Monitoring Series No. PO-17-MSTY-0498-1

THREE-YEAR COMPREHENSIVE MONITORING REPORT

Coast 2050 Region 1

BAYOU LABRANCHE WETLAND RESTORATION PROJECT
PO-17

First Priority List Beneficial Use of Dredged Material Project of the Coastal Wetlands Planning, Protection, and Restoration Act (Public Law 101-646)

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April 1998

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ACKNOWLEDGMENTS

We would like to thank the U. S. Geological Survey, National Wetlands Research Center (NWRC), particularly William Jones, Robert Greco, and Holly Gaudet, for conducting habitat analysis and assisting in the preparation of this monitoring report; and John Barras and Marty Beasley for their assistance with the GIS figures in this report. Special thanks to Brian Zielinski for his help with the figures and graphics, and critical review of this report. Critical reviews were also given by Van Cook, Ed Haywood, Dan Llewellyn, and Greg Steyer of LDNR/CRD; and Bill Hicks of the U.S. Army Corps of Engineers.

ABSTRACT

The Bayou LaBranche Wetland Restoration Project (PO-17) is located in St. Charles Parish, Louisiana on the southwestern shore of Lake Pontchartrain. The project goals were to create approximately 305 ac (123.5 ha) of shallow-water habitat conducive to the natural establishment of emergent wetland vegetation and to produce a ratio in the project area of 70% emergent marsh to 30% open-water within 5 years following project completion. To measure these goals, sediment elevation, soil properties, water level, and vegetation were monitored in the project area, and aerial photographs were used to compare land-to-water ratios in the project and reference areas. Results indicated that sediment elevation and water level variability decreased in the project area from April 1996 to December 1997. Species composition of vegetation changed in the project area over this time period, with a decrease in the frequency of upland or dry-tolerant species and an increase in the frequency of wetland-specific species. The land-to-water ratio increased in the project area after construction, whereas it remained unchanged in the reference area. The final goals of this project have not been fully met at this juncture; however, the trends in these data indicate that the project area is progressing toward the desired land-to-water ratio and plant species composition.

INTRODUCTION

The Bayou LaBranche Wetland Restoration Project (PO-17) encompasses 436 ac (176.4 ha) and is located 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).

Historically this area has been classified as a brackish marsh (O'Neil 1949; Chabreck and Linscombe 1968, 1988), as the hydrology of the LaBranche wetland is significantly influenced by Lake Pontchartrain. The wetland receives tide waters from the lake through two openings in the lake's shoreline, and much of the wetland is flooded during normal high tides. Water circulation in the area is also greatly influenced by winds. Thus, the wetland experiences flooding at times other than high tides and may also be drained at times other than low tide.

A combination of events, dating back to the 1800's, has contributed to an almost complete loss of marsh in the area and subsequent conversion into 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 1900's, 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 1960's, access canals were dug through the marsh, which further altered hydrology and provided a conduit for salt water intrusion from Lake Pontchartrain into the interior marsh. Two natural events that have received blame for land loss in the area were Hurricane Betsy in 1965 and Hurricane Camille in 1969. The tidal surge generated from these storms would have created prolonged flooding of the Bayou LaBranche marsh with higher saline water from Lake Pontchartrain. Because of the altered hydrology of this area, flood waters may have taken several weeks to drain from the marsh, thereby affecting vegetation (Montz and Cherubini 1973).

In addition to these seemingly major events that have impacted the LaBranche wetland, the continuous, yet sometimes imperceptible, processes such as subsidence and shoreline erosion have also contributed to land loss in the area. Pierce et al. (1985) determined that subsidence was estimated as 0.39 in (1 cm) per year in the LaBranche wetland, whereas 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).

A method that has been used to combat land loss in many states, including Louisiana, is to create or restore wetlands through the beneficial use of dredged materials (Patrick et al. 1984, Broome 1988, USACE and LSU 1995). Results summarized from various marsh creation projects indicate that the most important factor to consider when constructing wetlands is sediment elevation in relation to hydrologic regime of which the plants of interest are adapted (Broome 1988).

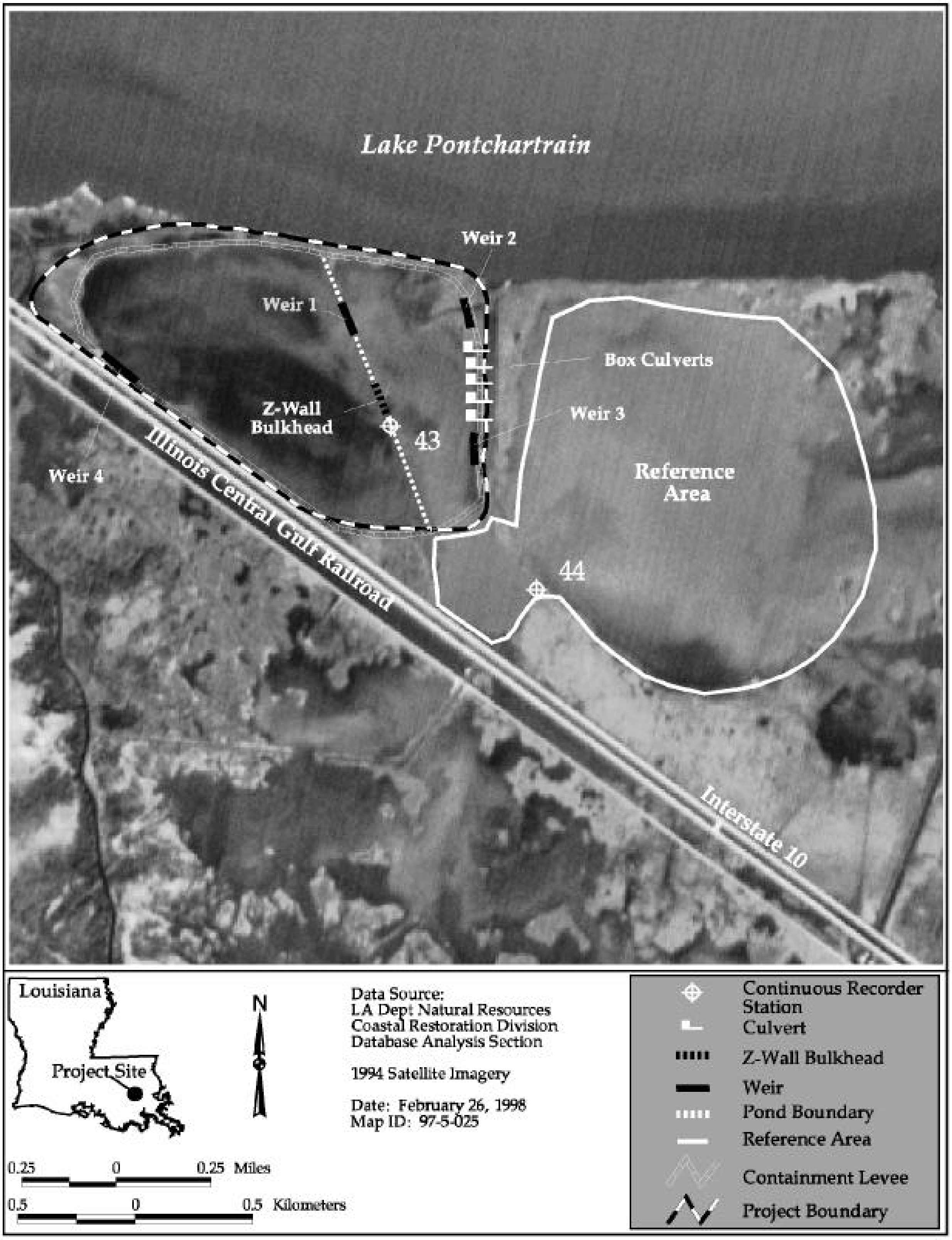

Figure 1. Bayou La Branche Wetland Restoration (PO-17) project features.

The purpose of this project was to create new vegetated wetlands in the open-water area of the Bayou LaBranche wetlands utilizing dredged sediment from Lake Pontchartrain. Project construction was completed April 1, 1994. The project features consist of an earthen berm that was constructed to confine the 2.7 million yds^3 (2.1 million m^3) of dredged sediment that were pumped into the project area. The area is divided by a spoil ridge that contains a sheet pile z-wall closure and a concrete weir (weir 1, figure 1). 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 located 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 1).

The measurable project goals are to create approximately 305 ac (123.5 ha) of shallow-water habitat conducive to the natural establishment of emergent wetland vegetation and to produce a ratio in the project area of 70% emergent marsh to 30% open-water within 5 years following project completion.

METHODS

Sediment elevations were recorded at 19 staff gauges (set to North American Vertical Datum, NAVD) on a quarterly basis to document the settling rate of the dredged sediment (figure 2). A paired t-test (a = 0.05) was used to compare mean sediment elevation in the project area between the initial survey in 1996 and the December 1997 survey. To determine if an elevation gradient existed in the project area, a one-way analysis of variance (a = 0.05) was used to compare mean elevation (in December 1997) of the stations in the northern section to mean elevation of the stations in the southern section. The same analysis was also used to compare mean elevation of the eastern stations to those in the western section of the project area.

To characterize sediment composition in the project area, duplicate 10-cm soil samples were collected at the 19 staff gauge stations with a Swenson corer (Swenson 1982). Soil samples were taken to coincide with vegetation surveys, once preconstruction and in 1996 and 1997 post-construction. The soil cores were analyzed to determine percent organic matter, bulk density (g/cc), and percent moisture. Because different soils were sampled pre- and post-construction (natural marsh soils vs. dredged sediments from Lake Pontchartrain), no statistical comparison was made between pre- and postconstruction samples. A paired t-test (a = 0.05) was used to compare mean percent organic matter, bulk density and percent moisture between the 1996 and 1997 samples.

Water level was recorded hourly at two continuous recorders (YSI Model 6000 or 6920 Water Quality Analyzers), one located in the project area (station 43) and one in the reference area (station 44; figure 1). Staff gauges were established at each continuous recorder station in January 1997 so that staff gauge data could be used to convert water level data from the recorders into a known datum (NAVD). Water elevation could then be used in concert with marsh elevation (NAVD) to determine the frequency and duration of flooding in the project and reference areas. However, because of logistical problems with transferring elevation from the staff gauge to the continuous recorders, water level data has not yet been converted to NAVD. Consequently, water level variability (range of depth above recorder sensor) was analyzed in this report instead of water elevation. The monthly range of water level was compared between the project and reference areas for 1996 and 1997.

Emergent vegetation was surveyed with the Braun-Blanquet sampling method to quantify species composition and relative abundance in the project area (Mueller-Dombois and Ellenberg 1974). A total of 42 stations were surveyed, with two replicate samples at each station. These stations were distributed at 440-ft (134.2 m) intervals along six transects (north-south) in the project area (figure 2). Vegetation was monitored once during preconstruction, and in 1996 and 1997 post-construction. All surveys were conducted during periods of peak vegetation biomass (April-August). Parametric statistical analyses of vegetation data were not valid due to the non-normal distribution of these data. Therefore, only the frequency of each species was reported for the vegetation surveys of 1996 and 1997.

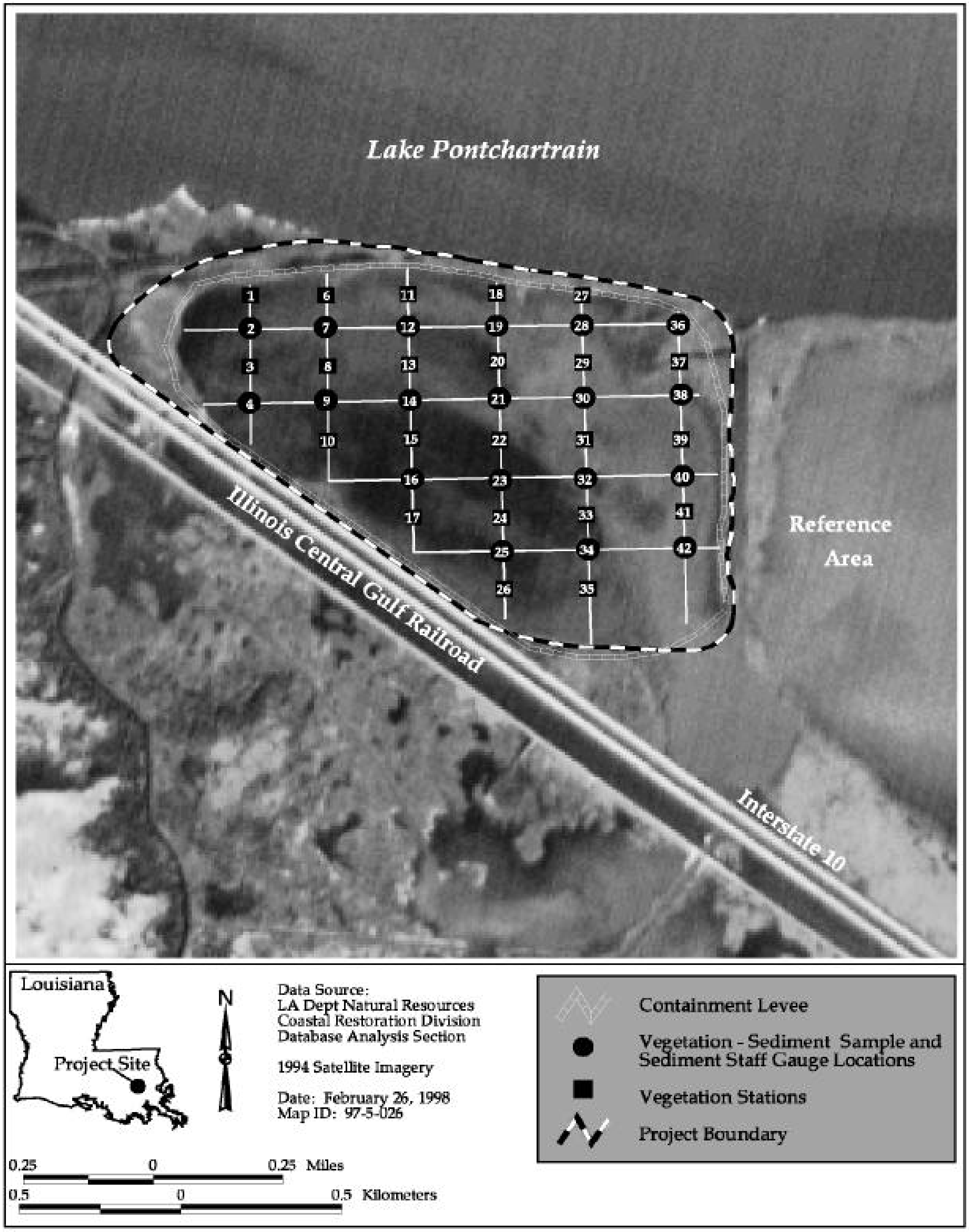

Figure 2. Bayou La Branche Wetland Restoration (PO-17) project vegetation stations, sediment stations, sediment staff gauges, and elevation survey transects.

Near-vertical, color-infrared aerial photography (1:12,000 scale) was taken in November 1993 (preconstruction), December 1994 (post-construction) and again in November 1997. Photographs were analyzed by the NWRC to determine the changes in marsh to open-water ratios within and between the project and reference areas for both years.

RESULTS

Comparison of sediment elevations over time revealed that mean elevation in the project area has significantly decreased ($t = -5.29$, $P = 0.0001$) from 1.42 ft ± 0.06 (SE) (0.43 m ± 0.02) NAVD in May 1996 to 1.27 ft ± 0.04 (0.39 m ± 0.01) NAVD in December 1997. There was no significant difference ($F = 2.11$, $p = 0.1645$) in mean elevation between the eastern (1.23 ft ± 0.05 [0.37 m ±0.02]) and western (1.34 ft ± 0.05 [0.41 m ± 0.02]) sections of the project area; however, mean elevation in the northern section (1.33 ft ± 0.05 [0.41 ± 0.02]) was significantly higher ($F = 5.57$, $p = 0.0305$) than mean elevation in the southern section (1.15 ft ± 0.05 [0.35 m ± 0.02]) of the project area. Interestingly, the greatest changes in elevation have occurred at the northern stations, as well (table 1).

Analysis of the preconstruction soil samples indicated that mean bulk density was 0.9 g/cc, mean organic matter was 5.6%, and mean soil moisture was 52.9%. As stated earlier, these samples were taken in the project area before dredged sediments were deposited and thus can not be compared to postconstruction samples. Comparison of soil properties between the 1996 and 1997 samples indicated that mean bulk density significantly decreased ($t = -7.61$, $P = 0.0001$), mean percent organic matter significantly decreased ($t = -25.55$, $P = 0.0001$), and mean percent moisture significantly increased ($t = 13.10$, $P = 0.0001$) during this time period (figure 3).

Inspection of water level variability in the project area suggested that there was less variability of water level in the project area than in the reference area (figure 4). This trend seemed consistent for both 1996 and 1997, with the exception of December 1996.

A preconstruction vegetation survey of 42 stations in the project area was conducted in February 1994. At that time 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.

The initial post-construction survey of the same 42 stations was conducted in May 1996. The project area was dominated by *Solidago sempervirens* (seaside goldenrod) and *Ranunculus* spp. (buttercup), which were both present at 34 out of 42 stations. Other frequently encountered species included *E. parvula*, *Baccharis halimifolia* L. (groundsel bush) and *Bacopa monnieri* (coastal water-hyssop), which were found at 18, 15, and 14 stations respectively. Twelve additional species were found, but at much lower frequencies (table 2).

The June 1997 survey revealed moderate changes in species composition with a decrease in species richness from 17 to 14 species. The most appreciable changes in frequency involved *Ranunculus* spp. This plant was encountered most frequently 1996, but was not observed at any station in 1997. Moreover, *B.halimifolia* was found at fewer stations and was observed to be either dead or dying in

Table 1. Bayou LaBranche (PO-17) sediment staff gauge elevations from May 1996 through December 1997.

Station	Location	Elevation May '96	Elevation Jun '96	Elevation Aug '96	Elevation Oct '96	Elevation Nov '96	Elevation Jan '97	Elevation Mar '97	Elevation May '97	Elevation Jun '97	Elevation Dec '97	Elevation Change May '96 thru Dec '97
2	North/East	1.60	1.50	1.40	1.30	1.40	1.38	1.30	1.30	1.45	1.30	-0.30
4	North/East	1.10	1.08	1.05	1.00	1.10	1.10	1.00	1.10	1.15	1.10	0.00
7	North/East	1.80	1.70	1.60	1.60	1.60	1.60	1.60	1.50	1.50	1.45	-0.35
9	North/East	1.60	1.50	1.45	1.30	1.55	1.50	1.50	1.40	1.45	1.45	-0.15
12	North/East	1.80	1.75	1.55	1.50	1.50	1.65	1.55	1.50	1.50	1.50	-0.30
14	North/East	1.55	1.50	.	1.35	1.40	1.30	1.30	1.40	1.35	1.30	-0.25
19	North/West	1.50	1.40	1.40	1.20	1.35	1.30	1.30	1.30	1.30	1.20	-0.30
21	North/West	1.30	1.30	1.15	1.20	1.30	1.15	1.20	1.15	1.20	1.20	-0.10
28	North/West	1.90	1.80	1.70	1.75	1.75	1.80	1.80	1.80	1.70	1.70	-0.20
30	North/West	1.25	1.25	1.20	1.00	1.30	1.25	1.10	1.20	1.30	1.20	-0.05
36	North/West	1.50	1.50	1.40	1.55	1.50	1.45	1.40	1.40	1.40	1.40	-0.10
38	North/West	1.50	1.45	1.40	1.40	1.40	1.40	1.20	1.40	1.35	1.20	-0.30
16	South/East	1.45	1.30	1.25	1.30	1.20	1.30	1.30	1.35	1.30	1.30	-0.15
23	South/West	1.30	1.25	.	1.15	1.10	1.15	1.15	1.15	1.20	1.20	-0.10
25	South/West	1.10	1.05	1.05	1.05	1.15	1.10	0.90	1.15	1.20	1.00	-0.10
32	South/West	1.20	1.10	1.05	1.00	1.20	1.10	1.10	1.10	1.20	1.20	0.00
34	South/West	1.40	1.35	1.35	1.15	1.30	1.27	1.20	1.30	1.30	1.30	-0.10
40	South/West	1.10	1.00	1.00	1.00	1.00	1.03	1.05	1.15	1.00	1.00	-0.10
42	South/West	1.00	1.00	0.95	0.75	0.95	0.95	0.90	1.15	1.10	1.10	0.10
Mean		**1.42**	**1.36**	**1.29**	**1.24**	**1.32**	**1.30**	**1.26**	**1.31**	**1.31**	**1.27**	**-0.15**

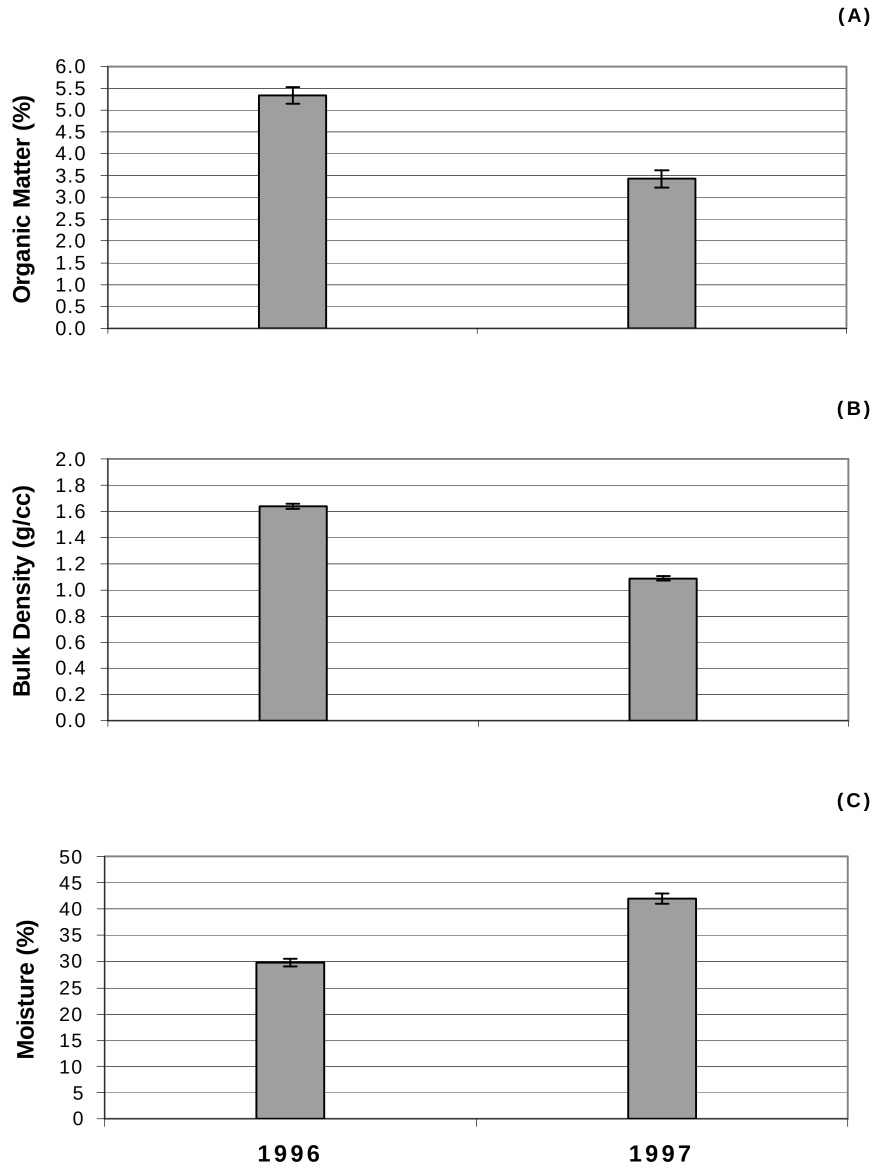

Figure 3. Mean percent organic matter (A), bulk density (B), and percent moisture (C) for dredged sediments for May 1996 and June 1997. Standard error bars are given for each mean.

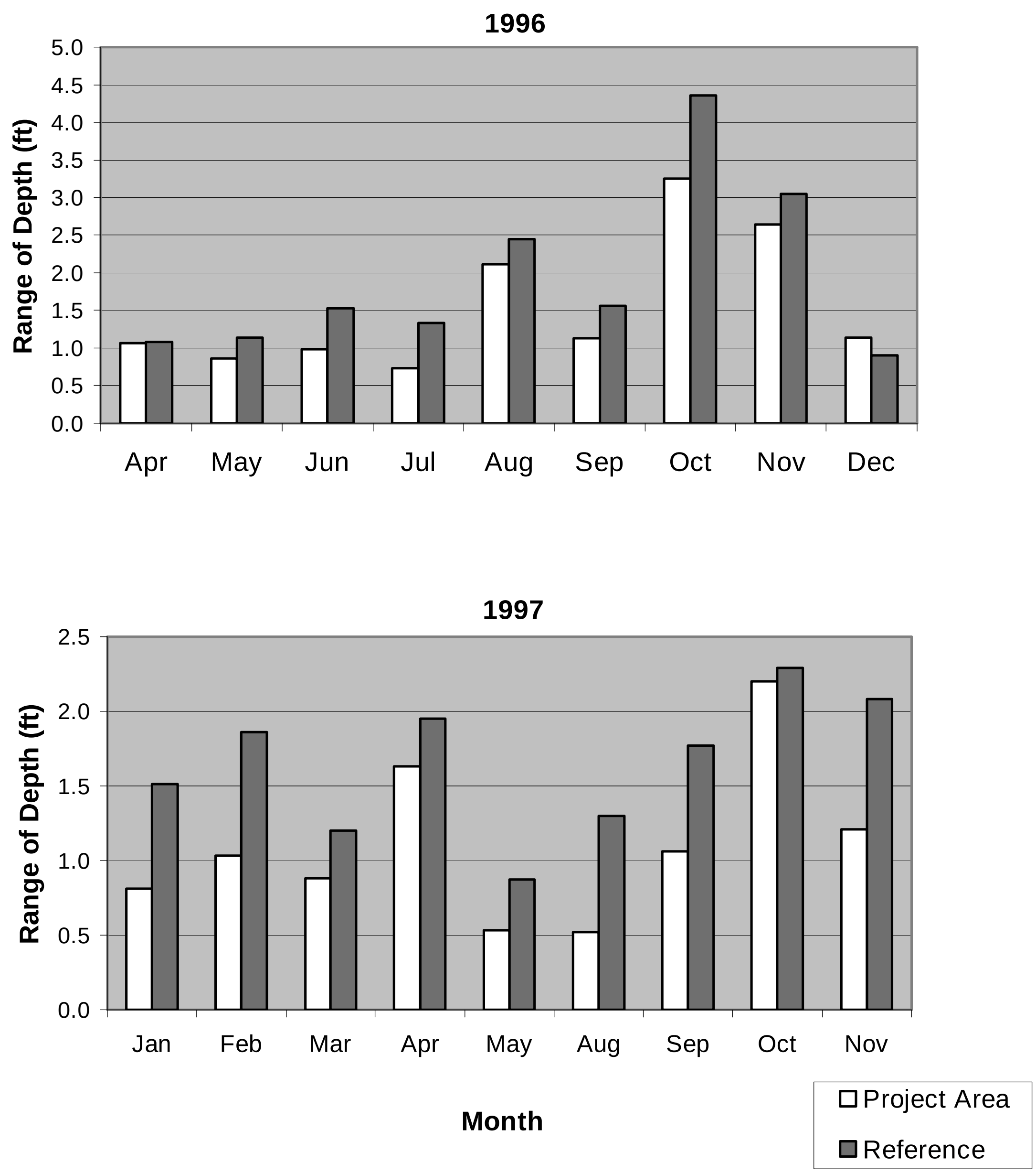

Figure 4. Monthly range of water level (ft) in project area (recorder station 43) and reference area (recorder station 44) for 1996 and 1997.

Table 2. Frequency of vegetation species at survey sites for the May 1996 vegetation survey.

Species	**Frequency**
Solidago sempervirens	34/42
Ranunculus spp.	34/42
Eleocharis parvula	18/42
Baccharis halimifolia	15/42
Bacopa monnieri	14/42
Panicum repens	3/42
Scirpus americanus	1/42
Polypogon interruptus	3/42
Rottboellia exaltata	1/42
Aster tenuifolius	6/42
Pluchea spp.	8/42
Sesbania macrocarpa	3/42
Echinochloa frumentacea	3/42
Paspalum repens	2/42
Amaranthus spp.	4/42
Senecio glabellus	3/42
Cyperus spp.	3/42
Poaceae spp.	2/42
Acnida spp.	2/42

much of the project area. *S. sempervirens* decreased in frequency, whereas *B. monneri* almost doubled in frequency (table 3). Two floating plants, *Lemna minor* (little duckweed) and *Azolla caroliniana* (mosquito fern), were also often encountered.

Analysis of the pre-construction aerial photographs revealed that of the 436 ac (176.4 ha) in the project area, 81 ac (32.8 ha) were land and 355 ac (143.7 ha) were open water (figure 5 and 6). In addition, the reference area contained 12 ac (4.9 ha) of land and 504 ac (204.0 ha) of open water. These data represent 19% land and 81% open water in the project area and 2% land and 98% open water in the reference area. The first post-construction aerial photographs were taken in December 1994; however, they were taken in the project area only (no photos of reference area). Analysis of these photographs showed a ratio of 94% land to 6% open water, which included 342 ac (138.4 ha) of newly created land (Carriere 1997). The most recent aerial photographs were taken in November 1997 (post-construction). At that time, there was 82% land to 18% open water in the project area, whereas the ratio of land to open water in the reference remained unchanged from pre-construction (figures 5 and 6).

Table 3. Frequency of vegetation species at survey sites for the June 1997 vegetation survey.

Species	**Frequency**
Solidago sempervirens	18/42
Eleocharis parvula	19/42
Baccharis halimifolia	8/42
Bacopa monnieri	27/42
Panicum repens	5/42
Scirpus americanus	4/42
Aster tenuifolius	2/42
Sesbania macrocarpa	5/42
Lemna minor	15/42
Azolla caroliniana	6/42
Setaria glauca	1/42
Daubentonia drummundii	1/42
Spartina alterniflora	1/42
Spartina patens	1/42

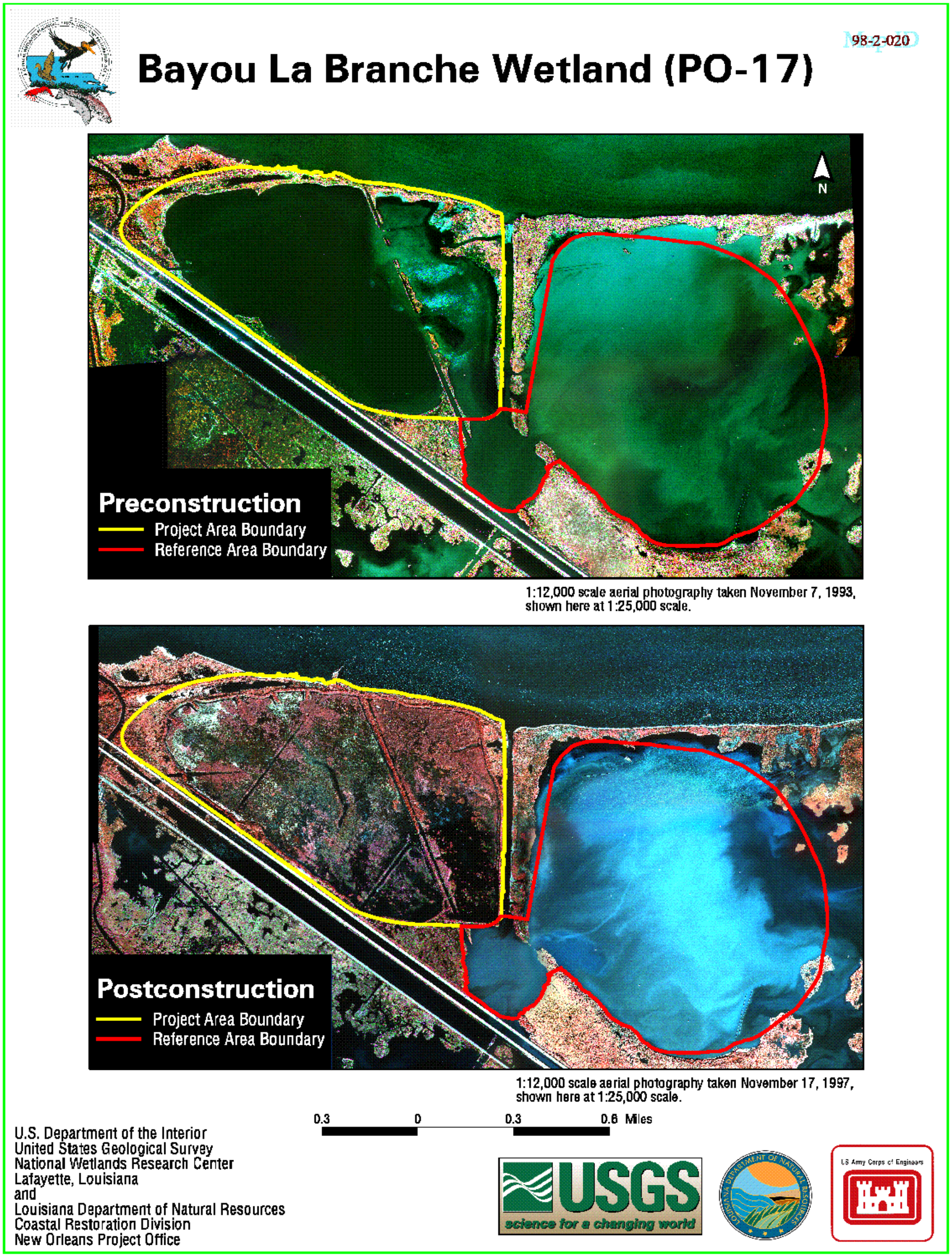

Figure 5. Preconstruction (top) and post-construction (bottom) aerial photography of Bayou LaBranche Wetland.

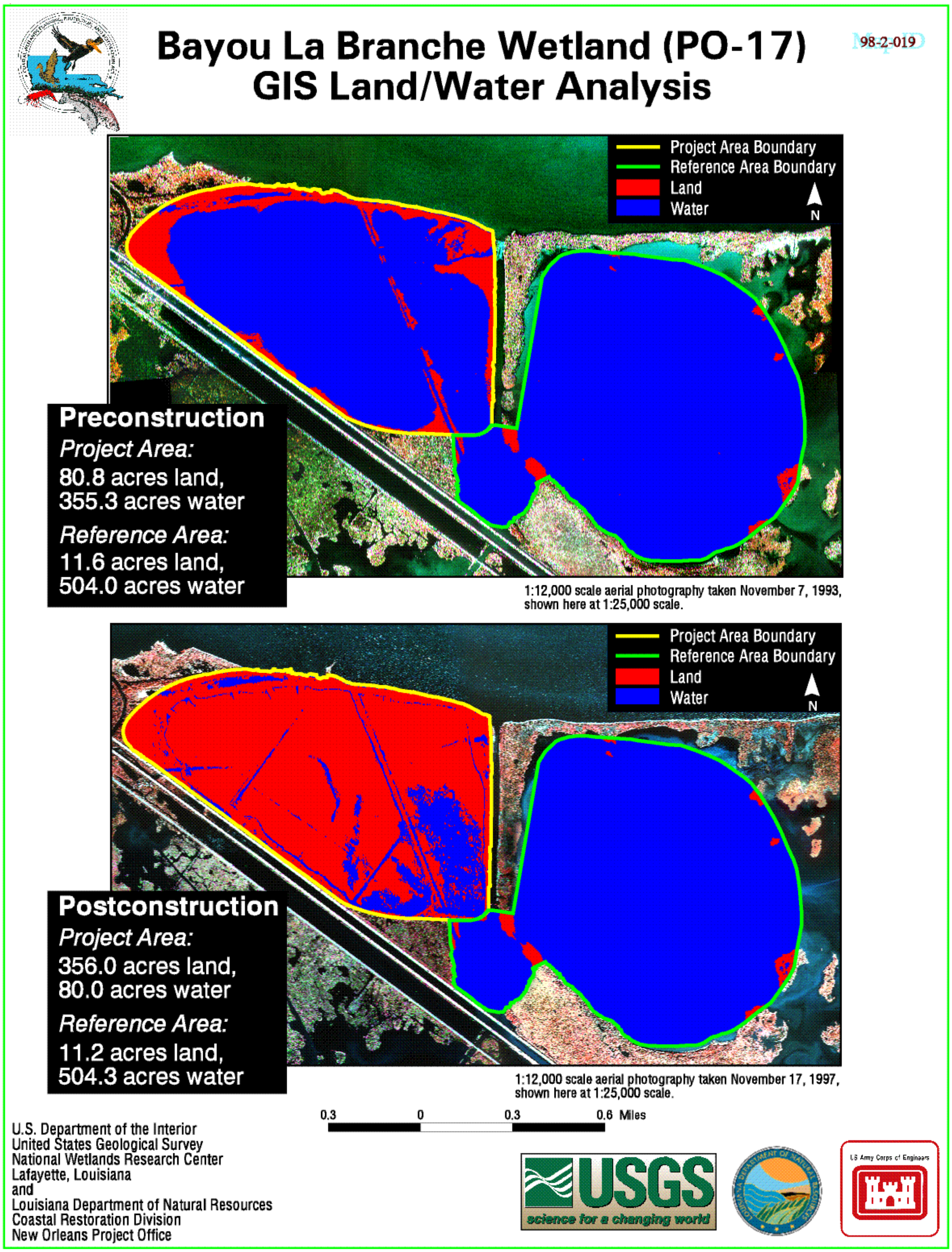

Figure 6. GIS land-water analysis of Bayou LaBranche (PO-17) before (top) and after (bottom) project constuction.

DISCUSSION

Maybe the most important factor to consider when creating a wetland is the elevation of the deposited sediments in relation to tidal regime (Broome 1988). Elevation affects frequency and duration of flooding, which determines the zonation of vegetation. The target range of sediment elevation for this project, after five years of consolidation, was estimated at 0.65 to 1.62 ft (0.20 - 0.49 m) NAVD (personal communication, Cottone 1996). With the exception of station 28, elevation at all of the staff gauge stations was within this target range (table 1). However, most elevations were in the higher end of this range, and it is apparent from the vegetation surveys that the higher end of the target range may not be suitable for the establishment of marsh vegetation. For instance, much of the project area contained an abundance of upland vegetation during both survey years. The data does indicate, however, that sediment elevation decreased in the project area from 1996 to 1997, which was probably due to consolidation of the deposited sediments. Although the greatest amount of consolidation likely occurred during the first two years after project construction (before sediment staff gauges were established) (Wilde 1997), continued consolidation will result in lower sediment elevations, which should benefit wetland vegetation.

Elevation in the southern section of the project was lower than in the northern section. This gradient may be explained by the manner in which the project area was filled with dredged sediments. During filling, no direct sediment discharge was allowed within 1000 ft (305 m) of the Interstate-10 bridge because of concerns that the deposited dredged sediments would displace the underlying peat foundation in the project area, possibly affecting the interstate's infrastructure (Wilde 1997). Thus, the southern section of the project area, much of which borders the interstate, received less sediment than the northern section during filling.

Soils with a low content of organic matter are characteristic of newly created wetlands (Odum 1988). For example, organic matter concentration has been found to be 2 to 4 times higher in natural marshes compared to created marshes near Galveston, Texas (Lindau and Hossner 1981). Thus, it was not surprising to see low values for percent organic matter (3.5% - 5.5%) in the project area relative to the surrounding wetlands, which have been shown to contain soils with greater that 50% organic matter (Palmisano and Chabreck 1972). It was surprising, however, to see a decrease in percent organic matter over time in the project area. Other studies have shown that percent organic matter steadily increased over time in habitats created with dredged materials (Lindau and Hossner 1981, Patrick et al. 1984). The decrease in bulk density was also unexpected; with the decrease in sediment elevation and percent organic matter, bulk density was expected to increase. The increase in percent moisture may be explained by the maintenance of water in the project area that resulted from the addition of two new weirs in the area. The changes in these soil characteristics are important to the development of the marsh in the project area, as soils can influence the distribution of vegetation in the coastal zone (Palmisano and Chabreck 1972).

The lower variability of water levels in the project area, compared to the reference area, was likely due to the semi-impoundment of the project area. The project plans called for two weirs to be constructed (figure 1; weir 1 and weir 2), of which only one was to be placed in the containment berm. However, two additional weirs (figure 1; weir 3 and weir 4) were built to close breaches in the containment berm. In addition, the drainage culverts in the eastern berm were blocked with lumber (2x4's). All of these construction modifications were performed without the consent of the federal or state project managers. Members of the LaBranche duck club were responsible for the modifications, and 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 (personal communication, Ensminger 1996). The variability of water levels in the project area is important, because water-level variability can affect the establishment of vegetation in a marsh (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, which can increase species diversity (Larrick and Chabreck 1976), and may increase the production of certain aquatic vegetation species (Davidson and Chabreck 1983). Conversely, other species of aquatic vegetation may be excluded if high water levels are maintained (Conner et al. 1981).

Of the 17 species encountered in the vegetation surveys, all but *Ranunculus* spp. and *B. halimifolia* are good vegetative indicators of wetlands (Tiner 1993). Both are normally considered upland or scrub-shrub species, but are occasionally found in marshes subject to frequent drying (Chabreck and Condrey 1979; Cowardin et al. 1979). Thus, it was not surprising to see that *Ranunculus* spp. and *B. halimifolia* were dominant at the vegetation stations in northern section of the project area where higher sediment elevations existed. Although *Ranunculus* spp. was not present in the vegetation plots during the 1997 survey, *B. halimifolia* was still present within the plots during this survey, but it was found at fewer stations.

Differences in the vegetation community between the two years were indicative of the changes in sediment elevation and water levels in the project area. With the decrease in sediment elevation and the maintenance of water on the marsh, the more dry-tolerant plants (*Ranunculus* spp., *B. halimifolia*, *S. sempervirens*) decreased in frequency, whereas the wet-tolerant plants (*B. monneri*, *L. minor*, *A. caroliniana*) increased in frequency. 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.

The area of open water increased in the project area by 12% from 1994 to 1997 (post-construction), with a corresponding decrease in land area. The increase in open water is reflective of the decrease in sediment elevation over time, and the elevation gradient in the project area. The new area of open water has mostly formed in the southern portion of the project area (figure 6), where lower elevations persist.

CONCLUSION

For the Bayou LaBranche Wetland Restoration Project, the goal of creating a shallow water habitat conducive to the natural establishment of wetland vegetation seems to have been partially met. However, not all of the vegetation in the project area is wetland-specific (e.g. *B. halimifolia)*. As sediment continues to consolidate and water is maintained in the area, upland vegetation is expected to be supplanted by more obligate wetland species. In addition, the project goal of creating a minimum of 70% marsh and 30% open water in the project area may still be attained as sediment elevation continues to decline.

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