Monitoring Series No. ME-04-MSPR-1099-5

PROGRESS REPORT NO. 5
For the period January 31, 1995 to October 01, 1999

Coast 2050 Region 4

FRESHWATER BAYOU WETLANDS
ME-04 (XME-21)

Second Priority List Hydrologic Restoration Project
of the Coastal Wetlands Planning, Protection, and Restoration Act
(Public Law 101-646)

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INTRODUCTION

The Freshwater Bayou Wetlands (State project No. ME-04, Federal project No. XME-21) project area comprises 33,292 acres (13,317 ha) of fresh, intermediate, and brackish marsh located between La. Hwy. 82, Schooner Bayou (old Intracoastal Waterway), Freshwater Bayou Canal (FBC), and Acadiana Marina Canal, approximately 5 mi east of White Lake in southeast Vermilion Parish, Louisiana (figure 1). Most of the project area is owned by Exxon Corporation and includes a number of oilfield canals and oil and gas production facilities, some of which are still active. The surface of Exxon's holdings are managed by Vermilion Corporation for fish and wildlife habitat, particularly for harvesting alligators (*Alligator mississippiensis*) and furbearers and waterfowl hunting. The northeast corner of the project area is managed for white-tailed deer (*Odocoileus virginianus*) habitat by the Schooner Bayou Hunting Club.

The hydrology in this general area has been dramatically altered by the construction of numerous oil and gas access canals since the 1950's and the construction of FBC in the 1960's. Channelization has increased tidal exchange in these historically low-energy, fresh marshes, which are borne on highly-erodible organic soils of the Allemands, Banker, and Larose series (U.S. Department of Agriculture, Natural Resources Conservation Service [USDA-NRCS] 1996b). Continuous spoil banks constructed along the banks as the canals were dug have provided a barrier against rapid tidal exchange and salt water intrusion into the project area marshes. However, boat wake–induced shoreline erosion, which averaged 12.5 ft/yr along each bank of FBC between 1968 and 1992 (Brown & Root 1992), has deteriorated the spoil banks along the channel, creating multiple breaches which allow tidal scour of the organic soils in the adjacent wetlands. Between 1968 and 1990, the bank width of this navigation canal increased from 172 ft to 583 ft, resulting in the loss of 1,124 acres of coastal wetlands due to bank erosion (Good et al. 1995). This has impacted the ME-04 project area which is bordered along most of its eastern edge by the spoil bank along the west side of the FBC channel. Marshes along FBC also have shifted from fresh towards intermediate and brackish marsh communities as a result of the influence of increased tidal exchange of saline water associated with the loss of spoil banks along the canal.

Wetlands in the project area also appear to be adversely affected by the influence of the Grand/White Lake system to the west, where elevated water levels are artificially maintained year-round by several locks and water control structures for navigation and agricultural purposes (Louisiana Wetland Conservation and Restoration Task Force [LWCRTF] 1993, USDA-NRCS 1997). The flow of freshwater from the Grand/White Lake system into the project area from the west through culverts under La. Hwy. 82 and through natural openings along Schooner Bayou west of Schooner Bayou Lock is believed to contribute to "ponding" and the conversion of emergent marsh to open water, particularly in the southern half of the project area. However, this flow also provides a freshwater "head" that helps to buffer saltwater intrusion from the FBC and Schooner Bayou east of Schooner Bayou Lock.

The estimated rates of subsidence and sea level rise in the project area, which are 0.33 cm/yr and 0.64 cm/yr, respectively (Penland et al. 1989), are relatively low, but they do contribute to ponding in the project area by effectively increasing tidal amplitude. Because sediment input into the project

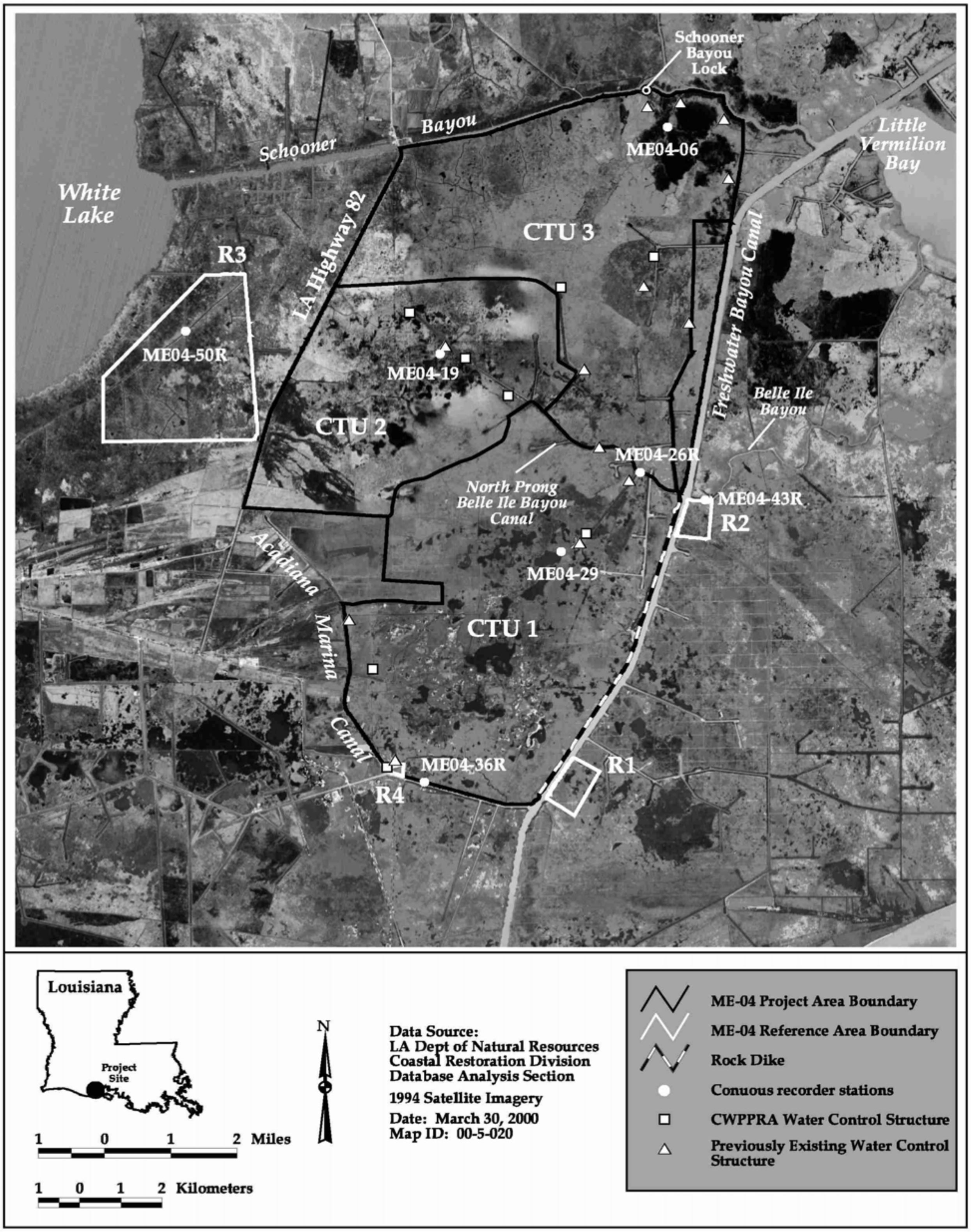


Figure 1. Freshwater Bayou Wetlands (ME-04) project area map showing locations of CTUs, reference areas, 13 existing and 8 CWPPRA water control structures, and 7 continuous data recorder monitoring stations.

area is very low, its organic marshes rely mainly on the production and accumulation of organic matter to overcome losses in elevation due to subsidence and sea level rise. Based on recent studies of the importance of organic matter accumulation to vertical accretion (Nyman et al. 1993), any reduction in plant productivity would be expected to increase the rate of marsh loss in the project area. Physiological stresses on vegetation associated with soil waterlogging during periods of prolonged high water levels (Mendelssohn and McKee 1988) have likely contributed to wetland loss in the project area through vegetation die-back, ponding, and shifts to marsh communities with reduced primary productivity and reduced fish and wildlife value.

Vermilion Corporation currently operates and maintains 9 water control structures and the Vermilion Parish Police Jury operates and maintains 2 water control structures to manage salinity and water levels inside the project area. All 11 structures are located in embankments of canals included within the project area or along its perimeter (figure 1). In addition, the U.S. Army Corps of Engineers (USACE) maintains Schooner Bayou Lock (figure 1), located on the north side of the project area, and Freshwater Bayou Lock, located south of the project area near the confluence of FBC and the Gulf of Mexico, as salinity barriers for the east side of the Mermentau River Basin, which includes the ME-04 project area.

The first objective of this restoration project is to prevent further widening of the FBC channel into the project area. To achieve the specific goal of decreasing the rate of erosion and wetland loss in the project area adjacent to the canal, approximately 28,000 linear ft (8.5 km) of free-standing, continuous rock dike were constructed along the west bank of the canal (figure 2). Construction of the dike (phase 1) began in October 1994 and was completed in January 1995.

The second objective is to lower water levels or reduce the frequency and duration of marsh inundation in the project area, in an effort to manage water levels to mimic natural conditions and reduce “ponding” in the southern half of the project area. The specific goals of increasing the occurrence of emergent marsh in the project area and maintaining salinity within the target range suitable for the growth of fresh to intermediate marsh (0-5 ppt) will be achieved through active and passive management of water and salinity levels using the 11 existing water control structures, along with 8 additional structures installed by Vermilion Corporation as phase 2 of this restoration effort (figure 1). Each of the new water control structures consists of a wooden box with 25 linear ft (7.6 m) of variable crest weirs along three sides of the box (marsh side)and a square, wooden flapgate (canal side) designed to leave a 2-inch (5.1-cm) horizontal opening between the bottom of the wooden box and the bottom lip of the flapgate when it is fully closed (figure 3). These were constructed at 3 sites along the perimeter of the project area, and 5 sites along canals in the center of the project area that are connected to FBC (figure 1) to increase capacity to move water out of and into the project area. Construction began in January 1998 and was completed in October 1998. Operation of all eight of these new Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) structures began in October 1998.

The project plan (USDA-SCS 1994, USDA-NRCS 1996a) divides the ME-04 project area into three Conservation Treatment Units (CTU's), two of which benefit directly from the shoreline protection work implemented under Phase 1 on the project.

Figure 2. Photo of the Freshwater Bayou Canal channel between CTU 1 (left side) and reference area R2 (right side) showing part of the ME-04 rock dike, deteriorated spoil banks, and ponded areas in the marsh along both sides of the channel.

Figure 3. Photo of CWPPRA structure 6 in CTU 1 of the ME-04 project area taken just after installation in March 1998.

The southernmost unit, CTU 1, consists of 13,800 acres (5,585 ha) of predominantly fresh marsh with zones of intermediate and brackish marsh along its eastern and southern boundaries (figure 1). It is dominated by *Sagittaria lancifolia* (bulltongue) and *Spartina patens* (saltmeadow cordgrass), and is managed for waterfowl, alligators, furbearers, and fisheries. Ponds range in depth from 1.7-2.0 ft (0.52 - 0.61 m), and many support aquatic plants, including *Myriophyllum spicatum* (spike watermilfoil), *Ceratophyllum demersum* (coontail), *Najas guadalupensis* (common waternymph),and *Nymphaea elegans* (tropical royalblue waterlily). This unit also includes a segment of the old Freshwater Bayou channel along its southern boundary, which is slightly deeper than the ponds, ranging from 1-4 ft deep. This channel generally supports an abundance of *Chara* sp. (muskgrass), *Ceratophyllum demersum*, and *Najas guadalupensis*, serves as a nursery for fisheries, and provides a feeding area for American alligator and alligator gar (*Lepisosteus spatula*). The Phase 1 dike now protects the eastern edge of CTU 1 from wave erosion and to a lesser extent, salt water intrusion from Freshwater Bayou Canal. To augment the water management capability of the four existing water control structures in this unit, three of the CWPPRA structures described above were installed along the perimeter of CTU 1 (figure 1).

Located in the west-central portion of the project area (figure 1), CTU 2 consists of 9,300 acres (3,764 ha) of fresh marsh dominated by *Sagittaria lancifolia, Sacciolepis striata* (American bagscale), *Echinochloa walteri* (water millet), and *Panicum hemitomon* (maidencane), with scattered of large colonies of *Salix nigra* (black willow), *Phragmites australis* (common reed) and *Typha latifolia* (common cattail). This unit is managed for waterfowl, alligators, furbearers, and fisheries. It also supports a small deer herd. Pond depths range from 1.7-2.3 ft (0.52-0.70 m), and many support aquatic plants, mainly *Nelumbo lutea* (American lotus), *Najas guadalupensis*, *Ceratophyllum demersum*, and *Nymphaea odorata* (white waterlily). Three CWPPRA structures were installed in CTU 2 to augment the water management capability of the one existing water control structure located in this unit (figure 1).

The northern section of the project area comprises CTU 3, which consists of 13,800 acres (5,585 ha) of predominantly fresh marsh dominated by *Sagittaria lancifolia*, *Sacciolepis striata*, *Panicum hemitomon, Leersia hexandra* (southern cutgrass), and *Echinochloa walteri*, with a band of intermediate marsh dominated by *Spartina patens, Scirpus americanus* (Olney's bulrush), and *Spartina cynosuroides* (giant cordgrass) along its eastern boundary. This unit is managed for waterfowl, alligators, deer, and furbearers. Pond depths range from 2.2-3.0 ft (0.67 - 0.91 m) in CTU 3, and many support the growth of aquatic plants, with those in the west side of this unit often covered with floating mats of *Hydrocotyle ranunculoides* (floating water pennywort), *Eichhornia crassipes* (water hyacinth), and *Salvinia minima* (water spangle). Two CWPPRA structures were installed in CTU 3 to augment water management capability provided by the six existing water control structures (figure 1) in this unit.

The eight CWPPRA structures are being operated in accordance with the operational schedule included in the USACE and LDNR/CMD permits issued for the ME-04 project. This water management scheme includes the following elements.

1. Spring drawdown phase. From January 15 to June 1, water levels inside the project area may be drawn down to a target water level of 12 inches (30 cm) below marsh elevation to encourage the growth of emergent plants. If a drawdown does not seem feasible by April 15 this phase is to be terminated and tried again the following year. After a successful drawdown is achieved, another drawdown will not be attempted until the third year after the successful drawdown.

2. Maintenance phase. For time periods other than drawdowns, the CWPPRA structures will be set to achieve a target water level of 6 inches (15 cm) below marsh elevation.

3. Standard safety features. Authorization is provided to modify structure operations following heavy rainfall, storm events, and salinity surges to preserve the integrity of the management system and so that the objectives of this restoration project are not compromised. Specifically,

    a. CWPPRA structures 2, 3, 4, 5, 6 and 7 will be closed when salinity exceeds 4.0 ppt in the exterior canals.

    b. CWPPRA structures 1 and 8 will be closed when salinity exceeds 8.0 ppt in the exterior canals.

    c. All eight CWPPRA structures will be opened when the water level inside the project area exceed 10 inches (25 cm) above marsh elevation.

To assist in evaluating project effectiveness over time, reference areas 1, 2, and 3 (figure 1) were approved to be monitored concurrently with the project area. When subsequent field work revealed that the southwest corner of CTU 1 is outside of the unit's perimeter embankment and thus un-managed, the area was teased out of CTU 1 and now serves as reference area R4 (figure 1). These four reference areas are each similar to one section or another of the much larger, and more diverse ME-04 project area in terms of soils, hydrology, and vegetation. Data collected within the project and reference areas will be used to make statistically valid comparisons of what the shoreline erosion rate, marsh loss rate, vegetation, salinity, and water level would be in the project area with and without this restoration project.

METHODS

A detailed description of the monitoring design to be used over the entire project life can be found in the revised project monitoring plan (Louisiana Department of Natural Resources [LDNR]1998). A general overview of the LDNR's standard monitoring procedures is provided in Steyer et al. (1995).

Habitat mapping: At the U.S. Geological Survey's National Wetlands Research Center (NWRC), 1:24,000 scale color infrared aerial photography was classified and photointerpreted to measure land/water ratios and map habitat types in the project and reference areas. Preconstruction photography was obtained January 11, 1997.

To determine land-to-water ratios, aerial photographs were scanned at 300 pixels per inch and georectified using ground control data collected with a global positioning system (GPS) capable of submeter accuracy. These individually georectified frames were then mosaicked together to produce a single image of the project and reference areas. Using geographic information system (GIS) technology, the photomosaic was classified according to pixel value and analyzed to determine land-to-water ratios in the project and reference areas. All areas characterized by emergent vegetation were classified as land, while open water, aquatic beds, and mud flats were classified as water. An accuracy assessment comparing the GIS land-water classification of 100 randomly chosen pixels to aerial photography determined an overall classification accuracy of 93.5%.

Using the National Wetlands Inventory (NWI) classification system (Cowarden et al. 1979), which identifies habitat types by system, subsystem, class, and subclass, the photography was photointerpreted by NWRC personnel and classified to the subclass level. The habitat delineations were transferred to 1:12,000 scale Mylar base maps, digitized, and checked for quality and accuracy.

When describing both upland and wetland habitats, the term "scrub-shrub" refers to woody vegetation less than 20 ft (6 m) in height. The term "forested" refers to woody vegetation taller than 20 feet. Where more than one class of vegetation exists, the uppermost layer of vegetation with canopy cover greater than 30% determines the NWI habitat type. For example, a habitat where canopy cover consists of 60% emergent marsh and 40% scrub-shrub would be classified as scrub-shrub because the scrub-shrub vegetation provides the uppermost canopy layer.

<u>Shoreline change</u>: In an effort to establish a more permanent set of shoreline markers and survey hubs than those installed by CRD personnel in 1995 (Vincent 1996) and reestablished in 1996 (Vincent 1998, Vincent and Sun 1997), a professional surveyor was contracted to conduct the 1997 shoreline marker survey. In September 1997 CRD personnel established a new shoreline marker at each of the 33 monitoring stations, 27 along the FBC shoreline behind the ME-04 rock dike, and six along the opposing bank, with three along the reference area R1 shoreline and three along the reference area R2 shoreline (figure 4). Shoreline position was delineated using either the vegetated edge of the bank (VEB) or the vertical face of the escarpment along the bank. The surveyor completed his survey in February 1998 using differential global positioning system (DGPS) survey equipment. Deliverables included establishment of a set of permanent monuments on the marsh side of the remaining FBC spoil bank at each of the 33 monitoring stations with DGPS coordinates for each; DGPS coordinates for the shoreline markers established by CRD personnel in September 1997, and DGPS-derived measurements of the distance from the permanent monuments to the 1997 shoreline markers, adjusted mathematically to make them comparable to the data collected by direct measurement in 1996.

<u>Water quality:</u> Water quality data were collected using YSI Model 6000 continuous data recorders established at seven (7) monitoring stations, one in each of the project area CTUs, and reference areas (figure 1). Water level (ft), water salinity (ppt), temperature (°C), and specific conductance ($\mu S/cm^2$) were recorded hourly at each station. Error in the salinity and water level data due to biofouling of recorder sensors was calculated using discrete specific conductance and water level readings taken with the recorders *in situ* prior to cleaning the sensors. The "dirty" specific

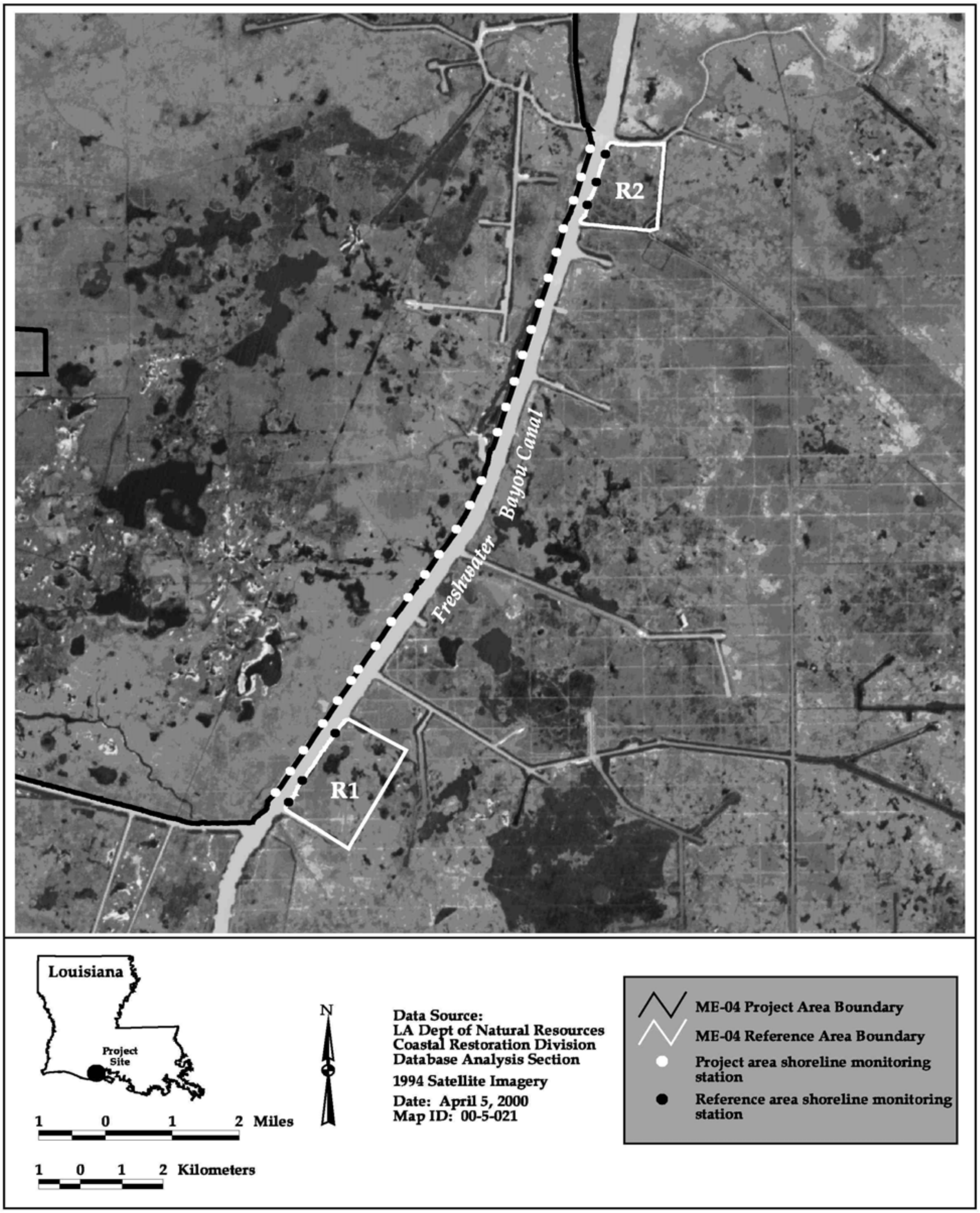


Figure 4. Approximate locations of the shoreline monitoring stations established along Freshwater Bayou Canal adjacent to CTU 1 of the ME-04 project area and reference areas R1 and R2.

conductance readings were then compared to "clean" readings taken simultaneously using a calibrated YSI Model 30 salinometer. Each "dirty" water level reading was compared to a "clean" water level reading taken with the same recorder *in situ* after its sensors were cleaned and its depth sensor recalibrated to 0.00 ft out of water. For each data file in which the percent difference in "clean" and "dirty" readings exceeds 5%, a linear shift was applied to correct for biofouling error.

Each data file was then purged of erroneous or faulty readings prior to calculating weekly mean salinity and weekly mean water level for each recorder station. Missing data are due to the removal of faulty data, which are collected periodically at several stations when low water levels cause the recorder sensors to become temporarily exposed out of the water, or due to instrument malfunction. The period of record for the weekly mean salinity data presented here is April 1996 through September 1999. The period of record for the weekly mean water level data is April 1997 through September 1999.

Discrete monthly salinity and water depth were also measured at 49 monitoring stations (including the seven recorder stations), 30 located inside the project area and 19 located outside the project area (in reference areas R2 and R3, and in exterior canals at two recorder stations and the eight CWPPRA structures). Staff gauge water level readings (ft) were also recorded monthly at the seven continuous recorder stations, inside and outside of the eight CWPPRA structures, and at the Vermilion Corporation boat house near reference area R2. Salinity and water level readings taken by the USACE inside and outside of Schooner Bayou Lock were also recorded once a month during the same week that monthly discrete data were collected by CRD personnel. The discrete monthly salinity data were used to calculate a mean monthly salinity for the preconstruction (March 1996 through September 1998) and postconstruction (October 1998 through September 1999) periods of record at each station.

Emergent vegetation: In September 1996, emergent vegetation was monitored using 2.0 m^2 sampling plots at 27 monitoring stations established uniformly across the project area along six east-west transects, at three stations along one southwest-northeast transect line in reference area R2, and at six stations along three east-west transects in reference area R3. Two additional stations were established along one east-west transect in reference area R4 in June 1997. To assist in relocating the stations over time, a compass was used to orient the plots and a steel or PVC pole was placed in the southeast corner of each plot. DGPS coordinates for these corner poles were then recorded. Due to the long time interval between completion of construction for phase 1 and phase 2, a second preconstruction data set was collected at each station in October 1998. For the four plots established in 1996 that could not be reasonably relocated in 1998, a new 2.0 m^2 plots was established in the vicinity of each missing plot. At each station, percent cover, dominant plant heights, and species composition were documented in the 2.0 m^2 sampling plots.

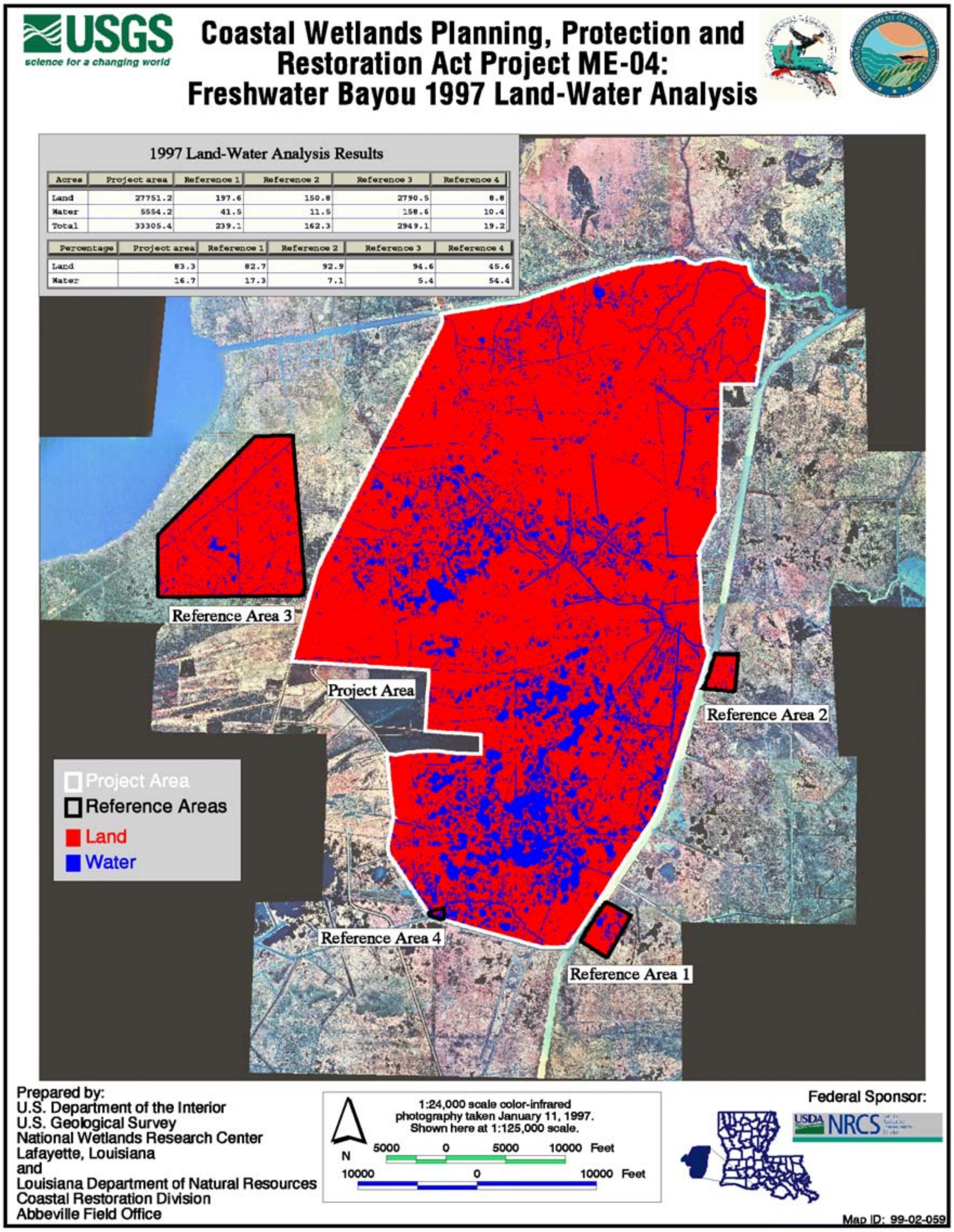
RESULTS

Habitat mapping: Preconstruction land and water areas in the project and reference areas are summarized in table 1 and illustrated in figure 5.

Table 1. Ratios and percentages of land to water in the ME-04 project and reference areas, based on GIS interpretations of infrared aerial photography taken preconstruction, on January 11, 1997.

Habitat Type	Project Area		Reference Area R1		Reference Area R2		Reference Area R3		Reference Area R4	
	Area ac (ha)	%	Area ac (ha)	%	Area ac (ha)	%	Area ac (ha)	%	Area ac (ha)	%
Land	27751.2 (11101.5)	83.3	197.6 (79.04)	82.7	150.8 (60.3)	92.9	2790.5 (1116.2)	94.6	8.8 (3.5)	45.6
Water	5554.2 (2221.7)	16.7	41.5 (16.6)	17.3	11.5 (4.6)	7.1	158.6 (63.4)	5.4	10.4 (4.2)	54.4
Total	33305.4 (13322.2)	100.0	239.1 (95.6)	100.0	162.3 (64.9)	100.0	2949.1 (1179.6)	100.0	19.2 (7.7)	100.0

The GIS analysis of the digital NWI habitat data derived from photointerpretation of the 1997 aerial photography indicates that the western half of the project area and reference area R3 are comprised of fresh marsh, the eastern and southern sections of the project area, and reference areas R1 and R2 are comprised of intermediate marsh, and the south-central section of the project area and reference area R4 are comprised of brackish marsh (figure 6). The classification of habitat types observed is listed in table 2.



Acres	Project area	Reference 1	Reference 2	Reference 3	Reference 4
Land	27751.2	197.6	150.8	2790.5	8.8
Water	5554.2	41.5	11.5	158.6	10.4
Total	33305.4	239.1	162.3	2949.1	19.2

Percentage	Project area	Reference 1	Reference 2	Reference 3	Reference 4
Land	83.3	82.7	92.9	94.6	45.6
Water	16.7	17.3	7.1	5.4	54.4

Figure 5. Preconstruction land to water relationships in the Freshwater Bayou Wetlands (ME-04) project and reference areas, based on 1997 aerial photography.

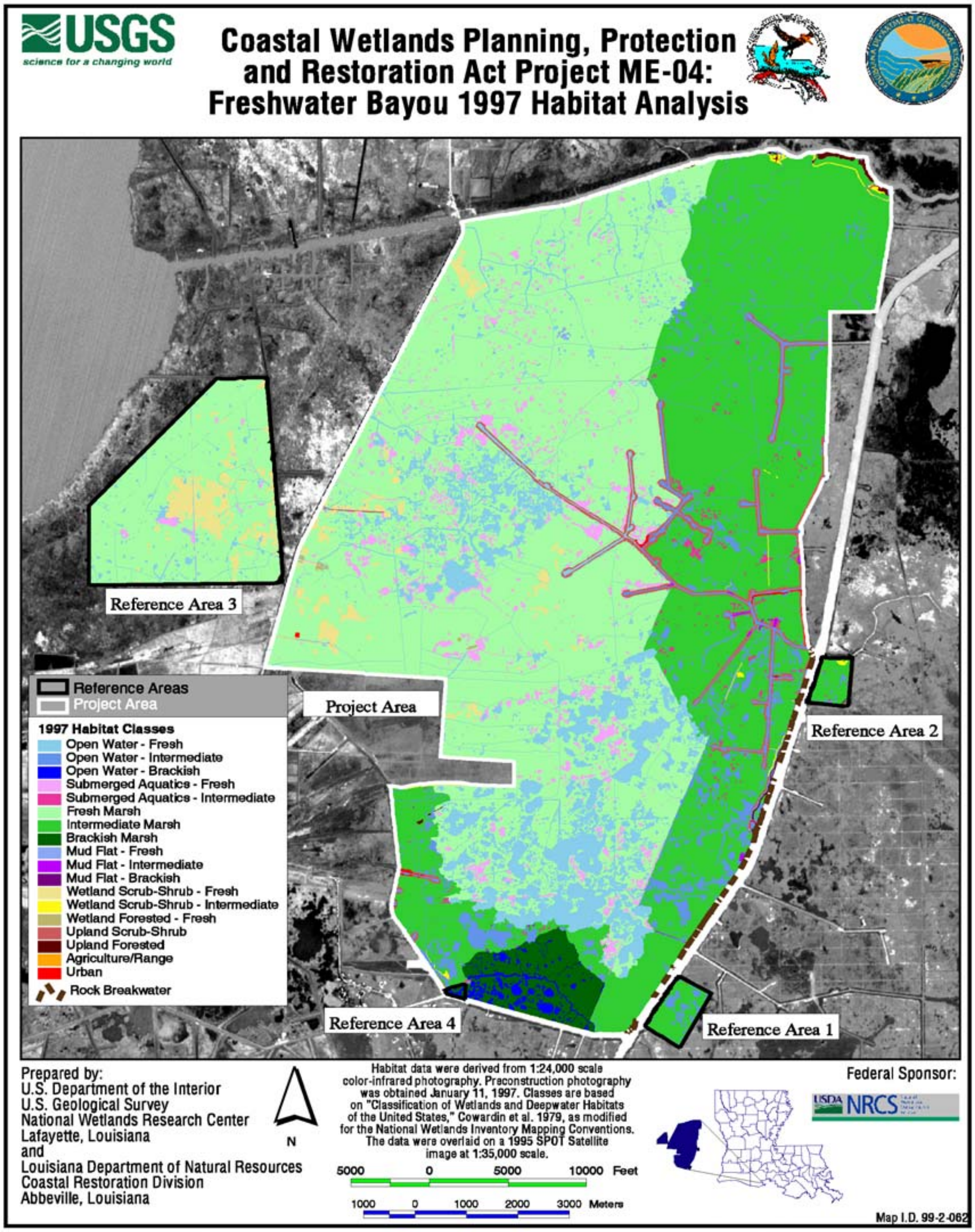


Figure 6. Preconstruction distribution of habitat types in the Freshwater Bayou Wetlands (ME-04) project and reference areas, based on 1997 aerial photography.

Table 2. Classification and acreage of the habitat types in the ME-04 project and reference areas, based on photointerpretation and GIS analysis of aerial photography taken preconstruction, on January 11, 1997.

Habitat Class	Project Area	Reference Areas			
		R1	R2	R3	R4
Open Water - Fresh	2,719.1	0.0	0.0	110.3	0.0
Open Water - Intermediate	1,174.7	38.4	9.9	0.0	1.1
Open Water - Brackish	181.9	0.0	0.0	0.0	7.8
Submerged Aquatics - Fresh	726.7	0.0	0.0	27.7	0.0
Submerged Aquatics Intermediate	68.5	0.0	0.9	0.0	0.0
Fresh Marsh	15,945.9	0.0	0.0	2,451.4	0.0
Intermediate Marsh	10,688.3	190.3	132.1	0.0	0.0
Brackish Marsh	705.9	0.0	0.0	0.0	7.0
Mud Flat - Fresh	11.1	0.0	0.0	0.0	0.0
Mud Flat - Intermediate	25.7	0.0	0.0	0.0	0.0
Mud Flat - Brackish	0.2	0.0	0.0	0.0	0.0
Wetland Scrub-Shrub - Fresh	266.5	0.0	0.0	327.9	0.0
Wetland Scrub-Shrub - Intermediate	33.4	0.0	3.8	0.0	0.0
Wetland Forested - Fresh	10.6	0.0	0.0	0.0	0.0
Upland Scrub-Shrub	598.6	9.9	0.0	22.6	2.8
Upland Forested	81.3	0.0	14.9	6.1	0.0
Agriculture/Range	21.0	0.0	0.0	0.0	0.2
Urban	33.0	0.0	0.3	0.0	0.0
TOTAL	**33,291.8**	**238.6**	**161.9**	**2,946.0**	**18.9**

<u>Shoreline change:</u> The project area shoreline prograded an average of 2.17 ft/yr (0.66 m/yr) between June 1995 and July 1996, and an average of 0.70 ft/yr (0.21 m/yr) between August 1996 and February 1998 (table 3). For the two periods combined (June 1995 to February 1998), the average rate of shoreline progradation was 1.53 ft/yr (0.47 m/yr).

Table 3. Shoreline changes at the project area monitoring stations along the west bank of Freshwater Bayou Canal behind the ME-04 rock dike between June 12, 1995 and February 11, 1998. Stations and settlement plates numbered from north to south.

Station No.	SP No.	1995-1996 Shoreline Change Rate (ft/yr)	1996-1998 Shoreline Change Rate (ft/yr)	1995-1998 Shoreline Change Rate (ft/yr)
ME04-66	1	1.24	-0.09	0.45
ME04-67	2	1.48	1.59	1.54
ME04-68	3	-0.37	na	na
ME04-69	4	0.00	0.00	0.00
ME04-70	5	5.00	0.25	2.17
ME04-71	6	0.00	0.00	0.00
ME04-72	7	3.61	-1.78	0.41
ME04-73	8	12.78	-1.02	4.55
ME04-74	9	1.30	na	na
ME04-75	10	10.65	-1.40	3.47
ME04-76	11	5.56	-1.40	1.42
ME04-77	12	-0.83	-0.76	-0.78
ME04-78	13	-0.37	0.25	0.00
ME04-79	14	-0.37	na	na
ME04-80	15	0.00	na	na
ME04-81	16	0.00	na	na
ME04-82	17	1.20	1.78	1.54
ME04-83	17a[a]	0.83	1.40	1.16
ME04-84	17b[a]	2.50	1.02	1.60
ME04-85	17c[a]	2.59	0.64	1.42
ME04-86	17d[a]	1.20	14.97	9.25
ME04-87	18	-0.28	na	na
ME04-88	19	4.72	-0.57	1.57
ME04-89	20	-0.19	0.13	0.00
ME04-90	21	7.59	0.70	3.47
ME04-91	22	-0.74	0.51	0.00
ME04-92	23	-0.56	-1.59	-1.16
	N:	27	21	21
	Time Period (yrs):	1.08	1.57	2.68
	Mean:	+2.17	+0.70	+1.53

SP=opposing settlement plate on ME-04 rock dike

[a]Rock dike section without settlement plates. Established 4 transects, referenced to "X" painted on large boulders at ±1,000-ft intervals, and numbered as settlement plates 17a-17d.

Conversely, between April 1995 and July 1996, erosion occurred at all six reference area monitoring stations (table 4) at an average rate of 6.69 ft/yr (2.04 m/yr), and between August 1996 and February 1998 they eroded at an average rate of 11.15 ft/yr (3.40 m/yr). Between June 1995 and February 1998, the reference area shoreline eroded at an average rate of 9.17 ft/yr (2.80 m/yr).

Table 4. Shoreline changes at the reference area monitoring stations along the east bank of Freshwater Bayou Canal opposite the ME-04 project rock dike from April 27, 1995 to February 13, 1998. Stations numbered from north to south.

Station No.	Ref. Area No./ Settlement Plate No.	1995-1996 Shoreline Change Rate (ft/yr)	1996-1998 Shoreline Change Rate (ft/yr)	1995-1998 Shoreline Change Rate (ft/yr)
ME04-93R	R2/1	-3.22	-39.36	-23.68
ME04-94R	R2/2	-5.76	-8.41	-7.22
ME04-95R	R2/3	-5.25	-4.33	-4.69
ME04-96R	R1/20	-1.61	-3.50	-2.67
ME04-97R	R1/22	-8.43	-8.66	-8.50
ME04-98R	R1/23	-15.89	-2.61	-8.25
	N:	6	6	6
	Time Period (yrs)	1.18	1.57	2.77
	Mean:	-6.69	-11.15	-9.17

A t-test of the 1995 to 1998 shoreline change rates indicates that the shoreline change rate in the project area was highly significantly different than that in the reference areas ($p < 0.0001$) for this time period. Thus, the ME-04 project rock dike has significantly reduced wave erosion of the protected segment of canal bank during the first postconstruction year and is currently meeting its specific goal of reducing shoreline erosion along the west bank of Freshwater Bayou Canal.

Water salinity: Weekly mean water salinity (ppt) calculated using hourly data from the 7 continuous recorders (figure 1) shows that water salinity in the project area during the period of record generally fell within the target range for fresh to intermediate marsh, which is 0-5 ppt (figure 7). Deviations from this pattern appear to be associated with either periods of drought, when the reduced inflow of freshwater from White Lake and rainfall allows salinity to increase, or during periods of tropical storm activity, when extreme high tides and storm surges cause an inflow of higher salinity water into the project area through breeches in the perimeter embankments and over the tops of some structures. During these time periods, weekly mean water salinity can range from 5-11 ppt. Weekly mean water salinity during the winter and spring months of the postconstruction period was generally higher than during the winter and spring months of the preconstruction period due to the lingering effects of the Tropical Storm Francis storm surge and drought conditions during 1999. These same pattern hold true for the exterior canals surrounding the project area and for reference area R2 (figure 8). Water salinity in reference area R3 is generally less than 1 ppt, with only slight increases during periods of drought and tropical storm activity (figure 9).

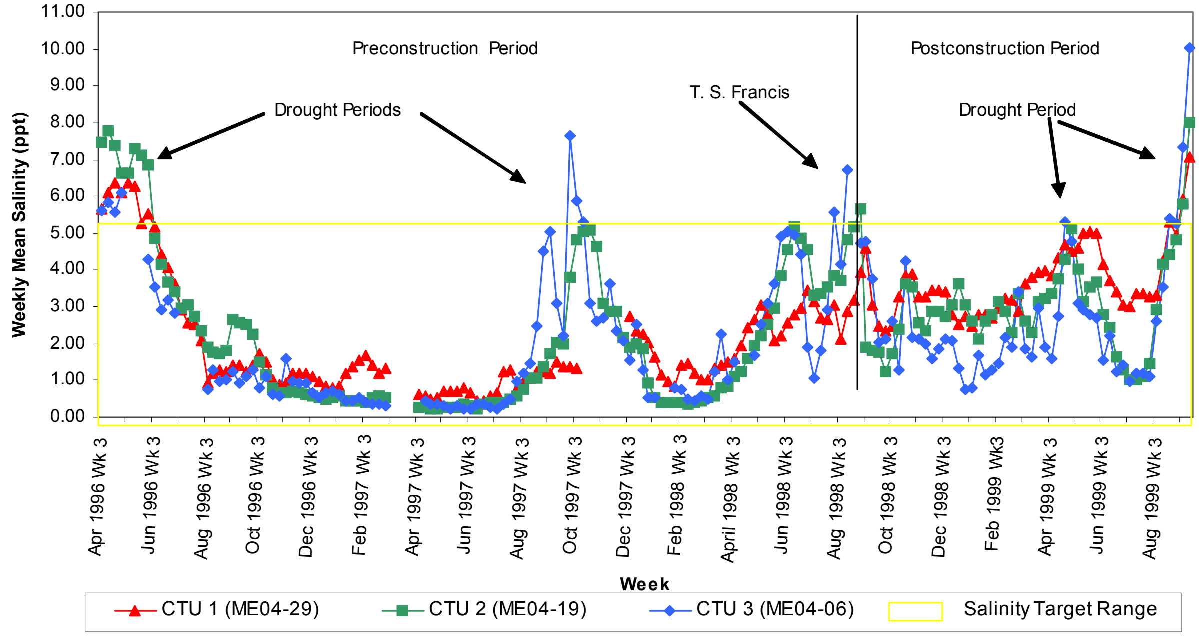


Figure 7. Weekly mean water salinity (ppt) in the ME-04 project area from April 1996 through September 1999, based on hourly data from continuous recorders located in CTU's 1,2, and 3 at stations ME04-29, ME04-19, and ME04-06, respectively. Data gaps represent time periods when recorders were out of service.

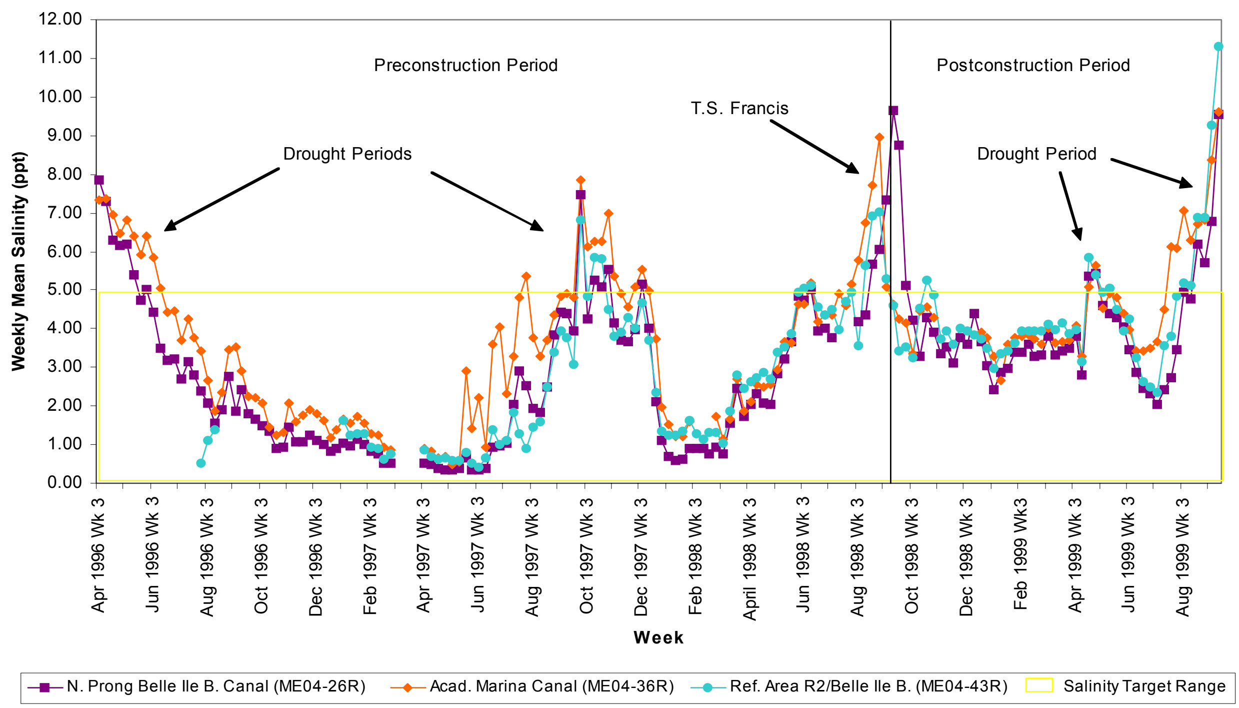


Figure 8. Weekly mean water salinity (ppt) in N. Prong Belle Isle Bayou Canal, Acadiana Marina Canal, and in the ME-04 reference area R2 access trenasse at its confluence with Belle isle Bayou , from April 1996 through September 1999, based on hourly data from continuous recorders located at stations ME0426R, ME04-36R, and ME04-43R, respectively.

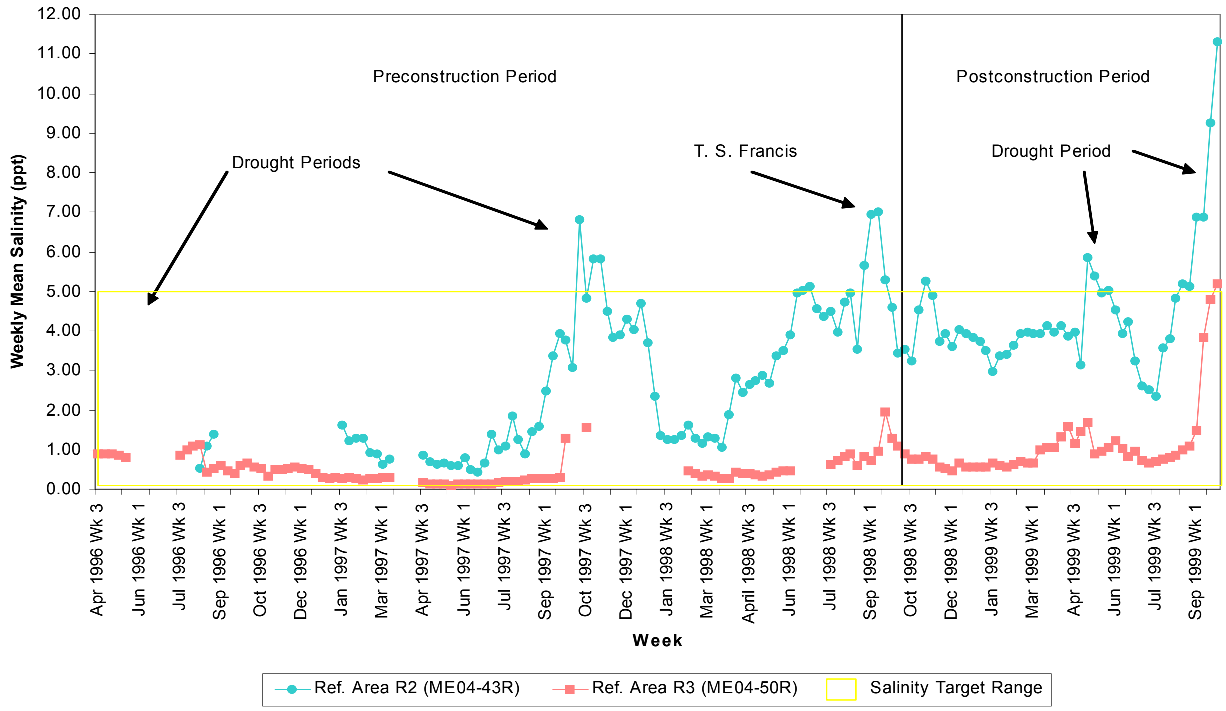


Figure 9. Weekly mean water salinity (ppt) in the ME-04 reference areas R2 and R3 from April 1996 through September 1999, based on hourly data from continuous recorders located at stations ME04-43R and ME04-50R, respectively. Data gaps represent time periods when the recorders were out of service.

Mean salinity (ppt) calculated from discrete monthly salinity data taken at monitoring stations throughout the project area, surrounding canals, and reference areas R2 and R3 clearly show a trend of increasing salinity from west to east both preconstruction (figure 10) and postconstruction (figure 11). The importance of Schooner Bayou Lock to maintaining freshwater in the western half of the project area, reference area R3, and eastern White Lake is clearly evident from the mean salinity values calculated using data collected by the USACE on the west and east sides if the lock. Higher mean salinities during the postconstruction period may be a result of the shorter period of record that began on the tail end of Tropical Storm Francis's storm surge and ended with the prolonged drought of 1999.

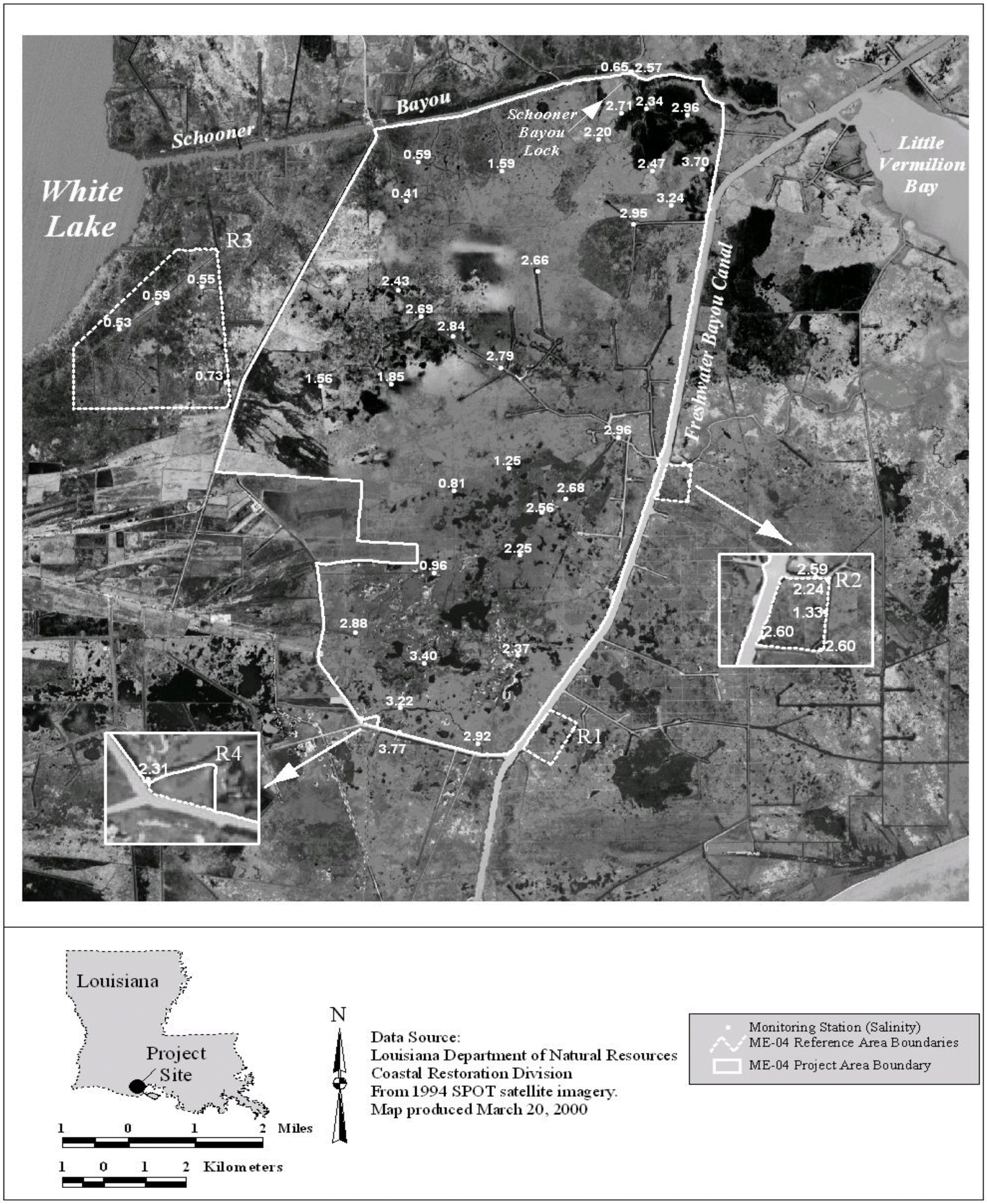


Figure 10. Mean monthly water salinity (ppt) at monitoring stations in the Freshwater Bayou Wetlands (ME-04) project and reference areas and surrounding canals, based on monthly discrete readings taken during the preconstruction monitoring period from March 1996 through September 1998.

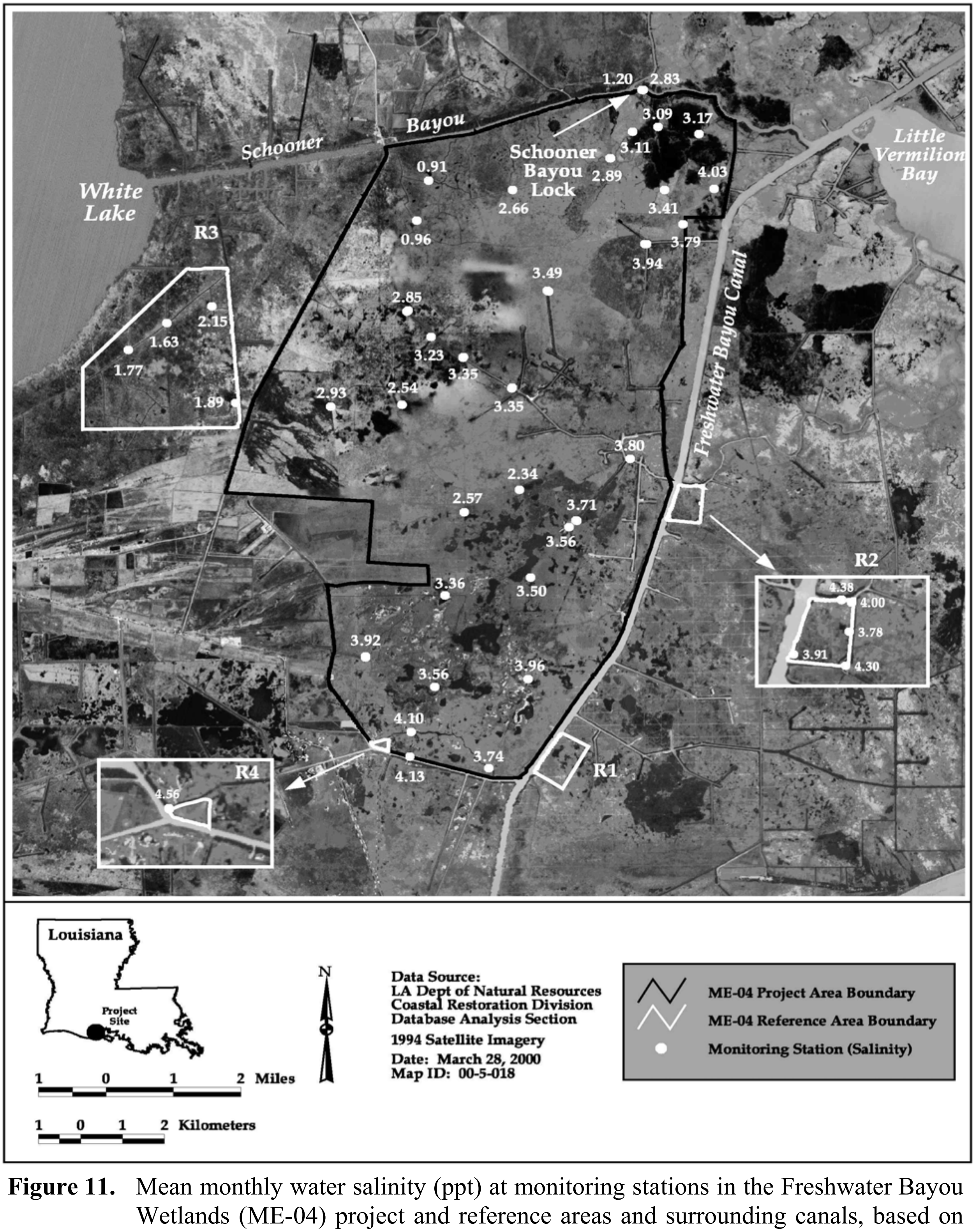


Figure 11. Mean monthly water salinity (ppt) at monitoring stations in the Freshwater Bayou Wetlands (ME-04) project and reference areas and surrounding canals, based on monthly discrete readings taken during the postconstruction monitoring period from October 1998 through September 1999.

Water level: Weekly mean water level (ft, relative to marsh elevation) calculated from hourly continuous recorder data shows that water level in CTU 1 of the project area (figure 12) generally fluctuated within the water level target range for fresh to intermediate marsh, which is 6 inches (15.2 cm) below to 2 inches (5 cm) above marsh elevation (figure 12). However, the weekly mean water level tended to remain above the target range for 1- to 5-week intervals, especially during the preconstruction period. Data from the CTU 2 recorder station (figure 13) shows that weekly mean water level in this unit generally fluctuated within the target water level range, but tended to remain above the target range for 1- to 8-week intervals, especially during the postconstruction period. Water level in the vicinity of the CTU 3 recorder station (figure 14) tended to fluctuate below the water level target range, usually falling between 6-12 inches (15.2-30.5 cm) below the marsh elevation recorded at this station. The pattern in the vicinity of the reference area R3 recorder station (figure 15) is similar to that of the CTU 1 recorder station (figure 12). Variation and fluctuation in water level is greatest in the vicinity of the recorder stations in the more tidally influenced canals surrounding the project area and in reference area R2 (figure 16), with the amplitude appearing to increase with increasing channel depth. This pattern is very similar to that seen at the CTU 3 recorder station (figure 14). Like water salinity, elevated water levels in the project and reference areas appear to be somewhat associated with extreme high tides and tropical storm activity.

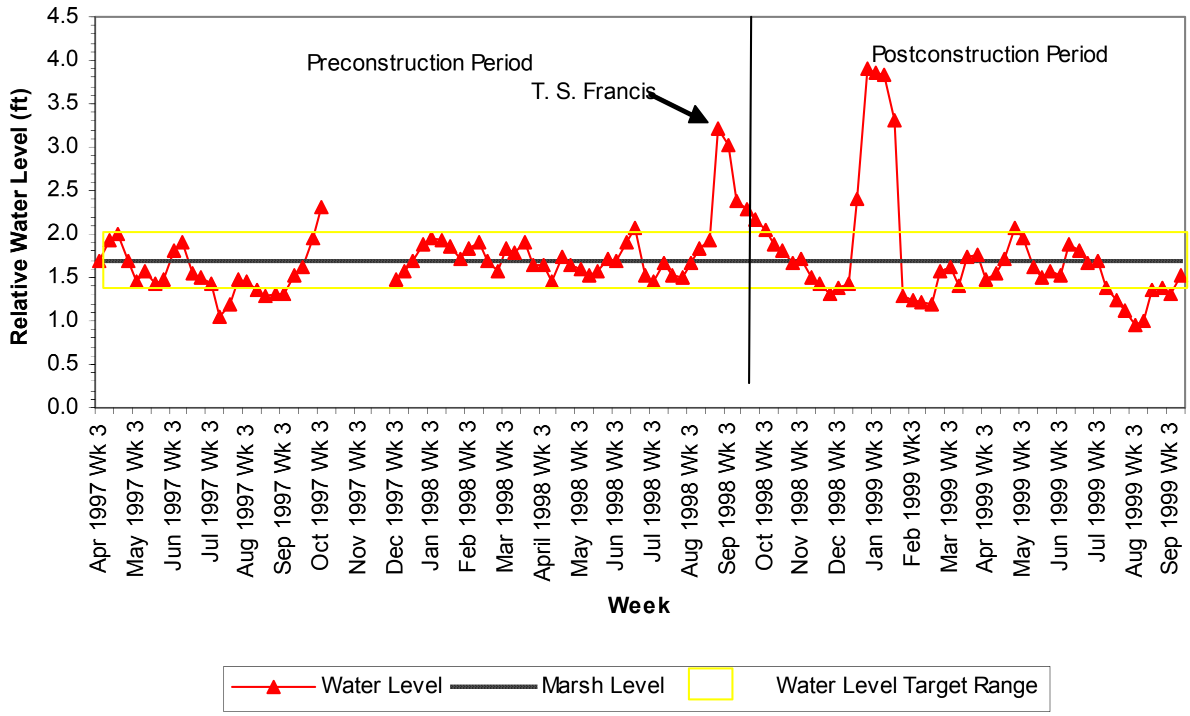


Figure 12. Weekly mean water level (ft) in relation to marsh level in CTU1 of the ME-04 project area, calculated from hourly data from a continuous recorder deployed at station ME04-29. Data gaps represent time periods when the recorder was out of service.

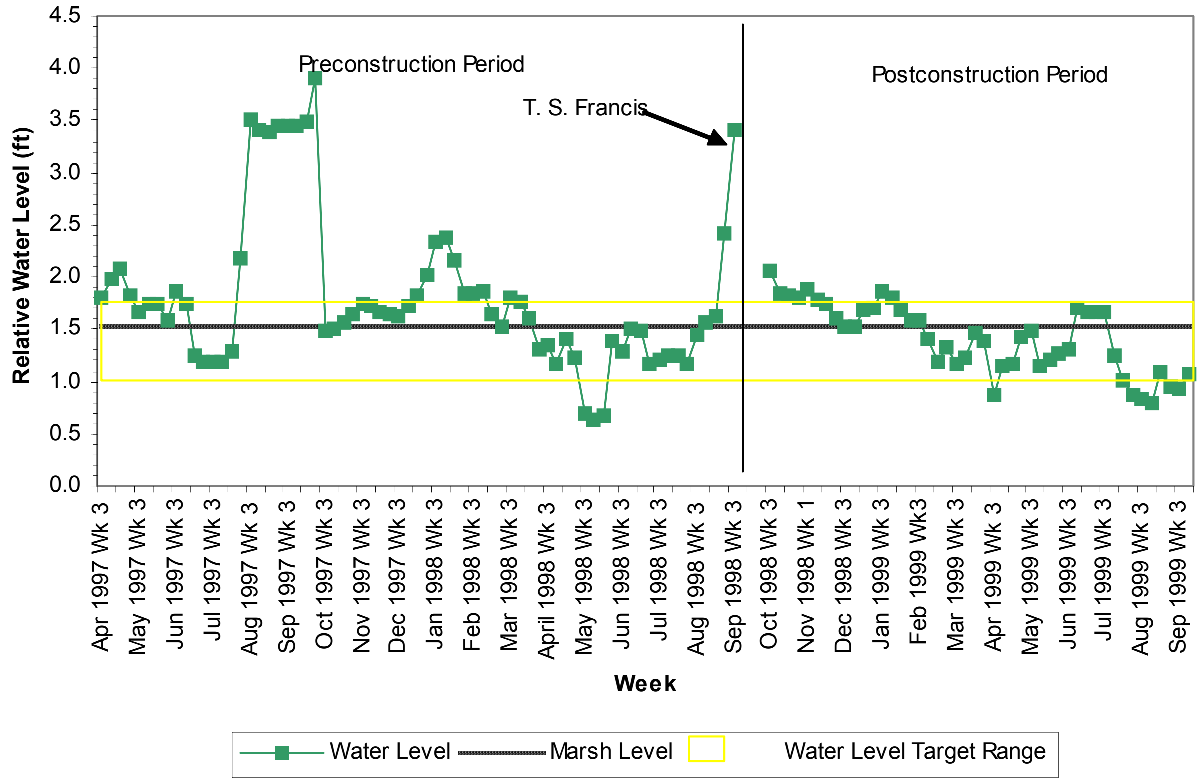


Figure 13. Weekly mean water level (ft) in relation to marsh level in CTU2 of the ME-04 project area, based on hourly data from continuous recorders deployed at station ME04-19. Data gaps represent time periods when the recorders were out of service.

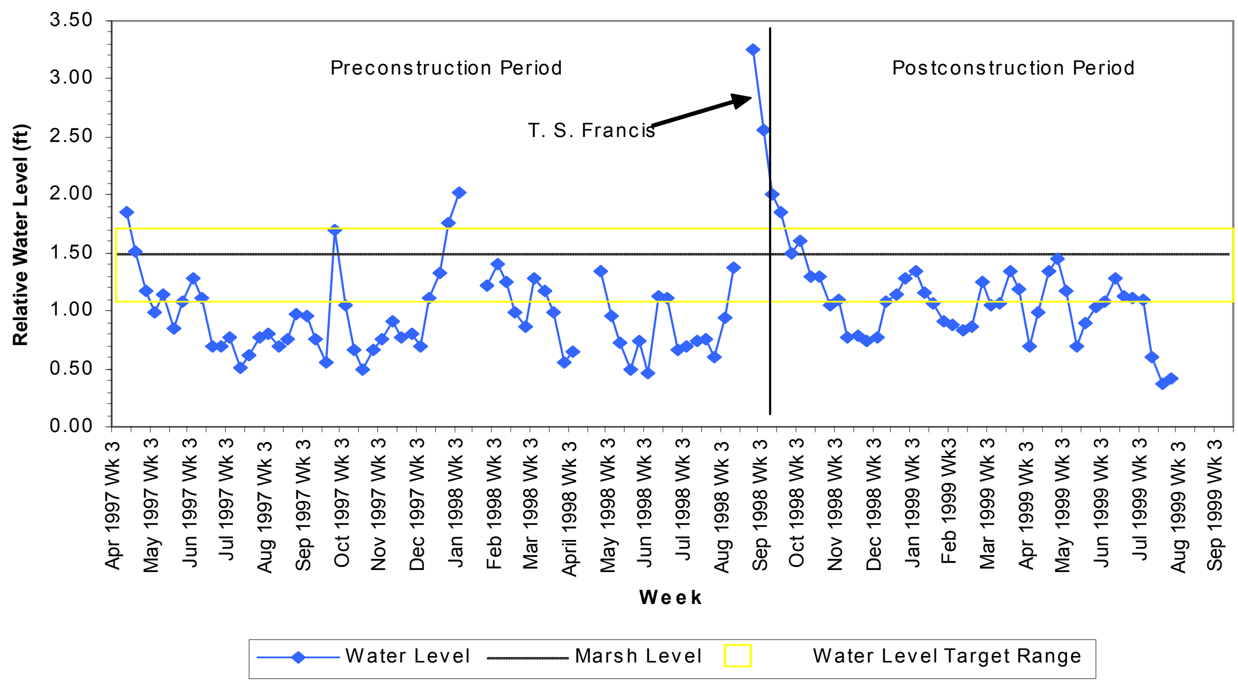


Figure 14. Weekly mean water level (ft) in relation to marsh level in CTU3 of the ME-04 project area, calculated from hourly data from a continuous recorder deployed at station ME04-06. Data gaps represent time periods when the recorder was out of service.

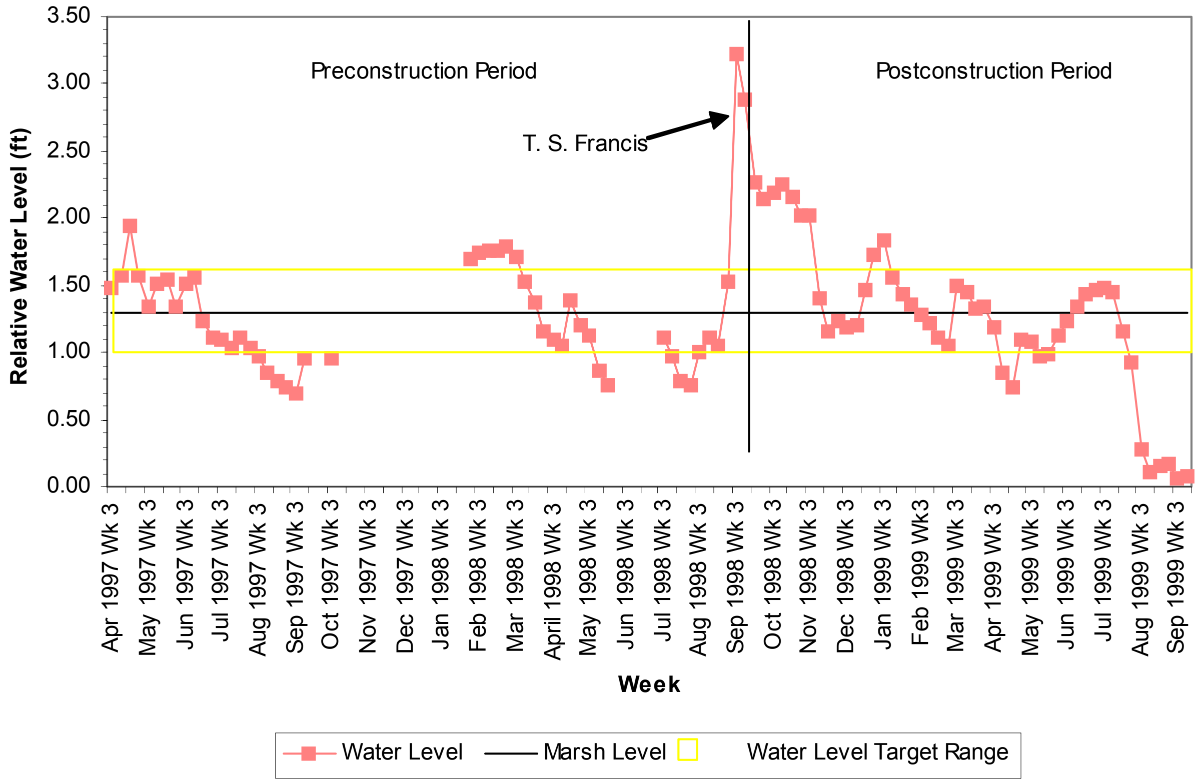


Figure 15. Weekly mean water level (ft) in relation to marsh level in reference area R3 of the ME-04 project area, based on hourly data from continuous recorders deployed at station ME04-50R. Data gaps represent time periods when recorders were out of service.

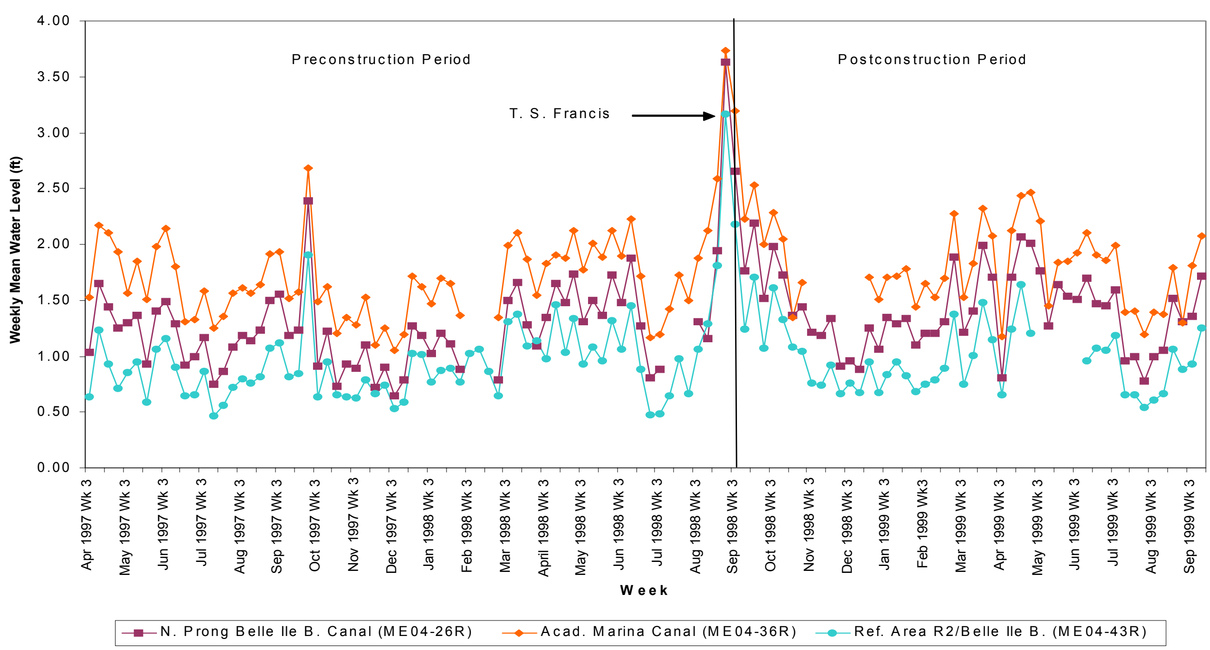


Figure 16. Weekly mean water level (ft) in N. Prong Belle Isle Bayou Canal, Acadiana Marina Canal, and in the ME-04 reference area R2 access trenasse at its confluence with Belle Isle Bayou, from April 1997 through September 1999, based on hourly data from continuous recorders located at stations ME04-26R, ME04-36R, and ME04-43R, respectively. Data gaps represent time periods when recorders were out of service.

<u>Emergent vegetation</u>: Marsh types observed at the 38 vegetation monitoring stations in September 1996 and October 1998 (figure 17) are consistent with marsh type zones determined by the GIS habitat analysis and photo-interpretation of the 1997 aerial photography (figure 6). The marsh at four stations in the eastern and southern sections of the project area and the three stations in reference area R2 were observed to be more intermediate or brackish in 1998 than in 1996. This trend is also consistent with the pattern of increasing water salinity from west to east across this area.

The species observed in the project and reference areas, along with their mean percent plot cover values by unit for 1996 and 1998 are presented in tables 5 through 10. Species richness in CTUs 1 and 3 of the project area (tables 5 and 7) and reference areas R2 and R3 (tables 9 and 10) was greater in 1996 than in 1998.

Comparison of the 1996 and 1998 vegetation data shows that the mean percent plot cover attributable to the dominant species involved changes noticeably in all three CTU's of the project area. In CTU 1 (table 5) plot cover provided by *Spartina patens*, *Sagittaria lancifolia*, and *Leersia hexandra* increased slightly, while *Typha latifolia* plot cover increased dramatically. Plot cover provided by *Sacciolepsis striata* decreased dramatically, while *Panicum hemitomon*, *Paspalum vaginatum*, and *Ipomoea sagittata* decreased slightly in plot cover. In CTU 2 (table 6) plot cover provided by *Panicum hemitomon* and *Sagittaria lancifolia* increased slightly, while *Spartina patens* and *Leersia hexandra* plot cover increased dramatically. Plot cover provided by *Echinochloa walteri*, *Panicum virgatum*, *Leptochloa fascicularis*, *Alternanthera philoxeroides*, and *Sesbania exaltata* decreased ramatically, while *Sacciolepis striata* plot cover decreased slightly. In CTU 3 (table 7) plot cover provided by *Juncus roemerianus*, *Scirpus americanus*, *Panicum hemitomon* and *Typha latifolia* increased slightly, while *Spartina patens* and *Panicum virginatum* plot cover increased dramatically. Plot cover provided by *Sagittaria lancifolia*, *Leersia hexandra*, *Sacciolepis striata*, *Polygonum punctatum* decreased dramatically, while *Ludwigia uruguayensis* decreased slightly in plot cover.

In reference area R4 (table 8) plot cover provided by *Spartina patens* and *Scirpus maritimus* decreased. In reference area R2 (table 9) plot cover provided by *Cyperus odoratus* increased slightly, while plot cover provided by *Spartina patens*, *Typha latifolia*, *Scirpus americanus*, *Sesbania exaltata*, *Bacopa monnieri*, and *Cyperus polystachyos* var. *filicinus* decreased dramatically. In reference area R3 (table 10) plot cover provided by *Spartina patens*, *Polygonum densiflorum*, *Polygonum setaceum*, *Sesbania drummondii*, and *Typha latifolia* increased slightly, while *Polygonum punctatum* plot cover increased dramatically. Plot cover provided by *Sacciolepis striata*, *Ludwigia uruguayensis* and *Echinochloa walteri* decreased dramatically.

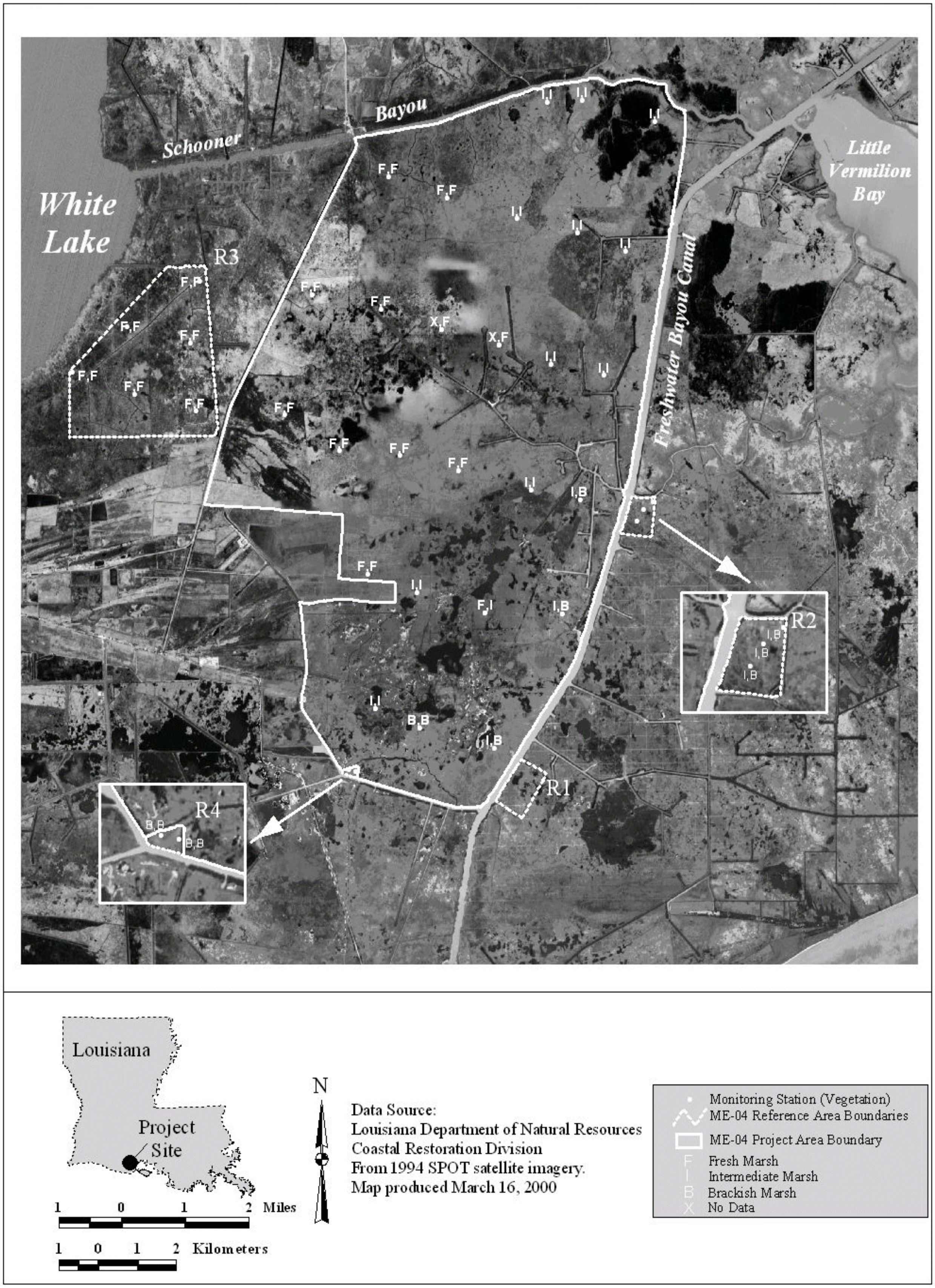


Figure 17. Preconstruction marsh types in the Freshwater Bayou Wetlands (ME-04) project and reference areas as observed at 38 monitoring stations in 1996 and 1998. Marsh types observed at each station are listed in chronological order (e.g., 1996, 1998).

Table 5. Mean percent plot cover of emergent vegetation species in CTU 1 of the Freshwater Bayou Wetlands (ME-04) project area, as recorded in September 1996 and October 1998.

Species	Common Name	% Cover 1996	% Cover 1998
Spartina patens	saltmeadow cordgrass	54.55	58.18
Sacciolepis striata	American cupscale	13.27	0.55
Panicum hemitomon	maidencane	8.18	7.27
Leersia hexandra	southern cutgrass	5.50	5.91
Sagittaria lancifolia	bull-tongue	4.59	6.36
Paspalum vaginatum	seashore paspalum	4.09	2.73
Ludwigia uruguayensis	Uruguayan primrosewillow	3.18	3.20
Ipomoea sagittata	marsh morning glory	2.77	0.30
Mikania scandens	hemp vine	1.36	
Echinochloa walteri	water millet	0.57	
Cyperus odoratus	fragrant flatsedge	0.48	0.02
Crinum americanum	string lily	0.11	0.64
Alternanthera philoxeroides	alligatorweed	0.09	0.55
Bacopa monnieri	coastal waterhyssop	0.09	
Typha latifolia	common cattail	0.09	4.14
Eleocharis sp.	spikesedge	0.05	
Vigna luteola	marsh cowpea	0.05	
Polygonum hydropiperoides	wild water pepper	0.02	
Polygonum punctatum	dotted smartweed	0.02	0.45

Table 6. Mean percent plot cover of emergent vegetation species in CTU 2 of the Freshwater Bayou Wetlands (ME-04) project area, as recorded in September 1996 and October 1998.

Species	Common Name	% Cover 1996	% Cover 1998
Panicum hemitomon	maidencane	25.00	26.67
Echinochloa walteri	water millet	18.88	
Panicum virgatum	switchgrass	17.50	
Sagittaria lancifolia	bull-tongue	10.50	11.67
Sacciolepis striata	American cupscale	10.13	9.25
Alternanthera philoxeroides	alligatorweed	8.75	1.33
Leptochloa fascicularis	bearded sprangletop	7.50	
Sesbania exaltata	hemp sesbania	7.50	
Spartina patens	saltmeadow cordgrass		5.00
Leersia hexandra	southern cutgrass	0.13	2.58
Phyla lanceolata	northern frogfruit	0.13	0.33
Vigna luteola	marsh cowpea	0.13	
Eclipta prostrata	pie plant	0.06	
Kosteletzkya virginica	seashore marsh-mallow	0.06	
Ludwigia uruguayensis	Uruguayan primrosewillow	0.06	0.96
Paspalum vaginatum	seashore paspalum	0.06	2.83
Eleocharis sp.	spikesedge		2.17
Polygonum hydropiperoides	wild water pepper		0.83
Polygonum punctatum	dotted smartweed		0.83
Iris virginica	southern blue-flag		0.50
Cyperus odoratus	fragrant flatsedge		0.04
Diodia virginiana	buttonweed		0.04

Table 7. Mean percent plot cover of emergent vegetation species in CTU 3 of the Freshwater Bayou Wetlands (ME-04) project area, as recorded in September 1996 and October 1998.

Species	Common Name	% Cover 1996	% Cover 1998
Spartina patens	saltmeadow cordgrass	45.50	64.05
Sagittaria lancifolia	bull-tongue	12.08	4.03
Leersia hexandra	southern cutgrass	8.00	2.50
Sacciolepis striata	American cupscale	7.00	0.50
Juncus roemerianus	needlegrass rush	4.55	7.03
Polygonum punctatum	dotted smartweed	4.00	0.70
Scirpus americanus	Olney's bulrush	3.20	6.00
Ludwigia uruguayensis	Uruguayan primrosewillow	3.00	2.60
Panicum hemitomon	maidencane	3.00	4.50
Cladium jamaicense	sawgrass		2.30
Typha latifolia	common cattail	2.15	2.30
Eleocharis parvula	dwarf spikesedge		2.00
Mikania scandens	hemp vine	2.00	
Panicum virgatum	switchgrass	2.00	9.00
Polygonum hydropiperoides	wild water pepper	1.63	
Echinochloa walteri	water millet	1.50	
Eleocharis fallax	spikesedge	1.15	1.50
Carex sp.	caric sedge	1.00	
Cyperus erythrorhizos	redroot flatsedge	1.00	
Cyperus odoratus	fragrant flatsedge	1.00	
Ipomoea sagittata	marsh morning glory	0.55	0.80
Alternanthera philoxeroides	alligatorweed	0.50	2.00
Eclipta prostrata	pie plant	0.50	
Vigna luteola	marsh cowpea	0.50	
Cyperus polystachyos var. filicinus	flatsedge	0.20	
Aster tenuifolius	saline aster	0.13	
Baccharis halimifolia	saltbush	0.10	
Diodia virginiana	buttonweed	0.10	
Kosteletzkya virginica	seashore marsh-mallow	0.08	0.35
Phyla lanceolata	northern frogfruit		0.05
Rhynchospora corniculata	horned beaksedge		0.05
Solidago sempervirens var. mexicana	seaside goldenrod	0.05	
Eupatorium capillifolium	dog fennel	0.03	
Lythrum lineare	wand loosestrife	0.03	
Pluchea odorata	marsh fleabane	0.03	

Table 8. Mean percent plot cover of emergent vegetation species in reference area R4 of the Freshwater Bayou Wetlands (ME-04) project, as recorded in September 1996 and October 1998.

Species	Common Name	% Cover 1996	% Cover 1998
Spartina patens	saltmeadow cordgrass	100.00	87.50
Scirpus maritimus	saltmarsh bulrush	2.75	2.50

Table 9. Mean percent plot cover of emergent vegetation species in reference area R2 of the Freshwater Bayou Wetlands (ME-04) project, as recorded in September 1996 and October 1998.

Species	Common Name	% Cover 1996	% Cover 1998
Spartina patens	saltmeadow cordgrass	76.67	63.33
Typha latifolia	common cattail	20.83	
Scirpus americanus	Olney's bulrush	18.33	1.67
Sesbania exaltata	hemp sesbania	13.33	
Bacopa monnieri	coastal waterhyssop	8.33	
Cyperus polystachyos var. filicinus	flatsedge	1.33	
Cyperus odoratus	fragrant flatsedge	0.33	3.33
Lemna sp.	duckweed		0.17
Ludwigia uruguayensis	Uruguayan primrosewillow		0.17
Lythrum lineare	wand loosestrife	0.17	
Pluchea odorata	marsh fleabane	0.17	
Vigna luteola	marsh cowpea	0.17	
Amaranthus australis	southern waterhemp	0.08	0.17
Ammannia coccinea	valley redstem	0.08	
Distichlis spicata	seashore saltgrass	0.08	0.17
Echinochloa walteri	water millet	0.08	
Polygonum hydropiperoides	wild water pepper	0.08	

Table 10. Mean percent plot cover of emergent vegetation species in reference area R3 of the Freshwater Bayou Wetlands (ME-04) project, as recorded in September 1996 and October 1998.

Species	Common Name	% Cover 1996	% Cover 1998
Sagittaria lancifolia	bull-tongue	43.33	46.67
Sacciolepis striata	American cupscale	41.67	3.75
Ludwigia uruguayensis	Uruguayan primrosewillow	17.58	4.25
Polygonum punctatum	dotted smartweed		7.50
Echinochloa walteri	water millet	6.83	
Eleocharis sp.	spikesedge	0.83	3.33
Phyla lanceolata	northern frogfruit	0.17	5.96
Polygonum densiflorum	dense-flowered smartweed		1.67
Polygonum setaceum	water pepper		1.67
Bidens laevis	smooth beggar's ticks		1.17
Alternanthera philoxeroides	alligatorweed		0.50
Polygonum hydropiperoides	wild water pepper	0.17	
Ludwigia leptocarpa	anglestem primrosewillow	0.08	
Mikania scandens	hemp vine	0.08	
Setaria magna	giant bristlegrass	0.08	
Cyperus odoratus	fragrant flatsedge	0.04	
Hibiscus moscheutos ssp. lasiocarpos	crimsoneyed rosemallow		0.04
Iris virginica	southern blue-flag	0.04	
Limnobium spongia	frog's bit	0.04	0.04
Panicum dichotomiflorum	fall panicum	0.04	
Sesbania drummondii	poisonbean	0.04	3.33
Typha latifolia	common cattail	0.04	1.67

Several environmental factors contributed to the differences in species richness and percent plot cover observed during the two surveys. The September 1996 survey was conducted at the end of a prolonged drought which had allowed Vermilion Corporation to achieve a successful drawdown during the spring of 1996 that extended well into late summer. Conditions were very dry throughout the growing season and water levels were generally low. This allowed for a number of annual species to succeed in growing to maturity, thereby increasing species richness in all units except reference area R4, as recorded during the 1996 vegetation survey (tables 5-10). The October 1998 survey was conducted shortly after the retreat of the storm surge from Tropical Storm Francis near the end of a very active tropical storm season in the northern Gulf of Mexico (Louisiana State Office of Climatology [LOSC] 1998). The marsh vegetation was stressed by this prolonged period of flooding with brackish water. As a result, some species recorded in the plots were dead or dying, and others may have been overlooked because they had already decayed and become unrecognizable by t he time of the1998 survey, decreasing species richness. This was probably partly responsible for the lower 1998 mean plot cover values seen in all units except CTU3. Presumably these effects of the differences in environmental conditions observed prior to each survey contributed to the overall mean percent plot cover by unit (table 11) being greater in 1996 than in 1998 in all units except CTU3 of the project area, where a slight increase was recorded in 1998.

Table 11. Comparison of the mean percent plot cover of emergent vegetation in the Freshwater Bayou Wetlands (ME-04) project and reference area units, as recorded in September 1996 and October 1998.

Unit	No. of Plots	1996 Cover	1998 Cover
CTU 1	11	80.00	65.00
CTU 2	5	93.00	58.40
CTU 3	10	86.00	87.00
R2	6	83.33	66.67
R3	3	85.83	52.50
R4	2	100.00	87.50

Structure Operations: Operations of the eight CWPPRA structures began in October 1998, when stop logs were removed to facilitate drainage of storm water produced by the tidal surge and heavy rains associated with several tropical systems that developed in September 1998, particularly Tropical Strom Francis (LOSC 1998). Structure operation data sheets obtained from the operator, Vermilion Corporation, provided some salinity and water level data, but no actual records of the structure settings or the dates that structure operations were performed. Also, staff gauges were not installed on the structures until May 1999, so only 5 months of water level data from these structures sites were available for this report. Settings observed at each structure by LDNR/CRD monitoring staff during monthly data collection events are reported in tables 12-19.

Table 14. Monthly salinity and water level readings, and flapgate and stop log settings recorded at CWPPRA structure 3 from October 1998 through September 1999. NOTE: Stop log settings are reported relative to the water level at the time of reading (i.e., "2.7 ft < WL" means 2.7 feet below the water level at the time of reading)

Month/ Year	Salinity (ppt)		Water Level (relative ft)*		Outside Gate Position	Stop Log Settings (ft relative to water level)		
	Inside	Outside	Inside	Outside		Rear Weir	Lateral Weir	Notes
10/98	1.6	1.7	no gauge	no gauge	closed	-	-	flowing out
12/98	2.5	2.5	no gauge	no gauge	closed	0.64 ft < WL	0.13 > WL	slight flow out between stop logs
01/99	1.0	1.0	no gauge	no gauge	closed	0.35 ft < WL	0.3 ft > WL	flowing out
03/99	2.4	2.4	no gauge	no gauge	closed	3.86 ft < WL	3.8 ft > WL	flowing in
04/99	2.7	2.7	no gauge	no gauge	closed	3.81 ft < WL	0.1 ft < WL	WL 1.1 ft higher outside than inside; flowing in
05/99	3.4	3.7	1.70	1.75	closed	-2.00	2.40	flowing in
07/99	1.0	1.0	1.75	1.54	closed	-2.05	>1.75	flowing out
08/99	1.2	1.6	1.15	1.10	closed	-2.25	1.65	no flow
09/99	4.2	4.2	1.40	2.08	closed	-1.90	2.10	slight flow in

* Due to an error in establishing NAVD in this project area, all water level readings are relative at this point. NAVD is currently being established within this project area, and subsequent reports will present water level relative to NAVD.

Table 13. Monthly salinity and water level readings, and flapgate and stop log settings recorded at CWPPRA structure 2 from October 1998 through September 1999. NOTE: Stop log settings are reported relative to the water level at the time of reading (i.e., "2.7 ft < WL" means 2.7 feet below the water level at the time of reading)

Month/ Year	Salinity (ppt)		Water Level (relative ft)*		Outside Gate Position	Stop Log Settings (ft relative to water level)		
	Inside	Outside	Inside	Outside		Rear Weir	Lateral Weir	Notes
10/98	-	-	no gauge	no gauge	closed	-	-	-
12/98	3.4	3.6	no gauge	no gauge	closed	2.3 ft < WL	1.7 > WL	slight flow out
01/99	2.1	2.1	no gauge	no gauge	closed	3.45 ft < WL	2 @ 0.65 ft > WL 1 @ 0.5 ft >WL	flowing out
03/99	3.5	3.5	no gauge	no gauge	closed	3.9 ft < WL	0.49 ft > WL	flowing out
04/99	3.9	3.9	no gauge	no gauge	closed	4.0 ft < WL	0.5 ft < WL	WL 0.9 ft higher outside than inside; flowing in
05/99	4.0	4.0	1.60	1.60	closed	-2.10	2.10	flowing out
07/99	2.3	2.3	1.40	1.45	closed	-2.10	>1.40	flowing out
08/99	3.2	3.2	0.80	0.87	closed	-2.20	1.80	no flow
09/99	2.8	2.9	1.72	1.90	closed	-2.08	2.10	slight flow in

* Due to an error in establishing NAVD in this project area, all water level readings are relative at this point. NAVD is currently being established within this project area, and subsequent reports will present water level relative to NAVD.

Table 12. Monthly salinity and water level readings, and flapgate and stop log settings recorded at CWPPRA structure 1 from October 1998 through September 1999. NOTE: Stop log settings are reported relative to the water level at the time of reading (i.e., "2.7 ft < WL" means 2.7 feet below the water level at the time of reading)

Month/ Year	Salinity (ppt)		Water Level (relative ft)*		Outside Gate Position	Stop Log Settings (ft relative to water level)		
	Inside	Outside	Inside	Outside		Rear Weir	Lateral Weir	Notes
10/98	-	-	no gauge	no gauge	closed	-	-	-
12/98	3.2	3.2	no gauge	no gauge	closed	2.7 ft < WL	1.35 > WL	flowing out
01/99	1.6	1.6	no gauge	no gauge	closed	3.8 ft < WL	0.2 > WL	flowing out
03/99	3.6	3.6	no gauge	no gauge	closed	4.47 ft > WL	0.49 ft > WL	no flow
04/99	2.4	2.5	no gauge	no gauge	closed	4.6 ft < WL	0.5 ft < WL	WL 1.0 ft higher outside than inside; flowing in
05/99	4.6	4.6	1.40	1.32	closed	-2.90	1.10	flowing out
07/99	2.8	2.8	1.45	1.40	closed	-2.75	1.20	flowing out
08/99	3.4	4.0	0.90	1.00	closed	-2.80	1.40	no flow
09/99	6.0	6.1	1.70	1.80	closed	-2.75	1.30	slight flow in

* Due to an error in establishing NAVD in this project area, all water level readings are relative at this point. NAVD is currently being established within this project area, and subsequent reports will present water level relative to NAVD.

Table 15. Monthly salinity and water level readings, and flapgate and stop log settings recorded at CWPPRA structure 4 from October 1998 through September 1999. NOTE: Stop log settings are reported relative to the water level at the time of reading (i.e., "2.7 ft < WL" means 2.7 feet below the water level at the time of reading)

Month/ Year	Salinity (ppt)		Water Level (relative ft)*		Outside Gate Position	Stop Log Settings (ft relative to water level)		
	Inside	Outside	Inside	Outside		Rear Weir	Lateral Weir	Notes
10/98	3.3	2.6	no gauge	no gauge	closed	-	-	flowing out
12/98	2.7	2.7	no gauge	no gauge	closed	0.13 ft < WL	0.67 > WL	flowing out
01/99	2.2	2.2	no gauge	no gauge	closed	0.2 ft < WL	2 @ 0.8 ft > WL 1 @ 1.2 ft >WL 1 @ 0.25 ft <WL	flowing out
03/99	3.1	3.4	no gauge	no gauge	closed	3.96 ft < WL	0.65 ft > WL	flowing in
04/99	3.6	3.6	no gauge	no gauge	closed	4.1 ft < WL	1.5 ft < WL	WL 1.0 ft higher outside than inside; flowing in
05/99	3.8	4.0	1.85	1.88	closed	-2.45	1.85	slight flow in
07/99	1.7	1.6	1.75	1.70	closed	-2.25	>1.70	no flow
08/99	2.4	2.4	1.00	1.00	closed	-2.10	2.00	no flow
09/99	4.4	4.5	1.70	2.08	closed	-0.30	2.70	flowing in

* Due to an error in establishing NAVD in this project area, all water level readings are relative at this point. NAVD is currently being established within this project area, and subsequent reports will present water level relative to NAVD.

Table 16. Monthly salinity and water level readings, and flapgate and stop log settings recorded at CWPPRA structure 5 from October 1998 through September 1999. NOTE: Stop log settings are reported relative to the water level at the time of reading (i.e., "2.7 ft < WL" means 2.7 feet below the water level at the time of reading)

Month/ Year	Salinity (ppt)		Water Level (relative ft)*		Outside Gate Position	Stop Log Settings (ft relative to water level)		
	Inside	Outside	Inside	Outside		Rear Weir	Lateral Weir	Notes
10/98	0.9	1.6	no gauge	no gauge	closed	-	-	flowing out
12/98	2.0	2.0	no gauge	no gauge	closed	2.59 ft < WL	1.4 > WL	flowing out
01/99	1.7	1.7	no gauge	no gauge	closed	3.7 ft > WL	0.2 ft > WL	flowing out
03/99	3.7	3.7	no gauge	no gauge	closed	4.15 ft < WL	0.2 ft > WL	flowing out
04/99	3.3	3.3	no gauge	no gauge	closed	4.2 ft < WL	0.3 ft < WL	WL 0.9 ft higher outside than inside; flowing in
05/99	3.6	4.0	1.92	1.94	closed	-2.38	1.92	no flow
07/99	1.6	1.6	1.58	1.70	closed	5.68	1.68	no flow
08/99	2.4	2.4	1.00	0.95	closed	-2.10	1.50	slight flow out
09/99	6.3	5.9	1.67	1.98	closed	-2.33	1.67	slight flow in

* Due to an error in establishing NAVD in this project area, all water level readings are relative at this point. NAVD is currently being established within this project area, and subsequent reports will present water level relative to NAVD.

Table 17. Monthly salinity and water level readings, and flapgate and stop log settings recorded at CWPPRA structure 6 from October 1998 through September 1999. NOTE: Stop log settings are reported relative to the water level at the time of reading (i.e., "2.7 ft < WL" means 2.7 feet below the water level at the time of reading)

Month/ Year	Salinity (ppt)		Water Level (relative ft)*		Outside Gate Position	Stop Log Settings (ft relative to water level)		
	Inside	Outside	Inside	Outside		Rear Weir	Lateral Weir	Notes
10/98	3.5	2.4	no gauge	no gauge	closed	-	-	flowing out
12/98	3.6	3.5	no gauge	no gauge	closed	0.15 ft < WL	0.34 > WL	flowing out
01/99	2.8	2.9	no gauge	no gauge	closed	3.48 ft < WL	0.55 ft > WL	flowing out
03/99	3.7	3.5	no gauge	no gauge	closed	> WL	> WL	no flow
04/99	4.1	4.1	no gauge	no gauge	closed	3.5 ft < WL	0.5 ft < WL	flowing out
05/99	4.2	4.2	no gauge	2.40	closed	4.4 ft < WL	0.4 ft < WL	flowing in
07/99	3.2	3.2	1.45	1.35	closed	-2.15	> 1.45	all stop logs in on lateral weirs; flowing out
08/99	3.1	3.1	1.00	0.95	closed	0.68	> 1.00	slight flow out
09/99	4.7	4.9	1.60	1.80	closed	1.30	1.80	slight flow in

* Due to an error in establishing NAVD in this project area, all water level readings are relative at this point. NAVD is currently being established within this project area, and subsequent reports will present water level relative to NAVD.

Table 18. Monthly salinity and water level readings, and flapgate and stop log settings recorded at CWPPRA structure 7 from October 1998 through September 1999. NOTE: Stop log settings are reported relative to the water level at the time of reading (i.e., "2.7 ft < WL" means 2.7 feet below the water level at the time of reading)

Month/ Year	Salinity (ppt)		Water Level (relative ft)*		Outside Gate Position	Stop Log Settings (ft relative to water level)		
	Inside	Outside	Inside	Outside		Rear Weir	Lateral Weir	Notes
10/98	4.3	4.1	no gauge	no gauge	closed	-	-	flowing out
12/98	4.3	2.5	no gauge	no gauge	closed	0.95 ft > WL	0.4 > WL	no flow
01/99	3.3	3.3	no gauge	no gauge	closed	0.1 ft > WL	0.3 ft > WL	slight flow out between stop logs
04/99	3.9	3.8	no gauge	no gauge	closed	< WL	< WL	flowing out
	4.3	4.3	no gauge	no gauge	closed	0.25 ft < WL	0.5 ft > WL	flowing out
05/99	4.1	4.1	2.10	2.30	closed	-1.40	1.60	flowing in
07/99	3.8	3.9	1.45	1.40	closed	-0.10	> 1.45	flowing out
08/99	3.8	3.9	1.00	0.95	closed	-0.65	> 1.00	slight flow out
09/99	5.6	5.7	1.30	1.50	closed	-0.70	1.70	slight flow in

* Due to an error in establishing NAVD in this project area, all water level readings are relative at this point. NAVD is currently being established within this project area, and subsequent reports will present water level relative to NAVD.

Table 19. Monthly salinity and water level readings, and flapgate and stop log settings recorded at CWPPRA structure 8 from October 1998 through September 1999. NOTE: Stop log settings are reported relative to the water level at the time of reading (i.e., "2.7 ft < WL" means 2.7 feet below the water level at the time of reading)

Month/ Year	Salinity (ppt)		Water Level (relative ft)*		Outside Gate Position	Stop Log Settings (ft relative to water level)		
	Inside	Outside	Inside	Outside		Rear Weir	Lateral Weir	Notes
10/98	-	4.5	no gauge	no gauge	closed	no gauge	no gauge	no flow; outflow channel to structure incomplete
12/98	-	3.8	no gauge	no gauge	closed	no gauge	no gauge	no flow; outflow channel to structure incomplete
01/99	-	3.6	no gauge	no gauge	closed	no gauge	no gauge	no flow; outflow channel to structure incomplete
03/99	3.5	3.5	no gauge	no gauge	closed	no gauge	no gauge	no flow; outflow channel to structure incomplete
04/99	4.0	4.4	no gauge	no gauge	closed	no gauge	no gauge	no flow; outflow channel to structure incomplete
05/99	4.7	4.5	no gauge	2.10	closed	0.30 ft < WL	2.2 ft < WL	WL equal on both sides of structure; no flow
07/99	3.9	4.1	no gauge	0.85	closed	> WL	> WL	no flow
08/99	3.9	4.0	no gauge	0.65	closed	> WL	1.0 ft < WL	slight flow out
09/99	6.5	6.6	no gauge	1.47	closed	0.6 ft < WL	2 @ 0.2 ft > WL 1 @ 0.4 ft < WL	slight flow in

* Due to an error in establishing NAVD in this project area, all water level readings are relative at this point. NAVD is currently being established within this project area, and subsequent reports will present water level relative to NAVD.

DISCUSSION

The Freshwater Bayou Wetlands Project (ME-04) involves a large, ecologically complex area with several marsh and soil types. It is affected on all sides by hydrological conditions that have been, and continue to be, constantly altered by human activity. A considerable amount of effort has already been expended by the landowner (Exxon Corporation), lessee (Vermilion Corp.), and government agencies (USACE, Vermilion Parish Police Jury) to keep the area intact prior to implementation of this restoration project. This makes data analysis very difficult and somewhat tenuous, especially for the short period of record reported herein.

The salinity and water level data examined for this report point to the dire need for maintenance on the embankment levees surrounding the project area to prevent uncontrolled tidal exchange, particularly along the entire reach of Freshwater Bayou Canal that is adjacent to the ME-04 project area. The ME-04 rock dike along the Freshwater Bayou Canal adjacent to CTU1 has worked quite well to reduce erosion along this shoreline, but since the structure is water permeable, it does very little to prevent tidal exchange during high tides and storm surges. Embankment maintenance is essential for maintaining salinity and water levels conducive to growth of fresh to intermediate marsh and to reduce ponding in CTU1, as the ME-04 restoration project features are supposed to accomplish. Based on the data presented here, there was very little difference in the salinity and water level regimes inside and outside of the project area during the period of record.

This is further complicated by the fact that the landowner and lessee already had 13 existing water control structures in the project area prior to implementation of this project, and the operation of which is not known. Operation of the 13 existing and the 8 CWPPRA structures is further confounded by the unauthorized manipulation of structure settings by persons hunting and fishing in the project area.

The climatology in the area has not been conducive to the success of this project. The current El Niño-La Niña cycle has skewed local weather patterns toward extremely dry conditions and long intervals of high tide conditions for the entire period of record.

These conditions have also affected the 1996 and 1998 preconstruction vegetation surveys which were conducted at the end of the growing seasons characterized by opposite extremes in weather conditions. The 1996 survey followed a drought stricken growing season. The 1998 survey followed a very active tropical storm season. From late August through September 1998, elevated tides associated with tropical storms Charley, Francis, and Hermine, hurricanes Earl and Georges, and heavy rains produced by tropical storm Francis flooded the coastal marshes with a tidal surge that reached 4.0 ft in the ME-04 project and reference areas.

A more thorough analysis of all ME-04 monitoring data collected through September 2001 will be included int the first comprehensive report on this project currently in review.

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