MONITORING PLAN

PROJECT NO. TE-40 TIMBALIER ISLAND MARSH/DUNE RESTORATION

DATE: June 25, 2007

Preface

The Barrier Island Comprehensive Monitoring (BICM) program has been initiated under the Louisiana Coastal Area Science and Technology (LCA S&T) office as a component of the System-wide Assessment and Monitoring (SWAMP) program (US Army Corps of Engineers, 2004). The BICM program is located along the Louisiana coastal shoreline, specifically those areas where barrier shorelines exist, from the northern tip of the Chandeleur Islands south to include all the Chandeleur Islands; and from Sandy Point west to Raccoon Point, as well as the Chenier Plain from Sabine pass east to the Mermentau Outlet. Currently the program is expected to monitor the sandy shorelines of the Louisiana coast every 5 years.

The advantage of BICM over the current project specific monitoring is that it will provide long term data on all of Louisiana's barrier islands, instead of just those islands with constructed projects. As a result, a greater amount of longer-term data will be available not only to evaluate constructed projects, but for planning and design of future barrier island projects, operations and monitoring (O&M) activities, and determining storm impacts. Because data will be collected for the entire barrier island system concurrently and with the same methodologies, those data will be more consistent, accurate, and complete than the current barrier island data collection efforts.

The objectives of BICM are to:

1. Determine the elevation, longevity, and conservation mass of the barrier islands.
2. Determine major habitat types and the distribution and quantity of each habitat over time on the barrier islands.
3. Determine geotechnical properties of sediments on the barrier islands.
4. Relate available data on environmental forces that affect the ecology and morphology of the barrier islands to other BICM data sets.
5. Determine species composition and diversity of vegetation within major habitat types on the barrier islands.

The BICM program will allow overall assessment of individual projects to be accomplished with additional monies needed only to address time sensitive issues or areas of specific interest not addressed by this comprehensive program such as survival of plantings, initial sediment transport, tidal channel development and fisheries use.

Background

Timbalier Island is considered part of the Bayou Lafourche barrier system and lies about 47 miles (75 km) west of the mouth of the Mississippi River and about 50 miles (80 km) south of

New Orleans (Figure 1). The island originated from the westward progradation of the Caminada-Moreau headland. When the spit breached during storms, the island was detached from the headland. Erosion from the Caminada-Moreau headland remains the primary source of sand to Timbalier Island.

An important function of barrier islands is to protect wetland areas from waves, storm surges, and salt water intrusion (McBride et al., 1992). Timbalier Island acts as a buffer for the bays, estuaries, and wetlands of the Terrebonne Basin, reducing the wave energy the marshes experience by shielding Timbalier Bay from the Gulf of Mexico. These bays, estuaries, and wetlands are important for commercial and recreational fisheries and wildlife, and as protection against storm damage to nearby oil and gas facilities and other infrastructure farther inland. In addition, barrier islands provide important stop over habitat for neotropical trans-gulf migrants and permanent homes for many native bird species.

Hurricane Andrew made official landfall in Louisiana as a category 3 hurricane at 0330 CDT on the morning of August 26, 1992 20 miles (32.19 km) west-southwest of Morgan City. The northeastern quadrant of Hurricane Andrew passed directly over the Isle Dernieres and Timbalier Islands and cut a 27.96 mile (45 kilometer) swath of destruction from Fourchon, through Cocodrie and Morgan City to Baton Rouge. Timbalier Island had much of its sand substrate removed, devastating much of the beach and dune habitat.

The long-term (1887 - 1988) gulfside average erosion rate was documented at -7.9 ft yr^{-1} (-2.4 m yr^{-1}) and the short-term (1978 - 1988) was documented at -22.9 ft yr^{-1} (-7.0 m yr^{-1}) (McBride et al., 1992). The impact of Hurricane Andrew temporarily accelerated the gulfside shoreline change rate between December 1990 and October 1992 to -137.1 ft yr^{-1} (-41.8 m yr^{-1}) (Penland et al., 1999). Bayside, (McBride et al., 1992) documented long-term (1887-1988) and short-term (1978-1988) shoreline change rates at -16.4 ft yr^{-1} (-5.0 m yr^{-1}) and -46.3 ft yr^{-1} (-14.1 m yr^{-1}) respectively. The Timbalier Island bayside shoreline change rate as a result of Hurricane Andrew was measured at -28.5 ft yr^{-1} (-8.7 m yr^{-1}) (Penland et al., 1999).

McBride et al. (1992) calculated the long-term (1887-1988) and short-term (1978-1988) area loss rates for Timbalier Island at -23.0 acres yr^{-1} (-9.3 ha yr^{-1}) and -112.9 acres yr^{-1} (-45.7 ha yr^{-1}) respectively. The area loss rate measured for Hurricane Andrew (1990-1992) was -106.5 acres yr^{-1} (-43.1 ha yr^{-1}). Hurricane Andrew changed the long-term (1887-1993) loss and short-term (1978-1993) loss rates to -25.2 acres yr^{-1} (-10.2 ha yr^{-1}) and -65.7 acres yr^{-1} (-26.6 ha yr^{-1}) respectively.

Between 1988 and 2002, the short-term erosion rate accelerated to -13.4 ft yr^{-1} with a range of -118.7 ft yr^{-1} to +31.9 ft yr^{-1} (Penland and Campbell, 2004). The high rates of change reflect the impact of the 1992 Hurricane Andrew and 2002 Hurricanes Isidore and Lili.

A longshore sediment transport model for Timbalier Island demonstrates net sediment transport is westward (Stone and Zhang, 2001). This suggests that sand being eroded from the east flank is

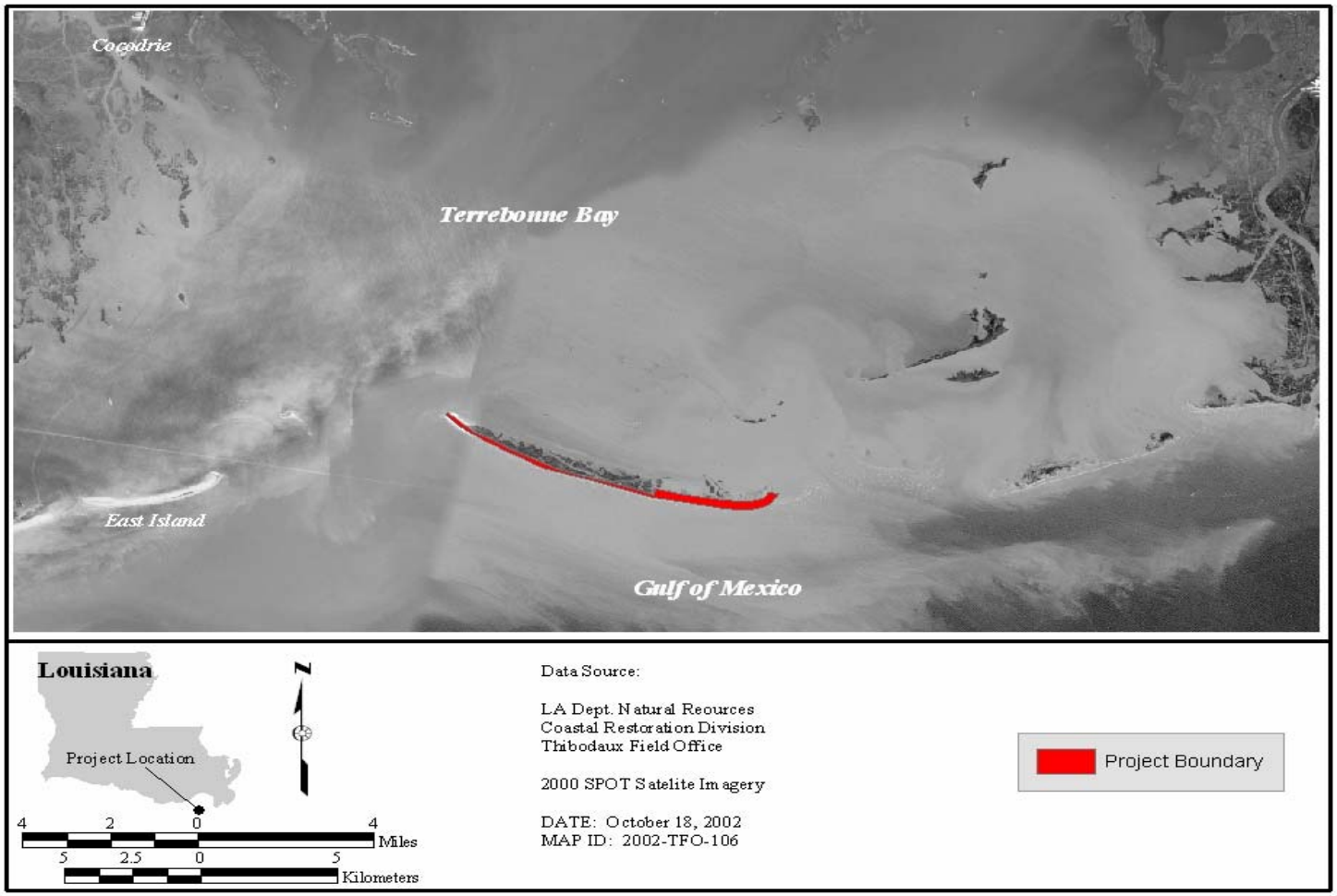

Figure 1. Satellite Image of Timbalier Island and Timbalier Island Marsh/Dune Restoration (TE-40) Project Location.

being transported to the west where it is deposited along the west flank of the island and in Cat Island Pass. The majority of passes are serving as sinks to longshore transport. As the model results show (Figure 2), the eastern flanks of the Timbalier Islands and the Isle Dernieres are serving as sediment sources for transport of sediment to spit ends and to the passes (Stone and Zhang, 2001).

The barrier islands on the Timbalier and Isle Dernieres chain have entered a final phase of disintegration that involves a complex structured longshore sediment transport system. Timbalier Island has decreased in size by 58% over the last century (Townson et al 1999). Coupled with the massive destruction of a major hurricane such as Hurricane Andrew, Timbalier Island could disappear by year 2050 without restoration (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority, 1998).

Project Description

The Timbalier Island Dune/Marsh Restoration (TE-40) project is a 20-year project designed to restore the eastern end of Timbalier Island through dedicated dredging of local sediment sources, and stabilization of the newly deposited sediment through sand fencing and vegetative plantings in Terrebonne Parish, Louisiana. The project is sponsored by the United States Environmental Protection Agency (EPA) and the Louisiana Department of Natural Resources/Coastal Restoration Division (LDNR/CRD) under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA, Public Law 101-646, Title III). The proposed plan would deposit dedicated dredge sediments to create beach, dune, and marsh habitat. This project would also aid in restoring the structural integrity of Timbalier Island through restoration of the littoral drift system and addition of sediment into the nearshore environment.

Project Goals and Strategies/Coast 2050 Strategies Addressed

These project goals are consistent with the Coast 2050 Region 3 ecosystem strategy to restore barrier islands and gulf shorelines. Construction of the dune and salt marsh will increase the area, width, and sediment/soil volume of Timbalier Island. Construction of the dune will immediately increase the area of dune and the maximum and average elevation on the island and construction of the salt marsh will immediately increase the area of salt marsh on the island. Planting vegetation and installing sand fencing should reduce the rate of loss of sand from treated areas.

Project Goals

- To restore the eastern end of Timbalier Island.
- To maintain the lateral migration of Timbalier Island.

Project Strategies

Dune and marsh platform will be constructed and stabilized through the deposition of dredged material, vegetation plantings, and sand fencing.

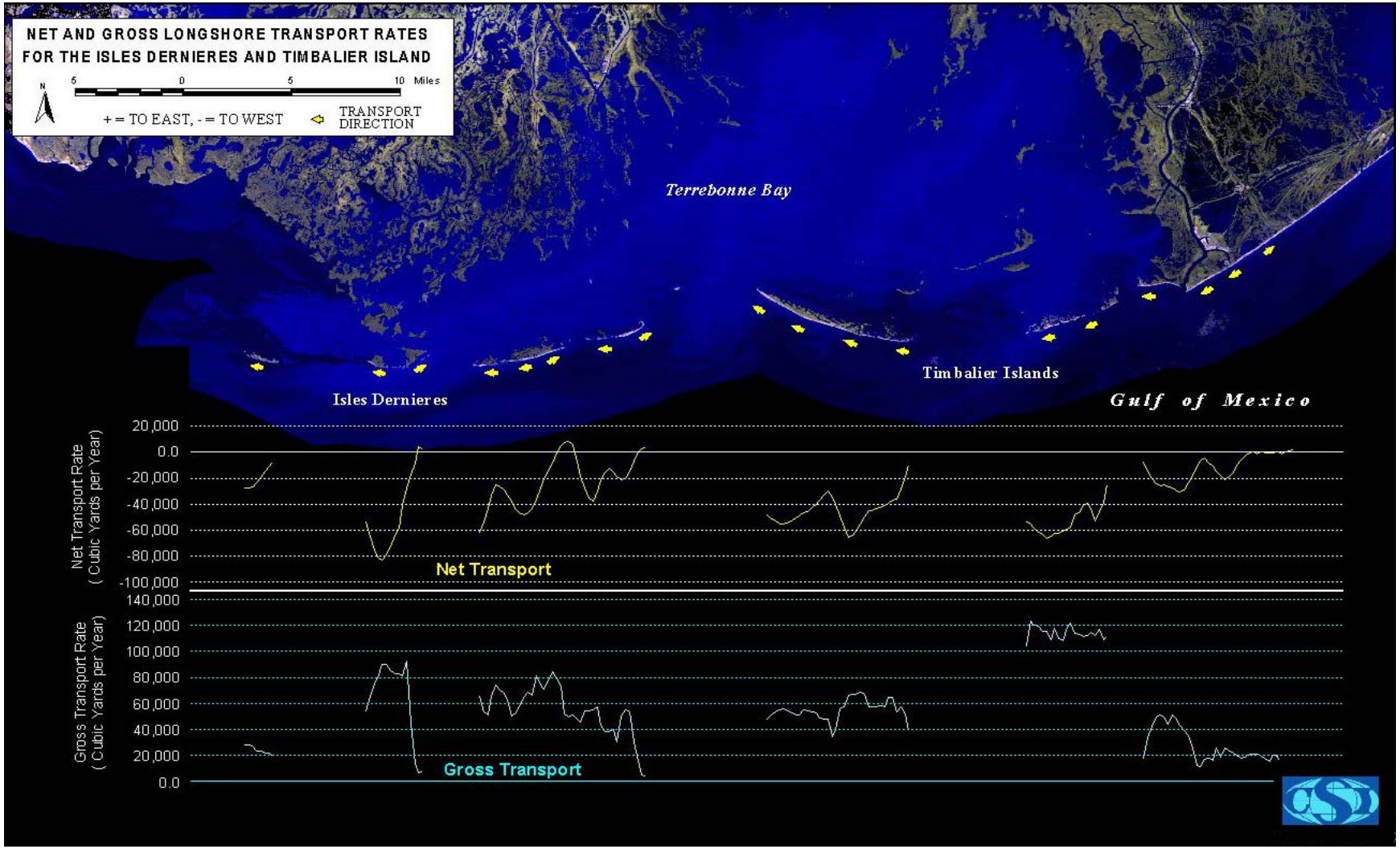

Figure 2. Net and gross longshore transport rates along the study area with longshore transport vectors indicating transport direction and cell location (Stone and Zhang 2001).

Project Features

The project boundary is divided into two sub-areas, Areas A and B, affecting approximately 739 acres (299 ha) of beach, vegetated dune, and marsh (Figure 3). Area A encompasses the area proposed to be restored through direct creation of dune and marsh on the east end of Timbalier Island. Area A currently consists of 254 acres (78 ha) of open water and 219 acres (81 ha) of beach, vegetated dune, and marsh. Area B currently consists of approximately 112 acres (45 ha) of land and 154 acres (62 ha) of open water. It includes the area enhanced through addition of sediment into the nearshore system maintaining the WNW migration of the island and attenuation of wave energy.

The eastern end of Timbalier Island will be restored by directly creating dune and marsh in Area A. Establishing sand fencing and planting vegetation will aid in the reduction of wind-driven sand loss. Sediment from Area A will naturally drift into Area B, maintaining the lateral migration of Timbalier Island. Sediment will be dredged from Little Pass Timbalier to a depth no deeper than 7.5 ft (2.29 m) below the existing bottom.

The constructed dune will have an elevation of +8 ft (+2.4 m) NAVD88 with a top width of 400 ft (121.9 m) and side slopes of 1 to 10 (T. Baker Smith & Son, Inc. 2001). The target range for construction of the marsh platform is 0.6 to 1.6 ft (0.18 - 0.49 m) NAVD88 with an average elevation of about 0.9 ft (0.27 m), a width of 800 ft (243.8 m). The marsh platform will be constructed so that the entire range of elevation is represented. Construction of the marsh platform in this manner should speed the development of tidal channels and ponds on the marsh platform and allow ingress and egress of marine organisms (T. Baker Smith & Son, Inc. 2002). Dune fencing will be placed laterally along the top of the dune. Spur fences will be placed at intervals perpendicular to the dune fence.

Spartina alterniflora, (Louisiana native smooth cordgrass), *Spartina patens* (saltmeadow cordgrass), *Panicum amarum var. amarum* (bitter panicum), and *Uniola paniculata* (sea oats) will be planted. The vegetation will bind the deposited sediments and assist in the accretion of wind blown sand.

Reference Area

It is not possible to identify an overall reference area, since other Louisiana barrier islands have all been restored to some extent. However, for the purpose of determining the effectiveness of methods to reduce the loss of sand from areas treated under this project, reference areas can be selected on Timbalier Island. These could include vegetated and non-vegetated natural dunes, vegetated created dunes, vegetated natural marsh, and non-vegetated created marsh. In this project, reference areas will not be selected because data from the Barrier Island Comprehensive Monitoring (BICM) plan may be considered reference data. BICM is a programmatic approach to monitor all of Louisiana's barrier islands using aerials and surveys. Project specific funding can now be used to investigate parameters such as sediments and tidal channel formation on Timbalier Island. Habitat elevations will be determined using LiDAR data, which is funded

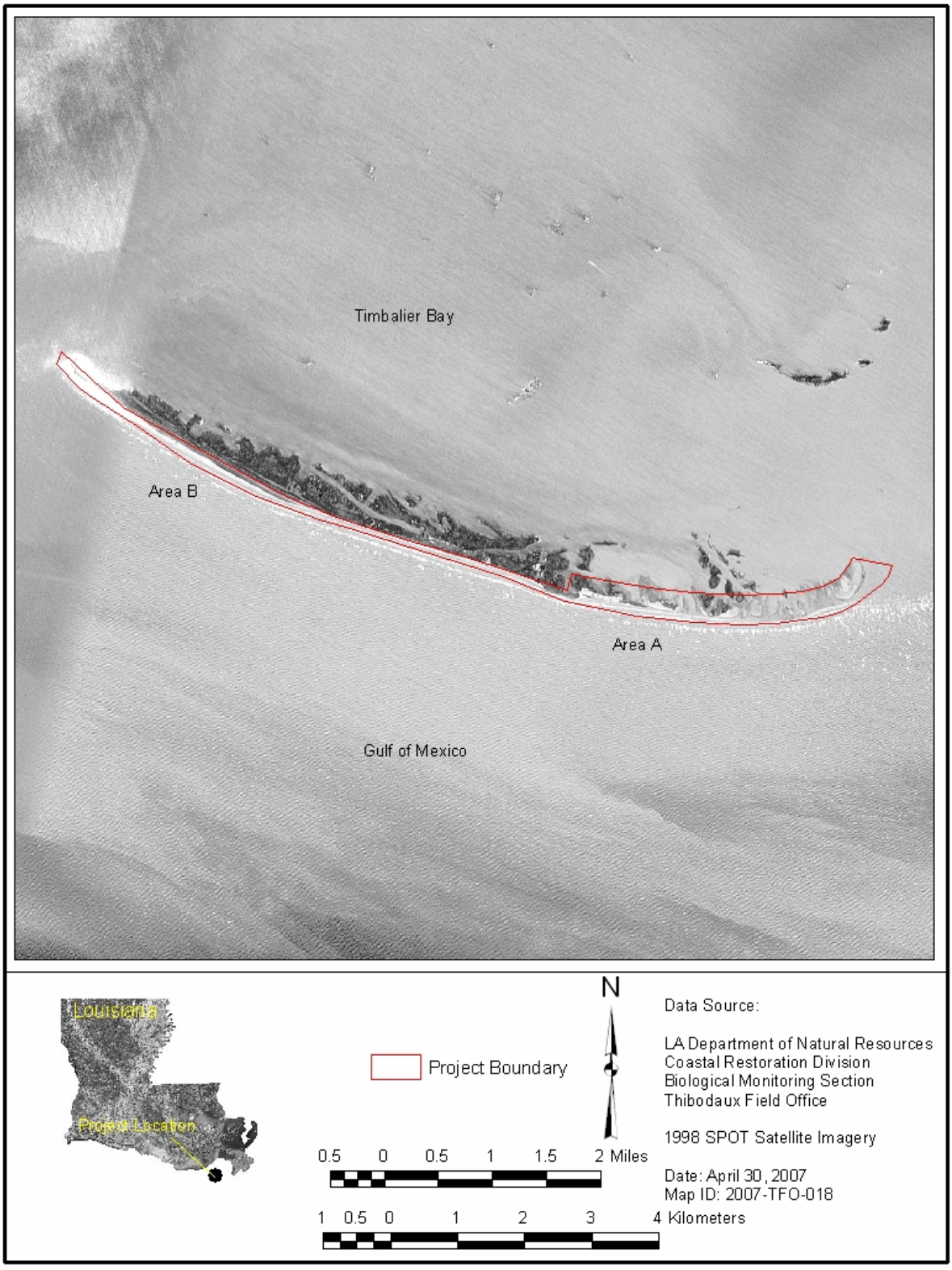

Figure 3. Timbalier Island Marsh/Dune Restoration (TE-40) Project: Areas A and B.

through other CWPPRA projects. Additionally, data from vegetation plantings exists from other similarly designed CWPPRA projects on barrier islands.

Monitoring Goals

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

1. Determine the area, average width, length, and position of Timbalier Island and the project area over time.
2. Determine the effectiveness of project features in reducing the rate of erosion as compared to historical rates of erosion and maintaining the littoral transport of the shoreline.
3. Determine sediment characteristics and their change over time.
4. Determine the evolution of tidal channel development.
5. Determine elevation and habitat classes in the project area.

Monitoring Strategies

1. Topography

LiDAR surveys acquired in March 2000, August 2001, and in October 2002 and 2006 will be utilized as the pre-construction standards for future changes in the island's dimension as well as post-construction. Topographic surveys were conducted in 2002, 2004 and 2005 as part of the project design and construction process. Additional LiDAR surveys will be conducted through BICM in 2011, 2016 and 2021. Data collected will be used to develop elevation models to compare elevation and volumetric changes. In 2007 and 2009, the monitoring budget will fund surveys of the constructed marsh platform to determine how tidal channels are forming and changing. Surveys will be conducted within a minimum of 3 randomly chosen 500 foot sections of the marsh platform. Transects will be established to match project stations and will be spaced 50 feet apart. Elevation points will be taken every 10 ft and along any significant elevation changes. This dense survey grid will determine micro-topographic changes within the marsh platform over time.

2. Bathymetry

Bathymetry surveys along Timbalier Island will be conducted and be timed to correspond with the collection of topographic data. The design and pre-construction surveys will collect information along transects 500 ft (152.4 m) apart. As-built surveys collected data along transects 100 ft (30.48 m) apart. BICM bathymetry data

		will be collected along transects every 1500 ft (457.2 m) on both the gulf and bay sides of the island. Gulf transects extend to 2 km offshore. Data will be collected along transects 4500 ft (1371.6 m) apart to 6 km offshore. The borrow sites will also be surveyed. Data collected will be used to determine change in elevation and volume. Bathymetry data was collected in 2002, 2004, 2005. BICM surveys were collected in 2006, and will be collected in 2011, 2016 and 2021. No funding from the project budget will be required.
3.	Aerial Photography	Near vertical, color-infrared aerial photography flown in 1996, 2002, 2004 and 2005 post- Hurricane Katrina and Rita will be available from BICM as the pre-construction standard for future changes in the island's dimensions, as well as immediate post storm effects. The photography will be georectified for land/water ratio using BICM standard operating procedures (Troutman et al., 2003). Analysis of the January 2005 (as-built) aerial photography obtained by EPA will be funded by the project budget. The 2006 aerials (post-construction) collected by EPA at a scale of 1:6000 were collected and will be analyzed through the project budget. The 2008 photography will be acquired through CRMS, funded through the project budget and analyzed in the same habitat classes as BICM. Habitat maps will be developed from this data and BICM to documents habitat and shoreline changes. Aerials will be obtained and analyzed in 2011 CRMS/BICM, and 2016 and 2021 CRMS/BICM.
4.	Sediment Properties/ Geotechnical	Grab samples or push cores will be collected at 7 locations along 5 cross-shore transects; back-barrier marsh, dune, berm, mean low water, depth approximately one third of depth of closure, depth approximately two thirds of depth of closure and depth of closure. The samples will be analyzed for sediment grain size, sorting, percent sand and fines, organic matter content and bulk density (Troutman et al., 2003). Sediment samples will be obtained in 2007, 2011, 2016 and 2021 through BICM. An additional sediment sample funded through the project budget will be collected in 2009 to augment the BICM data. Data collected will be analyzed to investigate the change in sediment composition over time.

Anticipated Statistical Tests

1. Descriptive and summary statistics for topography will be used to determine differences in mean elevations, habitat class, width and development and evolution of tidal channels as evaluated by an elevation model that will consider both spatial and temporal changes. The basic model will determine changes in island elevation, habitat classes, volume of island sediment, width of the project area after construction, and shoreline position.

   Goal: Re-build and stabilize a primary dune platform and back-swale using dredged material and sand fencing.

   Statement: The mean width of the project area after construction will be greater than or equal to the project design width. Mean height as well as elevation habitat classes above the intertidal area will be greater than pre-construction.

2. Descriptive and summary statistics for bathymetry will be used to determine differences in mean elevations, as evaluated by an elevation model that will consider both spatial and temporal changes. This basic model will determine changes in elevation, and the volume of sediment.

   Goal: Contribute to the restoration of the littoral drift of Timbalier Island.

   Statement: The sediment volume and average elevation will be greater post-construction than pre-construction.

3. Descriptive and summary statistics using the habitat map data will be used to determine changes in the habitat characteristics over time.

   Goal: To determine how the habitat characteristics of the eastern area of Timbalier Island change over time.

4. Descriptive and summary statistics using the geotechnical and sediment property data will be used to determine changes in the sediment content over time.

   Goal: To determine how the sediment properties of the eastern portion of Timbalier Island change over time.

Notes:

1.	Planned Implementation:	Start Construction:	July, 2004
		End Construction:	January, 2005
	EPA Point of Contact:	Patricia Taylor	214-665-6403
2.	DNR Project Manager:	Brad Miller	225-342-7549
	DNR Monitoring Manager:	Laurie Rodrigue	985-447-0996

3. The twenty year monitoring plan development and implementation budget for this project is $156,000.00. Comprehensive reports will be available in 2008, 2010, 2012 and 2018. These reports will describe the status and effectiveness of the project.

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