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Department of Natural Resources
Coastal Restoration Division and
Coastal Engineering Division

2004 Operations, Maintenance, and Monitoring Report

for

Cameron Creole Plugs Project

State Project Number CS-17
Priority Project List 1

May 2004
Cameron Parish

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For
Cameron Creole Plugs Project (CS-17)

Table of Contents

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.

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.

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 (2675 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. 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.

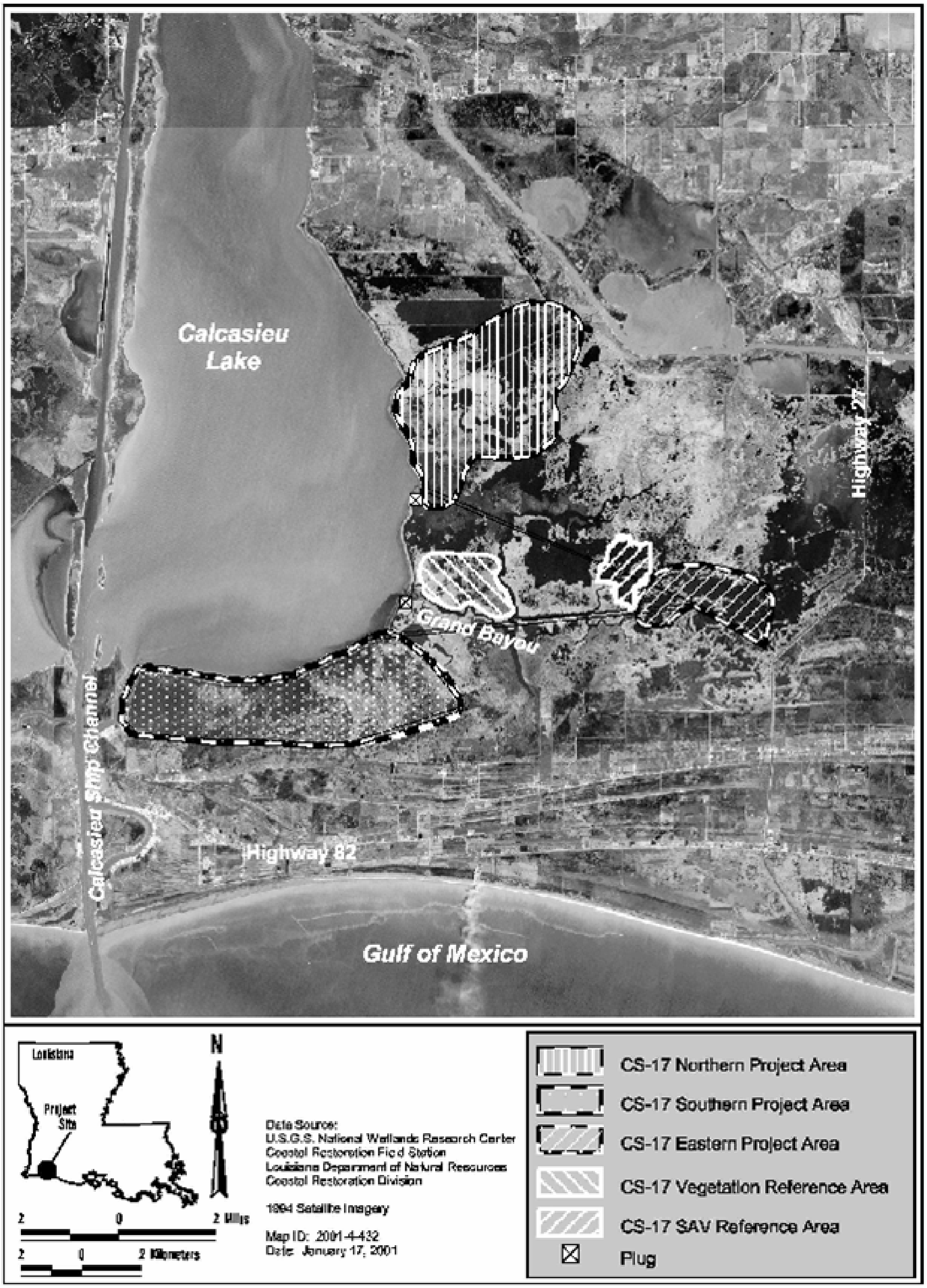


Figure 1. Cameron Creole (CS-17) project and reference areas.

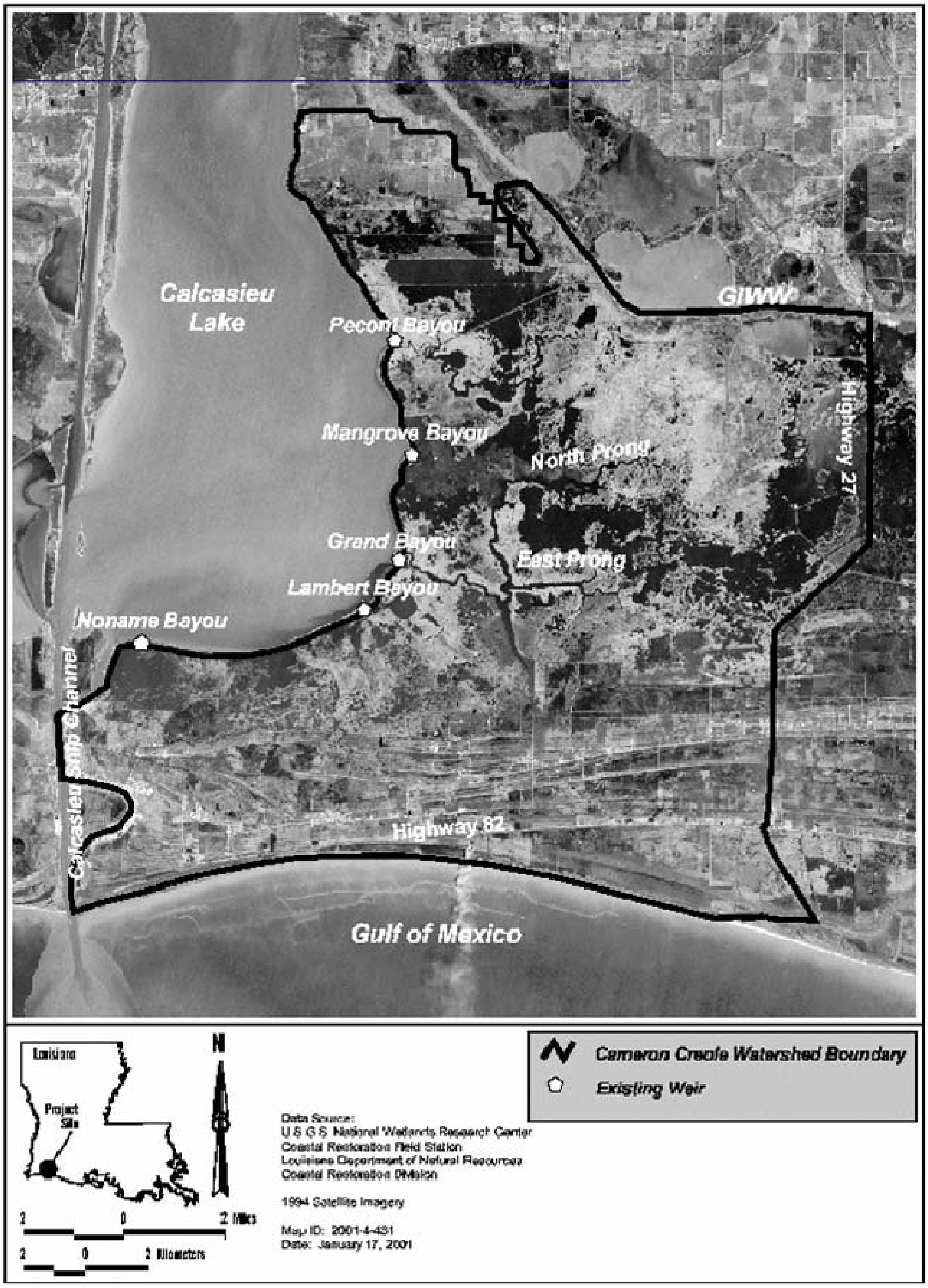


Figure 2. Cameron Creole Plugs (CS-17) project boundaries and structures.

Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Cameron/Creole Watershed 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, 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. A summary of past operation and maintenance projects completed since completion of the Cameron/Creole Project are outlined.

An inspection of the Cameron/Creole Watershed Project (CS-17) was held on May 21, 2004 under partly cloudy skies and warm temperatures. In attendance was Stan Aucoin and Dewey Billodeau from LDNR, and Jim Ashfield with USFWS. All parties met at the Big Pasture boat launch in Cameron Parish, LA. The annual inspection began at approximately 10:00 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 were used to determine approximate elevations of water, steel bulkhead structures and other project features. Photographs were taken at each project feature and Field Inspection notes were completed in the field to record measurements and deficiencies

b. Inspection Results

Structure #2—Grand Bayou structure

The structure is in relatively good condition. Signs are in immediate post construction condition. The sheet pile cap and the railing have rusted but only the railing will be replaced. USFWS personnel would like to incorporate soft bumpers into the boat bay. Lonnie Harper & Associates have begun preliminary engineering for this recommended maintenance. The structure, however, is functioning as designed.

Structure #1—Mangrove Bayou structure

Structure is in similar condition as Structure #2. The railing will be replaced and the soft bumpers will be installed. The structure is functioning as designed.

II. Maintenance Activity (continued)

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

As noted at each structure

ii. Programmatic/ Routine Repairs

None

III. Operation Activity

a. Operation Plan

Although the structures are operable, there are no active operations currently associated with this project.

b. Actual Operations

Although the structures are operable, there are no active operations currently associated with this project.

IV. Monitoring Activity

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 USGS/NWRC personnel. One postconstruction flight was budgeted into the project, however, the year was not specified.

Salinity:
To monitor the effects of the plugs on salinity in the project and reference area, salinity was measured at four permanent 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). 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 (figure 3) 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.

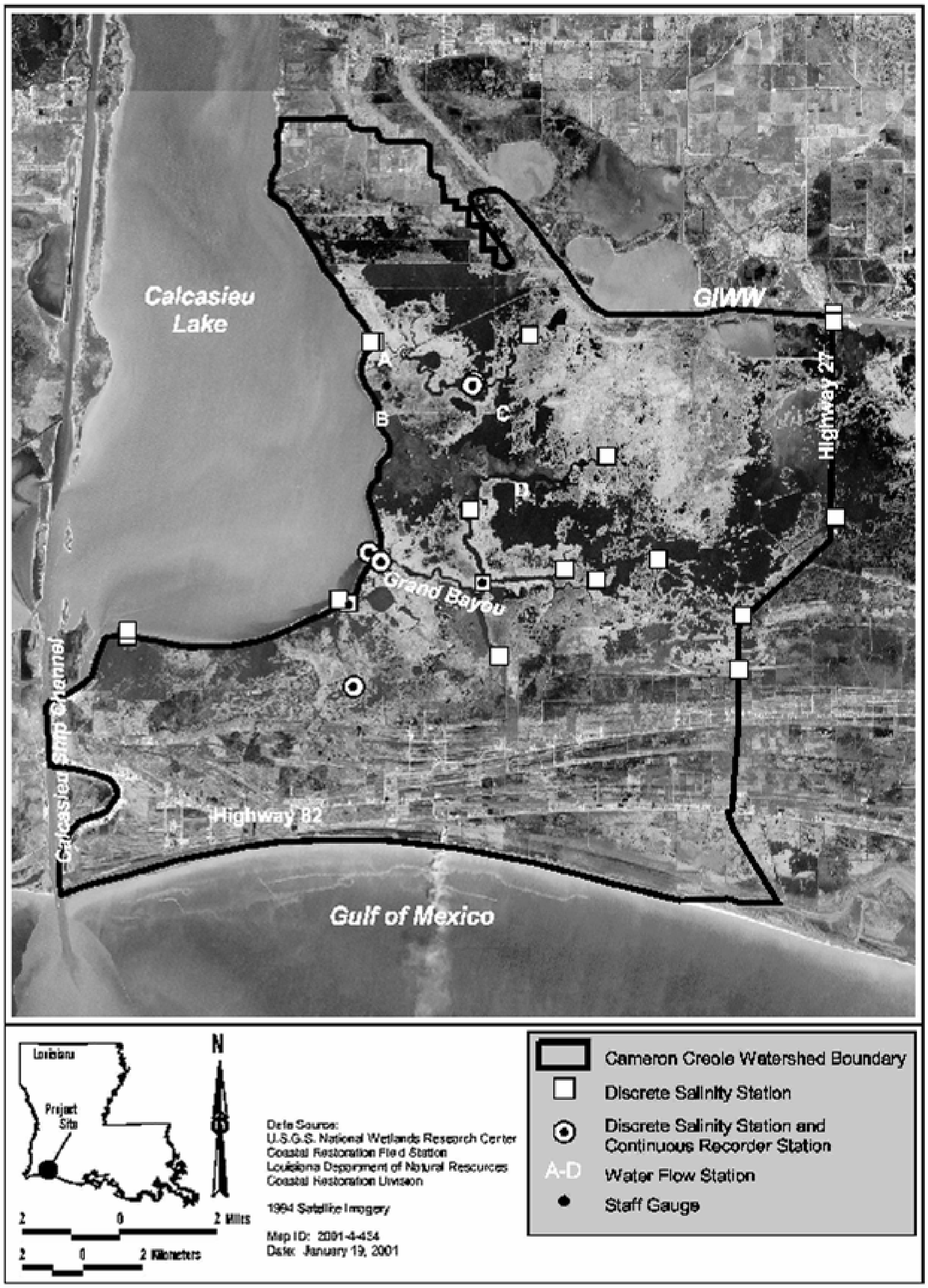


Figure 3. Cameron Creole Plugs (CS-17) permanent and discrete station locations.

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 permanent stations and at six staff gages (three located within the project area and three located outside the project area) (figure 3) surveyed to NAVD. Staff guages were monitored bi-weekly by USFWS personnel.

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 sixty 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. Emergent vegetation data were collected pre-construction in October 1996 and post-construction in October 1997, September 2000, and September 2002.

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

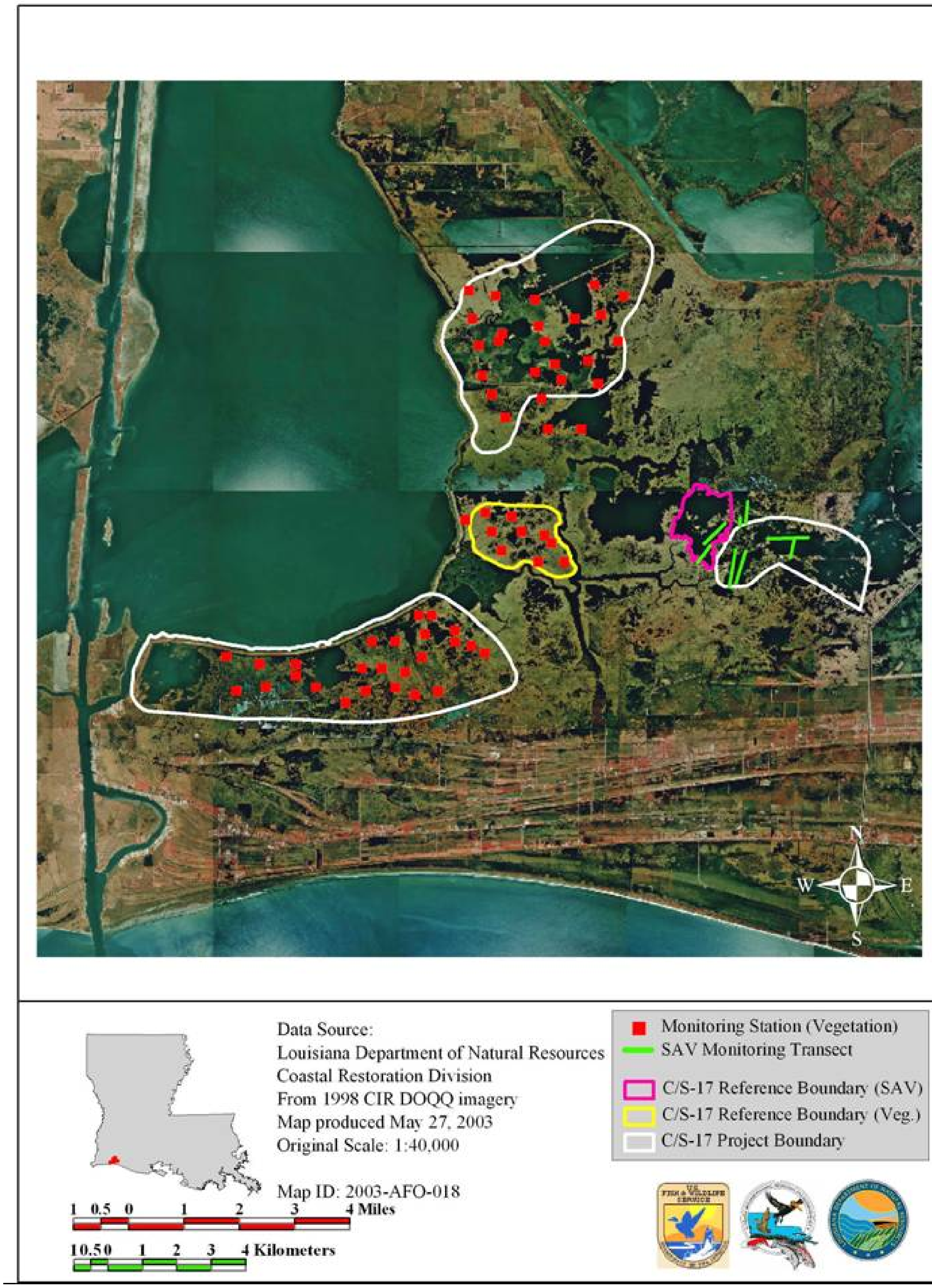


Figure 4. Cameron Creole Plugs (CS-17) vegetation and SAV sampling transects.

IV. Monitoring Activity (continued)

c. Preliminary Monitoring Results and Discussion

Data collected up to December, 2003 has been included in the following results and discussion. Project results using data collected through 2002 were discussed in detail in the 2003 CS-17 Comprehensive Report.

Aerial photography:
Aerial photography was obtained pre-construction in 1993 and has not been obtained post-construction. A habitat map and the acreages of each habitat are presented in figure 5 and table 1. The postconstruction flight has not been scheduled.

Salinity and Water Level:
Hourly salinity and water level data have been collected at the following continuous recorder stations (figures 6 thru 9):

Station	Data collection period
CS17-01R	5/10/94 - present
CS17-02R	3/10/94 - present
CS17-11	2/23/94 - present
CS17-12	2/23/95 - present

The water level data from 1994 to 1997 was not vented and is not comparable to measurements made since then.

Salinities were higher at CS17-01R than at the other stations for 2003 ($p<0.0001$) (figure 10). This is most likely because the recorder is located in Calcasieu Lake and is impacted by saltwater entering the lake through the Calcasieu Ship Channel. Salinity has shown the same trend at the four recorders in the CS-17 project since 1997 (figure 11). Of the other 3 stations, CS17-11 in the northern project area, had the lowest salinity and CS17-01R in Calcasieu Lake had the highest salinity. There were no specific project goals for salinity.

Water levels were lower at station CS17-01R than the other 3 stations in 2003 (figure 12). Water levels were highest at CS17-12 ($p<0.0001$). Stations CS17-02R and CS17-11 had approximately the same mean water level for the year. Water level and the percent of time the marsh was flooded at station CS17-12 in the southern project area has increased relative to the reference station CS17-02R since1999 (figures 13 and 14). One goal of the CS-17 project was to decrease the duration of flooding in the southern project area. These data show that water levels have increased in the southern project area.

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 2. Analysis of Variance 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 the other three years (figure 15). 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.

ANOVA of height of the dominant species revealed that height of the dominant species, *Spartina patens* was significantly higher in the reference area in 2002 than in the project areas in 2002 or any other year (figure 16). There was no difference in species richness in any years or areas. Richness was approximately 2 species per plot in all years and areas.

Submerged Aquatic Vegetation (SAV):

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 for each year can be found in table 3. Frequency decreased in 2000 in both the project and reference area, most likely due to drought. 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.

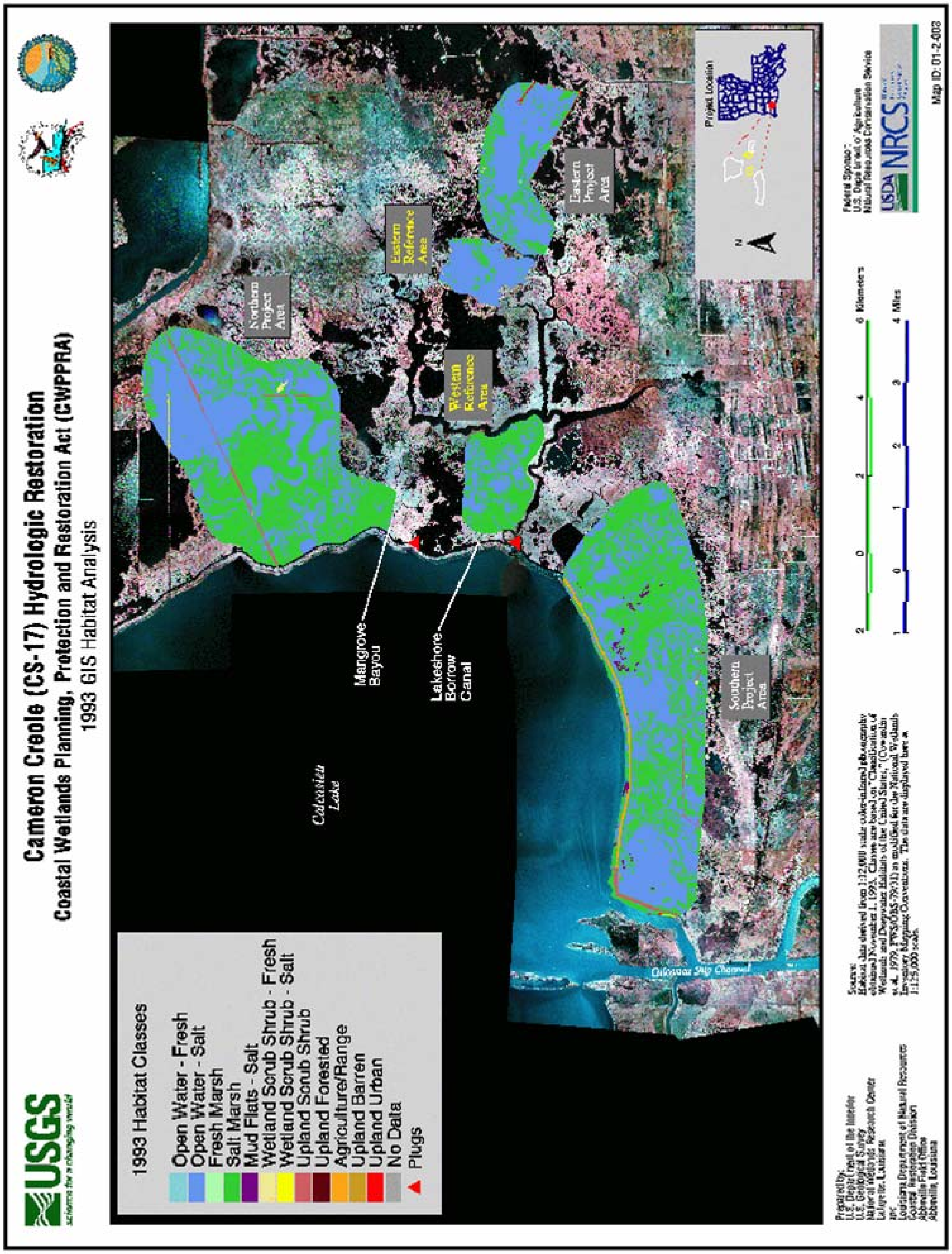


Figure 5. 1996 GIS habitat analysis of the Cameron Creole Plugs (CS-17) project area.

Table 1. Acreages of habitat types from the 1993 habitat analysis of the Cameron Creole Plugs (CS-17) project area.

Habitat Class	Northern Project Area	Southern Project Area	Eastern Project Area (SAV)	Vegetation Reference Area	SAV Reference Area
	Acres (Hectares) % of total area				
Open Water - Fresh	0	3 (1.2)	1.7 (0.7)	0	0
Open Water - Salt	2718 (1100.8) 45.1%	3151 (1276.2) 47.7%	1302.2 (527.4) 73.7%	565.1 (228.9) 90.1%	310.6 (125.8) 27.2%
Fresh Marsh	0	0.2	0	0	0
Salt Marsh	3233.2 (1309.4) 53.7%	3220.4 (1304.3) 48.7%	453.5 (183.7) 25.7%	62.2 (25.2) 9.9%	831.6 (336.8) 72.8%
Mud Flats - Salt	0	35.9 (14.5) 0.5%	0	0	0
Wetland Shrub Scrub -Fresh	7.9 (3.2)	1.5 (0.6)	0	0	0
Wetland Shrub Scrub -Salt	8.6 (3.5)	2.6 (1.1)	1.1 (0.4)	0	0
Upland Shrub Scrub	57.5 (23.3) 1%	58 (23.5) 0.9%	0	0	0
Upland forested	0.5 (0.2)	0	0	0	0
Agriculture/Range	0.6 (.2)	125.2 (50.7) 2%	0	0	0
Upland Barren	0	5.5 (2.2)	0	0	0
Upland Urban	0	3 (1.2)	8.2 (3.3) 0.6%	0	0
TOTAL	6026.3 (2440.7)	6606.3 (2675.6)	1766.7 (715.5)	627.3 (254.1)	1142.2 (462.6)
% Open Water	45.1	48.3	73.8	90.1	27.2
% Land	54.9	51.7	26.2	9.9	72.8

Station CS17-01R (1/1/03 -12/31/03)
Salinity and Water Level Data

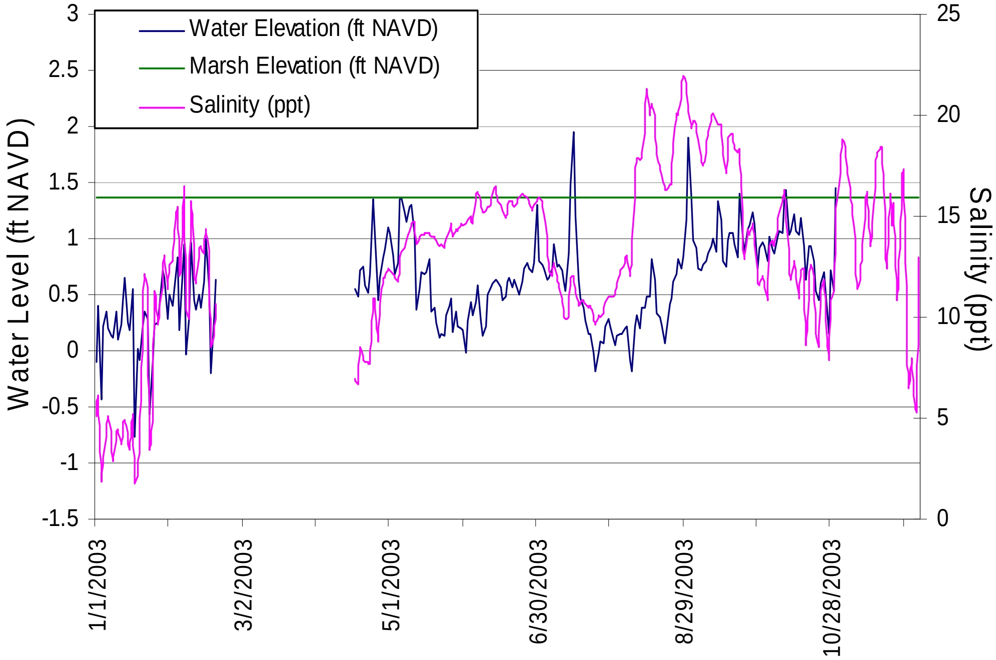
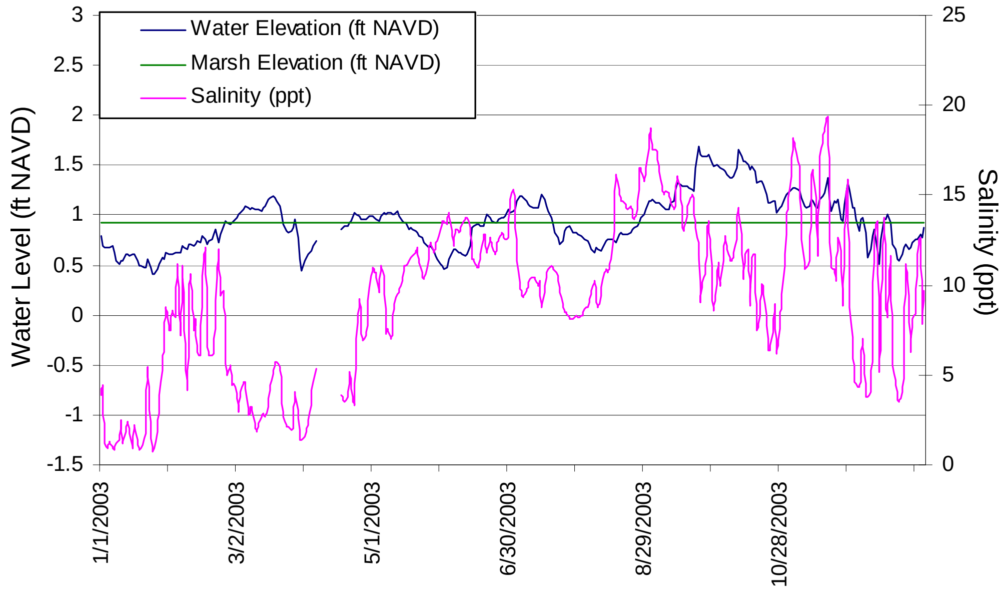


Figure 6. Hourly salinity and water level data at station CS17-01R in Calcasieu Lake. Water level readings above marsh elevation indicate that the marsh was flooded.

Station CS17-02R (1/1/03 -12/31/03)
Salinity and Water Level Data



Figures 7. Hourly salinity and water level data at station CS17-02R in the borrow canal. Water level readings above marsh elevation indicate that the marsh was flooded.

Station CS17-11 (1/1/03 -12/31/03)
Salinity and Water Level Data

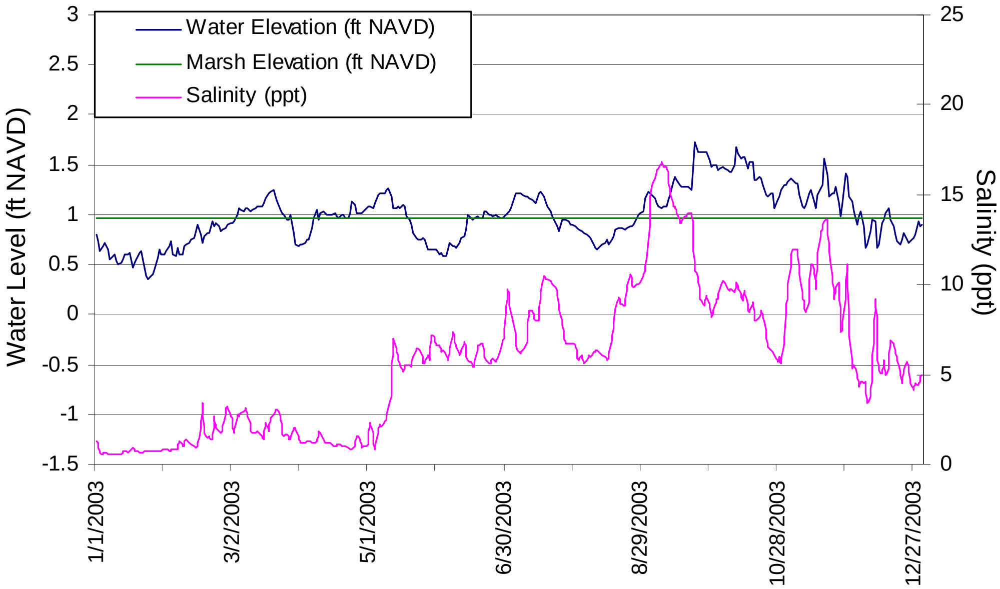


Figure 8. Hourly salinity and water level data at station CS17-11 in the northern project area. Water level readings above marsh elevation indicate that the marsh was flooded.

Station CS17-11 (1/1/03 -12/31/03)
Salinity and Water Level Data

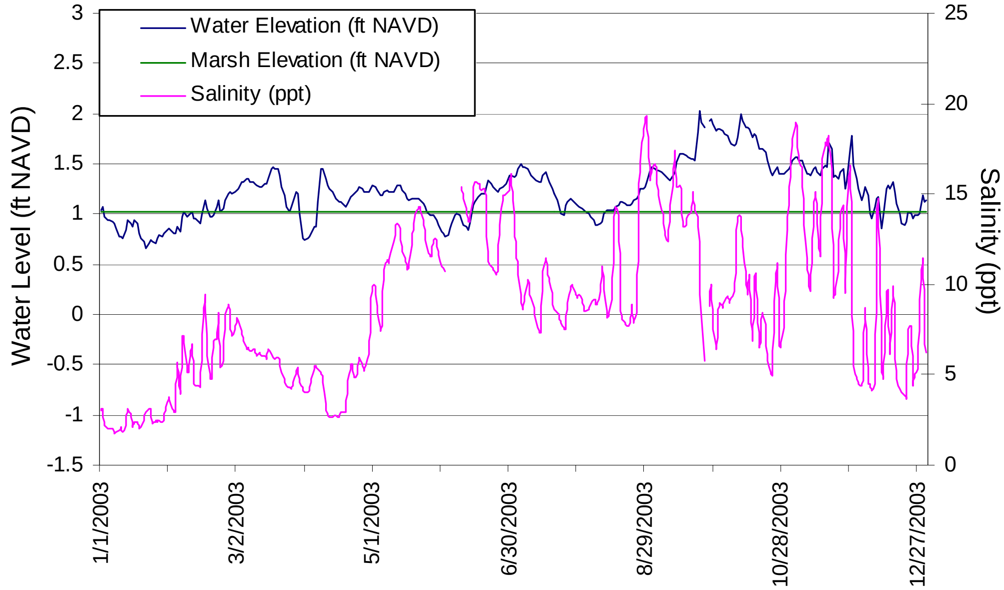


Figure 9. Hourly salinity and water level data at station CS17-12 in the southern project area. Water level readings above marsh elevation indicate that the marsh was flooded.

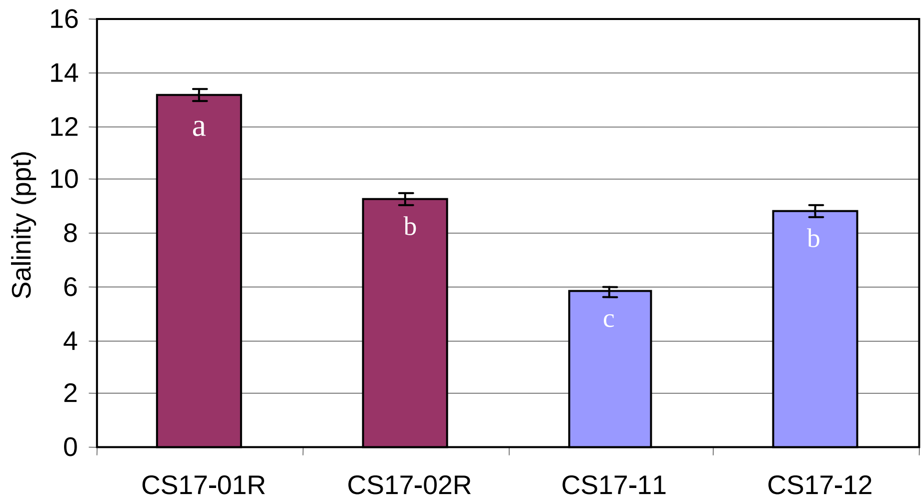


Figure 10. Yearly mean salinity of daily means for 2003 at each CS-17 recorder (Mean ± SE). CS17-01R, the recorder in the lake, was found to be significantly higher than the other three recorders. CS17-02R, the recorder in the borrow canal, was found to be higher than CS17-11 (in the northern project area) but not CS17-12 (in the southern project area). Levels not connected by the same letter are significantly different.

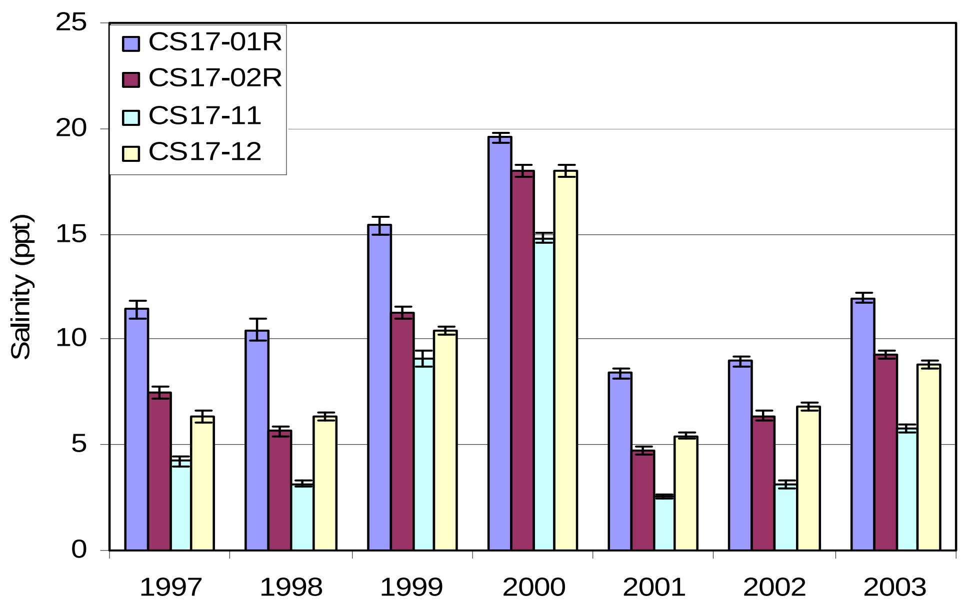


Figure 11. Yearly salinity over the course of the CS-17 project. Salinity has increased and decreased due to rainfall while salinity trends among the four recorders have remained the same since 1997.

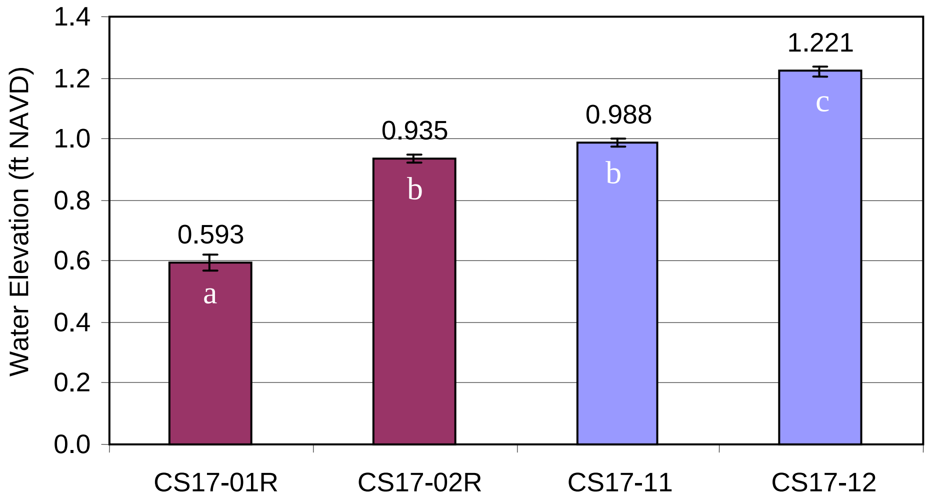


Figure 12. Yearly mean water level of daily means for 2003 at each CS-17 recorder (Mean ± SE). Water elevation at CS17-01R, the recorder in the lake, was found to be significantly lower than at the other three recorders. CS17-12, the recorder in the southern project area, was found to be higher than the other recorders. Levels not connected by the same letter are significantly different.

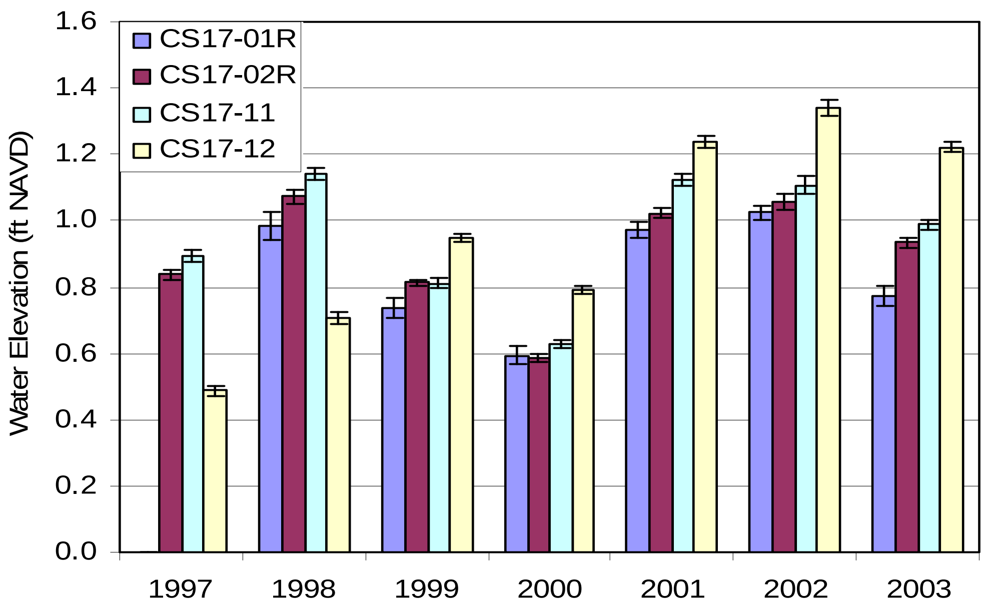


Figure 13. Yearly water levels at each of the stations since 1997. Station CS17-12 has increased relative to the reference stations since 1997.

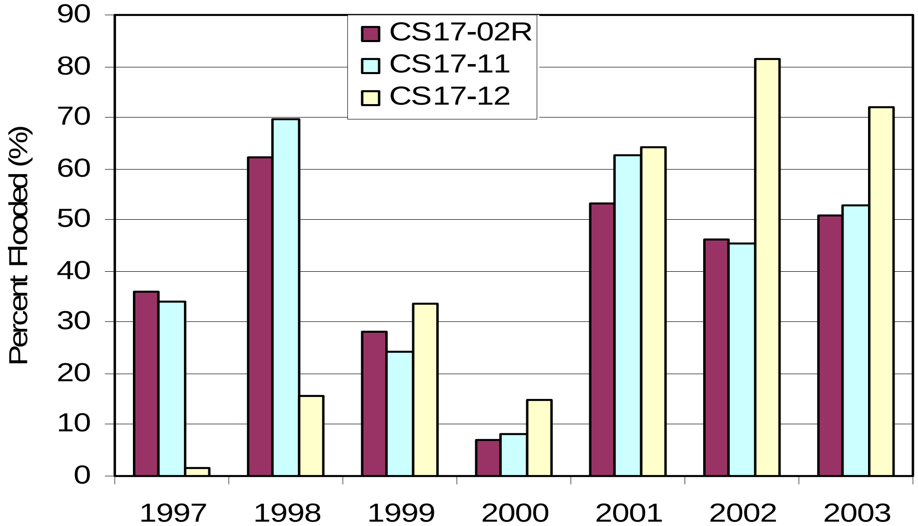


Figure 14. Percent of time the marsh was flooded at recorder stations in the CS-17 project area. Station CS17-12 has increased since 1999 relative to the reference recorder.

Table 2. Frequency of occurrence (%) of each species found in the CS-17 project and reference area. (n plots species present in/total plots)*100))

Species	Reference Area 1996	Reference Area 1997	Reference Area 2000	Reference Area 2002	Northern Project Area 1996	Northern Project Area 1997	Northern Project Area 2000	Northern Project Area 2002	Southern Project Area 1996	Southern Project Area 1997	Southern Project Area 2000	Southern Project Area 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

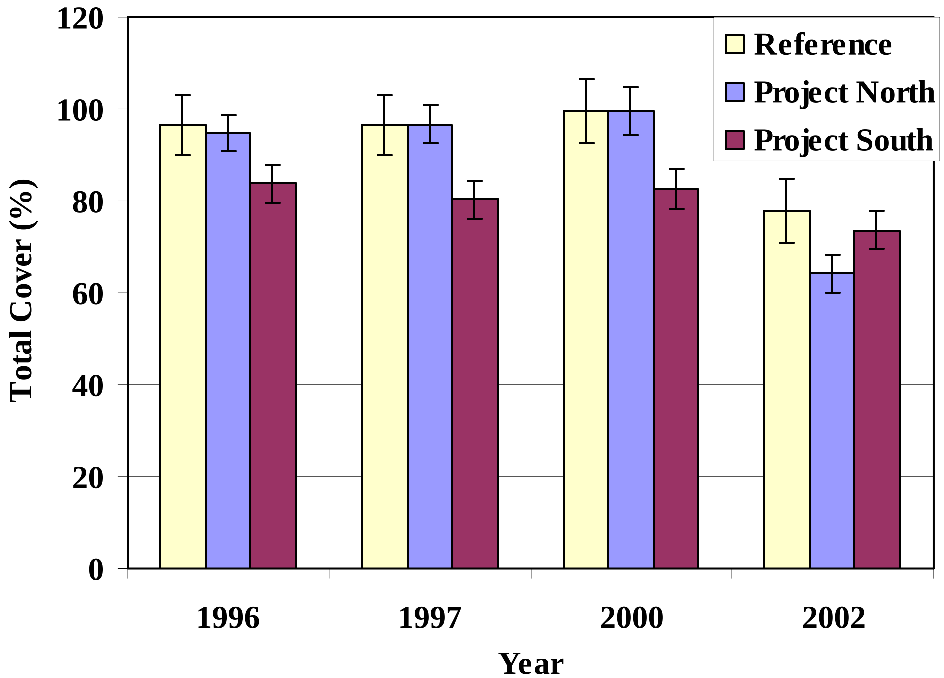


Figure 15. Total percent cover in the two project and reference areas for each sampling year for the CS-17 Cameron Creole Plugs project (LS Mean ± SE). Cover in 2002 was significantly lower than the other sampling years ($p<0.0001$). There was also a significant interaction between project/reference 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 (figure 14).

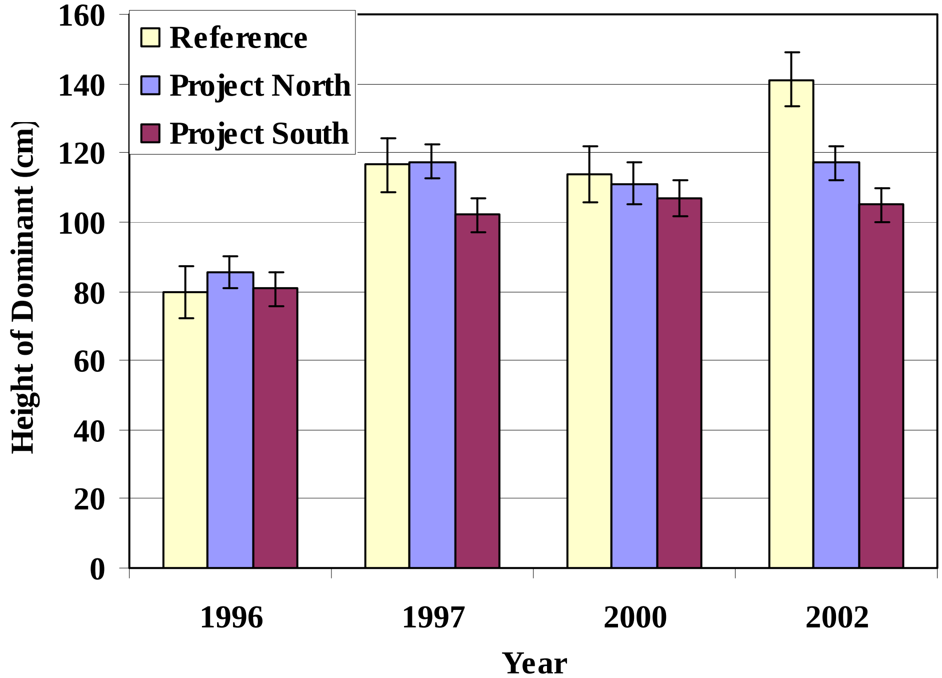


Figure 16. Height of the dominant species (*Spartina patens)* in the project and reference areas for each sampling year for the CS-17 Cameron Creole Plugs project (LS Mean ± SE). The Southern project areas was significantly lower in height in 2002 (p=0.0143). This may be due to more flooding (figure 14).

Table 3. 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

V. Conclusions

a. Project Effectiveness

As described in the 2003 CS-17 comprehensive report, it has been difficult to assess effectiveness of this project due to the fact that most of the pre-construction period was during a drought. All of the data (water level, vegetation, and SAV) show changes over time but in most cases, the project and reference areas have changed in the same manner over time. Salinity increased and decreased at all four recorders from year to year but the stations did not change relative to each other (figure 11). Water level has increased south of Calcasieu Lake relative to the reference stations (figure 13). This increase was the greatest from 1997 to 1999. Water level in the northern project area has not changed relative to the reference stations. These data suggest that the plugs did not result in lower water levels south of Lake Calcasieu. Water level and salinity data tend to track climatic trends and do not differ significantly in the project areas.

Percent cover of emergent vegetation was relatively similar in the northern project and reference area until 2002 (figure 15) when cover decreased in both the northern and southern project areas. Cover in the southern project area has been lower than in the reference area throughout the project. The decrease in cover could be due to increased frequency of inundation in 2001 and 2002 (figure 14) but that alone would not explain loss of cover in the northern project area because inundation there was approximately the same as the reference area which did not decrease as much as the northern project area did. SAV decreased in 2000 and returned in 2002 (table 3). Changes in SAV are most likely due to changes in salinity from year to year (figure 11).

Flow was only measured once (pre-construction) so there is no data to evaluate whether the plugs slowed water flow into the marsh. Mr. Glenn Harris, Refuge Manager of Cameron Creole Wildlife Refuge, on April 28, 2004, indicates that the plugs are very effective in slowing the rapid exchange of water through the borrow canals. He has observed that when a strong wind is blowing, the head difference can be up to 6 inches in difference at the plugs. DNR/CED personal has also noted this action on field trips to the project.

With existing data, it is impossible to differentiate the hydrologic impacts of the plugs from the manipulations of the five water control structures along Calcasieu Lake. The reference areas for vegetation and SAV are not independent of the structure manipulations and one of the reference areas has been used for a terrace project area.

b. Recommended Improvements

It was recommended in the comprehensive report (2003) that monitoring on this project as outlined in the original monitoring plan be discontinued due to the inability to discern project effects from environmental trends and from the five water control structures along Calcasieu Lake.

A bumper boat guide system should be installed to structure to aid the boats in passing thru the structure in a timely manner so that boaters will know that the structure is present. This maintenance project is being designed now and construction should begin in the fall of 2004.

c. Lessons Learned

Placement of reference areas within project areas that are influenced by pre-existing hydrologic structure manipulations is not recommended. This issue will be addressed through the implementation of CRMS – *Wetlands.*

A model of these structures would have been useful in determining if the structures would be effective in meeting the goals of the project, therefore, future projects of this nature will be modeled. Also, pile caps on these types of structures should be bolted on the sheet piles instead of being welded to make it easier to remove when the pile caps need to be changed.