



**Coastal Protection and Restoration
Authority of Louisiana,
Office of Coastal Protection and
Restoration**

**2008 Operations,
Maintenance, and Monitoring
Report**

for

**WHISKEY ISLAND
RESTORATION**

State Project Number TE-27
Priority Project List 3

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Terrebonne Parish

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2008 Operations, Maintenance, and Monitoring Report
For
Whiskey Island Restoration (TE-27)

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I. Introduction

Whiskey Island is part of the Isles Dernieres barrier island chain and is located along the southern Louisiana coast in Terrebonne Parish at 29° 03' 00" N and 91° 48' 00" W (figure 1). The Isles Dernieres, which separate Terrebonne Bay, Lake Pelto, and Caillou Bay from the Gulf of Mexico, is a 20 mile (32 km) long island arc segmented into four islands: Raccoon Island, Whiskey Island, Trinity Island, and East Island (McBride et al. 1989). Like all of Louisiana's barrier islands, Whiskey Island is experiencing island narrowing and land loss as a consequence of a complex interaction among global sea level rise, compaction subsidence, wave and storm processes, inadequate sediment supply, and significant anthropogenic disturbances (Penland et al. 1988, McBride et al. 1989, Penland and Ramsey 1990, List et al. 1997).

The Louisiana deltaic plain is fronted by a series of headlands and barrier islands that were formed as a result of the Mississippi River deltaic cycle. The Isles Dernieres is a barrier island arc transformed from the abandonment of the Caillou headland (part of the Lafourche delta complex), which occurred approximately 500 years B.P. (Frazier 1967, Penland and Boyd 1985). Barrier islands formed after delta lobe abandonment and marine processes reworked delta sands into barrier beaches. Submergence of the abandoned delta separated the headland from the shoreline forming a barrier island arc. The transgressive island arc cannot keep pace with the high rate of relative sea level rise and will eventually become an inner-shelf shoal (Penland et al. 1988).

Currently, the Isles Dernieres arc is exhibiting some of the highest rates of erosion of any coastal region in the world (Khalil and Lee 2006). Erosional models have estimated that the Isles Dernieres would gradually narrow, fragment, and transgress through time eventually becoming subaqueous sand shoals between 2007 (McBride et al. 1991) and 2019 (Penland et al. 1988) unless restoration efforts are made. Shoreline erosion along the Gulf side of the islands averages 53.5 ft/yr (16.3 m/yr), with some episodes of erosion causing a loss of as much as 98.8 ft/yr (30.1 m/yr). Bayside erosion is reduced, averaging 5.6 ft/yr (1.7 m/yr) with a maximum of 10.8 ft/yr (3.3 m/yr). Land loss resulted when repeated storm impacts depleted the limited barrier sand reservoir and washed sands into tidal inlet and inner-shelf sinks. These conditions have led to the rapid landward migration (barrier island rollover) and disintegration of the Isles Dernieres as well as a decrease in the ability of the island chain to protect the adjacent mainland marshes and wetlands from the effects of storm surge, saltwater intrusion, an increased tidal prism, and energetic storm waves (McBride and Byrnes 1997).

The inter-tidal zone on Whiskey Island's Gulf of Mexico side consists of a marsh peat platform that has been exposed by shoreline erosion. Above high tide level there is a mixture of sand and broken shells. With the exception of isolated, ring-shaped dunes (normally 2.3 ft [70 cm] high and 22.97 ft [7 m] in diameter), the surface consists of a bare washover flat with notable salt incrustation on the north side. The eroding central part of this island consists of a layer of bare sand and shell on the marsh peat platform (Ritchie et al. 1989). Soil types in the

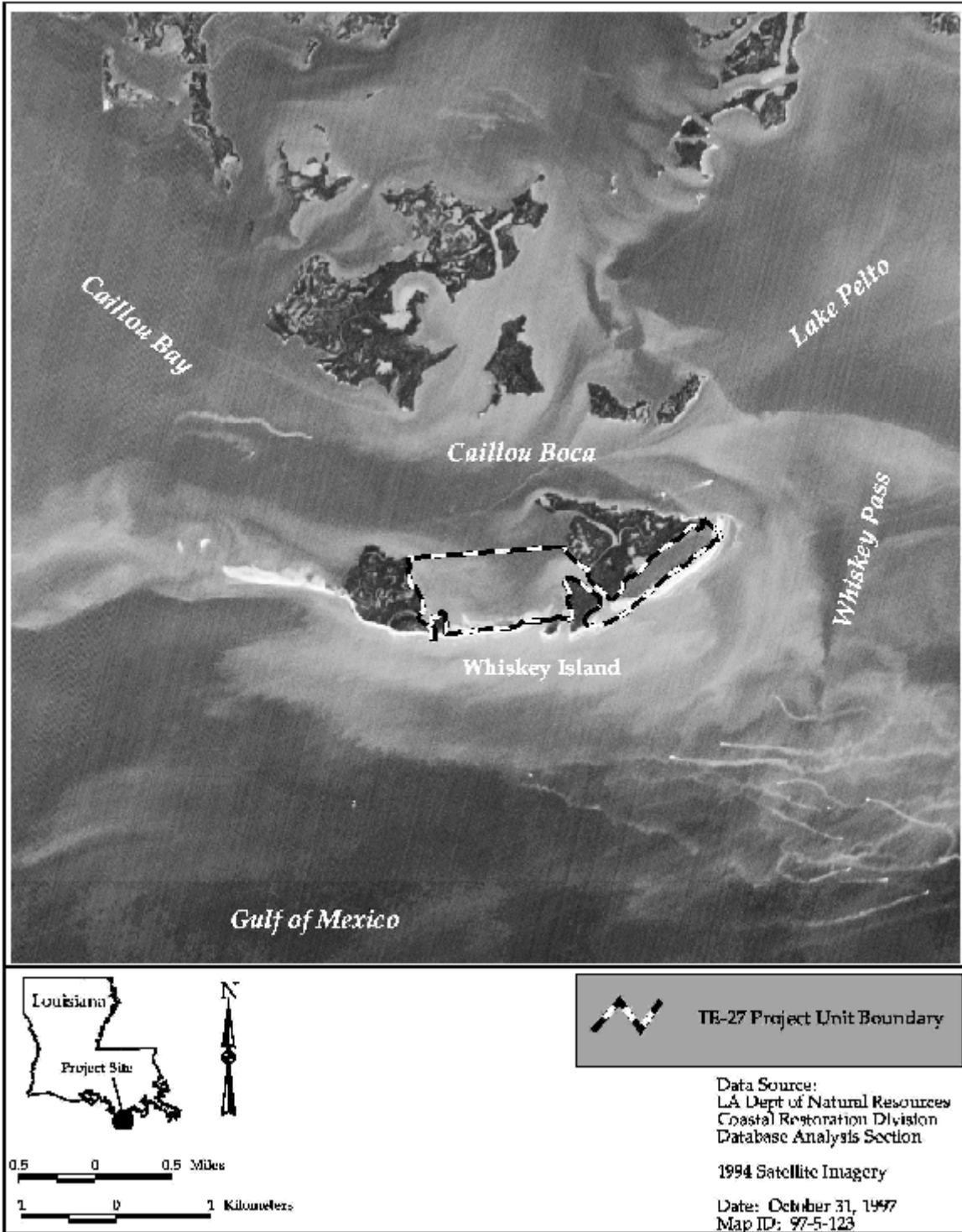


Figure 1. Whiskey Island, Terrebonne Parish, Louisiana, showing fill area.

project area are the sand beaches and the salt water marsh, clays and mucky clays (U.S. Soil Conservation Service 1960). Fine sand and shells distributed as the result of wave and wind action compose the sand beaches (Sc) soil type. The sediments may be from other beaches that have eroded or from the floor of the Gulf of Mexico. On Whiskey Island, extending inland of the sand beaches soil type is the salt water marsh, clays and mucky clays (Sa) soil type. This soil type consists of alluvial sediments which, through time, have been reworked by waves and tides. They occur at near-gulf level and are frequently flooded by normal tidal action. The sediments may be covered by several feet of salt water and transported inland during strong wind and/or storm events.

The Whiskey Island Restoration (TE-27) project was constructed through the Coastal Wetlands, Planning, Protection, and Restoration Act (CWPPRA, Public Law 101-646, Title III) and is administered by the U.S. Environmental Protection Agency (EPA) and the Office of Coastal Protection and Restoration of Louisiana (OCPR, formerly the Louisiana Department of Natural Resources, Office of Coastal Restoration and Management). The project included the creation of approximately 355 acres (177 ha) of supratidal (beach, dune, barrier flat) and intertidal (beach, marsh) habitat using sediments dredged from Whiskey Pass (figure 2). Target elevations ranged from +1 ft (0.3 m) to +4 ft (1.2 m) North American Vertical Datum of 1988 (NAVD 88). Vegetation was planted along the artificial fill surface to establish a protective cover that would facilitate fill stabilization as well as minimize wind-driven transport. Planted vegetation included *Spartina alterniflora* (smooth cordgrass), *Spartina patens* (marshhay cordgrass), *Panicum amarum* (bitter panicum), and *Avicennia germinans* (black mangrove). Construction of the Whiskey Island Restoration project commenced in February 1998 and was completed in the spring of 1999. The first phase of construction included hydraulic dredging of sediments from Whiskey Pass using a 30" Cutter Head Suction Dredge (7,200 hp) and Booster Pump Barge and was completed in late summer 1998. Approximately 2.9 million yd³ (2.2 million m³) of sediment were dredged from Whiskey Pass (borrow area) and placed on Whiskey Island (figure 2). Most of the dredged material was placed landward of the gulfside beach to restore the back-barrier portion of the island. Some material, however, was pumped onto the existing beach along the central portion of the island, in the vicinity of several breaches, as well as along the eastern section of the island near Coupe Nouvelle (figure 2).

The second phase of construction was conducted in the spring of 1999 and included the planting of several native species of vegetation along the newly restored dune terrace and back-barrier beach. In total, 14,200 *S. alterniflora*, 9,333 *S. patens*, 9,333 *P. amarum*, and 1,625 *A. germinans* were planted. The first vegetation sampling was conducted August 24 and 25, 1999 and additional vegetation sampling occurred September 19-20, 2001, September 15, 2003 and October 8-11, 2007.

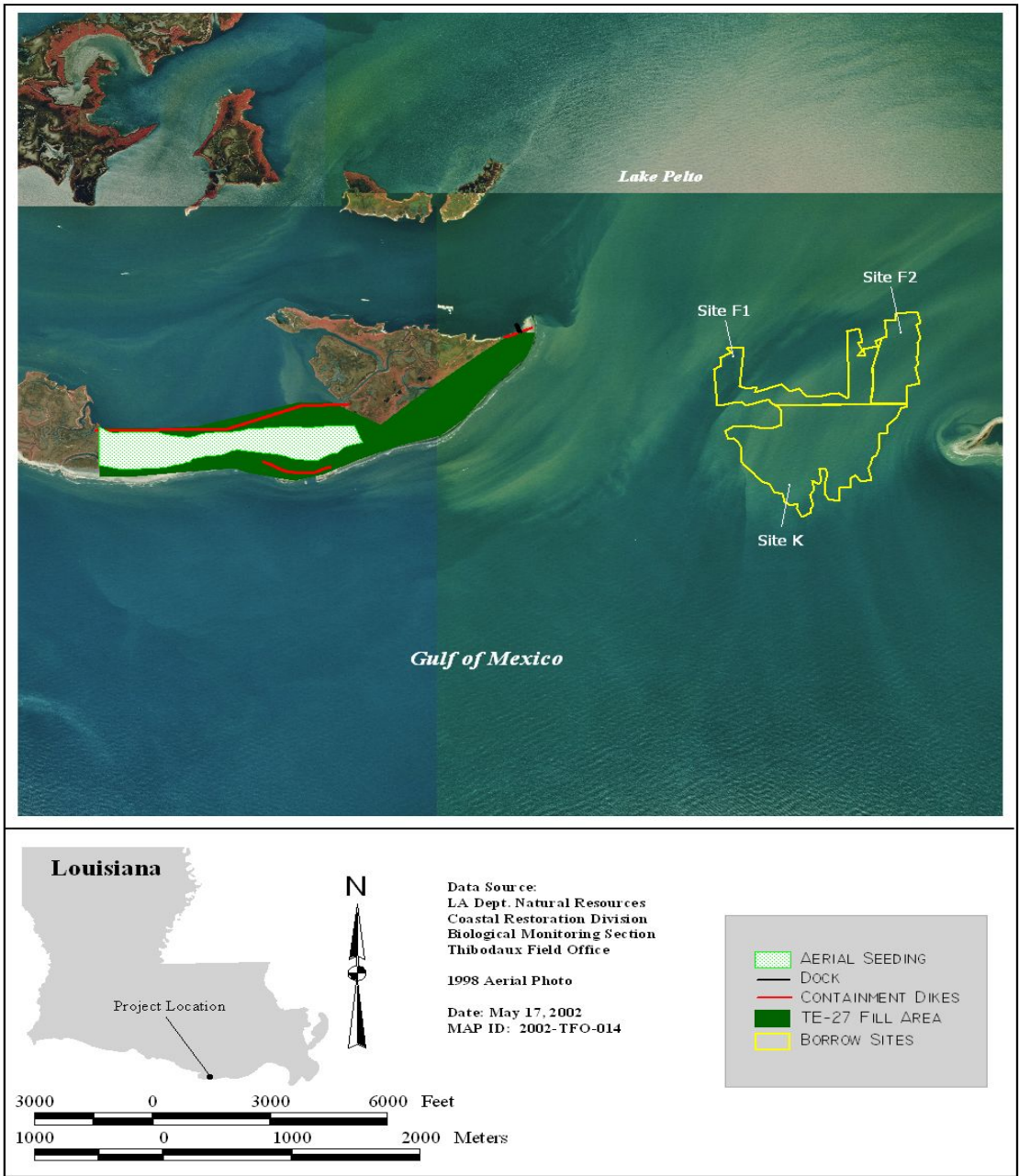


Figure 2. Project construction area, associated structures, and borrow sites for the Whiskey Island Restoration (TE-27) project.

II. Maintenance Activity

Over the past decade, numerous barrier island and headlands projects have been or are being restored by the state and their federal partners through the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) and other funding sources (Lindquist and Martin 2007). Unfortunately, scheduled maintenance of these projects has not been incorporated into their design or funding (Lindquist and Martin 2007). To account for the programmatic maintenance needs of the barrier islands and headlands, the state has implemented the Barrier Island Maintenance Program (BIMP) through House Bill 429, Act No.407, outlining the process by which the OCPR would annually develop a priority list of projects to be submitted to the House and Senate Committee on Natural Resources (Lindquist and Martin 2007) These projects would be funded by the Barrier Island Stabilization and Preservation Fund established to provide appropriations, donations, grants and other monies for the program. BIMP was created to coordinate and fund restoration barrier shorelines in Louisiana and formulate a much needed component of maintenance planning for existing projects without funding (Lindquist and Martin 2007). With the implementation of the BIMP, the state has also begun performing annual inspections of barrier island projects constructed under the CWPPRA program.

The most recent annual inspection conducted on Whiskey Island was completed on September 10, 2007. This inspection included the visual observations of the entire island features and collection of GPS points along established stations from the existing shoreline to the back barrier marsh. While finalizing the 2008 Operation, Maintenance and Monitoring report, Hurricanes Gustav and Ike severely impacted southern Louisiana, including the barrier island chain in Terrebonne Parish. As a result of the 2008 Hurricanes, CWPPRA authorized the Storm Recovery Contingency Fund to perform post-storm inspections of all constructed CWPPRA projects. The post-storm inspection of the Whiskey Island project was performed on September 24, 2008 and was attended by both OCPR and LDWF representatives. With the completion of the damage assessments and reports, recent up-to-date information such as general observations, photos, deficiencies, recommendations and estimated costs for repairs were obtained that will assist in estimating shoreline erosion and calculating volume changes along the island over the past year, pre and post storm. Committed to providing the most recent data in the OM&M reports, we have incorporated the data and subsequent analysis obtained from the 2007 annual inspection and 2008 damage assessment report into this OM&M report.

On September 24, 2008 a damage assessment over flight was conducted by a representative of the OCPR. The assessment began at approximately 3:00 pm and proceeded from the eastern tip of the island westerly to the islands end. Location of the shoreline was established with GPS during the 2007 inspection at several locations. This information will allow us to determine the shoreline change over the past year and with the Barrier Island Comprehensive Monitoring (BICM) Program shoreline change data determine any impacts from the Hurricanes (Figure 3). Below are general observations made during the damage assessment

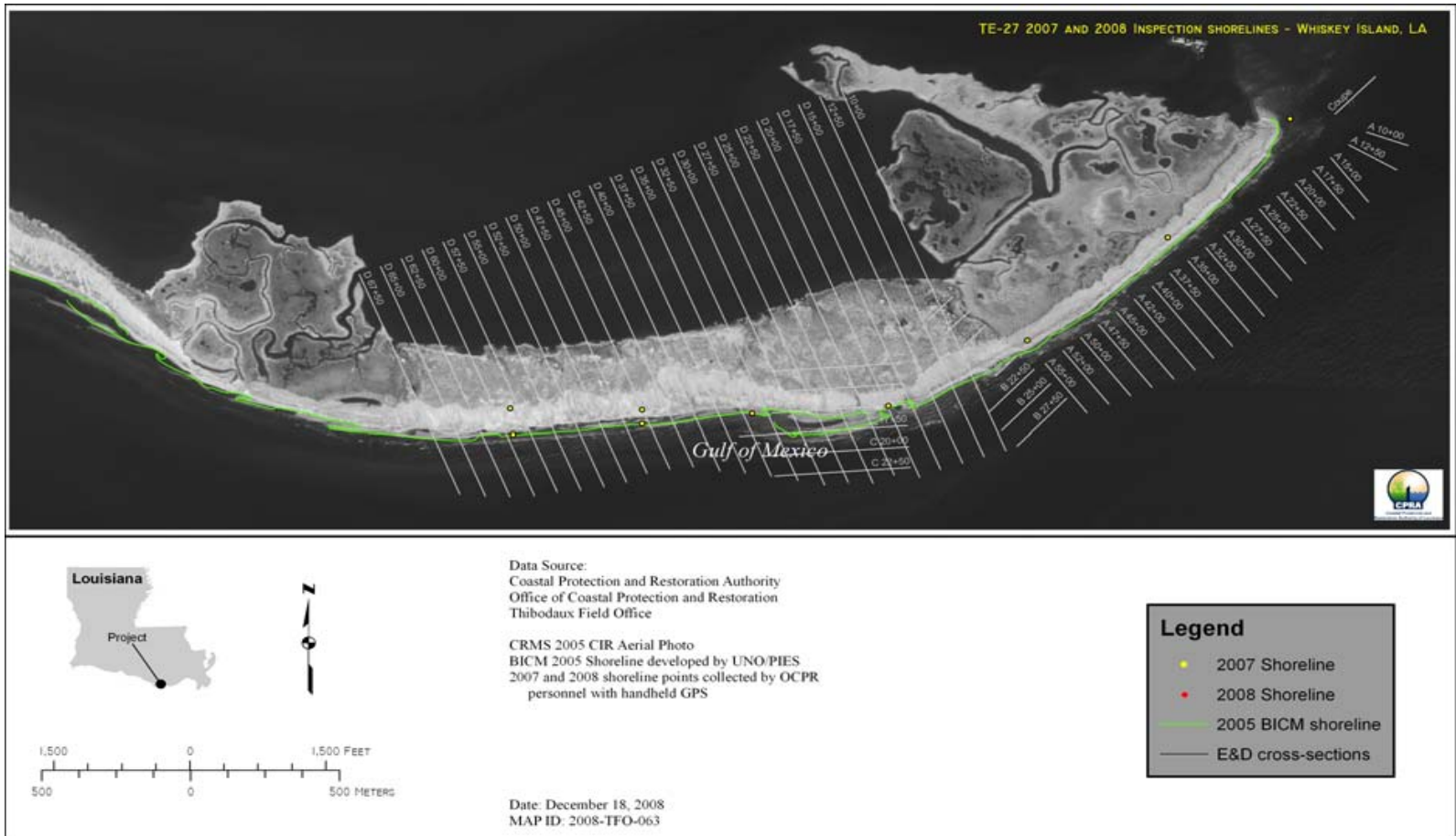


Figure 3. 2007 shoreline positions obtained during the annual inspection along with the BICM 2005 shoreline for the Whiskey Island (TE-27) project.

and costs for possible corrective actions. Photos taken during the assessment are found in Appendix A.

Observations of structure features which sustained damage:

1. Overall, the island showed shoreline erosion as the only damage. No breaches were observed and the dune feature did roll back in most instances where widths were wide enough to capture the sediment. Also, vegetation was salt burned, but these features are natural and should recover with rains and time.
2. Shoreline erosion was estimated from the photographs taken in 2007 and again post-hurricane. Locations of change were identified and measurements were made to determine erosion in those locations. The average erosion measured since the 2007 inspection was approximately -189.8 ft. BICM data shows an average erosion rate of -62.2 ft for this portion of the coast in the last decade (1990's to 2005) and -181.4 ft of erosion between 2004 and 2005 (Hurricanes Katrina and Rita). Removing the short-term erosion rate from that measured gives us an erosion rate of -127.4 ft. This is conservative since the BICM short-term erosion rate includes the 2005 hurricanes within it, which increases the average significantly. However, this also confirms that these storms caused erosion that approached or exceeded the 2005 Hurricanes (Katrina and Rita).
3. Repairs of hurricane impacts to the dune and beach features of the CWPPRA project would be completed through hydraulic dredging of appropriate sediment to replace that lost through shoreline erosion. With approximately 102 ft² of sediment removed from 3,601 ft of beach, we would need to replace 13,603 yd³ of sediment.

Estimated Project Budget:

Construction:

Mobilization and Demobilization: Lump Sum	\$3,000,000	
Hydraulic Dredging: (262,000 cu yd) @ \$15.00/cu. yd	\$ 204,045	
Sand Fencing: (2,000 linear ft.) @ \$15.00/ft	\$ 30,000	
Surveying: (Lump Sum)	<u>\$ 20,000</u>	
Construction Costs:	\$3,254,045	
Contingency (25%)	\$ 813,511	
Total Construction plus Contingency:		\$4,067,556

Professional Services:

Engineering and Design:	\$245,553	
Surveying:	\$ 30,000	
Construction Admin:	\$ 7,500	
Inspection:	<u>\$ 19,500</u>	
Total professions Services:		\$ 302,553

Total Estimated Project Budget: \$4,370,109

III. Operation Activity

This project has no operations and maintenance budget and no operations are required.

IV. Monitoring Activity

a. Monitoring Goals

The objectives for the this project are to strengthen and stabilize Whiskey Island through sediment addition and vegetative growth which will maintain the protective barrier between the Gulf of Mexico and the lower Terrebonne Basin estuary system.

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

1. Increase the elevation and width of Whiskey Island using dredged sediments.
2. Reduce loss of dredged sediments through the growth of vegetation.

b. Monitoring Elements

Due to the morphological changes since the last sampling event in 2003 and the inception of the BICM program, the data collection methods deviated from the July 23, 1998 monitoring plan. The following monitoring elements provide the methods used to gather the vegetation data in 2007 and the information obtained from the BICM program which was used to evaluate the specific goals of the project listed above.

Elevation

Topographic and bathymetric surveys were employed to document elevation and volume changes inside the Whiskey Island Restoration (TE-27) project fill area. Pre-construction (1997) and as-built (1998) elevation data were collected using traditional cross sectional survey methods. Subsequent post-construction topographic surveys were conducted using Light Detection and Ranging (LiDAR) procedures (Brock et al. 2002). These post-construction surveys were performed in 2000 (John Chance Land Surveys, LTD), 2001 (USGS), 2002 (USGS), and 2006 (USGS). The latter survey and a separate bathymetric survey were funded through the BICM program in 2006 (Troutman et al. 2003). The bathymetric survey (USGS) recorded subaqueous elevations in the shoreface, inlet, and bay regions surrounding Whiskey Island. The 2006 LiDAR and bathymetric surveys were joined to form a single continuous elevation contour of this barrier island. All survey data were established using or adjusted to the Louisiana Coastal Zone (LCZ) GPS Network. This network of secondary monuments were created and maintained by the LDNR/CED. The 2001 and 2002 LiDAR data were not applied to the following analysis because these surveys were not filtered for vegetation. The results of the data analysis for these two data sets are published in West and Dearmond (2004). 2000 and 2006 LiDAR data

were filtered for vegetation and present a more accurate illustration of island topography.

The 1997, 1998, 2000, and 2006 survey data were re-projected horizontally and vertically to the UTM NAD83 coordinate system and the NAVD 88 vertical datum in meters using Corpscon[®] software. The re-projected data were imported into ArcView[®] GIS software for surface interpolation. Triangulated irregular network models (TIN) were produced from the point data sets. Next, the TIN models were converted to grid models (2.0 m² cell size), and the spatial distribution of elevations were mapped. The grid models were clipped to the TE-27 fill area polygon to estimate elevation and volume changes within the fill area.

Elevation changes from 1997-1998, 1998-2000, and 2000-2006 were calculated by subtracting the corresponding grid models using the LIDAR Data Handler extension of ArcView[®] GIS. After the elevation change grid models were generated, the spatial distribution of elevation changes in the TE-27 fill area were mapped in half meter elevation classes. Lastly, volume changes in the fill area were calculated in cubic meters (m³) using the Cut/Fill Calculator function of the LIDAR Data Handler extension of ArcView[®] GIS. Note, these elevation and volume calculations are valid only for the extent of the survey area.

Shoreline Change

The use of ESRI[®] ArcMap[™] data collected as part of the as-built survey which defined the fill area, detailed field notes from the October 2007 vegetation data collection sampling, and the coordinates associated with the random numbers along the of vegetation transects allowed the measurement of shoreline change from project completion (late summer 1998) to October 2007. These measurements are only as accurate as the information collected through the surveying of the project features at the end of construction and the accuracy of the Trimble GeoXT GPS unit (sub-meter). The calculated shoreline change was measured using the ESRI[®] ArcMap[™] shapefile created from the survey data and the first random point with vegetation along the transect from the gulf side of the project area and the last point encountered with the presence of vegetation along the transect on the bay side. The distance was measured in ESRI[®] ArcMap[™] at a scale of 1:1,200.

Vegetation

1999-2003 Sampling

Species composition and percent cover of vegetation were determined in 1999, 2001 and 2003 using the Braun-Blanquet method (Mueller-Dombois and Ellenberg 1974; Folse and West 2005). The purpose of the initial vegetation sampling scheme was to sample the planted and unplanted areas to monitor planting success. The methods and results for the interval from 1999 to 2003 are described in West and Dearmond (2004).

2007 Sampling

Prior to the October 2007 event, previously sampled stations were superimposed on the 2005 Digital Orthophoto Quarter Quadrangle (DOQQ) photography and determined that the stations established bay and gulf side had been consumed by erosion (figure 4). This observation was confirmed during the first annual operations and maintenance inspection trip for barrier islands which took place on September 10, 2007. Because previously established stations were no longer accessible, a new sampling scheme was developed which would allow for future sampling, if necessary. The new sampling scheme catalogued the species found on the island, but did not sample to monitor planting success. Using the existing BICM bathymetric survey lines and ESRI® ArcMap™ software, lines (transects) were extended across the island. These transects were spaced 1500 feet apart (figure 5). Coordinates were generated every two (2) meters along each transect and assigned a numerical value to facilitate the random selection process when establishing stations in the field. Files generated in ArcMap™ were then transferred to a DGPS with sub-meter accuracy.

On sampling day (October 7-10, 2007), transects were located by field personnel using the Trimble GeoXT unit. Five stations per transect were randomly chosen in the three (3) different regions of the transect. On the September 2007 trip, it was determined that the project had 3 different geomorphic regions: upslope, swale, and marsh. On Whiskey Island, the upslope region consists of the area closest to the Gulf of Mexico, where the sand/water interface begins, rising upward in elevation until reaching the remnants of the constructed platform. The swale region is the area on the back side of the platform, sloping down to the marsh. The marsh region begins as the swale decreases in elevation as it nears the bay side of the island. Each region has a unique composition of emergent vegetation.

When a transect was located, the team identified the first point at the edge of the vegetation in the upslope region, then walked through the upslope region until it transitioned into the swale region, where an additional point was collected. The team continued until the transition from swale to marsh, if it existed, and collected a point. All three regions did not exist along all transects. The team then decided how to divide the number of stations per region and then randomly selected the stations in each. Stations were then marked for the sampling teams with a PVC pole. Two additional teams sampled alternating plots along the transects using the Braun-Blanquet method (Mueller-Dombois and Ellenberg 1974) as described in Folse and West (2005). Plots were oriented in a North-South direction. Species in 4-m² plots were recorded, and visual estimates of percent cover for the total plot and individual species were made. Cover classes used were: solitary, <1%, 1-5%, 6-25%, 26-50%, 51-75%, and 76-100%. Vegetation outside of each plot but within 15 feet were also identified and recorded.

Based on time and budget constraints, it was determined that five (5) stations per transect would be appropriate. The 5 stations per transect were divided amongst the regions based on the length of the region. Table 1 provides the number of stations per

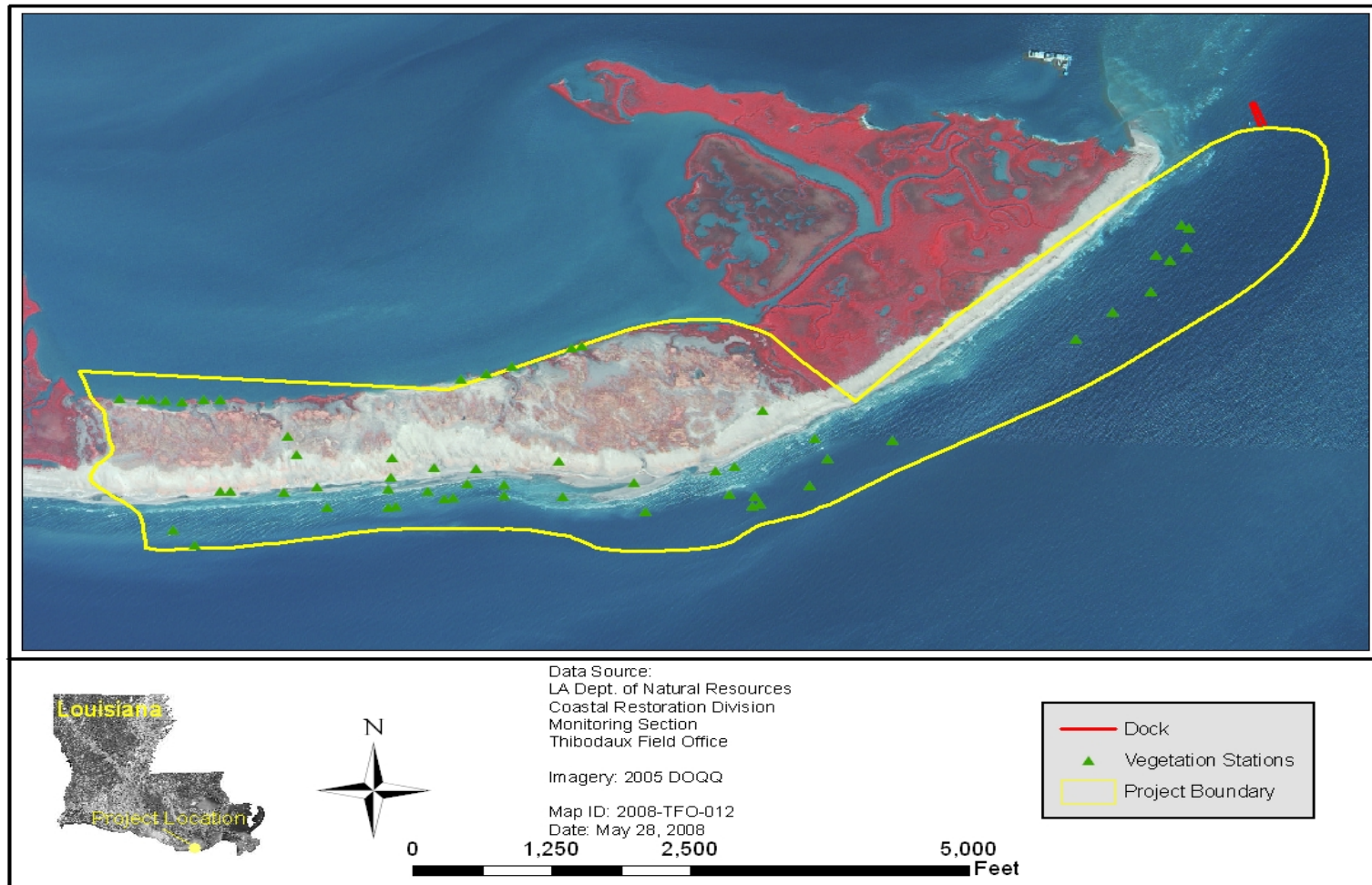


Figure 4. Vegetation sampling stations established prior to 2007 consumed by erosion at Whiskey Island Restoration (TE-27) project.

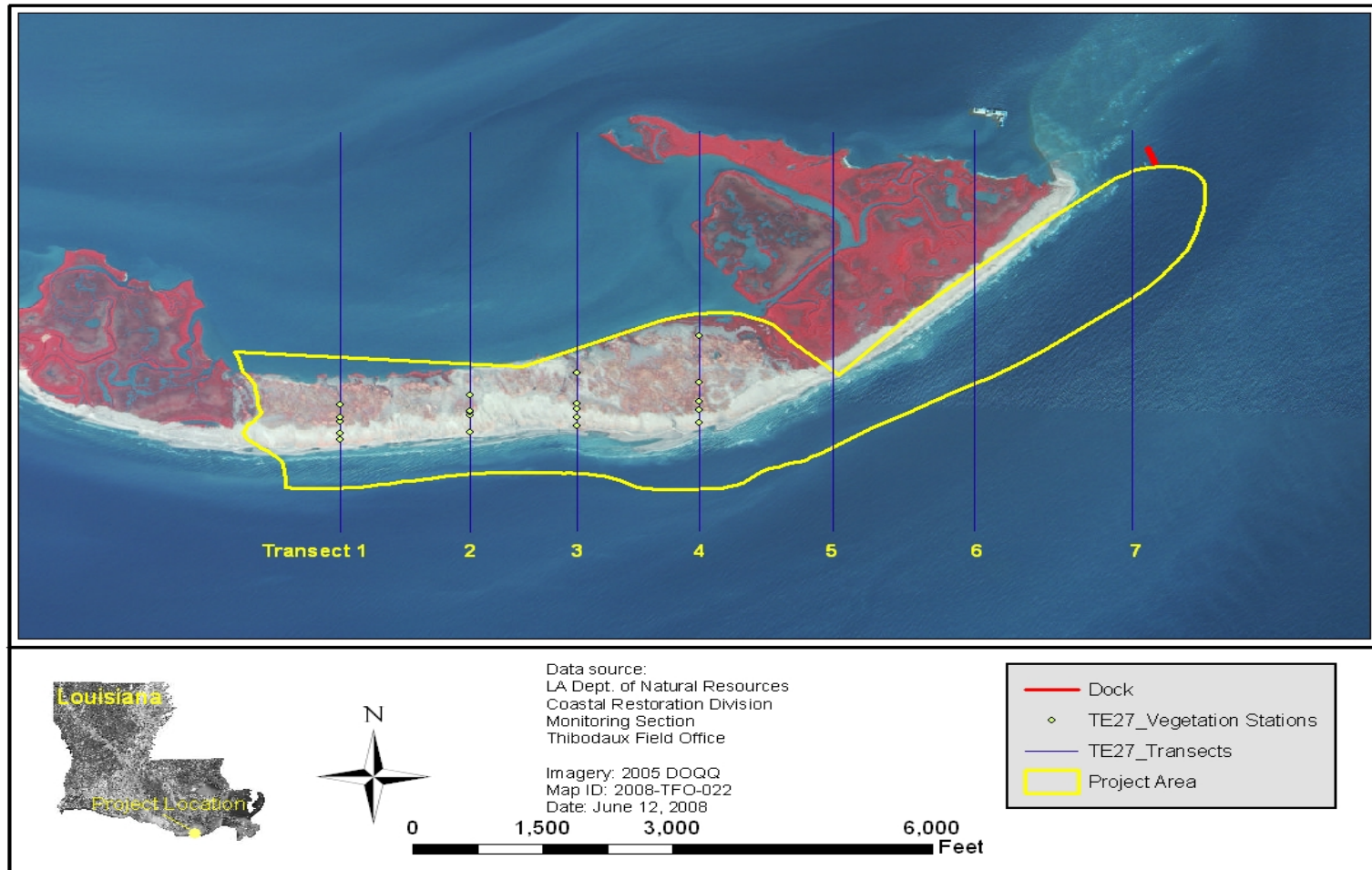


Figure 5. Vegetation transects and plots for the 2007 sampling scheme at the Whiskey Island Restoration (TE-27) project.

region for transects 1-4. A total of 20 stations were sampled. Transects 5-7 were not sampled due to the lack of emergent vegetation along the transects within the project boundary. Mangroves were present along the transects outside of the project boundary.

Table 1. Number of stations per region for each sampled transect.

Transect	Number of Upslope Stations	Number of Swale Stations	Number of Marsh Stations
1	2	3	0
2	2	3	0
3	2	3	0
4	1	3	1
Total	7	12	1

The 2007 data were grouped by region and by transect to determine the relative mean percent cover for each species. Bare ground was included as a separate species. The relative mean percent cover was calculated by summing all the individual percent cover values for each species for the region or transect depending on the analysis. Then the percent cover for each individual species is divided by the summation of the all species and multiplied by 100. This gives the relative percent cover for each species. When each relative percent cover for each species is summed the total is 100 percent. The data analysis was generated using SAS software. Copyright, SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

Habitat Mapping

Habitat mapping has been determined for Whiskey Island for 1996, 2002, 2004 and 2005 through the BICM program. The goal of BICM’s habitat change analysis is to classify and compare the habitat types present along Louisiana’s sandy shorelines for the four time periods. The habitat mapping was completed by the University of New Orleans Ponchartrain Institute for Environmental Sciences (UNO/PIES).

Habitat mapping consisted of six steps to acquire the final product. Briefly, these steps included: (1) Mosaicking which created a complete image of the shoreline / island to be classified, (2) Clipping, which removed the surrounding water from the image, (3) Creating Signatures, which defines the spectral values of each habitat class, (4) Supervised Classification, which is the classification of the mosaic based on collected signature or Unsupervised Classification partitions the mosaic into a user defined number of spectral classes, (5) Manual Cleaning, which is the final differentiation between habitat classes, and (6) Final Classified Image. These steps utilize Erdas Imagine version 9.1 software and ArcGIS version 9.2 software. More detailed methods are found in Fearnley et al. (2009).

c. Preliminary Monitoring Results and Discussion

Elevation

Dramatic changes have occurred to the Whiskey Island Restoration (TE-27) project fill area since construction was completed in 1998. Elevation change and volume distributions for the TE-27 fill area are shown in figure 6 (1998-2006). Elevation change and volume distributions for 1997-1998, 1998-2000, and 2000-2006 are provided in Appendix B. Approximately, 1,978,079 yd³ (1,512,350 m³) of sediment were deposited during construction in 1998. In the post-construction period, sediment volume in the fill area decreased by 19% from 1998 to 2000 and 116% from 2000 to 2006. The total sediment volume loss in the fill area from 1998 to 2006 was approximately 2, 462, 583 yd³ (1,882,780 m³), a 125% reduction in volume.

The primary cause for this large sediment loss inside the fill area is the rapid northwestern movement of the eastern part of Whiskey Island leaving an estimated 135 acres (55 ha) subaqueous. Moreover, segments of Whiskey Island have transgressed over 1000 ft (305 m) since construction. Although the volume in the fill area has decreased considerably, portions of the sand and sediment resources were conserved outside the fill area. The well documented westward drifting longshore transport (Stone and Zhang 2001; Georgiou et al. 2005; Peyronnin 1962) and tropical storm induced shoreline erosion (Peyronnin 1962; Stone et al. 1997; Stone et al. 1993; Georgiou et al. 2005) probably produced the change in shoreline position. West and Dearmond (2004) and Georgiou et al. (2005) reported volume losses on Whiskey Island after the passage of Tropical Storm Isidore and Hurricane Lilli in 2002. Hurricane Katrina (August 2005) and Hurricane Rita (September 2005) also altered the geomorphology of Whiskey Island by causing shoreline transgressions in the fill area (Barras 2006).

Elevation grid models for the 1997, 1998, 2000, and 2006 surveys are featured in Appendix C. The pre-construction (1997) elevation grid model shows a minimum elevation of - 1.27 m (4.16 ft) and a maximum elevation of 1.40 m (4.59 ft). The as-built (1998) model shows a minimum elevation of 0.21 m (0.68 ft) and a maximum elevation of 2.23 m (7.31 ft). The 2000 elevation grid model shows a minimum elevation of -0.49 m (1.60 ft) and a maximum elevation of 1.82 m (5.97 ft). The 2006 elevation grid model shows a minimum elevation of -3.57 m (11.71 ft) and a maximum elevation of 1.67 m (5.47 ft).

Shoreline Change

In table 2 the average rate of shoreline loss for Whiskey Island was calculated using the total distance divided by the eight (8) years between the survey and the 2007 data sampling period. Transects 5 and 6 contained no vegetation within the project fill area

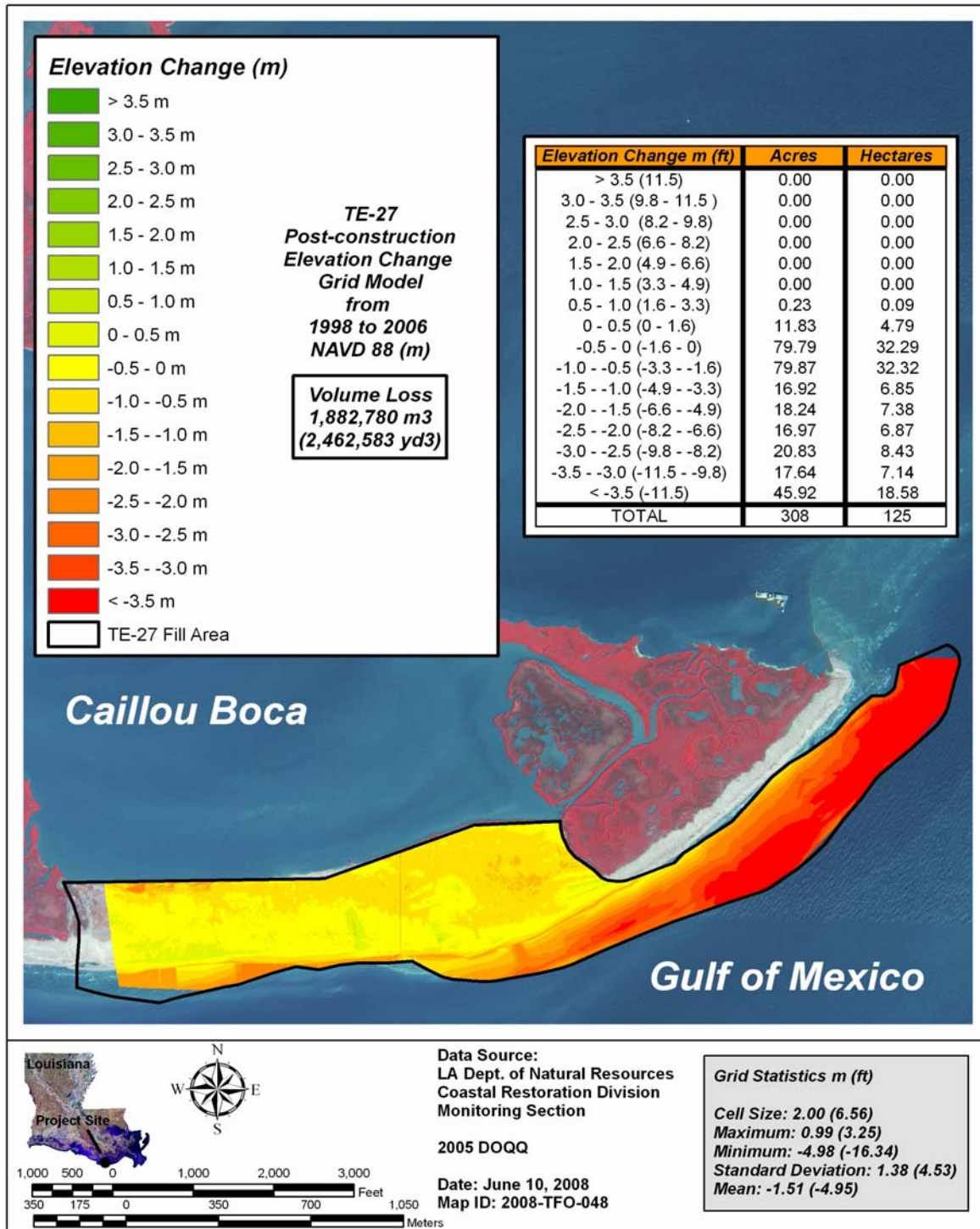


Figure 6. Elevation change and volume distributions for the Whiskey Island Restoration (TE-27) project fill area

on the Gulf side; however, pre-existing mangroves are still present in the marsh area north of the project boundary. However, field observations are showing as the island gets overwashed during high water events, sediment is moving into the existing mangroves and causing mortality. Mangroves were observed 260 feet north of the northern boundary of the fill area in transect 5. Mangroves were observed 555 feet north of the northern boundary of the fill area in transect 6. Transect 7 no longer has any island remnants in the project's fill area or north of the project's boundary.

Table 2. Gulf side and bay side shoreline change and average rate of shoreline change for the project area.

Transect	Gulf Side	Bay Side	Gulf Side	Bay Side
	Shoreline Change: As-Built to Oct. 2007 (Feet)	Shoreline Change: As-Built to Oct. 2007 (Feet)	Avg. Rate of Shoreline Change: As-Built to Oct. 2007 (Feet per year)	Avg. Rate of Shoreline Change: As-Built to Oct. 2007 (Feet per year)
1	-495	-170	-61.9	-21.3
2	-225	-40	-28.1	-5
3	-285	-260	-35.6	-32.5
4	-545	65	-68.1	8.1
5	-1035 ^a	*	-129.4	*
6	-1825 ^a	*	-228.1	*
Average	-735	-101	-91.9	-12.7

a Vegetation line begins north of fill area or project boundary.

* Existing marsh north of project fill area at time of construction.

As part of the BICM program, shoreline change analysis was performed along Whiskey Island as well as the entire Louisiana coastal shoreline. Documents show the rate of shoreline change on Whiskey Island in average feet per year for four (4) different time periods. Data is shown in table 3. The 2004-2005 rate is associated with the passing of Hurricanes Katrina and Rita. The rate of erosion has increased over the last century. The shoreline change values in table 1 appear to be within the accuracy of information published through the BICM program.

Table 3. Shoreline change rate comparison for different period ranges between Whiskey Island and the Isles Dernieres island chain.

	1800's-2005	1920-2005	1990's-2005	2004-2005
Whiskey Island	-52.1	-57.1	-62.2	-181.4
Isles Derniers	-34.1	-34	-32.9	-124.3

Average shoreline change for the Isles Dernieres was derived from BICM documents by combining the average shoreline change in feet per year of the 4 islands in the chain, Raccoon Island, Whiskey Island, Trinity Island and East Island and then dividing by four (4). Data is shown in table 3. Again, the 2004-2005 rate is

associated with the passing of Hurricanes Katrina and Rita. Shoreline change rates for Whiskey Island exceed those of the Isles Dernieres combined.

Vegetation

Based on time and budget constraints, it was determined that five (5) stations per transect would be appropriate. The 5 stations per transect were divided amongst the regions based on the length of the region. Table 4 provides the number of stations per region for transects 1-4. A total of 20 stations were sampled. Transects 5-7 were not sampled due to the lack of emergent vegetation along the transects within the project boundary. Mangroves were present along the transects outside of the project boundary.

Table 4. Number of stations per region for each sampled transect.

Transect	Number of Upslope Stations	Number of Swale Stations	Number of Marsh Stations
1	2	3	0
2	2	3	0
3	2	3	0
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The 2007 data were grouped by region and by transect to determine the relative mean percent cover for each species. Bare ground was included as a separate species. The relative mean percent cover was calculated by summing all the individual percent cover values for each species for the region or transect depending on the analysis. Then the percent cover for each individual species is divided by the summation of the all species and multiplied by 100. This gives the relative percent cover for each species. When each relative percent cover for each species is summed the total is 100 percent. The data analysis was generated using SAS software. Copyright, SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks of SAS Institute Inc., Cary, NC, USA.

The upslope region of Whiskey Island contained 12 different plant species, including bare ground (figure 7). Bare ground was treated as an individual species and assigned a cover value. The swale region showed the most diversity with 21 total species and the marsh region contained 10 total species (sample size was 1 station), both regions including bare ground. The relative mean percent cover of bare ground was 37.09 on the upslope, 33.12 on the platform and 31.22 percent on the marsh region.

As vegetation becomes established on barrier islands, distinct vegetative regions may form (Hester et al. 2005). The vegetation in the upslope or dune region assists sand collection and dune formation, which in turn allows the swale region to form. The swale region is a less stressful habitat for vegetation than the upslope or dune habitat,

**Whiskey Island Restoration (TE-27) Project
Relative Mean Percent Cover of Emergent Vegetation by Region**

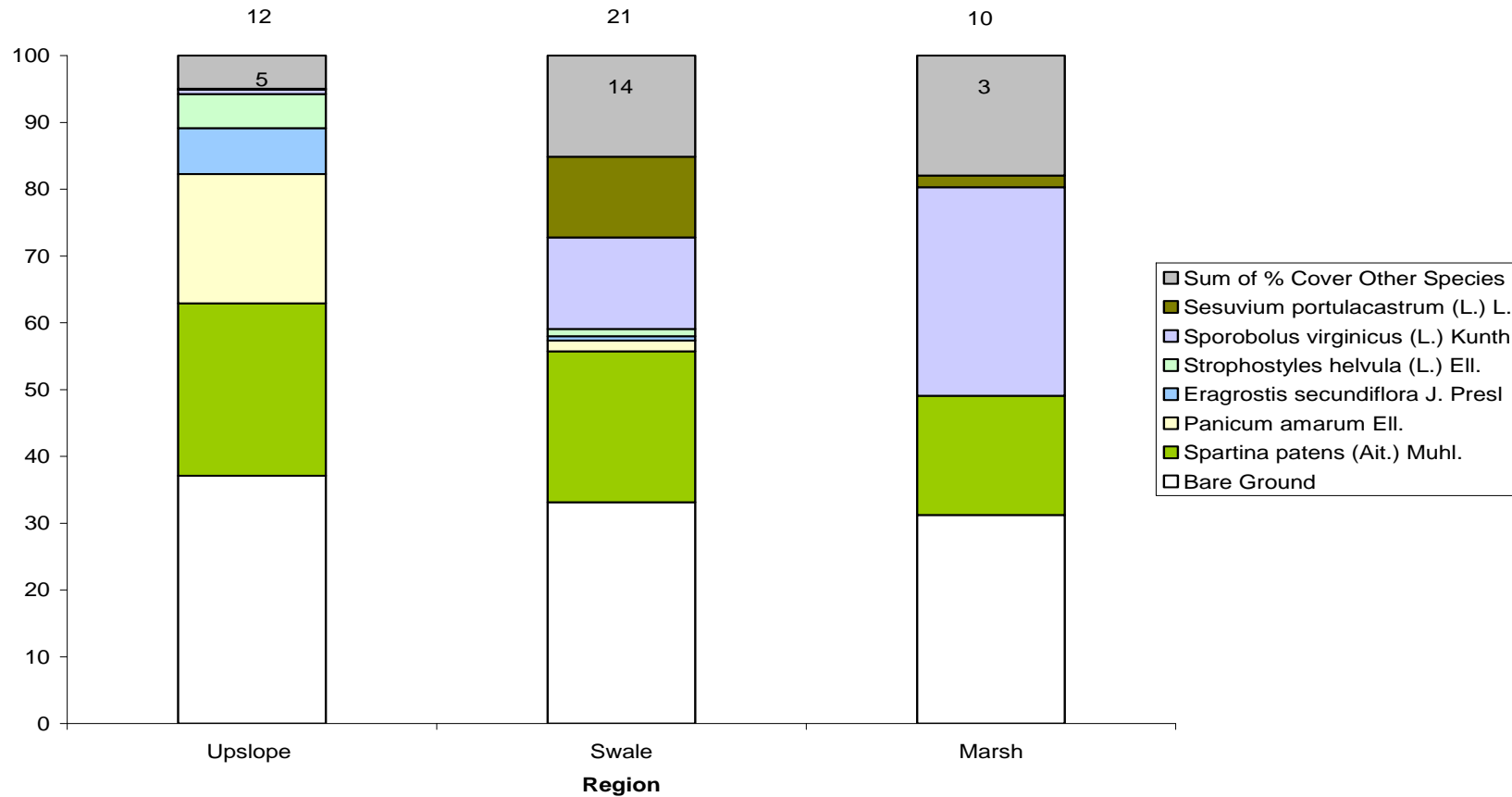


Figure 7. Relative mean percent cover of emergent vegetation by region in October 2007 showing the number of species grouped in the “Other” category and the total number of species found.

therefore more diverse in species content (Hester et al. 2005) as seen on Whiskey Island. Back barrier marshes may have two (2) zones of vegetation, high and low marsh, in which environmental stressors can further limit vegetative diversity in an already specialized plant community. On Whiskey Island, the marsh region contained the least number of species. Black mangrove, *Avicennia germinans* is frequently a dominant species in back barrier marshes in the northern Gulf of Mexico barrier islands (Hester et al. 2005) as observed on Whiskey Island.

Only 2 of the 3 originally planted species were found during vegetation sampling on Whiskey Island in 2007, *Spartina patens* and *Panicum amarum*. *Spartina alterniflora* was not identified in or within 15 feet of any of the plots. The relative mean percent cover of *Spartina patens* in the upslope region was 25.8, 22.6 in the swale and the marsh (figure 7). These values may be similar because elevation is in the 1-4 ft range across all three regions.

The relative mean percent cover per transect refers to the percent cover of an individual species, measured in five plots, across an entire transect, through the 3 different regions of Whiskey Island. Transect 3 exhibited the most diversity as it contained 16 species including bare ground (figure 8). A total of twenty-nine (29) species were identified in or within 15 feet of the vegetation sampling plots on Whiskey Island.

Table 5 illustrates the number of species found in, or both inside and within 15 feet of vegetation plots for all years sampled. This table also shows the total number of species found on Whiskey Island each year vegetation was sampled. The total number of species is the number found in the plots, both in the plots and within 15 feet of a plot and species found outside, but within 15 feet of a plot.

Table 5. Number of plant species found inside all stations and the total number of plant species found including outside the stations sampled by year.

	1999	2001	2002	2007
In	16	15	6	23
Total	22	20	9	29

Habitat Mapping

The BICM program funded habitat classification and change analysis for four (4) years of photography (1996, 2000, 2004, and 2005). This analysis was for Whiskey Island, not specific to the TE-27 project boundary. The habitat classes used for classification included: water, intertidal flat, marsh, barrier vegetation, bare land, beach, rip rap, and structure. This particular island had no rip rap; however, there is 1 acre of structure classified in the 4 time periods which is associated with the oil field. Table 6 summarizes the acres of each habitat class for each time period.

**Whiskey Island Restoration (TE-27) Project
Relative Mean Percent Cover of Emergent Vegetation by Transect**

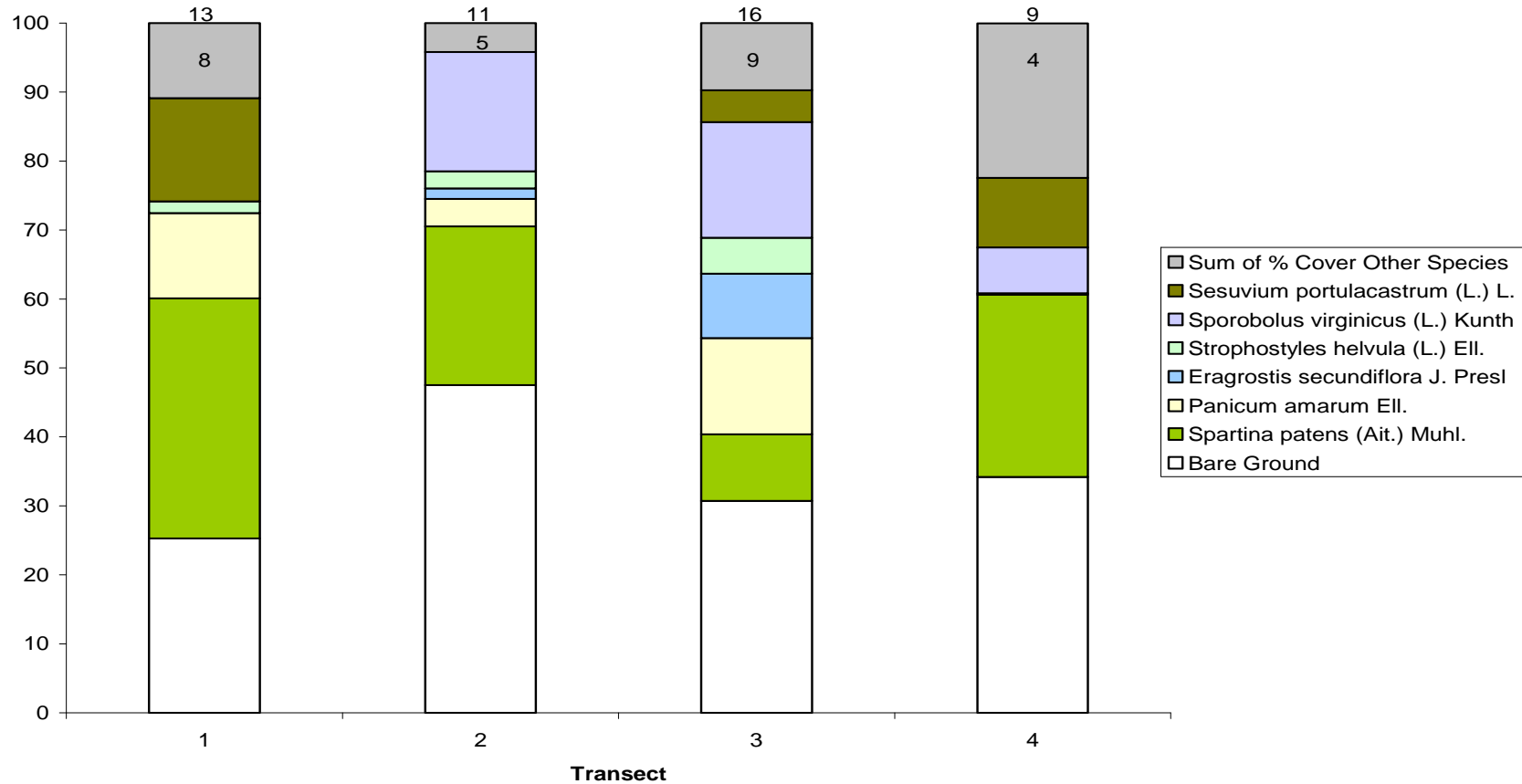


Figure 8. Relative mean percent cover of emergent vegetation by transect in October 2007 showing the number of species grouped in the “Other” category and the total number of species found.

Table 6. BICM Habitat Change Analysis: Whiskey Island Habitat Classification – 1996, 2002, 2004, and 2005.

Habitat Classes	1996	2002	2004	2005
Water	4388	4086	4337	4121
Intertidal Flat	73	321	64	252
Marsh	304	270	269	247
Barrier Vegetation	3	8	55	44
Bare Land	2	188	101	0
Beach	165	64	111	273
Rip Rap	0	0	0	0
Structure	1	1	1	1

Figures illustrating the habitat change classification for 1996 to 2002, 2002 to 2004, 2004 to 2005, and 1996 to 2005 are presented in Appendix E. Data from those figures are presented in table 7 for all time periods. Examining the project portion of the island, the most dramatic transformation between the 2004 and 2005 periods is the areas that were classified as bare land and barrier vegetation in 2004 has been mostly converted to beach and bare land habitat as a result of the 2005 hurricanes. Habitat mapping has not been conducted on any photography after 2005; consequently, there are no supporting data sets for the impacts of the 2008 hurricanes.

VI. Conclusions

a. Project Effectiveness

One of the goals of the project was to increase the elevation and width of Whiskey Island using dredged sediments. Sediment placed on the island in 1998 accomplished this goal. However, the total sediment volume loss in the fill area from 1998 to 2006 was approximately 2, 462, 583 yd³ (1,882,780 m³), a 125% reduction in volume.

The primary cause for this large sediment loss inside the fill area is the rapid northwestern movement of the eastern part of Whiskey Island. Although the volume in the fill area has decreased considerably, portions of the sand and sediment resources were conserved outside the fill area. Since construction, the island has experienced several tropical systems which have accelerated erosion of the sediment. As of the 2008 hurricanes, the island showed increased shoreline erosion. No breaches were observed and the dune feature did roll back in most instances where widths were wide enough to capture the sediment. Field observations are showing as the island gets overwashed during high water events, sediment is moving into the existing mangroves and causing mortality.

The second goal of the project was to reduce loss of dredged sediments through the growth of vegetation. Two of the three originally planted species were found during

Table 7. BICM Habitat Change Classification Analysis: Whiskey Island Habitat Classification – 1996 to 2002, 2002 to 2004, and 2004 to 2005.

Habitat Change Class (To - From)	1996 - 2002 Acreages	2002 - 2004 Acreages	2004 - 2005 Acreages
water - water	3920	4078	4077
unchanged land	257	410	330
intertidal flat - water	264	1	189
marsh - water	32	1	16
barrier vegetation - water	2	0	2
bare land - water	128	1	0
beach - water	40	6	53
water - intertidal flat	39	224	3
water - marsh	6	18	7
water - barrier vegetation	1	1	2
water - bare land	0	6	3
water - beach	119	8	29
water - structure	0	0	0
intertidal flat - marsh	17	0	11
intertidal flat - barrier vegetation	0	0	5
intertidal flat - bare land	0	1	11
intertidal flat - beach	26	18	16
marsh - intertidal flat	2	11	1
marsh - barrier vegetation	1	4	3
marsh - bare land	1	7	2
marsh - beach	1	1	0
barrier vegetation - intertidal flat	0	3	0
barrier vegetation - marsh	4	2	0
barrier vegetation - bare land	0	47	15
barrier vegetation - beach	0	2	4
bare land - intertidal flat	16	11	0
bare land - marsh	34	2	0
bare land - barrier vegetation	0	1	0
bare land - beach	9	2	0
beach - intertidal flat	3	29	39
beach - marsh	10	3	26
beach - barrier vegetation	0	0	23
beach - bare land	0	40	70
structure - structure	1	1	1

vegetation sampling on Whiskey Island in 2007. Prior to the 2008 hurricanes, twenty-nine (29) plant species were documented; the highest number of species recorded during project sampling. Transects 1-4 had high percentages of vegetative cover, while transects 5 and 7 had no cover. This is a function of the erosion and rollover (exacerbated by tropical systems) of the eastern tip of Whiskey Island because of its proximity to a large open pass, similar in situation to the eastern tip of the Isles Dernieres Restoration, Phase 0, East Island Project (TE-20).

Habitat mapping on the project portion of the island shows the most dramatic transformation between the 2004 and 2005 periods is the areas that were classified as

bare land and barrier vegetation in 2004 has been mostly converted to beach and bare land habitat as a result of the 2005 hurricanes. Habitat mapping has not been conducted on any photography after 2005; consequently, there are not supporting data sets for the impacts of the 2008 hurricanes.

b. Recommended Improvements

The O&M plan should define critical limits for the project area. Once these critical limits are reached, discussions within the CWPPRA and restoration community should commence on how to replenish the sediment that migrated from the project area.

Allocation of funding for maintenance of barrier island restoration projects was not considered due to the expense involved with replenishment of dredged material over the life expectancy of the project. Claims for FEMA assistance resulting from extensive or catastrophic damage to barrier islands from tropical storms and hurricanes are ineligible because there is no scheduled maintenance. Based on monitoring activity of the Isles Dernieres, it has been documented that these barrier islands are experiencing significant land loss due to barrier island rollover and island narrowing resulting from tropical and winter storm events. Therefore, it is recommended that maintenance funds be provided for the implementation of an inspection and maintenance program for assessment and replacement of dredged sediment and sand fencing necessary to maintain the integrity of these islands. The implementation of a maintenance program for barrier island projects would enable these projects to qualify for assistance under the Federal Emergency Management Program.

New projects should include a marsh component along with the gulfside restoration efforts. It has been noted that as the project area and other island's project areas get overwashed, the marsh platform on the bayside captures the sand from the gulfside. This helps to keep the dredged material on the island and conserves elevation for the next event that occurs. The marsh component keeps the dredged material in the barrier island system much longer. Also, back barrier marshes minimize the effects of winter storms.

Monitoring should include the entire island system, not just the project area as outlined during the project planning stages. Construction may not directly affect regions outside of the project area. However, through time and natural processes, the dredged materials migrate outside of the project area. Monitoring only the project area causes difficulty in analyzing how much material or benefit the entire island has received.

b. Lessons Learned

Barrier islands are often exposed to storm events resulting in substantial over-wash and breaching. It is important that a continuous dune of sufficient height and width is maintained on these islands to combat these processes. Sediment fencing has proven to be an effective technique in rebuilding dunes by capturing wind blown sediment and is less costly than periodically replenishing sediment by hydraulic dredge. We have learned from past projects that orienting the sediment fencing parallel to the shore face and perpendicular to the predominant wind direction has maximized the potential for maintaining a viable dune section.

The combined use of dredged sediment, sand fencing, and vegetative plantings are plausible ways to create quasi-stabilization and prolong the lives of barrier islands. The construction of sand fencing as well as vegetative planting should occur as soon as possible after the placement of dredged sediment to minimize loss. A different vegetative planting design must be determined to allow vegetative colonization quickly in order to maximize sediment stabilization

The original vegetation sampling set up was such that plots were established along original plantings. This pattern placed most plots near the gulfside or bayside of Whiskey Island. Most original plots are now open water, due to the migration of the island. The original set up was not conducive to the 20 year monitoring period, due to the ephemeral nature of barrier islands. In future situations, it may be more feasible to establish plots along transects as was done in the 2007 vegetation sampling season. The coordinates of the transects will not change, and the transects could be extended as the island migrates. Individual plots along transects may have to be reestablished to compensate for island migration or erosion. In this manner, statistical comparisons will be possible throughout the life of the project.

VII. References

Barras, John A. 2006. Land area change in coastal Louisiana after the 2005 hurricanes—a series of three maps: U.S. Geological Survey Open-File Report 06-1274.

Fearnley, S., I. Brien, L. Martinez, M. Miner, M. Kulp, S. Penland. 2009. Louisiana Barrier Island Comprehensive Monitoring Program (BICM) Vol 5: Chenier Plain, South Central Louisiana, and Chandeleur Islands, Habitat Mapping and Change Analysis 1996 to 2005. Prepared for the LA Dept. Natural Resources, Coastal Restoration Div. by the Univ. of New Orleans – PIES, New Orleans, LA.

Folse, T.M. and West J.L. 2005. A Standard Operating Procedures Manual for the Louisiana Department of Natural Resource's Coastal Restoration division: Methods for Data Collection, Quality Assurance/quality Control, Storage and Products. Louisiana Department of natural resources, Baton Rouge, LA. 226pp.

Frazier, D.E. 1967. Recent deposits of the Mississippi River, their development and chronology. Transactions, Gulf Coast Association of Geological Societies 17: 287-311.

Georgiou, I. Y., D. M. Fitzgerald, and G. W. Stone. 2005. The impact of physical processes along the Louisiana Coast. Journal of Coastal Research. SI 44: 72-89.

Hester, M.W., E.A. Spalding, and C.D. Franze. 2005. Biological Resources of the Louisiana Coast: Part 1. An Overview of Coastal Plant Communities of the Louisiana Gulf Shoreline. Journal of Coastal Research, SI(44), 134-145. West Palm Beach (Florida). ISSN 0749-0208.

Khalil, S.M. and D.M. Lee. 2006. Restoration of Isles Dernieres, Louisiana: some reflections on morphodynamic approaches in the northern Gulf of Mexico to conserve coastal/marine systems. Journal of Coastal Research, SI 39 (Proceedings of the 8th International Coastal Symposium), 65-71. Itajaí, SC, Brazil, ISSN 0749-0208.

Linquist, D.C. and S.R. Martin. 2007. Coastal Restoration Annual Project Reviews: December 2007. Louisiana Department of Natural Resources, Baton Rouge, LA. 132 pp.

List, J.H., B.E. Jaffe, A.H. Sallenger, and M.E. Hansen. 1997. Bathymetric comparisons adjacent to the Louisiana barrier islands: processes of large scale change. Journal of Coastal Research 13:670-678.

McBride, R.A., and M.R. Byrnes. 1997. Regional variations in shore response along barrier island systems of the Mississippi River Delta Plain: historical change and future prediction. Journal of Coastal Research 13: 628-655.

McBride, R.A., M.W. Hiland, S. Penland, S.J. Williams, M.R. Byrnes, K.A. Westphal, B.E. Jaffee, and A.H. Sallenger, Jr. 1991. Mapping barrier island changes in Louisiana: techniques, accuracy, and results. Seattle, WA: Coastal Sediments '91 Proceedings. pp 1011-1025.

McBride, R.A., S. Penland, B.E. Jaffe, S.J. Williams, A.H. Sallenger, and K.A. Westphal. 1989. Erosion and deterioration of the Isles Dernieres barrier island arc-Louisiana, U.S.A.: 1853-1988: Transactions of the Gulf Coast Association of Geological Societies 39:431-444.

Mueller-Dombois, D. and H. Ellenberg. 1974. *Aims and Methods of Vegetation Ecology*. John Wiley and Sons, New York. 547 pp.

Penland, S., and R. Boyd. 1985. Transgressive depositional environments of the Mississippi River delta plain: A guide to the barrier islands, beaches and shoals of Louisiana: Louisiana Geological Survey Guidebook Series No. 3, 233 pp.

Penland, S. and K.E. Ramsey. 1990. Relative sea-level rise in Louisiana and the Gulf of Mexico: 1908-1988. *Journal of Coastal Research* 6:323-342.

Penland, S., J.R. Suter, and R. Boyd. 1988. The transgressive depositional systems of the Mississippi River delta plain: A model for barrier shoreline and shelf sand development. *Journal of Sedimentary Petrology* 58:932-949.

Peyronnin, C.A., Jr. 1962. Erosion of the Isles Dernieres and Timbalier Islands. *Journal of the Waterways and Harbors Division, American Society of Civil Engineers*. 88: 57-69.

Ritchie, W., K. Westphal, R.A. McBride, and S. Penland. 1989. Coastal Sand Dunes of Louisiana: The Isles Dernieres. Baton Rouge, LA and Aberdeen, Scotland: Coastal Geology Technical Report No. 5.

Stone, G.W., J.M. Grymes III, J.R. Dingler, and D.A. Pepper. 1997. Overview and significance of hurricanes on the Louisiana Coast, U.S.A. *Journal of Coastal Research*. 13: 656-669.

Stone, G.W., J.M. Grymes III, K.D. Robbins, S.G. Underwood, G.D. Steyer, and R.A. Muller. 1993. A chronologic overview of climatological and hydrological aspects associated with Hurricane Andrew and its morphological effects along the Louisiana Coast, U.S.A. *Shore and Beach*. 61: 2-13.

Stone, G.W. and X. Zhang. 2001. A longshore sediment transport model for the Timbalier Islands and Isles Dernieres, Louisiana. Coastal Studies Institute, Louisiana State University, Baton Rouge, LA. 28 pp.

Troutman, J.P., D.M. Lee, S. M. Khalil, B.S. Carter, K.S. Gray, and L.A. Reynolds. 2003. Draft barrier island comprehensive monitoring program. Louisiana Department of Natural Resources Coastal Restoration Division Biological Monitoring Section.

United State Department of Agriculture, Soil Conservation Service. 1960. Soil Survey of Terrebonne Parish, Louisiana. Series 1956, No. 1.

West, J.L. and D. Dearmond. 2004. 2004 Operations, Maintenance, and Monitoring Report for Whiskey Island Restoration (TE-27), Louisiana Department of Natural Resources, Coastal Restoration Division, Thibodaux, Louisiana. 23pp.

Appendix A

Photos from Damage Assessment Field Trip





BICM oblique aerial photos of western marshes of Whiskey Island in 2005 (post-Katrina and Rita) and 2007. (Photos courtesy of UNO/PIES)



OCPR oblique aerial photos of western marshes of Whiskey Island on September 24, 2008 (post-Ike).



BICM oblique aerial photos of Whiskey Island near station D67+50 in 2005 (post-Katrina and Rita) and 2007. (Photos courtesy of UNO/PIES)



OCPR oblique aerial photos of Whiskey Island near station D67+50 on September 24, 2008 (post-Ike).



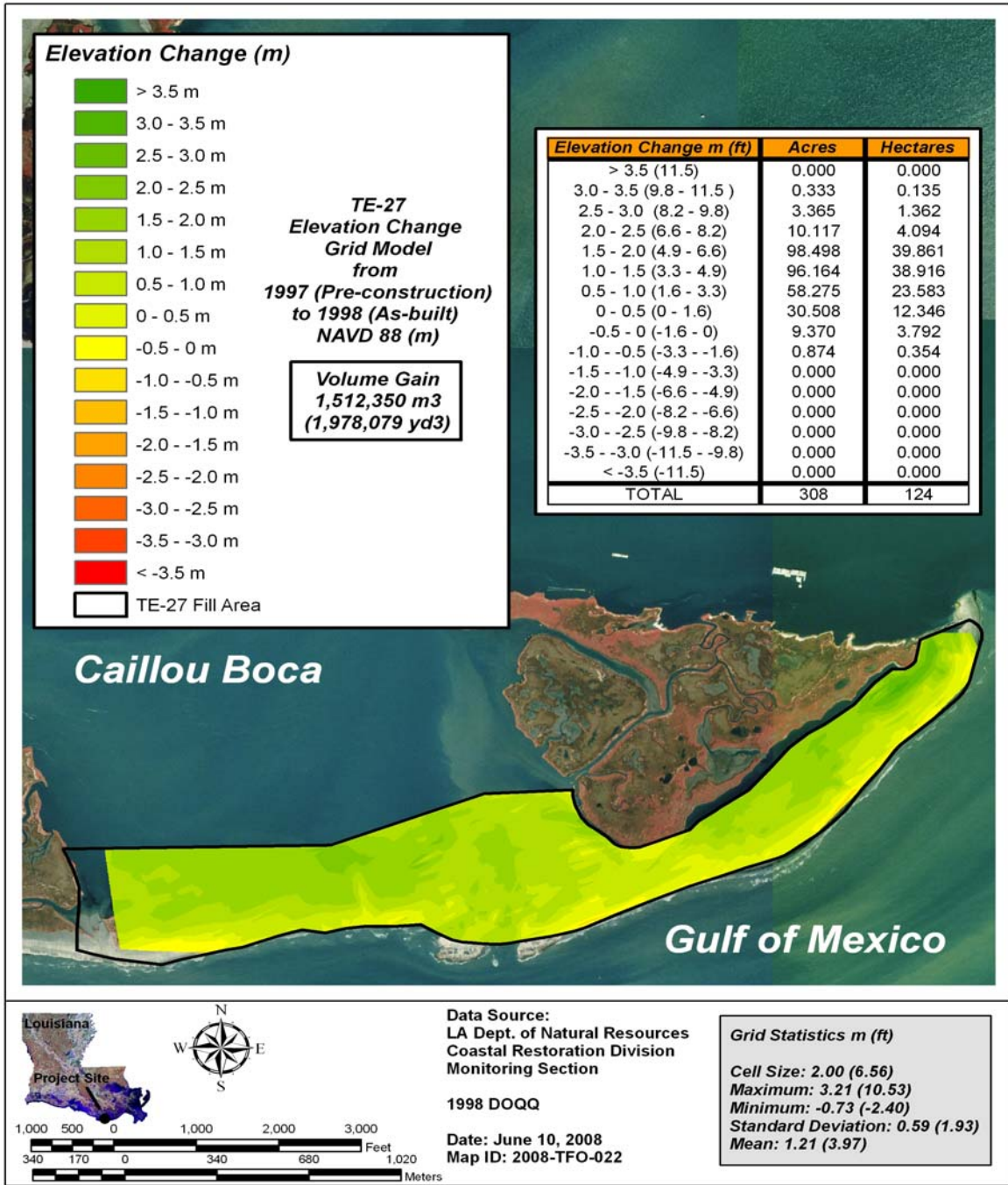
BICM oblique aerial photos of eastern marshes of Whiskey Island in 2005 (post-Katrina and Rita) and 2007. (Photos courtesy of UNO/PIES)



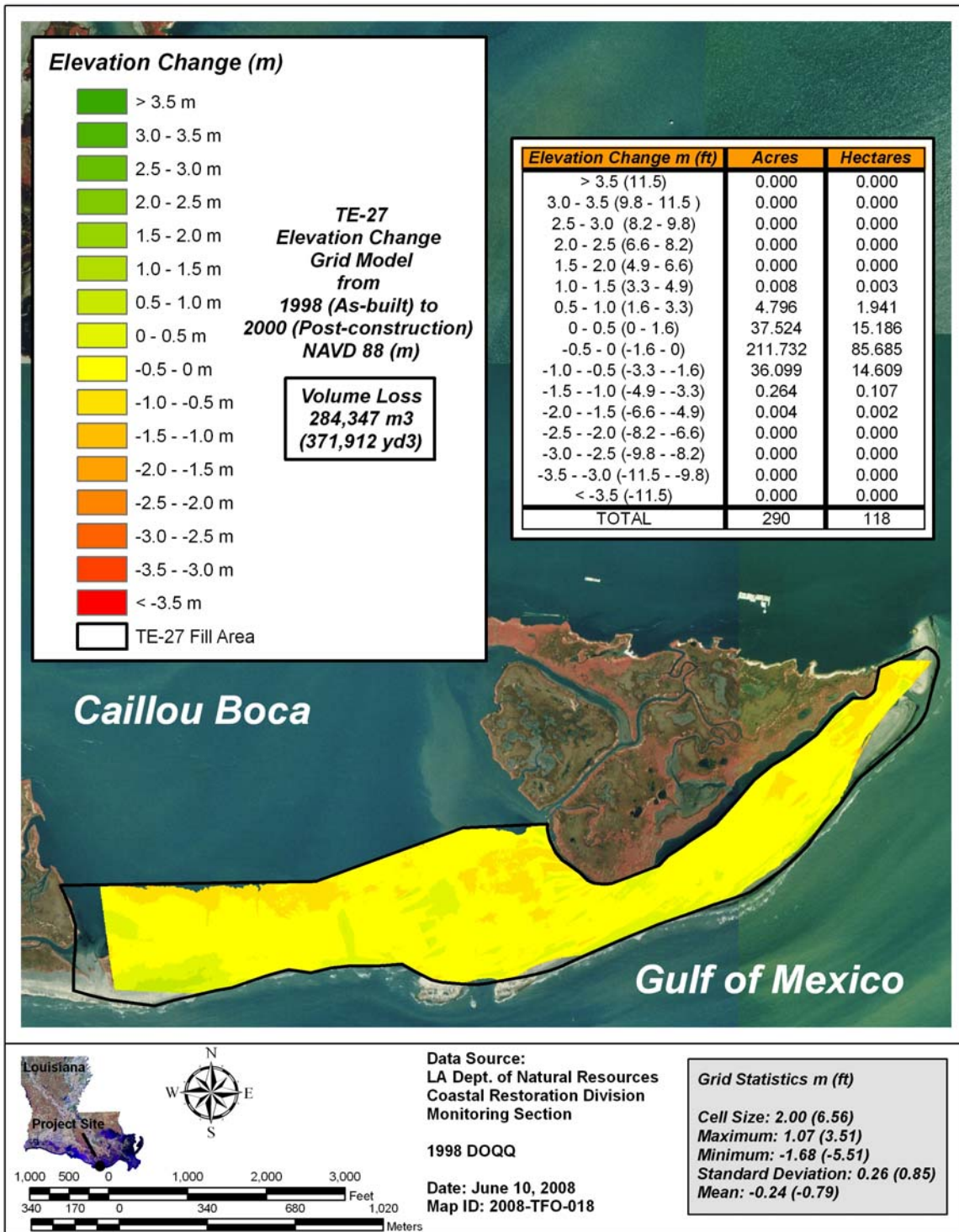
OCPR oblique aerial photos of eastern marshes of Whiskey Island on September 24, 2008 (post-Ike).

Appendix B

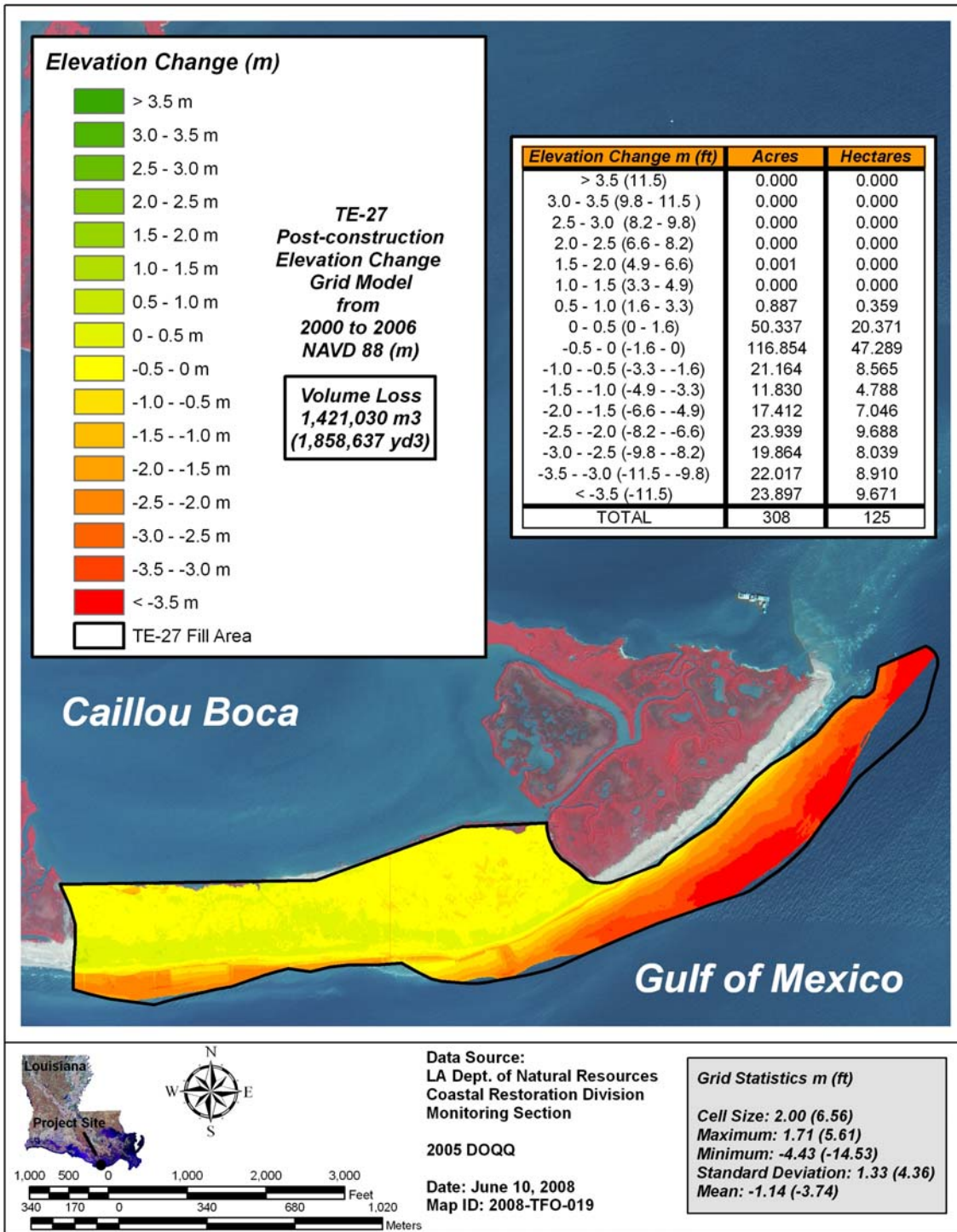
Elevation Change Model Maps



Elevation and volume change grid model from pre-construction (1997) to as-built (1998) at the Whiskey Island Restoration (TE-27) project.



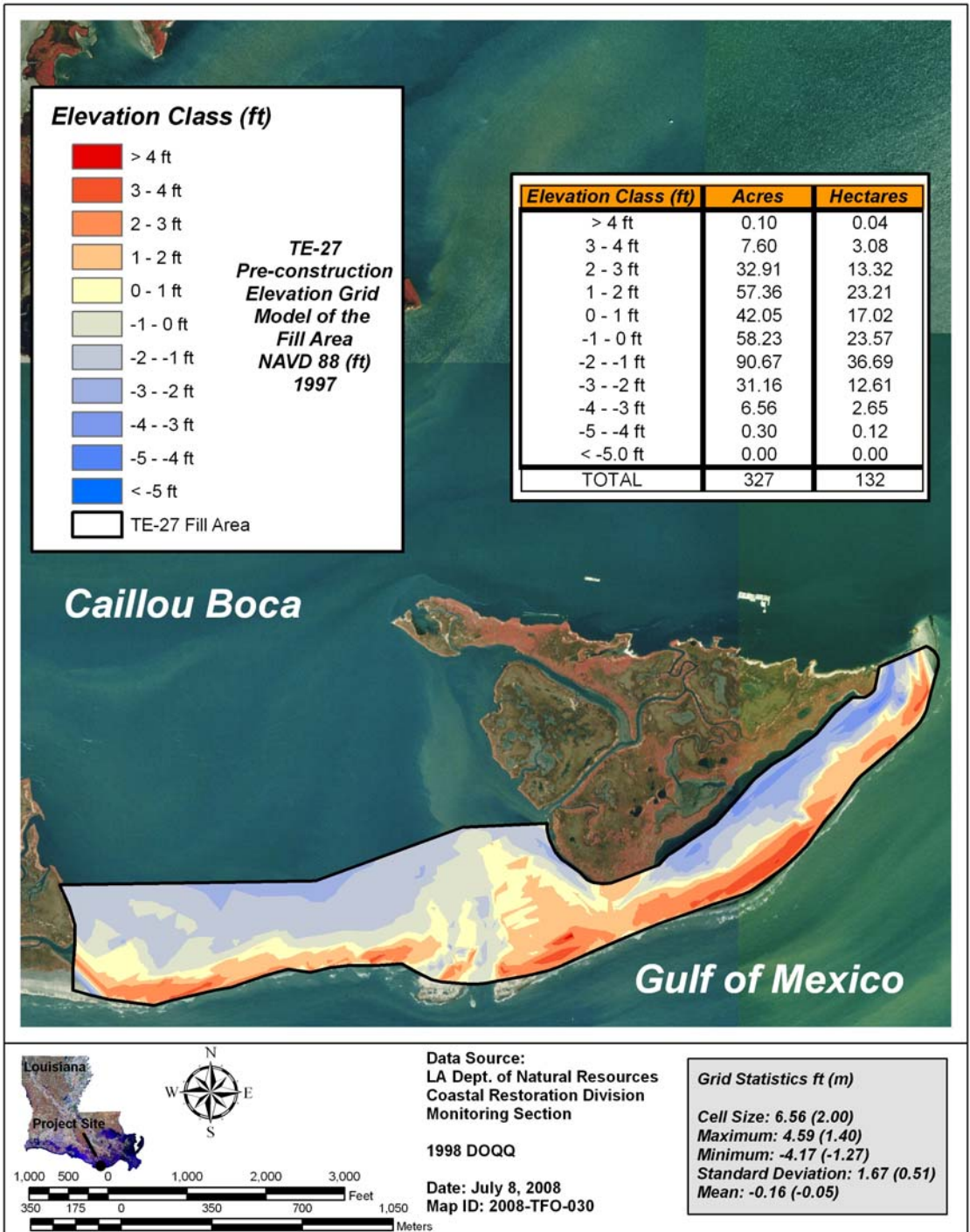
Elevation and volume change grid model from as-built (1998) to post-construction (2000) at the Whiskey Island Restoration (TE-27) project.



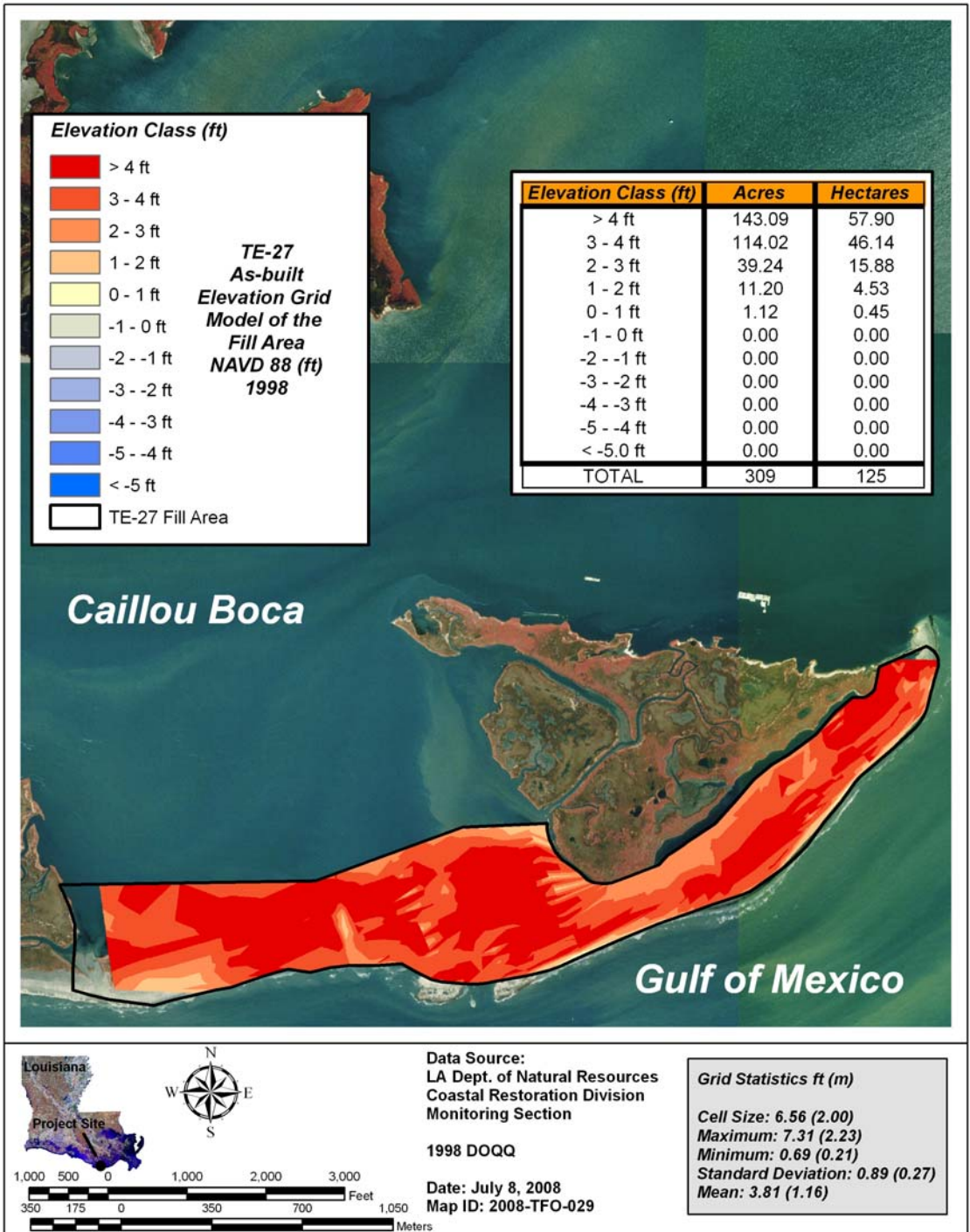
Post-construction elevation and volume change grid model from 2000 to 2006 at the Whiskey Island Restoration (TE-27) project.

APPENDIX C

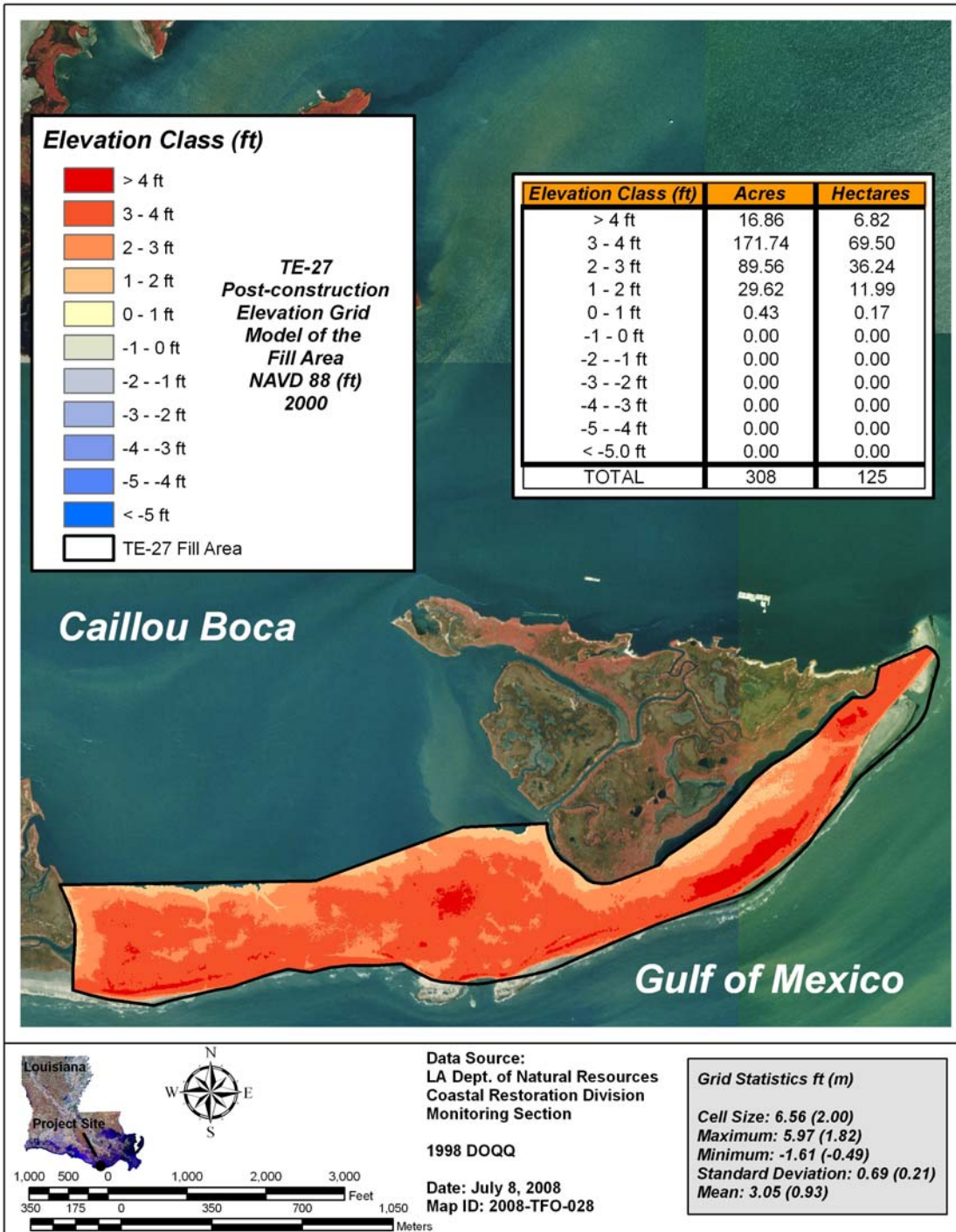
Elevation Grid Model Maps



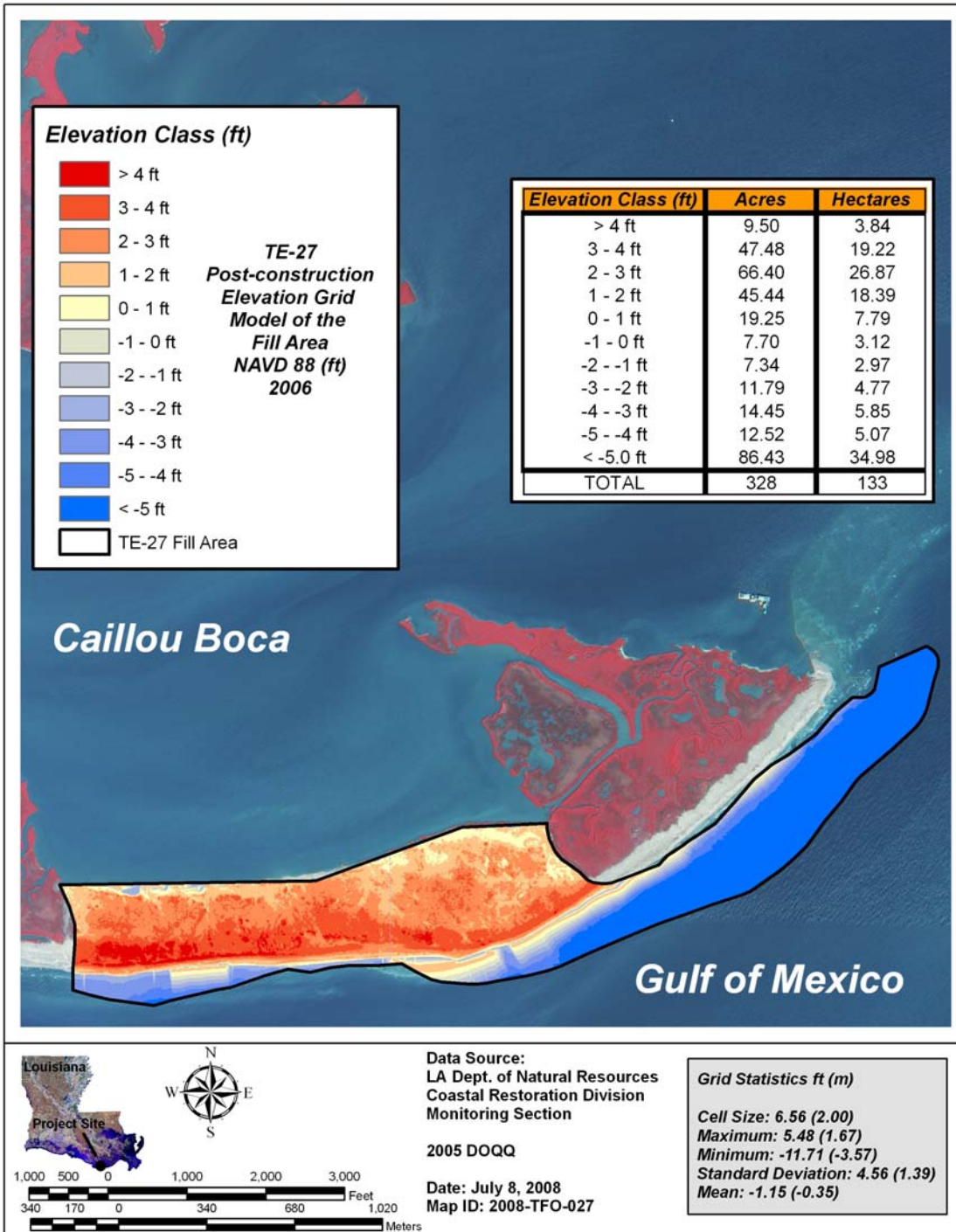
Pre-construction (1997) elevation grid model at the Whiskey Island Restoration (TE-27) project.



As-built (1998) elevation grid model at the Whiskey Island Restoration (TE-27) project.



Post-construction (2000) elevation grid model at the Whiskey Island Restoration (TE-27) project.

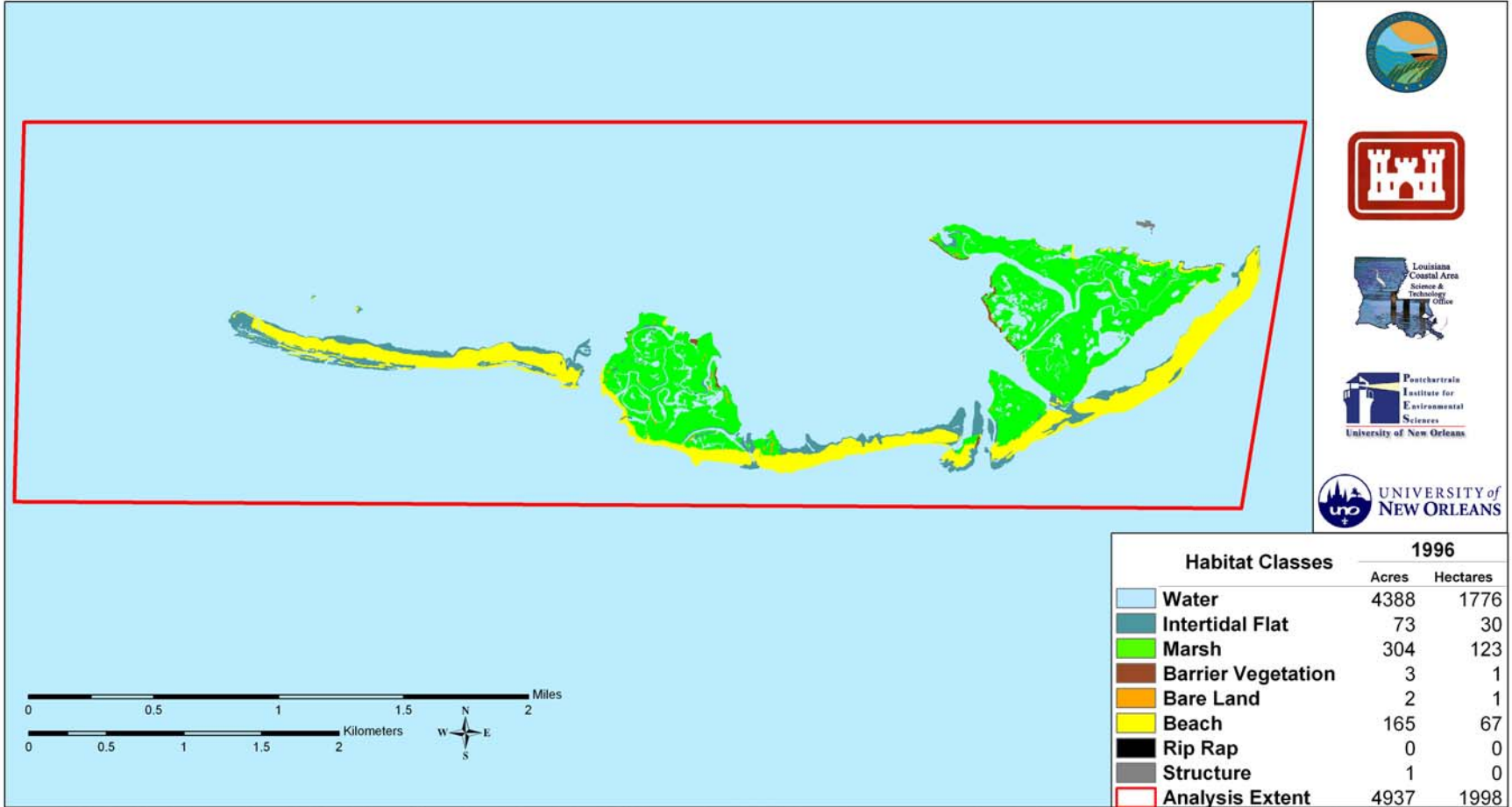


Post-construction (2006) elevation grid model at the Whiskey Island Restoration (TE-27) project.

Appendix D

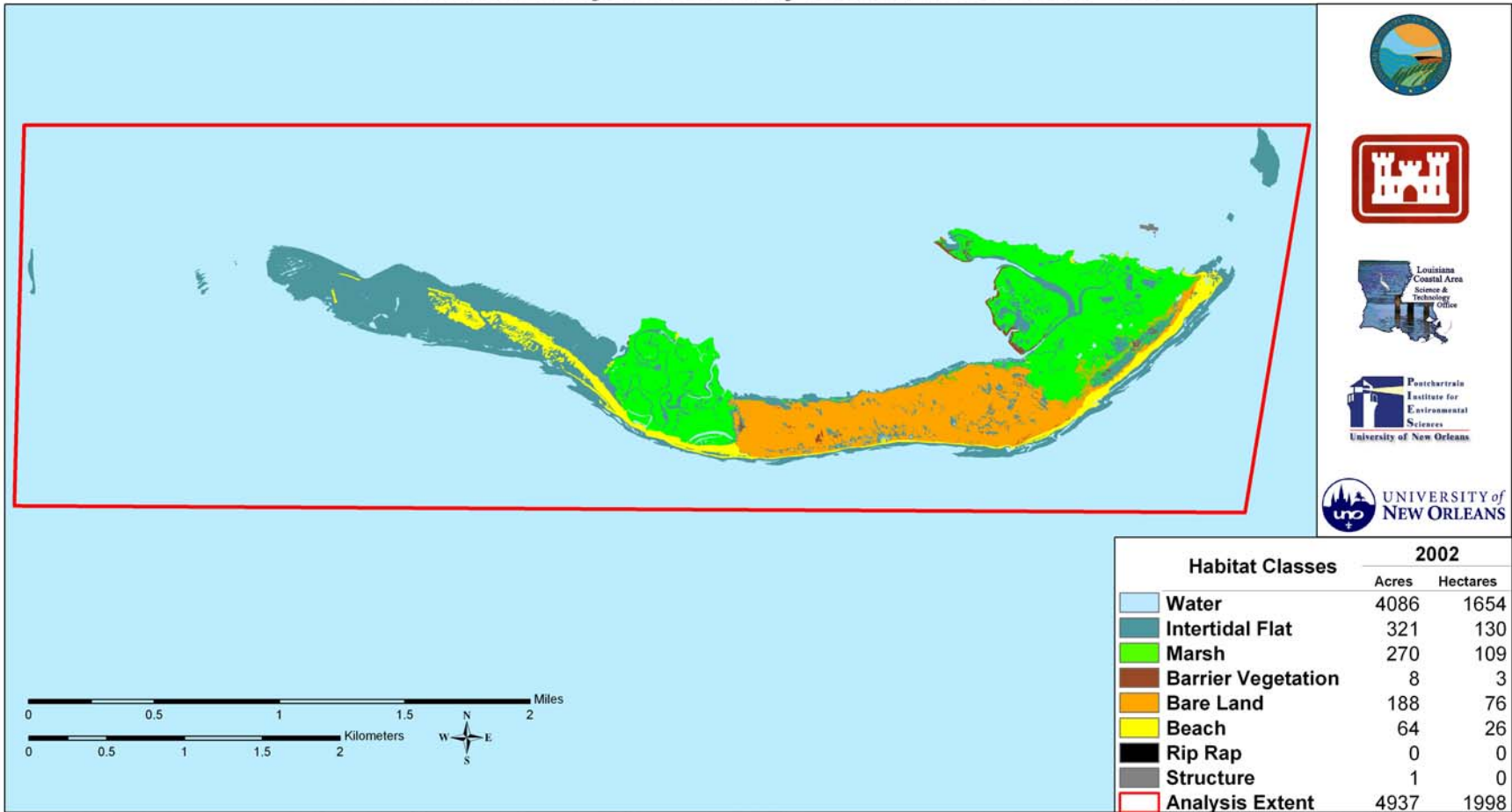
Habitat Classification Maps

BICM Habitat Analysis: Whiskey Island, Teche delta - 1996



The goal of the Habitat Analysis portion of the Barrier Island Comprehensive Monitoring (BICM) program is to classify the habitat types present along five delta regions in Louisiana for the time periods 1996/98, 2001/02, 2004, and 2005 and make comparisons between each time period. From west to east, the western Chenier Plain extends from Sabine Pass to the Lower Mud Lake Entrance in western Louisiana; the Teche delta extends from Raccoon Point to Wine Island Pass; the Lafourche delta extends from Cat Island Pass to Quatre Bayou Pass; the Modern delta extends from Quatre Bayou Pass to Sandy Point; and the Chandeleur Islands extend from Breton Island in the south to Hewes Point in the north. Funding for this project was provided by the LCA Science and Technology Program, a partnership between the Louisiana Department of Natural Resources (LDNR) and the US Army Corps of Engineers (USACE), through LDNR Interagency Agreement No. 2512-06-06. All work was completed by staff at the University of New Orleans - Pontchartrain Institute for Environmental Sciences.

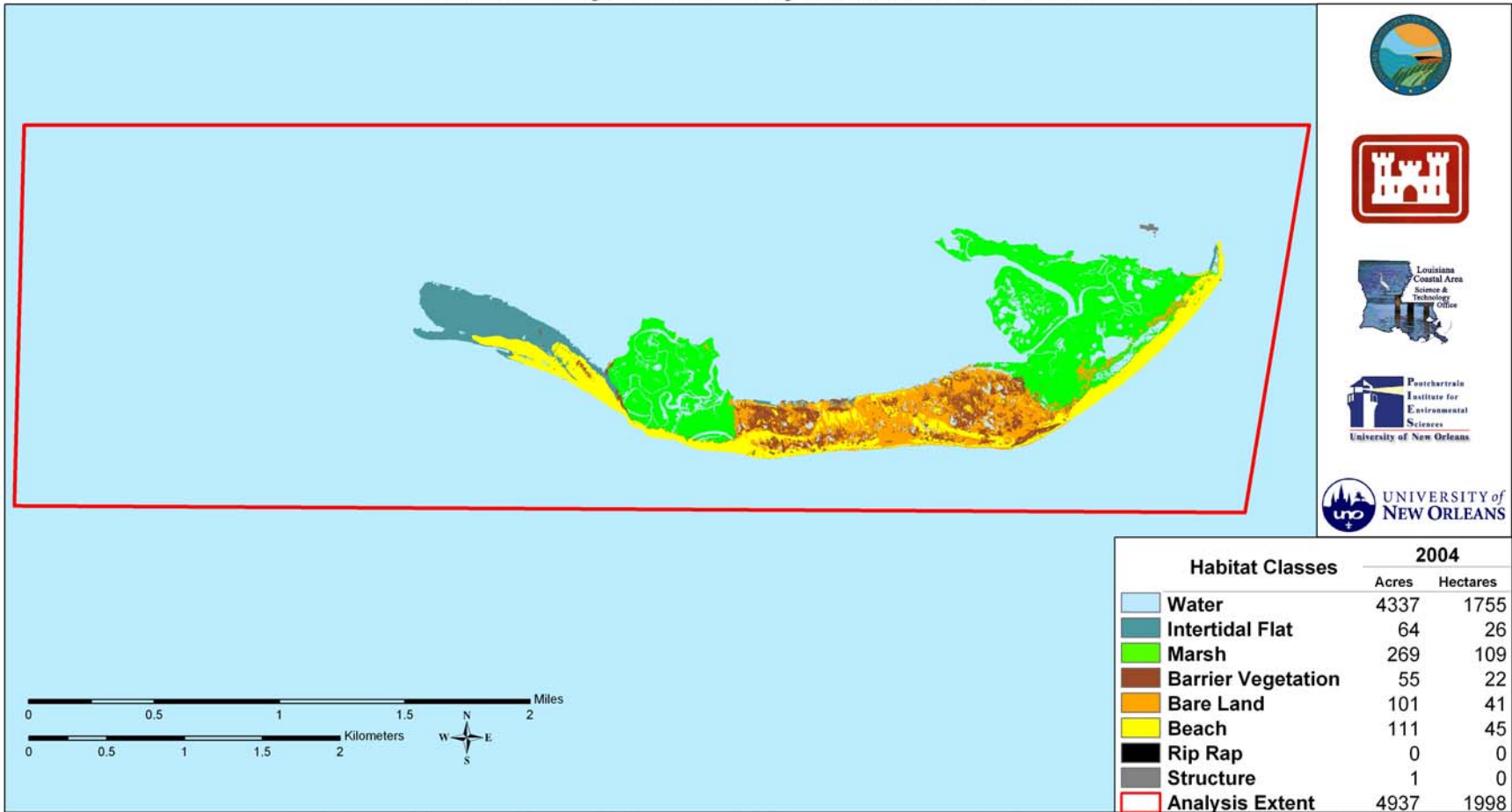
BICM Habitat Analysis: Whiskey Island, Teche delta - 2002



The goal of the Habitat Analysis portion of the Barrier Island Comprehensive Monitoring (BICM) program is to classify the habitat types present along five delta regions in Louisiana for the time periods 1996/98, 2001/02, 2004, and 2005 and make comparisons between each time period. From west to east, the western Chenier Plain extends from Sabine Pass to the Lower Mud Lake Entrance in western Louisiana; the Teche delta extends from Raccoon Point to Wine Island Pass; the Lafourche delta extends from Cat Island Pass to Quatre Bayou Pass; the Modern delta extends from Quatre Bayou Pass to Sandy Point; and the Chandeleur Islands extend from Breton Island in the south to Hewes Point in the north.

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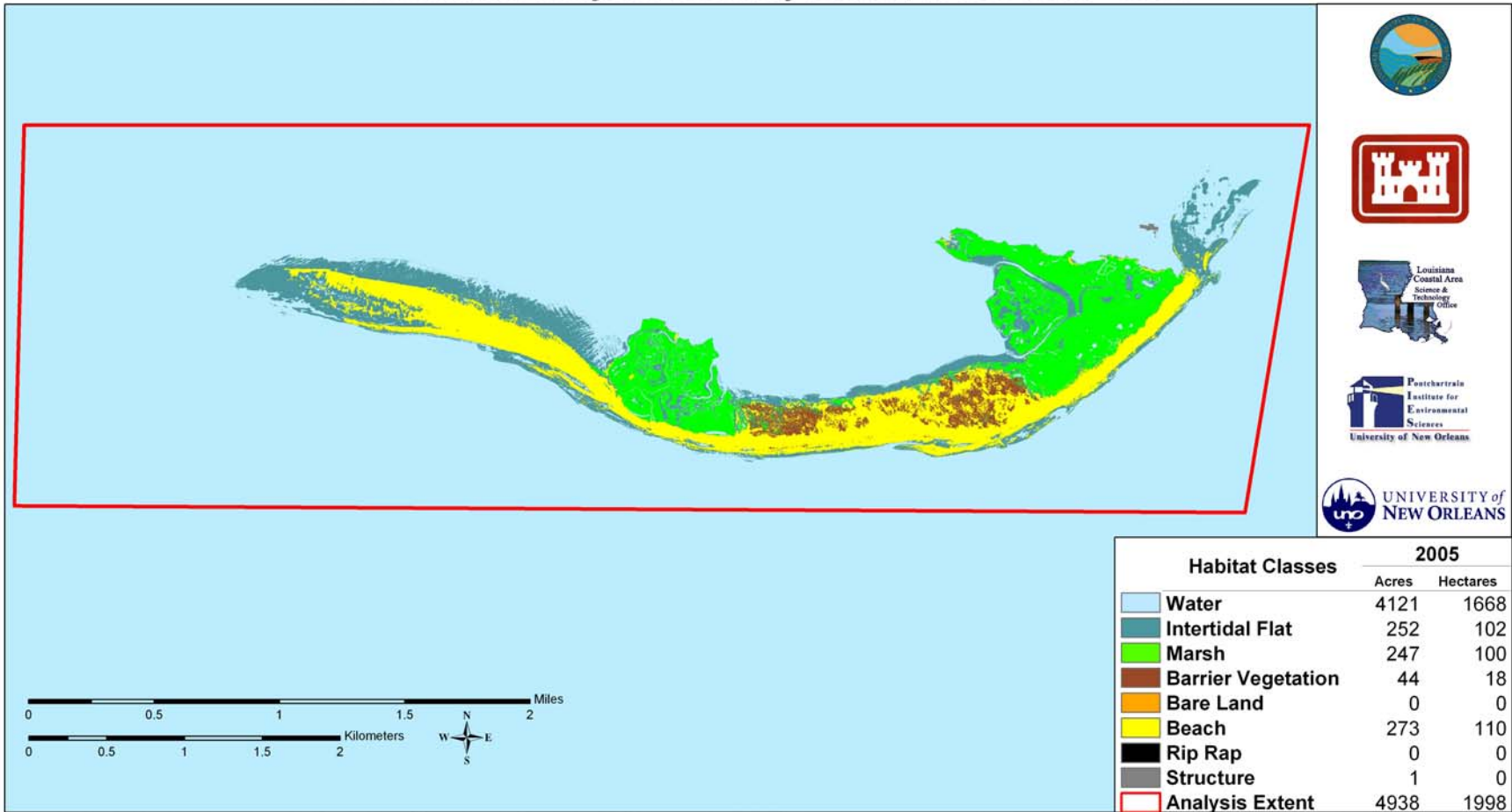
BICM Habitat Analysis: Whiskey Island, Teche delta - 2004



The goal of the Habitat Analysis portion of the Barrier Island Comprehensive Monitoring (BICM) program is to classify the habitat types present along five delta regions in Louisiana for the time periods 1996/98, 2001/02, 2004, and 2005 and make comparisons between each time period. From west to east, the western Chenier Plain extends from Sabine Pass to the Lower Mud Lake Entrance in western Louisiana; the Teche delta extends from Raccoon Point to Wine Island Pass; the Lafourche delta extends from Cat Island Pass to Quatre Bayou Pass; the Modern delta extends from Quatre Bayou Pass to Sandy Point; and the Chandeleur Islands extend from Breton Island in the south to Hewes Point in the north.

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BICM Habitat Analysis: Whiskey Island, Teche delta - 2005



The goal of the Habitat Analysis portion of the Barrier Island Comprehensive Monitoring (BICM) program is to classify the habitat types present along five delta regions in Louisiana for the time periods 1996/98, 2001/02, 2004, and 2005 and make comparisons between each time period. From west to east, the western Chenier Plain extends from Sabine Pass to the Lower Mud Lake Entrance in western Louisiana; the Teche delta extends from Raccoon Point to Wine Island Pass; the Lafourche delta extends from Cat Island Pass to Quatre Bayou Pass; the Modern delta extends from Quatre Bayou Pass to Sandy Point; and the Chandeleur Islands extend from Breton Island in the south to Hewes Point in the north.

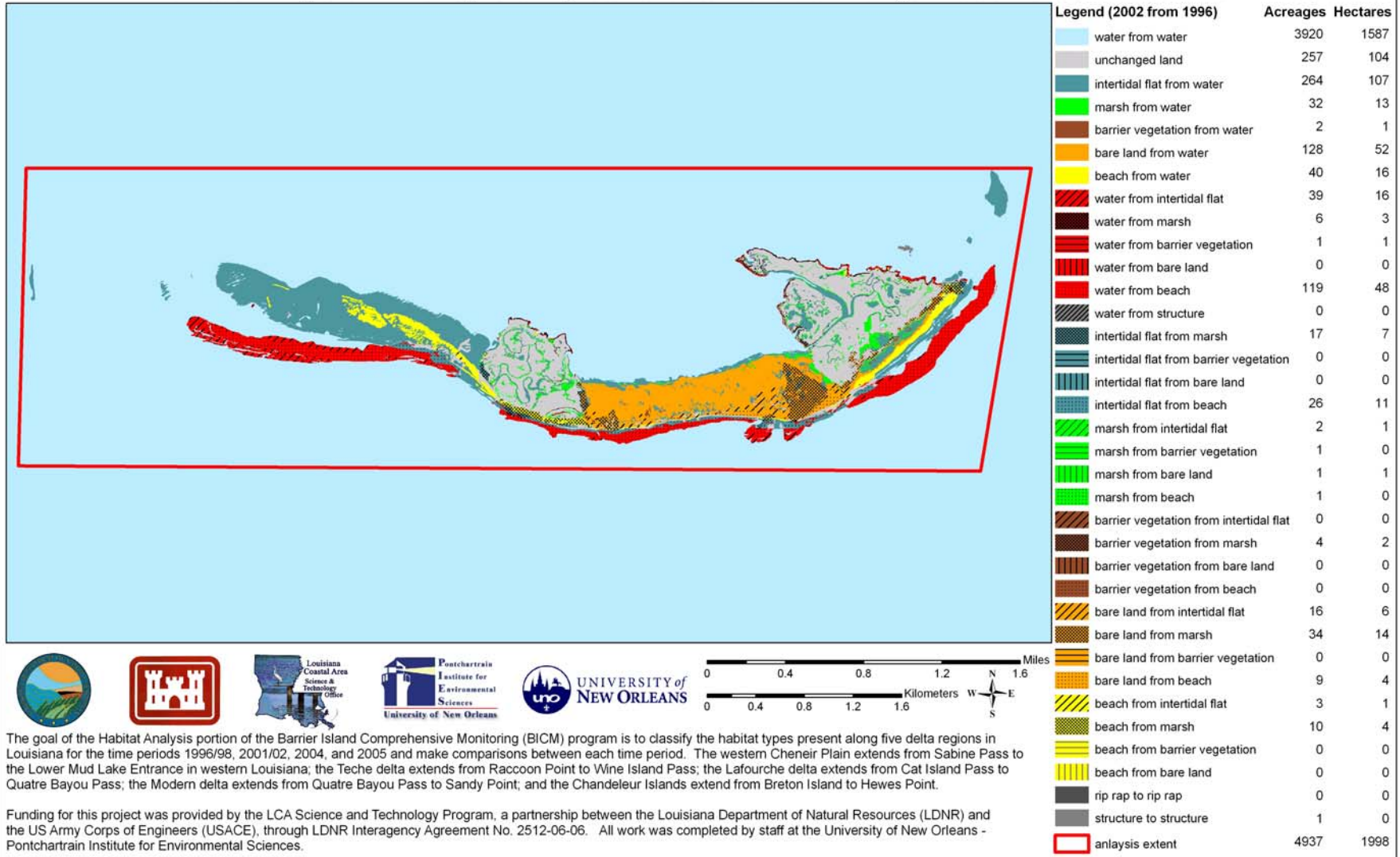
Funding for this project was provided by the LCA Science and Technology Program, a partnership between the Louisiana Department of Natural Resources (LDNR) and the US Army Corps of Engineers (USACE), through LDNR Interagency Agreement No. 2512-06-06. All work was completed by staff at the University of New Orleans - Pontchartrain Institute for Environmental Sciences.

Appendix E

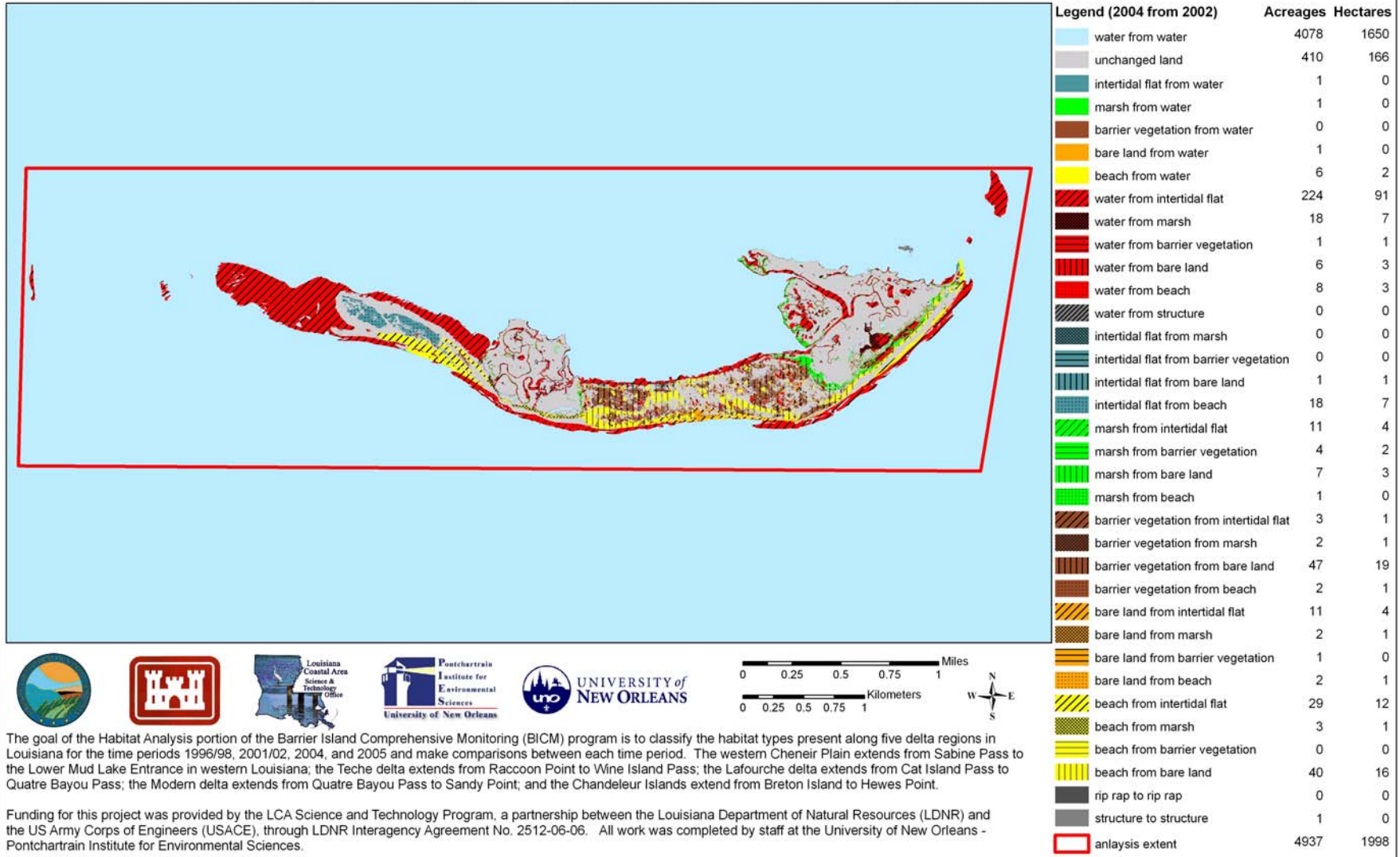
Habitat Change Maps



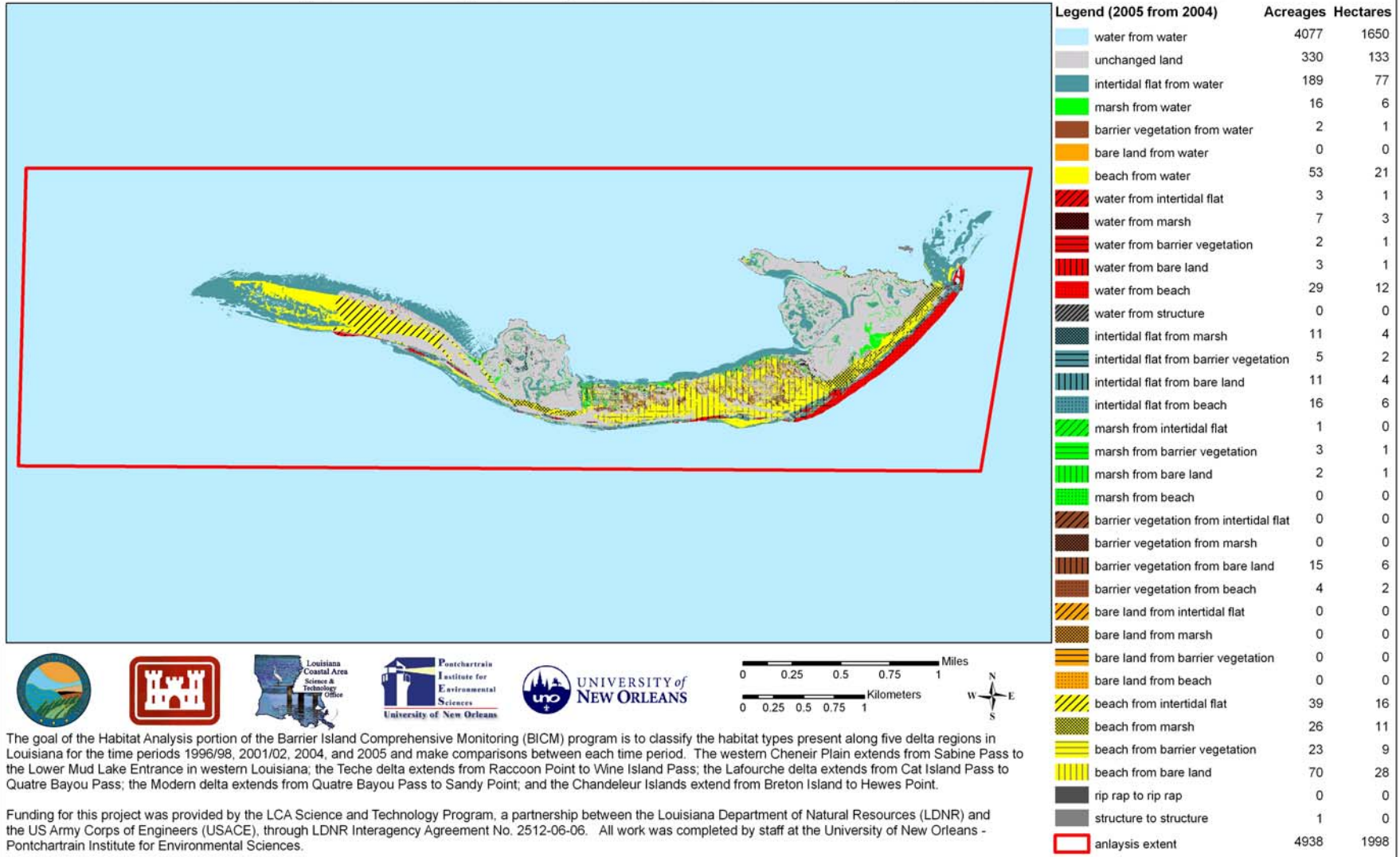
BICM Habitat Analysis: Whiskey Island, Teche delta Habitat Change Classification - 2002 from 1996



BICM Habitat Analysis: Whiskey Island, Teche delta Habitat Change Classification - 2004 from 2002



BICM Habitat Analysis: Whiskey Island, Teche delta Habitat Change Classification - 2005 from 2004



BICM Habitat Analysis: Whiskey Island, Teche delta Habitat Change Classification - 2005 from 1996

