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

2004 Operations, Maintenance and Monitoring Report

for

FRITCHIE MARSH RESTORATION

State Project Number PO-06
Priority Project List 2

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St. Tammany Parish

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2004 Operations, Maintenance and Monitoring Report
For
Fritchie Marsh Restoration (PO-06)

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Preface

The 2004 OM&M Report format is a streamlined approach which combines the Operations and Maintenance annual project inspection information with the Monitoring data and analyses on a project-specific basis. This new reporting format for 2004 includes monitoring data collected through December 2003, and annual Maintenance Inspections through June 2004. Monitoring data collected in 2004 and maintenance inspections conducted between July 2004 and June 2005 will be presented in the 2005 OM&M Report.

I. Introduction

The Fritchie Marsh project area contains 6,291-ac (2,546-ha) of intermediate and brackish marsh located southeast of Slidell in St. Tammany Parish (Figure 1). The area is bound by US Hwy 190 to the north, US Hwy 90 to the south and east, and LA Hwy 433 to the west and south.

From 1956 to 1984, 2,260-ac (915-ha) of emergent marsh within the project area have been converted to open water, with the greatest loss occurring in the northern project area. This loss reflects a pattern of marsh deterioration from north to south due to a reduction of freshwater and sediment input into the northern part of the project area. Natural hydrologic patterns have been disrupted by the construction of the perimeter highways. These embankments isolate the marsh from the West Pearl River and have restricted inflow of freshwater, nutrients, and sediment. Additionally, saltwater from Lake Pontchartrain enters the marsh through the W-14 canal and Little Lagoon during high tides and strong winds. As a result, the project area has converted from a predominantly fresh marsh in 1956 to a predominantly brackish marsh in 1990.

The objective of the Fritchie Marsh Restoration Project is to reduce marsh loss by restoring more natural hydrologic conditions in the project area through management of available freshwater. Specific objectives are (1) to increase freshwater flow and promote water exchange into the area from West Pearl River by enlarging the culvert at U.S. Highway 90 and by dredging portions of Salt Bayou and (2) increase freshwater flow into the northern project area by diverting flow from the W-14 canal.

The Fritchie Marsh Restoration Project was constructed in one phase beginning in October 2000 and completed in March 2001. The project has a 20-year economic life which began in March 2001.

The principal project features include:

- Installation (jack and bore) of a 72-inch diameter by 136-foot long concrete culvert under U.S. Highway 90, rock riprap lining of the Salt Bayou channel bottom and pipe outlets, and installation of 308 linear feet of sheet piling to form a bulkhead.

Figure 1. Fritchie Marsh Restoration (PO-06) project boundary, construction features, continuous recorder and staff gauge locations, and water flow monitoring locations.

- Installation of a weir in the W-14 canal. The weir consists of 108 linear feet of sheet pile with a 20-foot wide boat bay.
- Dredging of approximately 400 linear feet of the W-14 diversion channel and 5300 linear feet of the Salt Bayou channel.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The site was inspected on March 10, 2004 by George Boddie and Tom Bernard from LDNR as documented in the 2004 Annual Inspection Report (Bernard 2004). Brad Sticker from NRCS was scheduled to take part in the inspection; however, time did not permit it. The weather was clear and the temperature was 70°F. The field inspection included a complete visual inspection of the entire project site from both land and water. Photographs were taken and a Field Inspection form was completed in the field to record measurements and deficiencies.

b. Inspection Results

Hwy 90 Culvert and Stone Revetment

Slight erosion where the left descending bank meets the riprap lining for the Hwy 90 culvert was noted at the final inspection in March 2001, but does not show signs of increasing (Photos 1-4). The 72" x 136 L.F. RCP culvert beneath State Hwy 90 showed no apparent problems. No settlement or blockage of flow was noted. In addition, there were no signs of scour at the pipe ends (Photos 2-4). Some reflective cracking was noted in the asphalt riding surface on Hwy 90; and the aggregate shoulders need regrading in the vicinity of the pipe to remove the drop off between the pavement and shoulder (Photos 5). However, no evidence of settlement of the pipe or roadway has been noted since initial construction was completed in March 2001.

Salt Bayou Dredging

Spoil areas supported stable vegetation with no signs of significant settlement or erosion. Channel cross sections were not checked quantitatively as the dredging was recently completed. Channels appeared to convey flow easily

W-14 Weir

Structure is in excellent condition (Photo 6). All permanent signage was undamaged and in excellent condition. Hand rails were well marked with reflective tape and were undamaged. All

hardware was un-corroded. Tie-ins to the bank were well vegetated and showed no signs of erosion.

W-14 Diversion Channel Dredging

Spoil areas supported stable vegetation with no signs of significant settlement or erosion (Photo 6). Channel cross sections were not checked quantitatively as the dredging was recently completed.

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

- No immediate repairs are suggested.

ii. Programmatic/ Routine Repairs

- Re-grade the shoulders to remove the elevation difference the pavement and shoulder material.
- Monitor the reflective cracking in the asphalt in the vicinity of the RCP culvert.
- Monitor the erosion at the end of the stone riprap on the left descending bank of Salt Bayou.
- Install a staff gauge on the outside of the culvert and tie into network.

III. Operation Activity

a. Operation Plan

This project requires no operations, therefore no operation plan has been generated.

b. Actual Operations

This project requires no operations, therefore no structure operations have been conducted. DNR personnel removed (04/07/2003) the make-shift ladder/diving platform that was placed on one of the signage supports at the W-14 structure.

Photo No. 1
Pre-existing concrete box culvert under Hwy. 90 with adjacent stone riprap erosion protection placed in 2001.

Photo No. 2
Round 72” concrete culvert under Hwy. 90 with stone erosion protection was completed in 2001.

Photo No. 3
Steel sheet pile bulkhead and stone riprap erosion protection located adjacent to 72” concrete culvert on south side of Hwy 90.

Photo No. 4
Riprap stone erosion protection placed on bank on both sides of culverts on the north side of Hwy 90.

Photo No. 5
Newly placed asphalt surface at culvert crossing on Hwy 90 shows some slight cracking with little separation.

Photo No. 6
W-14 Weir Structure looking east

IV. Monitoring Activity

This is a comprehensive report and includes all data collected from the pre-construction period and the post-construction period through December 2003.

a. Monitoring Goals

The objective of the Fritchie Marsh Restoration Project is to restore more natural hydrologic conditions in the project area resulting in the protection of the existing marsh.

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

1. Decrease rate of marsh loss.
2. Increase freshwater flow and promote water exchange into the area from West Pearl River by enlarging the culvert at US Highway 90 and by dredging portions of Salt Bayou.
3. Increase freshwater flow into the northern project area by diverting flow from the W-14 canal.
4. Document species composition and relative abundance of vegetation to evaluate change over time.

b. Monitoring Elements

Habitat Mapping

Color-infrared aerial photography (1:12,000 scale) has been obtained to document vegetated and non-vegetated areas in the project area and reference area. The photography will be geo-rectified, photo-interpreted, mapped, and analyzed with GIS using standard operating procedures documented in Steyer et al. (1995, revised 2000). Photography was obtained in 1996 and 2000 (pre-construction) and will be collected in 2004, 2010, and 2019 (post-construction). It will always be flown at low water conditions.

Salinity

To monitor the effects of increased flow of freshwater into the project area at the Salt Bayou culvert, salinity has been recorded hourly at four permanent stations. Three continuous recorders were placed in Salt Bayou and one was placed in the marsh near the diversion of the W-14 canal to monitor hydrologic conditions pre-construction and post-construction. Salinity was monitored from 1997-2000 (pre-construction) and will be monitored from 2001 to mid 2005 (post-construction).

Water Level

To monitor the effects of increased flow of fresh water into the project area at the Salt Bayou culvert and its effects on the marsh, water level was recorded hourly at four permanent stations. Water level was monitored from 1997-2000 (pre-construction) and will be monitored from 2001 to mid 2005 (post-construction).

Water Flow

To monitor the increased flow of water into the project area at the Salt Bayou culvert and at the diversion at the W-14 canal, water flow was measured near the same locations where continuous recorders were present. Current meters were deployed and cross-sectional channel transects were conducted to characterize the vertical and horizontal flow structure and to calculate the instantaneous volume flux through the channel. The meters were deployed for a one year period prior to construction and for the same duration after construction.

Vegetation

Species composition and relative abundance of vegetation were documented in 1997 and 2000 (pre-construction) and will be documented in 2004, 2007, 2010, 2013, 2016, 2019 (post-construction) along vegetation transects in the project area. The Braun-Blanquet method is used to survey vegetation in 4-m^2 plots along the transects. Information on herbivory and submerged aquatic vegetation (SAV) occurrence will be recorded during the measuring of the vegetation stations.

IV. Monitoring Activity (continued)

c. Preliminary Monitoring Results and Discussion

Habitat Mapping

Habitat classification of the 1996 and 2000 pre-construction photography is currently being conducted by the NWRC, and results are not yet available. The photomosaic from the 2000 aerial photography is shown in figure 2.

Salinity and Water Level

Hourly salinity and water level data have been collected at the following continuous recorder stations (figure 3):

Station	Data collection period
PO06-01	2/6/1996 – present
PO06-03*	6/10/1997 – 3/18/1999
PO06-06	6/10/1997 – present
PO06-11	6/10/1997 – present
PO06-60*	3/18/1999 – present

*The continuous recorder at PO06-03 was removed because the water level dropped below the sonde sensor during normal low-water periods. The replacement station, PO06-60 was installed in deeper water closer to the Hwy. 90 culvert.

The effect of water level and salinity changes on the overall marsh within the project area will be evaluated by documenting response variables, such as vegetation frequency and abundance, and habitat change over time. Discrete staff gauge readings have also been recorded each month since March 1998 at the four continuous recorder stations and at two additional staff gauge locations.

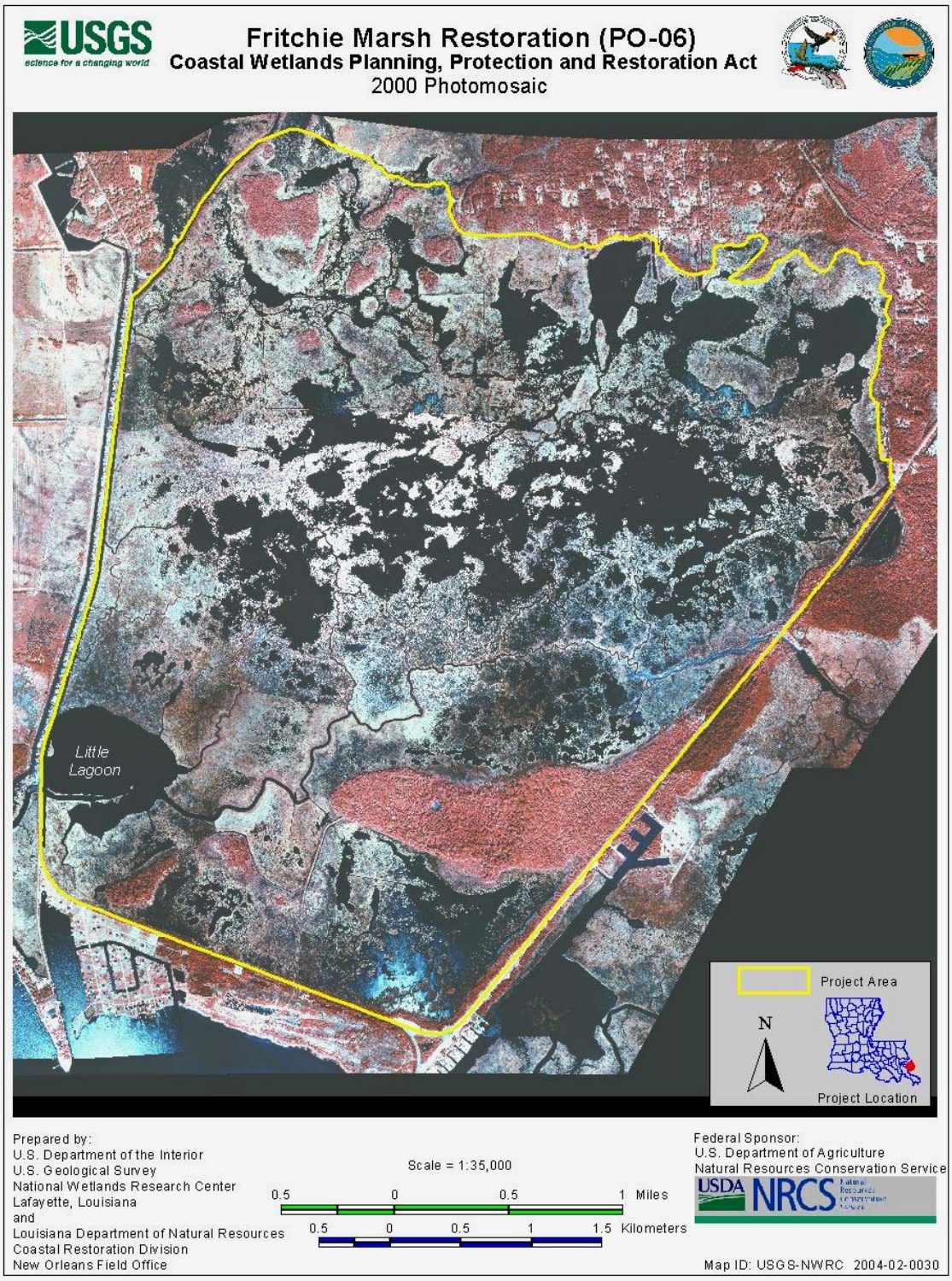

Figure 2. 2000 photomosaic of the Fritchie Marsh Restoration (PO-06) project area.

Salinity and Water Level (continued)

Mean weekly salinity and water level data were analyzed using a BACI analysis with a 2 X 4 factorial treatment structure. A standard BACI analysis uses a 2 X 2 factorial treatment structure, with the individual stations representing spatial replication within the two levels of the Control-Impact (CI) treatment (i.e. project area and reference area). However, all of the PO-06 stations are within the treatment area, thus the four stations represent four levels of the CI treatment. All four stations are potentially impacted by the project, and are not designated purely "control" or purely "impact". Because the measurements are made simultaneously at all four stations, the statistical design represents an extension of the BACI paired series (BACIP) design. Each week in the study represents a temporal block. The design matches the one described in Table 1.b of Underwood (1994) with the difference that no sub-sampling takes place, so the residual error term is the *T(B)*L* interaction. Pre-construction data before March 1999 were not included in the analysis.

Results showed that the mean weekly salinity was significantly lower and water level was significantly higher ($p<0.0001$) at all four continuous recorder stations during the post-construction period through the end of 2003, which is consistent with the goals of the project (figures 3 and 4). However, the project area was affected by a period of drought from September 1999 through December 2000, which led to increased salinity and lower water levels during the pre-construction period. By analyzing the BA*CI interaction, it is possible to determine whether the project is having an effect on the stations, despite the presence of confounding environmental factors such as the drought. In order to interpret a BA*CI interaction as evidence of impact, it must be assumed that if the project had an impact, it would apply unevenly among these four stations. It must also be assumed that environmental factors are affecting all of the stations evenly, or at least randomly.

These data showed a significant interaction ($p<0.0001$) between stations in both the salinity and water level analyses (figures 5 and 6). Although the changes observed in the project area following construction are consistent with post-drought conditions alone, the relative magnitude of these changes was different between stations. Therefore, we can conclude that the project is having some effect on the stations. When comparing changes in salinity between stations, it is most obvious that Station 60 experienced the smallest change in salinity (figure 5). However, this is somewhat misleading since this station was already the freshest station in the pre-construction period and was approaching zero ppt during the post-construction (0.54 ppt). The remaining three stations appear to behave more similarly to one another, however, when Station 60 is removed from the analysis the interaction remains highly significant ($p<0.0001$). Since Stations 11 and 01 are physically closer to the project features, it would be expected that salinity would be affected more by the project (i.e., steeper slope) at these stations than at Station 06 which is closest to Lake Pontchartrain. Out of the three stations, Station 06 did experience the smallest decrease in salinity (5.11 ppt), which supports the conclusion that the project is having the desired effect on the stations.

The interaction of mean water level between stations shows strong evidence of a project effect at Station 60, which is located near the 72-inch culvert (figure 6). Mean water level at this station

was effectively doubled in the post-construction period. The magnitude of water level change was much greater at this station (0.47 ft) than at the other three stations, indicating that the addition of the culvert had a significant effect on water level. In contrast, the interaction results indicate that the W-14 weir has had comparatively less impact on water levels in the project area. Station 11, which is located near the weir, experienced the smallest increase (slope) in water level out of the four stations (0.22 ft). Since most of the fresh water from Slidell flows straight down the W-14 Canal toward Lake Pontchartrain rather than entering the marsh, the weir was constructed to divert some of this flow of fresh water through a small channel into the interior marsh. It appears that the flow volume down the W-14 canal, coupled with the large boat bay required for navigation, may not be enough to have a large impact on water retention in the interior marsh. However, the effects of any resulting freshwater retention and salinity reduction on the interior marsh will be documented through vegetation surveys and habitat mapping.

Discrete water level readings were recorded at 6 staff gauges throughout the project area (at the 4 recorder stations and 2 additional stations). Water levels were documented on a monthly basis and exhibited no significant changes between pre- and post-construction time periods ($p=0.0961$) (figure 7). Seasonal variability in monthly water level was evident with lowest water levels occurring in January and February, and highest water levels generally occurring in September (figure 8).

Water Flow

Hourly current meter data were collected by LSU at five stations from October 1998 to January 2000 (pre-construction) and from December 2001 to December 2002 (post-construction) (figure 1). Flow volume estimates at each station were made using recorded current data, channel cross sections, and water level data from the associated continuous recorder station.

Water Flow Station	Associated Water Level Station
PO06-51	PO06-60
PO06-52	PO06-01
PO06-53	PO06-06
PO06-54	PO06-11
PO06-55	PO06-11

LDNR is investigating several inconsistencies in the water flow data collected by LSU. Although not yet statistically analyzed, pre-construction discharge appears to be substantially different from post-construction discharge at stations PO06-51, PO06-52, and PO06-54. Post-construction flow volumes at these stations indicate substantially decreased discharge both into and out of the project area. This is counter-intuitive since an additional 72-inch culvert was constructed under U.S. Highway 90 near station PO06-51 to facilitate increased water exchange. LDNR engineers report that the structure is operating properly and field observations indicate that discharge has increased. Discharge appears to be similar at PO06-53 and PO06-55 both before and after construction. These stations are the exchange points of the project area with the Lake Pontchartrain and the W-14 canal, respectively (see figure 1).

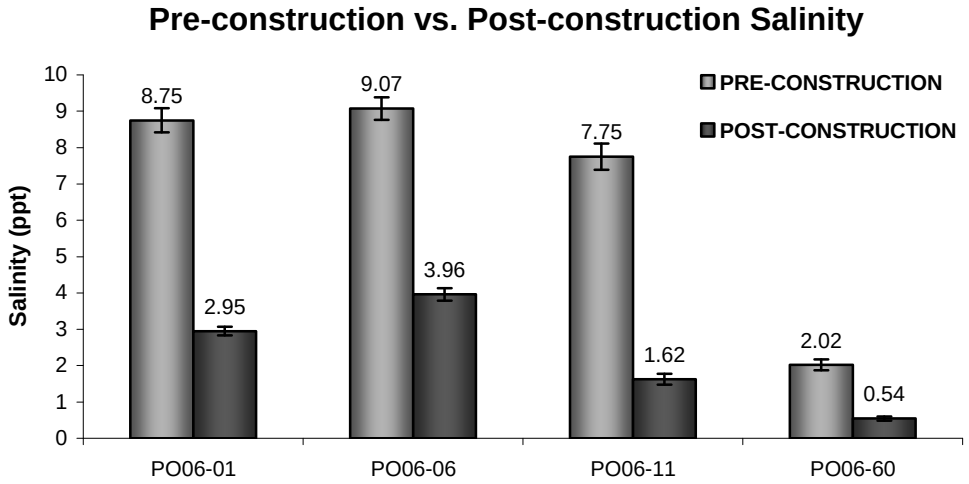

Figure 3. Mean weekly salinity at four YSI continuous recorder stations located in the Fritchie Marsh (PO-06) project area during pre-construction (3/1/99 - 2/28/01) and post-construction (3/1/01-12/31/03) periods. There was a significant decrease in mean salinity between pre- and post-construction periods at all stations (*p<0.0001*). It is important to note that pre-construction salinities were amplified due to drought conditions which persisted for much of the year 2000.

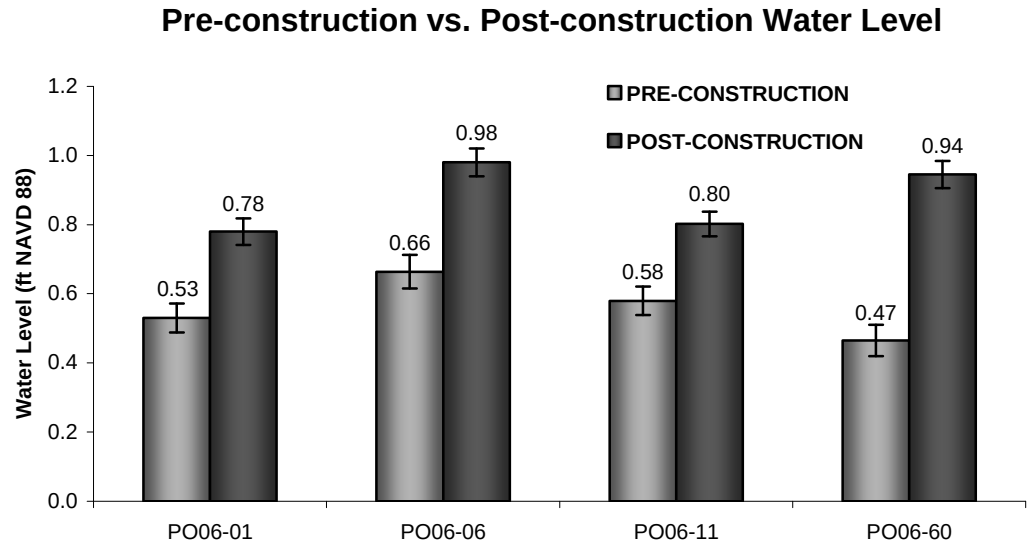

Figure 4. Mean hourly water level at four YSI continuous recorder stations located in the Fritchie Marsh (PO-06) project area during pre-construction (3/1/99 - 2/28/01) and post-construction (3/1/01-12/31/03) periods. There was a significant increase in mean water level between pre- and post-construction periods at all stations (*p<0.0001*). Pre-construction water levels may have been affected by drought conditions which persisted for much of the year 2000.

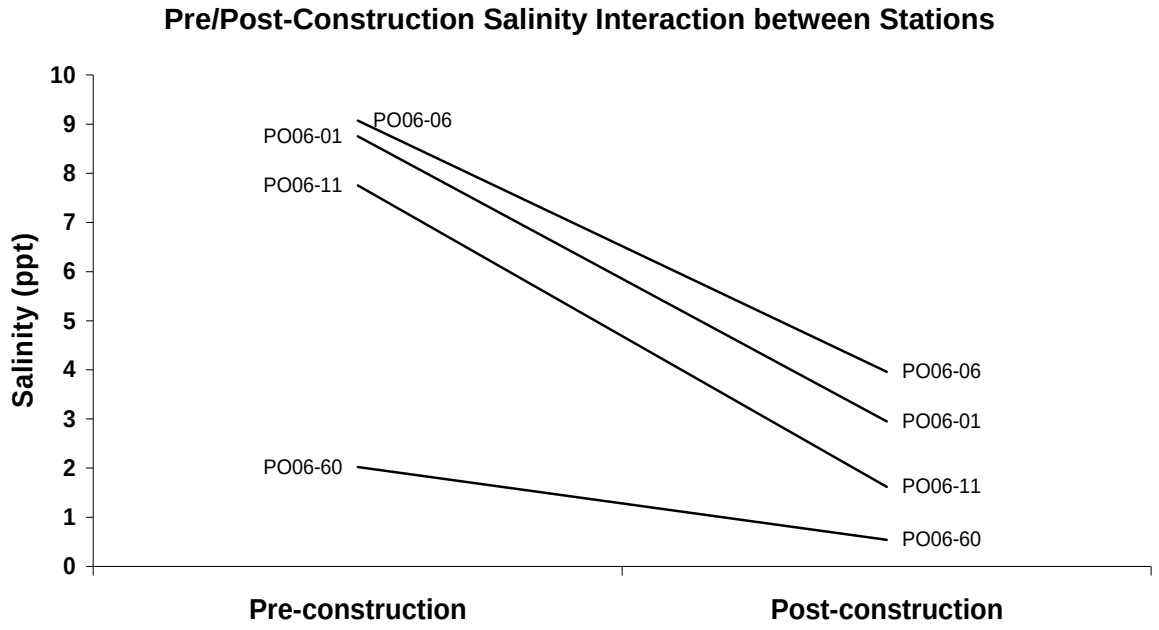

Figure 5. Interaction of mean weekly salinity during pre-construction and post-construction periods between four YSI continuous recorder stations in the Fritchie Marsh Restoration (PO-06) project area. A significant interaction (*p<0.0001*) between stations was detected indicating a project effect.

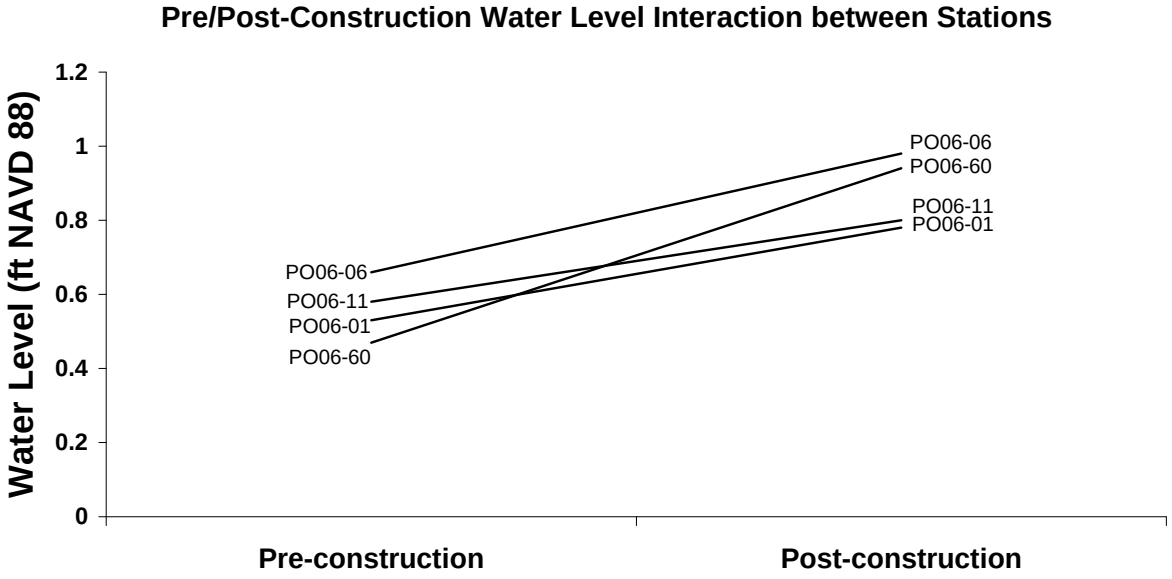

Figure 6. Interaction of mean weekly water level during pre-construction and post-construction periods between four YSI continuous recorder stations in the Fritchie Marsh Restoration (PO-06) project area. A significant interaction (*p<0.0001*) between stations was detected indicating a project effect.

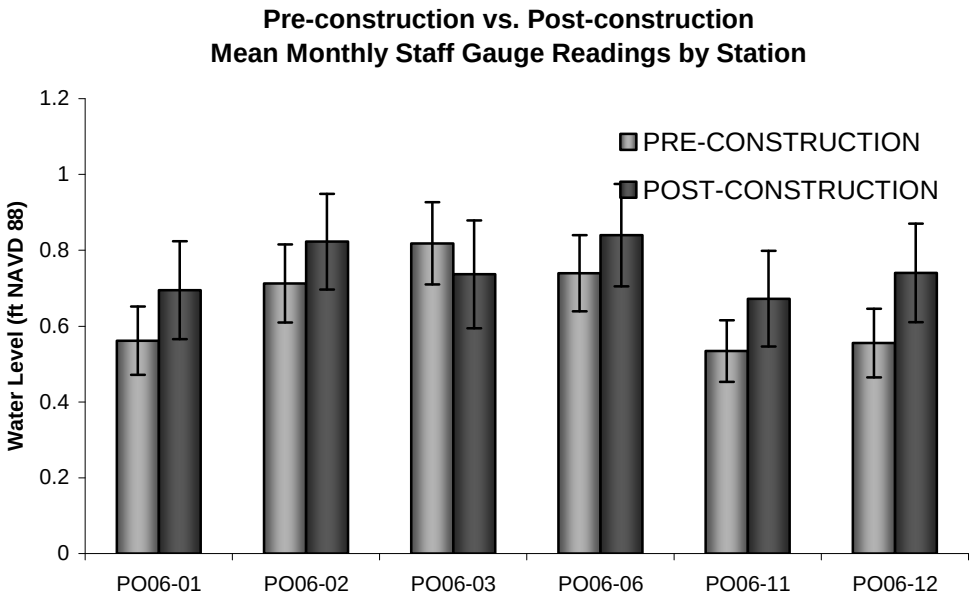

Figure 7. Mean of monthly staff gauge readings at the six staff gauges located in the Fritchie Marsh (PO-06) project area during pre-construction (3/98-2/01) and post-construction (3/01-12/03) periods. There was no significant difference in the mean staff gauge readings between the pre- and post-construction periods (*p=0.0961*) or between stations (*p=0.2069)* .

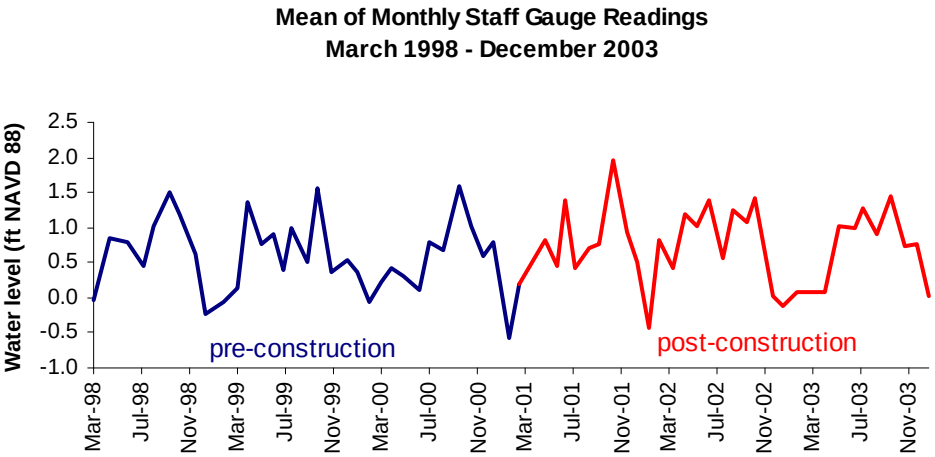

Figure 8. Mean of monthly readings from six staff gauges located in the Fritchie Marsh Restoration (PO-06) Project area from March 1998 to December 2003.

Vegetation

Vegetation surveys were conducted in September 1997 (N=25 plots), September 1999 (N=4 plots) and August 2000 (N=29 plots) during the pre-construction period. Because future landrights access was uncertain to four of the original 25 plots, four plots were added and surveyed in 1999 . *Spartina patens* (saltmeadow cordgrass) was the dominant species of vegetation in both 1997 and 2000, however the number of species observed in 2000 was much less than that recorded in 1997 (figure 9). In addition, the mean percent cover for every species collected in both 1997 and 2000, was substantially less in 2000 than it was in 1997 (table 1).

The first post-construction vegetation data set is scheduled to be collected in 2004 and should indicate whether the changes in salinity and water flow have had an impact on the vegetation community.

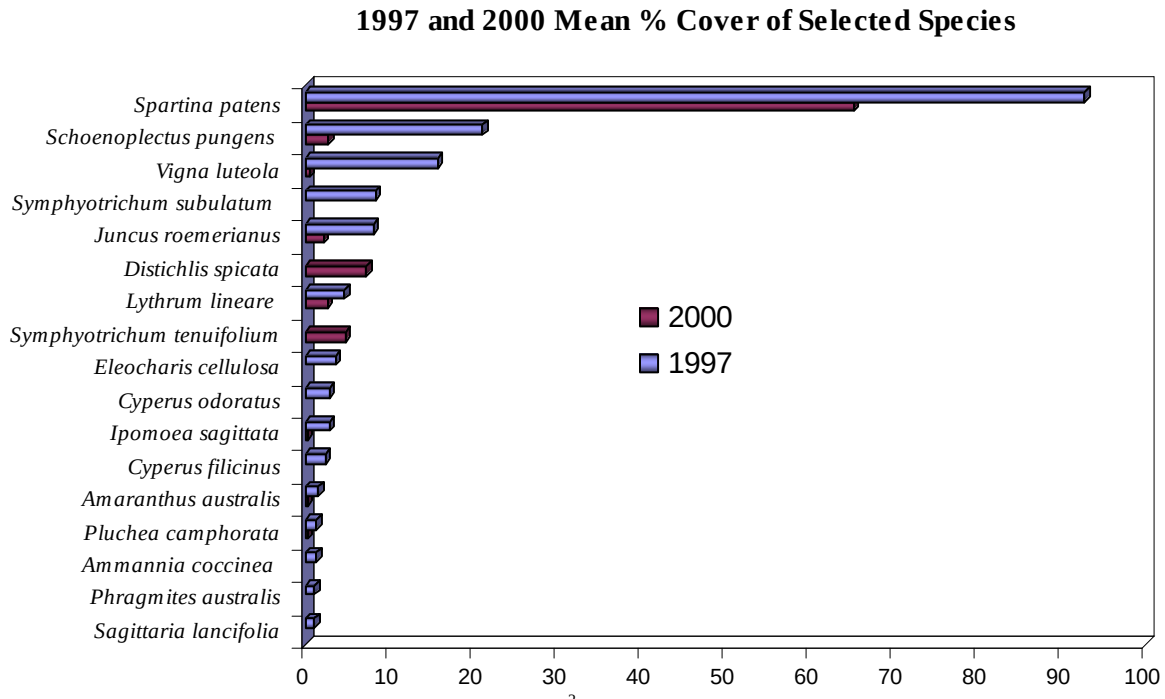

Figure 9. Mean % cover of selected species across all 4-m^2 plots within the PO-06 project area during September 1997 (N=25 plots) and August 2000 (N=29 plots). Vegetation was sampled using the Braun-Blanquet method.

Table 1. The percentage of the total number of vegetation plots where each species occurred and the mean percent cover of species within plots where they occurred during the 1997 (N=25 plots), 1999 (N=4 plots), and 2000 (N=29 plots) vegetation sampling of the PO-06 project area. Sampling was conducted within 4-m^2 plots using the Braun-Blanquet method.

Scientific Name	Occurrence of Total Plots (%)			Mean % Cover in Plots where Species Occurred		
	1997	1999	2000	1997	1999	2000
Spartina patens	100	100	100	93	78	65
Schoenoplectus pungens	44	25	21	48	10	13
Eleocharis cellulosa	8			45		
Juncus roemerianus	24	25	21	33	10	10
Vigna luteola	52	25	17	30	1	3
Phragmites australis	4			25		
Sagittaria lancifolia	4			25		
Symphyotrichum subulatum	36	25		23	5	
Cyperus sp.	4		3	20		5
Iva frutescens	4		10	20		5
Cyperus filicinus	16			15		
Distichlis spicata			48			15
Ipomoea sagittata	24	25	24	12	5	1
Pluchea camphorata	12	25	7	11	10	3
Lythrum lineare	44	25	31	10	2	8
Baccharis halimifolia	4		14	10		4
Symphyotrichum tenuifolium			45			11
Panicum repens	8	25		9	2	
Ammannia coccinea	16			8		
Amaranthus australis	20	50	17	7	6	1
Cyperus odoratus	40			7		
Bacopa monnieri	4		21	5		1
Eleocharis olivacea	4			5		
Polygonum hydropiperoides	4			4		
Echinochloa walteri	8			3		
Eleocharis parvula			3			3
Spartina alterniflora		25			3	
Kosteletzkya virginica	8			1		
Ludwigia leptocarpa	4			1		
Eclipta prostrata	8			1		
Unknown			3			0.3

V. Conclusions

a. Project Effectiveness

Overall, the constructed features of the Fritchie Marsh Restoration Project are in good to excellent physical condition with only minor maintenance problems noted. Slight reflective cracking was noted in the asphalt pavement of Hwy 90 directly above the RCP culvert and some settlement of the shoulder material was observed. Slight erosion at the end of the stone riprap was noted on an earlier inspection but has not increased.

The constructed features of the Fritchie Marsh Restoration Project appear to be having the desired effect on the hydrology of Fritchie Marsh. Salinity is significantly lower and water levels are significantly higher since project construction has been completed, suggesting increased flow of freshwater into the project area. Although this response would be expected during the post-construction period due to post-drought conditions, a project effect was detected for both salinity and water level through a significant BA*CI interaction between the four continuous recorder stations. The strongest evidence of a project effect was at Station 60, which experienced the largest increase in water level following the construction of the 72-inch culvert under Hwy 90. It was also determined that salinity at Station 06, which is closest to Lake Pontchartrain, is being affected less by the project than the other stations. The flow data collected by LSU is currently being evaluated to correct suspected errors. When these errors are corrected, statistical tests will be used to explain the effects of flow volume on salinity at each of the monitoring stations during the pre-construction and post-construction periods. Based on the preliminary data analyzed and presented in this report, it appears that the project is having the desired effect.

b. Recommended Improvements

1. **<u>Maintenance Dredging of Salt Bayou</u>.** Salt Bayou provides the main hydrologic connection between the Hwy.90 culvert and the rest of the project area, and was therefore dredged during construction to increase freshwater transport into the project area. Installation of the Hwy. 90 culvert substantially increased the amount of water available to flow via Salt Bayou into the project area. However, full benefit of the culvert has not been seen as the actual increase in water flow through the project area does not appear to be proportional to the theoretical increase in water flow made available by installation of the culvert. It is recommended that a survey be conducted along Salt Bayou to determine the causes of the suspected water holdup. If it is determined that water flow into the project area can be substantially improved by additional dredging of Salt Bayou, a dredging effort should be initiated. It should be noted that dredged material placed along the bayou during construction has become vegetated so there is no problem with spoil placement as long as it does not extend 0.5-ft above average marsh elevation.

2. **Three-Party Management.** A significant portion of the project area has recently been purchased by the USFWS and is now a part of the Big Branch National Wildlife Refuge. A three-party meeting involving DNR, NRCS, and USFWS is recommended to ensure that all agencies are aware of the activities being conducted within the project area.

3. **Structural Assessment.** In order to evaluate weir settlement, stability of the structure, toe scour, any vertical accretion of the structure, and in-fill of the dredging efforts on Salt Bayou, a structural assessment survey performed by a licensed engineering/land surveying firm is recommended within the first 5 years of construction. The date of the assessment survey is to be agreed upon by the state and federal sponsor at the annual maintenance inspection.

4. **Minor Maintenance.** Several minor maintenance activities are recommended:
   - **a.** Re-grade the shoulders to remove the elevation differential between the pavement and the shoulder material.
   - **b.** Monitor the reflective cracking in the asphalt in the vicinity of the RCP culvert.
   - **c.** Monitor the erosion at the end of the stone riprap on the left descending bank of Salt Bayou.
   - **d.** Install a staff gauge on the outside of the culvert and tie into network.

c. Lessons Learned

Monitoring activities are inherently linked to project feature construction. Large temporal gaps between the initiating of pre-construction monitoring and project construction can often result in the need to repeat pre-construction monitoring data collection due to changes in site conditions if the temporal gap is too wide. Because of such a gap, an additional round of pre-construction habitat analysis and vegetation monitoring was conducted in the year 2000. Efforts should be taken in the future to improve coordination on future projects.

Climatic anomalies, such as drought, may confound hydrologic data results, especially in cases where a reference area was not monitored. In this case, however, a suitable reference area for hydrologic monitoring did not exist. The approved Coastwide Reference Monitoring System (CRMS) will alleviate this problem in the future by providing a network of 'reference' sites across the Louisiana coast. These sites may be used to help evaluate projects for which no suitable reference area exists.

The most important lesson we should learn in the selection and design of future marsh management projects is to properly consider the structural integrity of existing topographic features, i.e., spoil banks, cheniers, etc., that our project structures will depend on to function. In the event they can be compromised through subsidence, increased water velocity, or erosion during the 20-year life of the project, then proper consideration should be given to the maintenance efforts and costs and these costs should be included in the selection criteria. In

addition, project goals and objectives should be carefully considered and clarified to minimize the possibility of discrepancies and contradictions in project analysis and evaluation.

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