X. Region 3

Region 3 is composed of two subregions (3a and 3b) that extend from north of the Cape Lookout lighthouse to Cape Hatteras just west of Buxton. Region 3 encompasses the eastern facing shores of Carteret County, the coastal portion of Hyde County, and the southern portion of Dare County to Cape Hatteras.

Region 3a encompasses the eastern facing shores of Carteret County from just north of the Cape Lookout lighthouse to just south of the town of Portsmouth. This stretch of shoreline comprises the Cape Lookout National Seashore, encompassing Core Banks and Portsmouth Island which are separated by Drum Inlet. Figure X-1 shows the boundaries of Region 3a.

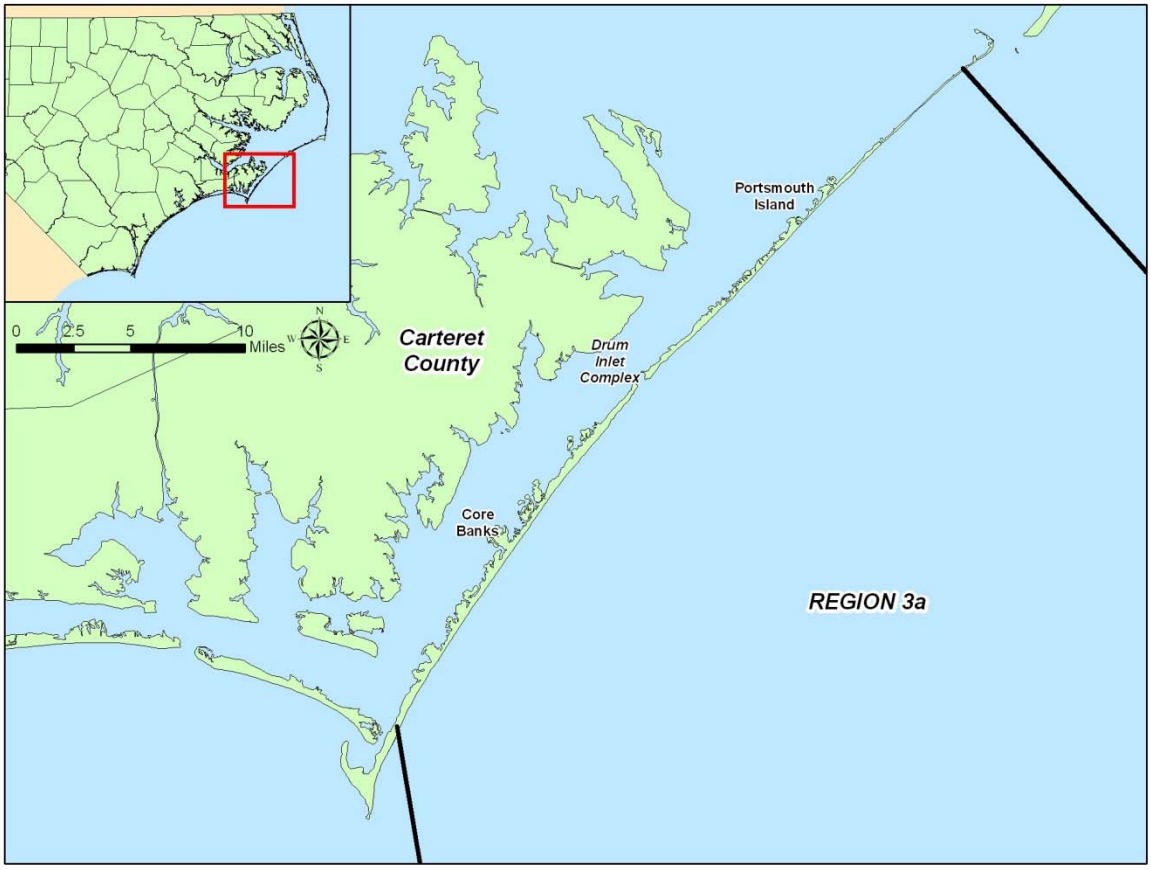

Figure X-1. Region 3a Boundaries

Table X-1 represents the length of developed shoreline in Region 3a.

Table X-1. Region 3a Shoreline Development Lengths

Shoreline Type	Shoreline Length (mi)
Not Developed	0
Developed	0
Not to be Developed	40
Total	40

The entirety of Region 3a shoreline is composed of federally owned lands in the form of Cape Lookout National Seashore. See Table X-2 for the approximate shoreline length.

Table X-2. Region 3a Shoreline Ownership Lengths

Shore Ownership	Shoreline Length (mi)
Municipal	0
State	0
Federal	40
Private	0
Total	40

The shoreline in Region 3a is not actively managed. (See Table X-3)

Table X-3. Region 3a Shoreline Management Lengths

Management	Shoreline Length (mi)
Managed	0
Not Managed	40
Total	40

Region 3b stretches from just south of Portsmouth Village to Cape Hatteras, just west of Buxton, including a small portion of Carteret County, Ocracoke Island in Hyde County, and the southern part of Dare County. Portsmouth, Ocracoke, and Hatteras are all included in this region. Ocracoke Inlet and Hatteras Inlet separate the barrier islands. Figure X-2 shows the boundaries of Region 3b.

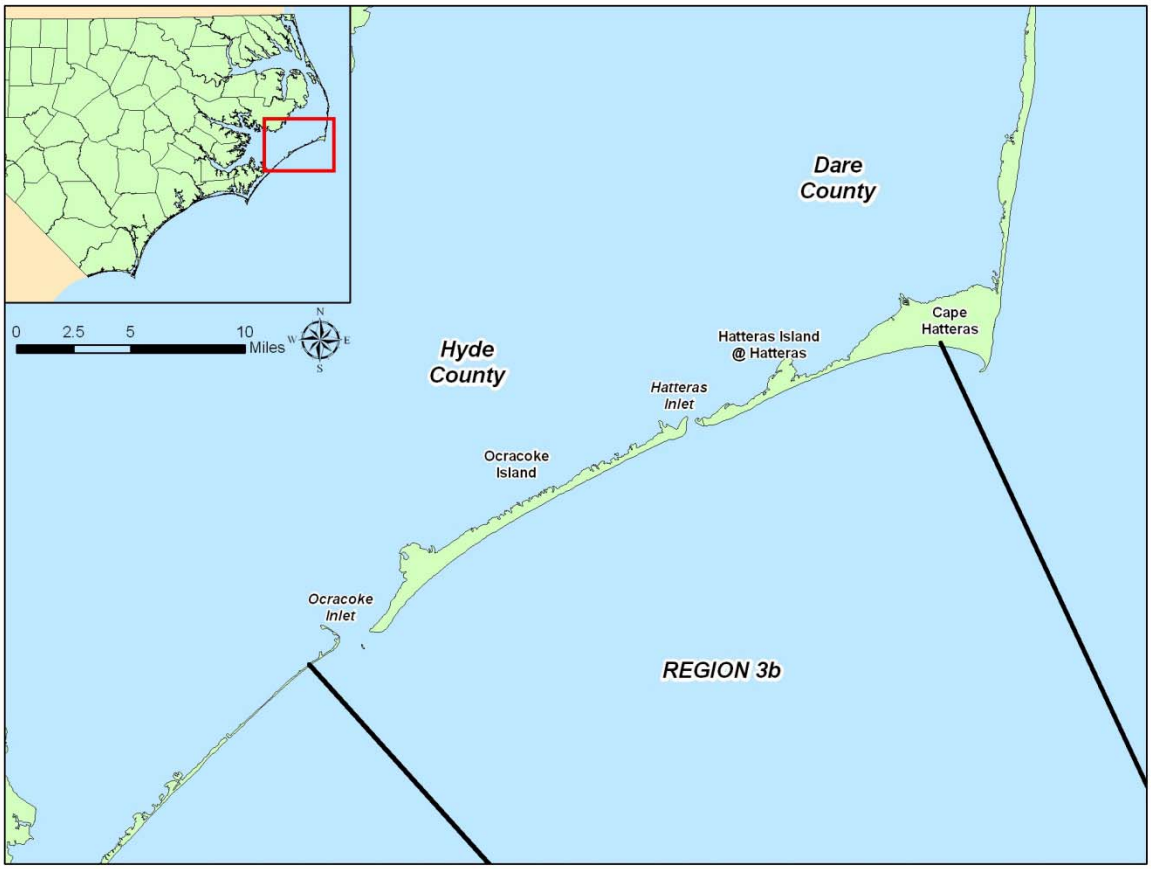

Figure X-2. Region 3b Boundaries

With the exception of NC 12, portions of Cape Hatteras are not developed. While technically National Seashore, the oceanfront areas of Hatteras Village and Ocracoke are considered to be developed for the purposes of this study. See Table X-4 for approximate developed shoreline lengths.

Table X-4. Region 3b Shoreline Development Lengths

Shoreline Type	Shoreline Length (mi)
Not Developed	2
Developed	8
Not to be Developed	20
Total	30

The majority of the shoreline in this region is owned by the National Park Service as the Cape Hatteras National Seashore. Ocracoke and Hatteras Village are the only significantly developed areas in the unincorporated area of Region 3b. See Table X-5 for approximate ownership lengths.

Table X-5. Region 3b Shoreline Ownership Lengths

Shore Ownership	Shoreline Length (mi)
Municipal	5
State	0
Federal	25
Private	0
Total	30

Currently, no active shoreline management occurs in Region 3b. See Table X-6 for approximate managed shoreline lengths.

Table X-6. Region 3b Shoreline Management

Management	Shoreline Length (mi)
Managed	0
Not Managed	30
Total	30

A. Current Available Pertinent Datasets

1. Waves and Water Levels

Beaches, as the transition zone between land and water, are susceptible to changes by waves, winds, and currents. Waves play a major role in the shaping and evolution of beaches and inlets. Moving water suspends and transports sediment while the severity, frequency, and direction of incoming waves influence beach behavior and geometry. The Region 3 shoreline is exposed to waves from a wider range of directions than the other BIMP regions. The geometry of the Outer Banks shields it from northerly waves, but the coast is exposed to waves coming from the southwest through the east. Waves can have short-term, seasonal, and long-term impacts on both the cross-shore and along-shore beach shape. Drastic changes in beach width and elevation can occur during a single hurricane, but it is the more frequent storms and wave events that generally drive the overall beach configuration. Winter storms and their associated higher wave activities typically move sand offshore, and gentler summer waves move the sand from the offshore back onto the beach. The typical angle of wave approach transports sand along the shoreline, and inlets interrupt sand movement, forming deltas due to the currents generated in the inlets by the rising and falling tides. Wave data along the North Carolina coast is available from long-term wave hindcast modeling and from measurements at various wave buoys operating at various locations offshore.

Wave hindcasts are numerical models which use historical wind and meteorological data to calculate or hindcast what the waves would have been at a specific offshore location. The United States Army Corps of Engineers Wave Information Study is an extensive hindcast model that provides wave information (height, period, and direction) for the 20

year period of 1980-99 at more than 300 stations offshore of the North Carolina coast. This data is available from the U.S. Army Corps of Engineer's website at http://www.frf.usace.army.mil/cgi-bin/wis/atl/atl_main.html.Data from representative WIS Stations (270, Region 3a and 263, Region 3b) are depicted in Figures X-3 and X-4. Figure X-5 and X-6 show the locations of WIS stations (locations where hindcast wave data is available) for the sub-regions of Region 3.

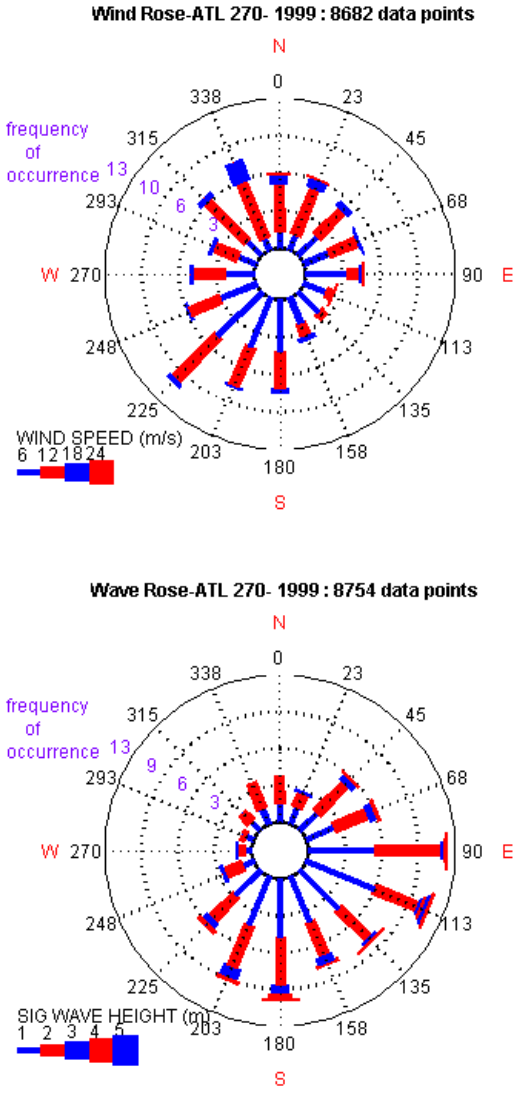

Figure X-3. Wind and Wave Roses from WIS Station 270 (Region 3a)

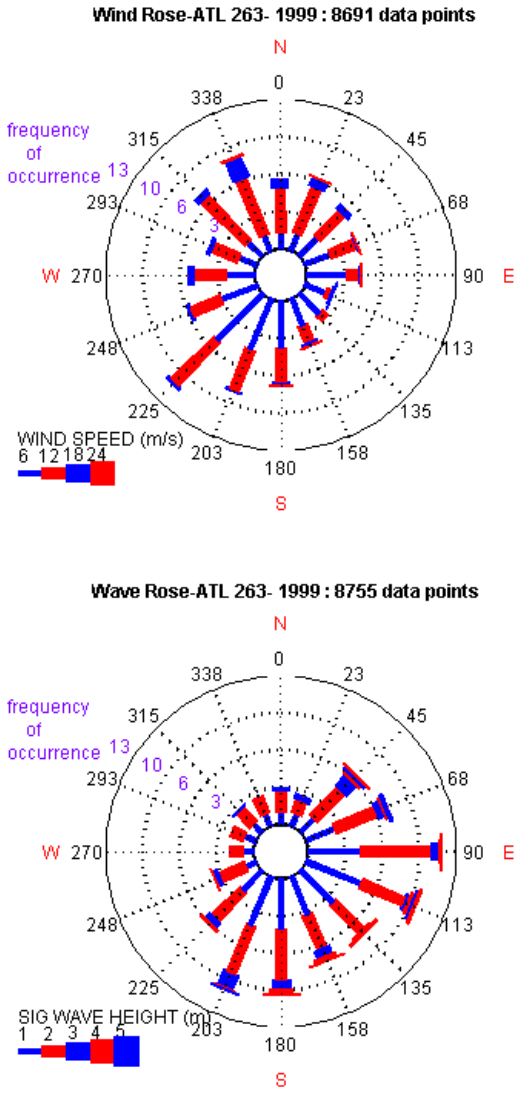

Figure X-4. Wind and Wave Roses from Representative WIS Station 263 (Region 3b)

Note the similarities in the respective wind and wave roses for the two subregions. Because of the similarities in the coastline direction, wind and waves act in much the same way along each stretch of shoreline.

Wave measurements can be obtained from wave buoys off the North Carolina coast and are available from the National Data Buoy Center (NDBC) website at http://www.ndbc.noaa.gov/. The wave buoys also collect climatological data. Both real time and historical data can be downloaded. Figure X-5 and X-6 show the locations of NDBC wave buoys for the subregions of Region 3.

In addition to wave activity, beaches and inlets are impacted by both temporal and spatial variations in the water level. Water level variations can be regular, such as the tides, or

periodic, such as storm surge. Water level changes can also occur over long periods of time due to sea level rise (climate change or relative change due to land subsidence).

Along the North Carolina coast, tides are typically semidiurnal, having two high tides and two low tides each day of similar heights. Tides are currently measured at six locations along the North Carolina Coast by the National Oceanic Atmospheric Administration (NOAA) and the USACE. There is currently no active NOAA tide station located in Region 3. The nearest active NOAA tide stations are at Beaufort (Region 2c) and Oregon Inlet Marina (Region 4b). Previously there was a station at Cape Hatteras Fishing Pier which was active from 1973-2003. Table X-7 provides the tidal datums, in feet, with respect to Mean Lower Low Water (MLLW) for the applicable NOAA tide stations. The NOAA tide stations data is available at the NOAA Tides and Currents website (http://tidesandcurrents.noaa.gov/).

Table X-7. Tidal Datums (ft) for Region 3 Stations

	Beaufort, NC	Oregon Inlet Marina	Hatteras (historical)
Datum	Sta 8656483	Sta 8652587	Sta 8654400
Mean Higher High Water (MHHW)	3.54	1.17	3.47
Mean High Water (MHW)	3.26	1.02	3.11
Mean Tide Level (MTL)	1.70	0.57	1.61
Mean Sea Level (MSL)	1.71	0.58	1.62
Mean Low Water (MLW)	0.15	0.13	0.12
Mean Lower Low Water (MLLW)	0.00	0.00	0.00
North American Vertical Datum (NAVD)	No Data	0.66	2.06
National Geodetic Vertical Datum (NGVD)	No Data	-0.34	0.96
Maximum Tide Level	6.29	5.66	5.98
Date Maximum Tide Level Recorded	9/16/1999	9/16/1999	11/18/1994

Shorter term water level fluctuations due to passing storms, both extratropical (northeasters) and tropical (tropical storms and hurricanes), can elevate water levels along the coast resulting in flooding and pushing storm surge further up the beach face thereby reshaping it. Storm-driven water levels along the coast are available for events with a one percent annual chance of occurrence (100-year return period) from the Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS) developed by the Federal Emergency Management Agency (FEMA). North Carolina is currently in the process of updating these along coastal regions, including extensive storm surge modeling. Information can be found at http://www.ncfloodmaps.com/.

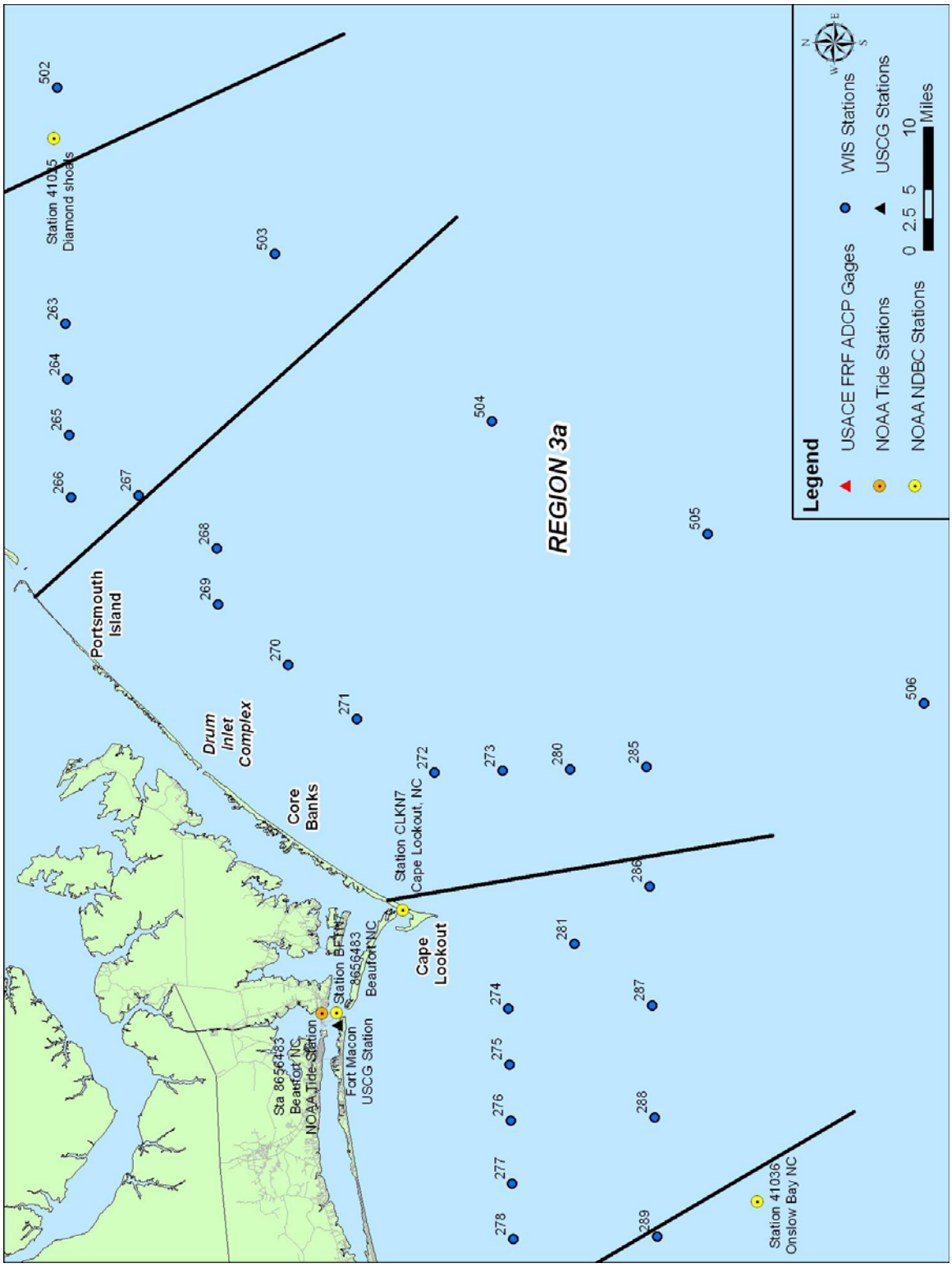

Figure X-5. Wave and Water Level Stations for Region 3a

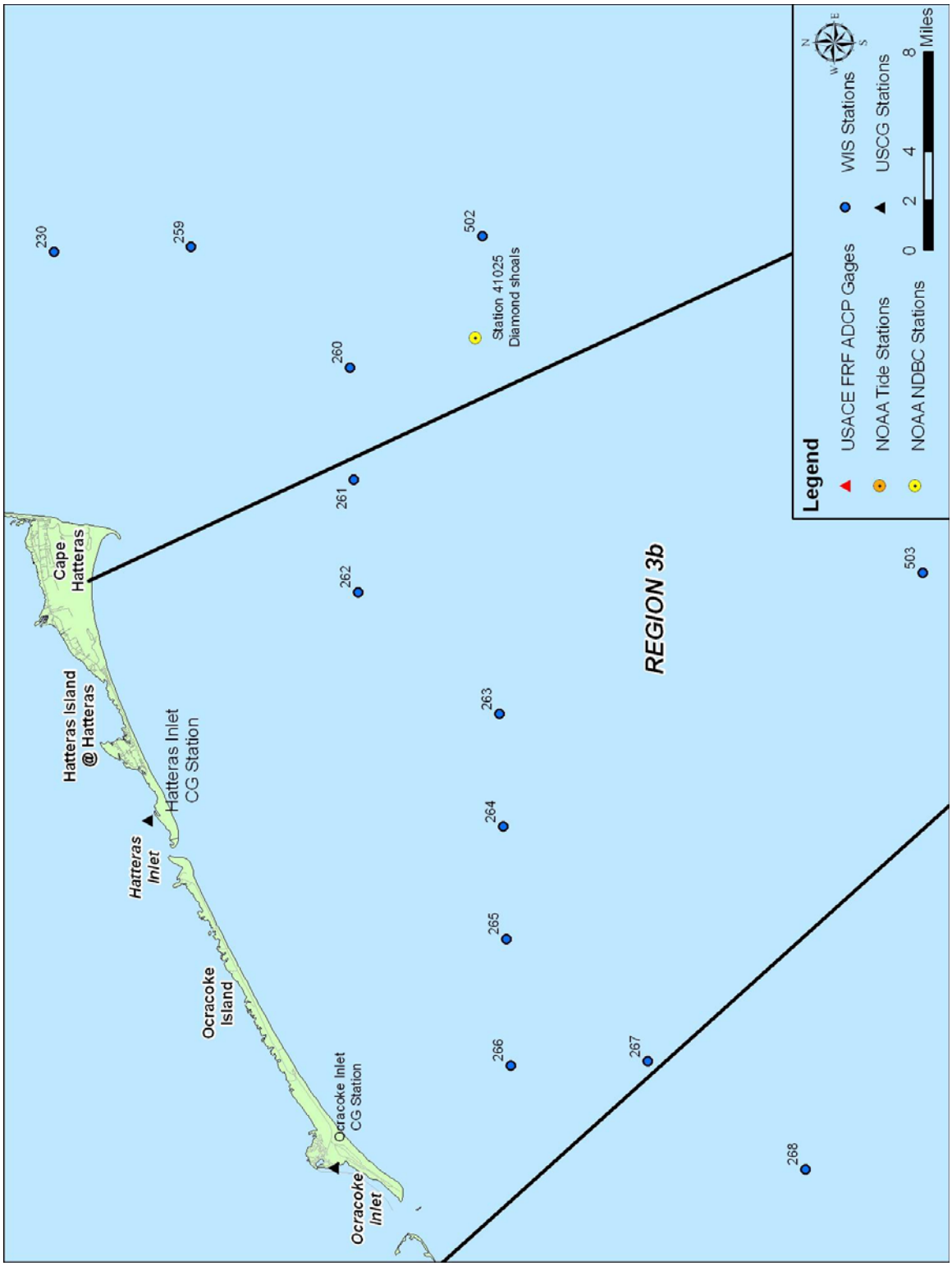

Figure X-6. Wave and Water Level Stations for Region 3b

Due either to land subsidence, global climate changes or other factors, relative sea level is rising along the North Carolina coast. The long-term tidal water level recording stations estimate the rate of this rise as approximately 1 to 1.5 feet over the last century along the N.C. coast. For the long-term NOAA tidal measurement station at Beaufort, the mean sea level rise trend is 3.71 mm/year (1.22 feet/century) with a standard error of 0.64 mm/year (0.21 feet/century) based on monthly mean sea level data from 1973 to 1999. Figure X-7 shows the sea level rise at a tide station at Beaufort, N.C. This is the only tide station along the North Carolina coast with an uninterrupted, long-duration measurement record for which this data has been developed.

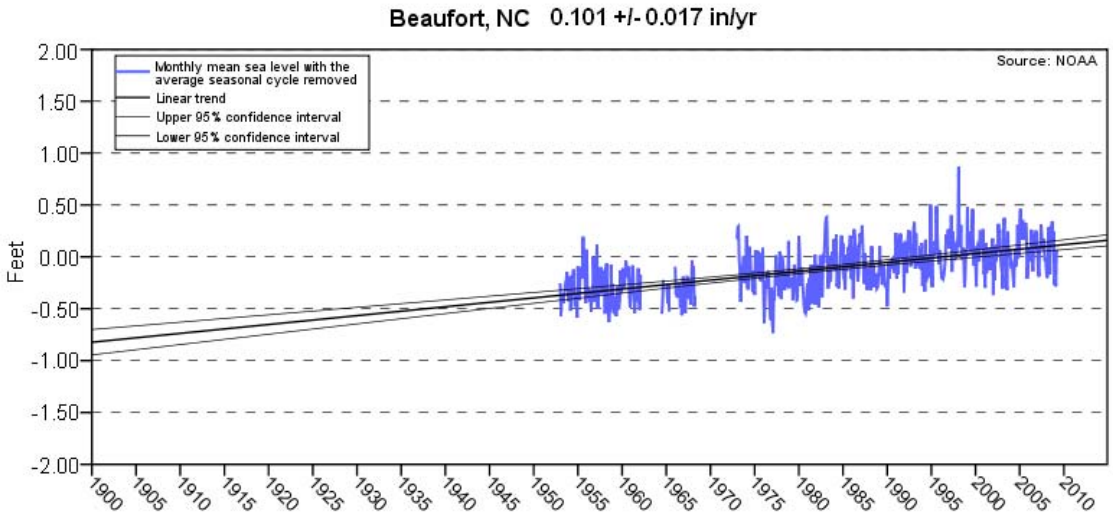

Figure X-7. Sea Level Rise at Beaufort, NC

Planning for long-term sea level rise is difficult since consensus on how much and how quickly it will rise is difficult to achieve. There are currently many researchers, government agencies and international organizations studying the topic with conflicting predictions and disputes over the causes of sea level rise. Short-term sea level rise from 1980 to 2000 at Duck, N.C. (Dare County), based on tide level readings, is estimated to be 1.5 feet/century (Riggs, 2008). Other studies show estimates of sea level rise for the Outer Banks of 10.5 inches/century (Pietrafesa *et al.*, 2005). Note that all of these estimates are based on extrapolation of measurements of less than 100 years. Nonetheless, the impact of rising sea levels, for which there is wide agreement, must be considered in long-term planning. It is possible to continue with strategies that are acceptable under current and shorter term historic changes, such as those predicted by the Beaufort gauge data, and then adapt as needed if conditions change in the coming years.

2. Tropical Storms

Tropical storms, especially hurricanes, can be a major episodic force in reshaping beaches and inlets (including breaching new inlets through the barrier islands). NOAA maintains a GIS database of the storm tracks for Atlantic hurricanes including approximate storm location, date, wind speed, pressure, and category recorded for storms since 1851. GIS shapefiles can be downloaded at NOAA's website. Region 3 has mainly been impacted by tropical storms but has been affected by Category 1, Category 2, and Category 3 hurricanes in the past. Maps displaying the recorded Atlantic hurricane tracks in Region 3 since 1851 are presented in Figure X-9 and X-10. Hurricane Connie (1955) and Hurricane Isabel (2003) were among the most significant storms to make landfall in Region 3a as Category 1 and Category 2 storms respectively, with Hurricane Isabel causing a breach in the barrier island between Hatteras and Frisco. Hurricane Barbara (1953) and an unnamed Category 3 hurricane in 1899 were the most significant storms to make landfall in Region 3b. The NOAA National Hurricane Center Risk Analysis Program has developed estimates for return periods of hurricanes of various intensities along the U.S. coast. Figure X-8 presents this data for the North Carolina coast. The numbers indicate the expected return period (in years) on average that a hurricane can be expected within 75 nautical miles (86 statute miles) of the location. Region 3 is among the more hurricane-prone areas of the coast, especially in the vicinity of Cape Hatteras, which typically, on average, can expect the passage of a Category 1 Hurricane within 75 nautical miles every five years. This area is almost twice as likely to see larger hurricanes as adjacent coastal areas. For example, a Category 1 hurricane is expected to hit this region once every five years while a Category 1 hurricane is only expected to hit the Cape Fear area once every 10 years (see upper left graphic of Figure X-8).

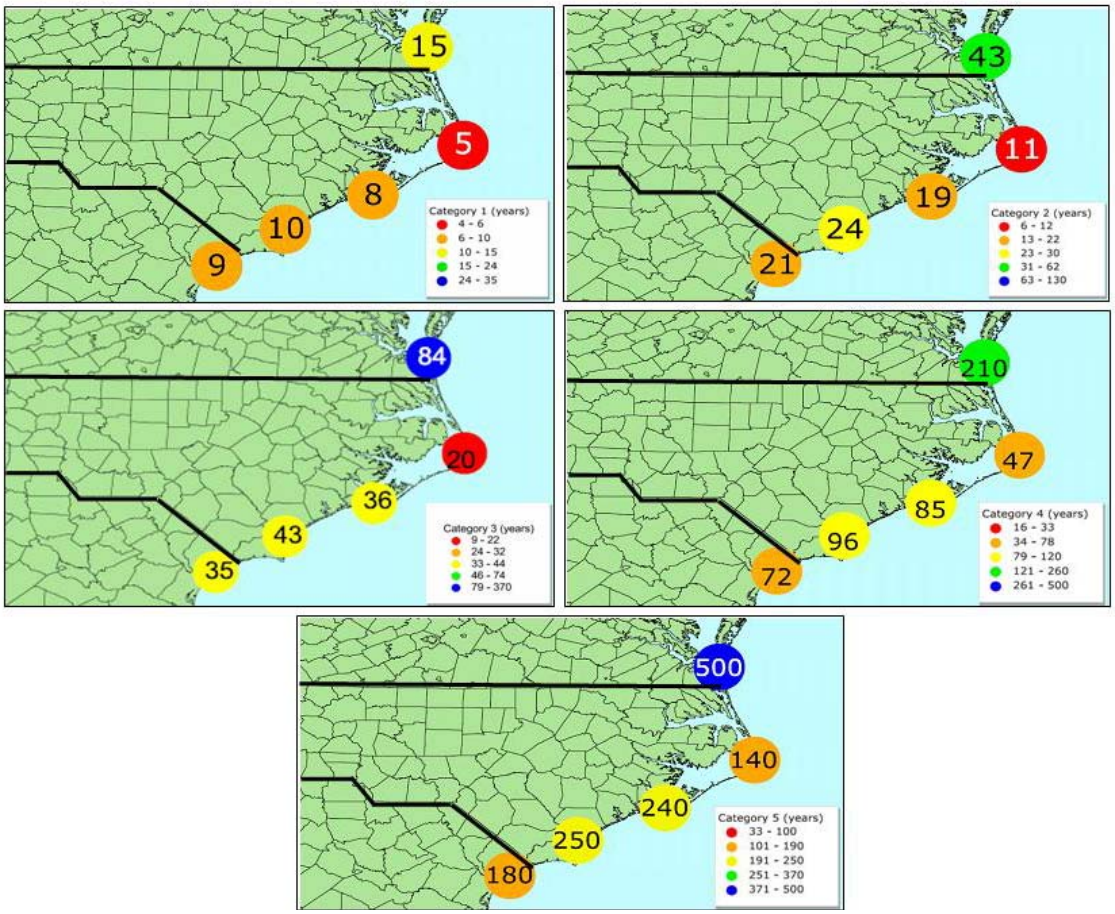

Figure X-8. Expected Return Period of Hurricanes

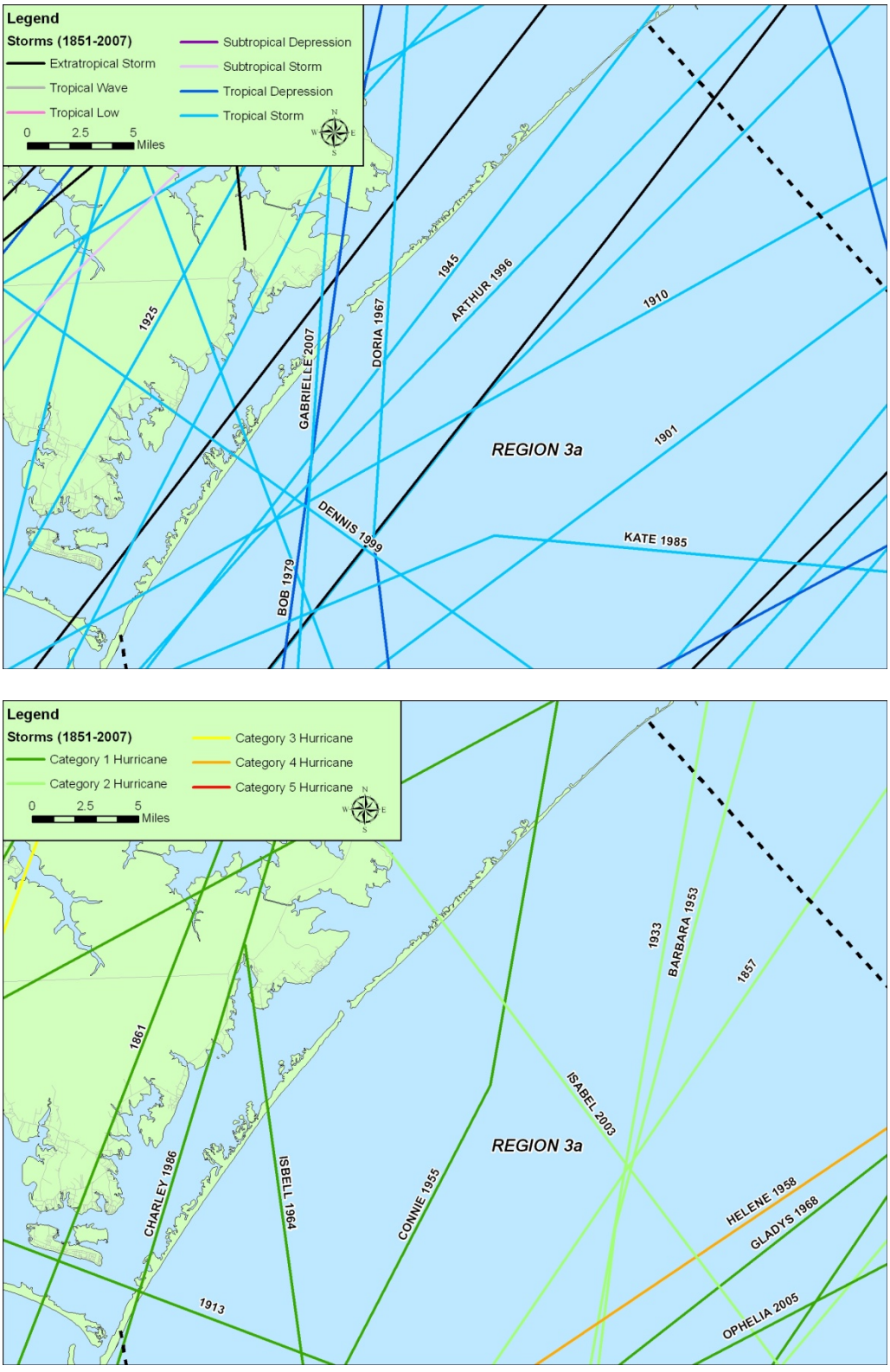

Figure X-9. Atlantic Storm and Hurricane Tracks for Region 3a

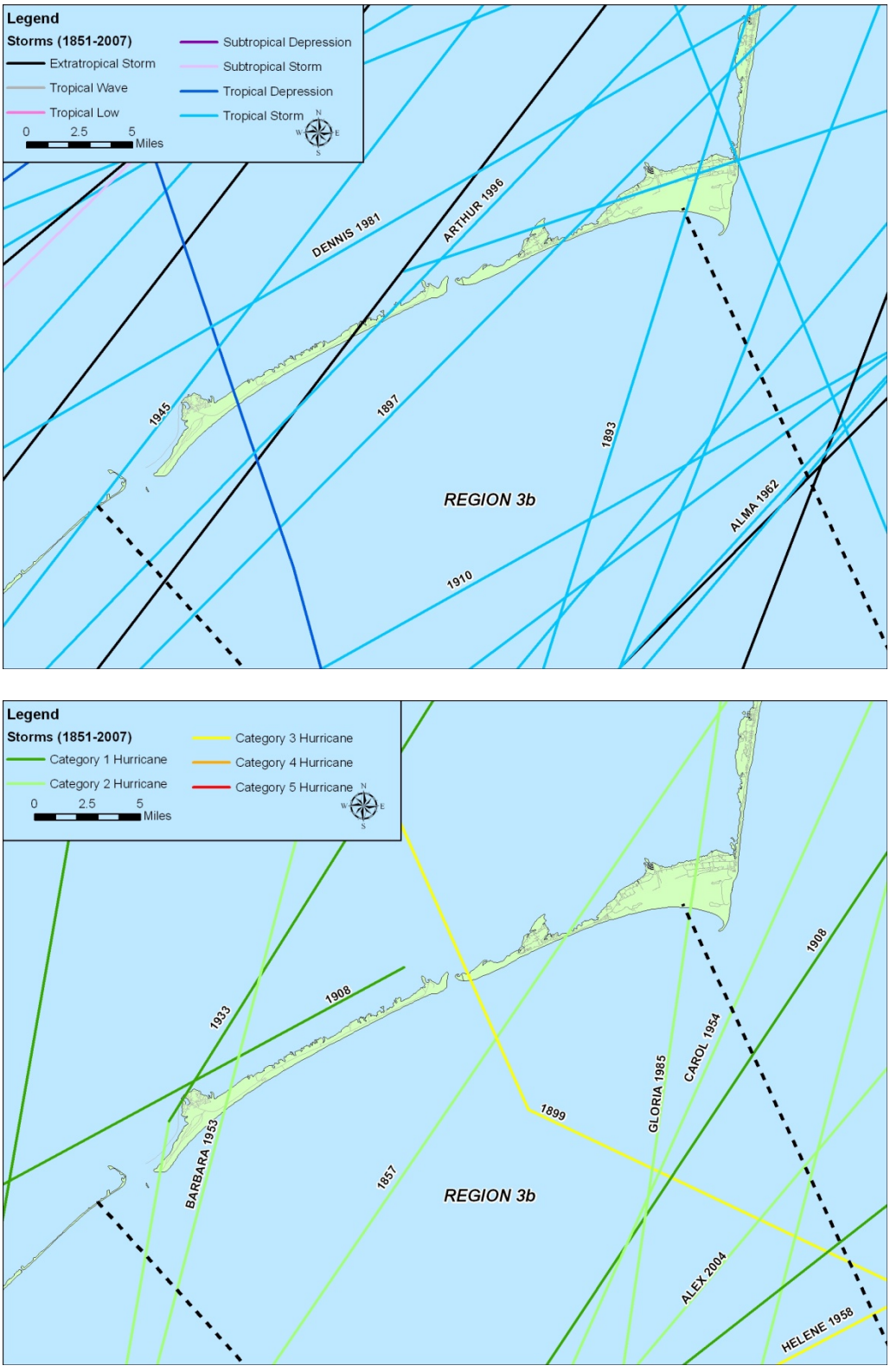

Figure X-10. Atlantic Storm and Hurricane Tracks for Region 3b

3. Digital Orthophotography

Photography is available from various sources including the Division of Coastal Management (DCM), USGS, National Agriculture Imagery Program, and individual county governments. Aerials of the entire oceanfront shoreline were taken in 1998 and 2004. In 2003, some post-Isabel aerials were taken of the ocean shoreline by USGS, with the exception of Dare and Hyde counties. In 2006, the National Agriculture Imagery Program created mosaics for orthotiles for the entire coastline. Various counties also have oceanfront aerial photography for a variety of dates. Tables X-8 and X-9 identify the available digital orthophotography for Region 3.

Table X-8. Digital Orthophotography for Region 3a

Inlet Photography (1992)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
1992	Drum Inlet	Mr. SID	Tiles	B&W	DCM	1'
1992	Drum Inlet	Mr. SID	Mosaic	B&W	DCM	1'
Oceanfront Photography (1998)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
1998	Cape Lookout to Hatteras Inlet	Mr. SID	Tiles	B&W	DCM	.5'
Oceanfront Photography (2004)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
2004	Fort Macon to Cape Lookout	Mr. SID	Mosaic	Color	DCM	.5'
2004	Core Banks	Mr. SID	Mosaic	Color	DCM	.5'
2004	Portsmouth Island	Mr. SID	Mosaic	Color	DCM	.5'
NAIP Photography (2006)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
2006	Carteret County	Mr. SID	Mosaic	Color	NAIP	1'

Table X-9. Digital Orthophotography for Region 3b

Inlet Photography (1940-2003)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
1940, 1958, 1971, 1977, 1980, 1992, 2003	Hatteras Inlet	TIFF	Mosaic	B&W	DCM	varies
1971, 1974, 1976, 1984, 1992	Ocracoke Inlet	Mr. SID	Mosaic	B&W	DCM	1'
Oceanfront Photography (1998)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
1998	Hatteras Island @ Hatteras to Pea Island	Mr. SID	Tiles	B&W	DCM	.5'
1998	Ocracoke Island	Mr. SID	Tiles	B&W	DCM	.5'
Dare County (2002)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
2002	Hatteras Island @ Hatteras to Kitty Hawk	Mr. SID	Tiles	Color	DCM	.25', 1'
Post-Isabel Photography (2003)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
2003	Hyde County (mainland)	Mr. SID	Mosaic	B&W	USGS	2'
Oceanfront Photography (2004)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
2004	Ocracoke Island	Mr. SID	Mosaic	Color	DCM	.5'
2004	Hatteras Isalnd @ Hatteras to Hatteras Island @ Salvo	Mr. SID	Mosaic	Color	DCM	.5'
NAIP Photography (2006)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
2006	Hyde County	Mr. SID	Mosaic	Color	NAIP	1'
2006	Dare County	Mr. SID	Mosaic	Color	NAIP	1'
Hyde County (2006)						
Date	**Coverage**	**Format**	**Mosaic/Tiles**	**Color**	**Source**	**Resolution**
2006	Ocracoke Island	Mr. SID	Tiles	Color	DCM	1'
2006	Hyde County Mainland	Mr. SID	Tiles	Color	DCM	1'
2006	Hyde County	Mr. SID	Mosaic	Color	DCM	1',2'

In addition, the USGS has Digital Orthophoto Quarter Quads (DOQQ) from 1998 for the entire coastline. These photos are Color Infrared MrSID images. MrSID, Multiresolution Seamless Image Database, is an image format developed for georeferenced raster graphics.

4. Historical Shorelines and Erosion Rates

In support of coastal planning efforts, DCM began developing a historical shoreline database starting in the 1970s. Shorelines were digitized for available years for the entire N.C. oceanfront using a variety of media dating back to 1933. The primary source of historical data is the geo-referenced T-Sheets, provided by NOAA Coastal Services Center (CSC). DCM has also collaborated with the USGS and USACE to document the most recent shorelines based both on delineation of the wet-dry line as interpreted from orthophotography, as well as deriving the Mean High Water Line based on LiDAR survey data. In addition to the statewide oceanfront shoreline datasets, DCM has compiled a historical shoreline database in the vicinity of inlets, varying in length on either side of the inlet from approximately 10,000 feet to 40,000 feet. The available shoreline data and extents vary widely depending on the availability of historical photographs. Inlet shorelines were digitized and developed from multiple data sources including: North Carolina Department of Transportation rectified aerials, DCM orthophotos and NOAA CSC T-Sheets. Tables X-10 and X-11 present the available

shorelines which cover the two subregions of Region 3. GIS shapefiles of historical shorelines may be accessed via DCM's website at http://dcm2.enr.state.nc.us/Maps/chdownload.htm.

Table X-10. Digitized NC Oceanfront Shorelines for Region 3

Oceanfront Shorelines			
Date	Coverage	Type	Source
1933-1952	NC Shoreline (Bird Island to Kill Devil Hills)	NOS T-Sheet (MHW)	DCM
1998	Entire NC Shoreline	Photo-Wet/Dry	DCM
2004	Entire NC Shoreline	NCDCM Photo-Wet/Dry	DCM
1849-1873	Entire NC Shoreline	NOS T-Sheet (MHW), CERC map	USGS, Coastal Carolina
1925-1946	Entire NC Shoreline	CERC map, USACE Photos, NOS T-Sheet (MHW)	USGS, NOAA, DCM
1970-1988	Entire NC Shoreline	CERC map, NOS T-Sheet (MHW)	USGS, NOAA, Coastal Carolina
1997	Entire NC Shoreline	LIDAR MHW Shoreline	USGS

Table x-11. Digitized Inlet Shorelines for Region 3b

Inlet Shorelines			
Date	Coverage	Type	Source
1940, 1958, 1971, 1977, 1980, 1992, 1998, 2003	Hatteras Inlet	Photo-Wet/Dry	DCM

Using the digitized shorelines, the N.C. Coastal Resources Commission (CRC) has established oceanfront development setbacks based on long-term shoreline change rates. Setback factors determine the distance back that development can be sited measured from the first line of stable and natural vegetation. Shoreline change has been calculated by DCM using the end point method, based on the distance from the earliest shoreline archived by the state (varies for segments of shoreline but typically from the 1940s) to the most recent (1998) divided by the number of years between them. Erosion rates are calculated at 50-meter (164 feet) transects along shore. These rates are then "smoothed" to account for local variance and influences of inlets. DCM then determines setbacks based on these "smoothed erosion rates." Details regarding the methods used to conduct the most recent update of setback rates (based on the 1998 shoreline location) are documented by Overton and Fisher (March 2004). Figures X-11and X-12 present DCM's long-term erosion rates for the two subregions of Region 3.

Since inlets can temporarily interrupt and intercept the flow of sediments along the coast and migrate over time, they are typically areas of the greatest variation in erosion and accretion. This can be seen in the erosion rates plotted in Figures X-11 and X-12. The shoreline erosion rates point to moderate long-term erosion of Core Banks and Portsmouth Island. This is to be expected given that there have not been any beach nourishment projects or other sand management activities on this portion of the coast. The portion of Ocracoke Island currently designated as an NCDOT hotspot is evident with long-term erosion rates between six and 10 feet per year. The accretional trend of Cape Hatteras is also apparent in the long-term rates as sediment is being trapped offshore at Diamond Shoals.

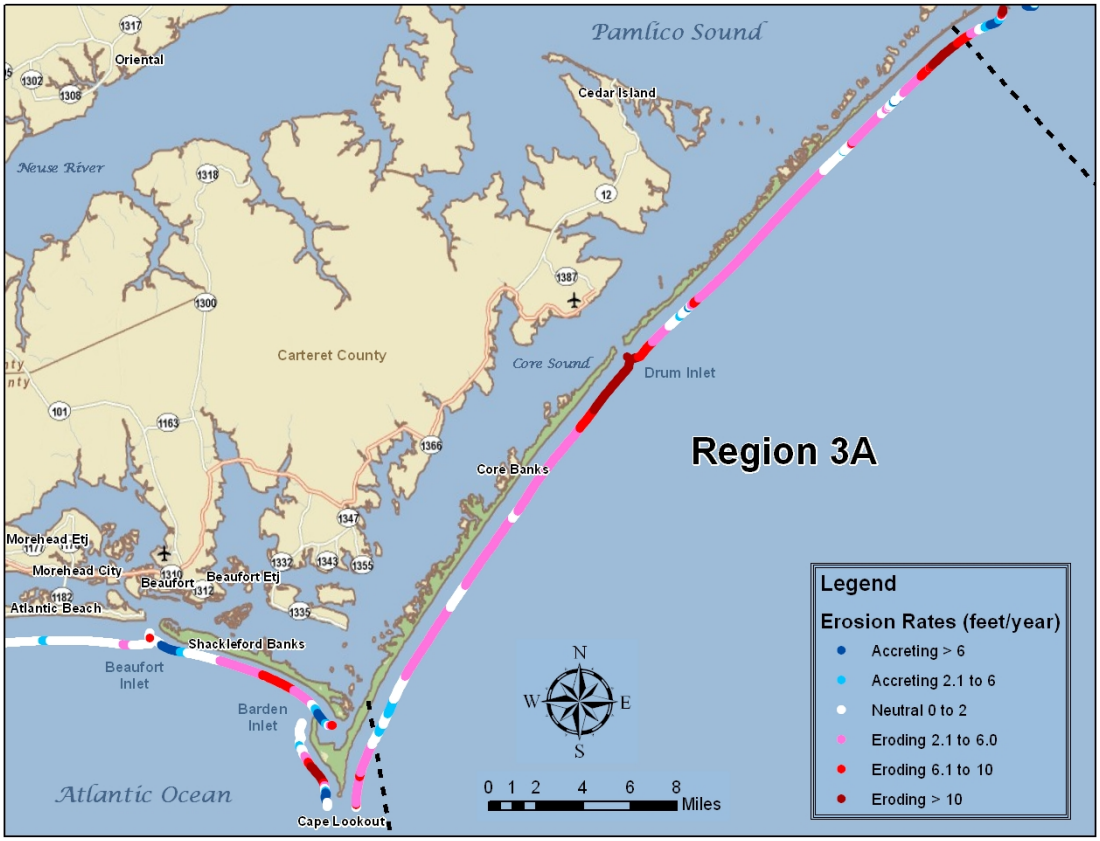

Figure X-11. DCM Erosion Rates for Region 3a

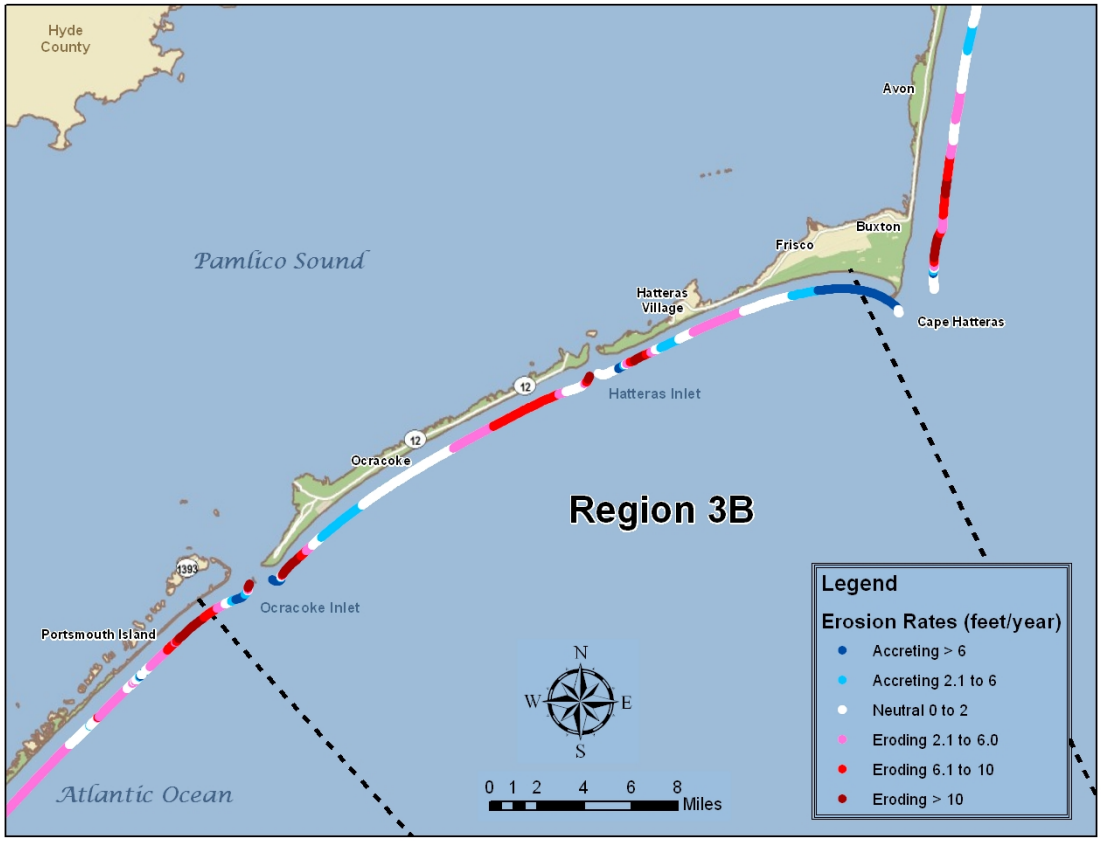

Figure X-12. DCM Erosion Rates for Region 3b

5. Beach and Inlet Surveys

Beach profile data has been collected for several beaches along the North Carolina coast. These data are available in various formats depending on the location. Available beach profile data locations for the subregions of Region 3 are presented in Figures X-13 and X-14.

As part of the Ocracoke Island-NC 12 vulnerability study, survey data is available for the portion of Ocracoke Island located in the NCDOT-established hotspot.

In addition to monitoring the beach through profile data, the Navigation Branch of the USACE Wilmington District maintains a database of hydrographic surveys for federal navigation channels. Surveys for Ocracoke Inlet and Hatteras Inlet can be accessed via the USACE website at http://www.saw.usace.army.mil/nav/inlets.htm. These inlets are part of federal dredge projects to maintain the navigation channels at authorized width and depth dimensions.

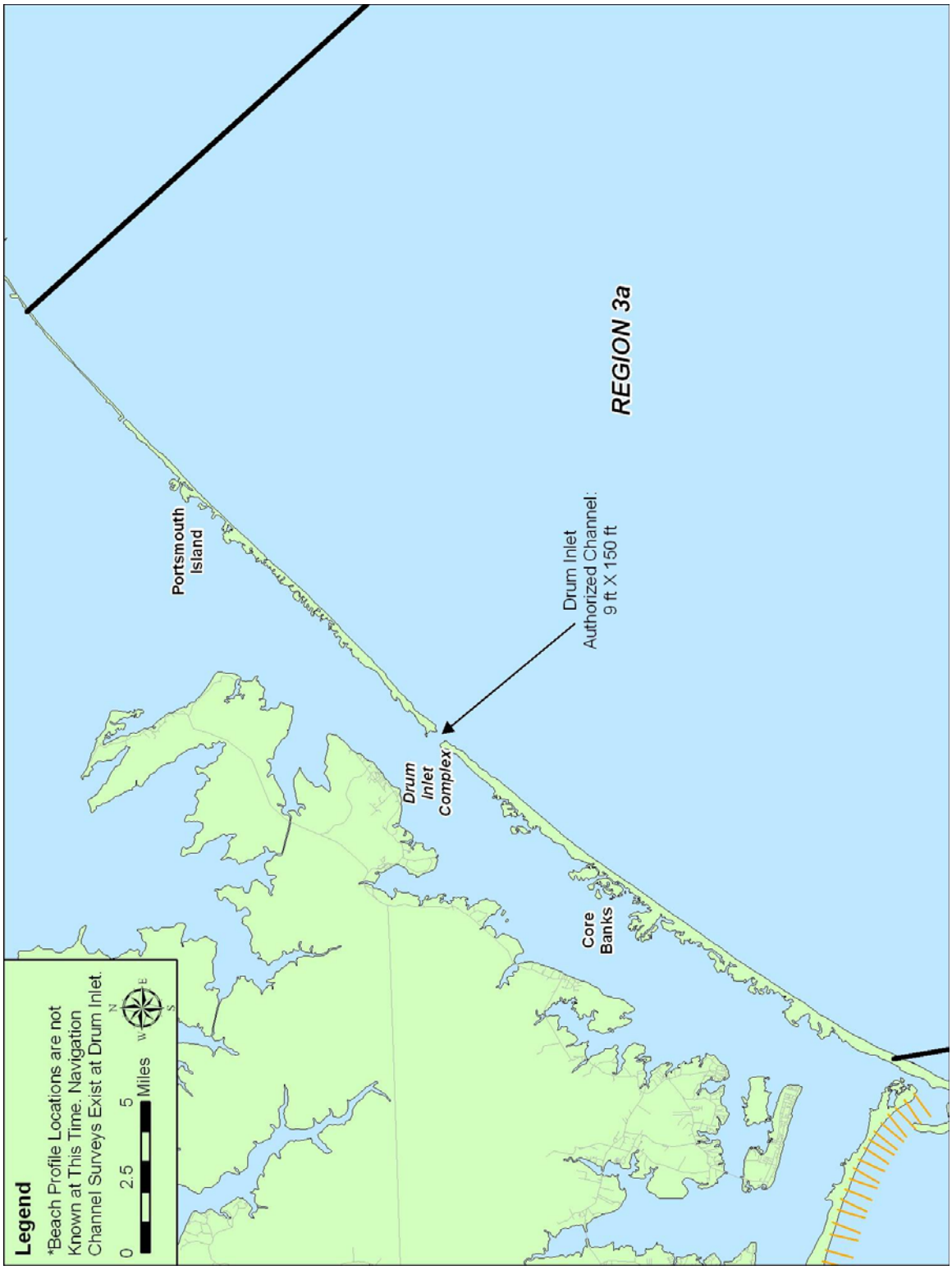

Figure X-13. Beach Profile Monitoring Locations for Region 3a

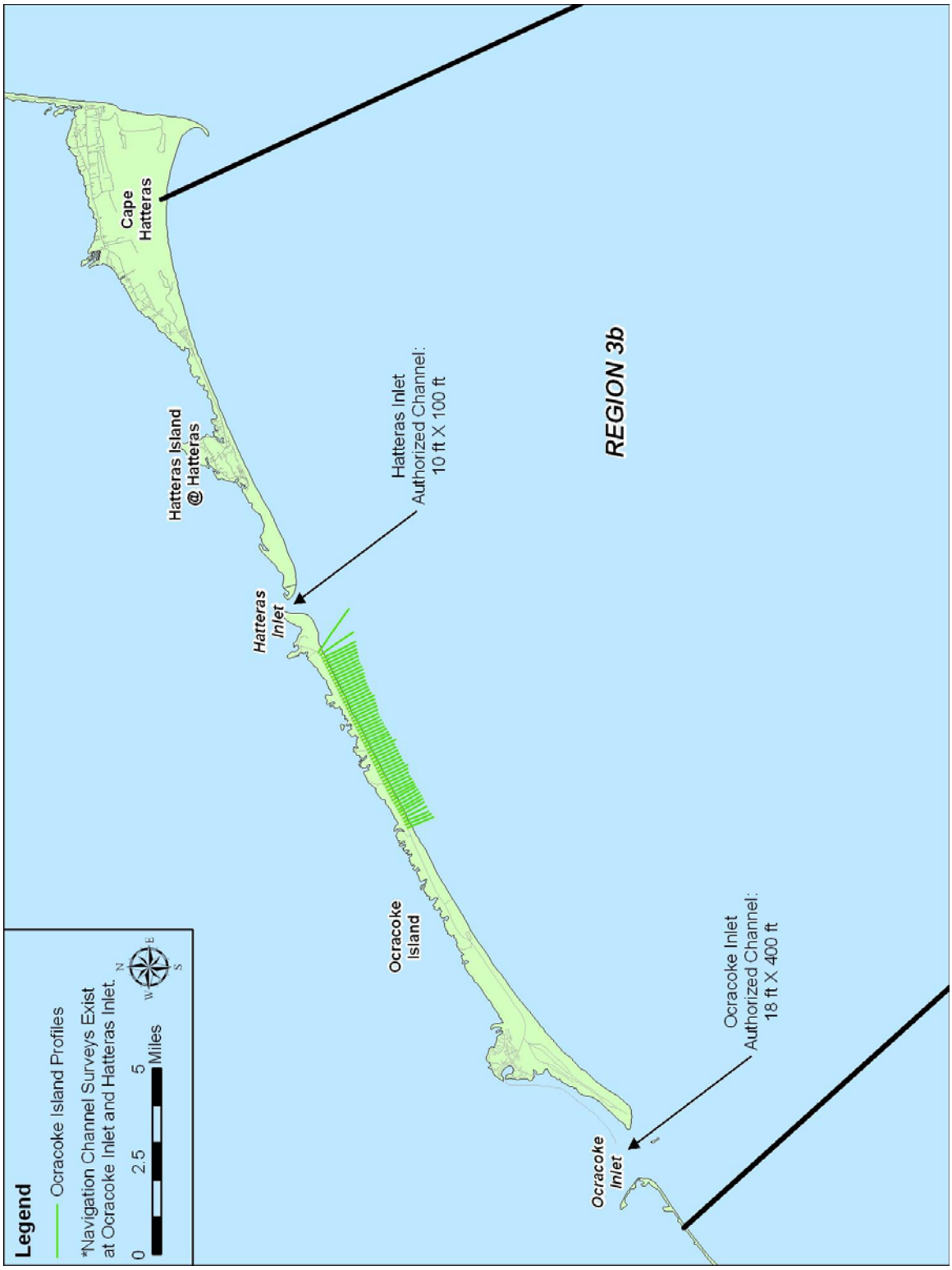

Figure X-14. Beach Profile Monitoring Locations for Region 3b

6. Geologic Framework

The geological composition of the North Carolina coast and the dynamic nature of its inlets play a vital role in beach behavior and potential sources and availability of sand resources. Coastal geology – the origin, structure, and characteristics of coastal sediments, combined with the geological formation of the coastline over thousands of years of physical and chemical processes – dictates the properties of the sediments. The inlets provide a temporary natural disruption to longshore sediment transport. Coastal processes, of varying temporal and spatial scales, driven by water level changes, tides, waves, currents and winds, interact with the local coastal geology and sediment supply to form and modify the configuration of the coastal region forming features such as beaches, dunes, and inlets.

Region 3 represents the start of the northern geological province spanning the coast from Cape Lookout to the Virginia border. North of Cape Lookout, the geological framework consists of a thick Quaternary sequence that fills a regional depositional basin called the Albemarle Embayment (Riggs *et al.*, 1995). The gentler slopes of this region are characterized by long barrier islands and broad expanses of drowned river estuaries, which now comprise Pamlico and Albemarle Sounds. This region is situated along the section of coast called Raleigh Bay, a cuspate formation between Cape Lookout and Cape Hatteras.

a) Region 3a - Beaches and Inlets

(1) Core Banks and Portsmouth Island (Cape Lookout National Seashore)

Core Banks is an undeveloped, low-relief narrow barrier island extending from Cape Lookout north to Portsmouth Island (Ocracoke Inlet). Core Banks is separated from the mainland by a narrow, shallow sound (Core Sound) and is part of the Cape Lookout National Seashore.

The southern part of Core Banks is generally a narrow ribbon of sand perched on the front of an extensive sequence of marsh platforms (Riggs and Ames, 2007). At the southwestern end of the banks, the land widens and hooks back on itself forming Cape Lookout Bight. Cape Lookout shoals extend south-southeast from the point of the Cape for approximately ten miles, with local water depths of three to four feet and less (Riggs and Ames, 2007). The general cuspate pattern of Core Banks is broken in the middle by Drum Inlet. Drum Inlet and past inlets in this area fluctuate (open, migrate, close) in direct response to sediment transport patterns, storm events and the underlying geology. Changes in the shoreline and shoreface geometry often reflect changes in the geologic materials underlying the barrier island. Riggs and Ames (2007) observed that two significant bends in the shoreline were a result of an upper Tertiary paleotopographic limestone ridge (south of Drum Inlet) and peat outcrops of the back-barrier marsh platforms that have been overridden by the shoreline as the barrier island recedes (midway between Drum Inlet and Portsmouth).

Low and narrow segments of the barrier island have been subject to overwash events and the opening and closing of ephemeral inlets. Currently Core Banks is modestly vegetated with an irregular dune system. Overwash occurs during some larger storm events. One such event was Hurricane Isabel, which resulted in significant areas of overwash. The data suggest increased vegetation growth has taken place in response to storm activity and the associated overwash that has substantially increased the island elevation since a 1961 USACE survey (Riggs and Ames, 2007).

The North Carolina Geological Survey (Coffey and Nickerson, 2007) has produced a series of geomorphic maps of Cape Lookout National Seashore from Cape Lookout to the northern end of Portsmouth Island. The maps of the geomorphic landforms were developed from interpretation of several digital data layers and aided by field mapping. Data sets included LiDAR elevation data, digital imagery, DCM wetland mapping and shoreline maps among others. Figure X-15 is an example of the mapping produced.

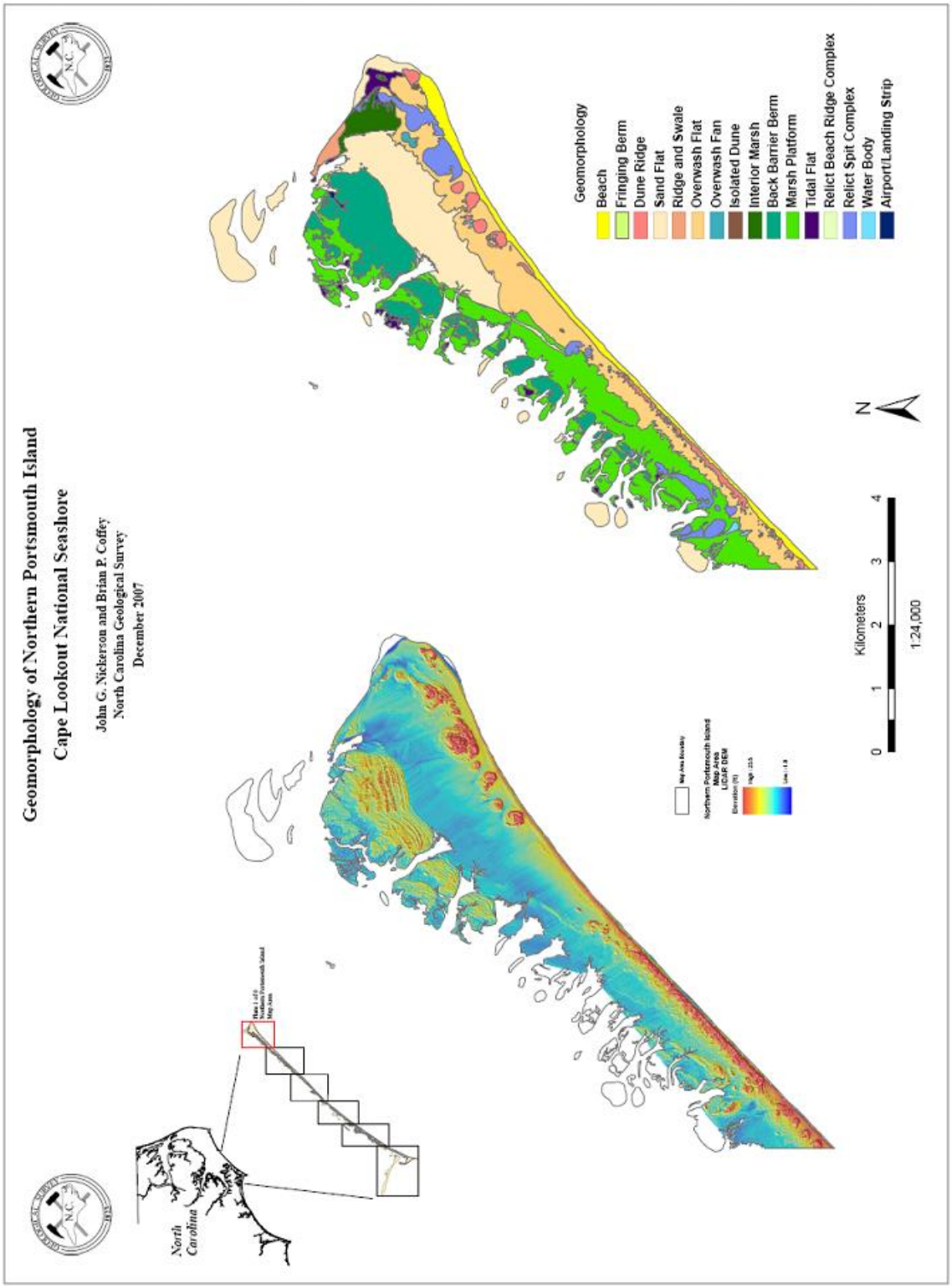

Figure X-15. Geomorphic Mapping Example - Cape Lookout National Seashore

(2) Drum Inlet Complex

Drum Inlet was intentionally opened in 1971, approximately 25 miles northeast of Cape Lookout and two miles southwest of Old Drum Inlet. Old Drum Inlet closed several months before the creation of the current Drum Inlet. The new inlet location was intended to provide a better route to offshore fishing from the towns along Core Sound.

Old Drum Inlet opened in about 1899, closed in 1919, and was reopened by a hurricane in 1933 (Mallinson *et al.*, 2008). Since then, Drum Inlet has had a history of opening and closing several times in an area that has been prone to inlet formation in the past (Cleary and Marden, 1999). Old Drum Inlet migrated more than a mile between 1940 and its closure in 1971. In 1999, Hurricane Dennis reopened Old Drum Inlet, now referred to as New-Old Drum Inlet, and in 2005 Hurricane Ophelia opened an inlet just southwest of Drum Inlet, which appears to be merging with Drum Inlet (Mallinson *et al.*, 2008). For the purposes of this report, all three inlets (Drum, New-Old Drum, and Ophelia Inlet) are considered as the Drum Inlet Complex.

b) Region 3b Beaches and Inlets

(1) Portsmouth

The north portion of Portsmouth Island is included in Region 3b since the historic Village of Portsmouth is located there, and Ocracoke Inlet, which borders it, is also in Region 3b. The geology of this area was described in the section covering Core Banks and the rest of Portsmouth Island in Region 3a.

(2) Ocracoke Inlet

Ocracoke Inlet is the largest of the four inlets located north of Cape Lookout, and separates Portsmouth Island from Ocracoke Island to the north. It is one of the more stable and deepest inlets in North Carolina, appearing on maps dating back to 1585 (Cleary and Marden, 1999). Its stability is probably due to the large tidal prism associated with Pamlico Sound and the Pamlico River, and that its location appears to be governed by an old river channel. Pamlico Creek drained the Pamlico Sound basin during the last glacial maximum, approximately 20,000 years ago, and it is likely this former river valley beneath the inlet accounts for its stability and longevity (Mallinson *et al.*, 2008).

Channel depths have varied in the last 60 years from nine feet to more than 20 feet. Since the mid-1880s, the inlet has migrated 1.8 miles to the southwest. Constriction and expansion of the inlet are direct functions of repositioning of the flood channels along the margins of the inlet. Ocracoke Inlet has maintained average width over the last 40 to 50 years of approximately 1.4 miles fluctuating by as much as half a mile (Cleary and Marden, 1999).

(3) Ocracoke Island

Ocracoke Island is a 16-mile long barrier island that is less than two miles wide at its widest point. It is part of the Outer Banks, and part of the Cape Hatteras National Seashore. The island is separated by Ocracoke Inlet to the south and Hatteras Inlet to the north.

(4) Cape Hatteras National Seashore

The North Carolina Geological Survey (Hoffman *et al.,* 2007) produced a series of geomorphic maps of Cape Hatteras National Seashore from Ocracoke Island to Bodie Island. The maps of the geomorphic landforms were developed from interpretation of several digital data layers, and by field mapping. Data sets included LiDAR elevation data, digital imagery, DCM wetland mapping and shoreline maps among others. Figure X-16 is an example of the mapping produced.

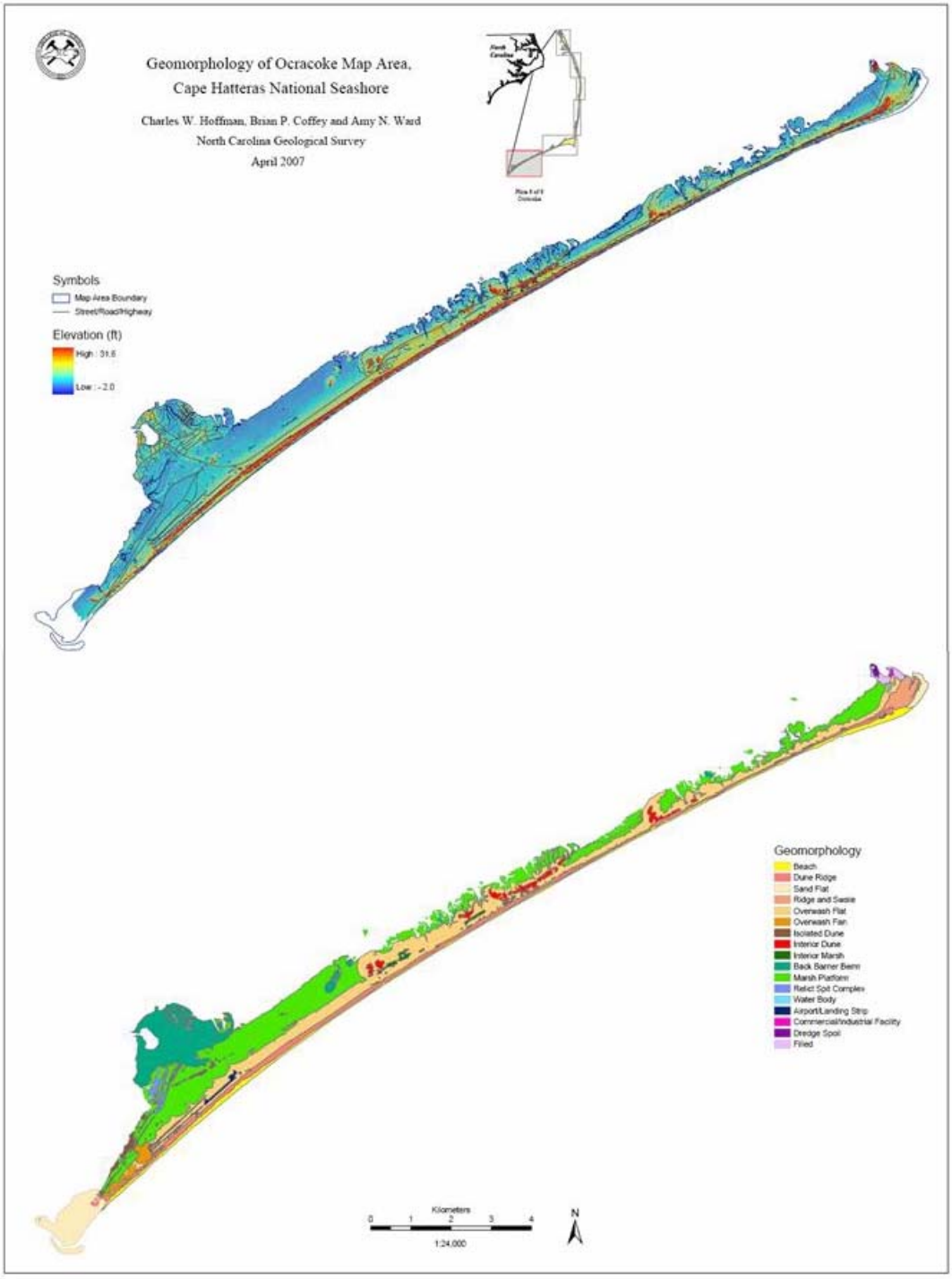

Figure X-16. Geomorphic Mapping Example - Ocracoke Island

(5) Hatteras Inlet

Hatteras Inlet is located approximately 12 miles west of Cape Hatteras, separating Hatteras Island from Ocracoke Island on the border of Hyde and Dare Counties. The inlet opened during a major hurricane in September 1846 that also opened Oregon Inlet to the north (Cleary and Marden, 1999). The inlet is relatively shallow and its shoals are continually changing. The width of the inlet has fluctuated from more than 1.5 miles wide to as little as 1,600 feet.

(6) Hatteras Island to Buxton

This portion of Hatteras Island extends from Hatteras Inlet to just west of Cape Hatteras. It is at the end of the Raleigh Bay formation. The island increases in width as it approaches the Cape. The remainder of Hatteras Island and more detailed discussion of the geology are presented in the following section dealing with Region 4.

7. Sediment Budgets

Significant gaps exist in sediment transport and sediment budget information. Park and Wells (2005) performed a sediment budget analysis for a portion of the area in Region 3a close to Cape Lookout. According to the budget, the net transport direction is to the south toward the Cape Lookout point and Cape Lookout Shoals. Locations of available sediment budgets for Region 3 are presented in Figure X-17. Some findings from Park and Wells' 2005 study can be seen in Figures X-18 and X-19.

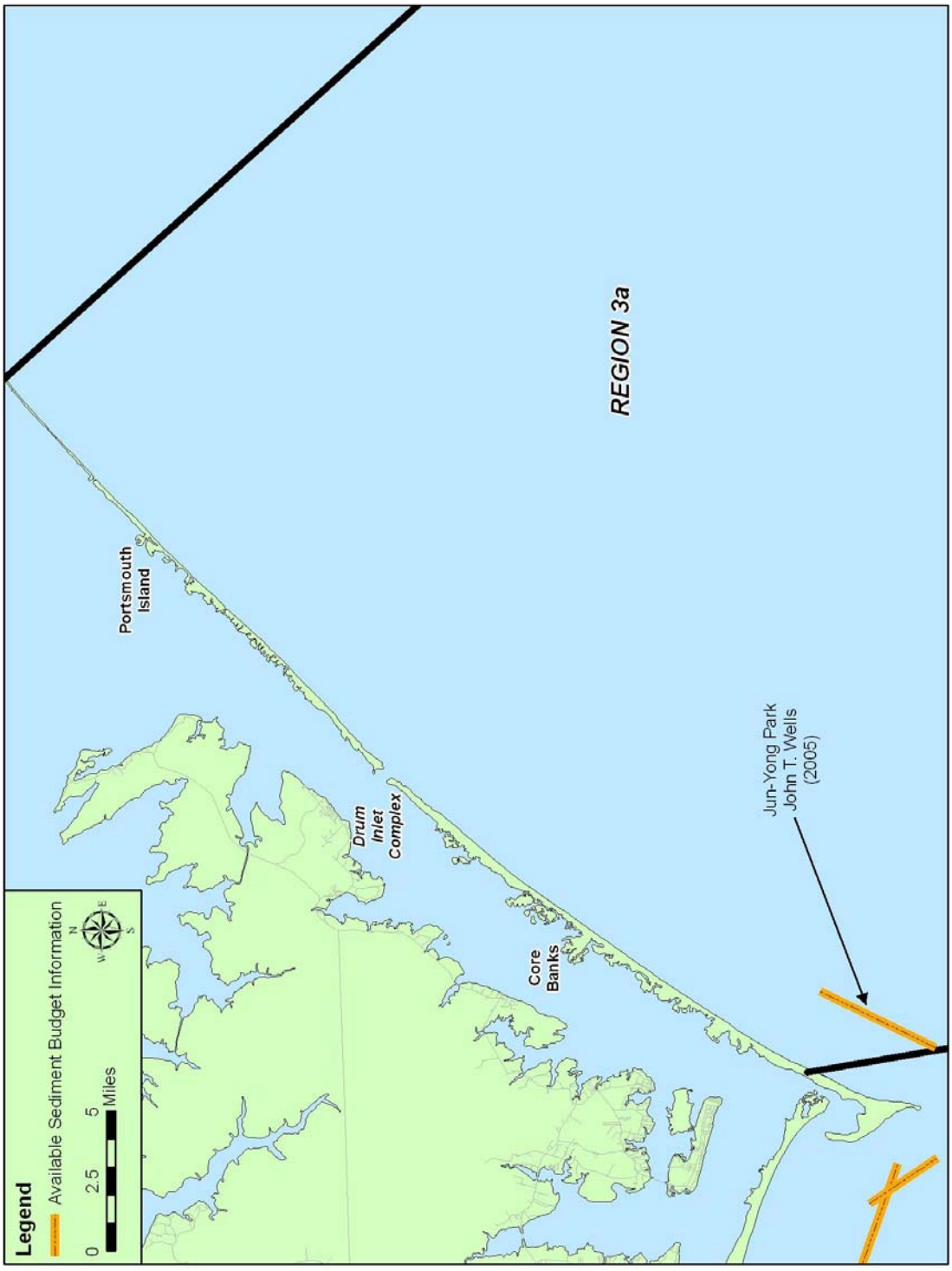

Figure X-17. Available Sediment Budgets for Region 3a

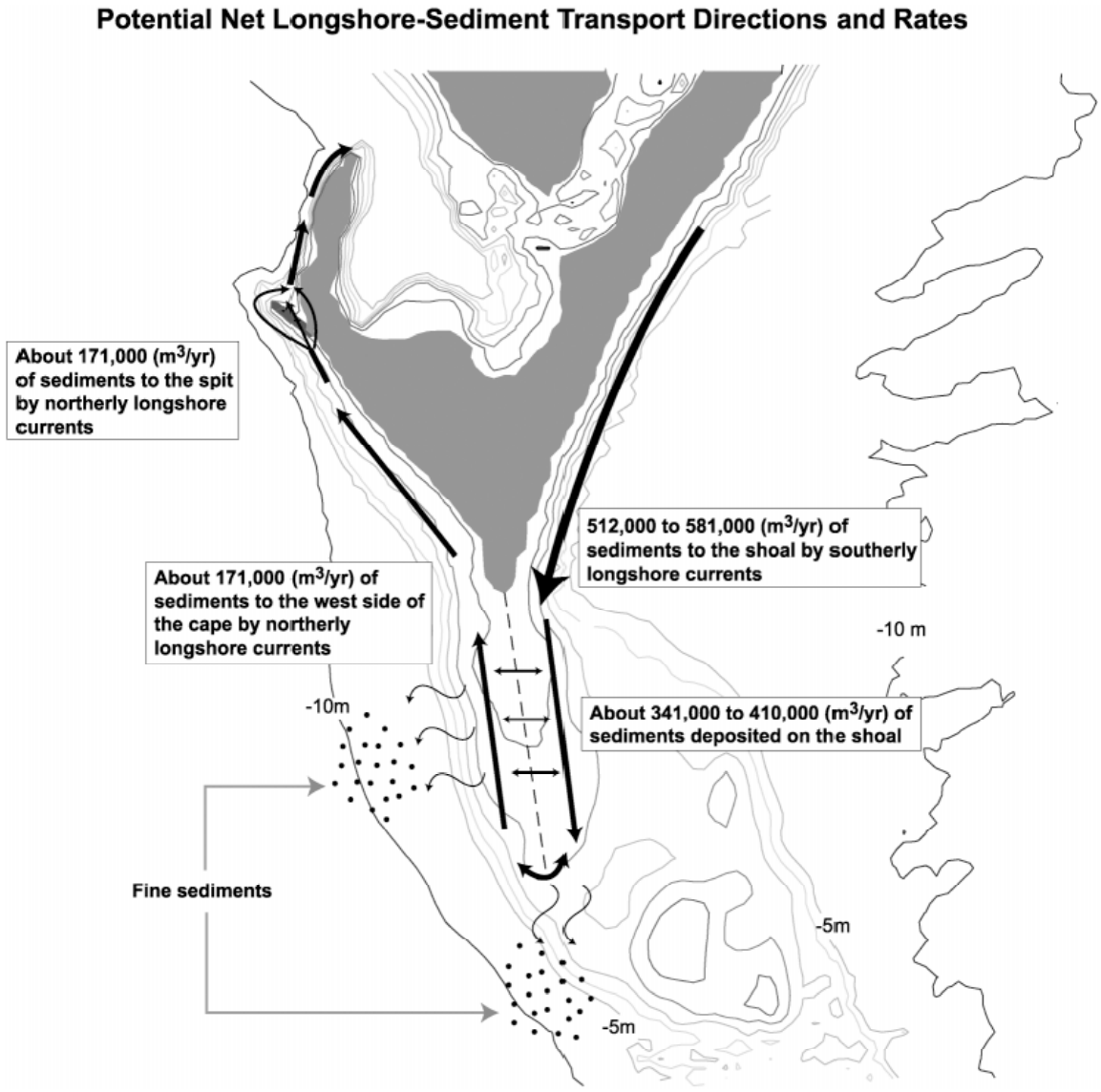

Figure X-18. Predicted Net Longshore Sediment Transport and Pathways (Park and Wells, 2005)

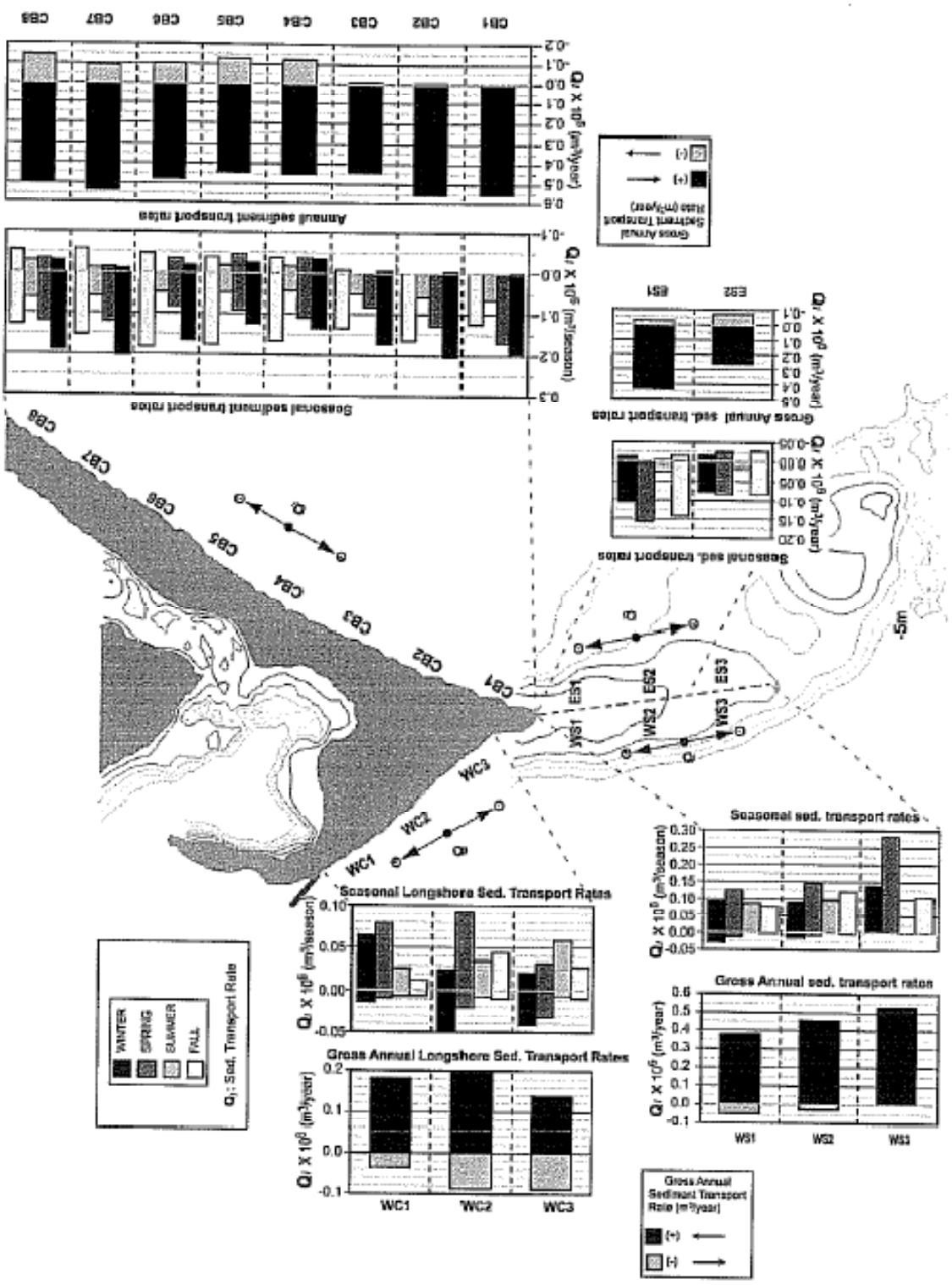

Figure X-19. Longshore Transport at Cape Lookout (Park and Wells, 2005)

8. Potential Sand Resources

Compatible sand resources for beach nourishment projects come from inlet dredging and offshore disposal sites containing previously dredged material. Potential sand resources are identified in various NCGS Open File Reports, USACE findings, USGS databases, and consulting firm investigations.

Region 3a has limited sand source options. According to the USGS SEABED database, there is a potential area offshore of Portsmouth Island which contains material with an acceptable grain size for many North Carolina beaches (phi size=1.0-2.0 or 0.25 mm-0.5 mm). This area should be examined further in the future to determine suitability.

Region 3b contains two inlets (Ocracoke and Hatteras) which have been used in the past as sediment sources for nearby beaches. Offshore sand sources in this region have been examined extensively by the NCGS (NCGS OFR-1_01 and NCGS Outer Banks Task Force Meeting Presentation-7/16/08). Sand resources identified are believed to be suitable for both fine- and medium-grained beaches but volumes have not yet been determined for all potential sites. Figures X-20 and X-21 show the potential sediment resources for the subregions of Region 3.

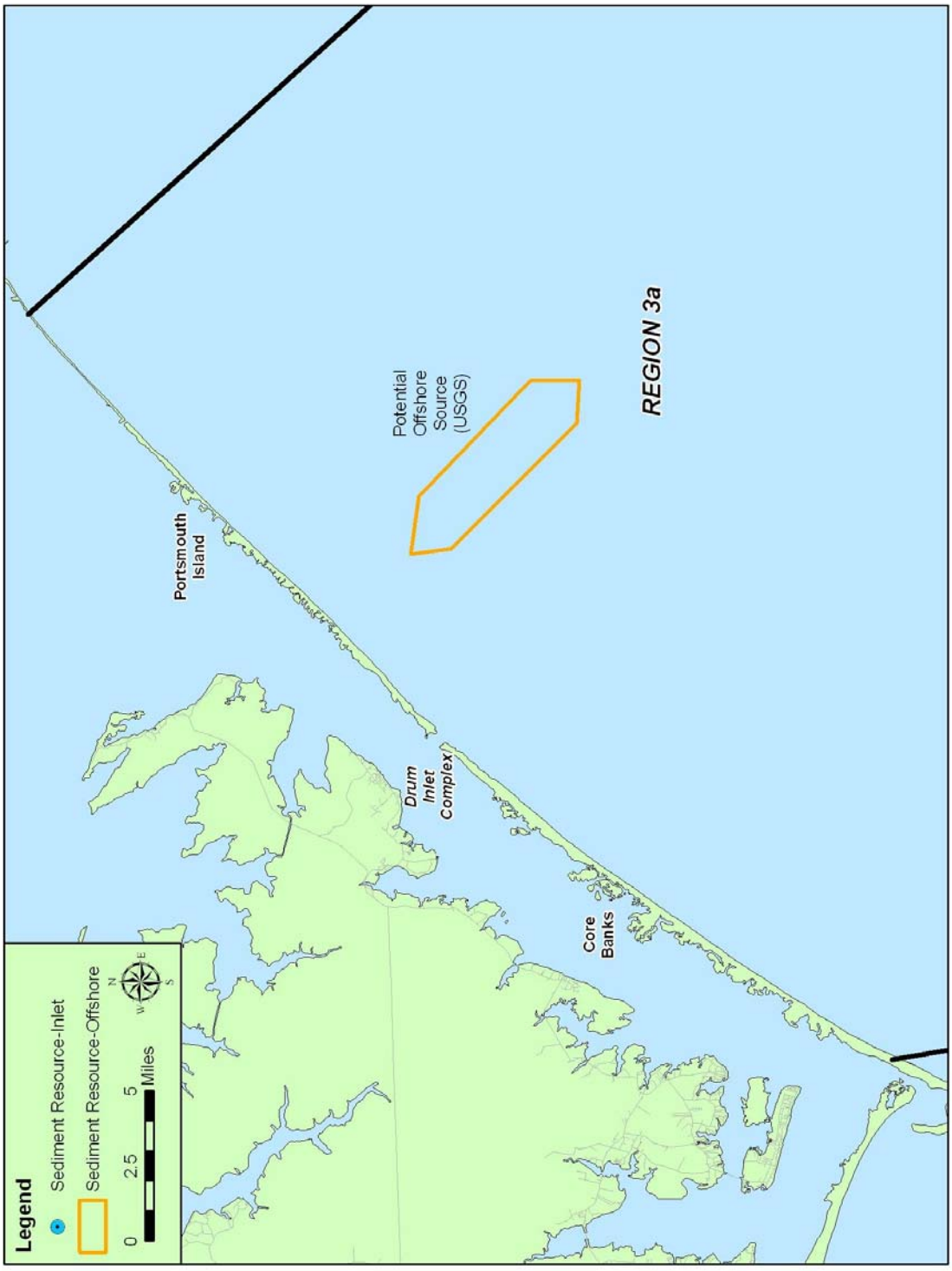

Figure X-20. Potential Sediment Resources for Region 3a

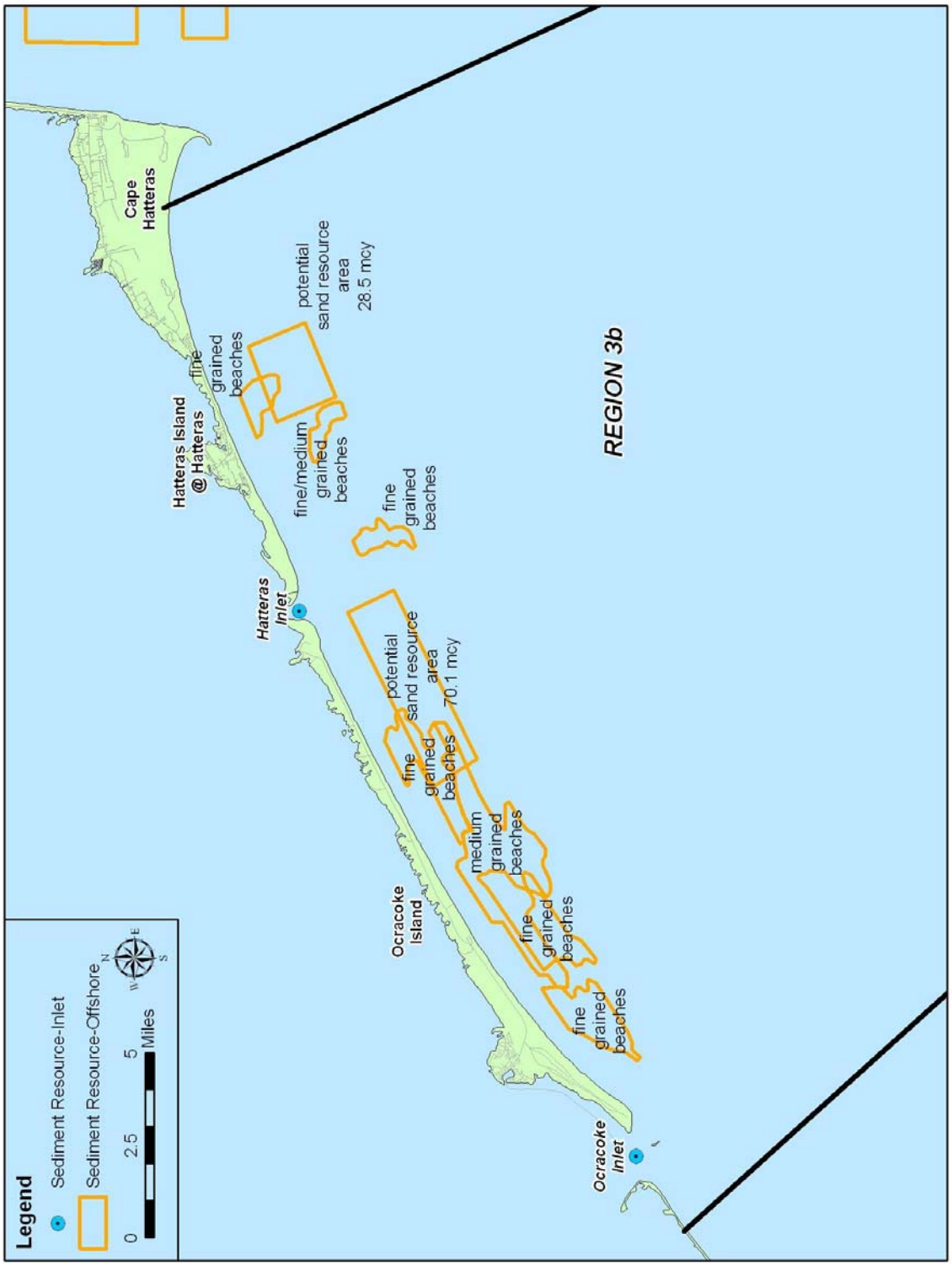

Figure X-21. Potential Sediment Resources for Region 3b

9. Environmental Considerations

The BIMP recognizes environmental concerns as a vital part of holistic beach and inlet management strategies. Environmental considerations can be constraints on strategy choices, projects, or timing of projects, but management strategies can also represent opportunities to preserve, restore, or create habitat. The Coastal Habitat Protection Plan (CHPP) identifies six primary habitats along coastal North Carolina that are vital to the health and function of North Carolina's coastal ecosystems and fisheries. This section identifies federally protected species, N.C. Natural Heritage Program (NHP) Element Occurrences, Critical Habitats, and Significant Natural Heritage Areas. Site specific concerns for each beach and inlet in Region 3 are also identified. Appendix F contains maps of the primary coastal habitats as well as protected species and critical wildlife habitat mapping.

a) Region 3a - Federal Protected Species, NHP Element Occurrences, Critical Habitats, and Significant Natural Heritage Areas

- NHP identifies element occurrences for plant and animal species within Region 3a, including the following species that could potentially occur within the identified project study area: seabeach amaranth, shortnose sturgeon, loggerhead sea turtle, green sea turtle, leatherback sea turtle, hawksbill sea turtle, Kemp's Ridley sea turtle, piping plover, roseate tern, and West Indian manatee. A site specific assessment and U.S. Fish and Wildlife Service (USFWS) coordination should be conducted during project planning to avoid impacts to protected species.

- USFWS identifies May 1 – November 15 as the moratoria period for sea turtle nesting areas.

- Site specific sea turtle nesting data can be obtained from the N.C. Wildlife Resources Commission (WRC) (http://www.seaturtle.org/nestdb/index.shtml?view=1).

- USFWS has identified critical habitat areas within Region 3a for the piping plover near Drum Inlet and the South Core Banks. Site specific information regarding these critical habitat areas can be obtained through USFWS at http://criticalhabitat.fws.gov/. Activities within critical habitat areas will require consultation with USFWS. All applicable USFWS and NCWRC moratoria should be observed. USFWS identifies April 1 – July 15 as the moratoria period for piping plover nesting areas.

- Region 3a contains significant habitat for colonial water birds, wading birds and shore birds, including known colonial wading bird colonies and gull-tern-skimmer colonies. All applicable USFWS and NCWRC moratoria should be observed.

- Site specific colonial water bird and shorebird data can be obtained from NCWRC.

- Site specific seabeach amaranth data can be obtained from USFWS and USACE as well as NHP.

b) Region 3a - Site Specific Concerns

The following details the environmental considerations specific to each beach/shoreline segment and inlet under the general headings of CHPP elements, protected species and wildlife elements, and any other notable considerations. The first section identifies elements related to the beach or inlet with respect to the CHPP. The second lists key protected species and wildlife issues and time of year restrictions on construction related activities. The third group, entitled "Other," lists any other environmental considerations, such as designated heritage or significant areas.

(1) Core Banks

CHPP Elements
- Class SA/ORW waters
- Salt marsh along rear of island
- Extensive submerged aquatic vegetation (SAV) in Core Sound
- Open shellfish waters in Core Sound
- Some shell bottom along south end of Core Banks

Protected Species & Wildlife Elements
- Shortnose sturgeon occurrence (February 1-June 15 moratoria)
- Colonial waterbird nesting (April 1-August 31 moratoria in nesting areas)
- West Indian manatee occurrence (June – October moratoria; observers possibly required)
- Loggerhead and leatherback sea turtle nest sites (May 1-November 15 moratoria)
- Seabeach amaranth (will require surveys)
- Piping plover nesting (April 1-July 15 moratoria in nesting areas)
- Crab spawning sanctuary inside Lookout Bight and inside Barden Inlet
- Essential Fish Habitat (EFH) for 14 species in Core Sound

Other
- Area of Regional and Federal Significance (Cape Lookout National Seashore)

(2) Portsmouth Island

CHPP Elements
- Class SA/ORW waters
- Patchy shell bottom in this portion of Core Sound
- Open shellfish waters
- Salt marsh on sound side
- Extensive SAV in Core Sound
- Hard bottom located within approximately three miles of Drum Inlet
- Artificial reef off of Drum Inlet

Protected Species & Wildlife Elements
- Shortnose sturgeon occurrence (February 1-June 15 moratoria)
- Colonial waterbird nesting (April 1-August 31 moratoria in nesting areas)
- Seabeach amaranth (will require surveys)
- Crab spawning sanctuary at Drum Inlet and Ocracoke Inlet
- EFH for 14 species in Core Sound; 70 species in Atlantic Ocean

Other
- Area of Regional and Federal Significance (Cape Lookout National Seashore)

Figure X-22 represents a sample of the environmental considerations which are present in Region 3a.

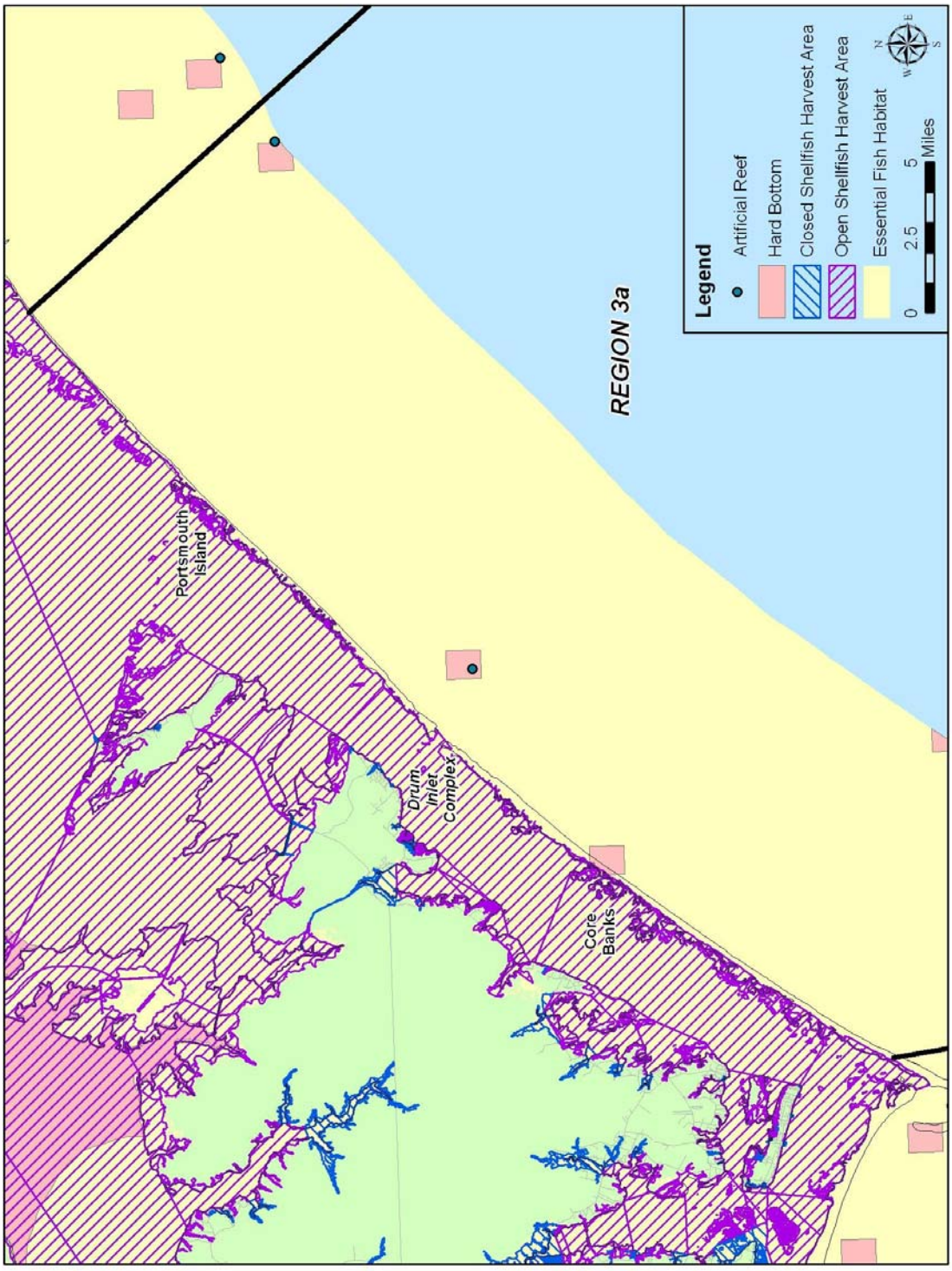

Figure X-22. Sample Environmental Considerations for Region 3a

c) Region 3b - Federal Protected Species, NCNHP Element Occurrences, Critical Habitats, and Significant Natural Heritage Areas

- NHP identifies element occurrences for plant and animal species within Region 3b, including the following species that could potentially occur within the identified project study area: seabeach amaranth, shortnose sturgeon, loggerhead sea turtle, green sea turtle, leatherback sea turtle, hawksbill sea turtle, Kemp's Ridley sea turtle, piping plover, roseate tern, and West Indian manatee. A site specific assessment and USFWS coordination should be conducted during project planning to avoid impacts to protected species.

- USFWS identifies May 1 – November 15 as the moratoria period for sea turtle nesting areas.

- Site specific sea turtle nesting data can be obtained from WRC (http://www.seaturtle.org/nestdb/index.shtml?view=1).

- USFWS has identified critical habitat areas within Region 3b for the piping plover near Ocracoke Inlet and an area within the sound just north of the Town of Hatteras. Site specific information regarding these critical habitat areas can be obtained through USFWS at http://criticalhabitat.fws.gov/. Activities within critical habitat areas will require consultation with USFWS. All applicable USFWS and NCWRC moratoria should be observed. USFWS identifies April 1 – July 15 as the moratoria period for piping plover nesting areas.

- Region 3b contains significant habitat for colonial water birds, wading birds and shore birds including known colonial wading bird colonies and gull-tern-skimmer colonies. All applicable USFWS and NCWRC moratoria should be observed.

- Site specific colonial water bird and shorebird data can be obtained from with NCWRC.

- Site specific seabeach amaranth data can be obtained from USFWS and USACE as well as NCNHP.

d) Shipwrecks

An assessment was made for the potential of the inlets and surrounding areas in Region 3b to contain underwater shipwrecks. Time periods assessed included the sixteenth and seventeenth centuries, the eighteenth and early nineteenth centuries, the Civil War, and the late nineteenth and twentieth centuries. Four categories of potential for underwater shipwrecks are given: low, moderate, high, and general:

- Low potential means that the area around the inlet has little potential to contain shipwrecks from that time period.

- Moderate potential means it is known the inlet was used by shipping during that time period and that wrecks from that time period are present in the area.
- High potential means that the inlet witnessed high volumes of ship traffic during that time period and that wrecks from that time period are present in the area.
- General potential means that shipping traffic used the inlet during that time period, but the volume and presence of wrecks in the area cannot be categorized.

Please note that shipwrecks are only listed in the following sections if there is a high probability of encountering them based on available data. Mapping of shipwrecks and other cultural resources is not as complete as needed for detailed assessments.

e) Region 3b - Site Specific Concerns

The following details the environmental considerations specific to each beach/shoreline segment and inlet under the general headings of CHPP elements, protected species and wildlife elements, and any other notable considerations. The first section identifies elements related to the beach or inlet with respect to the CHPP. The second lists key protected species and wildlife issues and time of year restrictions on construction related activities. The third group lists the potential for shipwrecks at the inlets where applicable. The fourth, entitled "Other," lists any other environmental considerations, such as designated heritage or significant areas.

(1) Ocracoke Inlet

<u>CHPP Elements</u>
- Class SA waters north of inlet; SA/ORW south of the inlet
- Open shellfish waters
- Patchy shell bottom
- Extensive SAV inside of inlet
- Hard bottom approximately five miles from inlet
- Soft bottom habitat possibly present with ebb-tidal delta

<u>Protected Species & Wildlife Elements</u>
- Shortnose sturgeon occurrence (February 1-June 15 moratoria)
- Colonial waterbird nesting (April 1-August 31 moratoria in nesting areas)
- Sea turtle habitat (limit takes during dredging)
- Piping plover nesting (April 1-July 15 moratoria if nests are present)
- Crab spawning sanctuary at Ocracoke Inlet
- EFH for 27 species

<u>Shipwrecks</u>
- Potential for 16th and 17th century shipwrecks

- High potential for 18th and early 19th century shipwrecks
- Low potential for Civil War shipwrecks
- Moderate potential for late 19th and 20th century shipwrecks
- Many locations around this inlet have been subjected to underwater archaeological survey
- Ocracoke National Register Historic District nearby

Other
- Area of Regional and Federal Significance (Cape Hatteras National Seashore)

(2) Ocracoke Island

CHPP Elements
- Class SA waters
- Extensive SAV on sound side of island
- Open shellfish waters except for Silver Lake
- Salt marsh along sound side; some interior wetlands on island
- Hard bottom approximately three miles off beach

Protected Species & Wildlife Elements
- Shortnose sturgeon occurrence (February 1-June 15 moratoria)
- Colonial waterbird nesting (April 1-August 31 moratoria in nesting areas)
- Loggerhead sea turtle nest sites (May 1-November 15 moratoria)
- Piping plover nesting (April 1-July 15 moratoria in nesting areas)
- Crab spawning sanctuary at Ocracoke Inlet
- Seabeach amaranth (will require surveys)
- West Indian manatee occurrence (June – October moratoria; observers possibly required)

Other
- Area of Regional and Federal Significance (Cape Hatteras National Seashore)

(3) Hatteras Inlet

CHPP Elements
- Class SA waters
- Open shellfish waters inside inlet
- Extensive SAV inside inlet
- Hard bottom within approximately six miles of inlet
- Artificial reefs offshore
- Soft bottom habitat possibly present with ebb-tidal delta

Protected Species & Wildlife Elements
- Shortnose sturgeon occurrence (February 1-June 15 moratoria)
- Colonial waterbird nesting (April 1-August 31 moratoria in nesting areas)
- Piping plover nesting (April 1-July 15 moratoria in nesting areas)
- Crab spawning sanctuary in Hatteras Inlet

- EFH for 33 species
- Sea turtle habitat (limit takes during dredging)

Shipwrecks
- Potential for 18th and early 19th century shipwrecks
- Low potential for Civil War shipwrecks
- High potential for late 19th and 20th century shipwrecks
- Many locations around this inlet have been subjected to underwater archaeological survey

Other
- Area of Regional and Federal Significance (Cape Hatteras National Seashore)
- High potential for shipwreck sites

(4) Hatteras Island at Hatteras

CHPP Elements
- Class SA waters
- Salt marsh sound side and some interior wetlands
- Extensive SAV in Pamlico Sound
- Closed shellfish waters near Hatteras Village; open elsewhere
- Hard bottom within approximately six miles of beach

Protected Species & Wildlife Elements
- Shortnose sturgeon occurrence (February 1-June 15 moratoria)
- Colonial waterbird nesting (April 1-August 31 moratoria in nesting areas)
- Loggerhead sea turtle nest sites (May 1-November 15 moratoria)
- Piping plover nesting (April 1-July 15 moratoria in nesting areas)
- Seabeach amaranth (will require surveys)

Other
- NCWRC Island (UNI, Hatteras Ferry Channel 1) near Hatteras Ocracoke ferry channel. This is identified as state-owned lands by NCWRC and is considered to be important habitat for colonial wading birds for both nesting and foraging

Figure X-23 presents a sample of the environmental considerations which are present in Region 3b.

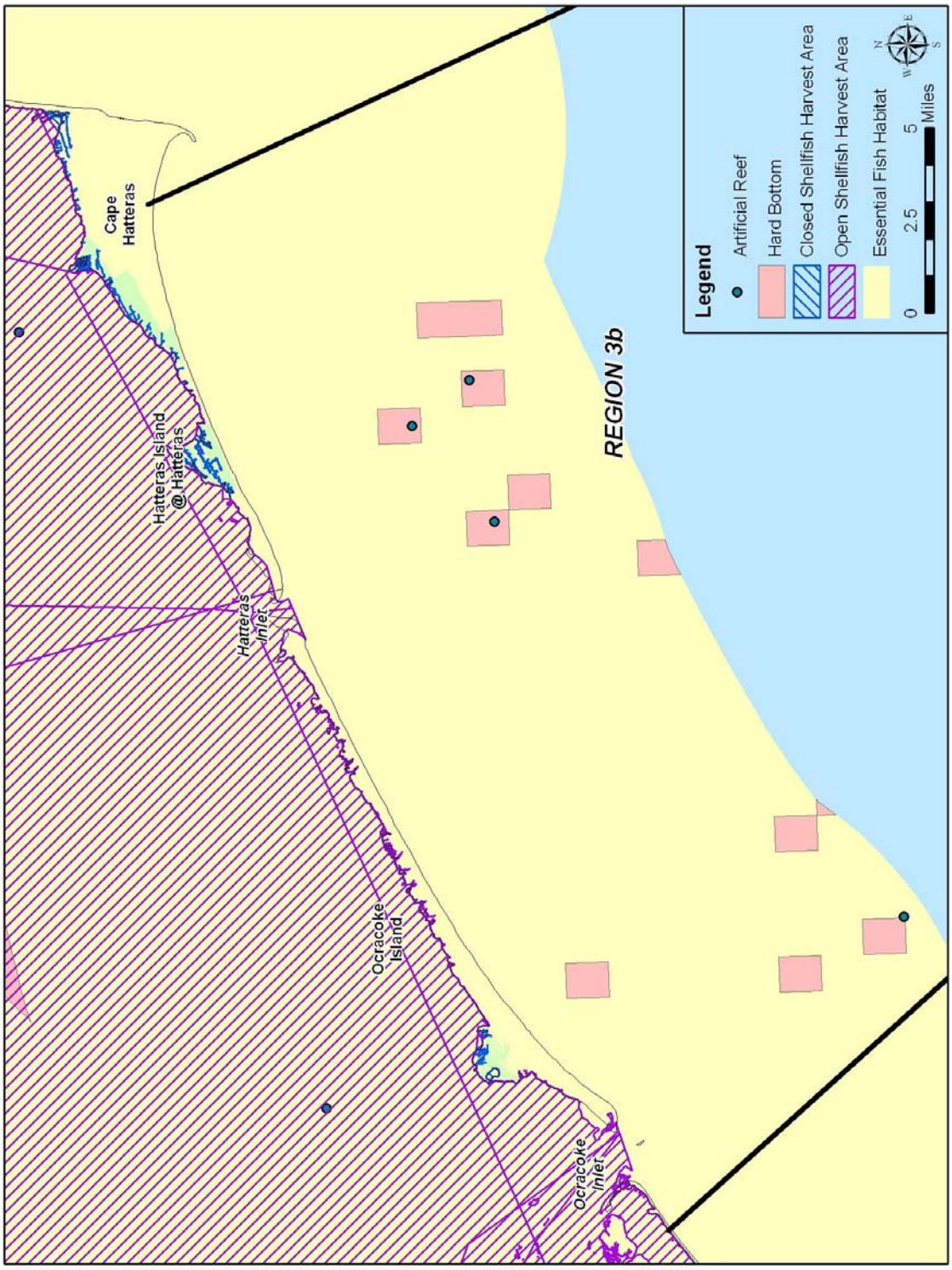

Figure X-23. Sample Environmental Considerations for Region 3b

10. Economic Valuation

a) Property Value at Risk

Tables X-12 and X-13 provide the value of property at risk from sea level rise for Region 3. Estimates were based on Bin *et al.* (2007) with a sea level rise scenario of 18.1 inches by 2080. As outlined in Chapter IV, the CRC Science Panel on Coastal Hazards released a report with a likely range of rise that should be adopted for policy development and planning purposes. The Science Panel found the most likely scenario for 2100 AD is a rise of 0.4 meter to 1.4 meters (15 inches to 55 inches) above present. In comparison to the BIMP scenarios presented in Table IV-1, the Science Panel ranges represent a rise in sea level between 0.29 and 1.02 feet by 2030 and between 1.02 and 3.57 feet by 2080. In addition, the North Carolina Sea Level Rise Risk Management Study being carried out by the N.C. Division of Emergency Management is ongoing with final scenarios expected in mid-2011.

It should be noted that while Region 3a falls within Carteret County, this portion of the county is not developed and therefore, Carteret County property value numbers are reported in the Region 2 section (Section IX). In addition, Region 3b is composed of Hyde County and a portion of Dare County. Hyde County was not included in the Bin *et al.* (2007) study. Since the majority of development in Dare County occurs in the Region 4, property values are presented in that section (Section XI).

Table X-12. Property Value At Risk From Sea Level Rise – Region 3a

Coastal Region	County	Beach	Value of Residential Coastal Property at Risk 2004	Value of Commercial Coastal Property at Risk 2004	Value of Residential Coastal Property at Risk 2008	Value of Commercial Coastal Property at Risk 2008
3a	Carteret	All	N/A	N/A	N/A	N/A

Table X-13. Property Value At Risk From Sea Level Rise – Region 3b

Coastal Region	County	Beach	Value of Residential Coastal Property at Risk 2004	Value of Commercial Coastal Property at Risk 2004	Value of Residential Coastal Property at Risk 2008	Value of Commercial Coastal Property at Risk 2008
3b	Hyde, Dare	All	N/A	N/A	N/A	N/A

b) Beach Recreation

The direct annual expenditures and the associated employment and estimated total economic impact including multiplier effects are presented in Tables X-14 and X-15 along with the consumer surplus value of beach recreation. The data has been aggregated to a beach segment level for the region.

Table X-14. Beach Recreation Values – Region 3a

Coastal Region	County	Beach	Beach Recreation 2005-2006 Total Impact Employment (jobs)	Beach Recreation 2008 Annual Direct Expenditures	Beach Recreation 2008 Annual Total Impact Output/ Sales/ Business Activity	Beach Recreation 2008 Annual Consumer Surplus
3a	Carteret	Core Banks	No Data	No Data	No Data	No Data
3a	Carteret	Portsmouth Island	No Data	No Data	No Data	No Data
REGION 3a TOTALS=			No Data	No Data	No Data	No Data

Table X-15. Beach Recreation Values – Region 3b

Coastal Region	County	Beach	Beach Recreation 2005-2006 Total Impact Employment (jobs)	Beach Recreation 2008 Annual Direct Expenditures	Beach Recreation 2008 Annual Total Impact Output/ Sales/ Business Activity	Beach Recreation 2008 Annual Consumer Surplus
3b	Hyde	Ocracoke Island	523	$22,888,436	$40,560,129	$951,759
3b	Dare	Hatteras Island @ Hatteras	348	$15,154,050	$26,850,386	$551,270
3b	Dare	Cape Hatteras	904	$39,387,231	$69,787,439	$1,432,334
REGION 3b TOTALS=			1,775	$77,429,717	$137,197,954	$2,935,363

c) Shore and Pier Fishing

In addition to beach recreation value, people attach value to fishing from the shore and from pier structures. This value defined here as consumer surplus is presented in Tables X-16 and X-17 for the Region 3 beaches.

Table X-16. Shore and Pier Fishing – Region 3a

Coastal Region	County	Beach	Annual Pier/Bridge/Jetty Fishing Consumer Surplus (2008)	Annual Shore/Bank Fishing Consumer Surplus (2008)
3a	Carteret	Core Banks	No Data	No Data
3a	Carteret	Portsmouth Island	No Data	No Data
REGION 3a TOTALS=			No Data	No Data

Table X-17. Shore and Pier Fishing – Region 3b

Coastal Region	County	Beach	Annual Pier/Bridge/Jetty Fishing Consumer Surplus (2008)	Annual Shore/Bank Fishing Consumer Surplus (2008)
3b	Hyde	Ocracoke Island	$0	$121,931
3b/4a	Dare	Cape Hatteras (Hatteras & Buxton)	$2,226,848	$7,424,967
REGION 3b TOTALS=			$2,226,848	$7,546,898

Note that Table X-17 contains a portion of Region 4a at the town of Buxton since Hatteras Village and Buxton were grouped into one category at Cape Hatteras for this analysis.

d) Marine Recreation Services

Marine recreational services are businesses that can be dependent on water access but are not direct beach recreation or fishing related. Some examples include ecotourism, canoe, kayak, and surf board rentals. Tables X-18 and X-19 provide the economic values associated with marine recreation services on a per county basis.

Table X-18. Marine Recreation Services – Region 3a

Coastal Region	County	Number Businesses (2007)	Annual Direct Sales (2007)	Direct Employment (jobs) (2007)	Annual Total Impact Output/ Sales/ Business Activity (2007)	Total Impact Employment (jobs) (2007)	Annual Direct Sales (2008)	Annual Total Impact Output/ Sales/ Business Activity (2008)
2c,3a	Carteret	37	$2,510,174	419	$5,272,502	438	$2,564,623	$5,386,871

Table X-19. Marine Recreation Services – Region 3b

Coastal Region	County	Number Businesses (2007)	Annual Direct Sales (2007)	Direct Employment (jobs) (2007)	Annual Total Impact Output/ Sales/ Business Activity (2007)	Total Impact Employment (jobs) (2007)	Annual Direct Sales (2008)	Annual Total Impact Output/ Sales/ Business Activity (2008)
3b	Hyde	Included in Dare Co. totals.						

Note that Table X-18 contains Region 2c and Region 3a since the analysis was done on a per county basis and Carteret County is split between both regions. In addition, the Hyde County values which would be applicable to Region 3b were included with the Dare County totals and can be seen in Section XI with the Region 4 data.

e) Commercial Fishing

The employment value of fish landings and associated seafood processing industry economic values are presented in Tables X-20 and X-21.

Table X-20. Commercial Fishing – Region 3a

Coastal Region	Waterway/Inlet	County	Estimated Direct Seafood Processing and Packing Output/Sales/Yr Supported by NC Seafood Landings 2007	Estimated Seafood Processing and Packing Jobs Supported by NC Seafood Landings 2007	Commercial Fishery Landings Direct Output/Sales (Dockside Value)/Yr 2007	Number of Commercial Fishing Jobs Supported 2007	Total Impacts on Business Activity/Sales 2008 (incl mult effects)	Total Jobs Supported 2008 (incl mult effects)
3a	AIWW	Carteret	N/A	N/A	N/A		N/A	
3a	Drum Inlet	Carteret	N/A	N/A	N/A		N/A	
2c	AIWW	Carteret	N/A	N/A	N/A		N/A	
2c	Barden Inlet	Carteret	$9,039,462	44	$2,621,444	885	$15,215,792.04	1364
2c	Bear Inlet	Onslow	N/A	N/A	N/A		N/A	
2c	Beaufort Inlet	Carteret	$28,317,441	139	$8,212,058		$47,665,701.33	
2c	Bogue Inlet	Carteret/Onslow	$8,692,366	43	$2,520,786		$14,631,537.26	
REGION 2c,3a TOTALS=			$46,049,269	226	$13,354,288	885	$77,513,031	1,364

Table X-21. Commercial Fishing – Region 3b

Coastal Region	Waterway/Inlet	County	Estimated Direct Seafood Processing and Packing Output/Sales/Yr Supported by NC Seafood Landings 2007	Estimated Seafood Processing and Packing Jobs Supported by NC Seafood Landings 2007	Commercial Fishery Landings Direct Output/Sales (Dockside Value)/Yr 2007	Number of Commercial Fishing Jobs Supported 2007	Total Impacts on Business Activity/Sales 2008 (incl mult effects)	Total Jobs Supported 2008 (incl mult effects)
3b	AIWW	Hyde (Ocracoke)	N/A	N/A	N/A	329	N/A	489
3b	Ocracoke Inlet	Hyde (Ocracoke)	$15,405,839	75	$4,467,693		$25,932,078.42	
REGION 3b TOTALS=			$15,405,839	75	$4,467,693	329	$25,932,078	489

As a note, Table X-20 contains Region 2c and Region 3a since the analysis was done on a per county basis and Carteret County is split in to both regions. In addition, Hatteras Inlet data (Region 3b) was included with the Dare County data for Region 4 and can be viewed in Section XI.

f) For Hire Fisheries

For hire fisheries include charter boats and head boats where people pay a fee to go fishing. Tables X-22 and X-23 outline the various spending, employment and economic impact of this industry segment.

Table X-22. For Hire Fisheries – Region 3a

Coastal Region	Waterway/Inlet	County	2008 For-Hire Fishery Passenger Direct Spending On Fishing Fees	2008 For-Hire Fishery Passenger Direct Spending On Other	2008 For-Hire Fishery Direct Captain & Crew Jobs Supported	2008 For-Hire Fishery Total Impact (incl mult effects) Business Activity	2008 For-Hire Fishery Total Impact (incl mult effects) Jobs Supported	2008 For-Hire Fishery Passenger Consumer Surplus
3a	AIWW	Carteret						
3a	Drum Inlet	Carteret						
2c	AIWW	Carteret	$12,798,461	$28,288,577	379	$83,694,419	1358	$38,211,223
2c	Barden Inlet	Carteret						
2c	Beaufort Inlet	Carteret						
2c	Bogue Inlet	Carteret/Onslow	$1,753,263	$3,875,256	57	$11,465,311	194	$5,501,941
2c	Bear Inlet	Onslow	N/A	N/A	N/A	N/A	N/A	N/A
REGION 2c,3a TOTALS=			$14,551,724	$32,163,833	436	$95,159,729	1,552	$43,713,164

Table X-23. For Hire Fisheries – Region 3b

Coastal Region	Waterway/Inlet	County	2008 For-Hire Fishery Passenger Direct Spending On Fishing Fees	2008 For-Hire Fishery Passenger Direct Spending On Other	2008 For-Hire Fishery Direct Captain & Crew Jobs Supported	2008 For-Hire Fishery Total Impact (incl mult effects) Business Activity	2008 For-Hire Fishery Total Impact (incl mult effects) Jobs Supported	2008 For-Hire Fishery Passenger Consumer Surplus
3b	Hatteras Inlet	Dare (Hatteras)	$11,322,394	$26,922,552	167	$77,341,738	963	$35,411,409
3b	AIWW	Hyde (Ocracoke)						
3b	Ocracoke Inlet	Hyde (Ocracoke)	$1,747,323	$4,154,811	36	$11,935,729	166	$11,720,722
REGION 3b TOTALS=			$13,069,717	$31,077,363	204	$89,277,467	1,129	$47,132,131

Note that Table X-22 contains Region 2c and Region 3a since the analysis was done on a per county basis and Carteret County is split in to both regions.

g) Private Boating

The direct expenditures of private recreational boaters as well as the multiplier effects and associated jobs are presented in Tables X-24 and X-25 together with the consumer surplus value.

Table X-24. Private Boating – Region 3a

Coastal Region	Waterway/Inlet	County	2008 Direct Private Boater Spending per Yr	2008 Total Impact Business Activity/Sales per Yr	2008 Total Impact Jobs	2008 Consumer Surplus
3a	AIWW	Carteret	$40,904,547	$77,457,546	1433	$12,347,143
3a	Drum Inlet	Carteret				
2c	AIWW	Carteret				
2c	Barden Inlet	Carteret				
2c	Bear Inlet	Onslow				
2c	Beaufort Inlet	Carteret				
2c	Bogue Inlet	Carteret/Onslow	$1,532,032	$2,901,082	54	$462,448
REGION 2c,3a TOTALS=			$42,436,579	$80,358,628	1,487	$12,809,591

Table X-25. Private Boating – Region 3b

Coastal Region	Waterway/Inlet	County	2008 Direct Private Boater Spending per Yr	2008 Total Impact Business Activity/Sales per Yr	2008 Total Impact Jobs	2008 Consumer Surplus
3b	Hatteras Inlet	Dare (Hatteras)	No Data	No Data	No Data	No Data
3b	AIWW	Hyde (Ocracoke)	No Data	No Data	No Data	No Data
3b	Ocracoke Inlet	Hyde (Ocracoke)	No Data	No Data	No Data	No Data
REGION 3b TOTALS=			No Data	No Data	No Data	No Data

Note that Table X-24 contains Region 2c and Region 3a since the analysis was done on a per county basis and Carteret County is split between both regions.

h) Boat Building

The boat building industry employs people at various locations along the state's waterways. Boat builders rely on the maintenance of the waterways to create interest in the boating industry and subsequent sales of boats. Tables X-26 and X-27 present the direct sales and economic impact of the boat building industry.

Table X-26. Boat Building – Region 3a

Coastal Region	Waterway/Inlet	County	2008 Number of Firms	2008 Direct Sales	2008 Direct Employment	2008 Total Impact Output	2008 Total Impact Employment
3a	AIWW	Carteret	No Data	No Data	No Data	No Data	No Data
3a	Drum Inlet	Carteret	No Data	No Data	No Data	No Data	No Data
REGION 3a TOTALS=			No Data	No Data	No Data	No Data	No Data

Table X-27. Boat Building – Region 3b

Coastal Region	Waterway/Inlet	County	2008 Number of Firms	2008 Direct Sales	2008 Direct Employment	2008 Total Impact Output	2008 Total Impact Employment
3b	Hatteras Inlet	Dare (Hatteras)	No Data	No Data	No Data	No Data	No Data
3b	AIWW	Hyde	7	$100,824,786	449	$127,438,549	753
3b	Ocracoke Inlet	Hyde (Ocracoke)	No Data	No Data	No Data	No Data	No Data
REGION 3b TOTALS=			7	$100,824,786	449	$127,438,549	753

i) Marinas

Coastal marinas support both private boating and for hire fishing charters. The data presented for marinas has some overlap with the private boating and for hire fishing data. Tables X-28 and X-29 provide the economic marina data for Region 3.

Table X-28. Marina Sales and Employment – Region 3a

Coastal Region	Waterway/Inlet	County	2008 Number of Marinas	2008 Estimated Direct Marina Sales/Year	2008 Estimated Direct Marina Employment
3a	AIWW	Carteret	No Data	No Data	No Data
3a	Drum Inlet	Carteret	No Data	No Data	No Data
REGION 3a TOTALS=			No Data	No Data	No Data

Table X-29. Marina Sales and Employment – Region 3b

Coastal Region	Waterway/Inlet	County	2008 Number of Marinas	2008 Estimated Direct Marina Sales/Year	2008 Estimated Direct Marina Employment
3b	Hatteras Inlet	Dare (Hatteras)	No Data	No Data	No Data
3b	AIWW	Hyde	36	$10,734,290	268
3b	Ocracoke Inlet	Hyde	Included above.	Included above.	Included above.
REGION 3b TOTALS=			36	$10,734,290	268

B. Potential Beach and Inlet Management Strategies

Development of draft management strategies for coastal North Carolina must take into account a variety of measures including current management practices, associated costs, environmental considerations, economic valuation of beaches and inlets, and potential funding options. This section will discuss the current and potential strategies applicable to Region 3.

1. Historical Strategies

Historical strategies in North Carolina have included beach nourishment, coastal zone management practices (*i.e.*, setbacks, retreat), storm recovery (*i.e.*, dune reconstruction, planting, beach bulldozing, breach fill), dredging, sand bypassing, inlet relocation, and hard structures. Current methods applicable to Region 3 are presented in the following sections. Costs associated with each of the strategies have been updated to reflect 2008 values.

a) Beach Nourishment

A beach nourishment database has been compiled from several sources to provide a comprehensive summary of the state's nourishment activities. Sources include the U.S. Army Corps of Engineers, Western Carolina's Center for Developed Shorelines, Carteret County Shore Protection Office, Spencer Rogers of North Carolina Sea Grant, and Tom Jarrett with Coastal Planning & Engineering, Inc. The database extends over a time period from 1939 through 2007. There have been no nourishment projects performed in Region 3a along Core Banks or Portsmouth Island. A summary of the beach nourishment data for Region 3b is presented in Table X-30. The relative size of the projects listed in Table X-30 can be found in Figure X-24. As can be seen from the figure and table, there have been very few projects performed in this region and all have been relatively small in size. Beach nourishment project locations for Region 3 can be seen in Figures X-27 and X-28. The complete beach nourishment database is in Appendix D following the report.

Table X-30. Summary of Beach Nourishment Data – Region 3b

Location	First Year of Record	Number of Times Nourished	Total Amount Nourished (cy)	Average Unit Cost ($ / cy)	Cost per Project ($ / proj)
HATTERAS ISLAND	1974	6	445,201	7.58	562,118
OCRACOKE ISLAND	1986	5	516,062	7.92	817,428
TOTAL REGION	**N/A**	**11**	**961,263**	**N/A**	**N/A**

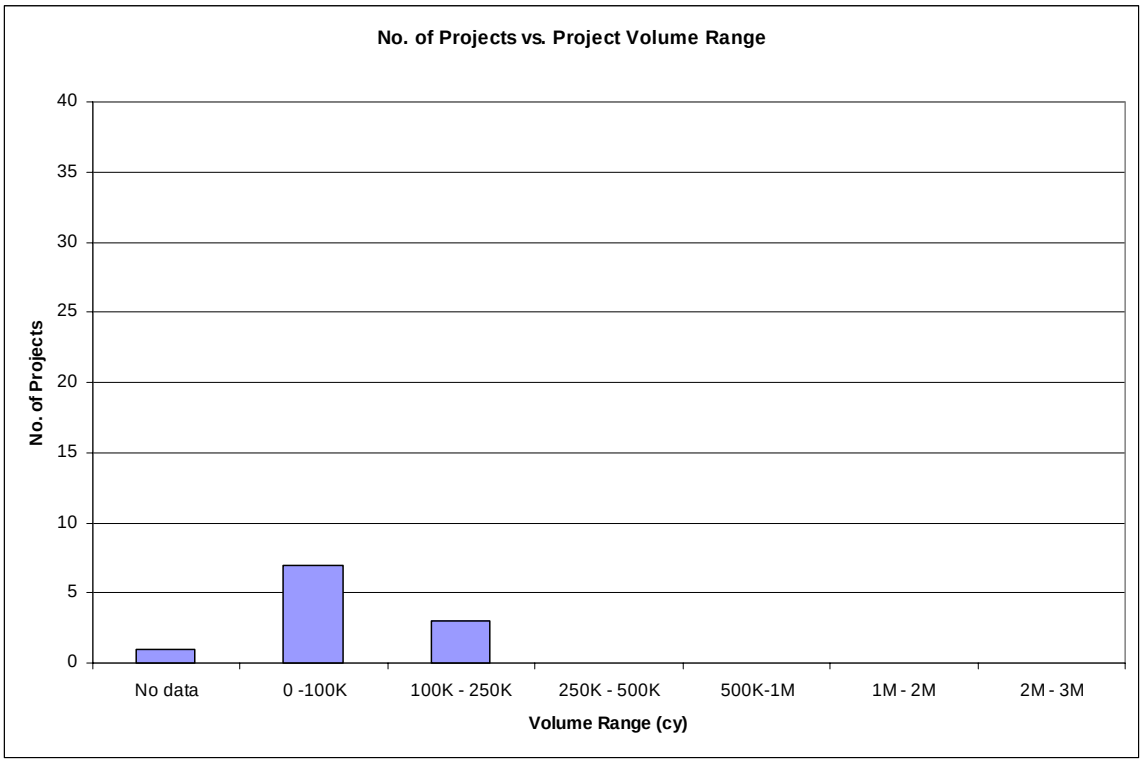

Figure X-24. Number of Nourishment Projects – Region 3b by Project Size

Nourishment material comes from nearby inlets and channels. Table X-31 shows the known historical borrow sources for each of the beaches in the Region 3b.

Table X-31. Historical Borrow Sources – Region 3b Beaches

Beach	Historical Borrow Sources
Ocracoke Island	Ocracoke Inlet
Hatteras Island	Hatteras Inlet

b) Coastal Zone Management

As mentioned previously, DCM has estimated long-term shoreline change rates based on the distance from the earliest digitized shoreline archived by the state (typically the 1940s) to the 1998 shoreline. Using these shoreline change rates, the CRC has established oceanfront setback factors that determine the minimum allowable distance between a structure and the first line of stable and natural vegetation during development. Currently, the minimum setback is 30 times the long-term average annual erosion rate (minimum of 60 feet) for all structures less than 5,000 square feet. Above 5,000 square feet, and every 5,000 square feet thereafter, the setback factor increases from 60 to 90 in increments of five. The maximum setback factor becomes 90 times the erosion rate for structures greater than or equal to 100,000 square feet. Setback factors for the entire coast can be seen on the DCM website (http://dcm2.enr.state.nc.us/Maps/SB_Factor.htm).

In Region 3a, the average annual erosion rate along Core Banks varies from 2.0 feet per year to 5.0 feet year along most of the coast, with the exception of the northern end near Drum Inlet where the rate increases to 30 feet per year. On the other side of Drum Inlet, the average annual erosion rate decreases quickly from 13.5 feet per year to 2.0 feet per year, and then varies between 2.0 feet per year and 5.0 feet per year until the northern portion of the island near Ocracoke Inlet, where the rate increases to 12.0 feet per year.

In Region 3b, the average annual erosion rate on Ocracoke Island is 2.0 feet per year for the majority of the shoreline, with the exception of the northern end near Hatteras Inlet where the rate increases to 9.0 feet per year. On Hatteras Island near Hatteras Inlet the rate is 13.5 feet per year and quickly decreases to 2.0 feet per year as distance from the inlet increases. The rate along the southern facing shores of Cape Hatteras remains at 2.0 feet per year.

c) Dredging

A dredging database has been compiled from 1975 to 2007 for projects performed or contracted by the USACE. Projects occurring prior to these dates were obtained from the North Carolina Historic Dredging Data book from the Wilmington District of the USACE. In a previous study by Moffatt & Nichol on shallow draft navigation (November 2005), a database was created of all shallow draft projects from 1975 through 2004. Deep draft projects and projects from 2005 to 2007 were added to this database. Dredge project locations for both subregions depicted in Figures X-27 and X-28**.** Figures X-25 and X-26 show the relative size of projects as well. The complete dredging database is available in Appendix E.

A summary of the dredge data from the database applicable to Region 3a is presented in Tables X-32 to X-34 for the whole dataset, the past 10 years, and the past five years.

Table X-32. Summary of Dredge Volume Data – Region 3a (1975-2007)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Volume
	(cy)	(cy)	(cy)	(cy)	(cy / YR)
DRUM INLET	460,882	0	96,991	50,610	37,804
OVERALL TOTAL (Potential Nourishment)	**460,882**	**0**	**96,991**	**50,610**	**37,804**

Table X-33. Summary of Dredge Volume Data – Region 3a (1997-2007)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Volume
	(cy)	(cy)	(cy)	(cy)	(cy / YR)
DRUM INLET	460,882	0	96,991	50,610	75,608
OVERALL TOTAL (Potential Nourishment)	**460,882**	**0**	**96,991**	**50,610**	**75,608**

Table X-34. Summary of Dredge Volume Data – Region 3a (2002-2007)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Volume
	(cy)	(cy)	(cy)	(cy)	(cy / YR)
DRUM INLET	0	0	0	0	0
OVERALL TOTAL (Potential Nourishment)	**0**	**0**	**0**	**0**	**0**

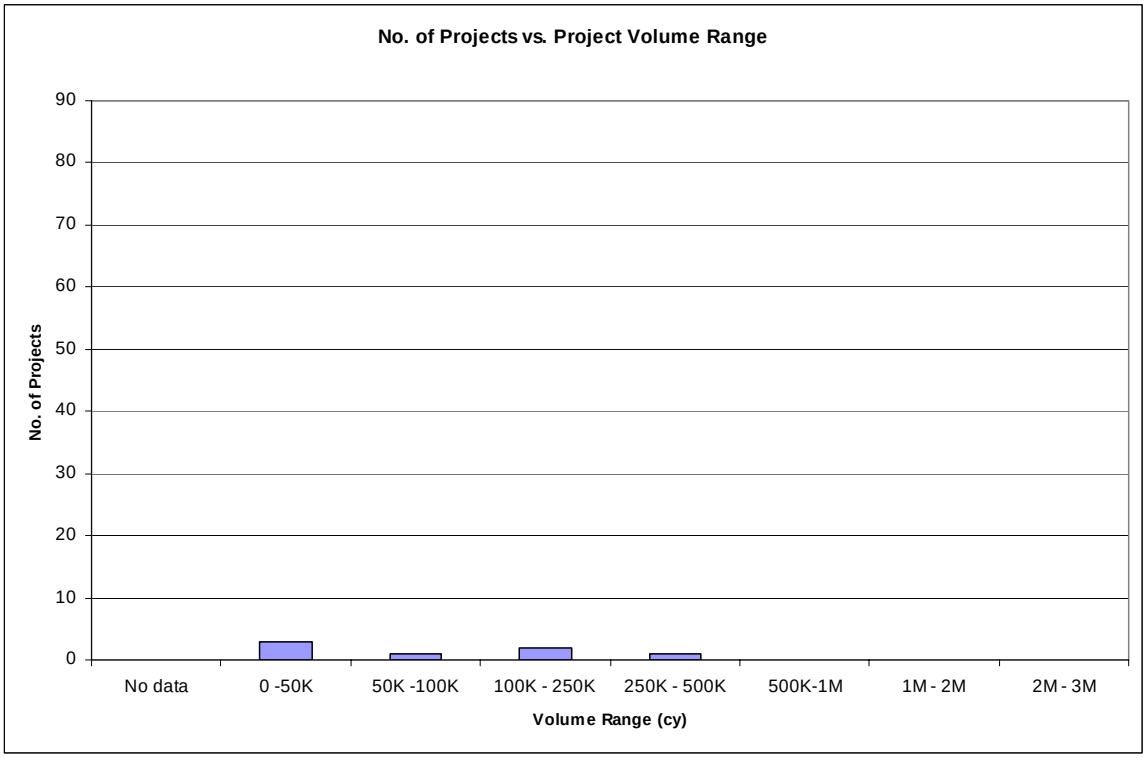

Figure X-25. Number of Dredge Projects – Region 3a by Project Size

A summary of the dredge data from the database applicable to Region 3b is presented in Tables X-35 to X-37 for the whole dataset, the past 10 years, and the past five years of data.

Table X-35. Summary of Dredge Volume Data – Region 3b (1975-2007)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Volume
	(cy)	(cy)	(cy)	(cy)	(cy / YR)
OCRACOKE INLET	0	0	548,786	10,800	18,653
HATTERAS INLET	0	0	1,376,398	26,630	140,303
OVERALL TOTAL (Potential Nourishment)	**0**	**0**	**1,925,184**	**37,430**	**158,956**
FAR CREEK	723,605	0	0	0	144,721
ROLLINSON CHANNEL	601,631	0	62,350	0	33,199
SILVER LAKE HARBOR	2,457,753	0	386,656	0	94,814
OVERALL TOTAL	**3,782,989**	**0**	**2,374,190**	**37,430**	**431,689**

Table X-36. Summary of Dredge Volume Data – Region 3b (1997-2007)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Volume
	(cy)	(cy)	(cy)	(cy)	(cy / YR)
OCRACOKE INLET	0	0	266,971	10,800	27,777
HATTERAS INLET	0	0	291,720	5,030	29,675
OVERALL TOTAL (Potential Nourishment)	**0**	**0**	**558,691**	**15,830**	**57,452**
FAR CREEK	0	0	0	0	0
ROLLINSON CHANNEL	371,900	0	62,350	0	43,425
SILVER LAKE HARBOR	460,860	0	213,115	0	67,398
OVERALL TOTAL	**832,760**	**0**	**834,156**	**15,830**	**168,275**

Table X-37. Summary of Dredge Volume Data – Region 3b (2002-2007)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Volume
	(cy)	(cy)	(cy)	(cy)	(cy / YR)
OCRACOKE INLET	0	0	211,141	0	42,228
HATTERAS INLET	0	0	83,730	0	16,746
OVERALL TOTAL (Potential Nourishment)	**0**	**0**	**294,871**	**0**	**58,974**
FAR CREEK	0	0	0	0	0
ROLLINSON CHANNEL	0	0	62,350	0	12,470
SILVER LAKE HARBOR	0	0	213,115	0	42,623
OVERALL TOTAL	**0**	**0**	**570,336**	**0**	**114,067**

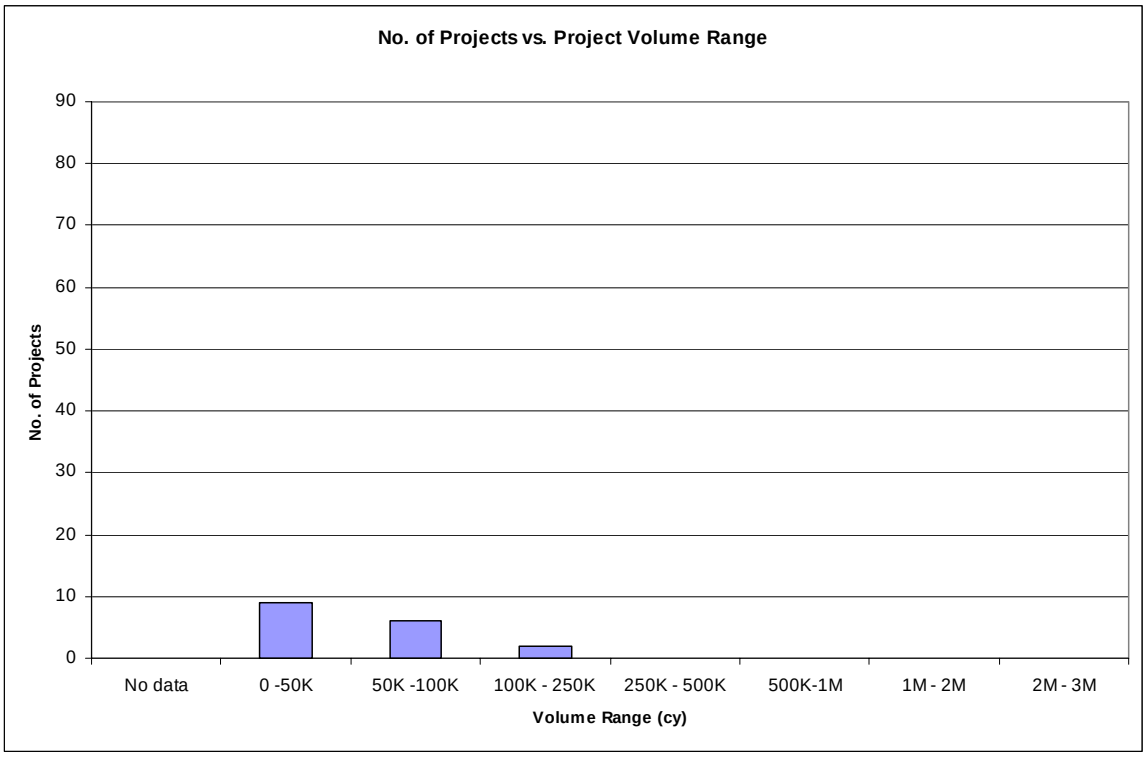

Figure X-26. Number of Dredge Projects – Region 3b by Project Size

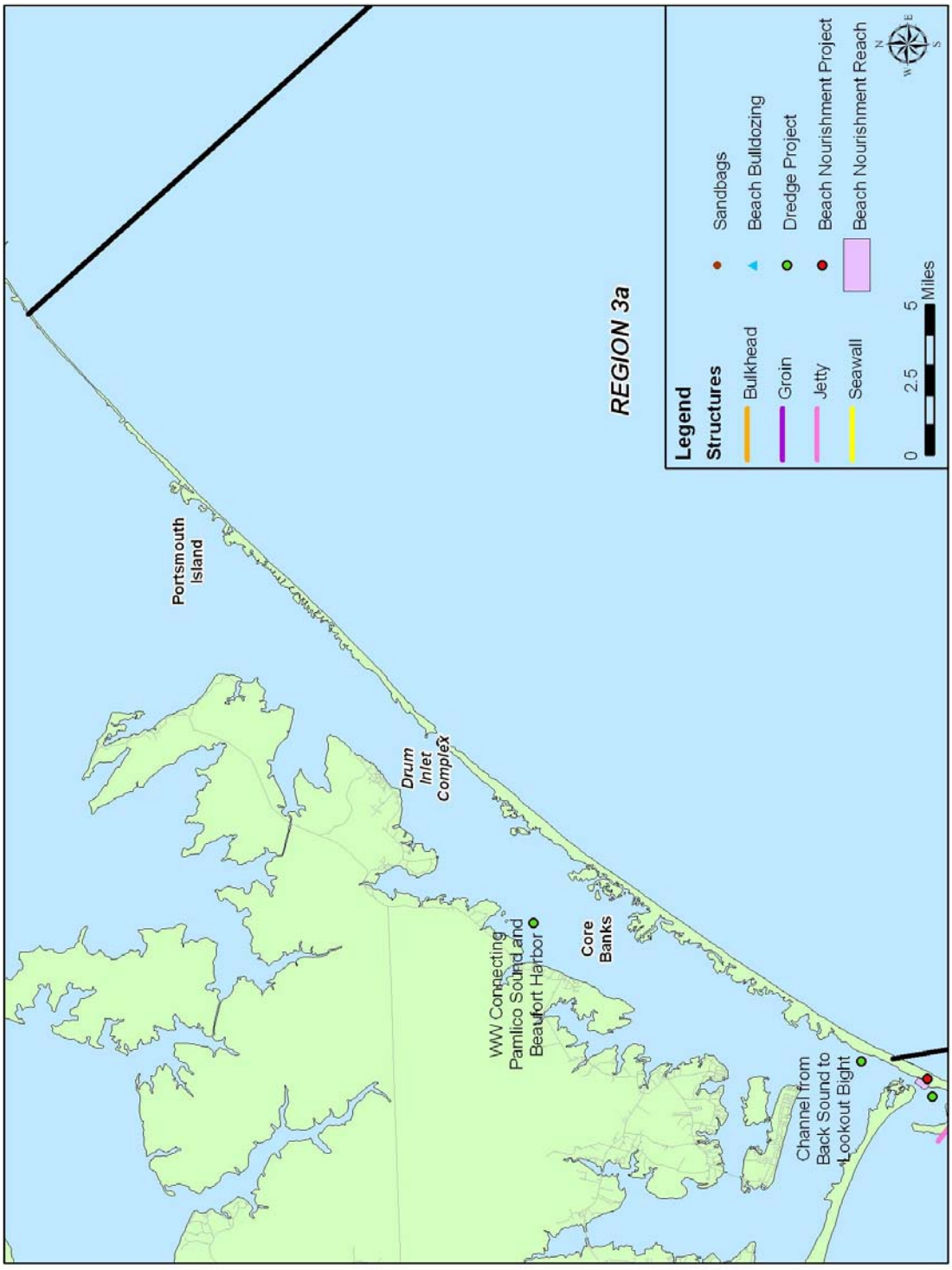

Figure X-27. Historical Management Strategies for Region 3a

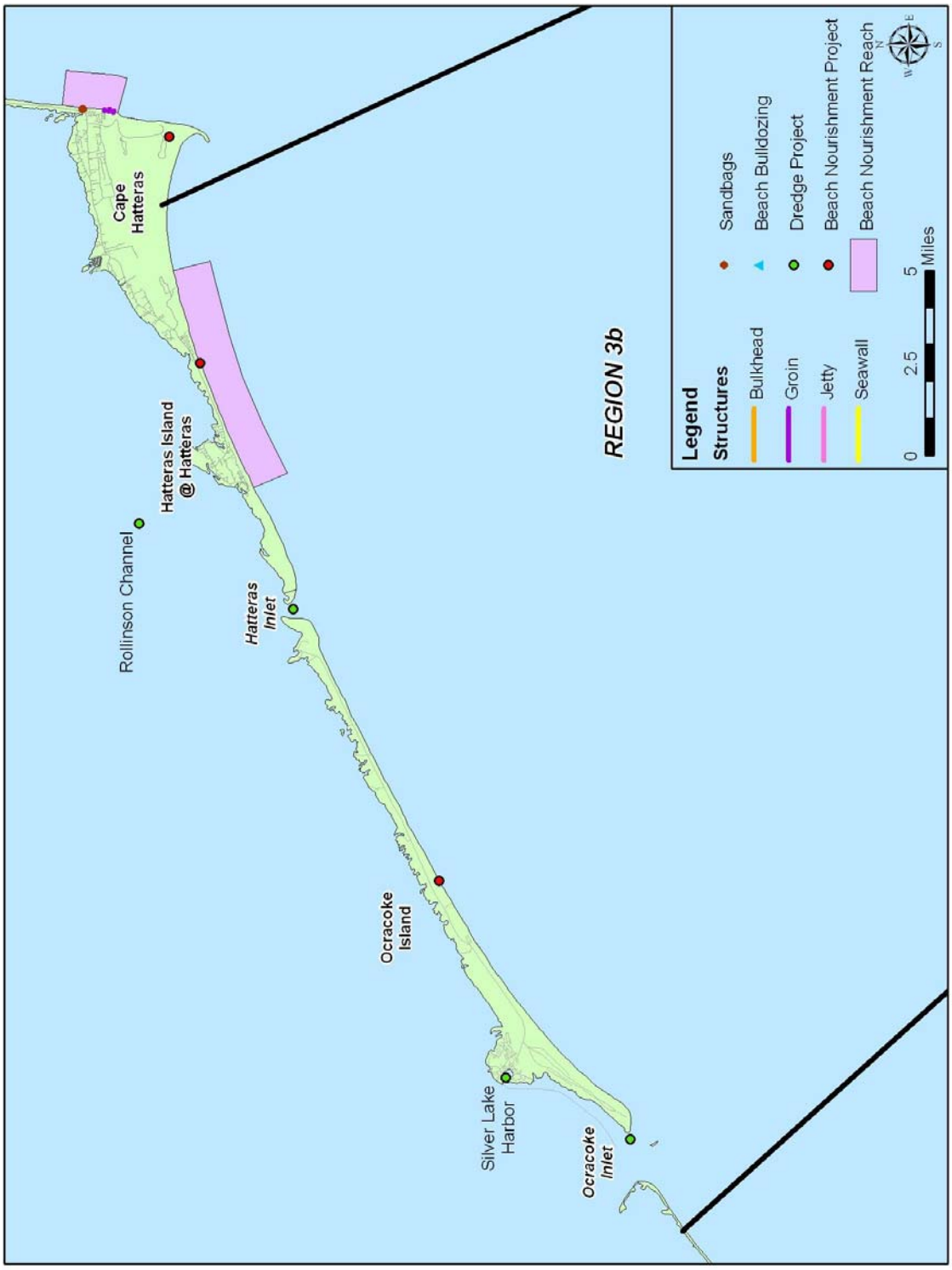

Figure X-28. Historical Management Practices for Region 3b

2. Potential Management Strategies

Current North Carolina policy relies on beach nourishment and dredging due to the prohibition on permanent erosion control structures. Continuation of these methods is expected with improvements in efficiency through the establishment of plans for location, frequency, quantity, and cost of nourishment projects on a cyclic basis. The adoption of a regional approach would also serve to ensure that all beach compatible sand from dredging projects is placed on the beach or back into the nearshore system. For example, coordinating dredging to maintain an inlet with beach nourishment or habitat creation would be an effective and efficient use of resources.

To begin this regionalized approach, sand sources within each region have been identified and tentatively assigned to various stretches of beach based on distance to the source. As discussed in Section VI (strategy development), using sediment from offshore borrow areas or inlets is only cost effective up to a certain distance from the beach. Figures X-29 and X-30 show the locations and distances of the most likely sediment borrow areas for the various subregions of Region 3. Section VI also contains a general discussion on the development of potential strategies and costs for the entire state.

Tables X-38 and X-39 show the nearest inlet and offshore sources of sediment for the beaches in Region 3a, as well as the most likely and reasonable source to be used for each beach based on distances and sediment quality.

Table X-38. Nearest Sediment Sources – Region 3a Beaches

Location	Nearest Inlet Source		Nearest Offshore Source	
	Name	Distance (mi)	Name	Distance (mi)
Core Banks	N/A	N/A	No Name (USGS)	16.5
Portsmouth Island	N/A	N/A	No Name (USGS)	9.5

Table X-39. Most Likely Sediment Sources – Region 3a Beaches

Location	Most Likely Source		Likely Dredge Type	Annual Need (CY)	Developed
	Name	Distance (mi)			
Core Banks	USGS Source	16.5	Hopper	647,292	N
Portsmouth Island	USGS Source	9.5	Hopper	656,995	N

Tables X-40 and X-41 show the nearest inlet and offshore borrow sources of sediment for the beaches in Region 3b, as well as the most likely and reasonable source to be used for each beach based on distances and sediment quality.

Table X-40. Nearest Sediment Sources – Region 3b Beaches

Location	Nearest Inlet Source		Nearest Offshore Source	
	Name	Distance (mi)	Name	Distance (mi)
Ocracoke	Ocracoke Inlet/Hatteras Inlet	8.0	No Name (NCGS)	1.5
Hatteras Island @ Hatteras	Hatteras Inlet	3.1	No Name (NCGS)	2.7
Cape Hatteras	Hatteras Inlet	10.1	No Name (NCGS)	4.4

Table X-41. Most Likely Sediment Sources – Region 3b Beaches

Location	Most Likely Source		Likely Dredge Type	Annual Need (CY)	Developed
	Name	Distance (mi)			
Ocracoke	Ocracoke/Hatteras Inlets/No Name (NCGS)	8.0/1.5	Pipeline/Hopper	452,252	Y
Hatteras Island @ Hatteras	Hatteras Inlet/No Name (NCGS)	3.1/2.7	Pipeline/Hopper	135,583	Y
Cape Hatteras	Hatteras Inlet/No Name (NCGS)	10.1/4.4	Pipeline/Hopper	178,033	N

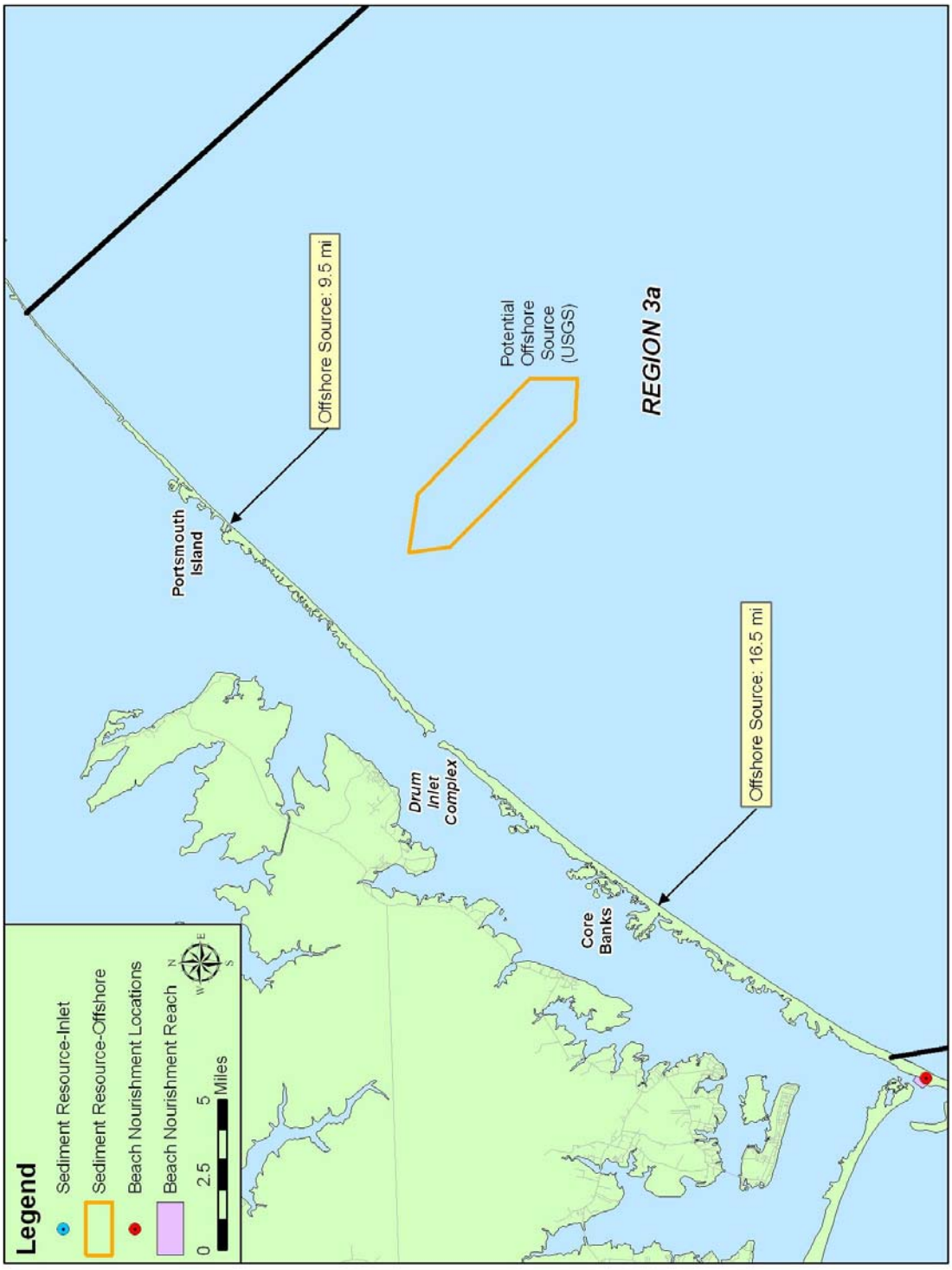

Figure X-29. Potential Sediment Resources for Region 3a

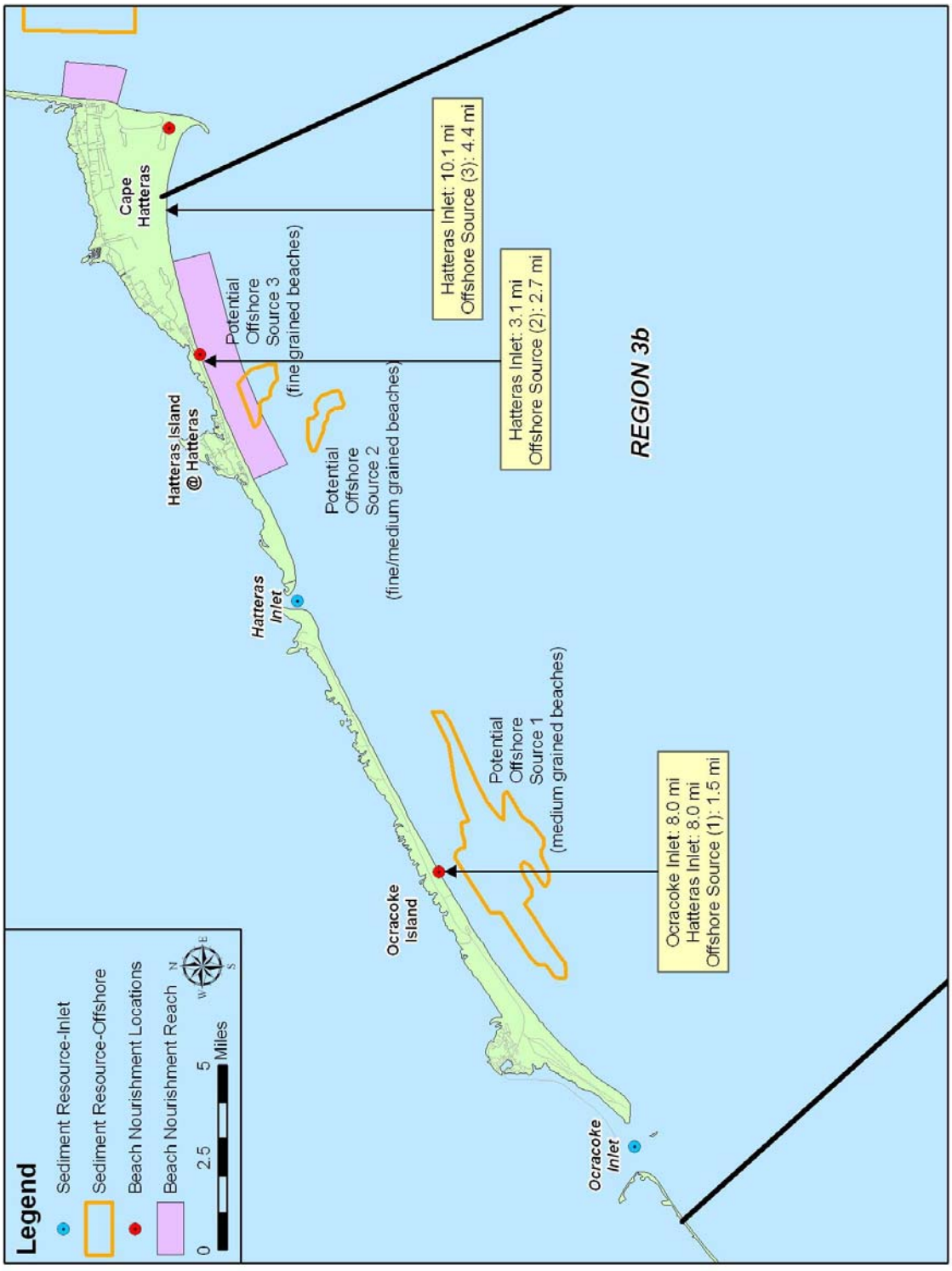

Figure X-30. Potential Sediment Resources for Region 3b

C. Costs and Effectiveness of Strategies

1. Historical Costs

The beach nourishment and dredge databases were used to analyze historical costs for projects. Not all projects in the two databases contained cost information; therefore analysis was done in each case for the whole dataset, the past 10 years, and the past 5 years. Attention was paid to projects which were particularly costly or inexpensive so as not to bias the average costs that were calculated in the end. Costs associated with each of the strategies have been updated to reflect 2008 values.

a) Beach Nourishment

Tables X-42 to X-44 show the costs over various time periods for beach nourishment projects which have taken place in Region 3b (Region 3a has had no nourishment projects). Although none of the nourishment projects for this region fall within recent years, Region 3b as a whole has averaged approximately $510,000 per year in beach nourishment activities when the whole dataset was taken into account.

Table X-42. Beach Nourishment Costs – Region 3b (Whole Dataset)

Location	First Year of Record	Number of Times Nourished	Average Unit Cost ($ / cy)	Avg Volume (cy/YR)	Avg Cost ($/YR)
HATTERAS ISLAND	1974	6	7.58	13,491	102,203
OCRACOKE ISLAND	1986	5	7.92	51,606	408,714
TOTAL REGION	**N/A**	**11**	**N/A**	**65,097**	**510,918**

Table X-43. Beach Nourishment Costs – Region 3b (1997-2007)

Location	Number of Times Nourished	Average Unit Cost ($ / cy)	Avg Volume (cy/YR)	Avg Cost ($/YR)
HATTERAS ISLAND	0	0	0	0
OCRACOKE ISLAND	0	0	0	0
TOTAL REGION	**0**	**N/A**	**0**	**0**

Table X-44. Beach Nourishment Costs – Region 3b (2002-2007)

Location	Number of Times Nourished	Average Unit Cost ($ / cy)	Avg Volume (cy/YR)	Avg Cost ($/YR)
HATTERAS ISLAND	0	0	0	0
OCRACOKE ISLAND	0	0	0	0
TOTAL REGION	**0**	**N/A**	**0**	**0**

b) Dredging

Tables X-45 to X-47 show the costs over various time periods for dredging projects which have taken place in Region 3a. Region 3a as a whole has averaged approximately $405,000 per year for dredging activities over the last 10 years of data. No dredging has taken place over the last five years.

Table X-45. Dredging Costs – Region 3a (Whole Dataset)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Cost
	($)	($)	($)	($)	($ / YR)
DRUM INLET	3,260,246	0	290,973	506,100	220,866
OVERALL TOTAL (Potential Nourishment)	**3,260,246**	**0**	**290,973**	**506,100**	**220,866**

Table X-46. Dredging Costs – Region 3a (1997-2007)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Cost
	($)	($)	($)	($)	($ / YR)
DRUM INLET	3,260,246	0	290,973	506,100	405,732
OVERALL TOTAL (Potential Nourishment)	**3,260,246**	**0**	**290,973**	**506,100**	**405,732**

Table X-47. Dredging Costs – Region 3a (2002-2007)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Cost
	($)	($)	($)	($)	($ / YR)
DRUM INLET	0	0	0	0	0
OVERALL TOTAL (Potential Nourishment)	**0**	**0**	**0**	**0**	**0**

Tables X-48 to X-50 show the costs over various time periods for dredging projects which have taken place in Region 3b. Region 3b as a whole has averaged approximately $2 million per year for dredging activities when the whole dataset was taken into account. However, recent trends in spending have been drastically lower.

Table X-48. Dredging Costs – Region 3b (Whole Dataset)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Cost
	($)	($)	($)	($)	($ / YR)
OCRACOKE INLET	0	0	1,996,494	29,484	67,533
HATTERAS INLET	0	0	4,722,911	72,700	479,561
OVERALL TOTAL (Potential Nourishment)	**0**	**0**	**6,719,405**	**102,184**	**547,094**
FAR CREEK	2,845,087	0	0	0	569,017
ROLLINSON CHANNEL	4,486,100	0	1,450,083	0	296,809
SILVER LAKE HARBOR	15,356,035	0	1,307,165	0	555,440
OVERALL TOTAL	**22,687,222**	**0**	**9,476,653**	**102,184**	**1,968,360**

Table X-49. Dredging Costs – Region 3b (1997-2007)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Cost
	($)	($)	($)	($)	($ / YR)
OCRACOKE INLET	0	0	971,245	29,484	100,073
HATTERAS INLET	0	0	692,069	13,732	70,580
OVERALL TOTAL (Potential Nourishment)	**0**	**0**	**1,663,314**	**43,216**	**170,653**
FAR CREEK	0	0	0	0	0
ROLLINSON CHANNEL	2,400,970	0	1,450,083	0	385,105
SILVER LAKE HARBOR	3,270,230	0	489,232	0	375,946
OVERALL TOTAL	**5,671,201**	**0**	**3,602,629**	**43,216**	**931,705**

Table X-50. Dredging Costs – Region 3b (2002-2007)

Location	Pipeline	Hopper	Sidecast	Currituck	Avg Cost
	($)	($)	($)	($)	($ / YR)
OCRACOKE INLET	0	0	768,135	0	153,627
HATTERAS INLET	0	0	198,639	0	39,728
OVERALL TOTAL (Potential Nourishment)	**0**	**0**	**966,774**	**0**	**193,355**
FAR CREEK	0	0	0	0	0
ROLLINSON CHANNEL	0	0	1,450,083	0	290,017
SILVER LAKE HARBOR	0	0	489,232	0	97,846
OVERALL TOTAL	**0**	**0**	**2,906,089**	**0**	**581,218**

2. Potential Costs

In addition to historical quantity and cost data for beach nourishment and dredging projects, unit costs were developed for each stretch of beach for various nourishment scenarios encompassing different types of dredges and distances from sediment sources. For each stretch of beach in Region 3, the historical DCM erosion rates were used to estimate future volumetric needs. Unit costs were then applied to these needs to estimate potential costs for each region, on a yearly basis, which could then be summed to predict the cost for the entire coast. Tables X-51 and Table X-52 present the predicted annual costs for each beach area of Region 3. Section VI also contains a general discussion on the methodology employed for the development of potential strategies and costs for the entire State. Based on the findings outlines in Section VI., the predicted annual costs for the beach strategies below should be factored up by 1.3 to 1.7 (assumed to be 1.5 for this report) to account for cubic yards lost per foot of shoreline due to storm impacts. While the overall costs may be large, it should be noted that only the developed sections of shoreline would likely ever be managed. In determining the predicted annual costs of beach nourishment, portions of the developed shoreline that have not received long-term beach fill placement (USACE or non-public funds) and are not included in a USACE beach fill study (Region 3a and 3b), have been excluded from the analysis. Since these shorelines comprise the National Seashore, the assumption is that they will not be nourished and are therefore not included in the overall nourishment needs assessment. The volumes and cost in Tables X-51 and X-52 are provided should these areas be considered as projects in the future. Note that the costs for the inlet maintenance (dredging) strategies are assumed to be equivalent to historical trends.

Table X-51. Predicted Annual Costs – Region 3a Beaches

Location	Shoreline Length	Total Volume Needed	Total Volume Cost
	MI	CY	$
Core Banks	18.55	647,292	9,767,632
Portsmouth Island	19.88	617,991	8,367,591
TOTAL DEVELOPED	**0**	**0***	**0***

*National Seashore or not included in USACE beach fill study

Table X-52. Predicted Annual Costs – Region 3b Beaches

Location	Shoreline Length MI	Total Volume Needed CY	Total Volume Cost $
Portsmouth Island	1.9	39,004	528,118
Ocracoke Island	16.16	452,252	4,373,277
Hatteras Village	6.12	135,583	1,408,706
Cape Hatteras	5.37	24,831	296,480
TOTAL DEVELOPED	**0**	**0***	**0***

*National Seashore or not included in USACE beach fill study

D. Data Gaps

During the data collection efforts several data gaps were identified that would greatly aid future updates to the BIMP and beach and inlet management projects. The following lists some of these key data gaps in Region 3 by general topic:

Geology

- Inlet bathymetry – Detailed inlet surveys covering morphological features of Drum Inlet, Ocracoke Inlet, and Hatteras Inlet were not located. (Navigation channel surveys for Ocracoke Inlet and Hatteras Inlet can be located through USACE navigation website - http://www.saw.usace.army.mil/nav/)
- Sand source investigations – Offshore sand source investigations have not been conducted in Region 3a. However, the area should not require management in the near future. More detailed investigations are warranted for Region 3b.

Physical Processes

- Sediment budget – Sediment budget data exists only for a small portion of Region 3 near Cape Lookout. The priority for further study would be for Region 3b.

Economics

- Extend property at risk study to include all coastal counties – Very little is known about Cape Lookout National Seashore economics (Region 3a) and estimates for Hyde County (Region 3b) are often made from Dare County.
- Extend and refine beach recreation value surveys/study to include all coastal counties – Very little is known about Cape Lookout National Seashore economics (Region 3a) and estimates for Hyde County (Region 3b) are often made from Dare County.

Monitoring

- Improved beach profile monitoring plans – The areas surrounding Hatteras and Ocracoke have had minimal monitoring efforts.