Teacher background information – Estuarine shorelines behind simple overwash barrier islands 1

Figures 1-13, 1-14, and 1-16 (see pg. 2) illustrate the difference between simple overwash barrier islands (narrow and low) and complex barrier islands (wide and high). The North Carolina Outer Banks consist of both types.

Back-barrier shorelines associated with simple overwash-dominated barrier islands, such as major portions of Pea Island, Ocracoke Island, and the Avon-Buxton site, are greatly affected by events occurring on the ocean side. Because these barrier segments tend to be sediment poor, they are extremely dynamic with severe erosion on the ocean side (between five to twelve feet per year, based on the N.C. Division of Coastal Management's long-term average annual erosion rates). The consequence is extensive formation of both overwash fans and inlets in response to storm surge events (figures 1-21 and 1-15 – see pg. 3). Sediments eroded from the ocean side are supplied through overwash and inlet processes to the continuous building of the back-barrier portion of the island at the expense of the ocean side. These deposits form extensive shallow-water sand platforms in the back-barrier estuaries that are quickly colonized by salt marsh and aquatic grasses. The growth of aquatic, inter-tidal, and subaerial vegetation stabilizes the sand platforms and continues to trap more sand with time. The heavy growth of vegetation helps to stabilize the newly developed estuarine shoreline.

When a storm directly impacts a narrow and weak portion of the simple overwash barrier islands, a new inlet will frequently form. Currents associated with the storm surge that opens the inlet, as well as subsequent tidal currents that keep an inlet open, build an extensive system of shallow sand shoals in the estuary behind the barrier known as the flood-tide delta. As long as the inlet remains open, the currents build these shallow-water sand shoals. However, as soon as the inlet closes down, either naturally or due to human intervention, the shallow sand shoals become heavily vegetated with aquatic and inter-tidal growth that stabilizes the sand platforms.

Marsh shorelines behind simple overwash barriers occur on distinct overwash fans and are composed of relatively thin (less than three feet) mixed peaty sand to sandy peats sediment. Because overwash processes nourish these fans over time, the associated marshes and their shorelines tend to be gently ramped and are fairly stable and persistent through time. However, with the human modification of the island through construction and maintenance of barrier-dune ridges to protect N.C. Highway 12, overwash processes have been minimized and many marsh platforms have begun to erode around the perimeter.

Overwash and inlet processes are crucial for the long-term maintenance of the islands in two ways (figures 1-21 and 1-15). First, both overwash and inlets add width to the back or estuarine side of the island. Second, overwash processes carry sand over the top of the island and build elevation on the very low portions along the back side of the barrier. These processes are crucial for the overall maintenance of island width and elevation because the islands are migrating upward and landward in response to the ongoing processes of sea-level rise (figure 1-6 – see pg. 4). Without either of these processes, the ocean side will continue to severely erode, resulting in the island becoming both narrower and lower until it ultimately drowns with the limited sand being spread out into a broad shoal system.

However, both of these natural and crucial processes are in serious conflict with human development. Neither process is friendly to houses, businesses, or roads that expect a permanent and non-mobile barrier island. Figures 1-14, 1-21, and 1-28 (see pgs. 2, 3, and 5) show the extensive overwash fans that resulted from Hurricane Isabel. The storm surge eroded out sections of the barrier dune ridge, buried or tore up segments of N.C. Highway 12, and opened a major inlet near Hatteras Village (figure 1-5 – see pg. 5). Also, these important processes built critical elevation and width essential for the long-term maintenance and health of the barrier island. The critical question is: How can humans and their economic development cope with a dynamic barrier island that is gradually rolling over itself as sea level rises?

Teacher background information – Estuarine shorelines behind simple overwash barrier islands 2

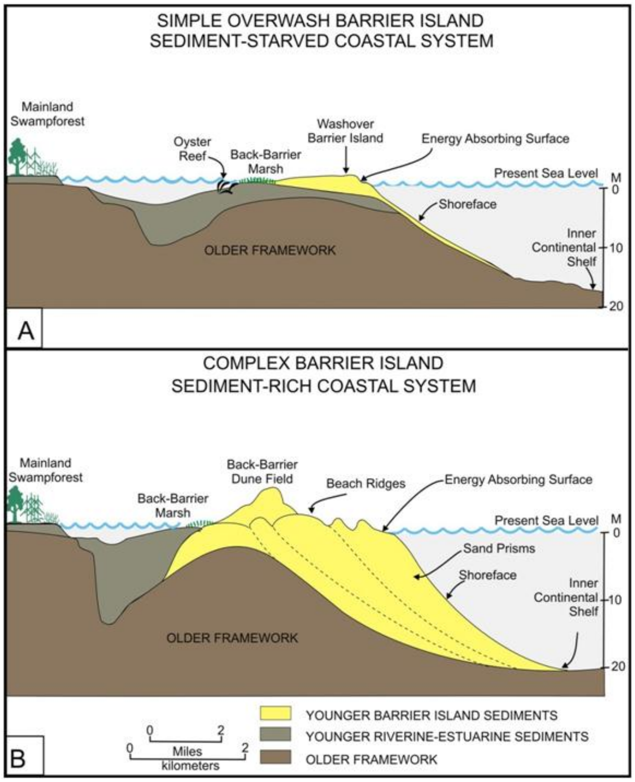

Figure 1-13. Schematic cross-sectional diagrams show a simple overwash (Panel A) and complex barrier islands (Panel B) and the associated back-barrier estuarine shorelines. The older framework sediments on the Outer Banks are Pleistocene in age (> 10,000 years), while the younger sediments are all Holocene in age (< 10,000 years). Figure 4-5-1, p. 50 in Riggs and Ames (2003).

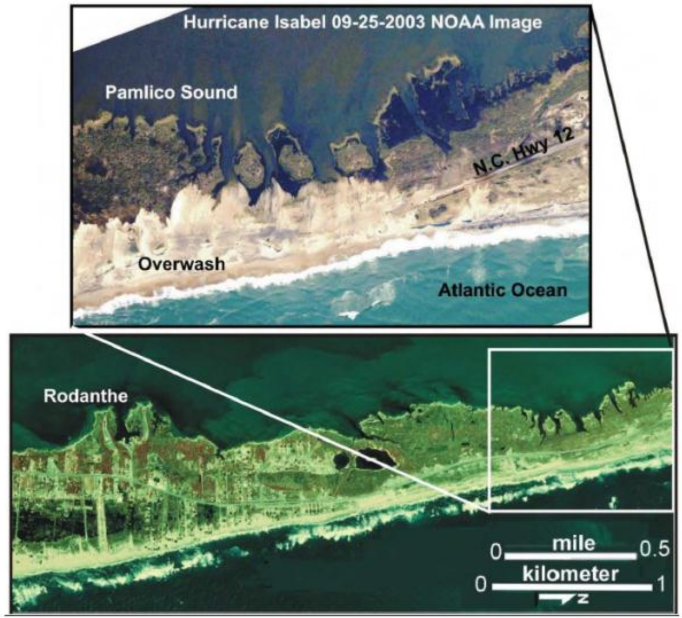

Figure 1-14. Pea Island aerial photographs show a segment of simple overwash barrier island just north of Rodanthe. The bottom panel is a 1998 aerial photograph of Pea Island with a box indicating the area in the NOAA 2003 post-Hurricane Isabel aerial photograph in the upper panel. Hurricane Isabel caused extensive overwash that buried N.C. Hwy. 12. The overwash sands add critical elevation to the barrier and width if the overwash sands are carried across the island to the estuarine side. Many houses in north Rodanthe were either destroyed or severely damaged in this storm.

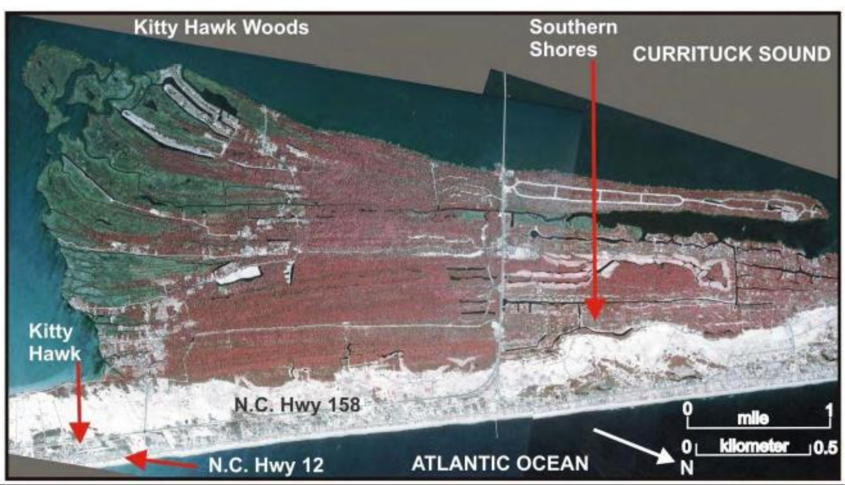

Figure 1-16. A 1982 infrared aerial photograph of Kitty Hawk shows the extensive sequence of beach ridges that constitute Kitty Hawk Woods. This is an example of a complex barrier island. The red color in this false color image taken in the winter, is photosynthesizing plants (e.g. pines, bay trees, live oaks etc.), whereas the gray-green color represents the marsh grasses. The white zone west of N.C. Hwy. 158 is a series of slightly developed back-barrier dunes, whereas the white zone east of N.C. Hwy. 158 is the highly developed active beach. Figure 4-5-3, Panel A, p. 52 in Riggs and Ames (2003).

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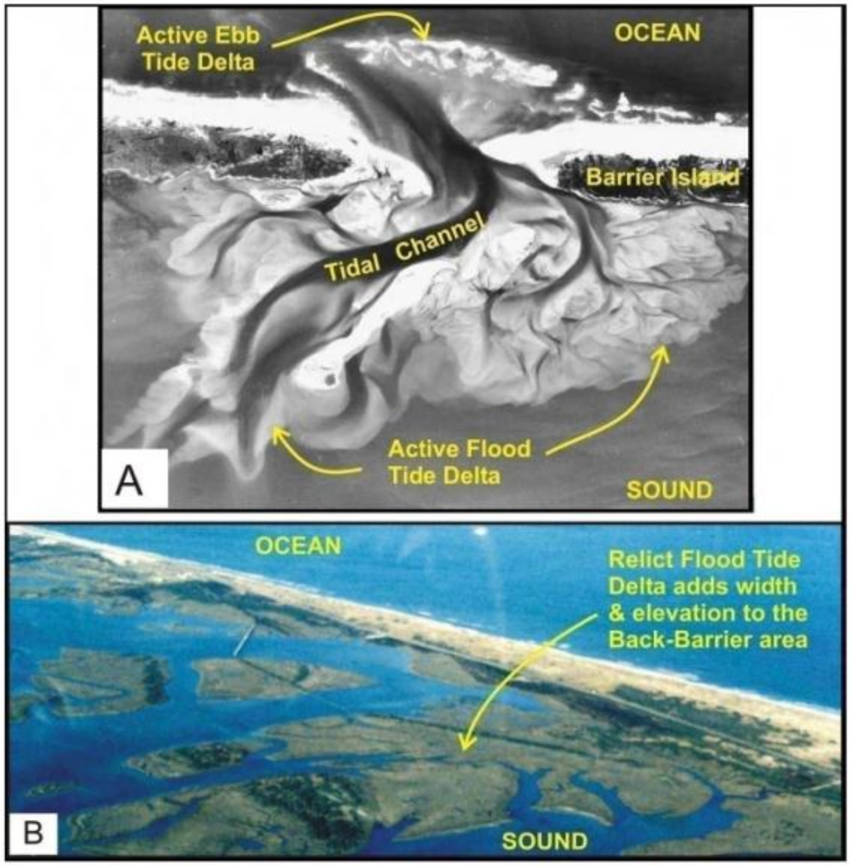
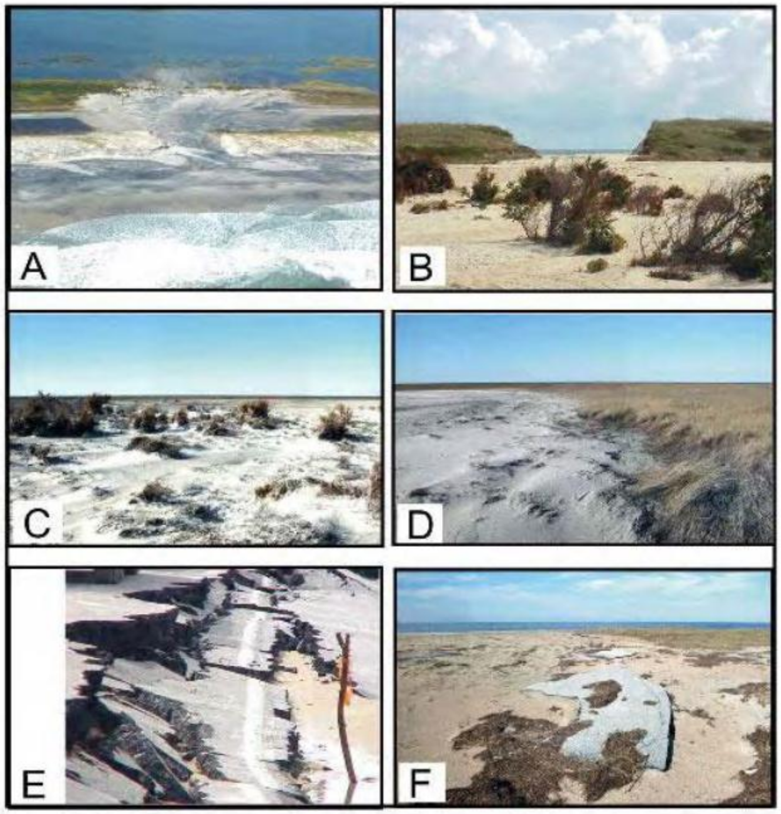
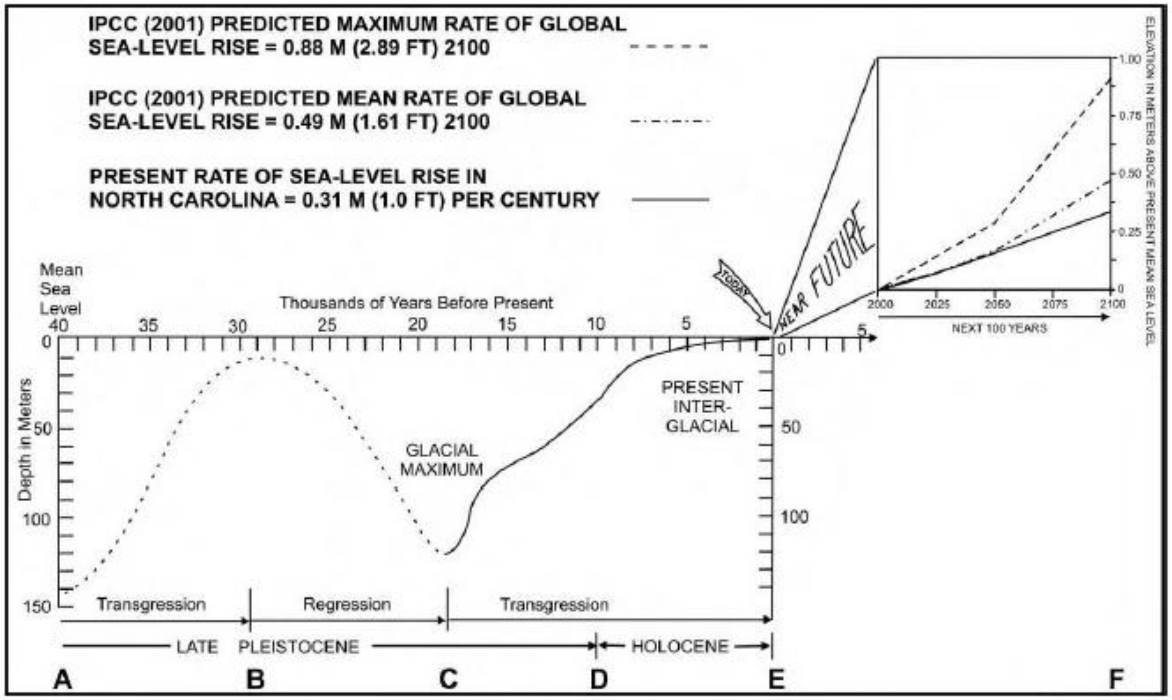


<u>Figure 1-15</u>. <u>Panel A</u>. The 1943 aerial photograph of Drum Inlet shows the separation of North and South Core Banks with extensive sand shoals associated with the tidal deltas. The ebb tide delta forms on the ocean side and the flood tide delta on the sound side of the barrier island. The deltas are formed by the deposition of sand sediment when the strong inlet tidal currents transporting the sand enter the adjacent ocean and estuarine water bodies. <u>Panel B</u>. This is a 1992 oblique aerial photograph of New Inlet flood-tide delta. The inlet closed in 1945 and all sand shoals have subsequently become vegetated by salt marshes. Notice the historic New Inlet Bridge that is still visible across the marsh.



<u>Figure 1-21.</u> Post-Hurricane Isabel photos of NE portion of Ocracoke Island that destroyed about 6 miles of N.C. Hwy. 12 and nourished the back-barrier marsh platforms. <u>Panel A</u>. Oblique aerial photo shows a breach in the barrier-dune ridge and the resulting overwash fan that buried N.C. Hwy. 12 and extended into the marsh. <u>Panel B</u>. Ground photo of a similar situation shown in Panel A. Notice the breach in the barrier-dune ridge through which the overwash fan was transported. <u>Panel C</u>. Photo shows an overwash fan that has buried the shrub-scrub zone and extends out into the back-barrier marsh. <u>Panel D</u>. Photo shows the end of an overwash fan that has buried and built up the platform marsh. <u>Panel E</u>. Photo shows a destroyed segment of N.C. Hwy. 12 that resulted from shoreline recession, placing the highway in the storm beach. <u>Panel F</u>. Overwash fan in the back-barrier marsh consists of beach sand, along with large pieces of N.C. Hwy. 12 that were transported along with sand into the marsh and out into the sound. Photographs A and B are by Cape Hatteras National Seashore personnel. Photographs C through F are by S. Riggs.



<u>Figure 1-6</u>. **Generalized sea-level curve for the past 40,000 years and predictions to year 2100 AD. Predictions are based upon IPCC (2001). Figure 6-2-1, p. 62 in Riggs and Ames (2003).**

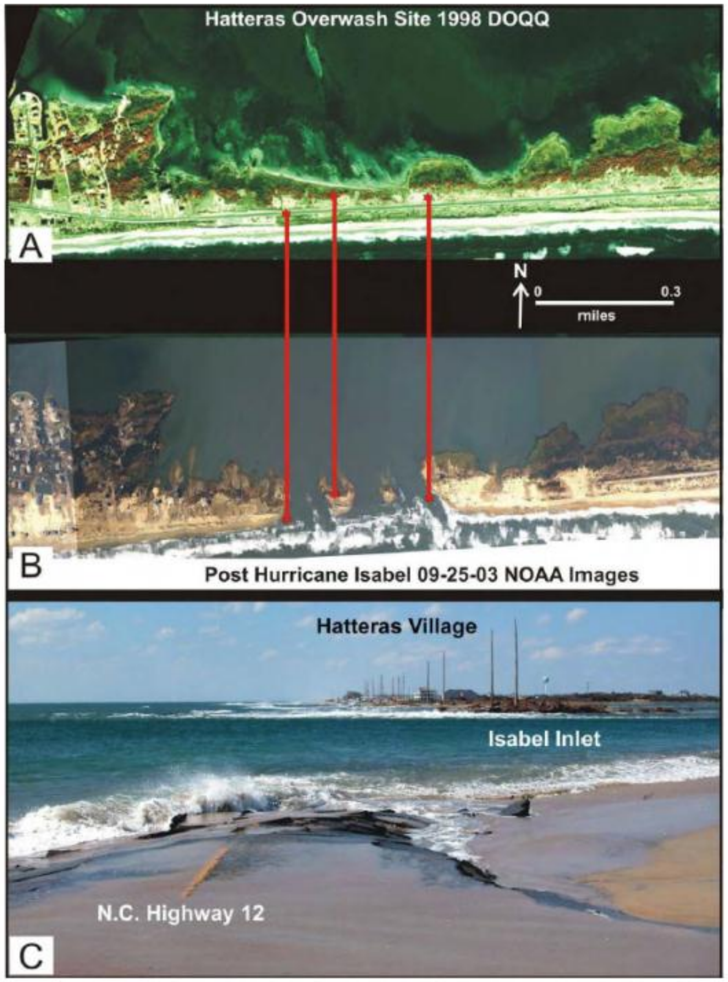


Figure 1-5. Aerial and ground photographs show the site of Isabel Inlet that opened on Sept. 18, 2003 in response to Hurricane Isabel. Panel A. A 1998 false color aerial photograph shows the east end of Hatteras Village and the potential inlet site. Panel B. An aerial photograph of the same area taken on Sept. 25, 2003 shows the location and three-part character of Isabel Inlet. The red points and associated lines on Panels A and B represent exact common points. Panel C. A ground level photo looks west across Isabel Inlet toward Hatteras Village with the "going-to-sea" N.C. Hwy. 12 in the foreground. Figure 8-4-18, p. 141 in Riggs and Ames (2003).

Figure 1-28. Post-Hurricane Isabel (2003) photographs show the damage in Hatteras Village and the newly opened and quickly closed Isabel Inlet. Panel A. Storm surge and overwash destroyed large segments of the barrier-dune ridge. Panel B. This oceanfront motel was destroyed when the barrier-dune ridge was breached by the storm surge. Panel C. This expensive process cleans the debris from overwash sand for use in building the new barrier dune-ridge. Panel D. A new barrier-dune ridge is being constructed in front of the destroyed motels. Panel E. Remnants of N.C. Hwy. 12 pavement within Isabel Inlet. Panel F. This photograph depicts the infilled Isabel Inlet, reconstructed N.C. Hwy. 12, and rebuilt barrier-dune ridge. Photographs are by S.Riggs.