E C O L O G I C A L R E V I E W

Raccoon Island Shoreline Protection/Marsh Creation, Phase A
CWPPRA Priority Project List 11
State No. TE-48

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This document reflects the project design as of the 95% Design Review meeting, incorporates all comments and recommendations received following the meeting, and is current as of September 16, 2004.

ECOLOGICAL REVIEW
Raccoon Island Shoreline Protection/Marsh Creation, Phase A

In August 2000, the Louisiana Department of Natural Resources initiated the Ecological Review to improve the likelihood of restoration project success. This is a process whereby each restoration project's biotic benefits, goals, and strategies are evaluated prior to granting construction authorization. This evaluation utilizes monitoring and engineering information, as well as applicable scientific literature, to assess whether or not, and to what degree, the proposed project features will cause the desired ecological response.

I. Introduction

The Raccoon Island Shoreline Protection/Marsh Creation project is located in Terrebonne Parish, approximately 50 miles south of Houma, Louisiana. Raccoon Island is part of the Isles Dernieres, a 20 mile long island arc composed of four islands: Raccoon Island, Whiskey Island, Trinity Island and East Island (Figure 1). Raccoon Island is currently a part of the Louisiana Department of Wildlife and Fisheries' Isle Dernieres Barrier Islands Refuge, and exhibits some of the highest species richness and abundance of nesting colonial water birds in the state. One of the most important brown pelican and roseate spoonbill nesting colonies in Louisiana is found on Raccoon Island. It is also one of the few nesting sites in Louisiana for the reddish egret. Other species that nest there in large numbers include, but are not limited to, the great egret, white ibis, black skimmer, least tern, sandwich tern, royal tern and gull-billed tern (Mike Carloss, Natural Resources Conservation Service, Personal Communications, June 18, 2004).

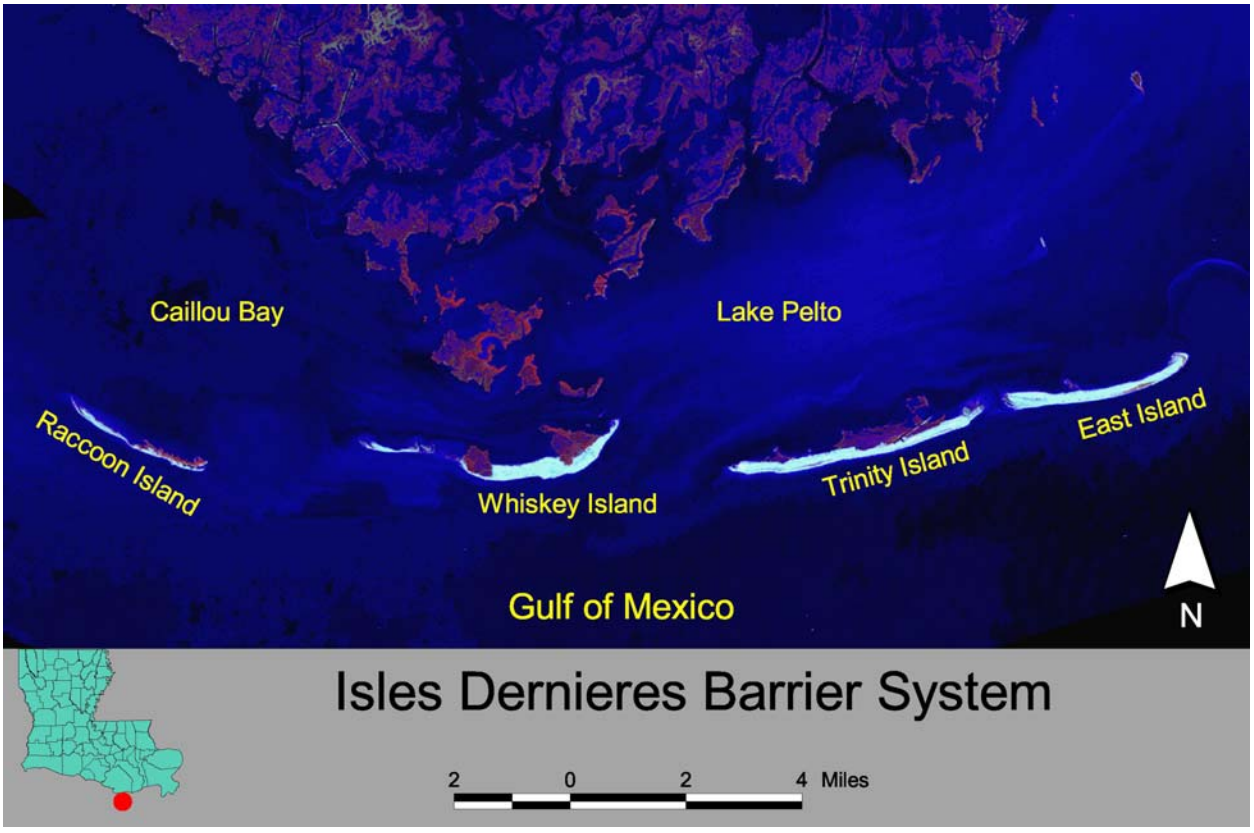

Figure 1: Isles Dernieres, Louisiana.

Raccoon Island is experiencing landward migration, area loss, bayside erosion and island narrowing due to an interaction of several factors such as subsidence, eustatic sea level rise, wave processes, storm impacts, inadequate sediment supply and human disturbances (McBride and Byrnes 1997). The average width of Raccoon Island has changed from 2,736 feet in the 1890's to 813 feet in 1988 (McBride et al. 1992) (Figure 2).

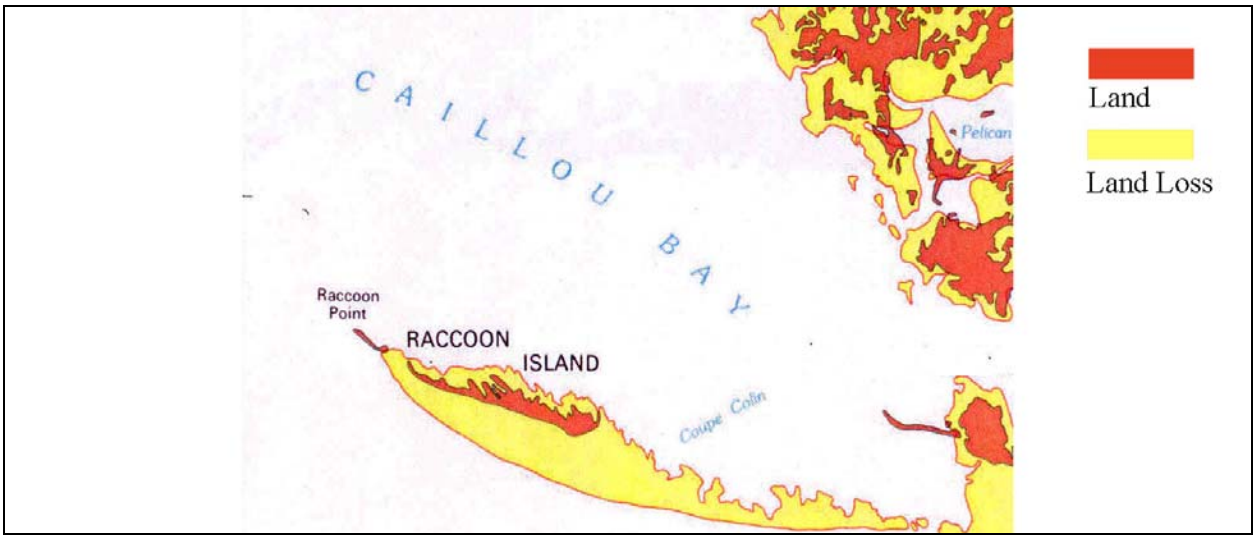

Figure 2: Historical shoreline change at Raccoon Island from the 1890's to 1988 (modified from McBride et al. 1992).

The Raccoon Island Shoreline Protection/Marsh Creation project is co-sponsored by the Natural Resources Conservation Service (NRCS) and the Louisiana Department of Natural Resources (LDNR) (Figure 3). The project is designed to reduce the rate of gulf shoreline retreat through the construction of rock breakwaters and to create over 60 acres of marsh as new habitat for avian species, through the direct placement of dredged material (NRCS and LDNR 2001). Restoring and maintaining the Isles Dernieres barrier island chain was recommended by Coast 2050 as regional ecosystem strategies [Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority (LCWCRTF&WCRA) 1999]. This strategy would restore the barrier island chain to a "condition suitable for maintaining the integrity of the estuarine system" (LCWCRTF&WCRA 1998).

In order to test the effectives of segmented breakwaters in mitigating shoreline erosion along the Louisiana barrier islands and to evaluate their potential role in future barrier island restoration projects, the Raccoon Island Breakwaters Demonstration (TE-29) project was constructed along the eastern gulf shoreline of Raccoon Island in June and July of 1997. Eight segmented breakwaters, labeled 0-7, were deployed approximately 300 feet off the southeastern shoreline of Raccoon Island and their effects on shoreline retreat were monitored (Figure 3).

Long term (1887-1988) gulf shoreline erosion rates of the Isles Dernieres are 36.4 feet/year (McBride and Byrnes 1997). The short-term (April 1997 to April 1998) erosion rate for the shoreline behind breakwaters 0, 1 and 2 was 31.0 feet/year (Armbruster 1999). The shoreline west of the Raccoon Island Breakwater Demonstration Project eroded at a rate of 52 feet/year

from 1996-2002, and is predicted to increase to 54 feet/year as a result of downdrift sediment deficit, without the proposed breakwaters (Coastal Planning and Engineering, Inc. 2004).

Figure 3: TE-48, Phase A, project features.

Difficulties and associated delays in identifying a suitable source of borrow material have prompted the federal and local sponsors to subdivide the project into two phases: Phase A will include the construction of additional breakwaters and terminal groin, and Phase B involves the placement of dredged material to create 60 acres of marsh. This action will enable the shoreline protection features to proceed in a more timely fashion through engineering and design and construction phases, during which time an adequate source of borrow material will be pursued. This Ecological Review focuses exclusively on Phase A.

A first 30% Design Review meeting for this project was held in September 2003. At the meeting, the LDNR project team recommended that a sediment budget for the project area be prepared and the effects of the proposed breakwaters on the Raccoon Island shoreline be predicted using engineering tools/modeling.

II. Goal Statement

Reduce shoreline erosion rates behind the proposed breakwater field on Raccoon Island by approximately 60% (from 52 feet/year to 21 feet/year, based on model calculations performed by Coastal Planning & Engineering, Inc. [2004]).

III. Strategy Statement

The project is anticipated to reduce the rate of shoreline erosion by approximately 60% through the construction of eight segmented breakwaters as a westward continuation of the Raccoon Island Breakwaters Demonstration (TE-29) project, and construction of a terminal groin at the eastern end of the breakwater field (Figure 3).

IV. Strategy-Goal Relationship

The reduction of wave energy by the use of segmented breakwaters on the gulf side of the island will decrease incident wave forces reaching the beach and upper shore face of the island. The eastern groin will eliminate tidal currents between the existing breakwaters (0, 1, and 2) and the shoreline.

V. Project Feature Evaluation

Eight additional segmented breakwaters will be constructed as a westward continuation of the TE-29 demonstration project. The eight, 300-foot long breakwaters will be constructed approximately 250 feet from shore, in 3 to 8 feet of water. Each breakwater will be constructed at a crest elevation of +4.5 feet NAVD-88, with a 10-foot crown and 1(V):3(H) side slopes. The gap between each breakwater will range from 160-300 feet based on results and recommendations from the sediment budget (Coastal Planning and Engineering, Inc. 2004) (Table 1).

Table 1: Breakwater length and gap length (Coastal Planning and Engineering, Inc 2004).

Breakwater Number	Length (feet)	Gap Width (feet)
8	300	300
9	300	280
10	300	260
11	300	240
12	300	220
13	300	200
14	300	180
15	300	160

An 952-foot terminal groin will be constructed at the eastern end of the breakwater field from the island to the end of breakwater 0, to stabilize the eastern end of the island and reduce tidal currents between breakwaters 0, 1, and 2, and the shoreline. The eastern terminal groin will be constructed at a crest elevation of +4.5 feet NAVD-88, with a 10-foot crown and 1(V):3(H) side slopes.

Soils in the project area in the first 12 feet below the mudline are composed of loose sand and silty sand, and from 12-50 feet below the mudline they are composed of soft clay and silty clay. The results of the geotechnical investigation estimate an anticipated structure settlement of

1.0-2.1 feet during the 20 year project life, and specify a side slope safety factor of 1.6-1.9 in 4 feet of water, and 1.5-1.7 in 8 feet of water (Soil Testing Engineers, Inc 2003). The accepted measure of a slope's stability is its safety factor which is the ratio of the forces or moments tending to prevent failure (soil strength, primarily) to those that cause failure (soil and surcharge weights plus seepage forces, primarily). For the soil conditions found within the Phase A project area, Soil Testing Engineers, Inc. established an acceptable safety factor of 1.3-1.5 for slope stability (Soil Testing Engineers, Inc 2003). The side slope safety factor of the proposed structures therefore exceeds the acceptable range.

VI. Assessment of Goal Attainability

Environmental data documenting the effects of the proposed project features in field applications are evaluated below to assess whether or not, and to what degree, the project features will cause the desired ecological response in Phase A.

Two projects using rock breakwaters have been implemented in the Gulf of Mexico to protect gulf shorelines from erosion.

- The Raccoon Island Breakwaters Demonstration (TE-29) project was constructed along the eastern gulf shoreline of Raccoon Island in June and July of 1997 to demonstrate the effectiveness of segmented breakwaters in mitigating shoreline erosion along the Louisiana barrier islands and to evaluate their potential role in future barrier island restoration projects. Eight experimental segmented breakwaters were constructed 300 feet off the southeastern shoreline of Raccoon Island, in 2 to 6 feet of water. Each breakwater was 300 feet in length, with a 10-foot crown at a crest elevation of +4.5 feet NAVD-88, and 1(V):3(H) side slopes (Figure 3). The gap between each breakwater was 300 feet. The results of monitoring conducted in October 1997 indicated that the breakwaters reduced incident wave height by 90% behind the structures and 0% in the gaps, and results from March 1998 indicated that the breakwaters reduced obliquely incident waves by 70% behind the structures and 50% in the gaps (Armbruster 1999). During the first twelve months of monitoring, the rate of shoreline retreat between breakwaters 4 through 7 was reduced to 10% below the long term average, and in the lee of the breakwaters, the shoreline experienced an average net progradation of 29.8 feet. Vertical accretion of sediment of 4 feet was measured in the lee of the breakwaters. By July 1998 sediment accretion behind breakwaters 3-7 led to the formation of a continuous emergent sand body (i.e., tombolo), while the eastern shoreline behind breakwaters 0-2 continued to erode. The erosion behind breakwaters 0-2 was probably associated with the shorelines exposure to easterly and northeasterly directed waves that accompany winter cold front passages, a steeper shoreface which reduces wave attenuation in the surf zone, a decrease in sediment transported to the area from the west (Armbruster 1999), and the extremely high velocity tidal currents between the shoreline and the breakwaters (Stone et al. 2003). Monitoring data indicates that a complex shoal, the erosional remnant of historical Raccoon Island, likely played a role in wave attenuation (Armbruster 1999) and was the likely source of the sediment that accreted behind the breakwaters (Armbruster 1999; Stone et al. 2003). The deposition of sediment in the lee of the breakwater, and the creation of reverse

salients, were unanticipated (Stone et al. 2003) and further study of the effects of the breakwaters was undertaken. The study by Stone et al. (2003) concluded that the breakwaters modified wave conditions, thereby facilitating the capture of sediment moving onshore from the shoal. Preferential deposition of sediment occurred behind breakwaters number 3-7 because of their position relative to tidal channels and tidal bays (Stone et al. 2003).

- The Holly Beach Breakwaters (CS-01bc) state project was designed to reduce wave energy effects along 7.3 miles of coast between Holly Beach and Ocean View Beach in southwest Cameron Parish, Louisiana. The long term shoreline erosion rate in the project area was 4.3 feet/year (Underwood et al. 1999). A total of 85 segmented breakwaters were constructed in different phases parallel to shore from 1991-1994. The breakwaters averaged 150 feet in length with 300 foot gaps and were built in 4-6 feet of water approximately 250-600 feet from shore. The breakwaters were constructed with a crown width of 9 feet and 4 feet above MSL. Overall the results from 1990 to 1995 indicated a net accretion of sediment; however that occurred only in the easternmost breakwaters. The breakwaters have failed to reverse net erosion rates in the central and western portions of the project area. The initial sediment deposition was very rapid, regardless of breakwater distance from shore. After the initial deposition, a reduction in the sediment volume occurred, especially in the middle and western breakwaters. Proximity of the breakwater to the sediment source, which was presumed to be longshore dominated, from east to west, seemed to play an important role in the shoreline response (Underwood et al. 1999). The breakwaters distance from shore did not seem to influence shoreline response in the initial construction phase, however as breakwaters were constructed up-current, the breakwater constructed 600 feet from shore lost the ability to trap longshore sediment transport (Underwood et al. 1999). The Holly Beach breakwaters have failed to reverse net erosion rates in the central and western portions of the project area, and as a result, the Holly Beach to Constance Beach Segmented Breakwaters Sand Management Project (CS-31) was implemented to restore the littoral drift system. This beach nourishment was accomplished through the placement of approximately 1.7 million cubic yards of dredged sediment on the beach.

Summary/Conclusions

Both rock breakwater projects, CS-01bc and TE-29, were somewhat successful in halting Gulf shoreline erosion; however a review of both projects reveals that their success hinges on both the ability of the breakwaters to reduce wave energies on the shoreline and the ability of these breakwaters to promote the deposition of suspended sediment. In the case of the Raccoon Island Breakwaters Demonstration (TE-29) project, the success of the project was enhanced by the presence of a shoal that provided the sediment that deposited behind the structures. A further study by Stone et al. (2003) questioned the longevity (years to decades) of the shoal, and the availability of the sediment to the proposed breakwaters. It is therefore likely that the success of the TE-29 breakwaters, in stopping shoreline erosion and accreting sediment, will not be duplicated for the proposed breakwaters, as sediment from the shoal may not be available. In consequence, at the conclusion of the first 30% Design Review meeting, it was decided that a sediment budget for the project area be prepared.

The development of the sediment budget enabled the design team to refine the design of the project, through the modification of the length of the gaps between breakwaters, and incorporating the addition of a terminal groin at the eastern end of the breakwater field. The design had originally incorporated a 600-foot terminal groin at the western end of the breakwater field from the island to the end of breakwater 15, to capture most of the sediment that would otherwise have passed through the breakwater field and been lost to the emergent portion of the island. The western groin would have greatly reduced the loss of sediment through longshore transport, which is predominantly east to west, and would have reduced shoreline erosion rates behind the proposed breakwater field on Raccoon Island by approximately 75% (from 52 feet/year to 12 feet/year, based on model calculations performed by Coastal Planning & Engineering, Inc. [2004]). Construction of the western groin would likely have resulted in an erosional shadow in the area to the west of the structure, caused by a sediment deficit. Because of the location of the structure at the western end of the island the emergent, vegetated portion of the project area would not have been affected; however, the sand spit located down drift from the structure would likely have been starved of sediment. After some concerns were expressed over the western terminal groin's potential impact on the sand spit, it was decided to remove the structure from the project design. This will likely result in a reduction of benefits to the project area, as the western terminal groin was expected to reduce shoreline erosion by an additional 15% (75% reduction with the groin and 60% reduction without the groin). The removal of the western terminal groin will result in an estimated increase in shoreline erosion of 9 feet/year (from 12 feet/year to 21 feet/year). This is equivalent to a loss of emergent vegetated island habitat of approximately 17 acres over the 20-year project life.

The 952-foot terminal groin that is designed at the eastern end of the breakwater field from the island to the end of breakwater 0, should stabilize the eastern end of the island and reduce tidal currents between breakwaters 0, 1, and 2, and the shoreline. This should result in the accretion of an additional 6 acres of beach, if the sediment from the shoal continues on being available (Coastal Planning and Engineering, Inc. 2004).

After review of the design of the project, the results of the sediment budget, and review of the monitoring information from previous breakwater projects in Louisiana, it is the opinion of the LDNR project team that the project will likely achieve the goal of reducing the shoreline erosion rate in the gulfside project area by approximately 60% (from 52 feet/year to 21 feet/year).

VII. Recommendations

Based on information gathered from similar restoration projects, engineering designs and related literature, the proposed strategies in the Raccoon Island Shoreline Protection/Marsh Creation, Phase A project will likely achieve the desired goals. At this time, the Louisiana Department of Natural Resources, Coastal Restoration Division recommends that the Raccoon Island Shoreline Protection/Marsh Creation, Phase A project be considered for CWPPRA Phase 2 authorization.

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