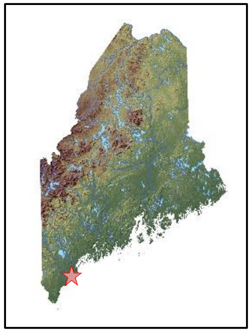
Maine Geologic Facts and Localities

January, 2018

Surveying Beach and Bathymetry Changes near the Scarborough River, Scarborough, Maine



43° 32‘ 29” N, 70° 19‘ 38” W

Text by
Peter A. Slovinsky

Introduction

In the past decade, the Maine Geological Survey (MGS) published several different Maine Geologic Facts and Localities on beach nourishment in 2006, how MGS measures shoreline erosion in 2011, and dune and beach restoration efforts in 2014 at Western and Ferry Beaches, adjacent to the Scarborough River in Scarborough, Maine.

The Scarborough River was once again dredged in winter 2015, and approximately 116,325 cubic yards of dredged material was placed onto nearby Western Beach to create a wide dry beach and restore sand dunes. In order to better understand how the nourished beach (and restored dunes) are responding, in September of 2016 and 2017, with funding from NOAA, marine geologists from the MGS completed topographic and bathymetric survey work in the vicinity of the Scarborough River, namely at Ferry, Western, and Pine Point Beaches in Scarborough, ME.

Map from Google Maps, December 2017

Figure 1. Google satellite imagery map of Scarborough River area.

Methodology Part I

The project was composed of two distinct survey methods. A network of stakes marking 135 shore-perpendicular transects were set using a Trimble handheld GPS. Each transect extended from the back dune seaward to near the mean low water mark. A pole-mounted Leica or Ashtech RTK-GPS was then used to acquire dune and beach elevations, taking a point of X and Y (Easting and Northing) position, and elevation (referenced to NAVD88) about every 10 paces. These were conducted at and near low tide so that scientists could wade as deep as possible into the water, collecting elevation points. This results in a point cloud of approximately 1,400 terrestrial data points.

Later, during higher tides, the MGS Nearshore Survey System (NSS), a personal watercraft-based survey platform outfitted with RTK-GPS and a precise single-beam echo-sounder (Figure 1), was used to collect bathymetry along the same shore perpendicular transects so that points could be overlapped (Figure 2). Additionally, survey transects were completed parallel to the beach. Points were collected at a rate of every 2 seconds, resulting in a point cloud of over 30,000 bathymetric points for the study area.

Photos by Peter A.Slovinsky

Figures 2a & b. MGS personal watercraft-based bathymetric survey system.

Methodology Part II

Collected bathymetric data with the NSS was then offset both horizontally (from the antenna to the position of the depth sounder) and vertically (from the antenna to the water level) in the office. Terrestrial and nearshore points were merged into one GIS file (Figure 3), and interpolated using an inverse-distance weighting (IDW) algorithm. Since the high-tide and low-tide measurements overlap with each other near the mean low water mark, this allowed the production of a continuous raster map of the bathymetry/topography of the entire inlet and dune system. Digital Elevation Models, or DEMs, for 2016 and 2017 are shown in Figures 4 and 5, respectively.

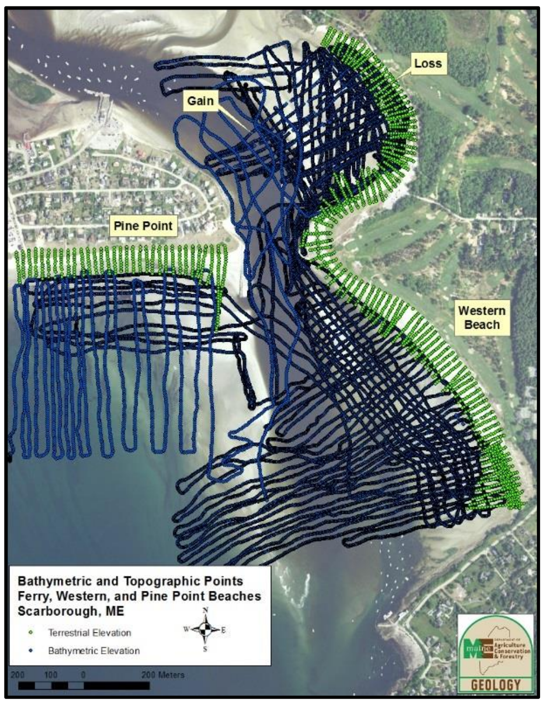


Figure 3.

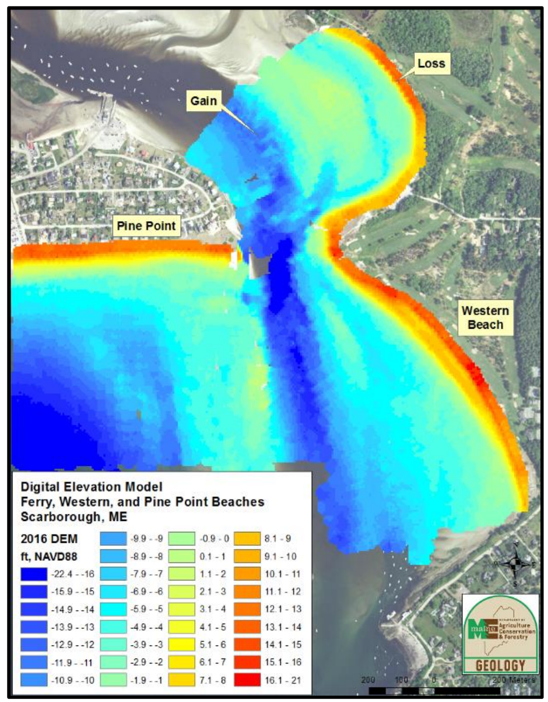


Figure 4.

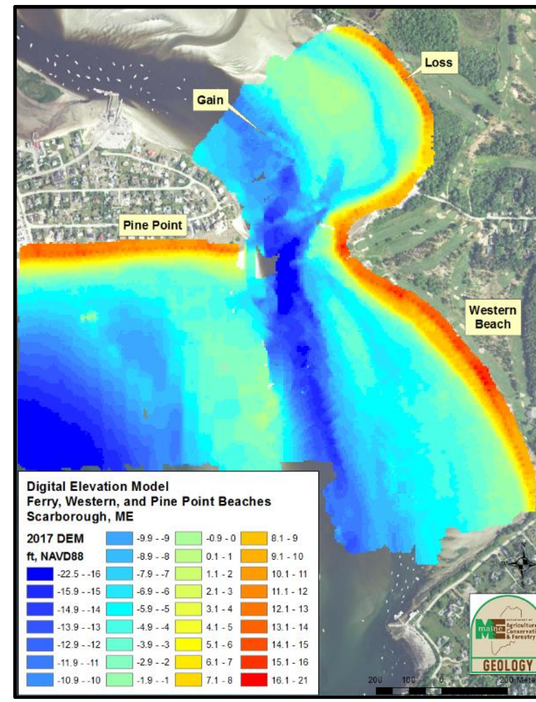


Figure 5.

Maps by Peter A. Slovinsky

Results

Since subsequent elevation surveys were completed in 2016 and 2017, the 2016 DEM was subtracted from the 2017 DEM, producing a map of the 2016-2017 changes in elevation (Figure 6). In this image, areas of elevation loss are shown in deepening colors of blue, while areas of elevation gain are shown in shades of yellow, orange and red.

In terms of elevation losses, the largest change occurred on the western side of the main channel of the Scarborough River, where the side of the channel deepened by up to 12 feet (Loss 1). Adjacent to this, the ebb-tidal shoal of the river gained large areas of sand in several distinct areas (Gain 1, Gain 2, and Gain 3). Just northeast of the jetty was a distinct area of elevation loss in the channel (Loss 2), but gains in several areas of the channel (Gain 4, 5), indicating channel shoaling. Along the central portion of Pine Point Beach was an area of beach loss (Loss 3), which connected to Loss 1, indicating a cut-channel had formed along the sandbar. Gains occurred on the beach (Gain 6) farther to the west.

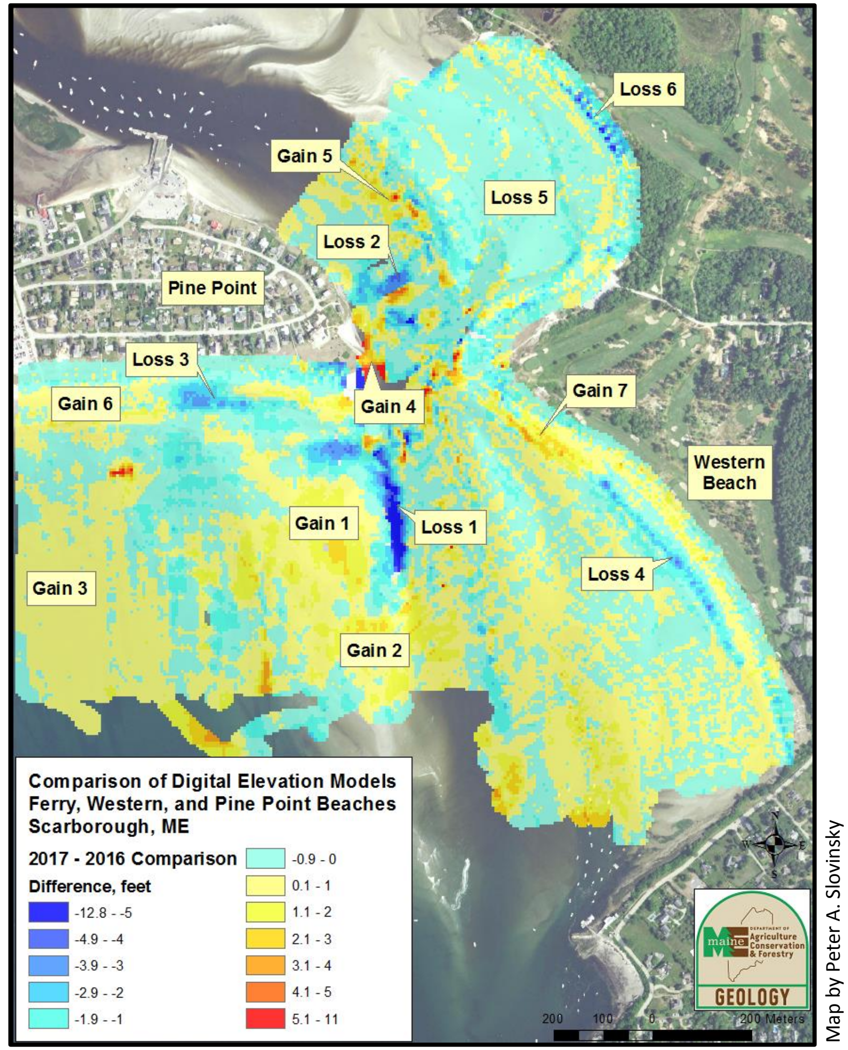
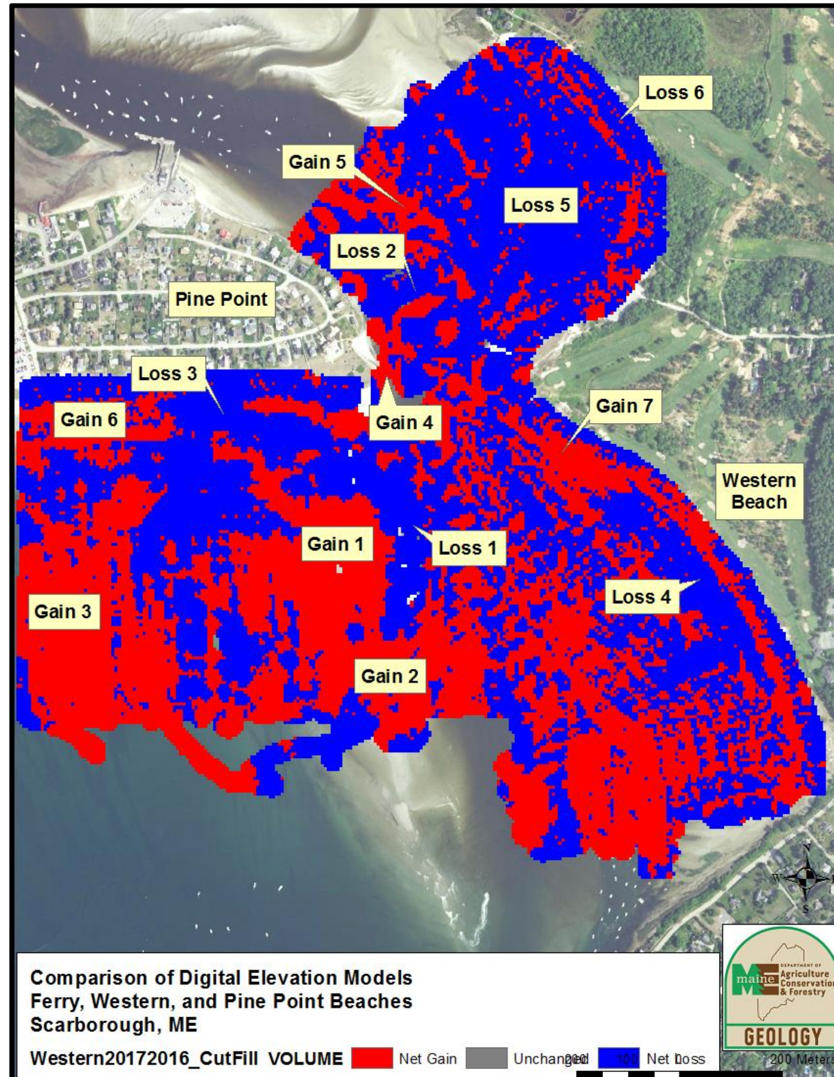


Figure 6. Map showing elevation gain or loss between the 2016 and 2017 surveys.

Results (continued)

The nourished beach at Western Beach lost elevation along a large section (Loss 4), but gained to the northwest (Gain 7), indicating that sediment moved northwest, along the beach. The large flood-tidal delta within the river appeared to lose elevation slightly (Loss 5), and the artificially constructed dune along Ferry Road clearly lost elevation (Loss 6). These changes may be more easily viewed as cut/fill (loss/gain), as shown in Figure 7.



Map by Peter A. Slovinsky

Figure 7. Map showing elevation cut/fill (loss/gain) between the 2016 and 2017 surveys.

Drone Imagery Comparison

During both years, the Greater Portland Council of Governments (GPCOG) was contracted to fly a unmanned aerial vehicle, or drone, to capture high-resolution ortho-imagery of the study area, thereby supplementing the elevation data with imagery. Subsequent drone flights by GPCOG allowed for further visual comparison of the morphologic changes between 2016 and 2017 in the vicinity of the Scarborough River. The differences in the imagery clearly show the areas of gain and loss from analysis of the elevation changes.

Images courtesy of the Greater Portland Council of Governments

Figure 8. Screen capture of the GPCOG imagery comparison tool – 2016 (left) and 2017 (right).

Conclusions

Terrestrial and bathymetric surveys in the vicinity of the Scarborough River indicate that, overall, there was more net gain (shoaling) in the study area than loss (erosion). This is likely due to sediment coming into the system from the southwest, from along Old Orchard Beach and the Saco beaches. Several distinct areas of sediment movement (e.g, deepening of the main channel and gains adjacent to the bar, loss of nourishment sand along Western Beach and gains to the northwest) provide some insight into sediment migration. The small secondary channel adjacent to Western Beach appears to be moving sediment from south to north, along the Beach, back towards the flood tidal delta. This is supported by anecdotal evidence which shows that currents move to the north, even during large portions of falling tides (water is entrained by the main channel as the tide ebbs, pulling water in this secondary channel to the north).

Changes adjacent to the main channel and along Pine Point Beach show the distinct deepening of the channel, and growth of the sandbars and shoals of the ebb tidal delta that extend from Pine Point southwards.

Continued subsequent surveys of the Scarborough River region are planned for 2018 and 2019. This will help us better understand sand migration patterns, and subsequently, how best to place dredged sediments in the future to ensure longer lifetime on the beach. This will help protect infrastructure, and benefit numerous recreational users and migratory bird species.