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Department of Natural Resources
Coastal Restoration Division and
Coastal Engineering Division

2007 Operations, Maintenance, and Monitoring Report

for

Jonathan Davis Wetland Protection

State Project Number BA-20
Priority Project List 2

July 30, 2007
Jefferson Parish

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Jonathan Davis Wetland Protection (BA-20)

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Preface

The 2007 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 2007 includes monitoring data collected through December 2006, and annual Maintenance Inspections through June 2007. Monitoring data collected in 2007 and maintenance inspections conducted between July 2007 and June 2008 will be presented in the 2008 OM&M Report.

I. Introduction

The Jonathan Davis Wetland Restoration (BA-20) project is located in Jefferson Parish within the Barataria Basin. It encompasses 7,199 acres (2,880 ha) of wetlands, which were classified as intermediate marsh in 1994 (Louisiana Department of Natural Resources [LDNR] 1998). The project is bounded on the north by the Pailet Canal, on the east by La. Hwy. 301, on the south by Bayous Perot and Rigolettes, and on the west by the Gulf Intracoastal Waterway (GIWW) (Figure 1).

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Overall, 1,393 ac (557 ha) of land were converted to open water between 1945 and 1989 (Coastal Environments Inc. 1991). The average rate of change from marsh to non-marsh (including loss to both open water and commercial development) has increased since the 1940s. Marsh loss rates were 0.56 %/yr between 1939 and 1956, 0.60 %/yr between 1956 and 1974, and 0.73 %/yr between 1983 and 1990 (Dunbar et al. 1992). In the National Biological Survey (NBS) Geographic Information System (GIS) habitat data from 1956, the majority of the area was characterized as fresh marsh (NBS 1994a). However, the 1978 and 1990 data indicated that the area had become more saline. In 1978, 1988, and 1990, the area was classified as primarily intermediate marsh (NBS 1994b; NBS 1994c; Chabreck and Linscombe 1988; respectively).

Large-scale factors influencing degradation in the Barataria Basin included subsidence, lack of sedimentation, and reduced freshwater influx due to the levee system on the Mississippi River and its major distributaries. The subsidence rate based on the U.S. Army Corps of Engineers (USACE) tide gauge readings (1947–78) at Bayou Rigaud, Grand Isle, Louisiana, was 0.80 cm/yr (Penland et al. 1989). Although some sediment entered via the GIWW, there were no substantial sources allowing inorganic sediment into the project area. In addition, the increase in oil field canals led to the exportation of indigenous inorganic and organic sediment during storm surges (U.S. Department of Agriculture, Soil Conservation Service 1994).

Additional factors that influenced wetland loss within the project area were increased water exchange, saltwater intrusion, tidal scour, and shoreline erosion along Bayous Perot and Rigolettes (U.S. Department of Agriculture, Soil Conservation Service 1994). Shoreline erosion from 1945 to 1989, caused primarily by wave action along Bayou Perot, was measured at 20 ft/yr (6.1 m/yr) (Coastal Environments Inc. 1991). Saltwater intrusion and tidal scour were enhanced during the construction of oil field canals dredged in the 1940s. At the time, oil companies were not responsible for maintaining a continuous spoil bank along canals. The resulting breaches were not repaired and the interior marsh was exposed to increased salinity and tidal flows during storm surges (U.S. Department of Agriculture, Soil Conservation Service 1993).

Project features consist of shoreline protection, rock armored plugs, rock weirs, and weirs with boat bays. Construction Unit No. 1 (CU1), which consists of project features 12, 13, 14, 15, 16, 17, 19, 20, and 21, was completed in September 1998 (Figure 2). Construction Unit No. 2 (CU2) was completed in May 2001. It encompassed the installation of a weir at site 22 and shoreline protection from Structures 20 to 22. Construction Unit No. 3 (CU3), which consists of shoreline protection extending from project feature 12 west to the Gulf Intracoastal Waterway, was completed on July 7, 2003. Construction of features 1, 2, 3, 6, 8, 9, 10, and 11 in the northern project area were deferred because: 1) The Davis Pond Diversion may have transformed these sites into avenues for freshwater (including fine-grain sediments and nutrients) entering the project area marshes from the north; 2) early attempts to secure landrights were unsuccessful; and 3) these sites did not appear to be causing any significant marsh erosion as a result of water exchange.

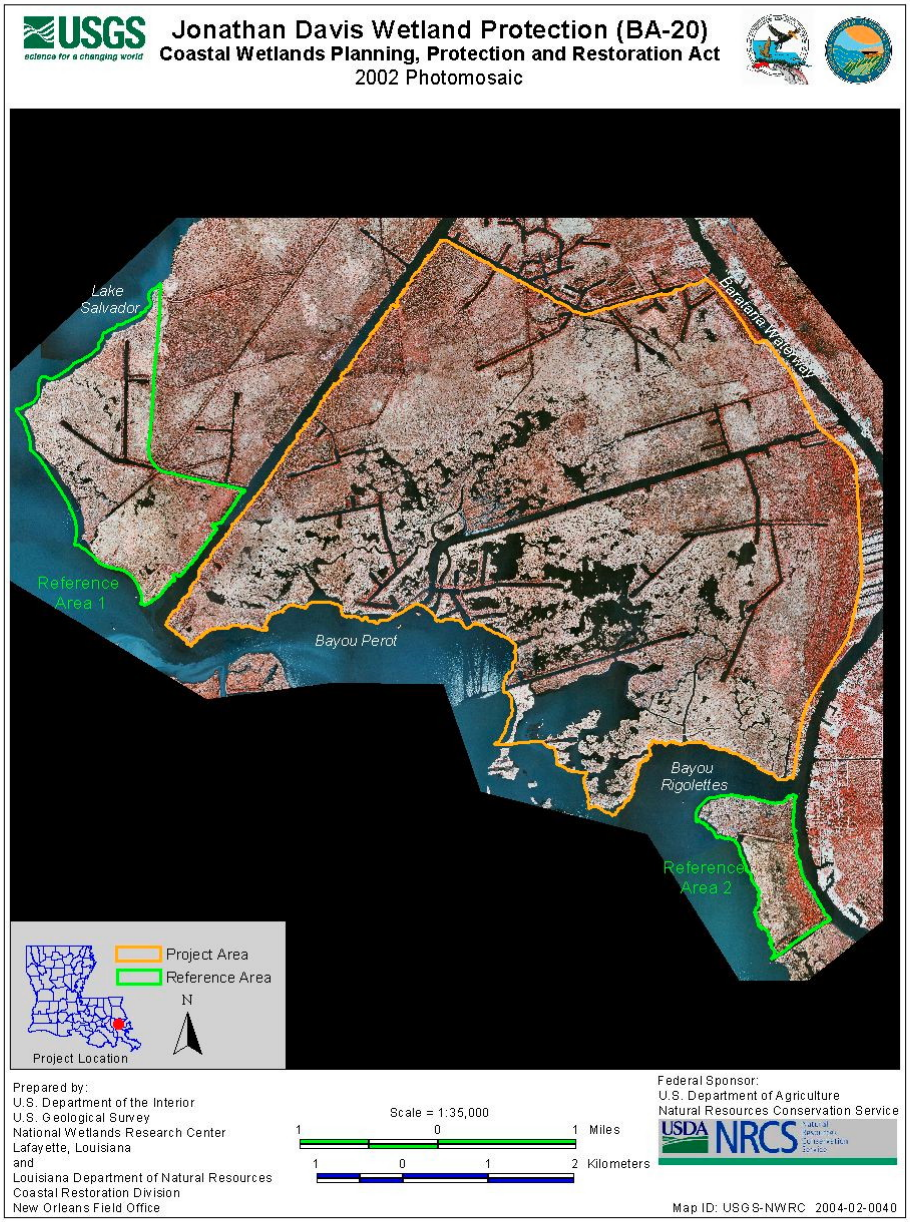


Figure 1. Jonathan Davis Wetland Restoration (BA20) 2002 photomosaic.

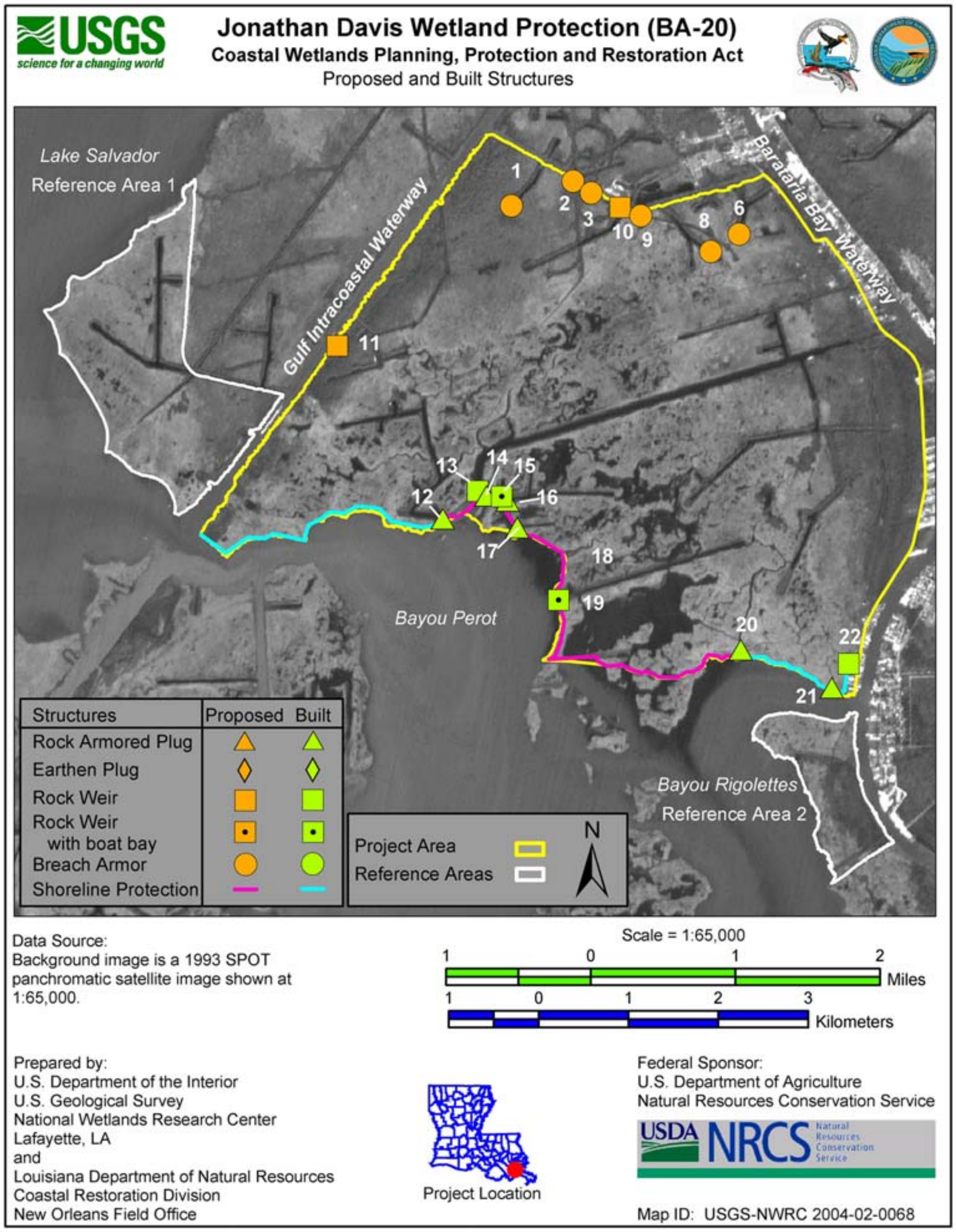


Figure 2. Project features for Jonathan Davis Wetland Restoration (BA-20) project.

II. Maintenance Activity

a. Project Feature Inspection Procedures

On January 30, 2002, Stone Energy Corporation was issued a Coastal Use Permit to plug and abandon existing wells within the Jonathan Davis Wetland Protection Restoration Project. This work was completed on July 18, 2002, and consisted of removing and replacing Structures 13 and 19. The cost associated with removing and replacing these structures was incurred entirely by Stone Energy Corporation. At the request of the Natural Resources Conservation Service (NRCS), LDNR was required to provide inspection services for this project. LDNR obtained the services of GSE Associates, Inc. to inspect the construction activities and prepare a project completion report and as-built drawings. These services were performed for a total cost of $9,394.13. The structure remained in this condition but NRCS and LDNR were researching the possibility of returning it to its original design.

As part of the construction documents prepared by NRCS for this project, Stone Energy Corporation was required to reconstruct Structure No. 13, increasing the boat bay crest from 50' to 100' in width and raising the crest elevation from -5.0' NGVD to -2.5' NGVD. No other maintenance work was performed on this project since the completion of CU3.

The purpose of the annual inspection of the Jonathan Davis Wetland Protection Project (BA-20) is to evaluate the constructed project features, identify any deficiencies, prepare a report detailing the condition of such features, and recommend any corrective actions (Babin 2002). In the event that corrective actions are needed, LDNR will provide a report containing a detailed cost estimate for engineering, design, supervision, inspection, construction contingencies, and an assessment of the urgency of such repairs (Babin 2002). The 2004 Annual Inspection Report contains a summary of maintenance projects performed since the completion of constructed features and the three year projected budget for operation and maintenance (Babin 2004).

An inspection of the Jonathan Davis Wetland Protection Project (BA-20) was held on March 20, 2007, by George Boddie, Barry Richard, Tom Bernard, and Peter Hopkins from LDNR; and Warren Blanchard of NRCS. There was a light southeast wind and the tide gauge, which was located approximately 0.8 miles north of C&M Marina on the east bank of the Barataria Bay Waterway, read +0.88 feet NAVD. Photographs of that inspection are included in Appendix A of this report.

b. Inspection Results

<u>Construction Unit No. 1</u>

Structure No. 12 – Rock rip-rap armored plug

The structure was in good condition. There was some slight settling near the edge of the plug adjacent to the two signs. All of the signs and supports were in good condition. At this time there is no need for any maintenance work to be done at this structure.

Structure No. 13 – Rock rip-rap armored weir w/ boat bay

We observed slight settlement on the west side of Structure No. 13. All signs and supports were in good condition. No maintenance will be required at this time. (Photo 1).

Structure No. 14 – Rock rip-rap armored plug

Upon a visual inspection, we noticed a large breach on the west side of the structure (Photos 2 and 3). Due to poor soil conditions, this structure has experienced significant settlement problems since the time it was constructed. Several attempts were made during construction to stabilize the structure by placing several lifts of rock, but the structure continued to settle. The maintenance work for this structure will be performed during the construction of Construction Unit 4 (CU4), which is expected to begin in the summer of 2007.

Structure No. 15 – Rock rip-rap weir w/ boat bay

Structure No. 15 appeared to be in good condition at the time of inspection, with little or no noticeable settlement of the rock weir (Photo 4). Signs and supports were also in good condition. The original design of this structure was modified to include a boat bay to accommodate oilfield activities and navigation on the interior marsh of the structure. During the construction of CU4, this structure will be modified so that it represents the original design more accurately. Construction Unit 4 (CU4) is scheduled to begin in the summer of 2007.

Structure No. 16 – Rock rip-rap channel plug

Structure 16 appeared to be in good condition with the exception of a low area on the south side of the channel plug (Photo 5). The maintenance work for this structure will be performed during the construction of Construction Unit 4 (CU4), which is scheduled to begin in the summer of 2007.

Structure No. 17 – Rock rip-rap channel plug

During the inspection, we observed significant settlement near the warning sign on the south side of the structure and just east of the warning sign on the north side of the structure (Photos 6 and 7). The maintenance of this structure will be performed during the construction of Construction Unit 4 (CU4), which is scheduled to begin in the summer of 2007.

Structure No. 19 – Rock rip-rap weir w/ boat bay

Structure No. 19 was in good condition with little signs of settlement of the rock weir. The warning signs and supports were also in good condition. NRCS and LDNR agreed that this structure did not require maintenance.

Structure No. 20 – Rock rip-rap armored plug

Structure 20 appeared to be in good condition with no signs of settlement of the rock weir. The warning signs and supports were also in good condition (Photo 8). NRCS and LDNR agreed that this structure did not require maintenance.

Structure No. 21 – Rock rip-rap armored plug

The rock armored plug was in good condition, with slight settlement on the east side of the structure. This was hard to fully assess due to the amount of growth on the structure. LDNR and NRCS agreed that the structure did not require maintenance.

Construction Unit No. 2

Structure No. 22 A – Canal bank stabilization

The structure looked to be in good condition. There were very few signs of settlement along the bank stabilization. LDNR and NRCS agree that maintenance of this structure is not needed at this time.

Structure No. 22 – Steel sheet pile weir w/ boat bay

The structure itself appears to be in good condition along with the signs, supports, and sheet pile caps (Photo 9). LDNR and NRCS agree that this structure will require no work at this time.

Bayou Rigolettes Bank Stabilization

The rock dike along the northern shore of Bayou Rigolettes appeared to be in good condition with a few signs of settlement (Photo 10). Maintenance work will not be needed at this time.

<u>Construction Unit No. 3</u>

<u>Bayou Perot Bank Stabilization</u>

The Bayou Perot Bank Stabilization was in good condition. There was some slight erosion at the western most portion of the structure (Photo 11). There was also some settlement between Sta. 90+00 and 92+00 (Photo 12). The maintenance work for this structure will be performed during the construction of Construction Unit 4 (CU4) which is scheduled to begin construction in the summer of 2007 (Photo 12).

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

None at this time.

ii. Programmatic/ Routine Repairs

The repairs noted at each structure will be included in the plans for Construction Unit 4.

III. Operation Activity

a. Operation Plan

There are no actively managed water control structures associated with this project; therefore no Structural Operation Plan was required.

b. Actual Operations

There are no actively managed water control structures associated with this project; therefore no required structural operations were required.

IV. Monitoring Activity

a. Monitoring Goals

<u>Project Objectives:</u>

1. Use structural measures to restore hydrologic conditions that reduce water level and salinity fluctuations (variability) and allow freshwater retention to increase the quantity and quality of emergent vegetation.

2. Reduce wetland loss through hydrologic restoration and reduce erosion through shoreline protection.

Specific Goals:
The following goals contributed to the evaluation of the above objectives:

1. Reduce rate of emergent marsh loss.

2. Decrease variability in salinity within the project area.

3. Decrease variability in water level within the project area.

4. Reduce marsh edge erosion rate along southern project boundary.

5. Stabilize or increase relative abundance of intermediate-to-fresh marsh plant species.

b. Monitoring Elements

Habitat Mapping:
Aerial photography was used to document marsh to open-water ratios and marsh loss rates as well as changes in vegetative community type. Color-infrared aerial photography (1:12,000 scale, with ground control markers) was obtained for both project and reference areas in 1994, 1997, and 2003, and will be collected in 2014.

Salinity:
Salinity was sampled hourly at three continuous recorders located within the project area and three located at reference sites (Figure 3). Salinity was sampled monthly at 17 discrete stations using a salinometer (Figure 4). Discrete data were used to characterize the spatial variation of salinity throughout the project and reference areas. These data will be used in concert with data collected from the continuous recorders to statistically model the system. Pre-construction monitoring for CU1 began in December 1995 and ended in October 1998 and Post-construction monitoring began in October 1998 and ended in August 2005. Pre-construction monitoring for CU2 began in March 1996 and ended in July 2001 and post-construction monitoring began in August 2001 and ended in August 2005.

Water Level:
Water levels were measured hourly at three continuous recorders inside the project area and three within the reference areas. One staff gauge was located next to each continuous recorder to compare recorded water levels to a known datum (NAVD 88). Marsh elevations were surveyed near each station and combined with water elevations to

calculate the duration and frequency of marsh flooding. Pre-construction monitoring for CU1 began in December 1995 and ended in October 1998 and post-construction monitoring began in October 1998 and ended in October 2003. Pre-construction monitoring for CU2 began in March 1996 and ended in July 2001 and post-construction monitoring began in August 2001 and ended in August 2005.

Shoreline Change:

To evaluate shoreline change, a Differential GPS (DGPS) was used to document marsh edge position. Several discrete stations were established along the 34,000 ft (10.4 km) of the rock rip-rap shoreline protection structure. Points were established on the actual structure as well as on the marsh edge adjacent to and behind the structure at maximum intervals of 50 ft (15.2 m). Stations were established at 50 ft intervals along the marsh edge in the reference area southeast of the project area. In addition, historical rates (as ft/yr loss) of erosion were obtained and compared to erosion rates after project implementation. As shoreline protection features were constructed, surveys were conducted post-construction and will be conducted in years 3, 6, 9, 12, 15, and 18.

Vegetation:

Vegetation sampling plots (stations) were established along five transects parallel to the GIWW spanning the project area. Surveys were conducted in 1996, 1999, and 2002. Species composition and relative abundance were evaluated in the project and reference areas using the Braun-Blanquet method. Plot sizes were 2 X 2 m, and were sampled at 0.8 km increments for a total of 28 stations within the project area. Four transects were established in two reference areas, yielding eight stations. These data will be supplemented with data from future CRMS stations and Chabreck and Linscombe data sets.

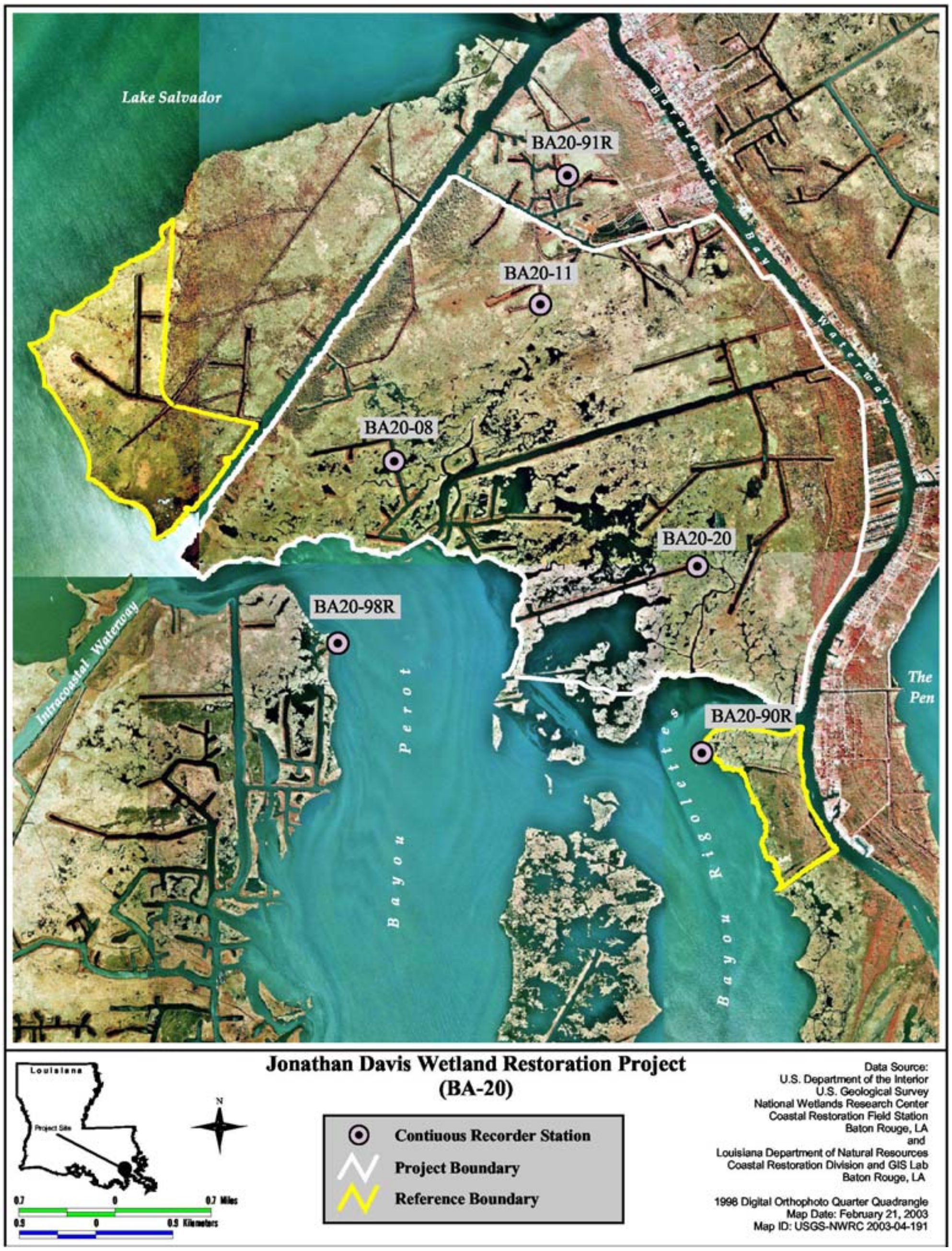


Figure 3. Continuous hydrographic recorder stations in Jonathan Davis Wetland Restoration (BA-20).

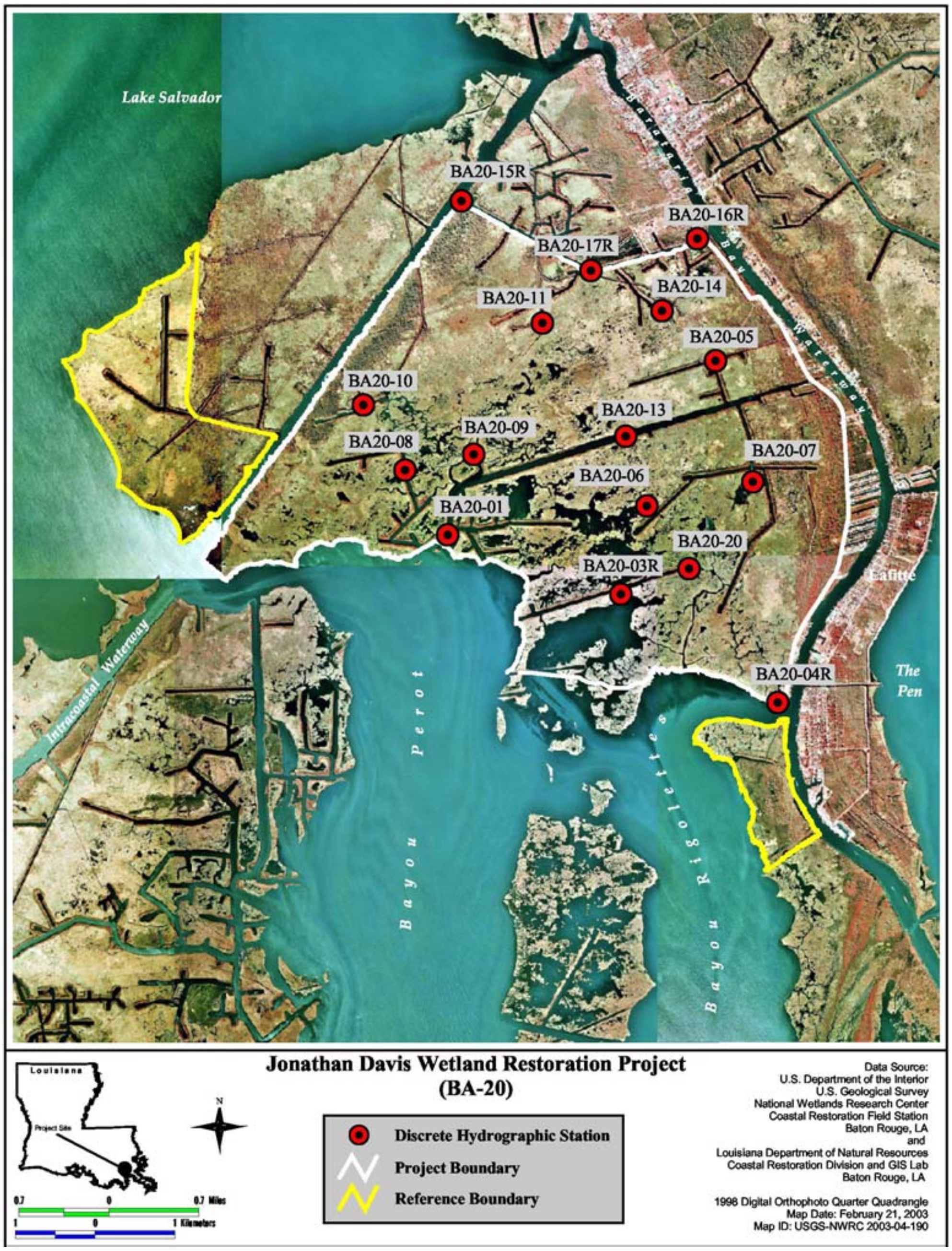


Figure 4. Discrete hydrographic stations at Jonathan Davis Wetland Restoration (BA-20).

c. Preliminary Monitoring Results and Discussion

Note: This is a comprehensive report and includes all data collected from the pre-construction period and the post-construction period through January 2005.

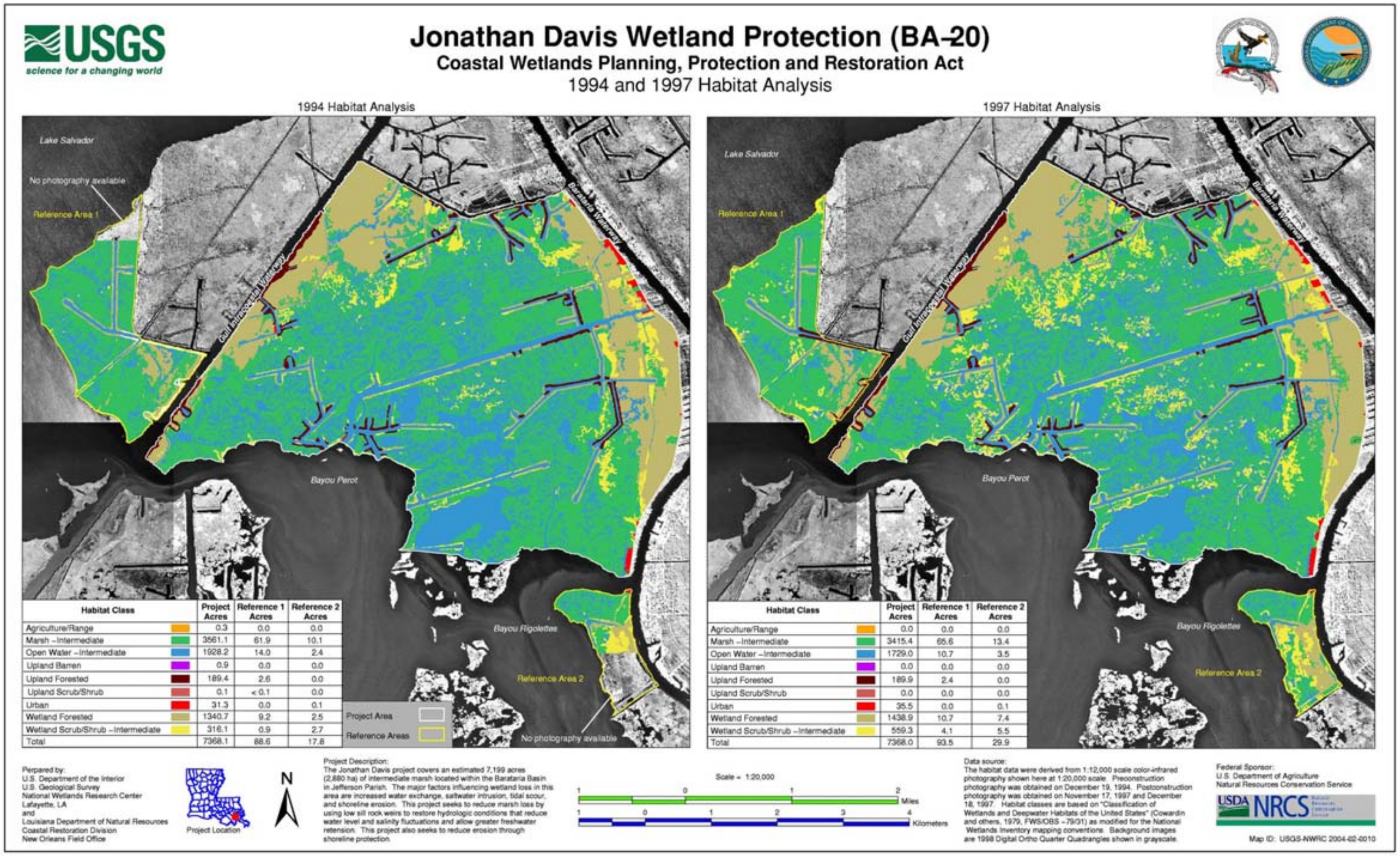
Habitat Mapping:

Recent and ongoing work by the U.S. Geological Survey (USGS) (John Barras and others) has revealed considerable variability in habitat and land:water classifications due to 1) clarity of image; 2) water level at time image was taken; 3) seasonality; 4) difficulty in distinguishing submerged, floating, and emergent vegetation; and 5) in the case of floating marshes, variable mat buoyancy and frequent vegetative changes. USGS has cautioned LDNR and NRCS regarding the simple comparison of imagery from two or three dates as a means of determining a change or trend in habitat types or land:water ratio. It is Barras' opinion that one must analyze imagery from a series of dates, and give consideration to water level at time images were taken, seasonality, the potential for misclassification of submerged, floating, and emergent vegetation, and variable mat buoyancy.

Pre-construction information regarding the land:water analysis is presented in Figure 5 with the caveat that the analysis should be used only for predicting trends. The habitat analysis completed in 2002 is presented in Figure 6. There was little change from 1997 to 2002 and this variability could be attributed to misclassification of vegetation types. Open water increased by 56 acres; however, both photographs were taken in December when water levels are low, making it difficult to distinguish between low water areas and established land.

Salinity:

Salinity at the continuous recorder stations followed the same general pattern from 1995 through 2003. Salinity spikes occurred in October 1996 and September 1998 from an influx of seawater caused by Hurricane Josephine and Hurricane Georges, respectively (Figures 7 and 8). A prolonged drought, declared by the National Weather Service, occurred from August 1999 to November 2000. Salinities peaked during the middle and end of this period. Above average rainfall caused a rapid salinity decrease during the winter of 2000-2001. In early June 2001, increased rainfall associated with Tropical Storm Allison further decreased salinities, creating near-freshwater conditions. Two tropical systems, Tropical Storm Isidore and Hurricane Lili, passed through southern Louisiana in late September and early October of 2002. Salinity barely increased in the project area, while the reference area experienced a higher peak (approximately 1 ppt higher than in the project area). Salinities fell rapidly after the passage of each storm. Fresh and intermediate vegetation should not have been negatively affected by such a miniscule salinity fluctuation. During the pre-construction and post-construction time periods, discrete salinity measurements revealed that mean salinities increased from the northern project area southward (down the estuary), as expected.



1994 Habitat Analysis

Habitat Class	Project Acres	Reference 1 Acres	Reference 2 Acres
Agriculture/Range	0.3	0.0	0.0
Marsh –Intermediate	3561.1	61.9	10.1
Open Water –Intermediate	1928.2	14.0	2.4
Upland Barren	0.9	0.0	0.0
Upland Forested	189.4	2.6	0.0
Upland Scrub/Shrub	0.1	< 0.1	0.0
Urban	31.3	0.0	0.1
Wetland Forested	1340.7	9.2	2.5
Wetland Scrub/Shrub –Intermediate	316.1	0.9	2.7
Total	7368.1	88.6	17.8

1997 Habitat Analysis

Habitat Class	Project Acres	Reference 1 Acres	Reference 2 Acres
Agriculture/Range	0.0	0.0	0.0
Marsh –Intermediate	3415.4	65.6	13.4
Open Water –Intermediate	1729.0	10.7	3.5
Upland Barren	0.0	0.0	0.0
Upland Forested	189.9	2.4	0.0
Upland Scrub/Shrub	0.0	0.0	0.0
Urban	35.5	0.0	0.1
Wetland Forested	1438.9	10.7	7.4
Wetland Scrub/Shrub –Intermediate	559.3	4.1	5.5
Total	7368.0	93.5	29.9

Figure 5. Habitat analysis of Jonathan Davis Wetland Restoration (BA-20) from 1994 to 1997.

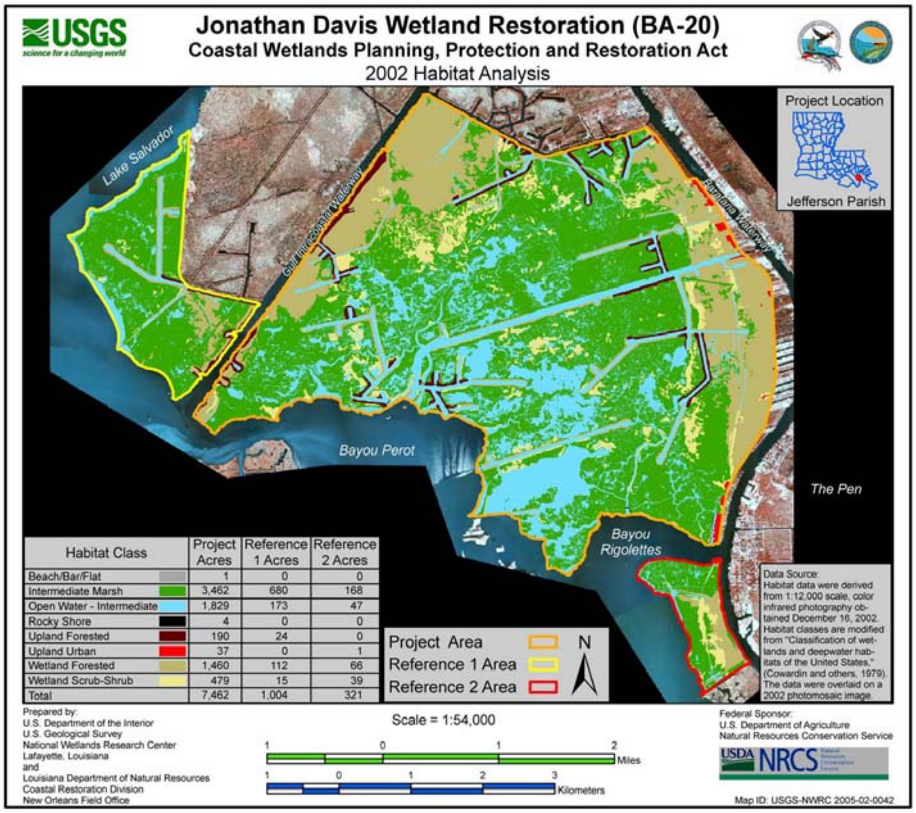


Figure 6. Habitat analysis of Jonathan Davis Wetland Restoration (BA-20) in 2002.

Comparison of weekly mean salinity for east sondes at Jonathan Davis Wetland Restoration (BA-20) during the entire monitoring period (1998-2005).

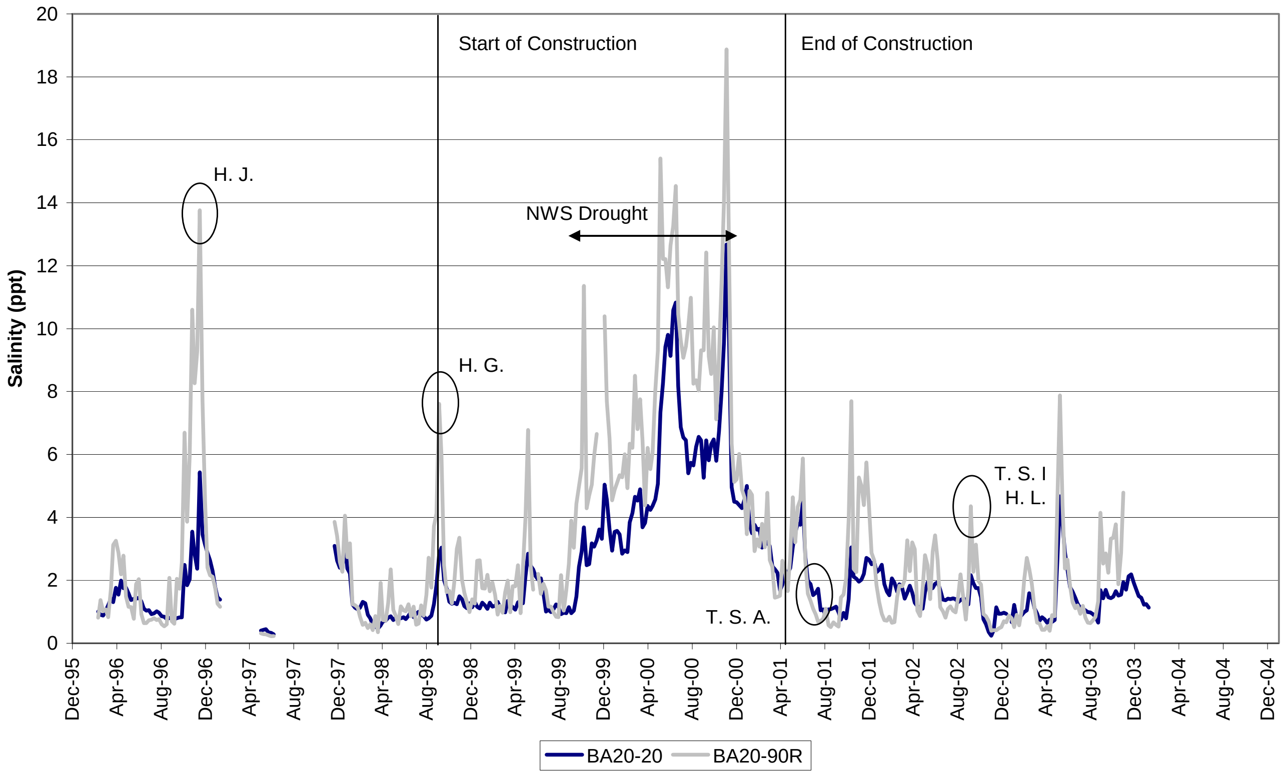


Figure 7. Comparison of weekly mean salinity for Jonathan Davis Wetland Restoration, eastern sondes (20 and 90R). The following storms are referenced in the chart: Hurricane Josephine (H. J.), Hurricane Georges (H. G.), Tropical Storm Allison (T. S. A.), Tropical Storm Isidore (T. S. I.), and Hurricane Lili (H.L.).

Comparison of weekly mean salinity for west sondes at Jonathan Davis Wetland Restoration (BA-20) during the entire monitoring period (1998-2005).

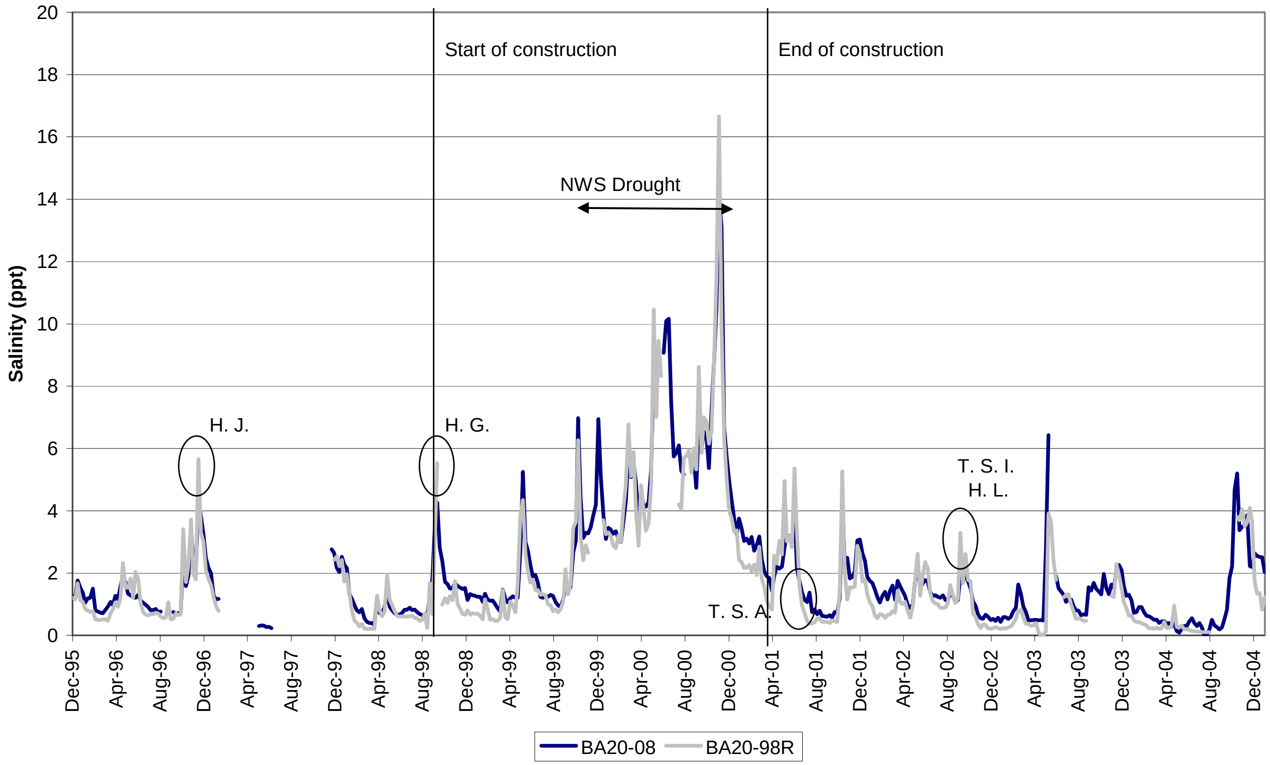


Figure 8. Comparison of weekly mean salinity for Jonathan Davis Wetland Restoration, western sondes (20 and 90R). The following storms are referenced in the chart: Hurricane Josephine (H. J.), Hurricane Georges (H. G.), Tropical Storm Allison (T. S. A.), Tropical Storm Isidore (T. S. I.), and Hurricane Lili (H.L.).

Delayed and staggered construction led to complications while testing project impact on overall mean salinity. Incomplete construction across the southern edge of the project area made it difficult to distinguish project effects from widespread regional influences. For this reason, separate tests were made on the eastern and western sections (each with separate, relative construction units). A third analysis tested the project as a whole by comparing three stages of construction.

Both of the separate east and west analyses compared salinity during the pre-construction period to salinity during the post-construction period using measurements from stations within the area of project impact ("project") paired with measurements from control stations outside the area of project impact ("reference"). The statistical model follows a 2X2 factorial analysis of variance (ANOVA) in which evidence for project impact comes only in the form of a statistically significant interaction between the main effects (*period* and *location*). This is an application of the BACI paired series design discussed in Stewart-Oaten et al. (1986), Underwood (1994), and Smith (2002).

A third, overall analysis tested for impact using a 3X2 BACI ANOVA in which the variable *period* was broken into pre-construction, during-construction, and post-construction periods as described below.

The statistical models depend on simultaneity of measurements among the various stations. For this reason, hourly salinity measurements were aggregated into weekly means, one week being enough time to average out temporal lags among the stations during tidal and meteorological events. Another advantage to using weekly means is that they exhibit less serial correlation than hourly means; an important underlying assumption of the statistical model is sample independence.

Hourly salinity measurements were transformed into common logarithms in order to meet assumptions of normal distribution and uniform variance. These log salinities were then aggregated into weekly means on which the statistics are based. Distributional assumptions were confirmed using exploratory data analysis and by *randomization testing*, a very robust but computation-intensive resampling technique.

The analysis was run using Proc GLM in SAS© Version 9 with *period* and *location* as fixed effects.

There were two different time periods in each analysis (pre-construction and post-construction). The eastern region, consisting of BA20-20 and BA20-90R, had pre-construction times of December 1995 – May 2001 and post-construction times of May 2001 – January 2005. The western region, consisting of BA20-08 and BA20-98R, had pre-construction times of December 1995 – September 1998 and post-construction times of September 1998 – January 2005. The third, overall analysis used three time periods, consisting of pre-construction December 1995 – September 1998, during-construction September 1998 – May 2001, and post-construction May 2001 – January 2005.

A special note must be made about BA20-11 and BA20-91R. These sondes were located on the northern edge of the project area (Figure 3). The original project specification included instructions for several structures to be built along the northern edge, including 1, 2, 3, 6, 8, 9, 10, and 11 (Figure 2). The structures were not built, but the data was still collected from these sondes. Because there were no structures between the project sonde (BA20-11) and the reference area sonde (BA-91R), there was no reason to expect an environmental effect as a result of the project. If there is a difference between the two sondes, it would most likely be due to pre-existing environmental factors. If structures in the southern area of the project caused a north-south gradient that extended as far north as the sondes in question there could be a project effect. However, it was unlikely to produce a measurable effect between the two sondes in question.

In the eastern project area, a test on the *period*location* interaction showed a statistically significant impact ($p = 0.0035$). This shows up graphically as lines out of parallel in Figure 9, which shows that salinity decreased slightly more at the reference station than it did inside the project. The statistical significance reflects the size of the data set, not the size of the impact, which was modest, amounting to a departure of less than one-half part per thousand from what would be expected if there were no impact.

The western project area also experienced a statistically significant impact ($p = 0.0355$). This shows up graphically as lines out of parallel in Figure 10, which shows that salinity increased slightly more in the project area than in the reference area. Again, the statistical significance corresponds to an impact with only modest biological significance, a departure of less than one half part per thousand from what would be expected had there been no impact.

The 3X2 BACI analysis of the complete southern project area (comprising sondes 08, 20, 90R, and 98R) also registered a statistically significant impact ($p < 0.0001$). This shows up graphically in Figure 11 as a reversal of relative salinities between the during-construction and post-construction periods. As in the other tests, the size of the impact was modest, representing a departure of less than one half part per thousand from what would be expected had there been no impact. Project and reference mean salinity increased about equally in the "during-construction" time period, a result of the drought that characterized much of the during-construction period.

One of the project objectives was to reduce salinity fluctuations, with the specific goal of decreasing salinity variability within the project area. In order to evaluate project impact on salinity variability, a folded F-test on salinity variance was performed for the eastern project area and for the western project area. Vegetation can more easily recover from hourly or daily exposures to stressful salinity levels (Visser 2007), so a variance estimate of the weekly mean salinity was used for the analysis.

In the eastern project area (as measured by station 20) post-construction variance ($s^2 = (0.66 \text{ ppt})^2$) was significantly lower ($p < 0.0001$) than the pre-construction variance ($s^2 = (2.19 \text{ ppt})^2$). This is probably a reflection of widespread conditions outside the project, where the change was more pronounced (1.41^2 versus 3.52^2, $p < 0.0001$, at station 90R).

In the western project area (as measured by station 08) post-construction variance (s^2 = $(2.10\ \text{ppt})^2$) was significantly higher ($p < 0.0001$) than the pre-construction variance (s^2 = $(0.87\ \text{ppt})^2$). This is probably a reflection of widespread conditions outside the project, where a comparable change occurred (2.20^2 versus 1.00^2, $p < 0.0001$, at station 98R).

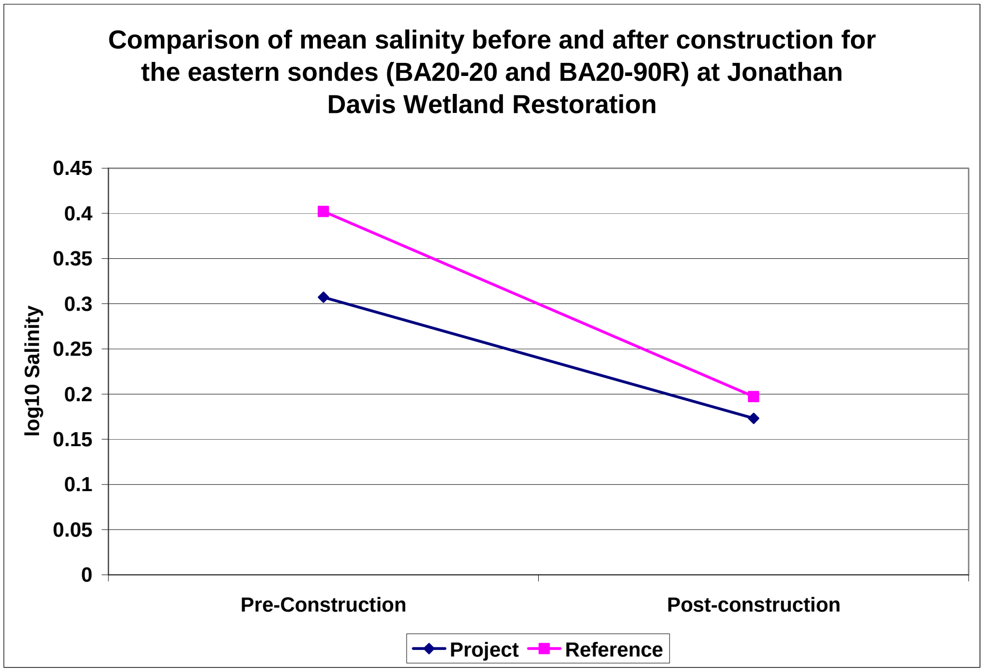


Figure 9. Comparison of mean salinity of eastern sondes (BA20-20 and BA20-90R).

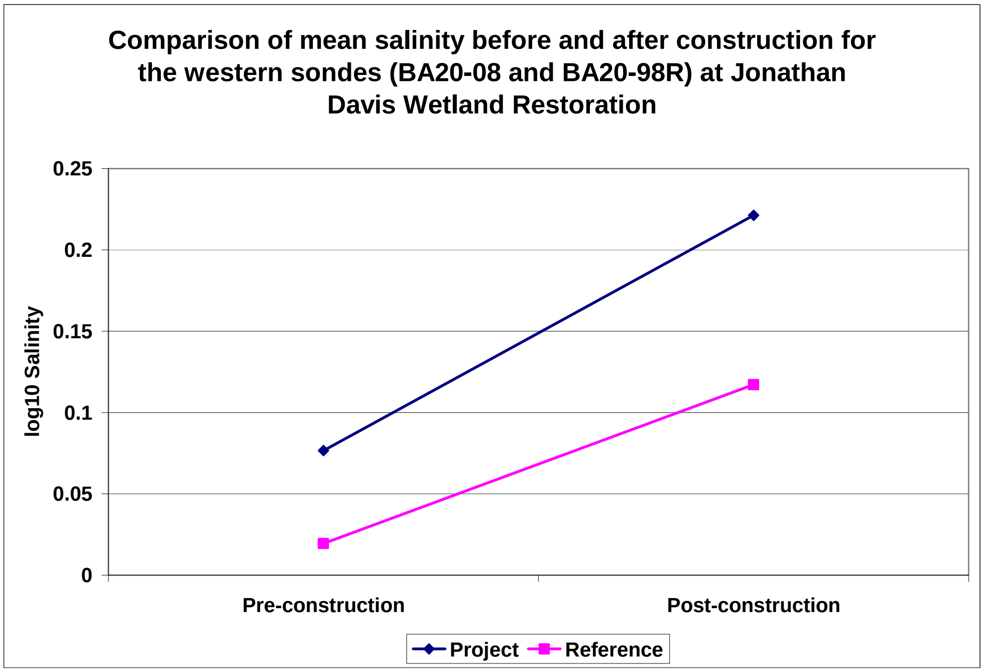


Figure 10. Comparison of mean salinity of western sondes (BA20-08 and BA20-98R).

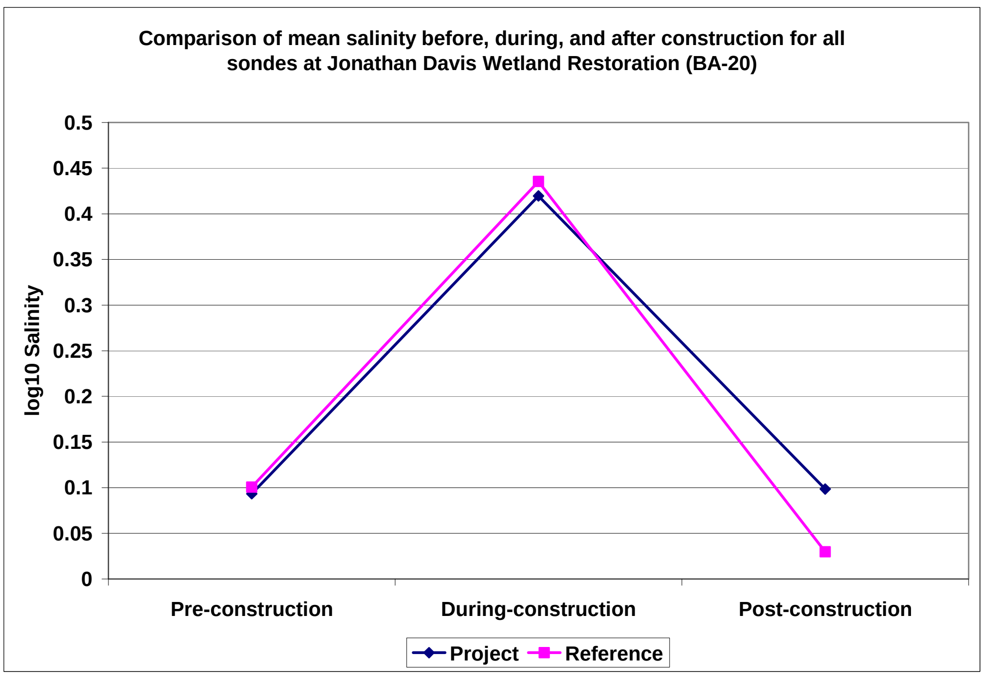


Figure 11. Comparison of mean salinity of all sondes (BA20-20, BA20-90R, BA20-08, and BA20-98R).

Water Level:

Water elevation at each continuous recorder station followed the same general pattern from 1997 through 2005. Water elevations were higher in spring, early summer, and fall, while lower levels occurred in late summer and winter (Figure 12). Heavy rainfall and storm surges associated with Hurricane Georges increased water elevations in September and October 1998. Tropical Storm Isidore and Hurricane Lili caused similar increases in September and October 2002.

Because continuous recorder stations 8 (project area) and 98R (reference area) are separated by the southwestern structures, and 20 (project area) and 90R (reference area) are separated by the southeastern structures, mean monthly water elevations were compared between stations 8 and 98R, and stations 20 and 90R. Stations 11 (project area) and 91R (reference area), located in the northern area, were not compared because it was decided that the northern structures would not be built.

Water elevations were similar in both project and reference areas except during major weather events (Figure 12). For example, in September 1998, Hurricane Georges caused a greater water level increase in the reference area than in the project area. Construction of the southwestern structures was almost complete at the time. It is possible that they may have reduced elevation increases caused by storm surges.

Variability in Water Level:

One of the stated goals of the project was to reduce water level fluctuations with the specific goal of reducing variability in water level within the project area.

One straightforward way to analyze water level variability is to study the sample variance, which is the purest estimate of the variability of a measurement. Because hourly and daily periods are considered too brief to apply much stress to marsh vegetation (Visser 2007), a variance estimate of the weekly mean water level gives a more meaningful statistic. The pre-construction water level variance of the weekly mean at each project station was compared to the post-construction variance using the folded F-test feature of Proc Ttest in SAS© Version 9.

East side: The post-construction variance at station BA20-20 (s^2 = $(0.4405\ \text{ft})^2$) was slightly lower than the pre-construction variance (s^2 = $(0.4556\ \text{ft})^2$) (Figure 13). The decrease was not statistically significant (p = 0.7134). Over the same period, the associated reference station, BA20-90, showed a slight but not statistically significant decrease in water level variance ($(0.4622\ \text{ft})^2$ versus $(0.4903\ \text{ft})^2$, p = 0.2087).

West side: The post-construction variance at station BA20-08 (s^2 = $(0.4353\ \text{ft})^2$) was slightly lower than the pre-construction variance (s^2 = $(0.5319\ \text{ft})^2$) (Figure 14). Statistically, the decrease was marginally significant (p = 0.0643). Over the same period, the associated reference station, BA20-98, showed virtually no change in water level variance ($(0.8456\ \text{ft})^2$ versus $(0.8428\ \text{ft})^2$, p > 0.9999).

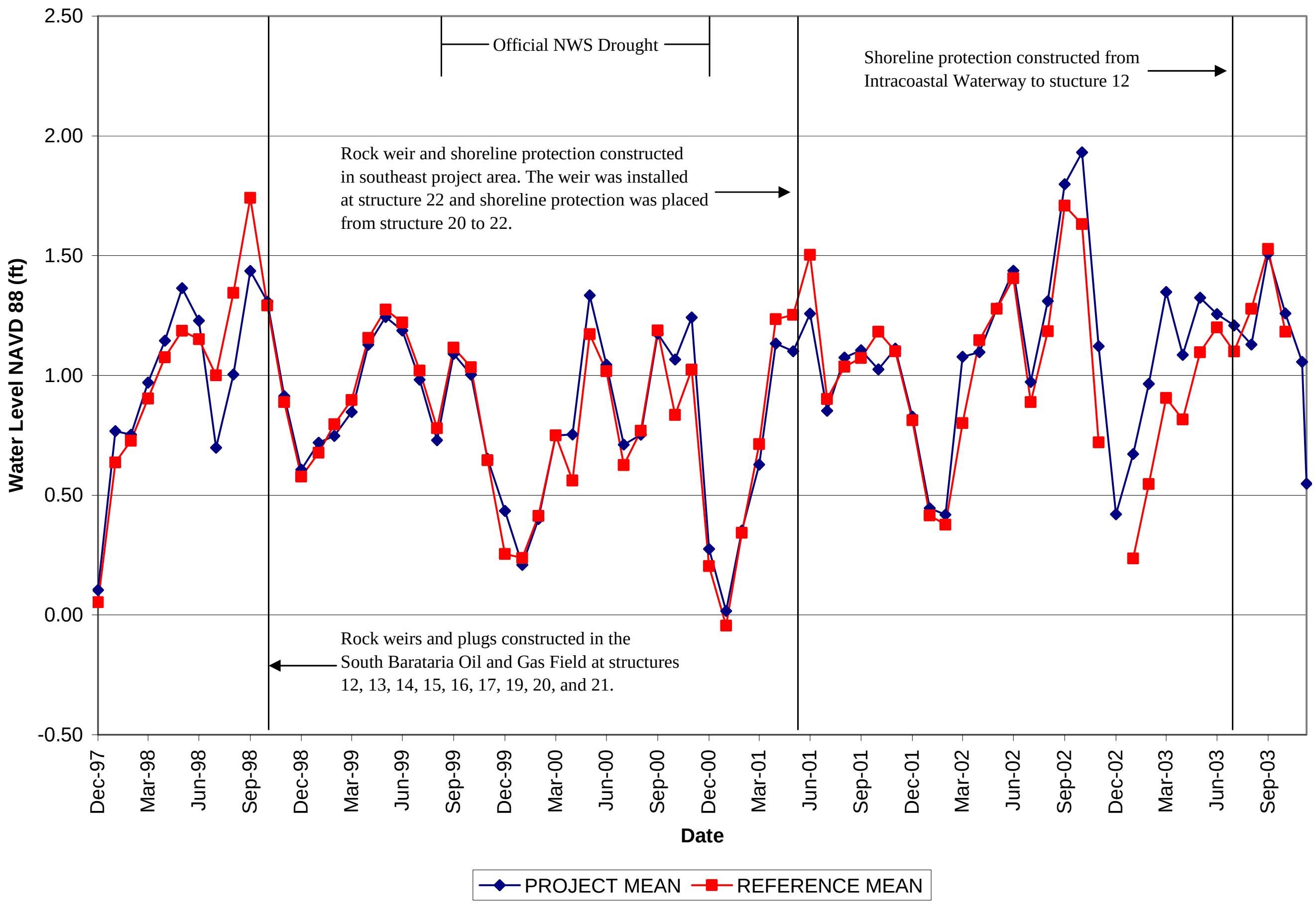


Figure 12. Mean monthly water levels NAVD 88 (feet) collected by continuous recorders in project and reference areas from December 1997 through December 2003.

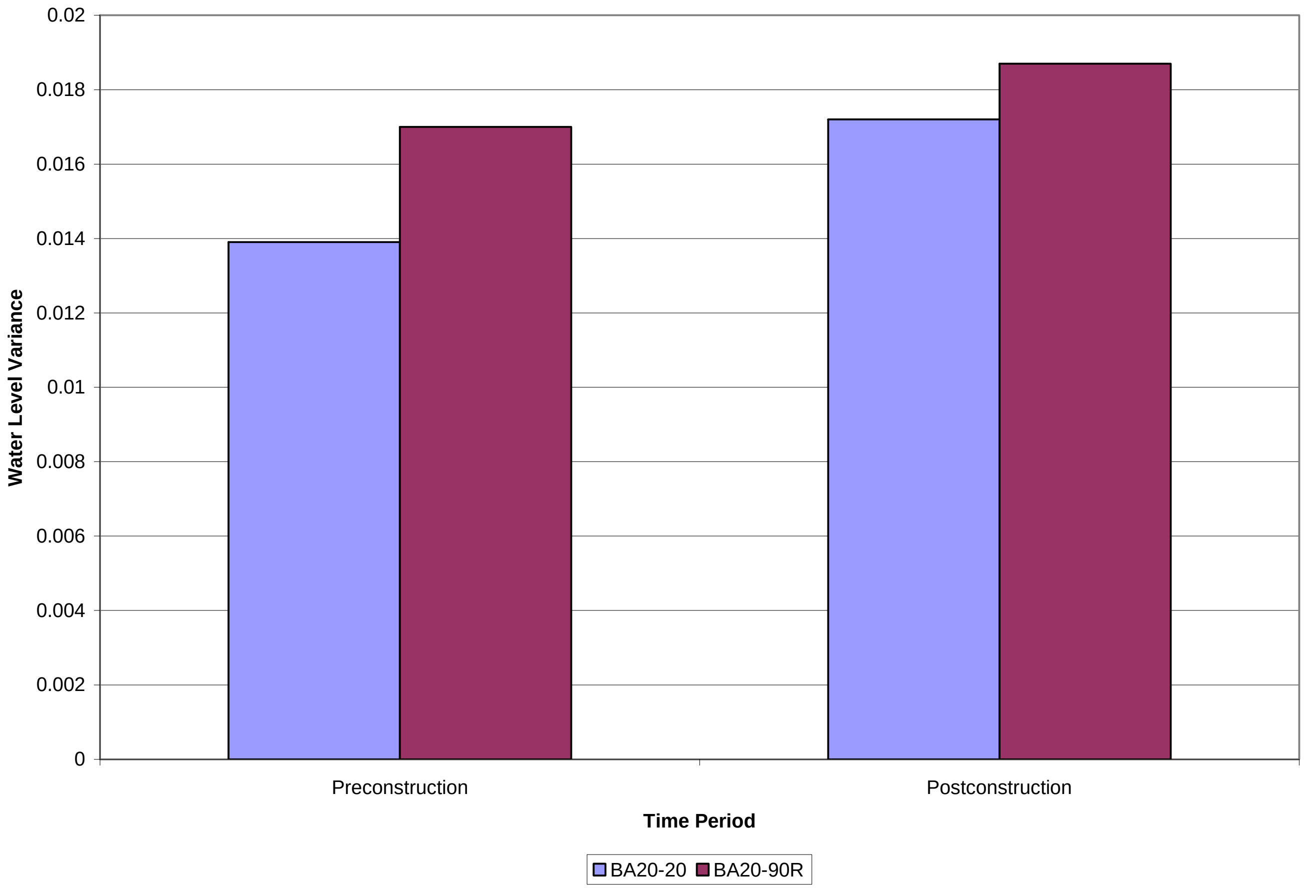


Figure 13. Mean water level variance NAVD 88 (feet) at continuous recorder stations BA20-20 (inside project area) and BA20-90R (reference area) during pre-construction and post-construction time periods.

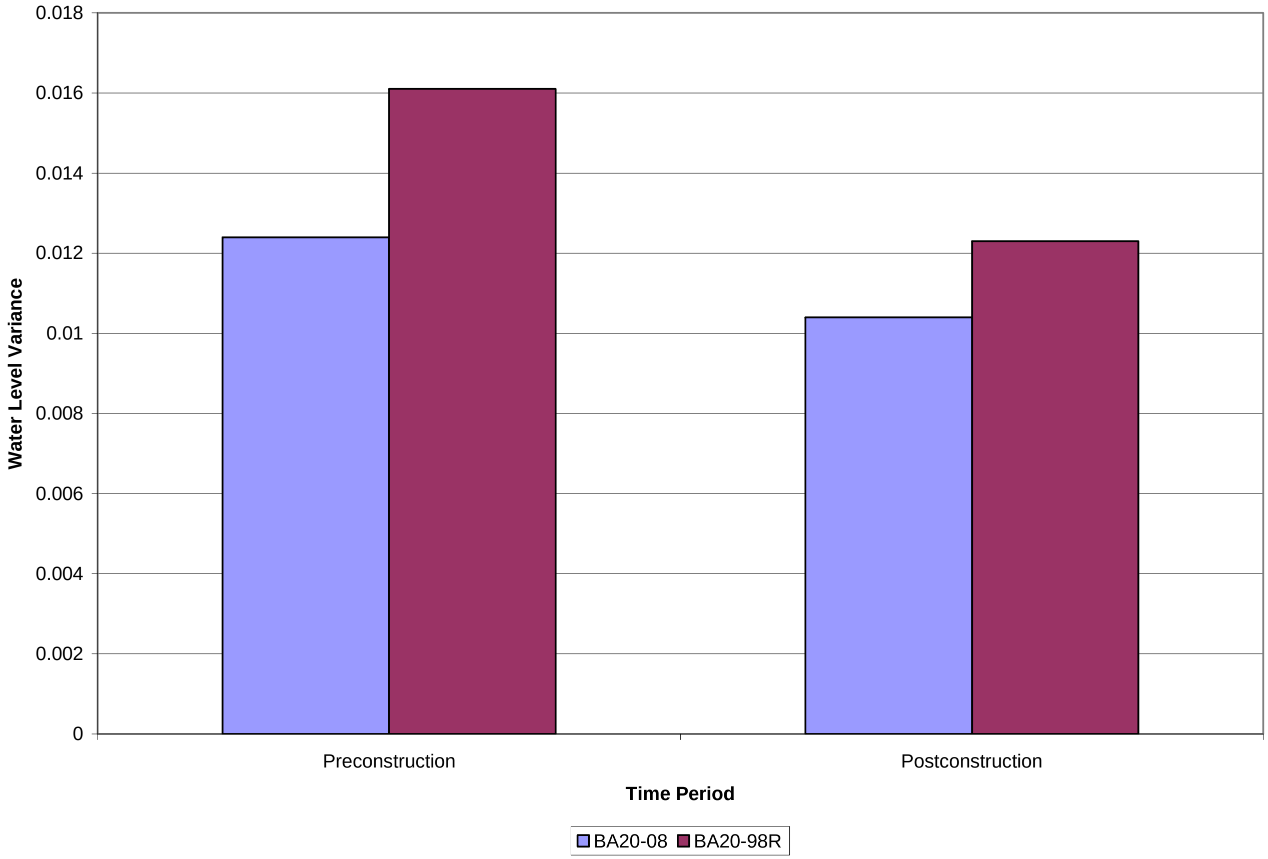


Figure 14. Mean water level variance at continuous recorder stations BA20-08 (inside project area) and BA20-98R (reference area) during pre-construction and post-construction time periods.

Shoreline Change:

Shoreline change analysis of Jonathan Davis showed a land gain rate of 4 ft/year in the project area a land loss rate of 8 ft/year in the adjacent reference area (Figure 15). This reference area can no longer be used due to the construction of the BA-27d project. The BA-27d project now protects the original reference area. In future analysis, it is suggested that the BA-20 post-construction rate of land gain be compared to the USGS generated pre-construction rate of land loss.

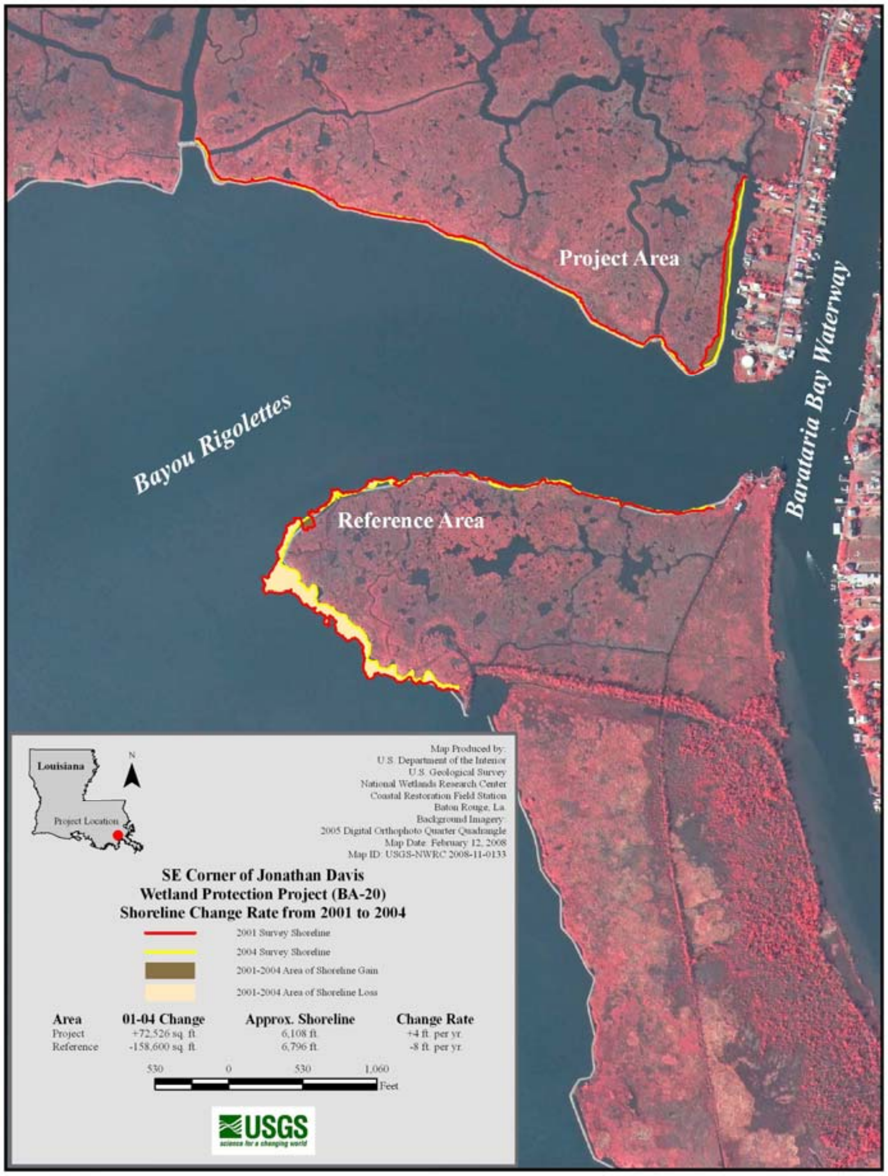


Figure 15. Shoreline change at BA20 (Jonathan Davis Wetland Restoration) from 2001 to 2004.

Vegetation:

Reference and project area vegetation mean percent cover changed similarly from 1996 to 1999 and from 1999 to 2002 (Figures 16 and 17, respectively). With decreases in *Sagittaria lancifolia* and increases in *Spartina patens*, both project and reference areas reflected a trend towards a higher percent cover of salt tolerant vegetation and a lower percent cover of fresh water plants. This was likely an effect of the drought from August 1999 to November 2000.

However, it should be noted that within the project area the mean percent cover of *Sagittaria lancifolia* decreased from approximately 68% to 28%, whereas the decrease in the reference area was more pronounced (from approximately 64% to 14%). Within the project area the mean percent cover of *Spartina patens* increased from approximately 24% to 36%, whereas the increase in the reference area was approximately 23%. These data suggested that because the effect of the drought (i.e., the trend towards a higher percent cover of salt tolerant vegetation) was more pronounced in the reference area, the project features may have retarded the drought-induced trend within the project area.

A simple comparison of the number of species present in all project vegetation stations and all reference stations revealed that project area richness had steadily increased. In 1996, the project area had 27 distinct species, rising to 30 in 1999 and to 32 in 2002. The reference area had 25 species in 1996, 29 species in 1999, and only 15 species in 2002. A comparison of the 11 most common occurring species revealed that *Sagittaria* was dominant in both the project and the reference area (Figures 18 and 19, respectively).

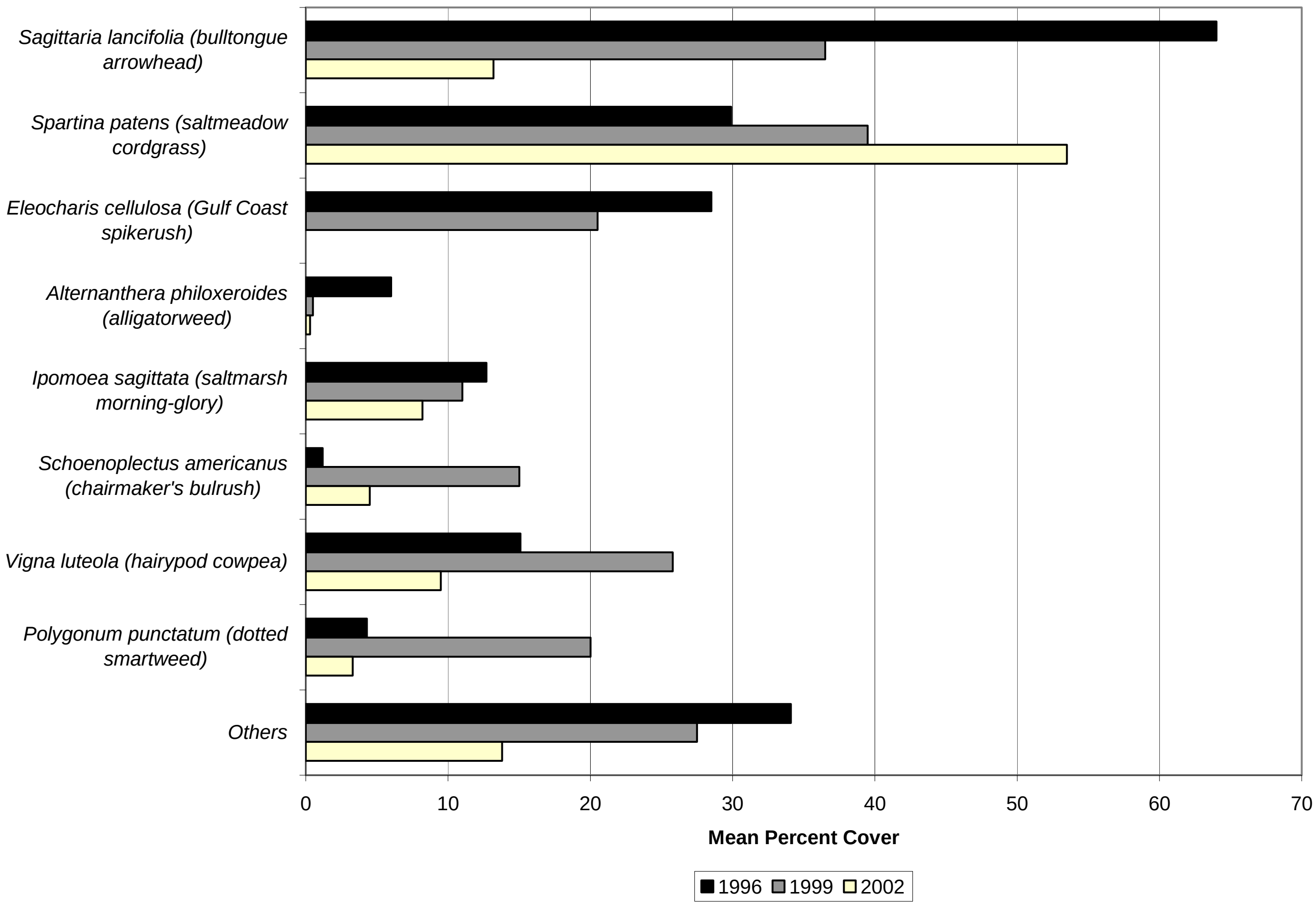


Figure 16. The 1996, 1999, and 2002 mean percent cover across all vegetation stations within the reference area.

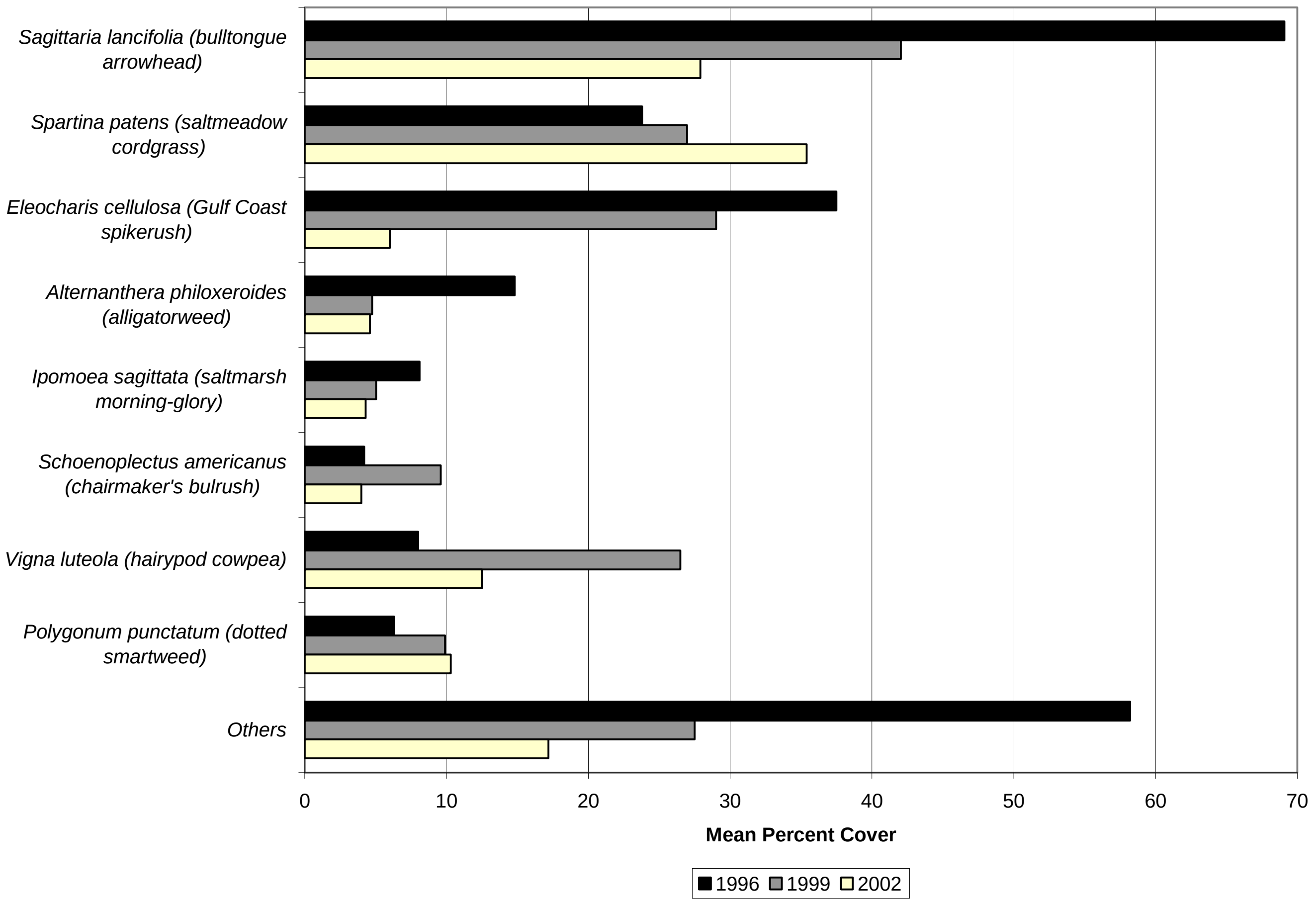


Figure 17. The 1996, 1999, and 2002 mean percent cover across all vegetation stations within the project area.

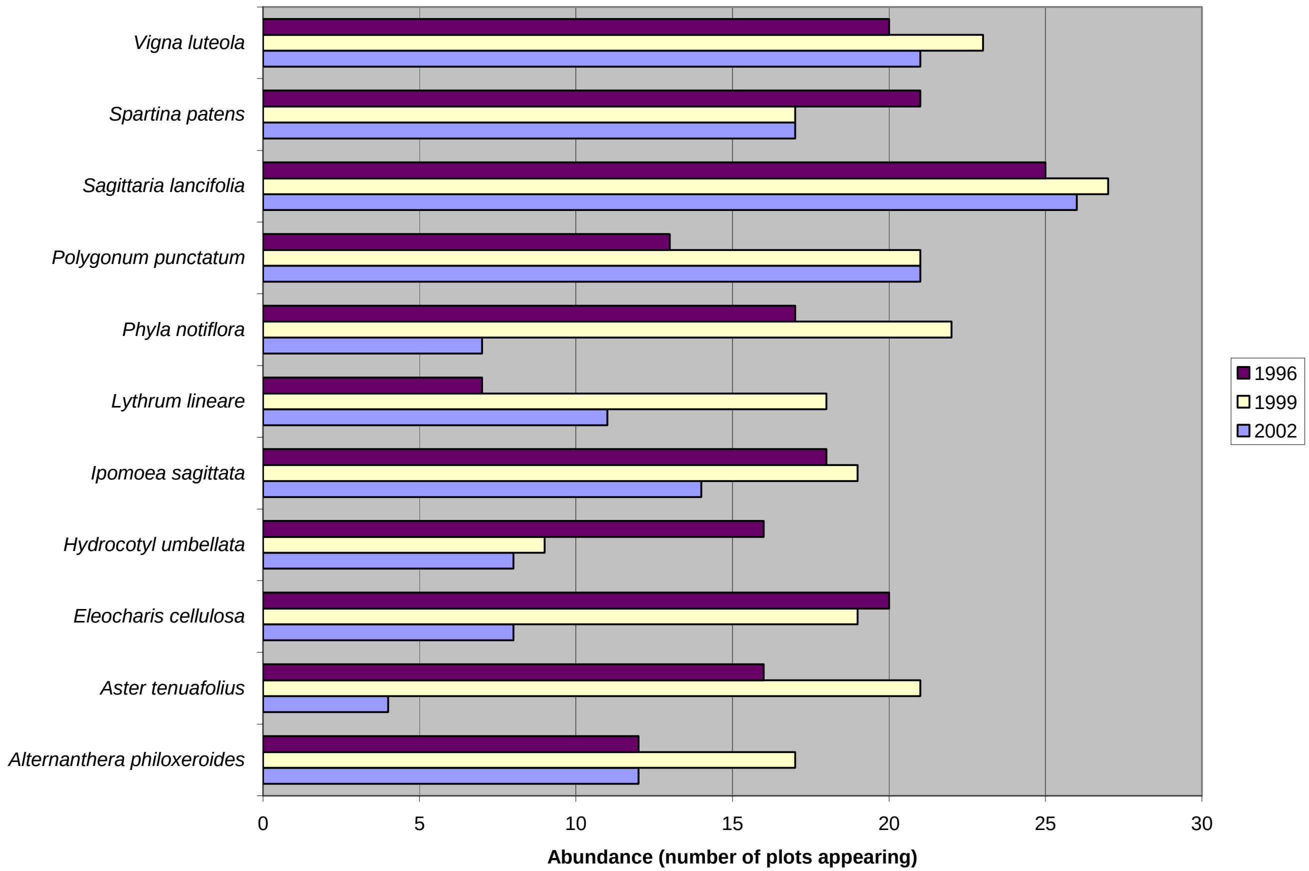


Figure 18. Abundance of the 11 most common occurring plant species in the project area from 1996 to 2002.

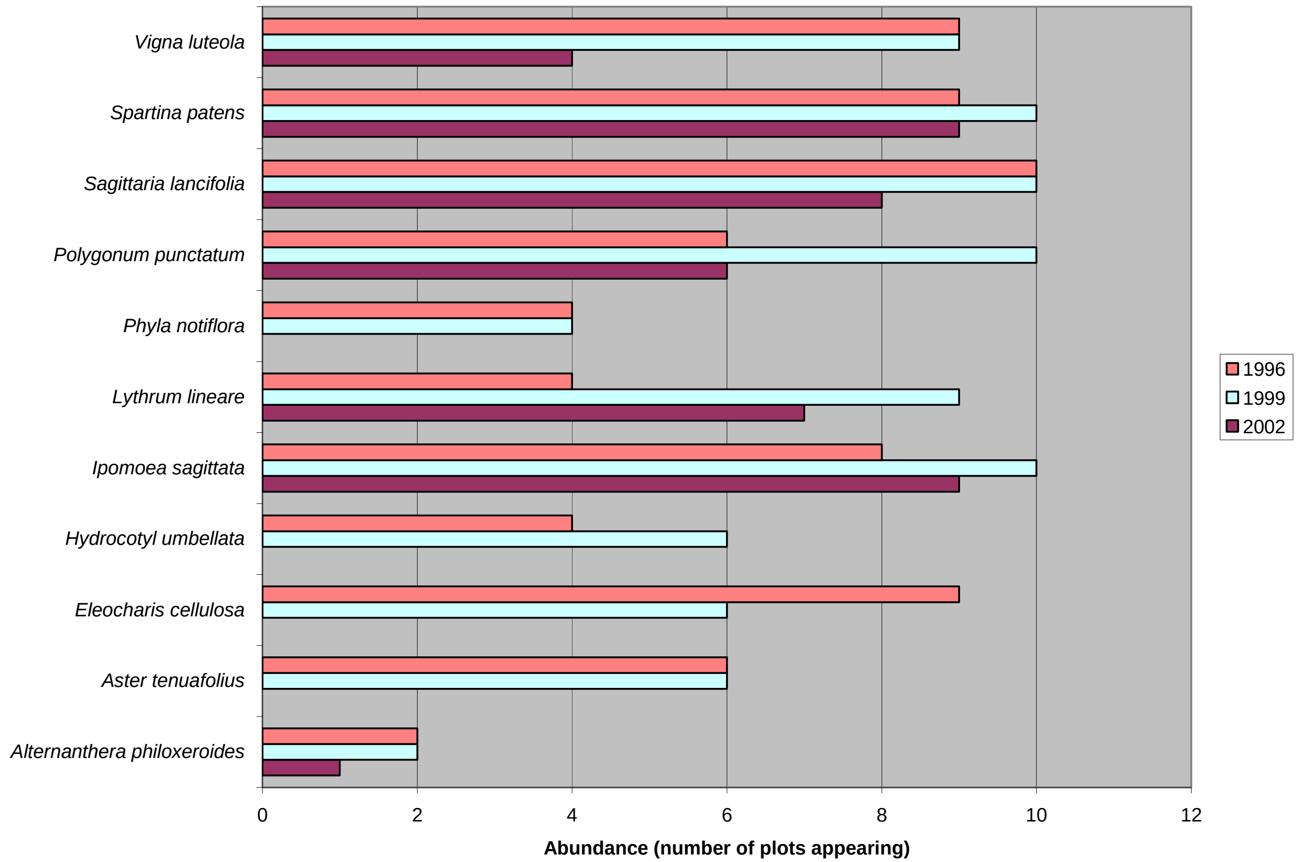


Figure 19. Abundance of the 11 most common occurring plant species in the reference area from 1996 to 2002.

V. Conclusions

a. Project Effectiveness

The staggered construction regime combined with a strong environmental stress (the drought) led to many inconsistencies in the data. A more complete evaluation of the project would come after several more years of data collection (post-construction and post-drought); however, this data is currently unavailable due to the monitoring schedule (hydrologic monitoring ended in 2005 and vegetation monitoring ended in 2002). In the near future there will be Coastwide Reference Monitoring System (CRMS-Wetlands) stations located in the project area that will be capable of providing hydrologic and vegetation data on a smaller scale. In addition, these stations will allow LDNR to look at additional factors in the project area such as accretion and subsidence rates.

The changes in salinity and water level data between the project area and the reference area are so minute that no definite conclusions can be made. The interpretation of vegetation data is also inconclusive because the monitoring period ended in 2002. The vegetation followed the same trend as salinity. The marsh transited from a freshwater community to a more saline community during the drought. However, unlike the salinity, the vegetation was not monitored long enough to see the possible shift back to a freshwater community. Instead the data suggests that the area was experiencing a long-term shift toward a more saline environment. There was a more pronounced shift towards a more saline marsh in the reference area, possibly suggesting that the structures acted as a buffer for the vegetative community in the project area.

The shoreline protection structures appeared to have a positive effect on the project area. Dredge materials added to the project area during construction most likely played a major role in the amount of land gained. However, the land loss in the reference area supports project effectiveness.

b. Recommended Improvements

In order to successfully evaluate the Jonathan Davis (BA-20) project, additional monitoring of hydrology and vegetation is required. LDNR recommends using the CRMS sites in the area to further evaluate the project.

In order to evaluate dike settlement, stability of the rock structure, toe scour, and any vertical accretion on the land side of the rock structure, a structural assessment survey is recommended within the first five years of construction. The date of assessment survey is to be agreed upon by the state and federal sponsor at the annual maintenance inspection.

c. Lessons Learned

The most important lesson learned, in regards to biological monitoring, was that a staggered, long-term construction regime can have a strong adverse effect on data interpretation as seen in Jonathan Davis (BA-20). In the future, monitoring of a project should be scheduled for 1-3 years pre-construction and 3-5 years post-construction (as determined by the final date of construction, not the start of construction). It seems unwise to assume construction occurs during a single point in time as this is not realistic.

Based on multiple O & M inspections, the rock dike has proven to be very effective in reducing shoreline erosion, while experiencing no deterioration and requiring no recommended maintenance. The foreshore rock dike on parts of the west reach of CU3 was constructed with zero crown width and 3:1 side slopes. This type typical section with zero crown width is impractical to construct due to the size of the stone. Future rock dike construction should specify a minimum crown top width. Parts of CU1 used a zero crown width. All subsequent design since that time used a specified minimum crown top width. Please refer to the as-built drawings in subsequent units and the adaptive management comments for this project where this was a case example cited for changing current methods of design.

VI. References

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VII. Appendices

Appendix A

Inspection Photographs

Photo 1
Structure #13
CU #1

Photo 2
Structure #14
CU #1

Photo 3
Breach on west side of Structure #14

Photo 4
Structure #15
CU #1

Photo 5
Structure #16
CU #1

Photo 6
Structure #17
CU #1

Photo 7
Low area in Structure #17

Photo 8
Structure # 20
CU # 1

Photo 9
Structure #22
CU # 2

Photo 10
West end of Bayou Rigolets Rock Dike
CU # 2

Photo 11
Bank erosion at west end of
Bayou Perot Rock Dike

Photo 12
Low area in Bayou Perot
Rock Dike
CU # 3

Appendix B
Three Year Budget Projection

Jonathan Davis Wetland Restoration Project / BA-20 / PPL NO. 2

Three-Year Operations & Maintenance Budgets 07/01/2007 - 06/30/2010

Project Manager	O & M Manager	Federal Sponsor	Prepared By
Barry Richard	*Barry Richard*	*NRCS*	*Peter Hopkins*

	2007/2008	2008/2009	2009/2010
Maintenance Inspection	$3,428.00	$3,517.00	$3,609.00
General Maintenance	$0.00	$0.00	$0.00
Structure Operation	$0.00	$0.00	$0.00
Administration	$0.00	$0.00	$0.00
Maintenance/Rehabilitation			

07/08 Description:

	2007/2008	2008/2009	2009/2010
E&D	$0.00		
Construction	$0.00		
Construction Oversight	$0.00		
Sub Total - Maint. And Rehab.	$ -		

08/09 Description:

	2007/2008	2008/2009	2009/2010
E&D		$0.00	
Construction		$0.00	
Construction Oversight		$0.00	
Sub Total - Maint. And Rehab.		$ -	

09/10 Description:

	2007/2008	2008/2009	2009/2010
E&D			$0.00
Construction			$0.00
Construction Oversight			$0.00
Sub Total - Maint. And Rehab.			$ -

	2007/2008	2008/2009	2009/2010
Total O&M Budgets	**$ 3,428.00**	**$ 3,517.00**	**$ 3,609.00**

O &M Budget (3 yr Total)	**$ 10,554.00**
Unexpended O & M Budget	**$ 7,230,722.92**
Remaining O & M Budget (Projected)	**$ 7,220,168.92**

OPERATION AND MAINTENANCE BUDGET WORKSHEET 2007/2008

Jonathan Davis Wetland Restoration Project / BA-20 / PPL NO. 2

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$3,428.00	**$3,428.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$0.00	**$0.00**
Operations Contract	LUMP	1	$0.00	**$0.00**
Construction Oversight	LUMP	1	$0.00	**$0.00**
ADMINISTRATION				
LDNR / CRD Admin.	LUMP	0	$0.00	$0.00
FEDERAL SPONSER Admin.	LUMP	0	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$0.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:

Secondary Monument	EACH	0	$0.00	$0.00
Staff Gauge / Recorders	EACH	0	$0.00	$0.00
Marsh Elevation / Topography	LUMP	0	$0.00	$0.00
TBM Installation	EACH	0	$0.00	$0.00
OTHER				$0.00
			TOTAL SURVEY COSTS:	**$0.00**

GEOTECHNICAL

GEOTECH DESCRIPTION:

Borings	EACH	0	$0.00	$0.00
OTHER				$0.00
			TOTAL GEOTECHNICAL COSTS:	**$0.00**

CONSTRUCTION

CONSTRUCTION DESCRIPTION:

Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
Navagation Aid		EACH	0	$0.00	$0.00
Signage		EACH	0	$0.00	$0.00
General Excavation / Fill		CU YD	0	$0.00	$0.00
Dredging		CU YD	0	$0.00	$0.00
Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
Timber Piles (each or lump sum)			0	$0.00	$0.00
Timber Members (each or lump sum)			0	$0.00	$0.00
Hardware		LUMP	1	$0.00	$0.00
Materials		LUMP	1	$0.00	$0.00
Mob / Demob		LUMP	1	$0.00	$0.00
Contingency		LUMP	1	$0.00	$0.00
General Structure Maintenance		LUMP	1	$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
				TOTAL CONSTRUCTION COSTS:	**$0.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: $3,428.00

OPERATION AND MAINTENANCE BUDGET WORKSHEET 2008/2009

Jonathan Davis Wetland Restoration Project / BA-20 / PPL NO. 2

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$3,517.00	**$3,517.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$0.00	**$0.00**
Operations Contract	LUMP	1	$0.00	**$0.00**
Construction Oversight	LUMP	1	$0.00	**$0.00**
ADMINISTRATION				
LDNR / CRD Admin.	LUMP	1	$0.00	$0.00
FEDERAL SPONSER Admin.	LUMP	1	$0.00	$0.00
SURVEY Admin.	LUMP	1	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$0.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:					
	Secondary Monument	EACH	0	$0.00	$0.00
	Staff Gauge / Recorders	EACH	0	$0.00	$0.00
	Marsh Elevation / Topography	LUMP	0	$0.00	$0.00
	TBM Installation	EACH	0	$0.00	$0.00
	Structure Survey	LUMP	1	$0.00	$0.00
				TOTAL SURVEY COSTS:	**$0.00**

GEOTECHNICAL

GEOTECH DESCRIPTION:					
	Borings	EACH	0	$0.00	$0.00
	OTHER				$0.00
				TOTAL GEOTECHNICAL COSTS:	**$0.00**

CONSTRUCTION

CONSTRUCTION DESCRIPTION:						
	Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
		0	0.0		$0.00	$0.00
		0	0.0	0	$0.00	$0.00
		0	0.0	0	$0.00	$0.00
	Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
	Navagation Aid		EACH	0	$0.00	$0.00
	Signage		EACH	0	$0.00	$0.00
	General Excavation / Fill		CU YD	0	$0.00	$0.00
	Dredging		CU YD	0	$0.00	$0.00
	Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
	Timber Piles (each or lump sum)			0	$0.00	$0.00
	Timber Members (each or lump sum)			0	$0.00	$0.00
	Hardware		LUMP	1	$0.00	$0.00
	Materials		LUMP	1	$0.00	$0.00
	Mob / Demob		LUMP	1	$0.00	$0.00
	Contingency		LUMP	1	$0.00	$0.00
	General Structure Maintenance (cap 15%)		LUMP	1	$0.00	$0.00
	OTHER				$0.00	$0.00
	OTHER				$0.00	$0.00
	OTHER				$0.00	$0.00
					TOTAL CONSTRUCTION COSTS:	**$0.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: $3,517.00

OPERATION AND MAINTENANCE BUDGET WORKSHEET 2009/2010

Jonathan Davis Wetland Restoration Project / BA-20 / PPL NO. 2

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$3,609.00	**$3,609.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$0.00	**$0.00**
Operations Contract	LUMP	1	$0.00	**$0.00**
Construction Oversight	LUMP	1	$0.00	**$0.00**

ADMINISTRATION

LDNR / CRD Admin.	LUMP	0	$0.00	$0.00
FEDERAL SPONSER Admin.	LUMP	0	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$0.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:					
	Secondary Monument	EACH	0	$0.00	$0.00
	Staff Gauge / Recorders	EACH	0	$0.00	$0.00
	Marsh Elevation / Topography	LUMP	0	$0.00	$0.00
	TBM Installation	EACH	0	$0.00	$0.00
	OTHER				$0.00
				TOTAL SURVEY COSTS:	**$0.00**

GEOTECHNICAL

GEOTECH DESCRIPTION:					
	Borings	EACH	0	$0.00	$0.00
	OTHER				$0.00
				TOTAL GEOTECHNICAL COSTS:	**$0.00**

CONSTRUCTION

CONSTRUCTION DESCRIPTION:							
	Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
		0	0.0	0	$0.00	$0.00
		0	0.0	0	$0.00	$0.00
		0	0.0	0	$0.00	$0.00
	Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
	Navagation Aid		EACH	0	$0.00	$0.00
	Signage		EACH	0	$0.00	$0.00
	General Excavation / Fill		CU YD	0	$0.00	$0.00
	Dredging		CU YD	0	$0.00	$0.00
	Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
	Timber Piles (each or lump sum)			0	$0.00	$0.00
	Timber Members (each or lump sum)			0	$0.00	$0.00
	Hardware		LUMP	1	$0.00	$0.00
	Materials		LUMP	1	$0.00	$0.00
	Mob / Demob		LUMP	1	$0.00	$0.00
	Contingency		LUMP	1	$0.00	$0.00
	General Structure Maintenance		LUMP	1	$0.00	$0.00
	OTHER				$0.00	$0.00
	OTHER				$0.00	$0.00
	OTHER				$0.00	$0.00
					TOTAL CONSTRUCTION COSTS:	**$0.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: $3,609.00

Appendix C

Field Inspection Notes

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No. Construction Unit No.3

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock dike along Bayou Perot

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good				
Armored Plug	Good				**Observation:** There have been no changes since the last inspection. The work to be done through the CU4 Construction Contract has not been completed due to contract issues.
Rock Dike	Good				
Earthen Embankment	Good				Some bank erosion was noted beyond the west end of the Bayou Perot rock dike

Construction Unit No.3

Structure Description: The rock dike consist of 13,088 linear ft. of rock dike with a 6 ft. top width and a crest elevation of +3.5 ft. The shoreline stabilization extends from Site 12 west to the Gulf Intracoastal Waterway

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No . Construction Unit No.2

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock dike along Bayou Rigolettes

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good				
Armored Plug	Good				**Observation:**
Rock Dike	Good				There have been no changes since the last inspection. The work to be done through the CU4 Construction Contract has not been completed due to contract issues.
Earthen Embankment	Good				

Construction Unit No.2

Structure Description: The rock dike consist of 3,967 linear ft. of rock dike with a 6 ft. top width and a crest elevation of +3.5 ft. The shoreline stabilization extends from Site 22A west to Structure No.20.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No. ____ Construction Unit No.1 -Site No. 12

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock rip-rap armored plug

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good			2	**Observations:**
Armored Plug	Good			2	There have been no changes since the last inspection. NRCS and DNR agree that no maintenance required at this time.
Earthen Embankment	Good			2	

Construction Unit No.1

Structure Description: 294 linear ft. rock rip-rap armored rock-filled plug located in a pipeline channel north of Bayou Perot, west of Bayou Barataria, and east of the GIWW The crest of the weir was set at an elevation of +3.9 ft. NGVD. The rock-filled plug contains 2,689 tons of rock filled with 2,518 tons of rip-rap armor. Aluminum warning signs are also located through the rock embankment.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No. Construction Unit No.1 -Site No. 13

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock rip-rap armored weir

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good				**Observations:** There have been no changes since the last inspection. NRCS and DNR agree that this structure is in good condition and will not require maintenance at this time.
Armored Plug	Good				
Earthen Embankment	Good				

Construction Unit No.1

Structure Description: 300 linear ft. rock rip-rap armored rock filled weir with a 50 ft. wide boat bay located north of Bayou Perot and Site 12, west of Bayou Barataria, and east of the GIWW. The crest of the weir is set at an elevation of +1.0 ft. NGVD. The invert of the boat bay is set at an elevation of -5.0 ft. NGVD. Rock wingwalls were constructed to an elevation of +3.6 ft. NGVD. On the west side and +4.0 ft. NGVD on the east side of the weir. The rock filled weir contains 1,093 tons of rock fill and 772 tons of rip-rap armor. Aluminum warning signs are located adjacent to the structure.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No. Construction Unit No.1 - Site No. 14

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock rip-rap armored plug

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good				**Observations:** There have been no changes since the last inspection. The work to be done through the CU4 Construction Contract has not been completed due to contract issues.
Armored Plug	Poor				
Earthen Embankment	Fair				

Construction Unit No.1

Structure Description: 138 linear ft. of rock rip-rap armored rock filled channel plug located in a pipeline channel north of Bayou Perot, west of Bayou Barataria and east of GIWW and Site 13. The crest of the plug was constructed to an elevation of +3.2 ft. NGVD. The rock filled plug contains 2,580 tons of rock fill and 1,346 tons of rock rip-rap armor. Aluminum warning signs are located through the rock embankment.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No. Construction Unit No.1 - Site No. 15

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock rip-rap armored weir w/ boat bay

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #
Signage and supports	Good			
Armored Plug	Good			
Rock weir	Good			
Earthen Embankment	Good			

Observations and Remarks

Observations:
There have been no changes since the last inspection. The work to be done through the CU4 Construction Contract has not been completed due to contract issues.

Remarks:
The original design of this structure was modified to a rock weir with boat bay to accommodate oilfield activities and navigation on the interior of the structure. During above mentioned maintenance this structure will be converted to a rock plug as originally designed.

Construction Unit No.1
Structure Description: 132 linear ft. of rock rip-rap armored weir with a 50 ft. wide boat bay located in a pipeline channel north of Bayou Perot, west of Bayou Barataria and east of the GIWW and Site 14. The crest of the rock weir was constructed to an elevation of +4.0 ft. NGVD. The invert of the boat bay is at and elevation of -3.0 ft. The rock filled weir contains 1,248 tons of rock fill with and 728 tons of rock rip-rap armor. Two (2) aluminum warning signs are located through the rock armored embankment on each side of the boat bay.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No. Construction Unit No.1 -Site No. 16

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock rip-rap armored plug

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good				
Armored Plug	Fair				**Observation:** There have been no changes since the last inspection. The work to be done through the CU4 Construction Contract has not been completed due to contract issues.
Earthen Embankment	Good				
					Remarks:

Construction Unit No.1

303 linear ft. of rock rip-rap armored rock filled plug located in a pipeline channel north of Bayou Perot, west of Bayou Barataria, east of the GIWW and Site 15. The crest of the plug was constructed to an elevation of +4.0 ft. NGVD. The rock filled plug contains 6,483 tons of rock fill and 1,766 tons of rock rip-rap armor. Two (2) aluminum warning signs are located through the rock plug embankment.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland** Date of Inspection: 3/20/2007 Time: 9:30 am

Structure No. Construction Unit No.1 - Site No. 17 Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock rip-rap armored plug Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good				
Armored Plug	Fair				**Observation:** There have been no changes since the last inspection. The work to be done through the CU4 Construction Contract has not been completed due to contract issues.
Earthen Embankment	Good				**Remarks:**

Construction Unit No.1
Structure Description: 197 linear ft. of rock rip-rap armored rock filled plug located in a pipeline channel north of Bayou Perot, west of Bayou Barataria, and east of the GIWW. The crest of the plug was constructed to an elevation of 3.8' NAVD. The rock filled plug contains2,253 tons of rock fill and 1,201 tons of rock rip-rap armor. Aluminum warning signs supported by galvanized pipe are located through the rock embankment.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No . Construction Unit No.1 - Site No. 19

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock rip-rap armored weir

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good				**Observation:**
Armored Plug	Good				There have been no changes since the last inspection. NRCS and DNR agree that this structure does not need maintenance at this time.
Earthen Embankment	Good				

Construction Unit No.1

Structure Description: 239 linear ft. of rock rip-rap armored rock filled fixed crest weir with a 60 ft. wide boat bay located in a pipeline channel east of the GIWW, north of Bayou Perot, and west of Bayou Barataria. The crest of the weir was constructed to an elevation of +1.9 ft. NGVD on the north side and +2.0 ft. NGVD on the south. The boat bay invert was constructed to an elevation of -2.5 ft. NGVD. The rock filled plug contains 1,014 tons of rock fill with 572 tons of rock rip-rap armor. Aluminum waring signs are located on each side of the barge bay through the rock embankment.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland** Date of Inspection: 3/20/2007 Time: 9:30 am

Structure No . Site No. 20- Construction Unit No.2 Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock rip-rap armored plug Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good				
Armored Plug	Good				**Observation:** There have been no changes since the last inspection. No maintenance required at this time. Will monitor this structure on future site visits.
Earthen Embankment	Good				

Construction Unit No.1
Structure Description: 170 linear ft. of rock rip-rap armored rock filled plug located north of Bayou Rigolettes, west of Bayou Barataria, and east of Bayou Perot. The plug crest was constructed to an elevation of +4.0 ft. NGVD. The rock filled plug contains 1,829 tons of rock fill with 795 tons of rock rip-rap armor. Two (2) aluminum warning signs are located on each end of the structure through the armored rock plug embankment.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No . Site No. 21 - Construction Unit No.2

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Rock rip-rap armored plug

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good			3	
Armored Plug	Good			3	**Observation:** There have been no changes since the last inspection. No maintenance will be required at this time.
Earthen Embankment	Good			3	

Construction Unit No.1
Structure Description: 83 linear ft. of rock rip-rap armored rock filled plug located north of Bayou Rigolettes, west of Bayou Barataria, and east of Bayou Perot. The plug crest was constructed to an elevation of +4.0 ft. NGVD. The rock filled plug contains 285 tons of rock fill and 220 tons of rock rip-rap armor. Two (2) aluminum warning signs supported by galvanized pipe are located on each end of the structure through the rock embankment.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No . Site No. 22 - Construction Unit No.2

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Steel sheet pile structure w/ boat bay

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Steel Bulkhead / Caps	Good				
Handrails Hardware, etc.	Good				**Observation:** There have been no changes since the last inspection. No maintenance required at this time.
Signage and supports	Good				
Rock weir	Good				
Earthen Wingwalls	Good				
Rock Armored Earthen Embankment	Good				

Construction Unit No.2

Structure Description: 58 linear ft. of steel sheet pile bulkhead with a crest elevation of +1.95 ft. and a 24' - 8-1/2" wide boat bay with a crest elevation of -0.93 ft. located off of Bayou Regolettes, west of Bayou Barataria and east of GIWW. The structure consists of a steel sheet pile weir with 1,426 square feet of sheet piling set at +1.95 ft. At the bottom the boat bay, is a 1.5 ft. thick rock rip-rap scour pad seciton with an invert of -0.93 ft. This structure ties into structure 22A on the west side. Aluminum warning signs supported by 12" diameter timber piles are located at the entrance of the boat bay.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **BA-20 Jonathan Davis Wetland**

Date of Inspection: 3/20/2007

Time: 9:30 am

Structure No . Site No. 22A - Construction Unit No.2

Inspector(s): Richard, Boddie, Bernard, Hopkins, Blanchard

Structure Description: Canal Bank Stabilization

Water Level Inside: N/A Outside: Approx. 0.9 ft

Type of Inspection: Annual, Post Storm, other Annual

Weater Conditions: Clear Skies, Light Wind

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage and supports	Good				**Observation:**
Rock Armored Bank	Good				There have been no changes since the last inspection. No maintenance is required at this time.
Earthen Embankment	Good				

Construction Unit No.2
Structure Description: Canal bank stabilization consisting of 1,385 linear ft. of rock rip-rap protection on the west bank of the access channel at the Baltazaar Point Subdivision. The rip-rap was constructed to an elevation of +3.0 ft.

Appendix D

Rationale for Nonparametric BACI Analysis for Coastal Projects

Fundamentals:

First, think of a BACI model as comprising a two-dimensional factor space. Time (Before-After) is one dimension, and space (Control-Impact) is the other.

Control Before	**Control After**
Impact Before	**Impact After**

The 2X2 "textbook" arrangement shown here is the simplest form it can take, a form that builds the BACI acronym: "Before-After" in time and "Control-Impact" in space. (Substitute "Pre-Post" and "Project-Reference" when applying this discussion to DNR coastal projects.) Nothing limits these factors to only two levels; the above table could measure 3X2 with time broken into "Before-During-After", or it could measure 2X8 with eight sampling locations in space.

Replication (see discussion below) is achieved within each cell by making repeated observations over time during the before and after periods.

What sets a BACI analysis apart from any common factorial model is this: evidence that the project had an impact comes only in the form of a statistically significant *interaction* between the main effects. Statistical significance in either of the main effects (the BA factor or the CI factor) may assist in interpreting the BA*CI interaction, but does not in itself indicate an impact.

One way to define an interaction is as *an inconsistency of one main effect across levels of another*. Stated differently, if a difference between the control and impact sites does not persist after construction, then an interaction exists between BA and CI.

Having simultaneous observations at the two stations makes them temporally *paired*. Subtracting these paired observations (Difference = Control – Impact) collapses the above table into a one-dimensional model:

Differences Before	Differences After

This is the situation described in Smith (2002) and Underwood (1994) as a BACI paired series (BACIP). A t-test comparing the means of these two cells is equivalent to the anova f-test for an interaction in the two-dimensional model.

Non-Parametric Approach:

Reducing a 2X2 anova to a 2-sample t-test has these benefits: First, it is easy to give computer software the wrong anova instructions when data are temporally paired; running a parallel t-test supplies a welcome confirmation of one's programming. Second, a 2-sample t-test has some non-parametric analogues, notably the Wilcoxon-Mann-Whitney and the median test.

Of these, the median test needs fewer assumptions, which makes it more useful. DNR projects produce data sets with severe departures from normality, many of them not tractable to normalizing transformations. Attempts to stabilize variance often fail as well.

The median test is considerably less powerful than the t-test or the Wilcoxon (see http://www.tufts.edu/~gdallal/npar.htm for a concise discussion of the relative efficiencies of these tests), but the size of project data sets makes statistical power a small consideration. With hundreds of observations, a test with only modest power can find statistical significance in an effect too small to have practical significance.

When the BA factor is extended to three levels, "Before-During-After", a one-way anova f-test on the three sets of differences is equivalent to an f-test for an interaction in a 3X2 factorial. The non-parametric tests also apply, as long as the control and impact stations remain paired. The Wilcoxon test becomes a Kruskal-Wallis, and the median test accommodates any number of groups.

When observations are not paired, or when the CI factor has more than two levels, the factor space cannot be collapsed by subtraction, and it is harder to find a non-parametric test. Methods are available for a non-parametric two-way anova, but these typically test main effects and not interactions. Randomization studies, planned for future statistical analysis on DNR projects, do allow fairly robust tests for interactions, but these also come with limitations when testing for interaction in a factorial design (See Edgington 1995).

Statistical significance reported by a non-parametric test does not mean exactly the same thing as significance by a t-test or an anova. The Wilcoxon and median tests compare the medians of two groups instead of their means. When studying chemical concentrations, the mean is a more valuable, though often less tractable statistic.

Use of the Weekly Mean:

In order to study a paired series of observations at the control and impact stations, one must find and control influences that detract from their simultaneity. One way to do this is to study and compensate for temporal lags. A simpler, but less poweful method is to aggregate the response variable by averaging over a period of time that is certain to be large compared to the duration of these lags. The DNR has chosen to use a weekly mean calculated by averaging daily means from continuous recorders.

Averaging the data over a week also has, potentially, the advantage of harnessing the central limit theorem, thus bringing the data closer to a normal distribution. In practice, averaging rarely succeeds in normalizing these data because they are serially-correlated; the central limit theorem depends on independent observations.

When transformations are made, the data are transformed first, then averaged. The order of these operations matters; the mean of the logarithms does not equal the logarithm of the mean.

Replication Issues:

Some dispute has appeared in the literature over the degree of replication it is possible to achieve when all of the measurements are based on a single project. See Hurlbert (1984) and Stewart-Oaten *et al* (1986).

The DNR has taken the position of Stewart-Oaten, summarized here:

Environmental *impact assessment*, which tests the effect of one specific application of a technology at a specific location, requires a different kind of replication than is needed to to test the general impact of that technology.

Example: A test of the general effectiveness of wier construction requires that one select a set of marsh locations, then divide these locations into two groups. Wiers are placed at one group of locations, and the other group serves as controls. Unless each group comprises more than one location, it is impossible to know if any observed change is large or small compared to random variability among these marsh locations. Without this degree of replication, in which the treatments (weir placement and non-placement) are applied independently to multiple experimental units (locations), the general effectiveness of wier construction is empirically unknowable. No amount spatial or temporal subsampling can overcome this problem when the observations are based on a single wier and on a single control. This is the core of Hurlbert's complaint against using a BACI model.

But monitoring a project for impact is a different proposition. It seeks to answer a different question: "Never mind the general effect of weir placement; did *this* particular weir placement have an impact?" Replication of the type described in the above experiment would not improve the information gained by comparing that single weir to its control.

Hurlbert asserts, in a related argument, that there is no way to distinguish a genuine impact from one caused by some random and unforseen influence that might occur after the placement of the weir. That is, a significant BA*CI interaction can not be interpreted as an impact except under the assumption that the differences between the control and impact locations would, without weir placement, have remained constant over time. But under the BACIP model this is not an unrealistically strong assumption. A well-chosen control site is subject to the same environmental influences as the impact site. If a nuisance fluctuation can masquerade as an impact, then there was a failure in choosing a suitable control site and not a failure in the fundamental design

References:

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