State of Maine's Beaches in 2015

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Contents

Maine Geological Survey
Open-File 15-25

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Background

The 2015 State of Maine's Beaches Report is the 5th report coinciding with the biennial Maine Beaches Conference. This report summarizes observed changes of Maine beaches that are monitored as part of the State of Maine Beach Profiling Project (SMBPP, Maine Sea Grant, 2015) and the Maine Beach Mapping Program (MBMAP).

The SMBPP uses trained volunteers to collect monthly beach profiles that start at a benchmark (in the front dune or in a seawall) and continue shore-perpendicular to roughly the low water line. Fixed starting locations are used with the Emery Method of beach profiling (Emery, 1961). 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), University of Maine, Maine Sea Grant, and Maine Coastal Program. Beaches participating in the SMBPP are shown in Figure 1.

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. MBMAP beaches are shown in Figure 1.

This report will focus on documenting changes at SMBPP and MBMAP beaches since 2010. Previous editions of this report (2011 and 2013), in addition to more recent studies (see *Setting the Stage: Sea Level Changes and Storms*) found that the winter of 2010 was especially erosive due to storms and higher than normal sea levels. Thus, this report will inspect subsequent changes at beaches from 2010 through winter 2015.

Spatial and Temporal Extent of: Beach Profile Data

Along each collected beach profile, topographic (elevation) points are collected at about 3-meter (10-foot) intervals, from the starting point (usually a stake in the dune crest or mark on a seawall) seaward to the low-water line using the Emery Method of profiling.

This report will compare profile data starting in 2010 with profile data from the subsequent closest months from 2010 to 2015, as available. The report analyzes changes in the "winter" and "summer" beach shapes from 2010 through the winter of 2015, or the summer of 2014, in order to investigate whether or not the typical recreational beach – usually defined by a wider, sand rich beach profile – was able to recover each year. Summer beach shapes are typically fully developed by August or September, after a season of gentle waves and accretion. Because we have not reached summer shapes for 2015 that data is not being included. Late spring is typically when the beach profile shape is lean, with little sand on the upper portion of the beach after a season of winter storms. Beach profiles that were used for this analysis are shown in Table 1.

Spatial and Temporal Extent of MBMAP Data

We will compare the horizontal positions of the surveyed **vegetation line** from 2010 to 2014, as data is available. MBMAP shorelines follow the color scheme used for the profile data**: 2010 (purple), 2011 (green), 2012 (red), 2013 (dark blue), and 2014 (orange)**. The **linear regression rate (LRR)**, or the shoreline change rate computed using a linear regression fit between available data, was calculated using the United States Geological Survey (USGS) Digital Shoreline Analysis System (DSAS) tool (Thieler and others, 2008), and shown for each beach. MBMAP data that was used for this report is also shown in Figure 1 and Table 1.

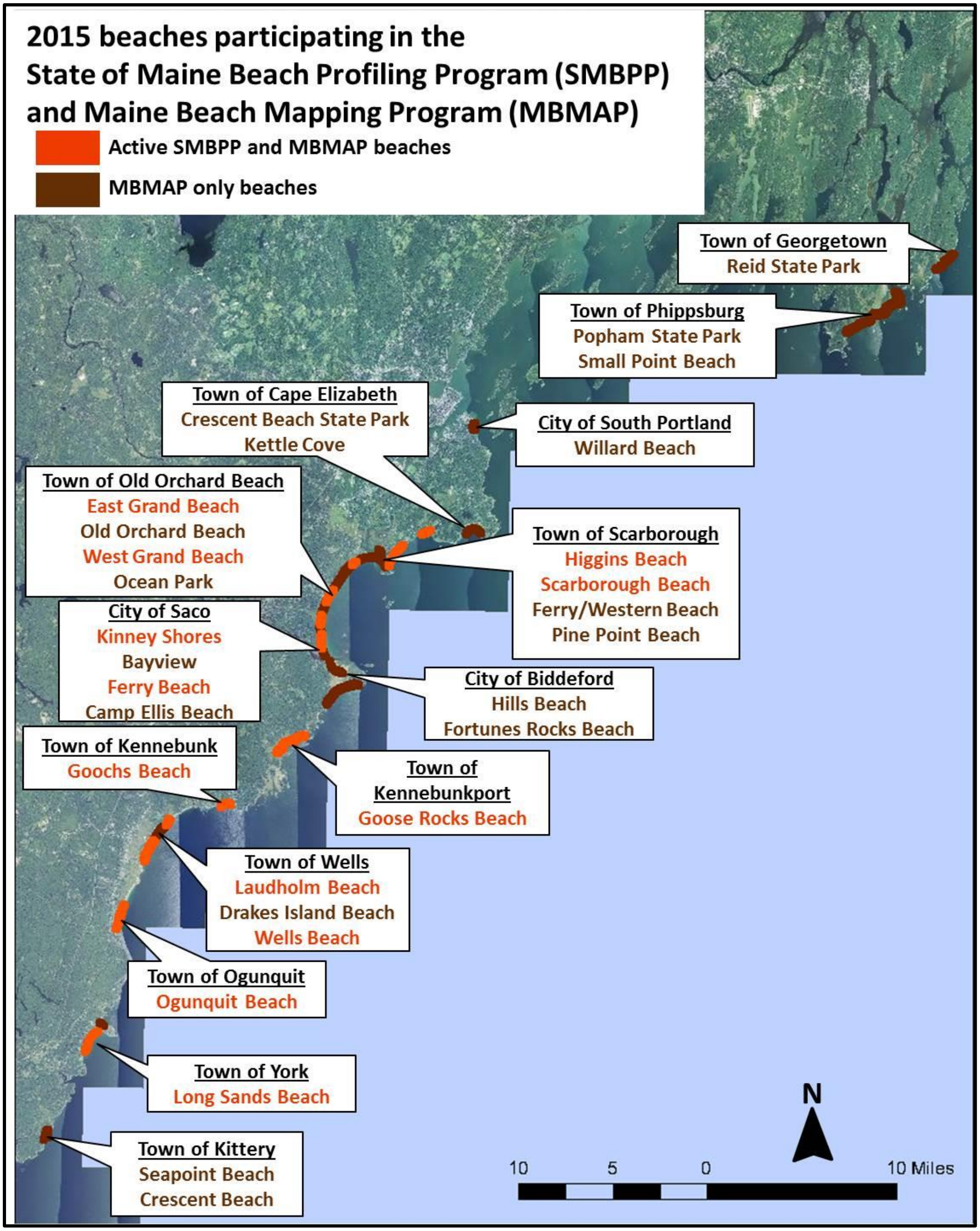

Figure 1. Beaches participating in the Maine Beach Mapping Program (MBMAP) and/or the State of Maine Beach Profiling Program (SMBPP). 2013 base imagery courtesy of Maine OGIS.

Beach	Municipality	State of Maine Beach Profiling Datasets											Maine Beach Mapping Program Datasets				
		Winter						Summer									
		2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Crescent	Kittery	Not part of SMBPP											-	8/12	8/29	12/13	9/18
Seapoint	Kittery	Not part of SMBPP											-	8/12	8/29	12/13	9/18
Long Sands	York	4/25	4/15	4/15	4/6	4/19	4/12	8/15	8/5	8/24	8/23	8/15	8/4	8/3	8/27	12/12	8/8
Ogunquit	Ogunquit	4/23	4/16	7/28*	5/3	5/3	5/15*	9/12	8/7	9/15	9/12	9/12	6/15	6/23	6/27	9/24	7/14
Wells	Wells	4/24*	3/27*	4/14*	4/6	1/25*	4/11*	7/16*	7/9*	8/26	9/14*	9/13*	6/21	7/28	8/14	-	7/21
Drakes Island	Wells	Not part of SMBPP											6/18	7/27	8/8	10/24	7/18
Laudholm	Wells	4/23	4/22	3/23	3/14*	5/22	-	8/13	8/5	5/12	8/2	7/21	6/18	7/27	8/8	10/24	7/18
Goochs	Kennebunk	4/25	4/15	4/24	4/5	4/19	4/11*	8/13	8/6	8/25	8/23	8/30	7/2	7/11	7/13	-	7/22
Goose Rocks	Kennebunkport	4/24*	4/15*	4/12	4/6	4/19	3/16*	8/14	8/6	8/26*	8/24	8/16	6/22	7/7	7/11	10/28	7/22
Fortunes Rocks	Biddeford	Not part of SMBPP											6/11	6/28	6/26	8/6	7/17
Hills	Biddeford	Not part of SMBPP											6/23	7/1	7/2	7/24	7/15
Camp Ellis	Saco	Not part of SMBPP											5/26	6/17	6/5*	6/19	7/1
Ferry Beach	Saco	4/23*	4/15	5/7	4/5	4/16	1/16	9/10*	9/23*	9/13*	9/16*	10/8*	5/26	6/17	6/5*	6/19	7/1
Bayview	Saco	Not part of SMBPP											5/26	6/17	6/5*	6/19	7/1
Kinney Shores	Saco	3/8	2/25	3/7	3/16*	7/21*	4/14	9/10	9/26	7/30	9/15	9/18	5/26	6/17	6/5*	6/19	7/1
Ocean Park	Old Orchard	Not part of SMBPP											6/2	6/27	6/16	7/16	7/10
West Grand	Old Orchard	-	-	-	6/12	-	5/14	-	-	-	10/15	10/3	6/2	6/27	6/16	7/16	7/10
East Grand	Old Orchard	4/21	3/30	4/12*	-	4/20*	4/12*	8/18	8/23	-	9/15	8/24	5/27	6/20	6/11	6/20	7/3*
Pine Point	Scarborough	Not part of SMBPP											5/27	6/20	6/11	6/20	7/3*
Western/Ferry	Scarborough	Not part of SMBPP											6/4	6/3	5/15	5/30	6/24
Scarborough	Scarborough	4/24*	4/22	4/11	4/30	12/27*	-	8/21	8/10	8/31*	8/31	-	-	6/8	6/8*	6/13	6/27
Higgins	Scarborough	4/23	4/14	4/10	4/5	4/21	4/12	8/17	8/29*	8/27	8/23	8/15	6/4	6/6	5/25	6/3	6/24
Crescent	Cape Elizabeth	Not part of SMBPP											6/4	6/6	6/1	6/10	6/27
Kettle Cove	Cape Elizabeth	Not part of SMBPP											6/4	6/6	6/1	6/10	6/27
Willard	South Portland	Not part of SMBPP											6/11	6/7	6/6	6/6	7/2
Small Point	Phippsburg	Not part of SMBPP											-	9/14	9/18	-	9/15
Popham	Phippsburg	Not part of SMBPP											6/30	7/21	8/3*	12/11	9/14
Reid	Georgetown	Not part of SMBPP											7/19	7/13	7/23	-	7/24

Legend	
(dark brown)	Beach surveyed only as part of MBMAP
(light red)	Beach surveyed as part of MBMAP and SMBPP
-	No data available
*	More than one date used in analysis

Table 1. As of 2015, beaches that are monitored as part of the State of Maine Beach Profiling Program (SMBPP) and/or the Maine Beach Mapping Program (MBMAP). The dates of either surveys or profiling used for analysis are shown. Note that some beaches have several different collection dates.

Setting the Stage: Sea Level Changes and Storms

Sea Level along the Maine Coast

Over the past century, sea level at the Portland tide gauge has risen at a rate of approximately 1.9 mm/year, or about 7.5 inches per century (Slovinsky, 2012). This has generally matched long-term global ocean trends over the past 100 years. However, over the last twenty years, global sea level rise rates have almost doubled to around 3.2 mm/year (US National Climate Assessment, 2014). Data from Portland has also shown a significant increase over the past 20 years when compared with the long-term trend, up to about 4.2 mm/year (Figure 2). 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.

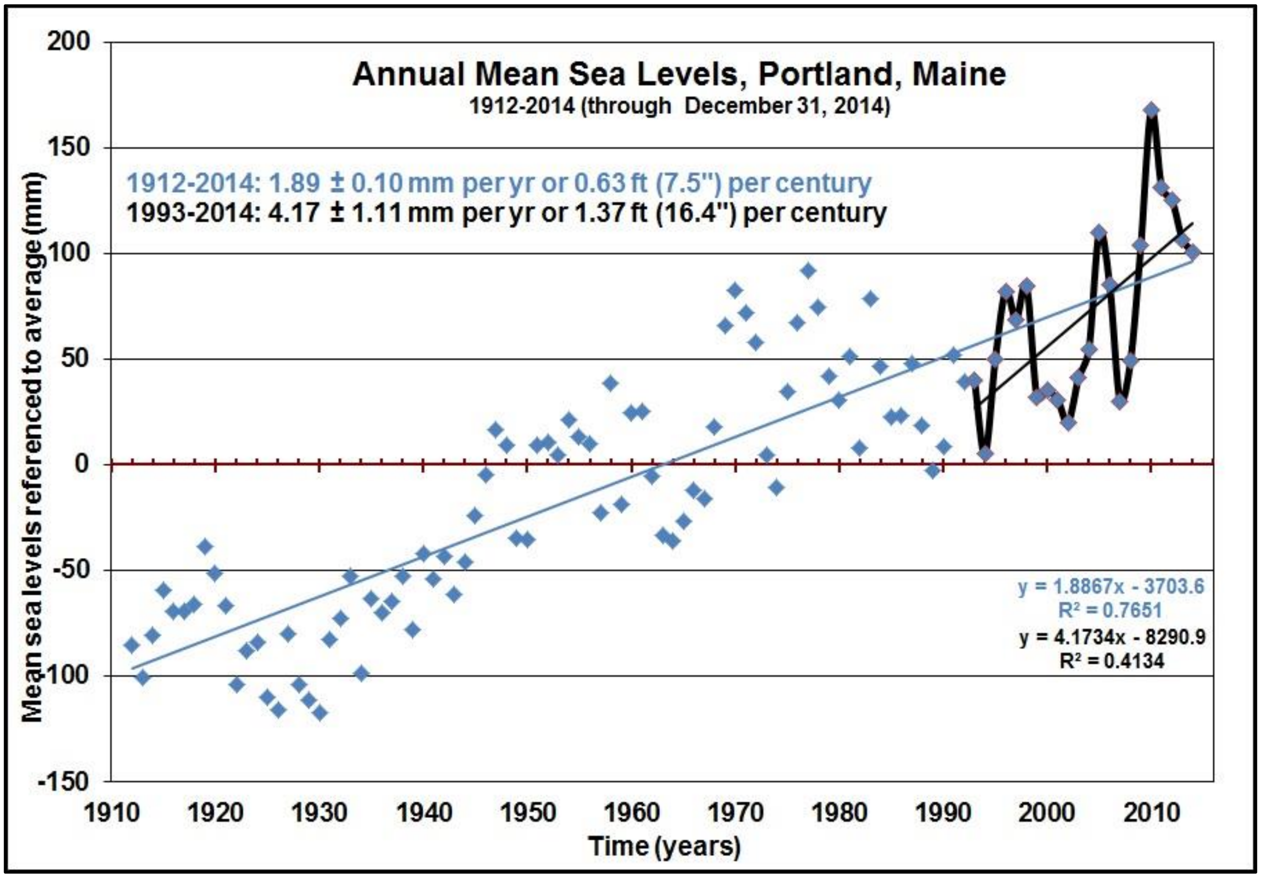

Figure 2. Annualized mean sea levels from 1912-2014 (blue dots and best-fit blue line), compared with a shorter-term trend from 1993-2014 (black line). Data has been adjusted so that "0" on the Y-axis refers to the averaged long-term sea level from the 1912-2014 time period. Data courtesy of NOAA-CO-OPs. Figure by P.A. Slovinsky, MGS.

Abrupt Sea Level Rise of 2009-2010

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, including in the Gulf of Maine (Sweet et al., 2009). This phenomenon was attributed to two factors 1) a period of steady northeasterly winds due to atmospheric conditions that resulted in water piling up against the coastline and subsequent elevated water levels; and 2) a slowdown in the Florida Current (supplying the Gulf Stream), which brings warm, salty water into the North Atlantic. Both of these 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. They concluded that the elevated sea levels were caused by a combination of 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, combined with a significant slowdown of the Gulf Stream portion of what is known as the Atlantic Meridional Overturning Circulation, or AMOC.

Figure 3 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 slight decrease, but the time period from 2009-2012 accounts for 9 of the highest annualized sea levels recorded since 1912.

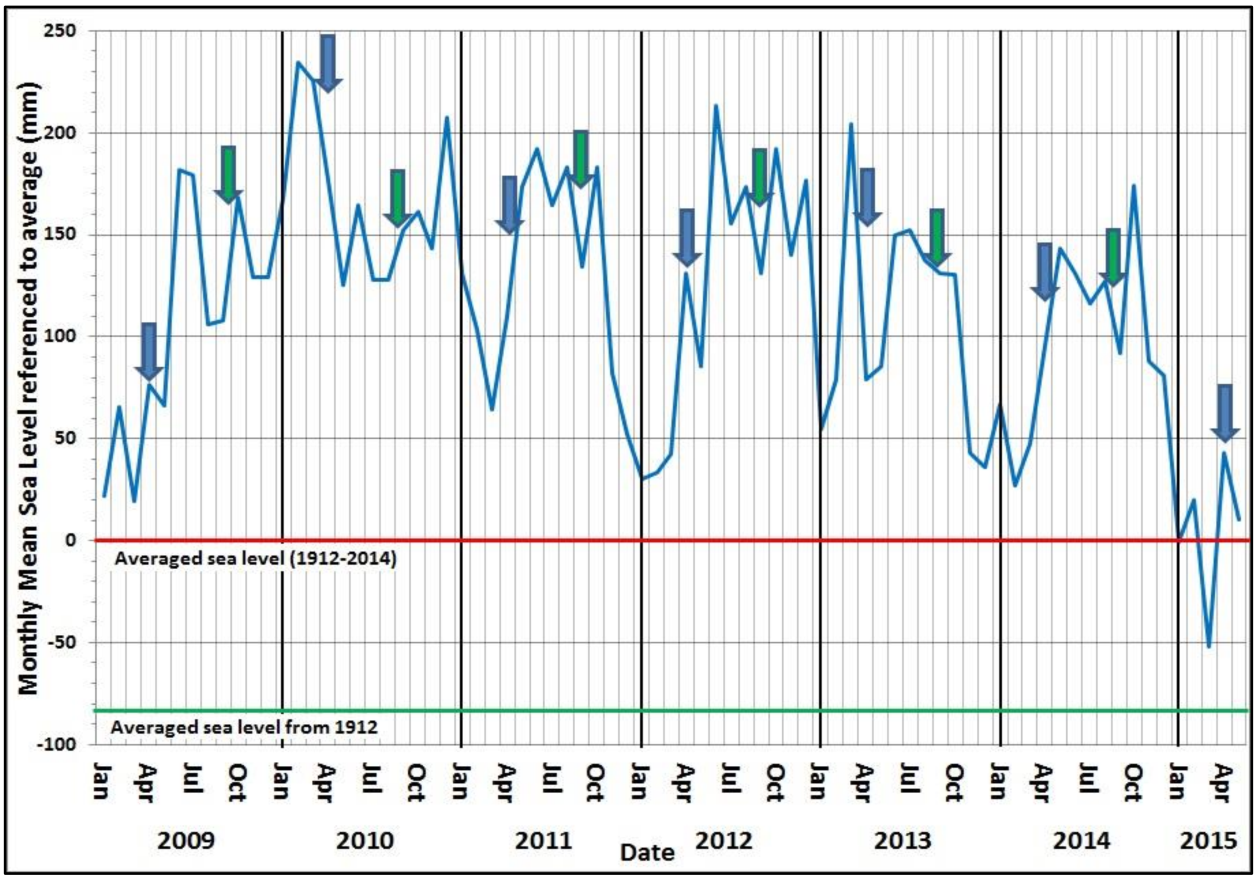

Figure 3. Monthly mean sea levels from January 2009 to May 2015, compared with a shorter-term trend from 1993-2014. Data has been adjusted so that "0" refers to the averaged long-term sea level from the 1912-2014 time period. Approximate times of beach profile data collection for winter (blue arrows) and summer (green arrows) is shown. Data courtesy of NOAA CO-OPS. Figure by P.A. Slovinsky, MGS.

In winter 2010, elevated sea levels due to a slowdown in the Gulf Stream, combined with a weather pattern that allowed northeasters to track up the Gulf of Maine coastline, resulted in some of the worst erosion seen. This was documented in the 2011 and 2013 State of Maine's Beaches reports (Slovinsky and Dickson, 2013; Slovinsky and Dickson, 2011). Figure 3 also shows sea level trends in relation to the seasonal beach profiling dates (mostly April for winter, August or September for summer) that were analyzed for these previous reports.

Wave Climate 2009-2015

This section of the report reviews major storm systems that impacted southern Maine beaches from January 2009 through May of 2015. Although this description will include details of multiple storms per month, Figures 4 and 5 summarize the peak weekly wave heights for the time period of 2009 to 2011, and 2012 to 2015. These values are good proxies of overall storminess. Some of the specific storm details described below are derived from hourly data at the Western Maine Shelf Buoy (B01, National Data Buoy Center Station 44030) and are slightly different from the weekly averages shown in Figures 4 and 5. Figure 4 shows weekly wave heights from 2009 to 2011, and Figure 5 shows data from 2012 to 2015.

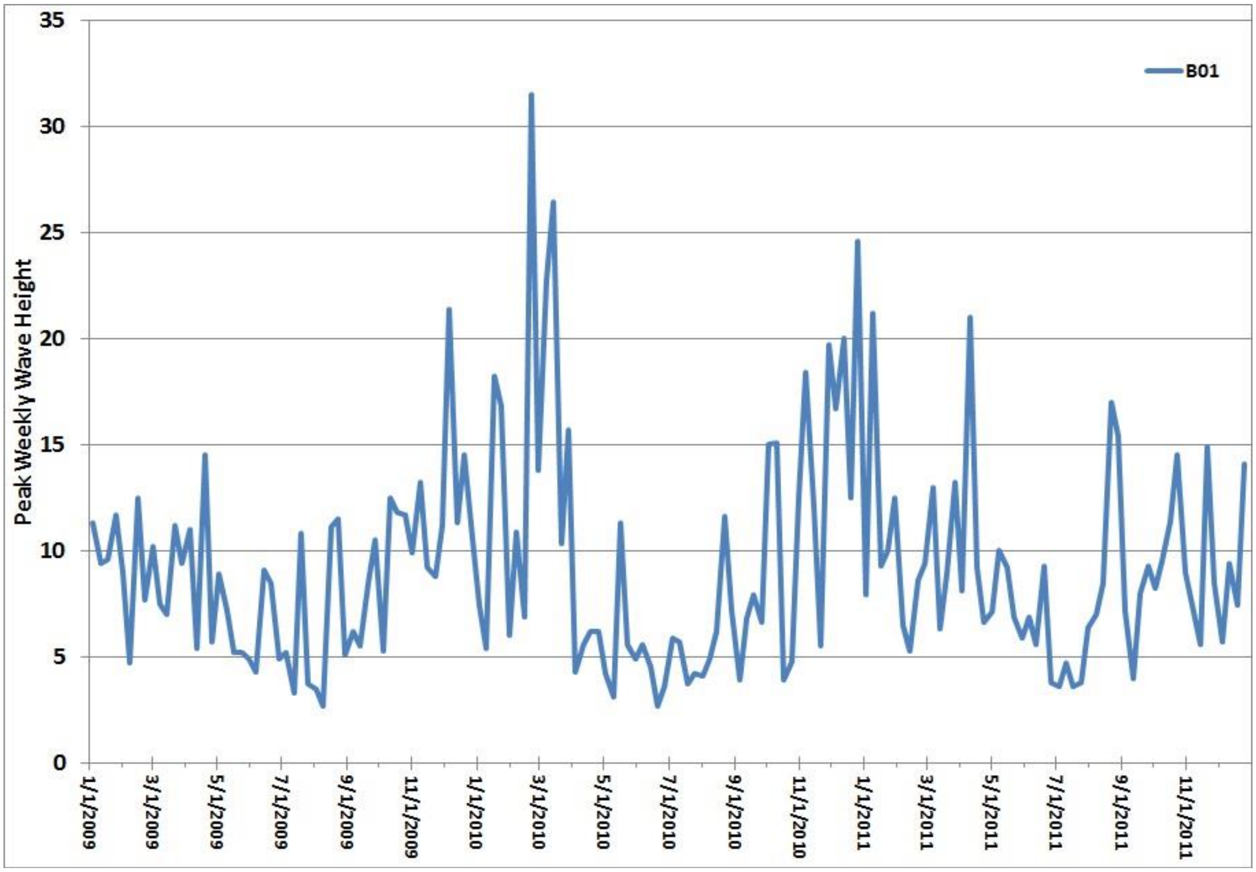

Figure 4. Peak weekly wave heights from 2009 to 2011. Data from NERACOOS Buoy B (NOAA 44030). Figure by. P.A. Slovinsky, MGS.

Winter of 2009-2010

Storm season started early with a July 23 northeaster. This storm coincided with an astronomically high tide of 11.5 feet MLLW and a 0.5-foot surge resulted in tides reaching the 12-foot level in Portland. A 993 millibar (mb) low pressure east of Cape Cod generated swells from the east-southeast that briefly reached 11 feet and sustained wind rose to 29 knots. The National Weather Service issued a coastal flood warning with a potential for beach erosion.

On August 23rd Hurricane Bill impacted Maine by sending long-period (16-17 second) swells rolling up into the dunes. This storm temporarily led to no dry beach around the time of high tide in Ogunquit. Waves peaked around 11 feet and the coastal pressure fell to 1004 mb. Wind speeds only reached 15 knots. Offshore the central pressure fell to 962 mb over Georges Bank. Tides did not reach the 12-foot mark so wave run-up was the highlight of this hurricane as it passed east of Georges Bank and grazed Nova Scotia.

August 29-30th the remnants of Tropical Storm Danny brought heavy rainfall and waves above 12 feet with a 10-second period. Neap tides and a surge of less than 1.5 feet resulted in no coastal flooding. Off the southern Maine coast the wind speed reached 30 knots (gale force) late on the 29th as a low pressure of 1000 mb formed from the degraded storm off Cape Cod and moved through the Gulf of Maine to Washington County.

September was relatively quiet and marked the beginning of an El Nino pattern that would last through the winter storm season.

October had a strong northeaster from the 16-17th from an offshore low east of Georges Bank with a central pressure of 986 mb. With moderately high tides and a 1.5-foot surge there was a storm tide of 11.8 feet. Surf Street in Saco experienced significant splashover along the revetment from waves that built from 8 to 12 feet with a period of 10-12 seconds over the two days. The coastal wind speed peaked around 25 knots, just below gale force.

December 3-4th saw a 989 mb southeaster track from the Ohio River Valley to northern Maine. That storm track generated 8-second, 11-foot waves from the southeast.

On December 10th the biggest storm of the entire 2009 calendar year (measured by wave height) originated around Chesapeake Bay and intensified rapidly as a meteorological “bomb” moving to New England. As the low tracked along the Maine coast from Kittery to Eastport, the storm’s central pressure fell to 986 mb. This gale produced back-to-back storm tides to 12.1 and 11.0 feet on the 9th and 10th respectively. Easterly winds of 30 knots produced waves of 21 feet with wave periods in the 10-12 second range.

The New Year started with a retrograde ocean storm January 2nd-3rd. With wind below gale force from the north to northeast, waves only reached 10 feet as the storm moved southwest from east of Nova Scotia into the Gulf of Maine with a central pressure of 975 mb. This slow-moving system generated a storm surge of 1.0 -1.5 feet for three days on top of astronomically high tides and resulted in 11.5- to 12.9-foot storm tides and coastal flooding.

A slow-moving northeaster produced a maximum storm surge of 1.7 feet near high tide on January 18th but the storm tide only reached 11.0 feet. The storm waves reached 18 feet on the 19th as the low deepened to 986 mb and tracked from Cape Cod to Georges Bank.

A January 25th southeaster with 16-foot waves generated a peak surge of 2.2 feet near high tide from a pressure of 990 mb. However, the tides were neap so the peak storm tide was 10.7 feet on the 26th and again on the 27th.

The largest storm of calendar year 2010 arrived in late February, and on the 25th, the National Weather Service (NWS) issued a storm warning. This storm produced the largest weekly mean peak wave heights in this report period (6.5 years, Figure 4). It developed well offshore of the Mid-Atlantic States and intensified as it moved into southern New England. This unusual track resulted in a 972 mb low over Rhode Island and then New York City before it moved to eastern Long Island and then back northwest to upstate New York on the 28th. In Portland, the storm surge peaked at 4.3 feet just before midnight on the 25th during a falling tide. The barometer fell to 985 mb over Casco Bay. This northeaster produced 32-foot waves off the southern Maine coast and sustained wind reached 40 knots with gusts to 52 knots (B01). Around midnight on the 25th, waves at the Portland buoy (44007) reached 38 feet. After gusts of 49 knots (whole gale or Beaufort Scale 10) buoy 44007 stopped recording wind speed and direction on the 26th. Seas remained high into early March. This storm cut a new channel at Popham Beach (Slovinsky and Dickson, 2011).

Another significant storm resulted from a low pressure center (994 mb) that lingered in the Mid-Atlantic Bight between New Jersey and Long Island before moving out to sea. On March 14-15th easterly wind produced waves over 26 feet approaching coastal Maine from the east-southeast.

The last winter storm arrived March 31st and produced 15-foot waves. This northeaster off eastern Long Island had a central pressure of 988 mb. Off the southern Maine coast wind speeds reached 25 knots from the northeast. With the easterly wind, the largest storm tide of 12.6 feet was produced by a 1.3-foot surge that occurred late on March 30th during a spring tide. In addition to the spring tide, the surge was influenced by a period of anomalously high sea levels (Goddard et al., 2015) so eight high tides exceeded 11 feet from March 28th to April 1st. The storm tracked east of Long Island and south of Georges Bank on April 1st.

As described in the section on sea level changes above, part of the surge levels described in this winter of storms was likely driven by (non-storm) forces outside the Gulf of Maine. This was a period when anomalously high water levels occurred for several months and likely contributed to the elevation of the storm tides in the winter of 2009-2010.

Winter of 2010-2011

Late summer and fall 2010 had a mix of downgraded hurricanes and northeasters. On August 31st Tropical Storm Earl tracked up the East Coast across the outer Gulf of Maine. On September 17th-20th Tropical Storm Igor sent in moderate long-period swells for 4 days. On September 30th Tropical Storm Nicole passed inland through New England, much like a southeaster. On October 15th, a northeaster produced a 3-foot storm surge but the tides were neap so the storm tide did not result in coastal flooding. An extended period of rough seas occurred in early November culminating with a northeaster that had 20-foot waves. A December 2nd southeaster produced waves to 15 feet.

Another southeaster followed on December 12th and 13th with 17 foot waves and a pressure down to 986 mb. Calendar year 2010 ended with a Blizzard on December 27th. The barometric pressure dropped to 962 mb as it entered the Gulf of Maine and produced waves over 23 feet (Figure 2 of Slovinsky et al., 2013). A classic northeaster (985 mb) passed quickly through the central Gulf of Maine on January 12, 2011. Waves from this storm briefly topped 21 feet with 34 knot winds. January 27th saw another northeaster pass up the East Coast. A February 2nd Ground Hog Day storm produced a storm tide of 11 feet. On March 7th, a southeaster (996 mb) tracked north through New England and waves remained in the 6-10 feet range for 4 days. Another southeaster followed on March 11th with 11 foot waves. An April Fools' Day northeaster produced a brief period of 12-foot waves and had a central pressure of 987 mb. The last major winter storm of the 2010-2011 season was a strong southeaster (995 mb) April 17th with a maximum sustained wind of 30 knots and seas that topped 20 feet.

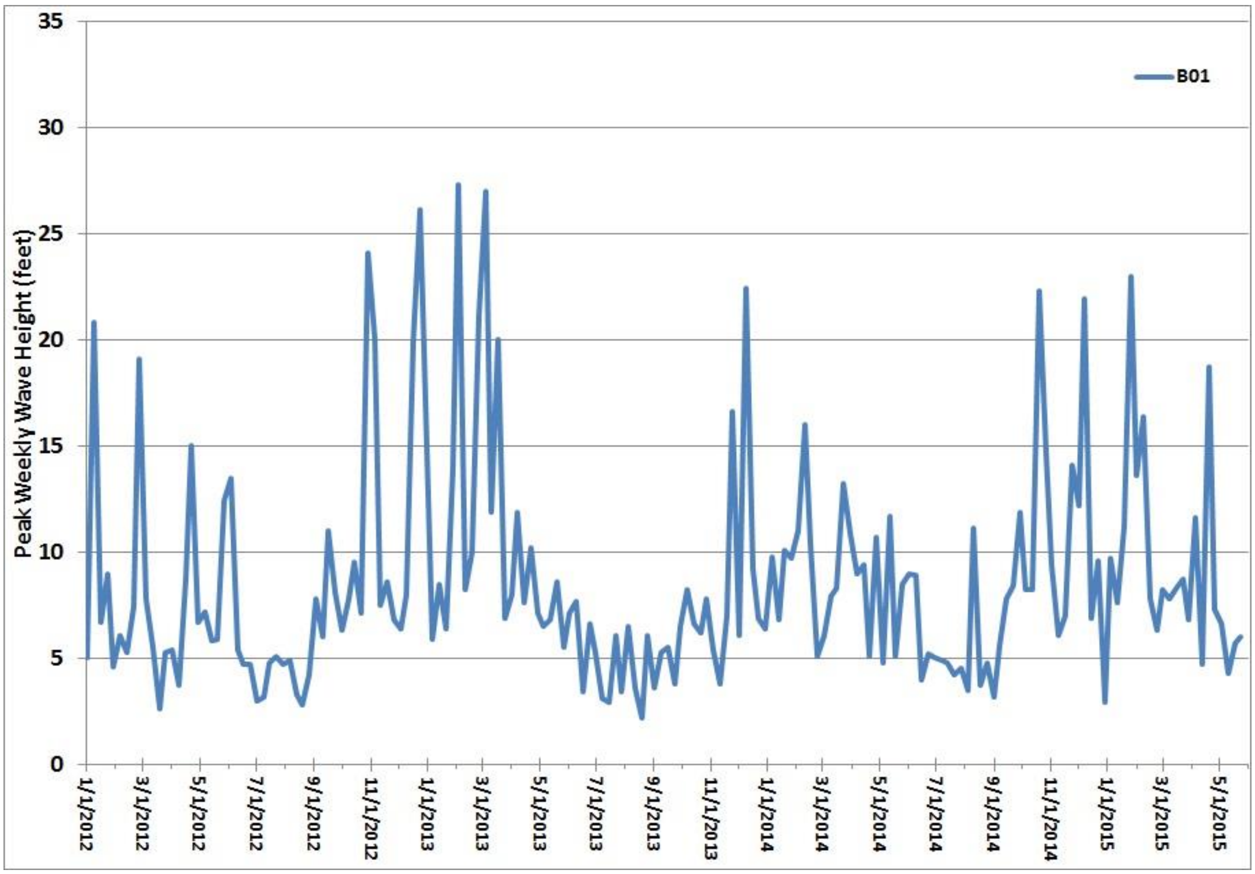

Figure 5. Peak weekly wave heights from 2012 to 2015. Data from NERACOOS Buoy B (NOAA 44030). Figure by. P.A. Slovinsky, MGS.

Winter of 2011-2012

After about four months or relative calm, the storm season began with a tropical influence. August 2011 is remembered from Hurricane Irene's track through interior New England on the 29th. Coastal state park campgrounds were evacuated due to the combination of high wind and surf. Waves reached 15 feet and the maximum storm tide reached 12 feet in Portland.

On October 30th a northeaster (984 mb) passed through the Gulf of Maine and left 5 inches of snow in Portland for Halloween. On November 23rd a northeaster (1000 mb) produced 15-foot waves. Calendar year 2011 closed out with a southeaster (988 mb) on December 28th that produced waves of 13 feet.

January 12th was the start of the 2012 storm season with a northeaster that produced a storm tide to 12 feet driven up by a 2-foot surge. Waves were up to 20 feet on the 13th and the pressure fell to 992 mb. Wind speeds reached 30 knots on the 12th and 14th. The rest of January and all of February were relatively quiet. Over March 1st and 2nd a 1012 mb northeaster generated 18-foot waves on the second day. By March 3rd the storm became a southeaster with 12-foot waves. After a quiet spell, another northeaster (993 mb) arrived April 23rd and produced 12-foot waves

A rare June northeaster (1003 mb) hit the beaches hard from June 4-6th. This storm could be considered a late spring storm that finally ended the winter storm season. Each day storm tides topped 12 feet and reached as high as 13 feet. This storm's 12-foot waves eroded the dune edge. Because of the unusual time of year for such a powerful storm, *many piping plover nests were washed away*.

Winter of 2012-2013

With only a 3-month respite, the next storm season began. On September 8th and 9th Hurricane Leslie produced long-period swells (15 seconds) with heights up to 7 feet. On September 18th there was a southerly gale and waves up to 11 feet with a long period over 16 seconds hit the beaches.

Hurricane Sandy was the highlight of the storm season in New York and southern New England on October 29th and 30th. Maine experienced the remnants of the "superstorm" (a post-tropical cyclone) with an impact similar to a strong winter easterly storm. Tides were near average (10 feet) and the storm surge ranged from 2 to 3 feet over two days. The highest storm tide occurred on the morning of the 29th and it reached the 12-foot level (about 2 feet below the Blizzard of 1978). Waves reached 23 feet and 11 second swells caused splashover, and beach and dune erosion. The storm caused shoaling in Wells Harbor.

On November 8th, a very strong (986 mb) storm passed offshore in the wake of Hurricane Sandy. This storm produced NE gale-force winds along the coast but received little notice since it was offshore and the media was focused on damage from Hurricane Sandy. Along the southern Maine coast the pressure dropped to 1003 mb. Nearshore waves reached 20 feet. A 2-foot surge on a neap tide resulted in only a 10-foot storm tide. Had this offshore storm tracked closer to the Maine coast there would likely have been very significant beach and dune erosion.

On December 18th a southeaster resulted in a storm tide of 12 feet driven up from a 2-foot surge. Waves ran in the 16- to 18-foot range. The final storm of the 2012 calendar year arrived on December 27th as a northeaster. This 999 mb low produced 11-second waves that reached up to 26 feet.

The first remarkable storm of 2013 was the Blizzard of February 9th (nicknamed "Nemo" by the media). This storm came 35 years after the record-setting Blizzard of 1978. The blizzard tracked up the East Coast and out across Georges Bank. It had a large surge of up to 3.5 feet but coincided with an average tide, not an exceptionally high tide as in 1978. In addition, the highest surge occurred at low tide, reducing the erosion impact to the upper beach and dunes. Consequently, the highest storm tide was just below the 12 foot level in Portland. An easterly gale (999 mb) arrived February 28th. Storm tides ran up to the 11-foot level due to a persistent 1- to 2-foot storm surge. Waves reached 27 feet with a period of 11 seconds.

An early March northeaster (1014 mb) on the 8th produced wave periods up to 12 seconds. This storm track came out to sea off the mid-Atlantic coast and then headed east of Cape Cod. Despite the more distant track, storm tides ran above normal from March 5-9th, exceeding the 11-foot level 6 of 9 times, but never topped the 12-foot level. The maximum storm surge was about 3 feet but arrived at low tide. Waves peaked around 27 feet. *Large amounts of beach and dune erosion as well as exposure of substrates underlying beach profiles were reported after this storm. This was noted at Drakes Island Beach, Goochs Beach, Higgins Beach, Ogunquit Beach, Scarborough Beach, and York Beaches (Short and Long Sands)*.

Yet another northeaster (1003 mb) arrived on March 19th with a low pressure center over Cape Cod. This storm had lower water levels due to neap tides. The storm tide only reached 9 feet MLLW with the assistance of a 1.5-foot storm surge. Waves peaked at around 18 feet and ran 10 feet or more for two days.

The winter of 2012-2013 was a season with 6 major storms that impacted Maine beaches (Figures 4 and 5 of Slovinsky et al., 2013). There were no exceptionally high storm tides, but on many occasions water levels approached the coastal flood threshold of 12 feet. Storm tracks were dominated by northeasters and only one major southeaster. Superstorm Sandy was less severe than a late December northeaster or the Blizzard of February 9th (Nemo). Despite the strong surf, coastal flooding - beyond the effects of splashover - was not significant due to storms passing farther offshore in the Gulf of Maine.

Winter of 2013-2014

After a relatively tranquil summer and early fall with ocean waves below 8 feet, the first fall storm began just before Thanksgiving with a steep barometric fall below 986 mb on November 23rd and strong southeasterly wind. This storm briefly produced 16-foot waves that remained above 10 feet for a day. This was a period of neap tides and even with a storm surge of 1.7 feet, the storm tide only rose to a peak of 9.5 feet around midnight after Thanksgiving.

The only other late 2013 storm of significance was a northeaster December 15th. This storm tracked from eastern Long Island across Georges Bank where it had a central pressure of 990 mb. Waves peaked at 22 feet but were elevated over 10 feet for only half a day. Coastal wind reached 30 knots. The peak storm tide occurred on the night of the 15th at 11.5 feet from a 1.5-foot surge. So despite its intensity, the storm only resulted in a surge for just one high tide and did not linger in the Gulf of Maine.

The first few months of 2014 were rather uneventful with only two events creating waves in the 15-foot range. On January 3rd a storm tide reached 12.9 feet as a 983 mb low crossed Georges Bank moving northeast after coming up from the Maryland coast. Waves were in the 12- to 14-foot range for a day driven by near gale-force winds of 25 to 32 knots off the southern Maine coast.

For the next month, three northeasters and one southeaster tracked away from the Maine coast but resulted in several lesser storms with waves that reached only 10 feet. A period of very high astronomical tides from January 31st to February 2nd was calm and, while tides reached to 11.5 feet, none exceeded the 12-foot flood stage.

On February 13th a 984 mb low moved off the Delmarva coast and tracked into Maine. When the low passed over Eastport a few hours later the pressure had dropped to 972 mb. Across the southern Maine coast wind speeds reached 33 knots and waves reached 16 feet. Due to a neap tide, the storm surge of 1.9 feet did not result in coastal flooding. Only two storm tides occurred and they reached 10.6 feet on the 13th and 11.0 feet on the 14th, both below flood stage. The strong northwesterly wind on the back side of the storm resulted in a set down (a suppressed tide) of a foot.

There were two late March storms that generated waves in the 12- to 13-foot range at the end of the month, but as in earlier winter months, seas remained relatively calm compared to other winters. This winter will be remembered for an “Omega block” that formed from an upper atmospheric pattern with a high pressure that sent Arctic air with very cold temperatures into eastern North America.

Winter of 2014-2015

On August 5th Hurricane Bertha tracked offshore and was downgraded to a tropical storm as it passed to the east of the Gulf of Maine. Long-period swells (13 seconds) rolled in to the Maine coast but only had a height of 2-3 feet on the 6th and 7th, with no significant storm surge or high tide.

Just after Bertha’s influence abated, a period of king tides (Adams, 2014) commenced. Starting August 8th astronomically high tides produced water levels between 11 and 12 feet through August 15th. Tides in this period were increased by a background elevated water levels of 0.2 to 1.2 feet recorded at the Portland tide gauge.

The largest summer 2014 wave event occurred as the king tides were waning on August 14th. A coastal low pressure tracked from southern New England across the beaches of southern Maine with a central pressure of 1,000 mb. This southeaster had wind of up to 27 knots and waves to 11 feet. However, there were back-to-back storm tides of 12.1-feet and 11.6 feet on August 14th as a combination of king tides and a small storm surge.

On October 22nd a classic fall northeaster produced rough seas up to 12-feet with wave periods of 6-7 seconds. Waves along the southern Maine beaches surpassed the 8-foot height for two days. With a pressure of 995 mb in the Gulf of Maine, the storm surge peaked at 1.5 feet and resulted in a maximum storm tide on the 23rd of 11.3 feet.

November 1st a northeaster moved up the East Coast and developed a low pressure of 978 mb over Georges Bank. The NWS issued a storm warning. The wind peaked over 33 knots, a full gale. A storm surge of 2.4 feet coincided with average tides to produce a peak storm tide of 10.9 feet. Seas remained above 8 feet for about 36 hours and reached a peak of 14 feet.

For the second year in a row there was a Thanksgiving northeaster. A storm that originated in the Gulf of Mexico tracked up the coast to reach the mid-Atlantic Bight on November 27th. This fast-tracking moderate gale only produced a storm surge of 1.3 feet and only a single 10.5-foot storm tide. Waves reached 14 feet and pressure fell to 995 mb in the Gulf of Maine.

On December 10th a northeaster tracked from offshore of North Carolina into southern New England. The northerly track slowed its advance and low pressure settled in around Boston and the western Gulf of Maine at 993 mb. This storm generated 22-foot waves from the southeast. Swells remained over 8 feet high for two days. The largest storm surge of 1.9 feet came at the time of low tide on the 9th. The peak storm tides were 10.8 feet on the 8th and 11.0 feet on the 10th a foot below flood level. As this storm stalled on the 10th it became retrograde and moved inland into northern New England and stalled through December 12th.

A large storm over Ontario, Canada on December 25th had an effect on the Maine coast. This far-away storm had a pressure of 976 mb and extended its influence across the eastern half of the U.S. Near the Maine beaches, wave heights reached 9 feet and astronomically high tides over 11 feet resulted in high wave action. The highest storm tide reached 11.8 feet on December 24th and 11.5 feet on Christmas Day.

The first major storm of 2015 was January 3rd-4th as a secondary low (998 mb) from a larger storm in the Great Lakes formed in the Gulf of Maine. This storm generated 10-foot waves with wind speed in the 20 knot range. The peak storm tide only reached 10.2 feet and the largest surge of 1.1 feet occurred at low tide. The wind increased on January 5th and 6th to nearly 30 knots and caused a set down (low tide than predicted) of as much as 1.7 feet around midnight on the 5th. With lingering swells in the 4-5 foot range upwelling (onshore bottom flow) may have moved sand ashore.

A January 19th northeaster with 11-foot waves was a minor event. The storm produced a 1-foot surge and an 11-foot storm tide. Higher water levels were reached January 22nd with spring tides.

The biggest event of 2015 was the January 27th Blizzard Juno. This intensifying storm had a central pressure of 975 mb moving into the Gulf of Maine from east of Cape Cod. The NWS issued a warning for hurricane-force wind and 45 knot wind with gusts to 60 knots affected the coast. The peak storm tide was 12.2 feet and the largest surge of 3.4 feet occurred at low tide on the 27th, avoiding what might have been a 13.5-foot tide if the timing of the storm had shifted by 6 hours. At the height of storm waves were recorded at 23 feet when the Western Maine Shelf Buoy (B01) temporarily malfunctioned.

On February 2nd a Groundhog Day northeaster tracked east along Long Island and up to Georges Bank. Sustained wind along the coast reached 50 knots; the barometer fell to 986 mb and waves built to 13 feet. This storm arrived during neap tides and the largest storm tide was only 10.4 feet. A peak surge of 1.3 feet came at low tide so water levels remained below flood stage.

A mild low (1006 mb) passed east of Georges Bank on February 10th generating waves up to 16 feet. Continuing neap tides and a minor surge kept storm tides below 10 feet. A 1.4-foot surge on the 11th only resulted in a 10.2-foot storm tide as a distant 987 mb low in the North Atlantic created a northeasterly wind.

The last major winter storm of 2015 was the February 14th Valentine's Day Blizzard (Neptune). This storm arrived on an easterly track and passed over Cape Cod with pressure falling to 996 mb. Waves built to 16 feet and there was a storm surge of a foot for over a day. However, the continuing neap tide resulted in the peak storm tide only reaching 11.2 feet on the 15th. A more persistent surge of a foot coincided with spring tides from the 18th and 19th. The combined surge and astronomically high tides raised water levels to as much as 11.5 feet on the 19th. Waves through this high-water period remained below 5 feet.

Astronomically high tides from April 18th through 22nd and a small surge of just under a foot resulted in high water levels peaking at 12.2 feet on the 22nd. Wind from the southeast in this spring storm exceeded 25 knots. Waves reached 18 feet on the 21st as a 999 mb low tracked northeast along the Maine coast.

On May 12th the remnants of Tropical Storm Ana decayed as a 1009 mb low centered over Cape Cod. There was no storm surge and tides were in the 10-foot range. Waves were above 10 feet for a day and peaked at 18 feet. Despite the media attention, this storm was not unusual for the Gulf of Maine.

Review of Beach Responses from Analysis of SMBPP and MBMAP Data

This portion of the report will review beach changes from 2010 to 2015 using analysis of available Maine Beach Mapping Program (MBMAP) and State of Maine Beach Profiling Project (SMBPP) datasets (Table 1). The analysis starts with the southern-most monitored beach (Crescent Beach in Kittery), and progresses north, ending with Reid State Park beaches in Georgetown.

As needed for each beach, a figure will be shown orienting the reader to the shape of the beach, and the location of SMBPP and MBMAP data. If no SMBPP data exists, only MBMAP data will be shown. To the maximum extent practical, figures for each beach have been created and rotated so that water appears on the bottom of each image. A north arrow is included in each figure to properly orient the map.

If SMBPP data exists, we will review profile changes using the winter 2010 beach profile shapes as a starting point for comparison with subsequent years from roughly the same months, through April or May 2015. Review of the "winter" beach profile shapes will allow us to detail whether or not the beaches have recovered from the significantly erosive 2010 winter season. For winter profile graphs, purple represents 2010, green 2011, dark red 2012, dark blue 2013, orange 2014, and light blue 2015.

We will also review profile changes and recovery from 2010 through the summer of 2014 for the "summer beach" profiles. This will include, as data is available, profile data from July, August or September of each year. The color schemes for summer profiles match that of the winter profiles; no data has been collected for summer 2015.
Each profile is 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. Note that this grading system is qualitative, and described in Table 2.

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 2. SMBPP and MBMAP grading system used as part of the State of Maine's Beaches in 2015 report.

In this ranking system, we consider a score of an A or B to indicate excellent or very good recovery or growth, a C to be considered a satisfactory (yet potentially cautionary) stability or recovery, and a D and F to be an unsatisfactory outcome for the beach recovery, signifying an ongoing erosion or instability problem.

For MBMAP data, calculated linear regression rates (LRR, in meters per year, m/yr) were completed at 10 meter transect intervals along each beach. The LRR calculation requires a minimum of three surveyed shoreline positions. Each beach surveyed as part of MBMAP will be reviewed in terms of the alongshore trends at each beach using the descriptive rankings below, and in terms of the overall mean value calculated for each beach (Table 2). These mean values are used to help establish a grading system based on MBMAP data. 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) despite distinct shifts in shoreline change patterns. Thus, we will describe these shifts in shoreline change trends in each MBMAP section.

Crescent Beach, Kittery

Crescent Beach is not part of the SMBPP, so no profile data is available.

Crescent Beach MBMAP Results

Crescent Beach is a small pocket beach on the south side of a headland that separates Crescent from Seapoint beach to the north. It consists of a narrow, cobble beach and dune, only a portion of which is vegetated. For this reason, only a small portion of the beach has three surveyed vegetation lines to calculate LRR values (Figure 6) including shorelines from 2011, 2012, and 2014. Based on available data, the central portion of the beach (transects 1-13) showed some erosion, while the eastern end of the beach showed stability to accretion (transects 14-24). The overall mean trend of -0.09 m/yr indicates that the beach was relatively stable, even though it is clearly growing in the eastern section, and eroding along the central section.

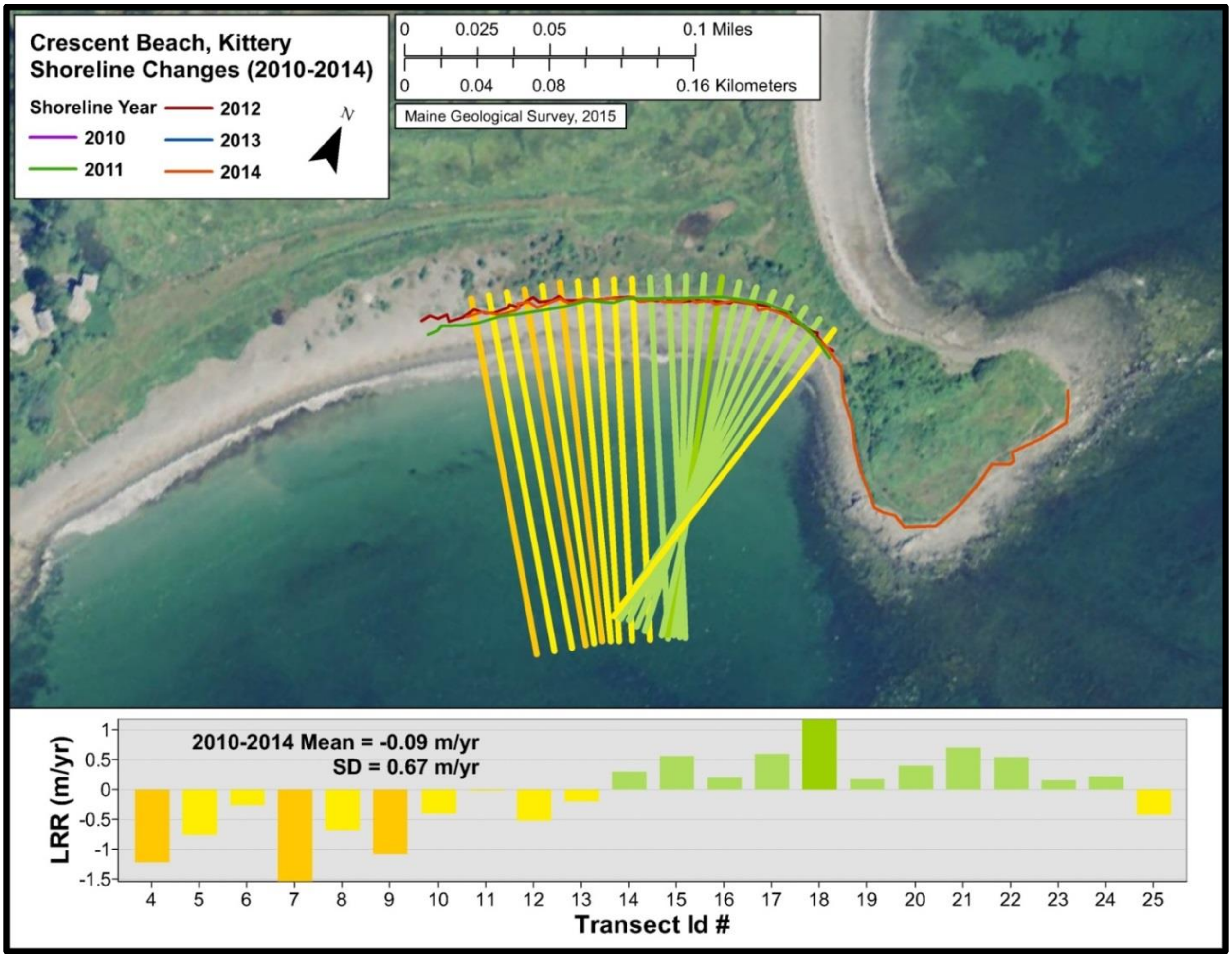

Figure 6. MBMAP data showing shoreline changes along Crescent Beach, Kittery. 2013 base imagery from Maine OGIS

Seapoint Beach, Kittery

Seapoint Beach is not part of the SMBPP, so no profile data is available.

Seapoint Beach MBMAP Results

Seapoint Beach is a small pocket beach on the northeast side of a headland that separates Seapoint from Crescent beach to the south. It consists of a sandy beach with a small dune system, which is vegetated along its entirety. The beach had surveys in 2011, 2012, 2013 (only the northern portion), and 2014. Based on available data, the majority of the beach was erosive to highly erosive at the central section. There is a small pocket of dune growth just north of the access path (transects 80-86), otherwise the beach has been slightly erosive, with a mean shoreline change rate of -0.31 m/yr.

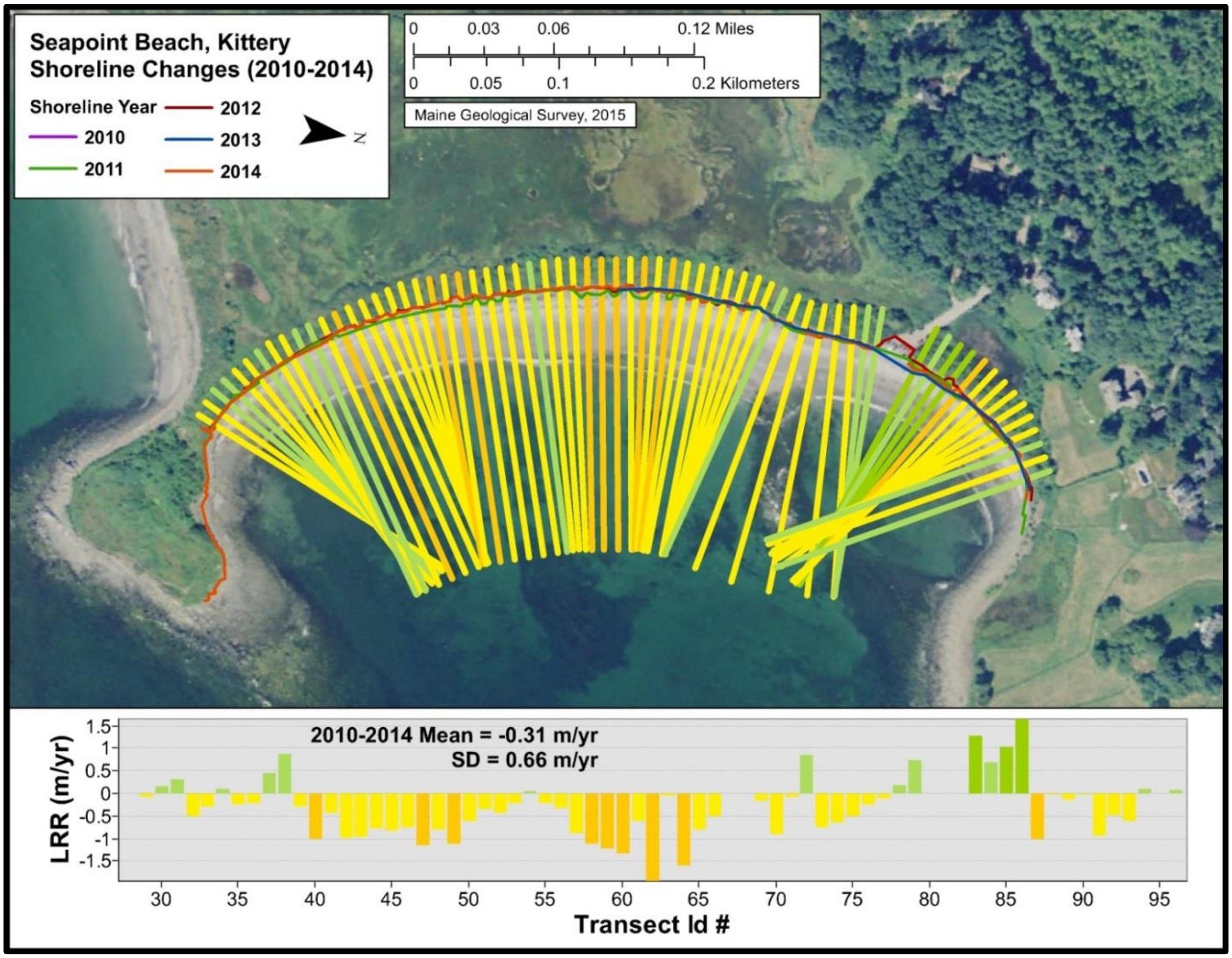

Figure 7. MBMAP data showing shoreline changes along Seapoint Beach, Kittery. 2013 base imagery from Maine OGIS.

Long Sands Beach, York

Profile LS01 is located in the northern half of the beach, while LS03 is located at a natural cobble dune and beach area south of the bath house (Figure 8). Figures 9 to 12 show winter and summer shapes for these profiles.

Figure 8. Volunteer profile locations along Long Sands Beach, York. 2013 base imagery from Maine OGIS.

Winter LS01 = B- (82). 2010 was the most erosive year. LS01 accreted in 2011 and 2012, with 2012 having the highest berm. By 2013, it eroded to the 2010 shape. It recovered in 2014 and in 2015 and reached near the 2012 shape, except for loss of the berm. Overall, LS01 showed good recovery since 2010, though it did not return to nor exceed its 2012 shape. 2010 and 2013 were the worst and 2012 the best for LS01.

Summer LS01 = B- (82). 2011 had an increase in sand elevation over the 2010 shape. Similar to the winter profile, 2012was the highest, and had the best defined berm. 2013 saw erosion to below 2010 levels. In 2014, it recovered at its upper portion to between 2011 and 2012, but lost seaward of 70 m to below the 2011 shape. Overall, the profile showed positive recovery since 2010, but loss in comparison with the 2012 high. 2013 was the worst and 2012 was the best year.

Winter LS03 = C (75). Years 2010 and 2011 were stable. LS03 grew in in 2012 seaward of 30 m. The berm eroded in 2013 and 2014 saw recovery but loss of sand on lower portions. 2015 showed gain at the dune but berm loss. 2010 and 2013 were the worst years, and 2012 and 2015 the best years.

Summer LS03 = B (85). 2010 was the most erosive shape. Through 2012, the profile was generally stable, with loss back to the 2010 shape in 2013. 2014 showed good recovery, above that of the other years. The summer profile appears to be growing since 2013.

Winter Summary: The profiles at Long Sands showed stability, to good recovery from 2010 to 2015, with 2012 being the best year, and either 2010 or 2013 the worst. **Winter Beach Grade: C+ (79).**

Summer Summary: Summer beach recovery at Long Sands Beach was relatively good at LS01 and quite good at LS03, with the profile gaining sediment from 2010 through 2012. At LS03, the profile showed general stability; however, it did not show marked growth. **Summer Beach Grade: B (84).**

Overall Summary: Long Sands Beach generally showed stability to recovery in both its winter and summer profiles. 2012 appeared to be the best year for LS01, and 2010 or 2013 the worst. At LS03, 2014 or 2015 were the best years, with 2013, generally the worst. **Overall Long Sands Beach Grade: B- (81).**

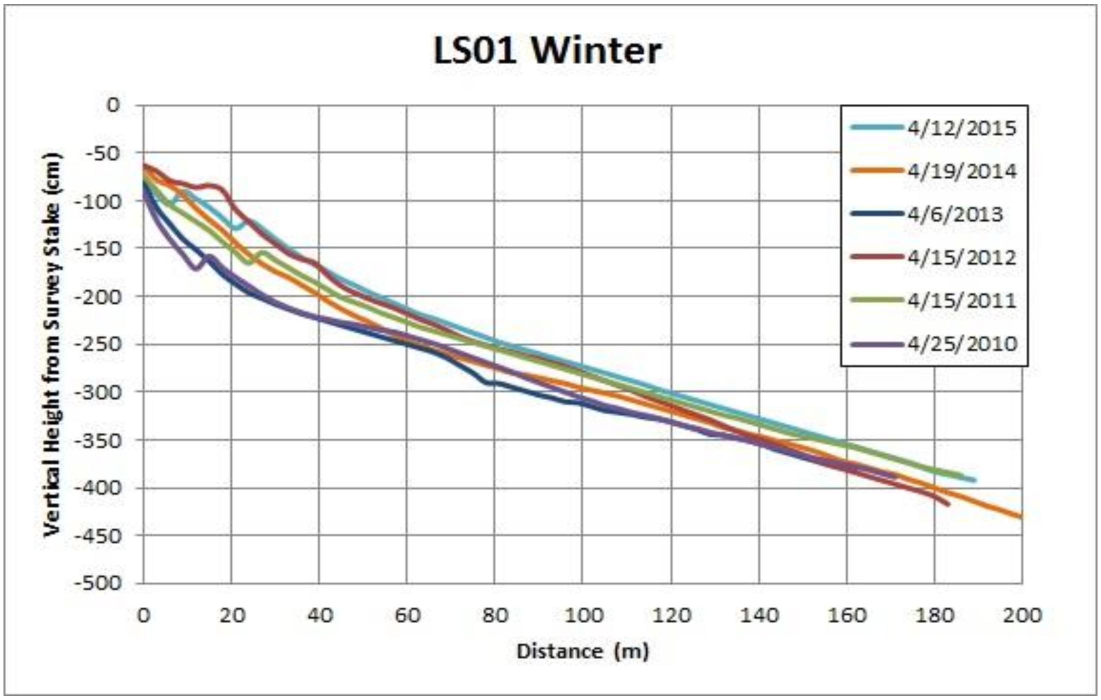

Figure 9. Winter beach profiles for LS01 from 2010 through 2015.

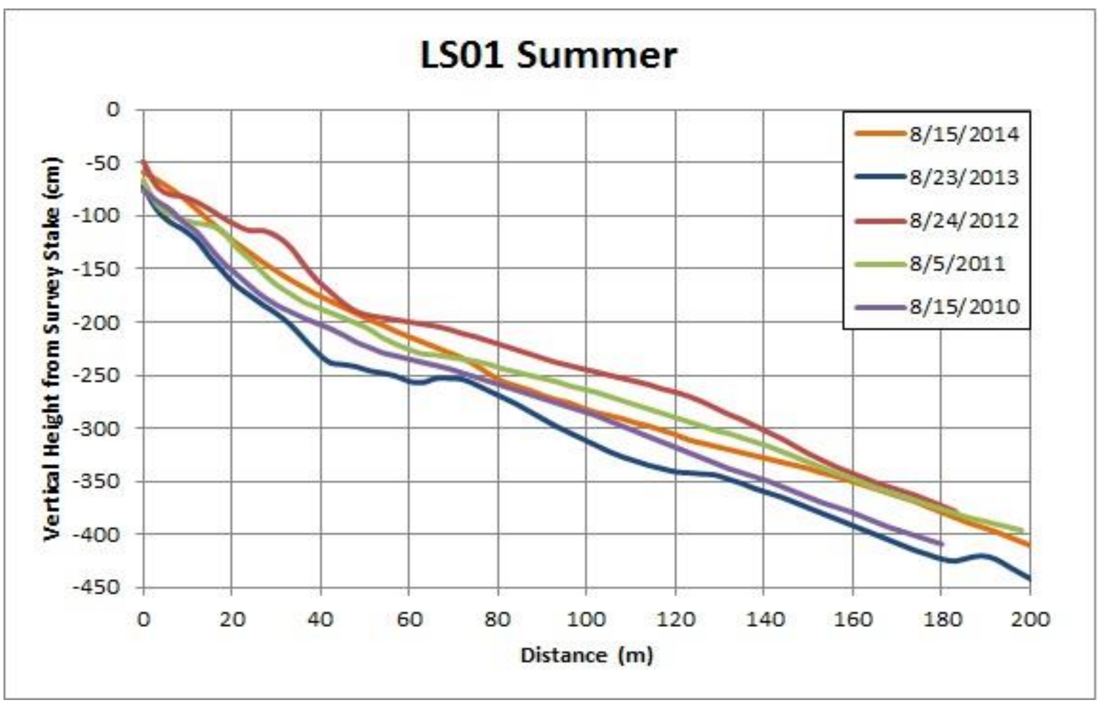

Figure 10. Summer beach profiles for LS01 from 2010 to 2014.

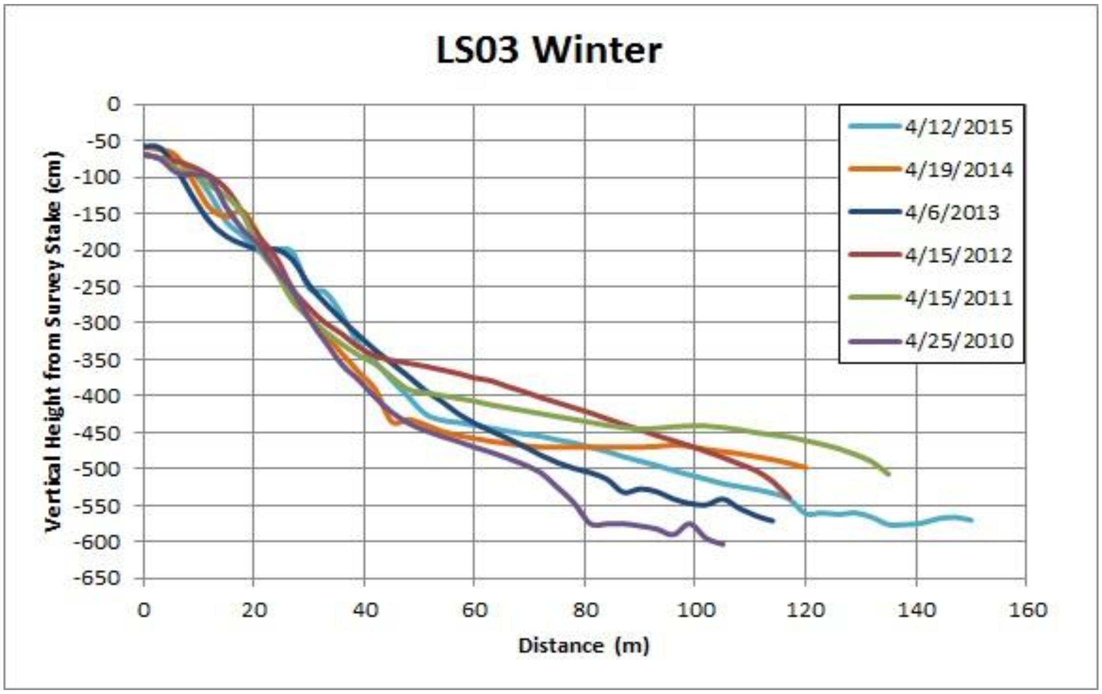

Figure 11. Winter beach profiles for LS03 from 2010 to 2015.

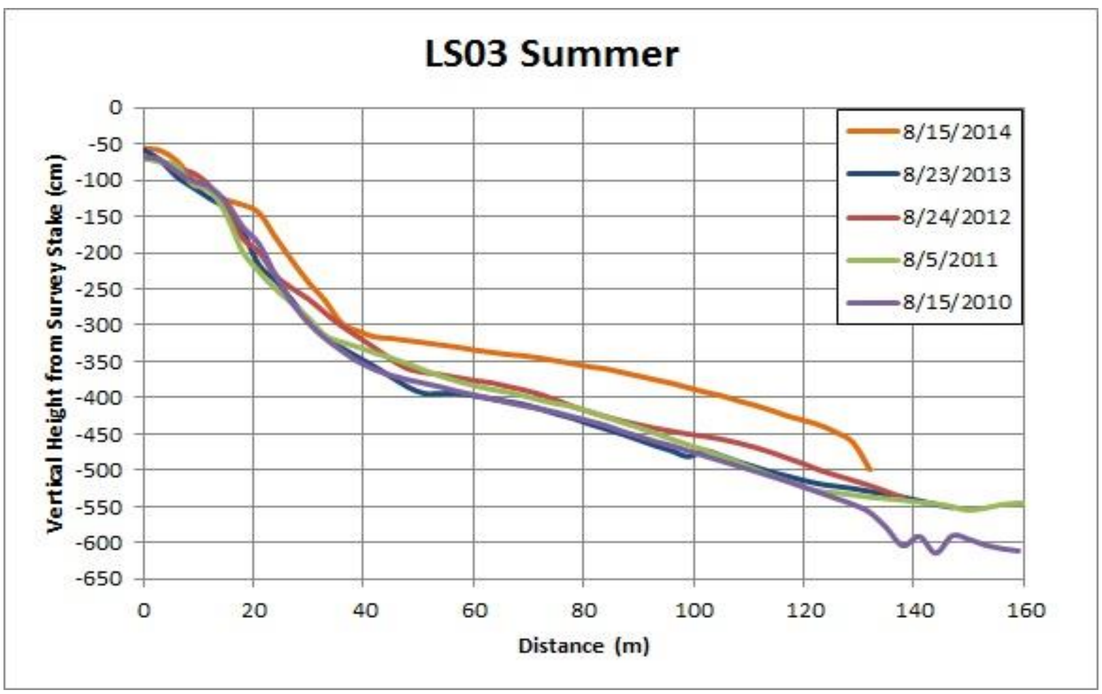

Figure 12. Summer beach profiles for LS03 from 2010 to 2014.

Long Sands Beach MBMAP Results

Only an extremely small section of Long Sands Beach (where profile LS03 is located) is comprised of vegetated cobble dune; the rest of the beach is seawall with no dune whatsoever. Thus, MBMAP analysis only includes this small area (Figure 13). The shoreline was surveyed in 2010-2012, and 2014. The dune here was **slightly accretive**, with a mean shoreline change rate of **+0.29 m/yr**. This stability to slight growth is reflected in the summer profile scores at LS03.

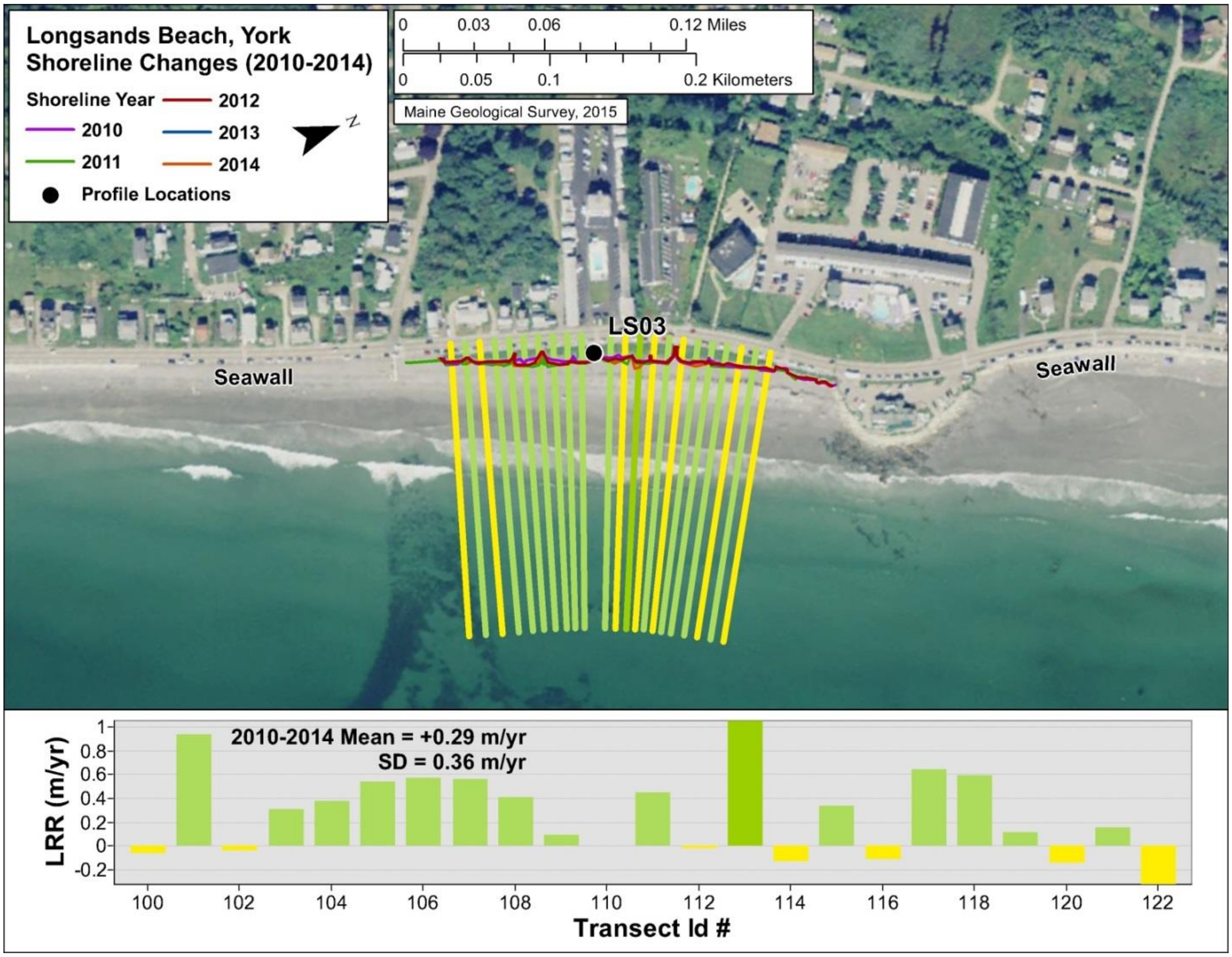

Figure 13. MBMAP shoreline change results for Long Sands Beach, York. 2013 base imagery from Maine OGIS.

Ogunquit Beach, Ogunquit

Profiles OG02 and OG07 were available for analysis (Figure 14); OG07 only has winter data from 2012 and 2015 and no summer data. OG02 is located near the treatment plant at the northern end of the beach, and OG07 is located at the seawall at the Norseman hotel. Figures 15 to 17 show seasonal changes at the profiles.

Figure 14. Volunteer profile locations along Ogunquit Beach, Ogunquit. 2013 base imagery from Maine OGIS.

Winter OG02 = C- (72). In 2010, the profile had a well-defined berm, but had the lowest elevations of all years. In 2011 and into 2012, the dune built higher, and OG02 accreted at the berm, and along the entire profile. In 2013, the berm was lost and the dune retreated landward, indicating erosion. In 2014, the dune lost elevation and the berm was eroded. In 2015, OG02 was stable at the dune and the berm and appeared relatively stable. Since 2012, the dune eroded, but the berm was somewhat stable.

Summer OG02 = C (75). From 2010 to 2011, OG02 was stable at the dune, gained slightly (but moved landward) at the berm, and gained sand offshore of 60 m. In 2012, the dune built farther seaward, and the berm built seaward at about 45 m. By 2013, the entire profile, including the dune and berm, gained in elevation, indicating accretion. However, by 2014, the dune had eroded substantially, and the berm flattened. The profile lost elevation from the 2013 high to near 2010 levels out to 40 m. OG02 accreted through 2013, and eroded in 2014.

Winter OG07 = D (65). Only winter data from 2012 and 2015 was available for comparison. Based on this, the entire profile lowered. However, since only two years are available for comparison, it is difficult to state with certainty that this is a definitive trend. *Therefore, we will not be including this in the calculation of a seasonal or overall score.*

Overall Summary: Based solely on analysis of OG02 (excluding OG07), it appears that the dunes grew through the winter of 2012 and entered an erosive period starting in the winter of 2013. That said, the 2013 summer profile was the best of all summer shapes. In summer, the profile built through 2013, and eroded in 2014 substantially. *We recommend adding a profile at the central section of the beach.* **Overall Ogunquit Beach Grade: C (74).**

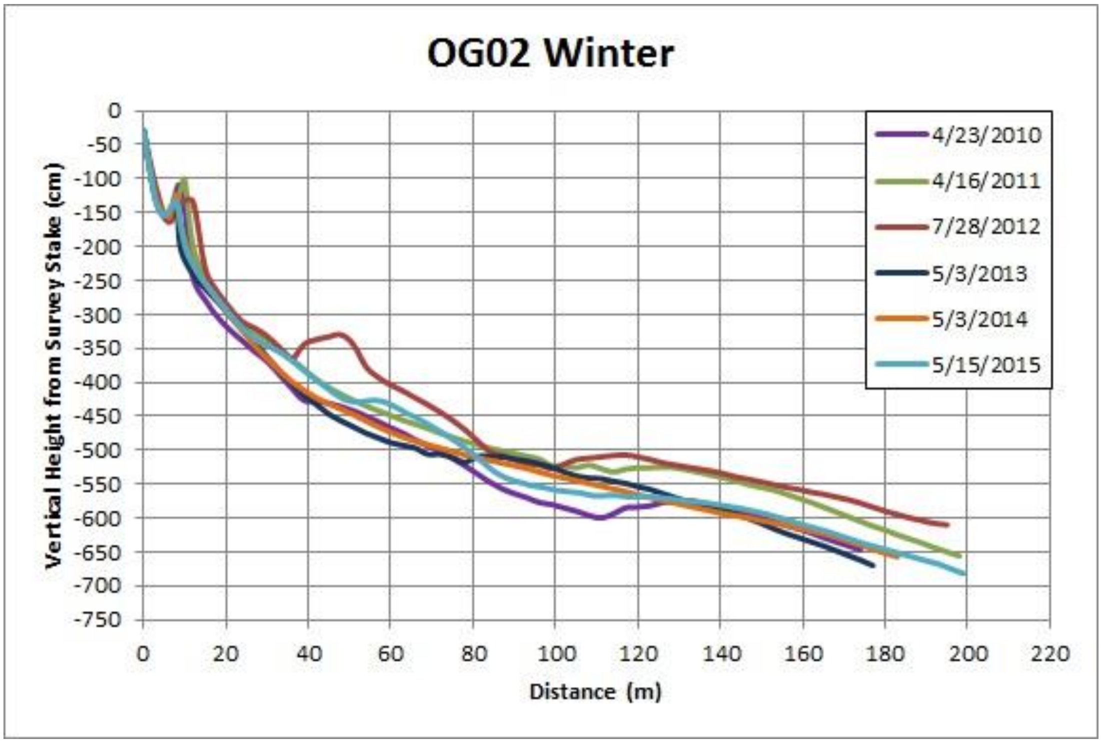

Figure 15. Winter beach profiles for OG02 from 2010 to 2015.

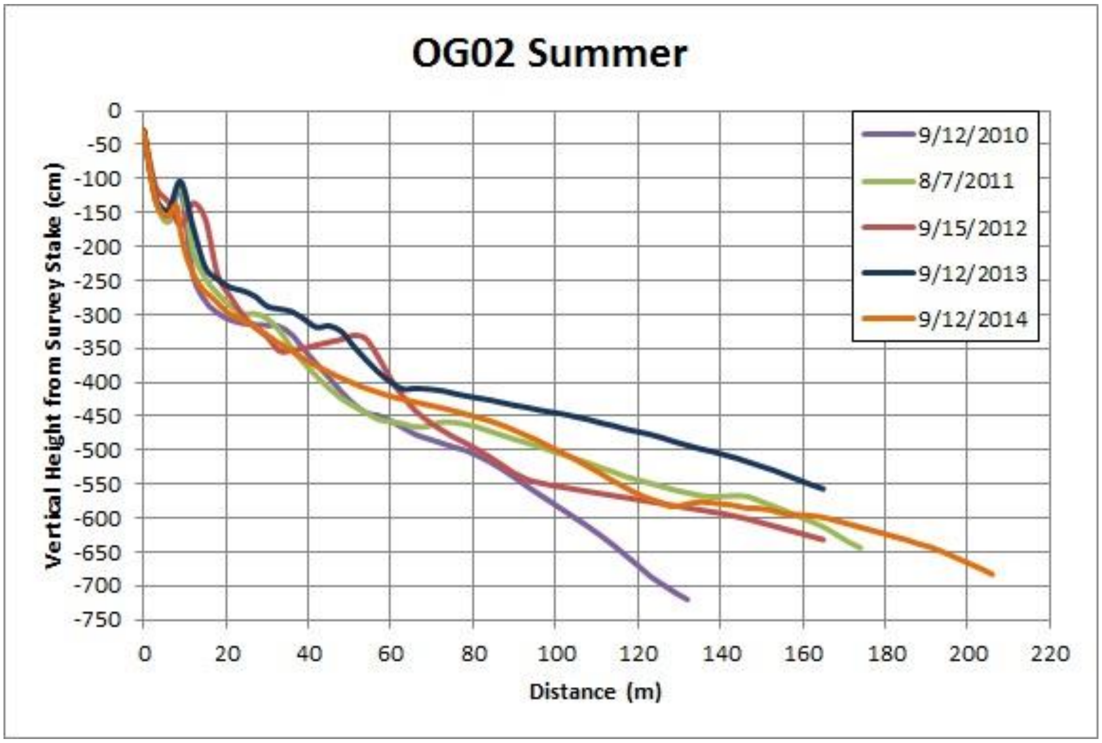

Figure 16. Summer beach profiles for OG02 from 2010 to 2014.

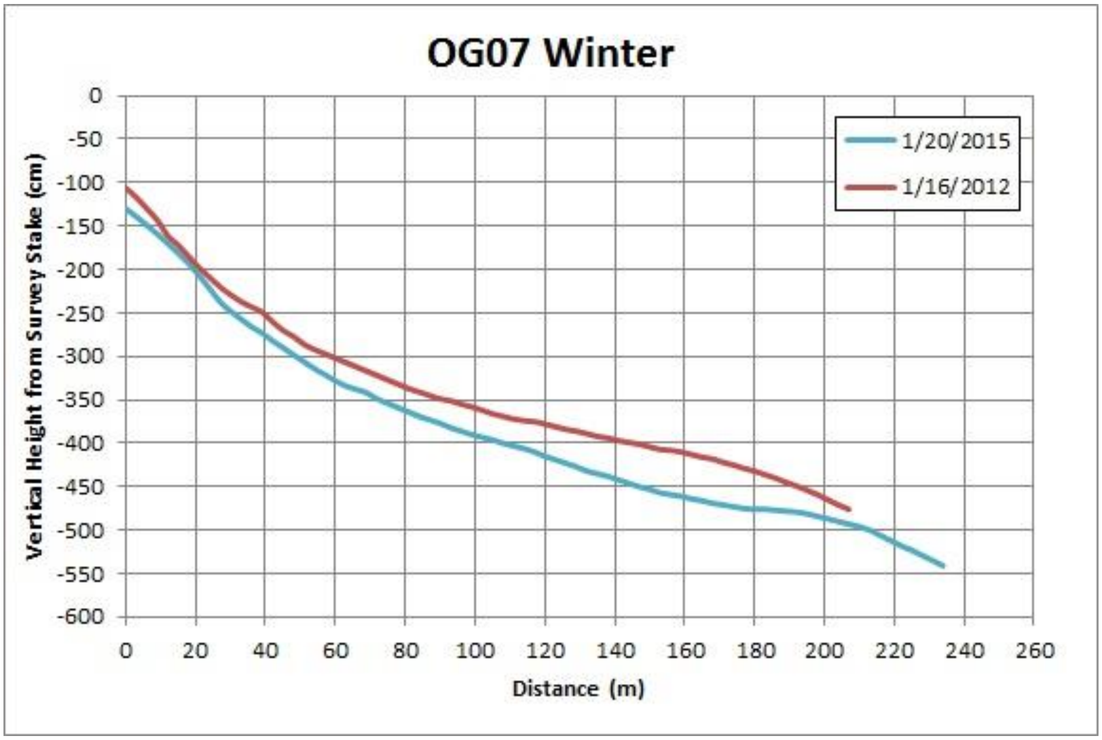

Figure 17. Winter beach profiles for OG07 from2012 and 2015.

Ogunquit Beach MBMAP Results

The vegetated dunes along Ogunquit Beach – in the south and north (where beach profiles are located) - have been **slightly erosive to erosive from 2010 to 2014**, while the dunes along the central portion of the beach (managed as a "natural area") were accretive to highly accretive (up to and over +1 m/yr). Erosion near OG07 is likely caused by end-effect of the seawall at the Norseman to the south. However, the **overall shoreline change rate was -0.05 m/yr, indicating a relatively stable system overall**. Note of course that this mean value is heavily influenced by the positive central portion of the beach. Without that, the shoreline change would be negative. We recommend adding a profile location at the natural area portion of the beach to help monitor changes.

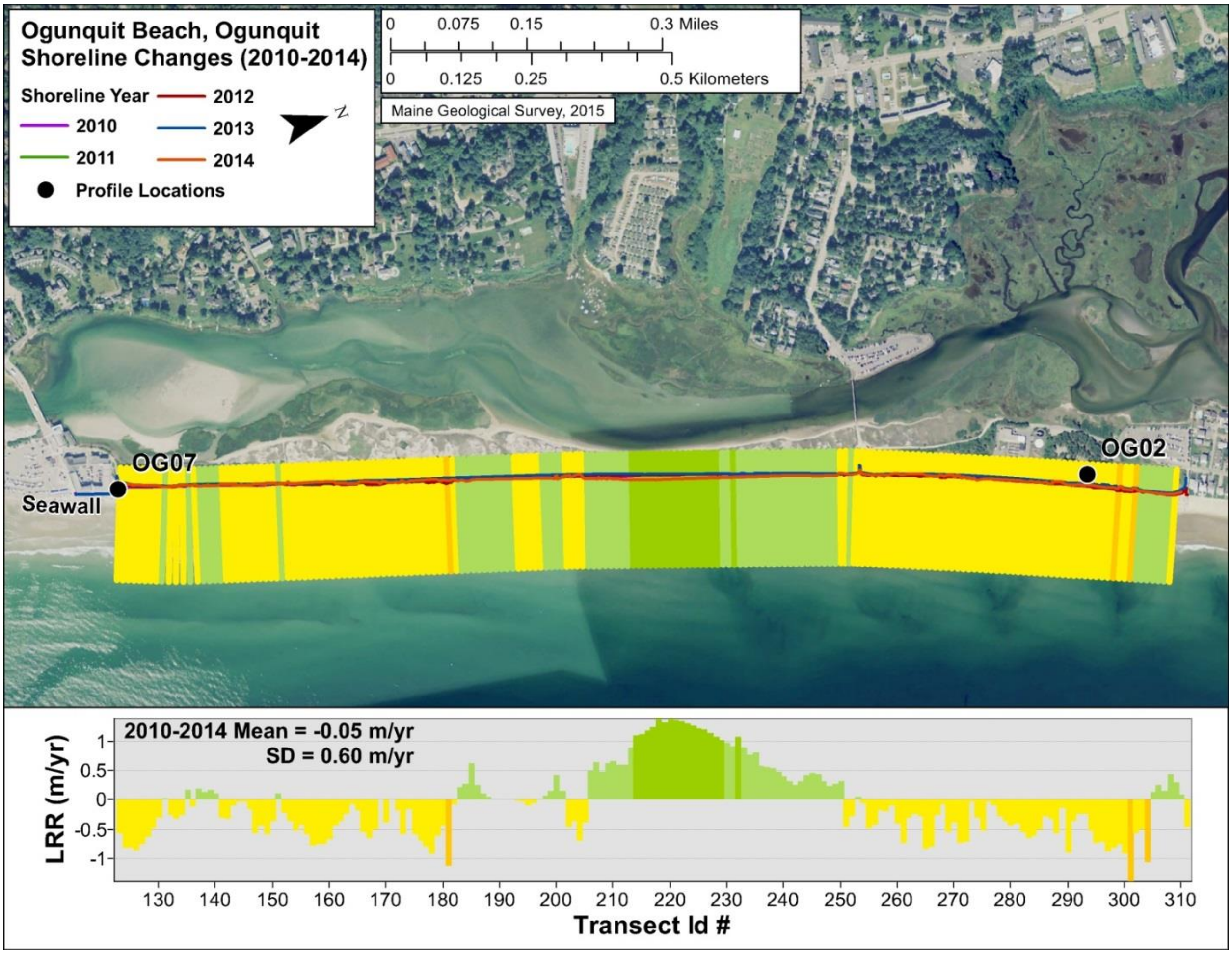

Figure 18. MBMAP shoreline change results for Ogunquit Beach, Ogunquit. 2013 base imagery from Maine OGIS.

Wells Beach, Wells

Four profiles (WE00, WE02-WE04, Figure 18) were available for analysis. WE00 is just south of Casino Point; WE02 is just north of Casino Point; WE03 is just south of the Webhannet River; and WE04 is directly adjacent to the Webhannet River. Figures 20 to 27 document seasonal changes.

Figure 19. Volunteer beach profile locations for Wells Beach, Wells. 2013 base imagery from Maine OGIS.

Winter WE00 = C (75). The 2010 profile was steep with a flat beach that likely represented the historical geologic surface. It recovered well in 2011 and reached a peak shape in 2012, gaining about 100 cm in elevation over 2010. However, it eroded in 2013 to almost 2010 levels. It recovered well in 2014, almost to 2012 levels, but then eroded in 2015, losing the berm and elevation down to below 2011 levels. 2010 was the most erosive and 2012 had the best profile shape. It appears the profile has been eroding the last few winters.

Summer WE00 = C+ (78). The 2010 profile had a defined berm, and convex shape. In 2011, it eroded and was more concave, with no berm. In 2012, it gained at its berm (out to about 30 m), but eroded below 2011 elevations. The berm grew slightly in 2013, but the profile steepened. In summer 2014, WE00 attained its most sediment rich shape. 2011 was the most erosive and 2014 had the best profile shape.

Winter WE02 = D (65). In 2010, WE02 had a large well developed berm. In 2011, the berm disappeared, and WE02 lost elevation at the dune and berm but was similar to 2010 from 35 m seaward. In 2012, WE02 steepened out to about 40 m, and then flattened to near the 2010 shape. By 2013, it lost sand at the dune/wall edge, gained in the berm area (remained below 2010), and steepened dramatically at around 40 m indicating large amounts of scour. The 2014 profile returned to the 2012 shape. The 2015 profile steepened near the profile pin, yet maintained a similar shape to 2014. It has been consistently eroding.

Summer WE02 = D (65). 2010 had a berm and steep slope to a deep trough near 70 m – this shape looked similar to the winter 2013 shape, likely eroded to the historical erosion surface. By 2011, it recovered along its end (seaward of 20 m), but lost berm elevation. In 2012, it gained elevation at the berm and offshore, but formed a deep trough near 30 m. By 2013, it lost elevation in the berm, and flattened dramatically. The 2014 shape showed a steep profile below 2010 and 2013, but sand seaward of 40 m above 2010.

Winter WE03 = C+ (78). The 2010 profile was from November, likely more of a "fall" shape. In 2011, it flattened and eroded, but maintained its elevation from 125 m seaward. In 2012, it showed recovery, with a berm returning, but seaward of about 50 m, it lost elevation. The 2013 profile had the steepest and most erosive profile shape. No data was available in winter 2014. The 2015 profile showed good recovery in the dune and berm areas. WE03 eroded from 2010 to 2013, but appears to have recovered in 2015 to 2010 levels.

Summer WE03 = C+ (78). November 2010 had a well-defined berm and gentle slope into the offshore. By 2011, WE03 lost its berm and elevation along its length – 2011 was the most eroded profile. In summer 2012, the profile showed dune growth, gained back its berm and showed elevation gains. In 2013, the dune maintained its shape, and a berm and swash bars were apparent. The 2014 profile showed a relatively consistent shape with 2013. This profile showed stability over the past 3 years.

Winter WE04 = B- (82). November 2010 had a high, well defined frontal dune that sloped to a small berm near 10 m, with a gradual slope offshore. In 2011, the frontal dune lowered, the berm disappeared, and the profile steepened. 2012 showed recovery, with the dune maintaining its position, a return of the berm, and the highest elevations along the profile. Winter 2013 showed significant dune loss and landward movement, in addition to profile steepening, and berm loss. There was no data from 2014. In 2015, the dune built slightly seaward, and the profile achieved some of its highest elevations seaward of 50 m. 2013 was the most erosive and 2015 probably the best profile shape.

Summer WE04 = C- (72). The November 2010 profile showed a well-defined dune ridge, small berm, and gradual slope offshore. By 2011, it showed slight landward migration of the dune, but a higher, better defined berm, and more sand offshore. This trend continued into 2012, with dune landward movement (but growth), and a well-defined berm and sand rich nearshore. 2013 had the most erosive profile, with loss of the dune and a deep trough at about 40 m offshore. The 2014 profile showed some recovery from this, but the dune was still eroded and elevations lower than that of the 2012 shape. The profile has been erosive the past few years.

Winter Summary: Profiles in the south part of Wells Beach (WE00 and WE02) underwent erosion from 2010 to 2013, some recovery by 2015. However, we remain cautionary about this trend. Winter profiles at the northern end of the beach were slightly better. **Winter Beach Grade: C (75).**

Summer Summary: Summer profiles at Wells Beach were somewhat stable to erosive from 2010 to 2014, with stable scores at WE00 and WE03, but erosive scores at WE02 and WE04. **Summer Beach Grade: C (73).**

Overall Summary: Profiles at Wells Beach underwent some erosion between 2010 and 2013, and some recovery in 2014 and 2015, but no data was available in winter 2014 to include in the analysis. **Overall Wells Beach Grade: C (74)**

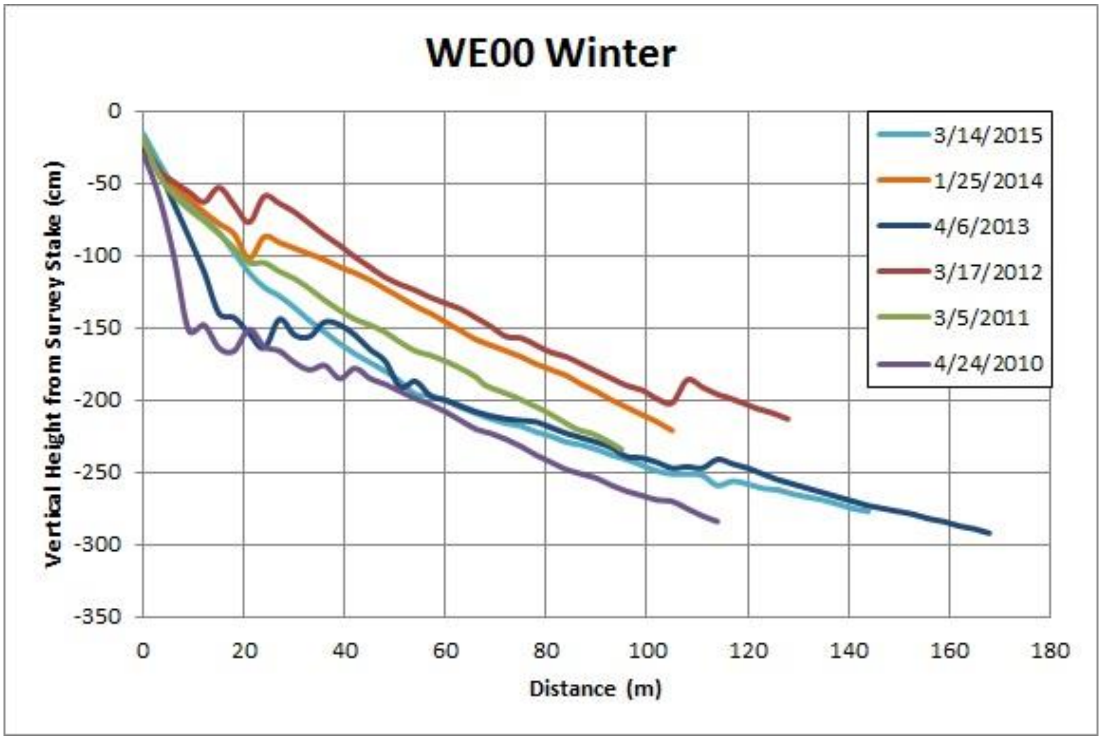

Figure 20. Winter beach profiles for WE00 from 2010 to 2015.

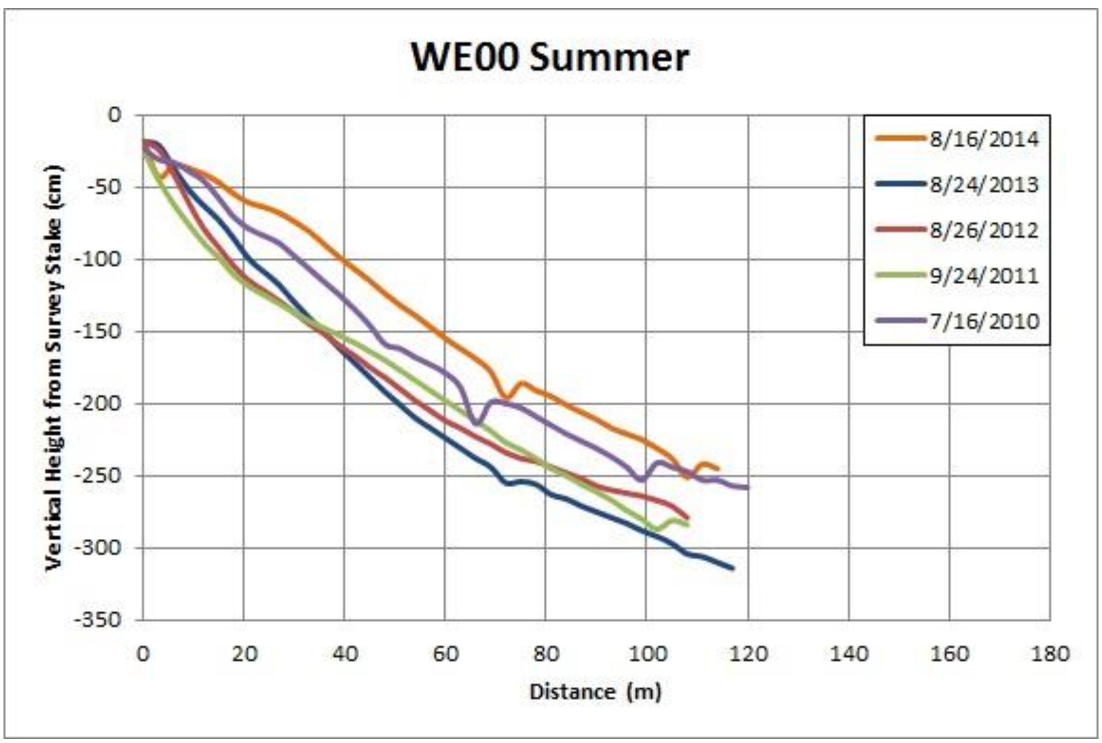

Figure 21. Summer beach profiles for WE00 from 2010 to 2014.

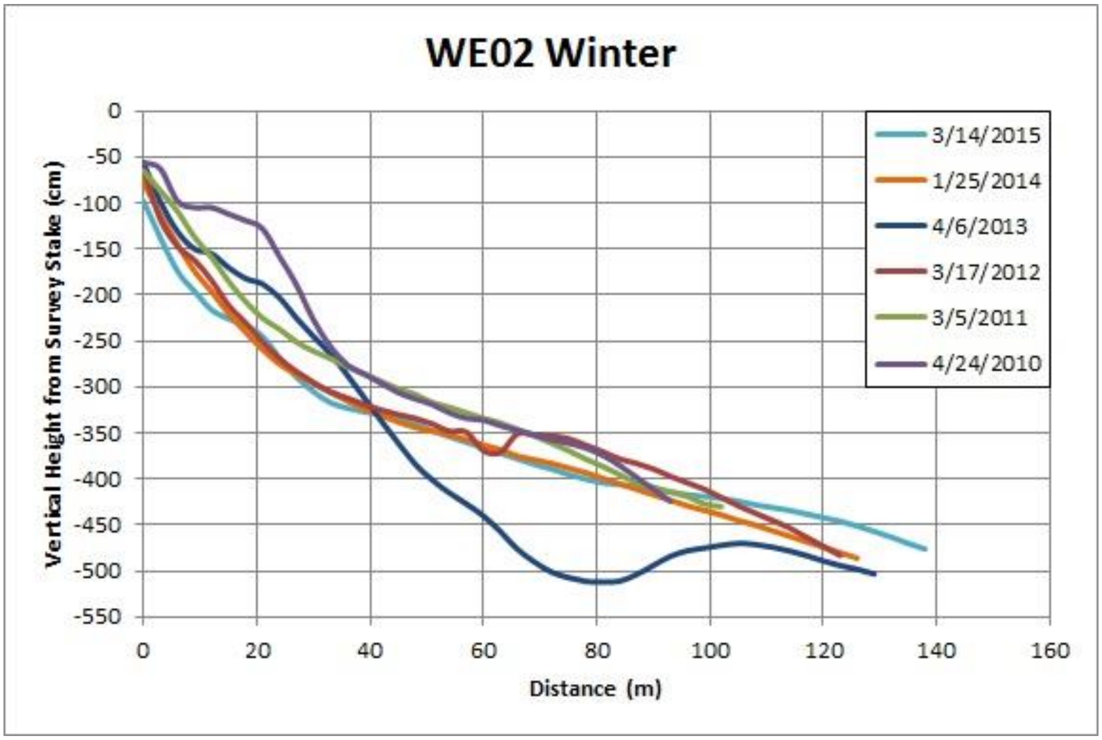

Figure 22. Winter beach profiles for WE02 from 2010 to 2015.

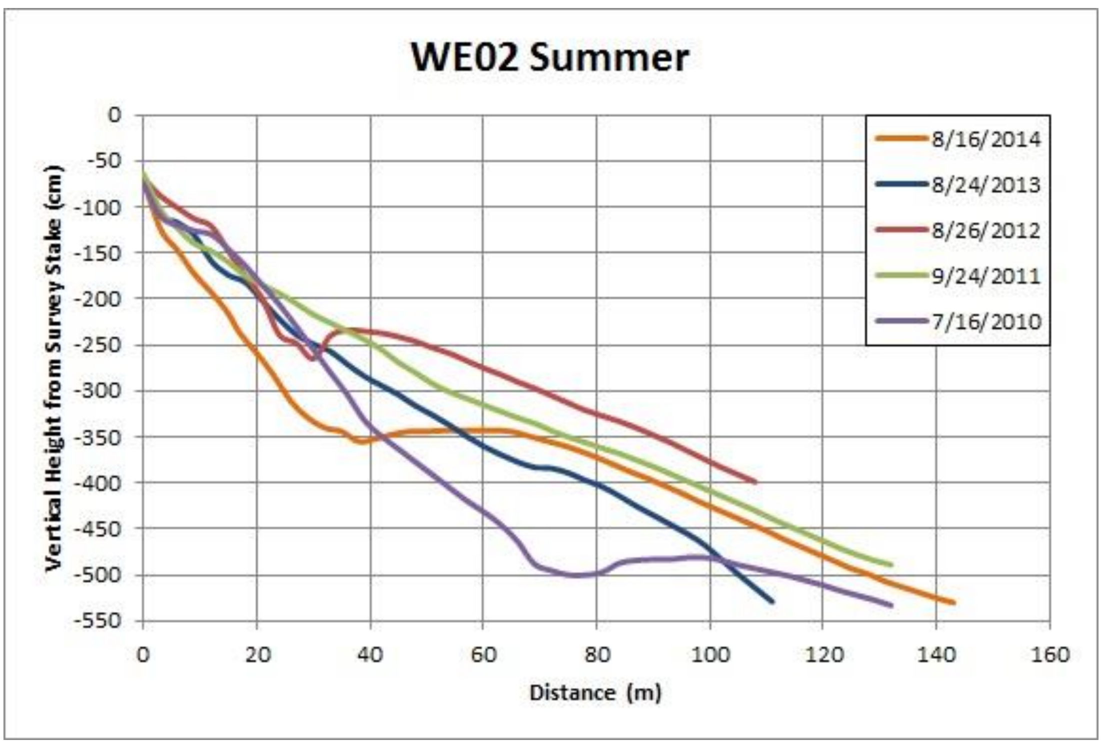

Figure 23. Summer beach profiles for WE02 from 2010 to 2014.

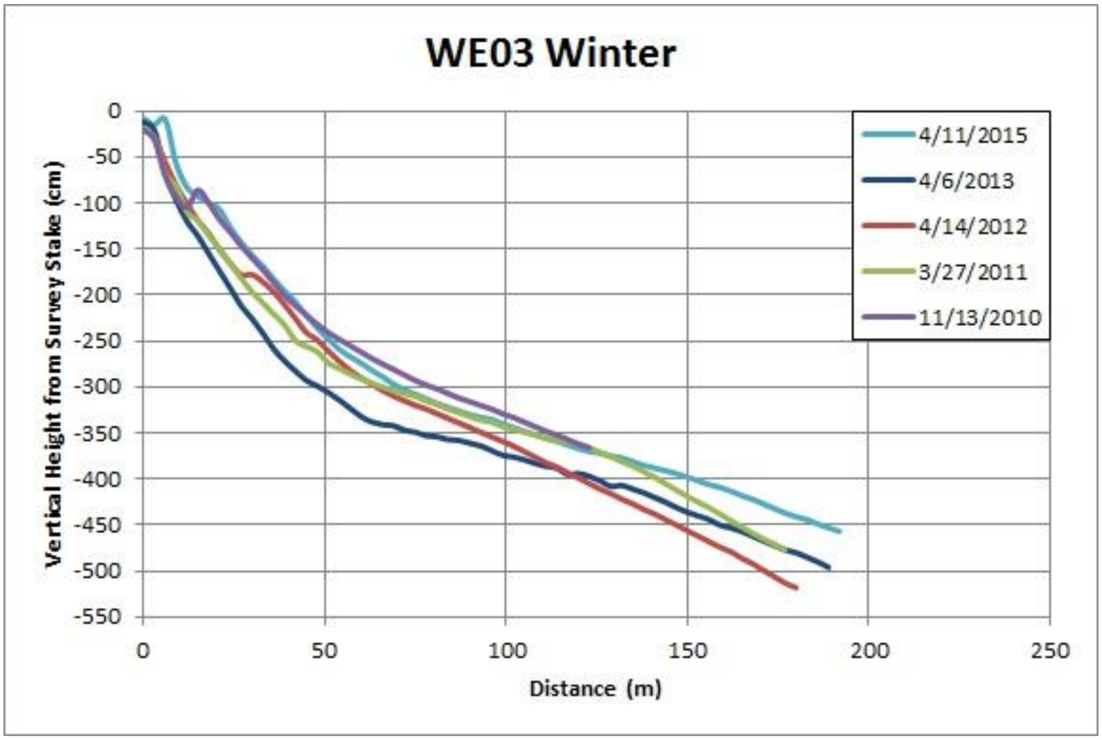

Figure 24. Winter beach profiles for WE03 from 2010 to 2013, and 2015.

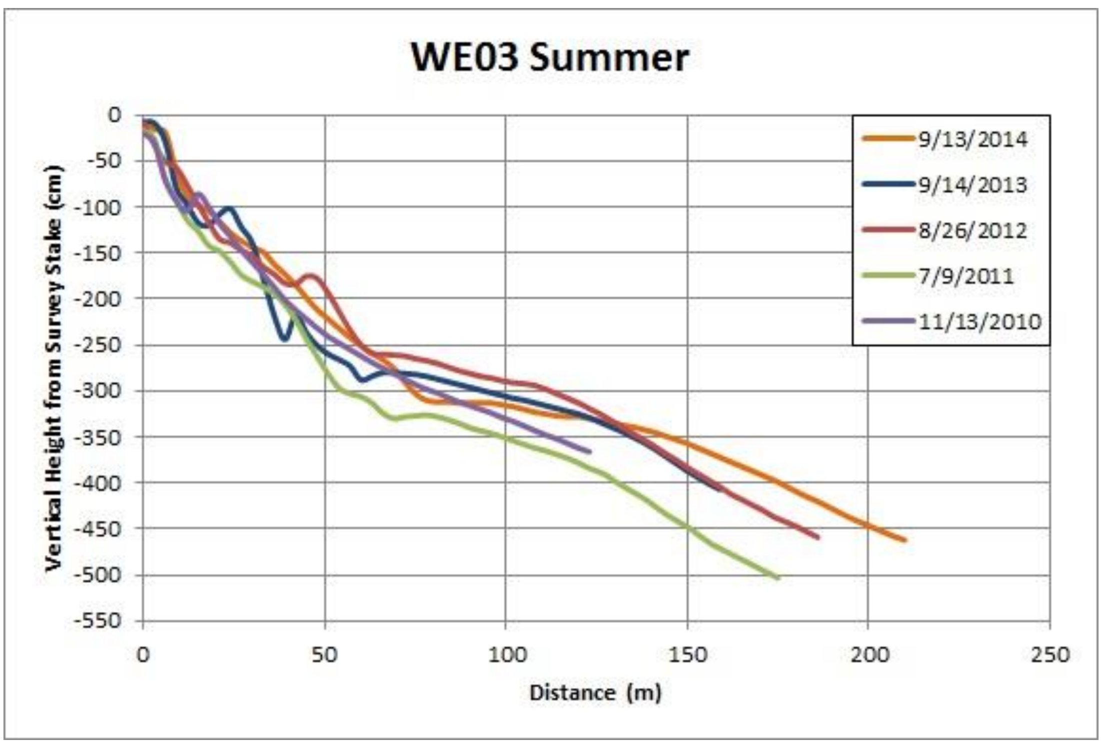

Figure 25. Summer beach profiles for WE03 from 2010 to 2014.

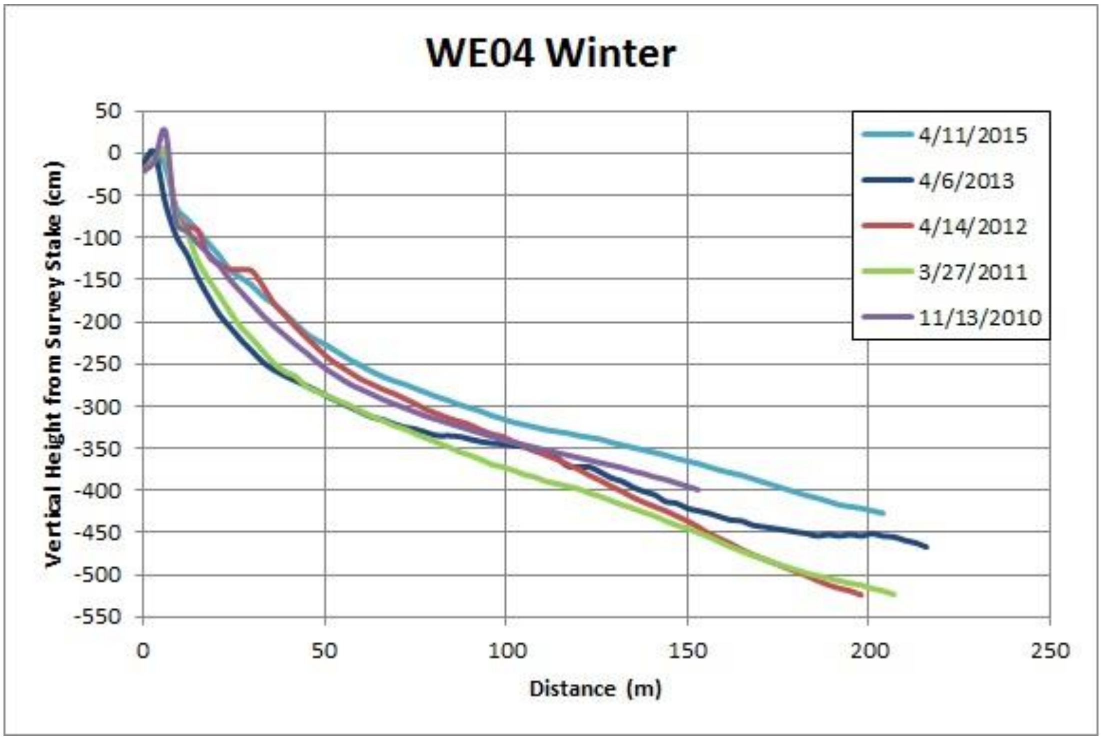

Figure 26. Winter beach profiles for WE04 from 2010 to 2013, and 2015.

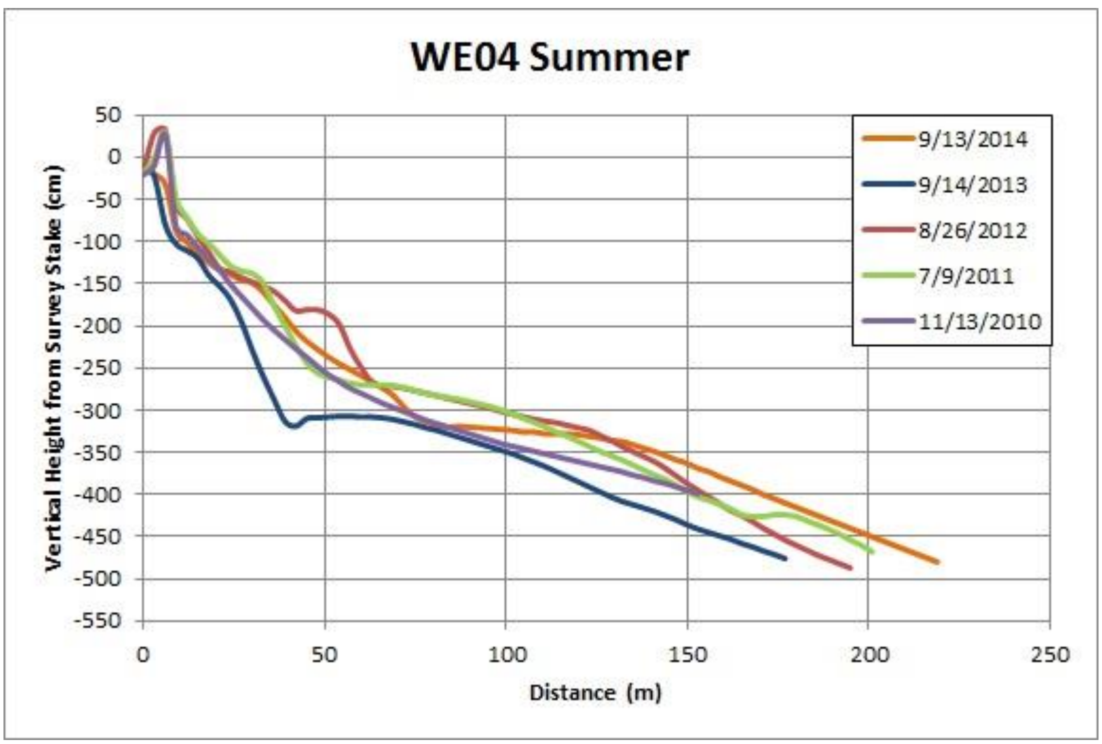

Figure 27. Summer beach profiles for WE04 from 2010 to 2014.

Wells Beach MBMAP Results

MBMAP data (2010-2012, and 2014) showed two distinct patterns in terms of vegetation line changes along the beach (Figure 28). From transects 310-380, the dune was either stable or growing seaward (an average of +0.6 m/yr), while from transects 405-460, the dune clearly eroded (at an average of -0.8 m/yr). This erosive trend for the northeastern stretch of beach was generally reflected by the summer profile shape at WE04, while WE03 remained relatively stable. The mean shoreline change rate for the entire stretch **was -0.18 m/yr, indicating a relatively stable (yet slightly erosive) trend.**

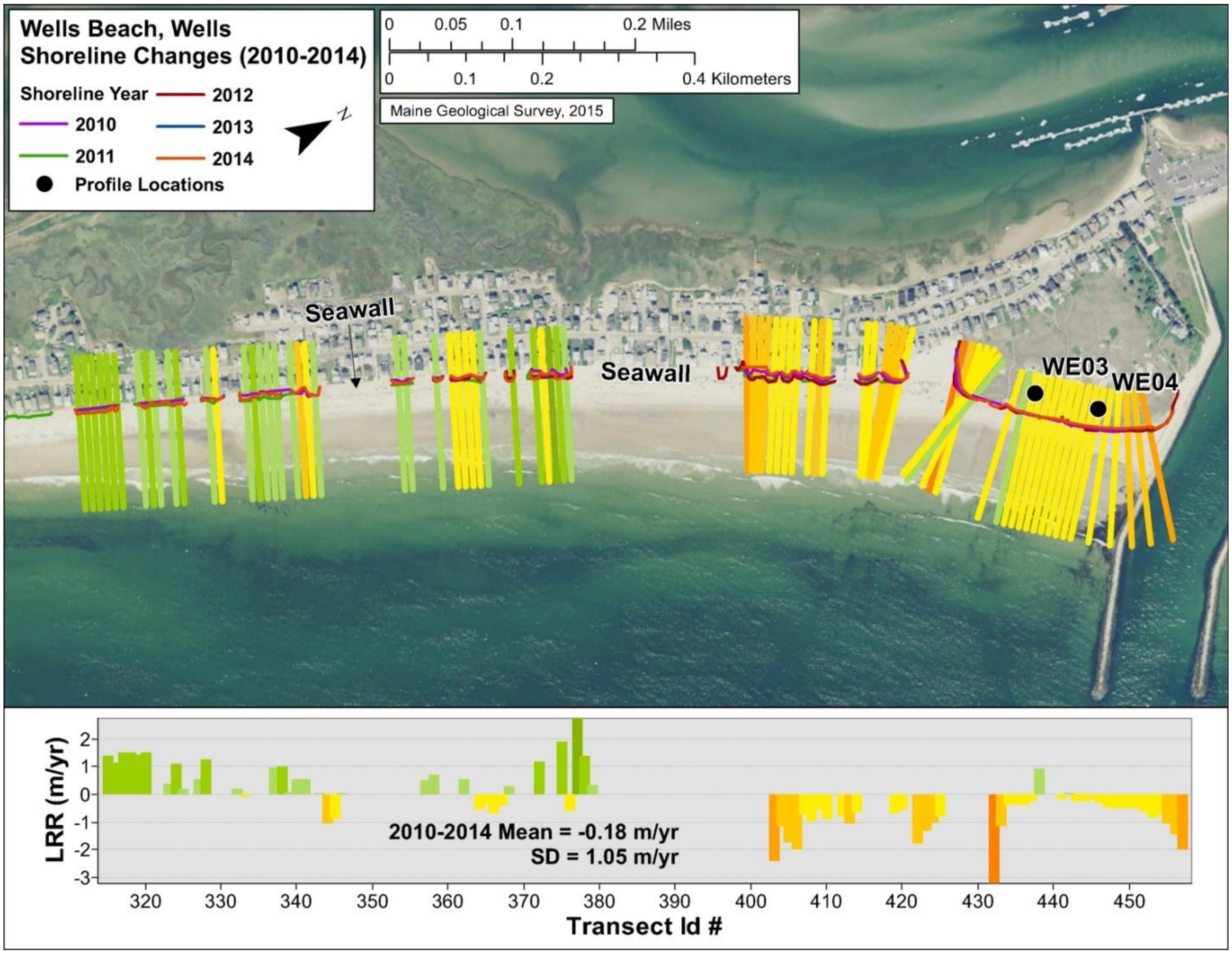

Figure 28. MBMAP shoreline change results along Wells Beach, Wells. 2013 base imagery from Maine OGIS.

Drakes Island Beach, Wells

Drakes Island Beach is not part of the SMBPP.

Drakes Island Beach MBMAP Results

Drakes Island Beach is just north of the Webhannet River, between Wells and Laudholm Beach. The dunes along the beach were surveyed in 2011 to 2014; the only section of vegetated dune is between the jetty and a seawalled portion of the beach to the northeast (Figure 29). Based on available data, the majority of the beach is generally stable to mildly eroding at rates of less than 0.3 m/year, with a few pockets of dune growth. The mean shoreline change rate was -0.05 m/yr indicating a relatively stable trend.

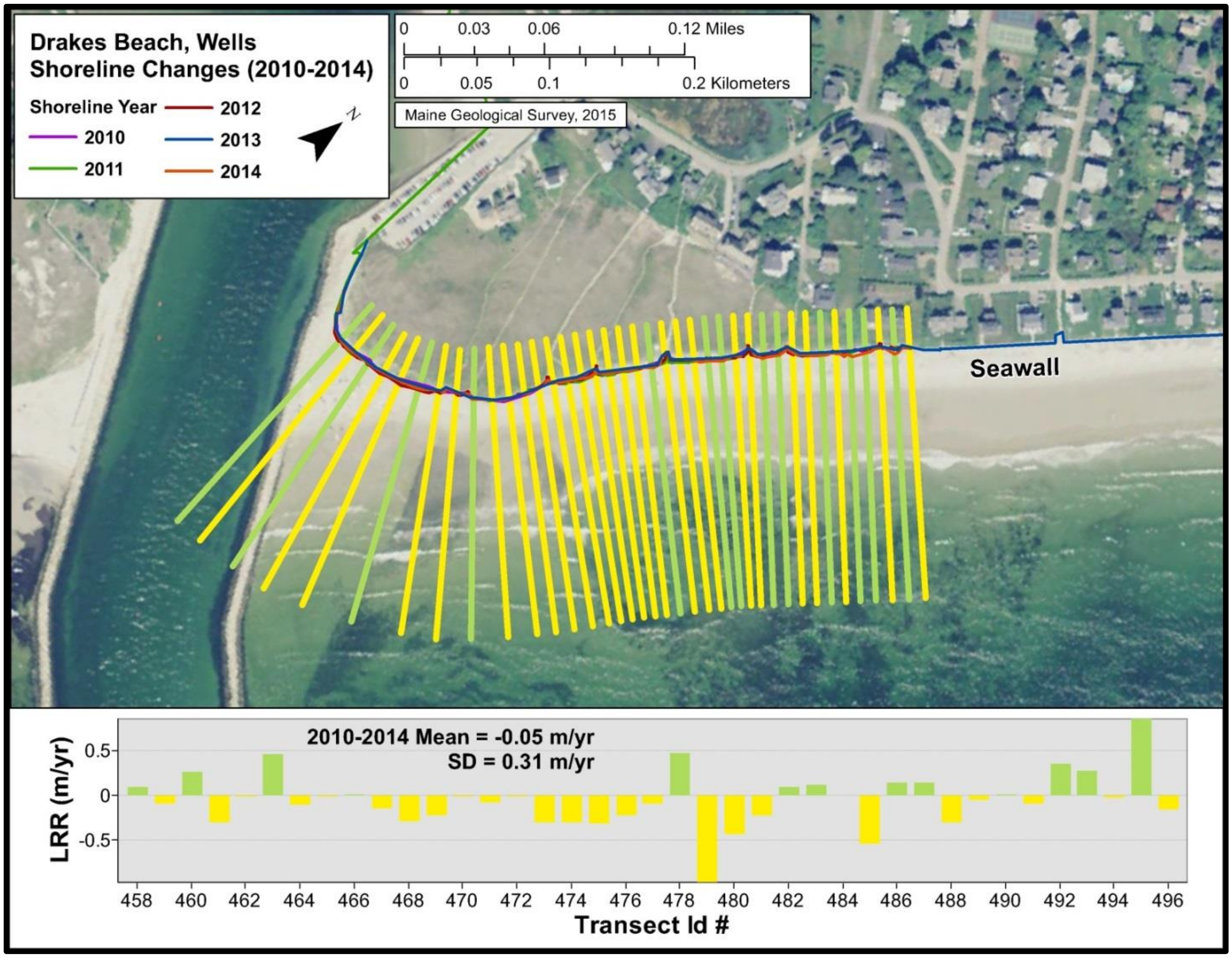

Figure 29. MBMAP data showing shoreline changes along Drakes Island Beach, Wells. 2013 base imagery from Maine OGIS.

Laudholm Beach, Wells

Four profiles (LH01-03, and LH05) were available for analysis (Figure 30). LH05 is located at the southern end of the beach, nearest to Drakes Island Beach, while LH01 to LH03 extend north along the beach towards the Little River inlet. Figures 31 to 38 show seasonal changes.

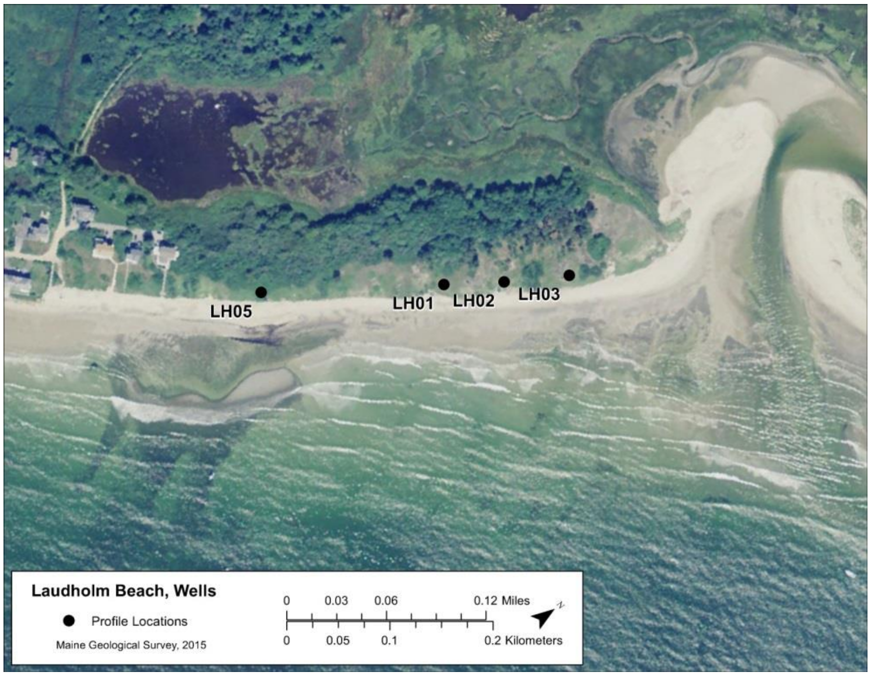

Figure 30. Volunteer beach profile locations along Laudholm Beach, Wells. Base imagery from Maine OGIS.

Winter LH01 = D (65). The 2010 profile had a well-defined dune crest and a nice berm at 20 m. In 2011, it had gained sand at the dune, lost some at the berm, but gained sand along the rest of the profile seaward. In 2012, it receded landward at the dune, lost its berm, but gained elevation seaward of 50 m. In 2013, the dune receded and the berm was lost. This continued in 2014, with additional sand lost at the dune, berm, and steepening of the beach. No 2015 data was provided. This profile eroded since 2011.

Summer LH01 = F (55). In 2010, the profile had a well-developed dune, small berm, and a relatively steep slope out to 30 m and then a series of swash bars. In each consecutive year since, the profile has moved landward and the dune has receded, indicating steady erosion. 2010 was the best and 2013/2014 the worst profile shapes.

Winter LH02 = D (65). From 2010 to 2011, the profile was stable at the dune, lost sand at the berm, but gained sand offshore. By 2012, it showed slight dune growth, berm recovery back to 2010 levels, and some continued elevation gains in its seaward portions. It eroded in 2013, losing its berm and sand in the nearshore. The 2014 profile was the most erosive, with extensive loss at the dune and along the profile. No 2015 data was provided. This profile showed stability through 2012, then consistent erosion since 2013.

Summer LH02 = D (65). In 2010, the LH02 had a well-defined dune, a break in slope at 30 m to a relatively flat profile. In 2011, it had slight dune and beach erosion, but elevation gains from 30 m seaward. In 2012, it showed additional beach and berm loss at 20 m, but gains in the offshore portion of the profile (30 m seaward). In 2013, the profile eroded at the berm and steepened, and in 2014, the dune and berm eroded substantially landward of 20 m, but gained offshore. Similar to winter, the profile showed stability through 2012 and erosion since 2013.

Winter LH03 = F (55). LH03 is closest to the Little River. In 2011, the dune eroded, the profile steepened, and the elevation decreased. In 2012, the dune stayed stable, and a berm and beach built back. 2013 saw more dune erosion and significant profile steepening, and in 2014, the profile lost its dune and berm even more. The profile has been eroding since 2013.

Summer LH03 = D (65). The profile showed consistent dune loss since 2010, with some stability in 2011 and 2012. The worst erosion appeared to occur in 2013 and 2014, with extensive dune loss. However, from 2013 to 2014, the profile did gain some sand seaward of about 10 m. It seems that sand is available to the lower profile, but like some of the others, the dune is being extensively eroded over the past few years.

Winter LH05 = C (75). LH05 is closest to Drakes Island. In 2010, it had a scarped dune, a defined berm, and a steep slope to low tide terrace. In 2011, the dune migrated landward but increased in elevation. In 2012, the dune and beach eroded, resulting in a steep slope, but slight sand gains offshore. By 2013 (it is unclear if this is the same starting location; we assume it is), it showed extensive dune loss, landward berm migration, but an increase in sand elevation in the berm. The 2014 shape saw good recovery of the dune and berm, but the dune crest is lower than the 2010 shape. The profile showed some recovery in 2014. No 2015 data was provided.

Summer LH05 = C (75). From 2010 to 2011 LH05 showed marked stability. However, in 2012 (May), it showed dune and beach erosion to 40 m, where there was an elevation gain seaward along the profile over the 2011 shape. 2013 saw extensive loss of the dune and the formation of a large trough between 40 and 70 m, but good berm growth. There is a large cobble bar that formed near the 80 m mark. In 2014, the berm eroded, but sand migrated onshore through the trough. This profile is more stable than the others over this reporting period, likely due to support of the lower profile by cobble.

Winter Summary: Excluding LH05, the profiles showed consistent erosion of the beach.
Winter Beach Grade: D (65).

Summer Summary: Aside from LH05, all profiles showed signs of significant erosion.
Summer Beach Grade: D (65).

Overall Summary: Profiles nearest the Little River are undergoing extensive erosion. Loss of sand on the low tide terrace exhumed salt marsh peat. The peat is removed by wave attack, which in turn lowers the profile further and allows either sand infill, or greater wave attack. It appears that some of LH05's stability may be due to the presence of cobble in the nearshore. Sand eroded from the beach and dunes appear to be going into the Little River spit.
Overall Laudholm Beach Grade: D (65).

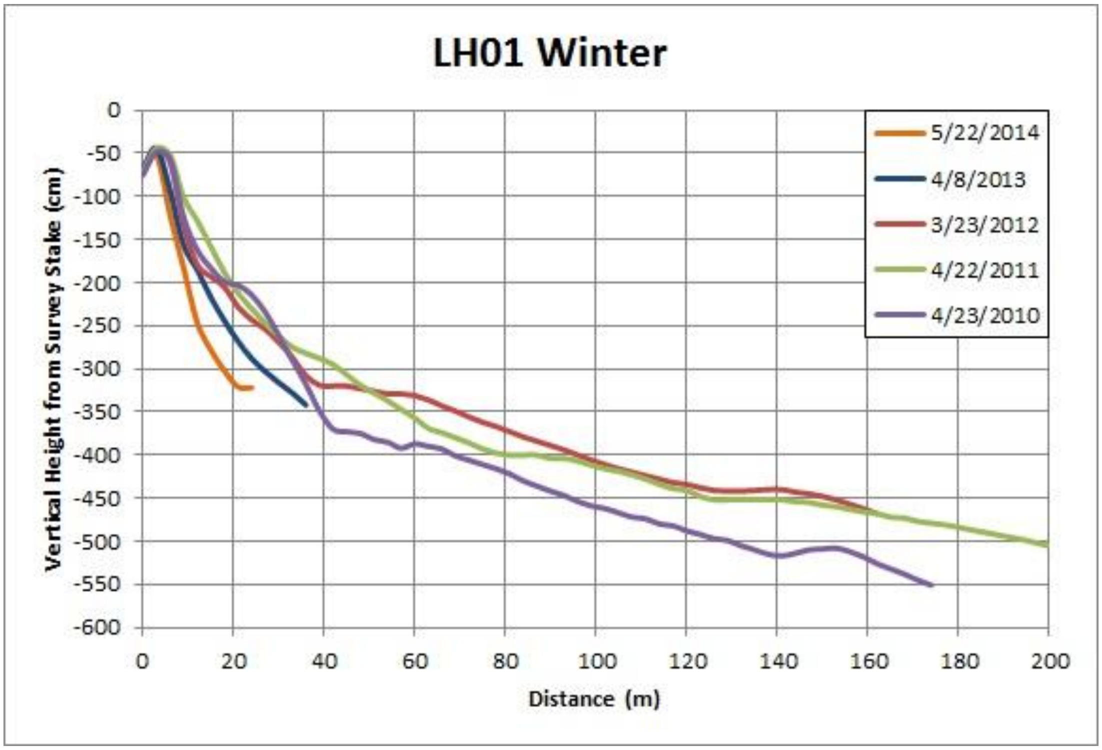

Figure 31. Winter beach profiles for LH01 from 2010 to 2014.

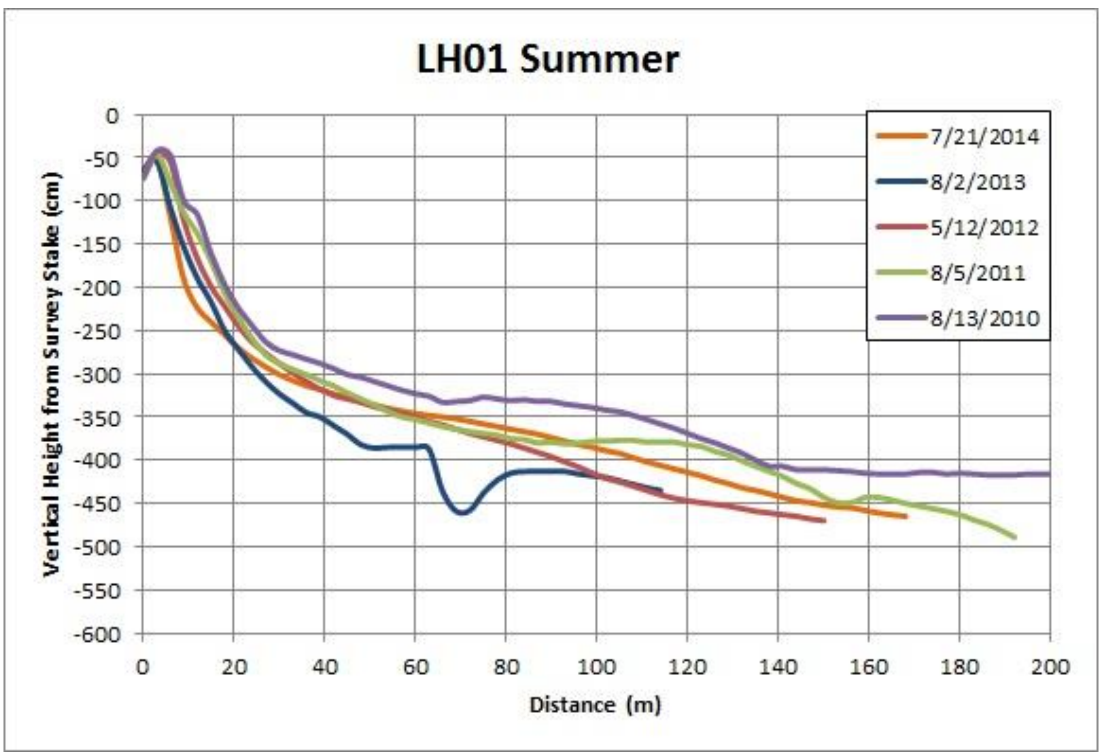

Figure 32. Summer beach profiles for LH01 from 2010 to 2014.

Figure 33. Winter beach profiles for LH02 from 2010 to 2014.

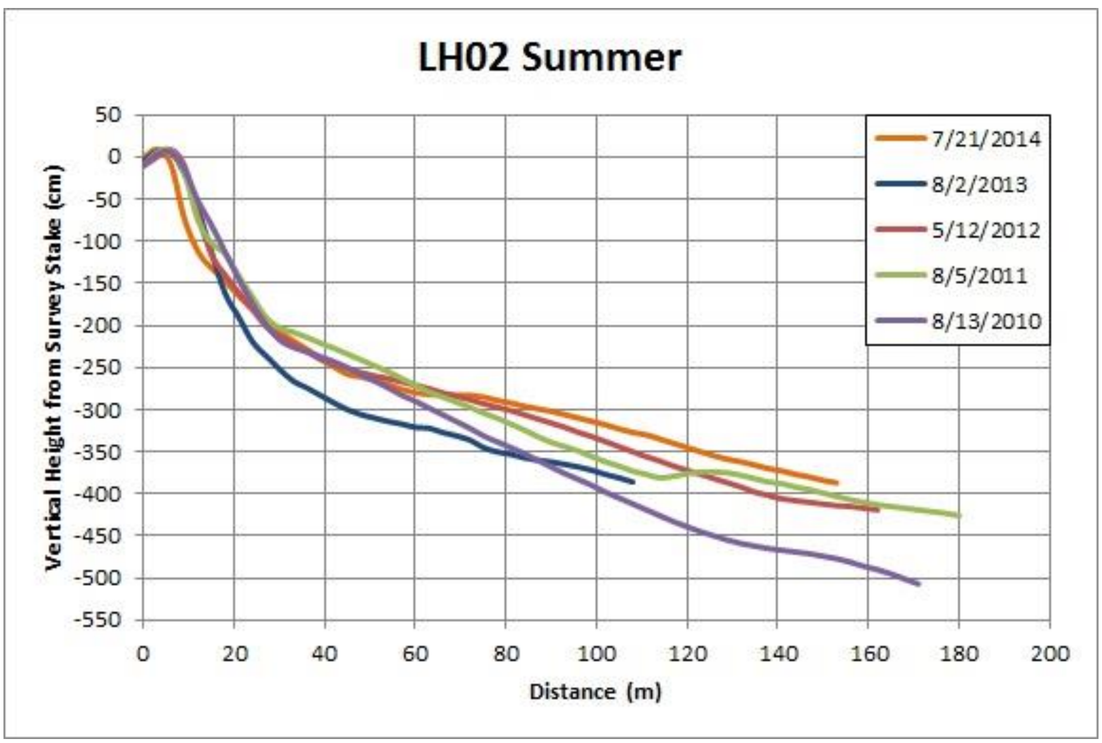

Figure 34. Summer beach profiles for LH02 from 2010 to 2014.

Figure 35. Winter beach profiles for LH03 from 2010 to 2014.

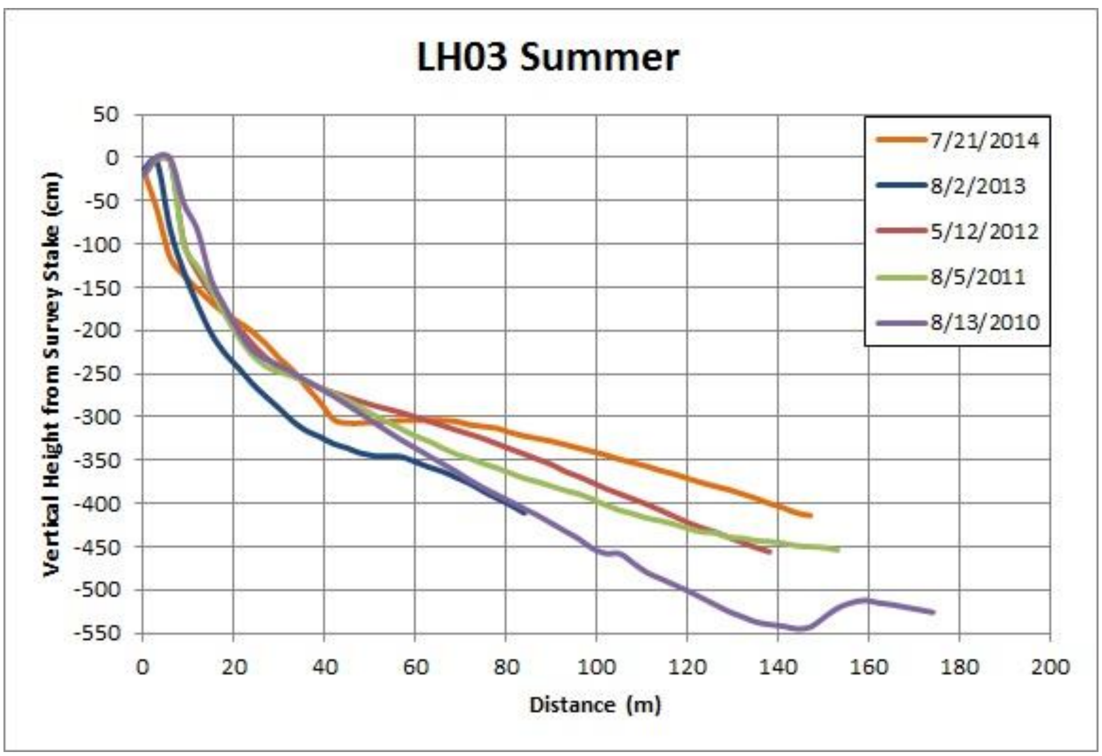

Figure 36. Summer beach profiles for LH03 from 2010 to 2014.

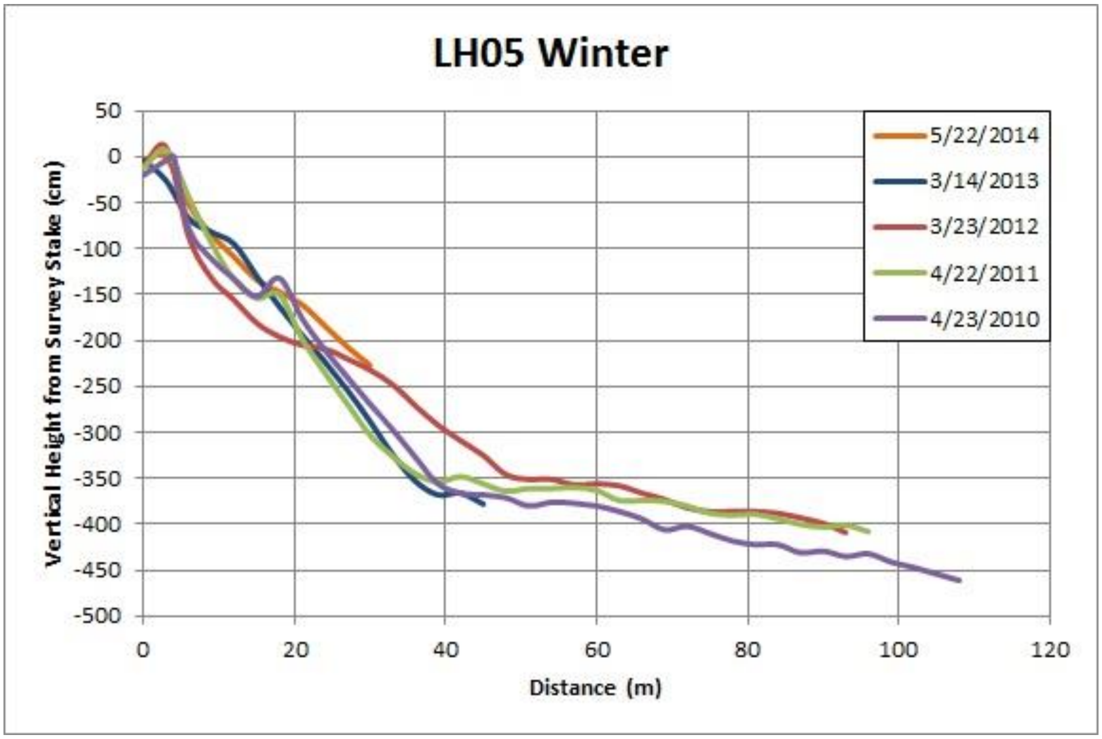

Figure 37. Winter beach profiles for LH05 from 2010 to 2014.

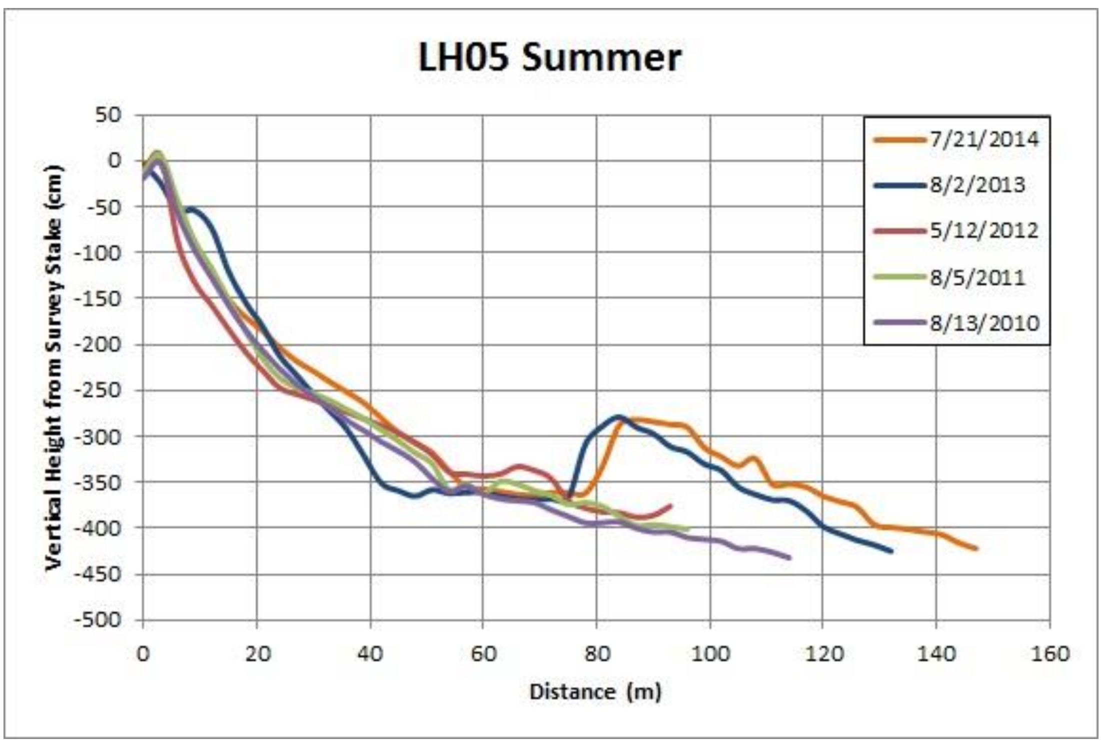

Figure 38. Summer beach profiles for LH05 from 2010 to 2014.

Laudholm Beach MBMAP Results

Vegetated shoreline exists from the seawall at Drakes Island Beach northeast to the Little River, and includes data from 2010 to 2014 (Figure 39). Shoreline erosion was quite high (-1 to -2 m/yr) at a pocket in the central portion of the beach (transects 620-630), and highest nearest the inlet (transects 660-665), on the order of -2 to -4 m/yr. At LH05 (farthest southwest) the erosion rate was about -0.5 m/yr; at LH01 and LH02, the erosion rate was around -0.75 m/yr, and at LH03, the rate was about -1.5 m/yr. The mean shoreline change rate was -1.19 m/yr indicating that Laudholm was highly erosive from 2010 to 2014.

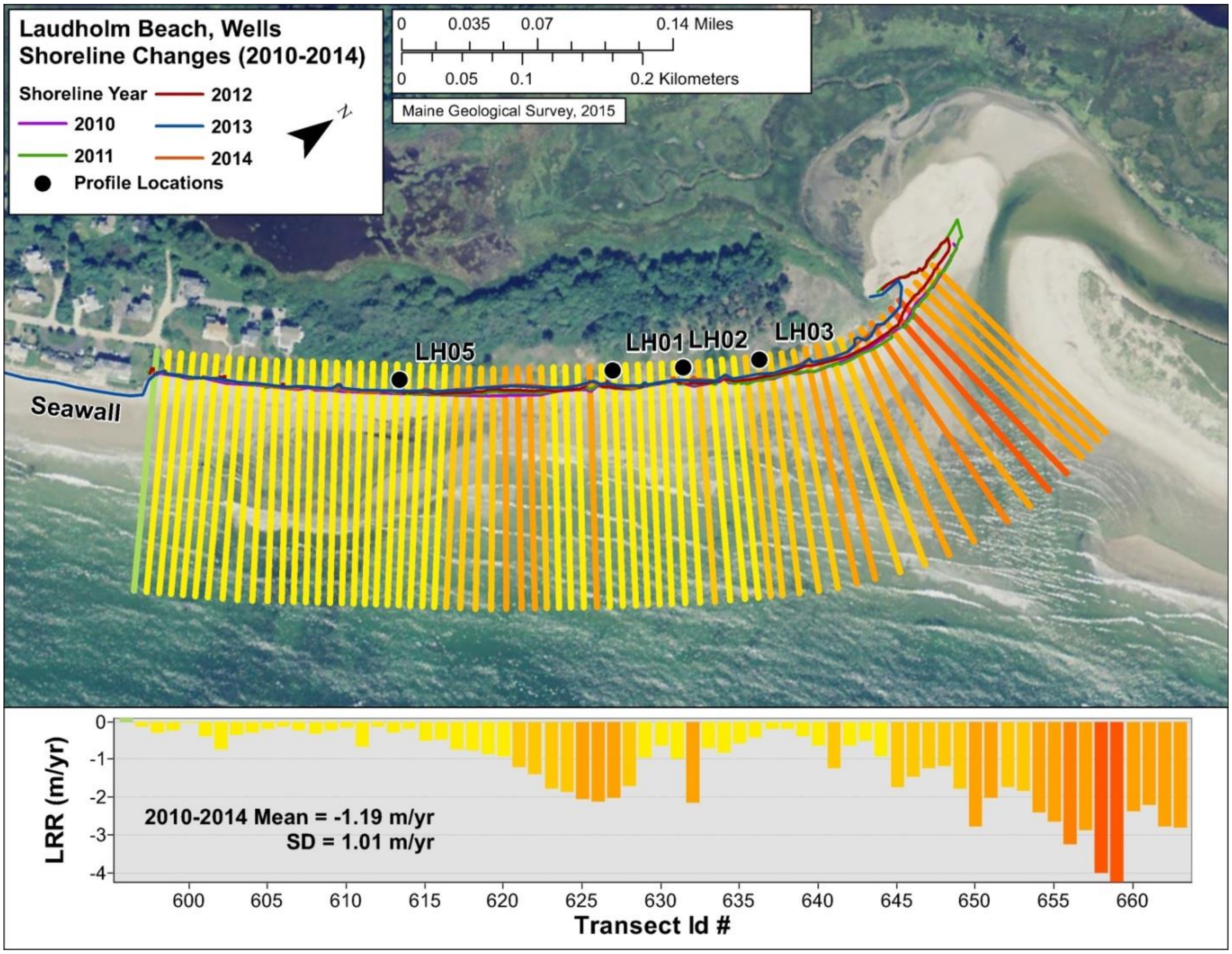

Figure 39. MBMAP shoreline change results for Laudholm Beach, Wells. 2013 base imagery from Maine OGIS.

Goochs Beach, Kennebunk

Four profiles (GO01 to GO04, Figure 40) were available for analysis. All are located in the seawall at the beach. GO01 is at the western end of the beach, while GO02 is centrally located. GO03 is the easternmost profile, and GO04 is located at the southeastern end of Middle Beach. Figures 41 to 48 show seasonal changes.

Figure 40. Volunteer beach profile locations at Goochs Beach, Kennebunk. 2013 base imagery from Maine OGIS.

Winter GO01 = D (65). From 2010 to 2011, GO01 eroded at the berm, lowering adjacent to the wall. In 2012, sand at the wall lowered, but GO01 built out to about 40 m. In 2013, it dramatically eroded, steepened, and lost around 60 cm of elevation – this was the most erosive profile. By 2014, the profile lowered more at the wall but recovered well seaward of 10 m. In 2015, a small berm appeared at the wall (likely due to freezing of the beach), but the profile lowered and steepened back to 2010 elevations. Seaward of 10 m, the profile showed some stability over the last few years, but has lost elevation at the wall and berm since 2012. Although it is above the worst year (2013), 2015 was worse than other years.

Summer GO01 = B (85). 2010 had a slightly convex shape. By 2011, GO01 gained elevation at the berm. By 2012, it gained sand within about 40 m of the wall. In 2013, GO01 dramatically eroded by about 50 cm. In 2014, it recovered well, with a starting point near 2010, an evident berm, and the highest sand elevations along the profile seaward of 20 m. The profile showed stability to growth from 2010 to 2012, extensive erosion in 2013, and recovery in 2014.

Winter GO02 = B (85). In 2010, GO02 was steep and concave, flattening out at 20 m. In 2011, it lowered at the wall, but gained elsewhere. In 2012, the sand at the wall dropped, but the berm grew. In 2013, it gained sand at the wall out to 25 m, but lost elevation seaward by about 1 m below 2010 elevations, likely exposing peat surfaces. In 2014, sand increased at the wall, and GO02 gained sand back to near 2011 levels. In 2015, GO02 lowered near the wall to 2011 levels, but gained a large volume of sand at 20 m seaward, raising the beach by 50 to 75 cm. GO02 recovered from 2010 to 2012, eroded in 2013, and recovered in 2014 and 2015.

Summer GO02 = C- (72). In 2010, GO02 had a starting elevation of 20 cm with sand above the starting pin and a steep slope that flattened at 20 m. By 2011, it lost 50 cm at its starting point, and fell along its entire length, indicating erosion. In 2012, it lost more sand at the wall – down to -70 cm. Seaward of 30 m, it had the same shape as 2010. In 2013, it eroded deeper to a historic erosion surface, but gained at the berm to wall. In 2014, it lost elevation at the wall (back to 2011), but gained slightly offshore. For this profile, 10 m is an inflection point where sand is exchanged from the berm to the beach. The summer shape was relatively stable, but lost sand at the wall while winter was much more variable.

Winter GO03 = C (75). In 2010, GO03 had its highest sand level at the wall, with a steep, concave slope that flattened at 20 m. In 2011, sand was lost at the wall, but the lower portion of the profile gained. In 2012, the profile had the highest berm at 30-40 m. In 2013, it gained slightly at the wall, but deepened seaward of 40 m. In 2013 it was lower than 2010 in all locations but for a narrow berm just seaward of the seawall. In 2014, it gained slightly at the wall, but lowered again in 2015. In general, GO03 is relatively stable and shows very little overall vertical movement from 2010-2014.

Summer GO03 = C+ (78). In 2010, G003 had a starting elevation near 0 and sloped sharply offshore until seaward of 15 m. In 2011, it lost 50 cm at the start, but gained a berm between 10-20 m and between 60-100 m. In 2012, it gained slightly in elevation (10 m seaward), but lost elevation at the wall. 2013 saw a good berm and the formation of a trough at 25 m. The profile recovered in summer 2014 and gained sand seaward of about 18 m – this gain could be related to 20,000 cy of dredged material which was placed in the nearshore in late March. GO03 did not change much from 2010-2014.

Winter GO04 = B (85). GO04 was flat, with a slight berm around 18 m in 2010. In 2011, it gained at the wall, and formed a well-defined berm at 10 m. The berm moved up the profile in 2012, but lost around 50 cm of elevation at the seawall and slightly steepened offshore. The berm maintained its position in 2013, but lost elevation at the wall. 2014 saw significant growth adjacent to the wall and at the berm. In 2015, this slightly lowered, but was still well defined. The profile has shown some recovery and stability since 2010.

Summer GO04 = B (85). 2010 had a starting point of -35 cm, and a well-defined berm. In 2011, it lost sand at the wall, and the berm migrated landward. By 2012, the profile's starting point moved back up to 2010 levels, but a trough feature formed landward of the berm (at the 4 m mark). 2013 and 2014 saw berm growth. The profile showed good recovery.

Winter Summary: GO01 showed instability and loss in the winter, while GO02 and GO03 performed relatively well. GO04, at Middle Beach, was variable, but recovered well. **Winter Beach Grade: C+ (78).**

Summer Summary: GO01 and GO02 were variable, especially nearest the wall, while GO03 was stable. GO04, along Middle Beach, showed good recovery. **Summer Beach Grade: B- (80).**

Overall Summary: Generally, profiles at Goochs Beach did fairly well in terms of stability and recovery since 2010. GO01 was the most erosive, especially in winter. This was verified by photographs from volunteers showing exposed bedrock in the surf zone. GO01, GO02, and GO04 (Middle Beach) have variable summer shapes generally with substantial vertical berm loss and gain. GO03 was the most stable profile through the seasons. **Overall Goochs Beach Grade: C+ (79).**

Figure 41. Winter beach profiles for GO01 from 2010 to 2015.

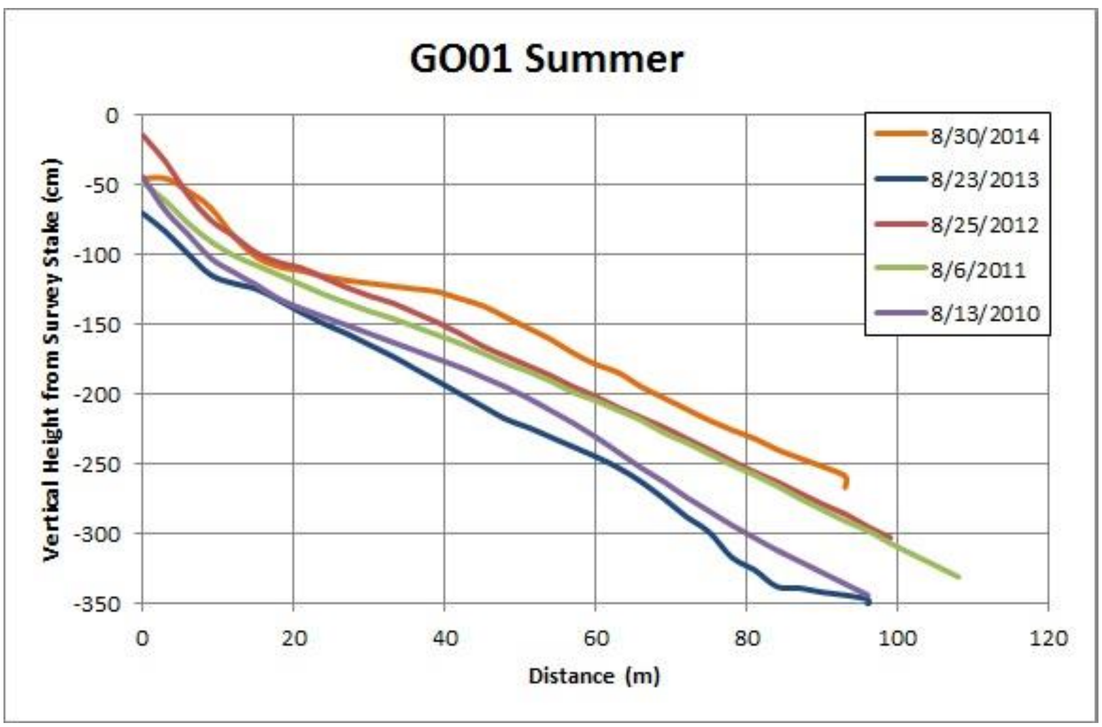

Figure 42. Summer beach profiles for GO01 from 2010, 2011, and 2012.

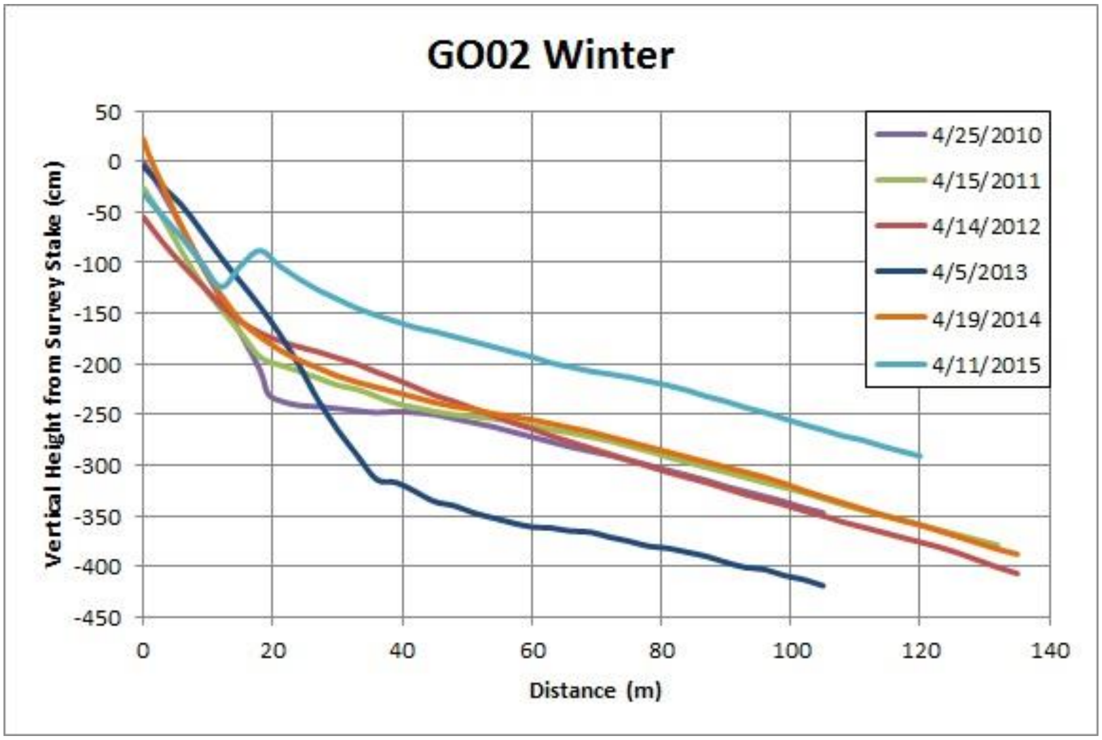

Figure 43. Winter beach profiles for GO02 from 2010 to 2015.

Figure 44. Summer beach profiles for GO02 from 2010 to 2014.

Figure 45. Winter beach profiles for GO03 from 2010 to 2015.

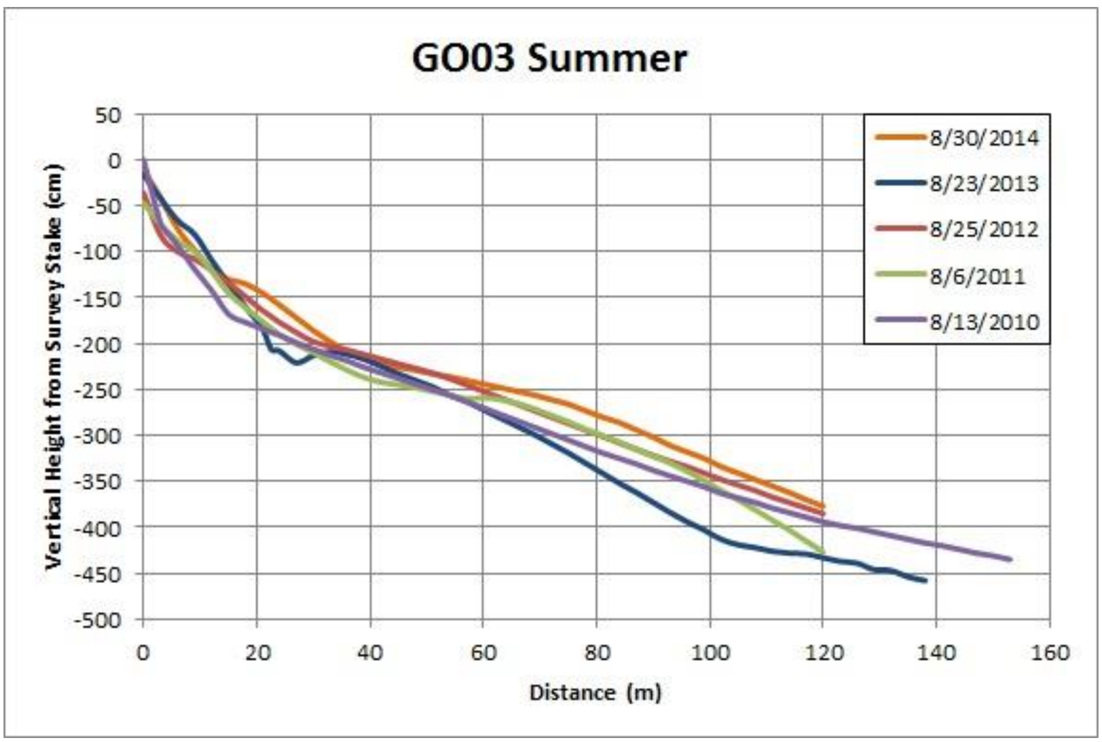

Figure 46. Summer beach profiles for GO03 from 2010 to 2014.

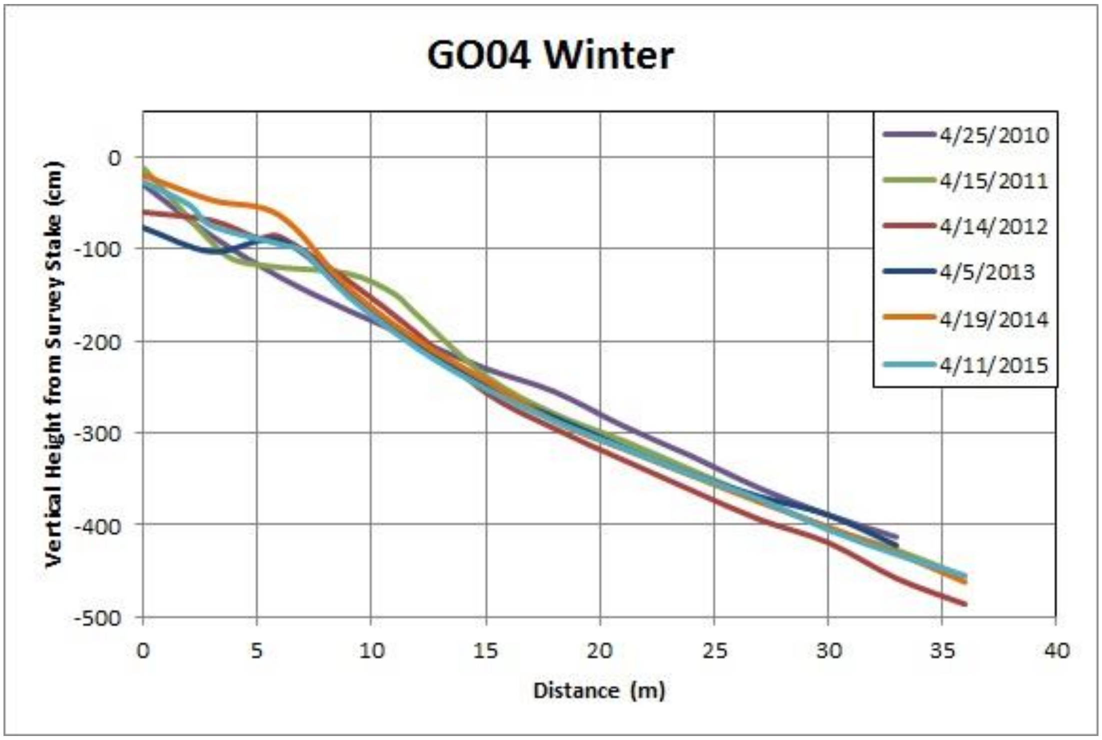

Figure 47. Winter beach profiles for GO04 from 2010 to 2015.

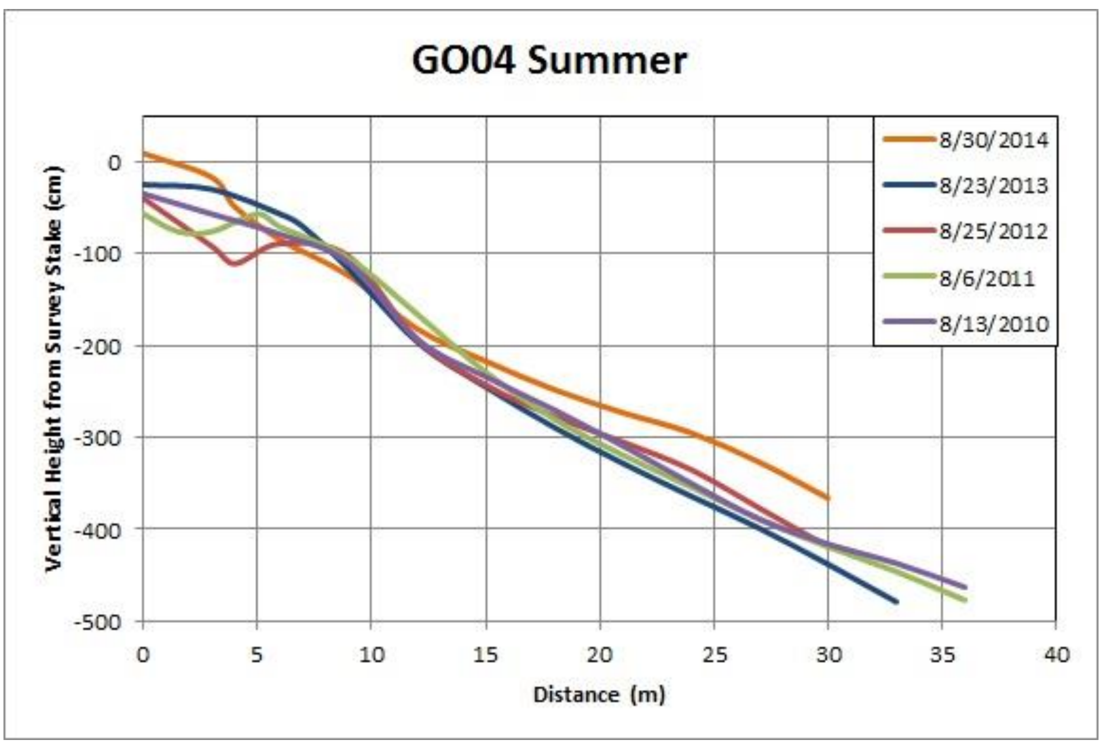

Figure 48. Summer beach profiles for GO04 from 2010 to 2014.

Goochs Beach MBMAP Results

Only a small section of vegetated shoreline exists adjacent to the seawall at the Kennebunk River (Figure 49). The remainder of Goochs Beach has a seawall with no measureable vegetation. Based upon this data, the mean shoreline change rate was -0.54 m/yr indicating that the dune near the jetty was **erosive from 2010 to 2014**. The dune eroded the most directly adjacent to the jetty.

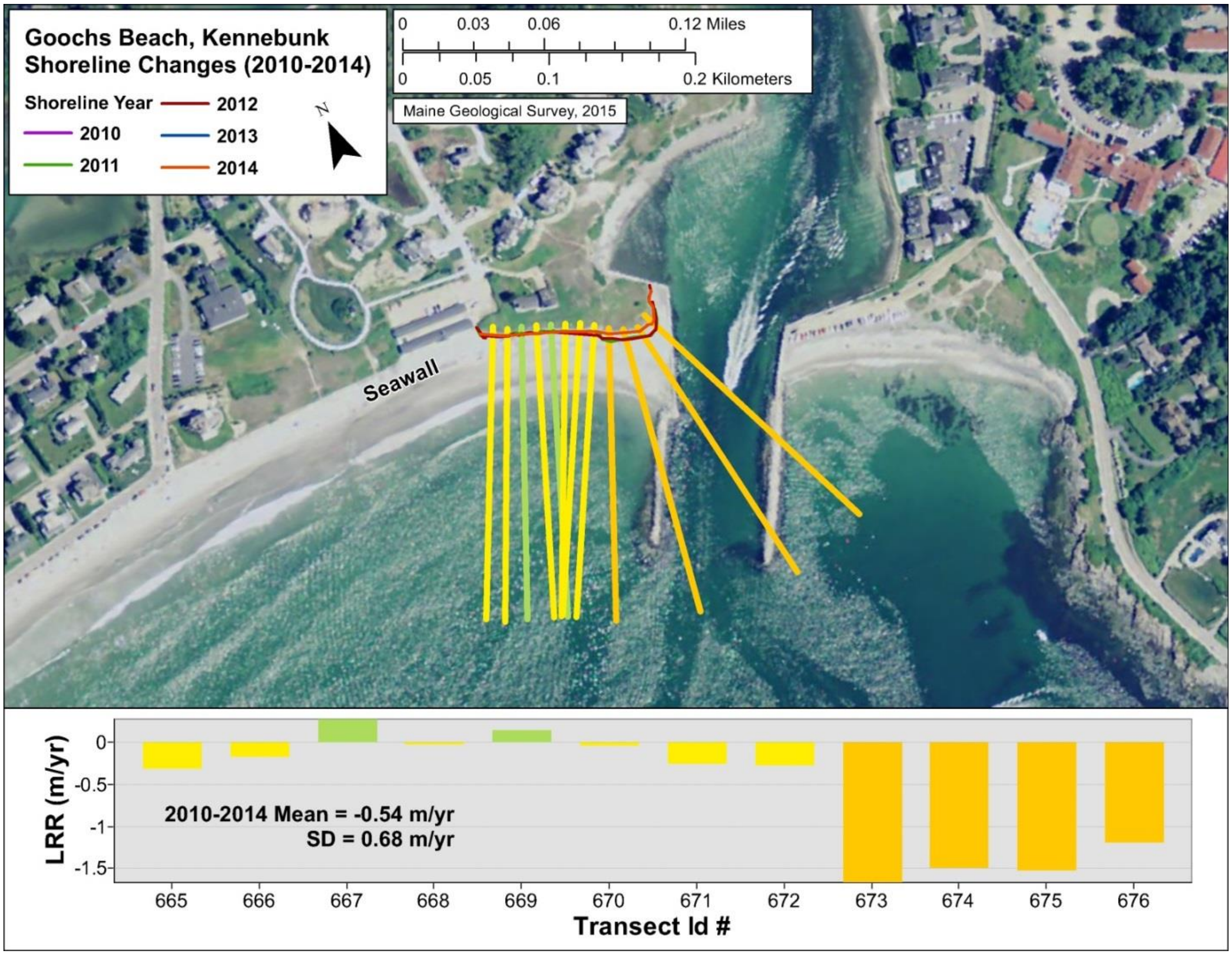

Figure 49. MBMAP analysis results for Goochs Beach, Kennebunk. 2013 base imagery from Maine OGIS.

Goose Rocks Beach, Kennebunkport

Four beach profiles (GR01 to GR04, Figure 50) were available for analysis. GR01 is at the south end of the beach, near the Batson River. GR02 is in a small cell in the central portion of the beach. GR03 is in a cove at the north third of the beach GR04 is adjacent to the Little River. Figures 51 to 58 show seasonal changes.

Figure 50. Volunteer beach profile locations for Goose Rocks Beach, Kennebunkport. 2013 base imagery from Maine OGIS.

Winter GR01 = B- (82). GR01 was highly variable due to its proximity to the river. In 2010, it had a small dune, berm, and numerous swash bars. In 2011 it gained in elevation. In 2012, it had dune growth, but fore-shore steepening, and loss at the low-tide terrace. In 2013, it had more dune growth, but loss and steepening of the beach, and landward migration of bars on the low tide terrace. In 2014, it maintained its dune, but lost at the berm and low-tide terrace. By 2015, the berm was well developed and the profile had additional swash bars. 2010 was the most erosive shape overall and 2013 was the most erosive at the berm. The profile was highly variable but with ample sand supply.

Summer GR01 = C (75). In 2010, GR01 had a low dune, defined berm, and steep slope to a flat low-tide terrace. In 2011, it gained elevation at the dune, the berm built seaward, and a large swash bar was visible. In 2012, it gained sand at the dune, lost at the berm, and was similar to 2010 offshore. 2013 had berm erosion, resulting in the steepest profile. In 2014, the dune was stable, the profile still steep, but had sand near the base of the berm. The profile grew from 2010 to 2012, but then eroded in 2013, and was relatively stable in 2014. Berm loss occurred but the dune was stable.

Winter GR02 = C- (72). From 2010 to 2011, GR02 gained at the berm but steepened seaward of 30 m. In 2012 it had more berm growth, but steepened and formed a trough at 35 m. The profile eroded severely in 2013 (below the 2010 shape). By 2014, it gained sand back at the upper 50 m of the profile, and was stable seaward. In 2015, it gained near the dune, but lost sand along the rest of the profile (below 2010 levels). GR02 showed some recovery through 2012, heavy erosion in 2013, recovery in 2014, and erosion in 2015 to below 2010 levels.

Summer GR02 = C+ (78). In 2010, the profile had a trough landward of a berm. By 2011, it gained sand while the berm moved seaward and flattened. By 2012, it gained dune elevation and the berm returned to about the 2010 shape. By 2013, the profile eroded back to the 2010 shape, with a defined trough near 15 m. In 2014, it recovered near the dune and the trough filled, but the berm was lost. 2012 was the best year. It generally gained sand since 2010, but has been variable.

Winter GR03 = B- (82). From 2010 to 2011 it changed very little with slight gains at its upper end. By 2012, it gained a large berm at the 50 m mark. The 2013 profile lost sand at the dune and berm (lower than 2010), and was equal to the 2010 shape from 100 m. In 2014, GR03 gained sand to its highest elevations, with a well-defined berm from 20-40 m, and lots of sediment offshore. By 2015, it gained slightly landward of 20 m, but lost elevation seaward of this. It recovered from 2010 to a high in 2014, but eroded this past winter.

Summer GR03 = B (85). 2010 was by far the most erosive profile shape. By 2011, it gained substantial elevation (about 50 cm over 2010 elevations) at the 40 m mark and swash bars formed around 110 m and 210 m. In 2012, the profile gained nearest the dune, but lowered elsewhere, indicating erosion. 2013 had the steepest most erosive dune and beach shape, which showed recovery in 2014 (but below 2011 high elevations). Generally, the profile recovered well from 2010.

GR04. GR04 has been extremely variable due to its proximity to the Little River. Note that the starting pin for GR04 was moved several times, so it is difficult to compare profiles collected from different starting points. Thus, we have analyzed profiles collected consistently at approximate 2 month intervals, but at two separate starting pins (June 2013 to February 2014, and July 2014 to March 2015). No seasonal scores will be given for GR04.

6/2013-2/2014 – From June to August 2013, the entire profile eroded dramatically to its lowest shape of the time period. By October, it recovered considerably from about 25 m seaward, but lost elevation near the seawall. By December, it gained back near the wall, but lost elevation seaward of 25 m. In February 2014, the profile gained at the wall, but lost at its berm and seaward. August 2013 was its most erosive shape, while probably December 2013 was the best.

7/2014 to 3/2015 – From July to September the profile was stable landward of 75 m, but lost elevation seaward of this. By November, it gained sand from the seawall out to 90 m, and stayed stable seaward of this. January 2015 was the most sand rich profile, gaining along its entire length. It eroded slightly in March seaward of 50 m.

GR04 had *better winter shapes than summer shapes*; this is likely due to its position related to northeasters, which appear to build sand up near the Little River during winter months. It has recovered somewhat well. Grade: **C+ (77).**

Winter Summary: GR02 showed heavier loss than the others; GR01 and GR03 recovered since 2010, with winter 2013 seeing some of the worst erosion. GR04 appears to grow in the winter. **Winter Beach Grade: C+ (79).**

Summer Summary: Summer profiles at GR01, GR02, and GR03 did relatively well. GR04 appears to erode in summer. **Summer Beach Grade: C+ (79).**

Overall Summary: GR01 and GR04 had good winter shapes, and GR02 and GR03 better summer shapes. GR03 recovered best overall. **Overall Goose Rocks Beach Grade: C+ (78).**

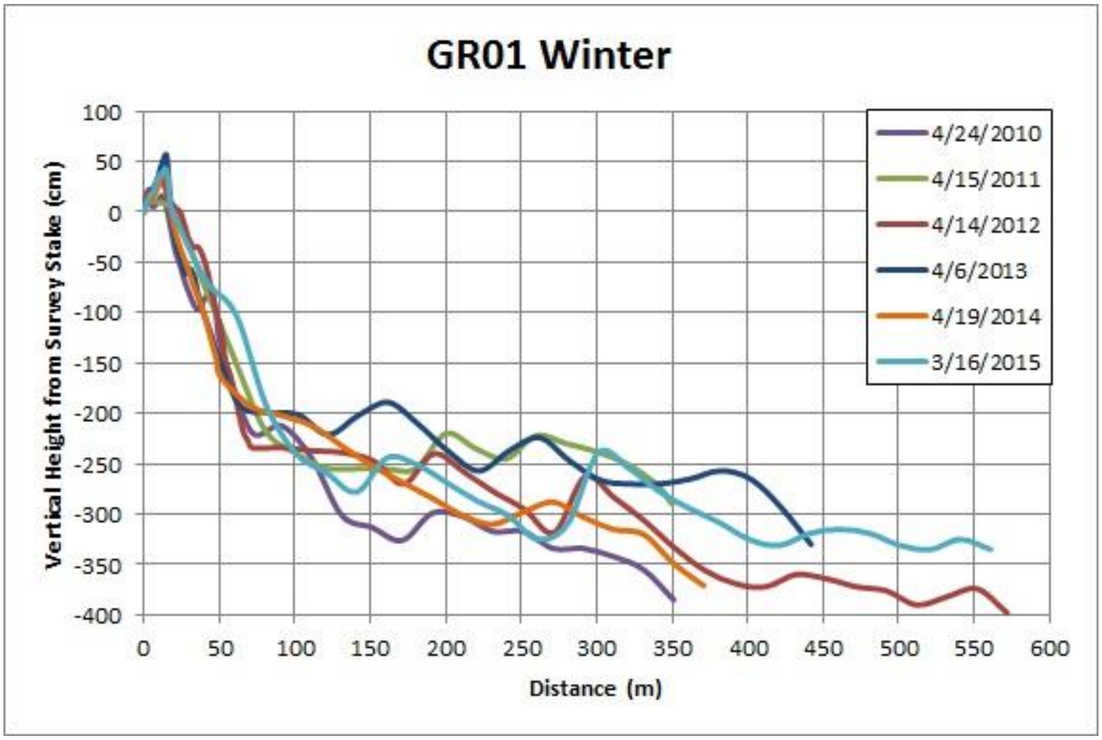

Figure 51. Winter beach profiles for GR01 from 2010 to 2015.

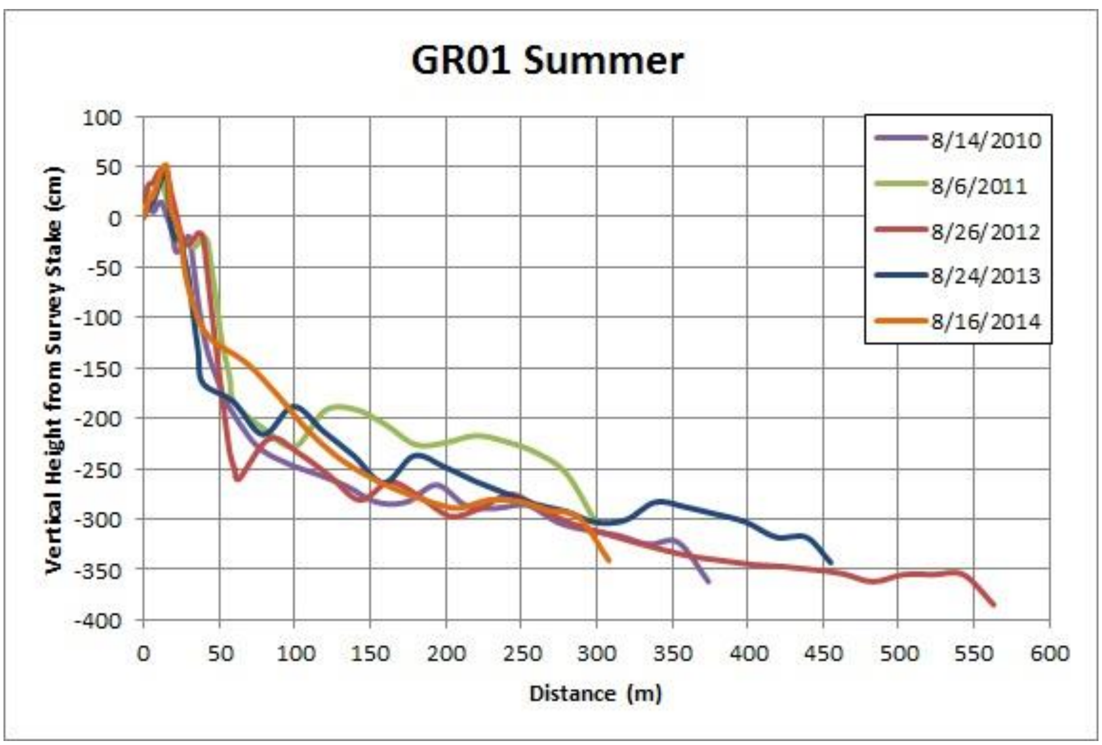

Figure 52. Summer beach profiles for GR01 from 2010 to 2014.

Figure 53. Winter beach profiles for GR02 from 2010 to 2015.

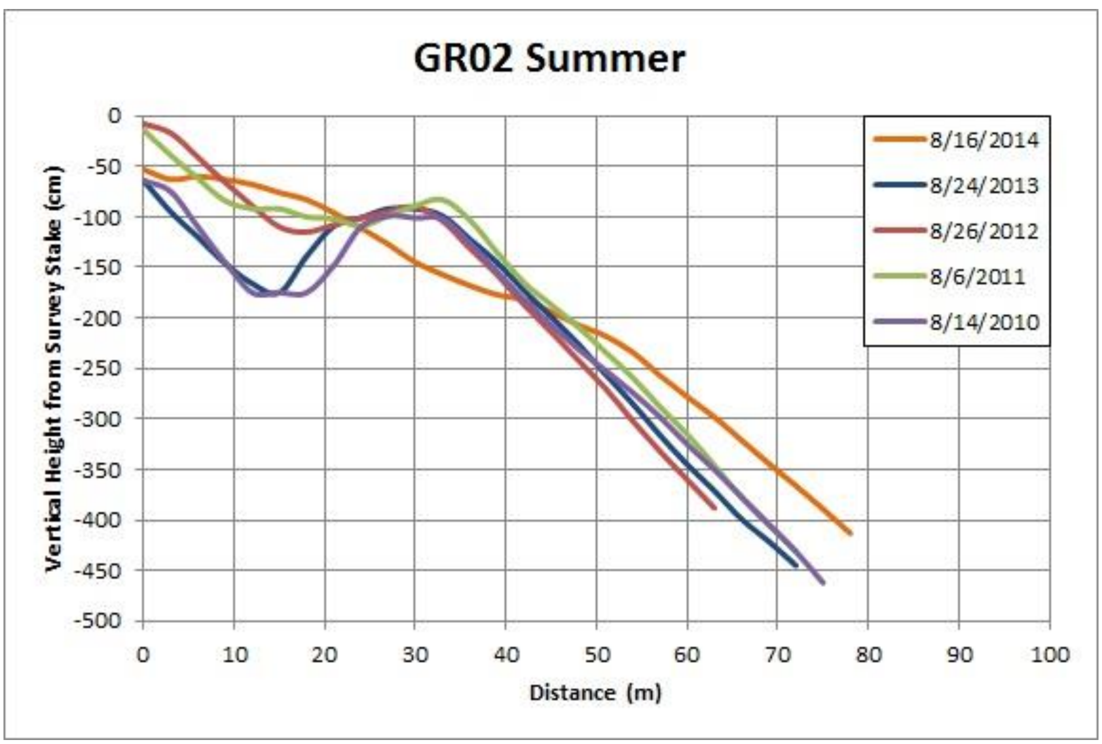

Figure 54. Summer beach profiles for GR02 from 2010 to 2014.

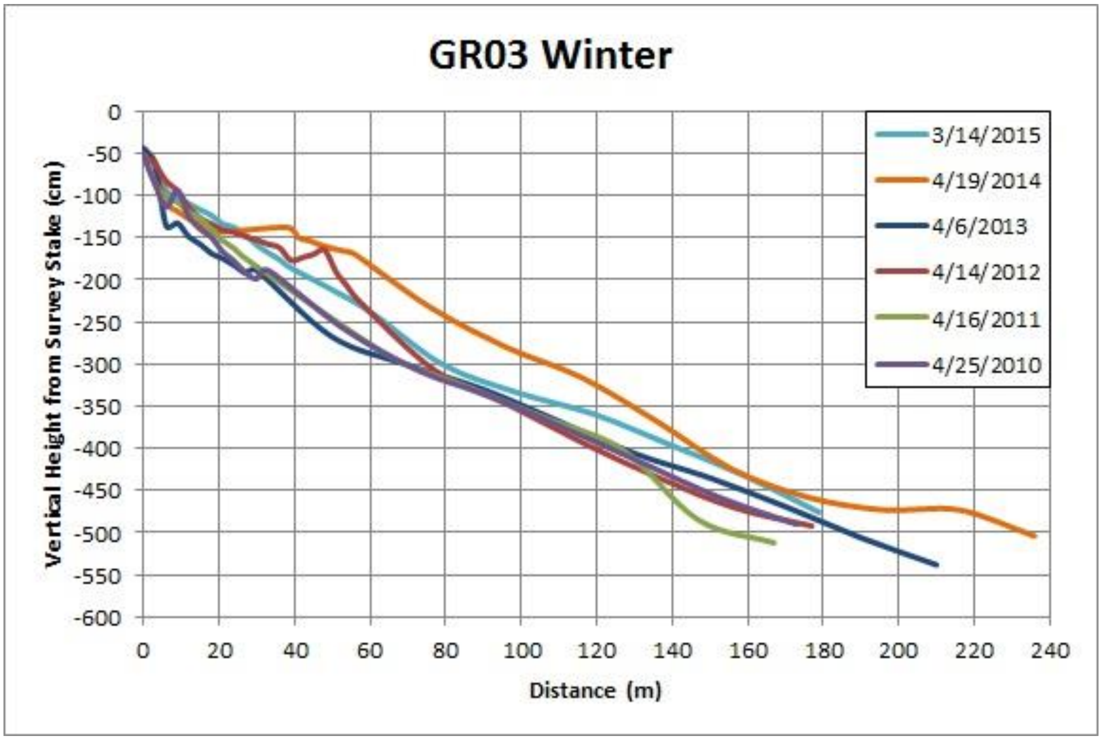

Figure 55. Winter beach profiles for GR03 from 2010 to 2015.

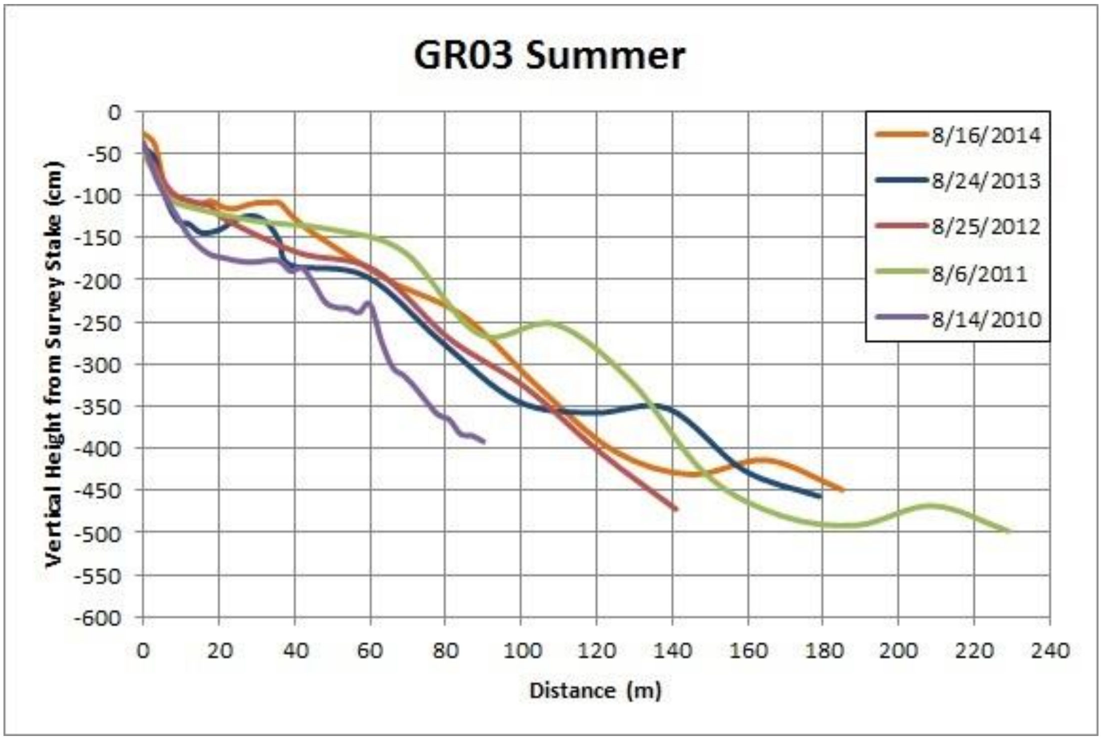

Figure 56. Summer beach profiles for GR03 from 2010, 2011, and 2012.

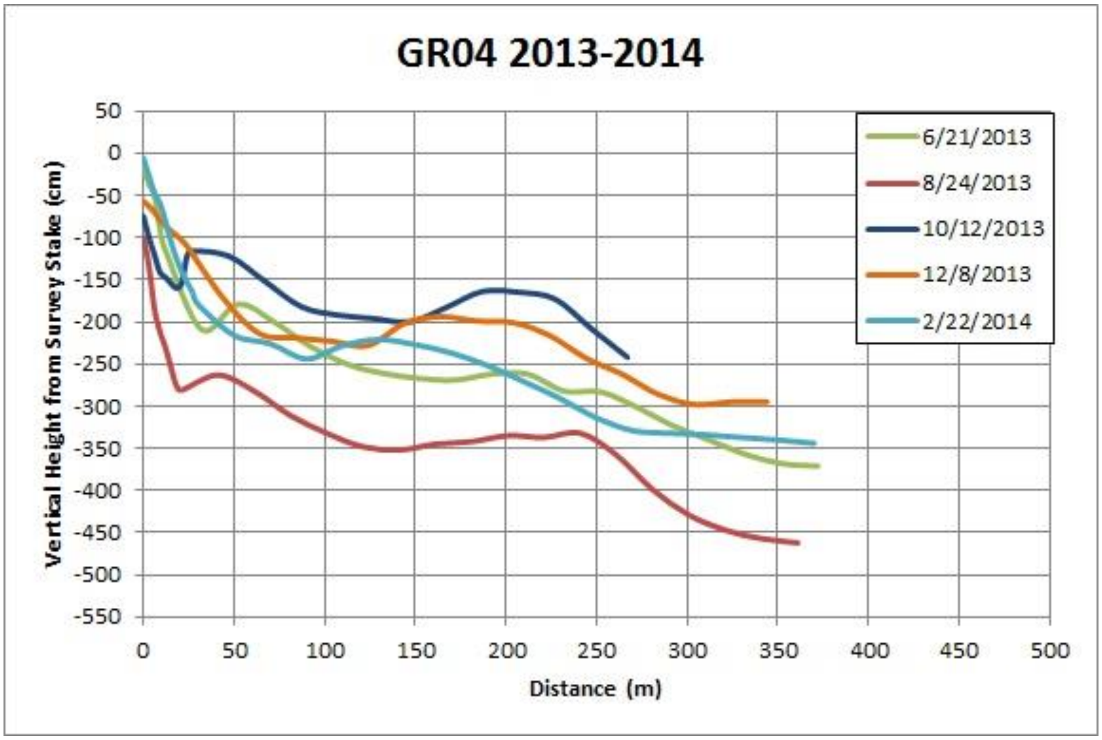

Figure 57. Beach profiles for GR04 from June 2013 through February 2014 at 2 month increments.

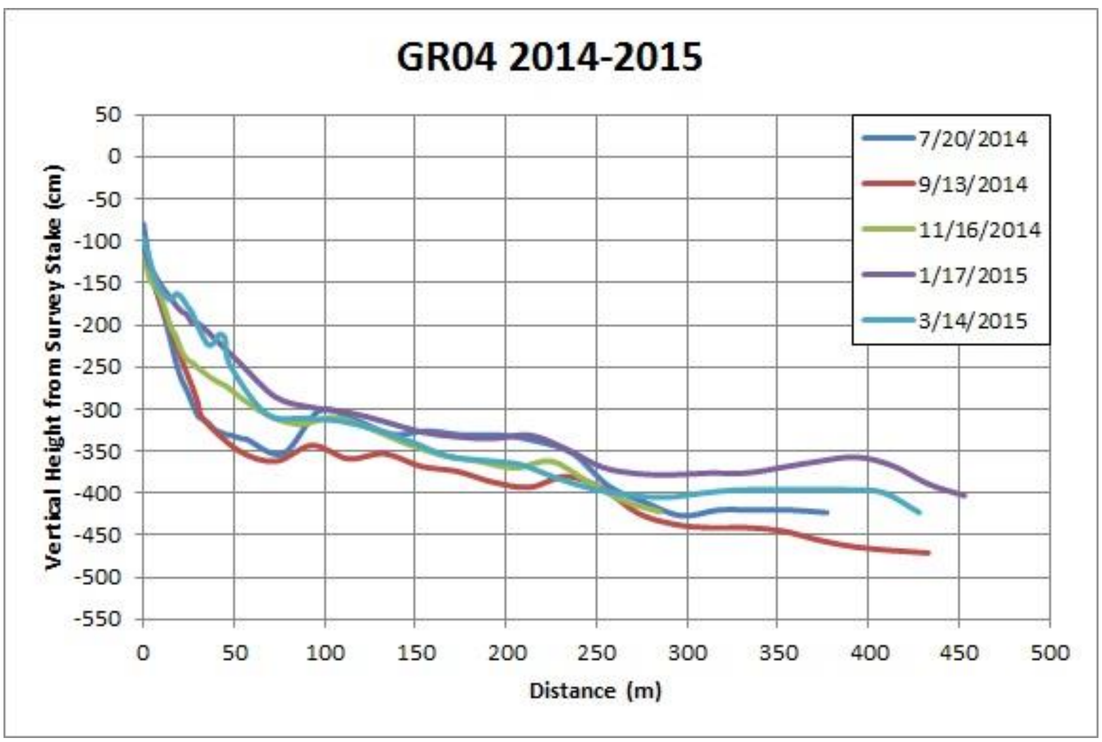

Figure 58. Beach profiles for GR04 from July 2014 to March 2015 at roughly 2 month increments.

Goose Rocks MBMAP Results

Goose Rocks Beach has several stretches of seawalls where no vegetation line data could be collected, as labeled below. MBMAP from surveyed vegetation shorelines indicates that from 2010-2014, the dune generally **was slightly accretive, with a mean rate of +0.40 m/yr** (Figure 59). However, there were localized pockets of erosion. Most significant was erosion directly adjacent to the Batson River, where the dune receded between -5 m/yr to about -15 m/yr (one of the highest rates of all beaches monitored)! This is indicative of the dynamic nature of tidal inlets.

Nearest GR01, the summer dune grew at up to 5 m/yr, especially from 2013-2014. This was reflected in a high, well developed dune in profile shapes (yet note that in profile analysis, the berm was lost). At GR02, the dune grew much less, but was stable. At GR03, the summer dune grew relatively consistently since 2010 at rates of +1 m/yr to +3 m/yr. GR04 has no vegetation line data.

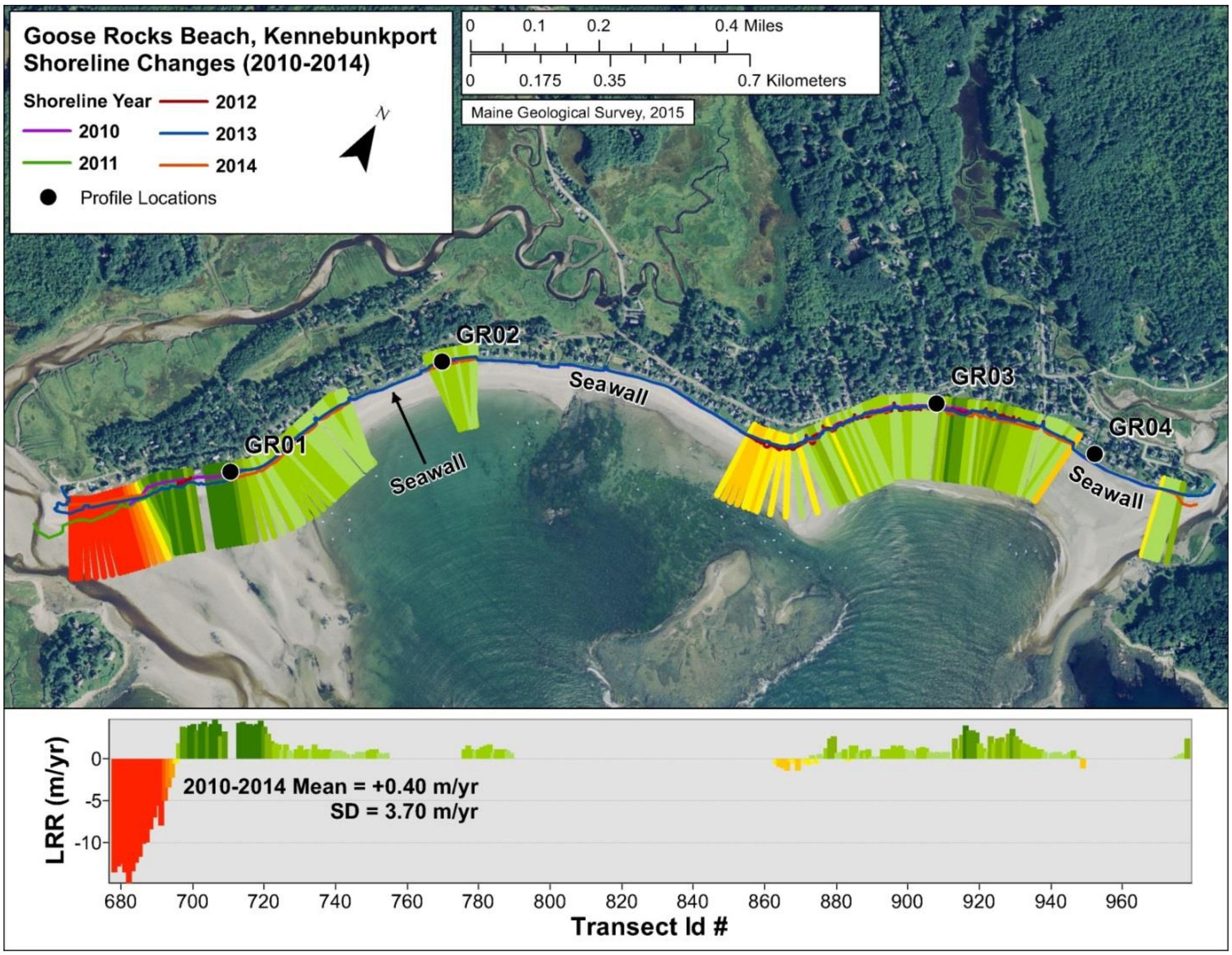

Figure 59. MBMAP shoreline change results for Goose Rocks Beach, Kennebunkport. 2013 base imagery from Maine OGIS.

Fortunes Rocks Beach, Biddeford

Fortunes Rocks Beach is not part of the SMBPP.

Fortunes Rocks Beach MBMAP Results

Fortunes Rocks Beach is a large pocket beach bound by a headland to the south and Biddeford Pool to the north. Several sections of the beach are continuously seawalled, especially in the southwest and central portion of the beach (Figure 60). Shorelines from 2010 to 2014 were surveyed. Based on available data, the southern end of the surveyed beach was accretive to highly accretive, with just a small pocket of dune erosion. The central portion (the majority of the beach) is seawalled, with no surveyed vegetation line. The northeastern section of the beach also grew seaward during this time period. **The overall mean trend of +0.8 m/yr indicated that the beach was accretive from 2010-2014.**

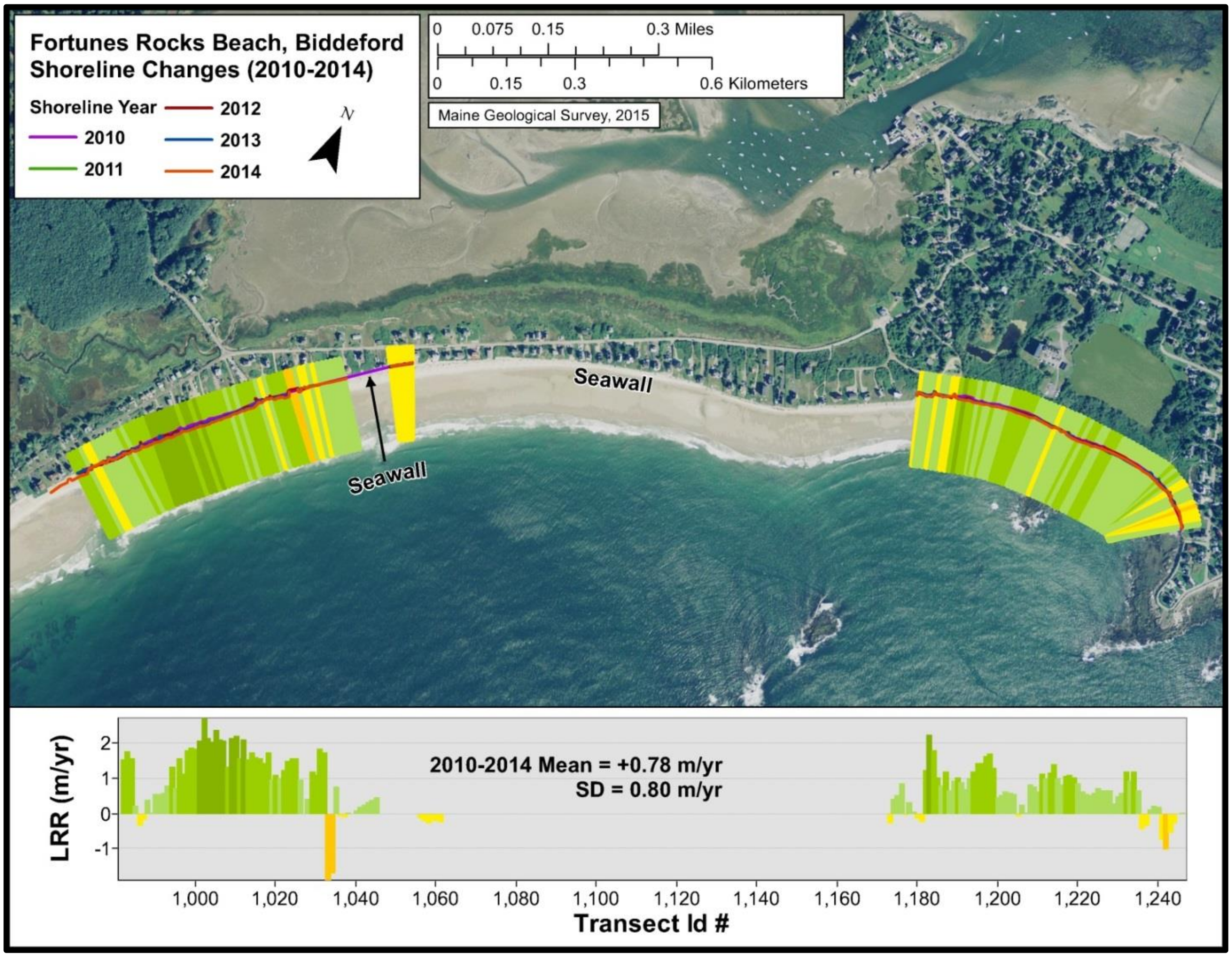

Figure 60. MBMAP shoreline change results for Fortunes Rocks Beach, Biddeford. 2013 base imagery from Maine OGIS.

Hills Beach, Biddeford

Hills Beach is not part of the SMBPP.

Hills Beach MBMAP Results

Hills Beach is a small pocket beach on the south side of the Saco river. It is bound to the north by the southern jetty of the river, and to the southeast by Biddeford Pool. A central portion of the beach has contiguous seawalls, and has no vegetation to measure as part of MBMAP (Figure 61). Shorelines from 2010 and 2012-2014 were surveyed. Based on available data, the southern end of the beach showed seaward growth, while the stretch of shoreline just northwest of this was highly erosive, to near the seawalls. North of the seawalled area, the beach was highly accretive, growing at greater than 1 m/yr. Nearest the southern jetty of the Saco River, some minor erosion of the dune occurred. The overall mean trend of +0.30 m/yr indicates that the **beach was stable to slightly accretive from 2010-2014**; however it appears that erosion is concentrated along the south-central section (and near the jetty), as evidenced by MBMAP data and the presence of seawalls on the beach.

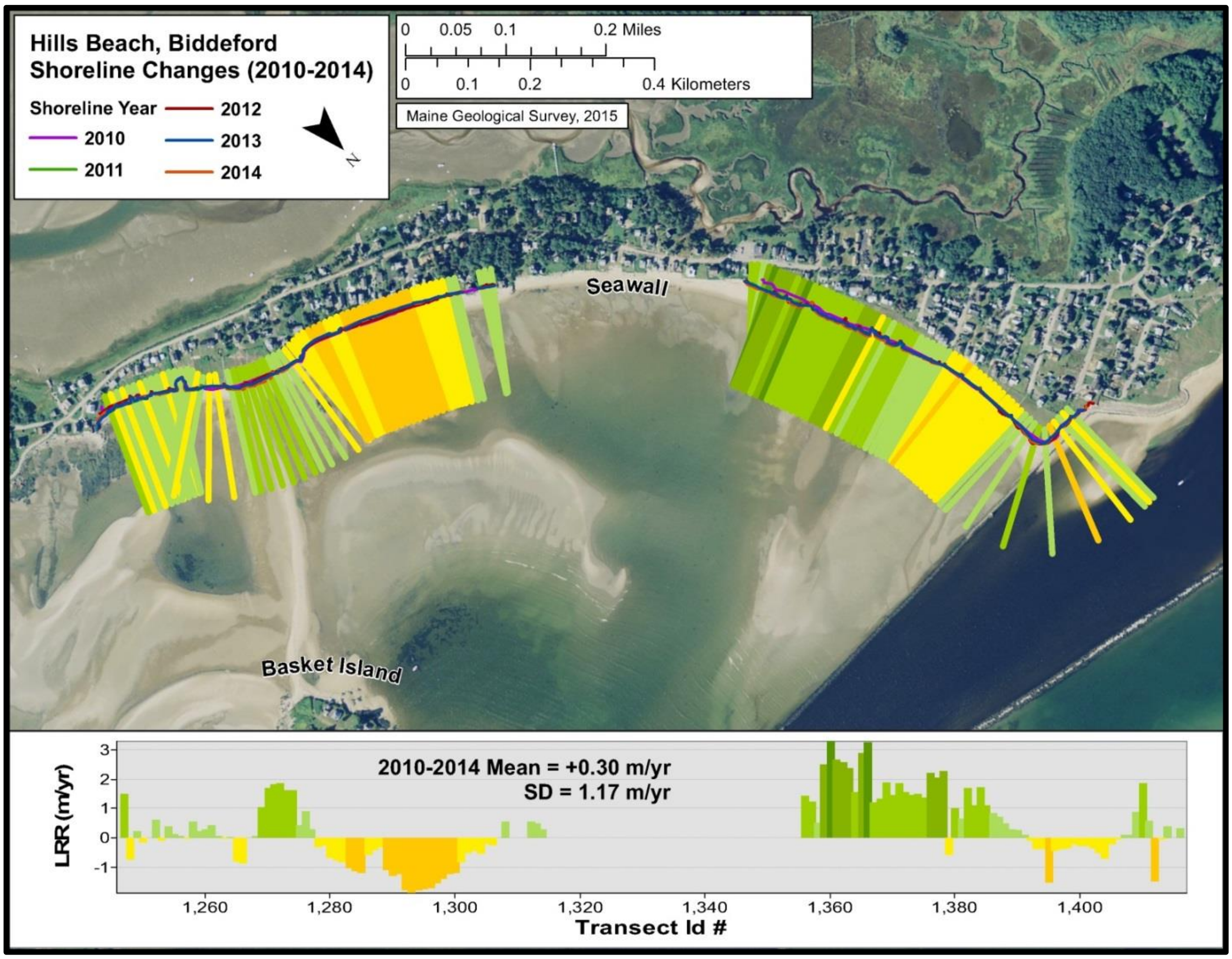

Figure 61. MBMAP shoreline change results for Hills Beach, Biddeford. 2013 base imagery from Maine OGIS.

Ferry Beach, Saco

Four beach profiles (FE01 to FE04, Figure 62) were available for analysis. They are located from north to south along a stretch of Ferry Beach near the Ferry Beach Ecology School. Note that some of the profiles have different starting points (front or back stakes), as discussed below. Figures 63 to 70 show seasonal changes at the profiles.

Figure 62. Volunteer monitoring profile locations at the beaches in Saco. FE01 to FE04 are located at the southern end of Ferry Beach. KS01 and KS02 are located in Kinney Shores, at the northern end of the beach, adjacent to Goosefare Brook. 2013 base imagery from Maine OGIS.

Winter FE01 = D (65). Data from 2010 to 2013 was collected at a front stake (solid lines), while data 2013 to 2015 was collected from a back stake (dashed lines) since the front stake was lost. *All data was shifted to the back stake starting point; however, comparison of data should be made from 2010 to April 2013 and from May 2013 to January 2015. It does not appear that profiles properly align. It is unclear to us why the data shift does not work.* From 2010 to 2012, FE01 built at the dune crest and developed a berm. The 2013 profile underwent additional berm and dune loss. From April 2013 to May 2013 (if the data is to be believed), the profile underwent massive erosion, shifting landward about 5 meters and losing its dune. From May 2013 to April 2014, the profile was stable in the dune and lost some of its berm. By 2015, the profile moved slightly landward, indicating erosion.

Summer FE01 = D (65). Data from 2010 to 2012 was collected at a front stake, while data from 2013 to 2014, a back stake, as the front stake was lost. Data was shifted to start from the back stake. From 2010 to 2012, the dune and berm flattened and consistently eroded landward. From 2012 to 2013 (if the data is to be believed), the entire frontal dune was eroded, losing about 50 cm in elevation, and about 5 m horizontally. From 2013 to 2014, there was some seaward growth of the dune and berm, indicating some recovery.

Winter FE02 = C- (72). FE02 was also shifted so that all data started from the back stake; the shift worked well. In 2011, the dune receded slightly, but the berm and lower portion built seaward. It returned to a very similar shape to 2010 in 2012, except for the dune showing more recession. In 2013, the frontal dune crest was lost and profiling began at the back stake. 2014 showed some additional loss of the dune but slight seaward growth of the berm. In 2015, the profile was back to near 2012 shape, but had no frontal dune crest. The lower portions of the profile did recover somewhat from 2010, but the dune eroded.

Summer FE02 = D (65). The 2010 profile was extremely steep and erosive, with no berm. In 2011, FE02 had good recovery of the berm but erosion of the dune. In 2012, FE02 remained relatively unchanged. By 2013 (profiling at the back stake), the rest of the dune was lost, but the profile gained slightly at the berm. In 2014, the dune lowered slightly, and the berm was lost. The lower portions of the profile did recover from 2010, but the dune eroded.

Winter FE03 = C- (72). Profiles were offset to a back stake as the front stake was lost after April 2013. Note that the 2010 profile used a July date because the starting pin was lost in May. From 2010 to 2011, the dune eroded landward but the rest of the profile was relatively stable. 2012 saw more dune recession and slight landward migration, but some profile stability. In 2013, FE03 showed dune growth landward (likely caused by overwash) and an otherwise stable profile shape. In 2014, it built slightly at the dune, but in 2015, it eroded at its berm to below 2010 levels, and the dune migrated slightly inland. Although FE03 is eroding, it changed less and was more stable than FE01 and FE02.

Summer FE03 = C (75). During summer FE03 showed steady landward movement of the dune from 2010 to 2013, but slight seaward migration of the lower part of the berm. This indicates the profile was flattening out and eroding. However, in 2014, the profile clearly built seaward at the dune and across the berm, indicating accretion. The overall trend was erosive, but it recovered extremely well last summer.

Winter FE04 = C- (72). From 2010 to 2012, FE04 was stable at the dune, but lost the berm present in 2010. By 2013, the dune eroded, but a berm reappeared, similar to but slightly higher than the 2010 shape. In 2014, the dune eroded further inland, but a better defined berm appeared. By 2015, the dune and berm had both eroded, leaving a steep, concave, featureless profile. However, this was above the 2010 and 2013 shapes.

Summer FE04 = D (65). 2010 had the profile with the most sand and elevation. The entire profile eroded inland from 2010 to 2012. In 2013, the dune eroded further, but a small berm appeared. By summer 2014, the dune slightly recovered, but was clearly scarped. The berm maintained an elevation near the 2013 high. This profile is mostly eroding.

Winter Summary: All profiles at Ferry Beach are showing, in general, landward movement (or loss) of the dune crest. This was evidenced by front stake losses at FE01, FE02, and FE03. Offshore, some sand is being stored, but the profiles are becoming flatter and more erosive. **Winter Beach Grade: C- (70).**

Summer Summary: Summer profiles clearly eroded over the past few years, although they appeared to be somewhat stable between 2011 and 2012. Erosion generally continued in 2013, with some recovery in 2014 at FE01, FE03, and FE04. **Summer Beach Grade: D (68).**

Overall Summary: Generally, the beach and dunes (especially the dunes) along Ferry Beach eroded from 2010 to 2015. **Overall Ferry Beach Grade: D (69).**

MBMAP Results for Ferry Beach, Saco will be discussed in the context of the entire Saco shoreline in the section after Kinney Shores.

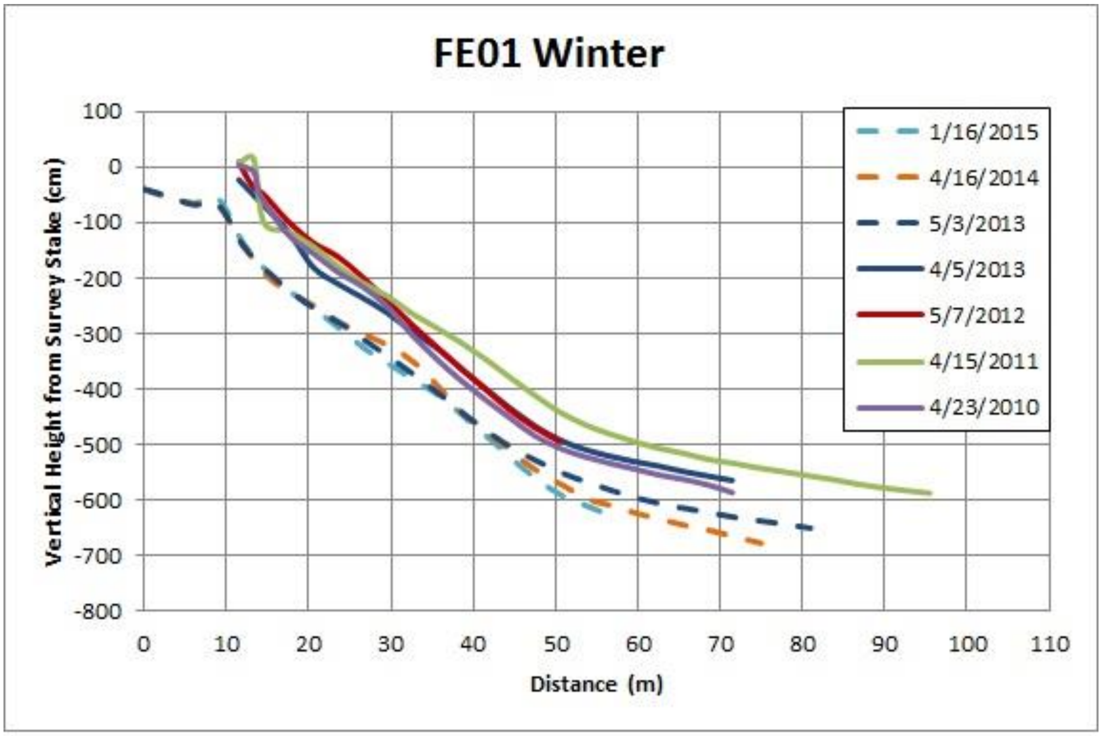

Figure 63. Winter beach profiles for FE01 from 2010 to 2014. Note that changes in starting pins (from front stake to back stake) required two separate plots be created; data starting from the front stake exists from 2010-2013 (solid lines), and data starting at the back stake exists from 2013-2015 (dashed lines).

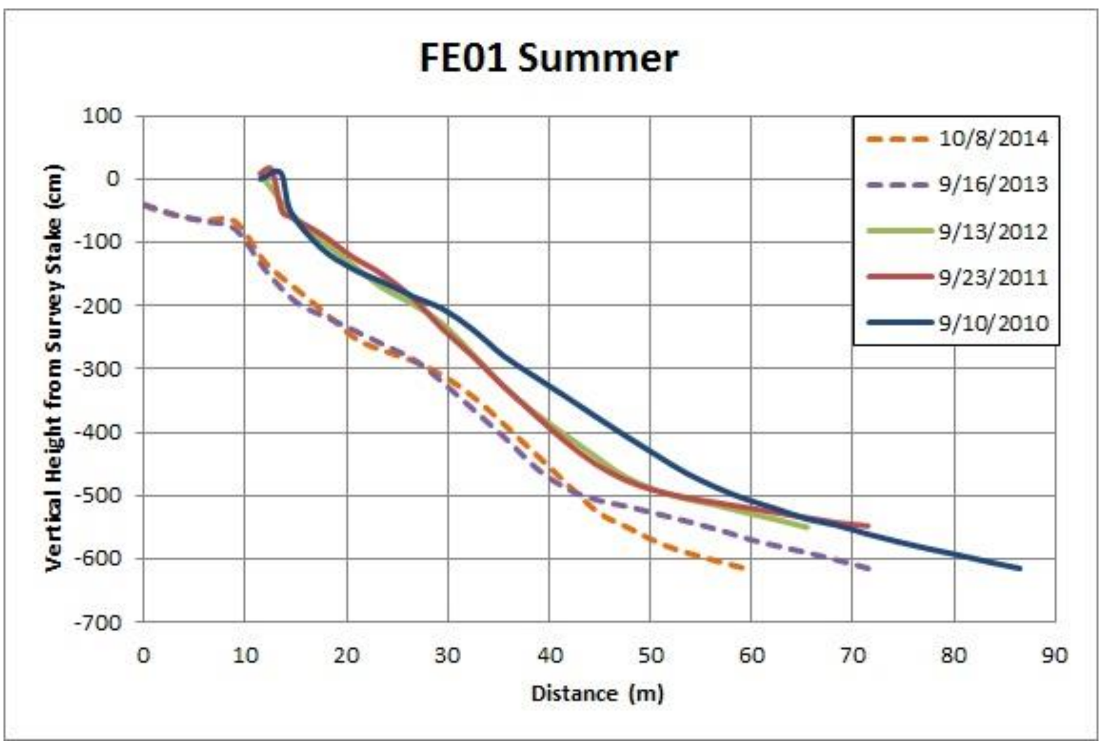

Figure 64. Summer beach profiles for FE01 from 2010 to 2014. Note the different starting location (back stake) for data from summer 2013 and 2014.

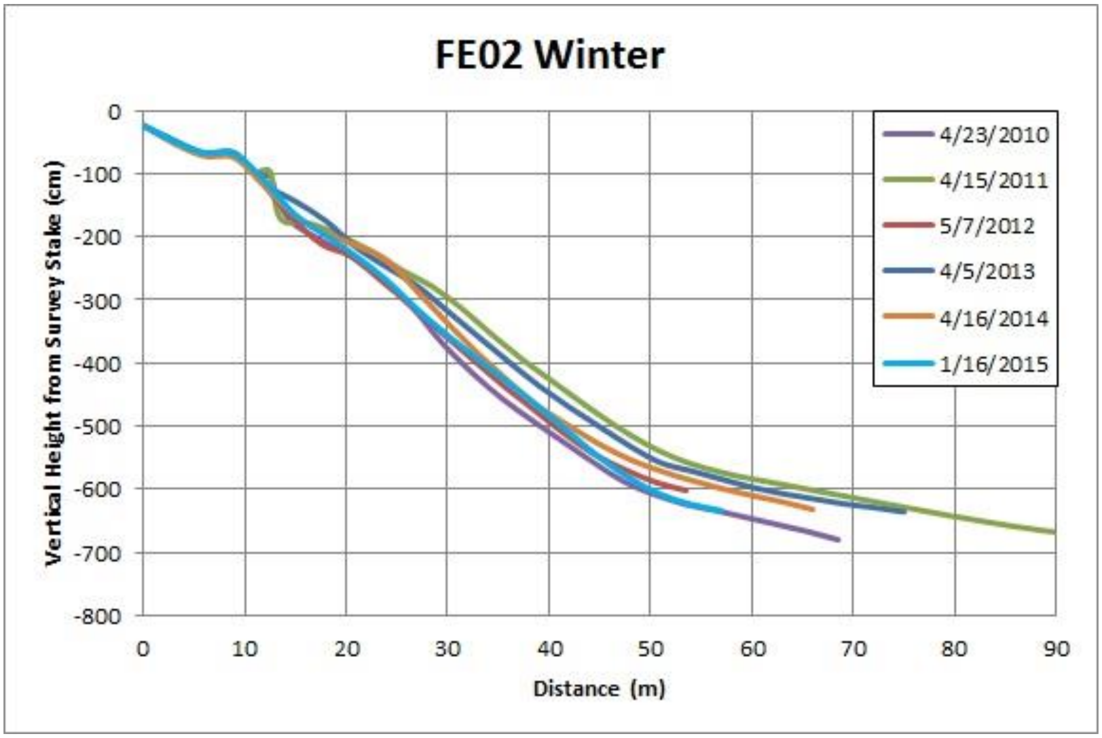

Figure 65. Winter beach profiles for FE02 from 2010 to 2015. Note that profiles collected from a front stake have been offset to the back stake for comparison.

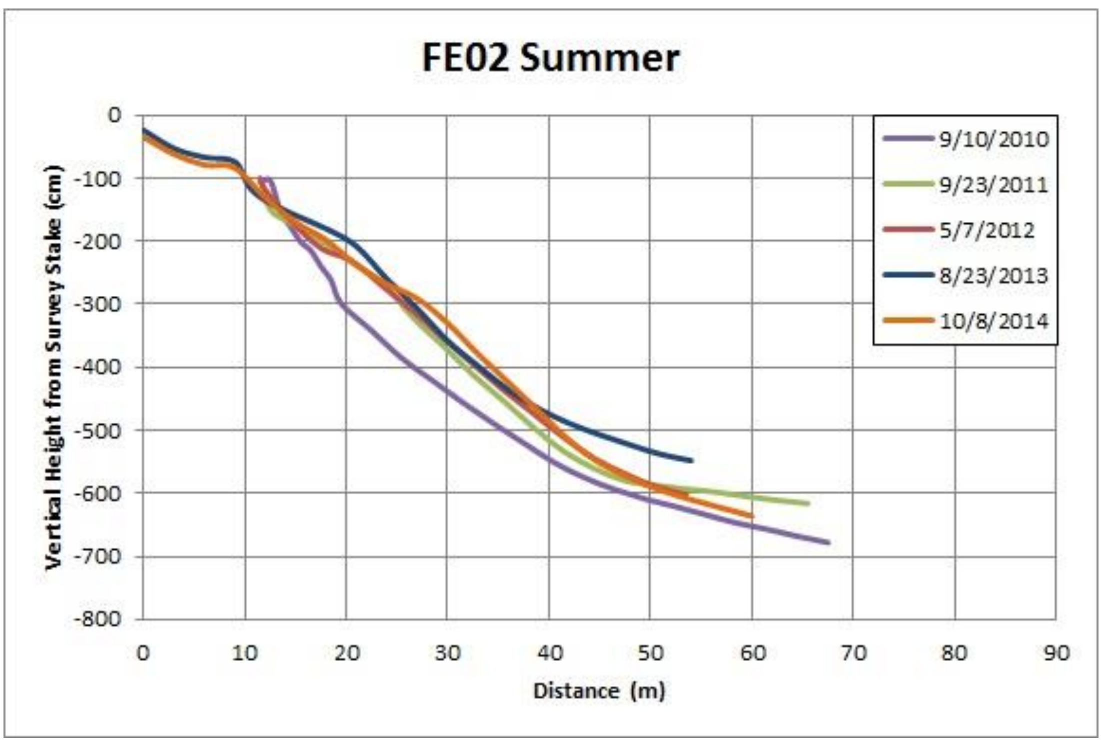

Figure 66. Summer beach profiles for FE02 from 2010 to 2015. Note that profiles collected from a front stake have been offset to the back stake for comparison.

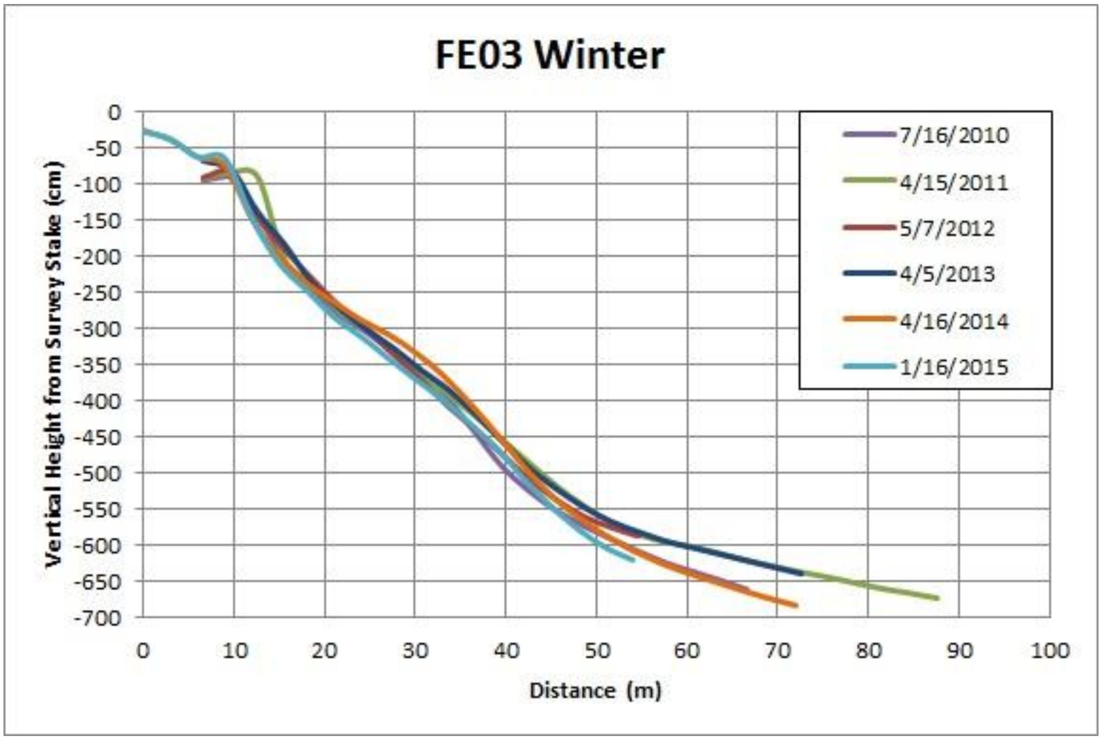

Figure 67. Winter beach profiles for FE03 from 2010 to 2015. Note that profiles collected from a front stake have been offset to the back stake for comparison.

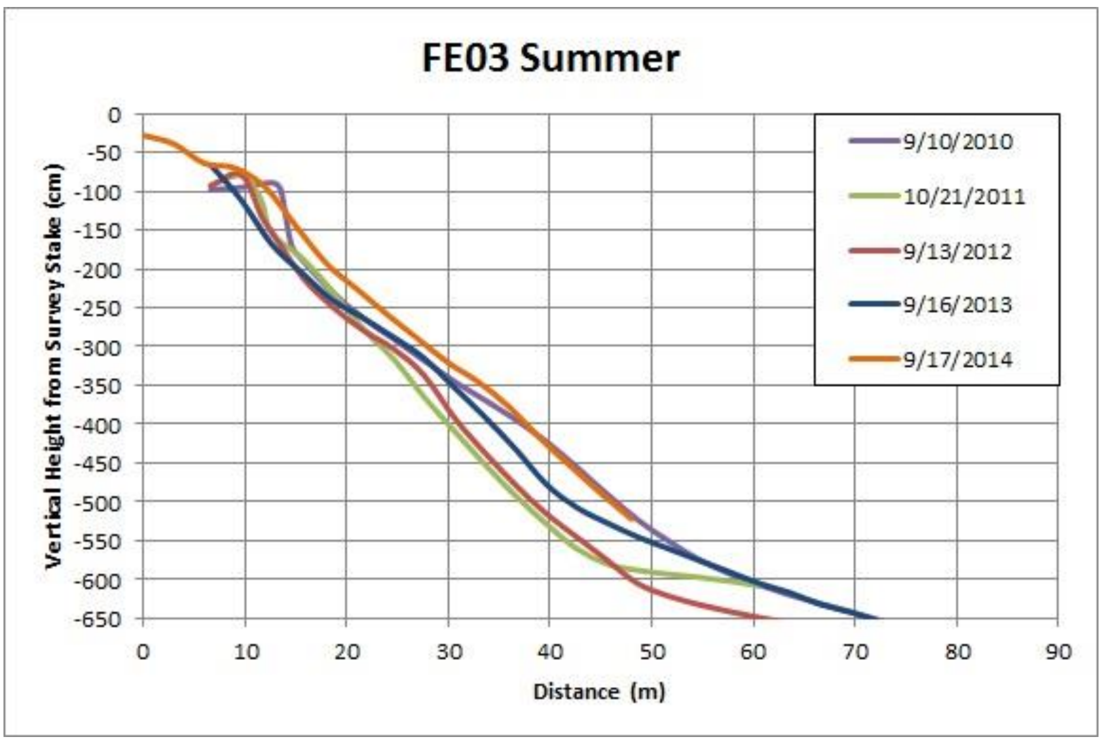

Figure 68. Summer beach profiles for FE03 from 2010 to 2014. Note that profiles collected from a front stake have been offset to the back stake for comparison.

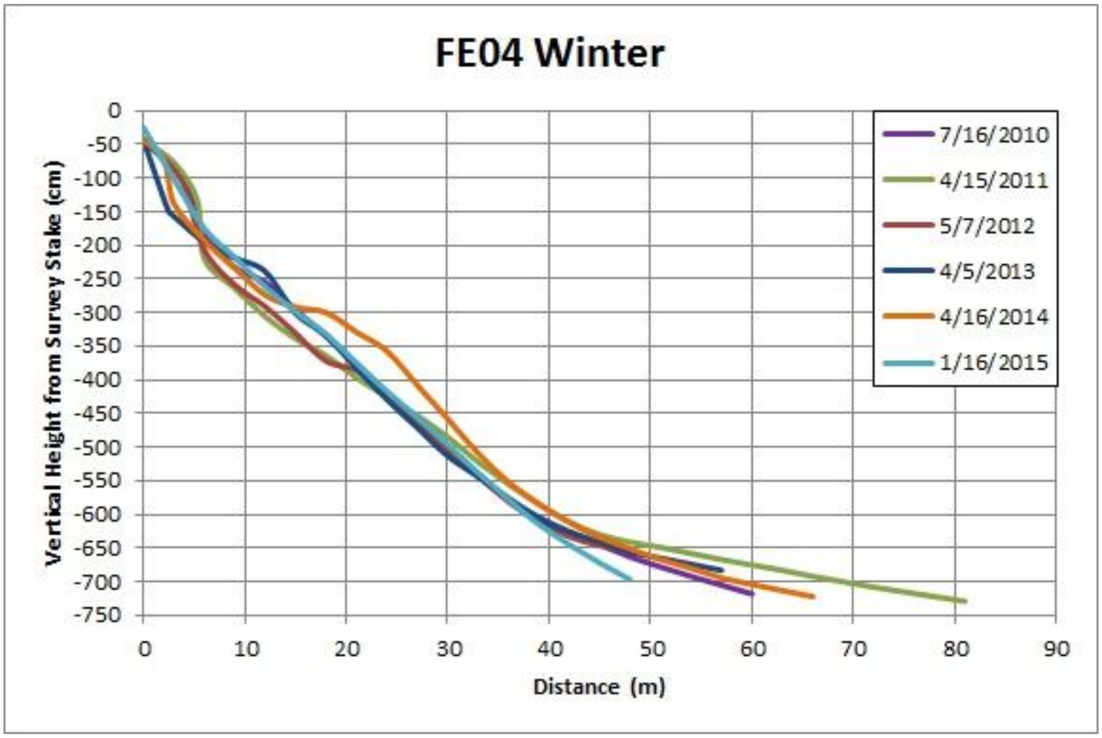

Figure 69. Winter beach profiles for FE04 from 2010 to 2015.

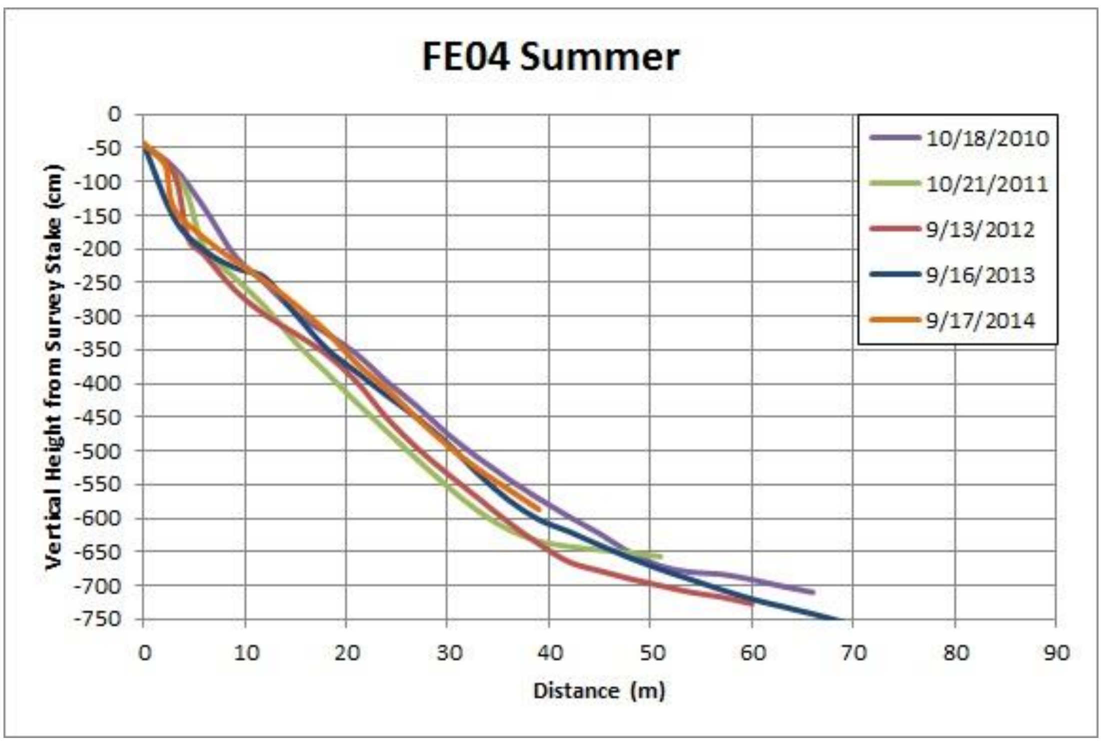

Figure 70. Summer beach profiles for FE04 from 2010 to 2014.

Kinney Shores, Saco

A total of two beach profiles (KS01, KS02 Figure 62) were available for analysis. Profile KS01 is located at the southern end of Kinney Shores in a natural dune. KS02 is located at the northern end of Kinney Shores in a seawall with a dune. Figures 71 to 75 show seasonal changes.

Winter KS01 = C- (72). There were shifts in use of back and front stakes at KS01, which makes comparison between years difficult. Profiles from 2010 to 2013 were collected at an old front stake, and data from 2014 to 2015 (dashed lines) from a new front stake. In 2010, KS01 had a steep foreshore, with a berm around 30 m. In 2011, KS01 gained elevation along its length and had a well-defined, higher berm near 20 m. However, by 2012, the profile lowered along its entire length. This trend continued into 2013, with a steep and very short reflective shape, but gains near the dune. Thus, the profile eroded from 2010 to 2013. A new front stake was used for data in 2014 and 2015. From 2014 to 2015, KS01 lost a bit of sand near the dune, and gained slightly at the berm, but generally stayed relatively stable.

Summer KS01 = C (75). Note that since there were shifts in the profile starting point, data from 2010 to 2012 will be compared first, in Figure 72. The 2010 profile exhibited a nicely defined berm right at the 20 m mark – this was the highest berm. By 2011, the profile gained some sand at the base of the dune, and the berm lowered in elevation and moved slightly landward. The profile also gained elevation offshore. However, by the summer of 2012, the berm lowered (by about 80 cm below the 2010 maximum), but maintained its location at the 20 m mark. At its landward edge and in the offshore, the profile showed good stability between 2011 and 2012. This showed loss of the summer berm from 2010 to 2012. Data from 2013 was from a different starting point, and includes May and September in order to see how the profile evolved during this time period. During this time period, the profile was very stable, with slight landward migration of the profile. From July 2014 to September 2014 (from a different starting point), the profile was extremely stable, except the berm was lost. The profile eroded from 2010 to 2012, but was stable in 2013 and 2014.

Winter KS02 = B (85). The 2010 profile was steep with a berm feature at 20-25 m. In 2011, KS02 gained dune and berm elevation, but steepened in the lower portion of the profile indicating landward retreat. By 2012, the profile showed good recovery, with additional dune gains and a well-defined berm out at the 40 m mark, and elevation gains offshore. In 2013, the dune built more, but the berm lowered slightly. In 2014, the dune was stable, and the berm returned to a high elevation. 2015 saw a very similar profile shape, with some lowering of the beach near 55 m. The dune accreted consistently through the time period.
The berm had a low in 2010 to highs in 2014 and 2015. The beach was highly variable, with a 2011 low, a 2012 high, and 2010, 2014, and 2015 at about the same location.

Summer KS02 = C (75). In 2010, KS02 had a small scarp in the dune, and a berm at 20 m. By 2011, the berm grew slightly, and the profile gained elevation seaward of the berm. In 2012, the dune and berm were stable, but a large swash bar came ashore at 40 m. By 2013, this bar moved up the profile, forming a well-defined berm, and causing sand gains at the dune near the wall. In 2014, the dune grew more, the lower part of the berm was lost, but the profile gained elevation seaward of 60 m. The profile showed general growth from 2010 to 2013 in the dune, and loss in 2014 at the berm. KS02 may be highly influenced by beach cusps, likely accounting for berm variability.

2010-2015 Winter Summary: KS01 had its highest profile in winter 2011 and KS02 its lowest. KS02 showed recovery and stability, and KS01 (slightly farther south), showed slight erosion. **Winter Beach Grade: C+ (79).**

2010-2014 Summer Summary: The summer profiles both exhibited seasonal summer berms, which lost elevation, while the dunes grew. **Summer Beach Grade: C (75).**

Overall Summary: Both beaches appear to have lost their berms slightly, though dunes appeared to be stable, or growing**. Overall Kinney Shores Beach Grade: C (77).**

Results for the Kinney Shores MBMAP results will be presented in the next section in the context of the larger Saco beach shoreline.

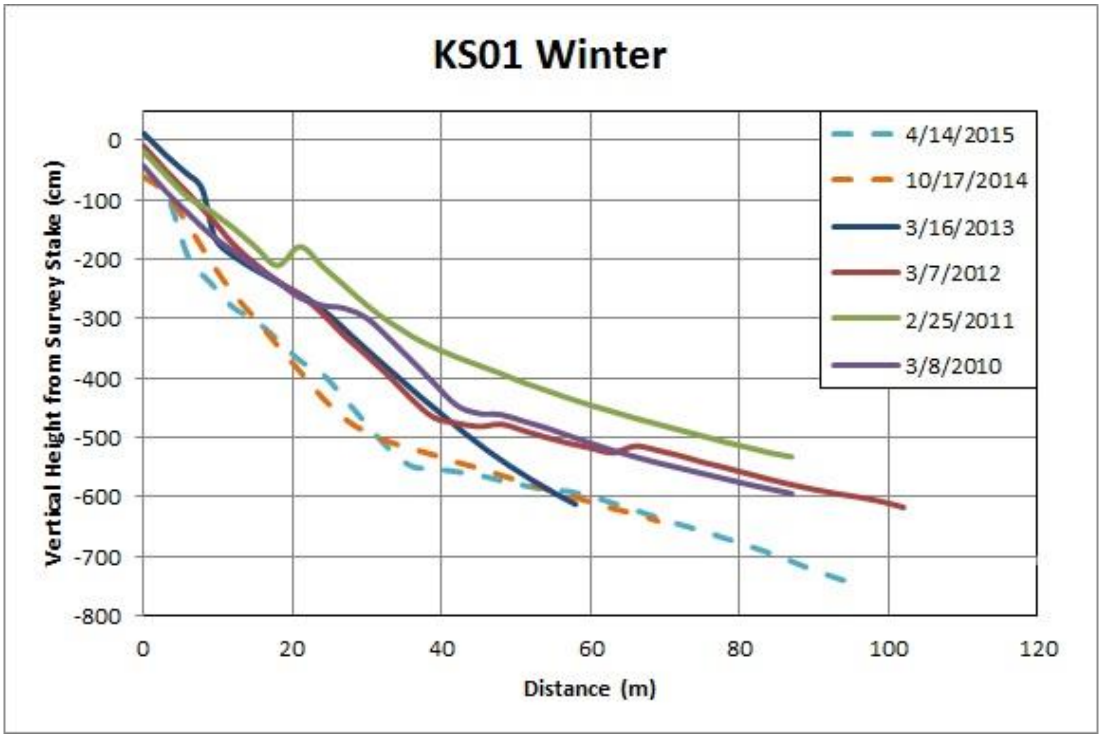

Figure 71. Winter beach profiles for KS01 from 2010 to 2015. Note that 2014 and 2015 start from a different location.

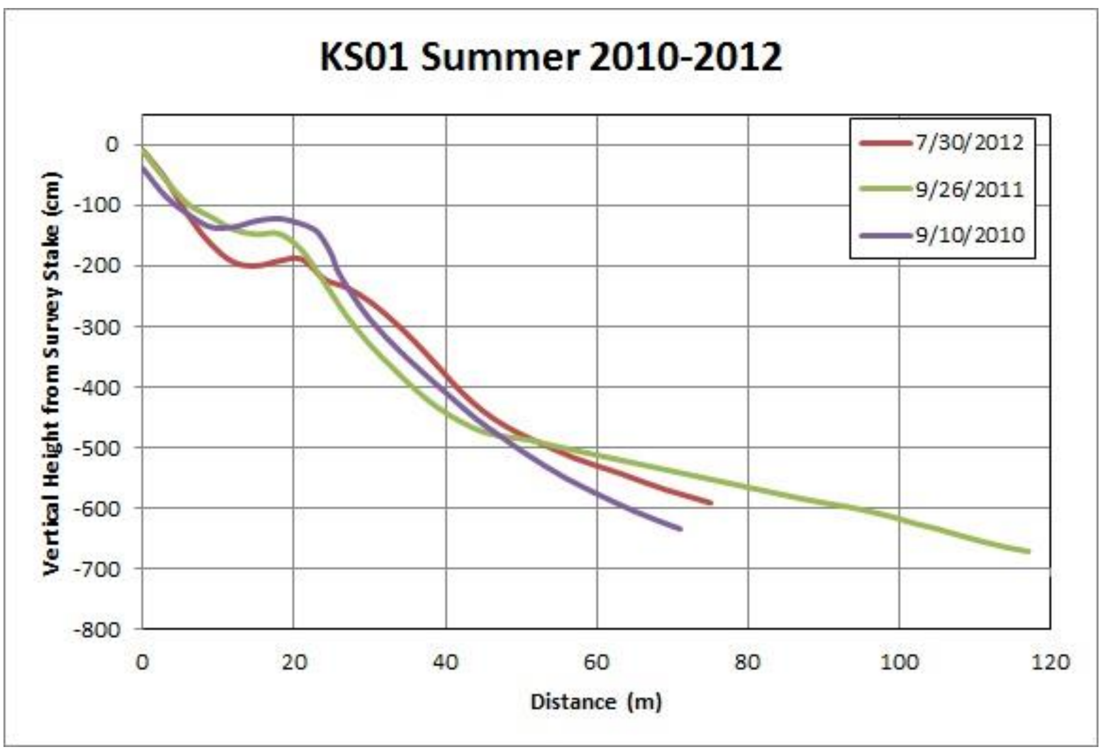

Figure 72. Summer beach profiles for KS01 from 2010 to 2012.

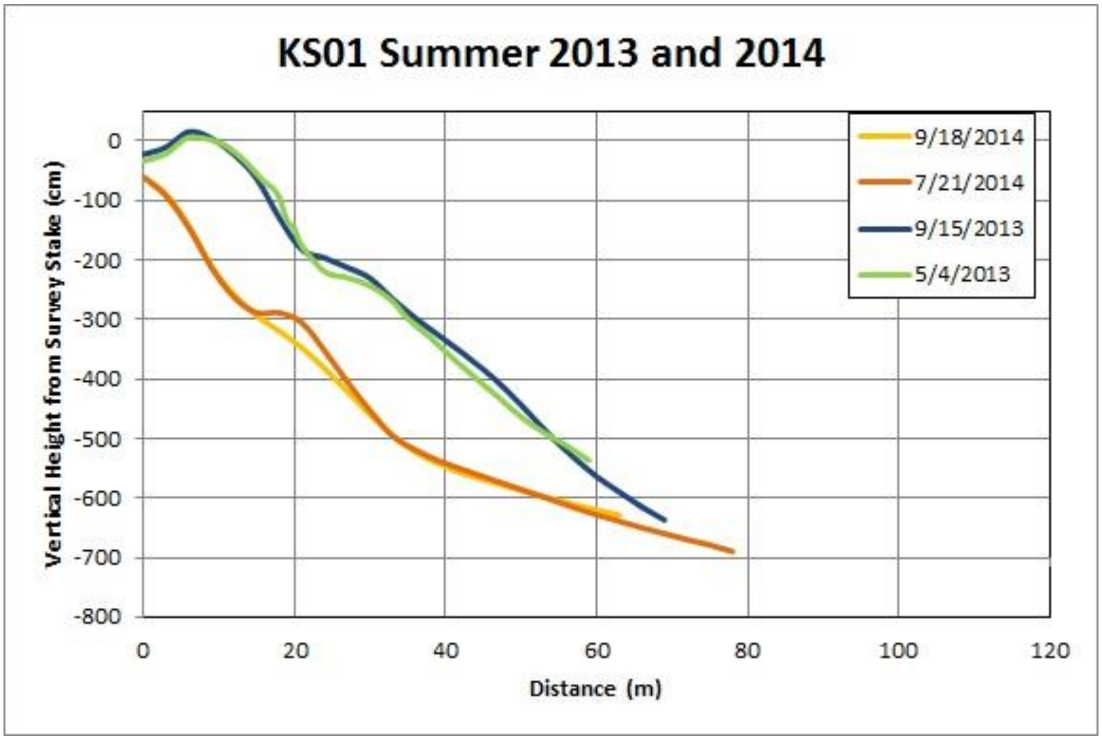

Figure 73. Summer beach profiles for KS01 from 2013, and 2014. Note separate starting point locations.

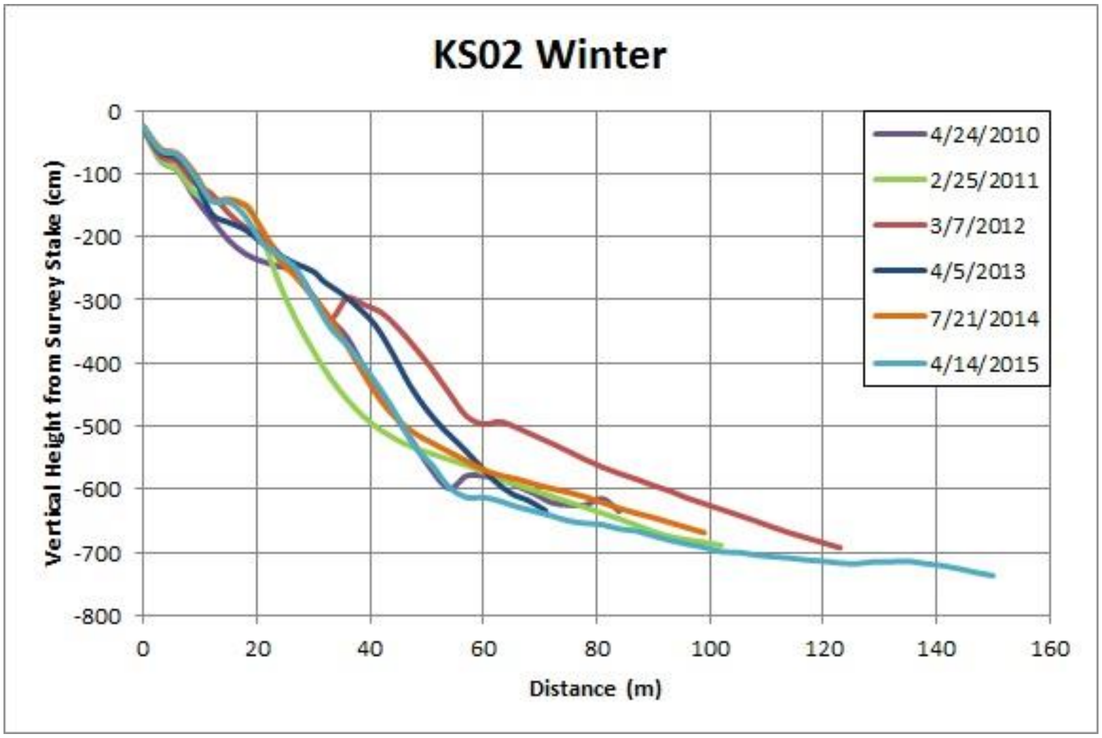

Figure 74. Winter beach profiles for KS02 from 2010 to 2015.

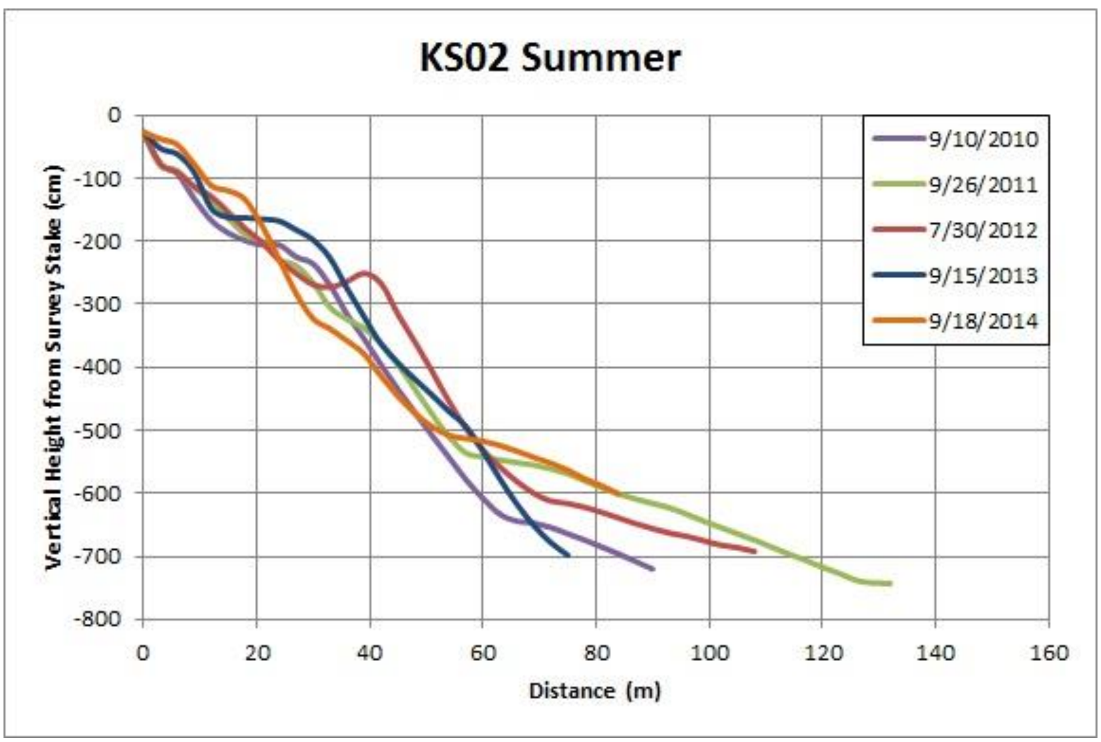

Figure 75. Summer beach profiles for KS02 from 2010 to 2014.

Saco Beaches (Camp Ellis Beach to Goosefare Brook) MBMAP Results

MBMAP data is presented below for the entire Saco area, including both Ferry Beach and Kinney Shores (Figure 76). The shoreline can be divided into two sections based on the apparent trends. The southern section stretches from the Saco geotube north to a stretch of seawalled shoreline, while the northern section stretches from the same seawall north to Goosefare Brook. **The southern stretch (transects 1420 to 1550) eroded an average of -1.2 m/yr from 2010 to 2014.** The highest erosion occurred in Camp Ellis, adjacent to the geotubes near the south end of the beach (rates between -1 and -3 m/yr, and a mean of -2.0 m/yr), and along a stretch of shoreline by Ferry Beach State park between transects 1470 and 1490, where erosion rates were greater than -2 m/yr. Profiles FE01 through FE04 are located along a stretch of this shoreline that averaged around -0.5 m/yr. **The northern stretch of shoreline (transects 1570 to 1720) had a mean shoreline change rate of +0.3 m/yr from 2010 to 2014.** Along this stretch, accretion dominated, with only a few isolated pockets of erosion, downdrift of the seawall area (in Bayview, with an average of -0.3 m/yr), and between KS01 and KS02. Profile KS01 is located in a more accretive stretch of shoreline than KS02. Kinney Shores was slightly accretive with an average of +0.4 m/yr. The overall mean for the entire Saco beach shoreline is about **-0.45 m/yr, indicating erosion**.

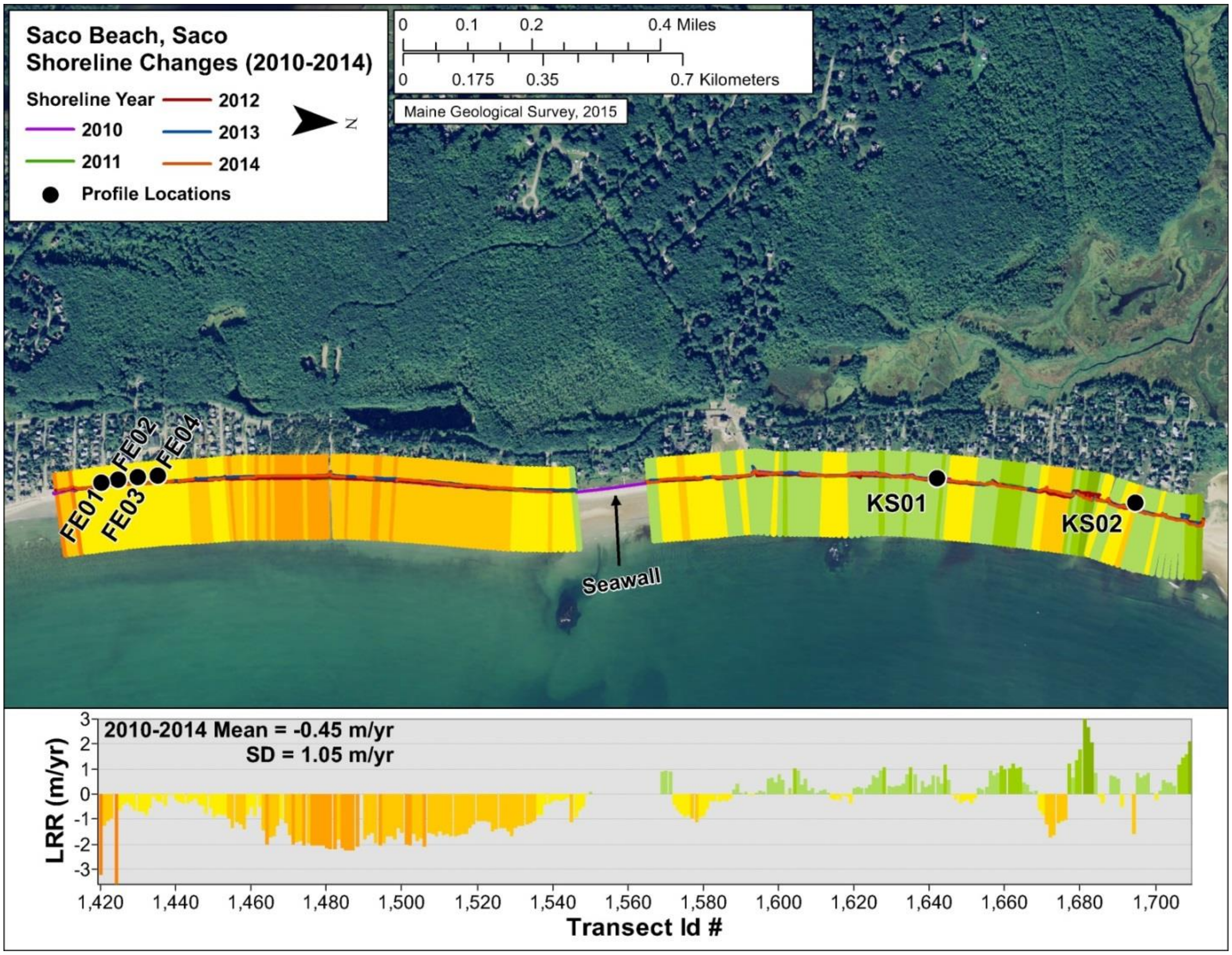

Figure 76. MBMAP shoreline change results for Saco beaches including Ferry Beach, Bayview, and Kinney Shores. 2013 base imagery from Maine OGIS.

West Grand Beach, Old Orchard Beach

West Grand Beach has four profiles (WG01-WG04, Figure 77) surveyed starting in 2013. They are located centrally in the dunes between the pier and Goosefare Brook, with WG01 being the farthest north. Data collected at these profiles do not cover all winter or summer months, but June, August, and October 2013, October 2014, and May 2015. Profiles will be graded based on seasonal shifts in shape. Figures 78 to 81.

Profiles from East Grand Beach are actually within Scarborough town boundaries and are discussed in the next section.

Figure 77. Volunteer beach profile locations along West Grand Beach, Old Orchard Beach. 2013 base imagery from Maine OGIS.

WG01. C+ (78). From June to August 2013, WG01 had a well-defined berm from 20-40 m that gained elevation. By October, the profile grew along its entire length to its best shape. In October 2014, the berm was slightly higher, and slightly landward than 2013. By May 2015, the berm had lowered to between June and October elevations, and had eroded at its seaward end. June 2013 to May 2015 showed a higher berm at the 20 m mark, but not as wide, with scouring at 40 m; seaward of this, the beach moved landward, indicating some erosion.

WG02. C (75). From June to August 2013, WG02 had a high berm between 20 to 30 m that gained elevation. By October, the entire profile eroded. By October 2014, the berm recovered, but seaward of 25 m, the profile moved landward. In May 2015, the dune was stable, while the berm was scoured, and the rest of the profile lowered to below June 2013 levels, indicating some loss of summer stability.

WG03. B (85). From June to August 2013, WG03 was stable out to 30 m, and gained sand seaward. By October, the entire profile continued to build, with dune growth and a large berm at 20 to 30 m. By October 2014, the profile accreted more, elevating by around 25 cm. This was the best profile. By May 2015, the profile slightly lowered within 30 m of the pin, and scoured seaward of 30 m. However, this was well above the June 2013 profile, indicating good summer growth since 2013.

WG04. C (75). From June to August 2013, WG04 gained in elevation along its length, building to its best shape. By October 2013, it eroded at the dune and berm, and migrated landward at the beach. The October 2014 profile showed dune and berm growth out to 30 m, but erosion of the beach seaward of this. No May 2015 profile was available for comparison. Although the dune grew and the berm was somewhat stable, the nearshore portion of the profile eroded.

West Grand Beach Summary: Profiles along West Grand Beach have shown dune growth, and highly variable berms that can change on the order of 50 to 100 cm vertically. All profiles were characterized by a very steep slope from the berm along the beach to the low-tide terrace. The lower portion of the beach in this area appeared to erode at all locations except WG03. **Overall Grade: C+ (78).**

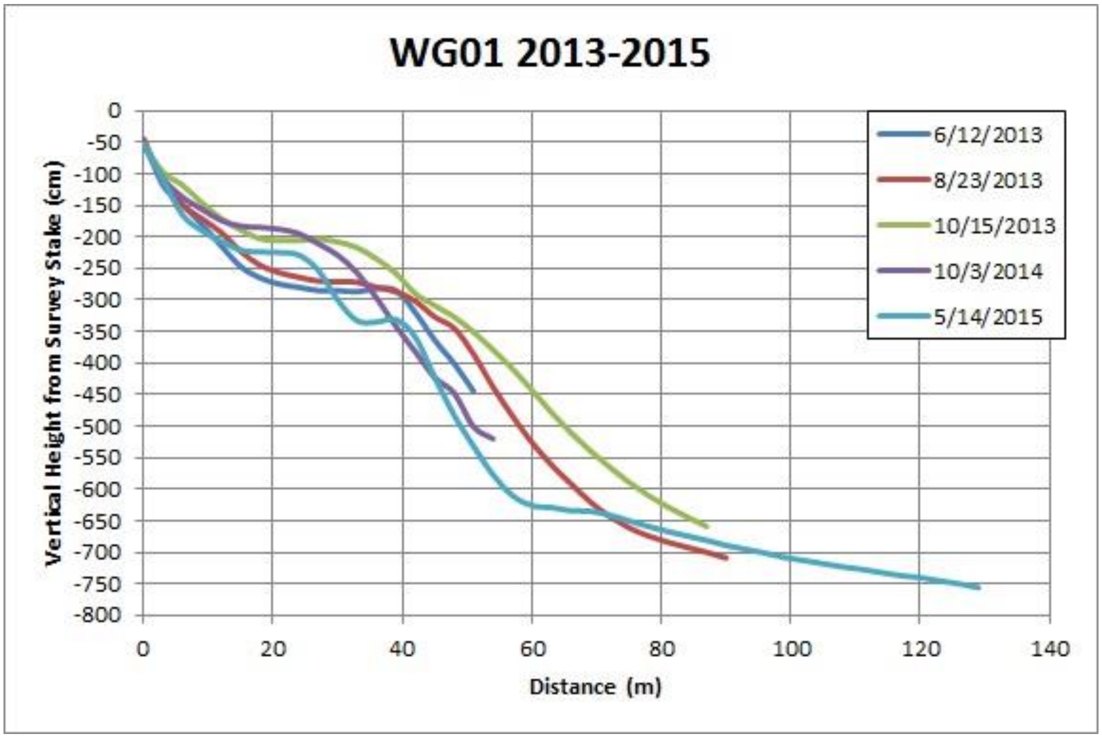

Figure 78. Beach profiles for WG01 from 2013 to 2015.

Figure79. Beach profiles for WG02 from 2013 to 2015.

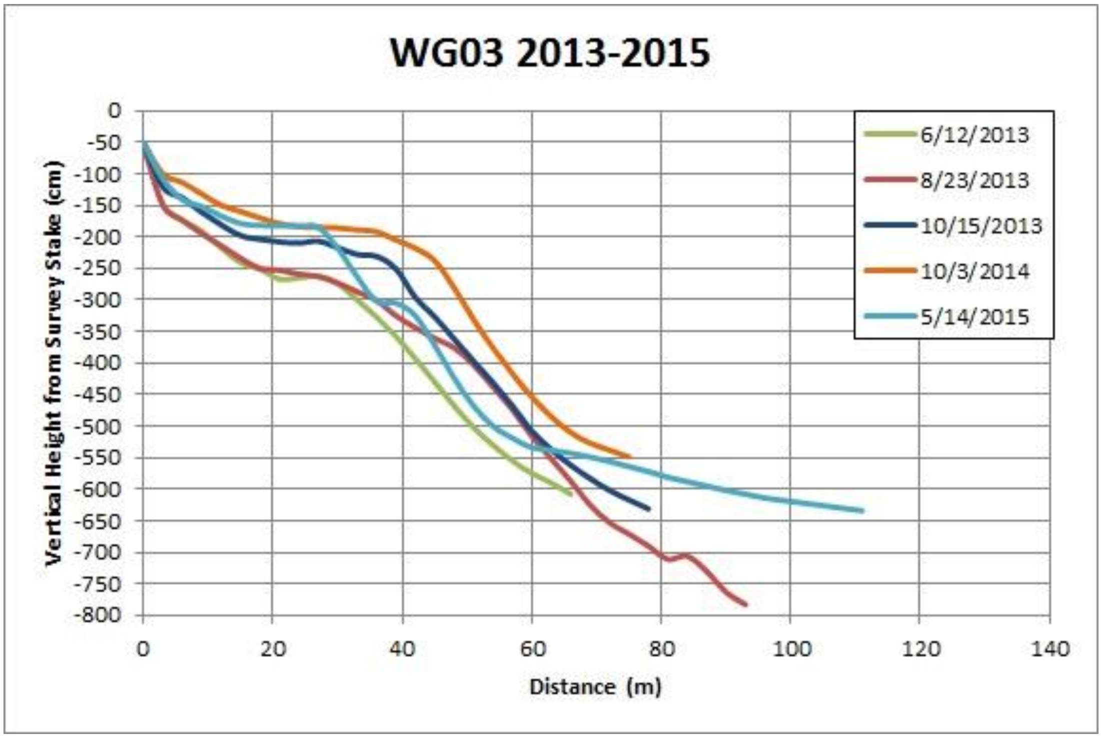

Figure 80. Winter beach profiles for WG03 from 2013 to 2015.

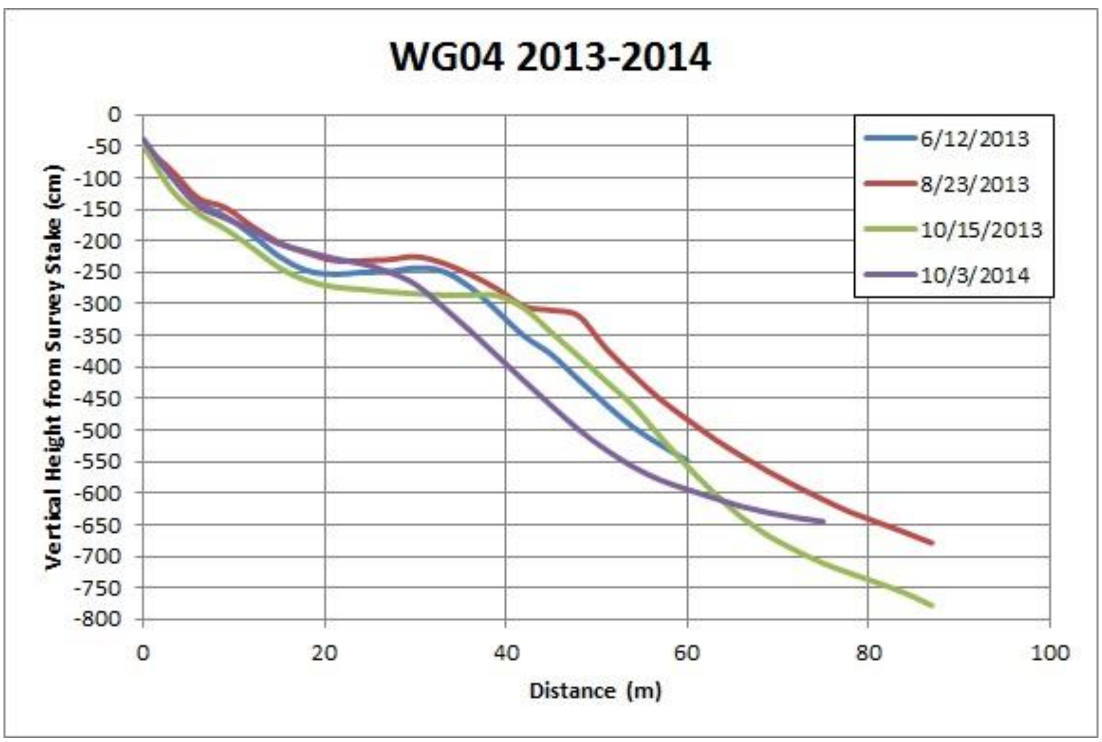

Figure 81. Beach profiles for WG04 from 2013 to 2014.

Old Orchard Beach (Ocean Park, West Grand Beach and East Grand Beach) MBMAP Results

Old Orchard Beach is one of the largest beach systems in the state, stretching from Goosefare Brook in the south to the border with Pine Point, Scarborough in the north. From Goosefare Brook to the pier is generally known as West Grand Beach, while from the pier north to near the Scarborough town line is known as East Grand Beach. The majority of the beach has vegetated dune except for a small portion in the northern end of the beach (Figure 82). Shorelines from 2010 to 2014 were available for analysis. In Ocean Park (to transect 1770), the mean shoreline change was +0.47 m/yr. In West Grand Beach (from transect 1771 to the pier), the mean was +0.28 m/yr. East of the pier to the seawall, at East Grand Beach, the mean trend was accretive at +0.96 m/yr. The overall mean shoreline change trend including all beaches was positive at **+0.62 m/yr, indicating that the dunes were accretive**. It appears that the northern portion of Old Orchard Beach – north of the pier - is growing at a higher rate than the southern portion (south of the pier). There is some noted anomalous dune erosion occurring adjacent to the seawall at the northern end of the beach.

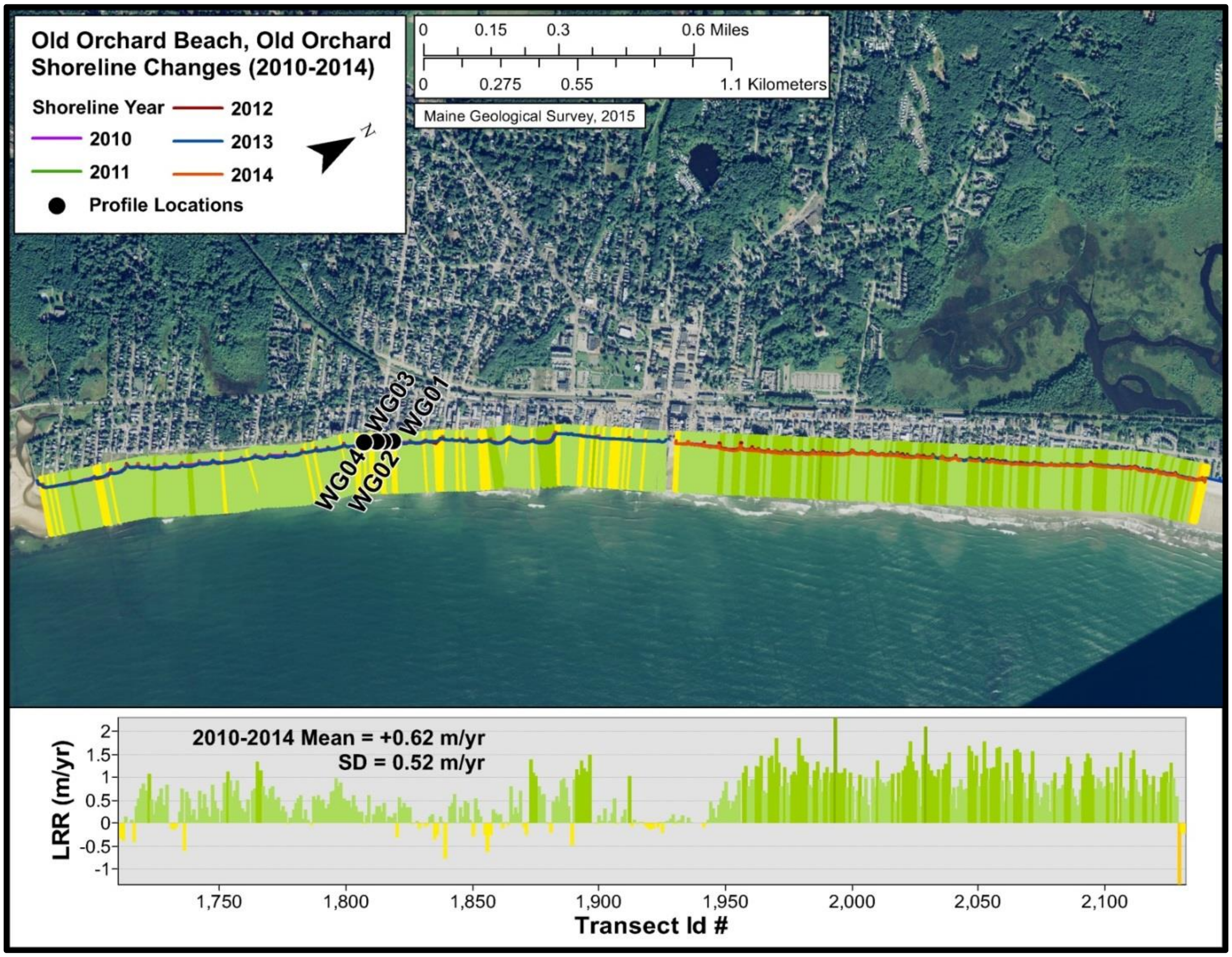

Figure 82. MBMAP data showing shoreline changes along Old Orchard Beach. 2013 base imagery from Maine OGIS.

East Grand Beach, Old Orchard Beach and Pine Point Beach, Scarborough

Two profiles (EG01 and EG04, Figure 83) were available for analysis with data from 2010 to 2015; these profiles are actually located in Scarborough, not Old Orchard Beach, but are listed as being part of East Grand Beach. Note that profiling at EG02 and EG03 stopped in 2012, so no data will be analyzed. Figures 84 to 87 show seasonal changes.

Figure 83. Locations of East Grand Beach volunteer monitoring profiles. Note that only data from EG01 and EG04 are analyzed, since EG02 and EG03 have not had data collected since 2012. 2013 base imagery from Maine OGIS.

Winter EG01 = C (75). From 2010 to 2011, EG01 accreted, and grew seaward, at the dune and along the beach. By 2012, it eroded along the entire profile to its most erosive shape. No winter 2013 data was available. By 2014, the dune grew by 30 cm, and the berm and recovered from the 2012 shape, but not back to 2010 or 2011 levels. In 2015, the dune remained stable, and the berm slightly moved landward. The remainder of the profile stayed about the same. EG01 saw extensive erosion in 2012, and generally has recovered. It has built in the dune, but its berm has been eroding relatively consistently since 2010.

Summer EG01 = C (75). From 2010 to 2011, the profile showed growth at the dune, loss of the berm, and growth seaward of 60 m. No 2012 data existed. In 2013, the profile's dune continued to grow, the berm recovered slightly, but the profile deepened back to 2010 levels seaward of 60 m. By 2014, the dune grew slightly more, yet the berm was lost. Seaward of 60 m, the profile gained back to 2011 levels. The profile showed dune and beach growth, but consistent berm loss.

Winter EG04 = C+ (78). From 2010 to 2011, EG04 had nice growth of the dune, a stable berm, and growth of the beach. The 2012 profile showed significant erosion of the entire profile to its most erosive shape. No 2013 data existed. By 2014, the dune grew about 30 cm, and the berm and beach recovered well. 2015 saw additional dune growth, slight berm erosion, but gaining of elevation in the offshore back to 2011 levels. Consistent with EG01, the dune here grew, but the berm eroded, but to a lesser extent.

Summer EG04 = C+ (78). From 2010 to 2011, EG04 had dune growth, and berm loss. No 2012 data existed. By 2013, the dune grew more, but the berm and beach migrated landward, signifying erosion. Summer 2014 saw a stable dune, but additional loss of the berm and beach. Similar to the other summer profiles, the dune crest moved inland and gained in elevation, but the berm was lost.

Winter Summary: 2012 appeared to be the most erosive year, with recovery occurring, especially in dune crests. However, beach berms have continually eroded. **Winter Beach Grade: C (77).**

Summer Summary: The profiles generally showed landward movement and growth of the dune, but consistent loss of the berm. It appears that these profiles underwent transgression (landward migration), but there is ample sediment supply to allow overwash to build up the dune in a landward direction. **Summer Beach Grade: C (77).**

Overall Summary: Although East Grand Beach profiles have shown berm loss and landward movement of the beach, they have also shown growth of dune crests, indicating an ample sediment supply to allow natural transgression to occur. **Overall Beach Grade: C (77).**

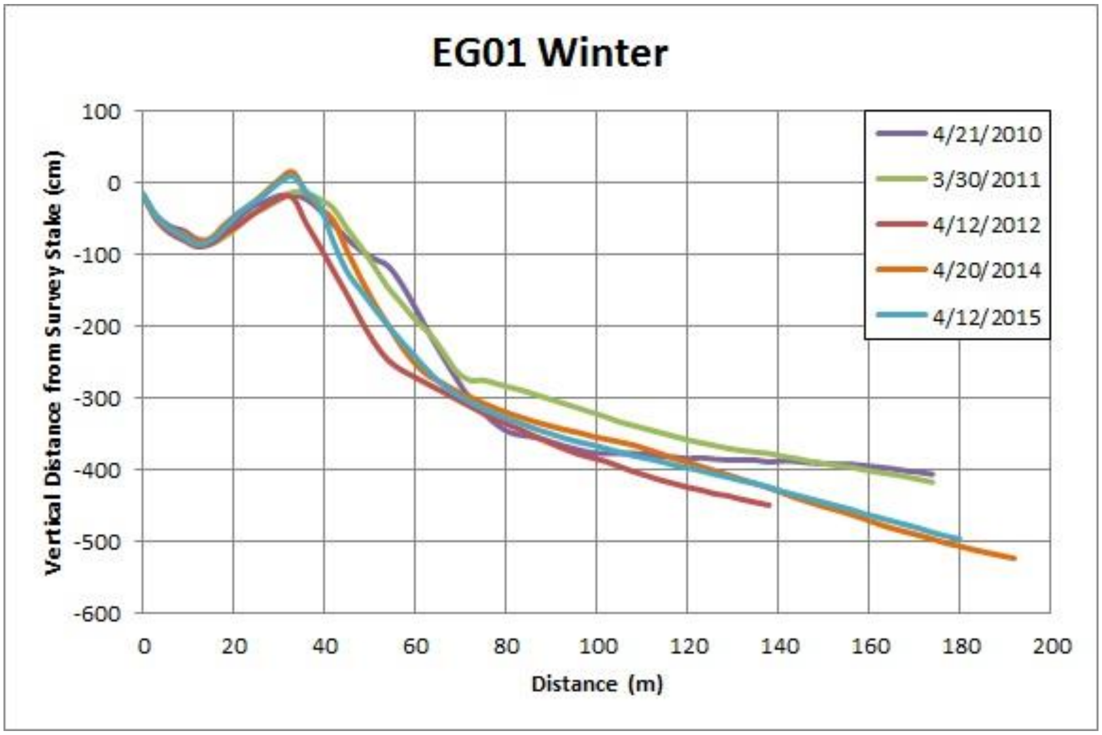

Figure 84. Winter beach profiles for EG01 from 2010 to 2012, and 2014 to 2015.

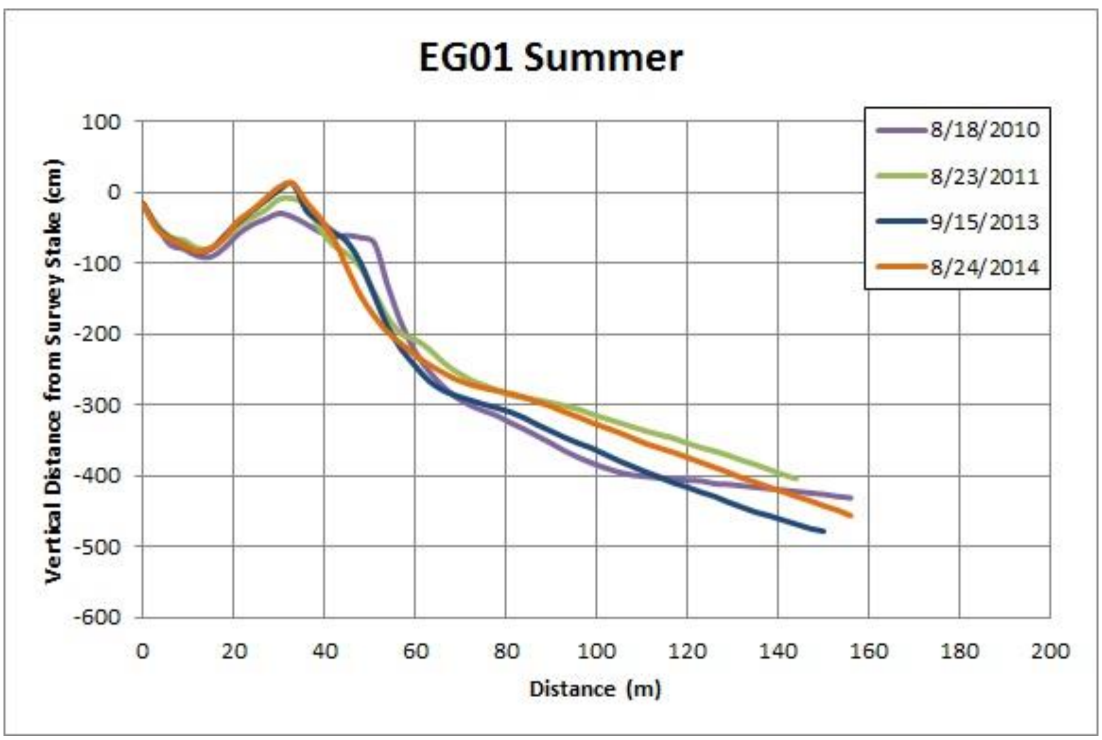

Figure 85. Summer beach profiles for EG01 from 2010 to 2011, and 2013 to 2014.

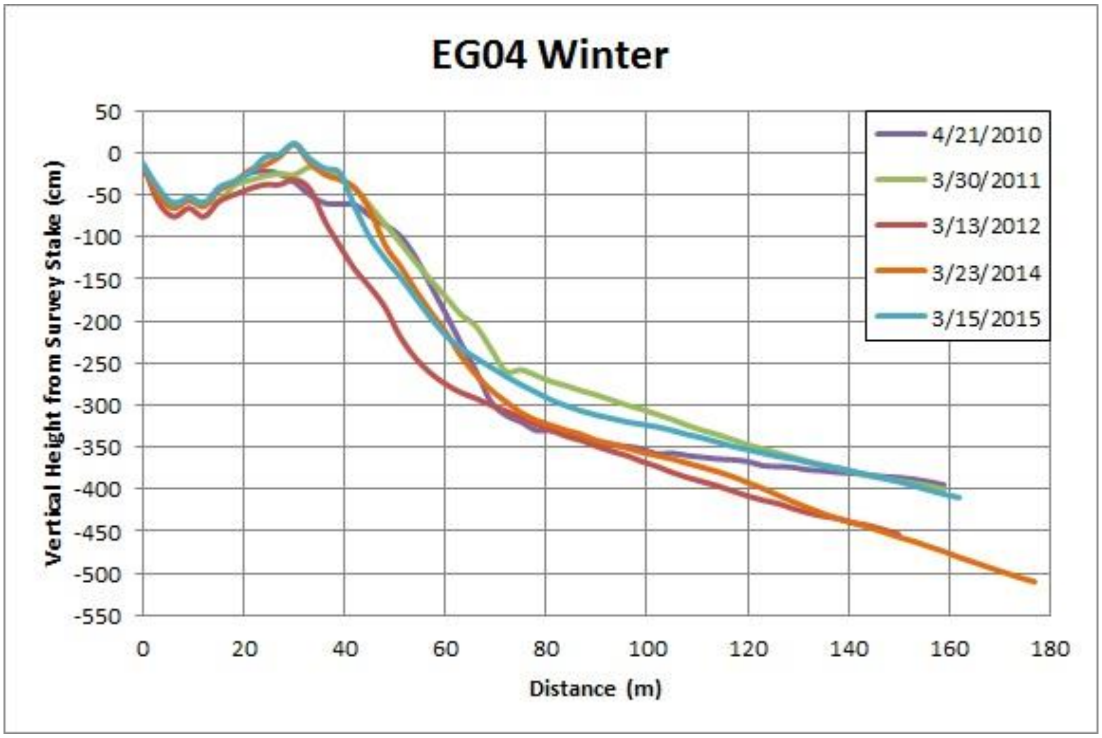

Figure 86. Winter beach profiles for EG04 from 2010 to 2012, 2014 and 2015.

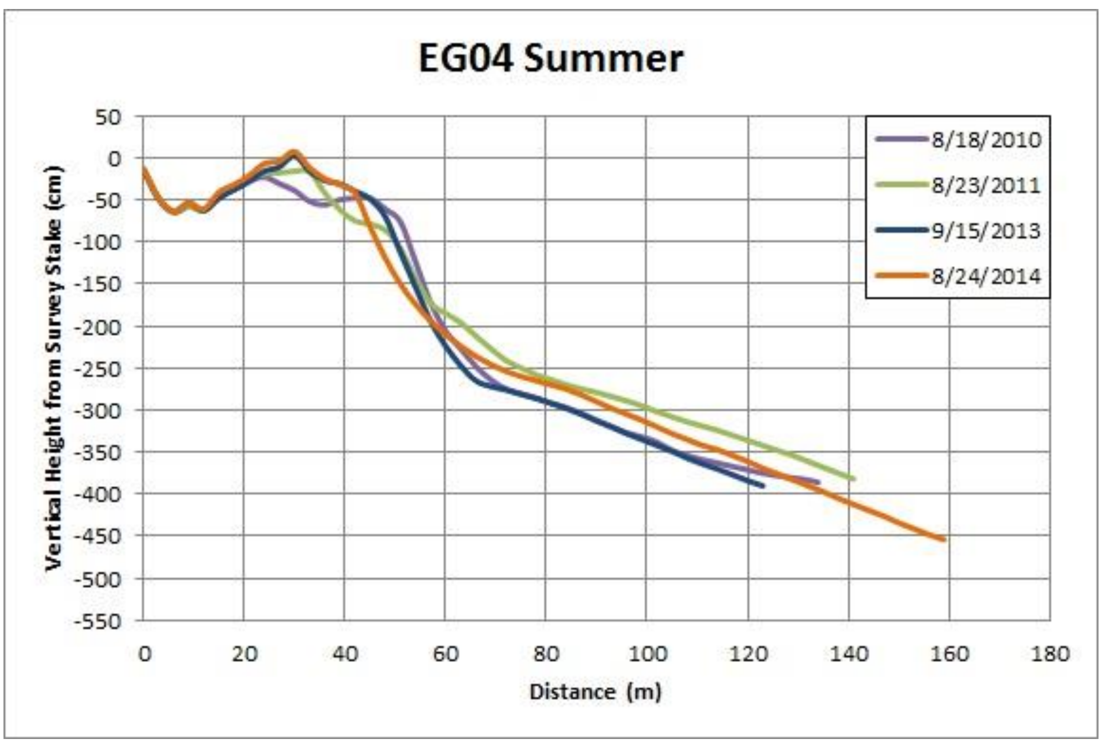

Figure 87. Summer beach profiles for EG04 from 2010 to 2011, and 2013 to 2014.

East Grand Beach and Pine Point MBMAP Results

Almost this entire stretch of the shoreline is vegetated, stretching from a seawall in East Grand Beach to the west, east to the jetty at the Scarborough River. MBMAP data of vegetation line positions were available from 2010 to 2014 (Figure 88). The overall mean trend was **+0.9 m/yr, indicating an accretive trend from 2010 to 2014**. Generally, the dunes from East Grand Beach into the western portion of Pine Point Beach are growing seaward (transects 2130 to 2330). The average shoreline change rate along this stretch of shoreline was +1.4 m/yr. However, this trend becomes generally erosive from transects 2330 to 2420 (with two small pockets of accretion at 2370 to 2379, and 2410 to the jetty) with a trend of -0.3 m/yr. The nodal point – or separation between these two – exists where the shoreline begins to curve to the east. The overall trend of **dune growth** that is seen at EG01 and EG04 beach profiles is reflected by the available MBMAP data.

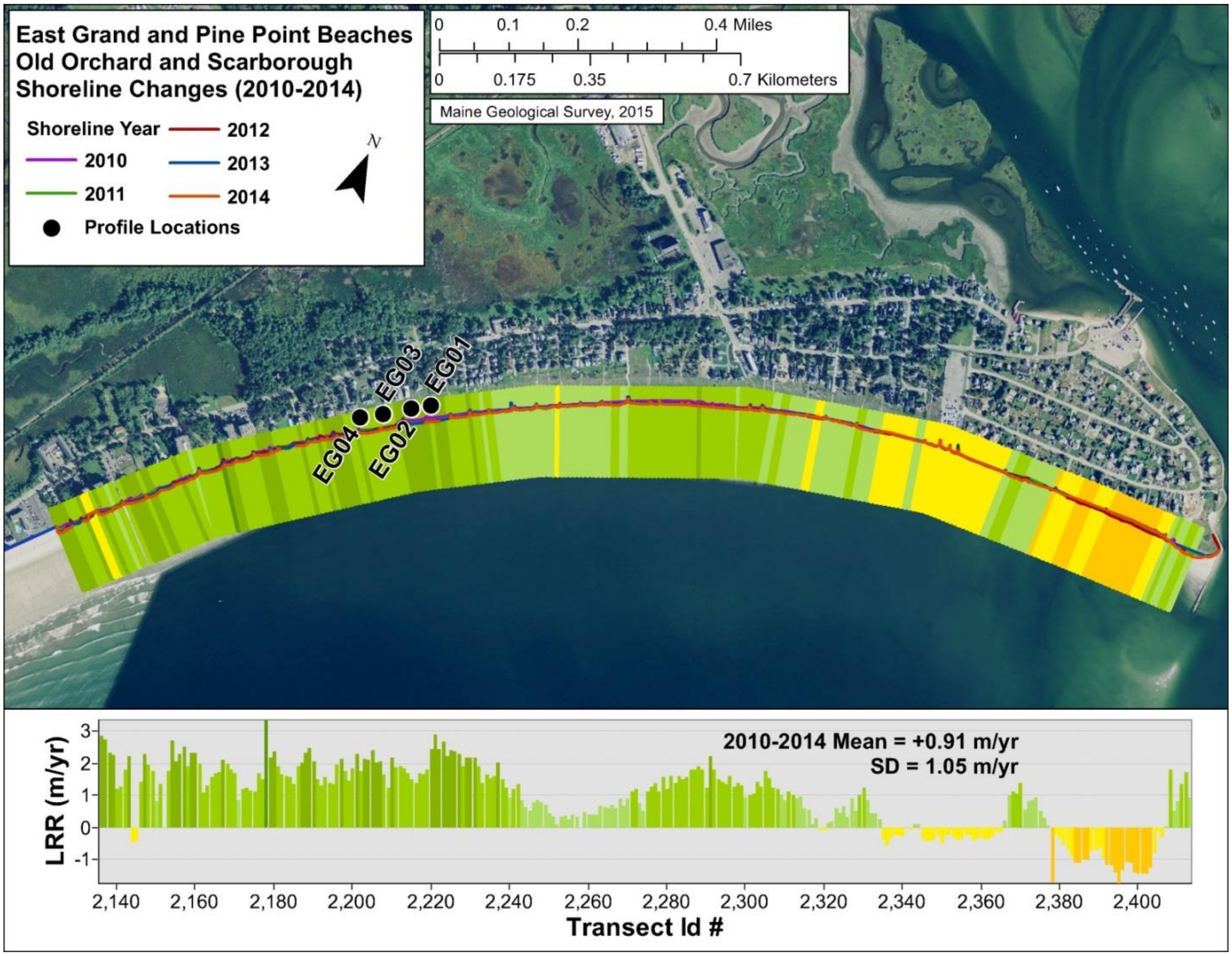

Figure 88. MBMAP shoreline change analysis results for the East Grand Beach and Pine Point areas. 2013 base imagery from Maine OGIS.

Ferry Beach and Western Beach, Scarborough

Ferry and Western Beaches are not part of the SMPP.

Ferry and Western Beach MBMAP Results

MBMAP data for the vegetation line along Western Beach and Ferry Beach was available from 2010 to 2014. This area can generally be divided into two almost separate cells (Figure 89): Ferry Beach (transects 2410 to 2510), located on the inside of and eastern bank of the Scarborough River, and Western Beach (transects 2510 to 2620). The two are separated by a bedrock outcrop. **At Ferry Beach, overall shoreline change was +0.24 m/yr**, but there were distinct pockets of accretion and erosion. The dunes built seaward from 2410 to 2435, then eroded at about -0.5 m/yr from 2435 to 2470. East of this generally accreted, with large amounts of accretion (up to and beyond +3 m/yr) from 2490 to 2510, near the point. Just on the opposite side of the point, some erosion occurred, up to -2 m/yr. **Along Western Beach, the overall average was -1.34 m/yr**. The dune built seaward along its western end (transects 2515 to 2530), and eroded very heavily (up to -4 m/yr) from 2535 to 2590. There was a small pocket of accretion east of this, then slight erosion to the Prouts Neck Headland. The overall shoreline **change rate for the whole system was -0.6 m/yr, indicating an erosive trend**.

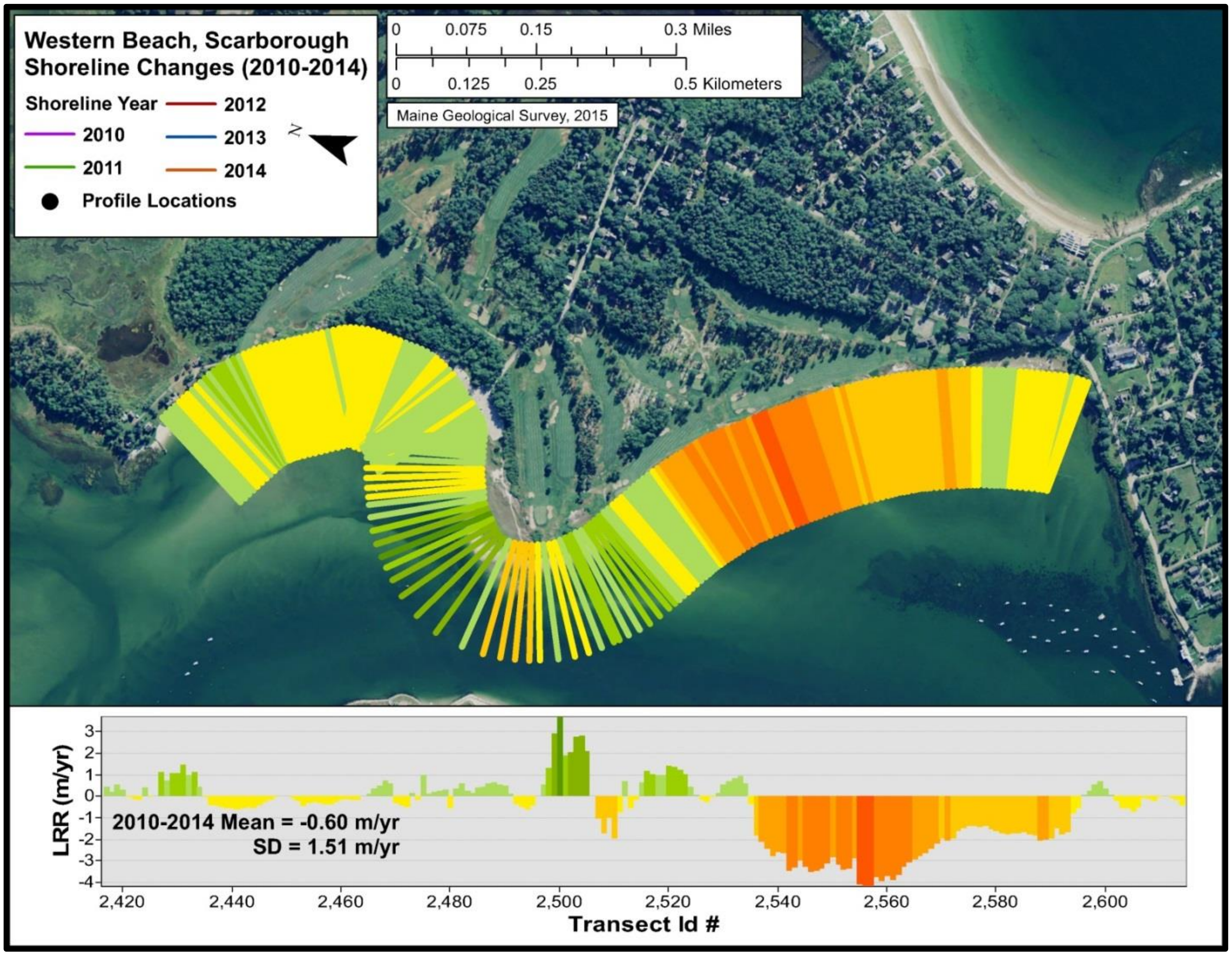

Figure 89. MBMAP data showing shoreline changes along Ferry and Western Beaches, Scarborough. 2013 base imagery from Maine OGIS.

Scarborough Beach, Scarborough

A total of four beach profiles (SC01 to SC04, Figure 90) were available for analysis. *However, only SC01 had 2014 data collected; all other profiles stopped data collection in December 2013, so no recent trends can be analyzed*. SC01 and SC02 are located northeast of the access path, while SC03 and SC04 are located southwest of the access path. Figures 91 to 98 show seasonal changes.

Figure 90. Volunteer beach profile locations at Scarborough Beach, Scarborough. 2013 base imagery from Maine OGIS.

Winter SC01 = C+ (78). In 2010, SC01 had a concave, erosive shape. From 2010 to 2011, SC01 gained elevation along the profile landward of 60 m. Profile growth continued in 2012, with about 100 cm of elevation gain along the profile (to its best shape). It eroded in 2013 but still above 2010 and 2011 shapes. In 2014, it generally showed stability, changing little from the 2013 shape. 2010 was the worst, and 2012 the best years for this profile. It eroded since 2012, but not back to 2010 levels.

Summer SC01 = B- (82). *Data were available only through 2013*. In 2010, a berm was clearly present at 20-30 m. In 2011, the berm eroded and this was the most erosive year. In 2012, a large, well-defined berm was present. In 2013, the berm gained substantial elevation, but the profile lost some sand at the dune.

Winter SC02 = B (85). *Data were available only through 2013*. In 2010, SC02 had a steep slope from the dune, and a well-defined berm. By 2011, the steep slope flattened, and the berm eroded. 2012 had additional sand gains along the profile; this shape was maintained through 2013, indicating good stability. This profile gained sediment in 2012, and was stable in 2013, with a low point in 2011.

Summer SC02 = B (85). *Data were available only through 2013*. From 2010 to 2011, the berm flattened, but the profile gained sand at the base of the dunes – 2011 was the most erosive. In 2012, the berm recovered, but to a lower elevation and a more seaward position. In 2013, the dune remained stable, and the berm grew higher, indicating growth.

Winter SC03 = C (75). *Data were available only through 2013*. In 2010, SC03 had a well-defined berm between 30-45 m, which eroded significantly in 2011 to its most erosive shape. It showed excellent recovery in 2012, with the highest elevations and a well-defined berm. In 2013, it eroded and the berm moved landward but stayed above

2011. Comparing 2010 and 2013, the berm was more landward (at 20 m instead of 30-45 m), and higher. The profile showed stability but landward berm movement, indicating slight erosion.

Summer SC03 =B+ (88). *Data were available only through 2013*. In 2010, SC03 had a prominent berm at 30 m. In 2011 it had its lowest elevations, with berm loss and flattening of the profile to 60 m. In 2012, it recovered, with berm reestablishment, and elevation gains. In 2013, SC03 underwent substantial dune and berm growth.

Winter SC04 = C- (72). In 2010, it had a well-defined berm near 40 m (Figure 22). This eroded in 2011, and the berm narrowed and lost elevation. In 2012, the beach recovered, with a berm reforming higher and more landward than 2011. In 2013, the profile eroded – it lost its berm, and eroded down to or below 2011 elevations. Comparing 2010 and 2013 profiles showed some landward sand movement, and berm loss. This profile was slightly erosive.

Summer SC04 = C+ (78). In 2010, a large, well defined berm was near the 30 m mark - this is the highest berm of all profiles (Figure 23). In 2011, the berm lost elevation while flattening and remaining in roughly the same place. Its seaward portion gained elevation while some erosion occurred between the dune and the berm. By 2012, the berm migrated landward very slightly. In 2013, SC04 had a re-established berm, but not quite back to 2010 levels.

Winter Summary: In general, winter 2012 had the most sediment-rich profiles, with either winter 2010 or winter 2011 being the most erosive. Profiles recovered from these low points through 2012, but showed signs of erosion in the winter of 2013. In this assessment, the profiles north of the access path (SC01 and SC02) showed more stability or accretion than those to the south of the path. **Winter Beach Grade: C+(78).**

Summer Summary: Generally, the summer of 2013 had the highest and best defined summer berms at each beach, while summer 2011 was generally most erosive. Berm growth mostly took place north of the access path. **Summer Beach Grade: B (83).**

Overall Summary: Note that available data did not allow inclusion of 2014 or 2015 data except for one profile. Profiles were relatively stable to slightly erosive, with the largest erosion near SC04. 2011 was generally the most erosive year. This profile is furthest south, and impacted by cobble migration associated with a salient stretching offshore. SC01 had the most "winter" shape (concave), while the others had winter and summer berms. The beach maintained good summer shapes, with some seaward growth of the berms, especially north of the access path. **Overall Scarborough Beach Grade: B- (80).**

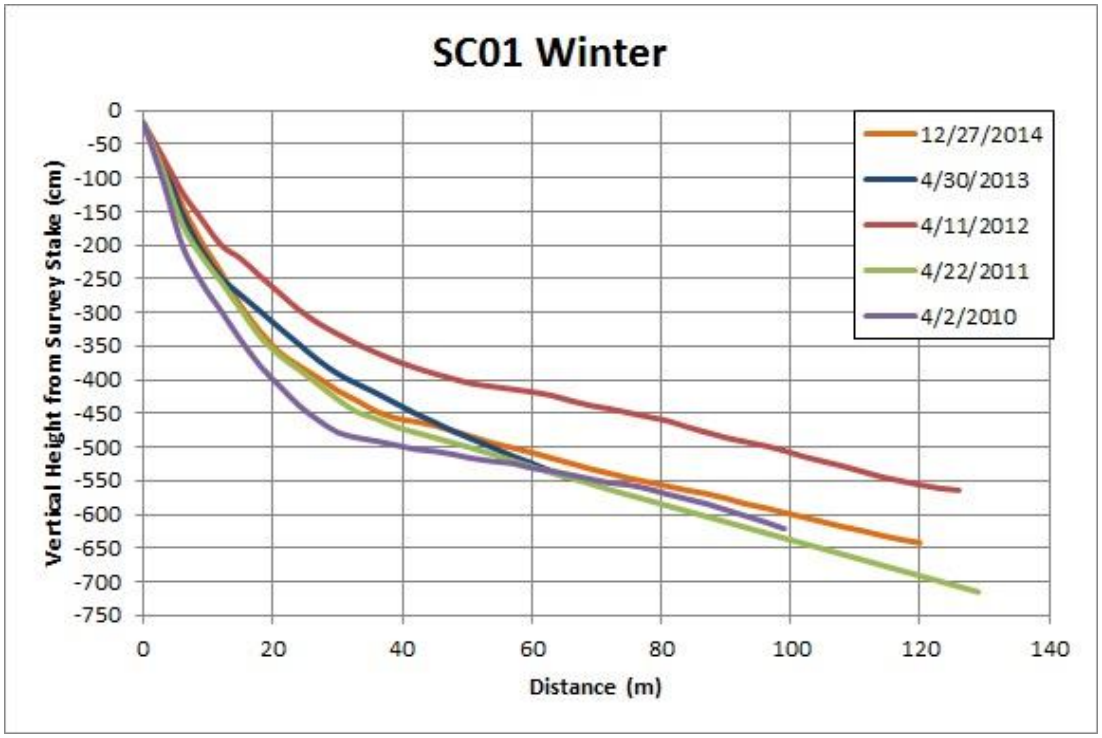

Figure 91. Winter beach profiles for SC01 from 2010 to 2014.

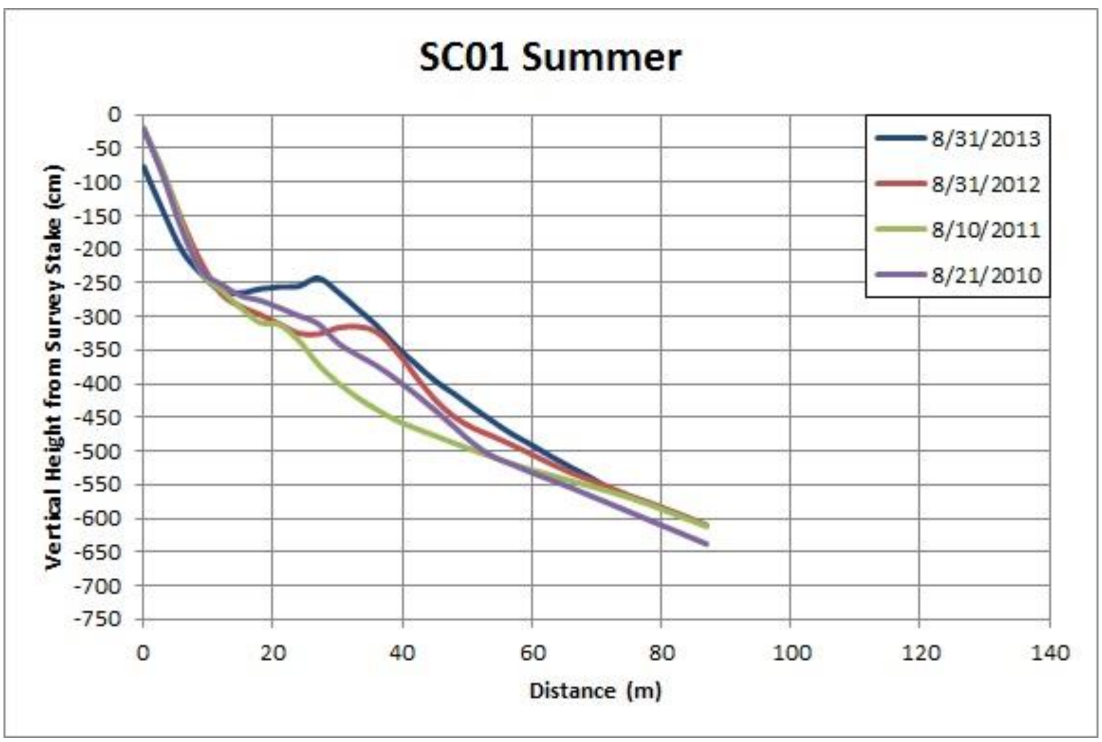

Figure 92. Summer beach profiles for SC01 from 2010 to 2014.

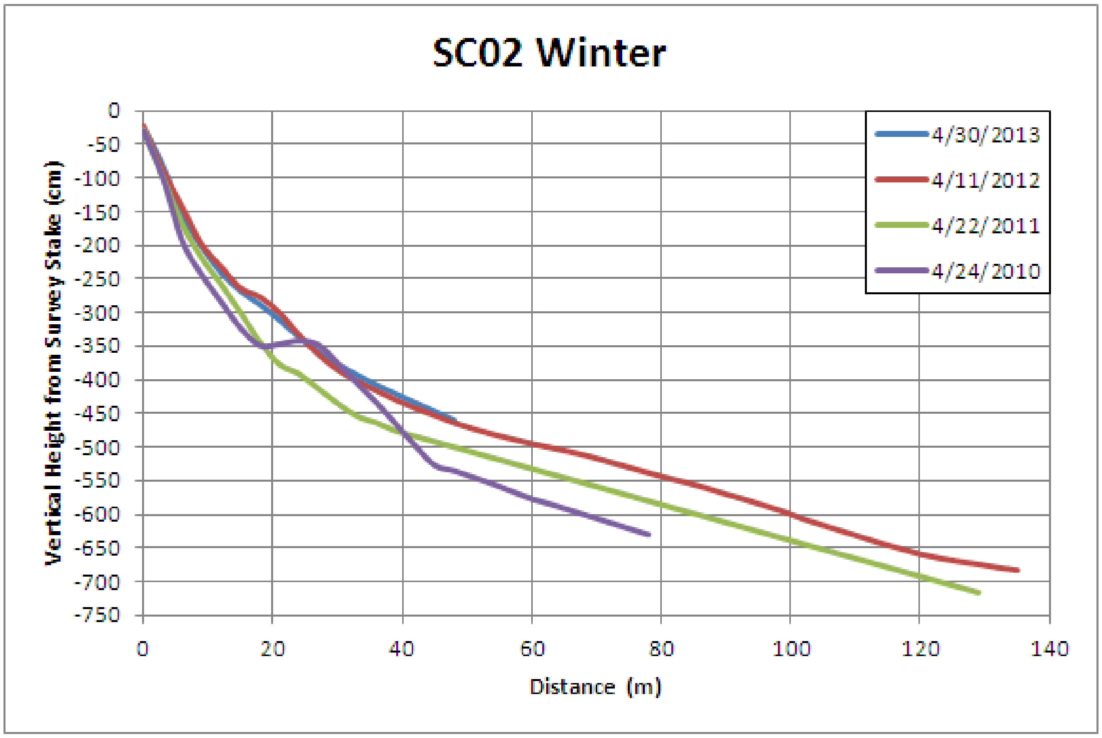

Figure 93. Winter beach profiles for SC02 from 2010 to 2013.

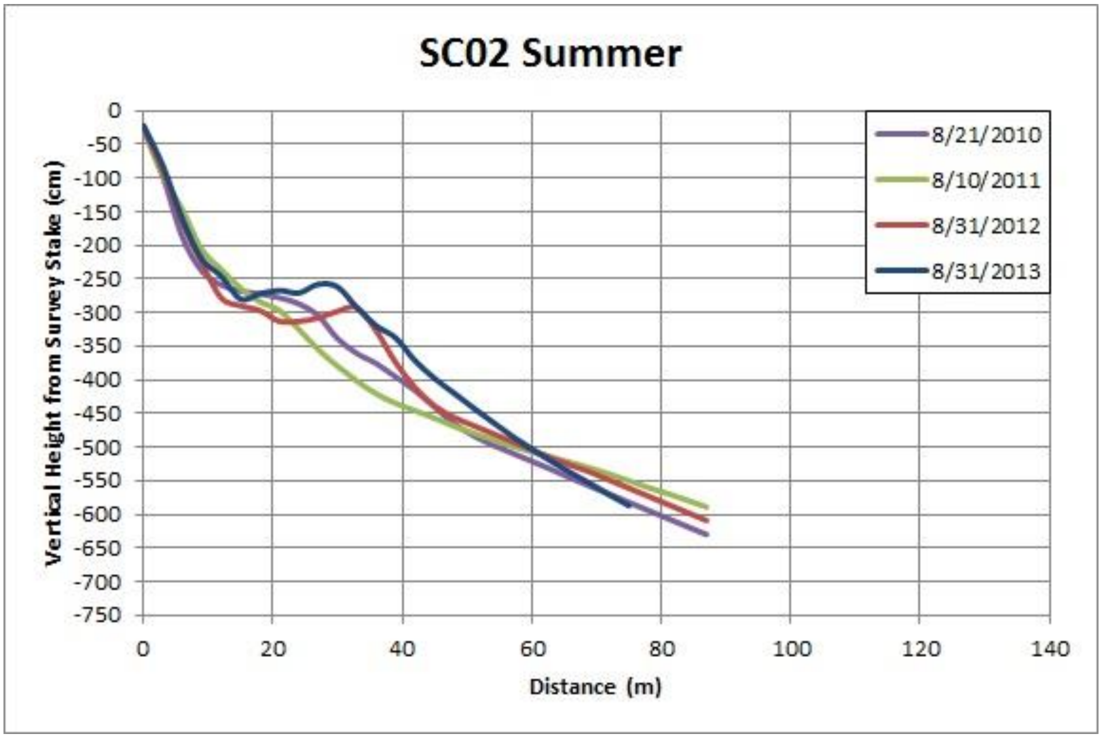

Figure 94. Summer beach profiles for SC02 from 2010 to 2013.

Figure 95. Winter beach profiles for SC03 from 2010 to 2013.

Figure 96. Summer beach profiles for SC03 from 2010 to 2013.

Figure 97. Winter beach profiles for SC04 from 2010 to 2013.

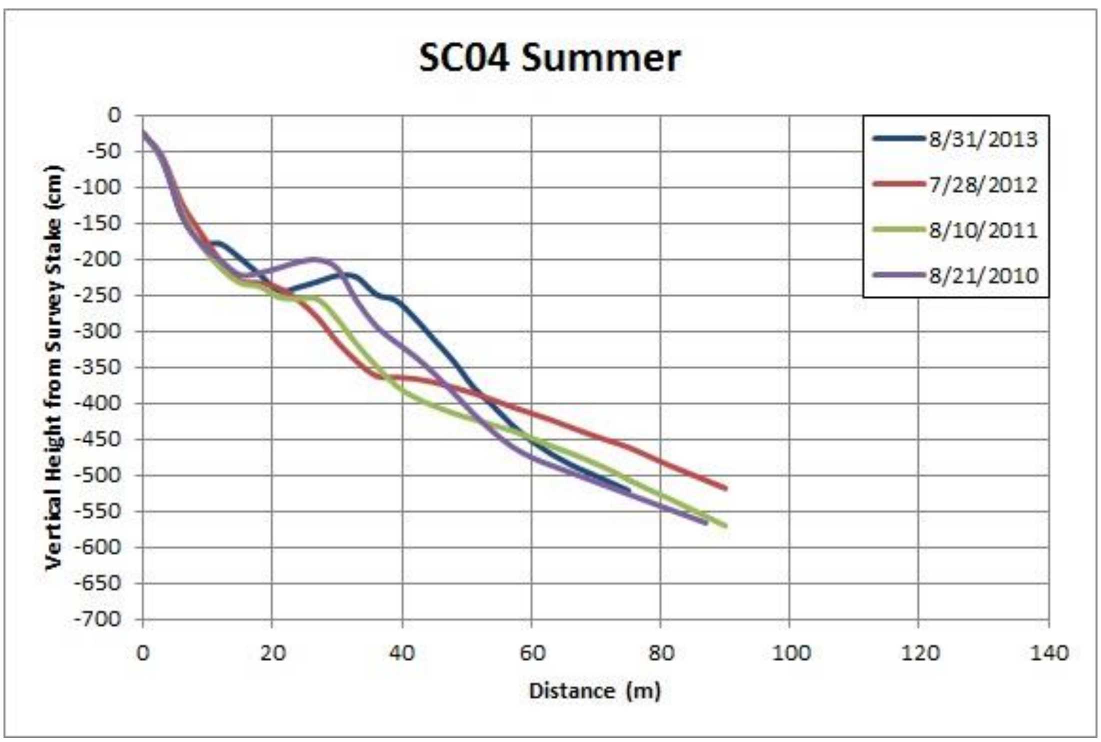

Figure 98. Summer beach profiles for SC04 from 2010 to 2013.

Scarborough Beach MBMAP Results

Vegetated shorelines were surveyed in 2010, and 2012 to 2014 (Figure 99). The overall shoreline change rate from **2010 to 2014 was +0.69 m/yr, indicating a somewhat accretive dune system**. Interestingly, the highest rates of accretion of the dune occurred south of the access path (transects 2620 to 2665). Although this is not reflected by profile data, profiling stopped in 2013, so changes over the past few years are not included. Just north of the access path, dune growth rates were slightly lower. North of this (transects 2685 to 2705), shoreline change rates were much higher, generally between +1 and +2 m/yr. The only real pockets of erosion occurred adjacent to the seawall (near 2610), and between 2710 and 2745. However, accretion at the north quarter of the beach is much less than the southern half of the beach.

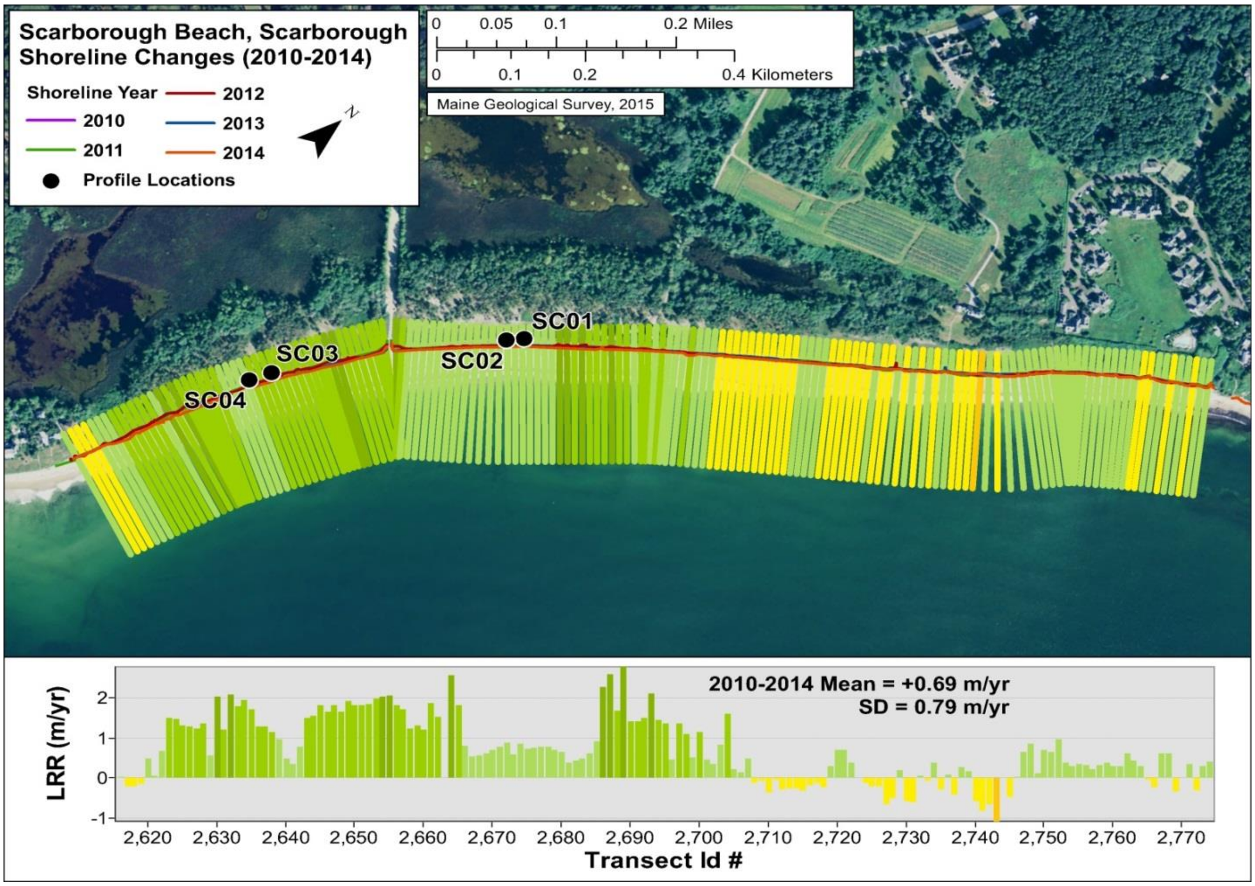

Figure 99. MBMAP results for Scarborough Beach, Scarborough. 2013 base imagery from Maine OGIS.

Higgins Beach, Scarborough

Three beach profiles (HI01, HI02, and HI03, Figure 100) were available for analysis. HI01(and HI01B, a backup point) are located in the rip-rap seawall along Bayview Ave. HI02 is located at a small seawall along the central portion of the beach, and HI03 is located in a wall landward of a natural dune area closer to the Spurwink River. Figures 101 to 106 show seasonal changes.

Figure 100. Volunteer profiling locations at Higgins Beach, Scarborough. 2013 base imagery from Maine OGIS.

Winter HI01 = B- (82). The 2010 profile was the lowest, most erosive shape, likely eroding down to a historical erosional surface (such as peat). By 2011, it gained about 100 cm of sand vertically along its length. In 2012, this trend continued, with additional growth on the order of 20-40 cm along most of the profile; however, nearest the wall, the beach scoured and lowered. In 2013, HI01 eroded to within about 50 cm of the 2010 shape, and was steeper nearest the wall. In 2014, it remained extremely steep near the wall, but gained about 50-60 cm in elevation on the beach. The 2015 shape regained sand at the wall, and was stable in the beach area of the profile. This profile showed recovery from 2010 to a high in 2012, erosion in 2013, and good recovery in 2014 and stability in 2015. All profiles remained above 2010 levels.

Summer HI01 = C (75). 2010 had a concave, erosive shape, with a steep sloped berm at the seawall. In 2011, it had minimal recovery, with slight elevation gains along the profile. 2012 had a large gain of sand nearest the wall, with a well-defined trough near the 40 m mark and a swash bar seaward of this. In 2013, it gained sand nearest the wall, but eroded to 2010 levels from 20 m seaward. In 2014, it lost sand at the wall, and gained slightly at the beach. HI01 showed good recovery through 2012, erosion in 2013, and some recovery in 2014, but loss of the berm nearest the wall.

Winter HI02 = B (85). 2010 was generally the most erosive shape. Slight recovery occurred in 2011. In 2012, HI02 lost sand at the seawall, but had a shallower slope with higher elevations on the beach. In 2013, it had a higher sand elevation at the wall; however, it eroded to near the 2010 shape out to about 40 meters. 2014 had the most sand rich profile, gaining all along the profile. 2015 had some loss adjacent to the wall, stability in the berm, and some loss seaward of 20 m. The profile showed good recovery from 2013, and stability in the last 2 years. Elevations of the profile are well above the 2010 lows.

Summer HI02 = C (75). The summer 2010 profile showed a steep shorefront, low berm, and a steep profile into the offshore . By 2011, the profile recovered well, with substantial amounts of sand gain and some of the highest elevations, especially within 30 m of the wall. By 2012, it eroded at the wall, lowering back to the 2010 level out to about 30 m. Seaward of this, out to about 80 m, a large bar formed, indicating a gain in sand; however, seaward of this bar, it lost elevation. In 2013, HI02 eroded significantly within 40 m of the wall, to below 2010 levels by 50 to 60 cm. In 2014, it steepened more nearest the wall, gained some sand from about 10 m to well offshore. However, it stayed below the 2011 and 2012 high elevations. The summer berm and beach shows high amounts of variability.

Winter HI03 = D (65). HI03 is influenced by the Spurwink River and undergoes extensive erosion and accretion. In 2010, it had several dune crests, and large volumes of sand seaward of the 40 m mark. By 2011, the dunes grew farther seaward – indicating accretion, but the profile steepened and lost elevation seaward of 40 m. In 2012, HI03 extensively eroded, resulting in scarping of the dune and a steep, concave and erosive profile. The 2013 profile had more dune loss, but a substantial gain in sediment at 10 m seaward. In 2014, dunes had rebuilt seaward substantially, indicating accretion. However, by 2015, this had all eroded back to near or below 2013 elevations. **This profile is highly dynamic and can undergo massive changes in a short time due to inlet dynamics**. MBMAP data discussed in the following pages showed these changes near HI03 very well.

Summer HI03 = D (65). From 2010 to 2011, HI03 maintained its elevation and overall shape, but eroded landward about 10 m. In 2012, the profile extensively eroded, resulting in significant loss of the whole dune system, and a steep, concave shape. In 2013, the dune system built out back to and seaward of the 2010 shoreline. By 2014, the dune had receded landward of the 2011 position, indicating erosion. 2012 was the worst year for HI03 and 2013 the best.

Winter Summary: Winter profiles at HI01 and HI02 recovered well from extremely erosive shapes. HI03 underwent huge erosion and accretion (but more erosion) due to its proximity to the Spurwink River. **Winter Beach Grade: C+ (77).**

Summer Summary: HI01 and HI02 are showing some signs of stability, but have seen some loss, especially near the seawalls. HI03 eroded, accreted, and then eroded. **Summer Beach Grade: C- (72).**

Overall Summary: Winter HI01 and HI02 have recovered generally well from extremely erosive shapes in 2010, and slightly less so in 2013. Changes in inlet dynamics at the Spurwink River have eroded large sections of beach and dune in the vicinity of HI03; however, a large, emergent bar is now present (see MBMAP results). We do expect that bar to hopefully move onto the beach in the summer months of 2015, bringing back a pattern of accretion at HI03. **Higgins Beach Overall Grade: C (75).**

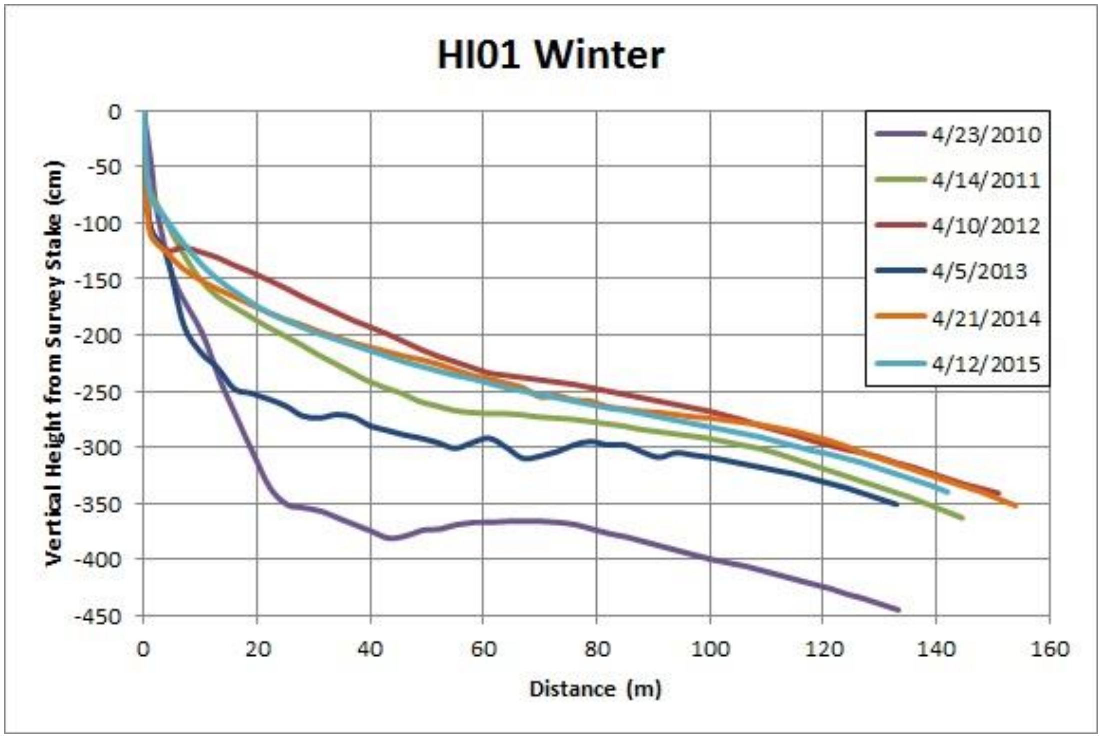

Figure 101. Winter beach profiles for HI01 from 2010 to 2015.

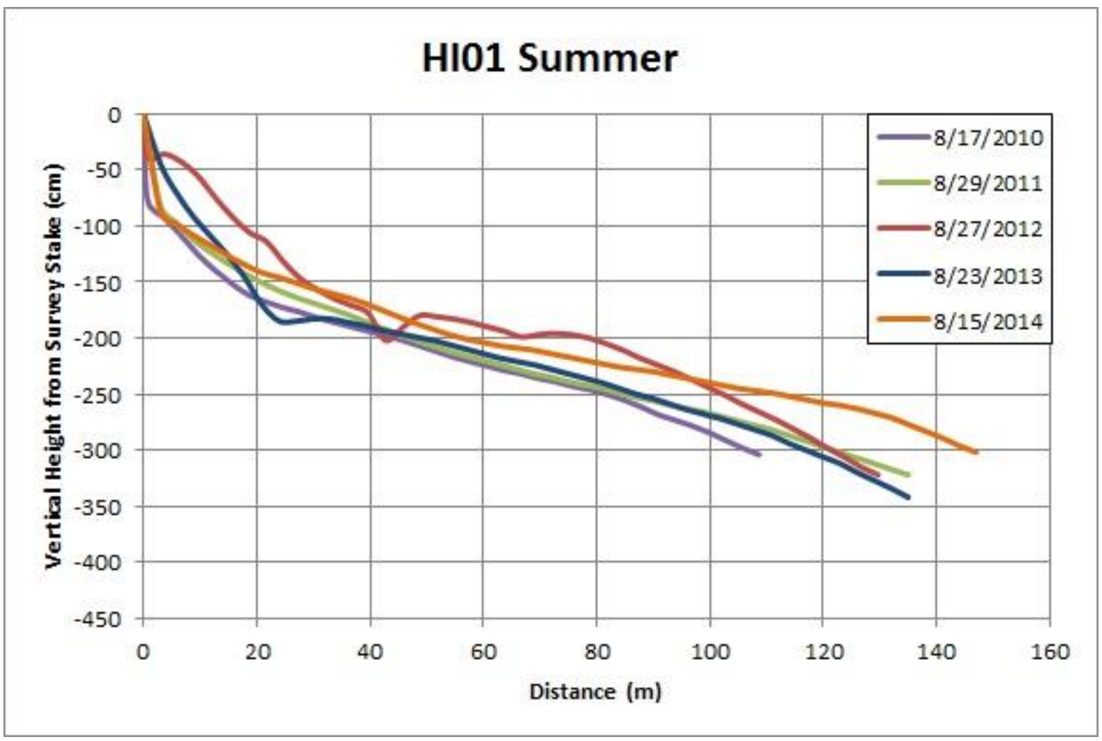

Figure 102. Summer beach profiles for HI01 from 2010 to 2014.

Figure 103. Winter beach profiles for HI02 from 2010 to 2015.

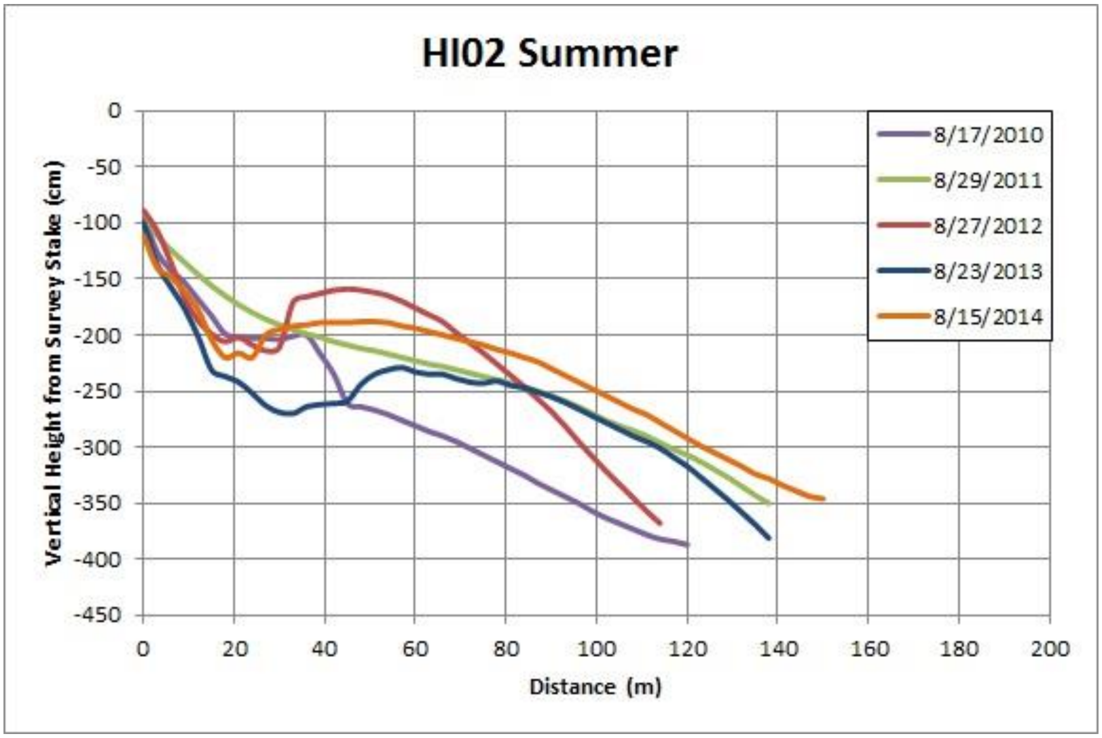

Figure 104. Summer beach profiles for HI02 from 2010 to 2014.

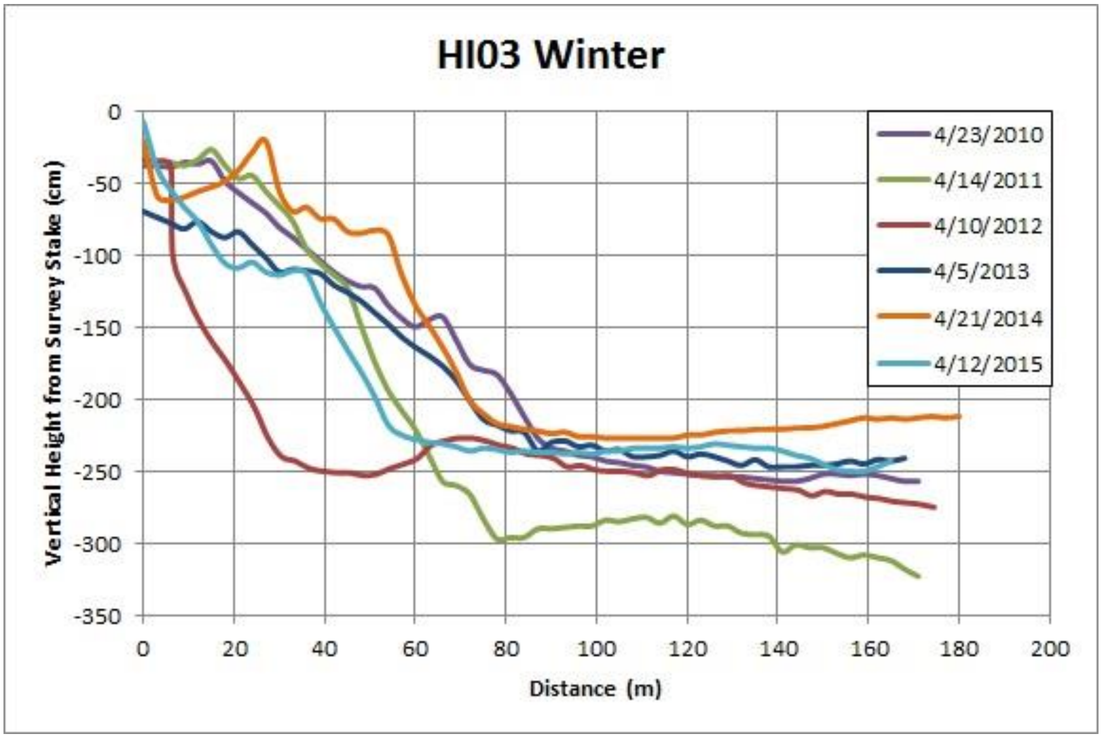

Figure 105. Winter beach profiles for HI03 from 2010 to 2015.

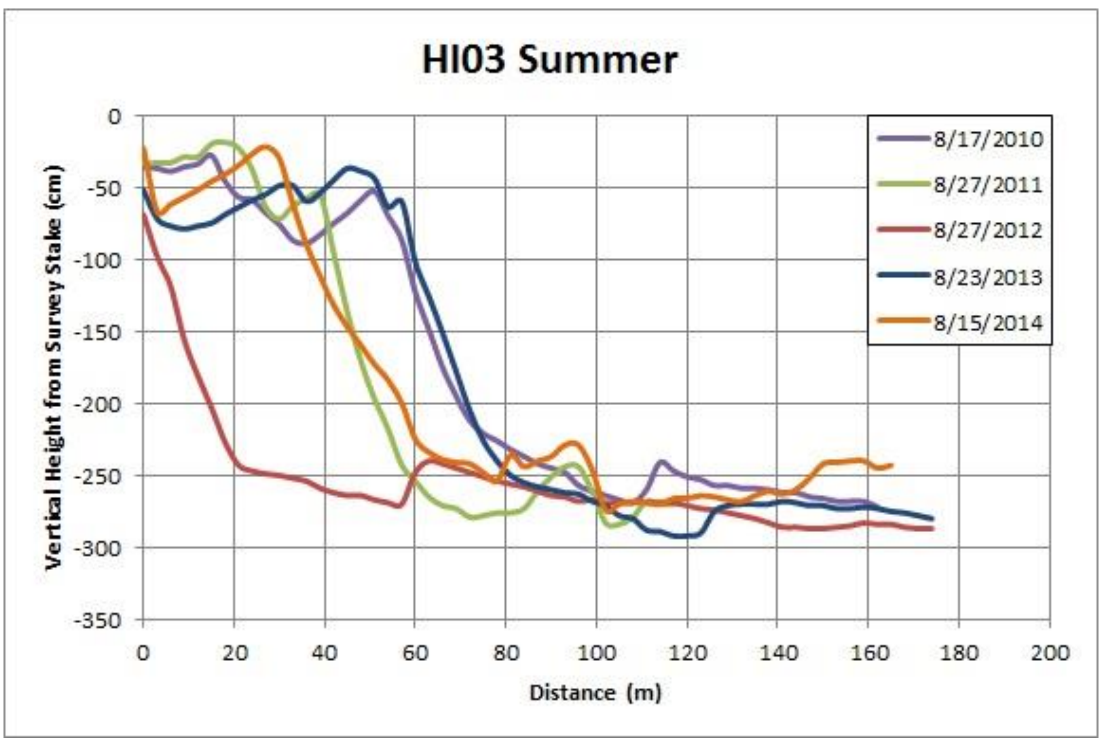

Figure 106. Summer beach profiles for HI03 from 2010 to 2014.

Higgins Beach MBMAP results

MBMAP vegetation line data was available from 2010 to 2014 (Figure 107), mostly adjacent to the Spurwink River, as the rest of the shoreline is lined with seawalls aside from a small pocket (transects 2775 to 2784). Between HI01 and HI02 is a small stretch of dune that has been relatively stable. The largest dune line changes occurred in the vicinity of HI03 and eastward, closer to the mouth of the Spurwink River. From transect 2821 to 2831, from 2010 to 2014, the shoreline eroded at an average of -3 m/yr, with an area directly adjacent to the seawall over -5 m/yr. East of this, the shoreline has extensively grown seaward as a swash bar welded onto the beach, built in elevation, and grew new dune vegetation. Along this stretch (transects 2832 to 2841), the shoreline **accreted at extremely high rates, with an average of +6 to +8 m/yr, with several transects up to +10 m/yr. Eastwards, closest to the river, the shoreline change trend has been highly erosive, averaging -4.7 m/yr. However, the overall average for the Higgins Beach vegetated shoreline is +0.5 m/yr, indicating a slightly accretive to accretive trend from 2010 to 2014**. Note that this is heavily skewed by the extremely high levels of accretion associated with swash bar welding.

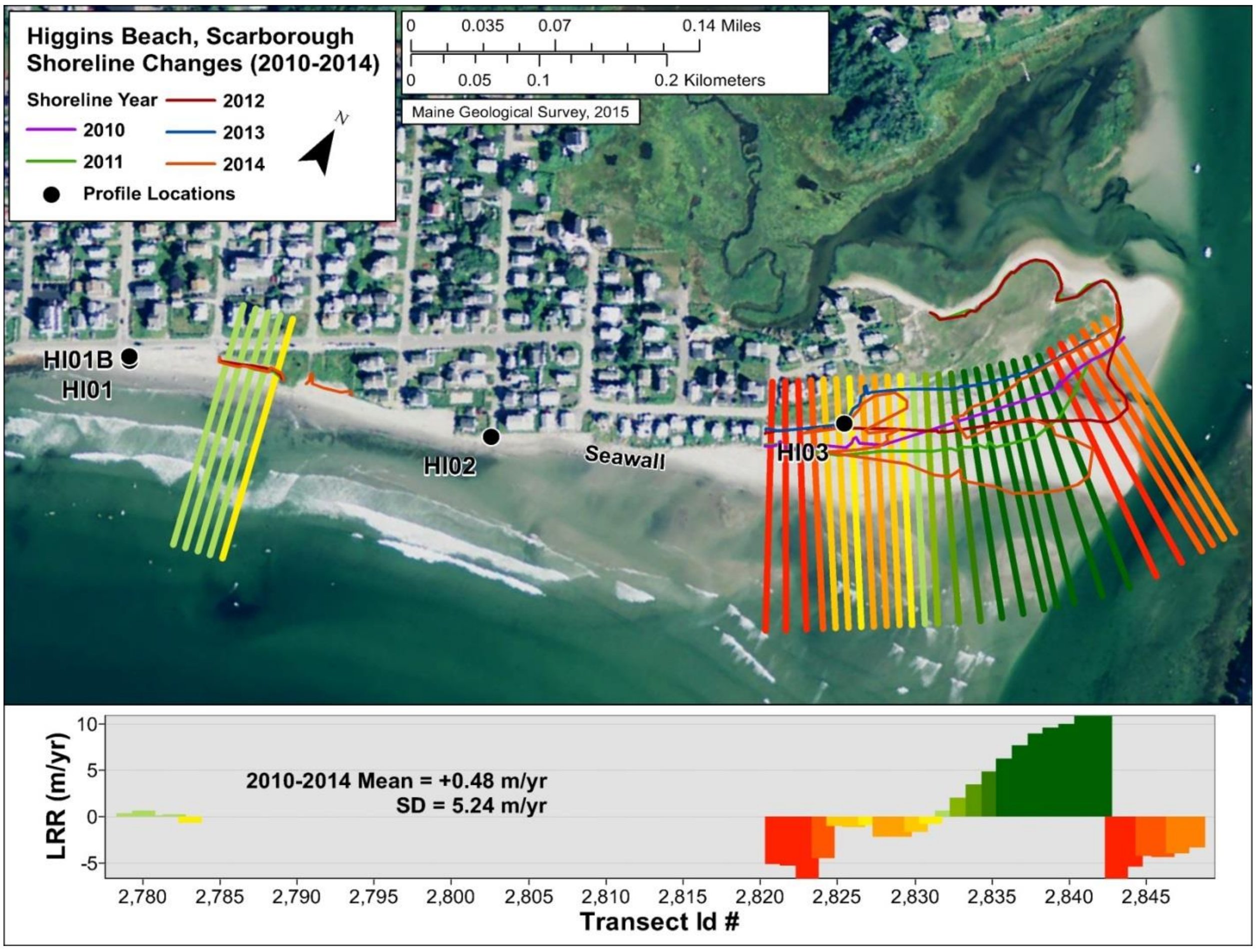

Figure 107. MBMAP data showing shoreline changes along the eastern end of Higgins Beach, Scarborough, nearest the Spurwink River. 2013 base imagery from Maine OGIS.

Crescent Beach, Cape Elizabeth

Crescent Beach is not part of the SMBPP.

Crescent Beach MBMAP Results

Crescent Beach is an approximate 1.3 km long pocket beach at Crescent Beach State Park. MBMAP data was available from 2010 to 2014 (Figure 108). **In general, the western and eastern thirds of the beach were slightly erosive, while the central portion accreted**. Dunes were generally stable at the western corner of the beach, from transects 2850 to 2870. The trend was slightly erosive from transects 2870 to 2912, with an average shoreline change rate of – 0.4 m/yr, and a high of –0.9 m/yr. East of this, from transects 2913 to 2955, the dunes built seaward at +1.2 m/yr and up to +2 m/yr. Some of these shifts are due to the migration and instability of two small streams along the beach. East of this, the dunes eroded slightly, at an average rate of -0.3 m/yr. Even though these distinct sections of erosion and accretion were noted, the **overall, the beach was stable (to slightly accretive) from 2010 to 2014, with an average rate of +0.19 m/yr**.

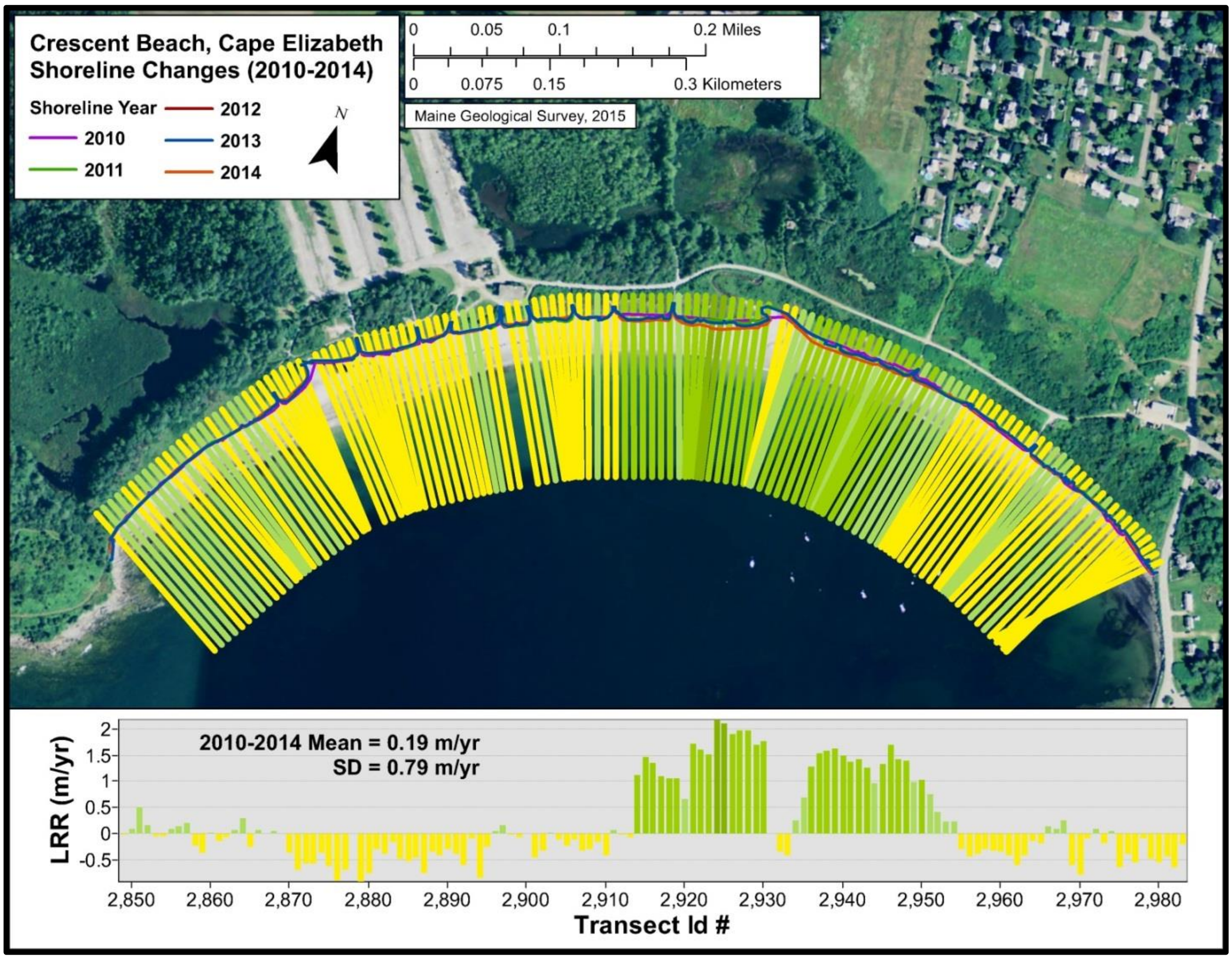

Figure 108. MBMAP data showing shoreline changes along Crescent Beach, Cape Elizabeth. 2013 base imagery from Maine OGIS.

Kettle Cove, Cape Elizabeth

Kettle Cove is not part of the SMBPP.

Kettle Cove MBMAP Results

Kettle Cove is a small pocket beach just to the southeast of Crescent Beach (Figure 109). MBMAP data was available from 2010 to 2014. The shoreline was generally accretive at either end, with slight erosion in the central portion, near a small stream that drains from the freshwater wetland behind the beach. The average shoreline change rate was **+0.19 m/yr, indicating a stable (to slightly accretive) trend from 2010 to 2014**.

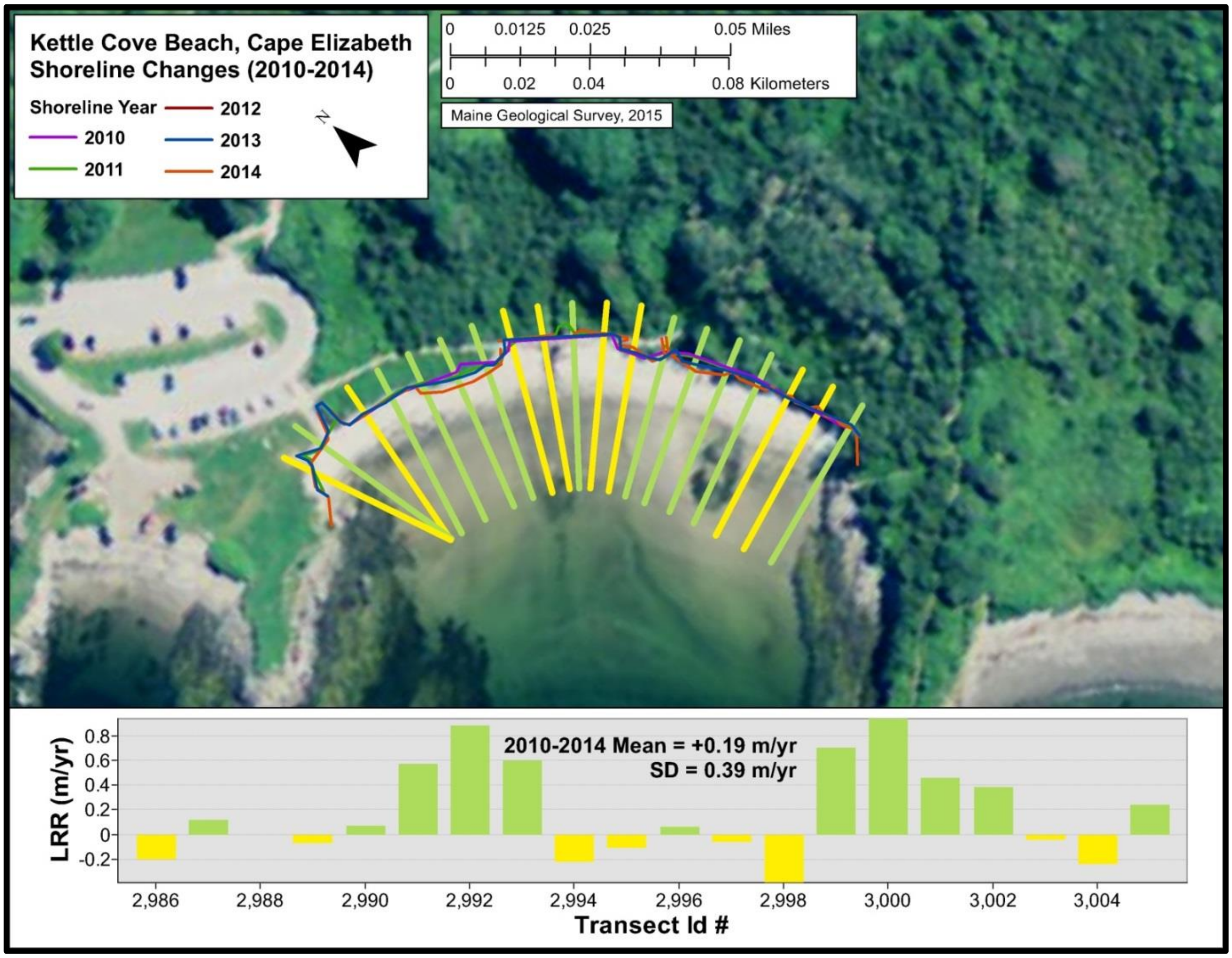

Figure 109. MBMAP data showing shoreline changes along Kettle Cove, Cape Elizabeth. 2013 base imagery from Maine OGIS.

Willard Beach, South Portland

Willard Beach is not included in the SMBPP.

Willard Beach MBMAP Results

Willard Beach is a small pocket beach in South Portland. MBMAP data was available from 2010 to 2014 (Figure 110). Overall, the dunes **were somewhat accretive, with an average shoreline change rate of +0.6 m/yr**. Aside from 2 transects, the entire dune has shown slight to high accretion rates, with some of the highest rates in excess of +2 m/yr. **Willard Beach is proving to have one of the most stable dune systems, and much of this has to do with the restoration and management efforts undertaken by the community**.

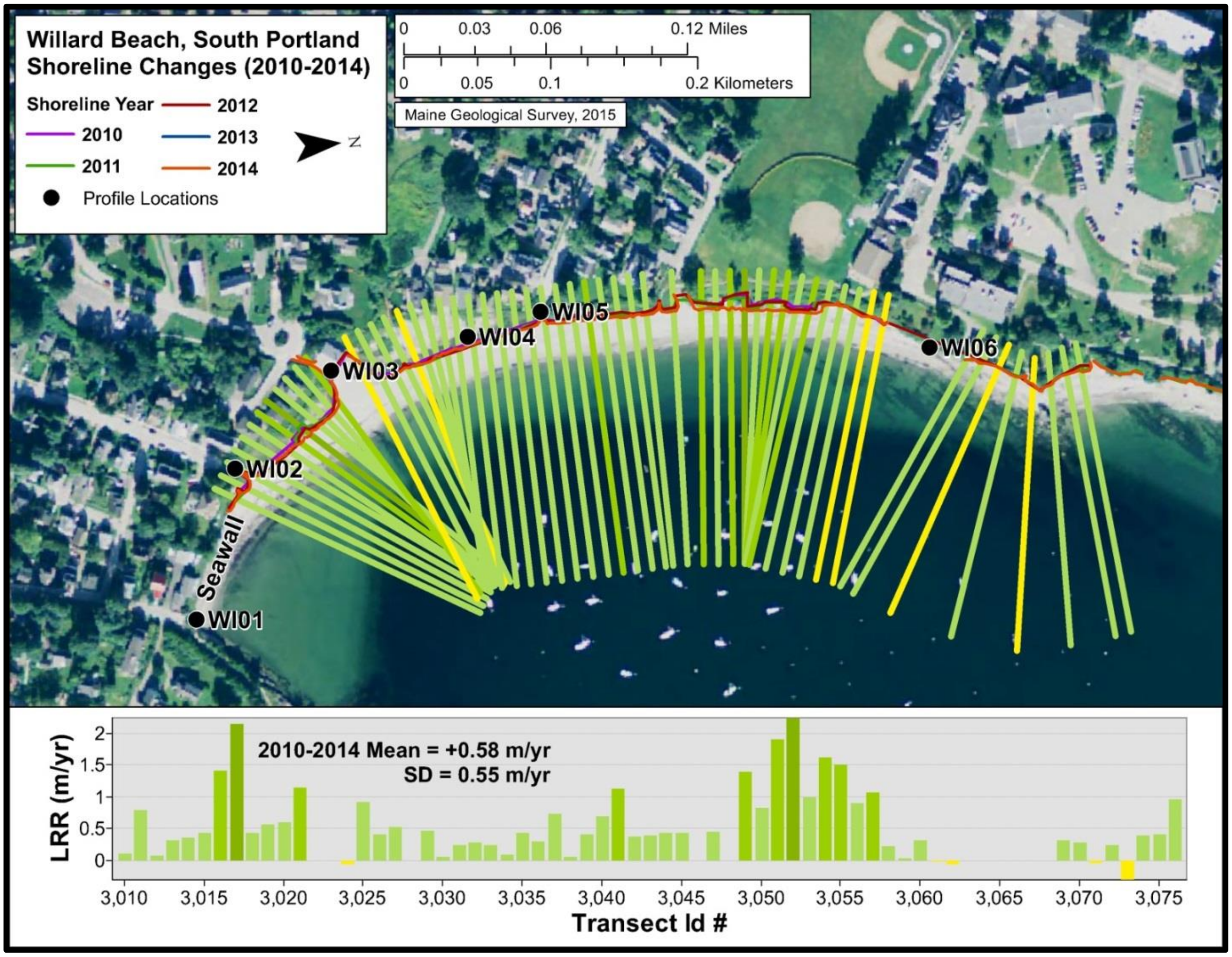

Figure 110. MBMAP data showing shoreline changes along Willard Beach, South Portland. 2013 base imagery from Maine OGIS.

Small Point Beach, Phippsburg

Small Point Beach is not included in the SMBPP.

Small Point Beach MBMAP Results

Small Point Beach is a barrier spit beach that extends southwest from a bedrock headland. The beach is in a natural state, with extensive sand dunes (Figure 111). MBMAP data was available from 2011, 2012, and 2014. From southwest to northeast, the dunes grew at about + 1.7 m/yr (transects 3111 to 3119), with a small stretch of an erosive area to the east where the dunes receded on average at -0.7 m/yr, from transects 3120 to 3132. East of this, the dunes were accretive, growing seaward at an average rate of +0.8 m/yr (transects 3133 to 3262). There is a small stretch of headland where no dune exists. Immediately east of this, there was a stretch of dunes (transects 3275 to 3296) that eroded at an average rate of -1.6 m/yr. The portion of the beach closest to the Morse River had some of the state's highest accretion rates, with an average of +8.35 m/yr, and some values up to and exceeding +15 m/yr. This area had some of the highest dune growth rates of all measured beaches. **Besides a few small pockets, Small Point Beach was highly accretive from 2010 to 2014, with an average rate of +1.71 m/yr**.

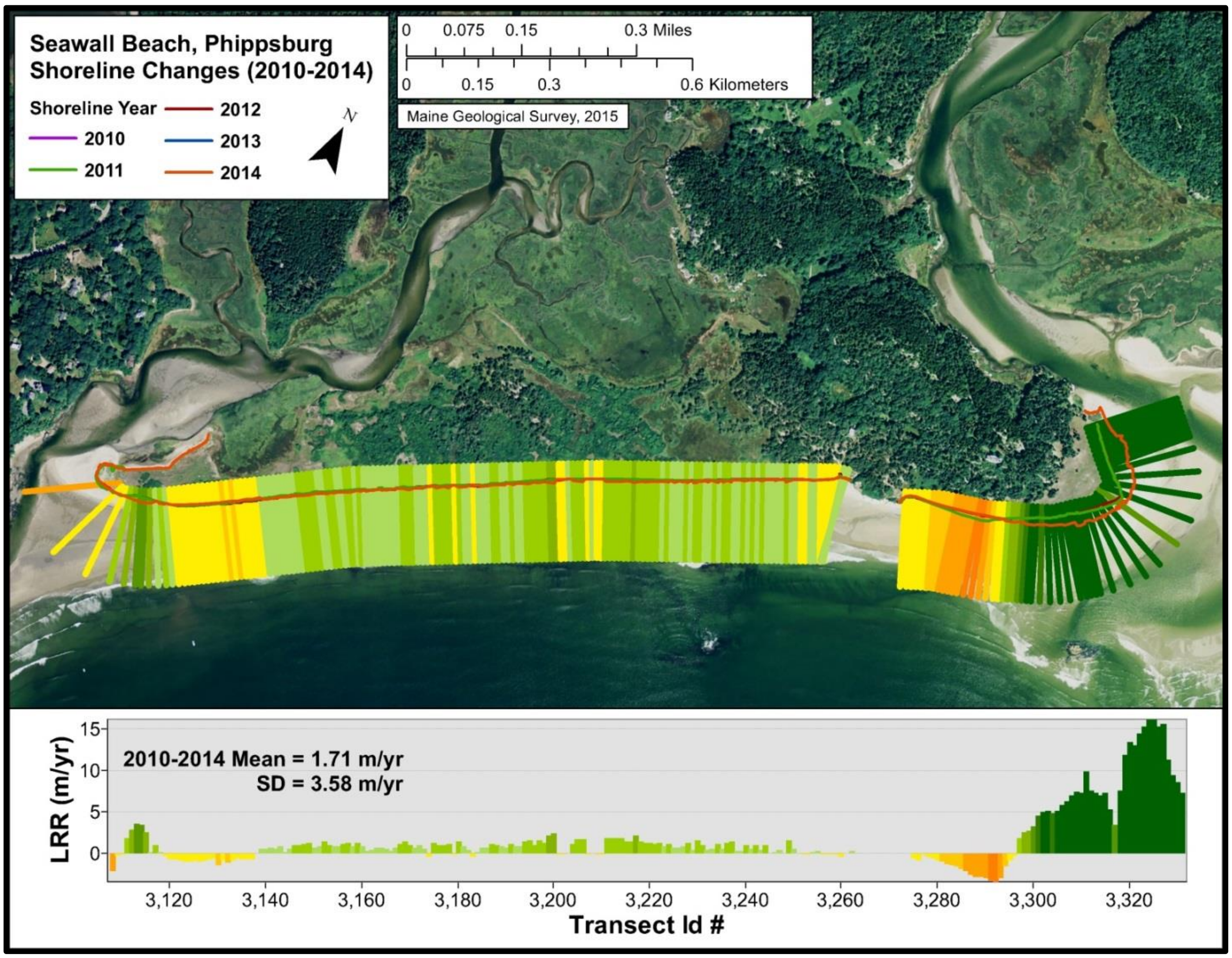

Figure 111. MBMAP data showing shoreline changes along Small Point Beach, Phippsburg. 2013 base imagery from Maine OGIS.

Popham Beach Complex Beaches, Phippsburg

The beaches along the Popham Beach Complex are not included in the SMPP.

Popham Beach MBMAP Results

Popham Beach is a large beach system complex, stretching from the mouth of the Morse River to the west, east-northeast and curving to the north, inside the mouth of the Kennebec River. From west to east, it is comprised of Popham Beach State Park, Hunnewell Beach, and Coast Guard Beach. Aside from a small seawalled area, the majority of the beach is vegetated and surveyed as part of MBMAP (Figure 112). Starting at its western end (along the Morse River), the dunes were stable or grew seaward at about +0.3 m/yr (transects 3336 to 3365). East of this is an area where not enough data was collected to calculate shoreline change rates due to GPS signal loss. The shoreline east of this, along Popham Beach State Park (transects 3393 to 3450) had variable shoreline changes, with a pocket of highly erosive shoreline from transects 3419 to 3429 where the dune eroded at up to -5 m/yr. Farther east, at the tombolo that stretches out to Fox Island, the dune accreted at rates of up to +5 m/yr. The mean for this overall stretch of Popham Beach State Park was +0.06 m/yr, indicating an overall stable beach system, even though there are large variations. Just around the corner of the beach to the northeast, along Hunnewell Beach and around to the mouth of the Kennebec River (transects 3470 to 3640) the shoreline was **extremely erosive**, with an average shoreline change rate of -3.7 m/yr with several transects in the -5 m/yr to -10 m/yr range. This was one of the most erosive areas of all measured beaches. North of this, along southern Coast Guard Beach (transects 3641 to 3703), the shoreline heavily accreted, with an **average rate of +4.4 m/yr**. The final stretch of shoreline, stretching up to Ft. Popham, eroded slightly, with an average rate of – 0.5 m/yr. Coast Guard Beach had an average of +2.6 m/yr. **Overall, the Popham Beach shoreline was erosive, with an average shoreline change rate of -0.79 m/yr**.

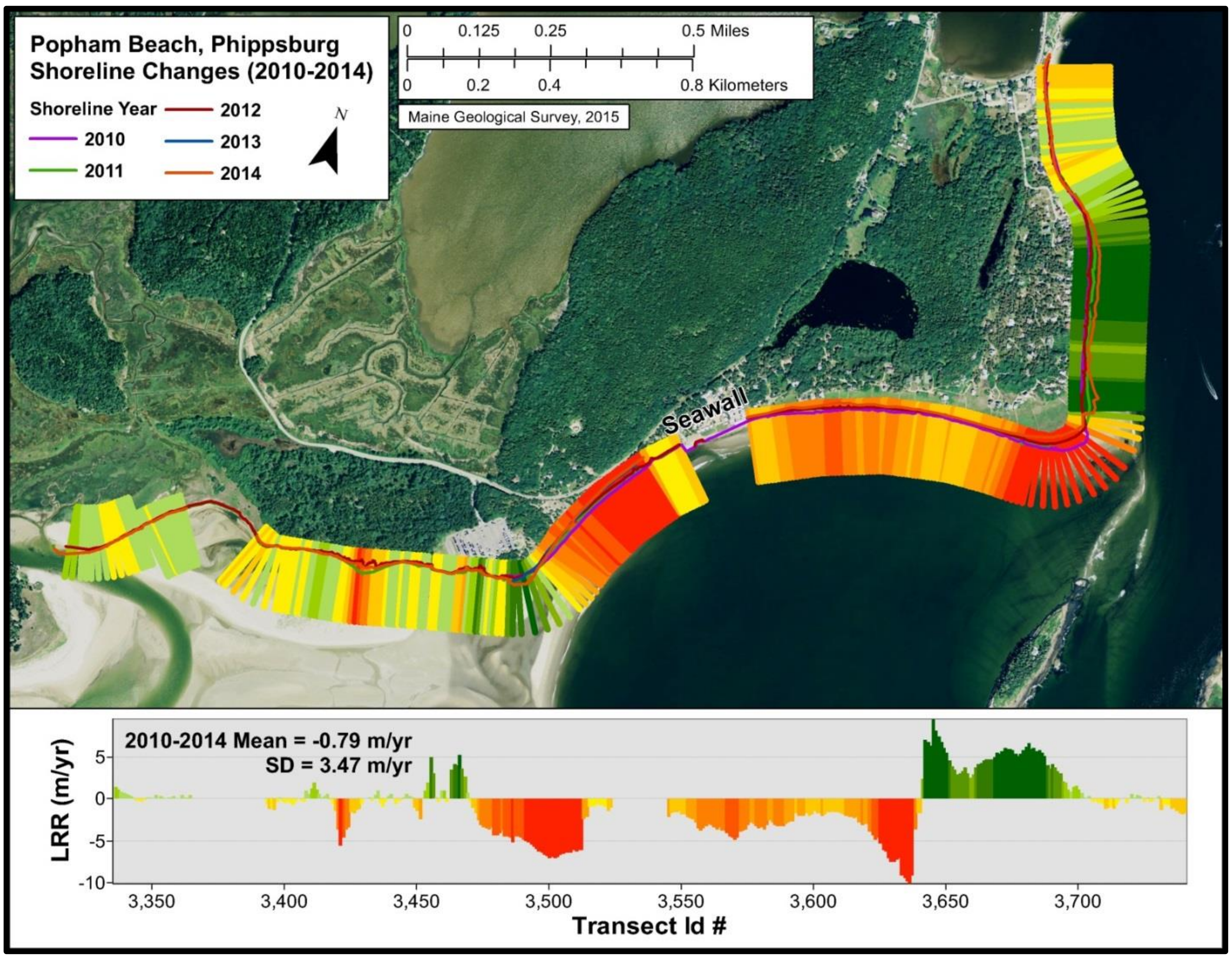

Figure 112. MBMAP data showing shoreline changes along the beaches comprising the Popham Beach complex in Phippsburg. 2013 base imagery from Maine OGIS.

Reid State Park Beaches, Georgetown

The beaches along Reid State Park are not included in the SMBPP.

Reid State Park Beach MBMAP Results

Reid State Park has two beaches that were surveyed as part of MBMAP – Half-Mile Beach (to the west) and Mile-Stretch Beach (to the east). Data was available from 2010 to 2012, and 2014 (Figure 113). At Half-Mile Beach, adjacent to the Little River, two distinct stretches of shoreline change trends were noted. From the river northeast to transect 3802, the shoreline accreted at rates of +1 to +2 m/yr. East of this, the shoreline was stable to slightly erosive, with an average rate of -0.1 m/yr, but pockets of up to -0.5 m/yr. **The overall average for Half-Mile Beach was +0.40 m/yr**. East of the Todds Point headland, Mile Stretch Beach dominantly accreted, with the highest accretion (rates of between +1 and +1.5 m/yr) between transects 3685 and 3912. To the east, the dunes accreted slightly less, and had pockets of erosion until Griffiths Head. **The overall average for Mile Stretch Beach was +0.76 m/yr**. Overall, the shoreline changed at a rate of **+0.64 m/yr, indicating a somewhat accretive trend from 2010 to 2014**.

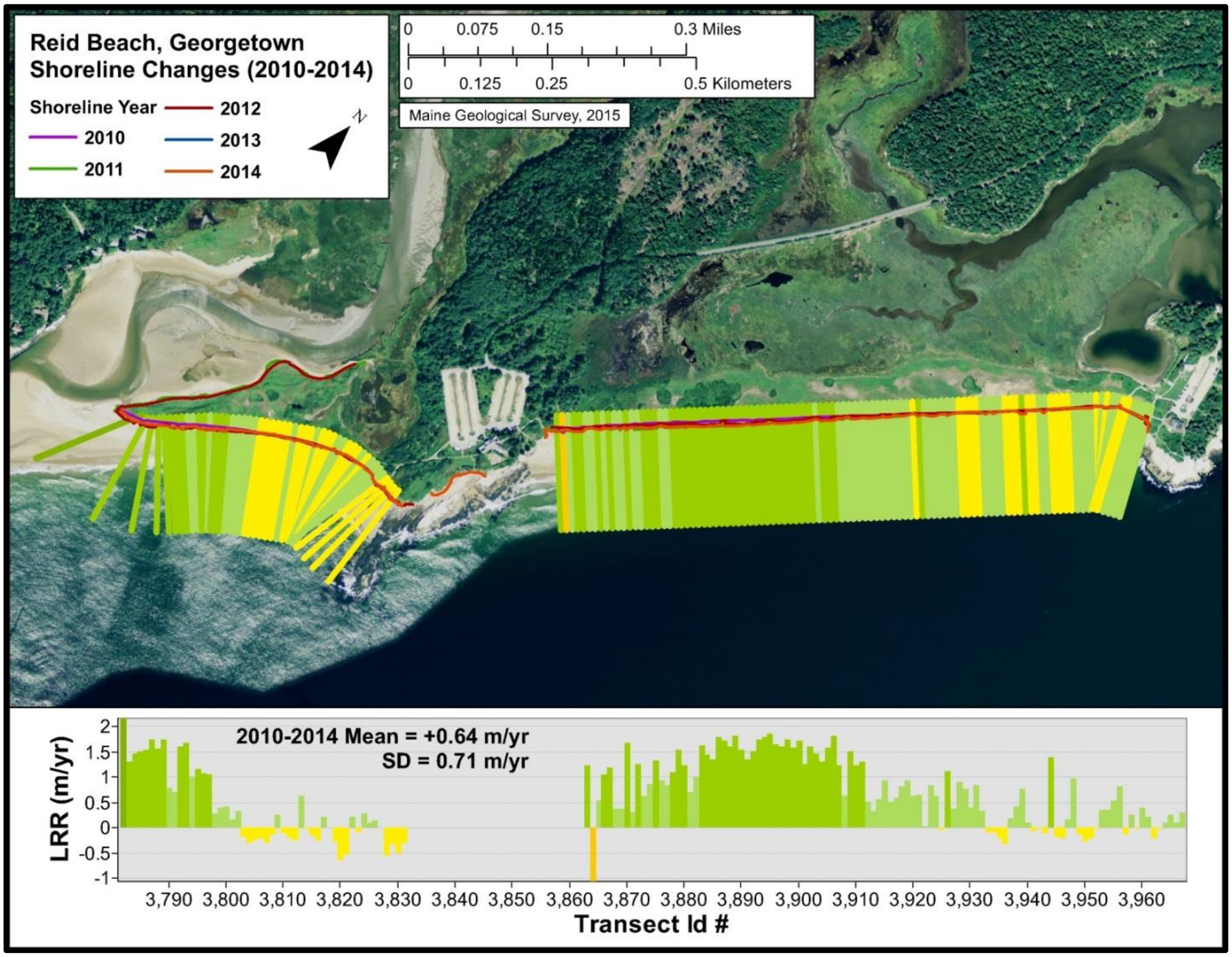

Figure 113. MBMAP data showing shoreline changes along Reid State Park beaches, Georgetown. 2013 base imagery from Maine OGIS.

Discussion of State of Maine Beach Profiling Project (SMBPP) Results

Overview of the Grading System

The first edition of the Maine Beaches Report (Slovinsky and Dickson, 2007) characterized beach profiles using quantitative, statistical techniques. Since then, the 2009, 2011, and 2013 reports (Slovinsky et al., 2013; Slovinsky and Dickson, 2011; 2009) used a lettered grading system and matching color coded system to provide a *qualitative* overview of the overall status of the beaches. Each beach was "scored" using a number and letter grade, with a corresponding color-coded system outlined in the beginning of this report: green, A or B; yellow, C; red, D or F. These grades were averaged for winter profiles, summer profiles, and overall (all) profiles for each beach system. Based on feedback from volunteers and conference attendees, this type of system was a better way of communicating beach changes than quantitative statistical methods.

The 2015 report used a similar system, but used 2010 beach profiles from April (for winter) and August (for summer) as the "starting point" for comparison with subsequent data from 2011 to 2015. This scoring system was first shown in Table 2, and is revisited in Table 3 on the following page for ease of review.

In doing the grading for this time period, one cannot simply compare a 2010 profile with a 2015 profile and determine whether or not a beach grew, eroded, or stayed stable. In some cases, 2010 was not the worst shape for a profile, but was instead 2011 or 2013. In other cases, a beach may have built back from a 2010 shape through 2012, but then eroded heavily in 2013, and recovered slightly in 2014 or 2015. *All of these subtle changes would be lost if only comparing a starting profile from 2010 and an ending profile in 2014 or 2015. Thus, profiles from each year were compared in determining the grade for a profile*.

Of course, one of the limitations of using "snapshots" in time (roughly the same month from each year, as is the case in this report) the analysis may miss, or overly weigh, a certain profile shape that was influenced by an event immediately preceding the recording of the beach profile, when a month later, the profile may show full recovery (or erosion). As much as possible, we confirmed trends using additional data not displayed in this report. However, this is something that is unavoidable unless all monthly profiles are displayed, which would be overwhelming.

It's also very important to note that in the grading system used, a score of a "C" is not necessarily considered to be "average", but should be considered "satisfactory". Thus, a beach that was relatively stable from 2010 to 2015, which is good, may have scored a C *because it did not show erosion, and it did not show growth*. Similarly, a beach that grew over a few years, but then eroded in the past year or two (or underwent a massive erosive event in one year) could have also scored a C, since C is also listed as satisfactory but cautionary. Using this scoring system, generally, beaches that have grown in consecutive years generally scored an A or a B, depending on the amount of growth. Beaches that have eroded in consecutive years generally scored a D or an F, depending on the amount of erosion.

Based on observations of profiles and from the field, the winters of 2010 and 2013 generally had some of the most erosive profile shapes of all years. At many locations, beaches were eroded down to historic erosional surfaces. For example, large peat deposits or old tree root systems were exposed at Higgins Beach, Goochs Beach, Laudholm Beach, and Ogunquit Beach.

2015 Report Results

The overall results for beaches profiled as part of the SMBPP from the 2015 report are presented in Table 4. This table shows the averaged winter, summer, and overall score results from for each profiled beach, from south to north. The table also summarizes important notes from each beach in terms of the overall trends observed.

Based on overall averaged scores from 2010 to 2015, the beaches had an overall grade of a C (76). However, only 2 beaches (16.5%) had green (A or B) scores, while 8 beaches (67%) had yellow (C) scores, and 2 beaches (16.5%) had red (D or F) scores. **As reflected by the overall grade, the majority of beaches were satisfactory (but cautionary).**

Overall, winter profiles from 2010 to 2015 had an average grade of a C (75). No beaches had green (A or B) scores, while 10 beaches (91%) had yellow (C) scores, and only 1 beach had a red (D or F) score.

Overall, the summer profiles from 2010 to 2014 had an average grade of a C (76), faring slightly better than winter shapes. This was reflected by the breakdown of scores: 3 beaches (27%) had green (A or B) scores, while 6 beaches (55%) had yellow (C) scores, and 2 beaches (18%) had red (D or F) scores.

It is not surprising that more beaches had lower scores during the winter than the summer; in fact, this is expected. This tells us that the winter storms that we have been seeing are negatively impacting beaches more, but the beaches have been showing an ability to recover during the summer to still have somewhat stable shapes and scores.

One trend we noted that is of concern is that although many of the profiles had **dunes that remained stable or grew**, many of these same profiles saw continued **erosion of the beach and berm**.

Grade	Numerical Score	SMBPP Score Description
A	95	**Excellent** (profile shows excellent recovery since 2010 with continued accretion and growth)
B	85	**Very Good** (profile shows very good recovery since 2010 with growth and stability)
C	75	**Satisfactory but Cautionary** (profile shows some growth or stability, but may have one or two years of erosion since 2010)
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)
F	55	**Fail** (profile shows no recovery since 2010, with extensive, continued erosion)
Note: scores can have a + or - which will add or subtract 3 points		

Table 3. SMBPP scoring system used to analyze profile responses from 2010 to 2015.

Beach	Municipality	SMBPP Scoring			Notable Trend Observed	Associated Figure, Page
		Winter	Summer	Overall		
Long Sands	York	79	84	81	2012 or 2014/15 were best years; 2010 and 2013, worst. Profiles showed good recovery and stability.	9-12, p. 19-20
Ogunquit	Ogunquit	72	75	74	Good recovery from 2010 lows to a 2013 high, but general dune erosion in the past year or two.	15-17, p. 23-24
Wells	Wells	75	73	74	General erosion from 2010 to 2013, with recovery in 2014 and 2015, but dune erosion at northern end.	20-27, p. 28-31
Laudholm	Wells	65	65	65	Since 2010, continued erosion, with losses of both dunes and berms, worst nearest Little River.	31-38, p. 36-39
Goochs	Kennebunk	75	80	79	Highly variable, especially at west end of beach; 2013 and 2010 worst years and 2014 or 2015 the best; Middle Beach was most stable.	41-48, p. 43-46
Goose Rocks	Kennebunkport	79	79	78	Highly variable due to swash bars, but winter growth at Batson and especially Little Rivers, relatively stable at GR02. GR03 scored best overall.	51-58, p. 50-53
Ferry Beach	Saco	70	68	69	Generally, continued erosion of berms and dunes since 2010.	63-70, p. 59-62
Kinney Shores	Saco	79	75	77	Slight erosion to the south and more stable to north. Slight losses of seasonal berms, but stable dunes.	71-75, p. 64-66
West Grand	Old Orchard	-	-	78	Dune growth but highly variable and slightly eroding berms and beaches.	78-81, p. 70-71
East Grand	Old Orchard	77	77	77	Healthy dune growth and transgression, but berm and beach losses.	84-87, p. 75-76
Scarborough	Scarborough	78	83	80	Better growth and stability of berms north of access path. Relatively stable dunes.	91-98, p. 81-84
Higgins	Scarborough	77	72	75	Good recovery at HI01 and HI02 from 2010, but currently highly erosive trend near Spurwink River.	101-106, p. 88-90
Averages		**75**	**76**	**76**	**Overall, summer profiles scored slightly better. Some dune erosion, but berm and beach erosion is common concern.**	
- Not enough data to compute						

Table 4. Comparison of the winter, summer, and overall scores from the beaches surveyed as part of SMBPP, with notable trends observed, and associated figures. Of note is that many of the profiles showed erosion of berms and beaches, but stable or growing dunes.

Discussion of Maine Beach Mapping Program (MBMAP) Results

Overview of the Grading System

The 2015 Beaches Report included analysis of MBMAP vegetation shoreline position data collected from summer/fall 2010 to 2014, as data were available. Data were collected at all 12 SMBPP profiled beaches, and at additional beaches as detailed in Table 1.

It's important to note that MBMAP shoreline change data documented the *changes in the seaward extent of the vegetation line* along the surveyed beach. This technique only captures the changes in the dune, either seaward growth or landward erosion. Since SMBPP data collects topographic transects across the beach, including the berm and the beach, and is scored on overall changes (not at just the dune), analysis of MBMAP data may show slightly different trends or scores than SMBPP data.

The scoring system used for analysis of MBMAP data followed the protocol outlined in Table 5. Generally, if a system was very highly accretive, it scored an A (95); accretive, it scored a B (85); stable, it scored a C (75); erosive, a D (65); and very highly erosive, an F (55). Scores could have a plus (+) or minus (-), which added or subtracted three points to the numerical score, respectively.

Using this system, a grade of a C- was assigned if a dune was slightly erosive (rates between -0.5 m/yr and -0.25 m/yr); a C was assigned if a dune was relatively stable (rates between -0.25 m/yr and +0.25 m/yr); and a C+ assigned if a dune was slightly accretive (rates between +0.25 m/yr and +0.5 m/yr). **Thus, a score of a C or better was considered a positive result**.

2015 Report Results

Overall results from MBMAP analysis is presented in two parts in Table 6, on pages 97 to 98. This table summarizes averaged scores, notable trends, and where associated figures can be found for each surveyed beach. There were a total of 33 different beaches surveyed as part of MBMAP. Note that some "beaches" were divided into sections. For example, Popham Beach was divided into four different sections (from east to west, Morse River, State Park, Hunnewell Beach, and Coast Guard Beach).

Of the 33 beaches surveyed, 8 beaches (24%) were relatively stable, while an additional 8 beaches (24%) were slightly accretive. Nine beaches (27%) were somewhat accretive to extremely accretive. This left only 25% of the beaches that were slightly erosive to extremely erosive. **Thus, 75% of the surveyed beaches had dunes that were either stable or growing from 2010 to 2014. This is a positive trend. The overall average shoreline change rate for all beaches surveyed was +0.22 m/yr, indicating a relatively stable with a slightly positive or growing trend from 2010 to 2014**.

Grade	Numerical Score	MBMAP Score Description
A	95	Extremely Accretive (+), Very Highly Accretive, Highly Accretive (-) (LRR > 1.25 m/yr)
B	85	Very Accretive (+), Accretive, Somewhat Accretive (-) (1.25 m/yr > = LRR > 0.5 m/yr)
C	75	Slightly Accretive (+), Relatively Stable, or Slightly Erosive (-) (0.5 m/yr >= LRR >= -0.5 m/yr)
D	65	Somewhat Erosive (+), Erosive, Very Erosive (-) (-0.5 m/yr > LRR >= -1.25 m/yr
F	55	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 5. Scoring system used for analysis of MBMAP survey data from 2010 to 2014.

Beach	Municipality	MBMAP Description	MBMAP Scores	Notable Trends Observed	Associated Figure, Page
Crescent	Kittery	relatively stable (-0.09 m/yr)	75	Slightly accretive to accretive east end, erosive central section.	6, p. 16
Seapoint	Kittery	slightly erosive (-0.31 m/yr)	72	Slightly erosive to erosive with small accretive section at central section.	7, p. 17
Long Sands	York	slightly accretive (+0.29 m/yr)	78	Slightly accretive to accretive with pockets of erosion.	13, p. 121
Ogunquit	Ogunquit	relatively stable (-0.05 m/yr)	75	Slightly erosive to erosive at south and north ends, with accretive to highly accretive central section.	18, p. 25
Wells	Wells	relatively stable (-0.18 m/yr)	75	Slightly accretive to accretive at southern end of beach, slightly erosive to highly erosive northern end of beach near Webhannet River.	28, p. 32
Drakes Island	Wells	relatively stable (-0.05 m/yr)	75	Majority slightly erosive with small pockets of slightly accretive areas.	29, p. 33
Laudholm	Wells	very erosive (-1.19 m/yr)	62	Slightly erosive southern end to extremely erosive central and northern sections near the Little River.	39, p. 40
Goochs	Kennebunk	somewhat erosive (-0.54 m/yr)	68	Erosive to highly erosive near the Kennebunk River jetty.	49, p. 47
Goose Rocks	Kennebunkport	slightly accretive (+0.40 m/yr)	78	Extremely erosive near the Batson River and a small pocket of slight erosion east of seawall. Rest of measured beach was accretive to highly accretive.	59, p. 54
Fortunes Rocks	Biddeford	accretive (+0.78 m/yr)	85	Accretive to highly accretive except a few small pockets next to seawalls.	60, p. 55
Hills	Biddeford	slightly accretive (+0.30 m/yr)	78	Accretive in the east, erosive just east of the seawall, and then accretive to highly accretive to slightly erosive near the Saco River jetties.	61, p. 56
Camp Ellis	Saco	extremely erosive (-2.03 m/yr)	55	Extremely erosive near the geotubes, then erosive.	76, p. 67
Ferry Beach	Saco	very erosive (-1.20 m/yr)	62	Slightly erosive in the south, becoming erosive to highly erosive in middle of beach, to slightly erosive at the northern end of the beach near the seawall.	76, p. 67
Bayview	Saco	slightly erosive (-0.30 m/yr)	72	Adjacent to the seawall, slightly accretive to erosive.	76, p. 67
Kinney Shores	Saco	slightly accretive (+0.40 m/yr)	78	Slightly accretive to highly accretive at Goosefare Brook; pockets of erosion.	76, p. 67
Ocean Park	Old Orchard	slightly accretive (+0.47 m/yr)	78	Slightly erosive in the south, near Goosefare Brook, becoming slightly accretive to accretive closer to West Grand Beach.	82, p. 72
West Grand	Old Orchard	slightly accretive (+0.28 m/yr)	78	From near the beach profiles, accretive to highly accretive northwards to the pier, with small pockets of erosion.	82, p. 72
East Grand	Old Orchard	accretive (+0.96 m/yr)	88	From the pier, accretive to highly accretive along the entire shoreline until adjacent to the seawall, where it becomes erosive.	82, p. 72
East Grand Pine Point	Old Orchard Scarborough	accretive (+0.91 m/yr)	88	Accretive to highly accretive until south of Hurd Park lot, where it becomes slightly erosive. After an accretive section, erosive to highly erosive, then accretive to highly accretive near Scarborough River jetty.	88, p. 77
Ferry	Scarborough	relatively stable (+0.24 m/yr)	75	From north to south, slightly accretive at the northern end of Ferry Beach, to slightly erosive, then to slightly accretive until the day marker.	89, p. 78
Western	Scarborough	highly erosive (-1.34 m/yr)	58	Highly accretive around the point, then extremely highly erosive to erosive along the remainder of Western Beach with a small pocket of accretion.	89, p. 78

Table 6. Comparison of the overall shoreline change rates, based on vegetation line surveys, from the 2010 to 2014. Note that the table continues on the following page for the remaining beaches.

Beach	Municipality	MBMAP Description	MBMAP Scores	Notable Trends Observed	Associated Figure, Page
Scarborough	Scarborough	somewhat accretive (+0.69 m/yr)	82	Slightly erosive adjacent to seawall, then accretive to highly accretive to park path. Accretive to very highly accretive until past 2 homes; becoming slightly erosive to erosive, then accretive at the eastern end of the beach.	99, p. 85
Higgins	Scarborough	slightly accretive (+0.48 m/yr)	78	Small pocket of dune east of HI01 was slightly accretive. At seawall near HI03, extremely erosive to extremely accretive due to swash bar and dune buildup. Becoming extremely erosive to erosive closest to Spurwink River.	107, p. 91
Crescent	Cape Elizabeth	relatively stable (+0.19 m/yr)	75	Slightly accretive at west end to slightly erosive along the beach in front of park facilities, to accretive to highly accretive until the eastern quarter of the beach, where it was slightly erosive.	108, p. 92
Kettle Cove	Cape Elizabeth	relatively stable (+0.19 m/yr)	75	Alternating pockets of slight erosion to slight accretion and accretion. Highest erosion centrally located at bridge.	109, p. 93
Willard	South Portland	somewhat accretive (+0.58 m/yr)	82	Dominantly accretive to highly accretive, with a small pocket of little change to slightly erosive adjacent to SMCC headlands.	110, p. 94
Small Point	Phippsburg	extremely accretive (+1.71 m/yr)	98	Accretive to highly accretive at spit, with a section of slightly erosive dune, becoming accretive to highly accretive to headland. North of headland, erosive to highly erosive, becoming extremely accretive at Morse River.	111, p. 95
Popham - Morse River	Phippsburg	slightly accretive (+0.30 m/yr)	78	Nearest the Morse River, slightly accretive to slightly erosive.	112, p. 92
Popham - State Park	Phippsburg	relatively stable (+0.06 m/yr)	75	Highly erosive to extremely highly erosive along forested bluff and along the bathhouse, but at Fox Island salient, becoming extremely highly accretive.	112, p. 96
Popham - Hunnewell	Phippsburg	extremely erosive (-3.70 m/yr)	52	Extremely erosive along beach and around the mouth of the Kennebec River.	112, p. 96
Popham - Coast Guard	Phippsburg	extremely accretive (+2.62 m/yr)	98	Highly accretive; section of slightly erosive to erosive near Fort Popham.	112, p. 96
Reid - Half Mile	Georgetown	somewhat accretive (+0.64 m/yr)	82	Extremely accretive near the river to slightly erosive near Todds Point.	113, p. 97
Reid - Mile Stretch	Georgetown	accretive (+0.76 m/yr)	85	Extremely accretive to highly accretive along majority of beach, then pockets of slight erosion and accretion to Griffith's Head.	113, p. 97
Average (for all beaches combined)		**relatively stable (+0.22 m/yr)**	**76**	**9 beaches (27%) were somewhat to extremely accretive. 18 beaches (55%) were stable to slightly erosive or accretive. 6 beaches (18%) were somewhat erosive to extremely erosive.**	

Table 6 (continued). Comparison of the overall shoreline change rates, based on vegetation line surveys, from the 2010 to 2014.

MBMAP Result Rankings

The 33 beaches surveyed as part of MBMAP were categorized from best to worst shoreline change rates and numerical scores, as shown in Table 7.

Based on this analysis, the three beaches with the best dune growth from 2010 to 2014 were Coast Guard Beach (Popham Beach, Phippsburg), Small Point Beach (Phippsburg), and East Grand Beach (Old Orchard Beach). The three beaches with the worst dune erosion were Western Beach (Scarborough), Camp Ellis Beach (Saco), and Hunnewell Beach (Popham Beach, Phippsburg).

As noted previously, using an averaged linear regression rate for a whole beach system does not reflect smaller patterns of erosion and accretion within a larger system. For example, the Coast Guard Beach section of Popham Beach had the highest positive shoreline change rate while the Hunnewell Beach section (just around the corner) had the highest negative shoreline change rate from 2010 to 2014. This reflects how dynamic smaller segments of beaches within an overall larger beach system can be. Hence, this is why we added a *notable trends* descriptive section to Table 6. This allows the variations within each larger system to be discussed, even though an overall shoreline change rate may indicate erosion or accretion.

Some of the beaches with accretive dune systems included Pine Point Beach in Scarborough (+0.91 m/yr), Fortunes Rocks Beach in Biddeford (+0.78 m/yr), and Mile Beach at Reid State Park (+0.76 m/yr).

On the other end of the spectrum were some very erosive dunes at Ferry Beach in Saco (-1.20 m/yr) and Laudholm Beach in Wells (-1.19 m/yr). These two areas have been consistently eroding over the past four years.

In the Saco Bay system, the dunes in the northern third of the bay (Pine Point to East Grand Beach) was accretive. Dunes in the middle third of the bay (West Grand Beach south to Kinney Shores) were slightly accretive. In the southern third of the bay (Ferry Beach to Camp Ellis), the dunes were very erosive to extremely erosive, respectively. This trend follows trends noted in previous editions of the beaches reports.

It is apparent that beach and dune systems adjacent to tidal inlets can undergo extremes in terms of accretion or erosion. For example, some of the highest mean erosion rates calculated for dunes occurred adjacent to tidal inlets, including Hunnewell Beach in Phippsburg, Camp Ellis Beach in Saco, Western Beach in Scarborough, and Laudholm Beach in Wells.

From 2010 to 2014, the highest erosion rates from all monitored beaches occurred adjacent to the Batson River (at Goose Rocks Beach, on the order of -10 m/yr or greater) and between Popham Beach State Park and Hunnewell Beach adjacent to the Morse and Kennebec Rivers (-5 m/yr or greater).

Conversely, some of the highest dune accretion rates also occurred directly adjacent to tidal inlets. At the eastern end of Small Point Beach in Phippsburg, adjacent to the Morse River, the dunes grew seaward on the order of +10 to +16 m/yr. Portions of Coast Guard Beach in Phippsburg, adjacent to the Kennebec River, grew at +8 to +10 m/yr, and the spit at the Spurwink River at Higgins Beach, Scarborough, grew at up to about +10 m/yr (while just to the west, dunes eroded at close to -4 to -6 m/yr).

These results truly show how dynamic tidal inlets can be in terms of influencing neighboring beach and dune stability. The trends reported in the 2015 edition of the beaches report may completely change as tidal inlets migrate in response to storms and sediment budgets.

The overall average MBMAP score for all surveyed beaches was a C (76), with an average shoreline change rate that was relatively stable, with a slightly positive trend (+0.22 m/yr). This overall score compares well with the overall averaged SMBPP grade (also a C, 76).

Continued MBMAP shoreline change monitoring of the dunes adjacent to inlets will help keep track of these dynamic areas. In addition, MBMAP data from all the beach systems provides a great snapshot of dune health, and also places the changes seen at individual beach profiles into the larger geomorphic context of changes to Maine's beaches over time

Rank	Beach	Municipality	MBMAP Description	Rate (m/yr)	Score
1	Popham - Coast Guard	Phippsburg	extremely accretive	2.62	98
2	Small Point	Phippsburg	extremely accretive	1.71	98
3	East Grand	Old Orchard	accretive	0.96	88
4	Pine Point	Scarborough	accretive	0.91	88
5	Fortunes Rocks	Biddeford	accretive	0.78	85
6	Reid - Mile Stretch	Georgetown	accretive	0.76	85
7	Scarborough	Scarborough	somewhat accretive	0.69	82
8	Reid - Half Mile	Georgetown	somewhat accretive	0.64	82
9	Willard	South Portland	somewhat accretive	0.58	82
10	Higgins	Scarborough	slightly accretive	0.48	78
11	Ocean Park	Old Orchard	slightly accretive	0.47	78
12	Goose Rocks	Kennebunkport	slightly accretive	0.40	78
13	Kinney Shores	Saco	slightly accretive	0.40	78
14	Popham - Morse River	Phippsburg	slightly accretive	0.30	78
15	Hills	Biddeford	slightly accretive	0.30	78
16	Long Sands	York	slightly accretive	0.29	78
17	West Grand	Old Orchard	slightly accretive	0.28	78
18	Ferry	Scarborough	relatively stable	0.24	75
19	Crescent	Cape Elizabeth	relatively stable	0.19	75
20	Kettle Cove	Cape Elizabeth	relatively stable	0.19	75
21	Popham - State Park	Phippsburg	relatively stable	0.06	75
22	Ogunquit	Ogunquit	relatively stable	-0.05	75
23	Drakes Island	Wells	relatively stable	-0.05	75
24	Crescent	Kittery	relatively stable	-0.09	75
25	Wells	Wells	relatively stable	-0.18	75
26	Bayview	Saco	slightly erosive	-0.30	72
27	Seapoint	Kittery	slightly erosive	-0.31	72
28	Goochs	Kennebunk	somewhat erosive	-0.54	68
29	Laudholm	Wells	very erosive	-1.19	62
30	Ferry Beach	Saco	very erosive	-1.20	62
31	Western	Scarborough	highly erosive	-1.34	58
32	Camp Ellis	Saco	extremely erosive	-2.03	55
33	Popham - Hunnewell	Phippsburg	extremely erosive	-3.70	52

Table 7. Ranking of the overall shoreline change rates for each beach from 2010 to 2014.

Discussion of Combined SMBPP and MBMAP Scoring Results

Scores from the different beach monitoring programs were combined in order to create a final, overall, score for each beach. We combined winter and summer profile scores with the MBMAP scores (where both were available), and created an average score for each location (Table 8). Where no SMBPP data was available (since only 12 of the 33 monitored beaches has SMBPP data), only MBMAP scores were used. If only MBMAP data was available, the actual shoreline change rates from Table 7 were compared to determine overall rankings.

Based on this combined approach, Table 8 lists the beaches in terms of highest to lowest overall scores. **Ten 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.

The top three highest scoring beaches were Coast Guard Beach (98), Small Point Beach (98), and Pine Point Beach (88). In descending order, the worst scoring beaches were Western Beach (58), Camp Ellis Beach (55), and Hunnewell Beach (52). Note that none of these included SMBPP datasets.

The top three highest scoring beaches that included both MBMAP and SMBPP scores were Scarborough Beach, Long Sands Beach, and East Grand Beach. In descending order, the worst three scoring beaches were Wells Beach (74), Ferry Beach in Saco (67), and Laudholm Beach (64).

When the scores from all beaches are combined and averaged, the overall score was a **C (76)**. This is consistent with the averages from just the SMBPP, and just from MBMAP**. These results indicate that beaches are in general undergoing satisfactory stability or recovery since 2010**.

By combining SMBPP and MBMAP datasets, we are able to cobble together a better picture of beach changes in not only larger geographic areas, but are able to better understand some of the different variations within beach cells in a larger system.

Monitoring both cross-shore profiles (which captures the shape of a dune, berm, and beach), and alongshore survey lines (which just captures the edge of the dune) allows for a more complete analysis of overall beach responses to storms and fluctuations in sea level rise.

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 8. Overall rankings of the beaches using combined SMBPP and MBMAP datasets, as available.

Discussion of Factors affecting the Health of Maine's Beaches

Since 2010, much attention has been given to "superstorms," Arctic cold, and sea-level rise "hotspots" in the northeast United States. In the last two State of Maine's Beaches reports (2011 and 2013), many beaches and dunes were showing signs of erosion, which caused concern in many municipalities. In this assessment we determined that 24 of 33 monitored beaches or 73% of Maine's beaches are showing trends of improving over the last 5 years (overall combined scores of 75, or a C, or greater, from Table 8). *This is a very positive trend considering what the beaches experienced from sea level and storms just 3-5 years ago*.

Influence of Storm Events

During periods of high waves, high storm tides, and coastal flooding, beaches and dunes can be severely eroded in a matter of days. Such major short-term events, like the largest storm in the last 5 years (on February 25, 2010 with waves over 30 feet, see Figure 4), left beaches eroded and very sand starved going into that summer and even beyond. Repeated storms (with waves of 25 feet, such as in the winter of 2012-2013, see Figure 5), left little time for beaches to regain sand before the next storm and also left beaches in an eroded state leading into the following summer. Conversely, winters with generally lower wave heights due to a lower number of storms (for example, 2011, 2012, and 2014) generally allowed beaches to recover.

Influence of Sea Level Rise

Since 2009, sea level in Portland has been 6 to 8 inches higher than the average for the last 100 years (Figure 2). From 2009 to 2010 "winter" sea level along the Maine beaches rose nearly 8 inches in one year (Figure 3). From a record high sea level in February 2010 to February 2015, sea level has returned to the around the 100-year average at the end of this assessment. This average, however, is still 3 inches higher than the 1912 average in Portland. Even a few inches of higher sea level can help storm tides exceed flood stage and allow surf higher into the dunes with greater frequency.

Influence of Tidal Inlets

In general, many of the beaches that fared the worst were influenced by adjacent tidal inlets and rivers, another compounding force that affects local sand budgets. For example, Laudholm Beach in Wells, adjacent to the Little River inlet, has consistently been one of the worst scoring beaches. At Goose Rocks Beach, though overall the beach scored well, the worst erosion of all beaches occurred at the dunes directly adjacent to the Batson River.
At the same time, some of the beaches with the highest rates of dune growth are also adjacent to tidal inlets. A good example of this was the eastern end of Small Point Beach in Phippsburg adjacent to the Morse River, and at Higgins Beach adjacent to the Spurwink River.

Tidal inlets and adjacent beach orientation can result in some of the highest erosion and accretion rates directly adjacent to one-another. This occurred at the Popham Beach Complex beaches at Hunnewell Beach, which was one of the most erosive sections of any beach, and adjacent Coast Guard Beach, which was one of the most accretive sections of beach reviewed in this report.

Other Influencing Factors

In the last two winter seasons (2013-2014 and 2014-2015) temperatures were unusually cold in the New England. As beach profile teams undoubtedly recall, the upper portion of the beach in the vicinity of the berm and into the dune was often frozen and buried in deep snow. While hard to quantify, it seems likely that these icy conditions may have helped reduce beach erosion on the upper profiles during the height of the winter storm season. The atmospheric pattern that produced cold conditions was also a deterrent to major storms (waves were below 25 feet; Figure 5) in the Gulf of Maine.

As shown in the data in this report, 73% of Maine's beaches are in satisfactory to good condition relative to the last 5 years. Most beaches did not experience similar trends overall. This is likely due to the orientation of the beaches and the types of storms they are most affected by (i.e., northeasters vs. southeasters). A great example of this is

Goose Rocks Beach and the orientation of the beach near the Little River inlet, where beach and dune growth has been documented during higher storm seasons (like the winter of 2013).

Portions of Goochs Beach, Wells Beach, and Western Beach also received beach nourishment in the second half of this assessment. Profiling at Goochs Beach likely captured the impact of 20,000 cy of sand coming ashore on the central section in 2015, a year after nearshore placement. Beach nourishment from Wells Harbor maintenance dredging placed approximately 50,000 cy of sand directly on the beach and resulted in a high 2014 winter and summer beach near Casino Point.

Taking all of these factors into account, the complexity of the "ups and downs" of the beach profiles and "back and forth" of the dune positions reflects, to the best of our understanding, the interplay of storms (surf and flooding), sea level changes, and frozen beaches. Persistent and unusually high sea levels and many significant storms with wave heights over 20 feet from 2009-2013 were, in combination, detrimental to Maine's beaches and dunes. Fortunately, the last two years of weaker storms and relatively lower sea levels and storm tides, combined with frozen beaches due to cold temperatures, have allowed some natural recovery and improved health for Maine's beaches and dunes.

Conclusions

The 2015 State of Maine's Beaches Report used beach profile data and vegetation line survey data to analyze beach and dune changes from 2010 to 2014 (or 2015). At the beginning of this report, we reviewed trends in storms and sea level rise during which data were collected – two major factors that influence the shape of the dunes and berms. Trends in mean sea level showed that between 2010 and 2015, sea levels rose to peaks 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 previous 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.

Based on this pattern of sea level changes and storms, we **expected that Maine's beaches and dunes would recover relatively well since 2010**. Analysis of available beach profile data from 2010 to 2014 (or 2015), in addition to surveyed vegetated dune data from 2010 to 2014 showed that:

- High sea levels, combined with a very active northeaster storm track in the winter of 2010 resulted in heavy erosion of many beaches. Late February 2010 had the largest storm between 2009 and 2015. Subsequently, at many locations, winter 2010 profiles were the most erosive in terms of beach, berm, and dune shapes.
- Some of the highest profile shapes – in terms of berms and dunes – occurred in 2011 or 2012, indicating that good recovery occurred from 2010 lows. Mean sea levels during this time, especially during winter, were generally lower than they were in the winter of 2010.
- During the winter of 2013, a series of strong northeast storms negatively impacted beach profiles and dunes. Combined with slightly higher than normal sea levels, this created erosive conditions. Many beach berms and dunes were eroded to, or in some cases, below winter 2010 elevations.
- The winter of 2014 had fewer storm events, and lower sea levels. This generally allowed for recovery of beach profiles and dunes. Some profiles had their highest elevations during this time.
- Although 2015 was characterized by many storms, intense cold and copious amounts of snow helped to stabilize beach berms and dunes. This, combined with the lowest mean sea levels over the past 5 years, allowed continued recovery at many beaches.
- Overall, 23 out of 33 beaches surveyed (70%) showed stability to growth from 2010 to 2015; 15% showed slight erosion, and only 15% showed continued or extensive erosion.
- Many beaches had dunes that were stable or grew from 2010 to 2015; however, at some of these same beaches, berms and beaches underwent erosion.
- For this report, the Maine beaches scored an overall mean **C (76) with a mean shoreline change rate of +0.22 m/yr**. Based on the way we have used the scoring systems for SMBPP and MBMAP data, we consider this to be a **positive result, indicating overall stability to slight growth from 2010 to 2015**.

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 volunteer monitors, is vital to better understanding monthly, seasonal, and yearly patterns of beach change. This data helps us 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.

Although the Maine Geological Survey does conduct annual shoreline surveys as part of the Maine Beach Mapping Program (MBMAP), we do not have the personnel or funding to support monthly beach profiling efforts. With the availability of the profiling data from the efforts of the volunteers and funded from local sources, we are able to utilize data that would simply not exist if not for the SMBPP.

As usual, analysis of summer 2015 profile data, from July or August, would help determine the latest trends in beach profile response to previous winters. Unfortunately, due to the timing of the Maine Beaches Conference in July 2015, we are unable to include summer 2015 profiles. Nevertheless, as of spring 2015, many Maine beaches were showing vigorous signs of dune vegetation growing seaward. We are optimistic that this positive trend will last through the summer.

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