



North Carolina 2025 Oceanfront Setback Factors & Long-Term Average Annual Erosion Rate Update Study: Methods Report

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Acknowledgements

The primary focus of this study is to refine and update foundational parameters used in NC's oceanfront coastal management, to include erosion rates, setback factors, and defining the landward boundary of the Ocean Erodible Area (OEA) within the Ocean Hazard System using up to date shoreline data. Based on a recommendation from the NC Coastal Resource Commission's Science Panel on Coastal Hazards, this update includes a comparison of erosion rate calculation methods which are informed by the latest scientific technology, incorporating long-term mapping data and advanced modeling techniques. This effort aims to support resilience to coastal hazards while continuing to serve as a robust foundation for oceanfront policy-making in North Carolina's dynamic coastal environment. This report provides a comprehensive analysis of shoreline change rates performed by Shoreline Management Specialist, Ken Richardson with the North Carolina Department of Environmental and Natural Resources's Division of Coastal Management.

Executive Summary

Since 1979, the North Carolina Division of Coastal Management (NC DCM) has utilized long-term erosion data to establish oceanfront construction setbacks and define the landward boundaries of Ocean Erodible Areas of Environmental Concern. These rates have historically been determined using the "End-Point" method, which measures shoreline position changes between the earliest available and most recent datasets. While widely recognized for its simplicity, cost-effectiveness, and reliability, the method does not model or predict future shoreline changes.

Advancements in Geographic Information Systems (GIS) technology and the availability of more comprehensive and accurate shoreline datasets have prompted a recommendation by the NC Coastal Resources Commission's Science Panel to transition from the end-point method to the least squares regression method. Unlike the end-point approach, which relies on only two data points, the least squares regression method incorporates multiple shoreline positions over time, offering a more refined and robust analysis of long-term erosion trends. This transition allows for a more statistically rigorous approach to calculating erosion rates and setback factors, reducing potential anomalies caused by short-term fluctuations in shoreline position.

This report presents findings from an erosion and accretion analysis conducted along North Carolina's oceanfront using both the least squares regression and end-point methods. The study examined 10,232 transects spaced 50 meters apart, covering approximately 318 miles of shoreline. Additionally, it compares results with previous studies that relied on the end-point method to assess consistency across methodologies.

Key findings from the analysis include:

- **Statewide Erosion Trends:** Both the least squares regression and end-point methods produced an identical average erosion rate of -1.9 feet per year. This consistency reinforces the reliability of the updated methodology.
- **Setback Factor Implications:** Of the total 318 miles of analyzed shoreline, 214.1 miles (67.3%) will experience no change in setback requirements, while 74.1 miles (23.3%) will

see a decrease in setback factors ranging from 0.5 to 14 feet per year (averaging 1.5 feet). An increase in setback requirements of 0.5 to 35 feet per year (averaging 3.0 feet) will be observed in 21.7 miles (7.8%).

- **Erosion Hotspots:** The highest variability in erosion and accretion rates continue to be observed around inlets and capes, where processes create dynamic shoreline conditions.
- **Comparison of Methodologies:** The study reaffirms that both the least squares regression and end-point methods yield highly consistent results. However, the least squares regression method provides a more comprehensive assessment.

This report marks North Carolina's first long-term update of annual erosion rates and setback factors using the least squares regression method. By adopting this enhanced methodology, the state aims to improve the accuracy of erosion assessments and ensure that oceanfront construction setback regulations are based on the best available science. These findings will serve as a critical foundation for future coastal management decisions, helping to balance development needs with the long-term sustainability of North Carolina's shoreline.

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1.0 Introduction

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 (NCDCM, 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.

It's essential to recognize that long-term erosion rates (over 50 years) can vary greatly from short-term rates. In 2000, the U.S. Geological Survey (USGS), East Carolina University (ECU), and the N.C. Geological Survey (NCGS) formed the Coastal Geology Research Cooperative to study the coastal geology of North Carolina, from Cape Lookout to Currituck County, and compare short- and long-term shoreline changes. While engineering efforts like dredging, erosion control structures, and beach nourishment can affect short-term erosion, in North Carolina, storm intensity and frequency play a larger role in shaping short-term changes. For example, beach

nourishment can artificially lower erosion rates, while storm event frequency and intensity can cause higher short-term erosion rates that don't necessarily reflect long-term trends.

The purpose of this study is to update oceanfront erosion rates and setback factors (SBF) along 318 miles of North Carolina's Atlantic Ocean shoreline (**Figure 1**), as well as the landward extent of the Ocean Erodible Area (OEA) within the Ocean Hazard Area of Environmental Concern (AEC). This area is defined by a significant risk of excessive shoreline erosion, based on long-term average annual 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, these long-term average annual shoreline change rates have been periodically updated, with the most recent update completed in 2019 and effective as of April 1, 2020. Oceanfront construction setback factors are used to determine appropriate siting for oceanfront development.

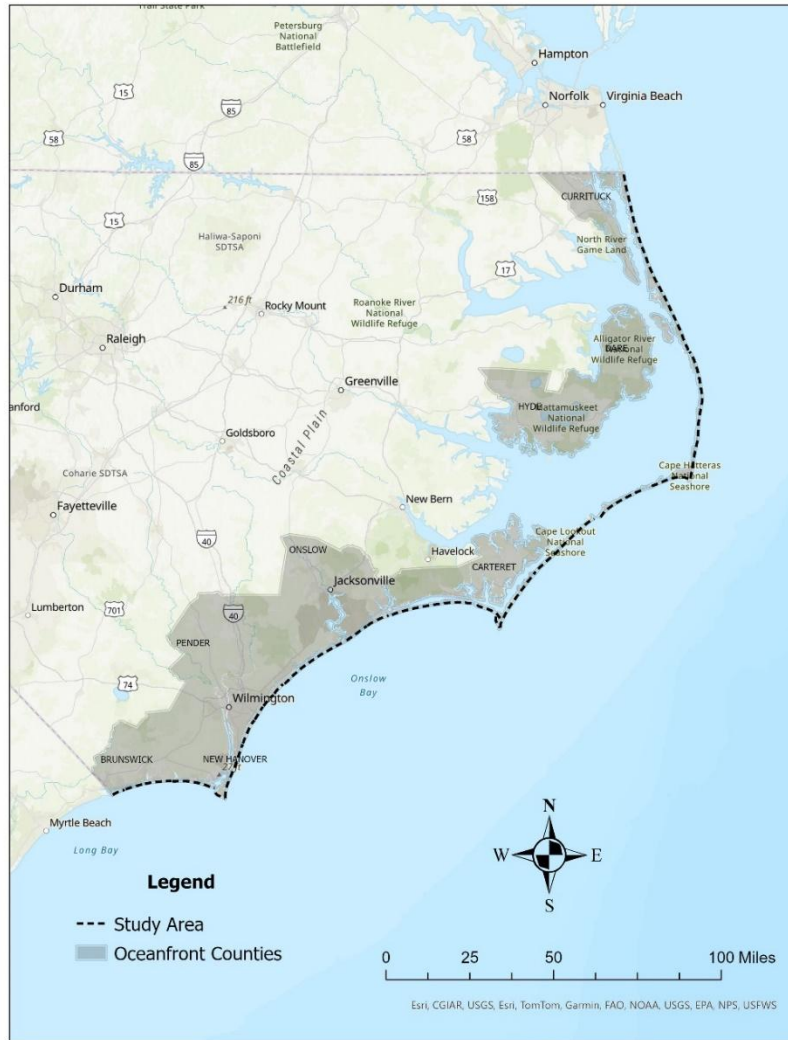


Figure 1. The study area encompasses North Carolina’s oceanfront, with 318 miles of shoreline analyzed.

Since the first study in 1979 (Tafun, Rogers, and Langfelder, 1979), shoreline change rates for North Carolina’s oceanfront have been calculated using the end-point method. This approach involves using the earliest and most recent shoreline data, along with shore-perpendicular transects, where the distance between the two shorelines is measured at each transect. The raw shoreline position change rates are then calculated by dividing the distance between the two shorelines (at the transect intersections) by the time elapsed, or the number of years between the two shoreline positions. To determine Setback Factors, these data are "smoothed" using a

17-point running average and "blocked" to identify shoreline segments, or "blocked areas," that exhibit similar erosion rates.

Over the past two decades, advancements in digital mapping technology have enabled the Division to develop a comprehensive shoreline database. By leveraging Geographic Information Systems (GIS) alongside the U.S. Geological Survey's Digital Shoreline Analysis System (DSAS), the Division can better streamline the process of analyzing and comparing shoreline change rates using multiple calculation methods. At the recommendation of the NC CRC's Science Panel on Coastal Hazards, this report presents shoreline change rates and setback factors derived from least squares regression. For context, these values are also compared with both current and historical results using the end-point method.

2.0 Methods

Since 1979, DCM has calculated long-term oceanfront shoreline change (erosion and accretion) using the end-point method. This approach focuses on the change in shoreline position between the earliest and most recent recorded shorelines. While useful for providing an overall picture of long-term shoreline movement, the method does not account for significant short-term fluctuations that may occur between those points in time, which can influence local shoreline behavior and differ from long-term trends. This limitation is particularly evident in inlet shorelines, where constant movement, tidal and storm influences, and sediment transport cause frequent position changes. The dynamic nature of these areas makes the end-point method less effective in accurately capturing the shoreline's behavior or estimating future trends.

To address this complexity, this study focuses on least squares regression, while still comparing the results to those generated using the end-point method. This statistical technique analyzes multiple shoreline positions over time, providing a more detailed view of shoreline variability and long-term trends (Thieler et al., 2009). By utilizing a broader dataset, the least squares regression method offers a more reliable and comprehensive analysis of shoreline dynamics, particularly in areas influenced by the unpredictable behavior of inlets. This approach enhances the understanding of erosion and accretion patterns, offering valuable insights that can inform coastal management strategies.

Shoreline data were analyzed using *ESRI's ArcPro® 3.x and ArcMap® 10.8x* Geographic Information System (GIS) and U.S. Geological Survey's (USGS) Digital Shoreline Analysis System (DSAS) versions 5.1 and 6.0. Geographic Information Systems (GIS) are a sophisticated suite of tools used to capture, store, analyze, manage, and visualize spatial or geographic data. These spatial mapping and analysis technologies combine layers of information about a location to help understand patterns, relationships, and trends.

The U.S. Geological Survey's (USGS) Digital Shoreline Analysis System (DSAS) is a specialized tool designed to calculate shoreline changes, including erosion and accretion rates. It tracks shoreline

movement over time by analyzing both historical and recent data. The following is a general overview of how DSAS is used to calculate shoreline erosion rates:

1. **Shoreline Data Input:** DSAS requires a series of shoreline positions from different time periods. These shorelines can be digitized from historical maps, aerial imagery, or satellite data.
2. **Baseline Creation:** A baseline is established landward or seaward of the shorelines. It acts as a reference for the calculation of changes.
3. **Transect Generation:** Perpendicular transects are automatically generated at regular intervals from the baseline, extending across the shorelines. These transects are the points where shoreline change is measured.
4. **Shoreline Change Calculation:** For each transect, DSAS computes the distance between different shoreline positions over time, using methods like:
 - a. **End Point Rate (EPR):** Measures the distance between the oldest and most recent shorelines divided by the time span between them.
 - b. **Linear Regression Rate (LRR):** Fits a least-squares regression line through all shoreline points for each transect, estimating the average rate of change.
 - c. **Weighted Linear Regression (WLR):** Like LRR, but weights more recent data more heavily to account for its higher relevance.
5. **Output:** DSAS generates statistical outputs for each transect, including the rate of shoreline change (in meters per year) and confidence intervals. These results help assess erosion risks, trends, and rates.

In summary, DSAS is used to calculate shoreline erosion rates by analyzing shoreline position changes over time, using automated transects and various statistical methods to provide precise and localized erosion rate data.

2.1 Shoreline Data

DCM's growing database shorelines facilitated this study by allowing use of more data that better reflects short-term fluctuations in shoreline position. Most of the shorelines analyzed were mapped using historic orthophotography to digitize the wet-dry line (**Figure 2**), considered a proxy for the Mean High Water (MHW) line; while others represented the location of MHW - either derived from lidar (1997 and 2004), or NOS T-Sheets (1930s and 1940s). Two studies carried out by DCM (Limber et al., 2007a; 2007b) indicated that the lidar-derived MHW line could be used interchangeably with the wet-dry shorelines without influencing long-term trends.

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." 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 using orthophotography.

The earliest shorelines used in this and subsequent studies (2004, 2013, 2020) were digitized by the North Carolina State University (NCSU) Kenan Natural Hazards Mapping Program, and 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.

The most current shoreline used in this study is a wet-dry interpretation digitized at a map scale of 1:1,000 utilizing 2020 North Carolina color imagery (6-inch pixel resolution). However, at Onslow Beach and Brown's Island, 2021 imagery (1-meter pixel resolution) was available from ESRI's basemap webservices, and used due to a 2020-imagery data gap.

2.2 Transects (50-Meter)

Transects used in this study are generally perpendicular to the shoreline, spaced 50 meters (approximately 164 feet) apart (**Figure 3**), and spatially consistent with those used in previous 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 comparisons of ocean hazard Setback Factors from this and earlier studies can be made, and not the actual shoreline change rates.

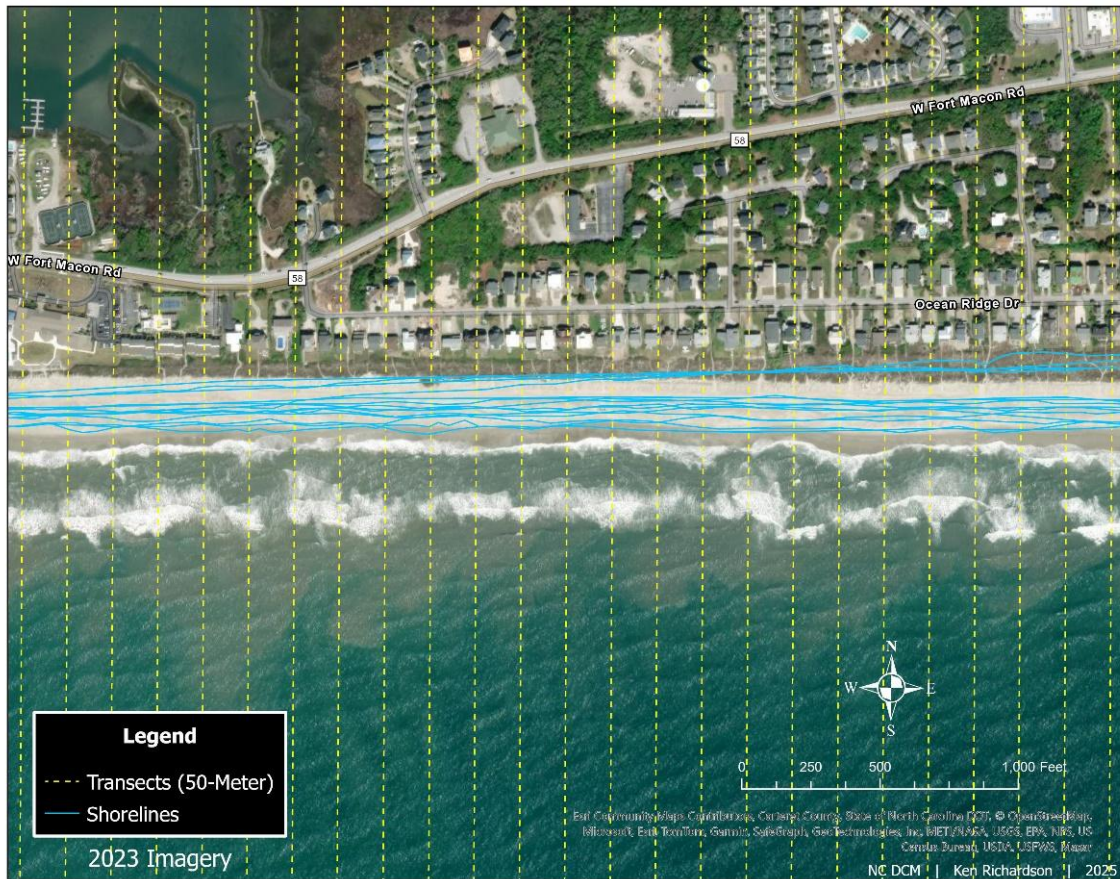


Figure 3. This map illustrates an example of shore-perpendicular 50-Meter transects (dashed yellow line).

For future studies, it is essential to evaluate the transect length to ensure they fully encompass the shoreline envelope, allowing for comprehensive data analysis. However, recasting the transects along the oceanfront will likely be unnecessary, as their current length of approximately 6,000 feet is sufficient. However, if needed, the transects can be extended further landward.

2.3 Shoreline Change Rates: Least Squares Regression

One limitation of the end-point method is its inability to account for significant short-term shoreline changes that occur between the two data points used in its analysis. Given the constant movement and fluctuation of ocean and inlet shorelines, this approach may not fully capture the

dynamic changes that take place between the earliest and most recent shoreline positions. To address this limitation, and following the recommendation of the CRC's Science Panel, this study utilized the least squares regression method, a statistical approach that incorporates multiple shoreline positions over time for a more comprehensive analysis (Thieler et al., 2009).

At each transect, there are a series of shoreline-transect intersections that represent the shoreline's position through time (**Figure 4**). Least squares regression (LRR) minimizes the distance between the known values (actual shoreline positions) fitting a least-squares regression line through all shoreline points for each transect, estimating the average rate of change (**Figure 5**). The slope of this line is the least squares regression of shoreline change or the local erosion or accretion rate.

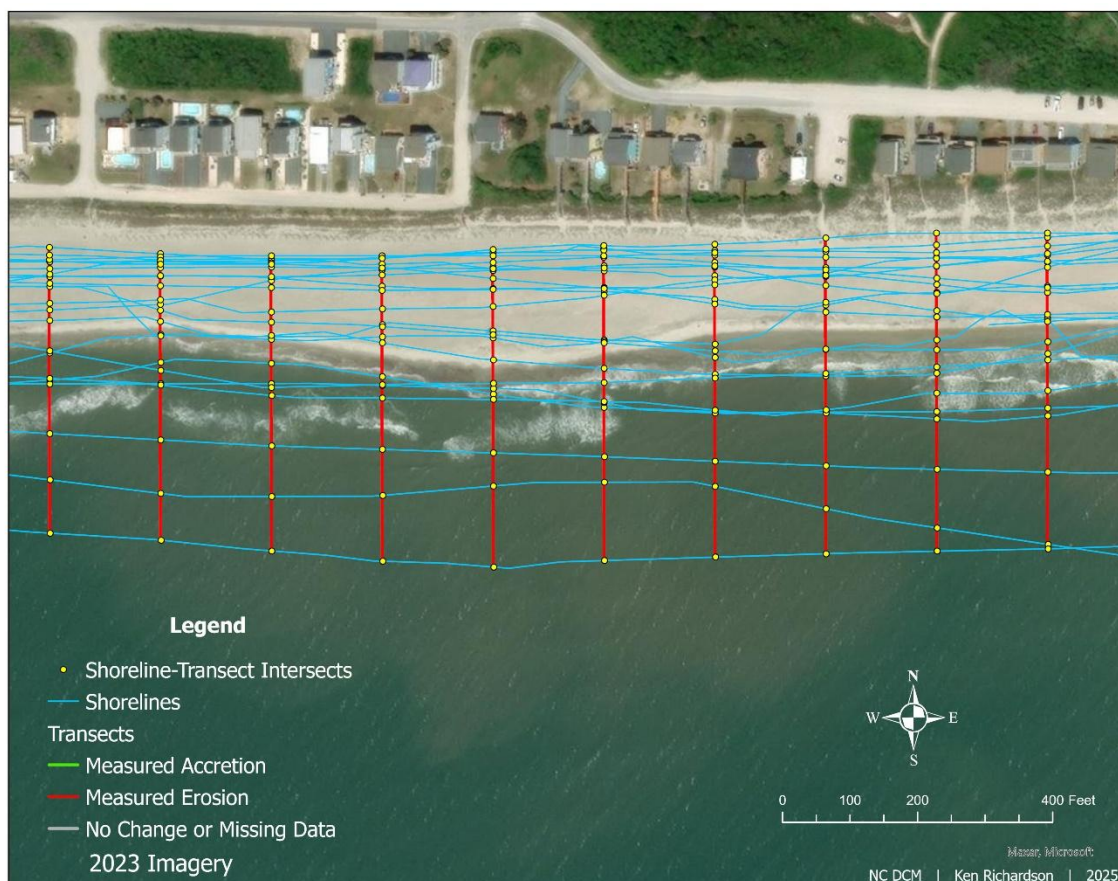


Figure 4. This map illustrates an example of point locations where shorelines intersect transects.

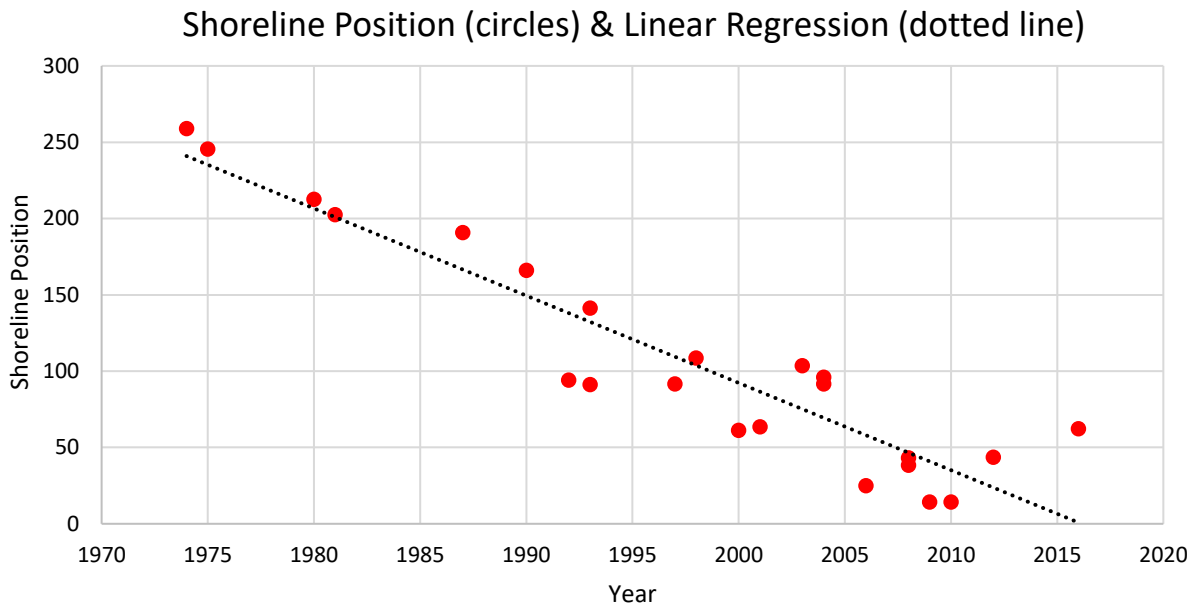


Figure 5. Relative shoreline position as a function of time (circles). The slope of the best fit, dotted line is the linear regression rate (LRR) of shoreline change (in this case, it is eroding at 19 feet per year).

The benefits of linear regression include (Dolan et al., 1991):

- All data is used, regardless of changes in trend or accuracy.
- The method is purely computational.
- The calculation is based on accepted statistical concepts.
- This method is easy to employ.

Although the least squares regression method is less sensitive to individual points, it is susceptible to outliers; it assumes that the computed trend is linear, and it tends to underestimate the rate of change relative to other statistics, such as the end-point rate (Dolan et al., 1991; Genz et al., 2007). To exclude outlier data, precautions were taken to avoid shorelines that reflect influences caused by a major storm event or beach nourishment. However, given that the practice of beach nourishment has become a frequently occurring common practice, avoidance of these shorelines is not always possible.

Once computed, the linear regression rate was then smoothed using a 17-transect running-average alongshore. This follows the blocking computation historically used for the oceanfront shoreline rates and further smooths the alongshore variation in the shoreline change rate.

2.4 Shoreline Change Rates: Smoothing

Smoothing raw data has been applied in all oceanfront shoreline position change studies since 1979 and serves as a method of removing high-frequency variations or noise, thereby highlighting the underlying trends and patterns. By doing so, short-term dynamic shoreline phenomena such as beach cusps, smaller sand waves, and the incorporation of landward migrating portions of offshore bar systems are effectively filtered out (**Figure 6**).

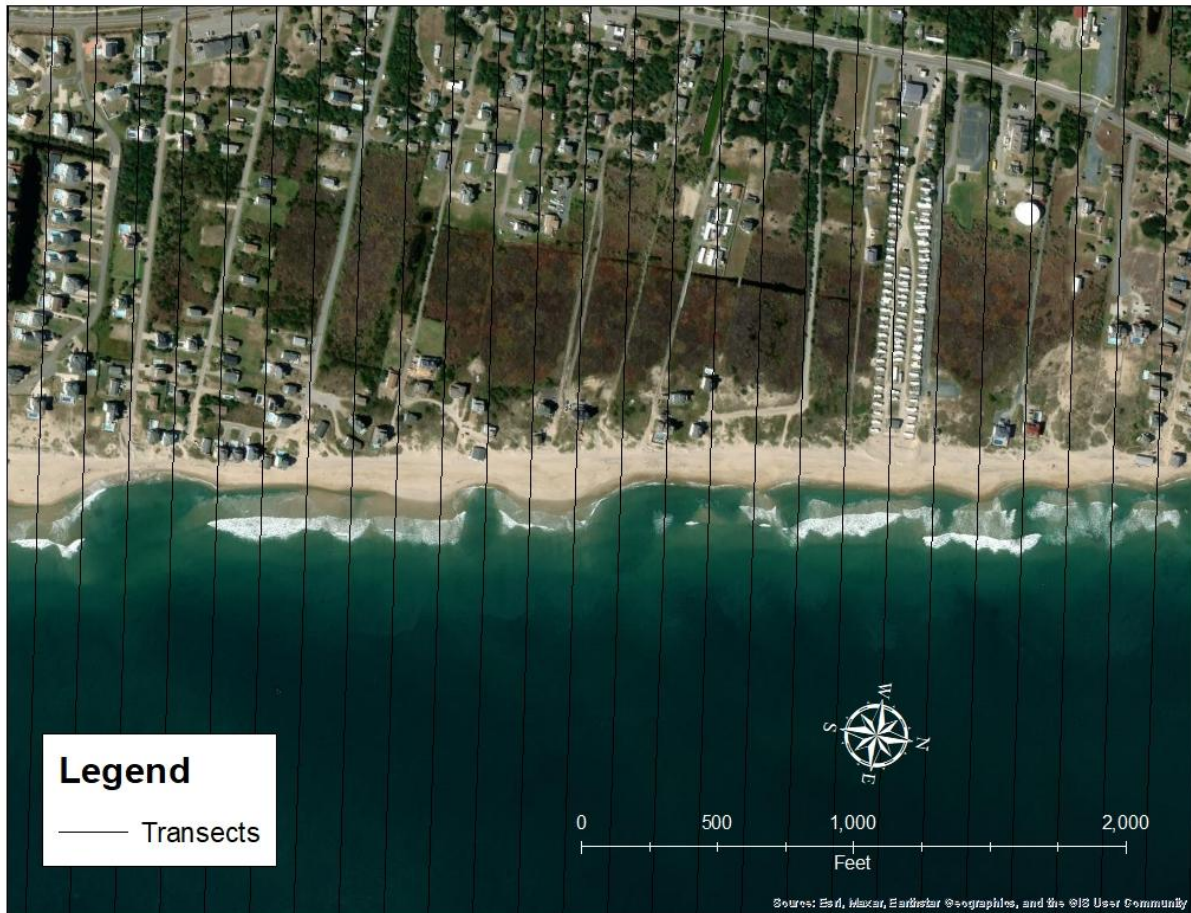


Figure 6. This image shows an example of beach cusps and nearshore sandbars relative to 50-meter transects.

Shoreline cusps and similar coastal features exhibit a wide range of sizes, from small formations approximately 5 feet in width to much larger structures reaching up to 5,000 feet. Their lifespans also vary considerably, with smaller features lasting only a few days, while larger ones, such as sand waves, can persist for entire seasons or even several years (Dolan and Ferm, 1968; Davis, 1978). This range in both size and duration reflects the dynamic and ever-changing nature of coastal environments, driven by processes like wave action, tidal patterns, and sediment transport.

Sandbars, another prominent coastal feature, typically measure more than 300 feet in length. These structures undergo migration and attachment processes, which unfold over time periods

ranging from seasons to years (Davis, 1978). The shifting position of these bars, combined with their ability to attach to different points along the shoreline, underscores the fluidity of coastal landscapes, where no feature remains fixed indefinitely.

Unlike smaller, more transient formations, larger and more durable features such as capes are resistant to smoothing processes commonly applied in coastal analysis. These capes remain prominent even after filtering, highlighting their scale and resilience. Despite their size, capes and similar features are not permanently anchored to a single location. They can migrate along the shoreline, shaped by continuous interactions with natural forces like currents, wind, and wave energy. This movement further illustrates the complex and evolving nature of shorelines, where even the largest features remain subject to gradual change.

The procedure for spatially smoothing shoreline change rate data involves a simple moving average or running mean technique, as described by Davis in 1973. Commonly known as the "17-point running average," this method typically includes at least 17 transects, each spaced 50 meters apart, covering approximately 2,482 feet (0.47 mile) of shoreline. To calculate the smoothed rate, an average is computed for each group of 17 transects, with the calculation centered on the ninth transect - having eight transects on either side (**Figure 7**).

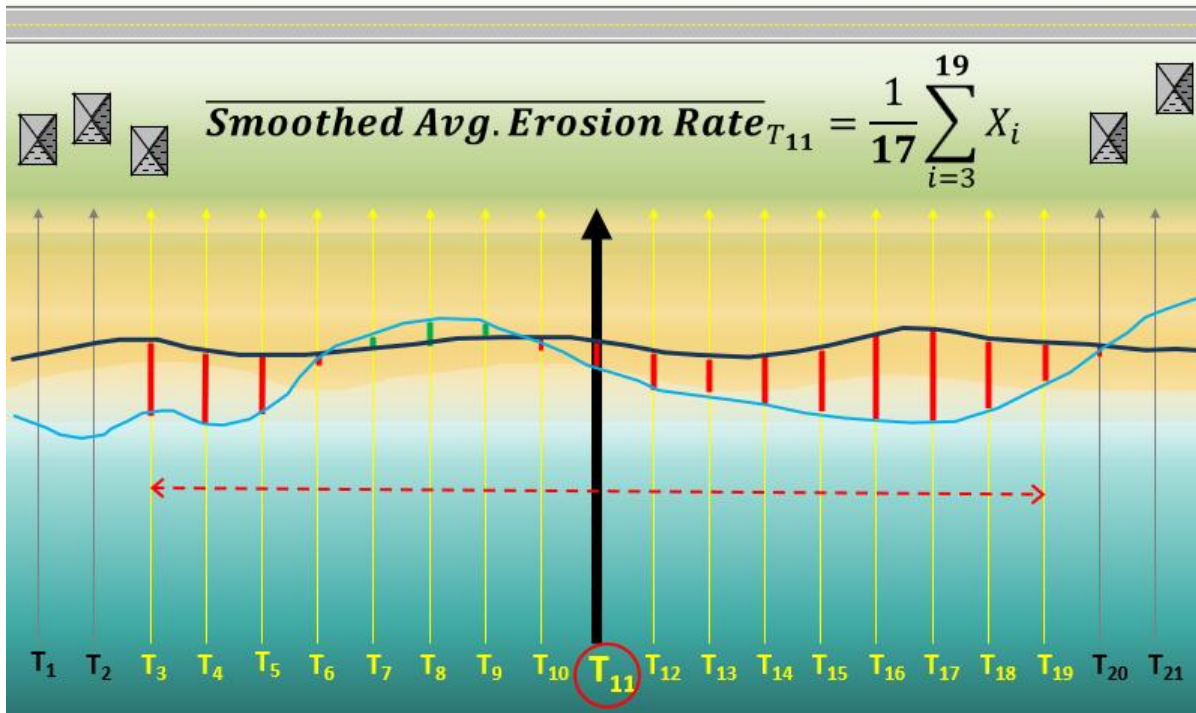


Figure 7. This graphic illustrates an example of the 17-point running average algorithm, where the raw erosion rate at each transect is averaged with the values from eight transects on either side, totaling 17 data points.

As the algorithm approaches an area with less than 17 transects, the number of transects used to calculate the average is reduced by two, dropping one from each side of the centered transect, until the end is reached. For the last value, a weighted average is calculated using only the final two transects. This approach ensures a smooth transition in areas with fewer available data points near shoreline boundaries or inlets.

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

R_s = smoothed rate

T_1 = erosion rate at last transect adjacent to the inlet

T_2 = erosion rate at second to last transect adjacent to inlet

As shown in **Figure 8**, the effects of smoothing are most apparent in areas undergoing accelerated erosion or accretion, such as near inlets. For analyzing erosion rate data, this method is one of the simplest techniques for smoothing time-series data. Its effectiveness in these studies is largely due to the equal spacing between transects, making it well-suited for capturing consistent shoreline change patterns.

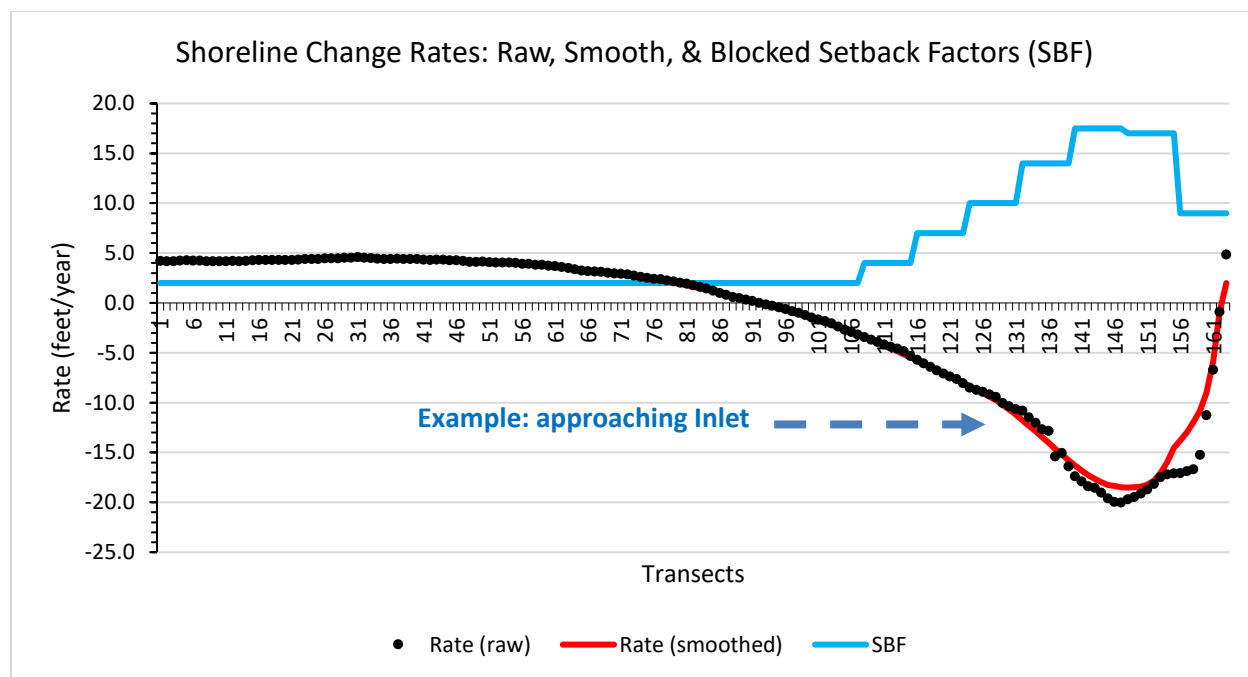


Figure 8. This example illustrates the raw data (black points), smoothed data (red line), and blocked erosion setback factors (blue line). Note that in areas where erosion rates are less than 2 feet per year, or where accretion occurs, the minimum setback factor defaults to 2. While setback factors are recorded as positive values, they directly correspond to erosion rates, particularly when the values surpass -2 ft/yr.

2.5 Shoreline Change Rates: Blocking

In late 1978 and early 1979, the North Carolina Coastal Resources Commission undertook an in-depth review and revision of the oceanfront regulations initially adopted in September 1977. One of the most significant updates introduced during this process was the concept of oceanfront development setbacks, which were then partially determined by the average annual long-term

erosion rates. These rates, calculated based on transects, helped define how far inland development should be placed to minimize risk from coastal erosion. Where rates are higher, the setbacks are greater to help buffer the risk.

However, because these transects only capture data at specific points along the shoreline, a method was required to establish broader setback areas, or “blocks,” where similar erosion rates could be applied consistently across continuous coastal sections. Following a 1979 study (Tayfun et al., 1979) it was determined that if the blocks or segments were too long, the accuracy of the erosion rates could be compromised, particularly in regions where the rates change rapidly over short distances. Long segments tend to oversimplify the data, failing to reflect these localized variations, which could lead to inappropriate setback distances in areas prone to higher erosion.

It wasn’t until the CRC’s 1986 study that this issue was addressed by decreasing the transect spacing from the original intervals to 50 meters. This closer spacing allowed for a more precise calculation of erosion rates and has been the standard practice in all subsequent studies of oceanfront areas. This refinement enabled a more accurate understanding of how erosion affects different parts of the shoreline, leading to better-informed coastal management and development decisions.

The technique of “blocking” smoothed rate data creates spatially consistent rate segments along the shoreline. Essentially, blocking groups neighboring transects along the same shoreline segment that exhibit similar smoothed shoreline change rates. This approach enables more uniform and consistent management practices for sections of the shoreline that experience the same or similar rates of change, rather than relying on individual rates at each transect or risking misinterpretations in the areas between transects.

The blocked shoreline change rate data are used as setback factors, commonly referred to as “erosion rates,” and are applied to determine construction setbacks within Ocean Hazard Areas of Environmental Concern (AECs), which include both Ocean Erodible Areas and Inlet Hazard Areas. This method ensures that setbacks are calculated consistently across similar shoreline segments, improving coastal management and reducing the risk of inappropriate development in high-erosion zones.

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. 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 6.0).
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 to 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.

Based on currentl rules (15A NCAC 07H.0304(1)¹), segments of the shoreline that result in measured accretion, or where measured erosion rates are less than two (2.0) feet per year, are assigned the default minimum, a blocked rate value (Setback Factor) of two (2) in accordance with the minimum setback of 60 feet, or 30 times the Setback Factor based on blocked shoreline change rates.

¹ NC Administrative Code (NCAC), Title 15A – Environmental Quality, Chapter 7, Sub-Chapter 0304(1)

3.0 Results

Data analysis was conducted using the least squares regression method at 10,232 transects, spaced 50 meters apart, covering approximately 318 miles of oceanfront shoreline. Of these, 7,019 transects (218 miles) recorded erosion rates ranging from less than -1.0 to -234 feet per year, with an average rate of -4.2 feet per year. Accretion, ranging from less than +1.0 to +69.4 feet per year, was observed at 3,193 transects, averaging 3.1 feet per year. As expected, the highest erosion and accretion rates were found near inlets and capes.

Statewide, the least squares regression method calculated an average erosion rate of -1.9 feet per year. Erosion rates below -2.0 feet per year were recorded at 4,343 transects, covering 134.9 miles (42.4% of the analyzed shoreline), while rates exceeding -2.0 feet per year were measured at 4,485 transects, spanning 139.3 miles (43.8%). Accretion was observed at 3,193 transects across 99.2 miles (31% of the analyzed shoreline). Despite using least squares regression, the results align closely with previous studies that employed the end-point method.

When comparing methodologies (**Table 1**), both least squares regression and end-point methods produced similar results. Statewide, the end-point method measured an average erosion rate of -1.9 feet per year, with rates ranging from -262 to +114 feet per year. Erosion was recorded at 6,711 transects, covering 208.5 miles (66% of the analyzed shoreline), while accretion was measured at 3,509 transects across 109 miles (34.3%).

As with past studies (**Table 2**), areas where erosion rates frequently fluctuate above North Carolina's average (-2 ft/yr) often exhibit setback factor variations of 1 foot, ½ foot, or more between assessments. Despite using least squares regression for these calculations, the results remain highly consistent when compared to the end-point method and previous studies.

Across the total 318 miles of analyzed shoreline, compared to the current effective setback factors (2020), updating erosion rate setback factors using least squares regression will result in:

- No change for 214.1 miles (67.3%) of shoreline

- A decrease in setback requirements for 74.1 miles (23.3%), ranging from 0.5 to 14 feet per year (average: 1.5 feet per year)
- An increase for 21.7 miles (7.8%), ranging from 0.5 to 35 feet per year (average: 3.0 feet per year). The largest setback values are found at inlets and capes.

Within the 2025 Ocean Erodible Areas (OEA), excluding the proposed 2025 updated Inlet Hazard Areas (IHA), setback requirements will remain unchanged for 201.4 miles relative to 2020 requirements (**Table 3**). Meanwhile, 70.3 miles will experience a decrease in setback factors ranging from 0.5 to 14 feet per year (average: 1.5 feet per year), while 12.6 miles will see an increase between 0.5 and 32 feet per year (average: 3.0 feet per year).

Focusing segments of developed shorelines only (144.6 miles), within the OEA, and *excluding* the proposed 2025 IHA updated boundaries:

- 124.9 miles (86%) will see no change
- 17.7 miles (12%) will experience a decrease between 0.5 and 3.5 feet per year (average: 1.0 foot)
- 2.0 miles (2%) will see an increase between 0.5 and 3.5 feet per year (average: 1.0 foot)

| Parameter | Lengths of shoreline for each parameter | |
|---|---|---------------------------------|
| | End-Point Method | Least Squares Regression Method |
| | Miles of Shoreline (%) | Miles of Shoreline (%) |
| Miles of Shoreline Mapped & Analyzed | 317.8 | 317.8 |
| Measured Accretion | 109 (34.3%) | 99.2 (31.2%) |
| Measured Erosion | 208.5 (65.6%) | 218 (68.6%) |
| No Change or No Output (no data) | 0.3 (<1%) | 0.6 (<1%) |
| Setback Factor = 2.0 | 196.8 (61.9%) | 193.7 (61%) |
| Setback Factor = 2.5 to 5.0 | 63.8 (20.1%) | 66.5 (20.9%) |
| Setback Factor = 5.5 to 8.0 | 34.1 (10.7%) | 33.7 (10.6%) |
| Setback Factor > 8.0 | 23.1 (7.2%) | 23.8 (7.5%) |

Table 1. This table presents the length and percentage of the total shoreline, comparing the calculated erosion rate setback factors determined by both the least squares and end-point methods. It is important to note that the minimum setback factor is 2, as defined in Rule 15A NCAC 07H.0306. A setback factor of 2 indicates that erosion is either less than -2.4 feet per year or that accretion was measured. Setback factors greater than 2 correspond to calculated erosion rates.

| Statewide Summary | 2025 Miles (% of total) | 2020 Miles (% of total) | 2013 Miles (% of total) | 2004 Miles (% of total) | 1997 Miles (% of total) | 1986* Miles (% of total) | 1980* Miles (% of total) |
|---|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|---------------------------------------|---------------------------------------|
| Miles of Shoreline Mapped/Analyzed | 317.8 | 304.5 | 307.4 | 312 | 300 | 237* | 245* |
| Setback Factor (2 ft/yr.) | 193.7 (61%) | 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.) | 66.5 (20.9%) | 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.) | 33.7 (10.6%) | 38.7 (12.7%) | 31.5 (10.2%) | 28 (9%) | 30 (10%) | 20 (8%) | 22 (9%) |
| Setback Factor (>8.0 ft/yr.) | 23.8 (7.5%) | 22.7 (7.4%) | 20.8 (6.8%) | 27 (8%) | 32 (10.7%) | 22 (9%) | 22 (9%) |
| No Data | 0.0 | 1.4 (<0.5%) | 2.8 (<1%) | 0 | 19 (6%) | 8 (4%) | 0 |

Table 2. This table presents a summary of length of analyzed shoreline and blocked shoreline change rates (Setback Factors) relative to previous studies dating back to 1980. Where the study year is marked with an asterisk (*), the total shoreline length is lower because either some or all the National Seashore was not mapped and analyzed (e.g., Shackleford Banks, Core Banks).

| Study Update | No Change miles (%) | Increase miles (%) | Decrease miles (%) |
|-------------------|---------------------|--------------------|--------------------|
| From 2020 to 2025 | 124.9 (86%) | 2 (1.4%) | 17.7 (12%) |
| From 2013 to 2020 | 120.5 (86%) | 20.3 (14%) | 3.8 (2.6%) |
| From 2004 to 2013 | 118.3 (82%) | 10.3 (7%) | 16 (11%) |
| From 1997 to 2004 | 111.6 (77%) | 10.4 (7%) | 22.6 (16%) |

Table 3. This table compares the total length of developed shoreline (144.6 miles) with the distances and percentages of shoreline that experienced no change, increased change, or decreased change in setback requirements when transitioning from the effective rate to the updated rate since 1997. It is important to note that these comparisons are relative to developed shoreline within the 2025 OEA, excluding areas within the proposed 2025 IHA update boundary.

The following sections present a comparison of end-point and least squares regression methods, supplemented with graphs and maps for visualization. While all data are included, setback factors are displayed on maps only within the Ocean Erodible Area (OEA) in relation to the proposed 2025 updates to Inlet Hazard Areas. Graphs show setback factors for each shoreline section, but mapped setback factors are limited to OEAs. For setback factors within the proposed 2025 Inlet Hazard Areas, refer to the report titled *NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update*.

In areas where erosion rates are less than -2 feet per year or where accretion occurs, the minimum setback factor defaults to 2 feet per year, per Rule NCAC 15A 07H.0304(1). Although setback factors are recorded as positive values, they directly correspond to erosion rates, particularly when exceeding -2 feet per year. For example, a setback factor of 3 indicates a shoreline section with a long-term average annual erosion rate between -2.6 and -3.4 feet per year.

3.1 Bird Island to Sunset Beach:

Bird Island and Sunset Beach are North Carolina's southernmost beaches and are 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. Several factors have had significant influences in defining today's shoreline position; a navigation jetty constructed at Little River inlet (left side of graph) between 1981 and 1983, closing of Madd inlet in 1998 (transect IDs 35-40) which separated Bird Island from Sunset Beach, and artificially relocation of Tubbs Inlet in 1970 farther east (closer to Ocean Isle).

The analysis examined twenty-two shorelines (**Figure 9**) along this oceanfront section over an 87-year period, from 1933 to 2020. During this time, shoreline movement varied considerably, with the shoreline envelope, representing the range of movement along each transect, spanning from a minimum of 310 feet to a maximum of 2,829 feet, averaging 917 feet. A relative standard deviation of 113 feet highlights the broad dispersion of shoreline positions, which have been primarily influenced by the proximity to the Little River Inlet navigation jetty, Tubbs Inlet (both its current and former locations), and the now-closed Mad Inlet. These features have collectively shaped shoreline dynamics, affecting sediment transport and long-term coastal changes. Despite these fluctuations, much of the beach has experienced a net gain in sediment, leading to overall beach accretion over time.

For comparison, both the end-point and least squares regression methods produced similar results, with the end-point method yielding an average shoreline change of +6.7 feet per year and the least squares regression method averaging +6.2 feet per year (**Figure 10**). Both approaches resulted in blocked erosion rate setback factors of two (2), aligning with previous studies for this section of shoreline.

Transitioning to the least squares regression methodology provides a more accurate representation of long-term shoreline movement; however, it does not significantly impact the updated setback factors relative to earlier studies (**Figure 11 to Figure 14** and **Table 4**). Using this method, the calculated setback factors for both Bird Island and Sunset Beach remain at two feet

per year, with no increases. For setback factors within the proposed updated Inlet Hazard Area, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

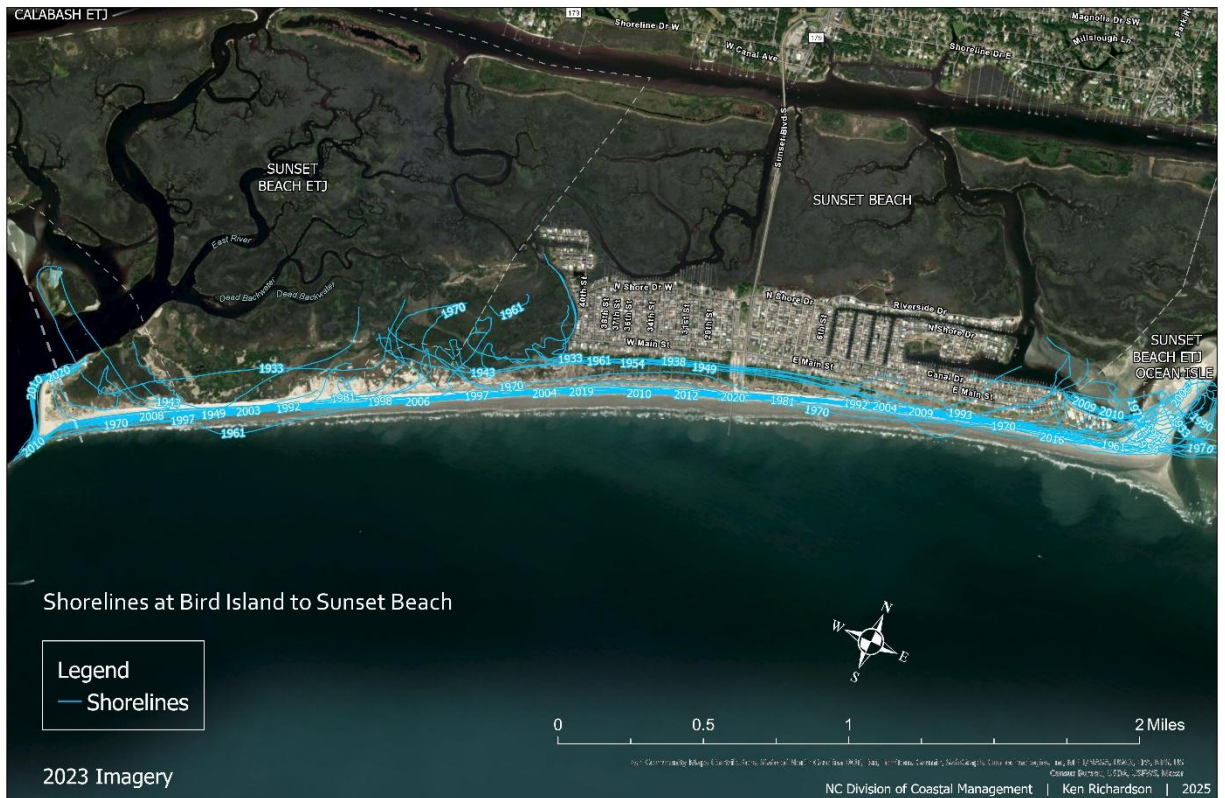


Figure 9. Shorelines included in the analysis (1933-2020) at Bird Island and Sunset Beach.

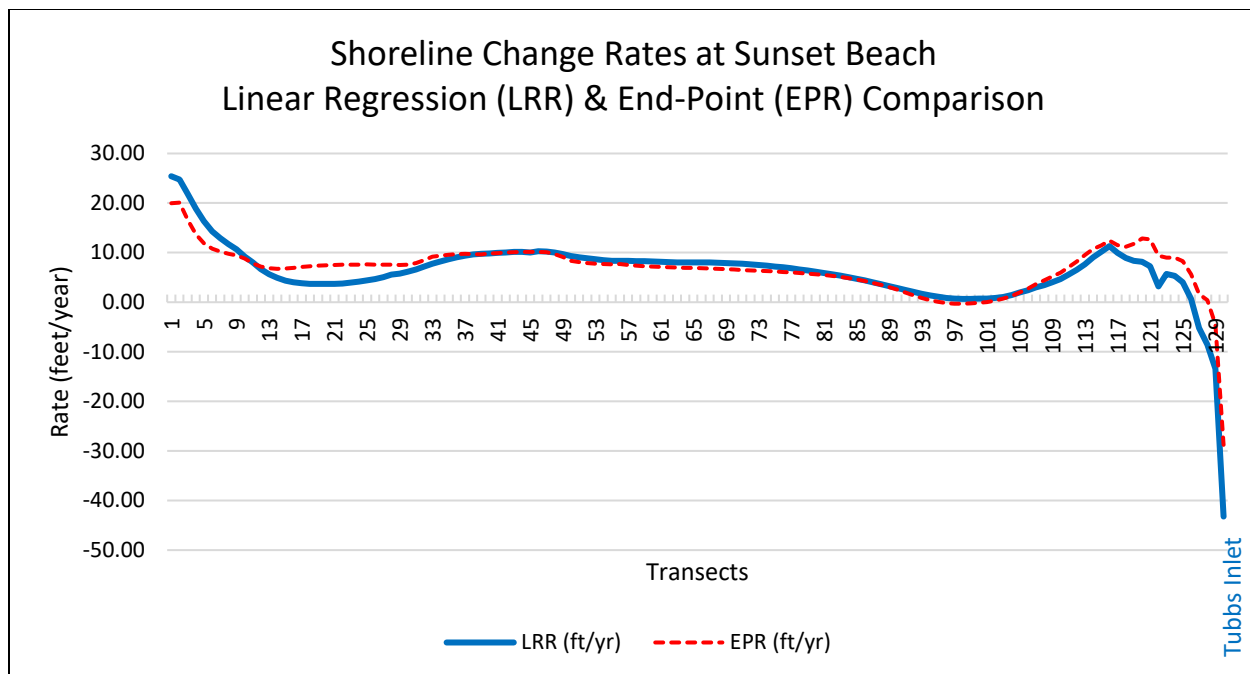


Figure 10. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

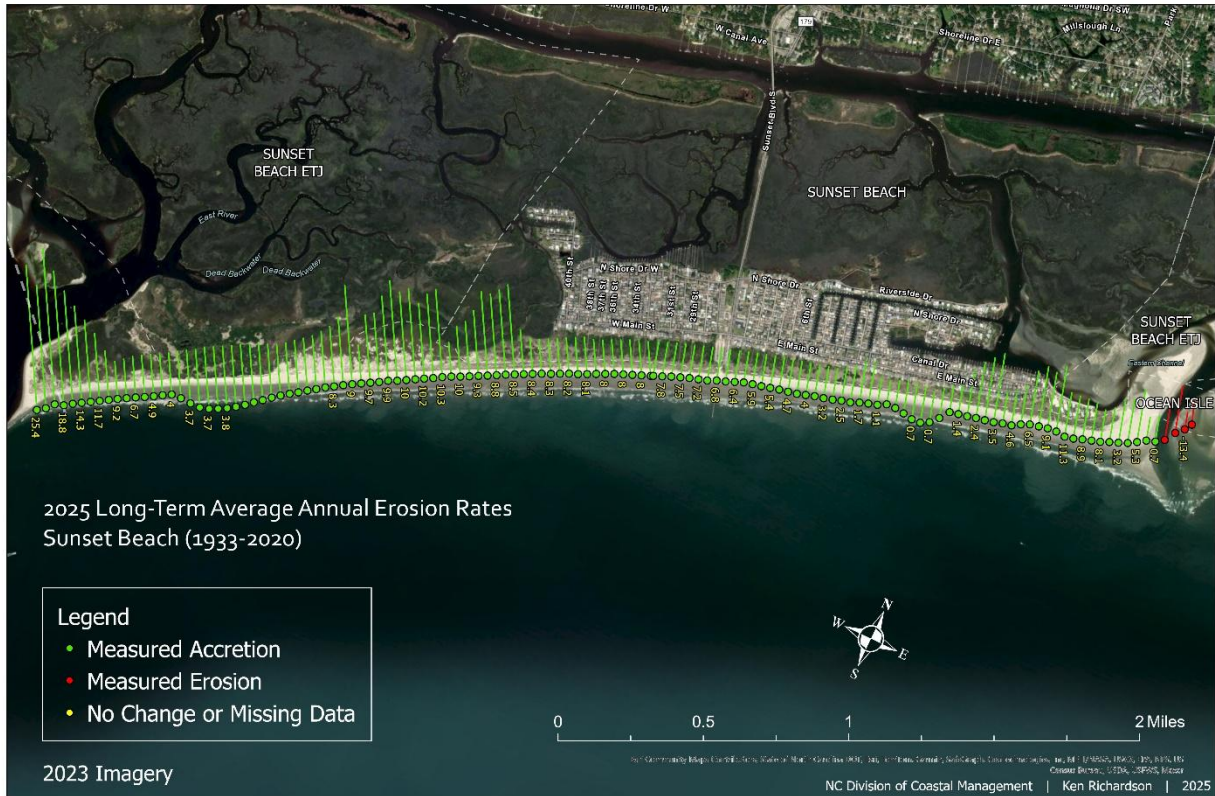


Figure 11. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

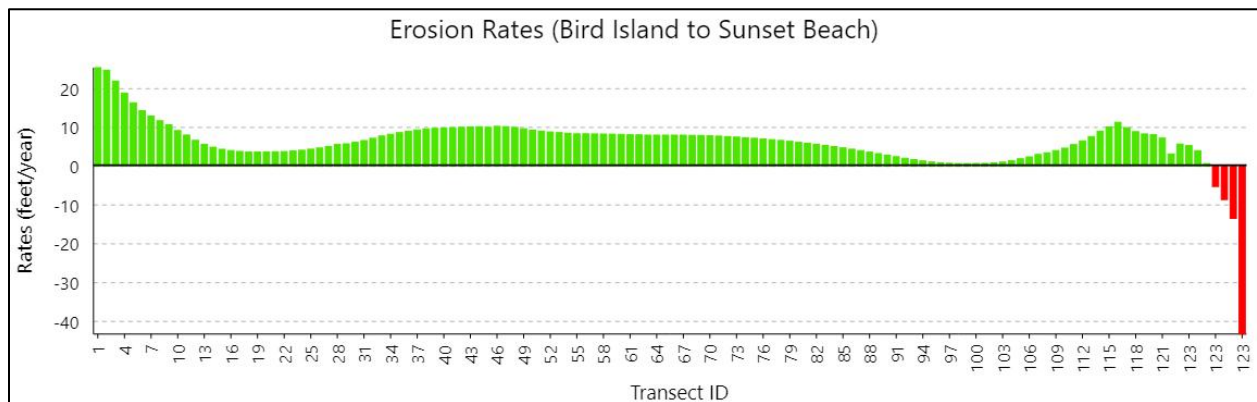


Figure 12. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

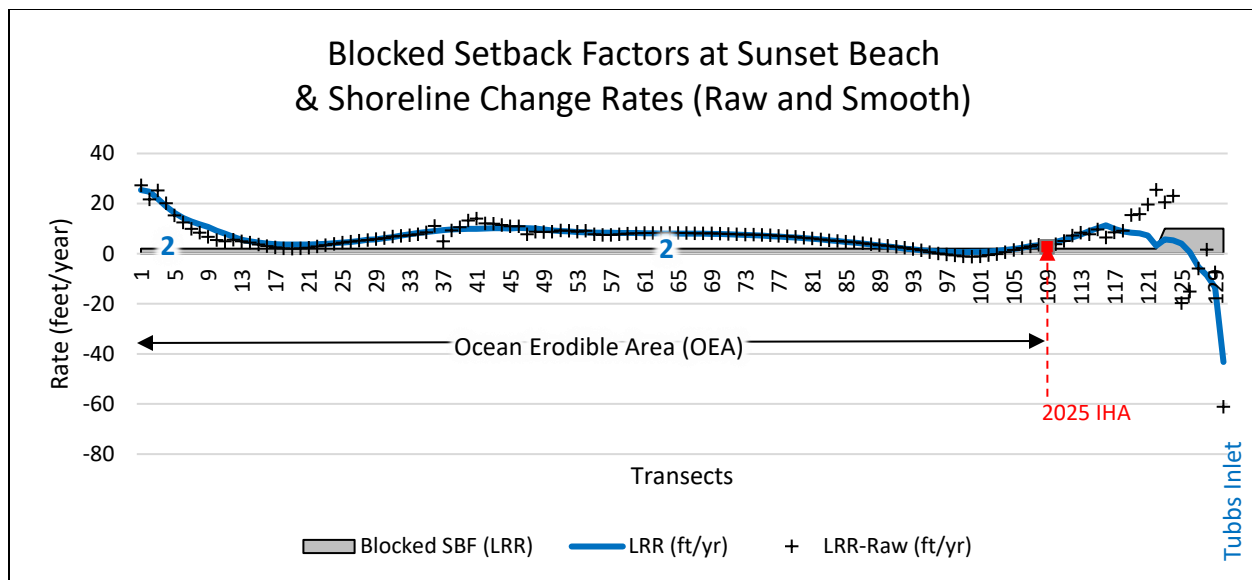


Figure 13. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

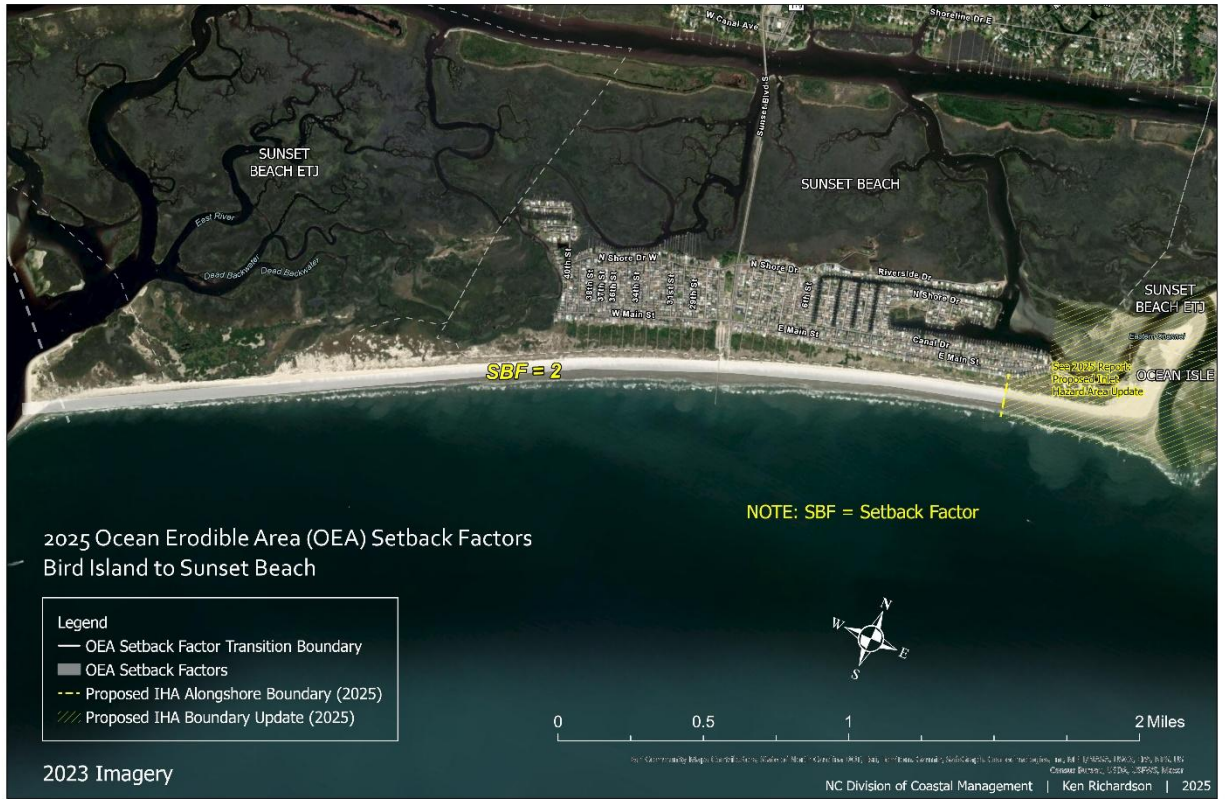


Figure 14. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Bird Island and Sunset Beach. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|------|------|------|
| SBF = 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

Table 4. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.2 Ocean Isle Beach

Ocean Isle Beach features a low-sloping, south-facing shoreline spanning approximately 5.7 miles. Since 1974, the oceanfront shoreline has undergone varying degrees of beach

nourishment. The first large-scale nourishment project, exceeding 300,000 cubic yards, took place in 2001 as part of the Federal Coastal Storm Damage Reduction (CSDR) initiative between transects 180 and 284. This was followed by routine maintenance in 2006, 2009, 2014, 2018, 2021, and 2022 across different sections of the same area. Additionally, a terminal groin was installed in 2022 to address high erosion rates at Shallotte Inlet. While the structure is designed to reduce erosion on its western side, further time and data are required to fully evaluate its effectiveness.

The analysis assessed twenty-nine shorelines along this oceanfront section over an 87-year period, from 1933 to 2020 (**Figure 15**). Since 2001, shoreline positions have been artificially influenced by regular beach nourishment. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 115 feet (oceanfront) to a maximum of 1,847 feet (inlet), with an average of 383 feet for the entire shoreline between Tubbs and Shallotte Inlets. However, within the oceanfront area between the 2025 proposed updated Inlet Hazard Areas, specifically between transects 136 and 270, the shoreline envelope varied from 114 to 335 feet, averaging 244 feet. This contrast highlights the differing influences of oceanfront and inlet dynamics on shoreline position. For these same areas, the calculated average relative standard deviation of shoreline position was 108 feet overall and 68 feet for the oceanfront section alone. Of the 5.7 miles of shoreline analyzed, approximately 2.1 miles (37%) resulted in measured erosion where rates averaged -4.4 feet per year adjacent to Tubbs and Shallotte Inlets.

For comparison, both the end-point and least squares regression methods produced similar results. The end-point method indicated an average shoreline change of less than 1 foot per year, while the least squares regression method yielded a similar rate of less than 1 foot per year. Within the oceanfront area between the 2025 proposed IHA boundaries (transects 136 to 270), the end-point method calculated an average change of 1.4 feet per year, whereas the least squares regression method estimated 1.7 feet per year (**Figure 16**). Both approaches result in a blocked erosion rate setback factor of two (2), consistent with previous studies for this section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement; however, it does not impact on the updated setback factors compared to previous studies. Using this approach, the calculated setback factors for Ocean Isle’s oceanfront, between the 2025 proposed updated Inlet Hazard Areas (approximately transects 136 to 270), remain at two feet per year, with no increases (**Figure 15** to **Figure 20**, and **Table 5**). For setback factors within the proposed updated Inlet Hazard Area, refer to the report titled *NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update*.

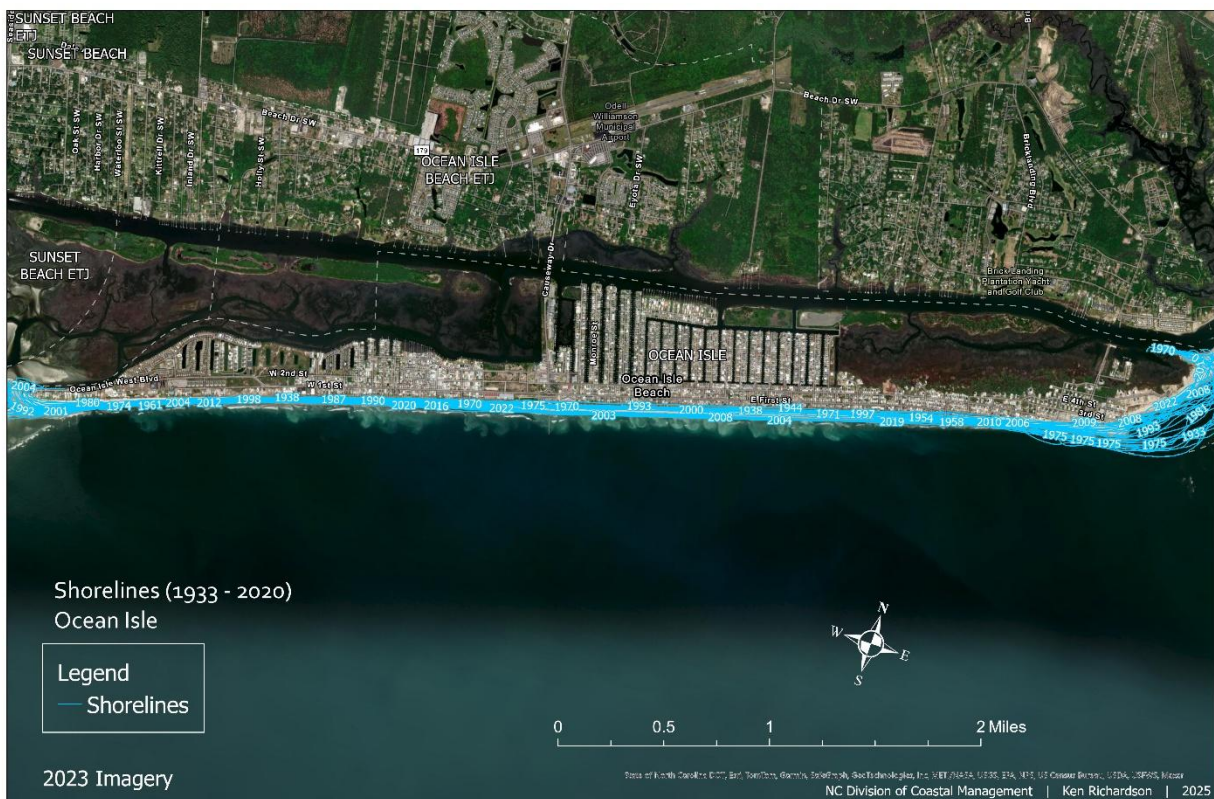


Figure 15. Shorelines included in the analysis: 1933, 1938, 1944, 1954, 1958, 1961, 1970, 1974, 1975, 1980, 1981, 1987, 1990, 1992, 1993, 1997, 1998, 2000, 2001, 2003, 2004, 2006, 2008, 2009, 2010, 2012, 2016, 2019, and 2020.

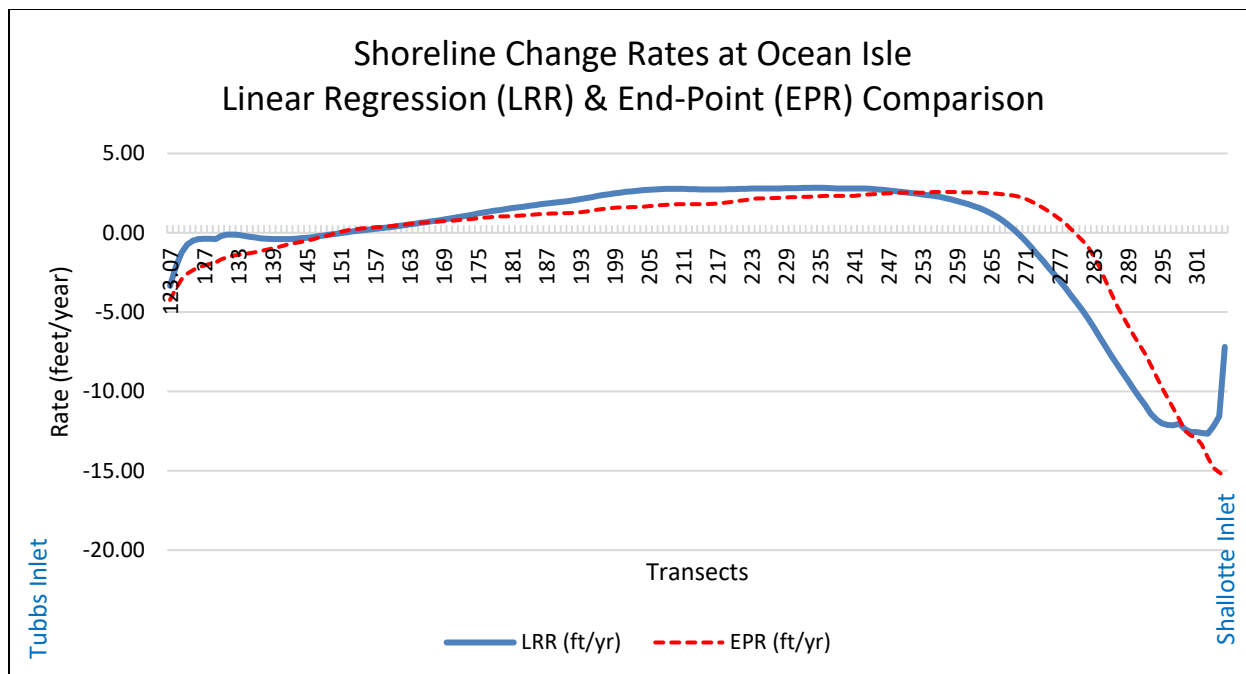


Figure 16. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

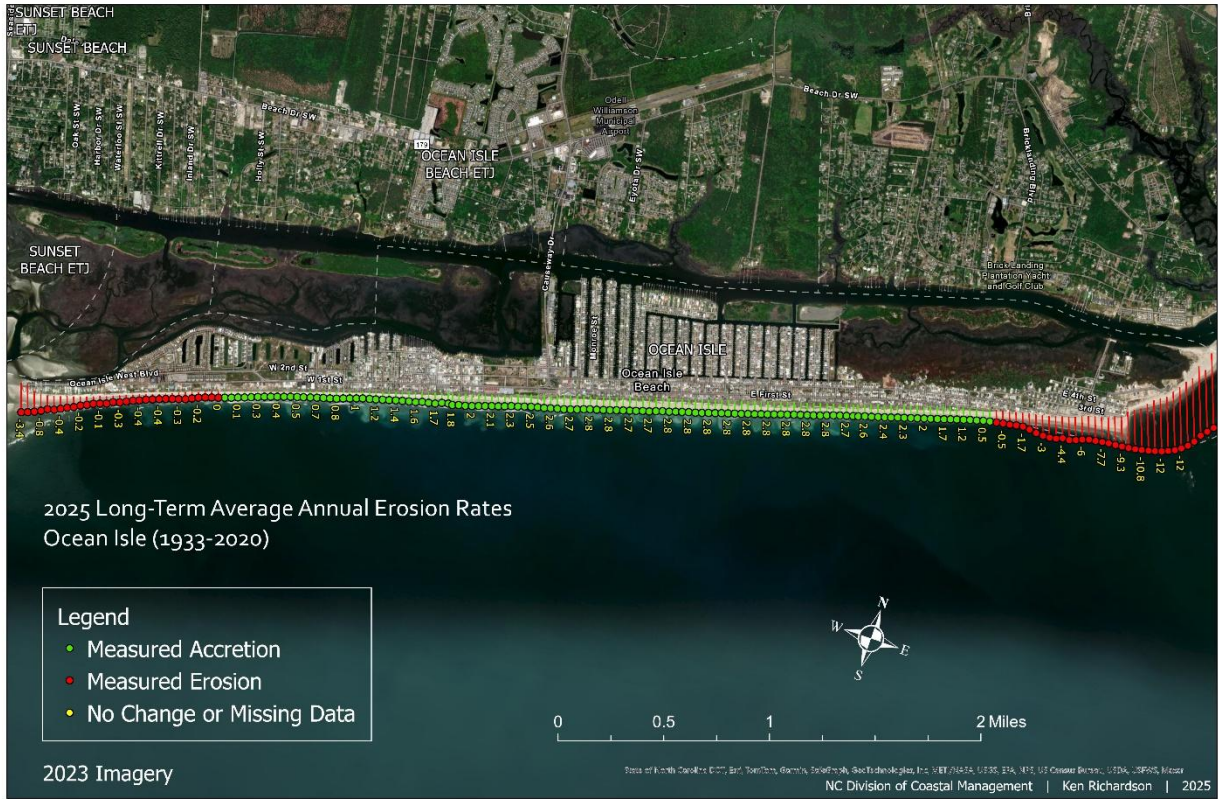


Figure 17. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

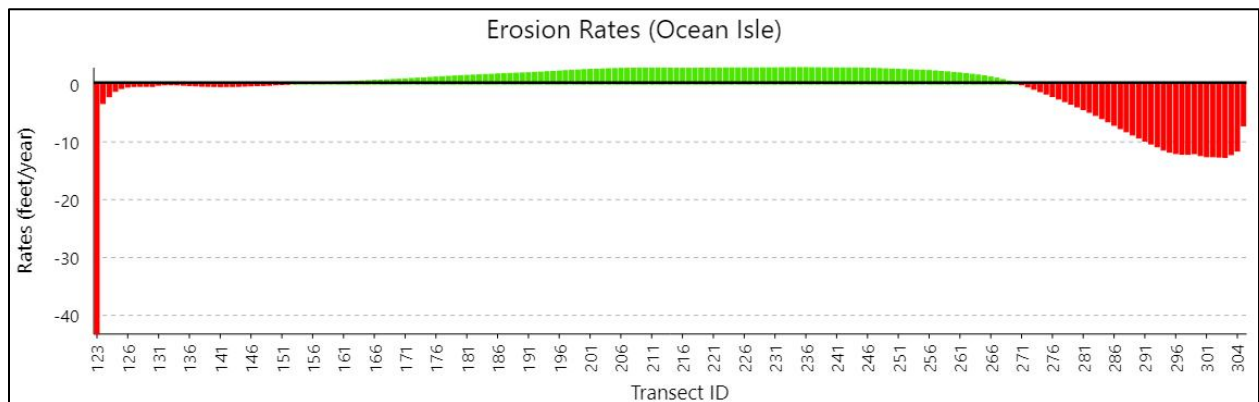


Figure 18. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

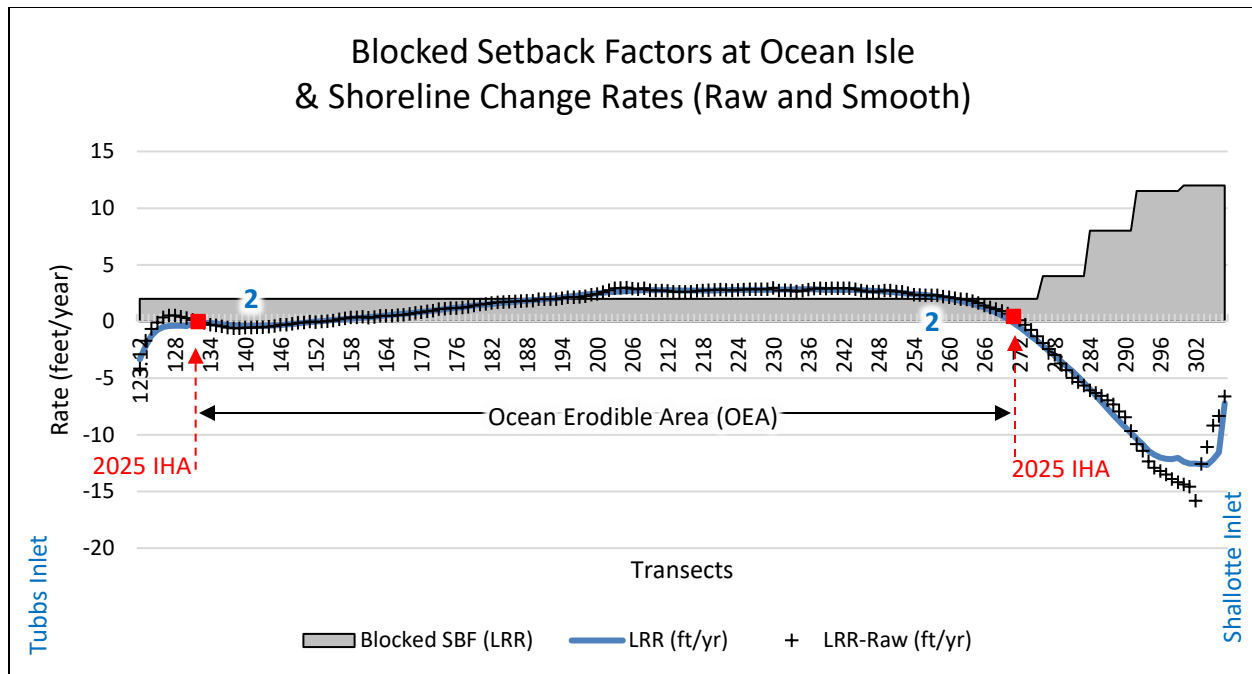


Figure 19. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors). For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

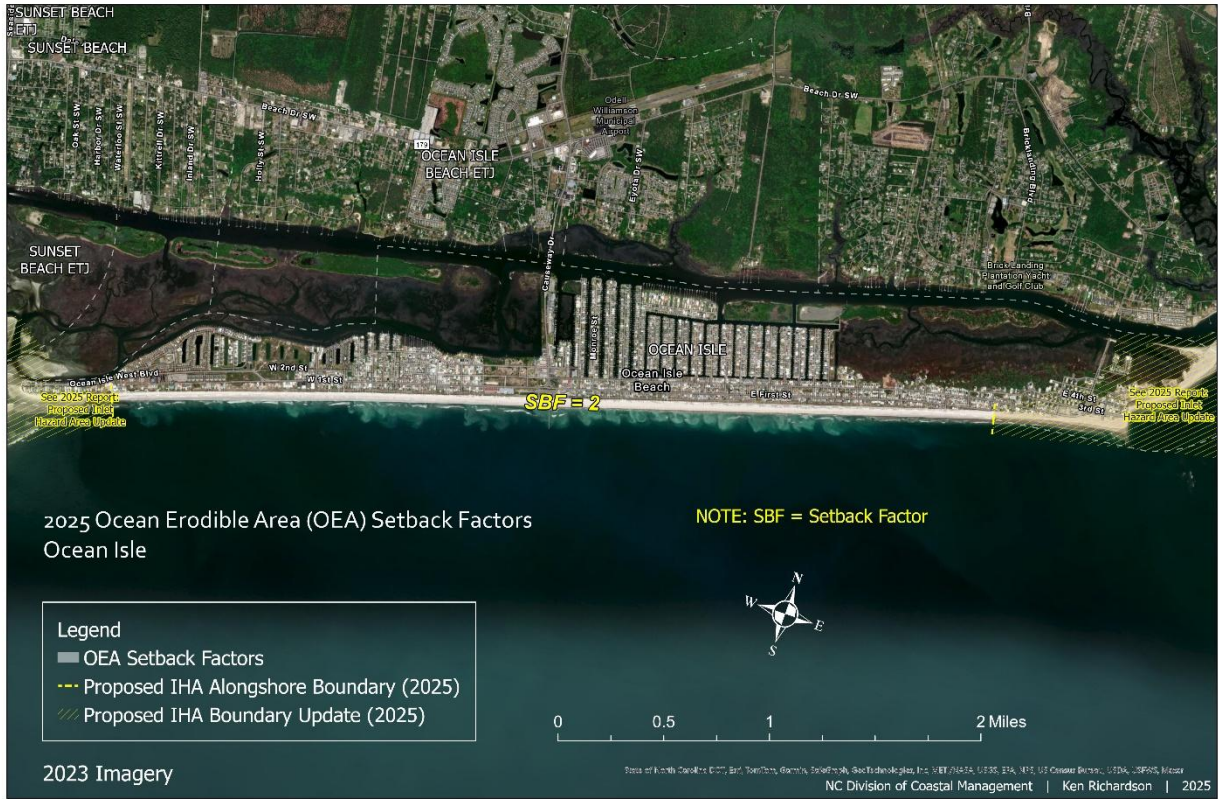


Figure 20. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Ocean Isle. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2 | 2, 3 | 2 | 2 |

Table 5. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.3 Holden Beach

Holden Beach is considered low sloping and a south-facing, with approximately 8.0 miles of oceanfront shoreline. The first large-scale beach nourishment, involving over 300,000 cubic yards of sand, took place in 2001 as part of the Federal Coastal Storm Damage Reduction (CSDR) project between transects 395 and 542, and has been followed by routine maintenance efforts in 2006, 2009, 2014, 2018, 2021, and 2022 along various portions of the same section of shoreline.

The analysis assessed twenty-four shorelines (**Figure 21**) along this oceanfront section over an 87-year period, from 1933 to 2020. Since 2001, shoreline positions have been artificially influenced by regular beach nourishment. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 109 feet (oceanfront) to a maximum of 1,619 feet (inlet), with an average of 357 feet for the entire shoreline between Shallotte and Lockwood Folly Inlets. However, within the oceanfront area between the 2025 proposed updated Inlet Hazard Areas, specifically between transects 370 and 537, the shoreline envelope varied from 109 to 362 feet, averaging 179 feet. This contrast highlights the differing influences of oceanfront and inlet dynamics on shoreline position. For these same areas, the calculated average relative standard deviation of shoreline position was 103 feet overall and 49 feet for the oceanfront section alone. Of the 8.0 miles of shoreline analyzed, approximately 5.5 miles (69%) resulted in measured erosion where rates averaged less than -2 feet per year.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 22**). The end-point method indicated an average shoreline change of less than 1 foot per year, while the least squares regression method yielded a similar rate of less than 1 foot per year. Within the oceanfront area between the 2025 proposed IHA boundaries (transects 370 to 537), the end-point method calculated an average change less than 1 foot per year, and the least squares regression method estimated less than 1 foot per year. Both approaches measured erosion rates between -2.4 and -2.8 feet per year within the OEA, leading to a blocked erosion

rate setback factor of two (2), which is consistent with previous studies for most of the same section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement. For most of the shoreline (between transects 370 and 518) the updated setback factors continue to be 2 feet per year making it consistent with previous studies; however, for the section approaching the Lockwood Folly Inlet 2025 proposed updated IHA boundary, between transects 319 and 519), the setback factors will decrease from 3 and 4 to 2 feet per year. Using this approach, the calculated setback factors for Ocean Isle’s oceanfront, between the 2025 proposed updated Inlet Hazard Areas (approximately transects 370 to 537), remain at two feet per year (**Figure 23 to Figure 26 & Table 6**). For setback factors within the proposed updated Inlet Hazard Area, refer to the report titled *NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update*.

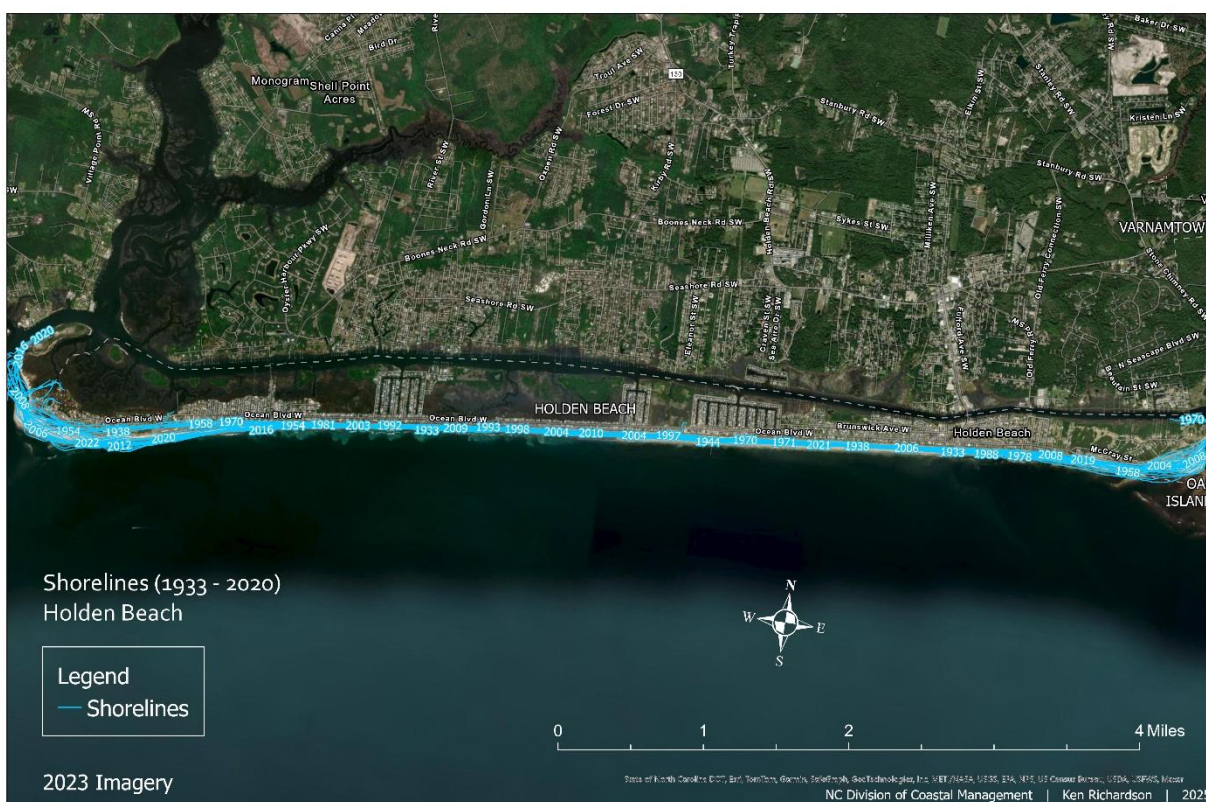


Figure 21. Shorelines included in the analysis (1933-2020) at Holden Beach.

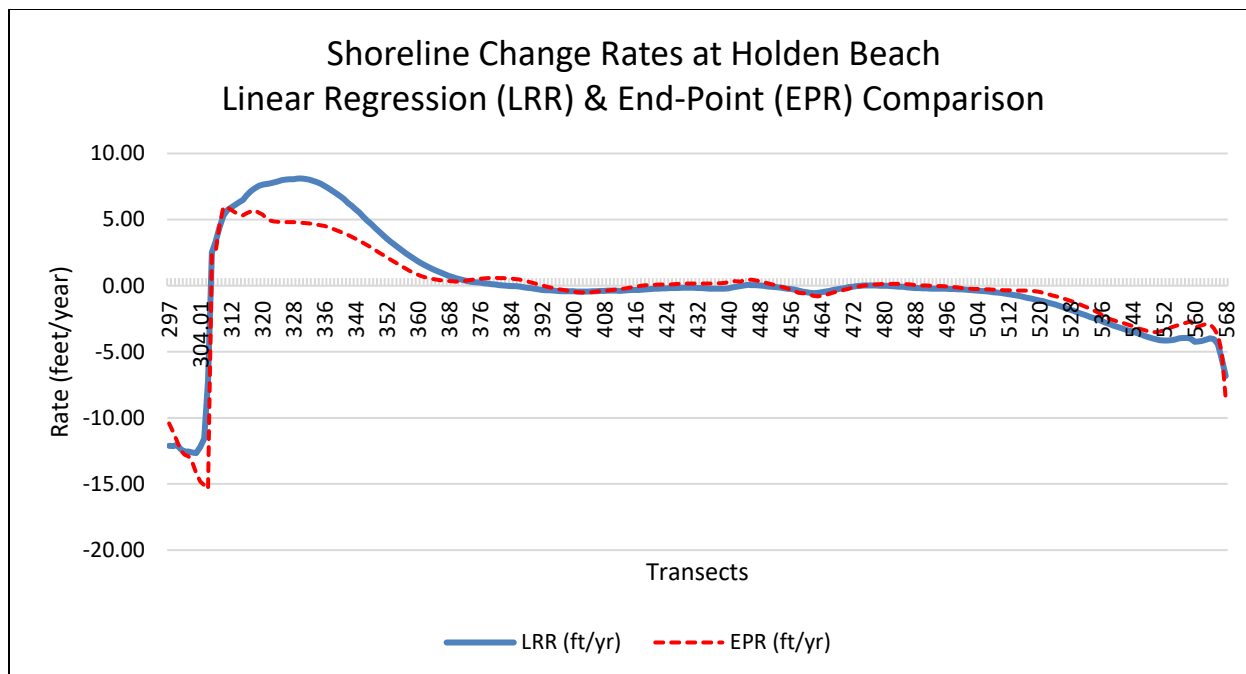


Figure 22. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

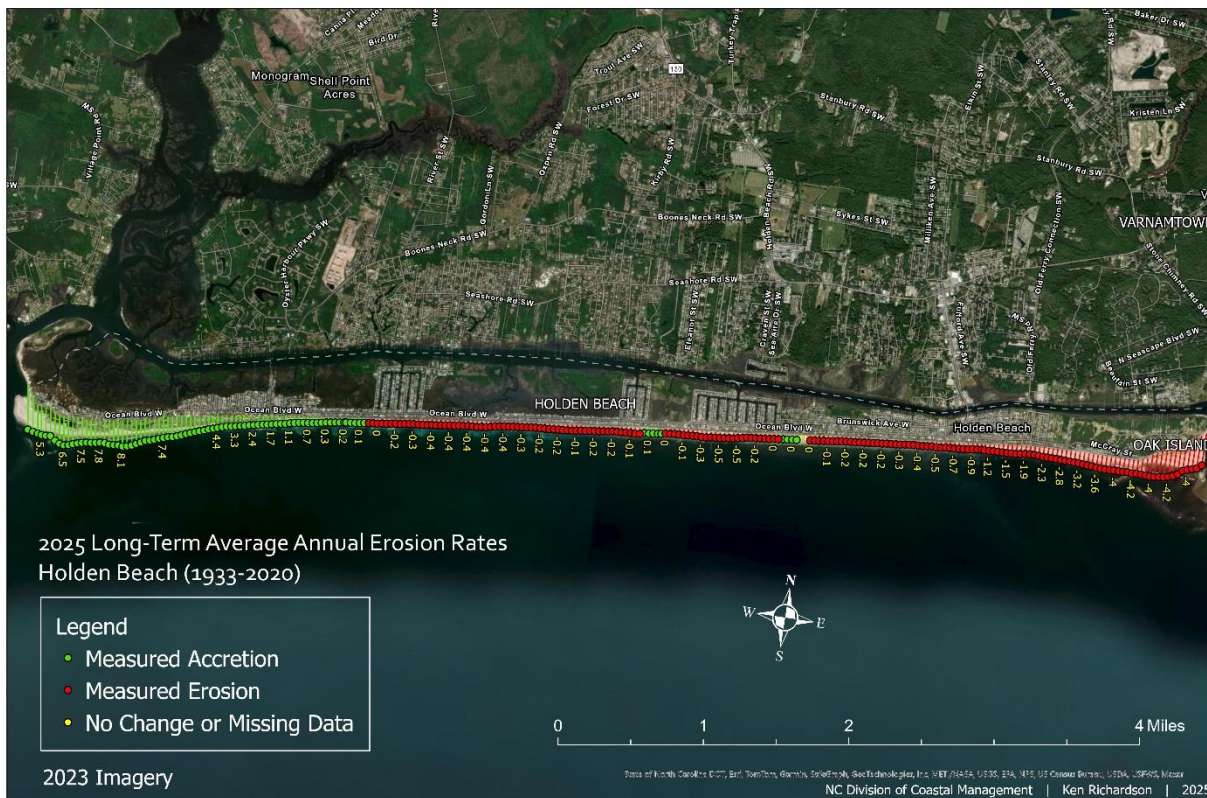


Figure 23. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

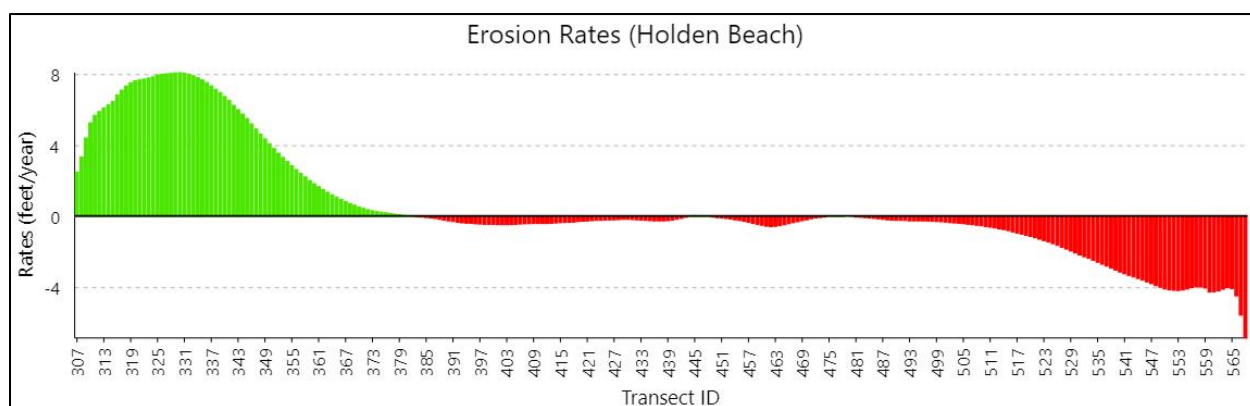


Figure 24. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

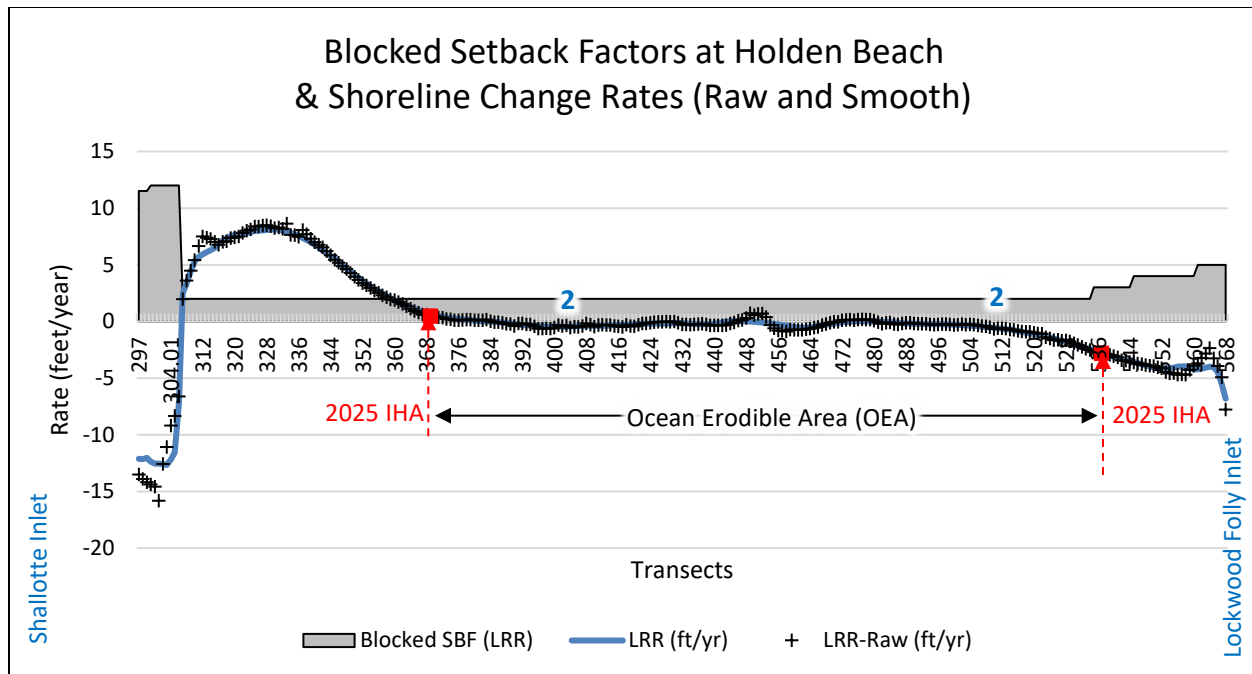


Figure 25. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

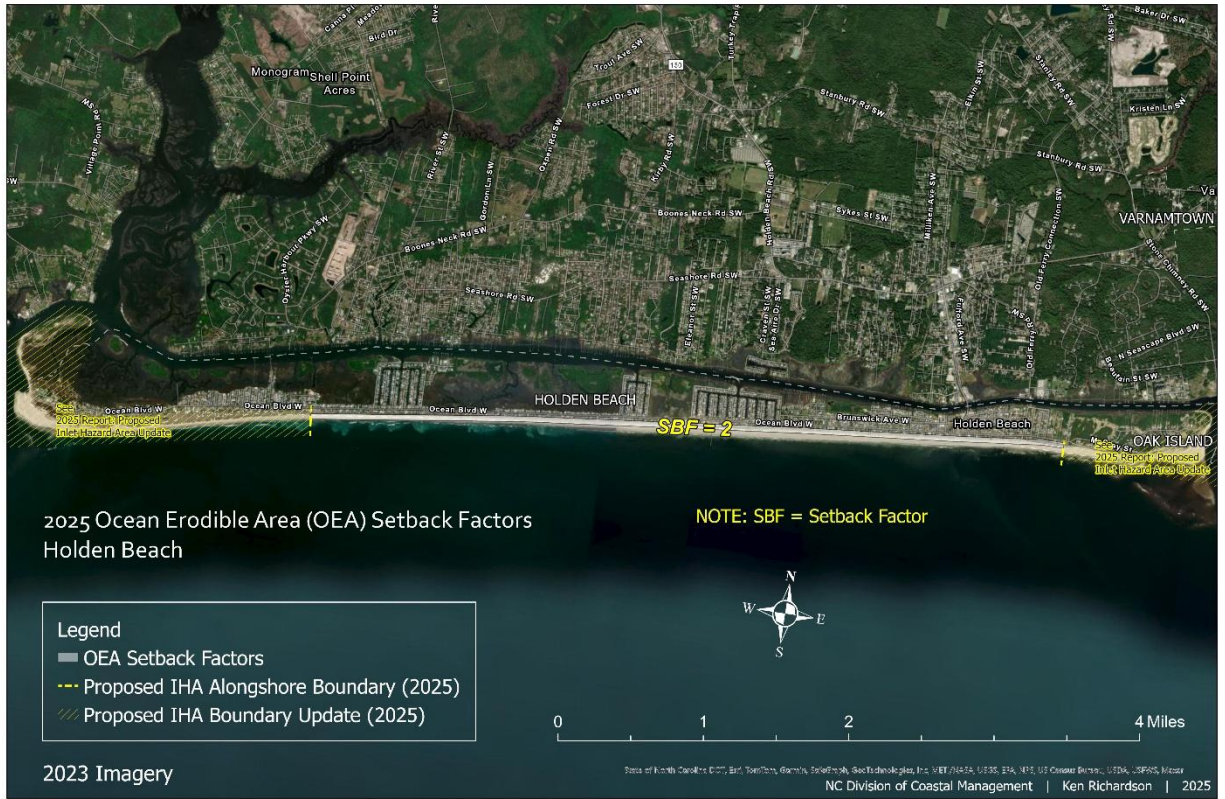


Figure 26. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Holden Beach. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|---------|---------------|-------------------|-------|------|------|------|
| Setback Factor (SBF) | 2 | 2,3 & 4 | 2, 2.5, & 3.5 | 2, 3, 4, 5, & 6.5 | 2 & 4 | 2 | 2 | 2 |

Table 6. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.4 Oak Island

The Town of Oak Island has a south-facing beach with approximately 9.3 miles of oceanfront shoreline. The Town installed its first large-scale beach nourishment project in 2001 where the western end of the project tapered off in the area just inside the proposed 2025 IHA boundary, approximately at transect 600. In 2019 and 2022, beneficial use of dredged material from the inlet, AIWW crossing and eastern channel was completed by the USACE's navigation initiatives resulting in material being placed along the western end of Oak Island stopping short of Lockwood Folly Inlet at near transect 577. Since 2001, several small-scale maintenance projects occurred in 2009, 2016, 2017, 2018, and 2019 for various segments of shoreline within the initial large-scale project area.

The analysis assessed thirty-five shorelines (**Figure 27**) along this oceanfront section over an 87-year period, from 1933 to 2020. Since 2001, shoreline positions have been artificially influenced by beach nourishment for portions of the beach. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 88 feet (oceanfront) to a maximum of 1,891 feet (inlet), with an average of 272 feet for the entire shoreline between Lockwood Folly Inlet and the Town's eastern limit near transect 869. Focusing specifically on the OEA, between transects-609 and -869, the shoreline envelope varied from 88 to 381 feet, averaging 218 feet. This contrast highlights the differing influences of oceanfront and inlet dynamics on shoreline position. For these same areas, the calculated average relative standard deviation of shoreline position was 66 feet overall and 55 feet for the oceanfront section alone. Of the 9.3 miles of shoreline analyzed, approximately 3.0 miles (32%) resulted in measured erosion where rates averaged less than -2 feet per year.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 28**). The end-point method indicated an average shoreline change of less than 1 foot per year, while the least squares regression method yielded a similar rate of less than 1 foot per year. Within the oceanfront area between transects 609 and 869, the end-point method calculated an average change less than 1 foot per year, and the least squares regression method

estimated to be less than 1 foot per year. Both approaches measure erosion rates less than 2 feet per year within the OEA, leading to a blocked erosion rate setback factor of two (2), which is consistent with previous studies for most of the same section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement. For most of the shoreline (between transects-609 and -869) the updated setback factors continue to be 2 feet per year making it consistent with the previous two studies (2020 and 2013); but it is lower in comparison to setback factors calculated for studies before 2013 (2004, 1997, 1986, 1983, and 1980) on the Town's eastern end between approaching SE 70th Street near transect 829. Using this method, the calculated setback factors for Oak Island's OEA, between transects 609 and 869, remain at two feet per year (**Figure 29 to Figure 32 & Table 7**). For setback factors within the proposed updated Inlet Hazard Area, refer to the report titled *NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update*.



Figure 27. Shorelines included in the analysis (1933-2020) at Oak Island.

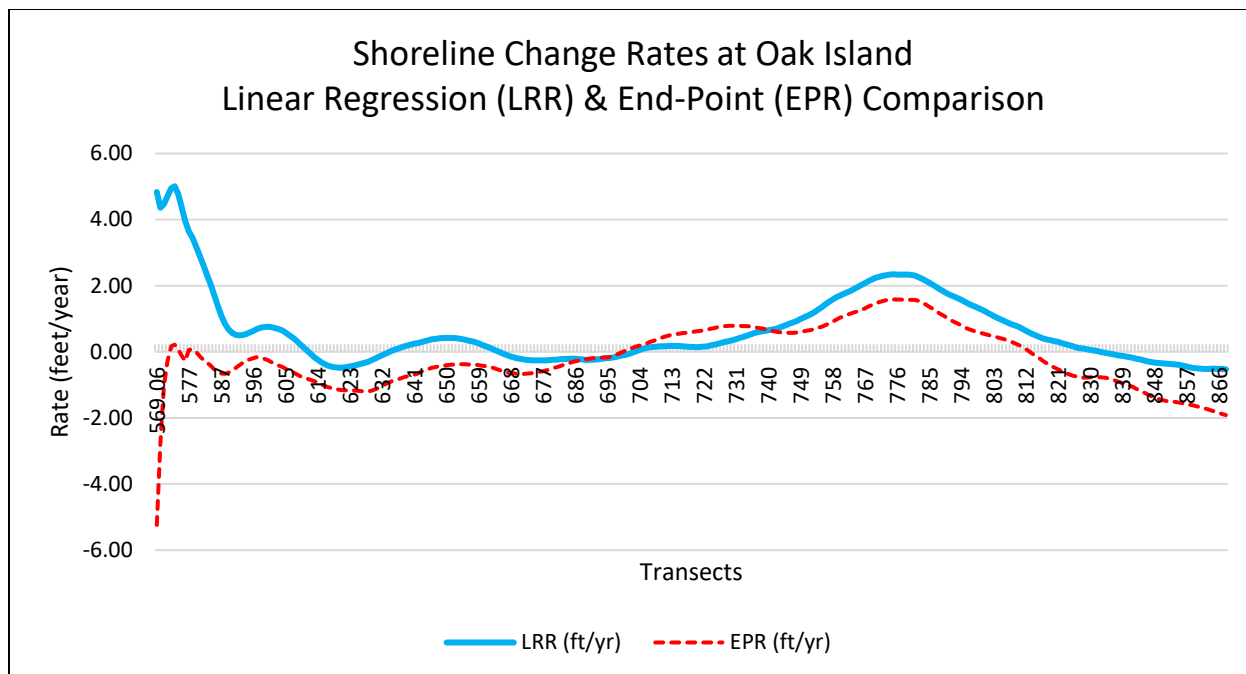


Figure 28. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

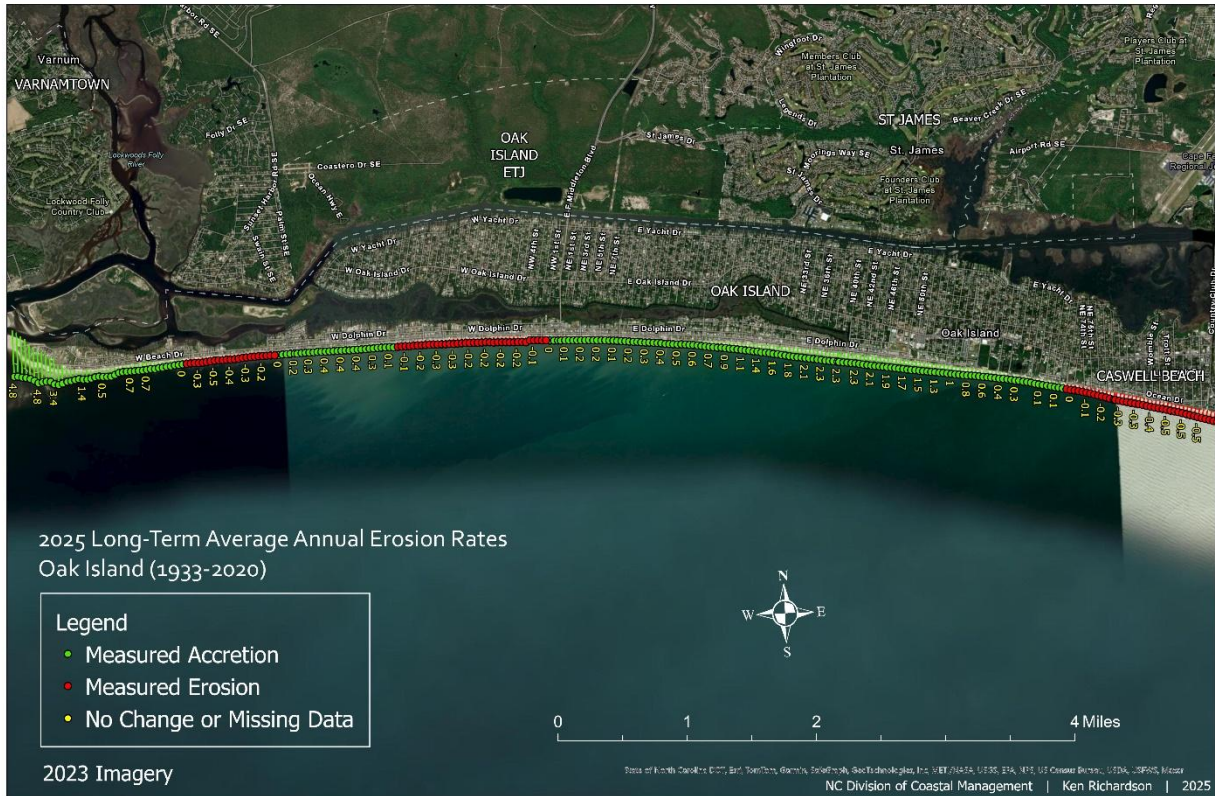


Figure 29. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

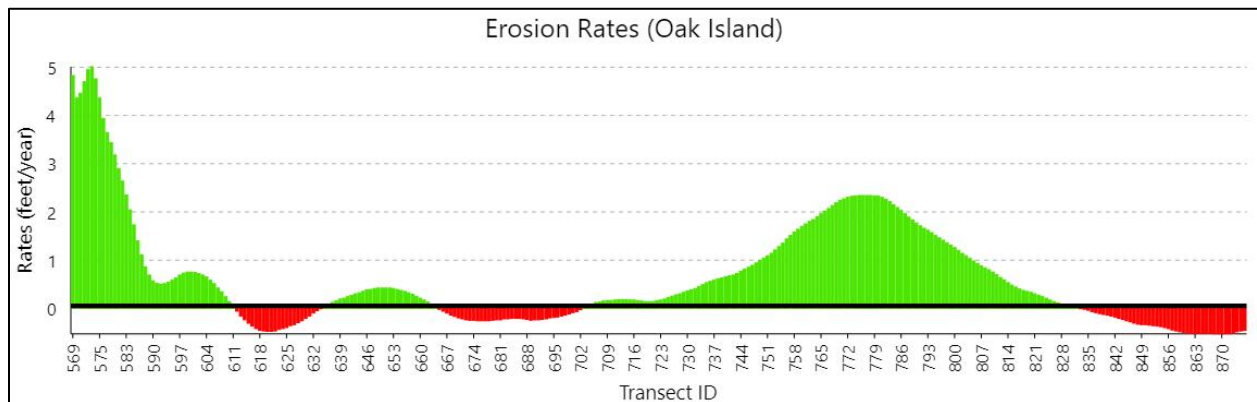


Figure 30. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

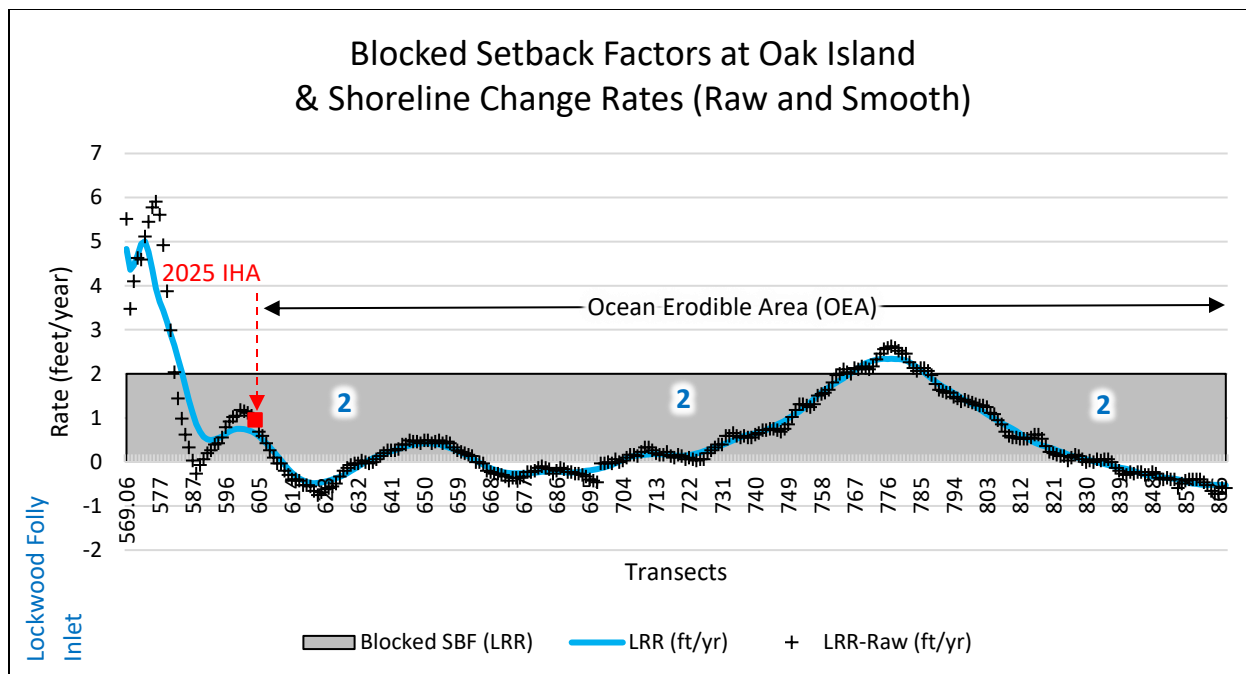


Figure 31. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

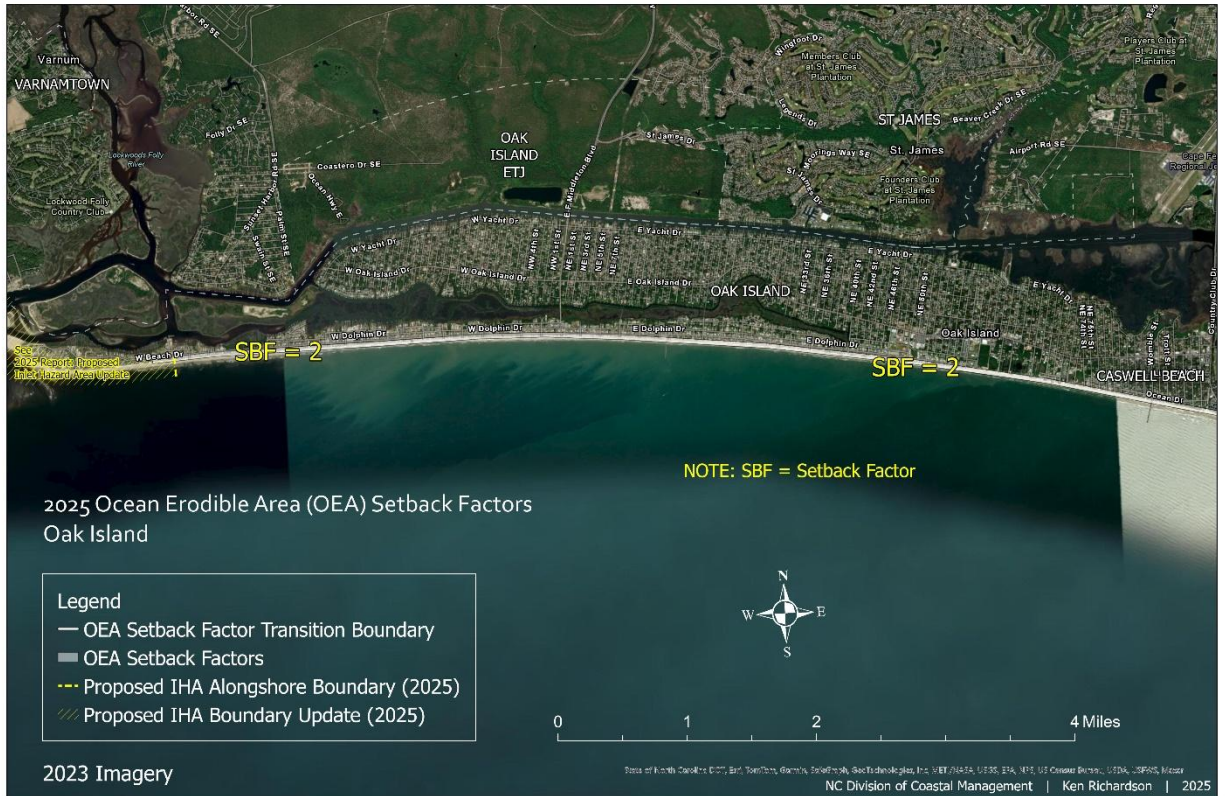


Figure 32. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Oak Island. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|--------------|---------------|-----------|-------------------|-------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2, 3, 4, & 5 | 2, 3, 4.5 & 6 | 2, 3, & 5 | 2, 3, 3.5, 4, & 5 | 2 & 5 |

Table 7. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.5 Caswell Beach and Fort Caswell

Caswell Beach and Fort Caswell have combined oceanfront shorelines totaling 3.5 miles. The Town is a recipient of sediment placed by the USACE through the Wilmington Harbor Sand Management Plan (SMP). In 2009, the Town received its first large-scale beach fill project along most of its oceanfront shoreline, followed by maintenance projects in 2018 and 2021.

The analysis assessed thirty-five shorelines (**Figure 33**) along this oceanfront section over an 86-year period, from 1934 to 2020. Since 2009, shoreline positions have been artificially influenced by beach nourishment for portions of the beach. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 228 feet (oceanfront) to a maximum of 3,026 feet (inlet), with an average of 399 feet for the entire shoreline between Town's western limit near transect 869 to the Cape Fear Inlet. This contrast highlights the differing influences of oceanfront and inlet dynamics on shoreline position. For the same area, the calculated average relative standard deviation of shoreline position was 95 feet. Of the 3.5 miles of shoreline analyzed, approximately 4,000 feet (19%) resulted in measured erosion where rates averaged less than -2 feet per year.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 34**). The end-point method indicated an average shoreline change of +2 feet per year, and the least squares regression method yielded a similar rate of +2 feet per year also. Both approaches measure erosion rates less than 2 feet per year within the OEA, leading to a blocked erosion rate setback factor of two (2), which is consistent with previous studies for most of the same section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement. The updated setback factors continue to be 2 feet per year making it consistent with the previous two studies (2020 and 2013); but it is lower in comparison to setback factors calculated for studies before 2013 (2004, 1997, 1986, 1983, and 1980) on the Town's western end between transect 869 and 911 along Caswell Beach Road. Using this

method, the calculated setback factors for Caswell Beach and Fort Caswell, between transects 869 and 981, remain at two feet per year (**Figure 35 to Figure 38 & Table 8**).

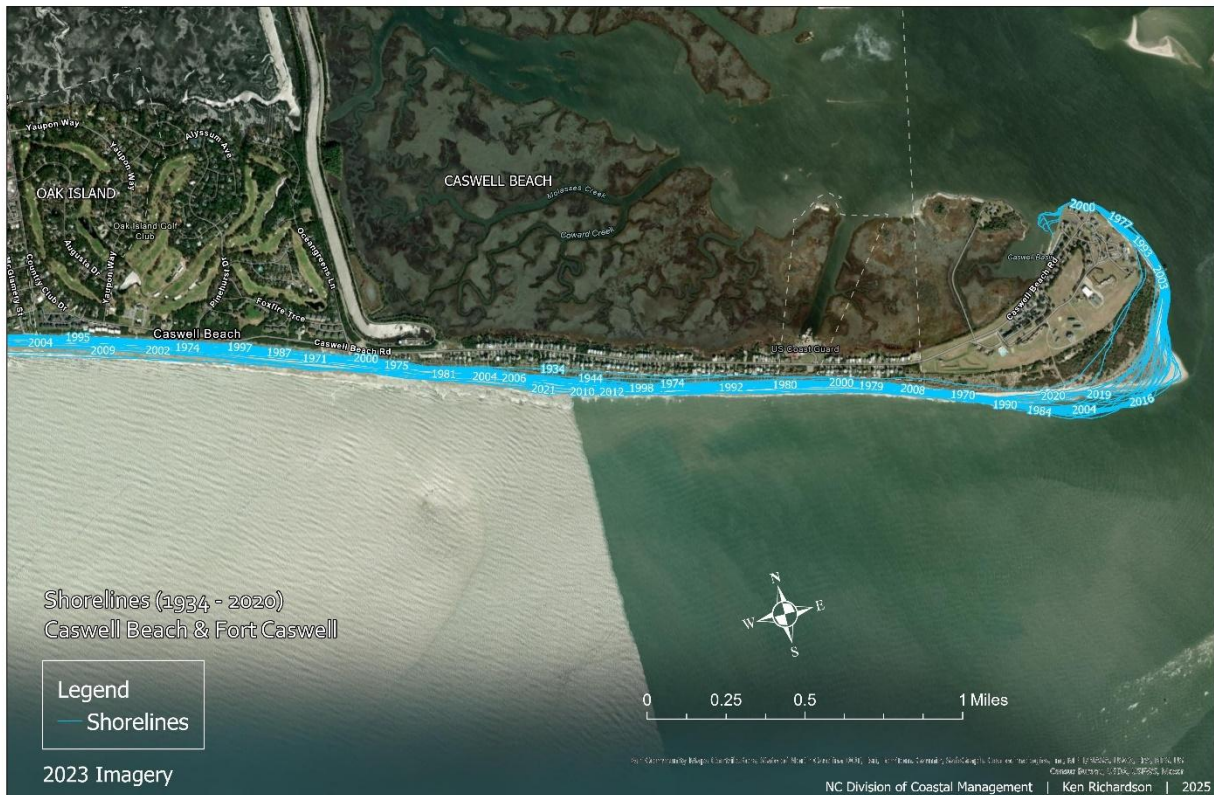


Figure 33. Shorelines included in the analysis (1934-2020) at Caswell Beach and Fort Caswell.

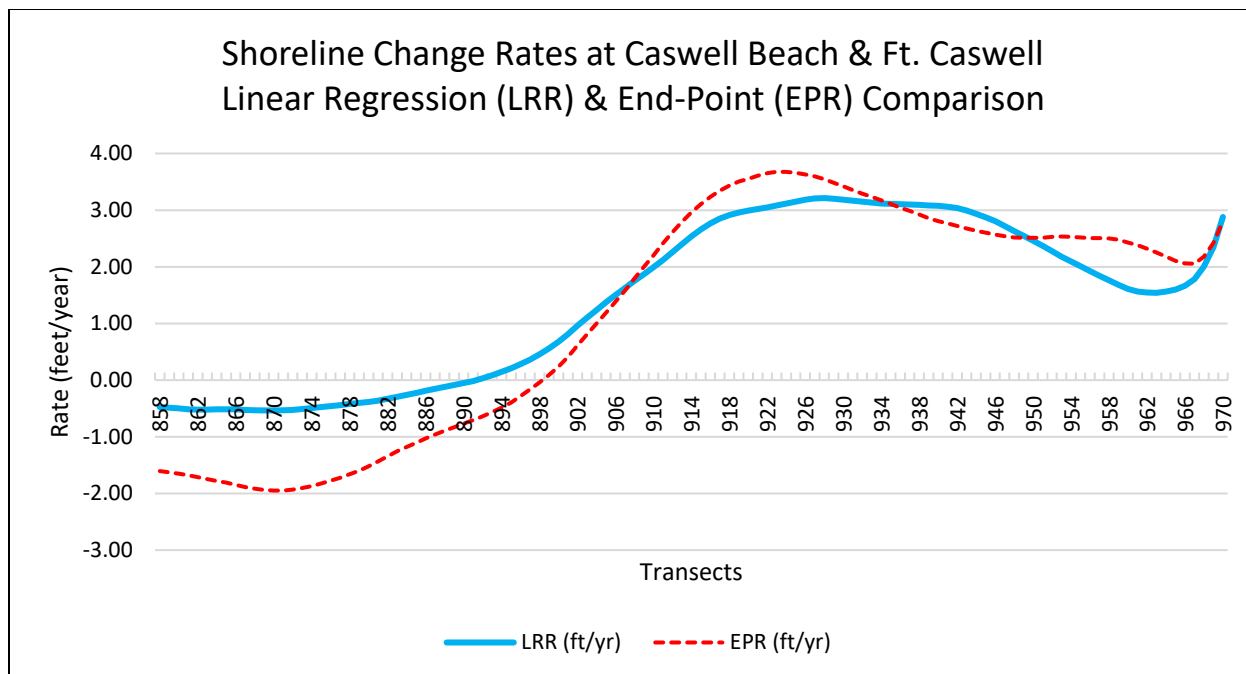


Figure 34. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 35. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

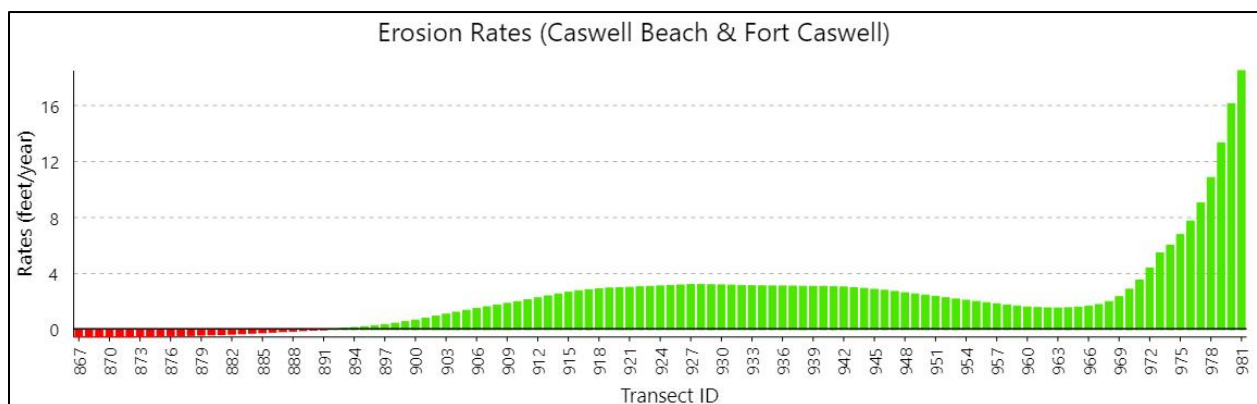


Figure 36. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

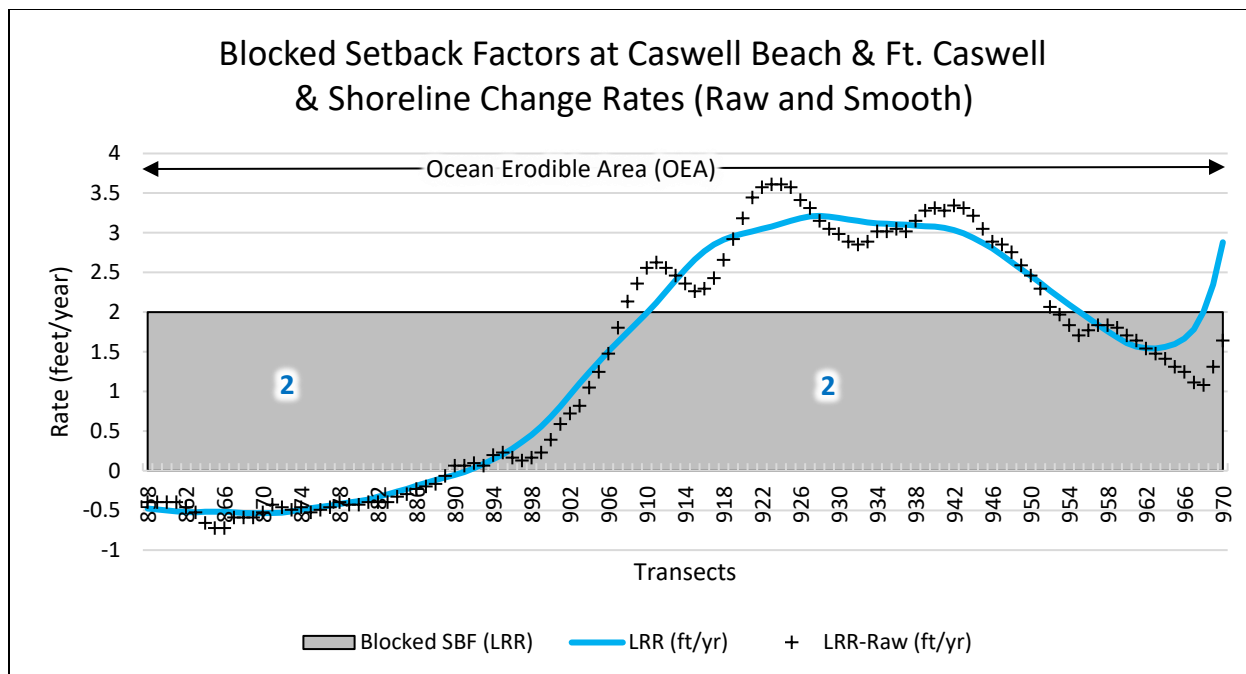


Figure 37. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 38. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Caswell Beach and Fort Caswell.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|---------|-------|-------|---------|-------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 & 3.5 | 2 & 4 | 2 & 4 | 2 & 3.5 | 2 & 5 |

Table 8. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.6 Bald Head Island (South-Beach)

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 has a history of being very dynamic as it is heavily influenced by inlet and cape processes, erosion mitigation efforts, and engineering practices (dredging, sandbags, terminal groin, groin tubes and beach nourishment). Starting in 1991 the Town installed its first small-scale beach fill project, followed by fourteen subsequent projects from 1996 to 2023. The Town installed its first large-scale beach fill project along its south-beach in 2007.

Since 1994, various erosion mitigation efforts have supplemented beach nourishment along south-beach, specifically adjacent to the Cape Fear Inlet. These began with the installation of a sandbag revetment, followed by the placement of sixteen soft groins (geotextile sandbag tubes) in 1996, along with ongoing rehabilitation and replacement efforts. Then a rock terminal groin was added in 2015, and in 2019, the remaining thirteen original geotextile sandbag tubes were removed and replaced. Collectively, these measures, along with routine beach nourishment, appear to have slightly reduced erosion rates along the approximately half mile stretch at the west end of South Beach compared to earlier studies.

The analysis assessed twenty-two shorelines (**Figure 39**) along this oceanfront section over an 86-year period, from 1934 to 2020. Since 1991, shoreline positions have been artificially influenced by beach nourishment and erosion mitigation efforts for portions of the beach. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 239 feet (oceanfront) to a maximum of 1,355 feet (cape), with an average of 579 feet for the entire shoreline between Town's western limit near Cape Fear Inlet to its eastern end at Cape Fear. This contrast highlights the differing influences of oceanfront and both inlet and cape dynamics on shoreline position. For the same area, the calculated average relative standard deviation of shoreline position was 159 feet. Of the 3.2 miles of shoreline analyzed, nearly all 3.1 miles (97%) resulted in measured erosion where rates averaged approximately -4 feet per year.

A comparison of the end-point and least squares regression methods showed slight differences in results (**Figure 40**). The end-point method indicated an average shoreline change of -2 feet per year (ranging from -13 to +5 feet per year) and calculated setback factors between 2 and 11 feet per year. In contrast, the least squares regression method produced an average change of -4 feet per year (ranging from -9.8 to +4 feet per year) with setback factors between 2 and 9.5 feet per year. While some variations were observed between the two methods, the results align with previous studies and remain consistent for most of the same shoreline section given the engineering practices and dynamic cape and inlet influences on shoreline position.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement. The updated setback factors, ranging from 2 to 9.5 feet per year, remain consistent with previous studies (2020, 2013, 2004, 1997, and 1986). Along South Beach, starting at Cape Fear Inlet and moving west toward Cape Fear, erosion setbacks progress as follows: 3.5 feet per year at the eastern end, increasing to 6.5 feet per year at transect-992, decreasing to 4.0 feet per year at transect 1001, 2.0 feet per year at transect 1009, then increasing again to 3.5 feet per year at transect 1047, 5.0 feet per year at transect 1055, 6.5 feet per year at transect 1063, 8.5 feet per year at transect 1071, and reaching 9.5 feet per year at transect 1079 near Cape Fear. Compared to the current effective setback factors (2020), the areas between transects 984.2 and 1008, as well as transects 1047 and 1054, will experience an increase of 0.5 to 1 foot per year (**Figure 39 to Figure 44 & Table 9**).

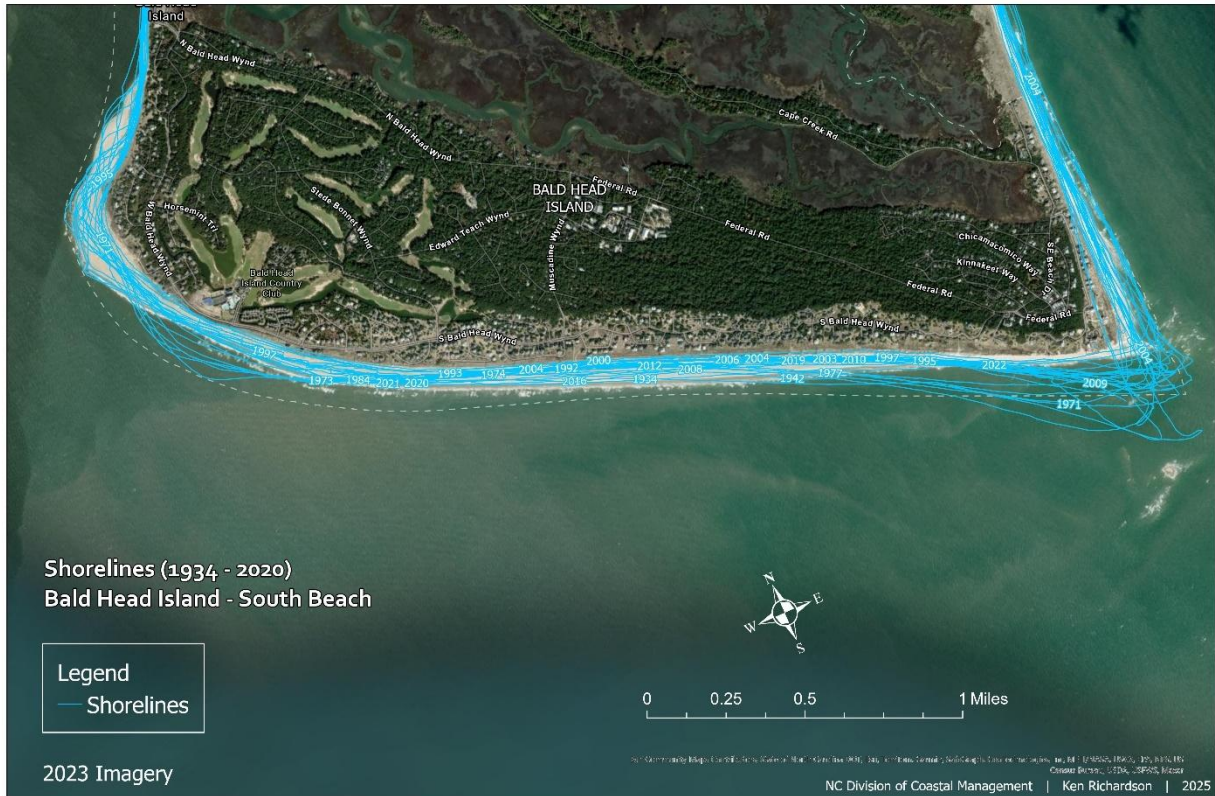


Figure 39. Shorelines included in the analysis (1933-2020) at Bald Head Island’s South-Beach.

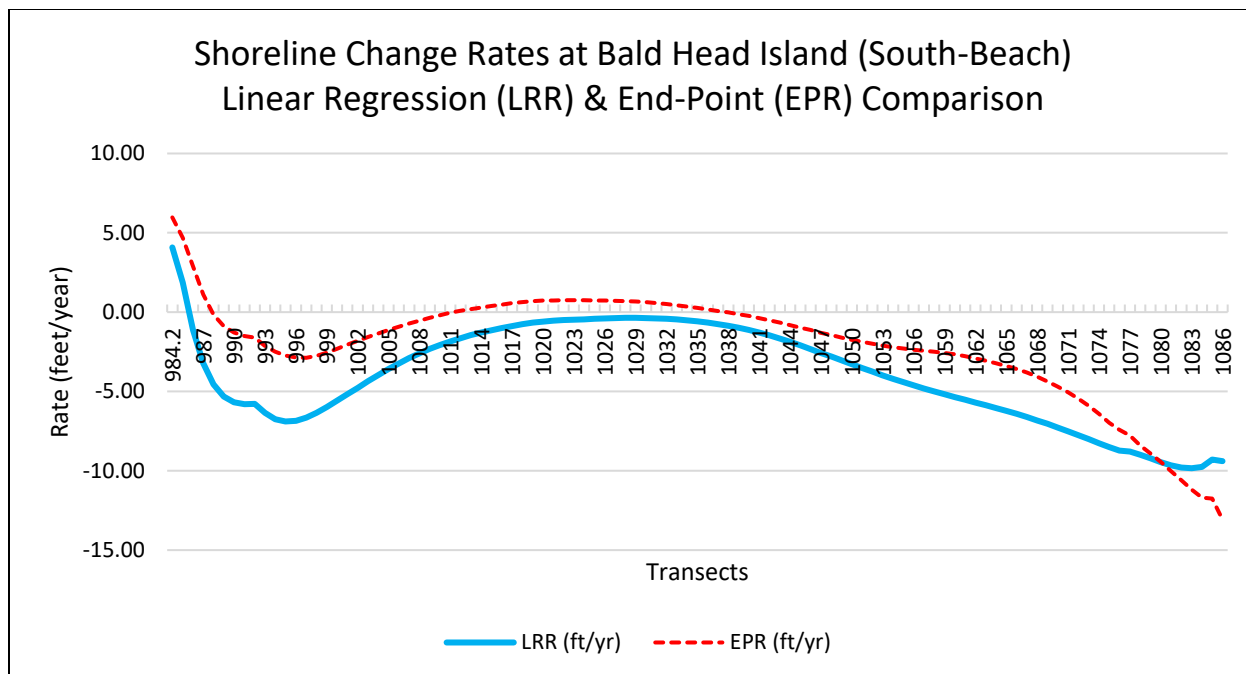


Figure 40. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

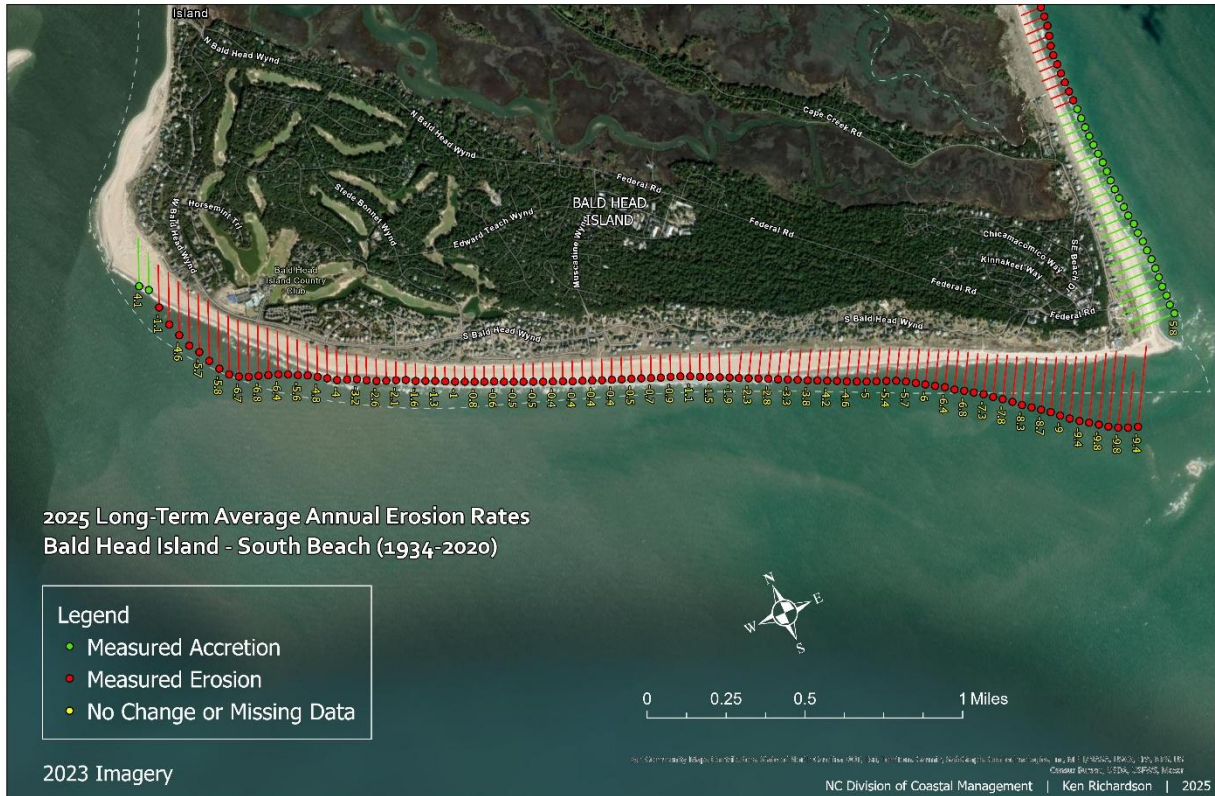


Figure 41. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

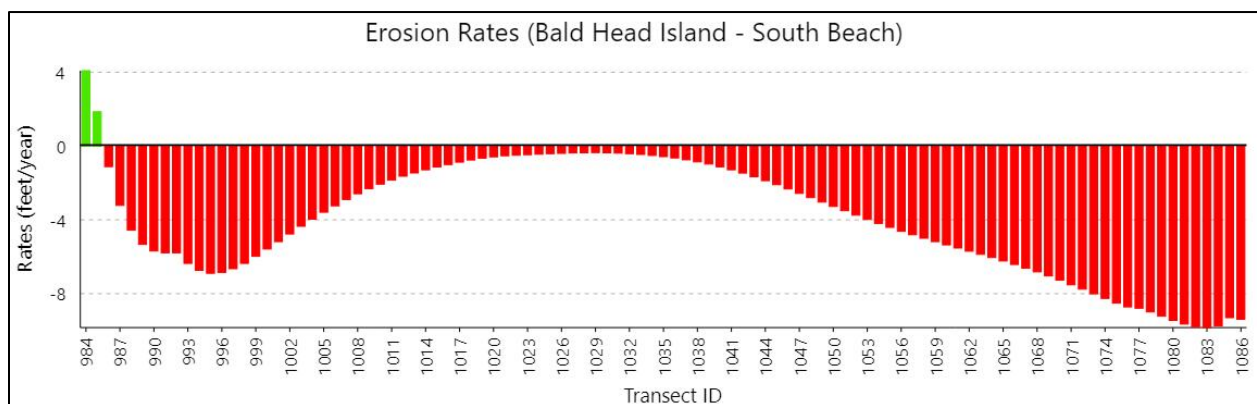


Figure 42. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

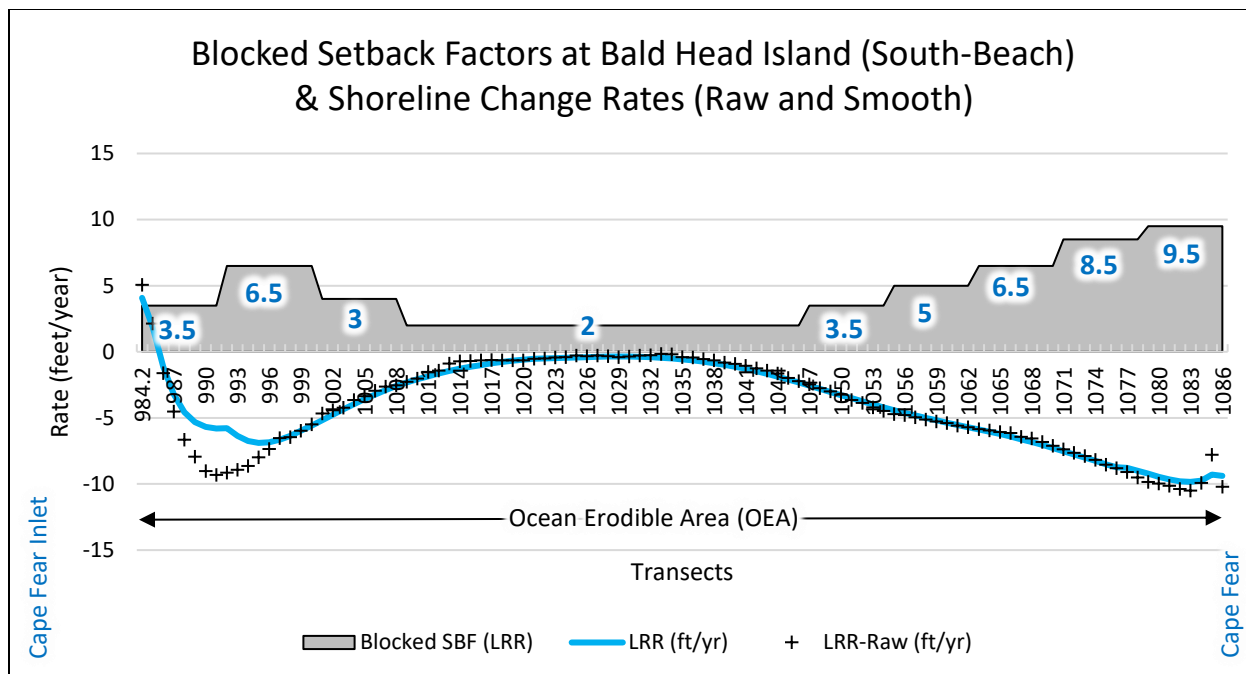


Figure 43. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 44. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Bald Head Island (south-beach).

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|----------|---------|-----------|---------|-----------|---------|--------|------|
| Setback Factor (SBF) | 2 to 9.5 | 2 to 13 | 2 to 10.5 | 2 to 15 | 2 to 11.5 | 3 to 11 | 2 to 7 | N/A |

Table 9. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.7 Bald Head Island (East-Beach)

As the shoreline transitions from Bald Head Island's South Beach to East Beach around Cape Fear, the data indicate an erosion-accretion pivot point. Historically, east-beach has remained relatively stable, as evidenced by long-term data trends. The analysis assessed twenty-two shorelines (**Figure 45**) along this oceanfront section over an 86-year period, from 1934 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 327 feet (oceanfront) to a maximum of 824 feet (at Cape Fear), with an average of 524 feet for the entire shoreline between Cape Fear and the Town's northern limit. For the same area, the calculated average relative standard deviation of shoreline position was 142 feet and ranged between 90 and 234 feet.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 46**). The end-point method indicated an average shoreline change of +2.5 feet per year, and the least squares regression method yielded a similar rate of +2.6 feet per year also. Both approaches measure erosion rates less than 2 feet per year within the OEA, leading to a blocked erosion rate setback factor of two (2), which is consistent with previous studies for most of the same section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement. The updated setback factors continue to be 2 feet per year making it consistent with the previous studies (2020, 2013, 2004, 1997, 1986, and 1983); Using this method, the calculated setback factors for Bald Head Island's east-beach remain at two (2) feet per year (**Figure 47 to Figure 50 & Table 10**).

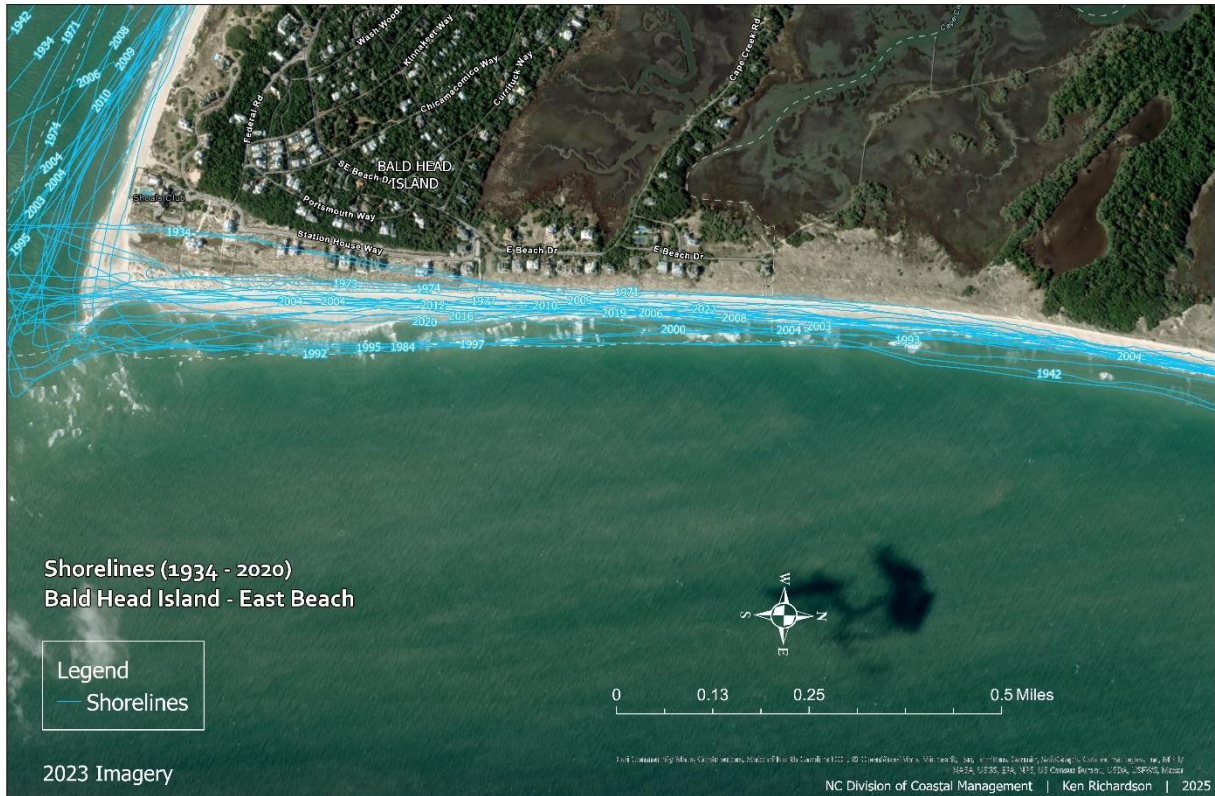


Figure 45. Shorelines included in the analysis (1934-2020) at Bald Head Island (east-beach).

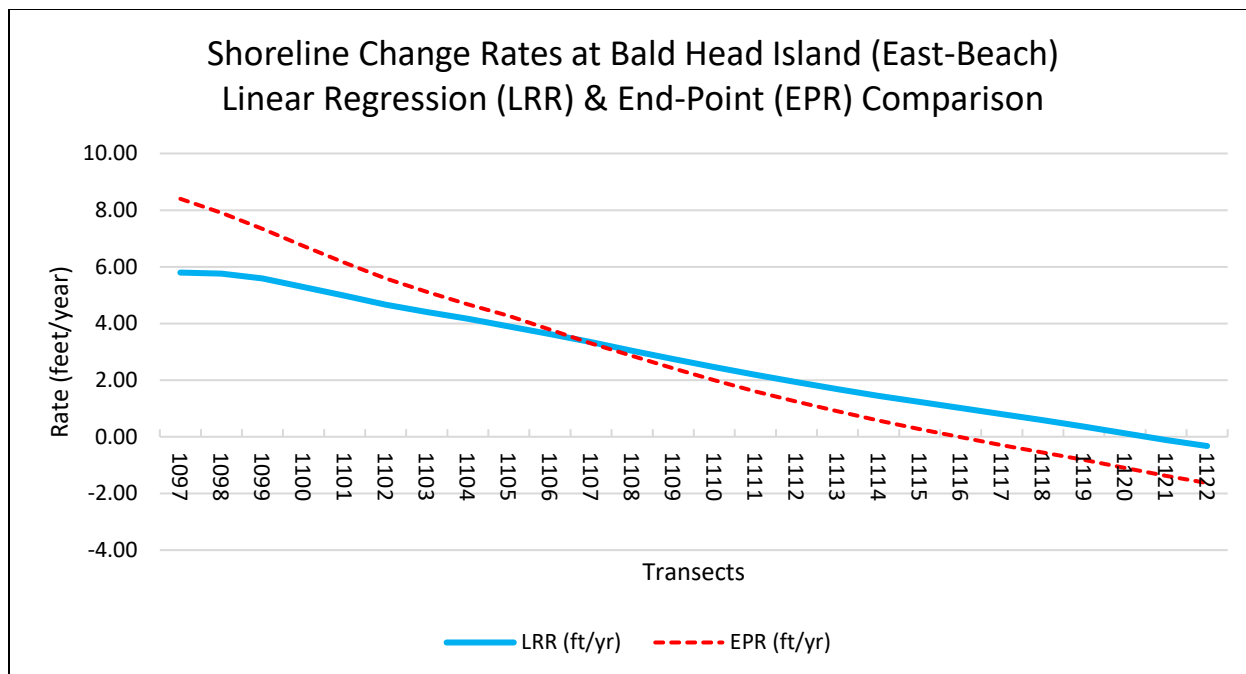


Figure 46. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

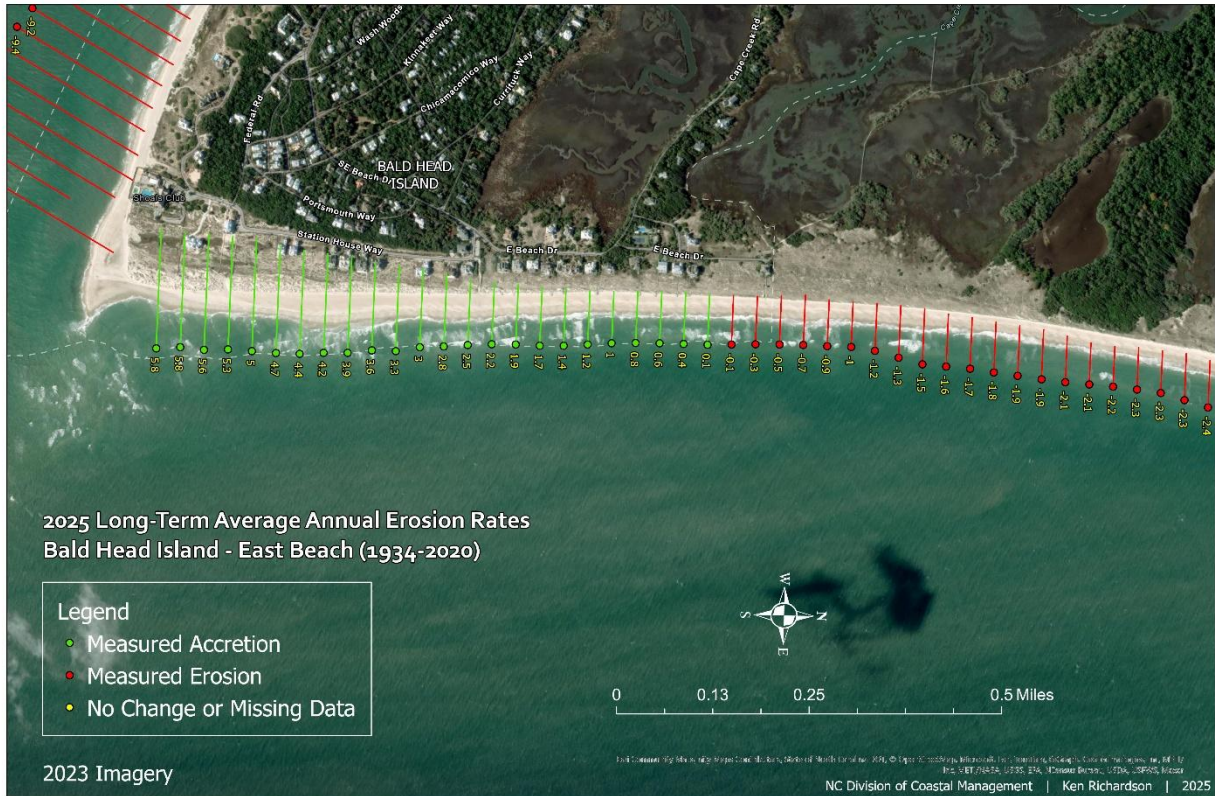


Figure 47. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

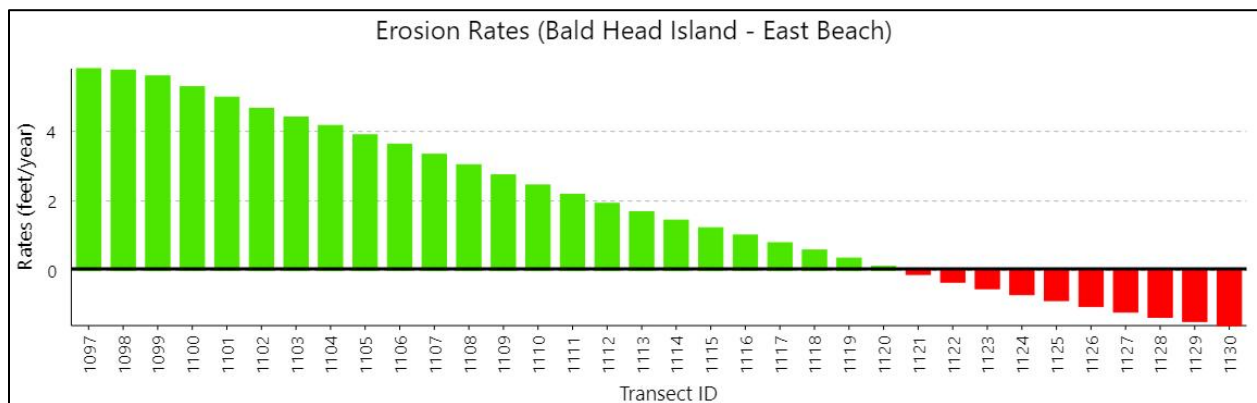


Figure 48. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

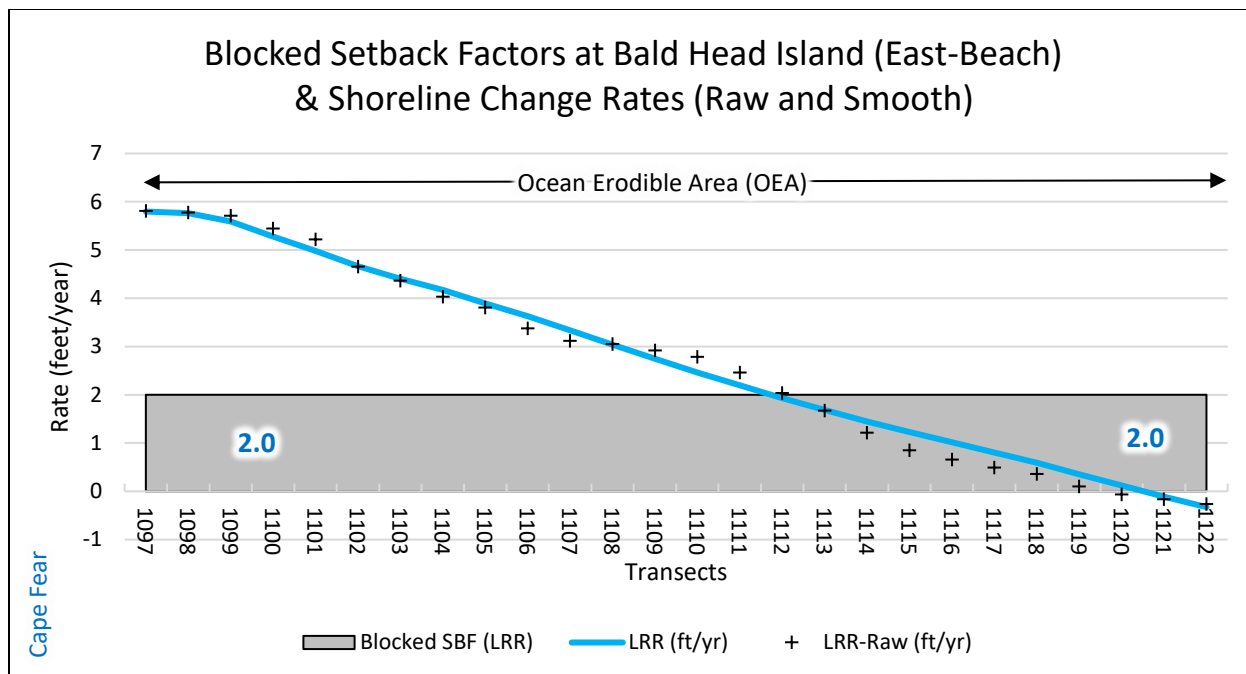


Figure 49. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

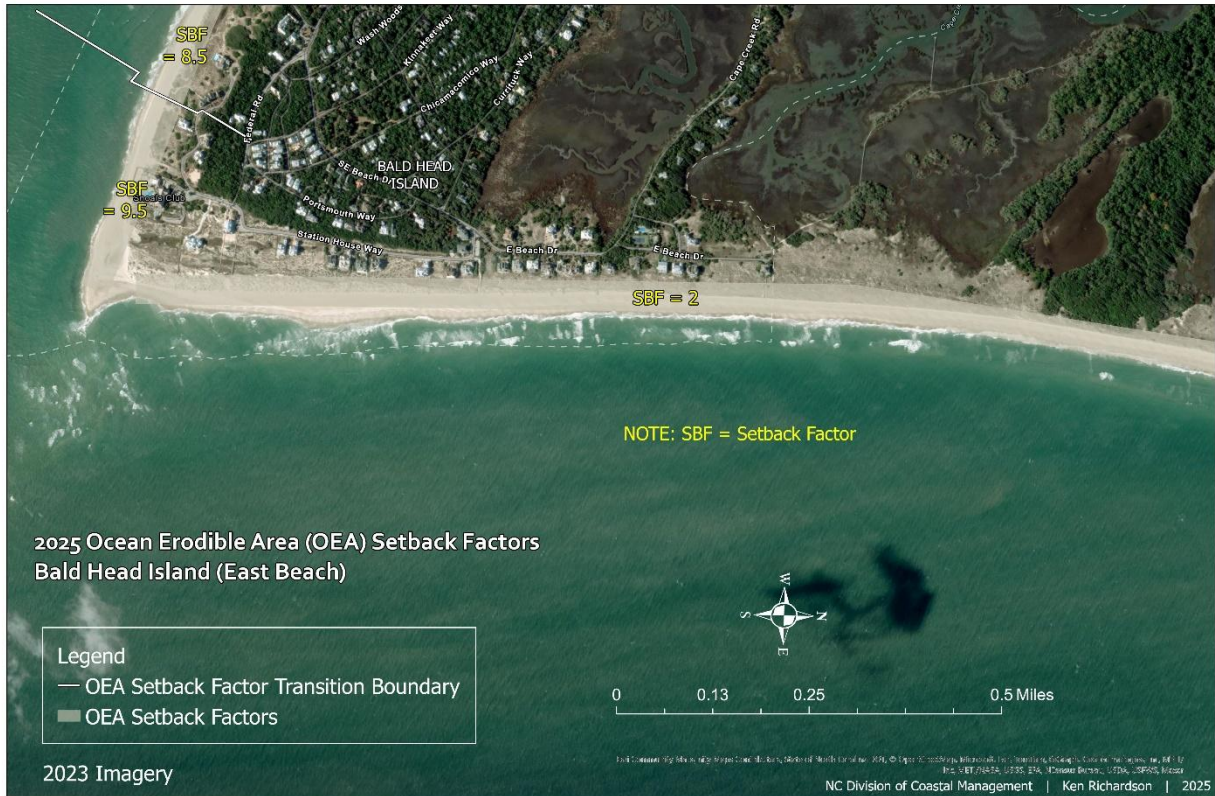


Figure 50. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Bald Head Island (east-beach).

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | N\A |

Table 10. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.8 Zeke's Island to Fort Fisher State Park

Historically, this 8.4 miles of shoreline has been influenced by New Inlet that closed in the late 1800s and Corncake Inlet that closed in the late 1990s due to Hurricane Bonnie (1998) and Floyd (1999). Although no beach fill projects have occurred since it is public land and not developed, a 3,040-foot rock revetment was installed in 1996 along the shoreline adjacent to Kure Beach to protect a Civil War earthworks historic site at Fort Fisher State Park.

The analysis assessed twenty-two shorelines (**Figure 51**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 182 feet to a maximum of 1,484 feet (at now closed Corncake Inlet), with an average of 631 feet. For the same area, the calculated average relative standard deviation of shoreline position was 164 feet and ranged between 56 and 335 feet. Of the 8.4 miles of shoreline analyzed, approximately 4.8 miles (57%) resulted in measured erosion where rates averaged -4.2 feet per year.

Both the end-point and least squares regression methods produced similar results (**Figure 52**). The end-point method showed shoreline change rates ranging from -6.4 to +11.3 feet per year, with an average of less than 1.0 foot per year. Similarly, the least squares regression method produced a range of -7.0 to +9.5 feet per year, also averaging less than 1.0 foot per year. Both approaches yielded comparable blocked erosion rate setback factors, averaging 3 feet per year, which aligns with previous studies for most of the same shoreline section.

Adopting the least squares regression methodology provides a more precise representation of long-term shoreline movement. The updated setback factors, ranging from 2 to 7 feet per year, remain consistent with previous studies (2020, 2013, 2004, 1997, 1986, and 1983) (**Figure 52 to Figure 56 & Table 11**).



Figure 51. Shorelines included in the analysis (1933-2020) from Zeke's Island to Fort Fisher State Park.

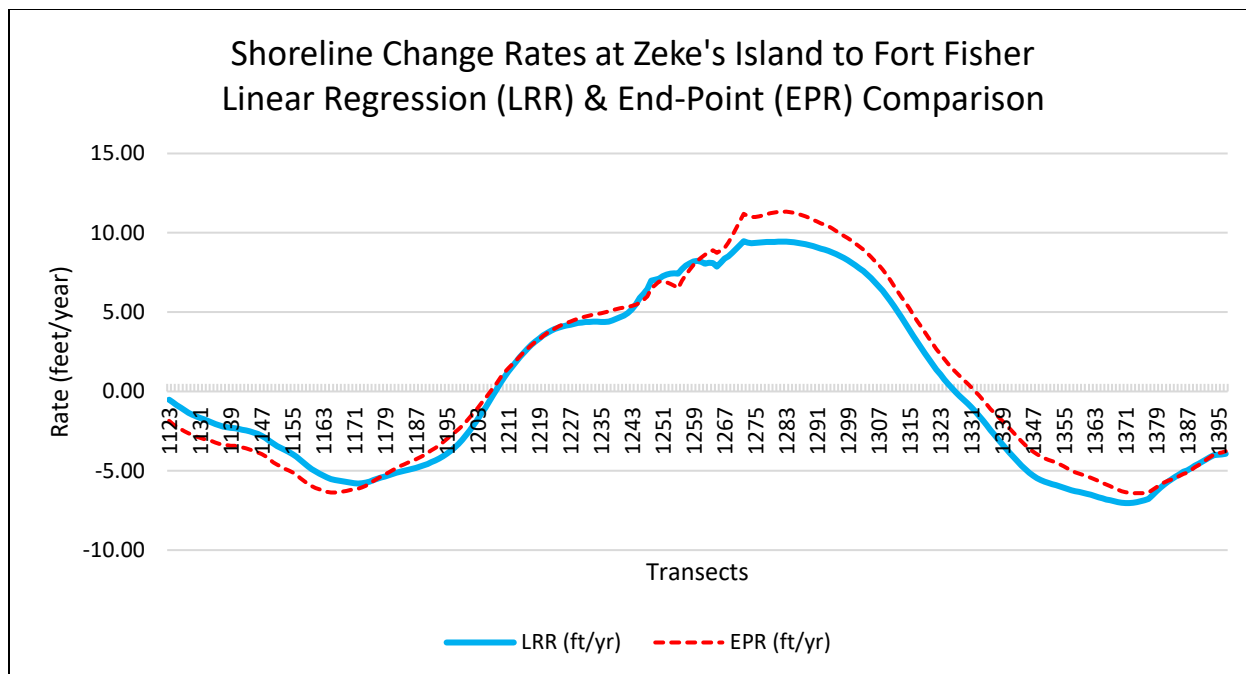


Figure 52. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 53. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

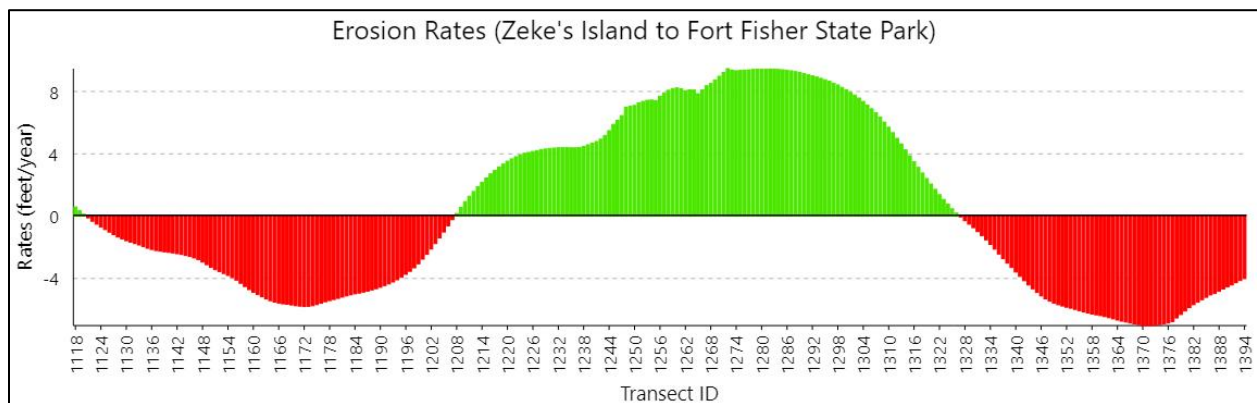


Figure 54. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

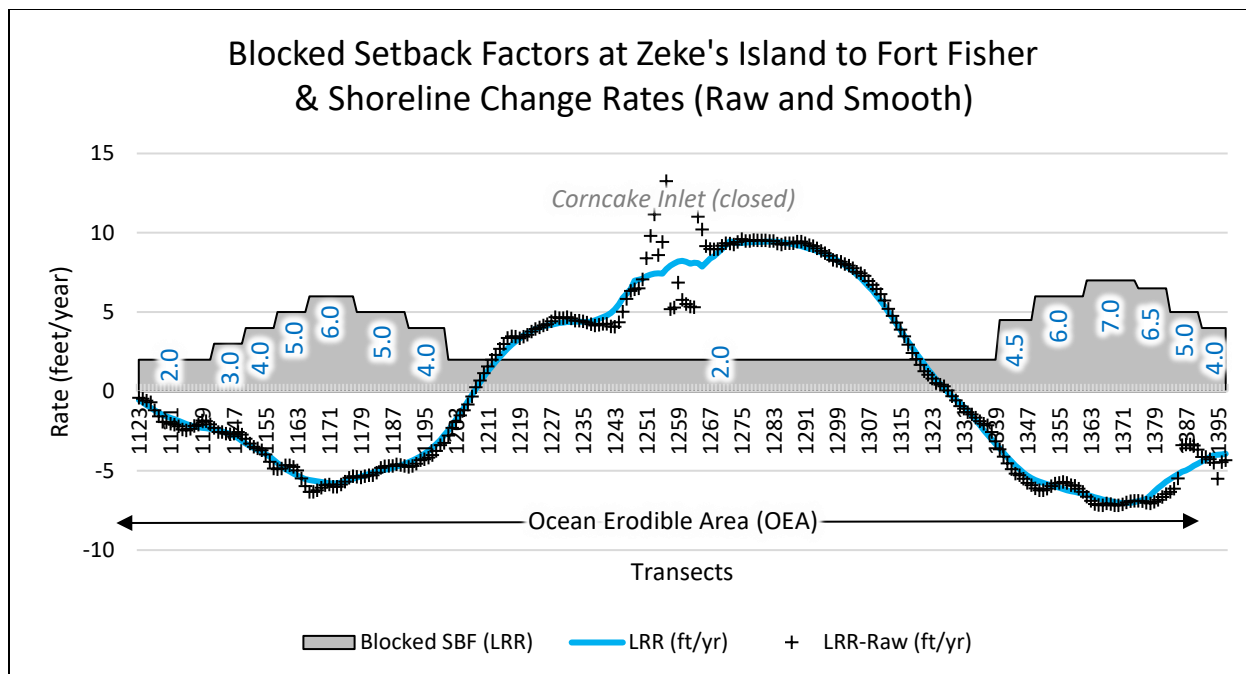


Figure 55. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

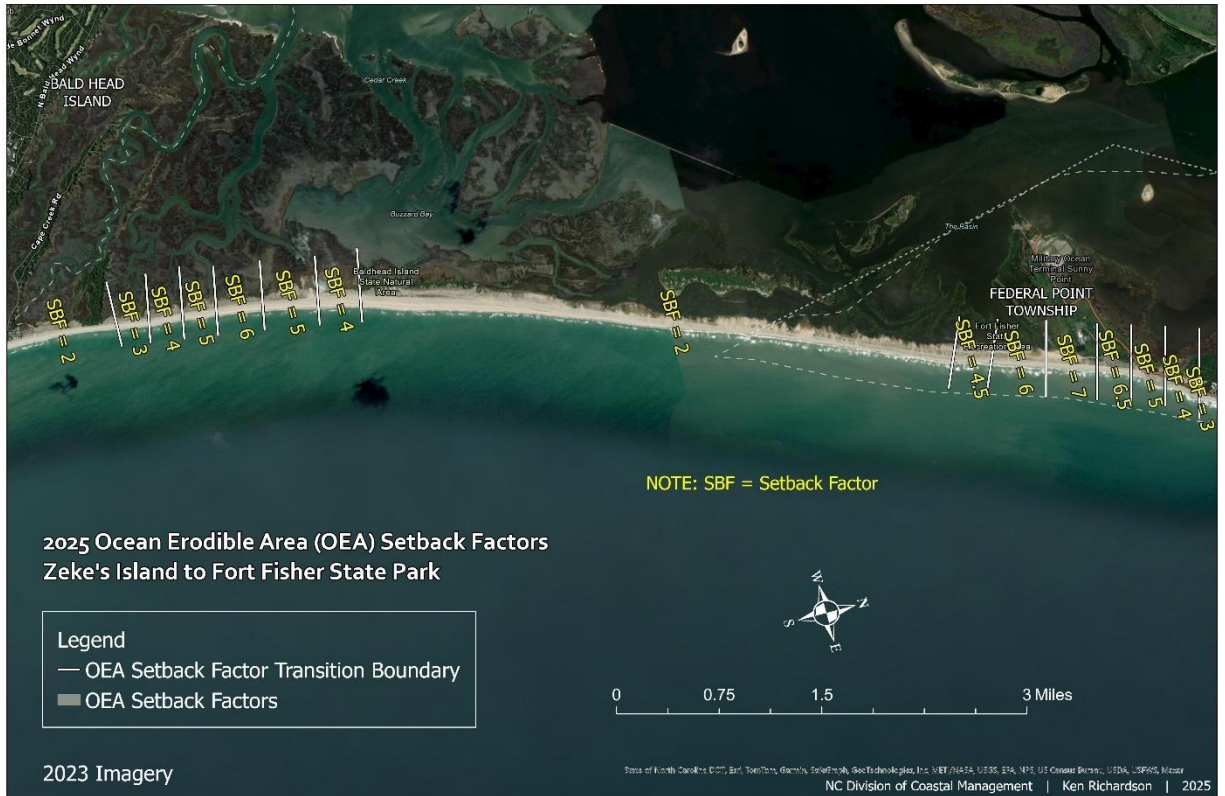


Figure 56. This map illustrates the erosion rate setback factors within the Ocean Erodible Area from Zeke's Island to Fort Fisher State Park.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|--------|--------|--------|---------|--------|---------|--------|------|
| Setback Factor (SBF) | 2 to 7 | 2 to 8 | 2 to 9 | 2 to 11 | 2 to 8 | 2 to 10 | 2 to 9 | N/A |

Table 11. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

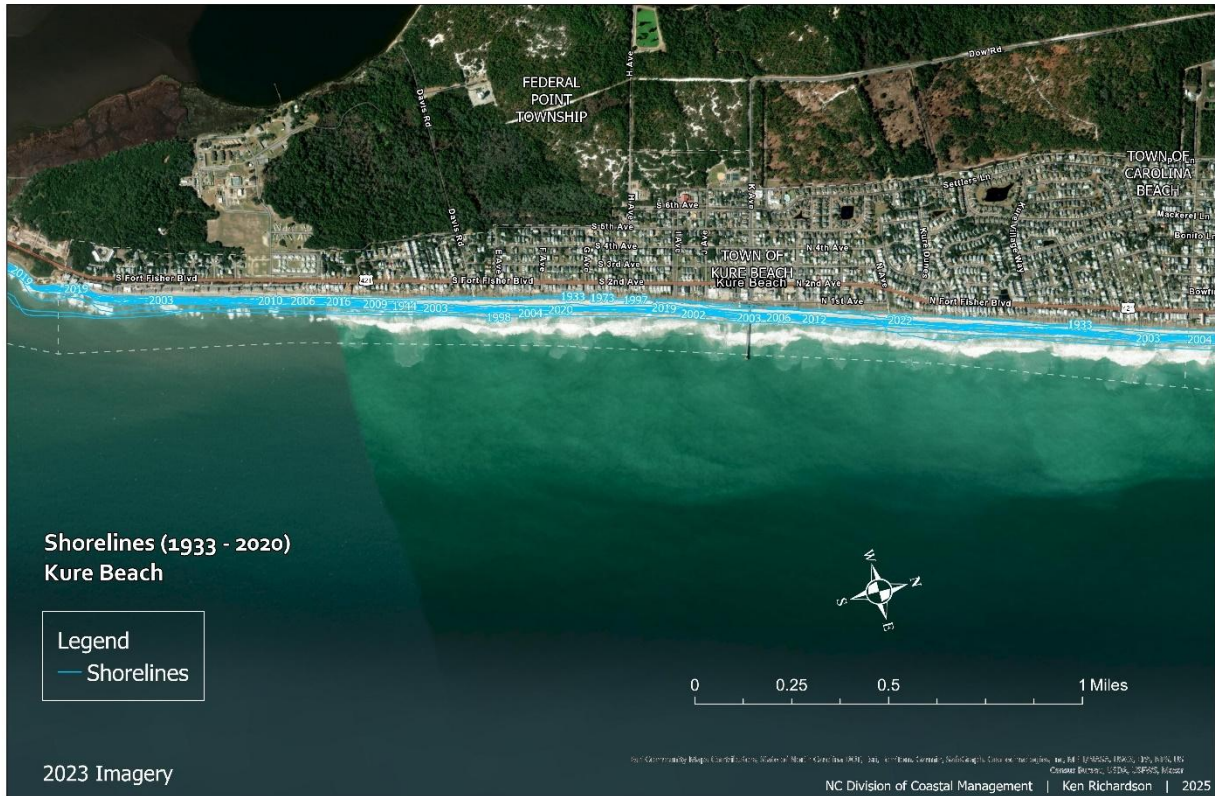
3.9 Kure Beach

Kure Beach is an east-facing beach with 2.9 miles of oceanfront shoreline. The Town installed its first beach fill project in 1997 followed by its first large-scale project in 2001. Since then, maintenance projects have been installed along portions of the shoreline in 2004, 2006-2007, 2010, 2013-2014, 2016, 2019 and 2022.

The analysis assessed fifteen shorelines (**Figure 57**) along this oceanfront section over an 87-year period, from 1933 to 2020. Since 1997, shoreline positions have been artificially influenced by regular beach nourishment. The shoreline envelope, representing the extent of movement along each transect, ranged from 197 feet to 428 feet, with an average of 250 feet for the entire shoreline between transects 1398 and 1491. For this same area, the calculated average relative standard deviation of shoreline position ranged from 52 feet to 120 feet and averaged 65 feet. Of the 2.9 miles of shoreline analyzed, approximately 3,500 feet (22%) resulted in measured erosion where rates averaged -2 feet per year, and as high as -4 feet per year along the Town's southern-most section of shoreline.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 58**). The end-point method resulted in a range of shoreline line change rates between -3.7 and +1.6 feet per year, averaging less than 1 foot per year; and the least squares regression method resulted in a range of shoreline line change rates between -3.9 and 1.6 feet per year, averaging less than 1 foot per year also. Both approaches result in blocked erosion rate setback factors of three (3) on the Town's southern limit adjacent to Fort Fisher State Park (transects 1398 to 1406), and two (2) through most of its oceanfront, which is consistent with previous studies for this section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement. For most of the shoreline (between transects 1407 and 1491) the updated setback factors continue to be 2 feet per year making it consistent with the previous two studies (2020, 2013, 2004, 1997, and 1986); but is lower between transects 1398 to 1404 where setback factors will decrease from 4 to 3 feet per year (**Figure 59 to Figure 62 & Table 12**).



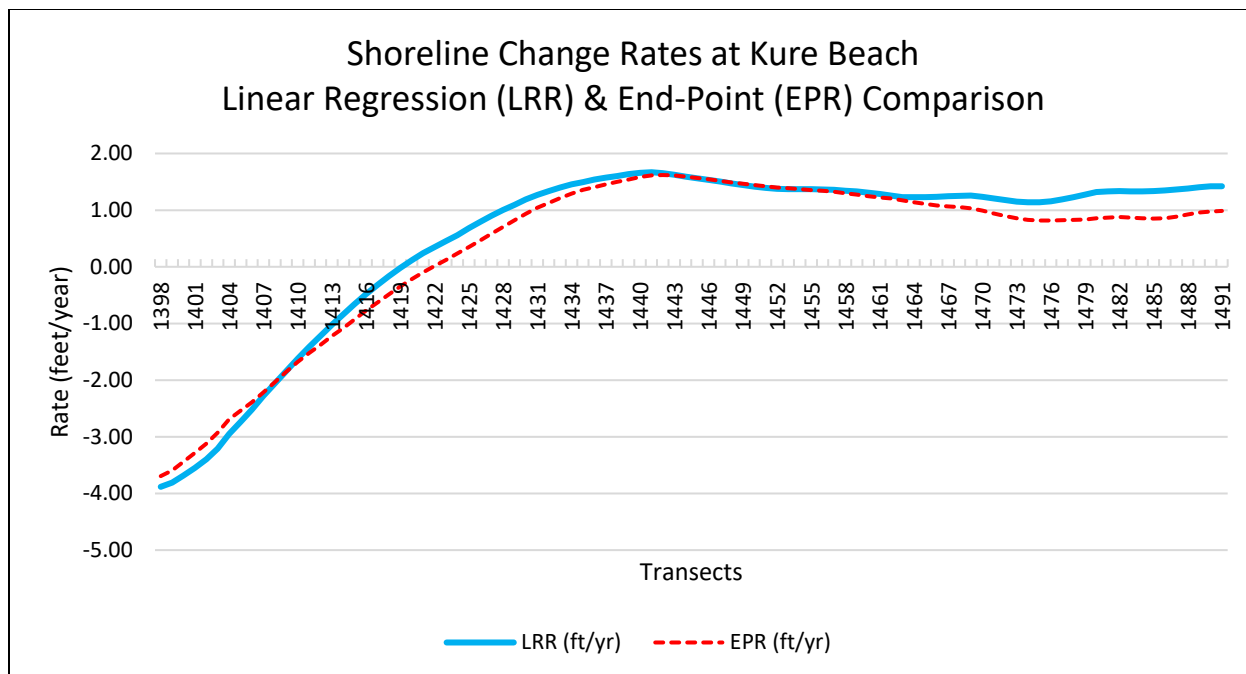


Figure 58. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 59. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

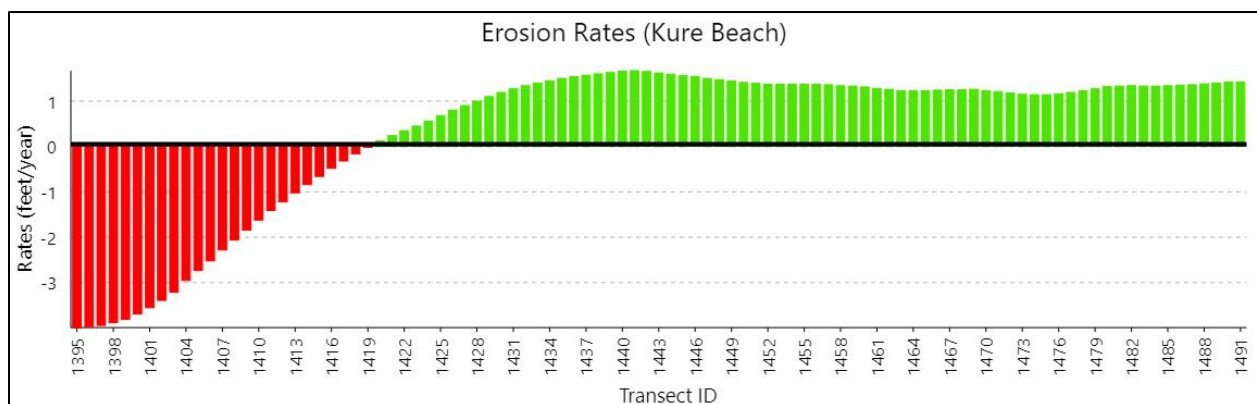


Figure 60. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

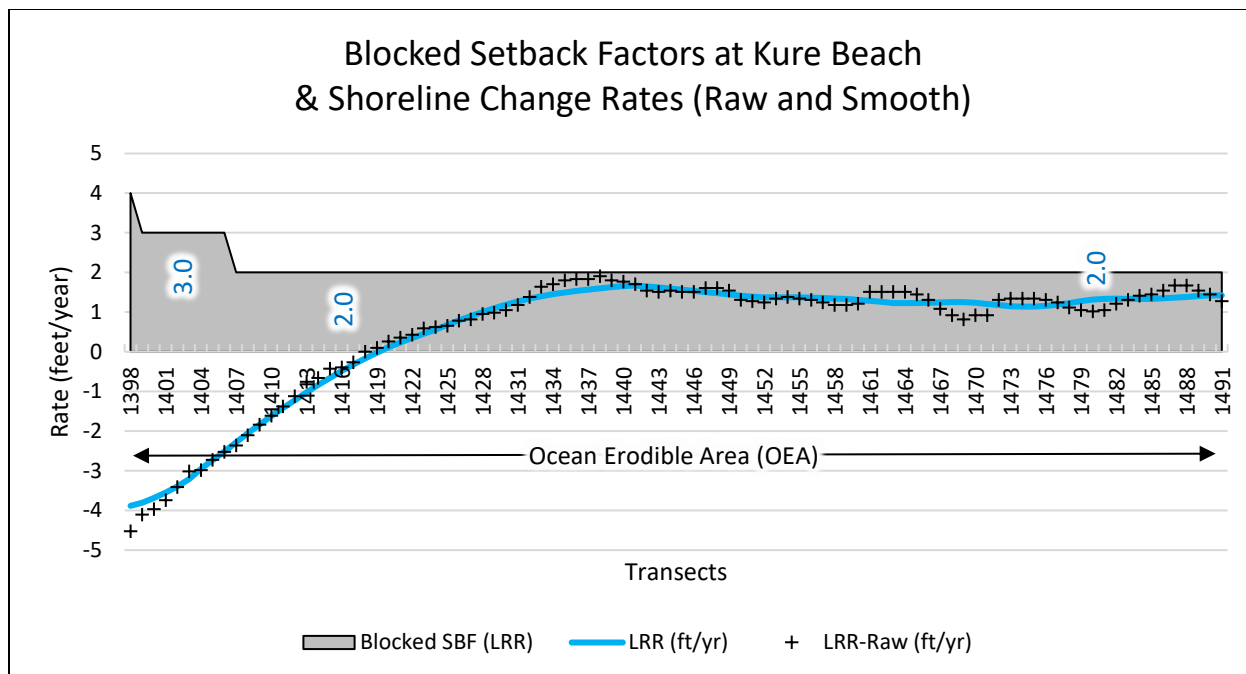


Figure 61. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

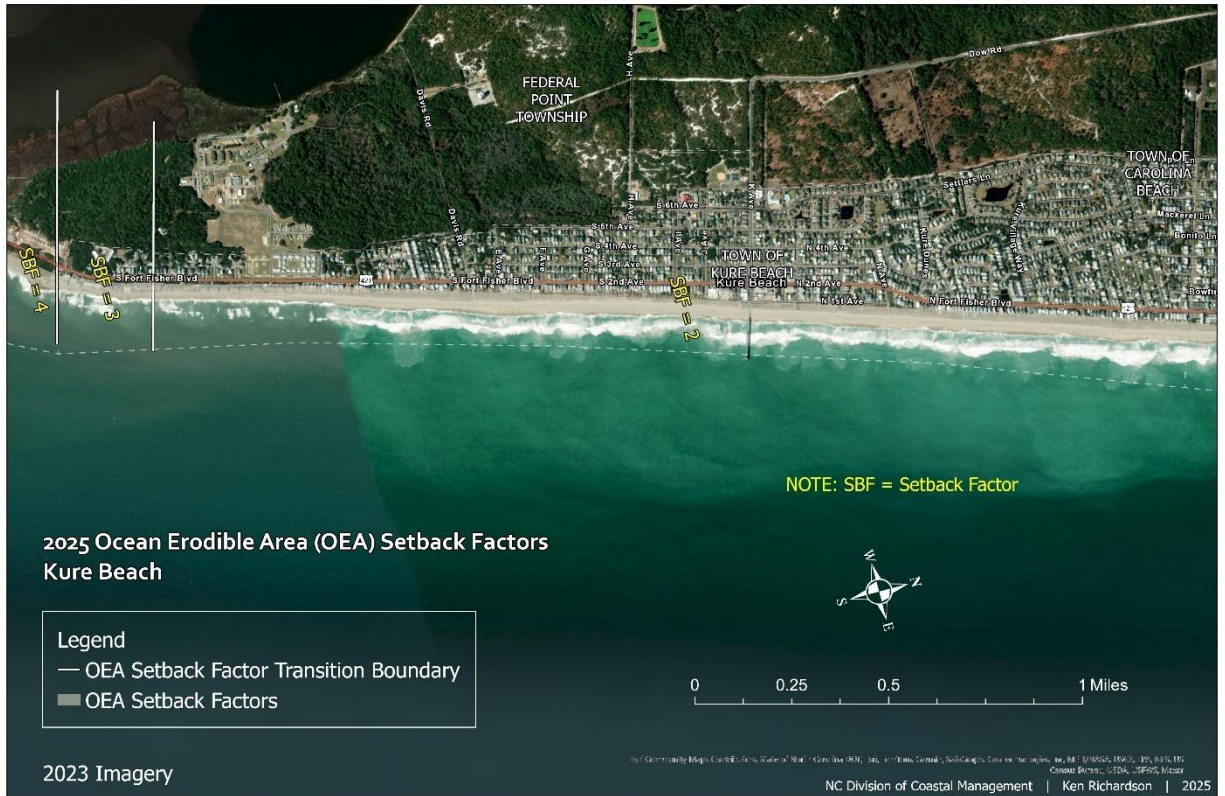


Figure 62. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Kure Beach.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|---------|--------|--------|--------|-------------|-------------------|------|
| Setback Factor (SBF) | 2, 3 | 2, 3, 4 | 2, 3.5 | 2, 3.5 | 2, 4.5 | 2, 3.5, 5.5 | 2, 3, 3.5, 4, 5.5 | 2 |

Table 12. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

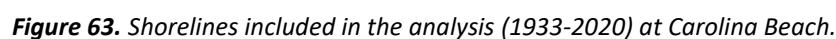
3.10 Carolina Beach

Carolina Beach is an east-facing shoreline spanning approximately four miles along the oceanfront. In 1952, the Carolina Beach Inlet was opened to support private interests. Following the inlet's opening, chronic erosion impacted both Carolina Beach and Masonboro Island. To mitigate this, the USACE constructed an initial 1,100-foot rock revetment in 1970, followed by an additional 950-foot section in 1973, extending the total structure to 2,050 feet. Between 1955 and 1998, relatively small-scale beach fill projects occurred that were primarily linked to navigational channel maintenance. However, in 2001, the U.S. Army Corps of Engineers (USACE) completed the Town's first large-scale project under the Coastal Storm Damage Reduction (CSDR) program, now known as Coastal Storm Risk Management (CSRM). Subsequent large-scale projects followed in 2006-2007, 2009-2010, 2014, 2018, and 2022.

The analysis assessed fifteen shorelines (**Figure 63**) along this oceanfront section over an 87-year period, from 1933 to 2020. Since 2001, shoreline positions have been routinely influenced by beach nourishment for portions of Carolina Beach. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 179 feet (oceanfront) to a maximum of 1,516 feet (inlet), with an average of 443 feet for the entire shoreline between Town's southern limit near transect 1492. Focusing specifically on the OEA, between transects 1492 and 1592, the shoreline envelope varied from 179 to 335 feet, averaging 263 feet. This contrast highlights the differing influences of oceanfront and inlet dynamics on shoreline position. For these respective areas, the calculated average relative standard deviation of shoreline position was 106 feet overall and 66 feet for the oceanfront section alone. Of the 4.0 miles of shoreline analyzed, approximately 1.7 miles (43%) resulted in measured erosion where rates averaged less than -2 feet per year approaching Carolina Beach Inlet.

For comparison, within the Ocean Erodible Area, between transects 1492 and 1583, both the end-point and least squares regression methods produced similar results (**Figure 64**). The end-point method indicated an average shoreline change of less than +2 feet per year, and the least squares regression method yielded a similar rate of less than +2 feet per year also. Both

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement. For most of the shoreline (between transects 1492 and 1583), and outside of the 2025 updated IHA boundary proposed, the updated setback factors continue to be 2 feet per year making it consistent with earlier studies (2020, 2013, 2004, 1997, and 1986). Using this method, the calculated setback factors for Carolina Beach's OEA, between transects 1492 and 1583, remain at two feet per year (**Figure 65 to Figure 68 & Table 13**). For setbacks within the proposed updated IHA boundary, refer to the report titled "*NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.*"



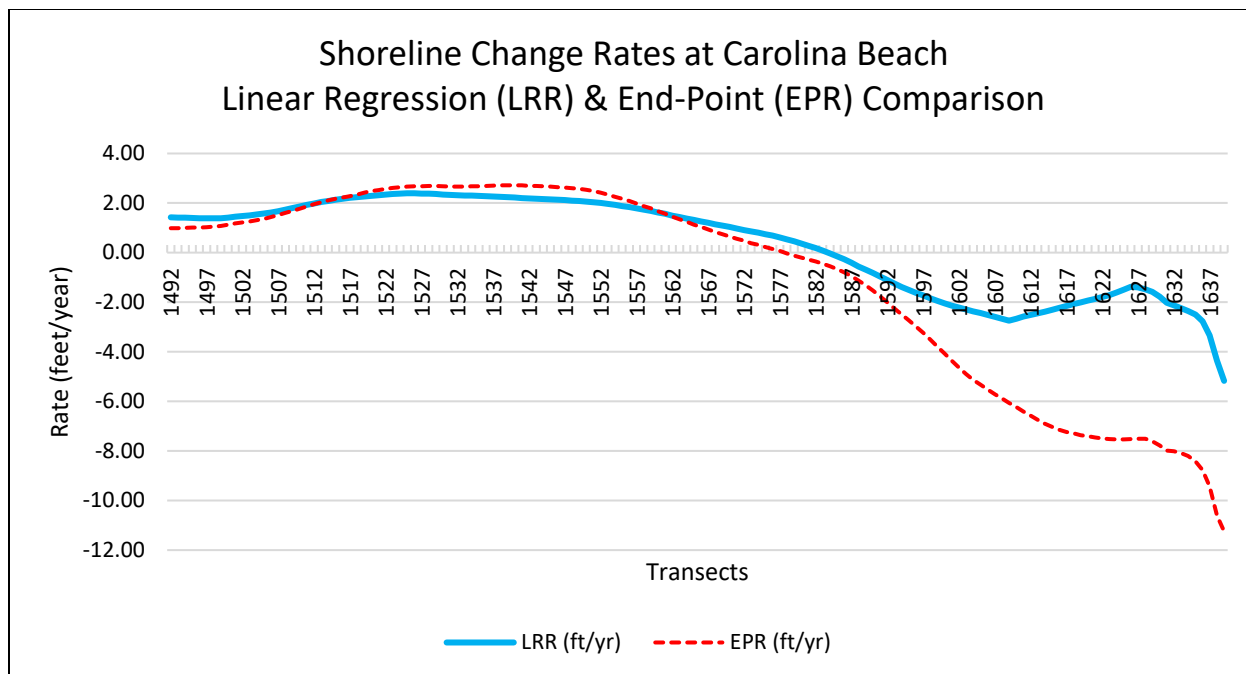
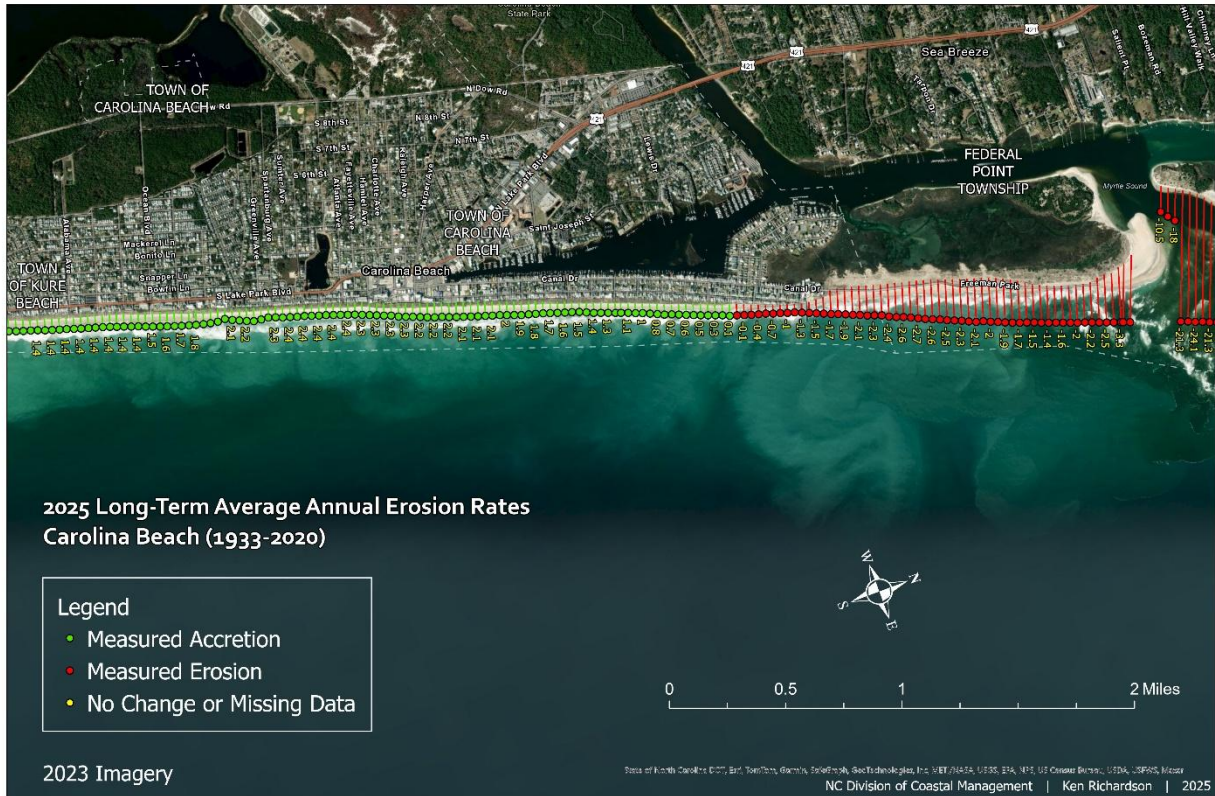


Figure 64. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



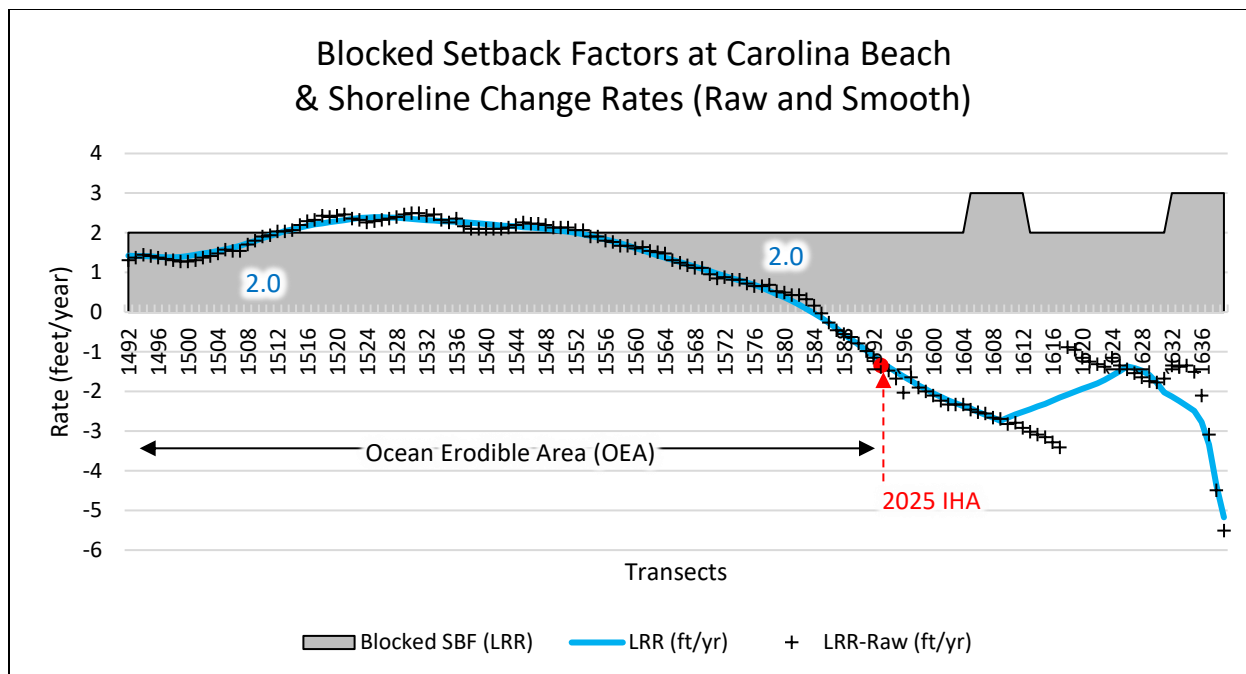


Figure 67. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

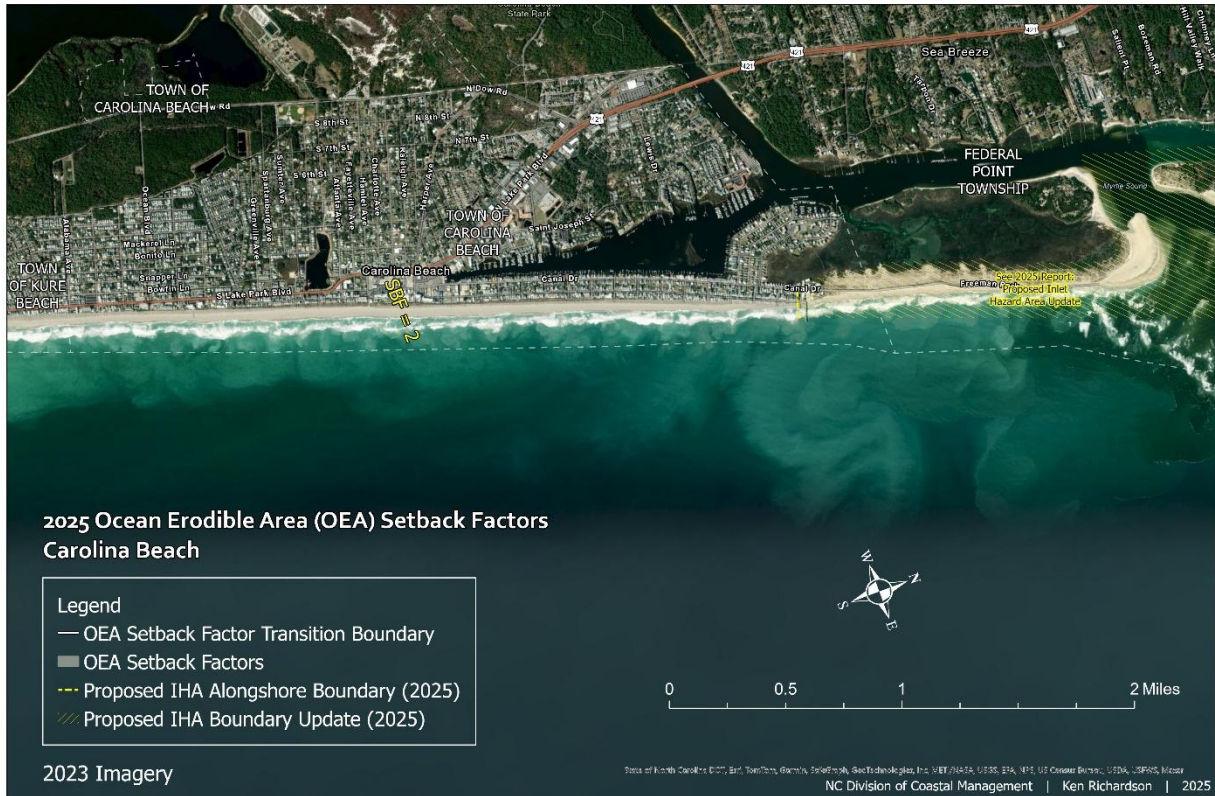


Figure 68. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Carolina Beach. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2 | 2 | 2, 5 | 2 |

Table 13. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.11 Masonboro Island

Erosion setback factors for Masonboro Island are not included in this report, as they can be obtained from the *NC Inlet Hazard Area (IHA) Erosion Rate and Setback Factors: 2025 Update* report. However, shoreline change rates are provided here for reference only.

Masonboro Island is an undeveloped barrier island and part of NC's Coastal Reserve system making it public land. Its oceanfront shoreline is east facing and extends 8 miles with Carolina Beach inlet on its southern end, and Masonboro inlet on its northern flank. While the island doesn't receive beach fill, the fillet area adjacent to the rock navigation jetty that was installed in 1980 at Masonboro Inlet, is regularly maintained; thus, artificially influencing shoreline change next to the jetty. It is estimated that the fillet has stabilized at least 3000 feet of Masonboro Island shoreline immediately south of the jetty.

The analysis assessed twenty-one shorelines (**Figure 69**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 331 feet to a maximum of 2,958 feet, with an average of 707 feet for the entire shoreline between Carolina Beach Inlet and Masonboro Inlet. The calculated standard deviation of relative shoreline change ranged between 101 and 918 feet, with an average of 219 feet. Of the 8.0 miles of shoreline analyzed, approximately 7.5 miles (94%) resulted in measured erosion where rates averaged -7.2 feet per year.

For comparison, both the end-point and least squares regression methods produced similar results. The end-point method resulted in shoreline change rates that ranged between -25.3 and +16.5 feet per year, with an average of -6.4 feet per year, and the least squares regression method yielded similar rates that ranged between -24 and +15.7 feet per year, with an average of -6.5 feet per year (**Figure 70 to Figure 72**).

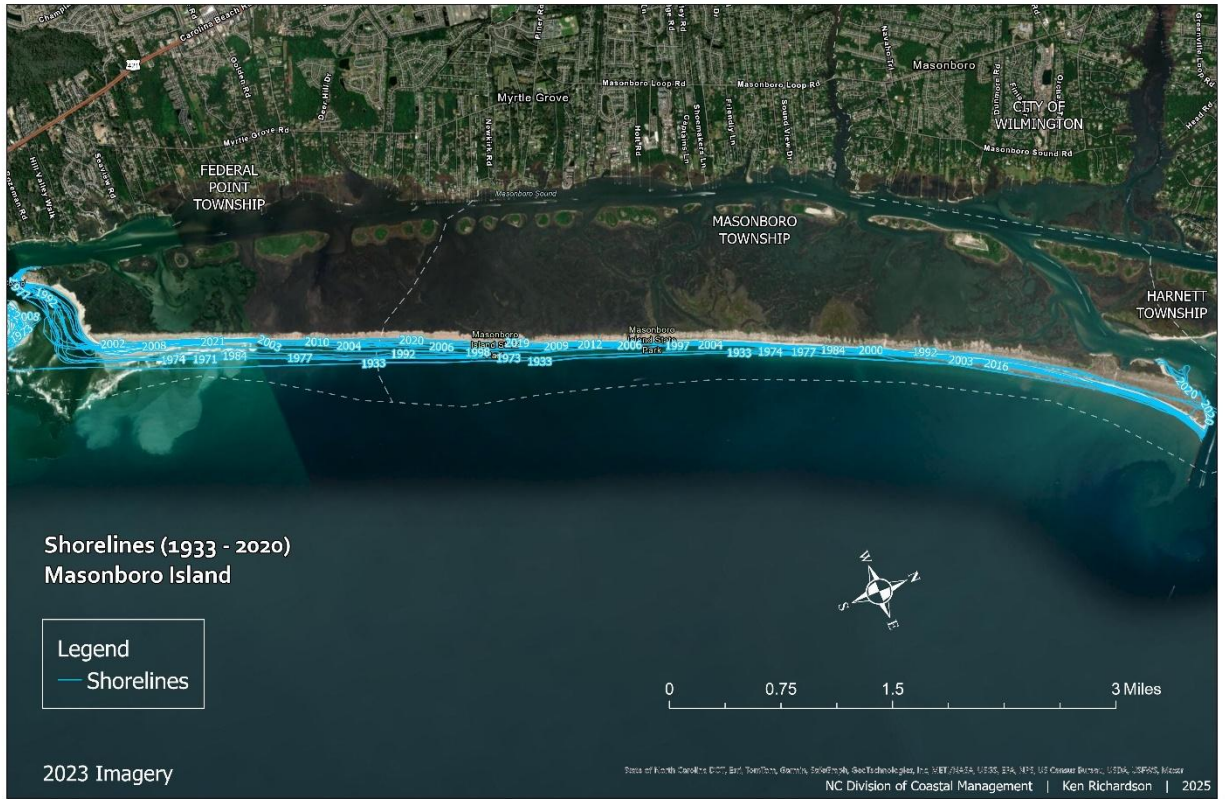


Figure 69. Shorelines included in the analysis (1933-2020) at Masonboro Island.

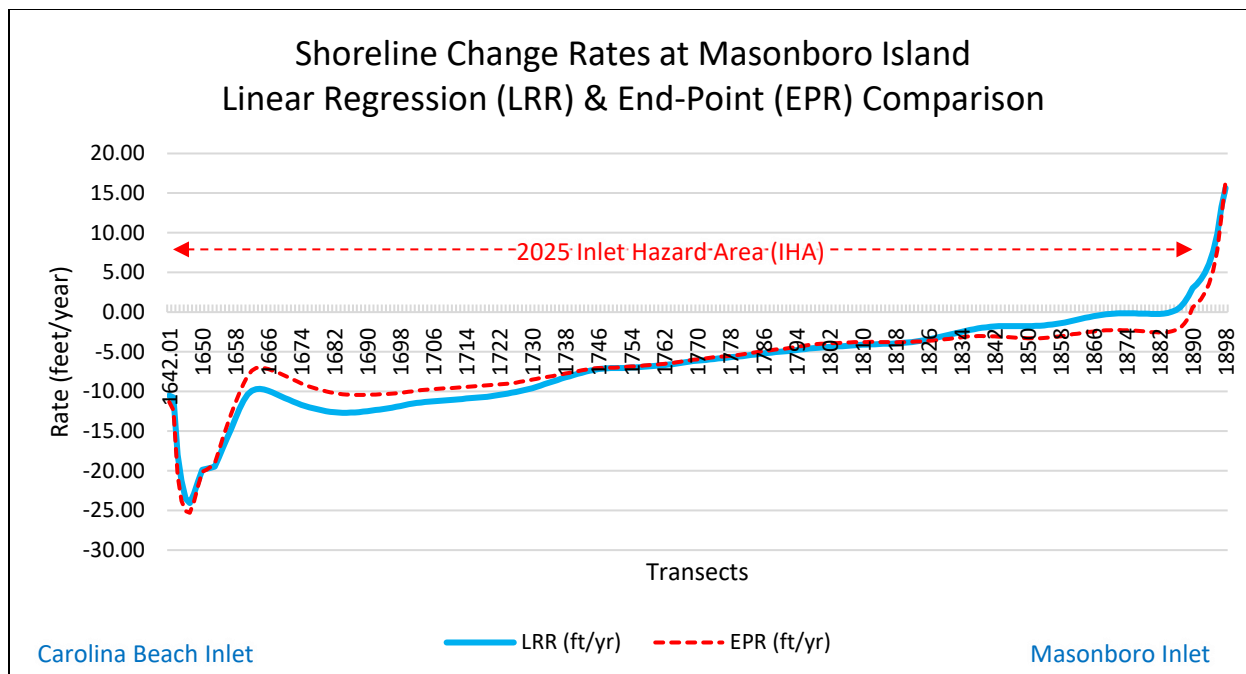


Figure 70. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 71. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

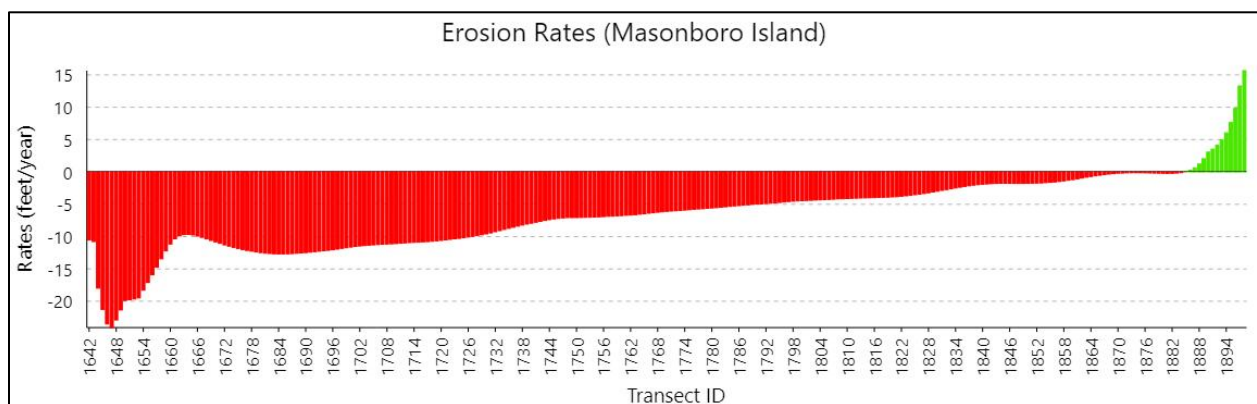


Figure 72. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

3.12 Wrightsville Beach

Wrightsville Beach spans approximately 4.5 miles of east-facing oceanfront shoreline, bordered by Masonboro Inlet to the south and Mason Inlet to the north. Masonboro Inlet is reinforced with two rock navigational jetties, one on each side (north jetty installed in 1965 and southern jetty installed in 1980), which provide stability for the inlet and aiding in navigation; and Mason Inlet was relocated approximately 3,000 feet to the north in 2001-2002 with its new position regularly maintained. The shoreline at Wrightsville Beach is regularly maintained through a U.S. Army Corps of Engineers (USACE) Storm Damage Reduction project.

Small-scale maintenance efforts associated with navigational channel upkeep began as early as 1939. However, larger-scale beach nourishment projects were not implemented until 1965-1966, following Congressional authorization in 1962. This coincided with the completion of the north jetty in 1966, which played a key role in stabilizing the shoreline. Despite these early efforts, North Carolina recognizes the first large-scale beach nourishment project at Wrightsville Beach as occurring in 1980-1981. Since then, regular maintenance and renourishment projects have taken place in 1986, 1991, 1994, 1998, 2002, 2006, 2010, 2014, 2018, and 2024, which have all artificially influenced shoreline position and lowering the effects of natural erosion.

This analysis assessed twenty-three shorelines (**Figure 73**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 223 feet (oceanfront) to a maximum of 1,836 feet (inlet), with an average of 475 feet for the entire shoreline between Masonboro and Mason Inlets. However, within the Ocean Erodeable Area between transects 1906 and 2019 (excluding areas inside the 2025 updated IHA proposed boundaries), the shoreline envelope varied from 223 to 676 feet, averaging 365 feet. For the same respective areas, the calculated average relative standard deviation of shoreline position was 121 feet overall and 92 feet for the oceanfront section alone. Of the 5.7 miles of shoreline analyzed, approximately 2.1 miles (37%) resulted in measured erosion where rates averaged -4.4 feet per year adjacent to Tubbs and Shallotte Inlets.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 74**).

The end-point method resulted in a range of shoreline line change rates between +1.0 and +4.1 feet per year, averaging +2.7 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between +1.5 and +4.5 feet per year, averaging +2.9 feet per year. Both approaches result in a blocked erosion rate setback factors of two (2), which are consistent with previous studies for this section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement; however, it does not impact on the updated setback factors compared to previous studies. Using this approach, the calculated setback factors within the OEA remain at two (2) feet per year between transects 1906 and 2019, and outside of the 2025 updated Inlet Hazard Areas proposed boundaries (**Figure 75 to Figure 78 & Table 14**). For setback factors within the proposed updated Inlet Hazard Area, refer to the report titled *NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update*.



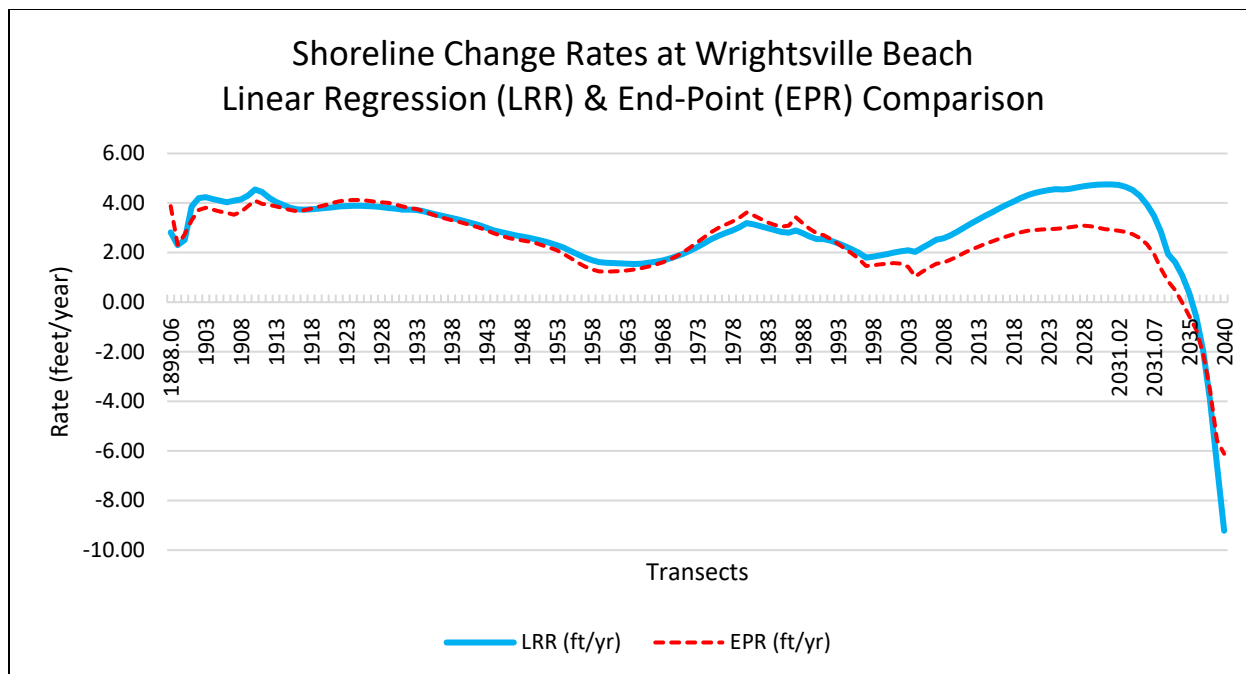


Figure 74. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

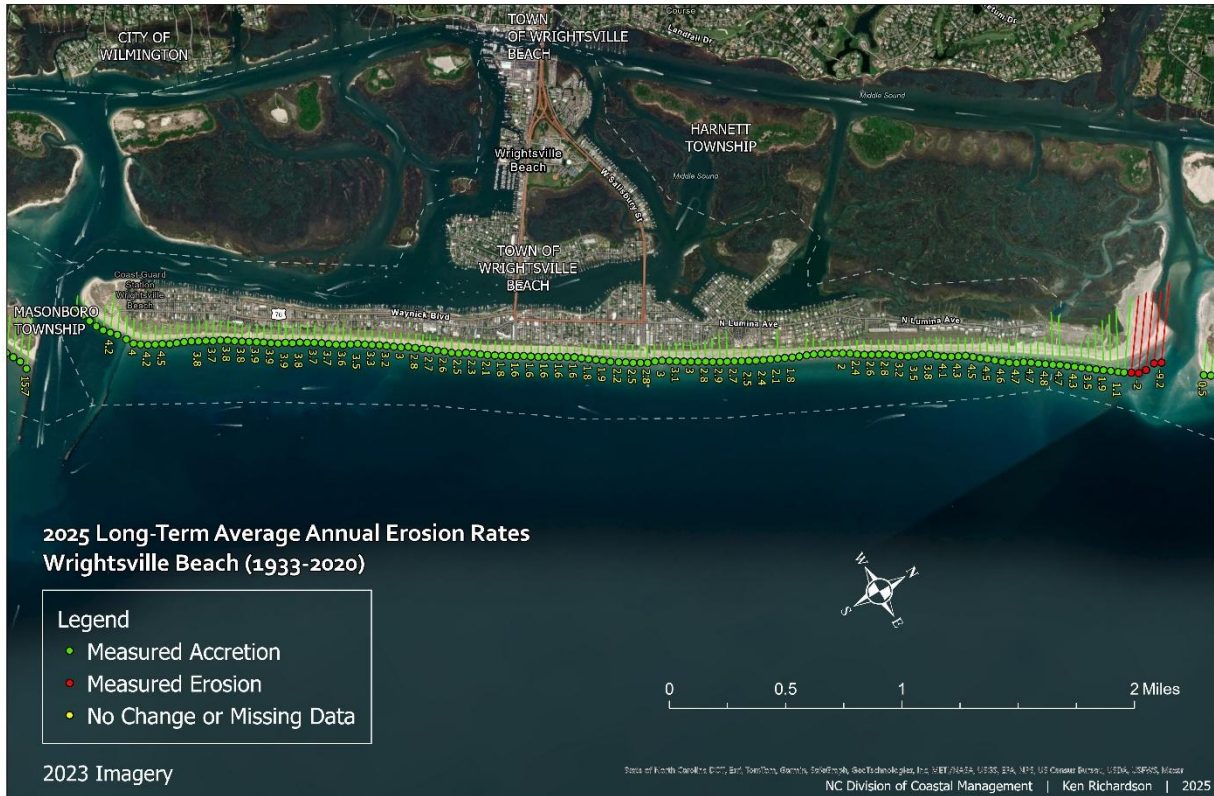


Figure 75. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

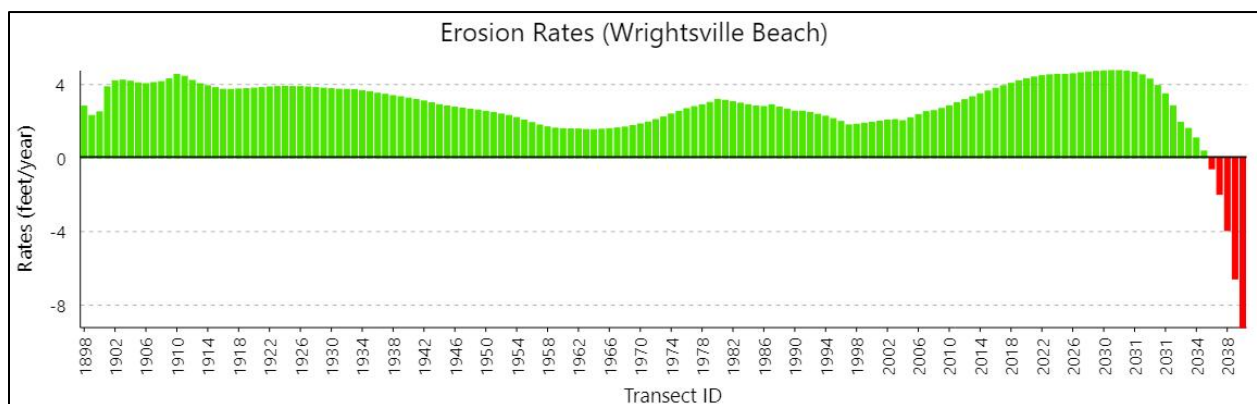


Figure 76. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

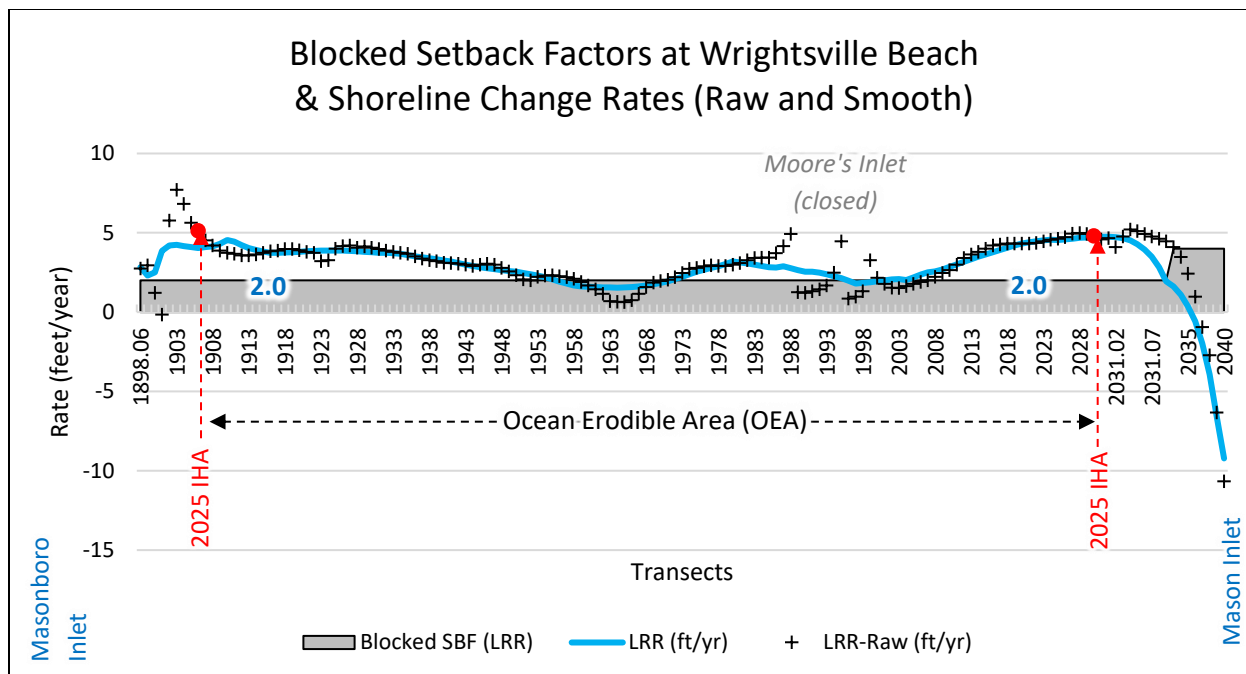


Figure 77. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

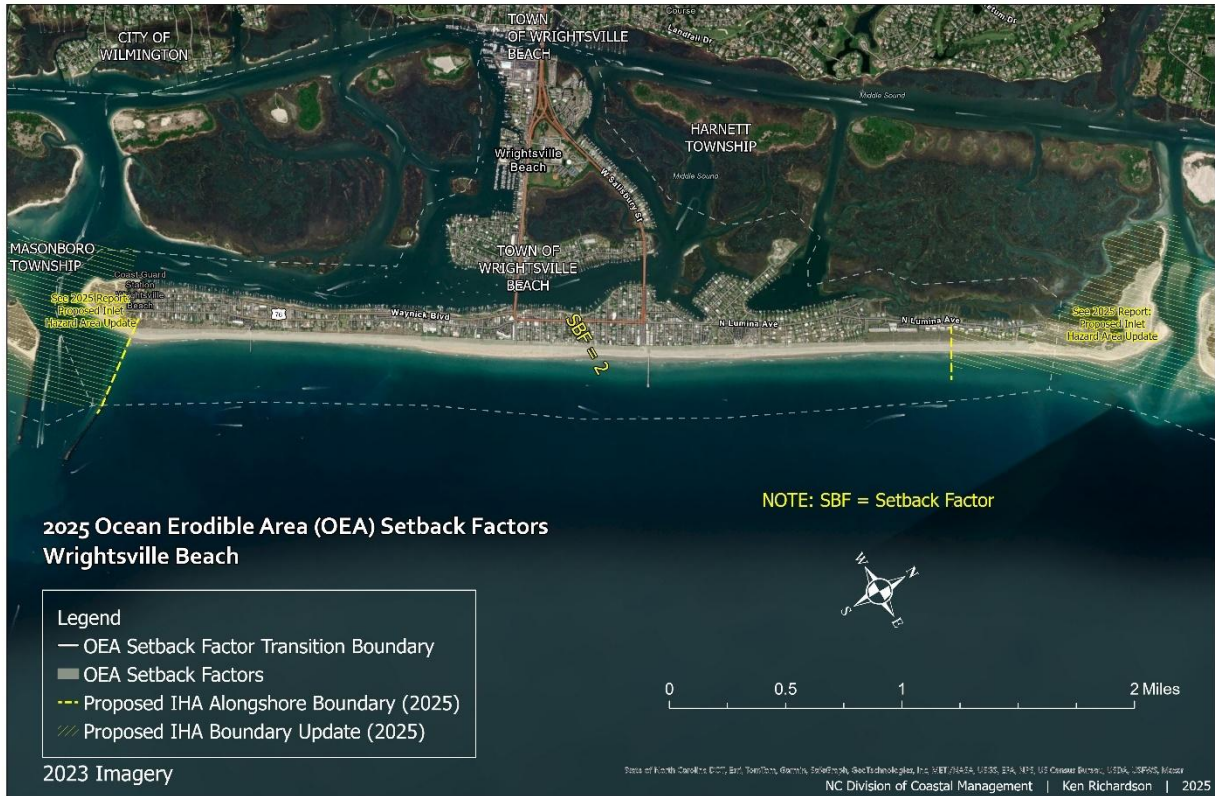


Figure 78. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Wrightsville Beach. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

Table 14. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.13 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), and has been the recipient of small-scale beach nourishment projects that started in 1977 followed by others in 1983, 1985, 1986, 1987, 1990, 1992, 1993, 1994, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005, 2006, 2009, 2011, 2013, 2016, 2019, and 2020. Collectively, while each did not span the full length of shoreline, they have contributed to artificial influences on shoreline position over time, thus reducing erosion rates.

This analysis assessed twenty-four shorelines (**Figure 79**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 176 feet (oceanfront) to a maximum of 1,655 feet (inlet), with an average of 379 feet for the entire shoreline between Mason and Rich Inlets. However, within the Ocean Erodible Area between transects 2064 and 2160 (excluding areas inside the 2025 updated IHA proposed boundaries), the shoreline envelope varied from 176 to 566 feet, averaging 256 feet. For the same respective areas, the calculated average relative standard deviation of shoreline position was 121 feet overall and 63 feet for the OEA alone. Of the 3.6 miles of shoreline analyzed, approximately 0.9 miles (25%) resulted in measured erosion where rates averaged less than one (-1) foot per year between transects-2067 and -2095.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 80**). The end-point method resulted in a range of shoreline line change rates between less than 1 foot and +3.6 feet per year, averaging +1.3 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between less than 1 foot and +3.1 feet per year, averaging less than 1 foot per year. Both approaches result in a blocked erosion rate setback factors of two (2), which are consistent with previous studies for this section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement; however, it does not impact on the updated setback factors compared to previous studies. Using this approach, the calculated setback factors within the OEA

remain at two (2) feet per year between transects 2064 and 2160, and outside of the 2025 updated Inlet Hazard Areas proposed boundaries (**Figure 80 to Figure 84 & Table 15**). For setback factors within the proposed updated Inlet Hazard Area, refer to the report titled *NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update*.



Figure 79. Shorelines included in the analysis (1933-2020) at Figure Eight Island.

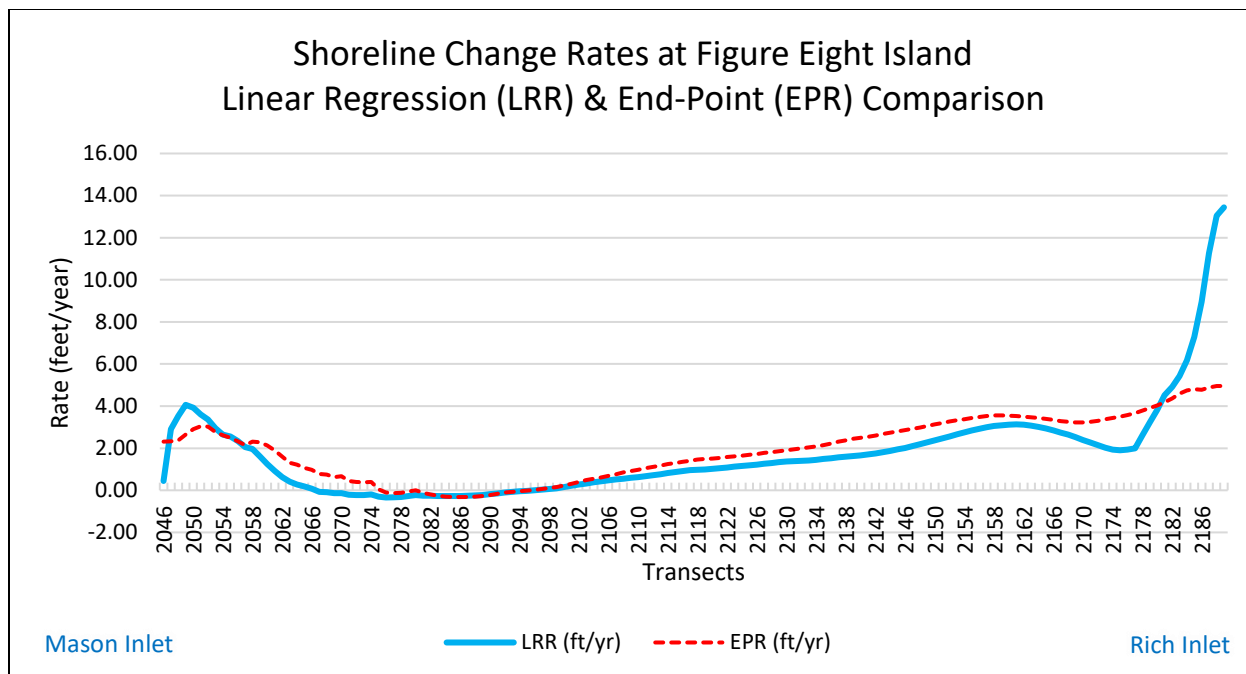


Figure 80. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 81. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

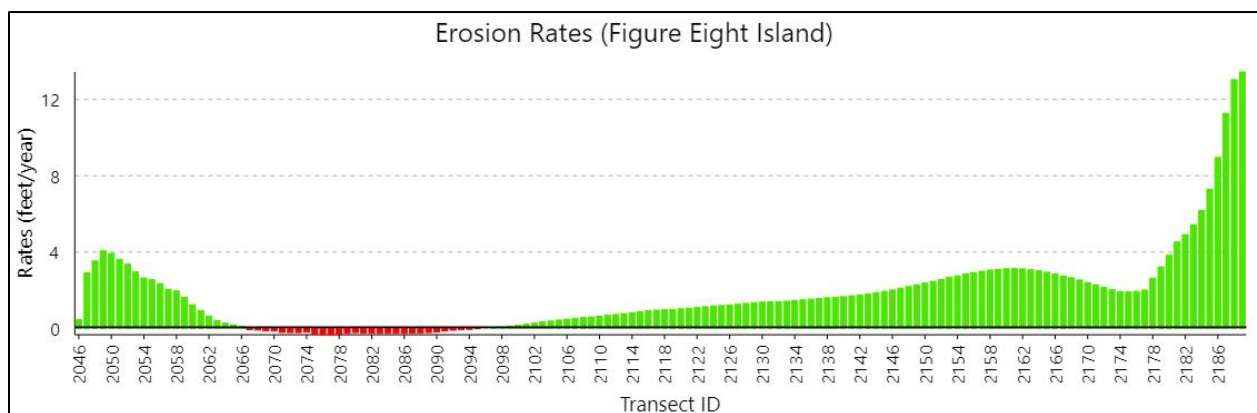


Figure 82. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

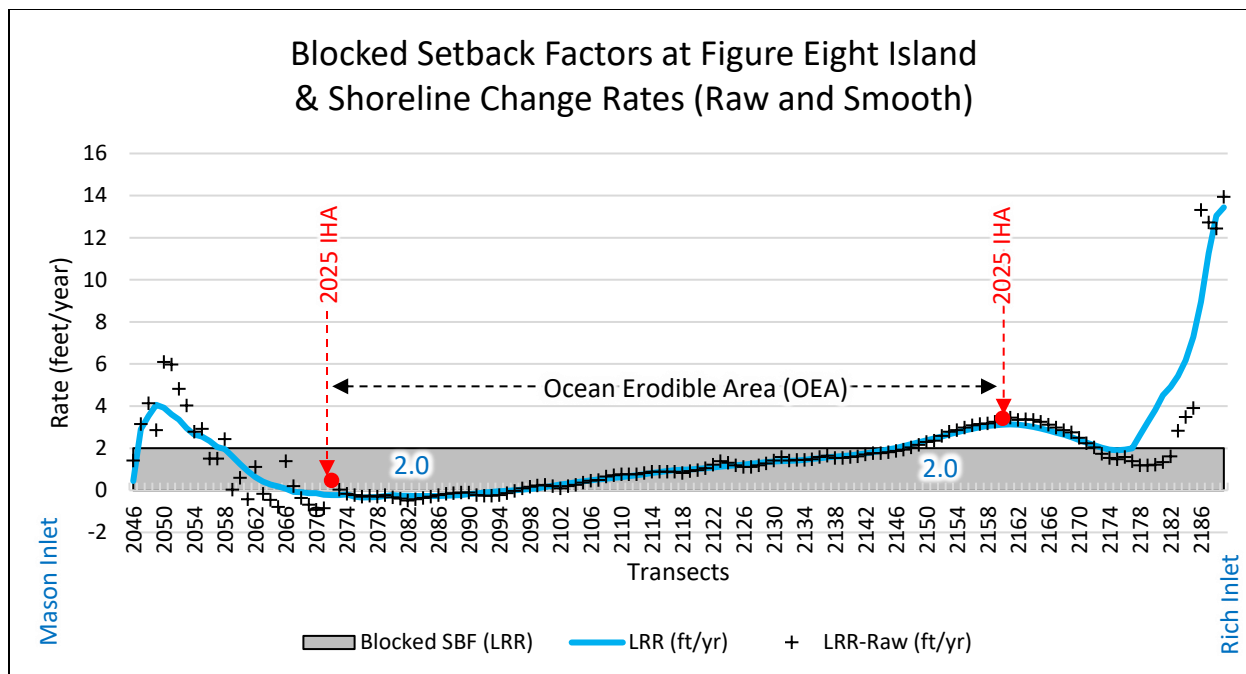


Figure 83. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 84. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Figure Eight Island. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2 | 2 | 2, 5 | 2.3 |

Table 15. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.14 Lea-Hutaff Island

Erosion setback factors for Lea-Hutaff Island are not included in this report, as can be obtained from the *NC Inlet Hazard Area (IHA) Erosion Rate and Setback Factors: 2025 Update* report. However, shoreline change rates are provided here for reference only.

Following the closure of Old Topsail Inlet in 1997, Lea and Hutaff Islands merged, forming Lea-Hutaff Island. Its east-facing oceanfront shoreline now extends approximately 3.6 miles, bordered by Rich Inlet to the south and New Topsail Inlet to the north. While portions of the island are privately owned, it is still undeveloped.

The analysis assessed twenty-seven shorelines (**Figure 85**) along this oceanfront section over an 86-year period, from 1934 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 503 feet to a maximum of 1,399 feet, with an average of 762 feet for the entire shoreline between Rich Inlet and New Topsail Inlet. The calculated standard deviation of relative shoreline change ranged between 139 and 387 feet, with an average of 210 feet. Of the 3.6 miles of shoreline analyzed, all 3.6 miles (100%) resulted in measured erosion where rates ranged from -11 to -3.7 feet per year and averaged -7.5 feet per year.

For comparison, both the end-point and least squares regression methods produced similar results. The end-point method resulted in shoreline change rates that ranged between -10 and -2.7 feet per year, with an average of -6.4 feet per year, and the least squares regression method yielded similar rates that ranged between -11 and -3.7 feet per year, with an average of -7.5 feet per year (**Figure 86 to Figure 88**).



Figure 85. Shorelines included in the analysis (1933-2020) at Lea-Hutaff Island.

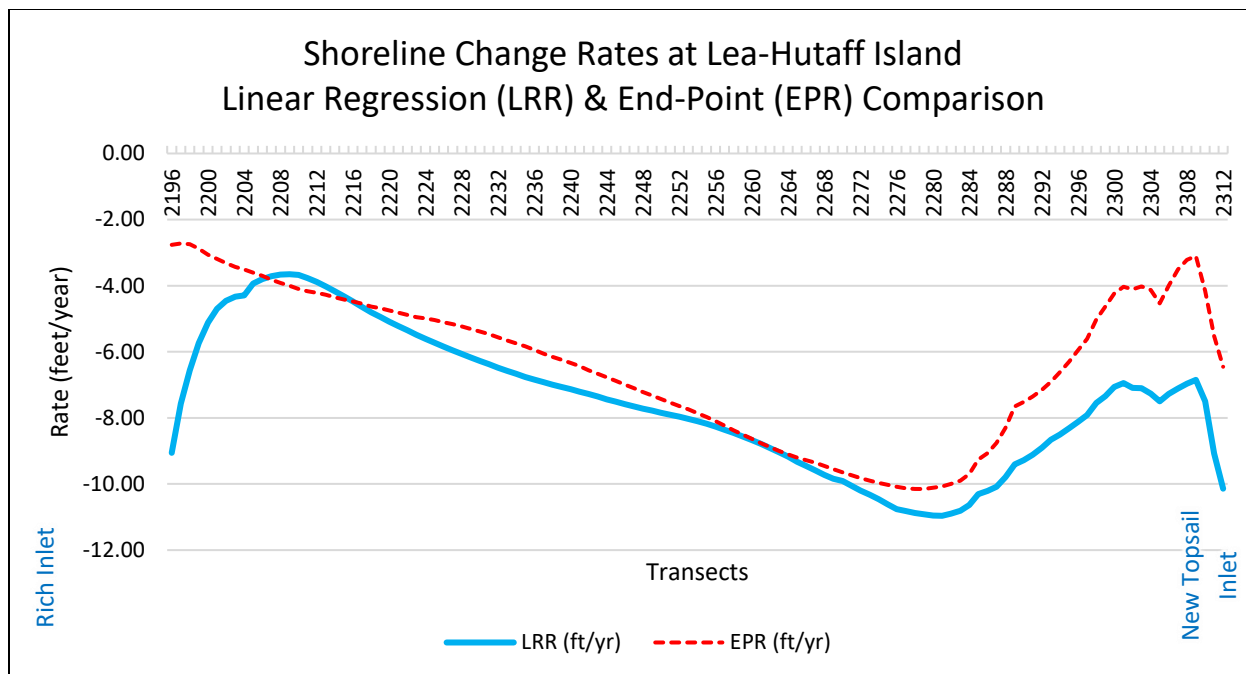


Figure 86. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

For setback factors within the proposed updated Inlet Hazard Area, refer to the report titled “*NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.*”

3.15 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).

Topsail Beach has been the recipient of small-scale beach fill projects that started in 1982; however, it wasn’t until 2011 when a large-scale project was installed that span most of the Town’s ocean shoreline. Since, the project area has received maintenance that occurred in 2015 and 2019. Collectively, these projects have artificially influenced shoreline position over time.

This analysis assessed twenty-five shorelines (**Figure 89**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 189 feet (oceanfront) to a maximum of 1,946 feet (inlet), with an average of 475 feet for the entire shoreline between New Topsail Inlet and the Town’s northern limit near transect 2478. However, within the Ocean Erodible Area between transects 2342 and 2478 (excluding areas inside the 2025 updated IHA proposed boundary), the shoreline envelope varied from 189 to 1,472 feet, averaging 299 feet. For the same respective areas, the calculated average relative standard deviation of shoreline position was 123 feet overall and 67 feet for the OEA alone. Of the 4.8 miles of shoreline analyzed, approximately 1 mile (48%) resulted in measured erosion where rates averaged less than one (-1) foot per year between transects-2355 and -2386.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 90**). The end-point method resulted in a range of shoreline line change rates between +1.2 and +8.3 feet per year, averaging +2.8 feet per year; and the least squares

regression method resulted in a range of shoreline line change rates between -1.1 and +6.2 feet per year, averaging less than 1 foot per year. Both approaches result in a blocked erosion rate setback factors of two (2), which are consistent with previous studies for this section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement; however, it does not impact on the updated setback factors compared to previous studies. Using this approach, the calculated setback factors within the OEA remain at two (2) feet per year between transects 2342 and 2478, and outside of the 2025 updated Inlet Hazard Areas proposed boundaries (**Figure 91 to Figure 94 & Table 16**). For setback factors within the proposed updated Inlet Hazard Area, refer to the report titled “*NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.*”

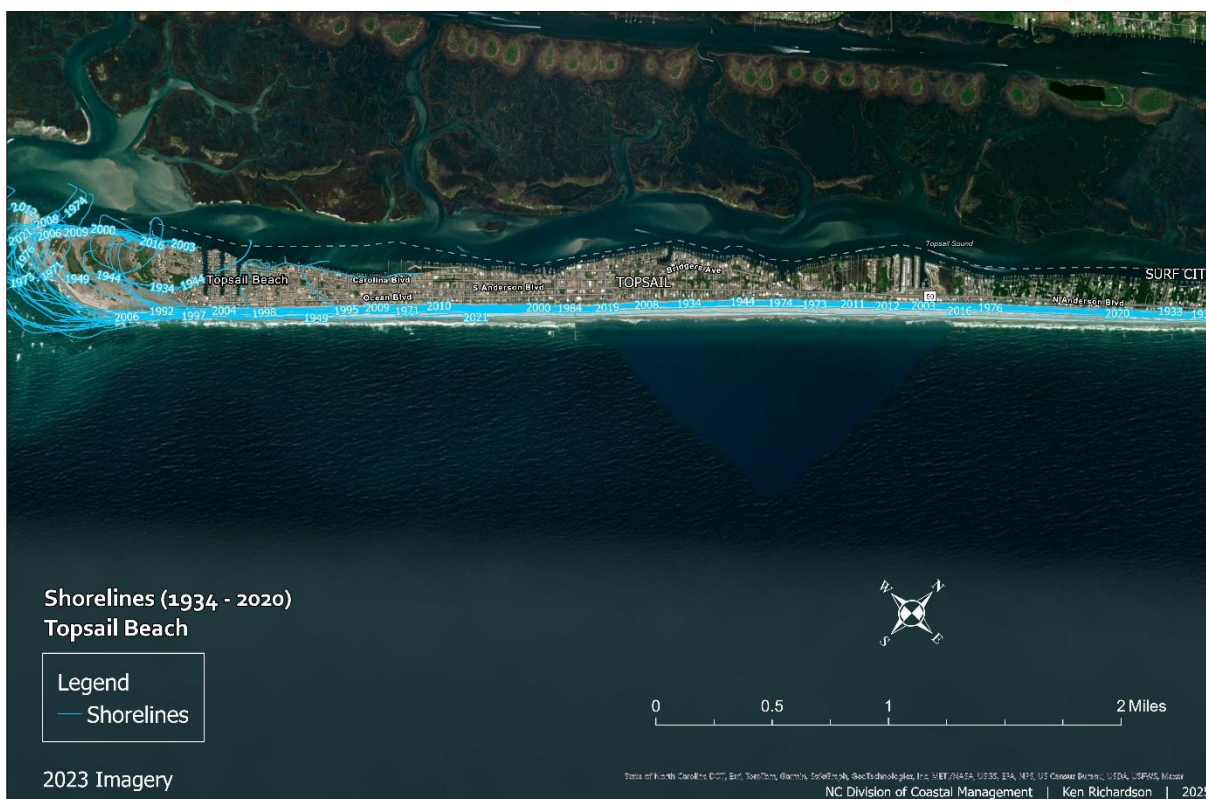


Figure 89. Shorelines included in the analysis (1934-2020) at Topsail Beach.

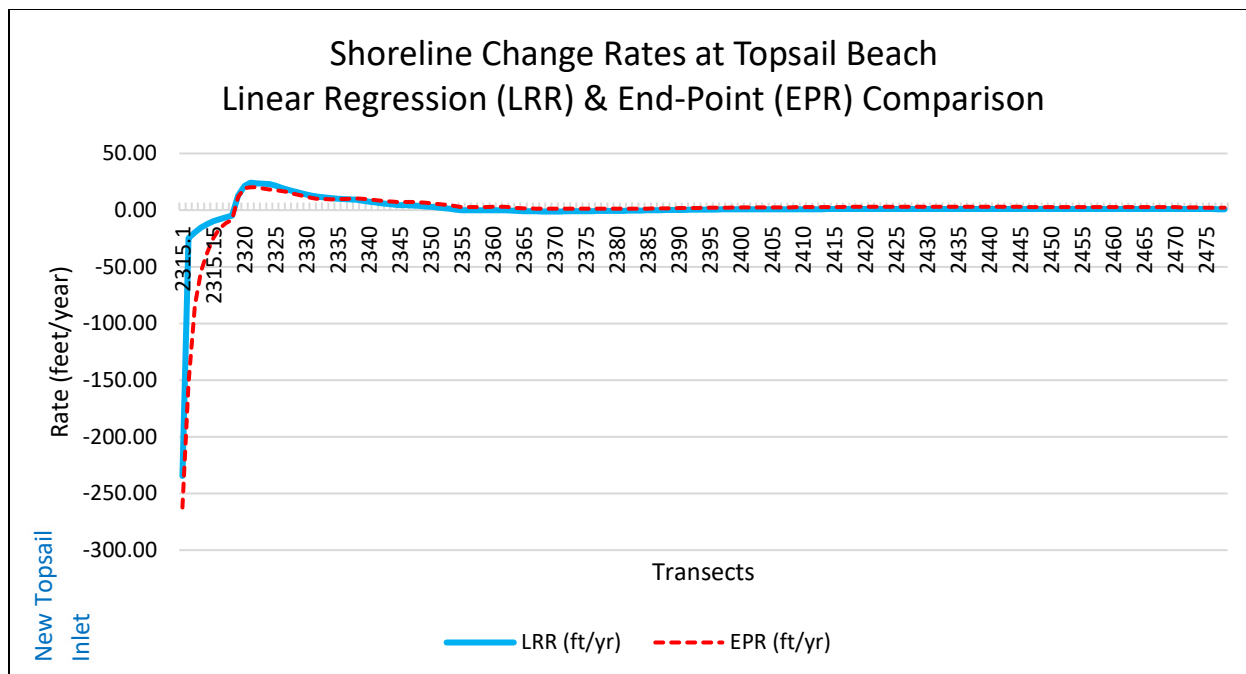


Figure 90. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

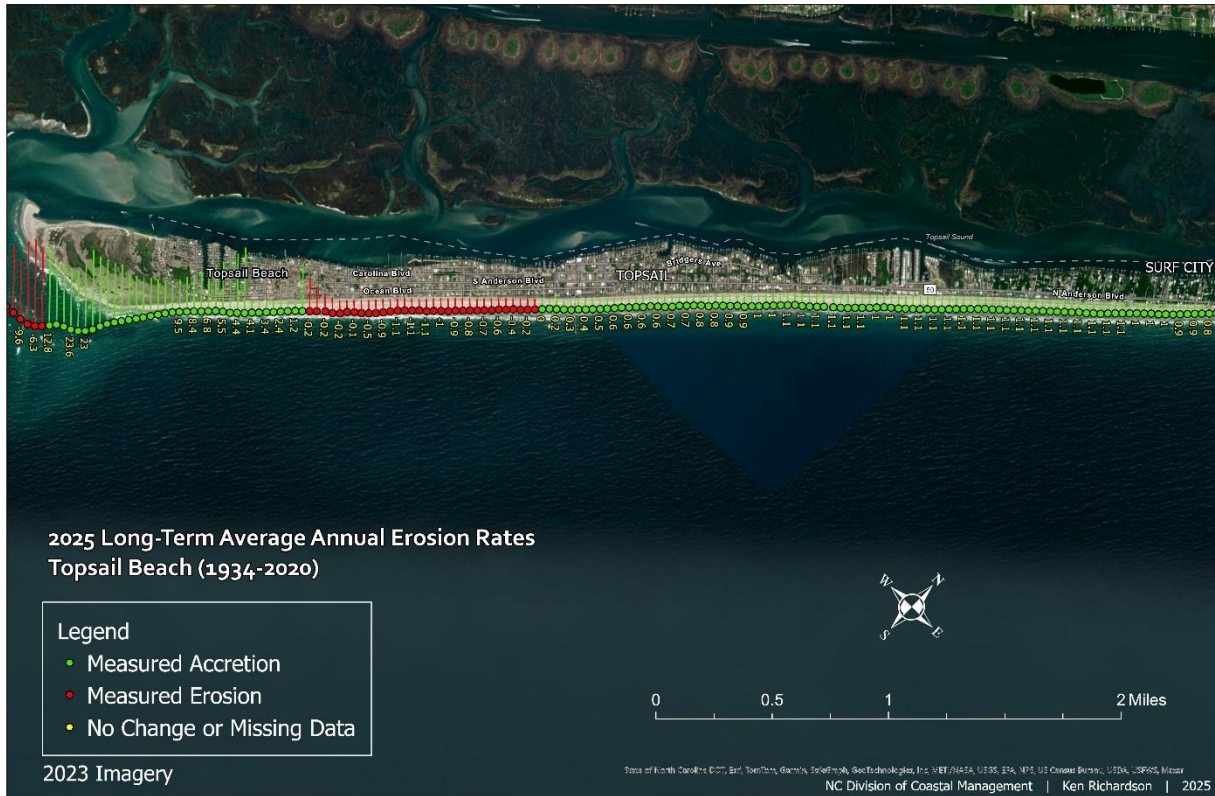


Figure 91. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

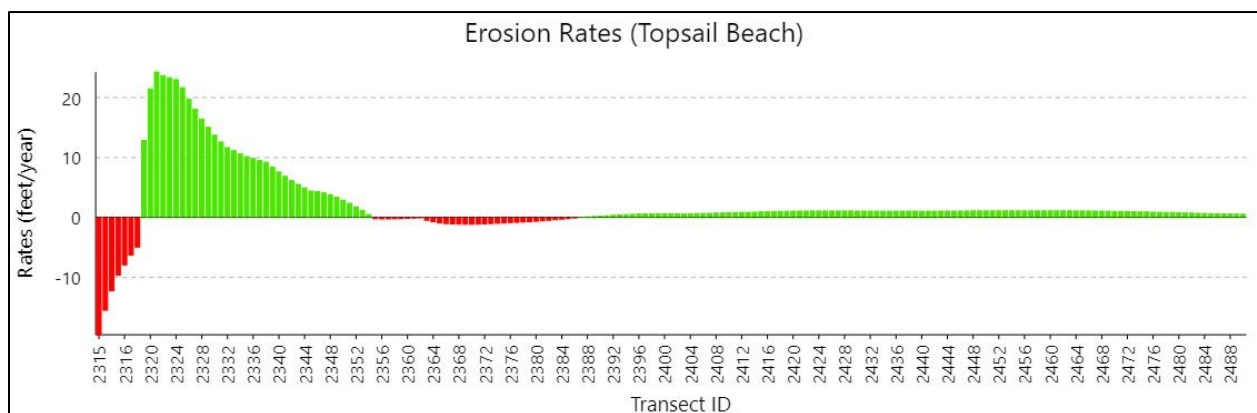


Figure 92. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

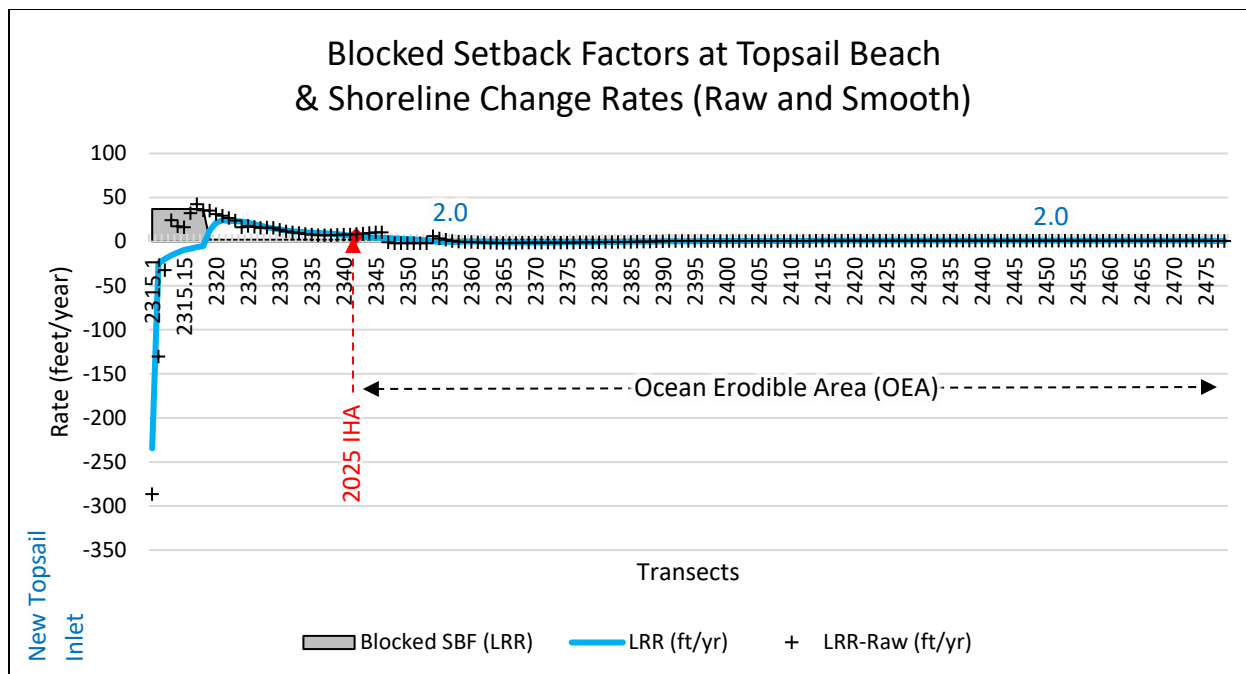


Figure 93. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

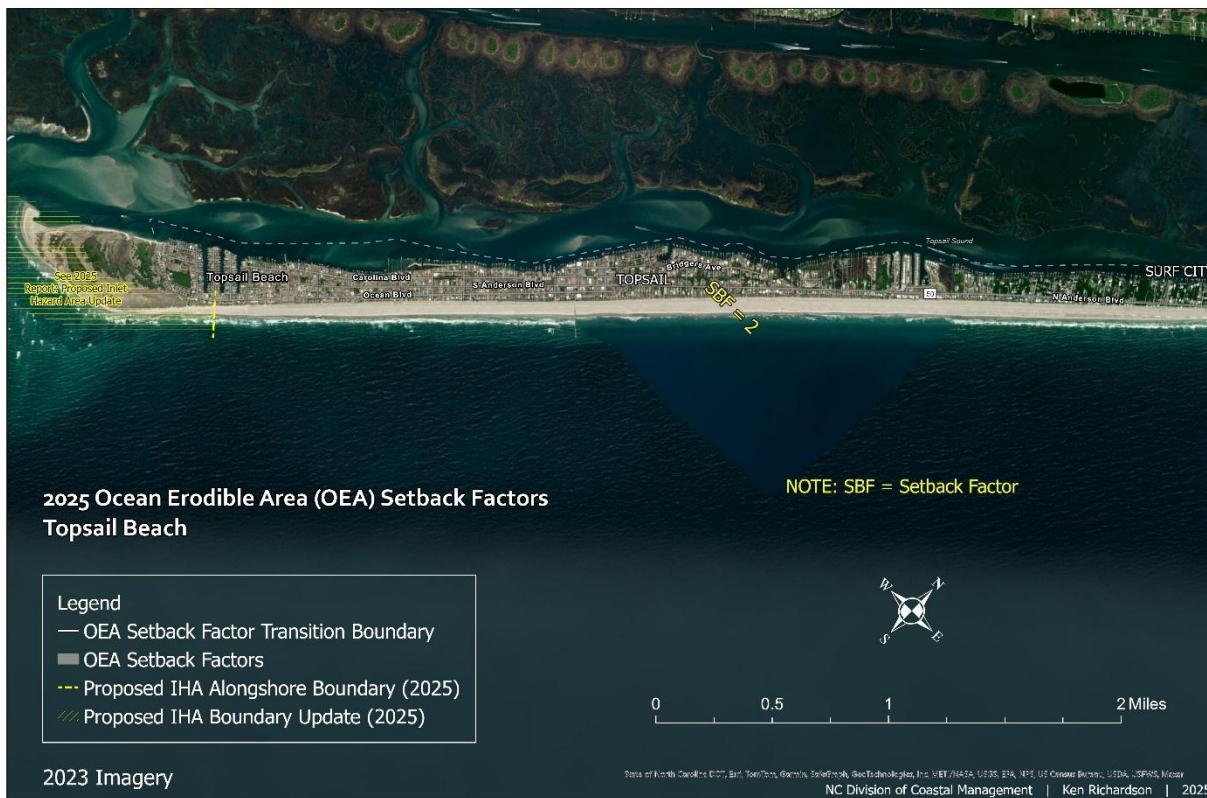


Figure 94. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Topsail Beach. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

Table 16. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.16 Surf City

The ocean shoreline at Surf City spans approximately 6.0 miles. In 2020 a portion was the recipient of its first and only large-scale beach fill project.

This analysis assessed twenty-five shorelines (**Figure 95**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 63 feet to a maximum of 173 feet, with an average of 98 feet. For the same area, the calculated standard deviation of relative shoreline position ranged between 19 and 39, with an average of 26 feet. Of the 4.8 miles of shoreline analyzed, approximately 1 mile (48%) resulted in measured erosion where rates averaged less than one (-1) foot per year between transects-2355 and -2386.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 96**). The end-point method resulted in a range of shoreline line change rates between less than 1 and +2.0 feet per year, averaging less than 1 foot per year; and the least squares regression method resulted in an average of less than 1 foot per year. Both approaches result in a blocked erosion rate setback factors of two (2), which are consistent with previous studies for this section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement; however, it does not impact on the updated setback factors compared to previous studies. Using this approach, the calculated setback factors within the OEA remain at two (2) feet per year between transects 2479 and 2672 (**Figure 97 to Figure 100 & Table 17**).

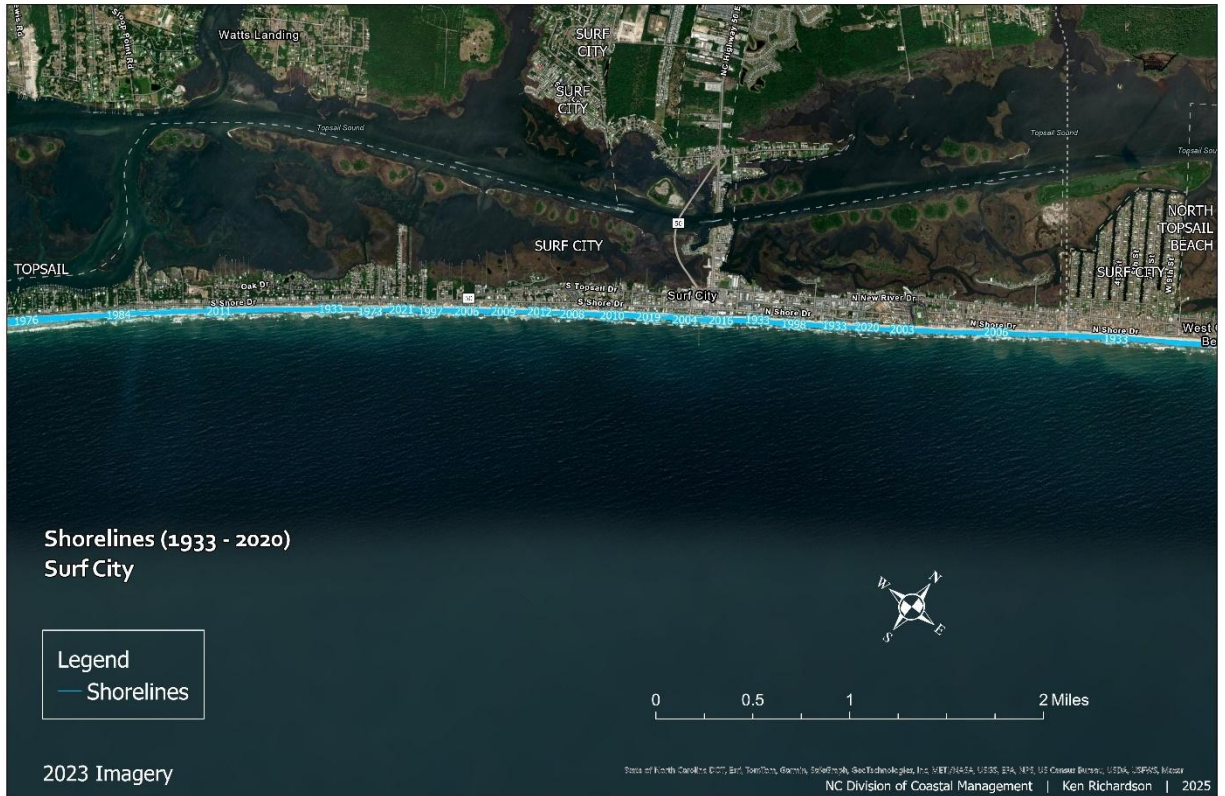


Figure 95. Shorelines included in the analysis (1933-2020) at Surf City.

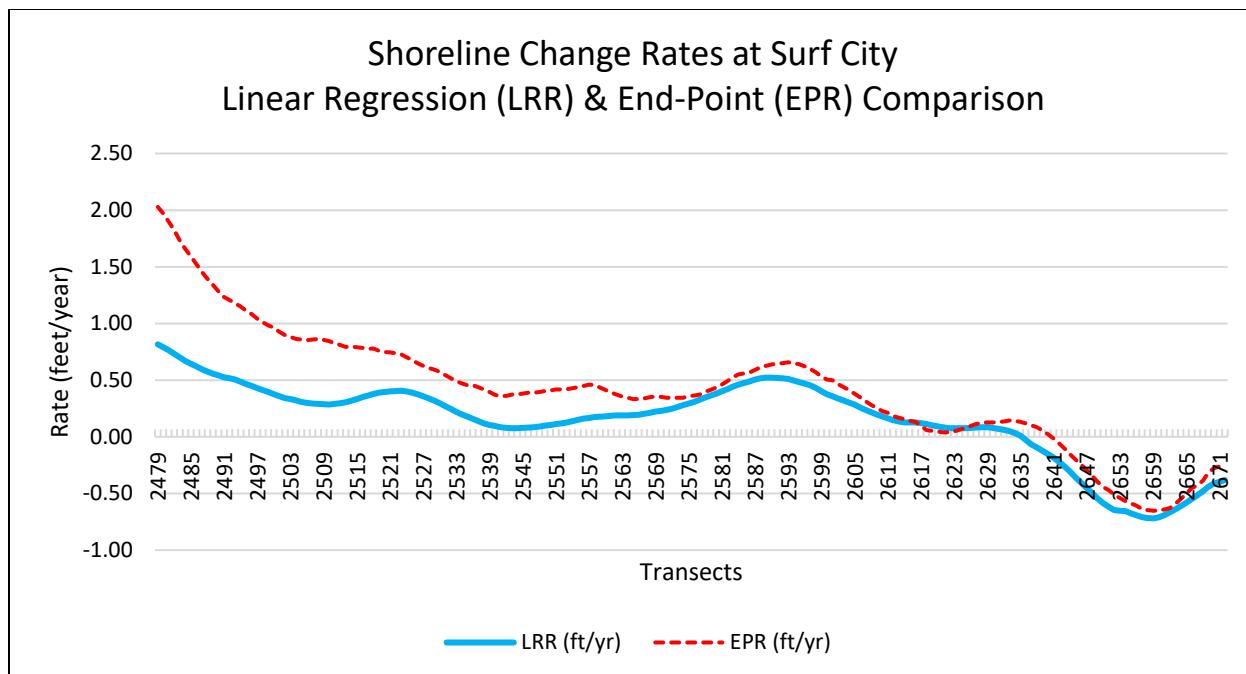


Figure 96. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

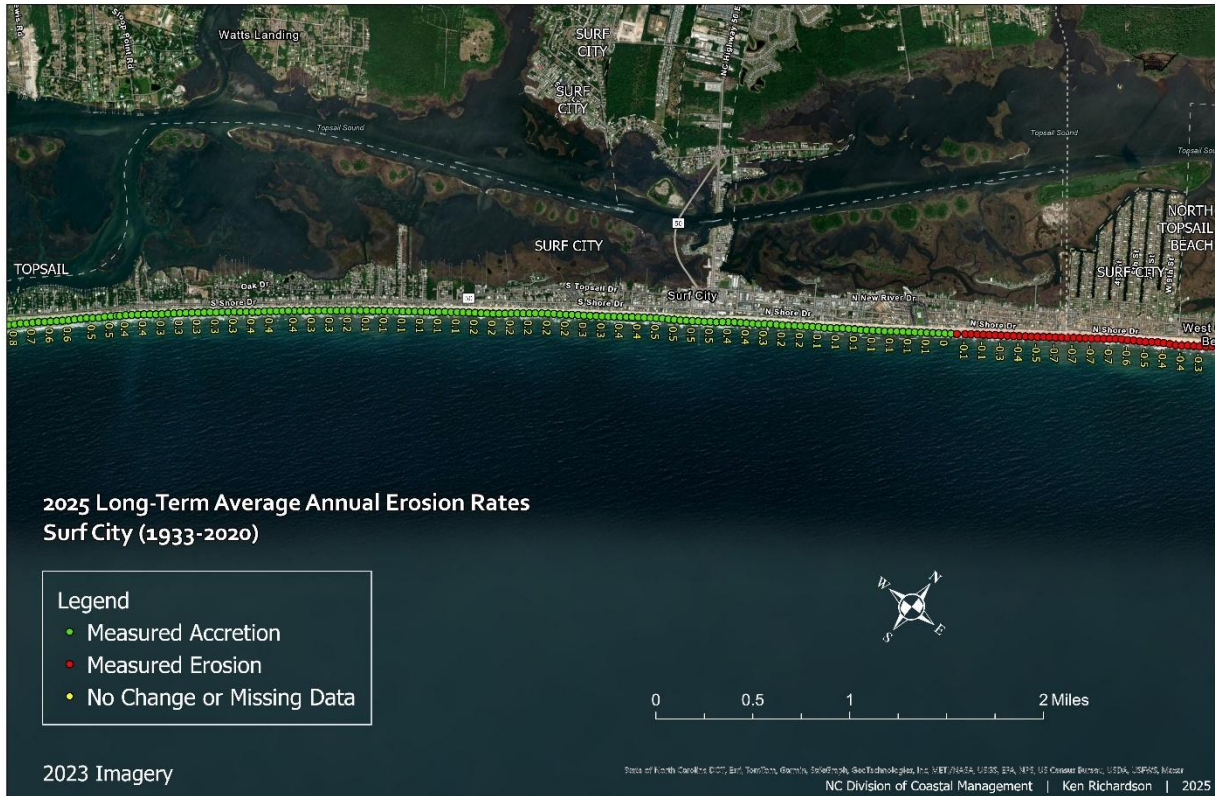


Figure 97. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

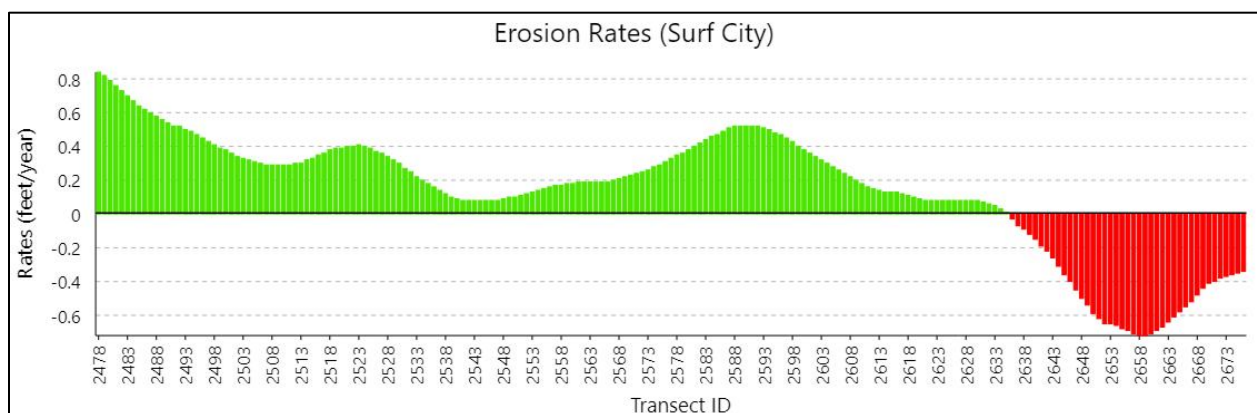


Figure 98. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

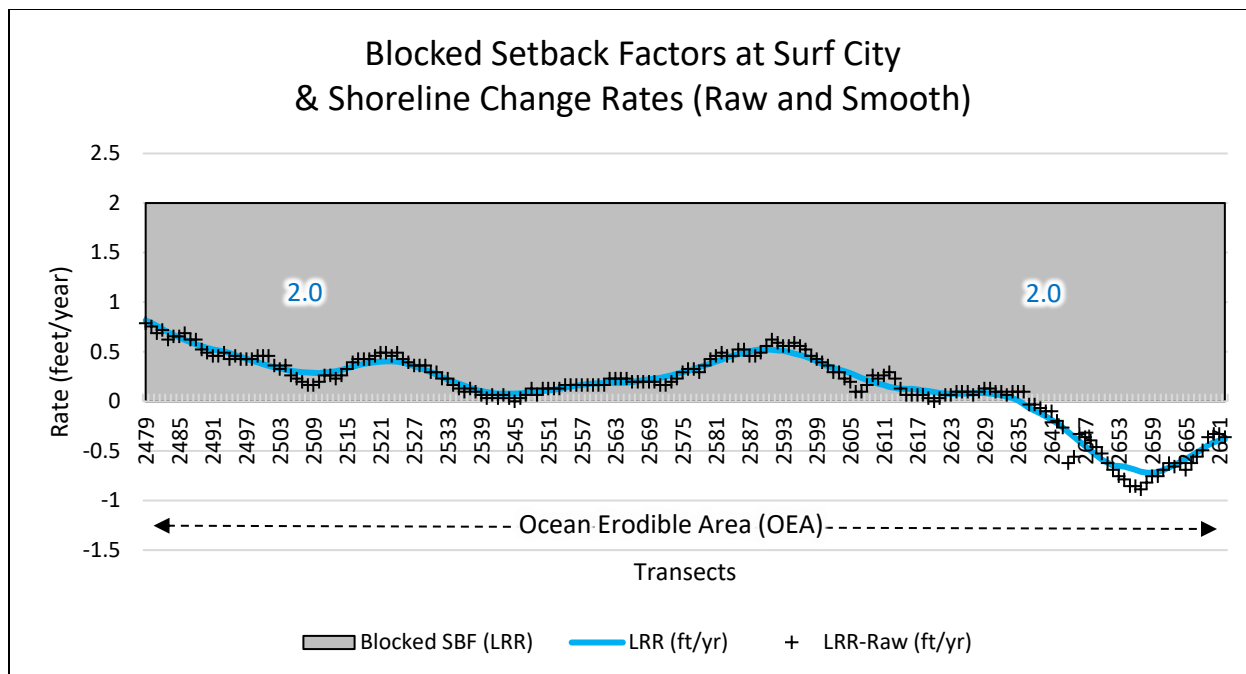


Figure 99. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 100. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Surf City. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

Table 17. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.17 North Topsail Beach

The oceanfront shoreline at North Topsail Beach stretches approximately 11.1 miles. While a few localized small-scale beach fill projects were implemented on portions of the shoreline beginning in 1997, large-scale beach nourishment did not occur until 2013. This was followed by maintenance efforts in 2015 and 2016. In addition to the installation of sandbag structures near New River Inlet, these projects have artificially altered shoreline positions over time, consequently affecting shoreline change rates.

This analysis assessed twenty-three shorelines (**Figure 101**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 68 feet (oceanfront) to a maximum of 2,838 feet (inlet), with an average of 184 feet for the entire shoreline between the Town's southern limit and New River Inlet. However, within the Ocean Erodeable Area between transects-2673 and -2999 (excluding areas inside the 2025 updated IHA proposed boundary), the shoreline envelope varied from 68 to 257 feet, averaging 152 feet. For the same respective areas, the calculated average relative standard deviation of shoreline position was 52 feet overall and 44 feet for the OEA alone. Of the 11.1 miles of shoreline analyzed, all (100%) resulted in measured erosion where rates averaged less than two (-2) feet per year.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 102**). The end-point method resulted in a range of shoreline line change rates between -2.0 and less than +1.0 feet per year, averaging less than -1.0 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -2.8 and less than -1.0 feet per year, averaging -1.1 feet per year. Both approaches resulted in a blocked erosion rate setback factors of two (2); however, least squares regression resulted in a small section where erosion setback factors equaled three (3) feet per year. This was the only difference between the two methods; however, these results remain consistent with previous studies for this section of shoreline.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement and does not influence results for this section of shoreline that make this study different compared to previous studies. Using this approach, the calculated setback factors within the OEA remain at two (2) feet per year between transects 2342 and 2940, transitions to three (3) feet per year between transects 2940 and 2967, then back to two (2) feet per year at transect 2967 and outside of the 2025 updated Inlet Hazard Areas proposed boundary. Compared to the current effective setback factors (2020), the areas between transects 2924 and 2939 will experience a decrease of 1 foot per year, while the area between transects 2962 and 2967 will experience a 1 foot per year increase (**Figure 103 to Figure 106 & Table 18**). For setback factors within the proposed updated Inlet Hazard Area, refer to the report titled, “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”



Figure 101. Shorelines included in the analysis (1933-2020) at North Topsail Beach.

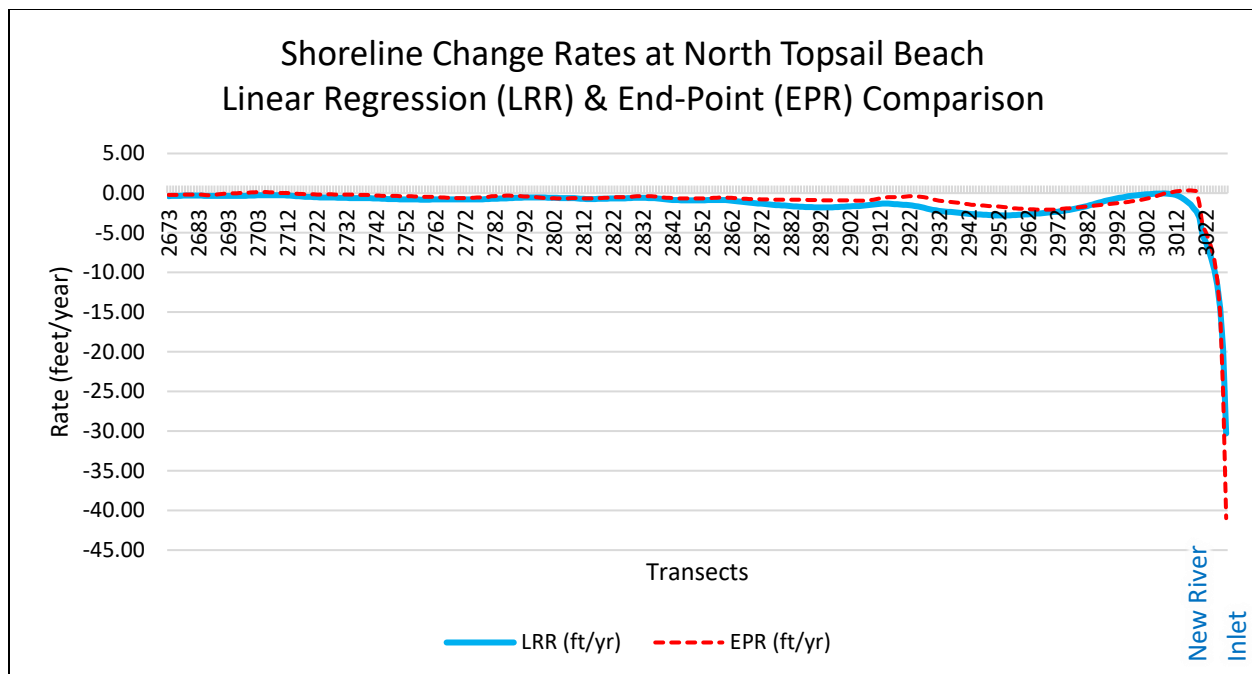


Figure 102. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

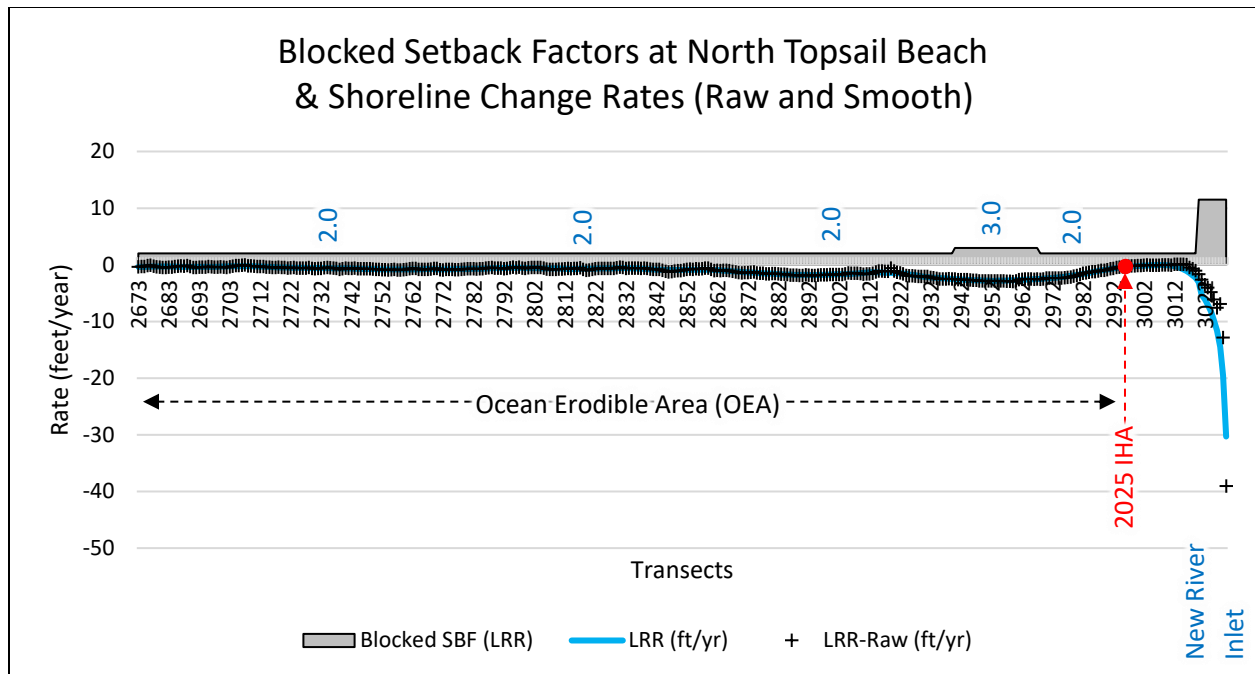


Figure 105. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

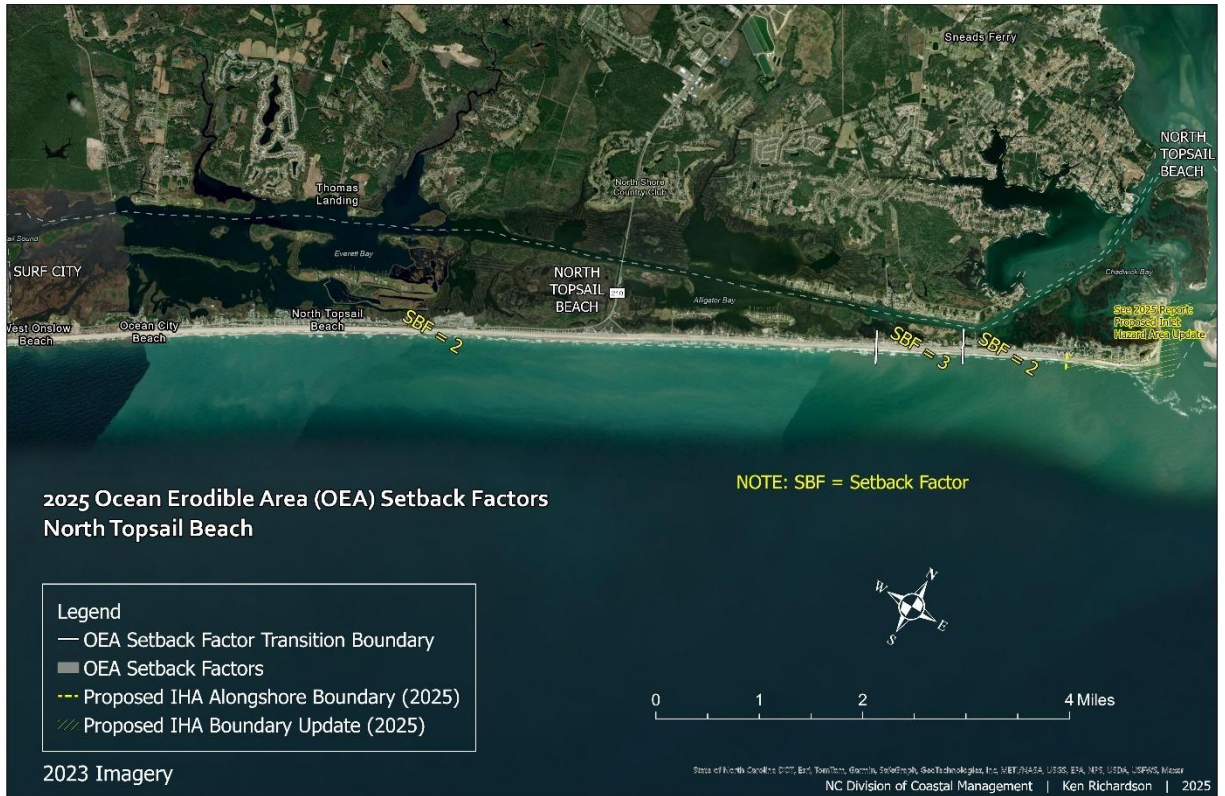


Figure 106. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at North Topsail Beach. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|--------|-----------|------|------------|------|------|
| Setback Factor (SBF) | 2, 3 | 2, 3 | 2, 2.5 | 2, 3, 3.5 | 2, 3 | 2, 3, 4, 5 | 2, 3 | 2.5 |

Table 18. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3. 18 Onslow Beach

Onslow Beach has approximately 7.3 miles of oceanfront shoreline, is east-facing and flanked by New River Inlet to the south and Brown's Inlet to the north. Here, the analysis assessed nineteen shorelines (**Figure 107**) along this oceanfront section over an 86-year period, from 1934 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 68 feet (oceanfront) to a maximum of 1,561 feet (inlet), with an average of 470 feet for the entire shoreline between New River Inlet and Brown's Inlet. The calculated relative standard deviation of shoreline position ranged between 21 and 412 feet, and an average of 130 feet. Of the 7.3 miles of shoreline analyzed, approximately 5.5 (75%) resulted in measured erosion where rates ranged between -12.6 and less than -1 feet per year and averaged five (-5) feet per year.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 108**). The end-point method resulted in a range of shoreline line change rates between -16.8 and +4.2 feet per year, averaging -3.3 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -12.6 and +6.5 feet per year, and averaging -3.0 feet per year. Both approaches resulted in similar blocked erosion rate setback factors. End-point setback factors ranged from two (2) to eleven (11) feet per year, and least squares regression ranged from two (2) to thirteen (13) feet per year.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement and does not influence results for this section of shoreline that make this study significantly different compared to previous studies. Using this approach, the calculated setback factors within the OEA range from two (2) to thirteen (13) feet per year (**Figure 109 to Figure 112 & Table 19**).



Figure 107. Shorelines included in the analysis (1934-2021) at Onslow Beach.

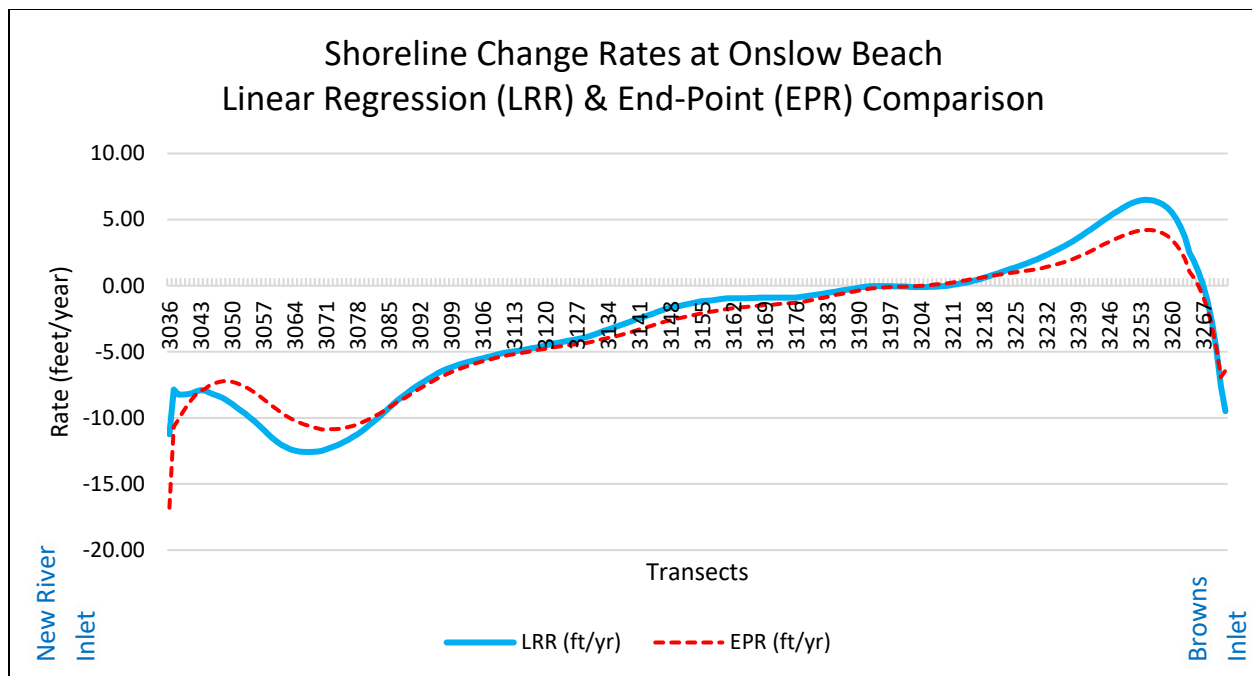


Figure 108. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 109. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

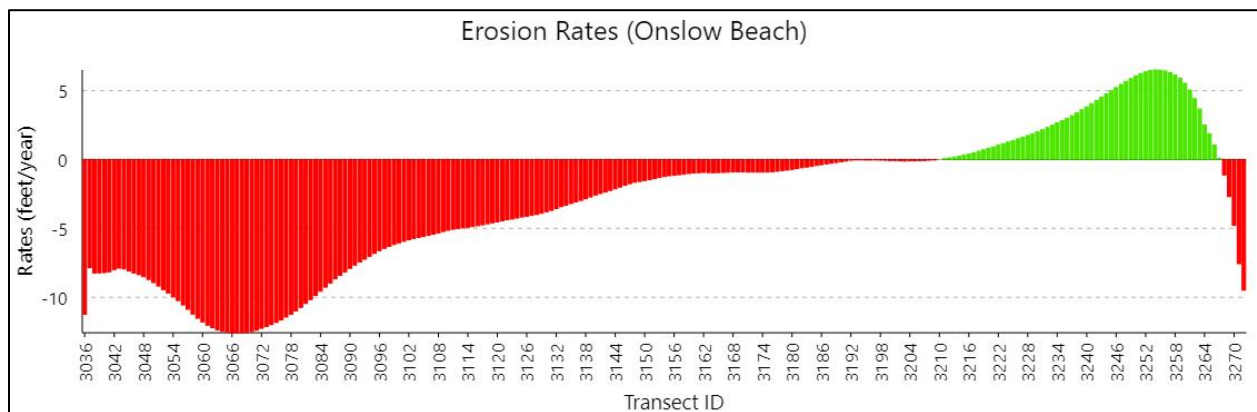


Figure 110. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

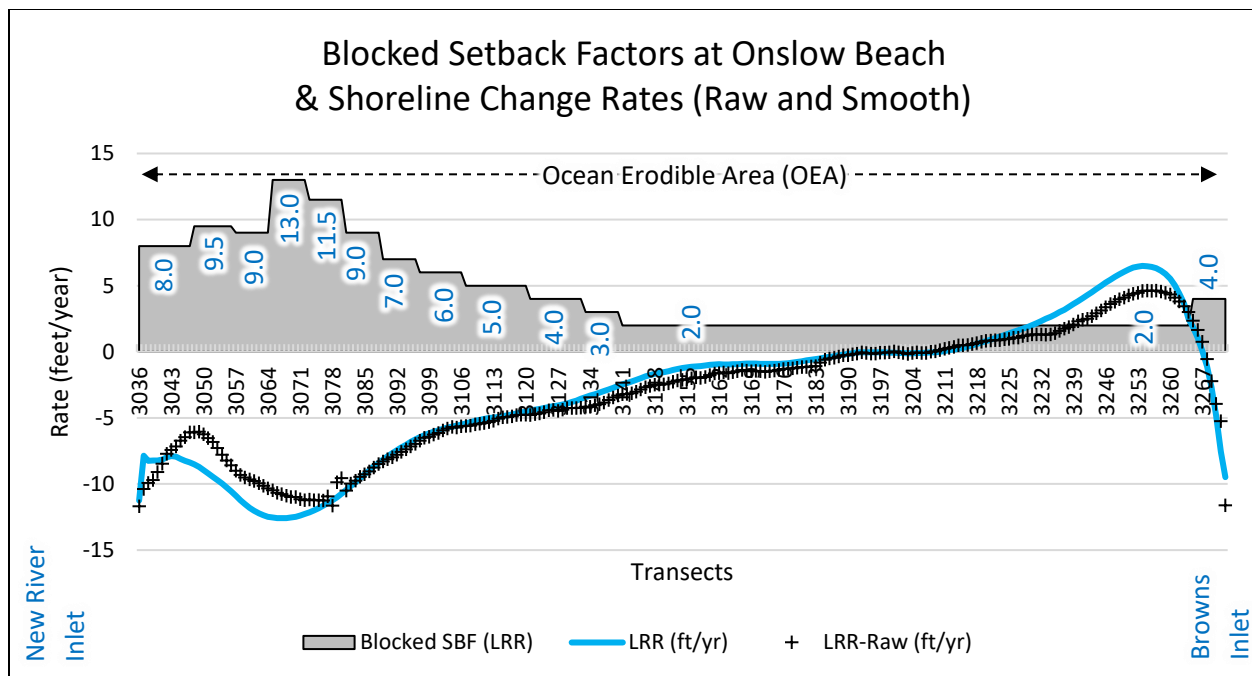


Figure 111. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

3.19 Brown's Island

Brown's Island features approximately 3.3 miles of east-facing oceanfront shoreline, bordered by Brown's Inlet to the south and Bear Inlet to the north. As the coastline transitions from Cape Fear to Cape Lookout, this area marks the point where the shoreline begins to shift to a more southerly orientation.

Here, the analysis assessed sixteen shorelines (**Figure 113**) along this oceanfront section over an 86-year period, from 1934 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 229 feet (oceanfront) to a maximum of 1,010 feet (inlet), with an average of 363 feet for the entire shoreline between Brown's Inlet and Bear Inlet. The calculated relative standard deviation of shoreline position ranged between 63 and 279 feet, and an average of 104 feet. Of the 3.3 miles of shoreline analyzed, all 3.3 (100%) resulted in measured erosion where rates ranged between -5.4 and less than -1 feet per year and averaged -3.1 feet per year.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 114**). The end-point method resulted in a range of shoreline line change rates between -4.7 and less than 1 feet per year, averaging -2.5 feet per year. Both approaches resulted in similar blocked erosion rate setback factors. End-point setback factors ranged from two (2) to four (4) feet per year, and least squares regression ranged from two (2) to five (5) feet per year.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement and does not influence results for this section of shoreline that make this study significantly different compared to previous studies. Using this approach, the calculated setback factors within the OEA range from two (2) to five (5) feet per year (**Figure 115 to Figure 118 & Table 20**).



Figure 113. Shorelines included in the analysis (1934-2021) at Brown's Island.

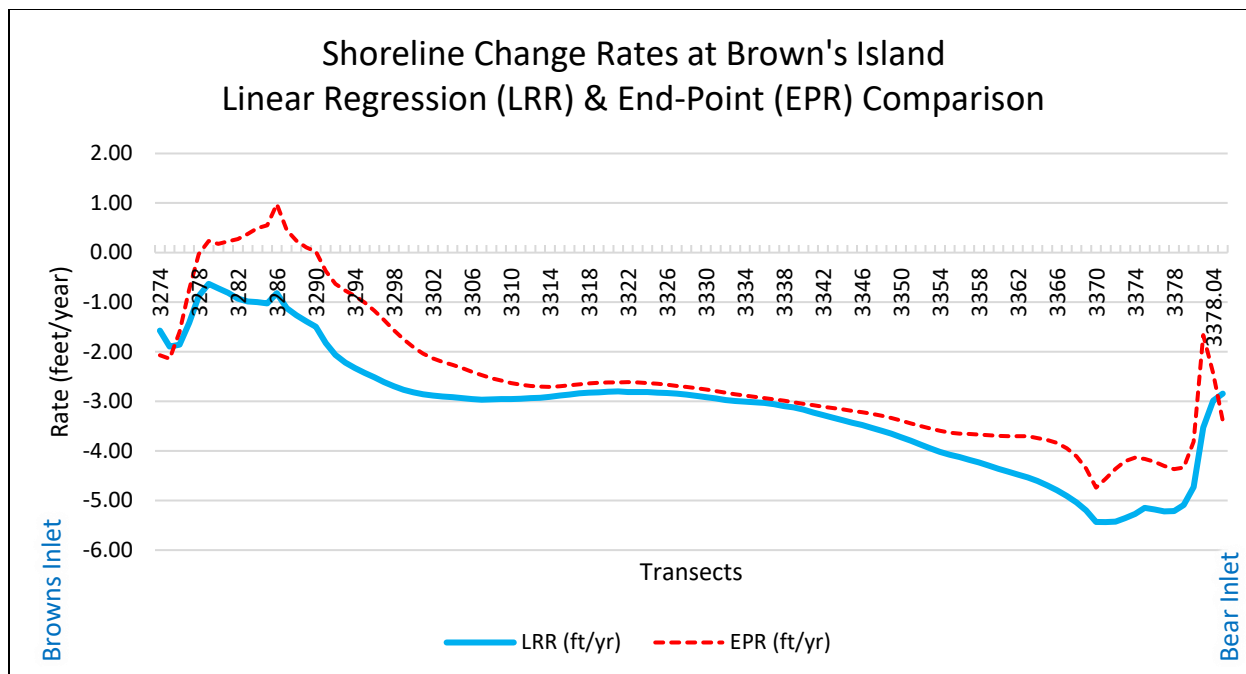


Figure 114. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

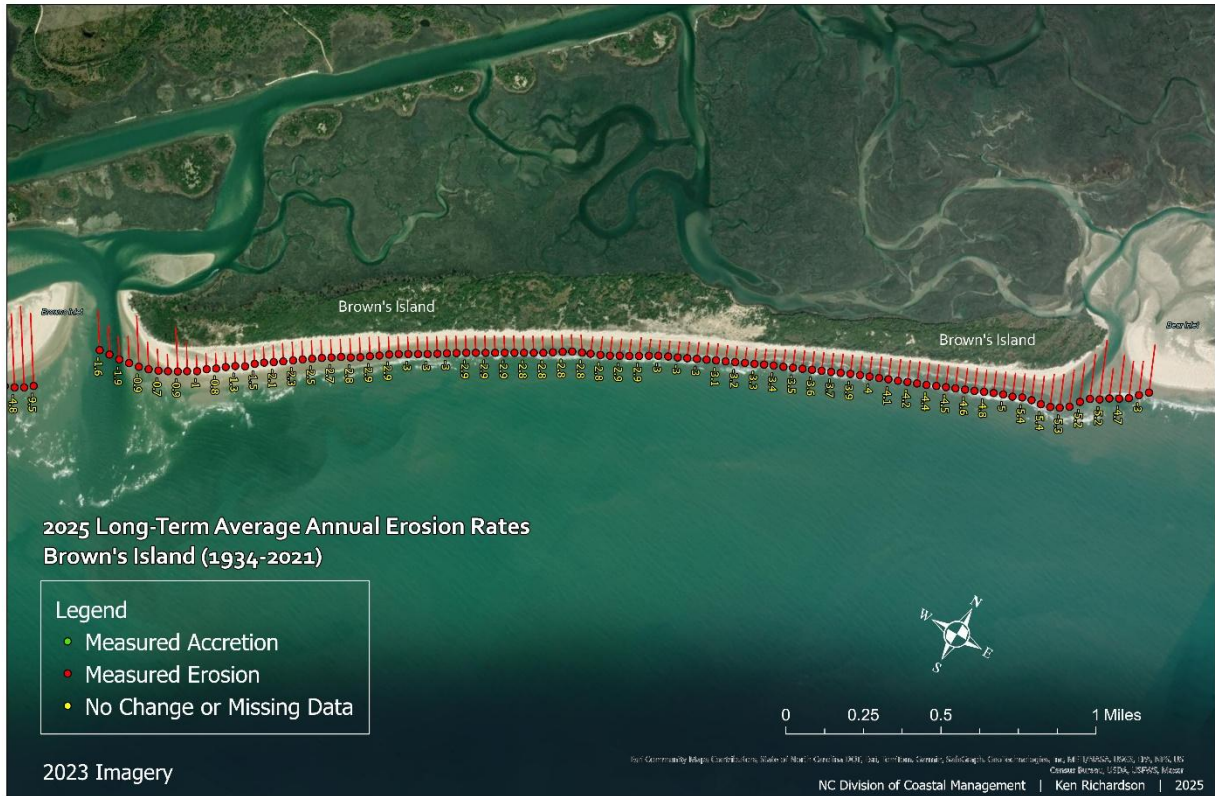


Figure 115. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

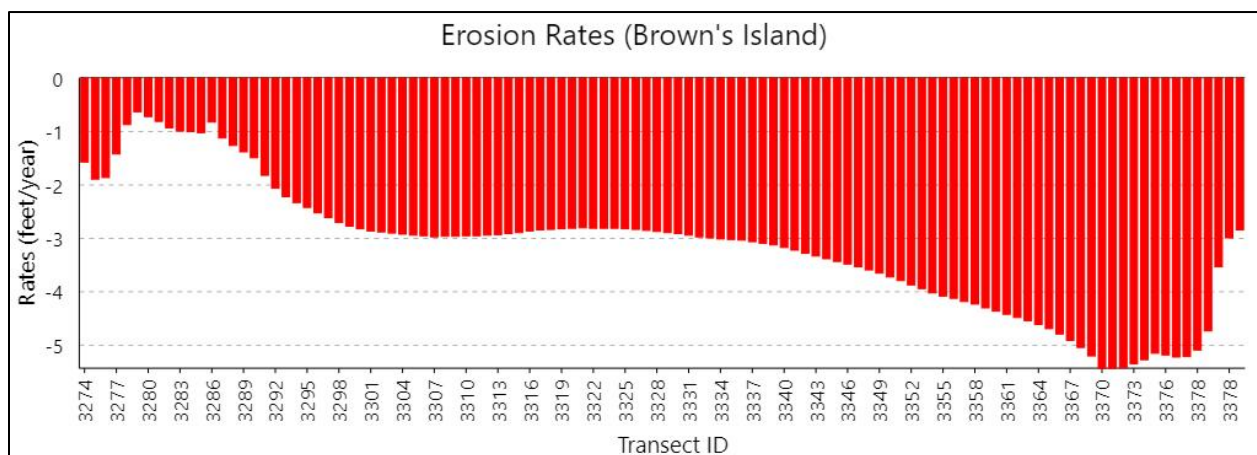


Figure 116. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

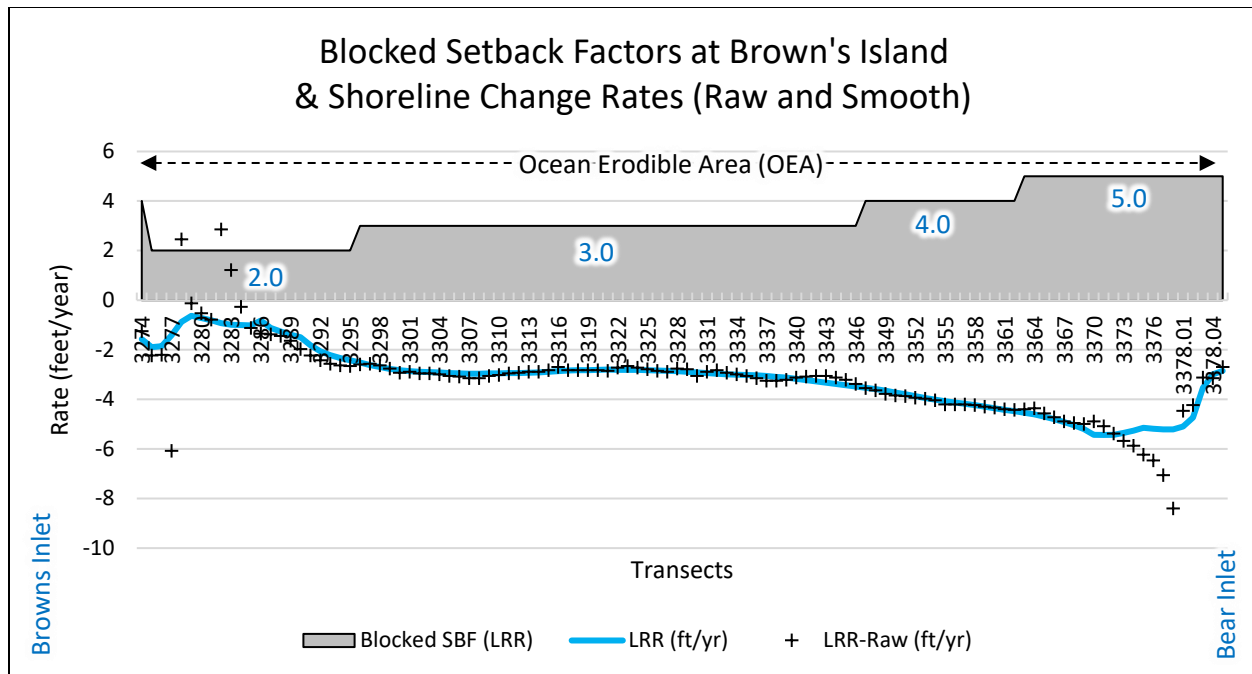


Figure 117. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

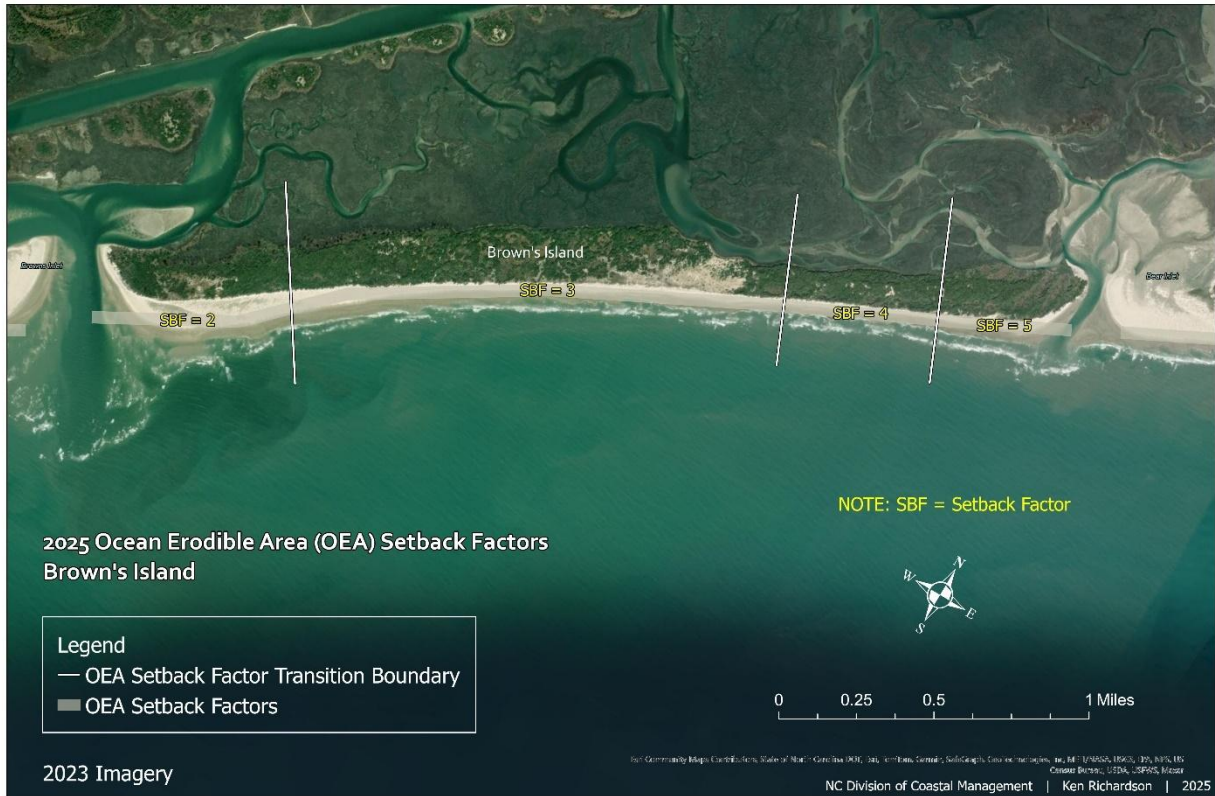


Figure 118. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Brown's Island.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|-----------------|------------------|-----------------|-----------------|-------------------|-----------------|-----------------|------|
| Setback Factor (SBF) | Range 2 to 5 | Range 2 to 14 | Range 2 to 6 | Range 2 to 7 | Range 3 to 7.5 | Range 3 to 5 | Range 2 to 3 | 2 |

Table 20. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.20 Bear Island (Hammocks Beach State Park)

Bear's Island (Hammocks Beach State Park) features approximately 3.0 miles of south-facing oceanfront shoreline, bordered by Bear Inlet to the south and Bogue Inlet to the north.

Here, the analysis assessed sixteen shorelines (**Figure 119**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 280 feet (oceanfront) to a maximum of 2,515 feet (inlet), with an average of 810 feet for the entire shoreline between Bear Inlet and Bogue Inlet. The calculated relative standard deviation of shoreline position ranged between 69 and 922 feet, and an average of 222 feet. Of the 3.0 miles of shoreline analyzed, approximately 2.3 miles (77%) resulted in measured erosion.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 120**). However, the area near Bogue Inlet exhibited exceptionally high erosion rates due to the presence of spit formations, which are often temporary features and likely skew the results. To account for this, data from transects 3483.01 and 3483.19 (the last 18 transects) has been excluded from this comparison. Between transects 3379 and 3481, the end-point method resulted in a range of shoreline line change rates between -1.9 and +11.3 feet per year, averaging +1.7 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -4.7 and +21.8 feet per year, averaging less than 1 foot per year. Both approaches resulted in similar blocked erosion rate setback factors. End-point setback factors equal two (2) feet per year, and the least squares regression ranged from two (2) to four (4) feet per year.

Adopting the least squares regression methodology offers a more accurate representation of long-term shoreline movement and does not influence results for this section of shoreline that make this study significantly different compared to previous studies. Using this approach, the calculated setback factors within the OEA range from two (2) to four (4) feet per year. By including the shoreline positions transitioning into Bogue Inlet (transects 3482 to 3483.19),

setback factors increase significantly from 4.5 to 25 feet per year (Figure 121 to Figure 124 & Table 21).



Figure 119. Shorelines included in the analysis (1933-2020) at Bear Island (Hammocks Beach State Park).

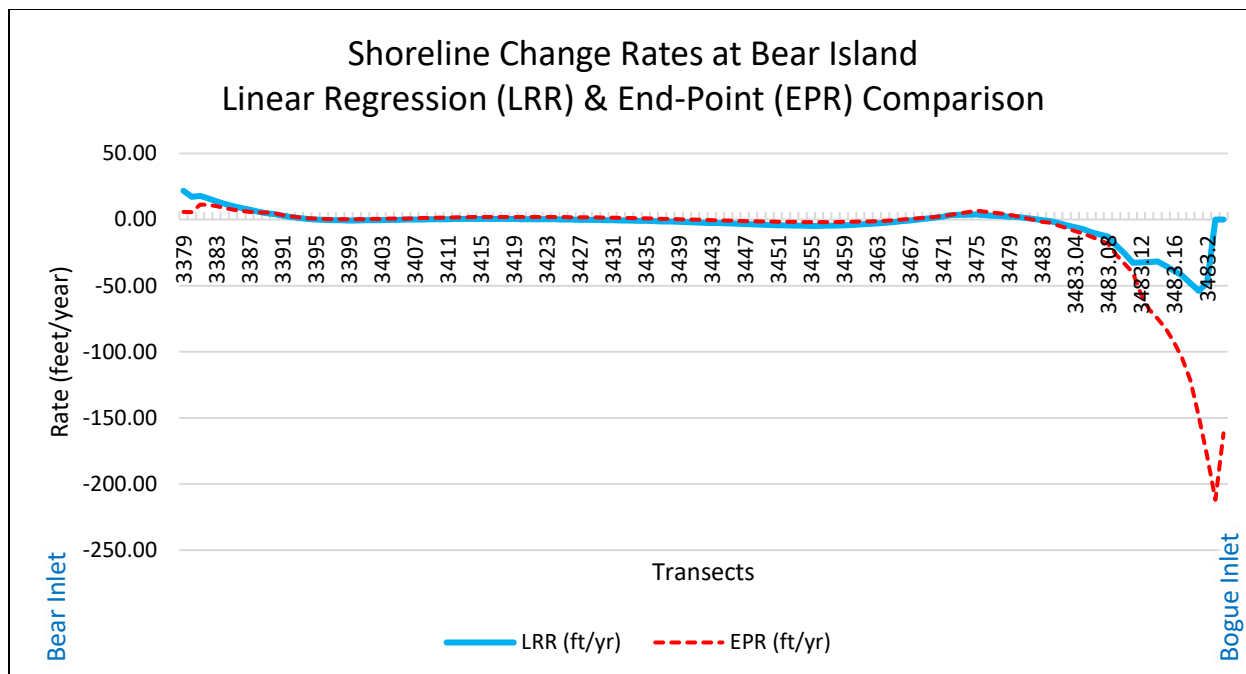


Figure 120. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 121. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

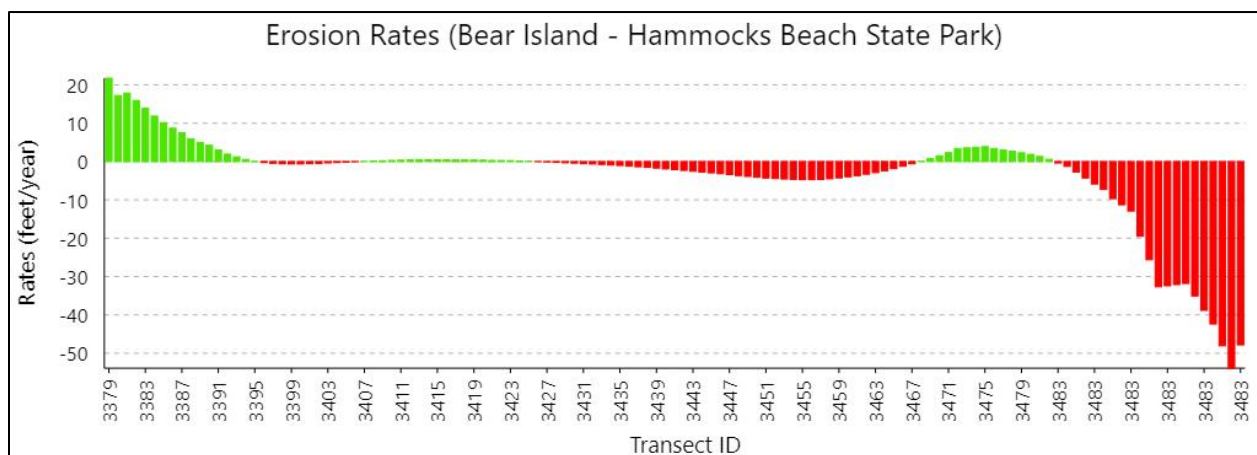


Figure 122. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

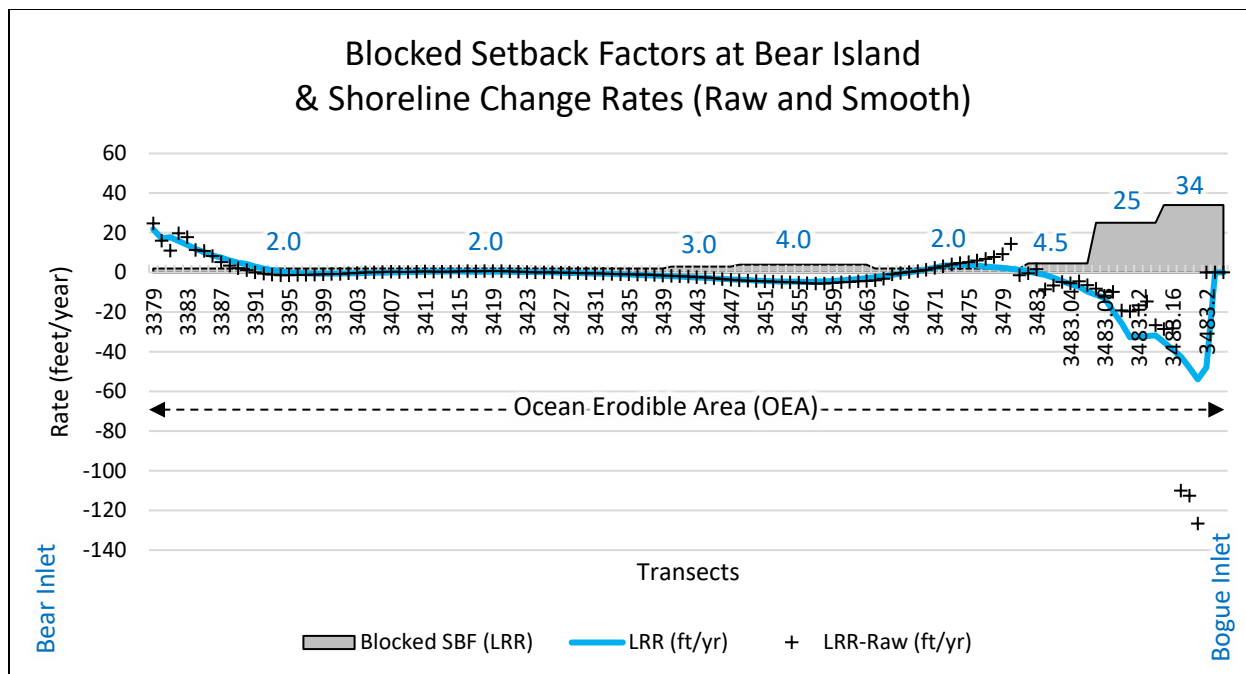


Figure 123. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 124. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Bear Island (Hammocks Beach State Park). For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|---|-------------------|-------------------|-----------------|------|------|------|------|
| Setback Factor (SBF) | Range 2 to 4 (Note: 25 at inlet) | Range 2 to 4.5 | Range 2 to 3.5 | Range 2 to 4 | 2 | 2 | 2 | 2 |

Table 21. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.21 Emerald Isle

Bogue Banks is a south-facing barrier island featuring nearly 25 miles of oceanfront shoreline, encompassing five townships and a state park. Emerald Isle accounts for approximately 11.2 miles (49%) of this shoreline. As part of the Bogue Banks Restoration Project, the eastern portion of Emerald Isle has undergone nourishment four times (2004, 2007, 2013, and 2019) following the initiation of a large-scale project in 2003. In 2020, a similar large-scale project was implemented on the western portion. Collectively, these efforts have helped shape shoreline positions and reduce erosion rates.

This analysis assessed nineteen shorelines (**Figure 125**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 97 feet (oceanfront) to a maximum of 2,996 feet (inlet), with an average of 226 feet for the entire shoreline between Bogue Inlet and the Town's eastern limit near transect-3846. However, within the Ocean Erovable Area between transects-3526 and -3846 (excluding areas inside the 2025 updated IHA proposed boundary), the shoreline envelope varied from 97 to 326 feet, averaging 149 feet. For the same respective areas, the calculated average relative standard deviation of shoreline position was 63 feet overall and 42 feet for the OEA alone. Of the 11.2 miles of shoreline analyzed, 2.8 miles (25%) resulted in measured erosion where rates averaged less than two (-2) feet per year.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 126**). The end-point method resulted in a range of shoreline line change rates between -1.7 and less than +2.0 feet per year, averaging less than 1.0 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -1.1 and less than -1.1 feet per year, averaging less than 1.0 feet per year. Between transects 3526 and 3846, and outside the 2025 updated IHA boundary proposed, each method resulted in blocked erosion rate setback factors of two (2), making these results consistent with previous studies for this section of shoreline; specifically, after beach nourishment began.

Using the least squares regression methodology provides a more accurate depiction of long-term shoreline movement; however, it does not alter the setback factor results for this section of shoreline in a way that distinguishes it from previous studies. Using this approach, the calculated setback factors within the OEA remain at two (2) feet per year between transects 3526 and 3846 (**Figure 127 to Figure 130 & Table 22**). For setback factors within the proposed updated Inlet Hazard Area, refer to the report titled *NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update*.

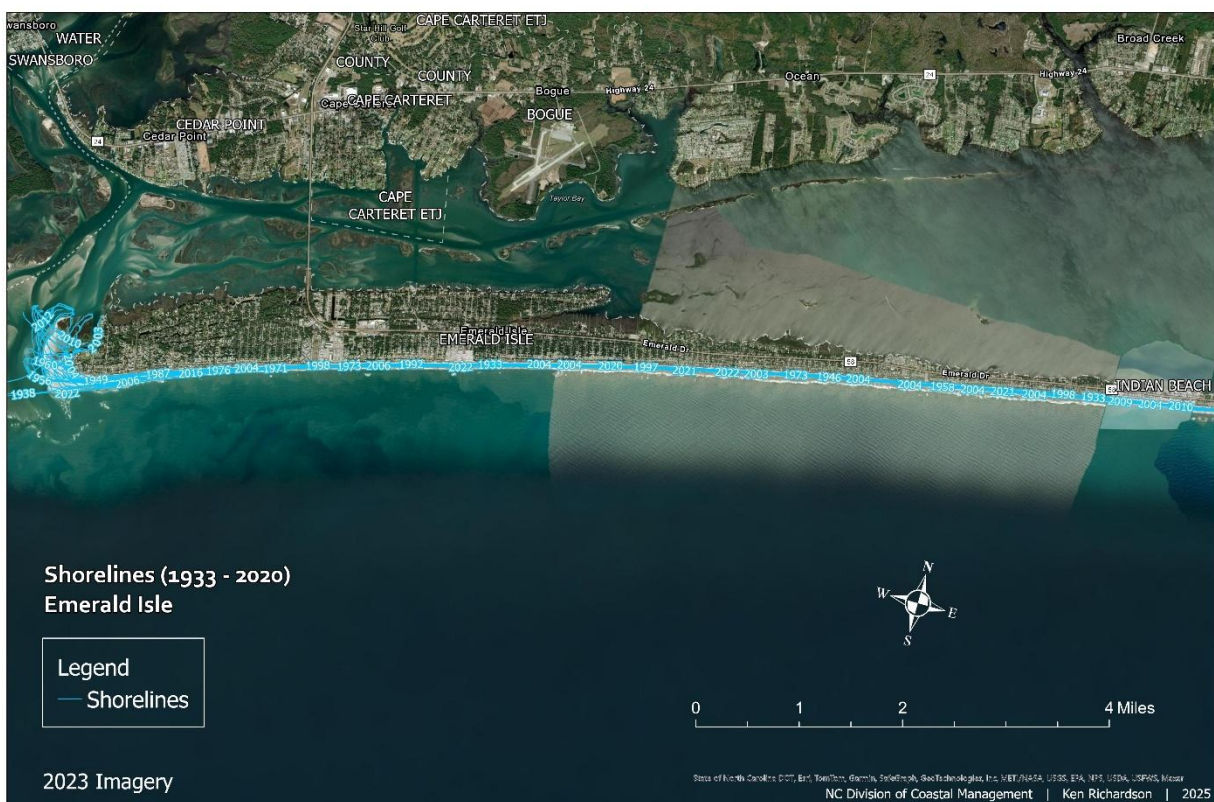


Figure 125. Shorelines included in the analysis (1933-2020) at Emerald Isle.

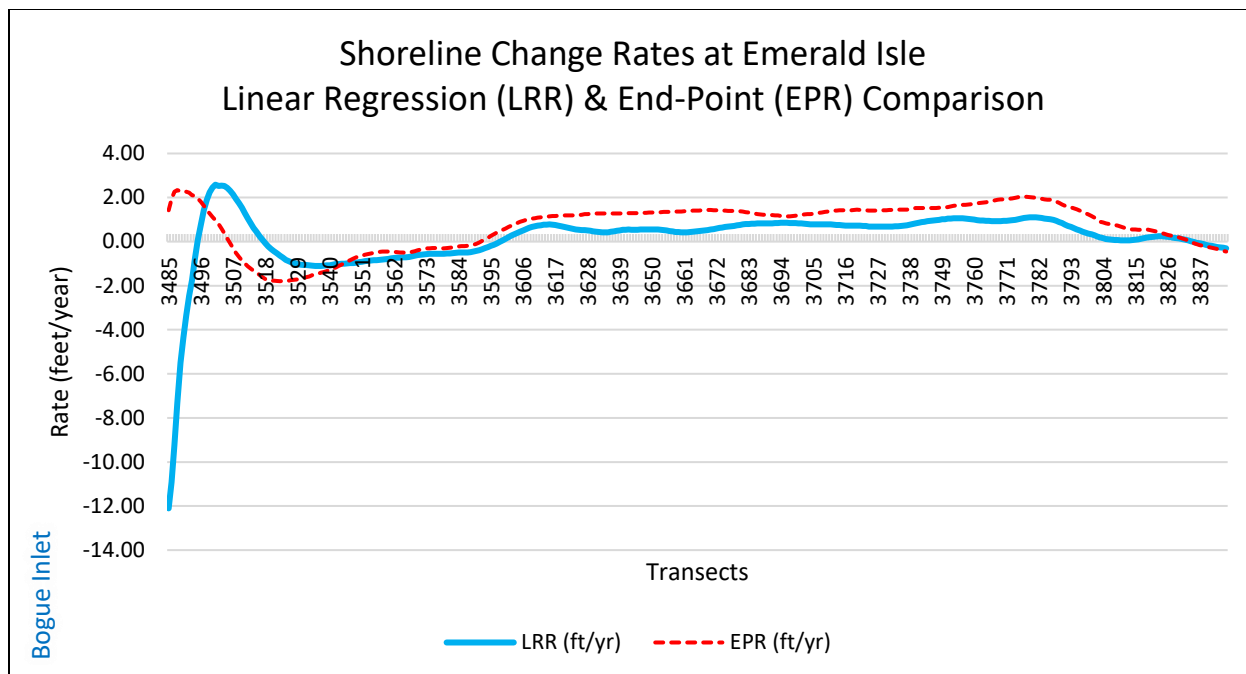


Figure 126. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

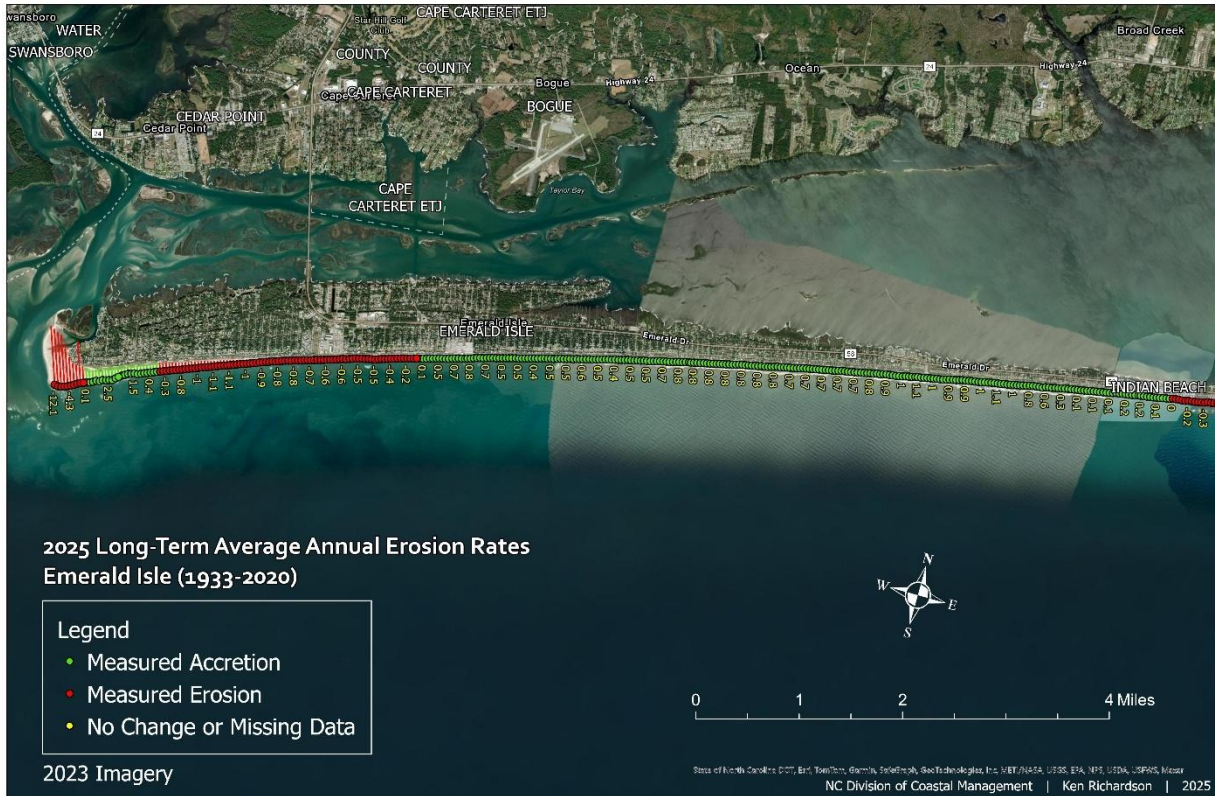


Figure 127. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

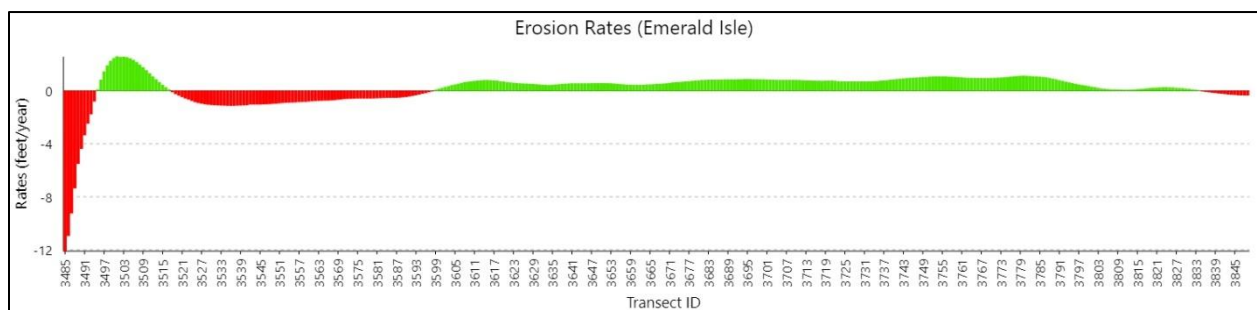


Figure 128. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

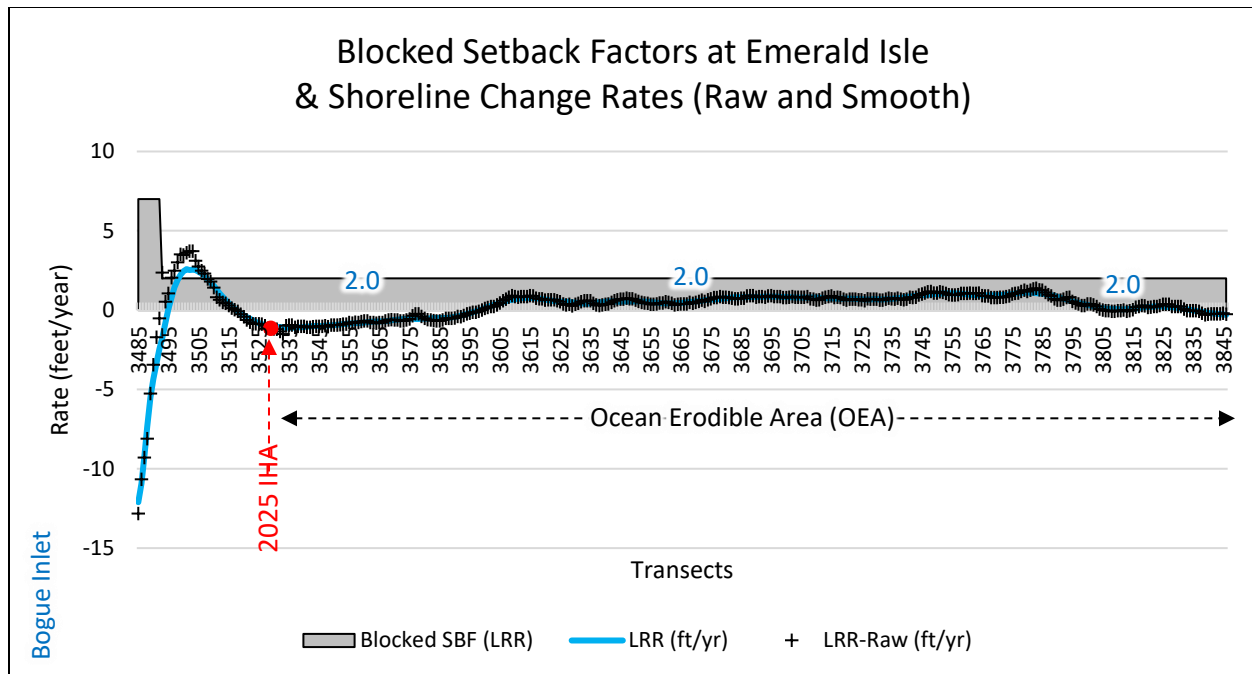


Figure 129. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

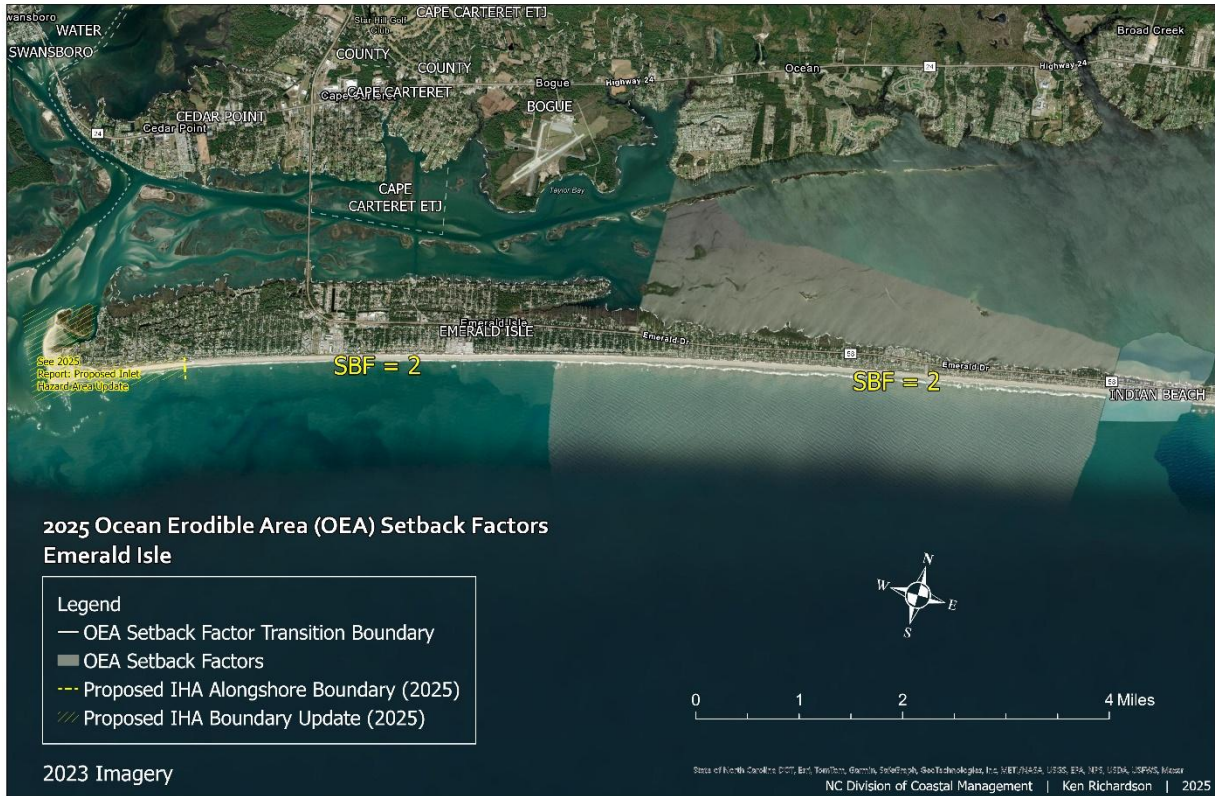


Figure 130. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Emerald Isle. For setbacks within the proposed updated IHA boundary, refer to the report titled “NC Inlet Hazard Area (IHA) Erosion Rate & Setback Factors: 2025 Update.”

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|--------|------|-----------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2, 2.5 | 2, 3 | 2, 3.5, 5 | 2, 3 | N/A |

Table 22. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.22 Indian Beach and Salter Path

Indian Beach and Salter Path accounts for approximately 2.5 miles (10%) of the shoreline along Bogue Banks. As part of the Bogue Banks Restoration Project, this area was the recipient of a large-scale beach nourishment project in 2001-2002, followed by four maintenance projects in 2004, 2007, 2019 and 2020. Collectively, these efforts have helped shape shoreline positions and reduce erosion rates.

This analysis assessed nineteen shorelines (**Figure 131**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 103 feet to a maximum of 160 feet, with an average of 128 feet for the shoreline between transects 3847 and 3927. The calculated relative standard deviation of shoreline position ranged from 29 to 47 feet and averaged 38 feet. Of the 2.5 miles of shoreline analyzed, all (100%) resulted in measured erosion where rates averaged less than one (-1) feet per year.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 132**). The end-point method resulted in a range of shoreline line change rates between -1.0 and less than -1.0 feet per year, averaging less than -1.0 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between less than -1.0 and less than -0.5 feet per year, averaging less than -1.0 feet per year. Each method resulted in blocked erosion rate setback factors of two (2), making these results consistent with previous studies for this section of shoreline; specifically, after beach nourishment began.

Using the least squares regression methodology provides a more accurate depiction of long-term shoreline movement; however, it does not alter the setback factor results for this section of shoreline in a way that distinguishes it from previous studies. Using this approach, the calculated setback factors within the OEA remain at two (2) feet per year between transects 3847 and 3927 (**Figure 133 to Figure 136 & Table 23**).

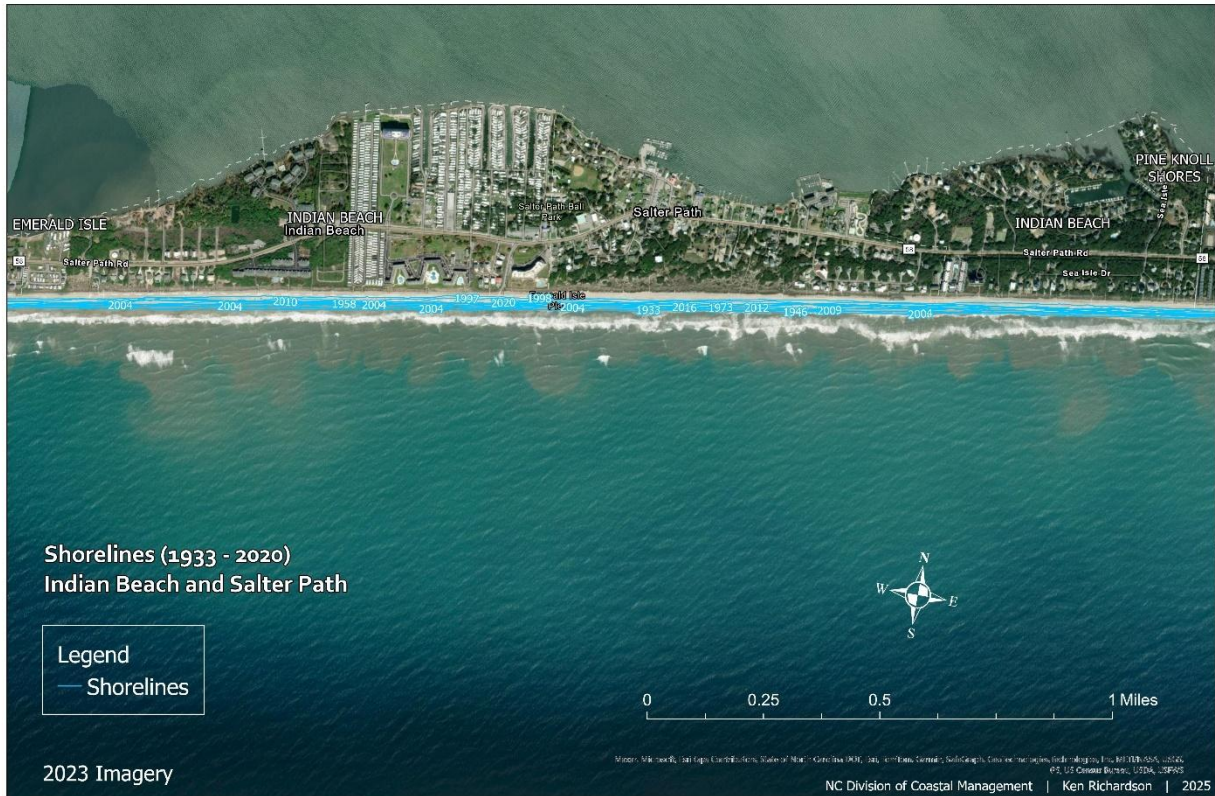


Figure 131. Shorelines included in the analysis (1933-2020) at Indian Beach and Salter Path.

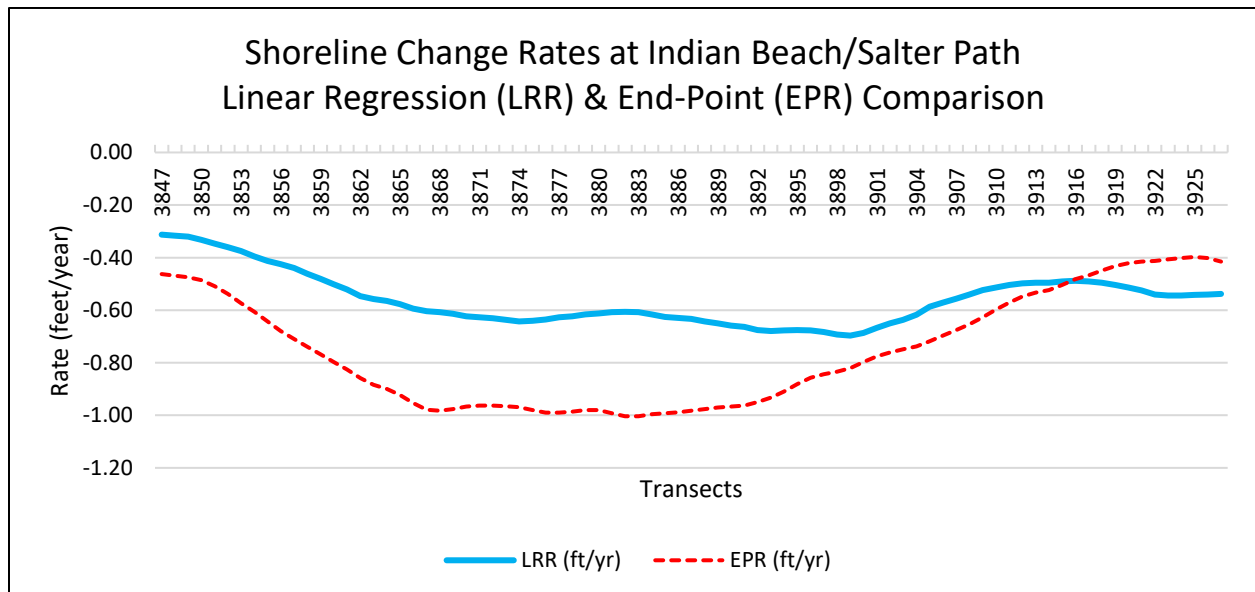


Figure 132. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

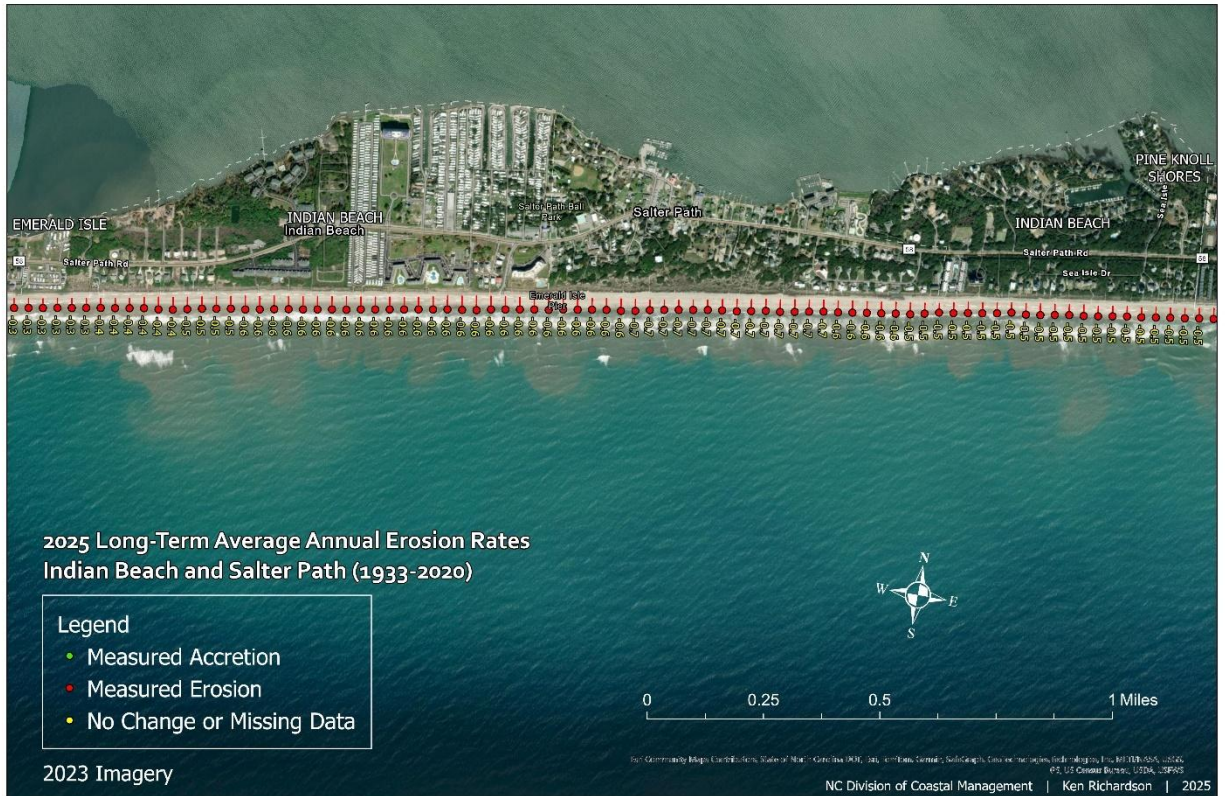


Figure 133. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

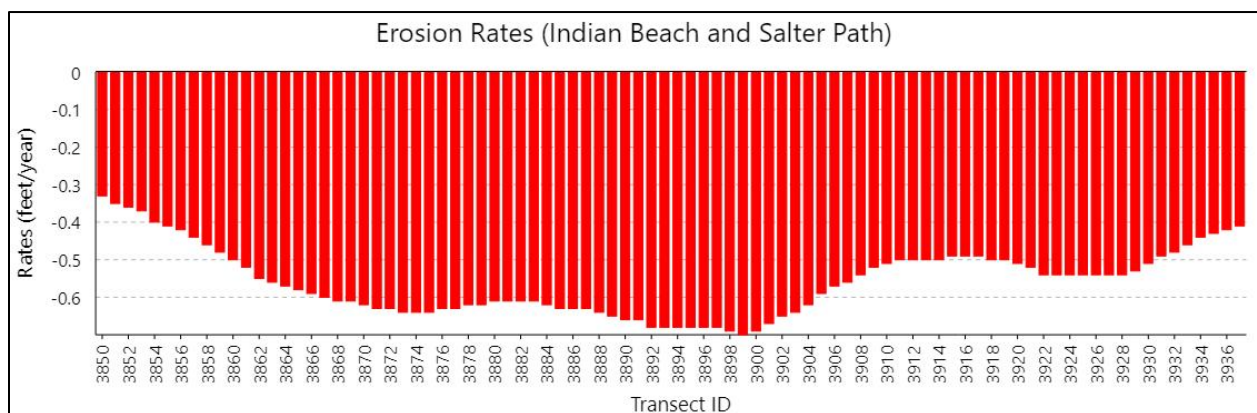


Figure 134. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

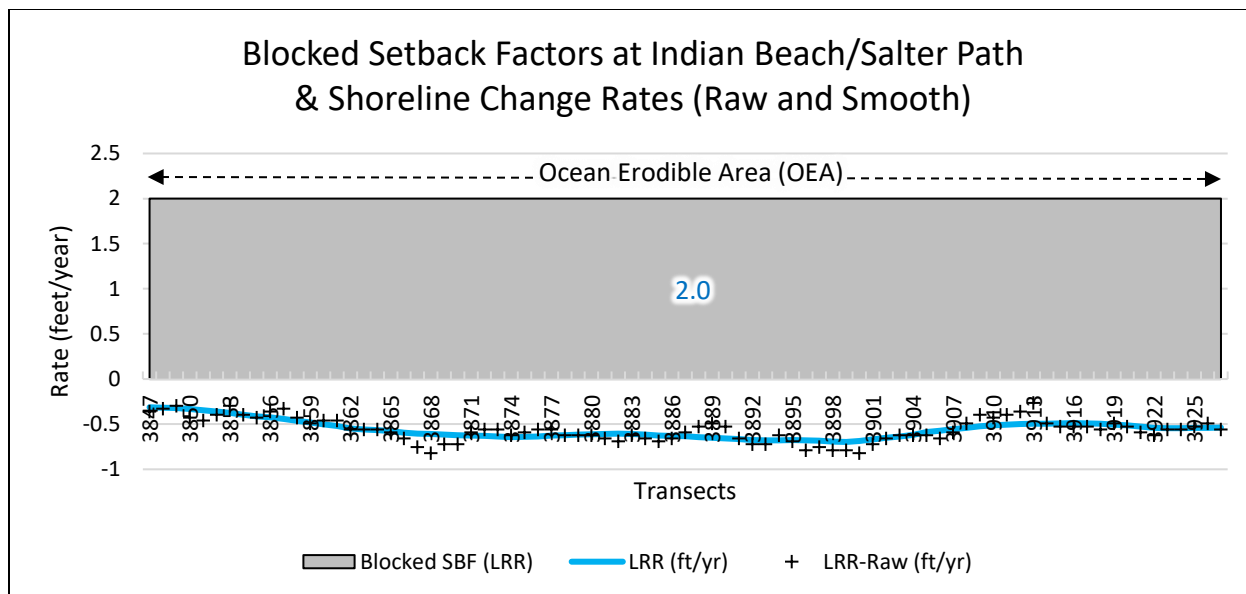


Figure 135. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

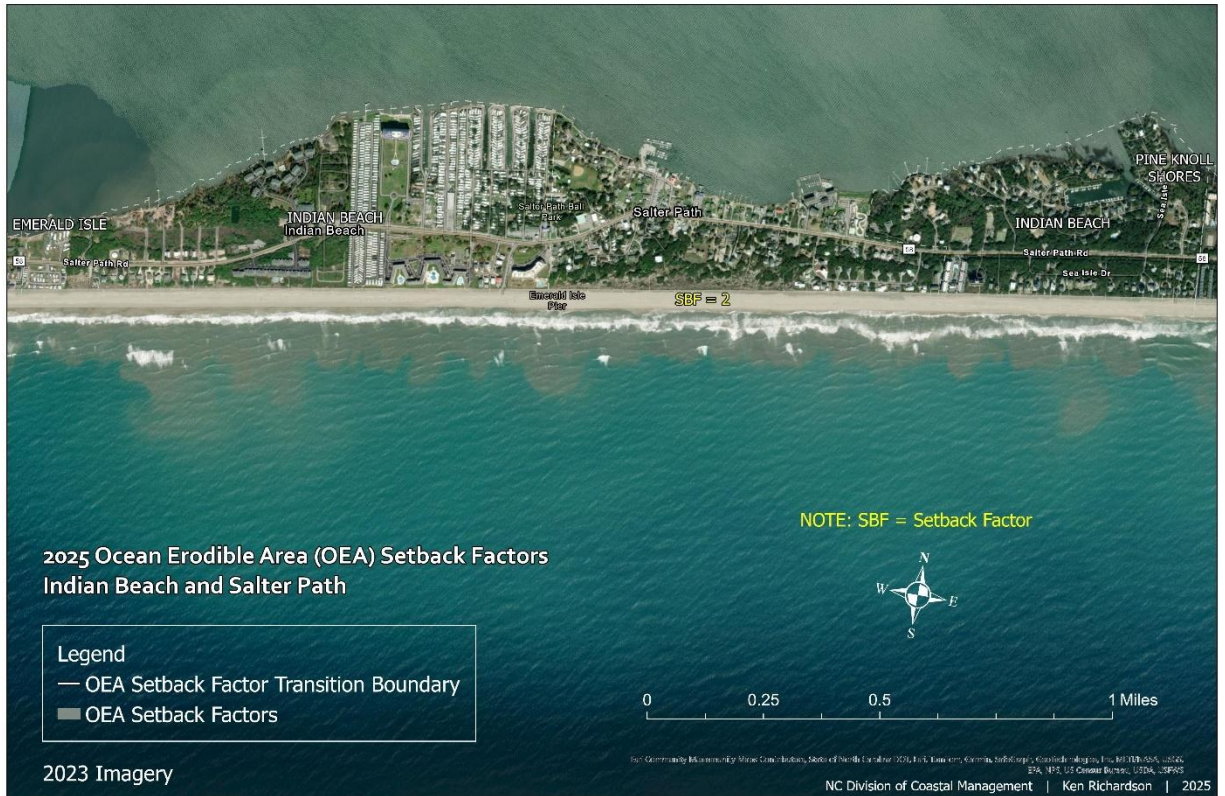


Figure 136. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Indian Beach and Salter Path.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | N/A |

Table 23. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.23 Pine Knoll Shores

Pine Knoll Shores accounts for approximately 4.8 miles (19%) of the shoreline along Bogue Banks. As part of the Bogue Banks Restoration Project, this area was the recipient of a large-scale beach nourishment project in 2001-2002, followed by four maintenance projects in 2004, 2007, 2013, and 2020. Collectively, these efforts have helped shape shoreline positions and reduce erosion rates.

This analysis assessed eleven shorelines (**Figure 137**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 77 feet to a maximum of 197 feet, with an average of 130 feet for the shoreline between transects 3928 and 4082. The calculated relative standard deviation of shoreline position ranged from 22 to 48 feet and averaged 35 feet. Of the 4.8 miles of shoreline analyzed, 2.4 miles (50%) resulted in measured erosion where rates averaged less than one (-1.0) feet per year.

For comparison, both the end-point and least squares regression methods produced similar results (**Figure 138**). The end-point method resulted in a range of shoreline line change rates between -1.0 and less than +1.0 feet per year, averaging less than +1.0 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between less than -1.0 and less than +1.0 feet per year, averaging less than +1.0 feet per year. Each method resulted in blocked erosion rate setback factors of two (2), making these results consistent with previous studies for this section of shoreline; specifically, after beach nourishment began.

Using the least squares regression methodology provides a more accurate depiction of long-term shoreline movement; however, it does not alter the setback factor results for this section of shoreline in a way that distinguishes it from previous studies. Using this approach, the calculated setback factors within the OEA remain at two (2) feet per year between transects 3928 and 4082 (**Figure 138 to Figure 142 & Table 24**).

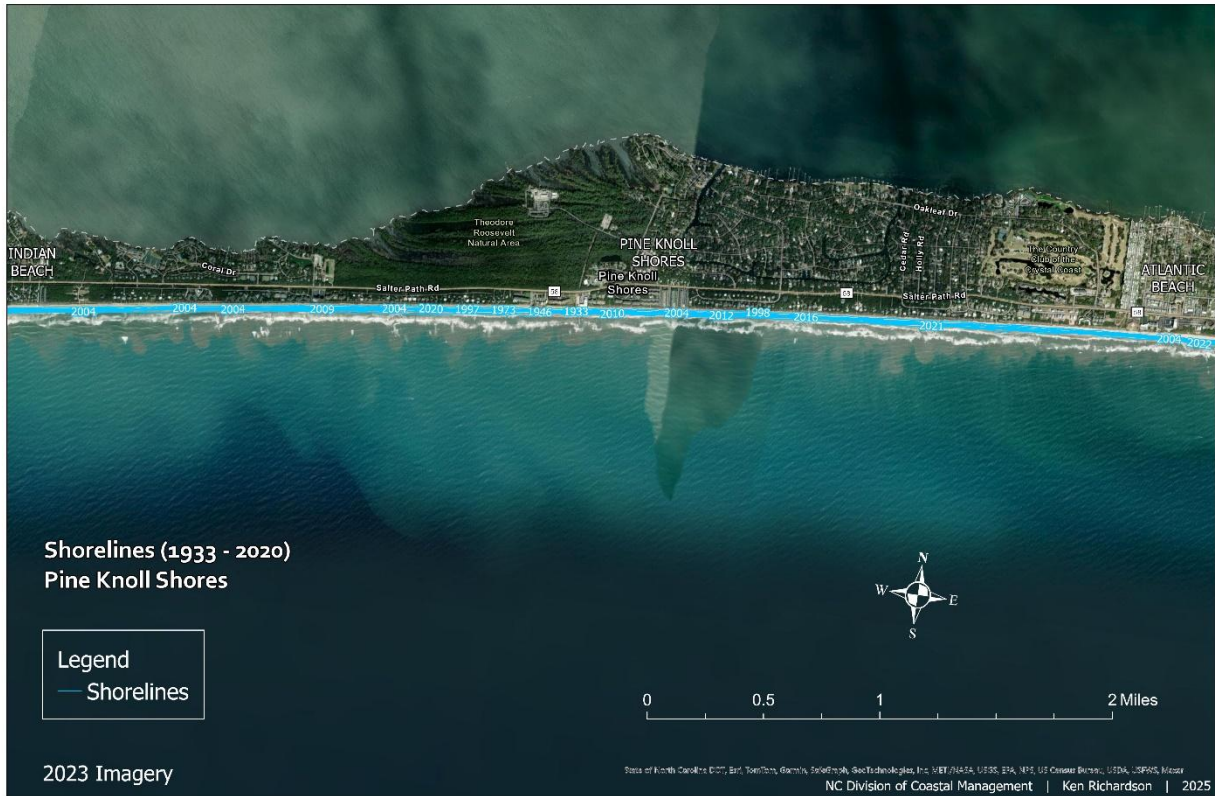


Figure 137. Shorelines included in the analysis (1933-2020) at Pine Knoll Shores.

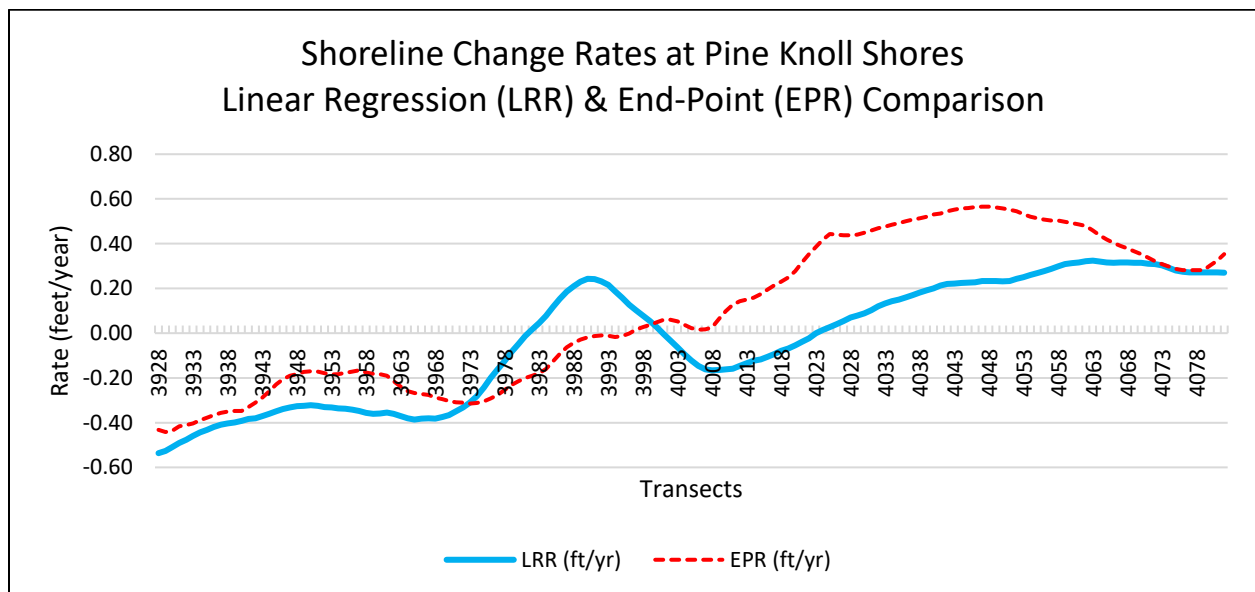


Figure 138. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 139. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

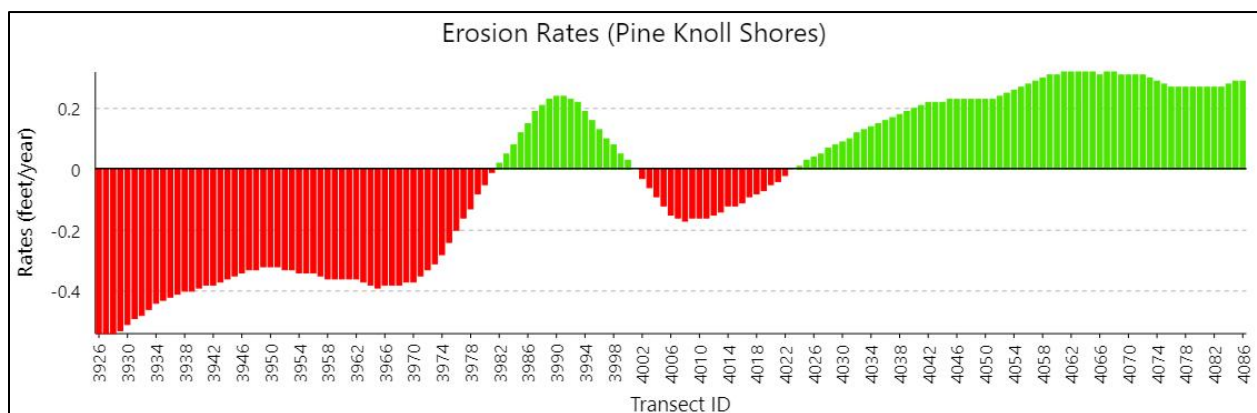


Figure 140. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

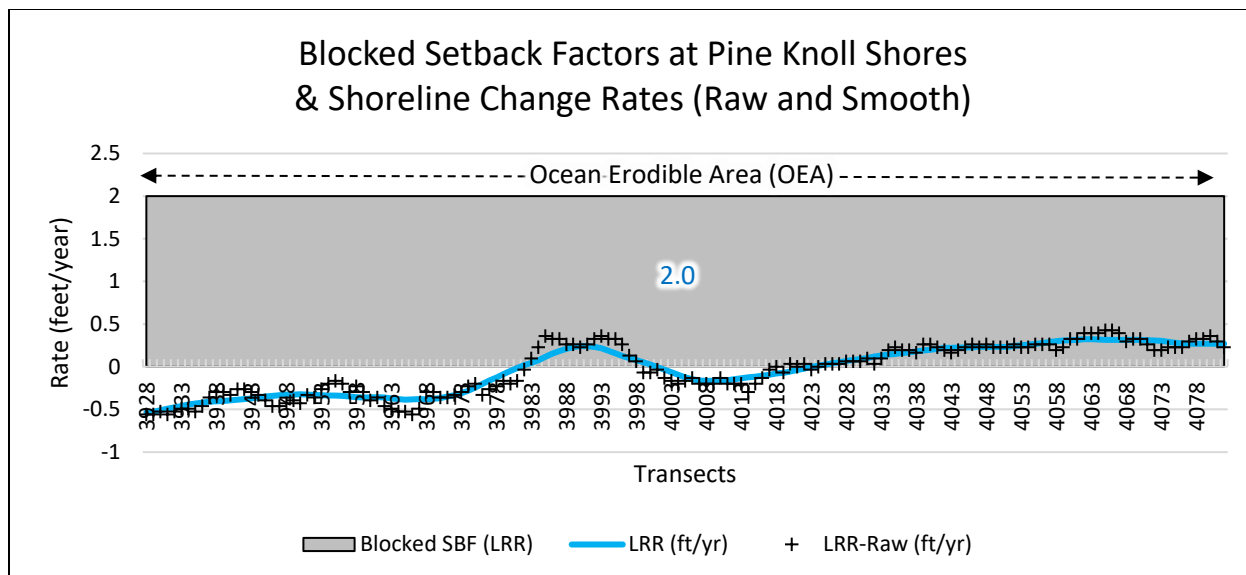


Figure 141. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 142. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Pine Knoll Shores.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|---------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2, 3 | 2, 3, 4 | 2 | N/A |

Table 24. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.24 Atlantic Beach and Fort Macon State Park

Atlantic Beach and Fort Macon State Park account for approximately 6.1 miles (24.4%) of the shoreline along Bogue Banks. This portion of the Bogue Banks shoreline has a broader history of being a recipient of beach nourishment in association with the Morehead City Harbor federal navigation project. Starting in 1978 followed by a 1986 project that served as the areas first as a large-scale project. Since maintenance projects occurred in 1994, 2002, 2005, 2007, 2011, 2014, 2015, 2017 and 2020. Collectively, these efforts have helped shape shoreline positions and reduce erosion rates.

This analysis assessed eleven shorelines (**Figure 143**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 67 feet (oceanfront) to a maximum of 948 feet (inlet area), with an average of 356 feet for the entire shoreline between transect-4083 and transect-4275. The calculated relative standard deviation of shoreline position ranged from 20 to 208 feet and averaged 93 feet. Of the 6.1 miles of shoreline analyzed, 1.2 miles (20%) resulted in measured erosion where rates ranged between -3.2 and less than -1.0 feet per year and averaged -2.1 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 144**). The end-point method produced shoreline change rates ranging from -6.2 to +3.7

feet per year, with an average of +1.0 feet per year. The least squares regression method showed a range from -3.2 to +3.3 feet per year, averaging +1.3 feet per year. In Atlantic Beach, both methods resulted in a blocked erosion rate setback factor of two (2). At Fort Macon State Park, historical setback factors have ranged from 2 to as much as 5 feet per year. These results remained consistent, with the end-point method ranging from 2 to 6 feet per year and the least squares regression method ranging from 2 to 3 feet per year. Overall, the findings align with previous studies for this section of the shoreline.

The least squares regression methodology offers a more accurate representation of long-term shoreline movement. At Atlantic Beach (transects 4083 and 4231), the results remain at two (2) feet per year. At Fort Macon State Park, most of the shoreline also maintains a rate of two (2) feet per year, except for an approximate half-mile section between transects 4249 and 4265, where the rate increases to three (3) feet per year. Relative to the current effective setback factors (2020), only the area between transects 4249 and 4265 at Fort Macon State Park will experience an increase of 1 foot per year. These findings do not alter the setback factor results in a way that differentiates them from previous studies (**Figure 145 to Figure 148 & Table 25**).

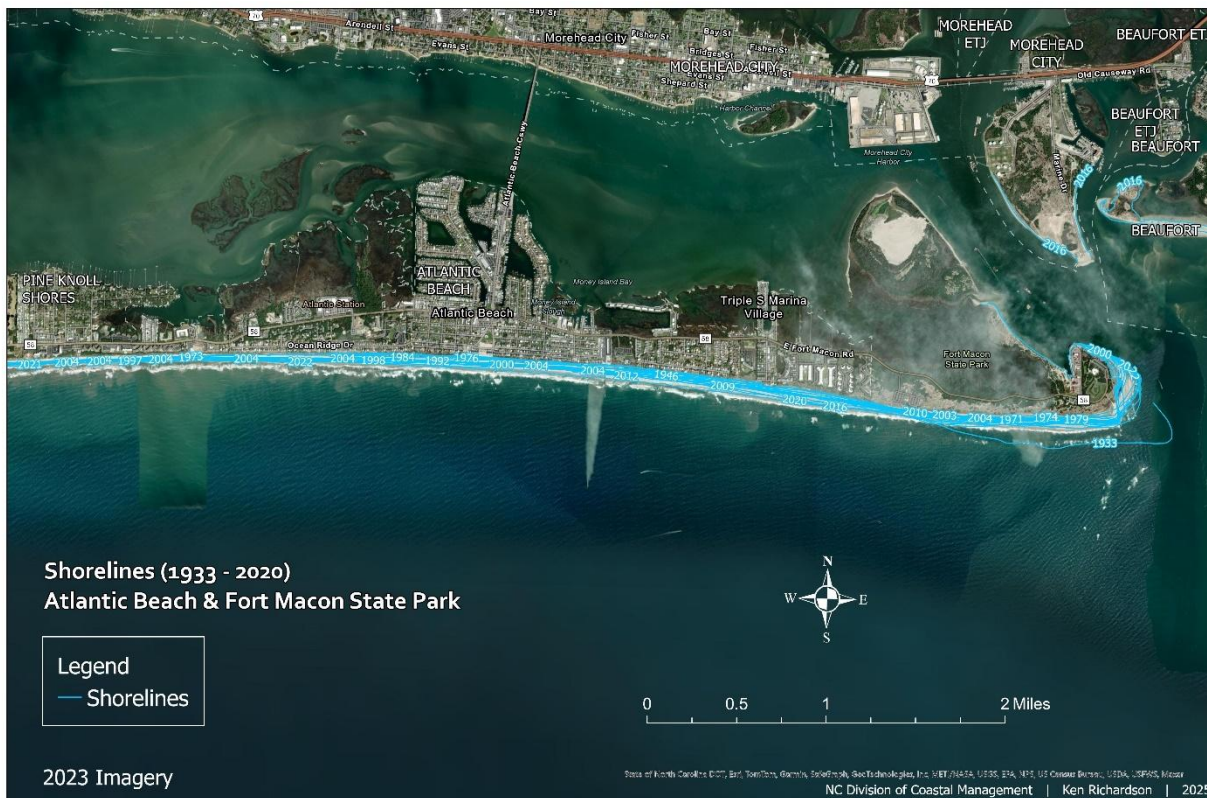


Figure 143. Shorelines included in the analysis (1933-2020) at Atlantic Beach and Fort Macon State Park.

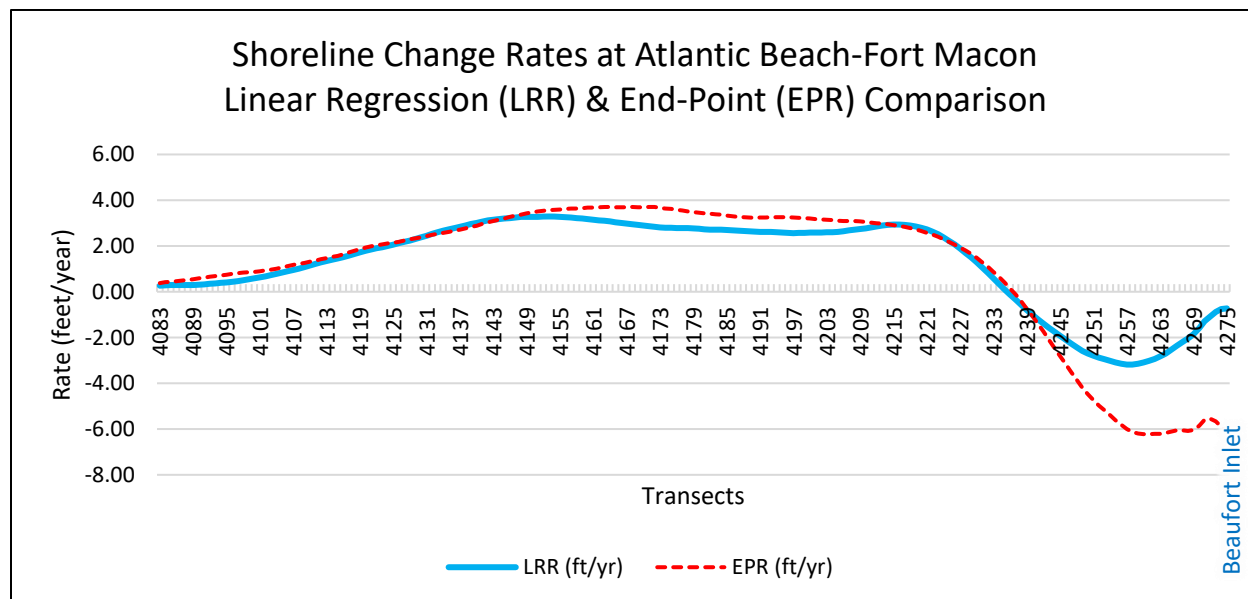


Figure 144. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 145. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

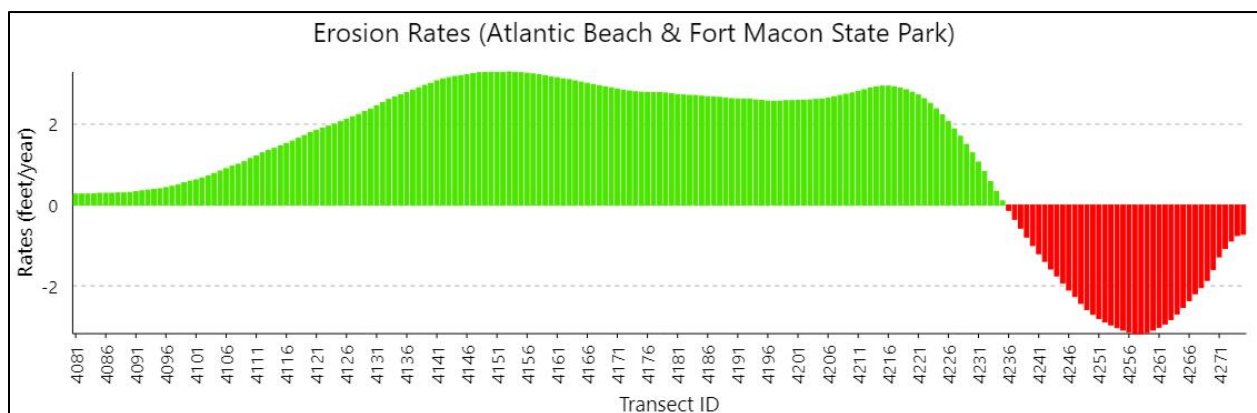


Figure 146. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

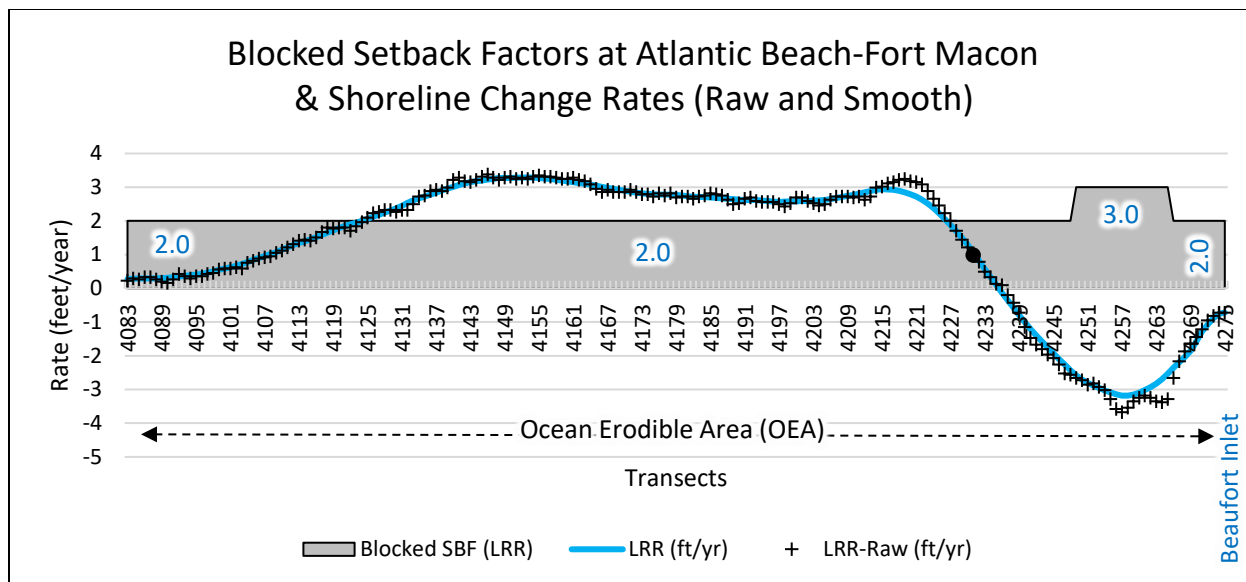


Figure 147. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

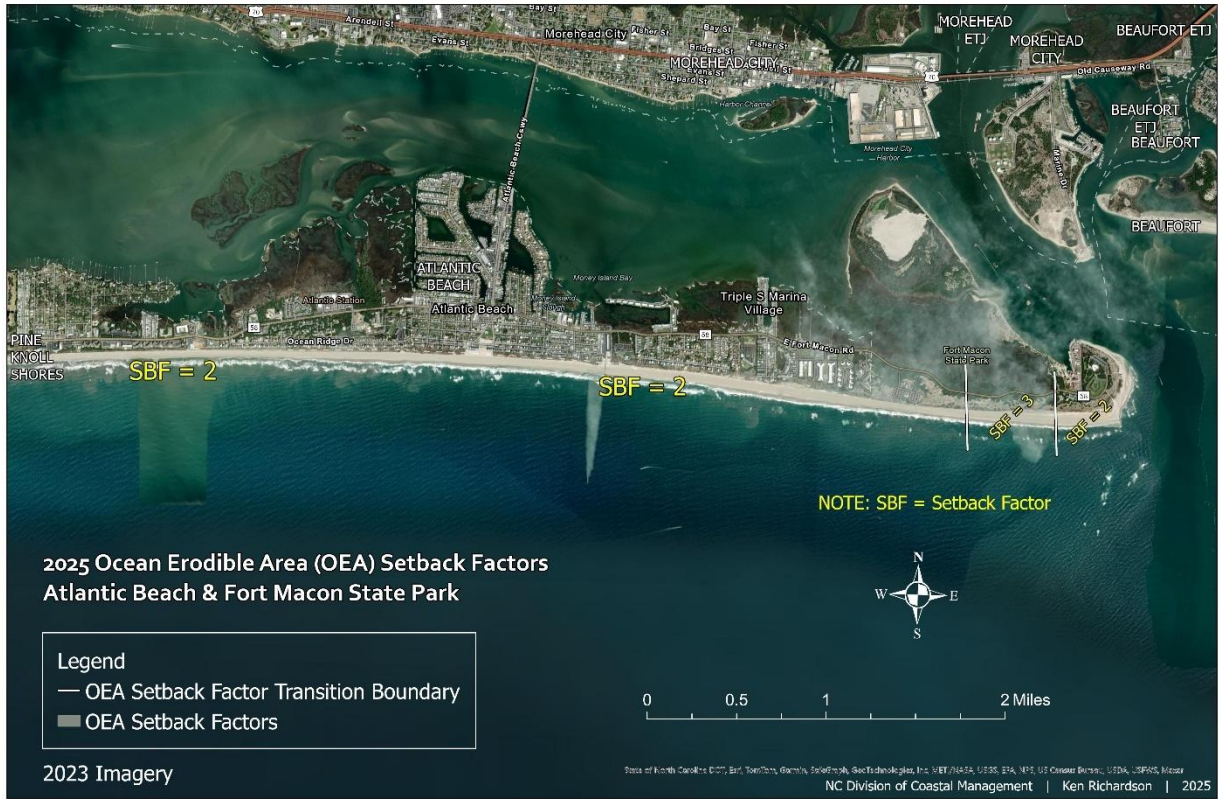


Figure 148. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Atlantic Beach and Fort Macon State Park.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|--------|--------|------|------|------|------|
| Setback Factor (SBF) | 2, 3 | 2 | 2, 2.5 | 2, 2.5 | 2, 3 | 2, 5 | 2 | N/A |

Table 25. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.25 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).

Here, the analysis assessed seventeen shorelines (**Figure 149**) along this oceanfront section over an 87-year period, from 1933 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 160 feet (oceanfront) to a maximum of 2,622 feet (inlet), with an average of 593 feet for the entire shoreline between Beaufort Inlet and Barden Inlets. The calculated relative standard deviation of shoreline position ranged between 57 and 866 feet, and an average of 186 feet. Of the 8.1 miles of shoreline analyzed, approximately 7.6 miles (94%) resulted in measured erosion where rates ranged between -18.5 and less than -1 feet per year and averaged -5.0 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 150**). Between transects 4279 and 4563, the end-point method resulted in a range of shoreline line change rates between -32.6 and +4.9 feet per year, averaging -5.5 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -18.5 and +9.0 feet per year, averaging -3.6 foot per year. The highest rates were measured adjacent to Beaufort Inlet where rapid erosion has occurred since 2010. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 28.5 feet per year, and least squares regression ranged from 2 to 16 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 4279 and 4563 range from 2 to 16 feet per year (**Figure 151 to Figure 154 & Table 26**).



Figure 149. Shorelines included in the analysis (1933-2020) at Shackleford Banks.

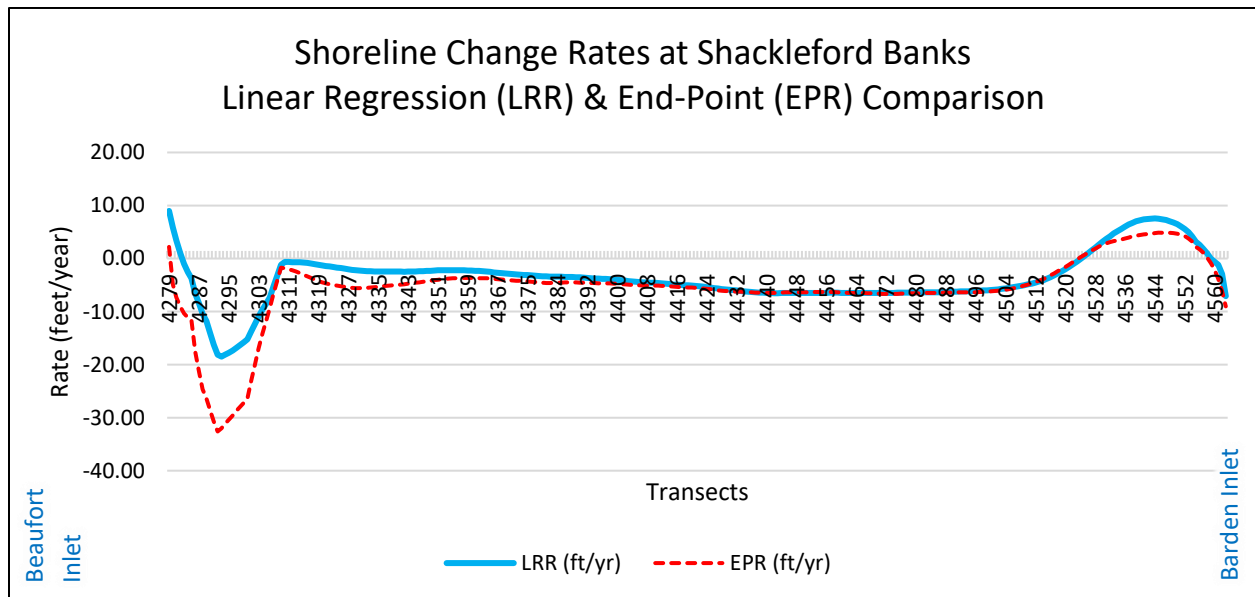


Figure 150. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 151. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

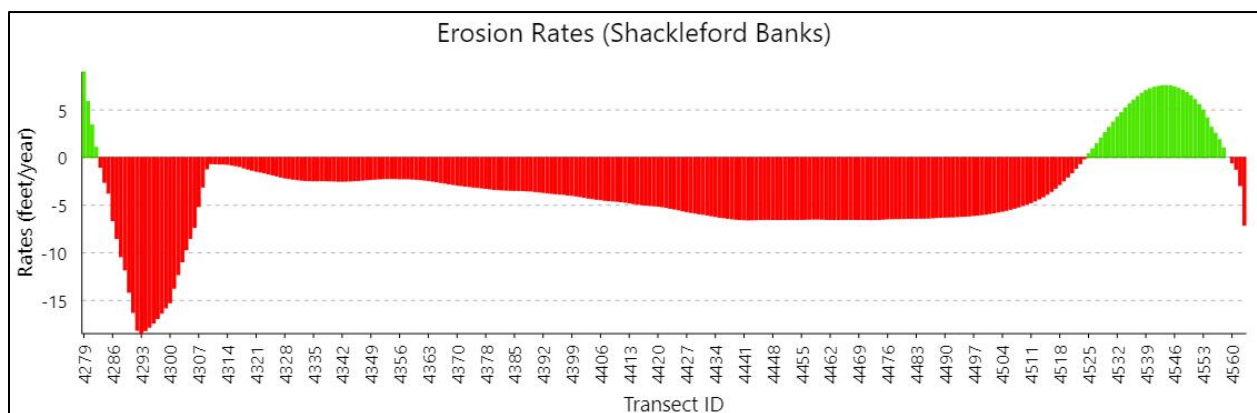


Figure 152. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

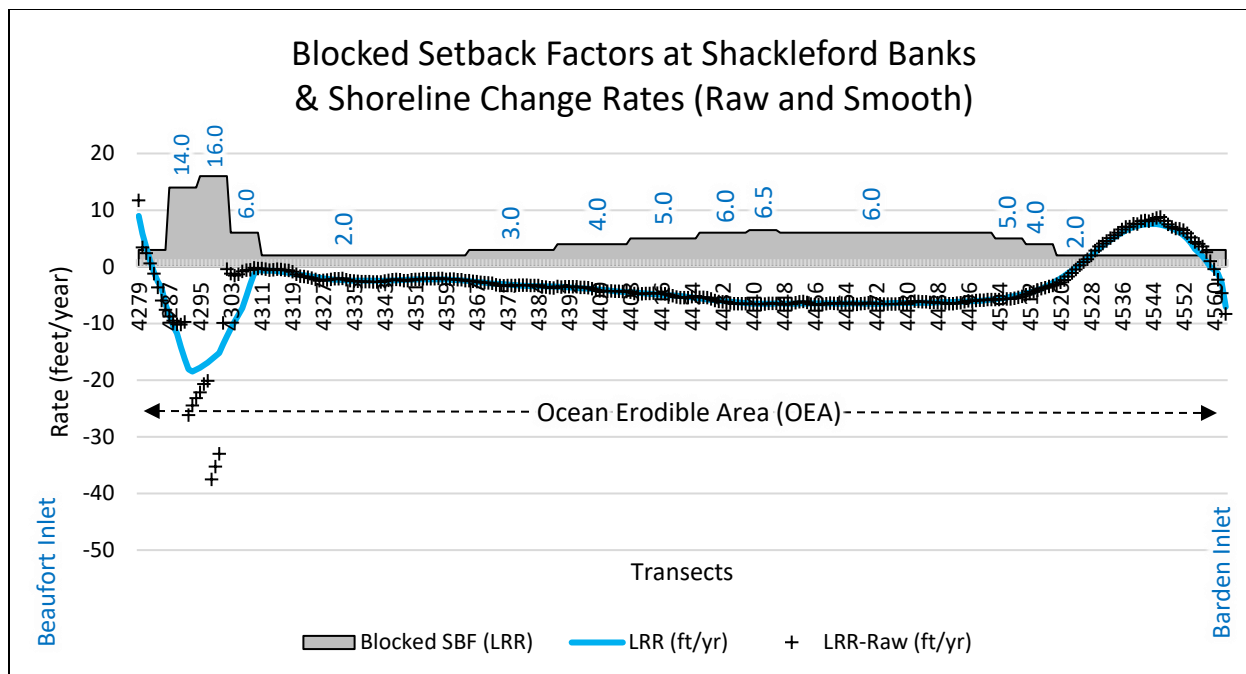


Figure 153. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 154. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Shackleford Banks.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------------------|-----------------|-------------------|-----------------|-------------------|------|------|------|
| Setback Factor (SBF) | Range 2 to 16 | Range 2 to 7 | Range 2 to 5.5 | Range 2 to 6 | Range 2 to 9.5 | N\A | N\A | N\A |

Table 26. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.26 Cape Lookout

At Cape Lookout starting at Barden Inlet moving towards the point at the cape is an undeveloped south-facing part of the Core Banks, with approximately 3.2 miles of oceanfront shoreline.

Here, the analysis assessed seventeen shorelines (**Figure 155**) along this oceanfront section over a 74-year period, from 1946 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 161 feet to a maximum of 1,558 feet, with an average of 642 feet for the entire shoreline between Barden Inlet and Cape Lookout. The calculated relative standard deviation of shoreline position ranged between 47 and 540 feet, and an average of 208 feet. Of the 3.2 miles of shoreline analyzed, approximately 2.2 miles (69%) resulted in measured erosion where rates ranged between -11.8 and less than -1 feet per year and averaged -5.5 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 156**). Between transects-4566 and -4685, the end-point method resulted in a range of shoreline line change rates between -12.3 and +45.1 feet per year, averaging +1.3 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -11.8 and +44.3 feet per year, averaging +1.3 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 12 feet per year, and the least squares regression ranged from 2 to 12 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 4566 and 4685 range from 2 to 12 feet per year (**Figure 157 to Figure 160 & Table 27**).



Figure 155. Shorelines included in the analysis (1946-2020) at Cape Lookout.

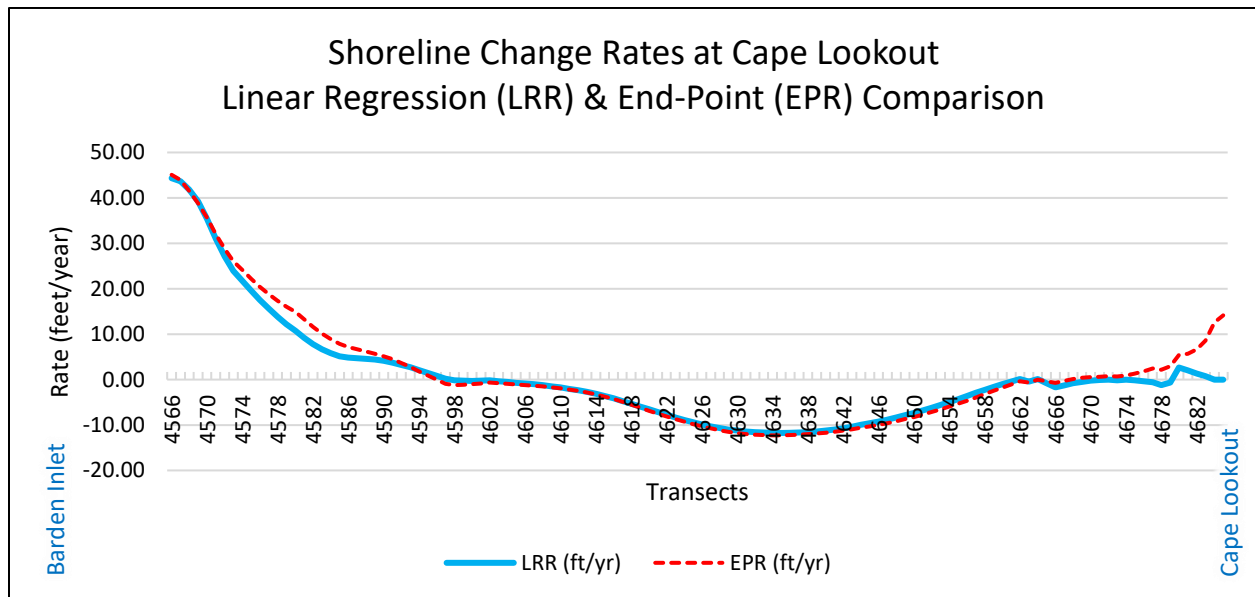


Figure 156. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 157. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

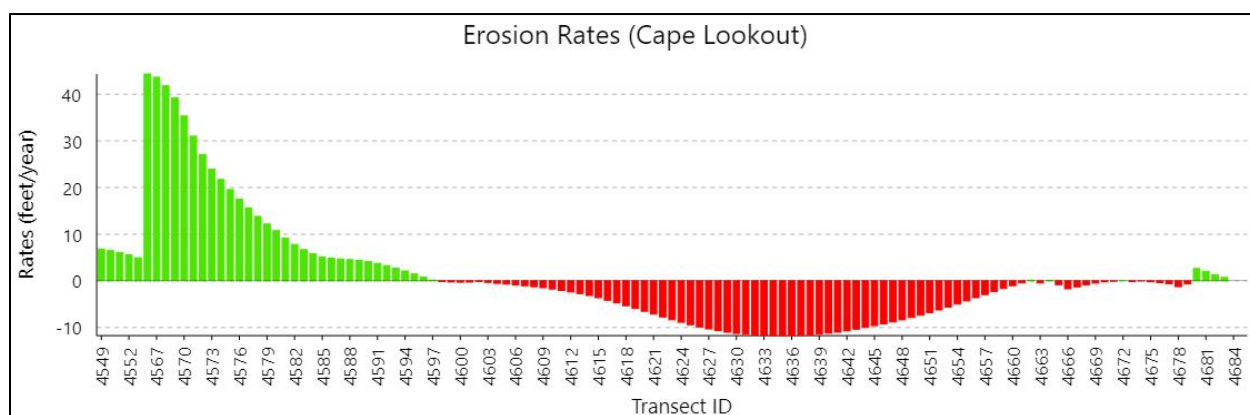


Figure 158. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

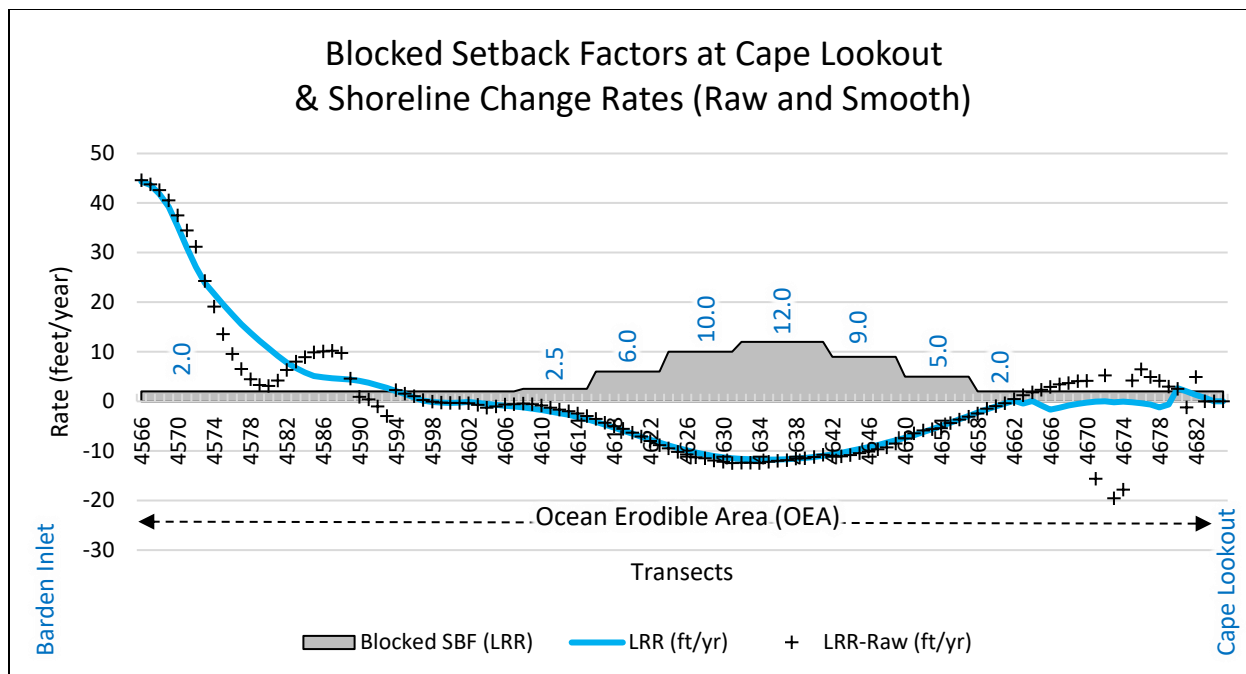


Figure 159. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------------------|------------------|------------------|--------------------|------------------|------|------|------|
| Setback Factor (SBF) | Range 2 to 12 | Range 2 to 12 | Range 2 to 11 | Range 2 to 14.5 | Range 2 to 16 | N\A | N\A | N\A |

3.27 Core Banks (Cape Lookout to Drum Inlet)

The shoreline spans 21.6 miles from Core Banks from Cape Lookout to Drum Inlet. Here, the analysis assessed ten shorelines (**Figure 161**) along this oceanfront section over a 74-year period, from 1946 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 61 feet to a maximum of 3,800 feet, with an average of 501 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between less than 1 and 1,399 feet, and an average of 159 feet. Of the 21.6 miles of shoreline analyzed, approximately 18.8 miles (87%) resulted in measured erosion where rates ranged between -25.7 and less than -1 feet per year and averaged -5.6 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 162**). Between transects 4686 and 5381, the end-point method resulted in a range of shoreline line change rates between -37.2 and +75.6 feet per year, averaging -5.1 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -25.7 and +18.7 feet per year, averaging -4.5 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 36 feet per year, and least squares regression ranged from 2 to 25 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 4566 and 4685 range from 2 to 25 feet per year (**Figure 162 to Figure 166 & Table 28**).

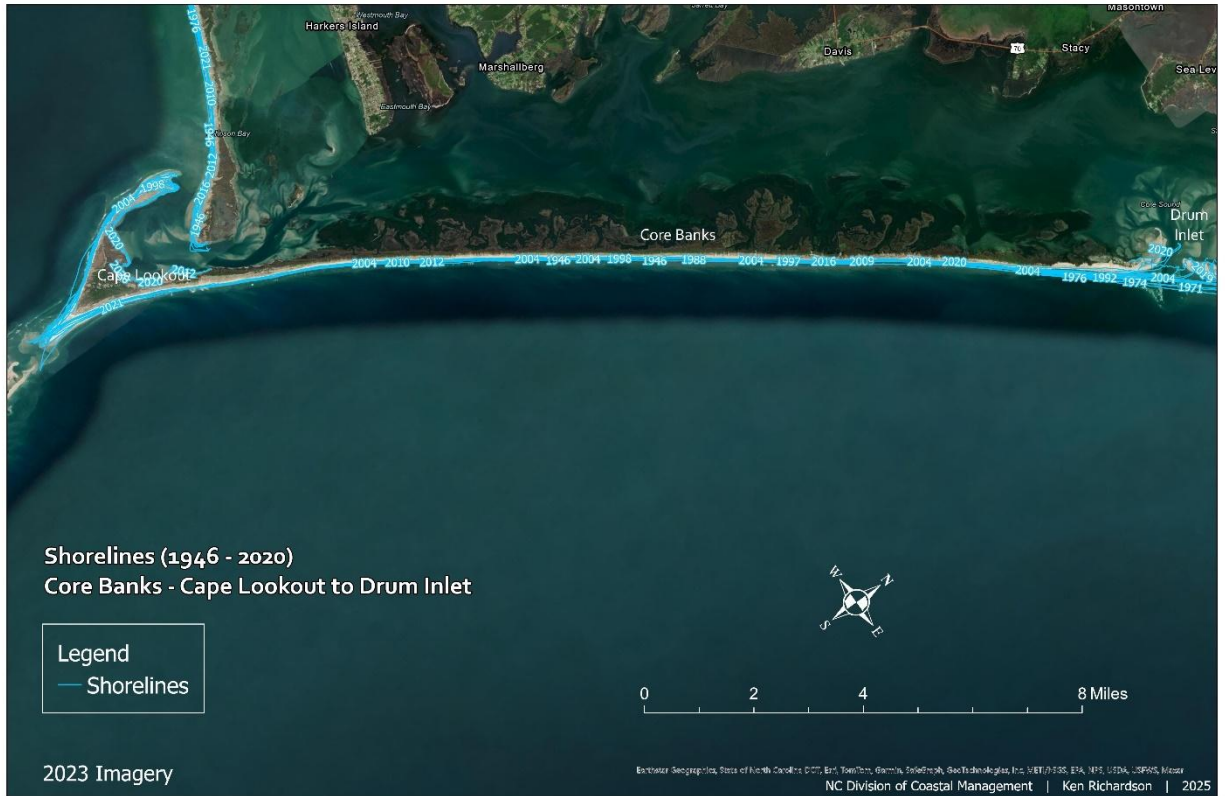


Figure 161. Shorelines included in the analysis (1933-2020) at Cape Lookout to Drum Inlet.

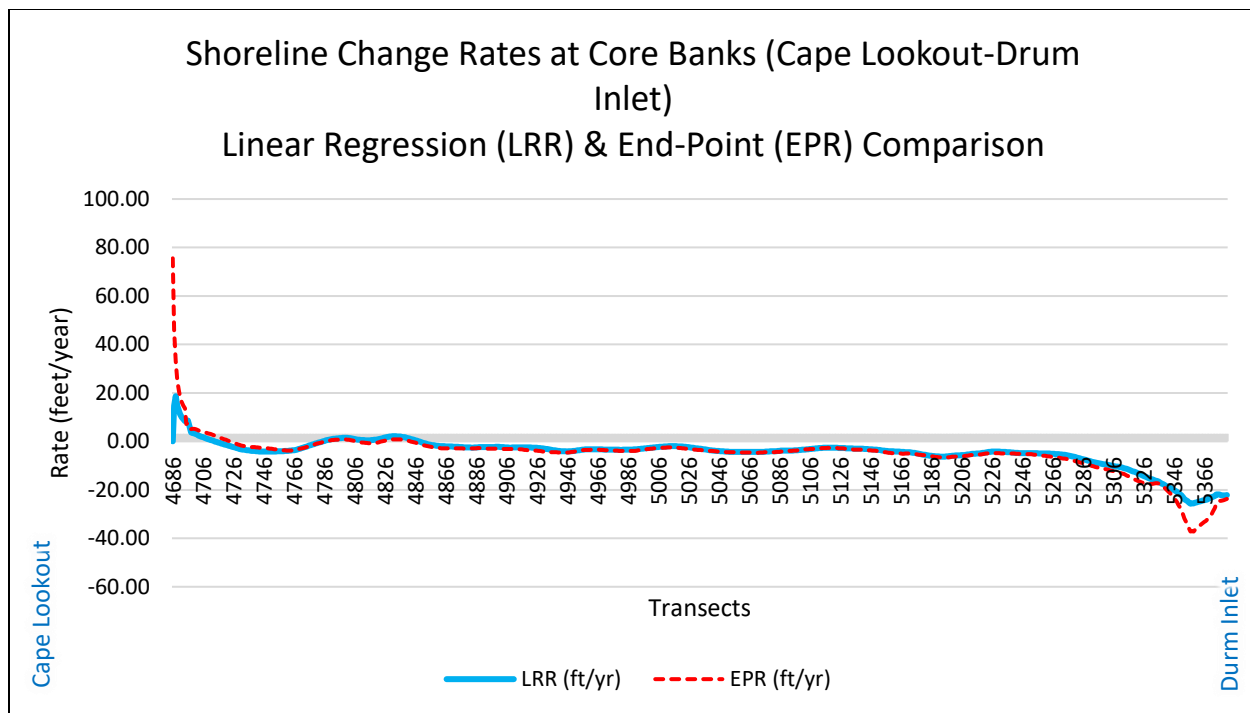


Figure 162. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 163. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

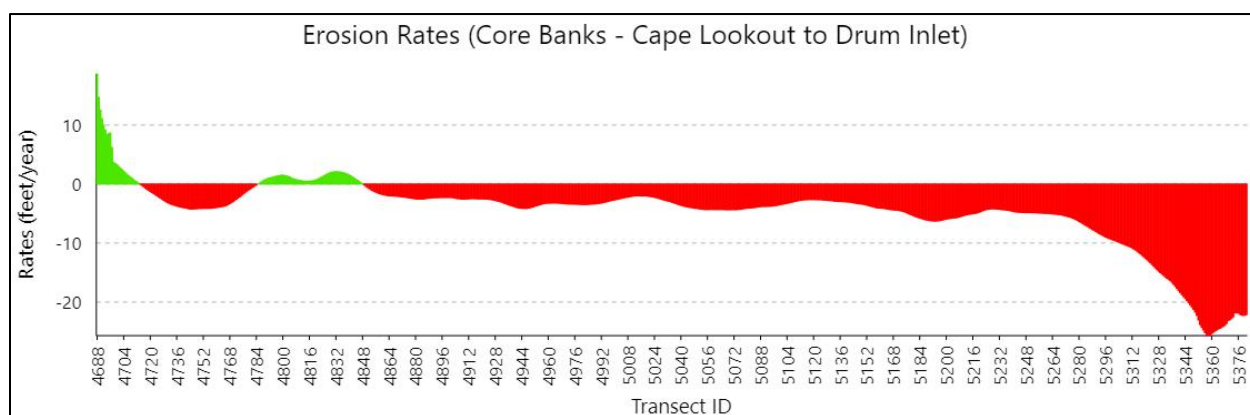


Figure 164. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

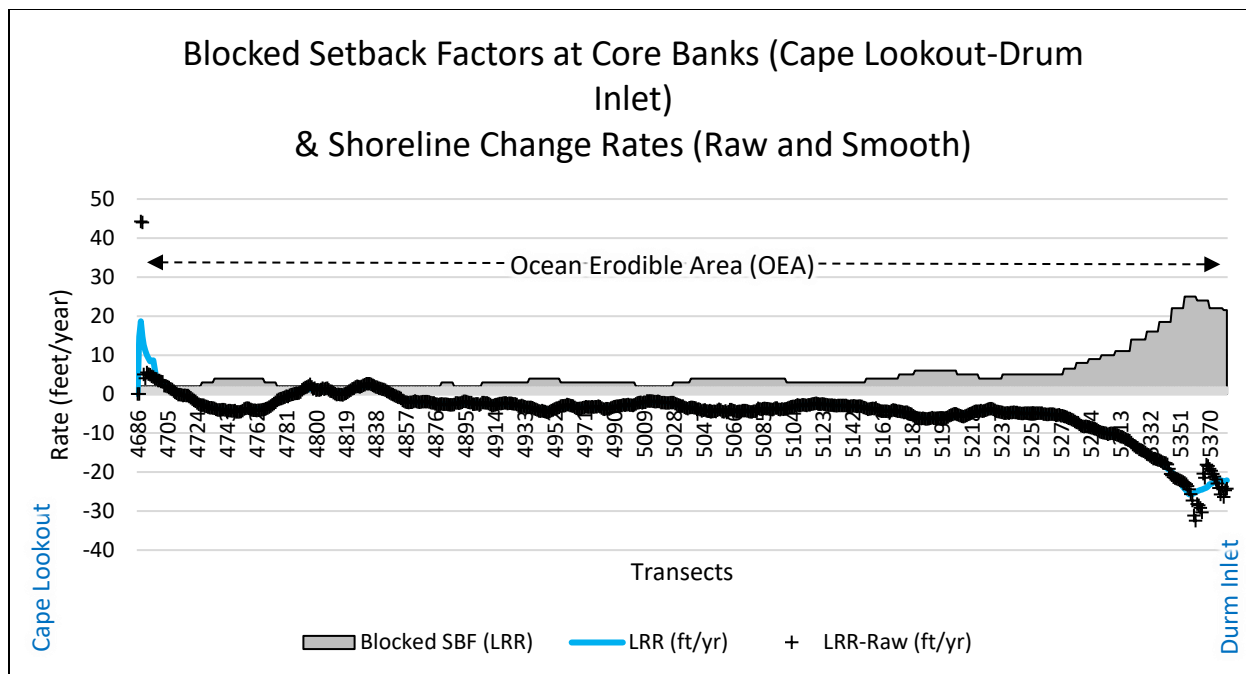


Figure 165. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 166. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Cape Lookout to Drum Inlet.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------------------|--------------------|------------------|------------------|--------------------|------|------|------|
| Setback Factor (SBF) | Range 2 to 25 | Range 2 to 28.5 | Range 2 to 18 | Range 2 to 16 | Range 2 to 14.5 | N\A | N\A | N\A |

Table 28. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.28 Core Banks (Drum Inlet to Ocracoke Inlet)

The shoreline spans 22.8 miles from Core Banks from Drum Inlet to Ocracoke Inlet. Here, the analysis assessed ten shorelines (**Figure 167**) along this oceanfront section over a 74-year period, from 1946 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 86 feet to a maximum of 3,057 feet, with an average of 586 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 30 and 885 feet, and an average of 183 feet. Of the 22.8 miles of shoreline analyzed, approximately 20.8 miles (91%) resulted in measured erosion where rates ranged between -22 and less than -1 feet per year and averaged -5.1 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 168**). Between transects 5385 and 6116, the end-point method resulted in a range of shoreline line change rates between -23.4 and +10.3 feet per year, averaging -4.7 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -22 and +7.9 feet per year, averaging -4.3 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 23 feet per year, and the least squares regression ranged from 2 to 21.5 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 5385 and 6116 range from 2 to 21.5 feet per year (**Figure 169** to **Figure 172** & **Table 29**).



Figure 167. Shorelines included in the analysis (1946-2020) at Drum Inlet to Ocracoke Inlet.

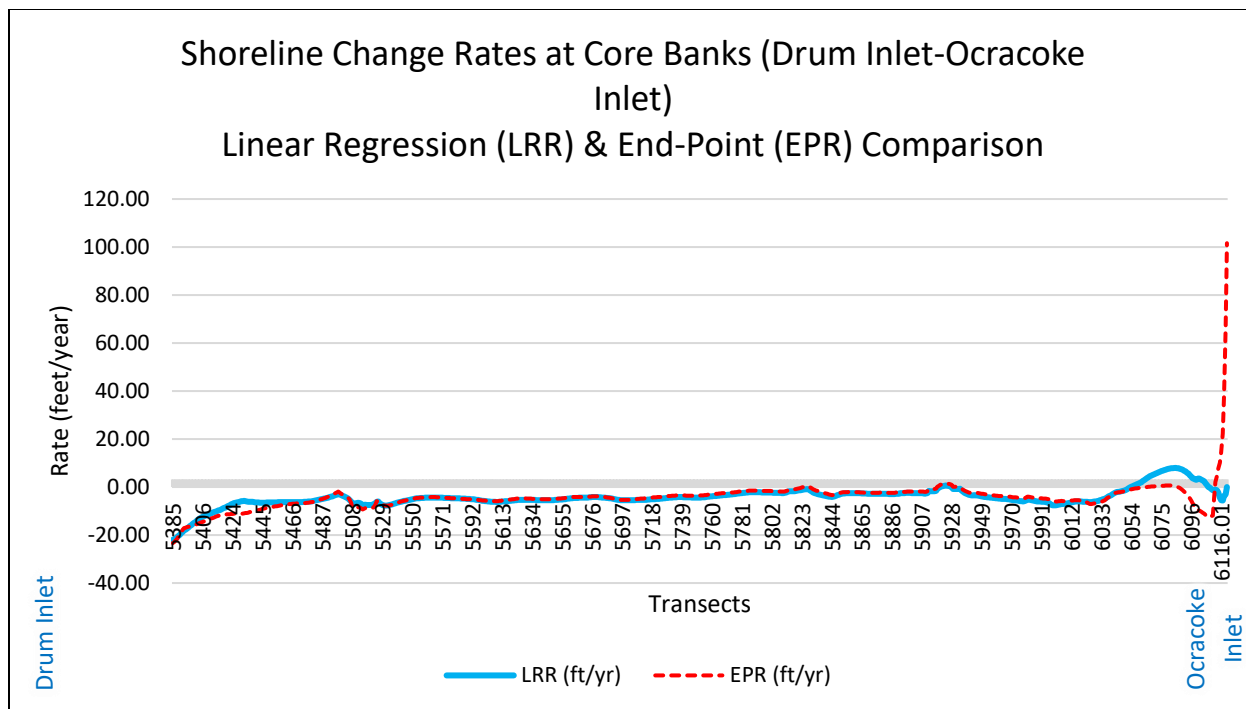


Figure 168. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

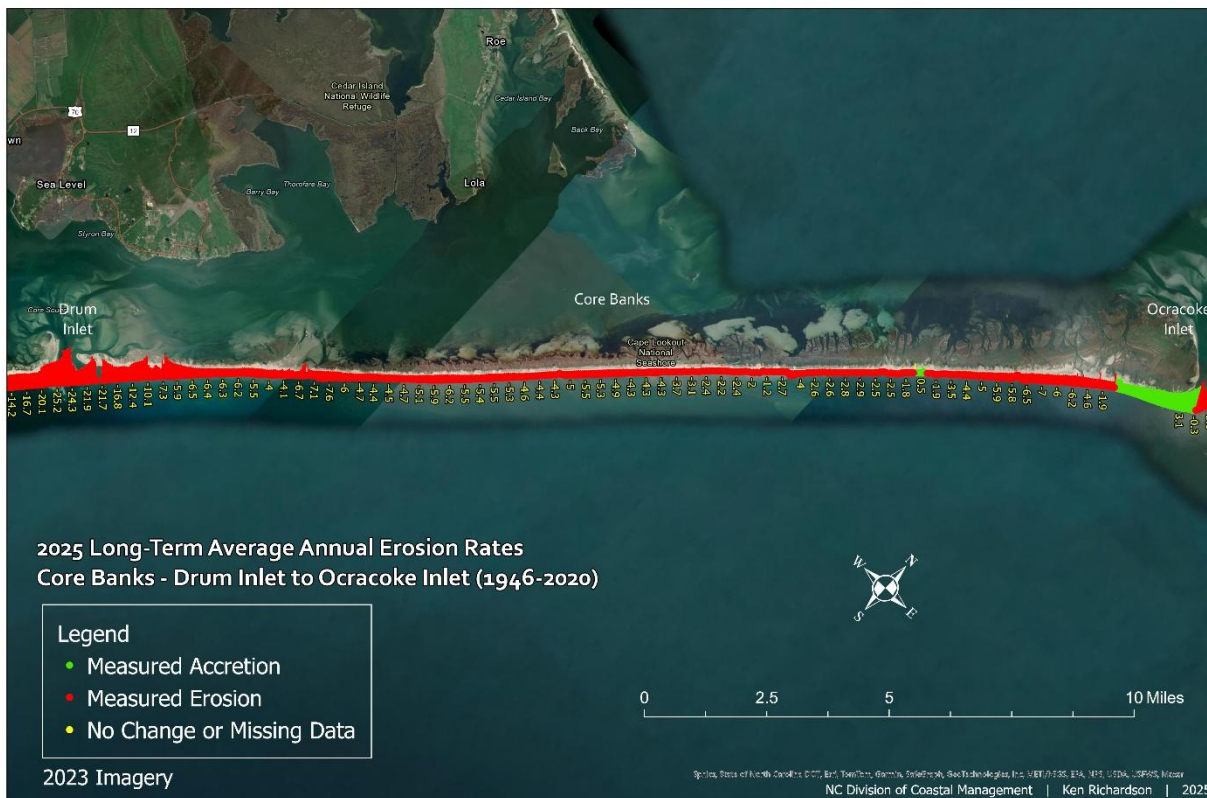


Figure 169. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

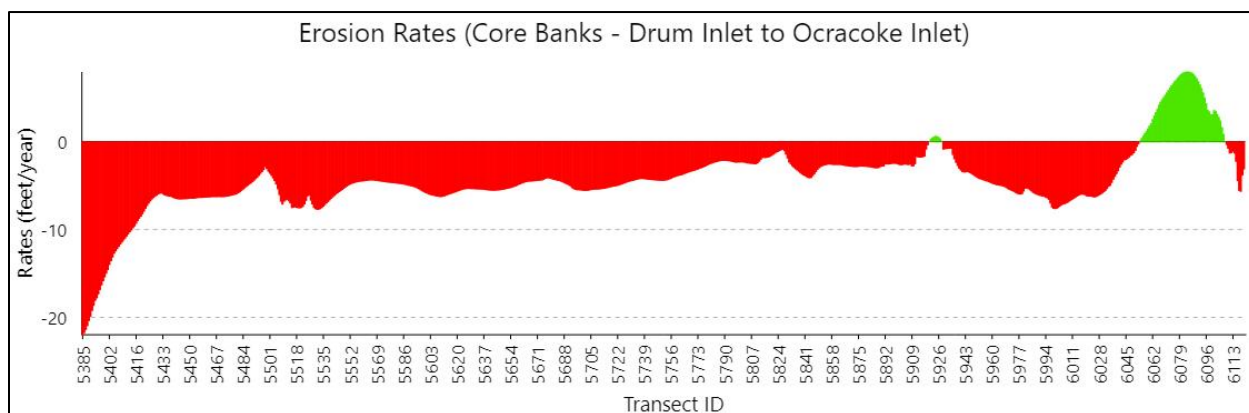


Figure 170. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

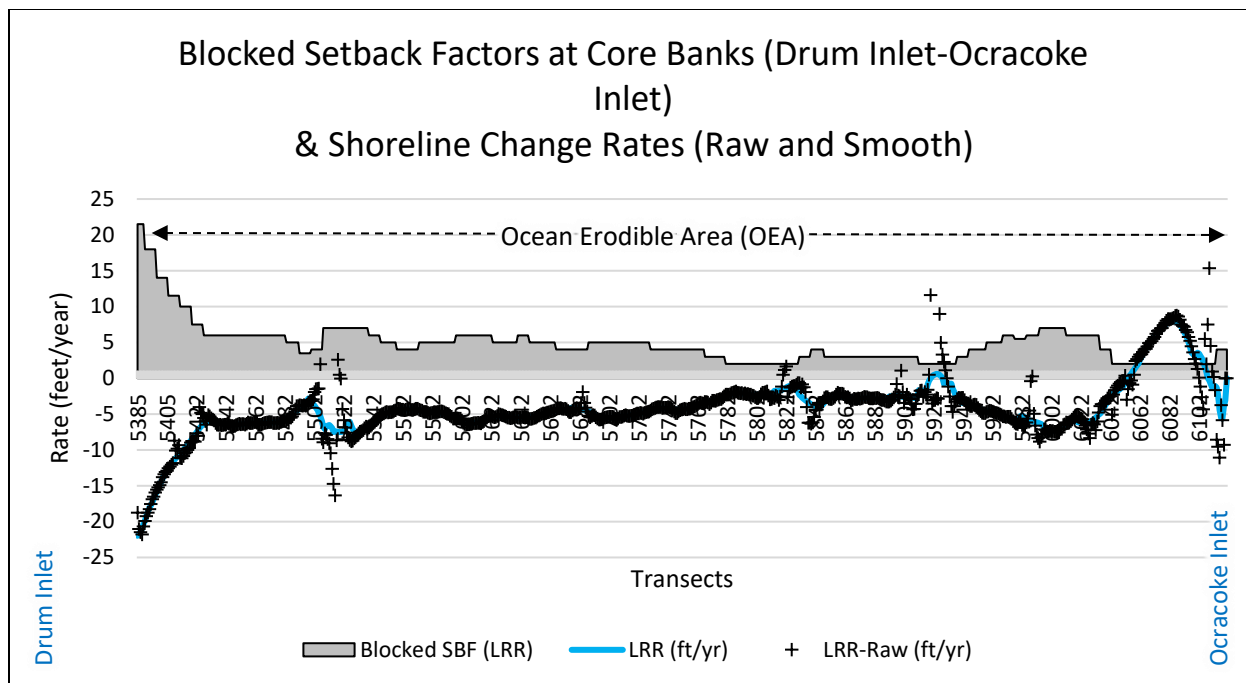


Figure 171. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

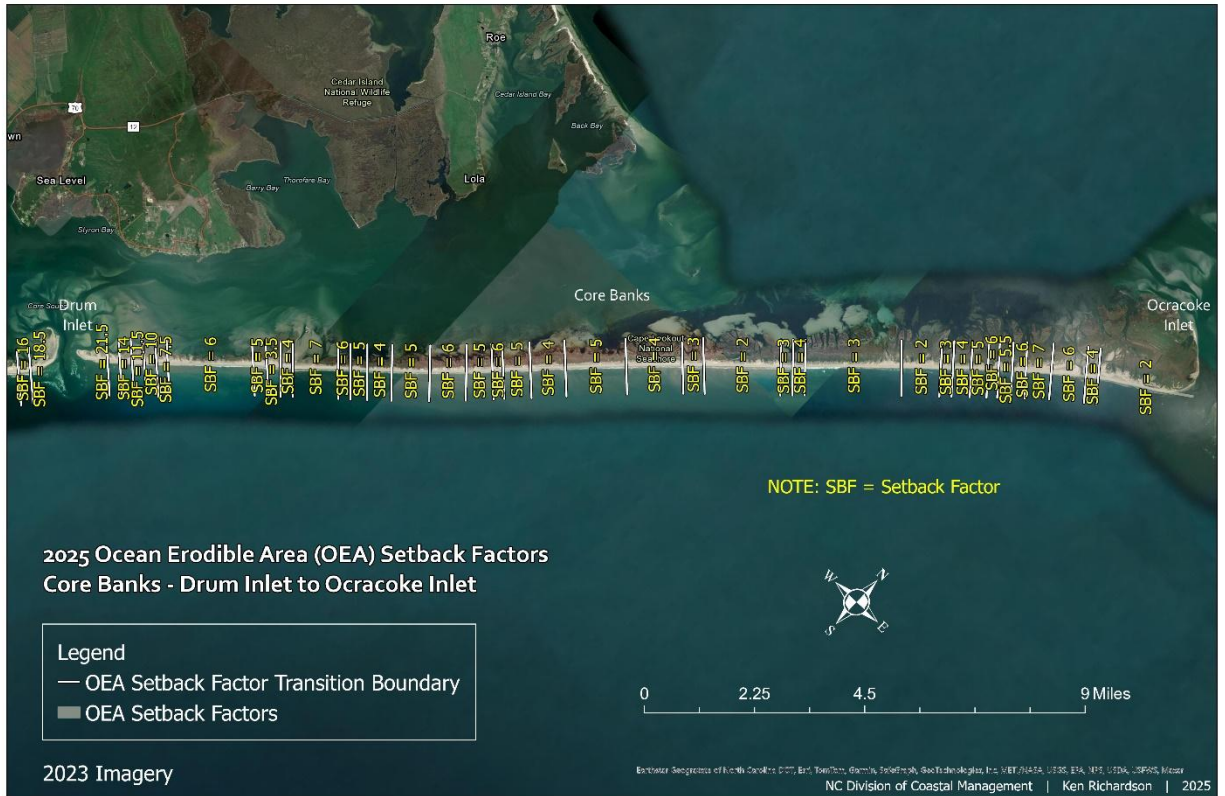


Figure 172. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Drum Inlet to Ocracoke Inlet.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|--------------------|------------------|-------------------|------------------|------------------|------|------|------|
| Setback Factor (SBF) | Range 2 to 21.5 | Range 2 to 11 | Range 2 to 8.5 | Range 2 to 30 | Range 2 to 17 | N\A | N\A | N\A |

Table 29. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.29 Ocracoke

At Ocracoke Island, the oceanfront shoreline spans 16.2 miles between Ocracoke Inlet to the south and Hatteras Inlet to the north. Here, the analysis assessed ten shorelines (**Figure 173**) along this oceanfront section over an 80-year period, from 1940 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 83 feet to a maximum of 3,910 feet, with an average of 568 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 26 and 1,073 feet, and an average of 172 feet. Of the 16.22 miles of shoreline analyzed, approximately 11.9 miles (73%) resulted in measured erosion where rates ranged between -16.8 and less than -1 feet per year and averaged -4.4 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 174**). Between transects 6117 and 6636, the end-point method resulted in a range of shoreline line change rates between -16.7 and +9.3 feet per year, averaging -2.4 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -16.8 and +14.6 feet per year, averaging -3.0 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 16 feet per year, and the least squares regression ranged from 2 to 28 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 6117 and 6636 range from 2 to 28 feet per year (**Figure 175 to Figure 178 & Table 30**).

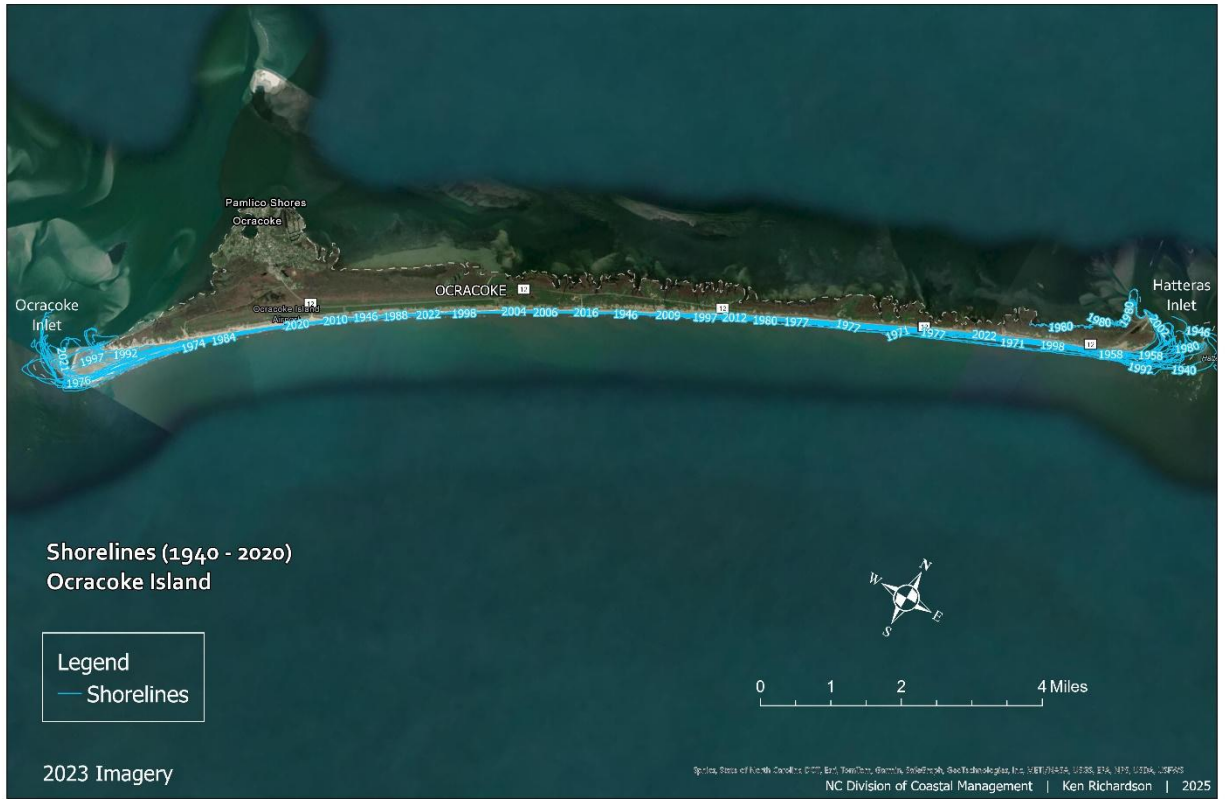


Figure 173. Shorelines included in the analysis (1940-2020) at Ocracoke Island.

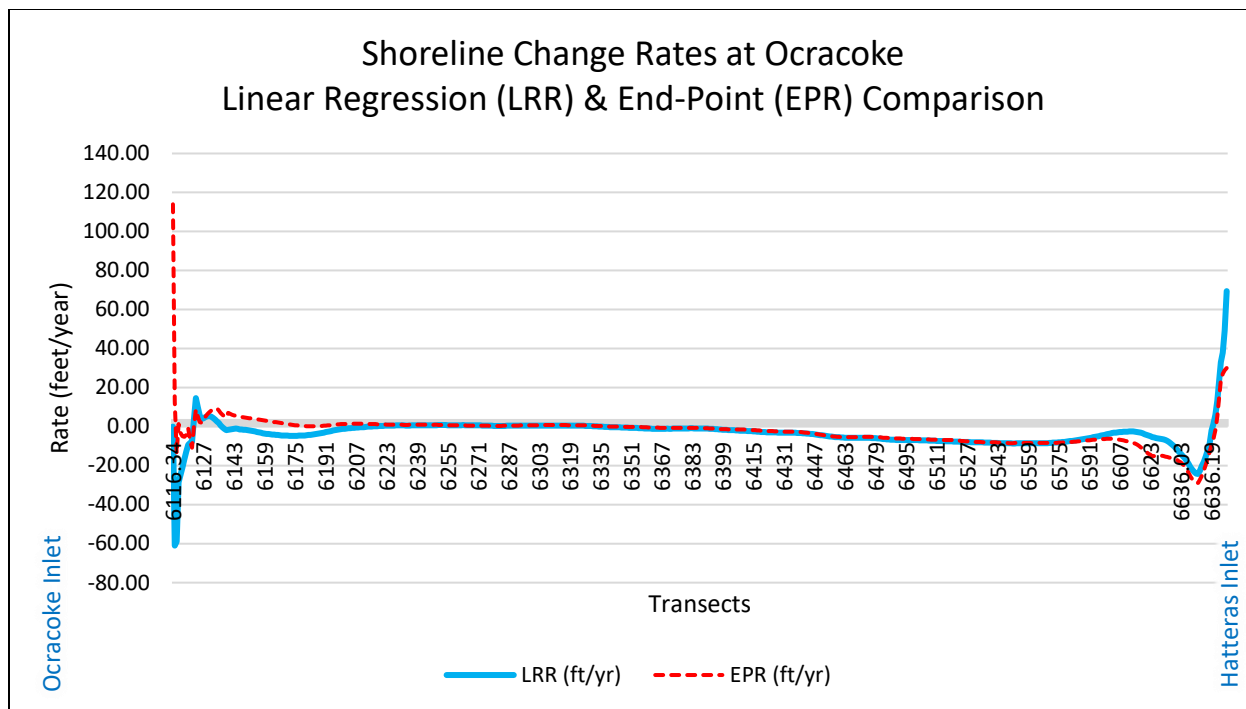


Figure 174. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

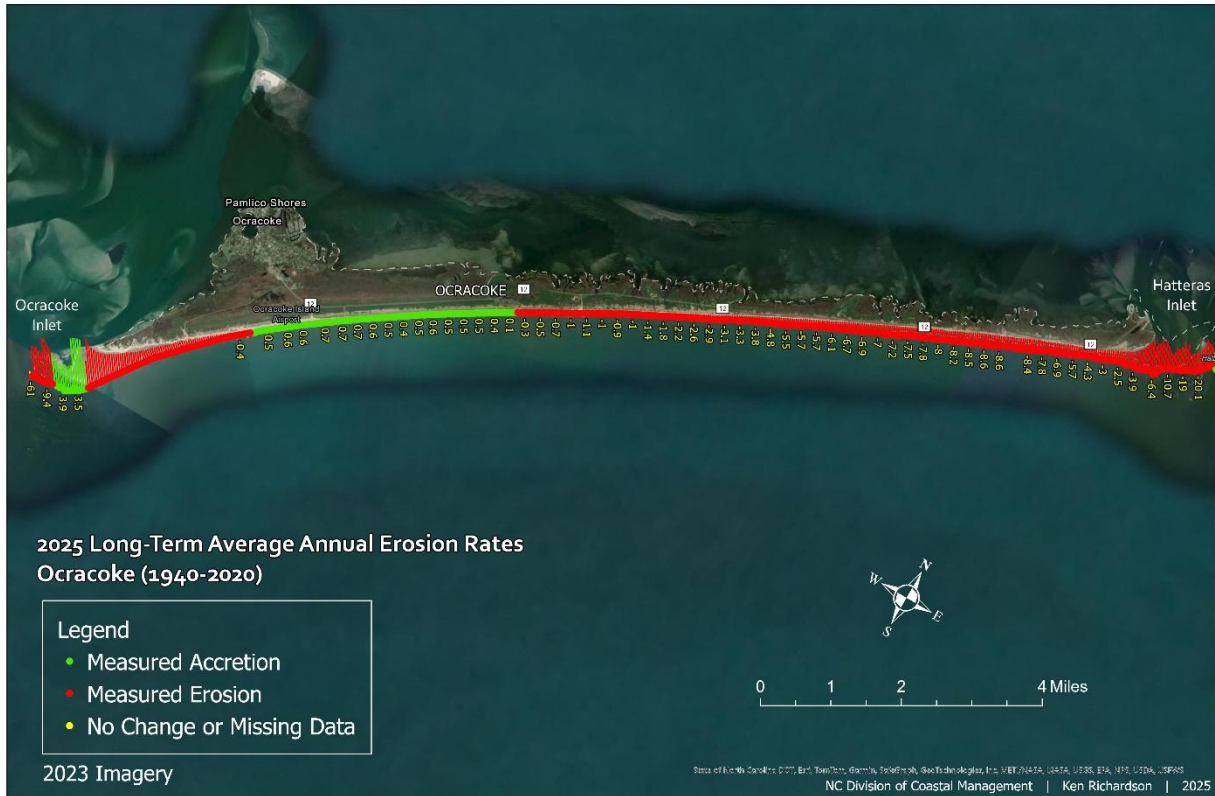


Figure 175. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

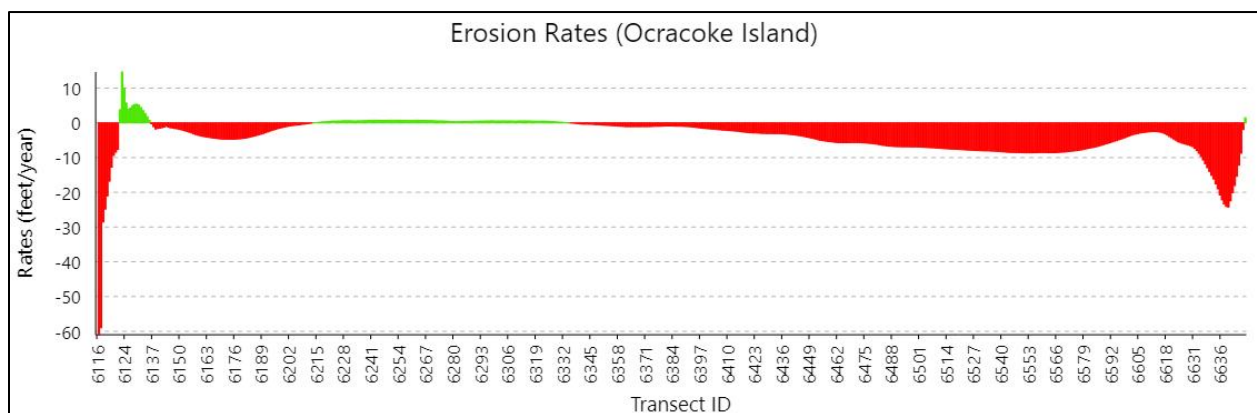


Figure 176. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

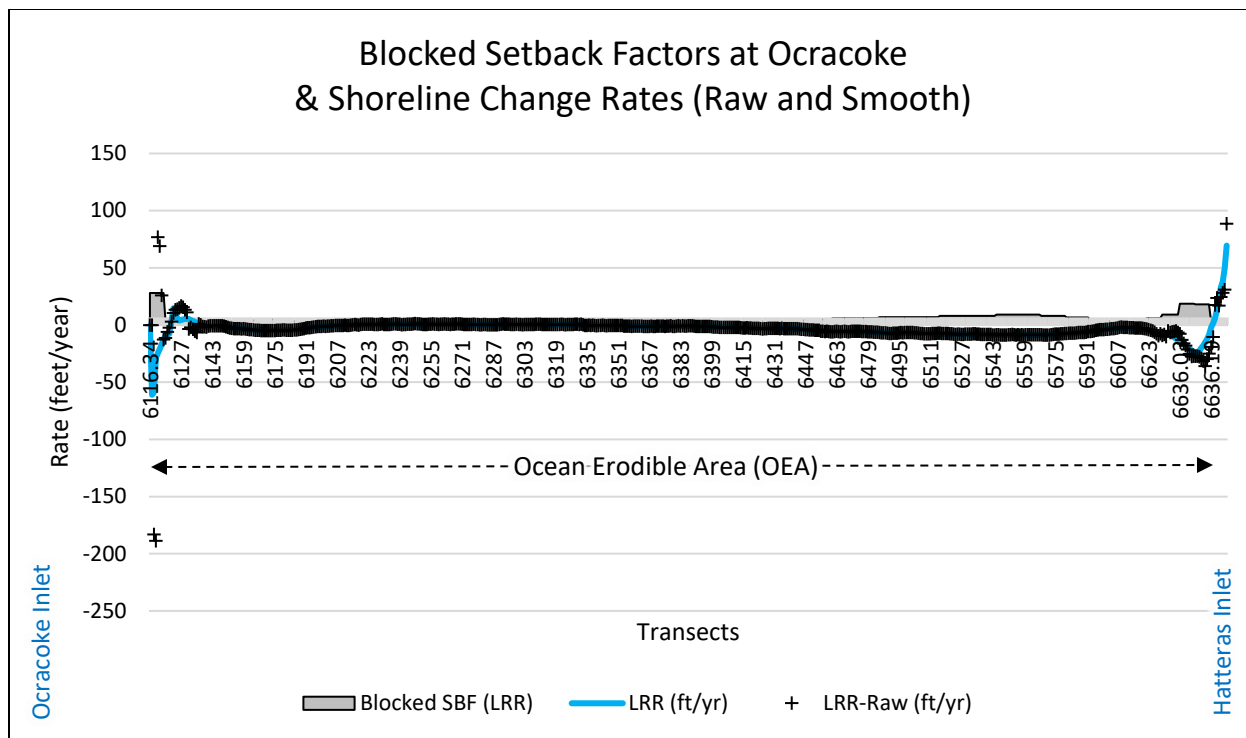


Figure 177. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 178. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Ocracoke Island.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------------------|-----------------|-------------------|-----------------|------------------|------------------|------|------|
| Setback Factor (SBF) | Range 2 to 28 | Range 2 to 9 | Range 2 to 8.5 | Range 2 to 9 | Range 2 to 43 | Range 2 to 17 | 2 | 2 |

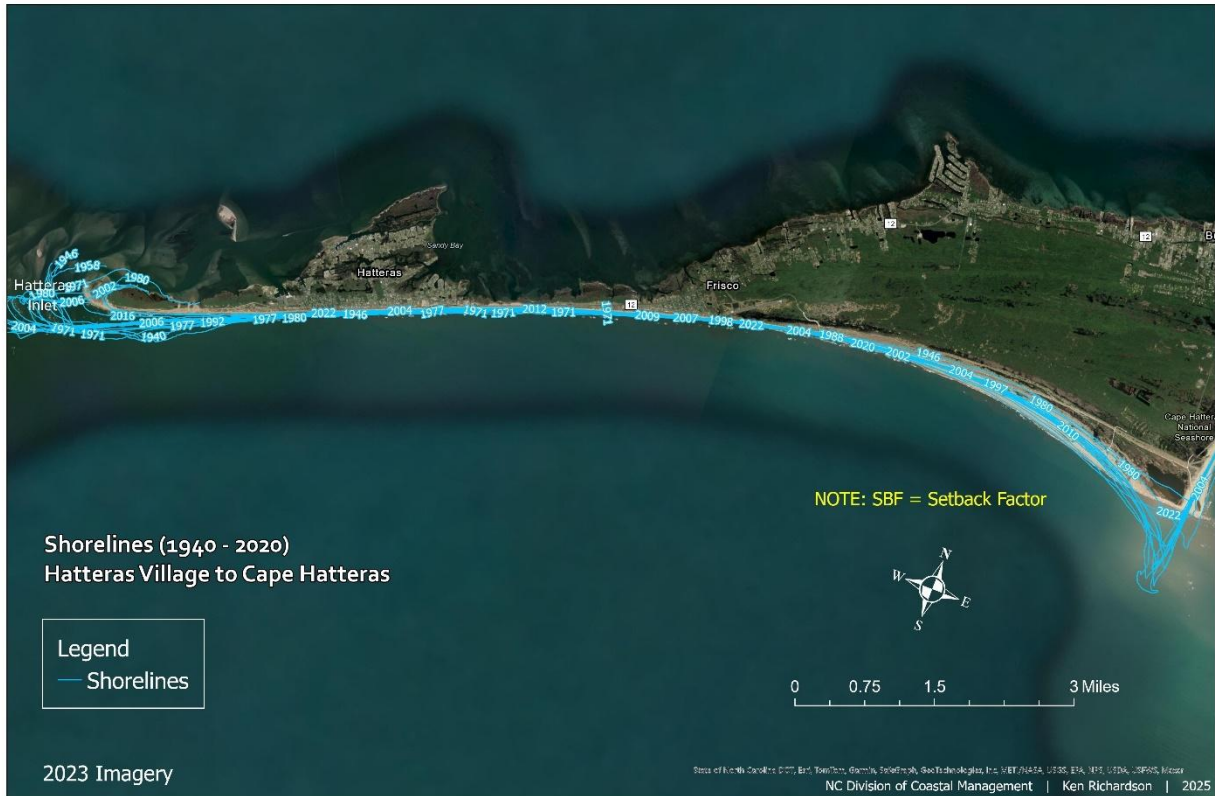
Table 30. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.30 Hatteras Village to Cape Hatteras

From Hatteras Inlet to Cape Hatteras, the analyzed oceanfront shoreline spanned 13.3 miles, including Hatteras Village and Frisco. Here, the analysis assessed sixteen shorelines (**Figure 179**) along this oceanfront section over an 80-year period, from 1940 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 97 feet to a maximum of 5,452 feet, with an average of 785 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 33 and 4,051 feet, and an average of 238 feet. Of the 13.3 miles of shoreline analyzed, approximately 7.3 miles (55%) resulted in measured erosion where rates ranged between -15.1 and less than -1 feet per year and averaged -4.2 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 180**). Between transects 6640 and 7077, the end-point method resulted in a range of shoreline line change rates between -20.3 and +30 feet per year, averaging +2.4 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -15.1 and +69.4 feet per year, averaging +3.2 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 16 feet per year, and the least squares regression ranged from 2 to 15 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 6640 and 7077 range from 2 to 15 feet per year. Compared to current effective setback factors (2020), this portion of the shoreline between transects 6789 and 6800 will experience a decrease by 1 foot per year (**Figure 181 to Figure 185 & Table 31**).



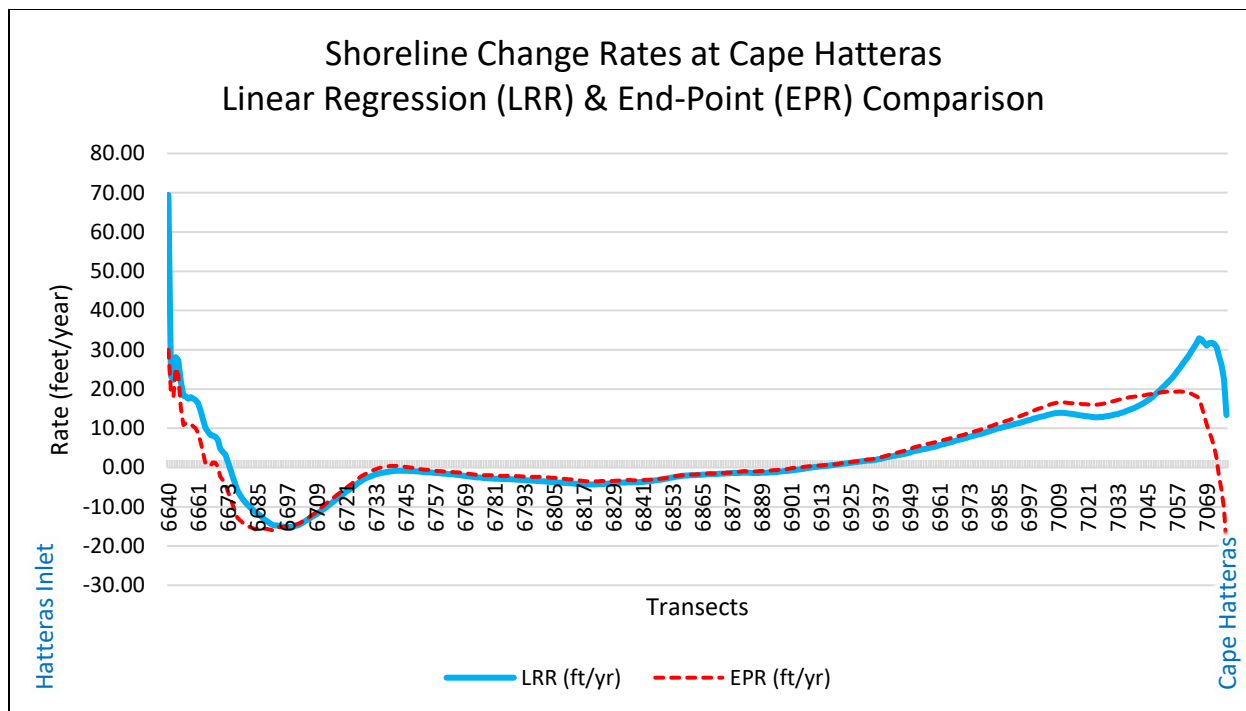


Figure 180. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

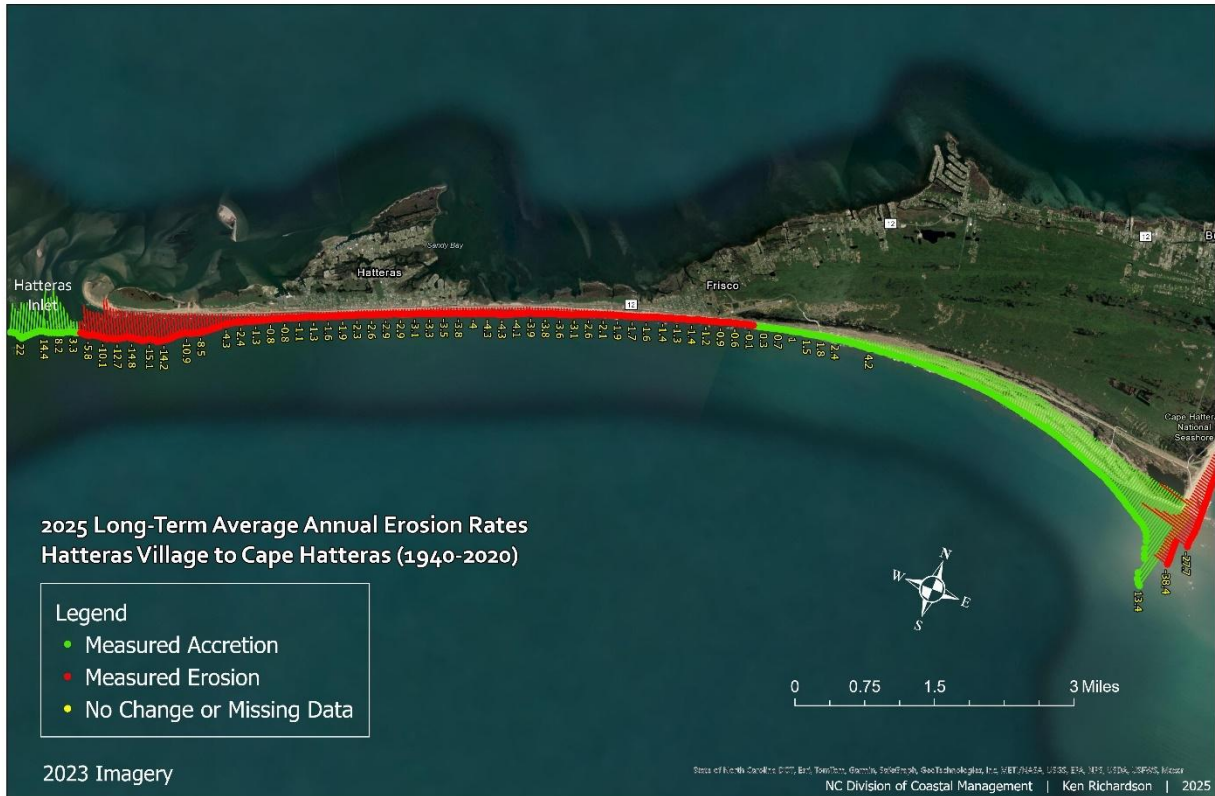


Figure 181. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

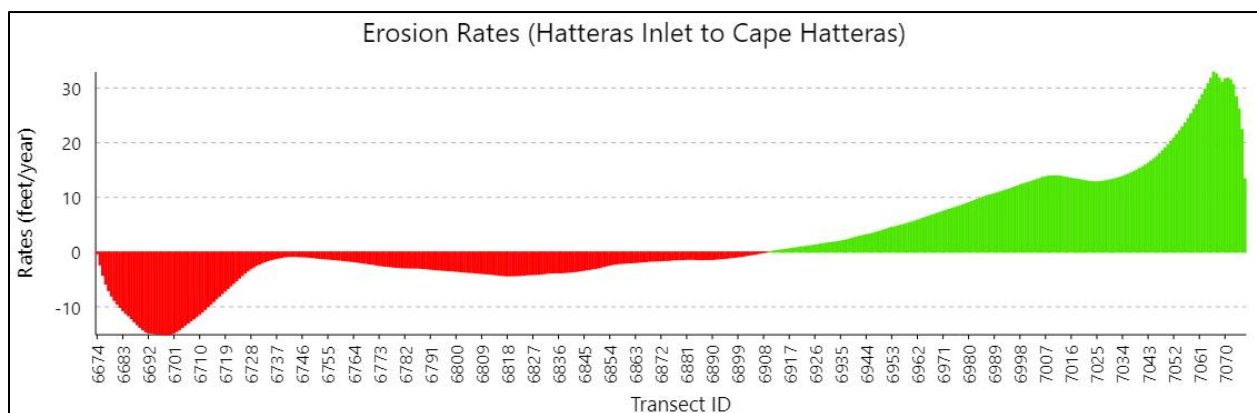


Figure 182. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

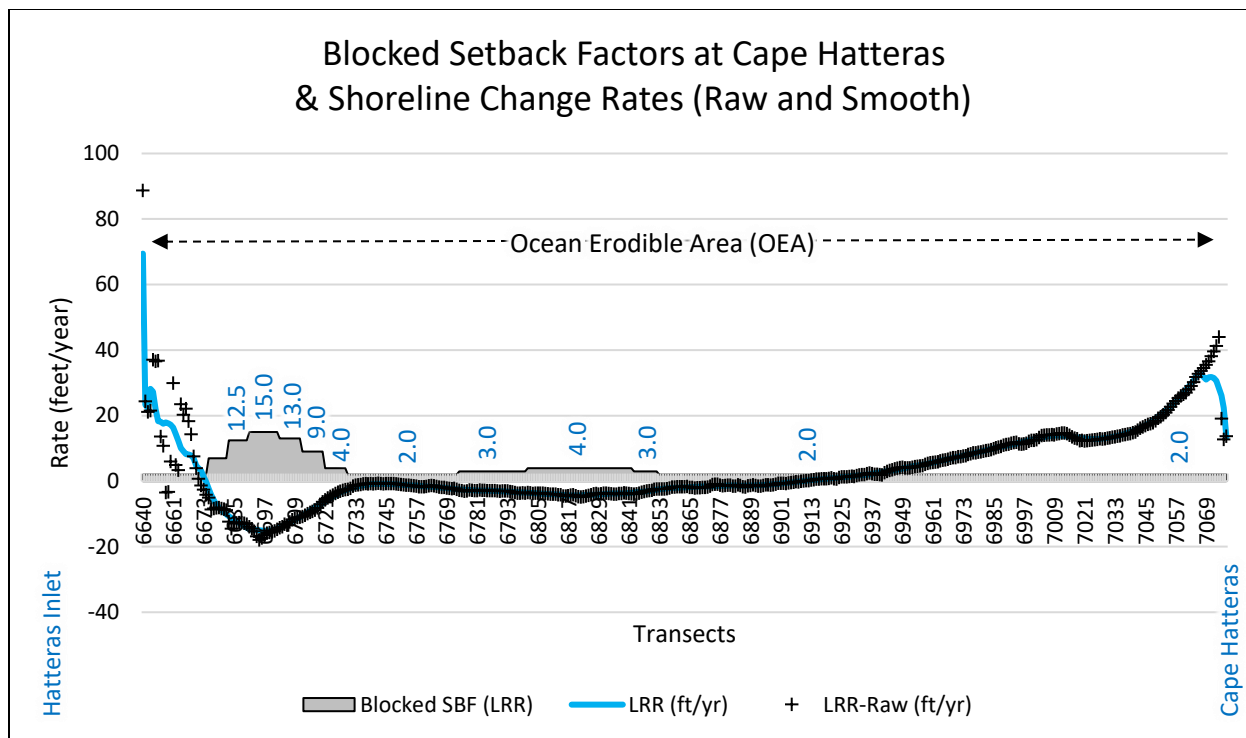


Figure 183. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 184. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Hatteras Village.



Figure 185. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Hatteras Inlet to Cape Hatteras.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------------------|--------------------|--------------------|--------------------|------------------|------------------|------|------|
| Setback Factor (SBF) | Range 2 to 15 | Range 2 to 16.5 | Range 2 to 11.5 | Range 2 to 13.5 | Range 2 to 13 | Range 2 to 10 | 2 | N/A |

Table 31. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.31 Cape Hatteras to Buxton

The analyzed shoreline extends 3.5 miles from Cape Hatteras to the northern boundary of Buxton, an area with a long history of significant erosion. Although this stretch has not been regularly nourished, numerous efforts have been made to mitigate erosion due to the areas historical and infrastructural significance of the Cape Hatteras Lighthouse, former U.S. Naval Facility and Coast Guard Station located just north of the lighthouse, and Highway-12.

Efforts to address erosion date back to 1966, when a small-scale project was implemented to protect the most vulnerable areas. In 1967, sandbags were introduced to safeguard the lighthouse, and three permanent groins were constructed near the lighthouse and naval base to stabilize the shoreline. However, despite these measures, erosion persisted along the adjacent shorelines to the north and south of the groin field, with rates equal to or exceeding those recorded before construction.

In the early 1970s, additional smaller beach fill projects were undertaken in 1971 and 1972 to provide temporary relief, though these efforts had limited long-term impact. Over the decades, the shoreline continued to experience erosion, posing ongoing threats to infrastructure, natural habitats, and historical landmarks. It wasn't until 2017–2018 that a large-scale beach nourishment project was installed. To maintain the effectiveness of this large-scale effort, a maintenance nourishment project was carried out in 2022. These interventions have played a crucial role in trying to slow erosion and have served to artificially influence the natural shoreline position, but the area remains highly dynamic.

Here, the analysis assessed twelve shorelines (**Figure 186**) along this oceanfront section over a 74-year period, from 1946 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 332 feet to a maximum of 3,405 feet, with an average of 774 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 103 and 804 feet, and an average of 219 feet. Of the 3.5 miles of shoreline analyzed, all 3.5 miles (100%) resulted in measured erosion where rates ranged between –38.4 and -1.5 feet per year and averaged -10.3 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 187**). Between transects 7078 and 7190, the end-point method resulted in a range of shoreline line change rates between -42.1 and +1.0 feet per year, averaging -10.0 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -38.4 and -1.5 feet per year, averaging -10.3 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 33 feet per year, and the least squares regression ranged from 2 to 31 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 7078 and 7190 range from 3 to 31 feet per year. Compared to current effective setback factors (2020), between transects 7174 to Buxton's northern boundary, this area will experience a decrease of 1 to 2 feet per year (**Figure 188 to Figure 191 & Table 32**).



Figure 186. Shorelines included in the analysis (1946-2020) at Cape Hatteras and Buxton.

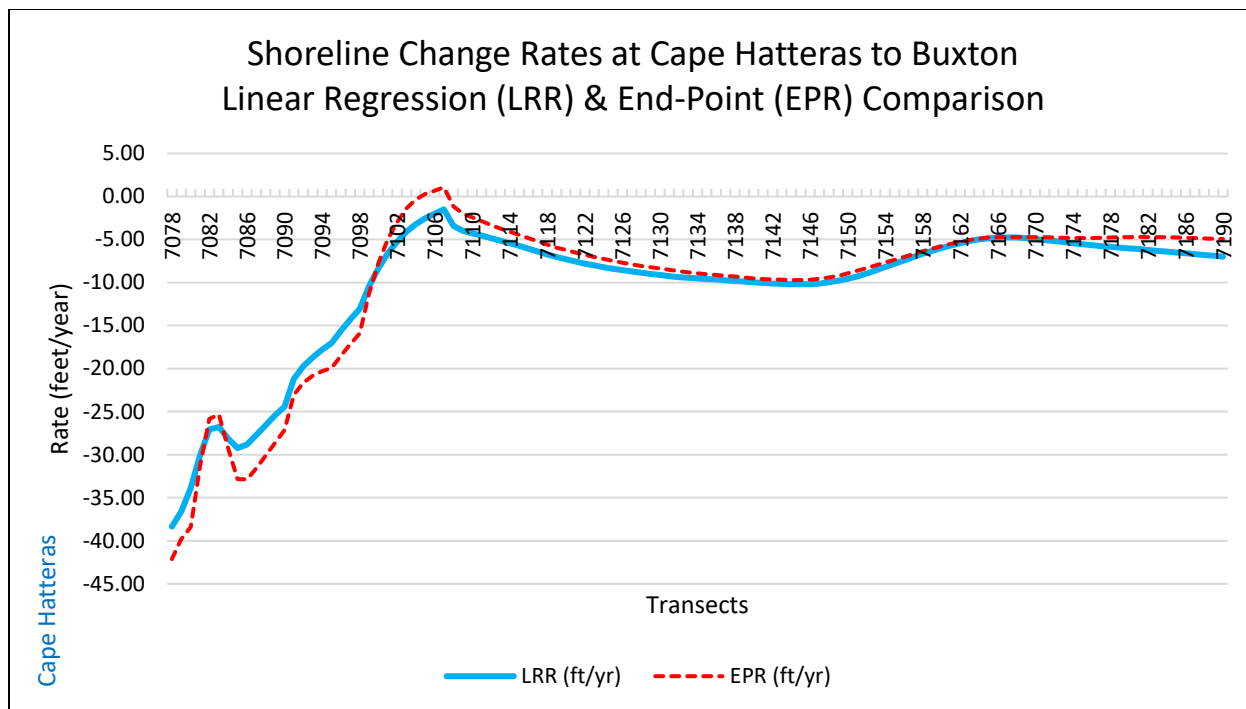


Figure 187. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

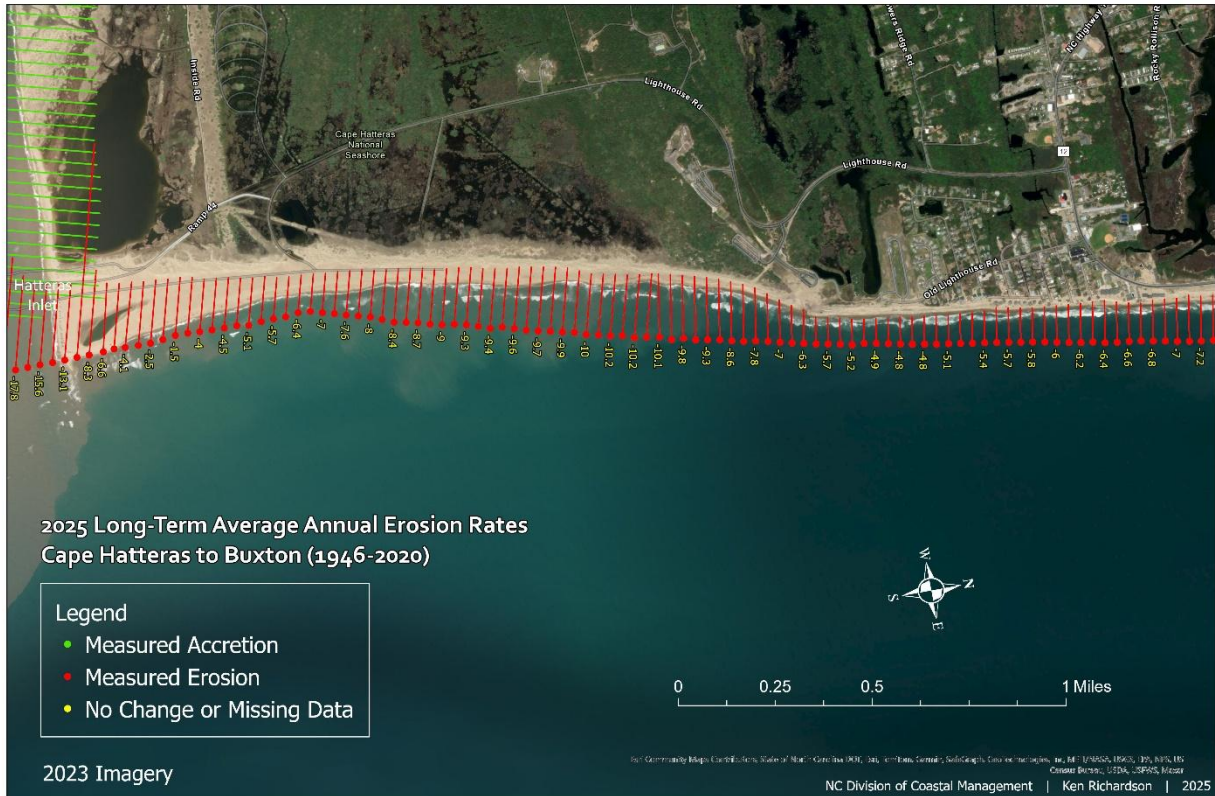


Figure 188. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

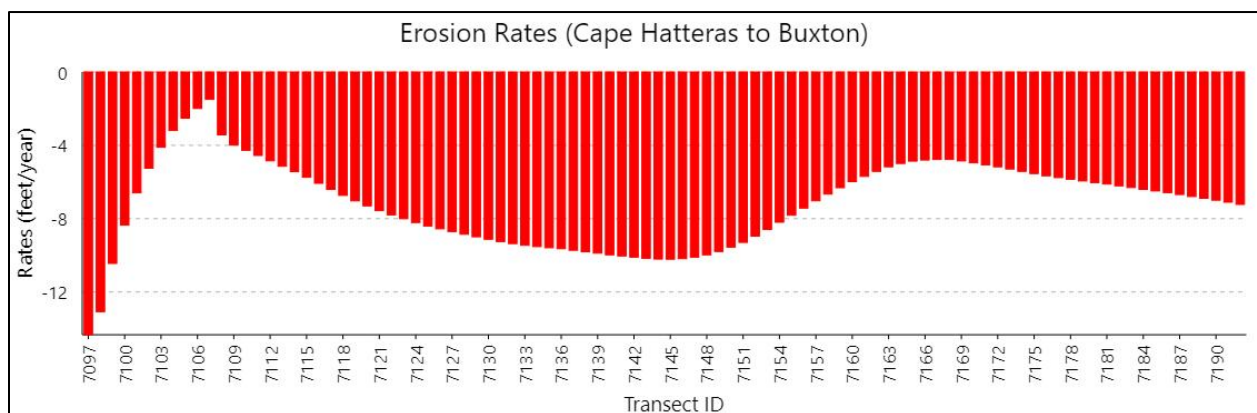


Figure 189. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

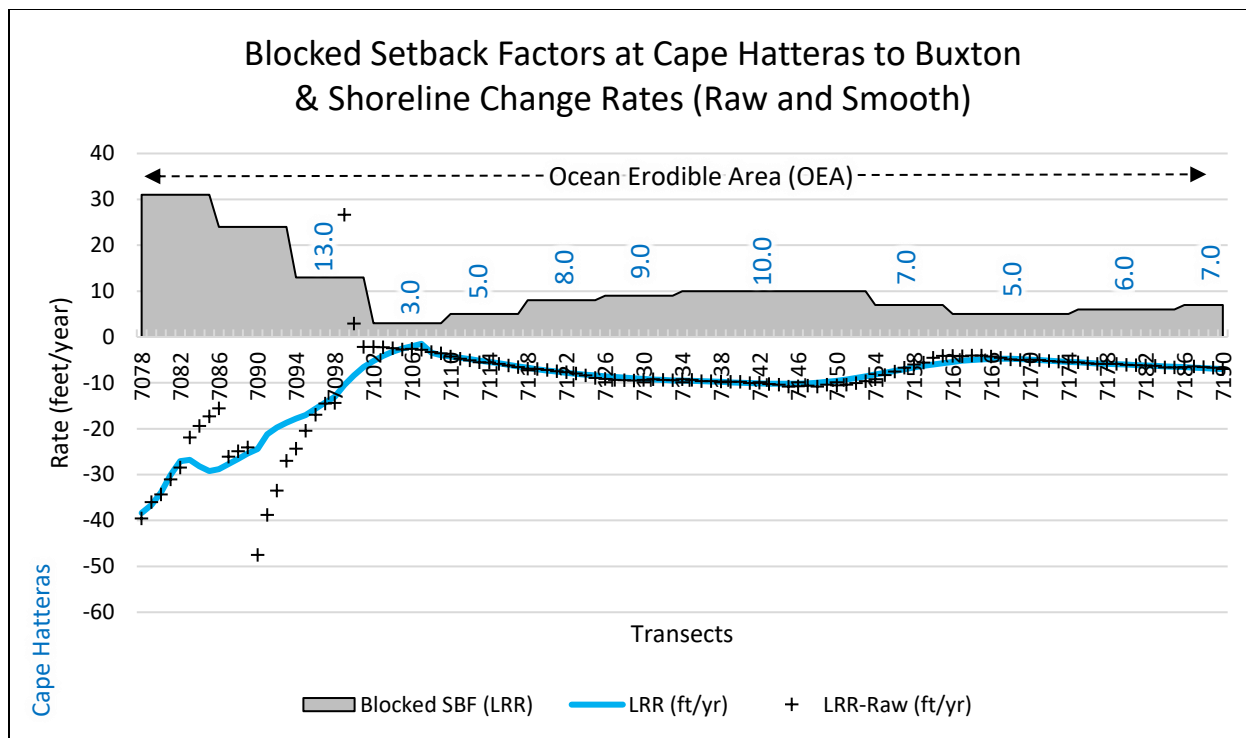


Figure 190. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

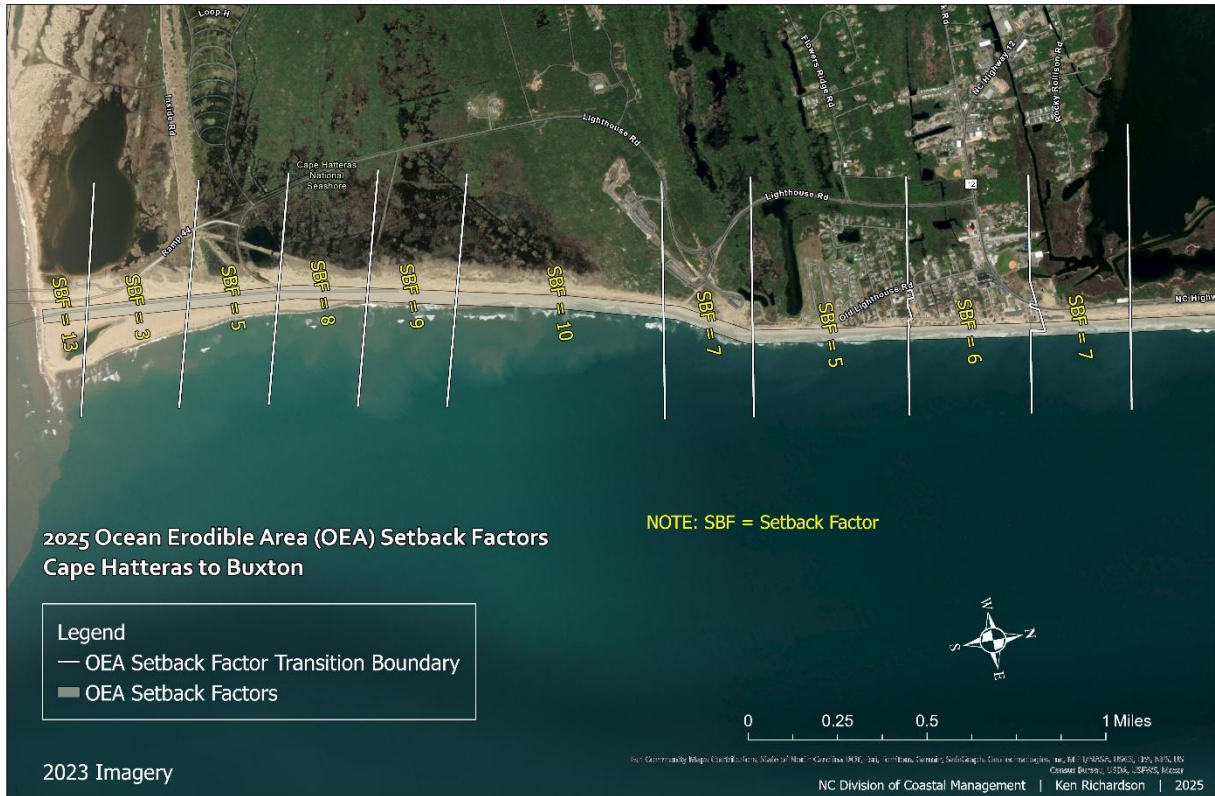


Figure 191. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Cape Hatteras and Buxton.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------------------|------------------|------------------|--------------------|------------------|--------------------|----------|------|
| Setback Factor (SBF) | Range 3 to 31 | Range 3 to 12 | Range 2 to 11 | Range 2 to 15.5 | Range 6 to 11 | Range 6 to 10.5 | 7.5 to 9 | N/A |

Table 32. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.32 National Seashore (Buxton to Avon)

Between Buxton and Avon, the oceanfront shoreline spans 3.9 miles. Here, the analysis assessed twelve shorelines (**Figure 192**) along this oceanfront section over a 74-year period, from 1946 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 127 feet to a maximum of 715 feet, with an average of 472 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 40 and 232 feet, and an average of 145 feet. Of the 3.9 miles of shoreline analyzed, all 3.9 miles (100%) resulted in measured erosion where rates ranged between -9.0 and -1.4 feet per year and averaged -5.7 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 193**). Between transects 7191 and 7316, the end-point method resulted in a range of shoreline line change rates between -7.8 and -1.1 feet per year, averaging -4.7 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -9.0 and -1.4 feet per year, averaging -5.7 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 8 feet per year, and the least squares regression ranged from 2 to 9 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 7191 and 7316 range from 2 to 9 feet per year (**Figure 193 to Figure 197 & Table 33**).



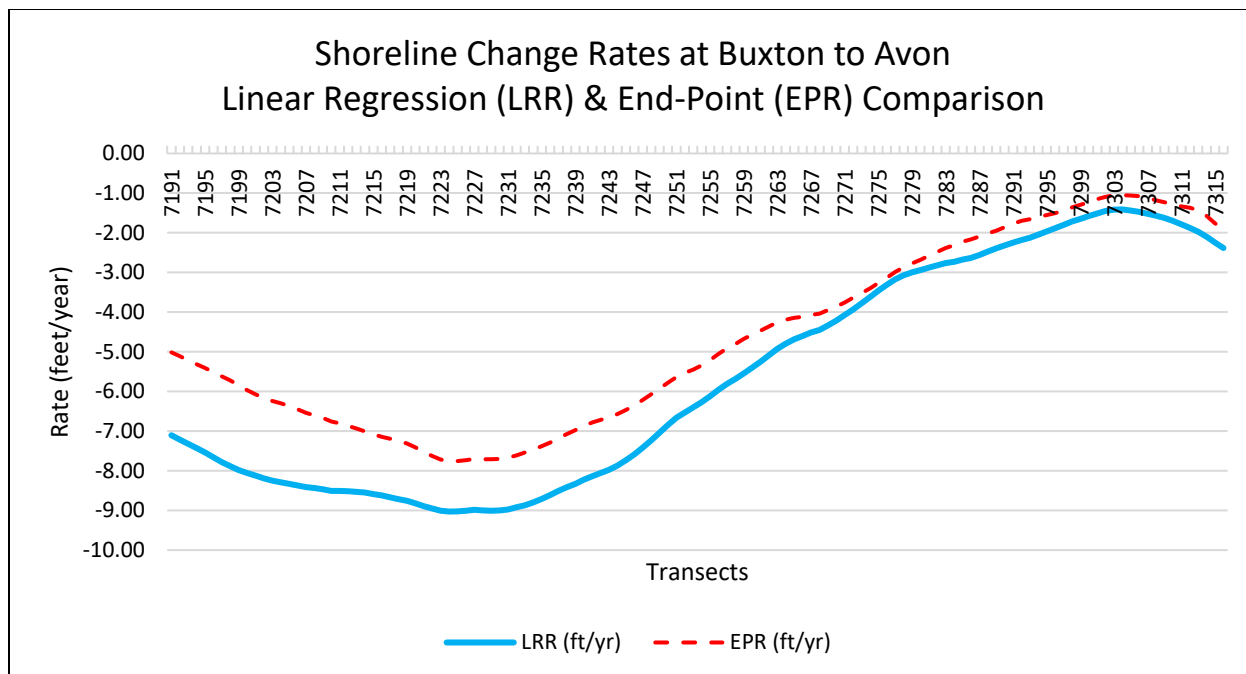


Figure 193. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

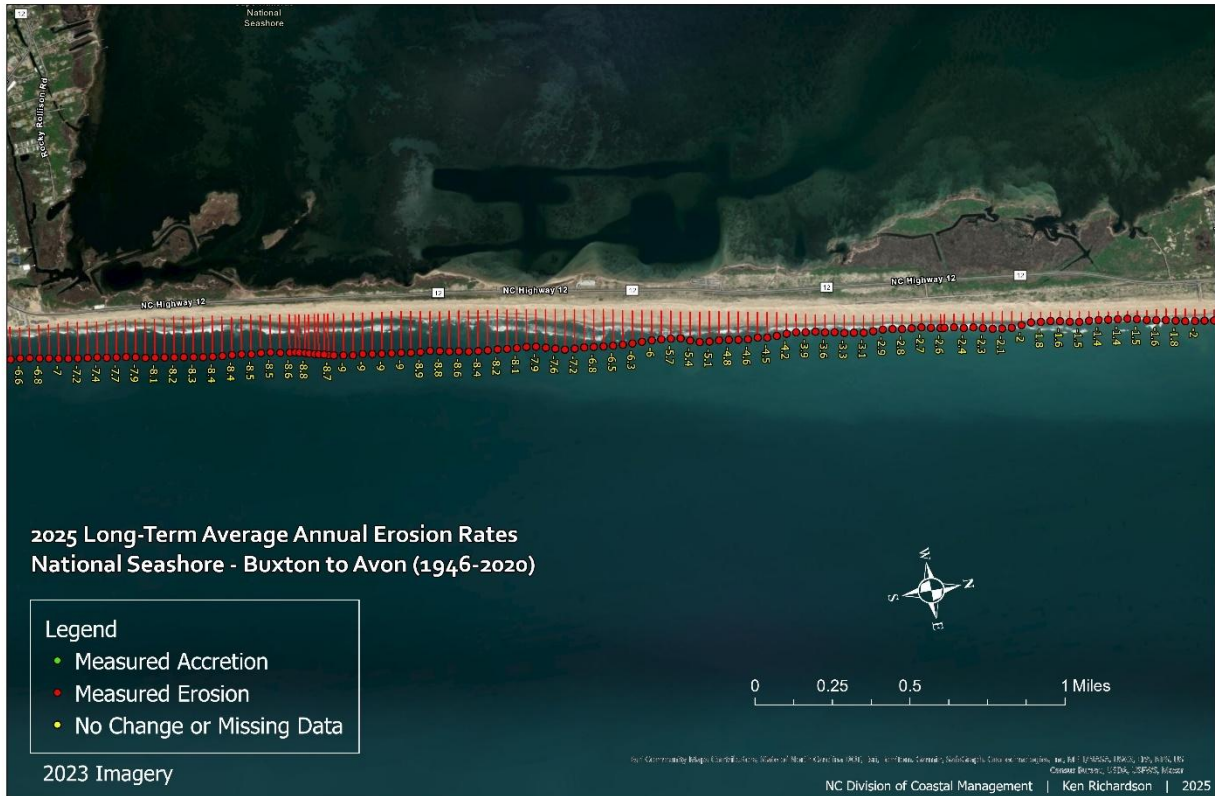


Figure 194. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

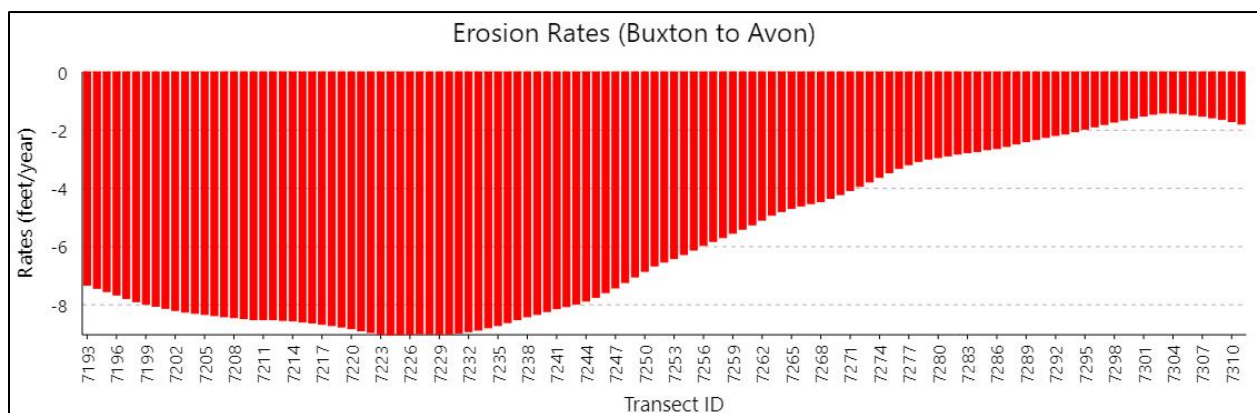


Figure 195. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

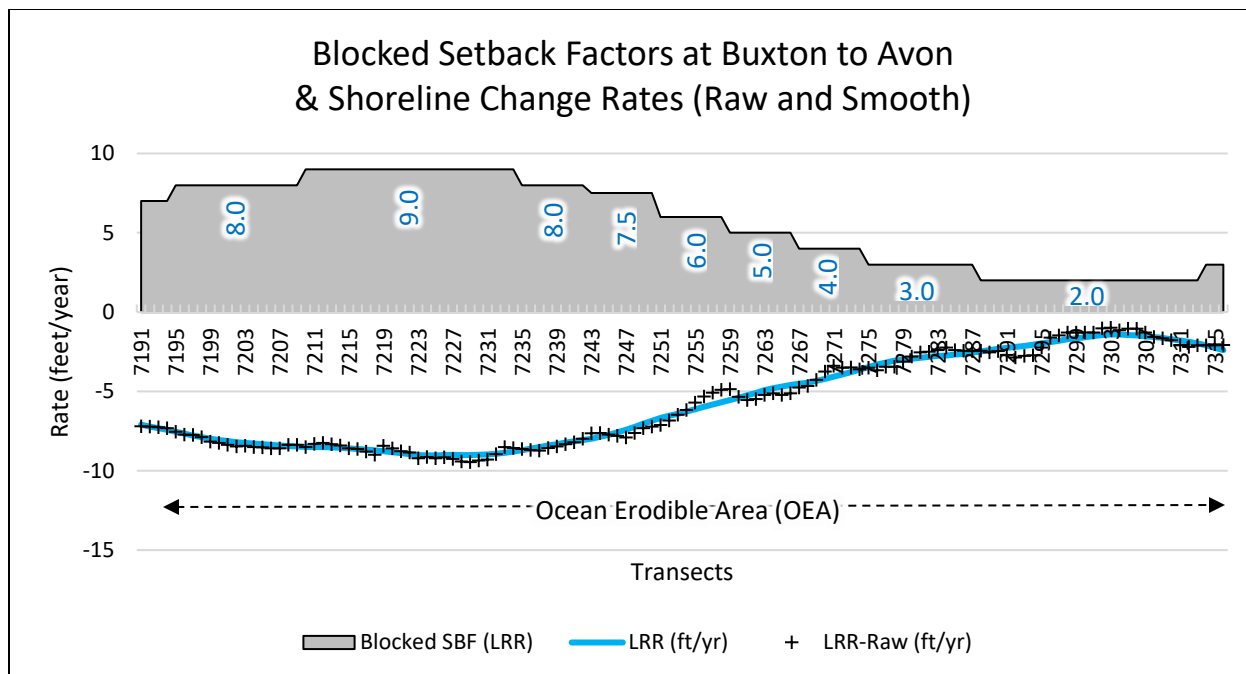


Figure 196. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 197. This map illustrates the erosion rate setback factors within the Ocean Erodible Area between Buxton and Avon.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|-----------------|------------------|------------------|--------------------|--------------------|------------------|-----------------|------|
| Setback Factor (SBF) | Range 2 to 9 | Range 2 to 10 | Range 2 to 10 | Range 2 to 10.5 | Range 4.5 to 10 | Range 4 to 10 | Range 5 to 9 | N/A |

Table 33. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.33 Avon

The oceanfront shoreline at Avon extends 3.4 miles and was the site of a large-scale beach nourishment project in 2022. However, this project did not impact the findings of this study, as it took place after the most recent shoreline data used in the analysis.

Here, twelve shorelines (**Figure 198**) were assessed along this oceanfront section over a 74-year period, from 1946 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 110 feet to a maximum of 528 feet, with an average of 329 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 37 and 159 feet, and an average of 100 feet. Of the 3.4 miles of shoreline analyzed, 2.4 miles (71%) resulted in measured erosion where rates ranged between -5.4 and less than -1.0 feet per year and averaged -3.6 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 198**). Between transects 7317 and 7428, the end-point method resulted in a range of shoreline line change rates between -4.8 and +3.7 feet per year, averaging -1.1 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -5.4 and +3.8 feet per year, averaging -1.7 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 5 feet per year, and the least squares regression ranged from 2 to 5 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 7317 and 7428 range from 2 to 5 feet per year. Compared to current effective setback factors (2020), most of the area between transects 7323 to 7382 will experience a 1 foot per year decrease (**Figure 200 to Figure 203 & Table 34**).

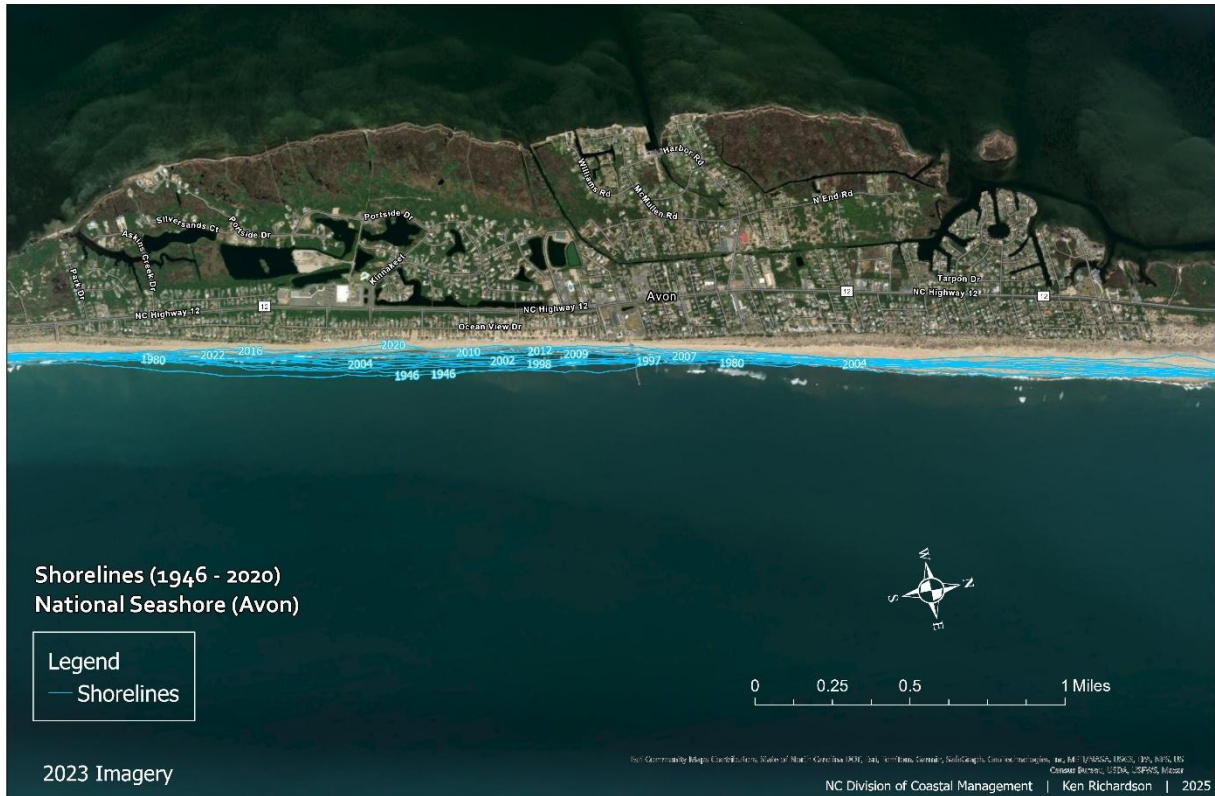


Figure 198. Shorelines included in the analysis (1946-2020) at Avon.

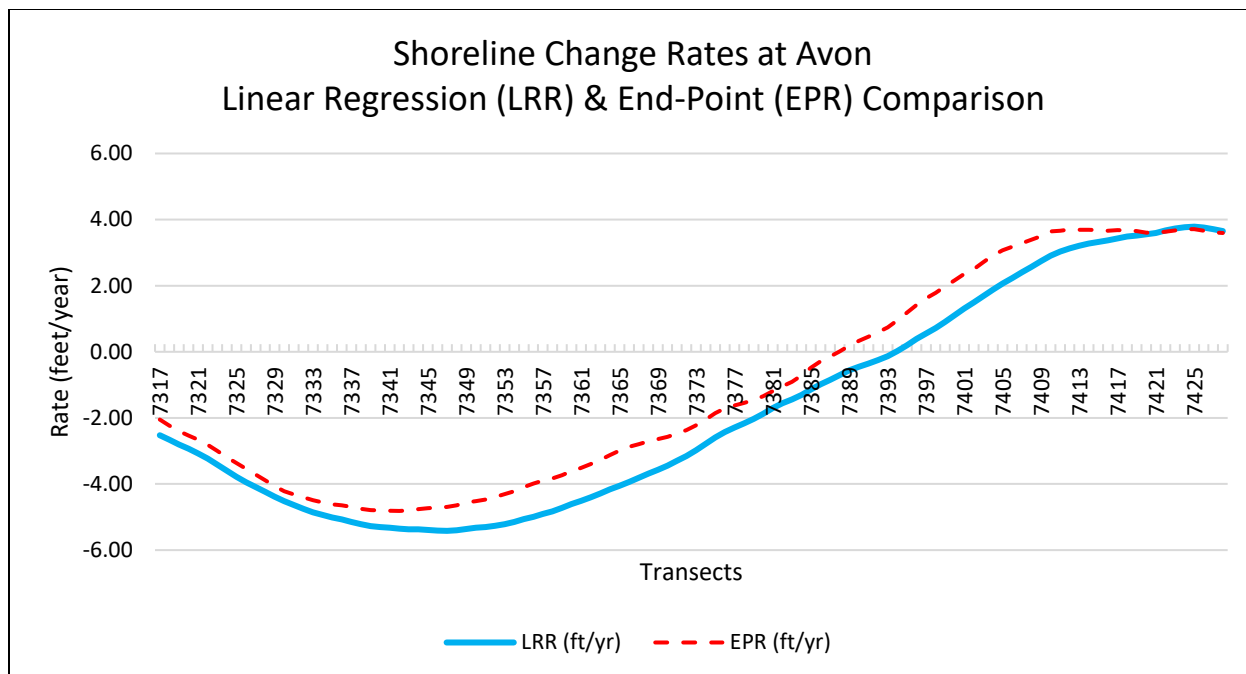


Figure 199. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 200. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

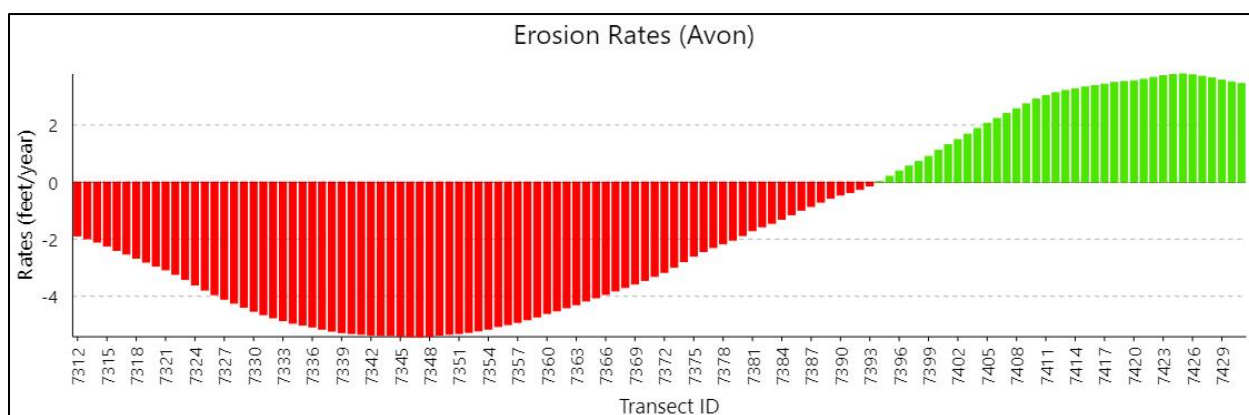


Figure 201. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

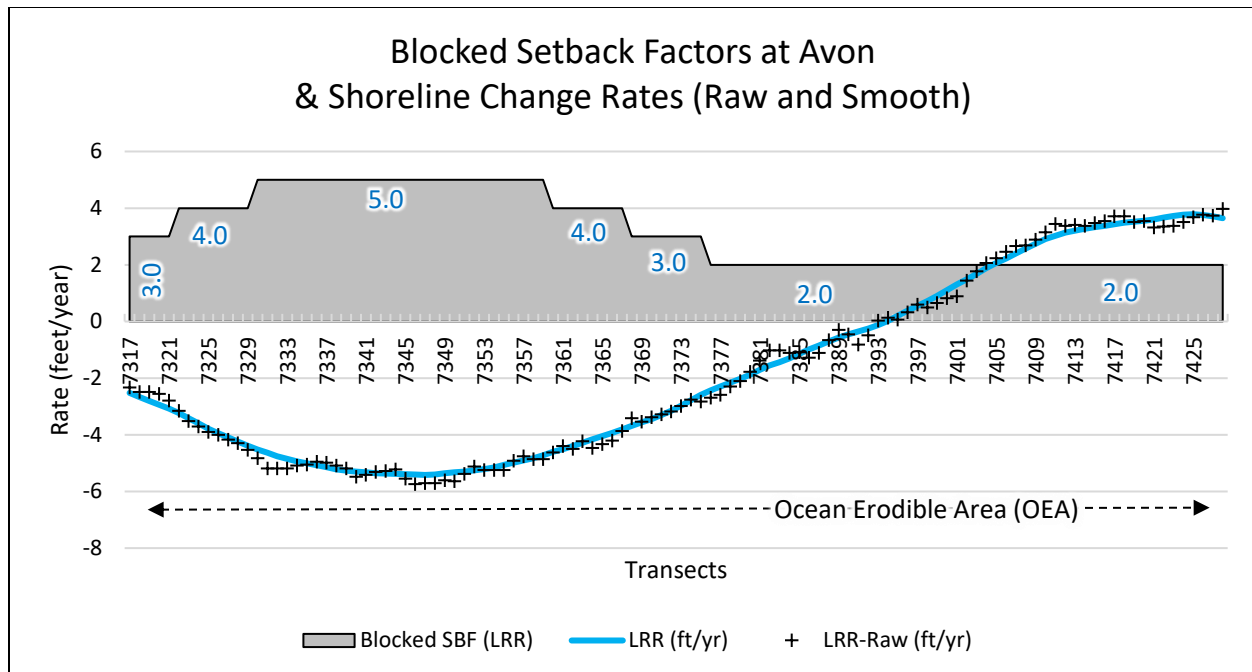


Figure 202. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 203. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Avon.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|-----------------|-----------------|-------------------|-----------------|-------------------|-----------------|-----------------|------|
| Setback Factor (SBF) | Range 2 to 5 | Range 2 to 6 | Range 2 to 4.5 | Range 2 to 3 | Range 2 to 4.5 | Range 2 to 6 | Range 2 to 5 | N/A |

Table 34. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.34 National Seashore (Avon to Salvo)

Between Avon and Salvo, the oceanfront shoreline spans 11.5 miles. Here, the analysis assessed twelve shorelines (**Figure 204**) along this oceanfront section over a 74-year period, from 1946 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 134 feet to a maximum of 445 feet, with an average of 282 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 41 and 132 feet, and an average of 84 feet. Of the 11.5 miles of shoreline analyzed, 8.4 miles (73%) resulted in measured erosion where rates ranged between -4.8 and less than -1.0 feet per year and averaged -2.7 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 205**). Between transects 7429 and 7799, the end-point method resulted in a range of shoreline line change rates between -5.0 and +5.0 feet per year, averaging -1.1 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -4.8 and +4.1 feet per year, averaging -1.3 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 5 feet per year, and the least squares regression ranged from 2 to 5 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 7429 and 7799 range from 2 to 5 feet per year (**Figure 206 to Figure 209 & Table 35**).



Figure 204. Shorelines included in the analysis (1946-2020) between Avon and Salvo.

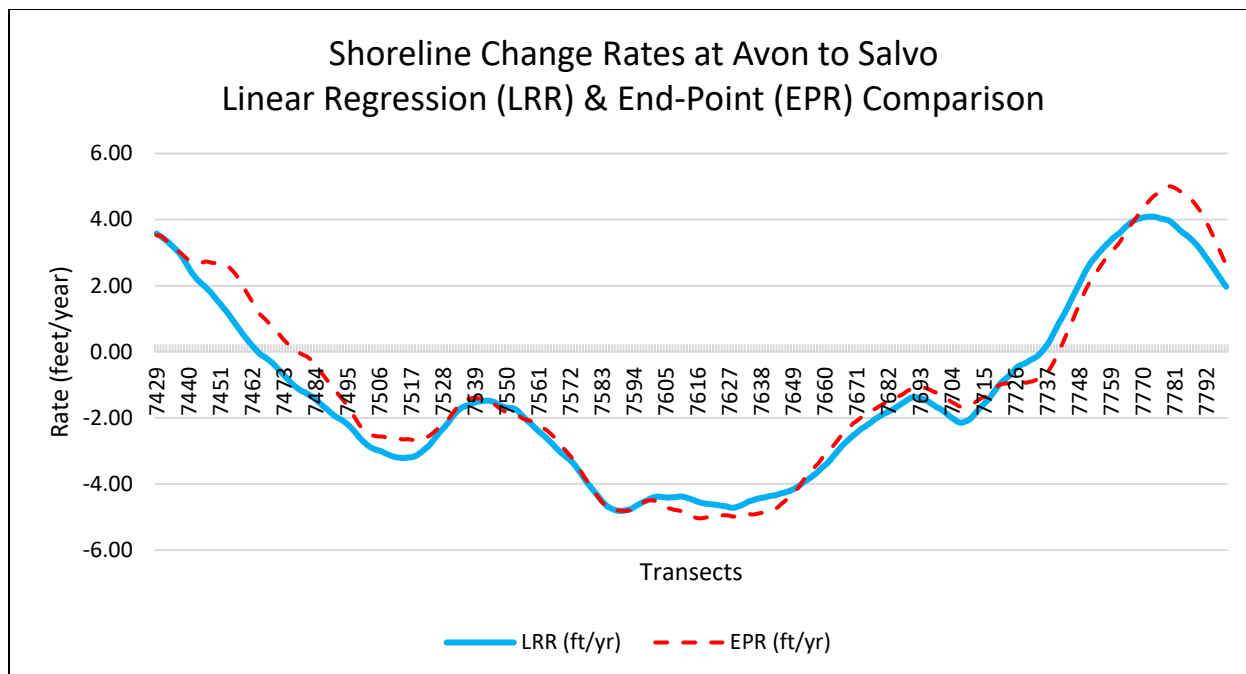


Figure 205. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 206. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

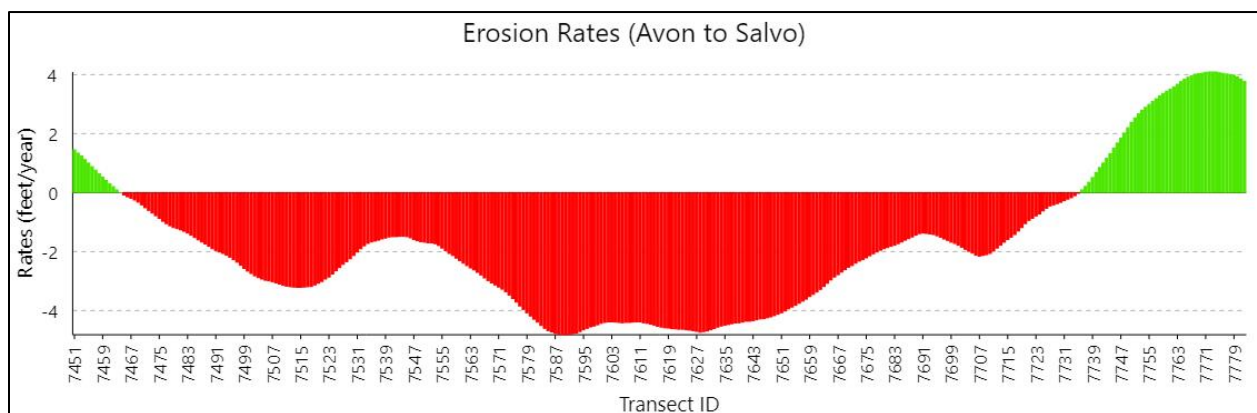


Figure 207. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

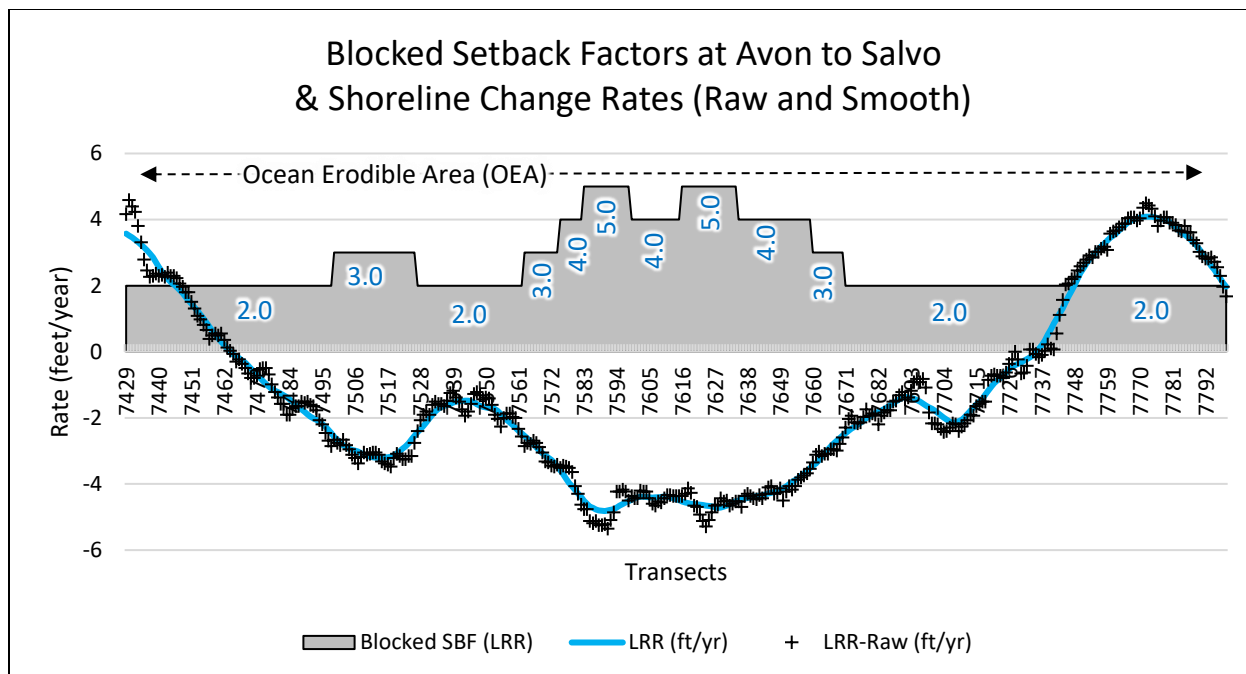


Figure 208. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 209. This map illustrates the erosion rate setback factors within the Ocean Erodible Area between Avon and Salvo.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|-----------------|-----------------|-----------------|-------------------|-----------------|-------------------|-----------------|------|
| Setback Factor (SBF) | Range 2 to 5 | Range 2 to 6 | Range 2 to 4 | Range 2 to 4.5 | Range 2 to 4 | Range 2 to 6.5 | Range 2 to 4 | N/A |

Table 35. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.35 Salvo, Waves and Rodanthe

The oceanfront shoreline at Salvo, Waves and Rodanthe extends 5.0 miles. The northern portion of this shoreline at the north end of Rodanthe at Mirlo Beach and NC Highway 12 was the site of a large-scale beach nourishment project in 2014.

Here, twelve shorelines (**Figure 210**) were assessed along this oceanfront section over a 74-year period, from 1946 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 126 feet to a maximum of 1,022 feet, with an average of 437 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 37 and 324 feet, and an average of 137 feet. Of the 5.0 miles of shoreline analyzed, 2.6 miles (52%) resulted in measured erosion where rates ranged between -12.6 and less than -1.0 feet per year and averaged -8.1 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 211**). Between transects 7800 and 7961, the end-point method resulted in a range of shoreline line change rates between -12.4 and +2.5 feet per year, averaging -3.7 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -12.6 and +1.9 feet per year, averaging -3.9 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 12 feet per year, and the least squares regression ranged from 2 to 13 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 7800 and 7961 range from 2 to 13 feet per year. Compared to current effective setback factors (2020), areas between transects 7881 and 7887, transects 7938 and 7941, and transects 7946 and 7950 will experience a 1 foot per year decrease; while the area between transects 7896 and 7905 will experience a 1 foot per year increase (**Figure 211 to Figure 216 & Table 36**).

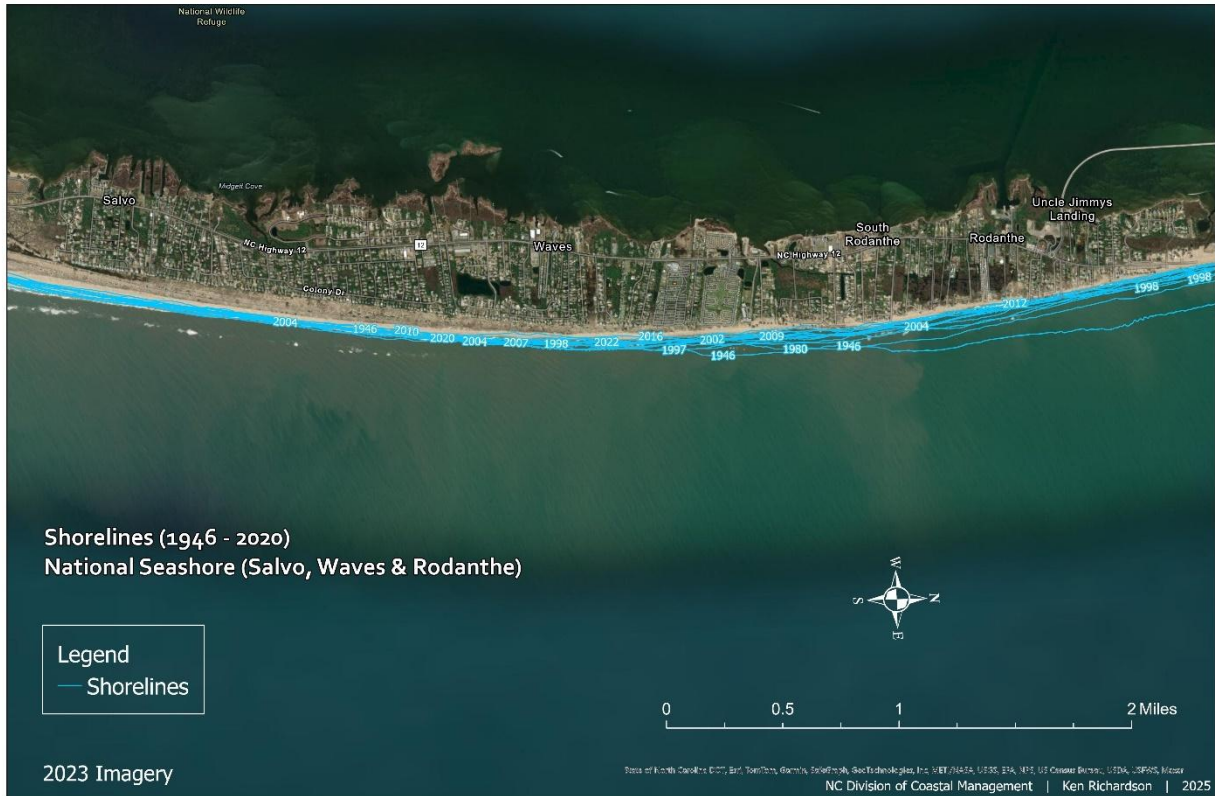


Figure 210. Shorelines included in the analysis (1946-2020) at Salvo, Waves and Rodanthe.

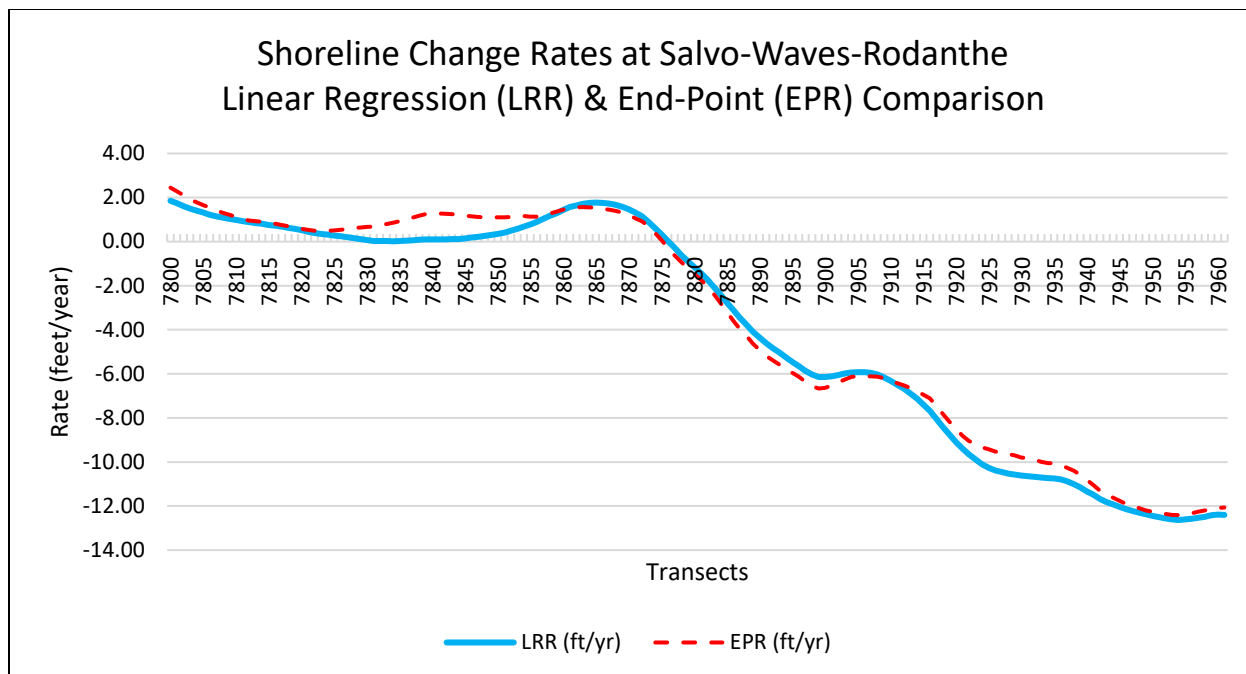


Figure 211. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

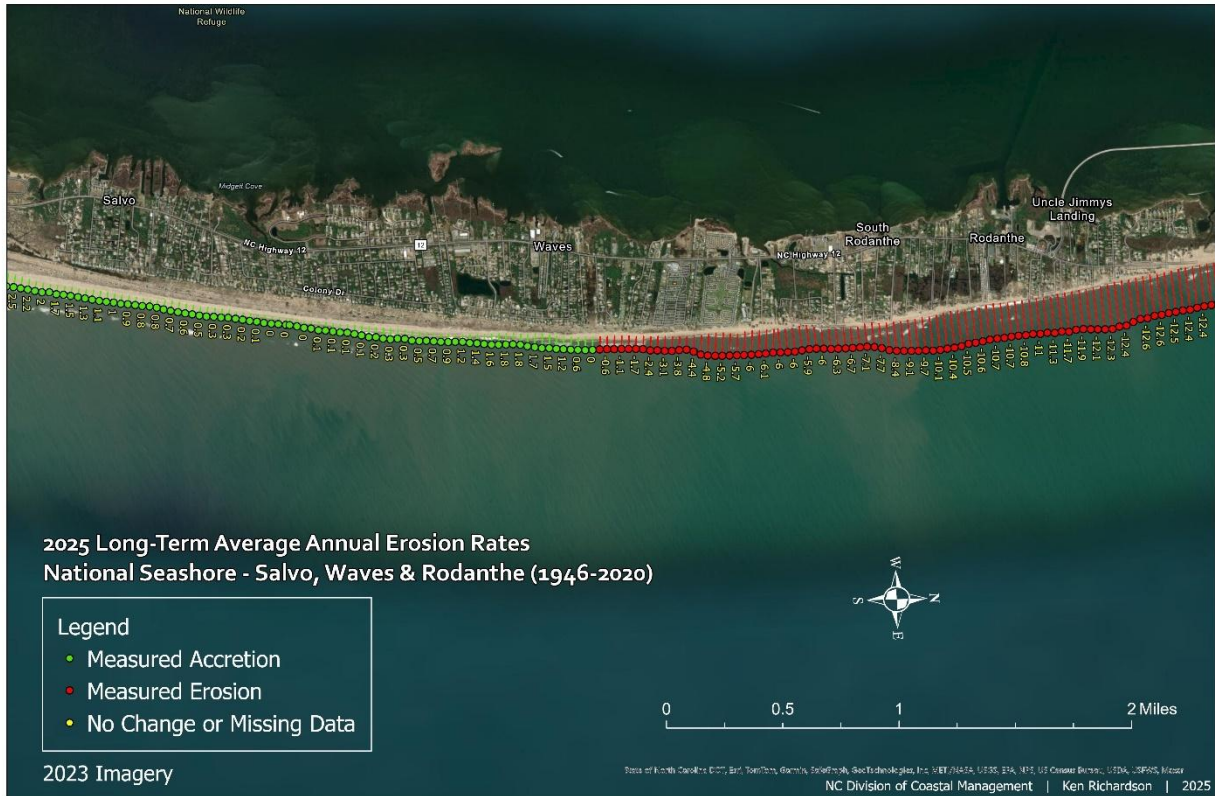


Figure 212. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

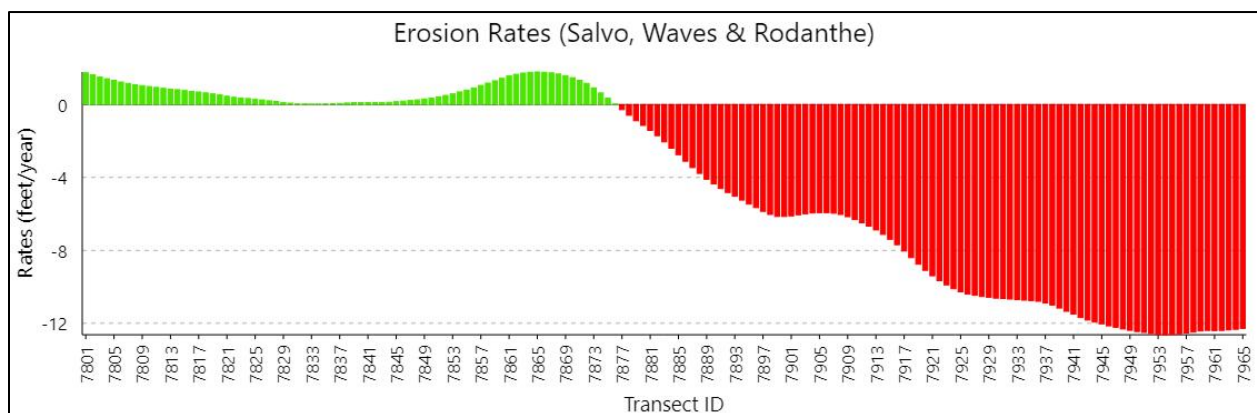


Figure 213. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

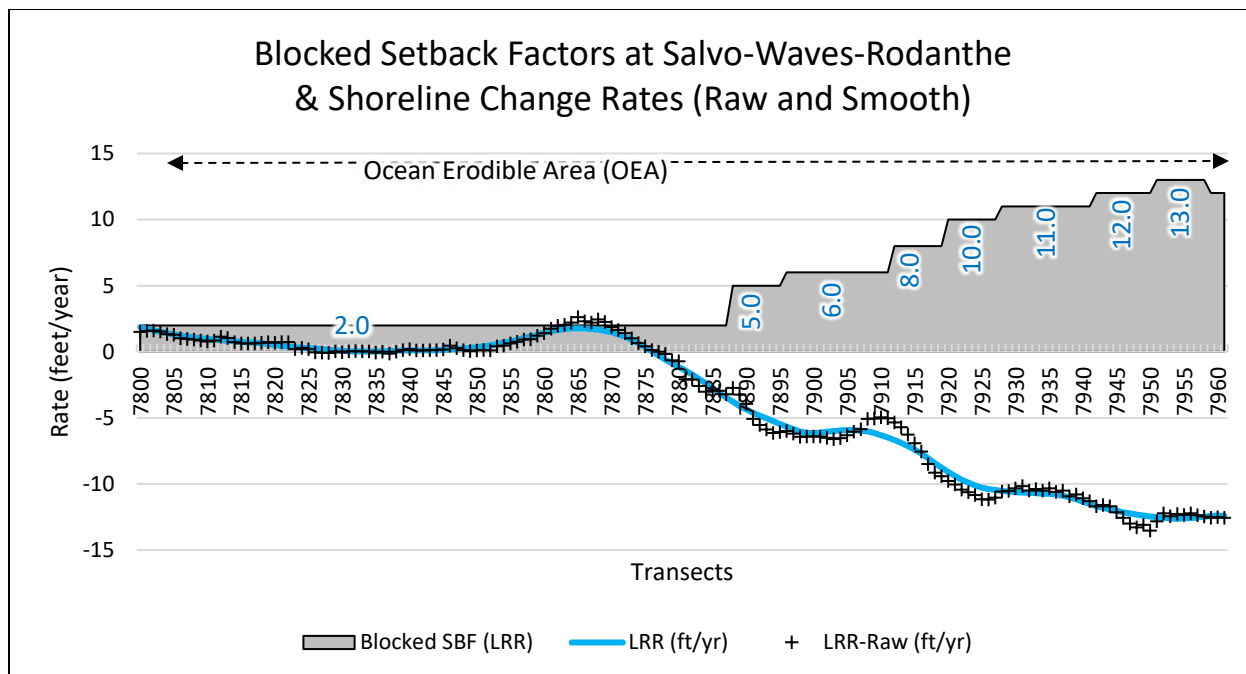


Figure 214. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

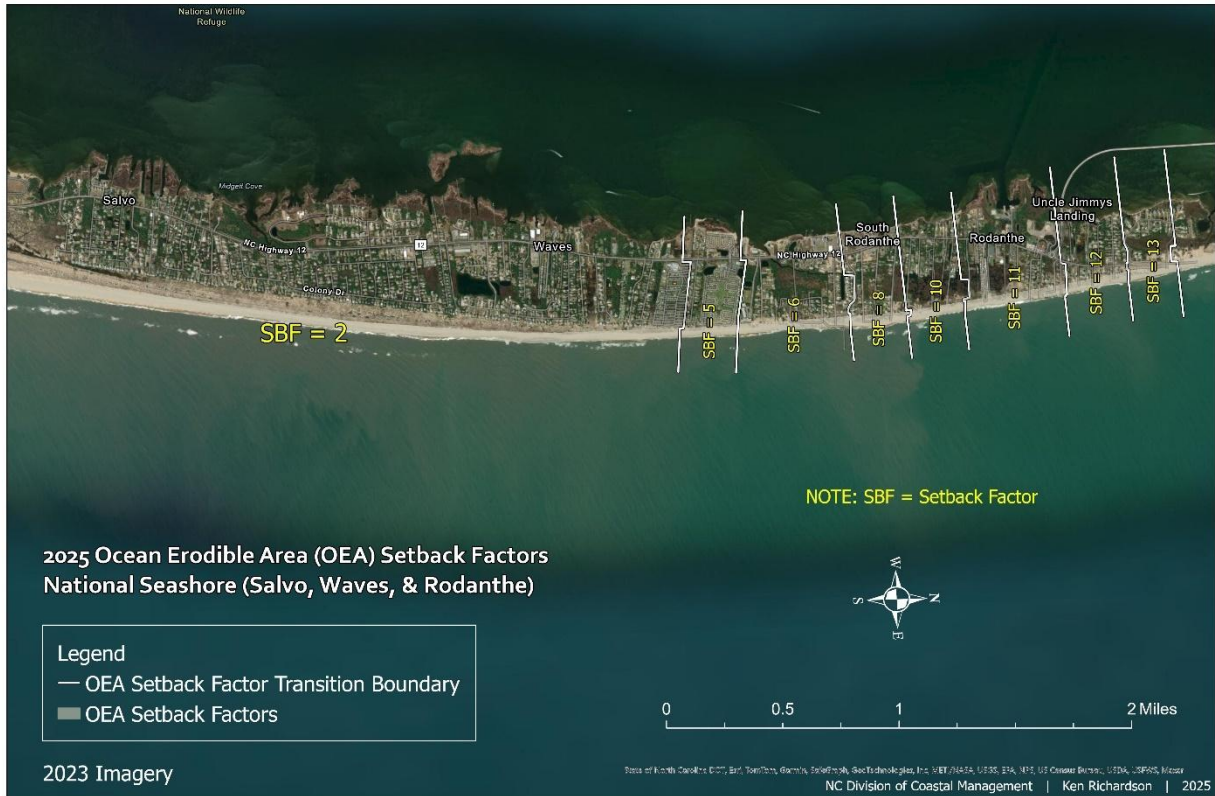


Figure 215. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Salvo, Waves, and Rodanthe.

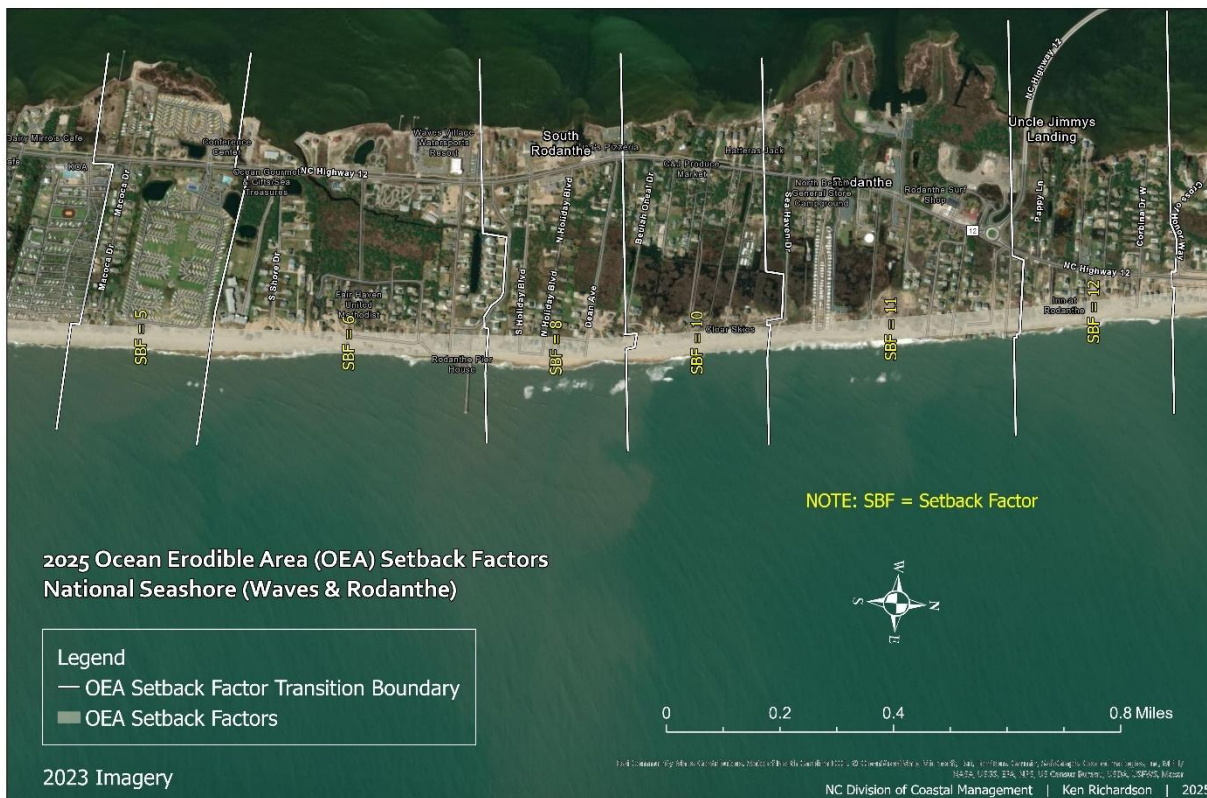


Figure 216. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Salvo, Waves and Rodanthe.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------------------|------------------|--------------------|------------------|------------------|------------------|------------------|------|
| Setback Factor (SBF) | Range 2 to 13 | Range 2 to 13 | Range 2 to 12.5 | Range 2 to 14 | Range 2 to 16 | Range 2 to 15 | Range 2 to 19 | N/A |

Table 36. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.36 National Seashore (Rodanthe to Oregon Inlet)

The oceanfront shoreline from Rodanthe to Oregon Inlet (Pea Island) extends 12.1 miles. Here, twelve shorelines (**Figure 217**) were assessed along this oceanfront section over a 74-year period, from 1946 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 104 feet to a maximum of 1,577 feet, with an average of 548 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 30 and 668 feet, and an average of 174 feet. Of the 12.1 miles of shoreline analyzed, 10.4 miles (86%) resulted in measured erosion where rates ranged between -29.5 and less than -1.0 feet per year and averaged -7.1 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 218**). Between transects 7962 and 8349, the end-point method resulted in a range of shoreline line change rates between -26.7 and +4.9 feet per year, averaging -5.4 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -29.5 and +5.0 feet per year, averaging -5.0 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 27 feet per year, and the least squares regression ranged from 2 to 29 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 7962 and 8349 range from 2 to 29 feet per year (**Figure 218 to Figure 222 & Table 37**).



Figure 217. Shorelines included in the analysis (1946-2020) between Rodanthe and Oregon Inlet (Pea Island).

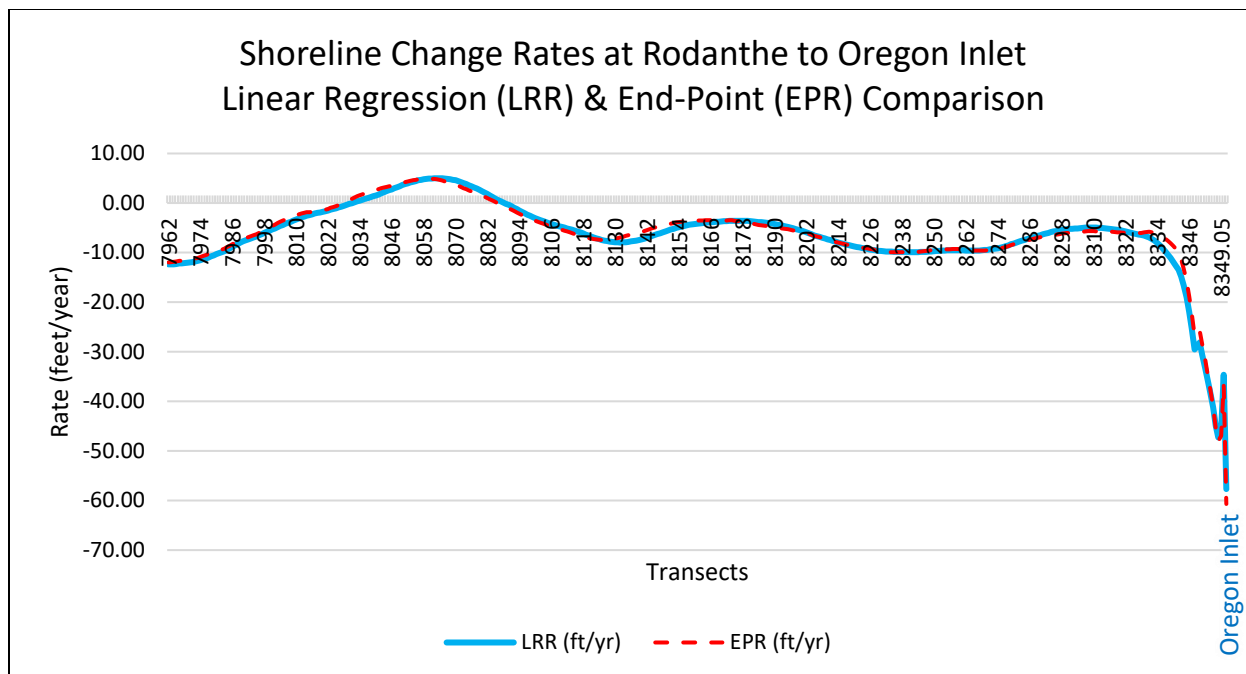


Figure 218. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 219. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

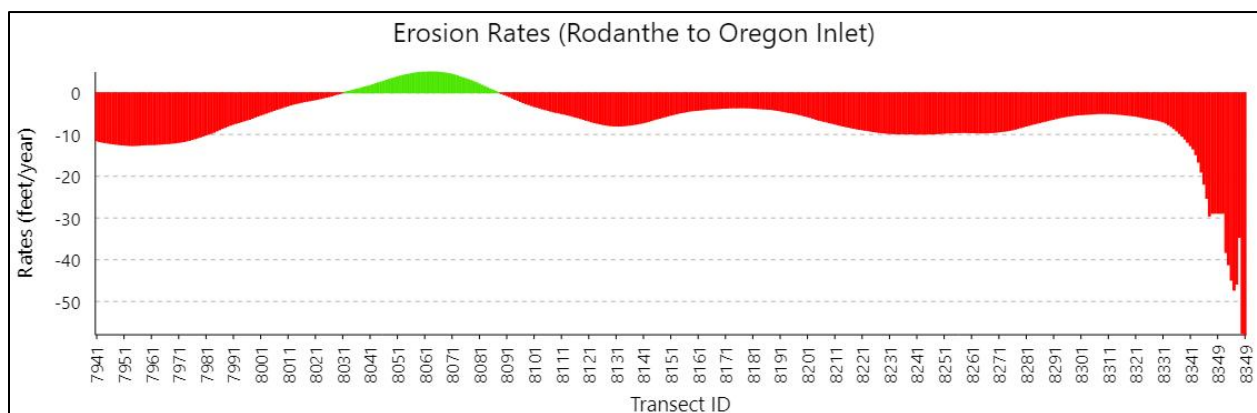


Figure 220. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

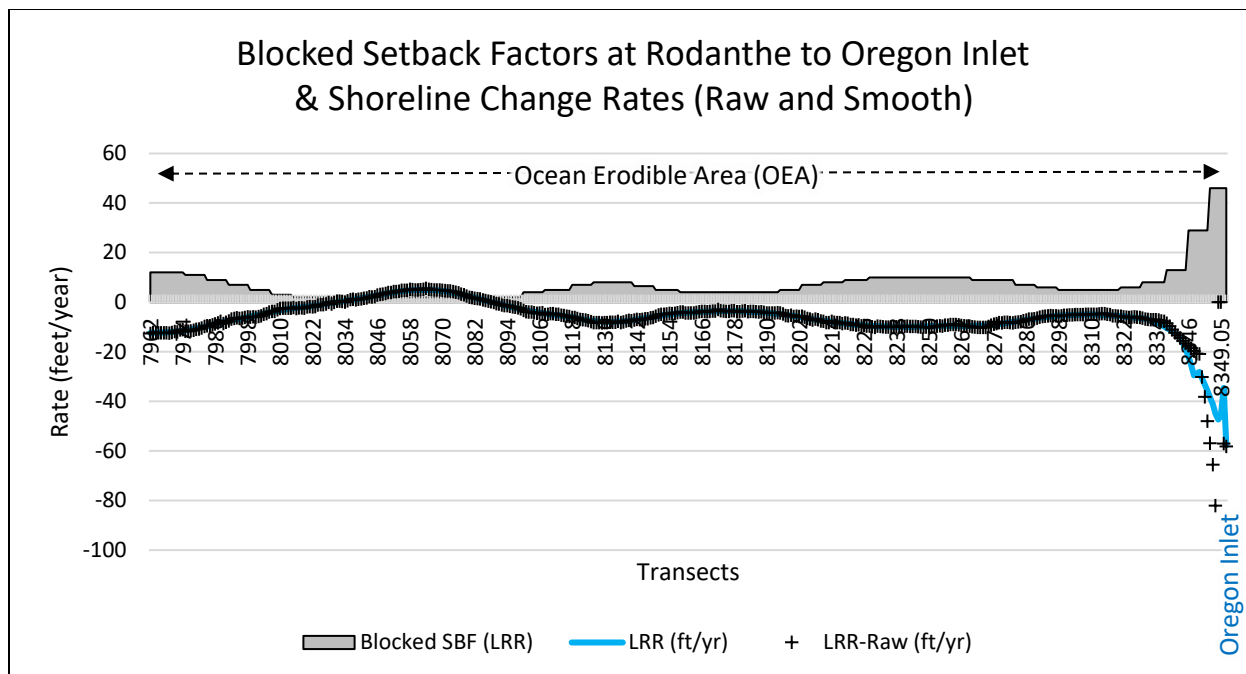


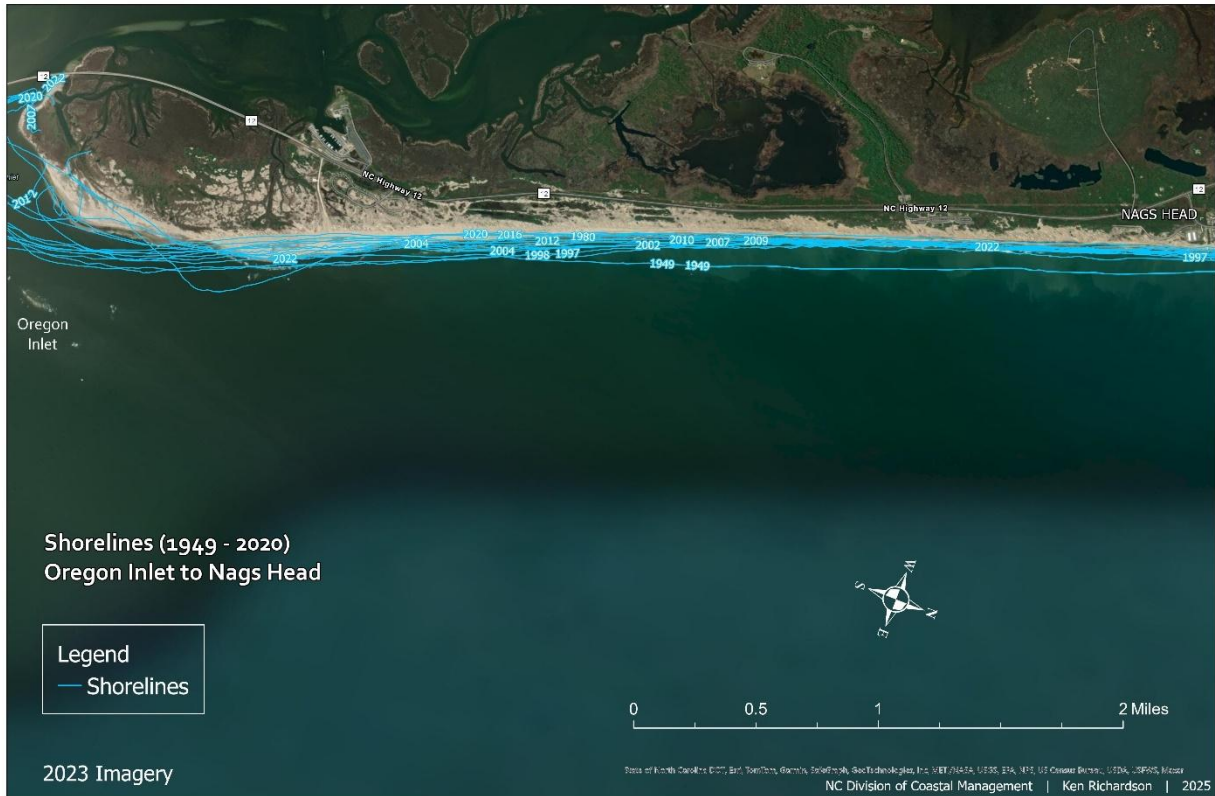
Figure 221. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

3.37 Oregon Inlet to Nags Head

The oceanfront shoreline from Oregon Inlet to Nags Head (Bodie Island) extends 5.0 miles. Here, twelve shorelines (**Figure 223**) were assessed along this oceanfront section over a 71-year period, from 1949 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 518 feet to a maximum of 2,384 feet, with an average of 839 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 151 and 750 feet, and an average of 254 feet. Of the 5.0 miles of shoreline analyzed, 4.1 miles (82%) resulted in measured erosion where rates ranged between -8.8 and less than -1.0 feet per year and averaged -6.5 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 224**). Between transects 8350 and 8511, the end-point method resulted in a range of shoreline line change rates between -8.5 and +24.3 feet per year, averaging -2.7 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -8.8 and +14.8 feet per year, averaging -3.8 feet per year. Like previous studies, both approaches resulted in a broad range of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 8.5 feet per year, and the least squares regression ranged from 2 to 9 feet per year.

Adopting the least squares regression methodology provides a more accurate representation of long-term shoreline movement and does not significantly alter results for this section of shoreline compared to previous studies. Using this approach, the calculated setback factors within the OEA between transects 8350 and 8511 range from 2 to 9 feet per year (**Figure 224 to Figure 228 & Table 38**).



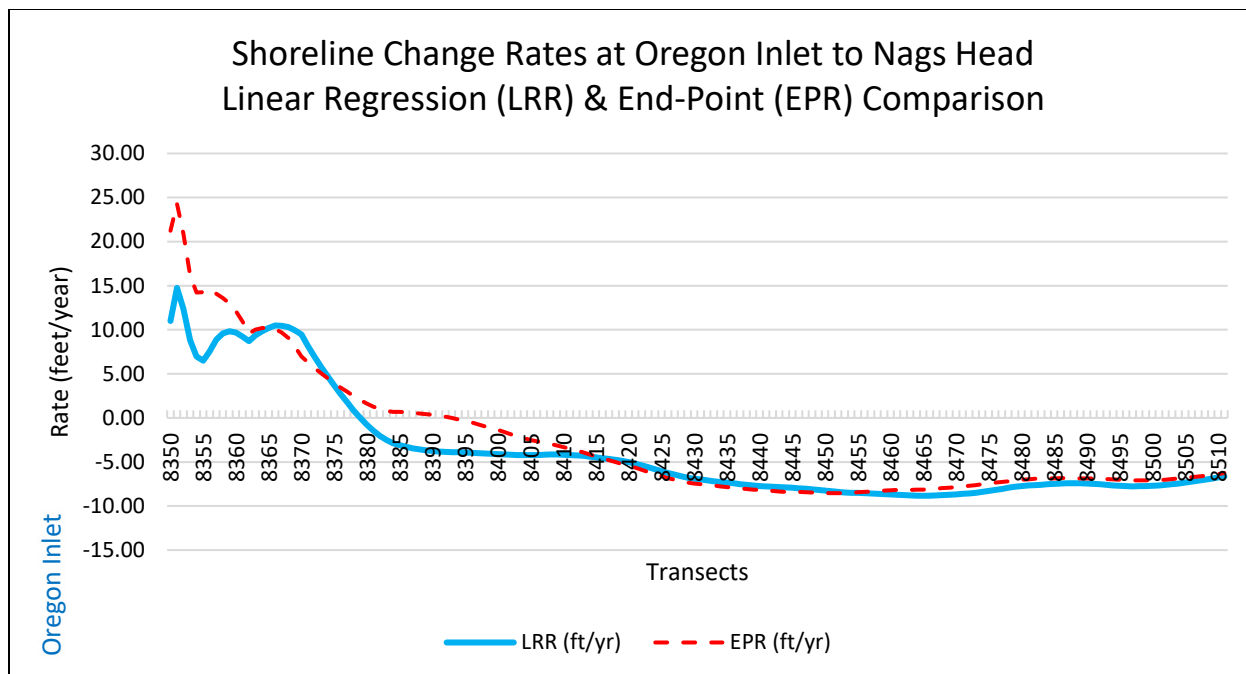


Figure 224. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 225. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

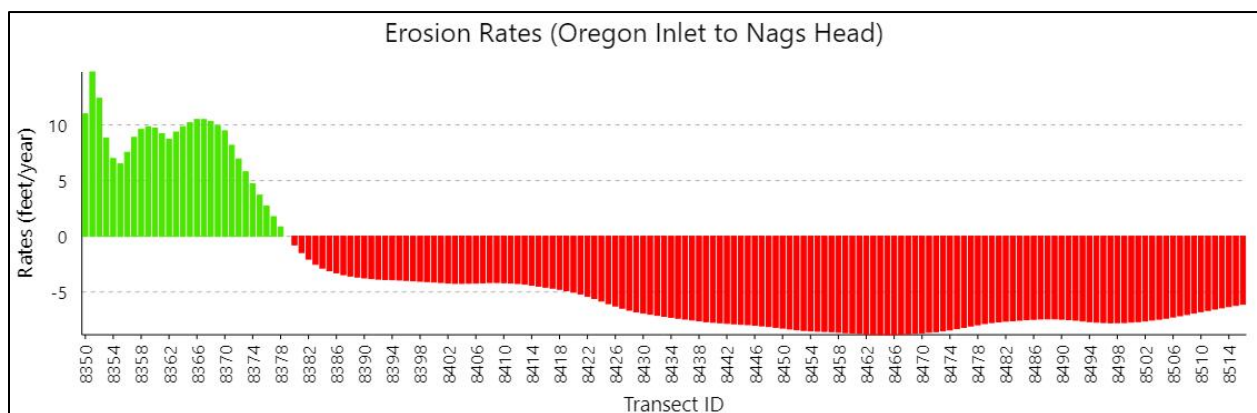


Figure 226. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

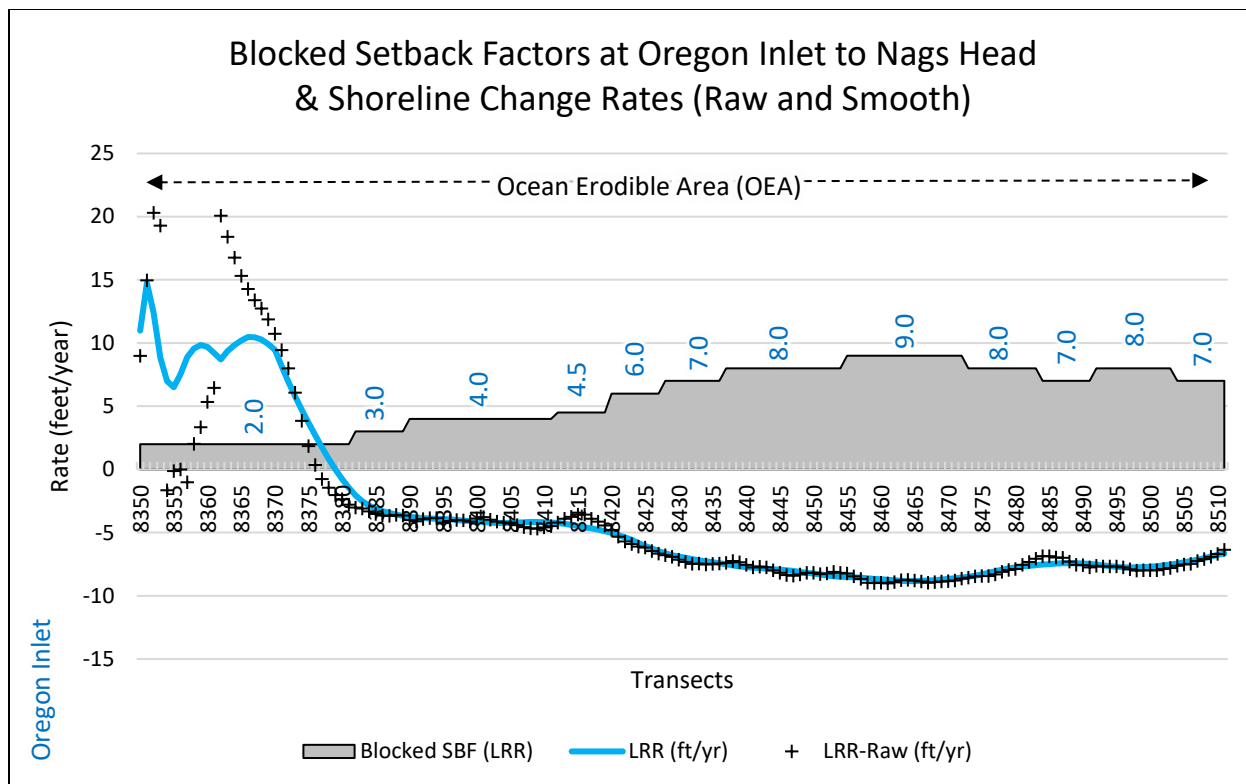


Figure 227. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 228. This map illustrates the erosion rate setback factors within the Ocean Erodible Area between Oregon Inlet and Nags Head (Bodie Island).

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|-----------------|------------------|------------------|------------------|------------------|------|------|------|
| Setback Factor (SBF) | Range 2 to 9 | Range 2 to 11 | Range 2 to 10 | Range 2 to 10 | Range 7 to 10 | N/A | N/A | N/A |

Table 38. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.38 Nags Head

The oceanfront shoreline at Nags Head stretches 11.2 miles. In 2011, approximately 10 miles of this shoreline underwent a large-scale beach nourishment project, followed by a 4.5-mile restoration project in 2022. Since the most recent shoreline data used in this study is from 2020, only the initial nourishment project has artificially influenced shoreline position, and potentially lowering shoreline change rates.

Here, twelve shorelines (**Figure 229**) were assessed along this oceanfront section over a 71-year period, from 1949 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 77 feet to a maximum of 533 feet, with an average of 238 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 24 and 533 feet, and an average of 238 feet. Of the 11.2 miles of shoreline analyzed, 10.9 miles (97%) resulted in measured erosion where rates ranged between -6.5 and less than -1.0 feet per year and averaged -1.9 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 230**). Between transects 8512 and 8873, the end-point method resulted in a range of shoreline line change rates between -6.1 and less than 1.0 feet per year, averaging -1.4 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -6.5 and less than 1.0 feet per year, averaging -1.9 feet per year. Like previous studies, both approaches yielded similar results of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 6 feet per year, and the least squares regression ranged from 2 to 7 feet per year – where higher result was measured in the southern portion of the Town's limit.

Utilizing the least squares regression methodology provides a more precise representation of long-term shoreline movement and yields results consistent with previous studies for this section of shoreline. Based on this approach, the calculated setback factors within the OEA between transects 8512 and 8873 range from 2 to 9 feet per year.

Beginning at the Town's southernmost boundary near transect 8512 and progressing north, setback factors are initially 6 feet per year, decreasing to 5 feet per year at transect 8523, 4 feet per year at transect 8543, and 3 feet per year at transect 8554. From transect 8592 through the Town's northern boundary near transect 8873, covering approximately 8.7 miles, the setback factor remains at 2 feet per year. Compared to current effective setback factors (2020), the areas between transects 8507 and 8646 (4.3 miles), and transects 8699 and 8780 (2.5 miles) will experience a 1 to 2 feet per year decrease (**Figure 231 to Figure 235 & Table 39**).



Figure 229. Shorelines included in the analysis (1949-2020) at Nags Head.

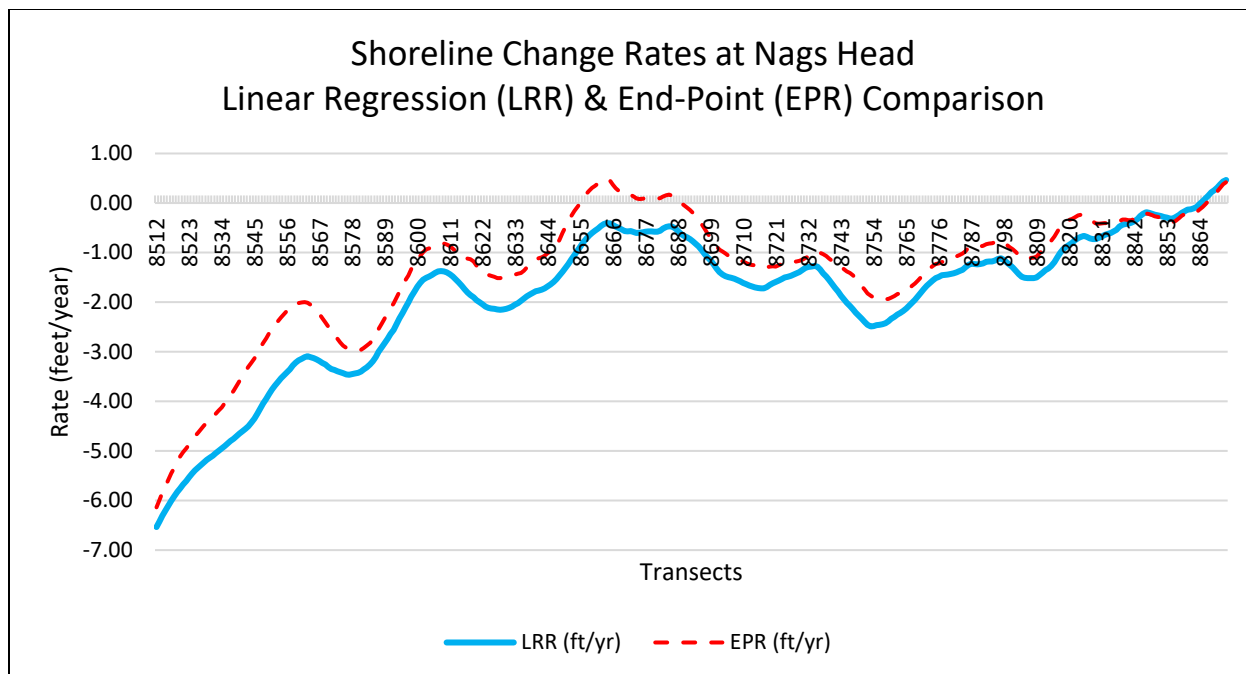


Figure 230. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 231. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

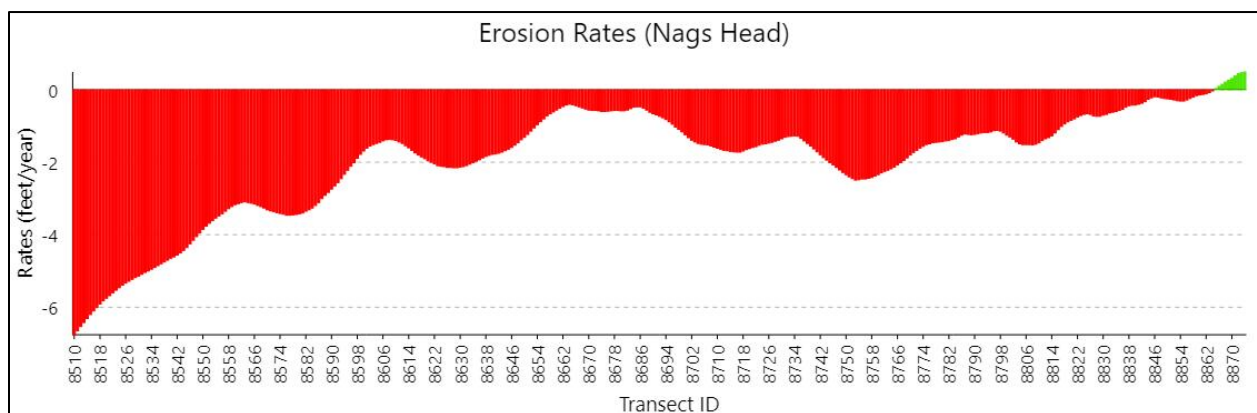


Figure 232. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

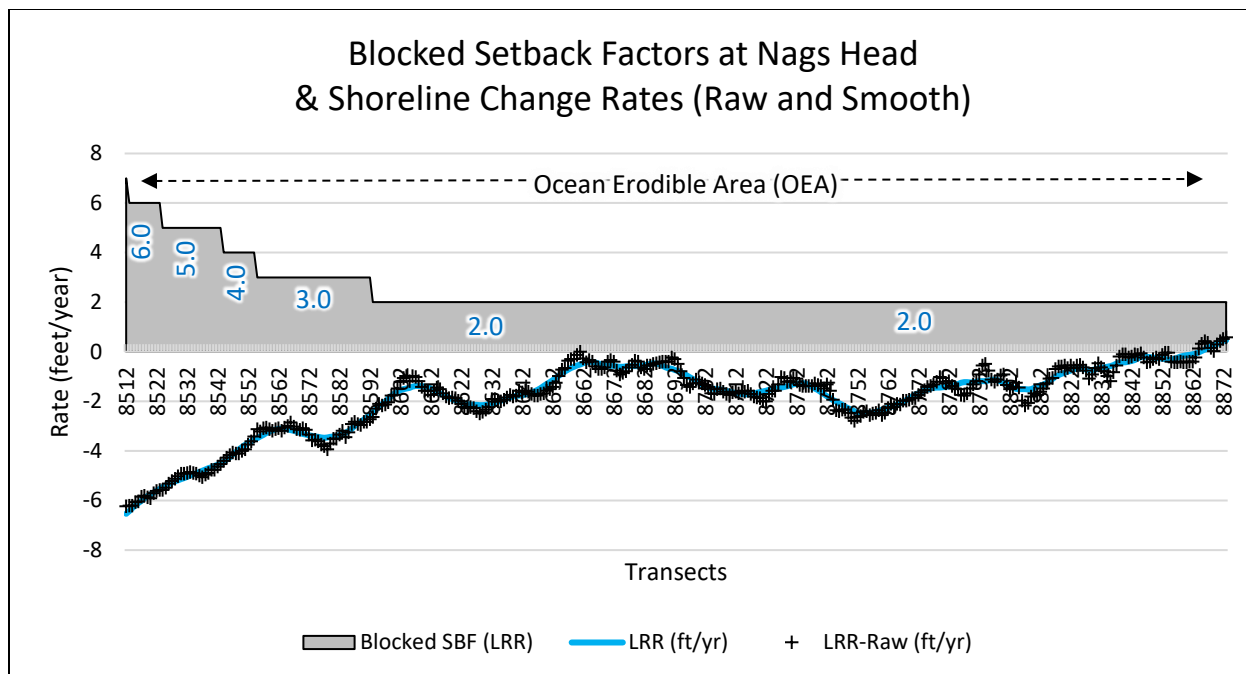


Figure 233. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 234. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Nags Head.



Figure 235. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Nags Head.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|-----------------|-----------------|-------------------|-------------------|------------------|-----------------|------|------|
| Setback Factor (SBF) | Range 2 to 6 | Range 2 to 8 | Range 2 to 7.5 | Range 2 to 7.5 | Range 2 to 10 | Range 2 to 7 | N/A | N/A |

Table 39. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.39 Kill Devil Hills

The oceanfront shoreline at Kill Devil Hills spans 4.7 miles. In 2017, a large-scale beach nourishment project was completed along approximately 2.9 miles of the northern section, starting near transect 8942 and extending beyond the town's northern boundary. This area later underwent a maintenance project in 2022.

Here, twelve shorelines (**Figure 236**) were assessed along this oceanfront section over an 80-year period, from 1940 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 71 feet to a maximum of 339 feet, with an average of 166 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 26 and 109 feet, and an average of 49 feet. Of the 4.7 miles of shoreline analyzed, 2.5 miles (53%) resulted in measured erosion where rates ranged between -3.1 and less than -1.0 feet per year and averaged -1.7 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 237**). Between transects 8874 and 9026, the end-point method resulted in a range of shoreline line change rates between -2.9 and less than 1.0 feet per year, averaging less than -1.0 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -3.1 and 1.0 feet per year, averaging less than -1.0 feet per year. Like previous studies, both approaches yielded similar results of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 3 feet per year, and the least squares regression ranged from 2 to 3 feet per year.

Utilizing the least squares regression methodology provides a more precise representation of long-term shoreline movement and yields results consistent with previous studies for this section of shoreline. Based on this approach, the calculated setback factors within the OEA between transects 8874 and 9026 range from 2 to 3 feet per year. Starting at the Town's southernmost boundary near transect 8874 and progressing north, setback factors start at 2 feet per year, increase to 3 feet per year at transect 8968, then decrease to 2 feet per year at transect 8984 and to the Town's northern boundary.

Compared to current effective setback factors (2020), the areas between transects 8963 and 8967, transects 8971 and 8979, and transects 8985 and 8987 will experience a 1 foot per year decrease (**Figure 238 to Figure 241 & Table 40**).

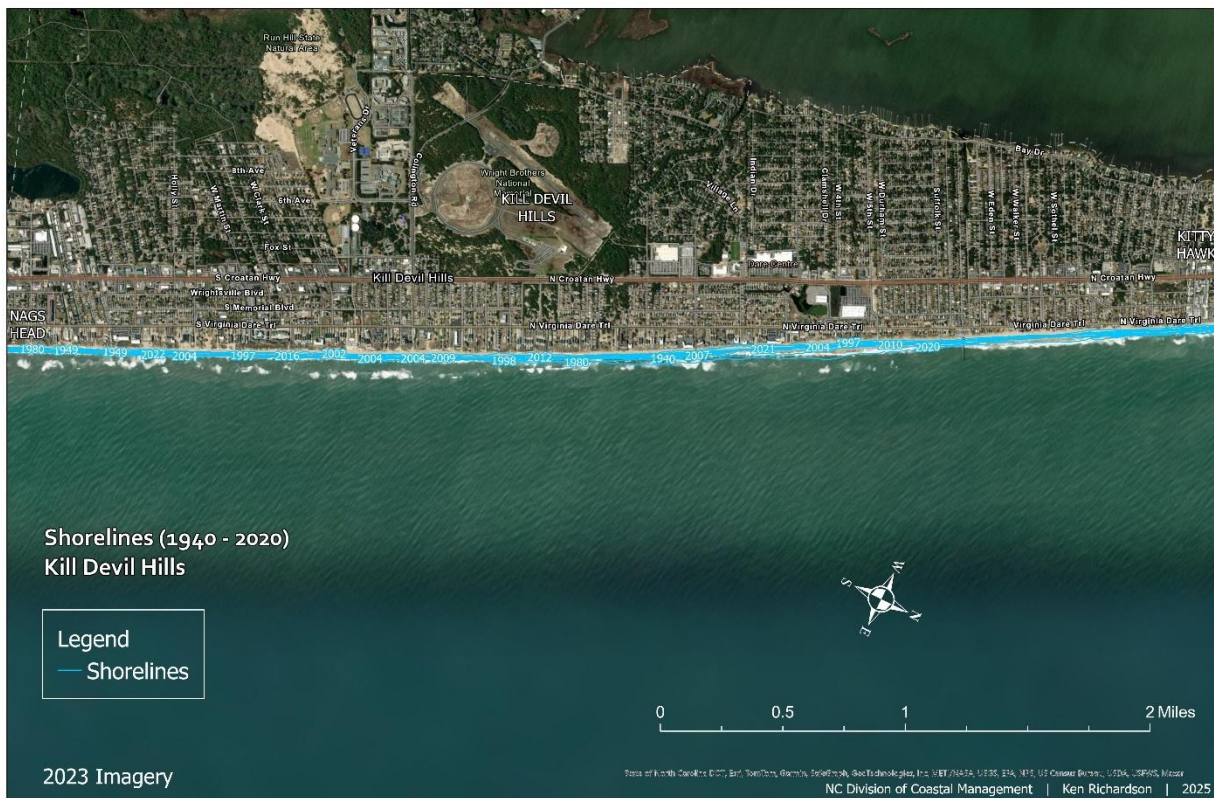


Figure 236. Shorelines included in the analysis (1940-2020) at Kill Devil Hills.

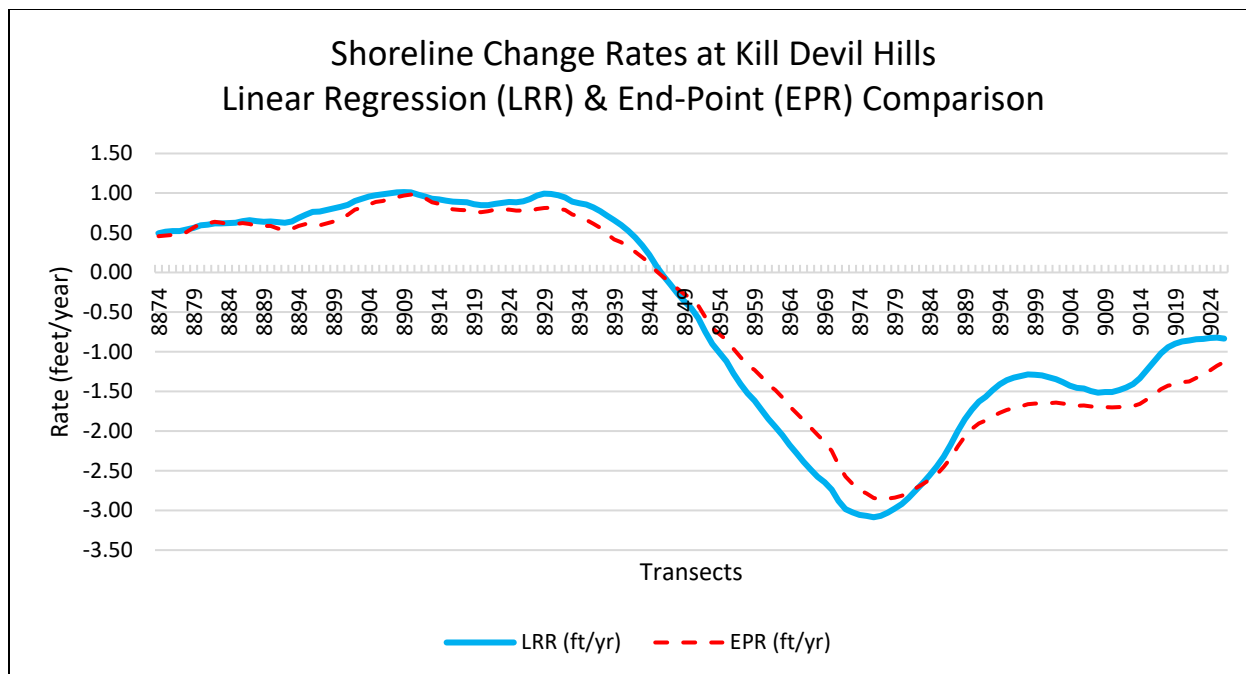


Figure 237. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 238. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

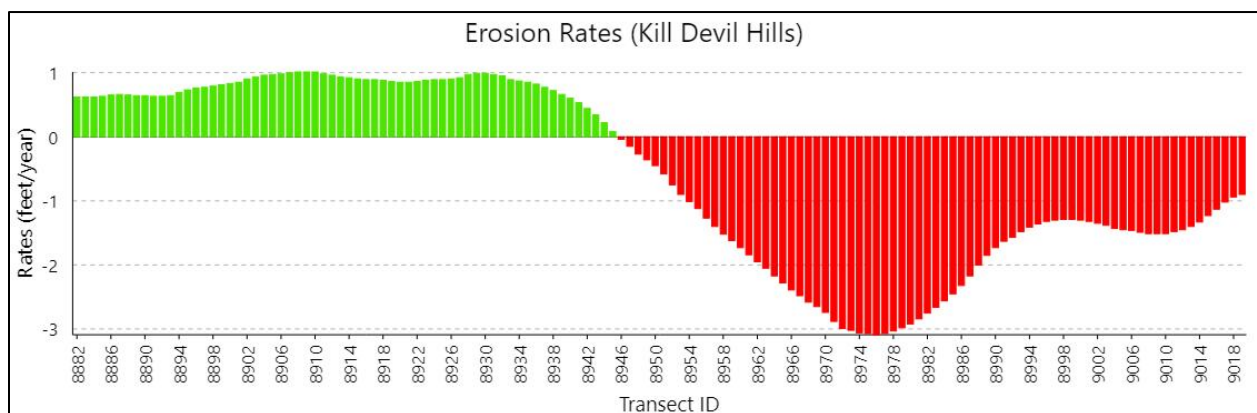


Figure 239. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

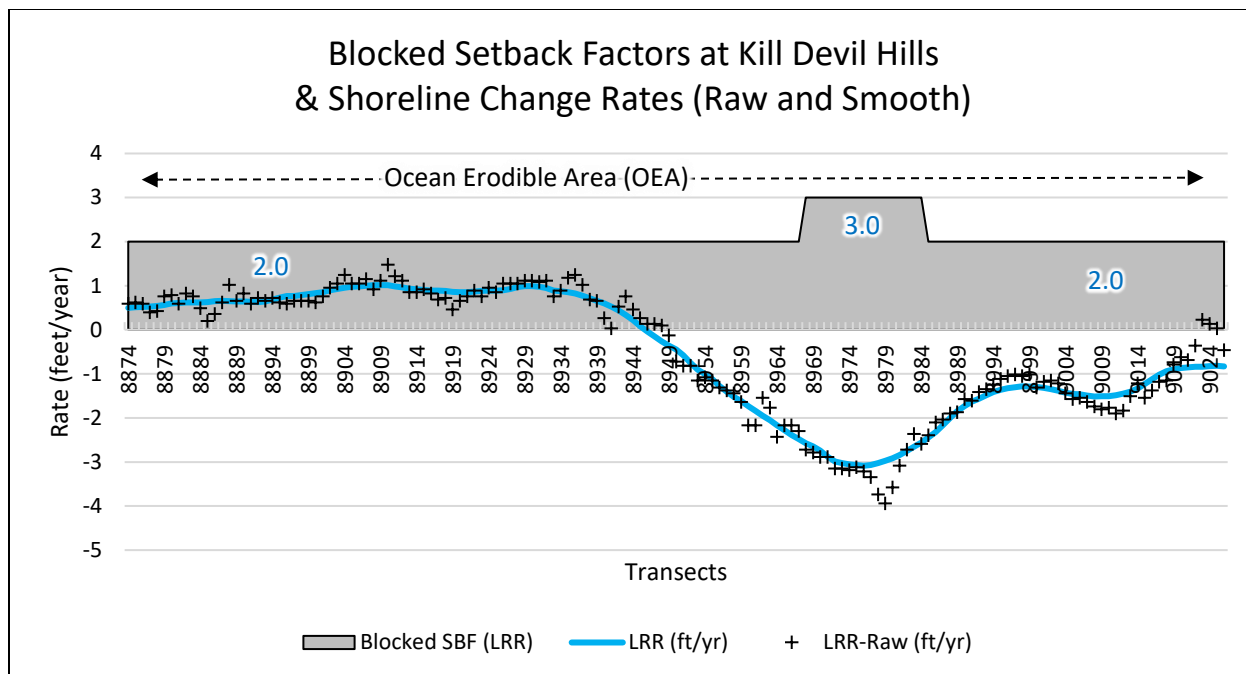


Figure 240. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

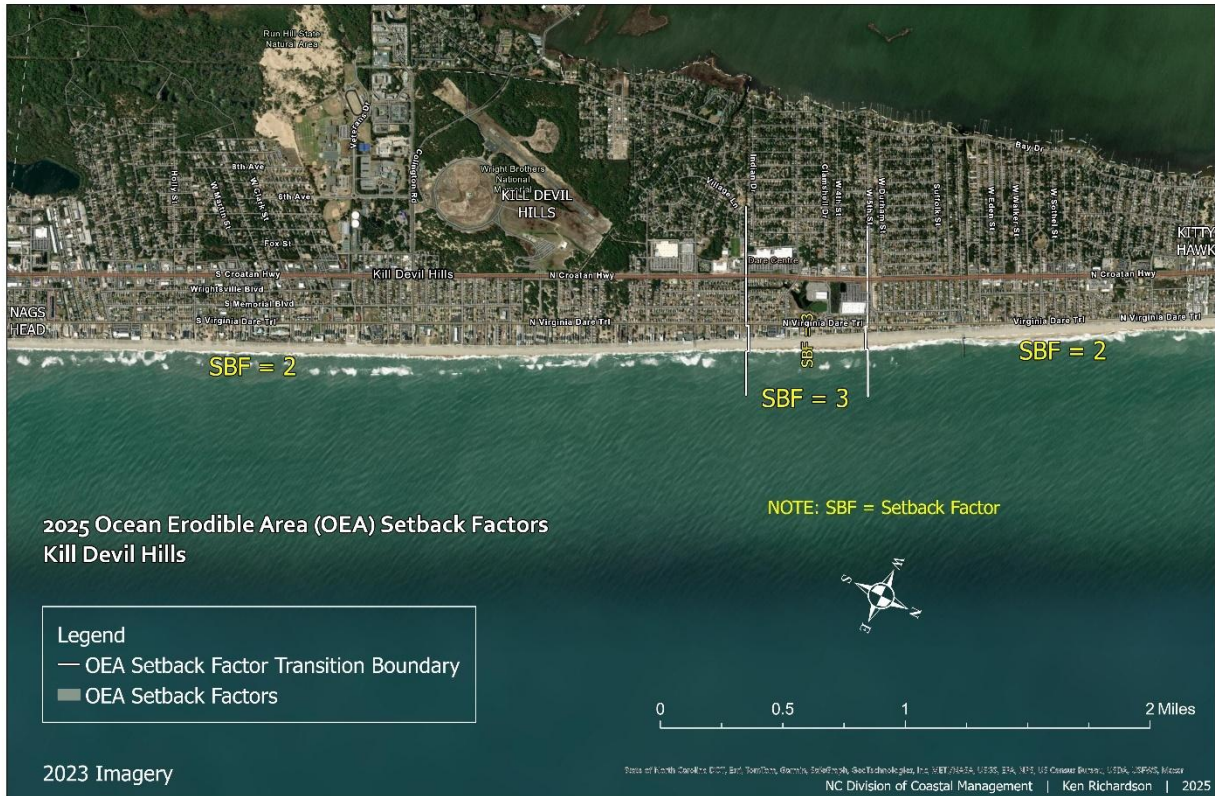


Figure 241. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Kill Devil Hills.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|-----------------|-----------------|-------------------|-------------------|-------------------|-------------------|------|------|
| Setback Factor (SBF) | Range 2 to 3 | Range 2 to 4 | Range 2 to 2.5 | Range 2 to 3.5 | Range 2 to 6.5 | Range 2 to 4.5 | N/A | N/A |

Table 40. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.40 Kitty Hawk

The oceanfront shoreline at Kitty Hawk spans 3.5 miles. In 2017, a large-scale beach nourishment project was completed along this section of shoreline, followed by a maintenance project in 2022.

Here, twelve shorelines (**Figure 242**) were assessed along this oceanfront section over an 80-year period, from 1940 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 102 feet to a maximum of 323 feet, with an average of 210 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 34 and 89 feet, and an average of 62 feet. Of the 3.5 miles of shoreline analyzed, all (100%) resulted in measured erosion where rates ranged between -2.7 and less than -1.0 feet per year and averaged -1.9 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 243**). Between transects 9027 and 9140, the end-point method resulted in a range of shoreline line change rates between -2.6 and -1.0 feet per year, averaging -1.9 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -2.7 and less than -1.0 feet per year, averaging less than -1.9 feet per year. Like previous studies, both approaches yielded similar results of blocked erosion rate setback factors. End-point setback factors equaled 2 feet per year, and the least squares regression equaled 2 feet per year.

Utilizing the least squares regression methodology provides a more precise representation of long-term shoreline movement and yields results consistent with previous studies for this section of shoreline. Based on this approach, the calculated setback factors within the OEA between transects 9027 and 9140 equaled two feet per year. Compared to current effective setback factors (2020), the area between transects 9059 and 9109 (1.5 miles) will experience a 1 foot per year decrease (**Figure 243 to Figure 247 & Table 41**).

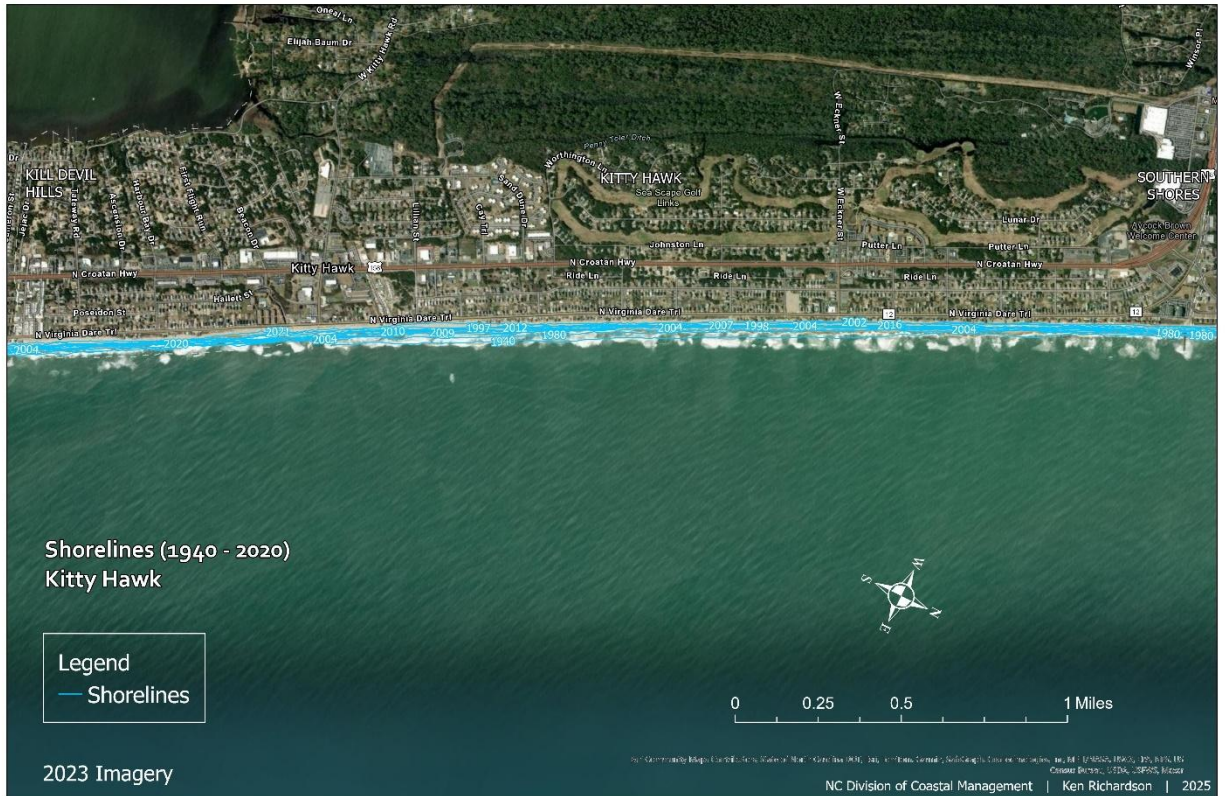


Figure 242. Shorelines included in the analysis (1940-2020) at Kitty Hawk.

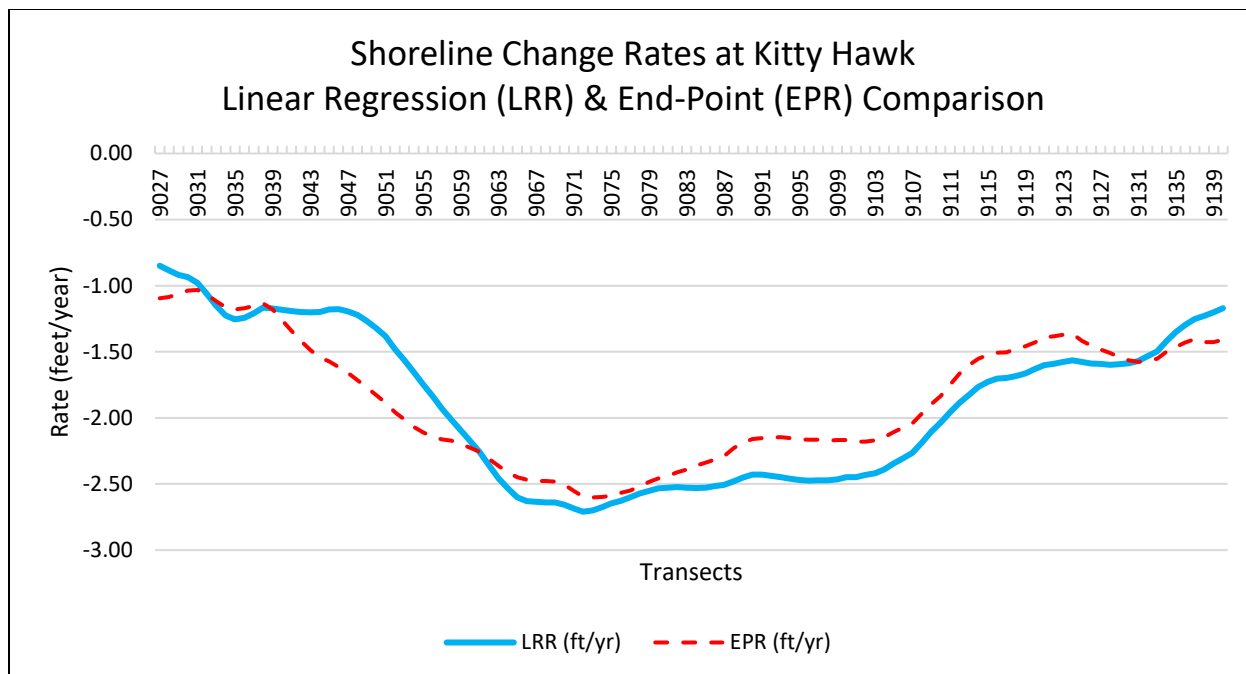


Figure 243. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 244. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

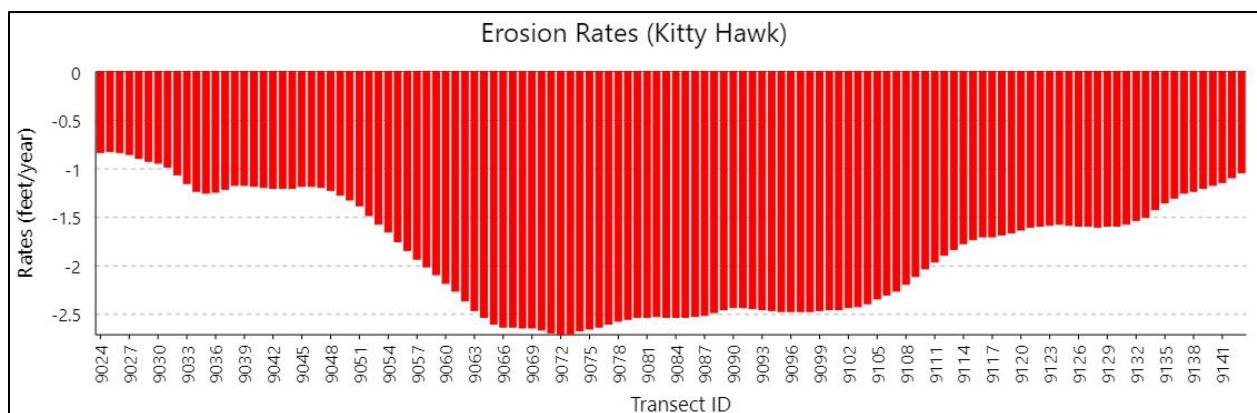


Figure 245. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

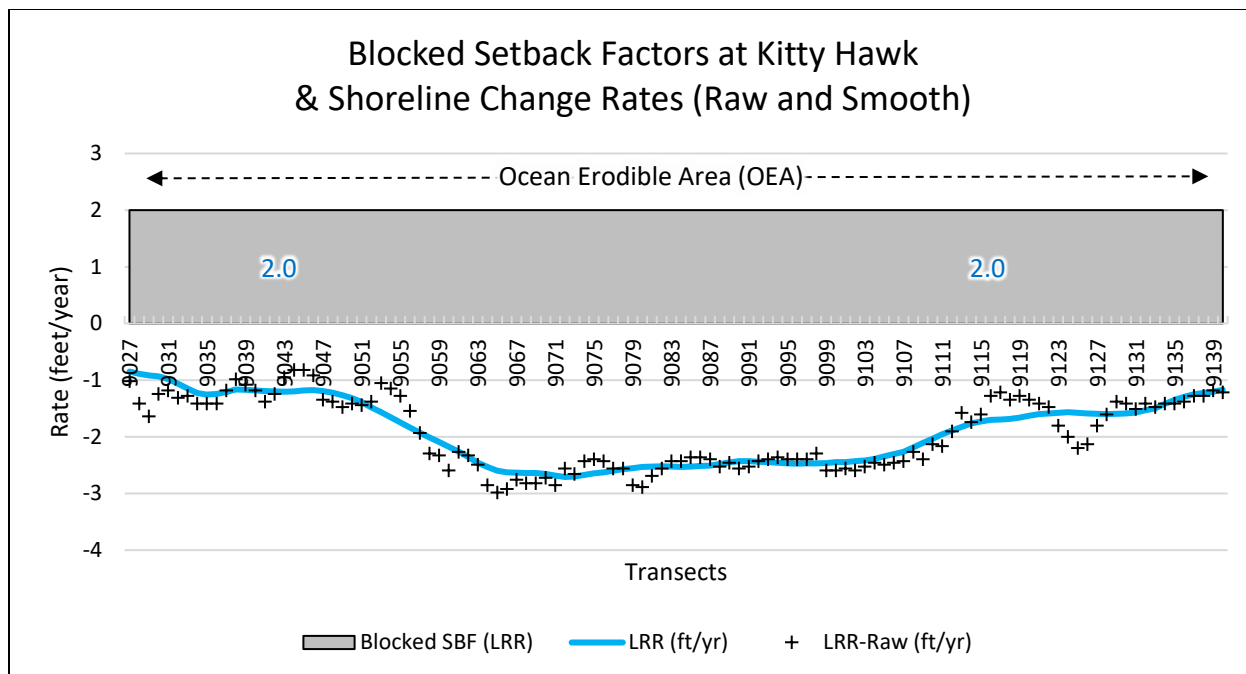


Figure 246. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

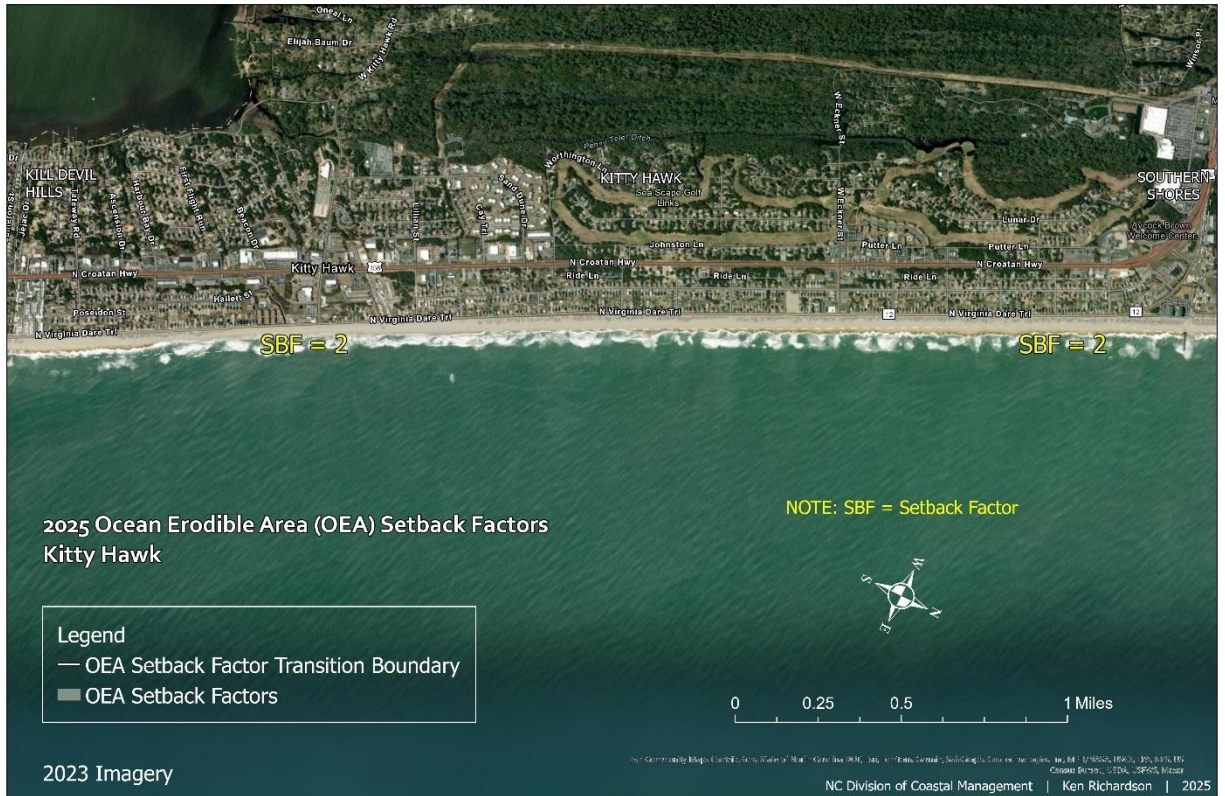


Figure 247. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Kitty Hawk.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|--------|----------|--------|--------|--------|------|------|
| Setback Factor (SBF) | 2 | 2 to 3 | 2 to 2.5 | 2 to 4 | 2 to 4 | 2 to 4 | N/A | N/A |

Table 41. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.41 Southern Shores

At Southern Shores, the oceanfront shoreline extends for 3.7 miles. In 2017, a large-scale beach nourishment project was installed that covered the southern portion of this shoreline spanning approximately 0.5-mile between transects 9141 and 9157; and then in 2022, another large-scale project was installed for the remaining portion of this shoreline section from transect 9158 to the Town's northern boundary near transect 9260.

Here, twelve shorelines (**Figure 248**) were assessed along this oceanfront section over an 80-year period, from 1940 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 86 feet to a maximum of 152 feet, with an average of 115 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 24 and 45 feet, and an average of 33 feet. Of the 3.7 miles of shoreline analyzed, 3.7 miles (100%) resulted in measured erosion where rates ranged between -1.1 and less than -1.0 feet per year and averaged less than -1.0 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 249**). Between transects 9141 and 9260, the end-point method resulted in a range of shoreline line change rates between -1.3 and less than -1.0 feet per year, averaging less than -1.0 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -1.1 and less than -1.0 feet per year, averaging less than -1.0 feet per year. Like previous studies, both approaches yielded similar results of blocked erosion rate setback factors. End-point setback factors equaled 2 feet per year, and the least squares regression equaled 2 feet per year.

Utilizing the least squares regression methodology provides a more precise representation of long-term shoreline movement and yields results consistent with previous studies for this section of shoreline. Based on this approach, the calculated setback factors within the OEA between transects 9141 and 9260 equaled 2 feet per year (**Figure 249 to Figure 253 & Table 42**).

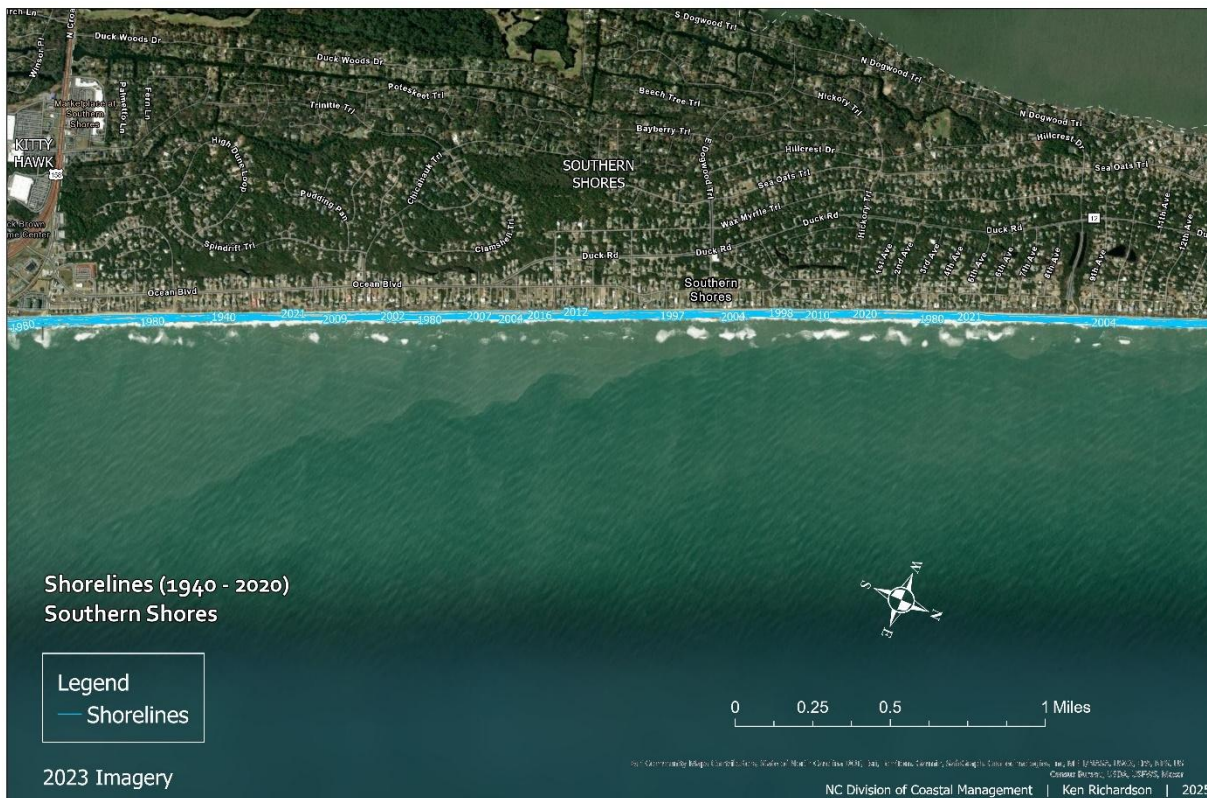


Figure 248. Shorelines included in the analysis (1940-2020) at Southern Shores.

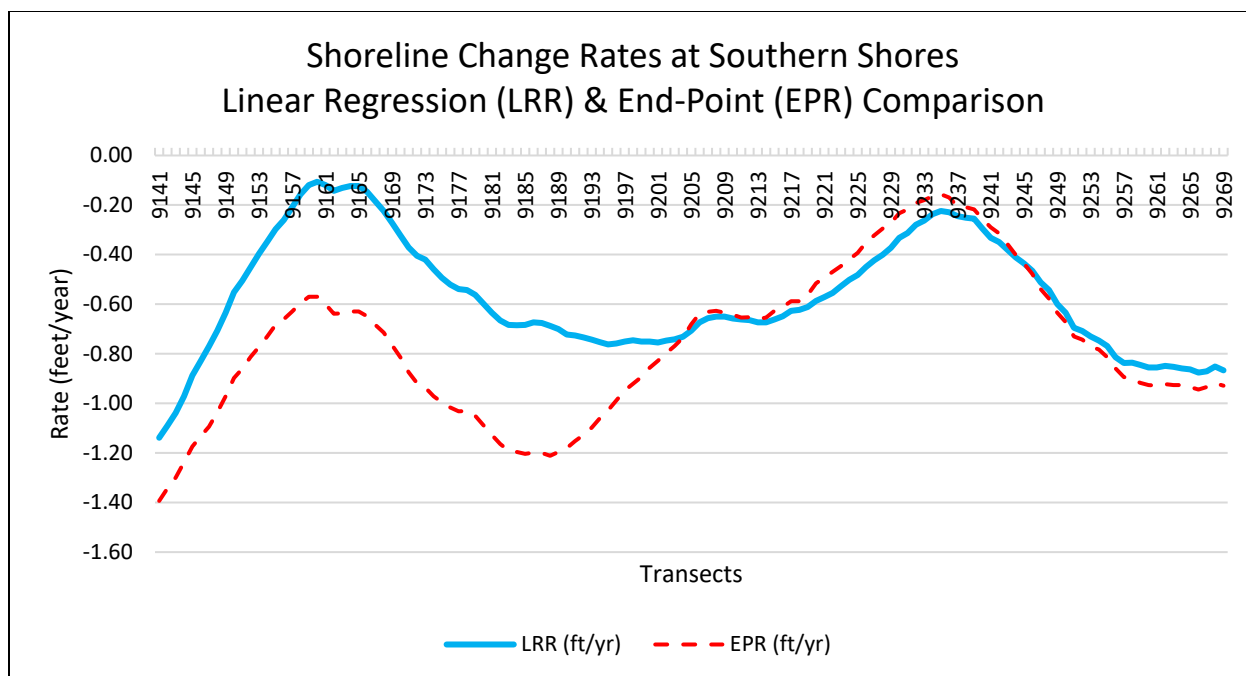


Figure 249. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

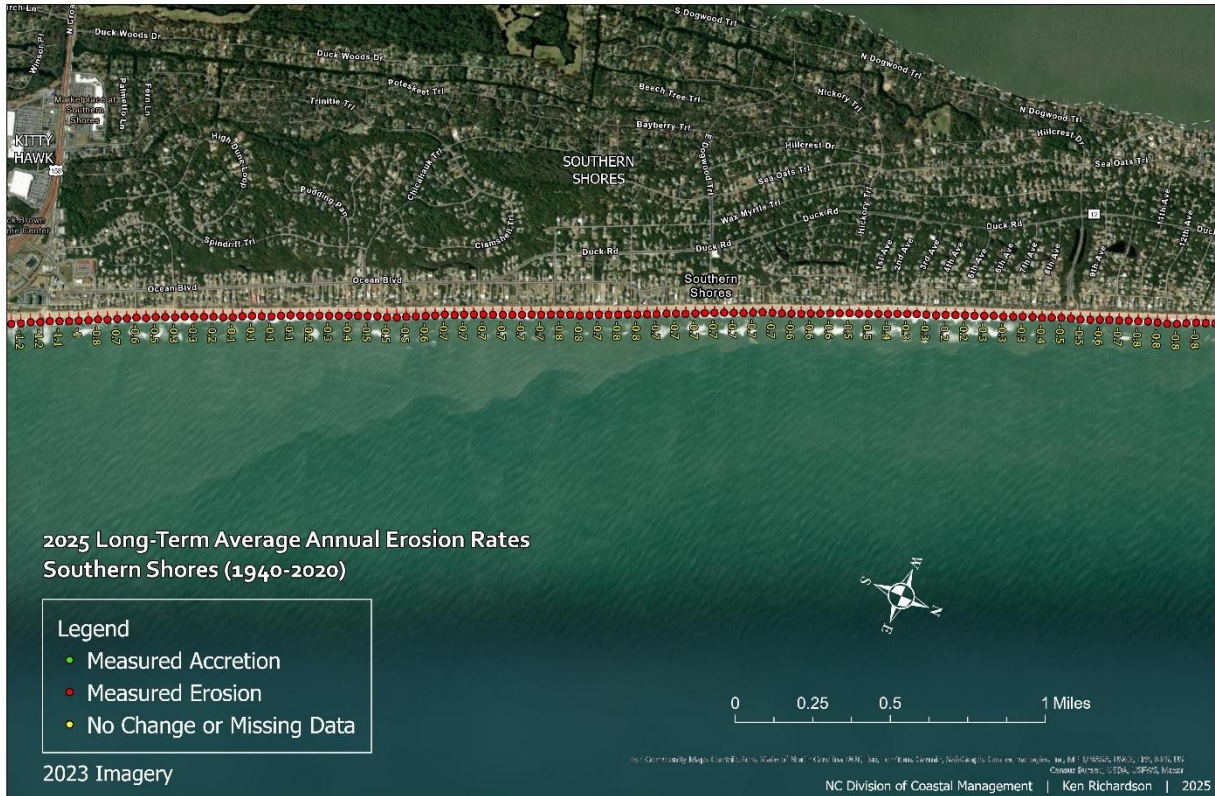


Figure 250. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

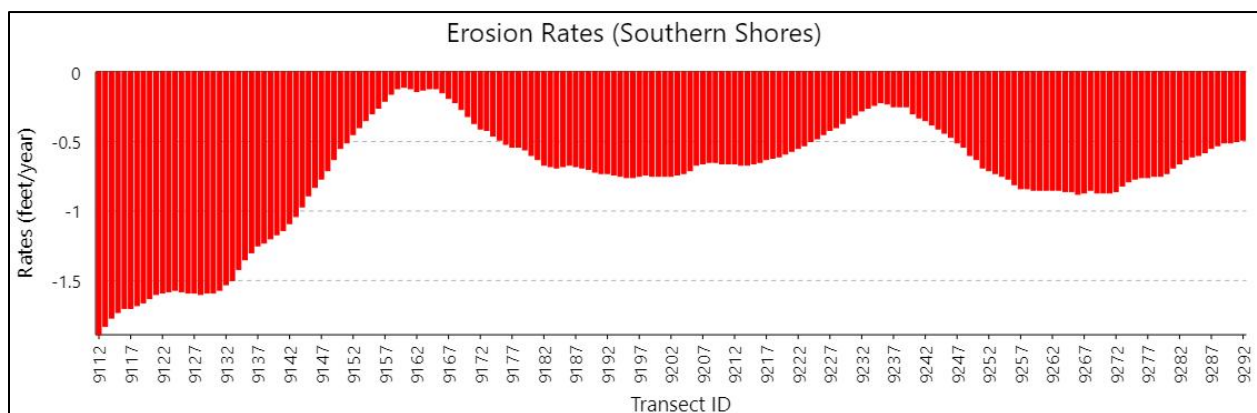


Figure 251. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

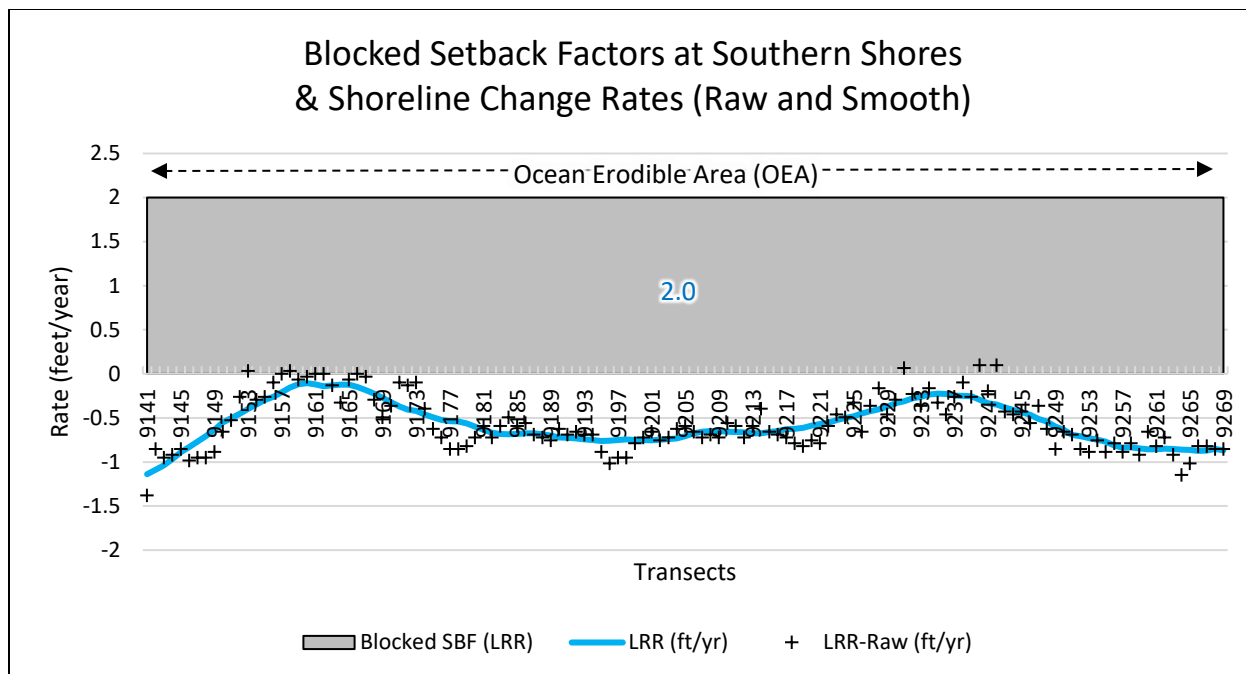


Figure 252. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

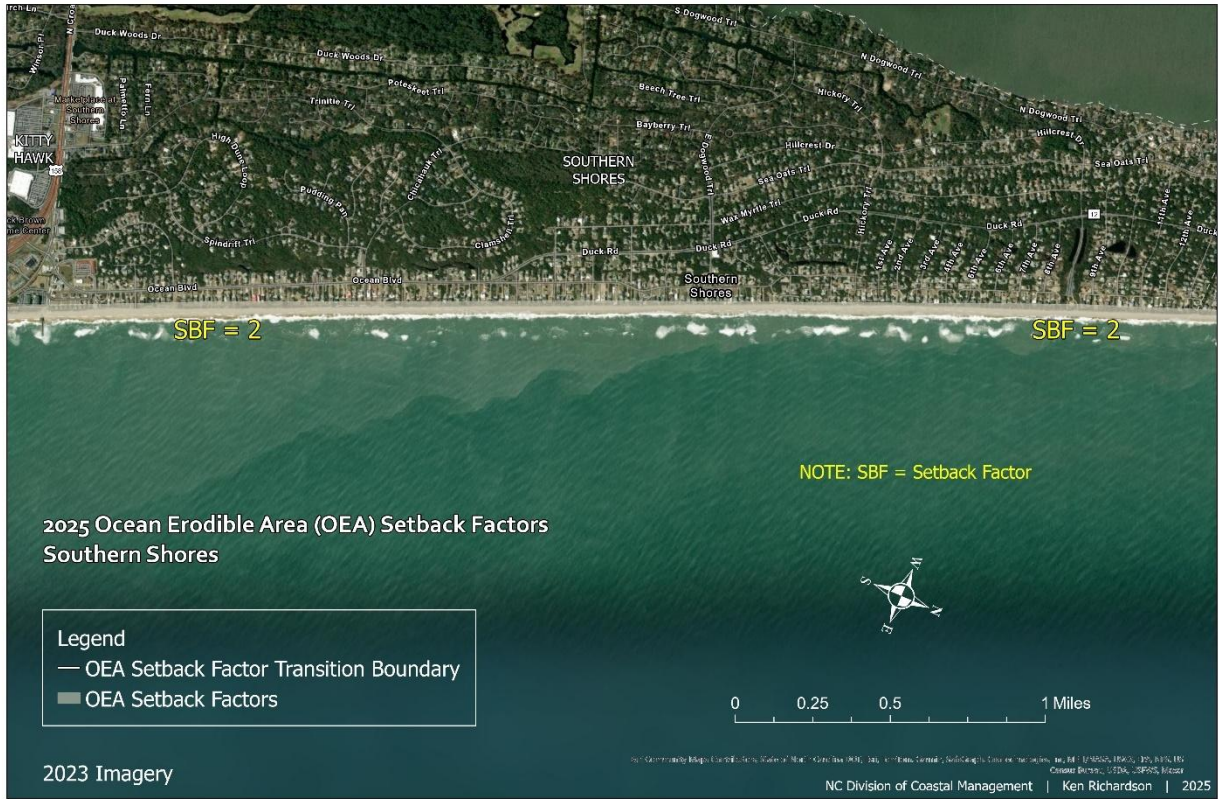


Figure 253. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Southern Shores.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|------|------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2 | 2 | N/A | N/A |

Table 42. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.42 Duck

In the area of Duck to the Dare and Currituck County line, this section of oceanfront shoreline extends for 5.9 miles. In 2017, a large-scale beach nourishment project was installed that covered 1.7 miles of shoreline between transects 9345 and 9396 (at Duck), followed by a maintenance project in 2023.

Here, twelve shorelines (**Figure 254**) were assessed along this oceanfront section over an 80-year period, from 1940 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 78 feet to a maximum of 258 feet, with an average of 153 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 26 and 68 feet, and an average of 44 feet. Of the 5.9 miles of shoreline analyzed, 5.0 miles (85%) resulted in measured erosion where rates ranged between -2.1 and less than -1.0 feet per year and averaged -1.1 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 255**). Between transects 9261 and 9452, the end-point method resulted in a range of shoreline line change rates between -1.8 and less than -1.0 feet per year, averaging less than -1.0 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -2.1 and less than -1.0 feet per year, averaging less than -1.0 feet per year. Like previous studies, both approaches yielded similar results of blocked erosion rate setback factors. End-point setback factors equaled 2 feet per year, and the least squares regression equaled 2 feet per year.

Utilizing the least squares regression methodology provides a more precise representation of long-term shoreline movement and yields results consistent with previous studies for this section of shoreline. Based on this approach, the calculated setback factors within the OEA between transects 9261 and 9452 equaled 2 feet per year (**Figure 255 to Figure 259 & Table 43**).



Figure 254. Shorelines included in the analysis (1940-2020) at Duck.

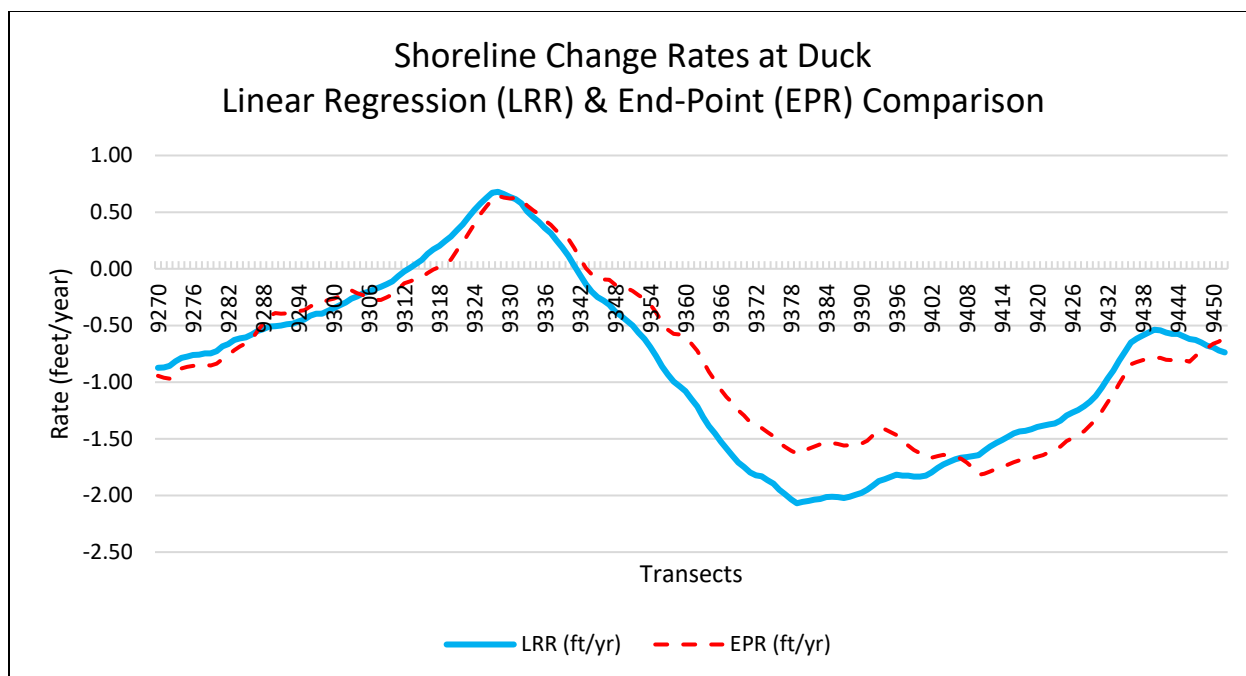


Figure 255. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

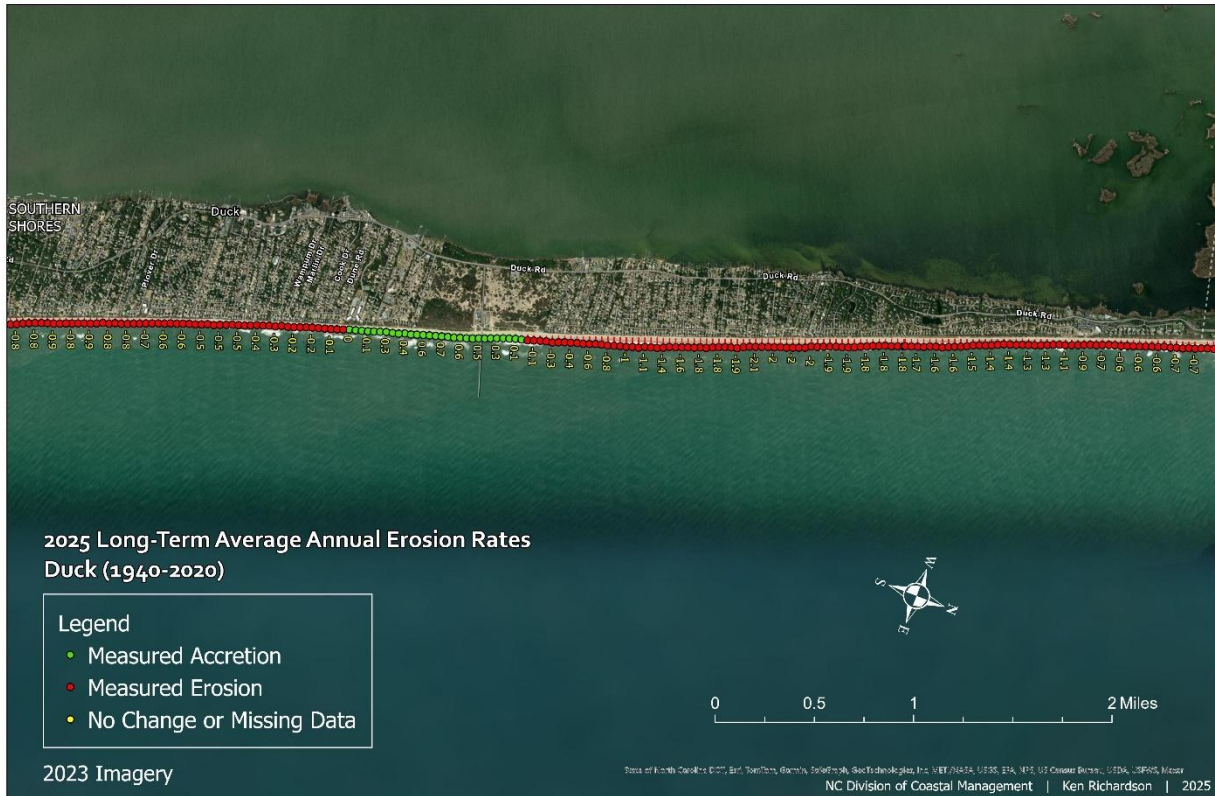


Figure 256. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

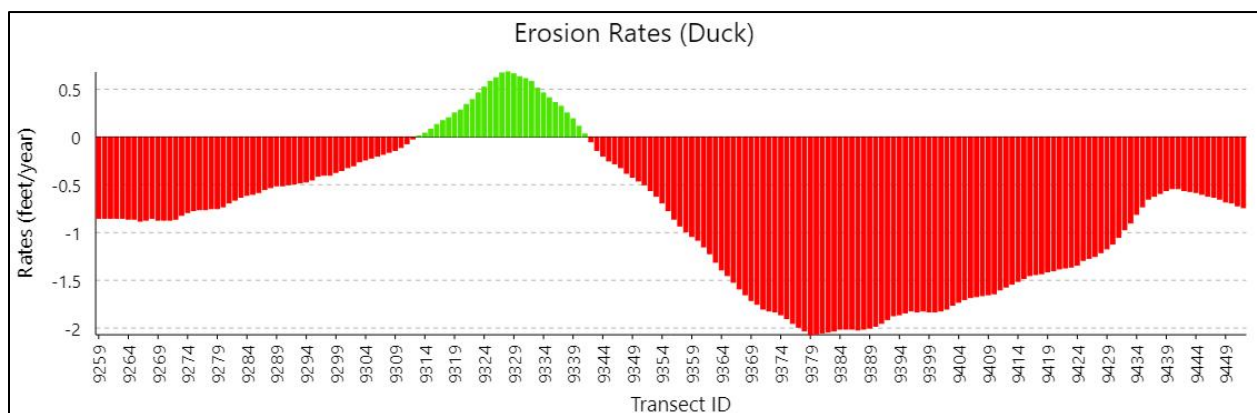


Figure 257. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

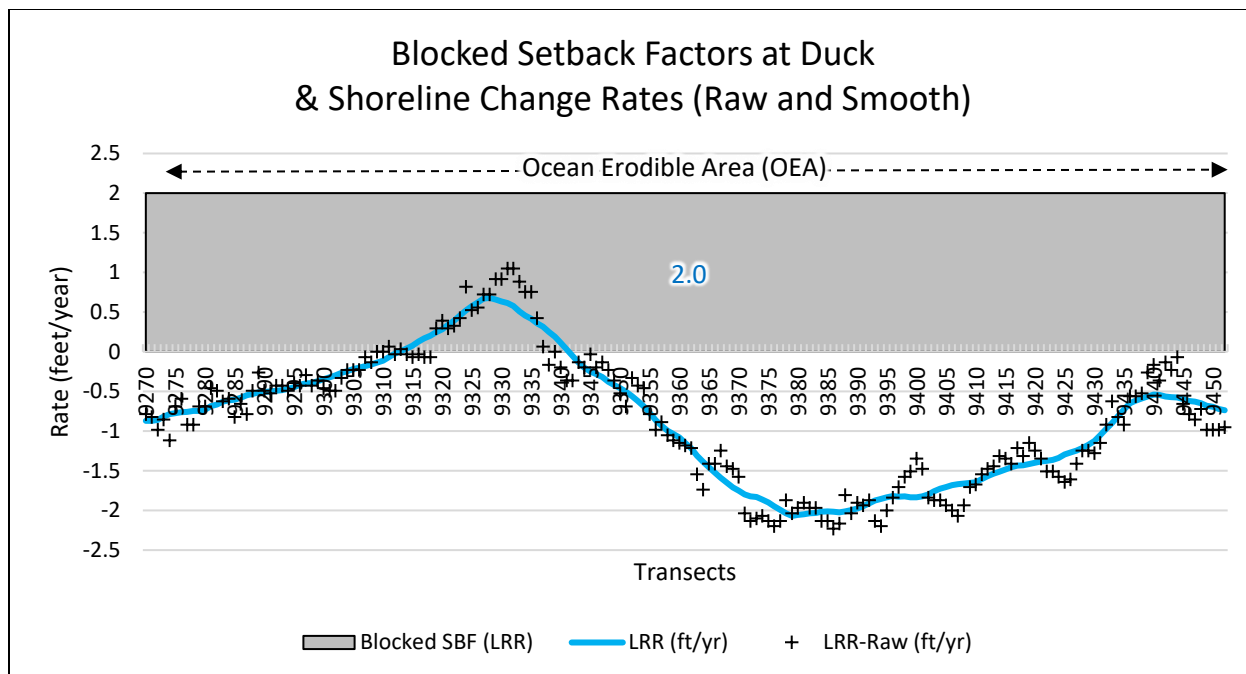


Figure 258. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 259. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Duck.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|--------|------|------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 to 3 | 2 | 2 | 2 | 2 |

Table 43. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.43 Duck to Corolla

In the area from Duck to Corolla, this section of oceanfront shoreline extends for 7.0 miles. Here, twelve shorelines (**Figure 260**) were assessed along this oceanfront section over an 80-year period, from 1940 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 60 feet to a maximum of 227 feet, with an average of 142 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 17 and 73 feet, and an average of 43 feet. Of the 7.0 miles of shoreline analyzed, 6.2 miles (89%) resulted in measured erosion where rates ranged between -2.2 and less than -1.0 feet per year and averaged less than -1.0 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 261**). Between transects 9453 and 9679, the end-point method resulted in a range of shoreline line change rates between -2.5 and less than +1.0 feet per year, averaging less than -1.0 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -2.2 and less than +1.0 feet per year, averaging less than -1.0 feet per year. Like previous studies, both approaches yielded similar results of blocked erosion rate setback factors. End-point setback factors equaled 2 feet per year, and the least squares regression equaled 2 feet per year.

Utilizing the least squares regression methodology provides a more precise representation of long-term shoreline movement and yields results consistent with previous studies for this section of shoreline. Based on this approach, the calculated setback factors within the OEA between transects 9453 and 9679 equaled 2 feet per year (**Figure 261 to Figure 265 & Table 44**).



Figure 260. Shorelines included in the analysis (1940-2020) at between Duck and Corolla.

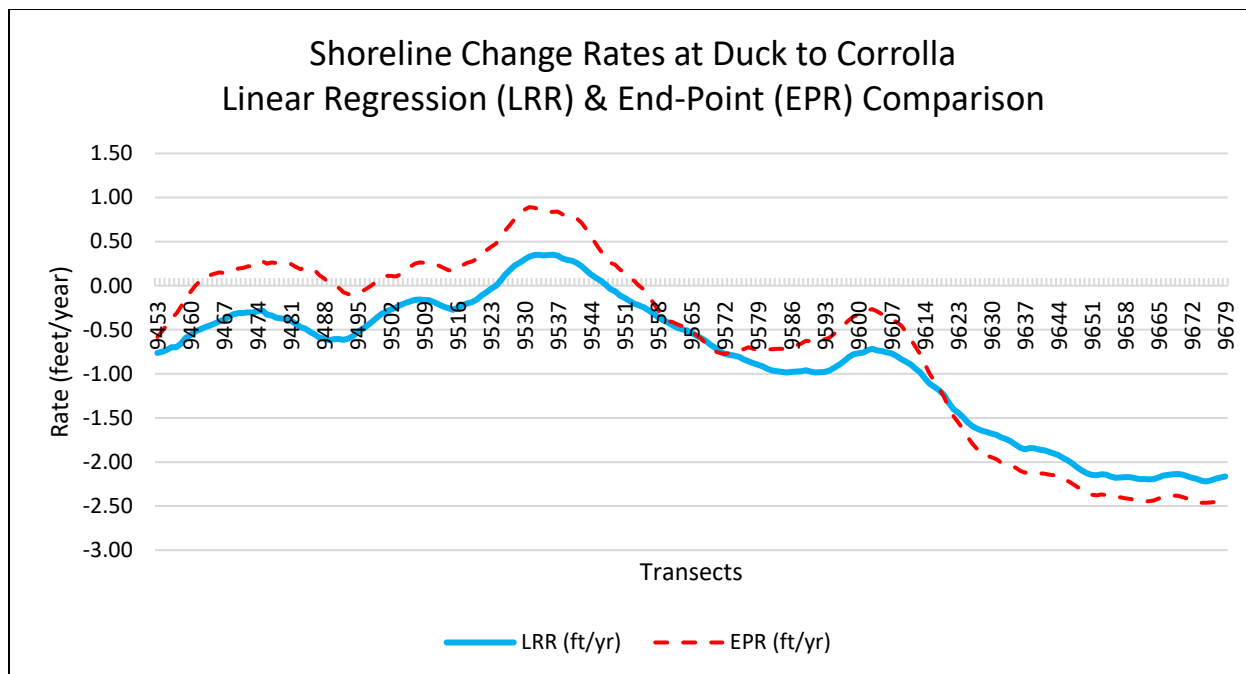


Figure 261. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

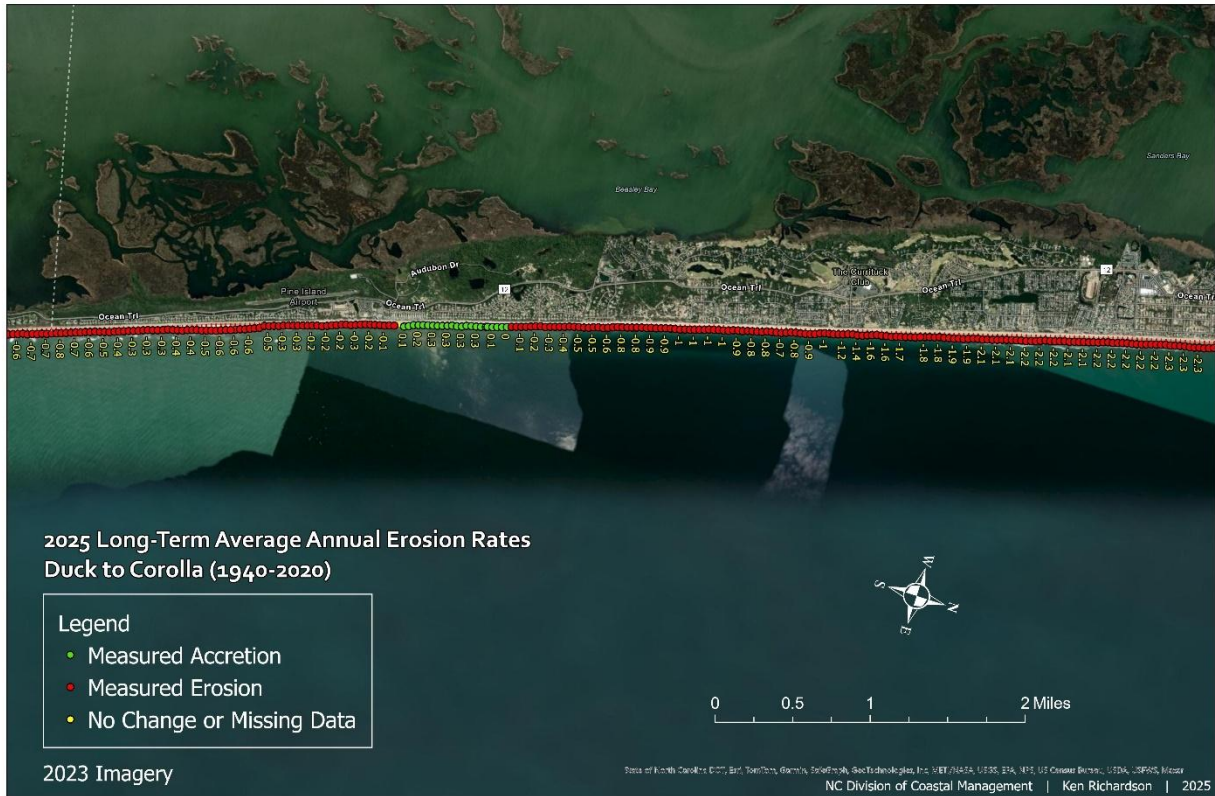


Figure 262. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

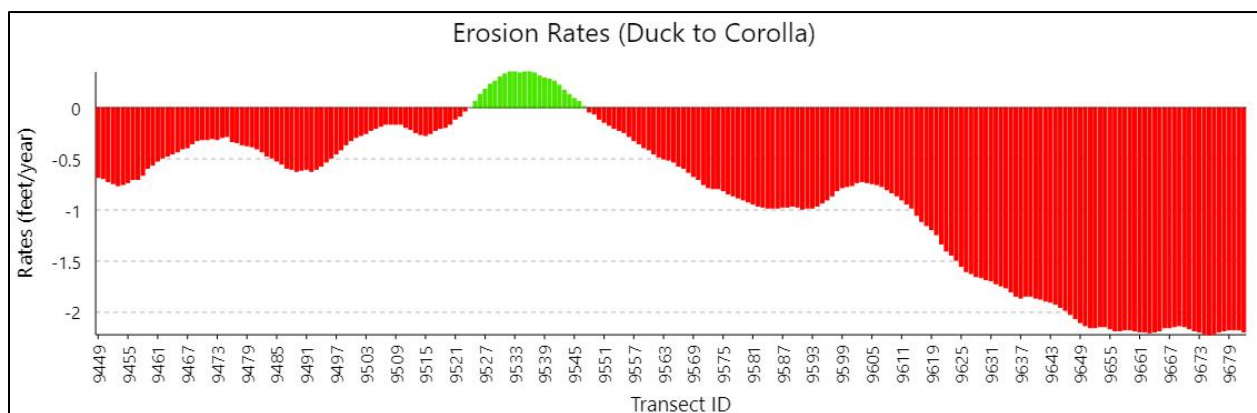


Figure 263. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

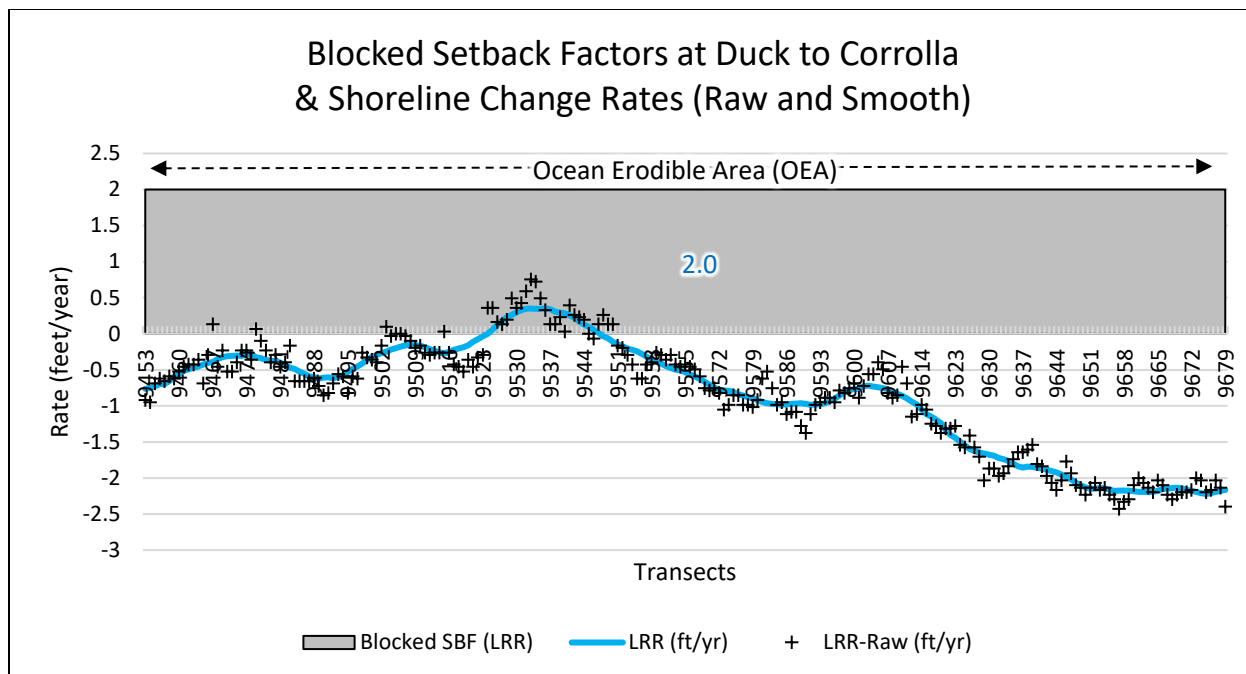


Figure 264. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

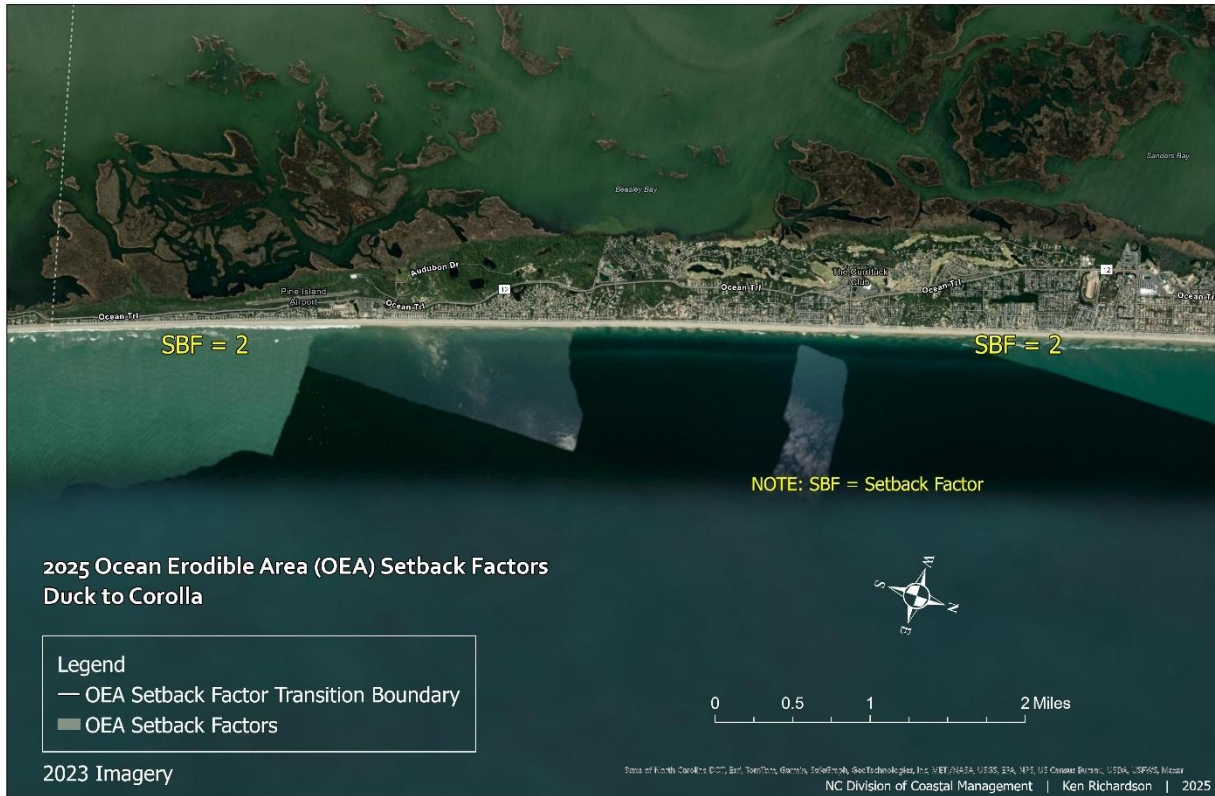


Figure 265. This map illustrates the erosion rate setback factors within the Ocean Erodible Area between Duck and Corolla.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|------|------|------|------|--------|--------|------|------|
| Setback Factor (SBF) | 2 | 2 | 2 | 2 | 2 to 3 | 2 to 6 | N/A | N/A |

Table 44. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.44 Corolla

In the area of Corolla, this section of oceanfront shoreline extends for 4.8 miles. Here, twelve shorelines (**Figure 266**) were assessed along this oceanfront section over an 80-year period, from 1940 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 148 feet to a maximum of 378 feet, with an average of 234 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 57 and 106 feet, and an average of 77 feet. Of the 4.8 miles of shoreline analyzed, all 4.8 miles (100%) resulted in measured erosion where rates ranged between -4.2 and -1.9 feet per year and averaged -2.5 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 267**). Between transects 9680 and 9833, the end-point method resulted in a range of shoreline line change rates between -3.4 and -2.1 feet per year, averaging -2.6 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -4.2 and -1.9 feet per year, averaging -2.5 feet per year. Like previous studies, both approaches yielded similar results of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 3 feet per year, and the least squares regression ranged from 2 to 4 feet per year.

Using the least squares regression methodology provides a more accurate depiction of long-term shoreline movement and produces results consistent with previous studies for this shoreline section. Based on this approach, the calculated setback factors within the OEA between transects 9680 and 9833 range from 2 to 4 feet per year. Rates begin at 2 feet per year near Corolla's southernmost boundary at transect 9680, increase to 3 feet per year near transect 9781, and reach 4 feet per year approaching the end of the paved surface of N Beach Access Road near transect 9828 (**Figure 268 to Figure 271 & Table 45**).



Figure 266. Shorelines included in the analysis (1940-2020) at Corolla.

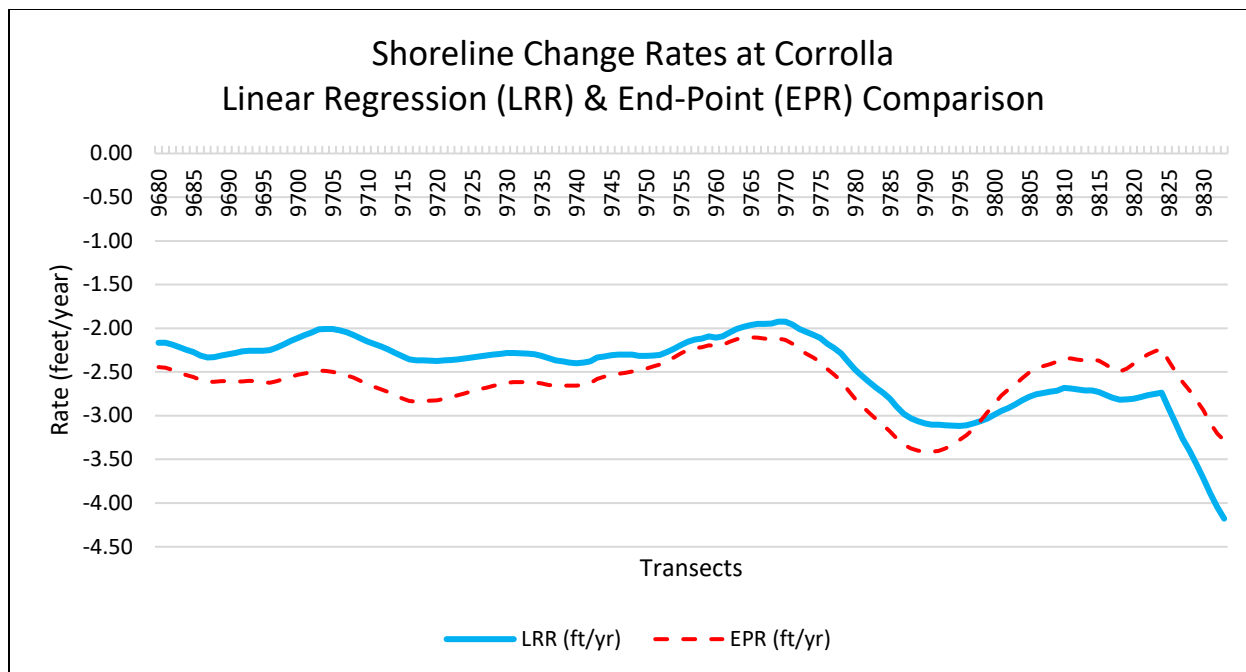


Figure 267. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).



Figure 268. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

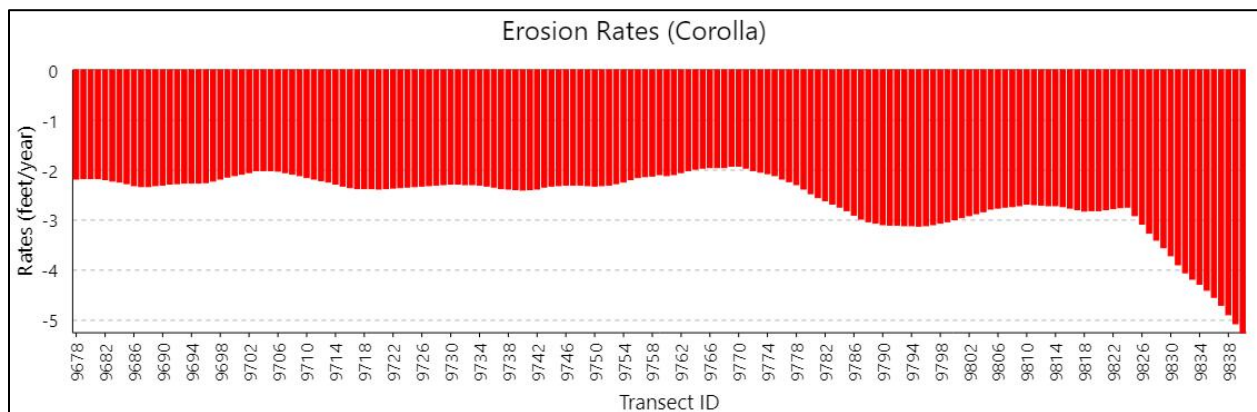


Figure 269. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

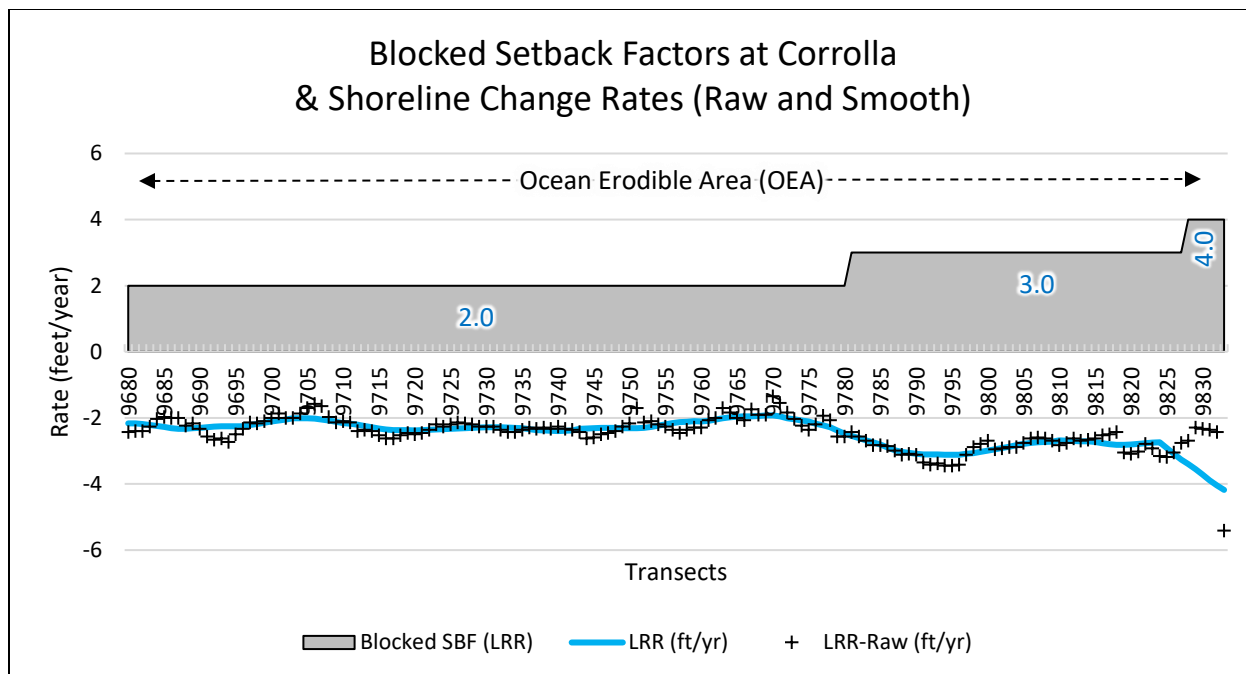


Figure 270. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

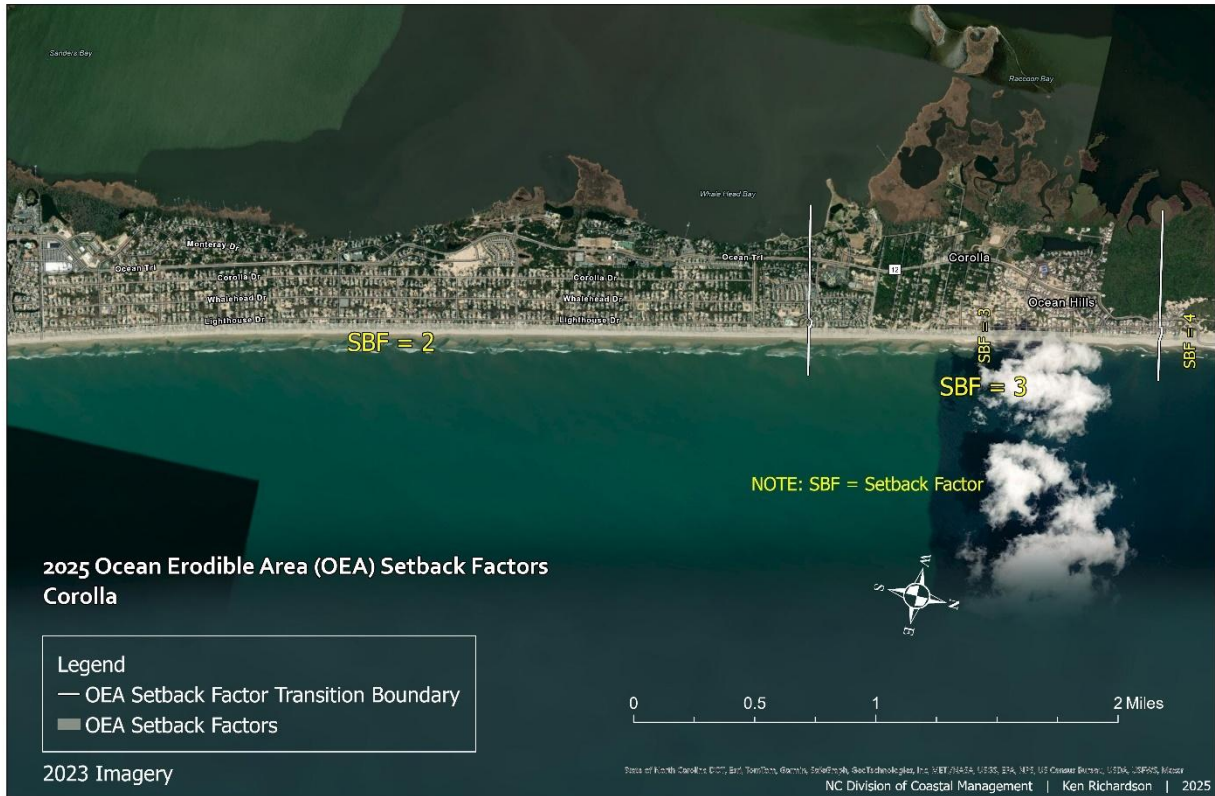


Figure 271. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Corolla.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|-----------------|-----------------|-----------------|------|-----------------|-----------------|------|------|
| Setback Factor (SBF) | Range 2 to 4 | Range 2 to 3 | Range 2 to 3 | 2 | Range 2 to 7 | Range 2 to 8 | N/A | N/A |

Table 45. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.45 Currituck National Wildlife Refuge

In the area of the Currituck National Wildlife Refuge, this section of oceanfront shoreline extends for 1.7 miles. Here, twelve shorelines (**Figure 272**) were assessed along this oceanfront section over an 80-year period, from 1940 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 286 feet to a maximum of 458 feet, with an average of 385 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 93 and 143 feet, and an average of 120 feet. Of the 1.7 miles of shoreline analyzed, all 1.7 miles (100%) resulted in measured erosion where rates ranged between -7.7 and -4.9 feet per year and averaged -6.5 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 273**). Between transects 9834 and 9890, the end-point method resulted in a range of shoreline line change rates between -6.6 and -3.3 feet per year, averaging -5.4 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -7.7 and -4.9 feet per year, averaging -6.7 feet per year. Like previous studies, both approaches yielded similar results of blocked erosion rate setback factors. End-point setback factors ranged from 3 to 6.5 feet per year, and the least squares regression ranged from 4 to 8 feet per year.

Using the least squares regression methodology provides a more accurate depiction of long-term shoreline movement and produces results consistent with previous studies for this shoreline section. Based on this approach, the calculated setback factors within the OEA between transects 9834 and 9890 range from 4 to 8 feet per year. Starting at transect 9834 and moving north, rates begin at 4 feet per year, increase to 5 feet per year near transect 9836, increase to 6 feet per year near transect 9845, increase to 7 feet per year near transect 9859, and reach 8 feet per year at transect 9881 (**Figure 273 to Figure 277 & Table 46**).



Figure 272. Shorelines included in the analysis (1940-2020) at Currituck National Wildlife Refuge.

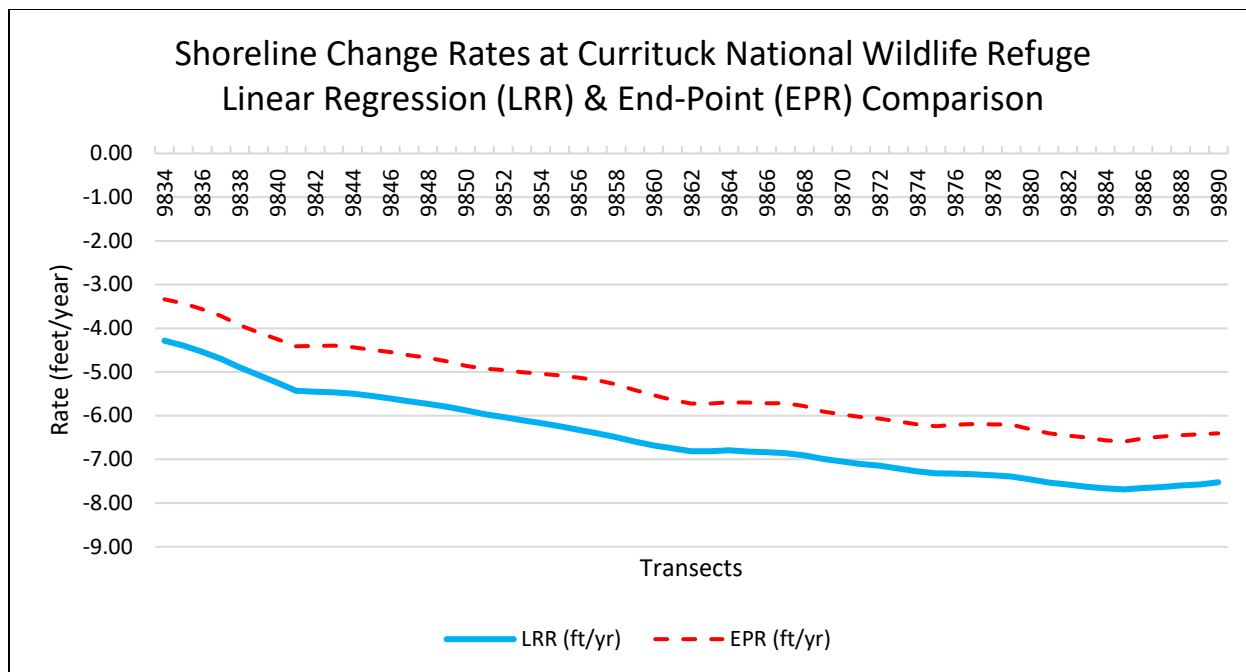


Figure 273. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

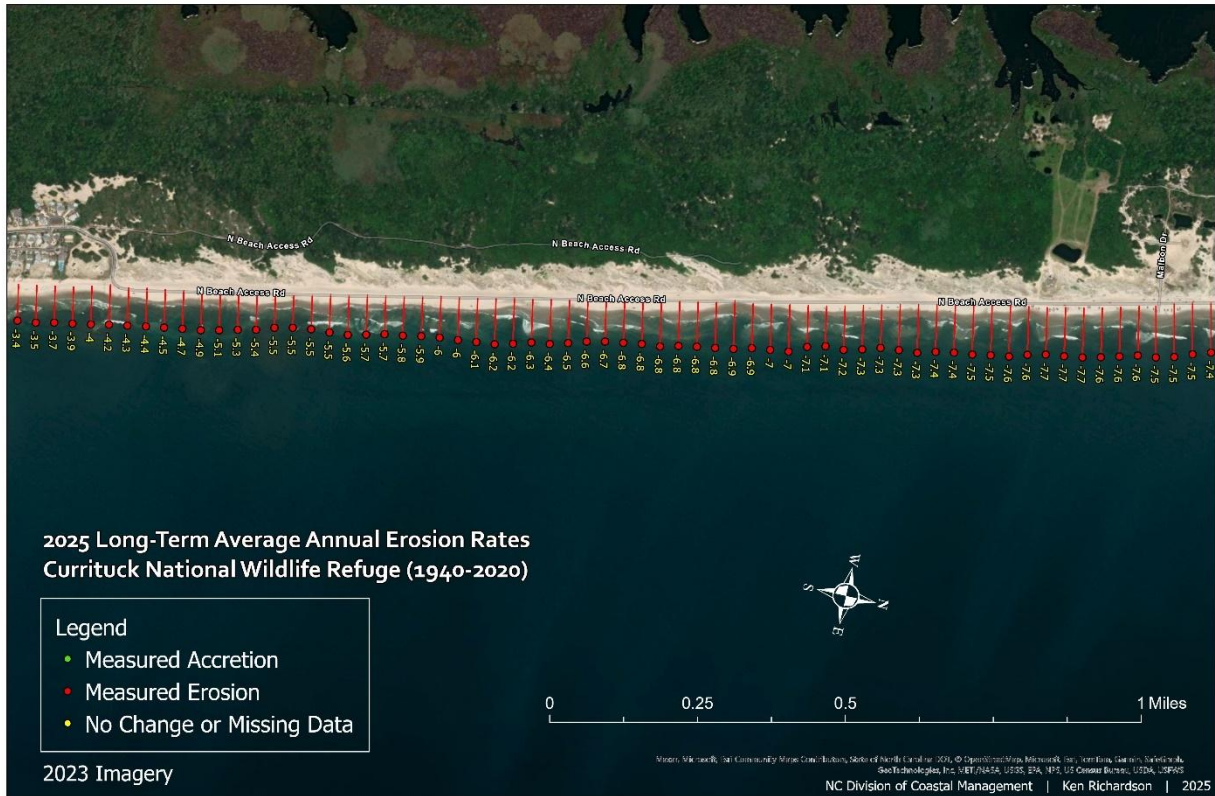


Figure 274. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

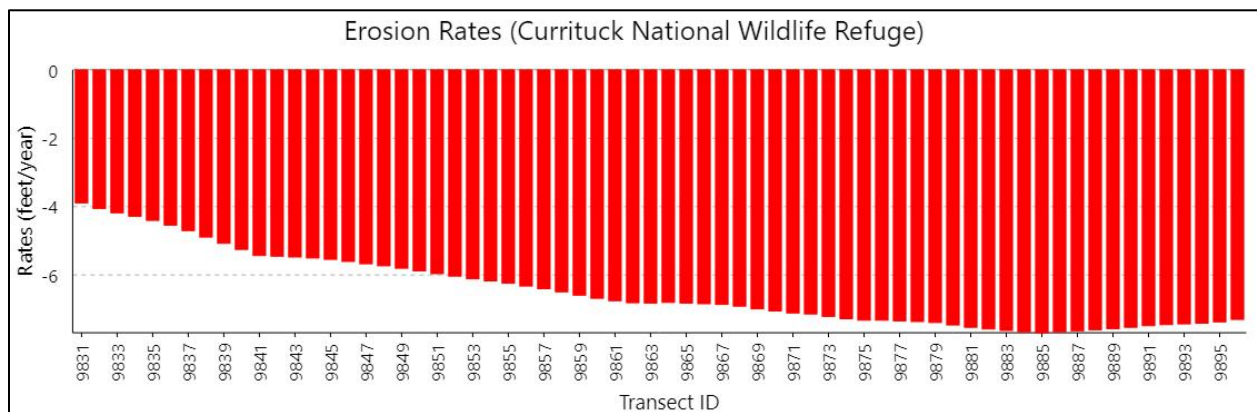


Figure 275. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

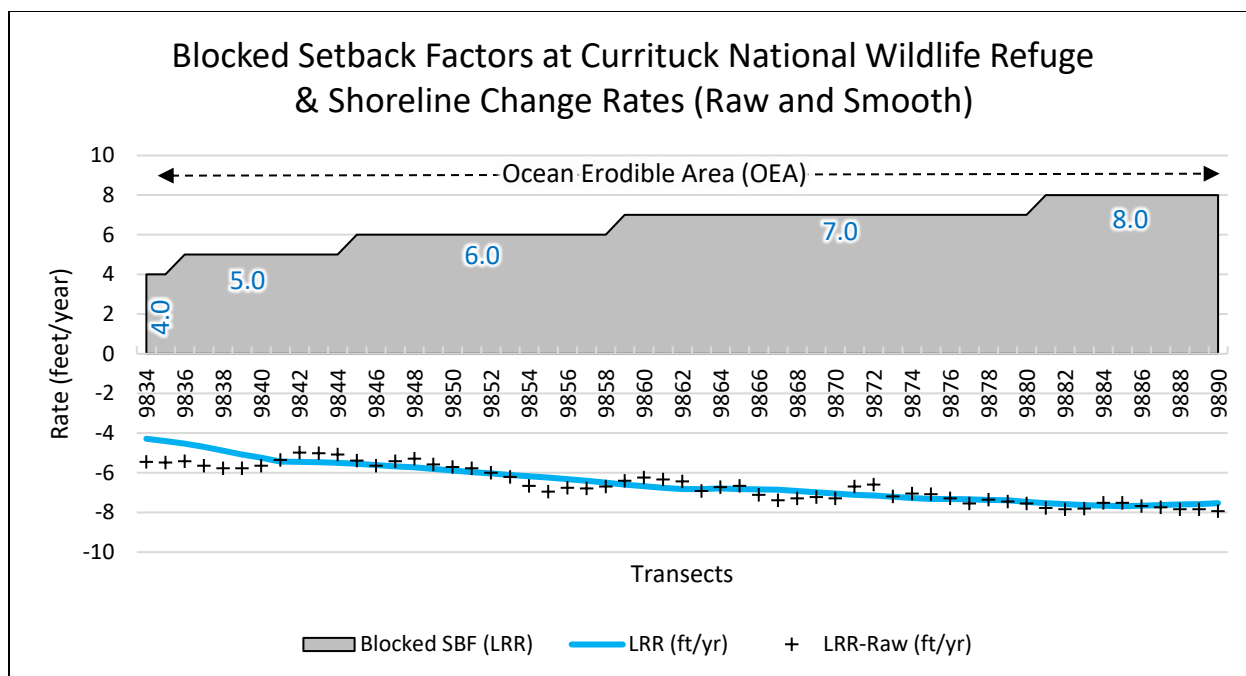


Figure 276. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

3.46 Currituck County (Currituck National Wildlife Refuge to Carova)

In the area between Currituck National Wildlife Refuge and Carova, this section of oceanfront shoreline extends for 4.8 miles. Here, twelve shorelines (**Figure 278**) were assessed along this oceanfront section over a 58-year period, from 1962 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 240 feet to a maximum of 510 feet, with an average of 382 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 79 and 144 feet, and an average of 113 feet. Of the 4.8 miles of shoreline analyzed, all 4.8 miles (100%) resulted in measured erosion where rates ranged between -7.5 and -3.1 feet per year and averaged -5.8 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 279**). Between transects 9891 and 10045, the end-point method resulted in a range of shoreline line change rates between -6.6 and -1.8 feet per year, averaging -4.9 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -7.5 and -3.1 feet per year, averaging -5.8 feet per year. Like previous studies, both approaches yielded similar results of blocked erosion rate setback factors. End-point setback factors ranged from 2 to 7 feet per year, and the least squares regression ranged from 3 to 7 feet per year.

Using the least squares regression methodology provides a more accurate depiction of long-term shoreline movement and produces results consistent with previous studies for this shoreline section. Based on this approach, the calculated setback factors within the OEA between transects 9891 and 10045 range from 3 to 7 feet per year. Starting at transect 9891 and moving north, rates begin at 7 feet per year, decrease to 6 feet per year near transect 9956, decrease to 5 feet per year near transect 9985, decrease to 4 feet per year near transect 10010, and then decrease to 3 feet per year at transect 10039 (**Figure 280 to Figure 283 & Table 47**).

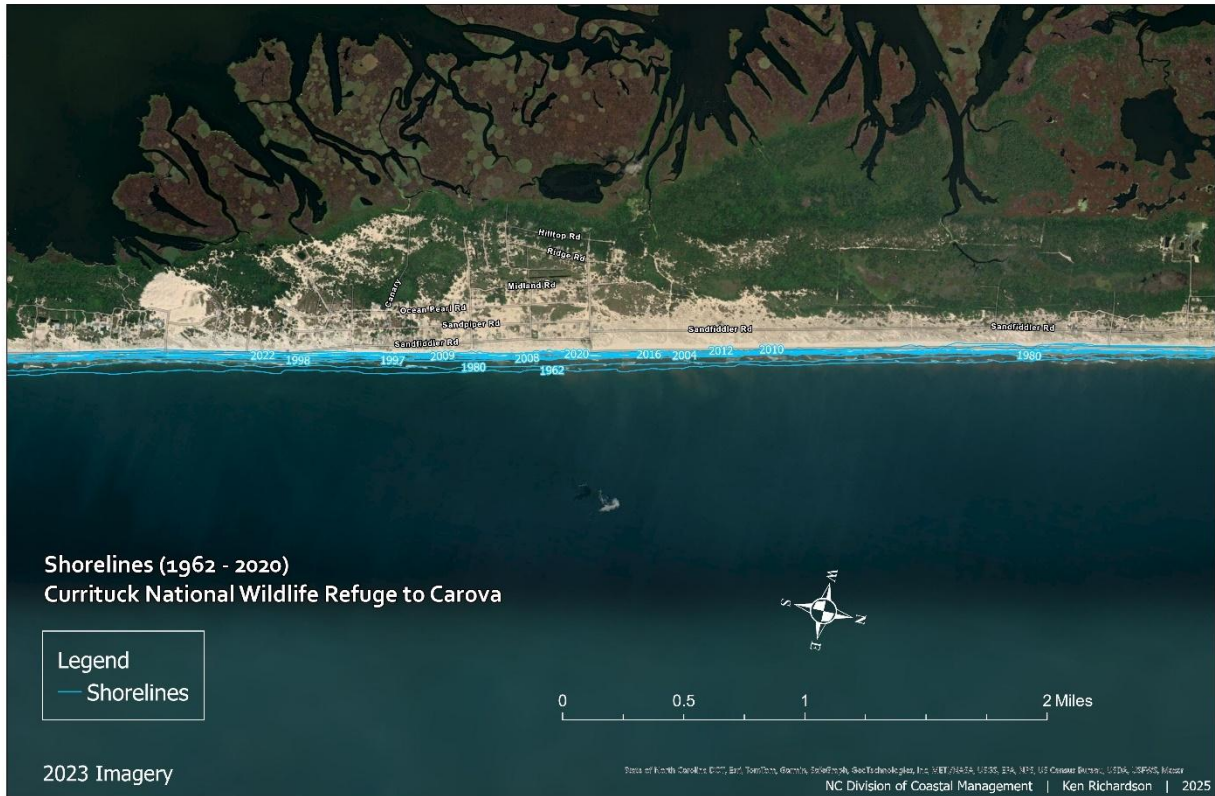


Figure 278. Shorelines included in the analysis (1962-2020) between Currituck National Wildlife Refuge to Carova.

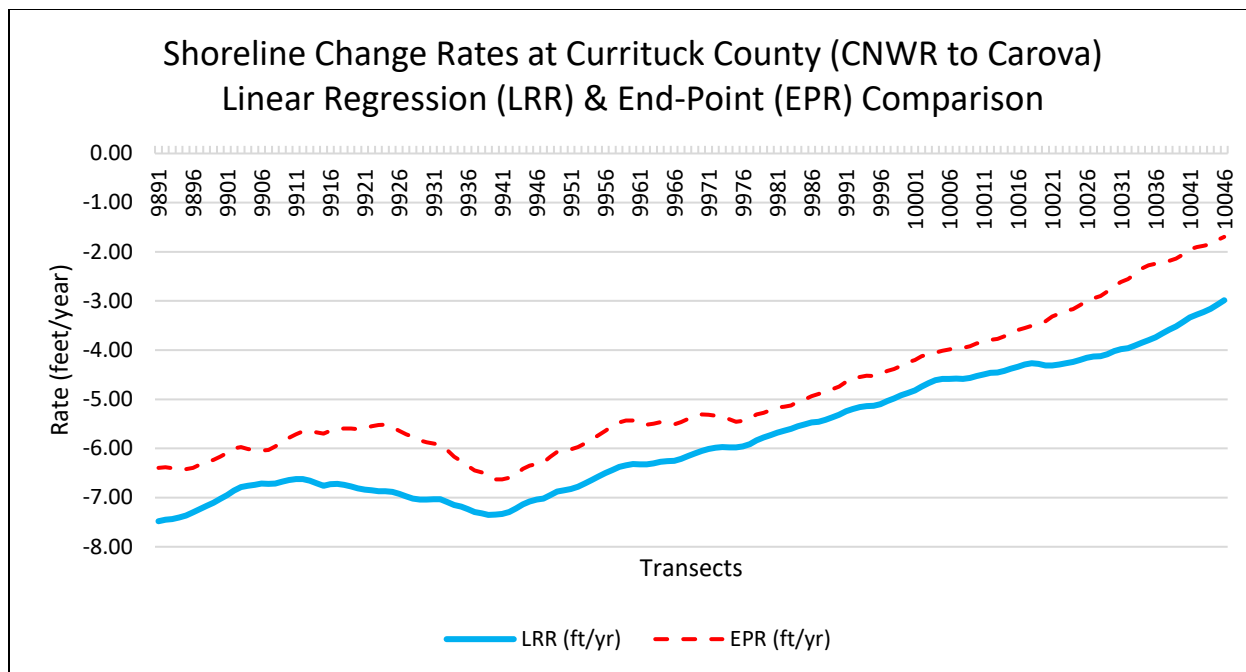


Figure 279. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

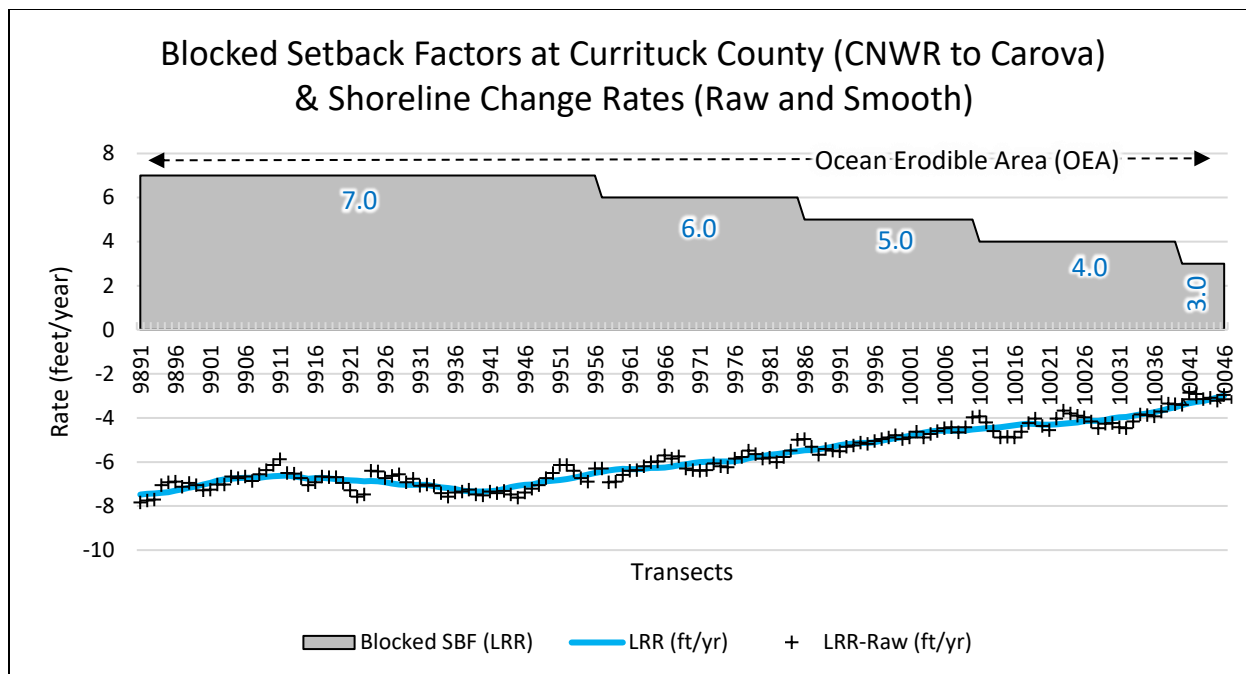


Figure 282. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).

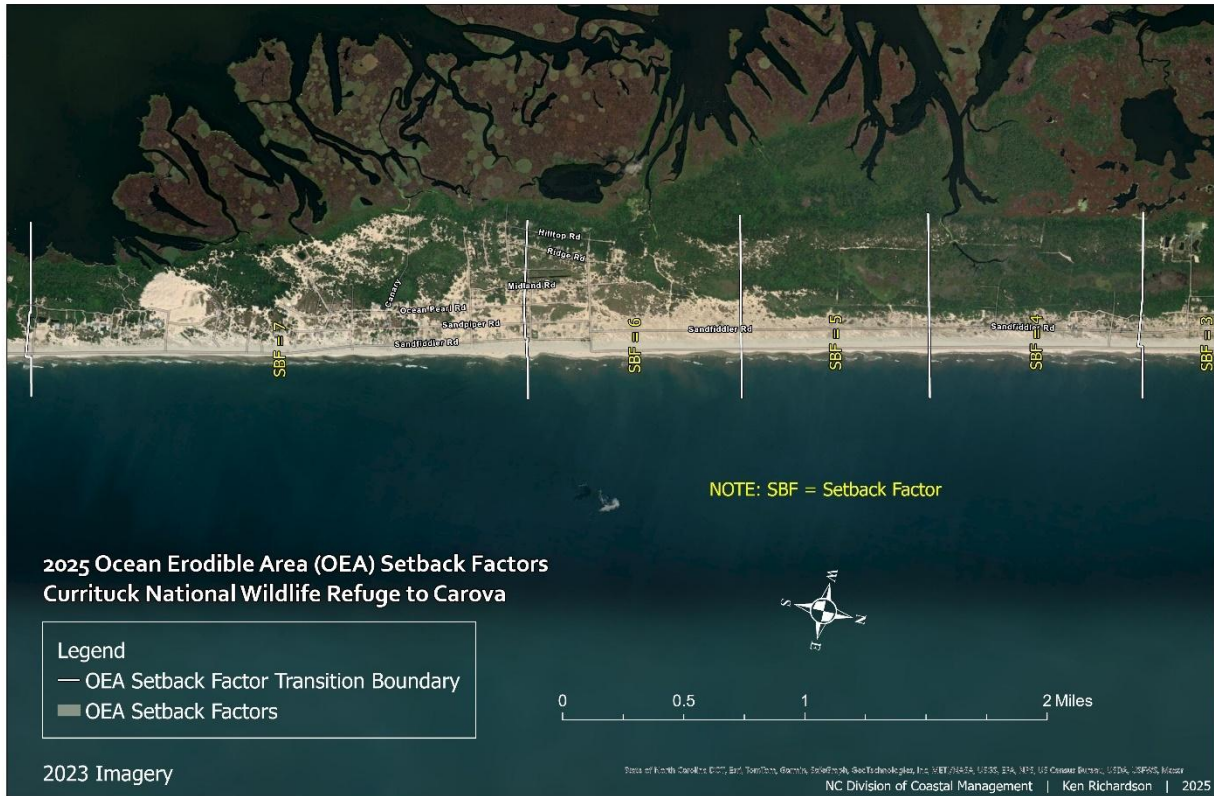


Figure 283. This map illustrates the erosion rate setback factors within the Ocean Erodible Area between Currituck National Wildlife Refuge and Carova.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|-----------------|-----------------|-----------------|-----------------|-------------------|-----------------|------|------|
| Setback Factor (SBF) | Range 3 to 7 | Range 4 to 8 | Range 3 to 7 | Range 2 to 8 | Range 3 to 9.5 | Range 2 to 9 | N/A | N/A |

Table 47. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

3.47 Currituck County (Carova)

In the area from Carova to the NC-VA boundary, this section of oceanfront shoreline extends for 4.3 miles. Here, twelve shorelines (**Figure 284**) were assessed along this oceanfront section over a 95-year period, from 1925 to 2020. The shoreline envelope, representing the extent of movement along each transect, ranged from a minimum of 103 feet to a maximum of 329 feet, with an average of 230 feet for this segment of shoreline. The calculated relative standard deviation of shoreline position ranged between 32 and 96 feet, and an average of 65 feet. Of the 4.3 miles of shoreline analyzed, less than 1.0 mile (22%) resulted in measured erosion where rates ranged between -3.0 and less than 1.0 feet per year and averaged -1.7 feet per year.

For comparison, both the end-point and least squares regression methods yielded similar results (**Figure 285**). Between transects 10046 and 10185, the end-point method resulted in a range of shoreline line change rates between -1.7 and +3.0 feet per year, averaging +1.5 feet per year; and the least squares regression method resulted in a range of shoreline line change rates between -3.0 and +2.7 feet per year, averaging less than +1.0 feet per year. Like previous studies, both approaches yielded similar results of blocked erosion rate setback factors. End-point setback factors equaled 2 feet per year, and the least squares regression ranged from 2 to 3 feet per year.

Using the least squares regression methodology provides a more accurate depiction of long-term shoreline movement and produces results consistent with previous studies for this shoreline section. Based on this approach, the calculated setback factors within the OEA between transects 10046 and 10185 range from 2 to 3 feet per year. Starting at transect 10046 and moving north, rates begin at 3 feet per year and then decrease to 2 feet per year at transect 10056 (**Figure 285 to Figure 289 & Table 48**).

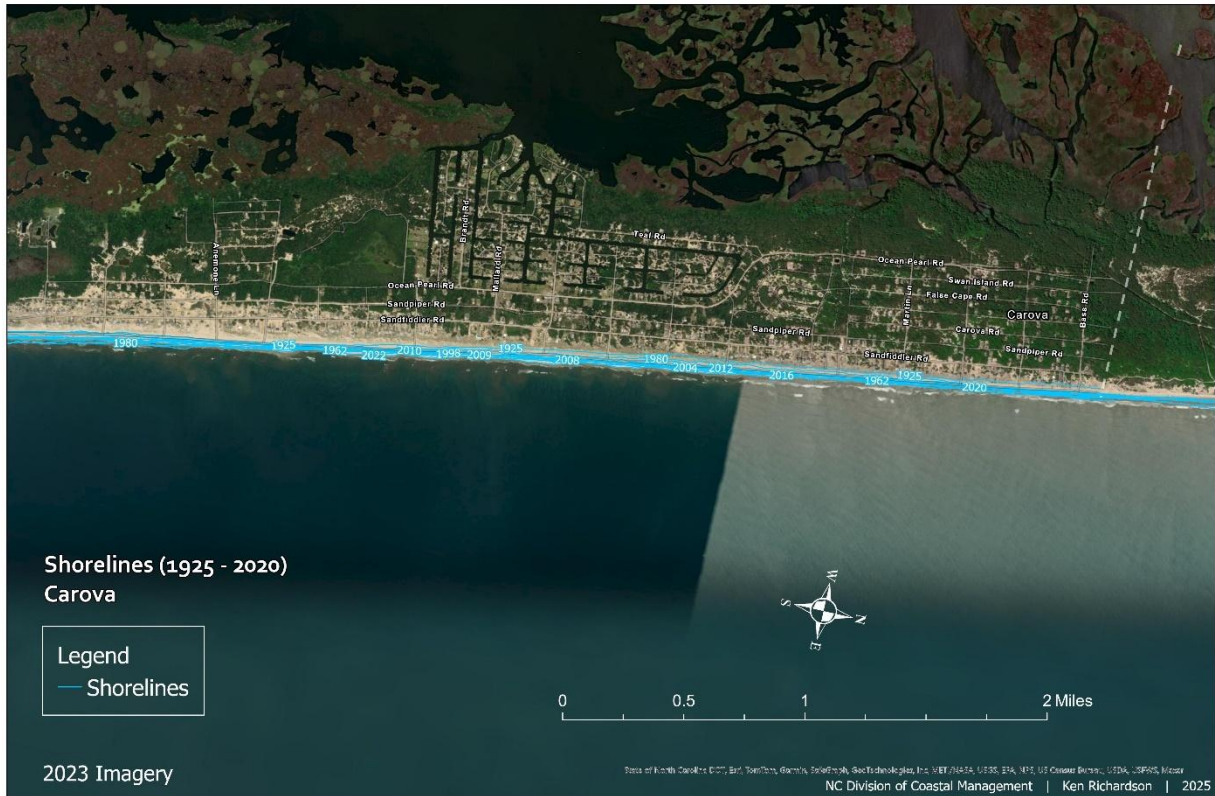


Figure 284. Shorelines included in the analysis (1925-2020) at Carova.

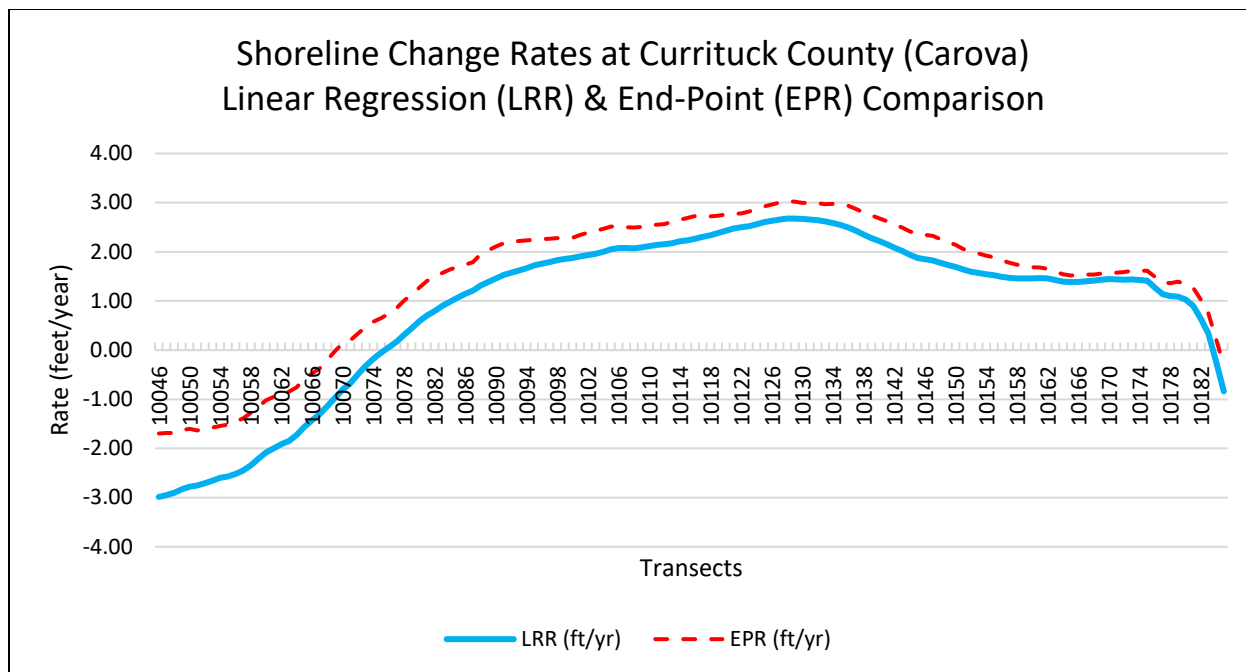


Figure 285. This graph compares erosion rates calculated using least squares regression (blue line) and end-point (dashed red line).

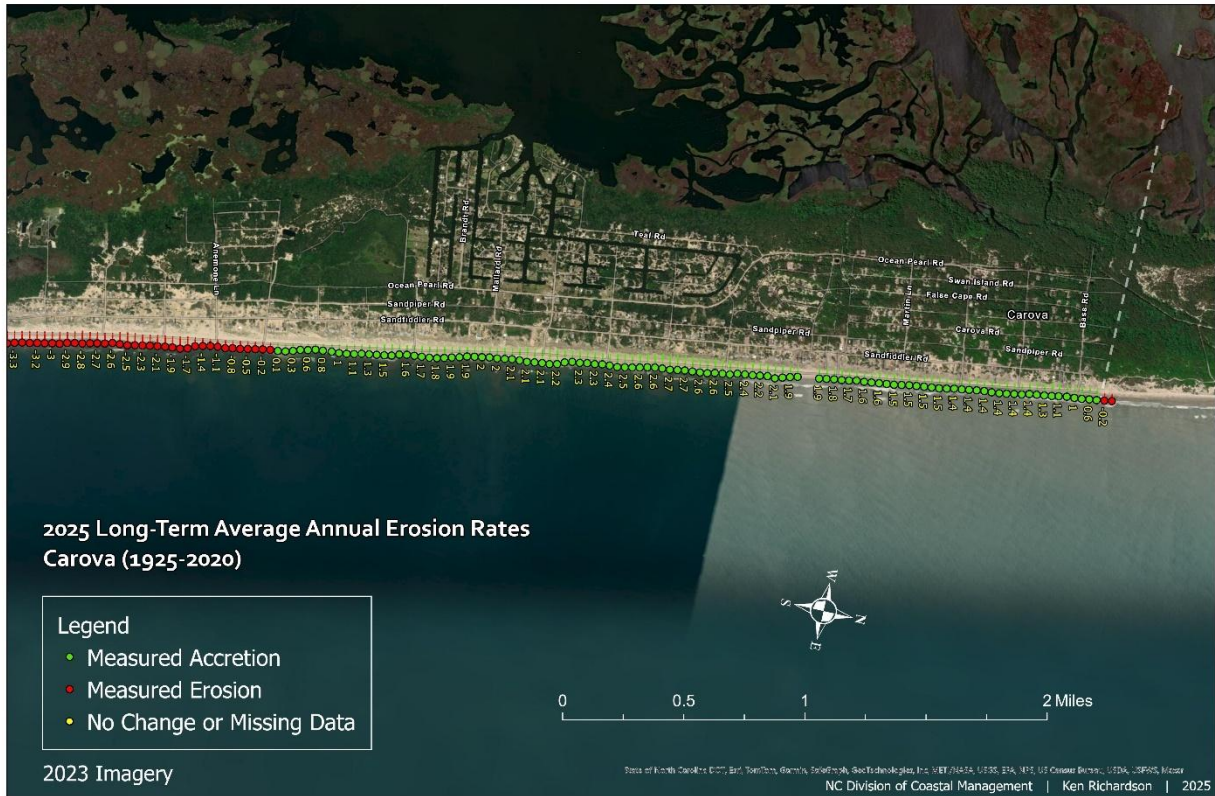


Figure 286. This map image illustrates the shoreline envelope at each transect, showing the area between the most oceanward and landward shorelines, labeled with erosion rates. Green lines indicate areas where accretion is measured, while red lines represent areas where erosion is measured using least squares regression.

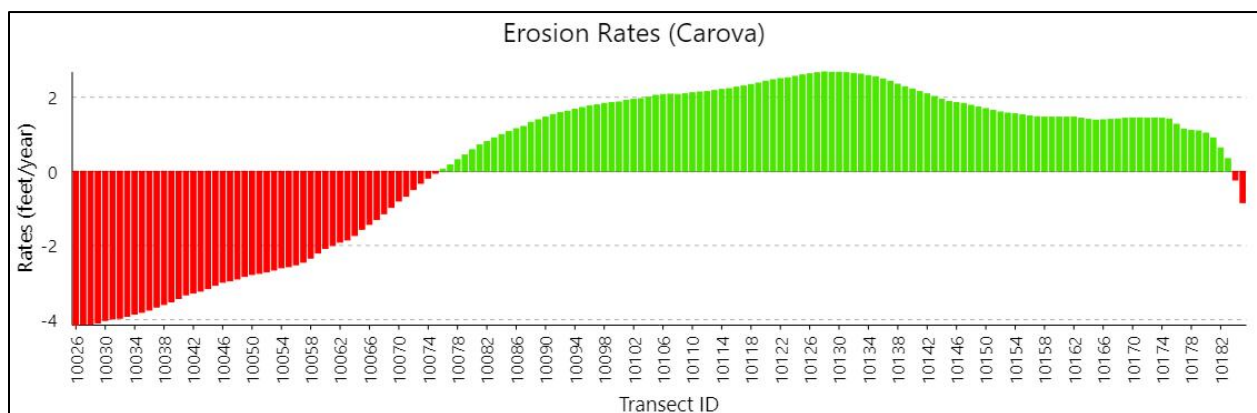


Figure 287. This graph illustrates shoreline change rates measured at each transect, with green bars representing areas of accretion and red lines indicating areas of erosion.

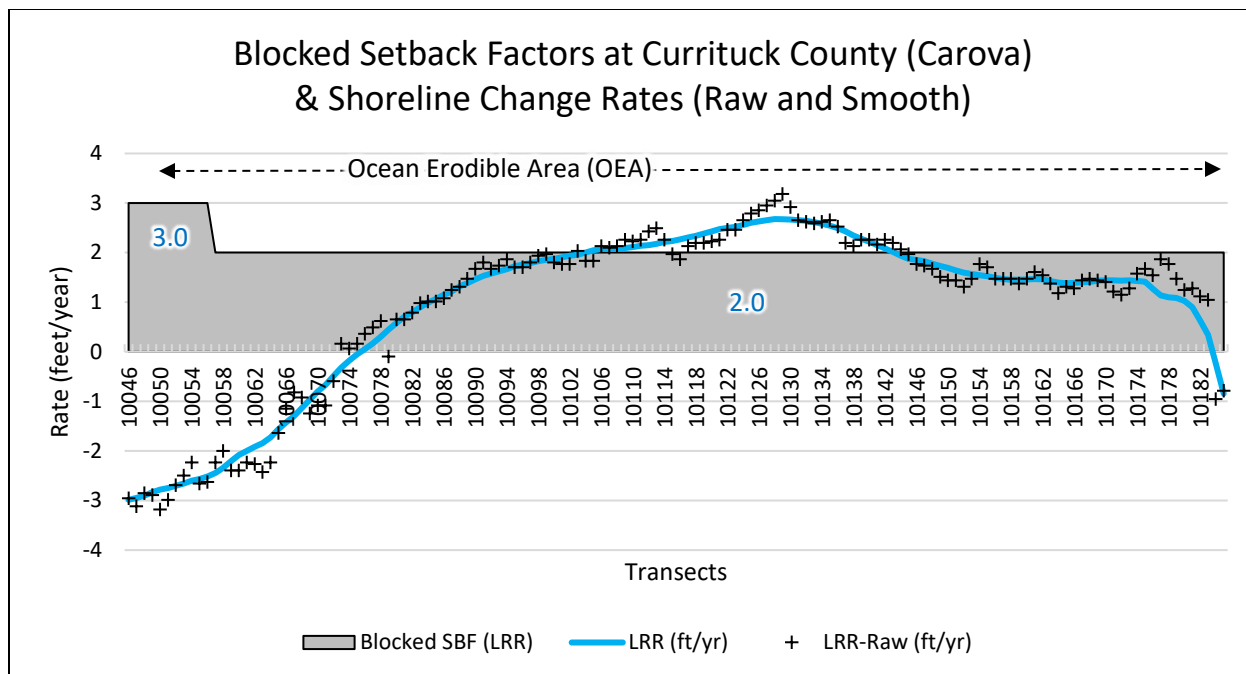


Figure 288. This graph illustrates shoreline change rates (erosion and accretion) and blocked rates (setback factors) calculated at each transect. Black cross points represent raw rates, the solid blue line shows the smoothed rates, and the gray area represents the blocked rates (setback factors).



Figure 289. This map illustrates the erosion rate setback factors within the Ocean Erodible Area at Carova.

| Ocean Erodible Area (OEA) | 2025 | 2020 | 2013 | 2004 | 1997 | 1986 | 1983 | 1980 |
|---------------------------|-----------------|-----------------|------|------|-----------------|------|------|------|
| Setback Factor (SBF) | Range 2 to 3 | Range 2 to 3 | 2 | 2 | Range 2 to 4 | 2 | N/A | N/A |

Table 48. This table compares setback factors from this study to those from previous studies. The 2025 values are derived from erosion rates calculated using the least squares regression method.

4.0 Summary

This analysis confirmed that erosion and accretion patterns align with previous studies, with both the least squares regression and end-point methods yielding consistent results. While most shoreline areas will maintain their current setback requirements, some locations will undergo minor adjustments. Inlets and capes remain the most dynamic regions, exhibiting the greatest variability in erosion and accretion rates. These findings will guide oceanfront construction setback factors for future development.

Although both methods produced comparable outcomes, this report marks North Carolina's first long-term update of annual erosion rates and setback factors using the least squares regression method.

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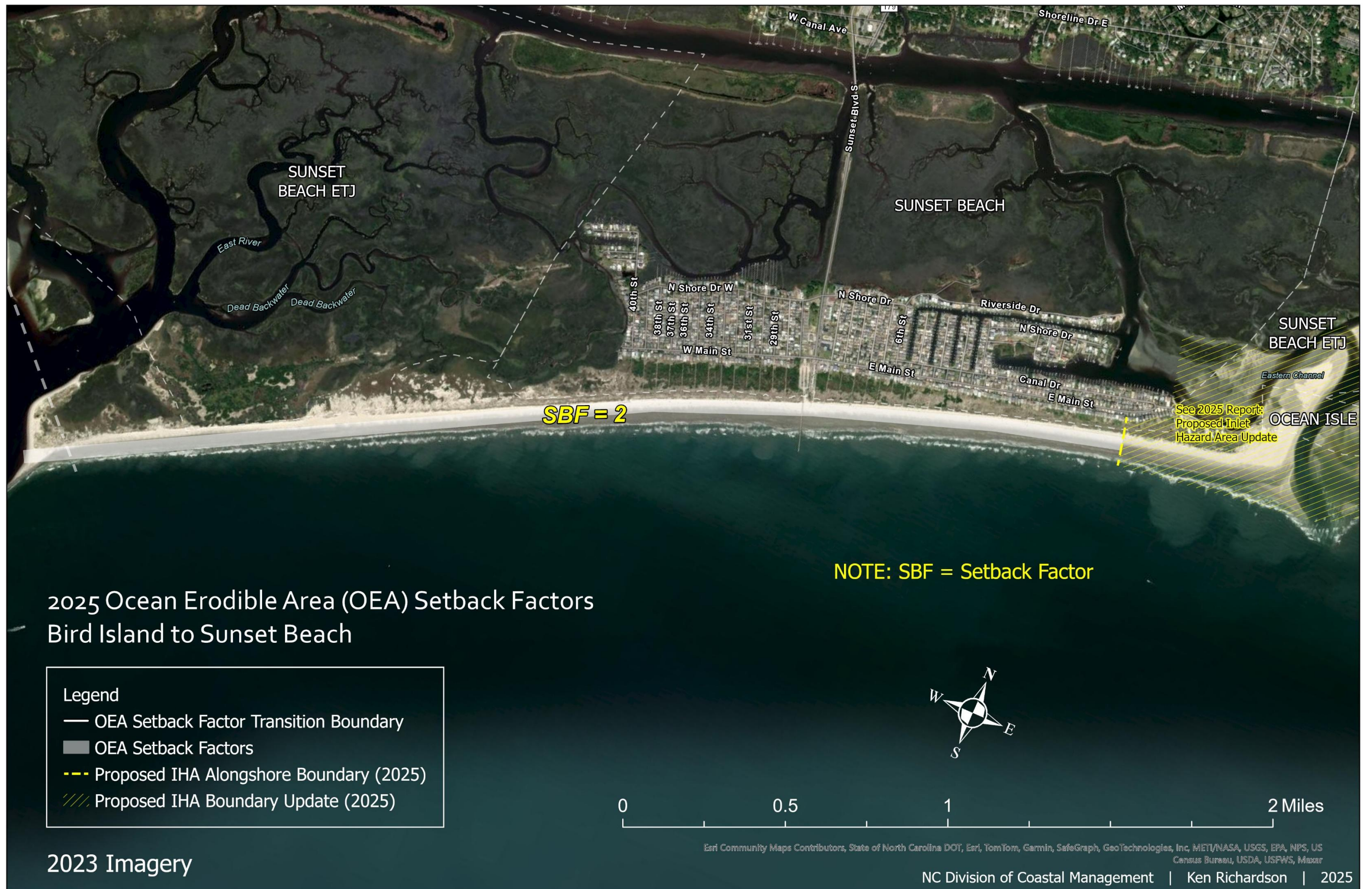
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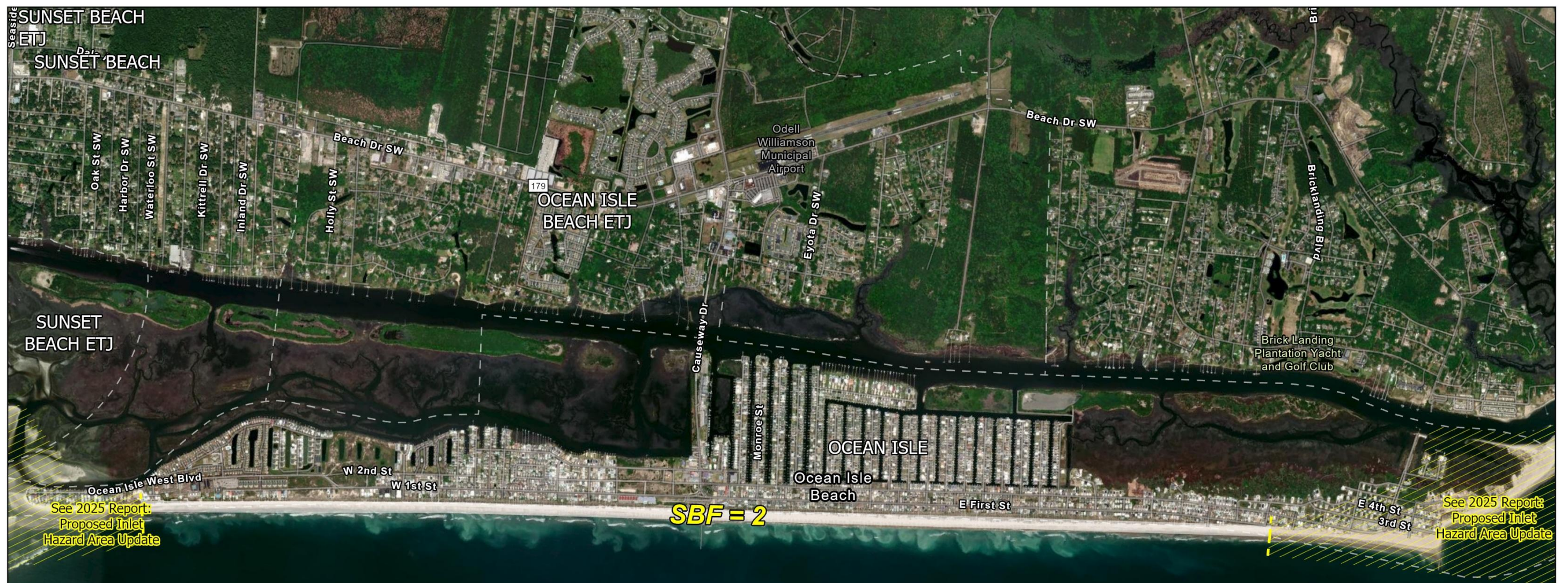
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Appendix A: Inlet Hazard Area Setback Factor Maps





2025 Ocean Erodible Area (OEA) Setback Factors Ocean Isle

NOTE: SBF = Setback Factor

Legend

- OEA Setback Factors
- Proposed IHA Alongshore Boundary (2025)
- /// Proposed IHA Boundary Update (2025)

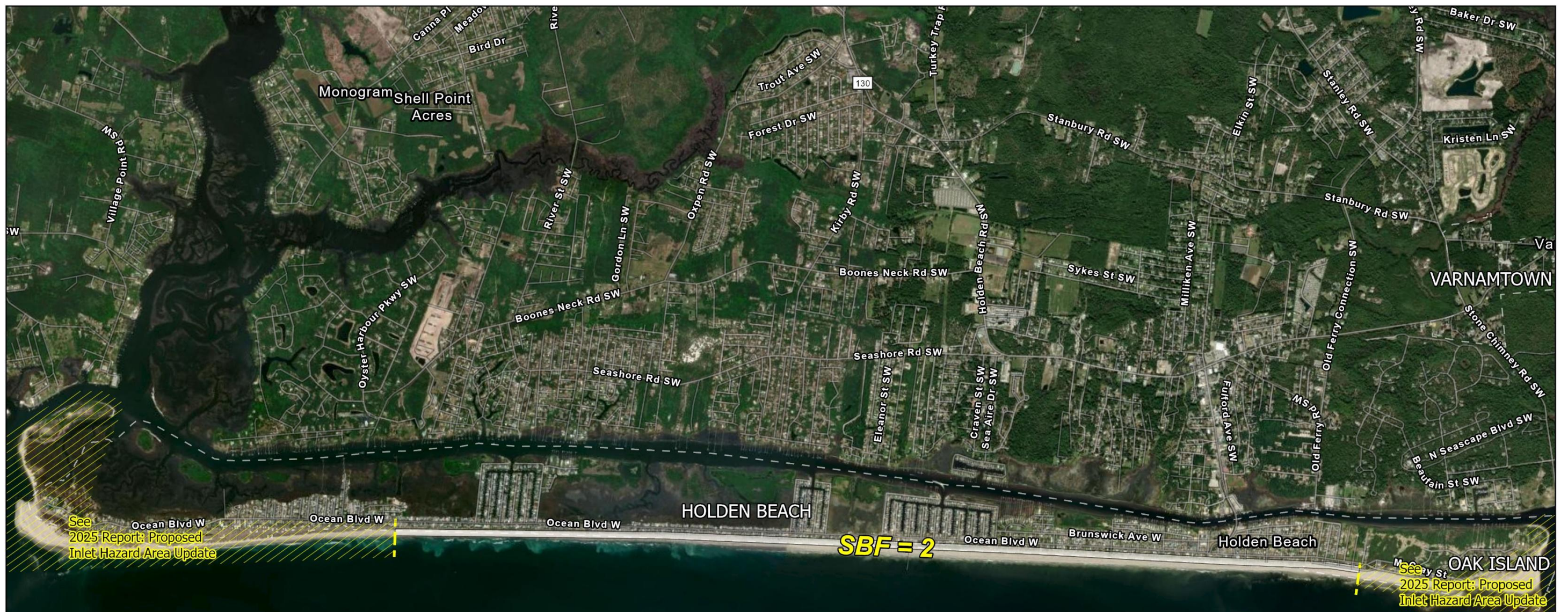


0 0.5 1 2 Miles

2023 Imagery

State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Maxar

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2025 Ocean Erodible Area (OEA) Setback Factors Holden Beach

NOTE: SBF = Setback Factor

Legend

■ OEA Setback Factors

--- Proposed IHA Alongshore Boundary (2025)

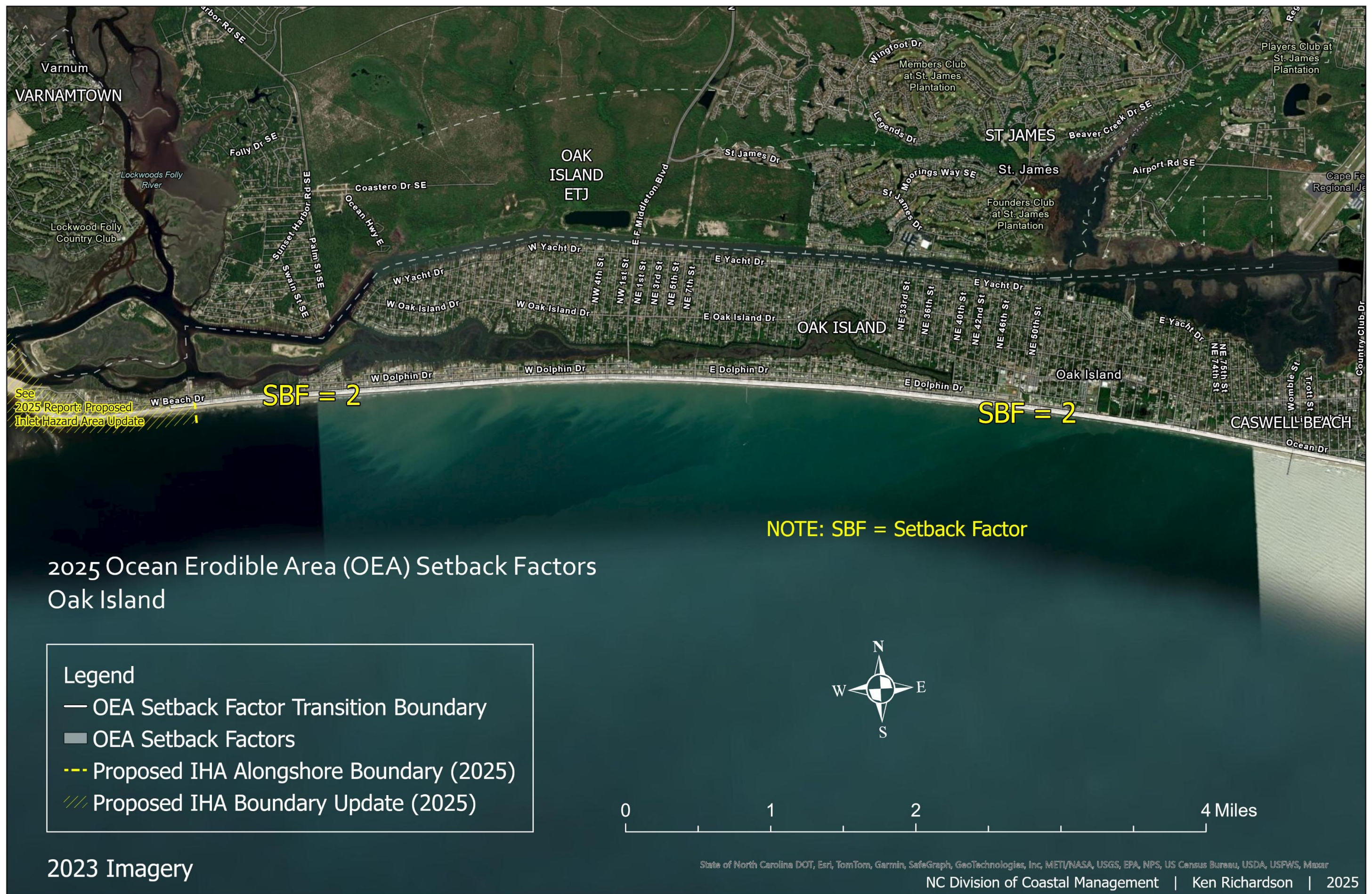
/// Proposed IHA Boundary Update (2025)



2023 Imagery

State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Maxar

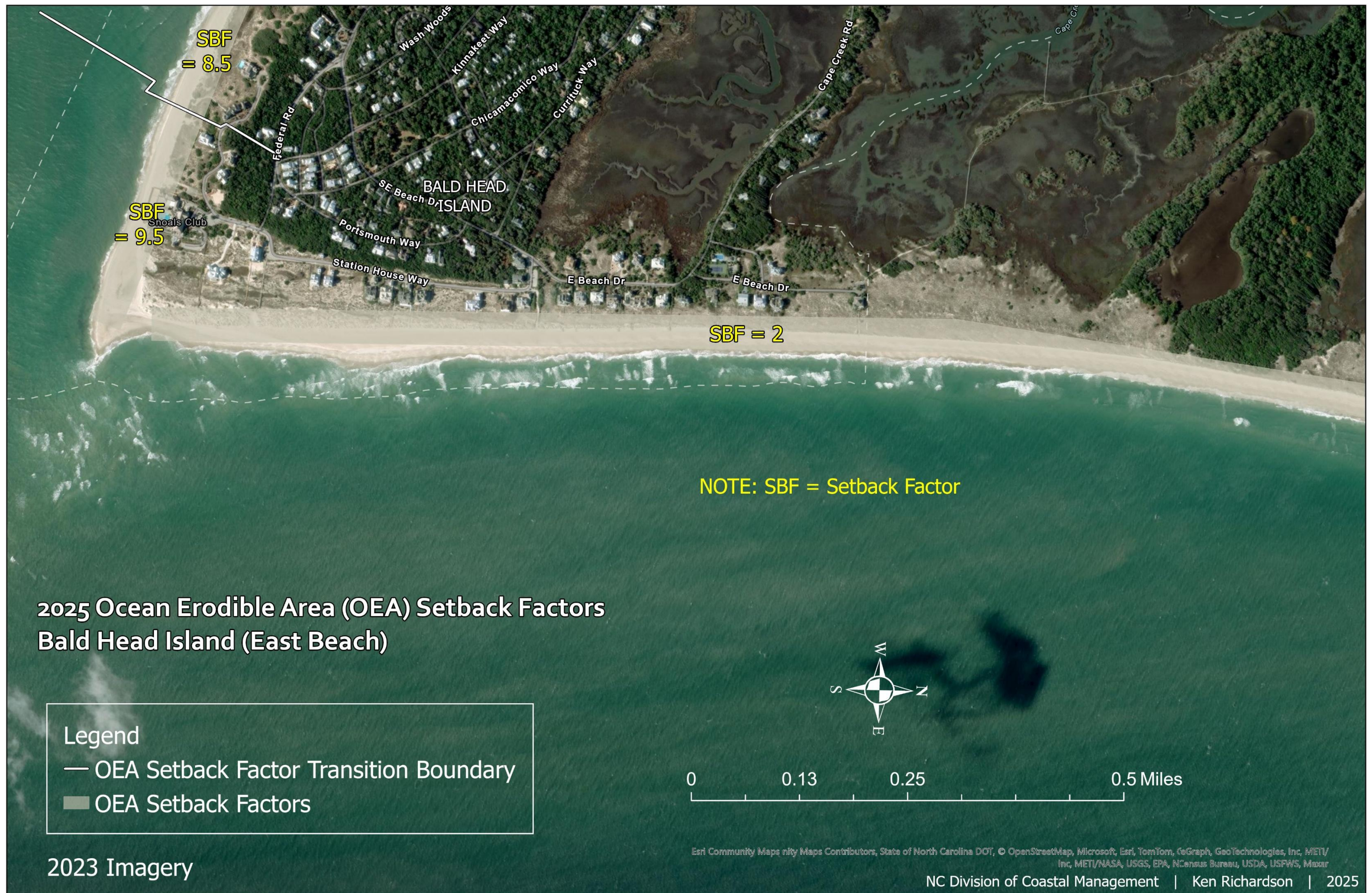
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Esri Community Maps Contributors, State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Maxar





NOTE: SBF = Setback Factor

2025 Ocean Erodible Area (OEA) Setback Factors Zeke's Island to Fort Fisher State Park

Legend

- OEA Setback Factor Transition Boundary
- OEA Setback Factors

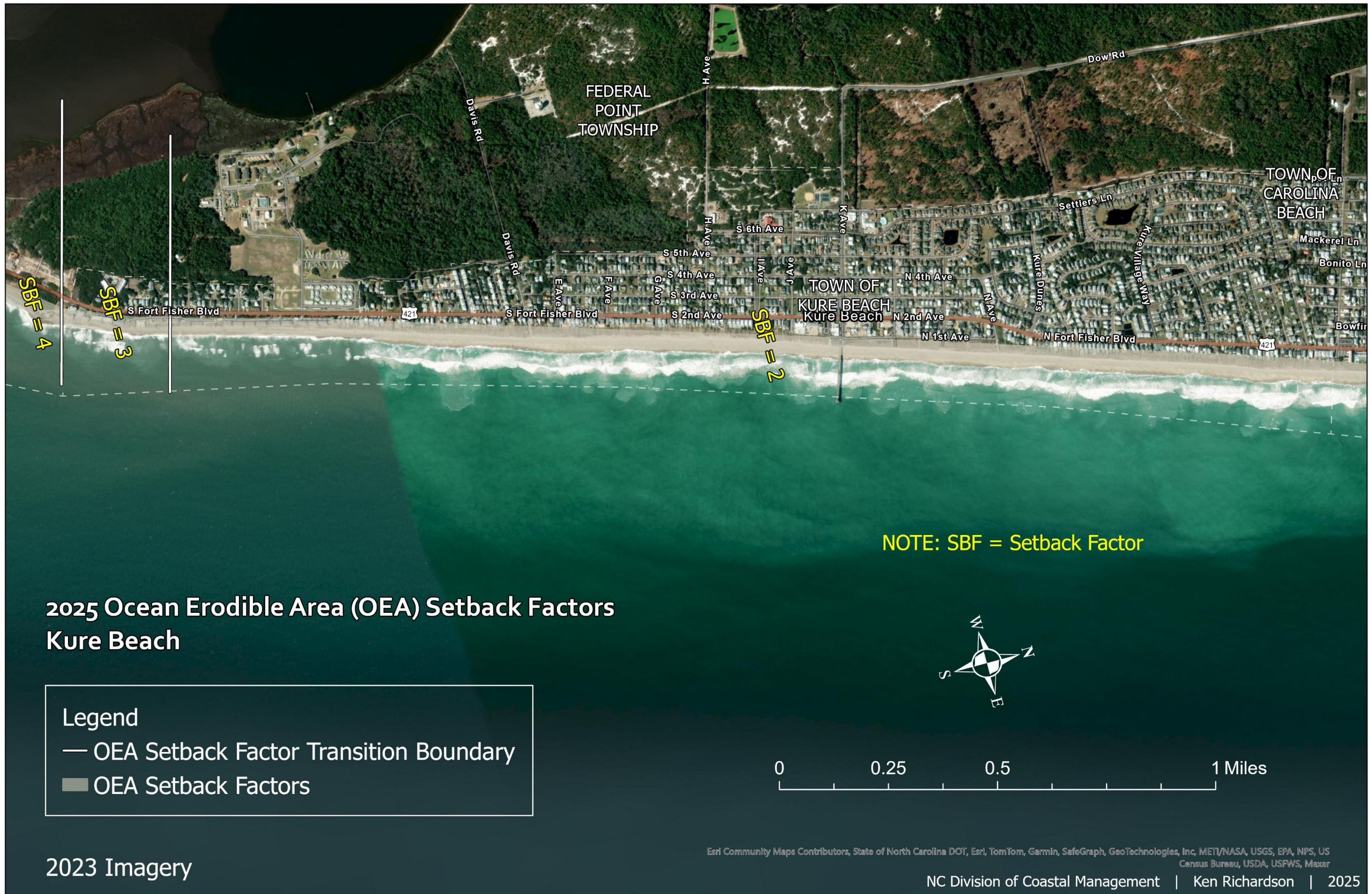


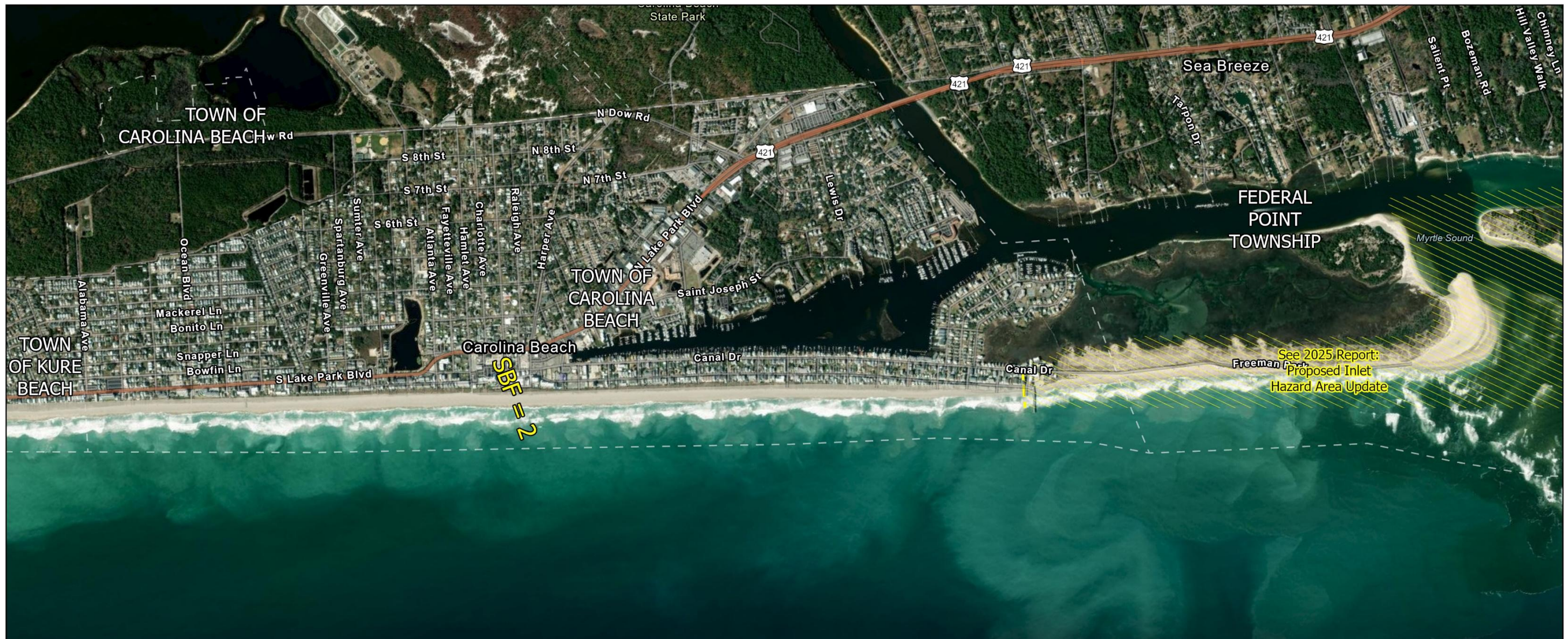
0 0.75 1.5 3 Miles

2023 Imagery

State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Maxar

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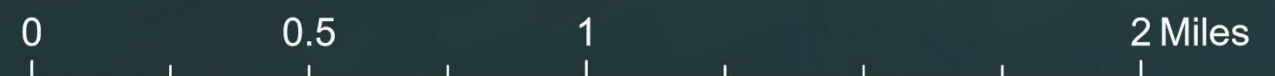




2025 Ocean Erodible Area (OEA) Setback Factors Carolina Beach

Legend

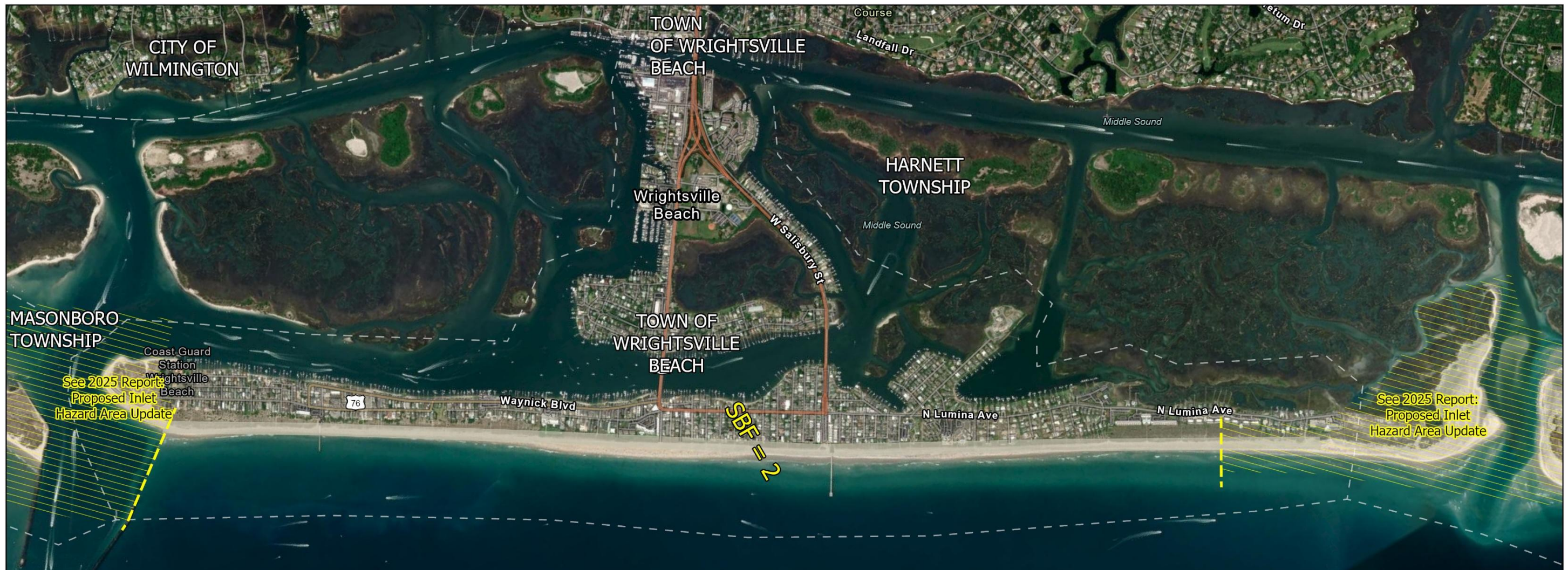
- OEA Setback Factor Transition Boundary
- OEA Setback Factors
- - - Proposed IHA Alongshore Boundary (2025)
- //// Proposed IHA Boundary Update (2025)



2023 Imagery

State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Maxar

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2025 Ocean Erodible Area (OEA) Setback Factors Wrightsville Beach

Legend

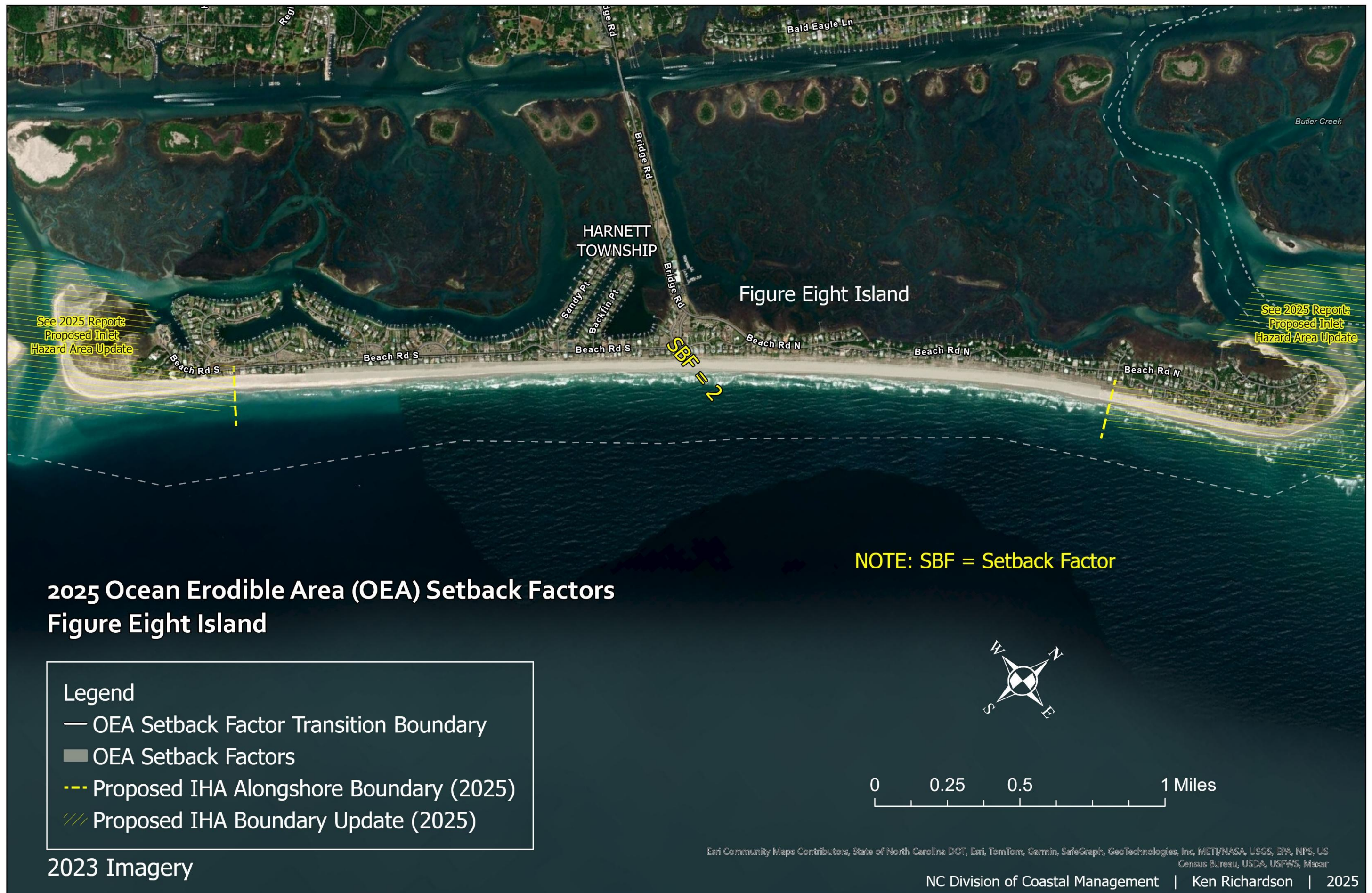
- OEA Setback Factor Transition Boundary
- OEA Setback Factors
- - - Proposed IHA Alongshore Boundary (2025)
- /// Proposed IHA Boundary Update (2025)

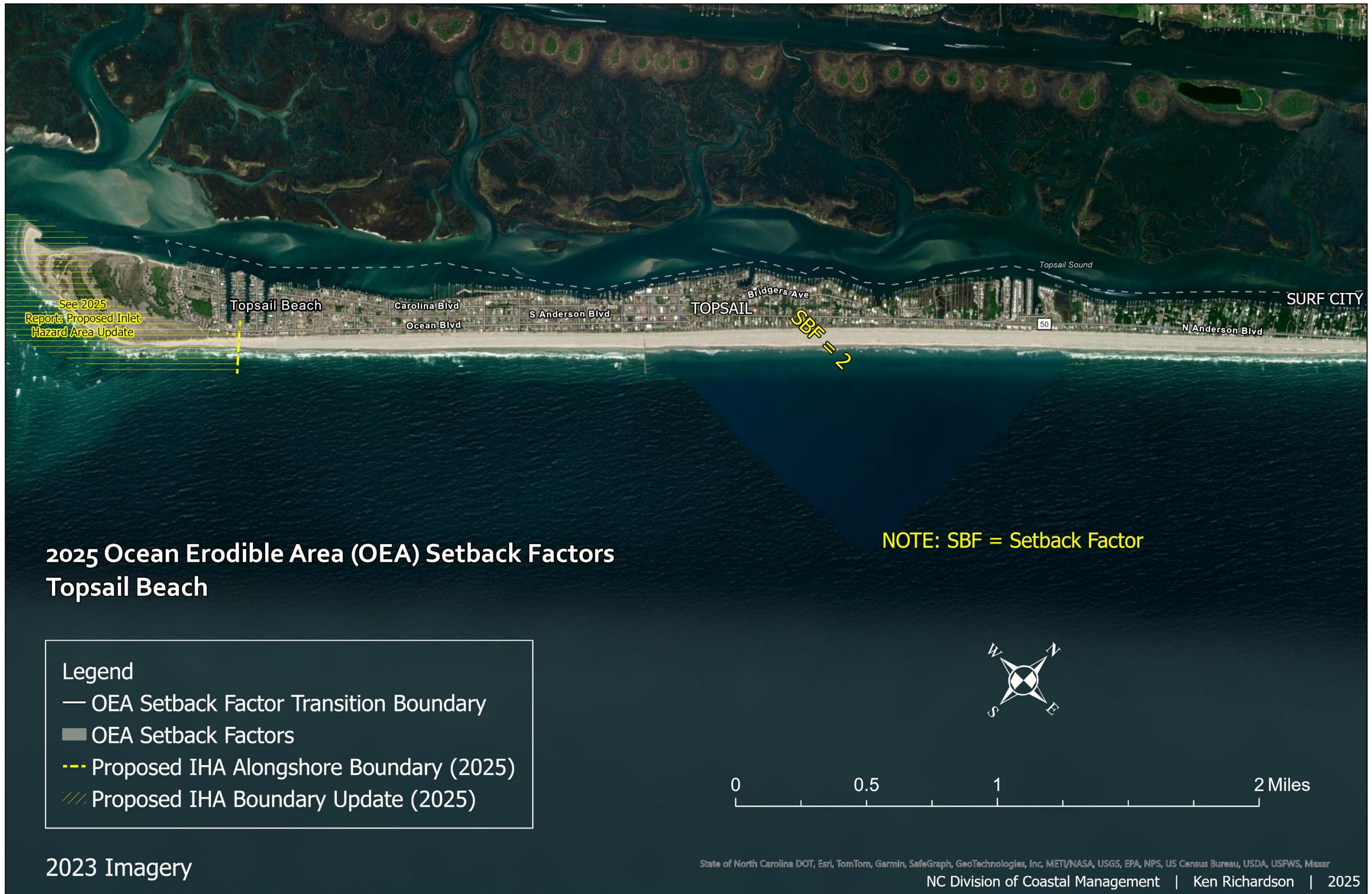
2023 Imagery

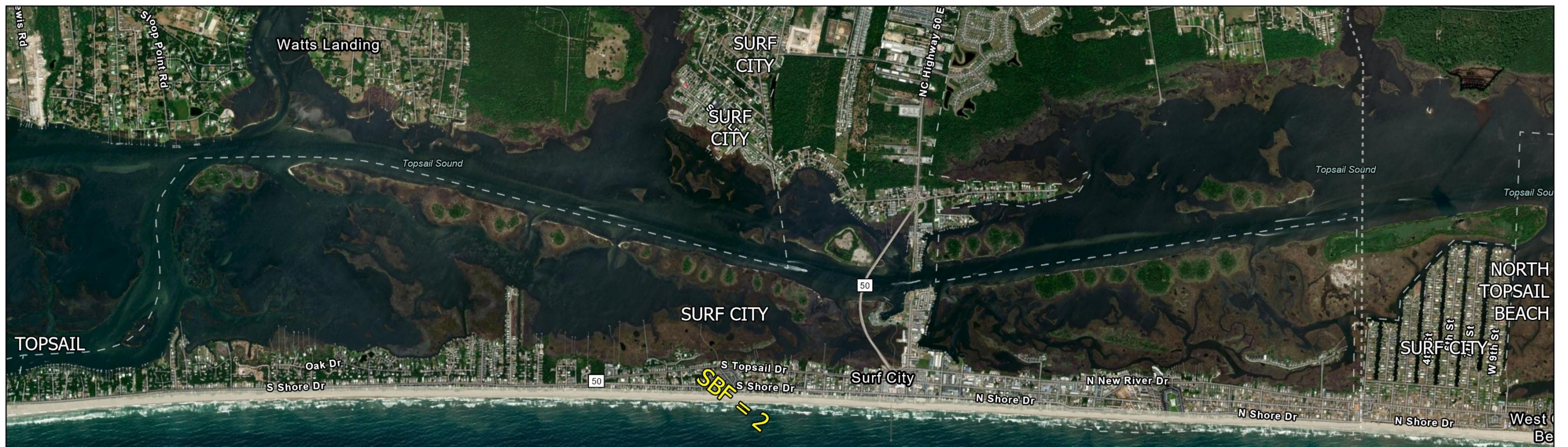
NOTE: SBF = Setback Factor



State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Maxar







2025 Ocean Erodible Area (OEA) Setback Factors Surf City

NOTE: SBF = Setback Factor

Legend

- OEA Setback Factor Transition Boundary
- OEA Setback Factors

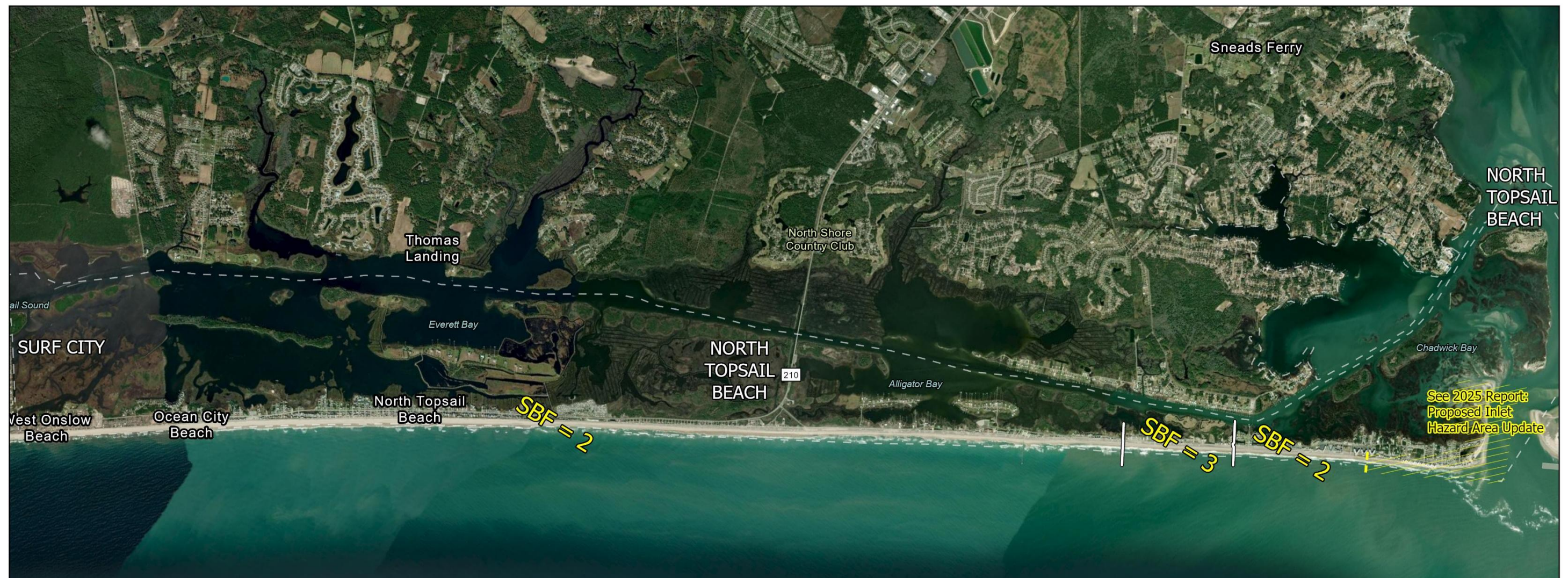


0 0.5 1 2 Miles

2023 Imagery

State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Maxar

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2025 Ocean Erodible Area (OEA) Setback Factors North Topsail Beach

NOTE: SBF = Setback Factor

Legend

- OEA Setback Factor Transition Boundary
- OEA Setback Factors
- - - Proposed IHA Alongshore Boundary (2025)
- //// Proposed IHA Boundary Update (2025)

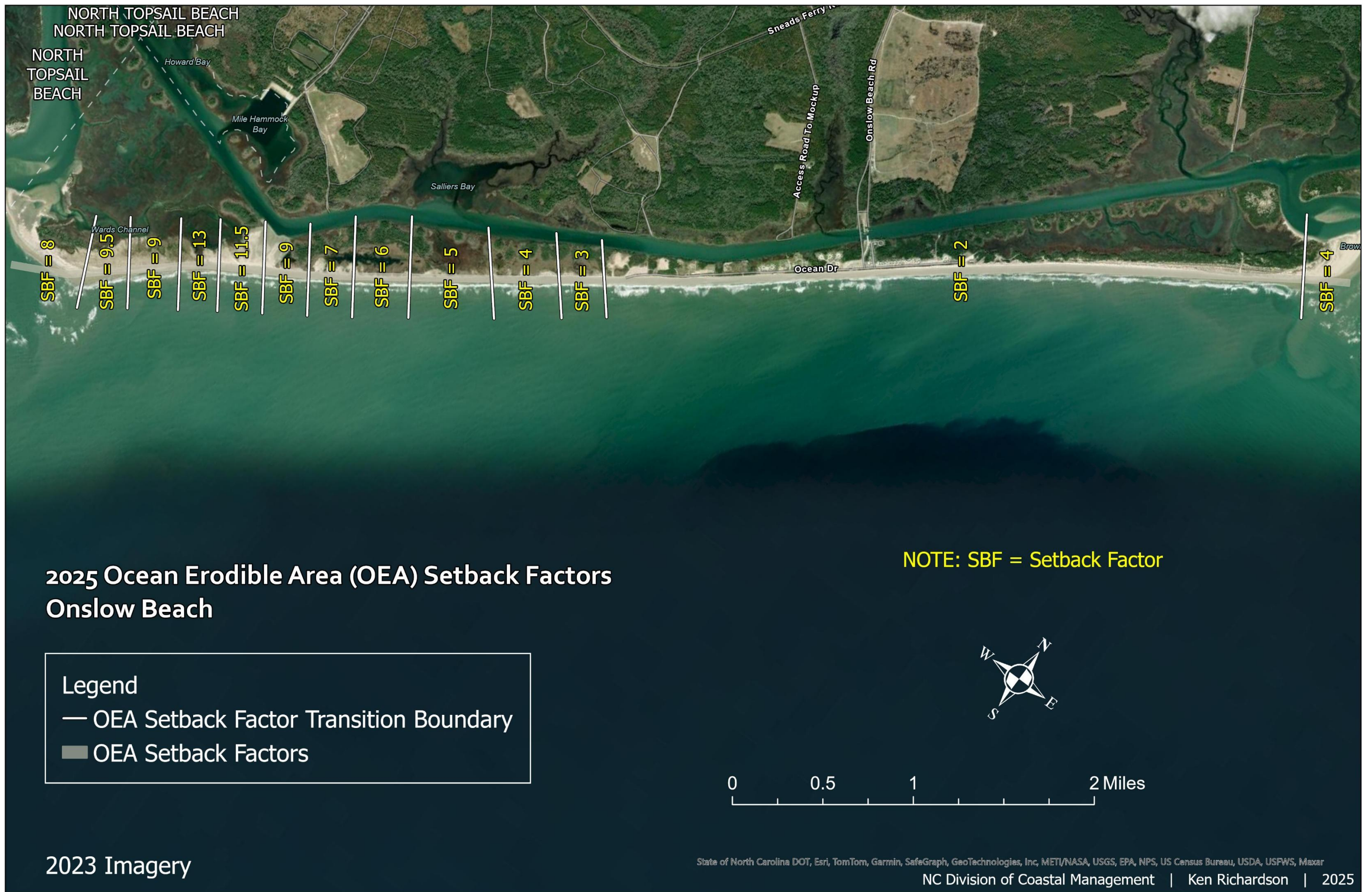
2023 Imagery

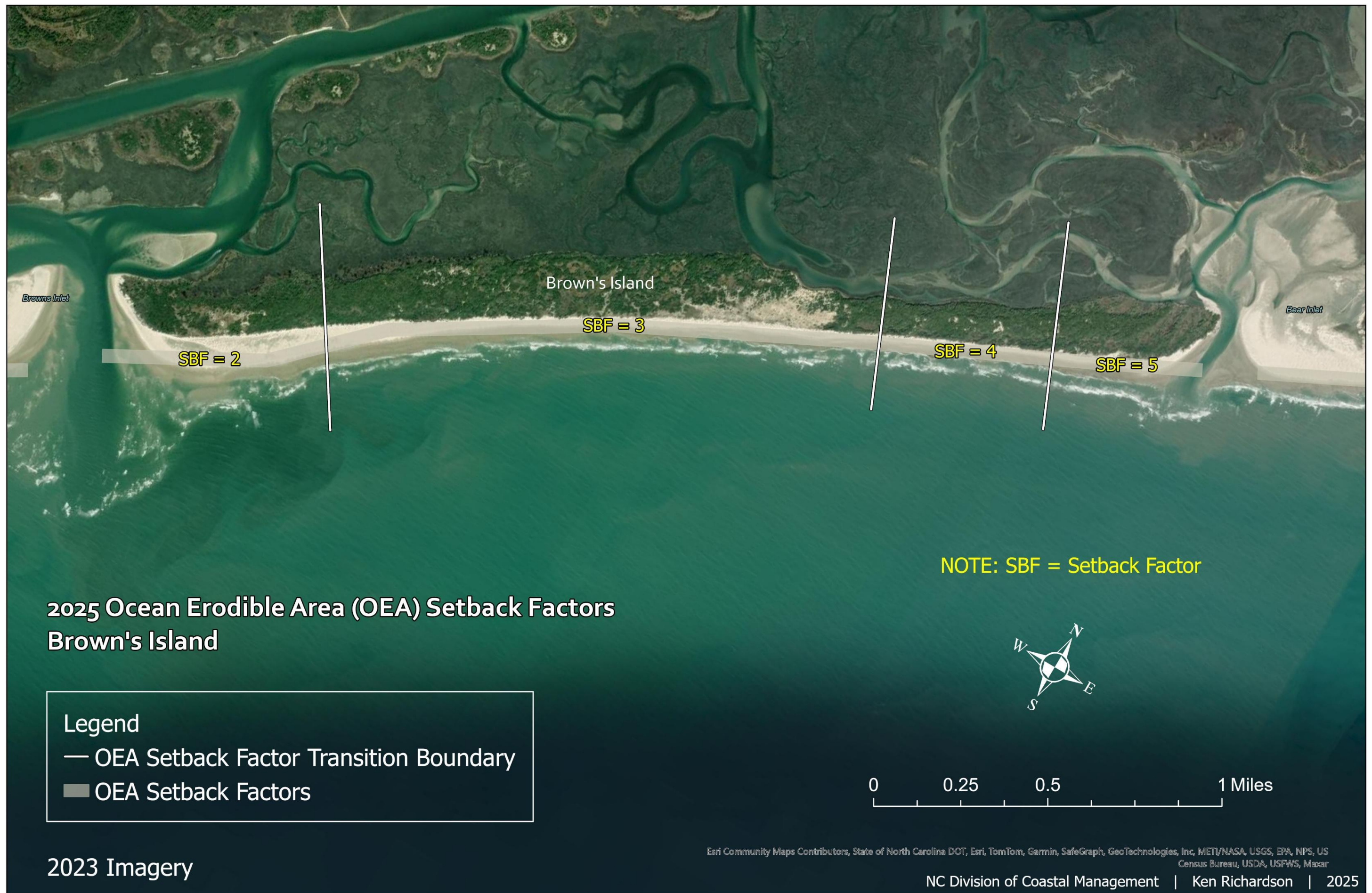


0 1 2 4 Miles

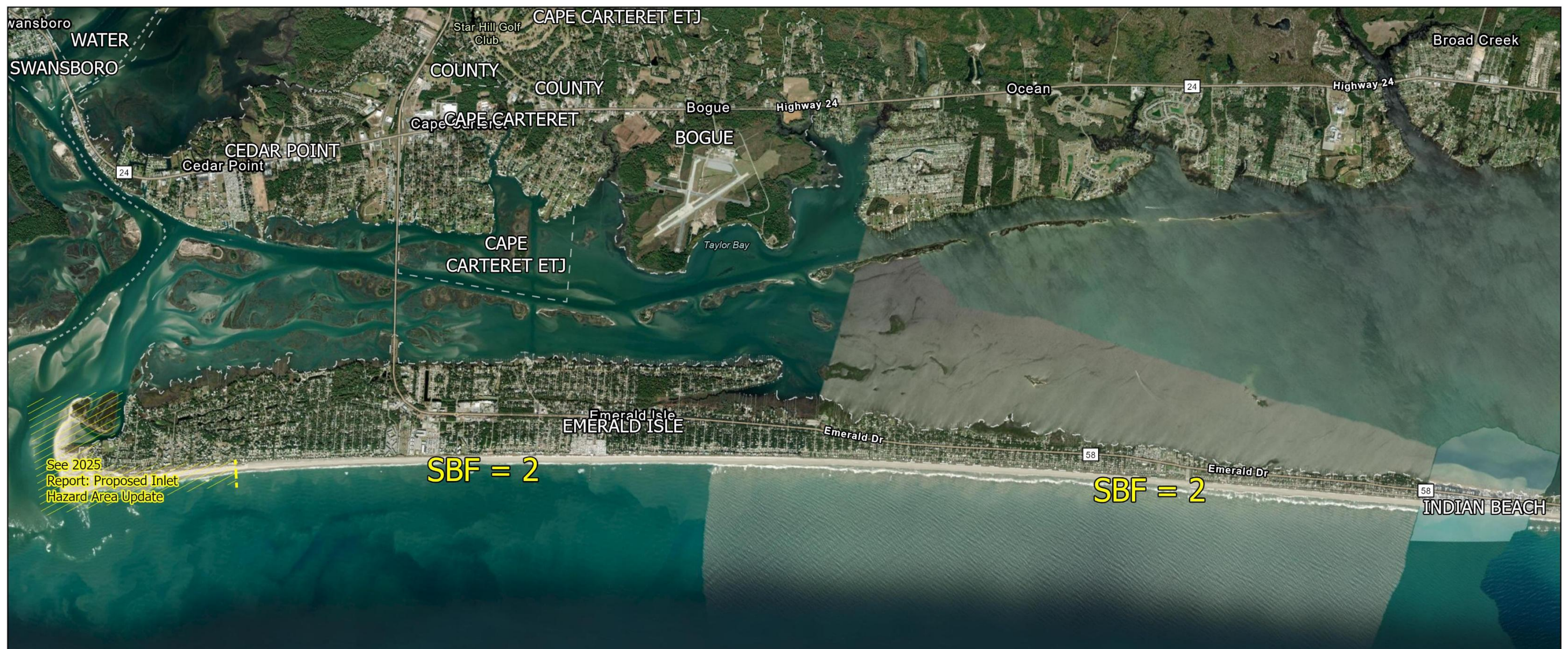
State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS, Maxar

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2025 Ocean Erodible Area (OEA) Setback Factors Emerald Isle

Legend

- OEA Setback Factor Transition Boundary
- OEA Setback Factors
- - - Proposed IHA Alongshore Boundary (2025)
- /// Proposed IHA Boundary Update (2025)

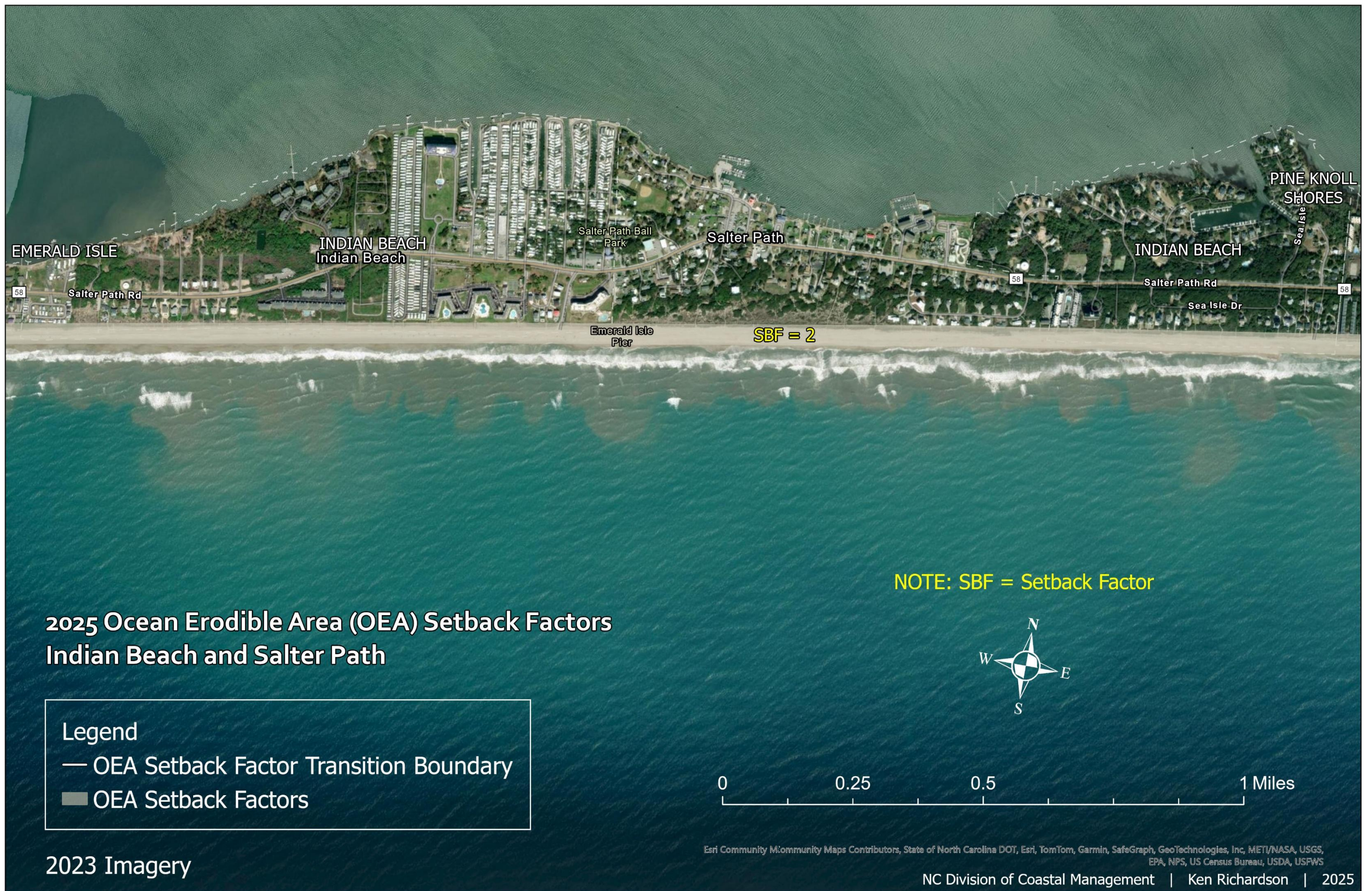


0 1 2 4 Miles

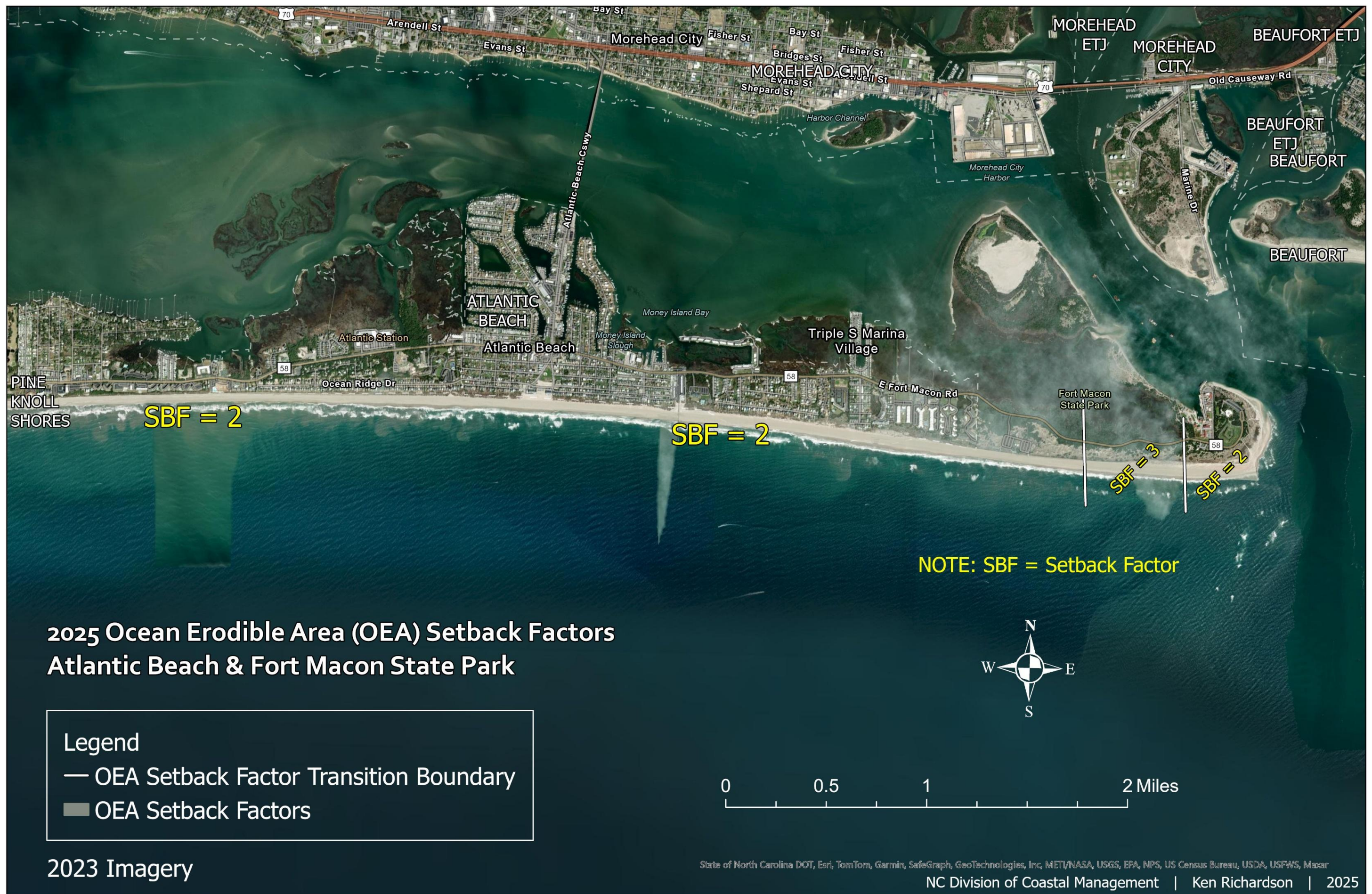
2023 Imagery

State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS, Maxar

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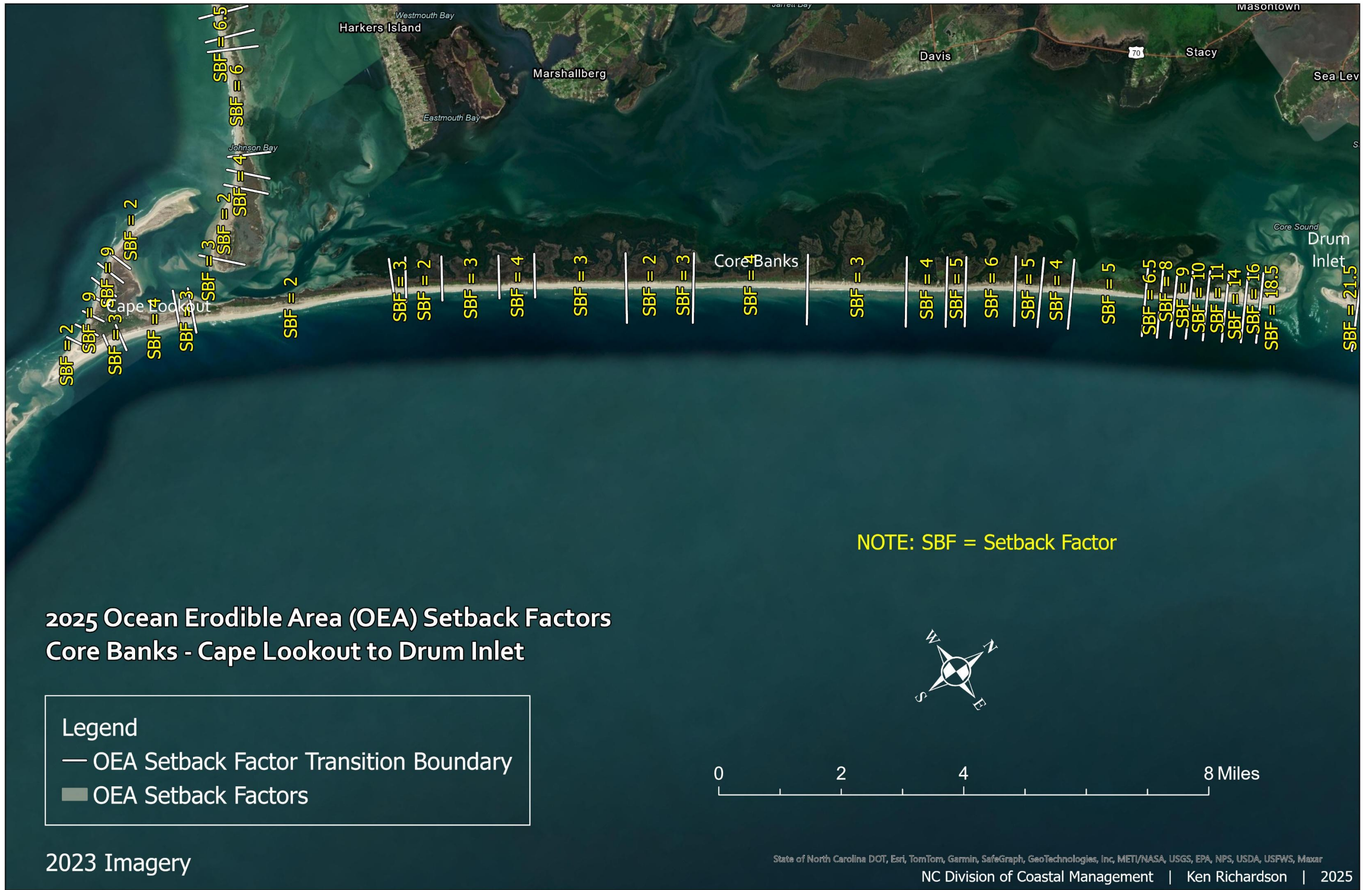


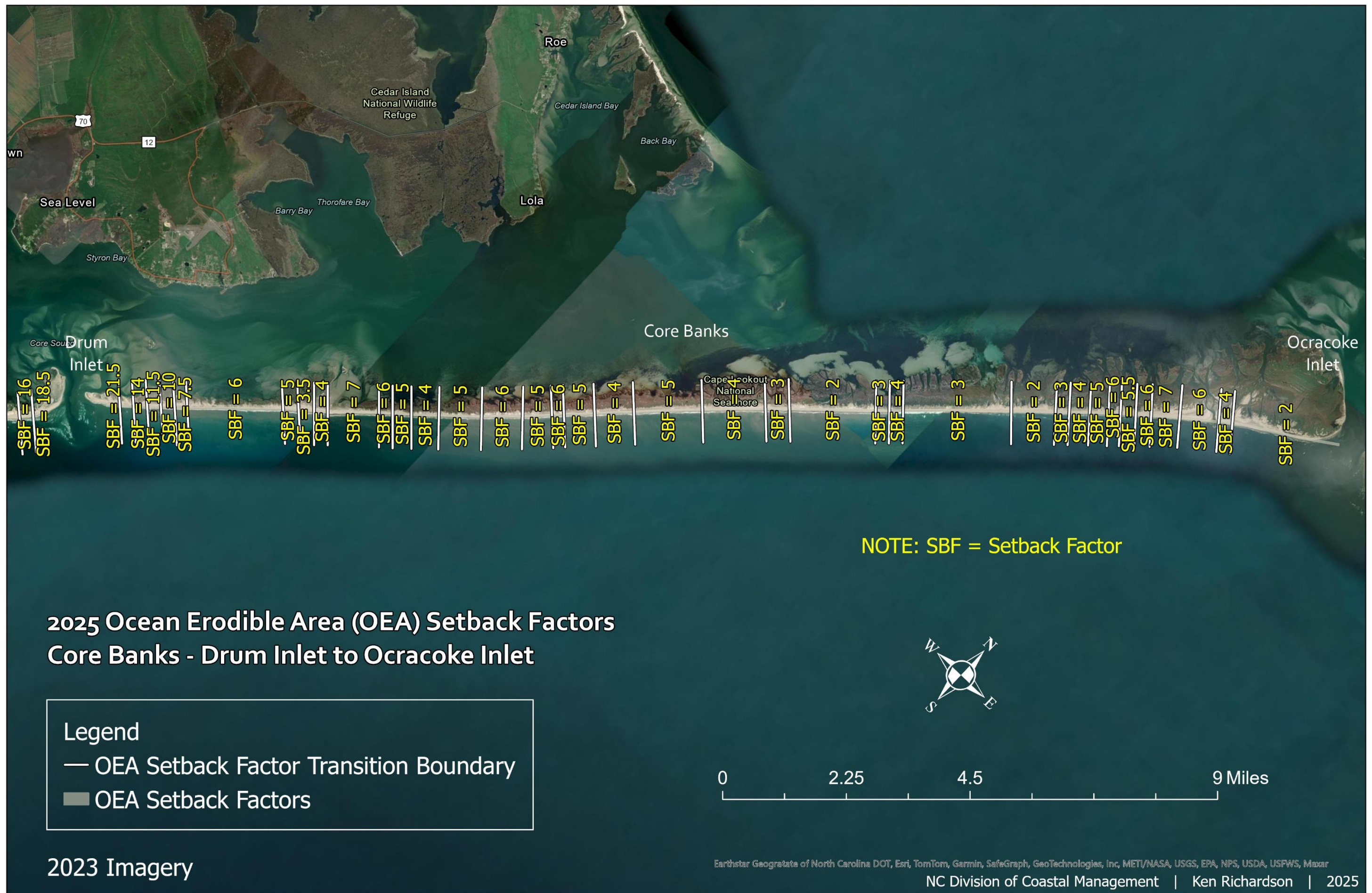


State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Maxar

NC Division of Coastal Management | Ken Richardson | 2025









Hatteras Inlet

SBF = 12.5

SBF = 15

SBF = 13

SBF = 9

SBF = 4

SBF = 2

SBF = 3

NOTE: SBF = Setback Factor

2025 Ocean Erodible Area (OEA) Setback Factors Hatteras Village at Cape Hatteras

Legend

—

OEA Setback Factor Transition Boundary

■

OEA Setback Factors



2023 Imagery

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NC Division of Coastal Management | Ken Richardson | 2025





2025 Ocean Erodible Area (OEA) Setback Factors Cape Hatteras to Buxton

NOTE: SBF = Setback Factor

Legend

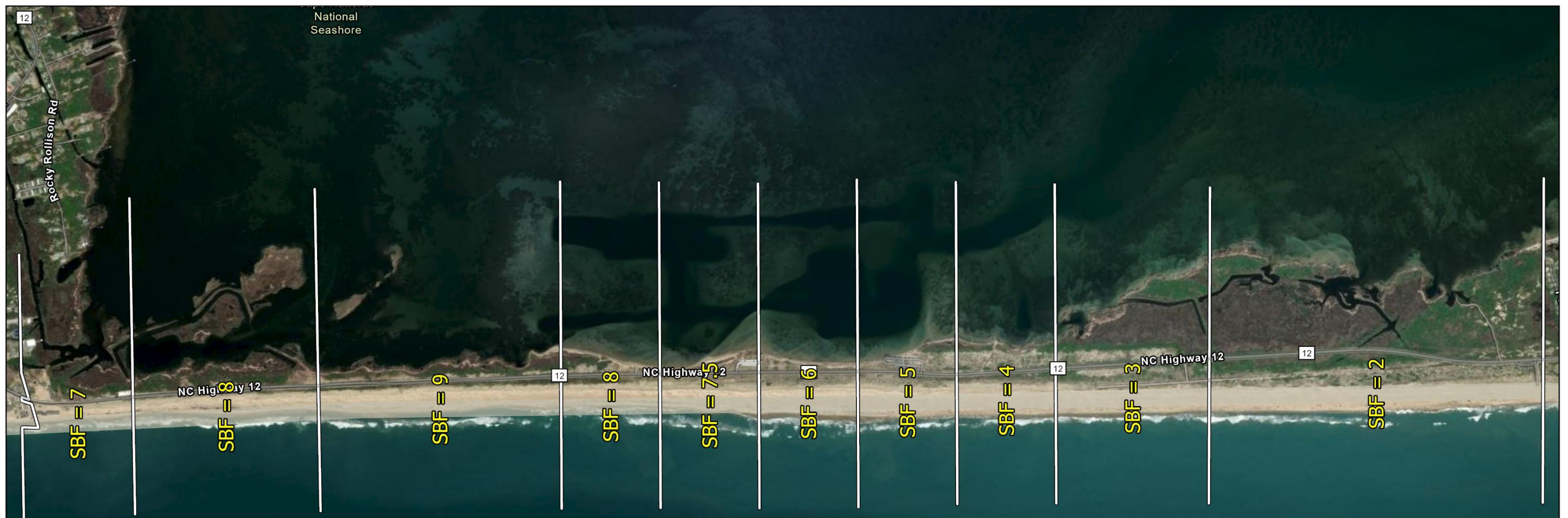
- OEA Setback Factor Transition Boundary
- OEA Setback Factors



2023 Imagery

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NOTE: SBF = Setback Factor

2025 Ocean Erodible Area (OEA) Setback Factors National Seashore (Buxton to Avon)

Legend

- OEA Setback Factor Transition Boundary
- OEA Setback Factors

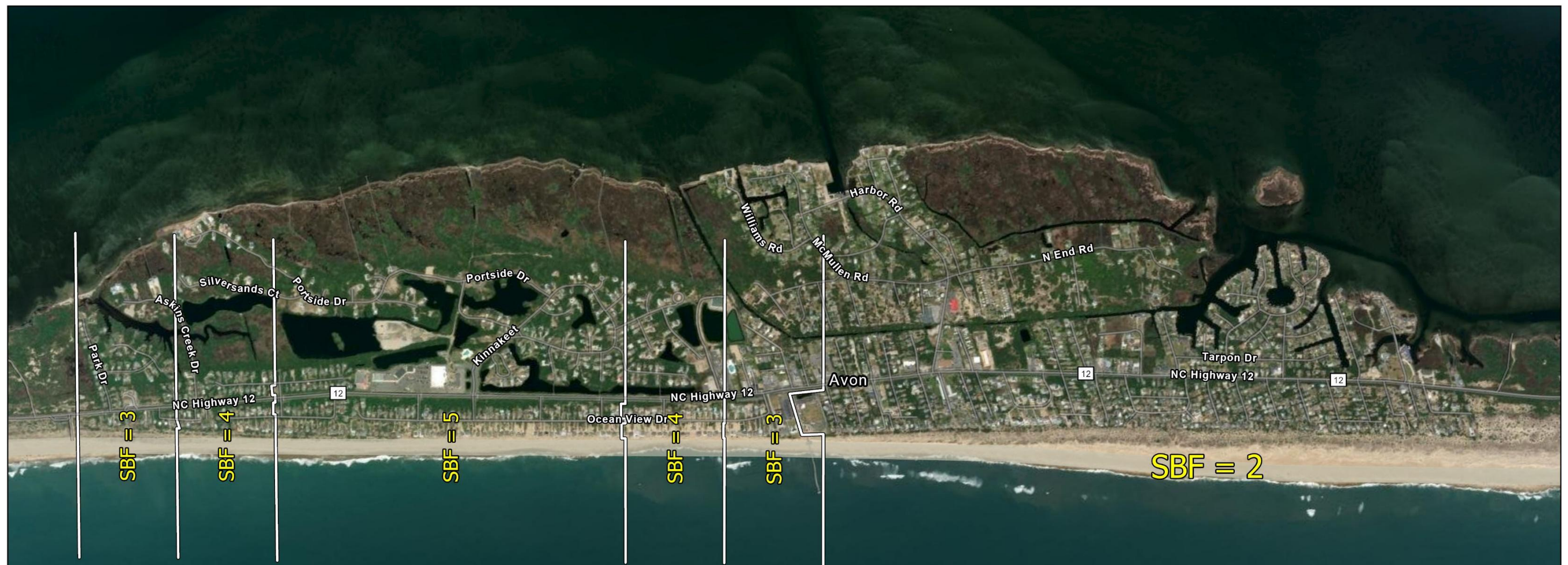
2023 Imagery



0 0.25 0.5 1 Miles

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NOTE: SBF = Setback Factor

2025 Ocean Erodible Area (OEA) Setback Factors National Seashore (Avon)

Legend

- OEA Setback Factor Transition Boundary
- OEA Setback Factors

2023 Imagery



0 0.25 0.5 1 Miles

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