



North Carolina 2019 Oceanfront Setback Factors & Long-Term Average Annual Erosion Rate Update Study: Methods Report

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North Carolina Division of Coastal Management



The purpose of this study is to update ocean hazard construction setback factors and Ocean Erodible Area of Environmental Concern; which are based on long-term average annual shoreline change rates.

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INTRODUCTION

The purpose of this study is to update ocean hazard construction Setback Factors and the Ocean Erodible Area of Environmental Concern which are based on the long-term average annual oceanfront shoreline change rates, commonly referred to as “erosion rates.” Initially established by the Coastal Resource Commission (CRC) under the Coastal Area Management Act (CAMA) in 1979, the long-term average annual shoreline change rates have been updated periodically since 1980, with the last update study completed in 2011, and effective on January 31, 2013. Oceanfront construction Setback Factors are used to site oceanfront development and determine the landward extent of the Ocean Erodible Area (OEA) within the Ocean Hazard Area of Environmental Concern (AEC), or the area where there is a substantial possibility of excessive shoreline erosion.

The coast of North Carolina continually changes in response to wind, waves, and fluctuating sea levels, as well as human influences. These coastal processes redistribute sand within the dune, beach, and nearshore systems. Geographic, geological and oceanographic differences collectively influence sediment availability, distribution, and transport, which when better understood can help to explain why trends of erosion and accretion differ along all portions of N.C.’s barrier island shorelines. Both short- and long-term changes can be dramatically different depending on where changes are measured and how much time passes between storm events. Factors used to try and predict short-term changes are less understood than those affecting long-term changes for a variety of reasons. Short-term changes are easily influenced by storm events and require routine monitoring, analyses, and modeling using high-resolution data to anticipate changes and anticipate where erosion will be the most extreme. Although factors affecting long-term changes are complex, the positions of the shoreline over a longer period can reveal trends in shoreline movement - unless beaches are nourished on a periodic cycle (NCDRCM, 2016).

Because beaches gain sand (accrete), and lose sand (erode) through a variety of natural forces and human actions and can erode rapidly during a single event (hurricane), Ocean Hazard Setback Factors are established in an effort to minimize losses of life and property resulting from

storms, long-term erosion, prevent encroachment of permanent structures on public beach areas, preserve the natural ecological conditions of the barrier dune and beach systems, and reduce public costs of inappropriately sited development.

Since the first study in 1979 (Tafun, Rogers, and Langfelder, 1979), North Carolina's oceanfront shoreline change rates have been calculated using the end-point method. This method uses the earliest and most current shorelines and shore-perpendicular transects, where the distance between the two shorelines is measured at each transect. Raw shoreline position change rates are then calculated by dividing distance between the two shorelines (shore-transect intersect) by time, or number of years between the two shorelines (Figure 1). To calculate Setback Factors, these data are then "smoothed" using a 17-point running average, and "blocked" to identify shoreline segments, or "blocked areas" that have similar rates.

Technological advances in Geographic Information Systems (GIS) have made calculation of end-point rates a relatively time-efficient process compared to techniques employed in earlier studies. Raw end-point rates were calculated using Environmental Systems Research Institute's (ESRI) *ArcGIS 10.6 ArcMap* GIS software with the United States Geological Survey's (USGS) Digital Shoreline Analysis System (DSAS) 4.3.4730 (Thieler, Himmelstoss, Zichichi, and Ergul, 2009) extension for *ArcMap*. The GIS tool requires three essential spatial data map layers; an early shoreline, a current shoreline, and a transect map layer perpendicular to the two shorelines.

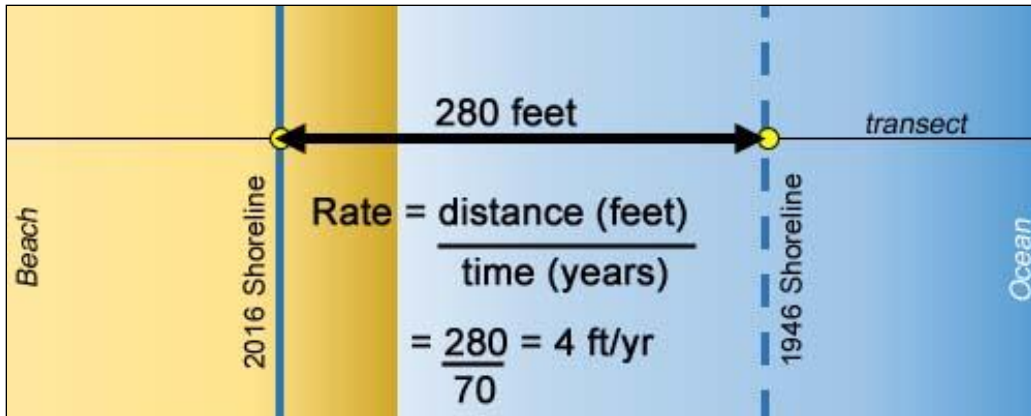


Figure 1. This example illustrates a shore-perpendicular transect where there is 280 feet between the early (1946) shoreline and current (2016) shoreline, and a period of 70 years. The shoreline change rate in this example is equal to 4 feet/year (where rate = distance/time = 280/70 = 4 ft/yr.). Since the most recent shoreline moved landward from its early position, the results would indicate erosion.

Shoreline Identification

When interpreted from aerial photography, North Carolina’s oceanfront shoreline is defined as the “wet-dry line”. This “line in the sand” references an interpretation where the wet sand ends and the dry sand begins and is typically distinguished by contrasting sediment color or shade, hence “wet-dry” (Figures 2 and 3). Wet-dry shoreline interpretation is the most readily identifiable and considered in the worst case to be between high and low tides (*e.g.*, Crowell, Leatherman, and Buckley, 1991; Dolan R. , Hayden, May, and May, 1980; Overton and Fisher, 2003).



Figure 2. Interpretation of the “wet-dry” shoreline is illustrated here



Figure 3. Wet-dry shoreline interpreted using imagery.

The early shoreline used in this study is also the same shoreline used in 2003 Overton and Fisher study, and the 2011 NC Division of Coastal Management (DCM) studies and was digitized by the North Carolina State University (NCSU) Kenan Natural Hazards Mapping Program. It represents a composite of both Mean High Water (MHW) shorelines digitized from National Ocean Survey Topographic Surveys (NOS T-sheets) (1933-1952), and wet-dry line interpretations made from historical (1940-1962) imagery (Overton and Fisher, 2003). Use of NOS T-sheet shorelines is

accepted by other researchers and has been adopted by the USGS in their shoreline erosion studies. A statewide set of NOS T-sheets for a single year do not exist; therefore, early dates do vary between 1933 and 1952. For approximately 30 miles of the state’s oceanfront shoreline (north of Oregon Inlet to North Carolina/Virginia State line) T-sheets were not available when the early shoreline was digitized. For this portion of the coast, a collection of early photography (1940–1962) was used to digitize a wet-dry shoreline. By using this early shoreline, consistent comparisons at each transect can be made between the multiple shoreline change rate studies (Appendix B).

The most current shoreline used in this study is a wet-dry interpretation digitized at a map scale of 1:1,000 utilizing 2016 North Carolina color imagery (6-inch pixel resolution). However, at Onslow Beach and Brown’s Island, 2017 imagery (1-meter pixel resolution) was available and used due to an imagery data gap in 2016.

Transect Locations

Transects used in this study are generally perpendicular to the shoreline, spaced 50 meters (approximately 164 feet) apart, and spatially consistent with those used in the 1992, 2003 and 2011 update studies. It is expected that they are also spatially like those established by Dr. Robert Dolan in his early shoreline erosion rate studies since they have similar spacing and end-point coordinates (Dolan, Hayden, and Heywood, 1978); however, it is not possible to confirm since they did not exist in a digital form prior to the 1992 study (Overton and Fisher, 2003). For this reason, only comparison of ocean hazard Setback Factors from this and earlier studies can be made, and not the actual shoreline change rates.

Study Area

North Carolina’s wave-dominated barrier island coastline is defined by a series of prominent cusped forelands (Cape Fear, Cape Lookout, and Cape Hatteras) (Hoyt, 1971) and embayments (Long Bay and Onslow Bay) with approximately 320 miles of oceanfront shoreline (Figure 4).

Approximately 66% of this shoreline is located on predominate east-facing beaches, while 34% are on southerly-facing beaches.

Beaches in North Carolina, are in a state of constant fluctuation due to normal erosional actions of wind, water, and sediment supply. The region's geologic makeup is a significant factor regarding sediment supply: North Carolina's northern coast is flatter and more sediment rich than the steeper, sediment-poor southern coast. North Carolina's combination of simple and complex barrier islands, shoreface orientation, and inlet systems also influence the sediment budgets among the state's beaches (Riggs & Ames, 2003). Some inlets, for example, tend to migrate in the same general direction over time, while others oscillate back and forth. This difference influences whether the beaches adjacent to the inlets experience chronic or short-term erosion or accretion and presents enormous management challenges and costs for property owners, local governments, and the state.

In 2016, annual significant wave heights in Long Bay ranged 1.1 to 18.2 feet and averaged 3.3 feet at buoy station 41108; in Onslow Bay heights ranged 1.2 to 21.2 feet and averaged 4.5 feet at buoy station 41159; and north of Cape Hatteras heights ranged 1.0 to 17.7 feet and averaged 4.0 feet at buoy station 44100 (National Oceanic and Atmospheric Administration, 2018). In one study using 2006 NOAA data (Limber, List, and Warren, 2007a.), semidiurnal tides ranged on average from approximately 3.3 feet along the northern coast to approximately 4.9 feet near the North Carolina/South Carolina border. Regional and local beach morphology is controlled by a combination of prevailing oceanographic conditions (Ashton, 2001), periodic storm events (Morton and Sallenger, 2003), inlet-related processes (Fenster and Dolan, 1996), and by underlying, antecedent geology (Riggs, Cleary, and Snyder, 1995).

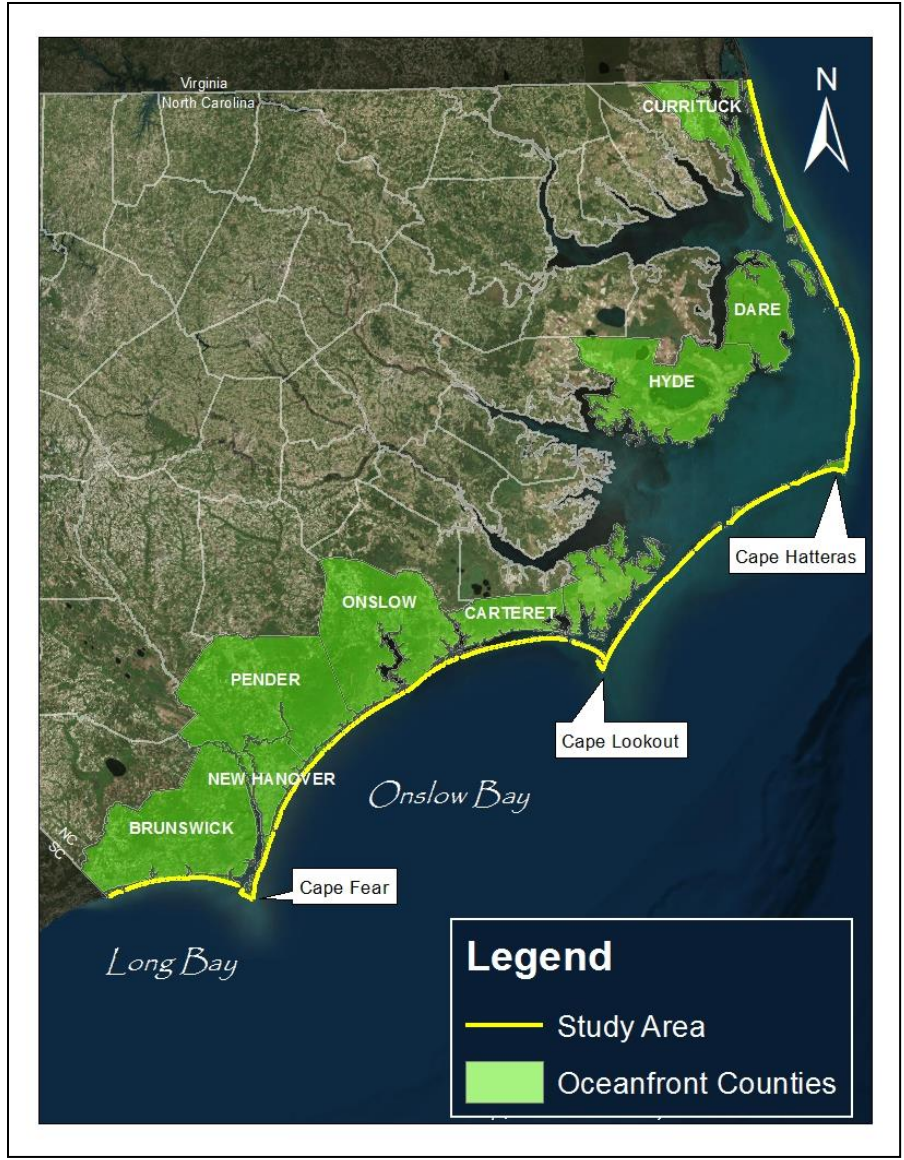


Figure 4. Study Area

The following sections detail the methodology and summarize findings for each island or oceanfront town starting at Sunset Beach in the south and ending in the north at the North Carolina-Virginia state line. Large maps (11 x 17 inch) are in Appendix A, and graphs illustrating rates calculated in this study relative to those calculated in the 2003 and 2011 studies are in Appendix B.

METHODOLOGY

Shoreline Preparations for Digital Shoreline Analysis System (DSAS)

Prior to the release of DSAS v4.2, shorelines were required to be digitized with the same spatial orientation. For example, when digitizing a shoreline on an east-west barrier island, all shorelines were required to consistently start from either the east or west side of the island so that each would have the same spatial left and right orientation. With the release of DSAS v4.2, this digitizing requirement was no longer necessary. DSAS does however require data to be managed within a personal Geodatabase in meter units in a projected coordinate system (Universal Transverse Mercator). In addition, there are specifications for naming and formatting attributes for shoreline, transect, and baseline GIS data.

Shoreline data require “DATE_” and “UNCERTAINTY” fields (Table 1). The “DATE” field stores the shoreline date and is referenced by DSAS when calculating the erosion rate according to the distance divided by time formula; and the “UNCERTAINTY” field accounts for positional uncertainties associated with natural influences (wind, waves, tide) or digitizing and measurement uncertainties. These fields must be created in GIS using the format shown in the table below.

Attribute Name	Attribute Data Type	Format
DATE_	Text	Field length = 10 Format = mm/dd/yyyy
UNCERTAINTY	Any numeric field	Double (<i>used in this study</i>)

Table 1. Attribute fields required by DSAS for shoreline GIS data.

Baseline and Transect Preparations for DSAS

Transects used in this study are believed to be geographically consistent with those defined in N.C.’s first erosion rate study (Tafun, Rogers, and Langfelder, 1979; Dolan, Hayden, and Heywood, 1978), and utilized in subsequent update studies thereafter. However, not until the 1992 update study (Benton, Bellis, Overton, Fisher, Hensch, and Dolan, 1997) were these data used in a

GIS environment, and not until the 2003 study (Overton and Fisher, 2003) that they were created as vector GIS data.

DSAS does require transect data to have several attribute fields associated with each unique identifier: *OBJECTID*, *SHAPE*, *BASELINEID*, *GROUP*, *TRANSORDER*, *PROCTIME*, *AUTOGEN*, *STARTX*, *STARTY*, *ENDX*, *ENDY*, and *AZIMUTH* (Thieler, Himmelstoss, Zichichi, and Ergul, 2009) (Table 2). When transects are cast from a baseline these attributes fields are automatically generated by DSAS. For transects not cast using DSAS (i.e. pre-existing transects like those used in this study), a few attributes (*BASELINEID*, *GROUP*, and *TRANSORDER*) are defined by the analyst prior to initiating the calculation.

Attribute Name	Data Type	Purpose
BASELINEID	Long Integer	DSAS can assign these values if left empty. Baseline segments with an ID equal to zero will be ignored by DSAS; no transects cast and will not be included in the analysis.
GROUP	Long Integer	Values in this field are assigned by DSAS and are based on analyst input for grouping transects. This field is used to aggregate shoreline data and the resulting measurement locations established by the transects into groups.
TRANSORDER	Long Integer	Can be assigned by DSAS, or the analyst. Each transect must have its own unique number. This field is used to sort transect data in a predetermined order

Table 2. Attribute fields required by DSAS for transect GIS data.

DSAS baselines are digitized by the analyst and serve as a starting point for casting shore-perpendicular transects and can be digitized either onshore or offshore at an offset-distance from all shorelines defined by the analyst. Although this study used pre-existing transects, DSAS still requires a baseline to be specified and contain specific attributes (Table 3).

Attribute Name	Data Type	Purpose
ID	Long Integer	DSAS uses this value to determine the ordering sequence of transects when the baseline contains multiple segments.
Group	Long Integer	Used for data management purposes to aggregate transects based on physical variations alongshore (i.e. shoreline type)
OFFshore	Short Integer	Used by DSAS to determine which direction to cast transects. A value of "0" indicates that the baseline is onshore, or landward of the input shorelines. A value of "1" indicates that the baseline is offshore, or seaward of the input shorelines.
CastDir	Short Integer	Used in conjunction with "OFFshore." A value of "0" will result in transects being cast to the left of the baseline based on segment flow. A value of "1" will result in the transect being cast to the right of the baseline based on segment flow direction.

Table 3. Attribute fields required by DSAS for baseline GIS data.

Digital Shoreline Analysis System (DSAS) and Statistical Analysis

As previously mentioned, all data used must be managed within a Personal Geodatabase using ArcGIS (ArcMap and ArcCatalog). The Geodatabase is a Microsoft Access® database designed to store and serve spatial data and provides data structure to enforce topology rules, or spatial data relationships. Additionally, DSAS requires data to be in meters, rather than feet (Figure 5). For purposes of presenting results in this report, data are converted from meters to feet.

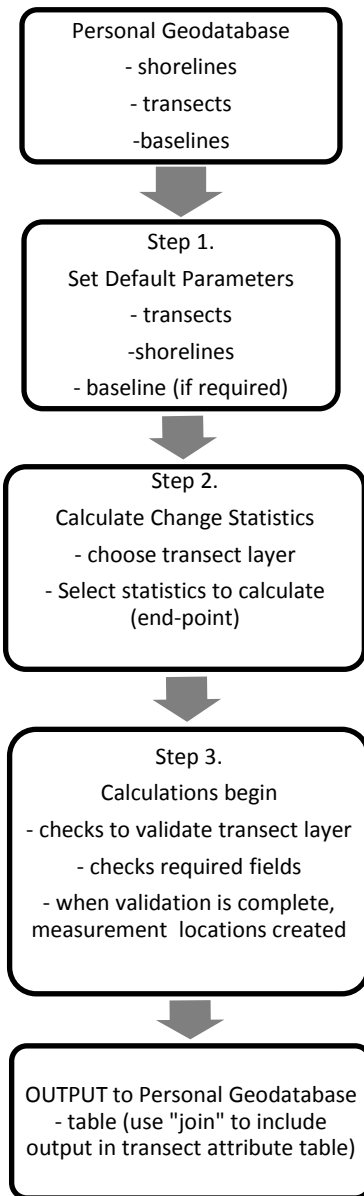


Figure 5. DSAS Workflow

Once the data were stored in the Geodatabase and properly attributed, DSAS is used within ArcMap as a GIS Extension to calculate shoreline change rates. First, data parameters were established by opening the *Set Default Parameters* user dialog (Figures 6 and 7), then selecting the *Shoreline Calculation Settings* tab. Required parameters include identifying the shoreline layer, selecting the date (*DATE*) and uncertainty fields (default 4.4 meters), then selecting Intersection Parameters (*Closest Intersection*). The intersection point defines which part of the

shoreline to analyze where a single transect might intersect the same shoreline twice (e.g. inlets and spits). Closest Intersection was selected to avoid using shoreline segments not considered to be oceanfront.



Figure 6. DSAS toolbar - Set/Edit Parameters

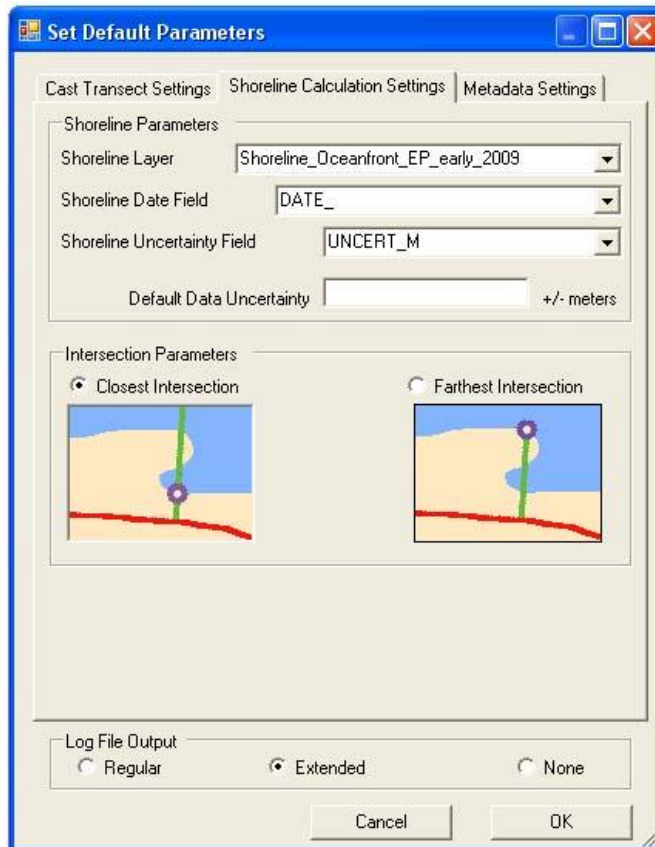


Figure 7. DSAS Set Default Parameter

Transect data layer were identified using the *DSAS Toolbar* and selecting it from the *Transect Layer* dropdown menu (Figure 8). This menu will only list qualified transect layers from the ArcMap document. If the transect layer is not properly attributed (*BASELINEID*, *GROUP*, *TRANSORDER*) it will not be recognized as a qualified option.



Figure 8. DSAS toolbar – will list qualified transect layers within ArcMap project.

With default parameters established and a transect layer identified, the last step is to select the output statistics (Figures 9 and 10). Once the *Calculate Change Statistics* dialog window opens, the only requirements are to: 1) select statistics to calculate; 2) apply confidence interval (accepted default 95 percent), and; 3) start calculation algorithms.



Figure 9. DSAS toolbar - Calculate Shoreline Change Statistics.

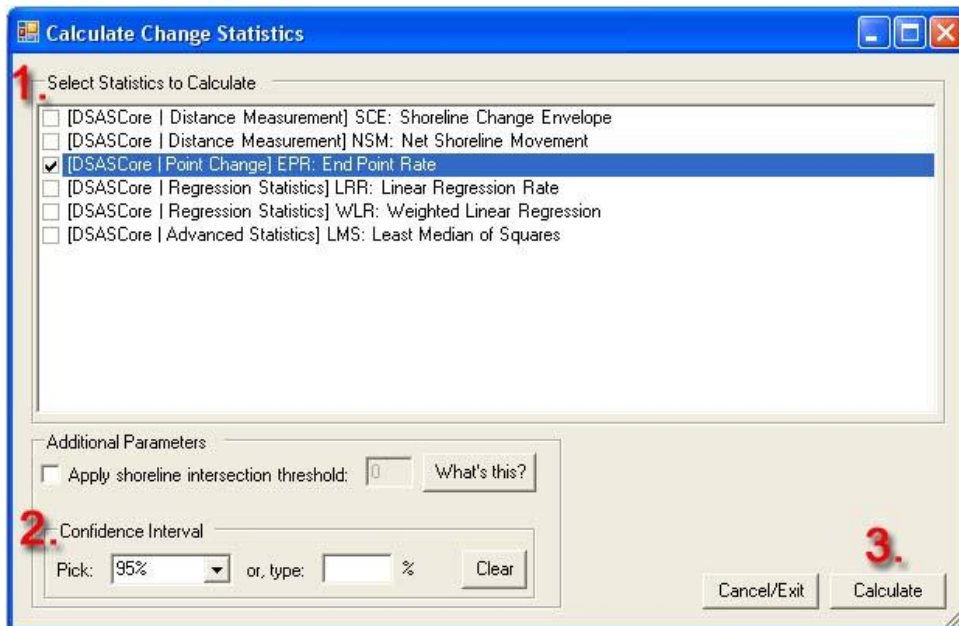


Figure 10. DSAS Calculate Change Statistics.

Long-term average annual shoreline change rates were calculated at 9,802 transects (approximately 305 miles of shoreline). No rates were calculated at 66 transects (approximately 2 miles of shoreline) because of “missing” shoreline segments. These gaps in the shoreline data are specific to areas where inlets have either closed (*e.g.* Madd, Corncake, Moore’s, and Old Topsail inlets) or have changed significantly due to accretion or erosion (*e.g.* New Topsail Inlet at Topsail Beach). For example, where early data might show a shoreline at an active inlet, current data will show a complete shoreline (not separated by channel) if the inlet has closed; thus, resulting in only one shoreline for that specific location.

DSAS generates raw end-point shoreline change rate data as a table inside the Geodatabase. To perform spatial queries, the tabular data must be joined to the transect GIS data by common attributes (*TRANSORDER* and *OBJECTID*) using ArcMap. Additional data processing (smoothing and blocking) required data to be imported into a Microsoft Excel 2016® spreadsheet to take advantage of its available math functions.

Long-Term Average Annual Shoreline Change Rate Calculations

Smoothing

Smoothing raw data has been applied in all previous studies, and effectively filters short-term dynamic shoreline phenomena such as beach cusps, smaller sand waves, and the attachment of landward migrating portions of offshore bar systems. Cusps and similar features range in size from approximately 5 feet to 5,000 feet and have a life span ranging from days (smaller features) to seasons or years (larger sand waves) (Dolan and Ferm, 1968) (Davis, 1978). Bars generally range around 328 feet in length with migration and attachment rates ranging from seasons to years (Davis, 1978). Variations associated with larger, longer lived features such as capes are not filtered by the smoothing.

The procedure for spatially smoothing shoreline change rate data is a simple moving average, or running mean technique described by Davis, 1973. Commonly referred to as “17-point running average,” this technique by default consists of at least 17 transects (approximately 0.5 miles of

shoreline), and an average is calculated for each of the 17 transects, each time centered on the ninth transect (with 8 transects on each side). This spatially averaged value is the “smoothed rate.” Approaching inlets, the number of transects used in the average is decreased by two (dropping one from each side of the centered transect calculation) until the end transect is reached. The last value is calculated by taking the weighted average using the last two transects.

$$R_s = (2 \times T_1 + T_2) / 3$$

R_s = smoothed rate

T₁ = erosion rate at last transect adjacent to the inlet

T₂ = erosion rate at second to last transect adjacent to inlet

As can be seen in Figure 11, results from smoothing are most noticeable in areas experiencing accelerated erosion or accretion (e.g. near inlets).

Blocking

The technique of “blocking” smoothed rate data creates spatially uniform rate segments. In other words, blocking groups neighboring transects along the same shoreline segment that have similar smoothed shoreline change rates. This allows for management of like sections of shoreline that have the same or similar shoreline change rates, rather than having to refer rates at each individual transect. Blocked shoreline change rate data serve as Setback Factors (historically referred to as “erosion rates”), and used to calculate the construction setback within Ocean Hazard AEC, and to calculate the landward boundary of the Ocean Erodible Area (OEA) (Figure 11).

Blocking procedures, itemized below, represent refinements and clarifications of procedures established by and used in all previous update studies. These refinements and clarifications are the result of improved accuracy of the data brought about by improvements in the shoreline delineation methodology and quantitative requirements that allow for increased repeatability of results. Transect spacing was reduced from 328 (100 meters) and 984 feet (~300 meters) (1980

Dolan study) to 164 feet (50 meters) in subsequent studies; and in the 2003 Overton and Fisher update study, the minimum number of transects required for blocking was reduced by half (from 16 to 8). In areas experiencing an accelerated change in rates, this refinement resulted in smaller blocked groups. The following list describes the process, or “rules” of blocking:

1. Group “like” erosion rate segments based on rate at transect (*e.g.*, 2.0, 2.2, 2.1, 2.5, 2.6, 2.1, . . . 2.9) and use the mean of each segment as the blocked rate. Transitioning at one-foot intervals are preferred for rate block boundaries. Fractional rates are rounded down to the nearest foot, or half foot interval for segments dominated by a half foot value and do not have values greater than the next highest one foot interval (*e.g.*, a rate segment equal to 5.4 would be rounded to 5.0; and 5.7 would be rounded to 5.5).
2. Blocked shoreline change rate segments must be comprised of at least eight (8) transects. In areas experiencing rapid erosion or accretion (*e.g.*, approaching inlets), it is not always possible achieve a one-foot transition from one blocked rate segment to the next, thus making it necessary to evaluate segments based on its mean so that transitions from one blocked segment to the next was as near to the one-foot interval as feasible.
3. In areas where blocked segments transition from one value to another (*e.g.*, from 3 to 4 feet per year) a determination must be made to select the transect that will serve as a delineation between the change in values. The lower rate would be applied towards the higher blocked segment.
4. Where two blocked boundaries meet and divide a property or parcel, the lower of the two blocked rates is applied in the direction of the higher rate in order to give the property owner the benefit of the lower rate. Where a large parcel containing multi-family structures was divided by a transition boundary, the lower of the two blocked rates is applied towards the higher rate so that no structure was split and also giving the structure the benefit of the lower rate.

5. For segments that result in measured accretion, or where measured erosion rates are less than two (2.0) feet per year, they are assigned the default minimum, a blocked rate value (Setback Factor) of two (2) in accordance with the minimum Ocean Hazard setback of 60 feet, or 30 times the Setback Factor based on blocked shoreline change rates (15A NCAC 07H .0306(a)(2)(A)).

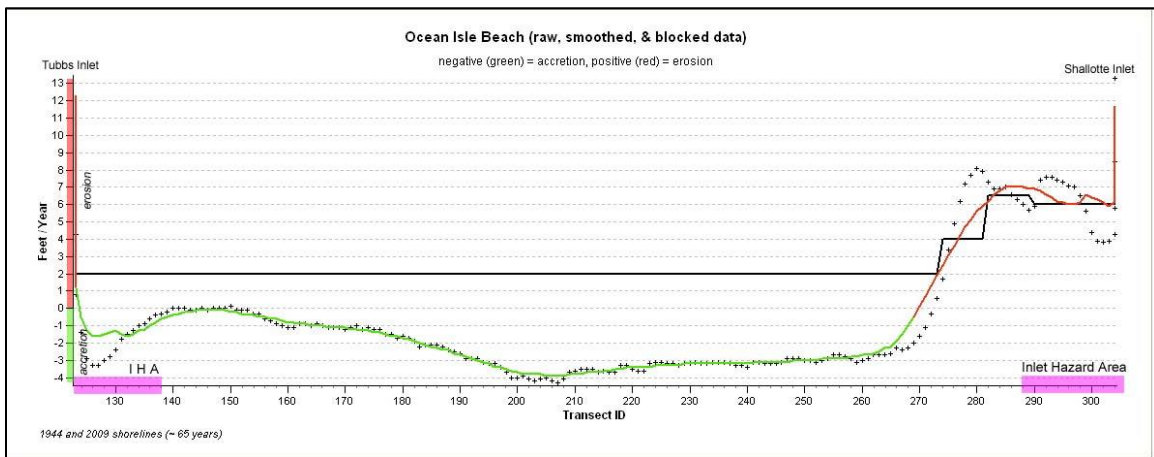


Figure 11. Example of Raw (points), Smoothed (solid green and red line), and Blocked (solid black line) data.

RESULTS

A statistical summary of the blocked shoreline change rates (Setback Factors) was calculated for this study, just as done in previous studies. These data are presented in below (Table 4). The percentages of shorelines are computed by dividing the number of miles of shoreline mapped in a given category (*e.g.*, Accreting) by the total number of miles of shoreline in a category (*e.g.*, south-facing). For purposes of this study, “south-facing” beaches are defined as those with shorelines, or beach faces, generally perpendicular and between South-East and South-West ($135^{\circ} - 225^{\circ}$); while “east-facing” between North-East and South-East ($45^{\circ} - 135^{\circ}$).

Statewide, the average blocked erosion rate value, or setback factor is 3.7, which is a slight increase (<1.0 ft.) relative to the average (3.4) calculated in the 2011 DCM update study using the 2009 shoreline. The average shoreline change rate for this study was 2.1 feet per year (erosion), and the median was 1.6 feet per year (erosion).

Table: 4A	Shoreline Length & Measured Erosion and Accretion Rate Comparison		
	South-Facing Beach Miles (% of total shoreline length)	East-Facing Beach Miles (% of total of total shoreline length)	Statewide Totals Miles (% of total shoreline length)
Miles of Shoreline Mapped & Analyzed	103.7 (34.1%)	200.8 (65.9%)	304.5
Measured Accretion	45.8 (44.2 %)	53.6 (26.3%)	103.7 (34.1%)
Measured Erosion	56.3 (54.3%)	147.1 (72.2%)	200.9 (65.4%)
No Output (<i>missing one of two shorelines</i>)	0.8 (<1%)	2.8 (1%)	2.8 (>1%)
Table: 4B	Shoreline Change Rate Statistical Comparison		
	South-Facing Beach (ft./yr.)	East-Facing Beach (ft./yr.)	Statewide (ft./yr.)
Average Shoreline Change Rate (ft./yr.)	2.8 ft/yr. (erosion)	<1.0 ft/yr. (erosion)	2.1 ft/yr. (erosion)
Median Shoreline Change Rate (ft./yr.)	<1.0 ft/yr. (erosion)	2.5 ft/yr. (erosion)	1.6 ft/yr. (erosion)
Table: 4C	Setback Factor Comparison (Minimum = 2 feet)		
	South-Facing Beach Miles (% of total shoreline length)	East-Facing Beach Miles (% of total of total shoreline length)	Statewide Totals Miles (% of total shoreline length)
Setback Factor (=2 ft)	76.5 (73.8%)	98.3 (49.0%)	174.6 (57.3%)
Setback Factor (between 2.5 & 5.0 ft)	13.0 (12.5%)	52.9 (26.3%)	67.1 (22.1%)
Setback Factor (between 5.5 & 8.0 ft)	9.5 (9.2%)	29.7 (14.8%)	38.7 (12.7%)
Setback Factor (>8.0 ft)	3.9 (3.8%)	18.5 (9.2%)	22.7 (7.4%)
Average Setback Factor (ft)	3.0	4.0	3.5
Median Setback Factor (ft)	2.0	3.0	2.0

Table 4. Summary of shoreline change rates and Setback Factors. **(4A)** Summarizes length of shoreline mapped and analyzed, and percentages of shoreline where either accretion or erosion was measured. **(4B)** Summarizes average and median shoreline change rates for south and east-facing beaches, and statewide totals. Although these values do include all measured accretion, the statewide values reflected erosion overall. **(4C)** Summarizes length of shoreline and percentage of the total shoreline, and its calculated Setback Factor. Because of migrating or closed inlets, not all locations near inlets had two shorelines (no early or 2016 shoreline). As a result, the analysis could not be performed for less than 1% of the total study area. Therefore, lengths and percentages in Table 4 when summed, may not always equal one hundred percent. It is important to note that the minimum setback factor is 2 as referenced in Rule *15A NCAC 07H.0306(a)(2)(A)*. A setback factor equal to 2 means that erosion is less than two feet per year, or accretion was measured. Setback factors greater than 2 do correspond to calculated erosion rates.

	2016 South Facing Miles (% of total)	2009 South Facing Miles (% of total)	Change (miles)
Miles of Shoreline Mapped/Analyzed	103.7 (34.1%)	103.9	0.2 (decrease)
Setback Factor (2 ft)	76.5 (73.8%)	77.3 (74.4%)	0.8 (decrease)
Setback Factor (2.5 to 5.0 ft)	13.0 (12.5%)	13.8 (13.3%)	0.8 (decrease)
Setback Factor (5.5 to 8.0 ft)	9.5 (9.2%)	9.0 (8.7%)	0.5 (increase)
Setback Factor (>8.0 ft)	3.9 (3.8%)	3.6 (3.5%)	0.3 (increase)

Table 5. 2018 update study summary of blocked shoreline change rates (Setback Factors), and comparison of change from previous study (2011) for south-facing beaches. This table is an illustrative comparison of total length of shoreline mapped and analyzed, and its calculated construction Setback Factor, where sixty feet is the minimum construction setback (2 ft. x 30 = 60 ft.). Length shown in the row labeled “Setback Factor (2 ft)” is inclusive of length of all accreting sections of shoreline, and those calculated to be eroding at two feet per year or less.

	2016 East Facing Miles (% of total)	2009 East Facing Miles (% of total)	Change (miles) from 2009 to 2016
Miles of Shoreline Mapped/Analyzed	200.8 (65.9%)	203.5	2.7 (decrease)
Setback Factor (2 ft)	98.3 (49.0%)	112.8 (55.4%)	14.5 (decrease)
Setback Factor (2.5 to 5.0 ft)	52.9 (26.3%)	48.3 (23.7%)	4.6 (increase)
Setback Factor (5.5 to 8.0 ft)	29.7 (14.8%)	22.4 (11.0%)	7.3 (increase)
Setback Factor (>8.0 ft)	18.5 (9.2%)	17.2 (8.5%)	1.3 (increase)

Table 6. 2018 update study summary of blocked shoreline change rates (setback factors), and comparison of change from previous study (2011) for east-facing beaches. This table is an illustrative comparison of total length of shoreline mapped and analyzed, and its calculated construction Setback Factor, where sixty feet is the minimum construction setback (2 ft. x 30 = 60 ft.). Length shown in the row labeled “Setback Factor (2 ft)” is inclusive of length of all accreting sections of shoreline, and those calculated to be eroding at two feet per year or less.

Shoreline change rates and setback factors calculated in this study can be compared to those presented in the 2011, and 2003 update study reports (NC DCM, 2011; Overton and Fisher, 2003) because they exist in digital and GIS format, and use the same early shoreline. However, setback factors from these studies (2018, 2011, and 2003) can only be generally compared to those calculated in earlier studies for several reasons: (1) there is a difference in the miles of shoreline analyzed (due to starting and stopping points near inlets and capes), (2) the early shoreline date used in the 1997 study (and earlier) is not the same as the one used in the 2003, 2011, and this study and; (3) changing the required minimum number of transects from 16 to 8 in the 2003 Overton and Fisher update study, and space-reduction between transects from 328 and 984 feet (100 and 300 meters) to 164 feet (50 meters) are refinements made in the blocking methodologies that may influence setback factor statistics only when comparing this and 2011, 2003 studies to earlier studies (1998, 1992, 1986, and 1980). Preliminary analysis of the data continues to show remarkable consistency with earlier updates (Table 7).

Statewide Totals Summary	2016 Miles (% of total)	2009 Miles (% of total)	1998 Miles (% of total)	1992 Miles (% of total)	1986* Miles (% of total)	1980* Miles (% of total)
Miles of Shoreline Mapped/Analyzed	304.5	307.4	312	300	237*	245*
Setback Factor (2 ft/yr.)	174.6 (57.3%)	190.2 (61.9%)	193 (62%)	165 (55%)	144 (61%)	149 (61%)
Setback Factor (2.5 to 5.0 ft/yr.)	67.1 (22.1%)	62.1 (20.2%)	64 (21%)	54 (18%)	43 (18%)	52 (21%)
Setback Factor (5.5 to 8.0 ft/yr.)	38.7 (12.7%)	31.5 (10.2%)	28 (9%)	30 (10%)	20 (8%)	22 (9%)
Setback Factor (>8.0 ft/yr.)	22.7 (7.4%)	20.8 (6.8%)	27 (8%)	32 (10.7%)	22 (9%)	22 (9%)
Insufficient Data	1.4 (<0.5%)	2.8 (<1%)	0	19 (6%)	8 (4%)	0

Table 7. Summary of blocked shoreline change rates (Setback Factors) for all studies. This table is an illustrative comparison of total length of oceanfront shoreline mapped and analyzed, and its calculated construction Setback Factor for each of the six studies; where sixty feet is the minimum construction setback (2 ft. x 30 = 60 ft.). Length shown in the row labeled “Setback Factor (2 ft)” is inclusive of length of all accreting sections of shoreline, and those calculated to be eroding at two feet per year or less. Where the year ends with an asterisk (*) in the table header, that total shoreline distance is less compared to others because some, or all, of the National Seashore was not mapped for that study (i.e. Shackleford Banks, Core Banks). (*) this study did not include the entire oceanfront shoreline (Core Banks or Shackleford Banks).

South-Facing Shoreline Dates	2016 Miles (% of total)	2009 Miles (% of total)	1998 Miles (% of total)	1992 Miles (% of total)	1986* Miles (% of total)	1980* Miles (% of total)
Miles of Shoreline Mapped/Analyzed	103.7 (34.1%)	103.9	96	106.8	82	80
Setback Factor (2 ft)	76.5 (73.8%)	77.3 (74.4%)	69 (72%)	58.4 (55%)	59 (72%)	70 (82%)
Setback Factor (2.5 to 5.0 ft)	13.0 (12.5%)	13.8 (13.3%)	14 (14%)	14.4 (13%)	12 (15%)	12 (14%)
Setback Factor (5.5 to 8.0 ft)	9.5 (9.2%)	9.0 (8.7%)	9 (9%)	5.9 (6%)	3 (4%)	3 (4%)
Setback Factor (>8.0 ft)	3.9 (3.8%)	3.6 (3.5%)	5 (5%)	9 (8%)	7 (9%)	0 (0%)

Table 8. South-facing beach summary of blocked shoreline change rates (Setback Factors) for all studies. This table is an illustrative comparison of total length of shoreline mapped and analyzed, and its calculated construction Setback Factor for each of the five studies, where sixty feet is the minimum construction setback (2 ft. x 30 = 60 feet). Length shown in the row labeled “Setback Factor (2 feet)” is inclusive of length of all accreting sections of shoreline, and those calculated to be eroding at two feet per year or less. Where the year ends with an asterisk (*), in the table header, that total shoreline distance is less compared to others because some, or all, of the National Seashore was not mapped for that study (i.e. Shackleford Banks, Core Banks).

East-Facing Shorelines	2016 Miles (% of total)	2009 Miles (% of total)	1998 Miles (% of total)	1992 Miles (% of total)	1986* Miles (% of total)	1980* Miles (% of total)
Miles of Shoreline Mapped/Analyzed	200.8 (65.9%)	203.5	216	192.8	155	160
Setback Factor (2 ft)	98.3 (49.0%)	112.8 (55.4%)	124 (58%)	89 (46%)	85 (55%)	78 (49%)
Setback Factor (2.5 to 5.0 ft)	52.9 (26.3%)	48.3 (23.7%)	50 (23%)	39.9 (21%)	31 (20%)	40 (25%)
Setback Factor (5.5 to 8.0 ft)	29.7 (14.8%)	22.4 (11.0%)	19 (9%)	24.3 (13%)	17 (11%)	20 (12%)
Setback Factor (>8.0 ft)	18.5 (9.2%)	17.2 (8.5%)	22 (10 %)	23.4 (12%)	15 (10%)	23 (14%)

Table 9. East-facing beach summary of blocked shoreline change rates (Setback Factors) for all studies. This table is an illustrative comparison of total length of shoreline mapped and analyzed, and its calculated construction Setback Factor for each of the five studies, where sixty feet is the minimum construction setback (2 ft. x 30 = 60 feet). Length shown in the row labeled “Setback Factor (2 feet)” is inclusive of length of all accreting sections of shoreline, and those calculated to be eroding at two feet per year or less. Where the year ends with an asterisk (*), in the table header, that total shoreline distance is less compared to others because some, or all, of the National Seashore was not mapped for that study (i.e. Shackleford Banks, Core Banks).

Barrier Island Summaries

The following graphs show oceanfront shoreline change rate data (raw, smoothed, and blocked) at each transect for all NC barrier islands. For purpose of this study and illustrating raw and smoothed with blocked data, positive rate values identify measured erosion (*positive = erosion*) while negative values represent measured accretion (*negative = accretion*). The black points, or crosshairs, are the raw data; the green and/or red lines are the smoothed data; and the bold-black line is the blocked data (setback factors). Units for the vertical axis are feet per year, and the horizontal axis corresponds to transect numbers.

Bird Island and Sunset Beach

Bird Island and Sunset Beach are North Carolina's southern-most beaches and considered to have low sloping south-facing beaches with approximately 3.3 miles of combined oceanfront shoreline. Sunset Beach has been naturally accreting and has not required any nourishment projects (Figure 12). Several factors have had significant influences in defining today's shoreline position; a navigation jetty constructed at Little River inlet (left side of graph), the closing of Madd inlet (transect IDs 35-40), and engineering (end of island and inlet configuration) of Tubbs Inlet prior to 1970. There was no change in blocked erosion rate factors since 2.8 miles (86.7 percent) of its shoreline resulted in measured accretion with only minor erosion (2 feet per year, or less) in the area adjacent to Tubbs Inlet for a shoreline distance equal to distance of 0.3 miles, or 11.4 percent of its oceanfront shoreline; therefore, the calculated setback factors for both Bird Island and Sunset Beach is 2 feet per year (Figures 12 & 13).

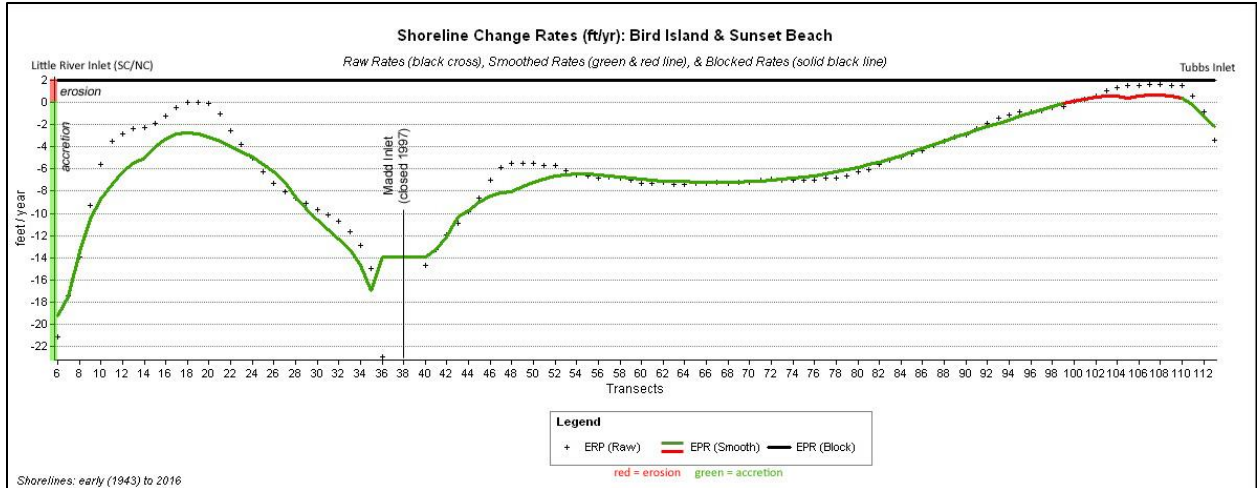


Figure 12. Bird Island and Sunset Beach shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

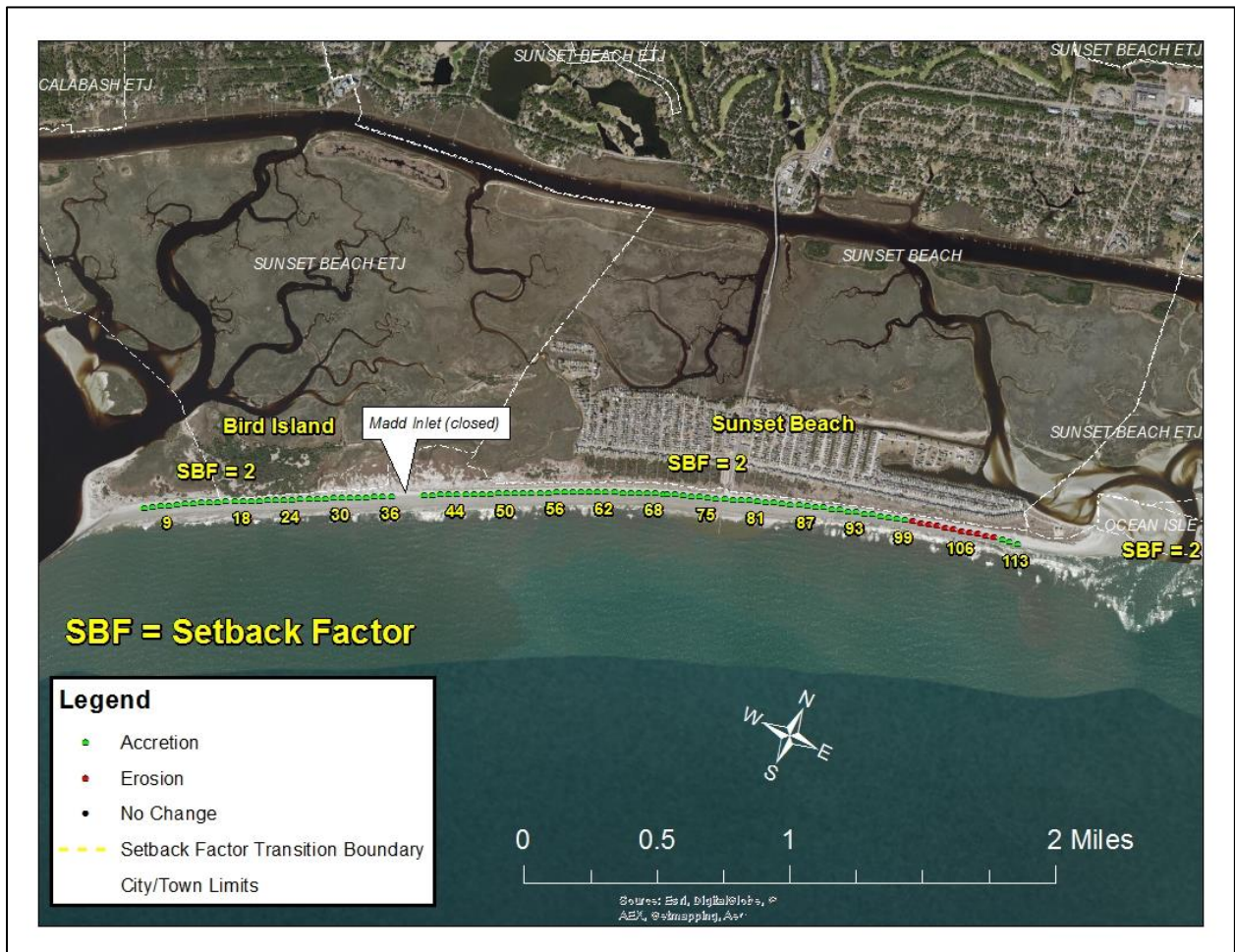


Figure 13. Bird Island & Sunset Beach. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Ocean Isle Beach

Ocean Isle Beach is considered low sloping and south-facing, with approximately 5.7 miles of oceanfront shoreline. Approximately 4.6 miles (80.6 percent) of this shoreline resulted in measured accretion, while 1.0 miles (18.3 percent) is eroding (Figure 14). Ocean Isle has received several nourishment projects since the 2000s which had immediate post-project influences on shoreline position, and potentially influenced degree of measured accretion. Those areas are adjacent to inlets (Tubbs and Shallotte) located on each shoulder of the barrier island. Most of the island resulted in a calculated Setback Factor of 2 feet per year, while a small portion adjacent to Shallotte Inlet continued to see factors greater than 2 (up to 5 ft./yr.) (Figure 14 and 15). Overall, Setback Factors remained the same or slightly lower compared to the 2011 study.

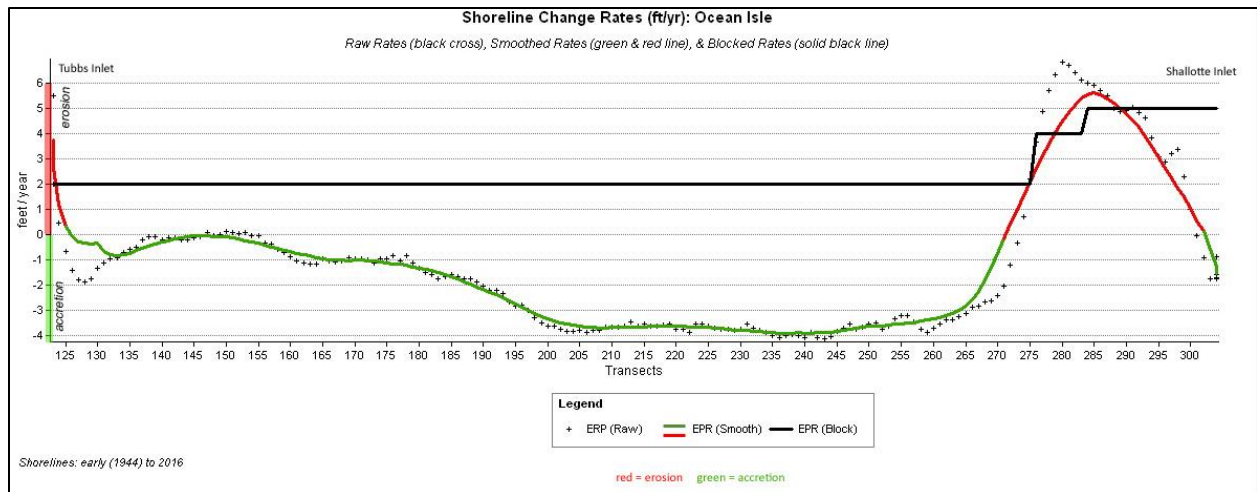


Figure 14. Ocean Isle shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

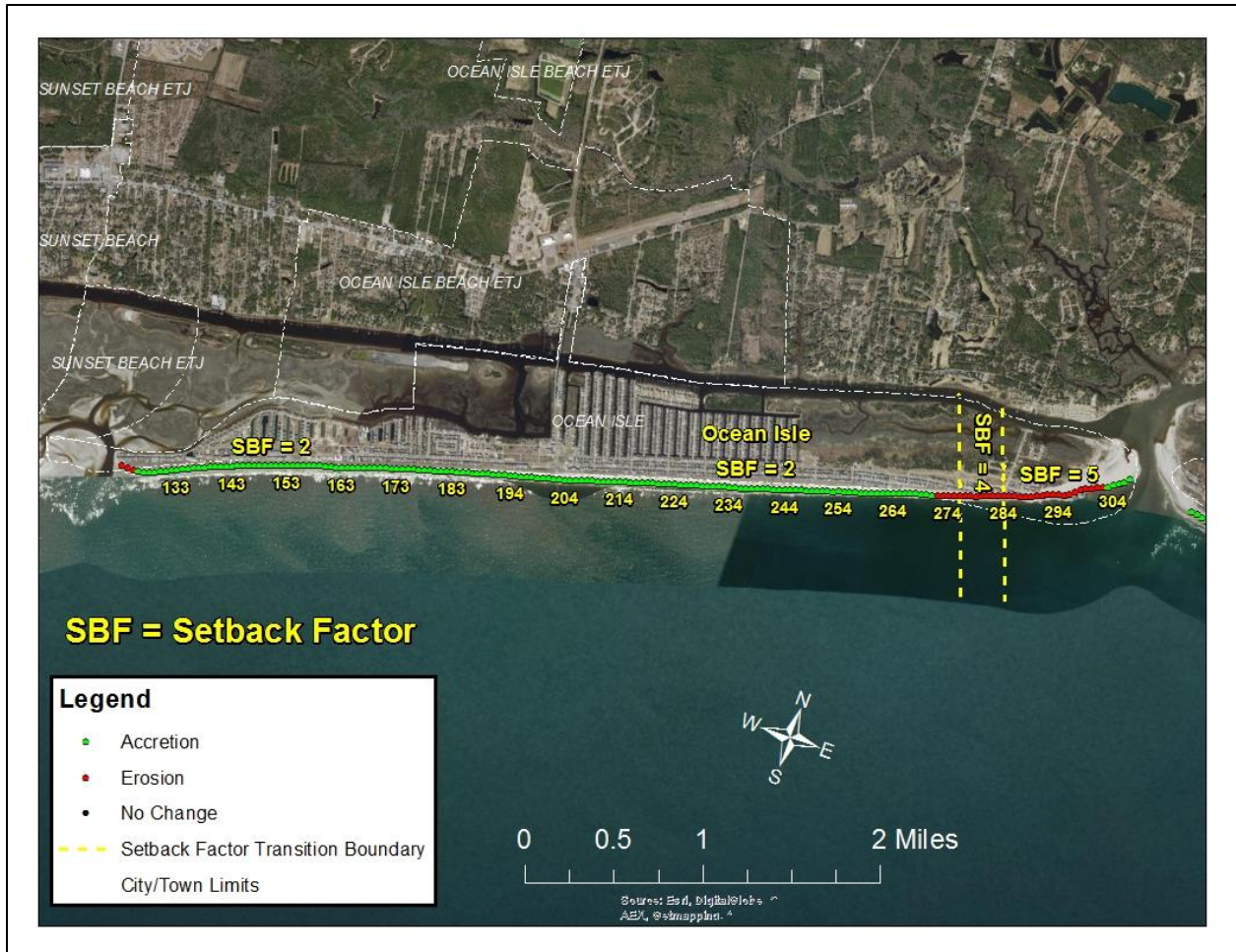


Figure 15. Ocean Isle Beach. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Holden Beach

Holden Beach is considered low sloping and a south-facing, with approximately 8.0 miles of oceanfront shoreline. Approximately 2.0 miles (24.8 percent) of this shoreline resulted in measured accretion, while 6.0 miles (74.8 percent) is eroding (Figure 16). Although down slightly from the 2011 study (58.9 percent), still most (54.7 percent) of the measured erosion is 2 feet per year or less. In 2017, Holden Beach placed approximately 1.3 million cubic yards of sand along four miles of its oceanfront shoreline, and it is the first project since 2006 and 2009. Although this project could have some measured influence on the next update study, this update was not influenced by recent nourishment. The area on Holden Beach with the highest erosion is adjacent to Lockwood Folly Inlet (located on right side of the graph) where setback factors

transition from 2 to 6 approaching Lockwood Folly Inlet (Figures 16 & 17). Overall, where factors were two feet per year in 2011, they continue to be two, however, Setback Factors are slightly higher adjacent to Lockwood Folly Inlet (range from 2 to 6 ft./yr.).

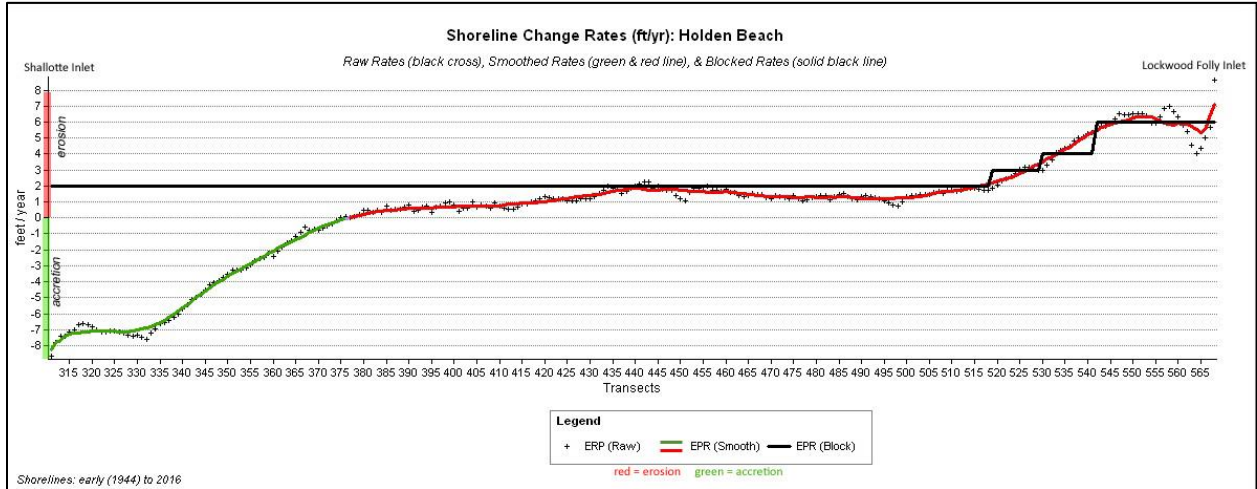


Figure 16. Holden Beach shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

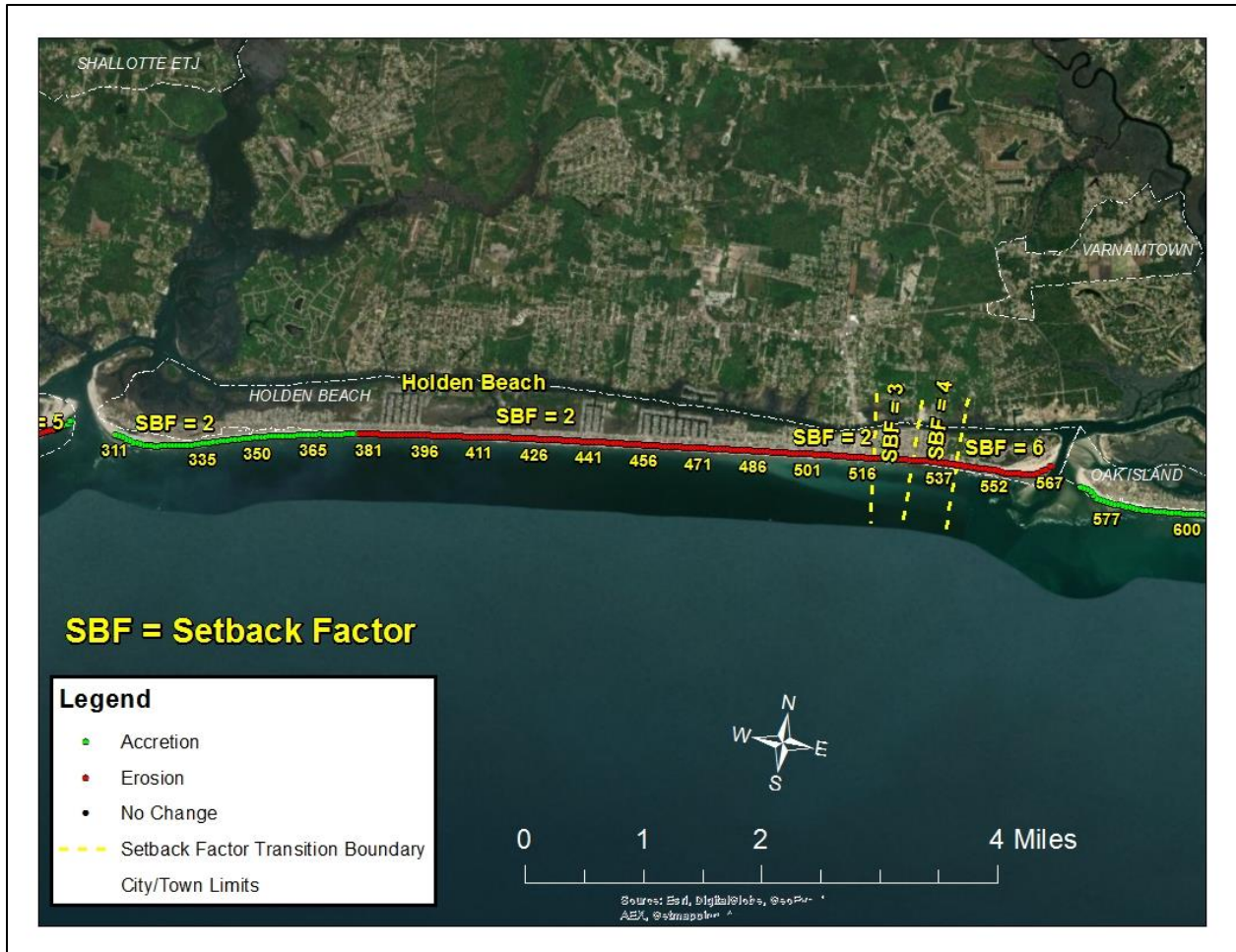


Figure 17. Holden Beach. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Oak Island

The Town of Oak Island has a south-facing beach with approximately 9.3 miles of oceanfront shoreline. Approximately 6.5 miles (70.7 percent) resulted in measured accretion, while the remaining 2.6 miles (28.6 percent) demonstrated measured erosion (Figure 18). Although the maximum measured erosion was 2.5 feet per year (transect # 861, near Oak Island/Caswell Beach Town limits), the average is less than 1.0 foot per year. The setback factor for the entire oceanfront shoreline is two (2) (Figure 19).

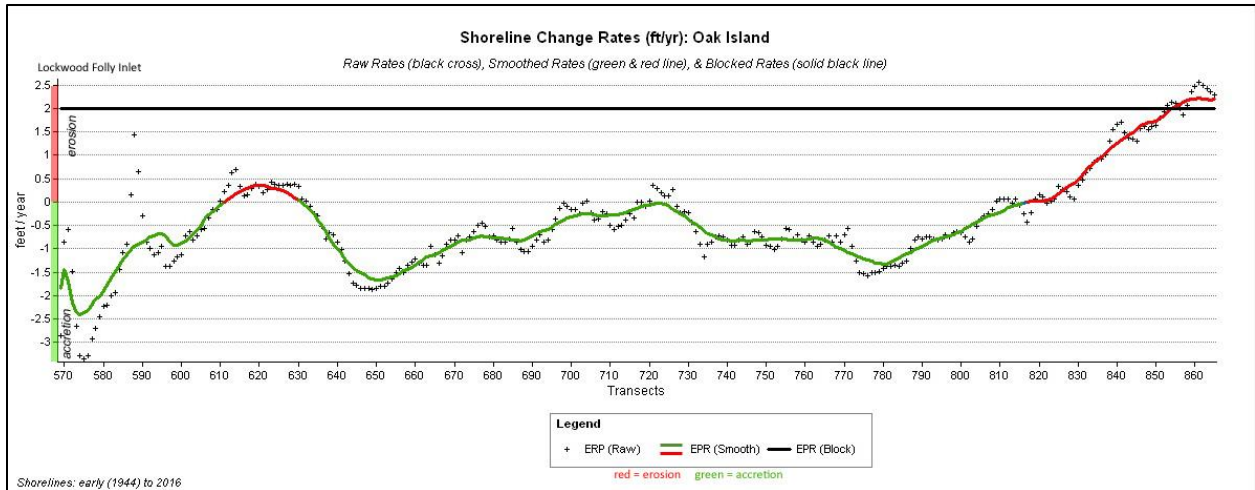


Figure 18. Oak Island shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

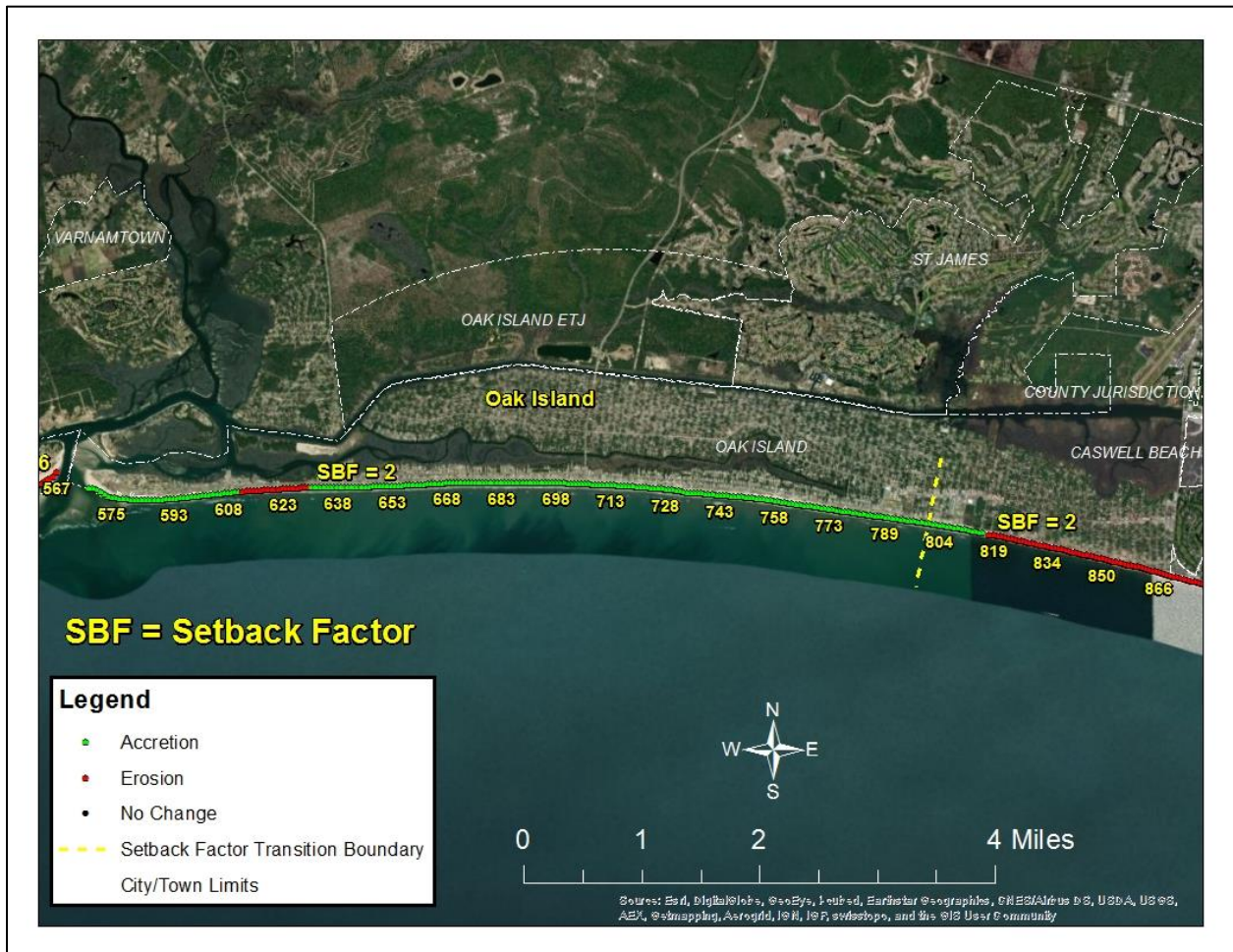


Figure 19. Oak Island. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Caswell Beach and Fort Caswell

Caswell Beach and Fort Caswell have combined oceanfront shorelines totaling 3.5 miles. Approximately 2.3 miles (65.5 percent) resulted in measured accretion, while 1.2 miles (34.5 percent) resulted in measured erosion (Figure 20). The average shoreline change rate was just under two feet per year (1.6), and the calculated setback factor is two (2) (Figure 21).

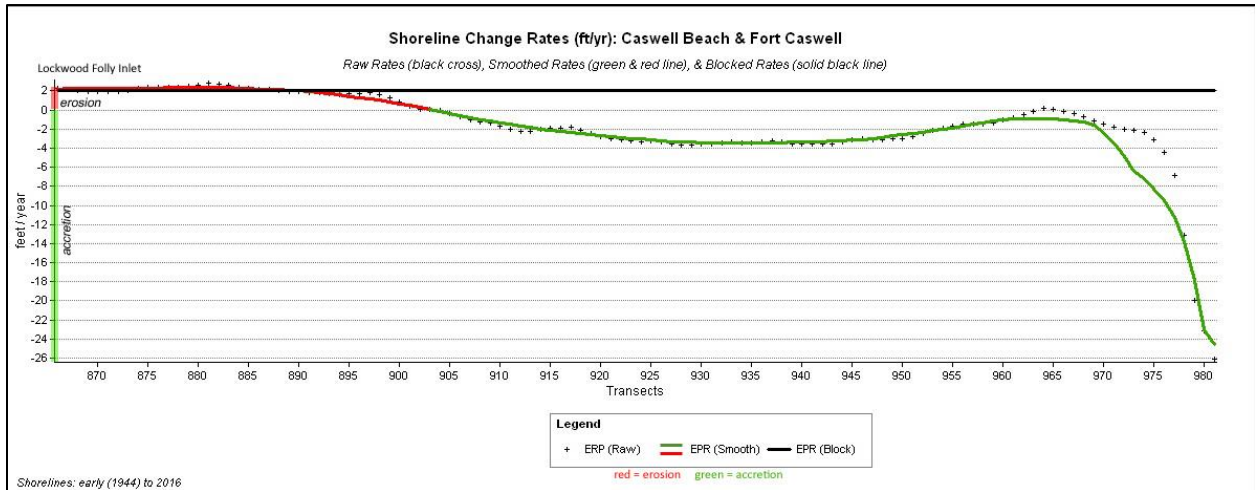


Figure 20. Caswell Beach and Fort Caswell shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

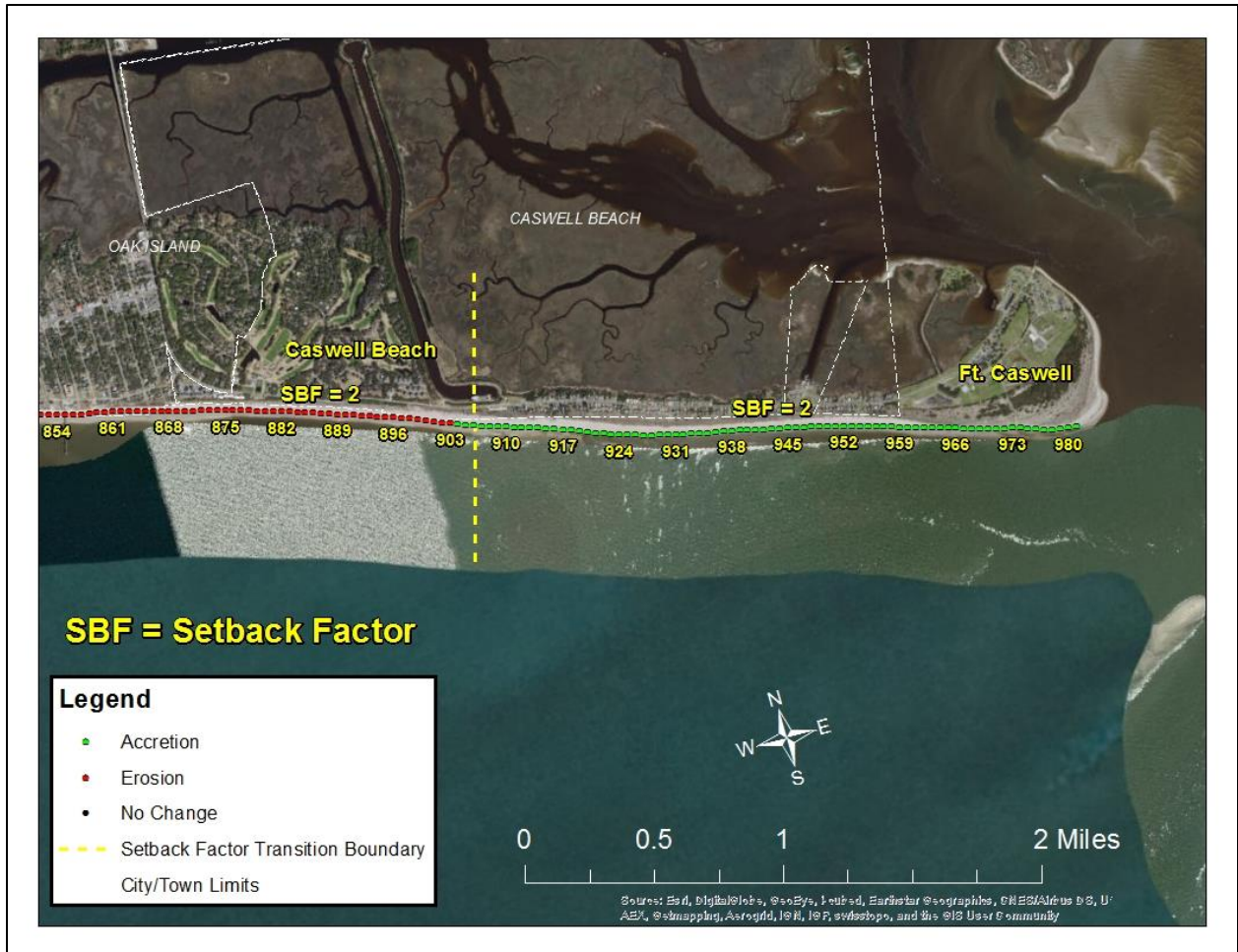


Figure 21. Caswell Beach and Fort Caswell. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Bald Head Island

Bald Head Island's "south-beach" is the last south-facing shoreline in Brunswick County just before transitioning to east-facing beaches at Cape Fear. This 3.2-mile oceanfront shoreline is the region's most dynamic, the state's second most dynamic developed shoreline, and has demonstrated consistently high erosion rates throughout all studies. However, with the completion of the terminal groin on south-beach and adjacent to the Cape Fear Inlet (near transect #985) in 2015, continued routine maintenance of beach east of the groin, and the groin field in the same region, all appear to have collectively lower rates slightly compared to previous studies for the approximate one-half mile segment of the shoreline at the west end of south-beach (average 3.4 feet per year). Overall, shoreline change rates for south-beach are generally

consistent with those from earlier studies where the average erosion rate is 3.9 feet per year (Figure 22). Blocked shoreline changes rates (setback factors) ranged between 2 and 13 and averaged approximately 4 feet per year. Setback factors did decrease for approximately 0.4 miles (13.6 percent) of shoreline (adjacent to terminal groin), but this shoreline position is dominated by erosional processes and resulted in an increase in setback factors for 0.9 miles of shoreline (28.2 percent) (Figures 22 and 23).

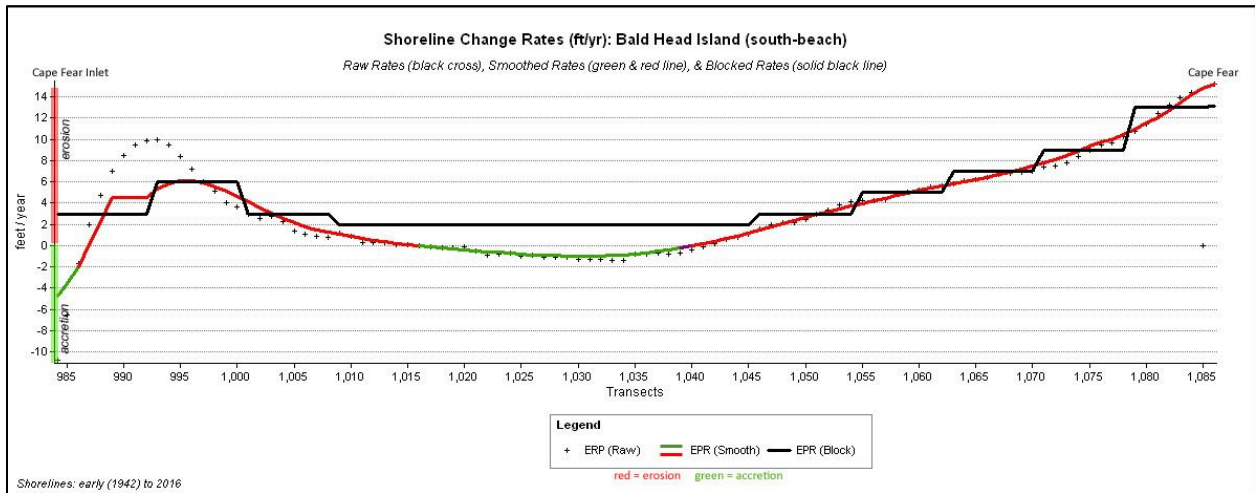


Figure 22. Bald Head Island (“south-beach”) shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

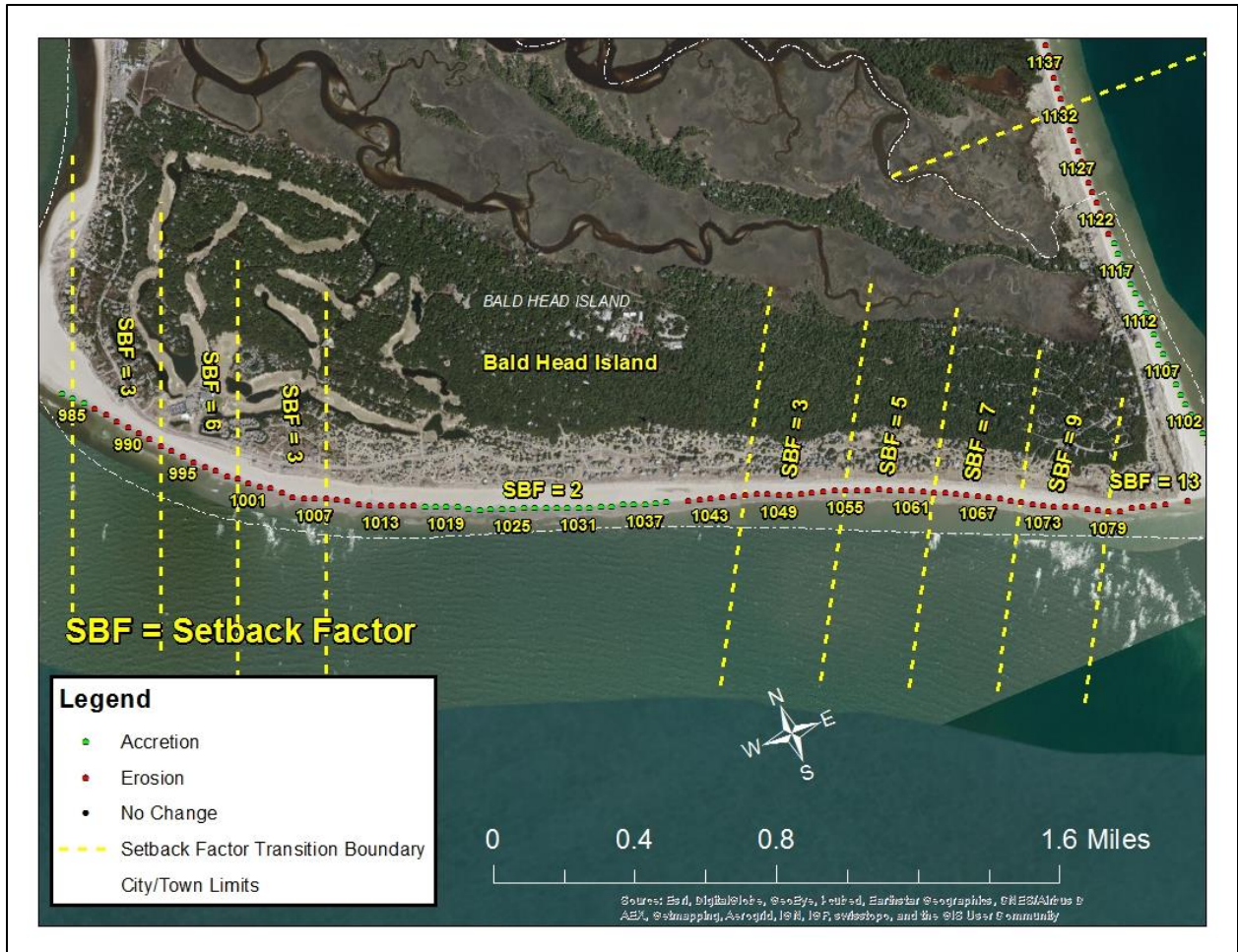


Figure 23. Bald Head Island’s south-beach. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph’s x-axis transect numbers.

Moving from Bald Head Island’s south beach to east beach while rounding Cape Fear the data show an erosion-accretion pivot point along the shoreline. Bald Head Island’s east beach under normal conditions has been demonstrated through the data to be accretional with shoreline change rate factors equal to two feet per year, and setback factors equal to two (Figures 24 and 25).

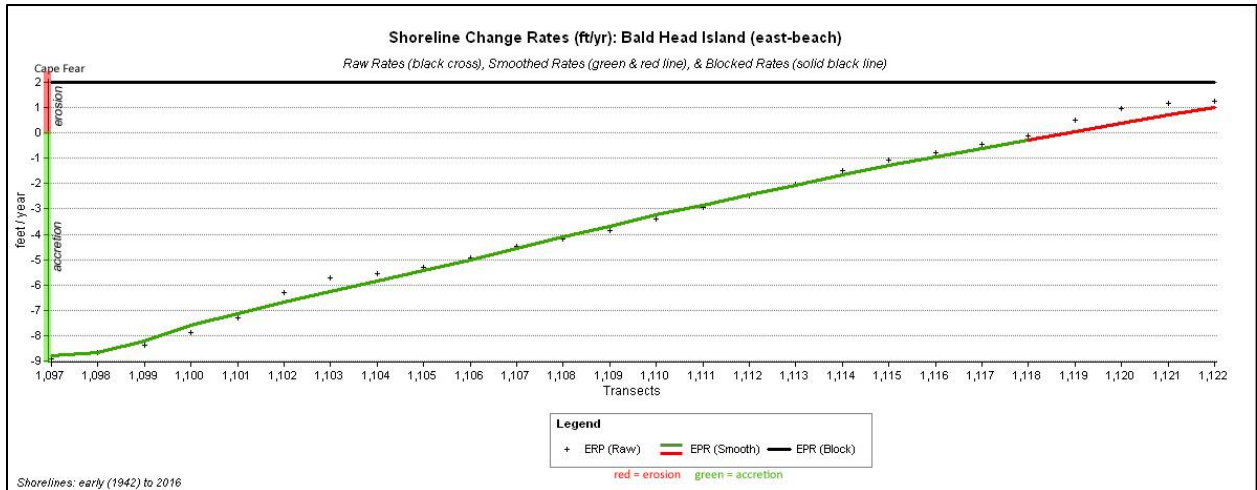


Figure 24. Bald Head Island’s east-beach shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

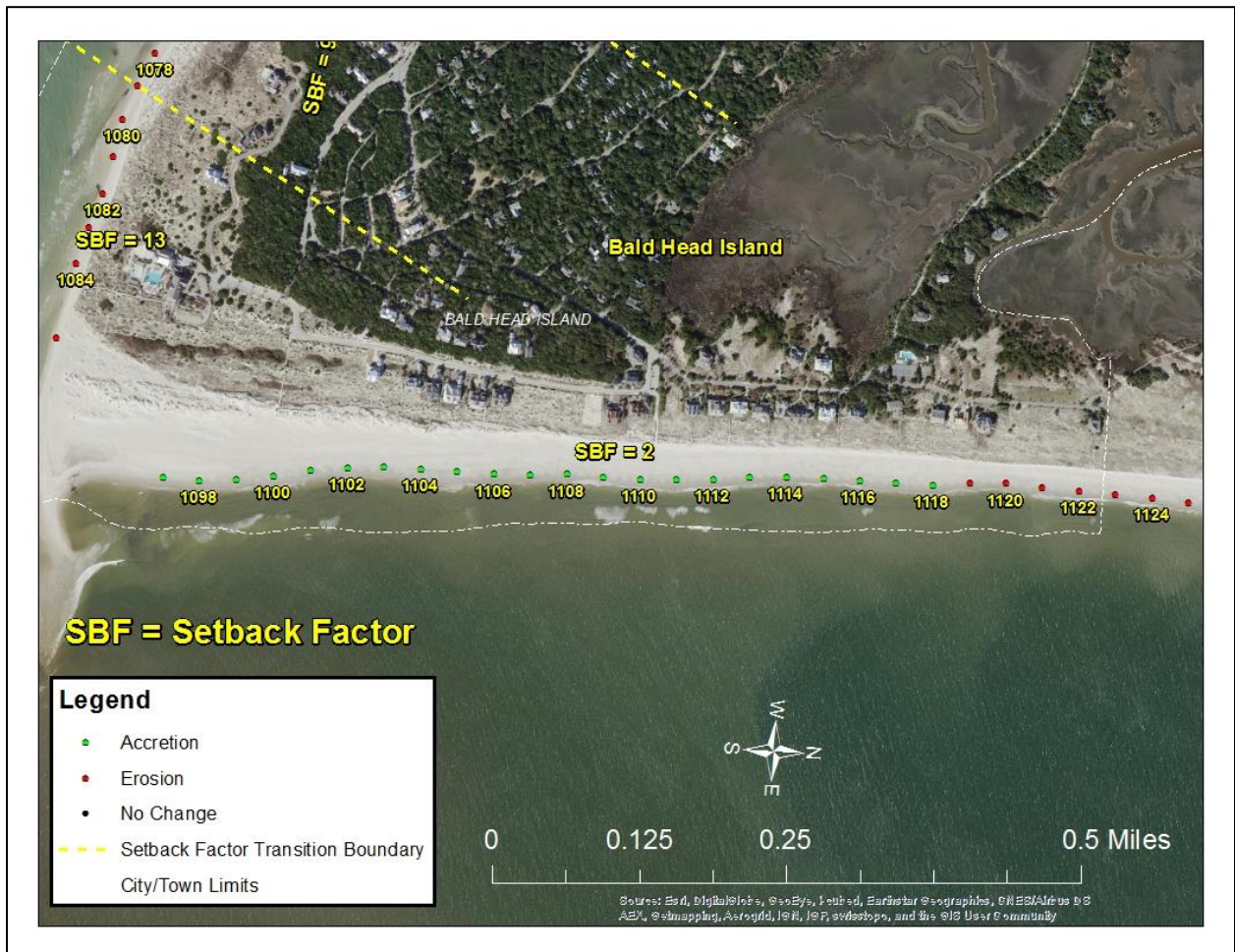


Figure 25. Bald Head Island’s east-beach. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Zeke's Island and Fort Fisher State Park

Moving northward towards the now closed Corncake Inlet, which formally separated Bald Head and Zeke's islands, the oceanfront shoreline at Zeke's Island and Fort Fisher State Park demonstrates consistent erosional characteristics. The extent of this shoreline segment is 8.4 miles, where 3.4 miles (41.1 percent) of this shoreline demonstrates accretional characteristics, while 4.9 miles (58.9 percent) is eroding. The average shoreline change rate is less 1 foot per year (erosion) with a median rate of 2.6 feet per year (erosion), and blocked shoreline change rates (setback factors) ranging between 2 and 8 with an average 4.0 feet per year (Figures 26, 27, and 28).

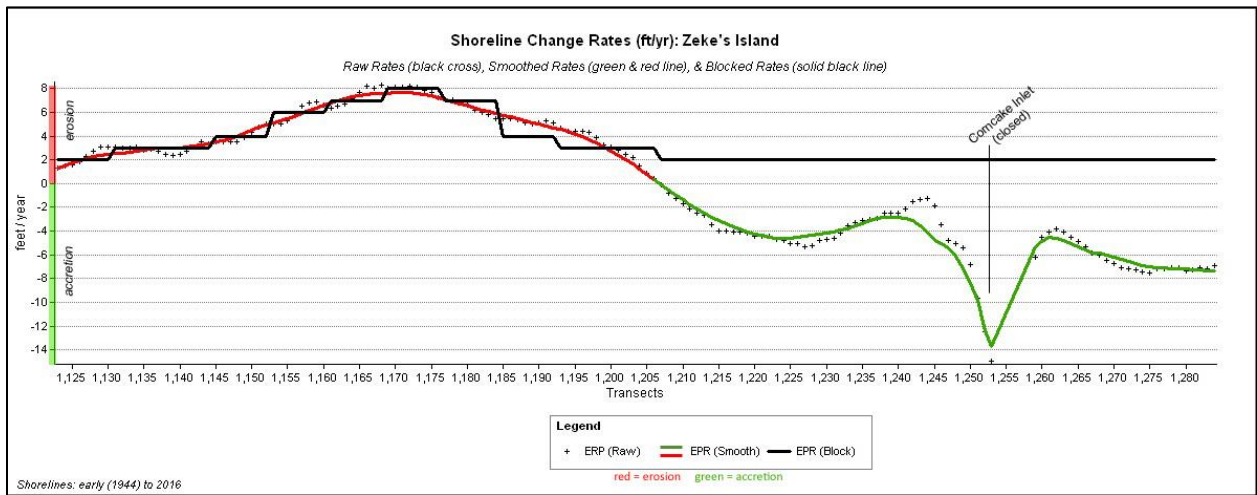


Figure 26. Zeke's Island (between Bald Head Island and Fort Fisher) shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

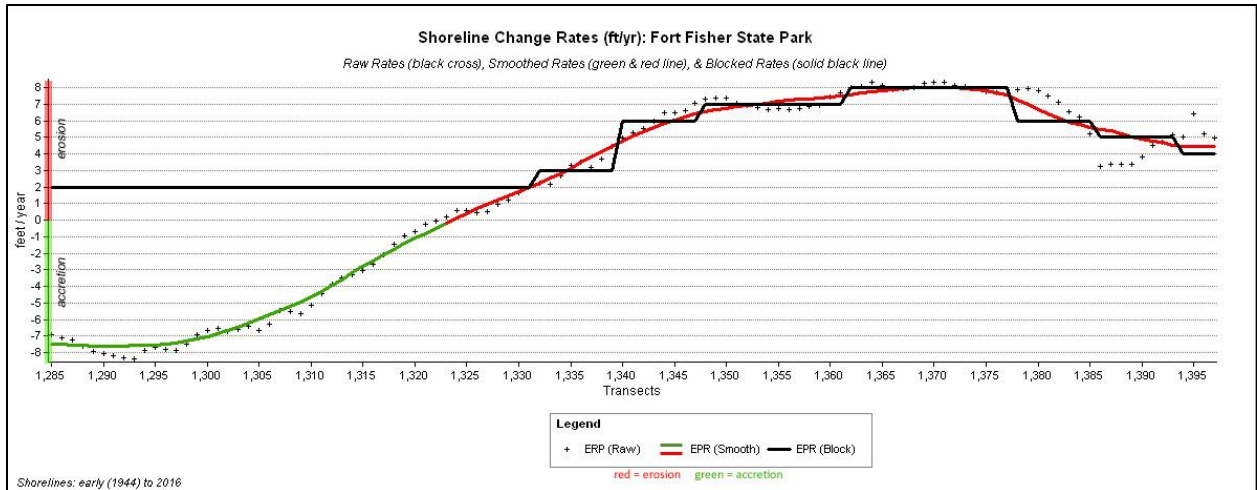


Figure 27. Fort Fisher State Park shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

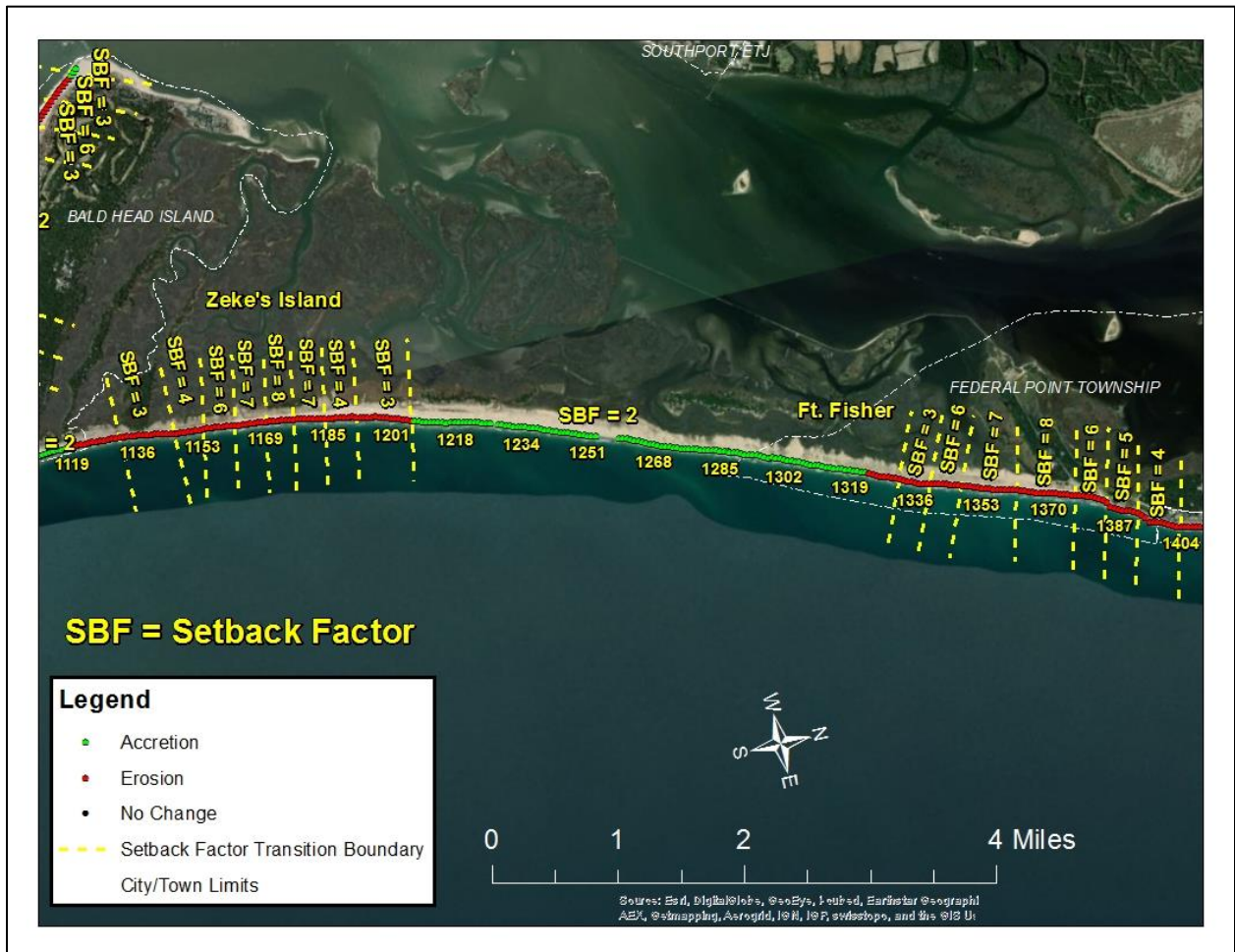


Figure 28. Zeke's Island and Fort Fisher State Park. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Kure Beach

Kure Beach is an east-facing beach with 2.9 miles of oceanfront shoreline where approximately one mile (35.1 percent) resulted in measured accretion, and the remaining 1.8 miles (63.8 percent) measured erosion (Figure 29). The highest rates at Kure beach are located adjacent to Fort Fisher State Park and the Town’s limit where erosion rates peaked at 6.4 feet per year and resulted in a setback factor of four. Compared to the 2011 study, there was a slight decrease for a 500 feet section of shoreline near Fort Fisher State Park, while the remaining 2.8 miles of shoreline experienced no change in setback factor values (Figures 29 and 30).

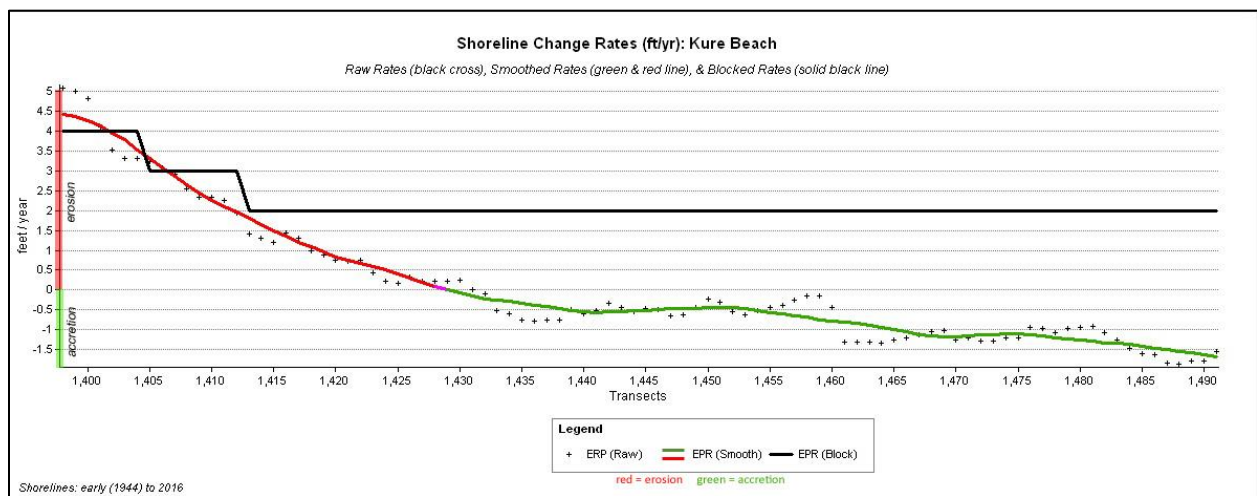


Figure 29. Kure Beach shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

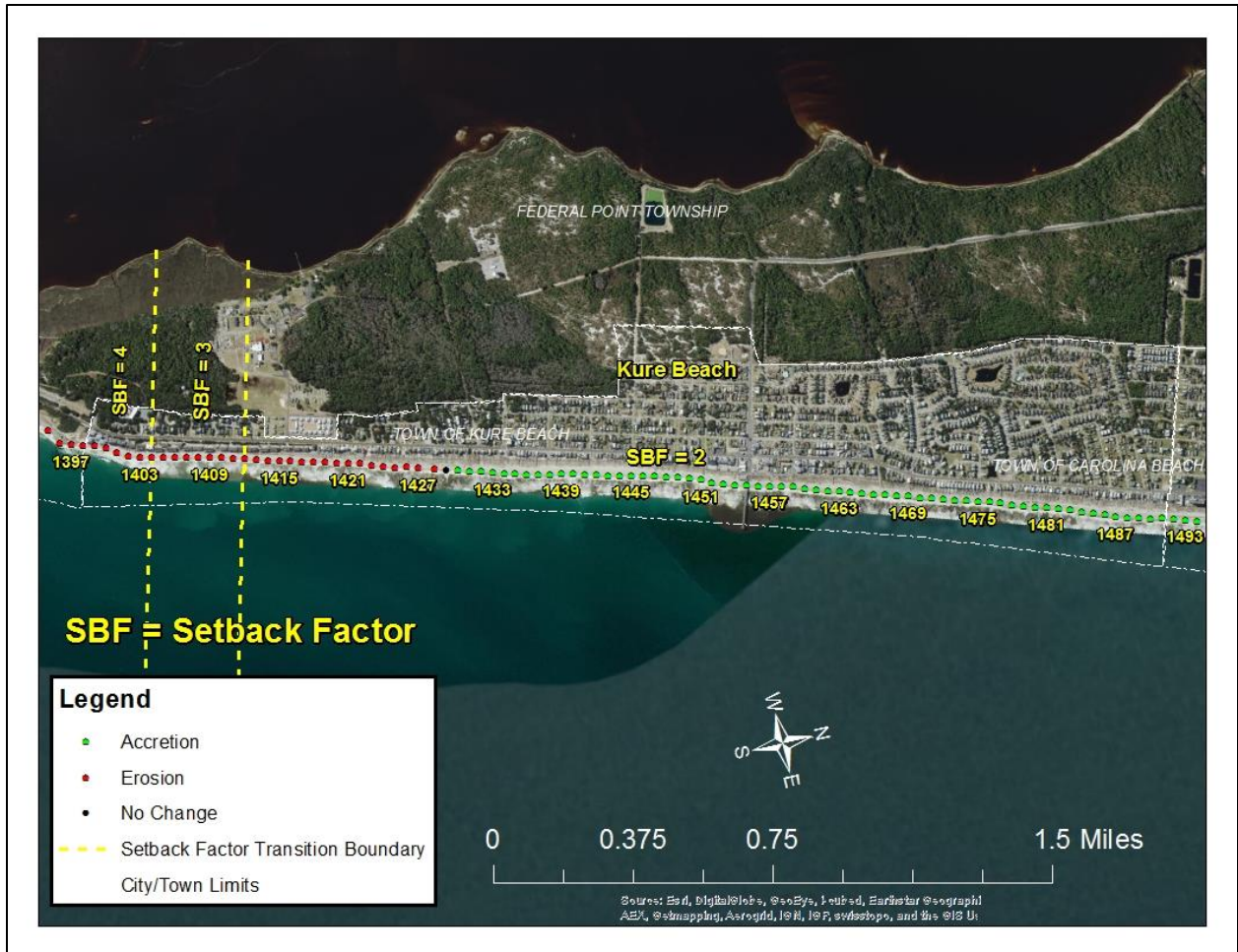


Figure 30. Kure Beach. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Carolina Beach

Carolina Beach is an east-facing beach with approximately four miles of oceanfront shoreline where 2.5 miles (65.1 percent) resulted in measured accretion, while the remaining 1.3 miles (34.1 percent) resulted in measured erosion. The average blocked erosion rate at Carolina Beach is 2.5, however, for most of the developed shoreline, the setback factor is 2. (Figure 31 and 32).

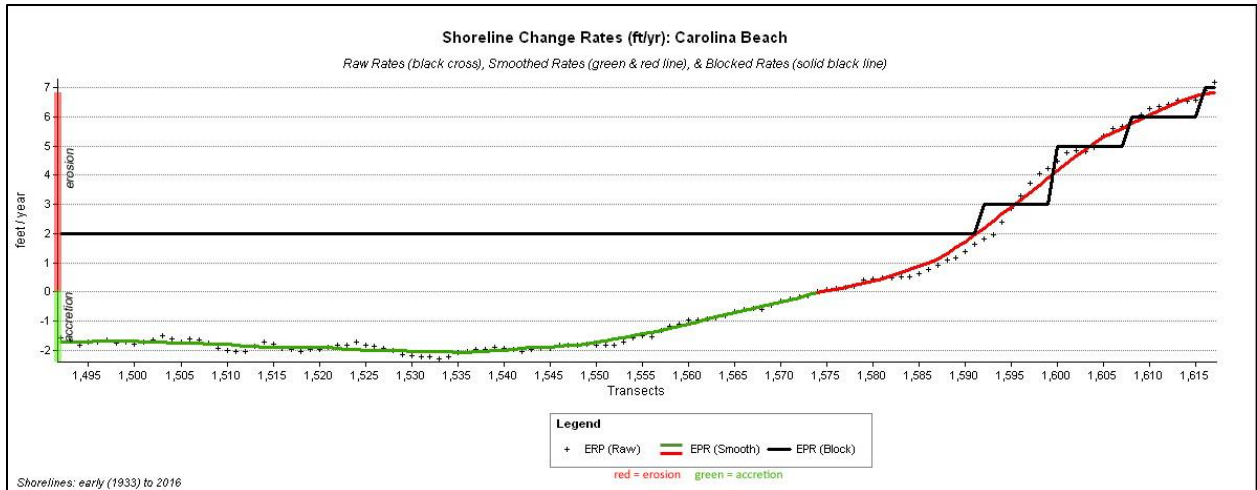


Figure 31. Carolina Beach shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

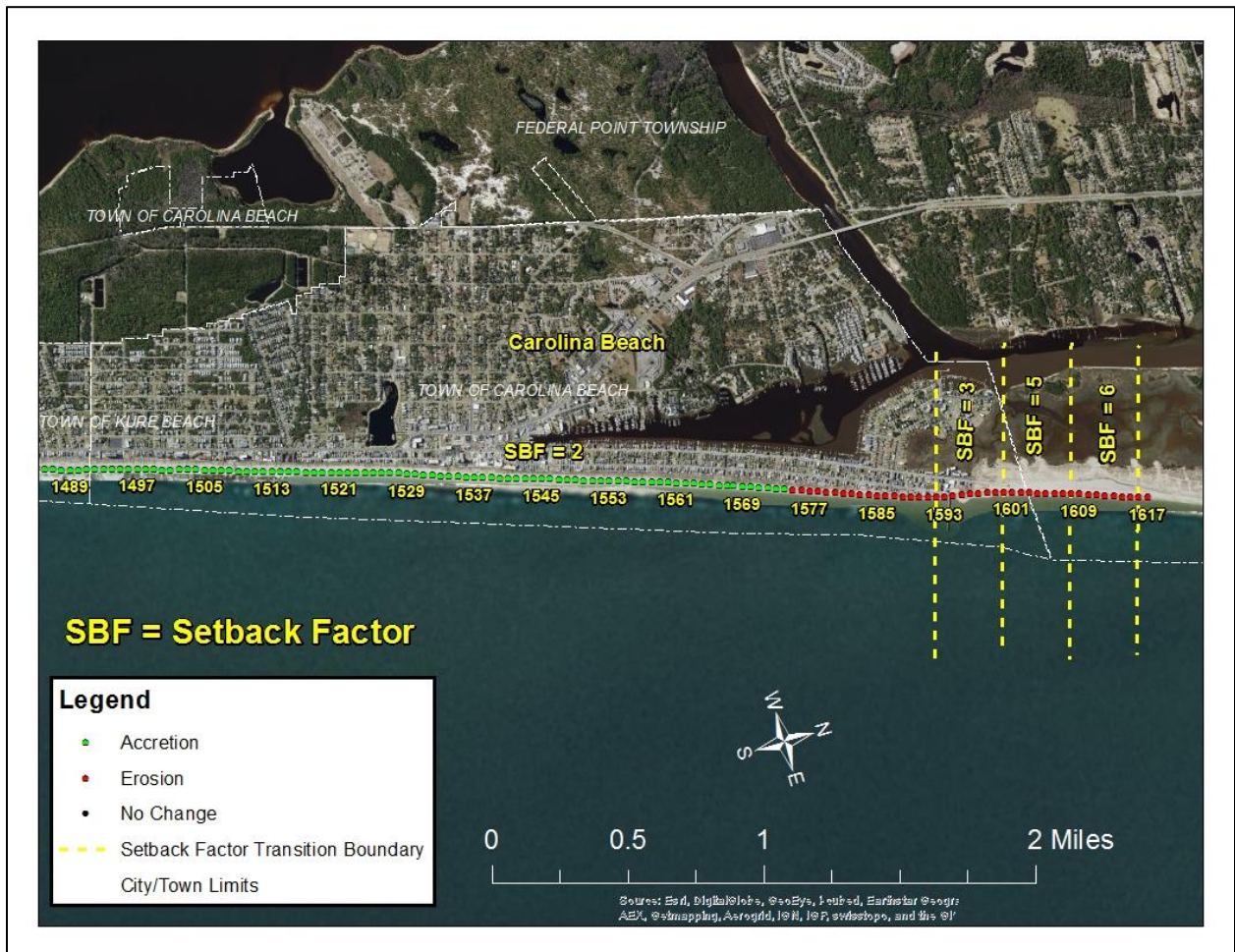


Figure 32. Carolina Beach. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Masonboro Island

Masonboro Island is an undeveloped barrier island. Its oceanfront shoreline is east facing and extends 7.8 miles with Carolina Beach inlet on its southern end (left side on the graph) and Masonboro inlet on its northern flank (right side on the graph). Approximately 7.7 miles (98.4 percent) of its shoreline resulted in measured erosion, while the remaining 0.1 miles (1.6 percent) resulted in measured accretion. The area with measured accretion is adjacent to the rock navigation jetty at Masonboro inlet where the fillet is regularly maintained; thus, artificially reducing shoreline change. The average blocked erosion rate at Masonboro Island is 7.0 feet per year, the maximum is 14 feet per year, and the minimum is two feet per year (Figure 33 and 34). The highest erosion factor occurs on the end adjacent to Carolina Beach Inlet.

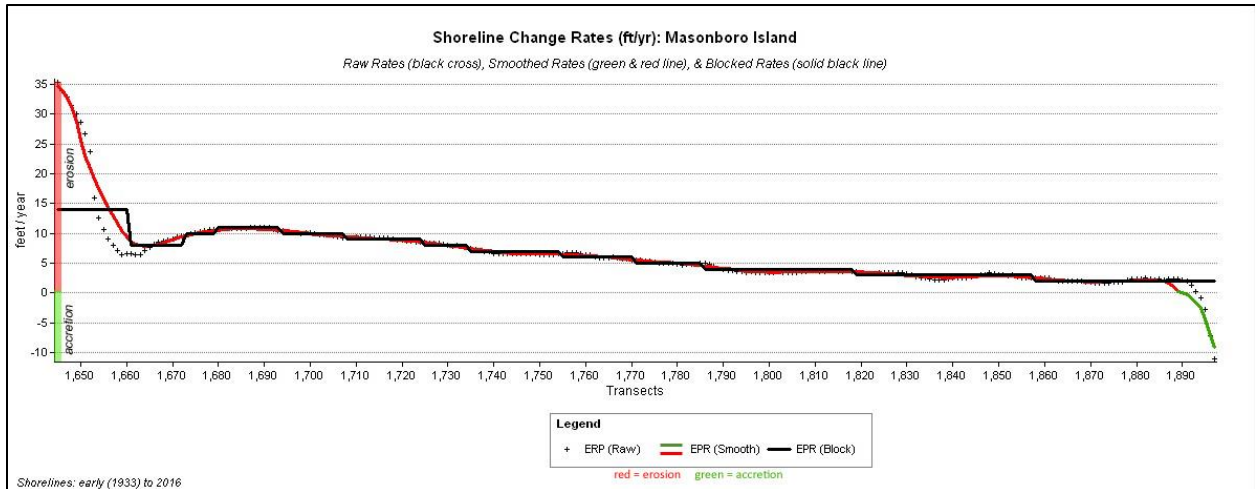


Figure 33. Masonboro Island Bird Island and Sunset Beach shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

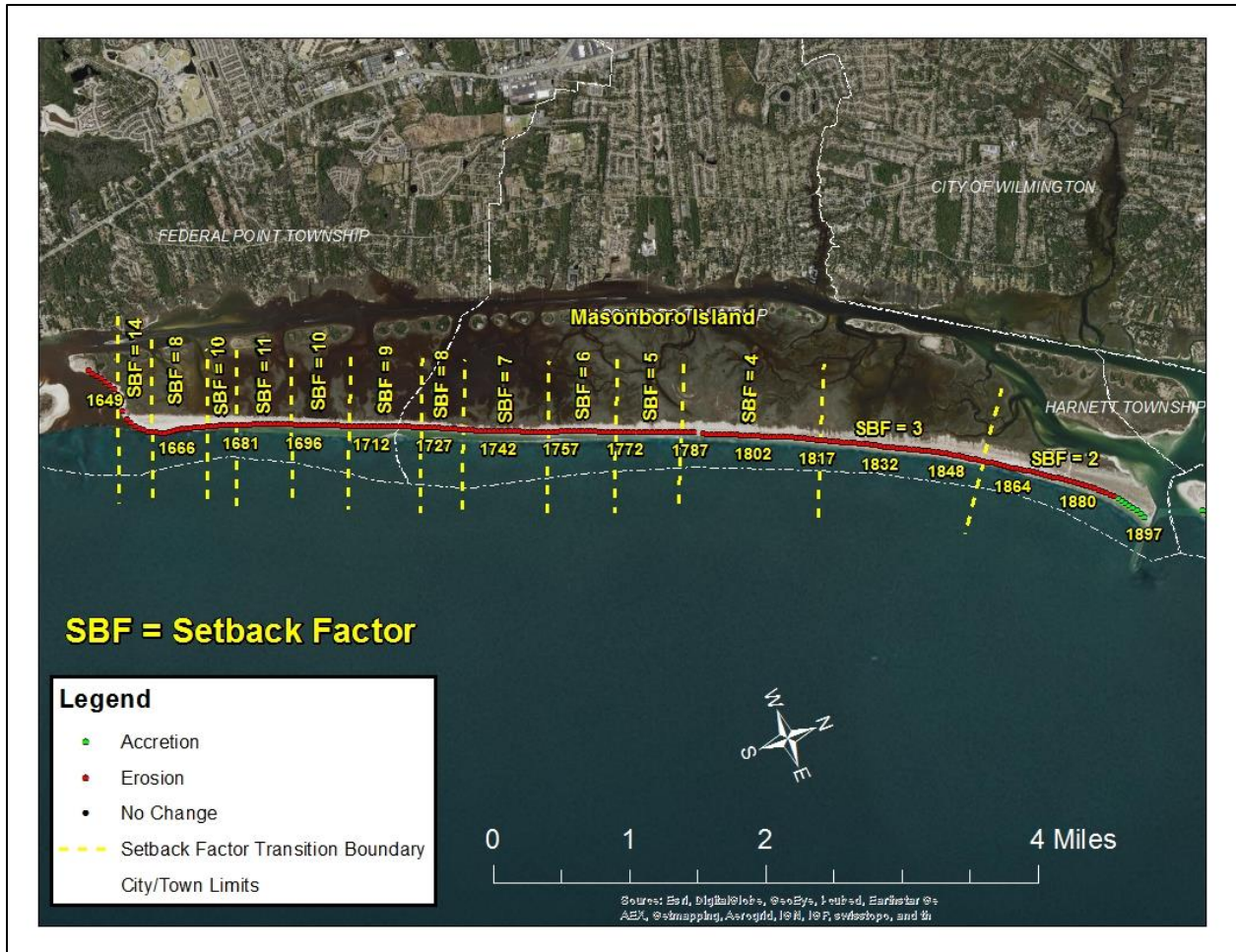


Figure 34. Masonboro Island. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Wrightsville Beach

Wrightsville Beach has approximately 4.5 miles of oceanfront shoreline, is east-facing, and flanked by two inlets (Masonboro and Mason). Masonboro Inlet is hardened with two rock navigational jetties (one on each side). Wrightsville Beach is routinely maintained as part of a USACE Storm Damage Reduction project. As a result, approximately 4.0 miles (95.6 percent) of its shoreline resulted in measured accretion, while the remaining 0.1 miles (2.2 percent) resulted in measured erosion. The average, maximum, and minimum blocked erosion rate at Wrightsville Beach is two feet per year (Figure 35 and 36). There is a data gap because the early shoreline reflects a time (1933) when Moore's Inlet was open.

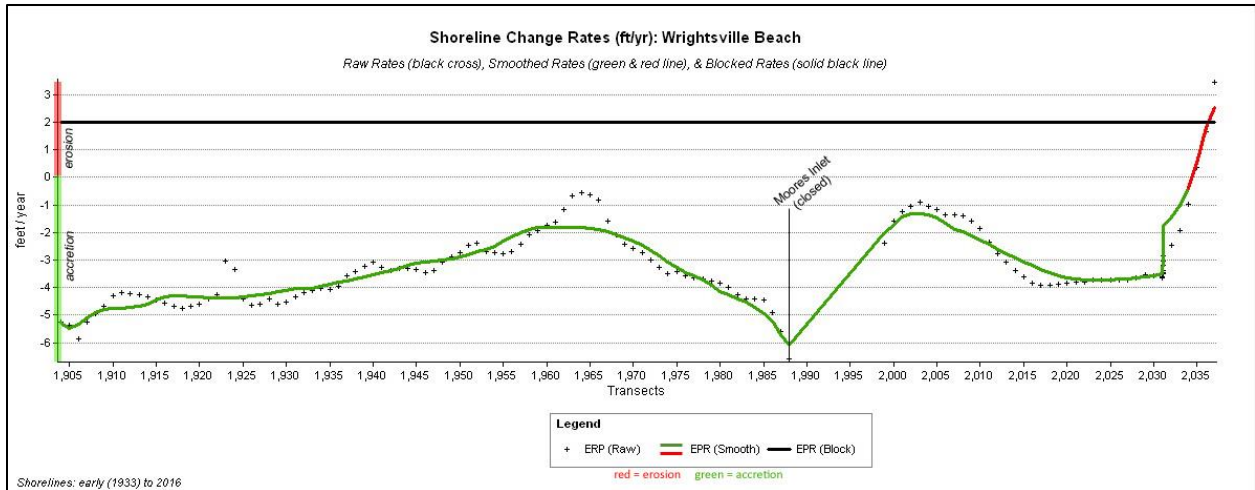


Figure 35. Wrightsville Beach shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

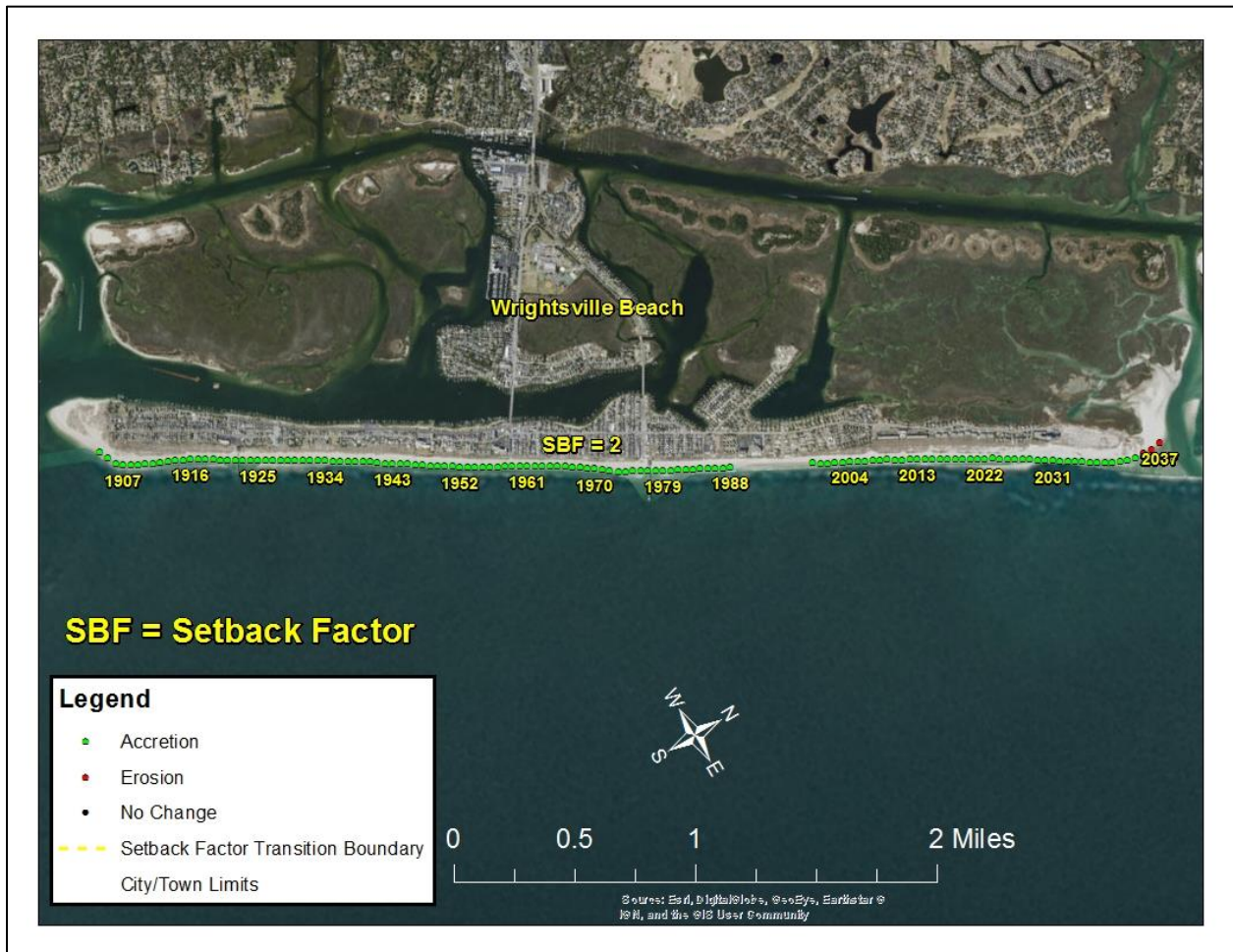


Figure 36. Wrightsville Beach. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Figure Eight Island

Figure Eight Island has approximately 3.6 miles of oceanfront shoreline, is east facing, and flanked by two inlets (Mason and Rich). Approximately 3.6 miles (100 percent) of its shoreline resulted in measured accretion. Erosion was minimized, and accretion measured high as a direct result of beach nourishment. The setback factor for all of Figure Eight Island’s oceanfront is two feet per year (Figure 37 and 38).

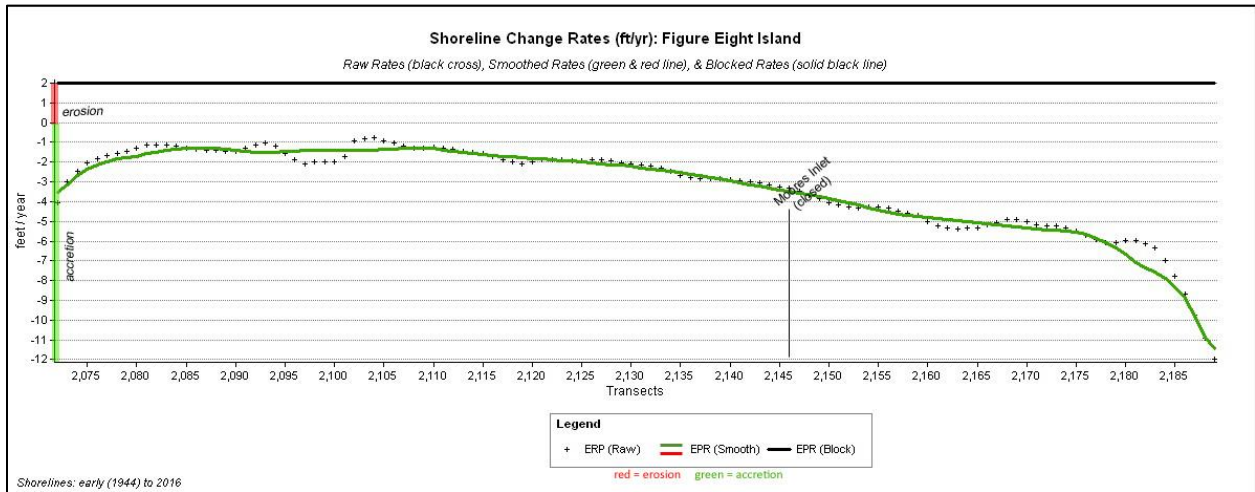


Figure 37. Figure Eight Island shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

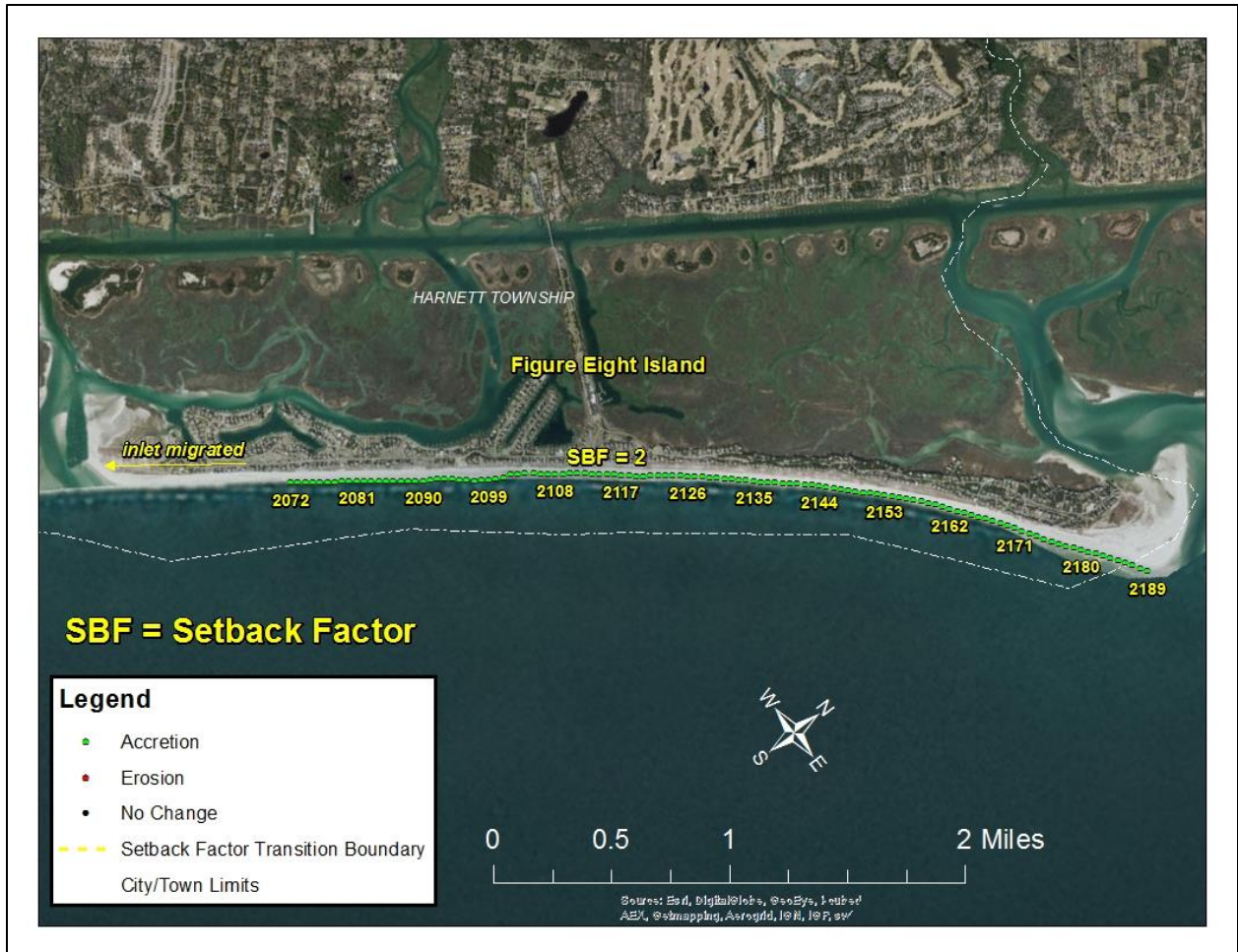


Figure 38. Figure Eight Island. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Lea-Hutaff Island

Lea-Hutaff Island has approximately 3.6 miles of oceanfront shoreline, is east-facing, and flanked by two inlets (Rich and New Topsail). Nearly all its oceanfront shoreline, 3.2 miles (89 percent) resulted in measured erosion characterized as eroding based on results, while the remaining 0.8 miles (22 percent) contains a data gap because of the closure of Old Topsail Inlet, which once separated Lea and Hutaff Islands. The average blocked erosion rate is 9.0 feet per year, the maximum is 10.0 feet per year near New Topsail Inlet (Figure 39 and 40).

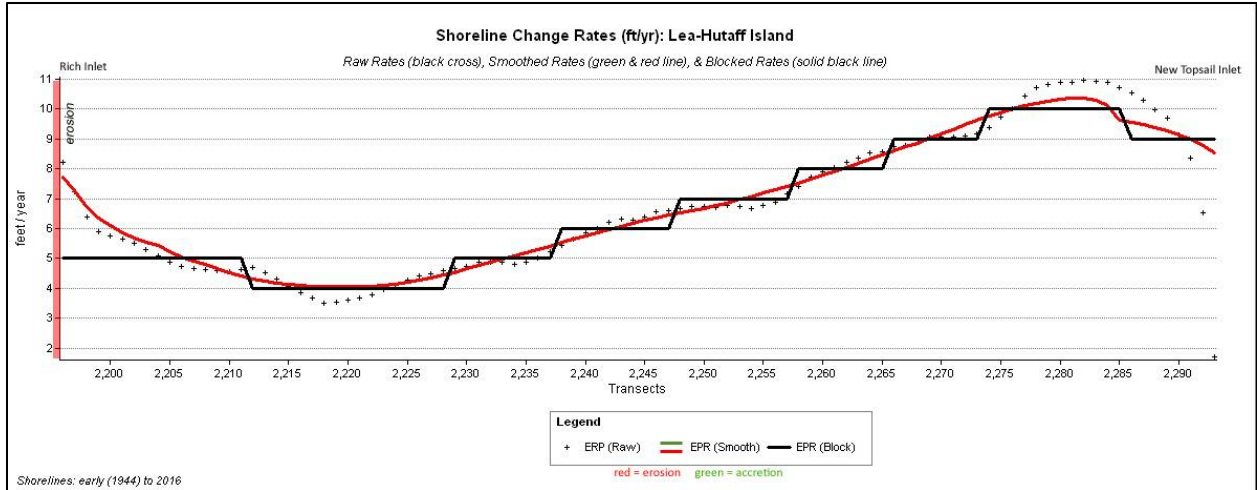


Figure 39. Lea-Hutaff Island shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

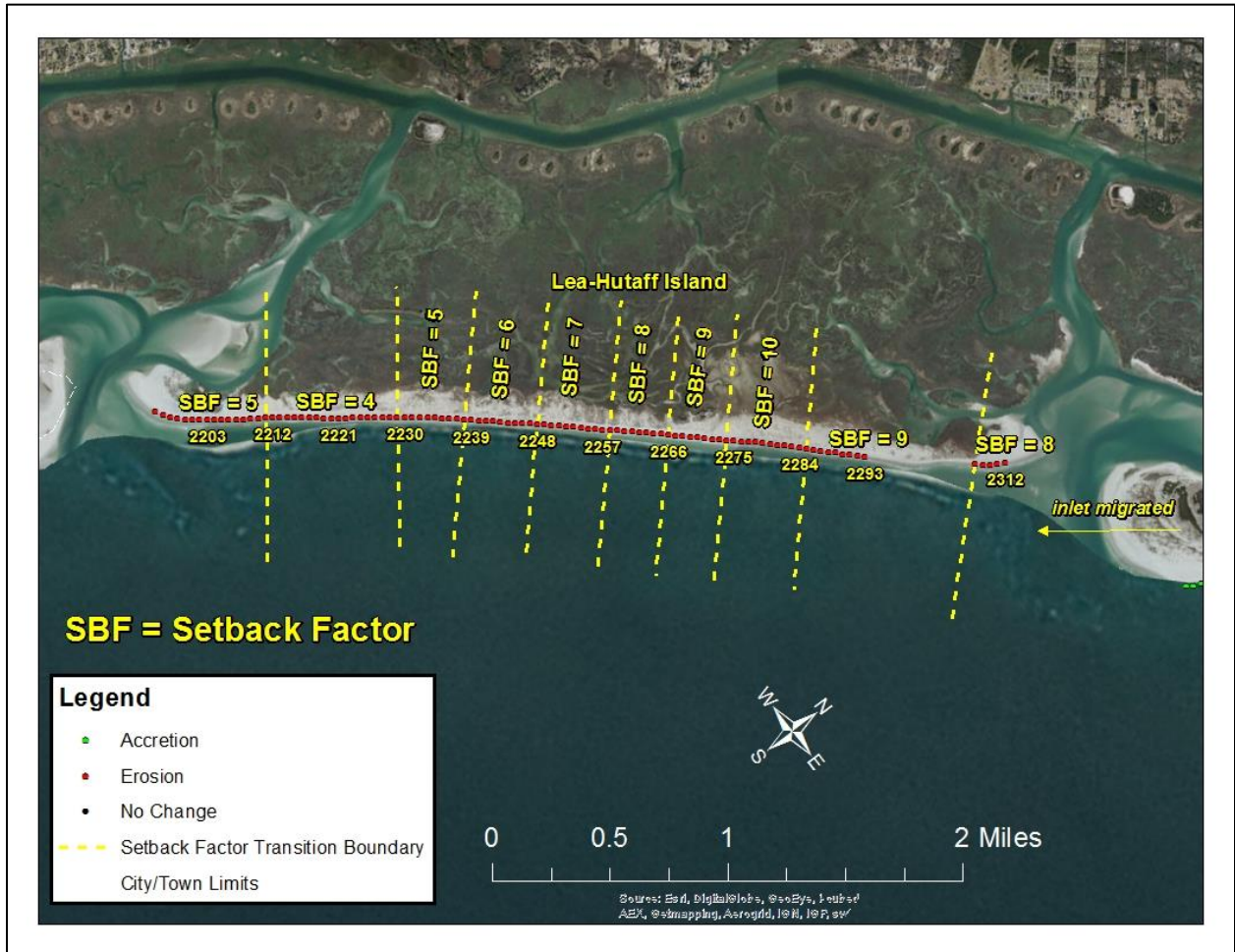


Figure 40. Figure Eight Island. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Topsail Beach

Topsail Island has approximately 22 miles of oceanfront shoreline and is an east-facing barrier island flanked by two inlets (New Topsail and New River). Topsail Beach makes up 28.1 percent (4.8 miles) of its shoreline, Surf City 27.3 percent (6.0 miles), and North Topsail Beach 50.1 percent (11.1 miles).

Approximately 3.9 miles (85.1 percent) of Topsail Beach's ocean shoreline resulted in measured accretion, while 0.5 mile (12.2 percent) resulted in measured erosion. The Town's most recent large-scale beach nourishment project was completed in 2011, which likely reduced actual erosion and increased accretion rates. The average shoreline change rate is 3.6 feet per year (accretion), and the blocked shoreline change rate (Setback Factor) is two feet per year (Figure 41 and 42).

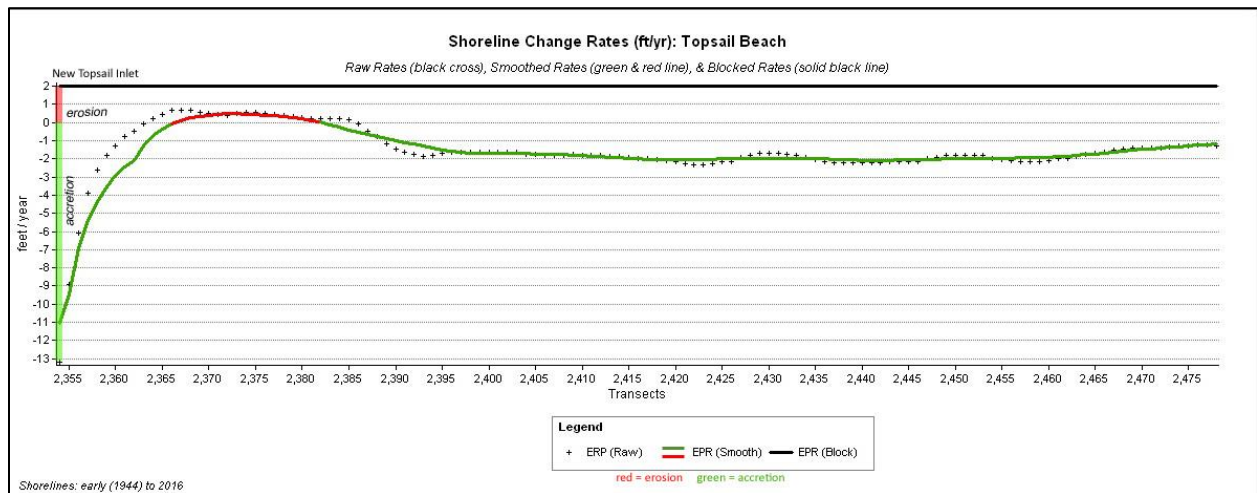


Figure 41. Topsail Beach. shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

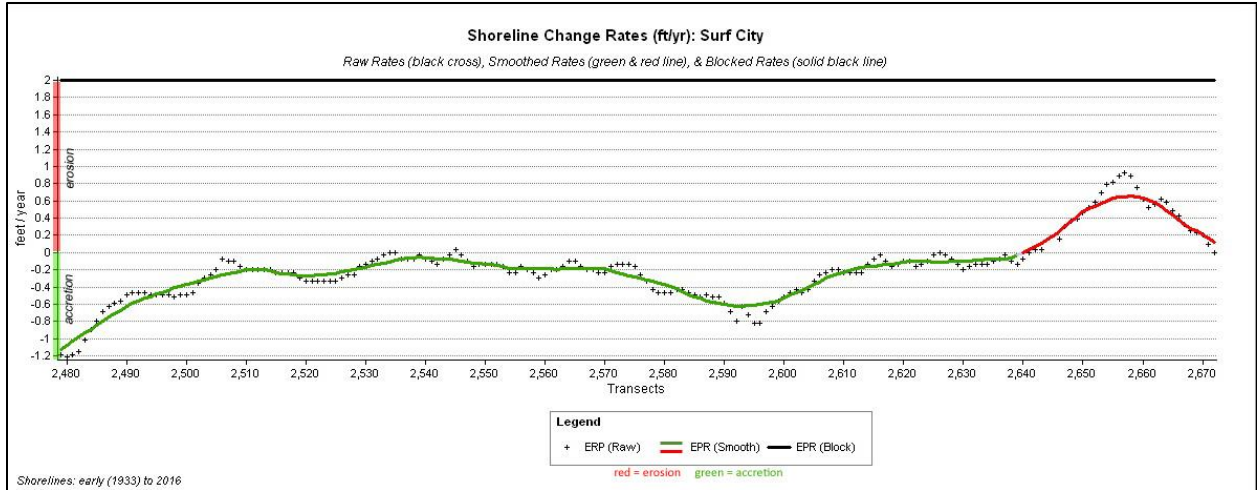


Figure 43. Surf City shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

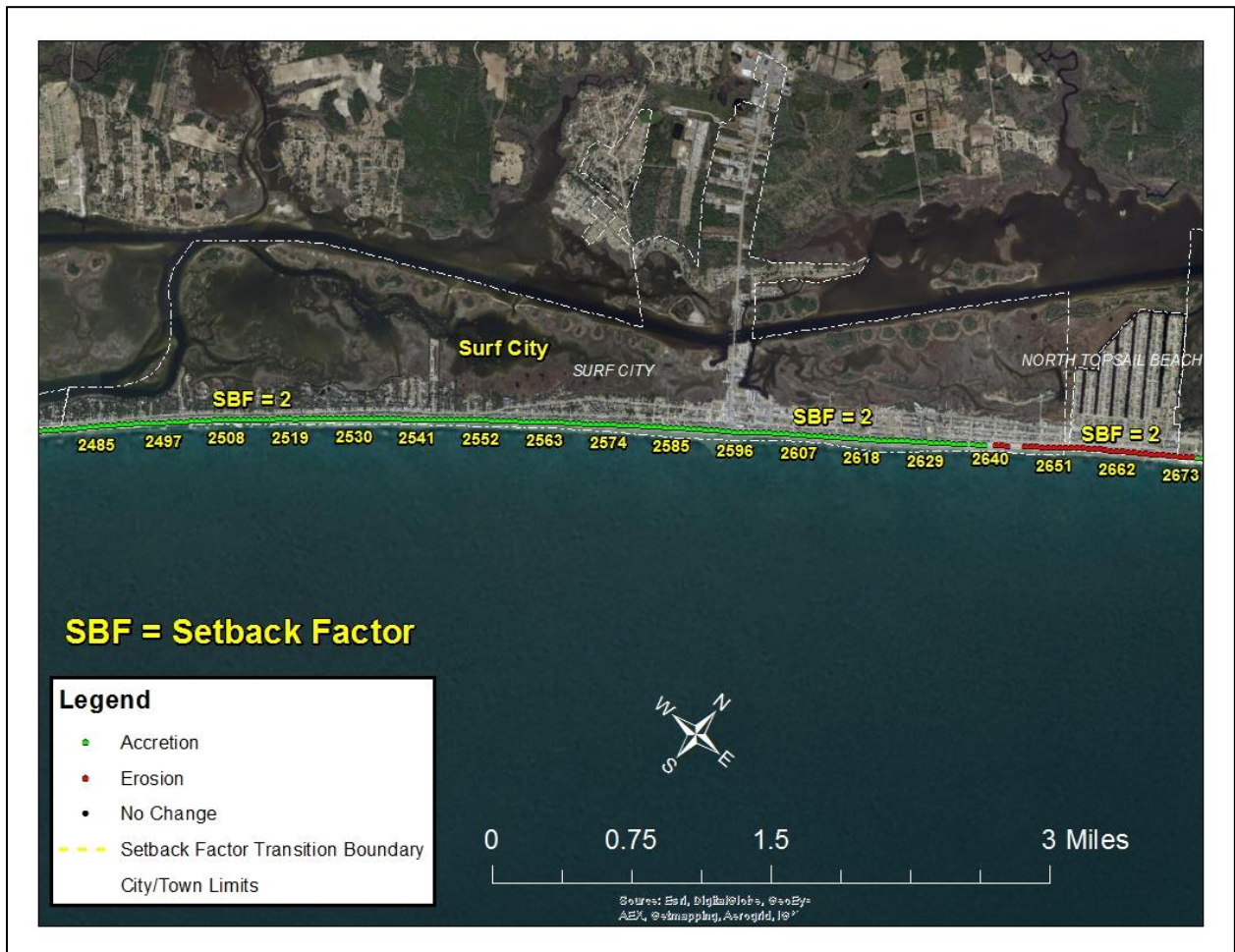


Figure 44. Surf City. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

North Topsail Beach

At North Topsail Beach, approximately 9.3 miles (83.8 percent) of its shoreline resulted in measured erosion, while 1.7 miles (15.4 percent) resulted in measured accretion. The average shoreline change rate is 1.1 feet per year (erosion), and most of the Town’s shoreline (7.4 miles) resulted in a blocked shoreline change rate (setback factor) equal to 2.0 feet per year, and a setback factor equal to 3 for a segment of shoreline nearing New River Inlet (Figure 45 and 46). The area adjacent to New River Inlet has experienced the highest erosion, however, the setback factor is equal to 2 feet per year because existing rules (15A NCAC 07H.0304) require that the setback factor immediately adjacent to an Inlet Hazard Area (IHA) be applied throughout the IHA.

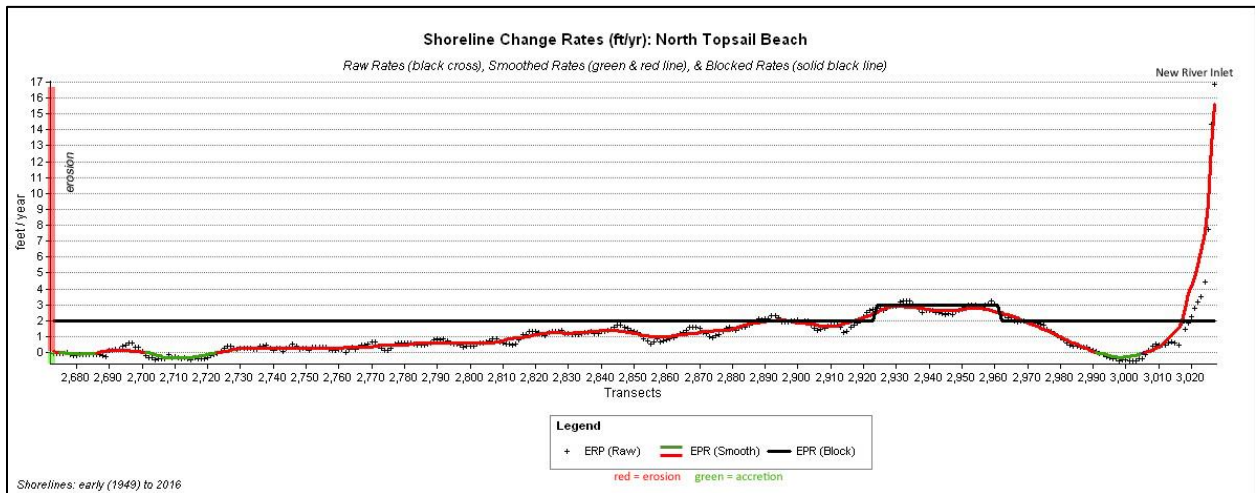


Figure 45. North Topsail Beach shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

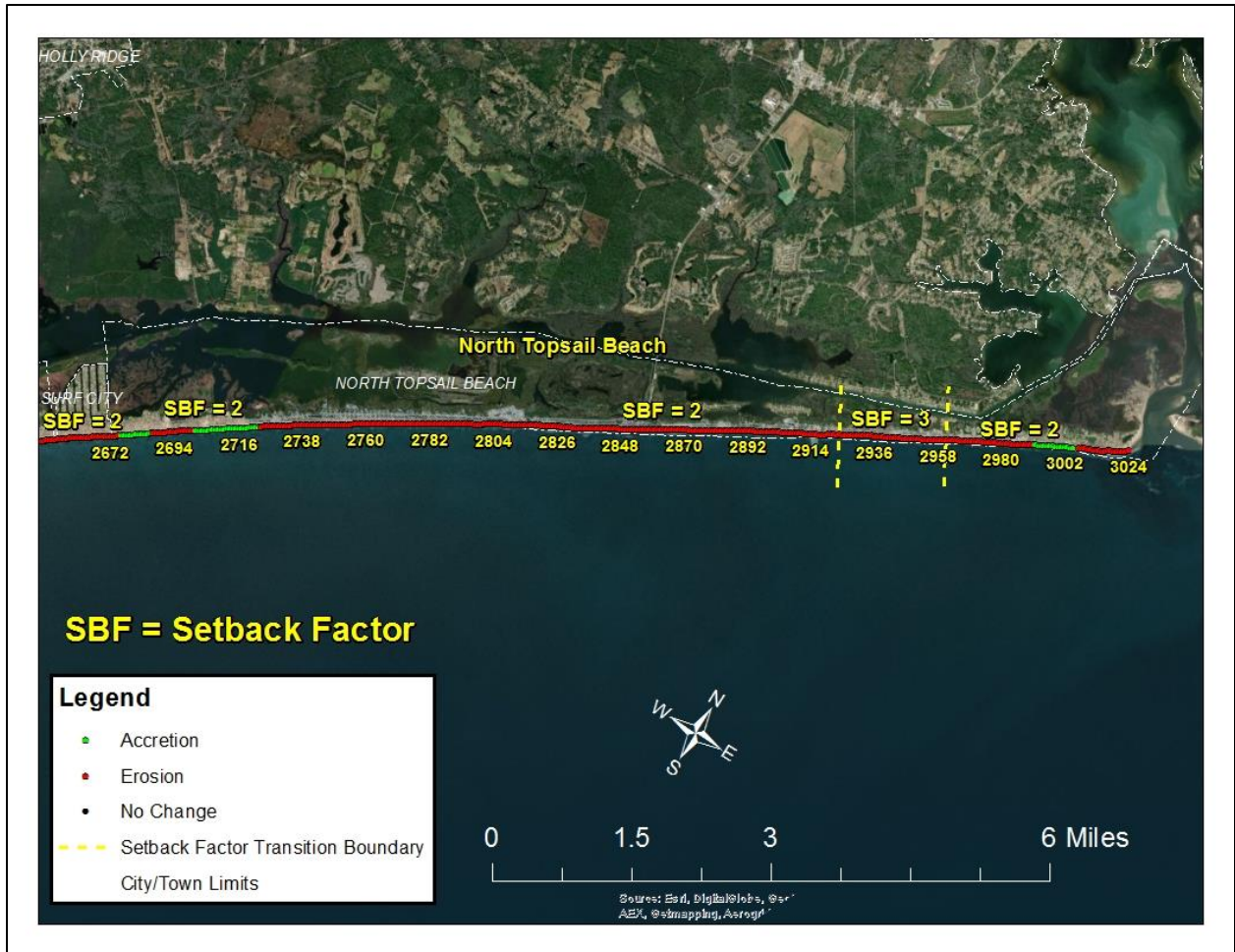


Figure 46. North Topsail Beach. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Onslow Beach

Onslow Beach has approximately 7.3 miles of oceanfront shoreline and is east-facing. Approximately 6.1 miles (83.5 percent) of its shoreline resulted in measured erosion, while 0.8 miles (11.4 percent) resulted in measured accretion. The average blocked erosion rate is 5 feet per year, the maximum is 11 feet per year, and the minimum is two feet per year (Figure 47 and 48). Rates for Onslow Beach were calculated using a 2017 shoreline, and not 2016, because there was a data gap in the 2016 shoreline.

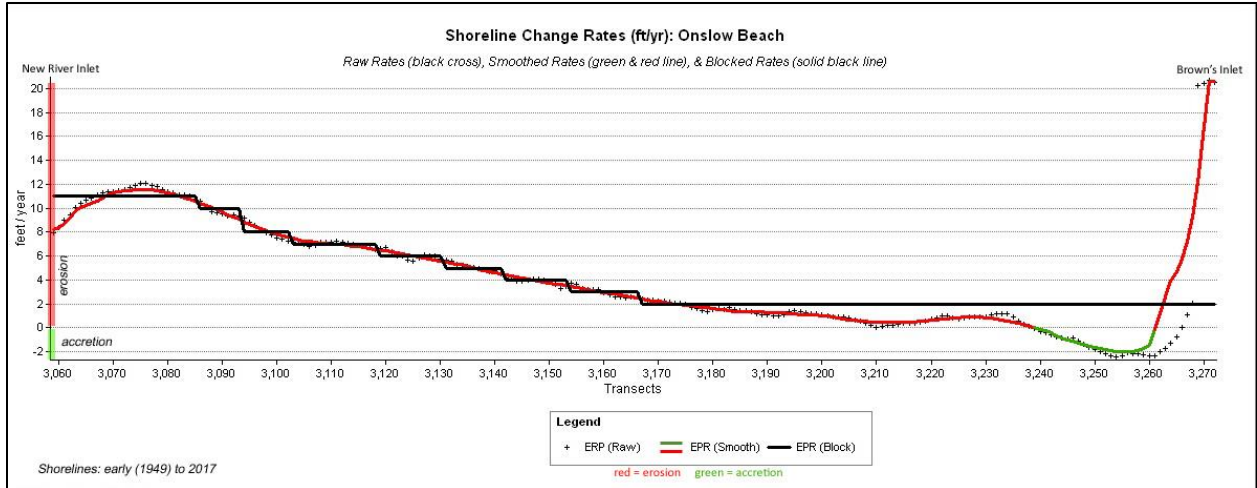


Figure 47. Onslow Beach shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

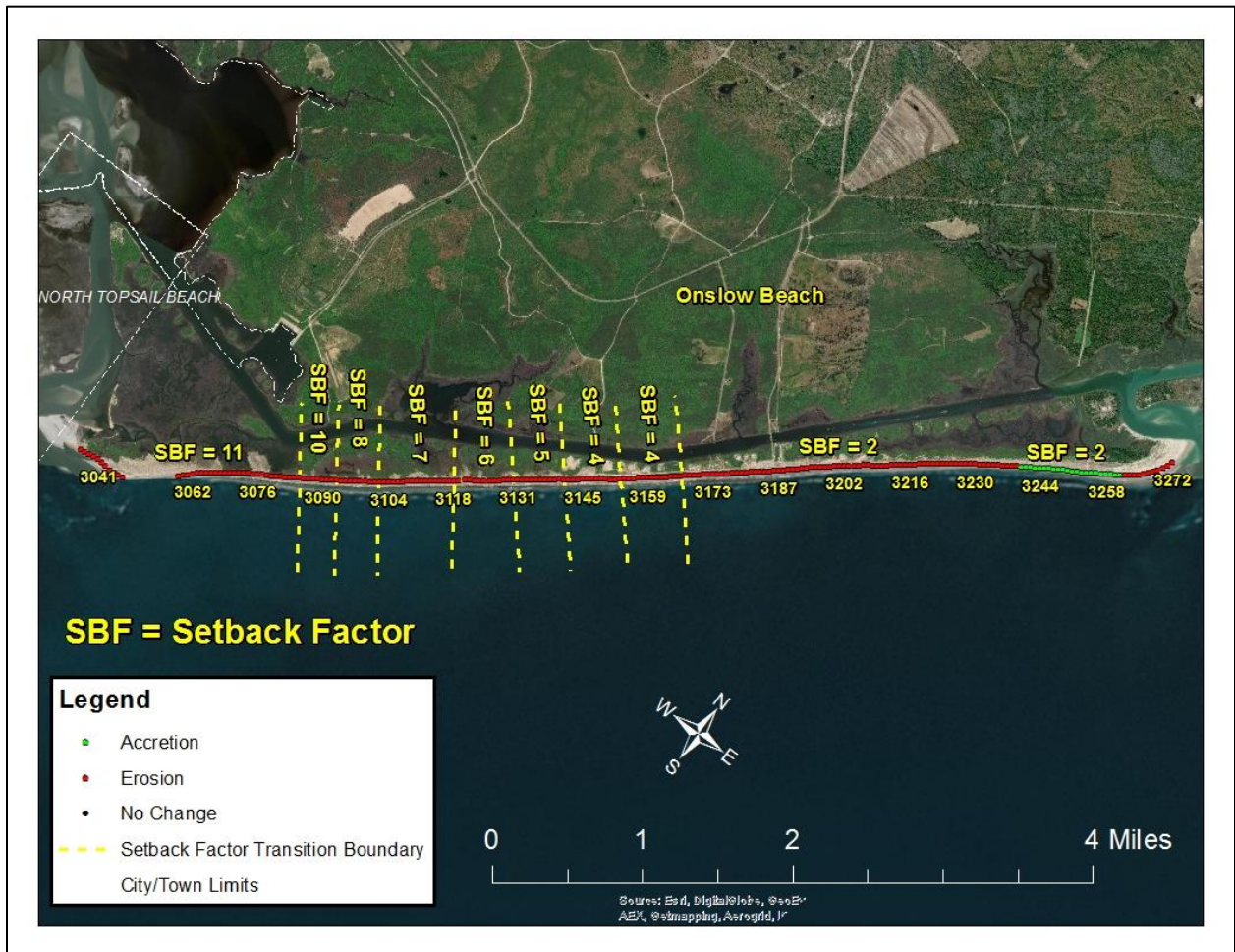


Figure 48. Onslow Beach. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Brown's Island

Brown's Island is an undeveloped barrier island and marks the transition point, moving up the coast from Cape Fear to Cape Lookout, where the beach begins facing a southerly direction. This island's oceanfront shoreline is approximately 3.3 miles long, with approximately 3.1 miles (94.3 percent) of shoreline with measured erosion, while 0.1 mile (3.8 percent) resulted in measured accretion. The average shoreline change rate is 3.5 feet per year (erosion), and blocked shoreline change rate (setback factor) is 4.0 feet per year (Figure 49 and 50).

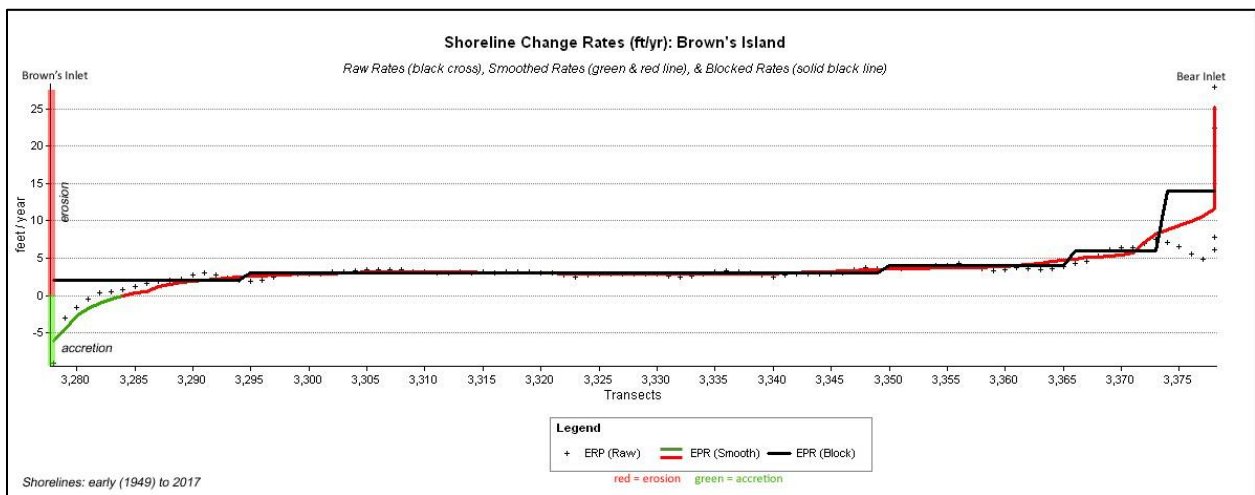


Figure 49. Brown's Island shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

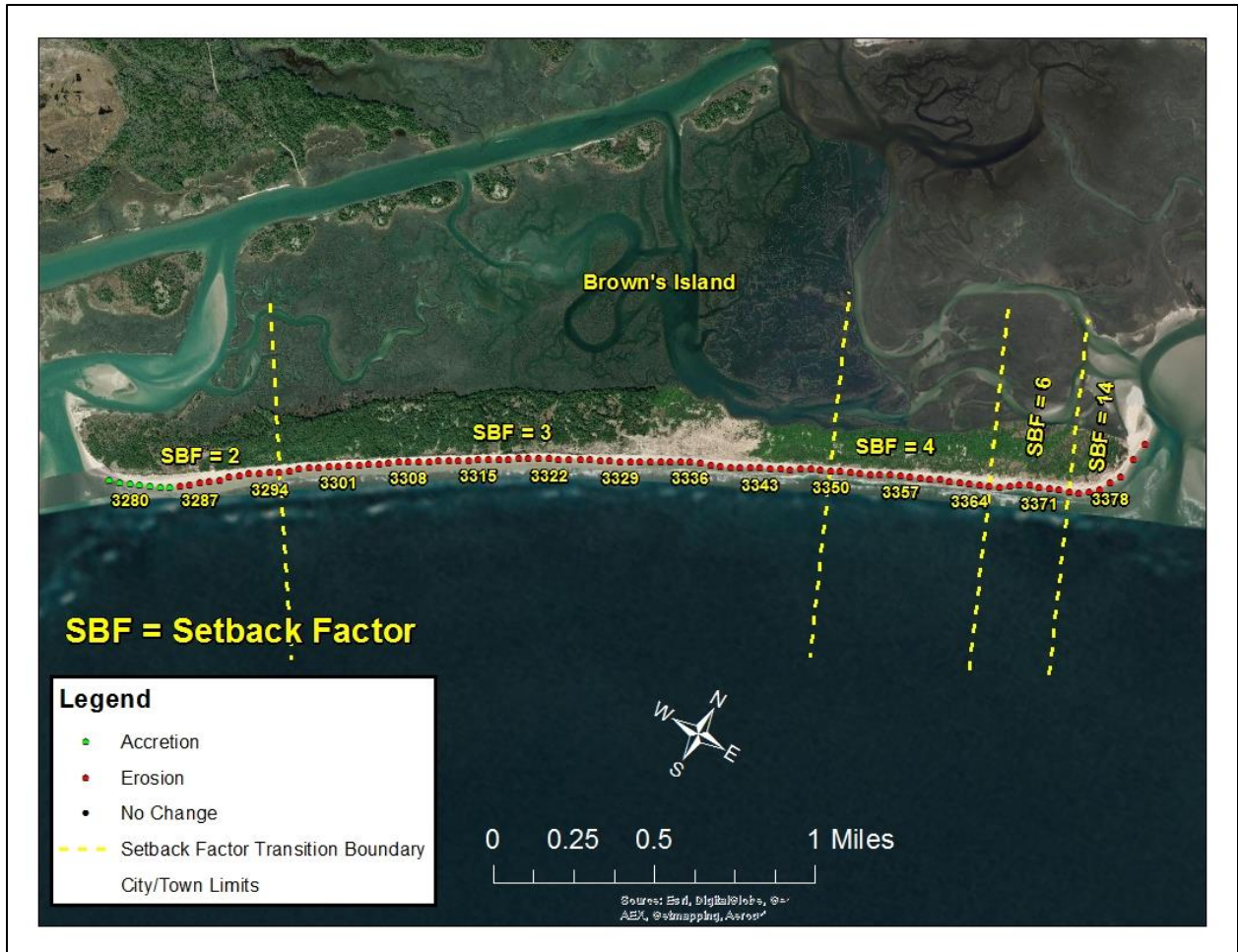


Figure 50. Brown's Island. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Bear Island (Hammocks Beach State Park)

Bear Island (Hammocks Beach State Park) is an undeveloped south facing barrier island with approximately 3.0 miles of oceanfront shoreline. Approximately 2.4 miles (78.6 percent) of its shoreline resulted in measured erosion, while 0.6 of a mile (21.4 percent) resulted in measured accretion. The average shoreline change rate is less than 1 foot per year (accretion), and the blocked shoreline change rate (setback factor) is 3 feet per year, the maximum is 4.5 feet per year, and the minimum is two feet per year (Figure 51 and 52).

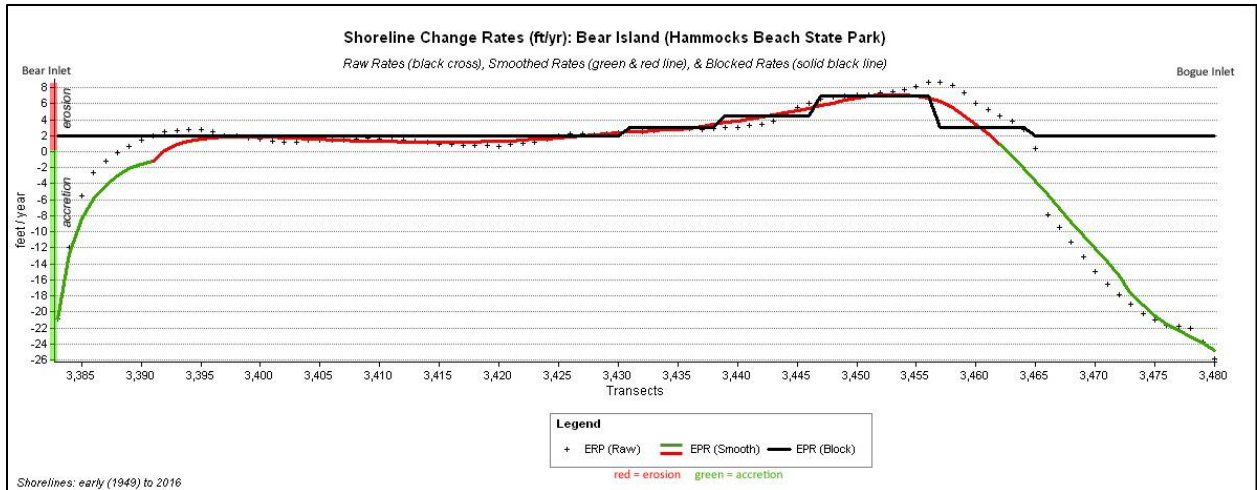


Figure 51. Bear Island shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

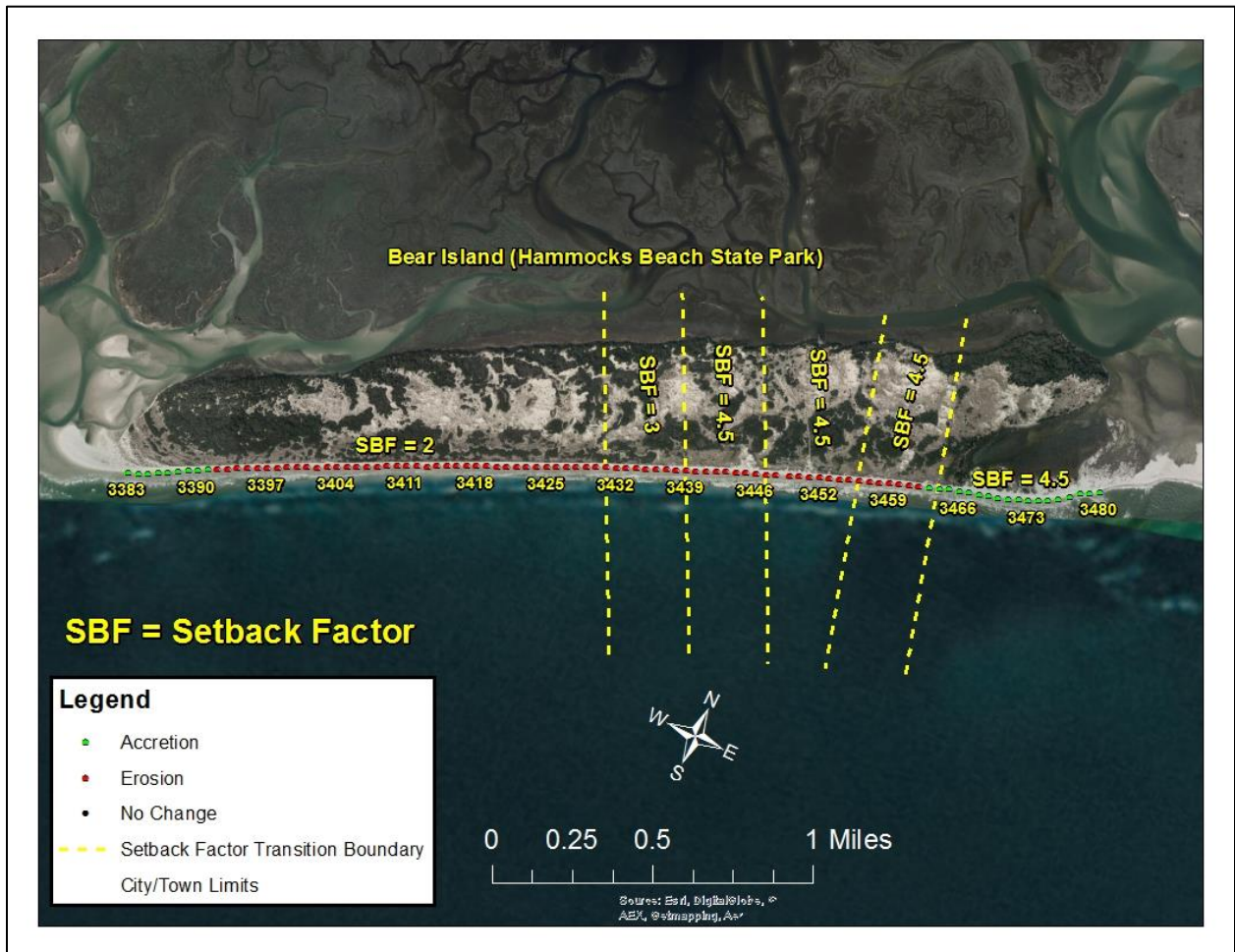


Figure 52. Bear Island. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Emerald Isle

Bogue Banks is a south-facing barrier island with nearly 25 miles of oceanfront shoreline and is comprised of five townships and a state park. Emerald Isle makes up approximately 11.2 miles (49 percent) of its shoreline, Indian Beach 1.7 miles (approximately 7 percent), Salter Path 0.8-mile, Pine Knoll Shores 4.8 miles (19.2 percent), and Atlantic Beach and Fort Macon State Park 6.1 miles (24.4 percent). It is also flanked by two inlets (Bogue and Beaufort).

At Emerald Isle, approximately 7.7 miles (69.1 percent) of its ocean shoreline resulted in measured accretion, while 3.4 miles (30.1 percent) resulted in measured erosion. The average shoreline change rate is 0.3 feet per year (accretion), the blocked shoreline change rate (setback factor) is 2.0 feet per year for all Emerald Isle’s oceanfront (Figure 53 and 54).



Figure 53. Emerald Isle shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

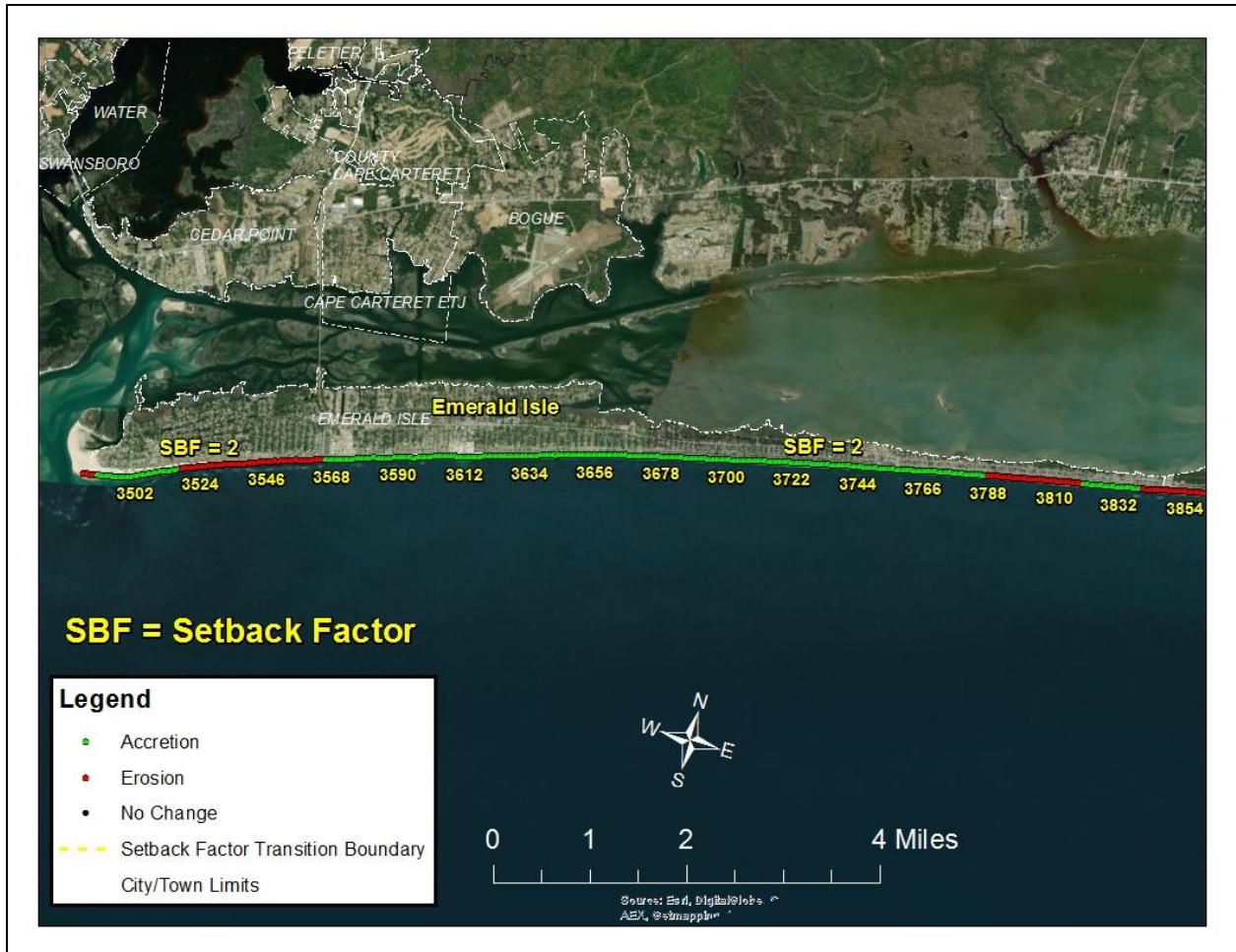


Figure 54. Emerald Isle. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Indian Beach & Salter Path

At Indian Beach, approximately 1.7 miles (100 percent) of its shoreline resulted in measured erosion, while no accretion was measured. Although erosion was measured, the average is less than 1 foot per year, and the blocked shoreline change rate (setback factor) is 2 feet per year for all Indian Beach (Figure 55 and 56).

At Salter Path, approximately 100 percent (0.8 mile) of its shoreline resulted in measured erosion (less than two feet per year). The average blocked shoreline change rate is two feet per year (Figure 55 and 56).

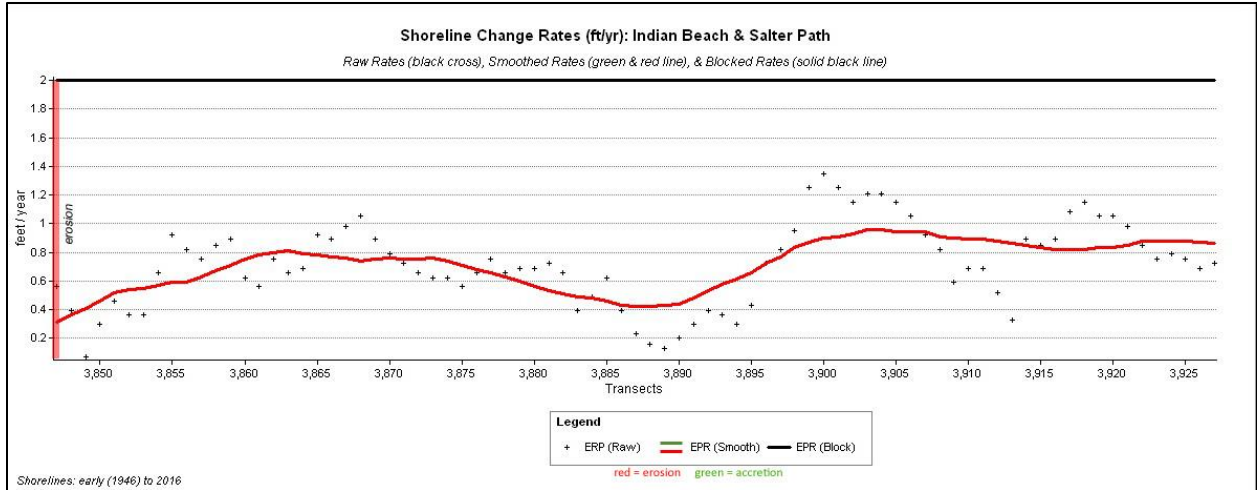


Figure 55. Indian Beach and Salter Path shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

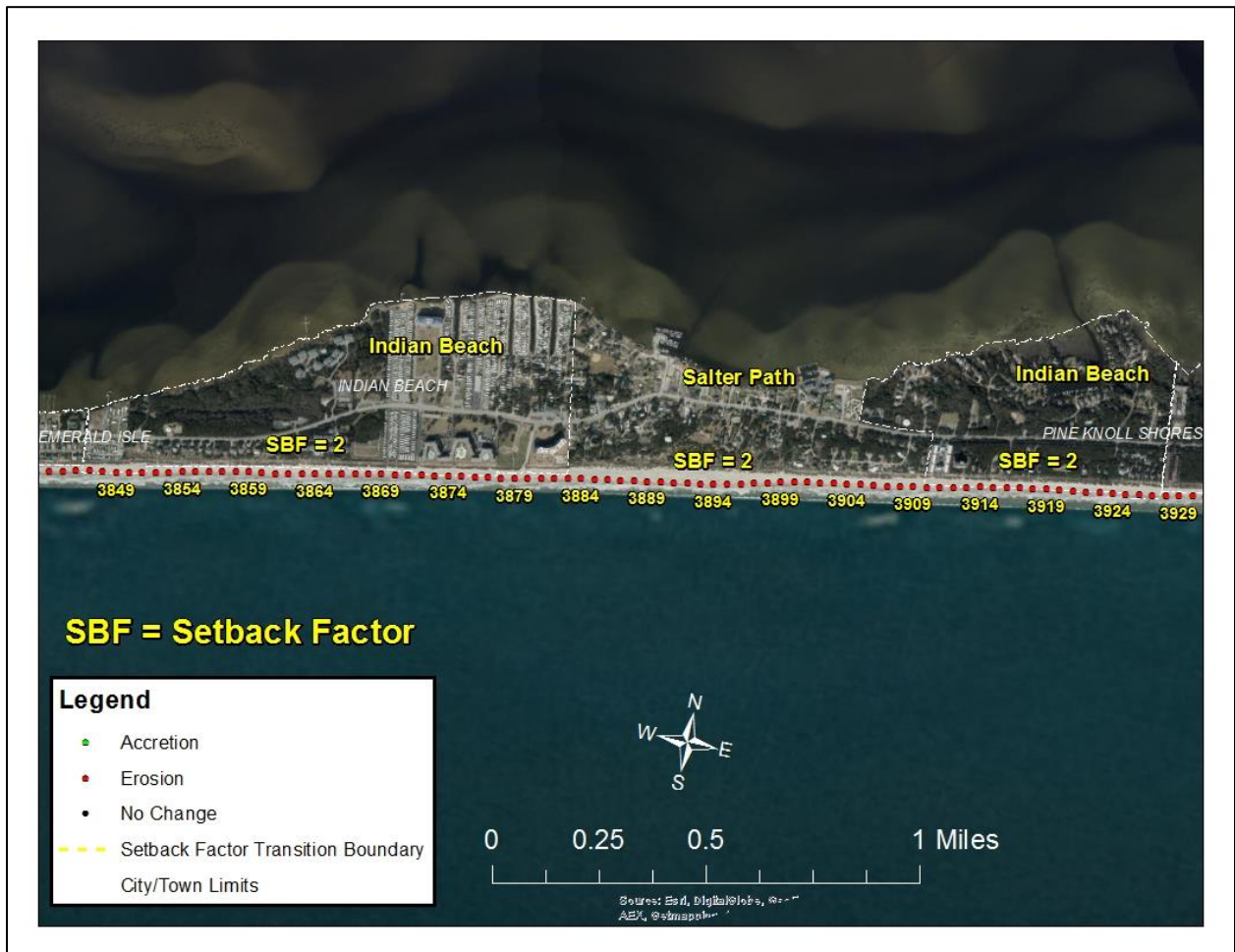


Figure 56. Indian Beach and Salter Path. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Pine Knoll Shores

At Pine Knoll Shores, approximately 3.5 miles (72.9 percent) of its shoreline resulted in measured erosion, while 1.1 miles (23.9 percent) resulted in measured accretion. The average shoreline change rate is less than 1 foot per year (erosion), and the blocked shoreline change rate is two feet per year (Figure 27).

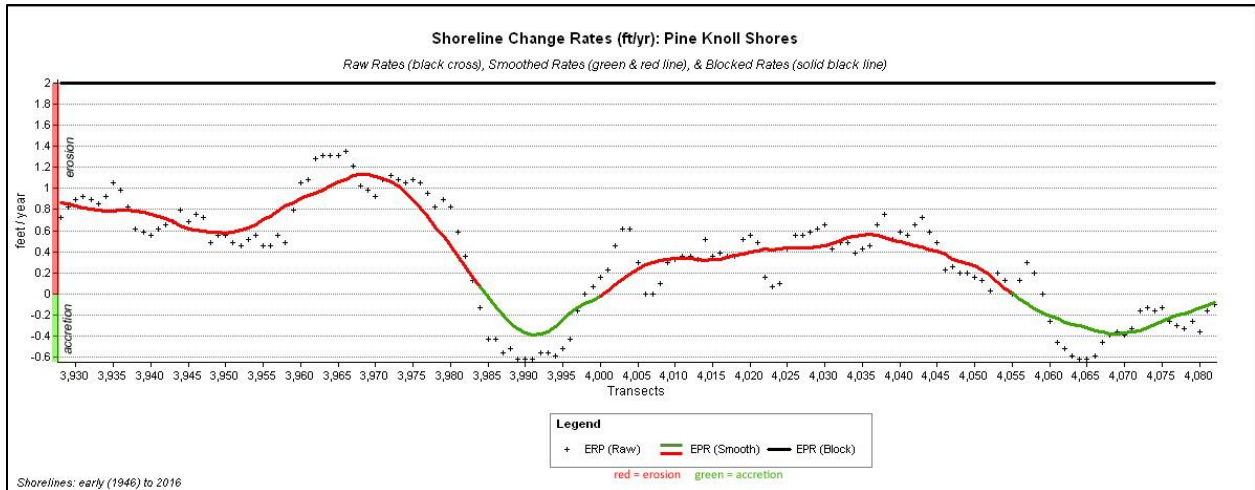


Figure 57. Pine Knoll Shores shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

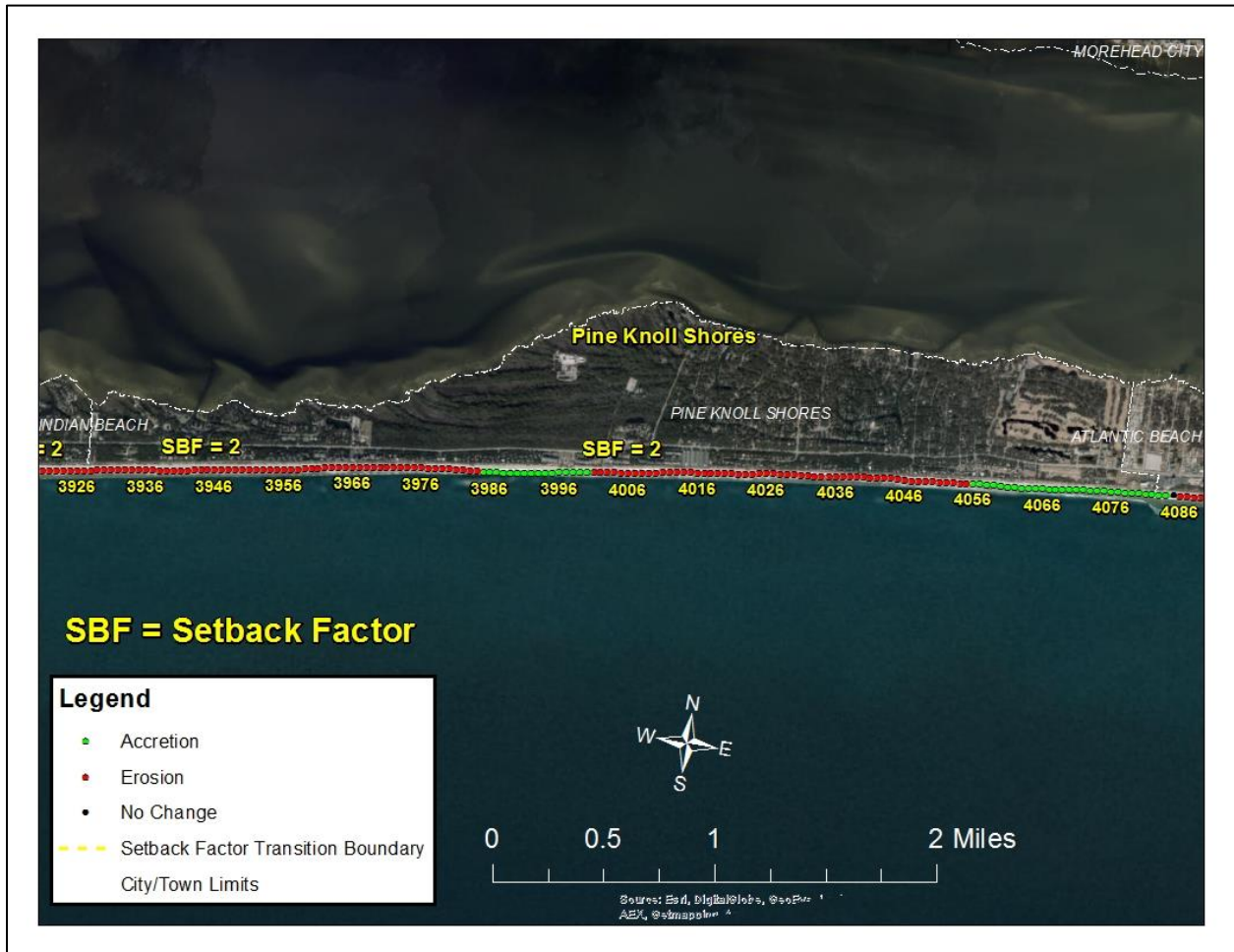


Figure 58. Pine Knoll Shores. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Atlantic Beach and Fort Macon State Park

At Atlantic Beach and Fort Macon, approximately 5.1 miles (84.2 percent) of its shoreline resulted in measured accretion, while 0.9 miles (15.3 percent) resulted in measured erosion. Both shorelines receive regular beach fill because of maintaining Morehead City Port channel (Beaufort Inlet), which significantly reduces erosion rates and artificially increased accretion. blocked shoreline change rate (setback factor) is two feet per year for all Atlantic Beach and Fort Macon (Figure 27).

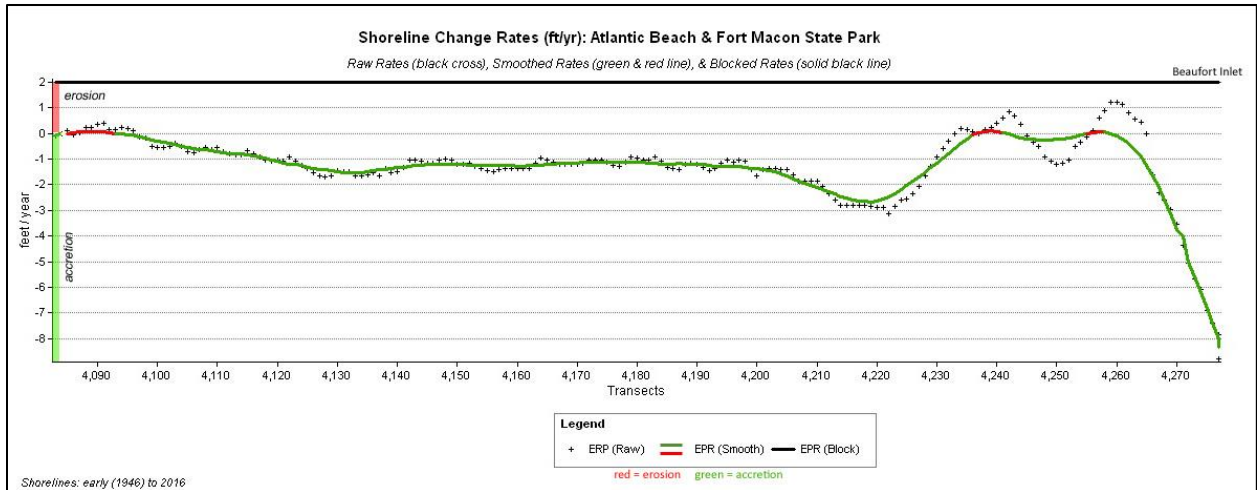


Figure 59. Atlantic Beach and Fort Macon State Park shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

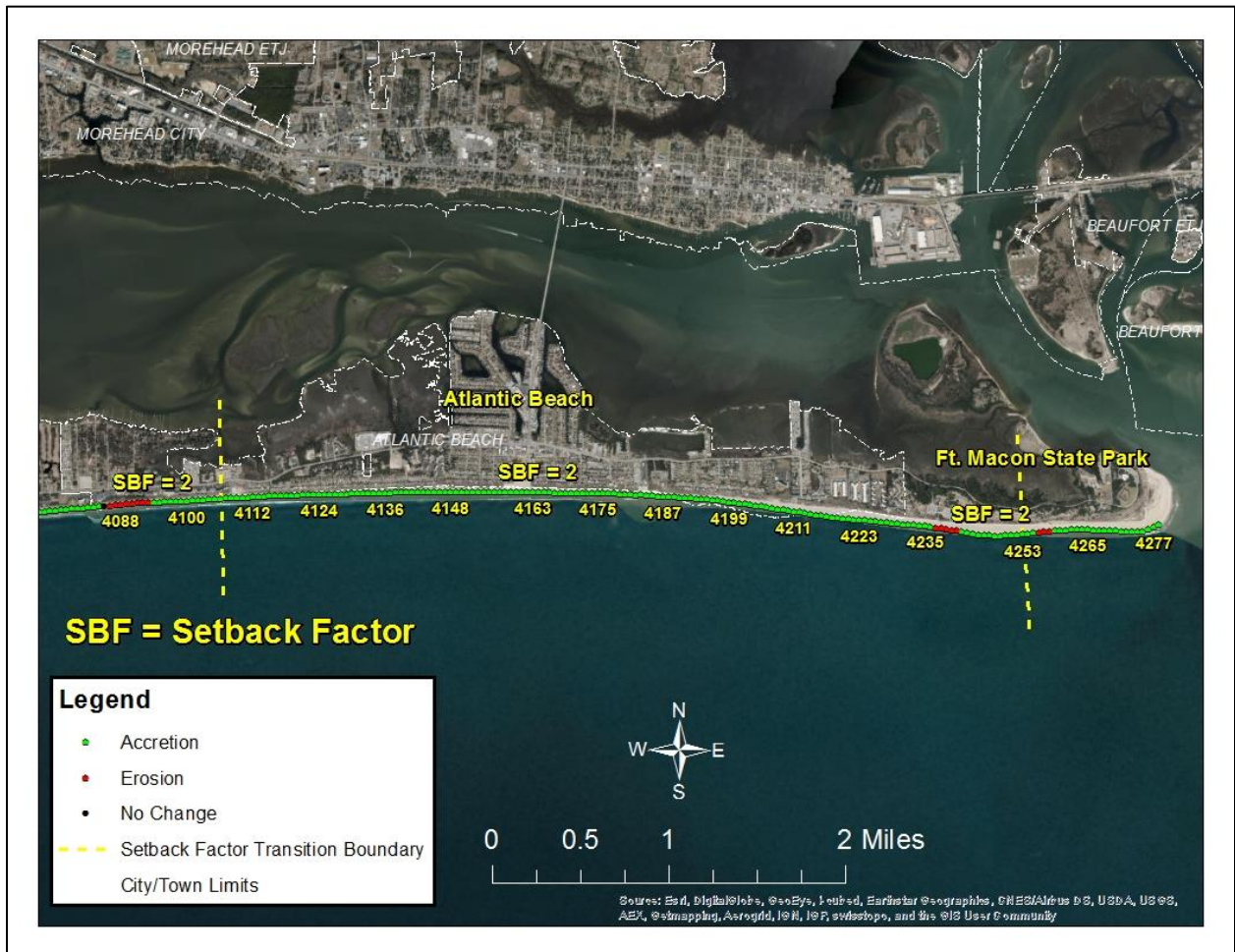


Figure 60. Atlantic Beach and Fort Macon State Park. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Shackleford Banks

Shackleford Banks is an undeveloped south-facing barrier island with approximately 8.1 miles of oceanfront shoreline and is flanked by two inlets (Beaufort and Barden). Approximately 6.4 miles (79 percent) of its shoreline resulted in measured erosion, while 1.7 miles (21 percent) resulted in measured accretion. Although the shoreline adjacent to Beaufort Inlet has been eroding at significant rates in recent years, the 2016 shoreline is nearing the same location as the early shoreline (1946); although small, still resulting in measured accretion. The average shoreline change rate is 2.7 feet per year (erosion), and blocked rate (setback factor) is 4.0 feet per year (Figure 61 and 62).

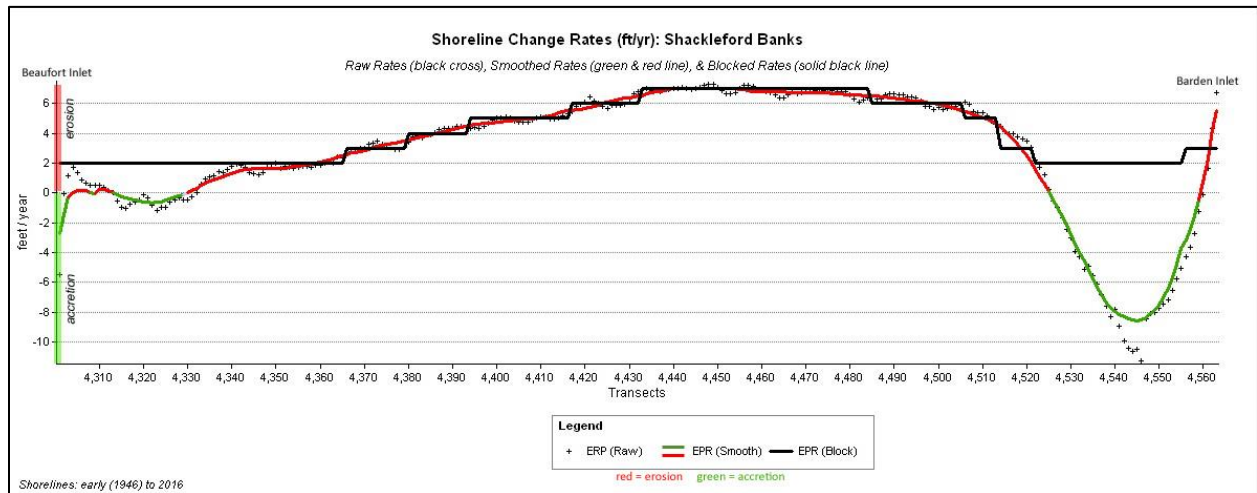


Figure 61. Shackleford Banks shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

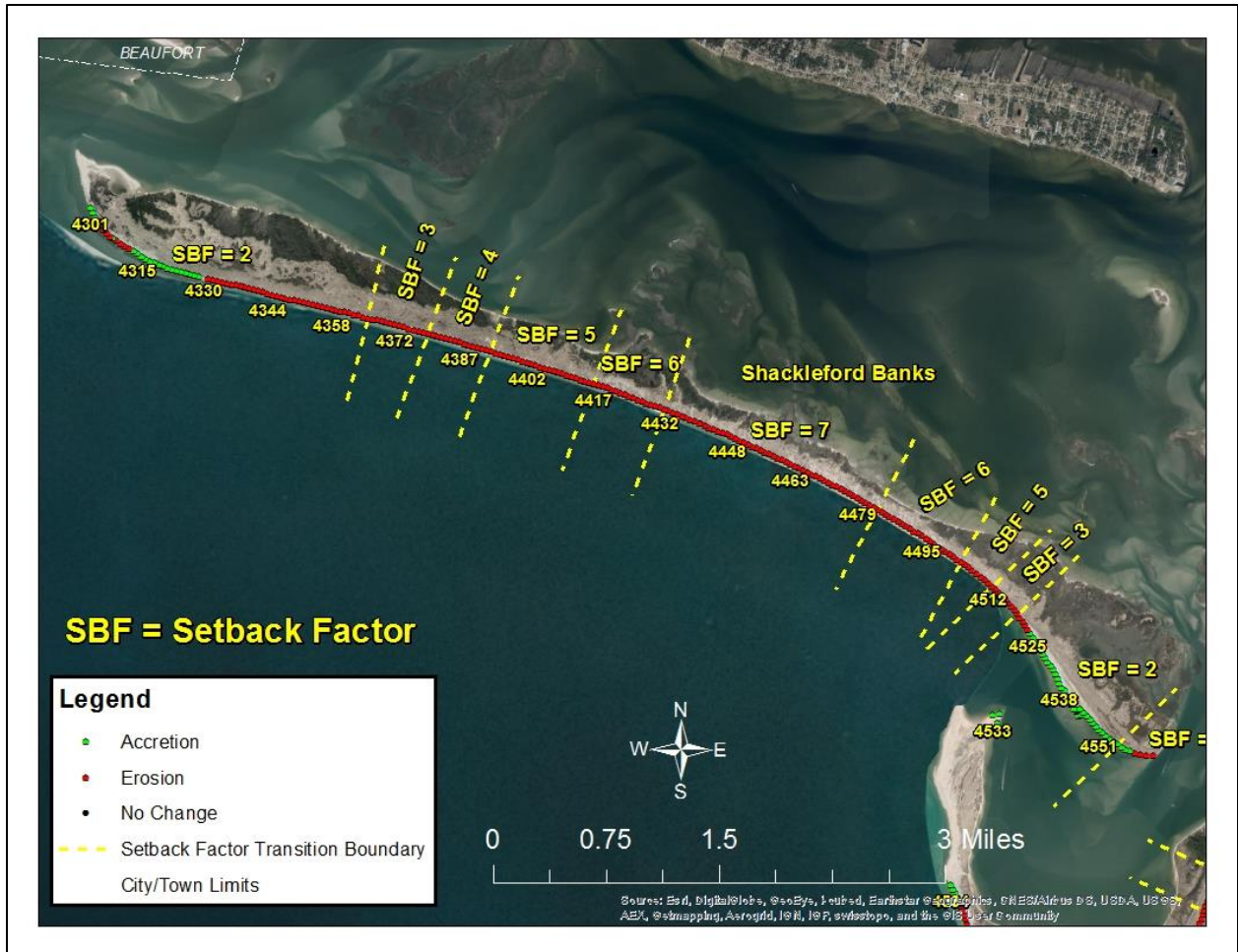


Figure 62. Shackleford Banks. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Cape Lookout

At Cape Lookout starting at Barden Inlet moving towards the point at the cape is an undeveloped south-facing portion of the Core Banks, with approximately 2.4 miles of oceanfront shoreline. Approximately 2.0 miles (83.1 percent) of its shoreline resulted in measured erosion, while 0.3 of a mile (15.6 percent) resulted in measured accretion. The average shoreline change rate is 5.3 feet per year (erosion), and 6.0 feet per year blocked rate (setback factor) (Figure 63 and 64).

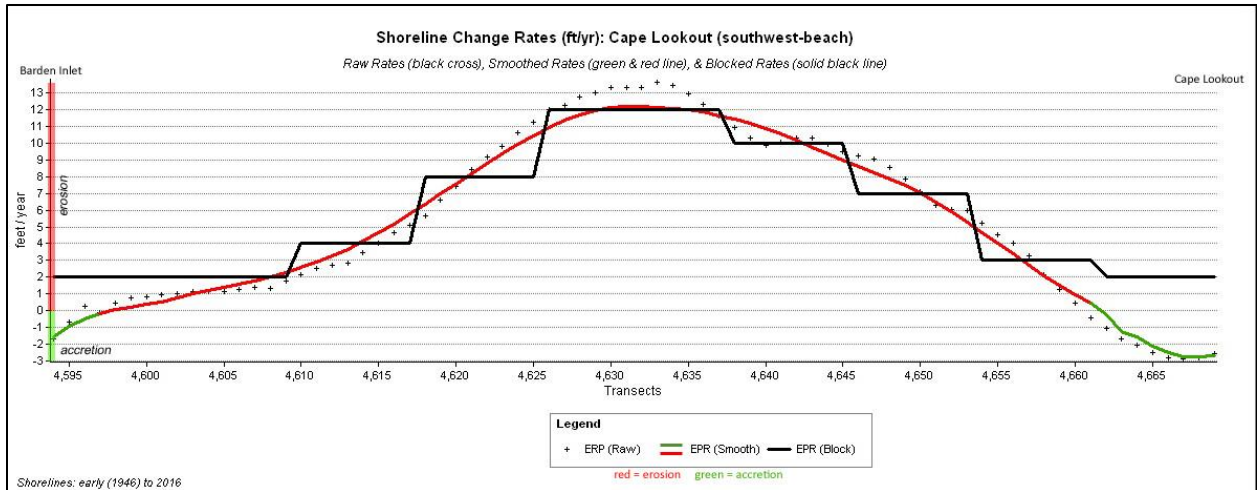


Figure 63. Cape Lookout shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

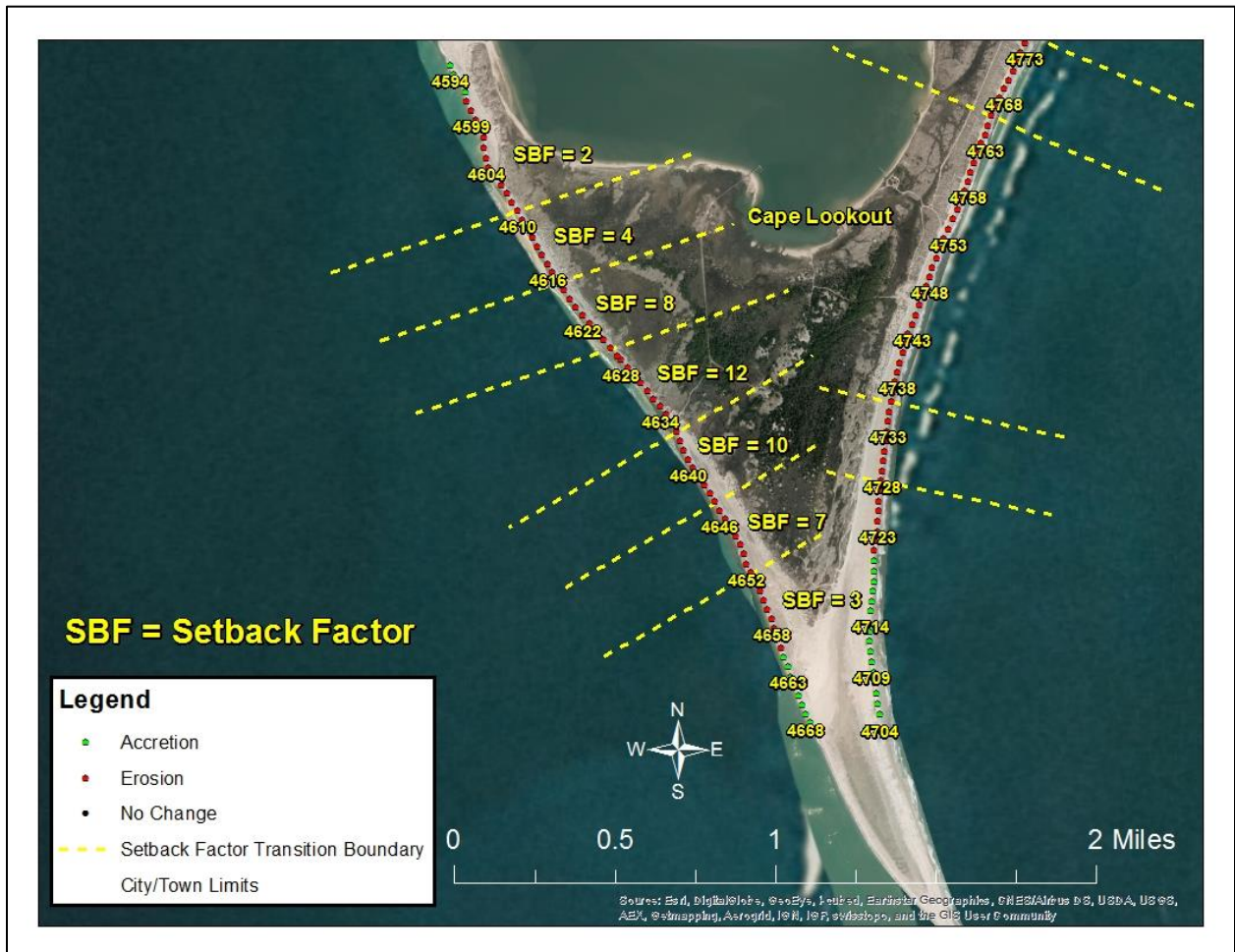


Figure 64. Cape Lookout (south-west beach). Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Cape Lookout starting at the point at the cape and moving towards Drum Inlet is an undeveloped east facing portion of the Core Banks with approximately 20.9 miles of oceanfront shoreline. Approximately 18.2 miles (87.1 percent) of its shoreline resulted in measured erosion, while 2.1 miles (10.2 percent) resulted in measured accretion. The average shoreline change rate is 4.3 feet per year (erosion), and blocked rate (setback factor) is 5.0 feet per year (Figure 65 and 66).

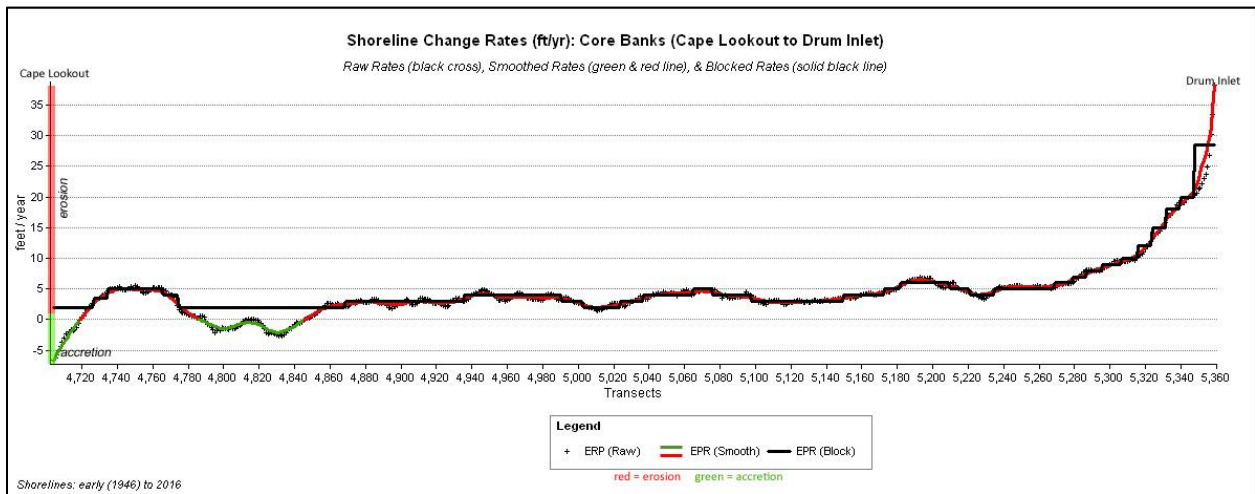


Figure 65. Cape Lookout to Drum Inlet shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

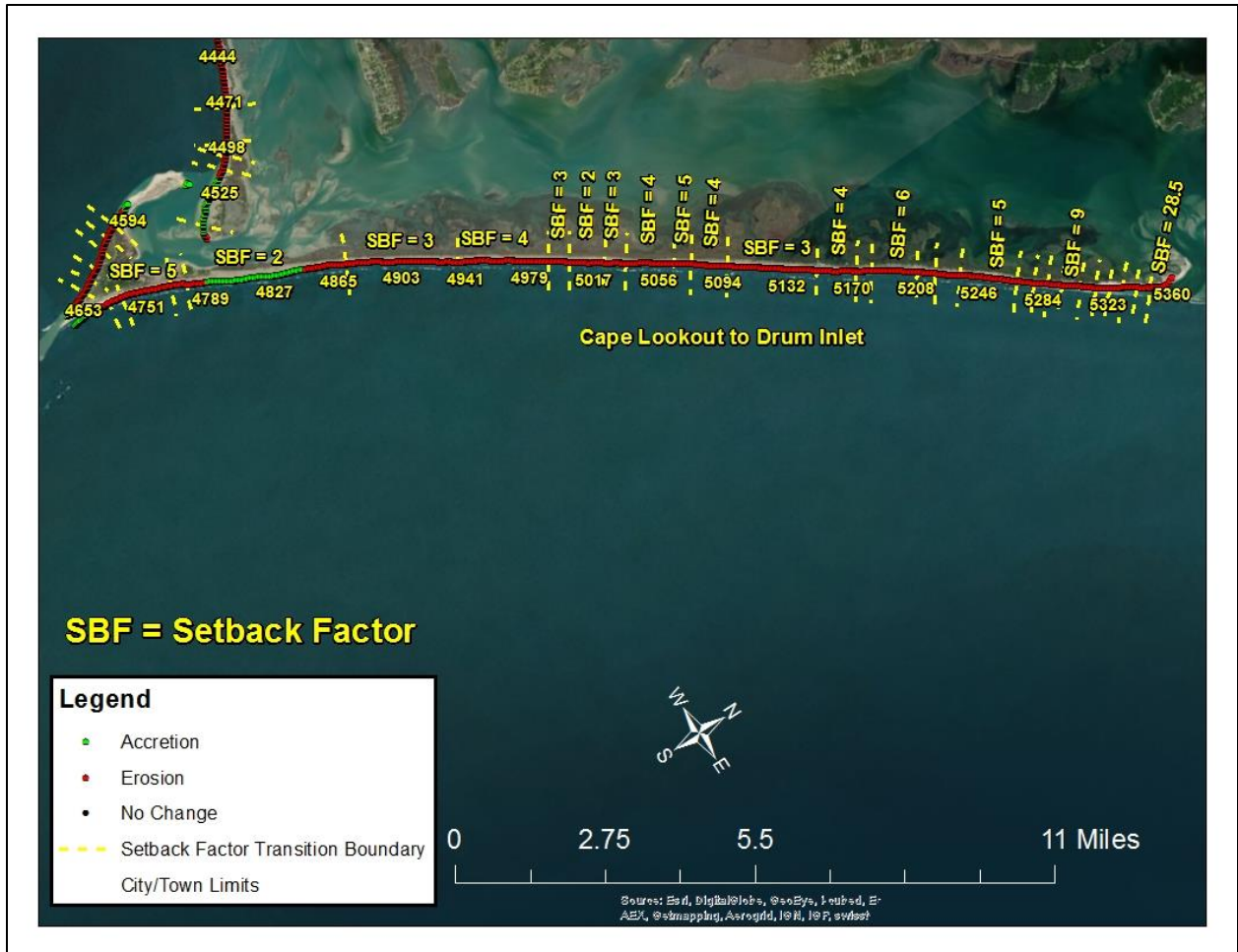


Figure 66. Cape Lookout to Drum Inlet. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Core Banks from Drum Inlet to Ocracoke Inlet is the remaining undeveloped east-facing portion of the Core Banks with approximately 21.5 miles of oceanfront shoreline. Approximately 18.8 miles (91.8 percent) of its shoreline resulted in measured erosion, while 1.4 miles (7.1 percent) resulted in measured accretion. The average shoreline change rate is 4.8 feet per year, and average blocked rate (setback factor) is 5.0 feet per year, ranging from 5 to 12 (Figure 67 and 68).

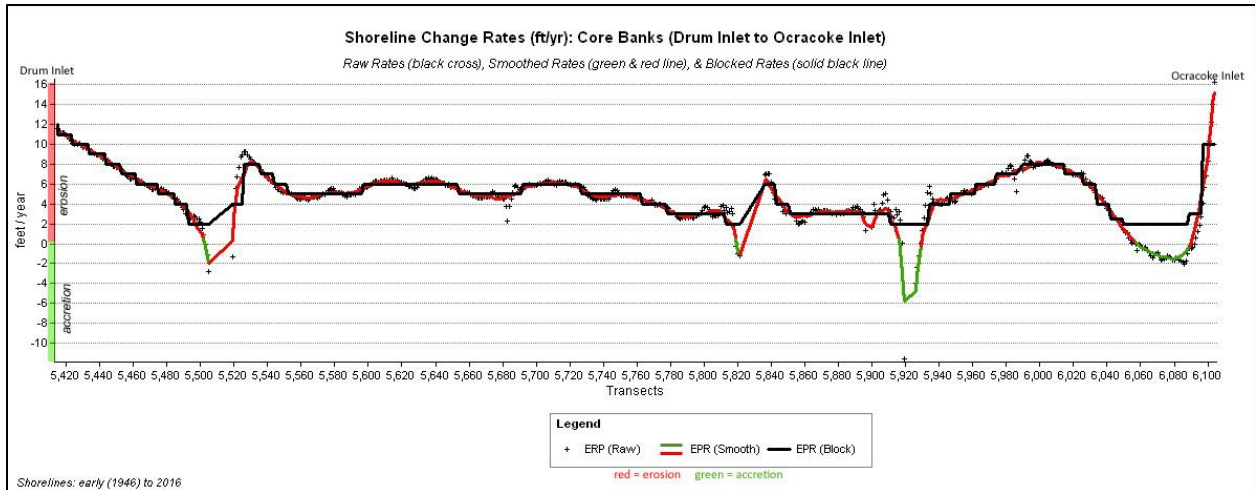


Figure 67. Core Banks (Drum Inlet to Ocracoke Inlet) shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

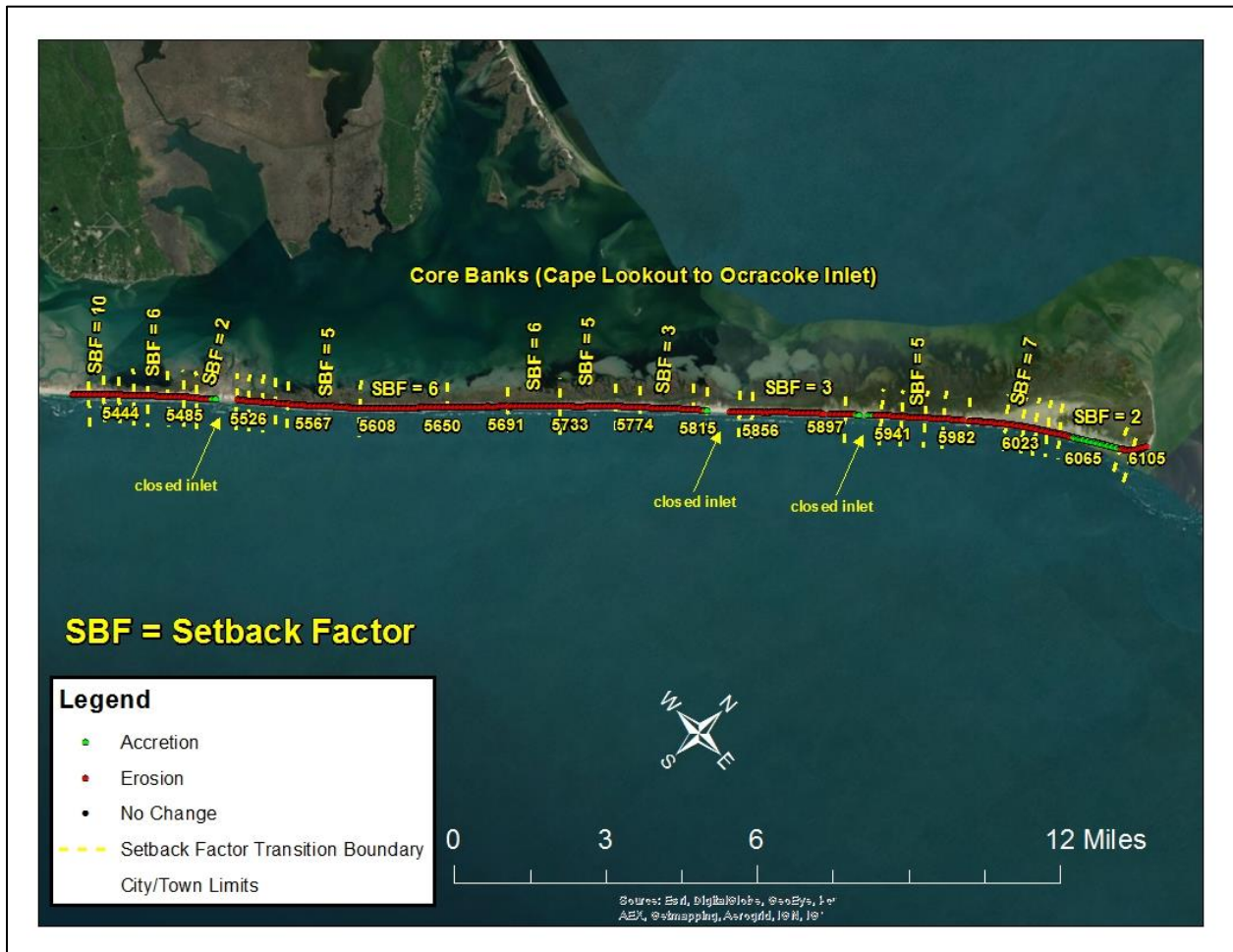


Figure 68. Core Banks (Drum Inlet to Ocracoke Inlet). Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Ocracoke Island

Ocracoke Island marks the transitional point from east to south facing beaches moving south to north approaching Cape Hatteras. Ocracoke’s oceanfront is undeveloped, and its shoreline is approximately 16.3 miles in length. Approximately 11.5 miles (70.9 percent) of its shoreline resulted in measured erosion, while 4.2 miles (26.1 percent) resulted in measured accretion. The average shoreline change rate is 3.2 feet per year, and average blocked rate (setback factor) is 4.0 feet per year, ranging between (Figure 69 and 70).

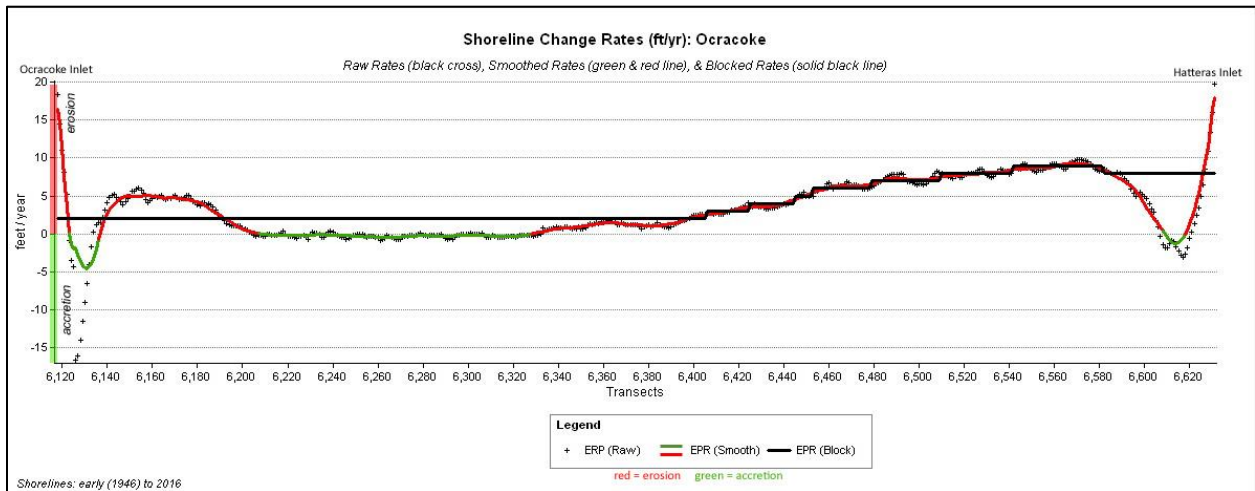


Figure 69. Ocracoke Island shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

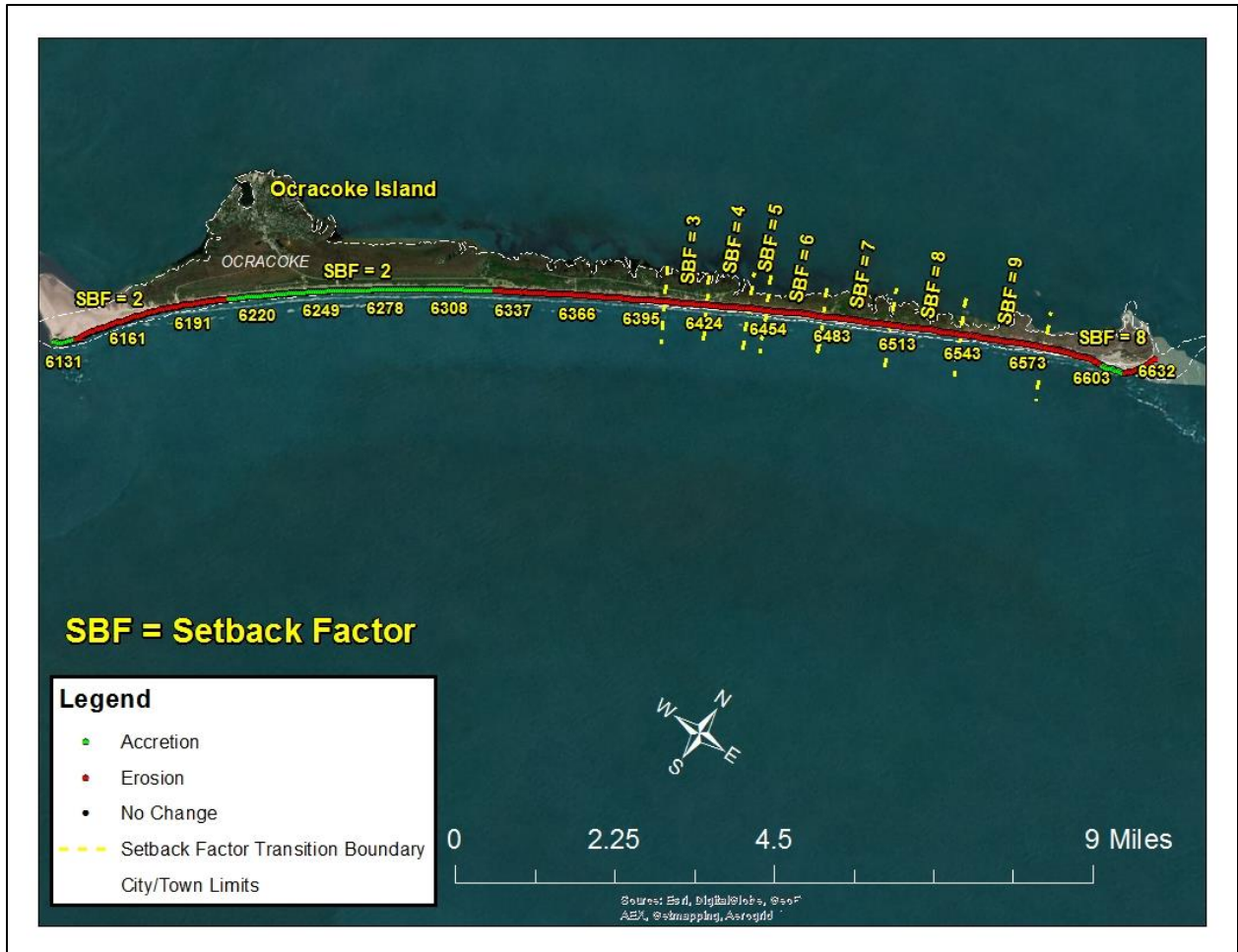


Figure 70. Ocracoke Island. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Cape Hatteras

Hatteras from Ocracoke Inlet to Cape Hatteras (includes Hatteras Village) has a south-facing shoreline and is approximately 12.9 miles in length. Approximately 6.8 miles (53.6 percent) of its shoreline resulted in measured erosion, while 5.4 miles (42.5 percent) resulted in measured accretion. The average shoreline change rate is 8.2 feet per year (erosion), and average blocked rate (setback factor) is 4 feet per year, ranging between 2 and 12 feet per year. (Figure 71 and 72).

Cape Hatteras and Buxton

At the Outer Banks from Cape Hatteras to Buxton, the oceanfront shoreline is on an east-facing beach with a combined length of approximately 5.3 miles. This entire segment of shoreline segment resulted in measured erosion with an average shoreline change rate of 8.3 feet per year, and 8.0 feet per year average blocked rate (setback factor). Setback factors range between 3.0 and 12.0 (Figure 73 and 74).

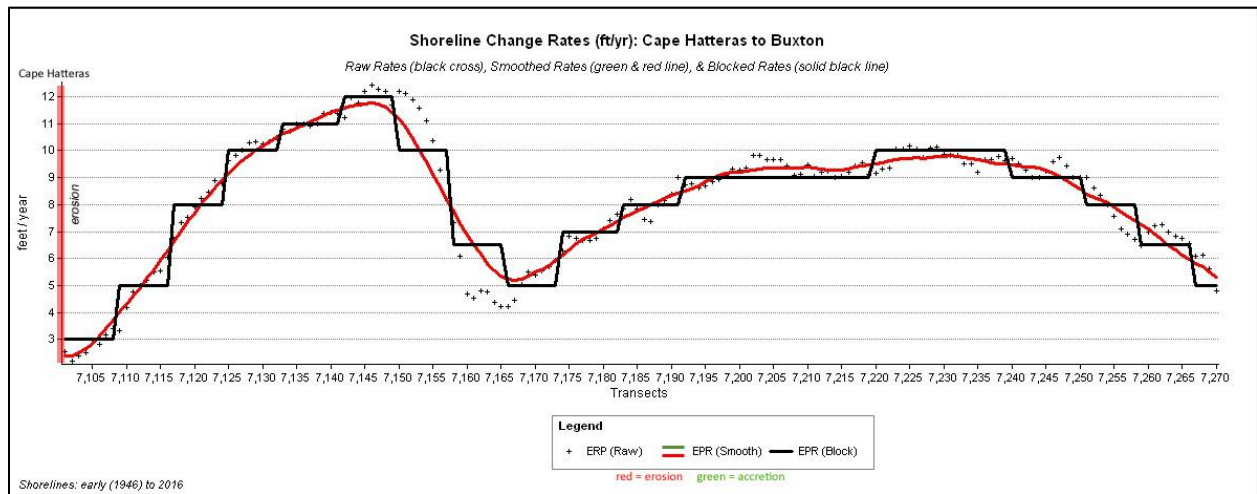


Figure 73. Cape Hatteras and Buxton shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

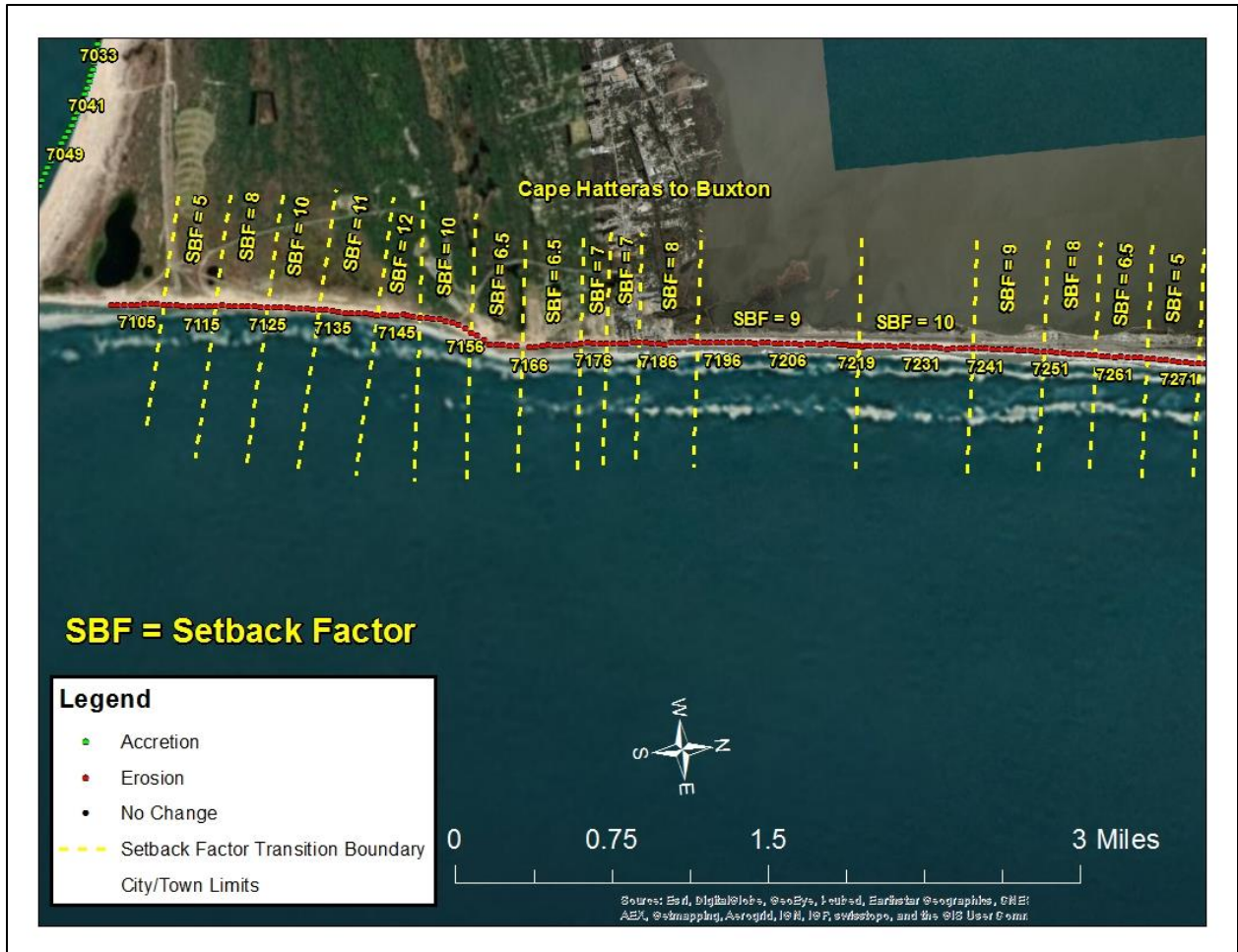


Figure 74. Cape Hatteras to Buxton. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

National Seashore (Outer Banks at Avon)

The shoreline segment adjacent to Avon is approximately 4.9 miles in length, and approximately 4.0 miles (82.4 percent) of Avon's shoreline resulted in measured erosion, while the remaining 0.8 miles (17.6 percent) resulted in measured accretion. The average shoreline change rate is 2.4 feet per year (erosion), and the average blocked rate is 3.0 feet per year, with a range between 2 and 6 feet per year (Figure 75 and 76).

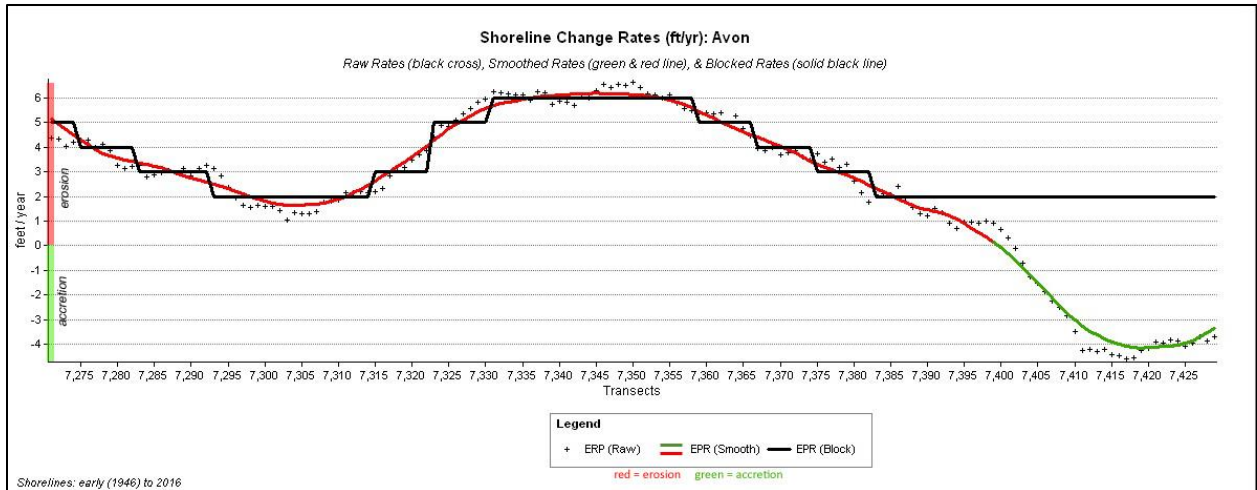


Figure 75. Avon shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

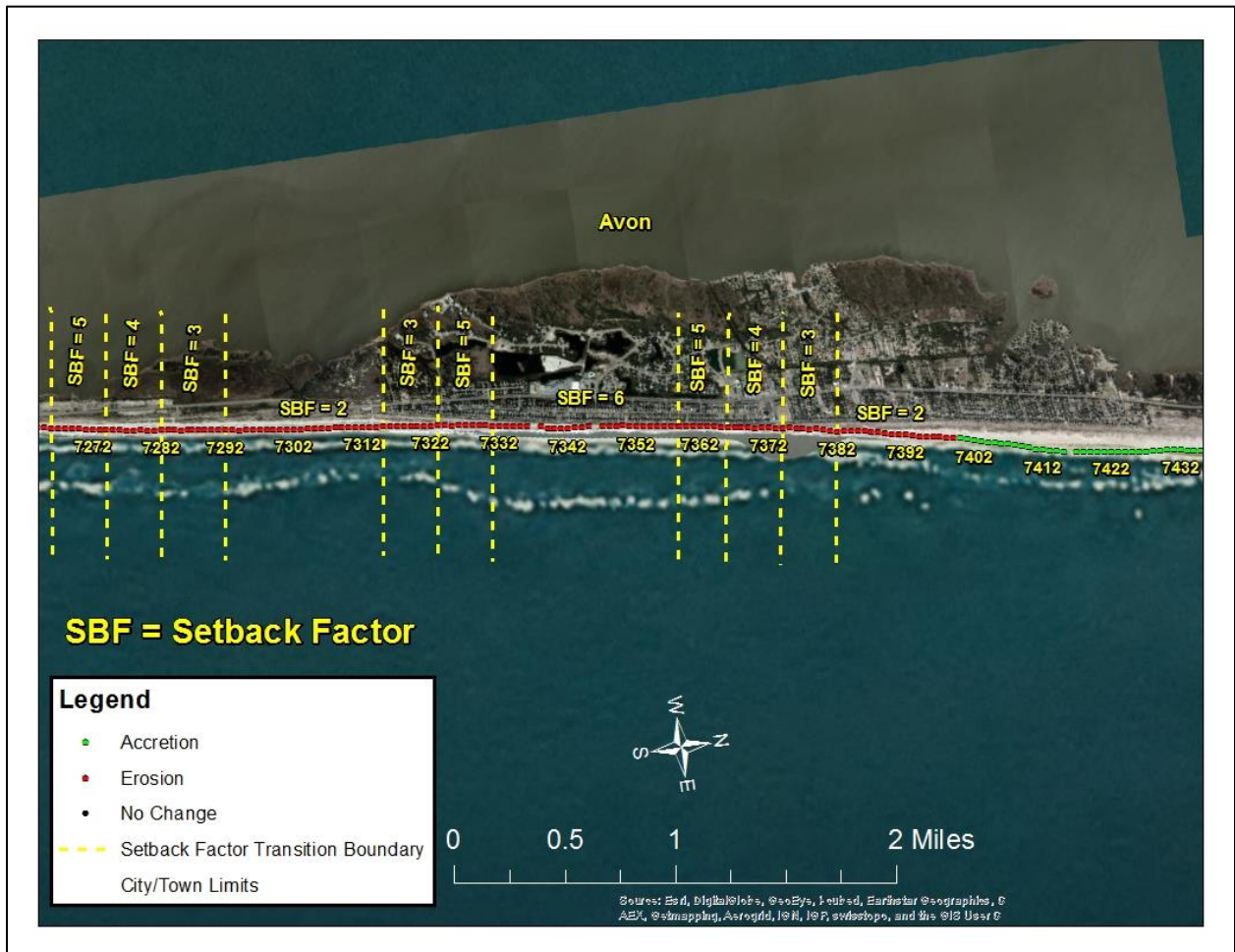


Figure 76. Avon. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

National Seashore (Outer Banks between Avon and Salvo)

The area along the National Seashore between Avon and Salvo has an east-facing beach with approximately 11.2 miles of ocean shoreline. Approximately 8.5 miles (75.8 percent) of this shoreline resulted in measured erosion, while the remaining 2.7 miles (24.2 percent) of shoreline resulted in measured accretion. The average shoreline change rate is 1.9 feet per year (erosion), and the average blocked rate (setback factor) is 3.0 feet per year, with a range between 2.0 and 6.0 feet per year (Figure 77 and 78).

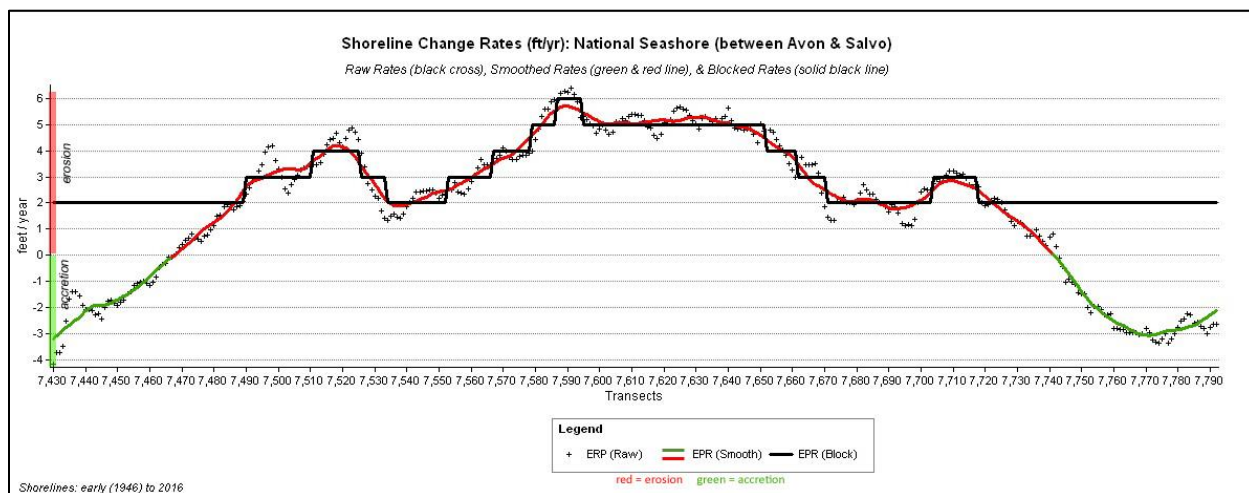


Figure 77. National Seashore between Avon and Salvo shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

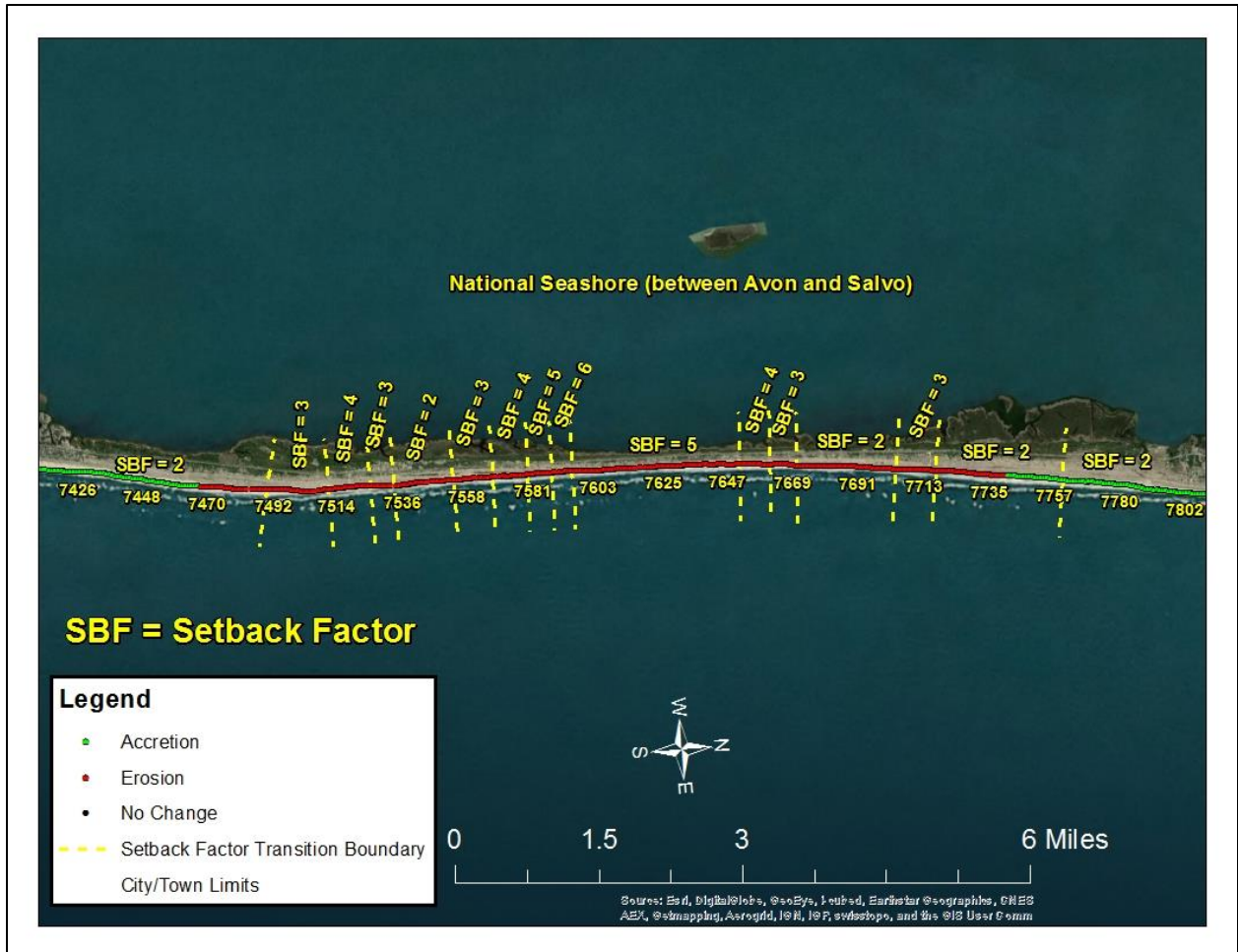


Figure 78. National Seashore between Avon and Salvo. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Salvo to Rodanthe

The area along the National Seashore at Salvo and Rodanthe has an east-facing beach with approximately 6.5 miles of ocean shoreline. Approximately 4.9 miles (76.2 percent) of this shoreline resulted in measured erosion, while the remaining 1.5 miles (22.9 percent) of shoreline resulted in measured accretion. The average shoreline change rate is 5.3 feet per year (erosion), and the average blocked rate (setback factor) is 6.0 feet per year, with a range between 2.0 and 13.0 feet per year (Figure 79 and 80).

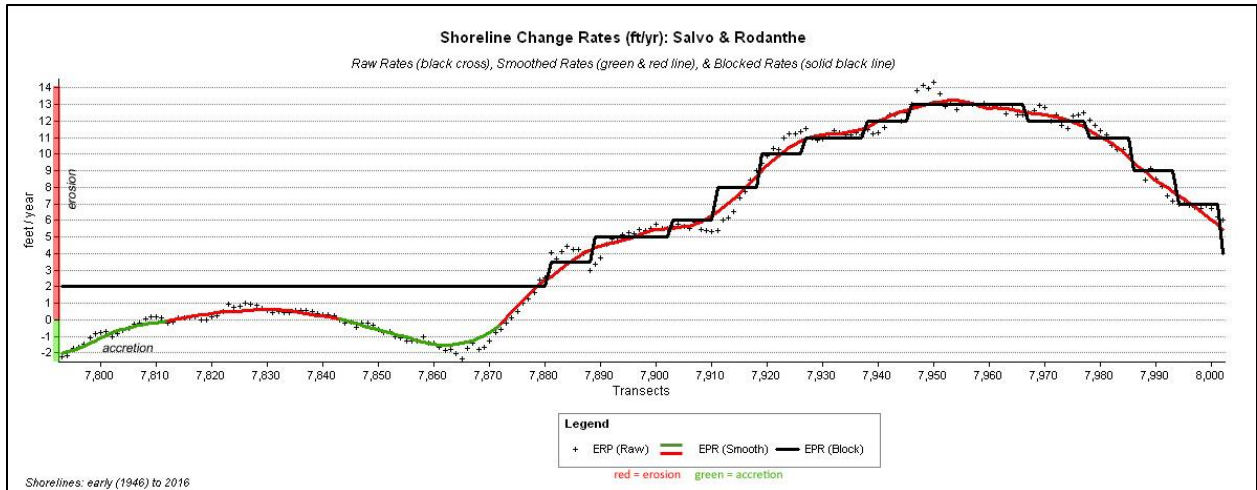


Figure 79. Salvo to Rodanthe shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

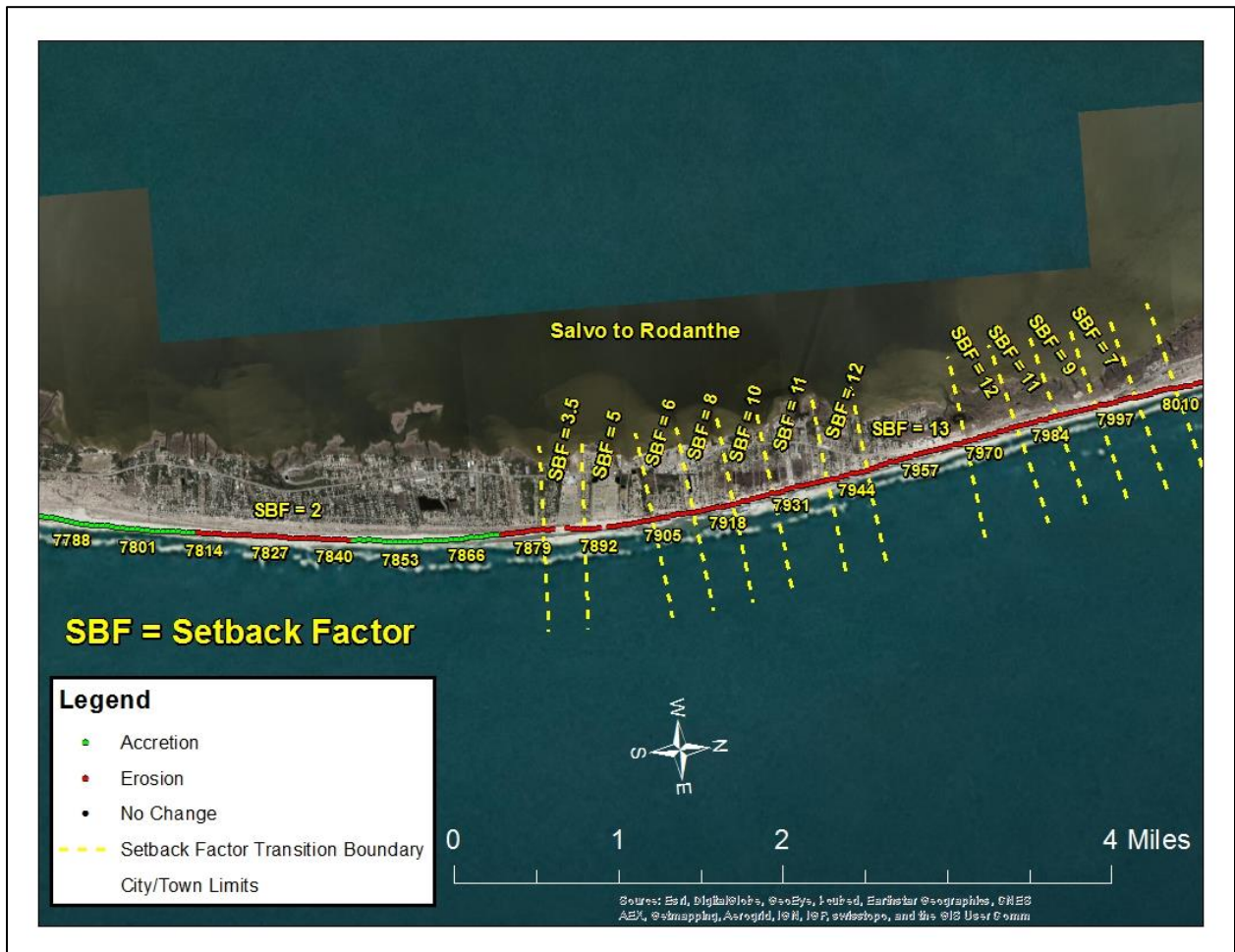


Figure 80. Salvo to Rodanthe. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

National Seashore between Rodanthe and Oregon Inlet (Pea Island)

At the Outer Banks from Rodanthe to Oregon Inlet, or Pea Island National Seashore, is an east-facing beach with approximately 10.8 miles of oceanfront shoreline. Approximately 9.1 miles (85 percent) of this shoreline resulted in measured erosion, while the remaining 1.6 miles (14.7 percent) resulted in measured accretion. The average shoreline change rate is 5.8 feet per year, and the average blocked rate (setback factor) is 7.0 feet per year with a range between 2 and 22 feet per year (Figure 81 and 82).

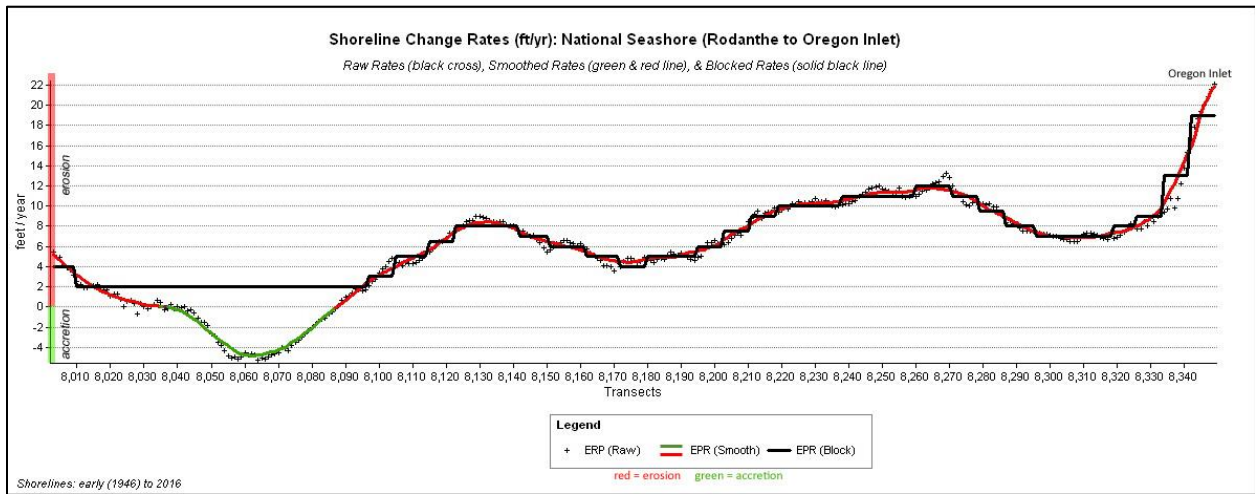


Figure 81. National Seashore between Rodanthe and Oregon Inlet (Pea Island) shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

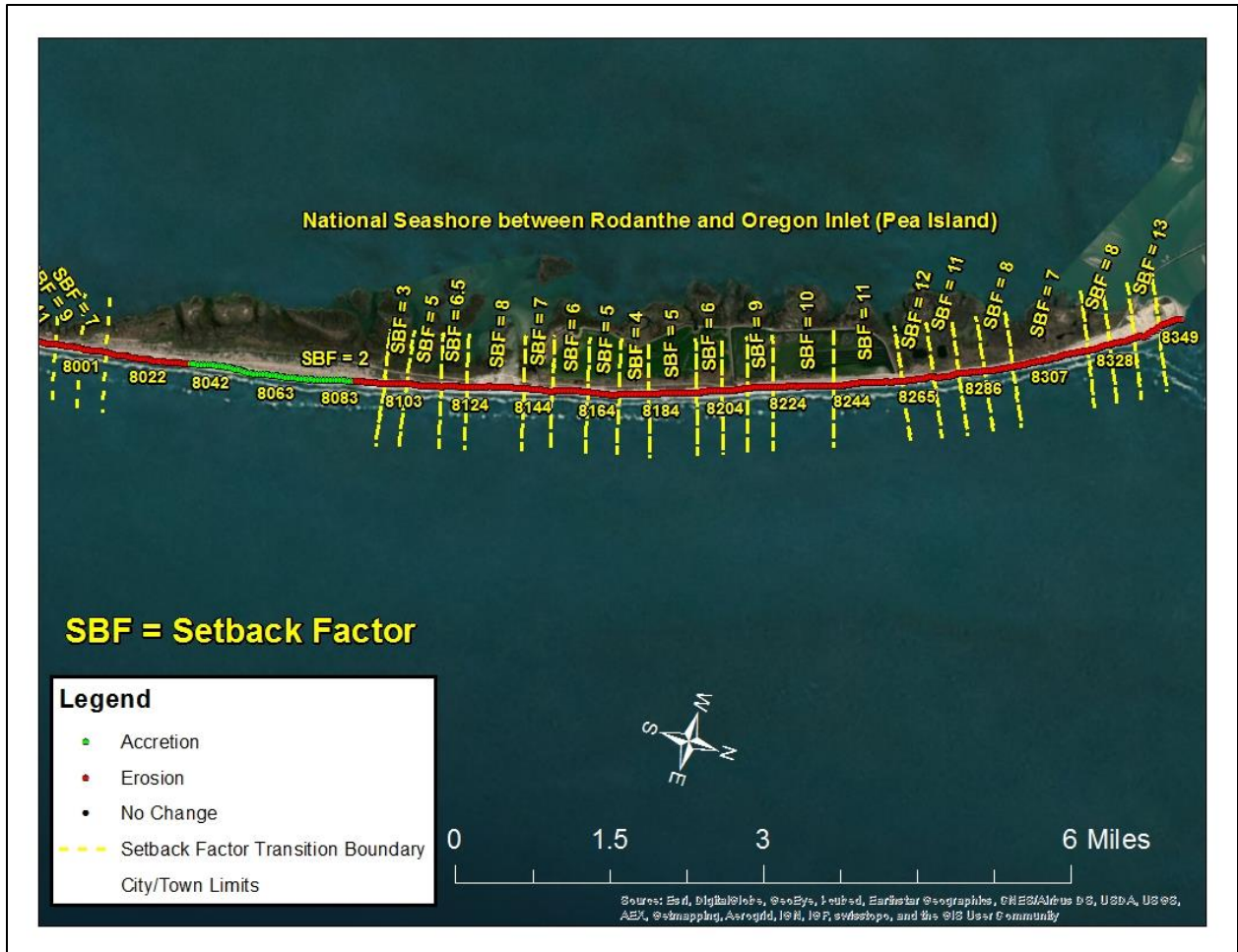


Figure 82. National Seashore between Rodanthe and Oregon Inlet (Pea Island). Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

National Seashore between Oregon Inlet and Nags Head (Boddie Island)

The National Seashore from Oregon Inlet to Nags Head (includes Boddie Island) has an east-facing shoreline and is approximately 4.6 miles long. Approximately 4.2 miles (90.7 percent) of this shoreline resulted in measured erosion, while the remaining 0.4 of a mile (9.3 percent) of shoreline resulted in measured accretion. The average shoreline change rate is 6.7 feet per year (erosion), and the average blocked rate is 8.0 feet per year with a range between 2 and 11 feet per year (Figure 83 and 84).

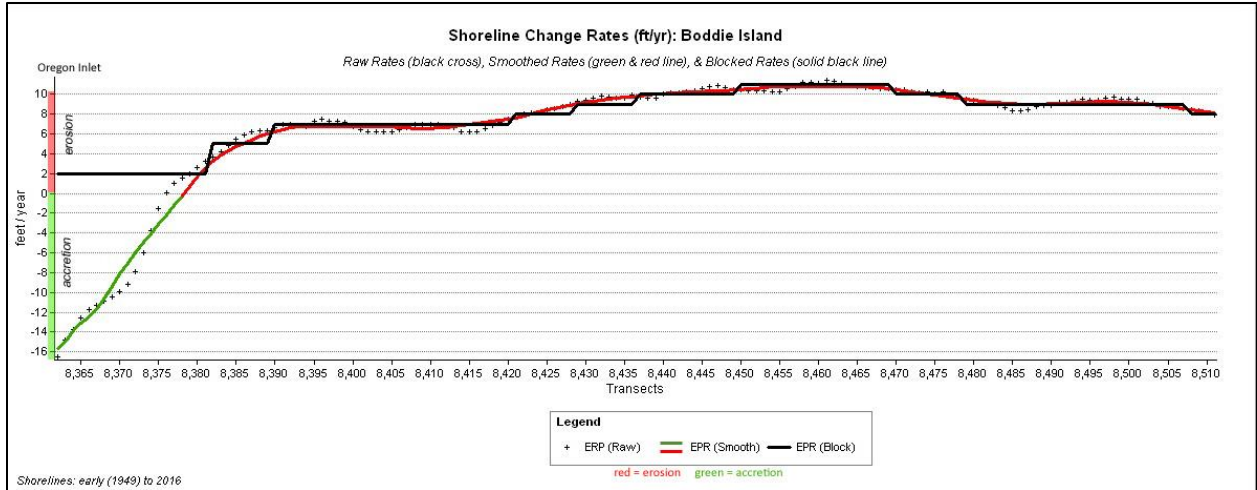


Figure 83. National Seashore between Oregon Inlet and Nags Head (Pea Island) shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

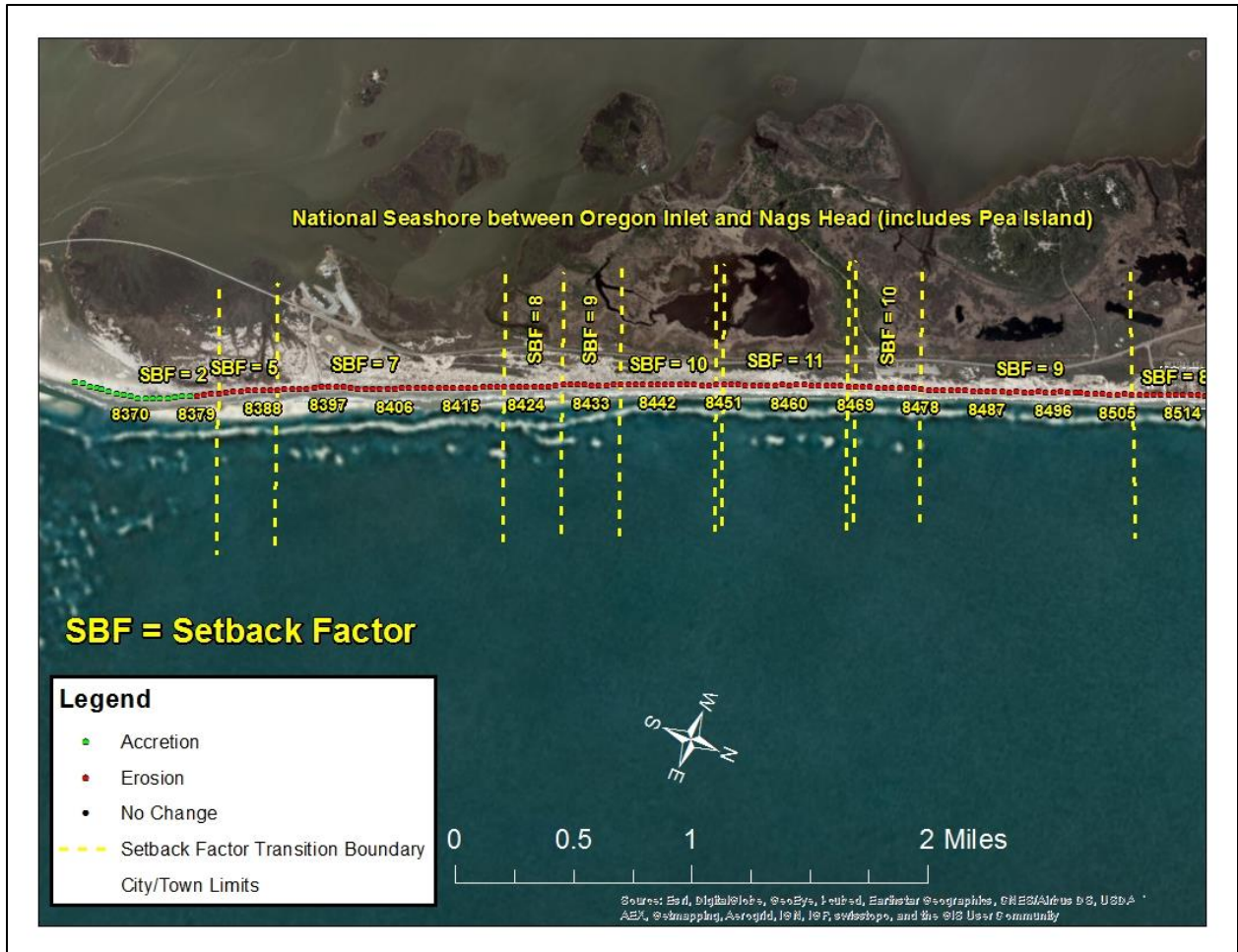


Figure 84. National Seashore between Oregon Inlet and Nags Head (Pea Island). Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Nags Head

Nags Head has an east-facing beach and its shoreline is approximately 11.2 miles long. Nearly all 11.2 miles (99.7 percent) of this shoreline resulted in measured erosion. Although the average shoreline change rate is less than 1 foot per year (erosion), the average blocked rate (setback factor) is 3 feet per year with a range between 2 and 8 feet per year (Figure 85 and 86).

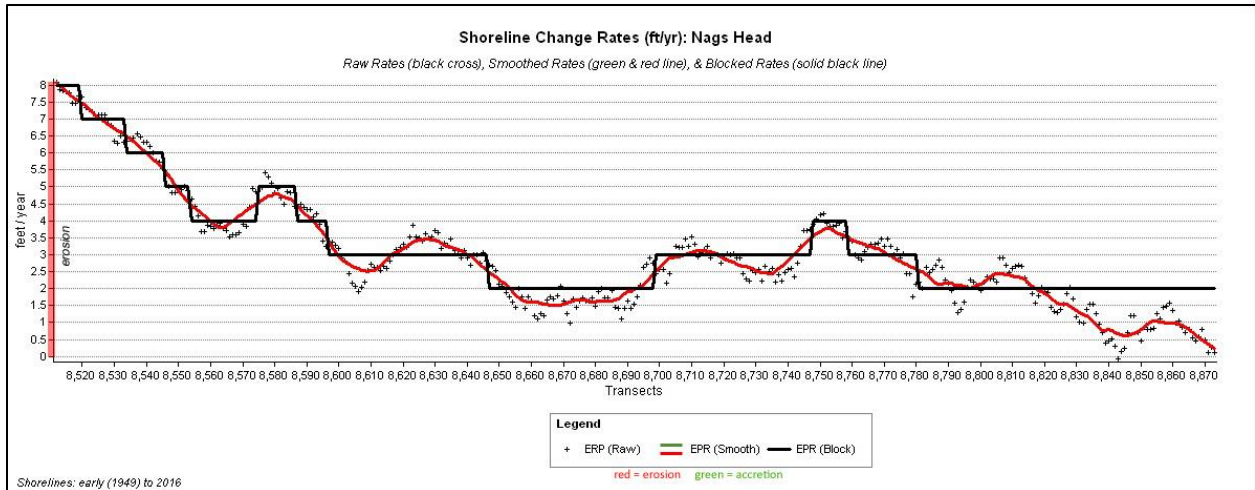


Figure 85. Nags Head shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

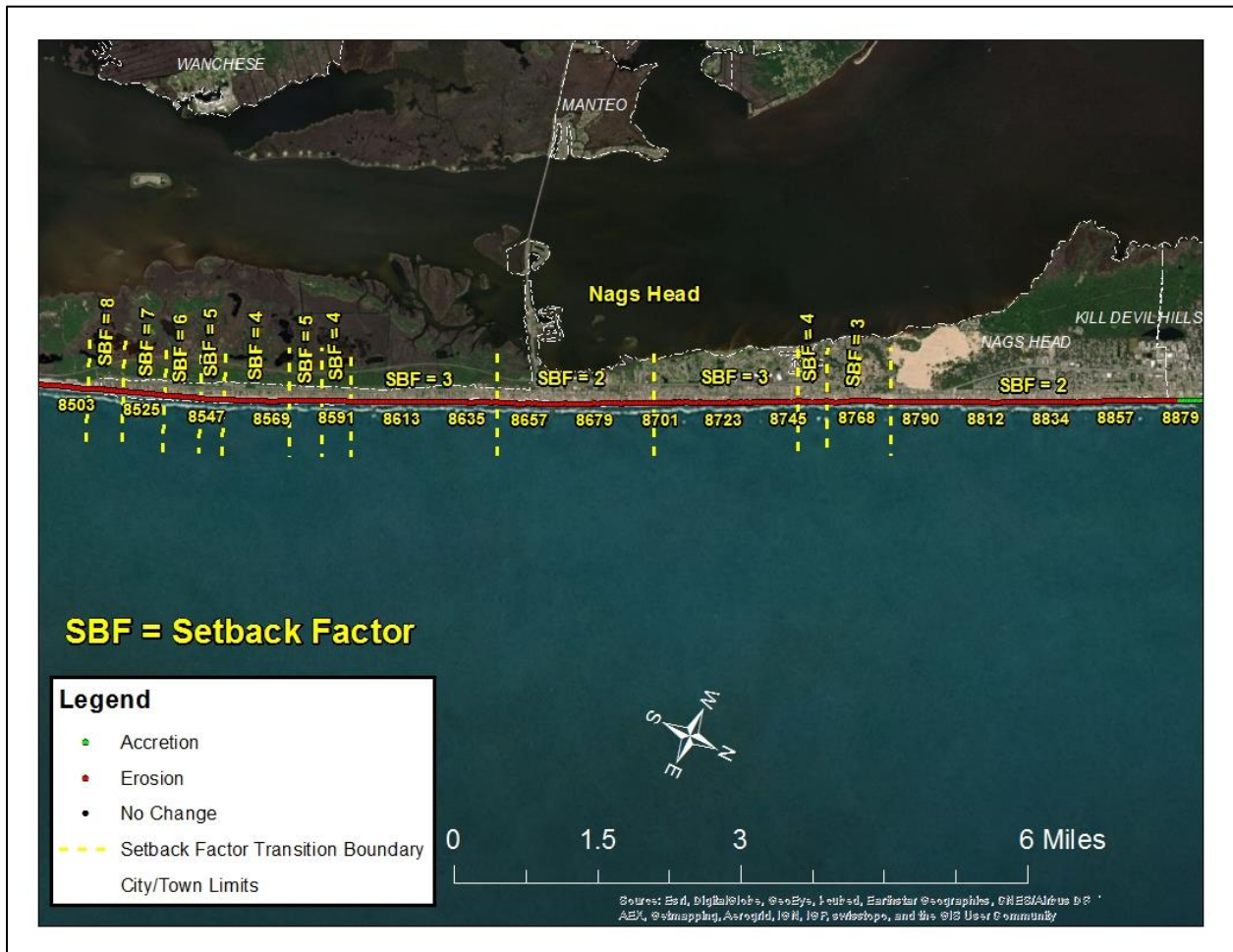


Figure 86. Nags Head. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Kill Devil Hills

Kill Devil Hills has an east-facing beach and its shoreline is approximately 4.7 miles long. Approximately 2.7 miles (56.9 percent) of its ocean shoreline resulted in measured erosion, and 1.9 miles (40.5 percent) resulted in measured accretion. The average shoreline change rate is less than 1 foot per year (erosion), and the average blocked rate is 2.0 feet per year with a range between 2 and 4 feet per year (Figure 87 and 88).

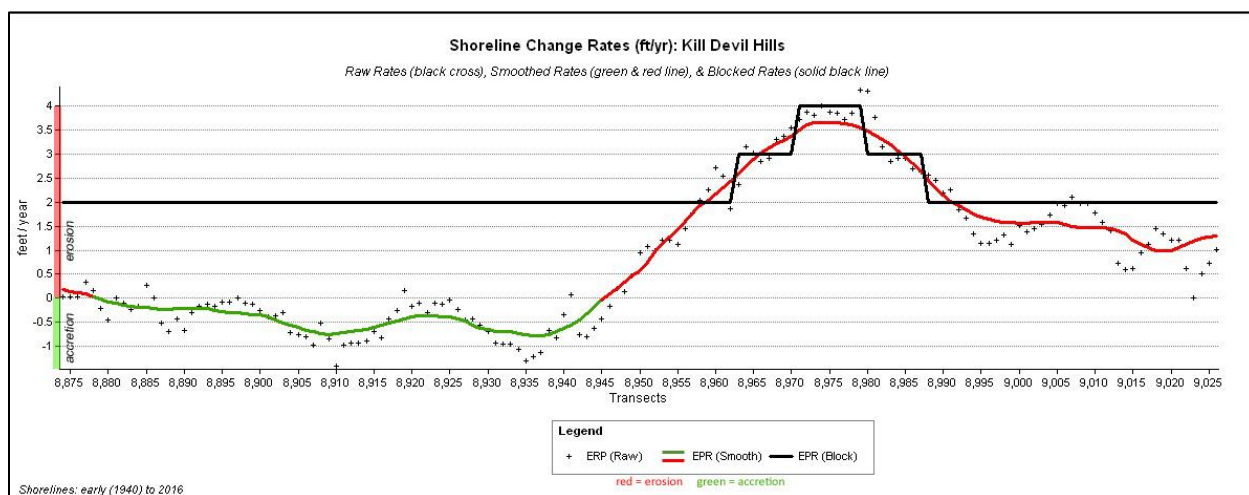


Figure 87. Kill Devil Hills shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

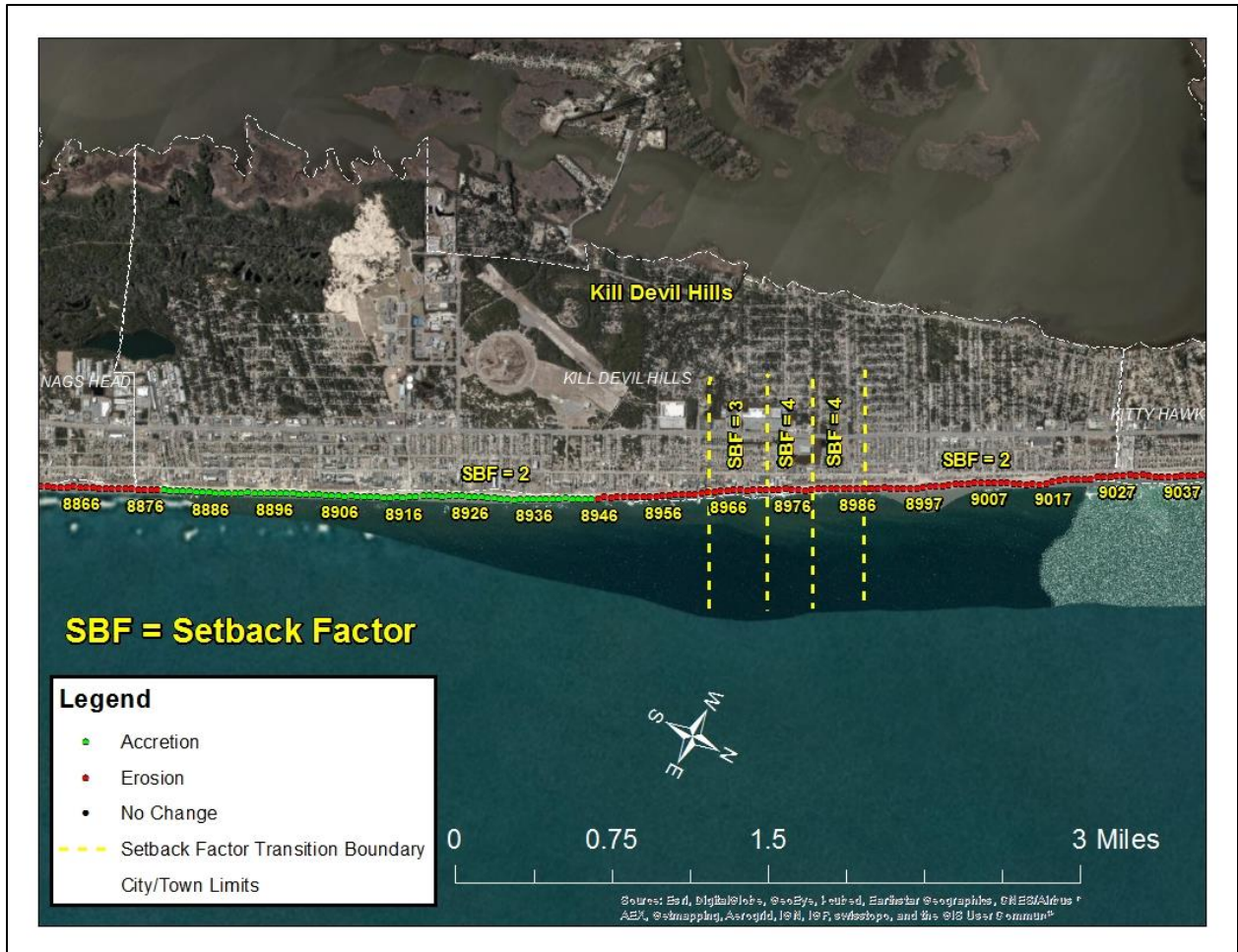


Figure 88. Kill Devil Hills. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Kitty Hawk

Kitty Hawk has an east-facing beach and its shoreline is approximately 3.5 miles long that resulted in measured erosion for the entire length. The average shoreline change rate 2.2 feet per year (erosion), and the average blocked rate (setback factor) is 2.0 feet per year with a range between 2 and 3 feet per year (Figure 89 and 90).

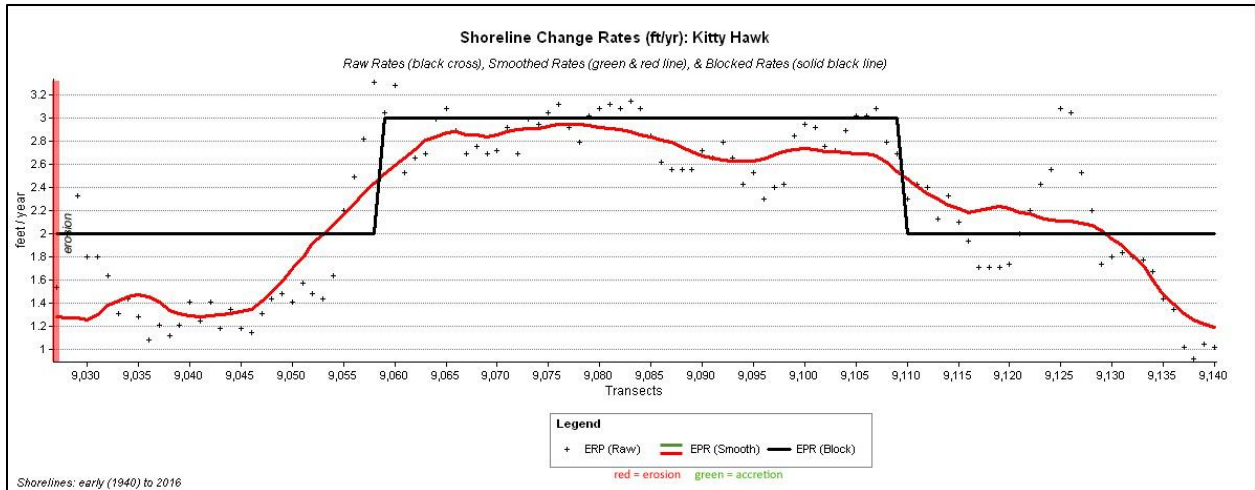


Figure 89. Kitty Hawk shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

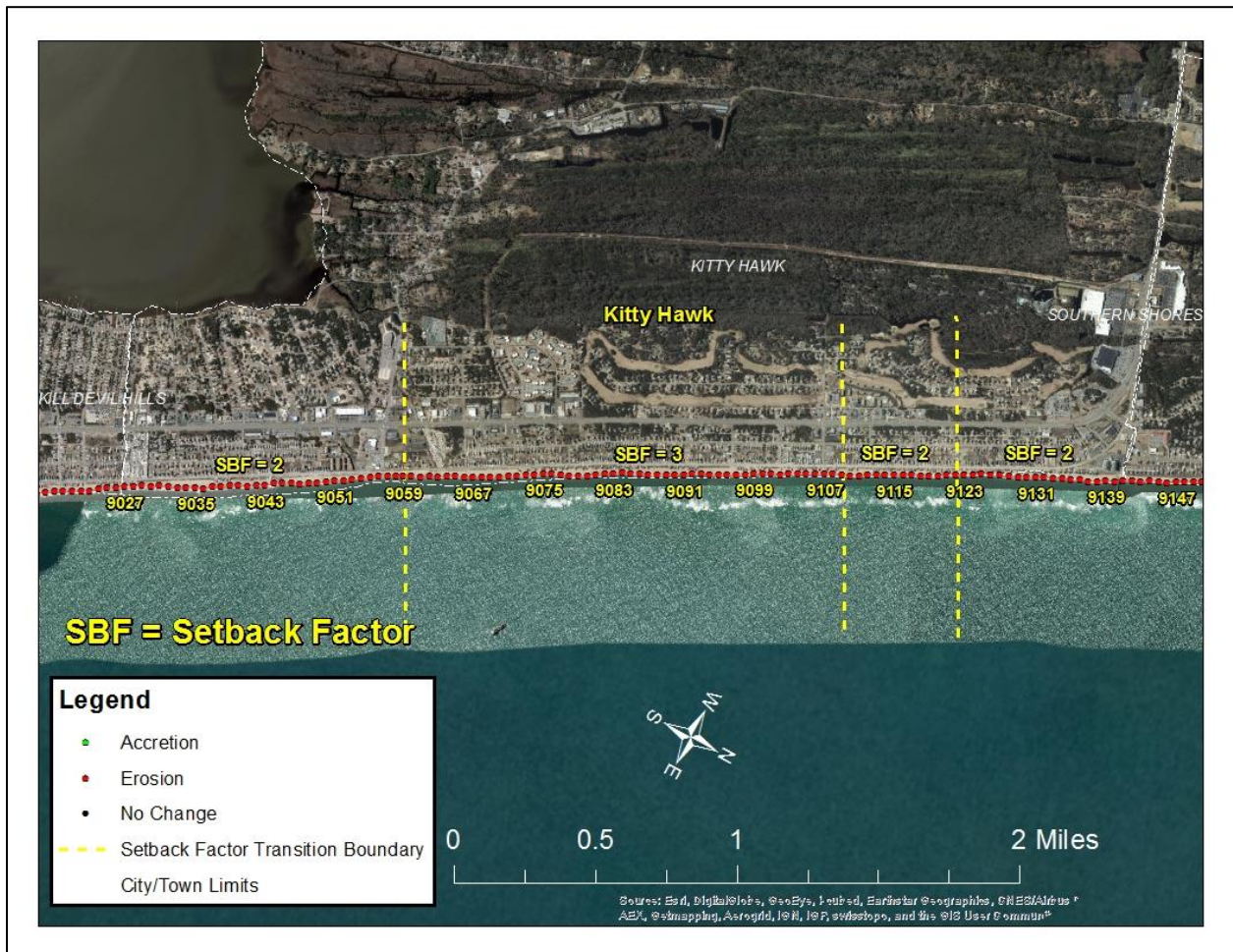


Figure 90. Kitty Hawk. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Southern Shores

Southern Shores has an east-facing beach and its shoreline is 4.5 miles long. Approximately 4.0 miles (88 percent) of its shoreline resulted in measured erosion, while the remaining 0.5 mile (11 percent) resulted in measured accretion. The average shoreline change rate 0.5 feet per year (erosion), and the blocked rate (setback factor) is 2.0 feet per year for Southern Shore's entire ocean shoreline (Figure 91 and 92).

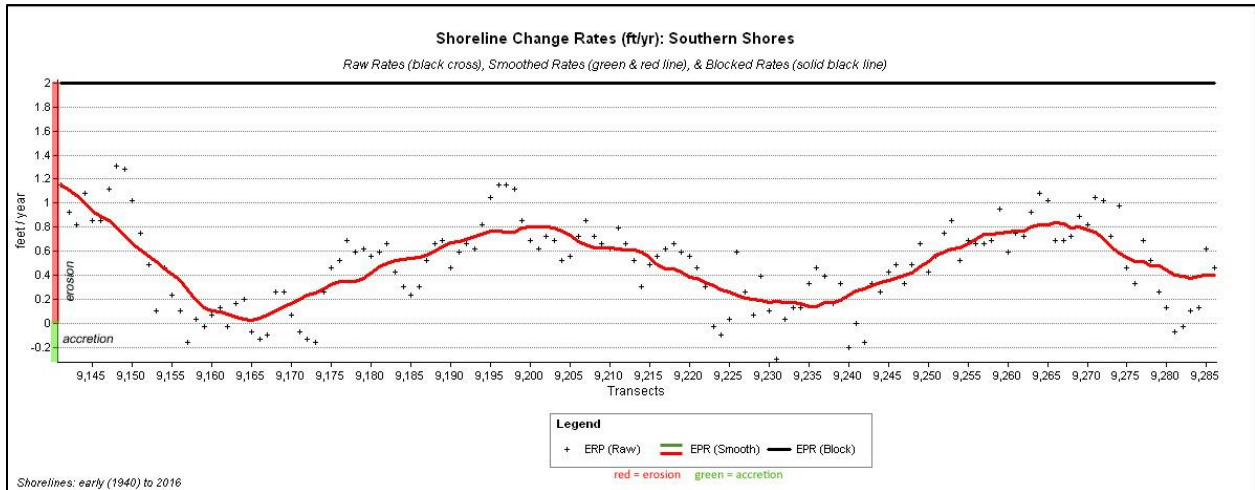


Figure 91. Southern Shores shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

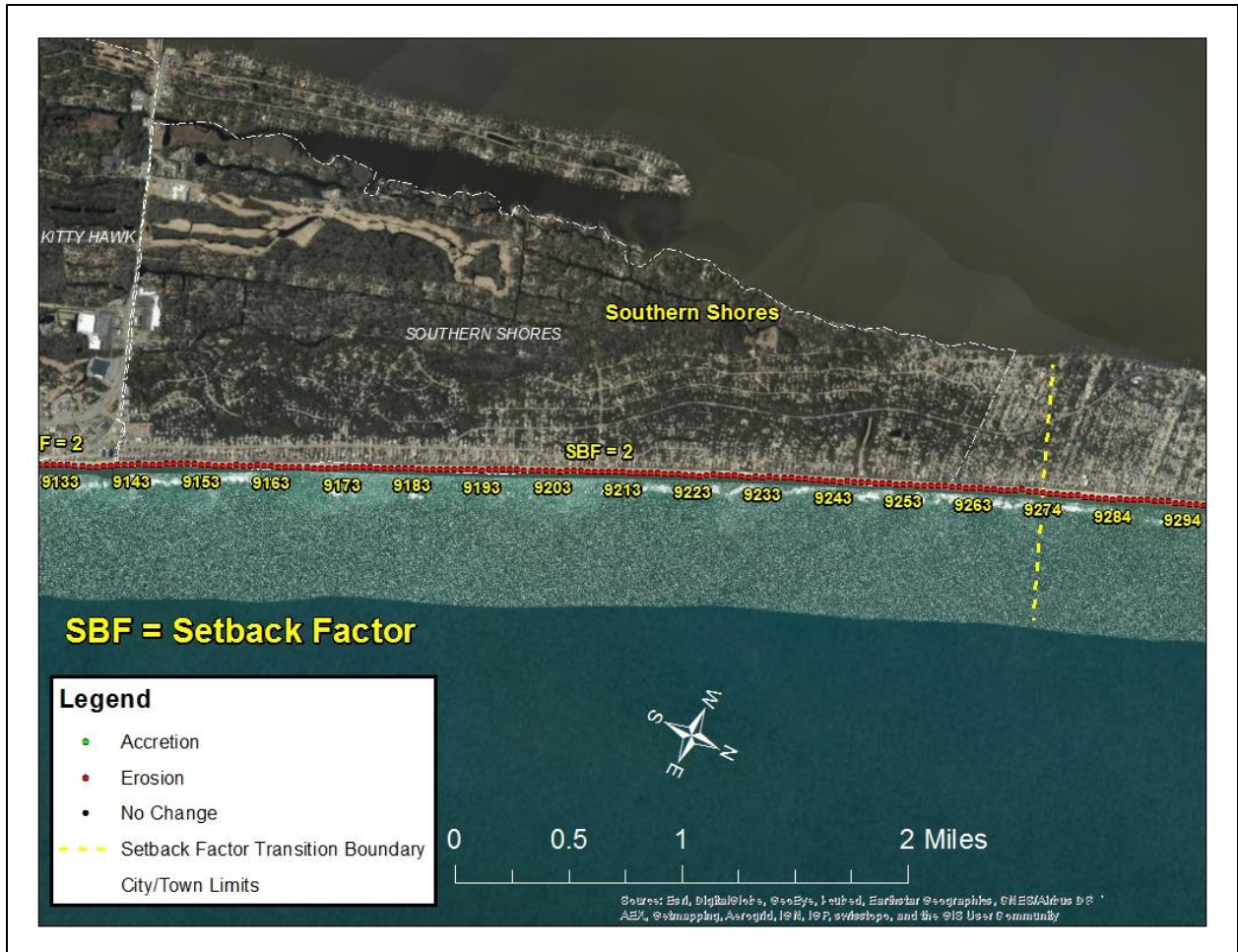


Figure 92. Southern Shores. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Duck

Duck has an east-facing beach and its shoreline is 1.8 miles long. Approximately 1.1 miles (64.4 percent) of its shoreline resulted in measured erosion, while the remaining 0.6 mile (33.9 percent) resulted in measured accretion. The average shoreline change rate is less than 0.5 feet per year (erosion), and the blocked rate (setback factor) is 2.0 feet per year for Duck's entire ocean shoreline (Figure 93 and 94).

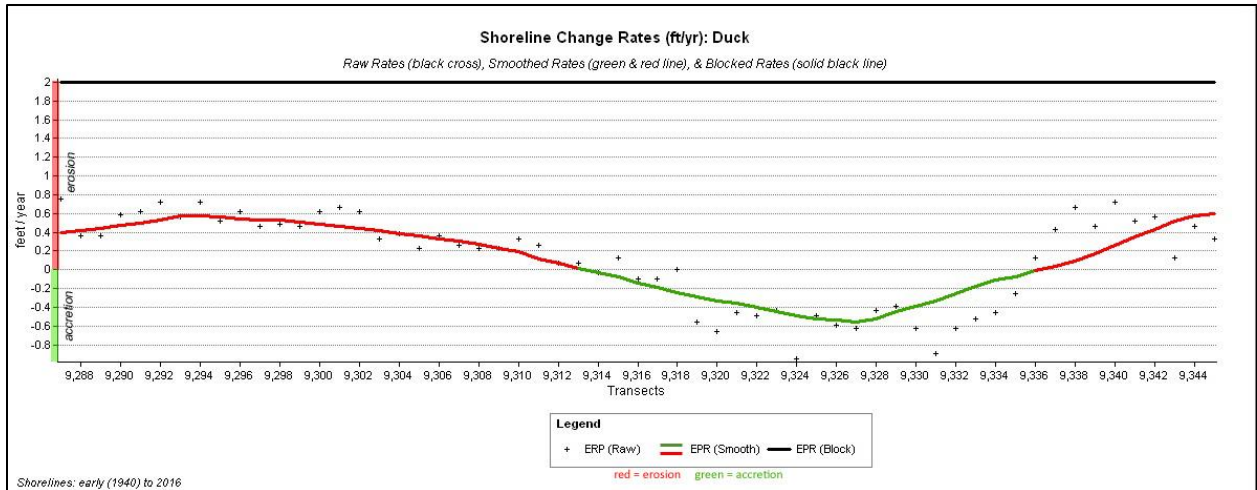


Figure 93. Duck shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).



Figure 94. Duck. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Corolla

Corolla has an east-facing beach and its shoreline is 15.1 miles long. Approximately 13.6 miles (90.1 percent) of its shoreline resulted in measured erosion, while the remaining 1.5 mile (9.9 percent) resulted in measured accretion. The average shoreline change rate is less than 1.3 feet per year (erosion), and the blocked rate (setback factor) is 2.0 feet per year with a range between 2 and 4 feet per year (Figure 95 and 96).

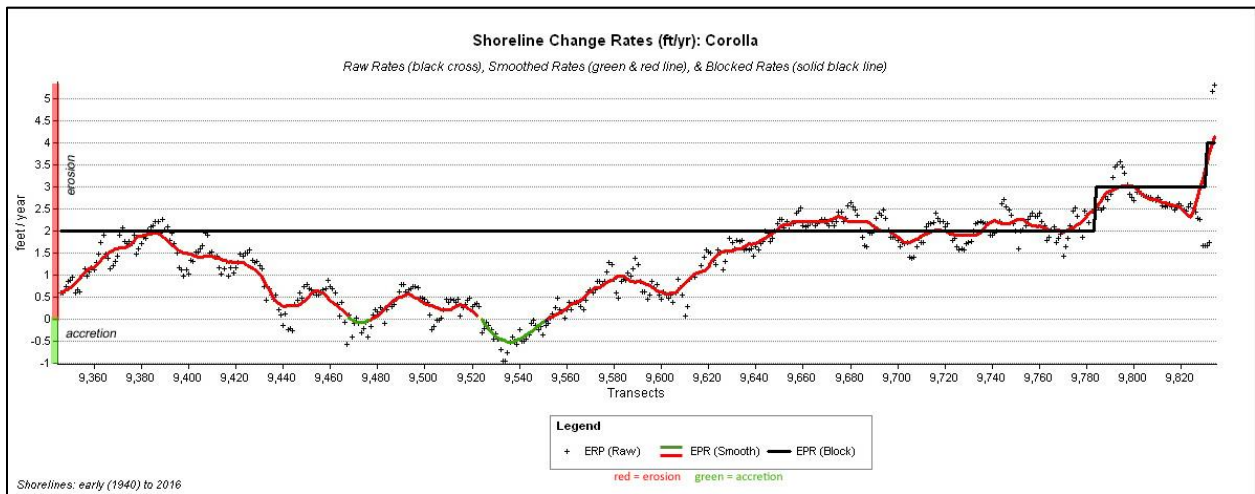


Figure 95. Corolla shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

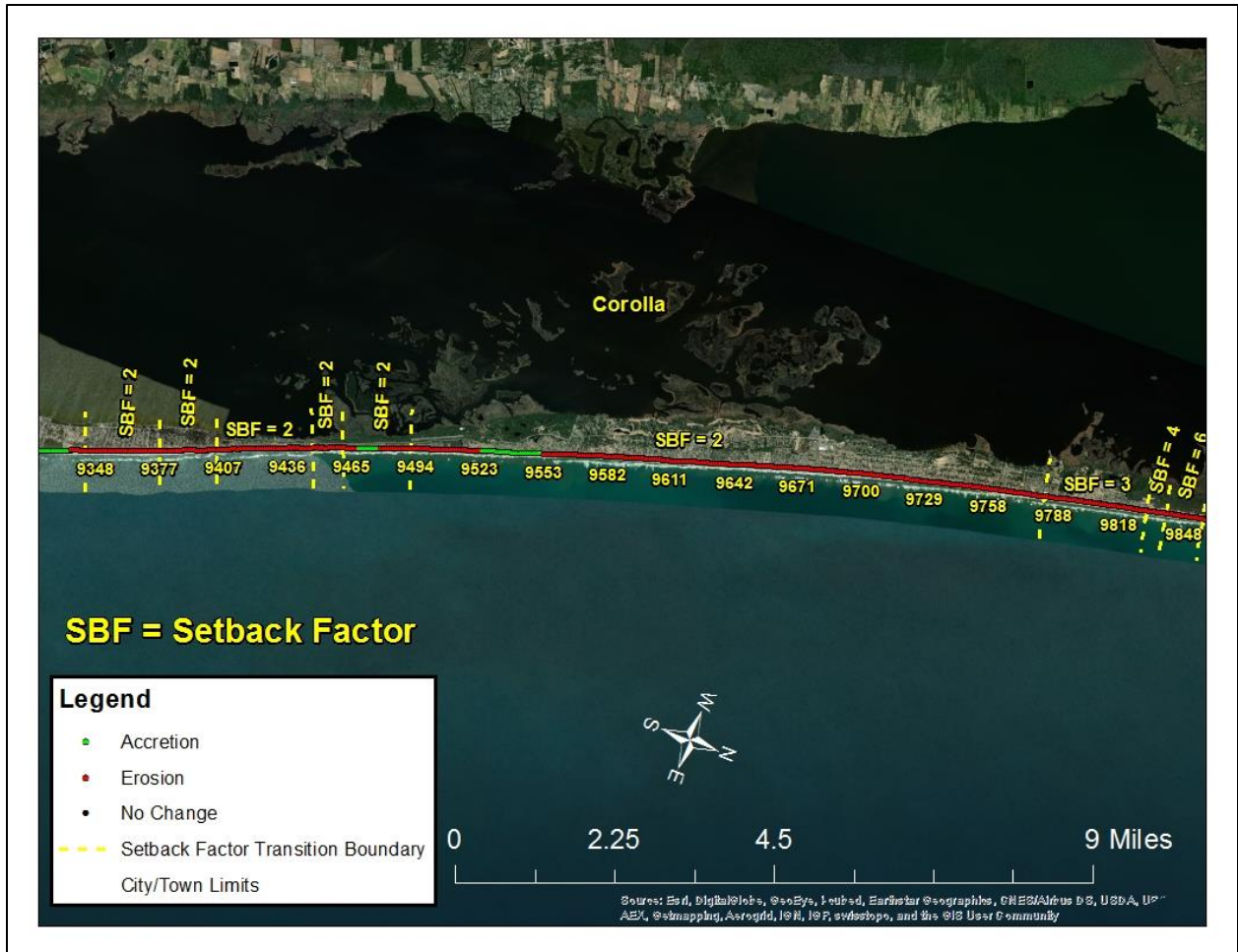


Figure 96. Corolla. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

Corolla to NC-VA State Line

The northern-most section of NC's ocean shoreline extends from Corolla to the NC-VA State line. This segment of shoreline is 10.9 miles in length. Approximately 8.1 miles (53.8 percent) of the shoreline resulted in measured erosion, while 2.7 miles (18.3 percent) of this shoreline resulted in measured accretion. The average shoreline change rate is 3.8 feet per year (erosion), and the average blocked rate (setback factor) is 5 feet per year, with a range between 2 and 8 feet per year (Figure 97 and 98).

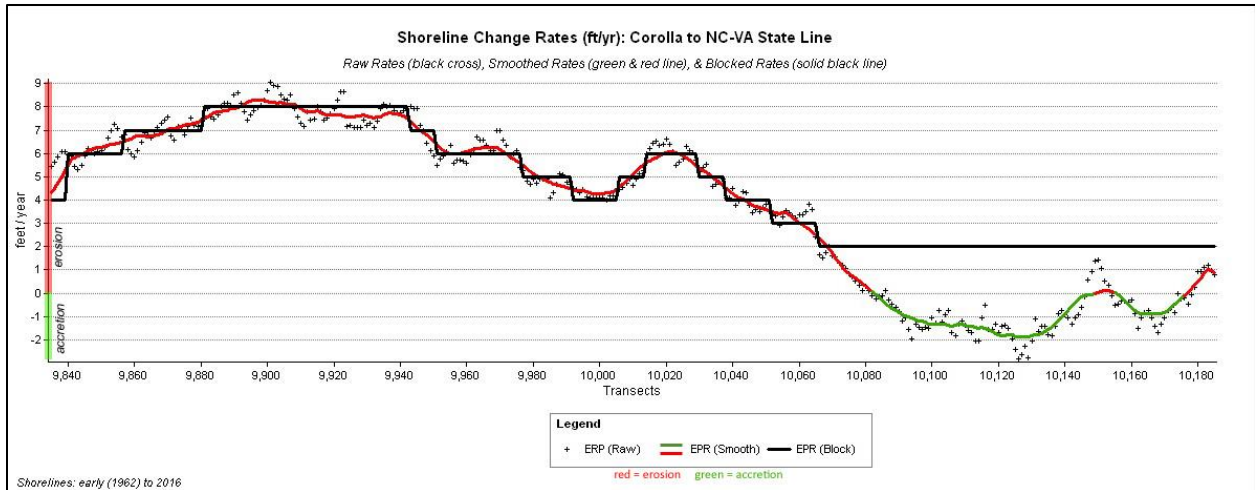


Figure 97. Corolla to NC-VA State line shoreline change rates and blocked rates (setback factors). Black-points represent all (erosion and accretion) raw rates; smoothed rates are represented by the solid green (accretion) and red (erosion) line; and the solid black line represents blocked rates (setback factors).

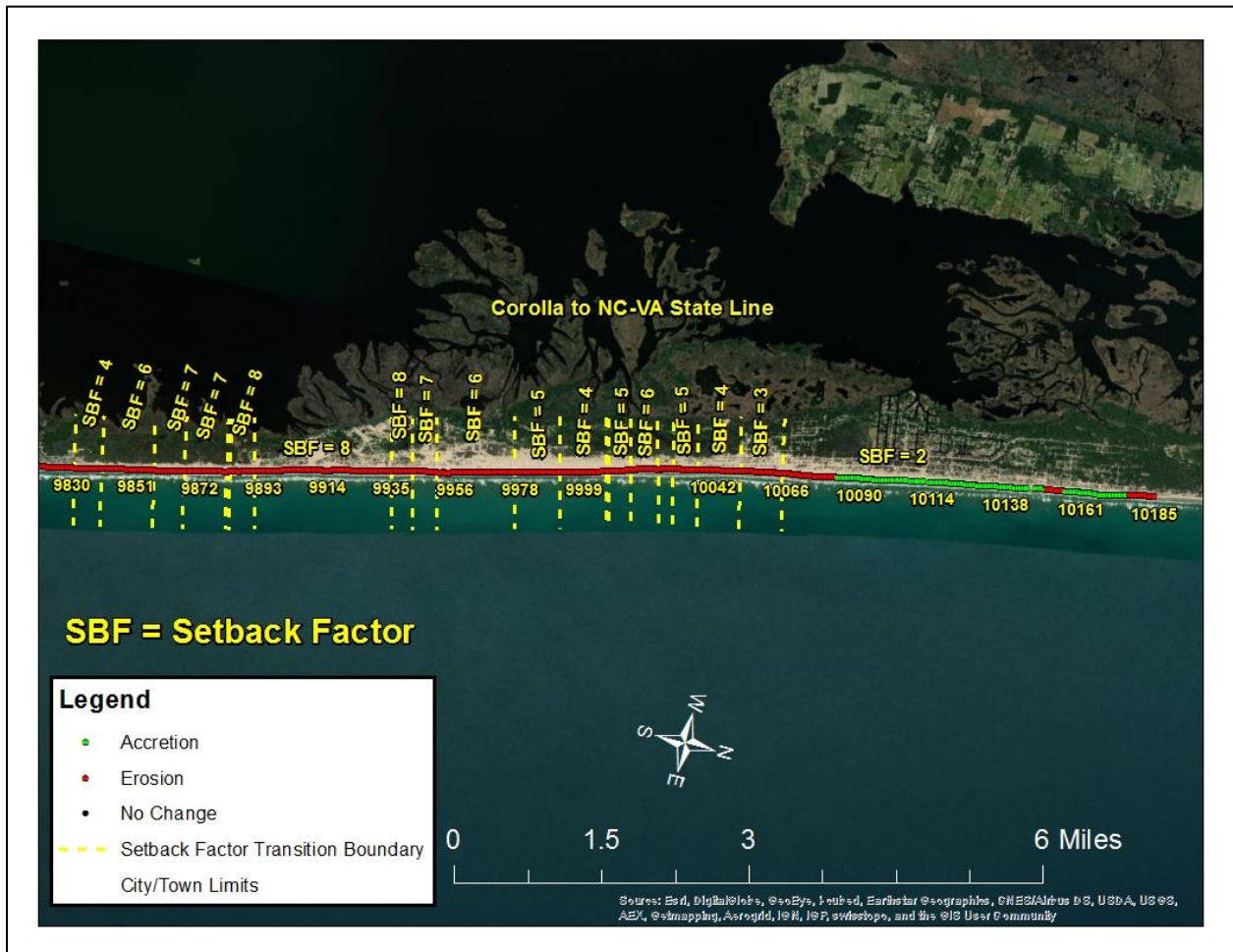


Figure 98. Corolla to NC-VA State line. Points represent transect-shoreline intersections on the 2016 shoreline; and number labels correspond to graph's x-axis transect numbers.

SUMMARY

Setback Factors and shoreline change rates south of Cape Lookout were generally consistent with those calculated in previous studies, and although some locations north of Cape Lookout resulted in slightly higher rates than were calculated in the previous study (NC DCM, 2011), they are still consistent overall when compared to the collective results from all studies. Given that most oceanfront communities now have experience with nourishing some portion of their beach on at least one occasion, it is important to emphasize that where “accretion” is measured, there is a distinct chance that while this does serve to reduce storm damage and maintain a healthy public beach, long-term beach nourishment does artificially lower actual erosion rates, and may not be the result of natural accretion.

For nearly forty years, the State has calculated oceanfront shoreline change rates using the end-point method using two shorelines (early and current). Although this method can serve to measure long-term trends, it does not always include significant short-term changes like those currently being experienced on the shoulder of Shackleford Banks adjacent to Beaufort Inlet. In preparations for the next update study in 2024, the Division of Coastal Management will compare alternative methods that incorporate multiple shorelines.

This report, data, and maps, will be made available for download and viewing on the Division’s website:

<https://deq.nc.gov/about/divisions/coastal-management>

or, internet browser key word search “NC DCM”

LITERATURE CITED

- Ashton, A., Murray, A. B., and Arnoult, O. (2001). Formation of shoreline features by large-scale instabilities included by high-angle waves. *Nature* , 414, 296-300.
- Benton, S. B., Bellis, C. J., Overton, M. F., Fisher, J. S., Hensch, J. L., and Dolan, R. (1997). *North Carolina Long-Term Average Annual Rates of Shoreline Change: Methods Report*. Division of Coastal Management, Department of Environment and Natural Resources, Raleigh, NC.
- Crowell, M., Leatherman, S. P., and Buckley, M. K. (1991). Historical shoreline change: error analysis and mapping accuracy. *Journal of Coastal Research* , 7 (3), 839-852.
- Davis, R. (1978). *Coastal Sedimentary Environments*. New York, NY: Springer-Verlag.
- Dean, R. G., and Dalrymple, R. A. (2002). *Coastal Processes with Engineering Applications*. Cambridge University Press.
- Dolan, R., and Ferm, J. C. (1968). Crescentic Landforms along the Atlantic Coast of the U.S. *Science* , 159, 627-629.
- Dolan, R., Hayden, B. P., May, P., and May, S. K. (1980). The reliability of shoreline change measurements from aerial photographs. 48 (4), 22-29.
- Dolan, R., Hayden, B., and Heywood, J. (1978). A New Photogrammetric Method for Determining Shoreline Erosion. *Coastal Engineering* , 2 (1), 21-39.
- Fenster, M., and Dolan, R. (1996). Assessing the impact of tidal inlets on adjacent barrier island shorelines. *Journal of Coastal Research* , 12 (1), 294-310.
- Hoyt, J., and Henry, V. (1971). Origin of capes and shoals along the southeastern coast of the United States. *Geological Society of America Bulletin* , 82 (1), 59-66.
- Limber, P. W., List, J. H., and Warren, J. W. (2007a.). Using topographic LiDAR data to delineate the North Carolina shoreline. *Proceedings of Coastal Sediments*, (pp. 1837-1850). New Orleans, Louisiana.
- Martin, J. (1997). *Analysis of the wet/dry line as an indicator of shoreline position on a sand beach*. Masters, Thesis, North Carolina State University, Raleigh, NC.
- Moore, L. J., Ruggiero, P., and List, J. H. (2006). Comparing mean high water and high water shorelines: should proxy-datum offsets be incorporated into shoreline change analysis? *Journal of Coastal Research* , 22 (4), 984-905.

Morton, R. A., and Sallenger, A. H. (2003). Morphological impacts of extreme storms on sandy beaches and barriers. *Journal of Coastal Research* , 19 (3), 560-573.

National Oceanic and Atmospheric Administration. (2018, November 1). *National Data Buoy Center*. Retrieved November 1, 2018, from National Oceanic and Atmospheric Administration: <http://www.ndbc.noaa.gov/>

North Carolina Division of Coastal Management (2016). *Coastal Erosion Study*. Division of Coastal Management, Department of Environmental Quality, Raleigh, NC.

North Carolina Division of Coastal Management (2011). *North Carolina Long-Term Average Annual Rates of Shoreline Change: Methods Report*. Division of Coastal Management, Department of Environment and Natural Resources, Raleigh, NC.

Overton, M. F., and Fisher, J. S. (2003). *The 1998 Long-term Erosion Rate Update for the North Carolina Shoreline*. Division of Coastal Management, NC Department of Environment and Natural Resources, Raleigh, NC.

Pajak, M. J., and Leatherman, S. (2002). The high water line as a shoreline indicator. *Journal of Coastal Research* , 18 (2), 329-337.

Riggs, S. R., & Ames, D. V. (2003). *Drowning the North Carolina Coast: Sea Level Rise and Estuarine Dynamics*. Raleigh, NC: North Carolina Sea Grant.

Riggs, S. R., Cleary, W. J., and Snyder, S. W. (1995). Influence of inherited geologic framework on barrier shoreface morphology and dynamics. *Marine Geology* , 126, 213-234.

Tafun, M., Rogers, S. M., and Langfelder, J. (1979). *A Method Report on: Delineation of an Ocean Hazard Zone for North Carolina*. NCSU Department of Marine Science and Engineering, Raleigh, NC.

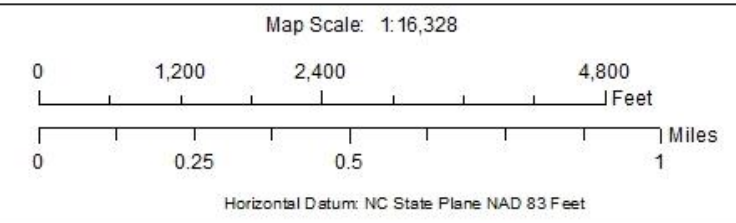
Thieler, E. R., Himmelstoss, E. A., Zichichi, J. L., and Ergul, A. (2009). *Digital Shoreline Analysis System (DSAS) version 4.0 - An ArcGIS extension for calculating shoreline change*. Open-File Report 2008-1278, U.S. Geological Survey.

APPENDIX A: Oceanfront Setback Factors & Average Annual Long-Term Shoreline Change Rate Maps



2019 Ocean Erodible Area & Setback Factor Update Sunset Beach

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H..

The information presented here is not predictive, nor does it reflect short-term erosion potential. This map may not be suitable for property specific determination of erosion rate factors near rate transition boundaries due to its small scale. For site specific determinations contact your CAMA Local Permit Official, or regional Division of Coastal Management field office.



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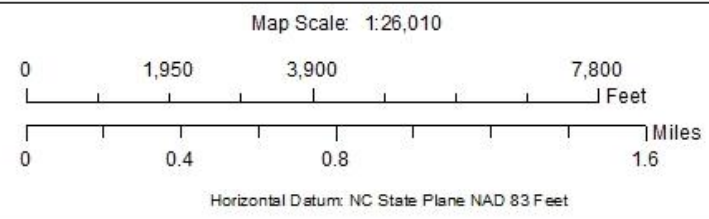
Map Number: 1 of 45

Figure A 1. Sunset Beach & Bird Island Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Ocean Isle

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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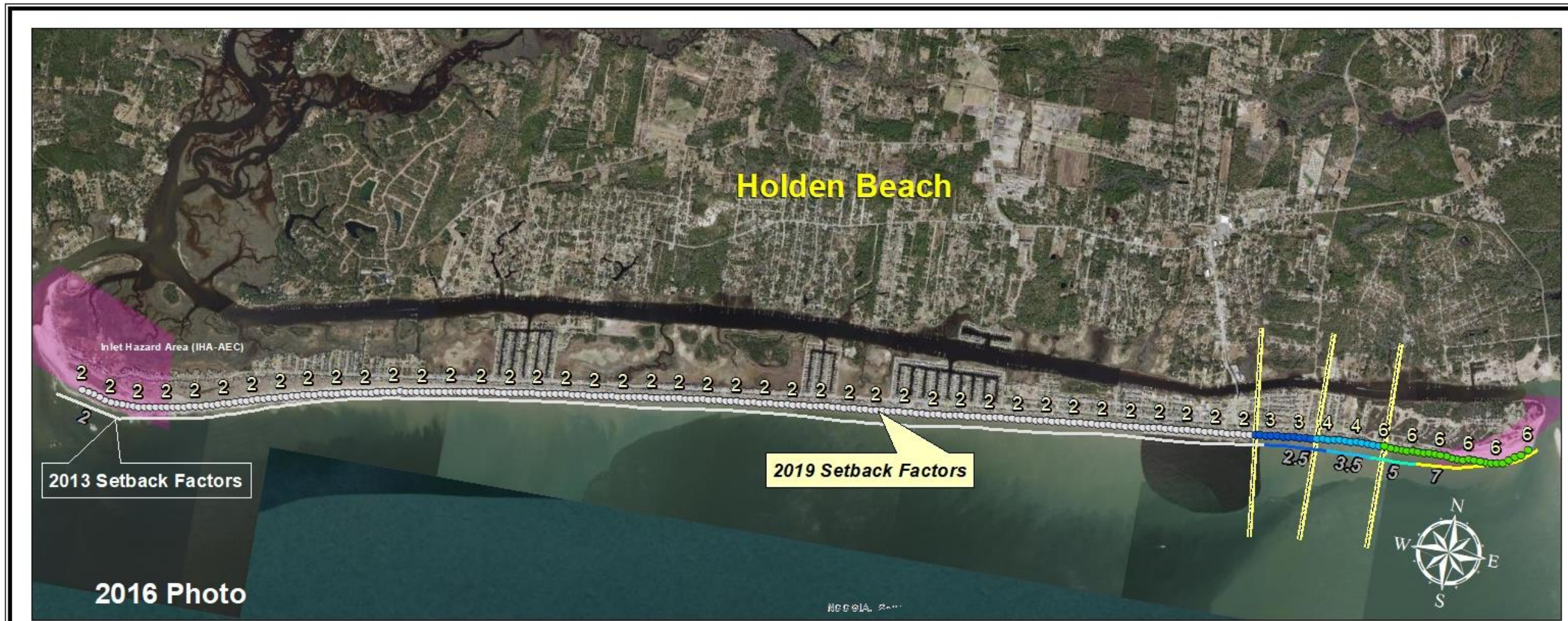


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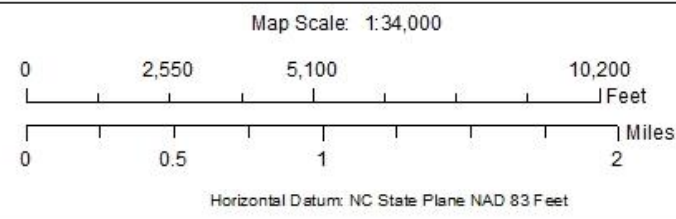
Map Number: 2 of 45

Figure A 2. Ocean Isle Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Holden Beach

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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Figure A 3. Holden Beach Setback Factors

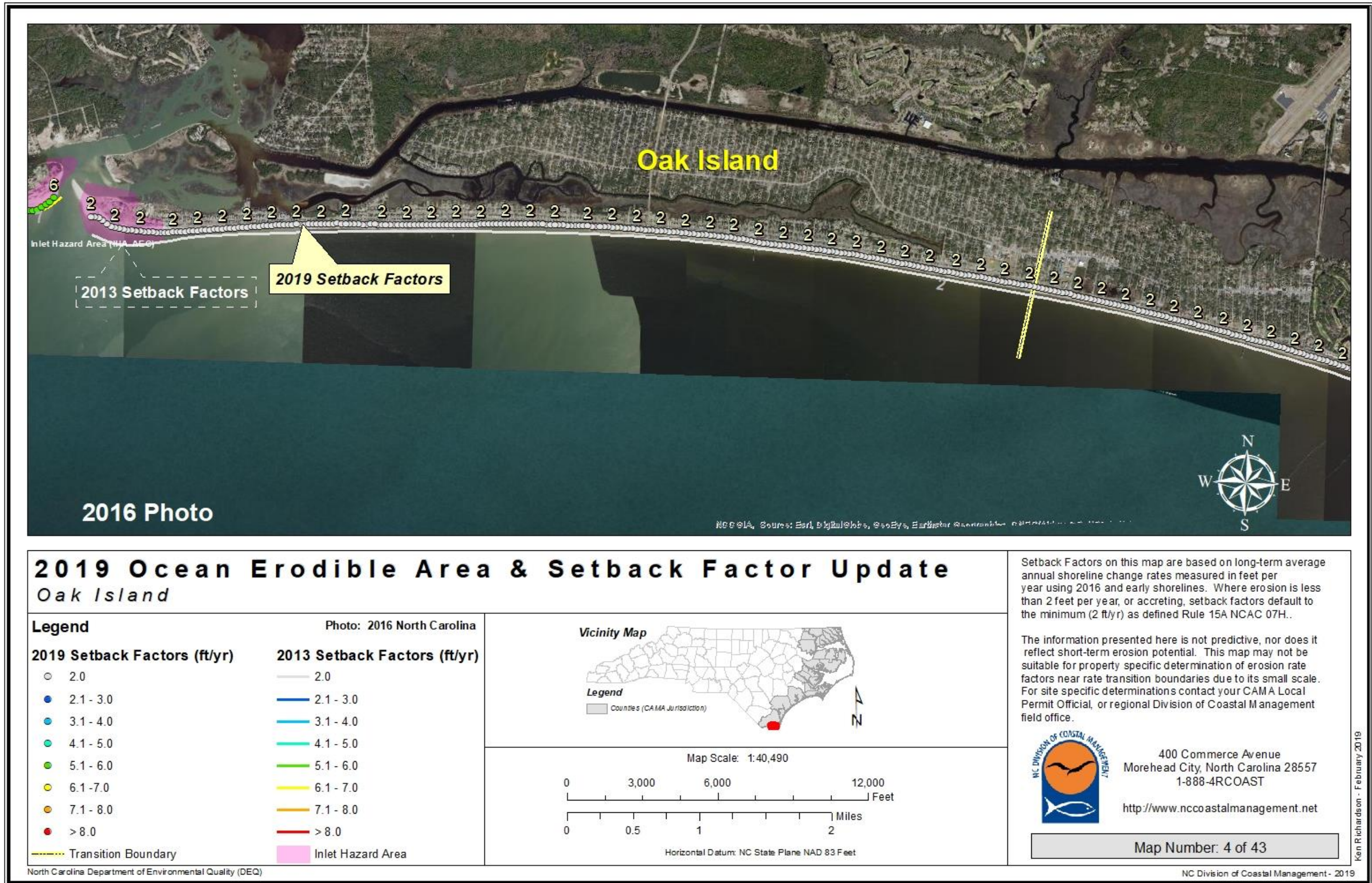


Figure A 4. Oak Island Setback Factors

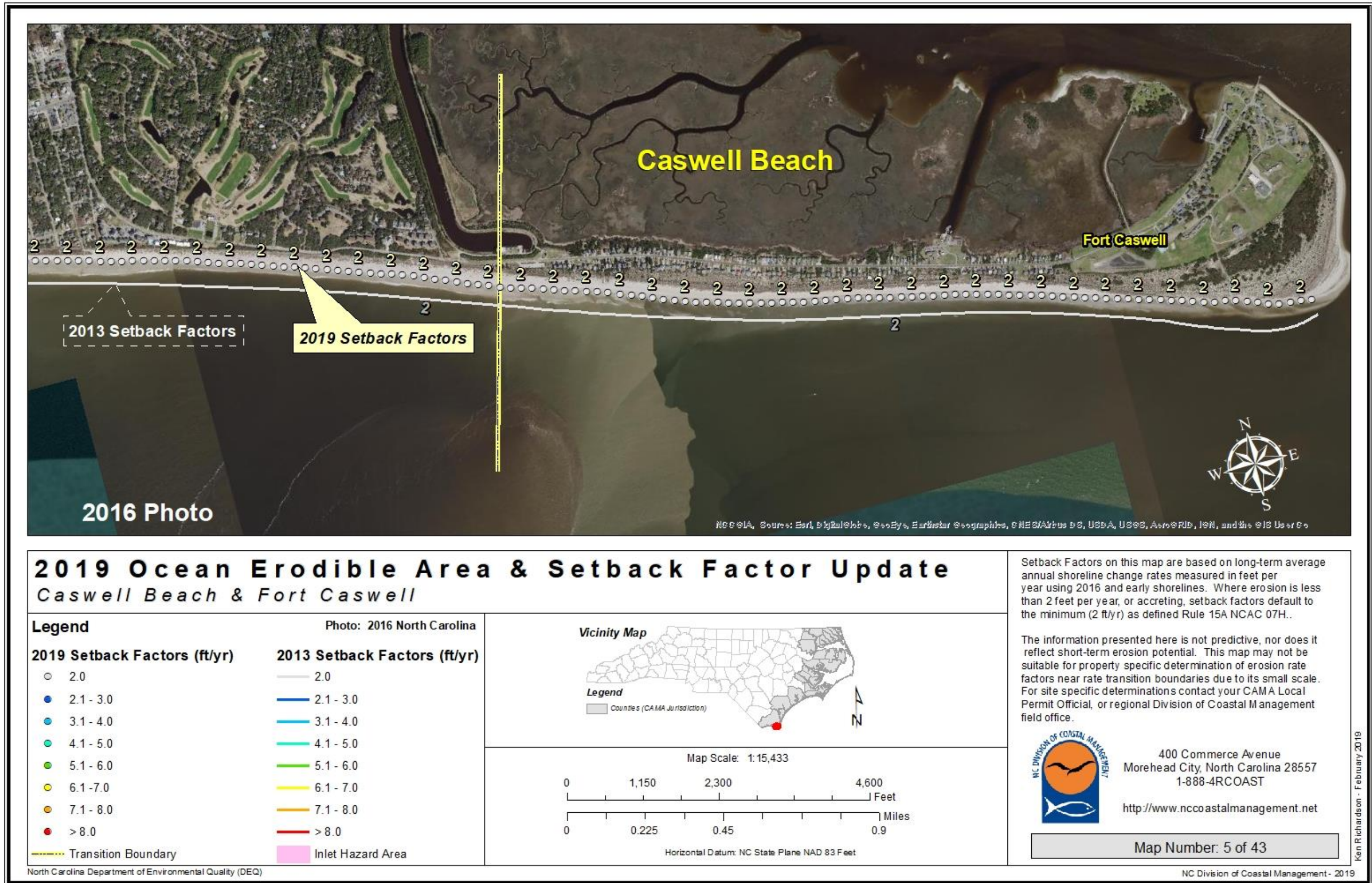


Figure A 5. Caswell Beach & Fort Caswell Setback Factors

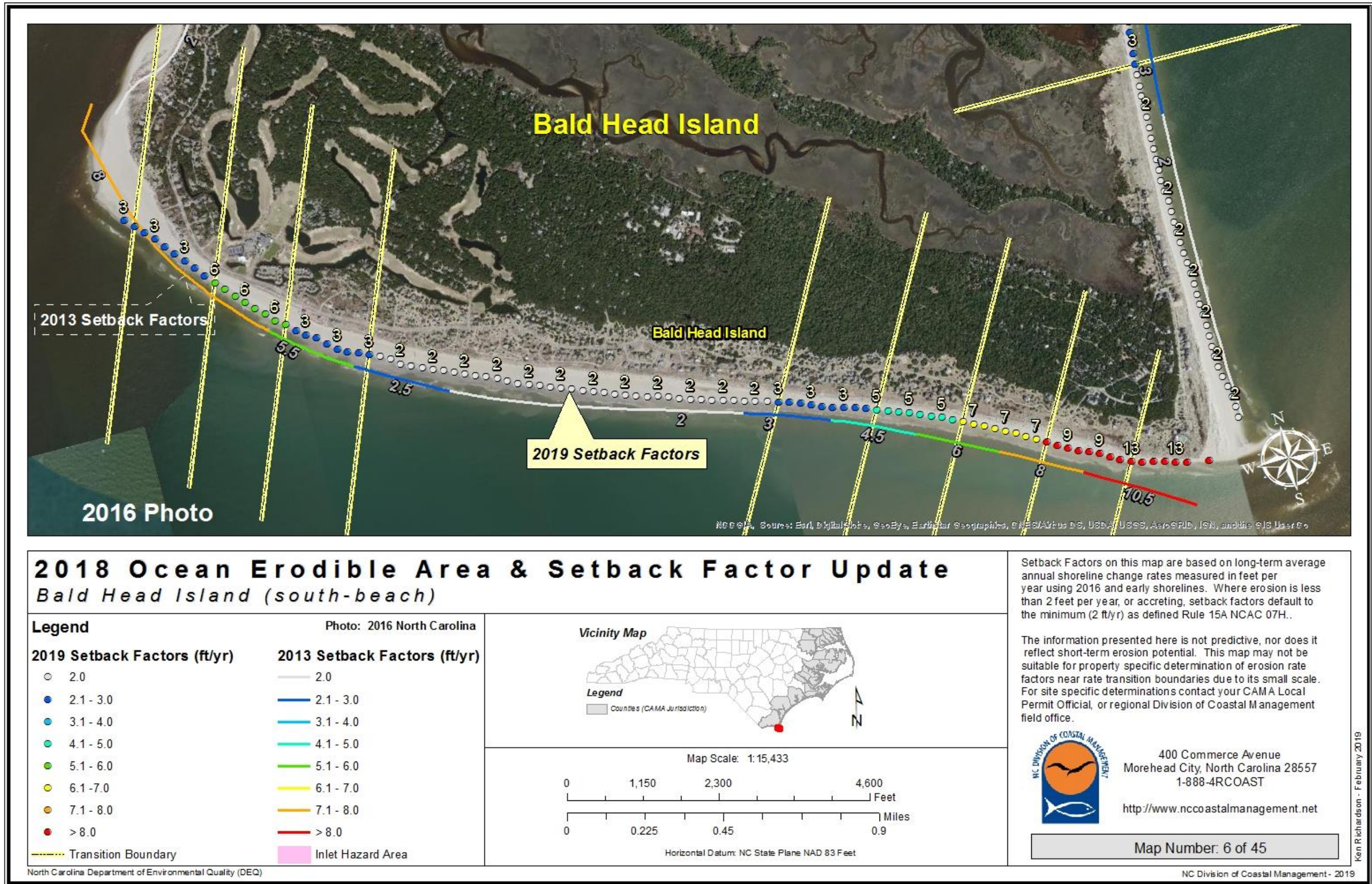


Figure A 6. Bald Head Island (south-beach) Setback Factors

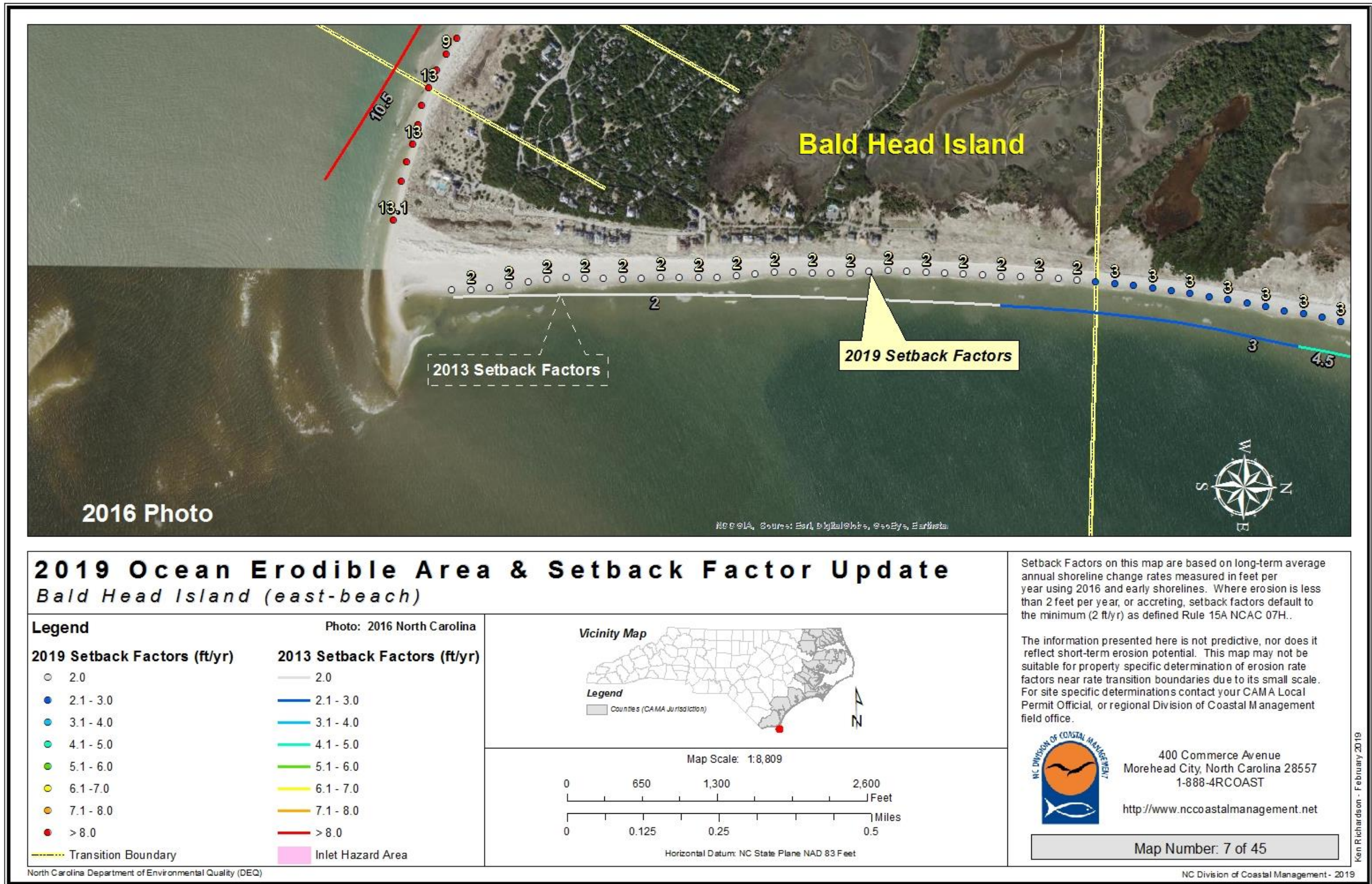
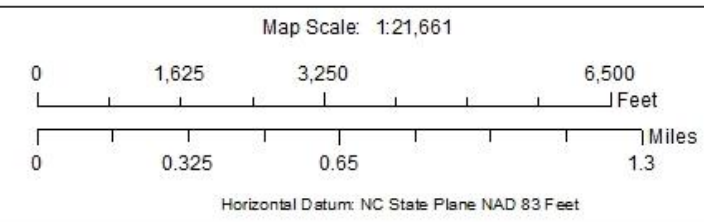


Figure A 7. Bald Head Island (east-beach) Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Zeke's Island

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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NC Division of Coastal Management - 2019

Ken Richardson - February 2019

Figure A 8. Zeke's Island Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Fort Fisher State Park

Legend		Photo: 2016 North Carolina
2019 Setback Factors (ft/yr)	2013 Setback Factors (ft/yr)	
○ 2.0	— 2.0	
● 2.1 - 3.0	— 2.1 - 3.0	
● 3.1 - 4.0	— 3.1 - 4.0	
● 4.1 - 5.0	— 4.1 - 5.0	
● 5.1 - 6.0	— 5.1 - 6.0	
● 6.1 - 7.0	— 6.1 - 7.0	
● 7.1 - 8.0	— 7.1 - 8.0	
● > 8.0	— > 8.0	
--- Transition Boundary	■ Inlet Hazard Area	

Vicinity Map

Legend
■ Counties (CAMA Jurisdiction)

Map Scale: 1:15,984

Horizontal Datum: NC State Plane NAD 83 Feet

Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H..

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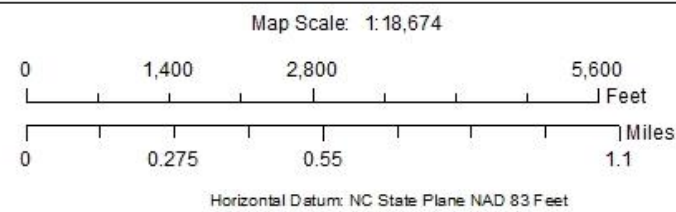
NC Division of Coastal Management - 2019

Figure A 9. Fort Fisher State Park Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Kure Beach

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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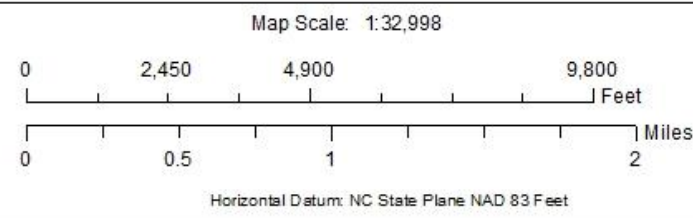
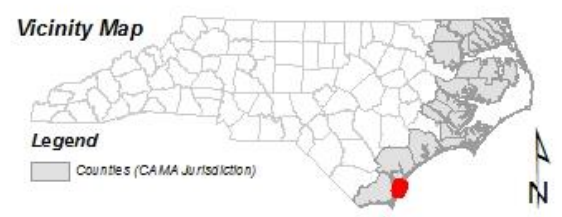
Map Number: 10 of 45

Figure A 10. Kure Beach Setback Factors



2019 Ocean Erodible Area & Setback Factor Update *Masonboro Island*

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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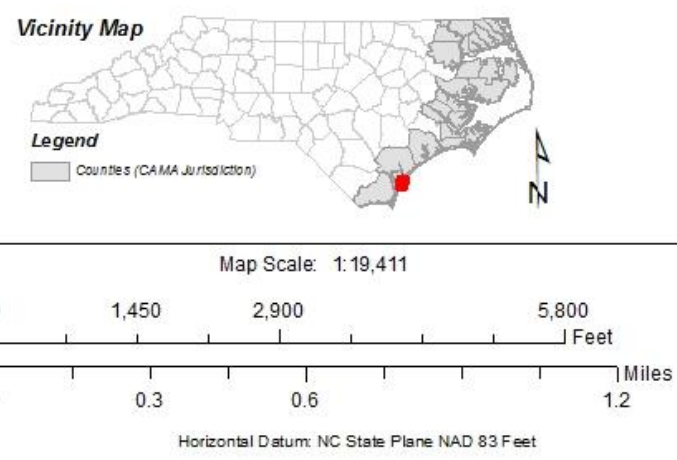
Map Number: 12 of 45

Figure A 12. Masonboro Island Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Wrightsville Beach

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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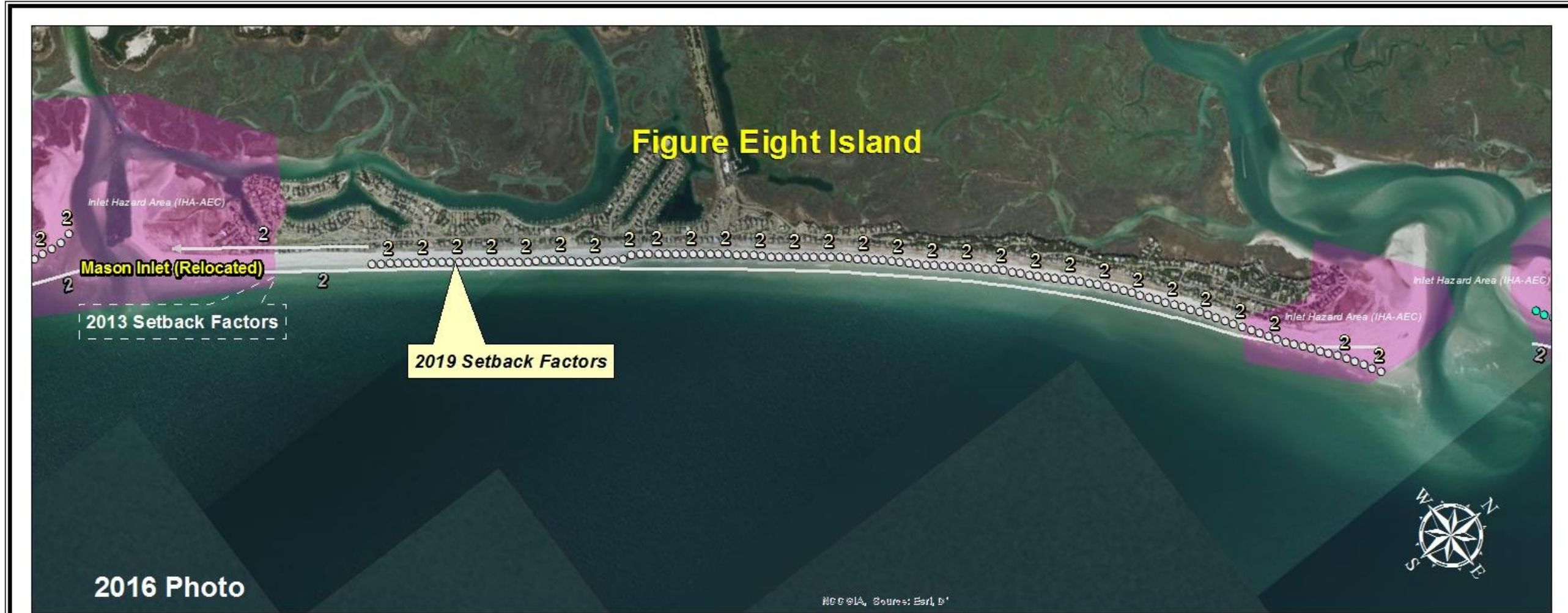


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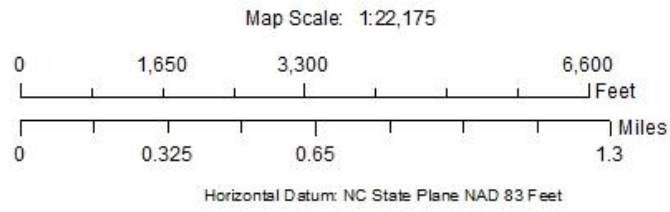
Figure A 13. Wrightsville Beach Setback Factors



2019 Ocean Erodible Area & Setback Factor Update

Figure Eight Island

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H..

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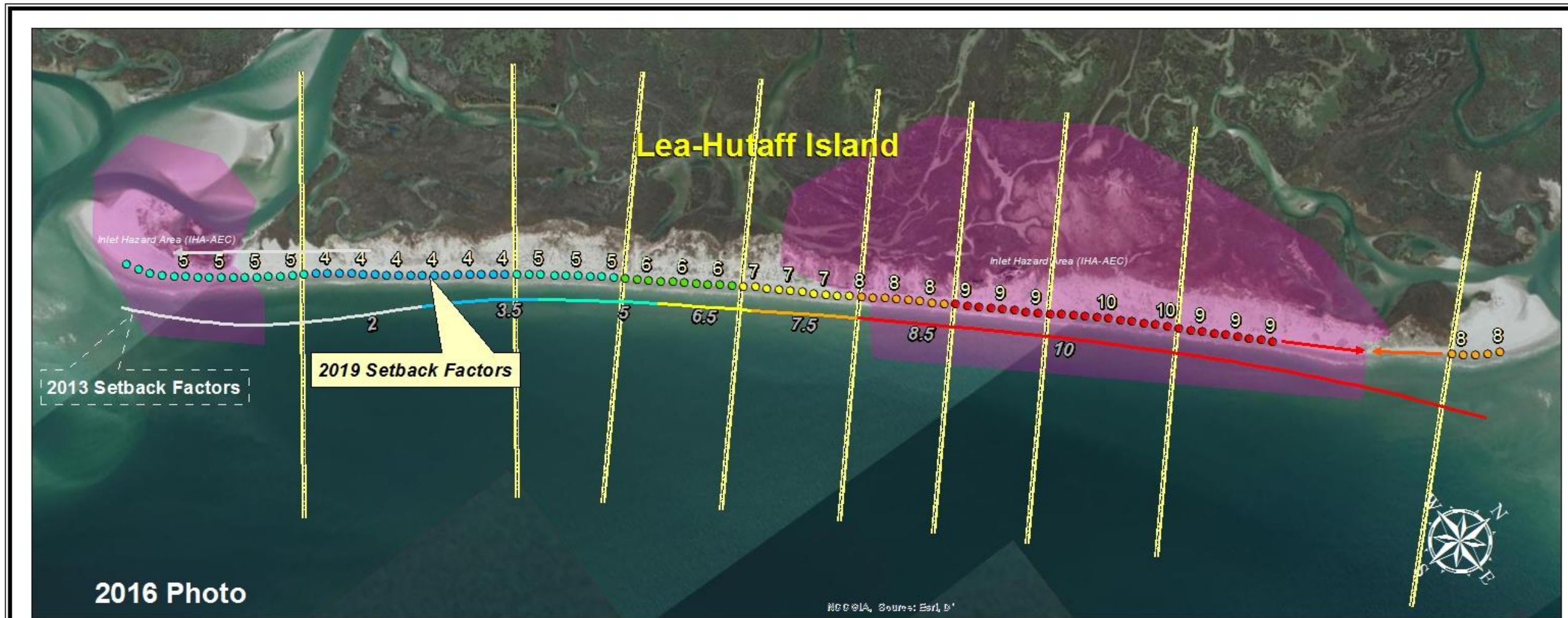


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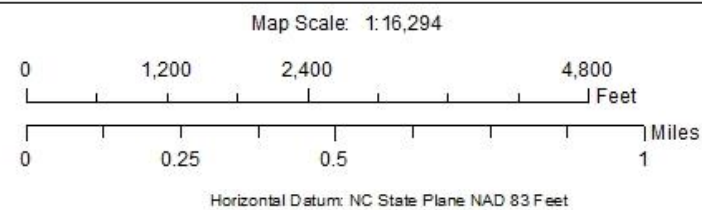
Map Number: 14 of 45

Figure A 14. Figure Eight Island Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Lea-Hutaff Island

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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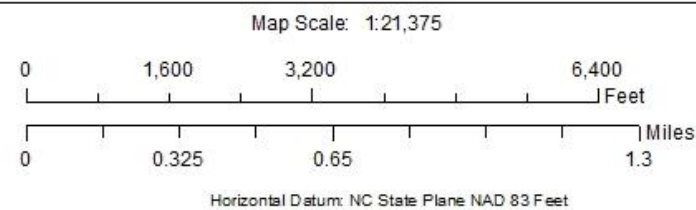
Map Number: 15 of 45

Figure A 15. Lea-Hutaff Island Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Topsail Beach

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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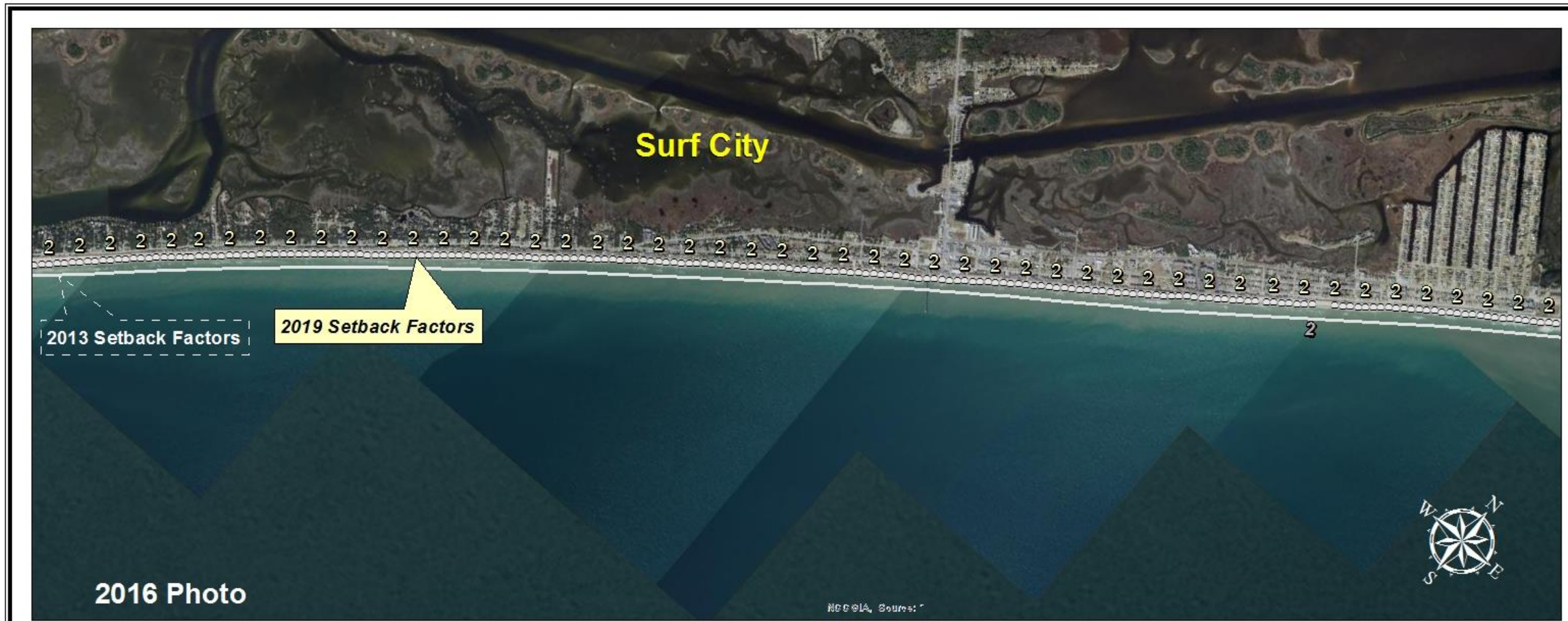


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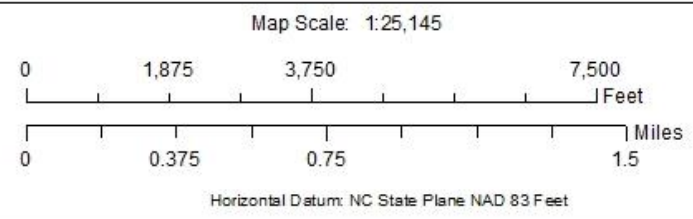
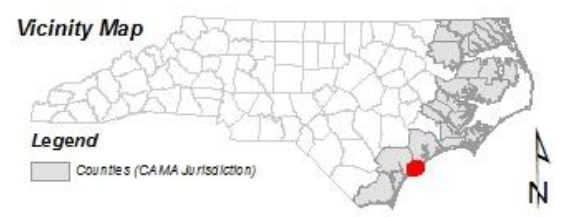
Map Number: 16 of 45

Figure A 16. Topsail Beach Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Surf City

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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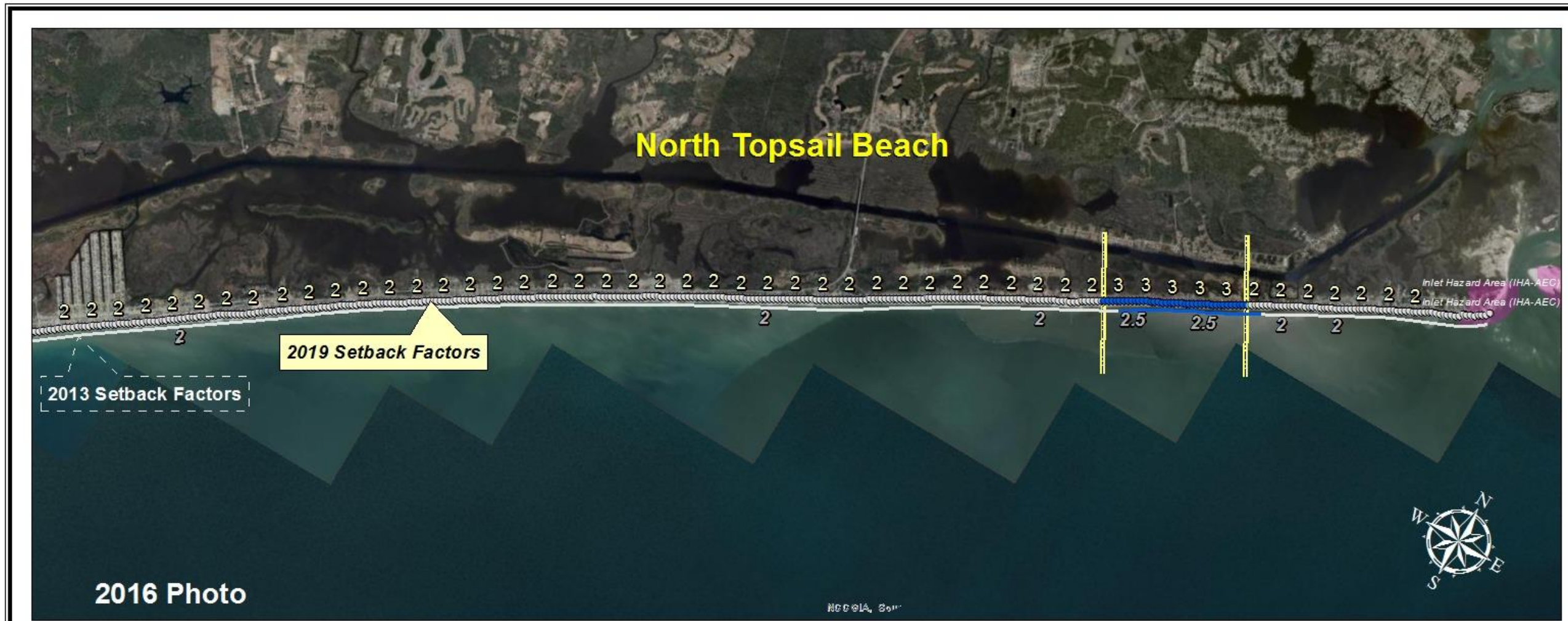


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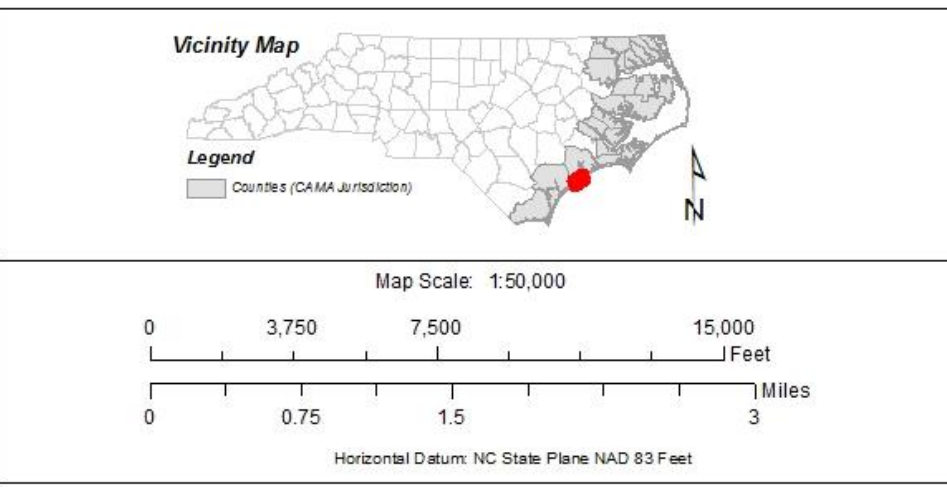
Figure A 17. Surf City Setback Factors



2019 Ocean Erodeable Area & Setback Factor Update


North Topsail Beach

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



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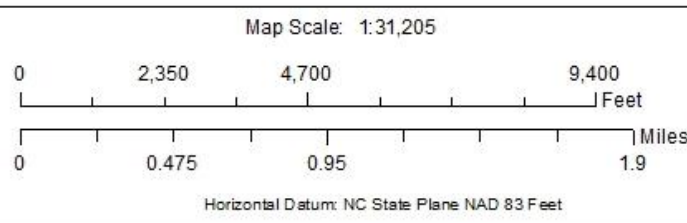
NC Division of Coastal Management - 2019

Figure A 18. North Topsail Beach Setback Factors



2019 Ocean Erodeable Area & Setback Factor Update Onslow Beach

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



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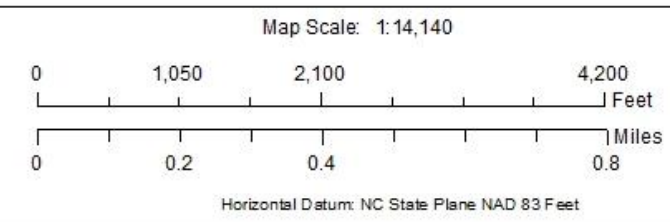
Ken Richardson - February 2019

Figure A 19. Onslow Beach Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Brown's Island

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



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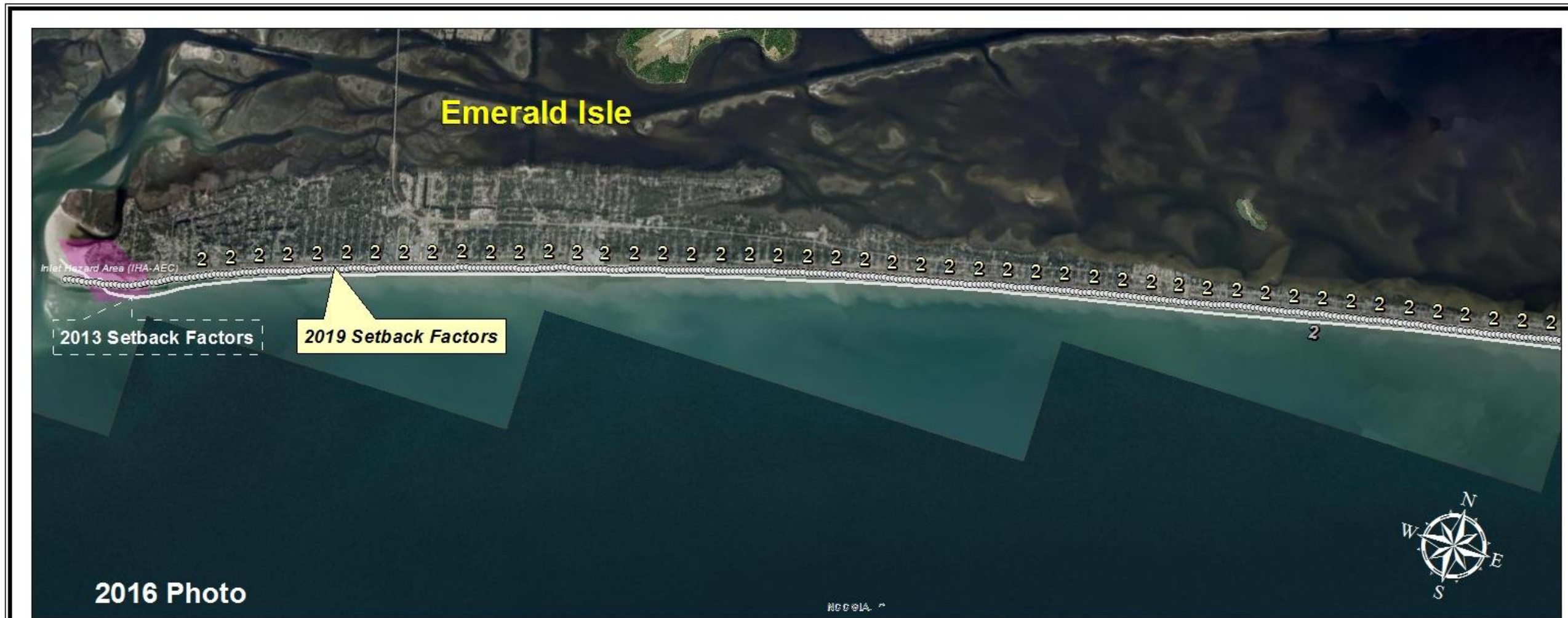
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North Carolina Department of Environmental Quality (DEQ)

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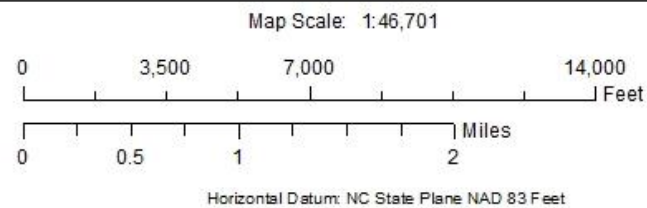
Ken Richardson - November 2019

Figure A 20. Brown's Island Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Emerald Isle

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H..

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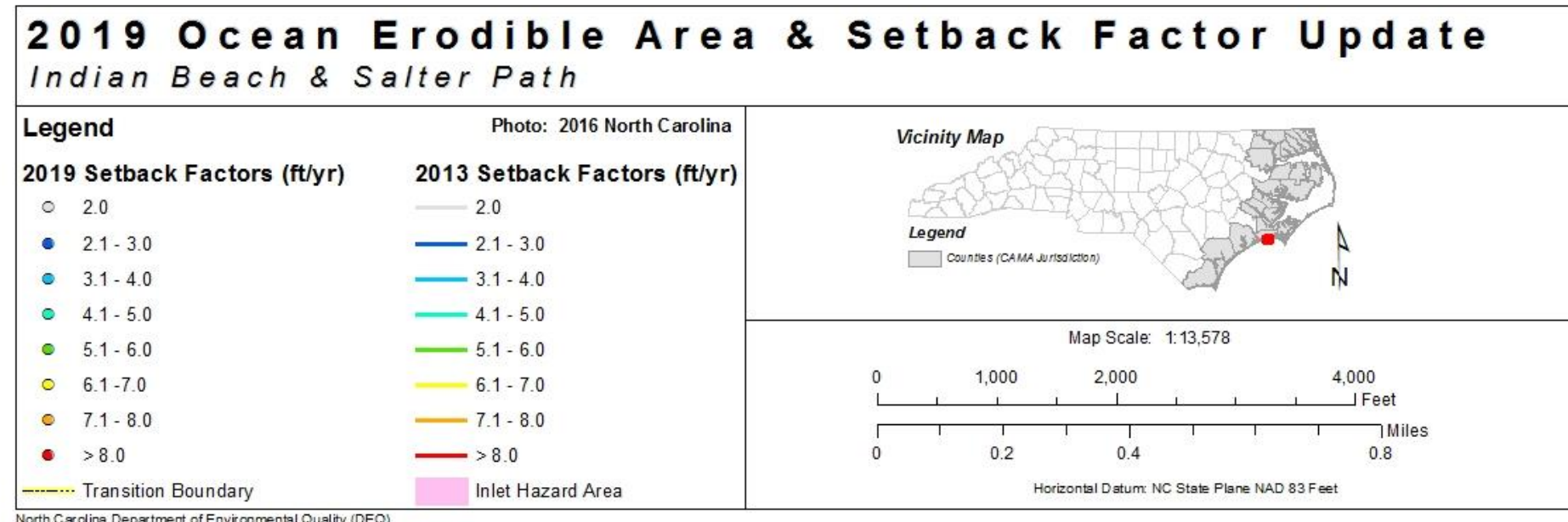
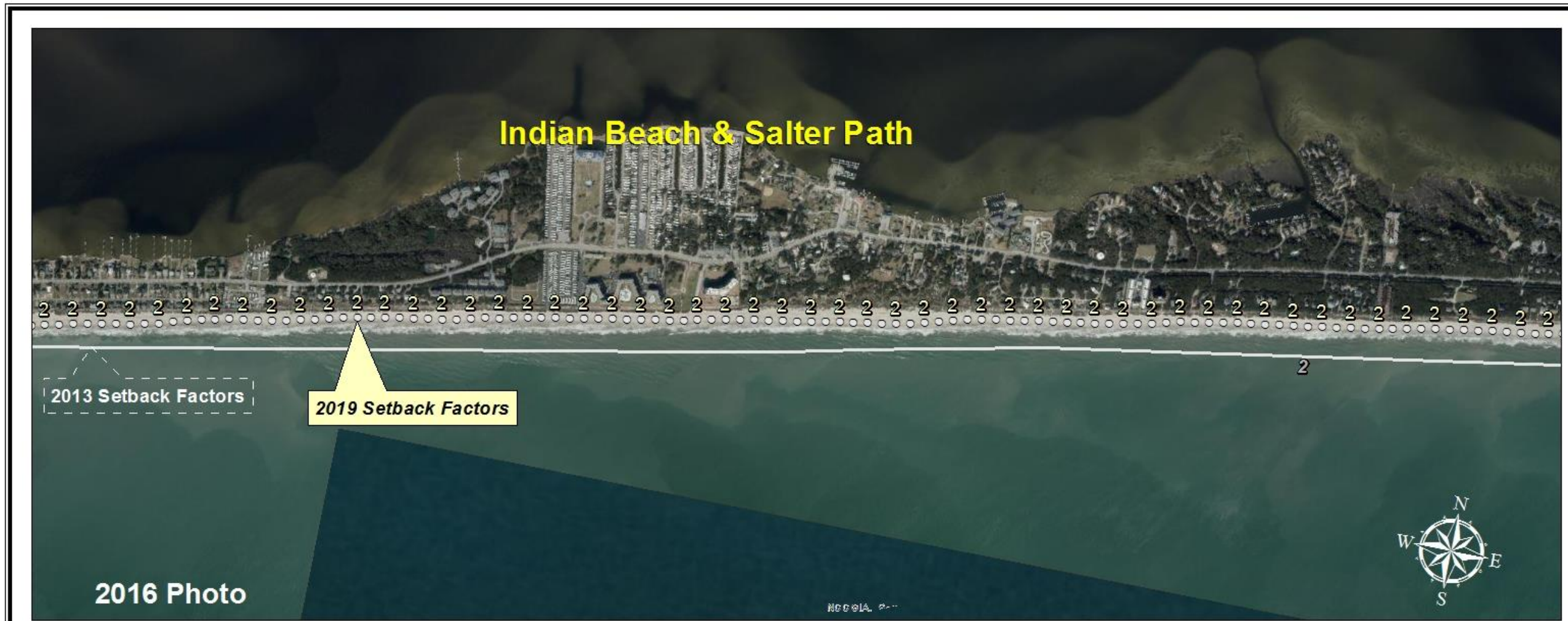


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Figure A 22. Emerald Isle Setback Factors



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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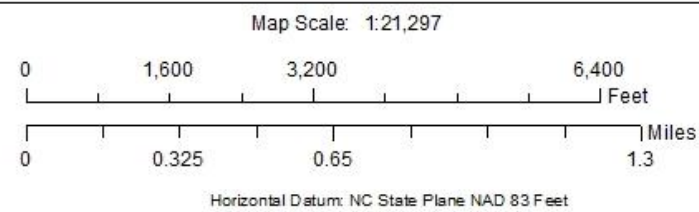
NC Division of Coastal Management - 2019

Figure A 23. Indian Beach & Salter Path Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Pine Knoll Shores

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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Figure A 24. Pine Knoll Shores Setback Factors

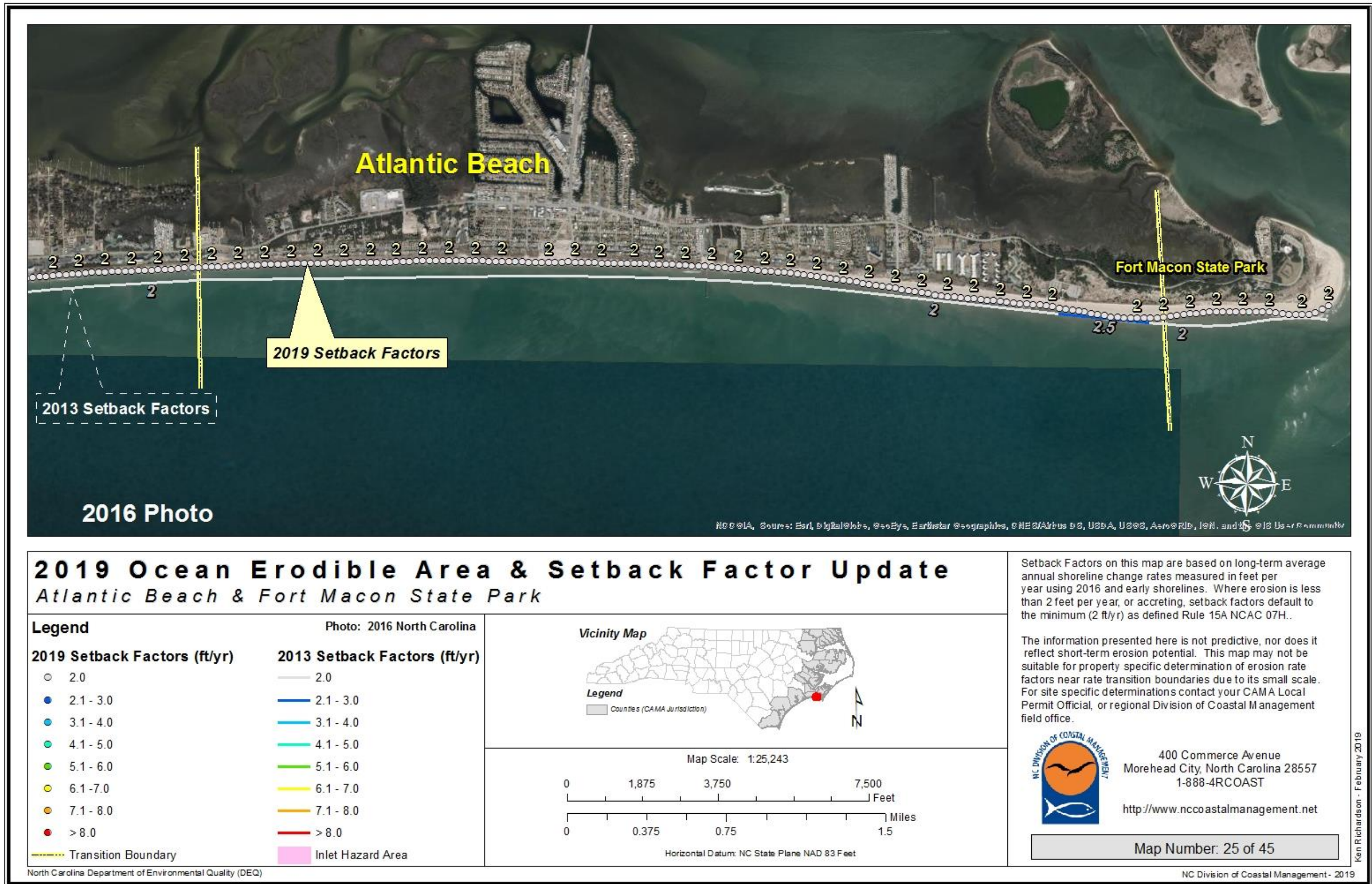


Figure A 25. Atlantic Beach & Fort Macon State Park Setback Factors

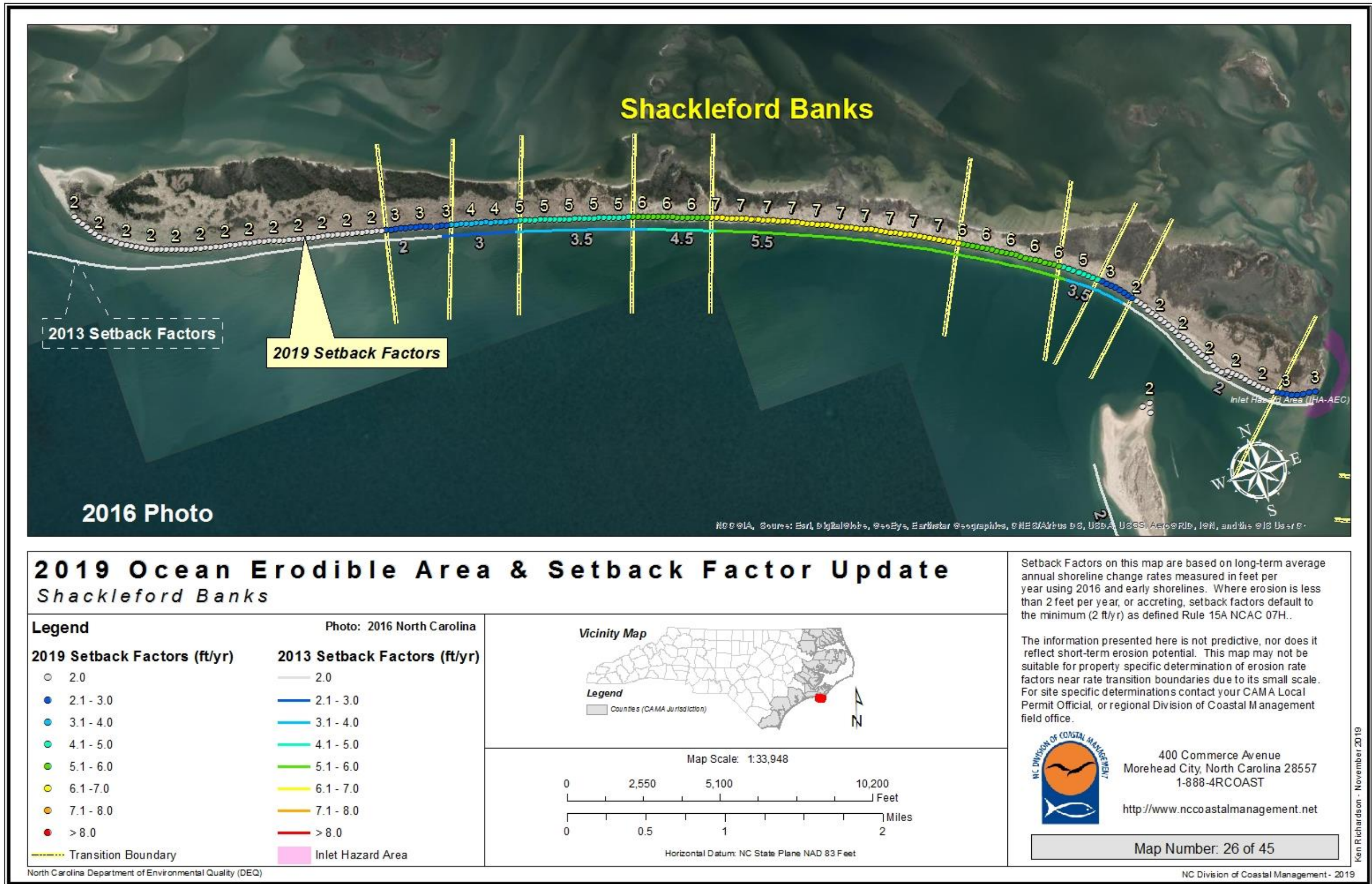
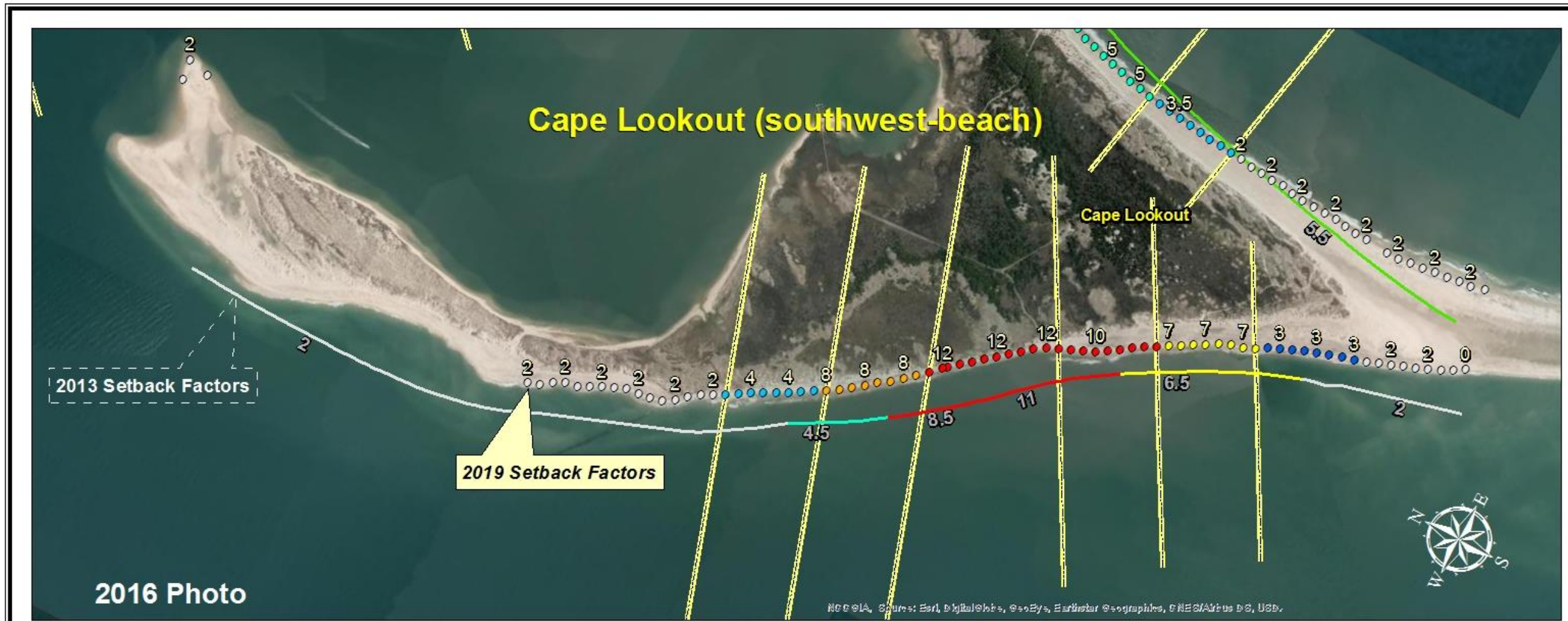
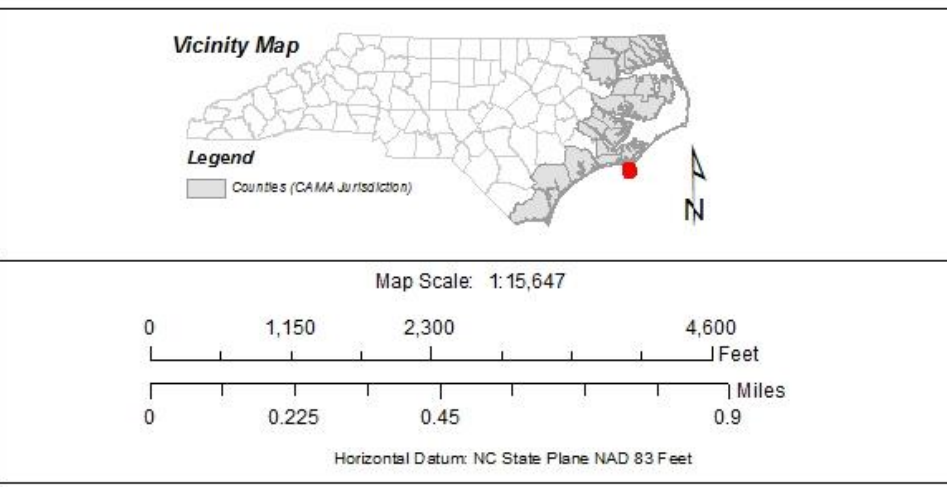


Figure A 26. Shackleford Banks Setback Factors



2019 Ocean Erodeable Area & Setback Factor Update Cape Lookout (southwest-beach)

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



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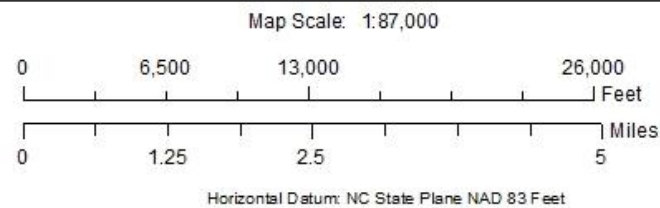
NC Division of Coastal Management - 2019

Figure A 27. Cape Lookout (southwest-beach) Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Core Banks (Cape Lookout to Drum Inlet)

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

The information presented here is not predictive, nor does it reflect short-term erosion potential. This map may not be suitable for property specific determination of erosion rate factors near rate transition boundaries due to its small scale. For site specific determinations contact your CAMA Local Permit Official, or regional Division of Coastal Management field office.



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Figure A 28. Core Banks (Cape Lookout to Drum Inlet)

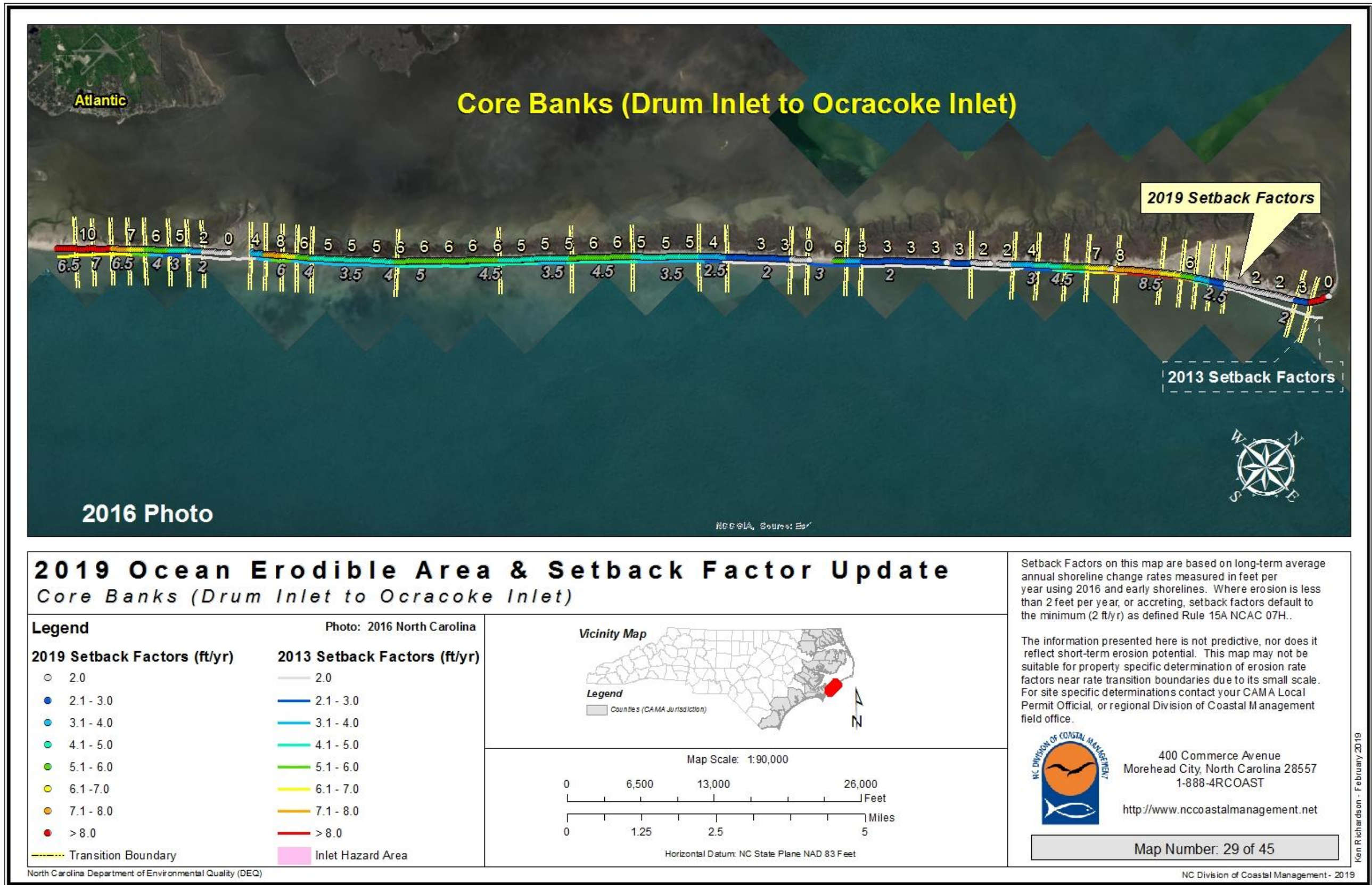


Figure A 29. Core Banks (Drum Inlet to Ocracoke Inlet)

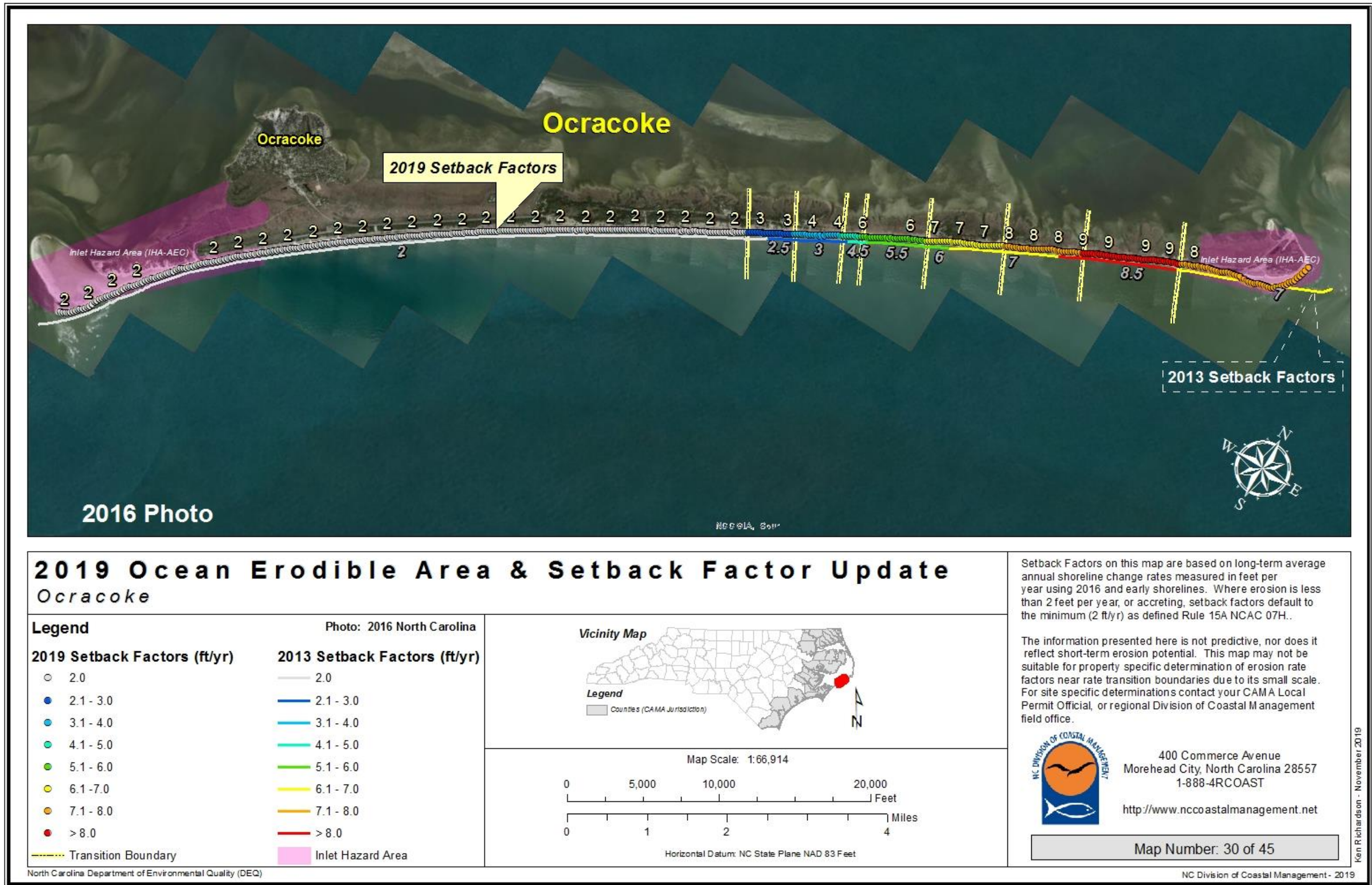


Figure A 30. Ocracoke Setback Factors

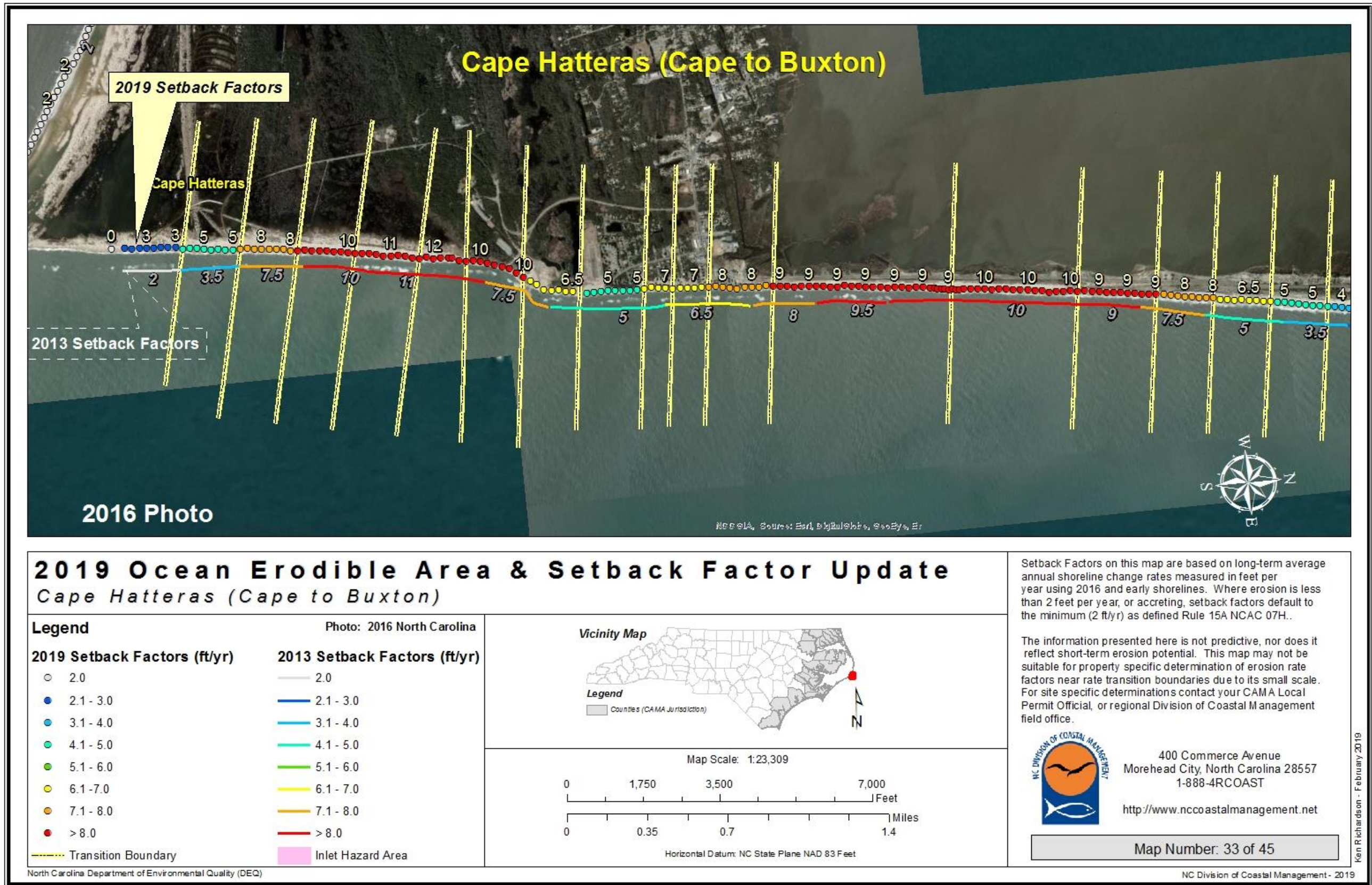


Figure A 32. Cape Hatteras (Cape to Buxton) Setback Factors

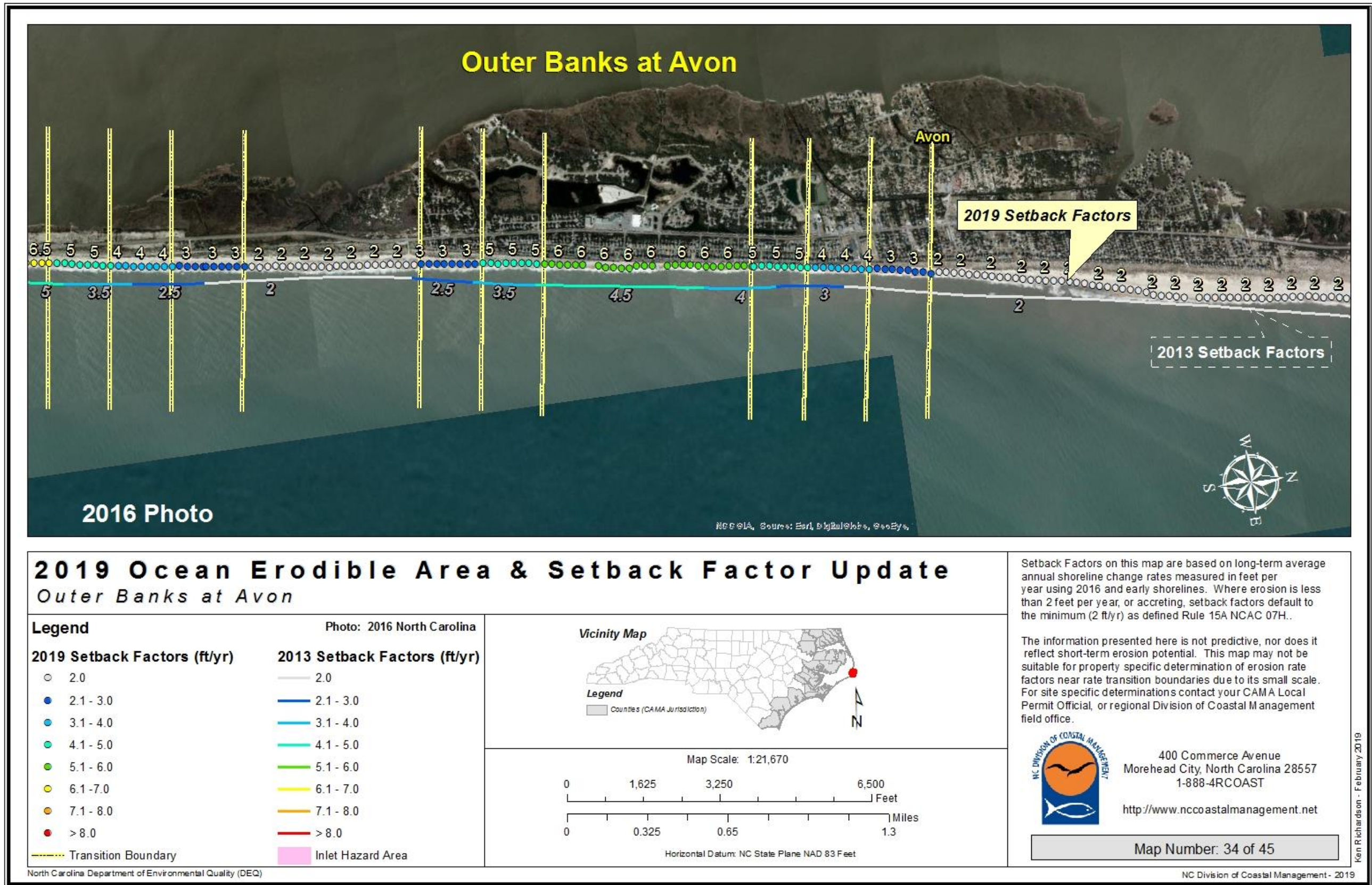
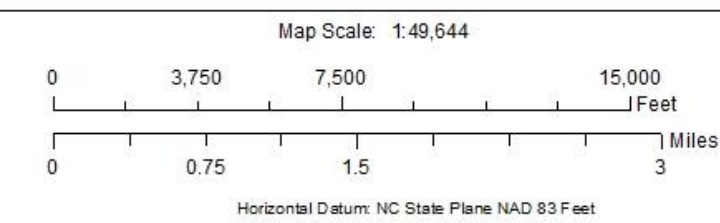


Figure A 33. Outer Banks at Avon



2019 Ocean Erodeable Area & Setback Factor Update Outer Banks (between Avon & Salvo)

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

The information presented here is not predictive, nor does it reflect short-term erosion potential. This map may not be suitable for property specific determination of erosion rate factors near rate transition boundaries due to its small scale. For site specific determinations contact your CAMA Local Permit Official, or regional Division of Coastal Management field office.



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Figure A 34. Outer Banks (between Avon and Salvo) Setback Factors

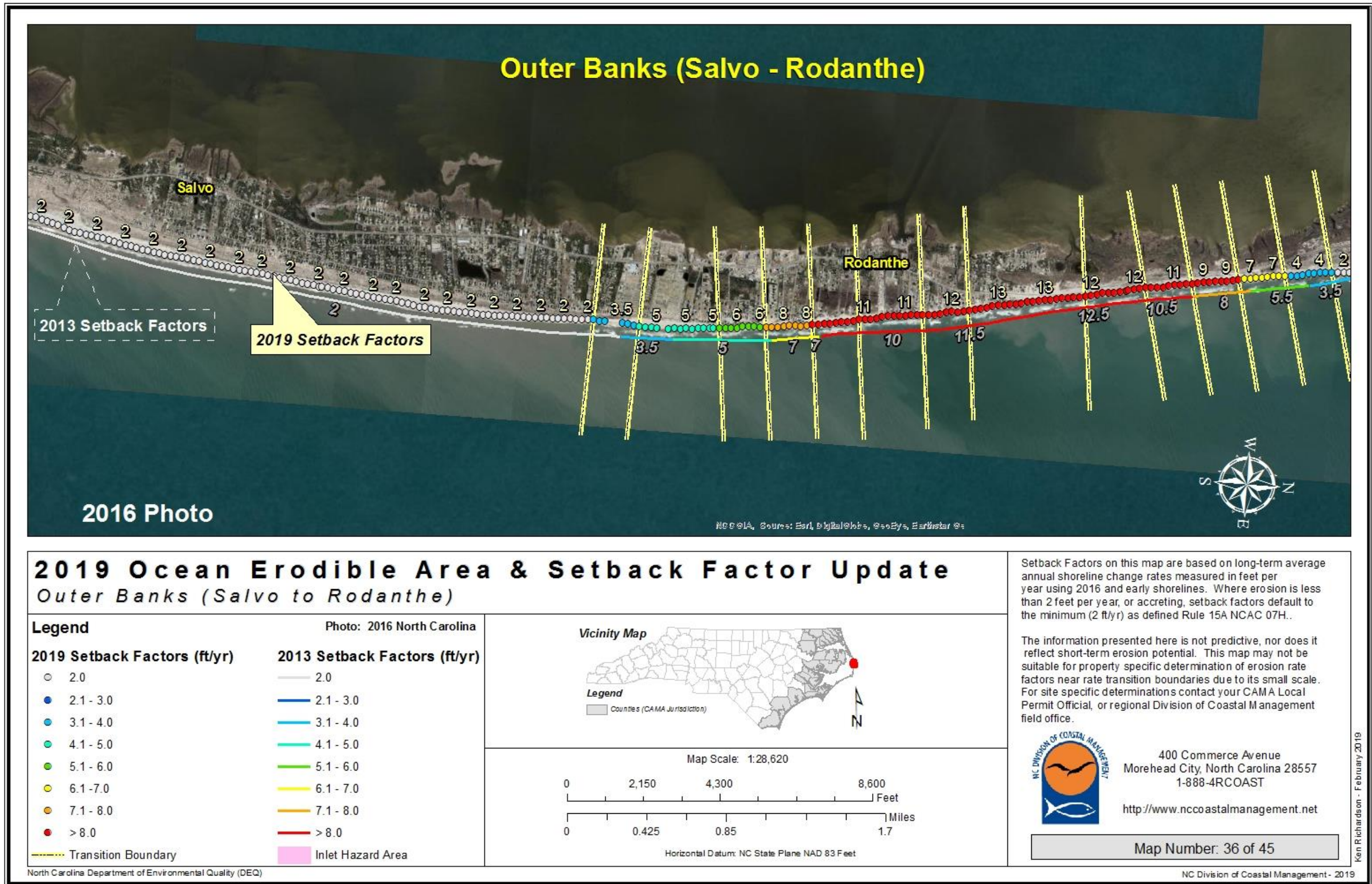


Figure A 35. Outer Banks at Salvo and Rodanthe Setback Factors



2019 Ocean Erodible Area & Setback Factor Update

Outer Banks (Rodanthe to Oregon Inlet)

Legend		Photo: 2016 North Carolina
2019 Setback Factors (ft/yr)	2013 Setback Factors (ft/yr)	
○ 2.0	— 2.0	
● 2.1 - 3.0	— 2.1 - 3.0	
● 3.1 - 4.0	— 3.1 - 4.0	
● 4.1 - 5.0	— 4.1 - 5.0	
● 5.1 - 6.0	— 5.1 - 6.0	
● 6.1 - 7.0	— 6.1 - 7.0	
● 7.1 - 8.0	— 7.1 - 8.0	
● > 8.0	— > 8.0	
--- Transition Boundary	■ Inlet Hazard Area	

Vicinity Map

Legend

■ Counties (CAMA Jurisdiction)

Map Scale: 1:50,000

0 3,750 7,500 15,000 Feet

0 0.75 1.5 3 Miles

Horizontal Datum: NC State Plane NAD 83 Feet

Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

The information presented here is not predictive, nor does it reflect short-term erosion potential. This map may not be suitable for property specific determination of erosion rate factors near rate transition boundaries due to its small scale. For site specific determinations contact your CAMA Local Permit Official, or regional Division of Coastal Management field office.

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Figure A 36. Outer Banks between Rodanthe and Oregon Inlet (Pea Island) Setback Factors



2019 Ocean Erodeable Area & Setback Factor Update

Outer Banks at Boddie Island (Oregon Inlet to Nags Head)

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	

Vicinity Map

Map Scale: 1:23,677

0 1,750 3,500 7,000 Feet

0 0.35 0.7 1.4 Miles

Horizontal Datum: NC State Plane NAD 83 Feet

Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

The information presented here is not predictive, nor does it reflect short-term erosion potential. This map may not be suitable for property specific determination of erosion rate factors near rate transition boundaries due to its small scale. For site specific determinations contact your CAMA Local Permit Official, or regional Division of Coastal Management field office.

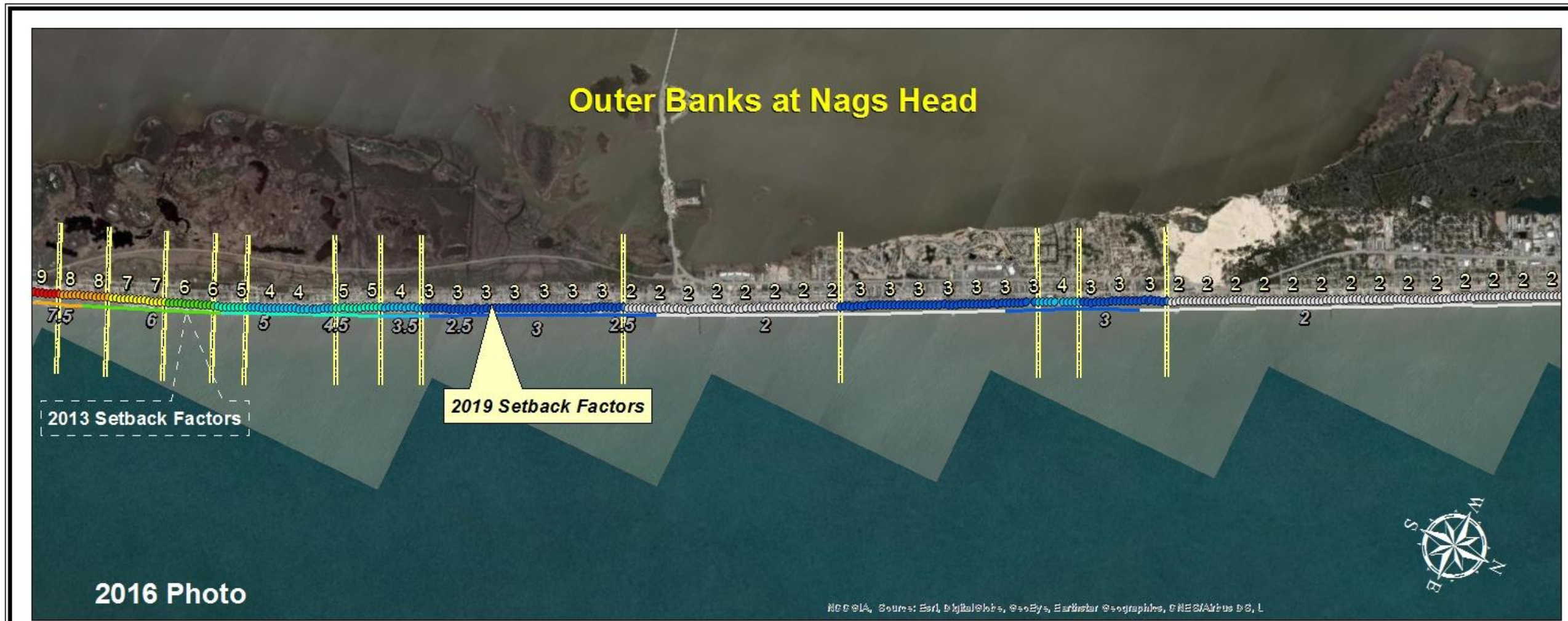
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Figure A 37. Outer Banks at Boddie Island Setback Factors



2019 Ocean Erodeable Area & Setback Factor Update Outer Banks at Nags Head

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	

Vicinity Map

Legend
■ Counties (CAMA Jurisdiction)

Map Scale: 1:47,064

Horizontal Datum: NC State Plane NAD 83 Feet

Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

The information presented here is not predictive, nor does it reflect short-term erosion potential. This map may not be suitable for property specific determination of erosion rate factors near rate transition boundaries due to its small scale. For site specific determinations contact your CAMA Local Permit Official, or regional Division of Coastal Management field office.

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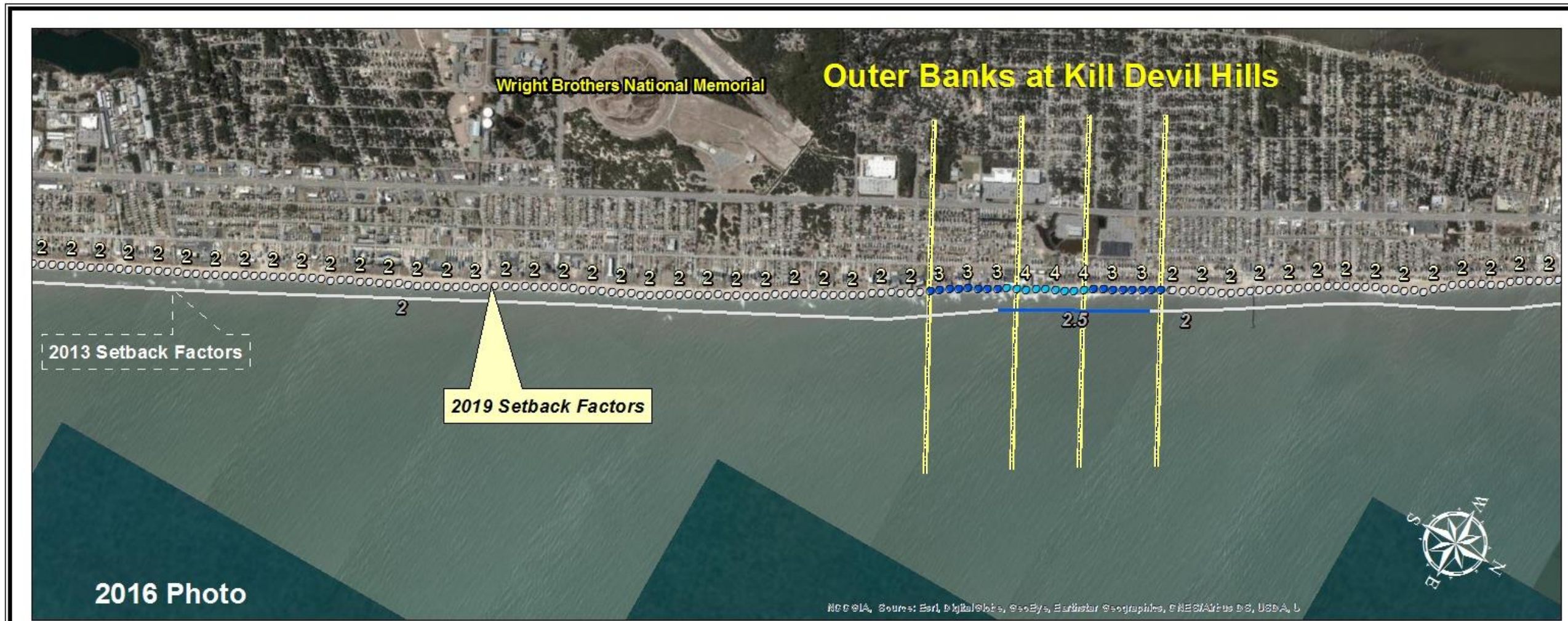
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Figure A 38. Outer Banks at Nags Head Setback Factors



2019 Ocean Erodible Area & Setback Factor Update *Outer Banks at Kill Devil Hills*

Legend		Photo: 2016 North Carolina
2019 Setback Factors (ft/yr)	2013 Setback Factors (ft/yr)	
○ 2.0	— 2.0	
● 2.1 - 3.0	— 2.1 - 3.0	
● 3.1 - 4.0	— 3.1 - 4.0	
● 4.1 - 5.0	— 4.1 - 5.0	
● 5.1 - 6.0	— 5.1 - 6.0	
● 6.1 - 7.0	— 6.1 - 7.0	
● 7.1 - 8.0	— 7.1 - 8.0	
● > 8.0	— > 8.0	
--- Transition Boundary	■ Inlet Hazard Area	

Vicinity Map

Map Scale: 1:19,996

0 1,500 3,000 6,000 Feet

0 0.3 0.6 1.2 Miles

Horizontal Datum: NC State Plane NAD 83 Feet

Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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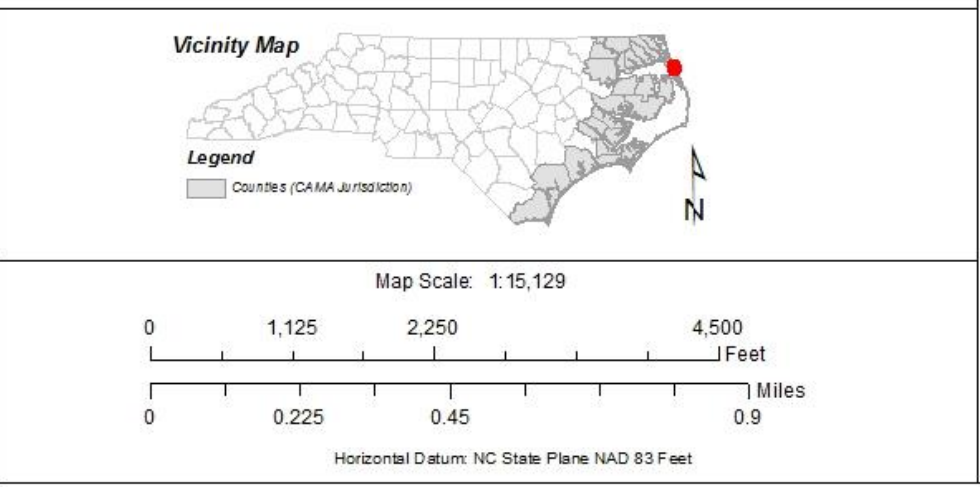
Figure A 39. Outer Banks at Kill Devil Hills Setback Factors



2019 Ocean Erodible Area & Setback Factor Update


Outer Banks at Kitty Hawk

Legend		Photo: 2016 North Carolina	
2019 Setback Factors (ft/yr)		2013 Setback Factors (ft/yr)	
○ 2.0		— 2.0	
● 2.1 - 3.0		— 2.1 - 3.0	
● 3.1 - 4.0		— 3.1 - 4.0	
● 4.1 - 5.0		— 4.1 - 5.0	
● 5.1 - 6.0		— 5.1 - 6.0	
● 6.1 - 7.0		— 6.1 - 7.0	
● 7.1 - 8.0		— 7.1 - 8.0	
● > 8.0		— > 8.0	
--- Transition Boundary		■ Inlet Hazard Area	



Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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Figure A 40. Outer Banks at Kitty Hawk Setback Factors

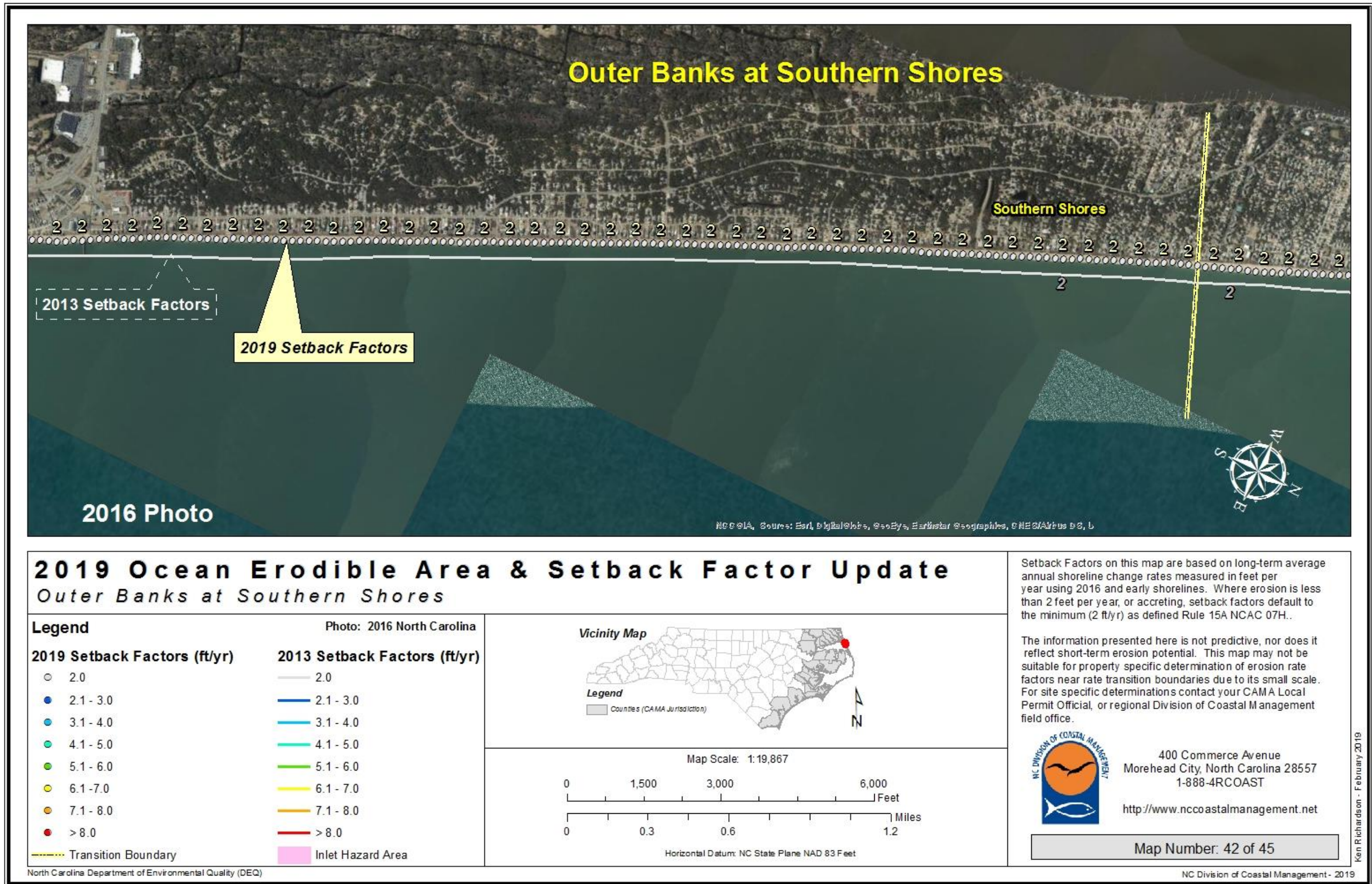


Figure A 41. Outer Banks at Southern Shores Setback Factors

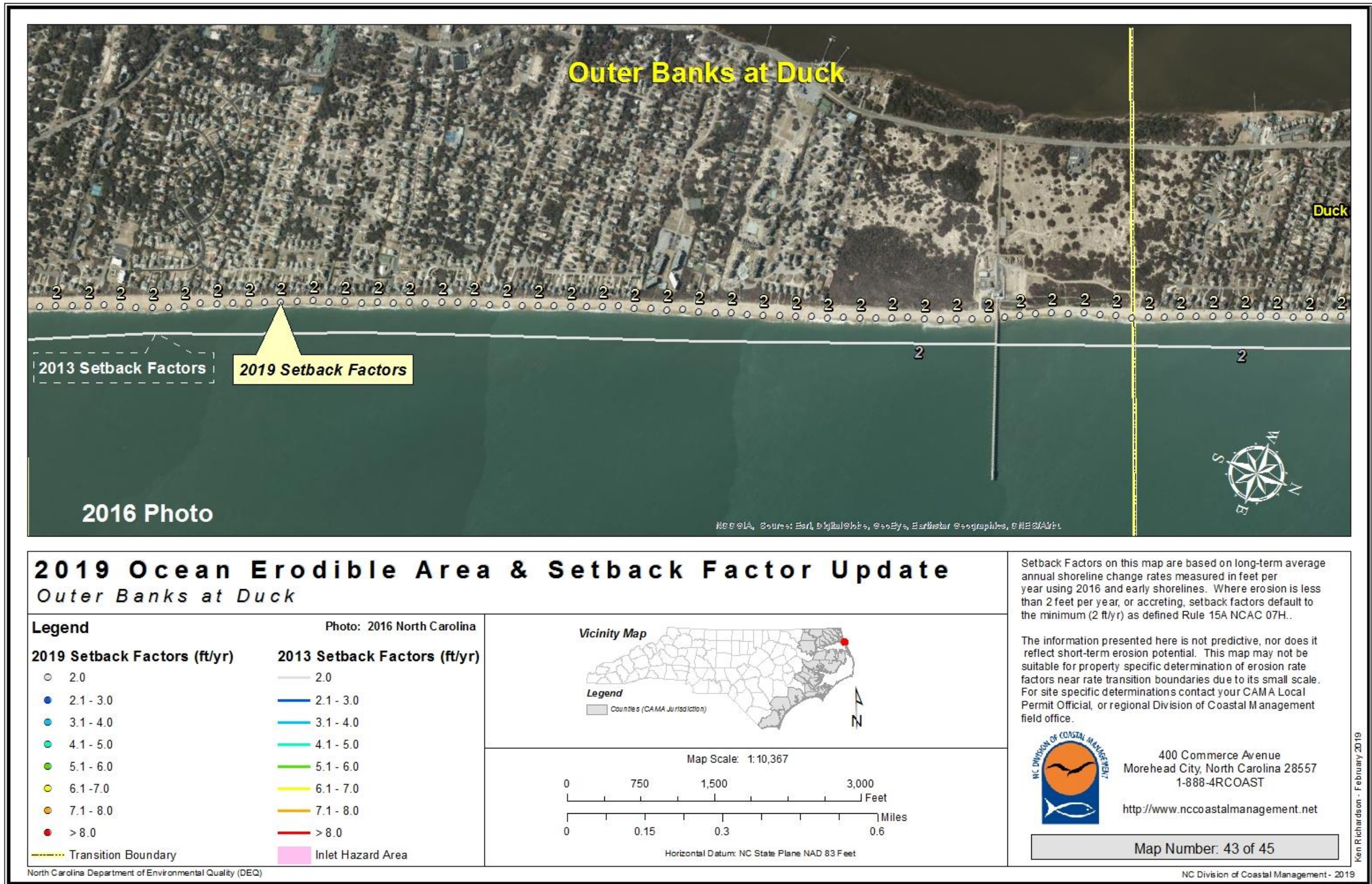
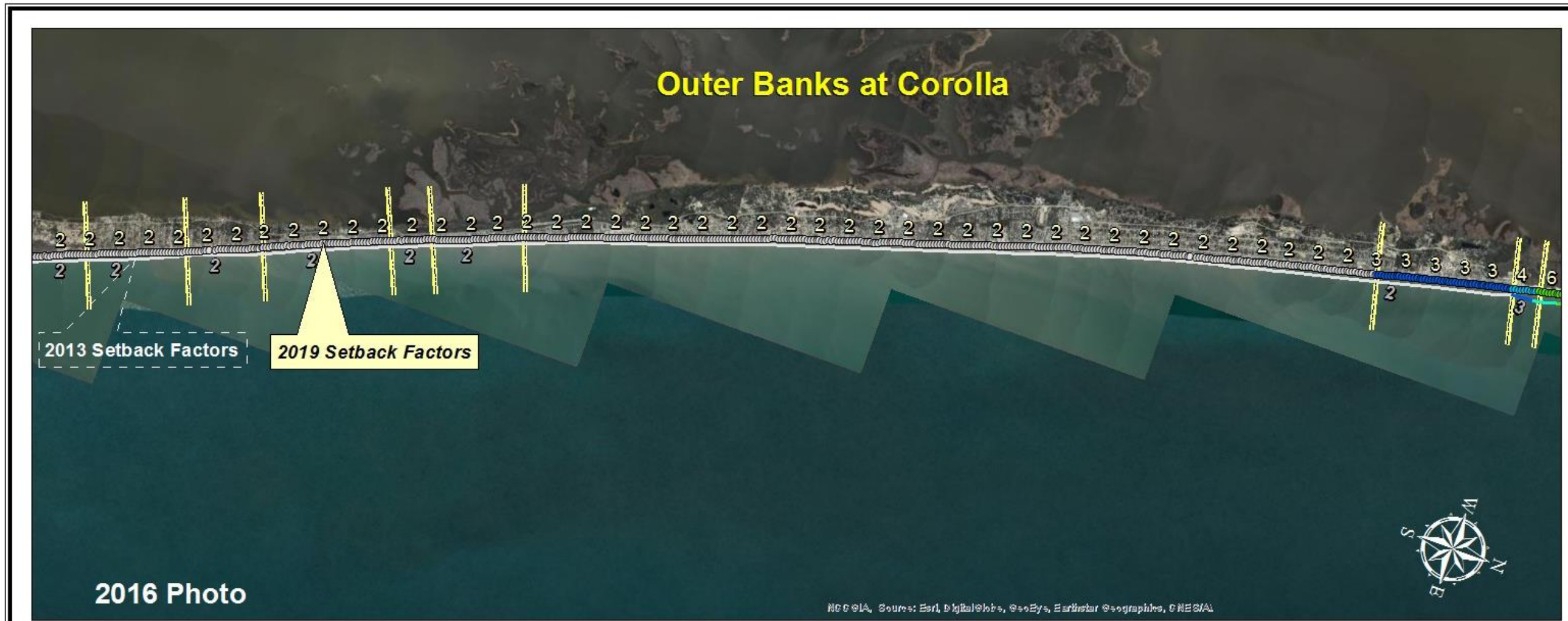


Figure A 42. Outer Banks at Duck Setback Factors



2019 Ocean Erodible Area & Setback Factor Update Outer Banks at Corolla

Legend		Photo: 2016 North Carolina
2019 Setback Factors (ft/yr)	2013 Setback Factors (ft/yr)	
○ 2.0	— 2.0	
● 2.1 - 3.0	— 2.1 - 3.0	
● 3.1 - 4.0	— 3.1 - 4.0	
● 4.1 - 5.0	— 4.1 - 5.0	
● 5.1 - 6.0	— 5.1 - 6.0	
● 6.1 - 7.0	— 6.1 - 7.0	
● 7.1 - 8.0	— 7.1 - 8.0	
● > 8.0	— > 8.0	
--- Transition Boundary	■ Inlet Hazard Area	

Vicinity Map

Map Scale: 1:65,271

0 4,875 9,750 19,500 Feet

0 1 2 4 Miles

Horizontal Datum: NC State Plane NAD 83 Feet

Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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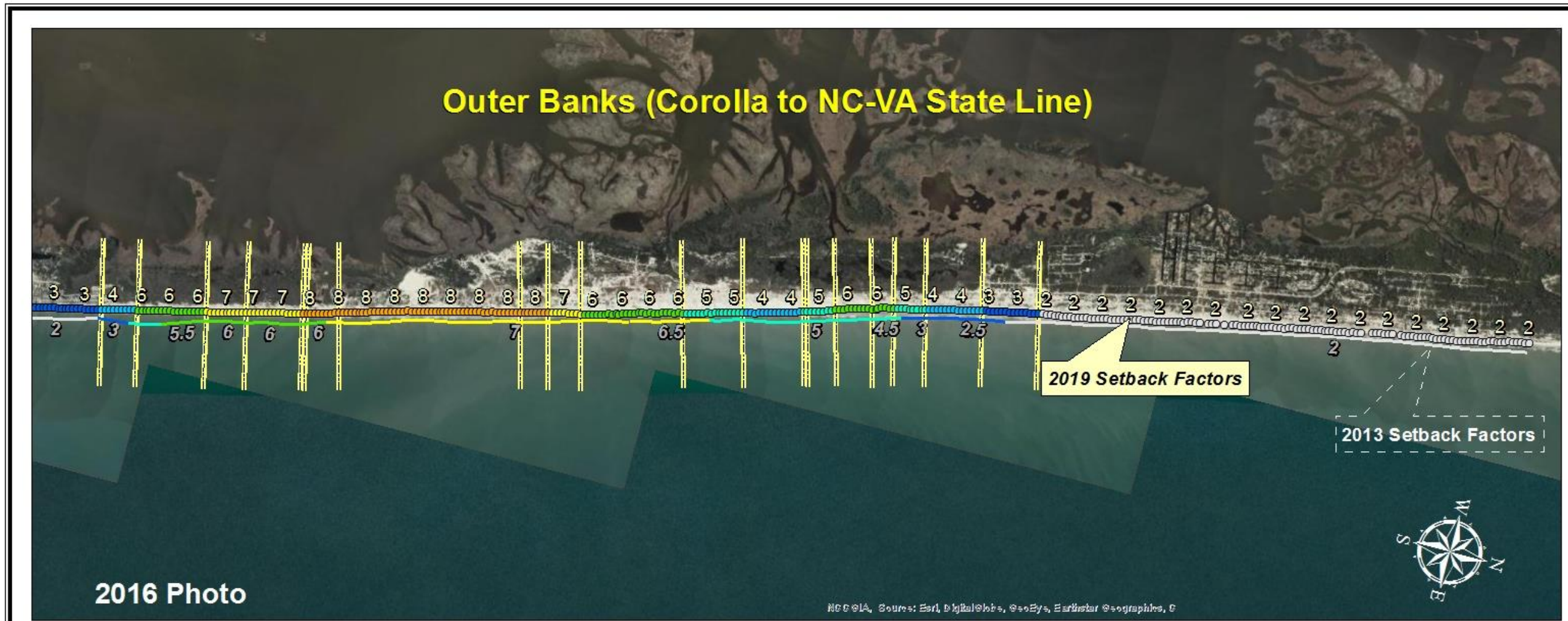
<http://www.nccoastalmanagement.net>

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Figure A 43. Outer Banks at Corolla Setback Factors



2019 Ocean Erodible Area & Setback Factor Update

Outer Banks (Corolla to NC-VA State Line)

Legend		Photo: 2016 North Carolina
2019 Setback Factors (ft/yr)	2013 Setback Factors (ft/yr)	
○ 2.0	— 2.0	
● 2.1 - 3.0	— 2.1 - 3.0	
● 3.1 - 4.0	— 3.1 - 4.0	
● 4.1 - 5.0	— 4.1 - 5.0	
● 5.1 - 6.0	— 5.1 - 6.0	
● 6.1 - 7.0	— 6.1 - 7.0	
● 7.1 - 8.0	— 7.1 - 8.0	
● > 8.0	— > 8.0	
--- Transition Boundary	■ Inlet Hazard Area	

Vicinity Map

Map Scale: 1:47,815

0 3,600 7,200 14,400 Feet

0 0.5 1 2 Miles

Horizontal Datum: NC State Plane NAD 83 Feet

Setback Factors on this map are based on long-term average annual shoreline change rates measured in feet per year using 2016 and early shorelines. Where erosion is less than 2 feet per year, or accreting, setback factors default to the minimum (2 ft/yr) as defined Rule 15A NCAC 07H.

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Figure A 44. Outer Banks at Corolla to NC-VA State Line Setback Factors

APPENDIX B: Comparison of Average Annual Long-Term Shoreline Change Rates from 2003, 2011, and 2018 Update Studies Using Early Shoreline and 1998, 2009, and 2016 Shorelines

Shoreline Change Rate Comparison (1998, 2009, 2016)
Bird Island & Sunset Beach

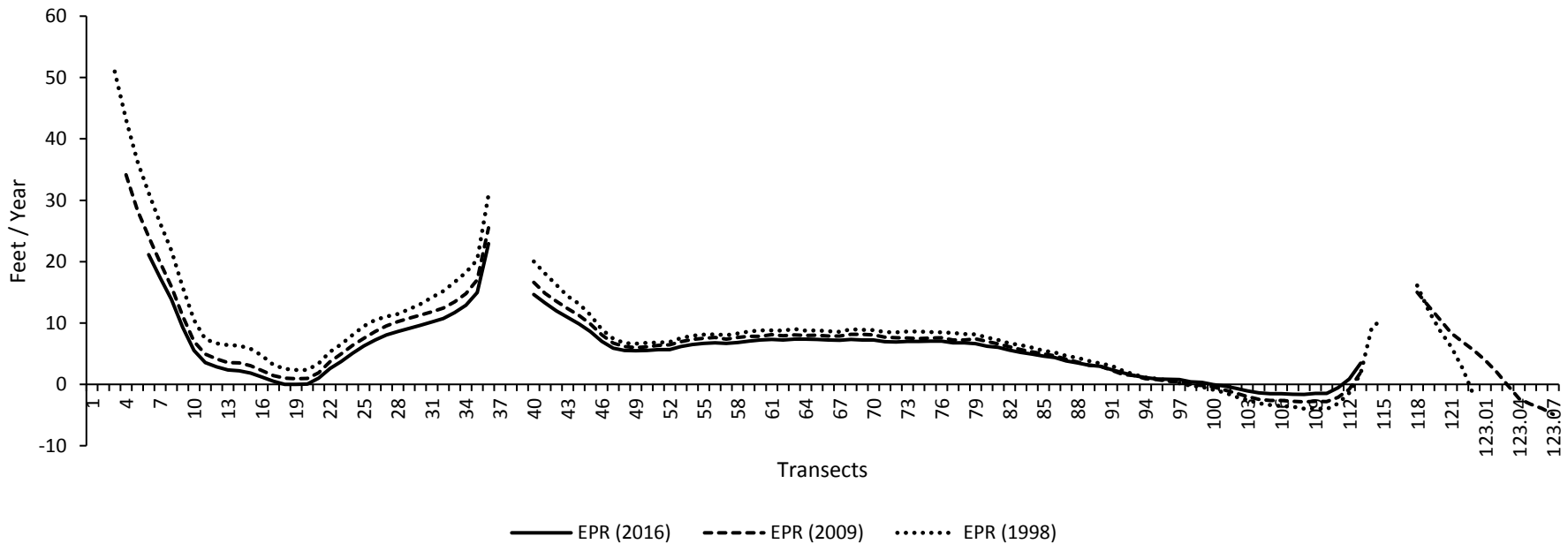


Figure B1. Shoreline change rate comparison at Sunset Beach using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented west to east, Little River Inlet of left-side, Madd Inlet (now closed) at transects 35-40 and Tubbs Inlet or right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Ocean Isle Beach

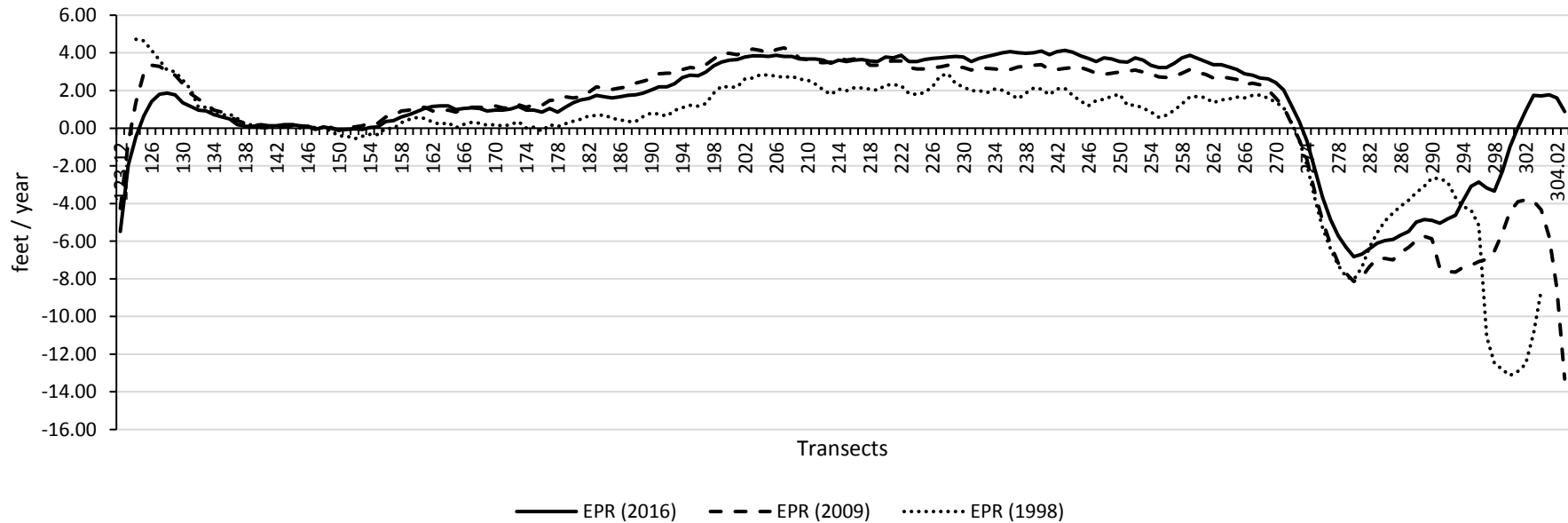


Figure B2. Shoreline change rate comparison at Ocean Isle using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented west to east, Tubbs Inlet on graph's left side, Shallotte Inlet on right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Holden Beach

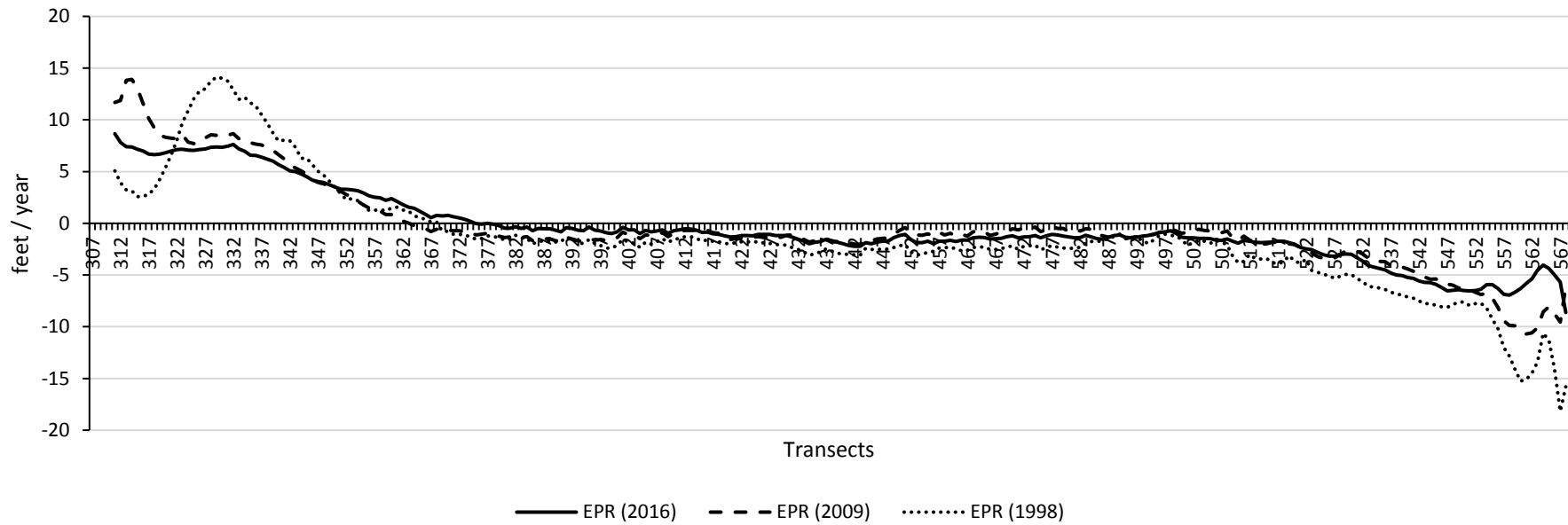


Figure B3. Shoreline change rate comparison at Holden Beach using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented west to east with Shallotte Inlet on left-side and Lockwood Folly Inlet on right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Oak Island

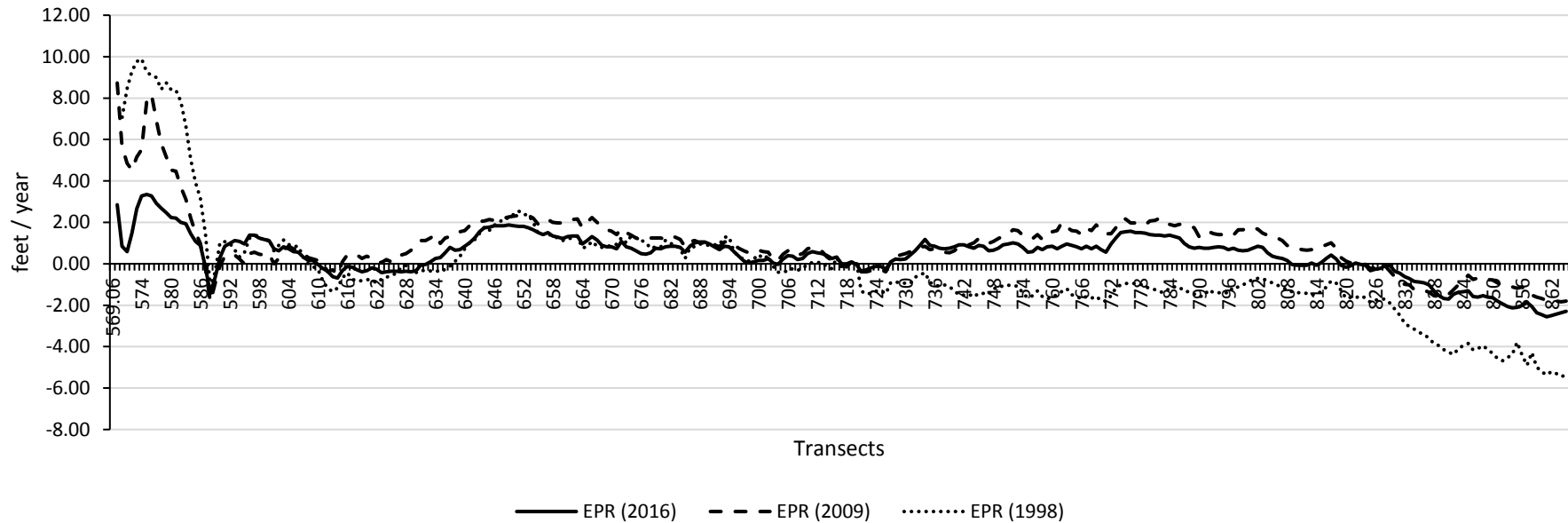


Figure B4. Shoreline change rate comparison at Oak Island using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from west to east with Lockwood Folly Inlet on left-side and Oak Island-Caswell Beach Town Limits on right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Caswell Beach & Ft. Caswell

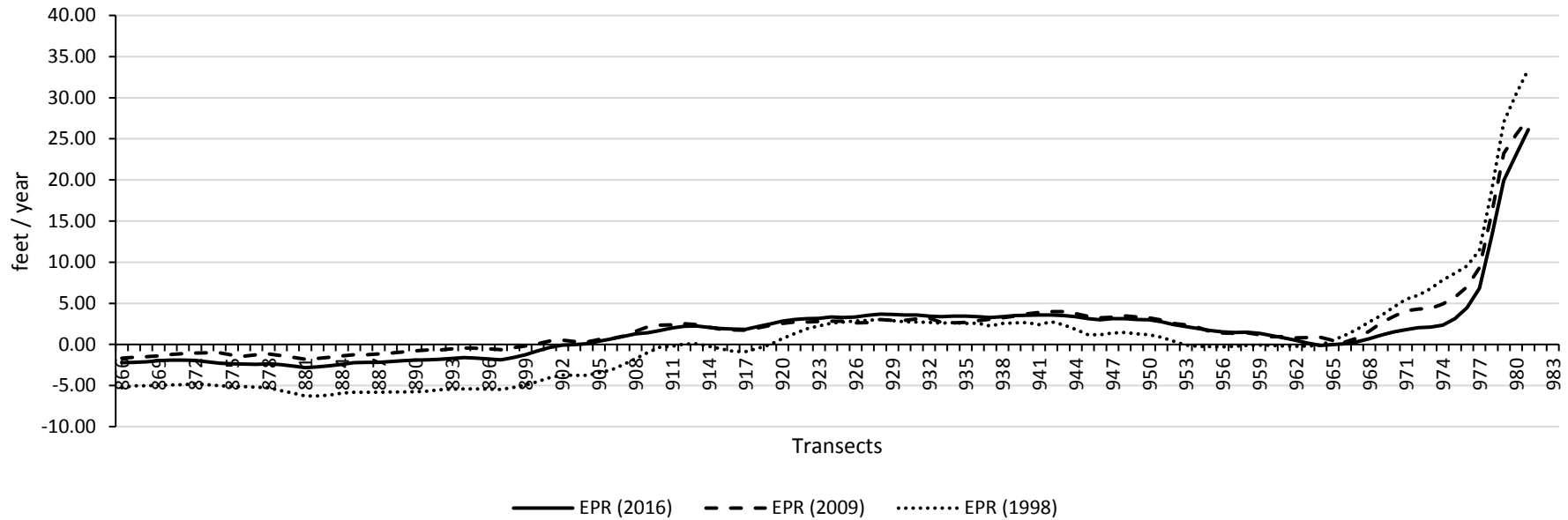


Figure B5. Shoreline change rate comparison at Caswell Beach and Fort Caswell using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from west to east with Oak Island-Caswell Beach Town Limits on left-side and Cape Fear Inlet on right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Bald Head Island (South-Beach)

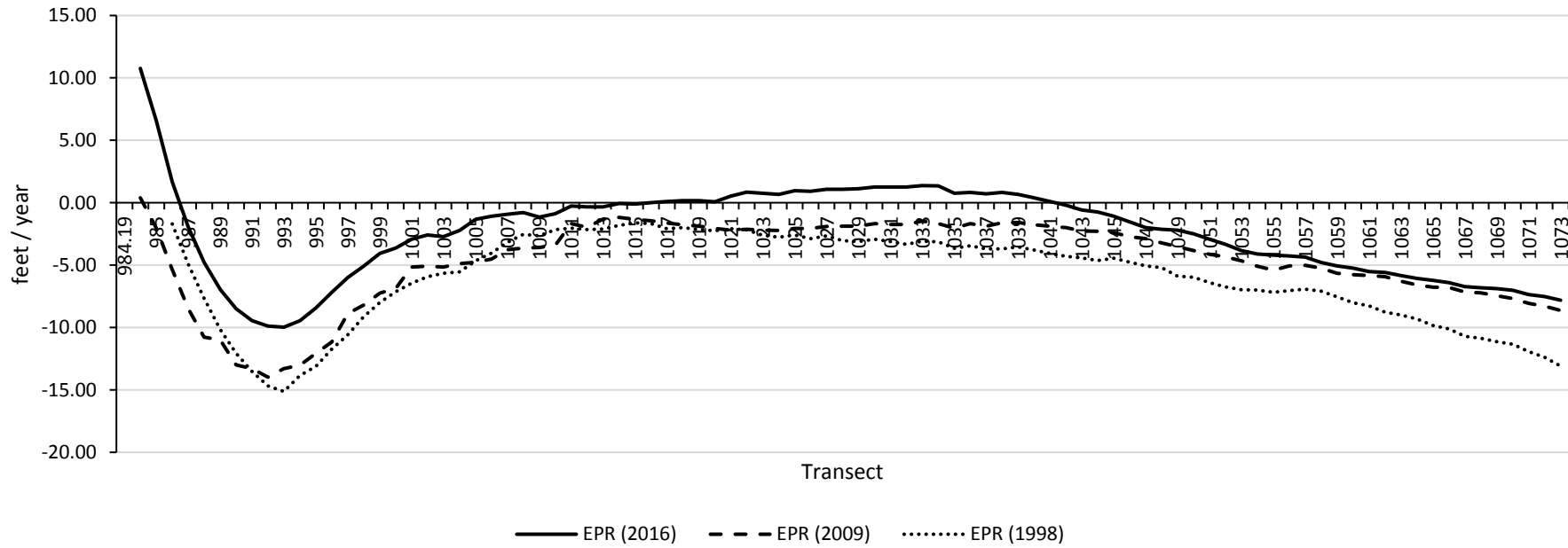


Figure B6. Shoreline change rate comparison at Bald Head Island (south-beach) using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented with Cape Fear Inlet on graph's left-side and Cape Fear on south-beach on right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Comparison (1998, 2009, 2018) Bald Head Island (East-Beach)

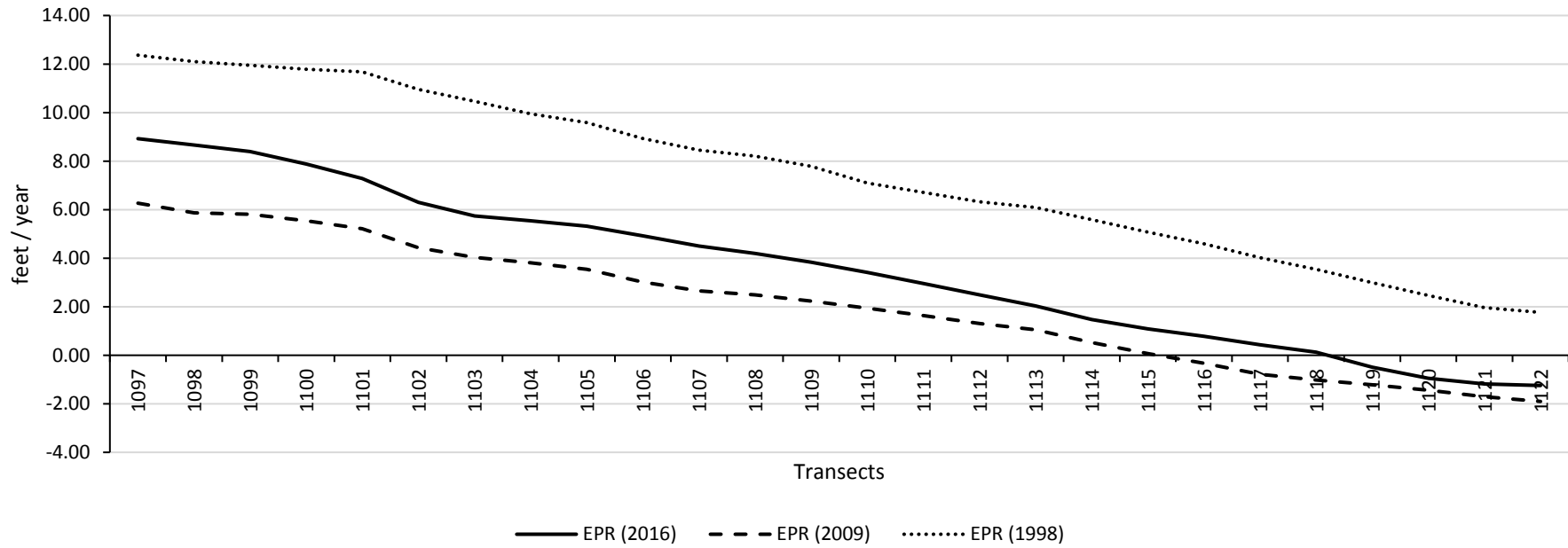


Figure B7. Shoreline change rate comparison at Bald Head Island (east-beach) using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented with Cape Fear on left-side and Bald Head Island limits on right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2018) Zeke's Island & Fort Fisher

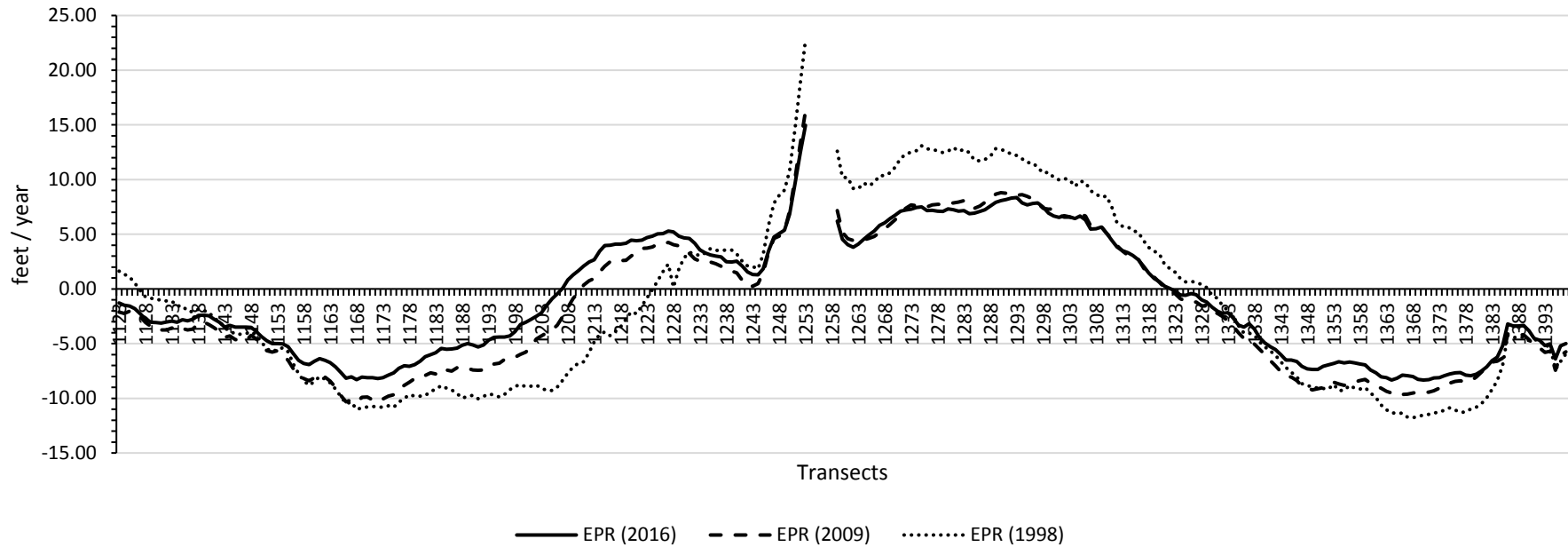


Figure B8. Shoreline change rate comparison at Zeke’s Island and Fort Fisher State Park using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented from south (left-side) to north (right-side). Data gap reflects former Corncake Inlet location. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2018) Kure Beach

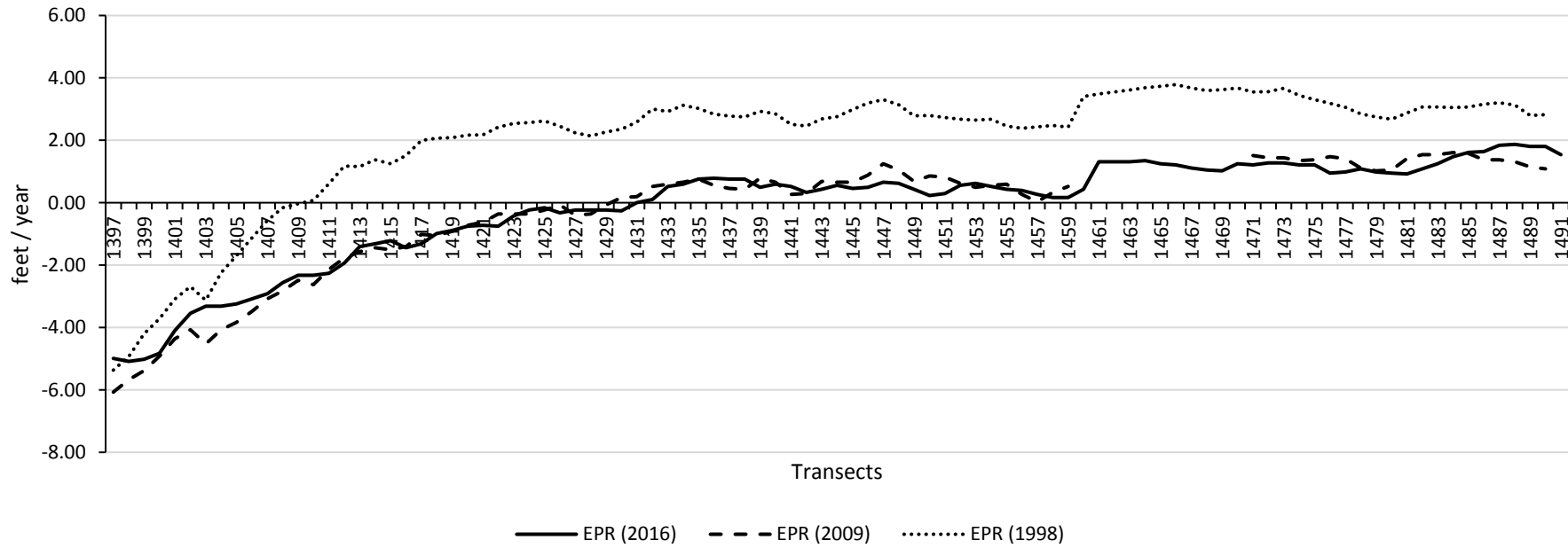


Figure 99. Shoreline change rate comparison at Kure Beach using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from south (left-side) to north (right-side) ending at Kure Beach and Carolina Beach Town Limits. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Carolina Beach

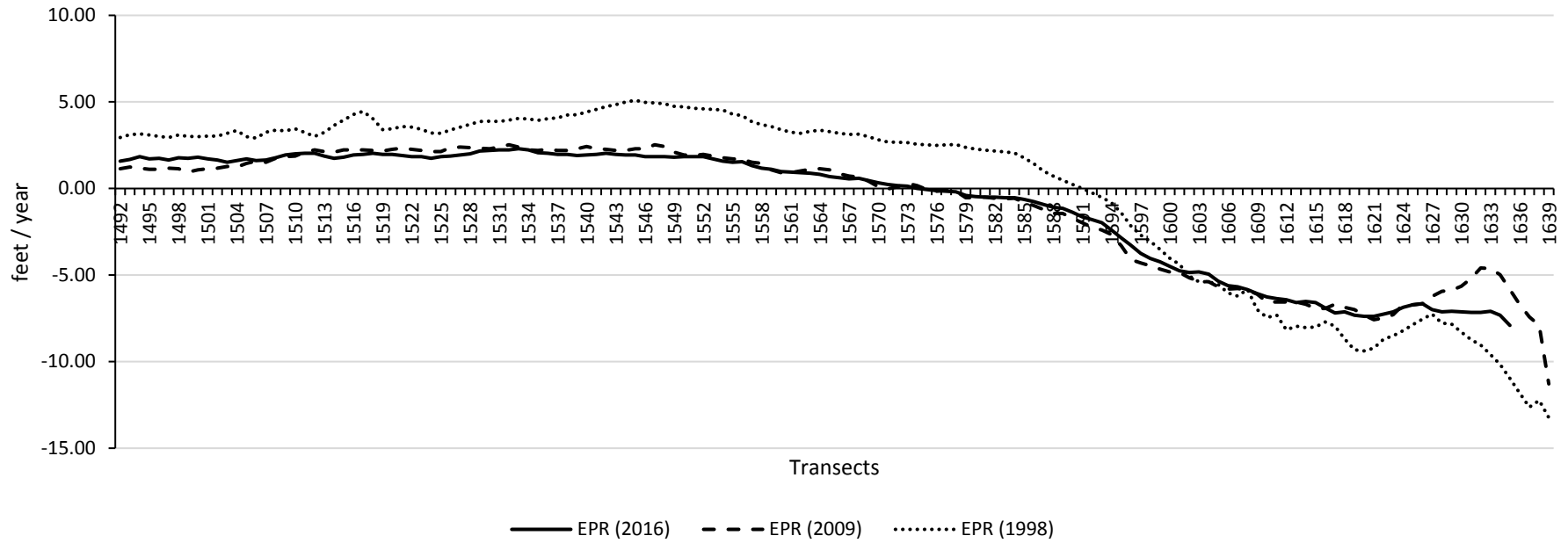


Figure B10. Shoreline change rate comparison at Carolina Beach using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from south (left-side) to north (right-side) ending at Carolina Beach Inlet. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2018) Masonboro Island

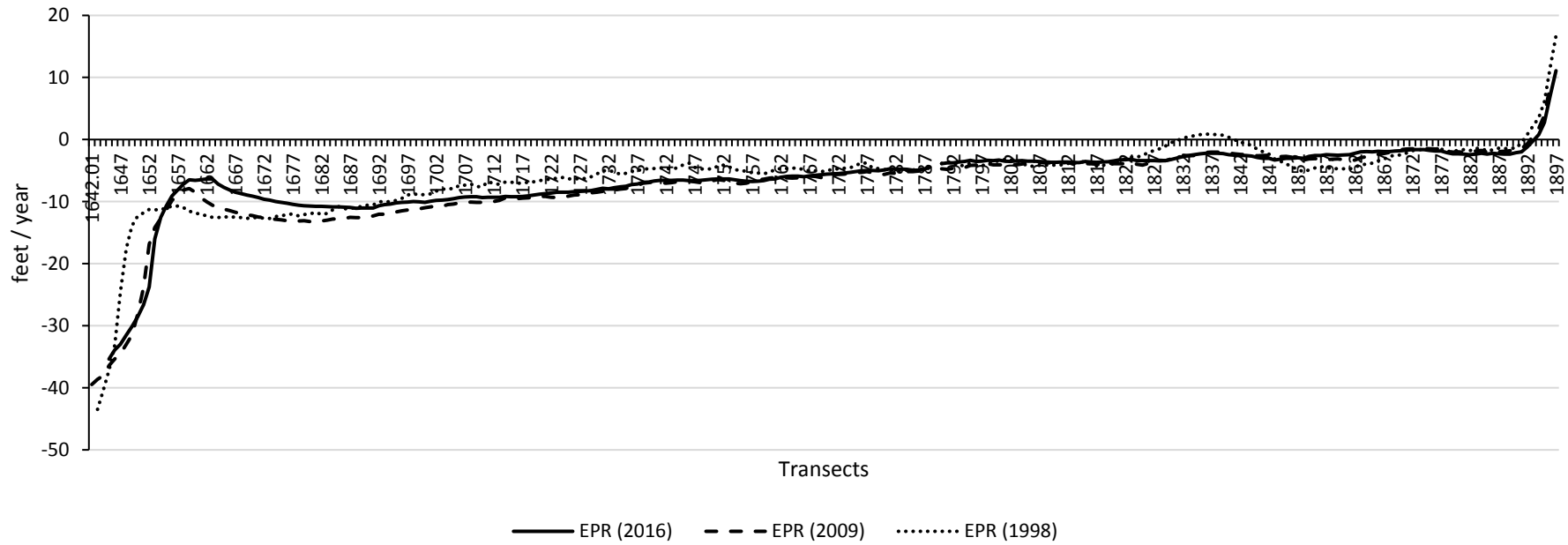


Figure B11. Shoreline change rate comparison at Masonboro Island using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Carolina Beach Inlet (graph left-side) to Masonboro Inlet (graph-right side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2004, 2018) Wrightsville Beach

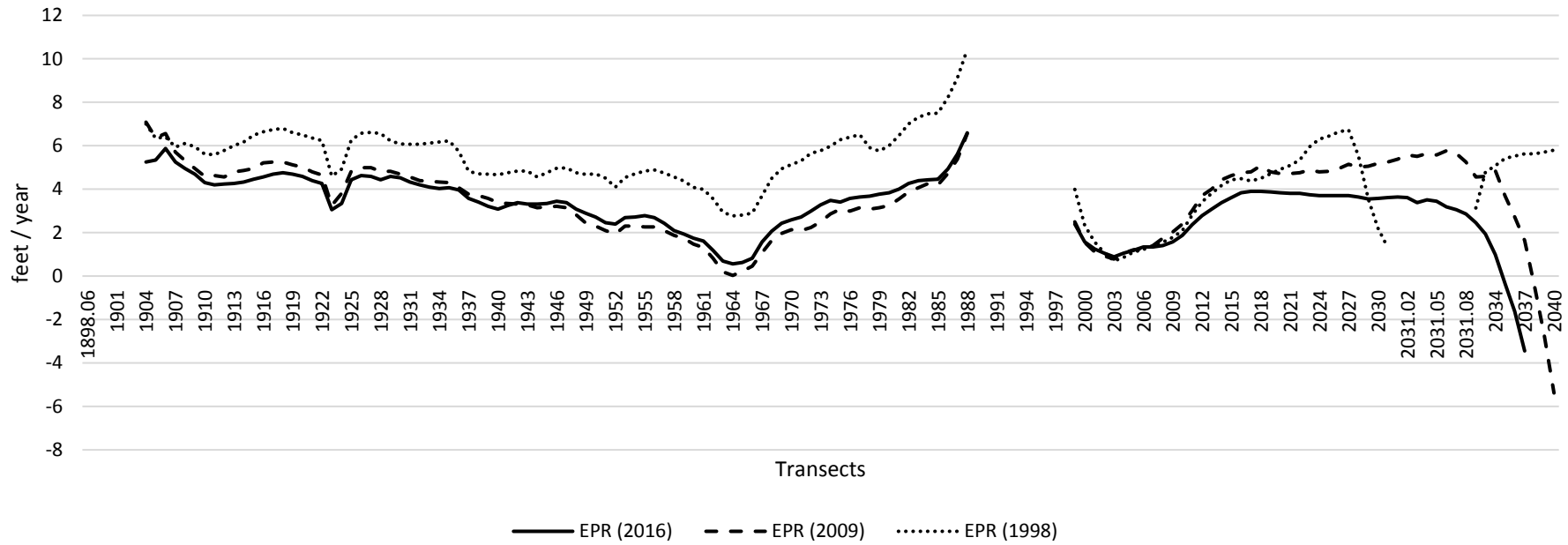


Figure B12. Shoreline change rate comparison at Wrightsville Beach using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Masonboro Inlet (graph left-side) to Mason Inlet (graph right-side). The data gap between transects 1988 and 1998 is the former location of Moore’s Inlet. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016)
Figure Eight Island

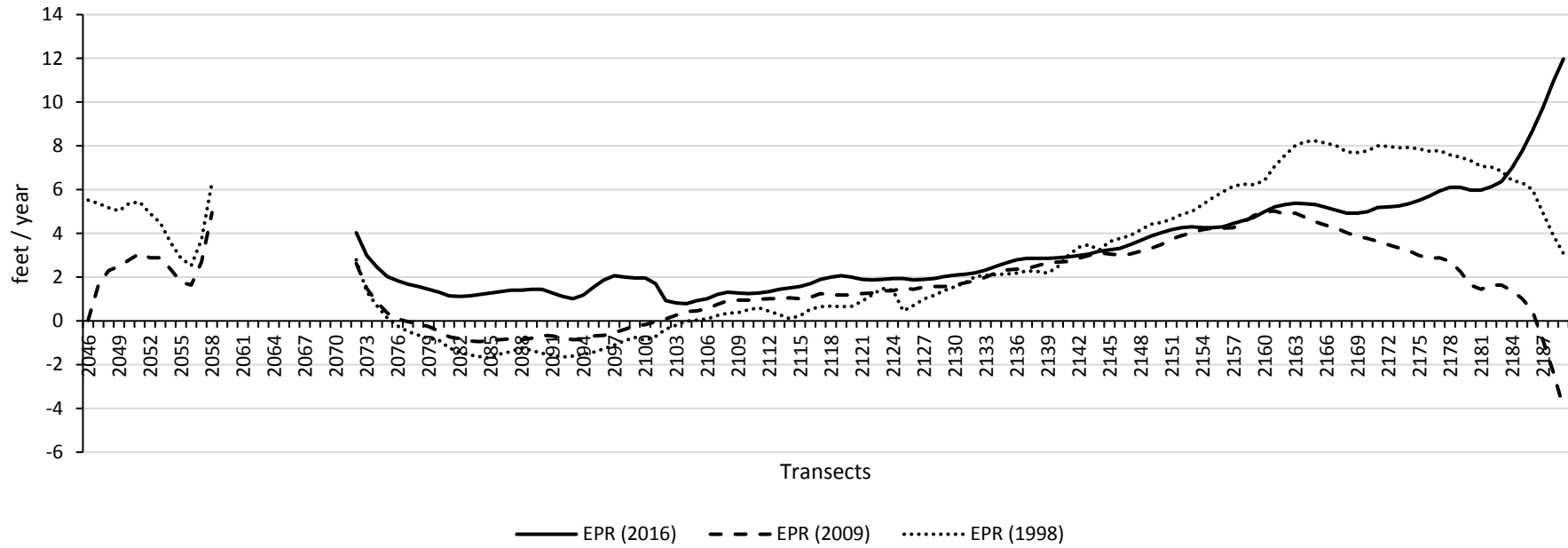


Figure B13. Shoreline change rate comparison at Figure Eight Island using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Mason Inlet (graph left-side) to Rich Inlet (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Lea-Hutaff Island

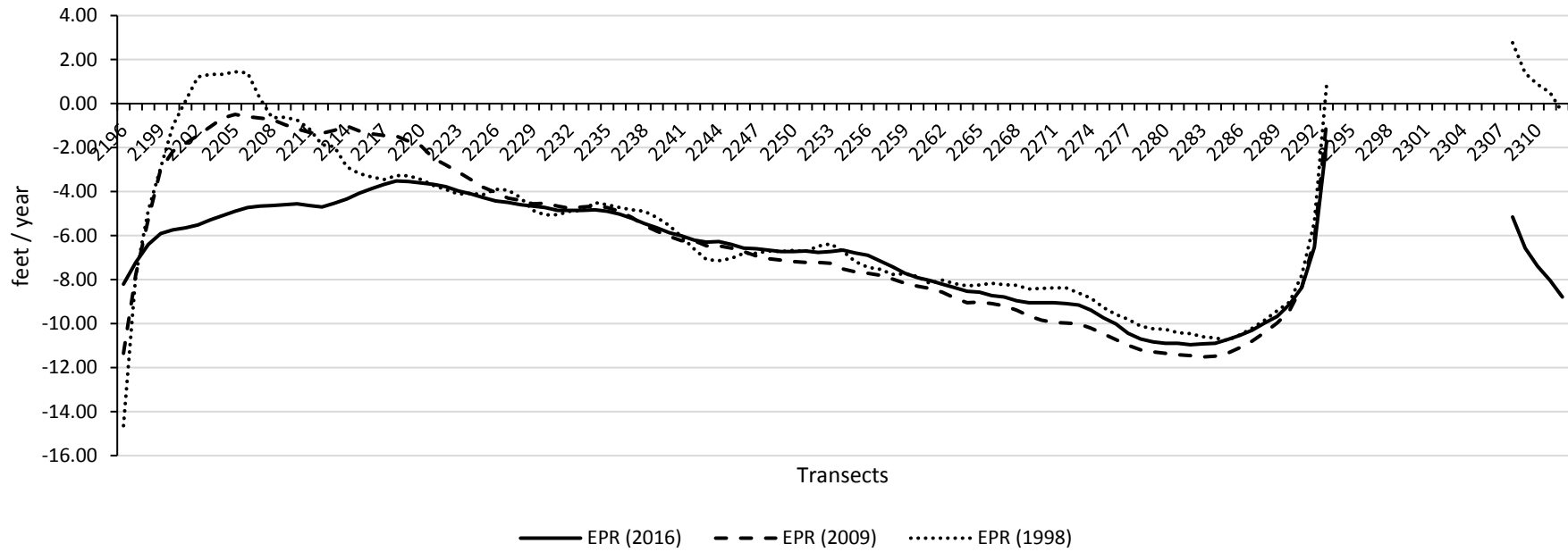


Figure B14. Shoreline change rate comparison at Lea-Hutaff Island using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Rich Inlet (graph left-side) to New Topsail Inlet (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Topsail Beach

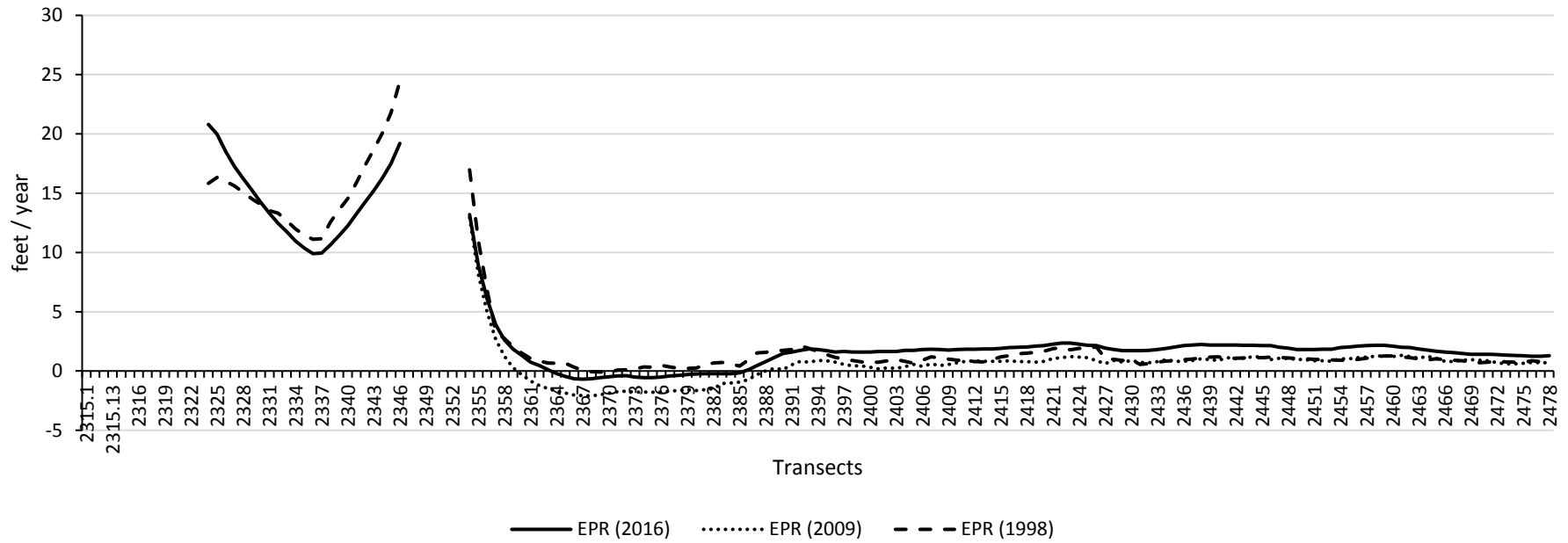


Figure B15. Shoreline change rate comparison at Topsail Beach using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from New Topsail Inlet (graph left-side) to Topsail Beach-Surf City town limits. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2004, 2016) Surf City

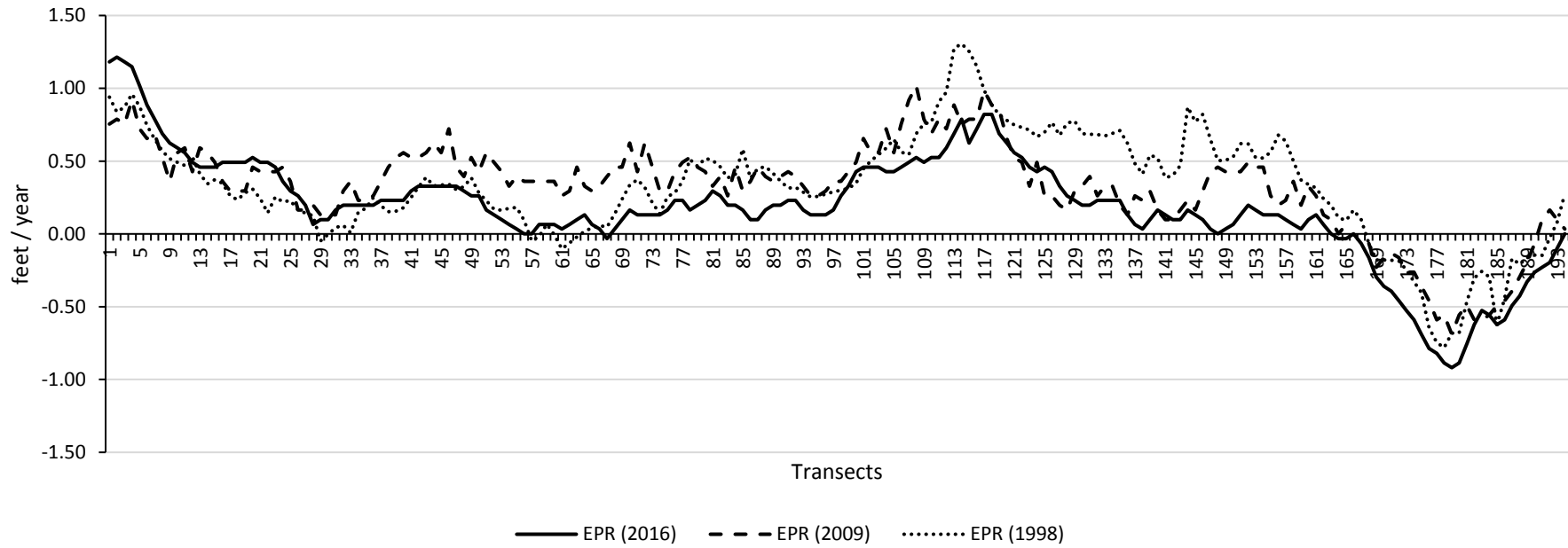


Figure B16. Shoreline change rate comparison at Surf City using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Topsail Beach-Surf City Town limits (graph left-side) to Surf City-North Topsail Beach Town limits (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) North Topsail Beach

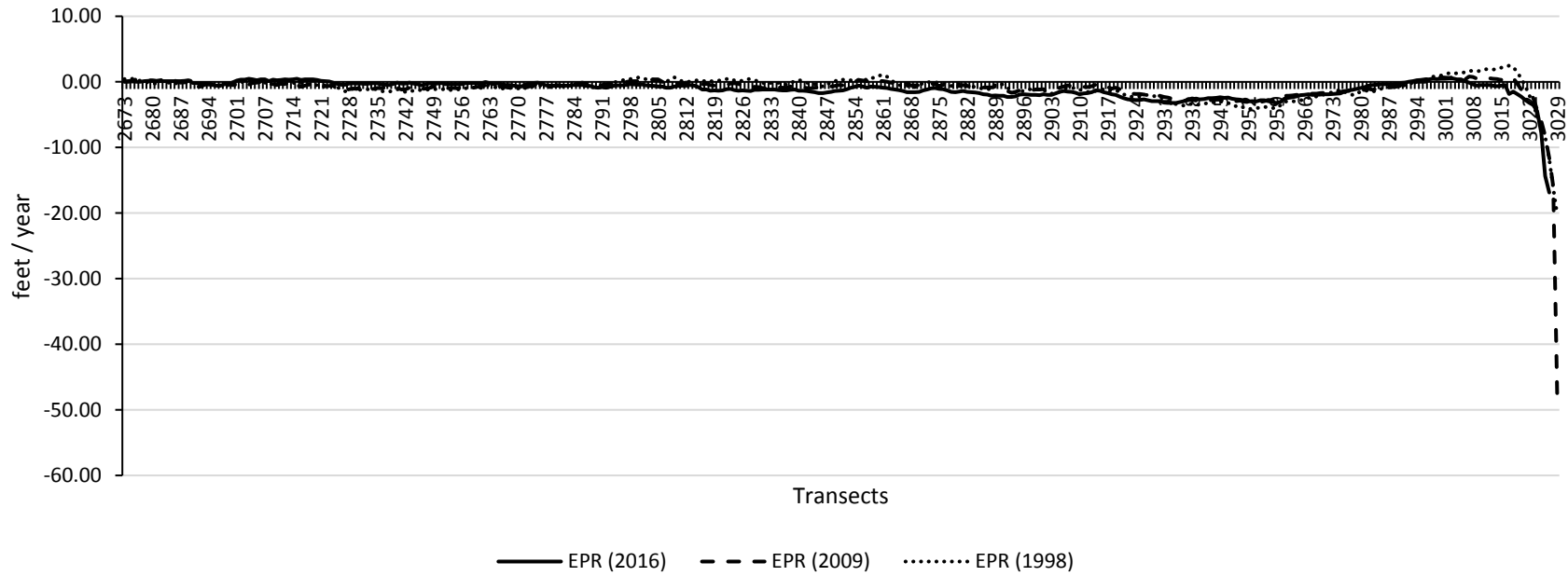


Figure B17. Shoreline change rate comparison at North Topsail Beach using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Surf City-North Topsail Beach town limits (graph left-side) to New River Inlet (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2017) Onslow Beach

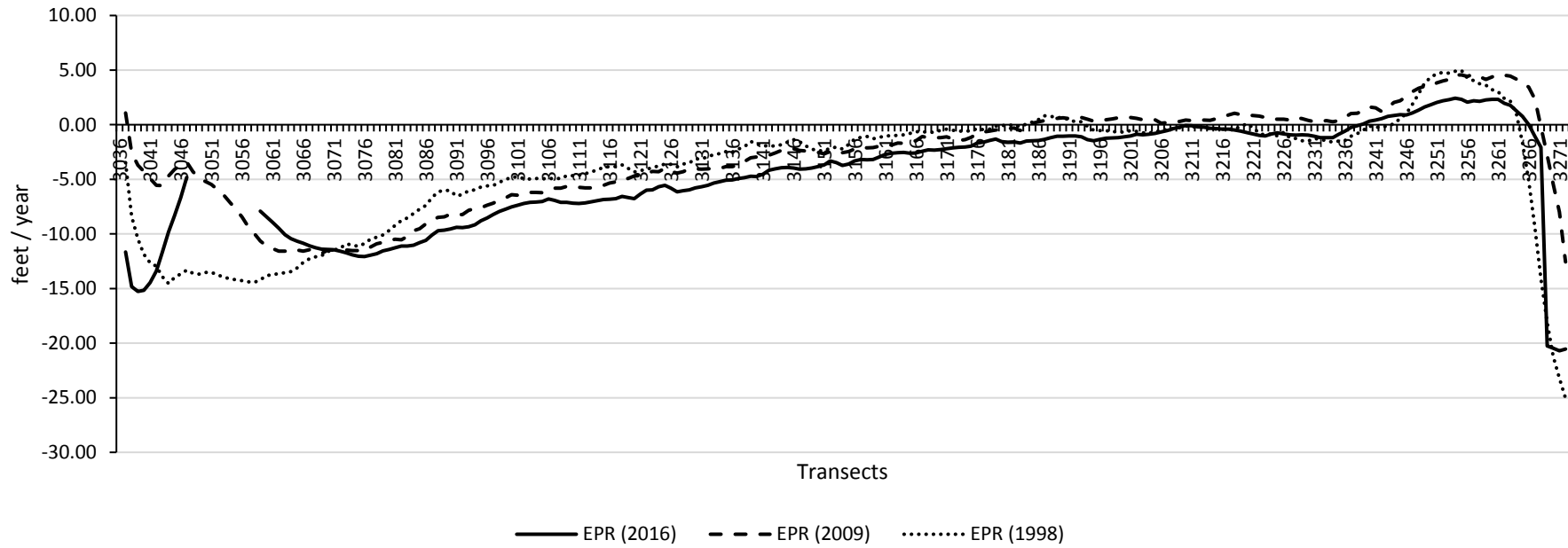


Figure B18. Shoreline change rate comparison at Onslow Beach using early shoreline and 1998, 2009, and 2017 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from New River Inlet (graph left-side) to Brown’s Inlet (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2017) Brown's Island

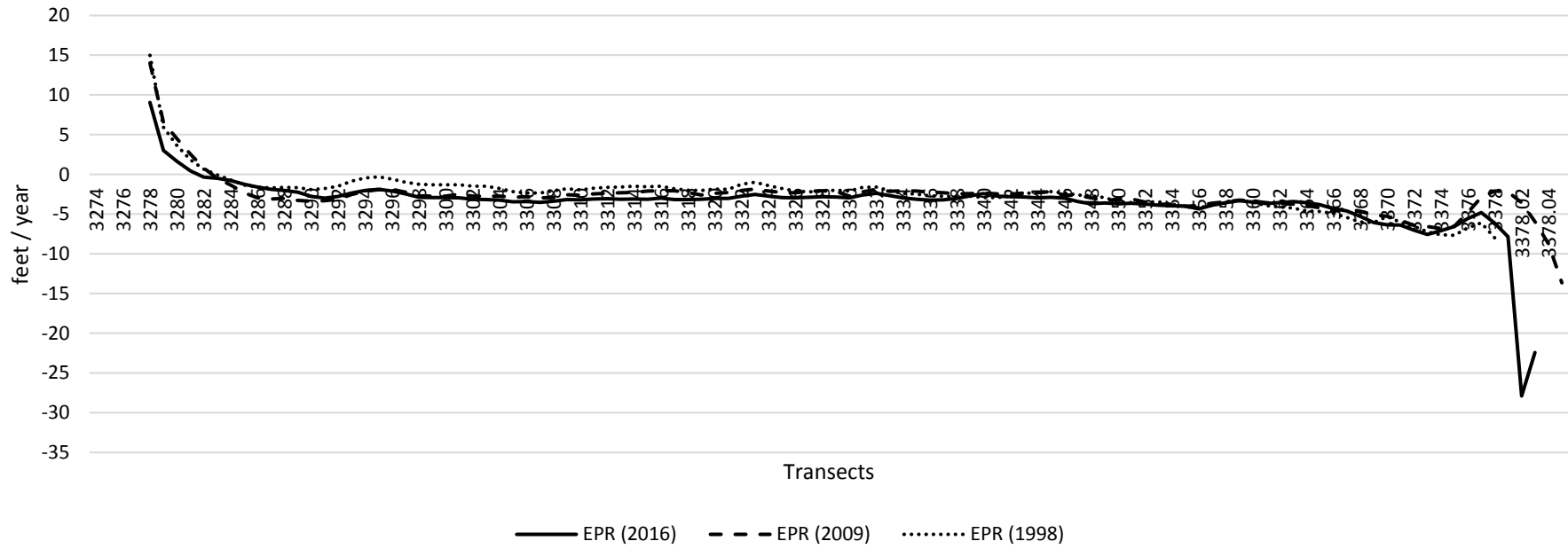


Figure B19. Shoreline change rate comparison at Brown’s Island using early shoreline and 1998, 2009, and 2017 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Brown’s Inlet (graph left-side) to Bear Inlet (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Bear Island (Hammock's Beach State Park)

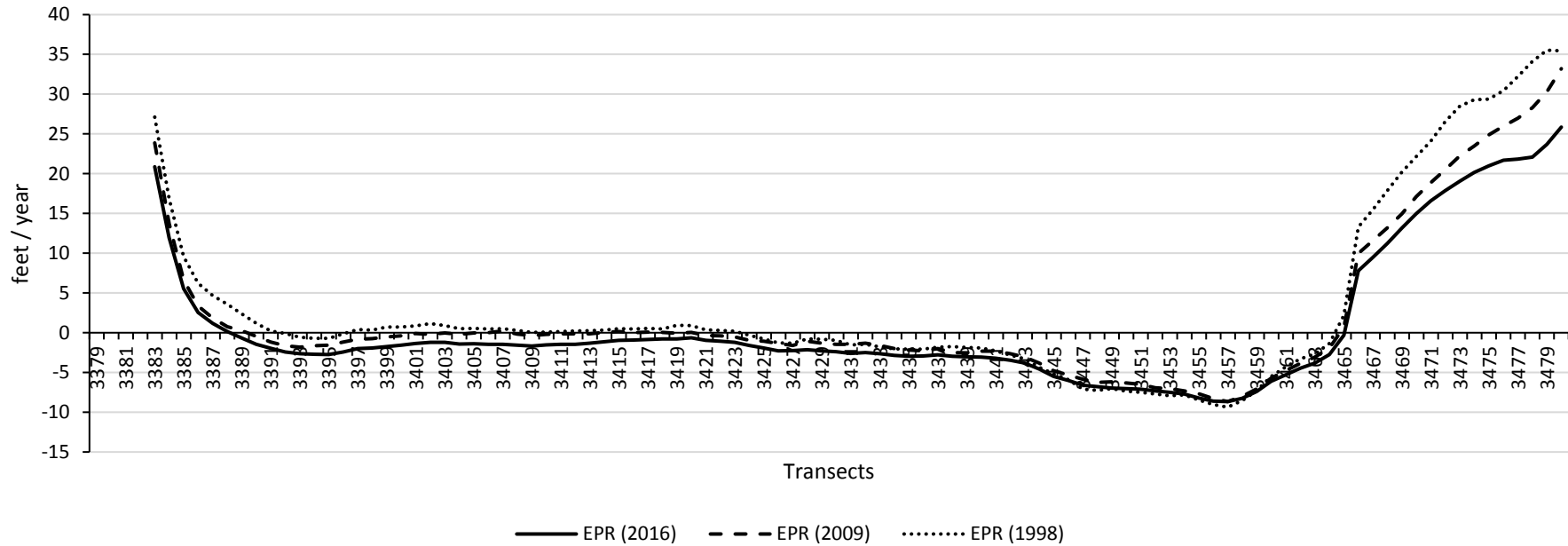


Figure B20. Shoreline change rate comparison at Bear Island (Hammocks Beach State Park) using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Bear Inlet (graph right-side) to Bogue Inlet (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Emerald Isle

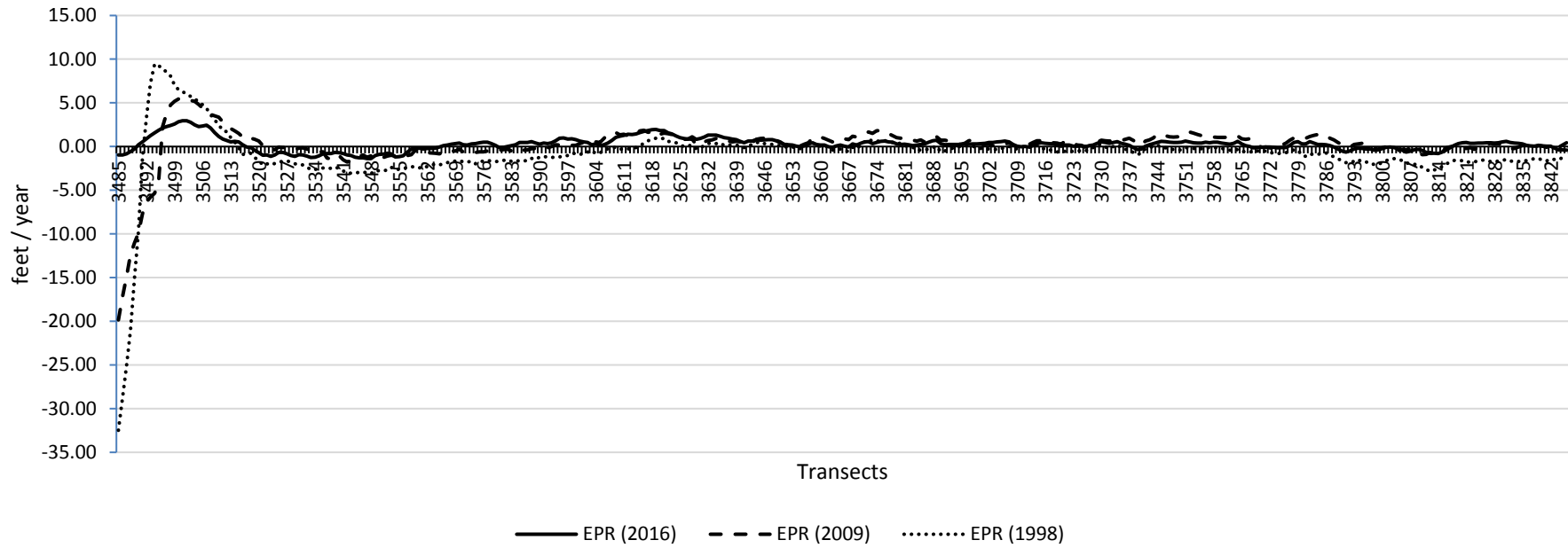


Figure B21. Shoreline change rate comparison at Emerald Isle using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Bogue Inlet (graph left-side) to Emerald Isle-Indian Beach town limits. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Indian Beach & Salter Path

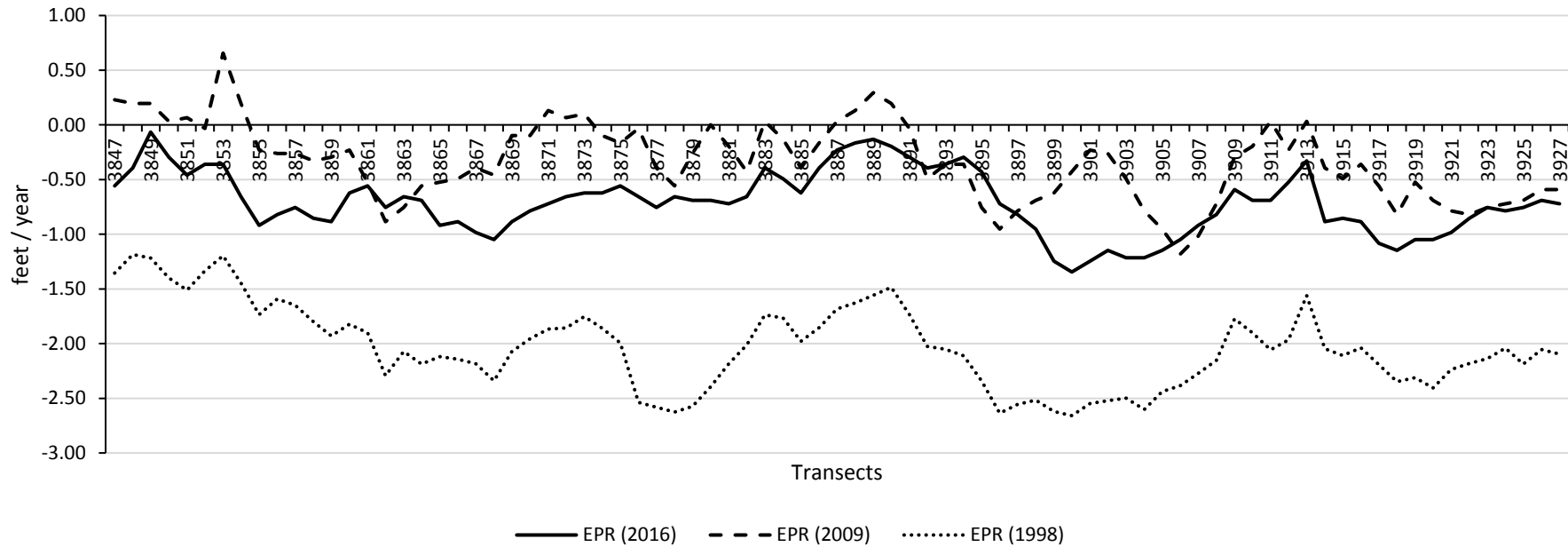


Figure B22. Shoreline change rate comparison at Indian Beach and Salter Path using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Emerald Isle-Indian Beach town limits (graph left-side) to Indian Beach-Pine Knoll Shores town limits (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Pine Knoll Shores

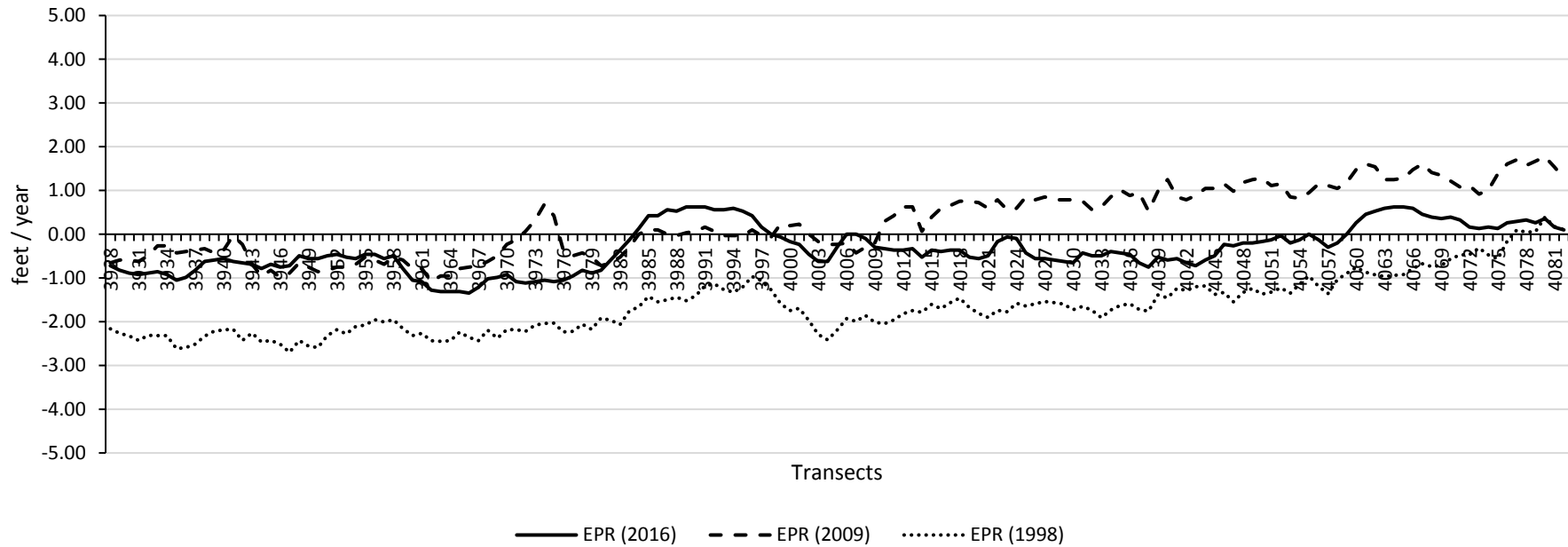


Figure B23. Shoreline change rate comparison at Pine Knoll Shores using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Indian Beach-Pine Knoll Shores town limits (graph left-side) to Pine Knoll Shores-Atlantic Beach town limits (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Atlantic Beach

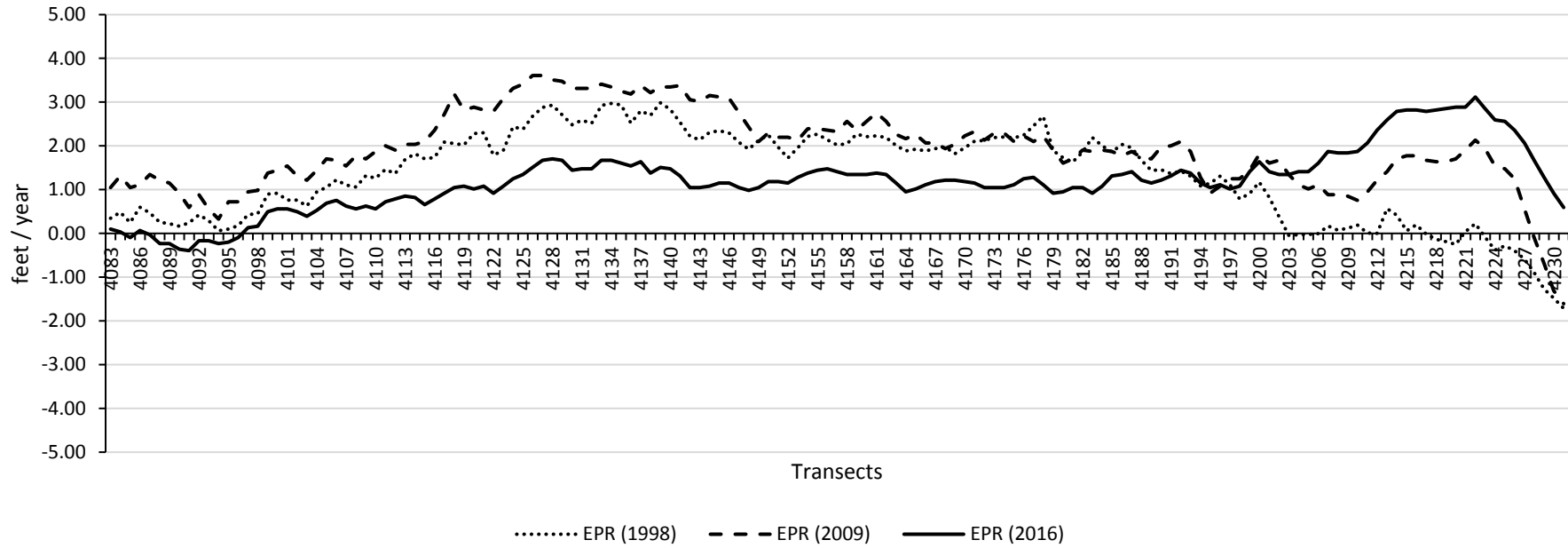


Figure B24. Shoreline change rate comparison at Atlantic Beach using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Pine Knoll Shores-Atlantic Beach town limits (graph left-side) to Fort Macon State Park (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Fort Macon State Park

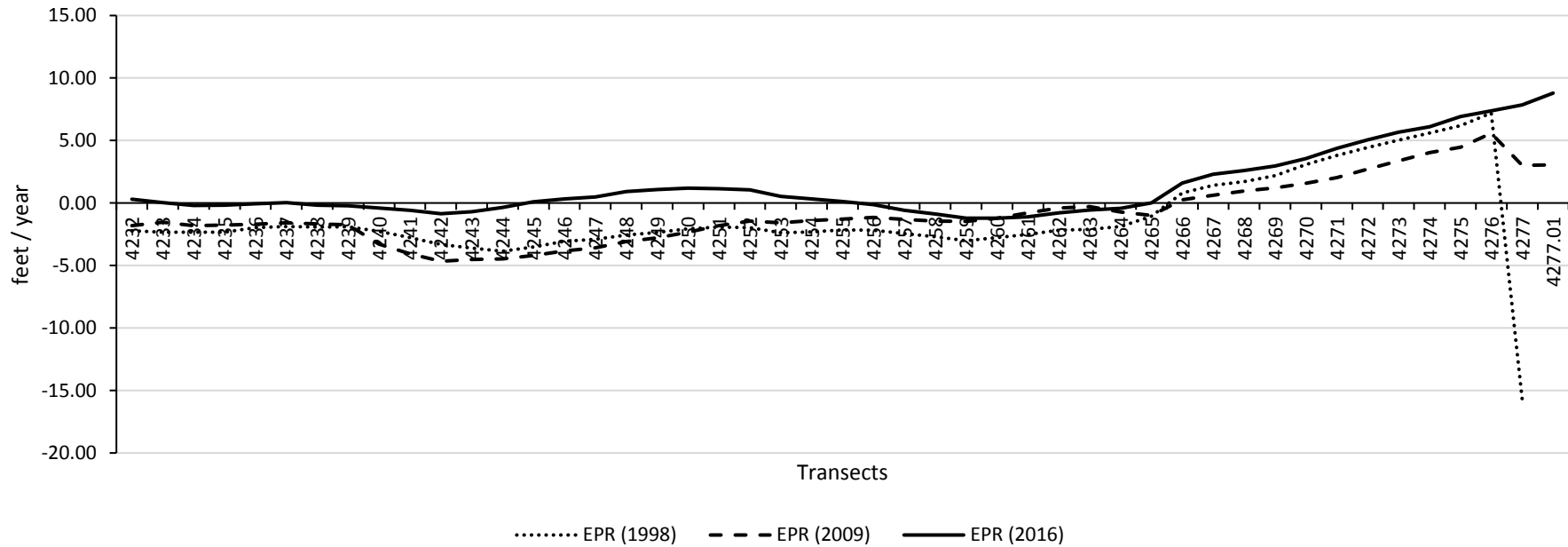


Figure B25. Shoreline change rate comparison at Fort Macon State Park using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Atlantic Beach-Fort Macon State Park boundary (graph left-side) to Beaufort Inlet (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Shackleford Banks

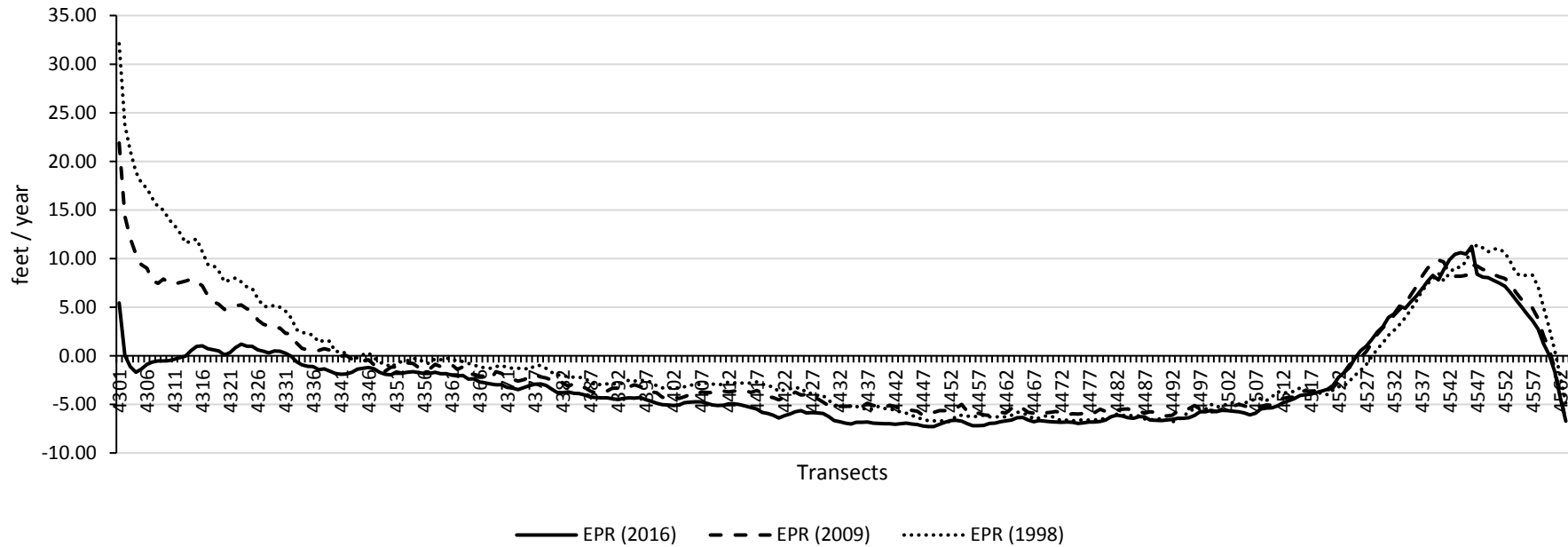


Figure B26. Shoreline change rate comparison at Shackleford Banks using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Beaufort Inlet (graph left-side) to Barden Inlet (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Cape Lookout (SouthWest Beach)

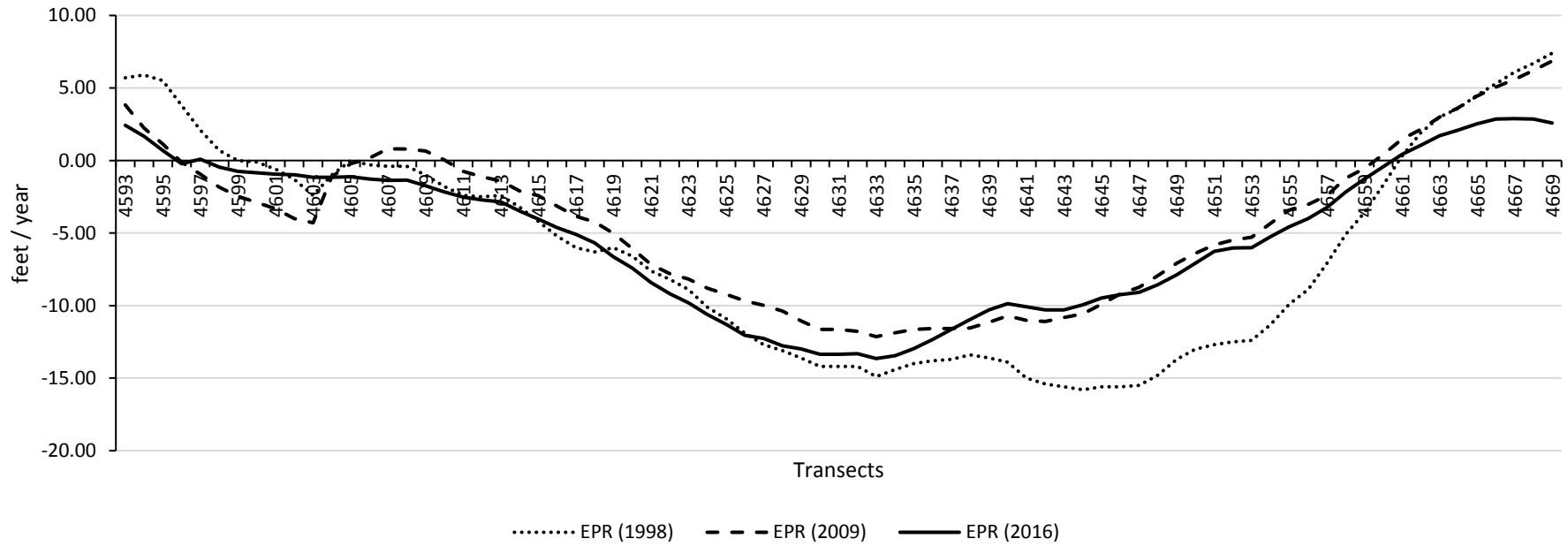


Figure B27. Shoreline change rate comparison at Cape Lookout (southwest-beach) using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from Barden Inlet (graph left-side) to Cape Lookout (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Cape Lookout to Drum Inlet

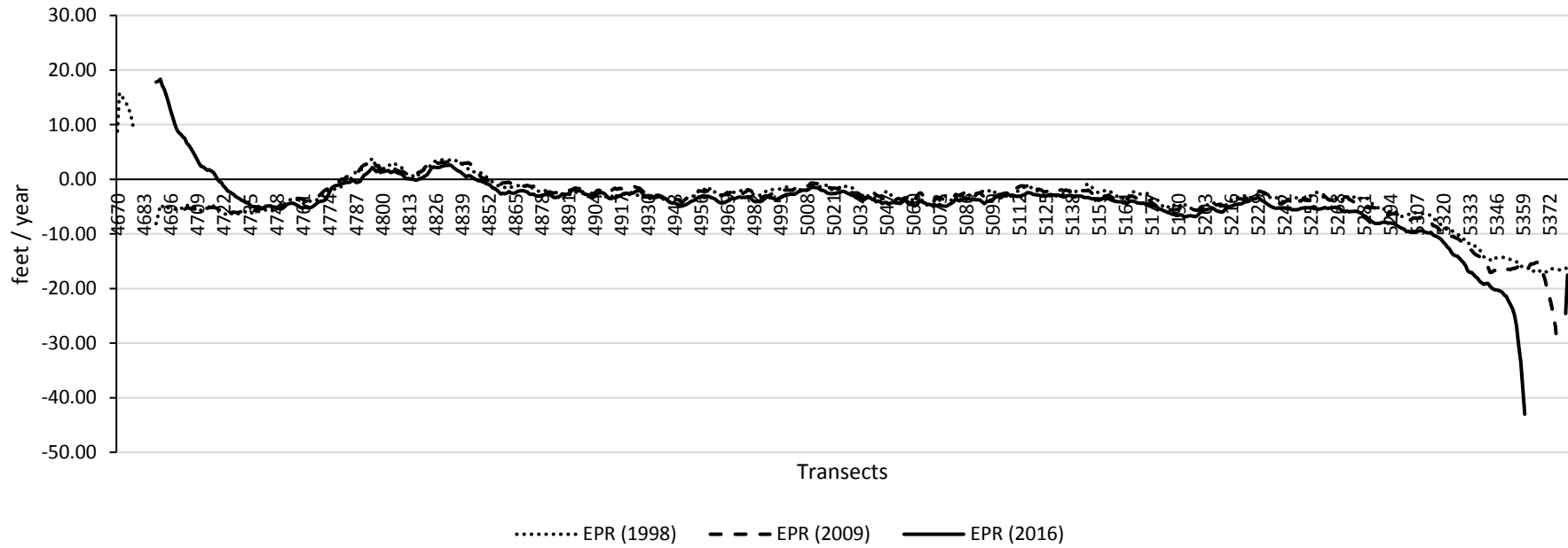


Figure B28. Shoreline change rate comparison at Core Banks (from Cape Lookout to Drum Inlet) using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph is oriented from south to north, with Cape Lookout on graph's left-side, and Drum Inlet on graph's right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Core Banks (Drum Inlet to Ocracoke Inlet)

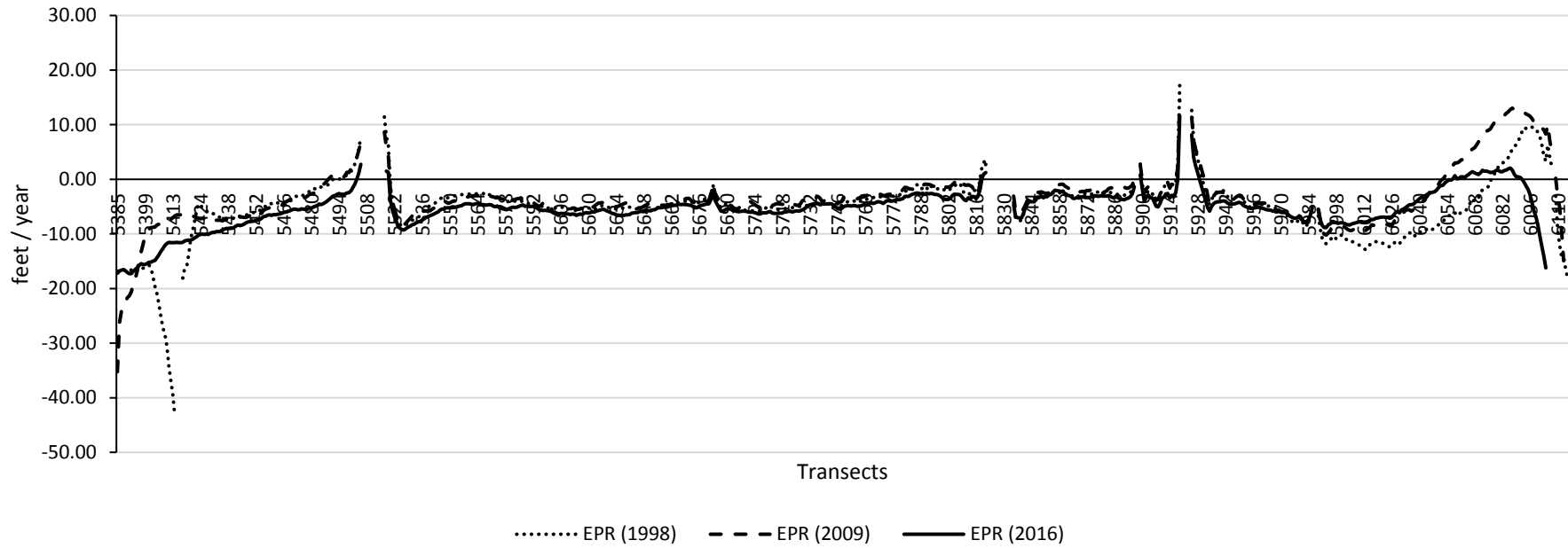


Figure B29. Shoreline change rate comparison at Core Banks (from Drum Inlet to Ocracoke Inlet) using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from south to north, with Drum Inlet on left-side and Ocracoke Inlet on right-side. Data gaps represent from inlet locations. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Ocracoke Island

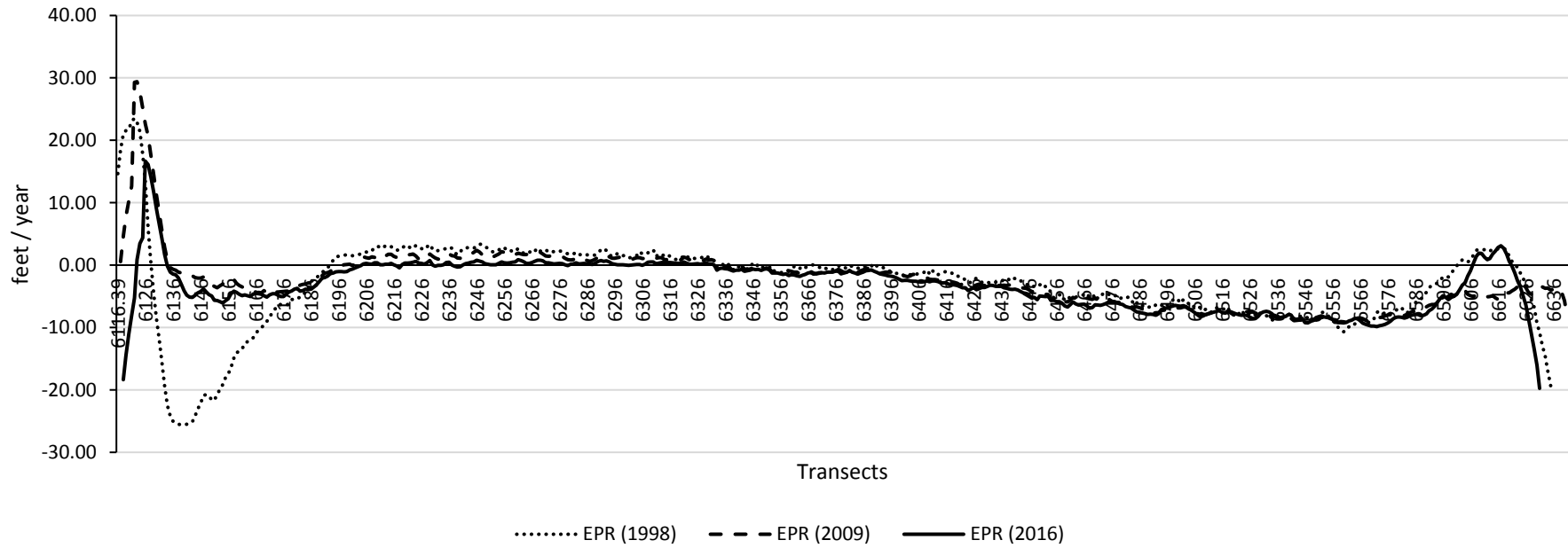


Figure B30. Shoreline change rate comparison at Ocracoke Island using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from Ocracoke Inlet (graph left-side) to Hatteras Inlet (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Cape Hatteras (Hatteras Inlet to Cape)

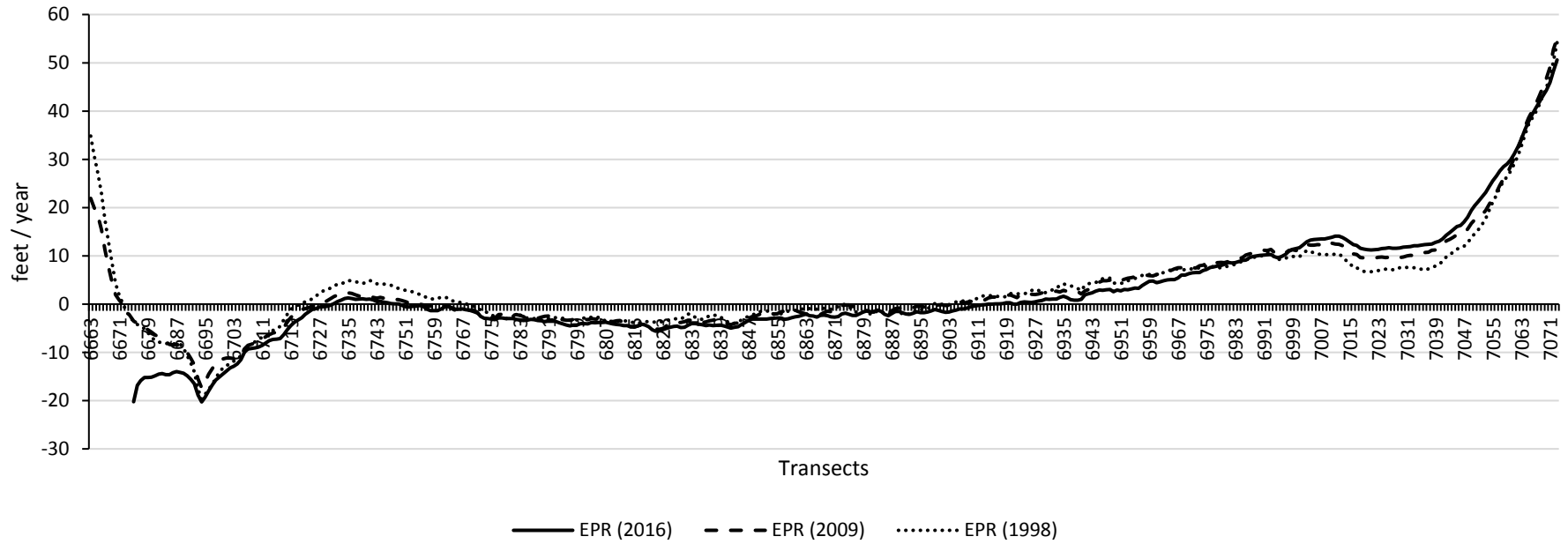


Figure B31. Shoreline change rate comparison at Cape Hatteras (from Hatteras Inlet to Cape) using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from Hatteras Inlet (graph left-side) to Cape Hatteras (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Cape Hatteras (Cape to Buxton)

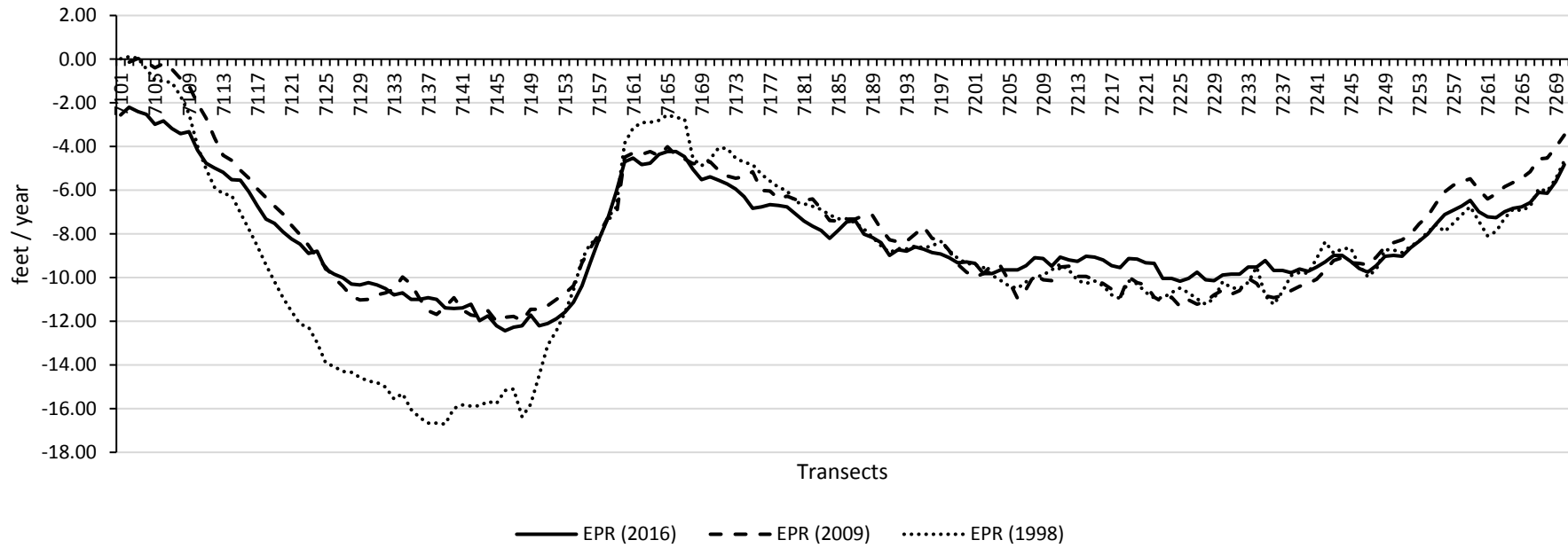


Figure B32. Shoreline change rate comparison at Cape Hatteras (from Cape to Buxton) using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from Cape Hatteras (graph left-side) to north of Buxton (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Avon)

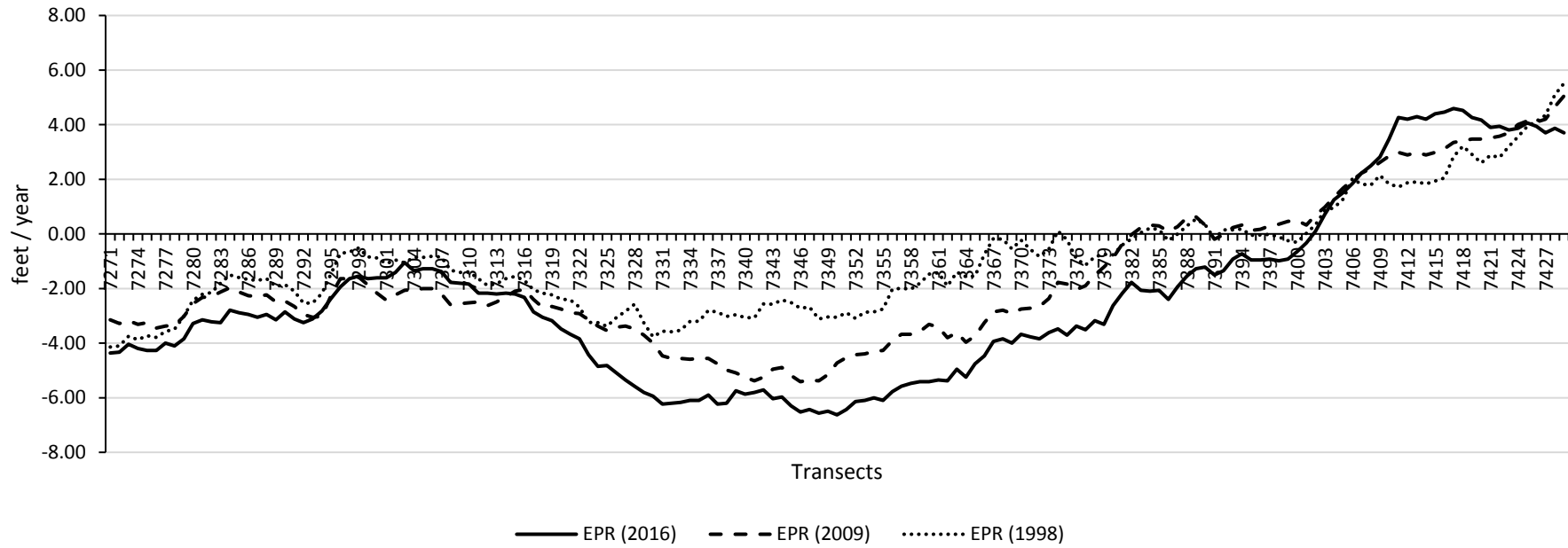


Figure B33. Shoreline change rate comparison at Outer Banks at Avon using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from south (graph left-side) to north at Avon (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (between Avon & Salvo)

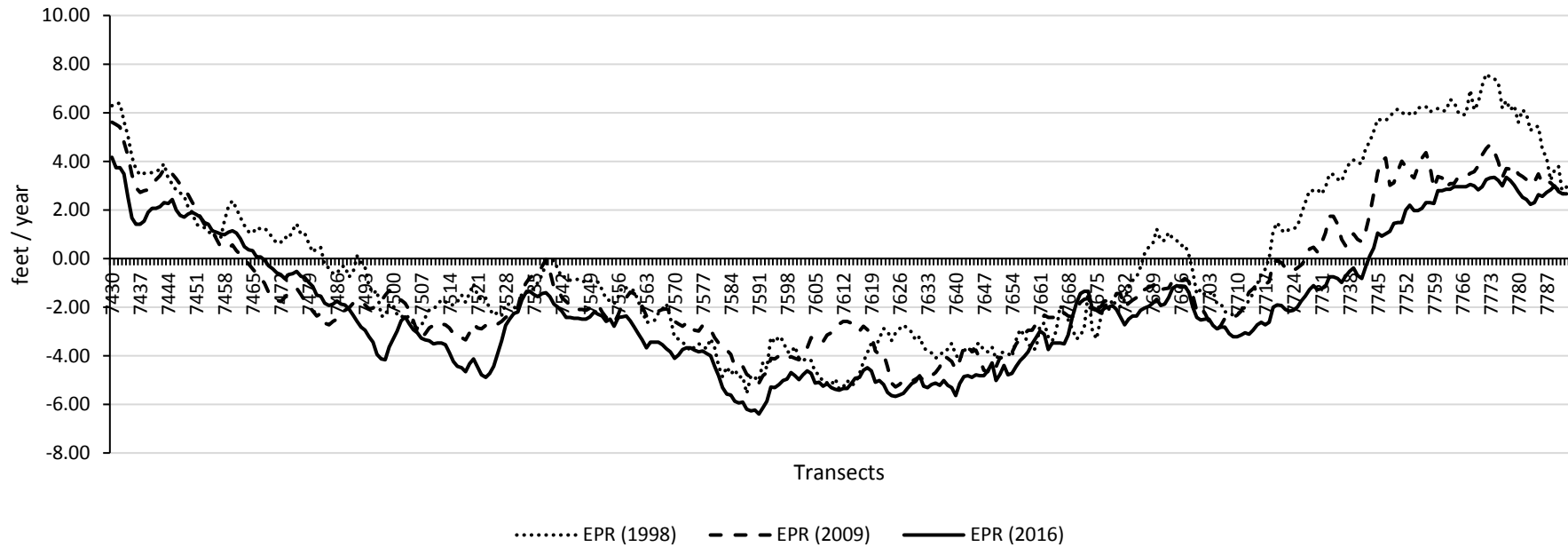


Figure B34. Shoreline change rate comparison at Outer Banks between Avon and Salvo using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from south (graph left-side) to north (graph right-side) between Avon and Salvo. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Salvo & Rodanthe)

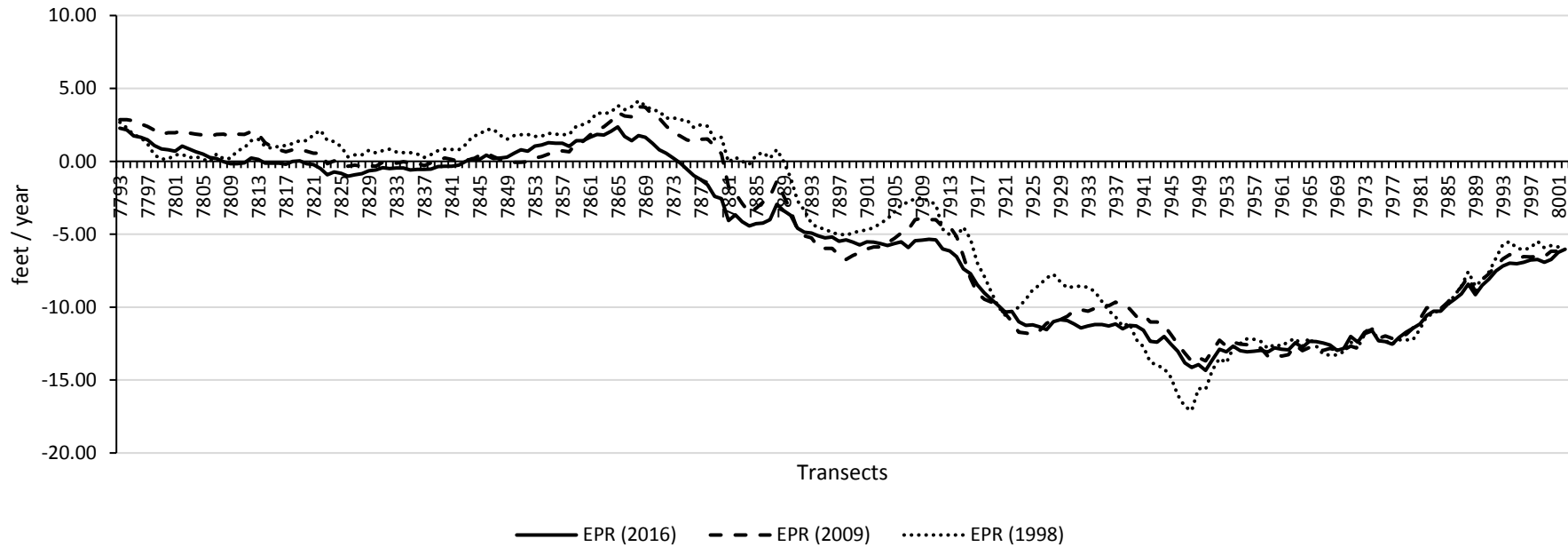


Figure B35. Shoreline change rate comparison at Outer Banks at Salvo and Rodanthe using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Graph oriented from south (left-side) to north (right-side) and includes Salvo and Rodanthe. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Rodanthe to Oregon Inlet)

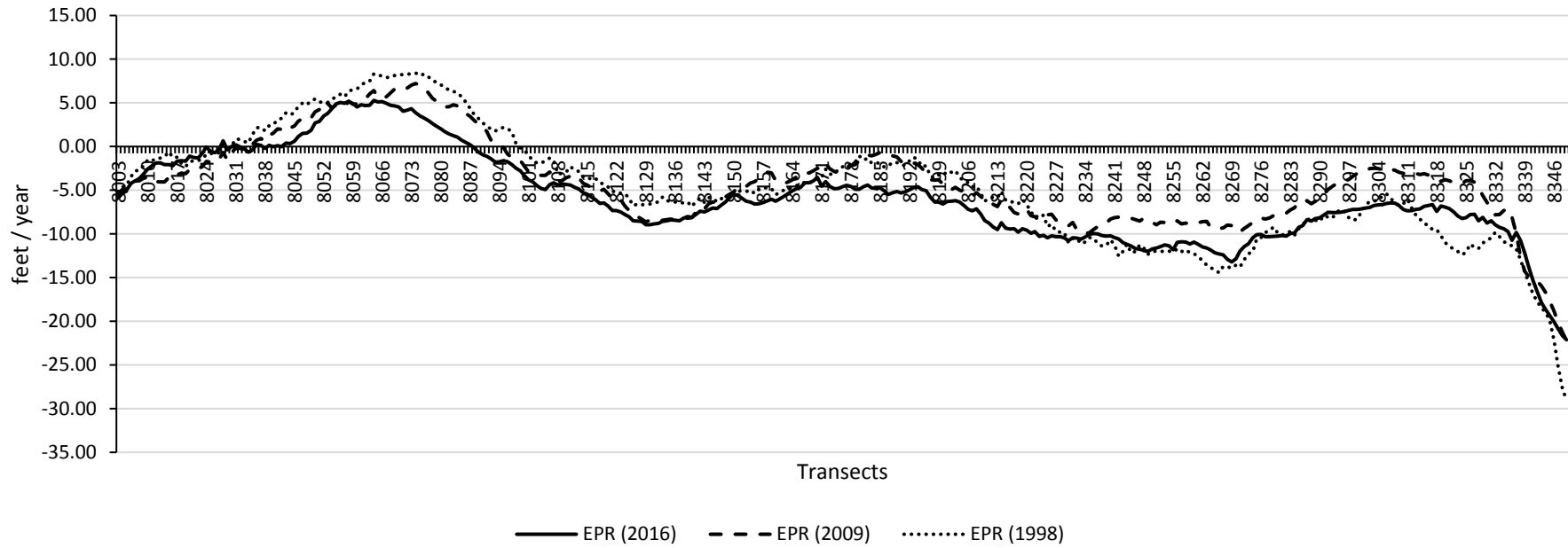


Figure B36. Shoreline change rate comparison at Outer Banks from Rodanthe to Oregon Inlet (Pea Island) using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented from Rodanthe (graph left-side) to Oregon Inlet (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Boddie Island)

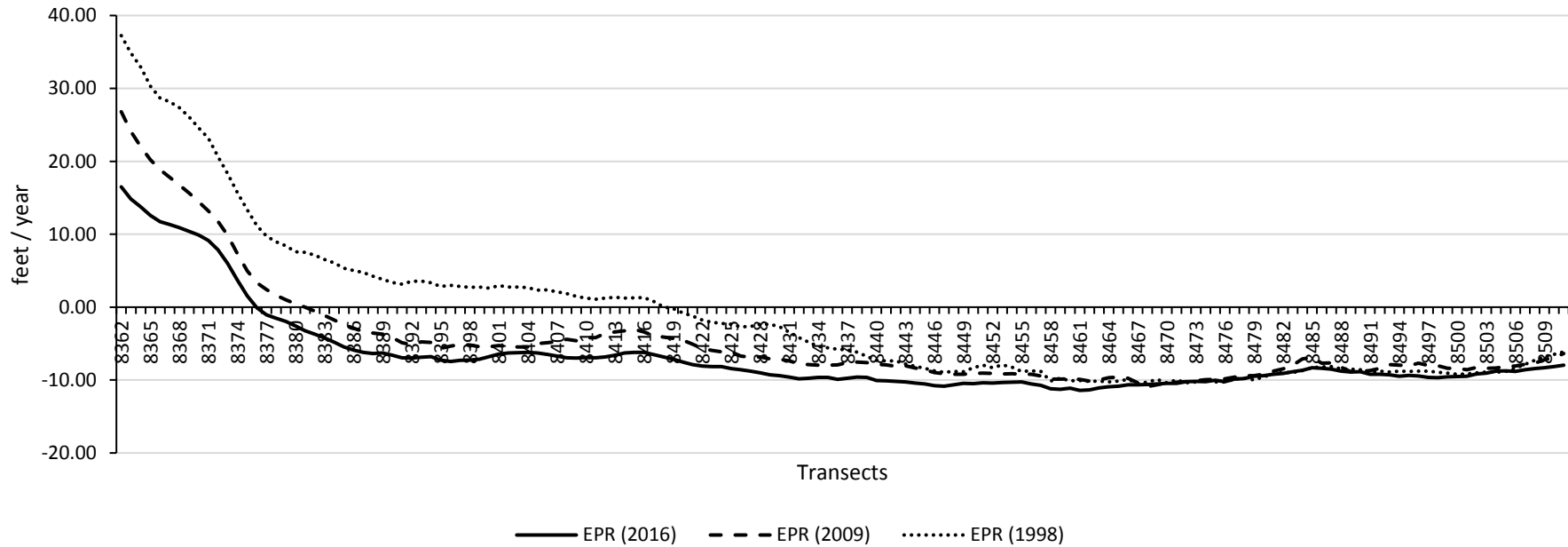


Figure B37. Shoreline change rate comparison at Outer Banks from Oregon Inlet to Nags Head (Boddie Island) using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented from south (graph left-side) to north (graph right-side) and includes Boddie Island. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Nags Head)

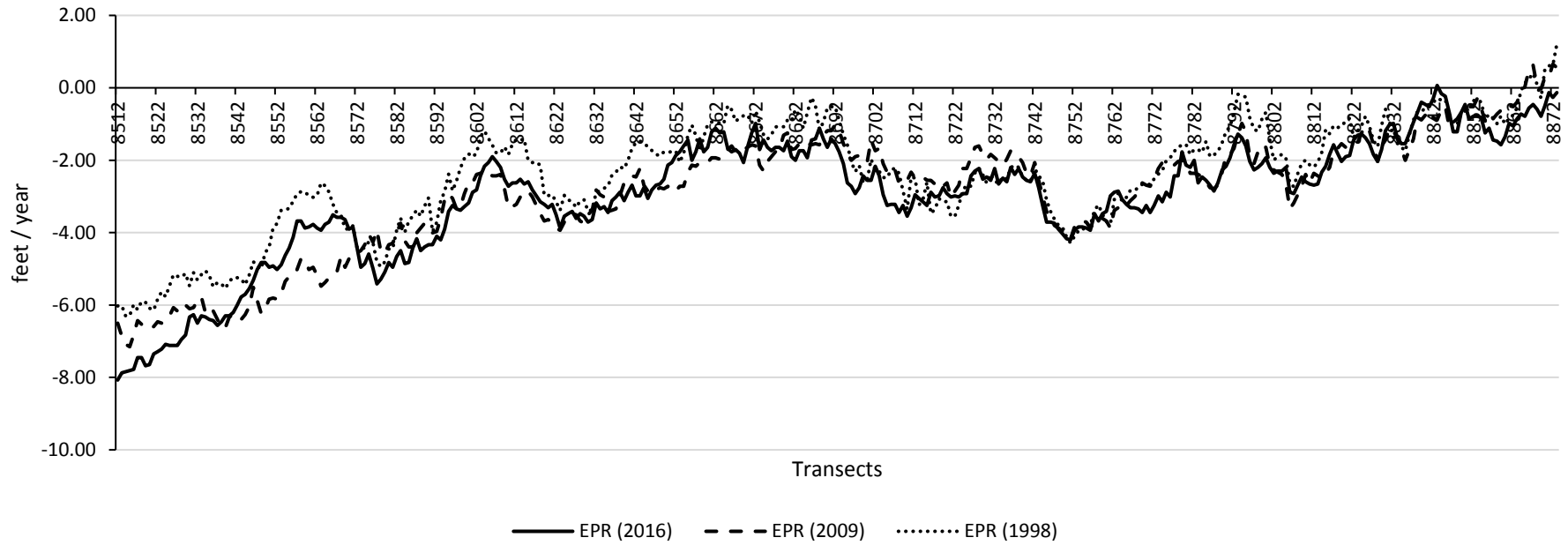


Figure B38. Shoreline change rate comparison at Outer Banks at Nags Head using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented from Nag Head’s southern limit (graph left-side) to its northern limit (graph right-side). Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Kill Devil Hills)

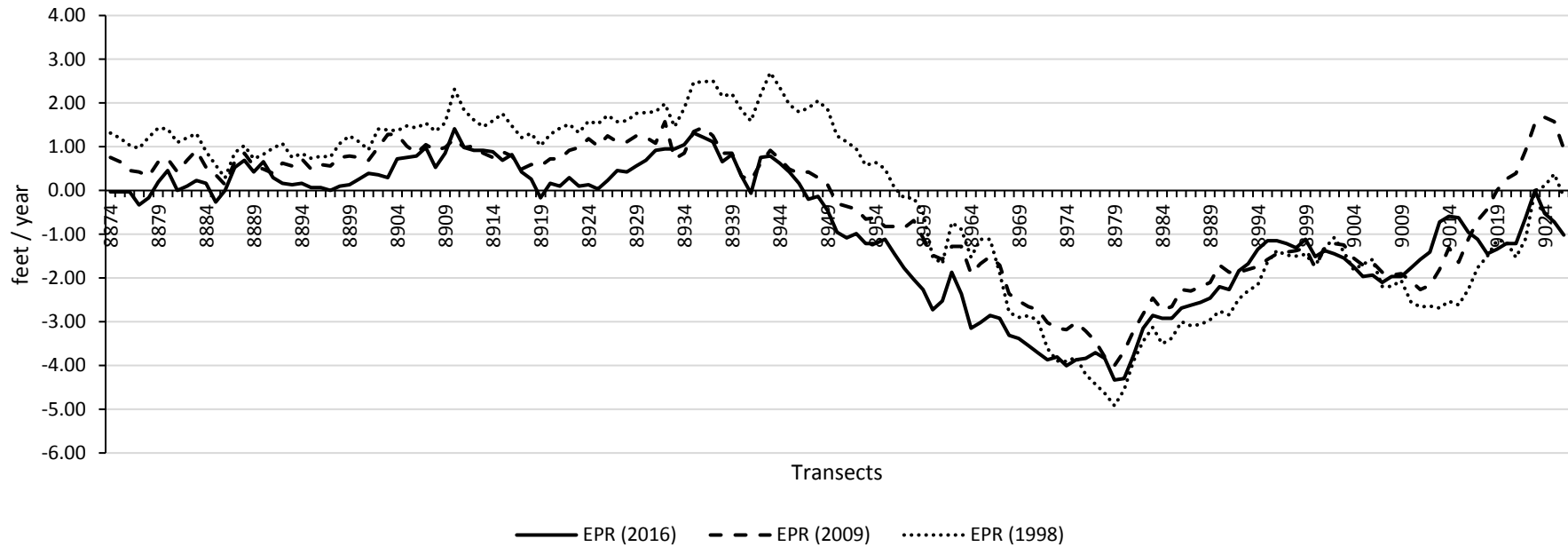


Figure B39. Shoreline change rate comparison at Outer Banks at Kill Devil Hills using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented from south to north, with Nags Head-Kill Devil Hills town limits on graph's left-side and Kill Devil Hills-Kitty Hawk town limits on graph's right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Kitty Hawk)

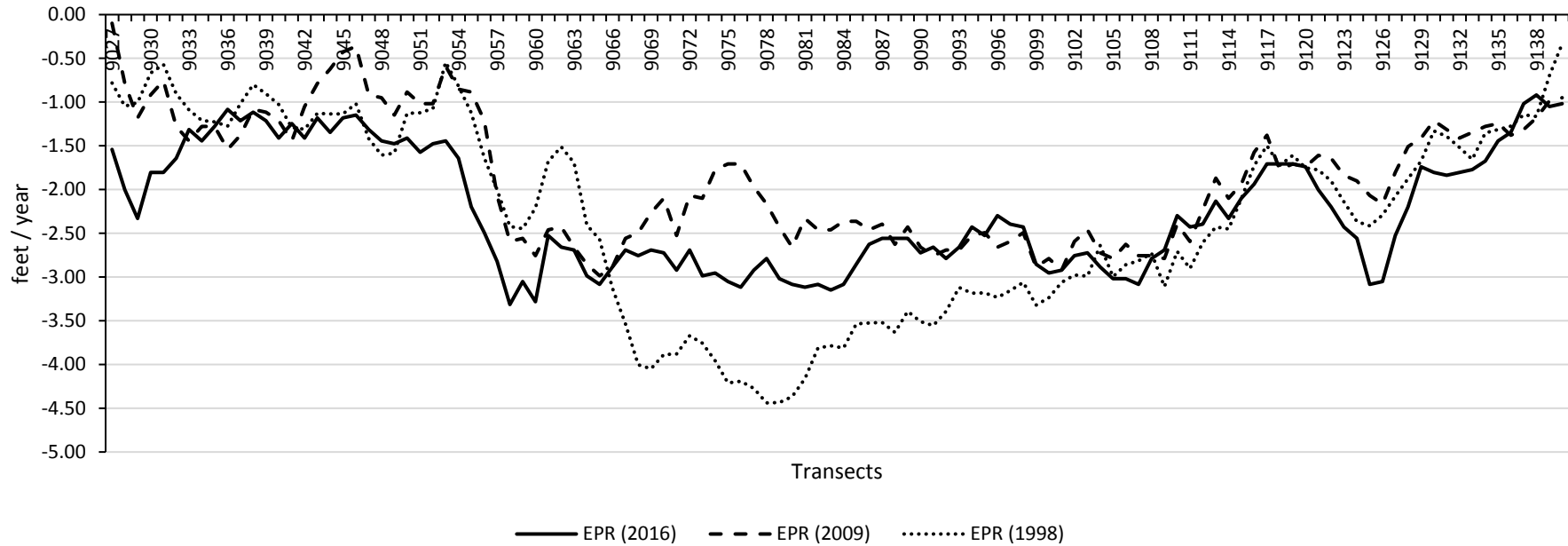


Figure B40. Shoreline change rate comparison at Outer Banks at Kitty Hawk using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented from south to north, with Kill Devil Hills-Kitty Hawk town limits on graph's left-side, and Kitty Hawk-Southern Shores town limits on graph's right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Southern Shores)

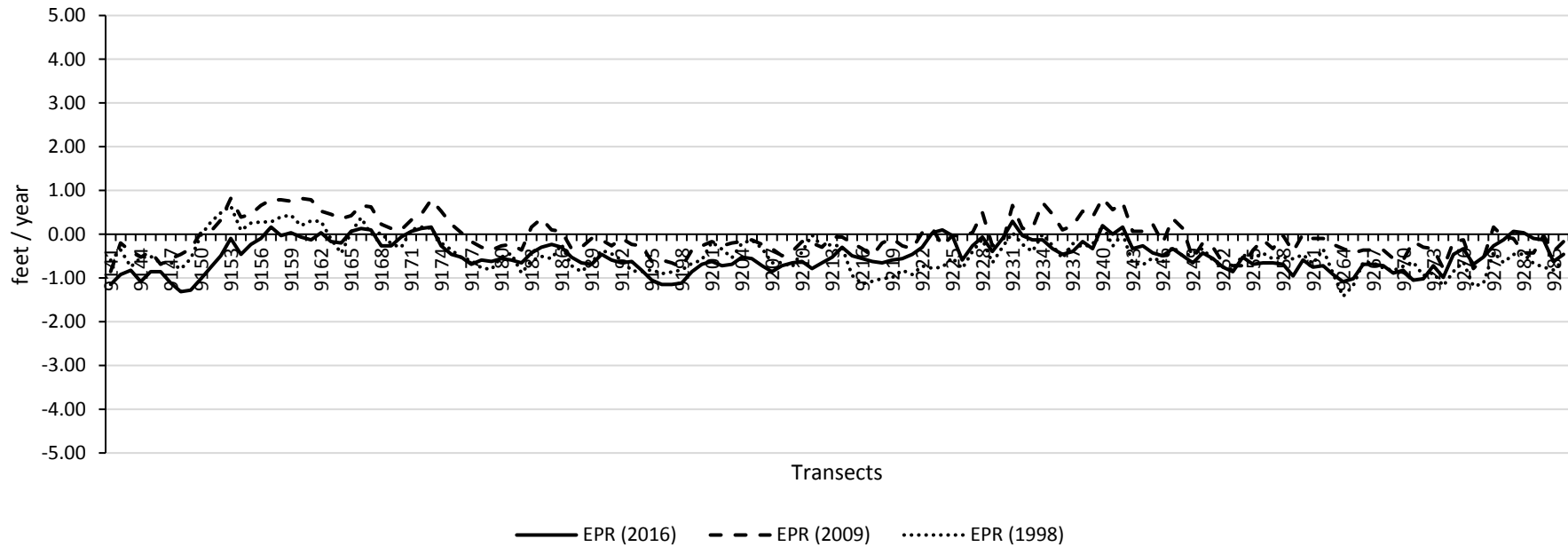


Figure B41. Shoreline change rate comparison at Outer Banks at Southern Shores using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented from south to north, with Kitty Hawk-Southern Shores town limits on graph's left-side, and Southern Shores-Duck town limits on graph's right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Duck)

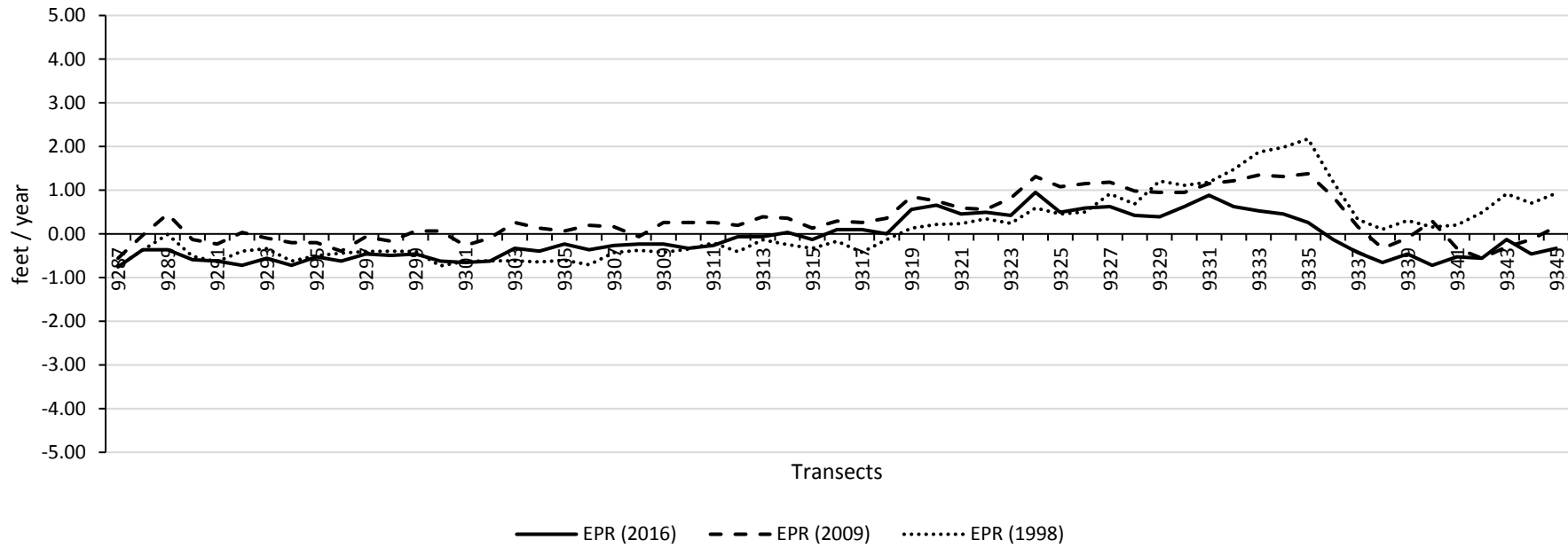


Figure B42. Shoreline change rate comparison at Outer Banks at Duck using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented from south to north, with Southern Shores-Duck town limits on graph's left-side and Duck-Corolla limits on graph's right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Corolla)

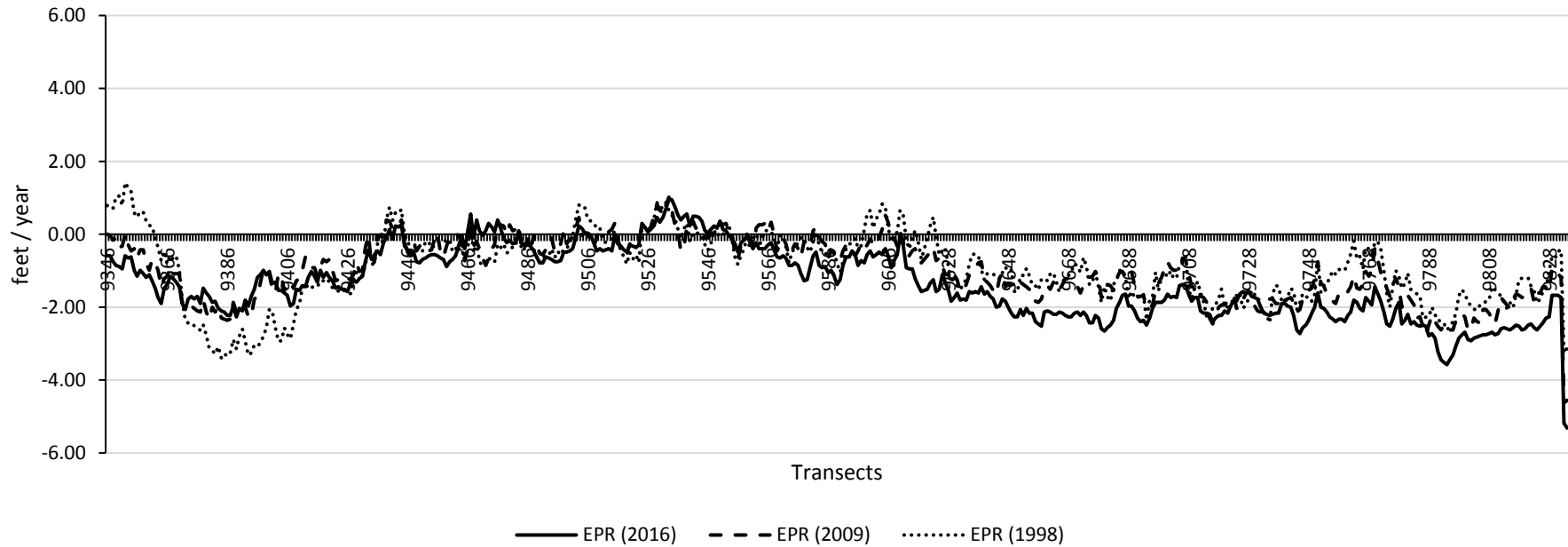


Figure B43. Shoreline change rate comparison at Outer Banks at Corolla using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented from south to north, with Duck-Corolla boundary on graph's left-side, and Corolla's northern limit on graph's right-side. Transect numbers correspond to those labeled on map in the results summary section.

Shoreline Change Rate Comparison (1998, 2009, 2016) Outer Banks (Corolla to VA)

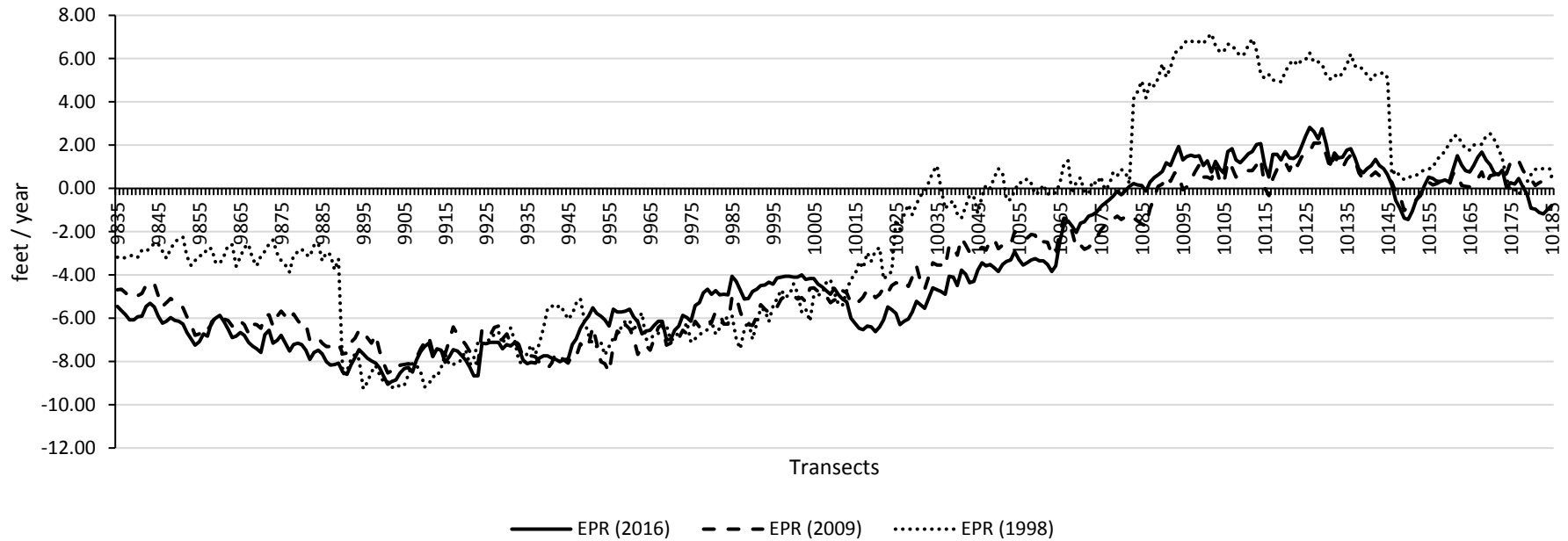


Figure B44. Shoreline change rate comparison at Outer Banks from Corolla to NC-VA State Line using early shoreline and 1998, 2009, and 2016 shorelines. On this graph, negative values represent erosion, and positive values represent accretion. Oriented from south to north from Corolla (graph's left-side) to NC-VA state line on graph's right-side. Transect numbers correspond to those labeled on map in the results summary section.



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