Coastal Protection and Restoration Authority of Louisiana

State of Louisiana
Coastal Protection and Restoration Authority

2014 Operations, Maintenance, and Monitoring Report

for

Hopedale Hydrologic Restoration (PO-24)

State Project Number PO-24
Priority Project List 8

September 1, 2014
St. Bernard Parish

Prepared by:
Bryan P. Gossman, Melissa K. Hymel, and Barry J. Richard

Coastal Protection and Restoration Authority
New Orleans Regional Office
CERM, Suite 309
2045 Lakeshore Dr.
New Orleans, LA 70122

Suggested Citation:

Gossman, B. P., M. K. Hymel, and B. J. Richard. 2014. *2014 Operations Maintenance and Monitoring Report for Hopedale Hydrologic Restoration (PO-24)*, Coastal Protection and Restoration Authority of Louisiana, New Orleans, Louisiana. 33 pp. and Appendices.

2014 Operations, Maintenance, and Monitoring Report
For
Hopedale Hydrologic Restoration (PO-24)

Table of Contents

Preface

The Hopedale Hydrologic Restoration (PO-24) project was funded through the Coastal Wetlands Planning and Protection Act (CWPPRA) on the 8th Priority Project List with the National Oceanic and Atmospheric Administration (NOAA) as the federal sponsor. This report includes monitoring data collected through December 2013, and Annual Maintenance Inspections through September 2014. The 2014 Operations, Maintenance, & Monitoring (OM&M) Report is the third in a series that includes monitoring data and analyses presented previously in the 2007 and 2010 OM&M reports (Carter et al. 2007, Carter et al. 2010), plus additional project-specific and CRMS data collected since the previous report. These reports will be made available for download at the following website:
http://sonris.com/direct.asp?path=/sundown/cart_prod/cart_bms_avail_documents_f

I. Introduction

The 4,656-acre (1,884-ha) Hopedale Hydrologic Restoration Project (PO-24) is located southeast of Yscloskey, Louisiana, and is bordered by LA Hwy 46 on the west, the Mississippi River Gulf Outlet (MRGO) spoil deposition area to the north, and Louisiana Highway 624 and Bayou La Loutre to the south and east (Figure 1). The project area was formed as part of the St. Bernard Delta Lobe which took place approximately 3,000 years ago when the Mississippi River flowed through what is now Bayou La Loutre, laying the foundation for present day St. Bernard Parish. In 1958, construction began on a shipping channel that would cut through the relic delta and Bayou La Loutre. The channel, the Mississippi River Gulf Outlet (MRGO), was completed in 1968. As part of the construction of the MRGO, a spoil containment dike was constructed to allow placement of material from the MRGO dredging operation. The dike almost completely impounded the surrounding marsh with the exception of the Back Dike Borrow Canal which directly connected to Bayou La Loutre. A plug and water control structure was placed in the Back Dike Borrow Canal approximately 400 ft from its intersection with Bayou La Loutre. This structure consisted of three iron culverts with flap gates and provided drainage from the area while limiting tidal increases in minimal storm events. By the mid 1990's the original plug installed during the MRGO construction, prior to the PO-24 project initiation, had settled and the water control structure did not function as designed and was in need of repairs.

Wetlands in the PO-24 project area are classified as mesohaline wiregrass and have been adversely impacted by increases in flood durations due to the near complete impoundment caused by the construction of LA Hwy 624 and the MRGO. During construction of LA Hwy 624, four sets of non-gated culverts were installed under the highway. These culverts allowed tidal exchange between Bayou La Loutre and previously impounded wetlands north of the highway. The area is predominately brackish marsh (3,086 acres) and open water (719 acres) with a small amount of saline marsh, bottomland hardwoods and bottomland scrub/shrub within the MRGO spoil deposition area.

In January 2004, construction began on the Hopedale water control structure at the junction of the Back Dike Borrow Canal and Bayou La Loutre. This involved removal of the 3 existing corrugated metal pipes and rock structure located within the Back Dike Borrow Canal and replacing it with a sheet pile/pipe pile gated structure, along with associated walkways and riprap

Figure 1. Hopedale Hydrologic Restoration (PO-24) project location and features.

protection. The structure, which was completed in November 2004, also required construction of temporary closure dams for dewatering the existing canal.

The goals of the Hopedale Hydrologic Restoration Project (PO-24) are to restore natural drainage patterns, to sustain or enhance the deteriorating marsh, and maintain or improve fisheries transport within the area.

The principle project features include:

- A sheet pile/pipe pile wall, which spans the channel and extends past both banks with an overall length of 137.9'. The top of cap plate elevation is set at +8.0' NAVD88.

- Three 82" diameter Whipps combination gates (flap/sluice gates) and two 24"x 84" Whipps fisheries access slots (fish gates) with the inverted elevation at –7.0' NAVD88.

- A walkway with guardrails and warning signs on each side of the structure for operating the gates safely and for prohibiting unwanted access. The channel spans 115' from the canal banks and is covered with riprap (1' thick 10-lb. and 1.5' thick 55-lb.). The top of 55-lb. riprap along the canal bottom is set at elevation –8.0' NAVD88.

II. Maintenance Activity

a. Summary of Past Operation and Maintenance

In 2005 the Hopedale structure suffered minor damage due to Hurricane Katrina. In 2007/2008 the repairs, at a cost of $64,900, were made as follows:

- Repaired and replaced all damaged fence panels.

- Replaced missing gate stem covers.

- Repaired damaged railing.

- Placed riprap into eroded areas.

- Replaced missing mechanical gate operator.

- Added support beam under walkway.

b. Inspection Purposes and Procedures

An inspection of the Hopedale Hydrologic Restoration Project (PO-24) was held on September 2, 2014 by CPRA representatives Barry Richard and Luke Prendergast. Photographs of that inspection are included in Appendix A of this report. The purpose of the annual inspection of the Hopedale Hydrologic Restoration Project (PO-24) is to evaluate the constructed project features, to identify any deficiencies, and to prepare a

report detailing the condition of project features and necessary corrective actions. Should it be determined that corrective actions are needed, CPRA shall provide a detailed cost estimate for engineering, design, supervision, inspection, and construction contingencies, and an assessment of the urgency of such repairs (LDNR 2005). The annual inspection report also contains a summary of maintenance projects and an estimated projected budget for the upcoming three (3) years for operation, maintenance and rehabilitation. The three (3) year projected operation and maintenance budget is shown in Appendix B.

c. Inspection Results

Water Control Structure

The fish gates were open at the time of the inspection in accordance with the Operation and Maintenance Plan. The flow through the project structure was generated from an approximated 0.5 ft. of head. The structure was observed to be in generally good condition, although one of the fish gate stem covers was damaged (Photo #2). The Field Inspection Form is included in Appendix C.

d. Maintenance Conclusions

The Hopedale Hydrologic Restoration Project (PO-24) is performing as designed. With the new operations contract in place the structure will continue to be maintained throughout the project life.

e. Maintenance Recommendations

Perform preventative maintenance on a regular basis.

Immediate Repairs

- Recommend replacement of damaged fish gate stem cover.

Programmed Maintenance

- Continue to check gates on structure for operability.

III. Operations Activity

A maintenance contract was initiated with the Lake Borgne Basin Levee District in 2011 to provide regular maintenance and operations for the structure.

IV. Monitoring Activity

Pursuant to a CWPPRA Task Force decision on August 14, 2003, the Coastwide Reference Monitoring System-Wetlands (CRMS) was adopted, which established a network of monitoring stations across the Louisiana coast. There is one CRMS site located in the project area, CRMS3800, which will be used to supplement existing project-specific data. There are three additional CRMS sites nearby, CRMS4548, CRMS4551, and CRMS4557, which will be used as reference sites.

a. Monitoring Goals

The objectives of the Hopedale Hydrologic Restoration Project are three-fold: (1) to maintain and enhance existing marsh in the project area by reducing the tidal influx of higher salinity water, (2) to reduce the intensity and duration of marsh inundation, and (3) to maintain organism exchange.

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

1. Maintain 99% of the pre-construction acres of vegetated wetlands over the life of the project.
2. Reduce the number and duration of flooding events.
3. Maintain or improve fisheries ingress and egress.

b. Monitoring Elements

Aerial Photography

To determine ratios of land to open water in the project area, near vertical, color-infrared aerial photography was obtained in November 2000 (preconstruction) and October 2012 (post-construction). The imagery was georectified, photo-interpreted, and analyzed to determine land:water ratios using standard operating procedures and techniques described in Steyer et al. (1995, revised 2000). All areas characterized by emergent vegetation, upland, wetland forest, or scrub-shrub were classified as land, while open water, aquatic beds, and mudflats were classified as water. The 2000 photography was acquired specifically for the PO-24 project at 1:12,000 scale with ground controls. The 2012 photography was obtained using CRMS aerial photography (Folse et al. 2012). The CRMS program uses digital imagery (Z/I digital mapping camera) with 1-meter resolution. Aerial photography will be acquired again in 2023 using CRMS aerial photography.

Continuous Hydrologic Data – Salinity and Water Level

Three PO-24 continuous recorder stations (PO24-01, -03, and -05) are located within the project area (project sites) and two PO-24 recorders (PO24-02 and -04) are located outside the project area (reference sites, Figure 1). Additionally, four CRMS sites will be included in the monitoring data discussions and analyses. CRMS3800 is within the PO-

24 project boundary (project site) and three CRMS sites are located outside of the project area (CRMS4548, 4551, and 4557; reference sites). For the purposes of this report, all analyses will include data from the beginning of each data record through December 31, 2013, unless otherwise indicated.

Hourly water level, temperature, specific conductivity, and salinity data are collected at each site. The continuous recorder is mounted on a wooden post in open water environments with sufficient water depths to inundate the recorder year round. Each continuous recorder station is serviced every 1 to 3 months to clean and calibrate the recorder and to download the data. During processing, the data are examined for accuracy and water level data are converted to a common vertical datum in relation to the elevation of a surveyed 'mark' (nail) located on the side of each post. The data are then loaded to the CPRA database and are available for download from the CRMS website (http://www.lacoast.gov/crms2).

Salinity data collection began in June 2000 at the five PO-24 stations, and will continue to be collected at two of the PO-24 stations, PO24-02 and PO24-05, through August 2014. Data collection was discontinued at PO24-01 and PO24-03 in April 2011 and at PO24-04 in September 2008 following Hurricanes Gustav and Ike. The CRMS sites included in this report have been active from January 2008 to present. A summary of the hydrologic recorders used for this project is included in Table 1.

Table 1. Summary of PO-24 hydrologic monitoring stations.

Station	Location	Data Collection Period	Marsh Surface Elevation (ft NAVD88)	Year of Active Survey
PO24-01	Project	6/1/00 – 4/7/11	0.72	2000
PO24-02	Reference	6/1/00 – 8/2014	NA	NA
PO24-03	Project	6/1/00 – 4/7/11	0.82 0.57	2000 2003
PO24-04	Reference	6/1/00 – 9/23/08	NA	NA
PO24-05	Project	6/1/00 – 8/2014	0.71 0.54 0.39	2000 2003 2013
CRMS3800	Project	1/23/08 – present	0.34	2007
CRMS4548	Reference	1/23/08 – present	0.68	2007
CRMS4551	Reference	1/23/08 – present	0.84	2007
CRMS4557	Reference	1/23/08 – present	0.99	2007

The same 9 recorders used to collect salinity data were also used to record water level. All 9 stations are surveyed to the North American Vertical Datum (NAVD 88) to allow the data to be converted to a known elevation. Average marsh elevation, which enables

assessment of frequency, depth and duration of project area marsh flooding, was determined directly adjacent to the three PO-24 stations within the project area at the time of establishment in 2000 (Table 1). Average marsh elevation was resurveyed in 2003 at PO24-03 and PO24-05 and in 2013 at PO24-05. The reference sites, PO24-02 and PO24-04, are not directly adjacent to marsh due to the high spoilbanks along Bayou La Loutre; therefore, average marsh elevation is unavailable for these stations. Average marsh elevation was surveyed at the four CRMS stations in mid to late 2007.

c. Monitoring Results and Discussion

i. Aerial Photography

Land-water analysis of the aerial photography acquired in 2000 indicates that there were 3,463 ac of land and 1,193 ac of water within the 4,656-ac project area prior to construction (Figure 2). This amounts to 74.4% land and 25.6% water. The 2012 land-water analysis indicates that there are currently 3,509 ac of land and 1,147 ac of water within the project area, or 75.4% land and 24.6% water (Figure 3). This represents a net gain of 46 ac or 1% of land over the 12-yr period.

Closer inspection of the 2000 and 2012 land-water analysis reveals that much of the land gain appears in two main areas; 1) north of the back dike borrow canal and 2) an area immediately south of the back dike borrow canal in the eastern portion of the project area. The land gain in the latter area can be attributed to the placement of spoil from a maintenance dredging event of the MRGO that took place in 2005 (Figure 4). The dredged spoil was placed in an area of broken marsh approximately 150 ac in size and has subsequently vegetated. Despite the gains in land acreage, there were land losses in the central portion of the project area between the back dike borrow canal and the Bayou La Loutre Ridge. This land loss is due to the continued degradation of the fragmented marsh in the area.

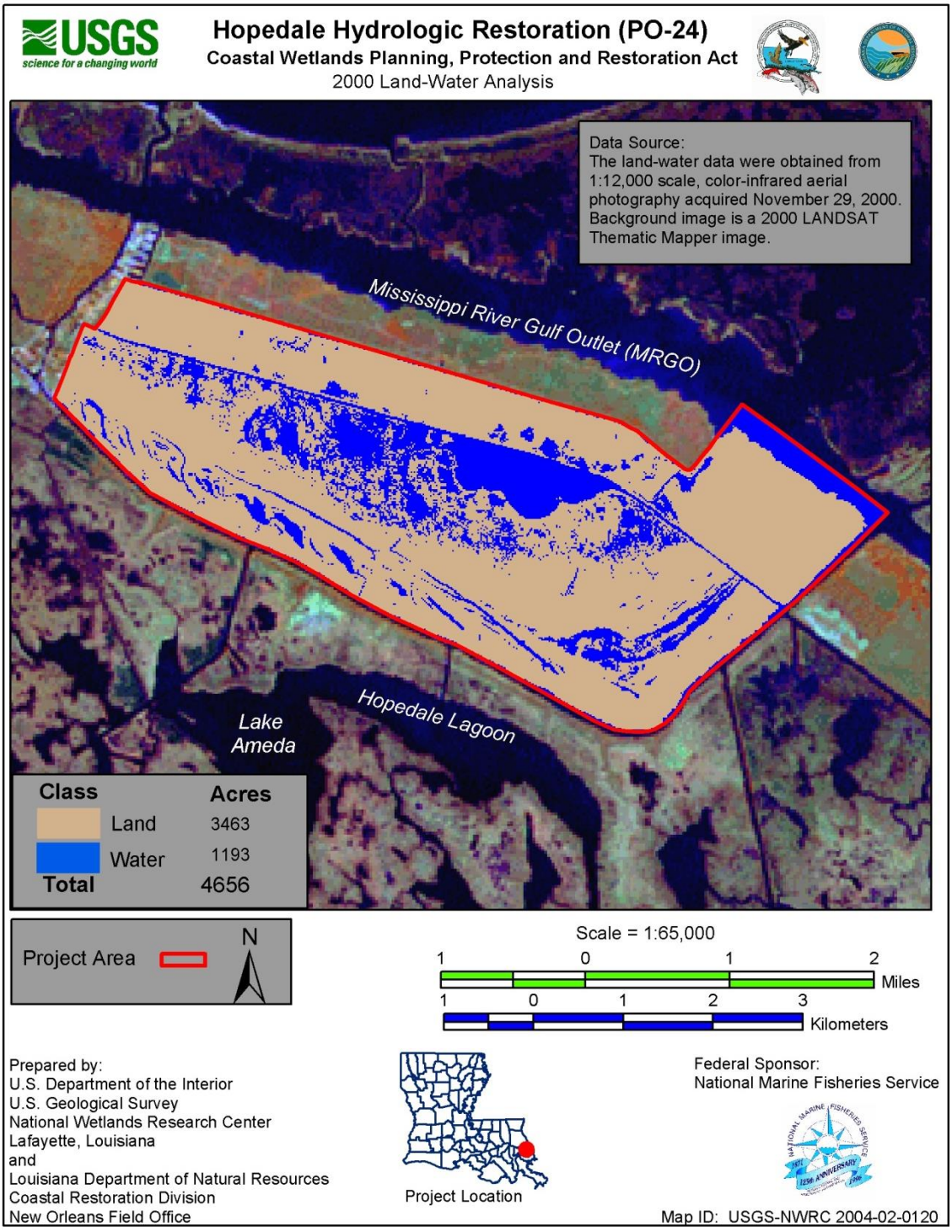

Figure 2. Land/water classification of 2000 aerial photography for PO-24.

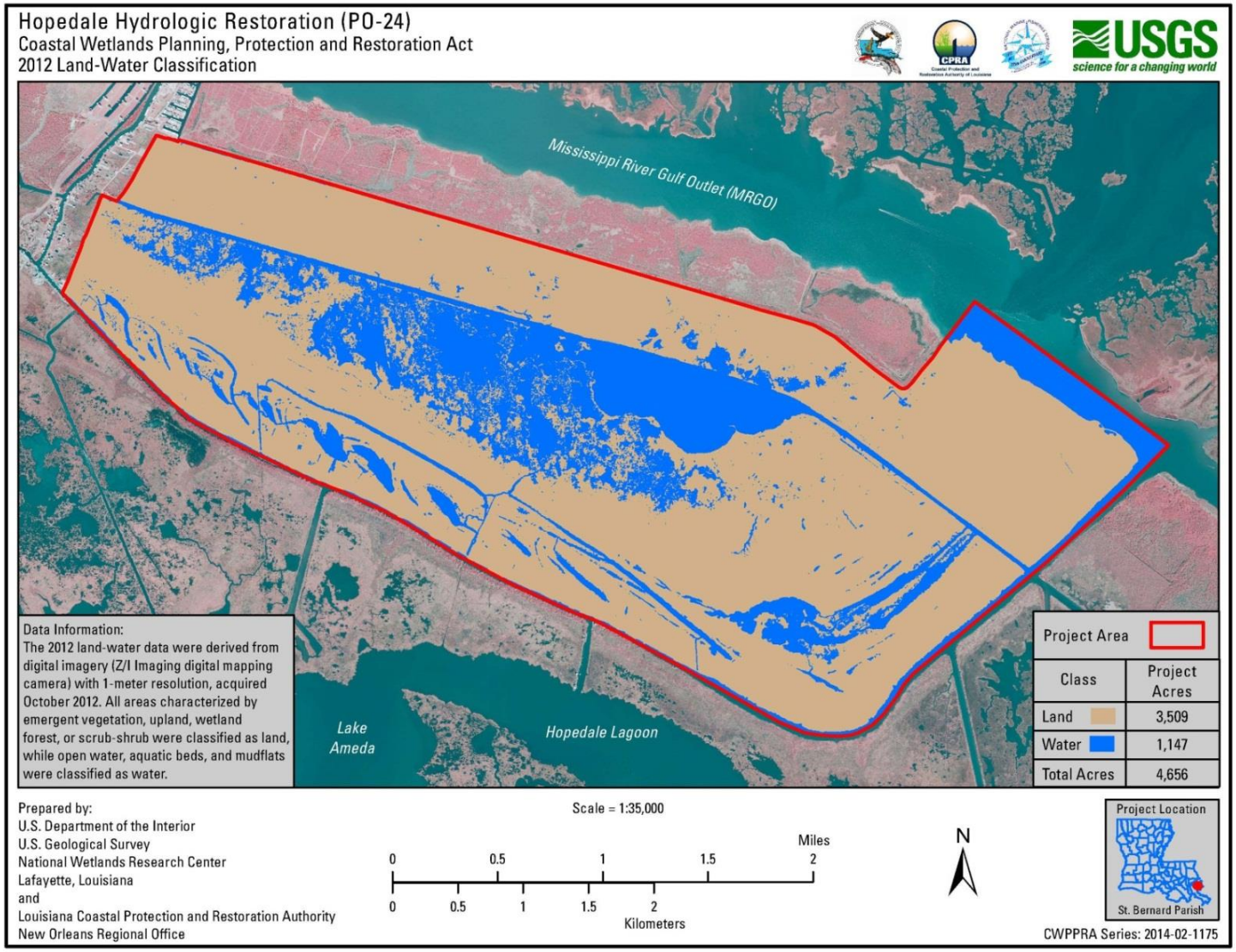

Figure 3. Land/water classification of 2012 aerial photography for PO-24.

Figure 4. Location of MRGO spoil deposition within the PO-24 project area in 1998 (left) and 2012 (right).

CRMS land-water analyses were conducted in 2005, 2008, and 2012 (Table 2). Although all of these analyses took place after project construction, they still offer a comparison of trends within the project and reference areas. The 1-km^2 area for land-water analysis at CRMS3800 is contained entirely within the PO-24 project area. Land:water ratios at this site have remained relatively steady; with land area increasing slightly between 2005 and 2008, then decreasing in 2012 but showing a net gain overall (Figure 5). There is no clear trend in land:water ratios among the three reference sites. CRMS4548 exhibits a similar trend as CRMS3800 (Figure 6). There was a net loss in land area at CRMS4551; with land area decreasing slightly with each analysis (Figure 7). Finally, there was a net gain at CRMS4557; with land area holding steady between 2005 and 2008 and increasing in 2012 (Figure 8).

Table 2. Percent land and water at CRMS sites 3800 (project) and 4548, 4551, and 4557 (reference) in 2005, 2008, and 2012.

Year	CRMS3800		CRMS4548		CRMS4551		CRMS4557	
	% Land	% Water	% Land	% Water	% Land	% Water	% Land	% Water
2005	65.7	34.3	35.1	64.9	35.9	64.1	81.0	19.0
2008	67.3	32.7	36.7	63.3	35.1	64.9	81.0	19.0
2012	66.1	33.9	35.9	64.1	33.1	66.9	82.3	17.1

CRMS3800

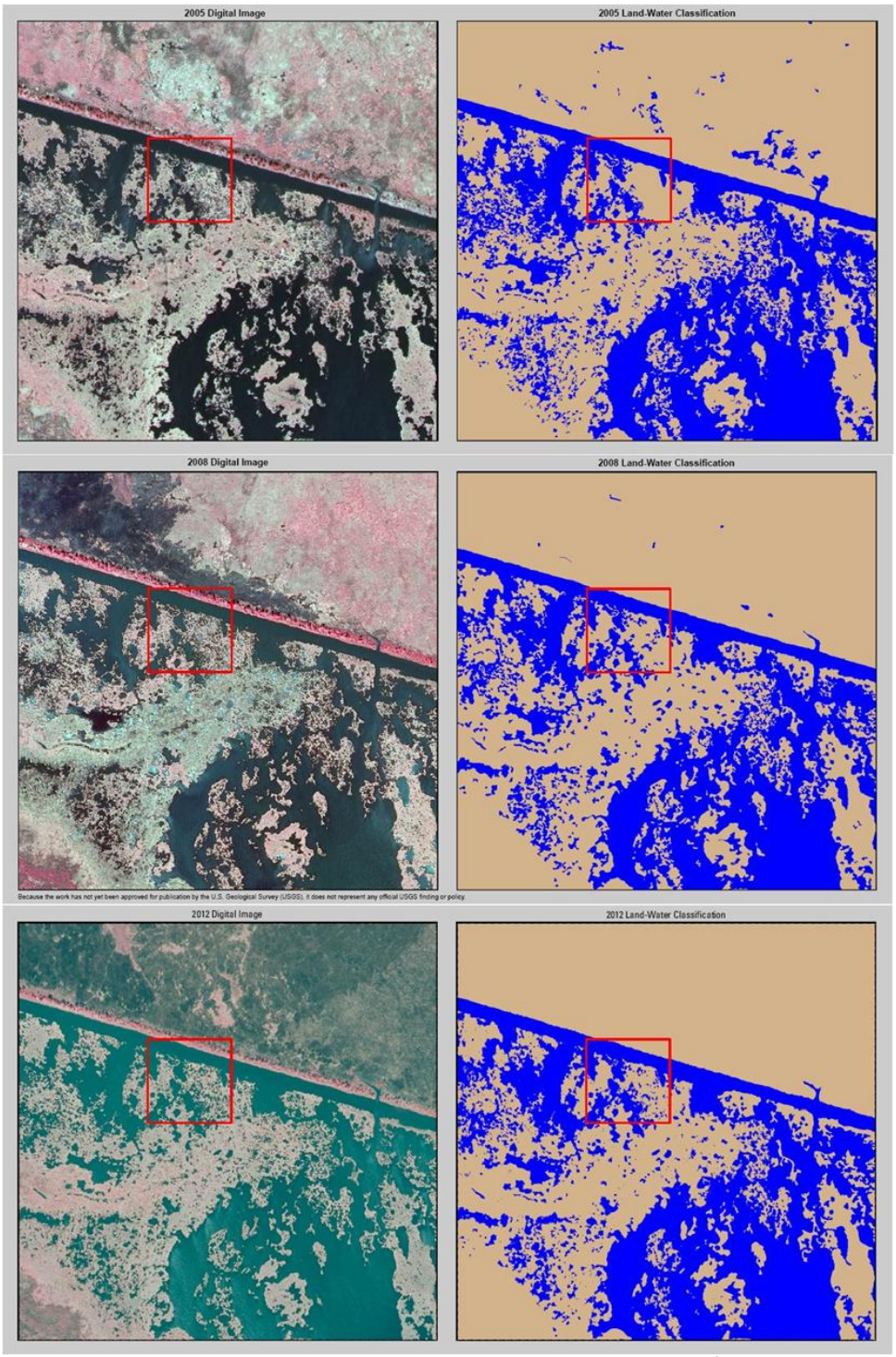

Figure 5. Color infrared aerial imagery and land-water analysis of 1-km^2 area at CRMS3800 for years 2005 (top), 2008 (middle), and 2012 (bottom).

CRMS4548

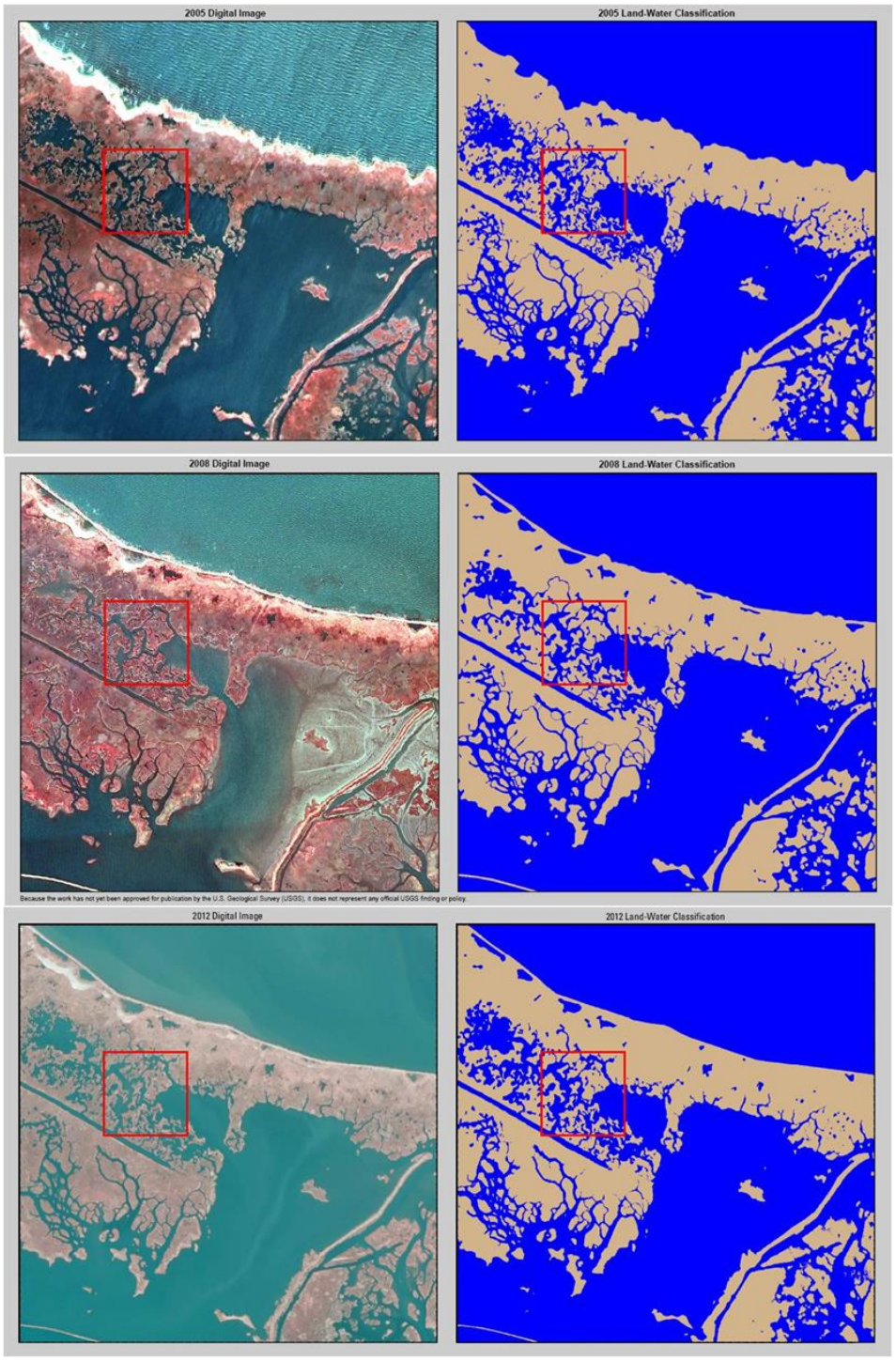

Figure 6. Color infrared aerial imagery and land-water analysis of 1-km^2 area at CRMS4548 for years 2005 (top), 2008 (middle), and 2012 (bottom).

CRMS4551

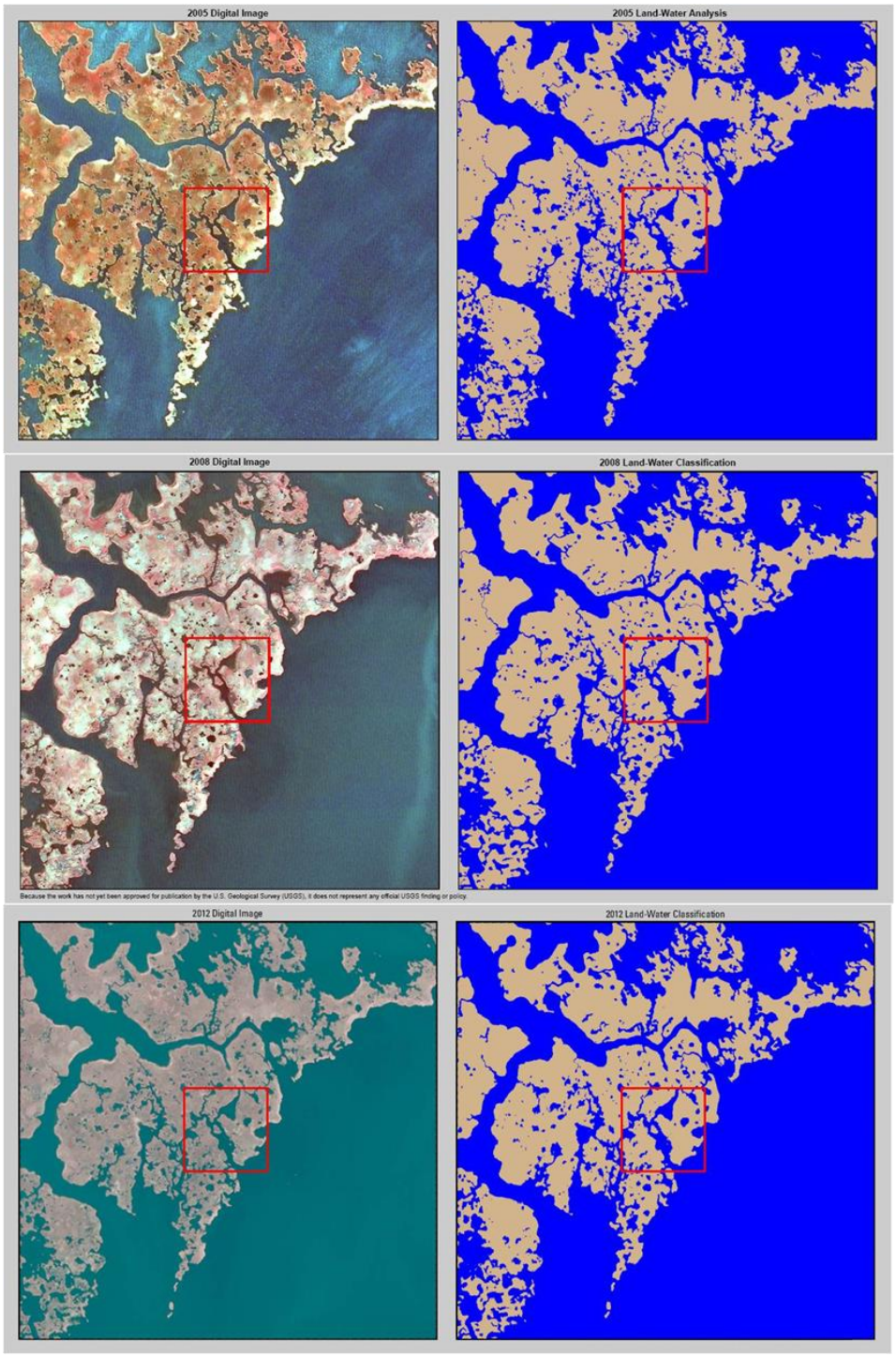

Figure 7. Color infrared aerial imagery and land-water analysis of 1-km^2 area at CRMS4551 for years 2005 (top), 2008 (middle), and 2012 (bottom).

CRMS4557

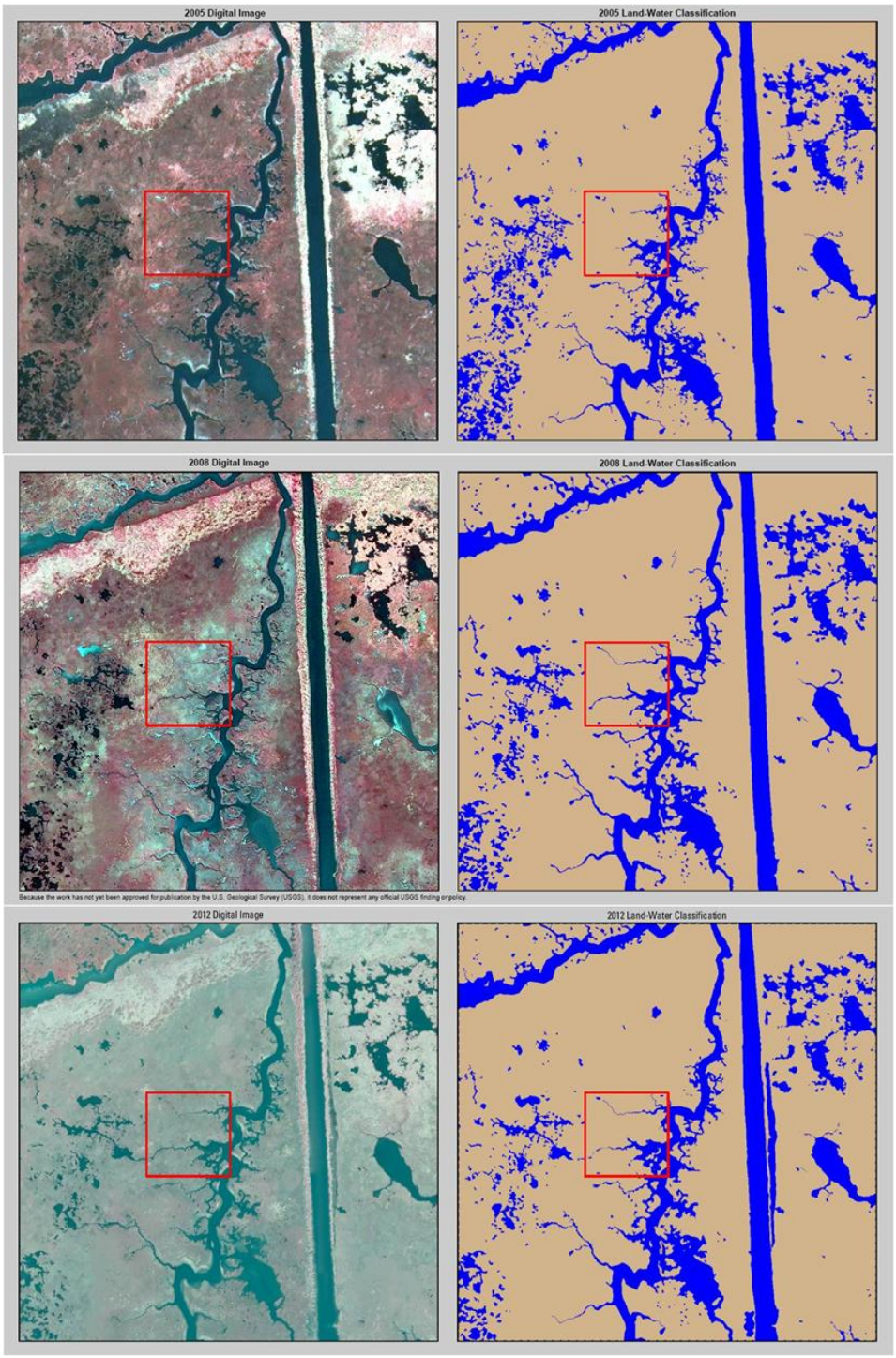

Figure 8. Color infrared aerial imagery and land-water analysis of 1-km^2 area at CRMS4557 for years 2005 (top), 2008 (middle), and 2012 (bottom).

ii. Salinity

The Back Dike Borrow Canal, which connects Bayou La Loutre to the project area, was completely blocked during construction to allow for structure placement, thus stopping water exchange. Data collected during the construction period (10 January 2004 – 30 November 2004; Table 3) were removed from the salinity data set for analyses, but are presented in the time series graphs (Figures 9-11). Hourly data were averaged to obtain mean weekly salinity readings which were used for all subsequent statistical analyses. Mean weekly observations were used to reduce the effects of diurnal tides and meteorological events in the data.

Table 3. Significant events and dates.

Event Description	Date
Initial Brown Marsh Event (drought)	Spring 2000 - early 2001
Tropical Storm Isidore	26-Sept-2002
Hurricane Lili	3-Oct-2002
Hurricane Ivan	16-Sep-2004
Tropical Storm Ivan	23-Sep-2004
PO-24 Control Structure Construction	Jan-Nov 2004
Hurricane Cindy	6-Jul-2005
Hurricane Katrina	29-Aug-2005
Hurricane Rita	24-Sep-2005
High River Event/Bonnet Carre Spillway Opening (160 bays open 31 days)	11-Apr-2008
High Discharge through Caernarvon Diversion (mean 7776 cfs)	Apr-2008
Hurricane Gustav	1-Sep-2008
Hurricane Ike	13-Sep-2008
MRGO Closure	Jan to Jul-2009
High Discharge through Caernarvon Diversion (mean >8000 cfs)	May-Jun 2010
High River Event/Bonnet Carre Spillway Opening (330 bays open 42 days)	09-May-2011
Hurricane Isaac	28-Aug-2012

The initial deployment of the Hopedale Hydrologic Restoration (PO-24) project continuous recorders occurred during a severe drought. The drought affected

southeast Louisiana from August 1999 to December 2000 during which time widespread dieback of marsh vegetation occurred throughout Louisiana's coastal zone (locally known as the Brown Marsh Dieback). Figures 9 and 10 depict salinity signals over the entire data record. The PO-24 stations recorded the highest salinity levels for the entire 13-year period of record during the drought with salinity values registering up to 10 ppt greater than normal conditions. Salinity incursions also occurred during tropical events and during periods of sustained strong east winds, which can be identified by spikes in Figures 9 through 11. The spikes from these meteorological events were short-lived compared to the increase in salinity associated with the drought at the beginning of data collection.

Visual observation of monthly means indicate that project and reference stations tracked one another fairly closely, even after completion of construction in November 2004. Salinity levels in mid-2010 were the lowest in the period of record at all four sites within the project area. Following the 2010 oil spill, the flow through the Caernarvon Diversion structure was opened to greater than 8,000 cfs in May and June in an effort to limit the oil from entering coastal waters. A similar reduction in salinity was observed in 2008 which coincided with another high discharge event at Caernarvon, as well as the opening of the Bonnet Carre Spillway. Freshwater introduced through these structures may have influenced the project area during these high flow periods and to a lesser degree during lower flow periods.

Figure 11 compares salinity data for the period of record containing CRMS data (beginning Jan 2008). Beginning in mid-2009, salinity values at CRMS4557 diverge from surrounding sites and increase by up to 10 ppt. The closure of the MRGO navigation channel during this same time period appears to have caused this divergence, as CRMS4557 is the only station southeast of the closure structure. Stations PO24-02 and PO24-05 have the longest period of record before and after the closure of the MRGO and were used to compare salinities before and after the MRGO closure. Approximately 5 years pre-closure and 5 years post-closure were compared (1/1/05-4/15/09 (PRE), 4/16/09-12/31/13 (POST). There was a significant decrease in mean weekly salinity of 5-6 ppt in the period following MRGO closure at both sites (ANOVA, $p<0.0001$) (Figure 12). There was no significant difference between the salinity response inside (PO24-05) and outside (PO24-02) of the project area based on a 2-sample median test of paired weekly means ($p=.0750$).

To test for PO-24 project effects in the pre- vs post-construction periods, the pre-construction period was defined as 3/1/2001-12/31/2003 and the post-construction period was defined as 12/1/2004 to 9/15/2008. Data was not included past 9/15/08 because of the effects of the MRGO closure and because that is the end of the data record for PO24-04. The mean weekly salinity concentrations were significantly lower during the post- construction period at all PO-24 stations except for PO24-

02; however, removing the drought from the pre-construction period caused the differences to be no longer significant (Figure 13). To test the interaction between project and reference sites in pre-construction and post-construction time periods, non-parametric Before After Control Impact (BACI) paired series analyses were performed. For this analysis, sondes were "paired" based on the field design. Differences were calculated by subtracting mean weekly salinity at the impacted (project) site from the control (reference) site (difference = reference – project). A 2-sample median test (a non-parametric analog of a 2-sample t-test) was used to compare the site differences before and after construction. The test is a non-parametric One-way ANOVA with a median test of Chi Square values, which was run using JMP 11.0.0 statistical software. The statistical model depends on simultaneous measurements among the paired sondes, therefore, only weeks in which there were data available to calculate differences were used in the analysis. In this case, the drought period was not removed because one of the statistical assumptions of the paired design is that the drought would affect both stations equally.

Results of the BACI paired analysis indicate significant interactions between project sites with reference site PO24-02, but no significant interaction between project sites with reference site PO24-04 (Figure 14). PO24-01 and PO24-05 (project sites) both had a significantly greater decrease in salinity in the post-construction period compared to PO24-02 (reference), which shows up as lines out of parallel in Figure 14. Salinity change in the post-construction period was about 1.2 ppt greater ($p<0.0001$) at PO24-01 and about 0.5 ppt greater ($p=0.0010$) at PO24-05 than the change at PO24-02. The level of decreased salinity was very small compared to the target salinity range for this marsh type (mesohaline, 5-18 ppt) suggesting that a change in marsh community is not likely. There were no significant interactions between project sites PO24-03 and PO24-05 with reference site PO24-04 (Figure 14) with both project sites showing a similar post-construction decrease in salinity as the reference site. Due to its location, reference site PO24-02 was more heavily influenced by the MRGO before its closure and therefore showed the greatest difference from the sites within the project area. In summary, while there was a significant difference in salinity reduction in the project area compared to reference site PO24-02, the ecological significance of this change is small. Future changes in the marsh community within the project area would more likely be attributed to the closure of the MRGO which reduced mean salinities in the area by 5-6 ppt.

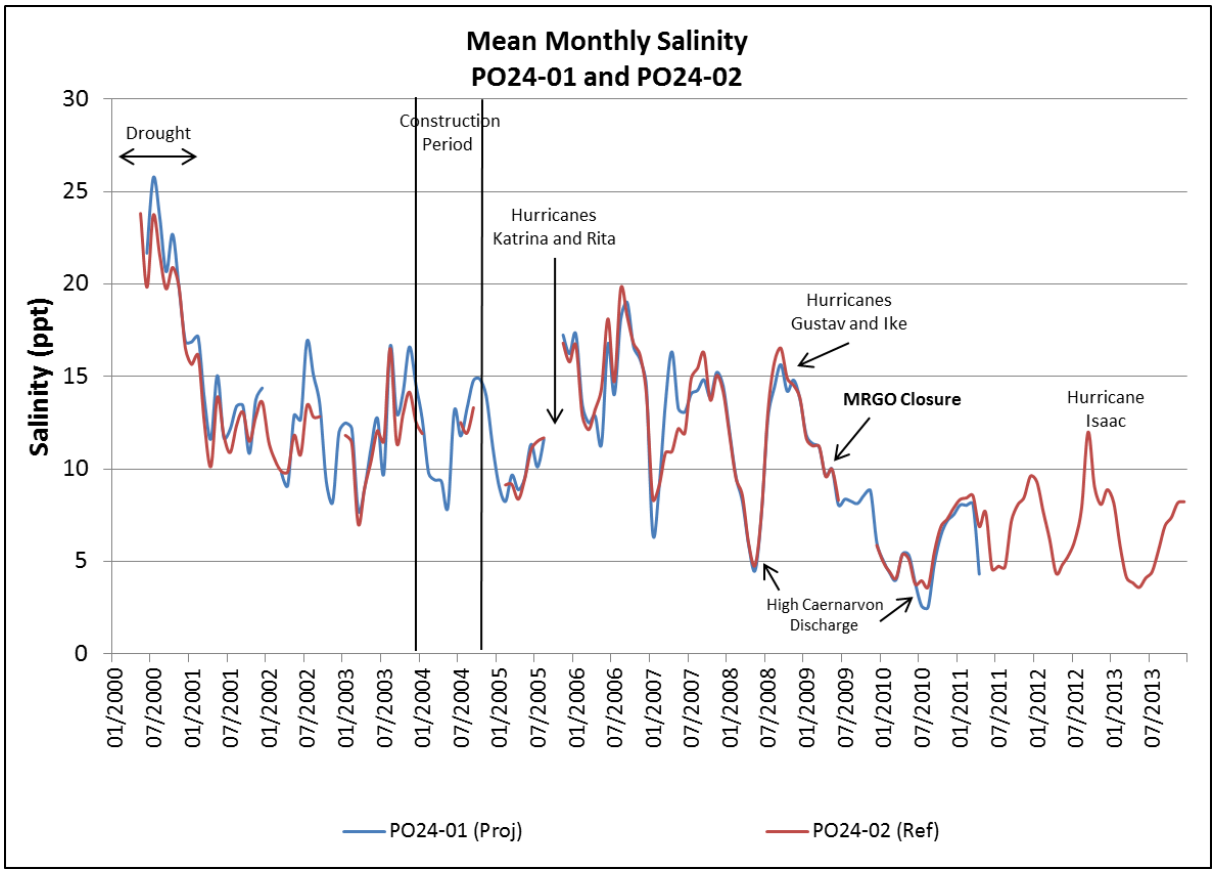

Figure 9. Mean monthly salinity for project station PO24-01 and reference station PO24-02 for the Hopedale Hydrologic Restoration (PO-24) project.

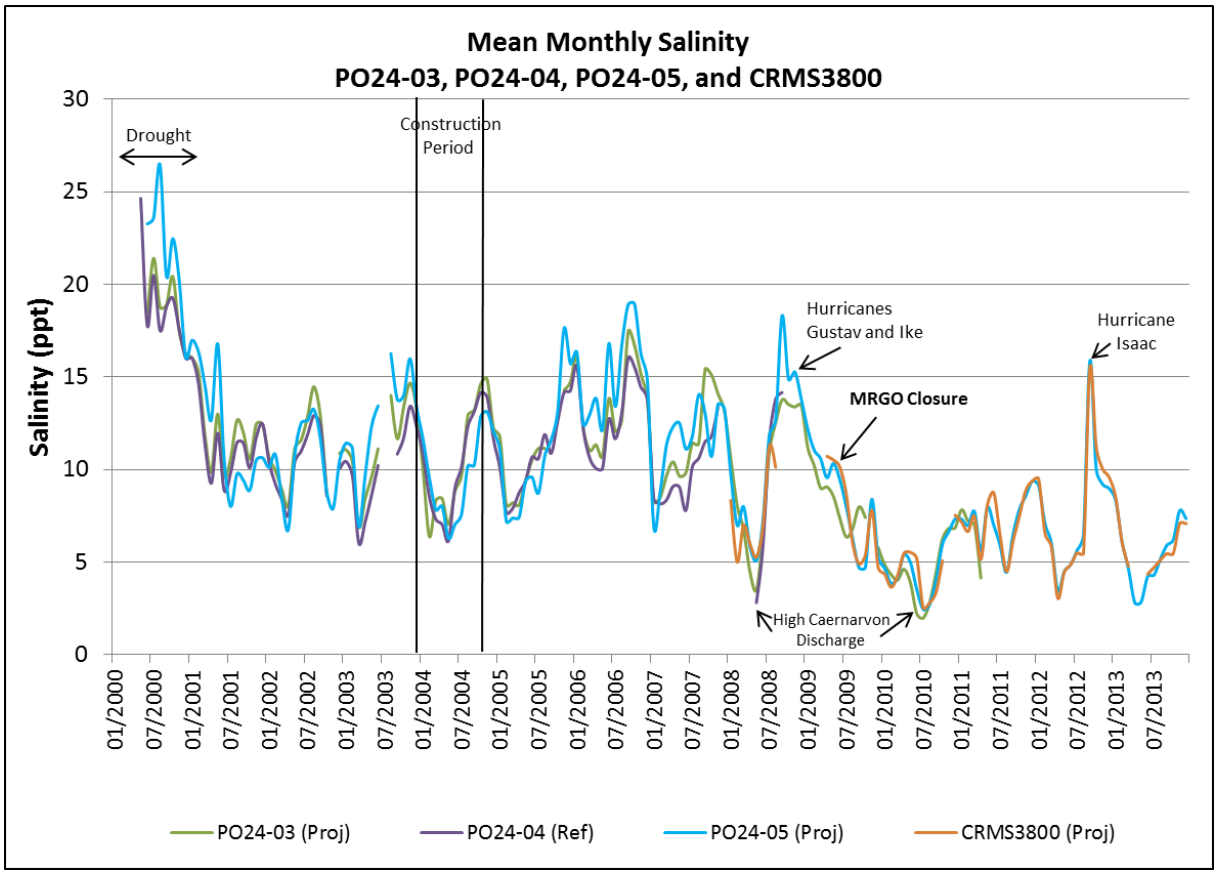

Figure 10. Mean monthly salinity for project stations PO24-03, PO24-05, and CRMS3800 and reference station PO24-04 for the Hopedale Hydrologic Restoration (PO-24) project.

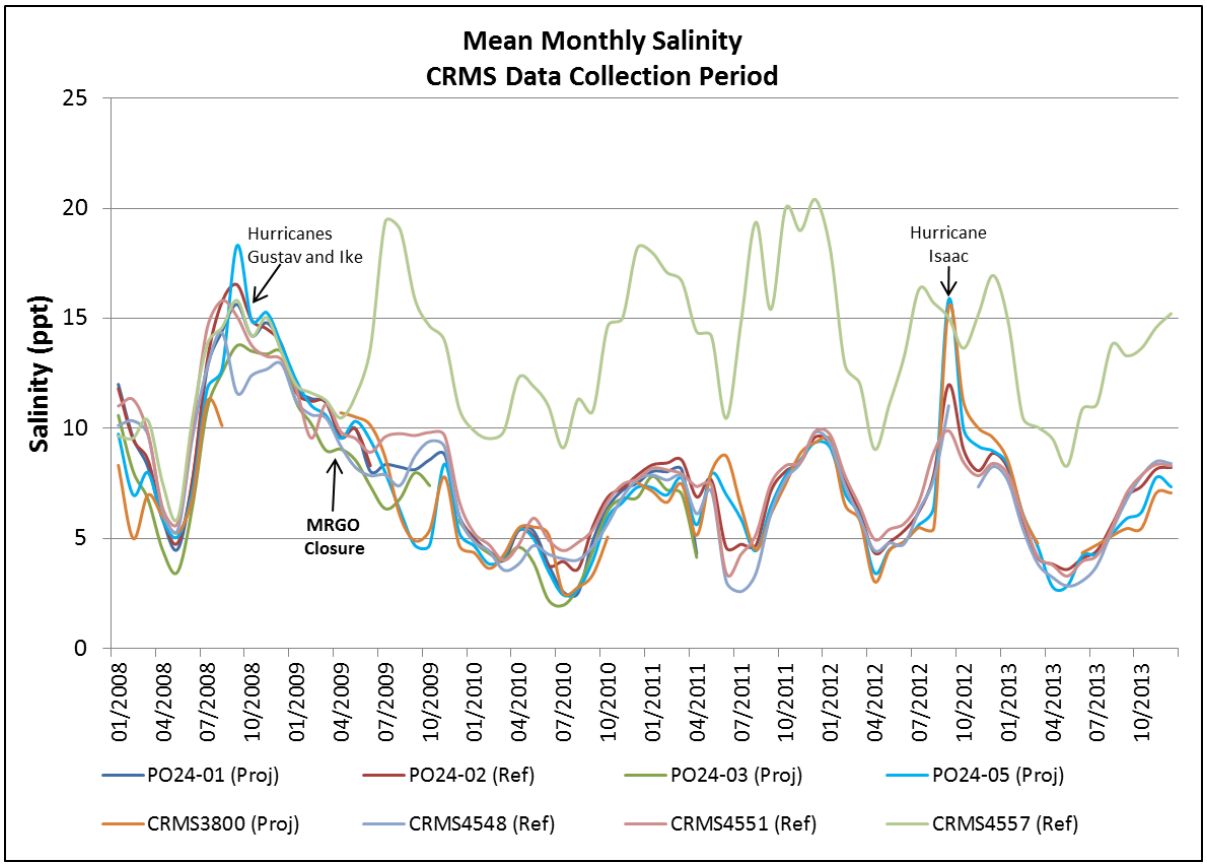

Figure 11. Mean monthly salinity for PO-24 and CRMS stations near the Hopedale Hydrologic Restoration (PO-24) project from 1/2008 to 12/2013.

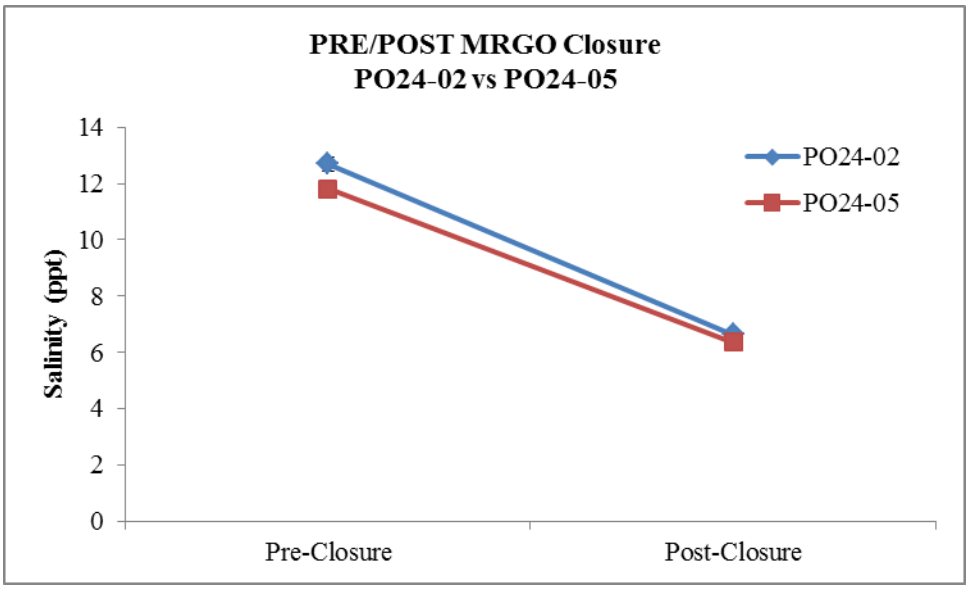

Figure 12. Change in salinity at PO24-02 (reference) and PO24-05 (project) following the closure of the Mississippi River Gulf Outlet (MRGO) in 2009.

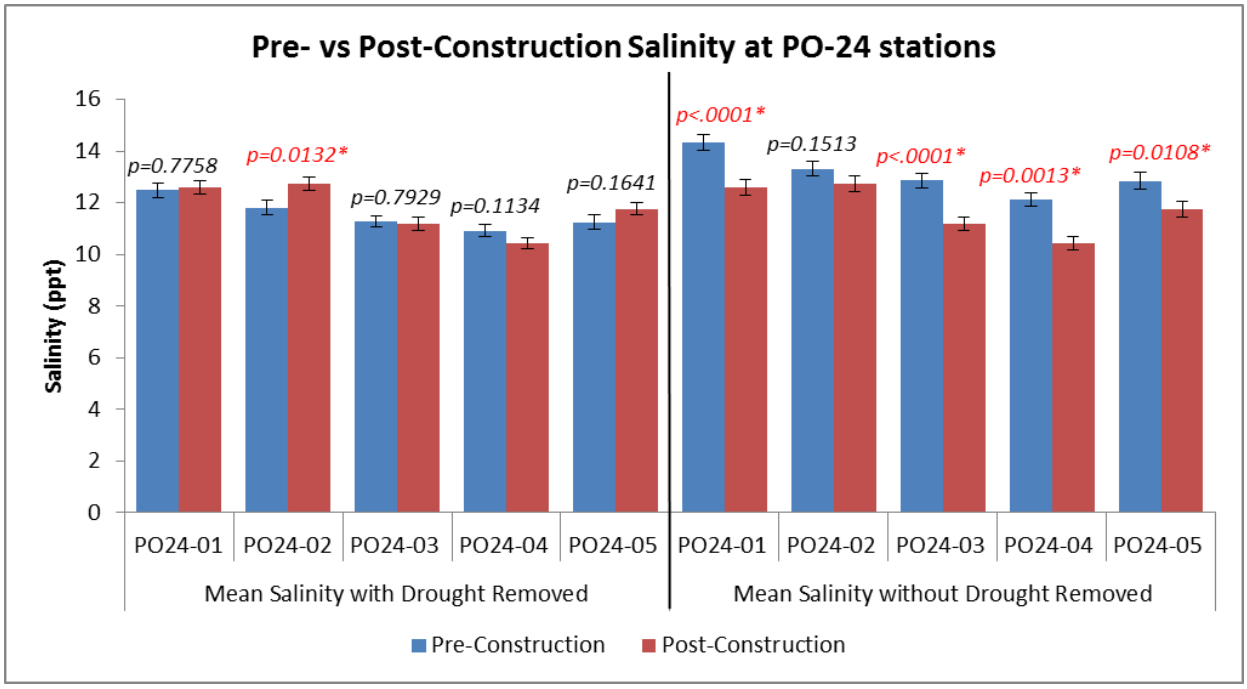

Figure 13. Average of mean weekly salinity for the pre- and post-construction periods of the Hopedale Hydrologic Restoration (PO-24) project. Removing the drought period caused no significant difference between pre/post periods at four of the stations. Statistics computed using ANOVA. Error bars represent the standard error of the mean.

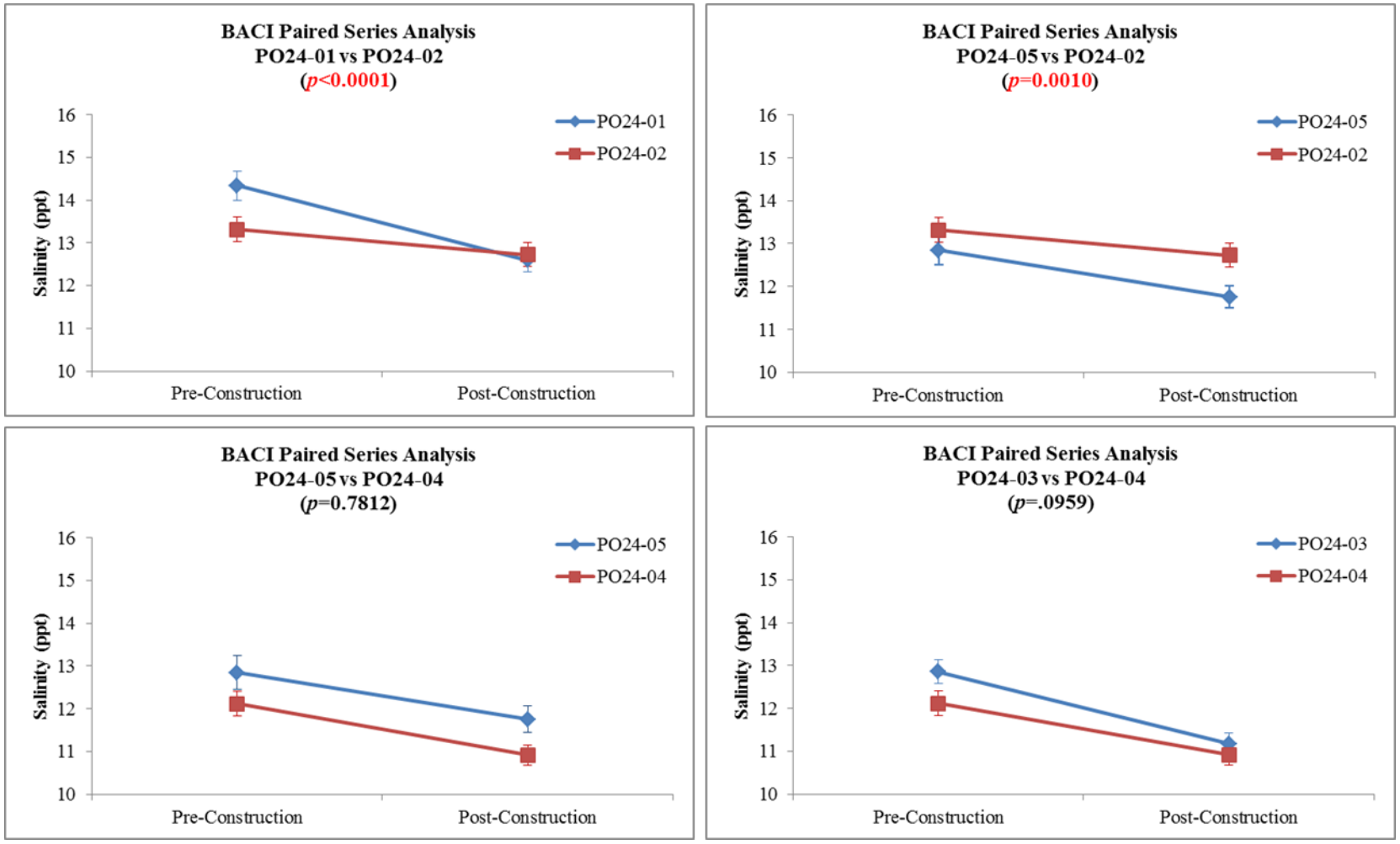

Figure 14. BACI paired series analysis graphs for salinity.

iii. Water Level

The Back Dike Borrow Canal, which connects Bayou La Loutre to the project area, was completely blocked during construction to allow for structure placement, thus stopping water exchange. Data collected during the construction period (January to November 2004) were removed from the water level data set for analysis, but are presented in the time series graphs. Hourly data were averaged to obtain mean weekly water level readings which were used for all subsequent statistical analyses unless otherwise indicated. Mean weekly observations were used to reduce the effects of diurnal tides and meteorological events in the data.

Visual observation of mean monthly water level shows project stations, PO24-01 and PO24-05, tracking closely with reference stations during the pre-construction period and then maintaining lower water elevations than reference stations during the post-construction period (Figures 15 and 16). The exception is PO24-03, which tracks closely with nearby reference station PO24-04 before and after construction. Figure 17 shows project and reference stations during the period of CRMS data collection from 2008 to 2013. Project stations PO24-01, PO24-05, and CRMS3800 generally track lower than the other stations during this data period, including project station PO24-03. Impacts from the closure of the MRGO on water levels are visually less evident than impacts on salinity; however, a comparison of weekly mean water level before and after the closure showed a significant increase in water level of 0.22 ft at project station PO24-05 ($p<0.0001$) in the post-closure period, while water level at reference station PO24-02 was not significantly different ($p=0.2978$) in the post-closure period (Figure 18).

Figure 19 shows a significant decrease in mean weekly water levels of approximately 0.4 ft at project sites PO24-01 and PO24-05 ($p<0.0001$) during the post-construction period. Removing the drought period from the pre-construction period did not alter the results as was seen with the salinity data. Station PO24-03 showed a slight decrease in water level but this decrease was not significant. The reduced project effect on water level at station PO24-03 is reasonable considering its location within the project area. Station 03 is located in a small unnamed bayou on the south side of the Bayou La Loutre ridge, near the south central boundary of the project area. The connection of this small bayou with Bayou La Loutre is through three 36” non-gated culverts which run under Hwy 624. These open culverts allow water to flow in and out of the project area freely, as opposed to the structure near station PO24-01 which only allows water out. Reference

stations PO24-02 and PO24-04 both showed increases in mean weekly water level following construction (Figure 19), however, only station 02 was significant (p=0.011). A comparison of CRMS reference stations (CRMS4548, CRMS4551, and CRMS4557) and project area stations (PO24-05 and CRMS3800) during the CRMS data collection period indicate that water levels inside the project area were significantly lower than those outside of the project boundaries (Figure 20).

To test the interaction between project and reference sites in pre-construction and post-construction time periods, mean weekly water level measurements were analyzed by the same method described for salinity data in the previous section. Results of the paired sites were significant for all comparisons (Figure 21) with water levels at PO24-01 and PO24-05 approximately 0.4 feet lower than what would be expected if the project had no impact. The project impact was reduced at PO24-03, yet still significant. When averaged, the project site water levels decreased from 0.70 ft to 0.41 ft, while reference site water levels increased from 0.58 ft to 0.71 ft between pre- and post-construction.

Frequency and duration of flooding in the pre-construction (2001-2003) and post-construction (2005-2007) periods were compared for the three project stations, PO24-01, PO24-03, and PO24-05. Inundation data for the reference stations, PO24-02 and PO24-04, cannot be calculated because an average marsh elevation is not available for these stations. At PO24-01 and PO24-05, the mean flood duration following construction was reduced by 5 and 8 days, respectively, and the % time flooded dropped by 26% (Table 4). Alternatively, there was no difference in mean flood duration (7 days) at PO24-03 between pre- and post-construction, and almost no difference in % time flooded (25.2 to 24.0%). The project goal of reducing the frequency and duration of flooding events was therefore achieved at sites PO24-01 and PO24-05, but PO24-03 did not experience a similar reduction in flooding since it is located near an open culvert which allows water to flow freely. During the CRMS data collection period (2008-2013), the project sites, PO24-05 and CRMS3800, displayed a greater mean flood duration and % time flooded than CRMS4548 and CRMS4551. However, the average marsh elevation is much lower at the project sites (mean 0.37 ft NAVD88) than at the two CRMS sites (mean 0.76 ft NAVD88) (Table 1). Frequency and duration of flooding was not calculated at PO24-01 for the CRMS data period because the marsh elevation has not been resurveyed since 2000, and subsequent surveys at stations PO24-03 and PO24-05 showed a decrease in marsh elevation at both sites (Table 1).

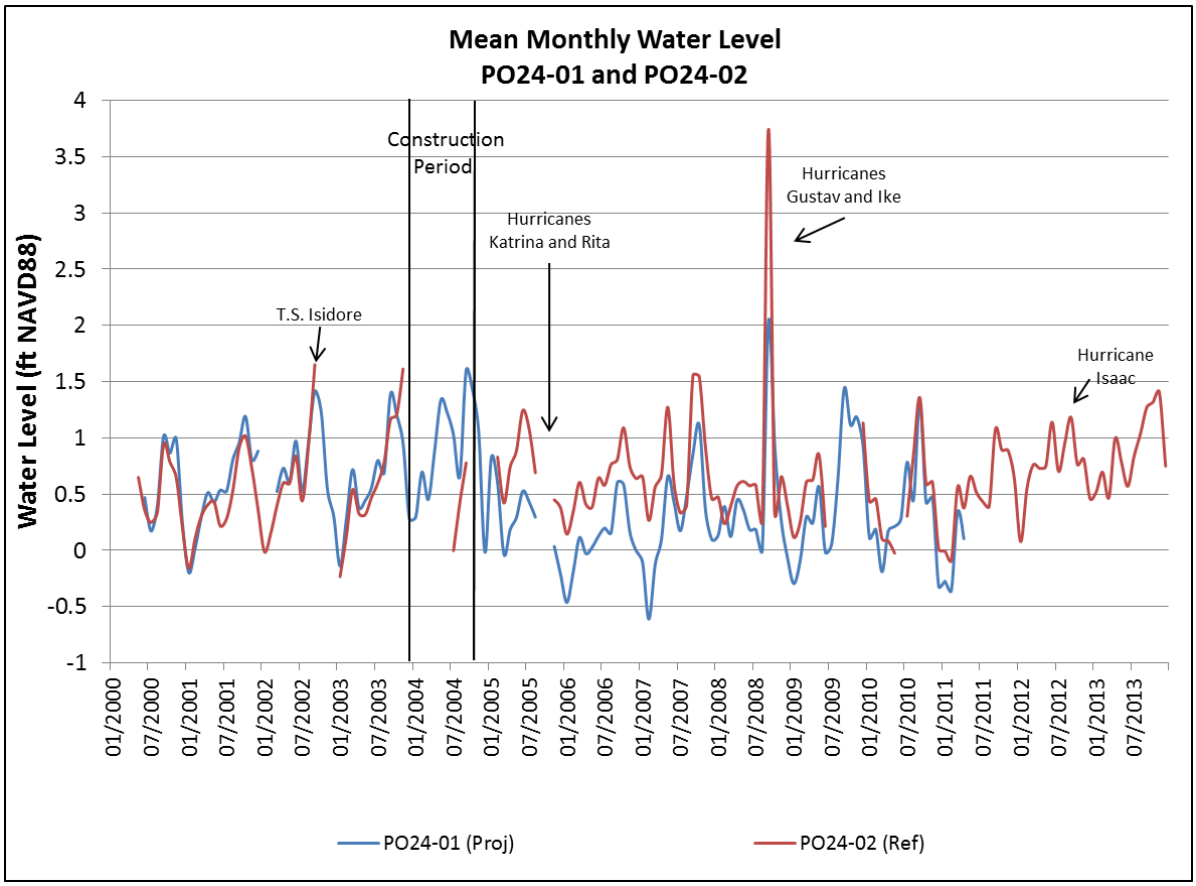

Figure 15. Mean monthly water level for project station PO24-01 and reference station PO24-02 for the Hopedale Hydrologic Restoration project.

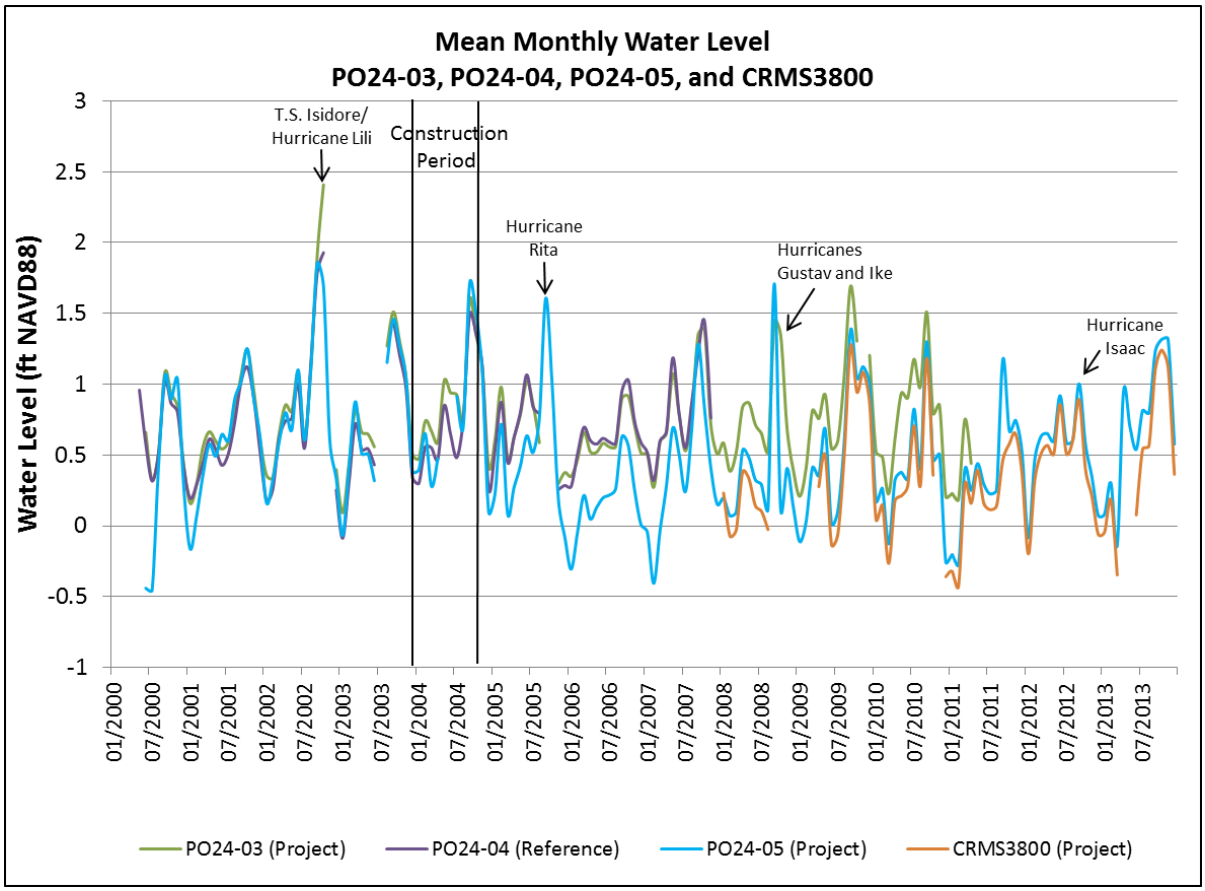

Figure 16. Mean monthly water level for project stations PO24-03, PO24-05, and CRMS3800, and reference station PO24-04 for the Hopedale Hydrologic Restoration project.

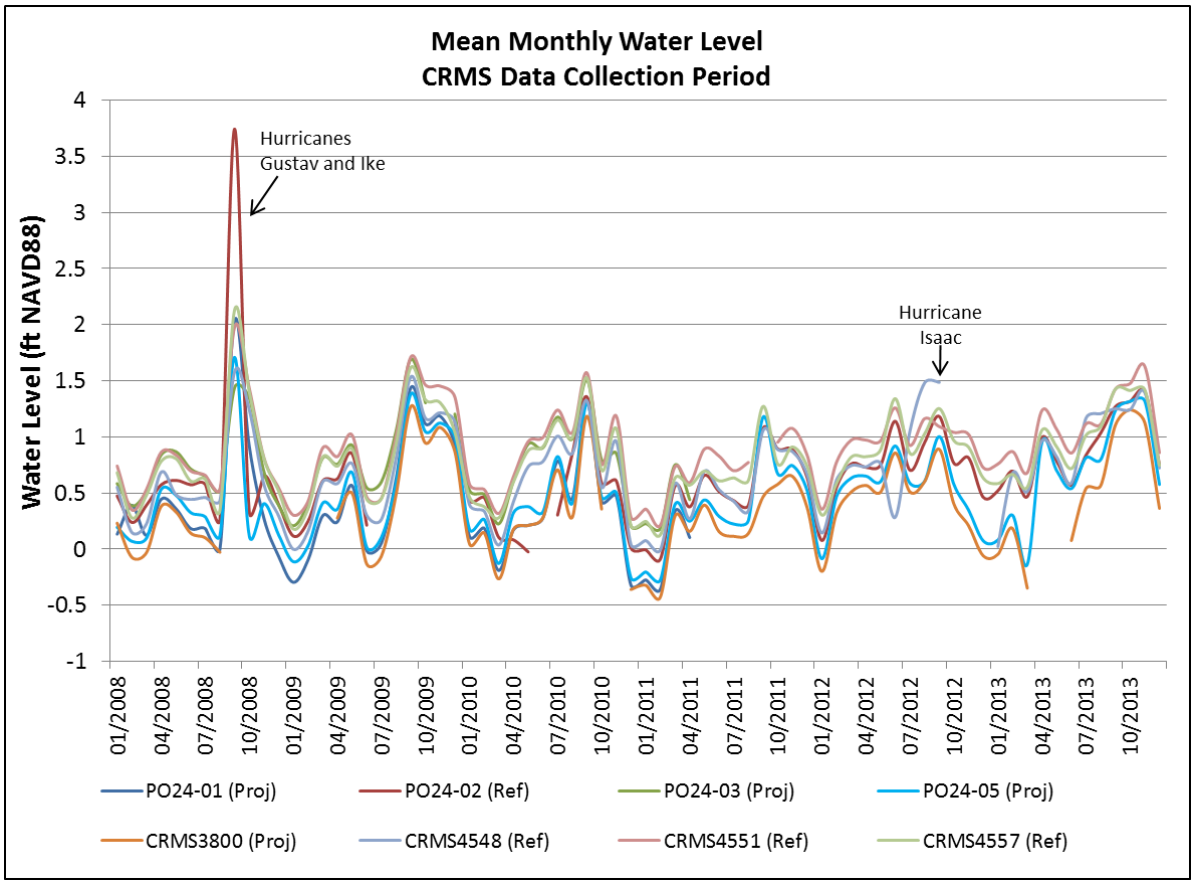

Figure 17. Mean monthly water level for the Hopedale Hydrologic Restoration project and reference stations during the CRMS data collection period.

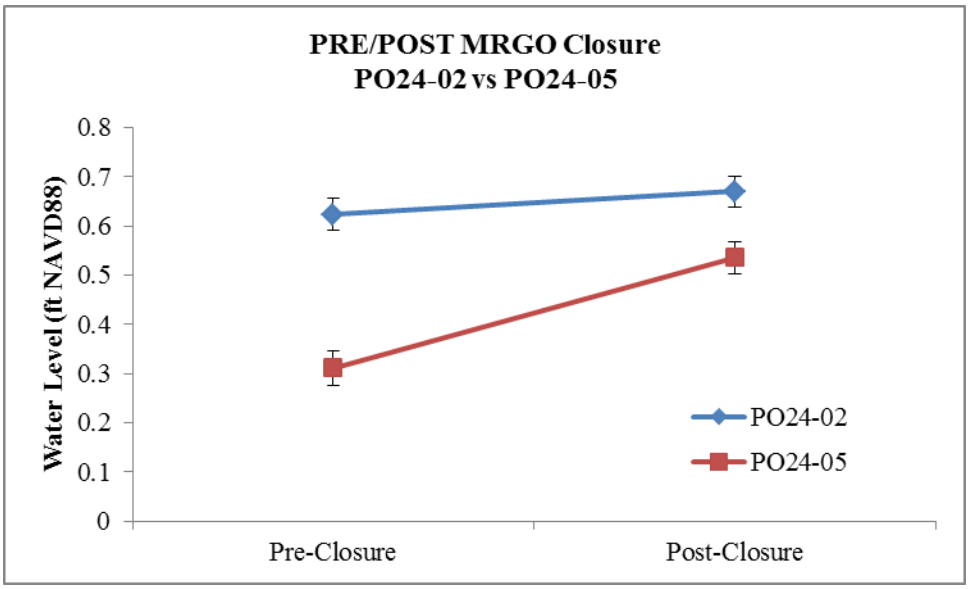

Figure 18. Change in water level at PO24-02 (reference) and PO24-05 (project) following the closure of the Mississippi River Gulf Outlet (MRGO) in 2009.

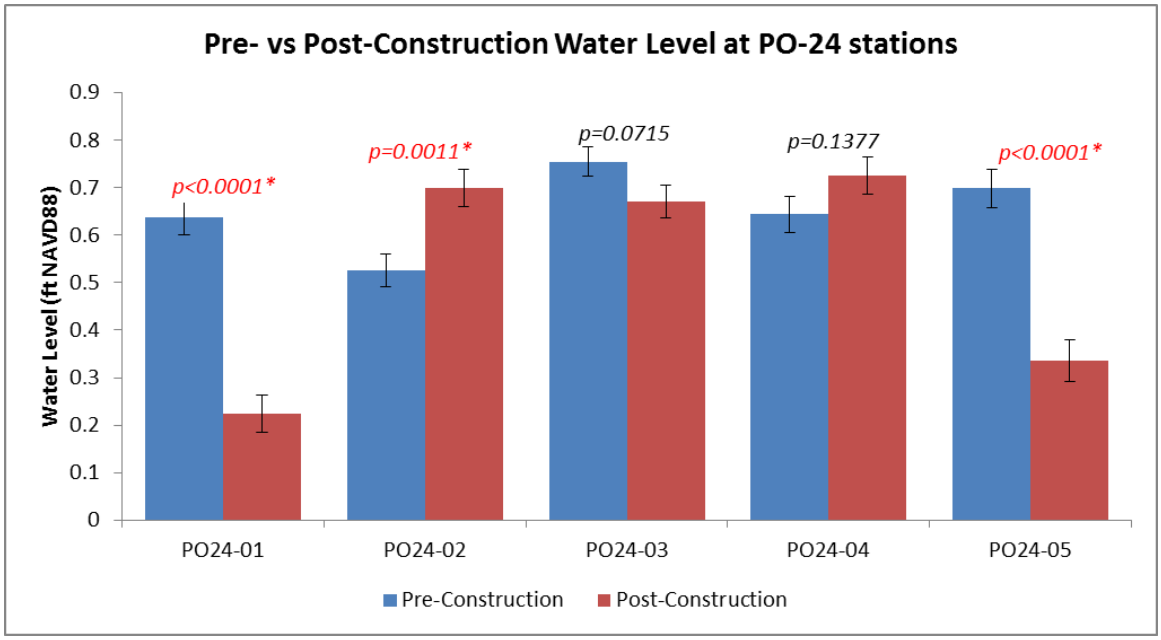

Figure 19. Average of mean weekly water level for the pre- and post-construction periods of the Hopedale Hydrologic Restoration project. Statistics computed using ANOVA.

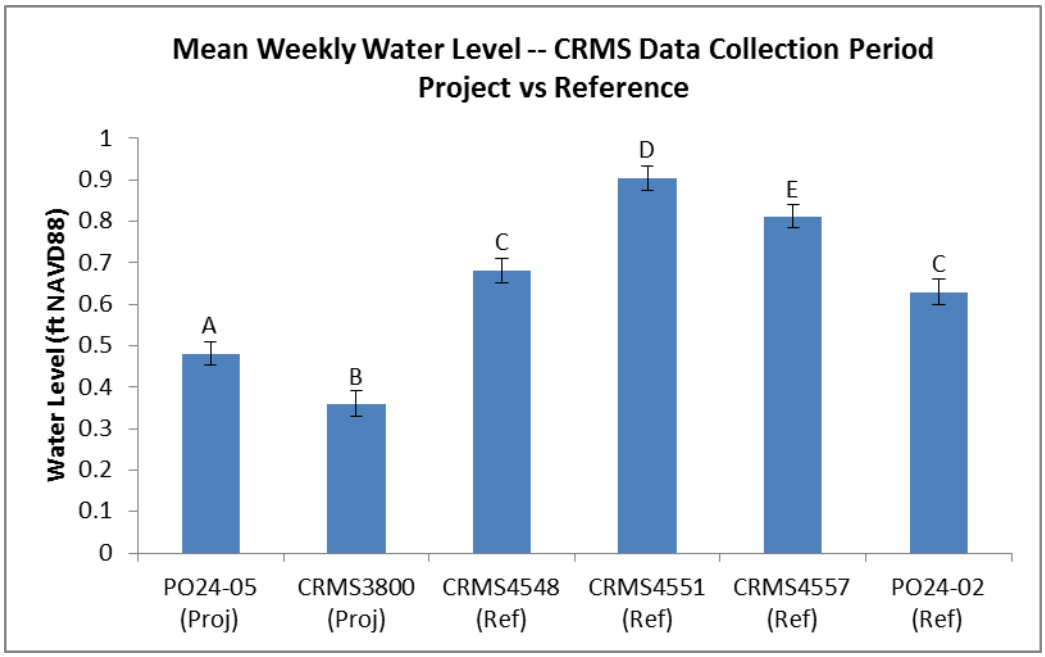

Figure 20. Average of mean weekly water level for project and reference stations during the CRMS data period, 1/1/08-12/31/13. Statistics computed using ANOVA. Different letters indicate significant difference.

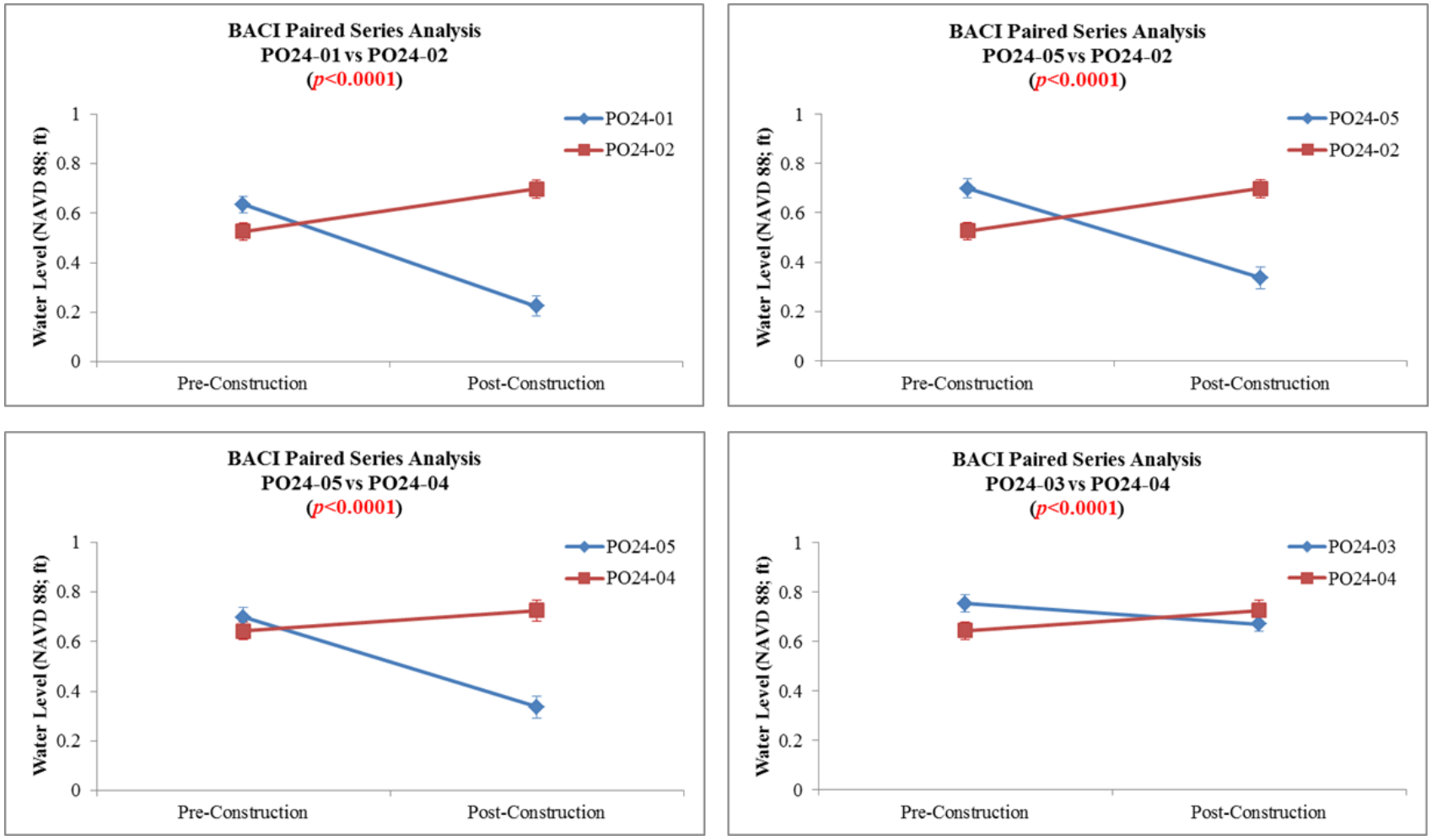

Figure 21. BACI paired series analysis graphs for water level.

Table 4. Frequency, depth, and duration of flooding for the Hopedale Hydrologic Restoration project and reference sites during the pre- and post-construction periods and the CRMS data collection period.

Station	PRE 2001-2003	POST 2005-2007	CRMS Period 2008-2013
PO24-01			
Mean Flood Duration (days)	11	6	
% Time Flooded	38.5	12.1	
Mean Flood Depth (ft)	0.36	0.41	
PO24-03			
Mean Flood Duration (days)	7	7	
% Time Flooded	25.2	24.0	
Mean Flood Depth (ft)	0.42	0.37	
PO24-05			
Mean Flood Duration (days)	13	5	14
% Time Flooded	44.9	18.3	22.9
Mean Flood Depth (ft)	0.43	0.47	0.49
CRMS3800			
Mean Flood Duration (days)			12
% Time Flooded			20.6
Mean Flood Depth (ft)			0.48
CRMS4548 (Ref)			
Mean Flood Duration (days)			9
% Time Flooded			15.4
Mean Flood Depth (ft)			0.50
CRMS4551 (Ref)			
Mean Flood Duration (days)			9
% Time Flooded			15.5
Mean Flood Depth (ft)			0.51

IV. Conclusions

a. Project Effectiveness

One of the monitoring goals of this project is to maintain 99% of the pre-construction acreage of vegetated wetlands over the life of the project. Comparison of the 2000 and 2012 land-water analyses indicate that a net gain in land acreage has occurred over this time period, suggesting that the project is meeting this goal. It is important to note, however, that there is some land loss occurring within the project area and that some of the land gains observed are attributable to the placement of dredged spoil within the project area. Additionally, CRMS land-water analysis from within the project area support the conclusion that the project is meeting the goal of maintaining pre-construction acreage. Although there is no pre-construction data at CRMS3800, land area there has remained steady throughout the period of data collection, from 2005 to 2012.

The goal of reducing the intensity and duration of flooding appears to have been achieved in the post-construction period. A significant reduction in mean water level occurred between the pre- and post- construction period at project area stations north of the Bayou La Loutre Ridge, while both reference stations experienced an increase in water level. The project impact was reduced at the station south of the Bayou La Loutre Ridge. Based on paired analyses, water levels inside the project boundary decreased by approximately 0.4 ft after project construction was complete. In addition, mean flood duration following construction was reduced by 5-8 days and % time flooded dropped by 26%. This decrease in water level coupled with reduced salinity will likely reduce stress to the marsh vegetation within the project area.

Reduction in salinity was not a specific goal of this project; however, there was a significantly greater decrease in surface water salinity in the project area following construction. While this change was statistically significant, the biological significance is likely minor. Salinity reductions resulting from the closure of the MRGO would be expected to have a comparatively greater impact on the project area.

Finally, a recent study published in the *Journal of Experimental Marine Biology and Ecology* measured ingress and egress of fisheries through the PO-24 water control structure and concluded the structure imposed no physical limitations (Kimball et al., 2010).

b. Recommended Improvements

There are no recommended improvements at this time.

c. Lessons Learned

Bayou La Loutre is a high traffic area. The continuous recorders located within the bayou were constantly being struck by marine vessels causing occasional data gaps. PO24-02 was eventually moved to the bridge over the Back Dike Canal at its intersection with Bayou La Loutre and remained intact for the remainder of its deployment. PO24-04 had no such permanent structure to which it could be attached, and ultimately was removed.

V. References

Carter, B., B. Richard, and P. Hopkins 2007. *2007 Operations, Maintenance, and Monitoring Report for Hopedale Hydrologic Restoration (PO-24)*, Louisiana Department of Natural Resources, Coastal Restoration Division, New Orleans, Louisiana. 35 pp.

Carter, B., B. Richard., and Coastal Estuary Services. 2010. *2010 Operations, Maintenance, and Monitoring Report for HopedaleHydrologic Restoration (PO-24)*, Office of Coastal Protection and Restoration, New Orleans, Louisiana. 35pp.

Folse, T.M., J.L. West, M.K. Hymel, J.P. Troutman, L.A. Sharp, D.K. Weifenbach, T.E. McGinnis, L.B. Rodrigue, W.M. Boshart, D.C. Richardi, C.M. Miller, and W.B. Wood 2012. A Standard Operating Procedures Manual for the Coast-wide Reference Monitoring System-Wetlands: Methods for Site Establishment, Data Collection, and Quality Assurance/Quality Control. Louisiana Coastal Protection and Restoration Authority. Baton Rouge, LA. 207 pp.

Kimball, M.E., L.P. Rozas, K.M. Boswell, and J.C. Cowan. 2010. Evaluating the effect of slot size and environmental variables on the passage of estuarine nekton through a water control structure. Journal of Experimental Marine Biology and Ecology 395: 181-190.

LDNR. 2005. Operation, Maintenance, and Rehabilitation Plan for the Hopedale Hydrologic Restoration Project (PO-24). Louisiana Department of Natural Resources, Coastal Engineering Division, Baton Rouge, Louisiana. 7 pp. and Appendices.

Steyer, G.D., R.C. Raynie, D.L. Steller, D. Fuller, and E. Swenson. 1995. Quality management plan for the Coastal Wetlands Planning, Protection, and Restoration Act monitoring program. Open-File Series No. 95-01. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division. 108 pp.

Appendix A
(Inspection Photographs)

Photo 1. Water Control Structure

Photo 2. Damaged Stem Cover

Appendix B
(Three Year O&M Budget Projection)

Hopedale Hydrologic Restoration																					
Federal Sponsor: NMFS																					
Construction Completed : January 6, 2005																					
PPL 8																					
Current Approved O&M Budget	Year 0	Year - 1	Year -2	Year -3	Year -4	Year -5	Year -6	Year -7	Year -8	Year -9	Year -10	Year -11	Year -12	Year -13	Year -14	Year -15	Year -16	Year - 17	Year -18	Year -19	Project Life	Currently
June 2009	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	Budget	Funded
State O&M																					$449,209	$449,209
Corps Admin																					$0	$0
Federal S&A																					$0	$0
Total																					$449,209	$449,209
																					Remaining	Current 3 year
Projected O&M Expenditures																					Project Life	Request
Maintenance Inspection (State)								$1,992	$2,044	$2,097	$2,151	$2,207	$2,265	$2,324	$2,384	$2,446	$2,510	$2,575	$2,642	$2,711	$24,214	$6,624
General Maintenance											$14,000										$14,000	$14,000
Operations								$10,920	$7,920	$7,920	$7,920	$7,920	$7,920	$7,920	$7,920	$7,920	$7,920	$7,920	$7,920	$7,920	$79,200	$23,760
Federal S&A								$2,428.80	$2,492	$2,557	$2,623	$2,691	$2,761	$2,833	$2,907	$2,982	$3,060	$3,140	$3,221	$3,305	$29,524	$8,076
State S&A								$436.80	$316.80	$316.80	$876.80	$316.80	$316.80	$316.80	$316.80	$316.80	$316.80	$316.80	$316.80	$316.80	$3,728	$1,510
Maintenance/Rehabilitation																					$0	$0
E&D																					$0	$0
Construction																					$0	$0
Construction Oversight																					$0	$0
Total					$0	$0	$0	$15,778	$12,773	$12,890	$27,571	$13,136	$13,263	$13,394	$13,528	$13,665	$13,806	$13,951	$14,100	$14,252	$150,667	$53,970
O&M Expenditures from COE Report				$153,131				Current O&M Budget less COE Admin					$449,209				Current Project Life Budget less COE Admin					$449,209
State O&M Expenditures not submitted for in-kind credit				$0				Remaining Available O&M Budget					$296,078				Total Projected Project Life Budget					$303,798
Federal Sponsor MIPRs (if applicable)				$0				**Incremental Funding Request Amount FY12-FY14**					**-$242,108**				**Project Life Budget Request Amount**					**-$145,411**
Total Estimated O&M Expenditures (as of April 2010)				$153,131																		

Appendix C
(Field Inspection Notes)

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **Hopedale Hydrologic Restoration Project (PO-24)** Date of Inspection: 9/2/2014 Time: 11:45 am

Structure No. _____ Inspector(s): Richard, Prendergast

Structure Description: Gated Sheetpile Structure Water Level Inside: N/A Outside: N/A

Type of Inspection: Annual Weather Conditions: Partly cloudy

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Swing Gates 84" D	Good	None	None	1	
Fish Gates 24" x 84"	Good	See Remarks	None	2	Stem cover damaged/missing on northeast fish gate
Handrails Grating Hardware etc.	Good	None	None	1	
Galv. Pile Caps	Good	None	None	1	
Signage /Supports	Good	None	None	1	
Riprap	Good	None	None	1	
Silt/Fill	Good	None	None	1	

Are there any signs of vandalism? No
Conditions of existing levees? Good
Noticable breaches? None