Maine Geologic Facts and Localities

February, 2012

Beach Scraping at Popham Beach State Park Phippsburg, Maine

43° 44‘ 2.36“ N, 69° 47‘ 39.29“ W

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Introduction

In the late winter of 2010, the Morse River cut a new channel to the sea during a period of storms and astronomically high tides (Dickson, 2011). This was a natural process and it resulted in the old channel of the Morse River becoming a back-barrier lagoon (tidal water body) between an offshore sand bar and sand dunes at Popham Beach State Park (Figure 1).

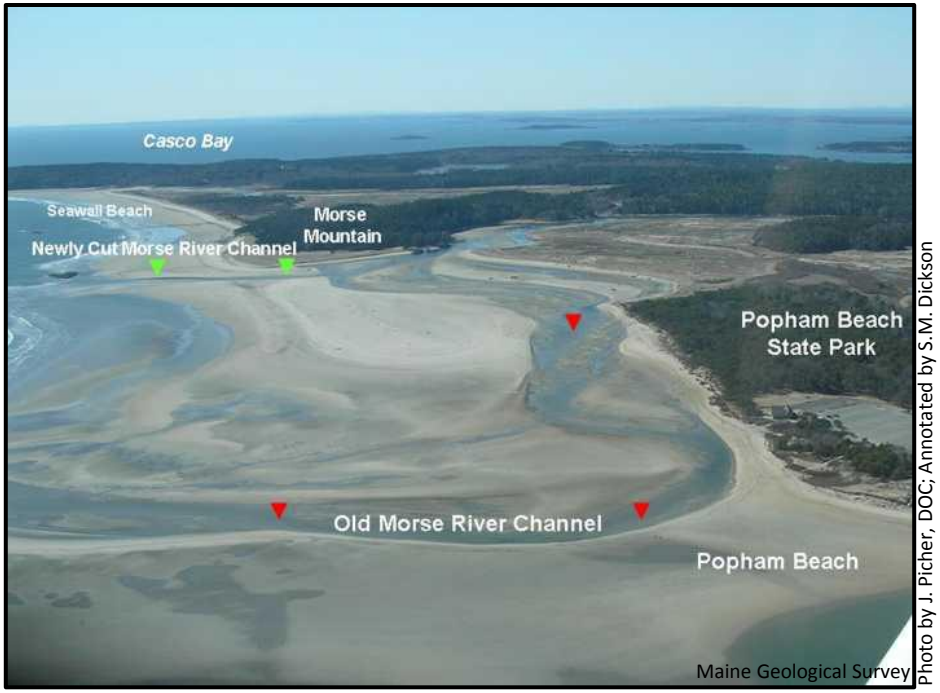

Figure 1. Since 2010 the Old Morse River has been choked with sand from the sand bar in the center of the picture and from sand carried up from the bottom of the photo. The accumulation of sand in the old channel has forced it to meander (curve) farther inland and threaten to undermine the bath house and leach field.

Popham Beach Erosion

Through 2010, sand built up along the east bank of the new Morse River to an elevation that required (and still requires) lagoon outflow to pass along a meandering (bending) course in front of the west bath house at Popham Beach State Park.

As a result of the 2010 Morse River channel avulsion (course change), unprecedented erosion has taken place at the center of Popham Beach State Park during a time when sand was expected to migrate ashore and rebuild the beach and dunes and concerns about erosion would be over. However, during the summer and late fall of 2011, acute erosion next to the west bath house began to move the tides closer and closer to the building and the parking lot.

This new phase of erosion can be attributed to a tidal channel with a tight bend immediately seaward of the bath house. Both flooding and ebbing tidal currents accelerated around this bend and reached speeds of several knots. The outer bend of this channel was a "cut bank" analogous to those in meandering rivers where the fastest currents and deepest channel are on the outside of the bend. On a daily basis, sand was swept away by tidal currents that passed swiftly around a tight bend in the Old Morse River channel.

Popham Beach Erosion

This cut bank continuously eroded sand to the point that the nearest corner of the bath house was about 25 feet from the top of a 10-foot high cut bank (Figure 2, Figure 3). Emergency protective measures taken in advance of the arrival of Hurricane Irene on August 29, 2011 (Fanelli and Fanelli, 2011) regrouped tree wattles at the toe of the embankment in front of the bath house.

Figure 2. A view of the beach and tree wattles immediately seaward of the bath house on July 19, 2011. This shoreline shows up in Figure 5.

Popham Beach Erosion

In addition, cement blocks (the size of Jersey barriers) were placed in a staggered array, on high ground and above the normal action of tides, seaward of the bath house to dissipate wave overtopping and flooding by forecast 30-foot waves. Following the passage of Irene, tidal currents continued to erode the cut bank in September.

Figure 3. Photos taken on August 23, 2011 show the tree wattles are more exposed by erosion and the shoreline is closer to the west bath house. At high tide the waterline is about 4 feet higher up the bank.

Popham Beach Erosion

Tidal current action resulted in about 8 cement blocks being undercut and falling into the channel (Figure 4).

Figure 4. Ongoing erosion of the bank and sand immediately seaward of the bath house resulted in cement blocks being undercut and falling into the tidal channel.

Evaluating the Erosion Threat

Through October, bank erosion continued to encroach on the bath house prompting the removal of the cement blocks from the intertidal zone in early November. On November 7-8, a second round of emergency protective measures rearranged fallen trees into wattles placed along the cut bank and anchored them to cement blocks at the top of the slope and above the reach of the tides. The tree wattles were expected to provide only minor relief from erosion and were not considered sufficient to prevent additional shoreline erosion by both tidal currents and winter storms. Without additional efforts to stem ongoing erosion, the bath house, which is 20-25 feet from the edge, could have been undercut and damaged within a few months by winter storms.

The threat of imminent collapse of the bath house prompted collaboration by two bureaus within the Department of Conservation. The Bureau of Parks and Lands and the Maine Geological Survey teamed up to rapidly evaluate additional efforts that could abate the erosion while working with the natural coastal processes. Ironically, the erosion problem was caused by the onshore migration of sand through a combination of shoaling waves and tidal currents. The offshore sand bar created by the avulsion of the Morse River has been migrating steadily in an east-northeasterly direction (Dickson, 2011, see Figure 19) through 2010.

Evaluating the Erosion Threat

Sand from this bar was naturally transported east-northeast by surf and rising tides. Initially from 2009 to 2010, sand movement led to shoaling in the former Morse River channel to build what geologists call a spit platform (an intertidal sand shoal between a beach and a tidal channel). From 2010 to 2011 this platform accumulated more and more sand and built upward to exceed the elevation of the normal high tides - in effect creating a sand island. This easterly extension and vertical buildup created a subaerial landform called a beach spit. The spit was very effective in forcing the incoming and outgoing tidal flow to and from the back-barrier lagoon farther and farther ashore.

The seaward outflow of the ebbing tidal current also encountered shoaling by onshore sand migration in the form of outer sand bars. These bars diverted the outflow across the Fox Island tombolo (a shore-perpendicular sand bar) in a manner similar to what happened in 2008 (Dickson, 2008) and in earlier episodes of Morse River meandering (Goldschmidt and others, 1991). The lowering of the tombolo has also resulted in a beach spit propagating west into the tidal channel and forcing the cut bank to remain at a fixed in location in front the bath house. Continued onshore sand migration forces the channel to migrate farther inland toward the bath house. Thus, the coastal processes in the fall of 2011 were expected to continue through the winter without intervention.

Evaluating the Erosion Threat

In order to better understand what might be done to alleviate the erosion by tidal currents at the cut bank, the shoreline was surveyed on November 5, 2011 at low tide. This survey delineated the beach spits and tidal channel in front of the bath house (Figure 5). This survey, combined with oblique aerial photography on November 6, 2011, helped illustrate the current conditions. A synthesis of coastal geological processes and sediment budgets has been provided in previous work (FitzGerald and others, 2000; Goldschmidt and others, 1991; Nelson, 1979).

Evaluating the Erosion Threat

Figure 5 shows the beach survey. Note about 50 feet of upland dune loss in the vicinity of the bath house between July and November. The low tide line is inland of the dune line (approximately the spring high tide line) in July. The narrow area between the two blue lines is where water remained at low tide. The outer cut bank of the Old Morse River channel is clearly delineated by the curve in the northernmost blue line. See Figure 7 for an oblique air photo taken on November 6, 2011.

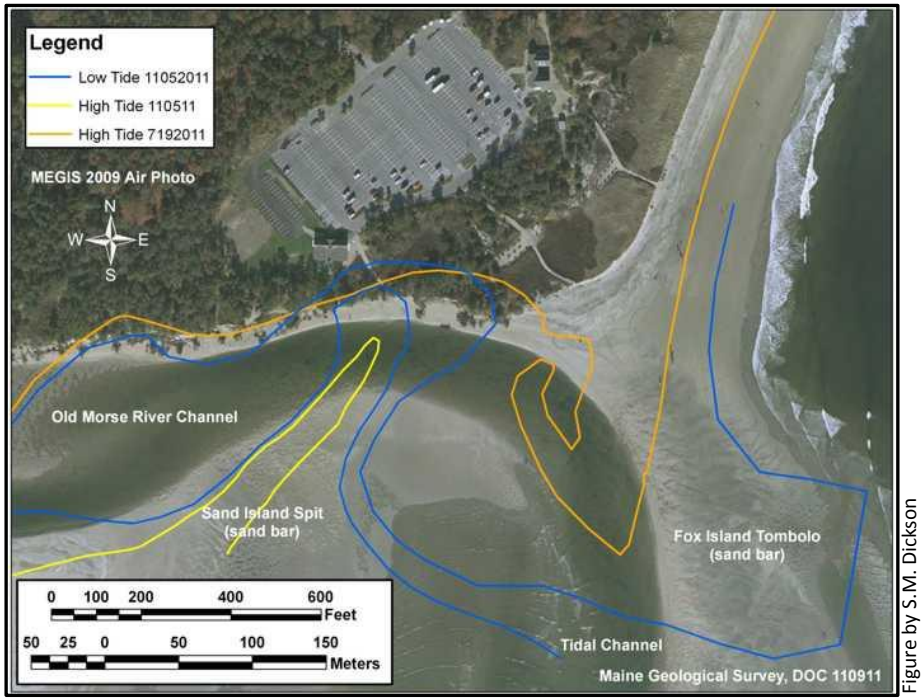

Figure by S.M. Dickson

Figure 5. The map base is a 2009 air photograph. The blue line is a shoreline survey of the low-tide position of the Old Morse River on November 5, 2011. The orange line is a survey of the July 19, 2011 dune edge (Figure 2). The yellow line is the portion of the sand spit that was above the high tide line on November 5, 2011.

Evaluating the Erosion Threat

The geomorphology seen in a time series of ground and aerial photographs plus historical shoreline change (Figure 6) and decades of direct observations at Popham Beach State Park by the Department of Conservation's Bureau of Parks and Lands led the Maine Geological Survey to recommend beach scraping to rapidly abate the erosion problem with minimal environmental impact.

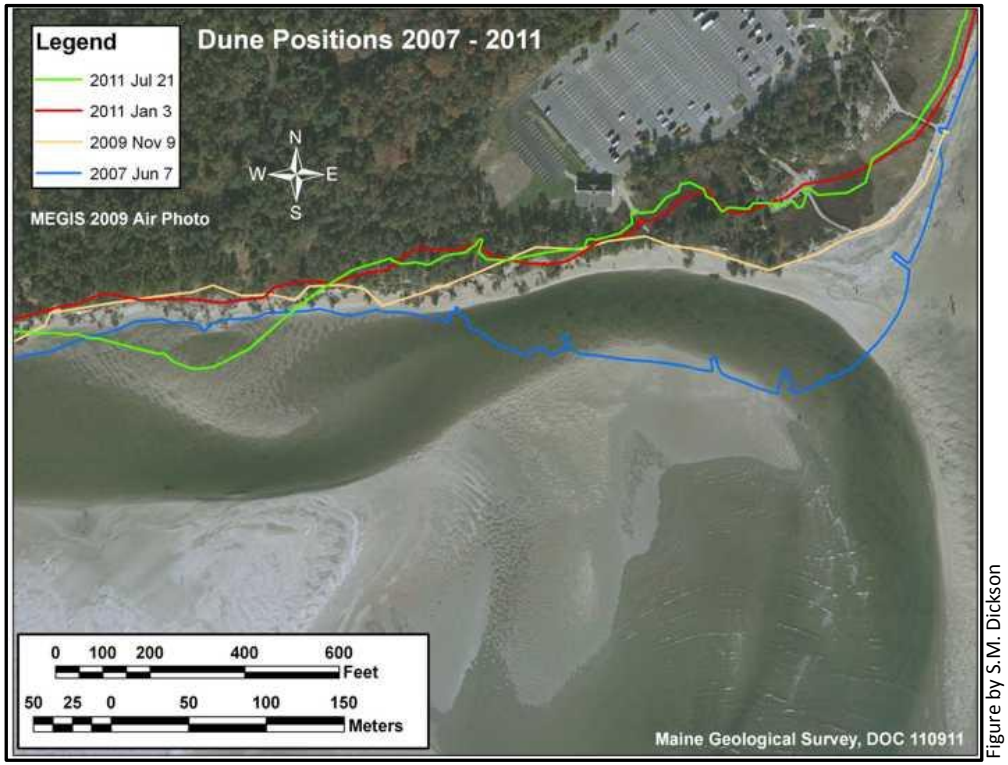

Figure by S.M. Dickson

Figure 6. Shoreline change represented by migration of the seaward edge of dune vegetation from June 2007 to July 2011. Over 300 feet of dune was lost between 2007 and 2011 at Popham Beach.

Responding with Beach Scraping

Beach scraping is a process of moving sand on a beach. The goal of beach scraping here was to redistribute and, following the natural onshore migrating direction, to infill the channel next to the bath house (Figure 7). This approach was considered the most natural way to quickly slow the erosion. In consultation with the U.S. Army Corps of Engineers and Maine Department of Environmental Protection, DOC applied and received permits for sand movement on the winter beach.

Figure 7. Pre-scraping conditions at the Old Morse River channel adjacent to the bath house. Sand would be moved from the spit to infill the channel in front of the bath house, restoring a beach slope, and plugging a constriction in the channel. Closing off the flow would also result in a new and shorter channel in the area marked New Channel Axis.

Responding with Beach Scraping

This effort was localized and took into consideration coastal processes, the beach sand budget, possible effects on neighboring properties, recent piping plover nesting habitat, and sensitive coastal sand dunes. The project did not import sand as is done in some beach restoration projects. Instead, sand was simply moved from one section of beach to another (Figure 8).

Figure 8. Beach scraping with bulldozers moved sand in a landward direction across the beach spit toward the bath house.

Responding with Beach Scraping

Beach scraping started on December 1, 2011 and was completed in a week. This effort was undertaken during daylight neap low-tide cycles and involved redistributing 10,000 cubic yards of beach sand in a landward direction (Figure 9).

Figure 9. Sand from the spit was loaded into dump trucks and used to fill the tidal channel.

Resulting Conditions

Channel infilling resulted in a landform that resembles the low-tide terrace that exists seaward of most beaches and occupies the lowest third of the tidal range. Most of the 10,000 cubic yards of sand was placed directly seaward of the bath house (Figure 10).

Figure 10. A view of the new beach face seaward of the bath house four days after it was created by beach scraping. Wind and wave action is gradually removing the tracks from the bulldozer. The tree wattles and vertical dune scarp are covered with sand. The recent high tide line is delineated at the upper reaches of the wet beach.

Resulting Conditions

Channel remnants remained in the form of troughs with standing water at low tide in areas upstream and downstream from the bath house. These troughs are likely to be ephemeral and infill once the tidal channel is displaced seaward (Figure 11).

Figure 11. Beach scraping infilled the channel and built a beach just seaward of the bath house at the corner of the parking lot at Popham Beach State Park. The new beach face is snow-covered and sloped above the limits of the high tide to provide wave dissipation during winter storms.

Resulting Conditions

With the removal of the bend in the channel, onshore migration of sand is expected during the 2012 winter (as it did from 2009-2010). Sand is also expected to accumulate in front of the bath house from wind and wave action from the east that blows or washes sand in a westerly direction across the tombolo. The resulting configuration without the channel next to the bath house will be similar to the pre-existing 2009 condition.

The work effort was over 500 feet away from the piping plover nesting areas fenced off and protected with predator enclosures in the summer of 2011. The habitat was undisturbed by beach scraping and the vegetated habitat remains and will likely be used in the upcoming 2012 nesting season.

The evolution of this system will be closely monitored by the Bureau of Parks and Lands and the Maine Geological Survey. Additional updates may be posted on the Maine Geological Survey web site in the future.

A Final Word of Caution

The rapidly shifting sand bars, troughs, pools, and tidal currents can result in soft areas of sand on the beach. Please use caution when walking on the beach. As time progresses, the sand will become more firmly packed and less unstable under foot. As always, at Popham Beach State Park, be mindful of the incoming tide and do not get stranded without an easy way to walk back to the mainland. Do notice the rapid changes to the beach and dunes since your last trip. We hope you enjoy your next visit with this background information in mind.

References and Additional Information

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