

II. PREVIOUS STUDIES RELATED TO NITROGEN MANAGEMENT

In most marine and estuarine systems, such as Rushy Marsh Pond in the Town of Barnstable, the limiting nutrient, and thus the nutrient of primary concern, is nitrogen. In large part, if nitrogen addition is controlled, then eutrophication is controlled. This approach has been formalized through the development of tools for predicting nitrogen loads from watersheds and the concentrations of water column nitrogen that may result. Additional development of the eutrophication management approaches via the reduction of nitrogen loads has also generated specific guidelines as to what is to be considered acceptable water column nitrogen concentrations to achieve desired water quality goals (e.g., see Cape Cod Commission 1991, 1998; Howes et al. 2003).

Until recently, these tools for predicting loads and concentrations tended to be generic in nature and overlooked some of the site-specific characteristics associated with a given water body. The present Massachusetts Estuaries Project (MEP) study focuses on linking water quality model predictions, based upon watershed nitrogen loading and embayment recycling and system hydrodynamics, to actual measured values for specific nutrient species. The linked watershed-embayment model is built using embayment specific measurements, thus enabling calibration of the prediction process for specific conditions in each of the coastal embayments of southeastern Massachusetts, including Rushy Marsh Pond.

A number of studies have been performed regarding the south shore of Cape Cod geomorphology. Specific to Rushy Marsh Pond, two Woods Hole Oceanographic Institution reports: Aubrey and Gaines (1982) and Aubrey and Goud (1983) illustrated the historic processes governing tidal exchange over the past 100 years. For the Rushy Marsh estuarine system, the process of barrier spit elongation and breaching has had a significant influence on tidal exchange, even though the barrier spit is part of the adjacent Popponesset Bay System to the west. Over the past 100 years, the Popponesset Beach barrier elongation and breaching processes have governed the stability of the Rushy Marsh inlet. Between the late 1800s and 1950, the Popponesset barrier elongated past the Rush Marsh tidal inlet. Due to the influx of sediment associated with this barrier elongation, the natural tidal inlet to Rushy Marsh closed. As described in Aubrey and Goud (1983), the loss of nearly one-half of the Popponesset Beach barrier between 1954 and the early 1980s led to concerns regarding future barrier spit migration. According to Aubrey and Gaines (1982), the present spit length has been historically the stable configuration. It wasn't until after about 1860 that the spit began to grow past its present location.

As the barrier spit elongated between the early 1900s and the mid-1950s due to regional littoral drift, the inlet channel to Popponesset Bay became less efficient, where the tide height within Popponesset Bay decreased and the lag time between high tide in the estuary and Nantucket Sound increased. This increase in tidal attenuation was remedied in 1954, when a hurricane breached the barrier spit, creating an efficient inlet to Popponesset Bay in the vicinity of the present inlet. Once the spit had breached, the remnants of the spit east of the inlet gradually overwashed and rejoined the shoreline (primarily in the vicinity of Rushy Marsh). This inlet spit growth and breaching process has been documented extensively for the southeastern coast of Massachusetts (e.g. Fitzgerald, 1993).

The specific influence of barrier elongation and breaching upon the Rushy Marsh system was described in a report to the Town of Barnstable prepared by the Coast & Harbor Institute and Robert L. Fultz Associates (2002). Although the inlet to Rushy Marsh had naturally closed

in the early 1900s, the influx of littoral sediment caused by the 1954 breach of the Popponeset barrier further widened the barrier beach system fronting Rushy Marsh. Efforts to maintain an effective inlet near the southern end of the Pond have been complicated by the unstable nature of the shoreline, the relatively weak littoral drift that continues to supply sediment to this region, and the small potential tidal prism exiting Rushy Marsh. Based upon limited sampling of water quality parameters (dissolved oxygen, salinity, and turbidity), Coast & Harbor Institute and Robert L. Fultz Associates concluded that the pond productivity is moderate or low, and the poor water clarity might be a result of tannins in the water, rather than algal accumulation.

As the stakeholder to the Rushy Marsh Pond System, the Town of Barnstable and its citizens have been active in promoting restoration of this system. This local concern also led to the establishment, in 2002, of a nitrogen related water quality monitoring program for Rushy Marsh by Three Bays Preservation. The program was an extension of the effort for the adjacent Three Bays Estuary. The Three Bays/Rushy Marsh Water Quality Monitoring Program was provided technical assistance by the Coastal Systems Program at SMAST-UMD and over the past several years has been incorporated into Barnstable's Town-wide embayment monitoring program. The initial findings of the monitoring program are that Rushy Marsh Pond is currently impaired by nitrogen enrichment (i.e. eutrophic). As a result of the restriction of tidal exchange nitrogen entering the system is generally recycled rather being flushed out to Nantucket Sound. The result is elevated nitrogen levels, phytoplankton blooms, macroalgal accumulations and periodic depletion of dissolved oxygen in bottom waters. In addition, restriction of tidal exchange allows the pond to freshen and at present Rushy Marsh Pond is a brackish salt pond only periodically attaining ½ strength seawater salinities.

As part of on-going research and engineering efforts related to Rushy Marsh Pond, the geologic history of the pond was determined as was the recent history of shoreline change (See Section V). The short and long term trends in coastal processes as relate to the ecological health of Rushy Marsh Pond set an important background for the present restoration and management of this system. The Three Bays/Rushy Marsh Water Quality Monitoring Program provides the quantitative watercolumn nitrogen data (2002-2005) required for the implementation of the MEP's Linked Watershed-Embayment Approach used in the present study. In addition, for the MEP modeling analysis, the data from the previous studies were evaluated relative to the needs of the Linked Watershed-Embayment Model.