Coastal Protection and Restoration Authority of Louisiana

**State of Louisiana Coastal Protection and Restoration Authority**

# 2011 Operations, Maintenance, and Monitoring Report

for

# Bayou LaBranche Wetland Creation (PO-17)

State Project Number PO-17
Priority Project List 1

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St. Charles Parish

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COASTAL WETLANDS PLANNING, PROTECTION, AND RESTORATION ACT

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For
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## Table of Contents

## Preface

The 2011 OM&M report format is a streamlined approach that combines the operation and maintenance annual project inspection information with the monitoring data and analyses on a project-specific basis. The report format for 2011 includes monitoring data collected from 1992 through December 2010.

## I. Introduction

The Bayou LaBranche Wetland Creation Project (PO-17) encompasses 436 ac (176.4 ha) in St. Charles Parish, Louisiana, on the southwestern shore of Lake Pontchartrain (Figure 1). The project area is bounded by Lake Pontchartrain (north), the Illinois Central Gulf Railroad (south), an unnamed pipeline canal (east) and Bayou LaBranche (west) (Figure 2).

Historically, the LaBranche wetlands were classified as brackish marsh (O'Neil 1949, Chabreck and Linscombe 1968, 1988), as the hydrology was significantly influenced by Lake Pontchartrain. The wetlands receive tidal waters from the lake through two openings in the shoreline and are flooded during normal high tide. Wind action also greatly influences water circulation in the area. Consequently, the wetlands can flood at times other than high tide and drain at times other than low tide.

A combination of events dating back to the 1800s has contributed to an almost complete loss of marsh in the area and a subsequent conversion to open water (Pierce et al. 1985). The construction of the Illinois Central Railroad in 1830 significantly altered the hydrology of the area by creating a barrier to drainage and sheet flow across the marsh from upland areas. In the early 1900s, an attempt to reclaim the area for agriculture failed, after which open water areas began to appear. During the construction of Interstate 10 in the 1960s, access canals were dug through the area, further altering the hydrology and providing a conduit for saltwater intrusion from Lake Pontchartrain into the interior marsh. Hurricane Betsy (1965) and Hurricane Camille (1969) have also likely contributed to land loss in the area. The tidal surge generated from these storms most likely created prolonged flooding of the Bayou LaBranche wetlands due to the influx of higher saline water from Lake Pontchartrain. Because of the altered hydrology of the area, flood waters may have taken several weeks to drain from the wetlands, thereby stressing vegetation and contributing to the loss of marsh acreage (Montz and Cherubini 1973).

Subsidence and shoreline erosion have also contributed to land loss in the area. Pierce et al. (1985) estimated that subsidence was 0.39 in/yr (1 cm/yr) in the LaBranche wetlands. Erosion of the Lake Pontchartrain shoreline was estimated to be 9.5 ft/yr (2.9 m/yr) between 1955 and 1972 (Coastal Environments, Inc. 1984).

Many states, including Louisiana, have employed the use of dredged sediment material to create or restore wetlands and impede land loss (Broome 1988, Patrick et al. 1984, USACE and LSU 1995). The literature suggests that dredged material sites may not perform exactly like nearby natural sites; however, they do provide some of the same functions of natural marshes

(Streever 2000). When creating a wetland with dredged materials, the most important factor to consider is the elevation of the deposited sediments in relation to the hydrologic regime of the vegetation (Broome 1988). Sediment elevation affects the frequency and duration of flooding within the wetland, which in turn affects the species of vegetation that become established and the distribution of those species throughout the area.

The Bayou LaBranche Wetland Creation project was the first project built through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) (http://www.lacoast.gov). Due to significant land loss, the project area was mostly shallow, open-water habitat, and only a narrow band of marsh along the shoreline separated the project area from the lake. Thus, the aim of the project was not only to create marsh, but also to create marsh in an area of critical need within the landscape by preventing shoreline breaching and subsequent exposure of interior wetlands to wave energy and other influences from Lake Pontchartrain.

Construction of the Bayou LaBranche Wetland Creation project was completed on April 1, 1994. The principal project features include an earthen berm that was constructed to confine the 2.7 million $yds^3$ (2.1 million $m^3$) of dredged sediment from Lake Pontchartrain that was pumped into the project area. The project area is divided by a spoil ridge that contains a sheet pile z-wall closure and a concrete weir (weir 1, Figure 2). The removal of several segments of the z-wall and the opening of the weir allows the exchange of water between these two areas. Three weirs and four box culverts constructed in the containment berm allow water to flow in and out of the project area and provide for ingress and egress of marine species during periods of high water (Figure 2).

Further construction details, environmental assessments, and progress reports for the PO-17 Bayou LaBranche Wetland Creation Project can be accessed on the CWPPRA website at http://www.lacoast.gov.

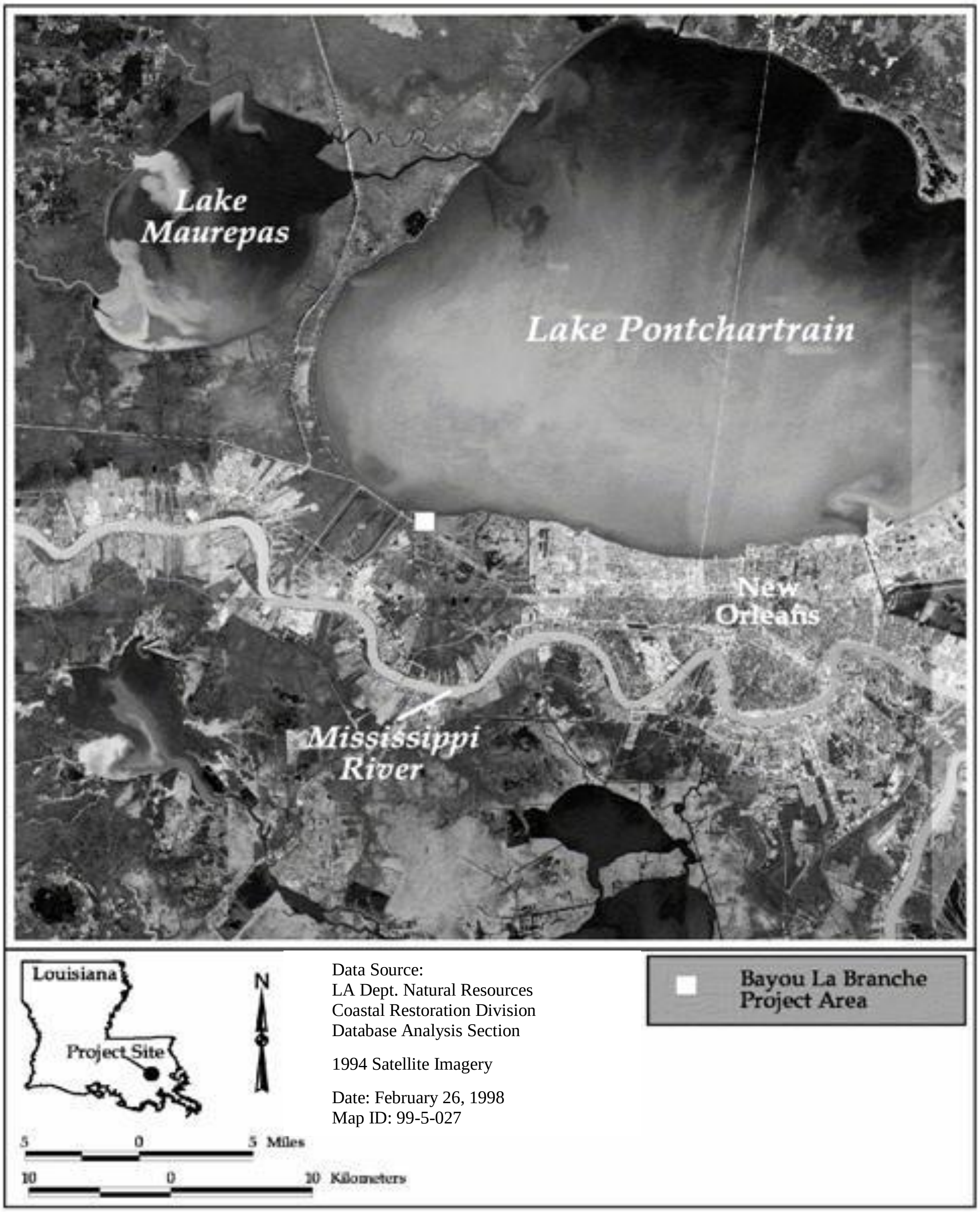


**Figure 1.** Location of the Bayou LaBranche Wetland Creation (PO-17) project.

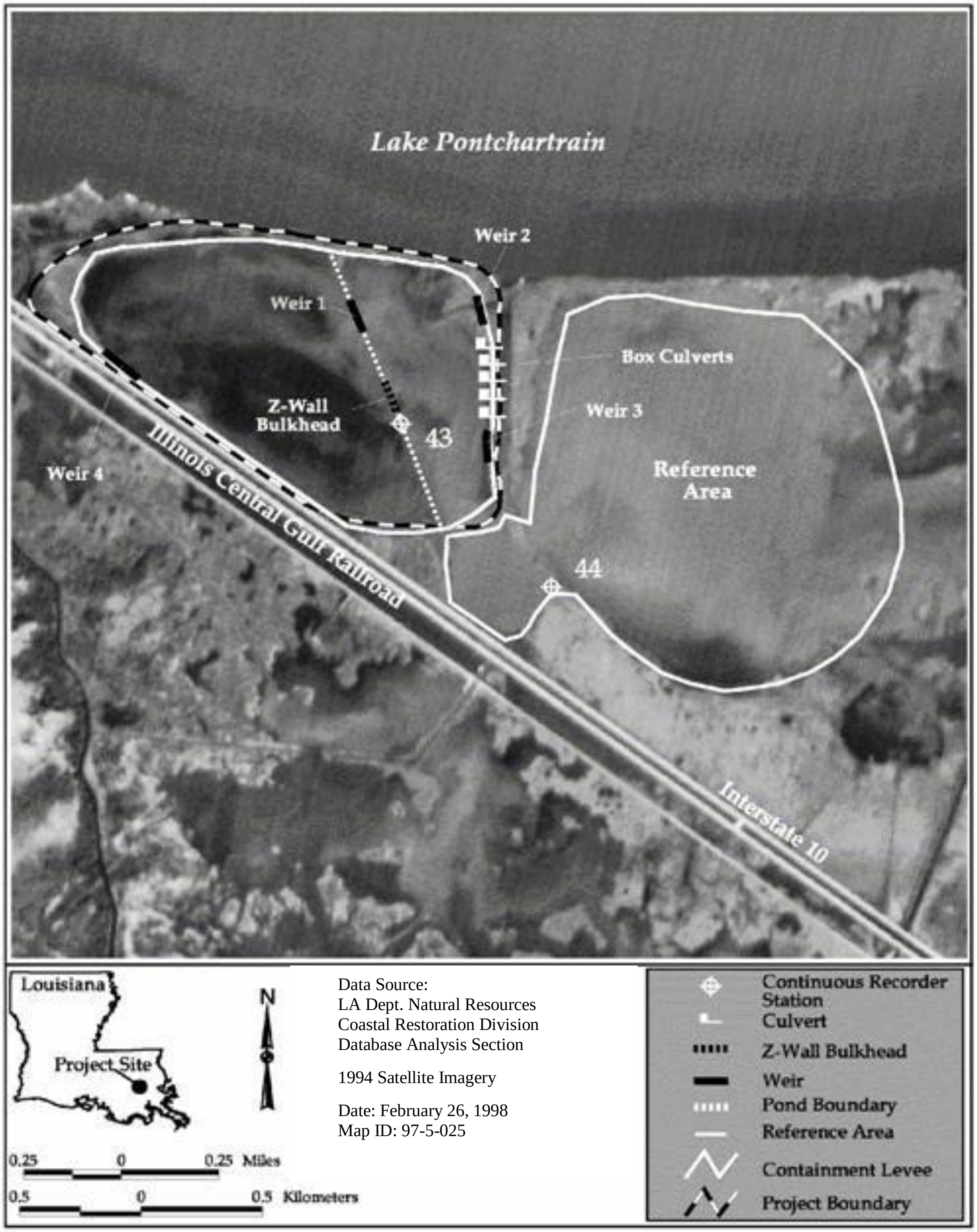


**Figure 2**. Location of the Bayou LaBranche Wetland Creation (PO-17) project area, reference area, project features and continuous recorder stations PO17-43 and PO17-44R.

## II. Maintenance Activity

*There is no maintenance planned in the near term for this project.*

## III. Operation Activity

*There are no operations for this project.*

## IV. Monitoring Activity

### a. Monitoring Goals

The objective of the Bayou LaBranche Wetland Creation Project is to create new vegetated wetlands in the Bayou LaBranche area utilizing dredged sediments.

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

1. Create approximately 305 acres (123 ha) of shallow-water habitat conducive to the natural establishment of emergent wetland vegetation.

2. Increase the marsh:open-water ratio in the project area to a minimum of 70% emergent marsh to 30% open water after 5 years following project completion.

### b. Monitoring Elements

**Habitat Mapping**

Color infrared aerial photography was classified and photo-interpreted by the U.S. Geological Survey's National Wetlands Research Center (NWRC) to measure land to open water ratios and map habitat types in the project and reference areas. Photography at 1:12,000 scale was taken in 1993 (pre-construction) and 1997, and will be taken again in 2012.

**Sediment Elevation**

Staff gauges (ft/NAVD 88) were installed in the project area to monitor elevation of the deposited dredged sediments. In 1994, seven temporary staff gauges were set up around the perimeter of the area. In 1996, 19 permanent staff gauges were installed along north-south transects, as outlined in the project monitoring plan. Data were collected twice per year from 1996−2000 (LDNR 1994) and annually in 2001, 2002, 2004, 2005, 2007 and 2010.

**Soil Properties**

Sediment cores were collected at 19 staff gauge stations with a Swenson corer (Swenson 1982) to characterize soil composition in the project area and to compare the soil properties of the project area to natural, regional wetlands. Soil samples were taken to coincide with vegetation surveys, once during pre-construction (1994) and post-construction in 1996, 1997, 1998, 2001, 2002, 2004, 2005, 2007, and 2010. The cores were analyzed to determine percent organic matter, bulk density ($g/cm^3$), and percent moisture.

## Salinity

Salinity was recorded hourly at two continuous recorder hydrographic stations from April 1996–June 2003 using YSI Model 6000 or 6920 Water Quality Analyzers. Station 43 was located in the project area and station 44R was located in the reference area (Figure 2). Salinity monitoring resumed in 2008 with the installation of two Coastwide Reference Monitoring System (CRMS) hydrographic stations. Hourly salinity data were collected at CRMS 6299 in the project area, and CRMS 2830 in the reference area. Salinity data were used to evaluate the changes in emergent wetland vegetation species and to characterize the spatial and temporal variation in salinity within the project and reference areas.

## Water Elevation

Water level was recorded hourly at two continuous recorder hydrographic stations from April 1996−June 2003 using YSI Model 6000 or 6920 Water Quality Analyzers. Station 43 was located in the project area and station 44R was located in the reference area. Staff gauges were established and surveyed at each continuous recorder station in August 1997 so that staff gauge data could be used to convert water level data from the recorders to the North American Vertical Datum 1988 (NAVD 88). Water elevation and marsh elevation data were used to calculate frequency and duration of flooding in the project and reference areas. Water elevation monitoring resumed in 2008 with the installation of two CRMS stations. Hourly water level data are collected at CRMS 6299 in the project area, and CRMS 2830 in the reference area.

## Vegetation

Species composition and relative abundance of emergent vegetation were quantified using techniques described in Steyer et al. (1995, revised 2000). Forty-two stations were surveyed pre-construction in 1994 and post-construction in 1996 and 1997. Due to budget cuts, the number of stations was reduced to 22 for the 1998 survey and 20 for subsequent surveys in 2001, 2002, 2005, 2007 and 2010. In 2004, only 19 stations were surveyed. CRMS monitoring stations 6299 (project) and 2830 (reference) (Figure 3) were installed in 2008 and species composition and relative abundance data were collected in 2008, 2009 and 2010. Each CRMS station has ten vegetation plots.

Floristic Quality Indices (FQI) were calculated to help quantify the historical integrity of the project site. This index is a standardized landscape assessment tool that is used to gauge the effectiveness of restoration techniques. The FQI is used to compare the integrity of a restored site, via the plant community structure, to its historical model (Herman et al. 2001). The calculation of FQI was originally developed by Swink and Wilhelm (1979), but has been modified by Cretini et al. (2009) to more effectively describe the coastal community in Louisiana. It is calculated using the percent cover for each species and its coefficient of conservatism (CC), a value that ranges from 0−10 to reflect whether a species would have been native to an area pre-disturbance (Swink and Wilhem 1994). A CC score of 10 implies that a species is restricted in habitat to that particular area, i.e., a native species. A CC score of 0 implies that a species is a generalist that has no historical fidelity to the area.

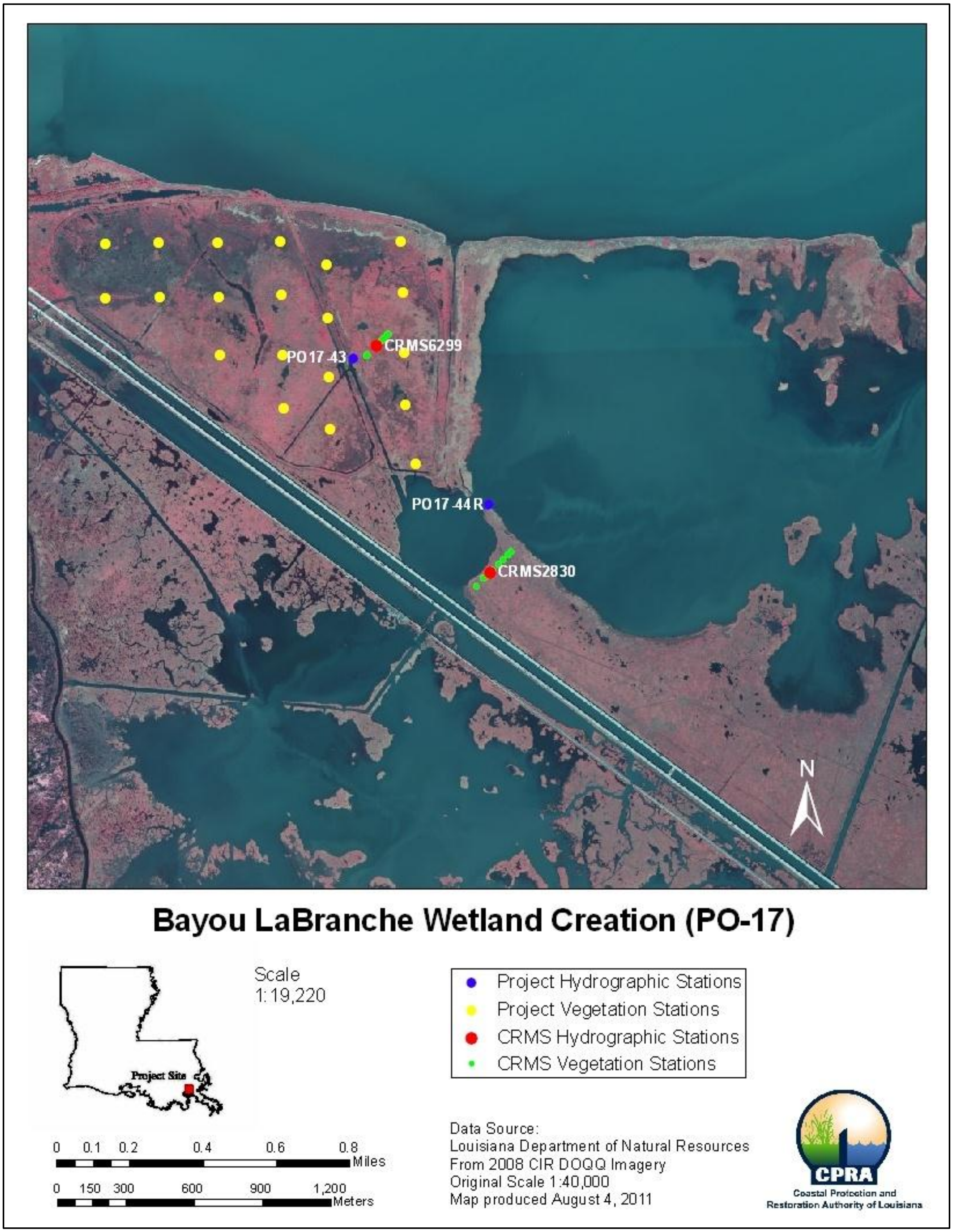


**Figure 3.** Location of project and CRMS monitoring stations associated with the Bayou LaBranche Wetland Creation Project.

## Statistical Analysis

The models (one-way ANOVA) were created in SYSTAT 10.2. Bonferonni Multiple Comparison Testing was analyzed to detect differences among means. Bray-Curtis Multi-Dimensional Scaling (MDS) was analyzed for some species in Primer 6.0, to indicate changes in percent cover (Clark and Gorley 2006). All graphs and tables were created in SAS, Sigma Plot and Excel 2007.

# V. Preliminary Monitoring Results

## Habitat Mapping

GIS land-water analysis of aerial photography revealed that the land to open water ratio in the project area increased between 1993 and 1997, but remained unchanged in the reference area during the same time period (Figure 4). In the project area, the proportion of land to water increased from 18.5% land and 81.5% water in 1993 to 81.7% land and 18.3% water in 1997. In the reference area, the land to open water ratio remained constant at 2.2% land and 97.8% water in both 1993 and 1997.

The most notable habitat changes in the project area were the increase in palustrine emergent marsh and scrub-shrub from 1.7 ac (0.69 ha) in 1993 to 305.6 ac (123.7 ha) in 1997 and the corresponding decrease in estuarine open water and aquatic beds from 356.9 ac (144.4 ha) in 1993 to 14.0 ac (5.7 ha) in 1997. Upland habitats in the project area increased from 8.0 ac (3.2 ha) in 1993 to 12.6 ac (5.1 ha) in 1997. In the reference area, only small changes in habitat distribution were evident. Total open water increased from 504.3 ac (204.1 ha) in 1993 to 505.1 ac (204.4 ha) in 1997. In addition, estuarine emergent wetland decreased from 8.4 ac (3.4 ha) in 1993 to 6.1 ac (2.5 ha) in 1997, whereas upland habitats increased from none in 1993 to 0.9 ac (0.4 ha) in 1997.

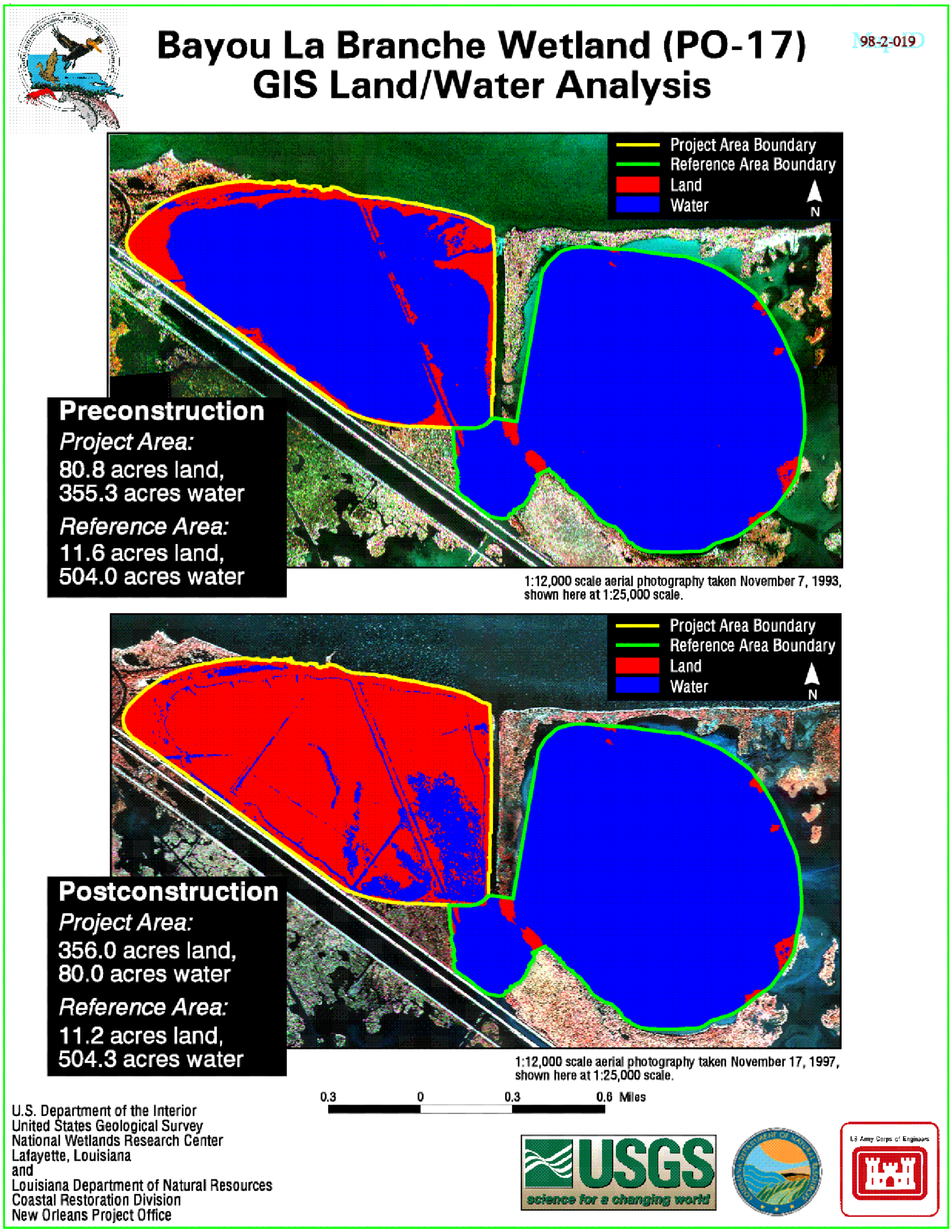


**Figure 4.** GIS land-water analysis of the Bayou LaBranche Wetland Creation (PO-17) project and reference areas before (1993) and after (1997) project construction.

## Sediment Elevation

Sediment elevation decreased significantly from 1994−1998 and then stabilized from 1998−2010 (Figure 5). The greatest variation in sediment elevation at the project site occurred between 1994 and 1998. Sediment elevation changed significantly between years ($F = 45.85$, $p < 0.001$) and is responsible for 55% of the variation in sediment elevation. The remaining variation in sediment elevation was between stations, among which significant differences ($df = 18$, $F = 29.57$, $p < 0.001$) were also present. In general, stations located in the northern project area had higher elevations than those in the southern project area. In addition, the greatest changes in elevation occurred at several of the northern stations.

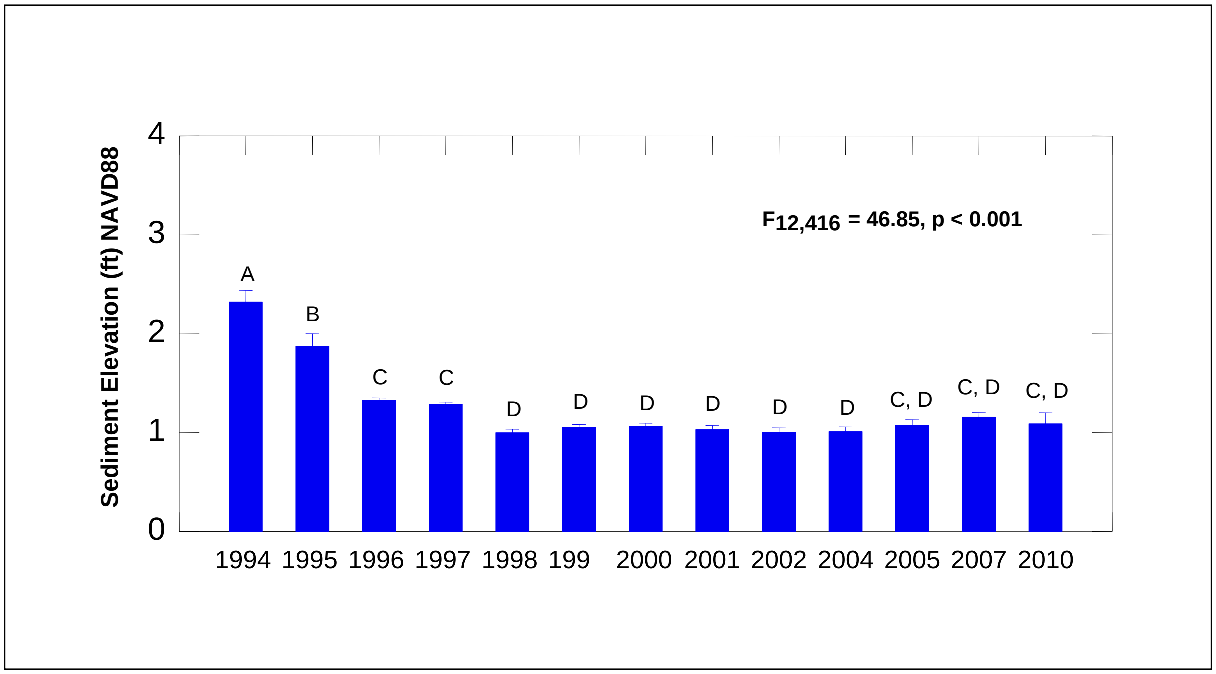


**Figure 5.** Yearly mean sediment elevation (± SE) from 1994−2010 for the PO-17 project area. Multiple comparison testing indicates that sediment elevation between 1998−2010 does not differ statistically.

## Soil Properties

Organic matter remained below 8% from 1994 to 2001 and was significantly different among years ($df = 9$, $F = 39.26$, $p < 0.001$) from 1996 to 2010 (Figure 6). Bulk density was also significantly different ($df = 9$, $F = 158.38$, $p < 0.001$) among years, with a generally decreasing trend from 1996, that has remained somewhat stable from 2004 to 2010 (Figure 7). Soil moisture content varied and was also significantly different ($df = 9$, $F = 50.32$, $p < 0.001$) among years (Figure 8). Moisture content remained near 47% during 2004, 2005, and 2007 and then decreased in 2010 to near 32%.

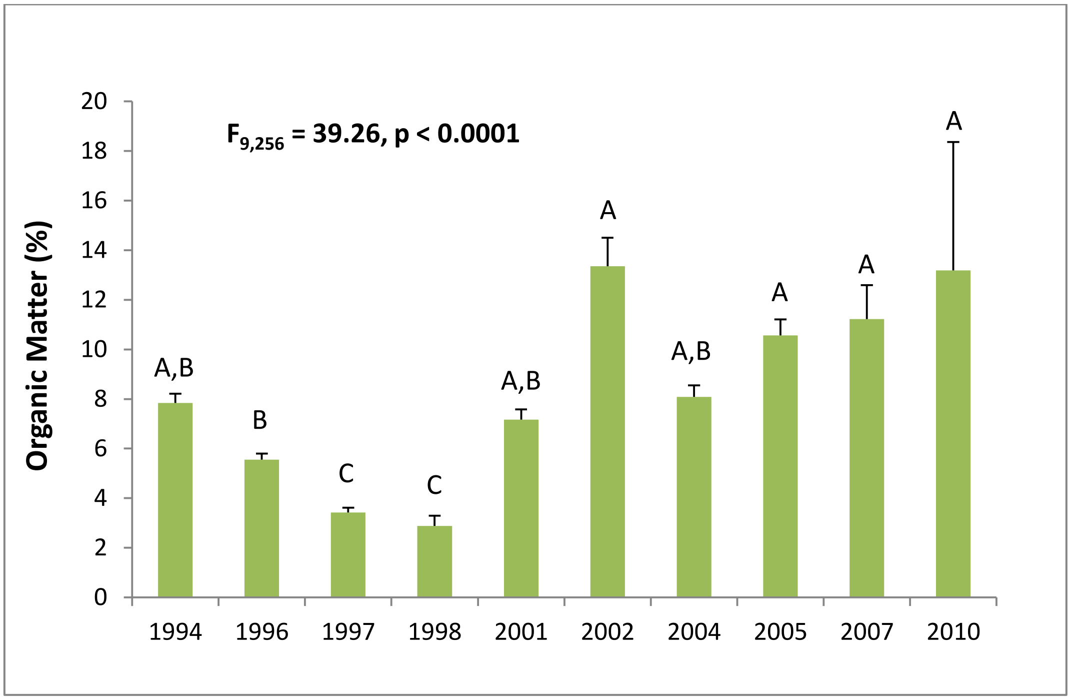


**Figure 6.** Mean percent organic matter for dredged sediments in the PO-17 project area from 1994–2010. Different letters represent differences among means. Multiple comparison testing indicates a decrease in percent organic matter from 1994–1998 and an increase since 2001.

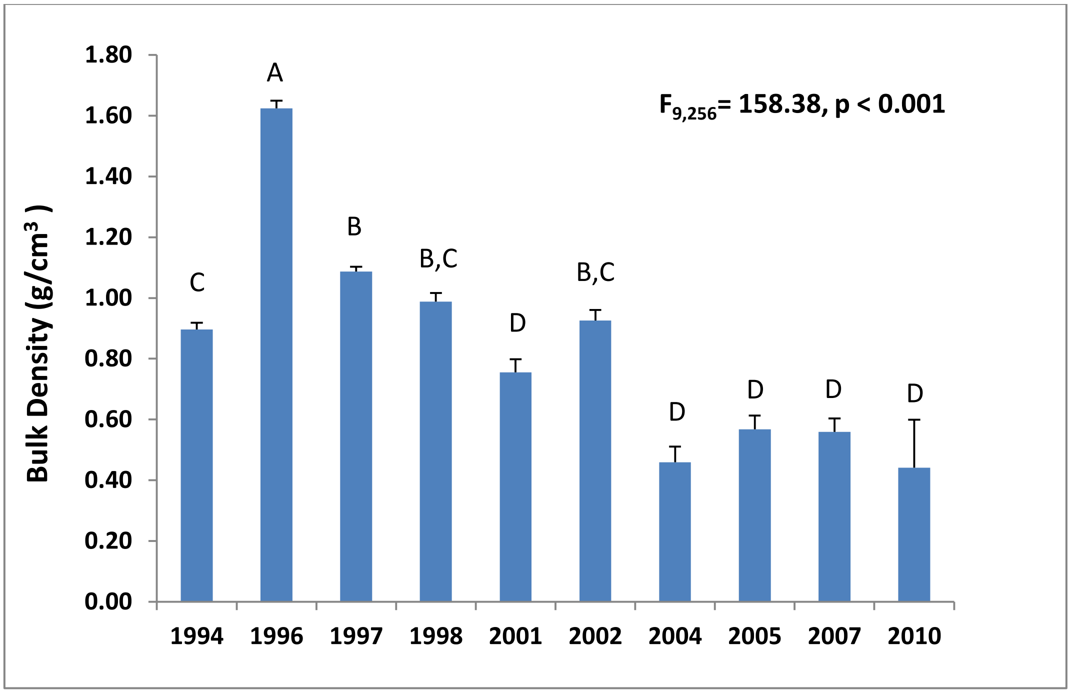


**Figure 7.** Yearly mean bulk density (±SE) of dredged sediment in the PO-17 project area. A consistent decrease in bulk density is seen since 2002. Different letters indicate that bulk density is statistically different between years.

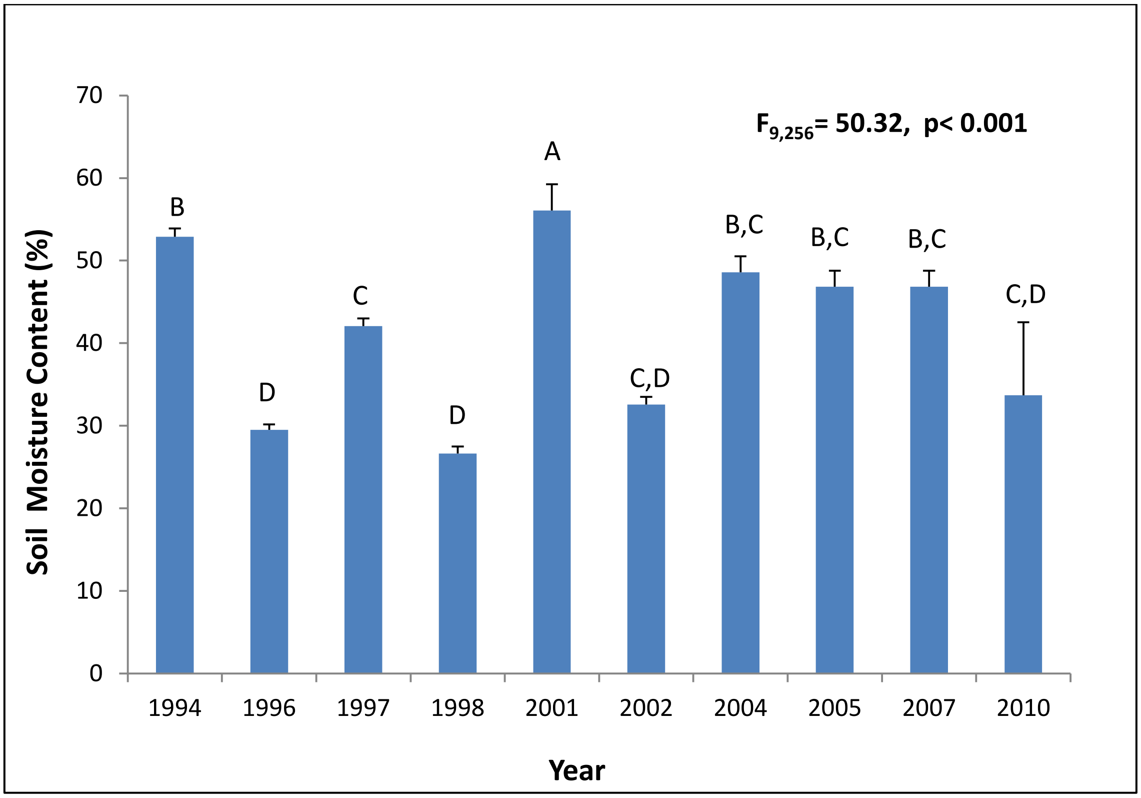


**Figure 8.** Yearly mean percent moisture content (±SE) of dredged sediments in the PO-17 project area. The greatest variability occurred between 1994−2001. Different letters indicate that yearly mean moisture content is statistically different between years.

## **Salinity**

Salinity in the project and reference areas of Bayou LaBranche followed similar patterns from 1994−2010 (Figure 9). Average monthly project area salinity (4.0 ppt) and reference area salinity (3.9 ppt) were not statistically different, although average salinity was slightly higher in the project area. Salinity in the project and reference areas was highest during the drought period that extended from September 1999 through December 2000 (Figure 9). Salinity was significantly different among years in both the project and reference site ($F_{10,188=}$ 52.18, $p < 0.001$).

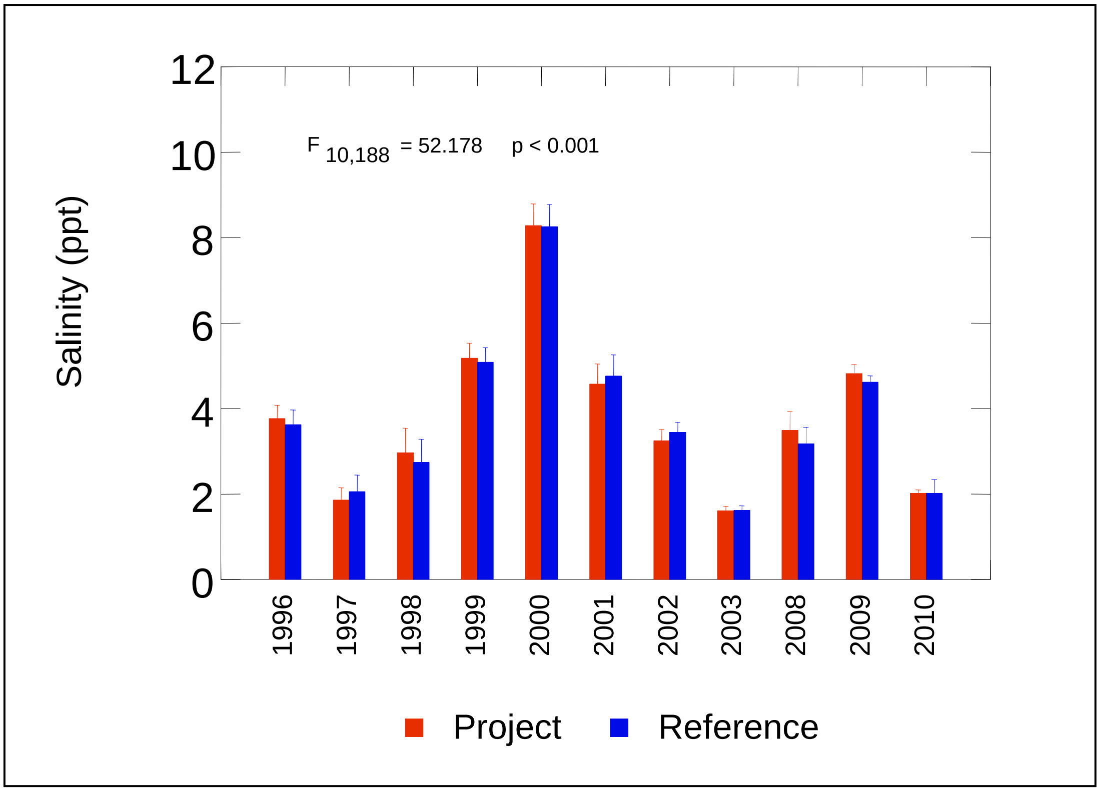


**Figure 9.** Average yearly salinity (±SE) in the PO-17 project and reference areas from 1996−2010. Salinity was recorded at stations 43/44R from 1996−2003 and at CRMS 6299 and CRMS 2830 (reference) from 2008−2010. Average yearly salinity for both the project and reference sites was greatest in 2000 and lowest in 2003.

## Water Elevation

Water level in the project and reference areas followed similar patterns from 1996 to 2002 and from 2008 to 2010 (Figure 10). Average water level in the project area (1.10 ft NAVD 88) was not significantly different ($F_{1,206}$= 2.486, p = 0.116) than average water level in the project area (1.00 ft NAVD 88).

Differences in frequency and duration of flooding were noted from 1996−2002. The reference area was inundated more frequently than the project area each year; however, the average duration of flooding was greater in the project area. The maximum duration of a single flood event in the project area was 122 days, whereas the maximum duration in the reference area was 46 days (Table 1).

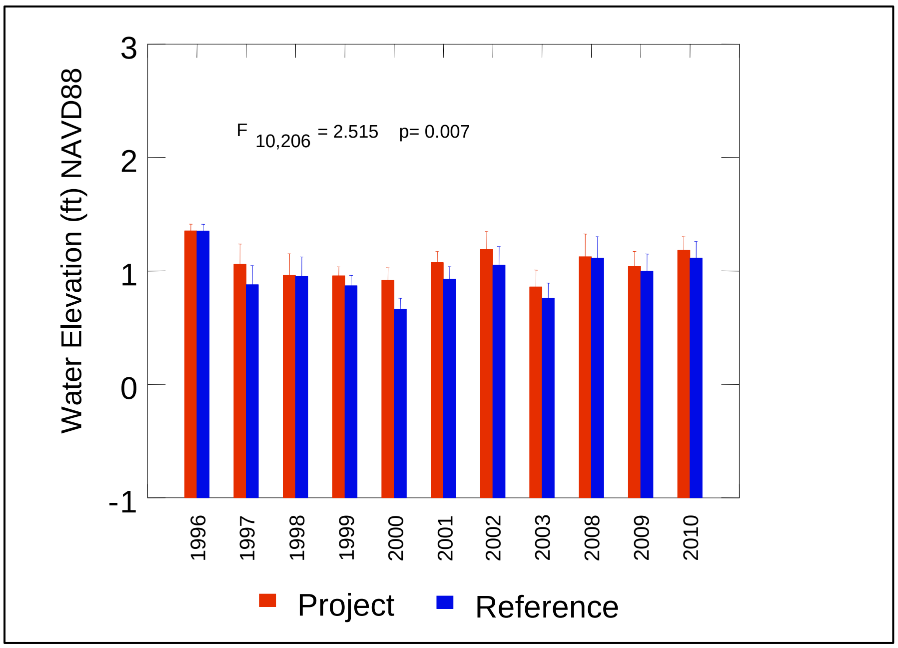


**Figure 10.** Water elevation (±SE) within the PO-17 project and reference area from 1996−2003 (stations 43 and 44R) and 2008−2010 (CRMS 6299 and CRMS 2830-reference).

**Table 1.** Frequency and duration of flooding in the PO-17 project and reference areas from 1997 to 2002.

| Year | PROJECT AREA | | | | REFERENCE AREA | | | |
|---|---|---|---|---|---|---|---|---|
| | # Flood Events | % Time Flooded | Mean Depth (ft) | Mean Duration (Days) | # Flood Events | % Time Flooded | Mean Depth (ft) | Mean Duration (Days) |
| 1997 | 3 | 35.37 | 1.25 | 17.3 | 12 | 17.19 | 0.93 | 2.75 |
| 1998 | 14 | 58.48 | 1.12 | 14.28 | 26 | 36.13 | 0.99 | 4.96 |
| 1999 | 21 | 54.79 | 0.96 | 9.52 | 17 | 30.48 | 0.85 | 4.8 |
| 2000 | 14 | 43.36 | 0.96 | 10.5 | 17 | 16.57 | 0.79 | 2.88 |
| 2001 | 18 | 61.64 | 1.04 | 12.5 | 21 | 36.29 | 0.87 | 6 |
| 2002 | 9 | 73.08 | 1.12 | 19 | 16 | 43.16 | 0.9 | 7.68 |

## Vegetation

At the time of the pre-construction vegetation survey (1994), the project area was mostly an open water pond and was dominated by *Myriophyllum spicatum* (Eurasian watermilfoil) and *Ceratophyllum demersum* (coontail grass). The only emergent vegetation that was present was *Eleocharis parvula* (dwarf spikerush), which occurred around the edges of the pond. During the initial post-construction vegetation survey conducted in May 1996, the project area was dominated by *Solidago sempervirens* (seaside goldenrod) and *Ranunculus* spp. (buttercup), which were present at 79% and 84% of the survey stations, respectively (Table 2). Other frequently encountered species included *E. parvula*, *Baccharis halimifolia* (Eastern baccharis) and *Bacopa monnieri* (coastal water-hyssop), which were found at 42%, 32%, and 26% of the stations, respectively. Ten additional species were found, but at much lower frequencies. In addition to being the most frequently encountered species in this 1996 survey, *S. sempervirens* and *Ranunculus* spp. also had the highest mean percent cover values.

The 1997 vegetation survey revealed moderate changes in species composition from the previous year with a decrease in number of species from 15 to 10. The most noticeable changes in frequency involved *Ranunculus* spp. This plant was encountered most frequently in 1996, but was absent in 1997. Moreover, *B. halimifolia* was found at fewer stations, yet had the highest percent cover within the survey plots, followed by *E. parvula*, *Schoenoplectus robustus* (sturdy bulrush), and *Lemna minor* (common duckweed).

The number of vegetation species surveyed increased to 26 in 1998. Interestingly, many of the species that were observed in 1996 were absent from the plots in 1997, but were again present in 1998. Two of these plants, *Pluchea camphorata* (camphorweed) and *Amaranthus* spp. (pigweed), occurred at a much higher percentage of stations in the 1998 survey (Table 2). Furthermore, *P. camphorata*, *B. halimifolia*, and *B. monnieri* were not only the most frequently encountered species, but were also the dominant species in percent cover. *Baccharis halimifolia* is normally considered a facultative upland or scrub-shrub species but is occasionally found in marshes subject to frequent drying (Reed 1998, Tiner 1993, Chabreck and Condrey 1979, Cowardin et al. 1992). Thus, in 1996 it was not surprising to see *B. halimifolia* dominate vegetation stations in the northern section of the project area when higher sediment elevations existed and again during a drought in 1998.

The number of species surveyed since the high of 26 in 1998 has ranged from 11 to 14. Bray-Curtis Multi-Dimensional Scaling (MDS) analysis (Clark and Gorley 2006) indicated an increase in emergent marsh vegetation such as *Spartina alterniflora* (smooth cordgrass) (Figure 11) and *Schoenoplectus robustus* (Figure 12) in both occurrence and percent cover across all stations post 1998, while scrub-shrub species such as *B. halimifolia* (Figure 13) have decreased in species cover over time.

**Table 2.** Presence-absence and frequency (% of stations where present) of vegetation species within the Bayou LaBranche Wetland Creation (PO-17) project area from 1996−2010.

| **Species** | **1996** | **1997** | **1998** | **2001** | **2002** | **2004** | **2005** | **2007** | **2010** |
|---|---|---|---|---|---|---|---|---|---|
| *Alternanthera philoxeroides* | . | . | 10 | . | . | . | . | . | . |
| *Amaranthus australis* | . | . | . | 5 | . | . | . | 10 | 5 |
| *Amaranthus* spp. | 11 | . | 25 | . | . | . | . | . | 15 |
| *Azolla caroliniana* | . | 6 | . | . | . | . | . | . | 5 |
| *Baccharis halimifolia* | 32 | 18 | 70 | 16 | 10 | 5 | 5 | 5 | . |
| *Bacopa monnieri* | 26 | 65 | 70 | 21 | 35 | 42 | 20 | 10 | . |
| *Cuscuta indecora* | . | | | | | | | 5 | 5 |
| *Cyperus compressus* | . | . | 10 | . | . | . | . | . | . |
| *Cyperus odoratus* | 5 | . | . | 5 | 5 | 11 | . | . | . |
| *Distichlis spicata* | . | . | 15 | 21 | 20 | . | 5 | 5 | 15 |
| *Echinochloa* spp. | 5 | . | . | . | . | . | 20 | . | . |
| *Echinochloa walteri* | . | . | 30 | . | . | . | . | . | . |
| *Eleocharis parvula* | 42 | 24 | 20 | 42 | 20 | . | . | . | . |
| *Ipomoea sagittata* | . | . | . | . | . | . | . | . | . |
| *Iva frutescens* | . | . | 5 | 5 | 5 | 16 | 10 | 30 | 10 |
| *Lemna minor* | . | 29 | . | . | . | . | . | . | . |
| *Leptochloa fusca* | . | . | . | . | 10 | . | 5 | . | . |
| *Packera glabella* | 5 | . | . | . | . | . | . | . | . |
| *Panicum capillare* | . | . | 5 | . | . | . | . | . | . |
| *Panicum* spp. | . | . | 15 | . | . | . | . | 5 | . |
| *Panicum repens* | . | 6 | 15 | 21 | 10 | 16 | 10 | 15 | 5 |
| *Paspalum* spp. | . | . | 5 | . | . | . | . | . | . |
| *Paspalum dissectum* | . | | . | | | 5 | . | . | . |
| *Paspalum vaginatum* | 5 | . | . | . | . | . | . | . | 5 |
| *Pluchea camphorata* | 11 | . | 95 | . | 15 | | . | . | . |
| *Polygonum punctatum* | 5 | . | . | . | . | . | . | . | . |
| *Polypogon interruptus* | 5 | . | . | . | . | . | . | . | . |
| *Ranunculus spp.* | 84 | . | . | . | . | . | . | . | . |
| *Salix nigra* | . | . | 20 | . | . | . | . | . | . |
| *Schoenoplectus americanus* | . | . | . | . | . | . | 5 | . | . |
| *Schoenoplectus californicus* | . | . | 5 | . | . | 5 | 5 | 5 | 5 |
| *Schoenoplectus pungens* | . | . | 10 | 42 | 25 | | . | . | . |
| *Schoenoplectus robustus* | . | 12 | 10 | . | . | 26 | 15 | 10 | 75 |
| *Sesbania drummondii* | . | . | 45 | . | . | . | . | . | . |
| *Sesbania herbacea* | 5 | . | . | . | . | . | . | . | . |
| *Sesuvium maritimum* | . | . | 5 | . | . | . | . | . | . |
| *Setaria pumila* | . | 6 | . | . | . | . | . | . | . |
| *Solidago* spp. | . | . | . | . | . | . | . | . | . |
| *Solidago sempervirens* | 79 | 35 | 10 | . | . | . | . | . | . |
| *Sorghum halepense* | . | . | . | . | 5 | | . | . | . |
| *Spartina alterniflora* | . | 6 | . | . | . | 47 | 45 | 70 | 70 |
| *Spartina cynosuroides* | . | . | 10 | 32 | 40 | | . | . | 5 |
| *Spartina patens* | . | . | 15 | 5 | 10 | 26 | 30 | 35 | 40 |
| *Symphyotrichum subulatum* | . | . | 65 | 21 | . | . | . | . | . |
| *Symphyotrichum tenuifolium* | 11 | . | . | 16 | 25 | 11 | 5 | 15 | . |
| *Typha spp.* | . | . | 5 | . | . | . | . | . | . |
| *Vigna luteola* | . | . | 10 | . | . | . | . | 5 | 5 |

## Bayou LaBranche Species Cover: *Spartina alterniflora*

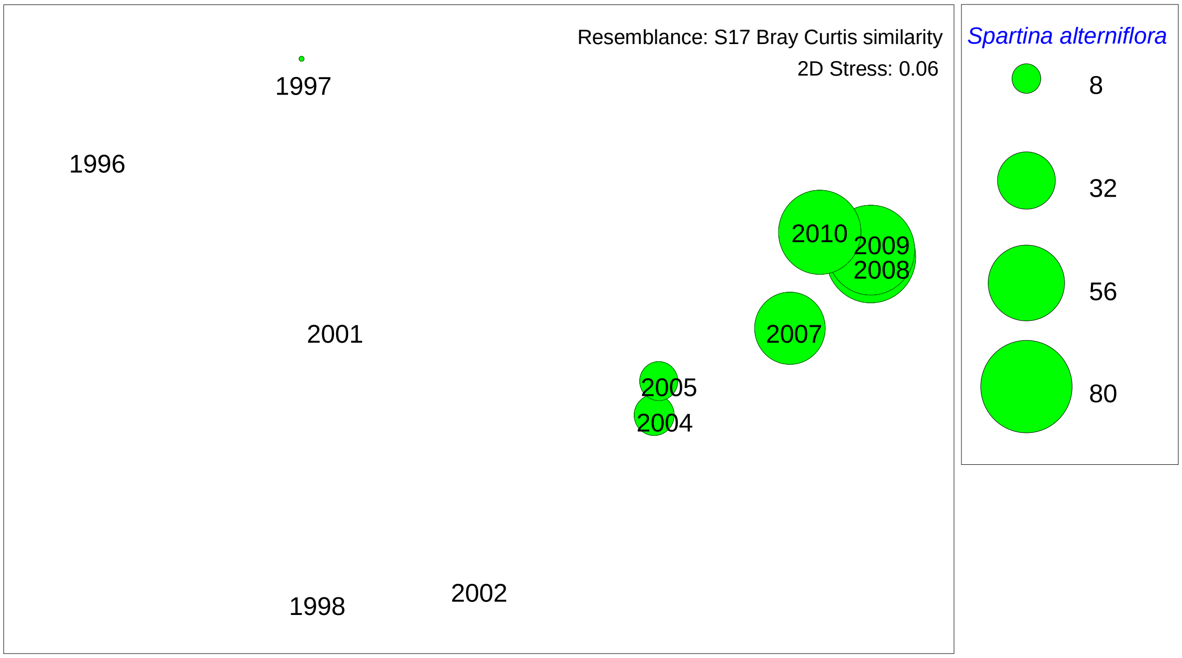


**Figure 11**. MDS ordination of *S. alterniflora* percent cover from 1996–2010. Mean percent cover for *S. alterniflora* increased across years.

## Bayou LaBranche Species Cover: *Schoenoplectus robustus*

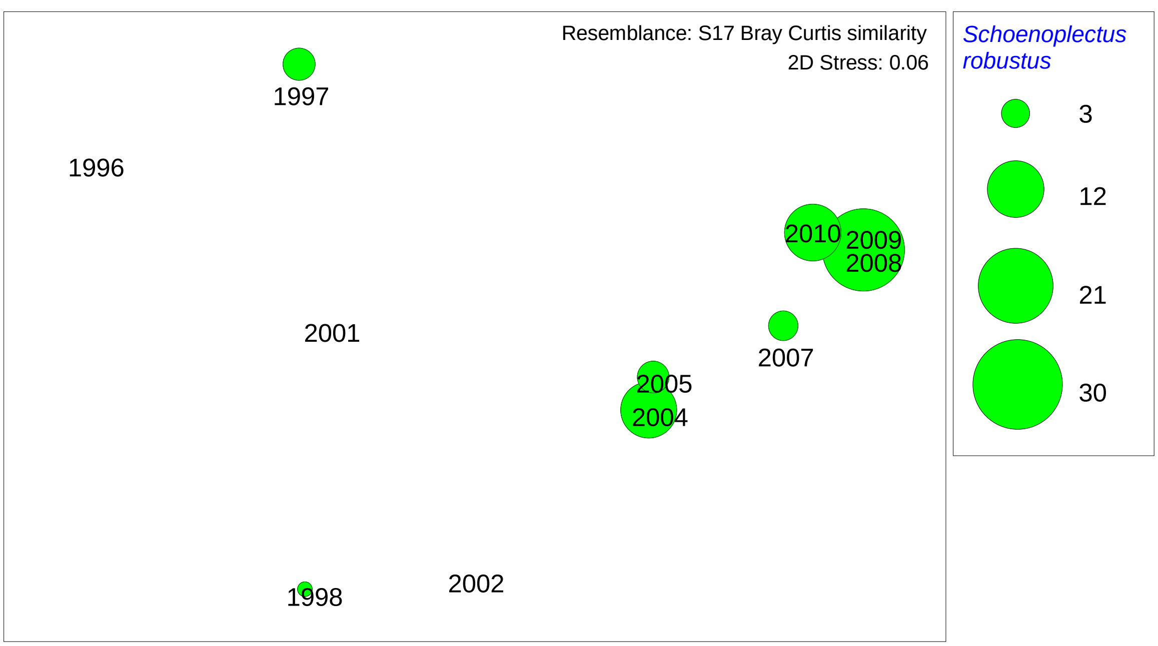


**Figure 12.** MDS ordination of *S. robustus* percent cover from 1996–2010. Mean percent cover for *S. robustus* varied from 1996–2002, then generally increased from 2004–2010.

## Bayou LaBranche Species Cover: *Baccharis halimifolia*

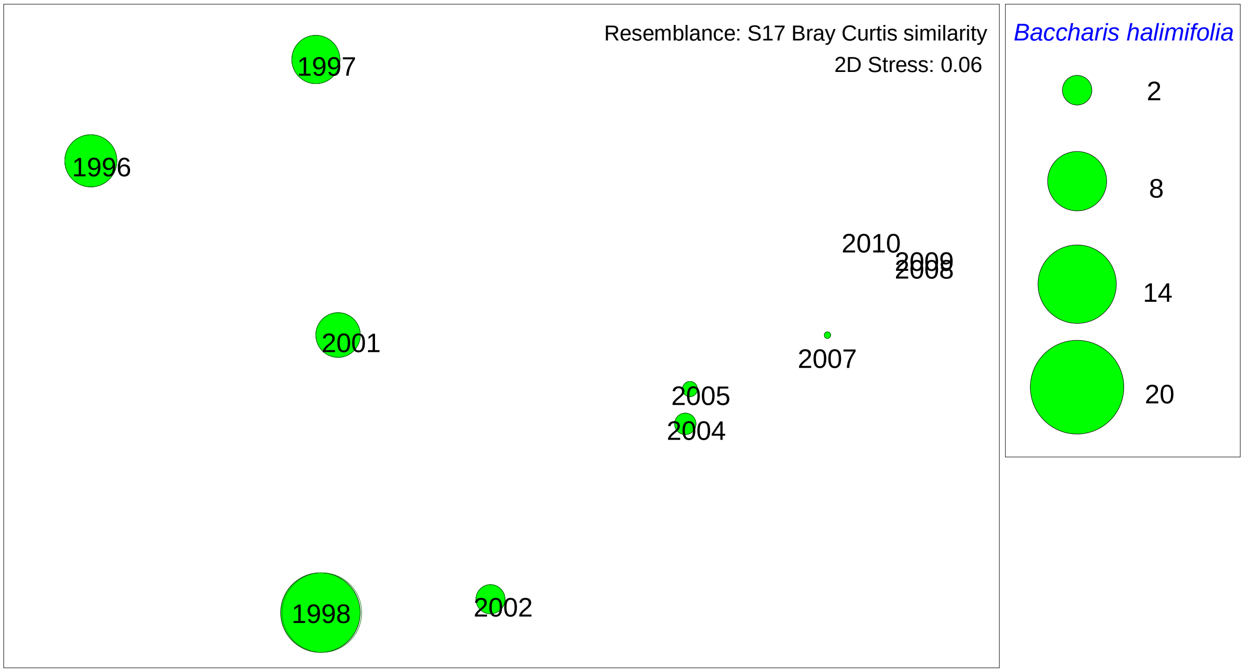


**Figure 13.** MDS ordination of *B. halimifolia* percent cover from 1996–2010. Percent cover for *B. halimifolia* increased from1996–1998, and then decreased through 2010.

The Floristic Quality Index (FQI) scores for the Bayou LaBranche Wetland Creation project have trended positively from 1996−2010 (Figure 14). The lowest FQI was 7.3 in 1997. By 2007, the FQI of the project area had increased to 70.9. The FQI calculated for the 2010 vegetation survey was 57.0, a high score and an indicator that the area is one of conservation that contains a high number of species native to the area.

The FQI score was also calculated for the CRMS project and reference stations using annual vegetation survey data that was collected between 2008−2010. The FQI for CRMS 6299 ranged from 87−90 (Figure 15), while the FQI for CRMS 2830 (reference) ranged from 70−75 (Figure 16). The project area has a higher FQI, which is indicative of the successful re-vegetation of the Bayou LaBranche project area with native plant species.

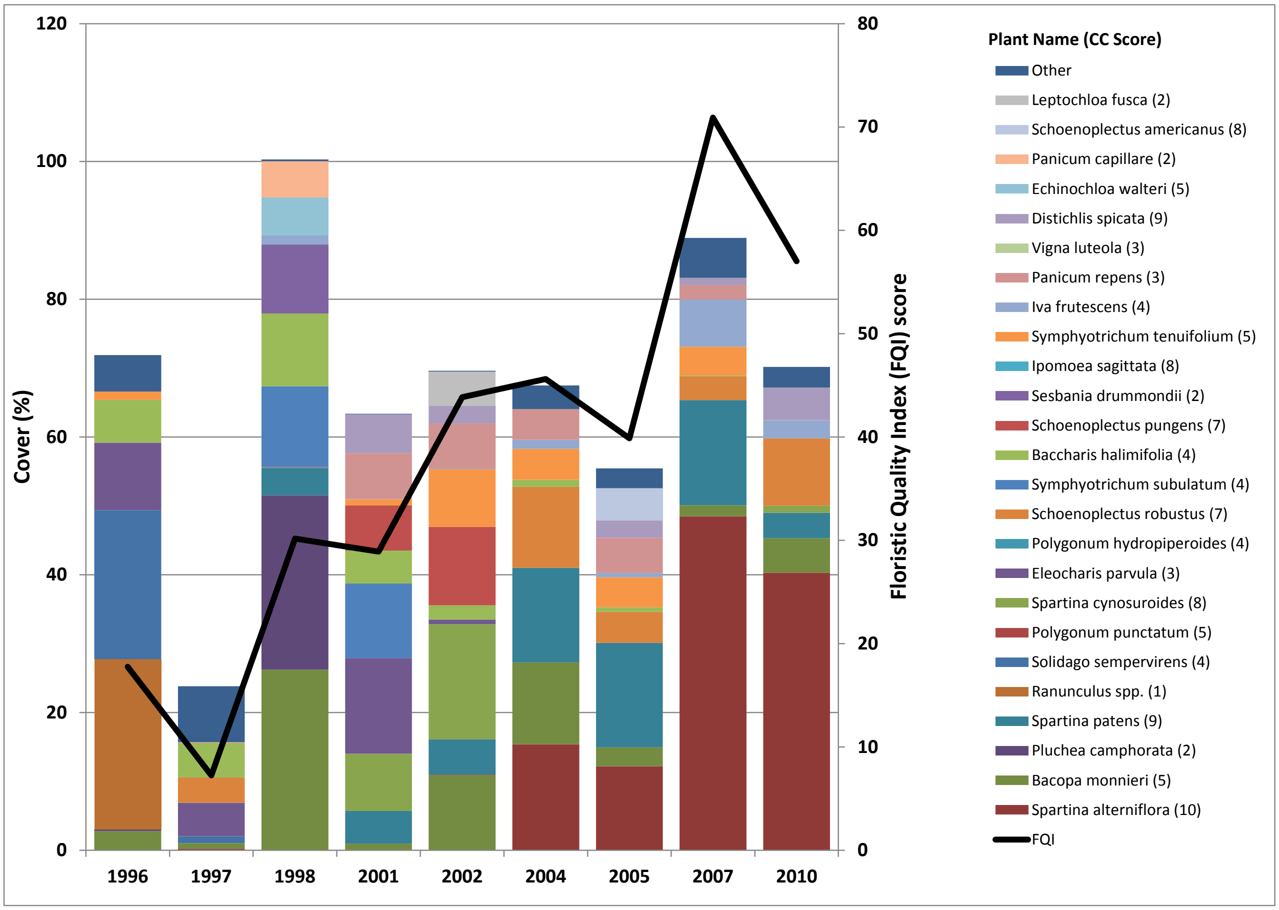


**Figure 14.** The floristic quality index score (FQI) of the Bayou LaBranche Wetland Creation project area has generally increased from 1996−2010. The FQI score peaked in 2007 at 70.9.

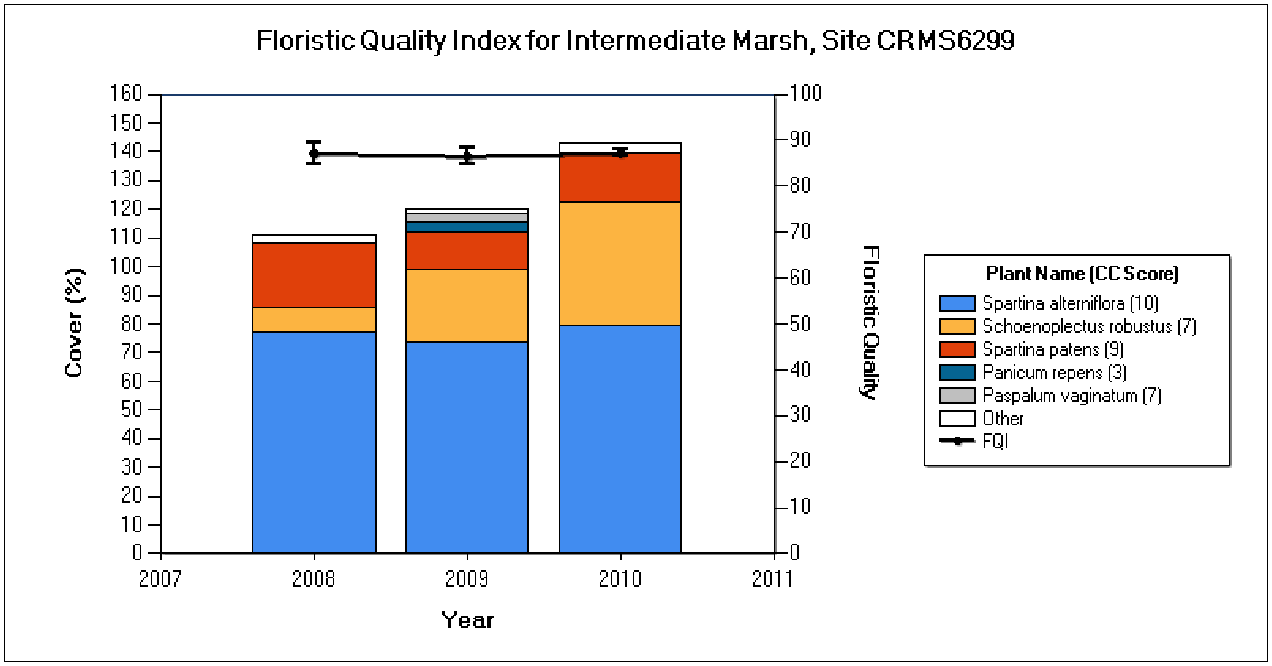


**Figure 15.** FQI and vegetation percent cover for CRMS 6299. The mean CC scores for plant species identified in the project area in 2008, 2009 and 2010 were 8.6, 7.2 and 8.6, respectively. FQI scores for the project area between 2008–2010 ranged from 87–90.

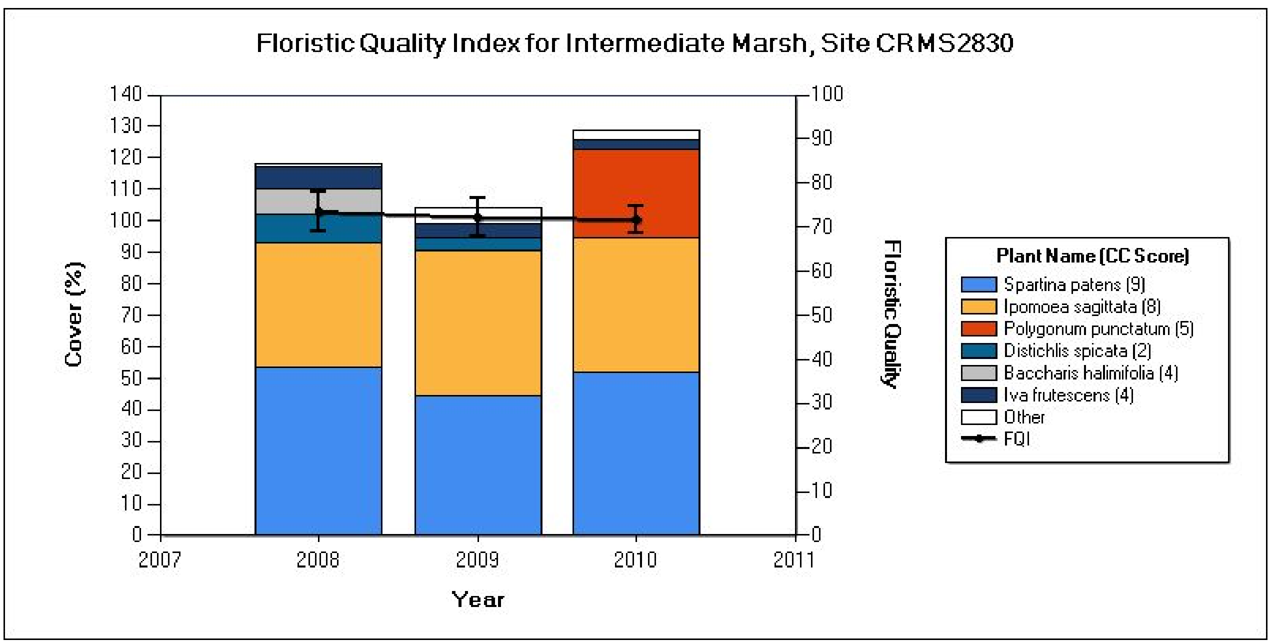


**Figure 16.** FQI and vegetation percent cover for reference site CRMS 2830. Mean CC scores for plant species identified in the reference area in 2008, 2009, and 2010 were 5.4, 5.8, and 6.5, respectively. FQI scores remained in the mid-70s for all three years.

The mean wetland status or prevalence index (i.e. OBL=1, FACW=2, and FAC=3) for the project area varied from a mean index reading of 1.50 in 1997 and 2005 to 1.79 in 2007. In 2010, the mean index reading across all species was 1.54. The mean index reading across all years is 1.62. An analysis of variance indicated that no significant differences were found in these index values among years, but there were significant differences among index values across years ($F_{2,121}$= 5.59, p = 0.005) (Figure 17). The index classifies the project area as hydrophitic vegetated wetland (a prevalence index < 3) for all years.

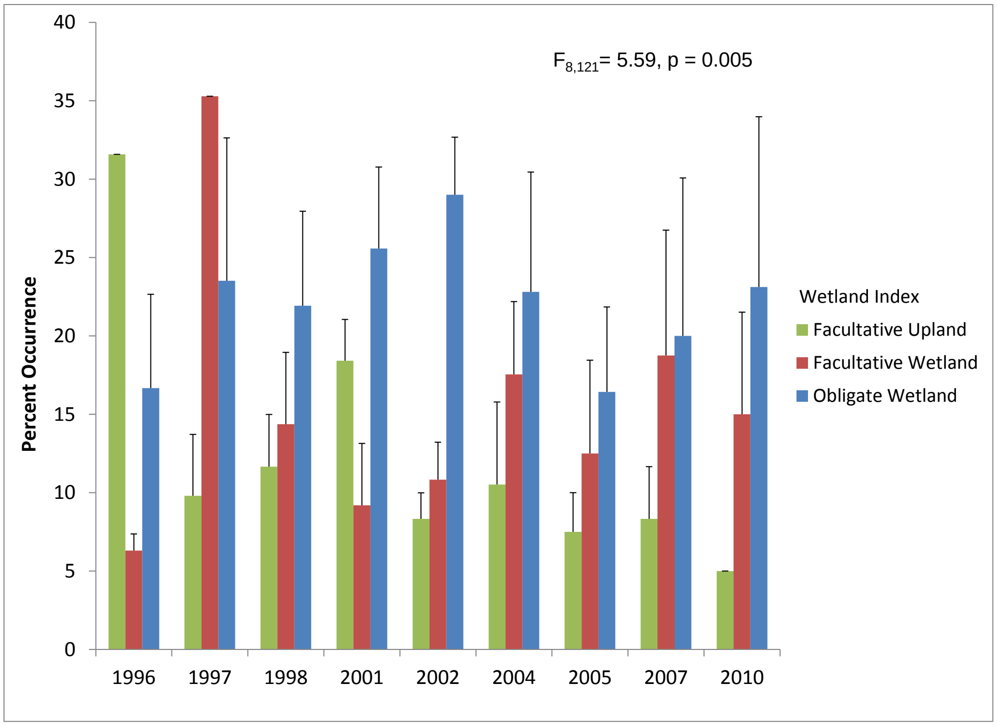


**Figure 17.** Occurrence (% of stations where present) of vegetation classes in the PO-17 project area between 1996−2010.

## VI. Discussion

### Habitat Mapping

The establishment of wetland vegetation in the project area is meaningful to the success of this project. Therefore, it is important to note that although the GIS land/water analysis indicated that approximately 82% of the project area was land in 1997, only 51% of the project area was emergent marsh. The remaining 31% of the area was scrub-shrub habitat, which mostly consisted of *Baccharis halimifolia* (groundsel bush) and upland habitats. The majority of the scrub-shrub habitat was confined to the northern section of the project area and along the canal banks. Although habitat analysis (post-1997) is not available (the next habitat analysis is scheduled for 2012), vegetation survey data show that scrub-shrub species decreased significantly over time and occupied less area than reported in the 1997 habitat analysis, with much of the area now being comprised of herbaceous vegetation.

## Sediment Elevation

One of the most important factors to consider when creating a wetland is the elevation of the deposited sediments in relation to the tidal regime (Broome 1988). Elevation affects the frequency and duration of flooding, which determines the zonation of vegetation. The estimated target range of sediment elevation for this project after five years of consolidation was 0.65−1.62 ft (0.20−0.49 m) NAVD (personal communication, Cottone 1996). As of August 2010, elevation at 15 of 19 staff gauge stations was within this target range. Data for two of the 19 staff gauge stations were not available during the field assessment in 2010.

The north-south elevation gradient in the project area may be explained by the way the dredged sediments were deposited. Direct sediment discharge was not allowed within 1000 ft (305 m) of the Interstate-10 bridge (in the southern project area) because of concern that it would displace the underlying peat foundation and affect the interstate's infrastructure (Wilde 1997). In order to address this concern, discharge pipes from the dredge were placed in several locations along the northern (lake) shore of the project area and the dredged sediments were allowed to flow south. This resulted in a larger amount of sediment deposition and a higher elevation in the northern region of the project area than in the southern region.

The greatest amount of sediment consolidation occurred during the first two years after project construction, followed by a more moderate decrease in elevation through year five. By 1998, the elevation "stabilized" and has been consistent through 2010. Interestingly, elevation was slightly lower in 1998 than the following years; however, an extended drought occurred from fall 1998 to winter 2000, during which water levels remained well below marsh elevation. During this period, large cracks in the sediment were observed throughout the project area and most of the deep channels in the area were void of standing water.

## Soil Properties

Soils of newly created wetlands are composed largely of mineral material and have low organic matter content (Odum 1988). Therefore, it was not surprising to see low values during the early years for percent organic matter in the Bayou LaBranche project area relative to the surrounding wetlands, which have been shown to contain soils with greater than 50% organic matter (Palmisano and Chabreck 1972). Further compaction of the sediments appears to have stabilized; therefore, it would be likely to see an increasing trend in percent organic matter as bulk density decreases. Percent moisture may be explained by water levels in the marsh at the time the soil samples were taken.

## Salinity

Differences in salinity in the project and reference areas were likely due to the semi-impoundment of the project area leading to less tidal flushing and the concentration of salts due to evaporation. Although at times the salinity levels were higher (prolonged drought period) and water levels lower, the marsh vegetation types in the project area did not seem to be affected. Average salinity levels in the project area were in the oligohaline range (0.5−5 ppt), which falls into the historical LaBranche classification of brackish marsh (0.5−18 ppt) (O'Neil 1949, Chabreck and Linscombe 1968, 1988).

## Water Elevation

Differences in the frequency and duration of flooding between the project and reference areas were likely due to the semi-impoundment of the project area. During construction, a small levee was built around the project area to contain the dredged sediments, and box culverts were installed to allow water to drain from the project area as the dredged sediments de-watered. Over the life of the project, the containment levee has been breached three times (once by USACE and twice naturally). One breach was left open and accounts for some tidal variation; however, the other two breaches were closed with weirs or sandbags. In addition, the drainage culverts in the eastern levee were blocked with lumber (2x4's) during the fall and winter months. All of these structures and modifications affect water flow into and out of the project area. Members of a local duck-hunting club were responsible for closing the two breaches and for blocking the culverts (personal communication, Ensminger 1996). It is presumed that they made these modifications to hold more water in the project area in order to create a more desirable habitat for wintering waterfowl.

The variability of water levels in the project area is important because it can affect the establishment of marsh vegetation (Chabreck and Hoffpauir 1965). Weirs prevent impounded areas from dewatering during low tides, and stabilize water levels by reducing tidal exchange (Cowan et al. 1988). In turn, stabilization of water levels reduces environmental stress on certain species of vegetation, which can increase diversity and production of certain aquatic vegetation species (Larrick and Chabreck 1976, Davidson and Chabreck 1983). Conversely, other species of aquatic vegetation may become stressed or even excluded if high water levels are maintained (Conner et al. 1981). For example, extended floods associated with consecutive tropical storms and hurricanes occurred in 1998, 2002 and 2008. Although Lake Pontchartrain and New Orleans were not directly impacted by these storms and hurricanes, storm surge from the Gulf of Mexico caused a temporary increase in water levels of three to four feet above normal. However, vegetation was not adversely affected during these storm events.

## Vegetation

Differences in the vegetation community among years were indicative of the changes in sediment elevation and water levels in the project area. The decrease in sediment elevation and the longer duration of flooding in the area caused the obligate wetland species to increase in occurrence (i.e. percentage of stations where present) and percent cover, and the facultative wetland species and facultative upland species to generally decrease in occurrence and cover (Figure 17). These results agree with Dell (1990), who found that higher water levels were the major force driving shifts in the vegetative community in a created marsh at Savage Island in the Delta National Wildlife Refuge, Louisiana.

## VII. Conclusions

### a. Project Effectiveness

The Bayou LaBranche Wetland Creation project has benefited the LaBranche wetlands by converting open water to marsh in an area of critical need along the Lake Pontchartrain shoreline. As of 1997, the project area contained approximately 82% land and 18% water, with an increase of 275 acres of land. The consolidation of dredged material over time has reached an elevation that appears to sustain the 70% emergent marsh to 30% open water goal for the project. Furthermore, the soil properties and the vegetation community of the project have developed into characteristic wetland habitat for the region. Current data indicate that the project has been effective in meeting project goals. The 2012 land-water analysis will provide updated land-water ratios and a view of project sustainability.

### b. Recommended Improvements

Gaps should be created in the containment dikes to increase tidal exchange for increased productivity of the project. Marsh elevation should continue to be monitored. If necessary, dredged material should be added to the project area to prevent open water conversion; however, minimum maintenance should be incorporated in the design.

### c. Lessons Learned

Data gathered should be utilized to a greater extent to facilitate the engineering, design and construction of future wetland creation projects. Thus, a greater degree of coordination between biologists and engineers should occur. Clearly, the data gathered for calculating and maintaining the correct elevations of the dredged material and its placement were the most important aspect in creating wetlands for this project.

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