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Coast 2050 Region 4

CAMERON PRAIRIE REFUGE PROTECTION ME-09 (ME-09)

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

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Abstract

Several factors, both natural and anthropogenic, have lead to the loss of freshwater marsh or conversion to more saline habitat in the Chenier plain marshes in Louisiana. The Cameron Prairie National Wildlife Refuge is located north of the higher salinity Gulf Intracoastal Waterway (GIWW) in Cameron Parish. In order to protect the southern portion of the refuge from wave-induced erosion, a 13,200 linear-foot (4,023 m) rock dike was constructed in 1994 along the northern bank of the GIWW. To assess the effectiveness of the rock dike, a monitoring plan was established to measure any shoreline position changes using survey points along the edge of bank vegetation. Aerial photography was used to document any changes in the land-to-water ratio within the project that could result from a failure to prevent the intrusion of the more saline waters of the surrounding canals. Analysis of the pre- and post-construction shoreline surveys indicate that shoreline erosion along the GIWW within the project area has been stopped, while the reference area sustained significant shoreline loss during this same period.

Introduction

The Cameron Prairie Refuge Protection project (ME-09) is a shoreline protection project from the 1st priority list of the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). The project area is located in north central Cameron Parish, Louisiana, along the north levee of the Gulf Intracoastal Waterway (GIWW) adjacent to the southern boundary of the Cameron Prairie National Wildlife Refuge (CPNWR) (figure 1). The project was designed to protect 350 acres (140 ha) of highly organic freshwater wetlands within the CPNWR from the wave-induced erosion of the adjacent GIWW waters. The freshwater wetlands of the CPNWR contain emergent, floating, and submersed vegetation which provides habitats for freshwater game fish, alligators, furbearers, and migratory and resident waterfowl.

Saltwater intrusion is a major contributor to wetland loss in coastal Louisiana which can be linked to several natural and anthropogenic causes. An example is the construction of channels and canals for navigation and exploration of oil and gas, which allow greater flow velocities and greater intrusion of saline Gulf waters. These secondary losses of wetlands occur gradually in addition to the primary losses that occur during construction due to dredging and disposal of spoil into adjacent wetlands. Additional secondary losses include the disruption of natural sheet flow and erosion of the channel bank resulting from vessel-generated wave wash (Good et al. 1995). When saline water rapidly invades areas of freshwater marsh, the mortality of existing vegetation may expose highly erodible substrate before more salt tolerant plant species can establish in the area (Turner and Cahoon 1987). Waterlogging of soils can intensify the detrimental effects of saltwater intrusion through the accumulation of sulfides, due to the highly reduced conditions (Turner and Cahoon 1987).

The GIWW was authorized by the Rivers and Harbors Act of 1925. Vessel traffic on the GIWW is a major source of erosion of the adjacent fresh and intermediate marshes. Wave-induced erosion has resulted in the current 500–600 ft (152–183 m) bank width of the GIWW (Louisiana Department of Natural Resources [LDNR] 1995), a tremendous increase from the originally authorized bank width of 150-200 ft (45.72-60.96 m) (Louisiana Coastal Wetlands Conservation and Restoration Task Force [LCWCRTF] 1993). Boat wake-induced erosion resulted in sloughing of spoil bank material into the GIWW and an estimated levee erosion rate of 2.5 ft/yr (0.76 m/yr) prior to project construction (U.S. Fish and Wildlife Service [USFWS] 1991). The estimate was based on observations of the bank line relative to the refuge boundary signs placed along the waterway, and applies to critical areas where the bank was almost completely deteriorated. Continued erosion could result in breaches of the levee, allowing higher salinity waters from the GIWW to enter the interior freshwater wetlands. Wave action caused by boat traffic within the GIWW has already eroded most of the spoil bank that protects the refuge, allowing the high energy saline waters of the GIWW to enter the project area. The resulting wave energy and saltwater intrusion has impacted the fragile interior freshwater wetlands, and could potentially result in considerable wetland loss (Cameron Prairie National Wildlife Refuge 1991).

Waves produced by boat traffic cause erosion of navigation channel banks and damage to nearby vegetation communities (Good et al. 1995). Water displaced from the channel by passing vessels

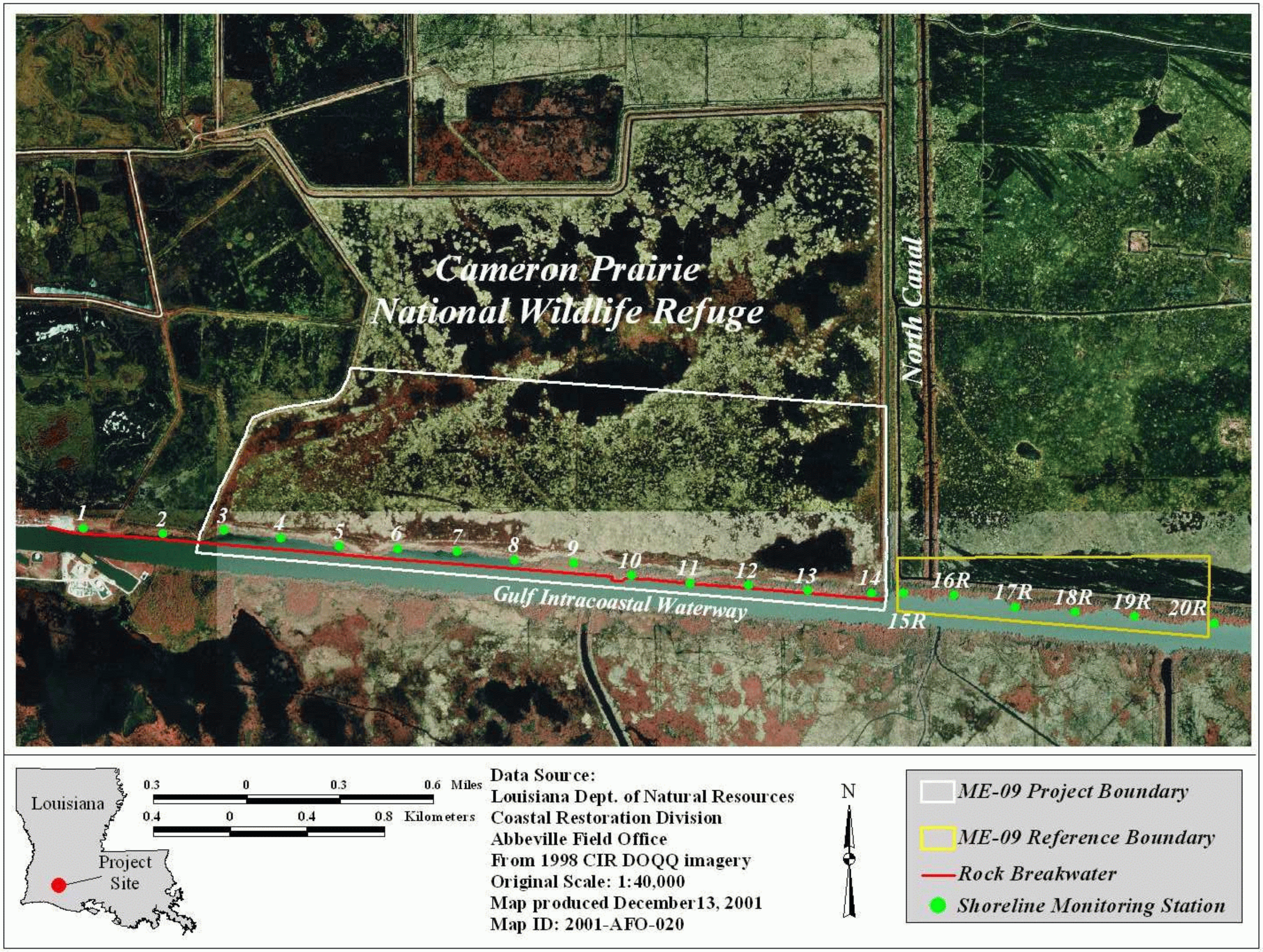

Figure 1. Cameron Prairie Refuge Protection (ME-09) project and reference areas with shoreline monitoring stations.

may overtop the banks of channels into the adjacent wetlands causing soil scour, vegetation damage, and rapid water level changes. Erosion of interior wetlands is accelerated by “blowouts” where a connection is formed between a channel and an inland water body (Good et al. 1995).

Rock breakwaters have been designed to prevent shoreline erosion and allow sediment accretion behind the structure through wave overtopping. A similar shoreline protection project along the GIWW at Clear Marais (CS-22) has resulted in observed sediment buildup between the rock dike and original shoreline (Miller 2001). The Cameron Prairie Refuge Protection project (ME-09) is designed to prevent further erosion of the existing spoil bank, and protect the existing freshwater wetlands from saltwater intrusion. Construction of approximately 13,200 ft (4,023 m) of free-standing, continuous rock breakwater was completed in August 1994 (figure 2) (Courville 1997). The breakwater was constructed using limestone rubble in the 125-275 lb. range placed above a layer of geotextile fabric (to prevent settling). No settlement plates were installed for this project.

The project objectives are to protect the emergent wetlands of the CPNWR adjacent to the GIWW and prevent the loss of approximately 247 ac (100 ha) of fresh and intermediate marsh by preventing the further widening of the GIWW into the CPNWR. The specific goals required to achieve these objectives are to:

1. Decrease the rate of spoil bank erosion along the south boundary of the 247 ac (100 ha) area adjacent to the GIWW within the CPNWR management unit.

2. Restore and maintain approximately 2 mi (3.2 km) of levee along the north bank of the GIWW by constructing a rock breakwater along the CPNWR/GIWW boundary.

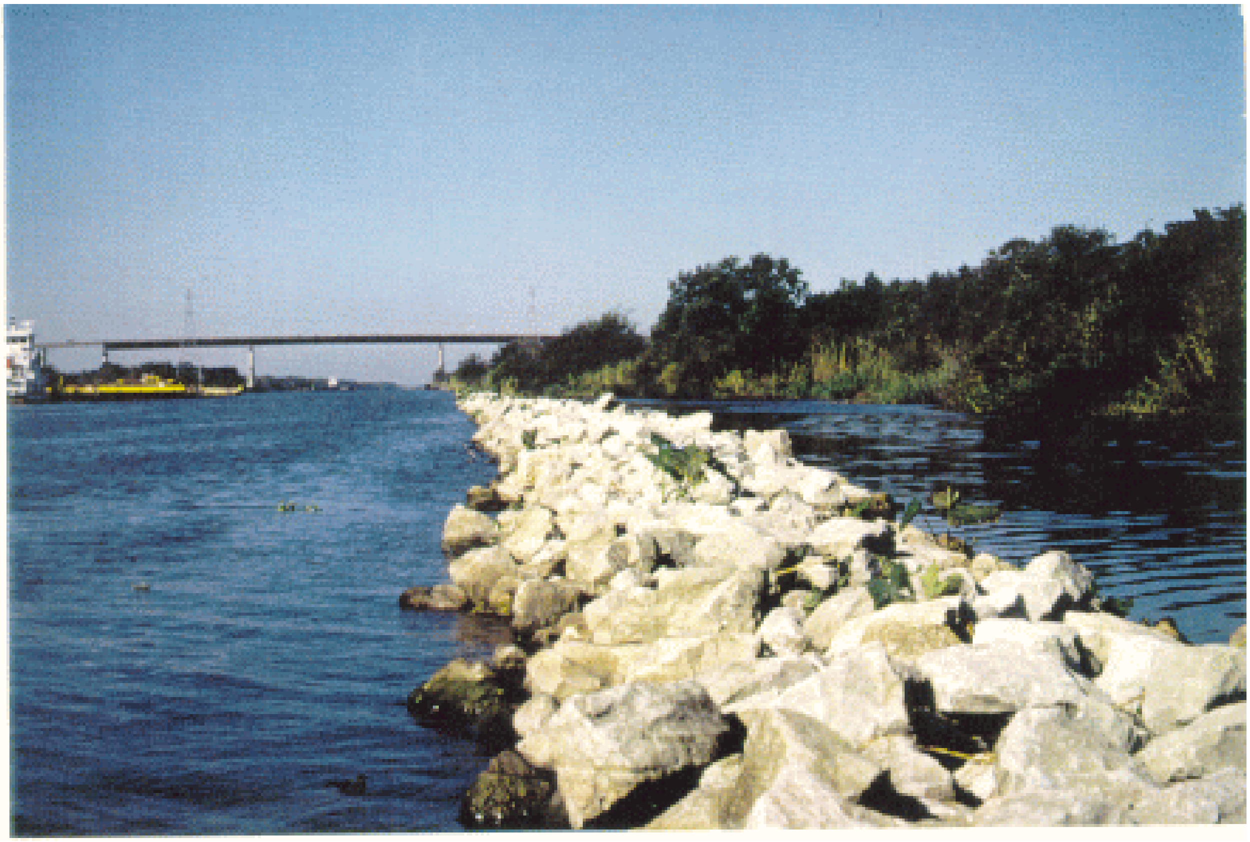

Figure 2. Photograph of the Cameron Prairie Refuge Protection (ME-09) project following construction in August 1994, illustrating the shoreline of the GIWW and the installed rock breakwater.

Methods

Analysis of Aerial Photography- Color-infrared aerial photography (1:12,000 scale) for the project and reference areas was obtained prior to construction on November 1, 1993 and post-construction on January 11, 1997 (Figure 3). A subsequent post-construction acquisition is also scheduled for 2009. Upon completion of the flights, the photography was checked for flight accuracy, color correctness, and clarity. The duplicate photography was prepared for scanning and analysis; the original film was archived. The photography was scanned and converted into a digital Tagged Image File Format (TIFF) file for mosaicking and georeferencing and will be used to document changes in marsh gain and loss rates over time in the project and reference areas.

During photo analysis, a digital TIFF file with a resolution of 300 pixels per inch (ppi) was created from the photography. Using ERDAS Imagine™, an image processing and Geographic Information System (GIS) software, the photography was rectified, mosaicked, and used to generate a base map. Optimal Global Positioning System (GPS) points were collected in the field in order to georeference the base map with the proper Universal Transverse Mercator (UTM) coordinate system. The resulting preconstruction and post-construction maps were then analyzed with ERDAS Imagine™ to determine land and water areas.

Shoreline Change Analysis- To document shoreline movement, shoreline markers (14 in the project area and 6 in the reference area) designating the edge of marsh vegetation were established at 1,000 ft (305 m) intervals along the north bank of the GIWW adjacent to the rock dike (figure 2). Shoreline markers were also established along the north bank of the GIWW adjacent (east) to the project area. Shoreline position and cross-sectional surveys were completed in March 1995 and May 1997. The surveys delineated the shoreline position and GIWW channel profile. In the project area, the original brass hubs were all recovered in good condition. Due to erosion of the GIWW canal bank, the reference area brass hubs had to be reset on the proper azimuth away from the existing canal bank following both the 1995 and 1997 surveys. However, information outlining the details of the 1997 survey hub relocation was not available from the contractor and therefore the distances that the hubs were moved could not be determined. Thus, shoreline change measurements in the reference area during the period 1997-2000 could not be ascertained and are not included in this report. Another survey was conducted in September 2000 by CRD personnel to determine shoreline change. In this survey, measurement of the distance (in ft) from the landward shoreline markers toward the edge of bank vegetation was collected, using a graduated tape, at each of the twenty stations [Steyer et al. 1995 (revised 2000)]. Due to the heavy vegetation cover present on the levee near several survey markers, stations were marked at the canal edge of the rock dike with both flagging tape and paint to facilitate recovery of survey hubs in the future. The baseline survey data collected in March 1995 were then compared to the May 1997 and September 2000 surveys for the project area and to the September 2000 survey for the reference area to evaluate project effectiveness in protecting the southern shoreline of the refuge. Descriptive and summary statistics were generated from the data and then compared. A two-sample, two-tailed t-test, using "=0.05, was performed to determine if the calculated shoreline change rates differed significantly between the project and reference areas. Shoreline position relative to the shoreline markers will continue to be monitored by direct measurement at 3 yr intervals with the next scheduled survey to be conducted in August 2003.

Results

GIS land and water analysis comparing preconstruction and post-construction photography revealed only small changes in the reference area; the project area showed a marked increase in the ratio of water to land. However, three principal difficulties were associated with the interpretation of this photography. First, during the acquisition of the post-construction photography, the project area contained standing water, which and submersed some of the emergent vegetation within the project area. These conditions may have contributed to the apparent increase in water in the analyzed portion of the project area. Second, the preconstruction photography showed large sections of floating vegetation throughout the project area and in canals within the reference area. Due to difficulties in distinguishing floating from rooted vegetation, some degree of classification error is expected. Finally, the post-construction flight was delayed until January 1997 because of unsatisfactory weather conditions. This possibly resulted in apparent vegetation differences in based on seasonality and senescence of some vegetation and may not be a true indicationof land changes within the project area. Differences measured in the photography may be a reflection of time of year rather than project effects. Quality control by the USGS-NWRC photointerpreters helped to minimize these factors, however, interpretation of these results must be cautious due to these possible sources of error.

The findings of the unsupervised GIS classification for the project and reference area land and water analysis are illustrated in figure 3 for the preconstruction and post-construction project and reference area land to water analyses. Overall, the 853 acre (345 ha) project area showed a 4.93% increase in water. By comparison, the 140 acre (57 ha) reference area experienced a 0.09% increase in water. This rate of loss in the project area equates to approximately 13.3 acres/yr (5.4 ha/yr) and only slight loss of land (0.1 acre [0.04 ha]) in the reference area during the 38 month study period. Although there was an apparent net loss of land within the project area, the GIS analysis revealed noticeable new vegetation present in the central portion of the project area, between the rock breakwater and the shoreline (figure 3).

This land gain between the rock dike and the shoreline is corroborated by the shoreline survey results presented in figures 4a and 4b. Shoreline change values between the survey markers and the edge of bank vegetation ranged from a 26.0 ft/yr (7.9 m/yr) gain in the project area to a 9.5 ft/yr (2.9 m/yr) loss in the reference area. Shoreline advance was detected at all project stations during the period between 1995 and 2000 (figures 5a and 5b). All stations in the reference area exhibited shoreline retreat. Mean shoreline change rate was calculated to be 9.8 $\pm$7.1 ft/yr (3.0 $\pm$ 2.2 m/yr) and -4.1 $\pm$3.1 ft/yr (-1.2 $\pm$ 0.9 m/yr) for the project and reference areas, respectively. The results of the two-sample t-test indicated that there was a significant difference in shoreline change rate detected between the project and reference areas ($\boldsymbol{P} < 0.001$).

Examination of the engineers' first annual inspection report (October 1996) and inspection by LDNR monitoring personnel in September 2000 provided evidence that the Cameron Prairie Refuge shoreline and the protective rock dike are in good condition.

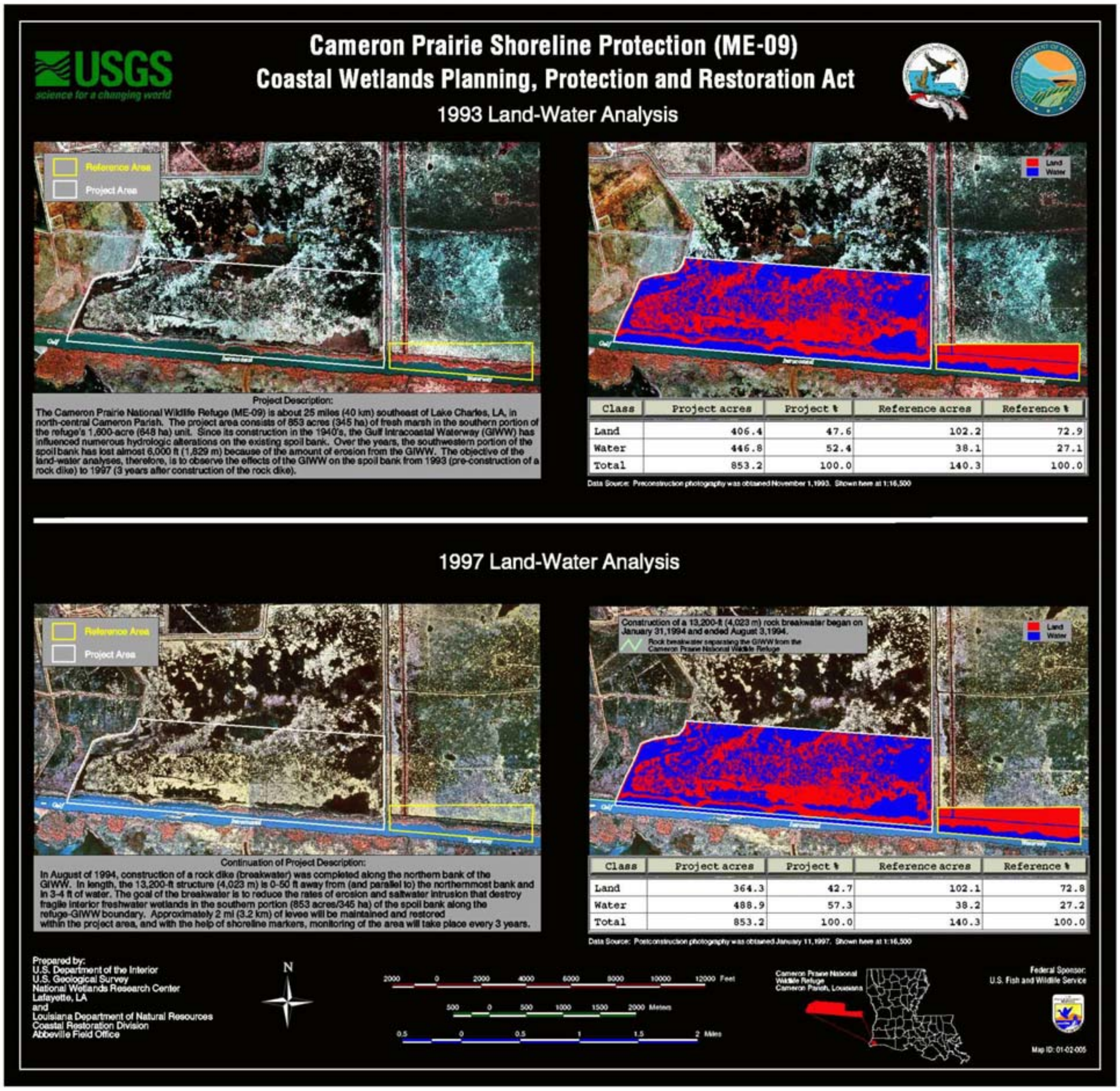

Figure 3. Cameron Prairie Refuge Protection (ME-09) GIS analysis of project and reference area preconstruction (1993) and post-construction (1997) aerial photography.

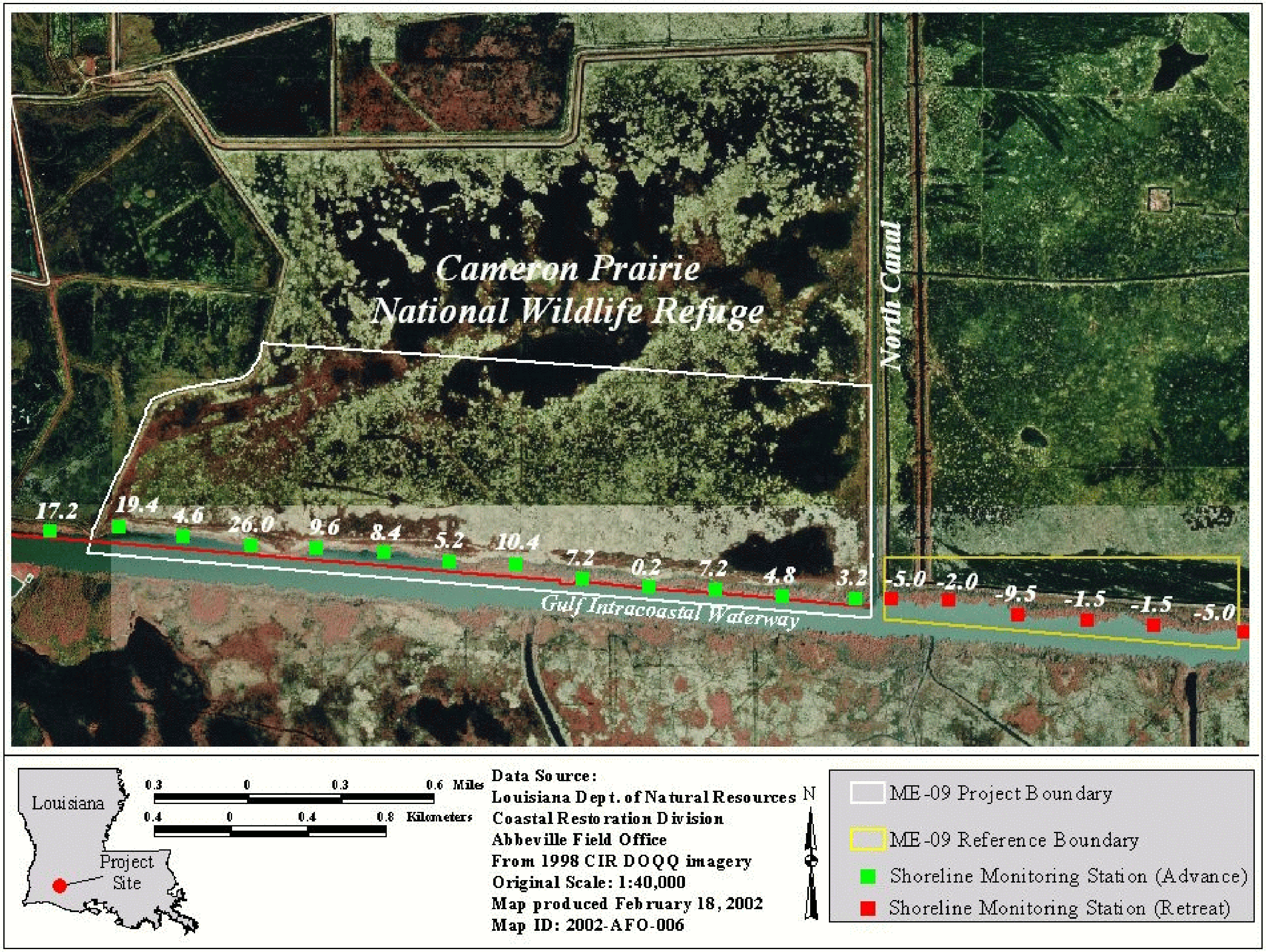

Figure 4a. Cameron Prairie Refuge Protection (ME-09) shoreline change (ft/yr) at project and reference area monitoring station locations between October 1995 and September 2000.

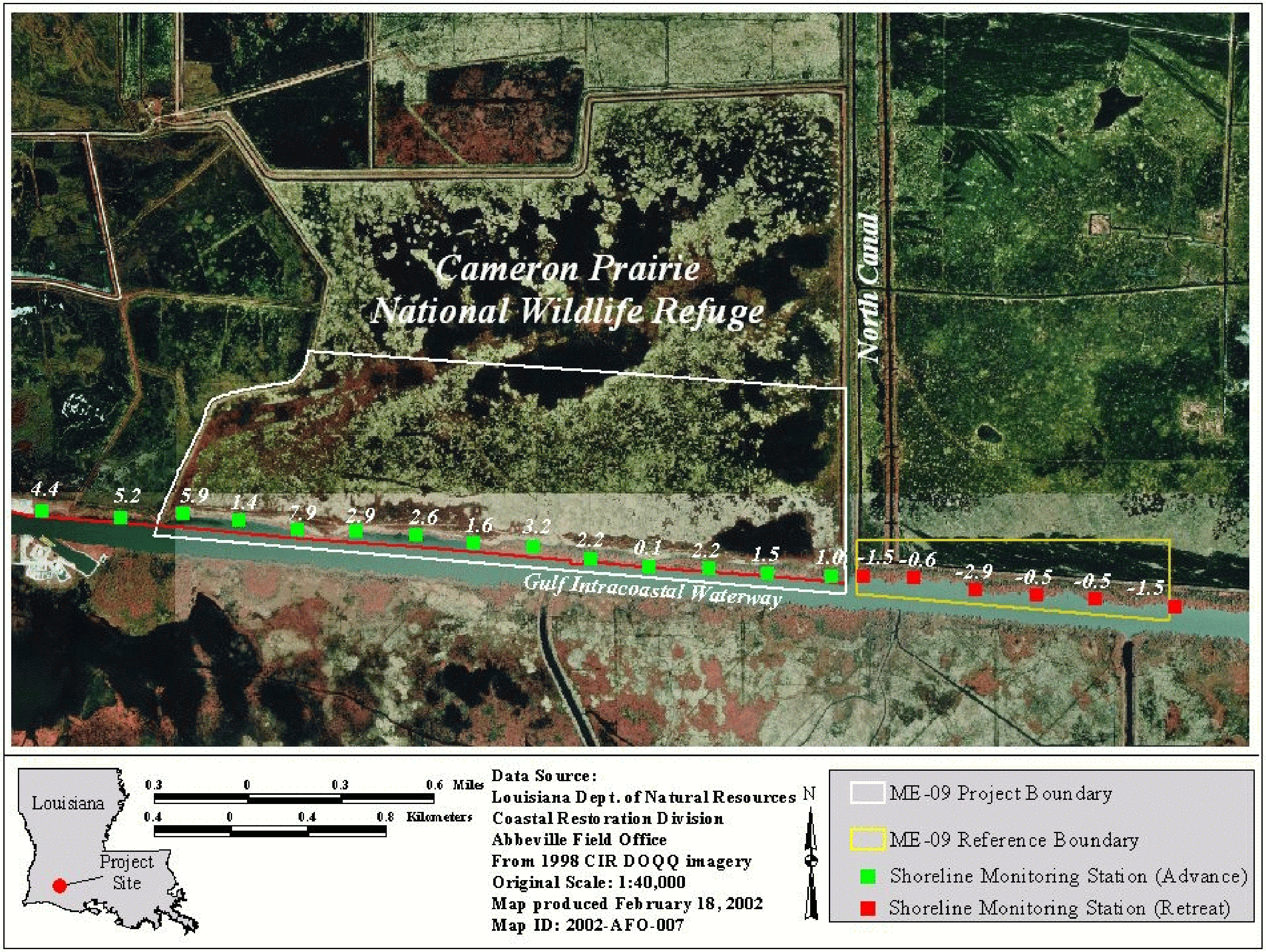

Figure 4b. Cameron Prairie Refuge Protection (ME-09) shoreline change (m/yr) at project and reference area monitoring station locations between October 1995 and September 2000.

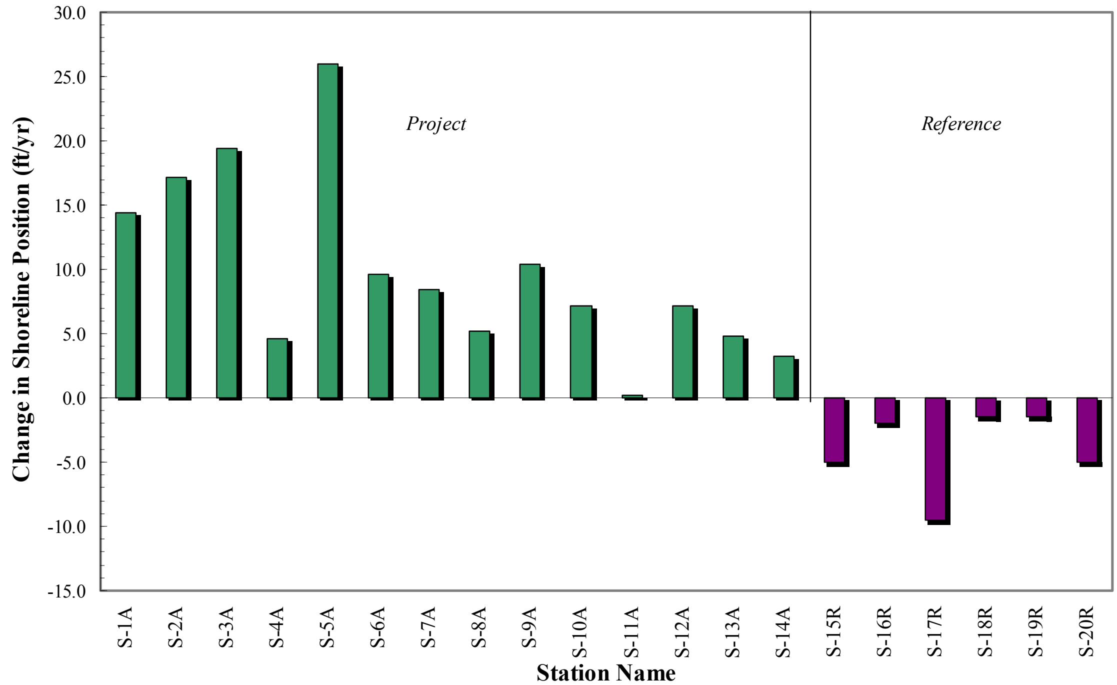

Figure 5a. Cameron Prairie Refuge Protection (ME-09) shoreline position change. Rates are calculated (in ft/yr) for the period 1995-2000.

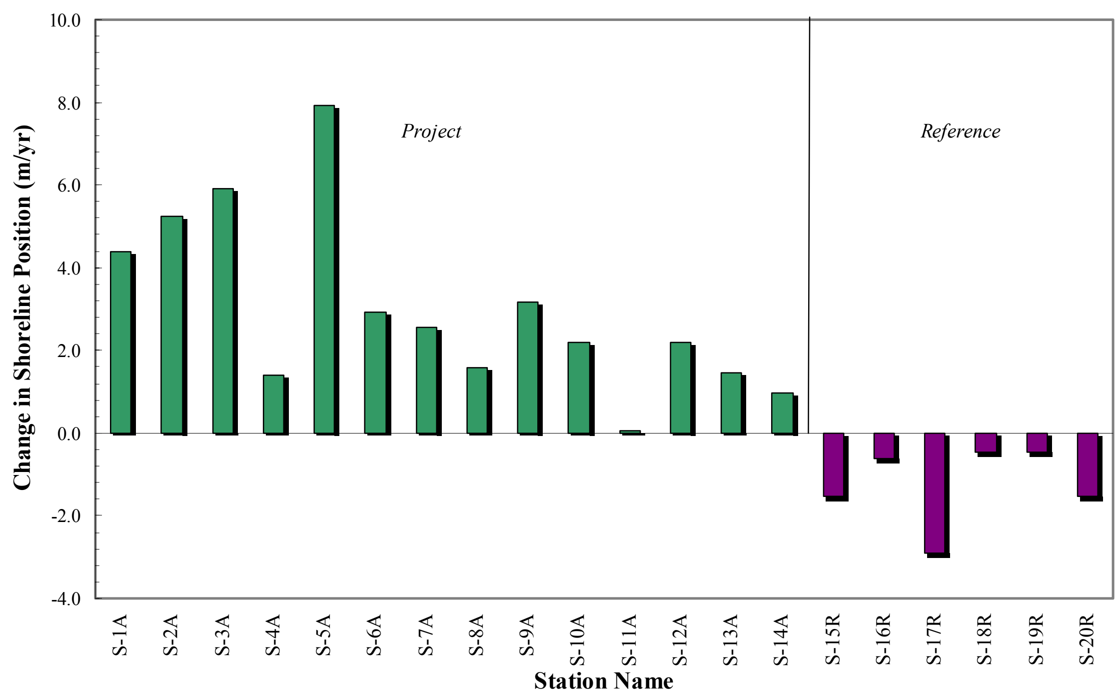

Figure 5b. Cameron Prairie Refuge Protection (ME-09) shoreline position change. Rates are calculated (in m/yr) for the period 1995-2000.

Discussion

The analysis of the preconstruction and post-construction aerial photography, which exhibited an apparent loss of land between 1993 and 1997 in the project area, may not be the function of actual land loss within the project area. Such an apparent change could result from water level and/or seasonal differences in vegetative cover and not be the result of subsidence or erosional processes. The lack of any significant land loss in the reference area could reflect the stability of the interior marsh of this area, which is also still protected from the waters of the GIWW by a spoil bank created during the channel's construction. However, the continued erosion of the shoreline along the GIWW in this area at the current rate (4.1 ft/yr; 1.2 m/yr) could cause drastic land loss in the near future, once the remaining section of spoil bank has been compromised or breached. Tremendous increases in erosion rates for the shoreline itself would also be expected due to the more fragile nature of the interior marsh. Survey marker hubs for the reference area have already been relocated twice due the rapid erosion of the shoreline and another relocation will most likely be required following the next scheduled shoreline change survey. Thus, the project has demonstrated significant effects in preventing shoreline erosion along this section of the GIWW and has been extremely effective in damping the wave energy responsible for the previously measured rates of erosion present in the project area. Boat wakes from vessels traveling along the GIWW are assumed to be the main source of energy eroding the spoil bank.

The 4.1 ft/yr (1.2 m/yr) spoil bank erosion rate observed in the reference area in this study falls within the range observed on the GIWW of 2.5 ft/yr (0.8 m/yr) – 6.6 ft/yr (2.0 m/yr) (USFWS 1991; Adams et al. 1978). Other highly navigable waterways such as Freshwater Bayou have experienced similar erosion rates of 6.56 ft/yr (2.0 m/yr) (Vincent 1997).

Considerable shoreline advance at most of the project stations behind the rock dike was also observed (figure 6). It is important to note that the shoreline advanced observed, as well as any future advance, will be restricted to the area behind the rock breakwater. In some areas vegetation is bordering the rock dike. However, in the areas where the rock dike is approximately 200 ft (60.96 m) away from the shoreline, progradation of the shoreline will require more time because the amount of sediment needed to fill this area is great. During the summer months, *Eichhornia crassipes* (Mart.) Solms (water hyacinth) (United States Department of Agriculture-Natural Resources Conservation Service 2001) fill these large open water areas which further reduces the amount of wave action reaching the shoreline (Courville 1997). The project area shoreline appears to be stable and the rock dike seems to be in good condition at this time, according to observations made by CRD personnel in 1997 and 2000. No breaches of the levee were found.

Figure 6. Photograph of the Cameron Prairie Refuge Protection (ME-09) project 6 years following construction in September 2000, showing shoreline advance between the rock breakwater and original shoreline at project station 11.

Conclusions

The goals and objectives of the monitoring plan appear to have been met thus far. The project has been effective in preventing erosion of the CPNWR southern boundary along the GIWW. Shoreline progradation averaging 9.8 ft/yr (3.0m/yr) was measured within the project area, whereas shoreline retreat averaging 4.1 ft/yr (1.2 m/yr) was observed along the unprotected reference area shoreline. Scheduled shoreline change surveys (for years 2003, 2006, 2009, and 2012), and subsequent monitoring reports will provide further monitoring documentation for this shoreline protection project (Miller 1994). Future inspections of the project area by CRD engineers will be conducted at regular intervals to document the condition of the rock breakwater and any required maintenance.

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