Louisiana Barrier Island Comprehensive Monitoring Program (BICM)
Timbalier Island (TE-40) Habitat Mapping and Change Analysis:
2005 to 2006
Final Report

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INTRODUCTION

The goal of the Habitat Analysis was to classify land from Timbalier Island for 2005 and 2006, which are the as-built and 1 year post-construction time periods for the Timbalier Island Dune and Marsh Restoration Project (TE-40). Secondly, comparisons of habitat change between the two time periods were made and the change statistics calculated. The approach presented herein follows according to the classification by Penland *et al*. (2004). The objective of this final report is to outline the methods used during the analysis, provide a description of results, and provide all maps required as part of the contract deliverables. Digital copies of this report and all deliverables are available in Appendix A.

The objective of the Timbalier Island Dune and Marsh Restoration Project (TE-40) habitat analysis is to document existing habitats within the project area and allow comparisons between the 2005 (as-built) and the 2006 (1 year post-construction) habitats. Habitat analysis was conducted using the same methods as the Barrier Island Comprehensive Monitoring (BICM) program's analyses for the time periods 1996/98, 2001/2002, 2004 and 2005. The 2005 and 2006 data along with the BICM data will allow long term analysis of habitat changes within the project and implications for future project impacts and performance.

The habitat analysis was funded by the project specific monitoring budget of Timbalier Island Dune and Marsh Restoration Project (TE-40) under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA). Work was conducted by the staff at the University of New Orleans- Pontchartrain Institute for Environmental Sciences through LDNR Interagency Agreement No. 2512-06-06.

METHODS

All habitat and imagery pixel analysis were completed using Erdas Imagine software, version 9.1. Figure 1 provides a flow chart of the entire classification procedure. ArcGIS software, version 9.2 was used for making maps. The habitat classification by Penland *et al.* (2004) used eight categories which were: Water, Intertidal, Marsh, Barrier Vegetation, Beach, Bare Land, Structure, and Rip-Rap.

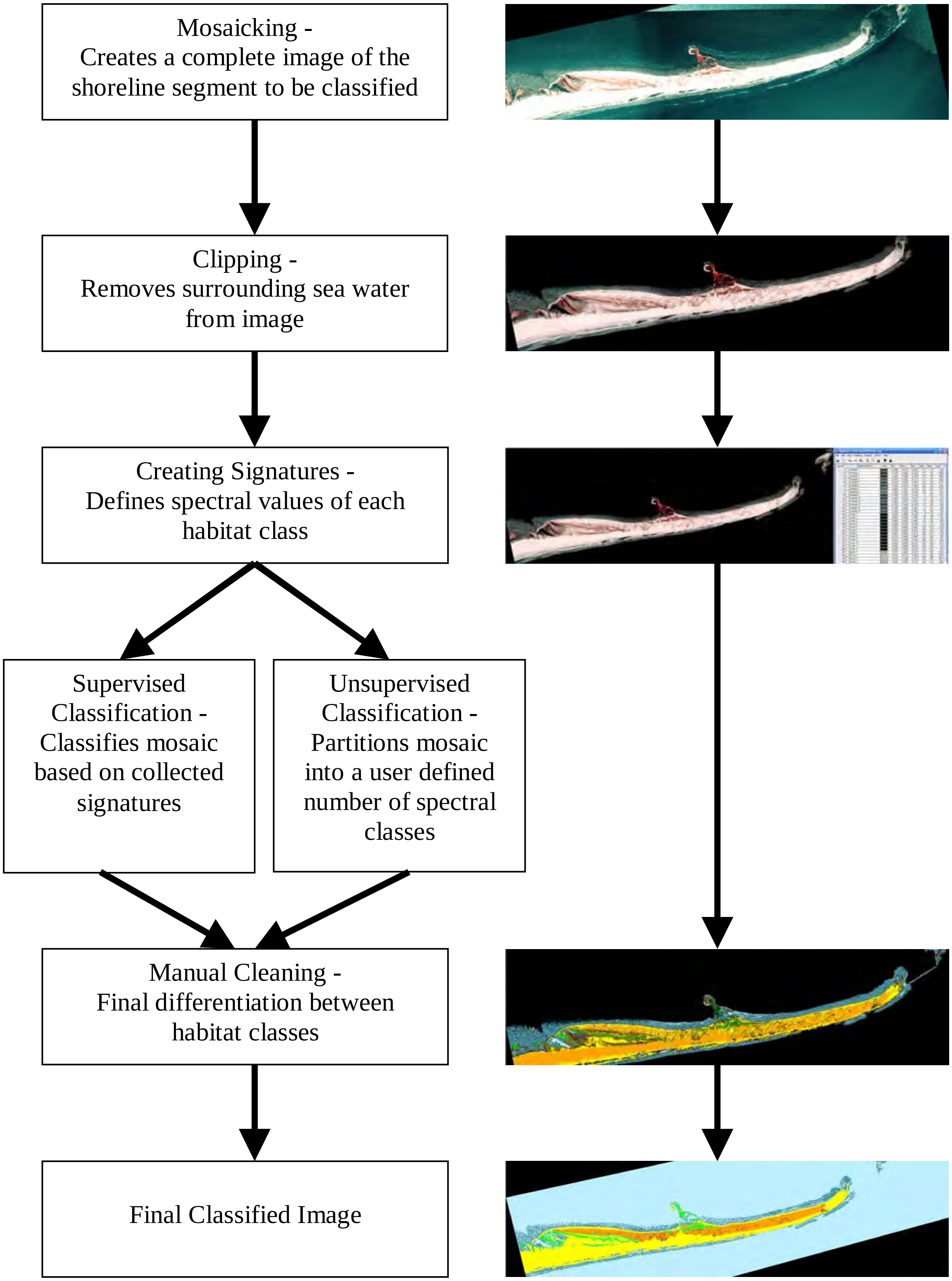


Figure 1. Flow chart of habitat classification with examples from the East Island 2005 classification analysis using Erdas Imagine software.

The definitions of each class identified in this analysis are as follows:

Water - any area that is not land.

Intertidal - shallow areas not supporting emergent vegetation and zones of deposition below normal high tide. Intertidal zones are capable of supporting submersed aquatic vegetation and are frequently colonized by marsh vegetation over time, which changes the classification from intertidal to marsh.

Marsh- vegetated area subject to regular inundation by marine waters or influenced by tidal action. Such areas are sufficient to support wetland-dependant, emergent vegetation. Because all of the study areas lie within saline waters salt marsh is the only marsh class pertinent to this investigation. Herein defined as marsh within in waters of high salinity (20-40ppt) and dominated by the flora *Spartina alterniflora, Juncus roemerianus,* and *Disticlis spicata*. Included are those areas dominated by *Avicennia germinans* (Black Mangrove), as this species also thrives in wetland environments subjected to tidal inundation, similar to marsh habitat.

***Barrier Vegetation* -** all elevated vegetated areas that are not subject to normal tidal action or inundation such that non-wetland species thrive. This class includes all barrier island habitats such as dune, upland, swale, grassland, and shrub.

***Beach* -** unvegetated area adjacent to open water that is subject to direct wave action at some time during the daily tidal cycle or during average storms. Beaches can sedimentologically consist of shell, sand, organic, or a mixture of clasts and grain sizes. Beach habitats do not support permanent vegetation because of frequent reworking by wave action. This includes recent washover deposits that have not yet become vegetated.

***Bare Land* -** areas that are unvegetated and not normally subject to direct wave action. This habitat type may develop as a result of freshly placed dredge material, sparse plant colonization or plant death, and of sediments stranded inland during extreme storm conditions.

***Structure* -** any man-made object fixed to the land surface as a result of construction. Includes roads, industry, residential recreational structures, and residential areas.

***Rip-Rap* -** any material used to armor shorelines against erosion. Includes rocks, cement, debris, and sunken barges.

Mosaiking

The first step in the habitat analysis procedure was to mosaic all the imagery and check that all years of available data were of the same geographic projection standards and formats. Resolution was an additional interest so that all images and georeferenced datasets were able to exactly overlay on top of one another. Such similarity is critical to the overall interpretations and results. In this study 2-m pixel resolution was the foundation for interpretation and all references were determined within UTM 83, zone 15. Digital, rectified imagery was provided by LDNR for all time periods used in the analysis (Figure 2).

Clipping

All of the images were clipped to remove as much of the surrounding water from the shoreline as possible and with a precision that prevented clipping out land or intertidal areas. The goal of the habitat analysis is to classify land and the surrounding ocean water in the image makes classification more difficult and unnecessary. Using Erdas Imagine analysis tools, all of the land in the image is selected by outlining the land with a narrow line dividing the land from the water. The image is then subset to remove the surrounding ocean water, which is not part of the classification analysis, from the image. The subset mosaic is then used for the remaining analysis.

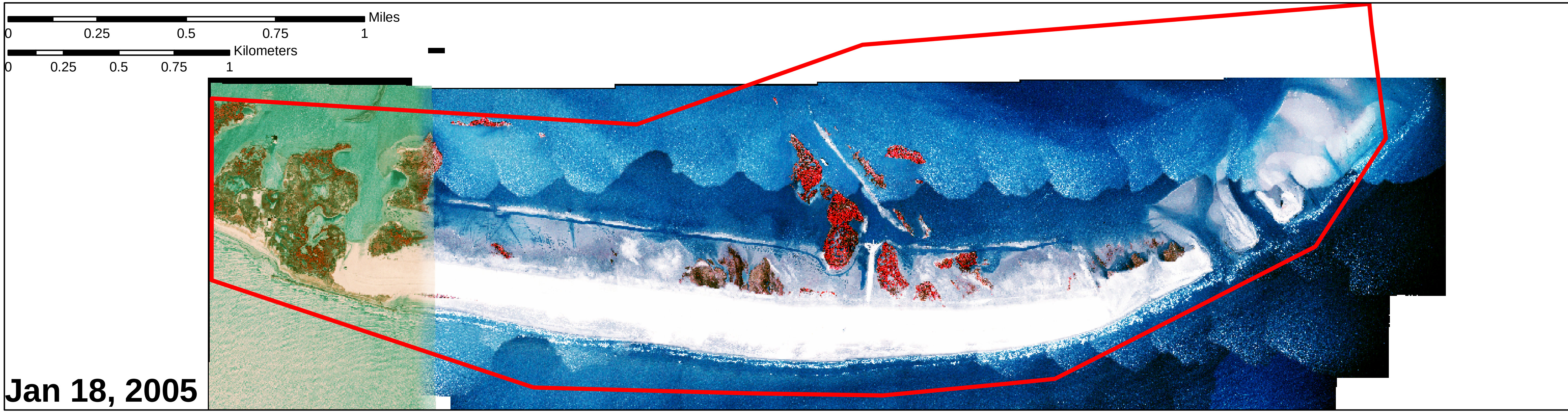
Creating Signatures

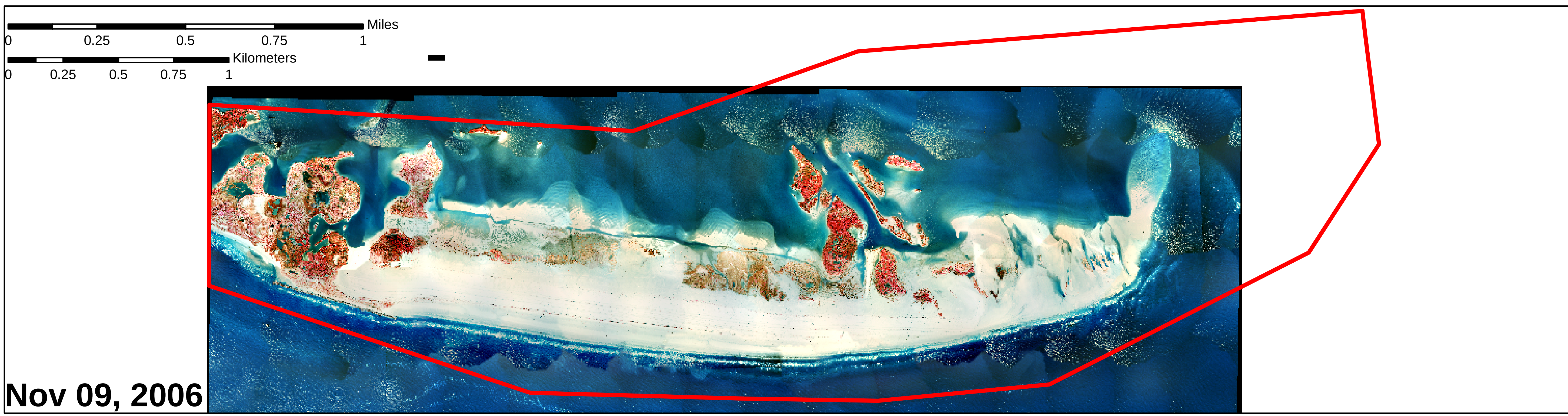
With the subset mosaic, a series of spectral signatures are collected and examined with the goal of defining the spectral value of each habitat class. The classification proceeds by a user selecting a pixel with a particular value that is representative of the class they are working with and creates a signature with corresponding red, green, and blue values for that class. Several signatures are selected for each class to accomplish two goals. The goals are to pick signatures that are representative of the class through out the entire image and also signatures that differentiate one class from another.

Supervised versus Unsupervised Classifications

When a sufficient number of signatures have been collected, which is usually between ten and thirty per class, the user classifies the image on the basis of the signatures. The number of

BICM Habitat Analysis: Timbalier Island (TE-40) Mosaic - 2005 and 2006





The objective of the Timbalier Island Dune and Marsh Restoration Project (TE-40) habitat analysis is to document existing habitats within the project area and allow comparisons between the 2005 (as-built) and the 2006 (1 year post-construction) habitats. Habitat analysis was conducted using the same methods as the Barrier Island Comprehensive Monitoring (BICM) program's analyses for the time periods 1996/98, 2001/2002, 2004 and 2005. The 2005 and 2006 data along with the BICM data will allow long term analysis of habitat changes within the project and implications for future project impacts and performance.

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Figure 2. The 2005 (as-built) and 2006 (1-year post construction) mosaic images of CWPPRA project TE-40 on Timbalier Island

signatures that should be collected depends on the variation of spectral values within each habitat class. Fewer signatures are needed if the spectral value of the habitat class through out the entire image is uniform and more signatures are needed when there is a high amount of variation within the class. This variation often exists because of transitions between image frames during the mosaicking process. The output of the supervised classification is an image in which the software has classified each pixel based on the signatures that the user collected. If the software is unable to classify a pixel it remains unclassified. The unclassified pixels remain blank in the image because the spectral values of these pixels do not fit into any of the defined habitat class signatures.

A second, unsupervised classification is also needed. In an unsupervised classification, the user defines a number of classes and the software separates all of the pixels within the image into the defined number of classes based on the spectral values of the individual pixels. The higher the number of specified classes, the higher the resolution of the unsupervised classification will be. If a small number of classes are chosen by the user, the software will categorize all of the individual pixels in the image into those classes with a large amount of variation within each class's spectral signature. If many classes are chosen, the amount of variation within each class's spectral signature is reduced. For the purposes of this analysis, 20-50 classes were specified for each shoreline segment.

Manual Cleaning

The final part of the analysis uses supervised and unsupervised classifications to classify the unclassified pixels from the supervised classification. The user selects pixels on the unsupervised image that correspond with the unclassified pixels on the supervised image and copies and pastes the locations of those pixels onto the supervised image. The user can then assign those pixels to a particular habitat class.

The unclassified pixels are very few in number compared to the total number of pixels contained within the image. Often an unclassified pixel will be surrounded by classified pixels of a particular class because of slight variations in the spectral values that cannot be recognized in the original mosaic that is used to define the signatures. The software is capable of differentiating between such subtle differences in spectral value. This is the advantage of using the unsupervised classification in the analysis.

As a result of mosaiking, pixels from the same class can have very different spectral values in different parts of the image. In this case, the unsupervised image is subset to select areas within the image that contain pixels from one particular class that are similar to each other in that portion of the image but dissimilar to pixels from the same class in other parts of the image. Pixels selected from the clipped unsupervised image will only paste onto the section of the supervised image that they correspond to. Thus, pixels with the same spectral values can be classified as different classes or alternatively, pixels with different spectral values can be classified as the same class.

The final QA/QC procedures involve examining the classified image manually. The classified image is layered over the mosaic and the user swipes back and forth between the images while zooming in and out to see both individual pixels and a more regional perspective of the image. Final corrections are thus made to the classified image.

Final Classified Image

The final classified images were clipped using one shapefile that represents the maximum extent of the analysis area for both years (2005 and 2006). The northing and easting coordinates in UTM, NAD 83 zone 15 are provided in Table 1. A shapefile of the analysis area is provided digitally in Appendix A.

Table 1. The northing and easting coordinates in UTM, NAD 83 zone 15 of the analysis extent area used in the analysis and presented in Figures 3, 4 and 5.

Vertex	Northing (m)	Easting (m)
1	3218157	745289
2	3217338	745287
3	3216855	746740
4	3216818	748315
5	3216893	749090
6	3217489	750263
7	3217978	750582
8	3218582	750507
9	3218399	748223
10	3218039	747205

Uncertainty and Accuracy of Measurements

Three categories of error can be attributed to this type of remote sensing analysis, including: 1) measurement errors made during rectification and mosaicking that effect the accuracy of each landform position, 2) sampling errors that are directly related to the pixel resolution of the imagery, and 3) statistical errors associated with compiling and comparing habitat type positions (Morton *et al,* (2004). Large measurement inaccuracies can exist in historical surveys (McBride *et al.*, 1992), however the exclusive use of photographic and satellite imagery in this analysis significantly reduce measurement errors to +/-2 m, which takes into account both GPS positioning errors and errors resulting from the resolution of the imagery (Martinez et al., 2009). Sampling error was standardized by re-sampling all imagery to 2m-pixel resolution prior to any habitat analysis. Error associated with statistical averaging of habitat type measurements is accounted for using the standard deviation of the data. All data tables were exported directly from the imagery attribute tables to minimize compilation errors.

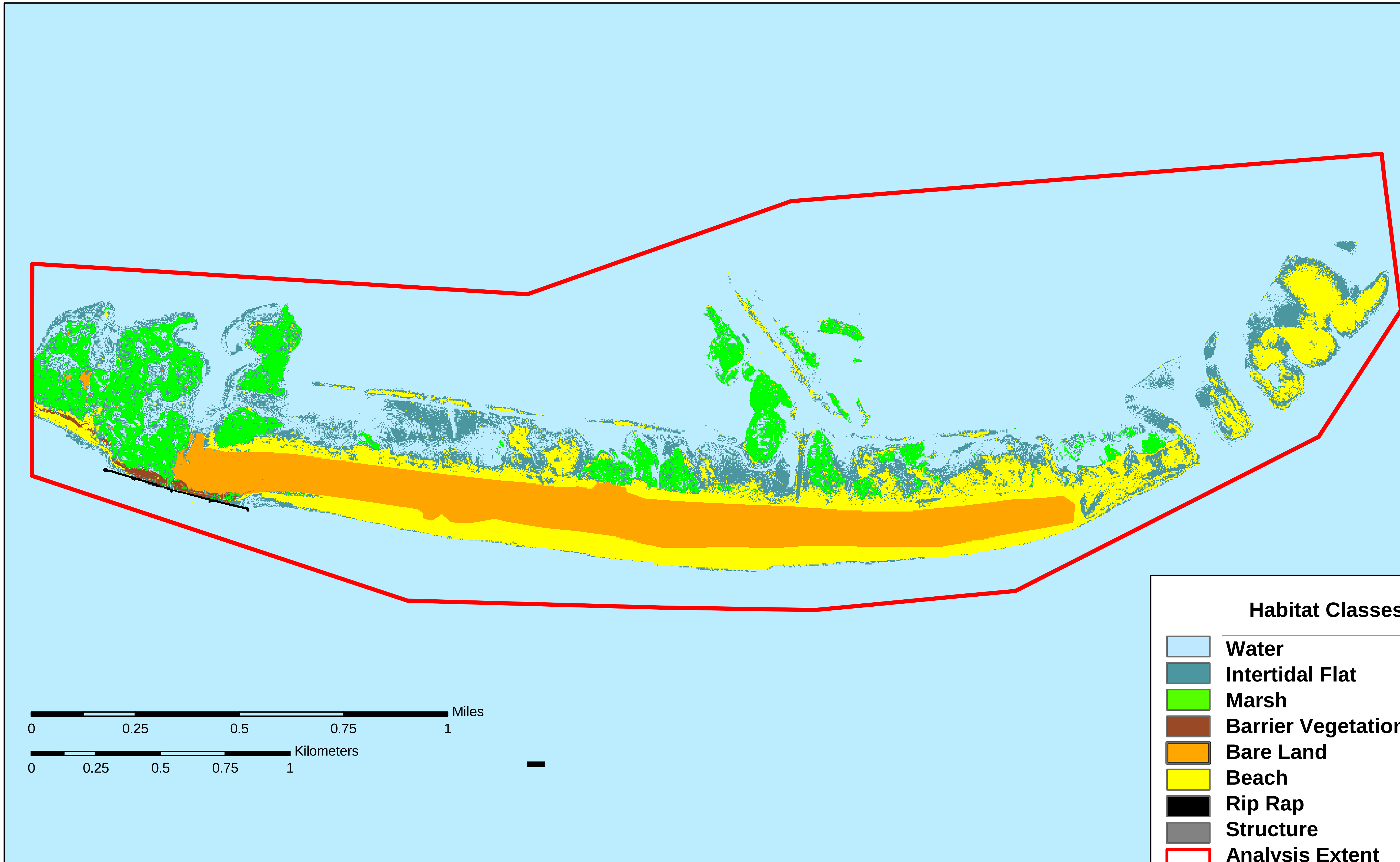
RESULTS AND INTERPRETATIONS

Timbalier Island (TE-40)

Timbalier Island, located in Terrebonne Parish and Bay in southeast Louisiana, is migrating rapidly to the west/northwest. Approximately 4.6 million cubic yards of material was dredged from the Little Pass area to the east of the island and placed on the eastern portion of the island between June and December 2004 (Louisiana Coastal Wetlands Conservation and Restoration Task Force (LCWCRTF), 2009). Sand fencing and vegetation planting followed during the following two years.

The habitat classification for 2005 clearly shows the placed dredge material as a broad expanse of bare land surrounded by a thin extent of beach habitat (Figure 3; Table 2). By 2006, the dredge material has begun to be redistributed throughout the island by wave and wind processes and the acres of bare land habitat decrease (Table 2). Accumulations of sand form beach habitat along the eastern point of the island and beach habitat is encroaching on the bare land all along the gulf shoreline (Figure 4). Further sand accumulations are apparent along the bay side of the island; some covering marsh habitat but most filling in low areas that were open water in 2005 (Figure 5).

BICM Habitat Analysis: Timbalier Island (TE-40) - 2005



Habitat Classes	2005 Acres	2005 Hectares
Water	1121	454
Intertidal Flat	127	51
Marsh	93	38
Barrier Vegetation	3	1
Bare Land	134	54
Beach	158	64
Rip Rap	1	1
Structure	1	1
Analysis Extent	1639	664

The objective of the Timbalier Island Dune and Marsh Restoration Project (TE-40) habitat analysis is to document existing habitats within the project area and allow comparisons between the 2005 (as-built) and the 2006 (1 year post-construction) habitats. Habitat analysis was conducted using the same methods as the Barrier Island Comprehensive Monitoring (BICM) program's analyses for the time periods 1996/98, 2001/2002, 2004 and 2005. The 2005 and 2006 data along with the BICM data will allow long term analysis of habitat changes within the project and implications for future project impacts and performance.

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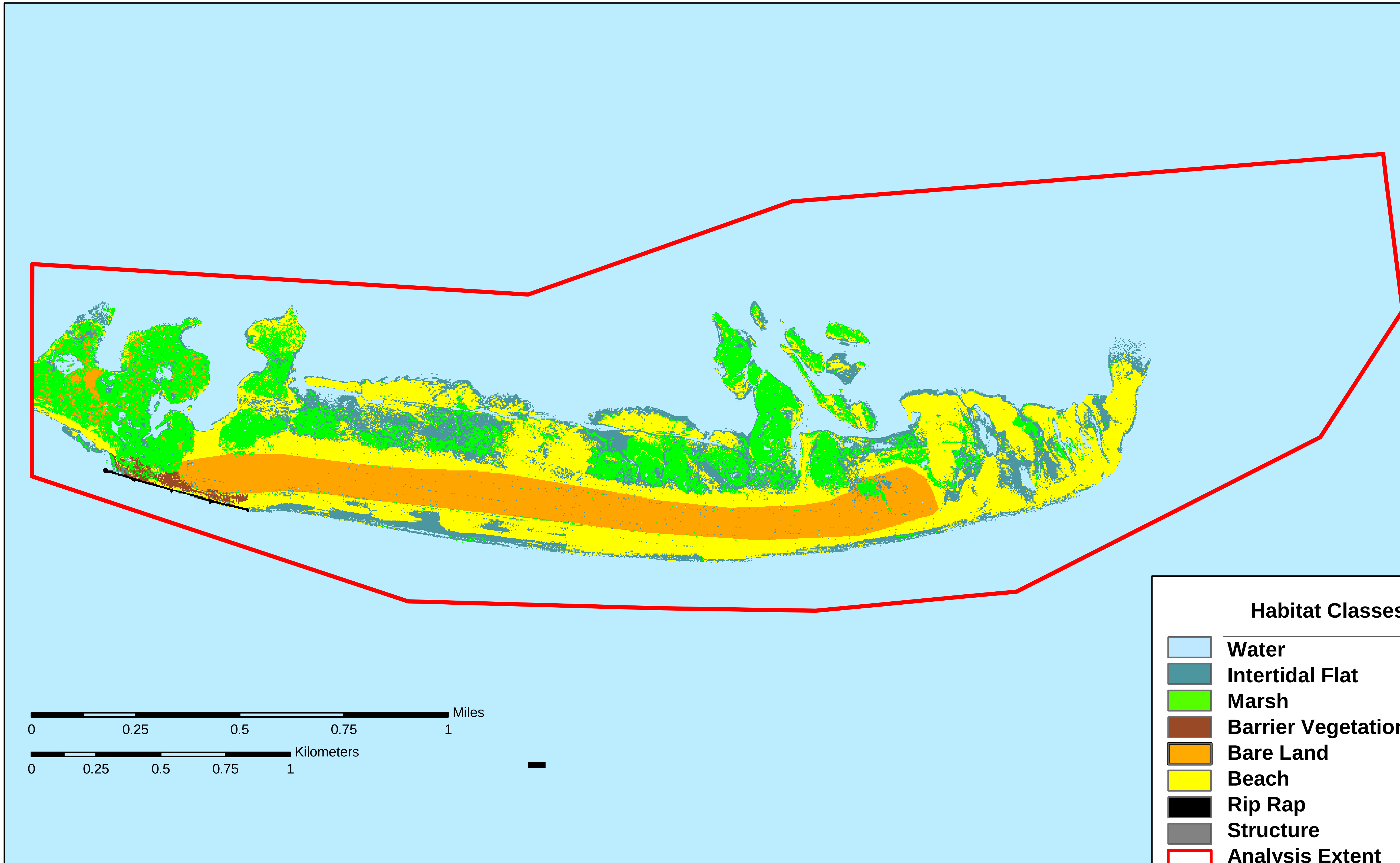
Figure 3. The 2005 habitat classification of the CWPPRA project TE-40 on Timbalier Island

BICM Habitat Analysis: Timbalier Island (TE-40) - 2006



Habitat Classes	2006 Acres	2006 Hectares
Water	1091	442
Intertidal Flat	107	43
Marsh	133	54
Barrier Vegetation	3	1
Bare Land	108	44
Beach	195	79
Rip Rap	1	1
Structure	1	1
Analysis Extent	1639	663

The objective of the Timbalier Island Dune and Marsh Restoration Project (TE-40) habitat analysis is to document existing habitats within the project area and allow comparisons between the 2005 (as-built) and the 2006 (1 year post-construction) habitats. Habitat analysis was conducted using the same methods as the Barrier Island Comprehensive Monitoring (BICM) program's analyses for the time periods 1996/98, 2001/2002, 2004 and 2005. The 2005 and 2006 data along with the BICM data will allow long term analysis of habitat changes within the project and implications for future project impacts and performance.

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Figure 4. The 2006 habitat classification of the CWPPRA project TE-40 on Timbalier Island

BICM Habitat Analysis: Timbalier Island (TE-40) Habitat Change Analysis - 2006 from 2005

Legend (2006 from 2005)	Acreages	Hectares
water from water	967	391
unchanged land	234	95
intertidal flat from water	52	21
marsh from water	37	15
barrier vegetation from water	0	0
bare land from water	1	0
beach from water	64	26
water from intertidal flat	44	18
water from marsh	8	3
water from barrier vegetation	0	0
water from bare land	12	5
water from beach	59	24
water from structure	0	0
intertidal flat from marsh	7	3
intertidal flat from barrier vegetation	0	0
intertidal flat from bare land	6	2
intertidal flat from beach	21	8
marsh from intertidal flat	25	10
marsh from barrier vegetation	1	0
marsh from bare land	2	1
marsh from beach	5	2
barrier vegetation from intertidal flat	1	0
barrier vegetation from marsh	1	0
barrier vegetation from bare land	0	0
barrier vegetation from beach	0	0
bare land from intertidal flat	4	2
bare land from marsh	5	2
bare land from barrier vegetation	0	0
bare land from beach	11	4
beach from intertidal flat	31	13
beach from marsh	9	4
beach from barrier vegetation	1	0
beach from bare land	27	11
rip rap to rip rap	1	1
structure to structure	1	1
anlaysis extent	1638	663

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Figure 5. The 2006 from 2005 habitat change analysis of the CWPPRA project TE-40 on Timbalier Island

Material is beginning to redistribute to the bayside of the island increasing the width but removal of material from the eastern point of the island results in little increase in the overall area of the island (Figure 6). Much of the material that made up a recurved spit on the eastern end of the island has disappeared by 2006; likely moved to the west by the dominant longshore current in the area. Acreages of intertidal flat, marsh, and barrier vegetation remain stable between the two time periods (Figure 6). More than 50 acres of open water is replaced with beach between 2005 and 2006 and there is a increase in bare land at the expense of beach and intertidal habitat (Figure 5; Table 3), which is in agreement with the general redistribution of dredged material placed on the island.

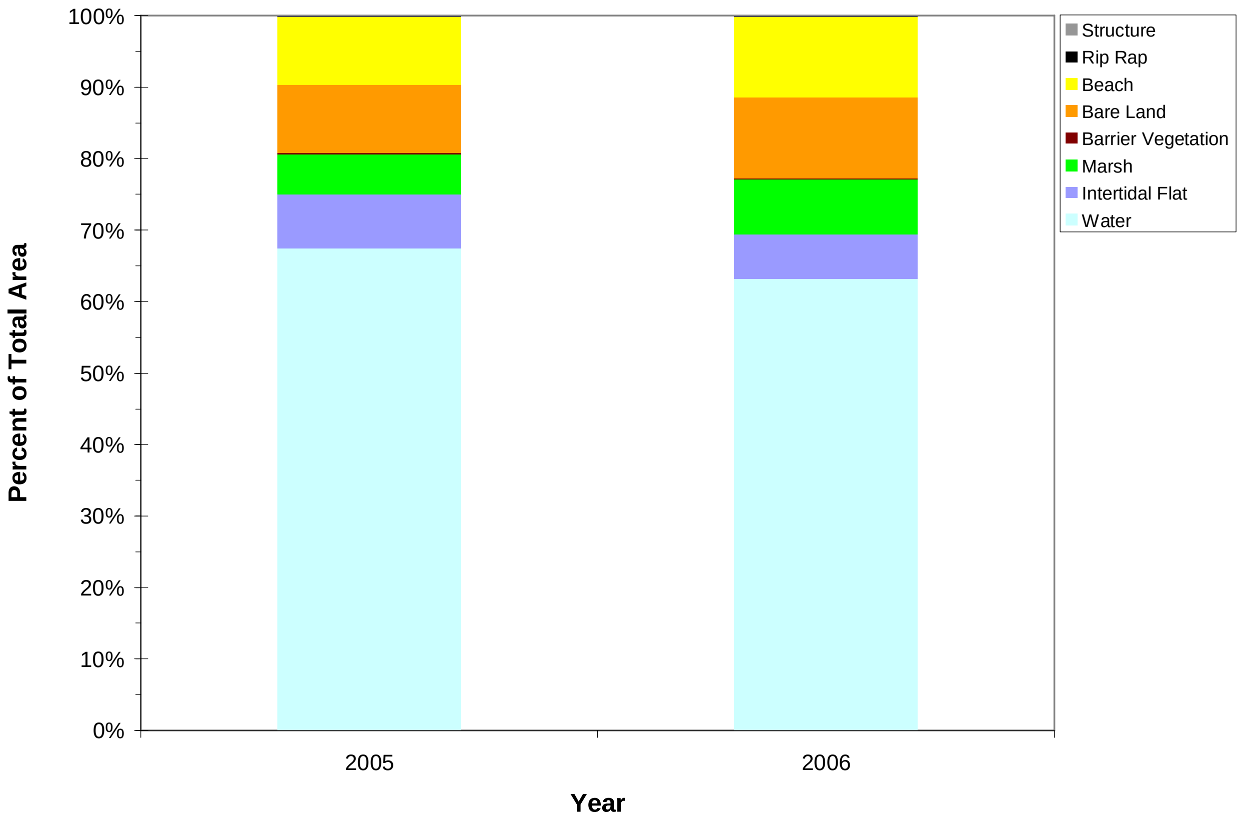

Figure 6. The percentage of different habitats on Timbalier Island in the Lafourche delta plain analysis area during the two analyses time periods. The entire analysis area is 1,639 acres in size.

Table 2. The total amount of land in each habitat class from Timbalier Island in the Lafourche delta plain for the time periods 2005 to 2006.

TE-40					
Habitat Classes	**2005**		**Habitat Classes**	**2006**	
	Acres	**Hectares**		**Acres**	**Hectares**
Water	1121	454	**Water**	1091	442
Intertidal Flat	127	51	**Intertidal Flat**	107	43
Marsh	93	38	**Marsh**	133	54
Barrier Vegetation	3	1	**Barrier Vegetation**	3	1
Bare Land	134	54	**Bare Land**	108	44
Beach	158	64	**Beach**	195	79
Rip Rap	1	1	**Rip Rap**	1	1
Structure	1	1	**Structure**	1	1
Analysis Extent	1639	664	**Analysis Extent**	1639	663

Table 3. Habitat change statistics for Timbalier Island in the Lafourche delta plain for the time periods 2005 to 2006.

Habitat Class			
2006	2005	Acreages	Hectares
water	water	967	391
unchanged land	unchanged land	234	95
intertidal flat	water	52	21
marsh	water	37	15
barrier vegetation	water	0	0
bare land	water	1	0
beach	water	64	26
water	intertidal flat	44	18
water	marsh	8	3
water	barrier vegetation	0	0
water	bare land	12	5
water	beach	59	24
water	structure	0	0
intertidal flat	marsh	7	3
intertidal flat	barrier vegetation	0	0
intertidal flat	bare land	6	2
intertidal flat	beach	21	8
marsh	intertidal flat	25	10
marsh	barrier vegetation	1	0
marsh	bare land	2	1
marsh	beach	5	2
barrier vegetation	intertidal flat	1	0
barrier vegetation	marsh	1	0
barrier vegetation	bare land	0	0
barrier vegetation	beach	0	0
bare land	intertidal flat	4	2
bare land	marsh	5	2
bare land	barrier vegetation	0	0
bare land	beach	11	4
beach	intertidal flat	31	13
beach	marsh	9	4
beach	barrier vegetation	1	0
beach	bare land	27	11
rip rap	rip rap	1	1
structure	structure	1	1
analysis extent		1638	663

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