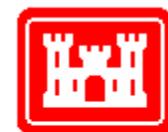




**Louisiana Barrier Island Comprehensive Monitoring Program (BICM)  
Volume 5: Chenier Plain, South-Central Louisiana, and Chandeleur Islands,  
Habitat Mapping and Change Analysis 1996 to 2005  
Part 1: Methods for Habitat Mapping and Change Analysis 1996 to 2005**

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## INTRODUCTION

The goal of the Habitat Analysis was to classify land from the five delta shorelines in the Louisiana Coastal Zone (Fig. 1) for four different time periods and make comparisons of habitat change between the time periods. The approach presented herein follows according to the classification by Penland *et al.* (2004). This is Part 1 of four parts in this Volume 5 of the BICM Final Report. All maps included with the deliverables are presented in Part 2, all data tables and statistical information are presented in Part 3, and the final results and interpretations are provided in Part 4. The objective of this Volume 5, Part 1 is to outline in detail the methods of analysis used to complete the Habitat Analysis for the aforementioned time frames.

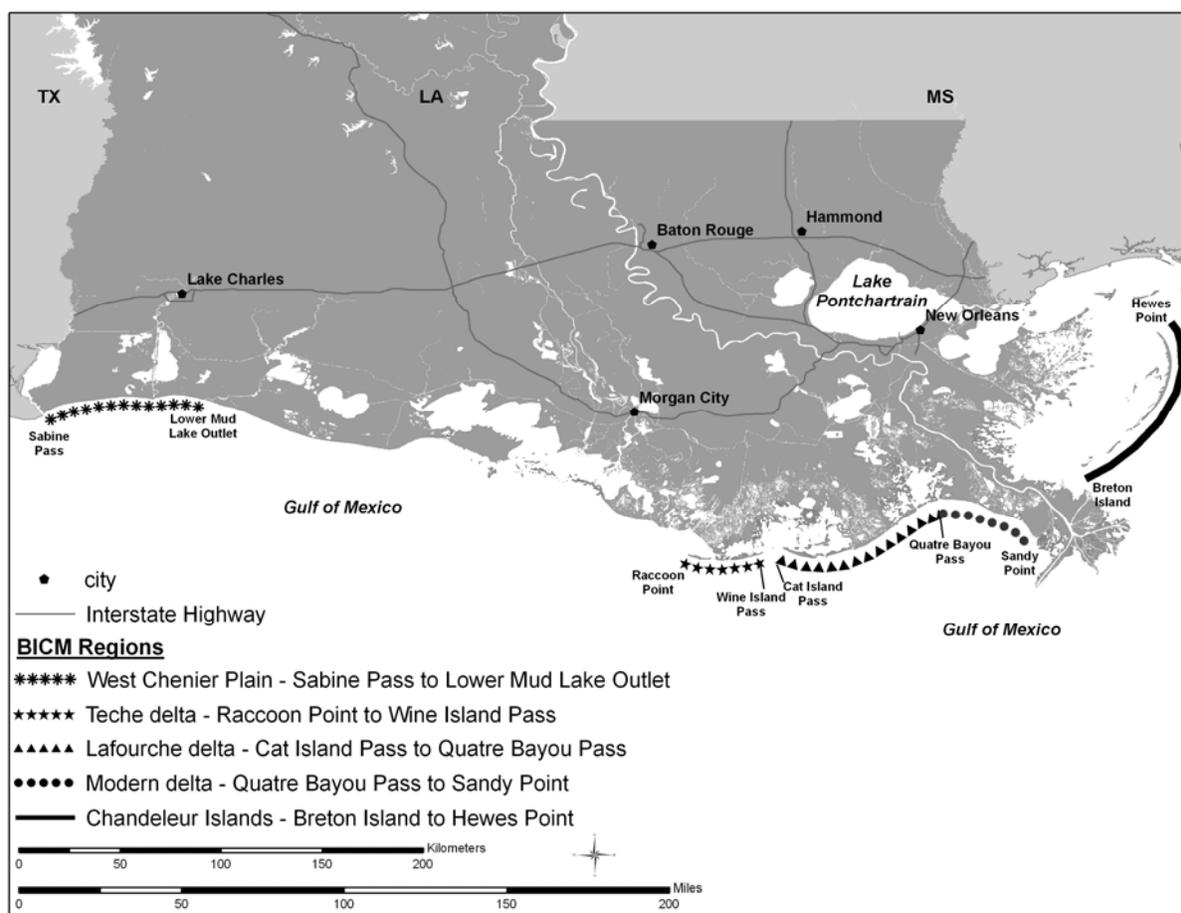


Figure 1. The five sections of shoreline used in the BICM Habitat Analysis include 1) Western Chenier Plain, which extends from the Texas/Louisiana border at Sabine Pass to the Lower Mud Lake Outlet; 2) Teche delta from Raccoon Pass to Wine Island Pass; 3) Lafourche delta from Cat Island Pass to Quatre Bayou Pass, 4) Modern delta continues from Quatre Bayou Pass to Sandy Point; and 5) Chandeleur Islands from Breton Island north to Hewes Point.

## METHODS

All habitat and imagery pixel analysis were completed using Erdas Imagine software, version 9.1. Figure 2 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. The original definitions of each class 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.

Imagery for the Isles Dernieres and East Timbalier Island in the Lafourche shoreline in 1996, and North Chandeleur Islands in 1999 originated as Color Infrared (CIR) aerial photography. CIR photography for the Western Chenier Plain in 2001 was provided digitally by the U.S. Geological Survey, however the frames were neither rectified or mosaiked. Imagery for all shorelines in 2002 came from Digital Globe QuickBird satellite imagery and the rest of the imagery originated as U.S. Geological Survey (USGS) digital orthophoto quarter quads (DOQQs) from 1998, 2004, and 2005 (Table 1). The CIR aerial photography used in this analysis was created from film scanned with 24-bit color and 1-meter spatial resolution. Each pixel on the photograph represents one meter or about three feet square on the ground. The CIR aerial photographs and QuickBird satellite imagery were registered to the USGS DOQQ's prior to shoreline extraction to ensure they meet National Map Accuracy Standards for 1:12,000-scale maps.

Mosaics created using imagery from sources listed in Table 1 existed for most areas prior to the start of this analysis. New mosaics were created for the Plaquemines shoreline for 2002, the Plaquemines and Lafourche shorelines for 1998, and the Western Chenier Plain shoreline for 2001. The existing mosaics were inspected to ensure that they covered the area of interest and were in the appropriate projection and resolution. Several of the images from 2005 including those for Timbalier and East Timbalier islands were in WGS 84 and had to be re-projected into the appropriate projection, UTM 83 zone 15.

Table 1. List of shorelines included and the source of the original imagery, which was classified into different habitat types based on the classification developed by Penland *et al.*, (2004). CIR indicates the source of the imagery was color infrared imagery, Quickbird indicates the source was Digital Globe QuickBird satellite imagery, and DOQQ indicates the imagery originated as U.S. Geological Survey (USGS) digital orthophoto quarter quads.

<b>Barrier Shoreline</b>		<b>1996/1998</b>	<b>2001/2002</b>	<b>2004</b>	<b>2005</b>
West Chenier Plain	Johnson's Bayou/Holly Beach	DOQQ(1998)*	CIR (2001)*	DOQQ(2004)*	DOQQ(2005)*
	Cameron/Hackberry Beach	DOQQ(1998)*	CIR (2001)*	DOQQ(2004)*	DOQQ(2005)*
Teche	Raccoon Island	CIR (1996)**	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	Whiskey Island	CIR (1996)**	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	Trinity Island	CIR (1996)**	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	East Island	CIR (1996)**	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
Lafourche	Timbalier Island	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	East Timbalier Island	CIR (1996)**	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	Caminada Headland	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	Grand Isle	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	Grand Terre	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
Modern Delta	Chaland Headland	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	Bay Jo Wise	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	Shell Island	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	Scofield	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	Sandy Point	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
Chandeleur Islands	Breton Island	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	Curlew/Gossier	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*
	North Chandeleur Island	DOQQ(1998)*	QuickBird <sup>+</sup>	DOQQ(2004)*	DOQQ(2005)*

\*U.S. Geological Survey

\*\*University of New Orleans-Pontchartrain Institute for Environmental Sciences (UNO-PIES)

<sup>+</sup>Digital Globe acquired by UNO-PIES

## **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 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.

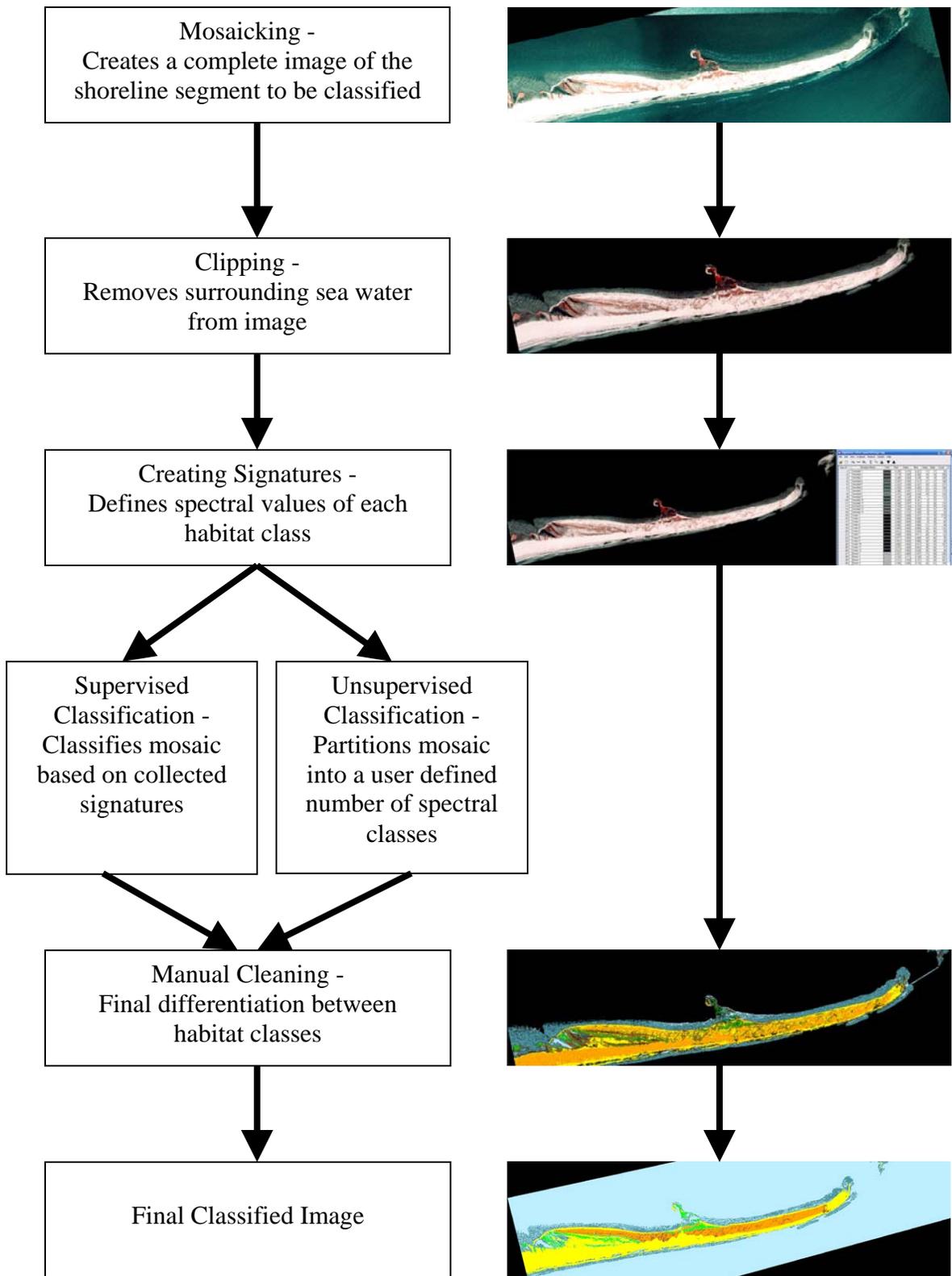


Figure 2. Flow chart of habitat classification with examples from the East Island 2005 classification analysis using Erdas Imagine software.

## **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.

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