Maine Geologic Facts and Localities

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A Summary of the 2015 State of Maine's Beaches Report

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Introduction

The 2015 State of Maine's Beaches Report is the 5th report in a biennial series (Slovinsky et al., 2013; Slovinsky and Dickson, 2011; 2009; 2007) that summarizes observed changes of Maine beaches monitored as part of the State of Maine Beach Profiling Project (SMBPP; Maine Sea Grant, 2015) and the Maine Beach Mapping Program (MBMAP). The time period for analysis of this report was 2010 to 2015.

The SMBPP uses trained volunteers to collect monthly beach profiles that start at a fixed benchmark (in the front dune or in a seawall) and continue shore-perpendicular to roughly the low water line using the Emery Method of beach profiling (Emery, 1961). Typical beach profile data from Laudholm Beach in Wells is shown below. The data are entered by volunteers into an online database where it can be viewed, graphed, and downloaded by others (Maine Shore Stewards, 2015). SMBPP is funded and managed by the Maine Geological Survey (MGS), Maine Sea Grant, Maine Coastal Program, and several municipalities.

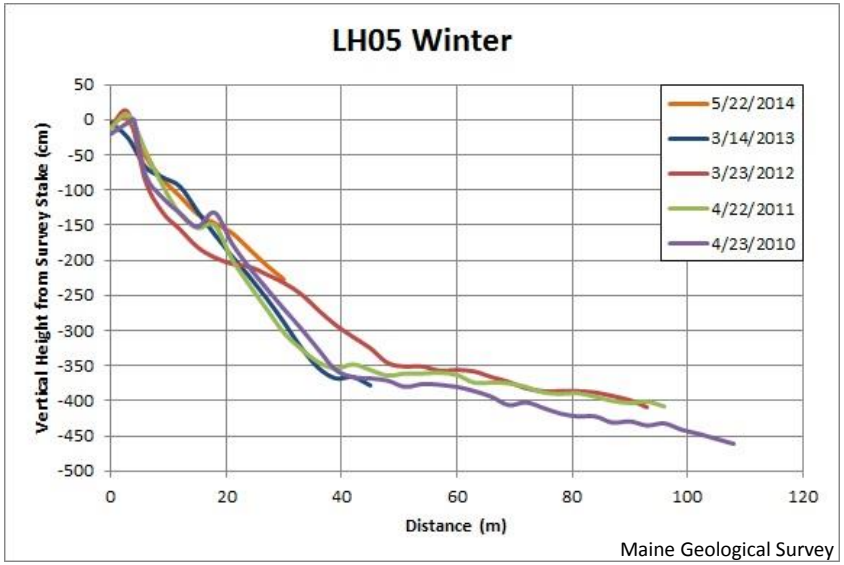

Figure 1. Example of winter beach profiles for profile LH05 (Laudholm Beach, Wells) from 2010 to 2014 that were used for the 2015 beaches report.

Data Collection

As part of MBMAP, MGS scientists collect shore-parallel data along the seaward extent of dominant dune vegetation along the larger beach systems in southern and mid-coast Maine. Data is collected using a Real Time Kinematic Global Positioning System (RTK-GPS) on an annual basis, and is compiled in GIS by the MGS. This data is then analyzed using USGS DSAS software (Thieler et al., 2008) to calculate shoreline change rates at cast transects along a beach.

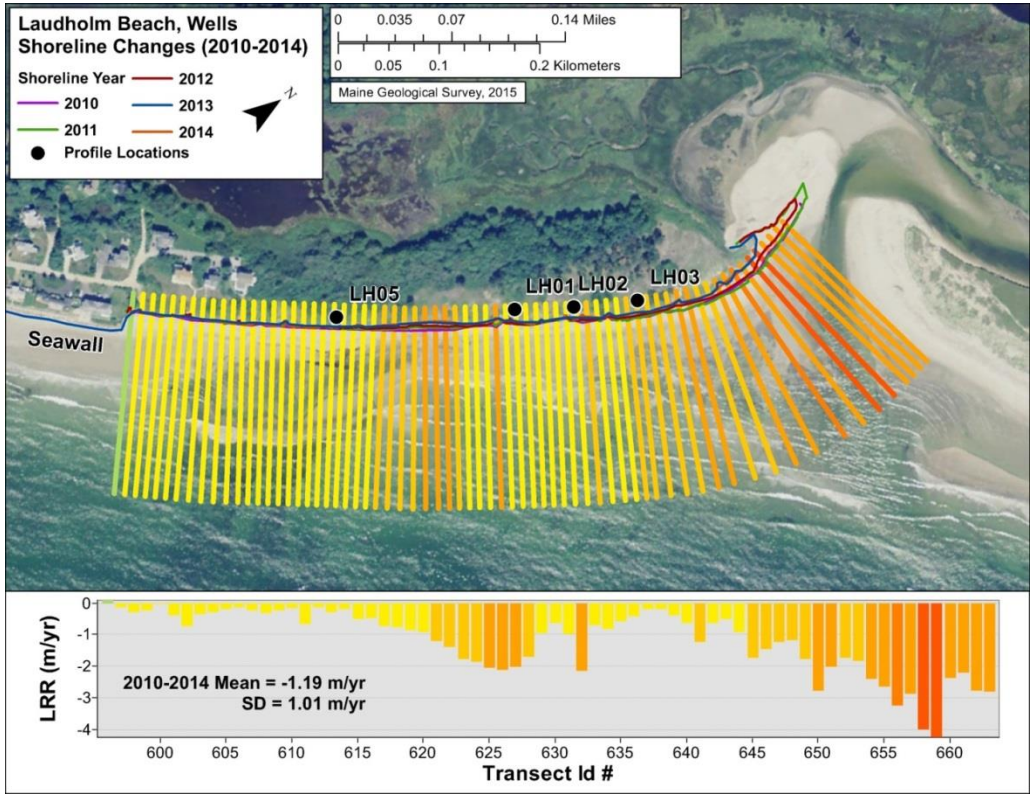

Figure 2. An example of MBMAP shoreline change results for Laudholm Beach, Wells. 2013 base imagery from Maine Office of GIS.

Beaches Profiled

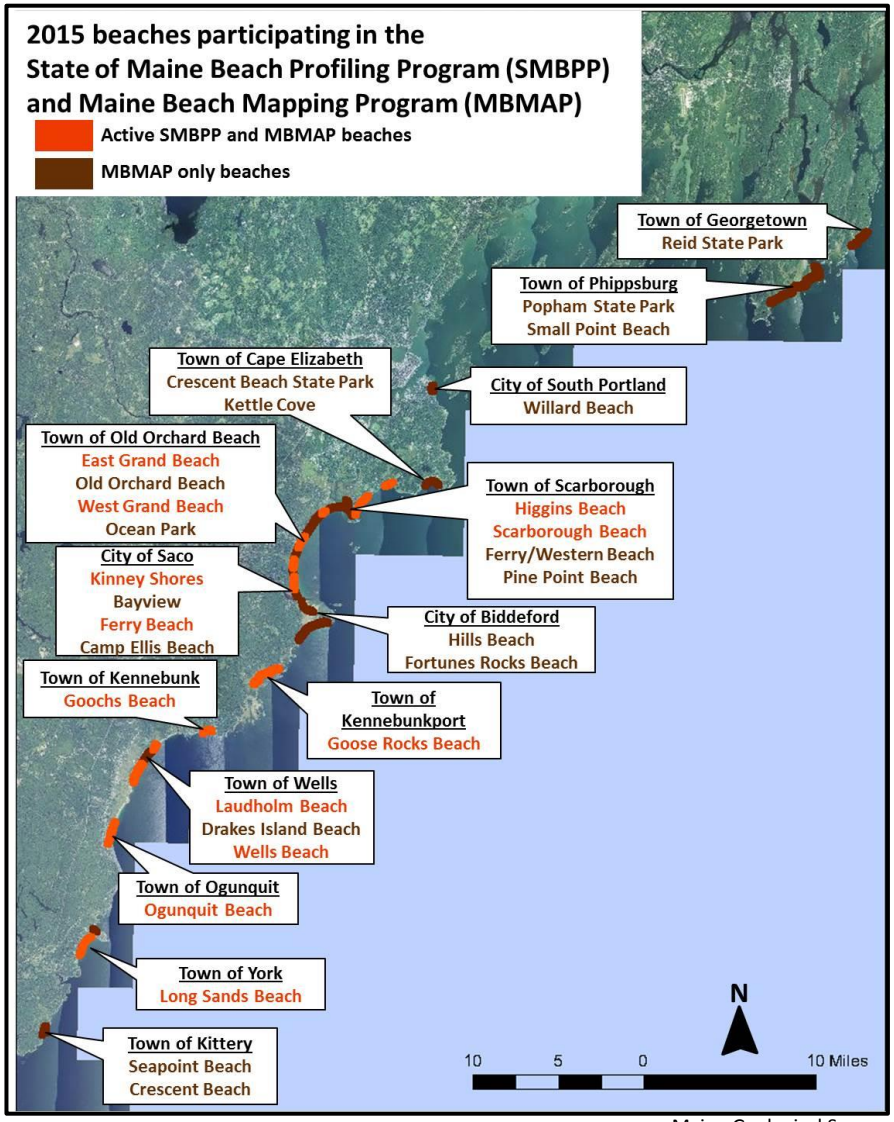

Figure 3. Beaches participating in the Maine Beach Mapping Program (MBMAP) and/or the State of Maine Beach Profiling Program (SMBPP). 2013 base imagery courtesy of Maine Office of GIS.

Factors Influencing Beach Erosion: Abrupt Sea Level Rise of 2009-2010

Over the past century, sea level at Portland, Maine rose at an average rate of about 1.9 mm/yr. Over the past 20 years, this has increased up to about 4.2 mm/yr. Some of the highest annual mean sea levels ever recorded at Portland occurred between 2010 and 2014, with 2010 having the highest recorded value over the 102 year period.

During a few months in the summer of 2009, higher than normal sea levels were observed up and down the East Coast of the United States (Sweet et al., 2009). This was attributed to two factors 1) a period of steady northeasterly winds due to atmospheric conditions; and 2) a slowdown in the Florida Current (supplying the Gulf Stream), which brings warm, salty water into the North Atlantic. These combined factors resulted in a sloshing effect that raised ocean elevations along the East Coast of the United States.

Additional research (Goddard et al., 2015; Yin and Goddard, 2013) determined that similar phenomenon extended into the winter of 2010, and that tide gauges in the Gulf of Maine exhibited the highest sea level rise changes on the East Coast. These elevated sea levels were likely caused by a combination of 1) atmospheric patterns (part of the North Atlantic Oscillation) which allowed formation of a number of northeast storms that moved up the coastline in the Gulf of Maine, and 2) a significant slowdown of the Gulf Stream portion of what is known as the Atlantic Meridional Overturning Circulation.

Factors Influencing Beach Erosion: Abrupt Sea Level Rise of 2009-2010

Figure 4 shows monthly mean sea levels at the Portland tide gauge from January 2009 to May 2015. Note how sea levels increased significantly in the summer of 2009, and then spiked in the early winter months of 2010. In fact, the highest sea levels ever recorded for January to April and December occurred in 2010. Since the peak in the winter of 2010, the overall trend has been a decrease with 2015 having some of the lowest readings during this time period. The time period from 2009-2012 accounts for 9 of the highest annual sea levels recorded since 1912.

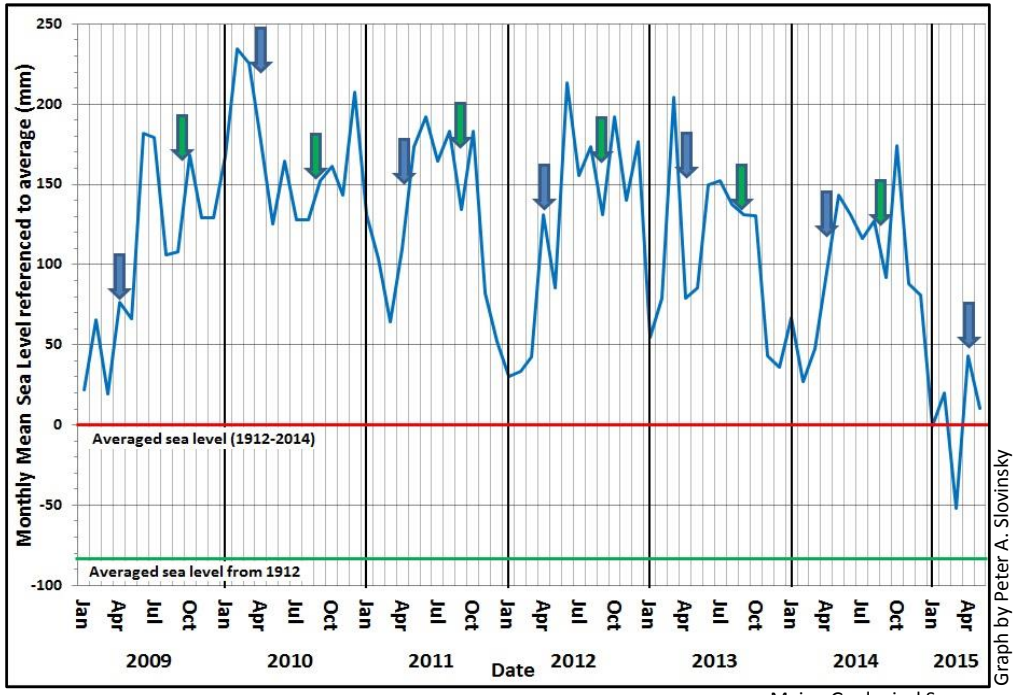

Figure 4. Monthly mean sea levels from January 2009 to May 2015. Data has been adjusted so that "0" refers to the average long-term sea level from 1912-2014. Approximate times of beach profile data collection for winter (blue arrows) and summer (green arrows) are shown. Data courtesy of NOAA CO-OPS.

Factors Influencing Beach Erosion: Winter Storms

Northeasters typically cause erosion of Maine's beaches and dunes, especially during winter months. Generally, the winters of 2009-2010 and 2012-2013 had some of the highest average and peak wave heights, while others were somewhat calmer. In winter 2010, elevated sea levels combined with a weather pattern that allowed northeasters to track up the Gulf of Maine coastline and resulted in some of the worst erosion seen. Generally, winter storms in 2014 and 2015 were less strong, and also coincided with lower sea levels than 2009 and 2010. For a detailed account of each winter's storms, please refer to the full beaches report.

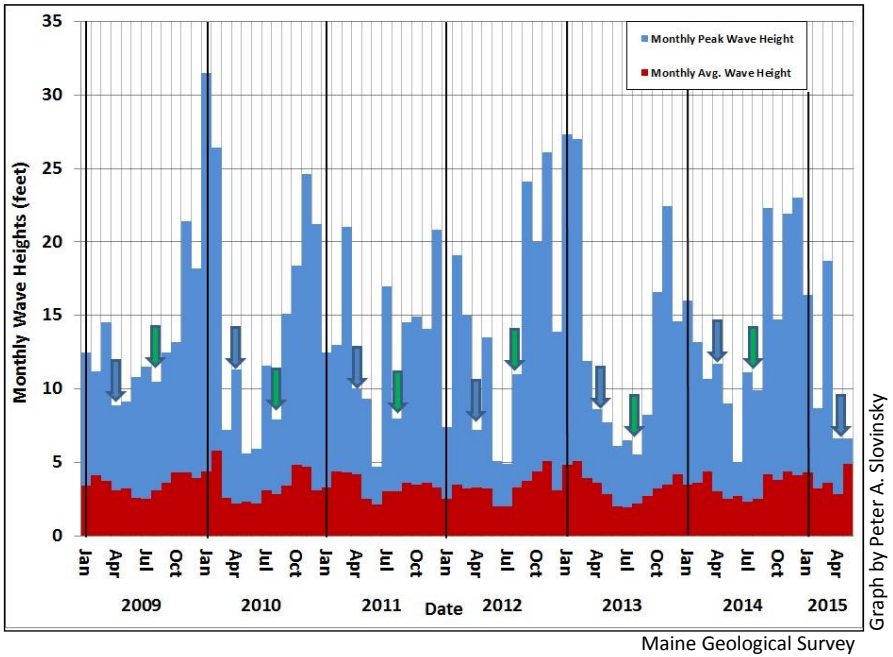

Figure 5. Monthly mean and peak wave heights, in feet, from January 2009 to May 2015. Note extremely high average and peak heights in January-February 2010, and January-February 2013. Approximate times of beach profile data collection for winter (blue arrows) and summer (green arrows) are shown. Data courtesy of NERACOOS.

Review of Beach Responses from Analysis of SMBPP and MBMAP Data

A scoring system was used to assess beach changes from 2010 to 2015 collected by the SMBPP. Each beach profile was assigned a "grade," based on the amount of erosion, stability, or growth exhibited by both summer and winter beach profile shapes. Then, for each beach, a mean grade for the "winter" beach changes (2010 to 2015) and the "summer" beach changes (2010 to 2014) was created. Finally, an overall beach grade was assigned, as an average of all the summer and winter profile scores. This grading system is qualitative but similar to that used in previous reports.

The MBMAP shoreline change data were used to calculate linear regression rates (LRR, in meters per year, m/yr) at 10-meter transect intervals along each beach. Mean values for each beach were calculated and then used to develop a grading system.

It's important to note that using a mean calculation for an entire beach is not necessarily representative of the beach's stability at all points. For example, a beach that is eroding along one stretch and accreting along another may have a mean value that indicates little change (a stable beach).

Grade	Numerical Score	SMBPP Score Description	MBMAP Score Description
A	95	**Excellent** (profile shows excellent recovery since 2010 with continued accretion and growth)	**Extremely Accretive (+), Very Highly Accretive, Highly Accretive (-)** (LRR > 1.25 m/yr)
B	85	**Very Good** (profile shows very good recovery since 2010 with growth and stability)	**Very Accretive (+), Accretive, Somewhat Accretive (-)** (1.25 m/yr > = LRR > 0.5 m/yr)
C	75	**Satisfactory but Cautionary** (profile shows some growth or stability, but may have one or two years of erosion since 2010)	**Slightly Accretive (+), Relatively Stable, or Slightly Erosive (-)** (0.5 m/yr >= LRR >= -0.5 m/yr)
D	65	**Very Cautionary** (profile shows lots of signs of instability since 2010 , including numerous years of erosion or massive erosion for a short period of time)	**Somewhat Erosive (+), Erosive, Very Erosive (-)** (-0.5 m/yr > LRR >= -1.25 m/yr
F	55	**Fail** (profile shows no recovery since 2010, with extensive, continued erosion)	**Highly Erosive (+), Very Highly Erosive, Extremely Erosive (-)** (LRR < -1.25 m/yr)
Note: scores can have a + or - which will add or subtract 3 points			
LRR = Linear Regression Rate			

Table 1. SMBPP and MBMAP grading system used in the State of Maine's Beaches in 2015 report.

Discussion of Combined SMBPP and MBMAP Scoring Results

Scores from the two beach monitoring programs were combined to create an overall score for each beach. Winter and summer profile scores were combined with the MBMAP scores, where both were available, to create an average score for each location. If only MBMAP data was available, the actual shoreline change rates were compared to determine overall rankings.

Rank	Beach	Municipality	SMBPP Scoring			MBMAP Scoring	Average SMBPP and MBMAP
			Winter	Summer	Overall		
1	Popham - Coast Guard	Phippsburg	-	-	-	98	98
2	Small Point	Phippsburg	-	-	-	98	98
3	Pine Point	Scarborough	-	-	-	88	88
4	Fortunes Rocks	Biddeford	-	-	-	85	85
5	Reid - Mile Stretch	Georgetown	-	-	-	85	85
6	Reid - Half Mile	Georgetown	-	-	-	82	82
7	Willard	South Portland	-	-	-	82	82
8	Scarborough	Scarborough	78	83	80	82	81
9	East Grand	Old Orchard	77	77	77	88	81
10	Long Sands	York	79	84	81	78	80
11	Goose Rocks	Kennebunkport	79	79	78	78	79
12	Ocean Park	Old Orchard	-	-	-	78	78
13	Hills	Biddeford	-	-	-	78	78
14	Popham - Morse River	Phippsburg	-	-	-	78	78
15	West Grand	Old Orchard	-	-	78	78	78
16	Kinney Shores	Saco	79	75	77	78	77
17	Higgins	Scarborough	77	72	75	78	76
18	Ferry	Scarborough	-	-	-	75	75
19	Crescent	Cape Elizabeth	-	-	-	75	75
20	Kettle Cove	Cape Elizabeth	-	-	-	75	75
21	Popham - State Park	Phippsburg	-	-	-	75	75
22	Drakes Island	Wells	-	-	-	75	75
23	Crescent	Kittery	-	-	-	75	75
24	Goochs	Kennebunk	75	80	79	68	74
25	Ogunquit	Ogunquit	72	75	74	75	74
26	Wells	Wells	75	73	74	75	74
27	Bayview	Saco	-	-	-	72	72
28	Seapoint	Kittery	-	-	-	72	72
29	Ferry Beach	Saco	70	68	69	62	67
30	Laudholm	Wells	65	65	65	62	64
31	Western	Scarborough	-	-	-	58	58
32	Camp Ellis	Saco	-	-	-	55	55
33	Popham - Hunnewell	Phippsburg	-	-	-	52	52
Averages			75	76	76	76	76

Table 2. Overall rankings of beaches using available SMBPP and MBMAP datasets.

Based on this combined approach, 10 of the 33 beaches (30%) had overall scores of a B- or higher. These beaches showed overall good to very good recovery between 2010 and 2014. Thirteen beaches (roughly 40%) had scores ranging from a C to C+, indicating relative stability with slight accretion. Five beaches (15%) were slightly erosive. And only five beaches (15%) had failing scores, noted as an average of a D or F.

This indicates that 70% of the monitored beaches had generally recovered from 2010 (or 2013 in some cases) lows, with 15% showing slight erosion, and 15% continued, extensive erosion during that time period.

When the scores from all beaches are combined and averaged, the overall score was a C(76). This is consistent with both SMBPP and MBMAP individual scores. These results indicate that beaches are, in general, stable or recovering since 2010.

Conclusions

In the last two State of Maine's Beaches reports (2011 and 2013), many beaches and dunes were showing signs of erosion. In the 2015 assessment,73% of the beaches showed trends of improving conditions. Trends in mean sea level showed that between 2010 and 2015, sea levels rose to a peak in 2010 and 2013, and fell in 2014 and 2015. Wave data indicated that storms were less severe in the winters of 2011, 2012, and 2014 than they were in 2010 and 2013. In 2015, although there were many winter storms, sea levels were much lower than in the previous 6 years. In addition, due to large amounts of snow and intense cold, much of the beach and dune remained frozen during the stormy winter months of 2014-2015 thus decreasing upper profile erosion. As of spring 2015, many Maine beaches showed vigorous signs of dune vegetation growing seaward.

The State of Maine's Beaches Report series provides volunteer monitors, general public, and local, regional, and state decision-makers and managers with a better sense of the status of southern and mid-coast Maine beaches. Data supporting this report, collected by volunteers and MGS scientists, are vital to better understanding monthly, seasonal, and yearly patterns of beach change. This data helps to understand the longer-term trends of beach changes along the southern Maine coast, and how beaches respond to storm events and variability in sea level.

The full text and figures of the 2015 Maine's State of the Beaches report can be accessed at:
http://www.maine.gov/dacf/mgs/explore/marine/beaches15/2015beachesreport.pdf

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