SHORELINES – October 2014

As presented to the *Island Review* magazine.

State of the Beach (2014)

In late August, the engineering firm of Moffatt & Nichol provided the Carteret County Beach Commission a presentation highlighting the most significant results of a comprehensive beach survey conducted in May/June 2014, which encompassed Bogue Banks and the islands located east and west of Bogue Banks as well - Shackleford Banks and Bear Island, respectively. If we compare the May/June 2014 survey to that of the year prior (April/June/July 2013); we are capturing all of the events that transpired during this roughly yearlong time period.

We depend heavily on a "credit – debit" volumetric approach with respect to our beach management philosophy and during the aforementioned survey period, Bogue Banks experienced a large "credit" compliments of maintenance dredging with concurrent beach nourishment associated with the Morehead City Harbor Federal Navigation Project that placed 1,107,585 cubic yards (cy) of sand along 1.8 miles of beach in Ft. Macon and Atlantic Beach. Conversely, the island did not experience any particularly notable sources of "debit" in the form of tropical cyclones (hurricanes/tropical storms), albeit the winter storm season was relatively strong (seven events when offshore waves exceeded 12 feet).

Monitoring Background

In 1999, 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 – **(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.

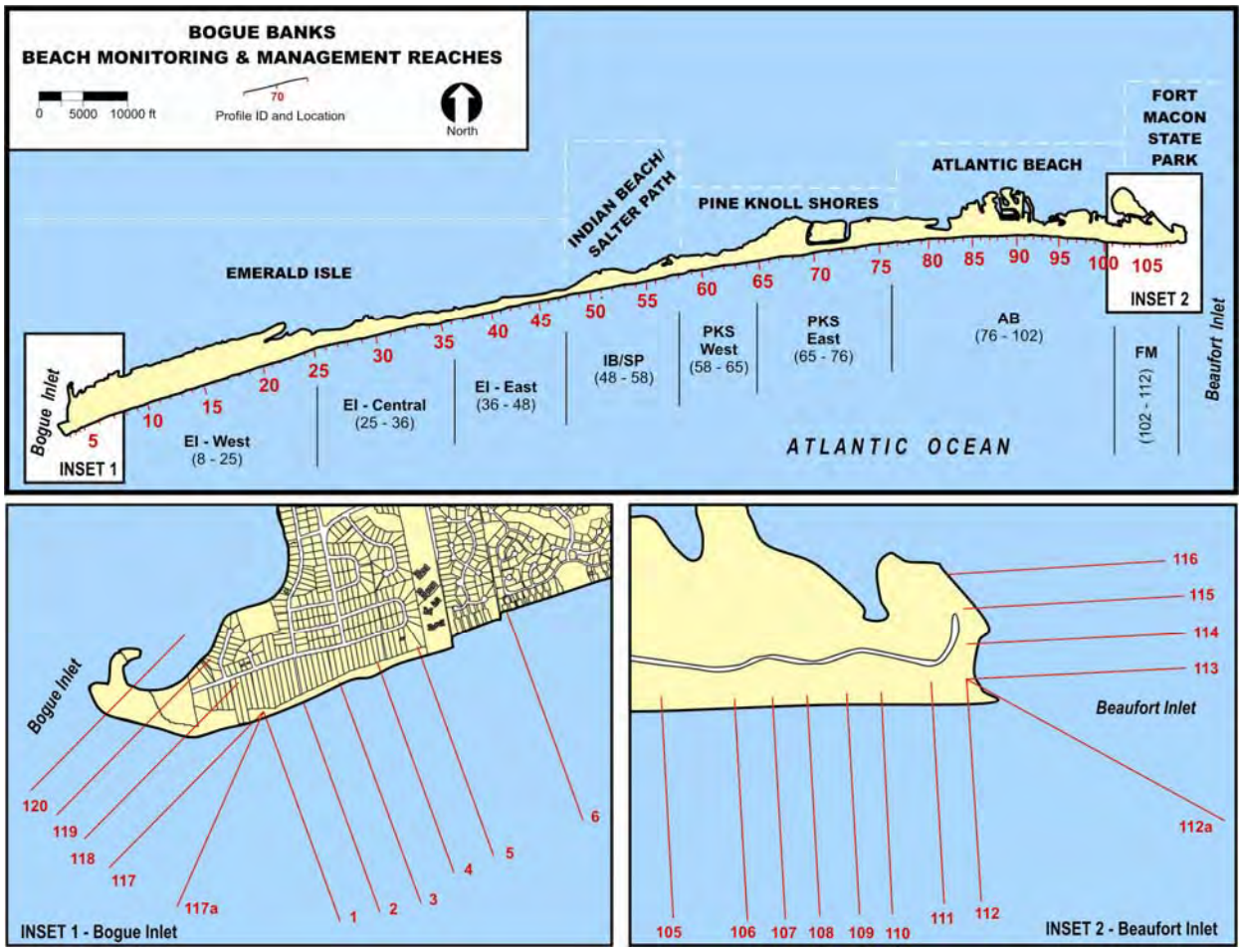

Figure 1 – Site map depicting the location and identification scheme of the 122 profiles positioned along Bogue Banks utilized for beach/nearshore monitoring purposes.

Beach Volume

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 and scientists most 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. The "volumetric approach" has been a primary tenet of our beach monitoring program, and the eight oceanfront reaches along Bogue Banks ***gained*** +1,178,856 cy of sand in 2013-14, which extends and includes all of Emerald Isle running eastward through Ft. Macon and equates to an average gain of +9.8 cy per linear feet (cy/ft). As one might expect, the gains reported are correlative to the sand that was placed along Ft. Macon and Atlantic Beach in April and May of this year.

Interestingly however, the gain reported along the entire oceanfront are +71,271 cy in excess of the +1,107,585 cy of nourishment placed on the beach during the reporting period. A more detailed review of the data reveals there is less sand residing in Ft. Macon and Atlantic Beach immediately after nourishment (1,010,055 cy) than the volume placed in these two reaches (1,107,585 cy) if compared to the summer 2013 volume. This indicates

there was roughly -97,530 cy of erosion *before* nourishment, yet across the island this loss was compensated and then some (+168,801 cy). We are postulating these across-the-island gains are the result of sand moving up the beach profile from just below our benchmark. Although the surveys go well offshore (-30 ft.), we "cut off" our comparative analyses at the -12 ft. benchmark (NAVD 88). So again, we believe the across the island gains are the result of sand moving from let's say -14 ft. as an example to -11 ft.

Also 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 fifteen years ago, and the entire island also meets our "target minimum volumetric threshold" established for Bogue Banks. The target minimum volumetric threshold is simply an average volume of sand per linear foot that is considered as a management benchmark – beaches with more sand than the target volume is advantageous. Beaches with less sand residing in any of the management reaches is obviously a cause for concern (225 cy/ft is the benchmark).

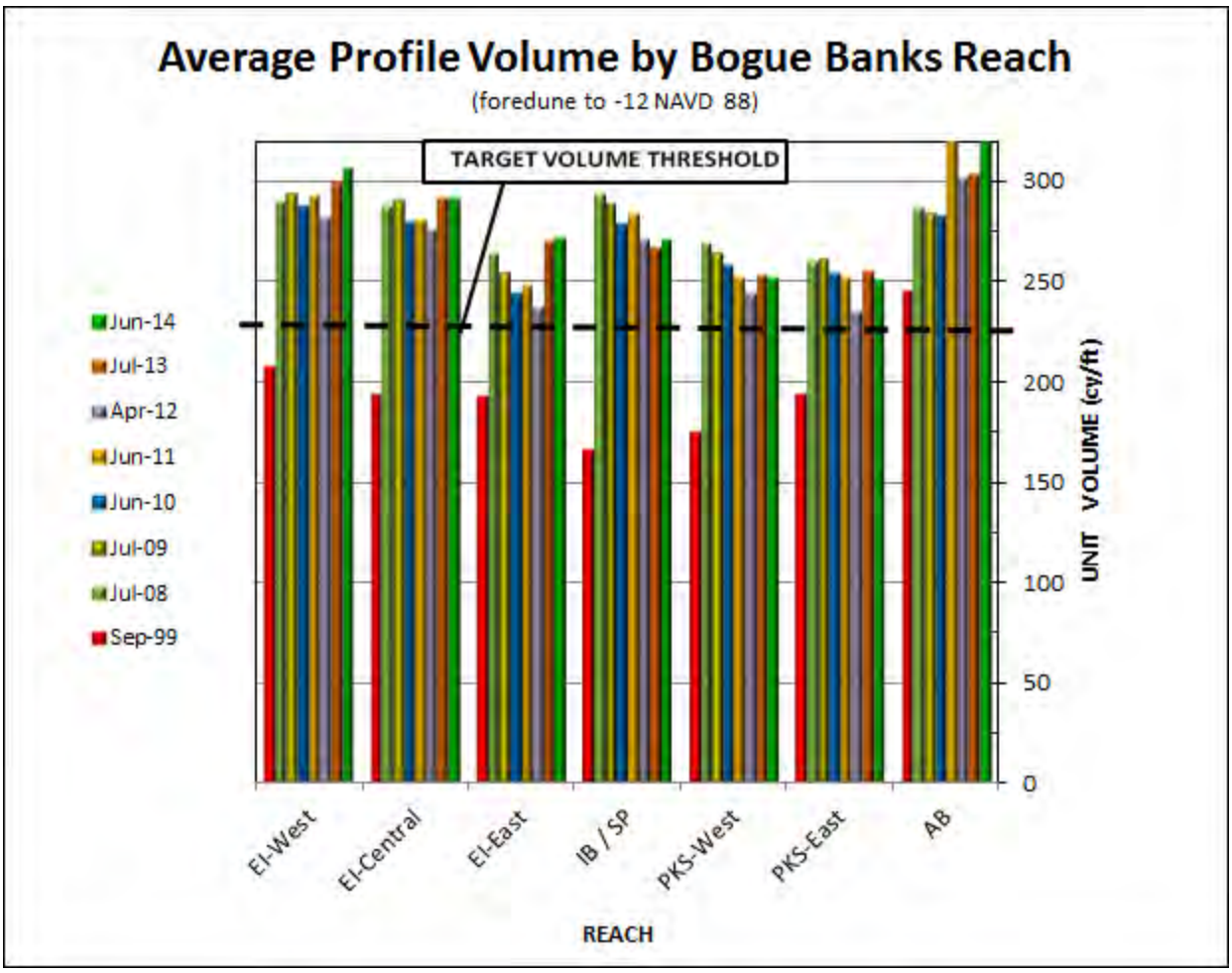

Figure 2 – Average profile volumes for September 1999, July 2008, July 2009, June 2010, June 2011, April 2012, July 2013, and June 2014 for seven oceanfront reaches along Bogue Banks. A target volume threshold of 225 cubic yards per linear foot (cy/ft) was established in 1999 as a benchmark for beach health.

The target volume was modeled after Atlantic Beach that has been a traditional recipient of beach nourishment associated with the dredging of the Morehead City Harbor well before *Floyd* (1999). Quite simply, immediately after *Floyd* we noticed Atlantic Beach

was relatively unscathed while the remaining island communities sustained significant dune erosion and property damage. As the red bar (1999) in Figure 2 demonstrates, the average volume of sand in Atlantic Beach was significantly higher than the adjacent beaches and was consequently selected as a beach health benchmark.

Shoreline Change

Another and more common/familiar measurement of beach health is shoreline change. To quantify and consistently compare shoreline positions over time, the "shoreline" is determined as the mean high water elevation established at +1.1 feet above sea level. 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.

Reach	Profiles	Linear Feet	Average Shoreline Change (July 2013 - June 2014)	Average Volume Change (July 2013 - June 2014)
Emerald Isle - West	8 - 25	22,344	-10 feet landward (-)	+7 cubic yard / linear foot
Emerald Isle - Central	25 - 36	15,802	-24 feet landward (-)	-0 cubic yard / linear foot
Emerald Isle - East	36 - 48	13,220	5 feet seaward (+)	2 cubic yards / linear foot
Indian Beach/Salter Path	48 - 58	12,850	-2 feet landward (-)	5 cubic yards / linear foot
Pine Knoll Shores - West	58 - 65	9,063	-19 feet landward (-)	-1 cubic yards / linear foot
Pine Knoll Shores - East	65 - 76	14,815	-12 feet landward (-)	-4 cubic yards / linear foot
Atlantic Beach	76 - 102	26,176	41 feet seaward (+)	+22 cubic yards / linear foot
Ft. Macon State Park	102 - 112	6,691	127 feet seaward (+)	+65 cubic yards / linear foot
Totals or Average =	**105**	**120,961**	**8 feet seaward (+)**	**+10 cubic yards / linear foot**

Figure 3 – Average shoreline and volume change from April/June/July 2013 to May/June 2014 for eight oceanfront reaches positioned along Bogue Banks.

Utilizing a datum-derived shoreline, the average net shoreline change from summer 2013 to Spring 2014 for Bogue Banks was +8 feet seaward with large, nourishment-driven shoreline advances reported in Atlantic Beach (+41 feet) and Ft. Macon (+127 feet) – Figure 3. Shoreline positions have reacted to an influx of nourishment sand or efflux of sand related to storms/background erosion over the past several years and movement of that sand in the alongshore and shore-perpendicular directions. Sand may be moving east or west along the beachfront or in some places, could be migrating in the offshore direction or conversely even welding itself to the visible dry beach. Again, the 2014 numbers most certainly reflect the influx of sand attributed to dredging/nourishment activities associated with the Morehead City Harbor.