SHORELINES – October 2016

State of the Beach (2016)

In late August, the engineering firm of Moffatt & Nichol provided the Carteret County Beach Commission a presentation highlighting the results of a comprehensive beach survey conducted along Bogue Banks. The survey, or "monitoring event" was completed during the March to May 2015 timeframe and included our neighboring islands to the east and west of Bogue Banks as well - Shackleford Banks and Bear Island, respectively.

So what exactly constitutes a beach survey? We can trace the origins our program to 1999 when 111 shore-perpendicular profiles were established along Bogue Banks to gain baseline information and begin assessing the overall health of the beach in the wake of the hurricanes that impacted the region in the decade of the 1990s – most notably *Bertha* (1996), *Fran* (1996), *Bonnie* (1998), *Dennis* "1 & 2" (1999), and *Floyd* (1999). Elevations of the dry and underwater (nearshore) portion of the beach have been obtained along these same profiles on a routine basis since 1999 and these measurements have been utilized to monitor two important beach parameters that will be discussed in more detail below – **(1)** the **volume** of sand residing in the beach system, and **(2) shoreline** movement.

The monitoring program has grown since its formative years and now includes 122 profiles along Bogue Banks (Fig. 1), in addition to 24 profiles along Shackleford Banks, and 18 along Bear Island. The beaches are ideally surveyed in the "pre-hurricane season" timeframe prior to July of each year.

As implied above, the monitoring program has continued to serve several very important functions, including; **(A)** Establish a monitoring network to determine volume deficiencies during formulation of the Bogue Banks Restoration Project (early 2000s) and future nourishment efforts, **(B)** Help assess the volume of sand lost during Hurricanes *Floyd* (1999), *Isabel* (2003), *Ophelia* (2005), and *Irene* (2011); and where applicable, obtain FEMA reimbursement to replace the sand lost during many of these disasters, **(C)** Serve as spatial control during beach construction events, **(D)** Assess the fate of various beachfills constructed along Bogue Banks since 2001, **(E)** Provide a method to determine the overall condition (health) and changing geomorphology of Bogue Banks and adjacent islands, and **(F)** Serve as the primary database foundation in formulating the Bogue Banks "Master Plan".

However in the more immediate term; if we compare the 2016 survey to that of the year prior (2015); we are capturing ALL of the events/storms transpiring during this yearlong time period and their impacts to those two important parameters introduced above - volume change and shoreline change. It would be cost-prohibitive to survey after each and every individual storm, thus we have to make inferences to what "minor" events triggered episodes of erosion and accretion throughout the year.

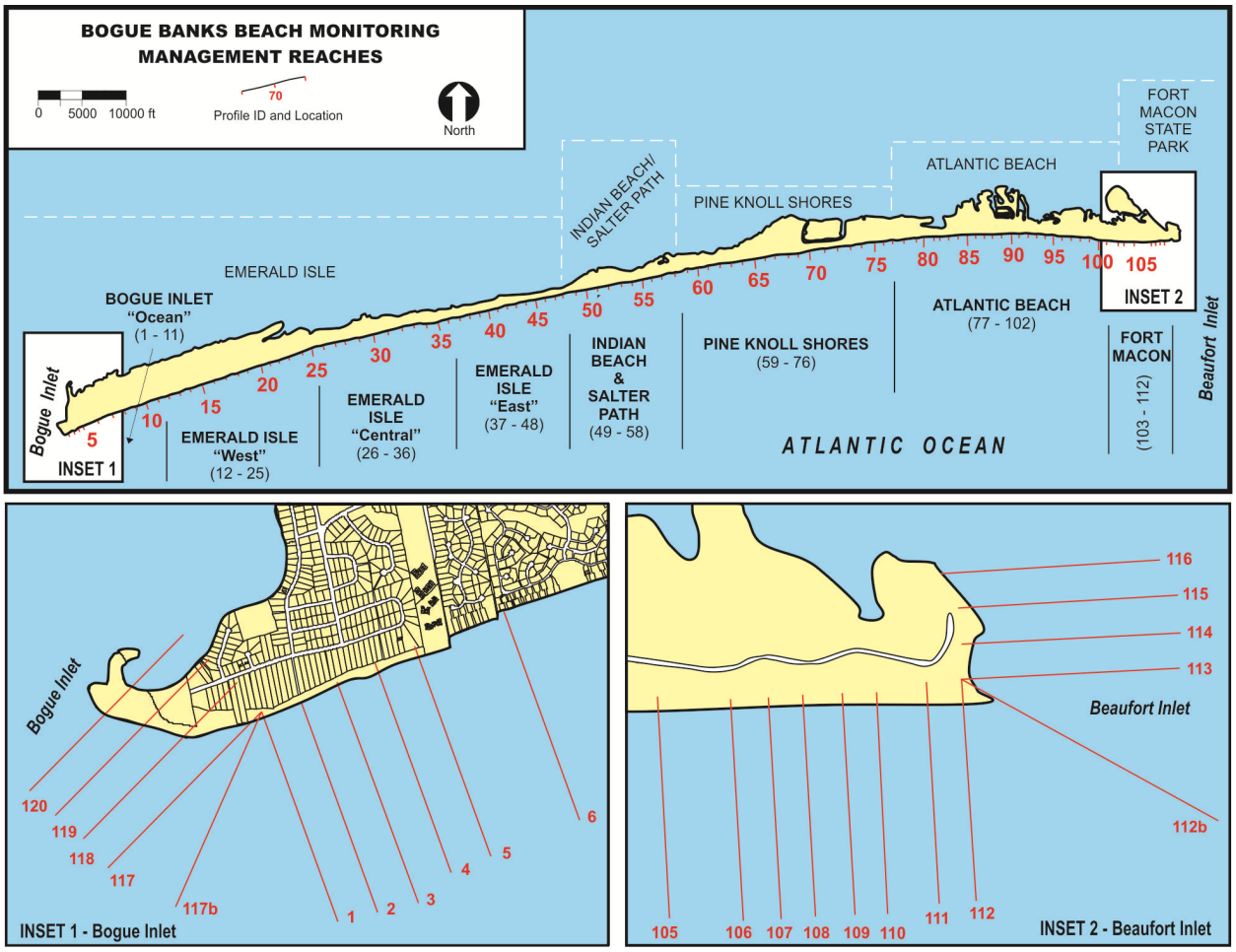

Figure 1 – Site map depicting the location/identification scheme of the 122 profiles positioned along Bogue Banks utilized for beach/nearshore monitoring purposes.

Results (Volume and Shoreline Changes)

One of the means to quantify beach health is to compare the volume of sand lost or gained over time along Bogue Banks and the adjacent islands. Engineers often use the measuring unit of a ***cubic yard (cy)*** to describe volume change, which can be envisioned as a 3 ft. by 3 ft. by 3 ft. block of sand, or 27 ft^3. A standard dump truck holds roughly 15 cubic yards of dry sand as a convenient mental image.

To this effect, we rely heavily on a "credit – debit" approach with respect to our overall beach management philosophy and to track volume change throughout time. During the 2015-16 survey period Bogue Banks did not experience any particularly notable "debits" in the form of tropical cyclones (hurricanes/tropical storms), nor winter storms. And likewise no large "credits" were realized in the past year either, with the exception of roughly 150,000 cy of sand that was placed near the Ft. Macon Bathhouse Regional Access area as part of Marinex Construction's December 2015 retrieval operation of a buried pipe located in the Morehead City Harbor Navigation Channel.

The "volumetric approach" has been a primary tenet of our beach monitoring program, and the 128,393 linear feet of oceanfront along Bogue Banks (profiles 1 – 112, figure 1) lost -324,867 cy of sand in 2015-16, equating to an average loss of -2.5 ***cy per linear foot (cy/ft)***. 2015-2016 therefore could be considered as a "typical" year – our long-term, 17-year (1999 – 2016) annual erosion rate is -2.7 cy/ft, again averaged across Bogue Banks examining the beach in cross section from the outer bar landward past the recreational beach area and up into the frontal dune. Interestingly however; the average shoreline position nudged slightly seaward (in the positive direction) by +3 feet in 2016.

By now you might be questioning why and how did the island lose sand last year but the shoreline crept seaward (???). We have to view the beach in cross-section and realize we normally reference the compartment encompassing volume changes above **-12 ft. NAVD88** to help make the data more manageable/understandable and to consistently measure change over time. Although we extend our surveys much deeper, the zone above –12 ft. NAVD88 can be considered as the main "shock absorber" for storms and undergoes the most change from year to year (Fig. 2).

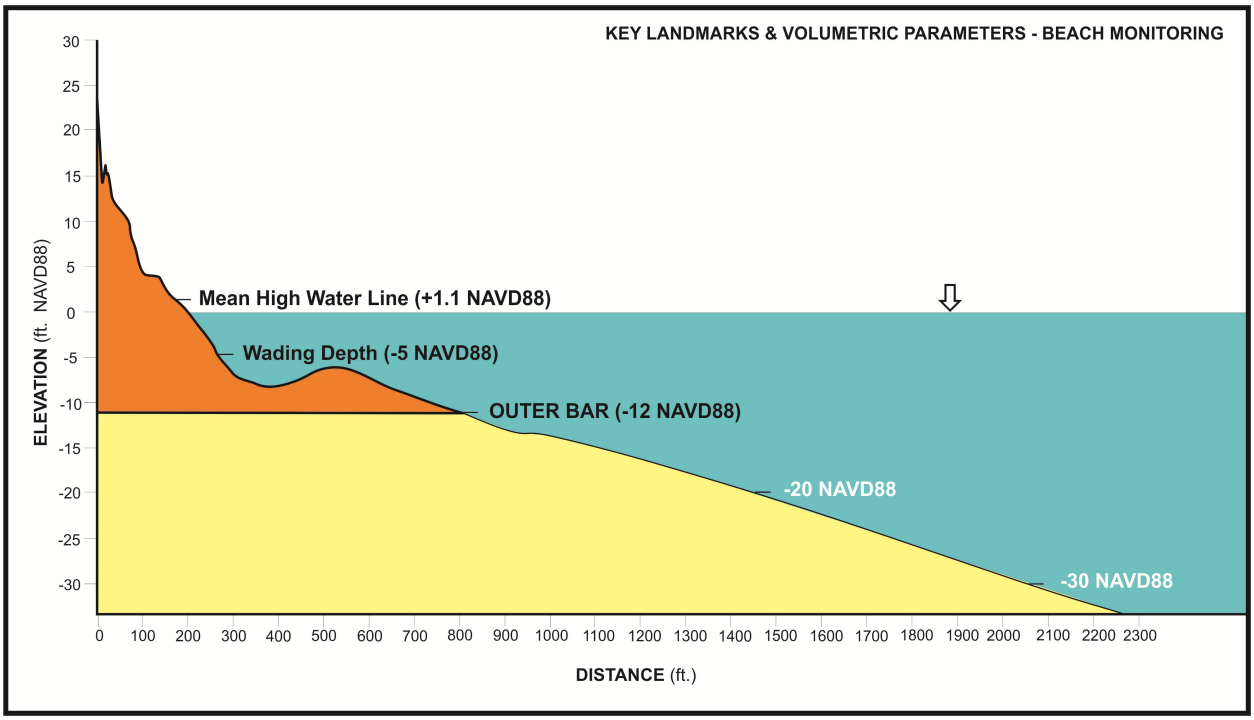

Figure 2 – Characteristic Bogue Banks profile in cross-section depicting the key "landmarks" monitored for changes in sand volume. Although changes are recorded above each of the landmarks depicted in the figure, the orange-colored fillet represents the positive or negative changes occurring at the elevation above "-12 ft. NAVD88", and is utilized as a common reporting baseline.

For 2015-16, sand moved from the zone in between the "Wading Depth" and "Outer Bar" to just past (deeper) the -12 ft. NAVD88 benchmark. Some sand from this same zone (between "Wading Depth" and the "Outer Bar") also moved up the beach profile and welded itself to the beach and dunes – hence why the shoreline advanced forward but from a mass balance perspective; we "lost" sand (see Table 1). Of course sand also moves in a shore parallel direction as well in between profiles. However, we do not think there is much sand from a gross standpoint that migrated (and stayed) from one management reach to the

other. In other words, we did not experience a large loss in one management reach coupled with a significant gain in an adjacent reach.

Reach	Profiles	Linear Feet	Average Shoreline Change (May 2015 - May 2016)	Average Volume Change (May 2015 - May 2016)
Bogue Inlet - Ocean	1 - 11	11,488	+22 feet seaward (+)	+1 cubic yard / linear foot
Emerald Isle - West	12 - 25	18,288	+6 feet seaward (+)	-3 cubic yard / linear foot
Emerald Isle - Central	26 - 36	15,802	-9 feet landward (-)	-3 cubic yard / linear foot
Emerald Isle - East	37 - 48	13,220	+6 feet seaward (+)	-7 cubic yards / linear foot
Indian Beach/Salter Path	49 - 58	12,850	+10 feet seaward (+)	-3 cubic yards / linear foot
Pine Knoll Shores	59 - 76	23,878	-5 feet landward (-)	-2 cubic yards / linear foot
Atlantic Beach	77 - 102	26,176	-5 feet landward (-)	-9 cubic yards / linear foot
Ft. Macon State Park	103 - 112	6,691	+34 feet seaward (+)	+28 cubic yards / linear foot
Totals or Average =	**112**	**128,393**	**+3 feet seaward (+)**	**-2.5 cubic yards / linear foot**

Table 1 – Average shoreline and volume change from May 2015 to May 2016 for eight oceanfront reaches positioned along Bogue Banks. Notice the impact of the ~150,000 cubic yards placed along Ft. Macon during the reporting period.

As a quick note with respect to shoreline change - the "shoreline" is determined as the mean high water elevation established at +1.1 ft. NAVD88 (Fig. 2). This measurement parameter is sometimes referred to as a "datum-derived shoreline" as we can numerically determine where along a profile the +1.1 feet elevation resides rather than depending upon more subjective determinations that are required by other methods, such as aerial photography (i.e., wet/dry line, the wrack line, etc.).

And lastly continuing on the concept of "cubic yards per linear foot" (cy/ft), the volume of sand residing along the entire island is significantly higher than our self-termed yardstick year of 1999, and is attributable to the many beach nourishment projects that have been constructed since 2001 (Fig. 3). All the island management reaches are also well in excess of our Master Plan "volumetric thresholds" -- or perhaps better conceptualized as beach nourishment triggers. Our Master Plan management reaches as depicted in Figure 1 were developed by; (A) evaluating dune/berm shape and height to group similar profiles into discrete reaches, and then (B) we subsequently utilized a 25-year storm event to model the volumetric needs in each of the new management reaches. Our 2016 management reach values in terms of average cy/ft and our minimum volumetric thresholds (i.e., nourishment triggers) are presented graphically in Figure 3 as well.

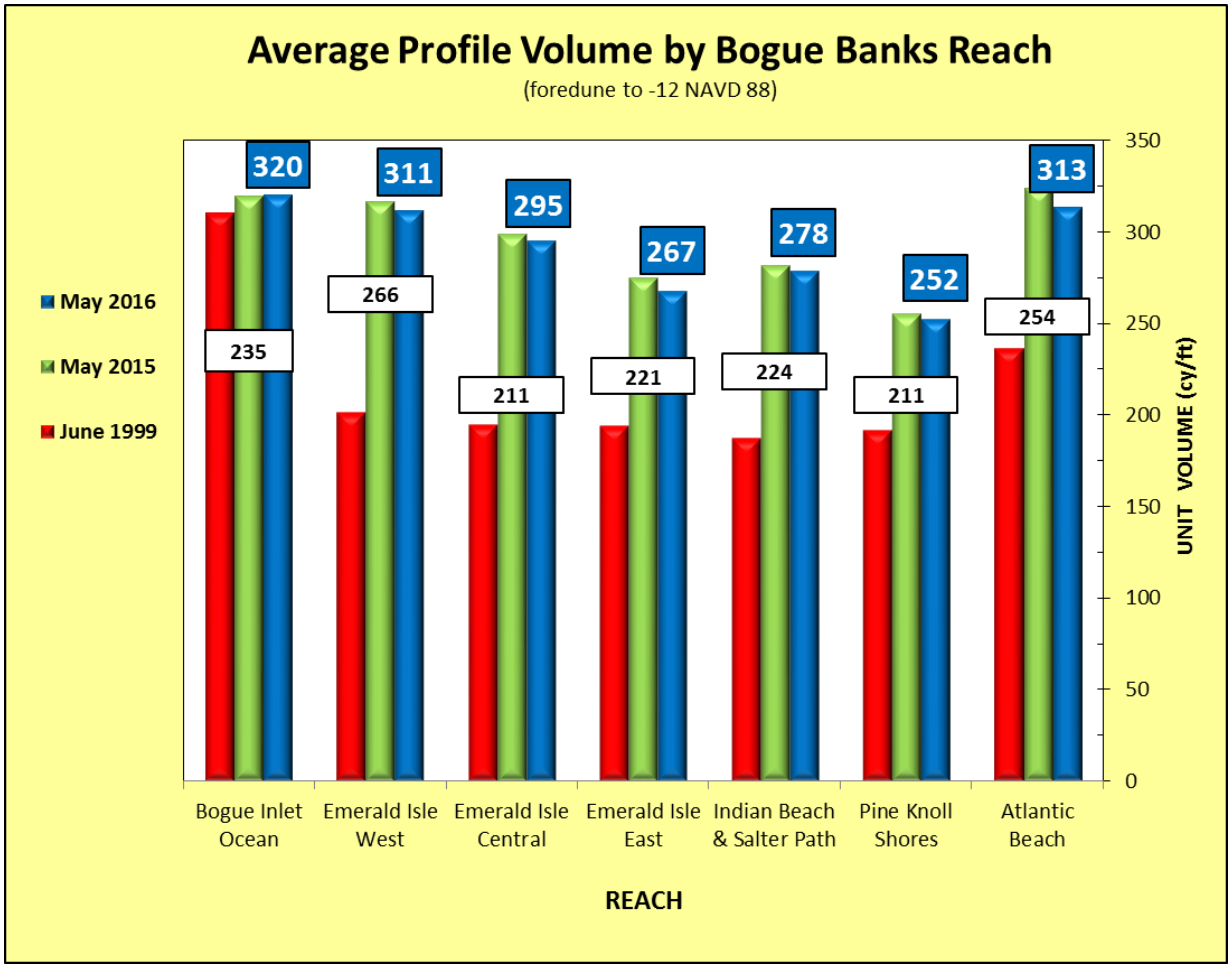

Figure 3 – Average profile volumes for September 1999 (baseline year), 2016 (the most recent survey), and 2015 (the immediately prior survey) for seven oceanfront management reaches along Bogue Banks. The minimum volumetric thresholds (i.e., nourishment triggers) are provided in the white call-out boxes with black font lettering while the 2016 average volume is represented in the blue call-out boxes with white font lettering.

This is obviously a brief review of the monitoring report, but don't hesitate to visit http://www.carteretcountync.gov/329/Monitoring if you would like more information regarding the report itself or the monitoring program in general.