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GEOLOGIC INVESTIGATIONS PROGRAM

COMPREHENSIVE SHORELINE MAPPING, BALDWIN AND MOBILE COUNTIES, ALABAMA: PHASE III

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by

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INTRODUCTION

The purpose of this study is to classify shoreline protection and general shoreline type and to quantify shoreline change, where applicable, in Mobile and Baldwin Counties, Alabama. The overall project is divided into Phases I through III. Field work efforts for Phase I occurred between March 16, 2009, and November 6, 2009, during which the GSA mapped and documented about 210 miles of shoreline in Mobile Bay, Weeks Bay, Fish River, Magnolia River, Deer River system, and Fly Creek (Jones and others, 2009). During Phase II the study areas included Bon Secour River, Oyster Bay, Little Lagoon, the Gulf Intracoastal Waterway (Alabama segment), Wolf Bay, the "Dog River System," and adjoining navigable tributaries as mapped between March 16, 2010, and October 29, 2010. The current or Phase III study areas include Perdido Bay including tributaries, Ono Island, Bayou St. John, Arnica Bay, Bayou La Launch and lower portion of Wolf Bay, North Wolf Bay including tributaries, Fowl River, North Dauphin Island, Bayou La Batre, Grand Bay, Portersville Bay, Fowl River Bay, Heron Bay and adjoining navigable tributaries as mapped between October 29, 2010, and February 23, 2012. This project is a cooperative effort between Alabama Department of Conservation and Natural Resources, Lands Division, Coastal Section (ADCNR) and the Geological Survey of Alabama (GSA) to accomplish the aforementioned tasks in Alabama's coastal zone.

Shoreline type and stabilization methods play an important role in the Alabama coastal area with both adverse and favorable impacts to shorelines. As a result of natural processes and anthropogenic influences, the intertidal area of coastal Alabama is constantly changing and change can occur extremely rapidly or subtly. Regardless of the rate of change, continuous development along coastal shoreline is inevitable and is a key factor in the observed change. Shoreline stabilization is the final overarching goal of erosion control projects and, because of persistence in coastal erosion, hard shoreline

structures and non-structural shoreline protection types are found throughout coastal Alabama.

Although erosion is a natural process along a tidal shoreline, hard shoreline stabilization techniques can limit erosion and potential effects of sea level rise. The installation of hard shoreline structures can negatively impact nearshore and intertidal zones and upland habitat, alter established littoral patterns and shoreline dynamics, destroy existing marsh and curtail marsh development seaward of hard structures, decrease the aesthetic value of property, as well as accelerate impacts of erosion on adjoining properties (Kana and others, 1995; Pennsylvania Department of Environmental Protection, 2001; LaRoche, 2007; National Park Service, 2009). Based on work by Stewart (2001), Johannessen and MacLennan (2006), LaRoche (2007), and the Louisiana Department of Natural Resources (2009), shoreline stabilization and type mapping can be used to:

- assist with shoreline planning, permitting coastal zone activities, Coastal Zone Management oversight, and further develop ordinances and regulatory guidelines;
- provide an effective tool for the assessment and forecasting of shoreline change and understanding cumulative and compounding effects of natural and anthropogenic influences through data acquisition;
- prioritize or evaluate protected shorelines for future conversion to a soft shoreline protective measure or alternative method and identify potential demonstration project areas for alternative methods;
- allow coastal managers access to up-to-date shoreline stabilization trends and characteristics through geospatial mapping;
- promote assessment of sediment management issues, coastal erosion, habitat protection, and flooding projects;
- promote new and improved methods for shoreline stabilization measures that have a positive impact on natural habitat, adjoining properties, and aesthetics; and
- promote governing and public education and awareness.

This report briefly describes shoreline protection and general type and shoreline change estimates within sections of the Alabama coastal zone in support of Section 309 of the Coastal Zone Management Act of 1972. Currently, no comprehensive inventory of geographic information system (GIS) thematic layers representing shoreline protection, shoreline type, and comprehensive compilation of public and private boat ramps for coastal Alabama exists. In addition, there is a need to further quantify areas of short-

term erosion in coastal Alabama. The main objectives of this study, through the application of GIS, are to classify shoreline protection methods, classify general shoreline types, and quantify shoreline rates of change based on the available orthophotography.

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PREVIOUS INVESTIGATIONS

Limited work has been done quantifying and mapping shoreline armoring and generalized type and shoreline change estimates within the tidal zones of Baldwin and Mobile Counties, Alabama. It has been recognized that both natural stressors and human activities play a role in hydrodynamics and shoreline change in coastal Alabama (Chermock, 1974; Hardin and others, 1976; Sapp and others, 1975; Alabama Coastal Area Board (ACAB), 1980; Smith, 1981; Douglass and Pickel, 1999a, b). Natural and human factors include the construction of waterways, roads, and hard shoreline stabilization structures; the clearing or filling of shoreline-adjoining habitats such as maritime forest, beach and dune, and wetland; sediment supply; soil properties; and exposure to currents, waves, and storms. Private property owners and governing entities have constructed shoreline structures to minimize shoreline erosion which often leads to erosion on adjoining shorelines and net loss in the intertidal zone (Sapp and others, 1976; Douglass and Pickel, 1999a).

SHORELINE CLASSIFICATION MAPPING

Until recently, the amount of shoreline armoring has been determined through historical maps and aerial photography with limited field data acquisition. Sapp and others (1976) determined that the filling of wetlands and the construction of jetties, groins, and seawalls were partly evident in the 1700s. Smith (1981) and ACAB (1980) also determined the position of bulkheads, groins, jetties, and other forms of stabilization as related to shoreline loss and sediment retention. Formally considered the most reliable estimate to date, the work by Douglass and Pickel (1999a, b) determined that 30 percent of the shoreline in Mobile Bay was armored by bulkheads and rubble by 1997; of the 153,400 feet of armored shoreline mapped, 71 percent, 21 percent, and 8 percent were bulkhead, rubble-mound revetment, and trash revetment, respectively. Their findings are tabulated in table 1.

Table 1.—Determined length of armored and natural shoreline in Mobile Bay, Alabama (modified from Douglass and Pickel, 1999a).

	Armored		Natural		Area of significant change in shoreline armoring
Year	Feet	Percent	Feet	Percent	
1955	39,900	8	475,600	92	Point Clear, Mullet Point
1974	72,000	14	443,500	86	Point Clear to Mullet Point, Morgan Peninsula, and part of western Mobile Bay
1985	132,000	26	383,500	74	western Mobile Bay, Mullet Point to Weeks Bay
1997	153,400	30	362,100	70	Fairhope to Weeks Bay, west Mobile Bay

Through a cooperative effort between ADCNR and GSA, a three phased mapping project was implemented to address the geospatial context of shoreline protection and change. Phase I findings for Mobile Bay and additional areas are tabulated in table 2. For example, about 721,776 feet (or 136 miles) of Mobile Bay shoreline was mapped with 38.4 percent found to be armored. Through the application of GIS technology and extensive field activities, Jones and others (2009) determined the most predominant shoreline protection structures are bulkheads followed by rubble/riprap. The main shoreline types were organic and vegetated bank.

Table 2.—Results from Phase I activities as mapped and calculated using GIS for Baldwin and Mobile Counties, Alabama (modified from Jones and others, 2009).

Mapped area	Shoreline length (feet)	Hard armored shoreline/natural (percent)	Unretained shoreline (percent)
Mobile Bay	721,776	38.4	61.4
Weeks Bay	60,192	26.1	73.9
Fish River	158,928	24.3	75.7
Magnolia River	81,312	16.5	83.5
Deer River System	80,256	31.1	68.9
Fly Creek	15,312	52.8	47.2

Jones and Tidwell (2011) expanded on the previous work of Jones and others (2009) to include the shoreline characterization and change analysis mainly within the Dog River System, the Bon Secour River, and Little Lagoon. Findings for shoreline protection for these and additional areas are tabulated in table 3. The largest area mapped was Dog River (about 127 miles of shoreline) with 31.7 percent protected. Of the 199.6 miles of shoreline mapped for protection, about 32 percent is protected mainly by bulkhead and riprap. The main shoreline types were organic and vegetated bank.

Table 3.—Results from Phase II activities as mapped and calculated using GIS for Baldwin and Mobile Counties, Alabama (modified from Jones and others, 2011).

Mapped area	Shoreline length (feet)	Hard armored shoreline/natural (percent)	Unretained shoreline (percent)
Dog River System	669,399	31.7	68.3
Bon Secour River System	184,841	28.8	71.2
Oyster Bay	55,179	18.4	81.6
Little Lagoon	174,449	31.7	68.3
Intracoastal Waterway	88,644	51.1	48.9
Wolf Bay	35,187	0.0	100.0

SHORELINE CHANGE

As summarized by Jones and others (2009). Mobile Bay has been the focus of previous shoreline erosion studies (Hardin and others, 1976; ACAB, 1980; Smith, 1981). This cooperative project allowed for the quantification of shoreline change. Results from

Phase I and Phase II investigations are presented below. The results represent selected transects with valid statistical significance from the total transects generated.

During Phase I, Jones and others (2009) determined shoreline change rates from orthophotography dating between 1996 and 2008, using the Digital Shoreline Analysis System (DSAS) (Thieler and others, 2009) for change analysis and statistics. In agreement with the findings by Hardin and others (1976) and ACAB (1980), areas of erosion were common on the western Mobile Bay and northern Morgan Peninsula shorelines. Although moderate erosion was quantified at other locations along western Mobile Bay, western Mobile Bay exhibited high recession trends in the vicinity of Deer River and Point Judith. A mean shoreline change rate of -8.2 ± 4.5 feet per year was quantified near the mouth of Deer River (Jones and others, 2009). Significant erosion was quantified in Mobile Bay on Morgan Peninsula in the vicinity of St. Andrews Bay, Little Point Clear, and Three Rivers where rates of shoreline erosion range from -5.0 ± 1.3 to -29.3 ± 4.5 feet. Similar to the findings by the ACAB (1980), eastern Mobile Bay exhibited slight erosion trends south of Ragged Point as did locations along Bon Secour Bay and the area between Fish River Point and Seymour Bluff.

Shoreline change detection for Wolf Bay, Little Lagoon, Cotton Bayou, and Terry Cove for Phase II was determined from orthophotography dating between 1996 and 2010. With a mean shoreline change rate of -1.69 ± 0.99 ft/yr determined for Wolf Bay, about 97 percent represented erosion with a maximum and mean of -6.36 ± 1.64 ft/yr and -1.79 ± 0.56 ft/yr, respectively. Erosion is most notable along the eastern shoreline, the western shoreline along and north of Mulberry Point, and the north shoreline. Represented by 556 selected transects covering 45 percent of the Little Lagoon shoreline, erosion and accretion were about 76 percent and 24 percent, respectively. A maximum erosion rate of -7.15 ± 1.48 ft/yr and a mean erosion of -1.09 ± 0.61 ft/yr were distributed along the shoreline and appear a function of boating and maintenance. For the Cotton Bayou shoreline, the maximum and mean erosion rates are -7.51 ± 2.98 ft/yr and -1.59 ± 0.83 ft/yr, respectively. A high percentage of selected Terry Cove transects (93 percent) was quantified as receding at a maximum rate of -3.97 ± 0.85 ft/yr with a mean of -1.79 ± 0.57 ft/yr.

STUDY AREA

Baldwin and Mobile Counties encompass over 2,800 square miles with the terrain area consisting mainly of mixed forest, evergreen forest, and agriculture-grassland cover types (U.S. Census Bureau, 2007; Keller and Bowman, 2006) and includes about 53 statute miles of Gulf of Mexico-fronting coastline and 607 statute miles of tidal shoreline (National Atlas of the United States, 2005). With the exception of developed areas, pine savannah, maritime forest, beach and dune, and marsh are the dominate land cover types in water-fronting land.

These counties lie within two physiographic districts: the Southern Pine Hills and the Coastal Lowlands (Sapp and Emplaincourt, 1975) (fig. 1). The Southern Pine Hills district is characterized by broad, rounded hills of low relief with segregated flat upland areas. As the number of incised channels increase with distance from the broad alluvium deposits, a dendritic drainage pattern is evident with well defined stream channels, narrow riparian buffers, and occasional steep stream banks. The Coastal Lowlands district is of very low relief and is characterized by abundant sand which allows for broad floodplains and wide riparian wetlands. The area is underlain by the Miocene series undifferentiated and the Citronelle Formation of Pliocene and Pleistocene age (fig. 1).

The study areas for Phase III and described herein are Ono Island, Bayou St. John, Northeast Perdido Bay, Southwest Perdido Bay and adjoining tribuatries, Arnica Bay, Bay La Launch and South Wolf Bay, Hammock Creek, Wolf Bay tributaries, North Fowl River, South Fowl River, Herron Bay, Fowl River Bay and Portersville Bay, Grand Bay, Bayou La Batre, Coden Bayou, Isle aux Herbes, Dauphin Island and Baldwin Beaches (fig2).

METHODOLOGY

This assessment was conducted for the purpose of developing shoreline protection and generalized type classification data. A shoreline vector modeling database was developed by using GIS during field reconnaissance and by using estimates of shoreline rates of change based on the GIS modeling of digitized historical shorelines from orthophotography.

Thematic development and modifications were performed using the Environmental Systems Research Institute, Inc. (ESRI®) ArcGIS® ArcInfo® 9.3 platform including ArcCatalog™ and ArcToolbox™. This software provided the necessary tools for data development, management, and portability. One update was needed to the GIS

platform to facilitate data acquisition. The visual basic script for ArcGIS, “legend attribute,” was acquired and installed to attribute polyline and point shapefiles with unique classification entries (Hare, 2006). The script or extension promoted initial development of the classification attributes and allowed for further classification modifications during field collection (Gallant, 2009).

The base layer selected for the project is 0.5-meter pixel resolution (mission date: March 2006; horizontal position accuracy: 5 meters) color orthophotography collected and processed by Aerials Express, LLC, for the USGS to supply “best available” orthophotography to end users for urban coverage and pre- and post-hurricane planning in coastal areas (USGS, 2007). Although this image set does not include the middle waters of Mobile Bay or extreme northern Baldwin and Mobile Counties, its use is desirable because it minimizes file size, increases GIS performance and response, and eliminates coverage outside the project extent.

It should be noted that because GIS themes were developed, metadata documentation was processed through ArcCatalog and written to provide specific theme reference information such as abstract, purpose, lineage, data quality, time and scale of data, spatial reference, process step(s), attributes, disclaimers, and other information. Metadata was formally parsed using mp 2.7.33 developed by the USGS in October 2002. The function of the mp program is to identify errors within a metadata document that are inconsistent with the Content Standard for Digital Geospatial Metadata (CSDGM) (FGDC, 1998). Every effort was made to identify and correct discrepancies and warnings in compliance with CSDGM while retaining the metadata record as developed by the originator.

Shoreline mapping was conducted using a 20-foot Blue Wave® 200 V-Bay boat provided by ADCNR and a Fujitsu LifeBook® T5010 tablet personal computer preloaded with GIS software, project base layer orthophotography, and GIS themes. Field acquisition was expedited through real-time GPS tracking within the GIS and continuous editing of the shapefiles. Shoreline protection and general type were classified by visual field interpretation. The shoreline protection classification was conducted by evaluating material placed in one of three places: seaward of the shoreline, along the shoreline, or landward of the shoreline. The shoreline was used to classify shoreline type, but when prohibited by shoreline stabilization, type was evaluated landward behind the shoreface to determine the shoreline type. For Phase III, field work began on October 29, 2010 and was concluded on February 23, 2012.

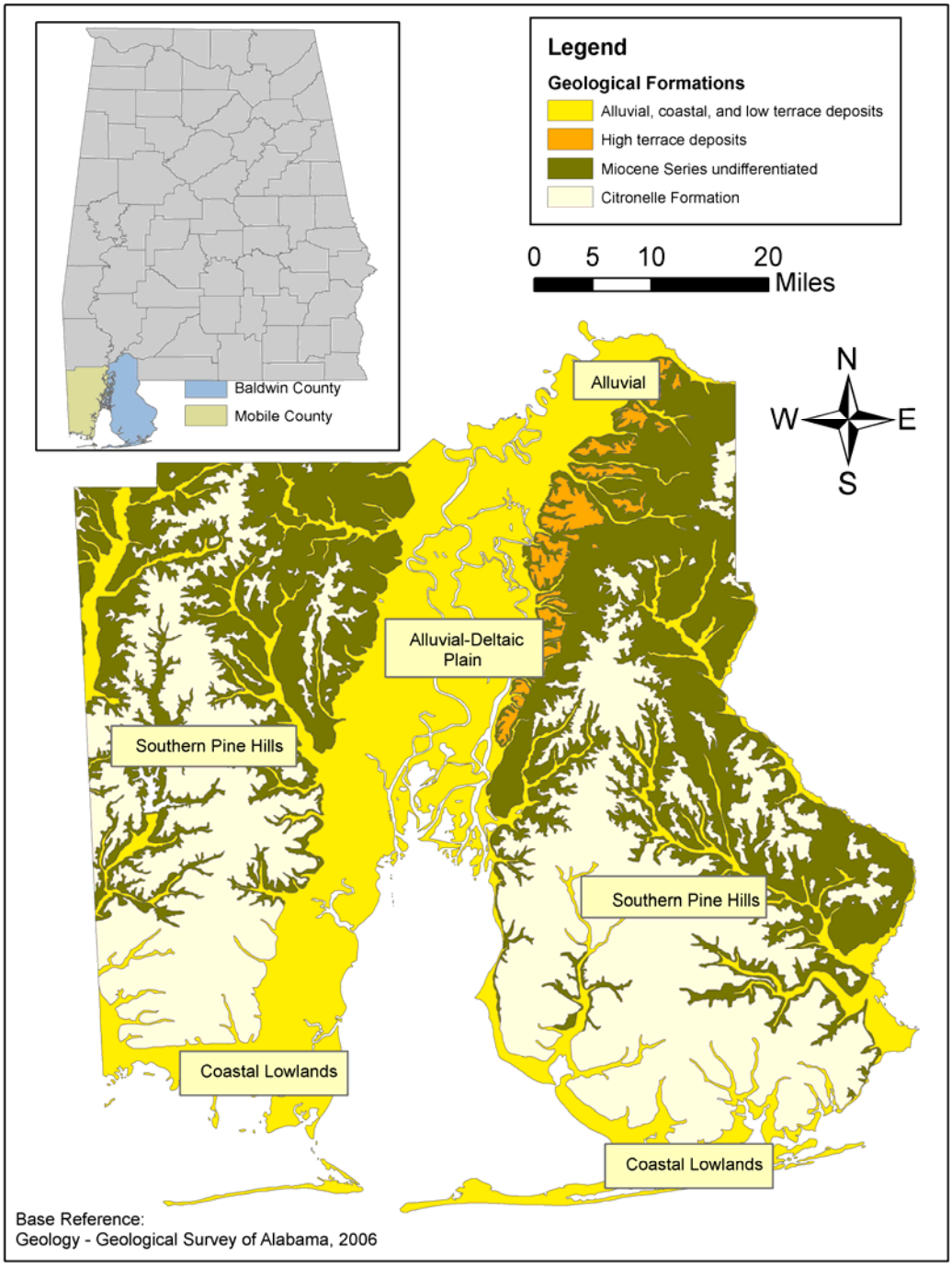

Figure 1.--Generalized geology and physiography in Baldwin and Mobile Counties, Alabama.

Figure 2.--Study area map.

SHORELINE CLASSIFICATION SCHEME

The shoreline protection and shoreline type categories were updated from last year to include areas where new shore protection types were encountered. Table 3 represents shoreline protection and type classifications. In addition to base layer data, the classification aspect consists of four geospatial thematic layers: shoreline protection polylines, shoreline type polylines, public and private boat ramp point locations, and photo point locations.

SHORE PROTECTION CLASSIFICATION

Sixteen categories were designated to describe shore protection where the bulkhead, rubble/riprap, and sill were subdivided with modifiers to better depict the types of hard shoreline protection (table 4). Jones and others (2009) detailed the types and provided examples of each hard shore protection classification. It should be noted that the natural, unretained shoreline represents a shore “protected” within a natural setting by only vegetation or sediment with no apparent hard shoreline modification to protect the land behind it. The natural, unretained shoreline is commonly associated with wetland environments and undeveloped properties. It is likely that the rubble/riprap classification used in this study represents that identified by Douglass and Pickel (1999a) as “trash revetments” and “rubble-mound revetments.”

SHORELINE TYPE CLASSIFICATION

Eight broad categories were designated to describe shoreline type (table 4). Jones and others (2009) detailed the types and provided examples of each shoreline type. Several subcategories were developed to better depict shoreline types and are mainly applied to vegetated bank, sediment bank, and organic categories. It should be noted that the growth of natural vegetation and hydrodynamic processes alter shorelines and, thus, delineating the artificial shoreline class can be problematic and is not always feasible.

Table 4.--Shoreline protection and type mapping classifications.

Shore Protection Classification (Shoreline Armoring)	Shoreline Type Classification (Natural Shoreline Characteristics)
1. Abutment 2. Artificial 3. Beach Nourishment 4. Berm 5. Berm (rock rubble) 6. Bioengineered (vegetated) 7. Boat ramp 8. Boom 9. Breakwater (reef balls) 10. Breakwater (offshore) 11. Breakwater (oyster shell) 12. Bulkhead (concrete, rock w/riprap and groin) 13. Bulkhead (concrete, rock w/riprap) 14. Bulkhead (concrete, rock) 15. Bulkhead (creosote fence post) 16. Bulkhead (steel, wood) 17. Bulkhead (w/groin) 18. Bulkhead (w/retaining walls and groin) 19. Bulkhead (w/retaining walls and riprap) 20. Bulkhead (w/retaining walls) 21. Bulkhead (w/riprap and groin) 22. Bulkhead (w/riprap and sill) 23. Bulkhead (w/riprap) 24. Bulkhead (w/riprap, sill and groin) 25. Bulkhead (w/sill) 26. Cement 27. Concrete rubble (nearshore) 28. Groin 29. Groin (detached) 30. Jetty (steel pile, rock, concrete) 31. Natural (rock) 32. Natural (w/retaining wall) 33. Natural, unretained 34. Oyster shells 35. Revetment 36. Rubble/riprap 37. Rubble/riprap (w/groin) 38. Rubble/riprap (w/silt fence) 39. Rubble/riprap (w/tires) 40. Seawall (concrete, steel piles) 41. Segmented Breakwater (bagged oyster shell) 42. Segmented Breakwater (oyster shell) 43. Segmented Breakwater (reef ball/oyster dome) 44. Segmented Breakwater (reefBLK) 45. Segmented Breakwater (riprap) 46. Segmented Breakwater (wave attenuation device) 47. Sill (rock, shell) 48. Sill (steel sheeting) 49. Sill (wood w/riprap) 50. Sill (wood) 51. Silt fence 52. Tires 53. Weir 54. Wetland Restoration 55. Wire fence	1. Artificial 2. Vegetated bank shoreline a. Bluff b. High bank c. Low bank 3. Sediment bank shoreline a. Bluff b. High bank c. Low bank 4. Organic shorelines a. Open shoreline vegetated fringe b. Swamp forest c. Marsh 5. Sediment bank shoreline a. Bluff b. High bank c. Low bank 6. Inlet a. Ebb-tide delta b. Flood-tide delta 7. Pocket beach 8. Rock bank (low)

SHORELINE RATE OF CHANGE

The GSA uses the Digital Shoreline Analysis System (DSAS) version 4.0 (Himmelstoss , 2009; Thieler and others, 2009) for shoreline change analysis. Functionality and attributes of DSAS are described in the user guide (Morton and others, 2004; Himmelstoss, 2009). The DSAS model is an extension that enhances the normal functionality of ArcGIS to model shoreline change rates and generate statistics from historical shoreline vector data. These data are provided in the GIS project and are attributed to the transect vectors. Incorporating the DSAS model into shoreline monitoring allows for repeatable, first approximation shoreline change analysis, creates an environment suitable for site specific analysis, facilitates updates as needed, and implements an existing modeling tool recognized across governmental agencies.

Imagery for the years of 1996, 1997, 2001, 2002, 2005, 2006, 2008, 2009 and 2010 were collected from sources such as the Baldwin County Commission, the Mobile County Department of Revenue, and the United States Geological Survey. These data were evaluated for spatial accuracy using ArcGIS®. Shoreline vectors were created for each year by digitizing the wet/dry line in ArcGIS. This process was conducted at a close scale to minimize spatial error. Continuous shoreline vectors are not possible due to various factors, including vegetated or canopied shorelines, bulkheads, or other manmade or natural features that obscured or prohibited change of the shoreline. As pointed out by Stewart (2001) and further modified during this study, limitations in the use of orthophotography for shoreline vector development and DSAS modeling is limited mainly by the resolution of source orthophotography, availability of historic orthophotography for the study area, and shadows, glare, aquatic vegetation, and over-head obstructions disallowing the development of shoreline vectors. An estimate of error (table 5) has been calculated for each vector as described in Fletcher and others (2003), Morton and others (2004), and Jones and Patterson (2007).

Table 5.--Shoreline vectors and error estimates used in Digital Shoreline Analysis System (DSAS) modeling.

Measurement Errors	1996, 50' (m)	1996, 100' (m)	1996, 200' (m)	1996, 400' (m)	1997 (m)
Rectification Error (E_r)	0.381	0.762	1.524	3.048	1.524
Digitizing Error (E_d)	2	2	2	2	2
T-sheet Surveying Error (E_t)	0	0	0	0	0
Shoreline proxy offset (E_o)	0	0	0	0	0
Lidar position error (E_l)	0	0	0	0	0
Total Position Error (E_{sp})	2.04	2.14	2.51	3.65	2.51
	2001 (m)	**2002 (m)**	**2005 (m)**	**2006 (m)**	**2008 (m)**
Rectification Error (E_r)	0.762	1.524	0.762	1.524	3.34
Digitizing Error (E_d)	2	2	2	2	2
T-sheet Surveying Error (E_t)	0	0	0	0	0
Shoreline proxy offset (E_o)	0	0	0	0	0
Lidar position error (E_l)	0	0	0	0	0
Total Position Error (E_{sp})	2.14	2.51	2.14	2.51	3.89
	2009 (m)	**2010 (m)**			
Rectification Error (E_r)	0.762	2			
Digitizing Error (E_d)	1	1			
T-sheet Surveying Error (E_t)	0	0			
Shoreline proxy offset (E_o)	0	0			
Lidar position error (E_l)	0	0			
Total Position Error (E_{sp})	1.26	2.24			

A baseline was constructed seaward and parallel to the shoreline trend. Using DSAS modeling and a 10-meter spacing and perpendicular to the baseline, transects were cast at 50 and 600 meters, depending on the baseline to shoreline distance. A confidence interval of 90% was applied. Fletcher and others (2003) reported vector error as random, uncorrelated, and unbiased, and therefore, it can be absorbed into the confidence interval calculated by the linear regression model.

To prevent inaccurate calculations, select transects were manually eliminated in areas represented by less than three historical shoreline vectors. Data validation included examining transect regression coefficients (R^2). Linear regression statistical techniques for expressing shoreline rates of change were applied because they have been shown to be the most statistically robust quantitative methods when limited data are available (Crowell and others, 1997; Crowell and Leatherman, 1999). The DSAS model calculates the correlation coefficient (R^2) and standard error of estimate (LSE); therefore, these values were evaluated for accuracy. The standard error of estimate supports the accuracy of the rate prediction of shoreline change. Morton and others

(2004) considered linear regression to be only adequate as a first approximation for shoreline change estimates because of inherent nonlinear behavior.

RESULTS

ONO ISLAND

SHORE PROTECTION

The shore protection classification mapped on Ono Island had fifteen different types. Combined shore protection classes make up 123,924 feet (23.5 miles) of shoreline. Table 6 summarizes shore protection types, lengths, and percentages. Figure 3 illustrates the distribution of shore protection on Ono Island.

About 96,365 feet (18.3 miles) or about 77.8 percent of the shoreline mapped is natural, unretained. About 5.2 miles or 22.2 percent was mapped with hard shore protection. Bulkhead shore protection makes up about 16,299 feet (3.1 miles) or about 13.2 percent of the total. Bulkhead (steel, wood) shore protection, the longest of the four subtypes mapped, makes up about 15,637 feet (3.0 miles) or about 12.6 percent of the total. Jetty (steel pile, rock, concrete), the second longest hard shoreline classification mapped, makes up about 4,830 feet (0.9 mile) or about 3.9 percent of the total shore protection. The remaining protection, about 41,462 feet, is mainly beach nourishment, rubble/riprap, and sill (table 6). There was only one private boat ramp encountered on Ono Island.

SHORELINE TYPES

There were nine shoreline types identified on Ono Island which were classified as follows: artificial, inlet, organic (marsh), organic (open, vegetated fringe), pocket beach, sediment bank (high), sediment bank (low), vegetated bank (high) and vegetated bank (low) (table 7). These shoreline types make up 126,884 feet or about 24 miles encountered on Ono Island. Figure 4 illustrates the distribution of the shoreline types on Ono Island.

Table 6.--Ono Island shore protection classification lengths and percentages.

Ono Island		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	194	0.2
Beach Nourishment	1,983	1.6
Boat Ramp	38	0.0
Bulkhead (steel, wood)	15,637	12.6
Bulkhead (w/groin)	307	0.2
Bulkhead (w/retaining walls)	148	0.1
Bulkhead (w/riprap)	207	0.2
Groin	133	0.1
Jetty (steel pile, rock, concrete)	4,830	3.9
Natural, unretained	96,365	77.8
Natural, unretained (w/retaining wall)	1,367	1.1
Rubble/riprap	1,829	1.5
Sill (rock, shell)	186	0.1
Sill (wood)	629	0.5
Silt fence	71	0.1
Total	123,924	100.0

Table 7.--Ono Island shoreline type classification lengths and percentages.

Ono Island		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	6,467	5.10
Inlet	121	0.09
Organic (marsh)	14,705	11.59
Organic (open, vegetated fringe)	60,816	47.93
Pocket Beach	173	0.14
Sediment bank (high, 5 - 20 ft)	969	0.76
Sediment bank (low, 0 - 5 ft)	22,670	17.87
Vegetated bank (high, 5 - 20 ft)	229	0.18
Vegetated bank (low, 0 - 5 ft)	20,735	16.34
Total	126,884	100.00

Figure 3.--Shore protection map of Ono Island.

Figure 4.--Shoreline type map of Ono Island.

Organic shoreline type makes up about 75,521 feet (14.3 miles) or about 59.5 percent of the total. Sediment bank shoreline type makes up about 23,639 feet (4.5 miles) or about 18.6 percent of the total. Vegetated bank shoreline type makes up about 20,964 feet (4.0 miles) or about 16.5 percent of the total on Ono Island. Artificial and pocket beach shoreline types makes up about 6,467 feet (1.2 miles) or about 5.1 percent and about 173 feet or less than 0.1 percent of the total shoreline type on Ono Island, respectively. There were five inlets identified.

BAYOU ST. JOHN

SHORE PROTECTION

Nineteen different types of shore protection were mapped in Bayou St. John which were classified as follows: artificial, beach nourishment, bioengineered (vegetated), boat ramp, bulkhead subtypes, groin, natural, unretained subtypes, revetment, rubble/riprap, seawall (concrete, steel pile), sill subtypes and tires. The detailed shore protection values for Bayou St. John are listed in table 8. These shore protection types make up 143,922 feet or about 27.3 miles of shore protection that were mapped in Bayou St. John (fig. 5).

Bayou St. John consists mainly of bulkhead shoreline having about 77,577 feet (14.7 miles) or about 53.9 percent of the total. Bulkhead (steel, wood) shore protection, longest of the five bulkhead subtypes observed, makes up about 71,966 feet (13.6 miles) or about 50.0 percent of the total. Natural, unretained shore protection makes up about 51,164 feet (9.7 miles) or about 35.5 percent of the total shore protection in Bayou St. John. Rubble/riprap shore protection makes up about 8,972 feet (1.7 miles) or about 6.2 percent of the total shore protection in Bayou St. John. There were 10 private boat ramps and 11 public boat ramps encountered in Bayou St. John (fig. 6). The remaining 4.3 percent of the shoreline is armored through various methods listed above and tabulated in table 8.

SHORELINE TYPES

There were nine different shoreline types found in Bayou St. John (table 9) making up 140,653 feet or about 26.6 miles mapped. Figure 7 illustrates the distribution of the shoreline types in Bayou St. John. Vegetated bank shoreline type makes up about 82,719 feet (15 miles) or about 58.8 percent. Artificial shoreline type makes up about 21,906 feet (4.1 miles) or about 15.6 percent of the total shoreline type in Bayou St.

John. Sediment bank shoreline type makes up about 21,713 feet (4.1 miles) or about 15.4 percent of the total shoreline type in Bayou St. John. Organic shoreline type makes up about 13,338 feet (2.5 miles) or about 9.5 percent of the total shoreline type. Pocket beach makes up about 900 feet or 0.6 percent of the total shoreline type mapped in Bayou St. John. There were six inlets observed in Bayou St. John.

Table 8.--Bayou St. John shore protection classification lengths and percentages.

Bayou St. John		
Shore protection classification	**Length (ft)**	**Percent**
Artificial	190	0.1
Beach Nourishment	198	0.1
Bioengineered (vegetated)	16	0.0
Boat Ramp	504	0.4
Bulkhead (concrete, rock)	2,673	1.9
Bulkhead (steel, wood)	71,966	50.0
Bulkhead (w/groin)	246	0.2
Bulkhead (w/retaining walls and riprap)	346	0.2
Bulkhead (w/riprap)	2,065	1.4
Bulkhead (w/sill)	280	0.2
Groin	207	0.1
Natural, unretained	51,164	35.5
Natural, unretained (w/retaining wall)	155	0.1
Revetment	1,541	1.1
Rubble/riprap	8,972	6.2
Seawall (concrete, steel piles)	347	0.2
Sill (rock, shell)	549	0.4
Sill (wood)	2,374	1.6
Tires	128	0.1
Totals	143,922	100.0

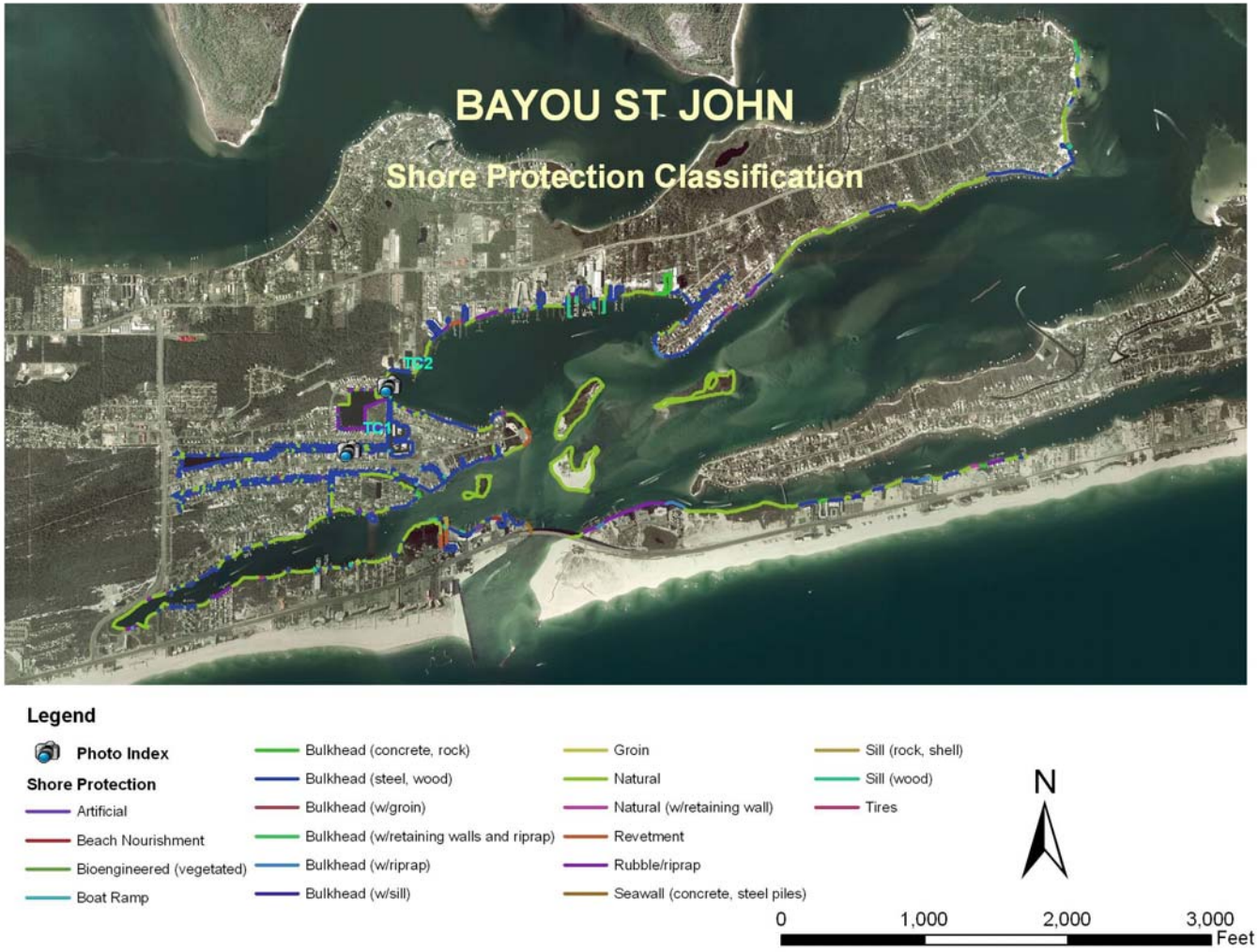

Figure 5.--Shore protection map of Bayou St. John.

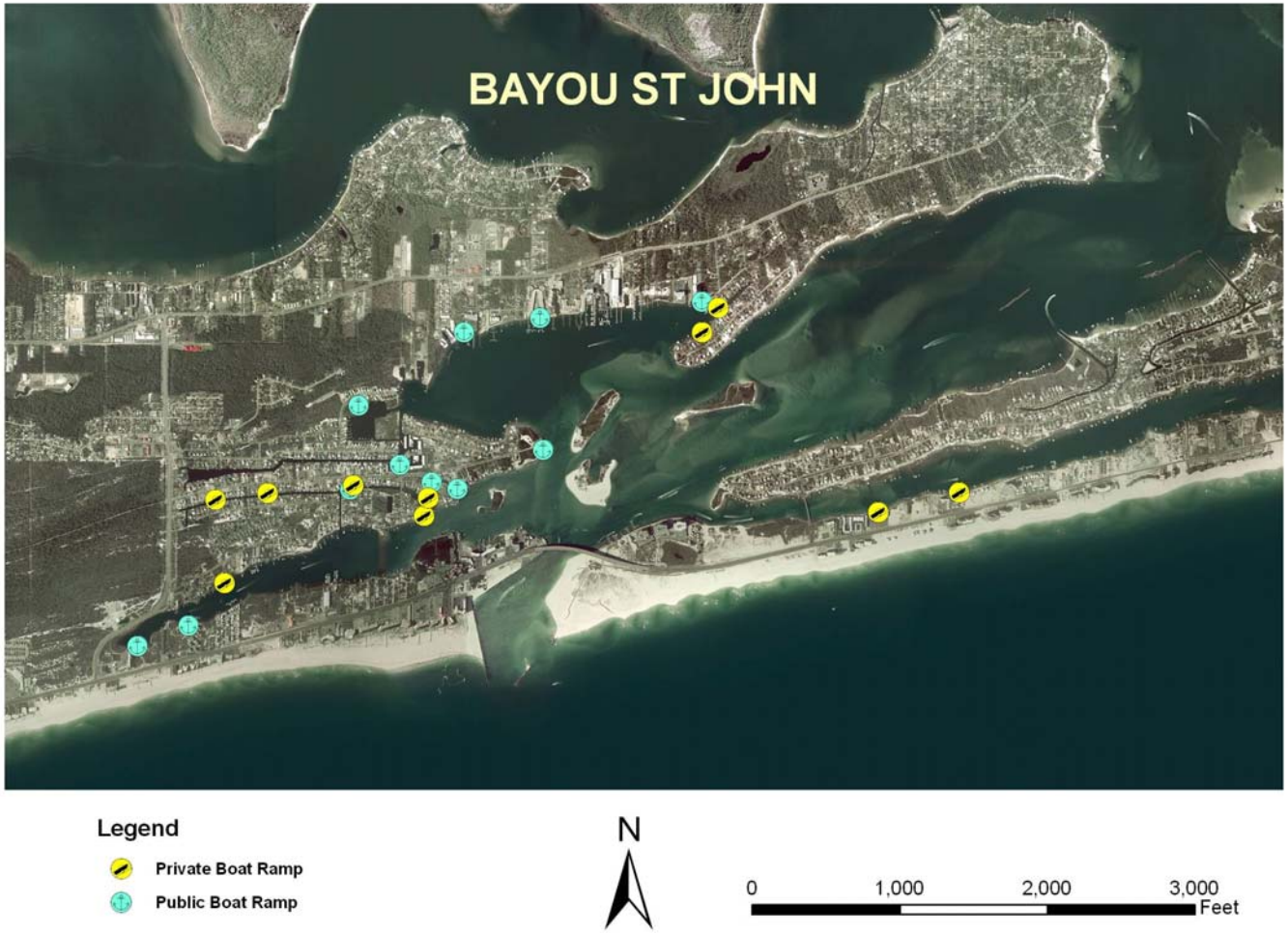

Figure 6.--Boat ramp distribution map of Bayou St. John.

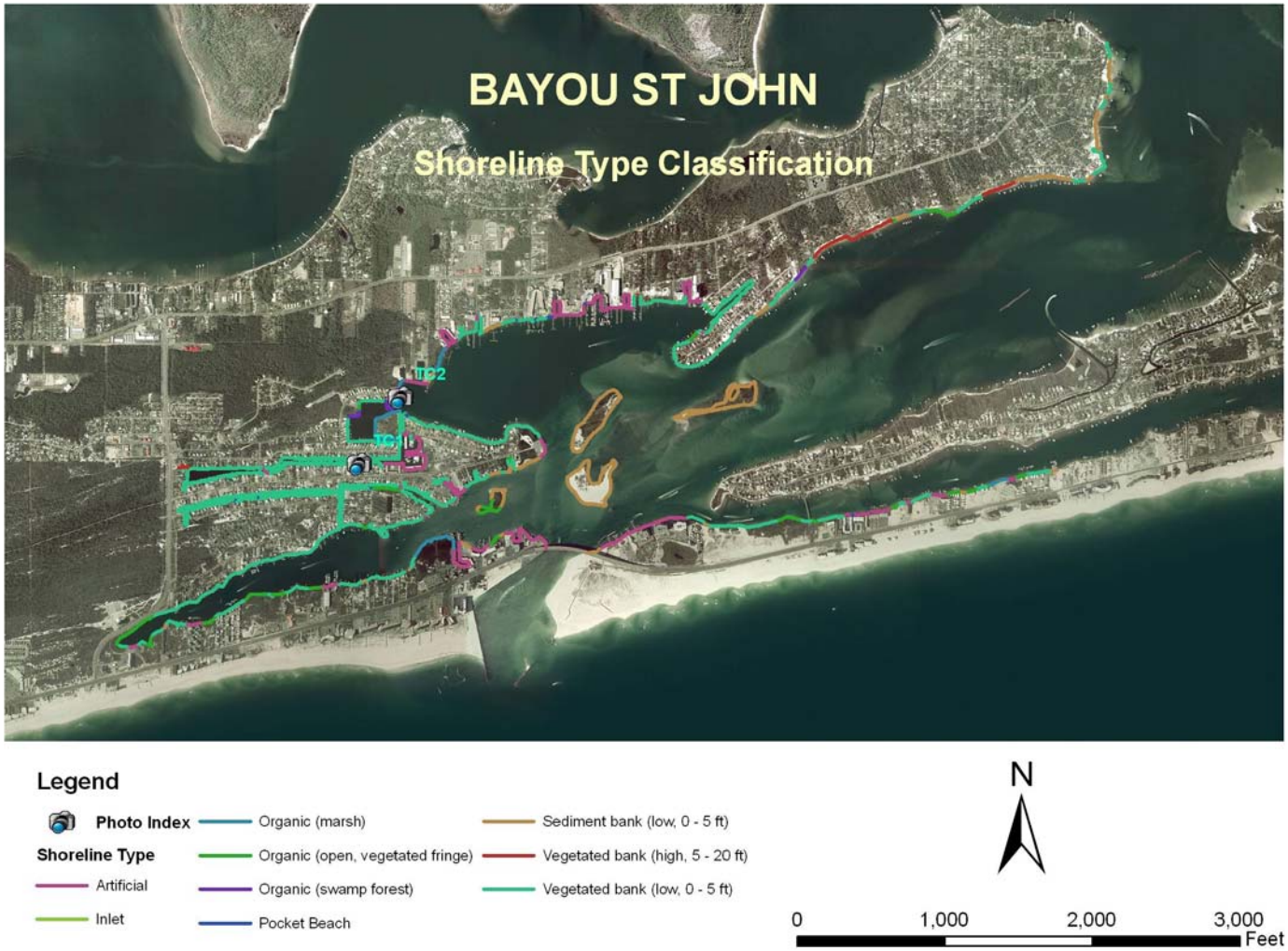

Figure 7.--Shoreline type map of Bayou St. John.

Table 9.--Bayou St. John shoreline type classification lengths and percentages.

Bayou St. John		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	21,906	15.6
Inlet	76	0.1
Organic (marsh)	4,032	2.9
Organic (open, vegetated fringe)	7,878	5.6
Organic (swamp forest)	1,428	1.0
Pocket Beach	900	0.6
Sediment bank (low, 0 - 5 ft)	21,713	15.4
Vegetated bank (high, 5 - 20 ft)	3,329	2.4
Vegetated bank (low, 0 - 5 ft)	79,390	56.4
Total	140,653	100.0

NORTHEAST PERDIDO BAY

SHORE PROTECTION

Seventeen different types of shore protection were mapped in Northeast Perdido Bay which were classified as follows: abutment, beach nourishment, boat ramp, bulkhead subtypes, groin, jetty (steel pile, rock, concrete), natural (unretained), natural subtypes and rubble/riprap subtypes. The detailed shore protection values for Northeast Perdido Bay are listed in table 10. These shore protection types make up 53,638 feet or about 10.2 miles of shore protection that were mapped in Northeast Perdido Bay (fig. 8).

Northeast Perdido Bay consists mainly of natural, unretained shoreline having about 33,769 feet (6.4 miles) or about 63 percent of the total. Bulkhead (steel, wood) shore protection, longest of the seven bulkhead subtypes observed, makes up about 6,631 feet (1.3 miles) or about 12.4 percent of the total. Rubble/riprap shore protection makes up about 2,776 feet or about 5.2 percent of the total shore protection in Northeast Perdido Bay. There were seven private boat ramps and one public boat ramp encountered in Northeast Perdido Bay. The remaining 19.4 percent of the shoreline is armored through various methods listed above and tabulated in table 10.

Table 10.--Northeast Perdido Bay shore protection classification lengths and percentages.

Northeast Perdido Bay		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	139	0.3
Beach Nourishment	65	0.1
Boat Ramp	190	0.4
Bulkhead (concrete, rock)	1,099	2.0
Bulkhead (steel, wood)	6,631	12.4
Bulkhead (w/groin)	2,136	4.0
Bulkhead (w/retaining walls and groin)	196	0.4
Bulkhead (w/retaining walls)	2,069	3.9
Bulkhead (w/riprap and groin)	214	0.4
Bulkhead (w/riprap)	1,942	3.6
Groin	1,485	2.8
Jetty (steel pile, rock, concrete)	42	0.1
Natural, unretained	33,769	63.0
Natural, unretained (w/retaining wall)	464	0.9
Natural, unretained (rock)	239	0.4
Rubble/riprap	2,776	5.2
Rubble/riprap (w/groin)	182	0.3
Total	53,638	100.0

SHORELINE TYPES

There were eleven shoreline types identified in Northeast Perdido Bay which were classified as artificial, inlet, organic (marsh), organic (open, vegetated fringe), organic (swamp forest), pocket beach, sediment bank (high), sediment bank (low), vegetated bank (bluff), vegetated bank (high) and vegetated bank (low) (table 11). Figure 9 illustrates the distribution of the shoreline types in Northeast Perdido Bay. Vegetated bank types make up about 30,444 feet (5.8 miles) or about 56.7 percent of the total. Sediment bank shoreline types make up about 14,968 feet (2.8 miles) or about 27.8 percent. Organic types make up about 7,701 feet (1.5 miles) or about 14.3 percent of the total shoreline in Northeast Perdido Bay. There were three inlets encountered in Northeast Perdido Bay.

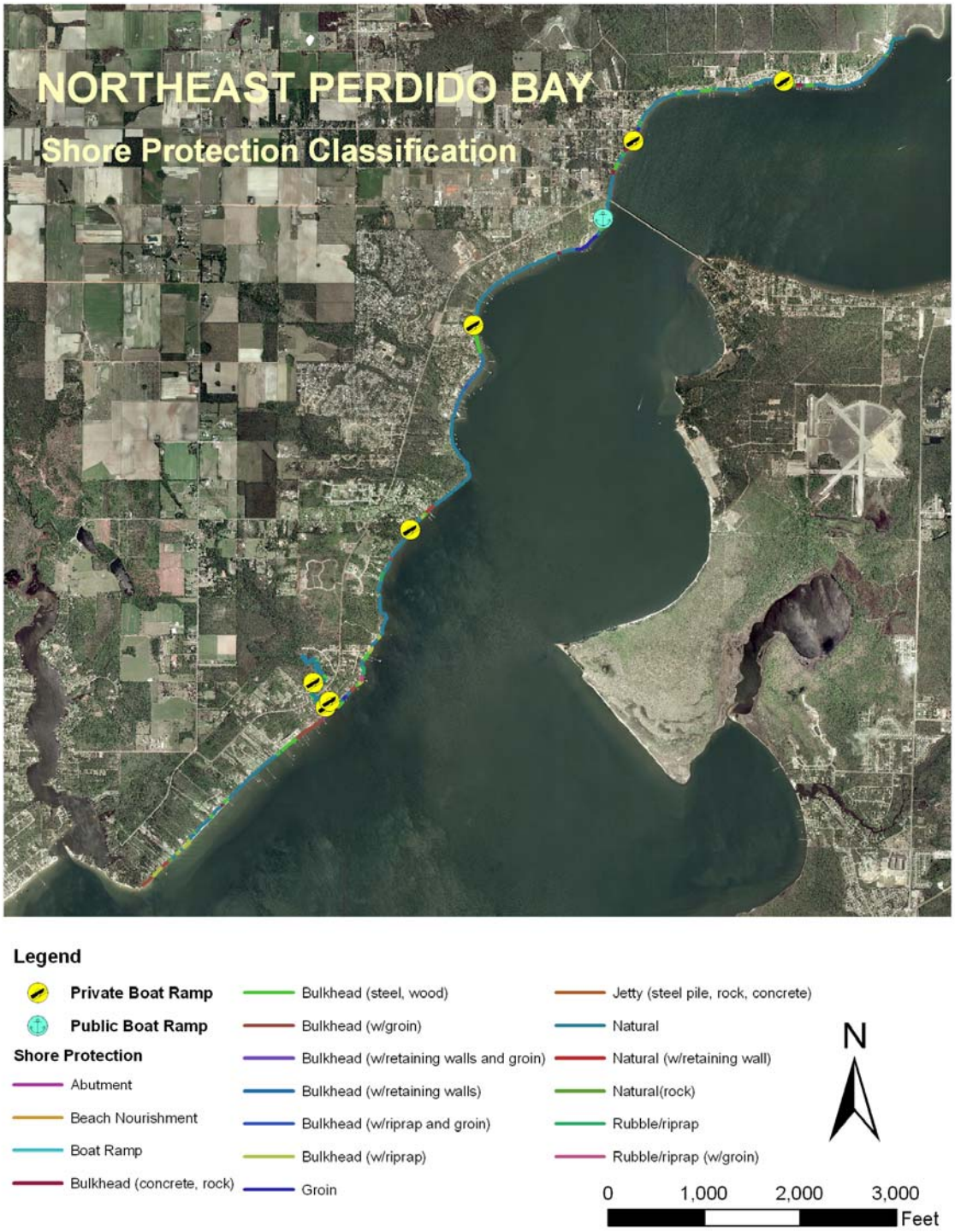

Figure 8.--Shore protection map of Northeast Perdido Bay.

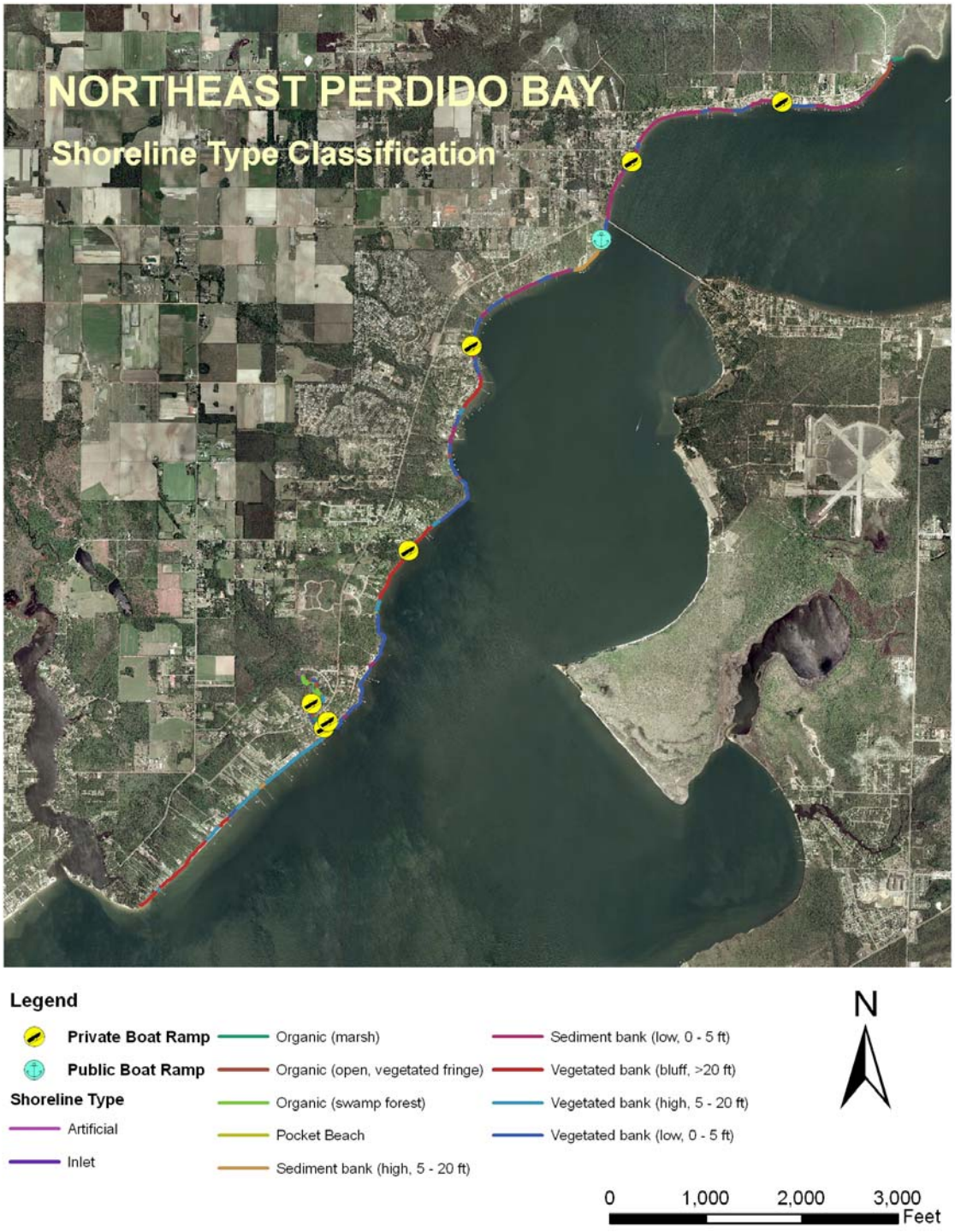

Figure 9.--Shoreline type map of Northeast Perdido Bay.

Table 11.—Northeast Perdido Bay shoreline type classification lengths and percentages.

Northeast Perdido Bay		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	267	0.5
Inlet	106	0.2
Organic (marsh)	2,146	4.0
Organic (open, vegetated fringe)	3,494	6.5
Organic (swamp forest)	2,061	3.8
Pocket Beach	196	0.4
Sediment bank (high, 5 - 20 ft)	1,958	3.6
Sediment bank (low, 0 - 5 ft)	13,009	24.2
Vegetated bank (bluff, >20 ft)	7,633	14.2
Vegetated bank (high, 5 - 20 ft)	6,043	11.3
Vegetated bank (low, 0 - 5 ft)	16,768	31.2
Total	53,682	100.0

SOUTHWEST PERDIDO BAY

SHORE PROTECTION

Shore protection classifications in Southwest Perdido Bay are numerous. Seventeen different classification types were observed, including beach nourishment, boat ramp, bulkhead subtypes, cement, groin, natural subtypes, rubble/riprap subtypes and sill subtypes. Detailed shore protection data are provided in table 12 where about 113,720 feet (21.5 miles) of shoreline were mapped for Southwest Perdido Bay. Figure 10 illustrates the distribution of shore protection as mapped in Southwest Perdido Bay.

Natural, unretained shoreline makes up about 75,257 feet (14.3 miles) and 66.2 percent of the total shore mapped under the shore protection classification. About 7.2 miles or 33.8 percent is hard, shoreline armored. Bulkhead shore protection is the longest mapped at 25 percent of the total; the bulkhead (steel, wood) subtype mapped had about 21,243 feet (4 miles) or 18.7 percent of the total. Rubble/riprap shore protection makes up about 6,423 feet (1.2 miles) or about 5.7 percent of the total shore protection in Southwest Perdido Bay. The remaining 3.2 percent of the shoreline is armored through various methods listed above and tabulated in table 12. There were 49 private boat ramps observed in Southwest Perdido Bay (fig. 11).

Table 12.—Southwest Perdido Bay shore protection classification lengths and percentages.

Southwest Perdido Bay		
Shore protection classification	**Length (ft)**	**Percent**
Beach Nourishment	609	0.5
Boat Ramp	831	0.7
Bulkhead (concrete, rock)	910	0.8
Bulkhead (steel, wood)	21,243	18.7
Bulkhead (w/groin)	2,070	1.8
Bulkhead (w/retaining walls and riprap)	126	0.1
Bulkhead (w/retaining walls)	682	0.6
Bulkhead (w/riprap and groin)	1,037	0.9
Bulkhead (w/riprap)	2,326	2.0
Cement	55	0.0
Groin	1,366	1.2
Natural, unretained	75,227	66.2
Natural, unretained (w/retaining wall)	31	0.0
Rubble/riprap	6,207	5.5
Rubble/riprap (w/groin)	216	0.2
Sill (rock, shell)	240	0.2
Sill (wood)	545	0.5
Total	113,720	100.0

SHORELINE TYPES

There were ten shoreline types identified in Southwest Perdido Bay which were classified as artificial, inlet, organic (marsh), organic (open, vegetated fringe), organic (swamp forest), pocket beach, sediment bank (high), sediment bank (low), vegetated bank (high) and vegetated bank (low) (table 13). Figure 12 illustrates the distribution of the shoreline types in Southwest Perdido Bay. Organic types make up about 57,205 feet (10.8 miles) or about 50.4 percent of the total shoreline in Southwest Perdido Bay. Vegetated bank types make up about 51,298 feet (9.7 miles) or about 45.1 percent of the total. Sediment bank shoreline types make up about 3,055 feet or about 2.7 percent of the total. There were 12 inlets encountered in Southwest Perdido Bay.

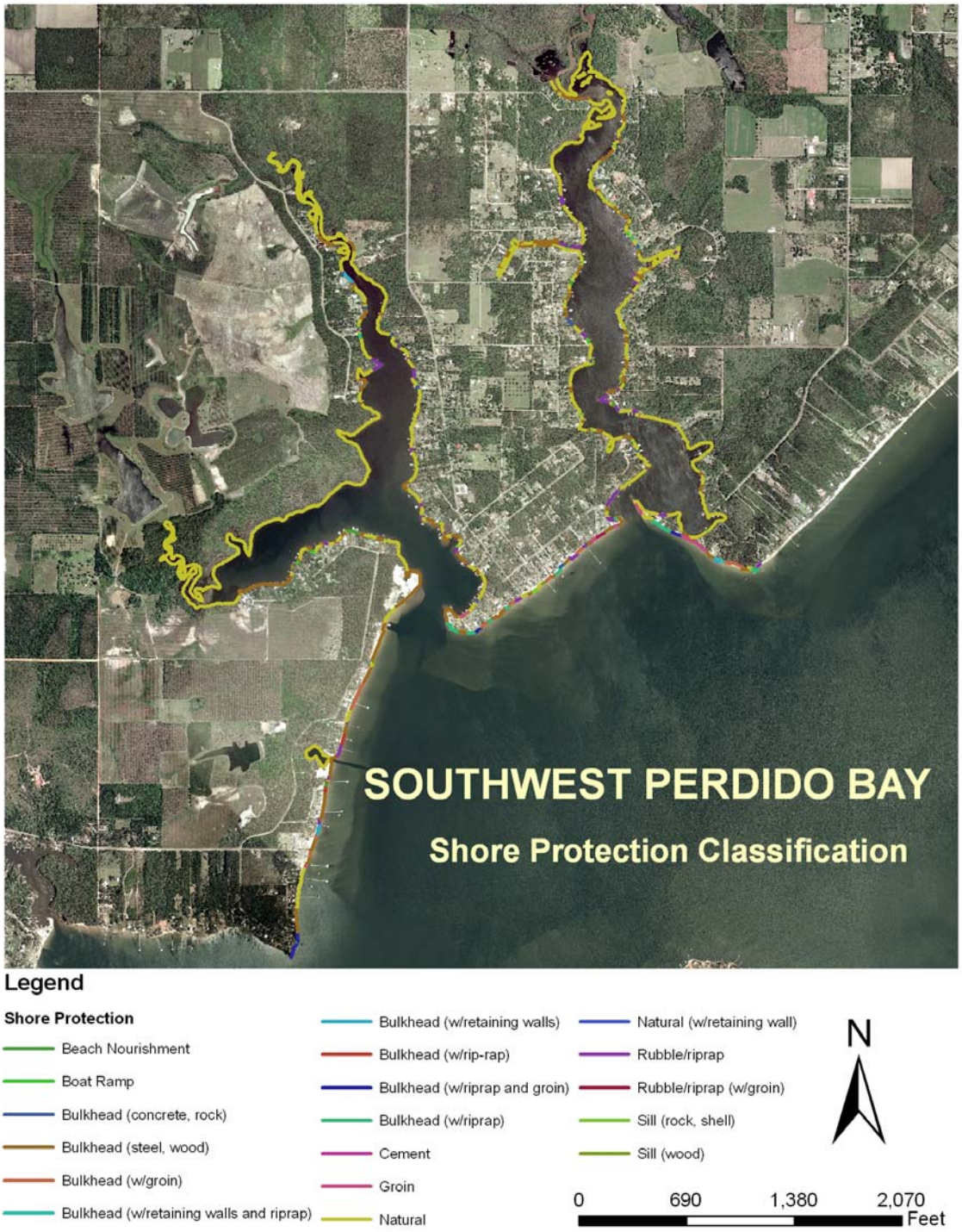

Figure 10.--Shore protection map of Southwest Perdido Bay.

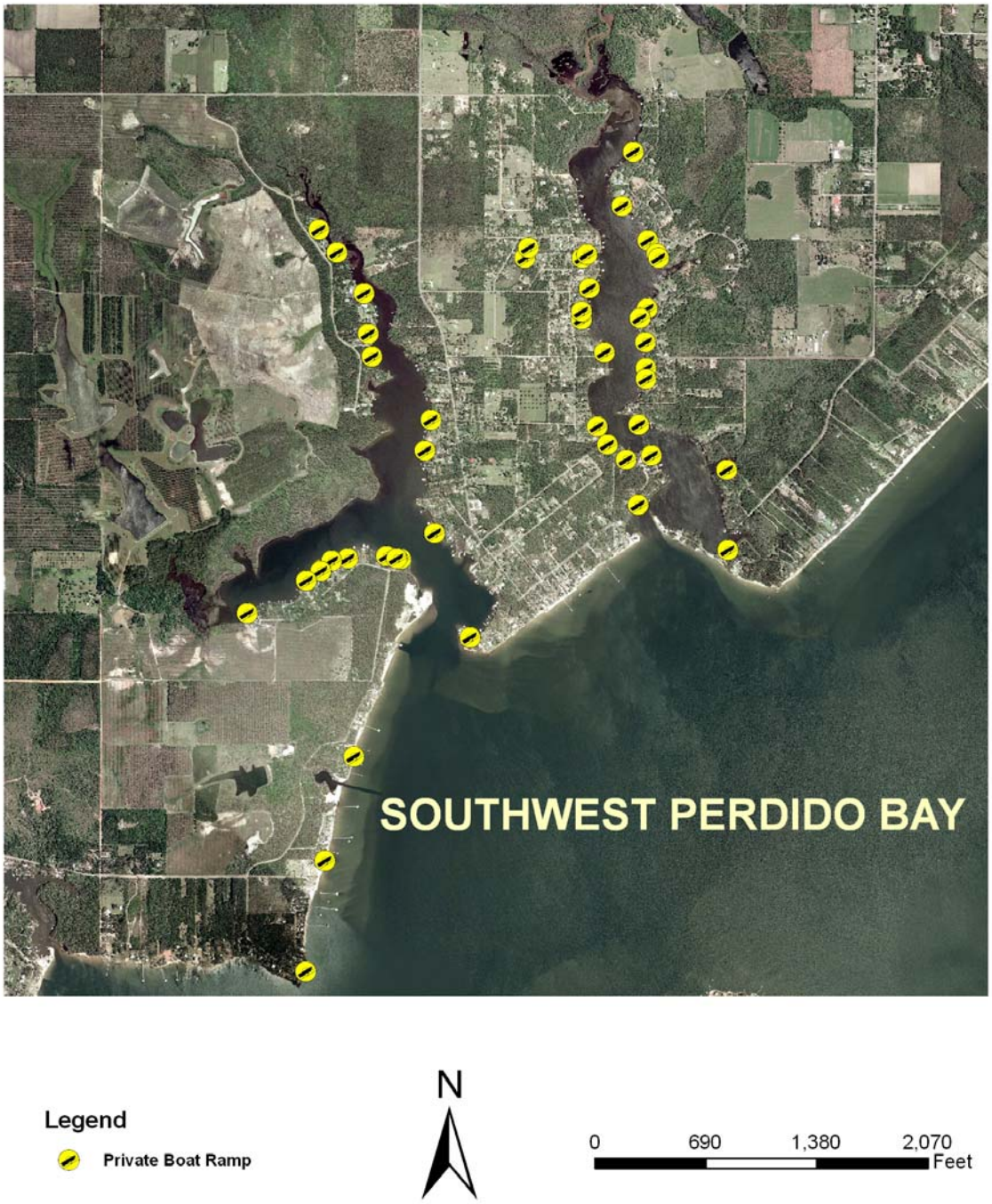

Figure 11.--Boat ramp distribution map of Southwest Perdido Bay.

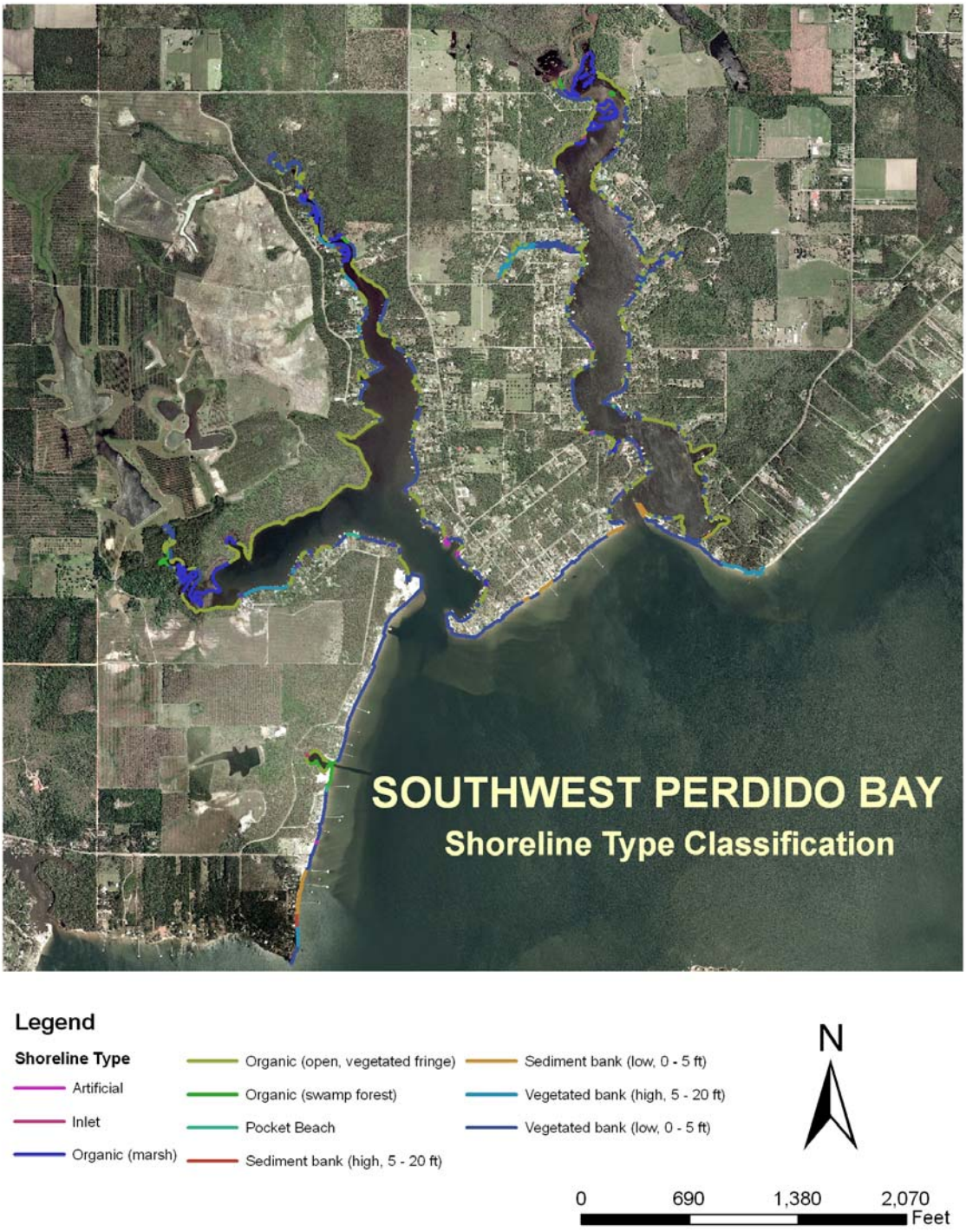

Figure 12.--Shoreline type map of Southwest Perdido Bay.

Table 13.—Southwest Perdido Bay shoreline type classification lengths and percentages.

Southwest Perdido Bay		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	1,228	1.1
Inlet	281	0.2
Organic (marsh)	14,653	12.9
Organic (open, vegetated fringe)	40,217	35.4
Organic (swamp forest)	2,335	2.1
Pocket Beach	570	0.5
Sediment bank (high, 5 - 20 ft)	321	0.3
Sediment bank (low, 0 - 5 ft)	2,734	2.4
Vegetated bank (high, 5 - 20 ft)	5,625	4.9
Vegetated bank (low, 0 - 5 ft)	45,673	40.2
Total	113,638	100.0

ARNICA BAY

SHORE PROTECTION

Sixteen different shore protection classifications were mapped in Arnica Bay. These included boat beach nourishment, boat ramp, bulkhead subtypes, cement, groin, jetty (steel pile, rock, concrete), natural, unretained, revetment, rubble/riprap subtypes, and sill (wood). Shore protection estimates for Arnica Bay are listed in table 14, and figure 13 depicts the distribution.

Bulkhead shore protection is the longest mapped at 52.7 percent of the total; the bulkhead (steel, wood) subtype mapped had about 20,998 feet (4 miles) or 36.5 percent of the total. Natural, unretained shoreline makes up about 23,314 feet (4.4 miles) and 40.6 percent of the total shore mapped under the shore protection classification. Rubble/riprap shore protection makes up about 1,317 feet or about 2.3 percent of the total shore protection in Arnica Bay. The remaining 4.4 percent of the shoreline is armored through various methods listed above and tabulated in table 14. There were six private boat ramps and one public boat ramp observed in Arnica Bay.

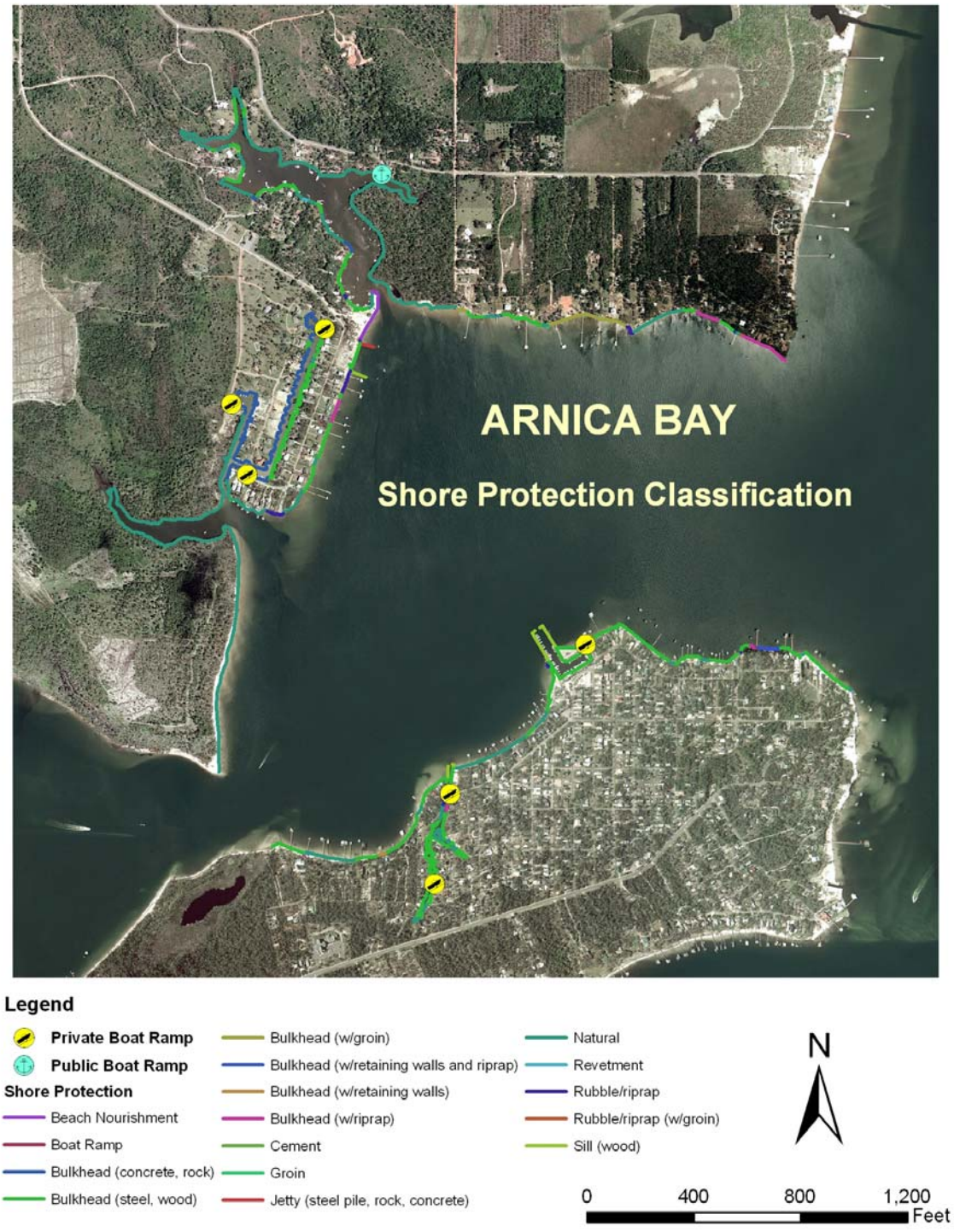

Figure 13.--Shore protection map of Arnica Bay.

Table 14.—Arnica Bay shore protection classification lengths and percentages.

Arnica Bay		
Shore protection classification	**Length (ft)**	**Percent**
Beach Nourishment	707	1.2
Boat Ramp	180	0.3
Bulkhead (concrete, rock)	6,303	11.0
Bulkhead (steel, wood)	20,998	36.5
Bulkhead (w/groin)	1,170	2.0
Bulkhead (w/retaining walls and riprap)	276	0.5
Bulkhead (w/retaining walls)	100	0.2
Bulkhead (w/riprap)	1,429	2.5
Cement	17	0.0
Groin	47	0.1
Jetty (steel pile, rock, concrete)	172	0.3
Natural, unretained	23,314	40.6
Revetment	83	0.1
Rubble/riprap	1,317	2.3
Rubble/riprap (w/groin)	76	0.1
Sill (wood)	1,261	2.2
Total	57,451	100.0

SHORELINE TYPES

Eight different shoreline type classifications were identified in Arnica Bay including artificial, inlet, organic (marsh), organic (open, vegetated fringe), pocket beach, sediment bank (low), and vegetated bank (high and low). Specific shoreline type values are listed in table 15. Figure 14 illustrates the distribution of Arnica Bay shoreline types.

The dominant shoreline type in Arnica Bay is vegetated bank making up about 32,724 feet (6.2 miles) or about 57.8 percent of the total in Arnica Bay with most classified in the low subtype. Sediment bank (low) shoreline, the second longest mapped, makes up about 10,729 feet (2 miles) or about 19 percent of the total. Organic shoreline type makes up about 10,082 feet (1.9 miles) or about 17.8 percent. There were seven inlets identified in Arnica Bay.

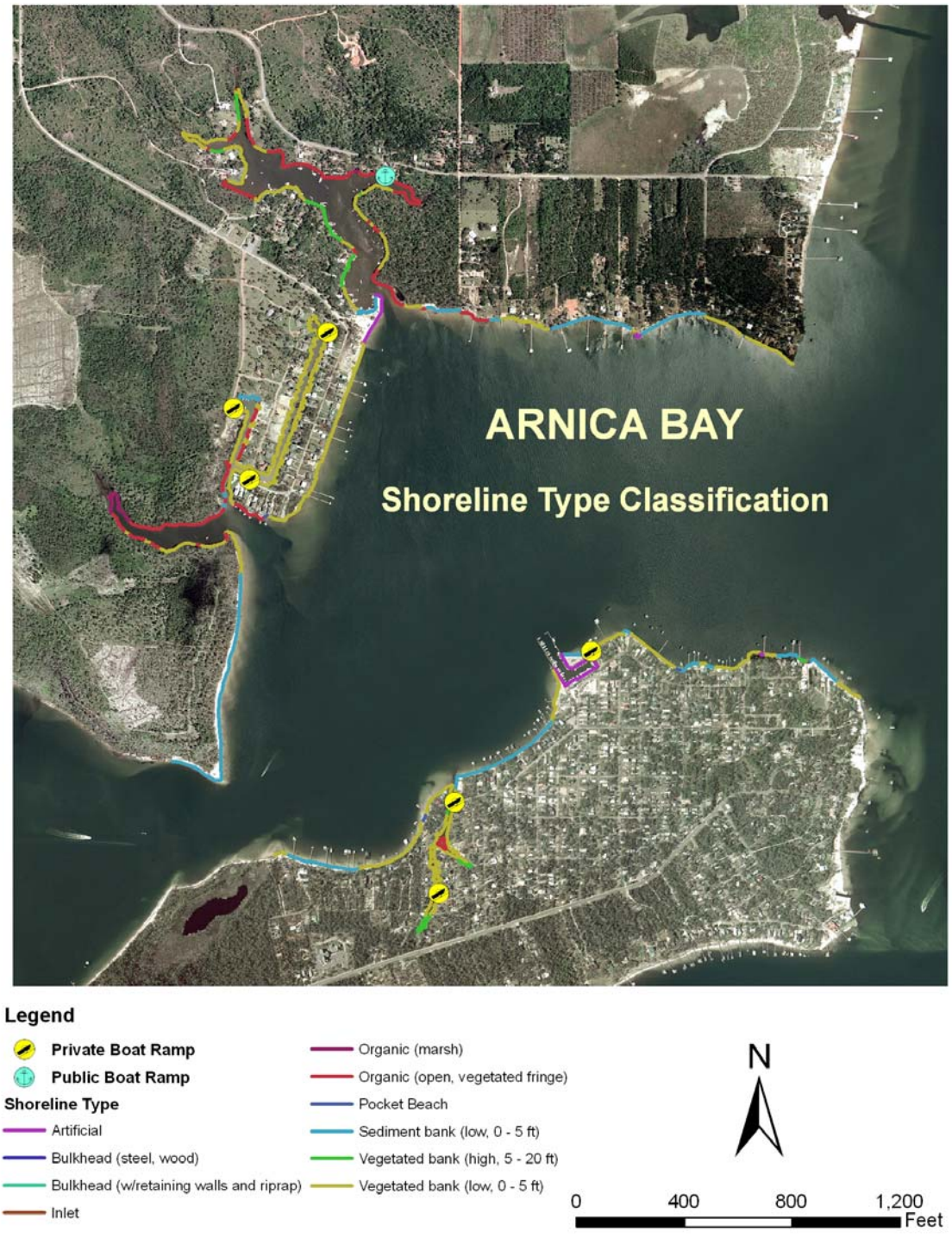

Figure 14.—Shoreline type map of Arnica Bay.

Table 15.--Arnica Bay shoreline type classification lengths and percentages.

Arnica Bay		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	2,377	4.2
Inlet	190	0.3
Organic (marsh)	801	1.4
Organic (open, vegetated fringe)	9,280	16.4
Pocket Beach	459	0.8
Sediment bank (low, 0 - 5 ft)	10,729	19.0
Vegetated bank (high, 5 - 20 ft)	2,895	5.1
Vegetated bank (low, 0 - 5 ft)	29,829	52.7
Total	56,561	100.0

BAY LA LAUNCH & SOUTH WOLF BAY

SHORE PROTECTION

Twelve different shore protection classifications were mapped in Bay La Launch and South Wolf Bay; these included artificial, boat ramp, bulkhead subtypes, cement, groin, jetty (steel pile, rock, concrete), natural, unretained, rubble/riprap, and sill (wood). Shore protection estimates for Bay La Launch and South Wolf Bay are listed in table 16 and figure 15 depicts the distribution.

Natural, unretained shore protection is the longest mapped at about 88,950 feet (16.8 miles) or about 80.4 percent of the total. The bulkhead subtypes protection makes up about 18,006 feet (3.4 miles) or 16.3 percent of the total, with bulkhead (steel, wood) being the largest. Rubble/riprap shore protection makes up about 2,208 feet or about 2.0 percent of the total shore protection in Bay La Launch and South Wolf Bay. The remaining 1.3 percent of the shoreline is armored through various methods listed above and tabulated in table 16. There were 15 private boat ramps and one public boat ramp observed in Bay La Launch and South Wolf Bay (fig. 16).

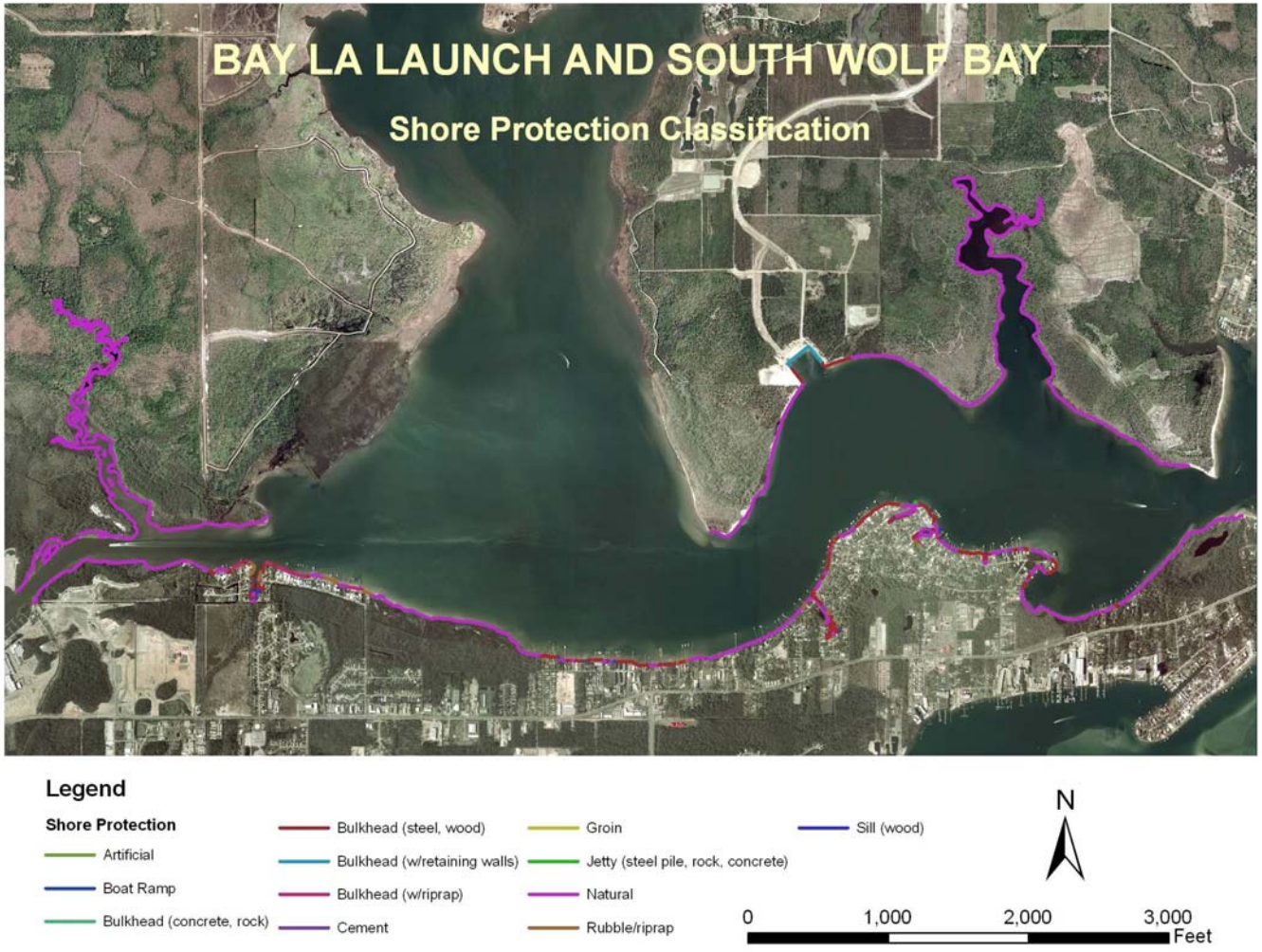

Figure 15.--Shore protection map of Bay La Launch and South Wolf Bay.

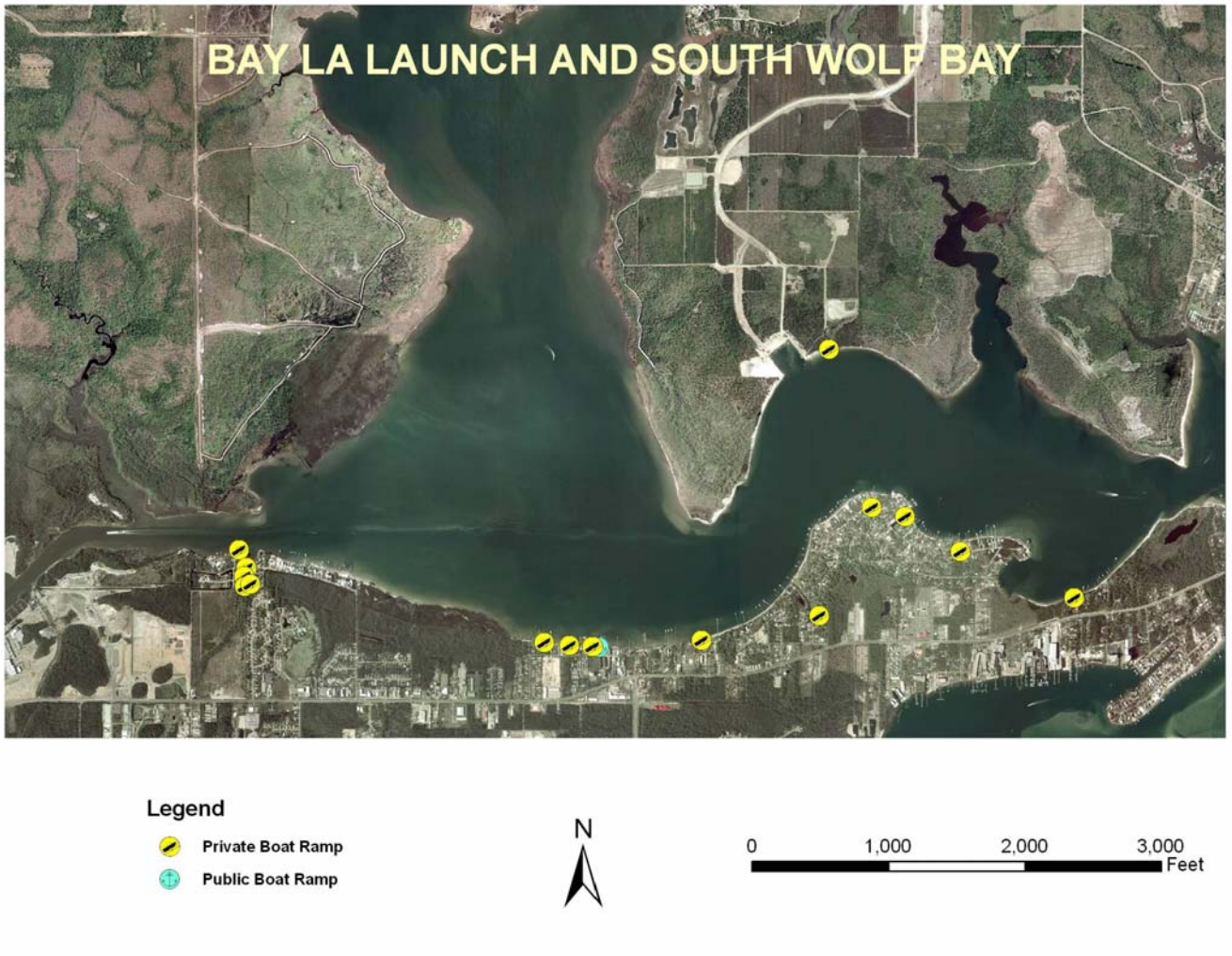

Figure 16.—Boat ramp distribution map of Bay La Launch and South Wolf Bay.

Table 16.—Bay La Launch and South Wolf Bay shore protection classification lengths and percentages.

Bay La Launch and South Wolf Bay		
Shore protection classification	**Length (ft)**	**Percent**
Artificial	192	0.2
Boat Ramp	318	0.3
Bulkhead (concrete, rock)	34	0.0
Bulkhead (steel, wood)	14,818	13.4
Bulkhead (w/retaining walls)	1,305	1.2
Bulkhead (w/riprap)	1,848	1.7
Cement	155	0.1
Groin	54	0.0
Jetty (steel pile, rock, concrete)	121	0.1
Natural, unretained	88,950	80.4
Rubble/riprap	2,208	2.0
Sill (wood)	578	0.5
Total	110,581	100.0

SHORELINE TYPES

Ten different shoreline type classifications were identified in Bay La Launch and South Wolf Bay such as artificial, inlet, organic subtypes, pocket beach, sediment bank (high and low), and vegetated bank (high and low). Specific shoreline type values are listed in table 17. Figure 17 illustrates the distribution of Bay La Launch and South Wolf Bay shoreline types.

The dominant shoreline type in Bay La Launch and South Wolf Bay is organic bank making up about 54,922 feet (10.4 miles) or about 49.7 percent of the total in Bay La Launch and South Wolf Bay with most classified as organic (open, vegetated fringe). Vegetated bank shoreline types, the second longest mapped, make up about 31,637 feet (6 miles) or about 28.6 percent of the total, with low subtype being the longest. Sediment shoreline types make up about 19,155 feet (3.6 miles) or about 17.3 percent of the total, with the low subtype being the longest. There were 22 inlets identified in Bay La Launch and South Wolf Bay.

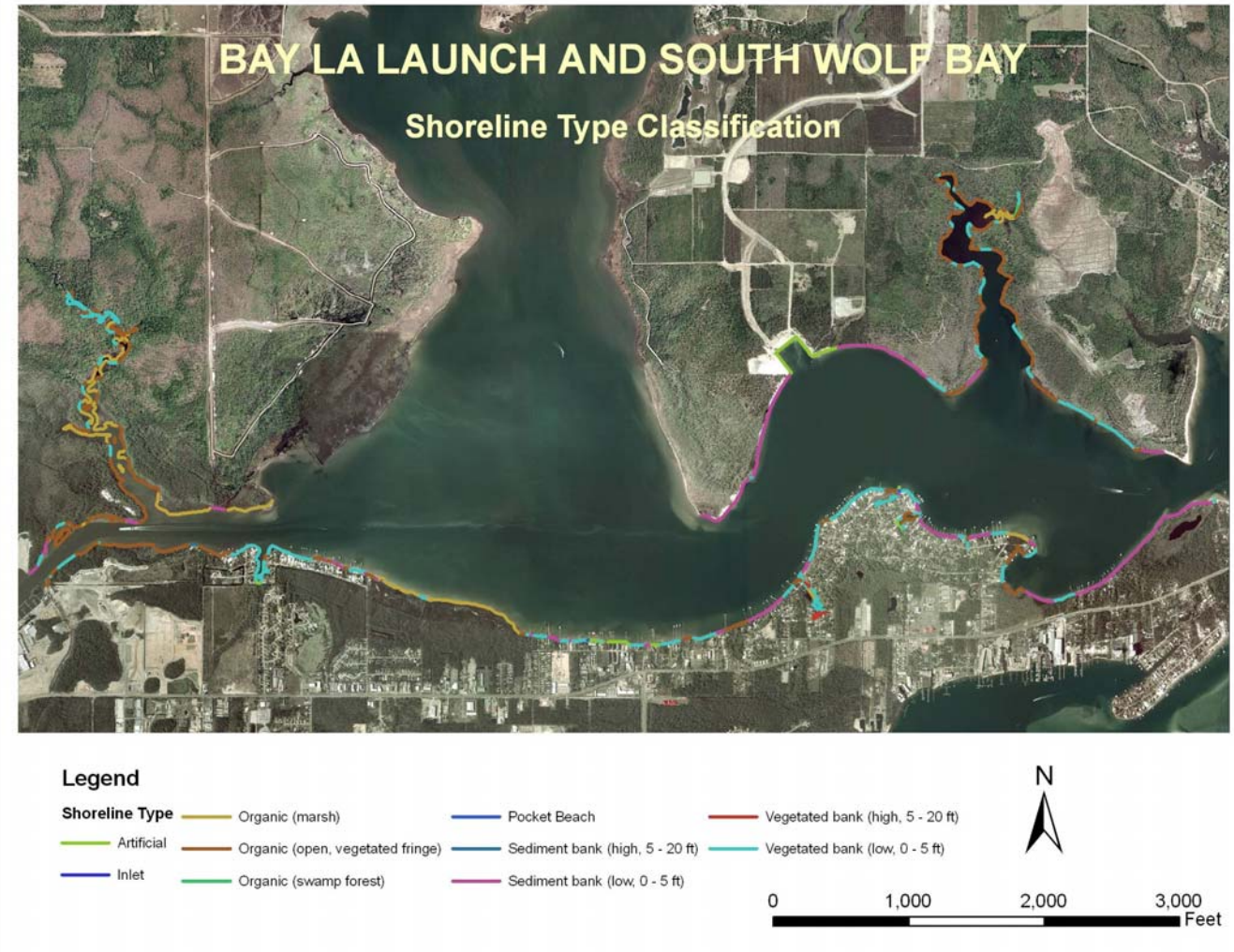

Figure 17.—Shoreline type map of Bay La Launch and South Wolf Bay.

Table 17.—Bay La Launch and South Wolf Bay shoreline type classification lengths and percentages.

Bay La Launch and South Wolf Bay		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	4,234	3.8
Inlet	376	0.3
Organic (marsh)	17,709	16.0
Organic (open, vegetated fringe)	36,848	33.4
Organic (swamp forest)	366	0.3
Pocket Beach	130	0.1
Sediment bank (high, 5 - 20 ft)	240	0.2
Sediment bank (low, 0 - 5 ft)	18,915	17.1
Vegetated bank (high, 5 - 20 ft)	814	0.7
Vegetated bank (low, 0 - 5 ft)	30,823	27.9
Total	110,454	100.0

HAMMOCK CREEK

SHORE PROTECTION

Eight different shore protection classifications were mapped in Hammock Creek; these included abutment, artificial, boat ramp, bulkhead subtypes, groin, natural, unretained, and rubble/riprap. Shore protection estimates for Hammock Creek are listed in table 18, and figure 18 depicts the distribution.

Hammock Creek consists mainly of natural unretained shoreline having about 47,486 feet (9 miles) or about 80.3 percent of the total. Bulkhead shore protection makes up about 9,446 feet (1.8 miles) or about 16 percent of the total shore protection, with bulkhead (steel, wood) being the largest, in Hammock Creek. Rubble/riprap shore protection makes up about 1,780 feet or about 3 percent of the total shore protection in Hammock Creek. The remaining 0.7 percent of the shoreline is armored through various methods listed above and tabulated in table 18. There were 15 private boat ramps observed in Hammock Creek (fig. 19).

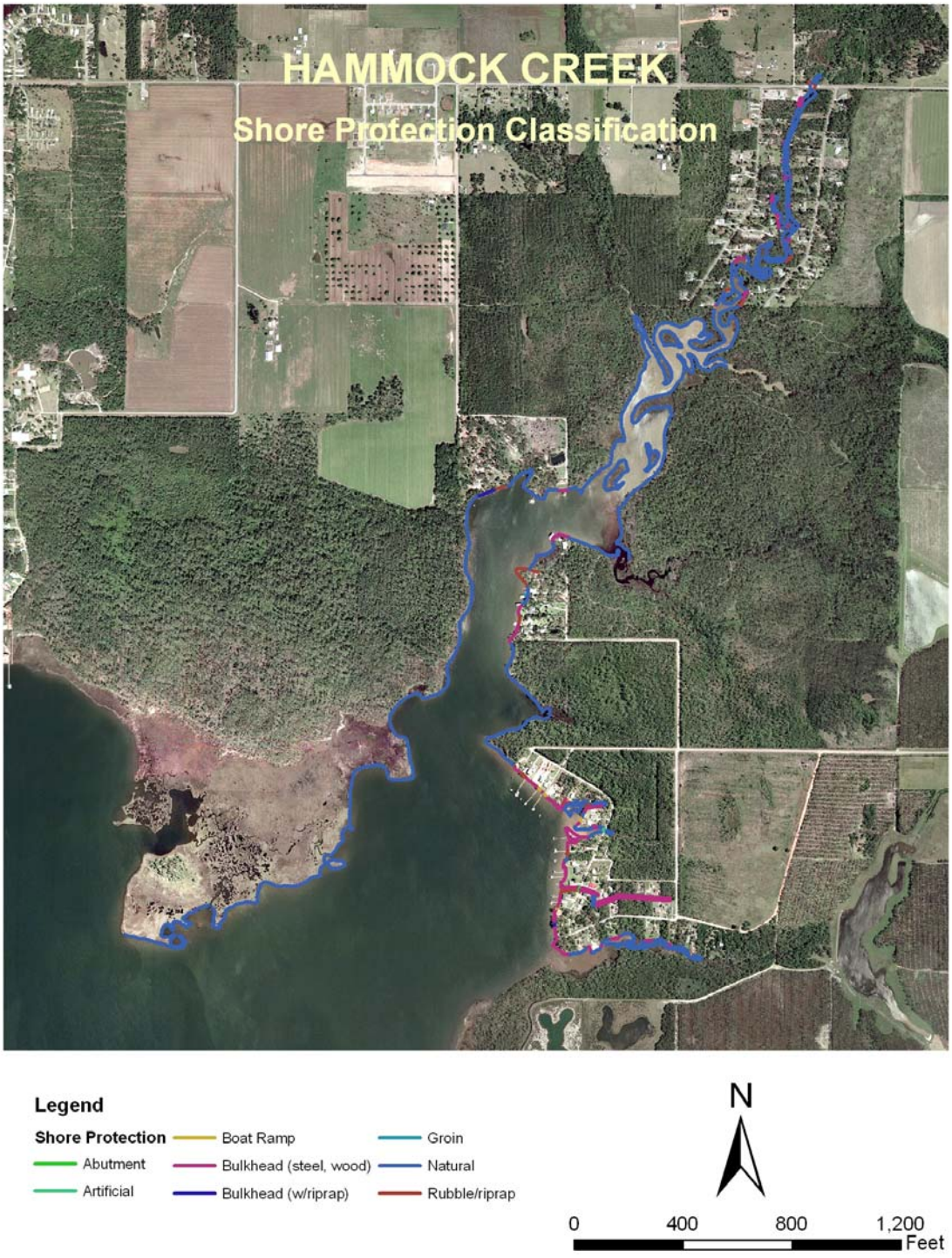

Figure 18.—Shore protection map of Hammock Creek.

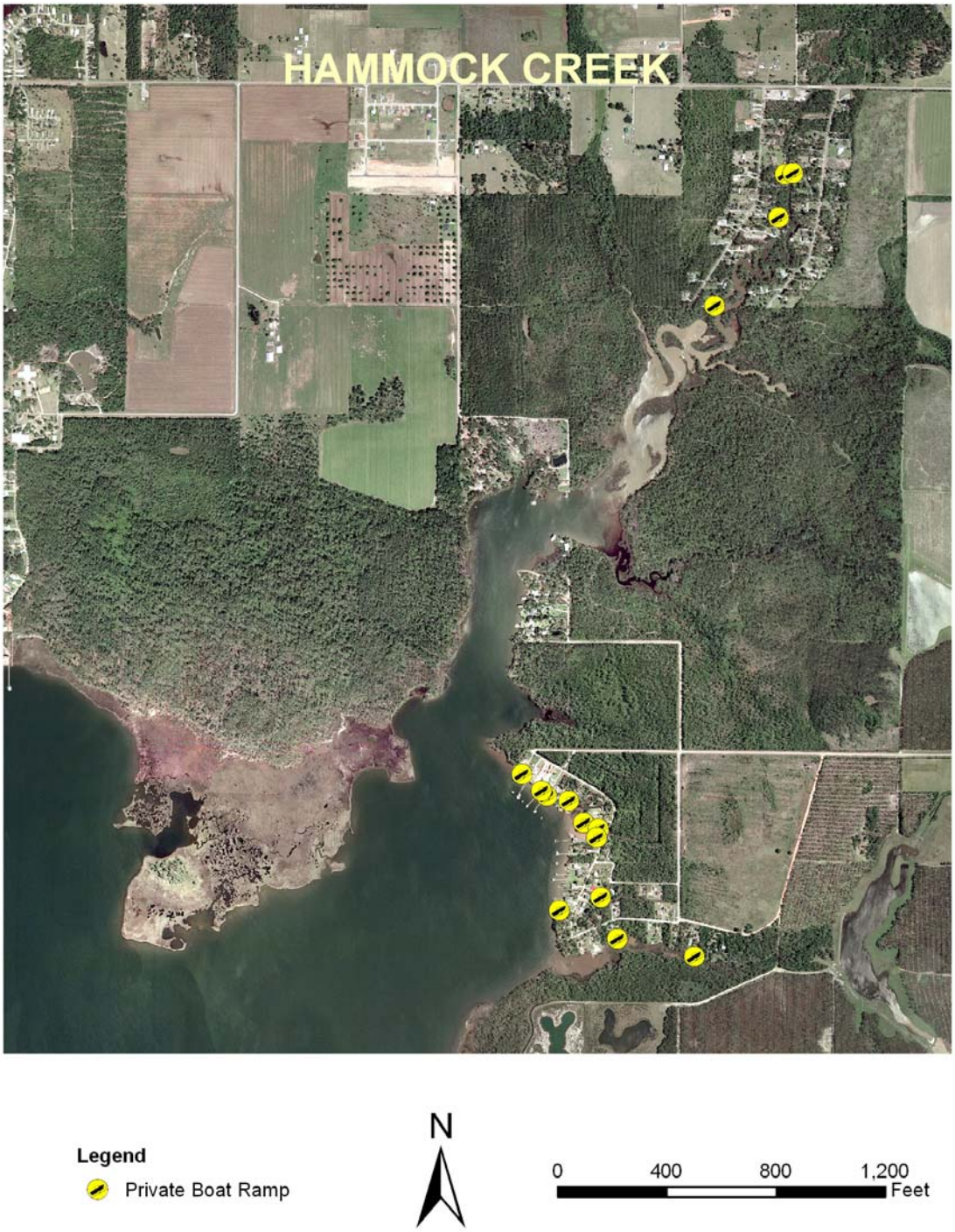

Figure 19.—Boat ramp distribution map of Hammock Creek.

Table 18.—Hammock Creek shore protection classification lengths and percentages.

Hammock Creek		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	53	0.1
Artificial	74	0.1
Boat Ramp	233	0.4
Bulkhead (steel, wood)	9,158	15.5
Bulkhead (w/riprap)	288	0.5
Groin	67	0.1
Natural, unretained	47,486	80.3
Rubble/riprap	1,780	3.0
Total	59,138	100.0

SHORELINE TYPES

Eight different shoreline type classifications were identified in Hammock Creek such as artificial, inlet, organic (marsh), organic (open, vegetated fringe), organic (swamp forest), sediment bank (low), and vegetated bank (high and low). Specific shoreline type values are listed in table 19. Figure 20 illustrates the distribution of Hammock Creek shoreline types.

The dominant shoreline type in Hammock Creek is organic shoreline types making up about 29,816 feet (5.6 miles) or about 50 percent of the total in Hammock Creek with most classified as organic (marsh). Vegetated bank shoreline types, the second longest mapped, makes up about 28,027 feet (5.3 miles) or about 47 percent of the total in Hammock Creek, with most classified as vegetated bank (low). Sediment bank (low) shoreline makes up about 843 feet or about 1.4 percent of the total mapped in Hammock Creek. There were15 inlets identified in Hammock Creek.

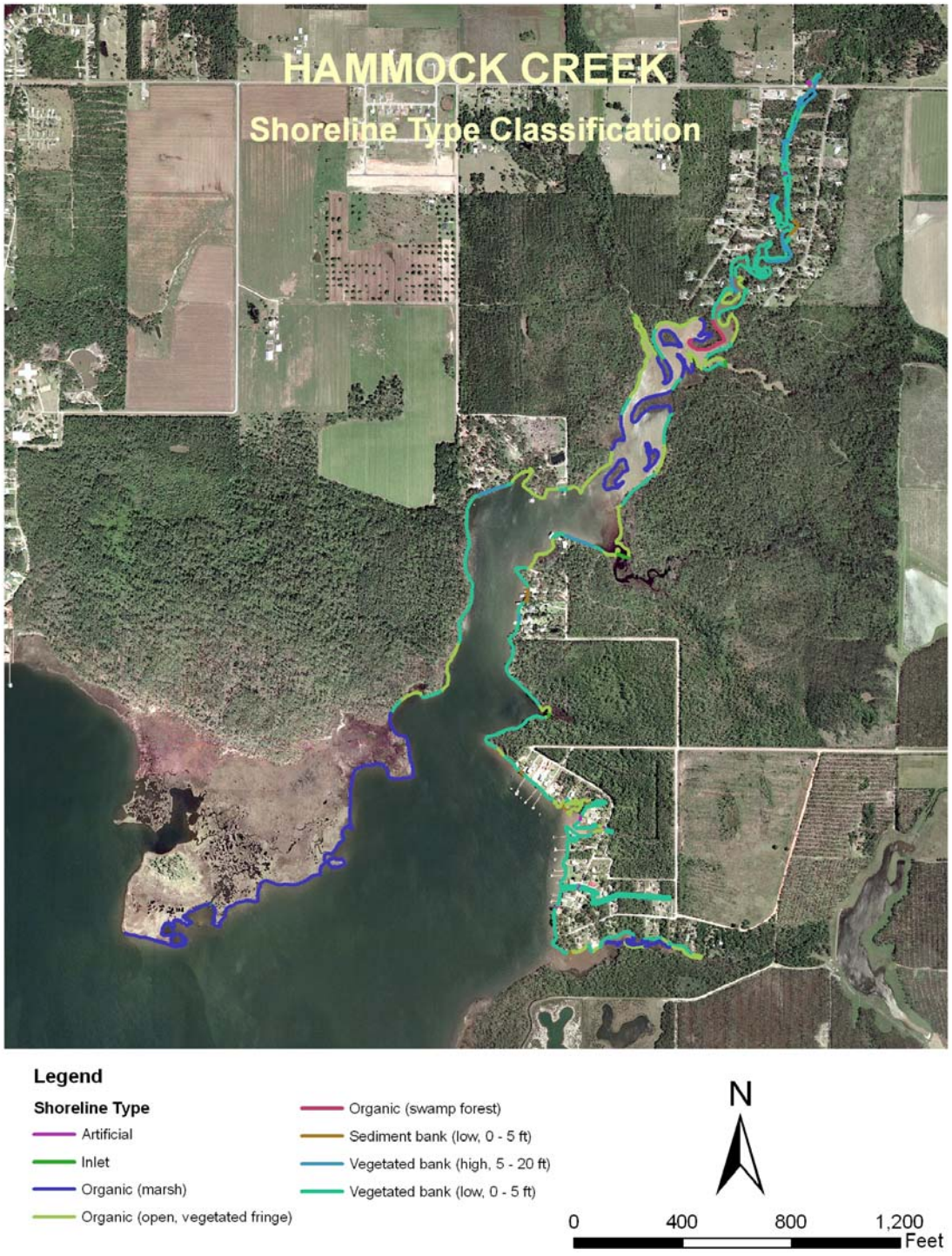

Figure 20.--Shoreline type map of Hammock Creek.

Table 19.—Hammock Creek shoreline type classification lengths and percentages.

Hammock Creek		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	455	0.8
Inlet	502	0.8
Organic (marsh)	16,586	27.8
Organic (open, vegetated fringe)	12,408	20.8
Organic (swamp forest)	822	1.4
Sediment bank (low, 0 - 5 ft)	843	1.4
Vegetated bank (high, 5 - 20 ft)	3,610	6.1
Vegetated bank (low, 0 - 5 ft)	24,417	40.9
Total	59,643	100.0

WOLF BAY TRIBUTARIES

SHORE PROTECTION

Twelve different shore protection classifications were mapped in the Wolf Bay tributaries (Wolf Creek, Miflin Gum Branch, Graham Bayou and Owens Bayou); these included abutment, beach nourishment, boat ramp, bulkhead subtypes, natural, unretained, rubble/riprap, and sill (wood). Shore protection estimates for the Wolf Bay tributaries are listed in table 20, and figure 21 depicts the distribution.

The Wolf Bay tributaries consist mainly of natural unretained shoreline having about 97,793 feet (18.4 miles) or about 79.8 percent of the total shore protection mapped in the Wolf Bay tributaries. Bulkhead shore protection subtypes make up about 19,454 feet (3.7 miles) or about 16 percent of the total shore protection in the Wolf Bay tributaries, with bulkhead (steel, wood) being the largest. Rubble/riprap shore protection makes up about 4,282 feet or about 3.5 percent of the total shore protection in the Wolf Bay tributaries. The remaining 0.7 percent of the shoreline is armored through various methods listed above and tabulated in table 20. There were 24 private and public boat ramps observed in the Wolf Bay tributaries (fig. 22).

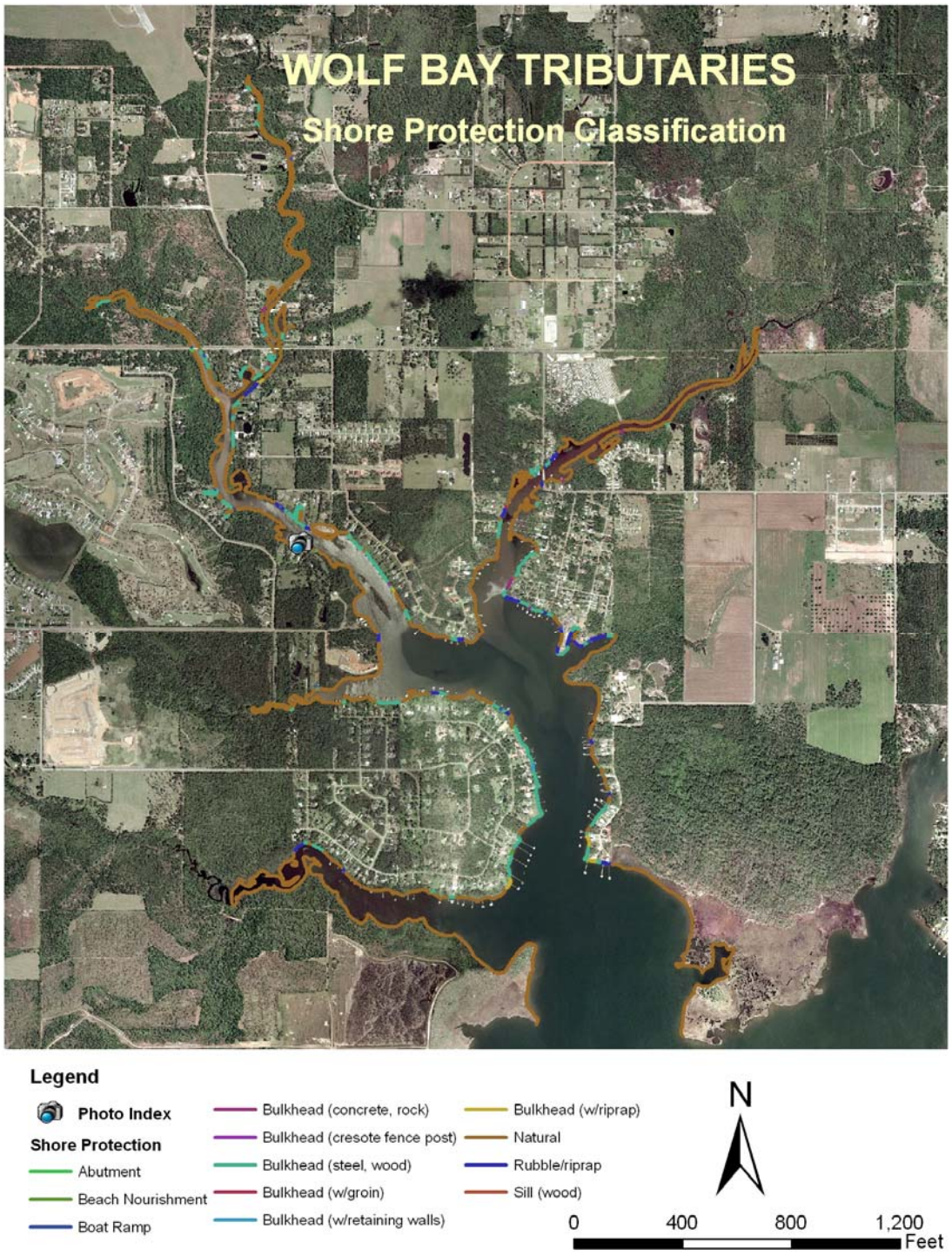

Figure 21.—Shore protection map of the Wolf Bay tributaries.

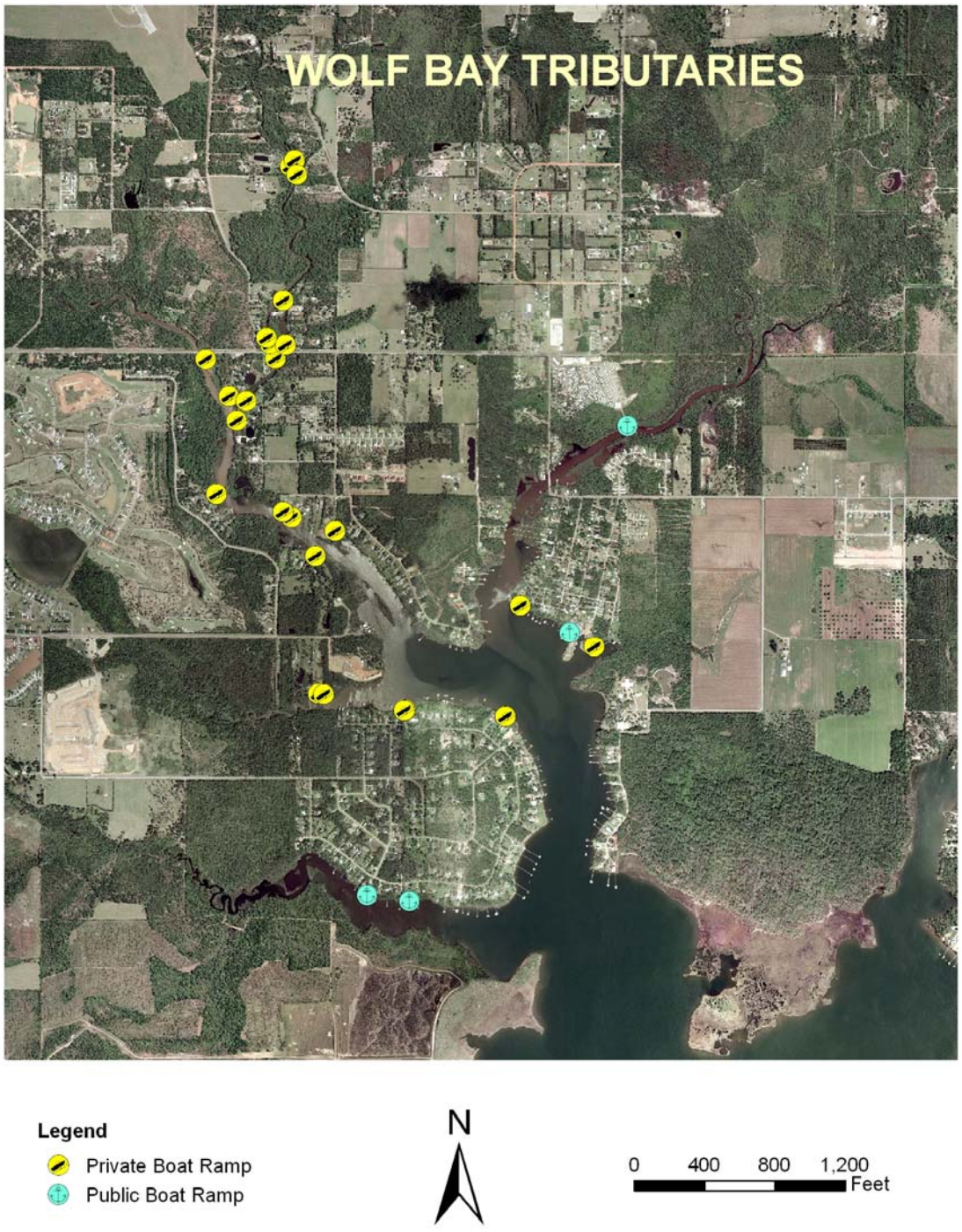

Figure 22.—Boat ramp distribution map of the Wolf Bay tributaries.

Table 20.—Wolf Bay tributaries shore protection classification lengths and percentages.

Wolf Bay tributaries		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	304	0.2
Beach Nourishment	47	0.0
Boat Ramp	446	0.4
Bulkhead (concrete, rock)	691	0.6
Bulkhead (cresote fence post)	168	0.1
Bulkhead (steel, wood)	17,404	14.3
Bulkhead (w/groin)	117	0.1
Bulkhead (w/retaining walls)	126	0.1
Bulkhead (w/riprap)	948	0.8
Natural, unretained	97,193	79.8
Rubble/riprap	4,282	3.5
Sill (wood)	70	0.1
Total	121,797	100.0

SHORELINE TYPES

Nine different shoreline type classifications were identified in the Wolf Bay tributaries such as artificial, inlet, organic (marsh), organic (open, vegetated fringe), organic (swamp forest), pocket beach, sediment bank (low), and vegetated bank (high and low). Specific shoreline type values are listed in table 21. Figure 23 illustrates the distribution of shoreline types in the Wolf Bay tributaries.

The dominant shoreline type in the Wolf Bay tributaries is vegetated shoreline types making up about 67,199 feet (12.7 miles) or about 54.6 percent of the total in the Wolf Bay tributaries with most classified as vegetated bank (low). Organic shoreline types, the second longest mapped, makes up about 52,267 feet (9.9 miles) or about 42.5 percent of the total in the Wolf Bay tributaries, with most classified as organic (open, vegetated fringe). Sediment bank (low) shoreline makes up about 1,633 feet or about 1.3 percent of the total mapped in the Wolf Bay tributaries. There were 15 inlets identified in the Wolf Bay tributaries.

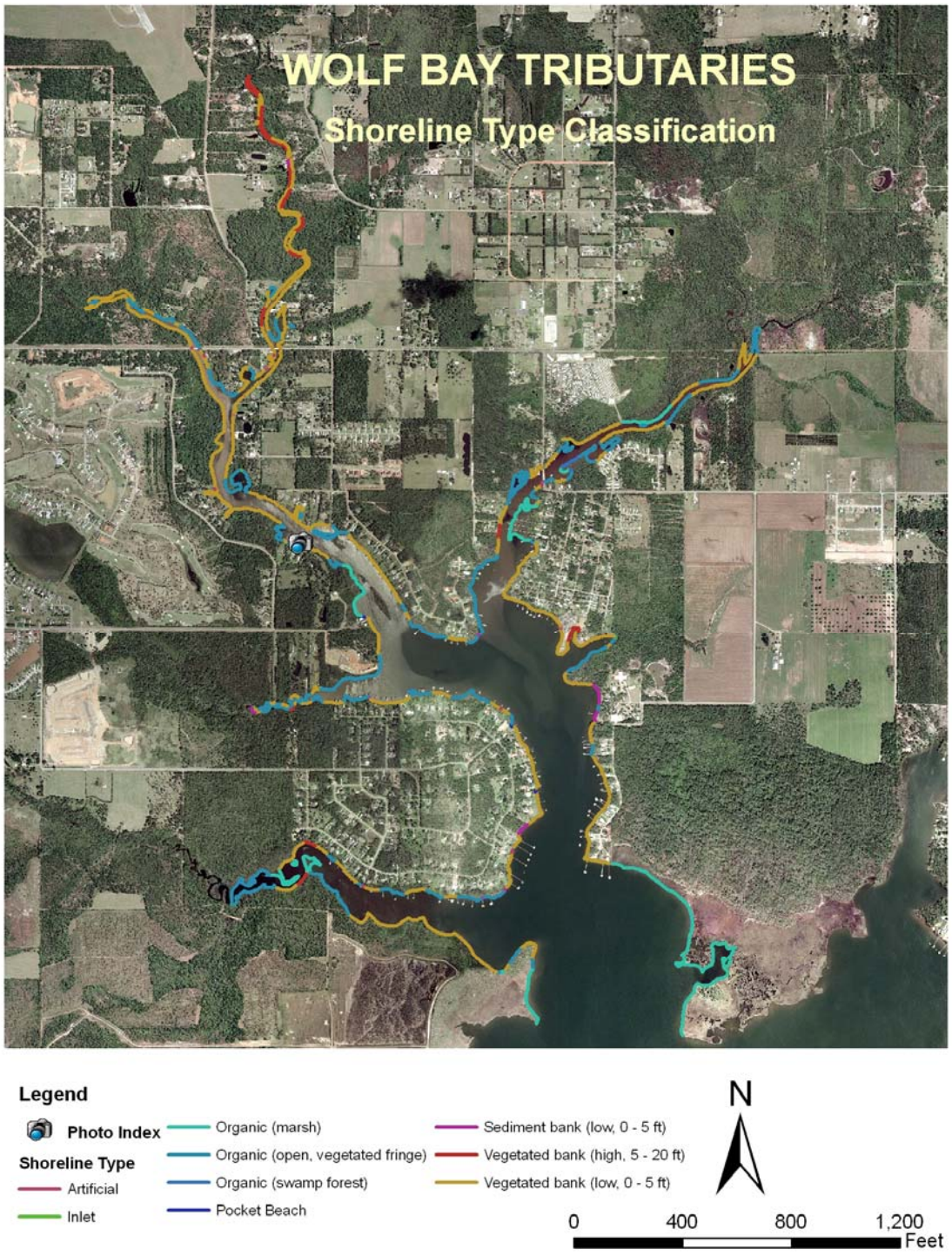

Figure 23.--Shoreline type map of the Wolf Bay tributaries.

Table 21.—Wolf Bay tributaries shoreline type classification lengths and percentages.

Wolf Bay tributaries		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	865	0.7
Inlet	645	0.5
Organic (marsh)	16,019	13.0
Organic (open, vegetated fringe)	35,822	29.2
Organic (swamp forest)	426	0.3
Pocket Beach	276	0.2
Sediment bank (low, 0 - 5 ft)	1,633	1.3
Vegetated bank (high, 5 - 20 ft)	5,695	4.6
Vegetated bank (low, 0 - 5 ft)	61,504	50.0
Total	122,886	100.0

NORTH FOWL RIVER

SHORE PROTECTION

Sixteen different shore protection classifications were mapped in North Fowl River including abutment, artificial, boat ramp, boom, bulkhead subtypes, natural, unretained subtypes, oyster shells, revetment, rubble/riprap subtypes, sill (wood) and wire fence. Shore protection estimates for North Fowl River are listed in table 22, and figure 24 depicts the distribution.

North Fowl River consists mainly of natural, unretained shoreline having about 147,326 feet (27.9 miles) or about 72.9 percent of the total shore protection mapped. Bulkhead shore protection subtypes, the second largest, make up about 46,143 feet (8.7 miles) or about 22.7 percent of the total shore protection in North Fowl River, with bulkhead (steel, wood) being the largest. Rubble/riprap shore protection subtypes make up about 6,230 feet (1.2 miles) or about 3 percent of the total shore protection in North Fowl River, with rubble/riprap being the largest. The remaining 1.3 percent of the shoreline is armored through various methods listed above and tabulated in table 22. There were 28 private and four public boat ramps observed in North Fowl River (fig. 25).

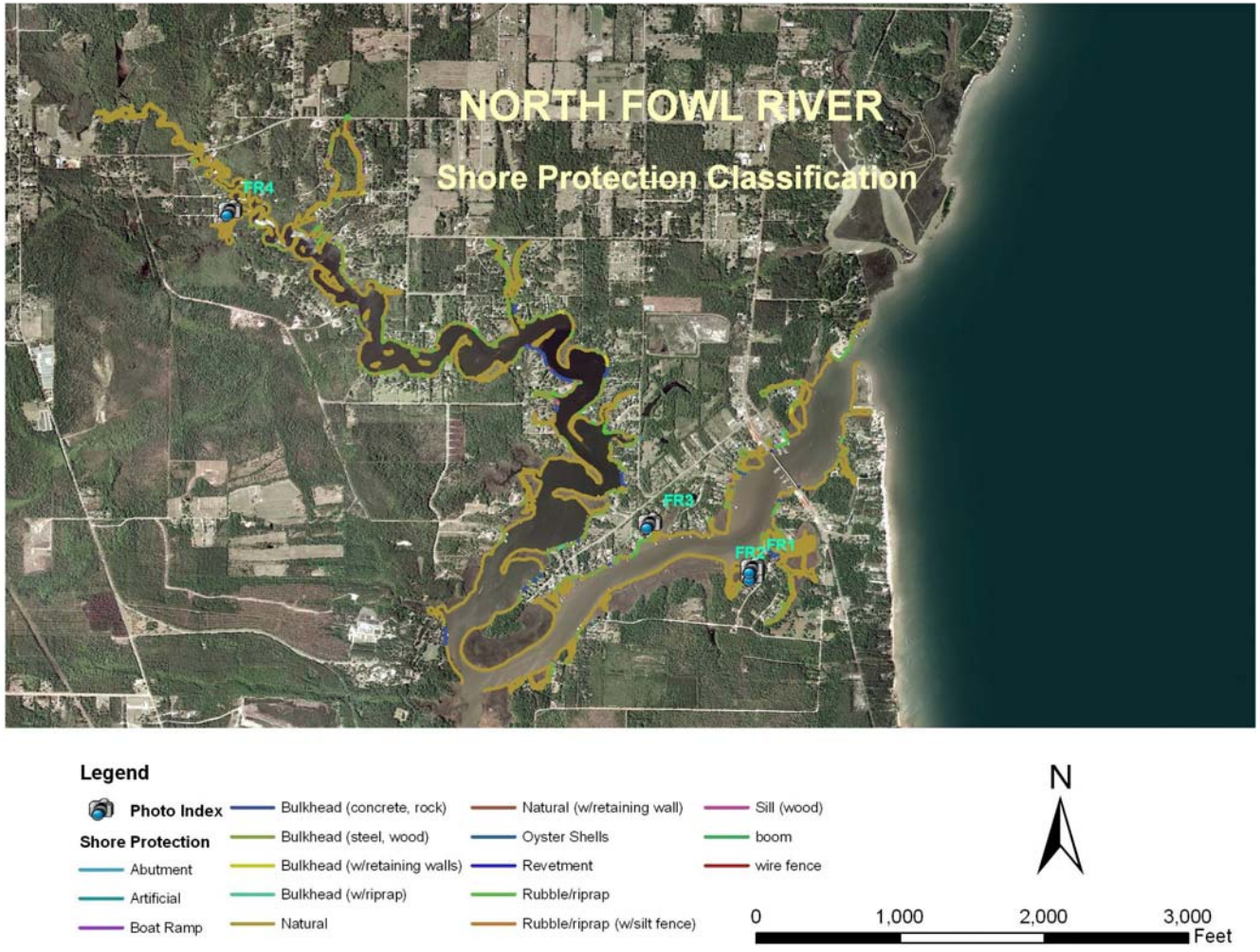

Figure 24.—Shore protection map of North Fowl River.

Figure 25.—Boat ramp distribution map of North Fowl River.

Table 22.—North Fowl River shore protection classification lengths and percentages.

North Fowl River		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	203	0.1
Artificial	118	0.1
Boat Ramp	830	0.4
Boom	33	0.0
Bulkhead (concrete, rock)	4,534	2.2
Bulkhead (steel, wood)	40,491	20.0
Bulkhead (w/retaining walls)	886	0.4
Bulkhead (w/riprap)	232	0.1
Natural, unretained	147,326	72.8
Natural, unretained (w/retaining wall)	171	0.1
Oyster Shells	375	0.2
Revetment	280	0.1
Rubble/riprap	6,163	3.0
Rubble/riprap (w/silt fence)	67	0.0
Sill (wood)	384	0.2
Wire fence	170	0.1
Total	202,263	100.0

SHORELINE TYPES

Ten different shoreline type classifications were identified in North Fowl River such as artificial, inlet, organic (marsh), organic (open, vegetated fringe), organic (swamp forest), pocket beach, sediment bank (high and low), and vegetated bank (high and low). Specific shoreline type values are listed in table 23. Figure 26 illustrates the distribution of shoreline types in North Fowl River.

The dominant shoreline type in North Fowl River is organic shoreline types making up about 121,700 feet (23 miles) or about 60.2 percent of the total in North Fowl River with most classified as organic (marsh). Vegetated bank shoreline types, the second longest mapped, makes up about 74,325 feet (14.1 miles) or about 36.7 percent of the total in North Fowl River, with most classified as vegetated bank (low). Sediment bank shoreline types make up about 2,811 feet or about 1.3 percent of the total mapped in North Fowl River, with most classified as sediment bank (low). There were 15 inlets identified in North Fowl River.

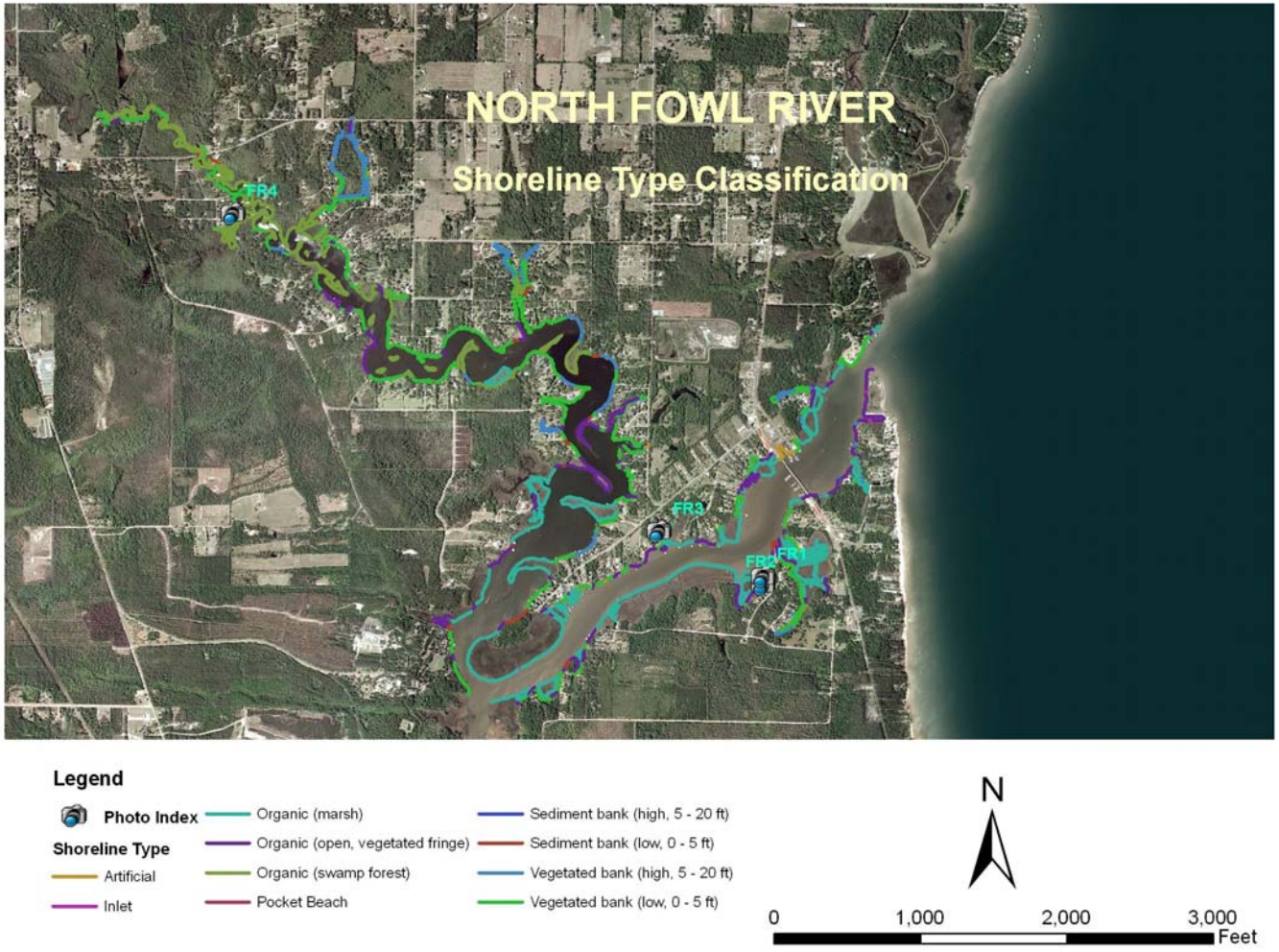

Figure 26.—Shoreline type map of North Fowl River.

Table 23.—North Fowl River shoreline type classification lengths and percentages.

North Fowl River		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	1,947	1.0
Inlet	1,153	0.6
Organic (marsh)	51,779	25.6
Organic (open, vegetated fringe)	29,295	14.5
Organic (swamp forest)	40,626	20.1
Pocket Beach	255	0.1
Sediment bank (high, 5 - 20 ft)	91	0.0
Sediment bank (low, 0 - 5 ft)	2,720	1.3
Vegetated bank (high, 5 - 20 ft)	18,237	9.0
Vegetated bank (low, 0 - 5 ft)	56,088	27.7
Total	202,192	100.0

SOUTH FOWL RIVER

SHORE PROTECTION

Eleven different shore protection classifications were mapped in South Fowl River including abutment, boat ramp, bulkhead subtypes, groin, natural, unretained, oyster shells, rubble/riprap, segmented breakwater, and tires. Shore protection estimates for South Fowl River are listed in table 24, and figure 27 depicts the distribution.

South Fowl River consists mainly of natural, unretained shoreline having about 132,209 feet (25 miles) or about 86 percent of the total shore protection mapped. Bulkhead shore protection subtypes, the second largest, make up about 16,195 feet (3.1 miles) or about 10.5 percent of the total shore protection in South Fowl River, with bulkhead (steel, wood) being the largest. Rubble/riprap shore protection makes up about 2,404 feet or about 1.6 percent of the total shore protection in South Fowl River. The remaining 1.9 percent of the shoreline is armored through various methods listed above and tabulated in table 24. There were 41 private boat ramps observed in South Fowl River (fig. 28).

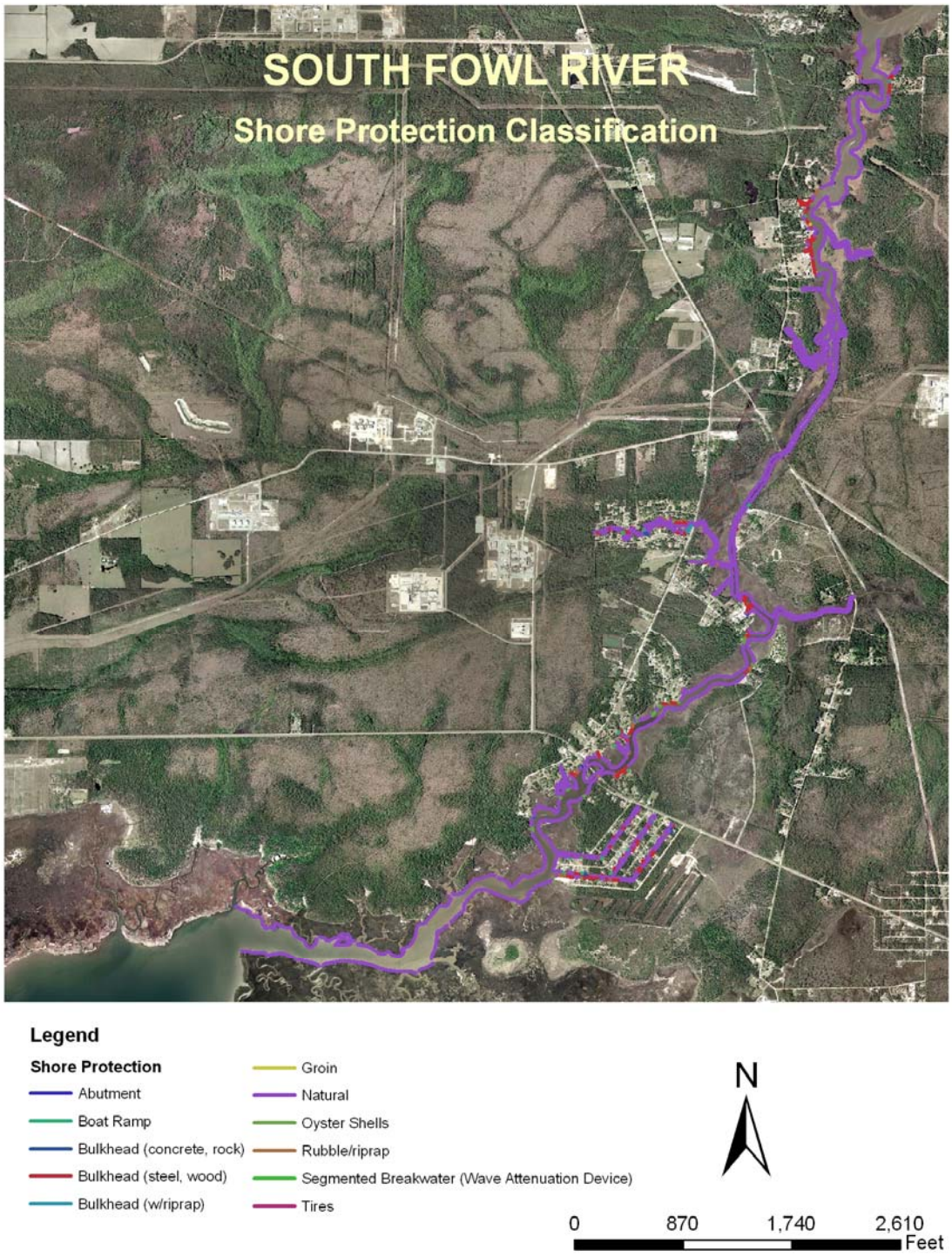

Figure 27.—Shore protection map of South Fowl River.

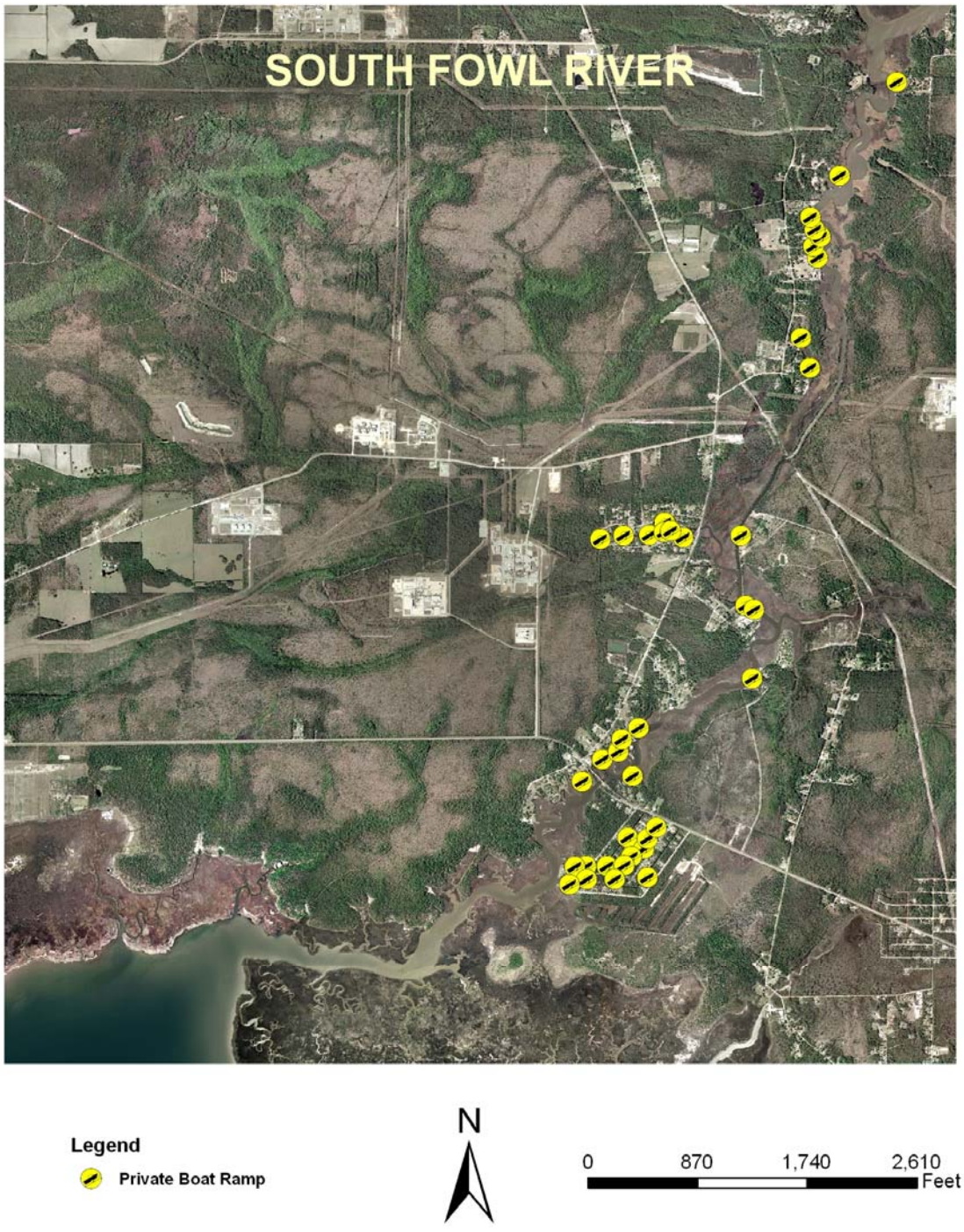

Figure 28.—Boat ramp distribution map of South Fowl River.

Table 24.—South Fowl River shore protection classification lengths and percentages.

South Fowl River		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	60	0.0
Boat Ramp	748	0.5
Bulkhead (concrete, rock)	666	0.4
Bulkhead (steel, wood)	15,246	9.9
Bulkhead (w/riprap)	283	0.2
Groin	12	0.0
Natural, unretained	132,209	86.0
Oyster Shells	2,006	1.3
Rubble/riprap	2,404	1.6
Segmented Breakwater (Wave Attenuation Device)	51	0.0
Tires	91	0.1
Total	153,776	100.0

SHORELINE TYPES

Ten different shoreline type classifications were identified in South Fowl River such as artificial, inlet, organic (marsh), organic (open, vegetated fringe), organic (swamp forest), pocket beach, sediment bank (high and low), and vegetated bank (high and low). Specific shoreline type values are listed in table 25. Figure 29 illustrates the distribution of shoreline types in South Fowl River.

The dominant shoreline type in South Fowl River is organic shoreline types making up about 96,173 feet (18.2 miles) or about 61.3 percent of the total in South Fowl River with most classified as organic (marsh). Vegetated bank shoreline types, the second longest mapped, makes up about 51,741 feet (9.8 miles) or about 33 percent of the total in South Fowl River, with most classified as vegetated bank (low). Sediment bank shoreline types make up about 4,257 feet or about 2.7 percent of the total mapped in South Fowl River, with most classified as sediment bank (high). There were 66 inlets identified in South Fowl River.

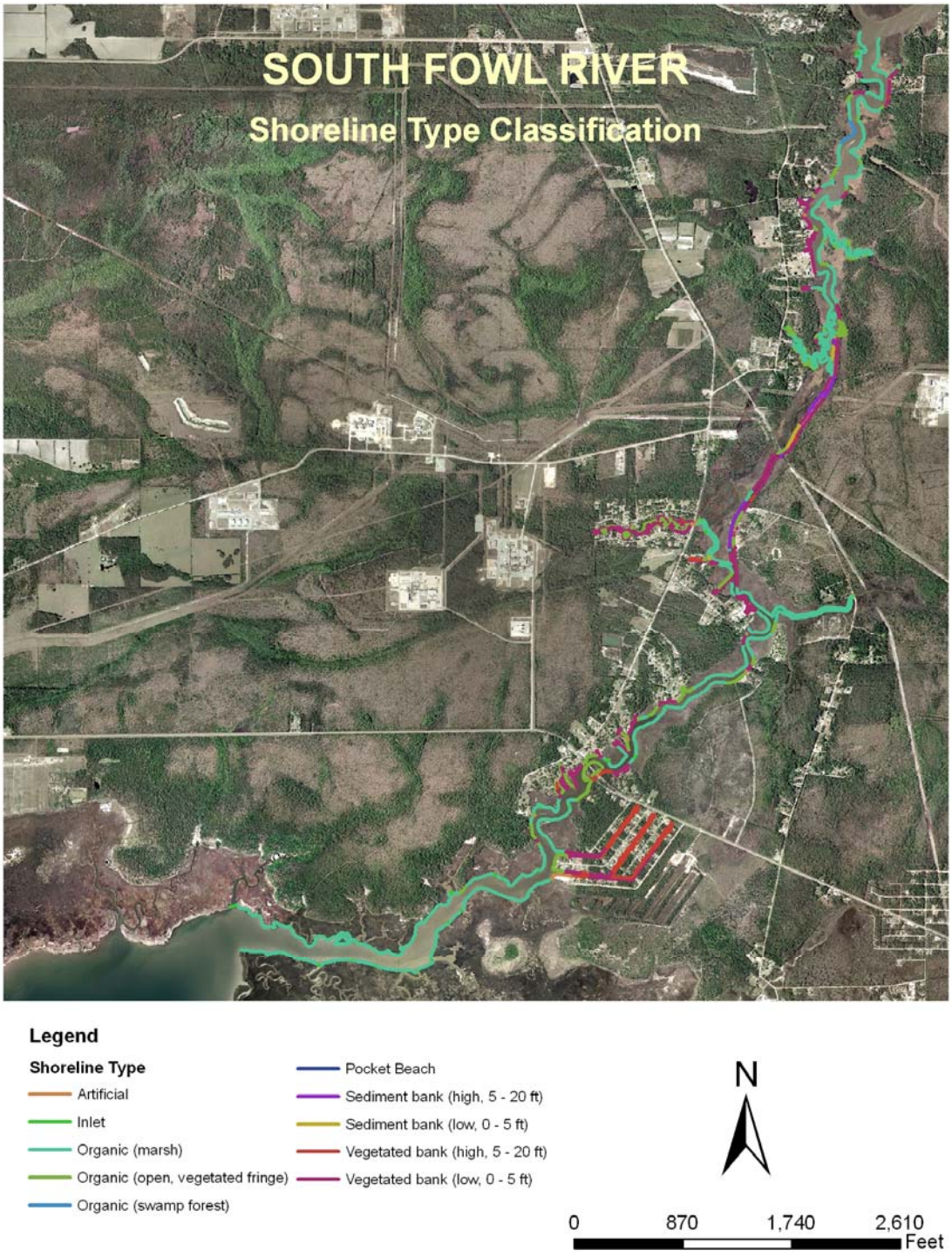

Figure 29.—Shoreline type map of South Fowl River.

Table 25.—South Fowl River shoreline type classification lengths and percentages.

South Fowl River		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	1,709	1.1
Inlet	2,790	1.8
Organic (marsh)	73,367	46.8
Organic (open, vegetated fringe)	21,967	14.0
Organic (swamp forest)	839	0.5
Pocket Beach	263	0.2
Sediment bank (high, 5 - 20 ft)	2,928	1.9
Sediment bank (low, 0 - 5 ft)	1,329	0.8
Vegetated bank (high, 5 - 20 ft)	14,226	9.1
Vegetated bank (low, 0 - 5 ft)	37,515	23.9
Total	156,933	100.0

HERON BAY

SHORE PROTECTION

Ten different shore protection classifications were mapped in Heron Bay. These included abutment, boat ramp, bulkhead subtypes, natural, unretained, oyster shells, revetment, rubble/riprap, and sill (wood). Shore protection estimates for Heron Bay are listed in table 26, and figure 30 depicts the distribution.

Heron Bay consists mainly of natural, unretained shoreline having about 140,803 feet (26.7 miles) or about 96.5 percent of the total. Bulkhead shore protection makes up about 1,698 feet or about 1.2 percent of the total shore protection in Heron Bay. Rubble/riprap shore protection makes up about 1,687 feet or about 1.2 percent of the total shore protection in Heron Bay. The remaining 1.2 percent of the shoreline is armored through various methods listed above and tabulated in table 26. There were four public boat ramps observed in Heron Bay.

Figure 30.—Shore protection map of Heron Bay.

Table 26.—Heron Bay shore protection classification lengths and percentages.

Heron Bay		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	211	0.1
Boat Ramp	145	0.1
Bulkhead (concrete, rock w/riprap)	855	0.6
Bulkhead (concrete, rock)	292	0.2
Bulkhead (steel, wood)	551	0.4
Natural, unretained	140,803	96.5
Oyster Shells	1,317	0.9
Revetment	90	0.1
Rubble/riprap	1,687	1.2
Sill (wood)	20	0.0
Total	145,971	100.0

SHORELINE TYPES

Eight different shoreline type classifications were identified in Heron Bay such as artificial, inlet, organic (marsh), organic (open, vegetated fringe), pocket beach, sediment bank (high and low), and vegetated bank (low). Specific shoreline type values are listed in table 27. Figure 31 illustrates the distribution of Heron Bay shoreline types.

The dominant shoreline type in Heron Bay is organic shoreline types making up about 132,530 feet (25.1 miles) or about 80.2 percent of the total in Heron Bay with most classified as marsh. Vegetated bank (low) shoreline, the second longest mapped, makes up about 14,046 feet (2.7 miles) or about 8.5 percent of the total. Sediment bank shoreline types makes up about 11,308 feet (2.1 miles) or about 6.9 percent. There were 66 inlets identified in Heron Bay.

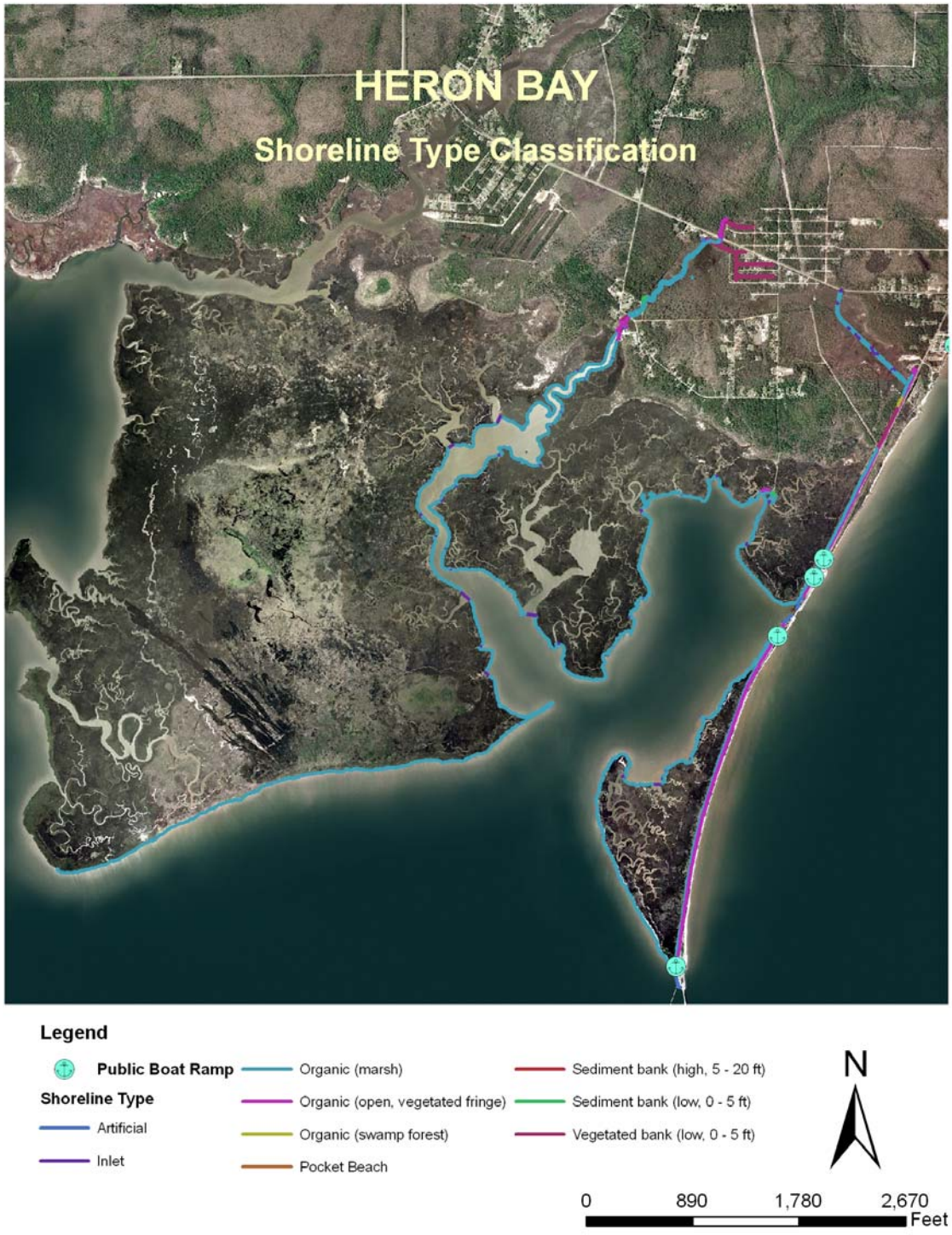

Figure 31.--Shoreline type map of Heron Bay.

Table 27.—Heron Bay shoreline type classification lengths and percentages.

Heron Bay		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	3,506	2.1
Inlet	3,632	2.2
Organic (marsh)	112,866	68.3
Organic (open, vegetated fringe)	19,664	11.9
Pocket Beach	131	0.1
Sediment bank (high, 5 - 20 ft)	1,592	1.0
Sediment bank (low, 0 - 5 ft)	9,716	5.9
Vegetated bank (low, 0 - 5 ft)	14,046	8.5
Total	165,153	100.0

FOWL RIVER BAY AND PORTERSVILLE BAY

SHORE PROTECTION

Eleven different shore protection classifications were mapped in Fowl River Bay and Portersville Bay. These included abutment, bulkhead subtypes, concrete rubble (nearshore), natural, unretained, oyster shells, rubble/riprap, segmented breakwater subtypes, and wetland restoration. Shore protection estimates for Fowl River Bay and Portersville Bay are listed in table 28, and figure 32 depicts the distribution.

Fowl River Bay and Portersville Bay consist mainly of natural, unretained shoreline having about 70,319 feet (13.3 miles) or about 75.3 percent of the total. Bulkhead shore protection makes up about 8,590 feet (1.6 miles) or about 9.2 percent of the total shore protection in Fowl River Bay and Portersville Bay. Segmented breakwater shore protection makes up about 5,275 feet or about 5.6 percent of the total shore protection in Fowl River Bay and Portersville Bay. The remaining 9.9 percent of the shoreline is armored through various methods listed above and tabulated in table 28.

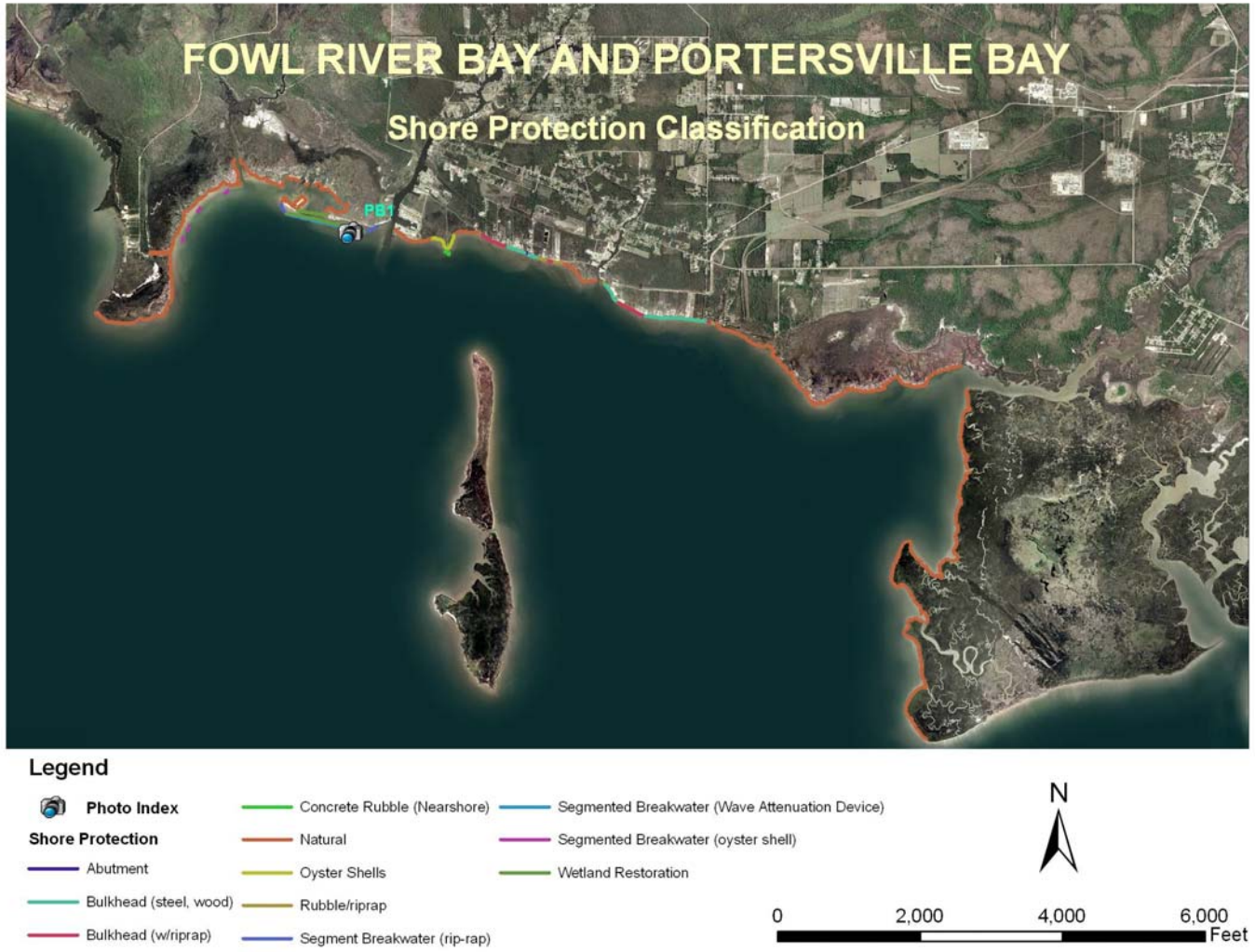

Figure 32.—Shore protection map of Fowl River Bay and Portersville Bay.

Table 28.—Fowl River Bay and Portersville Bay shore protection classification lengths and percentages.

Fowl River Bay and Portersville Bay		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	243	0.3
Bulkhead (steel, wood)	5,554	5.9
Bulkhead (w/riprap)	3,036	3.3
Concrete Rubble (Nearshore)	303	0.3
Natural, unretained	70,319	75.3
Oyster Shells	1,798	1.9
Rubble/riprap	1,771	1.9
Segment Breakwater (rip-rap)	1,332	1.4
Segmented Breakwater (oyster shell)	947	1.0
Segmented Breakwater (Wave Attenuation Device)	2,996	3.2
Wetland Restoration	5,101	5.5
Total	93,399	100.0

SHORELINE TYPES

Six different shoreline type classifications were identified in Fowl River Bay and Portersville Bay such as artificial, inlet, organic (marsh), organic (open, vegetated fringe), sediment bank (low), and vegetated bank (low). Specific shoreline type values are listed in table 29. Figure 33 illustrates the distribution of Fowl River Bay and Portersville Bay shoreline types.

The dominant shoreline type in Fowl River Bay and Portersville Bay is organic shoreline types making up about 80,544 feet (15.3 miles) or about 78.6 percent of the total in Fowl River Bay and Portersville Bay with most classified as marsh. Artificial shoreline, the second longest mapped, makes up about 11,791 feet (2.2 miles) or about 11.5 percent of the total. Sediment bank (low) shoreline type makes up about 4,664 feet or about 4.6 percent. There were 56 inlets identified in Fowl River Bay and Portersville Bay.

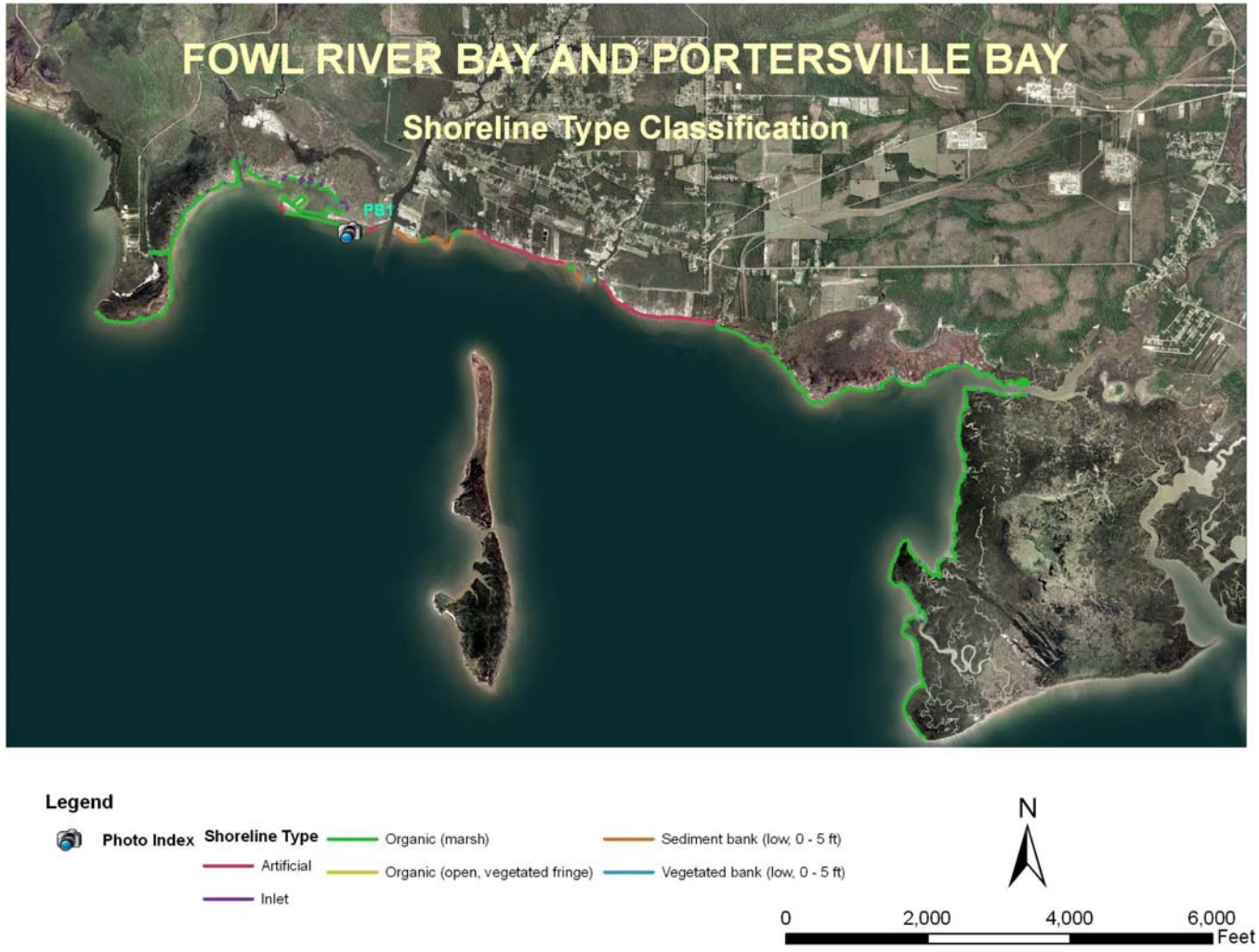

Figure 33.—Shoreline type map of Fowl River Bay and Portersville Bay.

Table 29.—Fowl River Bay and Portersville Bay shoreline type classification lengths and percentages.

Fowl River Bay and Portersville Bay		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	11,791	11.5
Inlet	5,010	4.9
Organic (marsh)	80,498	78.6
Organic (open, vegetated fringe)	46	0.0
Sediment bank (low, 0 - 5 ft)	4,664	4.6
Vegetated bank (low, 0 - 5 ft)	388	0.4
Total	102,398	100.0

GRAND BAY

SHORE PROTECTION

Seven different shore protection classifications were mapped in Grand Bay including boat ramp, bulkhead subtypes, Jetty (steel pile, rock, concrete), natural, unretained, and rubble/riprap. Shore protection estimates for Grand Bay are listed in table 30, and figure 34 depicts the distribution.

Grand Bay consists mainly of natural, unretained shoreline having about 114,011 feet (21.6 miles) or about 99.1 percent of the total shore protection mapped. Bulkhead shore protection subtypes, the second largest, make up about 422 feet or about 0.3 percent of the total shore protection in Grand Bay, with bulkhead (w/groin) being the largest. Rubble/riprap shore protection makes up about 388 feet or about 0.3 percent of the total shore protection in Grand Bay. The remaining 0.2 percent of the shoreline is armored through various methods listed above and tabulated in table 30. There were two private boat ramps observed in Grand Bay.

Table 30.—Grand Bay shore protection classification lengths and percentages.

Grand Bay		
Shore protection classification	**Length (ft)**	**Percent**
Boat Ramp	27	0.0
Bulkhead (concrete, rock)	49	0.0
Bulkhead (steel, wood)	168	0.1
Bulkhead (w/groin)	205	0.2
Jetty (steel pile, rock, concrete)	157	0.1
Natural, unretained	114,011	99.1
Rubble/riprap	388	0.3
Total	115,004	100.0

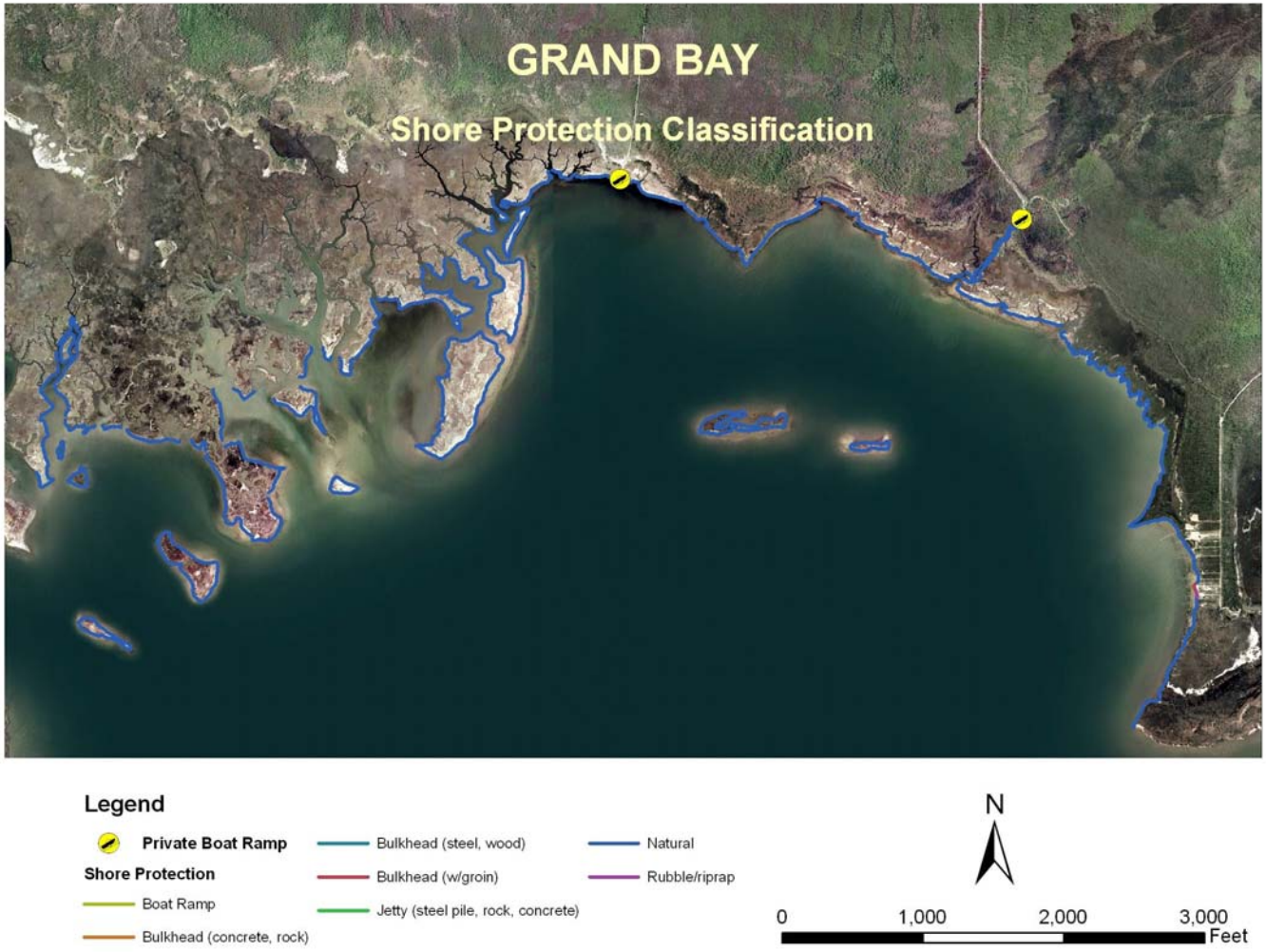

Figure 34.—Shore protection map of Grand Bay.

SHORELINE TYPES

Four different shoreline type classifications were identified in Grand Bay including organic (marsh), organic (open, vegetated fringe), and sediment bank (low). Specific shoreline type values are listed in table 31. Figure 35 illustrates the distribution of Grand Bay shoreline types.

The dominant shoreline type in Grand Bay is organic (marsh) making up about 108,213 feet (20.5 miles) or about 88.1 percent of the total in Grand Bay. Organic (open, vegetated, fringe) shoreline, the second longest mapped, makes up about 5,969 feet (1.1 miles) or about 4.9 percent of the total. Sediment bank (low) shoreline type makes up about 660 feet or about 0.5 percent. There were 91 inlets identified in Grand Bay.

Table 31.—Grand Bay shoreline type classification lengths and percentages.

Grand Bay		
Shoreline type classification	**Length (ft)**	**Percent**
Inlet	7,932	6.5
Organic (marsh)	108,213	88.1
Organic (open, vegetated fringe)	5,969	4.9
Sediment bank (low, 0 - 5 ft)	660	0.5
Total	122,774	100.0

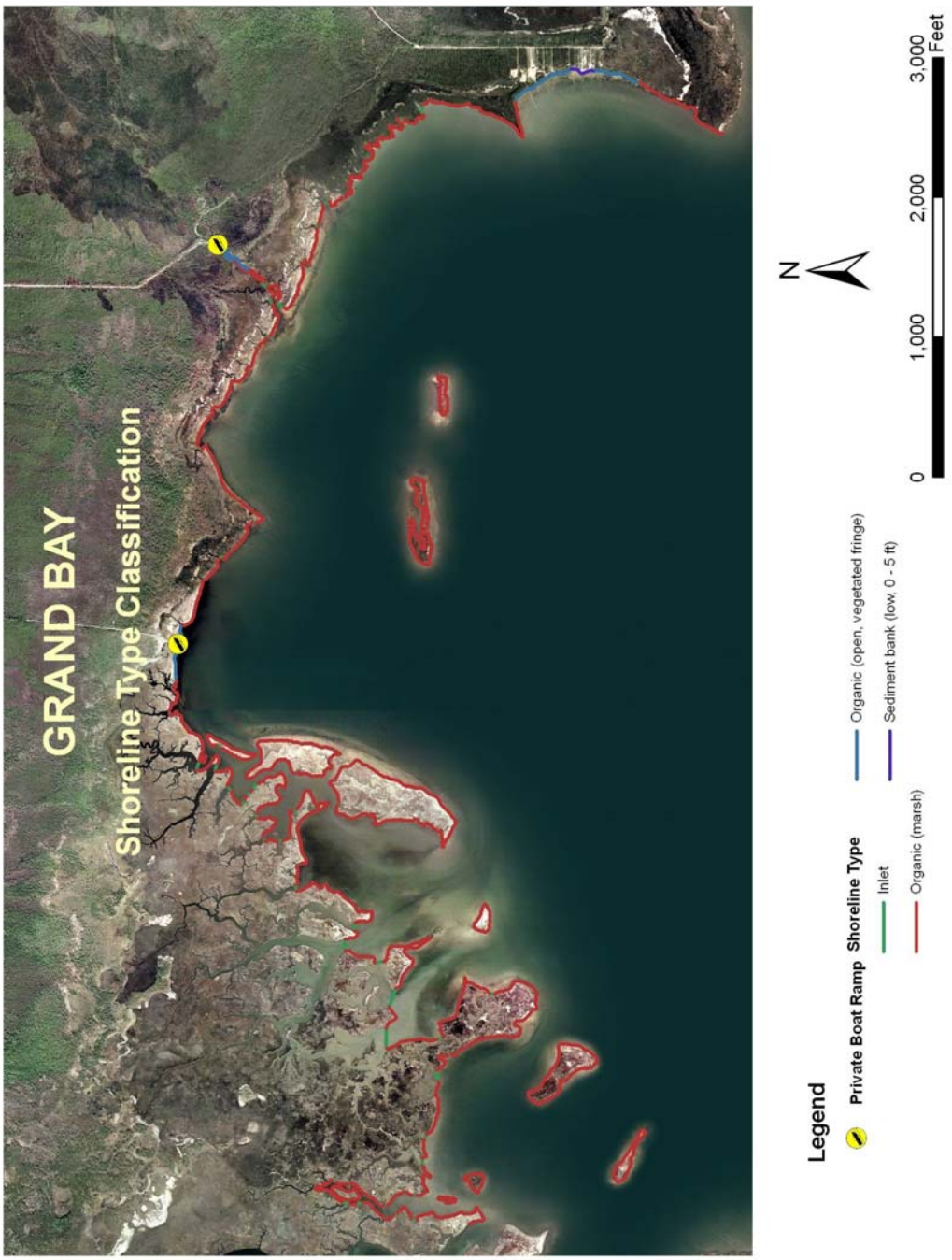

Figure 35.—Shoreline type map of Grand Bay.

SHORE PROTECTION

Twelve different shore protection classifications were mapped in Bayou La Batre. These included abutment, artificial, boat ramp, bulkhead subtypes, cement, natural, unretained, oyster shells, rubble/riprap, and sill (steel sheeting). Shore protection estimates for Bayou La Batre are listed in table 32 and figure 36 depicts the distribution.

Bulkhead shore protection is the longest mapped at 42.2 percent of the total; the bulkhead (steel, wood) subtype mapped had about 22,373 feet (4.2 miles) or 28.1 percent of the total. natural, unretained shoreline makes up about 31,487 feet (6 miles) and 39.6 percent of the total shore mapped using the shore protection classification. Rubble/riprap shore protection makes up about 11,846 feet (2.2 miles) or about 14.9 percent of the total shore protection in Bayou La Batre. The remaining 3.3 percent of the shoreline is armored through various methods listed above and tabulated in table 32. There were eight private boat ramps and four public boat ramps observed in Bayou La Batre.

Table 32.—Bayou La Batre shore protection classification lengths and percentages.

Bayou La Batre		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	721	0.9
Artificial	76	0.1
Boat Ramp	179	0.2
Bulkhead (concrete, rock w/riprap)	1,792	2.3
Bulkhead (concrete, rock)	7,665	9.6
Bulkhead (steel, wood)	22,373	28.1
Bulkhead (w/riprap)	1,733	2.2
Cement	94	0.1
Natural, unretained	31,487	39.6
Oyster Shells	1,445	1.8
Rubble/riprap	11,846	14.9
Sill (Steel Sheeting)	146	0.2
Total	79,558	100.0

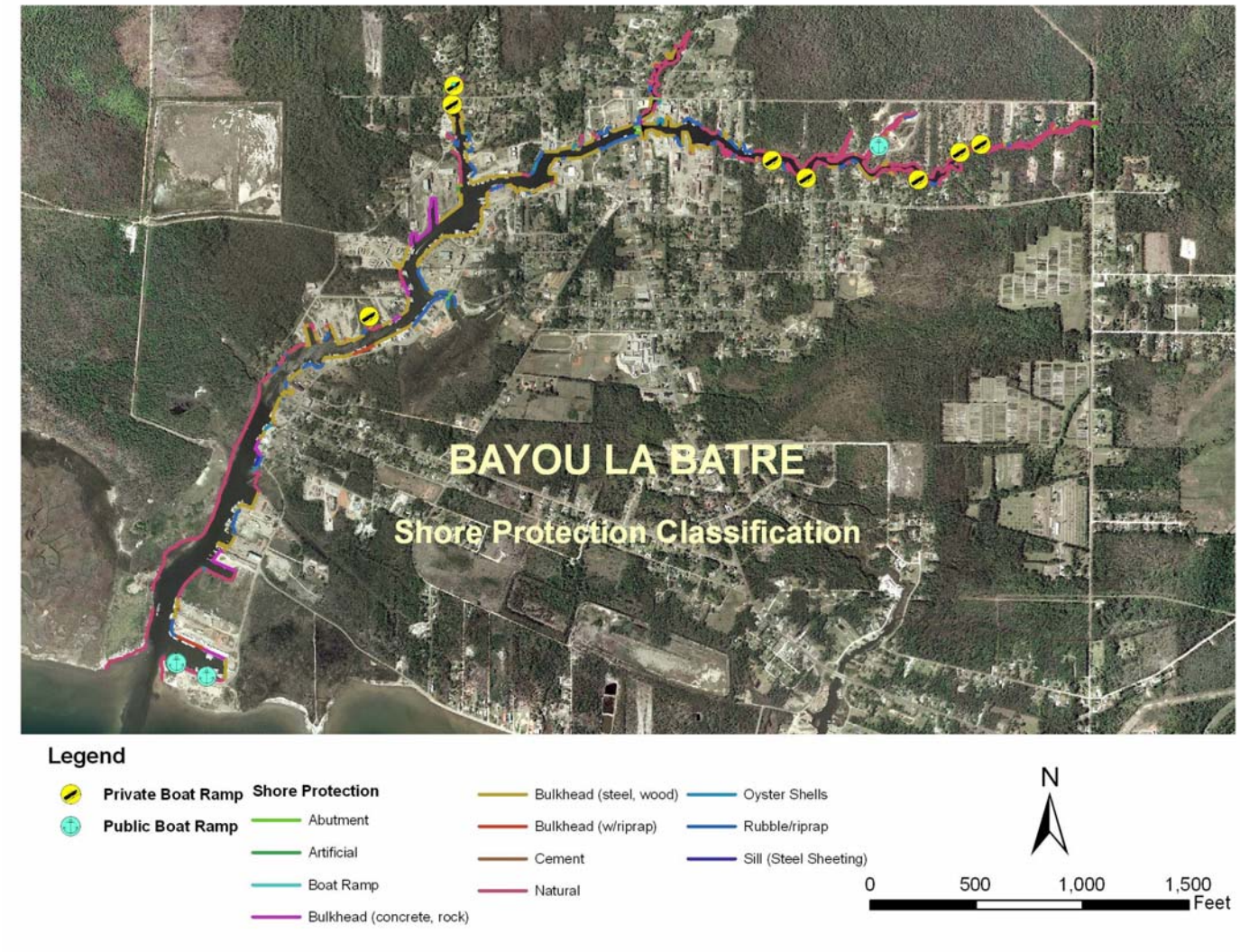

Figure 36.—Shore protection map of Bayou La Batre.

SHORELINE TYPES

Eight different shoreline type classifications were identified in Bayou La Batre such as artificial, inlet, organic (marsh), organic (open, vegetated fringe), sediment bank (high and low), and vegetated bank (high and low). Specific shoreline type values are listed in table 33. Figure 37 illustrates the distribution of Bayou La Batre shoreline types.

The dominant shoreline type in Bayou La Batre is vegetated bank making up about 32,239 feet (6.1 miles) or about 46.5 percent of the total in Bayou La Batre with most classified in the low subtype. Artificial shoreline, the second longest mapped, makes up about 23,211 feet (4.4 miles) or about 33.5 percent of the total. Organic shoreline types makes up about 8,682 feet (1.6 miles) or about 12.5 percent. There were 26 inlets identified in Bayou La Batre.

Table 33.—Bayou La Batre shoreline type classification lengths and percentages.

Bayou La Batre		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	23,211	33.5
Inlet	696	1.0
Organic (marsh)	3,129	4.5
Organic (open, vegetated fringe)	5,553	8.0
Sediment bank (high, 5 - 20 ft)	605	0.9
Sediment bank (low, 0 - 5 ft)	3,890	5.6
Vegetated bank (high, 5 - 20 ft)	2,542	3.7
Vegetated bank (low, 0 - 5 ft)	29,697	42.8
Total	69,323	100.0

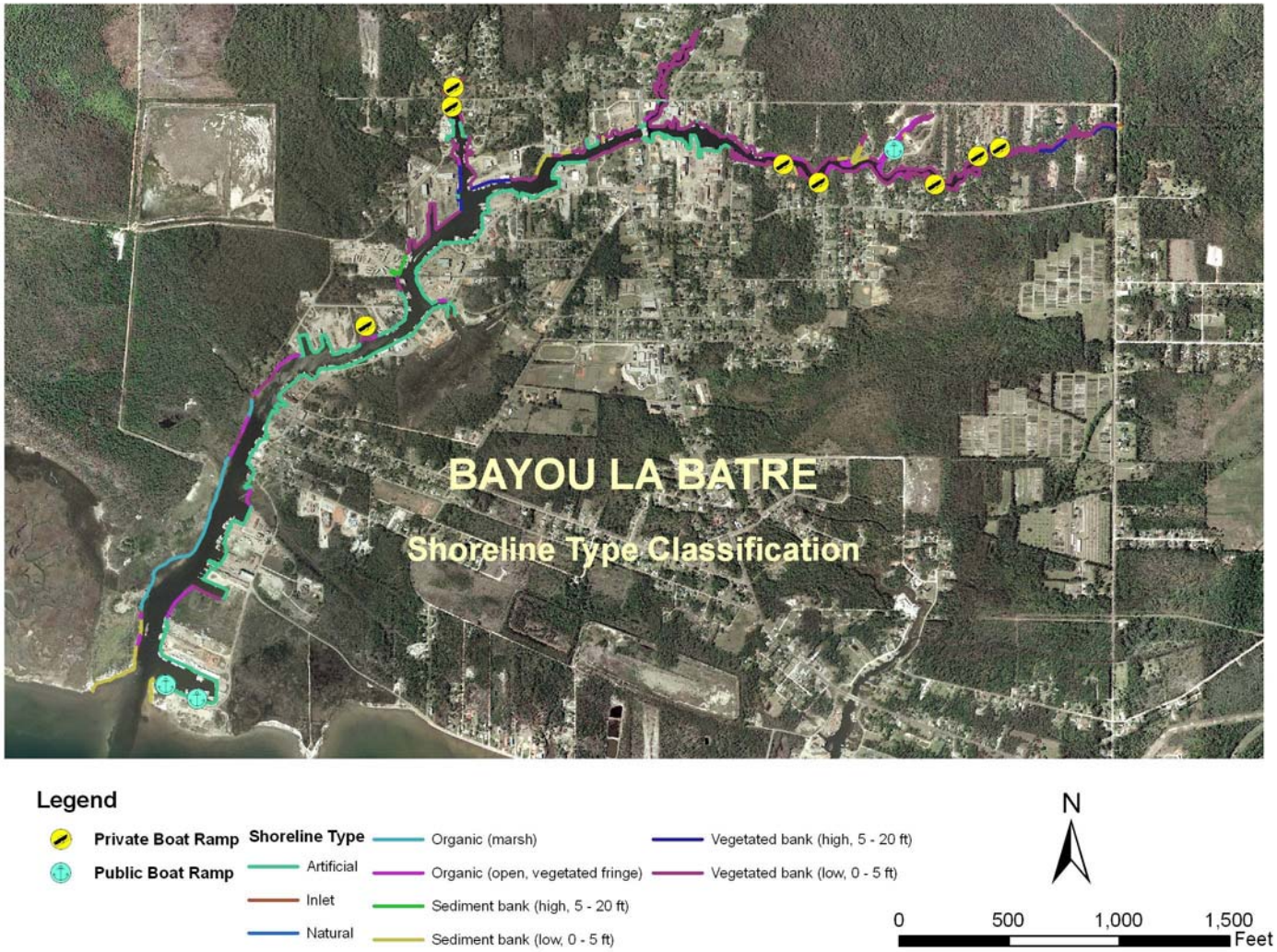

Figure 37.--Shoreline type map of Bayou La Batre.

CODEN BAYOU

SHORE PROTECTION

Seven different shore protection classifications were mapped in Coden Bayou, these included boat ramp, bulkhead subtypes, cement, natural, unretained, oyster shells, and rubble/riprap. Shore protection estimates for Coden Bayou are listed in table 34, and figure 38 depicts the distribution.

Natural, unretained shore protection makes up about 4,004 feet or about 29.7 percent of the total shore mapped in Coden Bayou. Rubble/riprap shore protection makes up about 3,570 feet or about 26.5 percent of the total shore protection in Coden Bayou. Oyster Shell shore protection makes up about 3,192 feet or about 23.6 percent of the total shore protection in Coden Bayou. Bulkhead shore protection subtypes make up about 2,609 feet or about 19.3 percent of the total shore protection in Coden Bayou, with bulkhead (steel, wood) being the largest. The remaining 0.9 percent of the shoreline is armored through various methods listed above and tabulated in table 34. There were four private boat ramps and two public boat ramps observed in Coden Bayou.

Table 34.—Coden Bayou shore protection classification lengths and percentages.

Coden Bayou		
Shore protection classification	**Length (ft)**	**Percent**
Boat Ramp	95	0.7
Bulkhead (concrete, rock)	352	2.6
Bulkhead (steel, wood)	2,257	16.7
Cement	28	0.2
Natural, unretained	4,004	29.7
Oyster Shells	3,192	23.6
Rubble/riprap	3,570	26.5
Total	13,497	100.0

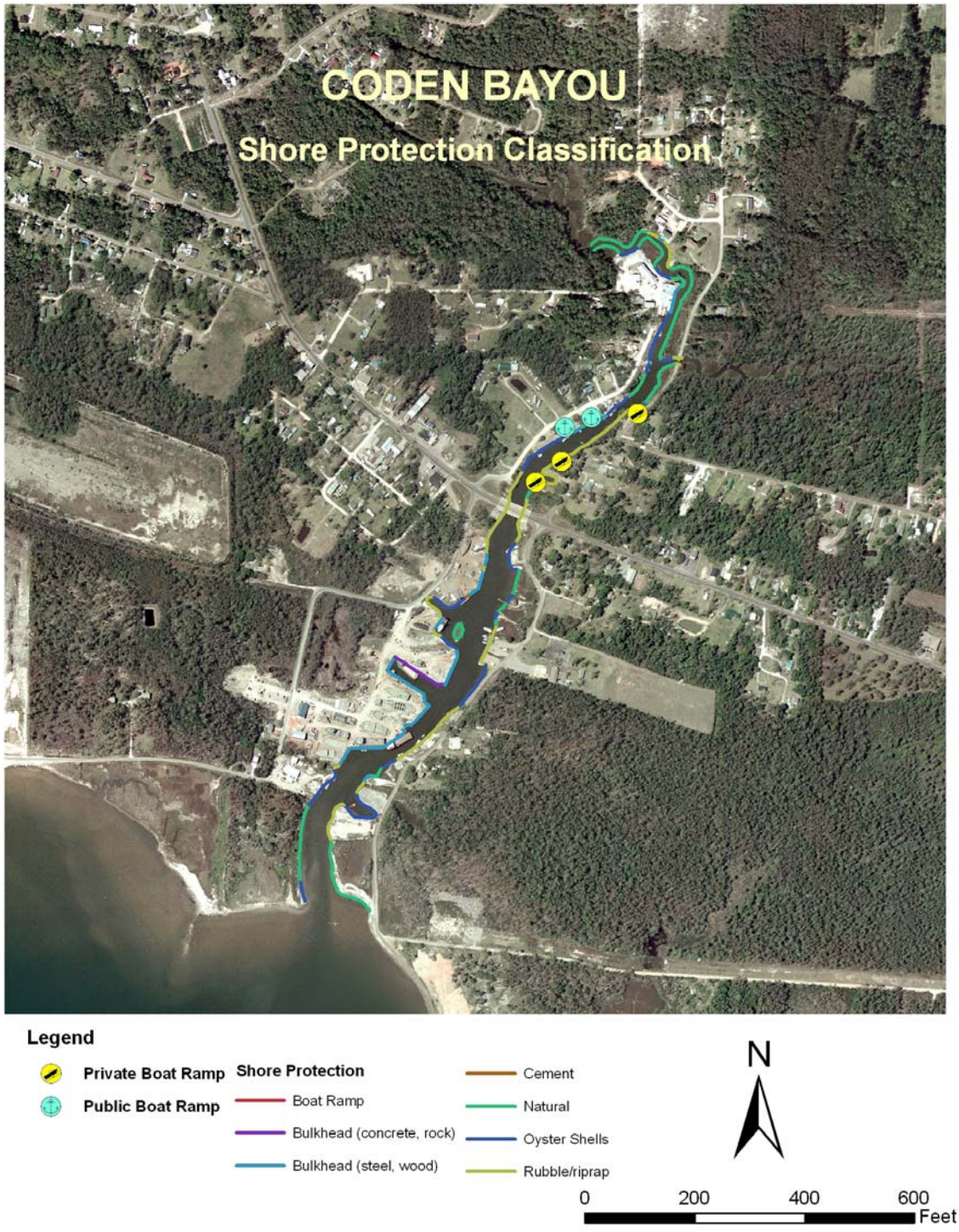

Figure 38.—Shore protection map of Coden Bayou.

SHORELINE TYPES

Six different shoreline type classifications were identified in Coden Bayou such as artificial, inlet, organic (marsh), organic (open, vegetated fringe), sediment bank (low), and vegetated bank (low). Specific shoreline type values are listed in table 35. Figure 39 illustrates the distribution of Coden Bayou shoreline types.

The dominant shoreline type in Coden Bayou is sediment bank (low) making up about 7,347 feet (1.4 miles) or about 54.2 percent of the total in Coden Bayou. Organic shoreline types, the second longest mapped, makes up about 4,066 feet or about 30 percent of the total shoreline type mapped in Coden Bayou. Artificial shoreline type makes up about 1,326 feet or about 9.8 percent. There were four inlets identified in Coden Bayou.

Table 35.—Coden Bayou shoreline type classification lengths and percentages.

Coden Bayou		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	1,326	9.8
Inlet	98	0.7
Organic (marsh)	224	1.7
Organic (open, vegetated fringe)	3,842	28.3
Sediment bank (low, 0 - 5 ft)	7,347	54.2
Vegetated bank (low, 0 - 5 ft)	728	5.4
Total	13,565	100.0

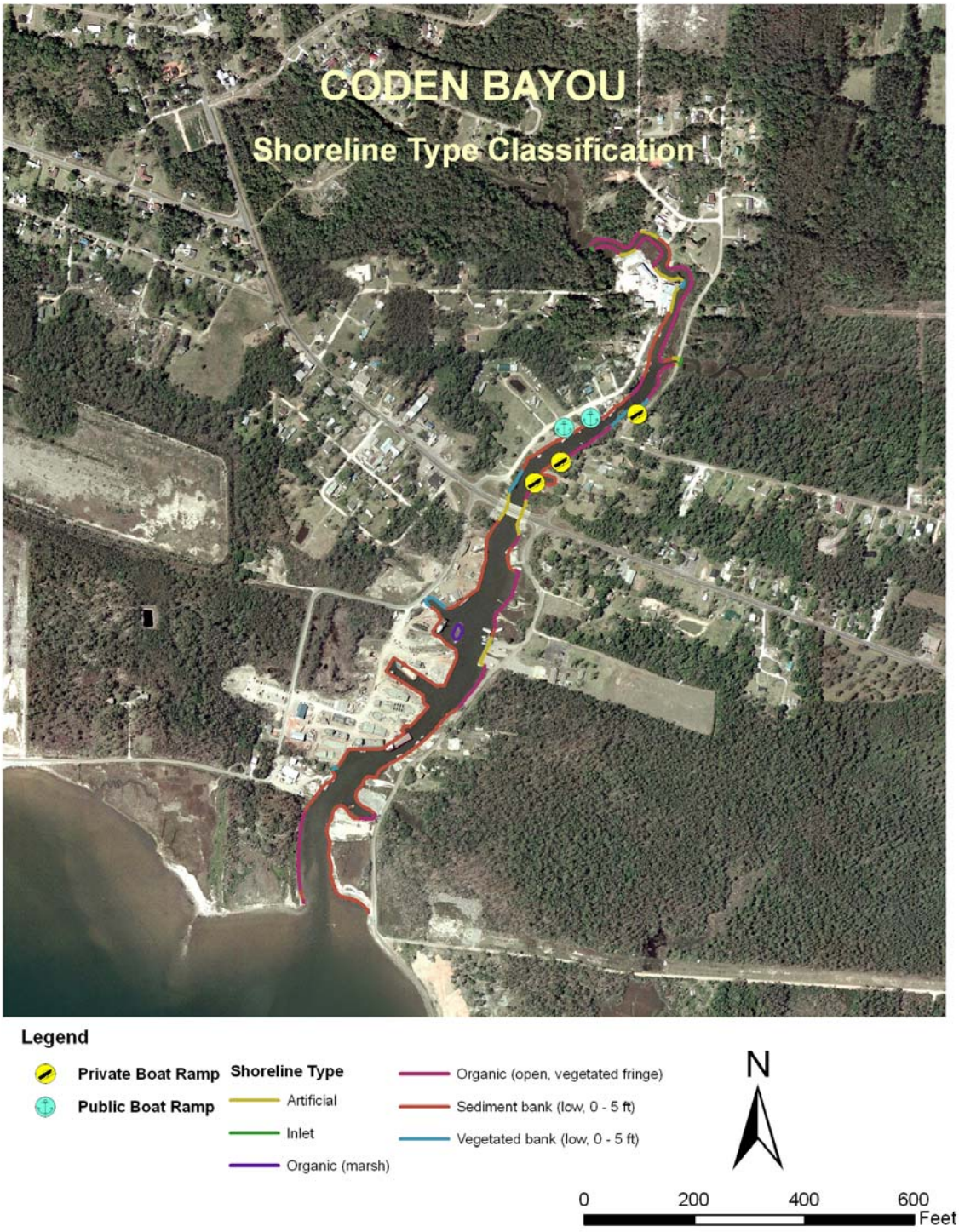

Figure 39.--Shoreline type map of Coden Bayou.

ISLE AUX HERBES

SHORE PROTECTION

Four different shore protection classifications were mapped on Isle aux Herbes, these included natural, unretained, segmented breakwater (bagged oyster shell), segmented breakwater (reefball/oyster dome), and segmented breakwater (reefBLK). Shore protection estimates for Isle aux Herbes are listed in table 36, and figure 40 depicts the distribution. Natural, unretained shore protection makes up about 40,113 feet (7.6 miles) or about 90.3 percent of the total shore mapped on Isle aux Herbes. Segmented breakwater subtypes make up about 4,319 feet or about 9.7 percent of the shore protection on Isle aux Herbes.

Table 36.—Isle aux Herbes shore protection classification lengths and percentages.

Isle aux Herbes		
Shore protection classification	**Length (ft)**	**Percent**
Natural, unretained	40,113	90.3
Segmented Breakwater (bagged oyster shell)	1,031	2.3
Segmented Breakwater (reef ball/oyster dome)	1,652	3.7
Segmented Breakwater (reefBLK)	1,636	3.7
Total	44,431	100.0

SHORELINE TYPES

There were only two shoreline types classified on Isle aux Herbes. Organic (marsh) makes up the total shoreline on Isle aux Herbes with a total of 40,113 feet (7.6 miles) of shoreline type on Isle aux Herbes. There were 13 inlets identified on Isle aux Herbes. Shoreline type estimates for Isle aux Herbes are listed in table 37, and figure 41 depicts the distribution.

Table 37.—Isle aux Herbes shoreline type classification lengths and percentages.

Isle aux Herbes		
Shoreline type classification	**Length (ft)**	**Percent**
Inlet	1,049	2.5
Organic (marsh)	40,113	97.5
Total	41,161	100.0

Figure 40.—Shore protection map of Isle aux Herbes.

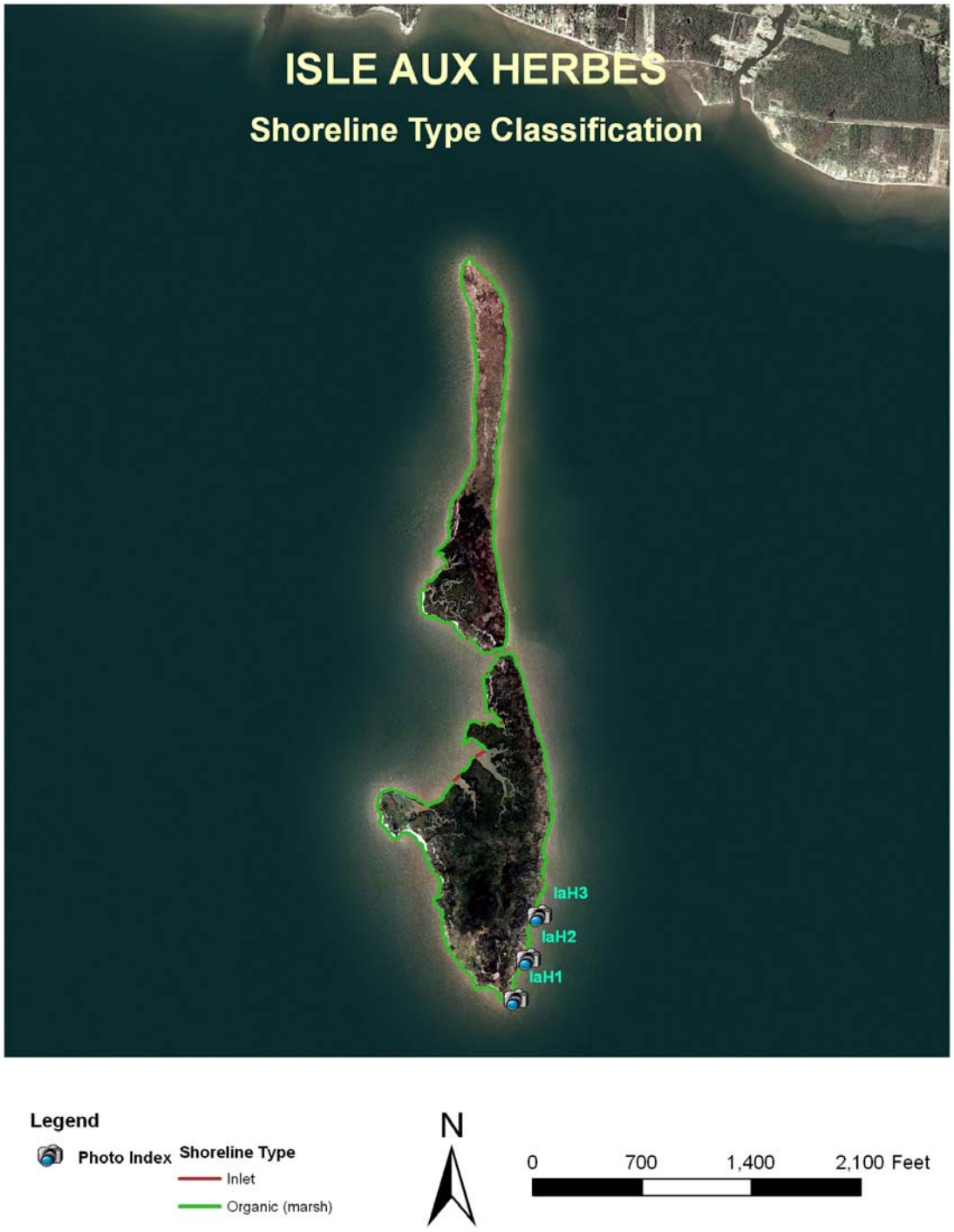

Figure 41.--Shoreline type map of Isle aux Herbes.

DAUPHIN ISLAND

SHORE PROTECTION

Twenty different shore protection classifications were mapped in Dauphin Island including abutment, artificial, beach nourishment, berm subtypes, boat ramp, breakwater (wave attenuation device), bulkhead subtypes, concrete rubble (nearshore), groin subtypes, jetty (steel pile, rock, concrete), natural, unretained, oyster shells, revetment,, rubble/riprap, and sill subtypes. Shore protection estimates for Dauphin Island are listed in table 38 and figure 42 depicts the distribution.

Natural, unretained shore protection is the longest mapped with 98,343 feet (18.6 miles) or 42.5 percent of the total mapped on Dauphin Island. Bulkhead shore protection subtypes, the second largest, makes up about 63,402 feet (12 miles) or about 27.4 of the total mapped on Dauphin Island, with bulkhead (concrete, rock) being the largest. Beach nourishment makes up about 38,591 feet (7.3 miles) or 16.7 percent of the total shore mapped on Dauphin Island. Berm shore protection subtypes make up about 19,089 feet (3.6 miles) or about 8.2 percent of the total shore protection on Dauphin Island, with berm being the largest. The remaining 5.1 percent of the shoreline is armored through various methods listed above and tabulated in table 38. There were 31 private and two public boat ramps observed on Dauphin Island (fig. 43).

SHORELINE TYPES

Nine different shoreline type classifications were identified on Dauphin Island including artificial, inlet, organic (marsh), organic (open, vegetated fringe), pocket beach, sediment bank (high and low), and vegetated bank (high and low). Specific shoreline type values are listed in table 39. Figure 44 illustrates the distribution of shoreline types on Dauphin Island.

The dominant shoreline type on Dauphin Island is sediment bank shoreline types making up about 102,126 feet (19.3 miles) or about 46.6 percent of the total, with most classified as sediment bank (low). Organic shoreline types, the second longest mapped, make up about 50,391 feet (9.5 miles) or about 23 percent of the total on Dauphin Island, with most classified as organic (marsh). Vegetated bank shoreline types make up about 44,258 feet (8.4 miles) or about 20.2 percent of the total mapped on Dauphin Island, with most classified as vegetated bank (low). There were 11 inlets identified on Dauphin Island.

Figure 42.—Shore protection map of Dauphin Island.

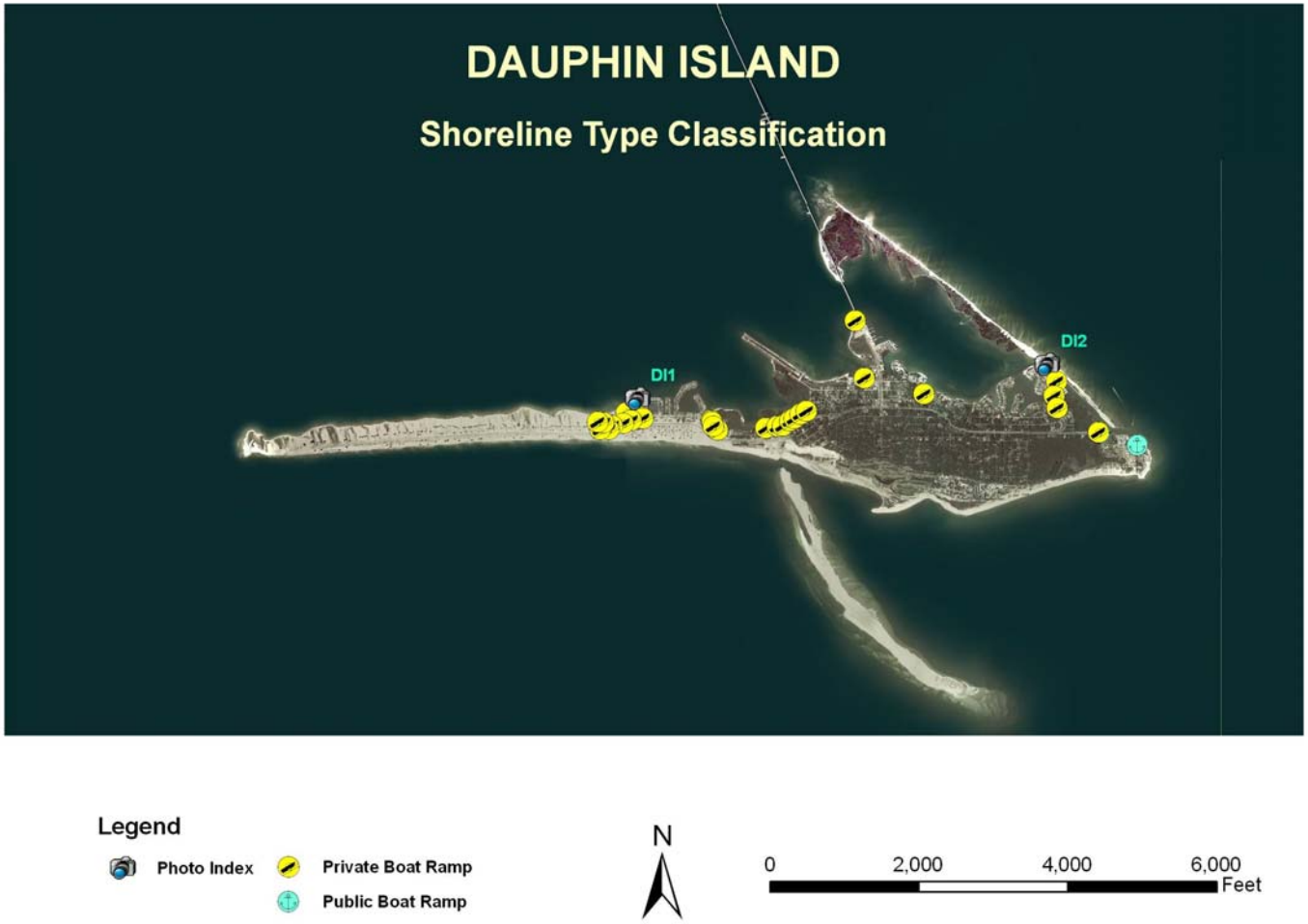

Figure 43.—Boat Ramp distribution map of Dauphin Island.

Table 38.—Dauphin Island shore protection classification lengths and percentages.

Dauphin Island		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	126	0.1
Artificial	40	0.0
Beach Nourishment	38,591	16.7
Berm	10,649	4.6
Berm (rock rubble)	8,440	3.6
Boat Ramp	613	0.3
Breakwater (Wave Attenuation Device)	496	0.2
Bulkhead (concrete, rock)	33,203	14.4
Bulkhead (steel, wood)	23,914	10.3
Bulkhead (w/riprap)	6,285	2.7
Concrete Rubble (Nearshore)	57	0.0
Groin	602	0.3
Groin (detached)	641	0.3
Jetty (steel pile, rock, concrete)	523	0.2
Natural, unretained	98,343	42.5
Oyster Shells	48	0.0
Revetment	277	0.1
Rubble/riprap	6,377	2.8
Sill (rock, shell)	642	0.3
Sill (wood)	1,479	0.6
Total	231,344	100.0

Table 39.—Dauphin Island shoreline type classification lengths and percentages.

Dauphin Island		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	21,301	9.7
Inlet	634	0.3
Organic (marsh)	39,074	17.8
Organic (open, vegetated fringe)	11,317	5.2
Pocket Beach	520	0.2
Sediment bank (high, 5 - 20 ft)	3,910	1.8
Sediment bank (low, 0 - 5 ft)	98,216	44.8
Vegetated bank (high, 5 - 20 ft)	167	0.1
Vegetated bank (low, 0 - 5 ft)	44,091	20.1
Total	219,231	100.0

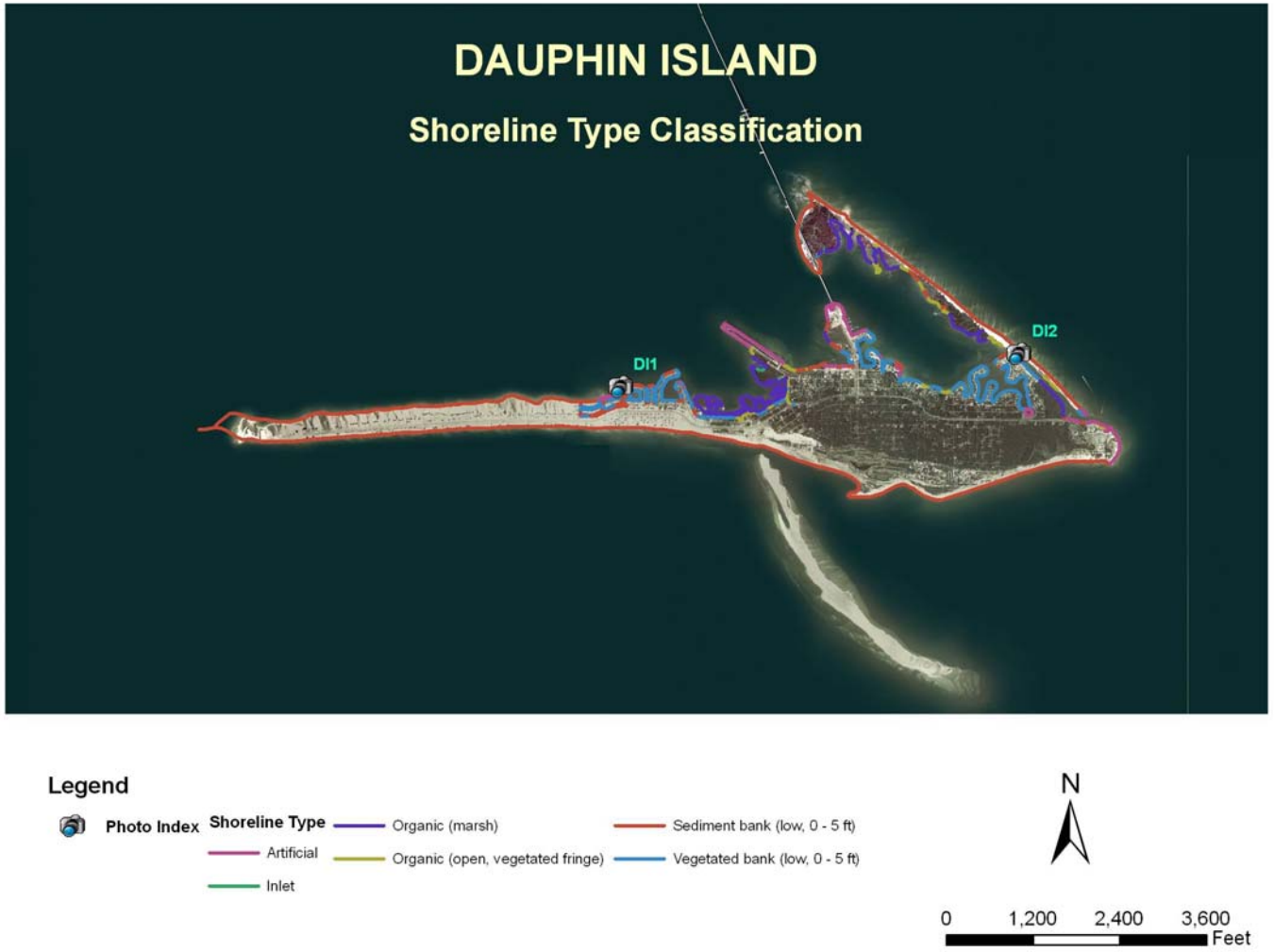

Figure 44.—Shoreline type map of Dauphin Island.

BALDWIN BEACHES

SHORE PROTECTION

Seven different shore protection classifications were mapped in Baldwin Beaches including beach nourishment subtypes, bulkhead (steel, wood), jetty (steel pile, rock, concrete), natural, unretained, seawall (concrete, steel pile) and weir. Shore protection estimates for Baldwin Beaches are listed in table 40 and figure 45 depicts the distribution.

Beach nourishment subtypes shore protection is the longest mapped with 90,402 feet (17.1 miles) or 53.0 percent of the total mapped on Baldwin Beaches. Natural, unretained shore protection, the second largest, makes up about 75,062 feet (14.2 miles) or about 43.9 of the total mapped on Baldwin Beaches. Jetty (steel pile, rock, concrete) makes up about 2,660 feet or 1.6 percent of the total shore mapped on Baldwin Beaches. The remaining 1.6 percent of the shoreline is armored through various methods listed above and tabulated in table 40.

Table 40.—Baldwin Beaches shore protection classification lengths and percentages.

Baldwin Beaches		
Shore protection classification	**Length (ft)**	**Percent**
Beach Nourishment	9,328	5.5
Beach Nourishment (Engineered)	81,074	47.5
Bulkhead (steel, wood)	134	0.1
Jetty (steel pile, rock, concrete)	2,660	1.6
Natural, unretained	75,062	43.9
Seawall (concrete, steel piles)	2,038	1.2
Weir	538	0.3
Total	170,834	100.0

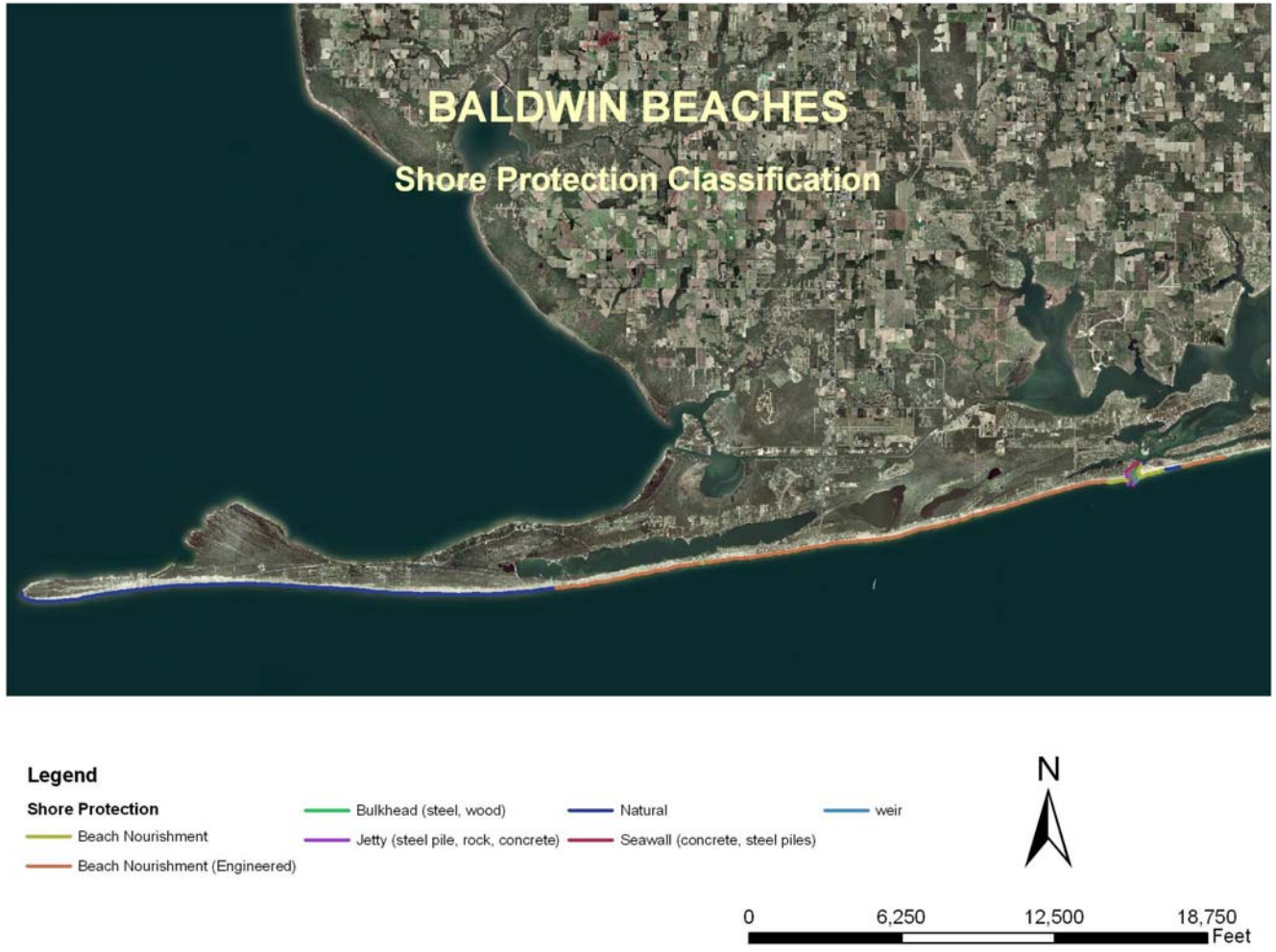

Figure 45.—Shore protection map of Baldwin Beaches.

SHORELINE TYPES

Two different shoreline type classifications were identified on Baldwin Beaches which are artificial and sediment bank (low) (table 41). The dominant shoreline type on Baldwin Beaches is sediment bank (low) shoreline type making up about 168,116 feet (31.8 miles) or about 99 percent of the total on Baldwin Beaches. Artificial shoreline type makes up about 773 feet or about 0.5 percent of the total on Baldwin Beaches. Figure 46 illustrates the distribution of shoreline types on Baldwin Beaches.

Table 41.—Baldwin Beaches shoreline type classification lengths and percentages.

Baldwin Beaches		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	773	0.5
Inlet	944	0.6
Sediment bank (low, 0 - 5 ft)	168,116	99.0
Total	169,832	100.0

SHORELINE CHANGE ANALYSIS

A total of 11,076 transects were generated by DSAS and represent Heron Bay, Fowl River Bay, Portersville Bay, Grand Bay, Isle aux Herbes and Little Dauphin Island. Table 42 provides transect type and count, overall mean shoreline change, and percentages and rates for erosion and accretion for the shoreline areas. Error is based on a 90 percent confidence interval. Transect type “all” refers to the total number of transects generated for that area. Transect type “selected” refers to transects where calculated regression values (R^2) are less than 0.75 and in which transect casts with two or less shorelines were discarded. Based on all transects for combined areas, an estimated 91 percent and 8.5 percent indicated limited shoreline erosion and accretion, respectively. Below are findings based only on selected values.

Based on 785 selected transects for Heron Bay (about 31 percent of all calculated), a mean shoreline change rate of -3.15 ± 1.82 ft/yr was quantified. About 93 percent represented erosion with a maximum and mean of -10.20 ± 0.92 ft/yr and -3.49 ± 1.90 ft/yr, respectively. Erosion is most notable along the southern shoreline, on the eastern shoreline close to Cedar Point, and on the western shoreline along and north of Barron Point (fig. 47). Areas of accretion were negligible.

Figure 46.—Shoreline type map of Baldwin Beaches.

Table 42. Tabulated results from Phase III Digital Shoreline Analysis System modeling.

Shoreline Areas	Transects		Mean Shoreline Change Rate (ft/yr)	Erosion %	Erosion Rates (ft/yr)		Accreation %	Accretion Rates (ft/yr)		No Change
	Type	Number			Max	Mean		Max	Mean	
Heron Bay	all	3114	-1.48 ± 2.21	78.84	-11.98 ± 2.95	-2.05 ± 2.24	19.78	12.93 ± 32.09	0.67 ± 2.15	1.38
	selected	785	-3.15 ± 1.82	92.61	-10.20 ± 0.92	-3.49 ± 1.90	7.39	5.74 ± 2.40	1.08 ± 0.83	0
Fowl River Bay	all	1866	-1.85 ± 2.36	83.82	-11.25 ± 12.89	-2.32 ± 2.29	15.11	5.54 ± 11.78	0.59 ± 2.74	1.07
	selected	684	-2.99 ± 1.62	97.08	-8.27 ± 4.49	-3.11 ± 1.64	2.92	2.59 ± 3.84	0.95 ± 1.06	0
Portersville Bay	all	955	-1.60 ± 4.26	60.10	-18.86 ± 16.73	-3.91 ± 3.19	39.48	10.63 ± 28.54	1.90 ± 5.93	0.42
	selected	296	-3.88 ± 2.37	79.05	-15.98 ± 5.31	-5.52 ± 2.53	20.95	8.10 ± 5.45	2.30 ± 1.80	0
Grand Bay	all	3027	-1.65 ± 6.40	70.30	-29.13 ± 63.78	-2.85 ± 6.41	29.17	18.50 ± 58.86	1.22 ± 6.43	0.53
	selected	1071	-2.93 ± 3.41	84.87	-29.13 ± 63.78	-3.68 ± 3.69	15.13	7.45 ± 20.51	1.29 ± 1.83	0
Isle aux Herbes	all	994	-6.14 ± 2.87	93.36	-22.67 ± 14.04	-6.73 ± 2.77	6.64	10.07 ± 2.20	2.21 ± 4.18	0
	selected	614	-6.87 ± 2.66	99.51	-18.18 ± 2.17	-6.92 ± 2.66	0.49	2.30 ± 0.69	1.96 ± 1.02	0
Little Dauphin Island	all	1120	-2.21 ± 2.07	81.34	-10.56 ± 2.6+9	-2.94 ± 2.06	18.21	7.87 ± 2.72	1.01 ± 2.07	0.45
	selected	633	-3.65 ± 2.01	90.05	-10.56 ± 2.69	-4.28 ± 2.04	9.95	7.87 ± 2.72	1.99 ± 1.83	0

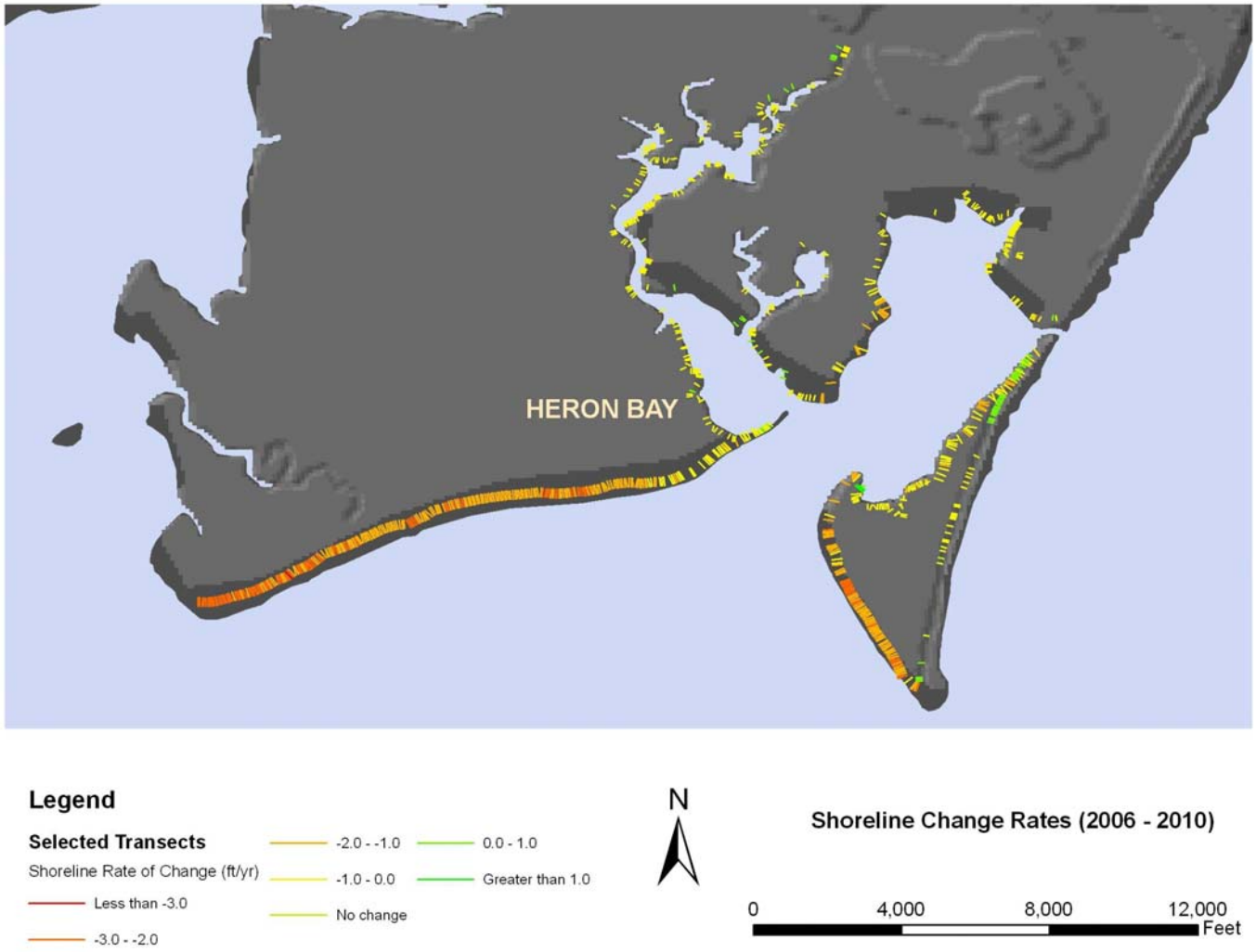

Figure 47.—Heron Bay results from Digital Shoreline Analysis System (2006 through 2010).

Erosion and accretion for Fowl River Bay was about 97 percent and 3 percent, respectively, which represented a mean of -2.99 ± 1.62 ft/yr quantified from 684 selected transects representing 37 percent of the shoreline. The distribution is depicted in figure 48. A maximum erosion rate of -8.27 ± 4.49 ft/yr and a mean erosion of -3.91 ± 3.19 ft/yr are distributed along the shoreline with the greater amount of erosion occurring at points that extend outward from the normal shoreline. Accretion occurred along cove type areas and at the base of Fowl River with a maximum rate of 2.59 ± 3.84 ft/yr and an average of 0.95 ± 1.06 ft/yr.

Erosion and accretion for Portersville Bay was about 79 percent and 21 percent, respectively, which represented a mean of -3.88 ± 2.37 ft/yr quantified from 296 selected transects representing 30 percent of the shoreline. The distribution is depicted in figure 49. A maximum erosion rate of -15.98 ± 5.31 ft/yr and a mean erosion of -5.52 ± 2.53 ft/yr are distributed along the shoreline with the greater amount of erosion occurring to the east of the mouth of Bayou La Batre and on the east side of Point aux Pins. Accretion occurred just inside of Bayou La Batre River and along protected areas with a maximum rate of 8.10 ± 5.45 ft/yr and an average of 2.30 ± 1.80 ft/yr.

Erosion and accretion for Grand Bay was about 85 percent and 15 percent, respectively, which represented a mean of -2.93 ± 3.41 ft/yr quantified from 1,071 selected transects representing 35 percent of the shoreline. The distribution is depicted in figure 50. A maximum erosion rate of -29.13 ± 63.78 ft/yr and a mean erosion of -3.68 ± 3.69 ft/yr are distributed along the shoreline with the greater amount of erosion occurring on the south side of the smaller islands in the middle of Grand Bay and on the west side of Point aux Pins. Accretion occurred on the north side of the same islands and along protected areas and at the mouth of rivers with a maximum rate of 7.45 ± 20.51 ft/yr and an average of 1.29 ± 1.83 ft/yr.

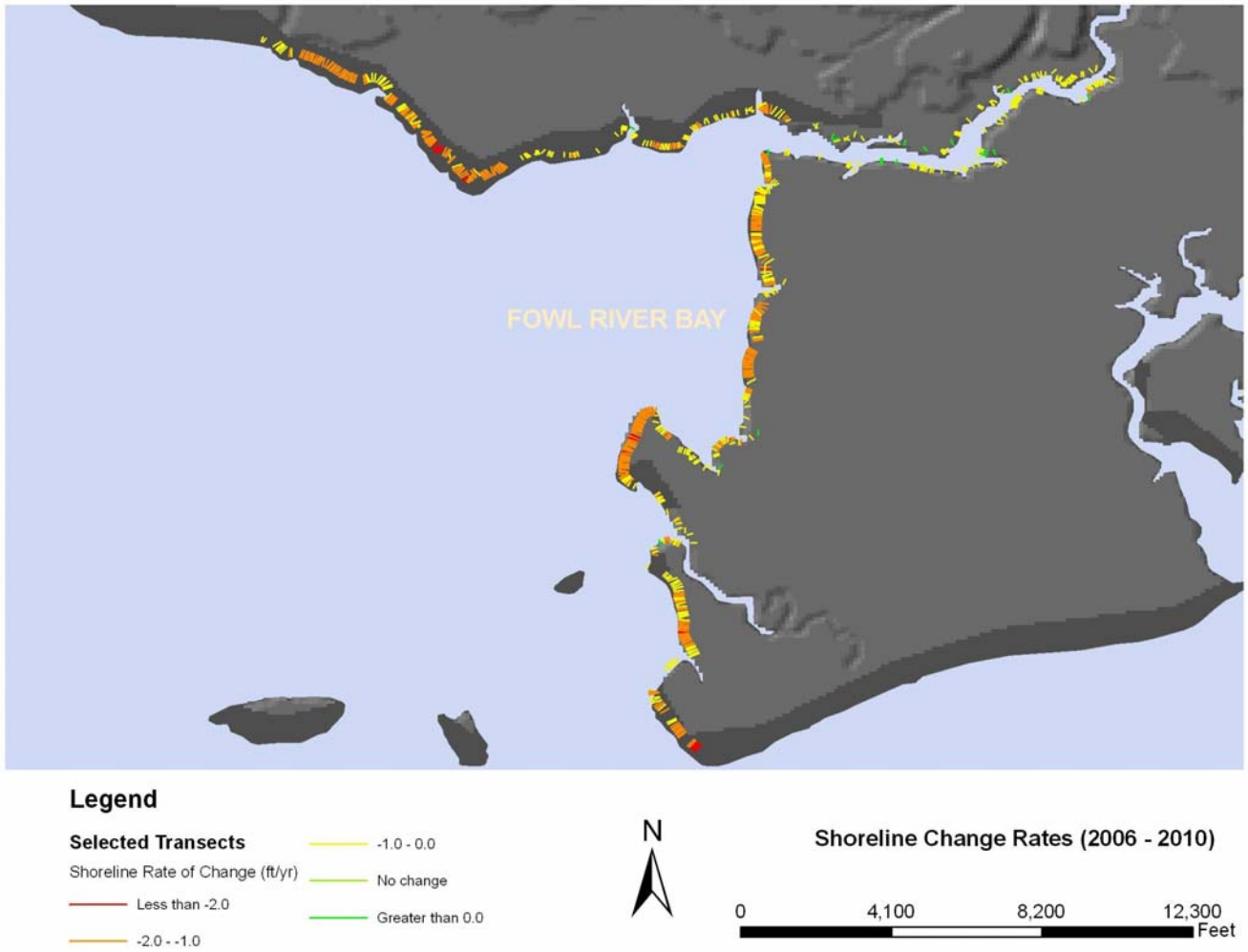

Figure 48.—Fowl River Bay results from Digital Shoreline Analysis System (1996 through 2010).

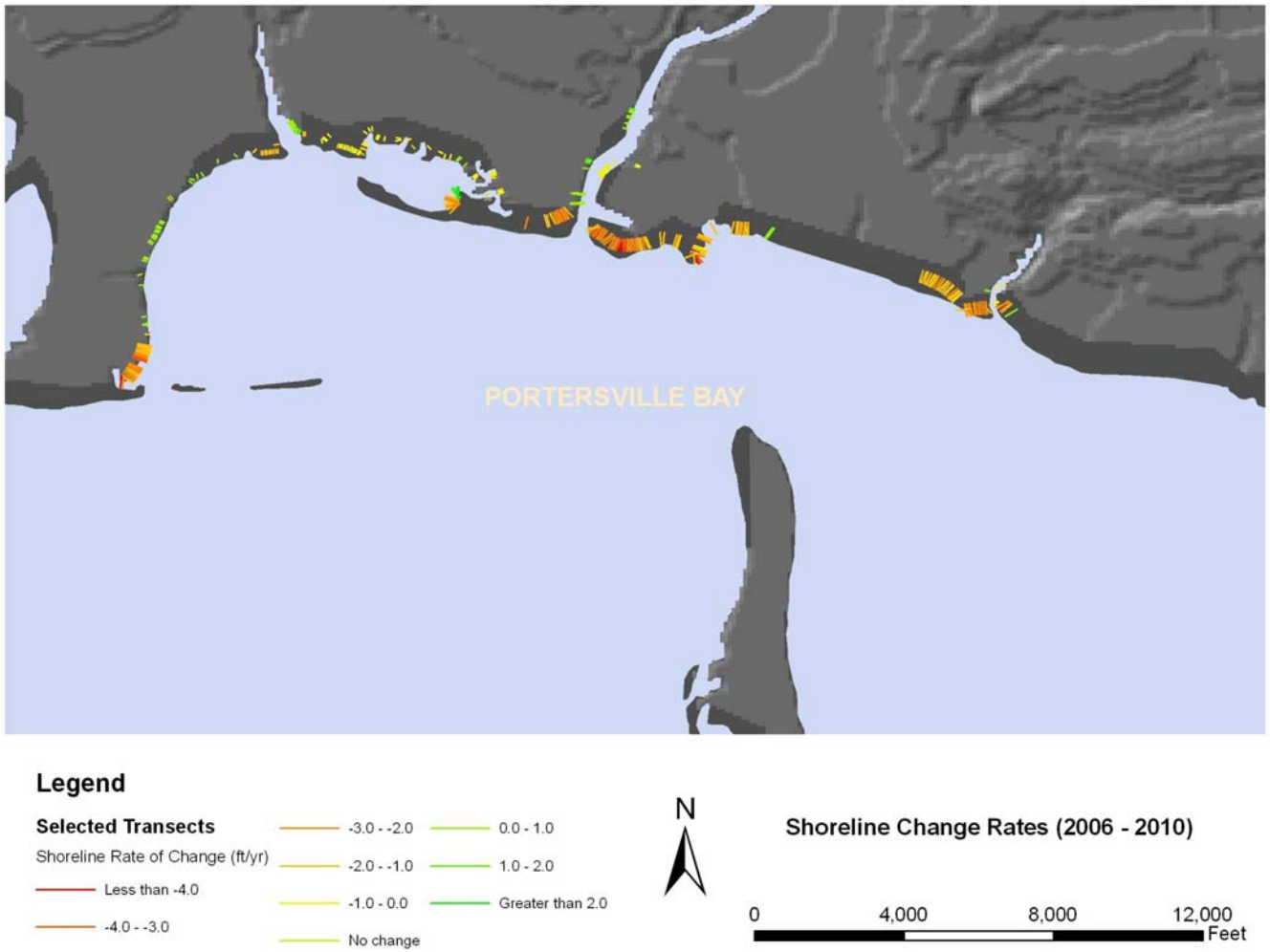

Figure 49.—Portersville Bay results from Digital Shoreline Analysis System (1996 through 2010).

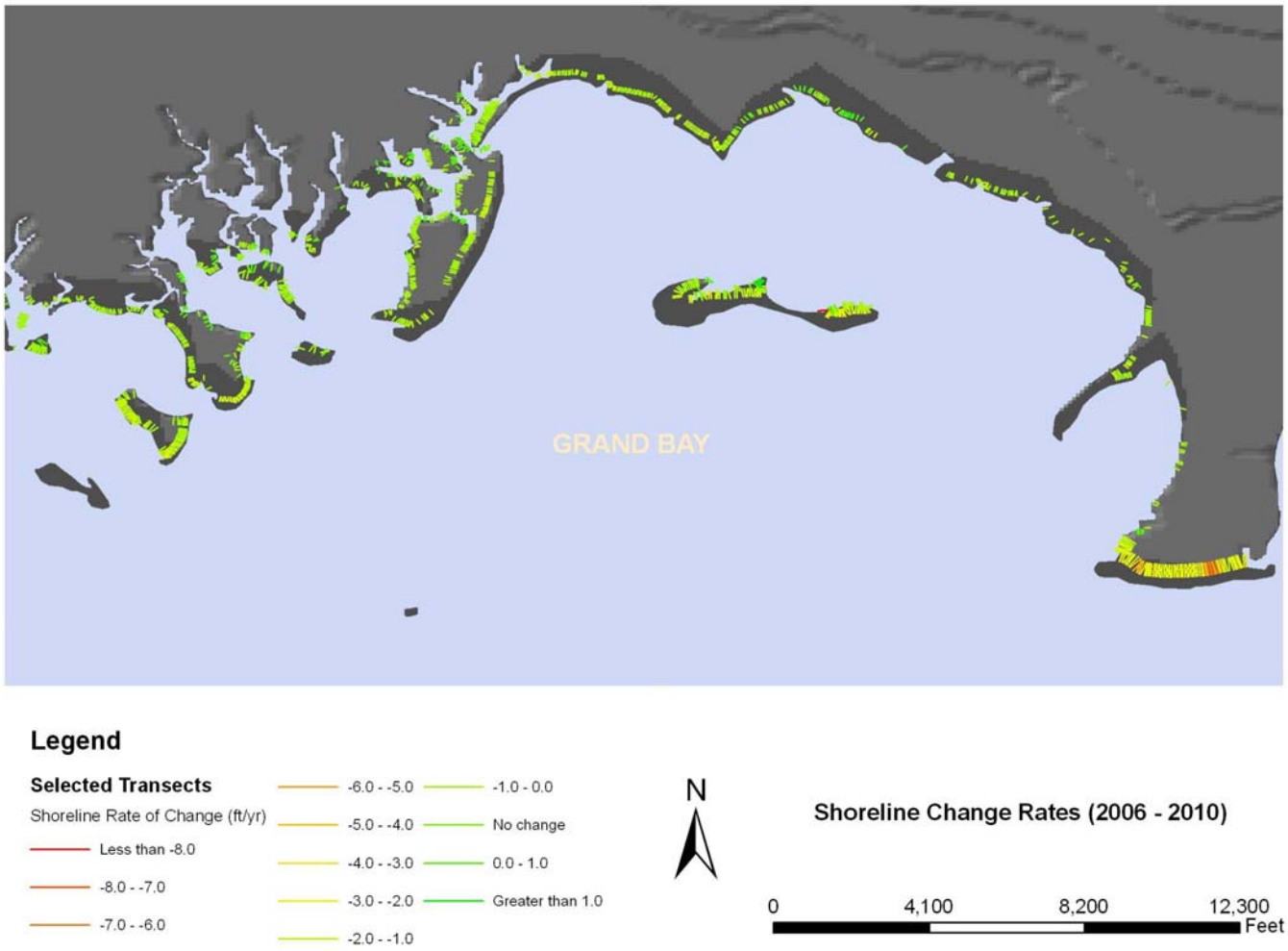

Figure 50.—Grand Bay results from Digital Shoreline Analysis System (1996 through 2010).

Erosion and accretion for Isle aux Herbes was about 99.5 percent and 0.5 percent, respectively, which represented a mean of -6.87 ± 2.66 ft/yr quantified from 614 selected transects representing 62 percent of the shoreline. The distribution is depicted in figure 51. A maximum erosion rate of -18.18 ± 2.17 ft/yr and a mean erosion of -6.92 ± ft/yr are distributed along the shoreline with the greater amount of erosion occurring on the west side of Isle aux Herbes. All accretion that occurred on Isle aux Herbes is a result of sediment redistribution from eroded areas with a maximum rate of 10.07 ± 2.20 ft/yr and an average of 2.30 ± 0.69 ft/yr.

Erosion and accretion for Little Dauphin Island was about 90 percent and 10 percent, respectively, which represented a mean of -3.65 ± 2.01 ft/yr quantified from 633 selected transects representing 57 percent of the shoreline. The distribution is depicted in figure 52. A maximum erosion rate of -10.56 ± 2.69 ft/yr and a mean erosion of -4.28 ± 2.04 ft/yr are distributed along the shoreline with the greater amount of erosion occurring on the unprotected sides of the islands. The majority of accretion that occurred on Little Dauphin Island was in protected areas of the island with a maximum rate of 7.87 ± 2.72 ft/yr and an average of 1.99 ± 1.83 ft/yr.

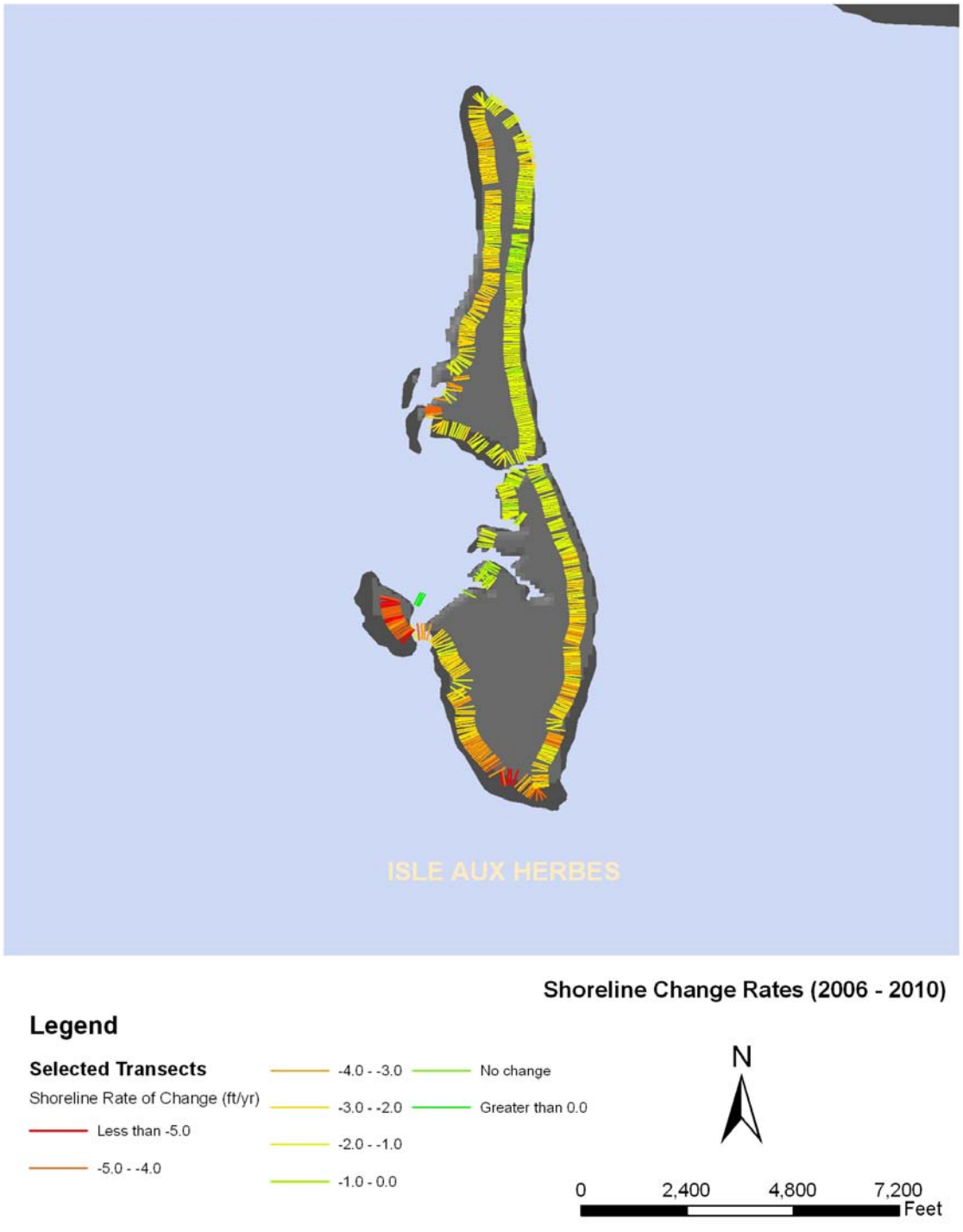

Figure 51.—Isle aux Herbes results from Digital Shoreline Analysis System (1996 through 2010).

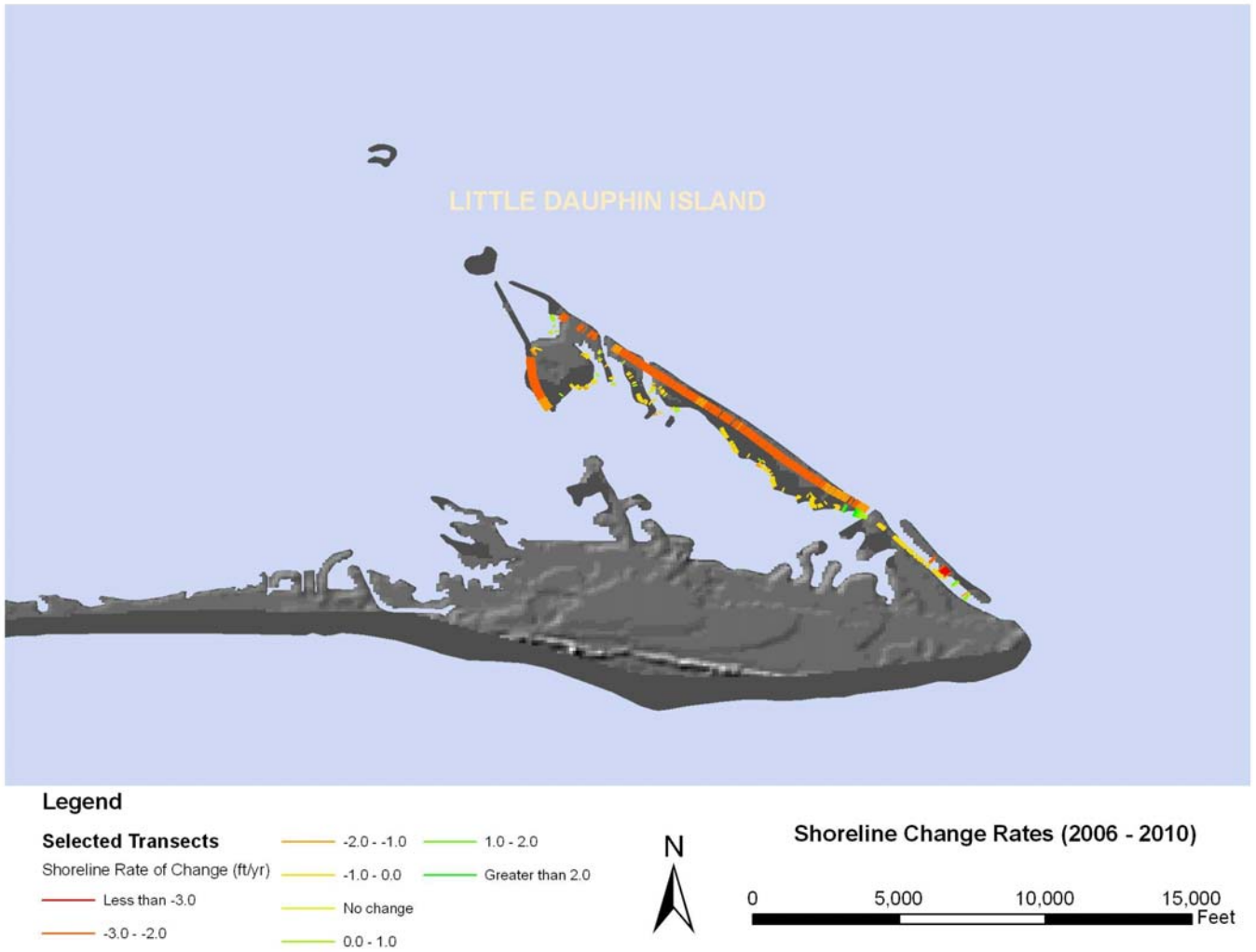

Figure 52.—Little Dauphin Island results from Digital Shoreline Analysis System (1996 through 2010).

CONCLUSIONS

In cooperation with the Alabama Department of Natural Resources, Lands Division, Coastal Section, funded in part by a grant from the National Oceanic and Atmospheric Administration (NOAA), Office of Ocean and Coastal Resource Management, Award No. 10NOS4190206, the Geological Survey of Alabama completed Phase III of a comprehensive shoreline mapping and shoreline change study in coastal Alabama. Shoreline protection and type and rates of change were quantified, where applicable, in the areas of Ono Island, Bayou St. John, East Perdido Bay, West Perdido Bay, Arnica Bay, Bay La Launch and South Wolf Bay, Hammock Creek, Wolf Bay tributaries, North Fowl River, South Fowl River, Herron Bay, Fowl River Bay and Portersville Bay, Grand Bay, Bayou La Batre, Coden Bayou, Isle aux Herbes, Dauphin Island, and on Baldwin Beaches.

An estimated 23.5 miles of shoreline were mapped on Ono Island for shore protection, and about 22.2 percent was hard shore armored. Bulkheads make up 3.1 miles (13.2 percent) and jetty (steel pile, rock, concrete) makes up about 4,830 feet (3.9 percent) of the total. Organic shoreline type makes up 14.3 miles (59.5 percent) and sediment bank is about 4.5 miles (18.6 percent) of the total. Only one private boat ramp was mapped.

Shore protection mapping for Bayou St. John was about 27.3 miles in length with 64.4 percent armored; about 9.7 miles (35.6 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 14.7 miles (53.9 percent) and 1.7 miles (6.2 percent) of the total hard shore protection. Vegetated shoreline type was 15 miles or 58.8 percent; artificial was about 4.1 miles or 15.6 percent of the total. There were a total of 10 private and 11 public boat ramps mapped.

Shore protection mapping for Northeast Perdido Bay was about 10.2 miles in length with 37 percent armored; about 6.4 miles (63 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 2.7 miles (26.6 percent) and 2,958 feet (5.5 percent) of the total hard shore protection. Vegetated shoreline type was 5.8 miles or 56.7 percent; sediment bank was about 2.8 miles or 27.9 percent of the total. There were a total of seven private boat ramps and one public boat ramp mapped.

Shore protection mapping for Southwest Perdido Bay was about 21.5 miles in length with 33.8 percent armored; about 14.3 miles (66.2 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 5.4 miles (25 percent) and 1.2

miles (5.6 percent) of the total hard shore protection. Organic shoreline type was 10.8 miles or 50.3 percent; vegetated was about 9.7 miles or 45.1 percent of the total. There were a total of 49 private boat ramps mapped.

Shore protection mapping for Arnica Bay was about 10.9 miles in length with 59.4 percent armored; about 4.4 miles (40.6 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 5.7 miles (52.7 percent) and 1,393 feet (2.4 percent) of the total hard shore protection. Vegetated shoreline type was 6.2 miles or 57.9 percent; sediment shoreline type was about 2 miles or 19 percent of the total. There were six private and one public boat ramps mapped.

Shore protection mapping for Bay La Launch and South Wolf Bay was about 20.9 miles in length with 19.6 percent armored; about 16.8 miles (80.4 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 3.4 miles (16.3 percent) and 2,208 feet (2 percent) of the total hard shore protection. Organic shoreline type was 10.4 miles or 49.7 percent; vegetated shoreline type was about 6 miles or 27.9 percent of the total. There were one public and 15 private boat ramps mapped.

Shore protection mapping for Hammock Creek was about 11.2 miles in length with 19.7 percent armored; about 9 miles (80.3 percent) was natural, unretained. Bulkhead (steel, wood) and rubble/riprap make up about 1.8 miles (16 percent) and 1,780 feet (3 percent) of the total hard shore protection. Organic shoreline type was 5.6 miles or 50 percent; vegetated shoreline type was about 5.3 miles or 47 percent of the total. There were 15 private boat ramps mapped in Hammock Creek.

Shore protection mapping for the Wolf Bay tributaries was about 23.1 miles in length with 20.2 percent armored; about 18.4 miles (79.8 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 3.7 miles (16 percent) and 4,282 feet (3.5 percent) of the total hard shore protection. Vegetated shoreline type was 12.7 miles or 54.7 percent; organic shoreline type was about 9.9 miles or 42.5 percent of the total. There were 20 private and four public boat ramps mapped in the Wolf Bay tributaries.

Shore protection mapping for North Fowl River was about 38.3 miles in length with 20.2 percent armored; about 27.9 miles (72.9 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 8.7 miles (22.8 percent) and 1.2 miles (3.1 percent) of the total hard shore protection. Organic shoreline type was 23 miles or 60.2 percent; vegetated shoreline type was about 14.1 miles or 36.8 percent of the total. There were 28 private and four public boat ramps mapped in North Fowl River.

Shore protection mapping for South Fowl River was about 29.1 miles in length with 14 percent armored; about 25 miles (86 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 3.1 miles (10.5 percent) and 2,404 feet (1.6 percent) of the total hard shore protection. Organic shoreline type was 18.2 miles or 61.3 percent; vegetated shoreline type was about 9.8 miles or 33 percent of the total. There were 41 private boat ramps mapped in South Fowl River.

Shore protection mapping for Herron Bay was about 27.6 miles in length with 3.5 percent armored; about 26.7 miles (86 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 1,697 feet (1.2 percent) and 1,687 feet (1.2 percent) of the total hard shore protection. Organic shoreline type was 25.1 miles or 80.2 percent; vegetated shoreline type was about 2.7 miles or 8.5 percent of the total. There were four public boat ramps mapped in Herron Bay.

Shore protection mapping for Fowl River Bay and Portersville Bay were about 17.7 miles in length with 24.7 percent armored; about 13.3 miles (75.3 percent) was natural, unretained. Bulkheads and wetland restoration make up about 1.6 miles (9.2 percent) and 5,101 feet (5.5 percent) of the total hard shore protection. Organic shoreline type was 15.3 miles or 78.7 percent; artificial shoreline type was about 4,664 feet or 4.6 percent of the total.

Shore protection mapping for Grand Bay was about 21.8 miles in length with 0.9 percent armored; about 21.6 miles (99.1 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 422 feet (0.4 percent) and 388 feet (0.3 percent) of the total hard shore protection. Organic shoreline type was 21.6 miles or 93 percent; sediment bank shoreline type was about 660 feet or 0.5 percent of the total. There were two private boat ramps mapped in Grand Bay.

Shore protection mapping for Bayou La Batre was about 15.1 miles in length with 60.4 percent armored; about 6 miles (39.6 percent) was natural, unretained. Bulkheads and rubble/riprap make up about 6.4 miles (42.2 percent) and 2.2 miles (14.9 percent) of the total hard shore protection. Vegetated shoreline type was 6.1 miles or 46.5 percent; artificial shoreline type was about 4.4 miles or 33.5 percent of the total. There were four public and eight private boat ramps mapped in Bayou La Batre.

Shore protection mapping for Coden Bayou was about 2.6 miles in length with 70.3 percent armored; about 4,004 feet (29.7 percent) was natural, unretained. Rubble/riprap and oyster shells make up about 3,570 feet (26.5 percent) and 3,192 feet (23.6 percent) of the total hard shore protection. Sediment shoreline type was 1.4 miles

or 54.2 percent; organic shoreline type was about 4,066 or 30 percent of the total. There were two public and four private boat ramps mapped in Coden Bayou.

Shore protection mapping for Isle aux Herbes was about 8.4 miles in length with 9.7 percent armored; about 7.6 miles (90.3 percent) was natural, unretained. Segmented breakwater types make up about 4,318 feet (9.7 percent) of the total hard shore protection. Organic shoreline type was 7.6 miles or 97.5 percent of the total.

Shore protection mapping for Dauphin Island was about 43.8 miles in length with 57.5 percent armored; about 18.6 miles (42.5 percent) was natural, unretained. Bulkheads and beach nourishment make up about 12 miles (27.4 percent) and 7.3 miles (16.7 percent) of the total hard shore protection. Sediment shoreline type was 19.3 miles or 46.6 percent; organic shoreline type was about 9.5 miles or 23 percent of the total. There were 31 private and two public boat ramps mapped on Dauphin Island.

Shore protection mapping for Baldwin Beaches were about 32.3 miles in length with 56.1 percent armored; about 18.6 miles (42.5 percent) was natural, unretained. Beach nourishments and seawalls make up about 17.1 miles (52.9 percent) and 2,038 feet (1.2 percent) of the total hard shore protection. Sediment shoreline type was 31.8 miles or 99 percent; artificial shoreline type was about 773 feet or 0.5 percent of the total.

For the determination of shoreline change along Heron Bay, Fowl River Bay, Portersville Bay, Grand Bay, Isle aux Herbes and Little Dauphin Island a total of 11,076 transects were generated by DSAS. Error is based on a 90 percent confidence interval. Based on all transects for combined areas, an estimated 91 percent and 8.5 percent indicated limited shoreline erosion and accretion, respectively. To improve data validation, calculated regression values (R^2) less the 0.75 were discarded; therefore, results are based on these selected transects.

Based on 785 selected transects for Heron Bay (about 31 percent of all calculated and of the shoreline), a mean shoreline change rate of -3.15 ± 1.82 ft/yr was quantified. About 93 percent represented erosion with a maximum and mean of -10.20 ± 0.92 ft/yr and -3.49 ± 1.90 ft/yr, respectively. Erosion is most notable along the southern shoreline, on the eastern shoreline close to Cedar Point and on the western shoreline along and north of Barron Point. Areas of accretion were negligible.

Erosion and accretion for Fowl River Bay was about 97 percent and 3 percent, respectively, which represented a mean of -2.99 ± 1.62 ft/yr quantified from 684 selected transects representing 37 percent of the shoreline. A maximum erosion rate of -8.27 ±

4.49 ft/yr and a mean erosion of -3.91 ± 3.19 ft/yr are distributed along the shoreline with the greater amount of erosion occurring at points that extend outward from the normal shoreline. Accretion occurred along cove type areas and at the base of Fowl River with a maximum rate of 2.59 ± 3.84 ft/yr and an average of 0.95 ± 1.06 ft/yr.

Erosion and accretion for Portersville Bay was about 79 percent and 21 percent, respectively, which represented a mean of -3.88 ± 2.37 ft/yr quantified from 296 selected transects representing 30 percent of the shoreline. A maximum erosion rate of -15.98 ± 5.31 ft/yr and a mean erosion of -5.52 ± 2.53 ft/yr are distributed along the shoreline with the greater amount of erosion occurring to the east of the mouth of Bayou La Batre and on the east side of Point aux Pins. Accretion occurred just inside of Bayou La Batre River and along protected areas with a maximum rate of 8.10 ± 5.45 ft/yr and an average of 2.30 ± 1.80 ft/yr.

Erosion and accretion for Grand Bay was about 85 percent and 15 percent, respectively, which represented a mean of -2.93 ± 3.41 ft/yr quantified from 1,071 selected transects representing 35 percent of the shoreline. A maximum erosion rate of -29.13 ± 63.78 ft/yr and a mean erosion of -3.68 ± 3.69 ft/yr are distributed along the shoreline with the greater amount of erosion occurring on the south side of the smaller islands in the middle of Grand Bay and on the west side of Point aux Pins. Accretion occurred on the north side of the same islands and along protected areas and at the base of rivers with a maximum rate of 7.45 ± 20.51 ft/yr and an average of 1.29 ± 1.83 ft/yr.

Erosion and accretion for Isle aux Herbes was about 99.5 percent and 0.5 percent, respectively, which represented a mean of -6.87 ± 2.66 ft/yr quantified from 614 selected transects representing 62 percent of the shoreline. A maximum erosion rate of -18.18 ± 2.17 ft/yr and a mean erosion of -6.92 ± ft/yr are distributed along the shoreline with the greater amount of erosion occurring on the west side of Isle aux Herbes. All accretion that occurred on Isle aux Herbes is a result of sediment redistribution from eroded areas with a maximum rate of 10.07 ± 2.20 ft/yr and an average of 2.30 ± 0.69 ft/yr.

Erosion and accretion for Marsh and Cat Islands were about 89 percent and 11 percent, respectively, which represented a mean of -9.72 ± 33.56 ft/yr quantified from 129 selected transects representing 59 percent of the shoreline. A maximum erosion rate of -23.62 ± 21.65 ft/yr and a mean erosion of -14.04 ± 31.13 ft/yr are distributed along the shoreline with the greater amount of erosion occurring on the south side of the

islands. All accretion that occurred on Marsh and Cat Islands was on the north side of the islands with a maximum rate of 28.15 ± 60.73 ft/yr and an average of 25.81 ± 53.54 ft/yr.

Erosion and accretion for Little Dauphin Island was about 90 percent and 10 percent, respectively, which represented a mean of -3.65 ± 2.01 ft/yr quantified from 633 selected transects representing 57 percent of the shoreline. A maximum erosion rate of -10.56 ± 2.69 ft/yr and a mean erosion of -4.28 ± 2.04 ft/yr are distributed along the shoreline with the greater amount of erosion occurring on the unprotected sides of the islands. The majority of accretion that occurred on Little Dauphin Island was in protected areas of the island with a maximum rate of 7.87 ± 2.72 ft/yr and an average of 1.99 ± 1.83 ft/yr.

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