The **Coastal Lagoons** of **Southern Rhode Island**

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Adorning the beautiful southern coastline of Rhode Island like jewels are about a dozen special and surprisingly diverse water bodies known collectively as "the salt ponds." In truth, none of these water bodies are actually ponds; most are more accurately referred to as "coastal lagoons," and one is an estuary (Figure 1).

It is surprising that in a mere 20-mile stretch of coastline, from Watch Hill in the west to Point Judith in the east, each of these water bodies can be so unique. Furthest to the west among the largest ten of these lagoons are tiny Maschaug and Little Maschaug Ponds, usually separated from the ocean by their coastal barrier and highly impacted by surrounding development and golf courses. Next in line are Winnapaug, Quonochontaug, and Ninigret Ponds, all of which have permanent, hardened connections to the ocean (breachways) constructed in the middle of the 20th century. Next is Green Hill Pond, surrounded and impacted by development and without its own breachway. Green Hill Pond does have limited water exchange with neighboring Ninigret Pond via a narrow channel. Trustom Pond, to the east of Green Hill Pond, is a fascinating, ongoing case study in the dynamic nature of coastal lagoons. Usually separated from the ocean by the Moonstone Barrier, Trustom Pond was a freshwater system until it was breached during extra-tropical storm Sandy. Cards Pond, also very small and usually separated from the ocean, is periodically breached manually to control water levels. The last coastal lagoon to the east is Potter Pond, which unlike the other coastal lagoons that are oriented parallel to the coast, is oriented more perpendicular to the coast. The northern basin of Potter Pond is a deep "kettle hole" created as the last glacier retreated. Potter's only water exchange with Block Island Sound is via a channel into adjacent Point Judith Pond, which is actually the estuary of the Saugatucket River. Point Judith Pond is home to the Port of Galilee, which is one of the largest fishing ports on the east coast.

Figure 1. The coastal lagoons of southern Rhode Island.

The southern Rhode Island coastal lagoons were formed after the retreat of the Laurentide Ice Sheet at the end of the last glaciation. The Laurentide Ice Sheet extended south to Nantucket, MA, Block Island, RI, and Long Island, NY, about 25,000 to 30,000 years ago (CRMC 1999). At that time, with so much water locked up in ice sheets, the coastline was almost 100 miles further south than it is now and the sea level was about 120 meters lower. The thick glacial ice carried with it material ranging in size from small particles to rocks and boulders, collectively referred to as glacial till.

As the climate warmed, the ice retreated until the ice margin reached a position just north of the current RI coastline approximately 21,000 years ago. The ice margin fluctuated at this location a time, forming a hill of glacial material known as the Charlestown Moraine (Dr. J. Boothroyd, personal communication). Additional sand and gravel was deposited by meltwater rivers flowing underneath the melting ice sheet, around its edges, and through breakout channels along the length of the ice margin. These deposits, along with the direct deposition of till by the ice, created a series of headlands along the coast. Rapid climate warming starting about 14,000 years ago melted enough glacial ice to bring the sea level up to its approximate current height by about 4,000 years ago (CRMC 1999).

With wind, waves, and time, glacial deposits were eroded and carried along the shoreline by currents (Figure 2). This eroded material formed barrier spits between the higher headlands. Continuing erosion and deposition of sediments by waves and long-shore currents caused the spits to grow away from the headlands parallel to the shoreline. Eventually the spits almost completely connected the headlands, isolating the coastal lagoons behind them from the ocean except for narrow inlets through which ocean tides flowed (CRMC 1999). Unlike today, the inlets were not fixed in one place; rather, they periodically closed, changed location, and were re-opened by storm surges and waves.

Storm waves, storm surges, and rising sea level are continuing the process of eroding the glacial deposits. During big storms, storm surges and waves roll over low, narrow barrier spits (overwash). The overwash transports sand from the ocean and beach face across the barriers and sometimes all the way to the lagoons. In severe storms, temporary storm-surge channels might cut through the barriers, allowing additional sediment into the lagoon. Over time, these processes cause coastal barriers to move landward and upward.

With people living and building businesses around the ponds and on the coastal barriers, the natural processes driving the configuration and migration of these features no longer proceed unfettered. For many decades, overwashed sand that landed on roads or developed property has been moved back to the beach face, interfering with the natural landward migration of the coastal barriers. In addition, ongoing, decades-long studies of the advance and retreat of the southern RI shoreline show that long-term, most of the shoreline is eroding (CRMC 1999). Prevention of sand from reaching the back of the coastal barriers during and after storms, combined with erosion of beach faces, over time will cause the coastal barriers to narrow. This is a problem, since narrow, developed coastal barriers do not provide as much storm protection to landward structures as wider, more natural barriers. An accelerating rate of sea level rise in the northeastern U.S., plus the prospect of increasing storm frequency and severity due to climate change, is driving a major policy effort in RI to address shoreline change and sea level rise adaptation statewide (www.beachsamp.org).

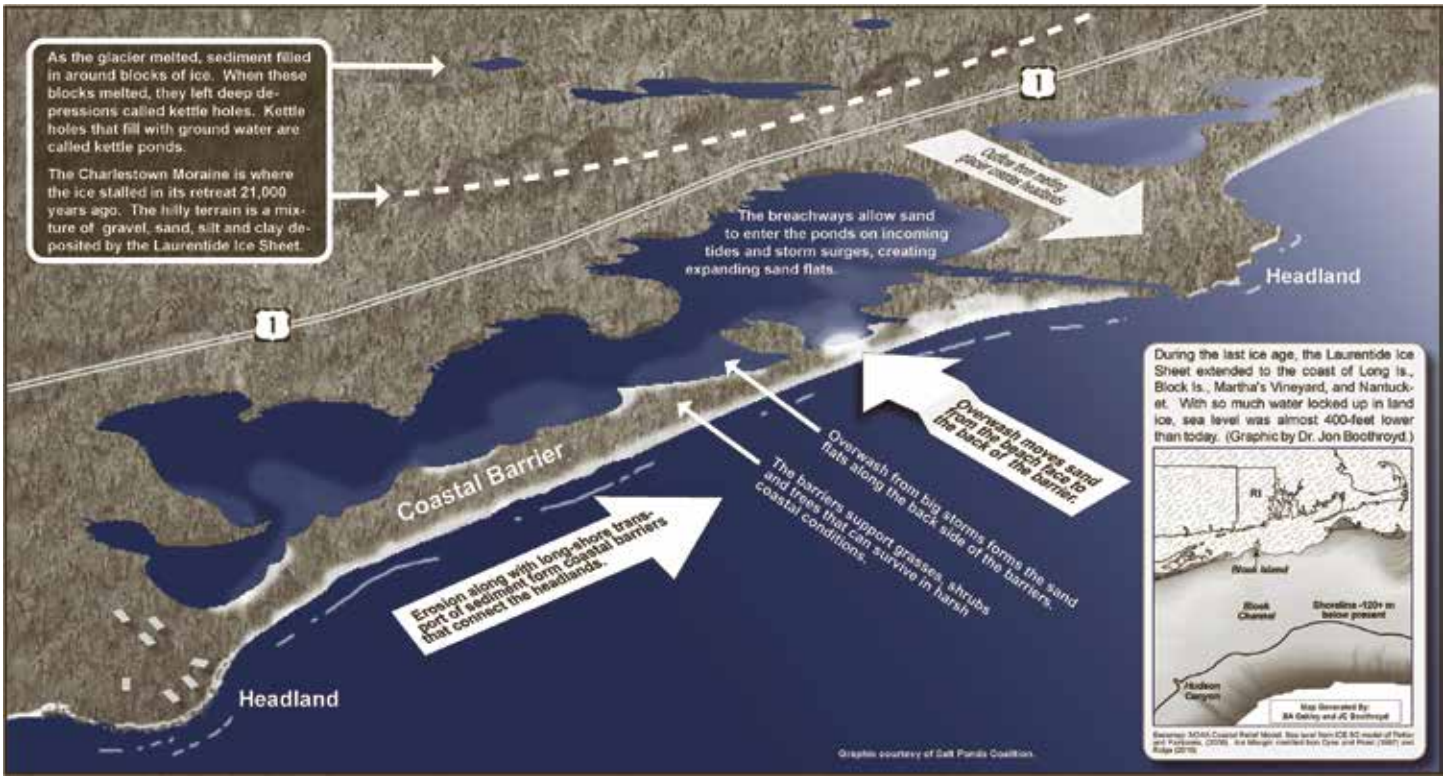

Figure 2. The geologic processes that formed southern Rhode Island's coastal lagoons.

Other Issues Facing the Coastal Lagoons

As is true for so many water bodies, the southern RI coastal lagoons are being impacted by the human activity taking place around them. Excess nutrients from septic systems, fertilizers, and animal waste are carried into the lagoons by surface runoff and groundwater. The excess nutrients fuel excess algal growth, which causes decreases in water clarity and dissolved oxygen concentrations. In addition, now that there are hardened, permanently fixed breachways into several of the lagoons, sand is transported through these inlets by incoming tides and then deposited within the lagoons as flood tidal deltas. This buries important eelgrass (seagrass) and shellfish habitat and decreases water circulation in the lagoons. Thus, the hardened breachways must be maintained through periodic dredging to maintain the exchange of pond waters with clean seawater and prevent shoaling within the ponds.

The coastal ponds of southern RI, and even different locations within a single pond, are affected by these stressors to varying degrees, depending upon how densely developed the shore is and how close to a breachway a location happens to be. Outreach efforts are ongoing to encourage people who live near the ponds to limit or eliminate their inorganic fertilizer use, properly maintain their septic systems, pick up after their pets, discourage Canada geese, and plant rain gardens and native plant shore-side buffers (Figure 3).

A wide array of uses and activities in and on the ponds results in user conflicts from time to time. Oyster aquaculture has been a booming industry in the ponds, which, thanks to the efforts of hard-working oyster farmers, produces a delicious and widely marketed product. However, other users of the ponds are sometimes resentful of the pond area used by aquaculture, currently capped at 5 percent of the area of each pond. Wild-harvest shellfishermen also work in the ponds, along with recreational clam diggers and fin-fishermen. The ponds are very popular with recreational sailors, boaters, and paddlers. In addition to RI's busiest fishing port, the Block Island ferry terminal and numerous marinas are located within Point Judith Pond. Managing all of these uses and users – the "social carrying capacity" of the ponds – is an ongoing challenge.

Trustom Pond: An Ongoing Case Study in Coastal Lagoon Dynamics

Trustom Pond is a 160-acre coastal pond completely within the boundaries of the U.S. Fish and Wildlife Service's (US F&WS) Trustom Pond National Wildlife Refuge (NWR) in South Kingstown, RI. Trustom Pond is unique in that it is Rhode Island's only coastal pond free of shoreline development. Moonstone Beach, which is the coastal barrier separating Trustom Pond from Block Island Sound, is managed by the Refuge for the benefit of migratory shorebirds and water birds, including the federally threatened piping plover.

From the 1600s to the 1900s, Trustom Pond was breached twice annually, usually by mechanical methods, to drain adjacent agricultural fields and encourage a healthy shellfish population in the pond. The Trustom Pond NWR was established in 1974 and from 1975-1996 the pond was breached about once per year, primarily to provide foraging habitat for piping plovers and other shorebirds. After 1996, a more natural breaching regime was allowed to take over and the pond was mechanically breached only once, in 2006. Mechanical breaching done by the Refuge typically resulted in the pond being open to the flow of seawater for a period of less than a day to as many as a few days.

Due to the lack of a recent breach, by 2012 Trustom Pond had become a freshwater ecosystem. In recent years, water quality monitoring in the Pond revealed some problems with nutrient enrichment. Each year, some nitrogen and phosphorus concentrations exceeded eutrophic, and occasionally hypereutrophic, levels. Concentrations of chlorophyll-a were also above the hypereutrophic level, and an algal bloom occurred during the summer of 2011. In addition, two species of exotic invasive freshwater aquatic plants, parrotfeather (*Myriophyllum aquaticum*) and Eurasian watermilfoil (*Myriophyllum spicatum*), had been discovered in the Pond between 2007 and 2009. A native aquatic plant, northern water-nymph (*Najas flexilis*), was over-abundant and growing in extremely dense mats.

Then, on October 28, 2012, Trustom Pond breached during extra-tropical storm Sandy. At the time of the breach, the water level in Trustom Pond was very high, which likely contributed to the breach being larger than it had been in previous years. While the breach was active, the water level in the Pond was at least four feet lower than pre-breach and the salinity averaged 29 ppt (seawater is about 35 ppt). These are the highest salinity measurements documented in Trustom Pond; previous breaching events resulted in salinity measurements ranging anywhere from 1.7 to 18 ppt. The breach stayed open for five months until closing naturally on March 24, 2013 (Figure 4). As of September 2013, thanks to the contributions of several freshwater tributaries and heavy spring rainfall, the salinity was down to about 9 ppt and the water level had risen by several feet.

The breach event had an immediate impact on the ecology of Trustom Pond. In past surveys, fish communities consisted of a variety of fresh- and brackish-water species, depending on how recently the pond had been breached. Immediately prior to the 2012 breach the fish community consisted mainly of common freshwater fish such as largemouth bass and pumpkinseed sunfish. Soon after the breach, many dead fish of these and other freshwater species were scattered on the mudflats around the pond, as they cannot survive in salt water. Summer 2013 surveys showed that the fish community in the pond consisted mainly of saltwater minnows like killifish, mummichogs, and sticklebacks. In addition, post-breach plant surveys have shown no evidence of the exotic invasive plants or water-nymph in the Pond, mainly replaced by a brackish-water plant called horned pondweed (*Zannichellia palustris*).

After observing the dramatic changes to Trustom Pond during the breach, many concerned members of the public wondered why the US F&WS had not manually closed the breach. The NWR staff had decided that the breaching event had the potential to both positively and negatively affect wildlife populations of various species. They also heard the opinions of several experts in coastal geology and morphology who (correctly) predicted that the breach would close on its own within a timeframe of weeks to months. Refuge staff collected data during 2013 on water quality, aquatic vegetation, rare plants, breeding and migrating

Figure 3. Steps pond-side residents can take to reduce their impact on water quality.

shorebirds, and fish communities. These data will provide important information on whether the US F&WS should employ a schedule of mechanical breaching as a pond management tool, or whether to allow natural events to dictate the breaching regime of Trustom Pond.

Summary

The coastal lagoons of southern RI are varied, beautiful, and ecologically, economically, and aesthetically valuable. They are also subject to stresses from a variety of sources. To know these ponds is to love them, and as we spread the word about these wonderful resources, we know that more residents of and visitors to their watersheds will become their active stewards and advocates.

References

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Rhonda Smith has worked as a Wildlife Biologist with the Rhode Island National Wildlife Refuge Complex (Refuge) for the past four years; prior to that she spent five years working in the biology field. While at the Refuge, she has coordinated projects such as a saltmarsh integrity assessment, shrubland bird monitoring, native habitat restoration and invasive plant control.

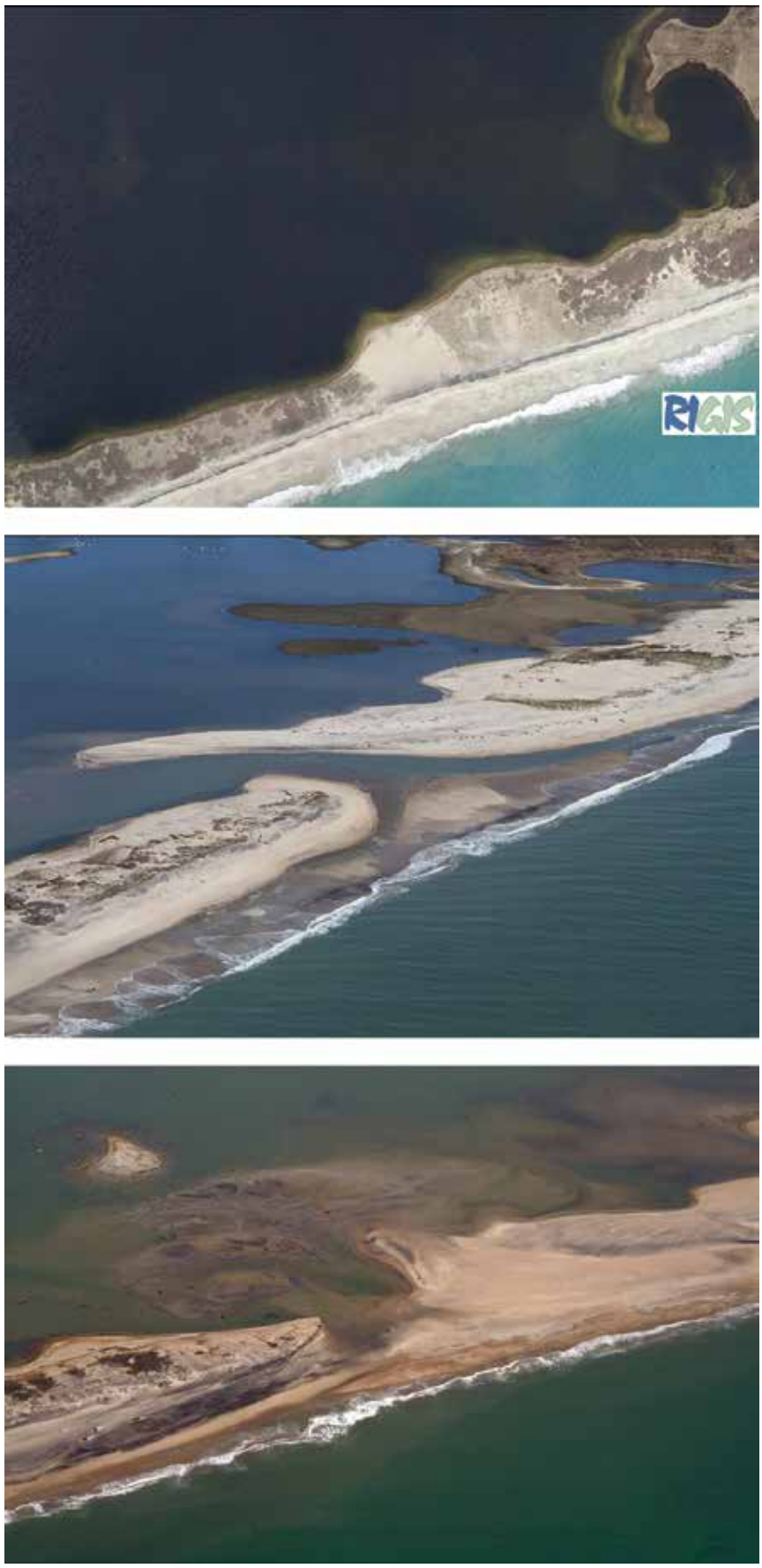

Figure 4. Before (top), during (middle), and after (bottom) photos of Trustom Pond's breach. Photo credits: before (RIGIS); during and after (U.S. Fish and Wildlife Service).