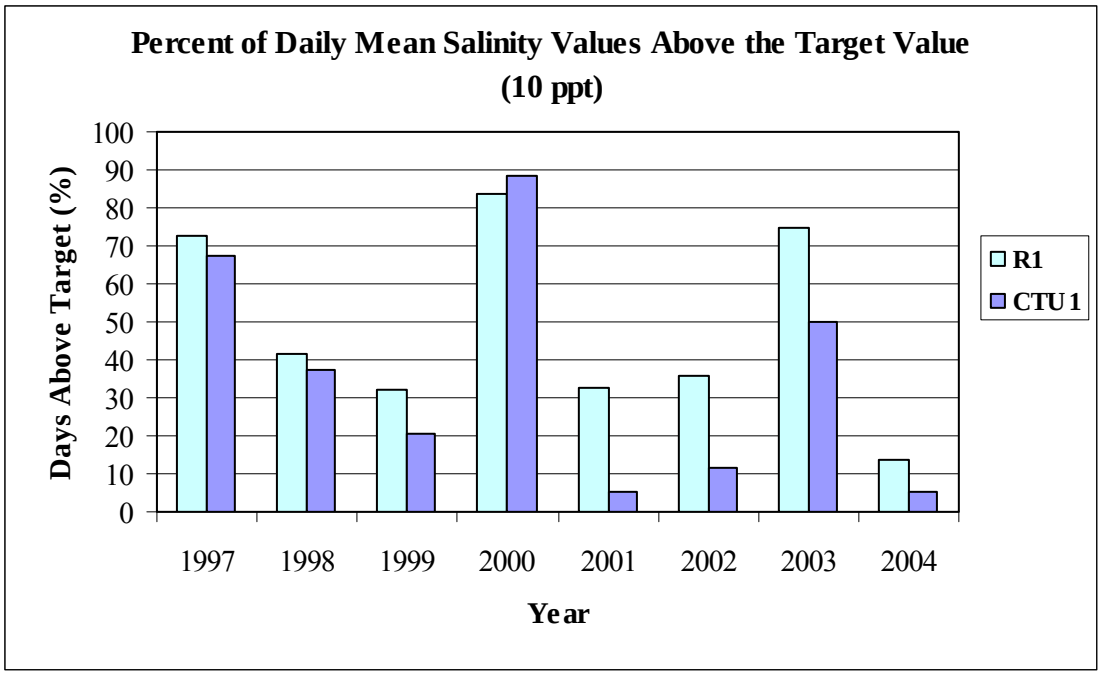

Figure 6. Percent of daily mean salinity values above the target value of 10 ppt in CTU 1 and R1 by years.

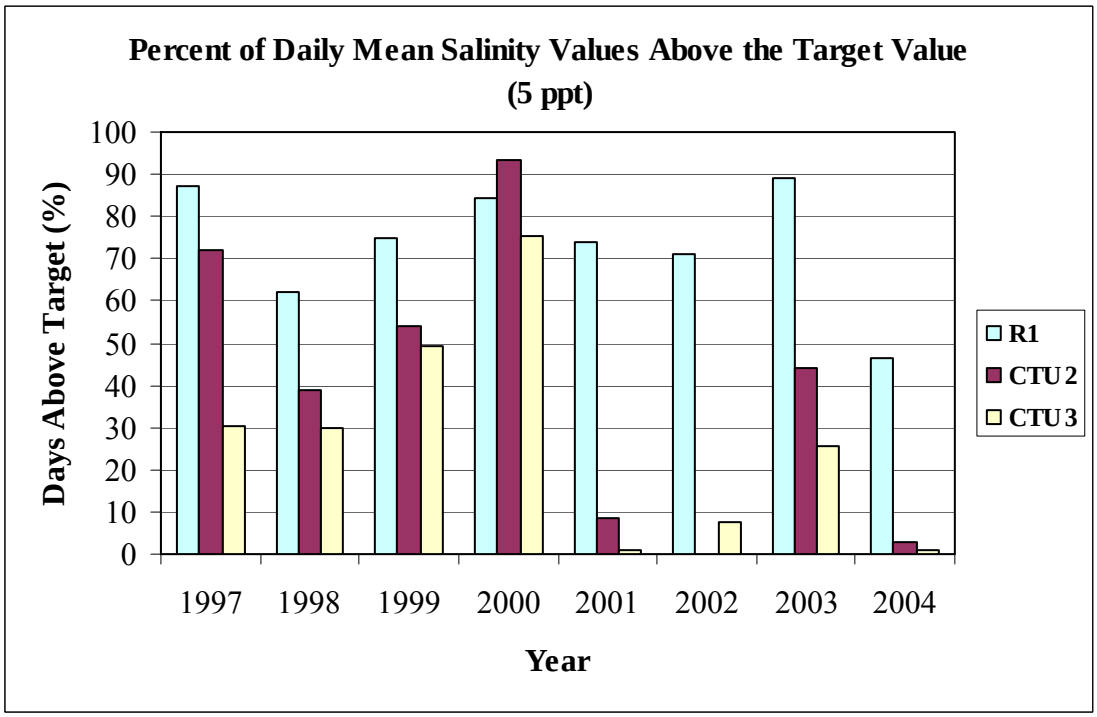

Figure 7. Percent of daily mean salinity values above the target value of 5 ppt in CTU 2, CTU 3, and R1 by years.

reference area were above 5 ppt 60% (1998) to almost 90% (2003) of the year from 1997 to 2004 (figure 7). Before project construction, salinities in CTU 2 and CTU 3 were rarely as high as in the reference area, but were consistently above the target range. During the drought of 2000, salinities in CTU 2 exceeded those in the reference area. Following project construction, salinities in CTU 2 and CTU 3 dramatically decreased and were within the target range more often, especially compared to the reference area, R1. CTU 3 has an open breach that connects it to the GIWW, so structure management does not directly affect this unit, although salinities have decreased in CTU 3 since construction. Structure operation when salinities are above 7 ppt will increase the effect of the project on salinities in CTU 2.

The project goal was to reduce water level variability in the project areas. This effect was tested using mean daily water level range (ft NAVD 88) by areas and years. The analysis indicates that the project has greatly reduced water level variability (or range) in the three project areas (figure 8). The mean daily range of water levels has increased each year from 1997 to 2004 in the reference area, R1. Following project construction completion in early 2000, water level range significantly decreased in CTU 1 and CTU 2 from between 0.6 and 0.8 ft NAVD 88 pre-construction to below 0.2 ft NAVD 88 post-construction (figure 8). Similarly, water level range in CTU 3 decreased from between 0.3 and 0.6 ft NAVD 88 pre-construction to below 0.4 ft NAVD 88 post-construction. Therefore the project has reached the goal of decreasing water variability. Note that although water level range decreased in the project areas, overall mean water level does not appear to have been affected by the project (figure 9).

Submerged Aquatic Vegetation

The project goal for SAV was to increase cover or frequency of occurrence. In 1996, 4.71% of stations in CTU 1 had SAV, the only species being an alga. Cover had increased to over 60% by 2002, the only species being *Ruppia maritima* (widgeongrass). In CTU 2, there was no SAV pre-construction and there was 85% *Ruppia* and 25% Algae post-construction. The other eight species found in the project area were in CTU 3 (figure 10). Between 1996 and 2002, *Ruppia,* Alga, *Najas guadalupensis* (southern waternymph), and *Eleocharis parvula* (dwarf spikerush) declined while *Chara* sp. (muskweed), *Myriophyllum spicatum* (spike watermilfoil), and *Vallisneria americana* (water celery) increased. There was little to no SAV in the reference area before construction and 33.7% *Ruppia* with 1.2% *Myriophyllum* post-construction. Overall, cover increased in CTU 1, CTU 2, and the reference area (R 2) and remained near 100% in CTU 3 (figure 11).

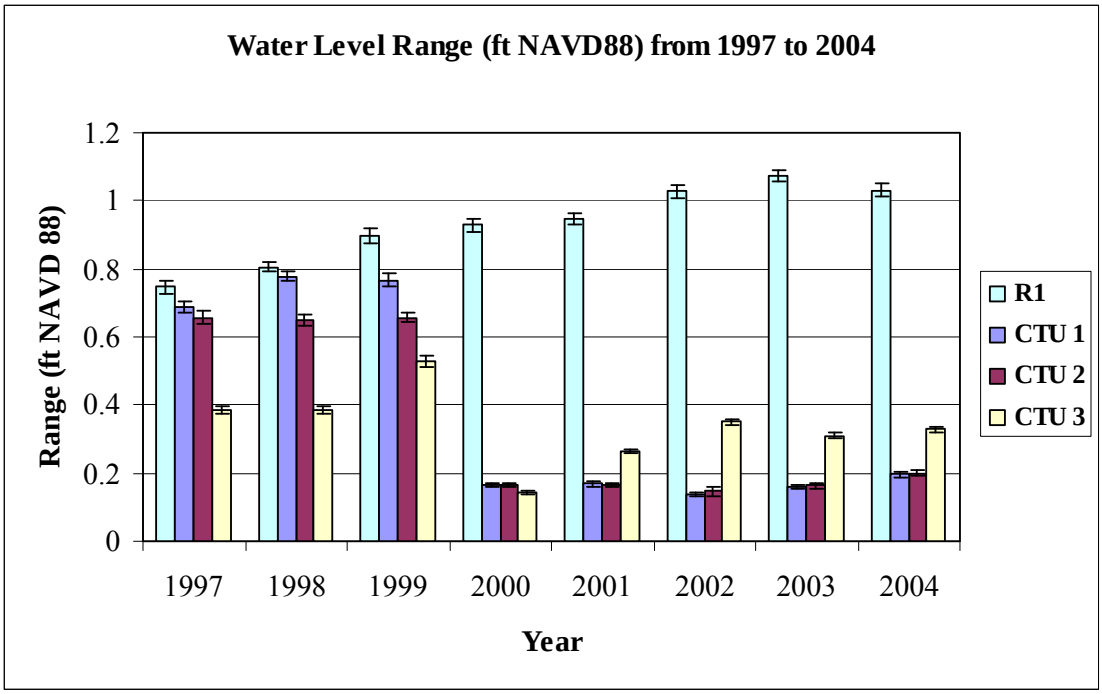

Figure 8. Water level range (ft NAVD 88) in the CS-21 Highway 384 project area from 1997 to 2004.

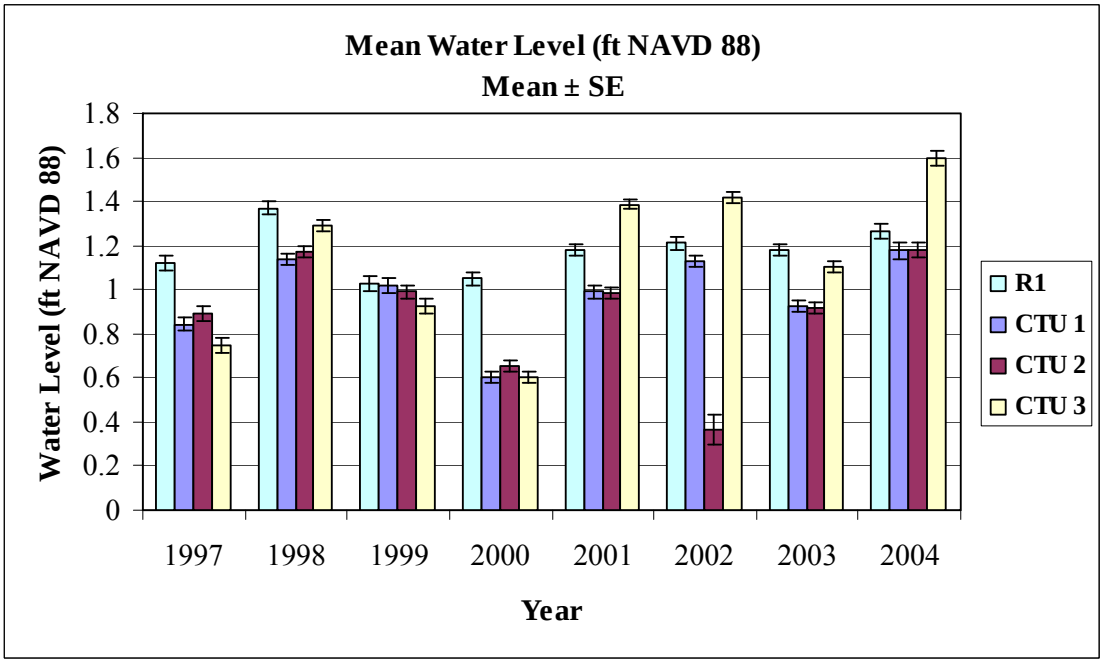

Figure 9. Yearly means of water level (ft NAVD 88) in the CS-21 Highway 384 project area from 1997 to 2004.

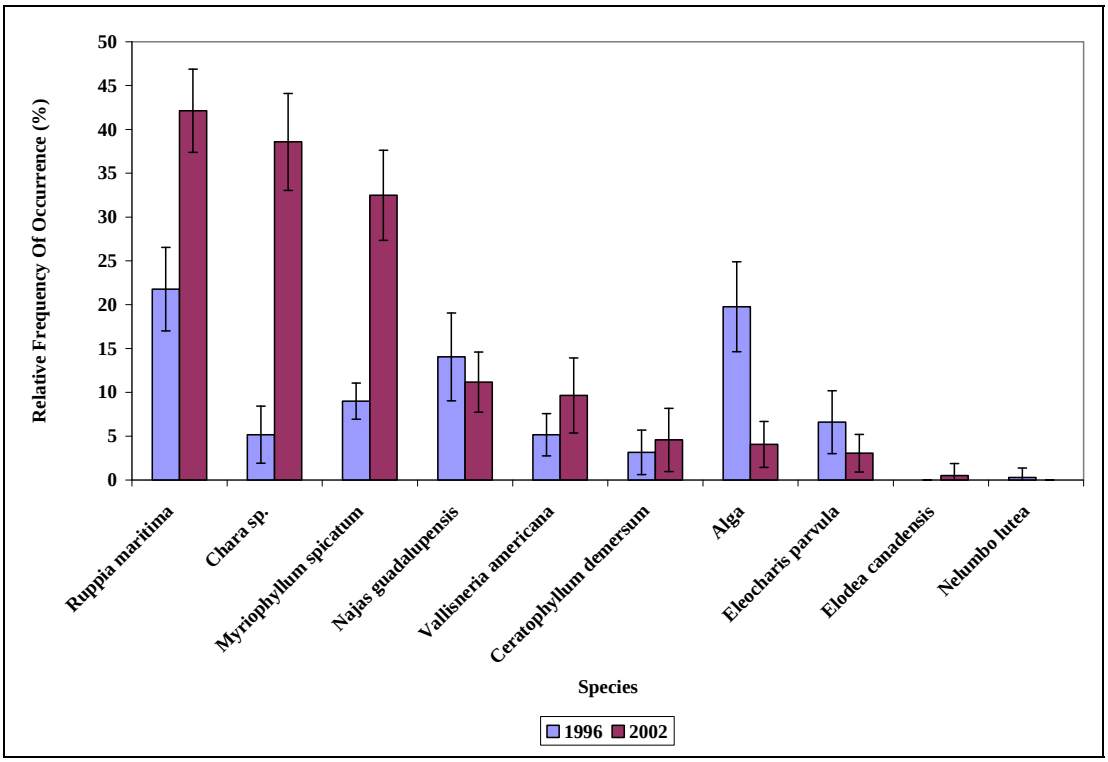

Figure 10. Frequency of Occurrence of SAV species in the project area (CTUs 1, 2 and 3 combined). Note that the majority of the occurrences were from CTU 3.

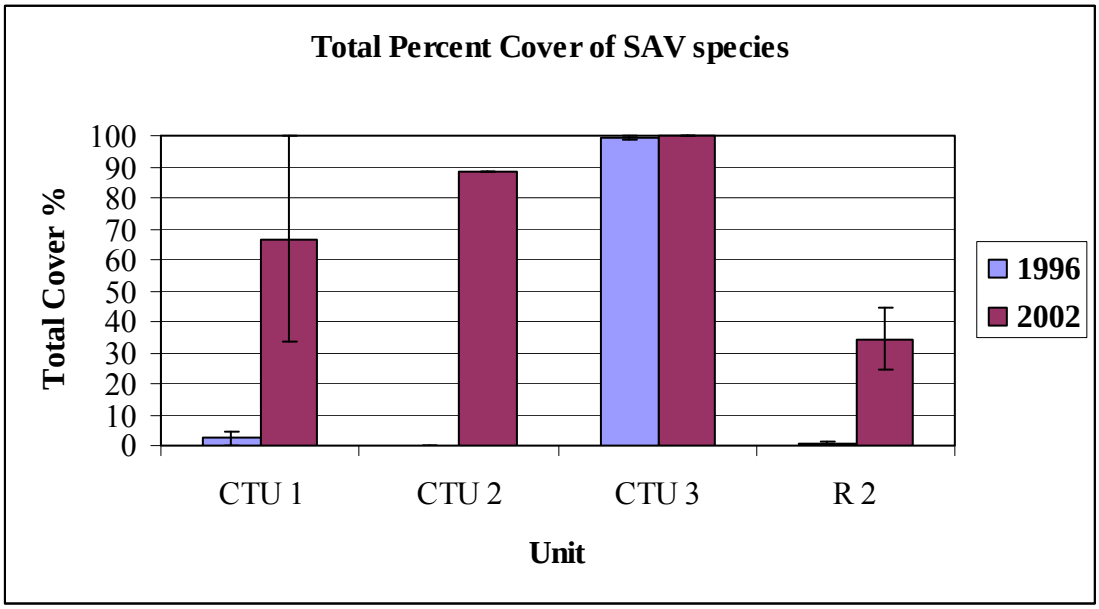

Figure 11. Total % Cover of SAV species in the CS-21 project and reference areas pre- and post-construction.

Emergent Vegetation

The project goal for emergent vegetation was to increase cover in the project area. This goal specifically refers to intermediate marsh in CTU 2 and CTU 3 and brackish marsh in CTU 1. Visser et al. (2000) has seven marsh type classifications for the Chenier Plain. These classifications are useful in determining the effect of restoration projects whose goals include specific vegetative assemblages. According to surveys performed pre-construction in 1997, CTU 1 was primarily dominated by *Juncus roemerianis* (needlegrass rush) with some *Spartina patens* (marshhay cordgrass) and some more saline species present, including *Spartina alterniflora* (smooth cordgrass) and *Distichlis spicata* (seashore saltgrass). These species would fit into either the Oligohaline Wiregrass or Mesohaline Mixture classifications. Since the salinities were within the brackish range for that year, the marsh should probably be classified as Oligohaline Wiregrass pre-construction. The 2002 survey showed an increase in *Spartina patens* and the presence of *Schoenoplectus robustus* (sturdy bulrush). Total percent cover increased post-construction from 58.8% to 91.3% and the post-construction assemblage was also Oligohaline Wiregrass which is in accordance with the project goal of increasing cover of brackish marsh in CTU 1 (figures 12 and 13).

Pre-construction in 1997, CTU 2 was dominated by *Spartina patens, Juncus roemerianis,* and *Eleocharis albida*. In 2002, several more species were present including *Paspalum vaginatum* (seashore Paspalum) and other intermediate marsh species (figure 14). The 1997 composition is consistent with the Visser et al. (2000) classification of Oligohaline Wiregrass due to the dominance of *Spartina patens*. The 2002 survey revealed that total percent cover had remained the same (73%) (figure 12) while species richness increased from 4.8 to 8.3 species per plot. The additional species and the decrease in the cover of common brackish species suggest Unit 2 is also on target for vegetation goals.

CTU 3 was dominated by *Spartina patens, Schoenoplectus californicus* (California bulrush), and *Sagittaria lancifolia* (bulltongue) in 1997 (figure 15). By 2002, the unit was dominated by *Spartina patens, Typha latifolia* (cattail), and *Juncus roemarianus,* species richness had increased from 6.6 to 10.5 species per plot, and total cover had increased from 59% to 79% (figure 12). Despite the shift in species assemblage, the Visser et al. (2000) classification remained Oligohaline Wiregrass. These results are consistent with the project goals of increasing the cover of intermediate marsh.

Reference Areas 1 and 2 showed little change from 1997 to 2002, being dominated by *Juncus* and *Spartina patens* (figures 16 and 17). *Spartina alterniflora* began to emerge and *Distichlis spicata* decreased post-construction in R1. The Visser classification for both reference units should be Oligohaline Wiregrass. Total cover increased in both units (figure 12) and species richness slightly decreased in R2 from 3.3 to 2.7 species per plot.

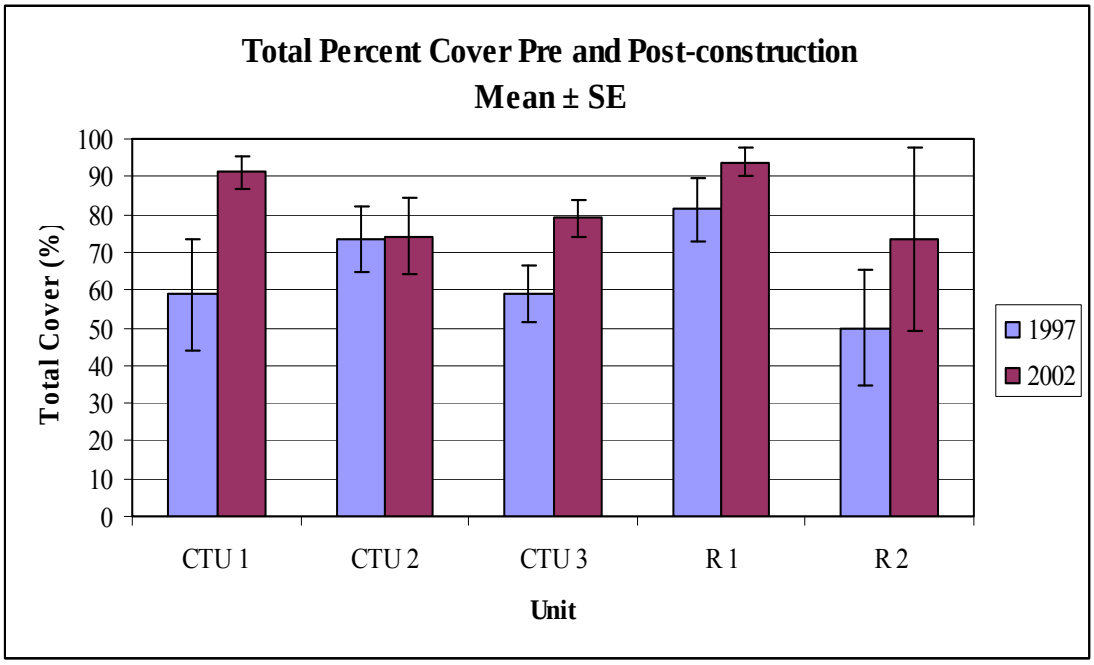

Figure 12. Total % Cover in vegetation plots at the CS-21 Highway 384 project pre- and post-construction in 1997 and 2002.

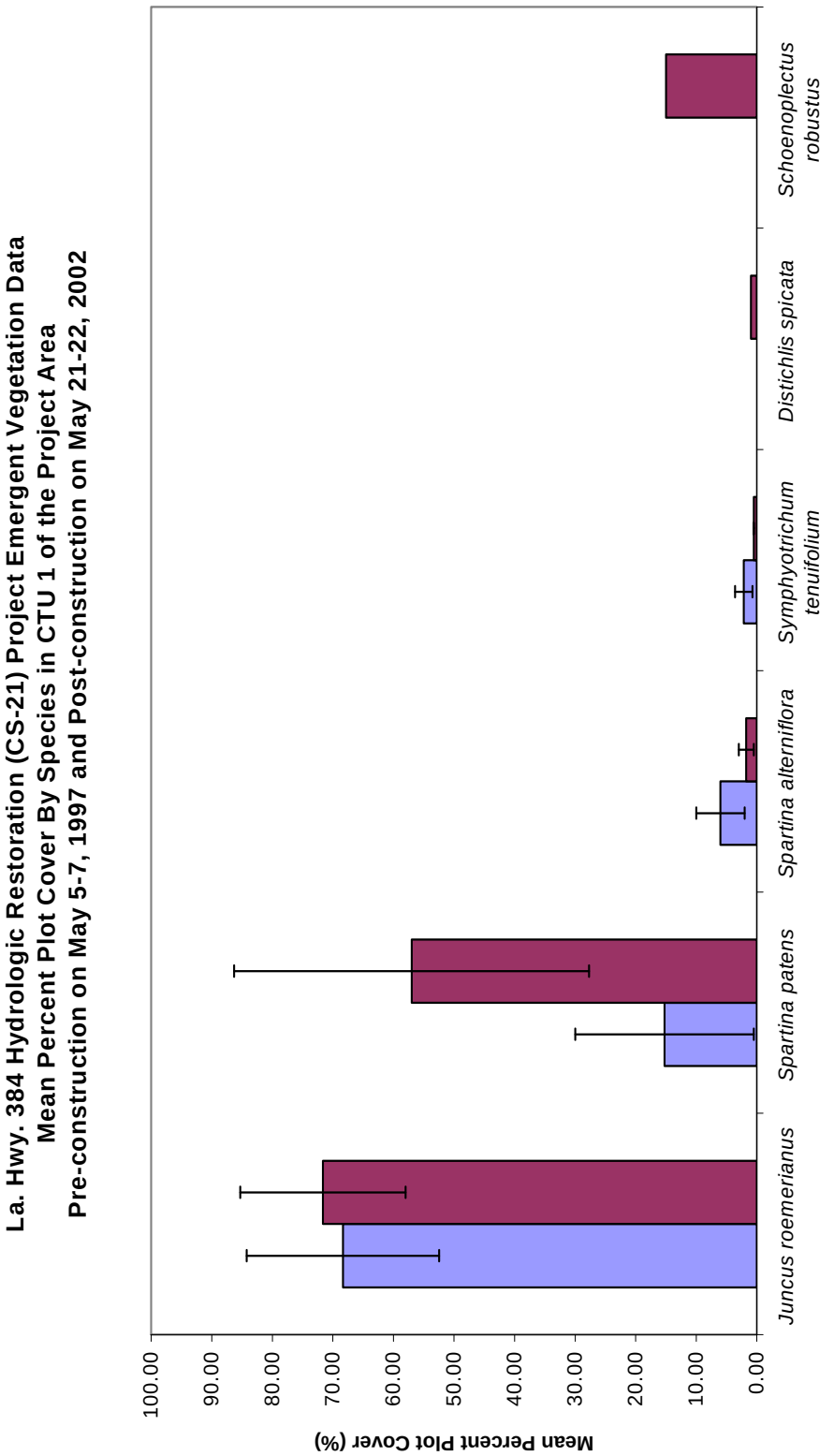

Figure 13. Percent cover of emergent vegetation in CTU 1 pre- and post-construction.

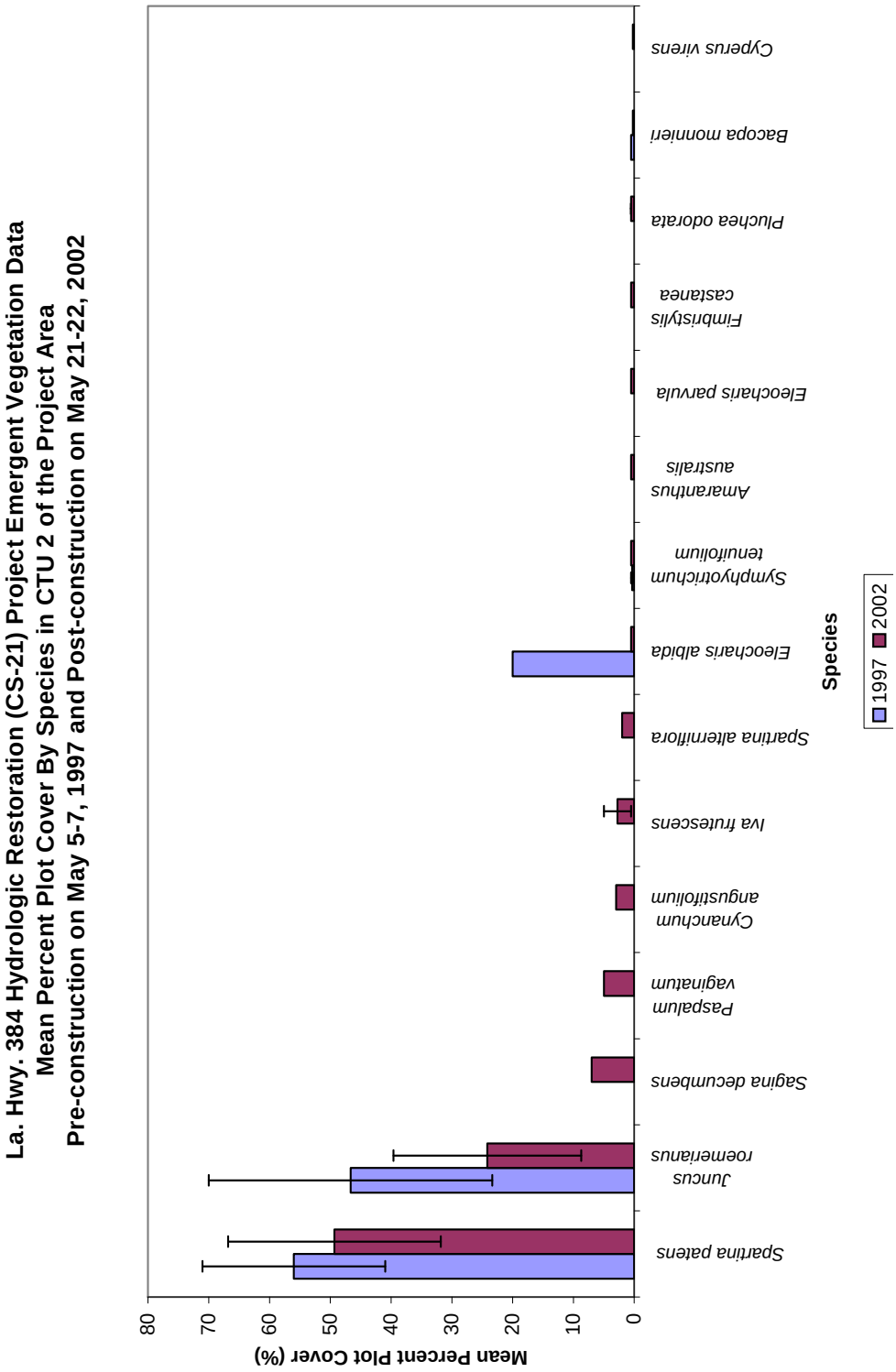

Figure 14. Percent cover of emergent vegetation in CTU 2 pre- and post-construction.

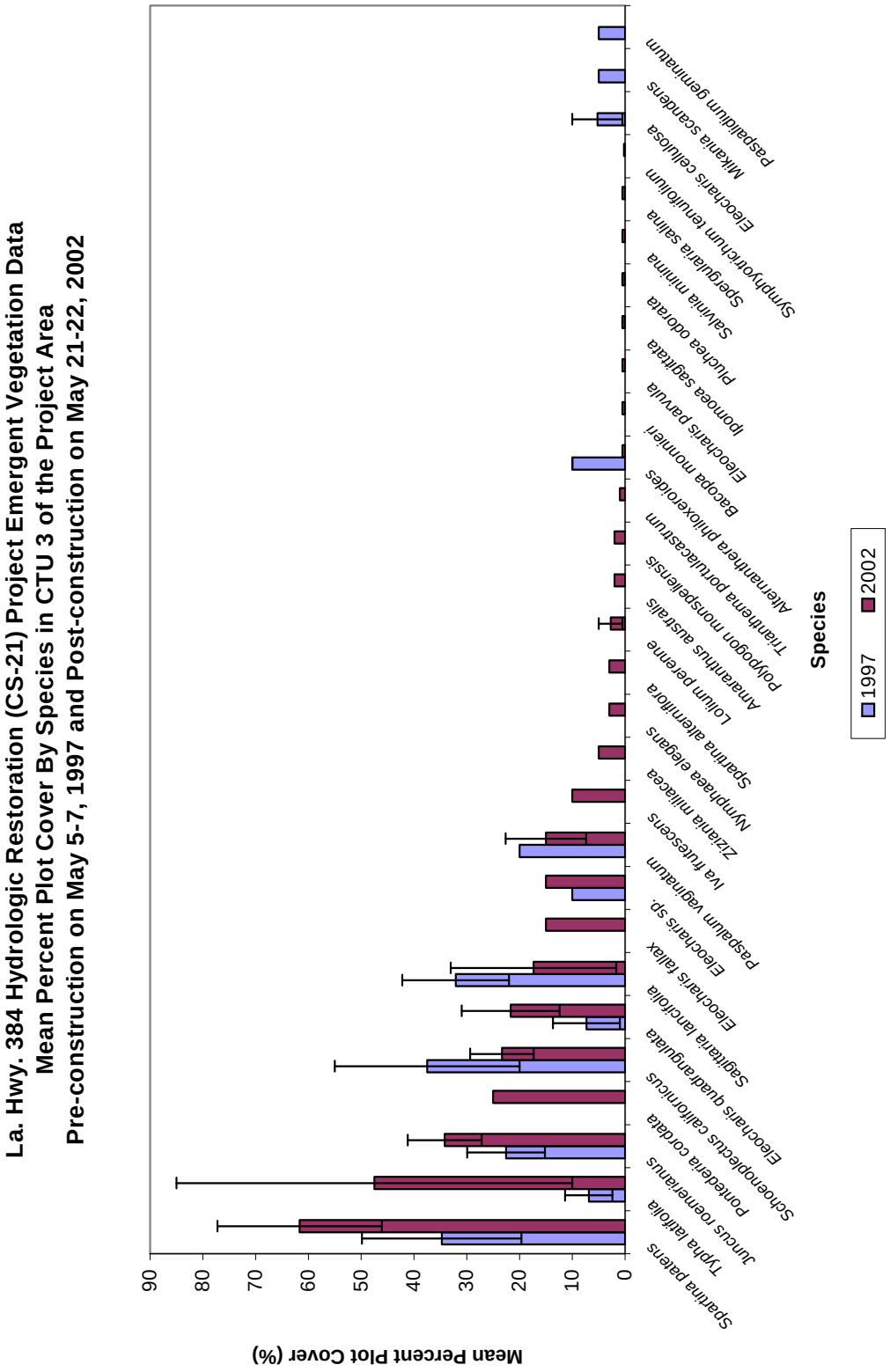

Figure 15. Percent cover of emergent vegetation in CTU 3 pre- and post-construction.

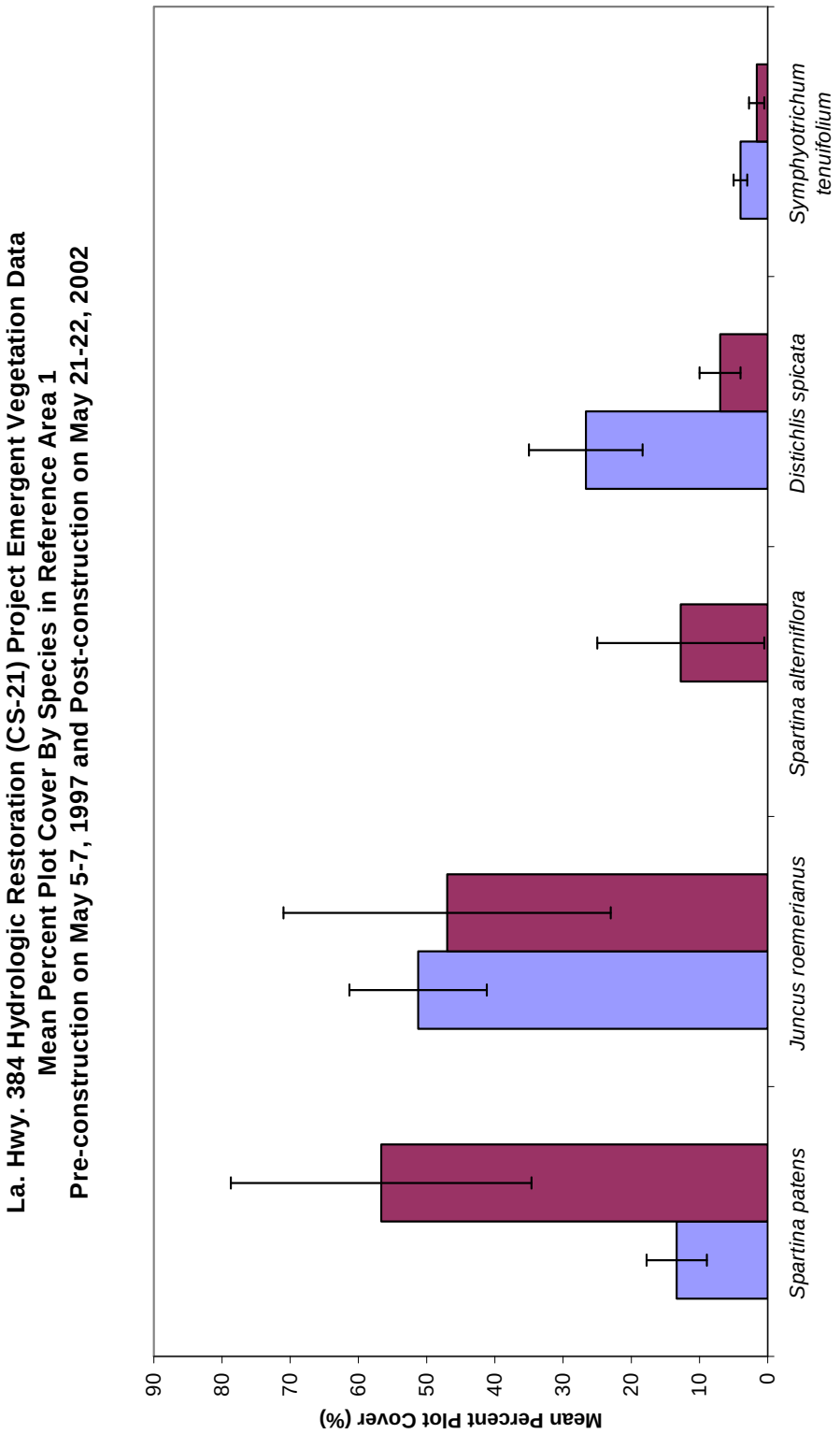

Figure 16. Percent cover of emergent vegetation in R1 pre- and post-construction.

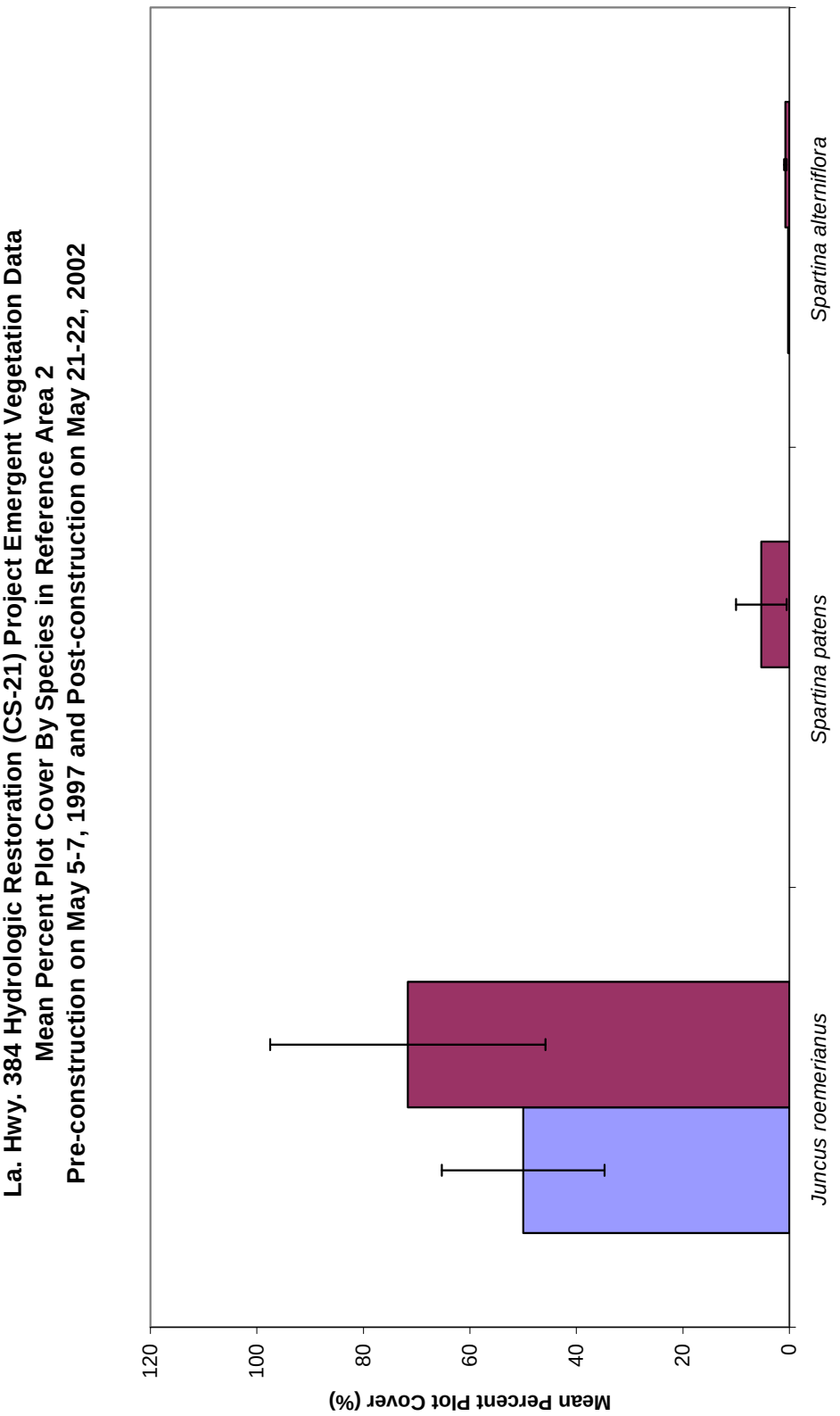

Figure 17. Percent cover of emergent vegetation in R2 pre- and post-construction.

Soil Characteristics

Soil characteristics were originally collected in 1997. Soil characteristics are consistent with brackish type marshes (table 2) (Palmisano 1972). Post-construction samples which were to be collected in conjunction with the vegetative sampling were not collected in 2005.

Table 2. Pre-construction (1997) soil characteristic data for Highway 384 Hydrologic Restoration (CS-21) project and reference areas.

Unit	Percent (%) Organic Matter (%)	Bulk Density (oven) (g/cm3)	Percent (%) Water (Moisture) (%)	Pore Water Salinity (ppt)	Organic Matter Density (oven) (g/cm3)	Mineral Matter Density (oven) (g/cm3)
CTU 1	0.20	0.68	0.72	17.65	0.13	0.54
CTU 2	0.21	0.70	0.71	18.32	0.12	0.58
CTU 3	0.12	0.85	0.49	12.63	0.09	0.75
Reference 1	0.26	0.49	0.75	18.53	0.12	0.37
Reference 2	0.11	0.81	0.63	17.10	0.39	0.72

POST-HURRICANE RITA EMERGENT VEGETATION

In the CS-21 project area, 23 stations were randomly chosen from the available stations (figure 18). In the last sampling before Hurricane Rita (2002), the vegetation was vigorous and only slightly stressed (figure 19). In 2005, 13% of the stations were severely stressed. By 2006, the percent of severely stressed stations had dropped to 4% (one station) and the other stations had recovered to pre-storm stress levels. Total cover and species richness were lower in 2005 and had recovered to pre-storm levels by 2006 (figures 20 and 21).

Although the stations had recovered in vigor, cover, and richness by 2006, the species assemblages had shifted from mostly Oligohaline Wiregrass (*Spartina patens* dominated) with some Fresh Bulltongue (*Sagittaria lancifolia* dominated) before Rita to a mixture of Oligohaline Wiregrass, Oligohaline Paspalum (*Paspalum vaginatum* and *Spartina patens* co-dominated), Oligohaline Bullwhip (*Schoenoplectus californicus* dominated) and Mesohaline Mixture (*Spartina alterniflora* and *Distichlis spicata* co-dominated) (figure 22).

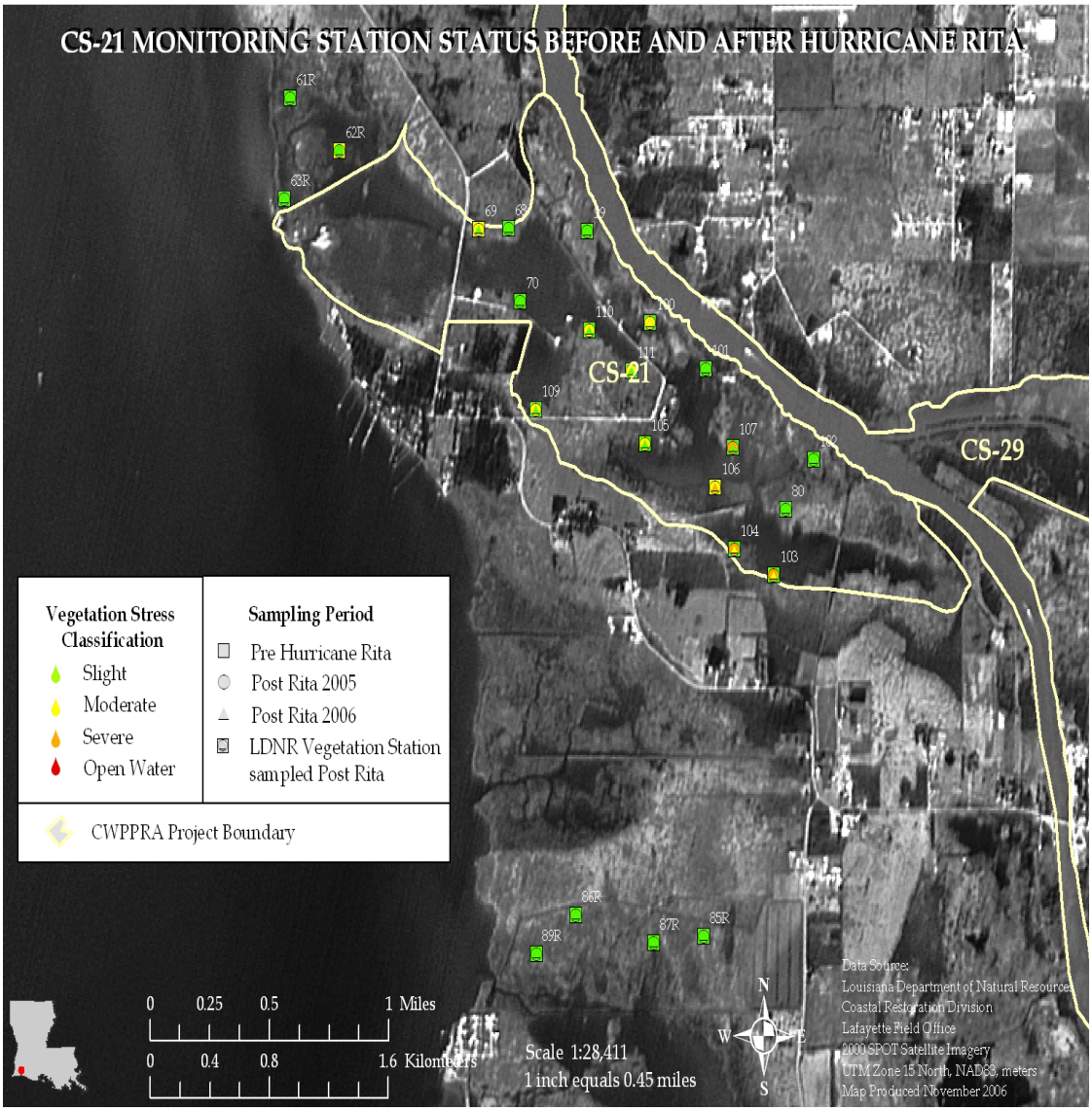

Figure 18. Location and status of CS-21 Vegetation stations sampled after Hurricane Rita.

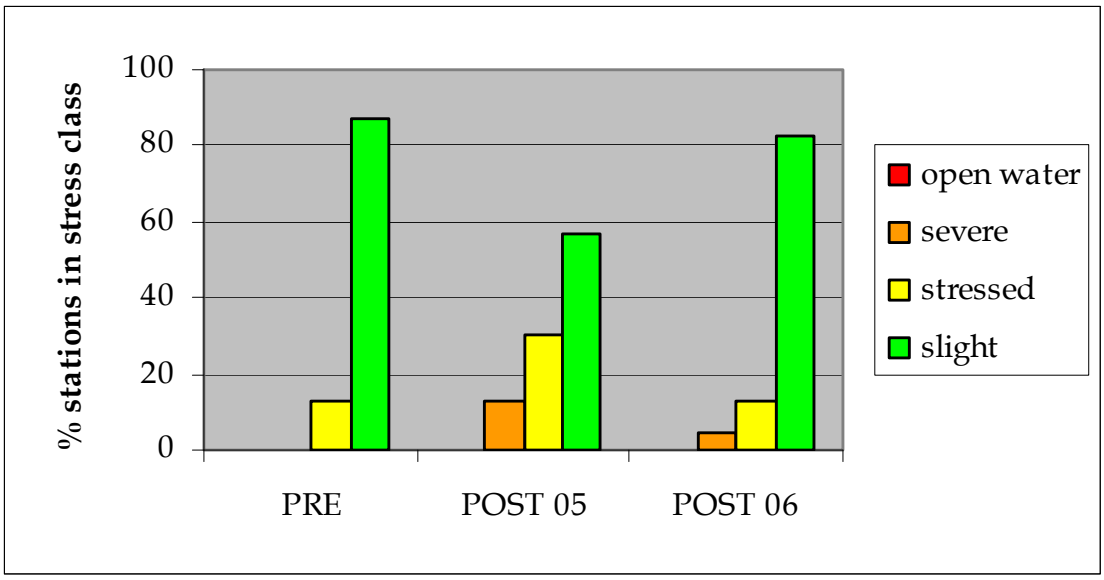

Figure 19. Percent of CS-21Vegetation stations in each stress class before and after Hurricane Rita (n=23).

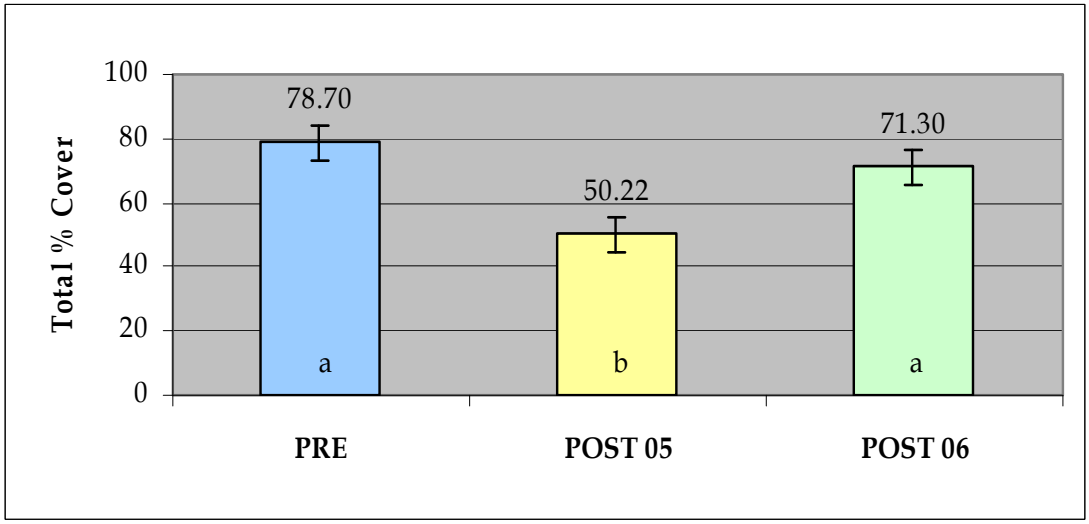

Figure 20. Total % Cover of vegetation at CS-21 Pre- and Post-Hurricane Rita. LS Mean ± SE (n=23 stations). $F_{2, 68}$=7.24, p=0.0014. Levels connected by the same letter are not significantly different.

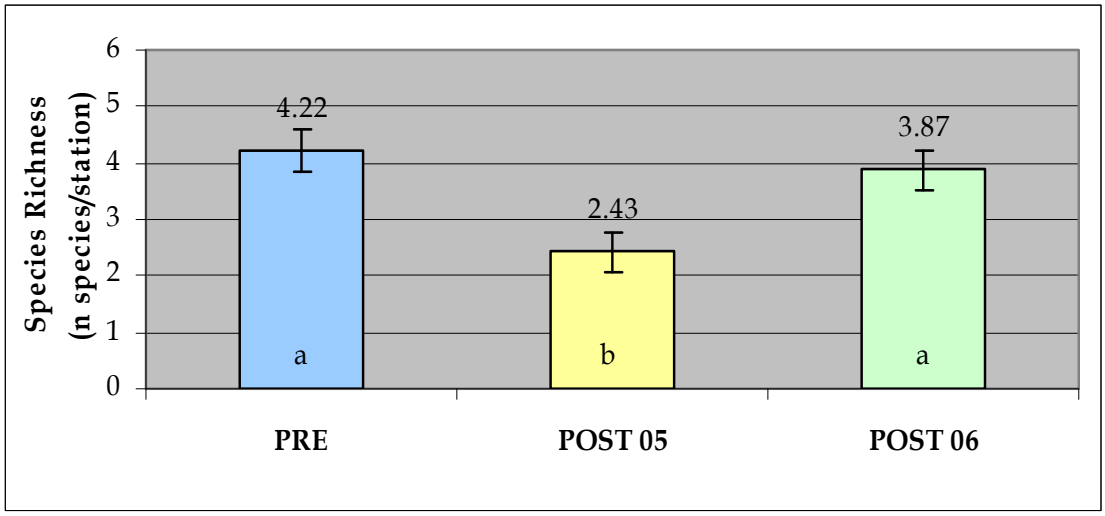

Figure 21. Species Richness at CS-21 Pre- and Post-Hurricane Rita. LS Mean ± SE (n=23 stations). $F_{2, 68}$=7.13, p=0.0016. Levels connected by the same letter are not significantly different.

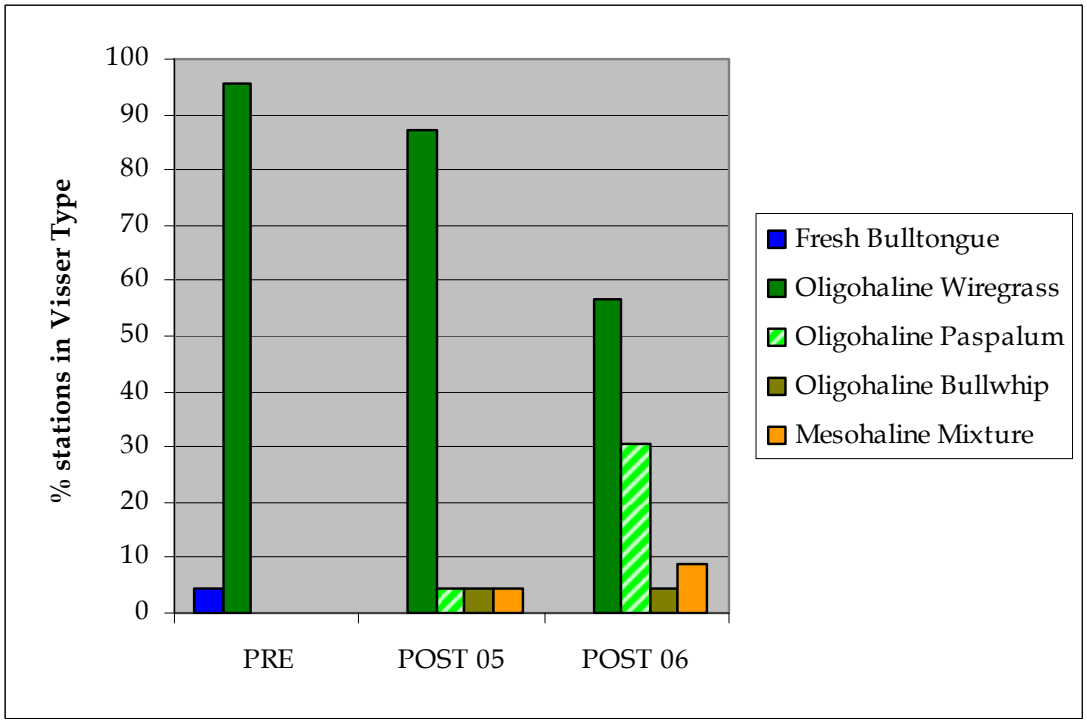

Figure 22. Percent of CS-21Vegetation stations in each Visser vegetation type before and after Hurricane Rita (n=23).

V. Conclusions

a. Project Effectiveness

Land to water ratios in the project and reference areas pre-construction were maintained post-construction (figure 5), therefore the goal of decreasing the rate of marsh loss was met. The total project area (3.4%) and reference areas (1.7%) made slight increases in land area. Because the reference areas increased a similar amount as the project areas, this change may not be attributed to the project.

Post-construction salinities were within the target range more often than pre-construction salinities in all three project areas (figures 6 and 7), with the exception of the year 2000. An extended drought in 1999 - 2000 caused salinities to exceed the target ranges for 70-90% of the year in all three CTUs. During this time, salinity in CTUs 1 and 2 was above the target range a higher percentage of the year than the reference areas. The drought began in 1999 and construction of the project ended in January 2000, therefore salinities were already prematurely high within the project area. The rock plug along Calcasieu Lake in CTU 3 is porous, allowing high salinity water to flow into the project area and the plugging of the GIWW inflow channel into CTU 2 trapped high salinity water in CTUs 1 and 2 for the duration of construction.

Water level variability as measured by range decreased dramatically post-construction in the project areas while it continued to rise in the reference area (figure 8).

Cover of SAV increased in all project and reference areas, increasing from near zero to over 50% in CTU 1 and CTU 2 and to around 30% in R2 (figure 11). This response could be due to the project effects of lowered salinity or it could be due to weather during the sampling years.

Total percent cover of emergent vegetation increased in all of the project and reference areas, most noticeably in CTU 1, CTU 3, and the reference areas (figure 12). Species richness increased in the two intermediate project areas (CTU 2 and CTU 3). The increases in cover and richness can most likely be attributed to the maintenance of salinity within the target ranges and the reduced water level range.

The subset of stations from CS-21 sampled 1 month and 1 year after Hurricane Rita behaved similarly to the whole dataset for southwestern Louisiana (Appendix A). Stations in the project were moderately stressed in 2005 and had nearly fully recovered by 2006. Interestingly, the Visser types that began to emerge in 2006 were not the same as had been there in 2002. Whether those stations will eventually revert back to their original Visser types or will continue as different species assemblages remains to be seen.

b. Recommended Improvements

Overall, the Highway 384 Hydrologic Restoration project structural components are in good condition and functioning as designed with only minor problems noted. The hyacinth fence that was installed during the maintenance project of June 2002 as well as the rock reinforcement of the bankline is performing well and should be incorporated into all structures of this type in the future. The access road repair with recycled concrete material turned out well and was economical. The two Portable Multi-Parameter Water Quality Troll 9500 units used for operation of this project are working very well and should be considered for future projects. A maintenance event is planned during 2007/2008 for the items listed below.

- Structure No. 1 – install bird excluder device on solar panel, replace staff gauge.
- Structure No. 12 – replace metal pile cap covers, install bird excluder device on solar panel.

The structures have proven effective in achieving the goals of the project except during extreme weather conditions such as the drought in 2000. A revision to the permitted structure operations was recommended by CED and CRD jointly in late 2005, to provide increased control, restricting high salinity water from entering the project area from the GIWW, particularly CTUs 1 and 2. This revision is also designed to increase the flow of freshwater into CTUs 1 and 2 when freshwater is available. A permit modification of the original operating procedures mandating closure of the sluice gates at Structure #1 when salinities exceed 7 ppt was approved and enacted in early 2006, reflecting these recommendations.

c. Lessons Learned

The access road repair with recycled concrete material turned out well and was economical in comparison to limestone aggregate.

No salinity data was available for the GIWW during the design phase of this project. It was assumed that the Calcasieu Locks prevented high salinity water from entering the GIWW from Calcasieu Lake. Data gathered since construction of the project proved this assumption to be erroneous. CTU 3, the intermediate marsh adjacent to the GIWW, is particularly vulnerable to elevated salinity flow from the GIWW, as no provisions were made to restrict this flow through this portion of the project area. Future designs should be based on actual information gathered at specific locations.

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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 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).

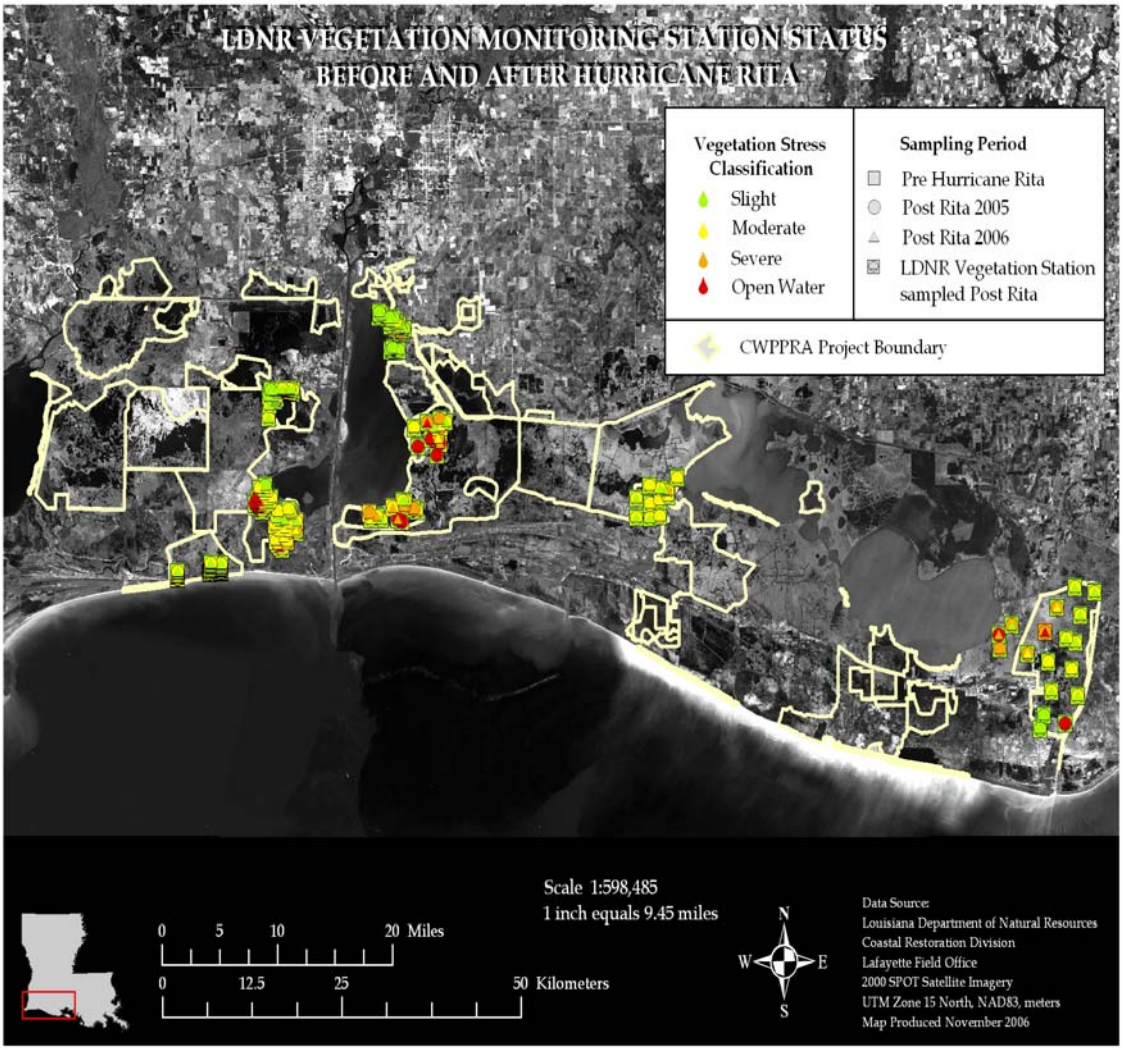

Figure 1. Location and status of LDNR Vegetation stations sampled after Hurricane Rita. Stations were classified according to storm induced stress as described in Table 1.

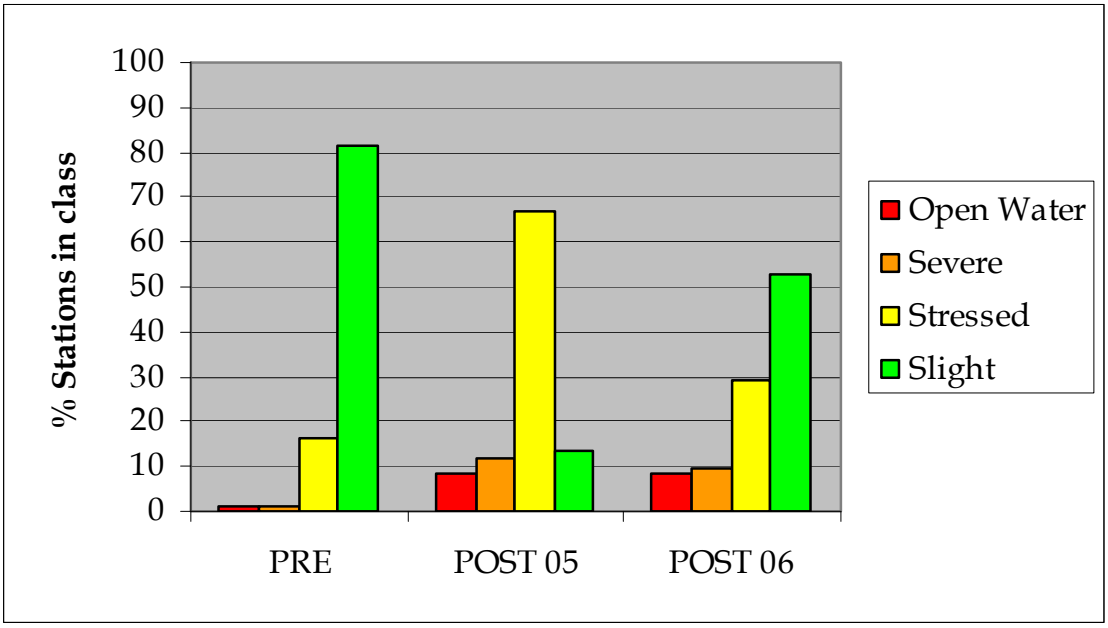

Figure 2. Percent of LDNR Vegetation stations in each stress class before and after Hurricane Rita (n=163).

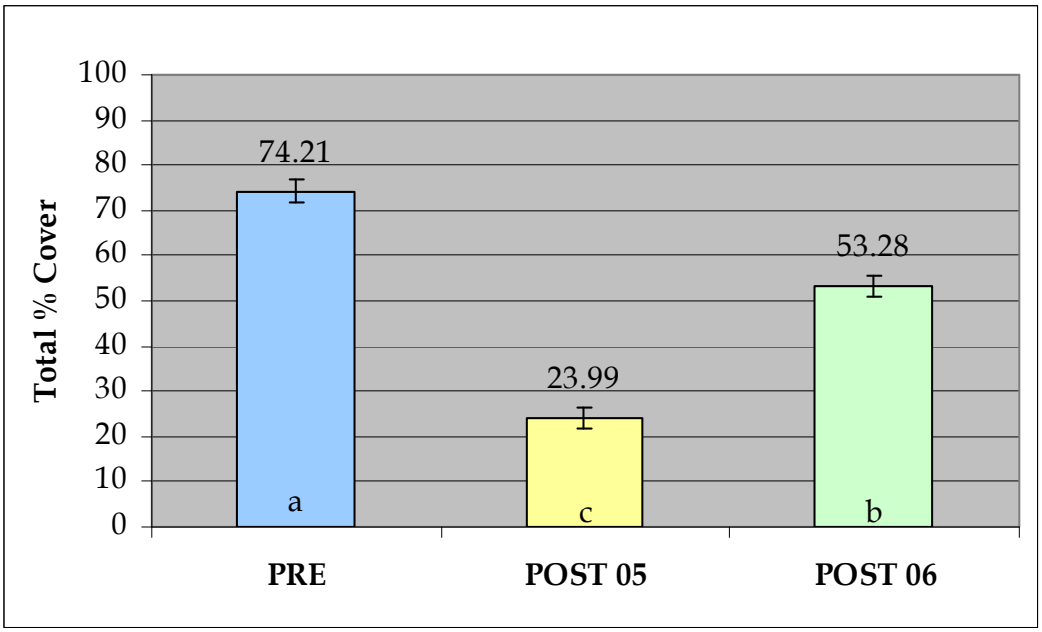

Figure 3. Total % Cover Pre- and Post-Hurricane Rita. LS Mean ± SE, n=163 stations, $F_{2, 488}$=109.7, p<0.0001. Levels not connected by same letter are significantly different.

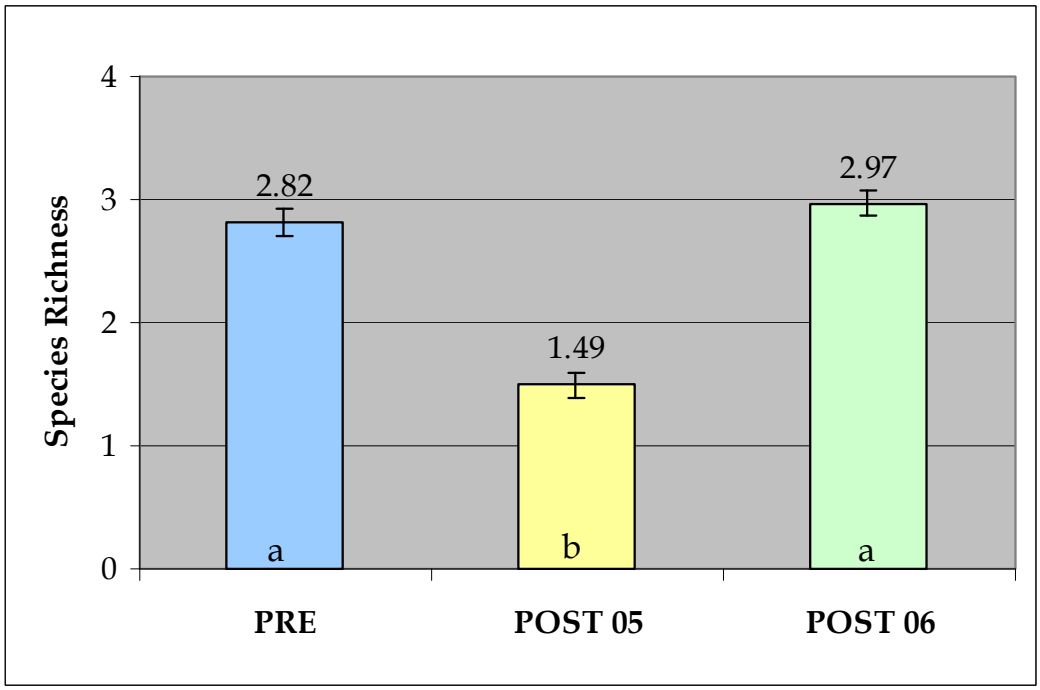

Figure 4. Species Richness Pre- and Post-Rita. LS Mean ± SE, n=163 stations, $F_{2, 488}$=56.8, p<0.0001. Levels not connected by same letter are significantly different.

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.

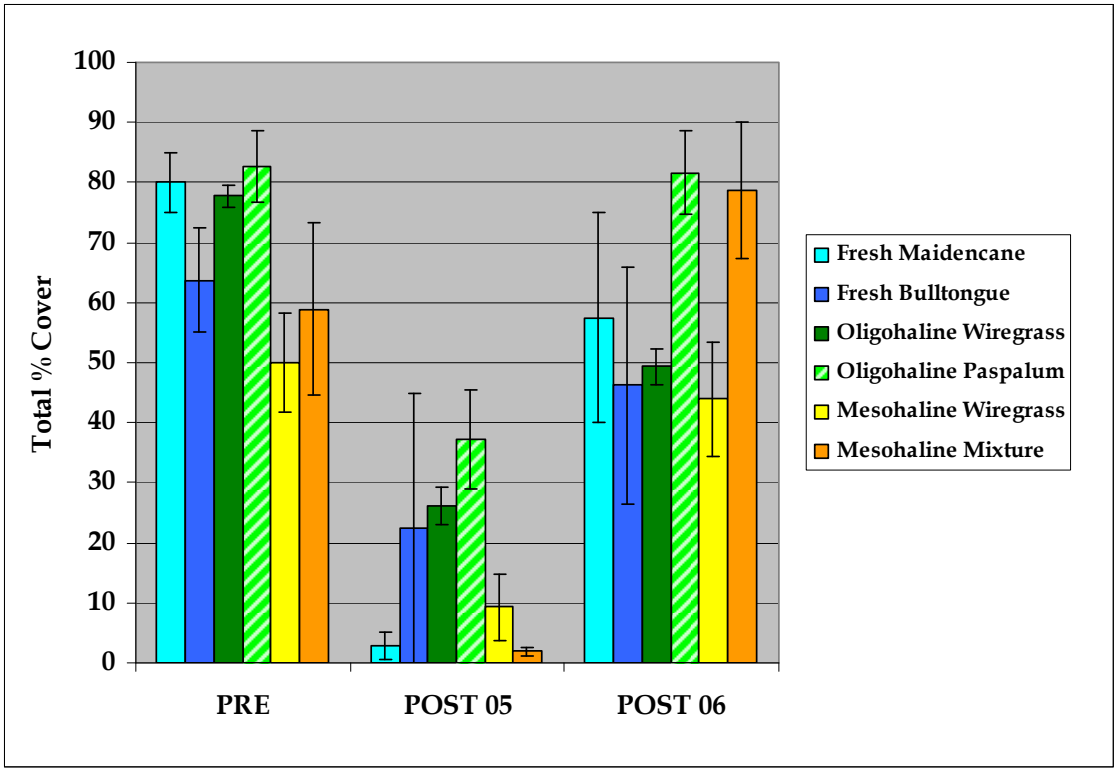

Figure 5. Total % Cover by Visser Vegetation Type. LS Mean ± SE, n=163 stations, $F_{17, 488}$=17.0, p<0.0001.

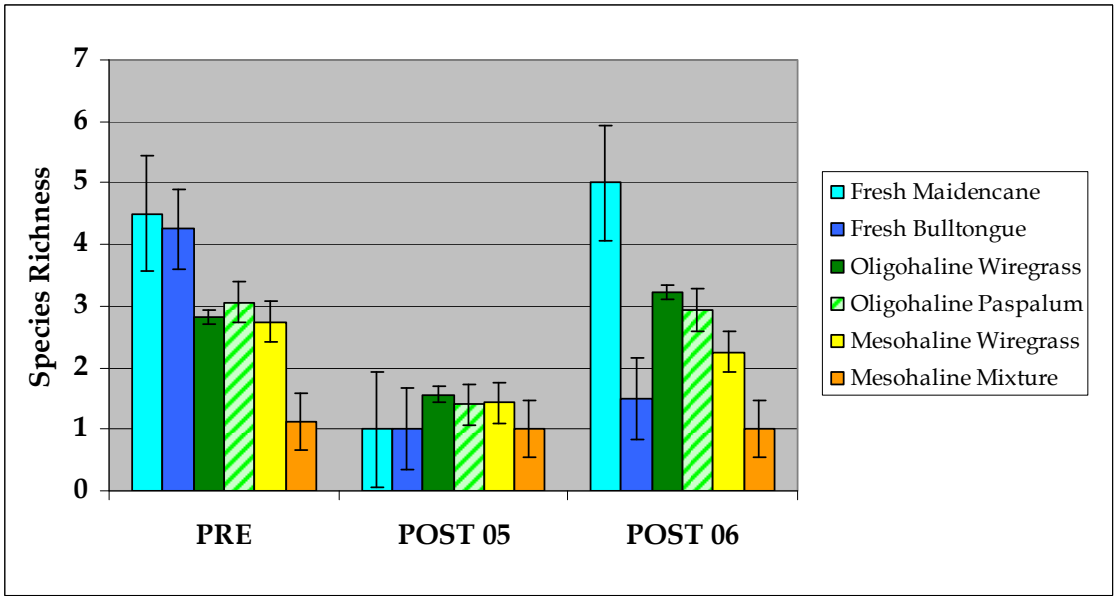

Figure 6. Species Richness by Visser Vegetation Type. LS Mean ± SE, n=163 stations, $F_{17, 488}$=10.9, p<0.0001.

DISCUSSION AND CONCLUSIONS

Most sites are still in recovery and transition from stressors introduced by Hurricane Rita, including prolonged elevated water levels for weeks following the storm, and elevated water and soil salinity which persists today in most areas. Total % Cover and Species Richness have recovered at most projects. The species that compose Cover and Richness are often disturbance species.

Generally, there was an increase in cover and occurrence of salt tolerant species. There was a decrease in fresh species in all project areas. There was an increase in opportunistic annual species in all marsh types. *Paspalum* sp. cover increased in all marsh types.

Within Visser Vegetation Types, stations that were Fresh Maidencane before the storm showed a shift in dominant species from *Panicum hemitomon* to *Echinochloa walterii* and *Cyperus* spp. Fresh Bulltongue dominant species shifted from *Sagittaria lancifolia* to *Echinochloa walterii* and *Cyperus* spp. Oligohaline Wiregrass showed an increase in cover of salt tolerant disturbance species and annual shrubs.

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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.

APPENDIX B
(Inspection Photographs)

Appendix B
(Inspection Photographs)

Photo 1. View showing hyacinth fence and sluice gates at Structure No. 1. (March 8, 2007)

Photo 2. View showing Portable Multi-Parameter Water Quality Troll 9500 (29r) with wooden boardwalk at Structure No. 1. (March 8, 2007)

Photo 3. View showing trash and debris within hyacinth fence that needs to be removed. (March 8, 2007)

Photo 4. Outlet side of Structure No. 1. (March 8, 2007)

Photo 5. Access roadway to Structure No.1, recently repaired with recycled concrete. (March 8, 2007)

Photo 6. Inlet side of Structure No. 12. (March 8, 2007)

Photo 7. Outlet pipes for Structure No. 12. (March 8, 2007)

Photo 8. View showing Portable Multi-Parameter Water Quality Troll 9500 (15r) with wooden boardwalk near Structure No. 12. (March 8, 2007)

Photo 9. Access roadway to Structure No. 12, recently repaired with recycled concrete. (March 8, 2007)

Photo 10. Rock plug at Structure No. 8. (March 8, 2007)

APPENDIX C
(Three Year Budget Projection)

Appendix C
(Three Year Budget Projection)

HWY 384/ CS-21 / PPL 2
Three-Year Operations & Maintenance Budgets 07/01/2007 - 06/30/10

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

	2007/2008	2008/2009	2009/2010
Maintenance Inspection	$ 5,407.00	$ 5,570.00	$ 5,737.00
Structure Operation	$ 10,600.00	$ 11,600.00	$ 12,600.00
Administration	$ 2,000.00	$ 2,000.00	$ -
Maintenance/Rehabilitation			

07/08 Description: Replace pile cap covers at Structure No. 12, install bird excluder devices at Structure No. 1 & 12. Replace staff gage at Structure No. 1

E&D	$ 7,000.00
Construction	$ 25,000.00
Construction Oversight	$ 1,000.00
Sub Total - Maint. And Rehab.	$ 33,000.00

08/09 Description: General Structure Maintenance

E&D	$ -
Construction	$ 5,000.00
Construction Oversight	$ -
Sub Total - Maint. And Rehab.	$ 5,000.00

09/10 Description:

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

	2007/2008	2008/2009	2009/2010
Total O&M Budgets	**$ 51,007.00**	**$ 24,170.00**	**$ 18,337.00**

O &M Budget (3 yr Total)	**$ 93,514.00**
Unexpended O & M Budget	**$ (57,179.77)**
Remaining O & M Budget (Projected)	**$ (150,693.77)**

OPERATION AND MAINTENANCE BUDGET WORKSHEET

HWY 384 HR / PROJECT NO. CS-21 / PPL NO. 2

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$5,407.00	**$5,407.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$5,500.00	**$5,500.00**
Operations Contract	LUMP	1	$10,600.00	**$10,600.00**
Construction Oversight	LUMP	1	$1,000.00	**$1,000.00**

ADMINISTRATION

LDNR / CRD Admin.	LUMP	1	$1,000.00	$1,000.00
FEDERAL SPONSOR Admin.	LUMP	1	$1,000.00	$1,000.00
SURVEY Admin.	LUMP	0	$2,000.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$2,000.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:	Replace staff gage at Structure No. 1				
	Secondary Monument	EACH	0	$0.00	$0.00
	Staff Gauge / Recorders	EACH	1	$1,500.00	$1,500.00
	Marsh Elevation / Topography	LUMP	0	$0.00	$0.00
	TBM Installation	EACH	0	$0.00	$0.00
	OTHER				$0.00
				TOTAL SURVEY COSTS:	**$1,500.00**

GEOTECHNICAL

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

CONSTRUCTION

CONSTRUCTION DESCRIPTION:	Replace metal pile cap covers at Structure No. 12, install bird excluder devices at Structures No. 1 & 12.				
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0		$60.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$12.00	$0.00
Navigation Aid		EACH	0	$0.00	$0.00
Signage		EACH	0	$0.00	$0.00
General Excavation / Fill		CU YD	0	$0.00	$0.00
Dredging		CU YD	0	$0.00	$0.00
Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
Timber Piles (each or lump sum)			0	$0.00	$0.00
Timber Members (each or lump sum)			0	$0.00	$0.00
Hardware		LUMP	1	$0.00	$0.00
Materials		LUMP	1	$0.00	$0.00
Mob / Demob		LUMP	1	$0.00	$0.00
Contingency		LUMP	1	$5,000.00	$5,000.00
General Structure Maintenance		LUMP	1	$20,000.00	$20,000.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
				TOTAL CONSTRUCTION COSTS:	**$25,000.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **$51,007.00**

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

HWY 384 HR / PROJECT NO. CS-21 / PPL NO. 2

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$5,570.00	**$5,570.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$0.00	**$0.00**
Operations Contract	LUMP	1	$11,600.00	**$11,600.00**
Construction Oversight	LUMP	1	$0.00	**$0.00**

ADMINISTRATION

LDNR / CRD Admin.	LUMP	1	$1,000.00	$1,000.00
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:	**$2,000.00**

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: Replace miscellaneous hardware at Structure No. 1 & 12.

Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0		$60.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$12.00	$0.00
Navigation Aid		EACH	0	$0.00	$0.00
Signage		EACH	0	$0.00	$0.00
General Excavation / Fill		CU YD	0	$0.00	$0.00
Dredging		CU YD	0	$0.00	$0.00
Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
Timber Piles (each or lump sum)			0	$0.00	$0.00
Timber Members (each or lump sum)			0	$0.00	$0.00
Hardware		LUMP	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	$5,000.00	$5,000.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
				TOTAL CONSTRUCTION COSTS:	**$5,000.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: $24,170.00

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

Highway 384 Hydrologic Restoration / CS-21 / PPL 2

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$5,737.00	**$5,737.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$0.00	**$0.00**
Operations Contract	LUMP	1	$12,600.00	**$12,600.00**
Construction Oversight	LUMP	1	$0.00	**$0.00**

ADMINISTRATION

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

MAINTENANCE / CONSTRUCTION

SURVEY

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

GEOTECHNICAL

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

CONSTRUCTION

CONSTRUCTION DESCRIPTION:					
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$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: **$18,337.00**

APPENDIX D
(Field Inspection Notes)

Appendix D
(Field Inspection Notes)

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name:	CS-21 Hwy. 384				Date of Inspection: March 8, 2007 Time: 11:30 am
Structure No.	1				Inspector(s): Dewey Billodeau, Darrell Pontiff - LDNR
					Dale Garber - NRCS
Structure Description:	3-24" Culverts				Water Level: Inside Outside 0.9
Type of Inspection:	Annual				Weather Conditions: Sunny and mild

Item	Condition	Physical Damage	Corrosion	Photo #	Observations and Remarks
Sluice Gate	Good			3	Sluice gates in open posistion.
Flap Gate	Good			4	Flap gates partially open.
Steel Grating	N/A				
Stop Logs	N/A				
Hardware	Good				
Hyacinth Fence	Fair			3	Trash within fence area from Hurricane Rita and other high water events.
Timber Piles	N/A				
Timber Wales	N/A				
Galv. Pile Caps	N/A				
Cables	N/A				
Signage /Supports	N/A				
Staff Gages	Poor			4	Staff gage outlet side of structure not readable.
Rip Rap (fill)	Good				
WQ Troll 9500 - 29r	Good			2	
Earthen Embankment					
Access Roadway	Good			5	

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

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: CS-21 Hwy. 384

Date of Inspection: March 8, 2007 Time: 11:00 am

Structure No. 8

Inspector(s): Dewey Billodeau, Darrell Pontiff - LDNR
Dale Garber - NRCS

Structure Description: Rock plug

Water Level: Inside Outside

Type of Inspection: Annual

Weather Conditions: Sunny and mild

Item	Condition	Physical Damage	Corrosion	Photo #	Observations and Remarks
Steel Bulkhead / Caps	N/A				
Steel Grating	N/A				
Stop Logs	N/A				
Hardware	N/A				
Timber Piles	N/A				
Timber Wales	N/A				
Galv. Pile Caps	N/A				
Cables	N/A				
Signage /Supports	N/A				
Staff Gages	Poor			10	Outside staff gage missing, inlet staff gage not readable.
Rip Rap (fill) (foreshore dike)	Good			10	The plug appears to be in good shape.
Earthen Embankment					The earthen levee that was rebuilt as part of the May '02 maintenance is in excellent condition beyond the limits of the channel.

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

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: CS-21 Hwy. 384

Date of Inspection: March 8, 2007 Time: 10:30 am

Structure No. 12

Inspector(s): Dewey Billodeau, Darrell Pontiff - LDNR
Dale Garber - NRCS

Structure Description: 2-48" Culverts

Water Level: Inside 0.5 Outside 0.9

Type of Inspection: Annual

Weather Conditions: Sunny and mild

Item	Condition	Physical Damage	Corrosion	Photo #	Observations and Remarks
Flapgates	Good			7	Flapgates closed.
Steel Grating	Good			6	
Stop Logs	Good				Position unknown.
Hardware	Good				
Timber Piles	Good				
Timber Wales	N/A				
Galv. Pile Caps	Good			7	Pile caps on outlet structure are corroded and will eventually need to be replaced.
Cables	N/A				
Signage /Supports	N/A				
Staff Gages	Fair			6	Staff gage on onlet side not readable.
Rip Rap (fill)	Good				
WQ Troll 9500 - 15r	Good			8	
Earthen Embankment Access Roadway	Good			9	

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