SHORELINES – October 2018

As presented to the *Island Review* magazine

State of the Beach (2018)

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 over the course of several weeks during Spring 2018 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? Jokingly of course, we can't interview sand grains and ask them about their travels over the course of the year. Rather the origins of the program date back to 1999 when 111 shore-perpendicular transects were established along Bogue Banks to gain baseline information and begin assessing the overall health of the beach in the wake of the hurricanes impacting 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 transects on a routine basis since 1999 and these measurements are utilized to monitor two important beach parameters we will be discussing 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 transects along Bogue Banks (Fig. 1), in addition to 24 transects 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.

If we compare the 2018 survey to that of the year prior (Spring 2017); we are capturing all of the events/storms that transpired 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 may have triggered episodes of erosion and accretion throughout the year.

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. x 3 ft. x 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.

Accordingly, we rely heavily on a "credit – debit" volumetric approach with respect to our overall beach management philosophy and to track change throughout time. Debits are

usually in the form of hurricanes, tropical storms, or other high energy events that remove sand from the beach profile, while credits are almost always attributed to beach nourishment, or to the rare occurrence of storms actually moving sand up the beach profile as we observed with Hurricane *Matthew* in 2016. To these ends, from spring 2017 to spring 2018 we didn't experience notable episodes of "debit" or "credit" - i.e., there was no beach nourishment and although the 2017 hurricane season was "hyperactive" (Accumulated Cyclone Energy Index of 223), there were minimal impacts to Bogue Banks. There also was not a spate of spring storms like we experienced the year prior. 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) interestingly gained 894,195 cy of sand in 2017-18, equating to an average gain of +7.0 ***cubic yards per foot (cy/ft)***.

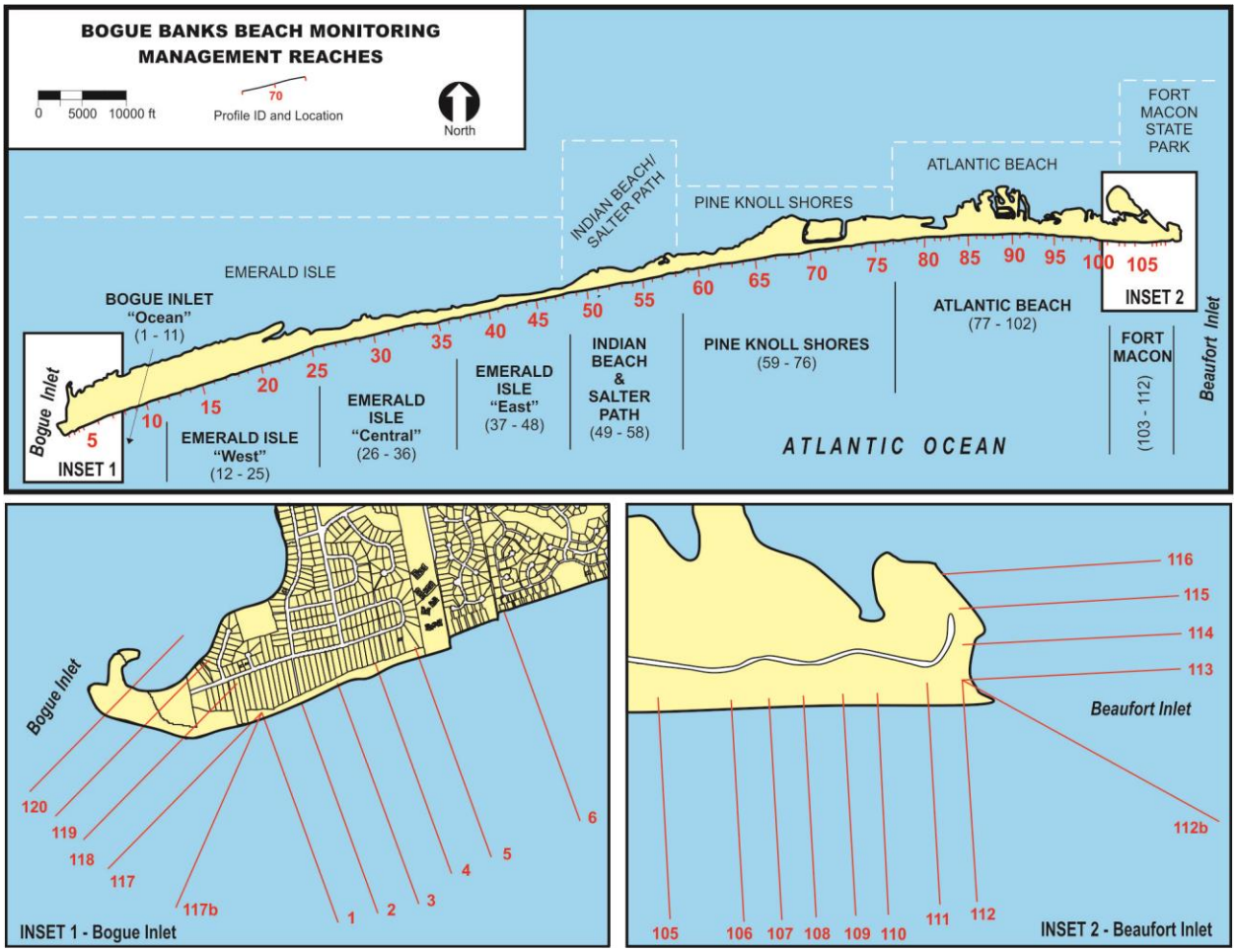

Figure 1 – Site map depicting the location/identification scheme of the 122 profiles positioned along Bogue Banks utilized for beach/nearshore monitoring purposes and the management reaches provided in the Bogue Banks Beach "Master Plan".

With respect to shoreline change - the "shoreline" is determined as the mean high water elevation established at +1.5 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 +1.5 feet elevation resides rather than depending upon more subjective determinations required by other methods, such as aerial photography (i.e., wet/dry line, the wrack line, etc.). For the 2017-18 reporting period the shoreline regressed landward (eroded) by -7 feet on average across Bogue Banks. Please be cognizant these

are just average numbers for the entire island, but generally holds true along each of the management reaches (see Table 1 for a summary of all the management reaches).

Reach	Profiles	Linear Feet	Average Shoreline Change (Spring 2017 - Spring 2018)	Average Volume Change (Spring 2017 - Spring 2018)
Bogue Inlet - Ocean	1 - 11	11,488	+17 feet seaward (+)	+10 cubic yard / linear foot
Emerald Isle - West	12 - 25	18,288	-2 feet landward (-)	+10 cubic yard / linear foot
Emerald Isle - Central	26 - 36	15,802	-1 feet landward (-)	+14 cubic yard / linear foot
Emerald Isle - East	37 - 48	13,220	-13 feet landward (-)	+11 cubic yards / linear foot
Indian Beach/Salter Path	49 - 58	12,850	-4 feet landward (-)	+9 cubic yards / linear foot
Pine Knoll Shores	59 - 76	23,878	-8 feet landward (-)	+7 cubic yards / linear foot
Atlantic Beach	77 - 102	26,176	-23 feet landward (-)	-0 cubic yards / linear foot
Ft. Macon State Park	103 - 112	6,691	-4 feet landward (-)	-7 cubic yards / linear foot
Totals or Average =	112	128,393	-7 feet landward (-)	+7 cubic yards / linear foot

Table 1 – Average shoreline and volume change from Spring 2017 to Spring 2018 for eight oceanfront reaches positioned along Bogue Banks. Notice in general the shoreline position regressed landward, but almost all the reaches gained sand during the reporting period.

By now you might be scratching your head trying to reconcile how we ***gained sand volume but the shoreline moved landward*** (eroded). On the surface that seems contradictory but once we look at the beach from a cross-sectional vantage point, the reasons become much more intuitive.

Where does the sand go?

Viewing the beach in cross-section; 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).

In general, we are experiencing a continuing trend of sand transitioning from the dry sand beach down the profile to depths that are just offshore/underwater while concomitantly, sand just below the outer bar offshore is moving up the profile. The result from a volumetric standpoint is that we are gaining sand overall from the top of the dune seaward to -12 feet NAVD88 (our cut-off lens, or "sand box"). As previously mentioned we ***gained*** an average of +7 cubic yards per linear feet (cy/ft) across the entire oceanfront reach of Bogue Banks last year but the shoreline ***retreated*** landward by -7 feet (average). Ironically now this makes sense because as mentioned immediately above, some sand moved from the shoreline zone up into the dunes, and mostly down the beach profile from the dry sand beach to slightly underwater/offshore. This is perhaps best depicted by examining the same transect superimposed upon one another from the 2018 and 2017 surveys (see Fig. 3).

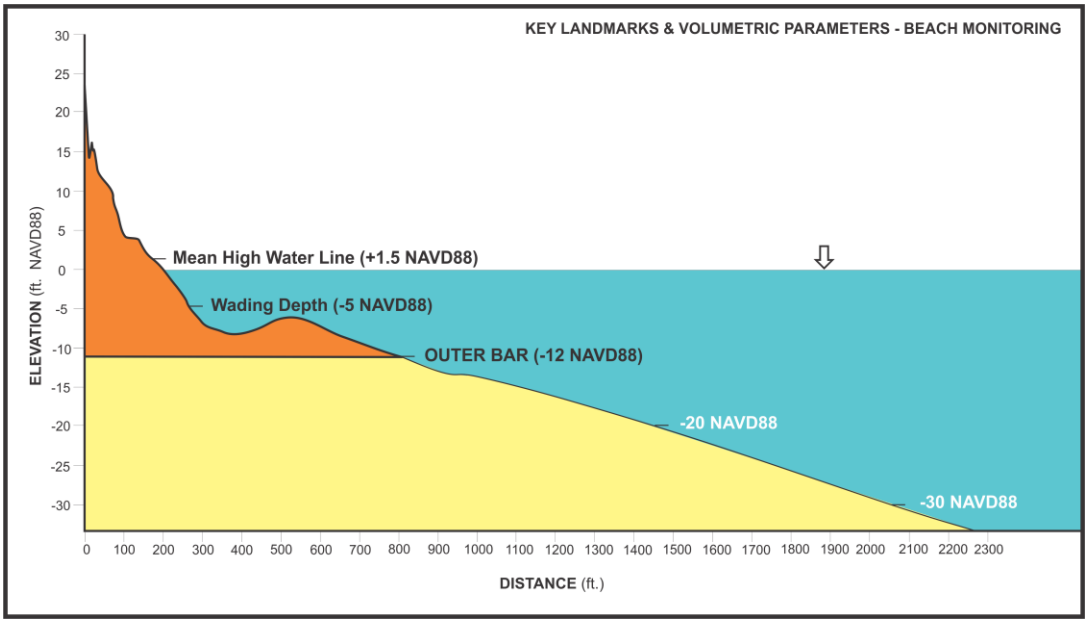

Figure 2 – Characteristic Bogue Banks profile in cross-section depicting the key "landmarks" monitored for changes in sand volume. Although changes are recorded above each of the landmarks depicted in the figure, the orange-colored fillet represents the positive or negative changes occurring at the elevation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

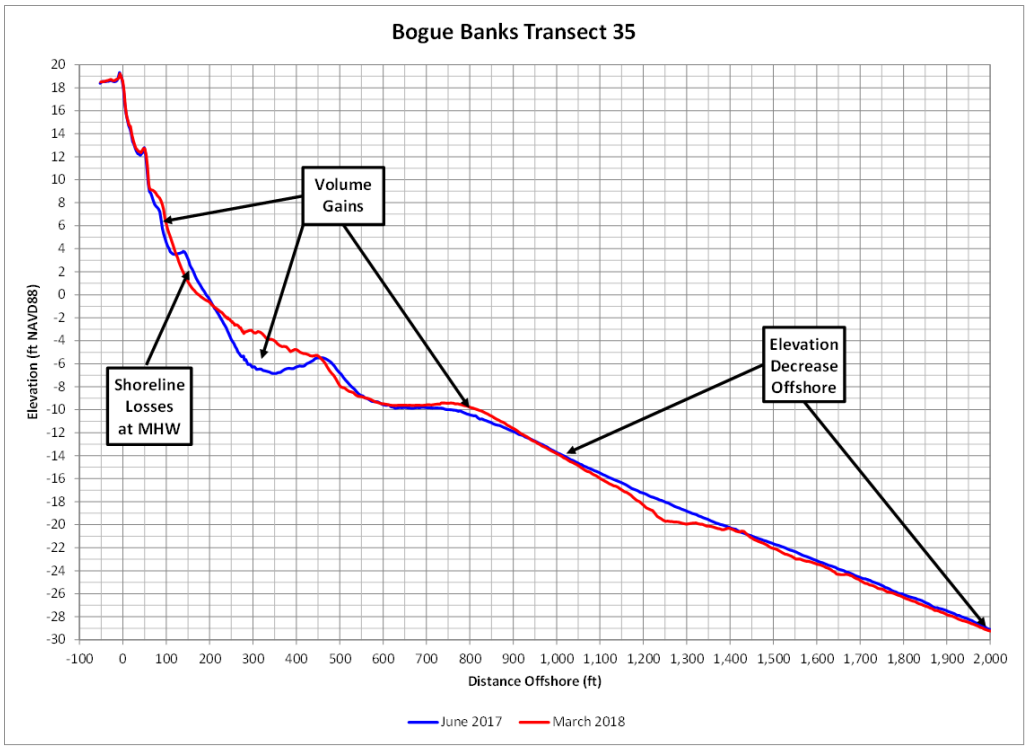

Figure 3 – Comparative surveys at Transect 35 in Emerald Isle depicting the profile geometries of the 2018 (red) and 2017 (blue) monitoring events. The vertical (y) axis is elevation and the horizontal (x) axis is distance from the dune on the left of the figure heading offshore towards the right of the figure. Notice near the shoreline at elevation +1.5 feet there is a loss of sand (volume) and recession of the shoreline itself, but is compensated and then some by gains "up slope" near the base of the dune and considerable gains "just underwater" (see the zone between -2 and -8 feet). There is also sand quite possibly moving "up slope" from deeper depths (see the zone between -16 and -20 feet). Most of the sand has collected above -12 feet NAVD88, and thus is considered as a volumetric gain.

From a long-term chronological perspective, we do not think there is "much" sand from a gross standpoint migrating (and staying) from one management reach to the other (shore-parallel). In other words, we almost never experience a large loss in one management reach coupled with a significant gain in an adjacent reach. Or *vice versa* – immediately adjacent reaches to those that received direct nourishment rarely experience significant gains the following year. Obviously this is just a general rule of thumb and is not valid for profiles/reaches near inlets. 2018 provides no exception to these trends – as just discussed, most of the gains and losses can be traced up and down the beach slope (shore perpendicular).

And lastly and continuing with 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-determined yardstick year of 1999, and is attributable to the many beach nourishment projects that have been constructed since 2001 (Fig. 4). All the island management reaches are also in excess of our Master Plan "volumetric thresholds" -- or perhaps better conceptualized as beach nourishment triggers. Our Master Plan management reaches as referenced in Figures 1 and 4, and Table 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 2018 management reach values in terms of average cy/ft and our minimum volumetric thresholds (i.e., nourishment triggers) are presented graphically in Figure 4 as well.

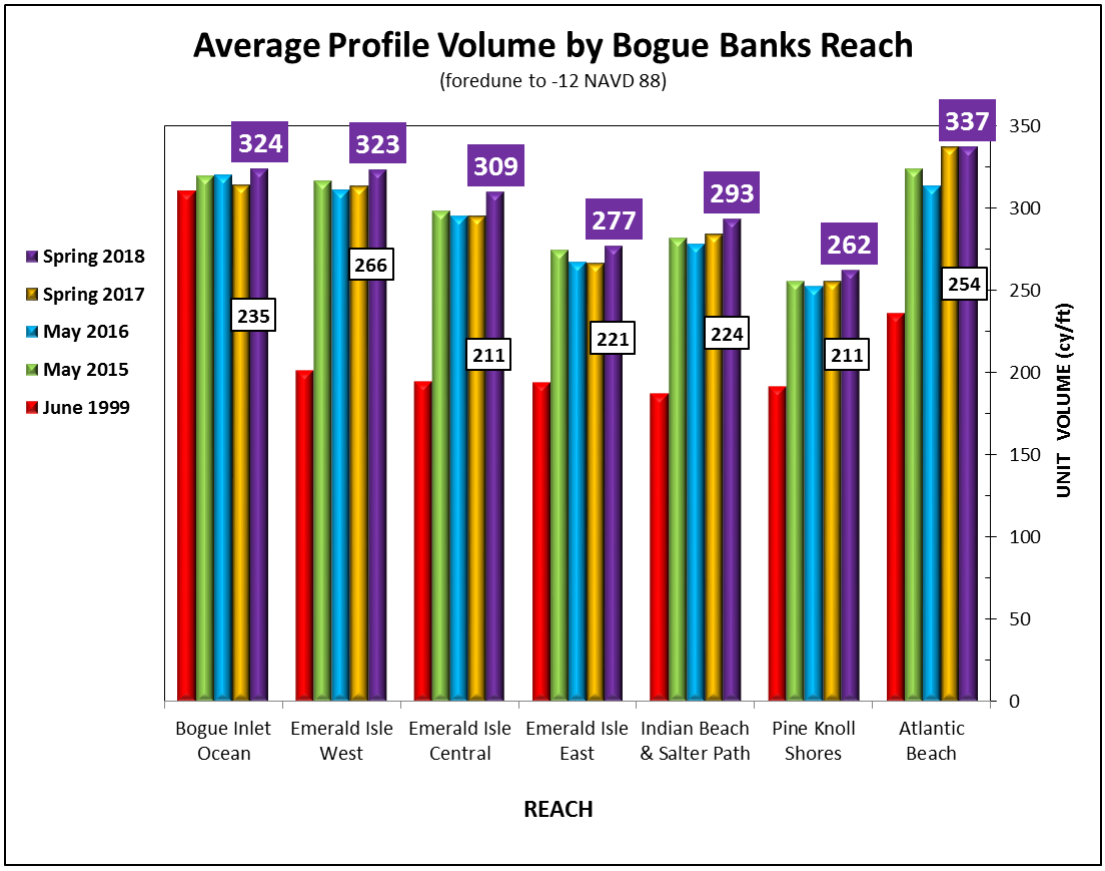

Figure 4 – Average profile volumes for September 1999 (baseline year), 2018 (the most recent survey), 2017, 2016, and 2015 for seven oceanfront management reaches along Bogue Banks. The minimum volumetric thresholds (i.e., nourishment triggers) are provided in the white call-out boxes while the 2018 average volume is represented in the purple call-out boxes.

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.