



# *State of Maine's Beaches in 2009*

***Peter A. Slovinsky***

*Senior Geologist, Maine Geological Survey*

***Stephen M. Dickson***

*Marine Geologist, Maine Geological Survey*

Maine Geological Survey  
DEPARTMENT OF CONSERVATION  
Robert G. Marvinney, *State Geologist*

**Open-File 09-57**

2009



Financial assistance to initiate this program was provided by the National Oceanic and Atmospheric Administration's Maine Sea Grant Program through a pilot grant *Co-Management of Maine's Beaches through Volunteer Monitoring by Homeowners, Technical Evaluation by Scientists, and Annual State-of-Maine's-Beaches Meetings* to J. T. Kelley, S. M. Dickson, and D. F. Belknap from January 1999 - December 2000.

A publication of the Maine Geological Survey for the Maine Coastal Program/Maine State Planning Office pursuant to National Oceanic and Atmospheric Administration Award No. NA08NOS4190424.

This analysis was supported in part by the financial assistance provided by the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resources Management, National Oceanic and Atmospheric Administration.

*Cover photo by Mark Sladen, Kinney Shores, Saco, Maine.*

### **Acknowledgments**

We would like to take this opportunity to thank all the profile volunteers involved in this project. This report would be impossible without your efforts. The scientific understanding of the state of our beaches would be lessened without your diligent and sometimes heroic data collection throughout the year. We thank all of the groups and municipalities that, with Maine Sea Grant and the Maine Coastal Program have jointly funded the program in the last three years. We greatly appreciate the collaborative efforts of the Maine Sea Grant Program and Wells Estuarine Research Reserve that have coordinated profiling teams, conducted education and outreach programs, provided quality control on the data, and provided the Shore Stewards web site and database. We thank you all for a superb team effort - you have made this report possible.

# *Contents*

<b>Introduction</b> . . . . .	<b>1</b>
Spatial and temporal extent of data for 2009 report . . . . .	1
The 2007 Patriots' Day storm . . . . .	4
<b>Review of Beach Responses</b> . . . . .	<b>6</b>
Willard Beach, South Portland. . . . .	7
Higgins Beach, Scarborough . . . . .	11
Scarborough Beach, Scarborough . . . . .	15
Western Beach, Scarborough. . . . .	19
East Grand Beach, Scarborough . . . . .	23
Kinney Shores, Saco . . . . .	27
Ferry Beach, Saco . . . . .	30
Goose Rocks Beach, Kennebunkport. . . . .	34
Goochs Beach and Middle Beach, Kennebunk. . . . .	38
Laudholm Beach, Wells . . . . .	42
Drakes Island Beach, Wells. . . . .	46
Wells Beach, Wells. . . . .	50
Ogunquit Beach, Ogunquit . . . . .	54
Long Sands Beach, York . . . . .	58
<b>Beach Grading Summary and Discussion</b> . . . . .	<b>61</b>
<b>Conclusion</b> . . . . .	<b>63</b>
<b>References.</b> . . . . .	<b>64</b>



## *State of Maine's Beaches in 2009*

*Peter A. Slovinsky  
Stephen M. Dickson  
Maine Geological Survey  
22 State House Station  
Augusta, Maine 04333-0022*

### **INTRODUCTION**

The 2009 State of Maine's Beaches report provides a two-year follow up from the first report issued in 2007 (Slovinsky and Dickson, 2007). The purpose of the report is to summarize morphologic characteristics and changes of Maine beaches that are monitored as part of the State of Maine Beach Profiling Project (SMBPP, Maine Sea Grant Extension, 2003). The SMBPP utilizes trained volunteers to collect monthly beach profiles which start at a known point or benchmark (usually in the frontal 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; Woods Hole Sea Grant, 2001). Volunteers enter collected data into an online database, where it is accessible for outside researchers (Maine Shore Stewards, 2007). The SMBPP is funded and managed by combined efforts of the Maine Geological Survey, University of Maine, Maine Sea Grant, and Maine Coastal Program.

The previous State of Maine's Beaches report discussed the data collection methodology used by the SMBPP program, and documented the changes that were observed in beach and dune topography at each beach profile on a year-by-year and seasonal (summer vs. winter) basis since the start of data collection (1999 for some beaches) and continuing through April 2006.

This report reviews the changes that have occurred at each beach profile in response to the Patriots' Day Storm of 2007 (April 2007) and documents the recovery of the beach and dune, or lack thereof, at each location.

### *Spatial and Temporal Extent of Data for 2009 Report*

The locations of beaches involved in the program as of June 2009 are shown in Figure 1. Generally, there are 2-4 profiling locations along each beach. Along each collected profile, topographic (elevation) points are generally collected at approximately 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. The beaches and profile numbers included in the 2009 report are shown in Table 1.

Several beaches have not had recent data recorded since 2006, including Fortunes Rocks Beach in Biddeford, and select profiles at certain other locations have incomplete datasets (see Table 1). Additionally, many beach profile starting points were lost in the Patriots' Day Storm, which led to some post-storm data gaps, or problems in relating profiles taken from front stakes (lost in the storm) to profiles recorded from back-stake starting points.

This report will compare profile data from immediately post-Patriots' Day Storm (i.e., April or May 2007), and profile data from the subsequent closest months from 2008 and 2009, as available. We also include profile data from a year before the 2007 Patriots' Day Storm (i.e., from April or May 2006, as available), for comparison's sake as "pre-storm" conditions. With this overall dataset, we are attempting to document the immediate impact of the storm, and review beach and dune recovery within the two-year post-storm period.

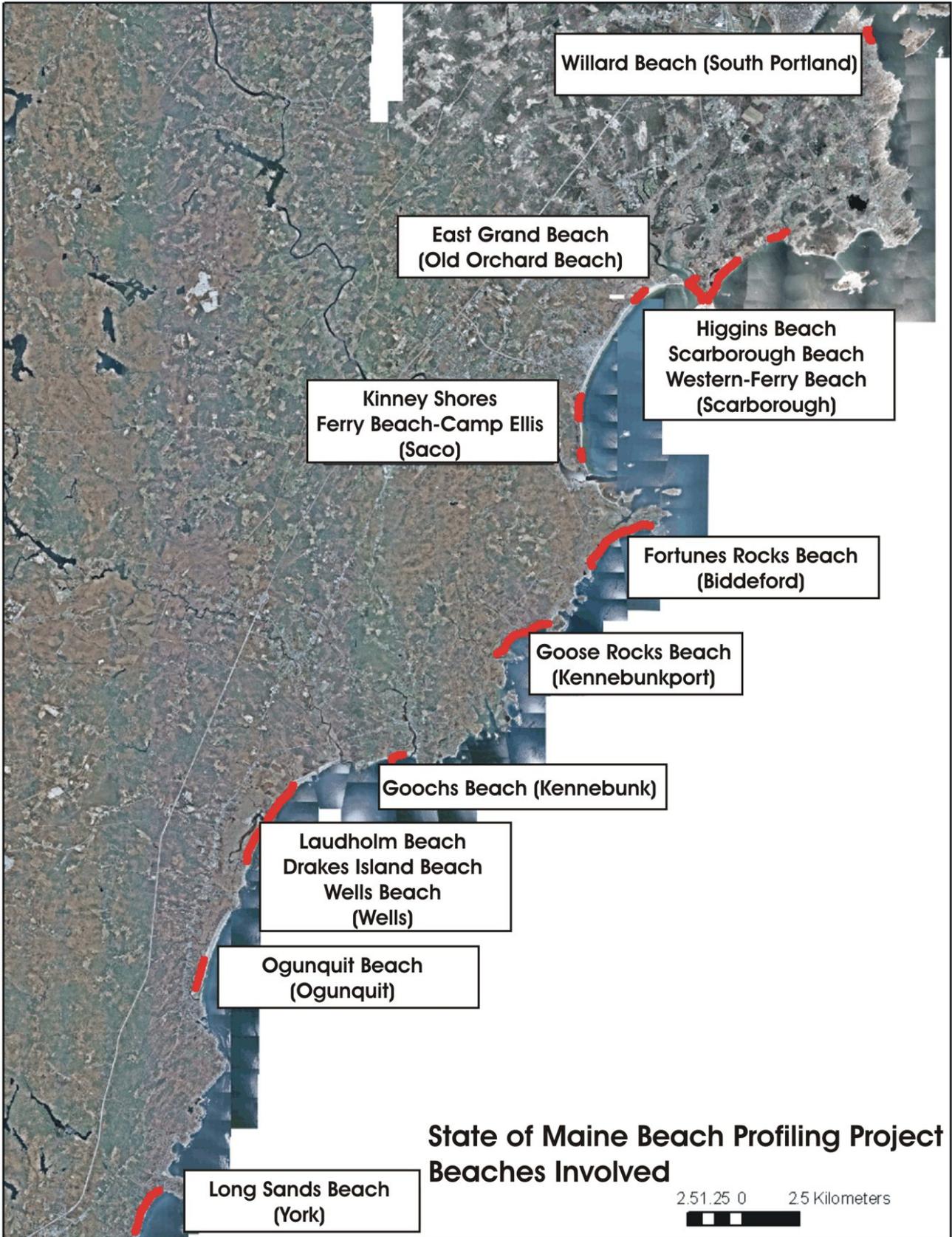


Figure 1. Locations of beaches that are monitored as part of the State of Maine Beach Profiling Program (SMBPP).

State of Maine's Beaches in 2009

**Table 1.** Beach profile location names and numbers, and dates of profiles used for analysis for this report. Most of the dates coincide with the months of April or May in 2006, 2007, 2008, and 2009.

Beach Name (Acronym)	#	Date			
		2006	2007	2008	2009
Willard (WI)	01	11/11	4/20	4/11	3/10
	03	11/11	4/20	4/11	3/10
	06	11/11	4/20	4/11	3/10
Higgins (HI)	01	4/2	4/22	4/11	4/5
	02	4/2	4/22	4/11	4/5
	03	4/2	4/22	4/11	4/5
Scarborough (SC)	01	4/3	4/21	4/14	5/3
	02	4/3	4/24	4/14	5/3
	03	4/3	4/24	4/14	5/3
	04	4/3	4/24	4/14	5/3
Western/Ferry (WS)	01	4/29			
	05		4/19	3/18	
	02	4/29			
	06		4/19	3/18	
	03	4/29			
	07		4/19	3/18	
	04	No data available			
East Grand (EG)	01	4/14	4/21	9/18	4/5
	02	4/14	4/21	9/18	4/5
	03	4/14	4/21	9/18	4/5
	04	4/14	4/21	9/18	4/5
Kinney Shores (KS)	01	3/31	4/22	3/6	3/16
	02	3/31	4/22	3/6	3/16
Ferry (FE)	01	3/31	4/20	4/15	5/1
	02	3/31	4/20	4/15	5/1
	03	3/31	4/20	4/15	5/1
	04	3/31	3/22	4/15	5/1
Fortunes Rocks (FR)	01	No data available			
	02				
	03				
	04				

Beach Name (Acronym)	#	Date			
		2006	2007	2008	2009
Goose Rocks (GR)	01	4/6	4/21	4/15	4/4
	02	4/6	4/21	4/15	4/4
	03	4/5	4/23	5/21	4/7
	04	4/5	4/23	4/14	4/7
Goochs (GO)	01	4/1	6/25	4/13	4/4
	02	4/1	4/22	4/13	4/4
	03	4/1	4/22	4/13	4/4
Laudholm (LH)	01	4/1	6/23	4/11	5/1
	02	4/1	4/20	4/11	5/1
	03	5/20	4/20	4/11	5/1
	04	No data available			
Drakes Island (DI)	05	4/1	4/20	4/11	5/1
	01	5/22	5/14	5/1	5/20
	02	5/22	5/14	5/1	5/20
	03	5/22	5/14	5/1	5/20
	04	5/22	5/14	5/1	5/20
Wells (WE)	00	4/2	4/21	4/12	4/4
	01	No data available			
	02	4/2	4/21	4/12	4/4
	03	4/2	4/21	4/12	4/4
Ogunquit (OG)	04	4/2	4/21	4/12	4/4
	01		5/19	5/24	11/22*
	02		4/21	5/24	11/22*
	03		5/19	5/24	9/21*
Long Sands (LS)	04		4/21	5/24	7/26*
	01	4/1	4/22	4/13	4/15
	02	No data available			
	03	4/1	4/22	4/13	4/15

\*Note - for 2009 at Ogunquit Beach, profiles from July, September, and November 2008 were the most recent available.



NOAA/NOS/CO-OPS  
Preliminary Water Level vs. Predicted Plot  
Portland, ME Tide Gauge

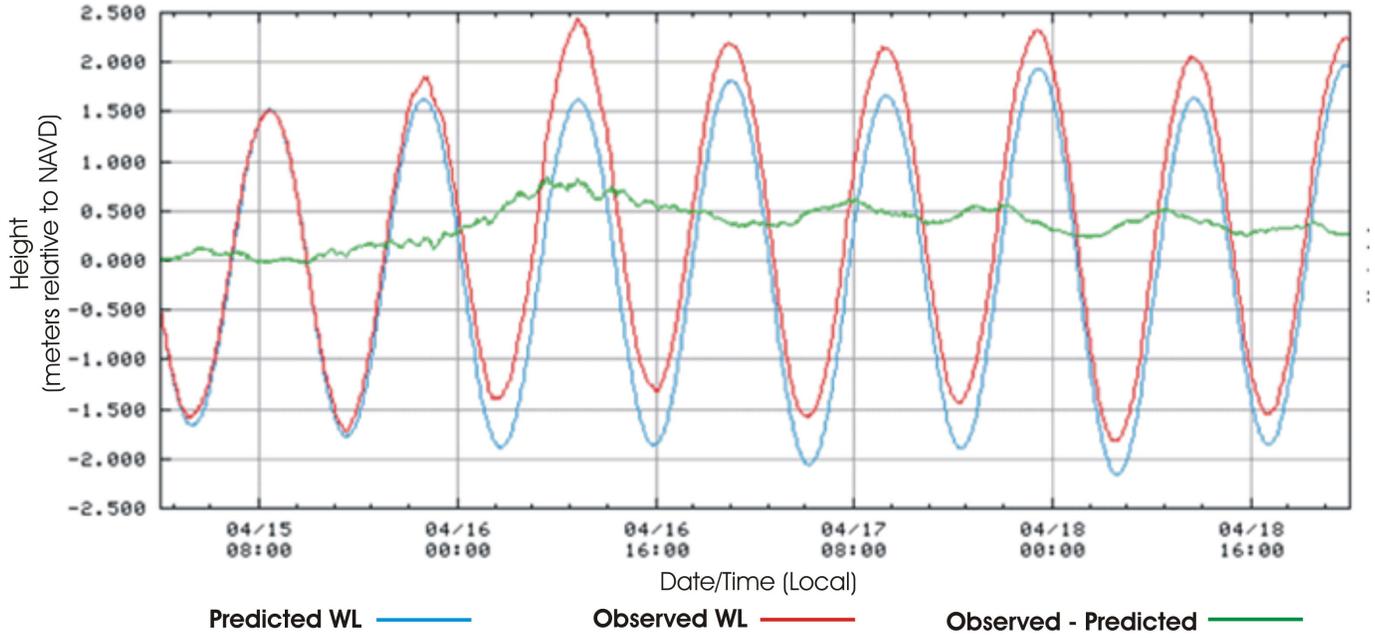


Figure 3. Tide gauge recordings of water levels in Portland Harbor during the Patriots' Day Storm of 2007.

## ***Review of Beach Responses***

This portion of the report will progress in a north-to-south format, starting with the northernmost monitored beach, Willard Beach in South Portland, and ending with Long Sands Beach, in York. No discussions of overall beach conditions and characteristics will be made, as this was completed in the previous report. However, we will review apparent impacts, as evidenced by individual beach profiles, immediately post-Patriots’ Day Storm, and beach and dune recovery over the next two years.

As data are available, each beach profile will be first described in terms of the visual impacts of the storm to the 2006 pre-storm profile shape. For this study, we consider the immediate 2007 post-storm beach profile to represent the “erosion level benchmark” from which each profile must recover. The recovery of each profile in reference to the post-storm shape will be discussed.

As part of this review, we assign a recovery “grade,” based on the amount of recovery (or lack thereof) exhibited by each profile location, and the overall beach. The grading system is qualitative, and described in Table 2.

We will also generally relate the overall beach recovery to the 2006 pre-storm profile shape, though this will not be used as the benchmark for comparison in terms of determining the level of beach recovery.

After a grade is assigned to each profile location at a beach, an averaged, overall score will be calculated for the entire beach. Note that in this ranking system, we consider an A and B to be very good recovery, a C to be considered a satisfactory (but cautionary) recovery, and a D and F to be an unsatisfactory outcome for the beach recovery.

**Table 2.** Beach recovery grading system used for describing beach response to the storm.

<b>Recovery Grade</b>	<b>Numerical Score</b>	<b>Beach Recovery Description</b>
A	95	Excellent (dramatically recovers after the post-storm profile)
B	85	Very good (slightly recovers after the post-storm profile)
C	75	Satisfactory (displays stability after the post-storm profile)
D	65	Below Average (continued loss after the post-storm profile)
F	55	Fail (dramatic loss after the post-storm profile)
Note: + and – signs may be indicated, as appropriate		

## *Willard Beach, South Portland*

Three beach profiles (WI01, WI03, and WI06) were available for comparison of post-Patriots' Day Storm recovery (Figure 4). The closest dates to the preferred dates where data were available were November 11, 2006, April 20, 2007, April 11, 2008, and March 10, 2009.

### **WI01 = A**

Prior to the Patriots' Day event, WI01 (Figure 5) exhibited a developed berm, which is apparent in the profile from 3 to 24 m from the pin; this then led to a flatter intertidal portion of the profile. This profile is located at the southeastern end of Willard Beach and is adjacent to a seawall and concrete ramp. After the storm, the profile responded with extensive loss of the berm, and loss of sand into the offshore portion of the profile. Note the wavy appearance of the lower portion of the profile – from about 30 m from the pin seaward. This could represent dispersed sand waves that are in the subaerial portion of the profile, and actually indicate some beach recovery. By one year post-storm, the mid to lower portions of the profile have fully recovered to pre-storm conditions, with just a slight gain in elevation above the November 2006 profile. The berm which existed pre-storm has still not recovered. However, by March 2009, the berm and entire profile exhibits excellent recovery, with a sand elevation that is approximately 0.5 m (1.6 feet) above the immediate, post-storm profile. This represents excellent recovery. We are not clear what the large anomalous elevation rises present in the 2008 and 2009 profiles represent.

### **WI03 = A**

WI03 (Figure 6) exhibited a very large, well defined berm extending to about 55 m from the pin, prior to the storm. This profile is located across the large berm near the jungle gym at the center of the beach. The post-storm profile showed dramatic erosion and lowering of the entire volume of sand in the berm out to 55 m; seaward of this, there was very little change in the pro-

file shape. Interestingly, the one year post-storm profile from April 2008 exhibited an even leaner profile, with loss of additional volume across the entire profile. Surprisingly, however, by March 2009, the profile had recovered fully, and actually gained elevation along its entire length as compared to the pre-storm profile. This profile exhibited dramatic recovery from the storm within the two-year period.

### **WI06 = B**

WI06 (Figure 7), located adjacent to the rock ledge at the northwestern end of the beach, showed a very steep upper section down to about 1.2 m below the pin, then flattened into the offshore. The post-storm profile showed a deepening of the sand elevation below the rock ledge starting point – by about 0.8 m (down to 2 m below the pin), and showed additional volumetric loss along the profile out to about 17 m. Seaward of this, the pre- and post-storm profiles appeared similar until the offshore, where several large bars were apparent. By the one-year post-storm mark, the profile overall appears very similar, with slight additional loss along the profile length. However, consistent with the other profiles, by March 2009, large gains of sand led to profile elevations very similar to the 2006 pre-storm profile shape, with slightly more sediment in the upper portion of the profile than the offshore.

### **Summary**

Overall, it appears that Willard Beach has quite successfully recovered from the beach and dune erosion that occurred as a result of the Patriots' Day Storm. The examined beach profiles showed dramatic loss – and dramatic recovery – by March 2009. Data indicate that it took a full two years for the profiles to recover from the event, as one year post-storm profiles were very similar to the immediate post-storm profiles (or worse), while the two-year post-storm profiles showed massive amounts of recovery.

**Overall grade = A-**



Figure 4. Location of beach profiles on Willard Beach, South Portland.

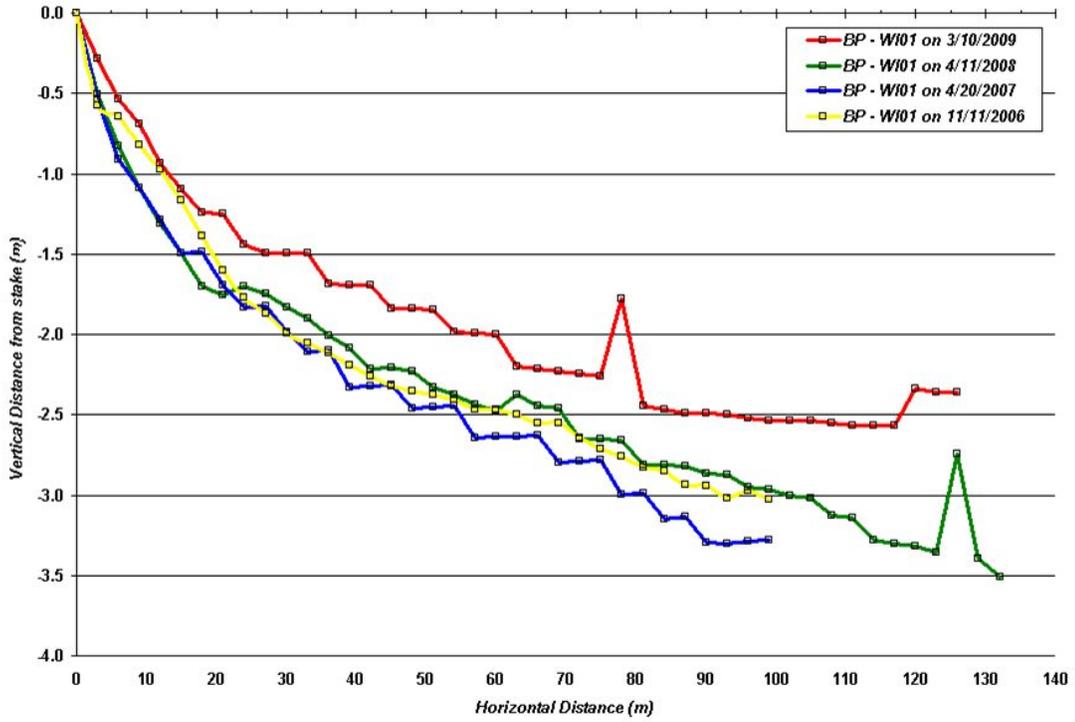


Figure 5. Beach profiles from Willard Beach profile line WI01.

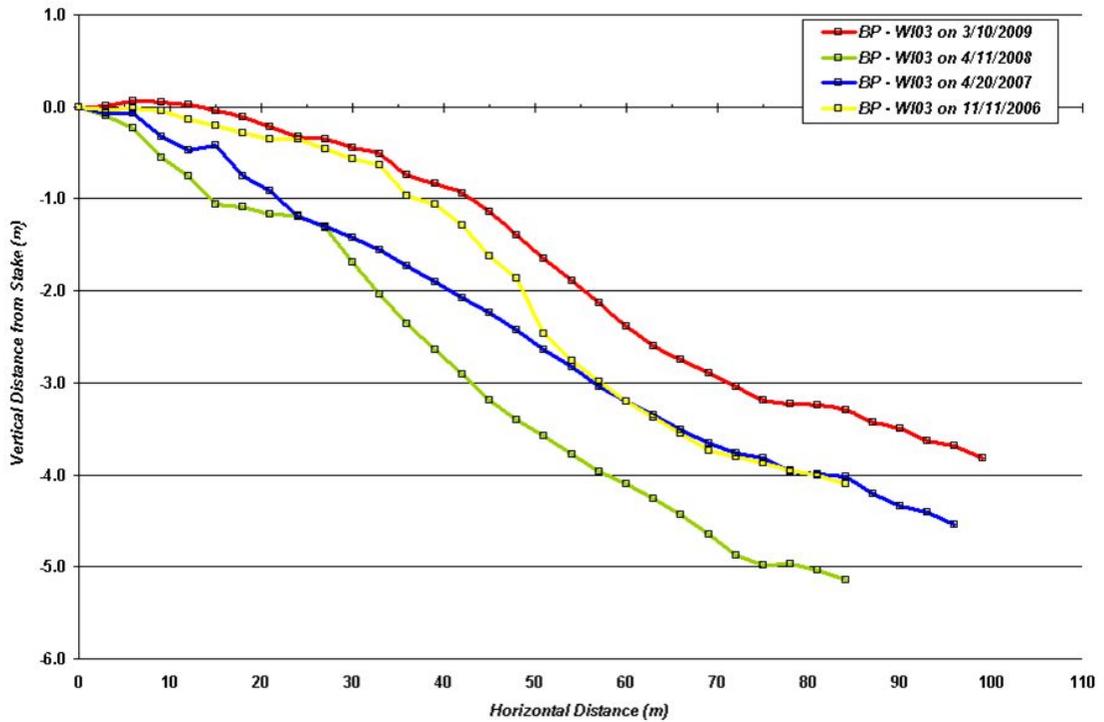


Figure 6. Beach profiles from Willard Beach profile line WI03.

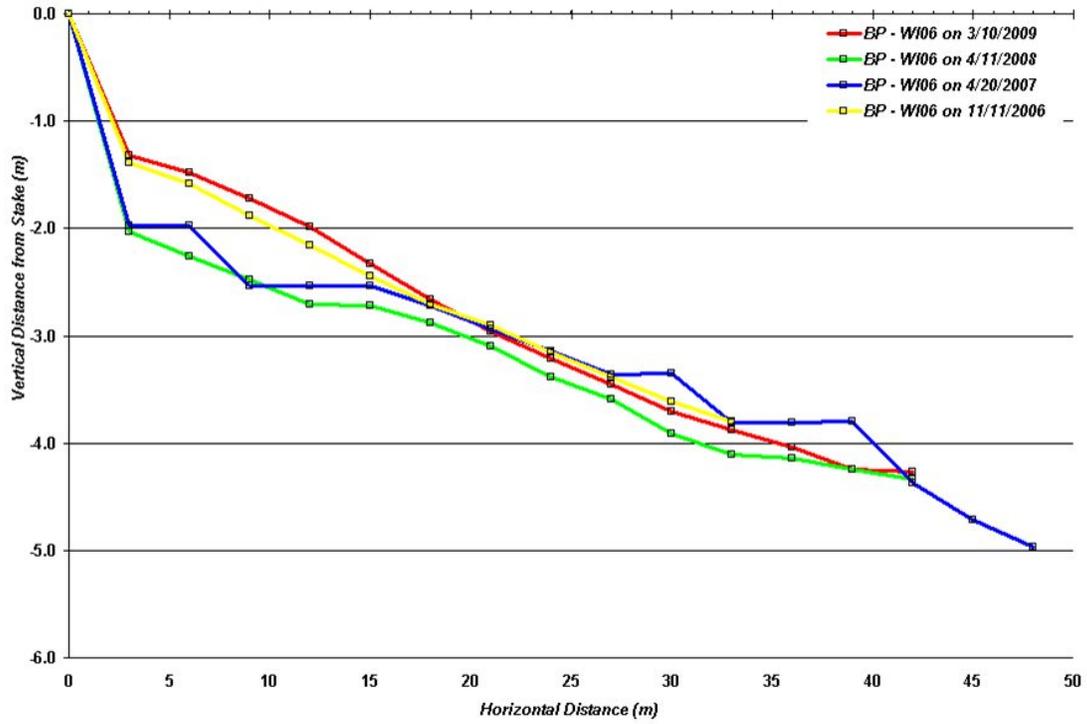


Figure 7. Beach profiles from Willard Beach profile line WI06.

## Higgins Beach, Scarborough

Three beach profiles (HI01, HI02, and HI03, Figure 8) were available for comparison of Patriots' Day Storm impacts and recovery. Beach profile data were available from April 2, 2006, April 22, 2007 (immediately post-storm), April 11, 2008, and April 5, 2009.

### HI01 = A

Profile HI01 (Figure 9), which was located along the seawall at the end of Ocean Avenue, underwent clear erosion – especially from about 175 cm below the starting pin, or roughly 10 m seaward of the pin. Sediment was lost along this entire seaward length of profile, and the berm that was somewhat apparent in the April 2006 profile was completely eroded by the Patriots' Day Storm. By 2008, the profile showed marked recovery from April 2007, with large gains in sediment along the uppermost portion of the profile, and at the 50 m mark and seaward of the 100 m mark. Recovery from the Patriots' Day Storm event seems to have occurred within one year, with the profile actually slightly exceeding the pre-storm shape. Unfortunately, it is impossible to compare the profiles between 2008 and 2009 since the seawall where the pin was located was reconstructed.

### HI02 = B

Profile HI02 (Figure 10), located along the middle of Higgins Beach, lost a berm and sediment in the offshore, resulting in a post-storm Patriots' Day Storm profile that was low in elevation and flat. However, within one year, the profile appears to have responded very well, with growth back to pre-storm elevations in the upper portion, and elevation gains in the offshore portion of the profile. By 2009, the profile seems to have achieved a shape very similar to the 2006 pre-storm shape, with a slight increase in elevation in the offshore.

### HI03 = C

Profile HI03 (Figure 11), located at the Spurwink River, clearly displays the influence of the Spurwink River on trapping sediment moving in an easterly-directed longshore drift. The 2006, pre-storm profile was actually significantly lower than the immediate post-storm profile from 2007. It appears that large amounts of sediment – potentially sourced from loss that occurred within the upper portions of the profile or other areas of the beach (or both) – were deposited along the profile as a result of the storm. The 2008 profile showed additional dune and beach berm building, along with a large offshore bar. However, the 2009 beach profile showed significant loss of sediment along the profile, especially starting near the -60 cm elevation, though there was additional seaward growth of the dune. This profile is highly variable because of its proximity to the Spurwink River, whose channel migrates rapidly. This profile underwent accretion immediately after the Patriots' Day Storm, and its offshore portions have been losing sediment since the storm; however, the upper portion (berm and dune) have been growing seaward, indicating recovery and stability. If we base the grade on the upper portion of the profile, it would be given a B; if we base it on the offshore portion of the profile, which has been losing sediment since the Patriots' Day Storm, it would receive an F. However, because of the variability and influence of the river, we assign HI03 a C, because it is clear that the storm actually positively influenced the offshore portion of the profile, and the upper portion has recovered in a satisfactory way.

### Summary

Overall, recovery of the profiles along Higgins Beach appears to have occurred, with HI01 and HI02 recovering well within one year of the Patriots' Day Storm. HI03 appears to have been positively influenced by the storm, especially along lower portions of the profile. Recovery seems to have occurred at HI03, but it has been eroding since 2007 along its lower portions, most likely due to channel migration and inlet instability.

**Overall grade = B**



Figure 8. Location of beach profiles on Higgins Beach, Scarborough.

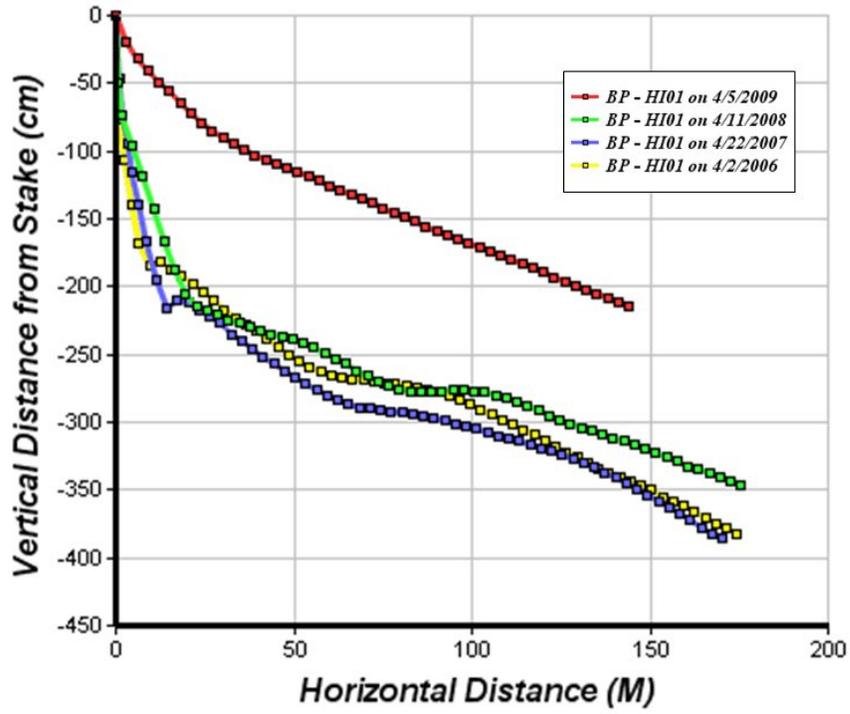


Figure 9. Beach profiles from Higgins Beach profile line HI01.

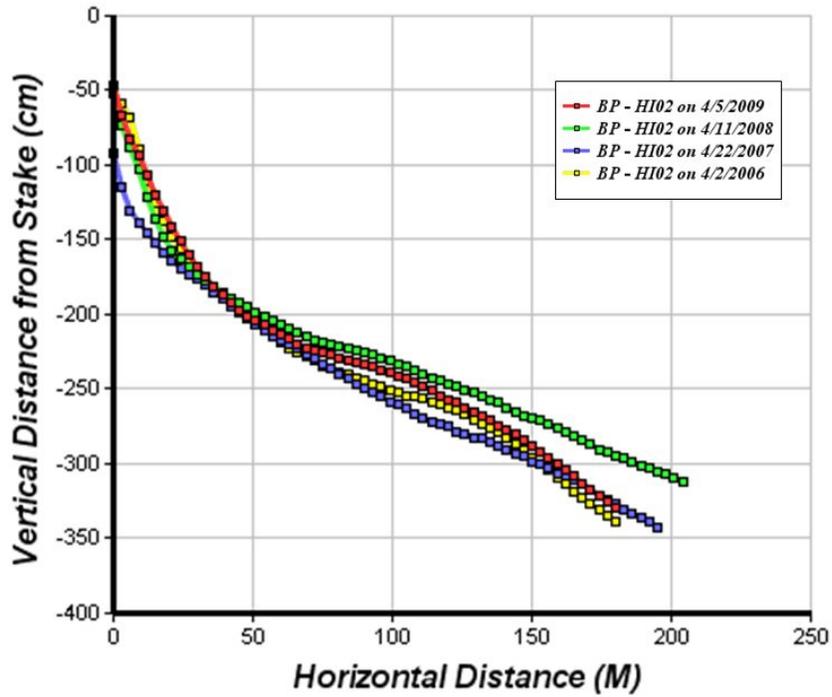


Figure 10. Beach profiles from Higgins Beach profile line HI02.

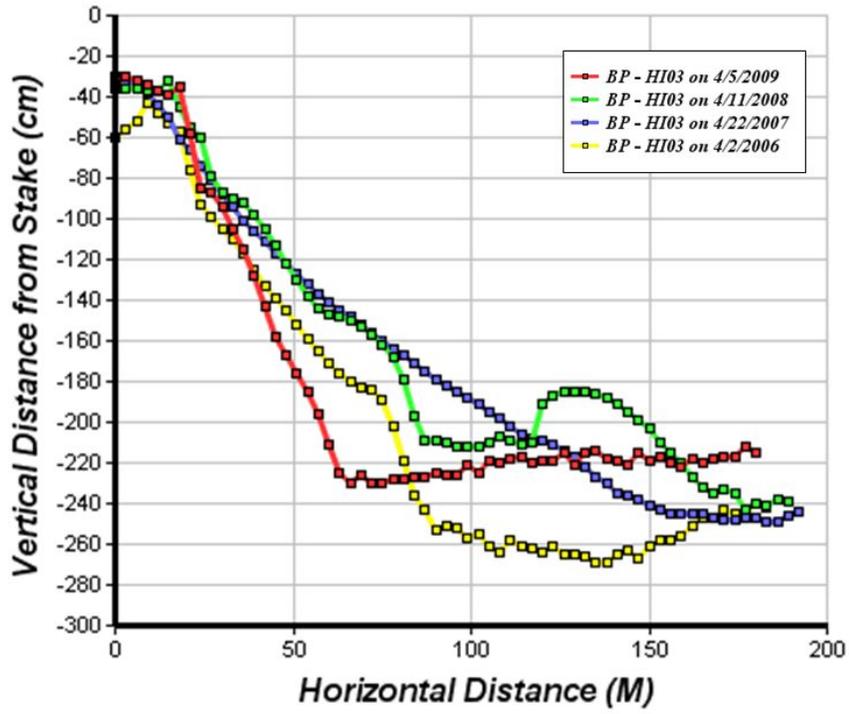


Figure 11. Beach profiles from Higgins Beach profile line HI03.

## Scarborough Beach, Scarborough

Four beach profiles (SC01 to SC04, Figure 12) were available for comparison of pre-storm profile shape and post-Patriots' Day Storm impacts. Stakes at SC02-SC03 were lost after the Patriots' Day Storm and relocated in the approximate area of the previous stakes. Beach profile data were available from April 3, 2006, April 21 and 24, 2007 (immediately post-storm), April 14, 2008, and May 3, 2009.

### SC01 = C+

The pre-storm profile at SC01 (Figure 13) was dramatically impacted by the Patriots' Day Storm, with the post-storm profile exhibiting the loss of approximately 1 m of sediment along the profile, from about 25 m along the profile in a seaward direction. The loss of volume along the profile was astounding – review of data sheets indicates that the starting pin for SC01 was not lost in the storm. By 2008, the beach profile had gained slight sediment along its length, mostly at the berm. The 2009 profile indicated some loss from the slight recovery that occurred in 2008. Although the profile never neared the pre-storm shape in terms of recovery, it did show some stability and slight recovery from the storm.

### SC02 = B

Profile SC02 (Figure 14) lost between 25-50 cm of sediment along its length, based on comparison between the pre- and post-storm profiles from 2006 and 2007, especially in the offshore portion of the profile. Recovery was noted along the upper portion of the profile – between 10 and 50 m from the pin in 2008 (berm), though the offshore portion underwent little change. The upper portion of the 2008 profile matches that of the 2006 pre-storm profile, but there is less recovery in the offshore. Notes from the volunteers state that the pin was lost in 2009 and reset in May 2009, so it is difficult to use the 2009 data for comparison. However, it appears that the profile underwent some additional loss between 2008 and 2009. The profile did recover

in its nearshore portion, out to about 40 m; seaward of this, additional loss has occurred.

### SC03 = C

According to volunteer notes, the profile starting pin at SC03 (Figure 15) was lost during the Patriots' Day Storm. The pre-storm 2006 profile, which was slightly concave, was eroded along its nearshore and offshore portions, with the formation of a bar immediately post-storm. A new pin position was located in March 2008 – this is likely the cause of the dramatic difference in the starting point elevation from the post-storm 2007 profile and the 2008 profile. The May 2009 profile has an erosive shape, and actually shows additional erosion below the immediate post-storm profile at several locations. Based on this data, SC03 is showing some signs of recovery.

### SC04 = C

SC04 (Figure 16) lost incredible amounts of sediment and elevation along its length in response to the storm – close to a full meter. The profile dramatically recovered by 2008 to near pre-storm conditions, even maintaining a similar overall shape to the pre-storm profile. However, by 2009, the profile had been eroded back to near the post-storm 2007 shape. This was likely due to a series of storms in mid April and early May 2009. The dramatic variation in shape may indicate SC04's response to storm events. Recovery has occurred slightly, but the highly variable nature gives this site a conditional grade of C.

### Summary

Scarborough Beach has undergone stability to slight recovery from the Patriots' Day Storm. It appears that the profiles are highly susceptible to storms and can vary dramatically in response.

**Overall grade = C+**



Figure 12. Location of beach profiles on Scarborough Beach, Scarborough.

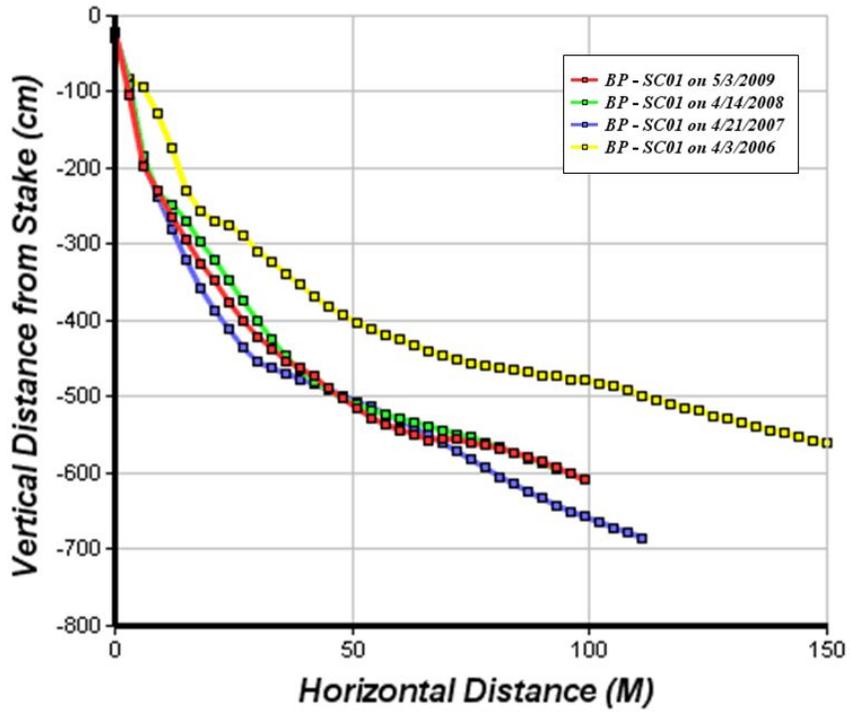


Figure 13. Beach profiles from Scarborough Beach profile line SC01.

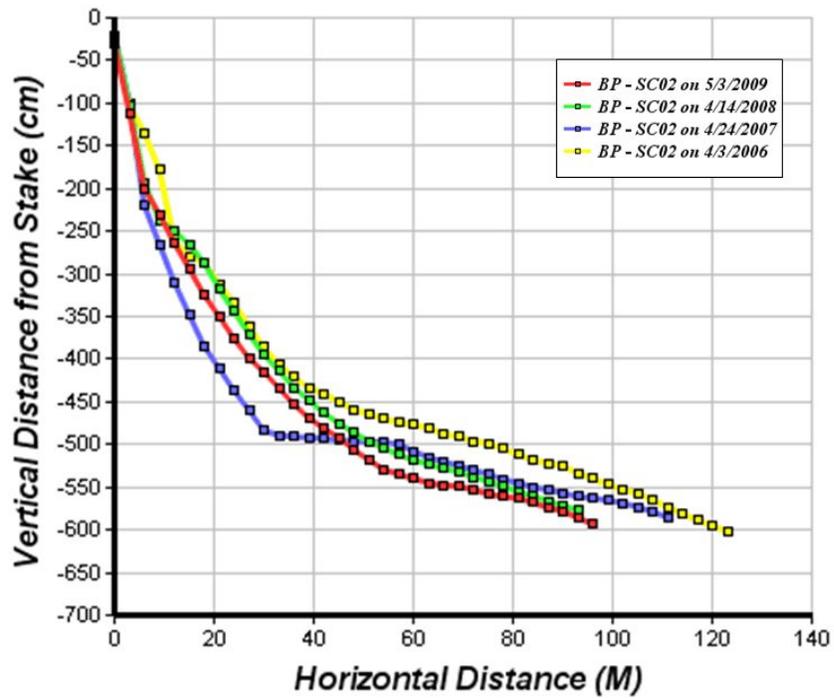


Figure 14. Beach profiles from Scarborough Beach profile line SC02.

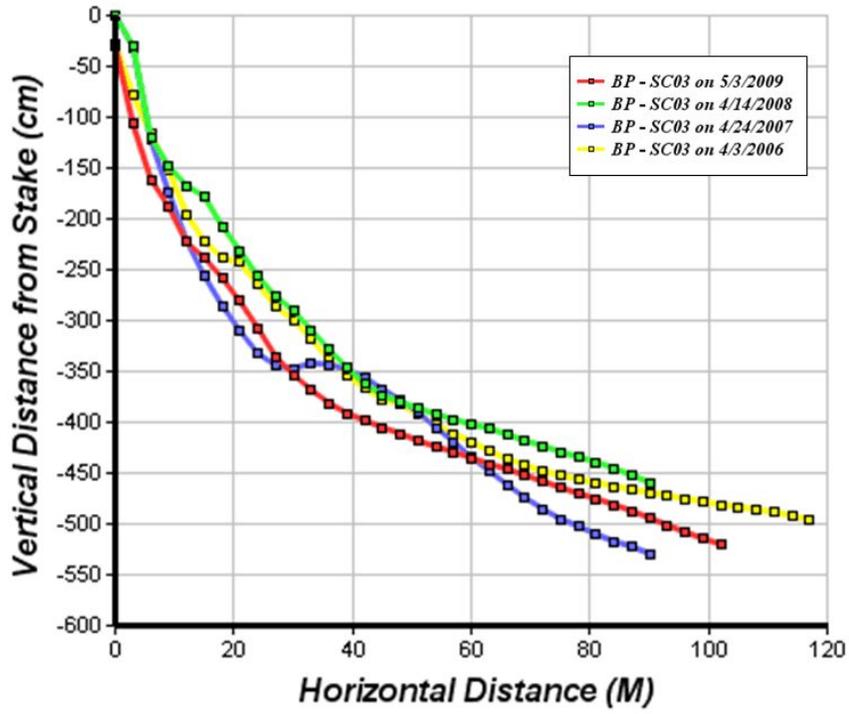


Figure 15. Beach profiles from Scarborough Beach profile line SC03.

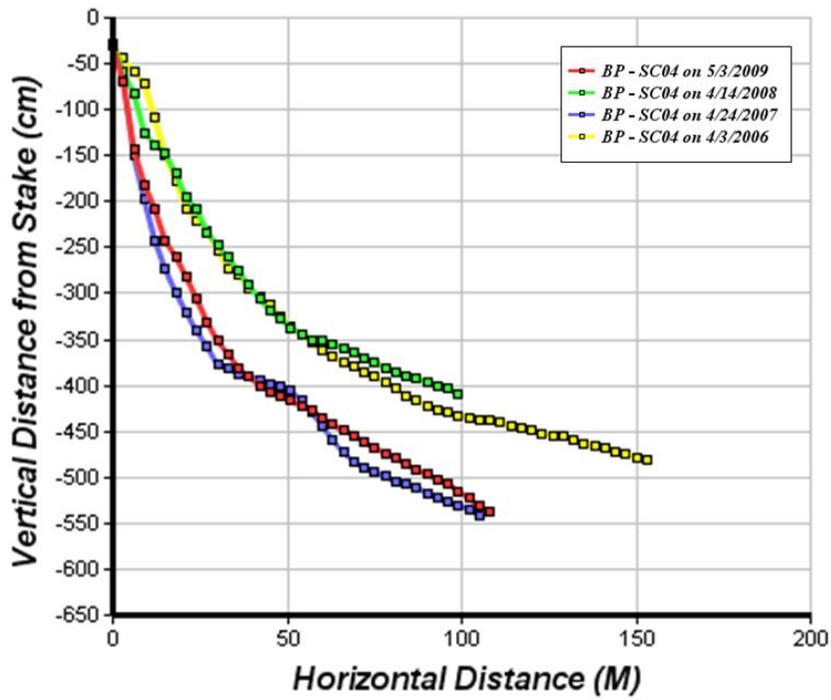


Figure 16. Beach profiles from Scarborough Beach profile line SC04.

## Western Beach, Scarborough

At Western Beach, profiling has been sporadic (Figure 17). Profile WS02 was lost in June of 2006, and reestablished as a different stake in a different location (as WS06) in February of 2007. Therefore, we will be using February 2007 as the first (pre-storm) profile for WS02/06. Consequently, profile WS01 was renamed as WS05, and WS03 as WS07 in February 2007. Data were available from April 29, 2006, April 19, 2007 (immediate post-storm), and March 18, 2008. No data were available in 2009.

### WS01 (WS05) = B

WS01/05 is located along Ferry Beach (Figure 18), which is sheltered and along the Scarborough River. The 2006 profile underwent minimal changes as a result of the storm. In fact, it appears that lower portions of the profile actually gained elevation immediately post-storm. By 2008, some additional elevation gain was noted.

### WS02 (WS06) = A

WS02/06 is also located in a sheltered area (Figure 19). The pre-storm profile, which is from April 2006, was positively impacted by the Patriots' Day Storm. The profile gained elevation along its entire length, especially between the 35-55 m marks. It also gained elevation at the dune crest. In 2008, the upper portion of the profile –from about 30 m and landward – con-

tinued to gain elevation, including the dune crest. However, the offshore portion of the profile lost some elevation.

### WS03 (WS07) = C

At WS03, which is located on the more exposed Western Beach (Figure 20), the profile underwent large losses of sediment and subsequent elevation along its entire length. Large, well developed dunes were lost, as was a well defined berm (between about 25-35 m offshore). The post-storm profile was flat, and had few beach features. The 2008 profile showed some recovery, along the upper portion of the profile, landward from about the 25 m mark. Seaward of this, the profile had not recovered from the post-storm shape.

### Summary

Ferry Beach appears to have fared very well during the Patriots' Day Storm, with the storm actually leading to growth along the profile. The Western Beach side underwent large amounts of erosion from the storm, with only slight recovery. Erosion of the beach nourishment along Western Beach has been noted for some time, with subsequent growth on the Ferry Beach side. Continued profiling at these sites would be prudent to help monitor the potential continued loss of sediment along Western Beach, and continued growth at Ferry Beach.

**Overall grade = B**



Figure 17. Location of beach profiles on Western and Ferry Beach, Scarborough.

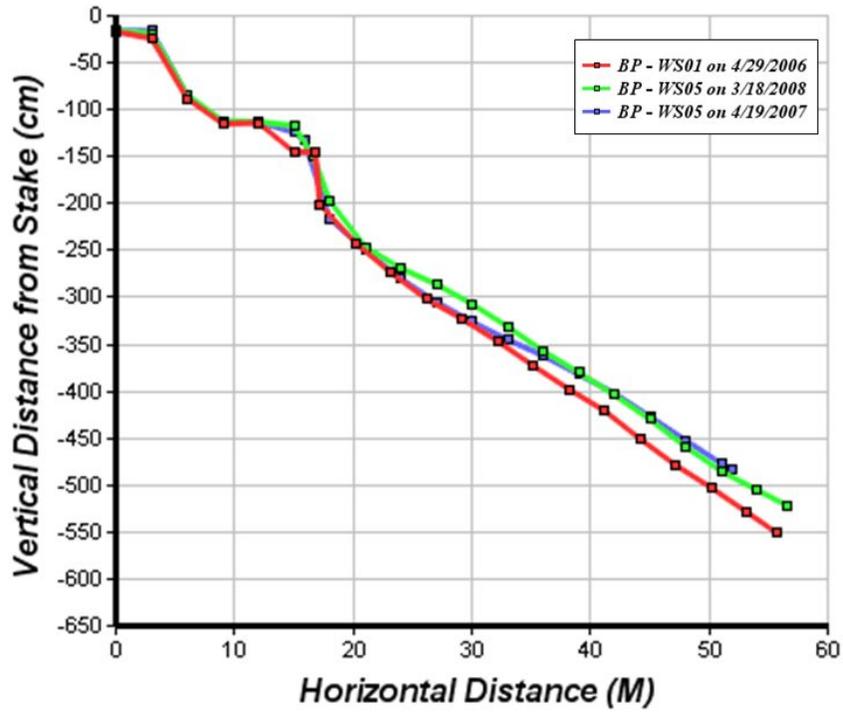


Figure 18. Beach profiles from Western Beach profile line WS01 (WS05).

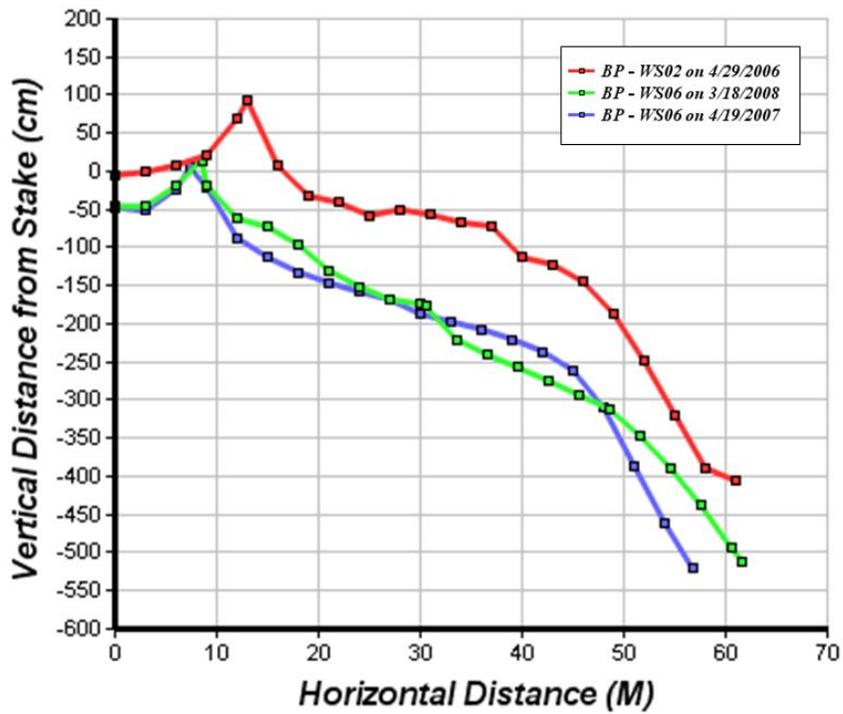


Figure 19. Beach profiles from Western Beach profile line WS02 (WS06).

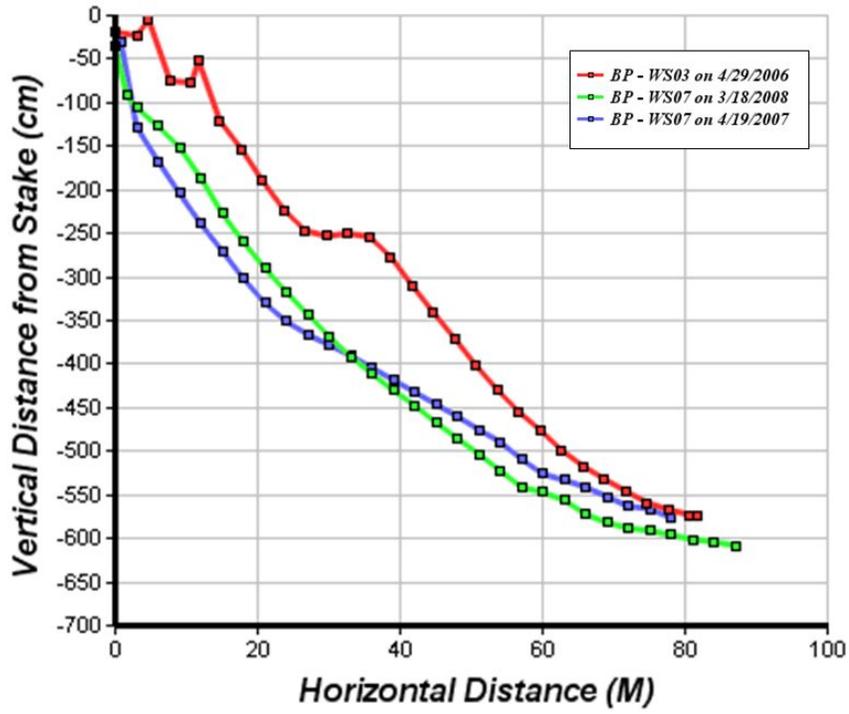


Figure 20. Beach profiles from Western Beach profile line WS03 (WS07).

## East Grand Beach, Scarborough

Four beach profiles (EG01 to EG04, Figure 21) were available for comparison of pre-storm profile shape and post-Patriots' Day Storm impacts. Volunteer notes indicate that the profiling stakes at all four locations were lost in the storm. New stakes were established in approximate previous locations. Beach profile data were available from April 14, 2006, April 21, 2007 (immediately post-storm), September 18, 2008, and April 5, 2009.

### EG01 = C

The pre-storm profile of EG01 (Figure 22) was eroded, and transgressed in a landward direction in response to the storm. The post-storm profile exhibited a higher dune crest (due to overwash), and a more landward and slightly steeper beach slope, with loss of sediment along the profile from about seaward of the 40 m mark. By 2008, it appears that the dune crest had further receded in a landward direction and lost some of its elevation. However, the middle and lower portions of the profile exhibited growth and elevation gains. Although the 2009 profile exhibited a slightly lower dune crest, it had grown (accreted) seaward slightly. The lower portion (seaward of 60 m) of the 2009 profile had slightly less elevation than the 2007 post-storm profile.

### EG02 = A

The pre-storm 2006 profile (Figure 23) underwent large amounts of erosion in response to the storm, losing over 50 cm of elevation in the lower portion of the profile – the dune crest appeared to stay relatively stable, with only a slight decrease in elevation. By 2008, the entire profile showed incredible recovery, with the addition of over 1 m of sediment to the lower portion of the profile. The 2009 profile reflected some erosion from the combination of early April storms, and the profile adjusted accordingly, losing about half of the elevation gained by the 2008 profile. However, recovery here was quite good.

### EG03 = A

The pre-storm profile was dramatically eroded, and the entire profile transgressed in a landward direction in response to the storm (Figure 24). The dune crest gained elevation and moved about 5 meters inland. By 2008, the profile had responded well to the storm, with sediment accreting along the majority of the profile from about 25 m seaward. The dune crest, however, was about 40 cm below the post-storm crest, but about equal to the pre-storm (2006) dune crest height. In 2009 the profile underwent some erosion along its mid and lower portions, but gained elevation, surpassing the 2006 pre-storm profile shape.

### EG04 = B-

The storm eroded the 2006 profile along its middle portion, and resulted in a larger dune crest and an elevation gain in the offshore, from 60 m seaward (Figure 25). By 2008, the profile had maintained its post-storm dune crest, and also gained additional elevation along its length. However, in 2009, the profile lost sand elevation from about the 45 m mark seaward, resulting in a profile shape that was actually below the level of the post-storm profile.

### Summary

Overall, recovery at East Grand Beach was very good. The profiles here responded to the storm with apparent transgression – that is, shifting of the profile shape in a landward direction. The dune crest at most locations was actually higher than the pre-storm crest, likely due to the process of overwash resulting from the storm. This is the sign of a healthy transgression in response to the storm event.

**Overall grade = B**



Figure 21. Location of beach profiles on East Grand Beach, Scarborough.

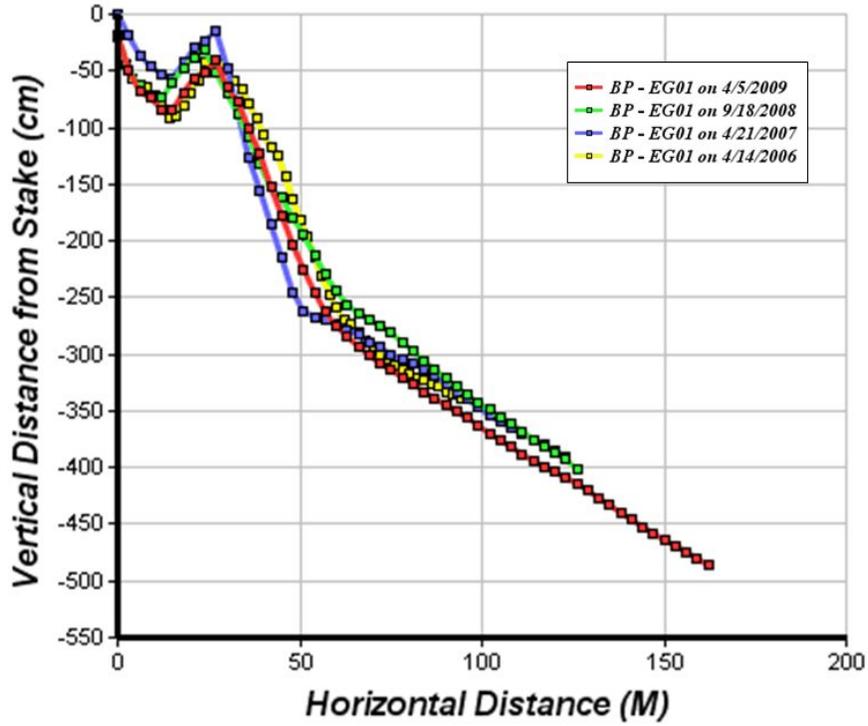


Figure 22. Beach profiles from East Grand Beach profile line EG01.

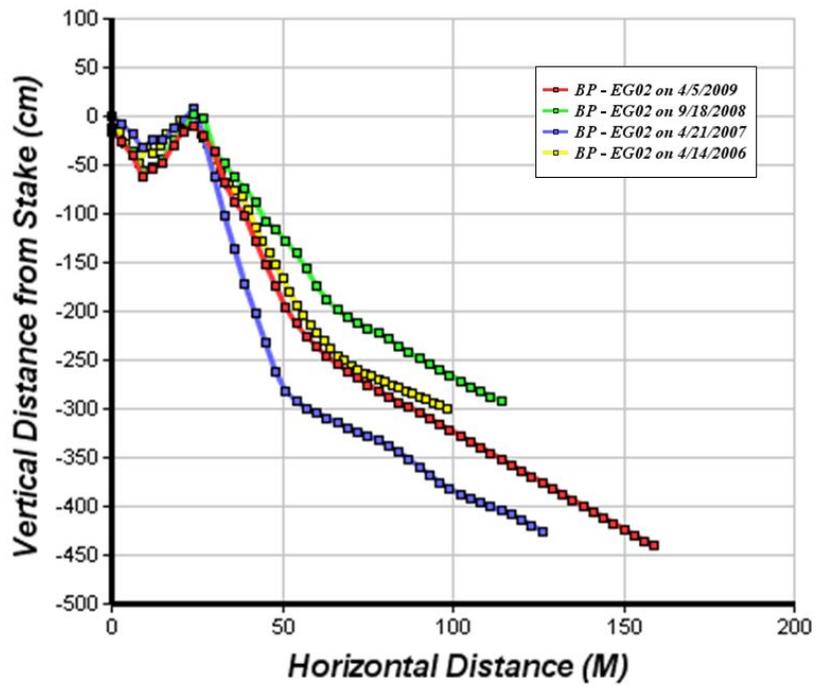


Figure 23. Beach profiles from East Grand Beach profile line EG02.

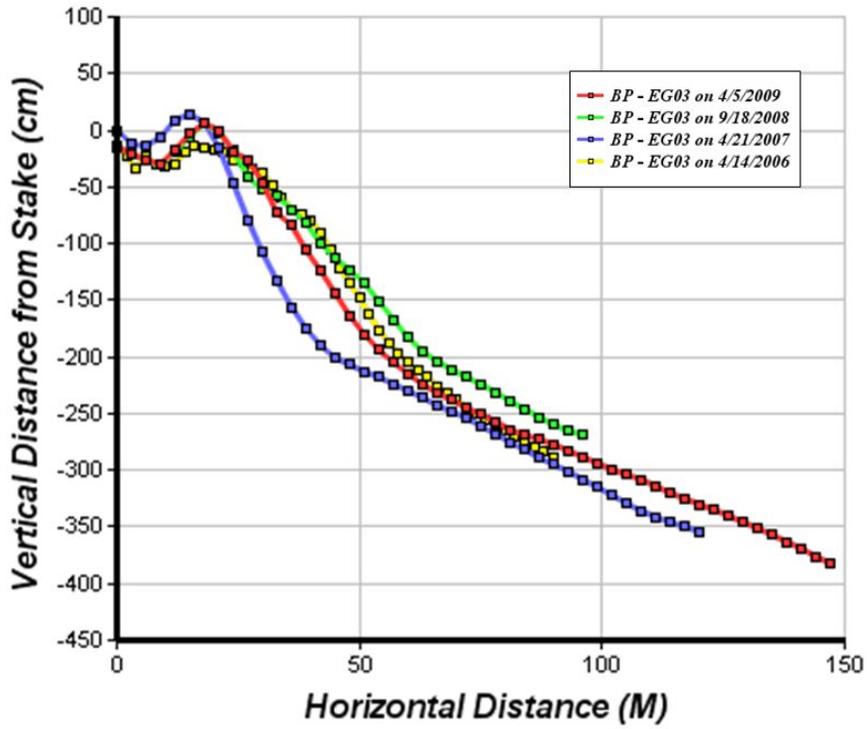


Figure 24. Beach profiles from East Grand Beach profile line EG03.

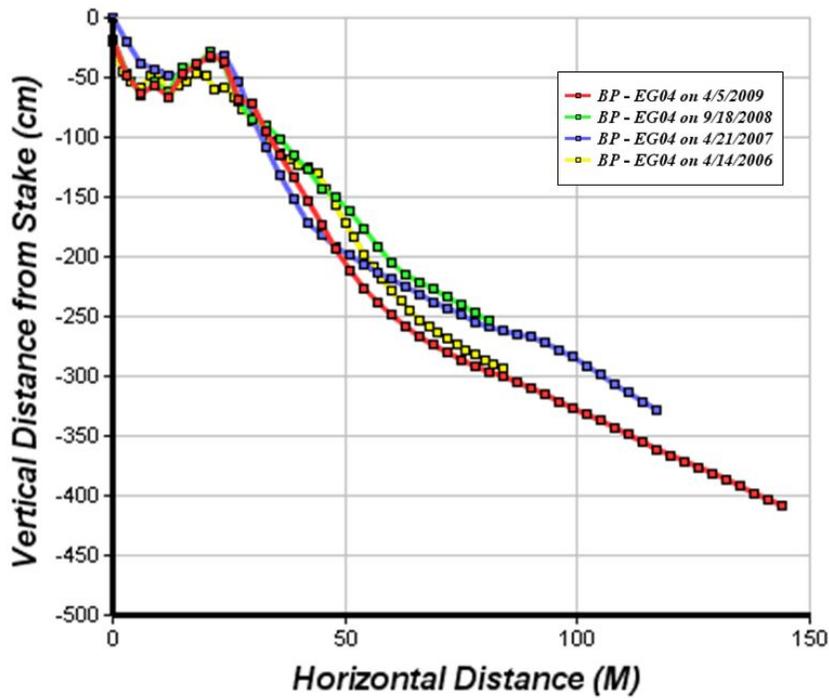


Figure 25. Beach profiles from East Grand Beach profile line EG04.

## *Kinney Shores, Saco*

Two beach profiles (KS01, KS02, Figure 26) were available for comparison of pre-storm profile shape and post-Patriots' Day Storm impacts. Beach profile data were available from March 31, 2006, April 22, 2007 (immediately post-storm), March 6, 2008, and March 16, 2009.

### **KS01 = C**

The Patriots' Day storm eroded between 15-50 cm of sediment along the entire profile at KS01, leaving an evident but much lower berm structure about 20 m from the pin (Figure 27). By March of 2008, the upper portion of the profile underwent very good recovery, however lower portions still retained the immediate post-storm shape from about 20 m and seaward. By March 2009, the upper part of the profile had recovered to pre-storm elevations, aside from the dune height at the start of the pin. However, from about 20 m seaward, it remained up to about 50 cm lower than the 2006 pre-storm profile. Some of the variation in beach height around the 20 m distance may be a consequence of the changing shape of beach cusps (a curved seaward edge of the berm or dry beach). Photographic documentation of the beach by the volunteer team shows all spring months have beach cusps present. These cusps vary considerably in size – both in wavelength along the shoreline and height – over time so some of the lack of recovery may be due to

the position of the profile line across a horn or embayment of a beach cusp. Overall, the profile may need more time to fully recover.

### **KS02 = A-**

At KS02, the storm dramatically eroded the pre-storm profile along its entire length, including the dunes, berm, and lower beach (Figure 28). By 2008, recovery of the upper berm and dune portion had begun, but little recovery was evident from about 30 m seaward. Additional beach, berm, and dune recovery occurred between 10 and 55 m from the pin by the March, 2009 profile. Although extensive recovery did occur, the profile never reached the pre-storm shape in its upper or lower portion - it is possible that more recovery time is necessary for the profile to potentially recover to pre-storm conditions.

### **Summary**

Although the Kinney Shores beach profiles underwent noted recovery, they underwent significant erosion during the storm, and it appears that the profiles may need more time to fully recover (especially KS01). This slower response may be due to a lack of readily available sediment from erosion-prone up-drift beaches to the south.

**Overall grade = B**



Figure 26. Location of beach profiles on Kinney Shores and Ferry Beach, Saco.

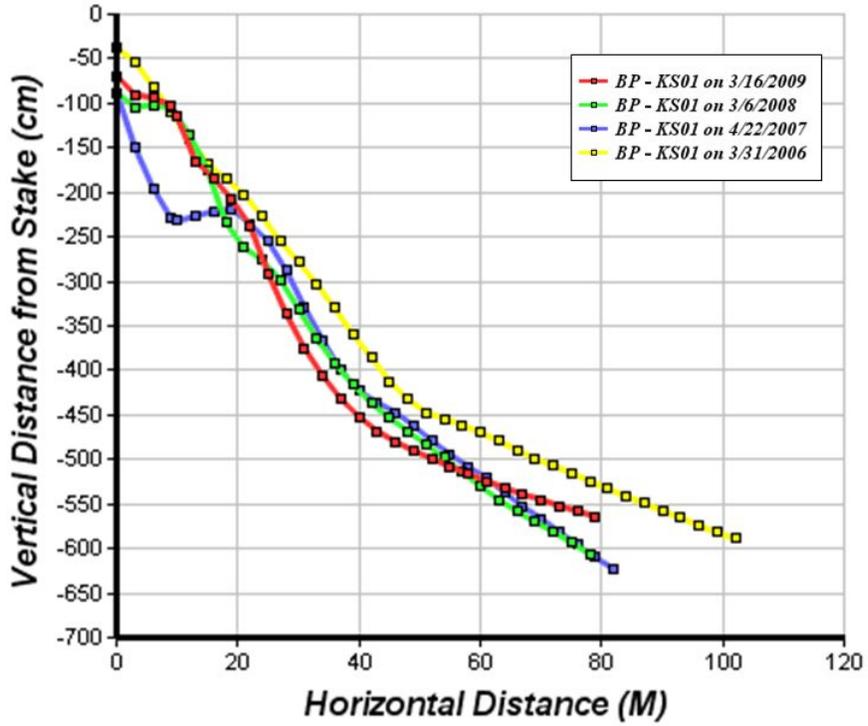


Figure 27. Beach profiles from Kinney Shores profile line KS01.

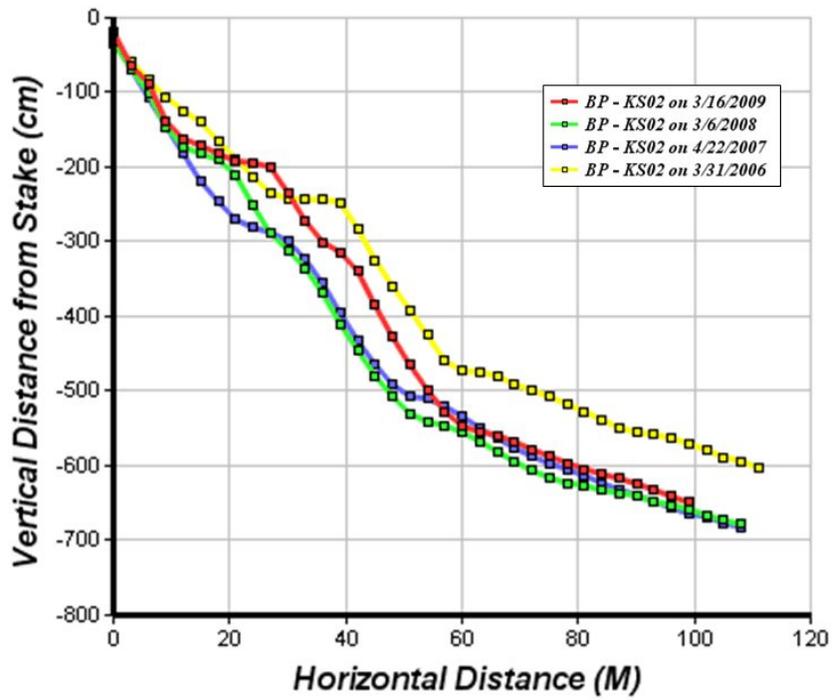


Figure 28. Beach profiles from Kinney Shores profile line KS02.

## *Ferry Beach, Saco*

Four beach profiles (FE01 to FE04, Figure 29) were available for comparison of pre-storm profile shape and post-Patriots' Day Storm impacts. It is important to note that the front stake at FE04 was lost during the storm, and profiling was re-established at a back stake. Beach profile data were available from March 31, 2006, March 22 and April 20, 2007 (immediately post-storm), April 15, 2008, and May 1, 2009.

### **FE01 = D**

The pre-storm profile had a well developed dune that was completely eroded by the storm (Figure 30). The profile was flattened substantially and lost about 1m in dune elevation, though there was a gain in elevation in the offshore. By 2008, the profile had maintained its basic post-storm shape out to about 20 m, where it lost elevation in comparison with the post-storm shape. In 2009, the profile continued to lose elevation, including the dune crest. The profile does not appear to be recovering well.

### **FE02 = D**

Similar to FE01, the dune crest was obliterated, and sediment deposited in the offshore portion of the profile (Figure 31). In 2008, the profile showed further erosion, transgressing farther landward along its length. There was minimal recovery of the profile by the 2009 monitoring date, with some elevation gains, especially within the berm area (40 m and landward). However, recovery never reached the post-storm profile shape, and was not considered satisfactory.

### **FE03 = F**

Again, the profile's dune was completely eroded (Figure 32). The 2008 profile showed little recovery, and the 2009 profile showed little change from the 2008 shape. This profile has undergone continued erosion since the immediate post-storm shape, and recovery in 2008 and 2009 is relatively non-existent.

### **FE04 = A**

The pre-storm profile was eroded somewhat, but it is important to note that the profile is from March 2007, since the Patriots' Day Storm subsequently eliminated the front stake at FE04. After the storm the back stake was the new starting point (Figure 33). In 2008, the profile was very flat and steep, with few discernable features. By 2009, however, the profile showed a large, well-developed dune crest, and excellent recovery. This gain likely relates to the construction of a dune restoration project by the Ferry Beach Park Association and local property owners.

### **Summary**

Overall, the beach and dunes along Ferry Beach are struggling to recover from the impacts of the storm. Ferry Beach has not seen satisfactory levels of recovery. Artificial dune restoration dramatically helped the profile at FE04, though its impacts are not seen at FE01-FE03. Continued monitoring at these profiles is essential to tracking erosion rates.

**Overall grade = C-**



Figure 29. Location of beach profiles on Kinney Shores and Ferry Beach, Saco.

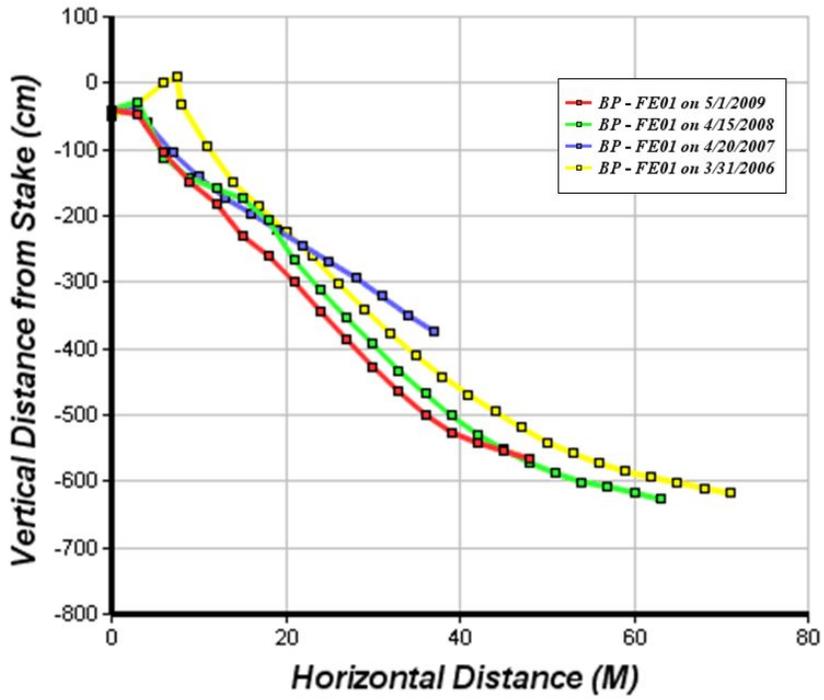


Figure 30. Beach profiles from Ferry Beach profile line FE01.

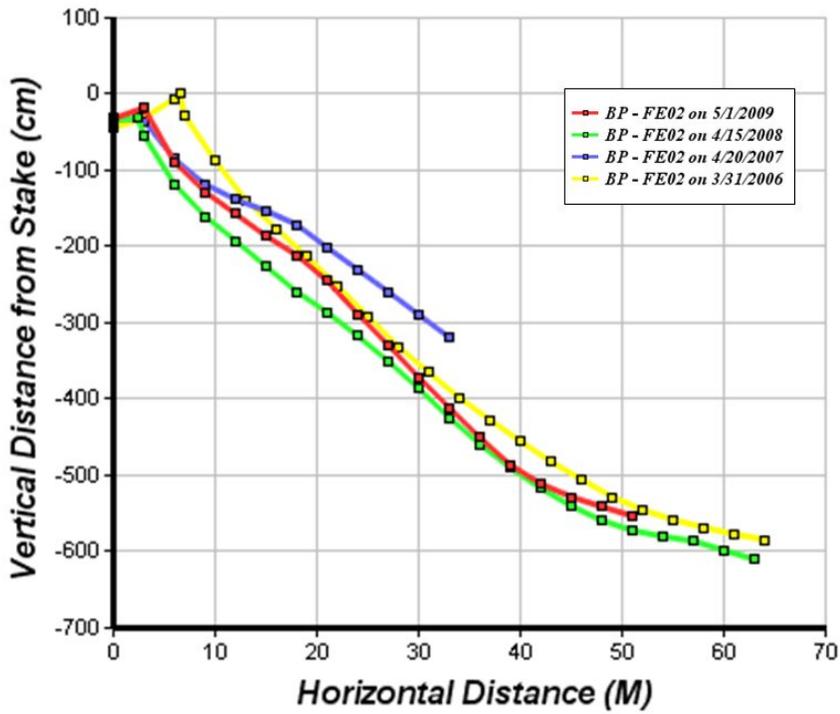


Figure 31. Beach profiles from Ferry Beach profile line FE02.

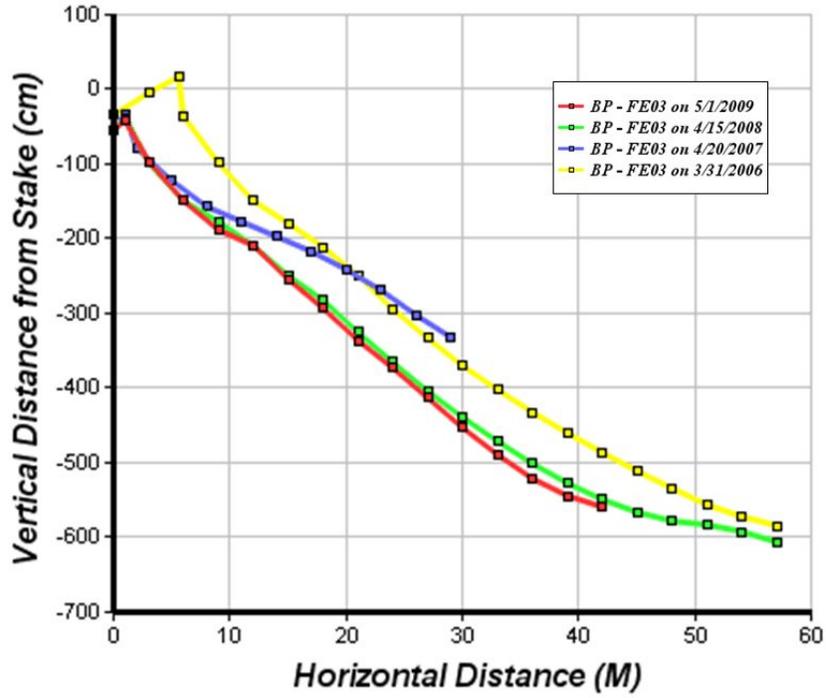


Figure 32. Beach profiles from Ferry Beach profile line FE03.

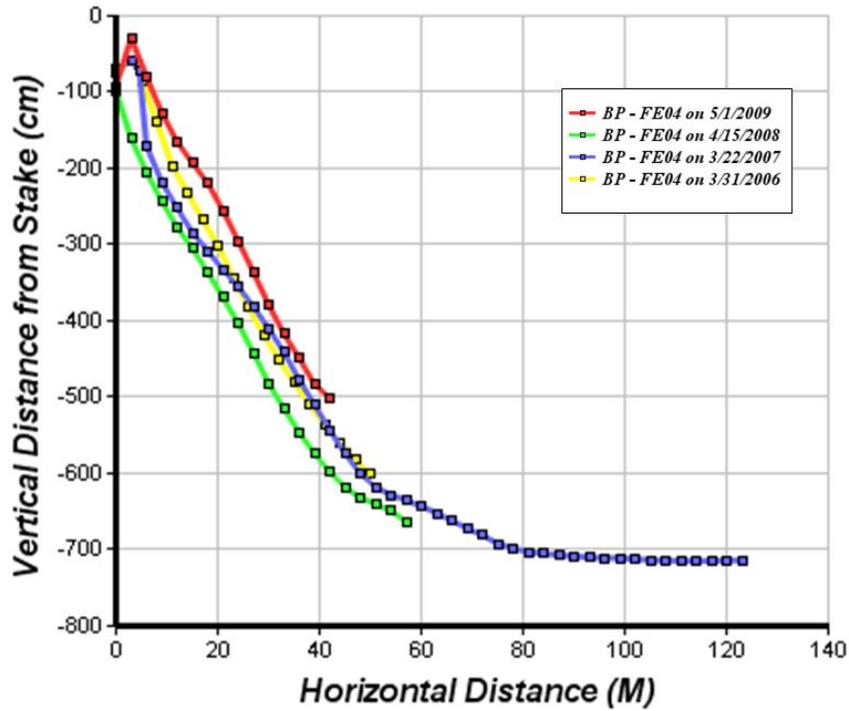


Figure 33. Beach profiles from Ferry Beach profile line FE04.

## Goose Rocks Beach, Kennebunkport

Four beach profiles (GR01 to GR04, Figure 34) were available for comparison of pre-storm profile shape and post-Patriots' Day Storm impacts. It is important to note that all starting stakes were lost in the storm; however, new stakes were established by volunteers in *approximate* previous locations. Beach profile data were available from April 5 and 6, 2006, April 21 and 23, 2007 (immediately post-storm), April 14 and 15, 2008, and April 4 and 7, 2009.

### GR01 = B-

This profile is located adjacent to the Batson River, at the southwest end of the beach (Figure 35). The immediate post-storm profile underwent apparent recovery by 2008 with the formation of numerous swash bars, which dramatically raised the elevation of the upper portion of the profile, and along most of the remainder of the profile. In 2009, the upper portion of the profile continued to grow, while the lower portion remained somewhat similar to the immediate post-storm profile, with its middle portion being lower in elevation than the post-storm profile.

### GR02 = A

GR02 is located in the central portion of the southern embayment of Goose Rocks Beach (Figure 36). Starting with the post-storm profile, dramatic recovery occurred in 2008, with the development of a well-defined berm. Additional recovery of the upper portion of the berm and in the offshore portion of the profile occurred by 2009, indicating excellent recovery within the two-year post-storm period.

### GR03 = C-

Most likely due to starting stake loss, the data for the April 2007 profile at GR03 did not appear to be recorded correctly

(Figure 37). Therefore, we used the May 21, 2007 profile data as our post-storm profile. The storm clearly eroded sediment from the profile along its length out to approximately 100 m offshore. Noted recovery occurred in 2008, with the profile developing a well-defined berm, and elevation increase along the length of the profile. However, the profile was eroded by April 2009. A high berm remained, but the offshore portion of the profile was at elevations below the 2007 post-storm profile. This may be due to an early April 2009 storm. Based on 2008 recovery, we would give GR03 an A, but based on the 2009 profile, it would receive a C-, as this kind of response suggests that the profile is now vulnerable to additional storm events.

### GR04 = B

GR04 is adjacent to the inlet of the Little River, at the northeast end of the beach. The post-storm profile indicates that dramatic beach lowering and erosion occurred, with over 1 m of elevation loss in the offshore (near the 300 m mark, Figure 38). Dramatic recovery occurred by 2008, with the profile undergoing extensive elevation gains. In 2009, the upper portion of the profile increased in elevation; however, the offshore portion (seaward of 90 m) underwent erosion along its entire length. Although this loss did occur, the 2009 profile was only lower in elevation at one point along its length than the immediate post-storm profile, and though it did not maintain the 2008 shape, it did represent good recovery.

### Summary

Overall, Goose Rocks Beach recovered relatively well from the storm. There is dramatic variation in profile shapes at the end members (GR01 and GR04) due to influence of the adjacent rivers. Profiles at Goose Rocks appear to have been influenced by storms in early 2009, which may account for the lowered profile shapes, and subsequently lower scores.

**Overall grade = B-**



Figure 34. Location of beach profiles on Goose Rocks Beach, Kennebunkport.

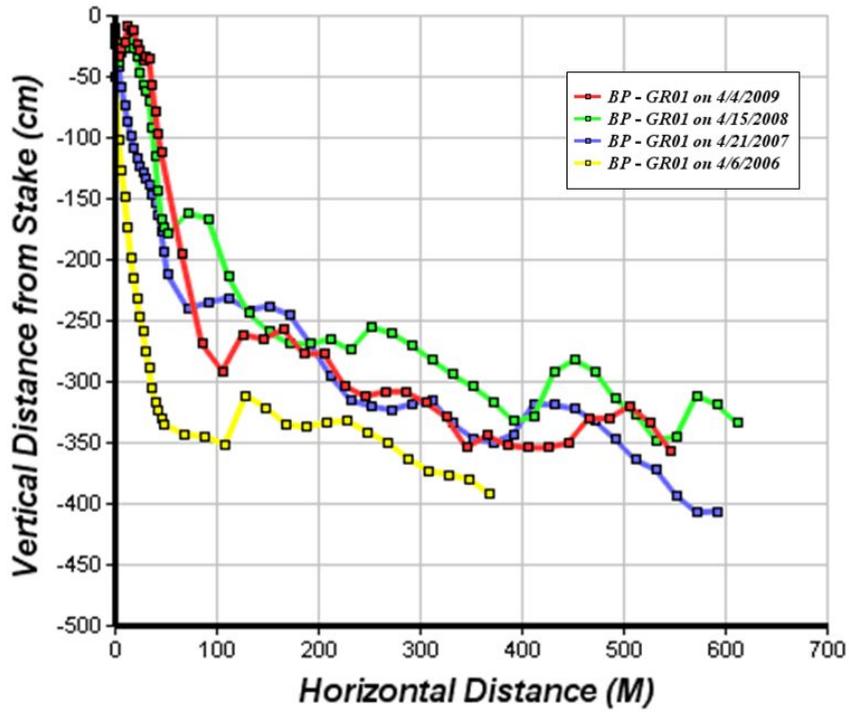


Figure 35. Beach profiles from Goose Rocks Beach profile line GR01.

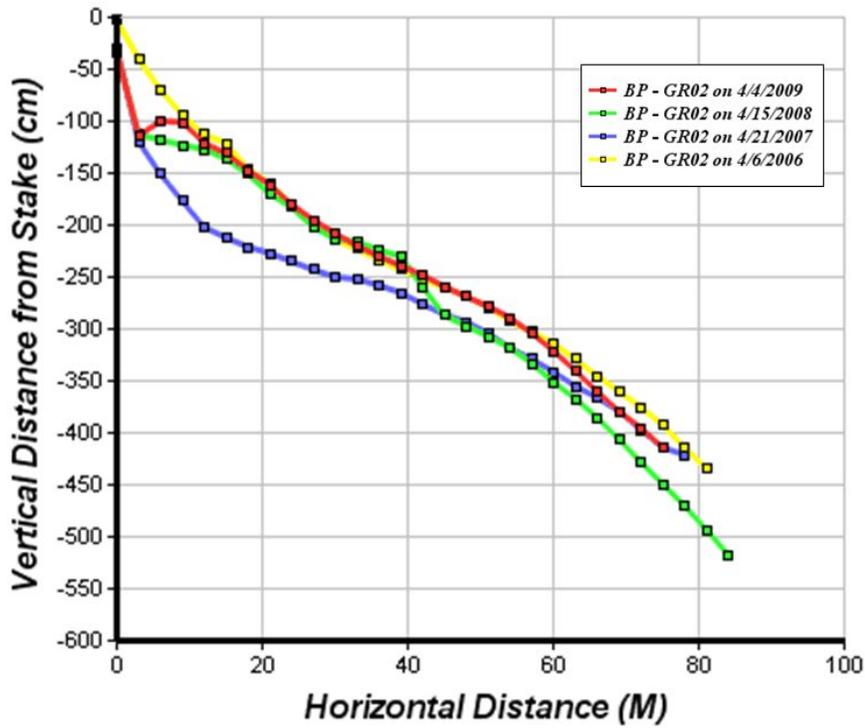


Figure 36. Beach profiles from Goose Rocks Beach profile line GR02.

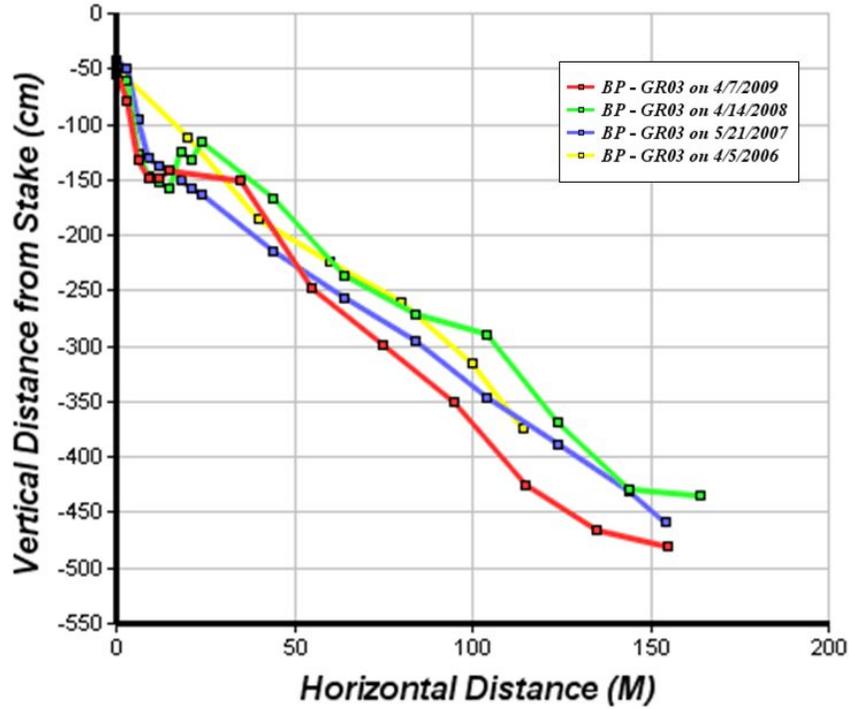


Figure 37. Beach profiles from Goose Rocks Beach profile line GR03.

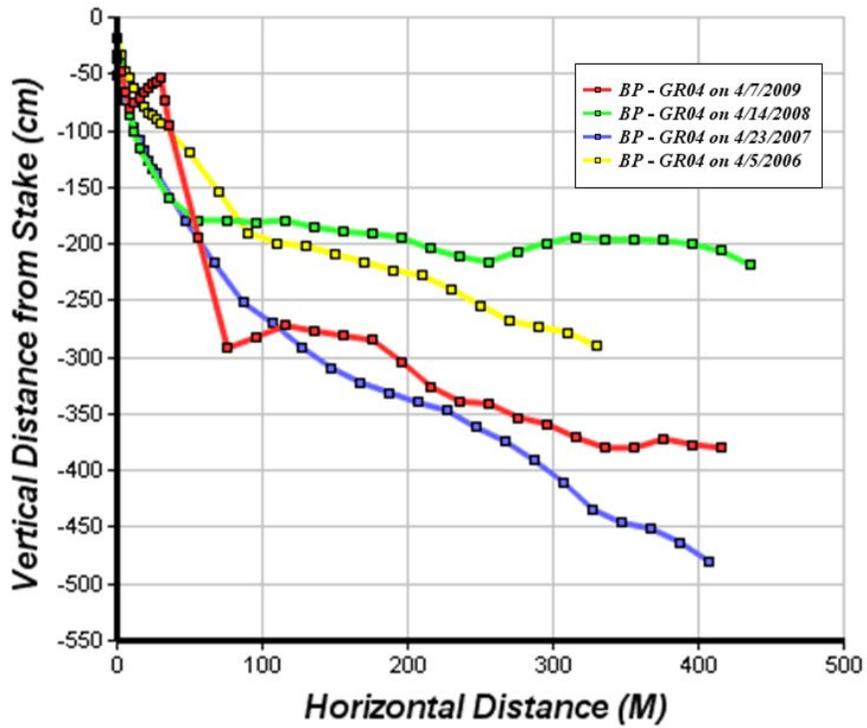


Figure 38. Beach profiles from Goose Rocks Beach profile line GR04.

## *Goochs Beach and Middle Beach, Kennebunk*

Three of four beach profiles (GO02 to GO04, Figure 39) were available for comparison of pre-storm profile shape and post-Patriots' Day Storm impacts. Profile GO01 was lost during the storm, and profiling was not resumed until June 2007 at this point – for this point, we use the June 2007 profile for comparison. Beach profile data were available from April 1, 2006, April 22 and June 25, 2007 (immediately post-storm), April 13, 2008, and April 4, 2009.

### **GO01 = A**

It appears that the starting pin at GO01 (southwest end of the beach) was lost in the Patriots' Day Storm, as data were not recorded for April 2007, but in June 2007 instead (Figure 40). The post-storm June profile displays a steep nearshore, and large berm/bar structure near the 10 m mark. In comparing post-storm profiles, it is evident that very good recovery occurred, as the 2008 and 2009 beach profiles all show a much healthier, more voluminous beach and berm than the June 2007 profile.

### **GO02 = A**

At GO02, which is somewhat centrally located along the beach, it is clear that the storm led to dramatic loss of sediment along the entire profile (Figure 41). The 2006 beach profile was flattened and sediment lost from the entire profile. However, by 2008, good recovery from the storm was noted, though it did not reach the pre-storm conditions. By 2009, the beach appeared to have fully recovered.

### **GO03 = B**

The GO03 post-storm profile showed lowering of the beach elevation by about 20 cm, consistently along the length of the profile, when compared with the pre-storm profile (Figure 42). In 2008 and 2009, the profile exhibited slight gradual recovery along its length, with slight increases in profile elevation at its nearshore portion.

### **GO04 = C**

GO04, located along Middle Beach, showed consistent loss of sand and cobble elevation between 2006 and the post-storm 2007 profile (Figure 43). In 2008, the upper berm portion of the profile markedly grew. However, the profile exhibited steepening in the offshore, and seaward of about 12 m, was actually steeper than the 2007 post-storm profile. The 2009 profile maintained this shape. Although the upper portion of the profile appears to have gained elevation, the lower profile actually has lost significant elevation and sediment since the 2007 storm, leading to a cautionary grade.

### **Summary**

Recovery at Gooch's Beach appears to be occurring very well, though Middle Beach appears to be struggling to recover from the impacts of the Patriots' Day Storm.

**Overall grade = B**



Figure 39. Location of beach profiles on Goochs Beach and Middle Beach, Kennebunk.

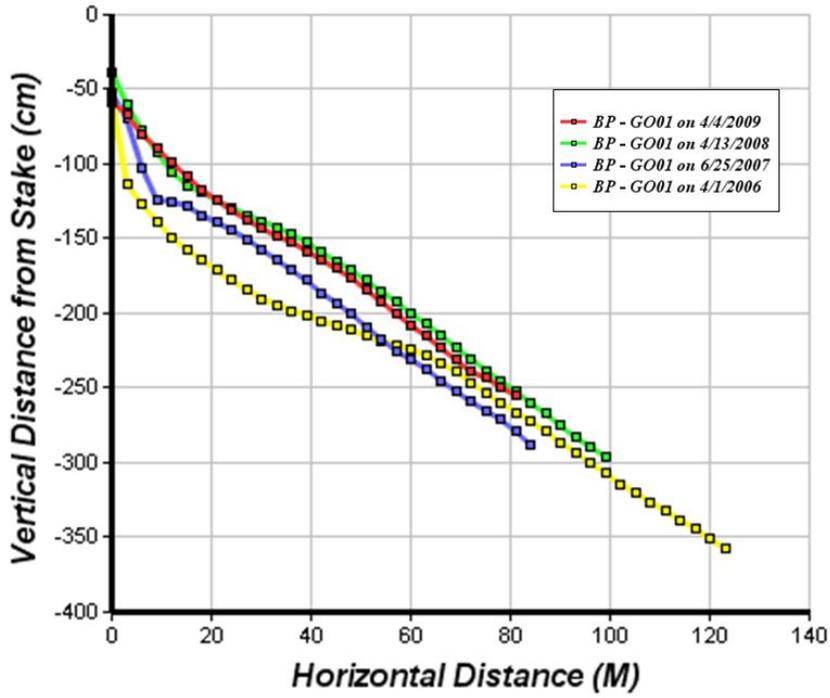


Figure 40. Beach profiles from Goochs Beach profile line GO01.

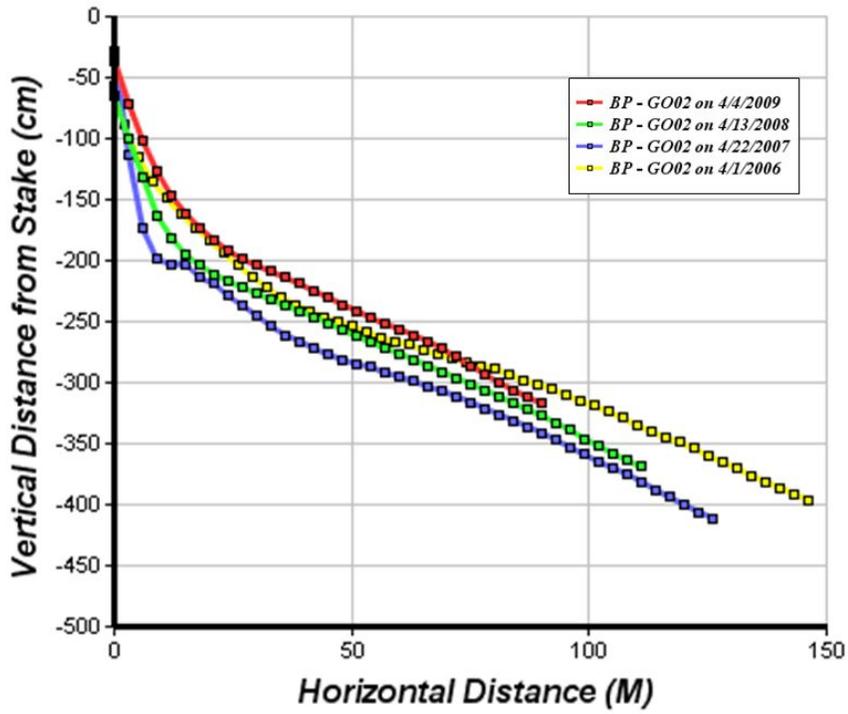


Figure 41. Beach profiles from Goochs Beach profile line GO02.

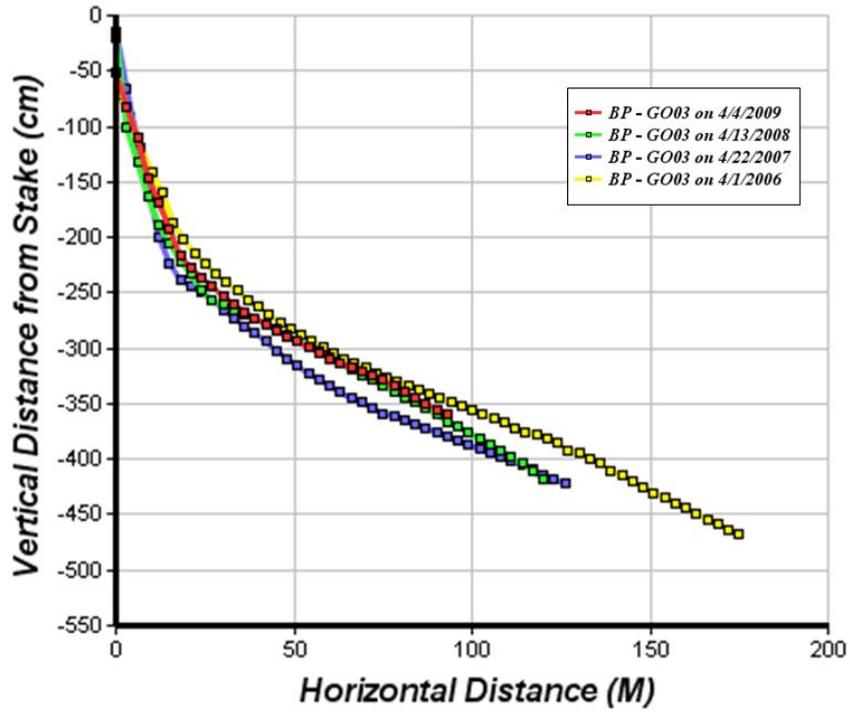


Figure 42. Beach profiles from Goochs Beach profile line GO03.

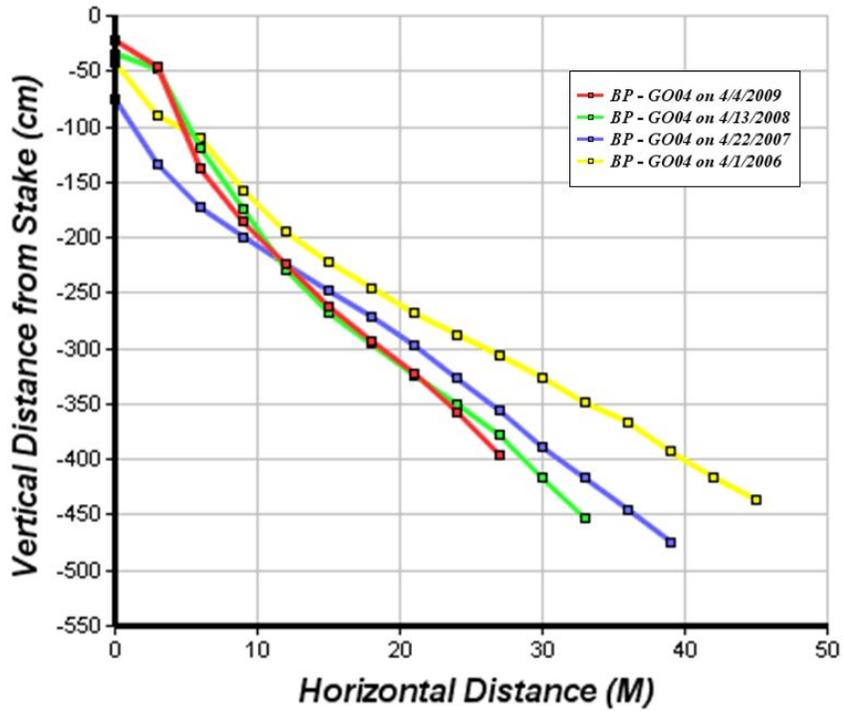


Figure 43. Beach profiles from Middle Beach profile line GO04.

## ***Laudholm Beach, Wells***

Four of five beach profiles (LH01-03, LH05, Figure 44) were available for analysis of beach recovery. LH04 was abandoned in 2006. At LH01, the front profile stake was lost, and profiling was resumed at the back stake in June 2007. Profile data were available from April 1 and May 20, 2006, April 20 and June 23, 2007 (immediate post-storm), April 11, 2008, and May 1, 2009.

### **LH01 = B-**

At LH01, the profile stake was lost during the Patriots' Day Storm, thus it is impossible to compare the profiling started in June 2007 (back stake) with pre-storm profiling from 2006 (Figure 45). Using the June 2007 profile as the baseline, by April 2008, the post-storm profile had recovered, most notably at the 50 m mark, where the storm caused the formation of a trough, and in the offshore (seaward of 100 m), where the sand elevation recovered. The 2009 profile maintained roughly the same shape as the 2008 profile. The profile seems stable since the 2007 storm, but has only undergone slight increases in elevation.

### **LH02 = B**

The Patriots' Day Storm eroded the majority of the profile, by about 20-30 cm, out to about 125 m offshore (Figure 46). By 2008, the majority of the profile demonstrated good recovery. However, in 2009, the profile eroded along its length, though it did maintain elevations above the 2007 post-storm shape. This erosion was likely due to the mid-April and early May 2009 storms.

### **LH03 = B**

The pre-storm profile was eroded along its length, and the dune eroded landward slightly in response to the storm (Figure 47). The upper portion of the profile added elevation by 2008, but the middle portion (between 50-80 m offshore) continued to deepen. In 2009, the profile had gained more elevation and slightly exceeded the 2007 post-storm profile along its length.

### **LH05 = B-**

At LH05, the profile lost about 50 cm of sediment along the profile, and again the dune eroded landward in response to the storm (Figure 48). By April 2008, the upper portion of the profile (from 40 m offshore landward), had recovered very well, and gained elevation and built seaward; however, in the offshore, the profile did not respond the same way. This may be due to offshore outcrops and cobble deposits. The 2009 profile showed some dune and beach erosion along the upper portion of the profile, and did not change much in the offshore.

### **Summary**

Overall, Laudholm Beach appears to have recovered well from the storm, with some of the profiles not recovering quite as well as others. However, satisfactory to above-average recovery did occur at all profiles.

**Overall grade = B**



Figure 44. Location of beach profiles on Laudholm Beach, Wells.

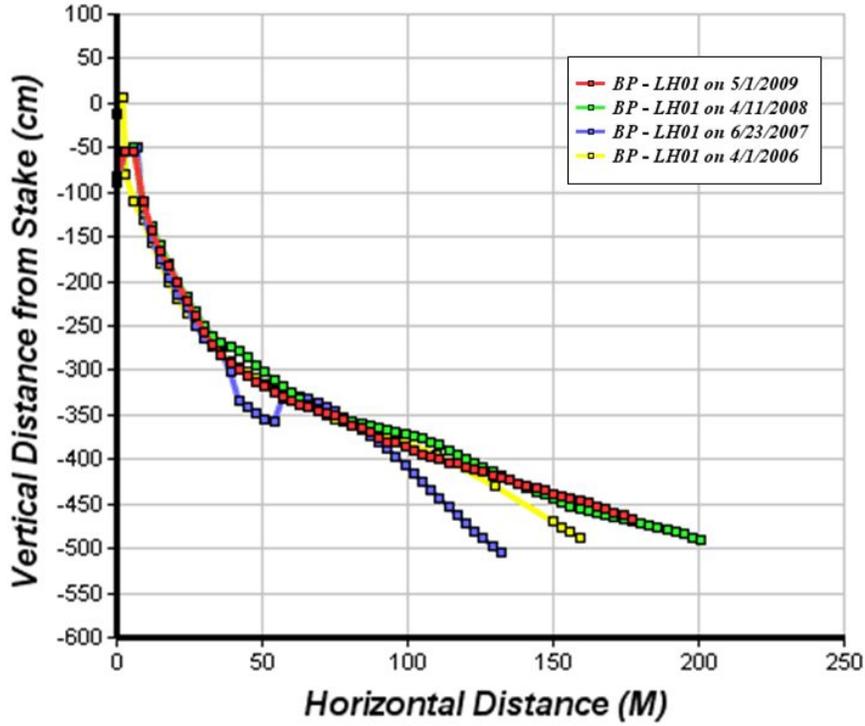


Figure 45. Beach profiles from Laudholm Beach profile line LH01.

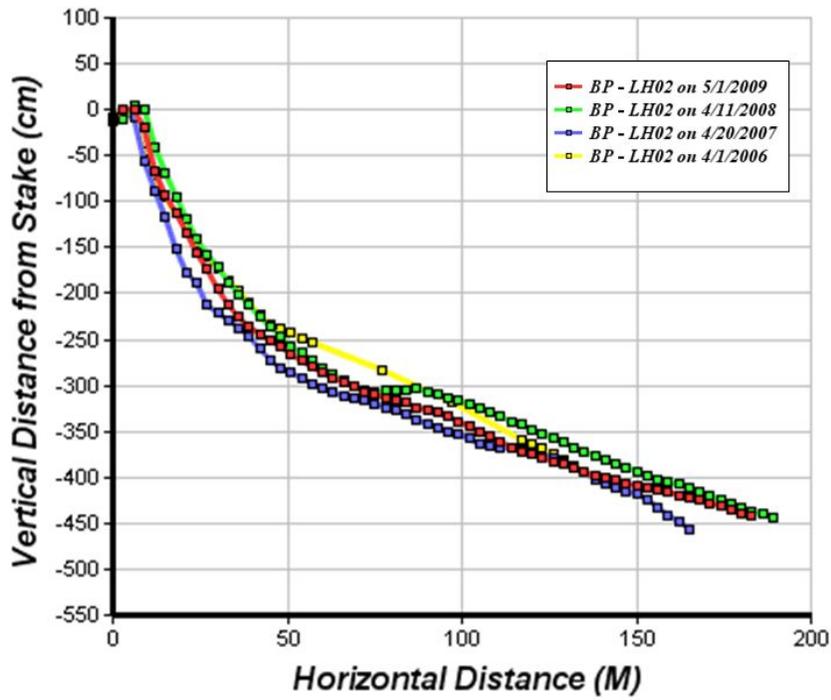


Figure 46. Beach profiles from Laudholm Beach profile line LH02.

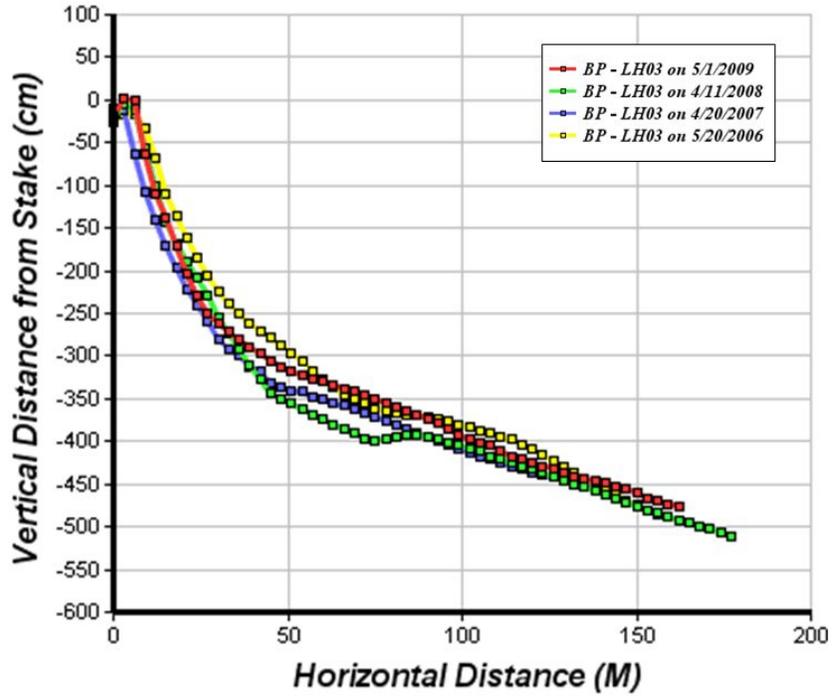


Figure 47. Beach profiles from Laudholm Beach profile line LH03.

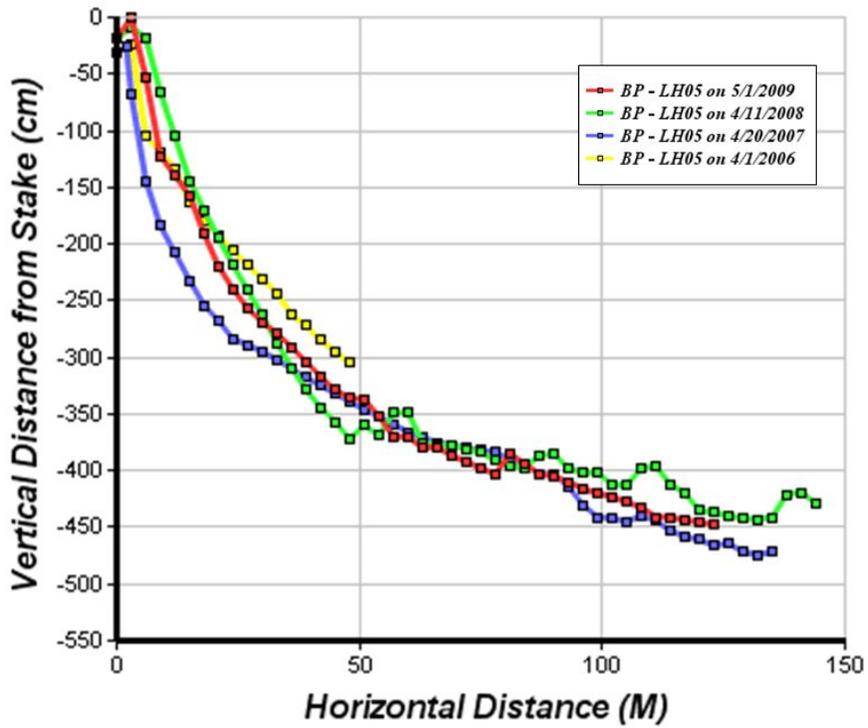


Figure 48. Beach profiles from Laudholm Beach profile line LH05.

## ***Drakes Island Beach, Wells***

Four beach profiles (DI01-DI04, Figure 49) were available for analysis of beach recovery. Profile data were available from May 22, 2006, May 14, 2007 (immediate post-storm), May 1, 2008, and May 20, 2009.

### **DI01 = A**

Located adjacent to the north jetty at the Webhannet River, DI01 underwent dramatic erosion, losing upwards of 1 m of sand elevation along certain sections of the profile, resulting in the formation of a steep berm and bar (Figure 50). Recovery occurred along the majority of the profile by 2008, with the eroded berm returning. Recovery continued into 2009, with additional profile elevation gains along the length of the profile.

### **DI02 = A**

At DI02, the storm actually caused the movement of sediment (likely cobbles) from the lower portions of the profile (apparent in 2006 near 70 m offshore), to the upper portion of the profile in 2007 (near 25 m offshore, Figure 51). The uppermost portion of the profile did not appear to change. By 2008, the entire profile underwent accretion, with elevation being gained along the entire length. Some slight erosion of the profile is apparent in 2009, but the extensive recovery that appears to have occurred remained.

### **DI03 = D**

The storm actually caused the profile to gain in elevation at the 20 m (berm) and 50 m marks, likely due to the deposition of

cobbles on the profile during the storm (Figure 52). By 2008, the profile had significantly eroded along its length, losing between 20-50 cm of elevation. The 2009 profile showed some recovery from the 2008 shape, with minimal gains in the nearshore, and larger elevation gains in the offshore. DI03 was apparently impacted by a large storm in the end of April, 2008, where wave heights reached over 3.2 m (10 feet) between April 28 and April 30. This apparently slowed down recovery at this profile.

### **DI04 = D**

The storm eroded the profile from a relatively flat, slightly concave shape, to a series of bars, with loss of elevation along the profile (Figure 53). Similar to DI03, the profile eroded in 2008, likely in response to the same storm, resulting in the lowest elevations of the four profiles compared. By 2009, some recovery had occurred in the offshore, though the upper portion of the profile was still below the 2007 storm shape.

### **Summary**

Profiles closer to the jetty along Drakes Island recovered very well from the storm. It appears that the storm positively influenced the profile at DI03. Both DI03 and DI04 were adversely impacted by a relatively strong storm at the end of April 2008, which eroded each of these profiles to the lowest elevations of all four. The impacts of these storms may indicate that DI03 and DI04 have not recovered, and remain susceptible to erosion from smaller events.

**Overall grade = B-**



Figure 49. Location of beach profiles on Drakes Island Beach, Wells.

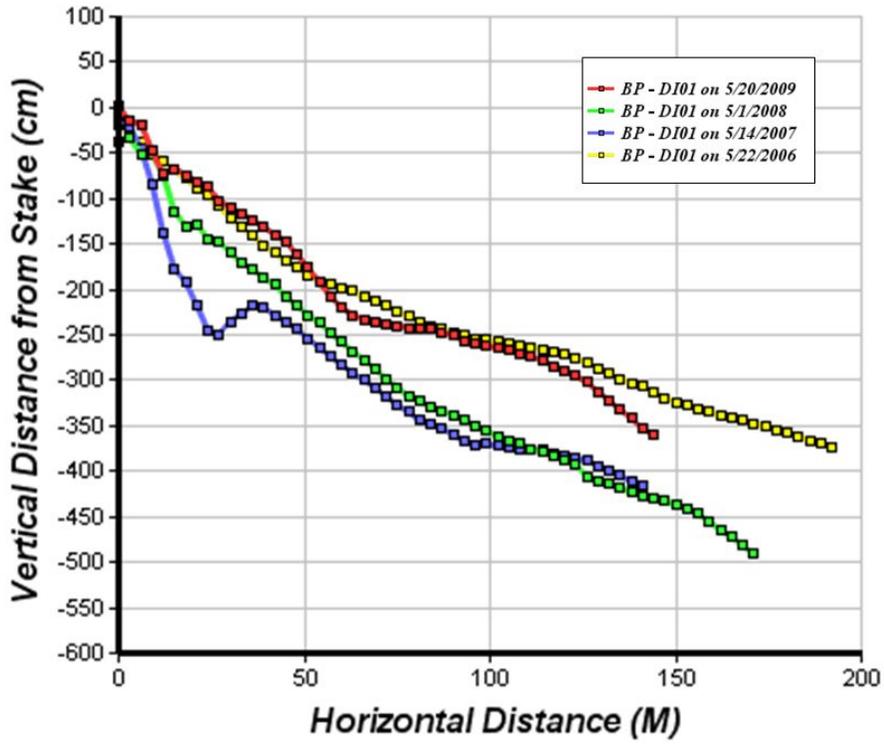


Figure 50. Beach profiles from Drakes Island Beach profile line DI01.

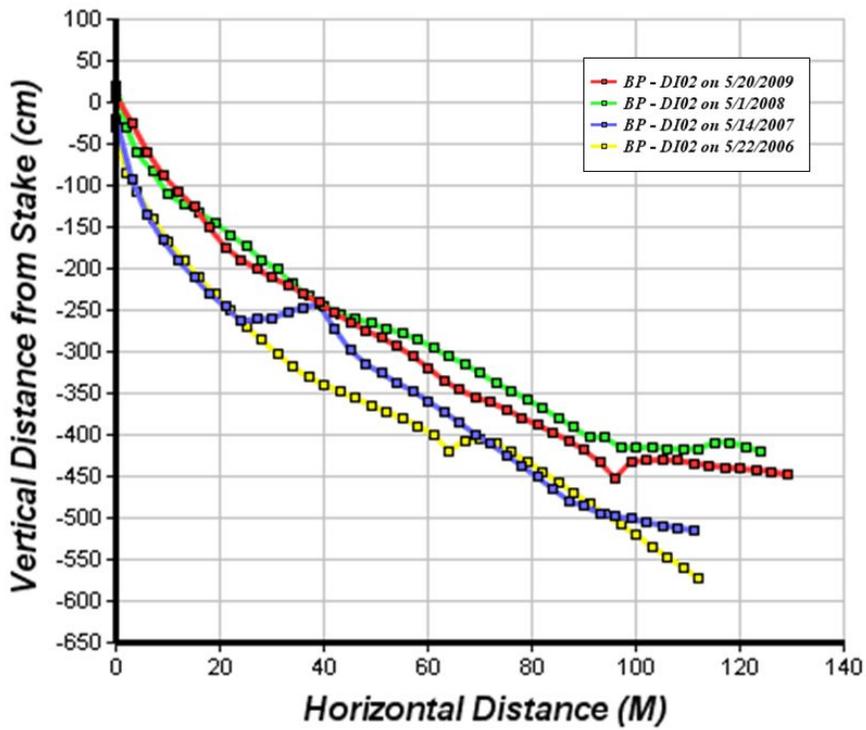


Figure 51. Beach profiles from Drakes Island Beach profile line DI02.

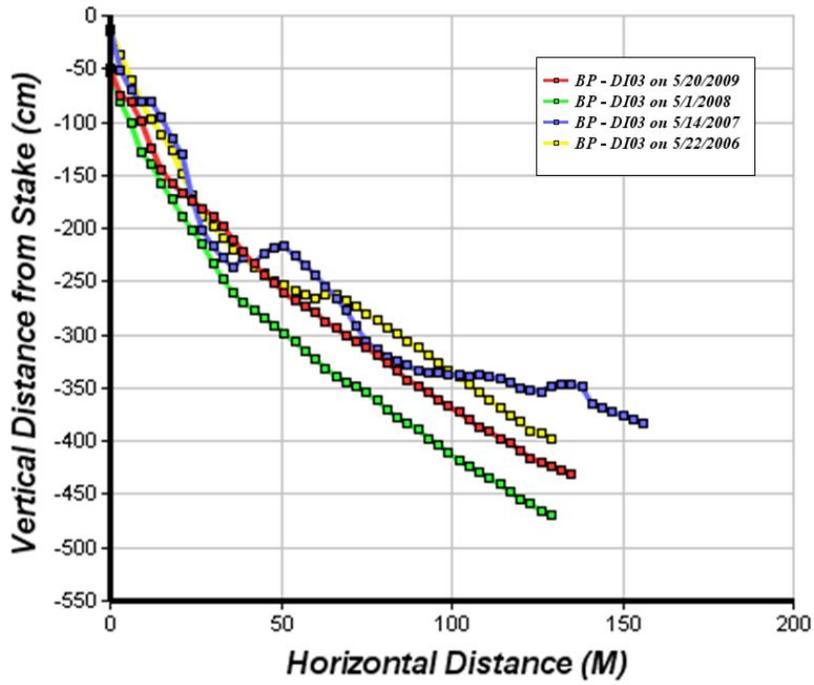


Figure 52. Beach profiles from Drakes Island Beach profile line DI03.

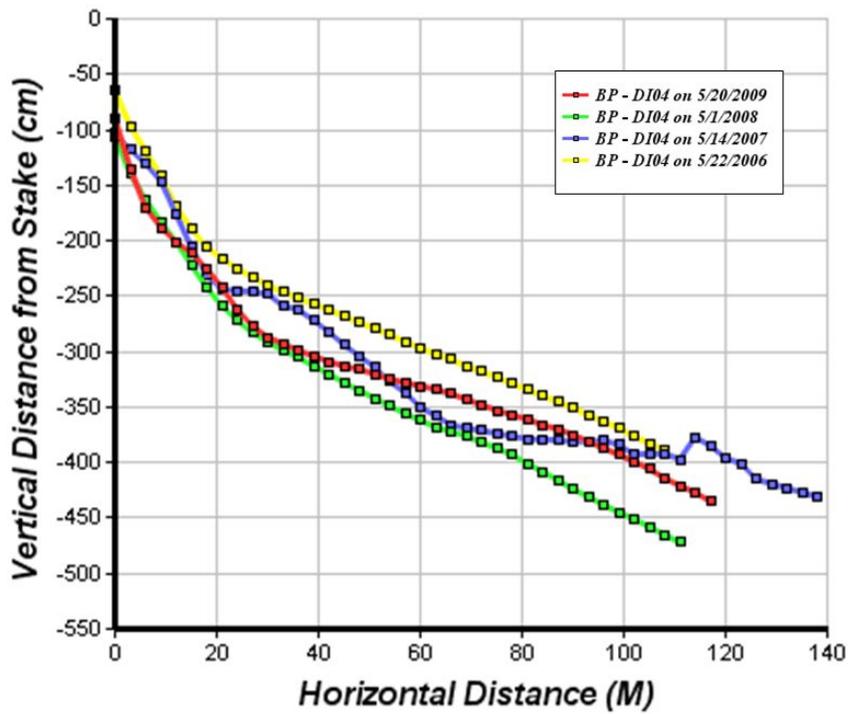


Figure 53. Beach profiles from Drakes Island Beach profile line DI04.

## *Wells Beach, Wells*

Four beach profiles (WE00, WE02-WE04, Figure 54) were available for analysis of beach recovery. Profile data were available from April 2, 2006, April 21, 2007 (immediate post-storm), April 12, 2008, and April 4, 2009.

### **WE00 = A**

Located south of Casino Point, WE00 exhibited large amounts of erosion - up to about 50 cm - along the upper portion of the profile, from about 60 m and landward (Figure 55). A relatively large berm was completely removed by the storm. Off-shore of the 60 m mark, there were few changes; this may relate to a hard substrate (cobble) bottom covered by a little sand. By 2008, the berm had returned, though it had a slightly steeper face up to the starting pin. The 2009 profile showed that recovery had occurred, with a berm forming that was larger than the previous one in 2006.

### **WE02 = A**

Located north of Casino Point, WE02 lost beach elevation along its entire length, with the most notable losses (50 cm or more) between the 40-100 m offshore marks (Figure 56). The profile here is concave, with few berm or bar features. By 2008, the profile had recovered substantially – almost to the same shape as the pre-storm 2006 profile. By 2009, the beach had continued to recover, with over 60 cm of difference between the

2009 profile and the immediate post-storm profile, especially near the 40-50 m mark.

### **WE03 = A-**

WE03 is located south of the Webhannet River jetties. As a result of the storm, the upper portion of the profile (berm) was eroded, while there was some elevation gain in the middle portions of the profile (Figure 57). Recovery by 2008 occurred, with the profile gaining elevation along its entire length. Similarly, berm development was noted in the 2009 profile.

### **WE04 = A**

WE04, directly adjacent to the Webhannet River jetties, actually underwent accretion in response to the Patriots' Day Storm, with substantial growth of the dune and upper berm (Figure 58). This growth actually continued in 2008, and into 2009, with additional elevation increases in the berm area.

### **Summary**

Wells appears to have responded exceedingly well in terms of recovery from the Patriots' Day Storm. Growth occurred at all of the profile locations, especially at WE04, which actually underwent accretion in response to the storm. This is likely due to trapping of sediment alongside the Webhannet River jetties during, and after the storm event.

**Overall grade = A**



Figure 54. Location of beach profiles on Wells Beach, Wells.

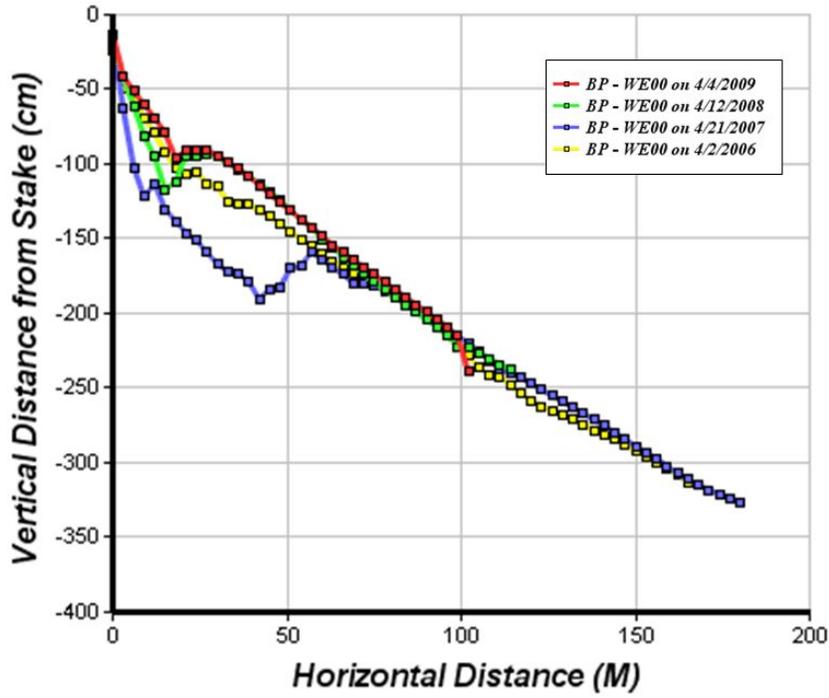


Figure 55. Beach profiles from Wells Beach profile line WE00.

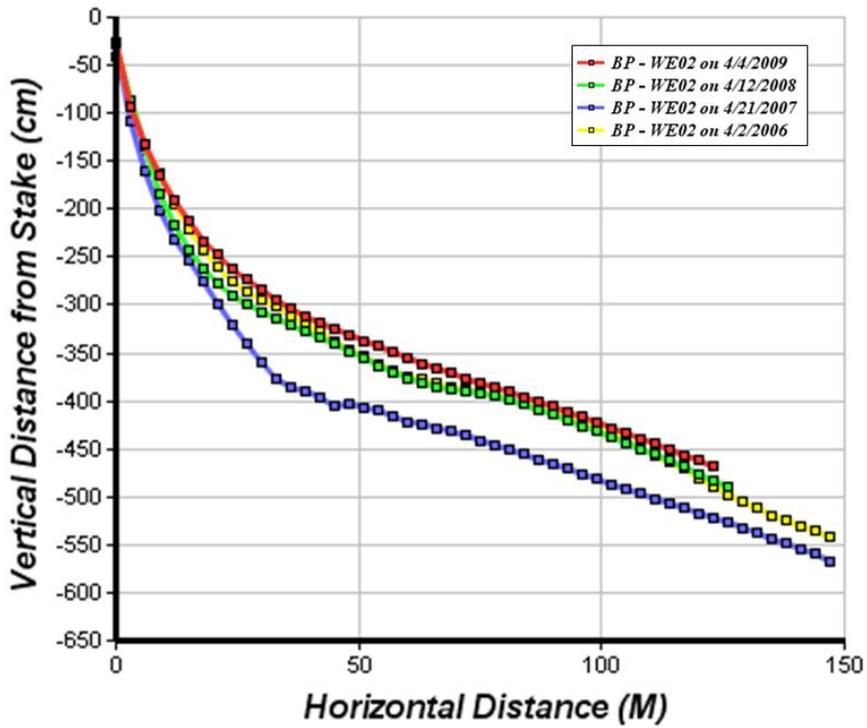


Figure 56. Beach profiles from Wells Beach profile line WE02.

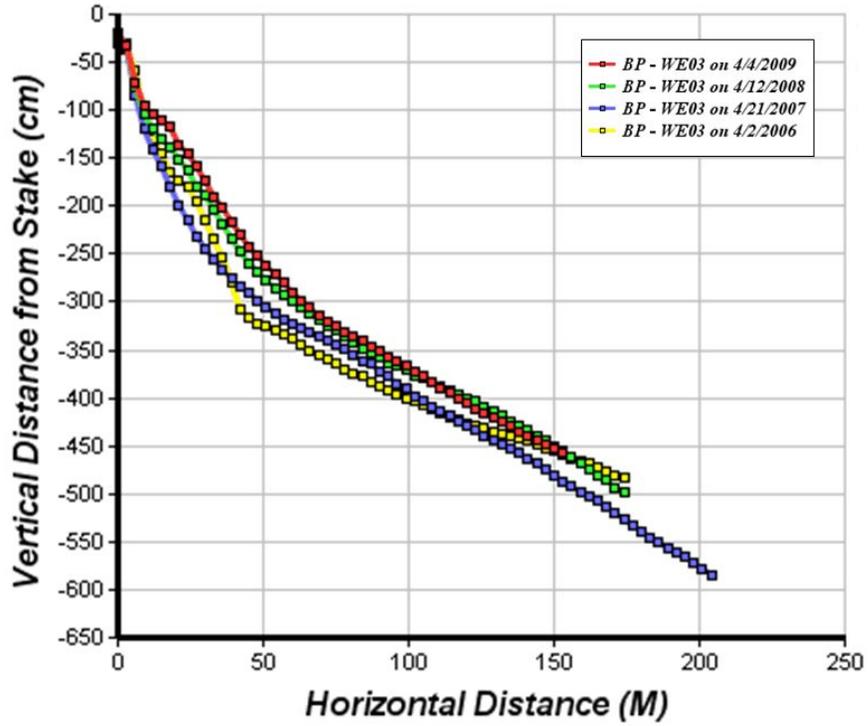


Figure 57. Beach profiles from Wells Beach profile line WE03.

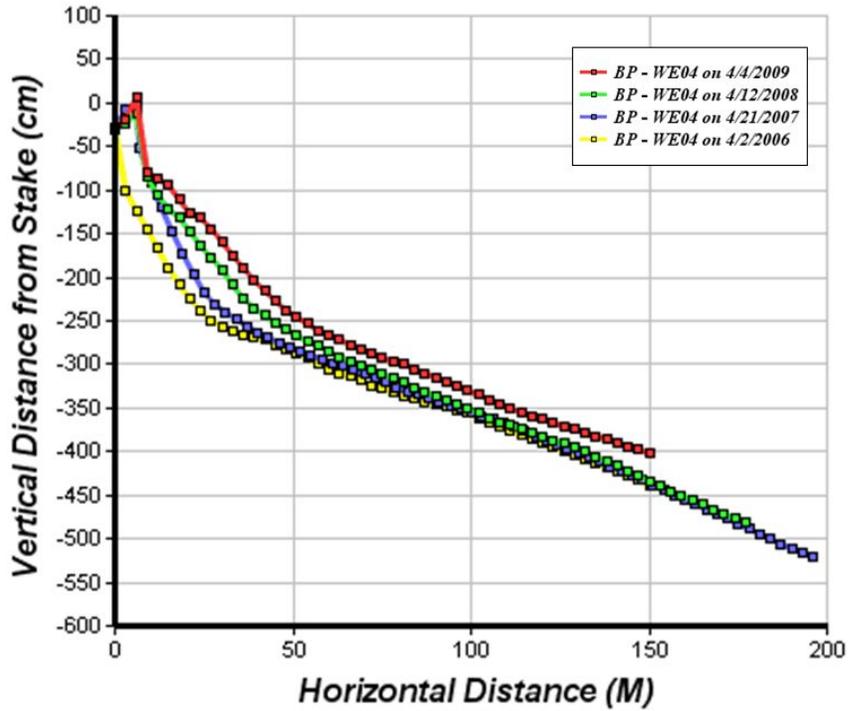


Figure 58. Beach profiles from Wells Beach profile line WE04.

## Ogunquit Beach, Ogunquit

Four beach profiles (OG01 to OG04, Figure 59) were available for comparison; however, at each location, profiling had been occurring at the front stake, and post-storm, profiling was initiated from the back stake. It is difficult to relate front-to-back stake profiling, thus we have not included the pre-storm (2006) profile shapes for the Ogunquit beaches, so it is impossible to describe the immediate impacts of the storm. Also, no data from profiles collected in 2009 were available via the Shore Stewards website. Therefore, we chose to use the latest available data for each profile, which varied from July to November 2008. Beach profile data were available from April 21 and May 19, 2007 (post-storm), and May 24, 2008, along with subsequent July, September, or November 2008 dates.

### OG01 = C

Since no 2006 profile is available from the back stake, we can only describe the recovery from 2007-2008 comparison. The 2008 profile, from May, showed clear erosion and lowering of the profile along its entire length when compared with the 2007 profile from the same month (Figure 60). This may be related to a series of storms in May which had waves over 1.5 m (5 feet) in height on May 5, and waves consistently over 2 m (6.5 feet) from May 11 - May 15, 2008. By November 2008, the profile had gained over 50 cm of elevation along its nearshore to offshore portions, from about 20 m seaward. The largest gains were near the 200 m mark (close to 1 m in elevation gain from the May 2008 profile). Although the November 2008 profile exceeds the 2007 post-storm profile from the 50 m mark and seaward, the upper portion of the profile never comes close to attaining the immediate post-storm dune elevation.

### OG02 = C

The 2007 profile had a relatively concave shape, with an apparent scarp cut into the dune near the 10 m mark (Figure 61). By 2008, the upper portion of the profile (40 m landward) had either remained stable, or had gained elevation, especially nearest the starting stake. Offshore, however, seaward of the 40 m mark, the 2008 profile lost elevation and remained below the 2007

post-storm profile. However, by November 2008, the profile had regained much of its elevation in reference to the immediate post-storm profile, and shows some sense of profile stability.

### OG03 = B+

At OG03, the post-storm profile had a well developed dune, and then a concave shape into the offshore (Figure 62). By 2008, the dune crest appears to have lost a slight bit of elevation, but the remainder of the profile in a seaward direction gained about 10-25 cm along its length. The latest profile available was from September 2008, which showed massive amounts of elevation gain along the profile, especially seaward of 25 m. This was in the form of onshore migrating bars. However, the upper portion of the profile had not increased in elevation.

### OG04 = B

The post-storm profile showed an apparent berm at about the 20 m mark, and a relatively concave profile shape into the offshore (Figure 63). By 2008, the upper portion of the profile gained elevation remarkably (from 10 m landward), but seaward of this, the entire profile appears to have lowered well below the 2007 profile shape. The latest profile available was from July 2008; by this time, the profile recovered very well, with additional dune growth, and the remainder of the profile mimics or slightly exceeds the immediate post-storm profile.

### Summary

For the Ogunquit Beach profiles, there appeared to be good recovery of the profiles through the late summer and fall months of 2008, which was the latest profile data available. No 2009 data were available, so we were unable to compare April or May 2008 to April or May 2009 data. The late summer and early fall months are typically when profiles are most developed, and have the most sediment within their shapes and therefore highest elevations. Therefore, the recovery noted may be a somewhat false indicator, since these shapes are being compared with typically 'leaner,' more erosive, springtime shapes from the other years.

**Overall grade = B-**



Figure 59. Location of beach profiles on Ogunquit Beach, Ogunquit.

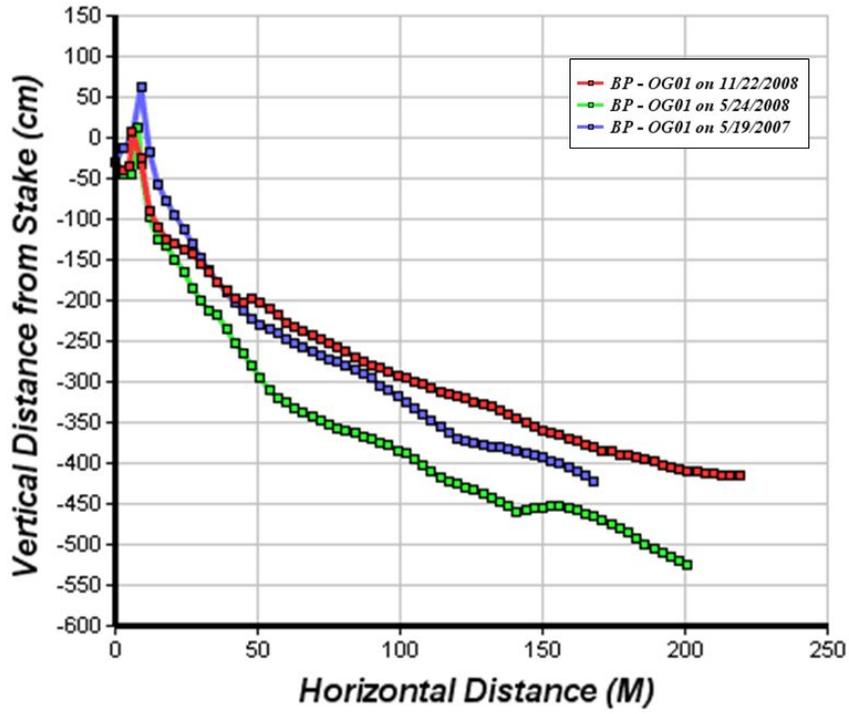


Figure 60. Beach profiles from Ogunquit Beach profile line OG01.

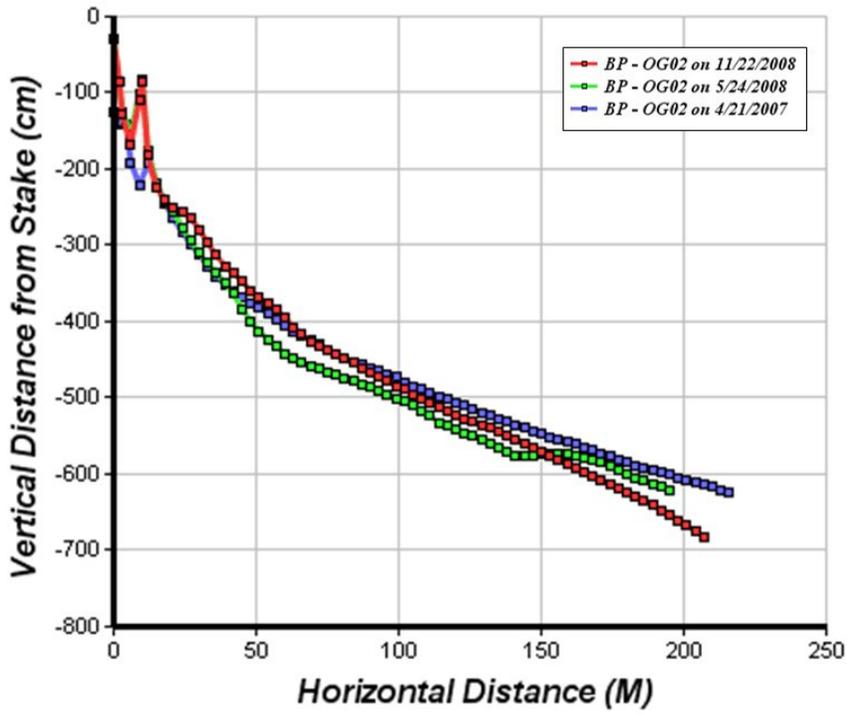


Figure 61. Beach profiles from Ogunquit Beach profile line OG02.

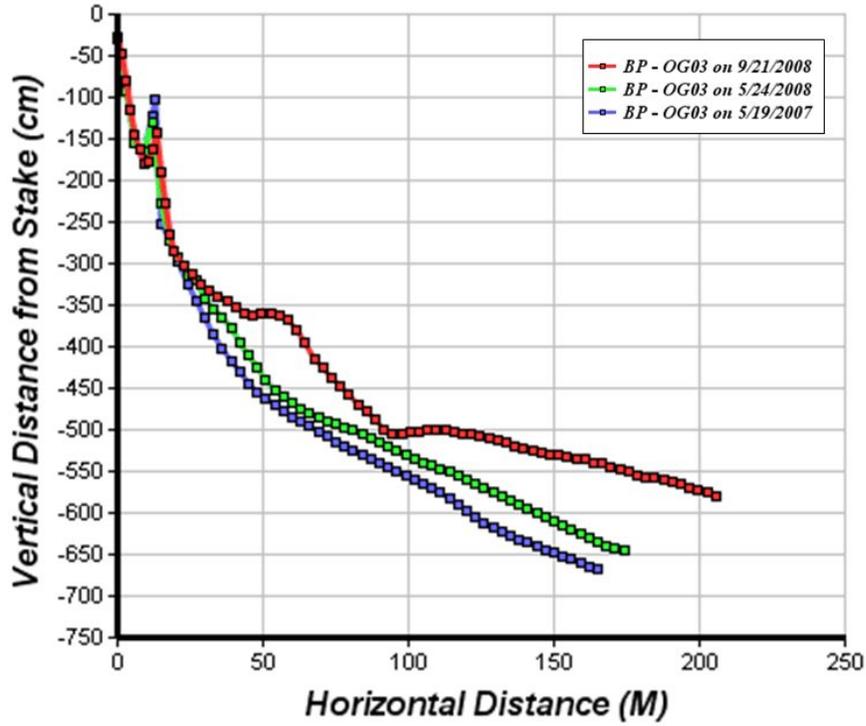


Figure 62. Beach profiles from Ogunquit Beach profile line OG03.

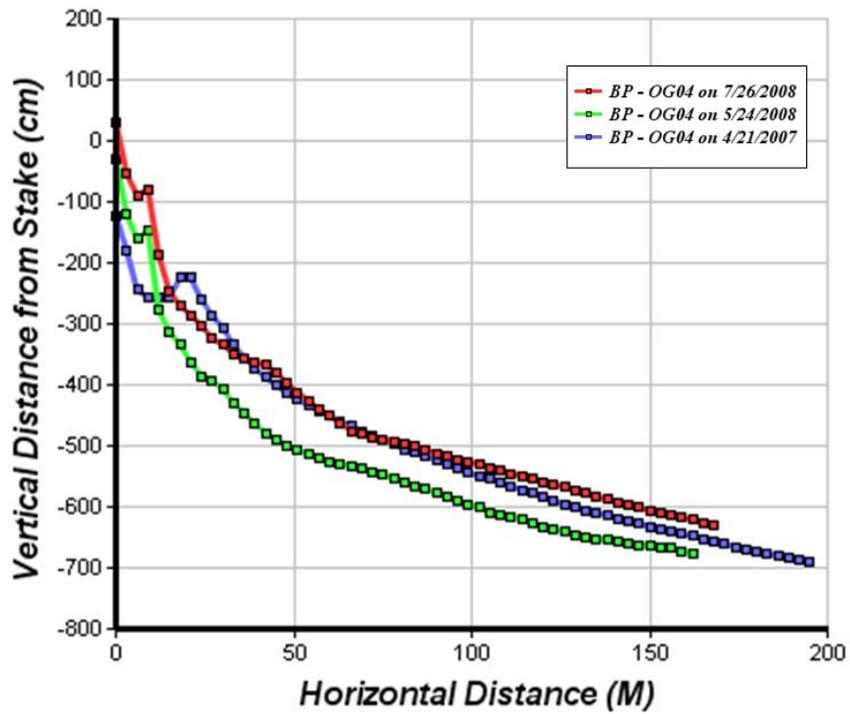


Figure 63. Beach profiles from Ogunquit Beach profile line OG04.

## ***Long Sands Beach, York***

Two of three beach profiles (LS01 and LS03, Figure 64) were available for comparison. Profile LS02 was lost during the storm, and profiling not resumed. Beach profile data were available from April 1, 2006, April 22, 2007 (immediately post-storm), April 13, 2008, and April 15, 2009.

### **LS01 = B**

The post-storm profile exhibited slight changes; there was some loss of elevation in the upper portion of the profile (from 50 m landward), and sediment gain in the offshore (Figure 65). This relates to erosion of sediment and transfer into offshore bars. The 2008 one-year post storm profile showed marked erosion, with the majority of the profile elevations being below those of the immediate post-storm profile. However, the 2009 profile underwent dramatic elevation gains, especially in the nearshore portion of the profile, from about 50-60 m and landward, though the offshore portion basically matches the immediate post-storm shape.

### **LS03 = B**

Immediately post-storm, the beach profile showed signs of erosion of the beach and berm, and lowering of the profile between 50-75 m offshore (Figure 66). The 2008 profile showed slight berm recovery, and a gain in elevation of sediment in the offshore portion of the profile, from about 50 m seaward. By 2009, the profile developed a distinct berm feature at the 20 m mark, and although the nearshore developed a steeper slope, the offshore portion of the profile (40 m and seaward) increased in elevation by about 30 cm from 2008 elevations.

### **Summary**

Recovery at Long Sands Beach has been quite good, with significant elevation gains along the profiles. Although some portions of the profiles were very low through 2008, good gains were made in 2009.

**Overall grade = B**



Figure 64. Location of beach profiles on Long Sands Beach, York.

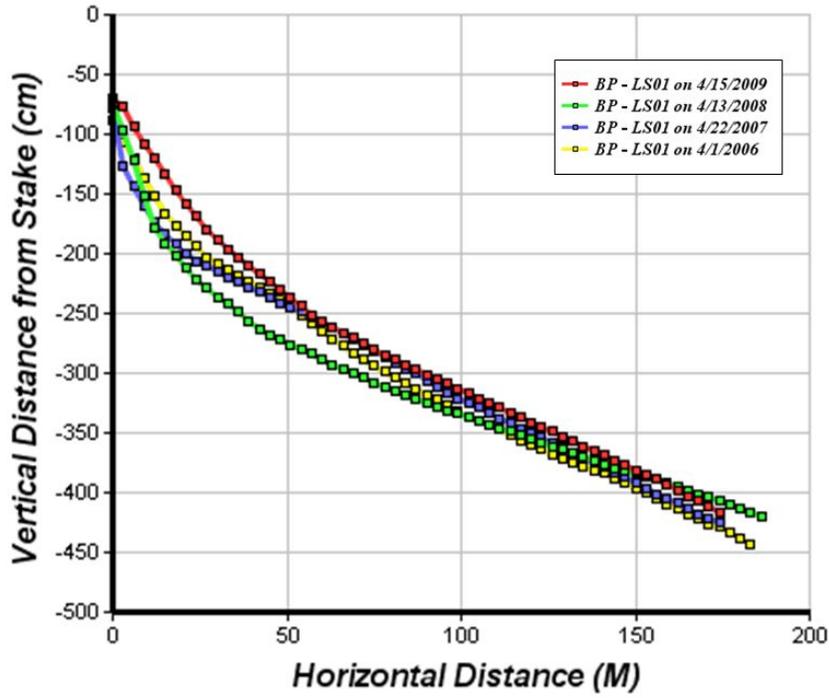


Figure 65. Beach profiles on Long Sands Beach profile line LS01.

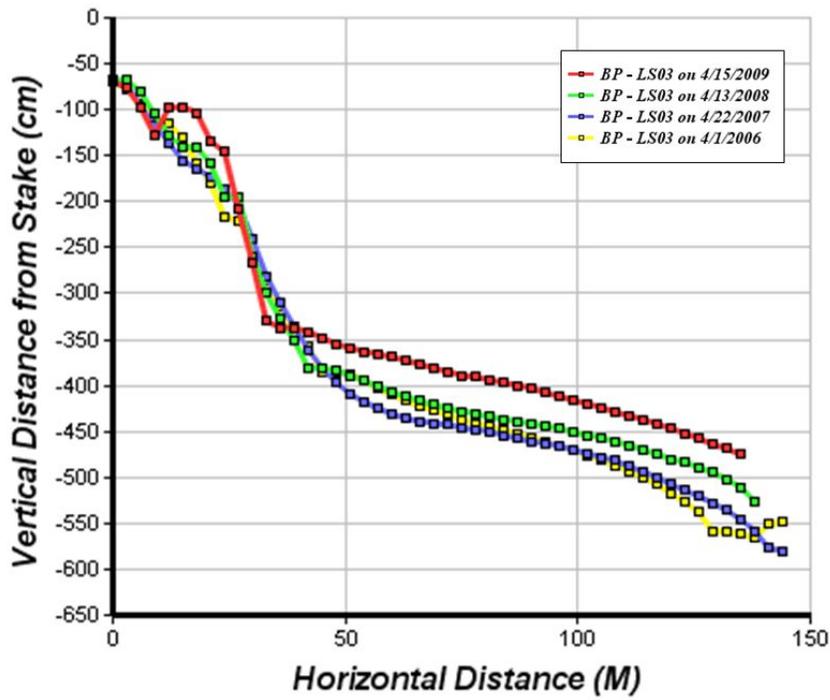


Figure 66. Beach profiles on Long Sands Beach profile line LS03.

## *Beach Grading Summary and Discussion*

Overall, the beaches in southern Maine, based on volunteer profile data collected, have recovered relatively well from the Patriots' Day Storm of 2007, scoring an overall grade of **B/B-** (see Table 3). It appears that some of the beach profiles were adversely affected by spring storms in April and May 2008, and the same months in 2009. These later storms may have had a negative impact on the overall grade of individual profiles. One of the limitations of using "snapshot" points in time (such as the same month through consecutive years, as is the case in this report) is that 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.

In the two years since the Patriots' Day Storm there were other spring storm events of lesser magnitude that influence this inter-annual analysis. In many locations the profiles also showed variable responses to storms in the spring of 2008 and 2009. Spring 2008 had 10 storms from March through May that had waves of 1 m (3.3 feet) or more. In March 2008 there were six such storms (with beginning dates of March 1, 5, 8, 15, 19, and 26) most of which lasted two days with the exception of March 26-28 with a longer duration storm. These storms had wave heights that peaked from 2.0 to 3.3 m (6.5 to 11 feet). Two storms on April 6 and 27 each lasted three days with wave heights of 2.2 m (7 feet) and 3.0 m (10 feet) respectively. May 2008 had a stormy period from the 10 – 14<sup>th</sup> with waves on the order of 1.5 m (5 feet) to 2.0 m (6.5 feet) and a short storm around the 27<sup>th</sup> with 1.7 m waves (5.6 feet).

The spring of 2009 was marked by 8 moderate storms in March, one large and two moderate storms in April, and two smaller storms in May. As in 2008, the March 2009 storms were spaced evenly through the month at about three or four days apart with waves commonly 1.5 m (5 feet) to 2.0 m (6.5 feet). The largest March storm peaked on March 25<sup>th</sup> with waves reaching 3.1 m (10 feet). Around April 4, 2009 storm waves peaked at 2.4 m (8 feet) and on April 7 waves reached 3.2 m (10 feet). These back-to-back storms led to erosion without any time in between for the beach to recover. The strongest April storm occurred on April 21 with waves of 3.5 m (11 feet). On May 6, 2009 a storm generated waves of 1.9 m (6 feet). Less than two weeks later a storm created waves of 2.2 m (7 feet). While significantly smaller than the Patriots' Day Storm, these spring storms also reduced or postponed the recovery of several beaches to spring 2006 sand levels.

Some of the beaches have recovered from the Patriots' Day Storm naturally, with little anthropogenic influence or effort.

However, Willard Beach in South Portland owes much of its recovery to teamwork and the guidance of the Willard Beach Management Plan (Wiper and others, 2008), which stipulated the replanting of dune grass, dune restoration, and beach access path rerouting. All of these actions apparently had a positive influence on the beach, considering Willard Beach saw upwards of 40 feet of dune erosion as a result of the Patriots' Day Storm (Slovinsky, 2007). Similarly, the dune construction project at Ferry Beach in Saco resulted in notable recovery at one of the profiles in the area (FE04). Similar efforts in other communities also led to positive post-storm recovery in the beach and dune system.

The volunteer profiling program has been instrumental in documenting the impacts – and subsequent recovery – of the beaches of Maine after the Patriots' Day Storm of 2007. Locations such as East Grand Beach in Scarborough demonstrated typical barrier island and frontal dune transgression in response to the storm, with the entire profile, including the dune crest, shifting up and in a landward direction, and then recovering as sediment is dispersed along the profile. This response is expected in beach systems that have an adequate supply of sediment. East Grand Beach is at the northern end of Saco Bay, which historically has been the "downdrift" end of the bay, so sand migrates to this area from the southern end of the bay.

Conversely, the responses at Saco's Ferry Beach profile locations were quite different. The frontal dunes exhibited by the profiles prior to the storm were completely wiped out. Although overwash did occur, there was little vertical buildup of dune elevation in response to the event, like that recorded at East Grand Beach. Also, many of the Ferry Beach profiles have not fully recovered, which is likely the result of a negative sand budget at this end of the bay. Similarly, although located in more of a pocket, the profiles at Scarborough Beach have been struggling to recover, demonstrating similar profile responses, with only satisfactory dune regrowth and stability.

Data indicate that Scarborough Beach, which is a generally isolated but long pocket beach, underwent large amounts of erosion, and only demonstrated limited to satisfactory recovery from the storm. This may be due to the fact that Scarborough Beach faces generally due east, and may have taken the brunt of wave attack during the Patriots' Day Storm and subsequent northeast storms from 2008 and 2009.

The volunteer profiling program has also been important in monitoring the fate of beach nourishment. At Ferry and Western Beaches in Scarborough, the profiles clearly show stability and growth at Ferry Beach, while the profile at Western Beach

**Table 3.** Grades and overall grades for each of the beach profile locations, and the subsequent beach systems.

Beach Name (Acronym)	#	Grade	Overall
Willard (WI)	01	A	A-
	03	A	
	06	B	
Higgins (HI)	01	A	B
	02	B	
	03	C	
Scarborough (SC)	01	C+	C+
	02	B	
	03	C	
	04	C	
Western/Ferry (WS)	01/05	B	B
	02/06	A	
	03/07	C	
East Grand (EG)	01	C	B
	02	A	
	03	A	
	04	B-	
Kinney Shores (KS)	01	C	B
	02	A-	
Ferry	01	D	C-
	02	D	
	03	F	
	04	A	
Fortunes Rocks (FR)	01	N/A	N/A
	02		
	03		
	04		

Beach Name (Acronym)	#	Grade	Overall
Goose Rocks (GR)	01	B-	B-
	02	A	
	03	C-	
	04	B	
Goochs (GO)	01	A	B
	02	A	
	03	B	
	04	C	
Laudholm (LH)	01	B-	B
	02	B	
	03	B	
	05	B-	
Drakes Island (DI)	01	A	B-
	02	A	
	03	D	
	04	D	
Wells (WE)	00	A	A
	02	A	
	03	A-	
	04	A	
Ogunquit (OG)	01	C	B-
	02	C	
	03	B+	
	04	B	
Long Sands (LS)	01	B	B
	03	B	
Overall Grade	B/B-		

(which was nourished in 2004; Slovinsky, 2006) was eroding. The sediment eroded from the Western Beach berm that was created by the beach nourishment project has been entering the inlet and supplying sediment to Ferry Beach.

Some of the beaches with seawalls recovered from the Patriots' Day Storm rather well. Locations such as Wells Beach and Goochs Beach, which are heavily engineered with seawalls, appeared to have gained sand back after the storm event. Pre-storm elevations, for the most part, were met, and sometimes exceeded at these locations, with the post-storm profile typically being well exceeded, indicating good recovery. This is a welcome result, considering the potentially negative influence of seawalls on the fronting beach.

Even though beaches with seawalls recovered somewhat from the Patriots' Day Storm event, when compared with the pre-storm 2006 shapes some net lowering of the overall profile elevations did occur. Comparison with pre-storm shapes may in-

dicate whether or not a profile is able to recover to a "pre-storm" baseline, instead of a "post-storm" (or erosive) baseline.

For example, although some recovery from the storm did occur, profiles at GO03 (Goochs) and GO04 (Middle Beach) never returned to pre-storm shapes. The same occurred at seawalled locations along Drakes Island Beach (DI03 and DI04), where post-storm recovery was quite minimal, and the pre-storm shapes were not even nearly achieved. These areas may need more time to fully recover.

The same lack of recovery occurred at profiles recorded along naturally vegetated dune stretches of shoreline. This was most notable for the profiles at the Ferry Beach, Saco area, where the only dramatic positive recovery was a result of anthropogenic influences (beach and dune restoration); the remainder of the profiles showed little to no recovery from the storm. This likely reflects the general lack of sediment at the southern end of the bay, while impacts at the northern end of the bay appeared to be more minimal, and recovery much better.

## *Conclusion*

The State of Maine Beach Profiling Project, with its volunteer beach monitors, is vital to better understanding the monthly, seasonal, and yearly patterns of beach change. It has also proven to provide valuable data to support analysis of the impacts of large storm events, in this case, the Patriots' Day Storm of 2007.

The Maine Geological Survey, which conducts annual and sometimes biannual shoreline surveys on its own, does not have the personnel or funding to support monthly beach profiling efforts. However, 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 program. These data are extremely important in understanding the impacts of, and documenting the recovery from, large storm events.

Analysis of profile data have shown that:

The majority of southern **Maine's beaches have recovered** from the Patriots' Day Storm in two years.

The degree of recovery generally ranges from **satisfactory** to **excellent**.

Together all the beaches have overall mean value of a **good** rating.

Continued monthly profiling over the next few years will help determine whether or not some of the beaches that did not score highly after two years simply needed more time to fully recover. Time will tell if there will be lasting changes to some beaches or if full recovery never occurs before the next major storm arrives.

This kind of data – especially when collected over a long period of time - is important for future decision-making processes that incorporate different aspects of beach management, including identification of stable, eroding, or accreting shorelines, potential beach nourishment projects, dune restoration or construction projects, dune grass management, and where to best spend public (or private) funds in order to get the highest return on dollars spent.

## *References*

- Emery, K. O., 1961, A simple method of measuring beach profiles: *Limnology and Oceanography*, v. 6, p. 90-93.
- Maine Sea Grant Extension, 2003, Southern Maine beach profile monitoring: Mapping the State of Maine's beaches: <http://www.seagrant.umaine.edu/files/pdf-global/00bpm.pdf>
- Maine Shore Stewards, 2007, Online data collaborative: <http://www.maineoastdata.org/>
- NOAA COOPS, 2007, Tide gauge data for the Patriots' Day storm, Portland, ME tide gauge: [http://tidesandcurrents.noaa.gov/data\\_menu.shtml?stn=8418150%20Portland,%20ME&type=Tide%20Data](http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=8418150%20Portland,%20ME&type=Tide%20Data)
- Slovinsky, P. A., 2006, Beach nourishment at Western Beach, Scarborough, Maine: Benefits for the beaches and the birds: Maine Geological Survey, <http://www.maine.gov/doc/nrimc/mgs/explore/marine/sites/jun06.htm>
- Slovinsky, P. A., 2007, The Patriots' Day Storm at Willard Beach, April 2007: Maine Geological Survey, <http://www.maine.gov/doc/nrimc/mgs/explore/marine/sites/may07.htm>
- Slovinsky, P.A. and Dickson, S.M., 2007, State of Maine's beaches in 2007: Maine Geological Survey, Open-File Report 07-99, <http://www.maine.gov/doc/nrimc/mgs/explore/marine/beaches/contents.htm>
- Wiper, T. and others, 2008, The Willard Beach System: Resource Guide and Management Guide, Willard Beach Neighborhood Association, Beach Committee, [http://www.willardneighborhood.org/beach\\_resource\\_guide.htm](http://www.willardneighborhood.org/beach_resource_guide.htm)
- Woods Hole Oceanographic Institution Sea Grant Program, 2001, Marine Extension Bulletin, Beach and Dune Profiles: An Educational Tool for Observing and Comparing Dynamic Coastal Environments. <http://www.whoi.edu/seagrant/education/bulletins/profiles.html>