



SHORELINES – December 2008

As presented to the *Island Review Magazine*

What is Beach Erosion?

Beach erosion – it's an expression casually used, but what do we really mean when it becomes the subject of a public meeting or a morning coffee table discussion? Actually the textbook definition of beach erosion is, *"The physical removal of sand from the beach which is transported offshore, alongshore, or into bays and lagoons via inlets. Erosion results in shoreline recession – landward retreat of a shoreline indicator such as the high water line, vegetation line, of dune line."* And obviously erosion is the opposite of accretion, which is defined as, *"The deposition of sediment, usually sand, which is evident by the seaward advance of a shoreline indicator, such as the high water line, berm crest, or vegetation line. Accretion causes the beach to become wider."*

By just taking a cursory look at these definitions, we can already begin to see some conflicts beginning to surface beyond the fundamental premise that if beaches erode – they lose sand; if they accrete – they gain sand. For instance, what landmark(s) are we going to use to track shoreline changes? - the mean high tide line?, the vegetation line?, or the top of the dune? What methods do we need to employ to continually track the landmarks we choose? And finally, besides tracking the landward or seaward migration of our landmarks, how do we determine an overall volume of sand we are losing or gaining?

As you may expect, there are no easy answers or one ultimate approach to address these questions. And as with everything, time and money constraints also come into play. So with this framework in mind, we're going to briefly discuss the current state of affairs concerning beach erosion.

Landmarks and Measurements

The most common landmark to track is the "high water line", which is also often considered as the mean high water line, representing the average of all the high water heights observed over the National Tidal Datum Epoch. This is an important "line in the sand" because the State of North Carolina utilizes the high water line to establish erosion rates for the entire coast, which is subsequently used in determining oceanfront building setback requirements. Monitoring the high water line also provides us a consistent way to determine when the shoreline is encroaching on dunes and infrastructure.

The State (Division of Coastal Management) first evaluated long-term average erosion rates in 1979, and tries to update the dataset every five years by obtaining new aerial photographs of the ocean shoreline. The photographs depict the high water line, or the edge of the wet sand visible on the photographs, where it is consequently marked. Its position (relative to a fixed baseline) is added to an existing database and an average long-term erosion rate is generated by comparing the current shoreline position to the earliest available position and dividing the distance by the number of years that have passed between photography dates. Thus, if the 1992 shoreline is compared with the 1942 shoreline, then the distance the shoreline has moved is divided by 50. If the difference



between 1942 and 1992 is 200 feet, the long-term average erosion rate is 4 feet per year. The most recent shoreline erosion rates were adopted in 2004 and utilized a series of 1998 photographs (http://dcm2.enr.state.nc.us/Maps/SB_Factor.htm).

To add some conjecture and no offense to our good friends at the Division of Coastal Management; I've personally never been a big fan of the State's method – there's just simply too much subjectivity involved and they do not obtain state of the art data. The aerial photos have to be taken on a crystal clear day which trumps an important concern relating to tidal or other events imposed on the wet/dry line such as spring tides, or another event resulting in higher or lower than normal water at the time the photos are taken (e.g., long period waves or a couple days after a major storm). Even if the weather and sea conditions are perfect, then someone has to manually look at the photos, squint a little, and pick exactly where the wet/dry line resides – that doesn't quite live up to the principles of the scientific method whereby results obtained through observations and/or experiments are ones that anyone can reproduce. In some instances, you could have three different persons looking at the same aerial photograph and picking three different wet/dry lines. Granted, the differences may only result in a few feet, but those differences add up cumulatively over the years of records (3 feet perhaps of error in 1998, 4 feet in 1979, another 3 feet of error in the 1946 dataset, etc.), and can especially make a difference in areas where erosion/accretion rates are low. Additionally, the last dataset is from 1998 – that's more than a decade ago.

To be fair however, the State hasn't designated the financial resources to use other methods of shoreline monitoring that extrapolate topographical/bathymetric data. The latest rounds of beach nourishment throughout the State have also added a layer of complexity – has a beach really "accreted" if the area received millions of cubic yards of sand the year prior to the aerial photograph? And finally, even though there is subjectivity in the "wet/dry line" analysis, the results have been consistent with other methods.

For Carteret County we utilize what can be called as the profile approach – since 1999 we have established 123 shore-perpendicular profiles along Bogue Banks, which are spaced roughly 1,000 feet apart from one another (Fig. 1 and 2). Professional surveyors are retained to collect elevation measurements (both topography and bathymetry) along each profile in May or June each year. These data are subsequently used to generate a graphic depiction of the beach profile (cross-section). Older surveys can be superimposed on the most recent profile data as well to calculate differences not just along one contour such as the high water line, but multiple landmarks (Fig. 3). Another advantage of this system is that we can generate a "datum-derived shoreline". So rather than trying to interpret where the wet/dry line exists on a photo, we can use an elevation of let's say +2 foot above sea level to serve as the mean high water line, and find exactly where that elevation resides along the profile. We can select other datums to monitor as well, such as +7 feet for the berm crest, or +9 feet as the toe of the dune, etc.

The main disadvantages to this system include cost, which is significantly more than aerial photography, and there is some interpretation that has to occur between profiles (i.e., the +2 feet elevation along one profile has to be connected/interpreted to the +2 feet elevation mark on the next profile a 1,000 feet down the beach. But one of the main

advantages of the profile approach is the ability to not only monitor contours, but to calculate volumetric losses and gains as well. The volume of sand along a profile can be compared to data obtained during future and past surveys and quantitatively, we can determine how much sand a beach is gaining or losing, e.g., we lost 10,000 cubic yards of sand this year in Indian Beach. Likewise, we can also use the volumetric approach to track our beach nourishment projects as well. For instance, if we place 1,000,000 cubic yards of sand on the beach one year and this same area of the beach loses 100,000 cubic yards the next year; we can grossly conclude that 90% of the beachfill is still in place.

Ideally and in perfect world, the State would establish its own dense network of profiles and conduct annual surveys that would be made available to the public. Aerial photos would then be used to help augment the profile data and provide a graphical reference for the data as well. A State profile network could also be used as a baseline for the entire coast to be used for nourishment project benchmarking or if a community needs to conduct their own surveys on a more routine basis. In the future, air- or land-based LIDAR or other remotely sensed data acquisition systems may provide a better cost alternative while yielding very accurate data. But despite their advantages (coverage of large areas quickly), both of these aspects (cost or accuracy) need some work.

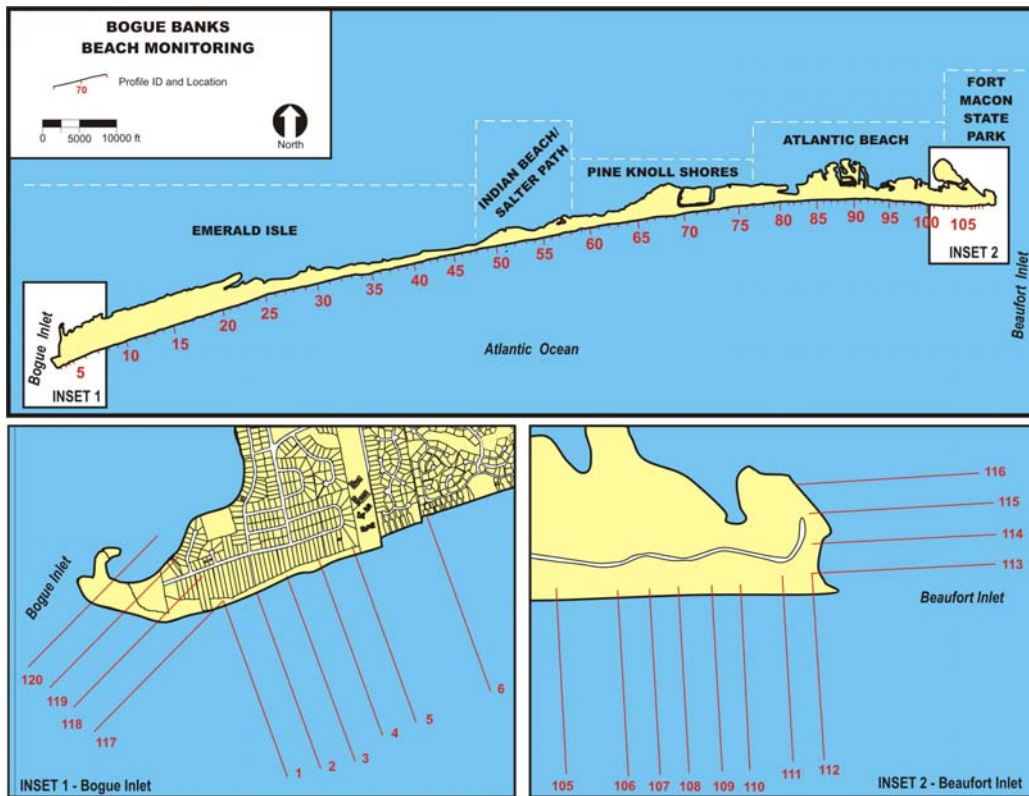


Fig. 1 – Site map identifying the 120 profiles positioned along Bogue Banks utilized for beach/nearshore monitoring purposes. Three profile locations were not included in this graphic.



Fig. 2 – A 2004 aerial photograph at the bath house, Ft. Macon State Park. Three of the County's profiles are positioned and labeled in the photograph in addition to multiple shorelines that have been traced using the wet/dry method described in this article (only the 1933, 1946, & 2004 pictures are labeled).

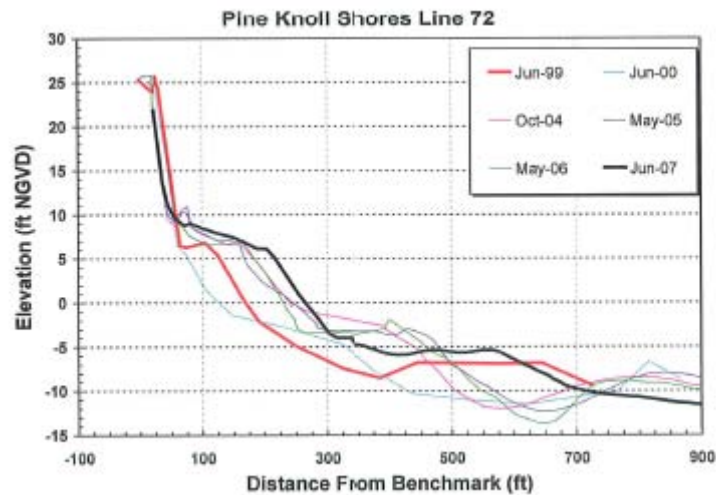


Fig. 3 – Graphic depictions of profile data obtained at the Memorial Park Access in Pine Knoll Shores. Notice how much sand was lost (eroded) between the June 1999 (red line) and June 2000 (baby blue line) datasets; the interval when hurricanes *Dennis* and *Floyd* impacted Bogue Banks. Compare these lines with the June 2007 black line - after nourishment (black line).