

PhD Dissertation Defense

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Title: Stratigraphic architecture, morphodynamics, and evolution of breaches along Cedar Island, VA: a low-profile, washover-dominated, transgressive barrier island

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ABSTRACT

Island breaching has occurred at least three times (1956, 1993, and 1998) over the past 60 years along southern Cedar Island, VA. Each time, the breach captured enough tidal prism to remain open and become a tidal inlet, migrated laterally to the south in the direction of net longshore sediment transport, and closed in four to nine years. Twenty-five sediment cores were analyzed to determine the horizontal and vertical trends within the inlet throat, flood-tidal delta, and washover deposits. When open, the latest tidal inlet (open 1998–2007) had a maximum depth of 2.6 m to 4.5 m and ranged in width from 54 m to 250 m. The latest tidal inlet (open 1998–2007) initially captured approximately $9.35 \times 10^6 \text{ m}^3$ (18%) of the available tidal prism from Wachapreague Inlet, VA, which was $5.31 \times 10^7 \text{ m}^3$ in 2007 (Richardson, 2012). Fifteen primary facies were identified that consist mostly of sand, shell, and mud layers. They represent four depositional environments: 1) The sand facies were deposited in the beach–washover–aeolian, tidal-inlet, and flood-tidal delta environments; 2) the shell facies were deposited in the beach–washover–aeolian environment or 3) at the base of the tidal-inlet environment (channel floor); and 4) the mud facies were deposited in the estuarine environment. The gross sedimentology (shell, sand, silt, and clay) of the tidal-inlet fill sediments typically showed a fining-upward succession with a coarse shell lag at the channel base and grading upward to fine sand. The grain-size analyses of some sediment cores coarsened upward in their sand, silt, and clay fractions.

The evolution of an ephemeral tidal inlet was studied to determine the stages in the life of a wave-dominated inlet based on Cedar Island Inlet. From this, eight stages were identified in which an ephemeral tidal inlet evolves during the time that it is open. The inlet begins as a shore-normal breach, which captures enough of the existing tidal prism to remain open and evolves into a tidal inlet. Then the inlet migrates in the direction of net longshore sediment transport, which is southerly. During lateral migration, the inlet begins to rotate counterclockwise with a resulting shore-oblique channel orientation of 47 degrees to the adjacent shoreline. Finally, the inlet loses hydraulic efficiency causing the tidal prism to decrease and then the inlet closes. An eight-stage model is presented that synthesizes the morphodynamic evolution of Cedar Island Inlet from opening to closing.