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

2004 Operations, Maintenance, and Monitoring Report

for

Humble Canal Hydrologic Restoration

State Project Number ME-11
Priority Project List 8

May 2004
Cameron Parish

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2004 Operations, Maintenance and Monitoring Report
For
Humble Canal Hydrologic Restoration (ME-11)

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I. Introduction

The Humble Canal Hydrologic Restoration project area encompasses 4,030 acres (1,228 ha) of fresh marsh in Cameron Parish, Louisiana (figure 1). The project area is bounded by Little Chenier Ridge to the south, the Mermentau River to the east, and oilfield canals to the north and west.

The marsh is classified as fresh marsh with 74 percent of the project area being marsh and 26 percent of the project area being open water, based on the Louisiana Department of Natural Resources (LDNR) GIS data for 1988-1990. Dominant emergent vegetation in the project area includes *Spartina patens* (marsh-hay cordgrass), *Typha latifolia* (cattail), and *Sagittaria lancifolia* (bulltongue). Dominant submerged aquatic vegetation (SAV) in the project area includes *Najas guadalupensis* (southern naiad), *Alga* sp., and *Chara* sp. (muskgrass).

Soils found in the project area have been recently mapped as Allemands muck, Clovelly muck, Larose muck, Bancker muck, Aquents frequently flooded, Peveto fine sand, Hackberry loamy fine sand and Hackberry-Mermentau complex (USDA/SCS 1995). Most of the soils within the project area are classified as muck and are associated with brackish or freshwater marsh. The Aquents frequently flooded are hydraulically excavated soils that occur along the Mermentau River. The Peveto, Hackberry, and Hackberry-Mermentau are on the Little Ridge that comprises the southern boundary of the project.

Land loss data indicate that, from 1932 to 1990, approximately 826 acres (334 ha) of land were converted to open water in the Humble Canal project area. Land alteration, including the construction of Humble Canal in the 1950's and dredging of the Mermentau River to facilitate greater commercial use, has resulted in excessive water levels in some areas and saltwater intrusion from the south and east.

To aid in the removal of excess water without permitting saline water into the project area, five 48-inch culverts with variable crest weir inlets and flapgated outlets were constructed in an oilfield access canal north of Marseillais Bayou. Construction began in September 2002 and ended with implementation in March 2003.

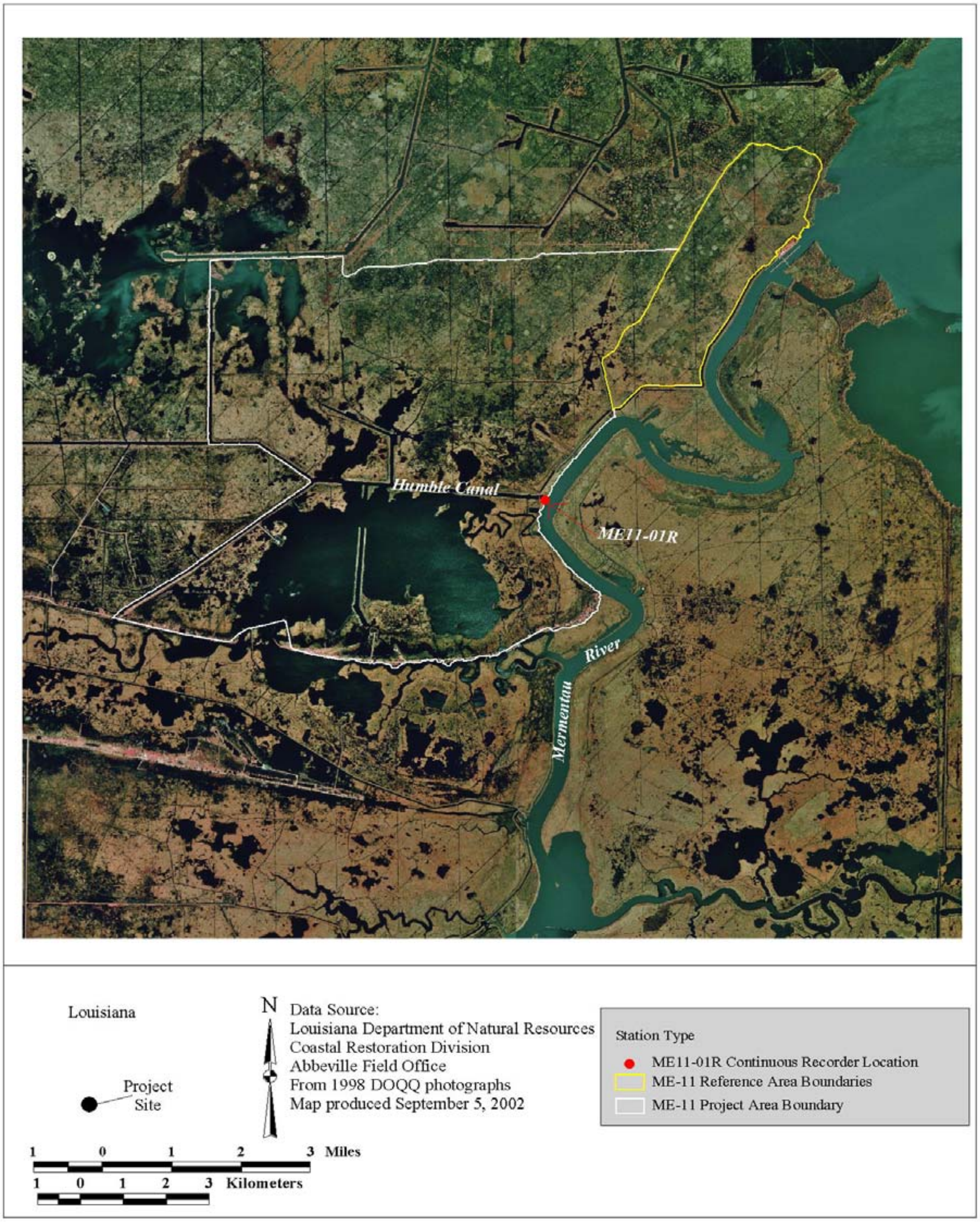


Figure 1. Humble Canal Hydrologic Restoration Project (ME-11); project and reference areas.

II. Maintenance Activity

a. Inspection Purpose and Procedures

The purpose of the annual inspection of the Humble Canal Hydrologic Restoration Project (ME-11) is to evaluate the constructed project features to identify any deficiencies and prepare a report detailing the condition of project features and recommended corrective actions needed. Should it be determined that corrective actions are needed, LDNR shall provide, in the report, a detailed cost estimate for engineering, design, supervision, inspection, and construction contingencies, and an assessment of the urgency of such repairs (LDNR 2003).

An inspection of the Humble Canal Hydrologic Restoration Project (ME-11) was held on February 27, 2004 under clear skies and mild temperatures with a 10-15 mph N. wind. In attendance were Stan Aucoin and Patrick Landry from LDNR, and Brad Sticker representing NRCS. All parties met at the Lafayette Field Office of CED, proceeded to the boat launch on the Mermentau River in Grand Chenier, and traveled north to the Humble Canal Structure. The annual inspection began at approximately 10:30 a.m. at the marine barrier on the juncture of the Humble Canal Outfall Channel and the Mermentau River.

The field inspection included a complete visual inspection of all features. Staff gauge readings were used to determine approximate elevations of water, rock weirs, earthen embankments, steel bulkhead structures and other project features. Photographs were taken at each project feature and Field Inspection notes were completed in the field to record measurements and deficiencies.

b. Inspection Results

<u>Marine barrier fence</u>

The structure is in excellent condition. Some shrinkage of the sign lettering has occurred. Bank tie-ins, pile caps, hardware, etc. are in excellent shape. No maintenance is required at this time.

<u>Hyacinth guard</u>

The structure is in excellent shape. No maintenance is required at this time.

Water control structure

Overall, the structure is in excellent post construction condition. Some slight sloughing of the rock covered earthen wingwalls on both the inlet and discharge sides of the structure has occurred, possibly due to the steep slopes involved. This situation will be monitored to see if it worsens. As of now, no maintenance is recommended or required. Hardware, grating, etc. associated with the structure are in excellent condition. Water levels on the inside of the project area were +2.2 ft NAVD88. Stoplogs had been removed to approximately -0.5 ft NAVD88 as allowed in the permit. The fish slot was closed for reasons unknown and was reopened by DNR & NRCS personnel. Although no soundings were taken, both the inlet and outfall channels appeared to be clear and adequate. It was agreed by both agencies, to perform cross sections on both channels in 2005/2006 to compare to as-built conditions.

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

See recommendations made at each project feature.

ii. Programmatic/ Routine Repairs

None.

III. Operation Activity

a. Operation Plan

b. Actual Operations

2003 Structure Operations: In accordance with the operation schedule outlined in the Operation and Maintenance Plan, structures were manipulated as required by Miami Corporation personnel at no cost to LDNR. At present, a contract is being developed between LDNR and Miami Corporation for Miami to continue to operate the structure according to the permitted operational plan at no cost to LDNR.

IV. Monitoring Activity

a. Monitoring Goals

The objective of the Humble Canal Hydrologic Restoration Project is to improve removal of excess water without permitting saline water into the freshwater marsh of the project area.

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

1. Increase present (yr 2000) land to water ratio.
2. Maintain mean water levels in the project area between 6 in below and 2 in above marsh level.
3. Maintain mean monthly salinity (0–3 ppt) in the project area after construction and prevent salinities from exceeding 7 ppt.
4. Increase or maintain the occurrence and cover of fresh marsh vegetation species in the project area.
5. Increase frequency of occurrence of submerged aquatic vegetation (SAV) in the project area.

b. Monitoring Elements

Aerial Photography:
Near-vertical color-infrared aerial photography (1:12,000 scale) was used to measure land to open water rations and land change rates for the project and reference areas. The photography was obtained in 2000 prior to project construction and will be obtained post-construction in 2005 and 2017. The original photography was checked for flight accuracy, color correctness, and clarity and was subsequently archived. Aerial photography was scanned, mosaicked, and geo-rectified by USGS/NWRC personnel according to standard operating procedures (Steyer et al. 1995, revised 2000).

Water level:
To monitor water levels, one continuous data recorder and staff gauge are deployed in the project area and one continuous data recorder and staff gauge are deployed in the Mermentau River (figure 2). Water level data are used to determine if the project area water level is being maintained within the target range. Water level will also be monitored at least monthly by 2 staff gauges located on the weir. The continuous data recorders will be maintained until 2017.

Salinity:
Salinities are monitored monthly at permanent discrete sampling stations within the project area (figure 2). In addition, continuous data recorders are deployed to record salinity at one location in the project area and at one location in the Mermentau River. Salinity data are used to characterize the spatial variation in salinity throughout the project area, and to determine if project area salinity is being maintained within the target range. Salinity will be monitored until 2017.

Emergent Vegetation:

To document the condition of emergent vegetation in the project area over the life of the project, vegetation is monitored at sampling stations (figure 3) established systematically in the project and reference areas using a modified Braun-Blanquet sampling method. Four north-south transects are established uniformly across the project area, and sampling stations are established uniformly along each transect line to obtain an even distribution throughout the project area. Two north-south transects are delineated across reference area # 1 to establish the sampling stations. Percent cover, dominant plant heights, and species composition are documented in 4 m^2 sampling plots marked with 2 corner poles to allow for revisiting the sites over time. Vegetation was evaluated at the sampling sites in the fall of 2000 (pre-construction) and in the fall of 2003 (post-construction), and will be continued in 2006, 2009, 2012, 2015, and 2018.

SAV:

The effect of the project on SAV abundance is determined by comparing SAV abundance before and after project construction. Three permanent locations are sampled in the project area, and three reference locations are sampled outside the project area (figure 4). Frequency is determined on two transects in each pond; there will be at least 20 stations per transect. Frequency is determined by methods described in Chabreck and Hoffpauir (1962) and Nyman and Chabreck (1995) except that the stations are as short as possible because the ideal area of a station is a point (Mueller-Dumbois and Ellenberg 1974:69-80). When water clarity permits, cover and species abundance is estimated visually on each transect. SAV was evaluated in the fall of 2000 (pre-construction) and in the fall of 2003 (post-construction), and will be continued in 2006, 2009, 2012, 2015, and 2018.

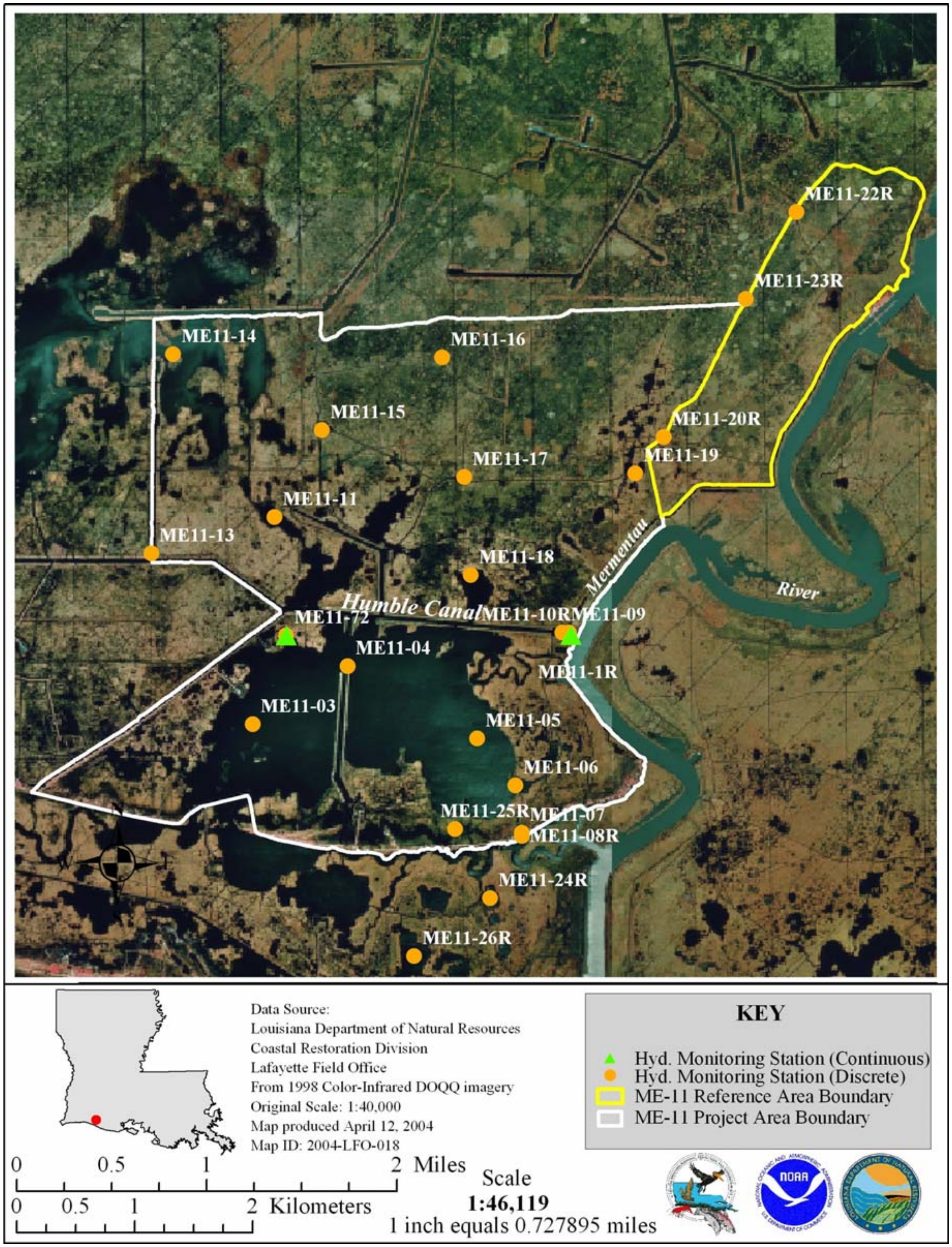


Figure 2. ME-11 project area with locations of continuous data recorders and discrete sampling stations.

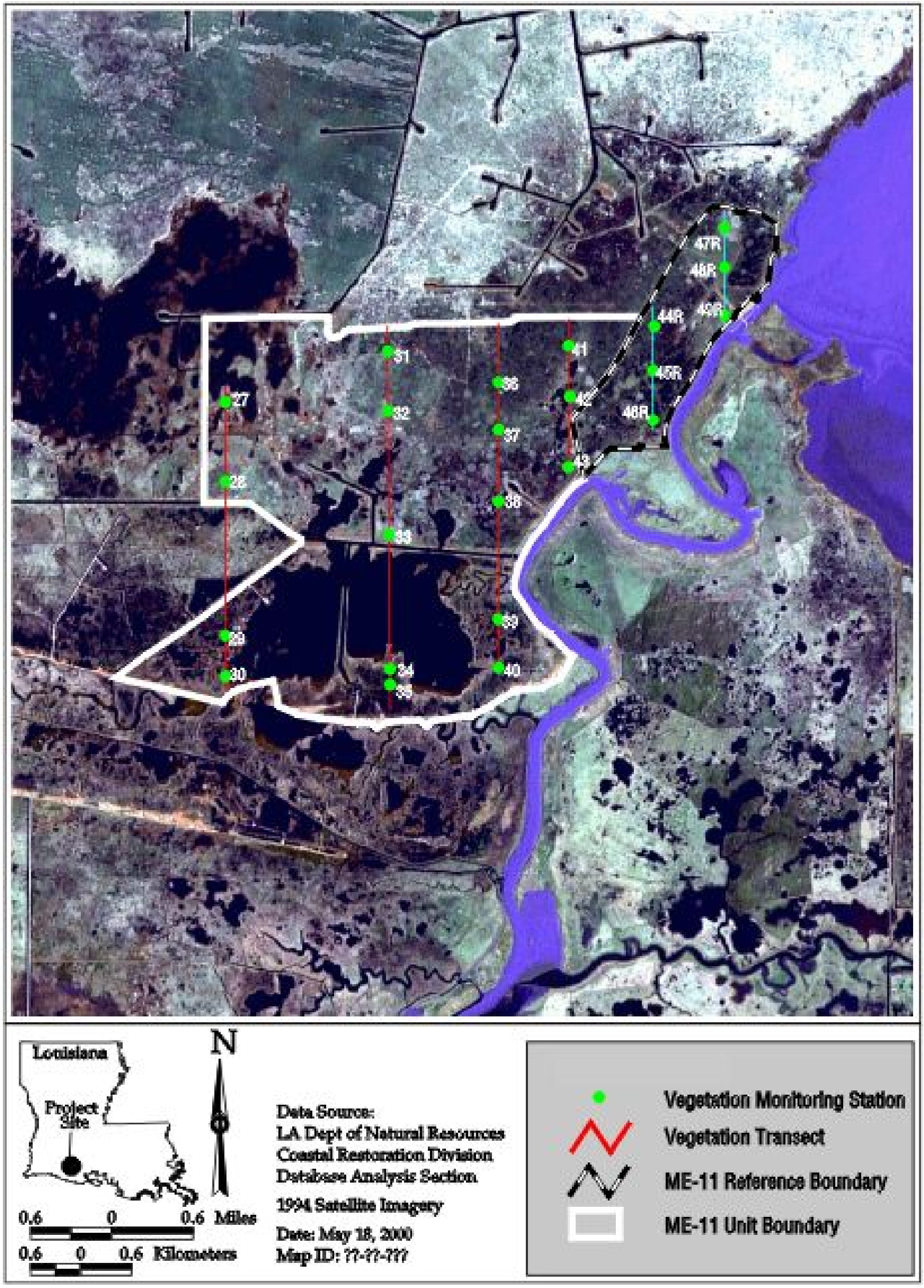


Figure 3. Location of vegetation monitoring transects and sampling points.

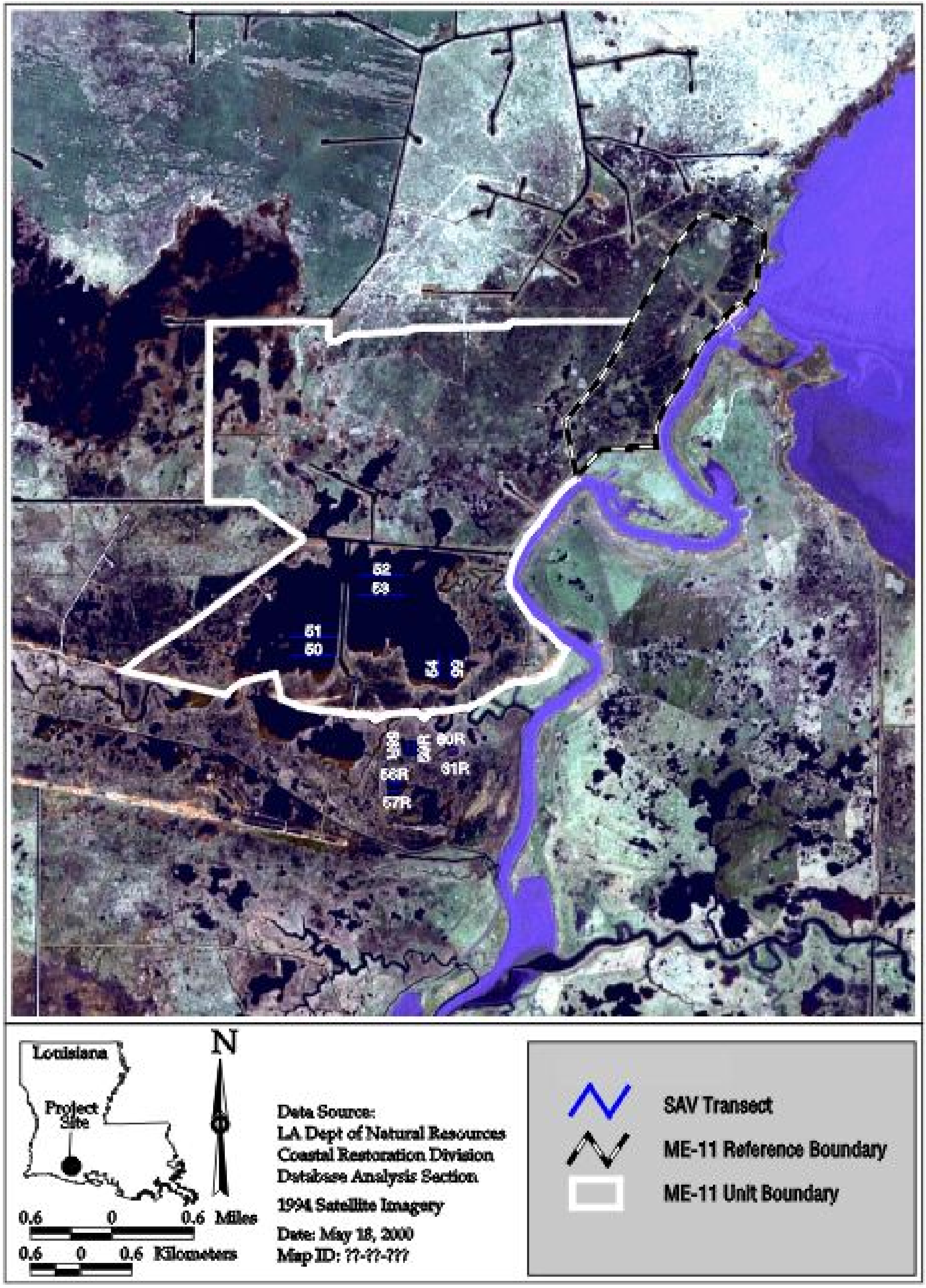


Figure 4. **L**ocation of SAV monitoring transects and sampling points.

IV. Monitoring Activity (continued)

c. Preliminary Monitoring Results and Discussion

Aerial photography:

Land/water analysis of project and reference areas was completed for 2000 aerial photography (pre-construction) and is shown in figure 5. In the project area, 2,993 acres (1,211 hectares) were classified as land and 1,401 acres (567 hectares) were classified as water. In the reference area, 683 acres (276 hectares) and 9 acres (3.6 hectares) were classified as land and water respectively. Until 2005 post-construction photography is obtained and analyzed, no comparison can be made to determine land loss/gain in the Humble Canal Hydrologic Restoration project.

Water Level:

Water level variability was much lower in the project area during 2003, as shown in the yearly graphs for the project and reference stations (figures 6a-b). Water level at station ME11-72 inside the project area remained within the target range only 34% of the time during the 2003 post-construction period, a significant increase from 16% recorded preconstruction. Water level at reference station ME11-01R remained within the target range 40% of the time during the 2003 post-construction period and 32% of the time preconstruction (figure 7a). .

Mean water level at station ME11-72 significantly decreased (P<0.001) post-construction with respect to reference station ME11-01R, although the value was slightly above the target range (table 1). During pre-construction and post-construction, the maximum water level reading at station ME11-72 was lower than at station ME11-01R while the minimum reading was higher. Pre-construction time period is from May 29, 2001 to January 31, 2003 and post-construction time period is from March 5, 2003 to December 31, 2003. Data collected during construction, from February 1 to March 4, 2003, was not included in the analysis.

Water Salinity:

Salinity variability was much lower in the project area during 2003, as shown in the yearly graphs for the project and reference stations (figures 6a-b). Salinity at station ME11-72 inside the project area remained within the target range 100% of the time during the 2003 post-construction period, while salinity at reference station ME11-01R remained within the target range only 65% of the time during the 2003 post-construction period (figure 7b). During pre-construction, the percentage was 99% at station ME11-72 and 85% higher at station 1R. Mean salinity at reference station ME11-01R significantly increased (P<0.001) post-construction with respect to station ME11-72 (table 2). Maximum salinity was much higher at station ME11-01R than at station ME11-72 for pre- and post-construction periods.

Salinity readings at all discrete sampling stations within the project area have remained below 3 ppt since project implementation. Figure 8a shows four stations that represent the spatial expanse of the southern portion of the project area, experiences more salinity variability than the northern portion. The only avenue for saltwater intrusion is from the south, so salinities in the northern portion have not exceeded salinities in the southern portion. Salinity readings at discrete reference sampling stations have been above 3 ppt on multiple occasions (figure 8b).

Emergent vegetation:

Mean percent cover by species for year 2000 and 2003 is displayed in figure 9a (project area) and 9b (reference area). Species diversity (tables 3 and 4), mean total percent cover (figures 10a-b), and mean species richness (figures 11a-b) decreased in both project and reference areas from 2000 to 2003 although these results were not significant ($P>0.05$). Dominant species found in 2000 and 2003, in both the project and reference areas, were *Spartina patens* (marsh-hay cordgrass), *Typha latifolia* (cattail), and *Sagittaria lancifolia* (bulltongue). There was a significant decrease in the coverage of *S. patens* within the project area ($P<0.05$) with respect to the reference area.

New species encountered in 2003 with significant percent coverage included: *Cladium jamaicence* (sawgrass), *Leersia hexandra* (Southern cutgrass), and *Salix nigra* (black willow). Other new species encountered in the project and reference areas with minimal coverage included: *Iva frutescens* (marsh elder), *Kosteletzkya virginica* (marsh hibiscus), *Schoenoplectus californicus* (California bulrush), *Vigna luteola* (deer pea), and *Pontedaria cordata* (pickerel weed).

Submerged aquatic vegetation:

The presence of SAV has markedly increased in the project area post-construction, while some increase was experienced in the reference area. Eight species of SAV were encountered in 2003, whereas no SAV was encountered in 2000 (tables 5 and 6). Two species, *Cabomba carolinianum* (fanwort) and *Nelumbo lutea* (water lotus), were found in the project area and not in the reference area in 2003. Also during 2003, the mean frequency of occurrence of SAV species in the project area approached levels encountered in the reference area (figure 12a-b).

During the pre-construction period in 2000, the area was experiencing an extreme prolonged drought which raises salinity in fresh to intermediate marshes and inhibits SAV growth. Mean salinities recorded during SAV sampling in both the project and reference areas were greater than 20 ppt in 2000 but did not exceed 5 ppt in 2003 (figures 13a-b). In the reference area, the salt-tolerant *Ruppia maritima* (widgeon grass) comprised approximately 70% of the mean frequency of occurrence in 2000, yet in 2003 it was absent. In 2003, the fresh-to-intermediate species *Potamogeton pusillus* (baby pondweed) comprised 70% of the mean frequency of occurrence.

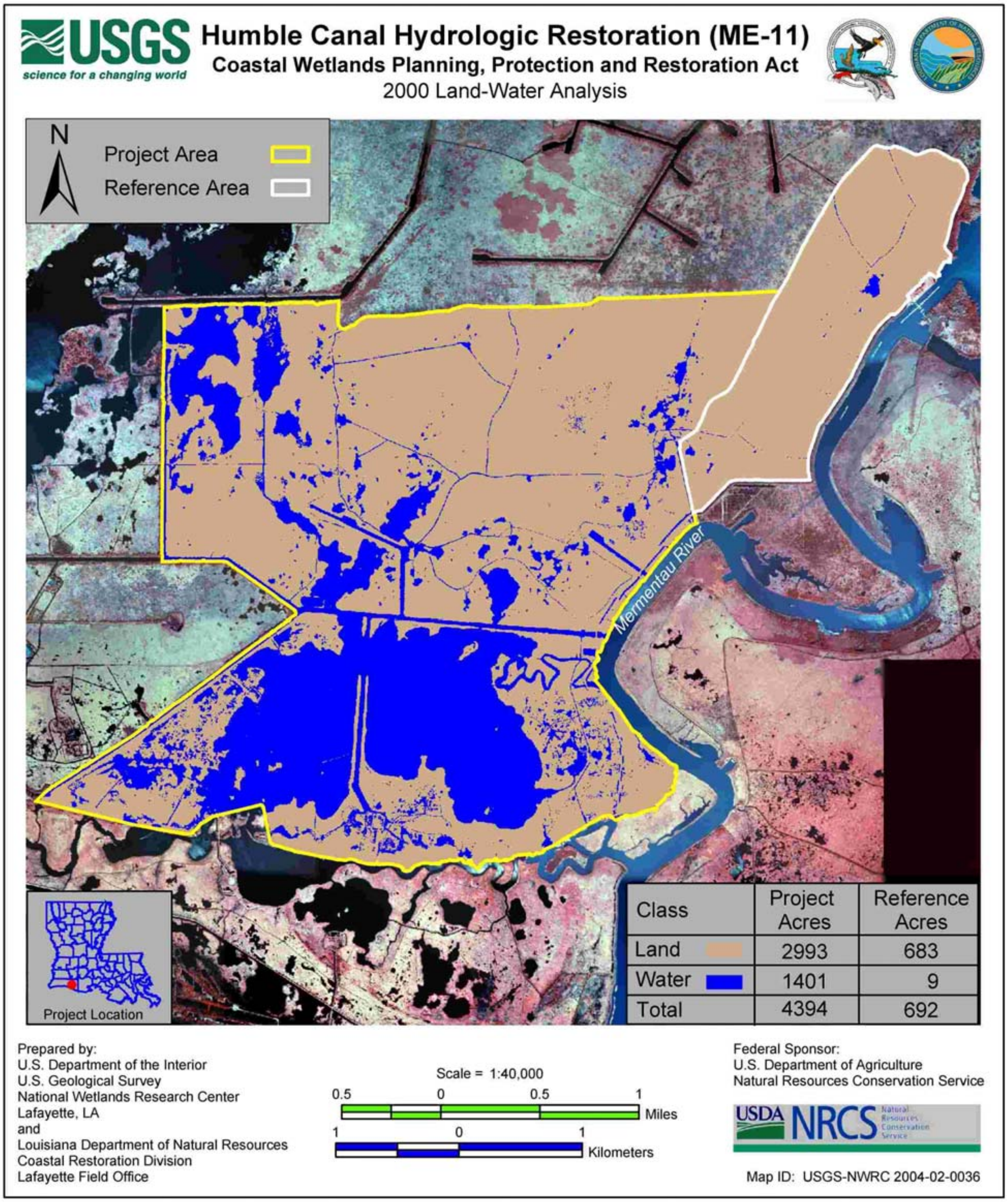
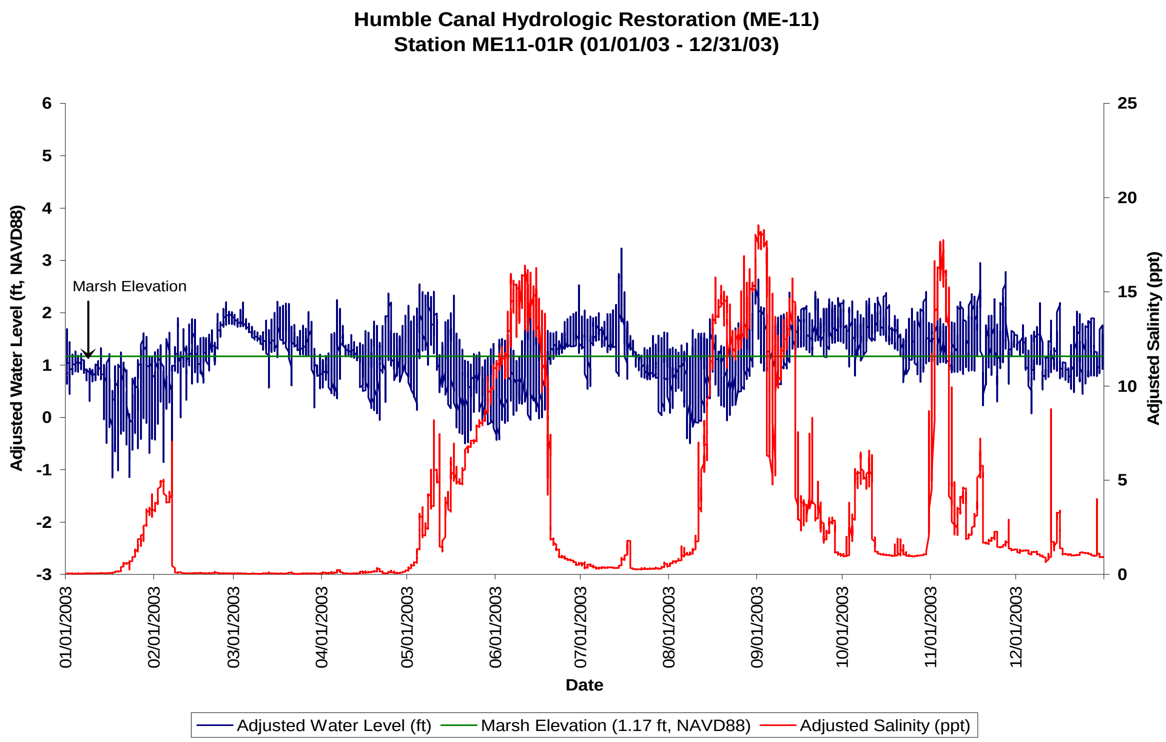


Figure 5. Land/water analysis of 2000 aerial photography showing the acreage of land and water in the project and reference areas of Humble Canal Hydrologic Restoration.

a



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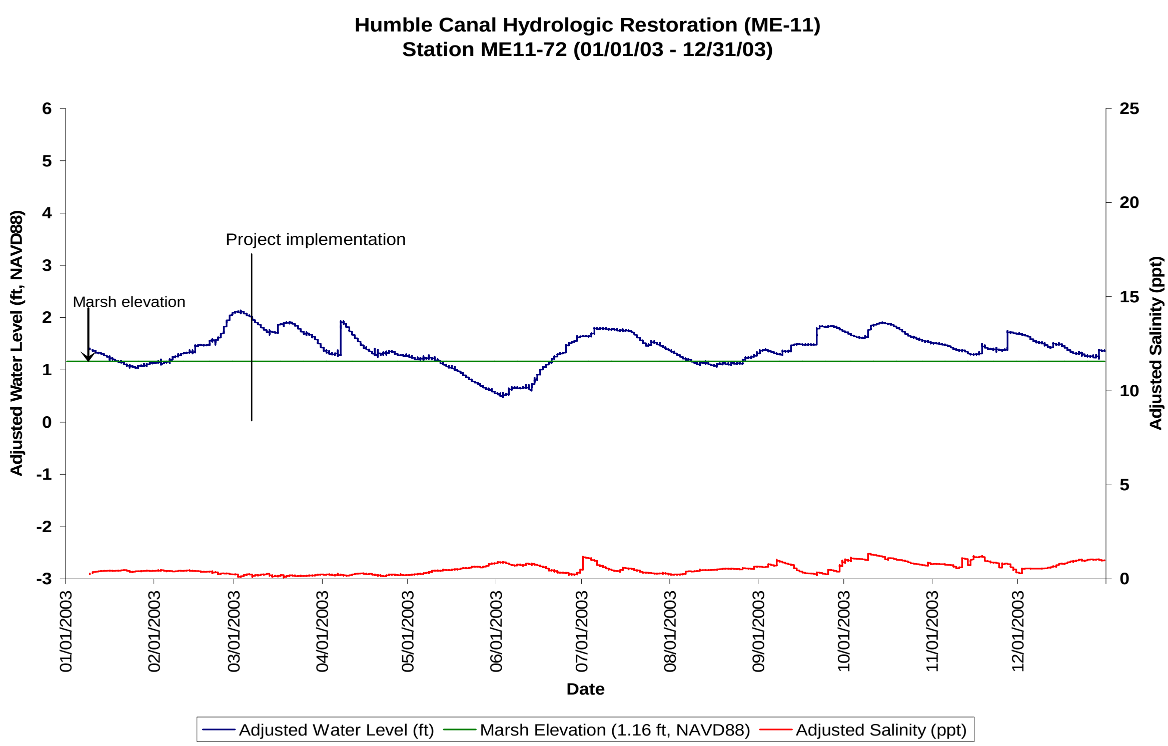


Figures 6a-b. Water level and salinity data from stations a) ME11-01R and b) ME11-72 shown in feet.

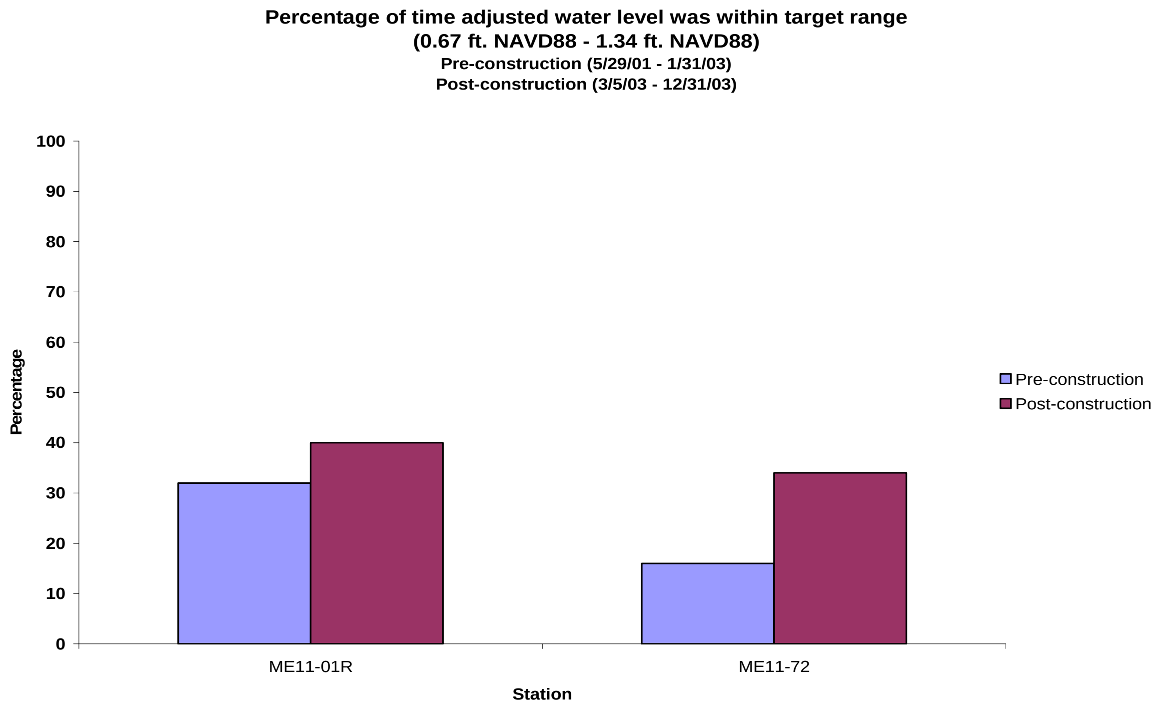
Table 1. Mean, maximum, and minimum values of water level and salinity in the pre-construction period (5/29/01 – 1/31/03) for stations ME11-01R and ME11-72.

	Adjusted Water Level (ft. NAVD88)		Adjusted Salinity (ppt)	
	ME11-01R	**ME11-72**	**ME11-01R**	**ME11-72**
Mean ± S.D.	1.34 ± 0.02	1.86 ± 0.03	1.37 ± 0.11	0.89 ± 0.13
Maximum	3.44	3.77	12.48	3.12
Minimum	-1.26	0.32	0.01	0.09

Table 2. Mean, maximum and minimum values of water level and salinity in the post-construction period (3/5/03 – 12/31/03) for stations ME11-01R and ME11-72.

	Adjusted Water Level (ft. NAVD88)		Adjusted Salinity (ppt)	
	ME11-01R	**ME11-72**	**ME11-01R**	**ME11-72**
Mean ± S.D.	1.32 ± 0.03	1.41 ± 0.03	4.00 ± 0.15	0.57 ± 0.15
Maximum	3.23	2.08	18.54	1.34
Minimum	-0.50	0.48	0.03	0.08

a



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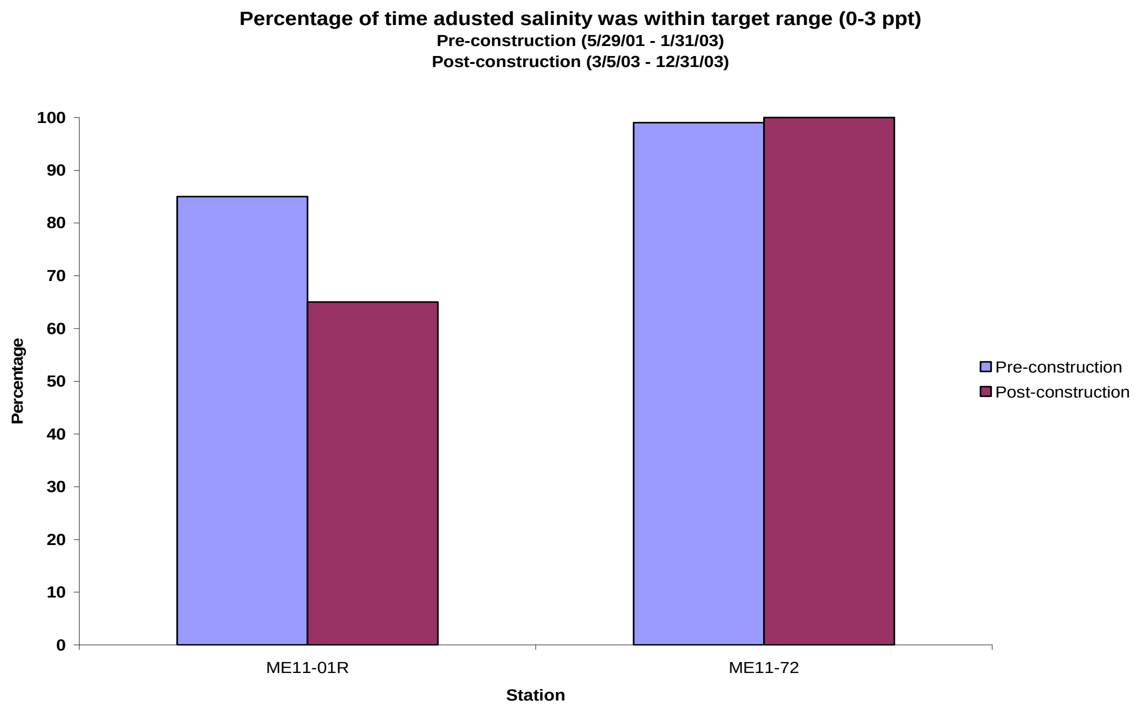
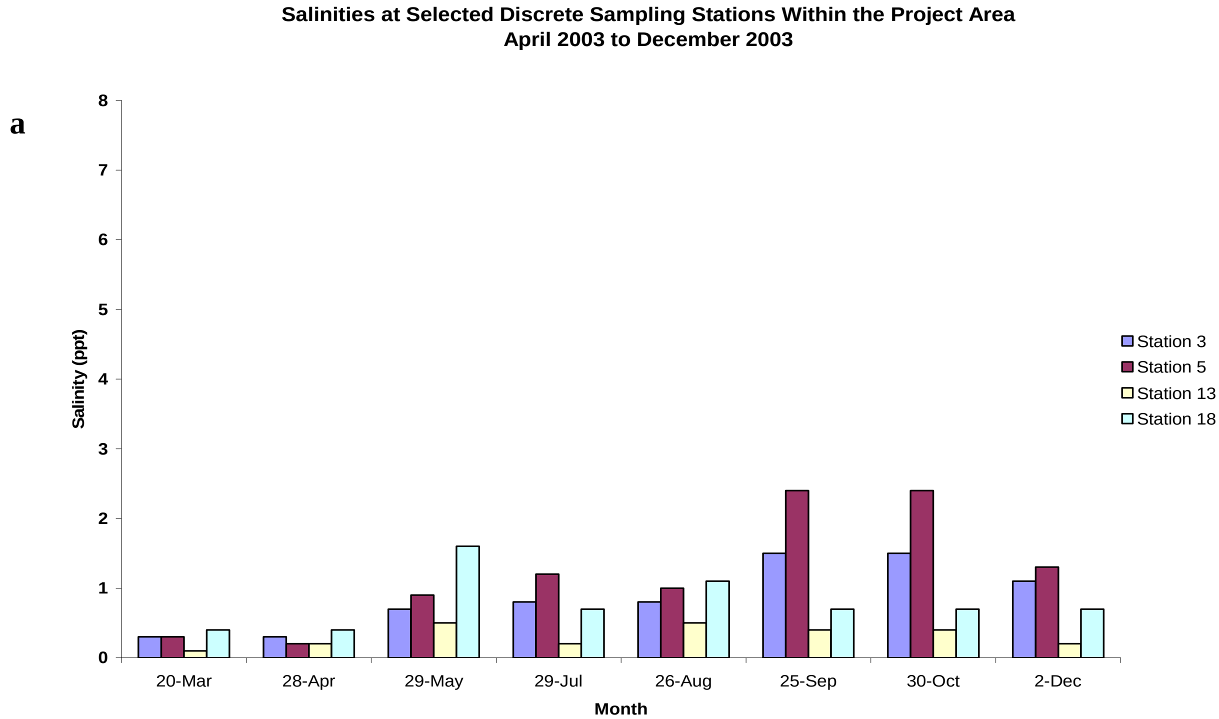


Figures 7a-b. Percentage of time that a) water level and b) salinity measurements in the project and reference areas were within target range for pre- and post-construction periods.



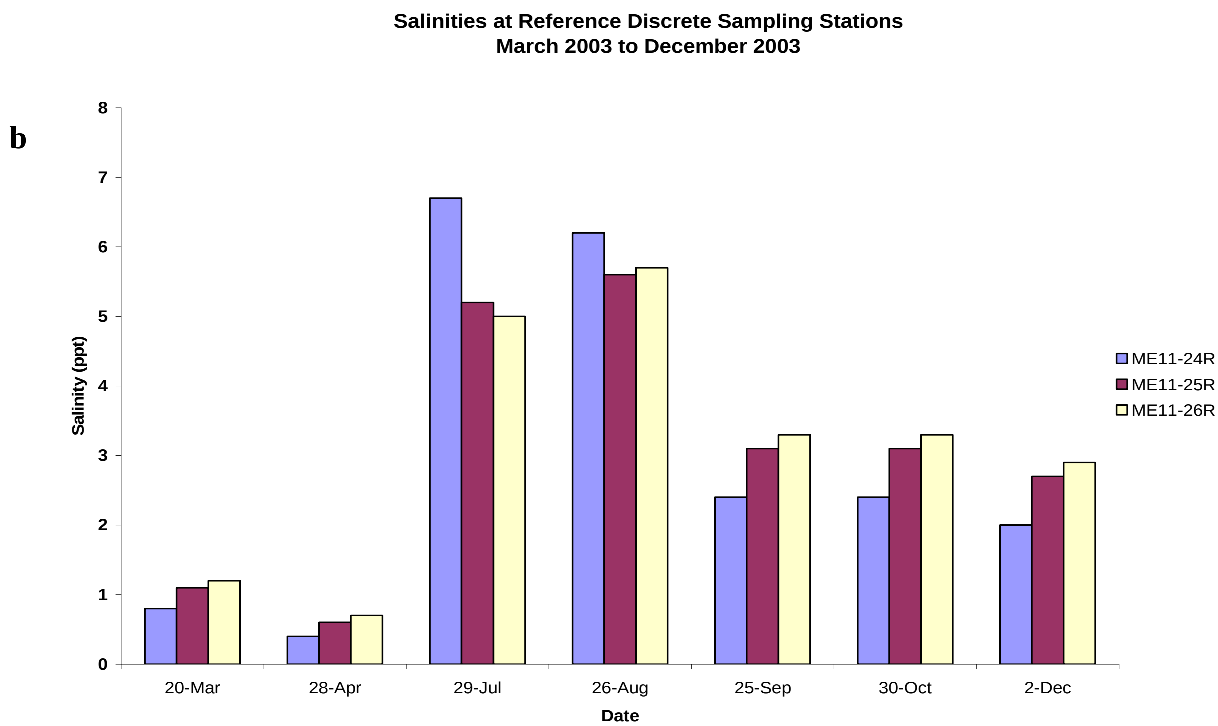
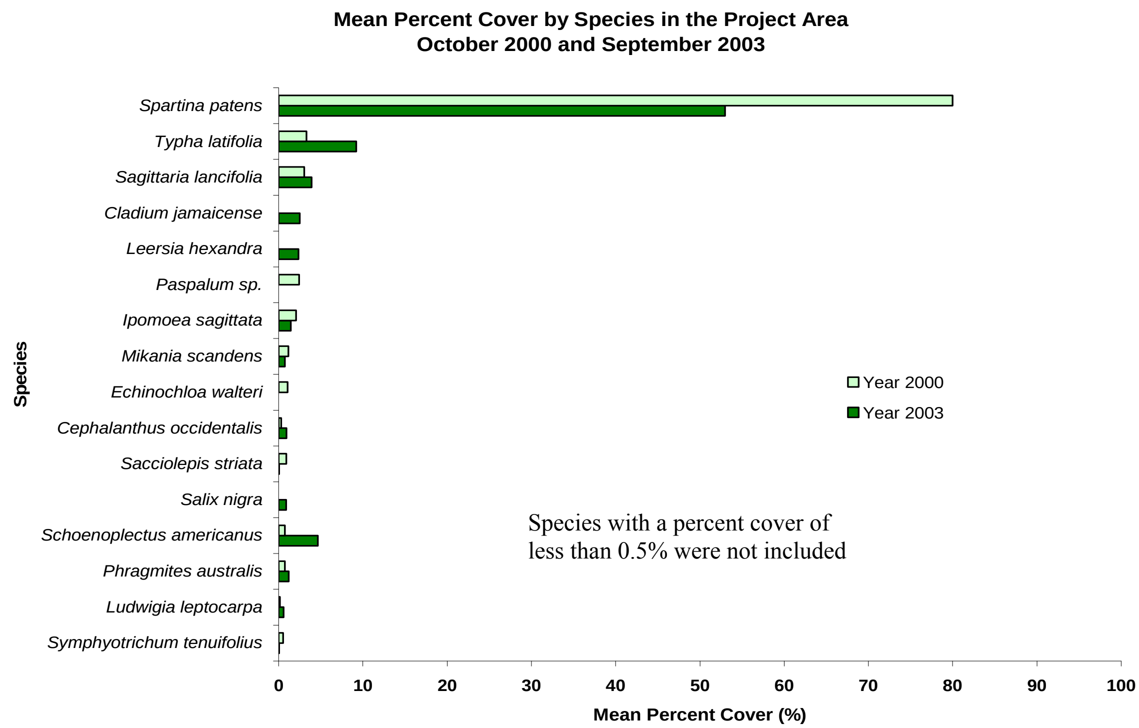


Figure 8a-b. Salinities at discrete sampling stations within the a) project area and at b) reference stations since project implementation.

a



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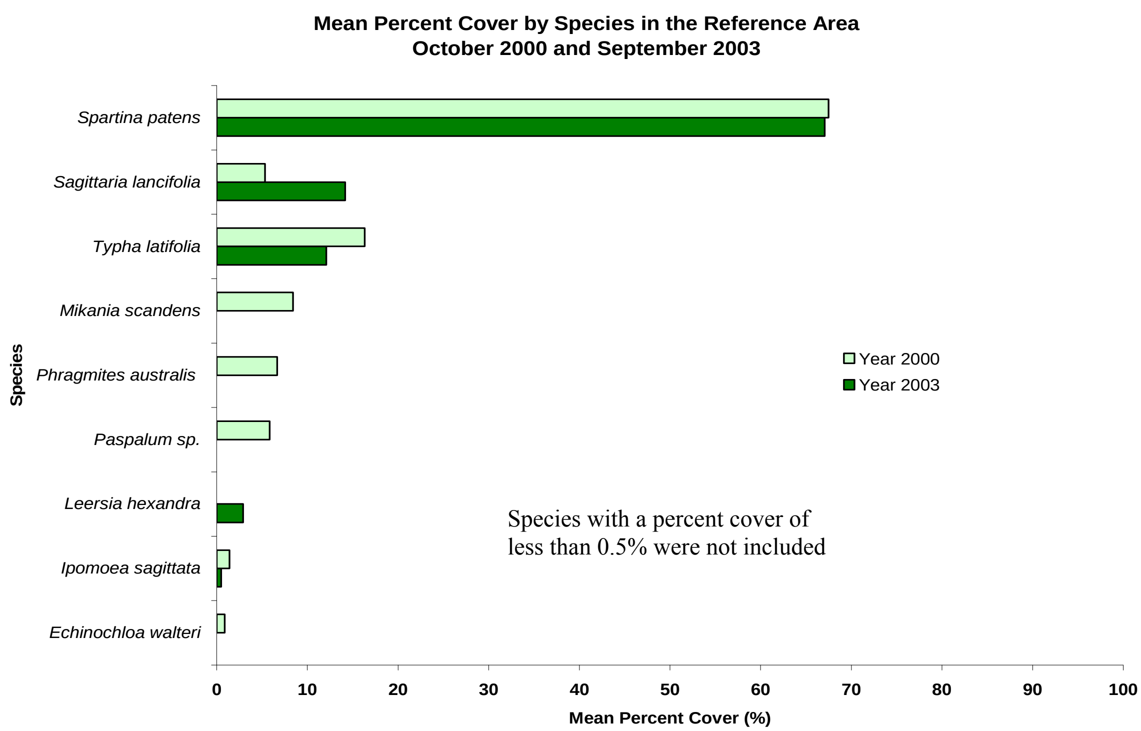

Figures 9a-b. Mean percent cover of selected species across all plots within the a) project area (N=17 plots) and b) reference area (N=6 plots) during October 2000 and September 2003.

Table 3. Scientific and common names for emergent vegetation species observed in the project area.

Year 2000		Year 2003	
Scientific name	**Common name**	**Scientific name**	**Common name**
Alternanthera philoxeroides	Alligatorweed	*Cephalanthus occidentalis*	Buttonbush
Baccharis halimifolia	Saltbush	*Cladium jamaicense*	Saw grass
Cephalanthus occidentalis	Buttonbush	*Cyperus odoratus*	Fragrant flatsedge
Cyperus odoratus	Fragrant flatsedge	*Ipomoea sagittata*	Marsh morning glory
Echinochloa walteri	Water millet	*Iva frutescens*	Marsh elder
Eupatorium capillifolium	Dog fennel	*Kosteletzkya virginica*	Marsh hibiscus
Ipomoea sagittata	Marsh morning glory	*Leersia hexandra*	
Ludwigia leptocarpa	Anglestem primrosewillow	*Ludwigia leptocarpa*	Anglestem primrose willow
Mikania scandens	Climbing hempweed	*Mikania scandens*	Climbing hempweed
Paspalum sp.	Paspalum	*Phragmites australis*	Common reed
Phragmites australis	Common reed	*Polygonum punctatum*	Dotted smartweed
Pluchea odorata	Marsh fleabane	*Sacciolepis striata*	Bagscale
Polygonum hydropiperoides	Wild water pepper	*Sagittaria lancifolia*	Bull-tongue
Sacciolepis striata	Bagscale	*Salix nigra*	Black willow
Sagittaria lancifolia	Bull-tongue	*Schoenoplectus americanus*	Three-corner grass
Salix nigra	Black willow	*Schoenoplectus californicus*	California bulrush
Schoenonplectus americanus	Three-corner grass	*Spartina patens*	Saltmeadow cordgrass
Schoenoplectus robustus	Saltmarsh bulrush	*Symphyotrichum tenuifolius*	Perennial salt-marsh aster
Setaria glauca	Yellow bristlegrass	*Typha latifolia*	Common cattail
Setaria magna	Giant bristlegrass	*Vigna luteola*	Deer pea
Spartina alterniflora	Saltmarsh cordgrass		
Spartina patens	Saltmeadow cordgrass		
Symphyotrichum tenuifolius	Perennial salt marsh aster		
Typha latifolia	Common cattail		
Zizaniopsis mileacea	Southern wildrice		

Table 4. Scientific and common names for emergent vegetation species observed in the reference area.

Year 2000		Year 2003	
Scientific name	**Common name**	**Scientific name**	**Common name**
Alternanthera philoxeroides	Alligatorweed	*Cyperus odoratus*	Fragrant flatsedge
Baccharis halimifolia	Saltbush	*Ipomoea sagittata*	Marsh morning glory
Cyperus odoratus	Fragrant flatsedge	*Leersia hexandra*	Southern cutgrass
Echinochloa walteri	Water millet	*Polygonum punctatum*	Dotted smartweed
Eclipta prostrata	Pie plant	*Pontedaria cordata*	Pickerel weed
Ipomoea sagittata	Marsh morning glory	*Sacciolepis striata*	Bagscale
Mikania scandens	Climbing hempweed	*Sagittaria lancifolia*	Bull-tongue
Paspalum sp.	Paspalum	*Salix nigra.*	Black willow
Phragmites australis	Common reed	*Schoenoplectus americanus*	Three-corner grass
Pluchea odorata	Marsh fleabane	*Spartina patens*	Saltmeadow cordgrass
Polygonum hydropiperoides	Wild water pepper	*Typha latifolia*	Common cattail
Sacciolepis striata	Bagscale	*Zizaniopsis miliacea*	Giant cutgrass
Sagittaria lancifolia	Bull-tongue		
Salix nigra	Black willow		
Setaria glauca	Yellow bristlegrass		
Spartina patens	Saltmeadow cordgrass		
Symphyotrichum tenuifolius	Perennial salt-marsh aster		
Typha latifolia	Common cattail		

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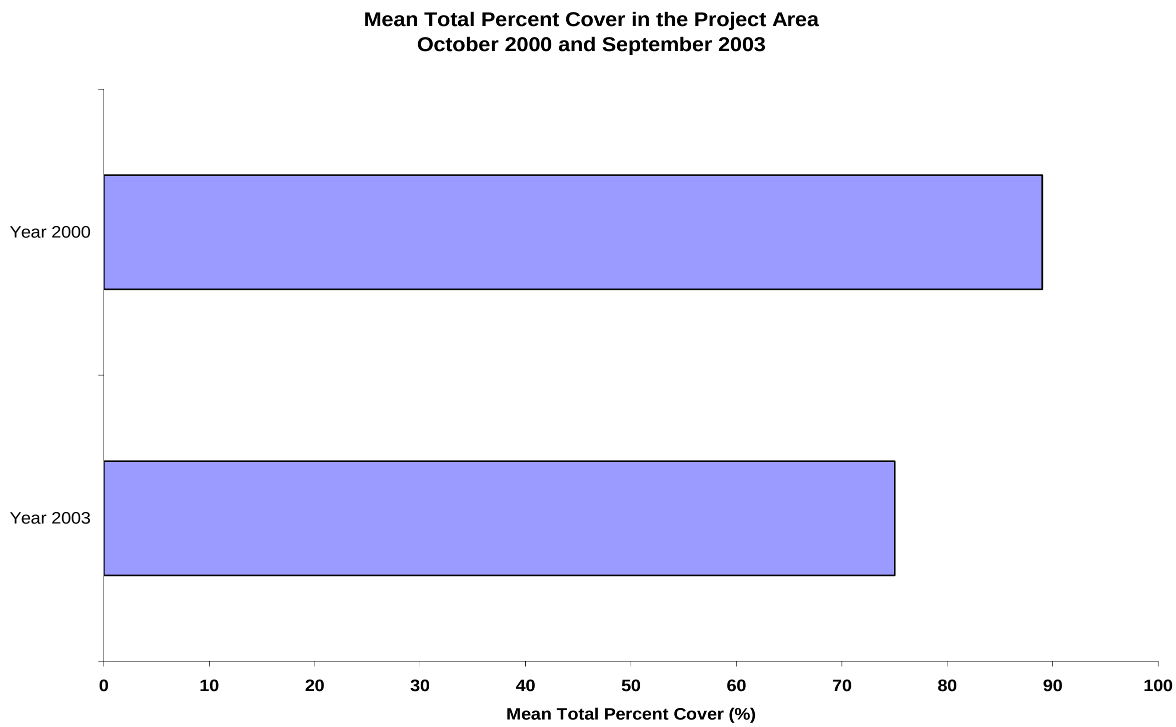

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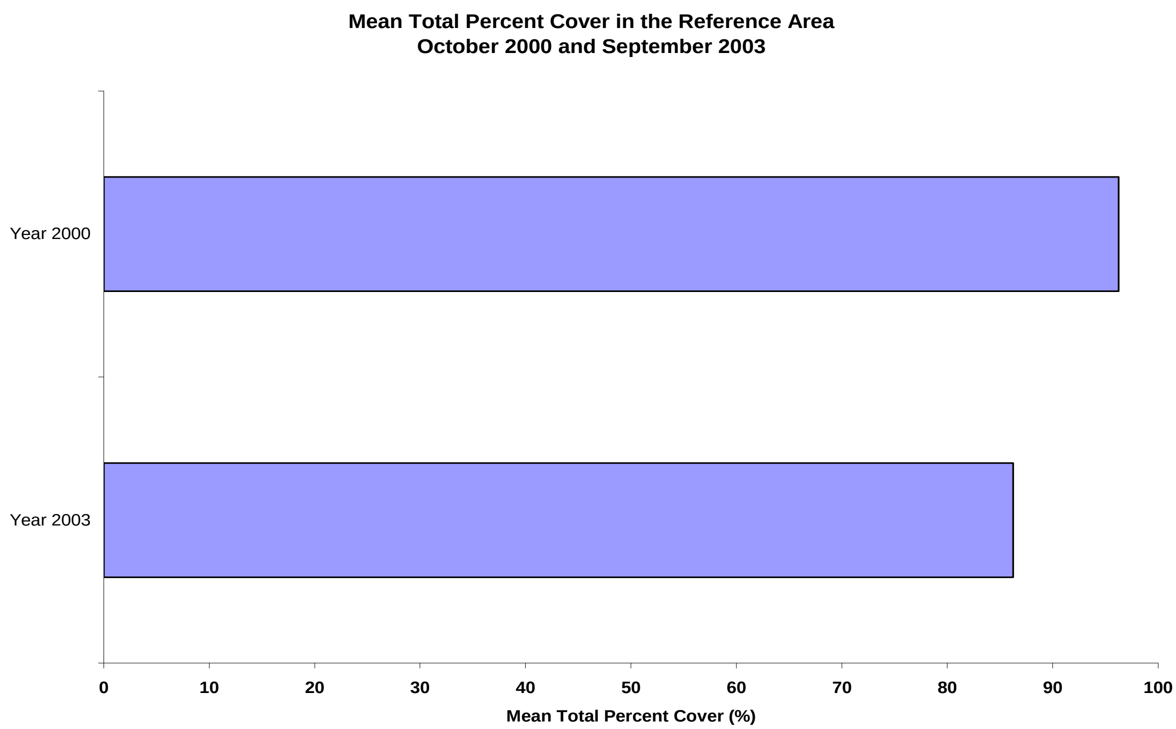
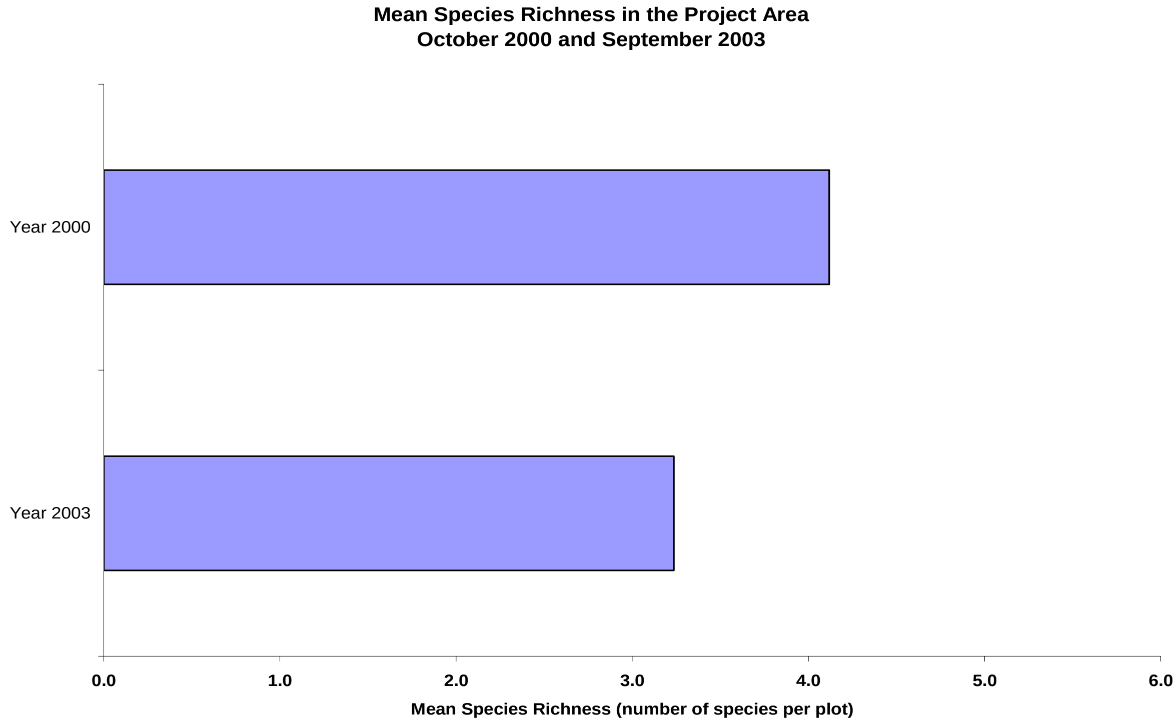


Figures 10a-b. Mean total percent cover in the a) project area (N=17) and b) reference area (N=6) during October 2000 and September 2003.

a



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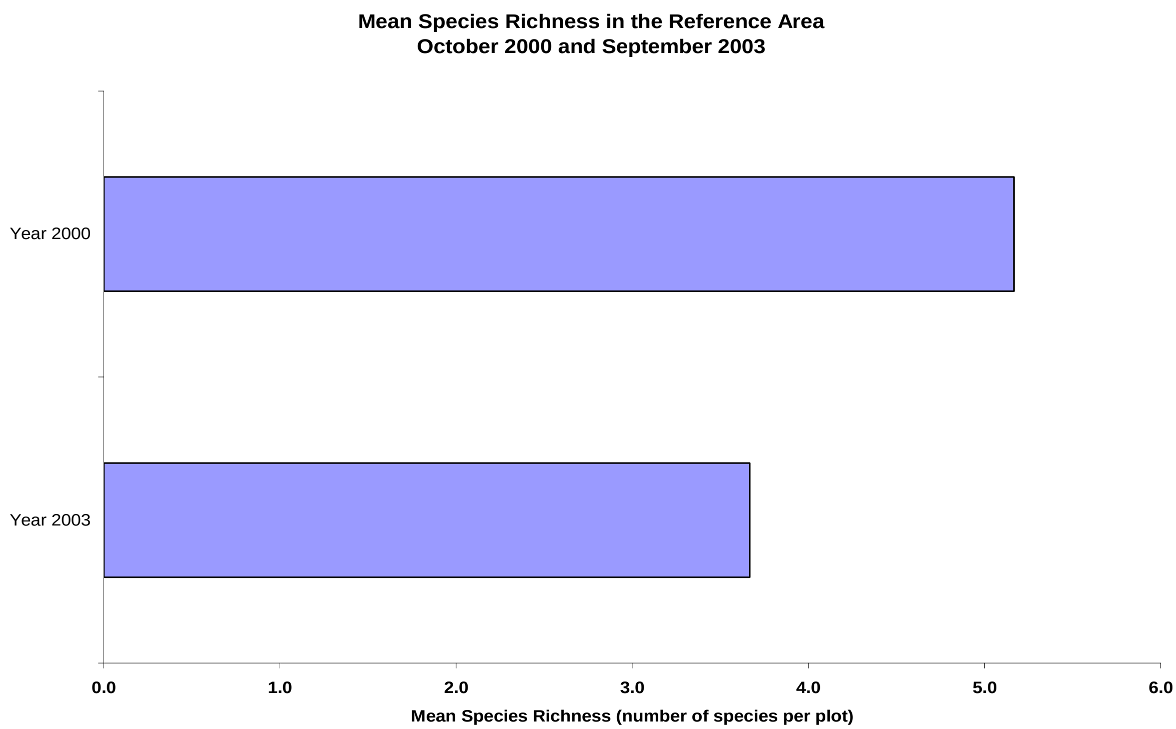


Figures 11a-b. Mean species richness in the a) project area (N=17) and b) reference area (N=6) during October 2000 and September 2003.

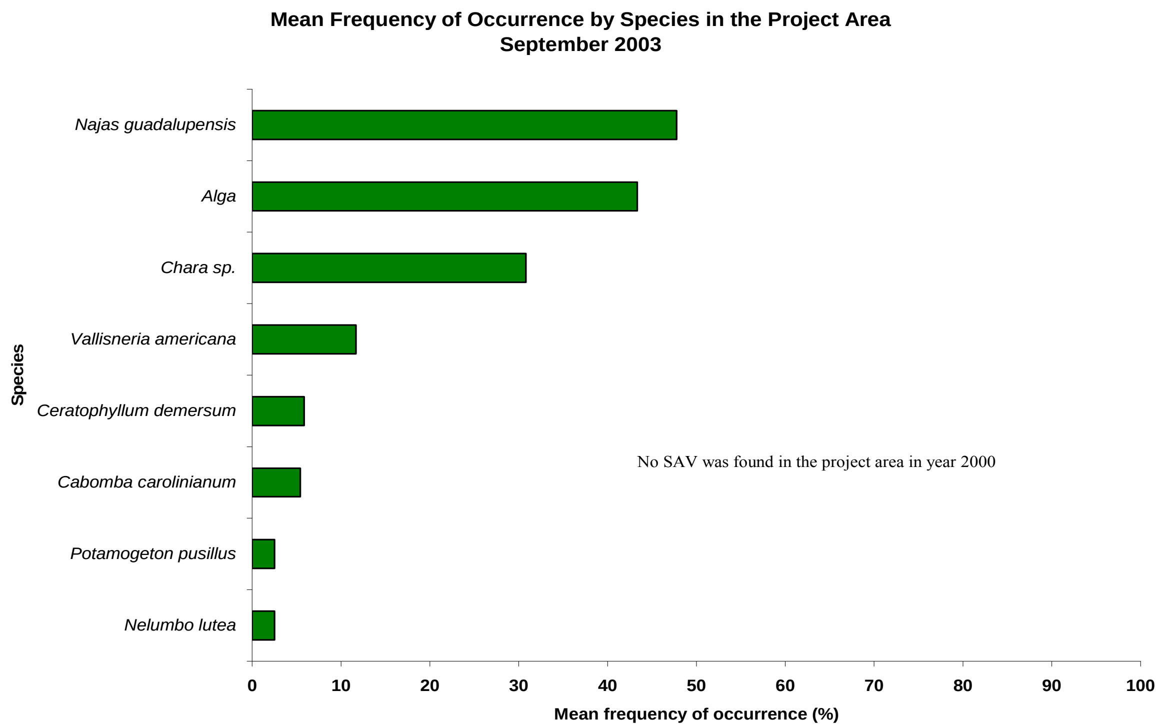
Table 5: Scientific and common names for submerged aquatic vegetation species collected in the project area.

Year 2000		Year 2003	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**
None		*Alga*	
		Cabomba carolinianum	Fanwort
		Ceratophyllum demersum	Coontail
		Chara sp.	Muskgrass
		Najas guadalupensis	Southern naiad
		Nelumbo lutea	Water lotus
		Potamogeton pusillus	Baby pondweed
		Vallisneria americana	Water celery

Table 6. Scientific and common names for submerged aquatic vegetation species collected in the reference area.

Year 2000		Year 2003	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**
Alga		*Alga*	
Ceratophyllum demersum	Coontail	*Ceratophyllum demersum*	Coontail
Ruppia Maritimus	Widgeon grass	*Chara* sp.	Muskgrass
		Lemna sp.	Duckweed
		Najas guadalupensis	Souther naiad
		Potamogeton pusillus	Baby pondweed
		Vallisneria americana	Water celery

a



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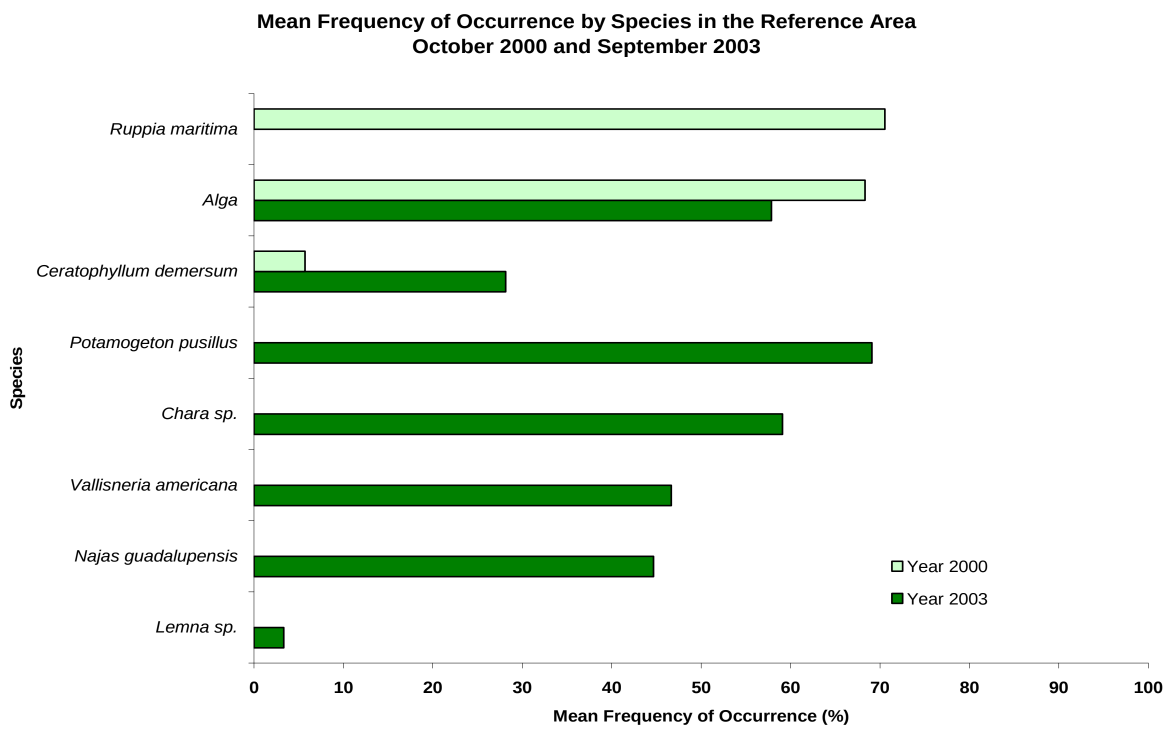
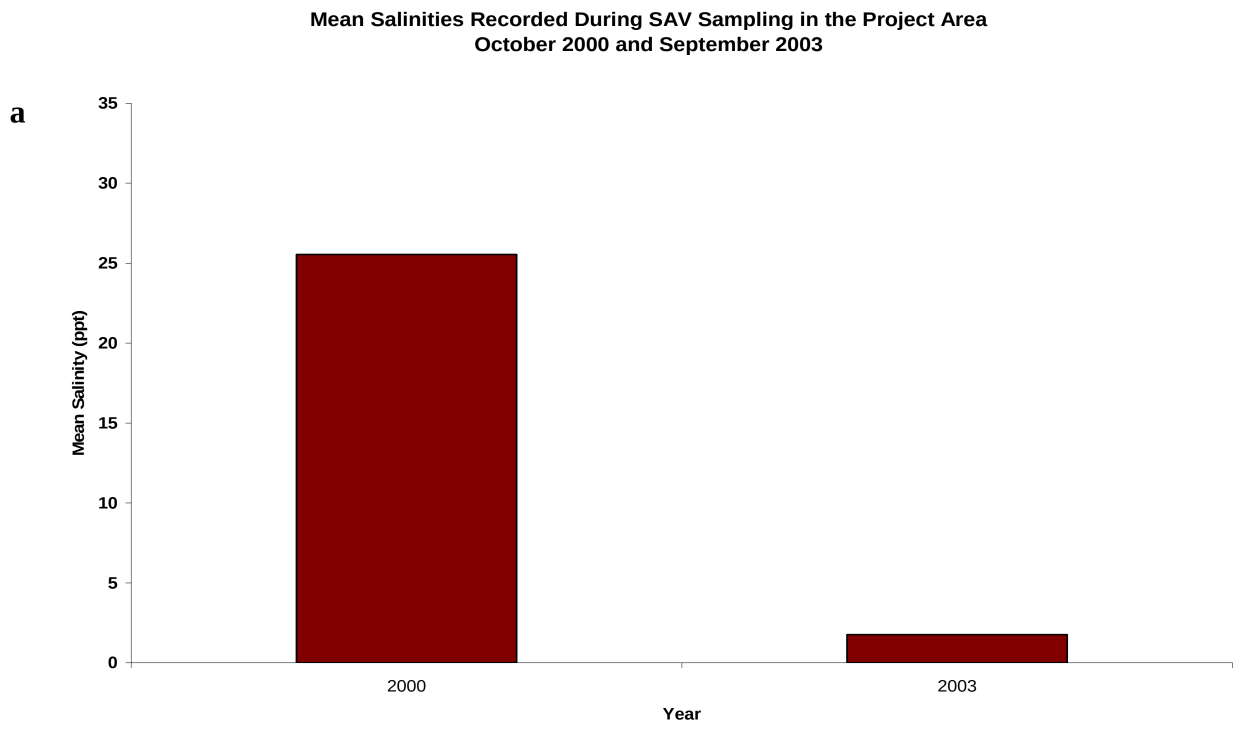
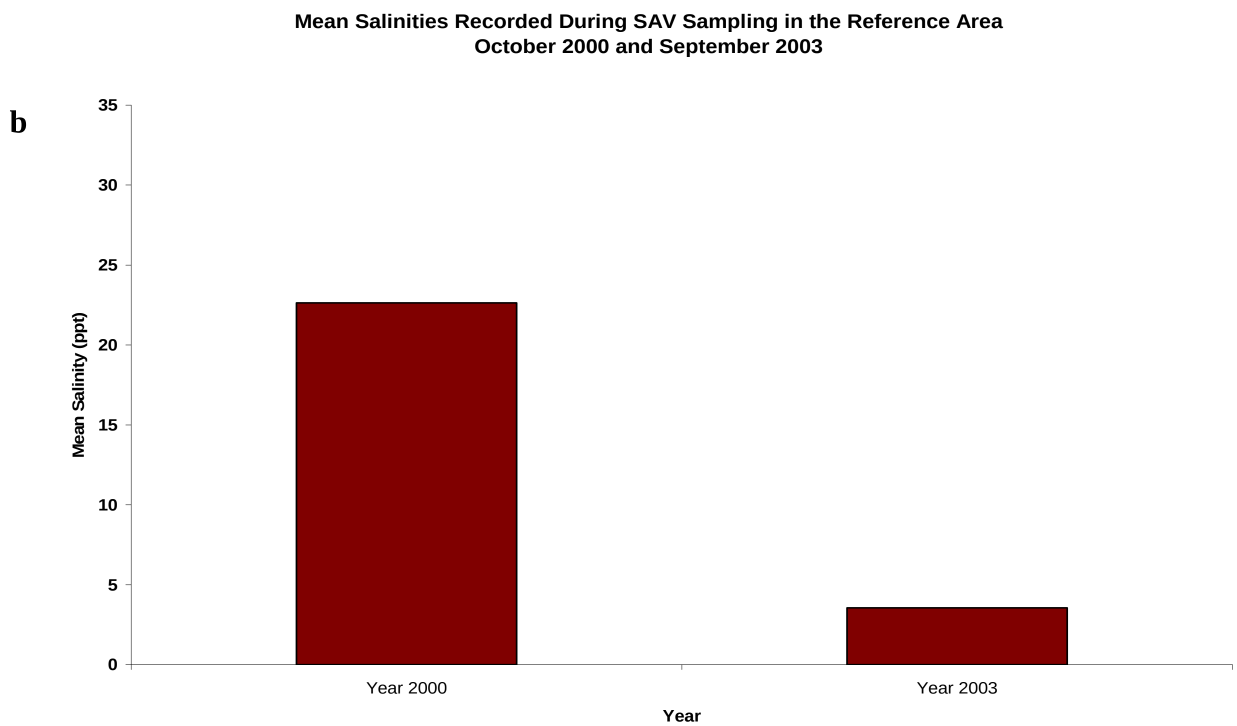


Figures 12a-b. Mean frequency of occurrence across all transects in the a) project area (N=6) and b) reference area (N=6) during October 2000 and September 2003.





Figures 13a-b. Mean salinities recorded during SAV sampling in the a) project area and b) reference area during October 2000 and September 2003.

V. Conclusions

a. Project effectiveness

No post-construction analysis is available yet to determine changes in land/water ratio. During the 2003 post-construction time period, the project area experienced a decrease in water level with respect to the reference mean water level, although project area mean water level was slightly above the target range. Since salinity remained below 3 ppt in the project area 100% of the time post-construction while salinity frequently rose well above 3 ppt at the reference station, saltwater was effectively restricted. However, since salinity at the project station remained within the target range 99% of the time pre-construction, results cannot be attributed to project implementation.

The 2003 emergent vegetation survey was carried out only six months after project implementation, and these vegetation communities likely have a longer response time to hydrologic conditions brought about by project construction. The dramatic contrast in SAV presence between sampling years can most likely be attributed to lower salinity since the drought in 2000, although these results may also be due to project effectiveness in restricting saltwater.

b. Recommended improvements

Modification to the land rights agreement with Miami Corp. is currently being done in an effort to designate Miami as structure operator for the project.

c. Lessons learned

The ME-11 structure design incorporated the use of aluminum stoplogs and removable lifting devices. This type of structure design is recommended on future projects, providing for easier and safer operations of the structure.

The structure design was modified during construction to add five small platforms above the flapgates of each barrel. This allowed for safer operator access to manipulate the opening handles that are used to lift the flapgates, and is recommended to be incorporated in future designs.

The structure design was modified during construction to replace the ¼" thick aluminum channel system supporting the stoplogs with an extruded ½" channel system. The thicker ½" extruded channel system is free of any warps to which the ¼" system would be subjected. This allows the stoplogs to move more freely and is recommended to be incorporated in future designs.

VI. Literature Cited

Chabreck, R. H., and C. M. Hoffpauir 1962. The use of weirs in coastal marsh management in coastal Louisiana. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 16:103-12.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation ecology. New York: John Wiley and Sons. 547 pp.

Louisiana Department of Natural Resources. 2003. Operations Maintenance, and Rehabilitation Plan for the Humble Canal Hydrologic Restoration Project (ME-11), Louisiana Department of Natural Resources, Coastal Engineering Division.

Nyman, J. A., and R. H. Chabreck 1996. Some effects of 30 years of weir management on coastal marsh aquatic vegetation and implications to waterfowl management. Gulf of Mexico Science 14:16-25.

Steyer, G. D., R. C. Raynie, D. L. Steller, D. Fuller, and E. Swenson. 1995. Quality management plan for Coastal Wetlands Planning, Protection, and Restoration Act monitoring plan. Open-file series 95-01. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division.

U. S. Department of Agriculture, Soil Conservation Service 1995. Soil survey of Cameron Parish, Louisiana. Publication No. 1995−386−441/00020. Washington, D.C.: U.S. Government Printing Office. 135 pp, 122 maps. Scale 1:20,000.