National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Northeast Coastal and Barrier Network Shoreline Position (1D) and Coastal Topographic (2D) Change Monitoring

2012-2013 Annual Data Summary Report for Gateway National Recreation Area

Natural Resource Data Series NPS/NCBN/NRDS—2015/992



ON THE COVER
Severe erosion of coastal foredune and overwash into parking area associated with Hurricane Sandy, Lot E, Sandy Hook Unit, Gateway National Recreation Area, November 9, 2012.
Photograph by Dr. Norbert P. Psuty.

Northeast Coastal and Barrier Network Shoreline Position (1D) and Coastal Topographic (2D) Change Monitoring

2012-2013 Annual Data Summary Report for Gateway National Recreation Area

Natural Resource Data Series NPS/NCBN/NRDS—2015/992

Dr. Norbert P. Psuty

William Schmelz

Andrea Spahn

David Riddell

Katy Ames

Kyle Nicholas

Sandy Hook Cooperative Research Programs
N.J. Agricultural Experiment Station
Rutgers - The State University of New Jersey
74 Magruder Road
Highlands, New Jersey 07732

December 2015

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the Northeast Costal and Barrier Network website (http://science.nature.nps.gov/im/units/ncbn/publications.cfm) and Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

Please cite this publication as:

Psuty, N. P., W. Schmelz, A. Spahn, D. Riddell, K. Ames, and K. Nicholas. 2015. Northeast Coastal and Barrier Network shoreline position (1D) and coastal topographic (2D) change monitoring: 2012-2013 annual data summary report for Gateway National Recreation Area. Natural Resource Data Series NPS/NCBN/NRDS—2015/992. National Park Service, Fort Collins, Colorado.

NPS 646/130778, December 2015

Contents

Page

Figures v

Appendices xiii

Executive Summary xv

Acknowledgments xvii

Introduction 1

Site and Situation 3

Shoreline Position Surveys, Spring 2012 – Spring 2013 5

Timing of Shoreline Position Surveys 5

Natural and Cultural Events Affecting Shoreline Position 6

Natural Events 6

Cultural Events– Artificial Emplacement of Sediment 8

Results of Monitoring Efforts: Change in Shoreline Position 8

Sandy Hook 10

Breezy Point - Oceanside 12

Breezy Point - Bayside 15

Plumb Beach 17

Great Kills – Oceanside 19

Great Kills - Bayside 22

Miller Field 24

Fort Wadsworth 27

Impacts of Hurricane Sandy 29

Sandy Hook 30

Breezy Point – Oceanside 33

Breezy Point – Bayside 36

Plumb Beach 39

Great Kills – Oceanside 39

Great Kills – Bayside 42

Miller Field 44

Contents (continued)

Page

Fort Wadsworth 47
Coastal Profile Surveys, Spring 2012 – Spring 2014 51
Timing of Coastal Profile Surveys 51
Defining Profile Features and Datums 53
Results of Monitoring Efforts 53
Sandy Hook 54
Breezy Point 64
Plumb Beach 71
Great Kills 75
Miller Field 81
Fort Wadsworth 83
Spatial Association 85
Sandy Hook 85
Breezy Point 88
Plumb Beach 89
Great Kills 91
Miller Field 93
Fort Wadsworth 95
Conclusions 97
Literature Cited 99

Figures

Page

Figure 1. Location of coastal areas in Gateway NRA monitored following the shoreline position and the dune/beach profile protocols. 3

Figure 2. Date of shoreline survey and recorded elevation of previous neap-tide high-tide. Source: NOAA tide gauge 5

Figure 3. Water level variation and survey dates in the several parts of GATE from January 2012 through May 2013 7

Figure 4. Dates and characteristics of storms during 2012-2013, derived from the Sandy Hook tide gauge. 8

Figure 5. Alongshore distribution of shoreline displacement of the surveyed shorelines at Sandy Hook, Spring 2012 - Spring 2013 10

Figure 6. Distribution of difference measurements for the annual shoreline change of Sandy Hook between Spring 2012 and Spring 2013 11

Figure 7. Alongshore distribution of shoreline displacement of the surveyed shorelines at Breezy Point-Oceanside, Spring 2012 - Spring 2013 12

Figure 8. Distribution of difference measurements for the seasonal shoreline change of Breezy Point - Oceanside between Spring 2012 and Fall 2012 13

Figure 9. Distribution of difference measurements for the seasonal shoreline change of Breezy Point - Oceanside between Fall 2012 and Spring 2013 13

Figure 10. Distribution of difference measurements for the annual shoreline change of Breezy Point - Oceanside between Spring 2012 and Spring 2013 14

Figure 11. Alongshore distribution of shoreline displacement of the surveyed shorelines at Breezy Point-Bayside, Spring 2012 - Spring 2013 15

Figure 12. Distribution of difference measurements for the seasonal shoreline change of Breezy Point - Bayside between Spring 2012 and Fall 2012. 15

Figure 13. Distribution of difference measurements for the seasonal shoreline change of Breezy Point - Bayside between Fall 2012 – Spring 2013 16

Figure 14. Distribution of difference measurements for the annual shoreline change of Breezy Point - Bayside between Spring 2012 and Spring 2013 16

Figure 15. Alongshore distribution of shoreline displacement of the surveyed shorelines at Plumb Beach, Spring 2012 - Spring 2013 17

Figure 16. Distribution of difference measurements for the annual shoreline change of Plumb Beach between Spring 2012 and Spring 2013 18

Figure 17. Alongshore distribution of shoreline displacement of the surveyed shorelines at Great Kills-Oceanside, Spring 2012 - Spring 2013 19

Figures (continued)

Page

Figure 18. Distribution of difference measurements for the seasonal shoreline change of Great Kills-Oceanside between Spring 2012 and Fall 2012 20

Figure 19. Distribution of difference measurements for the seasonal shoreline change of Great Kills-Oceanside between Fall 2012 and Spring 2013. 20

Figure 20. Distribution of difference measurements for the annual shoreline change of Great Kills-Oceanside between Spring 2012 and Spring 2013. 21

Figure 21. Alongshore distribution of shoreline displacement of the surveyed shorelines at Great Kills-Bayside, Spring 2012 - Spring 2013 22

Figure 22. Distribution of difference measurements for the seasonal shoreline change of Great Kills-Bayside between Spring 2012 and Fall 2012. 22

Figure 23. Distribution of difference measurements for the seasonal shoreline change of Great Kills-Bayside between Fall 2012 and Spring 2013 23

Figure 24. Distribution of difference measurements for the annual shoreline change of Great Kills-Bayside between Spring 2012 and Spring 2013 23

Figure 25. Alongshore distribution of shoreline displacement of the surveyed shorelines at Miller Field, Spring 2012 - Spring 2013. 24

Figure 26. Distribution of difference measurements for the seasonal shoreline change of Miller Field between Spring 2012 and Fall 2012 25

Figure 27. Distribution of difference measurements for the seasonal shoreline change of Miller Field between Fall 2012 and Spring 2013 25

Figure 28. Distribution of difference measurements for the annual shoreline change of Miller Field between Spring 2012 and Spring 2013 26

Figure 29. Alongshore distribution of shoreline displacement of the surveyed shorelines at Fort Wadsworth, Spring 2012 - Spring 2013 27

Figure 30. Distribution of difference measurements for the seasonal shoreline change of Fort Wadsworth between Spring 2012 and Fall 2012 28

Figure 31. Distribution of difference measurements for the seasonal shoreline change of Fort Wadsworth between Fall 2012 and Spring 2013 28

Figure 32. Distribution of difference measurements for the annual shoreline change of Fort Wadsworth between Spring 2012 and Spring 2013. 29

Figure 33. Alongshore distribution of shoreline displacement of the surveyed shorelines at Sandy Hook, from pre- and post- Sandy shorelines. 30

Figure 34. Distribution of difference measurements for the storm event shoreline change of Sandy Hook between Spring 2012 and post-Sandy 31

Figures (continued)

Page

Figure 35. Distribution of difference measurements for the storm event shoreline change of Sandy Hook between post-Sandy and Spring 2013 31

Figure 36. Distribution of difference measurements for the annual shoreline change of Sandy Hook between Spring 2012 and Spring 2013 32

Figure 37. Alongshore distribution of shoreline displacement of the surveyed shorelines at Breezy Point-Oceanside, from pre- and post- Sandy shorelines 33

Figure 38. Distribution of difference measurements for the storm event shoreline change of Breezy Point-Oceanside between Fall 2012 and post-Sandy 34

Figure 39. Distribution of difference measurements for the storm event shoreline change of Breezy Point-Oceanside between post-Sandy and Spring 2013 34

Figure 40. Distribution of difference measurements for the annual shoreline change of Breezy Point-Oceanside between Spring 2012 and Spring 2013 35

Figure 41. Alongshore distribution of shoreline displacement of the surveyed shorelines at Breezy Point-Bayside, from pre- and post- Sandy shorelines 36

Figure 42. Distribution of difference measurements for the storm event shoreline change of Breezy Point-Bayside between Fall 2012 and post-Sandy 37

Figure 43. Distribution of difference measurements for the storm event shoreline change of Breezy Point - Bayside between post-Sandy and Spring 2013. 37

Figure 45. Alongshore distribution of shoreline displacement of the surveyed shorelines at Great Kills -Oceanside, from pre- and post- Sandy shorelines 39

Figure 46. Distribution of difference measurements for the storm event shoreline change of Great Kills – Oceanside between Fall 2012 and post-Sandy 40

Figure 47. Distribution of difference measurements for the storm event shoreline change of Great Kills – Oceanside between post-Sandy and Spring 2013. 40

Figure 48. Distribution of difference measurements for the annual shoreline change of Great Kills – Oceanside between Spring 2012 and Spring 2013 41

Figure 49. Alongshore distribution of shoreline displacement of the surveyed shorelines at Great Kills-Bayside, from pre- and post- Sandy shorelines 42

Figure 50. Distribution of difference measurements for the storm event shoreline change of Great Kills – Bayside between Fall 2012 and post-Sandy 42

Figure 51. Distribution of difference measurements for the storm event shoreline change of Great Kills – Bayside between post-Sandy and Spring 2013 43

Figure 52. Distribution of difference measurements for the annual shoreline change of Great Kills – Bayside between Spring 2012 and Spring 2013 43

Figures (continued)

Page

Figure 53. Alongshore distribution of shoreline displacement of the surveyed shorelines at Miller Field, from pre- and post- Sandy shorelines 44

Figure 54. Distribution of difference measurements for the storm event shoreline change of Miller Field between Fall 2012 and post-Sandy 45

Figure 55. Distribution of difference measurements for the storm event shoreline change of Miller Field between post-Sandy and Spring 2013. 45

Figure 56. Distribution of difference measurements for the annual shoreline change of Miller Field between Spring 2012 and Spring 2013 46

Figure 57. Alongshore distribution of shoreline displacement of the surveyed shorelines at Fort Wadsworth, from pre- and post- Sandy shorelines 47

Figure 58. Distribution of difference measurements for the storm event shoreline change of Fort Wadsworth between Fall 2012 and post-Sandy 48

Figure 59. Distribution of difference measurements for the storm event shoreline change of Fort Wadsworth between post-Sandy and Spring 2013 48

Figure 60. Distribution of difference measurements for the annual shoreline change of Fort Wadsworth between Spring 2012 and Spring 2013 49

Figure 61. Date of shoreline survey and recorded elevation of previous neap-tide high-tide 51

Figure 62. Water level variation and survey dates in the several parts of GATE during the reporting period 52

Figure 63. Relationship of 1983-2001 tidal epoch water levels to the North American Vertical Datum of 1988, to the 1929 National Geodetic Vertical Datum, and to a representative beach profile at Sandy Hook 53

Figure 64. Location of 16 monuments and their accompanying azimuths on Sandy Hook used in recording the 2D beach/dune profiles. 54

Figure 65. For profiles SH1 and SH2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 55

Figure 66. For profiles SH3 and SH4, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 56

Figure 67. For profiles SH5 and SH6, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 57

Figures (continued)

Page

Figure 68. For profiles SH7 and SH8, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 58

Figure 69. For profiles SH9.1 and SH9.2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 59

Figure 70. For profiles SH10 and SH11, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 60

Figure 71. For profiles SH12 and SH13, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 61

Figure 72. For profiles SH14 and SH14, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 62

Figure 73. For profile SH16, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 63

Figure 74. Location of 11 monuments and their accompanying azimuths on Breezy Point used in running the 2D beach/dune profiles..... 64

Figure 75. For profiles BP1 and BP2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 65

Figure 76. For profiles BP3 and BP4, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 66

Figure 77. For profiles BP5 and BP6, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 67

Figure 78. For profiles BP7 and BP8, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 68

Figure 79. For profiles BP9 and BP10, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 69

Figure 80. For profiles BP11, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 70

Figures (continued)

Page

Figure 81. Location of five monuments and their accompanying azimuths at Plumb Beach used in running the 2D beach/dune profiles.....71

Figure 82. For profiles PB1 and PB2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 72

Figure 83. For profiles PB3 and PB4, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 73

Figure 84. For profiles PB5, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 74

Figure 85. Location of nine monuments and their accompanying azimuths at Great Kills used in running the 2D beach/dune profiles.....75

Figure 86. For profiles GK1 and GK2, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 76

Figure 87. For profiles GK3 and GK4, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 77

Figure 88. For profiles GK5 and GK6, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 78

Figure 89. For profiles GK7 and GK8, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 79

Figure 90. For profiles GK9.1 and GK9.2, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 80

Figure 91. Location of two monuments and their accompanying azimuths at Miller Field used in running the 2D beach/dune profiles.....81

Figure 92. For profiles MF1 and MF2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 82

Figures (continued)

Page

Figure 94. For profiles FW1 and FW2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 84

Figure 95. For profiles FW3, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys. 85

Figure 96. Alongshore seasonal differences of selected topographical variables at Sandy Hook, Spring 2012, Fall 2012, post-Sandy, and Spring 2013, incorporating dune/beach profile sites along the ocean side, inlet, and bay side situations. 86

Figure 97. Alongshore annual difference of dimensions of selected topographical variables at Sandy Hook, Spring 2012 –Spring 2013, incorporating dune/beach profile sites along the ocean side, inlet, and bay side situations. 87

Figure 99. Alongshore seasonal differences in dimensions of selected topographical variables at Breezy Point, Spring 2012, Fall 2012, and Spring 2013. 89

Figure 100. Alongshore annual differences of dimensions of selected topographical variables at Breezy Point, Spring 2012 –Spring 2013. 90

Figure 101. Alongshore seasonal differences of dimensions of selected topographical variables at Great Kills, Spring 2012, Fall 2012, post-Sandy, and Spring 2013. 91

Figure 102. Alongshore annual differences in dimensions of selected topographical variables at Great Kills, Spring 2012 - Spring 2013. 92

Figure 103. Alongshore seasonal differences of dimensions of selected topographical variables at Miller Field, Spring 2012, Fall 2012, post-Sandy, and Spring 2013. 93

Figure 104. Alongshore annual differences of dimensions of selected topographical variables at Miller Field, Spring 2012 – Spring 2013. 94

Figure 105. Alongshore seasonal differences of dimensions of selected topographical variables at Miller Field, Spring 2012, Fall 2012, post-Sandy, and Spring 2013. 95

Figure 106. Alongshore annual differences of dimensions of selected topographical variables at Fort Wadsworth, Spring 2012 – Spring 2013. 96

Appendices

Page

Appendix A: Dimensions of Distance and Area, Spring 2012 – Spring 2013, GATE Profiles 101

Appendix B: Dimensions of Seasonal and Annual Change on GATE Profiles 107

Executive Summary

This Monitoring Report incorporates the changes of shoreline position (1D) and the changes of on dune/beach profiles (2D) in Gateway National Recreation Area from the spring of 2012 through the spring of 2013. Although too early to identify trends of change, the data do provide a series of dimensions regarding linear distances of shoreline shifts and linear dimensions and cross-sectional areas of beach and dune features on the profiles. A variety of figures and tables portray the metrics derived from the monitoring programs for each of the seasonal surveys and the differences among the seasonal surveys for the span of one year. Detailed analyses will await the Trend Report.

Acknowledgments

Many people participated in the collection of the field surveys and processing of the data sets and contributed to this product. Early members of the Rutgers survey and data processing team included Billy Hudacek, Joelle Freeman, Michael Towle, Monica Patel, Carlos Carvajal, Tucker Fullmer, Sean McLoughlin, and Allison Huggan. Members of Gateway NRA provided great assistance. They consisted of Jeanne McArthur-Heuser and Frank DeLuca of the Sandy Hook Unit, Tony Luscombe of the Jamaica Bay Unit , and Mark Christiano of Headquarters.

This project is supported by the Inventory and Monitoring Program of the Northeast Barrier Network of the National Park Service, Sara Stevens, Director. It is carried out under Task Agreement P13AC00907, Cooperative Agreement P09AC00212.

Introduction

The National Park Service is committed to creating and maintaining a data base on coastal evolution within the parks in the Northeast Coastal and Barrier Network (Stevens et al. 2005). As described in the document on 'vital signs' (Allen 2000), information on shoreline change and on coastal topographical change (dune/beach profiles) are among the most important and most beneficial data sets to support basic knowledge of the vectors of change at the coast and they are fundamental to the establishment of resource management decisions in the coastal parks. And, as established in the foundation document on monitoring coastal morphological changes in Psuty et al. (2010b), there are specific protocols to be followed in tracking shoreline position changes as well as dune/beach profile changes in the coastal parks to assure quality control and comparability in the data set.

This is a Report on the changes of shoreline position and the changes to dune/beach profiles in the coastal units in Gateway National Recreation Area. The collection and portrayal of shoreline position follows the protocol established in Psuty et al. (2010b) and the collection of the profiles and their representation in this report follows the protocol on two-dimensional changes established in Psuty et al. (2012). They were applied throughout Gateway in a consistent manner starting in the spring of 2010. The surveys conducted in Spring 2012, Fall 2012, and Spring 2013 form the basis of this monitoring report. In addition, surveys were conducted soon after Hurricane Sandy (Sandy was Oct 29, 2012) to record the changes produced by the storm.

The goal of the annual report is to document the collection of shoreline position and profile data that describe the short-term variation that has occurred. The changes in the shoreline position and profile configuration are generally descriptive of the seasonal contrasts (lower energetics in the summer period versus higher energetics in the winter period) that support accumulation during summer and erosion during the winter. However, there are many other variables that affect the gains and losses of sediment and the changes to the profiles. Therefore, the short-term annual report is but one step in the understanding of the conditions that characterize the coastal components of the Gateway units and is meant to establish a continuum of comparable information for subsequent characterizations and analyses. Discussions and analyses of vectors of profile change and likely associations will be the theme of the longer-term (5 years) Trend Reports.

Site and Situation

The portion of Gateway National Recreation Area (GATE) covered in this report is composed of two coastal areas exposed to the ocean processes (Sandy Hook and Breezy Point), and four other areas shielded to various degrees from the direct exposure to ocean conditions (Great Kills, Miller Field, Fort Wadsworth, and Plumb Beach). They each respond to the relative intensity of the energetics associated with their position and to the sediment supply reaching their position, as described in Psuty et al. (2010a).

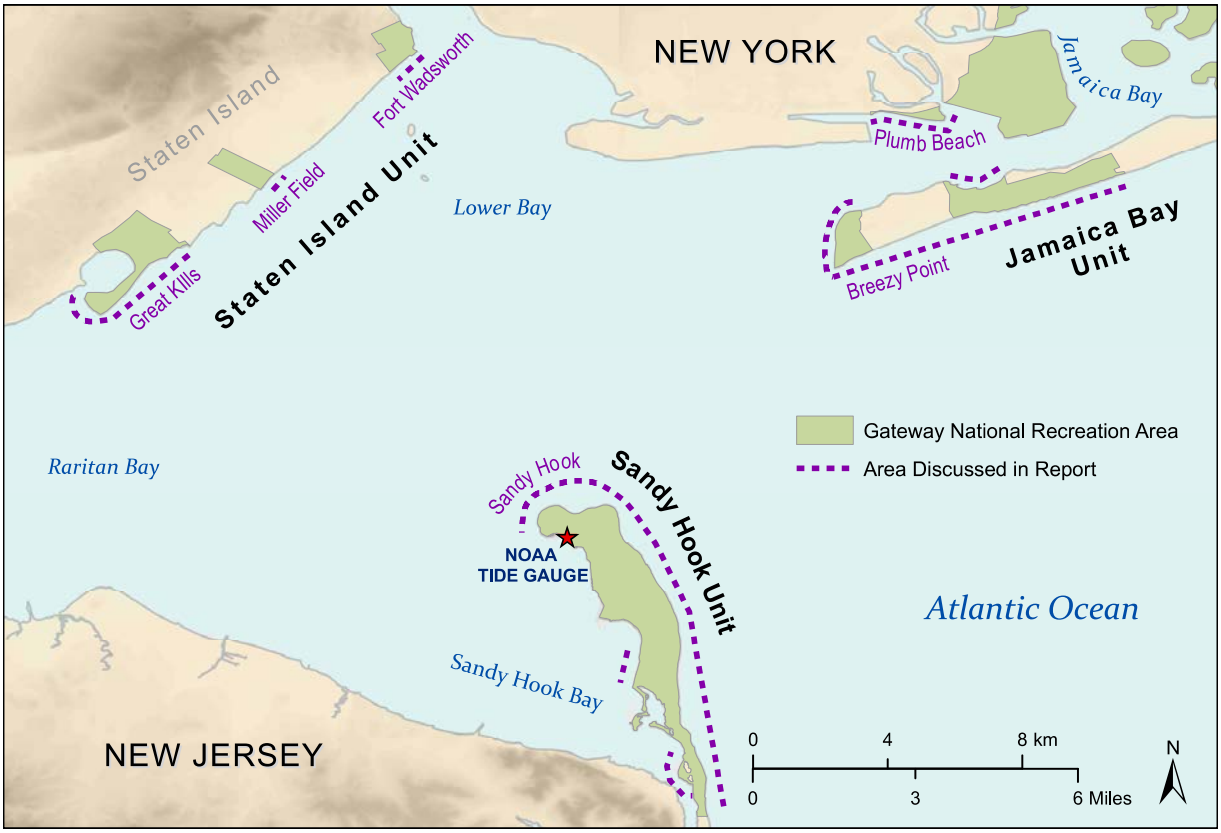


Figure 1. Location of coastal areas in Gateway NRA monitored following the shoreline position and the dune/beach profile protocols.

Shoreline Position Surveys, Spring 2012 – Spring 2013

Timing of Shoreline Position Surveys

Three seasonal surveys and one post-storm survey of the neap-tide, high-tide swash-line are included in this report (Fig. 2).

Season / Park	Date of survey	Previous High Tide Height* (m)	Previous High Tide Time
Spring 2012			
Sandy Hook	30 Mar 2012	1.295	01:12 PM
Great Kills	30 Mar 2012	1.295	01:12 PM
Miller Field	30 Mar 2012	1.295	01:12 PM
Fort Wadsworth	30 Mar 2012	1.295	01:12 PM
Plumb Beach	27 Mar 2012	1.340	10:49 AM
Breezy Point	29 Mar 2012	1.343	12:22 PM
Fall 2012			
Sandy Hook	-	-	-
Great Kills	11 Oct 2012	1.202	03:47 AM
Miller Field	11 Oct 2012	1.202	03:47 AM
Fort Wadsworth	11 Oct 2012	1.202	03:47 AM
Plumb Beach	-	-	-
Breezy Point	24 Oct 2012	1.545	03:03 AM
Post Sandy			
Sandy Hook	5 Nov 2012	1.460	11:32 AM
Great Kills	9 Nov 2012	1.215	03:06 AM
Miller Field	9 Nov 2012	1.215	03:06 AM
Fort Wadsworth	9 Nov 2012	1.215	03:06 AM
Plumb Beach	-	-	-
Breezy Point	21 Nov 2012	1.572	01:57 PM
Breezy Point	27 Nov 2012	1.598	06:34 AM
Spring 2013			
Sandy Hook	19 Apr 2013	1.413	02:32 PM
Great Kills	18 Mar 2013	1.471	04:20 AM
Miller Field	20 Mar 2013	1.199	02:17 PM
Fort Wadsworth	20 Mar 2013	1.199	02:17 PM
Plumb Beach	22 Mar 2013	1.471	03:26 AM
Breezy Point	16 Apr 2013	1.318	12:02 PM

*Tide elevation values are refereced to Mean Low Water (MLLW)

Figure 2. Date of shoreline survey and recorded elevation of previous neap-tide high-tide. Source: NOAA tide gauge (#8531680) Sandy Hook, NJ (http://tidesandcurrents.noaa.gov/geographic.html)

Natural and Cultural Events Affecting Shoreline Position

Natural Events

The existing protocol for shoreline monitoring is directed at identifying the seasonal, annual, and longer sediment balances at the ocean shoreline by recording changing positions of the prescribed water-land contact. Storms are important drivers of the shoreline change and the protocol is attempting to monitor the results of stormy and non-stormy periods as net conditions, or seasonal contrasts. A measure of storminess is garnered by the water level data collected at the Sandy Hook, New Jersey, tide gauge (Figs. 3 and 4).

A storm threshold of 2.0 m (6.56 ft) above mean lower low water (MLLW) is chosen because it represents an elevation on the berm surface (above the beach face). The absolute value of the threshold is not diagnostic in itself, but it represents an elevation that is reached occasionally. When it is reached, the upper beach and potentially the foredune undergo erosion and sediment redistribution, and overwash may occur. All of the daily water levels are depicted in Figure 3 with a solid vertical blue line that represents the maxima and minima of that date. Cyclonic storms (nor'easters and hurricanes) tend to be represented by several days of high water levels and frequently have a combination of very high waters during the periods that the winds are onshore followed by very low water levels during the succeeding periods when the winds are offshore. The patterns of water levels tend to depict the more frequent occurrence of storms during the winters and springs versus the less stormy summers. This reporting period had a great number and magnitude of storms (Figs. 3 and 4), with the maximum water elevation of 4.280 m reached during Hurricane Sandy in October 2012 and the second highest water elevation of 2.348 m reached during December 2012. The greatest duration of high water was during December 13-19 (8 high tides), October 2010 (8 high tides), and September 2011 (7 high tides). The winter 2012-2013 season was very stormy.

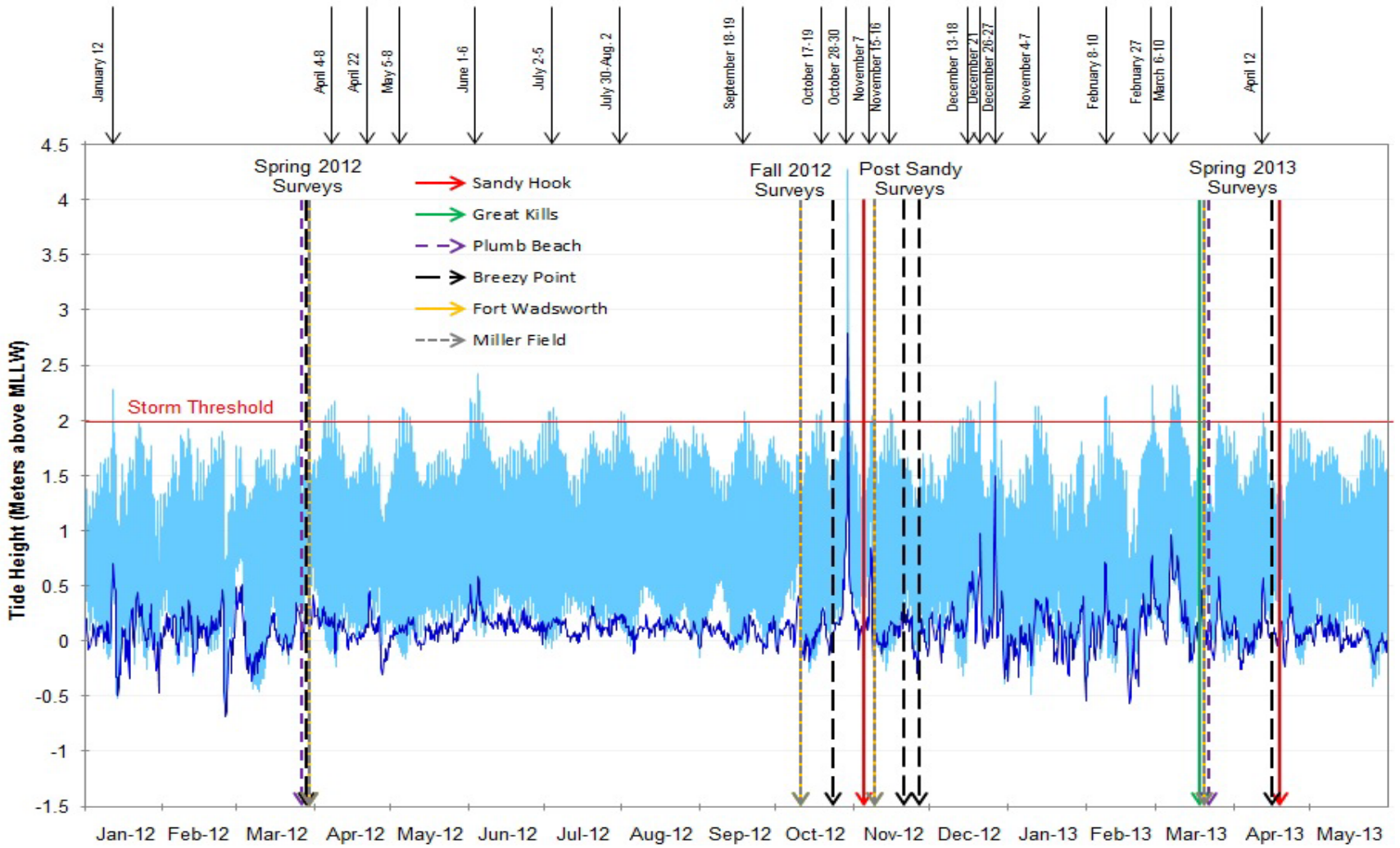


Figure 3. Water level variation and survey dates in the several parts of GATE from January 2012 through May 2013. Dark blue line is a measure of surge (difference of actual water level compared to predicted). Water level data are derived from the Sandy Hook tide gauge (http://tidesandcurrents.noaa.gov/geographic.html).

Storm	Number of tides higher than 2.0 m (Storm threshold)	Maximum Tide		
		Tide height (m)	Date	Measured surge (m)
January 12, 2012	1	2.277	01/12/12	0.697
April 4-8, 2012	5	2.172	04/08/12	0.252
April 22, 2012	1	2.043	04/22/12	0.423
May 5-8, 2012	5	2.114	05/05/12	0.134
June 1-6, 2012	7	2.427	06/04/12	0.447
July 2-5, 2012	4	2.112	07/04/12	0.192
July 30-Aug. 2, 2012	4	2.081	07/31/12	0.221
September 18-19, 2012	2	2.074	09/18/12	0.214
October 17-19, 2011	3	2.091	10/19/12	0.261
October 28-30, 2012	5	4.280	10/29/12	2.790
November 7, 2012	2	2.043	11/07/12	0.733
November 15-16, 2012	2	2.100	11/15/12	0.150
December 13-18, 2012	8	2.131	12/16/12	0.361
December 21, 2012	1	2.176	12/21/12	0.806
December 26-27, 2012	2	2.348	12/27/12	0.826
January 12-14, 2013	3	2.130	01/13/13	0.330
February 8-10, 2013	4	2.222	02/09/13	0.452
February 27, 2013	2	2.321	02/27/13	0.771
March 6-10, 2013	7	2.320	03/07/13	0.770
April 12, 2013	1	2.067	04/12/13	0.577

* Tide elevation values are referenced to Mean Lower Low Water (MLLW)

Figure 4. Dates and characteristics of storms during 2012-2013, derived from the Sandy Hook tide gauge.

Cultural Events– Artificial Emplacement of Sediment

Placement of 127,000 yds^3 (97,000 m^3) at Plumb Beach was completed shortly prior to the arrival of Hurricane Sandy. A geotube groin was constructed along the eastern margin of the fill to serve as a temporary boundary to the emplaced fill. In addition, there was beach nourishment of 272,000 yds^3 (208,000 m^3) placed at Rockaway Beach (updrift of Riis Park and Breezy Point) during October 2012-November 2012, and 800,000 yds^3 (612,000 m^3) of fill at Monmouth Beach (updrift of Sandy Hook) in November 2012.

Results of Monitoring Efforts: Change in Shoreline Position

Following application of the field collection protocol for each of the shoreline surveys in this Annual Report, each surveyed shoreline is registered to a common base and distances are measured from an offshore baseline along transects spaced at 10 m intervals following the Digital Shoreline Analysis System (DSAS) program created and maintained by the U.S. Geological Survey (Thieler et al. 2009) (see SOP # 7, Psuty et al. 2010b). The product of the first part of this procedure is a plot of the shoreline positions, the offshore baseline, and transects. The second part of the procedure is a measure of the distances along the transects to each surveyed shoreline. The complete table of me

measurements of distances from the baseline to the surveyed shoreline, spaced at 10 m intervals, is available from the NCBN data manager in GIS format.

The change in shoreline position is derived from a comparison of surveyed neap-tide, high-tide swash lines over time (Psuty et al. 2010b) and is conveyed as a measure of differences between distances for each transect location (Table 1). Although the intent of the survey is to document the change in shoreline position produced by gains or losses in sediment, shoreline position is also affected by other variables and thus there is a measure of uncertainty, or error, associated with the collected line position. There are four contributors to the uncertainty. Their character and dimension are: 1) the recording instrument is a GPS unit with sub-meter accuracy, its variability is about 0.5 m; 2) the wave runup to create the neap high-tide swash line may vary as much as 3 m on ocean beaches; and 3) there is some small position error associated with the operator's tracking of the swash line on the beach face, 0.2 m. Together, these contributors create a possible uncertainty in position approaching +/- 3.7 m. Therefore, any surveyed shoreline has an intrinsic uncertainty of +/- 3.7 m and any comparison between two survey lines, as an example, would have a statistical uncertainty of +/- 5.2 m (calculated as the square root of the sum of the squares of the two measures of uncertainty). The fourth contributor to uncertainty is the comparative difference in tidal elevation creating the neap-tide high water line. Small differences result in little additional uncertainty, whereas large differences in tidal elevation can displace the specific swash line comparison by several meters and increase the uncertainty for that specific comparison.

The portrayal of the distribution of dimensions of change is created by the application of the Shoreline Change Mapper, a software application that works within the ArcGIS software from ESRI, and developed by Rutgers University for the purpose of this protocol. The application generates a new geographical data set that represents the dimension of change as a bar-graph-type series of lines - corresponding to the location of a sampling transect - that can be overlaid on existing base maps (incorporated in a succession of applications, beginning with Fig. 5). A running bar graph depicts the relative difference in shoreline position between any two surveys. Differences of less than the range of uncertainty, varying from +/-10 m on exposed ocean shorelines to +/-2 m on sheltered bay shorelines, of seaward or inlandward displacement are shown as gray, whereas seaward displacement (accretion/gain) greater than the range of uncertainty is shown as shades of blue and inland displacement (erosion/loss) in shades of red. The length of each line represents the magnitude of change between two chosen dates. These data sets (differences between surveys) are portrayed spatially in a series of figures that depict the seasonal differences as well as the annual change, from Spring 2012 to Spring 2013, for example. The figures also include the traces of the surveyed shorelines as well as measures of the mean values of the temporal changes. Together, these figures incorporate the essential information on the measures and distributions of change through the succession of seasons, and through the annual cycle.

The following sequence portrays the surveyed displacements in the several shoreline areas of Gateway NRA.

Sandy Hook

Surveys using the 1D protocol were conducted along the entire oceanside shoreline, the northern inlet shoreline, and the bayside shoreline to the limit of the Coast Guard property. The shoreline was not surveyed in the fall of 2012 because of the impacts of Hurricane Sandy prior to landfall.

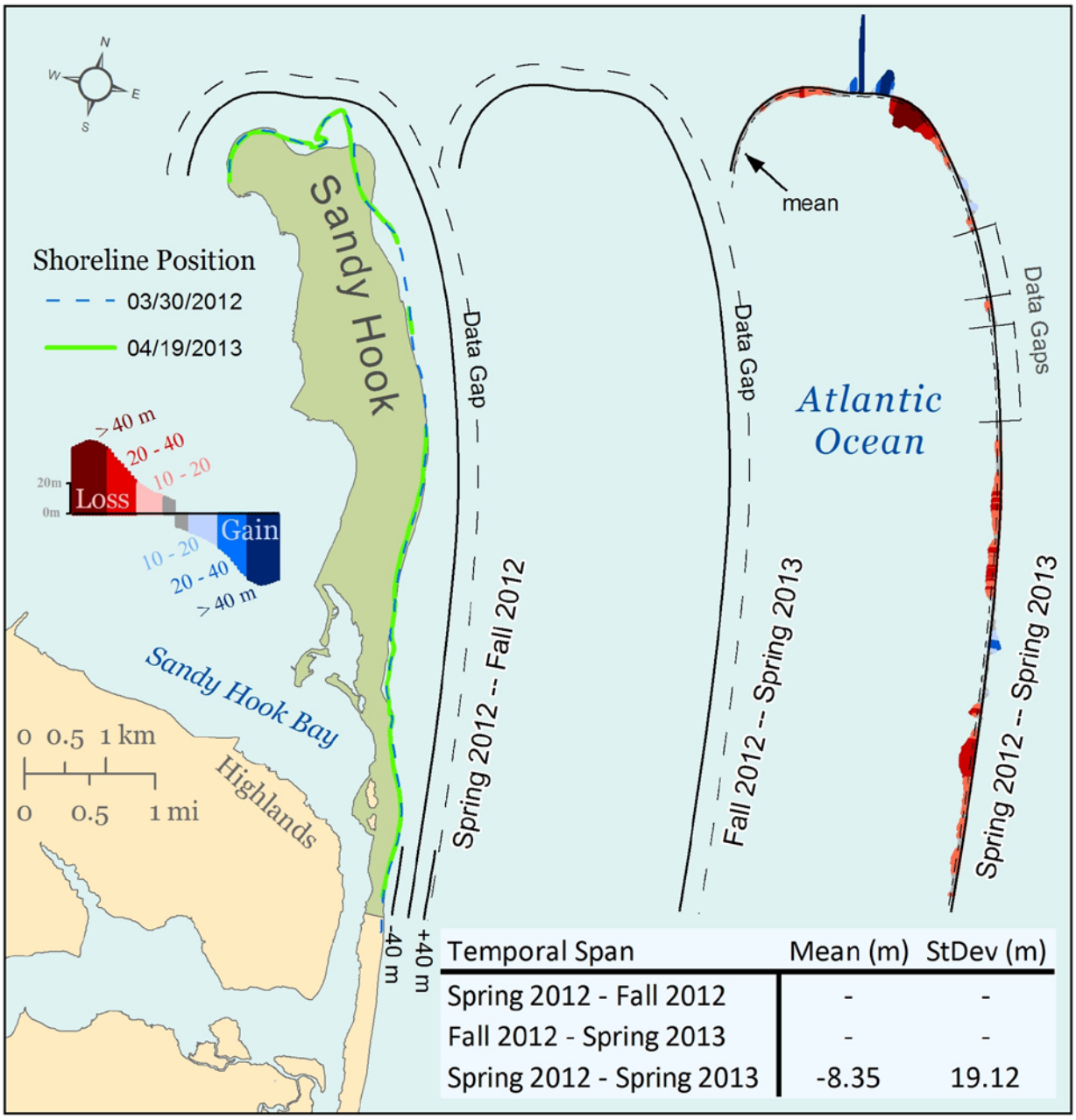


Figure 5. Alongshore distribution of shoreline displacement of the surveyed shorelines at Sandy Hook, Spring 2012 - Spring 2013, incorporating surveyed shoreline position, seasonal and annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

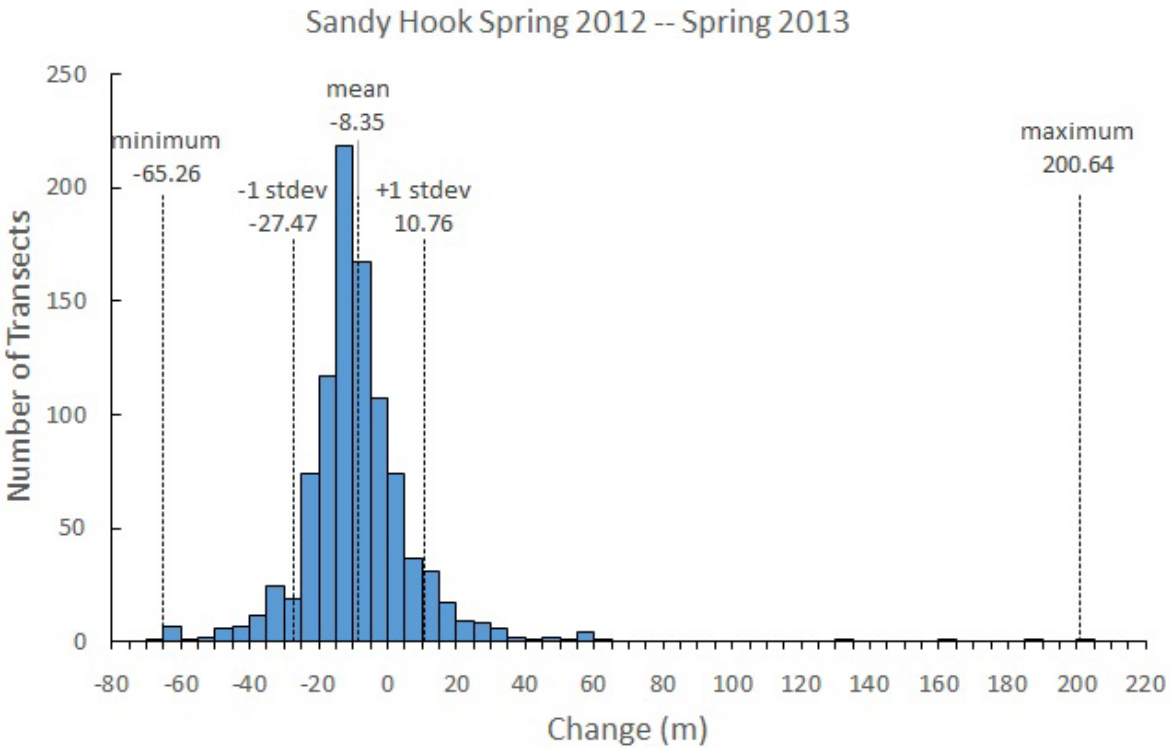


Figure 6. Distribution of difference measurements for the annual shoreline change of Sandy Hook between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Breezy Point - Oceanside

The Breezy Point shoreline is composed of two segments, 1) the ocean-facing portion with an exposure to the south, and 2) the portion toward the west and bayside. The two segments are separated by a jetty that is at the western terminus of the spit and limits alongshore transport of sediment. The two segments have differing exposures to wave action and thus have differing responses.

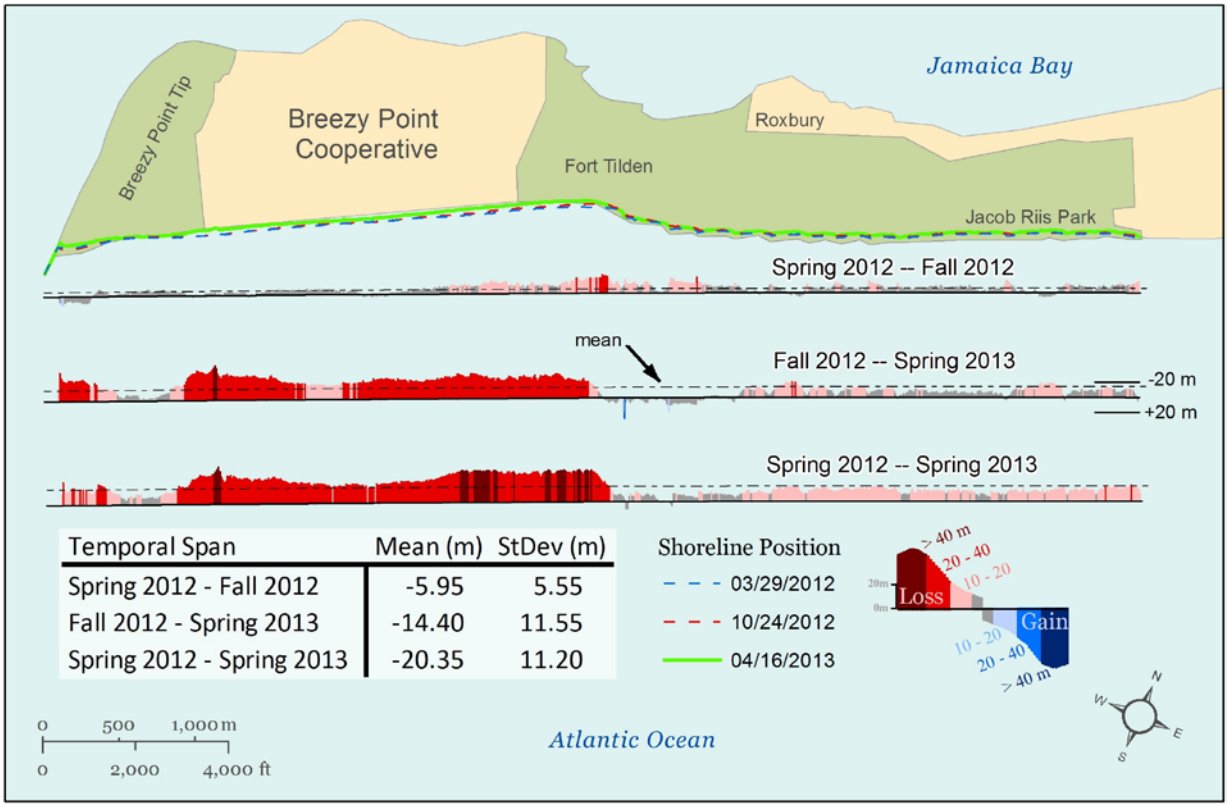


Figure 7. Alongshore distribution of shoreline displacement of the surveyed shorelines at Breezy Point-Oceanside, Spring 2012 - Spring 2013, incorporating surveyed shoreline position, seasonal and annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

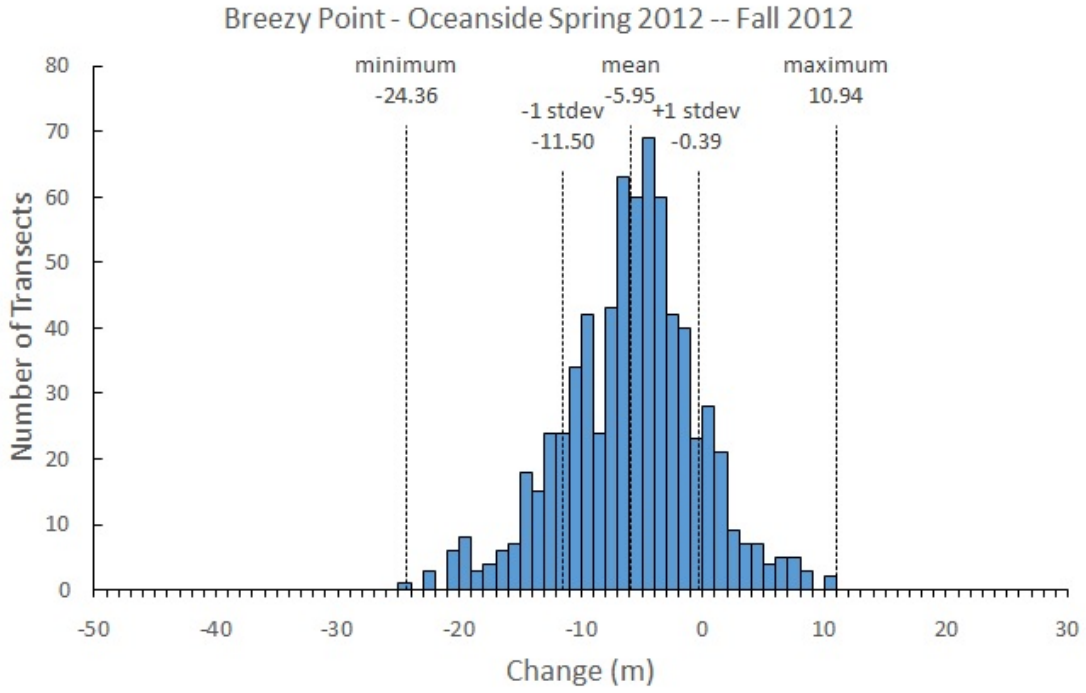


Figure 8. Distribution of difference measurements for the seasonal shoreline change of Breezy Point - Oceanside between Spring 2012 and Fall 2012, incorporating the mean change value, standard deviation, maximum, and minimum values.

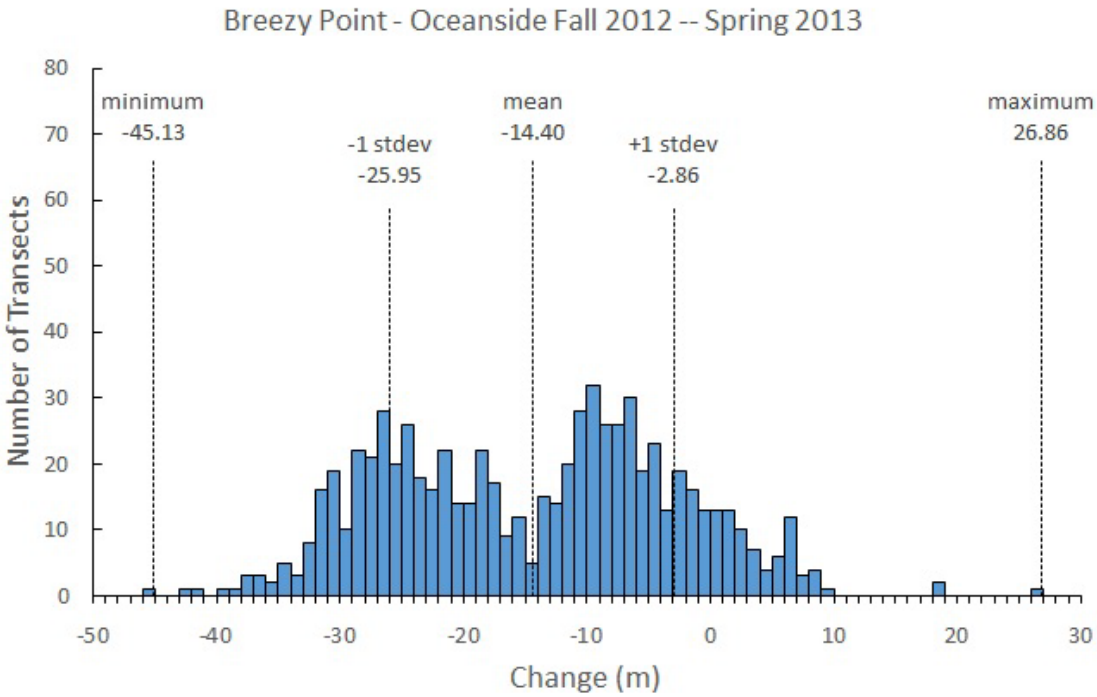


Figure 9. Distribution of difference measurements for the seasonal shoreline change of Breezy Point - Oceanside between Fall 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

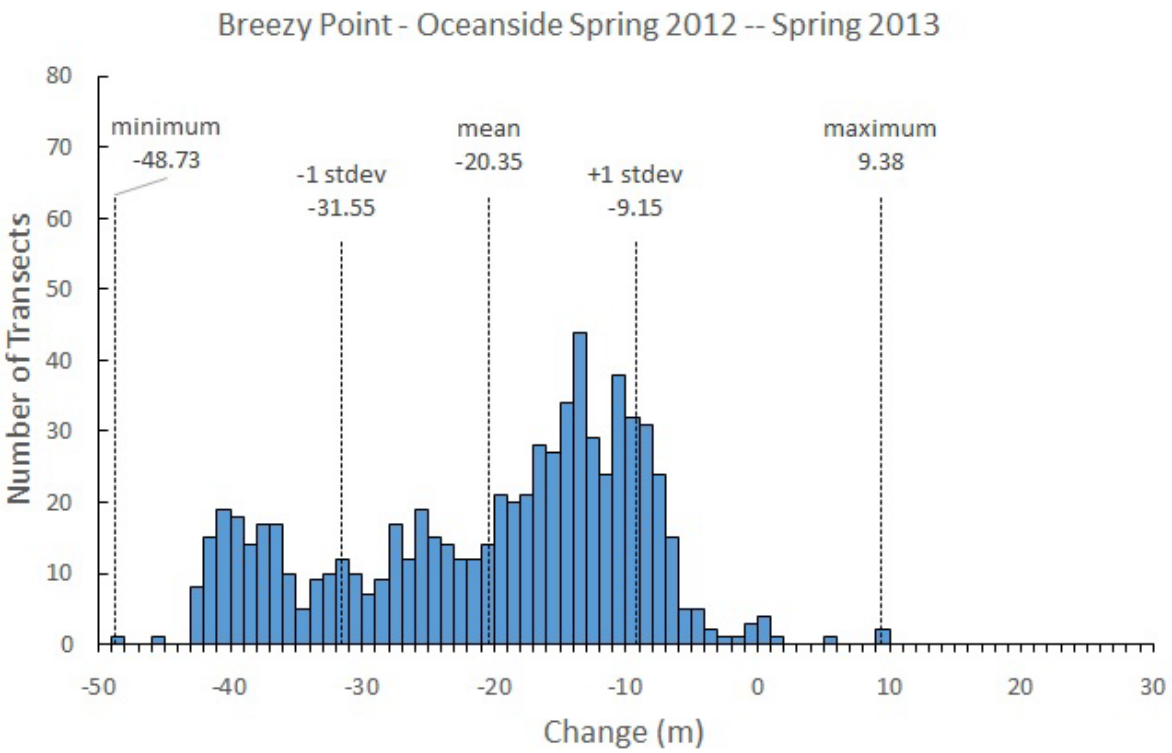


Figure 10. Distribution of difference measurements for the annual shoreline change of Breezy Point - Oceanside between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Breezy Point - Bayside

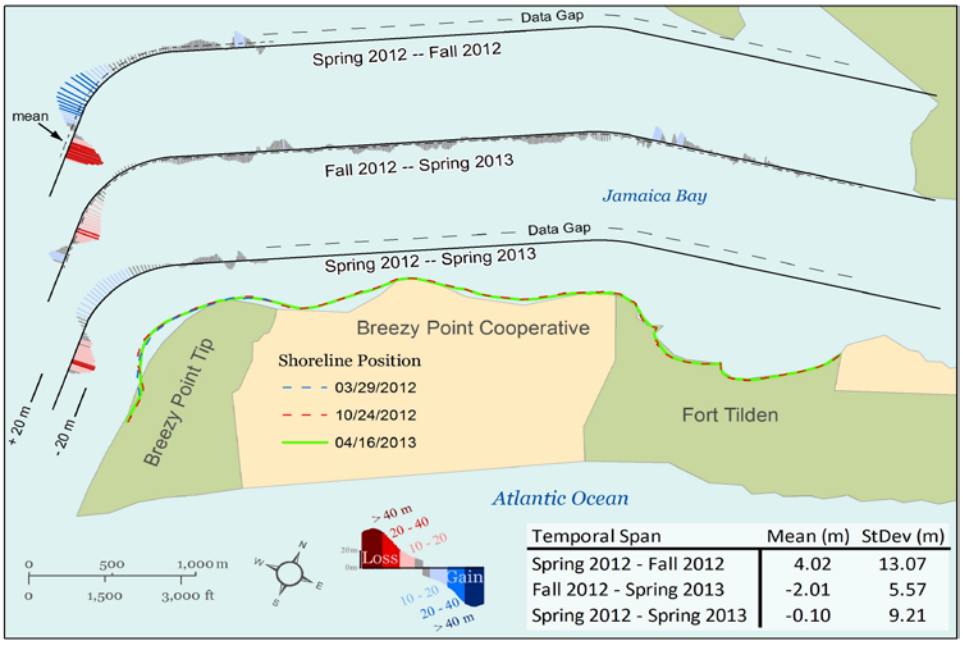


Figure 11. Alongshore distribution of shoreline displacement of the surveyed shorelines at Breezy Point-Bayside, Spring 2012 - Spring 2013, incorporating surveyed shoreline position, seasonal and annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

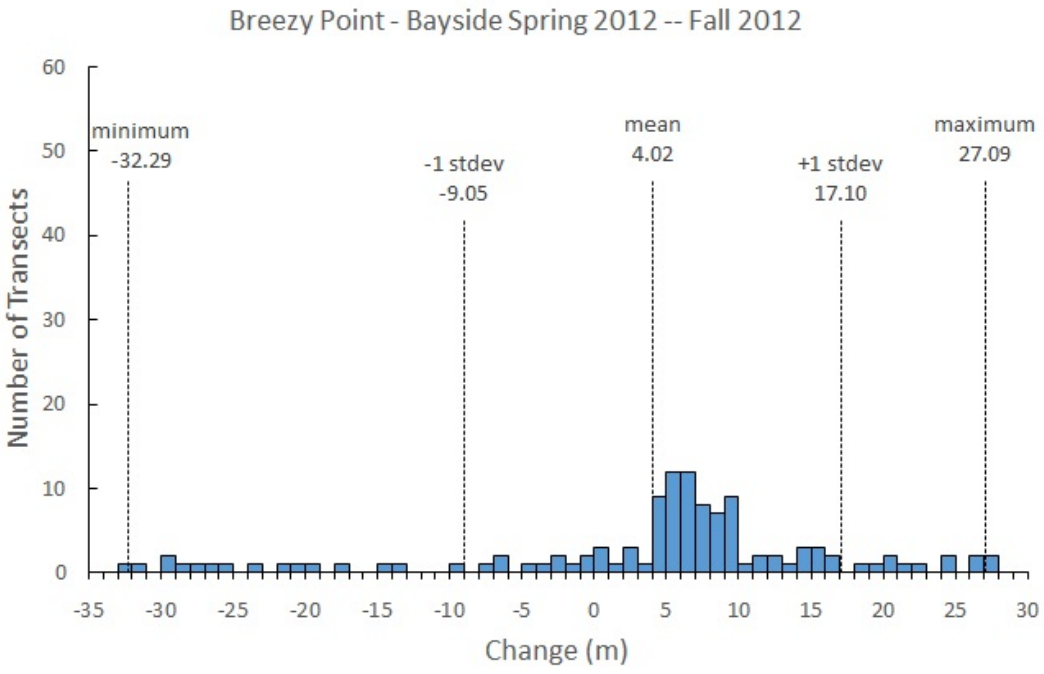


Figure 12. Distribution of difference measurements for the seasonal shoreline change of Breezy Point - Bayside between Spring 2012 and Fall 2012, incorporating the mean change value, standard deviation, maximum, and minimum values.

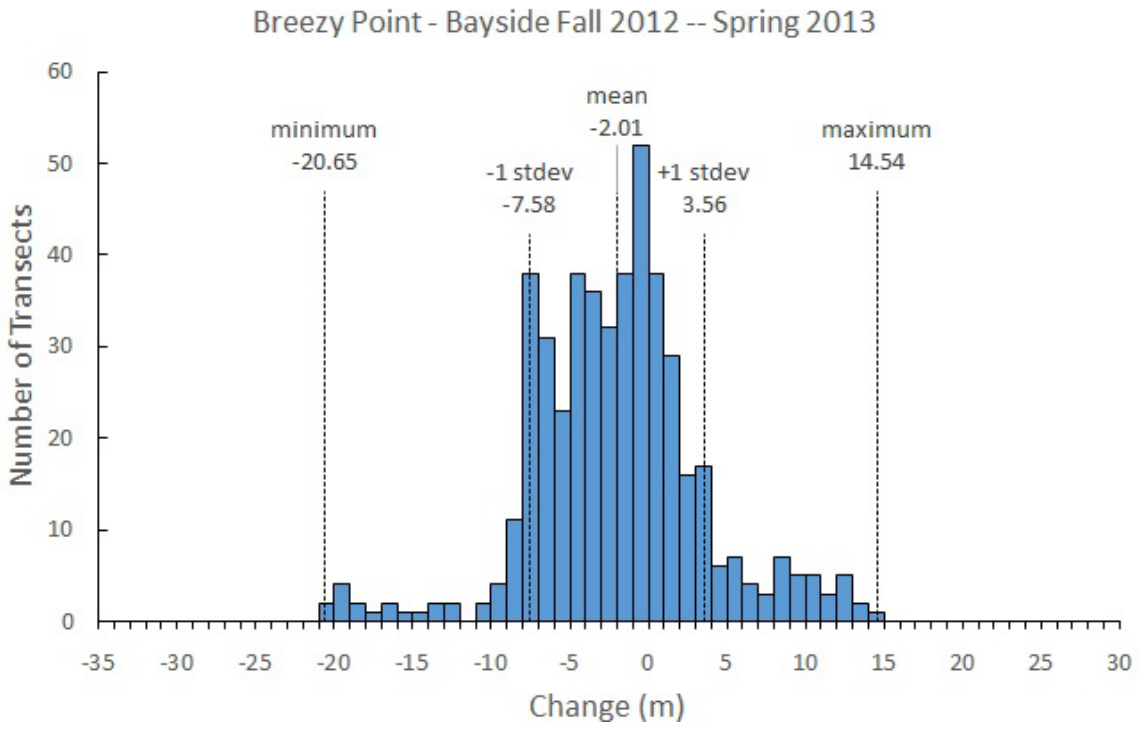


Figure 13. Distribution of difference measurements for the seasonal shoreline change of Breezy Point - Bayside between Fall 2012 – Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

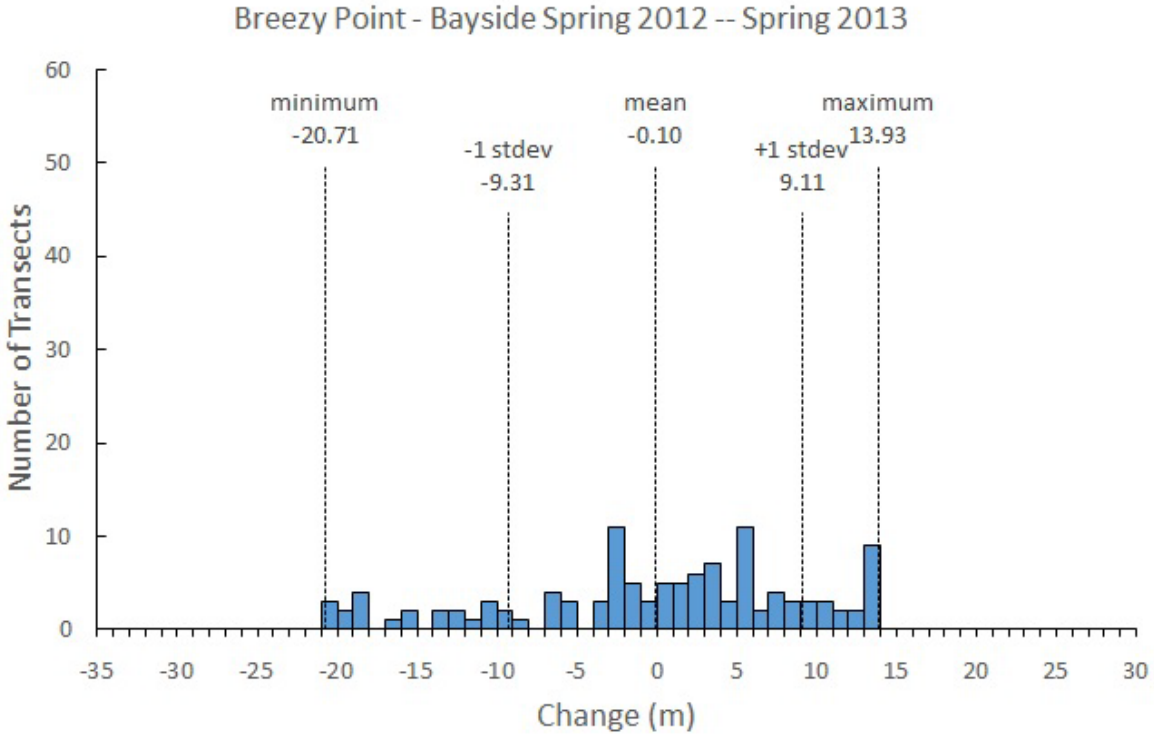


Figure 14. Distribution of difference measurements for the annual shoreline change of Breezy Point - Bayside between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Plumb Beach

A portion of this site had beach nourishment as well as a confining structures imposed during this survey period. The survey team could not access this site in the fall survey period, nor post-Sandy. Thus, any comparisons based on Fall 2012 or post-Sandy are not possible to derive for this report.

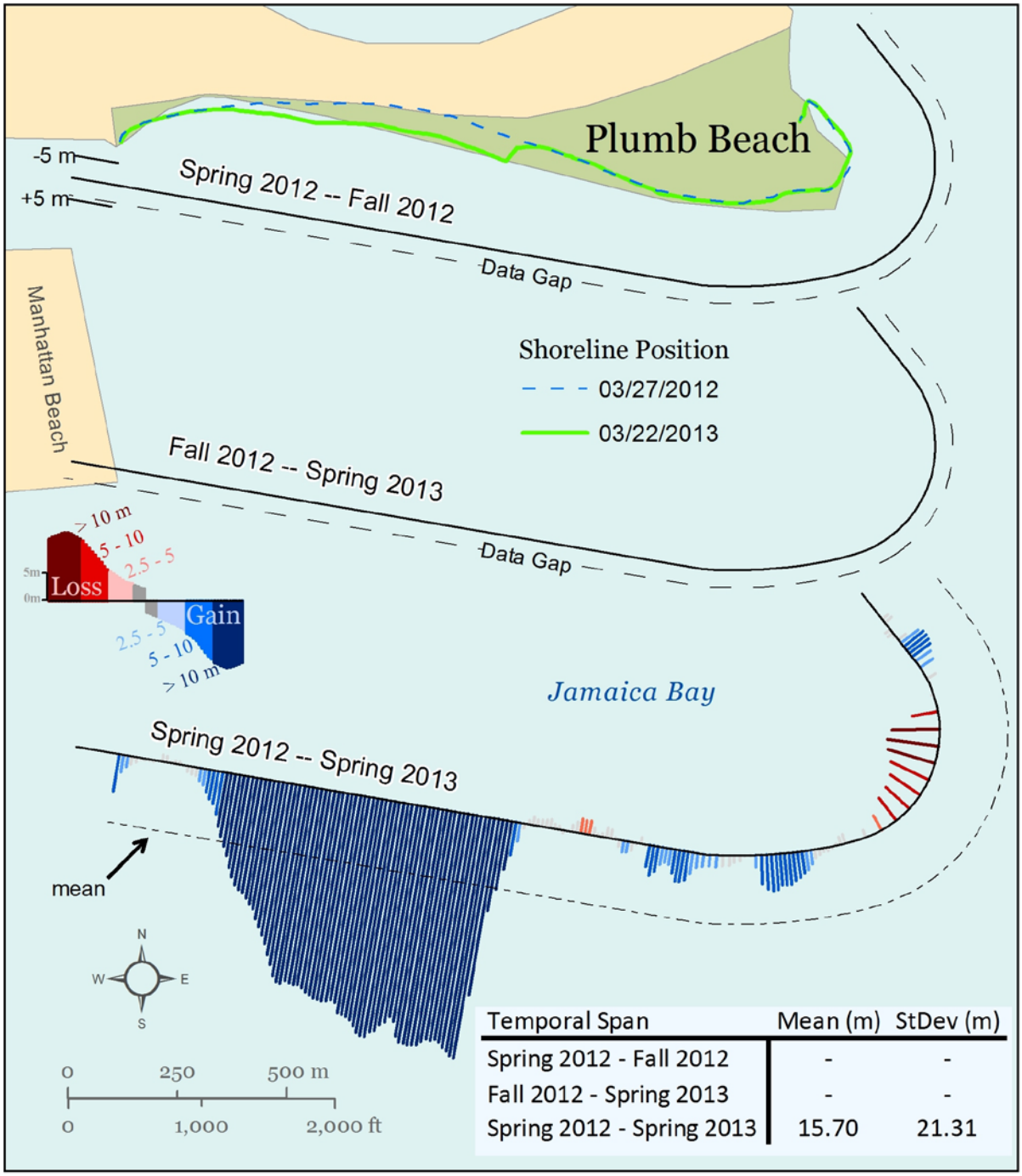


Figure 15. Alongshore distribution of shoreline displacement of the surveyed shorelines at Plumb Beach, Spring 2012 - Spring 2013, incorporating surveyed shoreline position, seasonal and annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

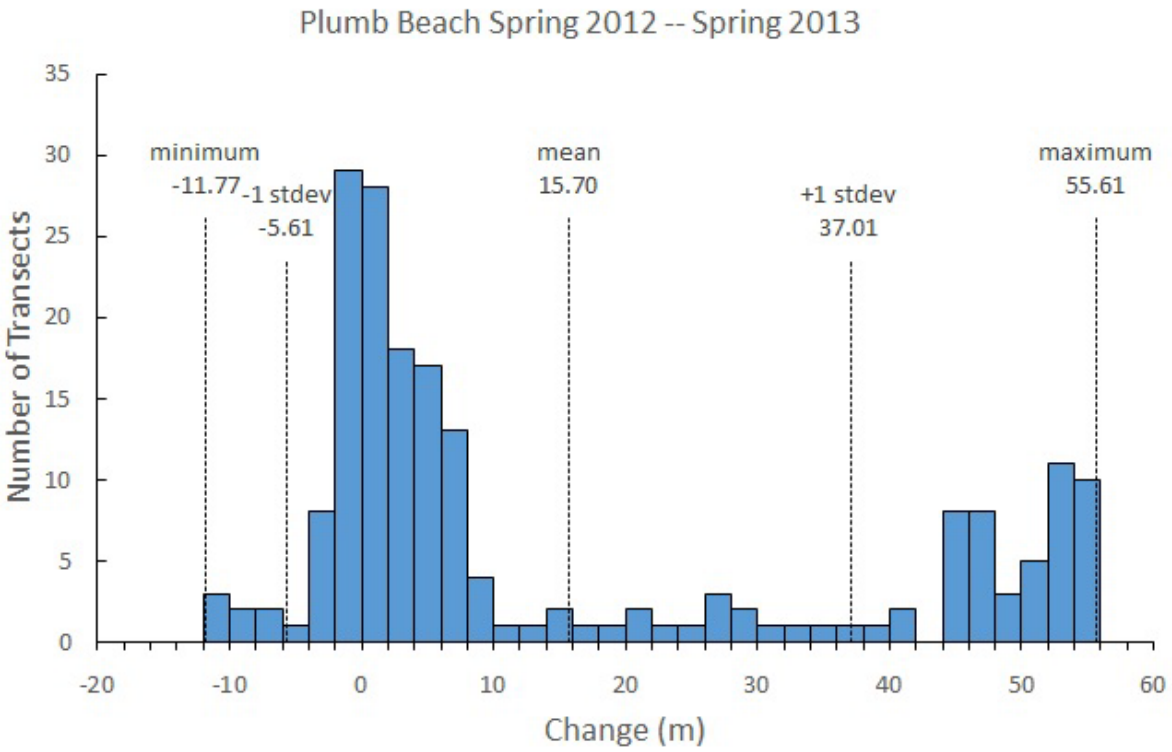


Figure 16. Distribution of difference measurements for the annual shoreline change of Plumb Beach between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Great Kills – Oceanside

The Great Kills shoreline is separated into two compartments: 1) ocean-facing; and 2) oriented toward the bay.

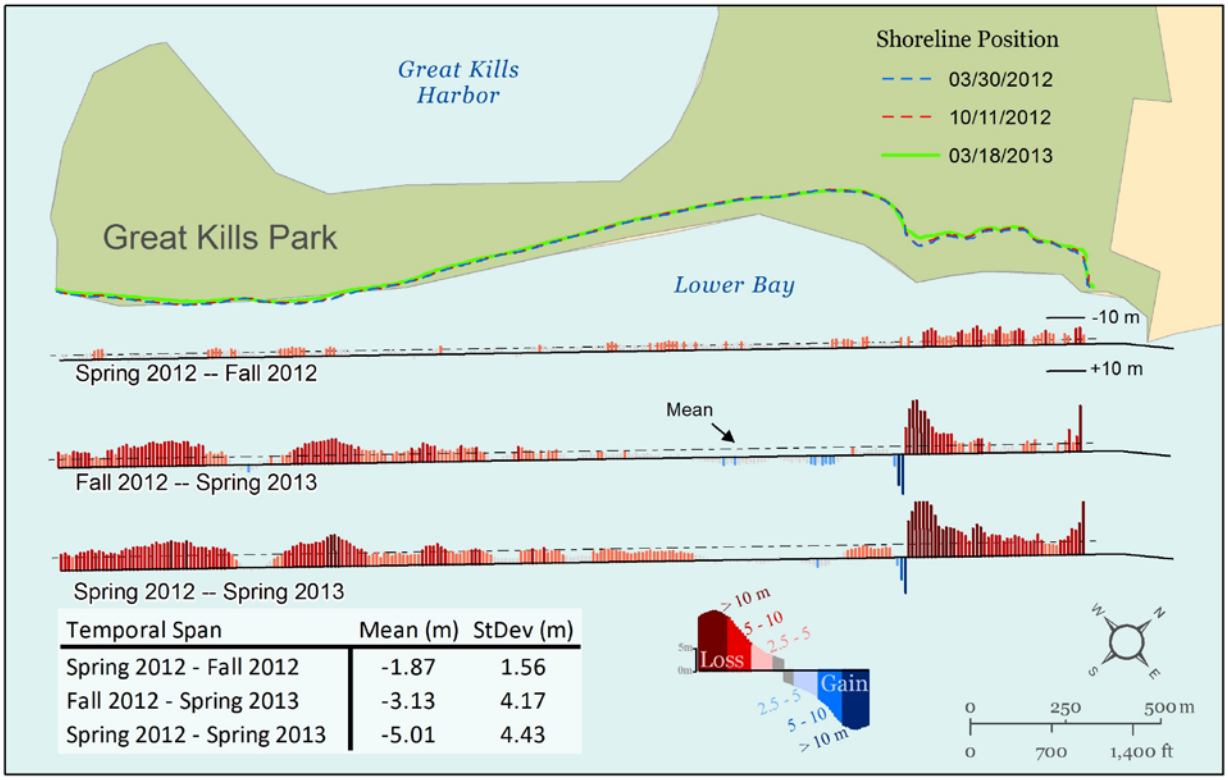


Figure 17. Alongshore distribution of shoreline displacement of the surveyed shorelines at Great Kills-Oceanside, Spring 2012 - Spring 2013, incorporating surveyed shoreline position, seasonal and annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

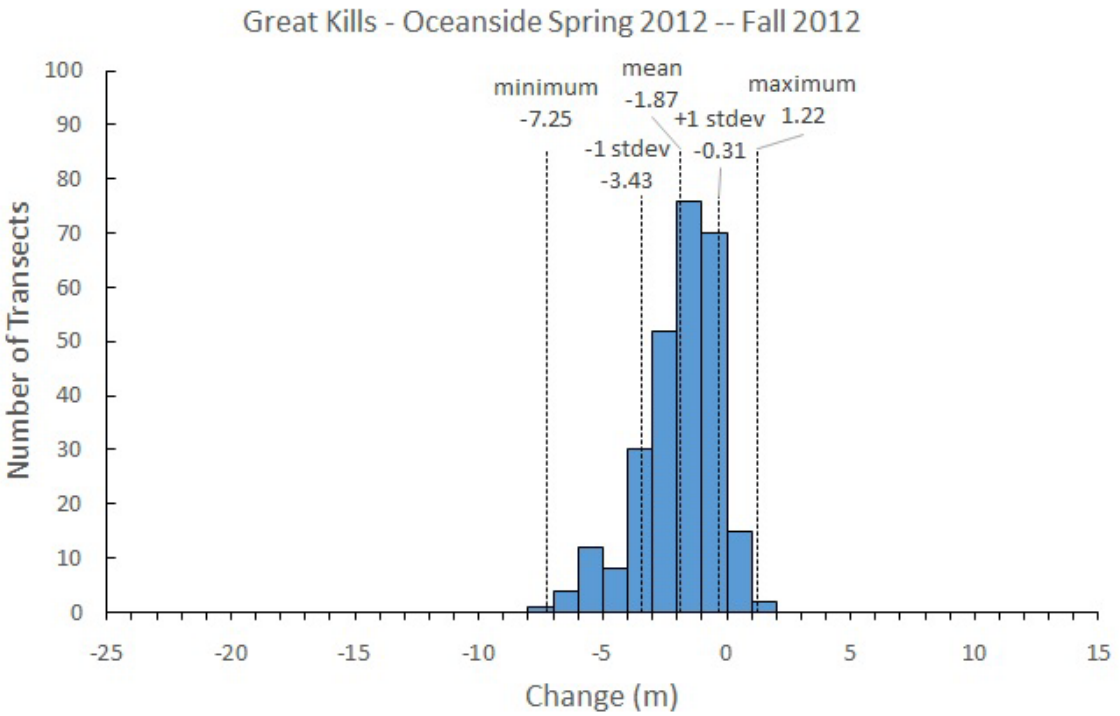


Figure 18. Distribution of difference measurements for the seasonal shoreline change of Great Kills-Oceanside between Spring 2012 and Fall 2012, incorporating the mean change value, standard deviation, maximum, and minimum values.

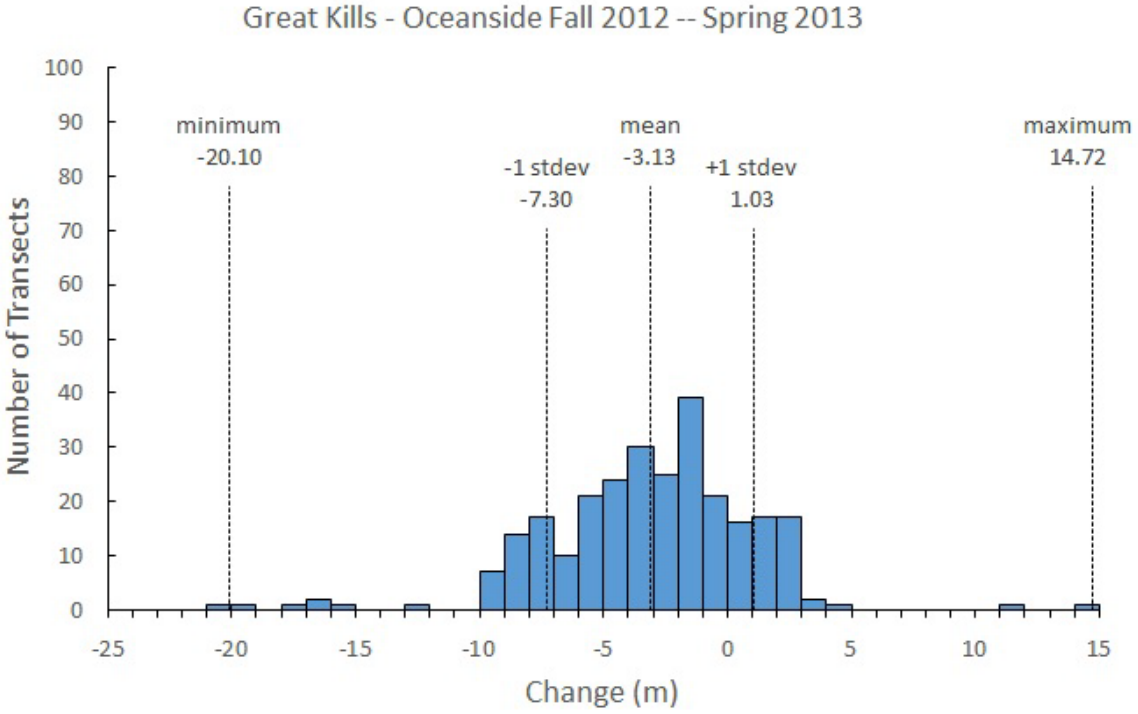


Figure 19. Distribution of difference measurements for the seasonal shoreline change of Great Kills-Oceanside between Fall 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

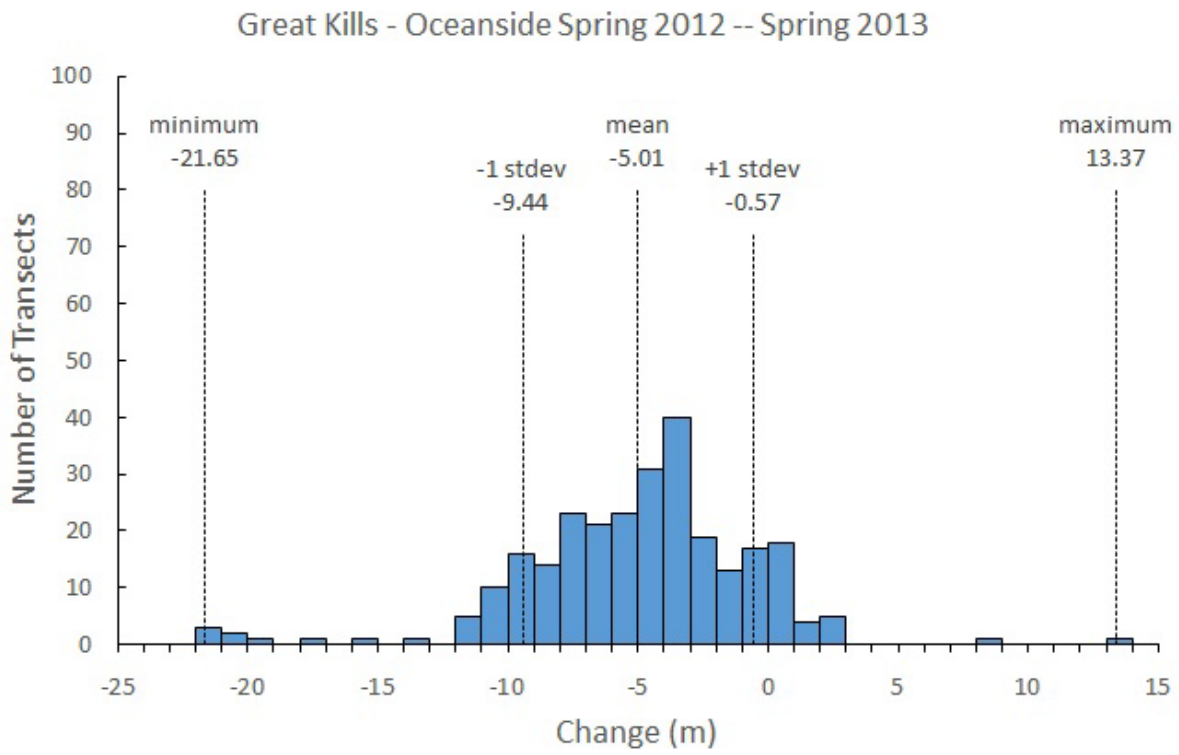


Figure 20. Distribution of difference measurements for the annual shoreline change of Great Kills-Oceanside between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Great Kills - Bayside

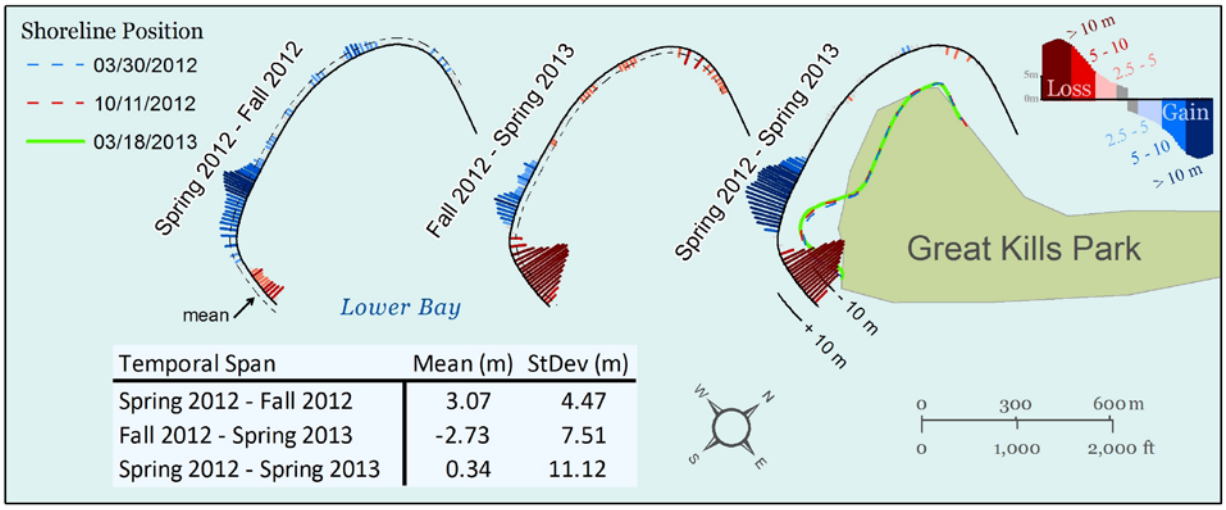


Figure 21. Alongshore distribution of shoreline displacement of the surveyed shorelines at Great Kills-Bayside, Spring 2012 - Spring 2013, incorporating surveyed shoreline position, seasonal and annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

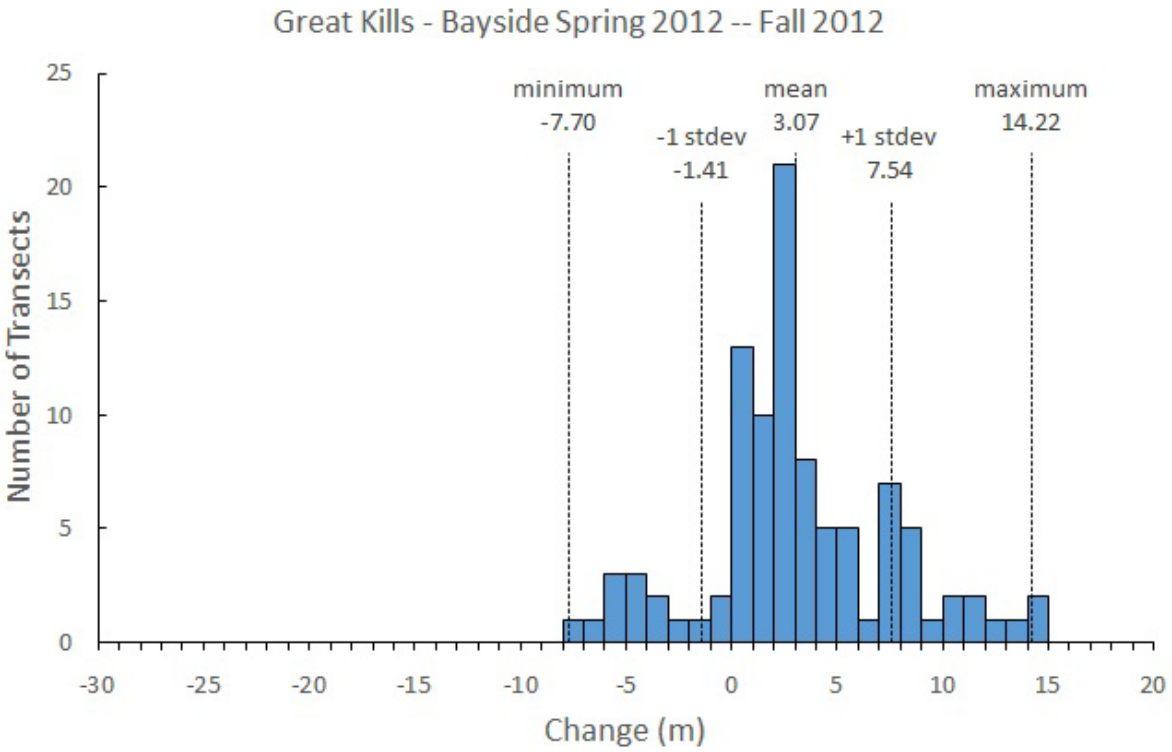


Figure 22. Distribution of difference measurements for the seasonal shoreline change of Great Kills-Bayside between Spring 2012 and Fall 2012, incorporating the mean change value, standard deviation, maximum, and minimum values.

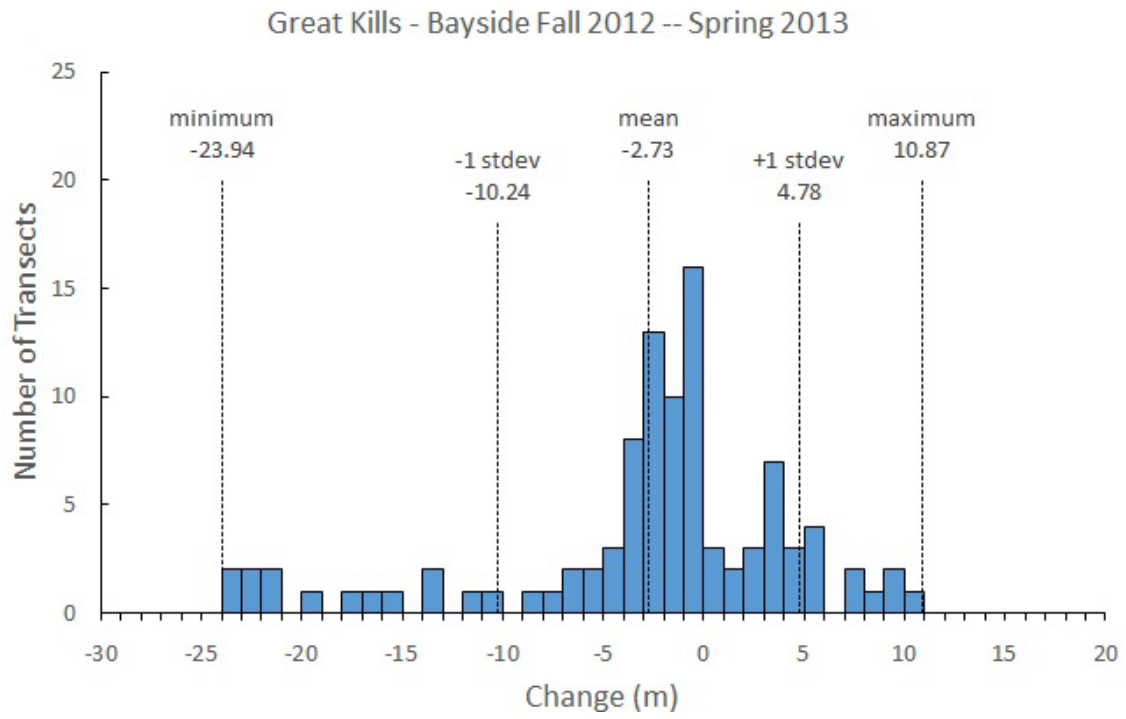


Figure 23. Distribution of difference measurements for the seasonal shoreline change of Great Kills-Bayside between Fall 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

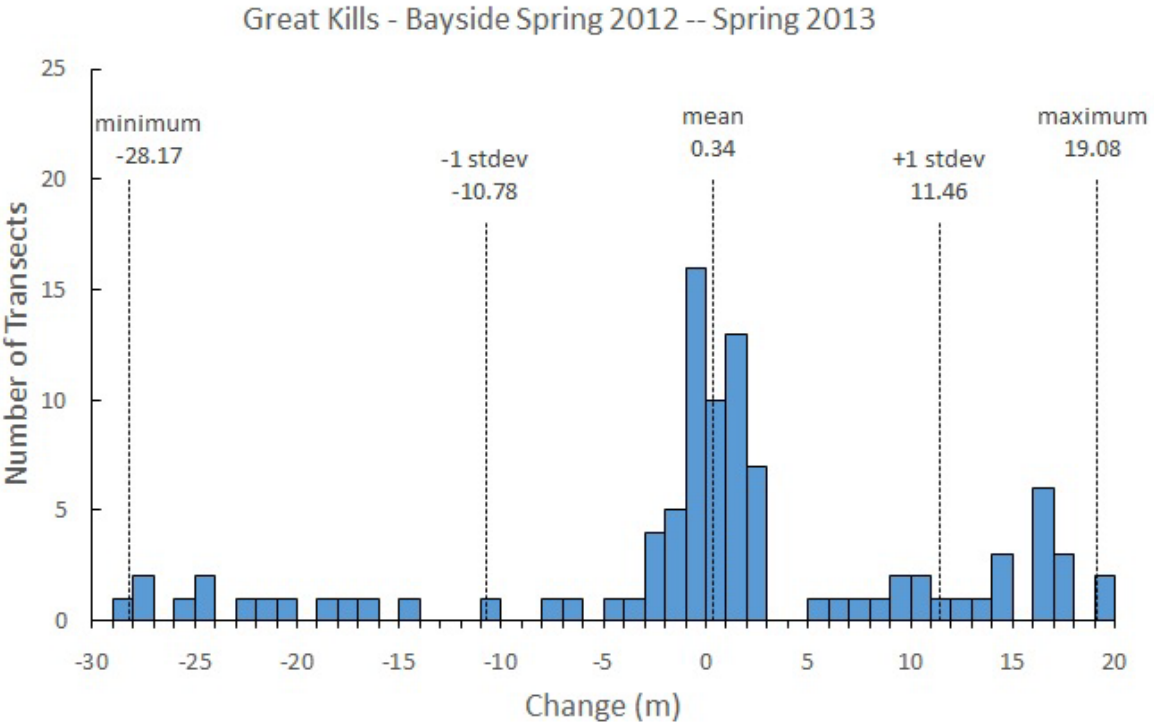
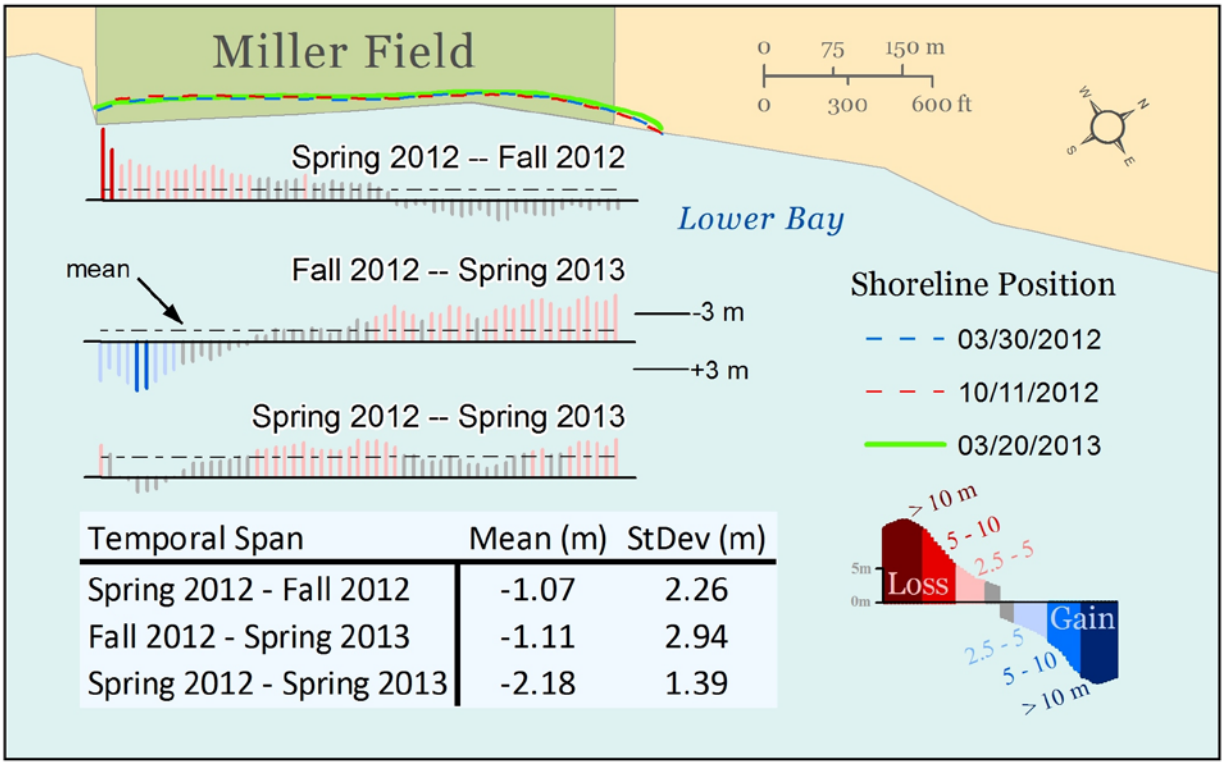


Figure 24. Distribution of difference measurements for the annual shoreline change of Great Kills-Bayside between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Miller Field

This site is relatively short alongshore, about 0.6 km, and is positioned between groins at either margin (Fig. 25).



Temporal Span	Mean (m)	StDev (m)
Spring 2012 - Fall 2012	-1.07	2.26
Fall 2012 - Spring 2013	-1.11	2.94
Spring 2012 - Spring 2013	-2.18	1.39

Figure 25. Alongshore distribution of shoreline displacement of the surveyed shorelines at Miller Field, Spring 2012 - Spring 2013, incorporating surveyed shoreline position, seasonal and annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

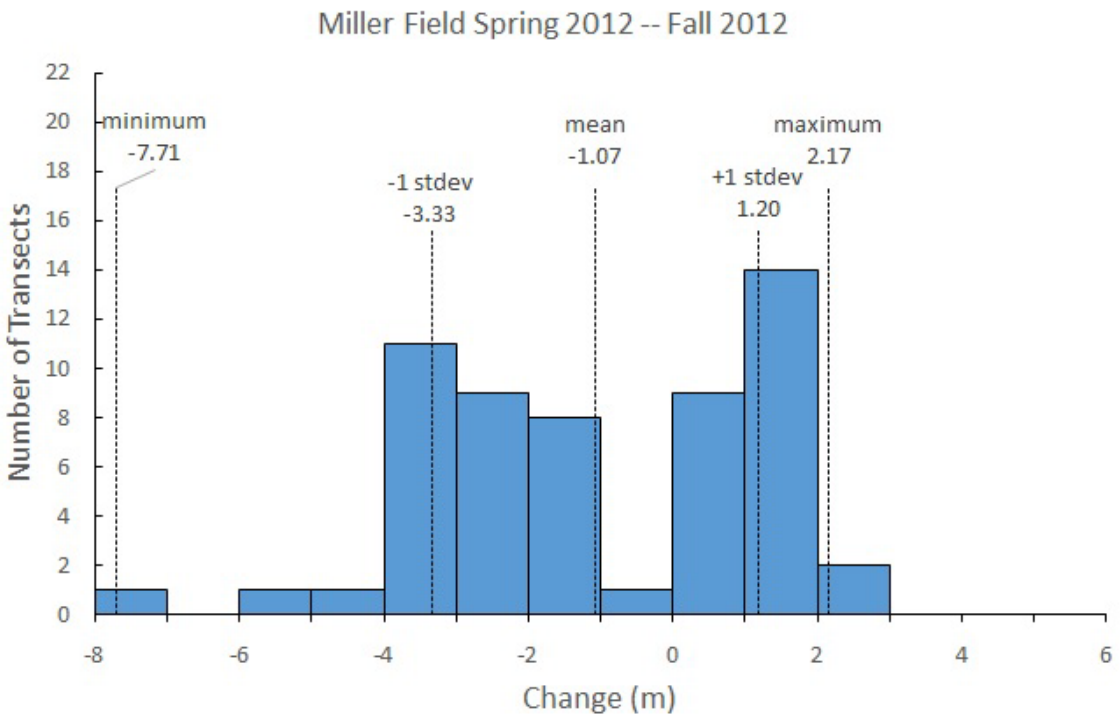


Figure 26. Distribution of difference measurements for the seasonal shoreline change of Miller Field between Spring 2012 and Fall 2012, incorporating the mean change value, standard deviation, maximum, and minimum values.

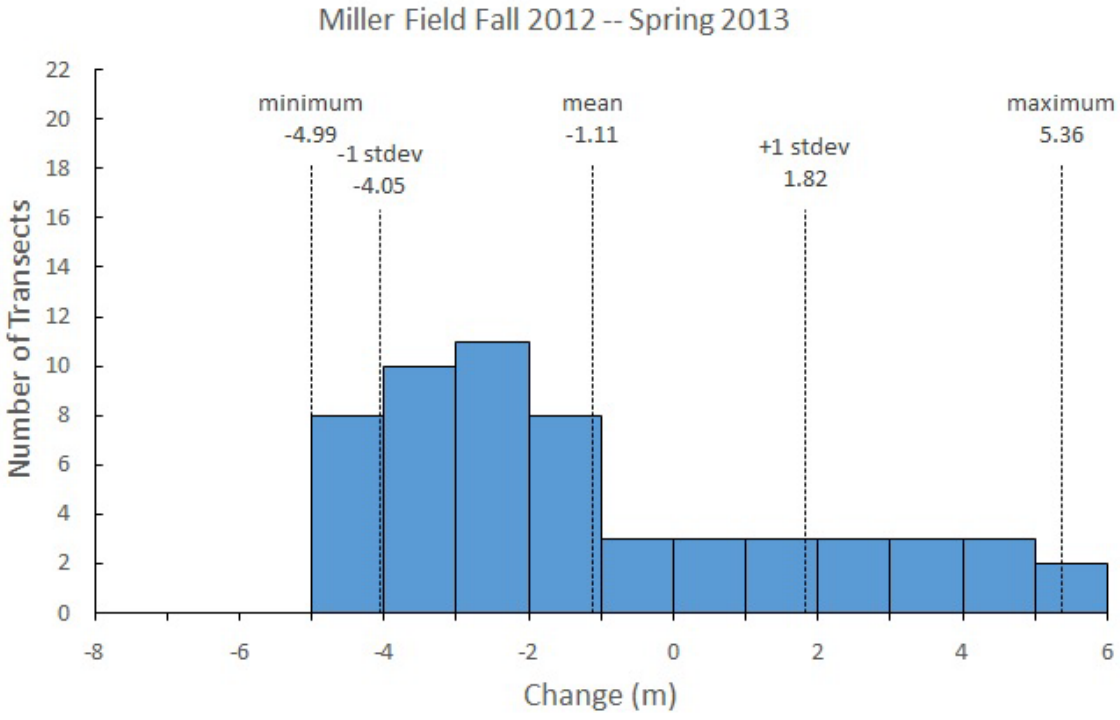


Figure 27. Distribution of difference measurements for the seasonal shoreline change of Miller Field between Fall 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

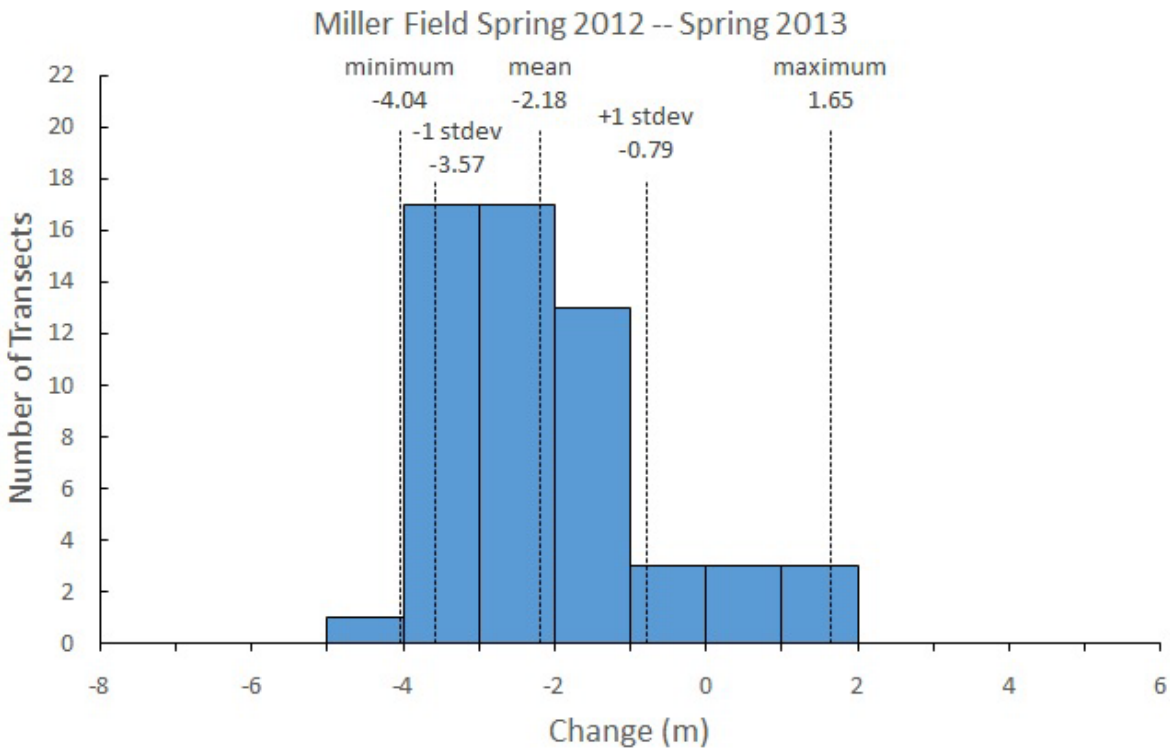
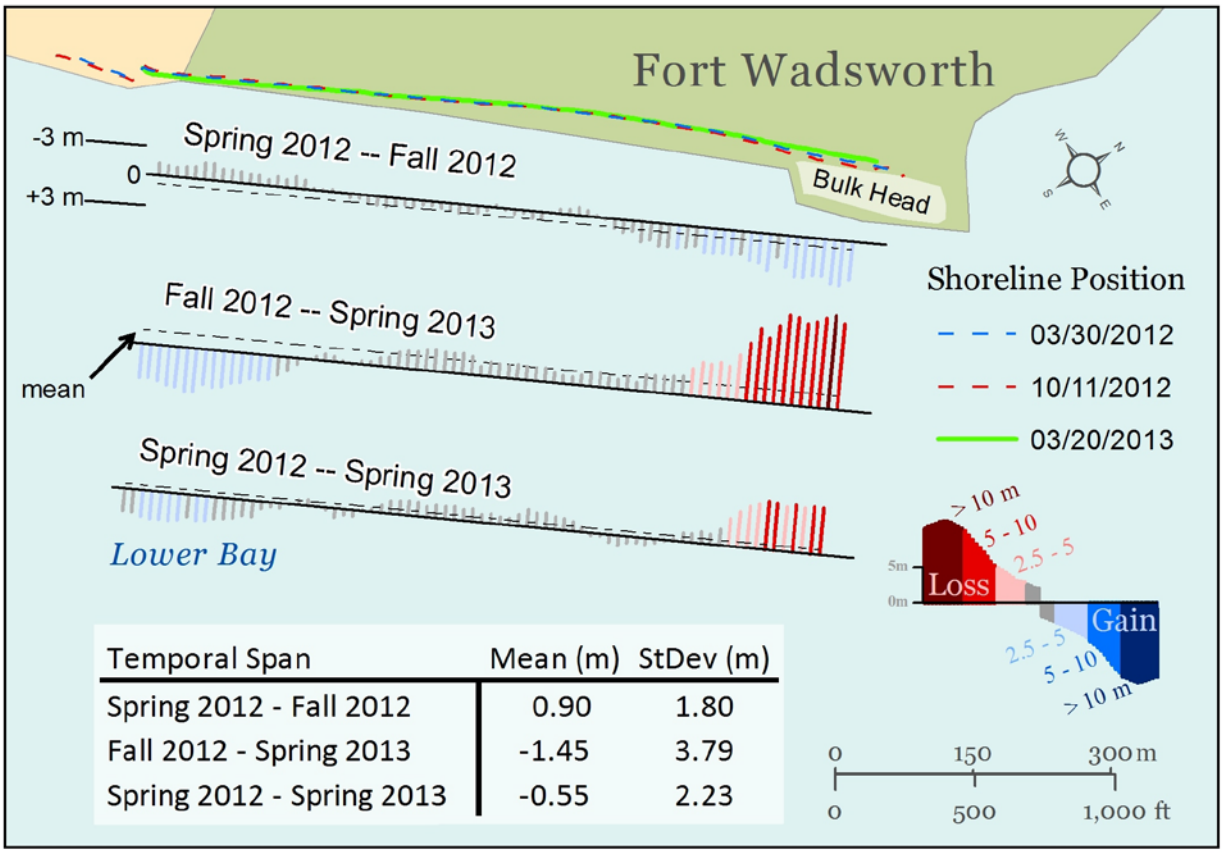


Figure 28. Distribution of difference measurements for the annual shoreline change of Miller Field between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Fort Wadsworth

The Fort Wadsworth shoreline is influenced by a groin located near its western margin and a concrete rubble structure along the eastern 100 m. There is a sandy beach seaward of some of the rubble.



Temporal Span	Mean (m)	StDev (m)
Spring 2012 - Fall 2012	0.90	1.80
Fall 2012 - Spring 2013	-1.45	3.79
Spring 2012 - Spring 2013	-0.55	2.23

Figure 29. Alongshore distribution of shoreline displacement of the surveyed shorelines at Fort Wadsworth, Spring 2012 - Spring 2013, incorporating surveyed shoreline position, seasonal and annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

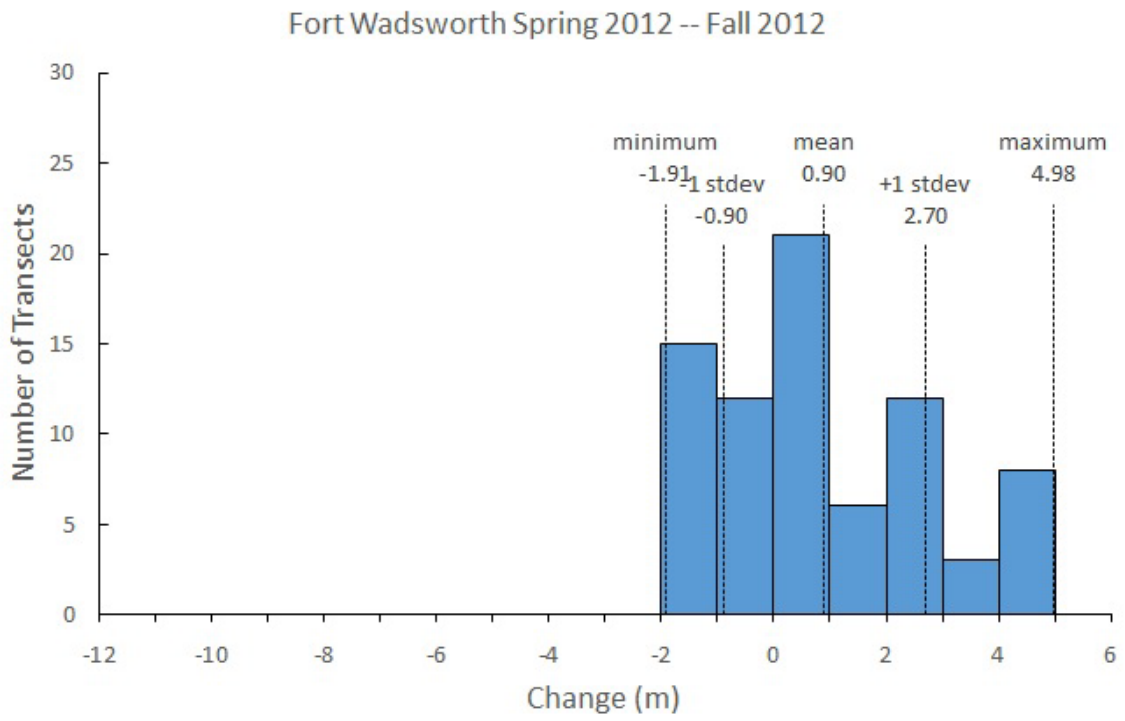


Figure 30. Distribution of difference measurements for the seasonal shoreline change of Fort Wadsworth between Spring 2012 and Fall 2012, incorporating the mean change value, standard deviation, maximum, and minimum values.

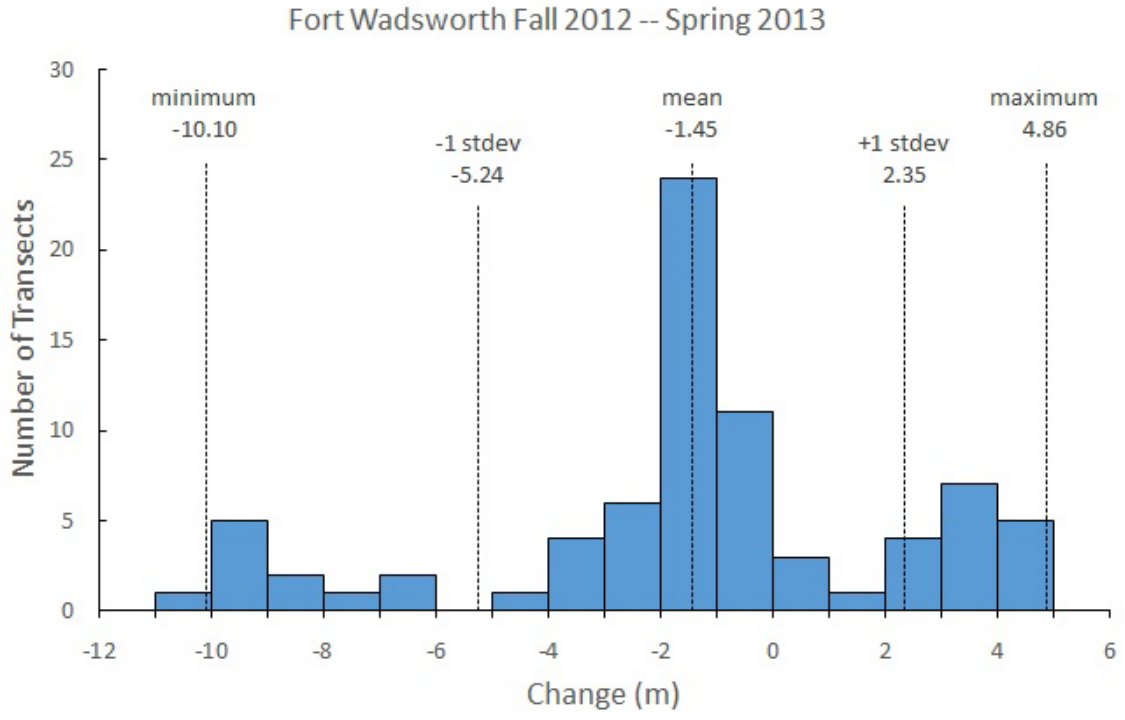


Figure 31. Distribution of difference measurements for the seasonal shoreline change of Fort Wadsworth between Fall 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

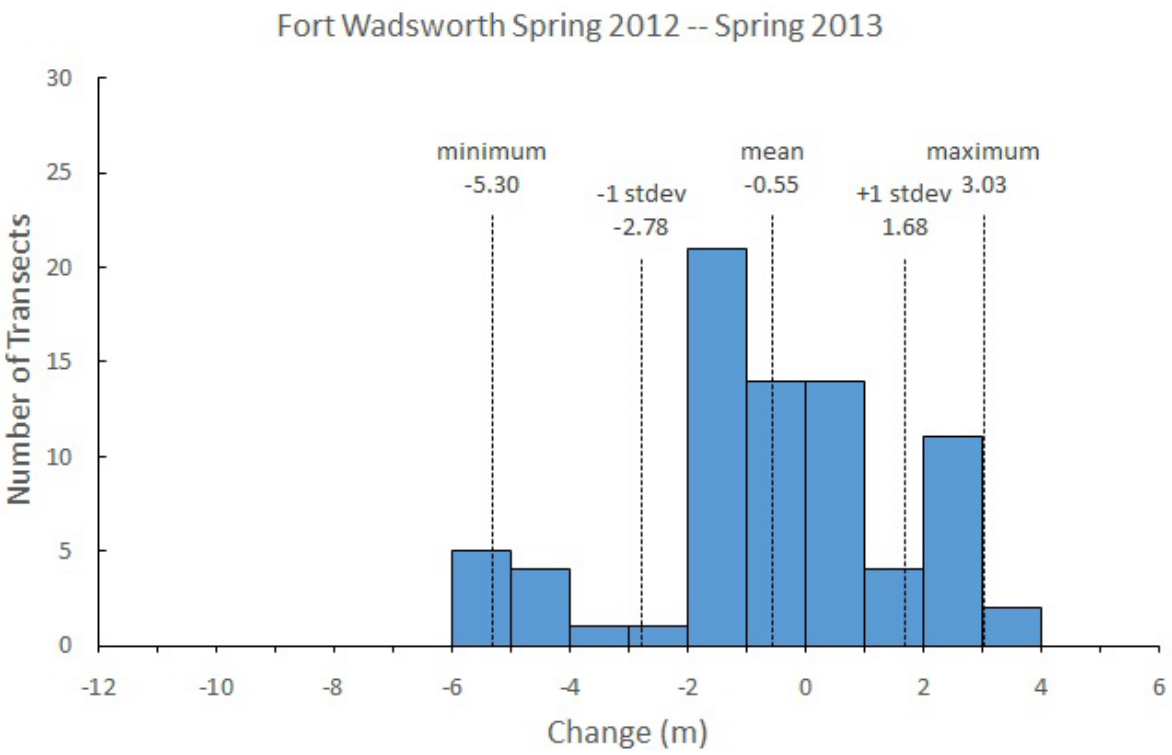


Figure 32. Distribution of difference measurements for the annual shoreline change of Fort Wadsworth between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Impacts of Hurricane Sandy

Sandy impacted the Gateway area shortly after the Fall 2012 survey was conducted. Following Sandy, surveys were conducted within 3-5 weeks. Where available, the data are presented for the Fall 2012 survey to Sandy, and from Sandy to the Spring 2013 survey. The Spring 2012 to Spring 2013 change is incorporated into the figure for comparison with the impacts caused by Sandy.

Sandy Hook

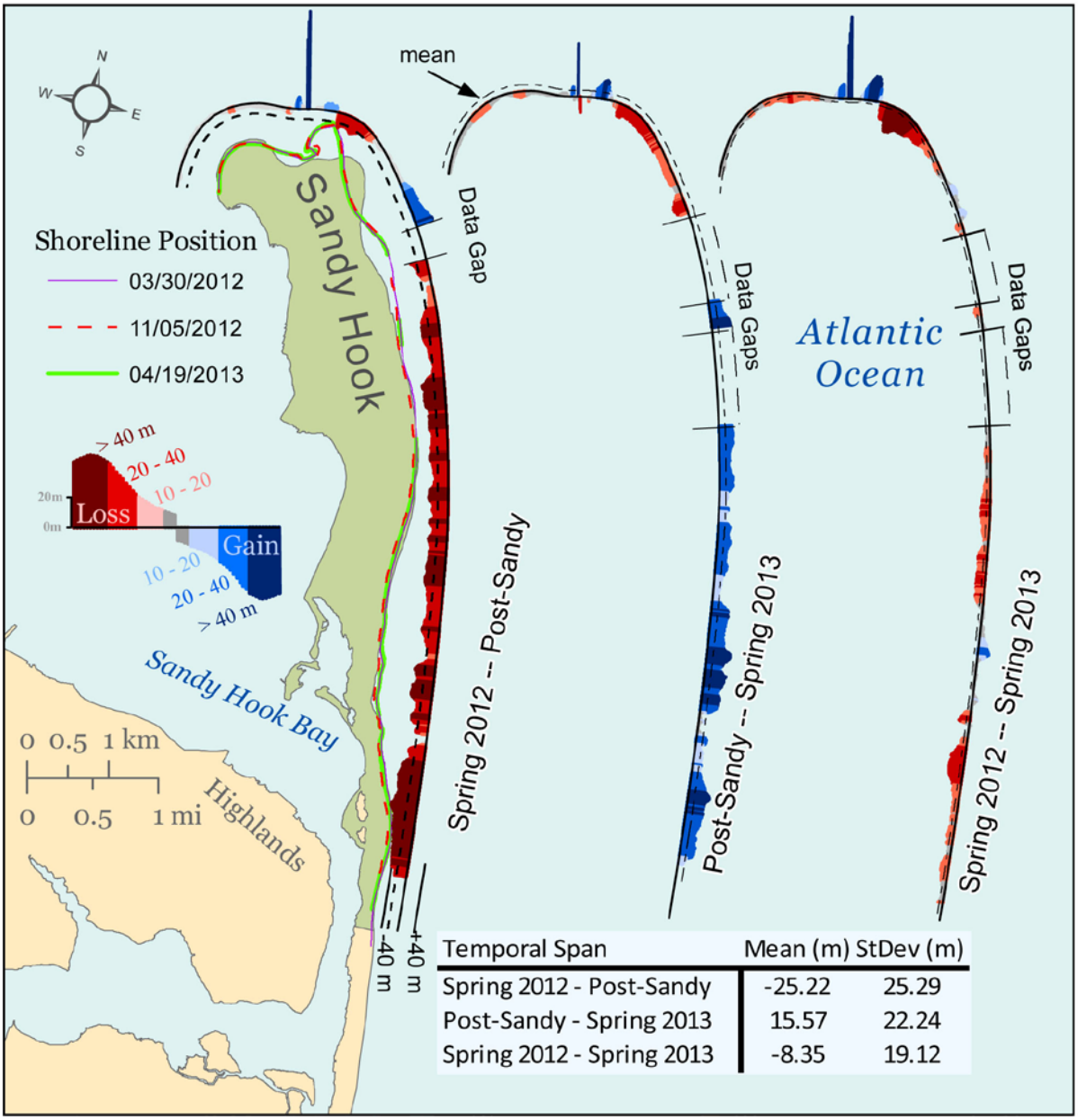


Figure 33. Alongshore distribution of shoreline displacement of the surveyed shorelines at Sandy Hook, from pre- and post- Sandy shorelines, incorporating surveyed shoreline position, annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

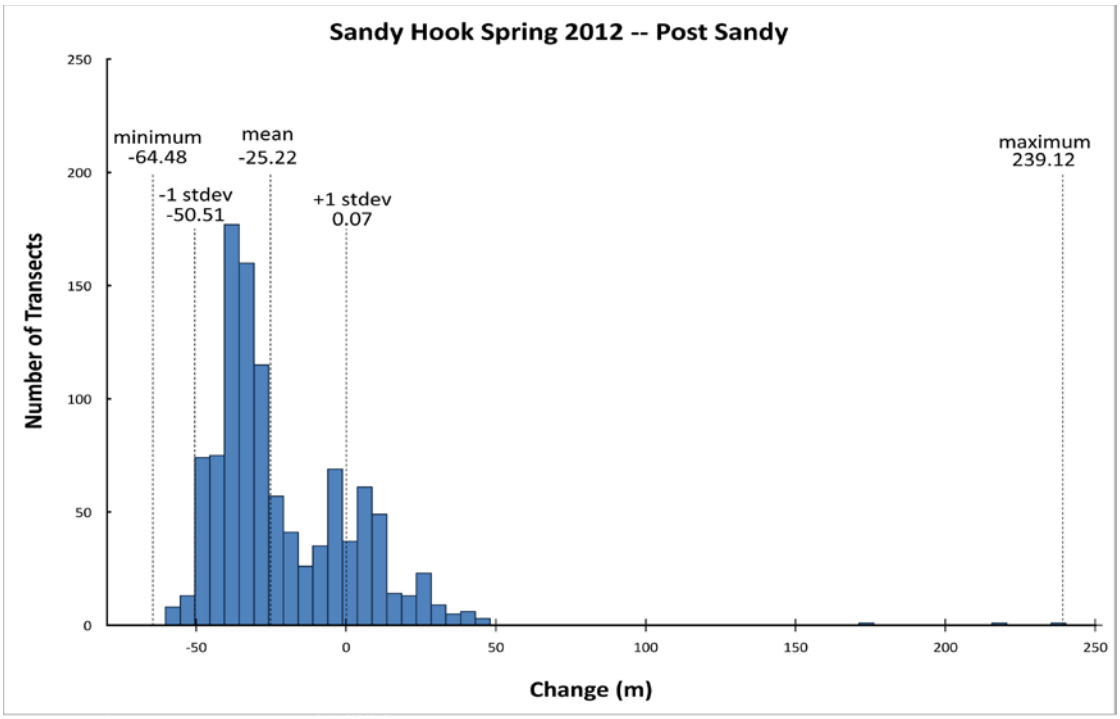


Figure 34. Distribution of difference measurements for the storm event shoreline change of Sandy Hook between Spring 2012 and post-Sandy, incorporating the mean change value, standard deviation, maximum, and minimum values.

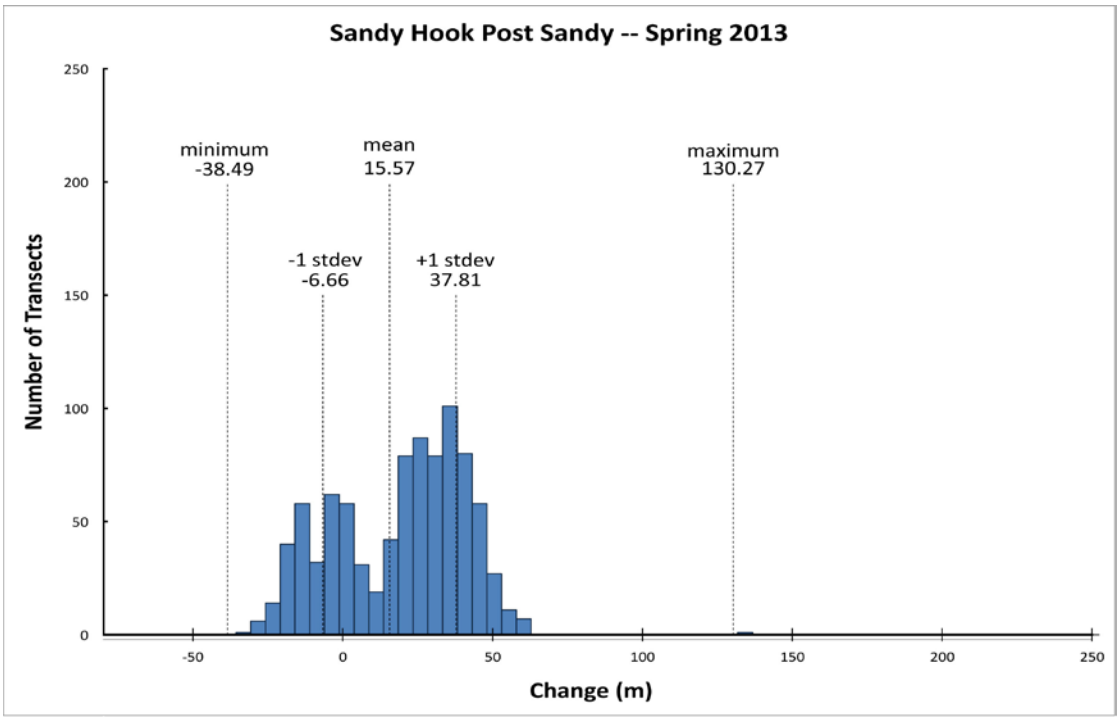


Figure 35. Distribution of difference measurements for the storm event shoreline change of Sandy Hook between post-Sandy and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

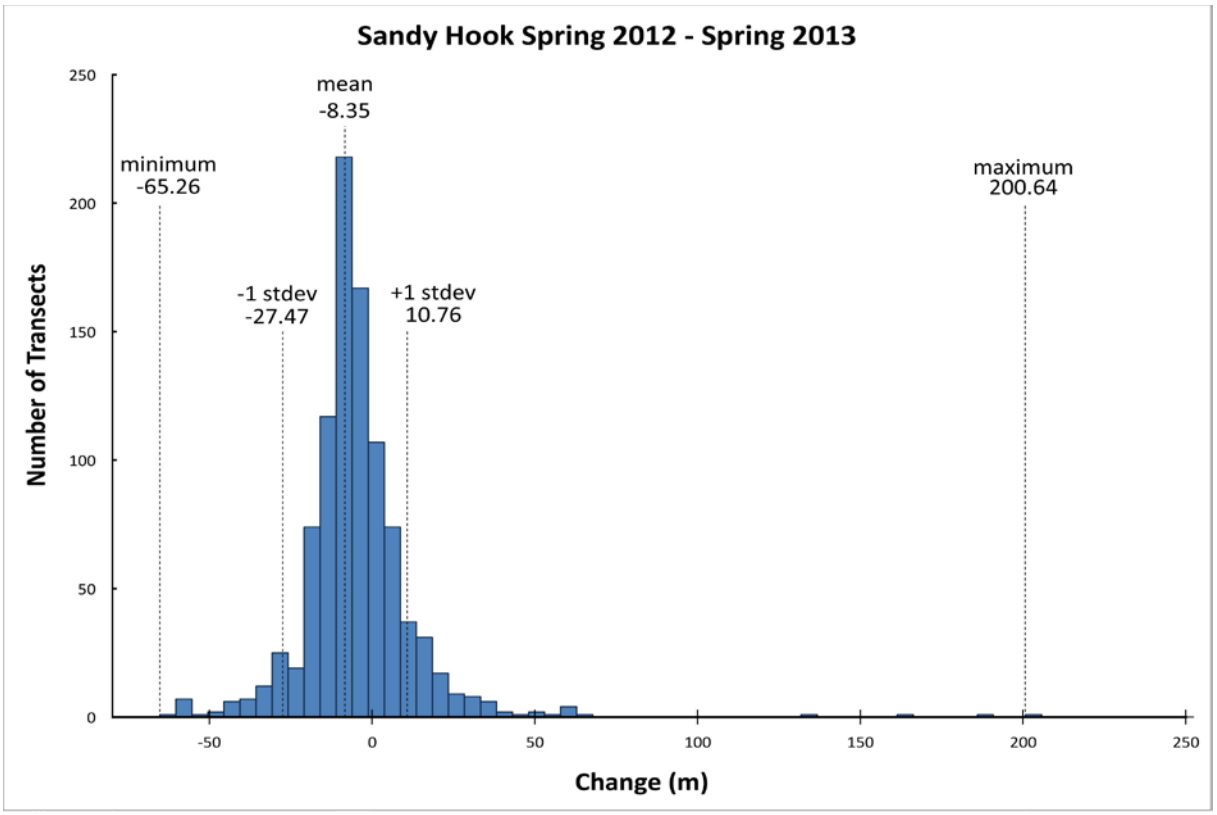


Figure 36. Distribution of difference measurements for the annual shoreline change of Sandy Hook between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Breezy Point – Oceanside

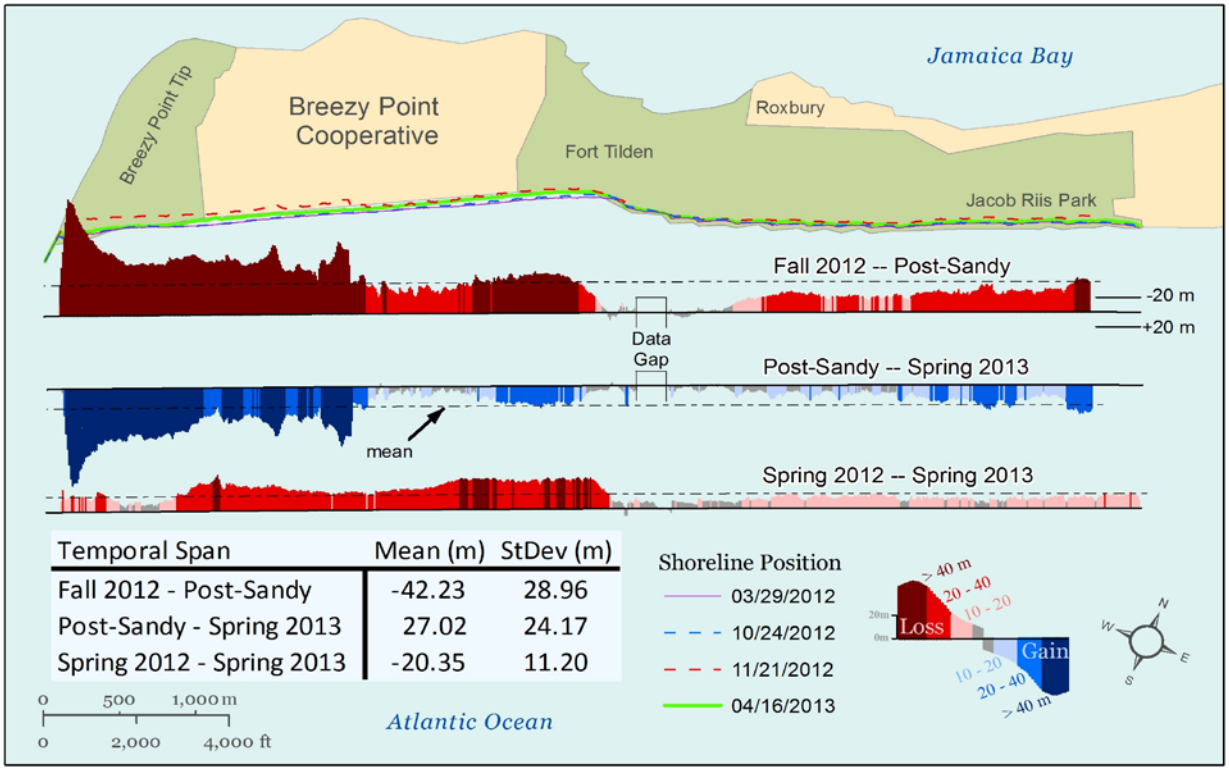


Figure 37. Alongshore distribution of shoreline displacement of the surveyed shorelines at Breezy Point-Oceanside, from pre- and post- Sandy shorelines, incorporating surveyed shoreline position, annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

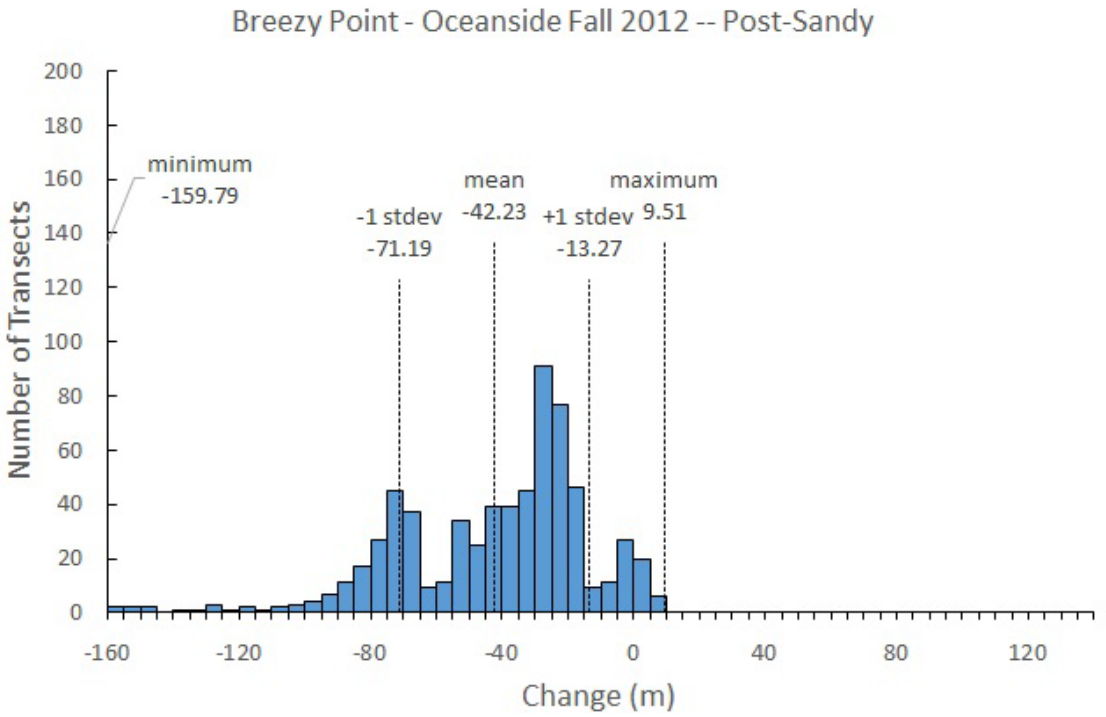


Figure 38. Distribution of difference measurements for the storm event shoreline change of Breezy Point-Oceanside between Fall 2012 and post-Sandy, incorporating the mean change value, standard deviation, maximum, and minimum values.

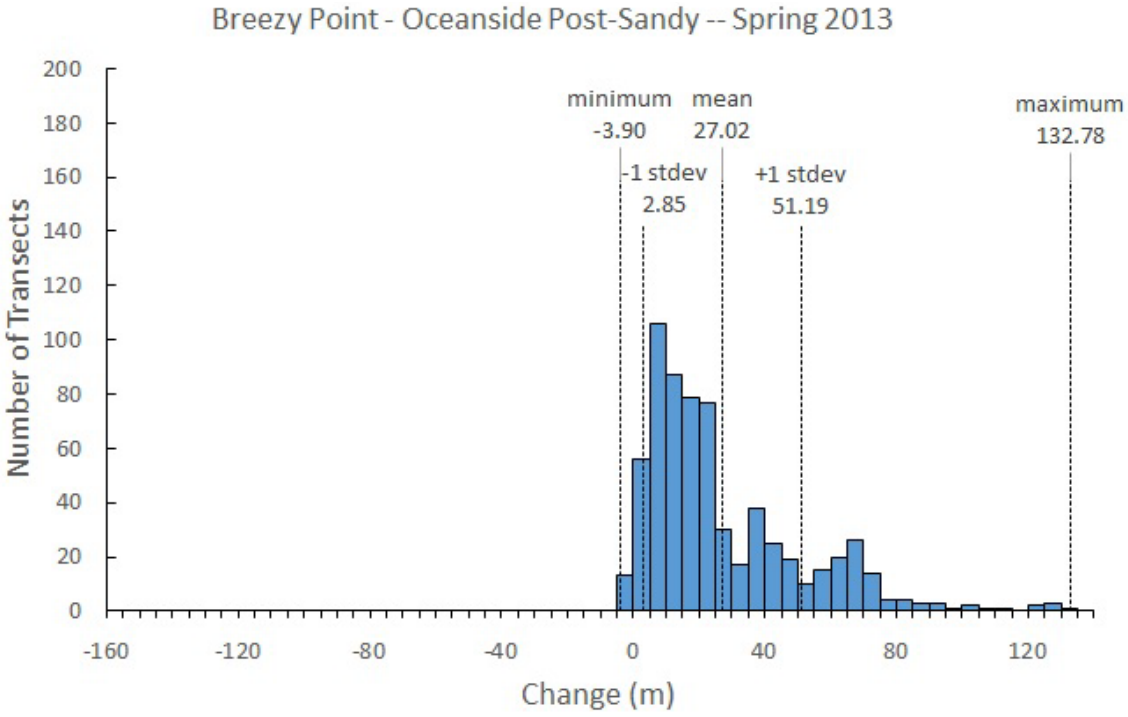


Figure 39. Distribution of difference measurements for the storm event shoreline change of Breezy Point-Oceanside between post-Sandy and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

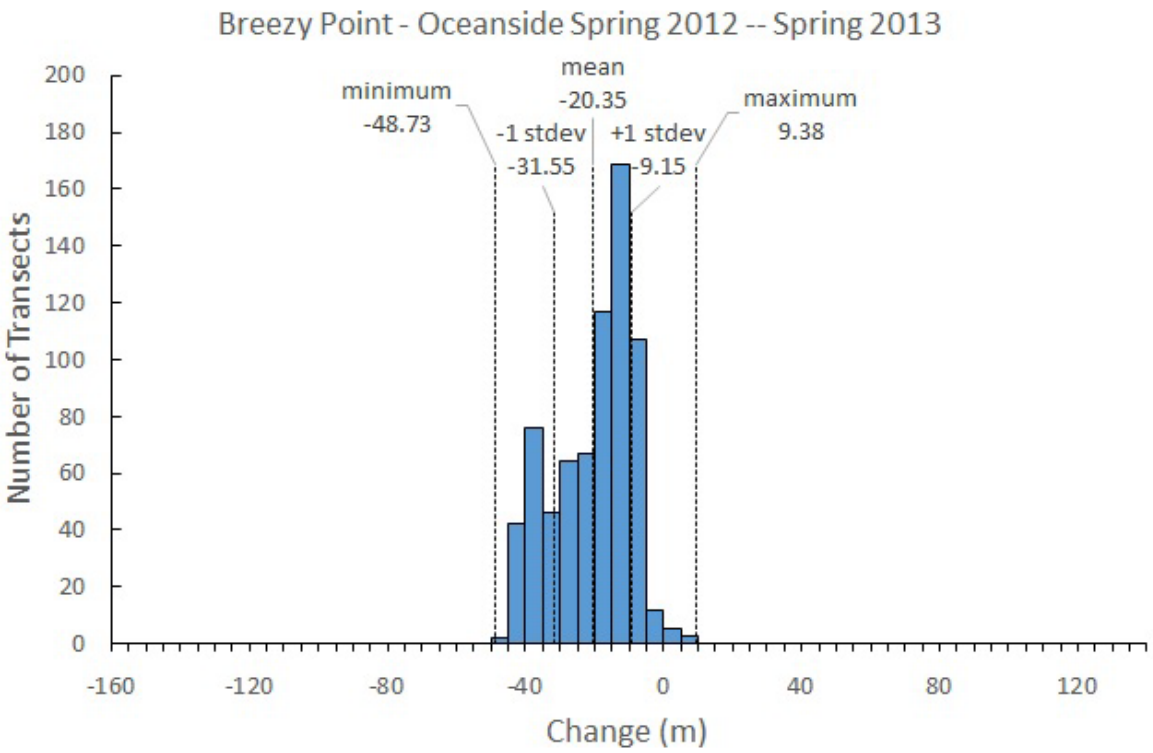


Figure 40. Distribution of difference measurements for the annual shoreline change of Breezy Point-Oceanside between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Breezy Point – Bayside

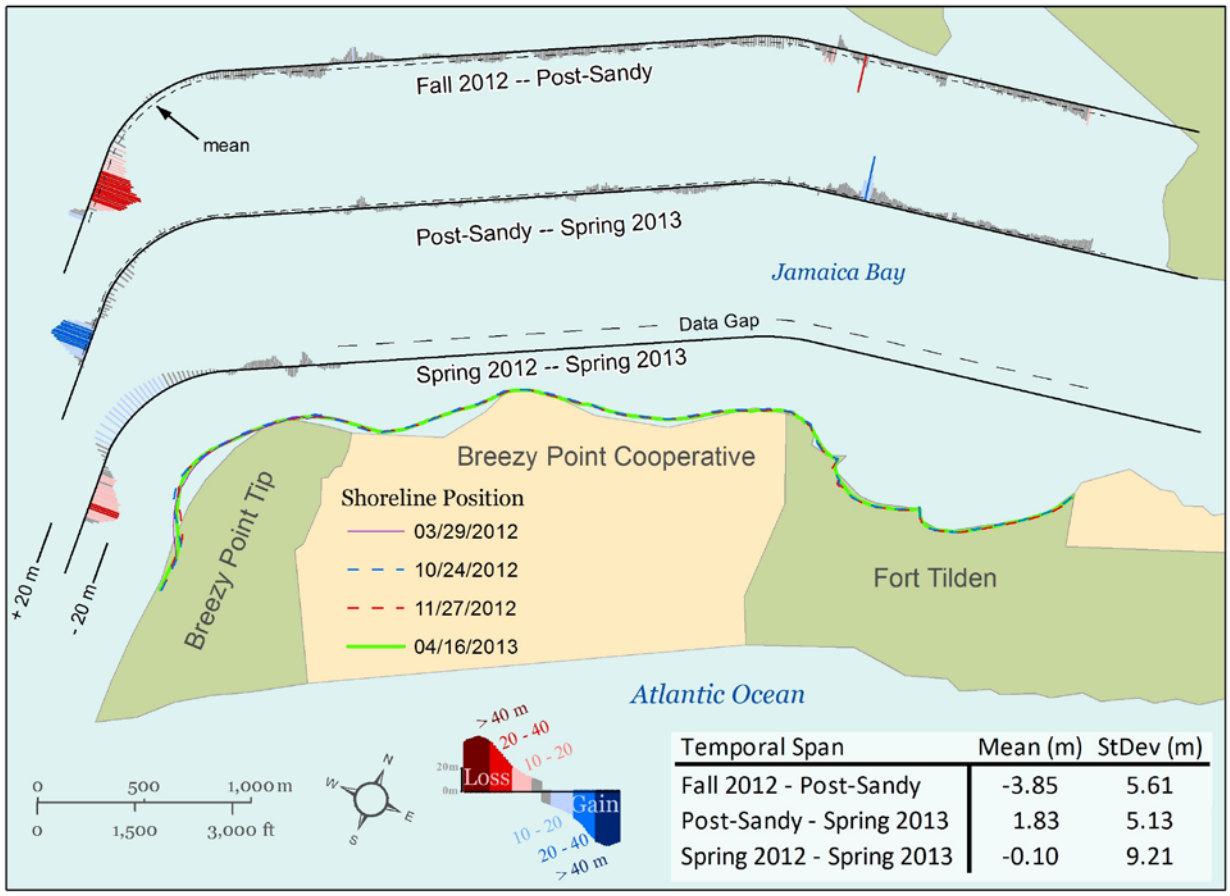


Figure 41. Alongshore distribution of shoreline displacement of the surveyed shorelines at Breezy Point-Bayside, from pre- and post- Sandy shorelines, incorporating surveyed shoreline position, annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

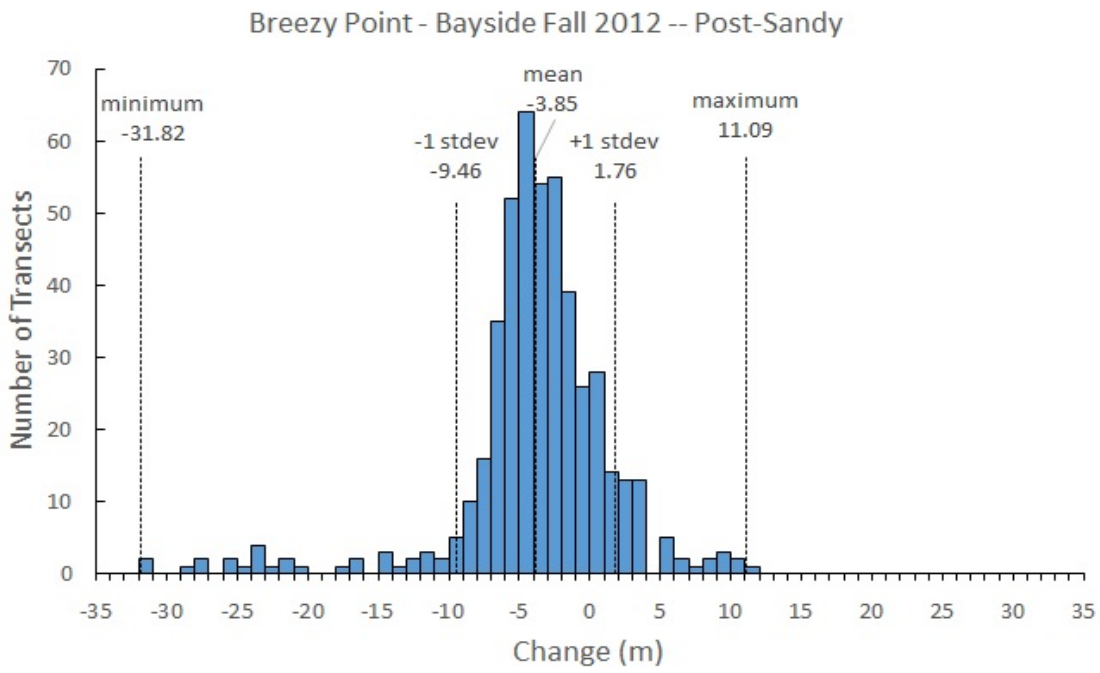


Figure 42. Distribution of difference measurements for the storm event shoreline change of Breezy Point-Bayside between Fall 2012 and post-Sandy, incorporating the mean change value, standard deviation, maximum, and minimum values.

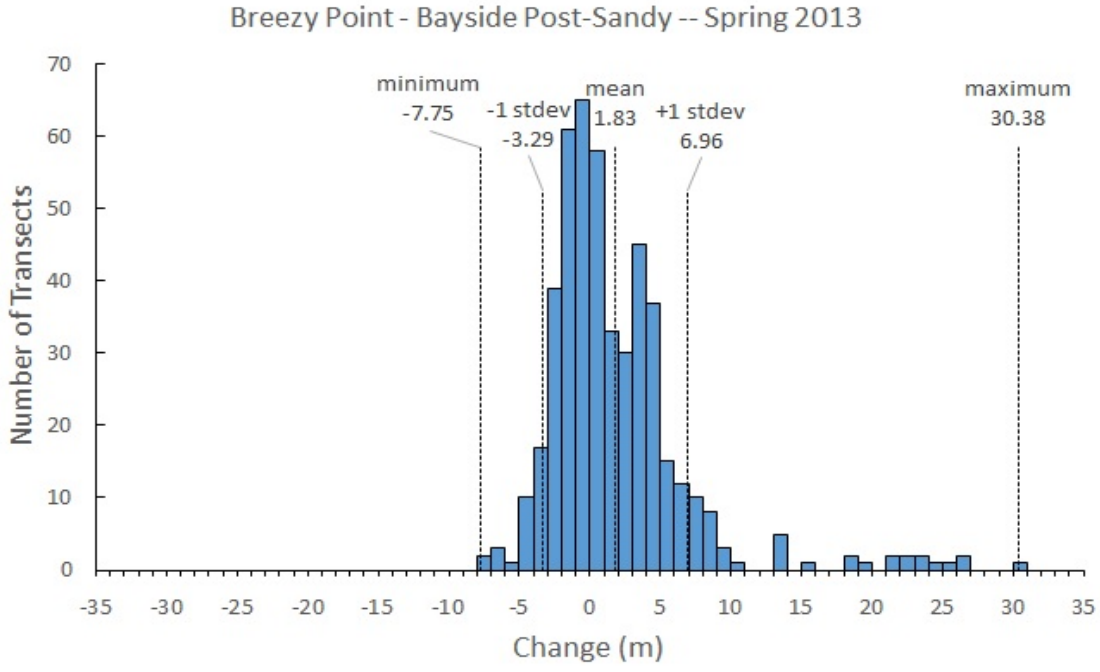


Figure 43. Distribution of difference measurements for the storm event shoreline change of Breezy Point - Bayside between post-Sandy and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

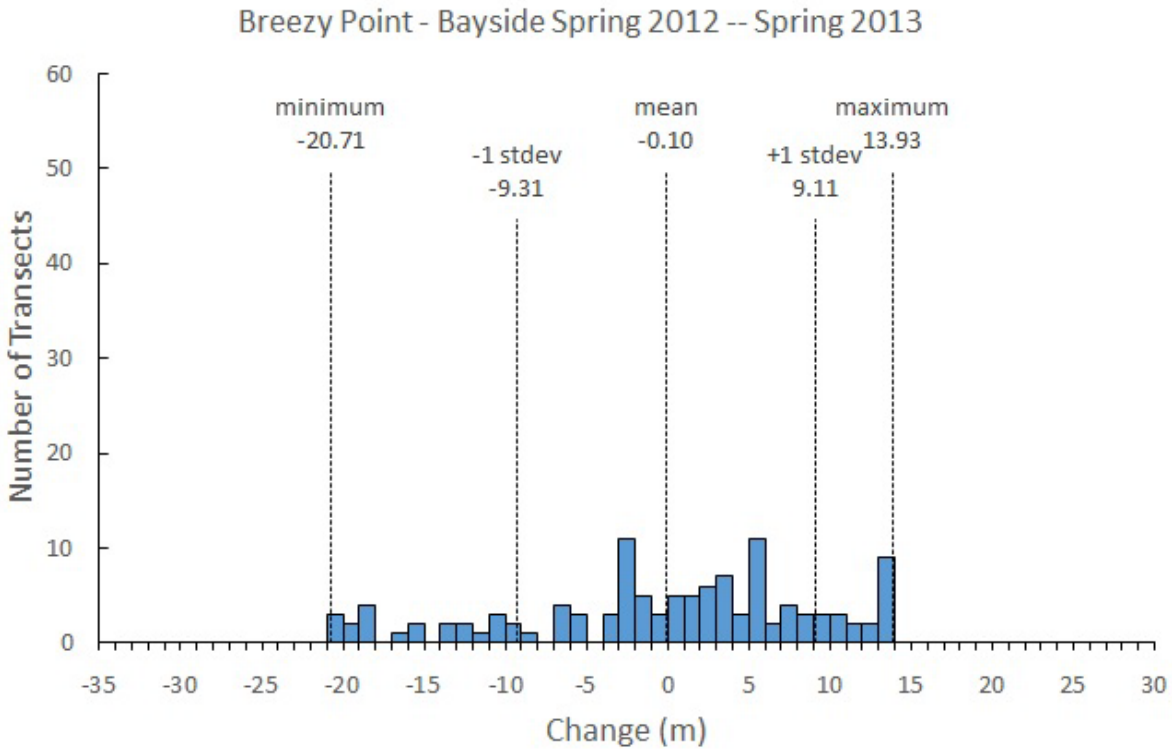


Figure 44. Distribution of difference measurements for the annual shoreline change of Breezy Point-Bayside between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Plumb Beach

Beach nourishment was ongoing during the fall survey period and we were not allowed access. Following Sandy, there was construction of beach groins in the area, and we were not allowed access, therefore there are no surveys representing the impacts of Sandy at Plumb Beach.

Great Kills – Oceanside

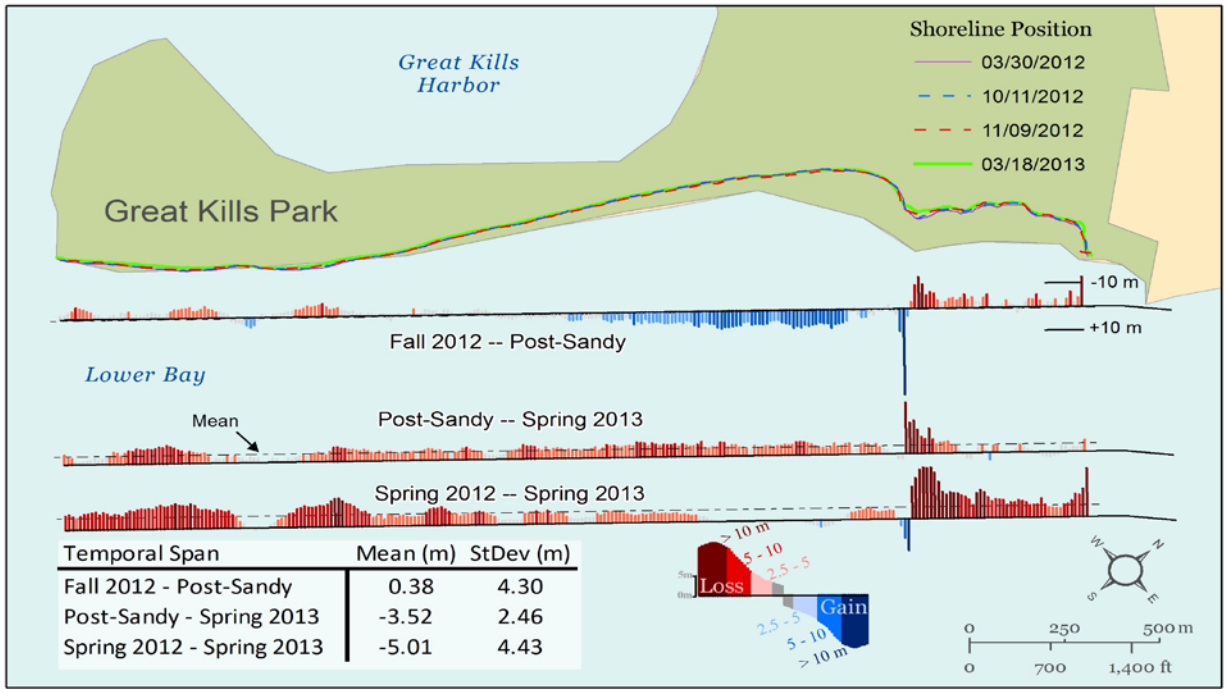


Figure 45. Alongshore distribution of shoreline displacement of the surveyed shorelines at Great Kills - Oceanside, from pre- and post- Sandy shorelines, incorporating surveyed shoreline position, annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

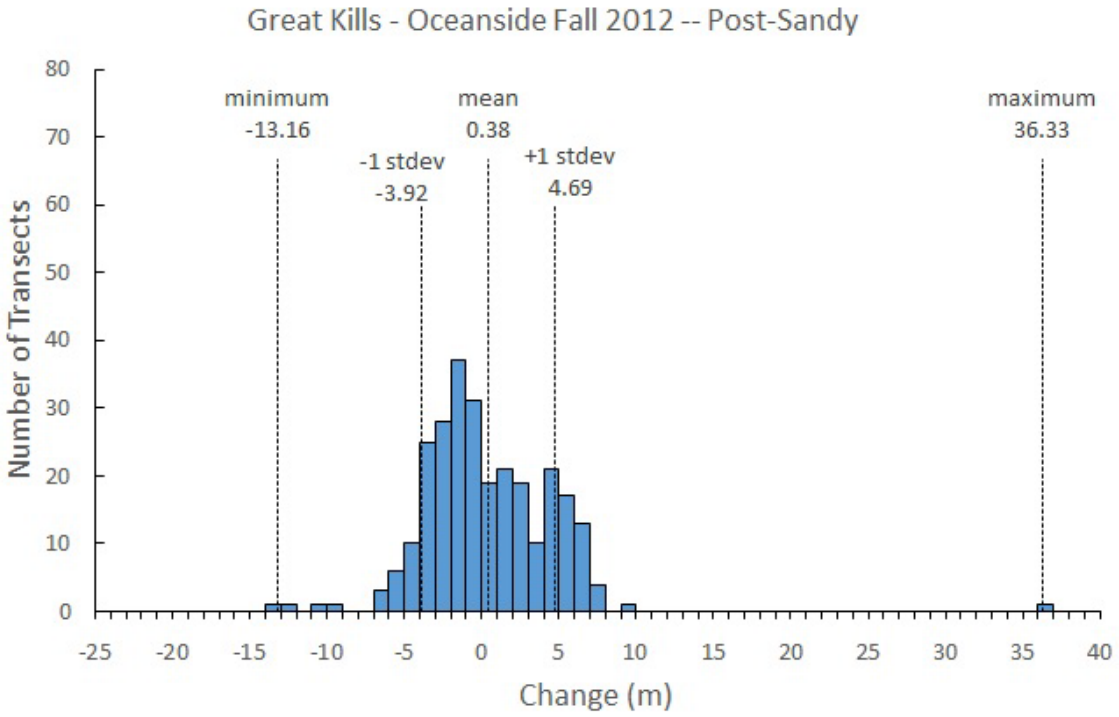


Figure 46. Distribution of difference measurements for the storm event shoreline change of Great Kills – Oceanside between Fall 2012 and post-Sandy, incorporating the mean change value, standard deviation, maximum, and minimum values.

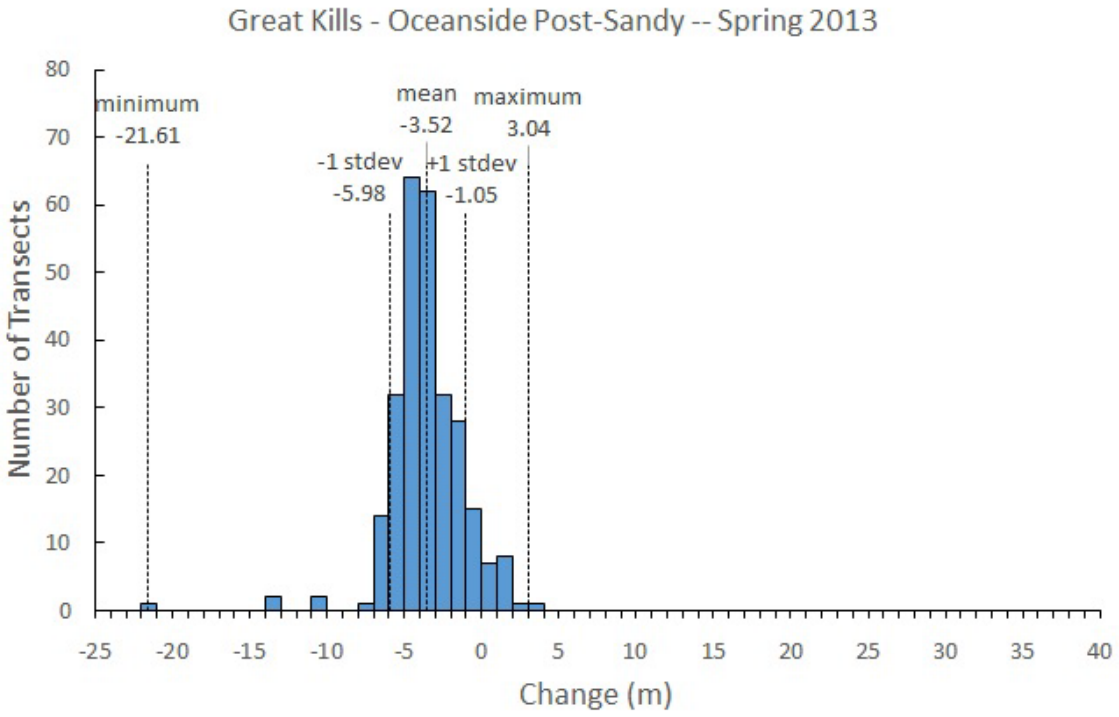


Figure 47. Distribution of difference measurements for the storm event shoreline change of Great Kills – Oceanside between post-Sandy and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

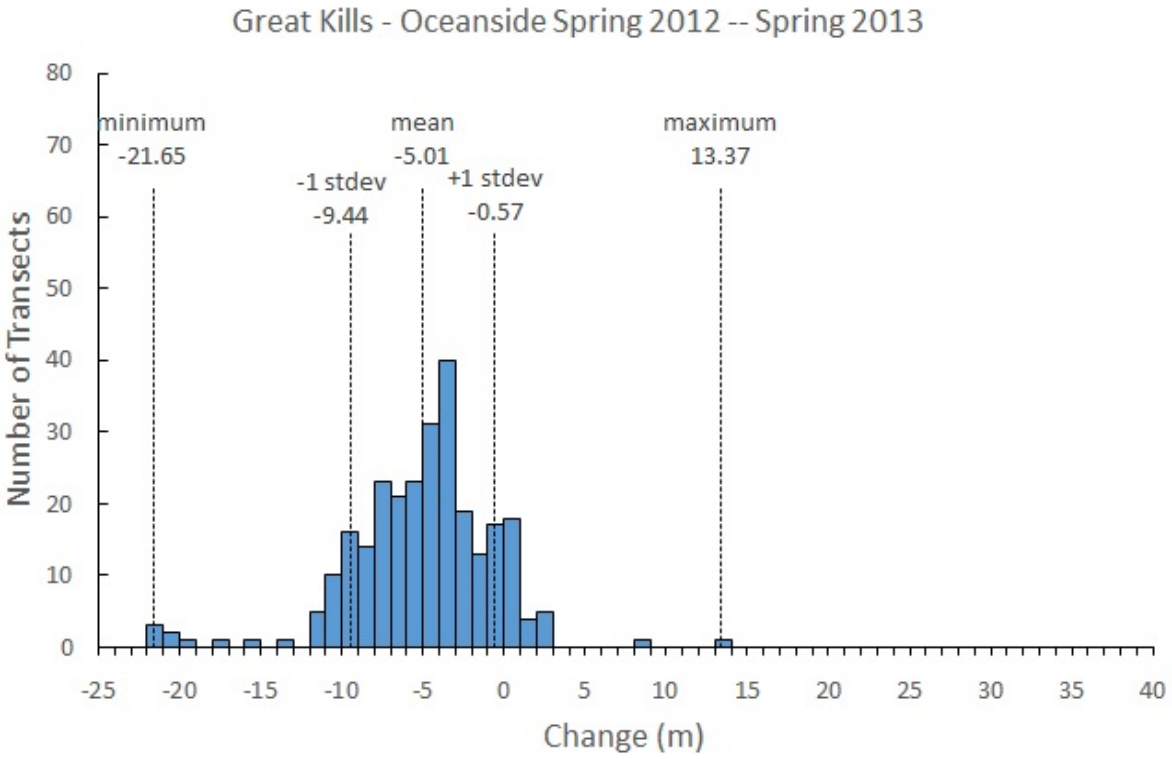


Figure 48. Distribution of difference measurements for the annual shoreline change of Great Kills – Oceanside between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Great Kills – Bayside

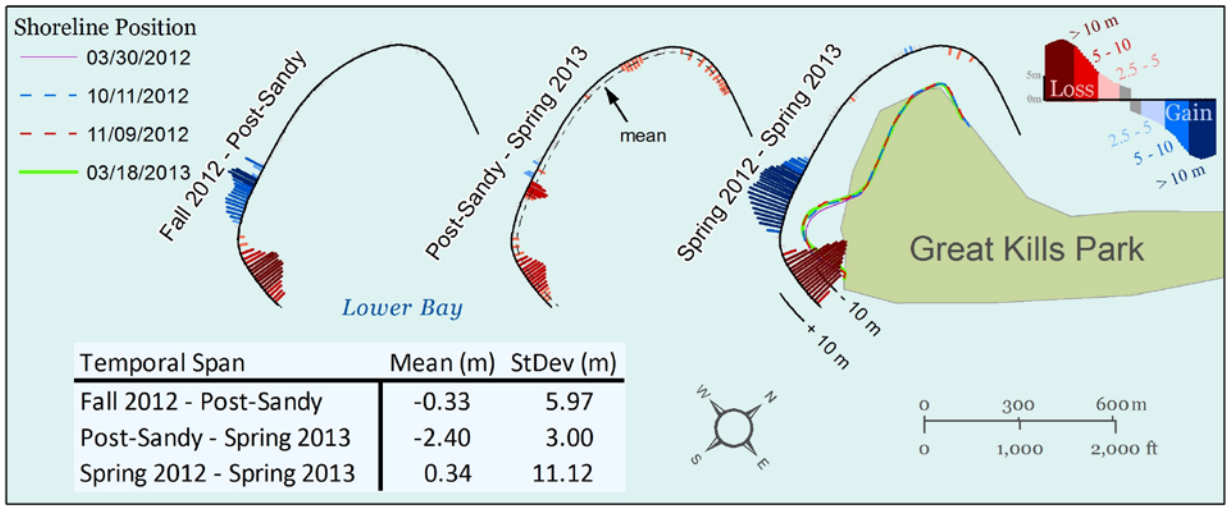


Figure 49. Alongshore distribution of shoreline displacement of the surveyed shorelines at Great Kills-Bayside, from pre- and post- Sandy shorelines, incorporating surveyed shoreline position, annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

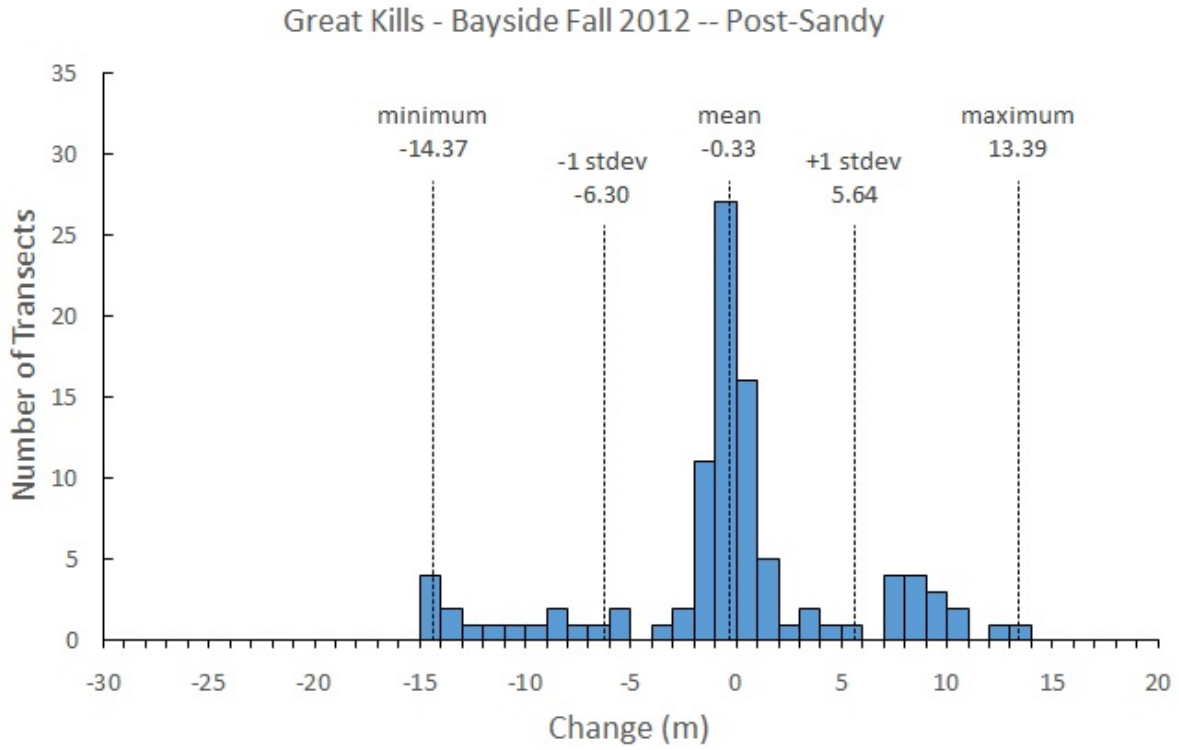


Figure 50. Distribution of difference measurements for the storm event shoreline change of Great Kills – Bayside between Fall 2012 and post-Sandy, incorporating the mean change value, standard deviation, maximum, and minimum values.

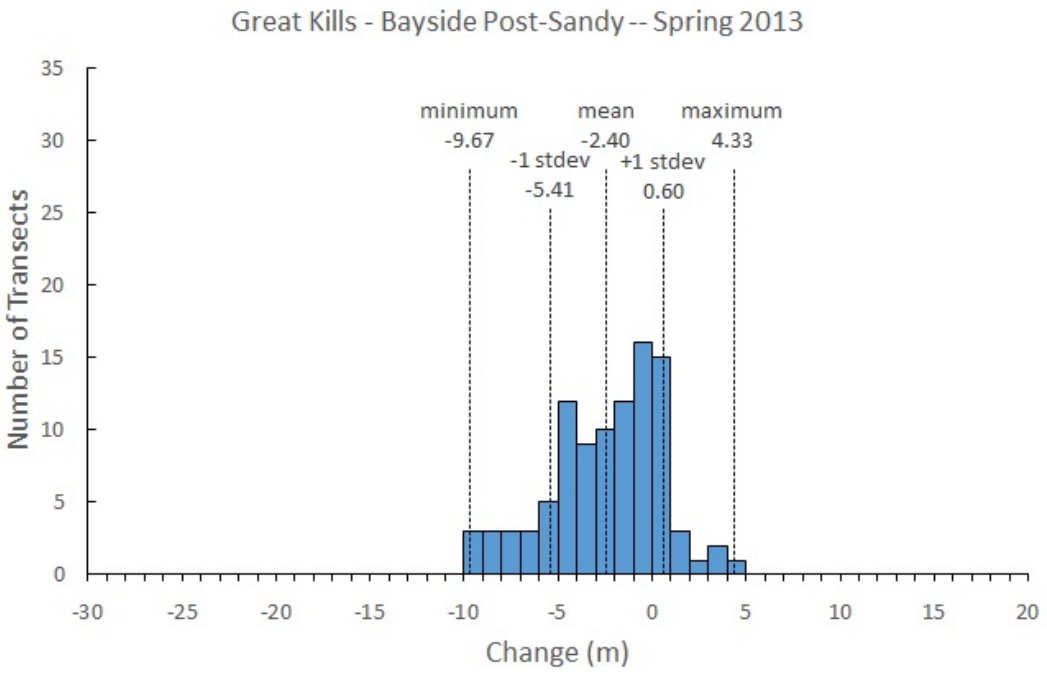


Figure 51. Distribution of difference measurements for the storm event shoreline change of Great Kills – Bayside between post-Sandy and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

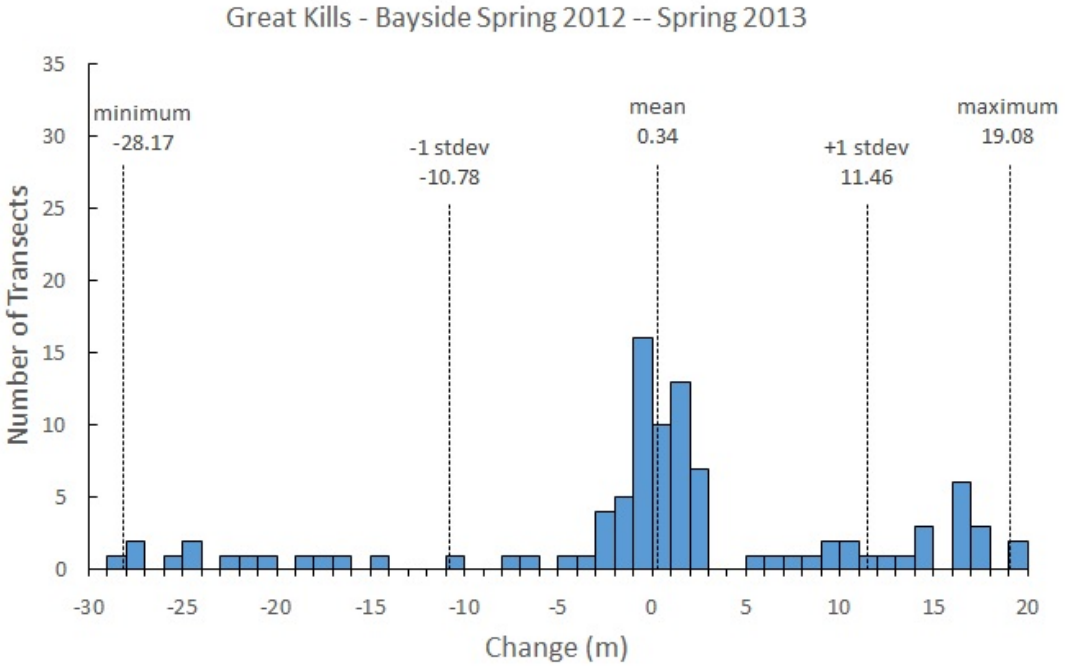
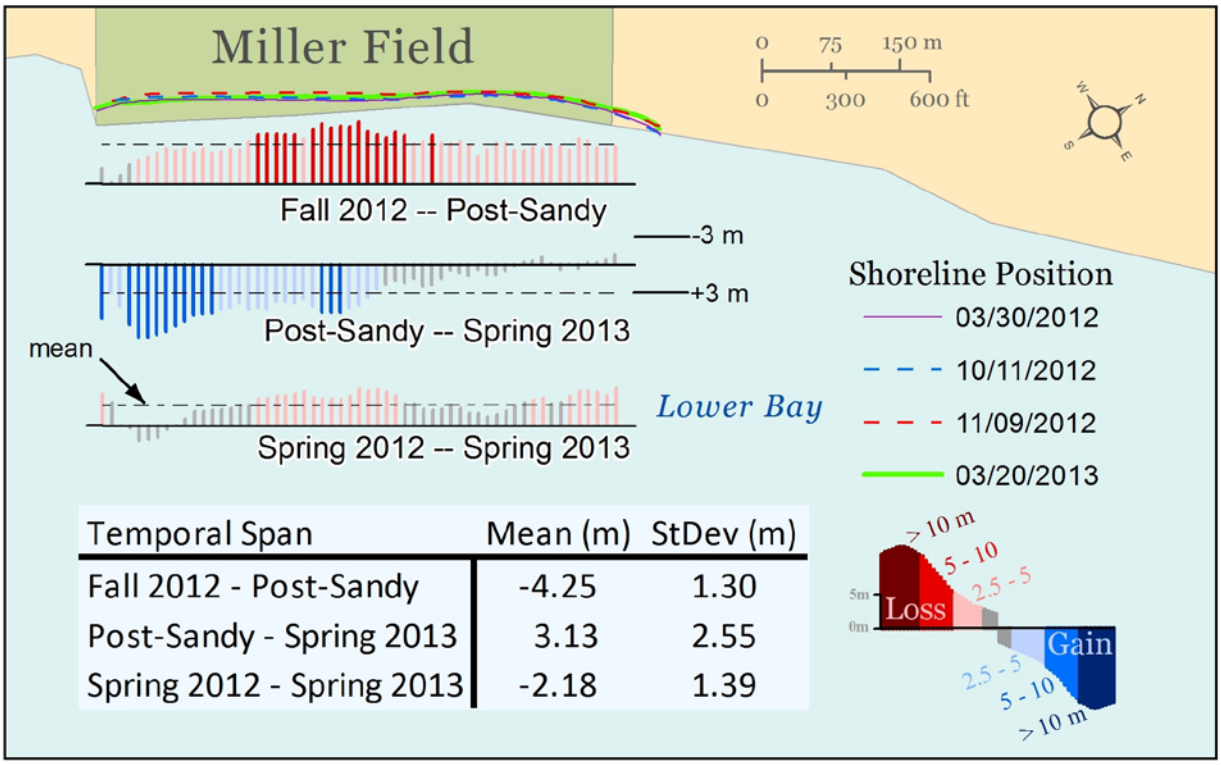


Figure 52. Distribution of difference measurements for the annual shoreline change of Great Kills – Bayside between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Miller Field



Temporal Span	Mean (m)	StDev (m)
Fall 2012 - Post-Sandy	-4.25	1.30
Post-Sandy - Spring 2013	3.13	2.55
Spring 2012 - Spring 2013	-2.18	1.39

Figure 53. Alongshore distribution of shoreline displacement of the surveyed shorelines at Miller Field, from pre- and post- Sandy shorelines, incorporating surveyed shoreline position, annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

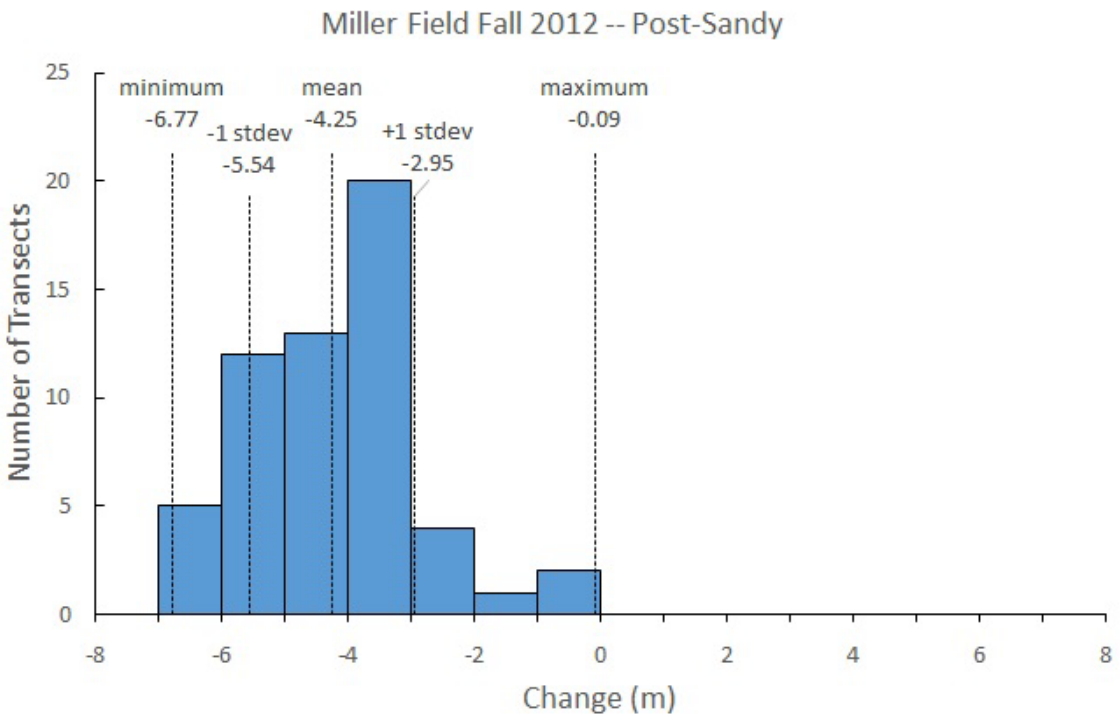


Figure 54. Distribution of difference measurements for the storm event shoreline change of Miller Field between Fall 2012 and post-Sandy, incorporating the mean change value, standard deviation, maximum, and minimum values.

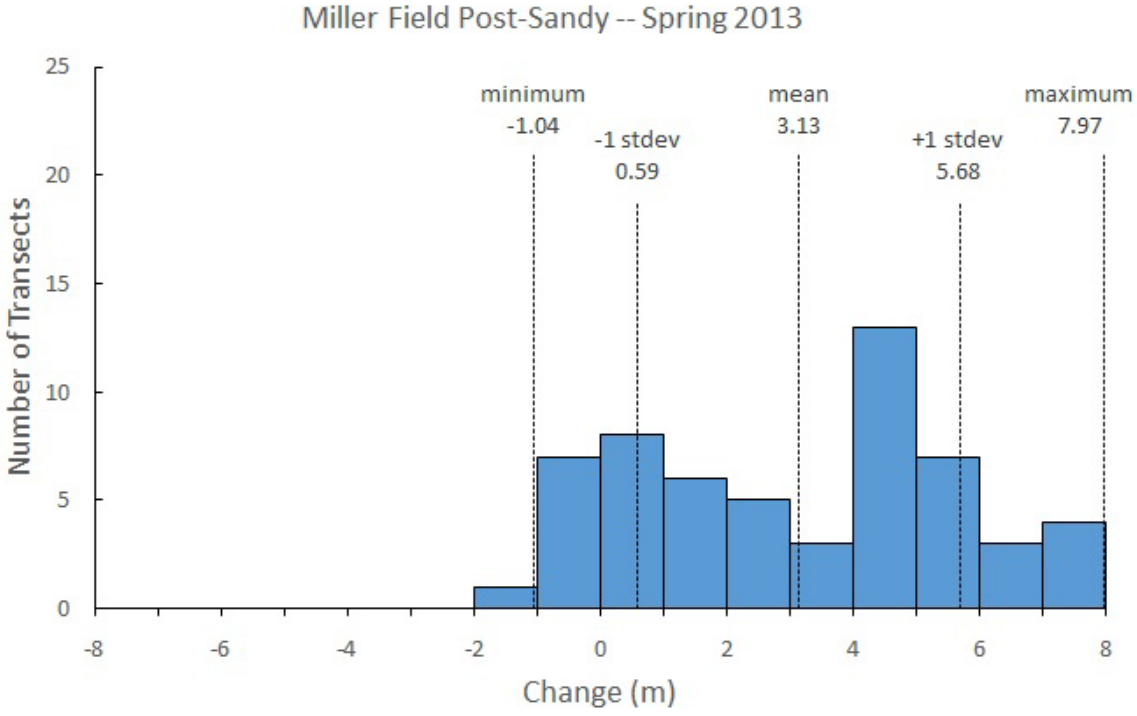


Figure 55. Distribution of difference measurements for the storm event shoreline change of Miller Field between post-Sandy and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

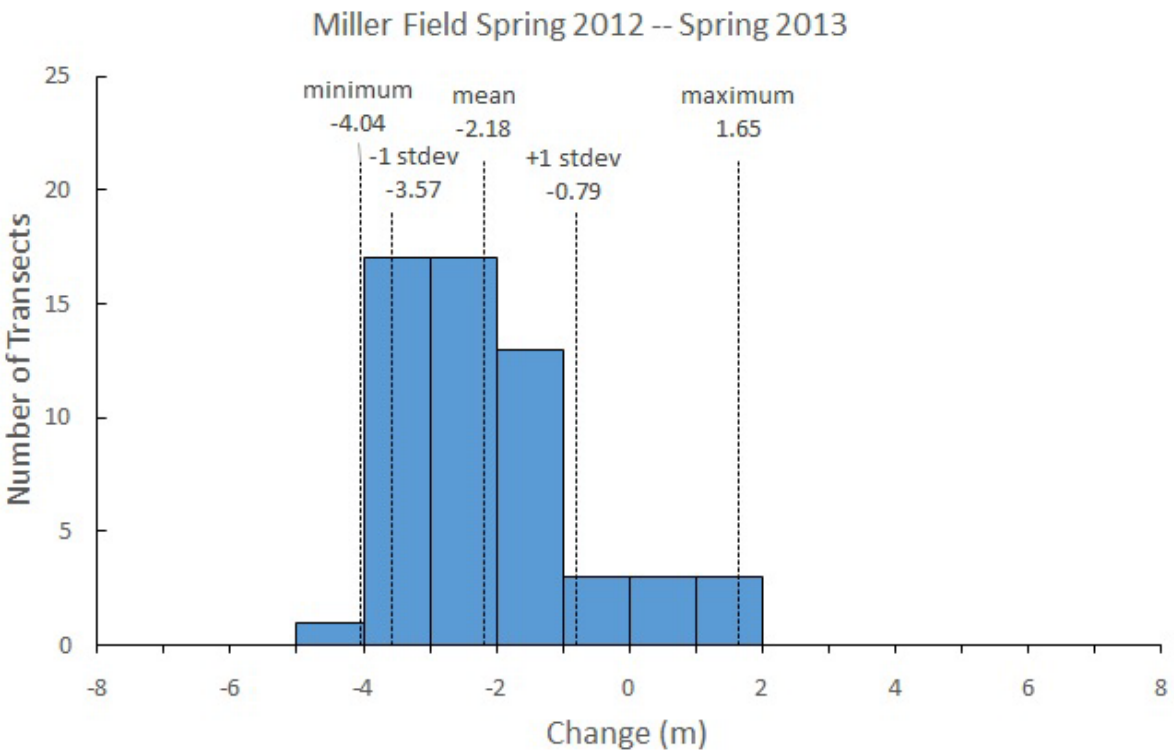
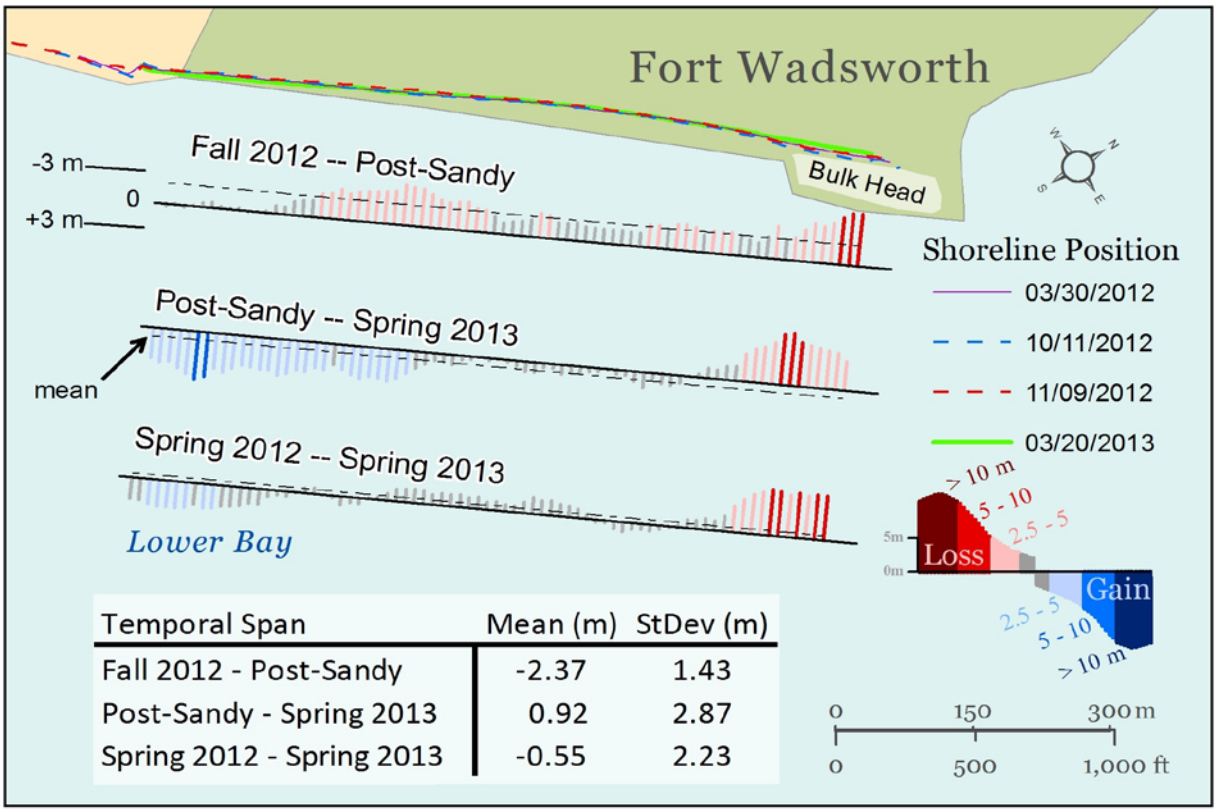


Figure 56. Distribution of difference measurements for the annual shoreline change of Miller Field between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Fort Wadsworth



Temporal Span	Mean (m)	StDev (m)
Fall 2012 - Post-Sandy	-2.37	1.43
Post-Sandy - Spring 2013	0.92	2.87
Spring 2012 - Spring 2013	-0.55	2.23

Figure 57. Alongshore distribution of shoreline displacement of the surveyed shorelines at Fort Wadsworth, from pre- and post- Sandy shorelines, incorporating surveyed shoreline position, annual dimensional changes, and accompanying statistics. The scale of the displacement on the transects and the mean values of change are incorporated on the figure.

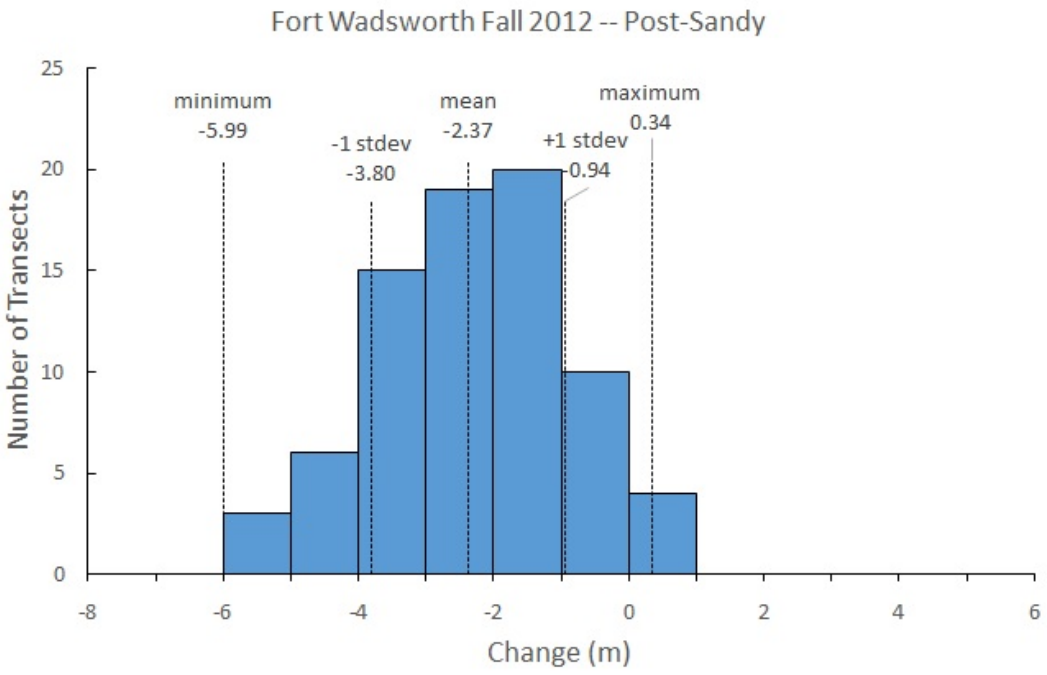


Figure 58. Distribution of difference measurements for the storm event shoreline change of Fort Wadsworth between Fall 2012 and post-Sandy, incorporating the mean change value, standard deviation, maximum, and minimum values.

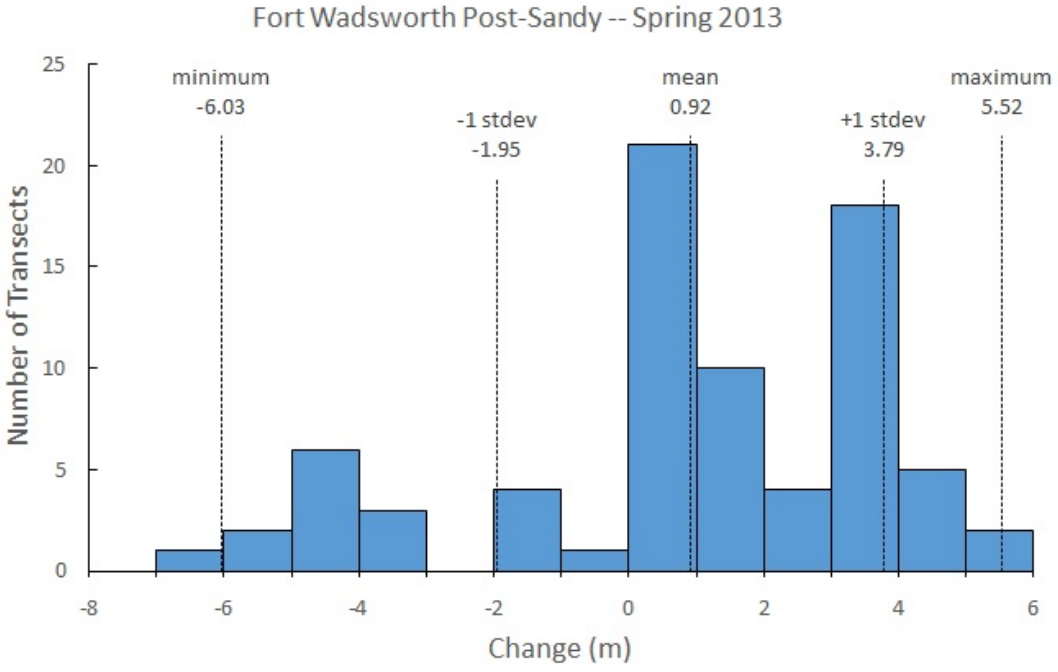


Figure 59. Distribution of difference measurements for the storm event shoreline change of Fort Wadsworth between post-Sandy and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

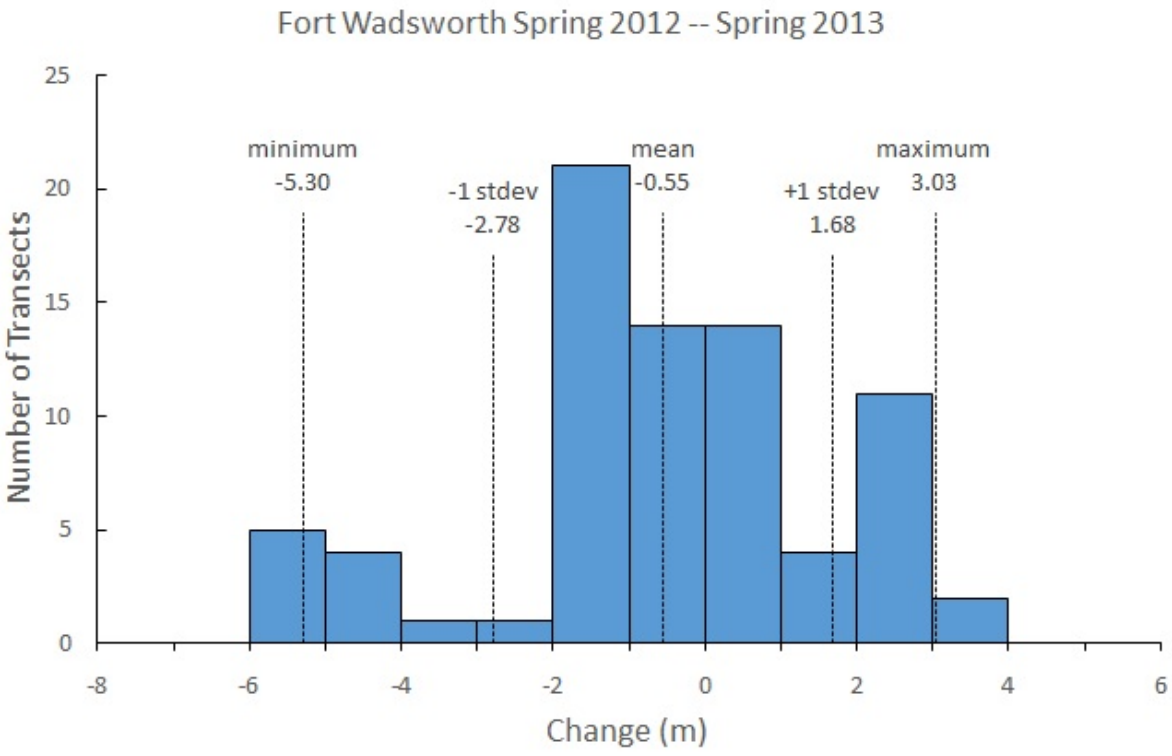


Figure 60. Distribution of difference measurements for the annual shoreline change of Fort Wadsworth between Spring 2012 and Spring 2013, incorporating the mean change value, standard deviation, maximum, and minimum values.

Coastal Profile Surveys, Spring 2012 – Spring 2014

Timing of Coastal Profile Surveys

The surveys are conducted during spring tide conditions to expose as much of the beach profile as possible and to facilitate the collection of the profile to at least the NAVD88 datum position (near mean sea level). On the basis of the protocol, the surveys occur at the end of the winter stormy period and at the end of the summer calm period, recording the seasonal variation of the dune/beach geomorphological system. As depicted in Figures 61 and 62, the surveys in the several units of GATE conform fairly well to the intended contrast of storminess. The first of the surveys was after a relatively mild winter and was succeeded by a relatively storm-less summer period. Hurricane Sandy occurred at the end of October, after the fall survey. Following Sandy, there was a succession of storms until the spring 2013 surveys. Thus, the seasonal contrasts in storminess are generally consistent with the objectives of monitoring the changes in the dune/beach profiles associated with contrasts in energetics at the shoreline. And, there is very good timing to record the impacts of Hurricane Sandy throughout most of Gateway.

Figure 61. Date of shoreline survey and recorded elevation of previous neap-tide high-tide. Source: NOAA tide gauge (#8531680) Sandy Hook, NJ (http://tidesandcurrents.noaa.gov/geographic.html)

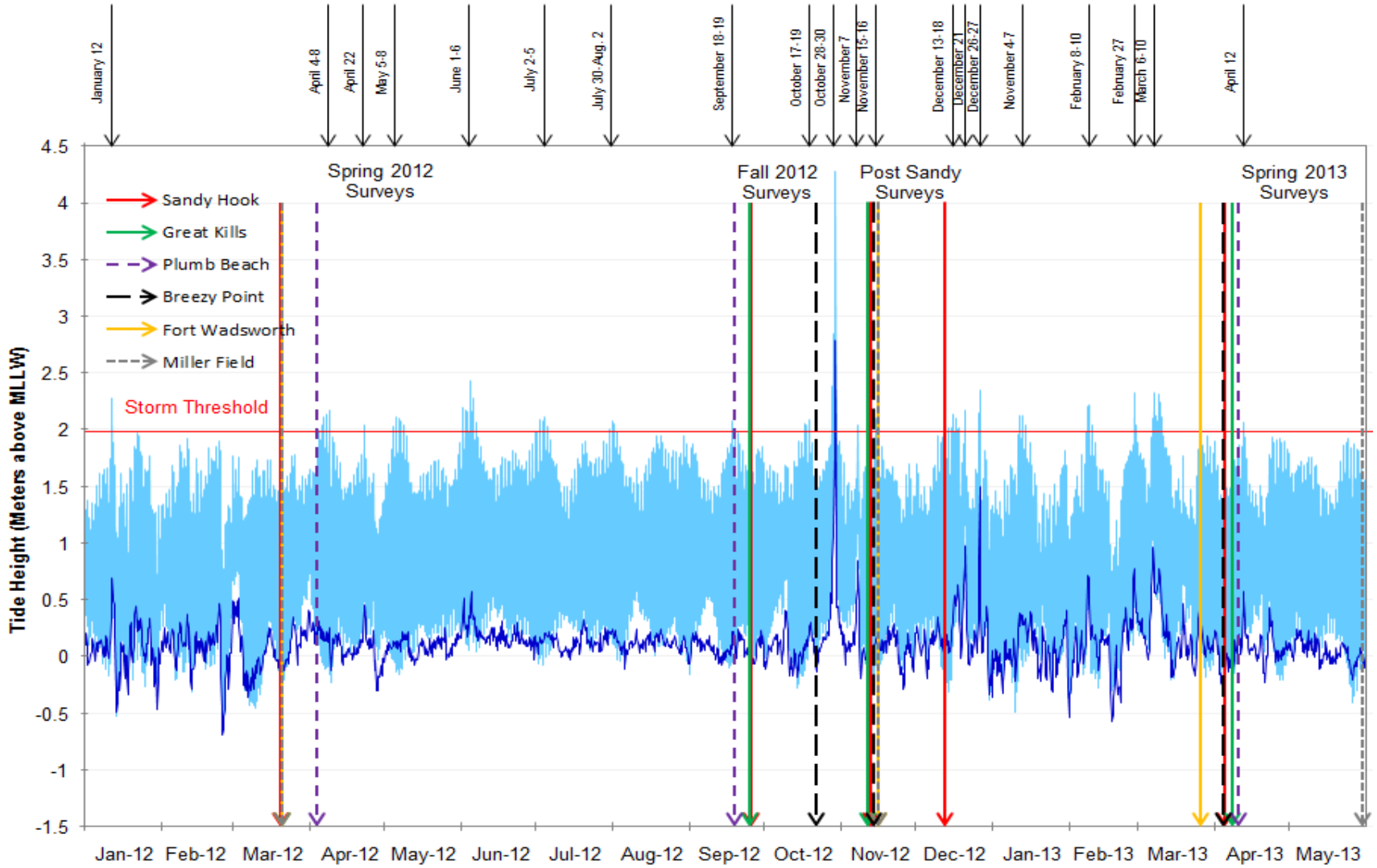


Figure 62. Water level variation and survey dates in the several parts of GATE during the reporting period. Dark blue line is a measure of surge (difference of actual water level compared to predicted). Water level is derived from the Sandy Hook tide gauge data.

Defining Profile Features and Datums

The dune/beach profiles are surveyed and recorded relative to a fixed datum, the North American Vertical Datum of 1988 (NAVD88). At the present time, NAVD88 and mean sea level are at similar elevations and the dune/beach topography has a similar relationship to these two elevations. However, as sea level rises through time, the topography will adjust and variation will increase. Referencing a constant elevation and position with a fixed monument will permit the monitoring of spatial and elevation evolution as the profile responds to changes in sediment supply and increased water level.

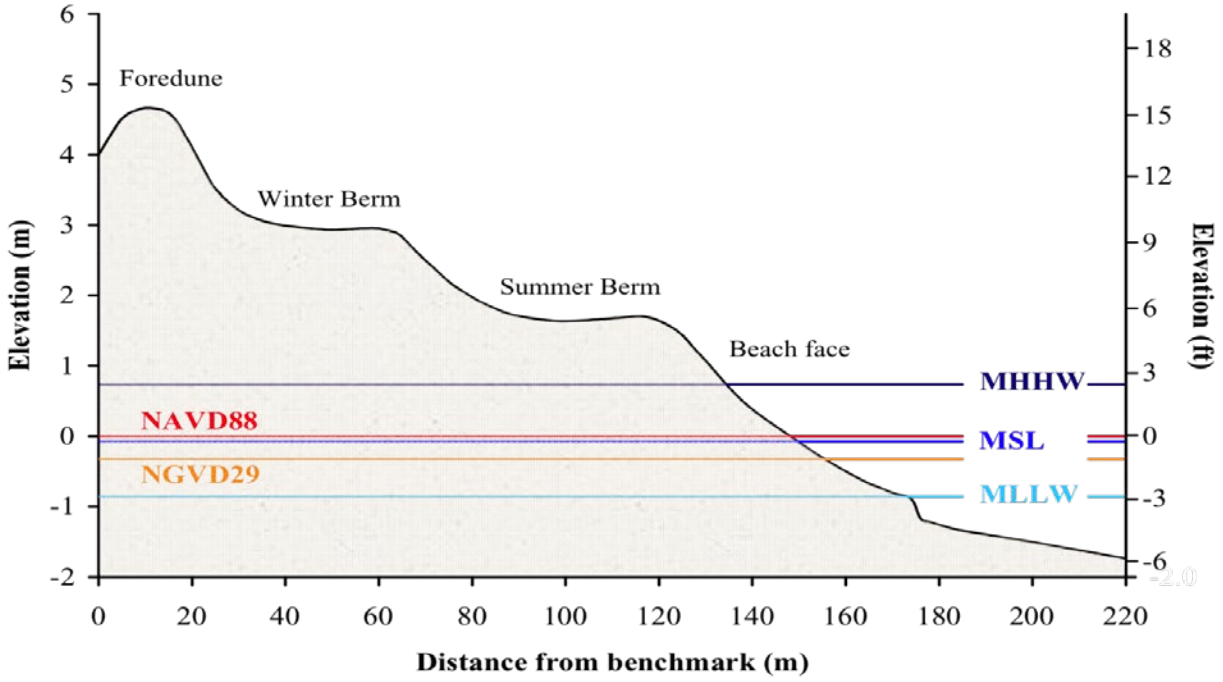


Figure 63. Relationship of 1983-2001 tidal epoch water levels to the North American Vertical Datum of 1988, to the 1929 National Geodetic Vertical Datum, and to a representative beach profile at Sandy Hook. All values are portrayed relative to NAVD88. Other terms are: MLLW = mean lower low water; NGVD29 = National Geodetic Vertical Datum of 1929; MSL = mean sea level; and MHHW = mean higher high water.

Results of Monitoring Efforts

The short-term changes depicted in one year of monitoring are not indicative of the trends of the changes, but they do depict the type of information that is derived from the surveys. This presentation is a simple catalog of the dimensional changes described as possible outcomes in the Protocol document (Psuty et al. 2012). It is not meant to be all-inclusive. Further, only some of the spatial results are presented, as examples, because of the limitations of one year of data. Each profile site of the GATE topographical monitoring program is presented to depict its location and the seasonal changes at each site. Dimensions of change are incorporated on each of the Profile figures and in summary tables in Appendix A and Appendix B. Values in brackets on the profile figures represent linear and areal dimensions that are seaward of the benchmark, and are comparable to the 2011-2012 Annual Report. The values outside of the brackets represent linear and areal dimensions

that are initiated inland of the benchmark, at a new starting point, because the location of the original benchmark may have been compromised. Values in brackets are usually slightly smaller. Adjustments will be incorporated in the 5-year trend report. Profile lines are color-coded to represent the period of the survey. Position of the dune crest on the profile is denoted with a color-coded symbol representing the period of the survey.

Sandy Hook

Sixteen monuments have been established along the ocean and bay shoreline of Sandy Hook (Fig. 64). They may be tied to some pre-existing item, such as a concrete pad, or they may be tied to a newly-installed PVC pipe filled with concrete. The location, description, coordinates of the Sandy Hook monuments are detailed in a booklet prepared for this purpose (Psuty et al. 2010g).

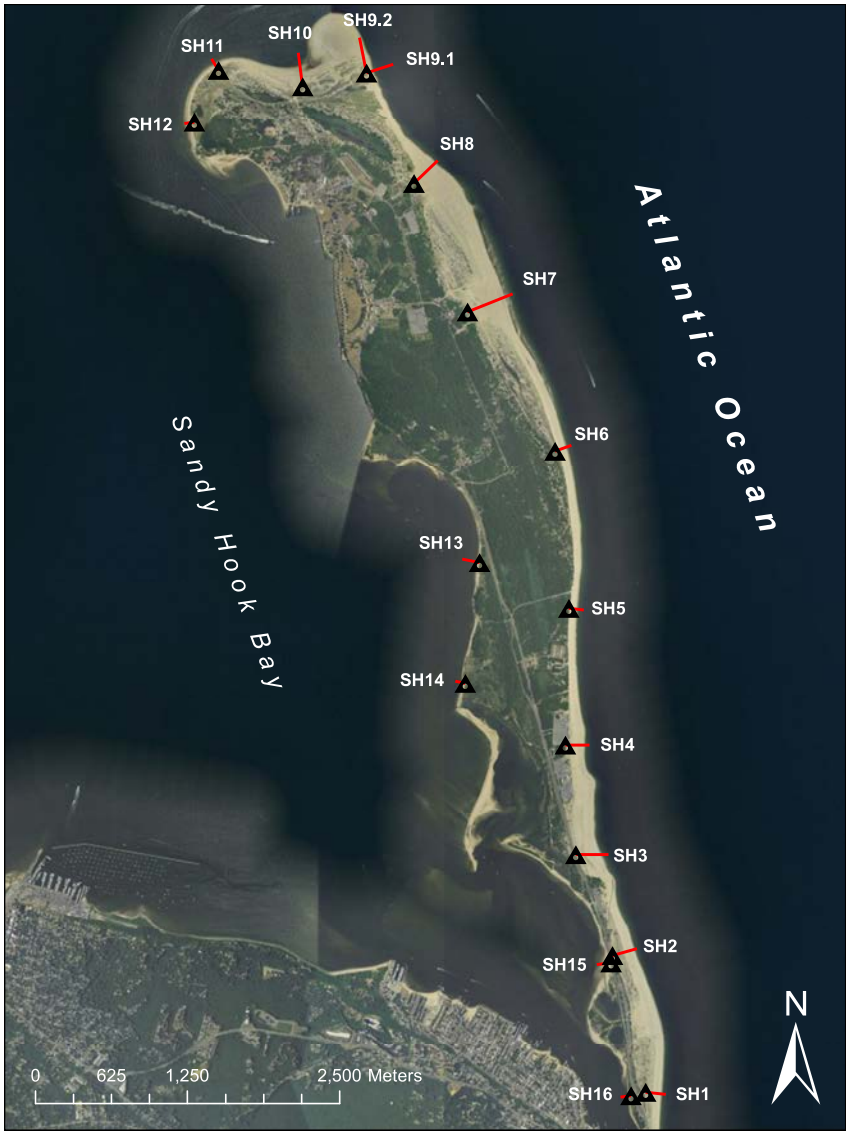


Figure 64. Location of 16 monuments and their accompanying azimuths on Sandy Hook used in recording the 2D beach/dune profiles.

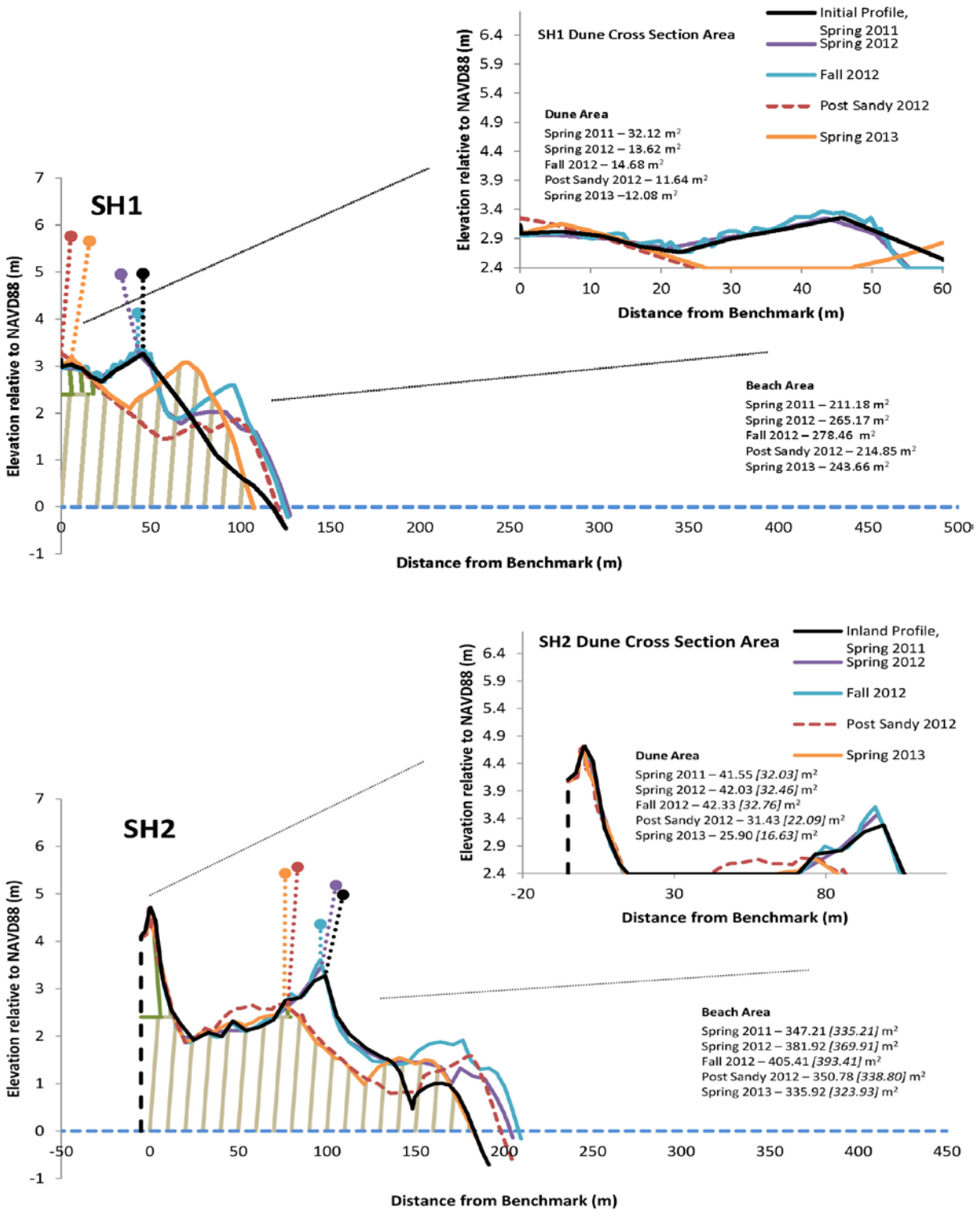


Figure 65. For profiles SH1 and SH2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

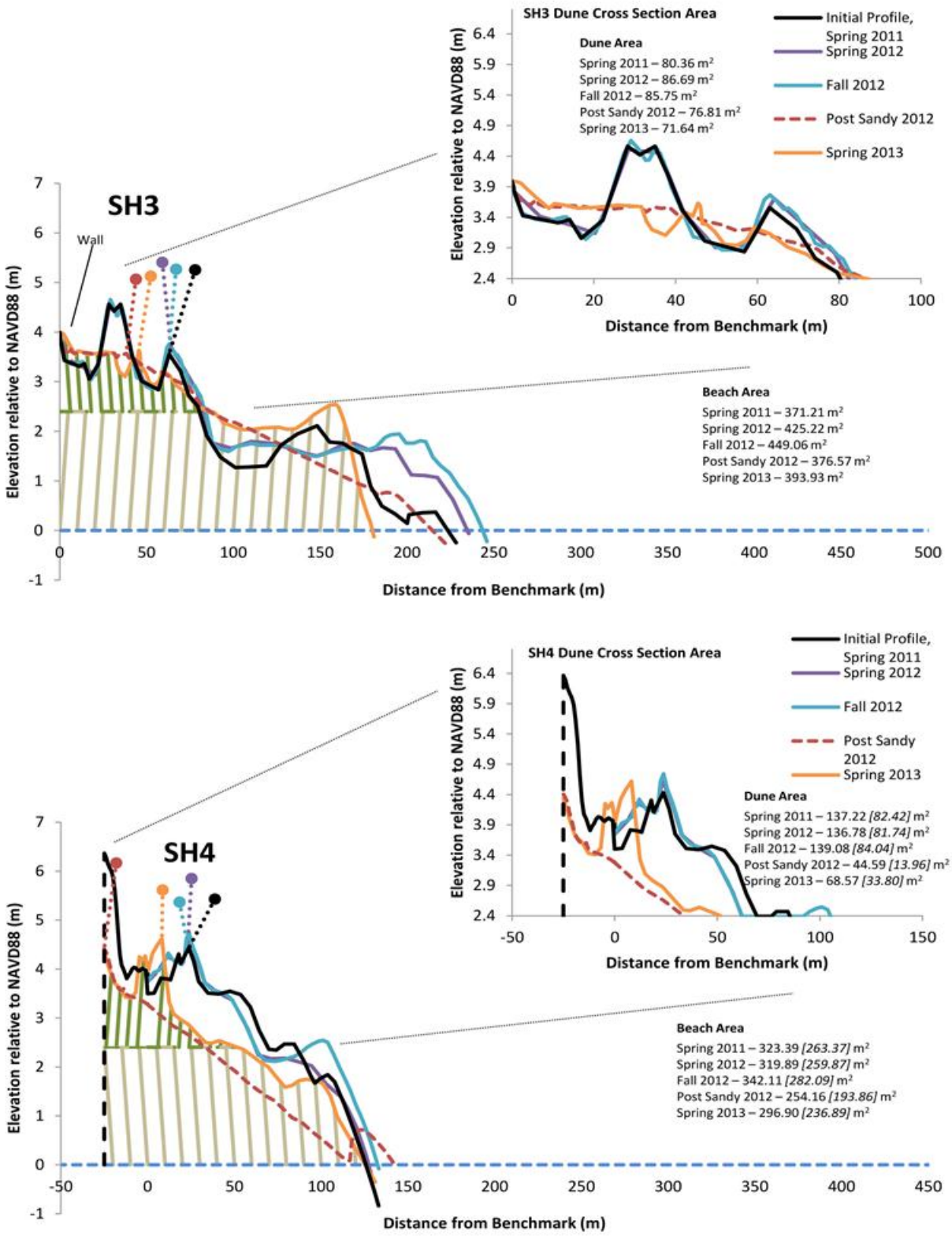


Figure 66. For profiles SH3 and SH4, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

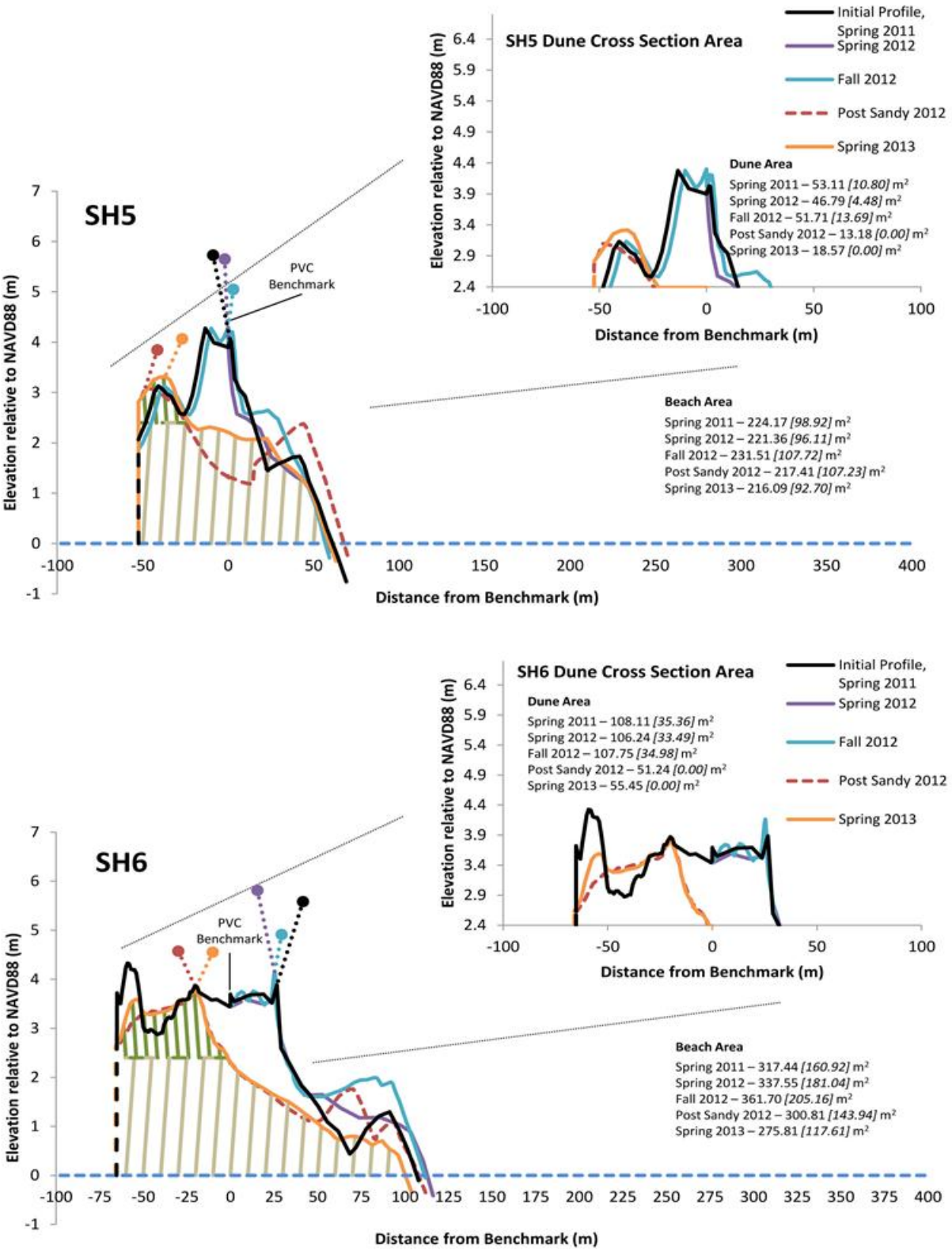


Figure 67. For profiles SH5 and SH6, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

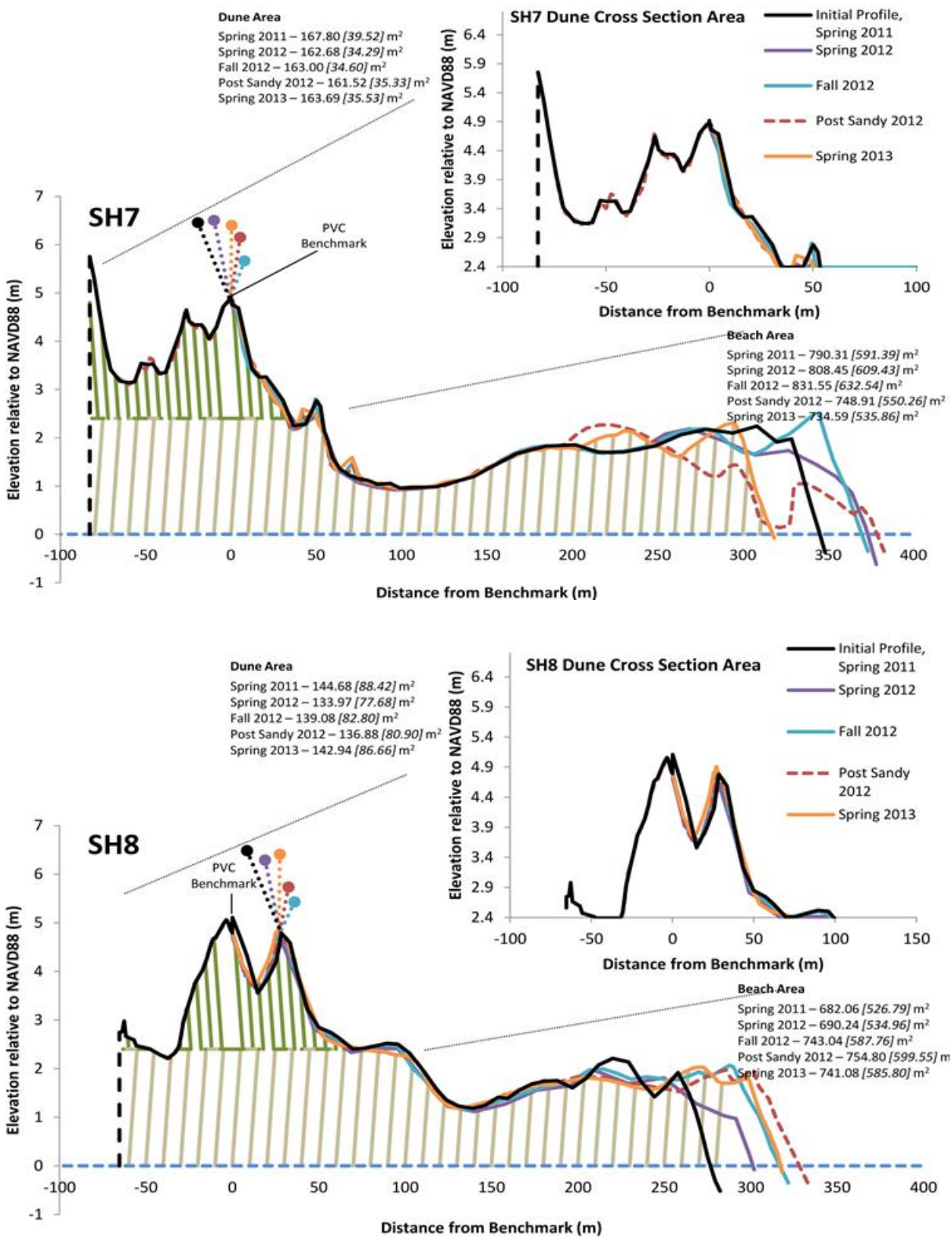


Figure 68. For profiles SH7 and SH8, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

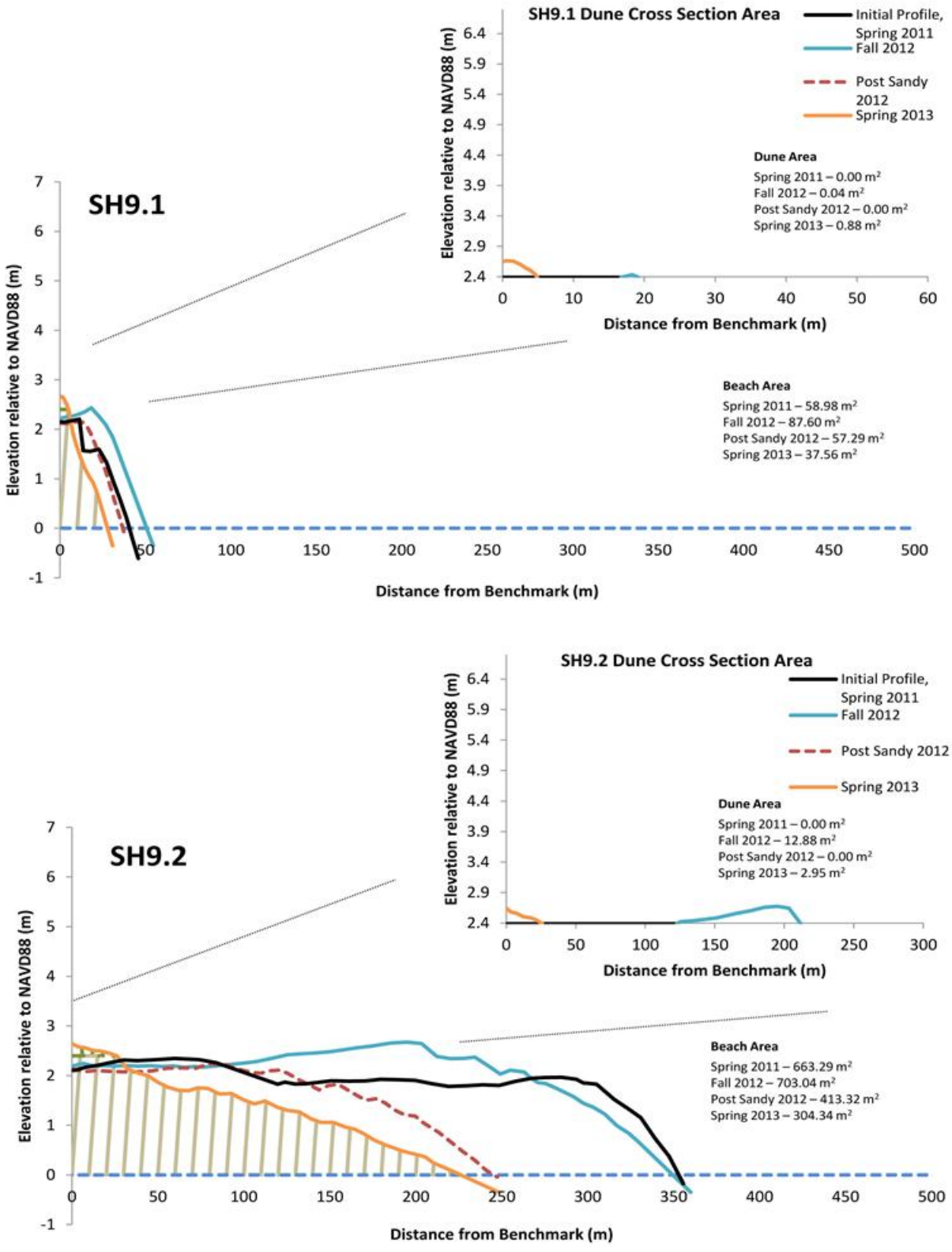


Figure 69. For profiles SH9.1 and SH9.2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

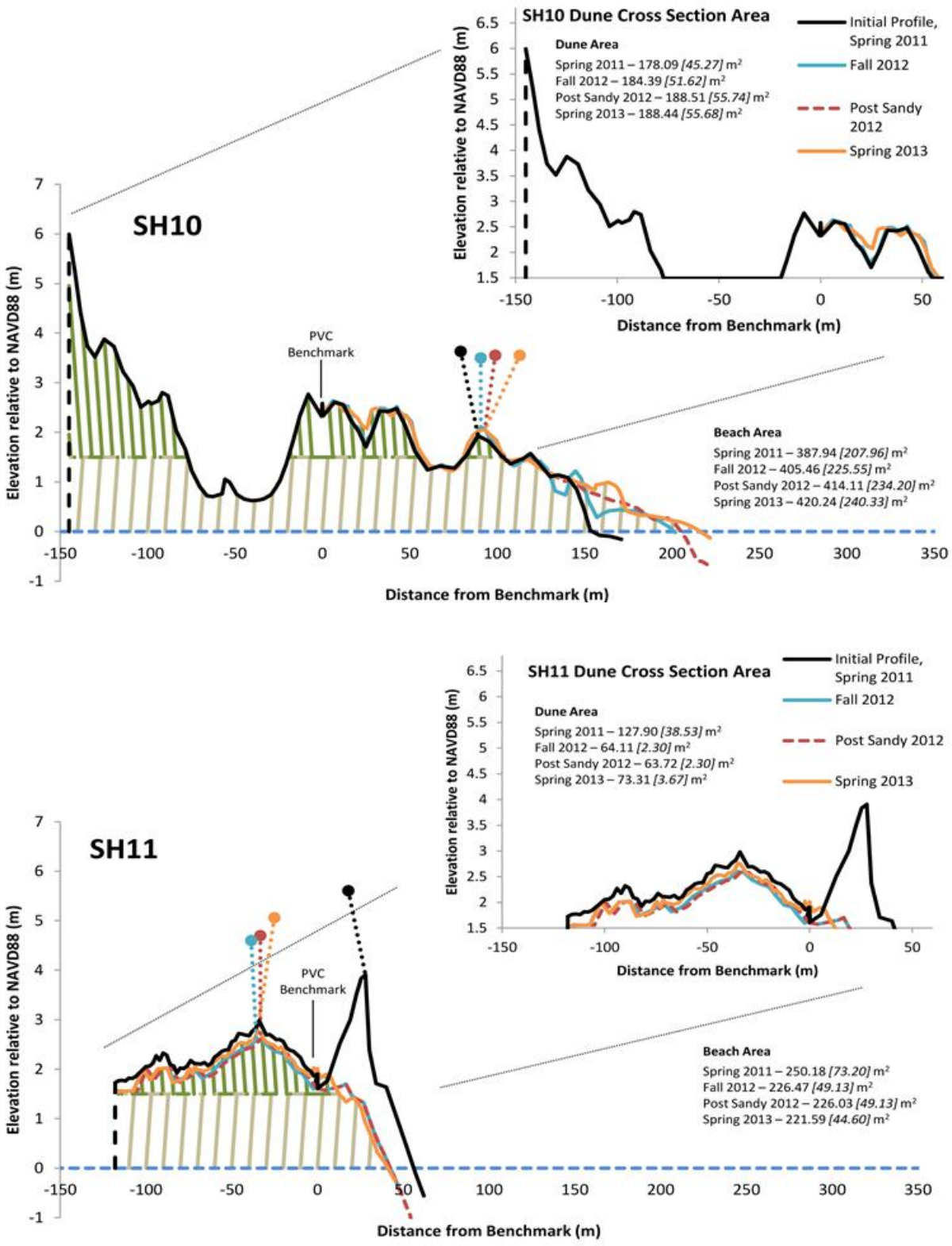


Figure 70. For profiles SH10 and SH11, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

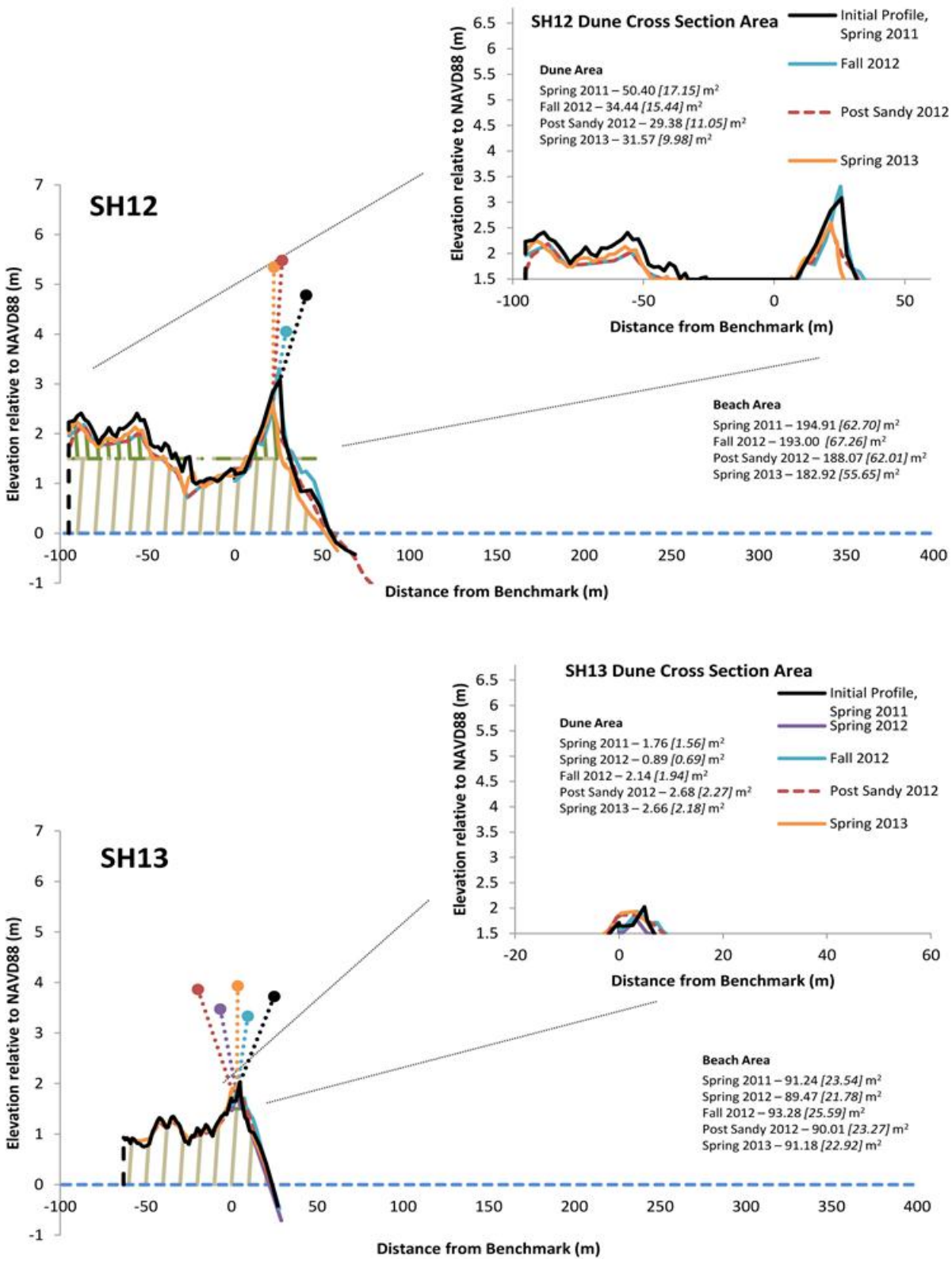


Figure 71. For profiles SH12 and SH13, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

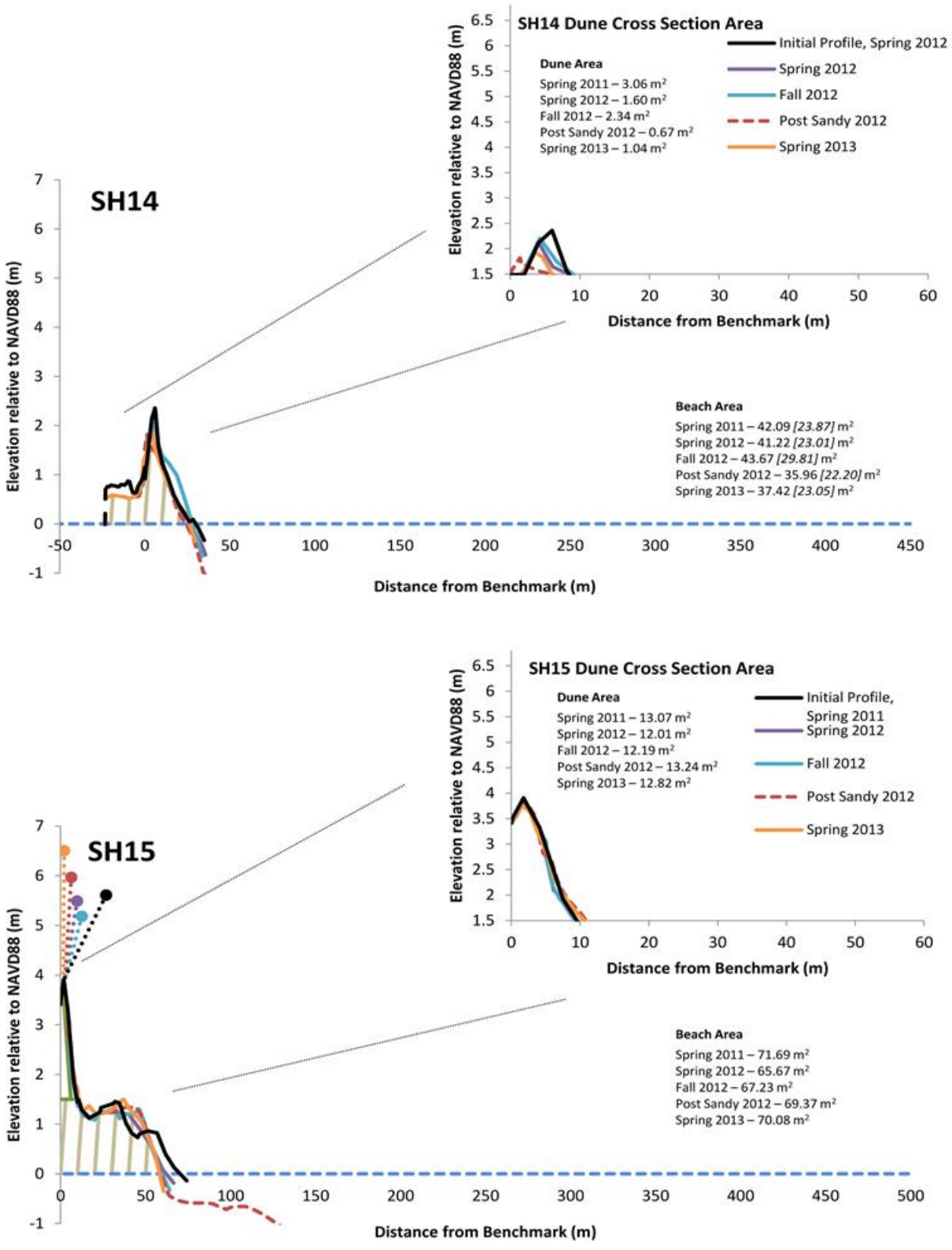


Figure 72. For profiles SH14 and SH14, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

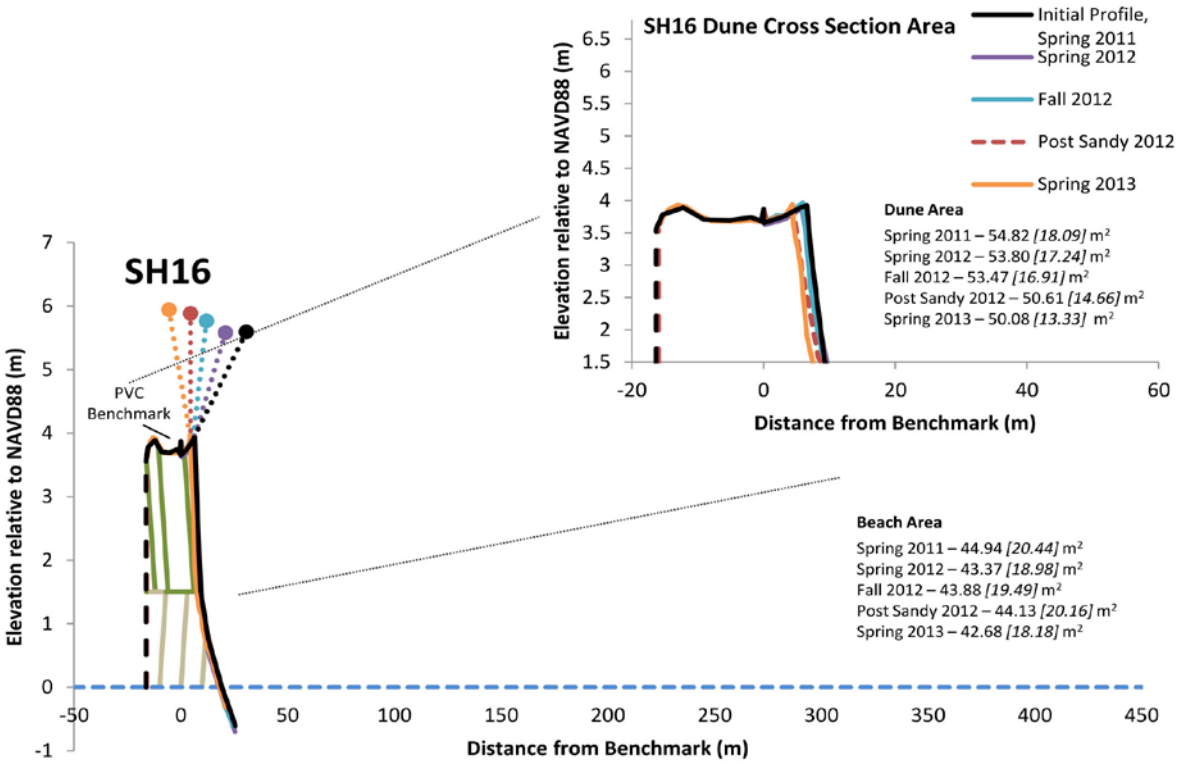


Figure 73. For profile SH16, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

Breezy Point

Eleven monuments have been established along the ocean and bay shoreline of Breezy Point (Fig. 74). They may be tied to some pre-existing item, such as a concrete pad, or they may be tied to a newly-installed PVC pipe filled with concrete. The location, description, coordinates of the Breezy Point monuments are detailed in a booklet prepared for this purpose (Psuty et al. 2010c).

Problem

The Breezy Point Spring 2012 survey data set is missing. The survey was run and the Field Data Form has no mention of any difficulty in collecting the data. Attempts to find the data are ongoing. The file may have been mislabeled or may have been erased. It may have been misplaced in the cleaning of the files. All of the figures lack any input from the Spring 2012 survey period.



Figure 74. Location of 11 monuments and their accompanying azimuths on Breezy Point used in running the 2D beach/dune profiles.

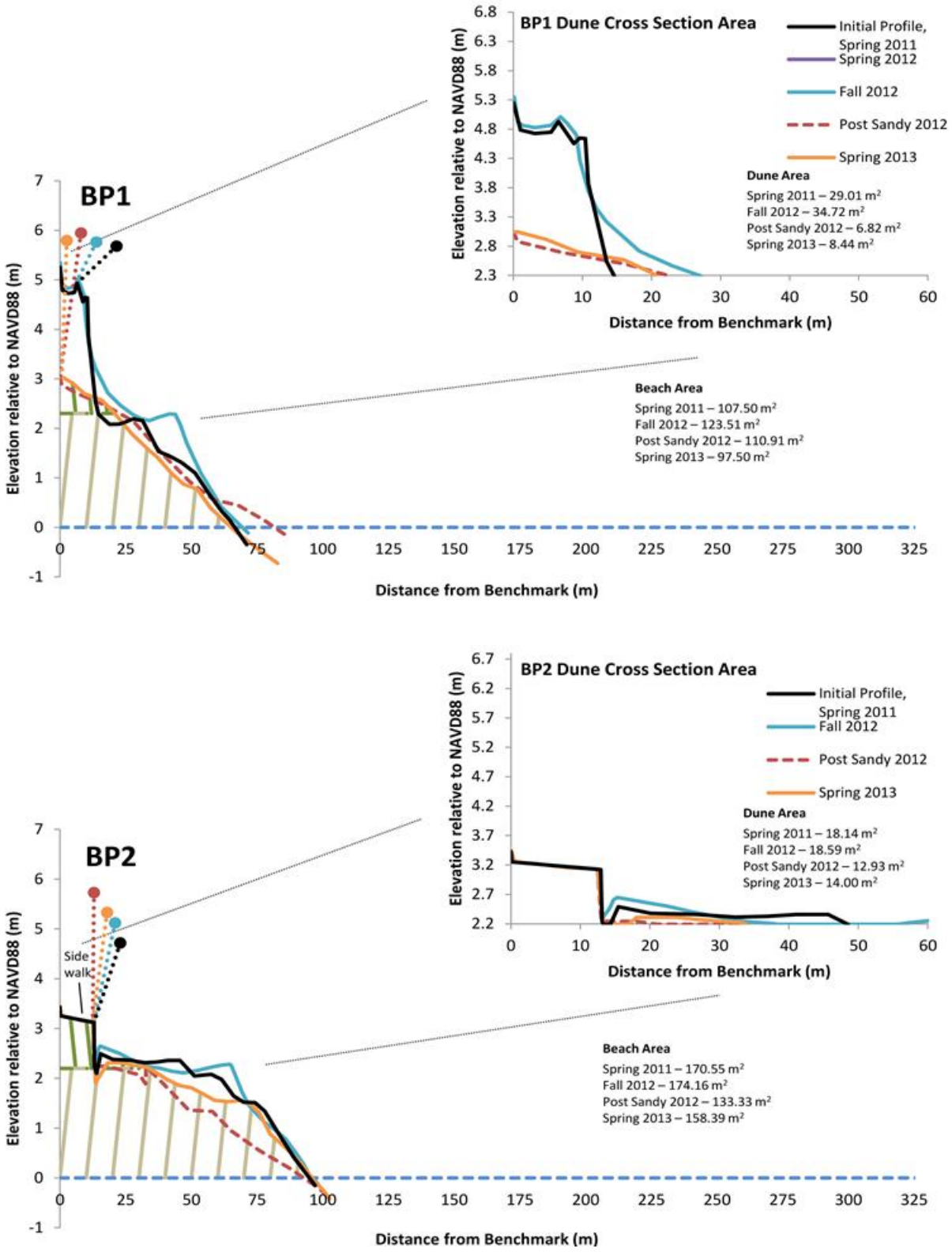


Figure 75. For profiles BP1 and BP2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

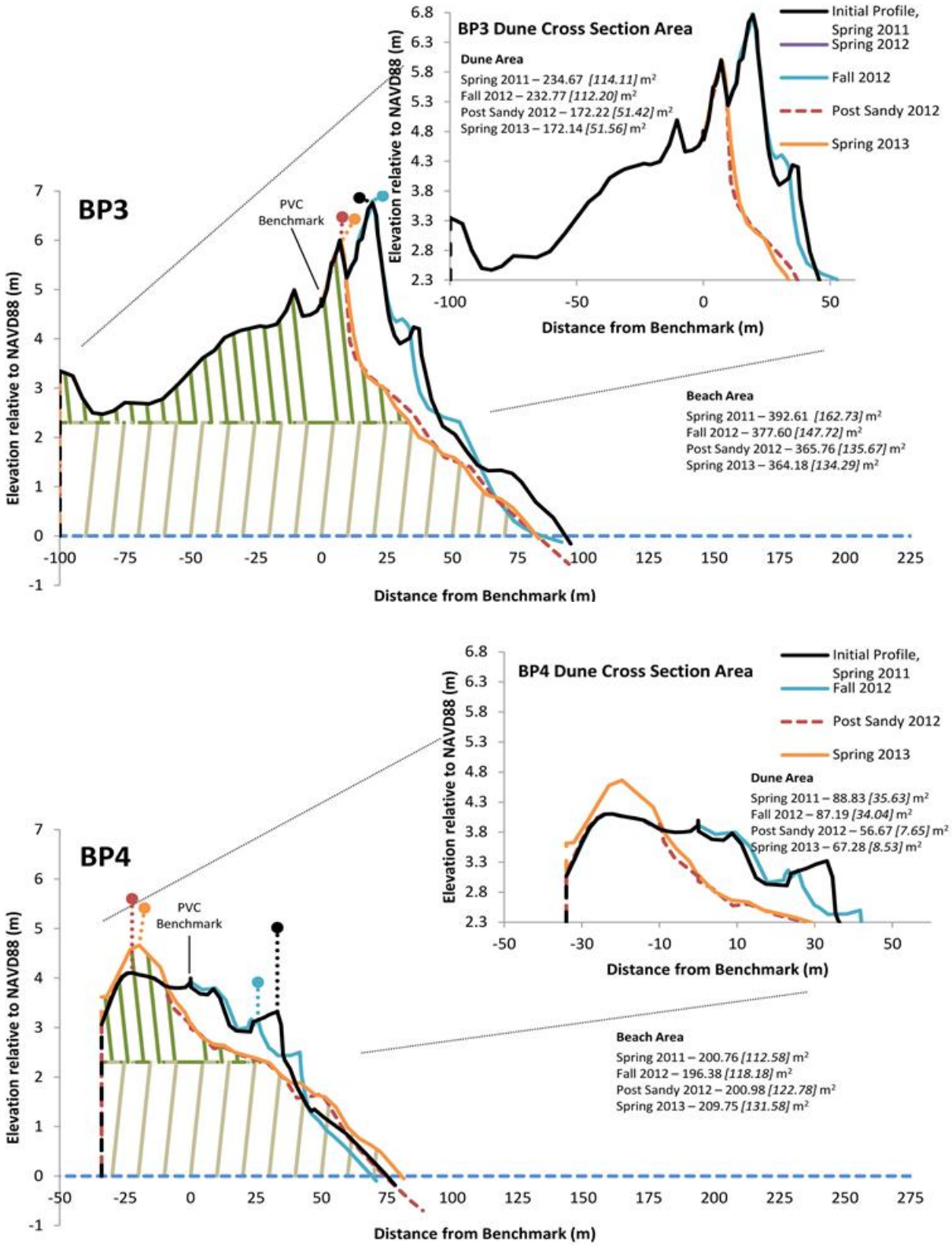


Figure 76. For profiles BP3 and BP4, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

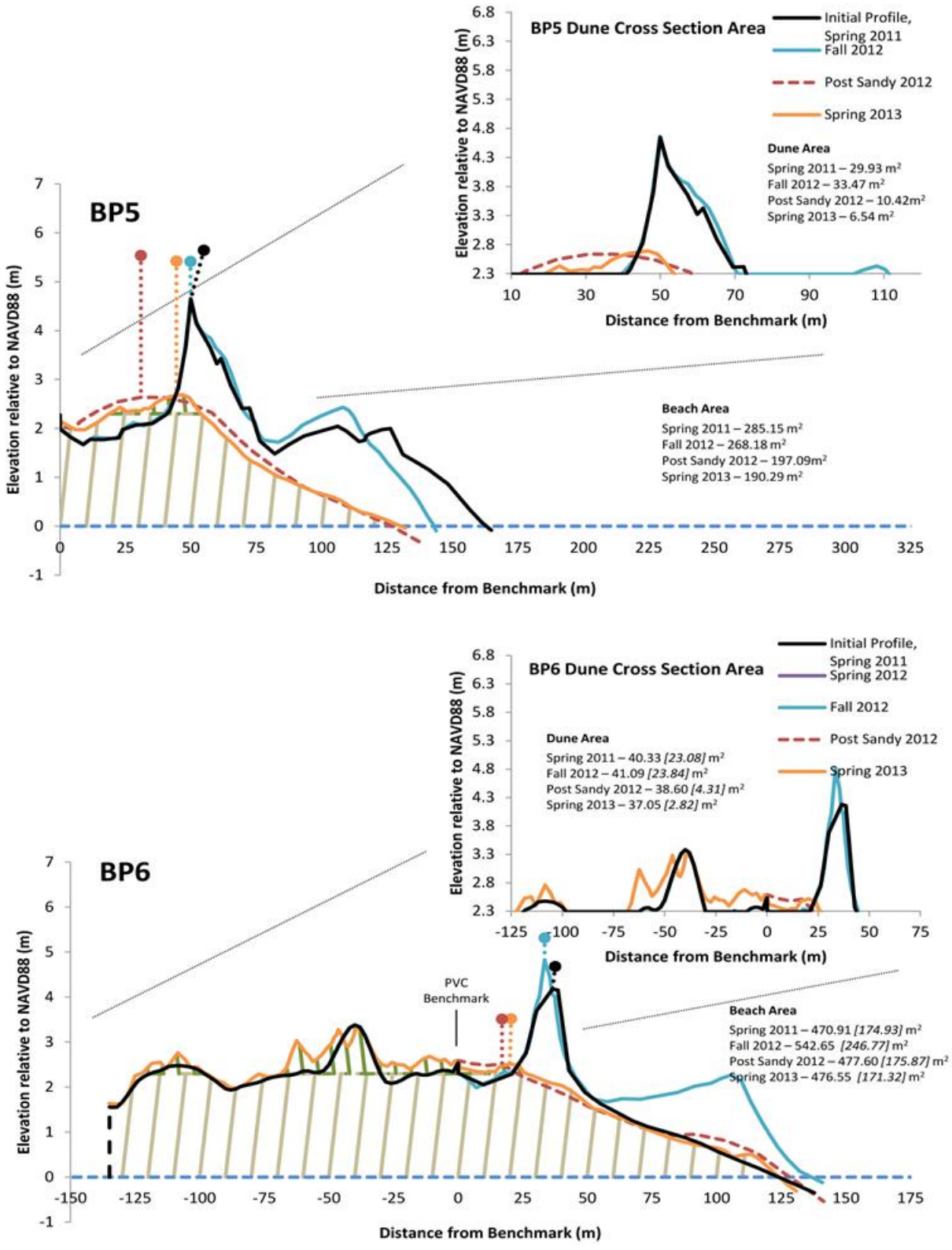


Figure 77. For profiles BP5 and BP6, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

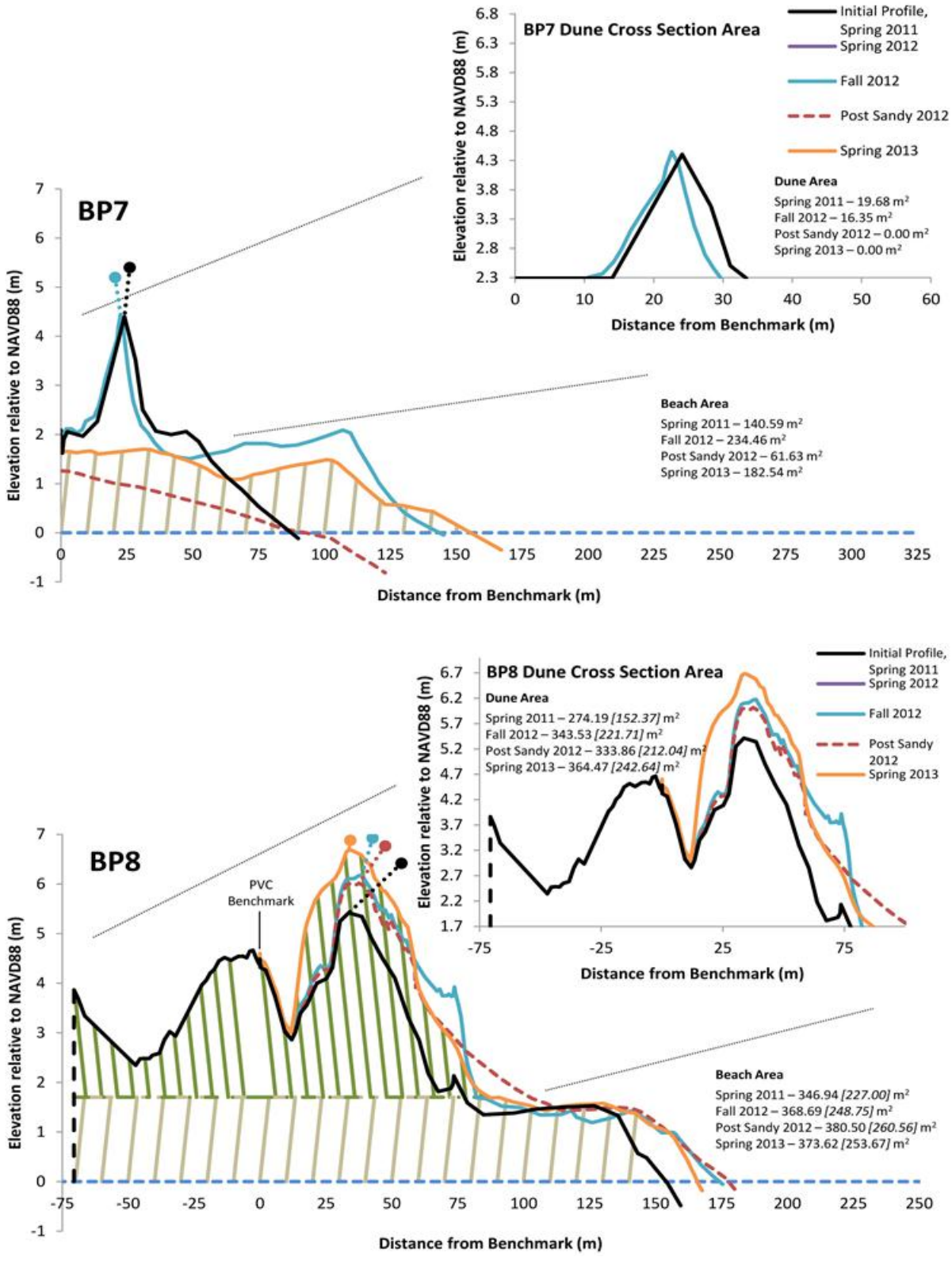


Figure 78. For profiles BP7 and BP8, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

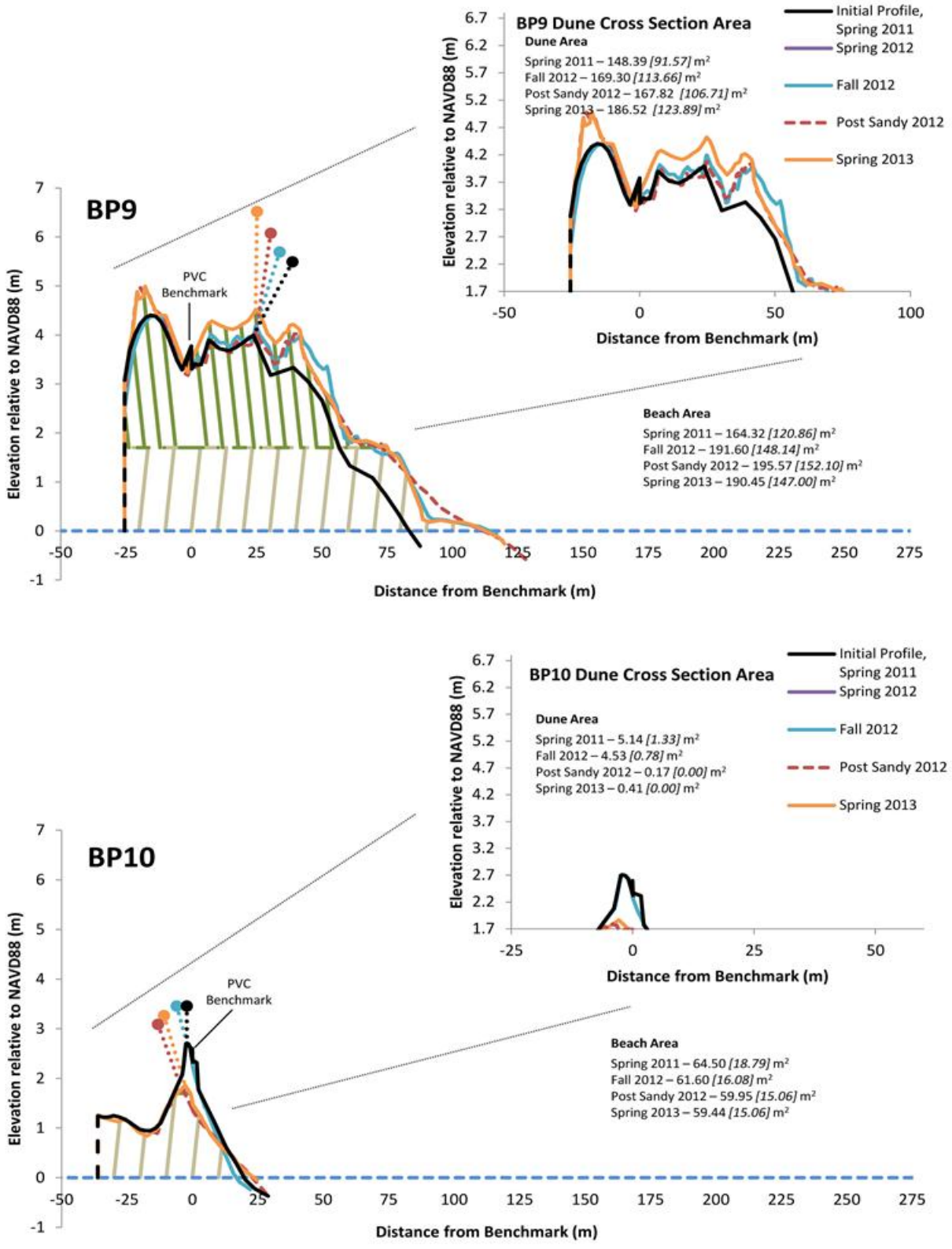


Figure 79. For profiles BP9 and BP10, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

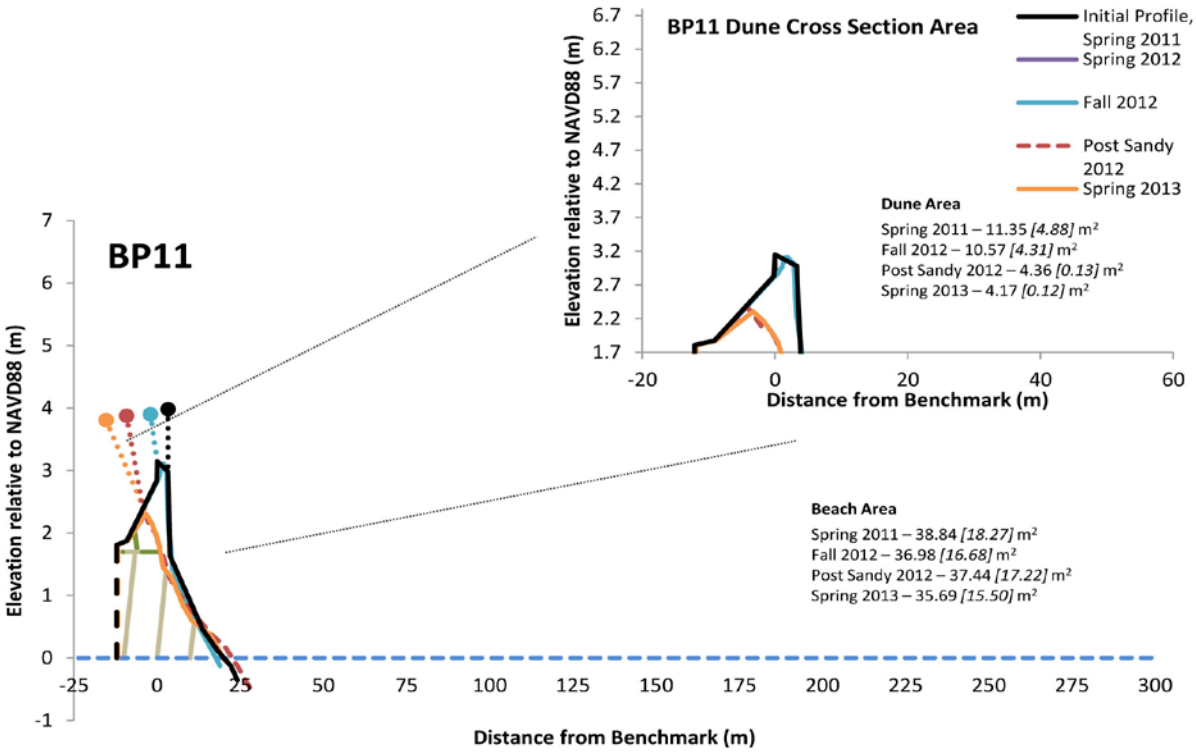


Figure 80. For profiles BP11, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

Plumb Beach

Five monuments have been established along the ocean-facing shoreline of Plumb Beach (Fig. 81). They may be tied to some pre-existing item, such as a concrete curb, or they may be tied to a newly-installed PVC pipe filled with concrete. The location, description, coordinates of the Plumb Beach monuments are detailed in a booklet prepared for this purpose (Psuty et al. 2010f).

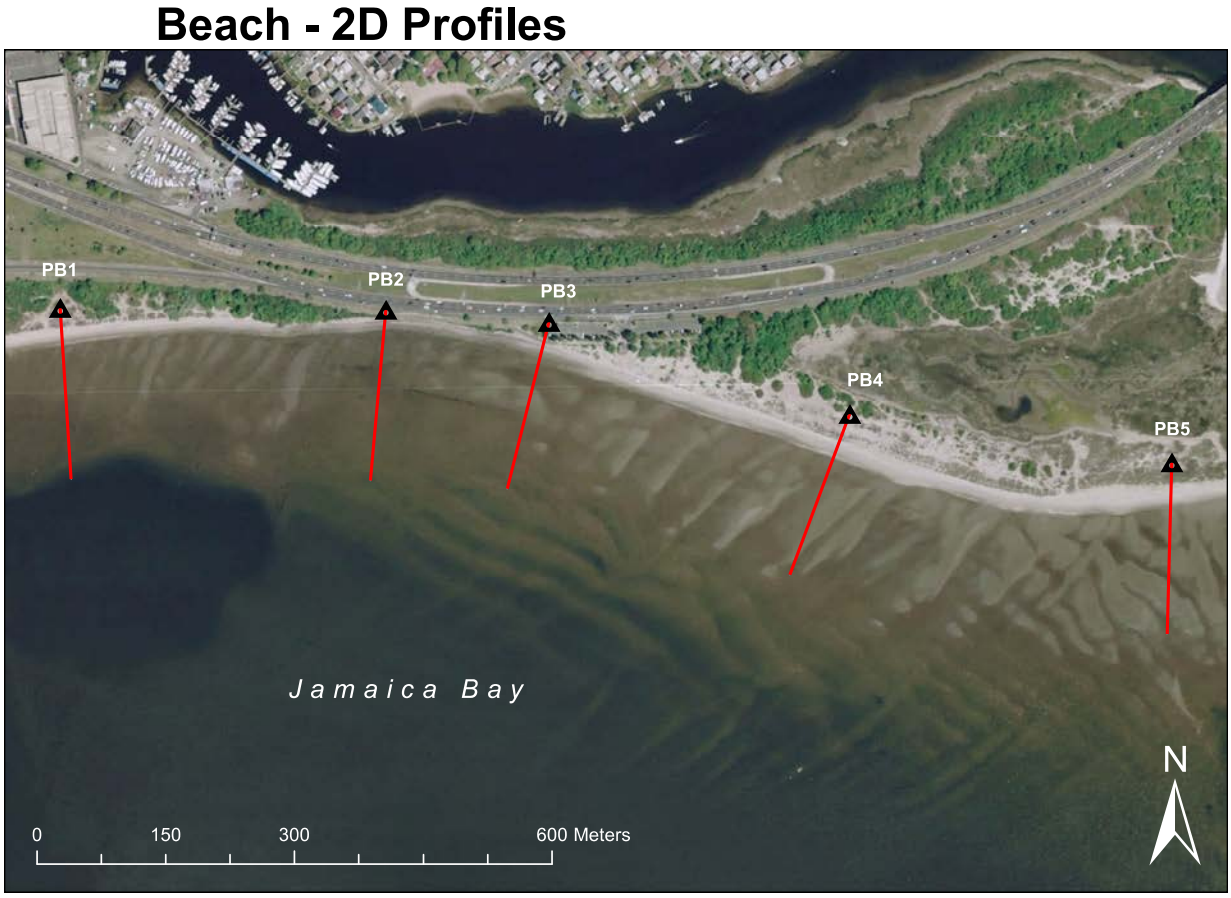


Figure 81. Location of five monuments and their accompanying azimuths at Plumb Beach used in running the 2D beach/dune profiles.

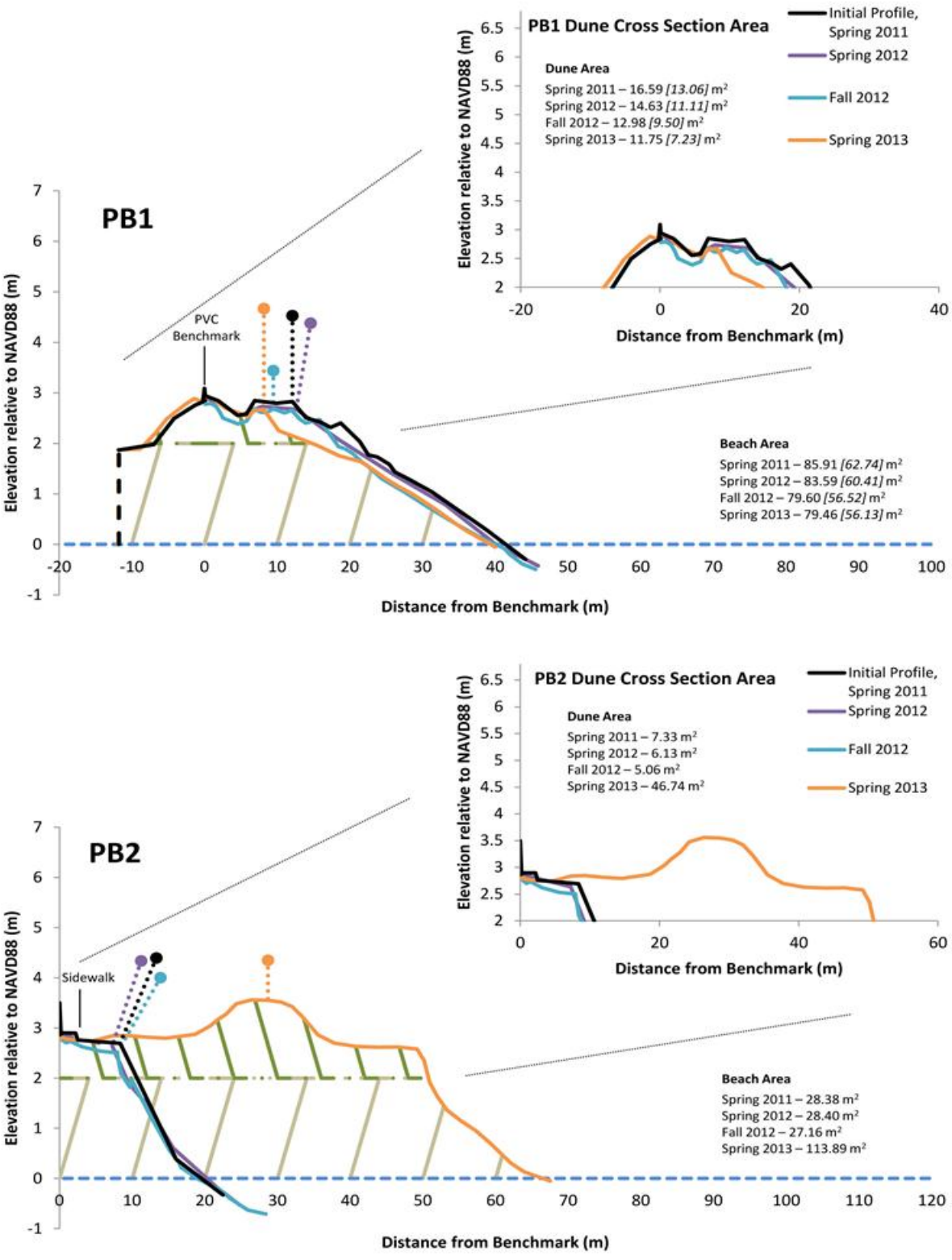


Figure 82. For profiles PB1 and PB2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

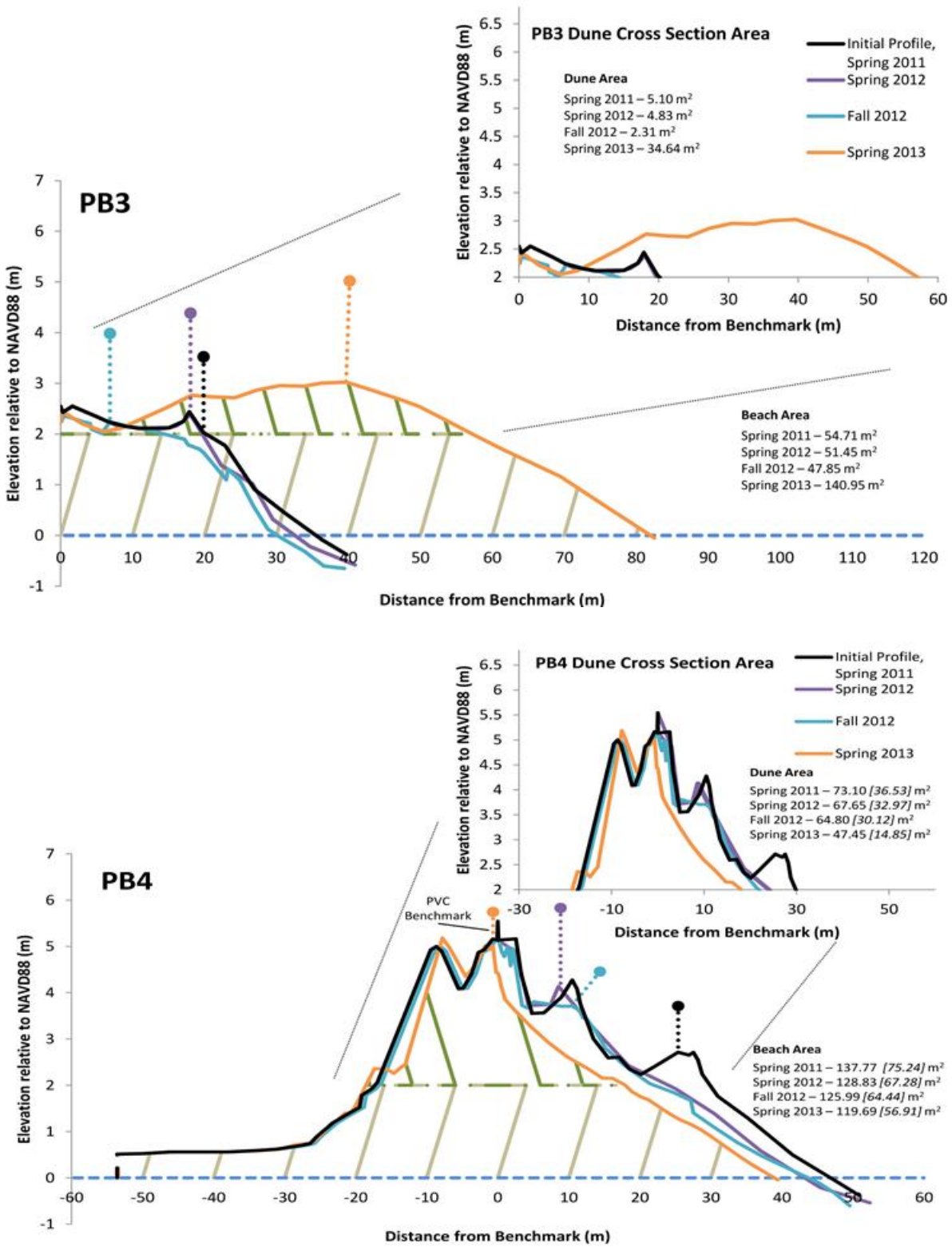


Figure 83. For profiles PB3 and PB4, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

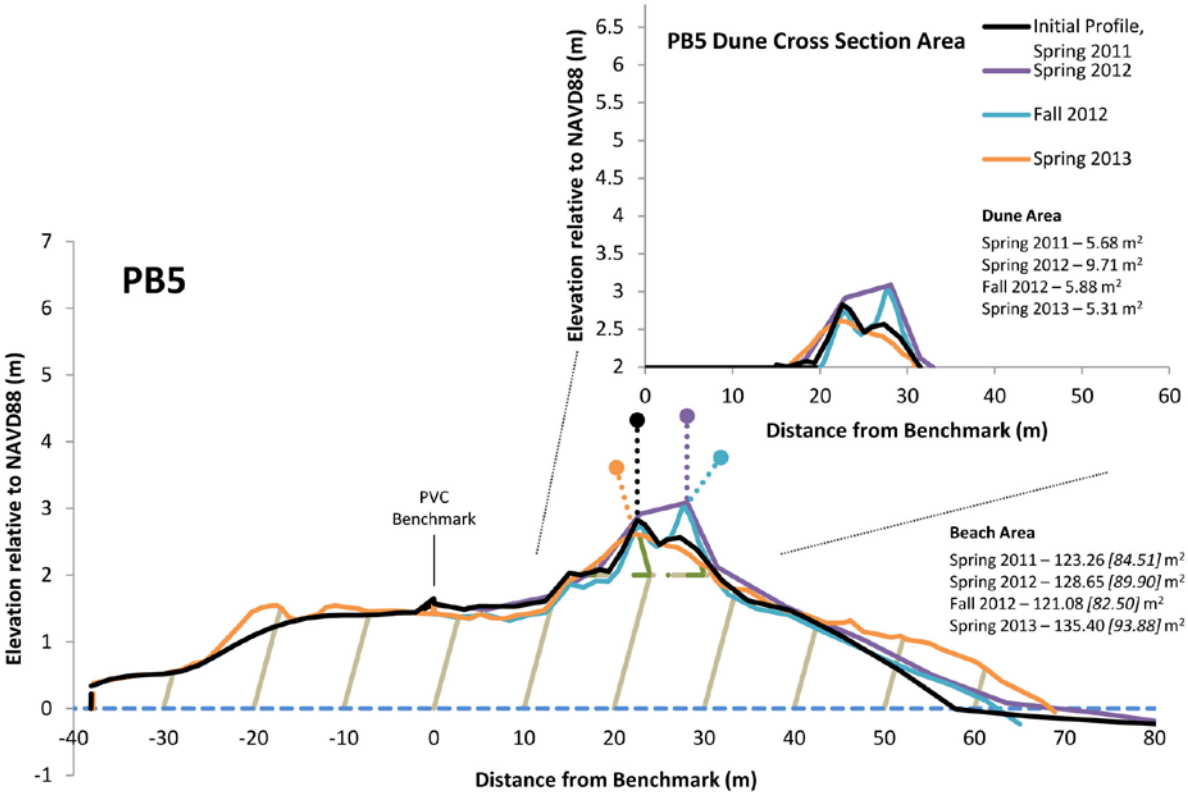


Figure 84. For profiles PB5, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

Great Kills

Nine monuments have been established along the ocean-facing shoreline of Great Kills (Fig. 85). They may be tied to some pre-existing item, such as a concrete curb, or they may be tied to a newly-installed PVC pipe filled with concrete. The location, description, coordinates of the Great Kills monuments are detailed in a booklet prepared for this purpose (Psuty et al. 2010d). Profile data are missing for GK6 in Spring 2013 due to a malfunction in the radio antenna during the survey.

files



Figure 85. Location of nine monuments and their accompanying azimuths at Great Kills used in running the 2D beach/dune profiles.

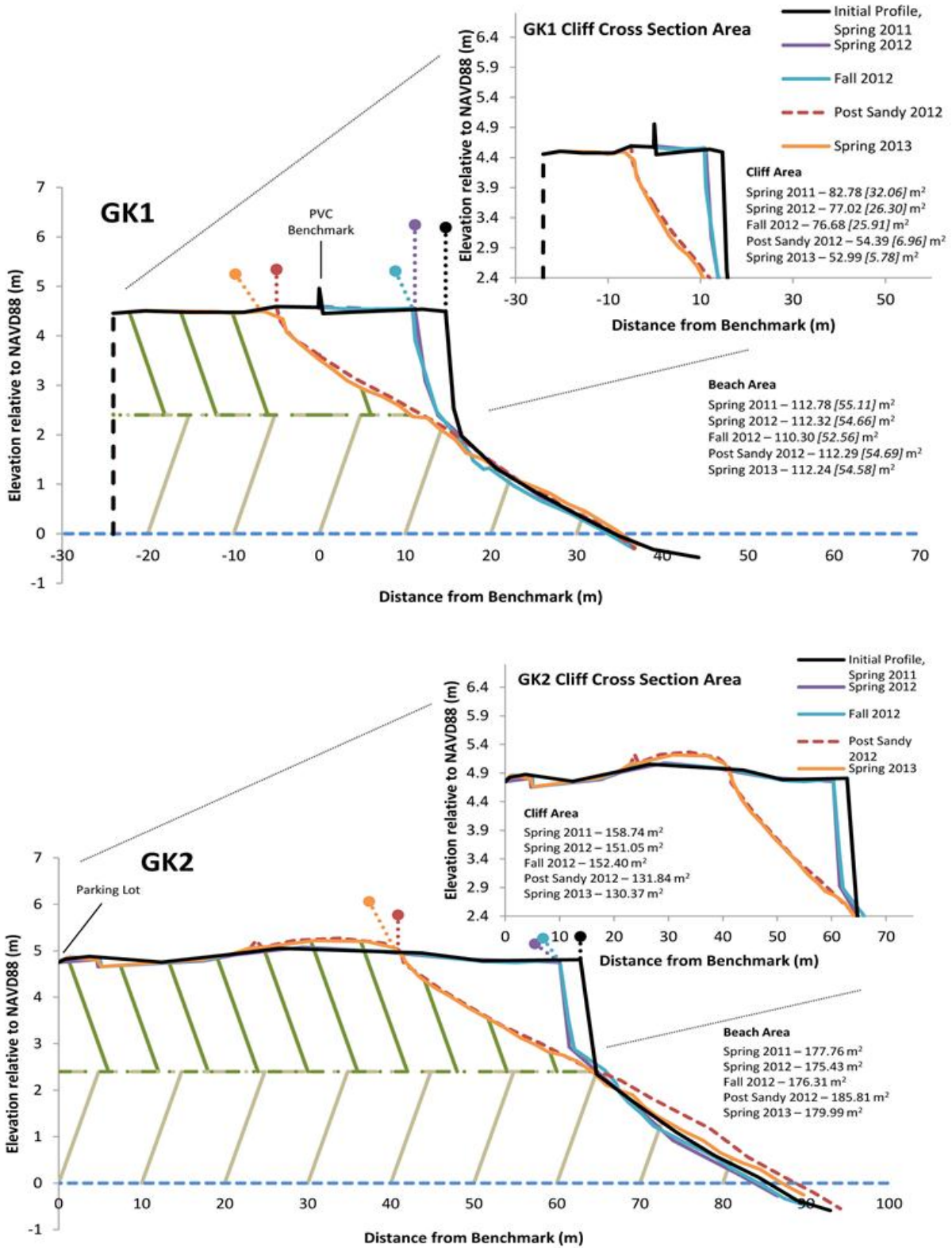


Figure 86. For profiles GK1 and GK2, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

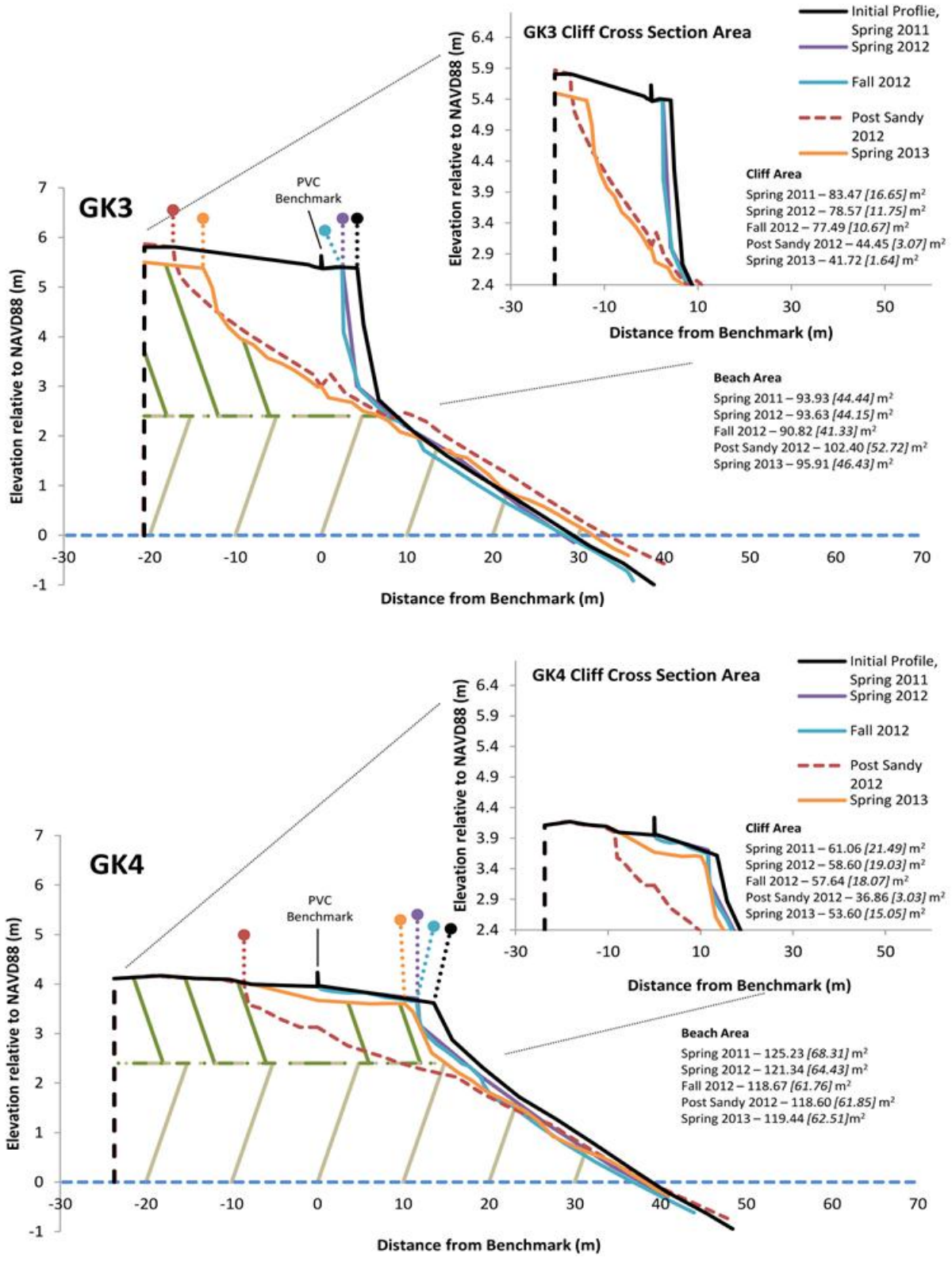


Figure 87. For profiles GK3 and GK4, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

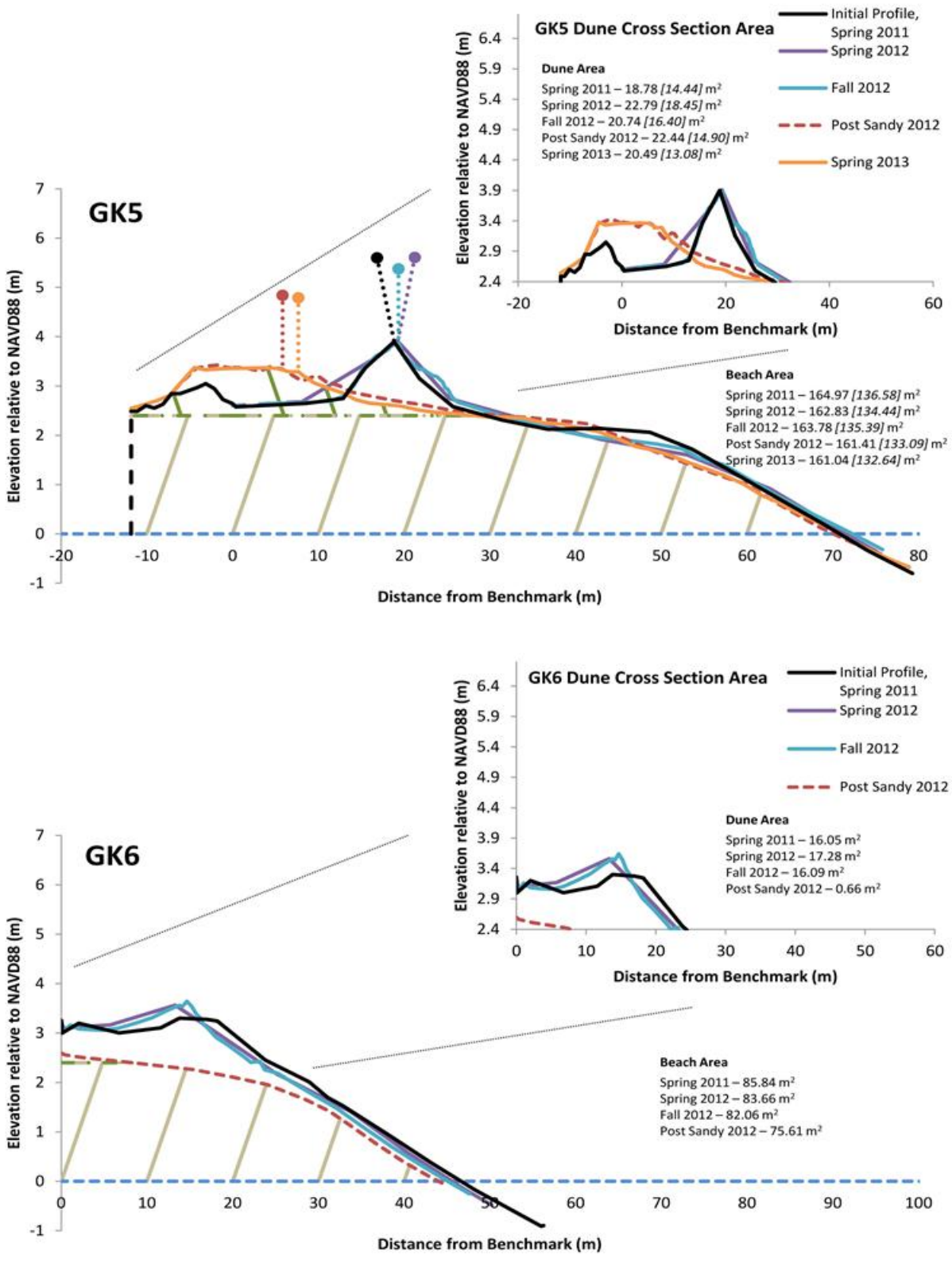


Figure 88. For profiles GK5 and GK6, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

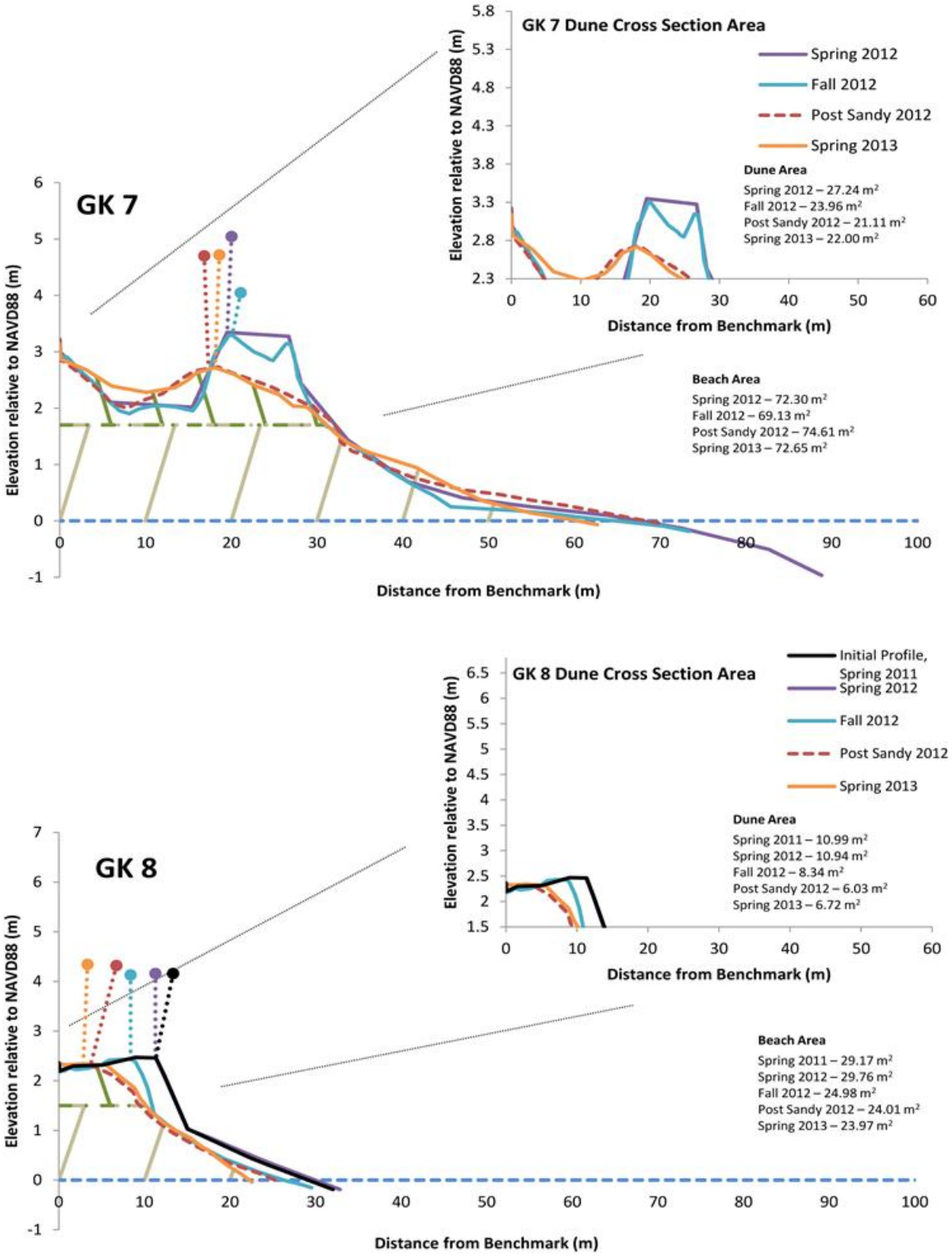


Figure 89. For profiles GK7 and GK8, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

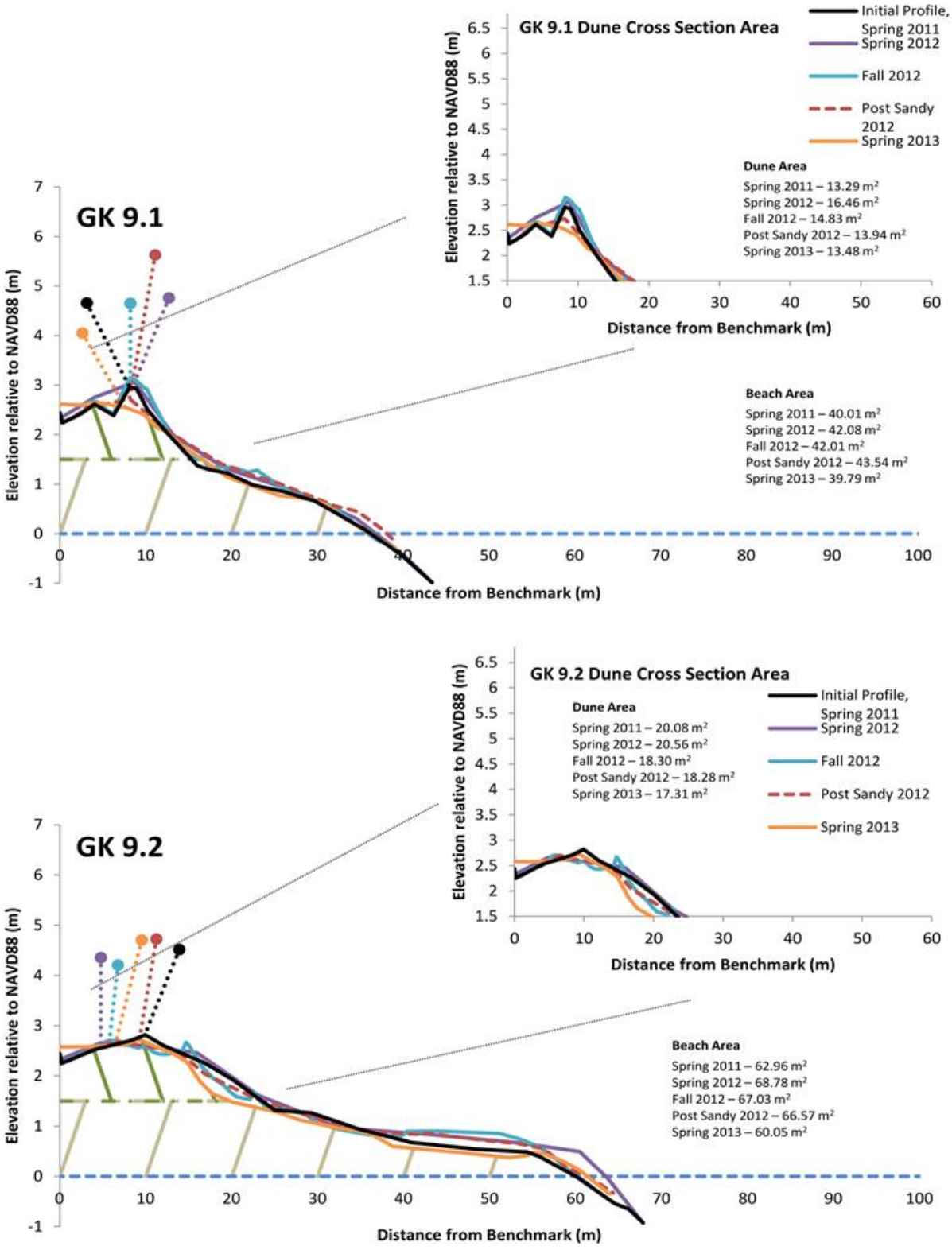


Figure 90. For profiles GK9.1 and GK9.2, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

Miller Field

Two monuments have been established along the ocean-facing of shoreline of Miller Field (Fig.91). They may be tied to some pre-existing item, such as a concrete step, or they may be tied to a newly-installed PVC pipe filled with concrete. The location, description, coordinates of the Miller Field monuments are detailed in a booklet prepared for this purpose (Psuty et al. 2010e).



Figure 91. Location of two monuments and their accompanying azimuths at Miller Field used in running the 2D beach/dune profiles.

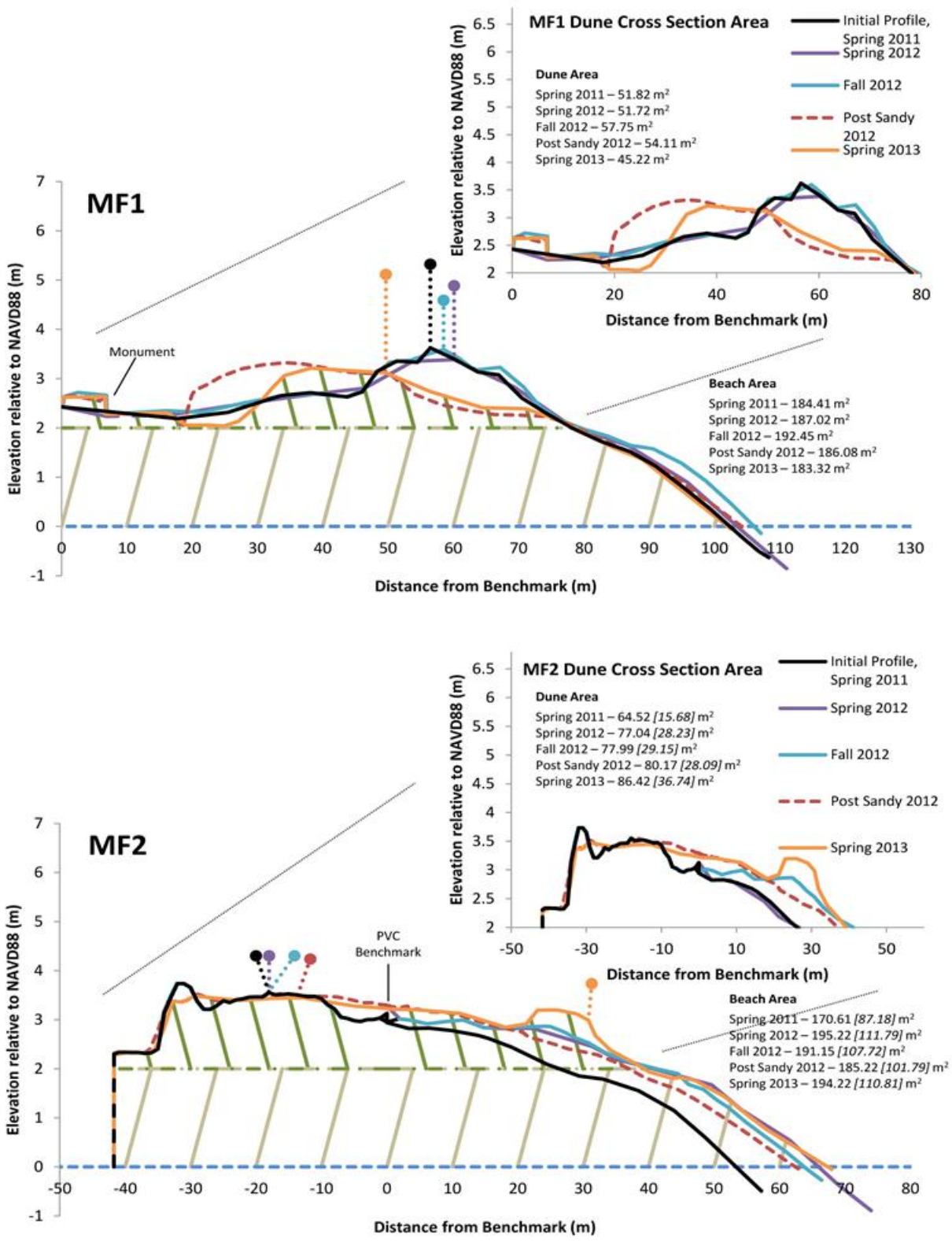


Figure 92. For profiles MF1 and MF2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

Fort Wadsworth

Three monuments have been established along the ocean-facing shoreline of Ft. Wadsworth (Fig. 93). They may be tied to some pre-existing item, such as a concrete pad, or they may be tied to a newly-installed PVC pipe filled with concrete. The location, description, coordinates of the Ft. Wadsworth monuments are detailed in a booklet prepared for this purpose (Psuty et al. 2010e).

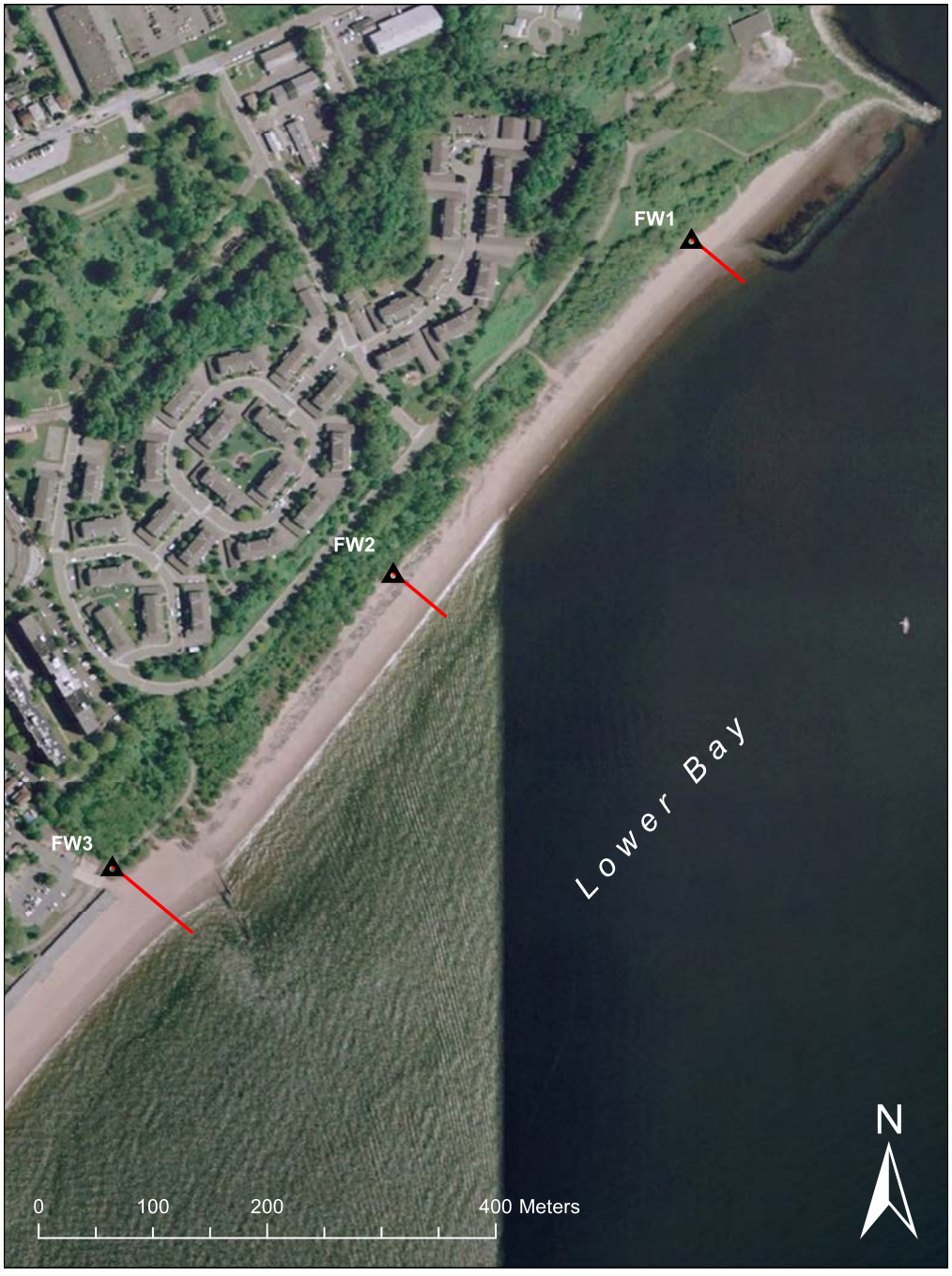


Figure 93. Location of 3 monuments and their accompanying azimuths at Fort Wadsworth used in running the 2D beach/dune profiles.

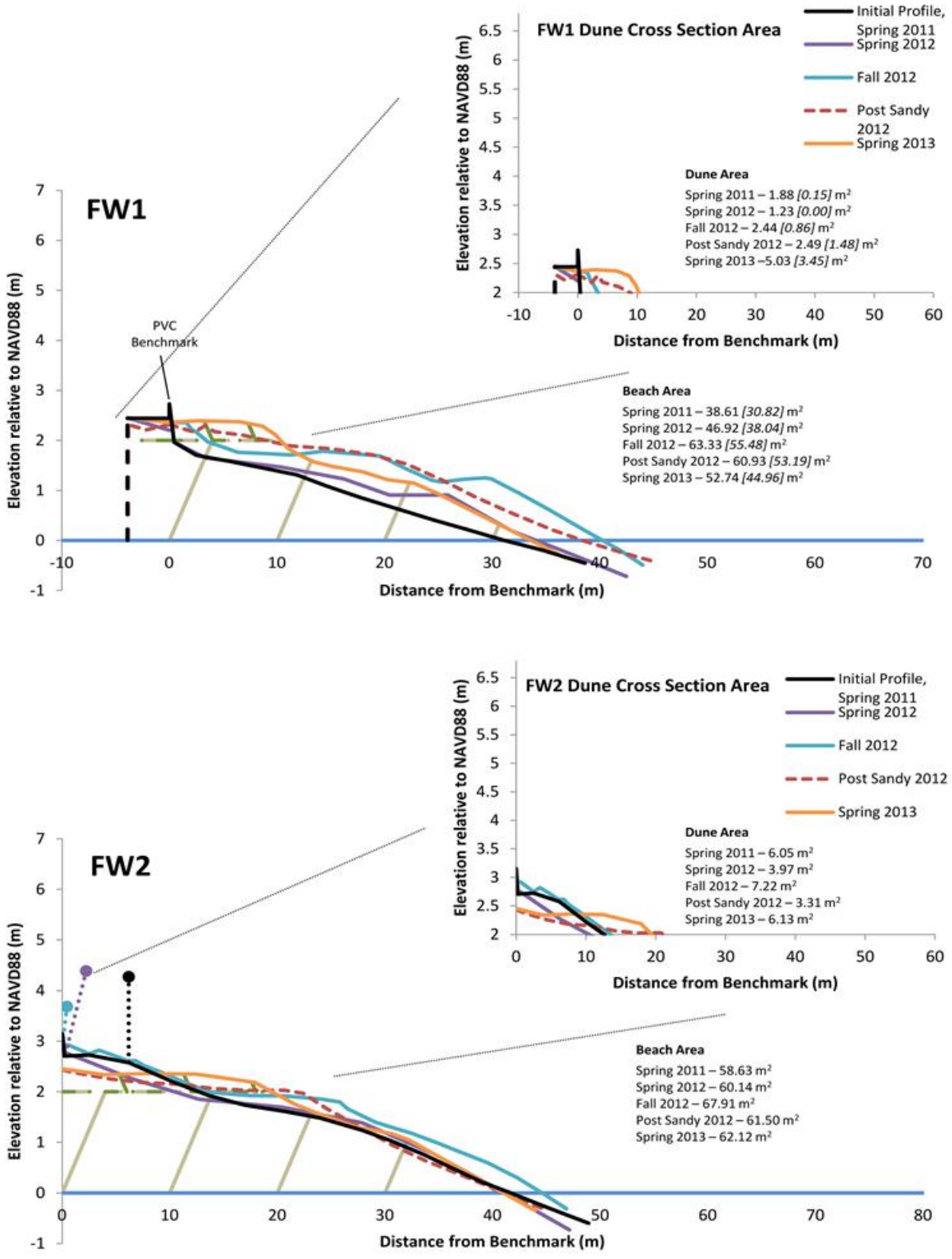


Figure 94. For profiles FW1 and FW2, the dune crest is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

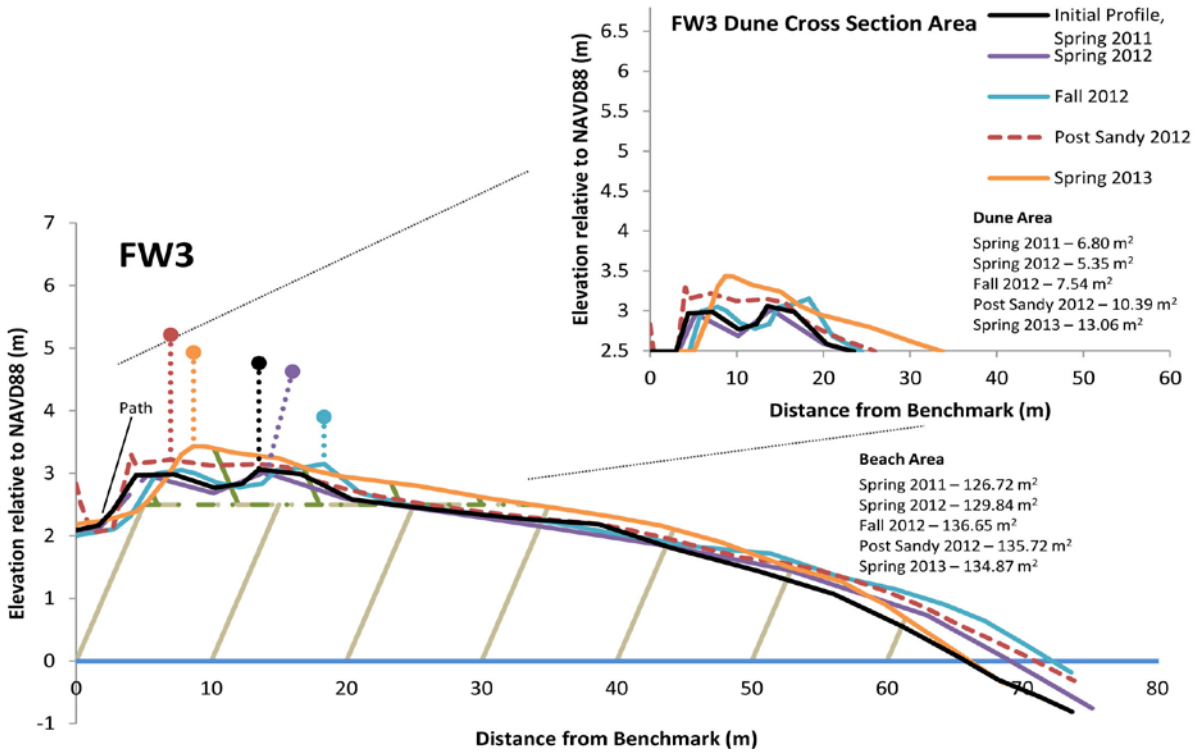


Figure 95. For profiles FW3, the dune crest or cliff edge is identified with a marker and the cross-sectional area is calculated for both the beach and the dune using each of the three seasonal surveys, as well as the Spring 2011 and Post Hurricane Sandy surveys.

Spatial Association

The spatial association of the data sets portrays the modifications of the profiles in the alongshore direction, relating the dimensions of change to the conditions of sediment availability and sediment budget, and to the variety of exposures to the ambient energetics. The results of distance to NAVD88, cross section area, distance to foredune crest, and elevation of foredune crest are depicted as examples of the type of comparative measures available from the profile surveys

Sandy Hook

At Sandy Hook, the downdrift effect of beach nourishment outside of the Park and the changing exposure to the incident energies are represented by a general increase of area to the beach from south to north (Fig. 96), until reaching the northern extent of Sandy Hook. Then the changes are driven by relative exposure to the dominant winds and waves on the bayside. This is but one example of the type of information that is incorporated in the topographical data sets. A more complete presentation and interpretation will be part of the trend report.

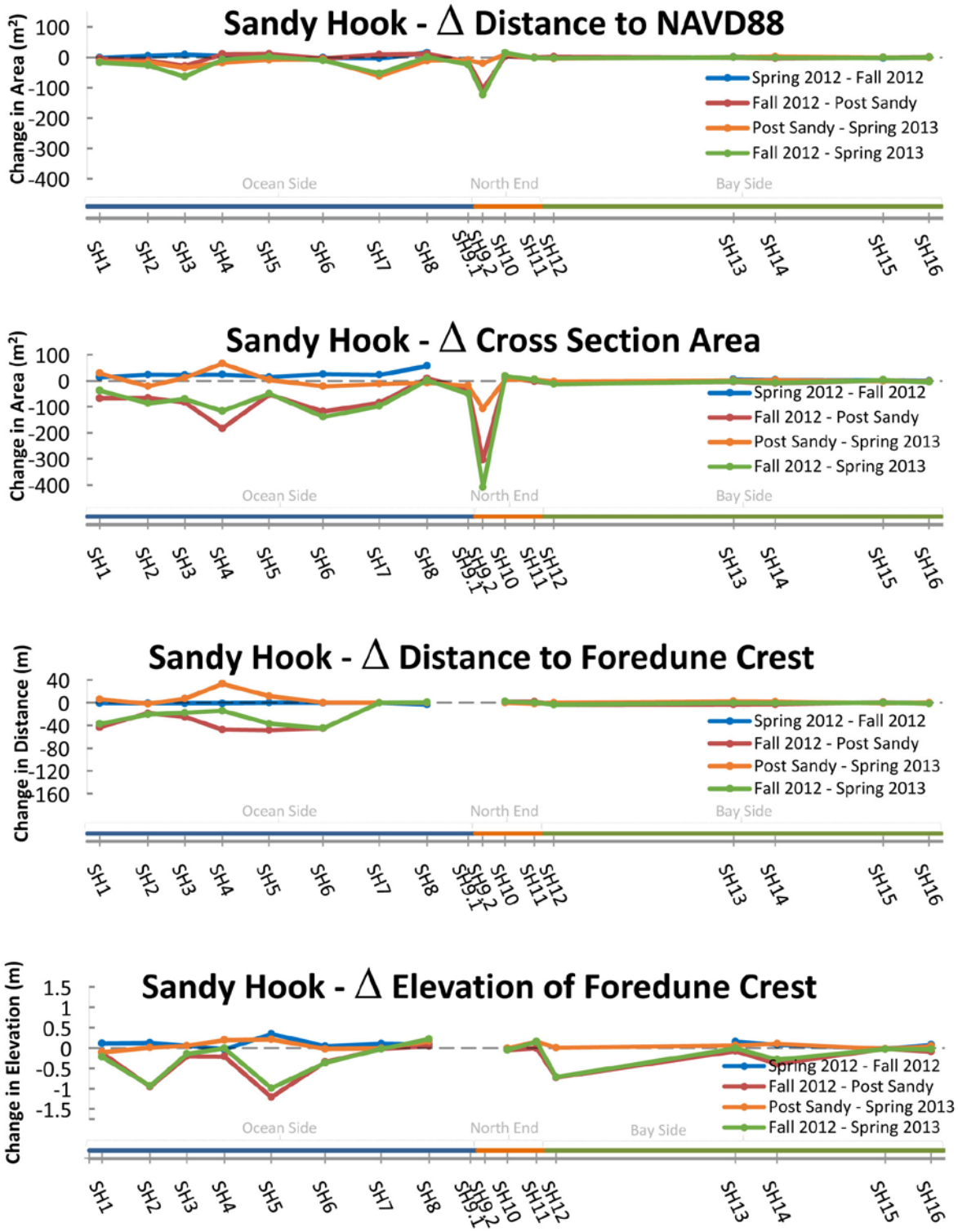


Figure 96. Alongshore seasonal differences of selected topographical variables at Sandy Hook, Spring 2012, Fall 2012, post-Sandy, and Spring 2013, incorporating dune/beach profile sites along the ocean side, inlet, and bay side situations.

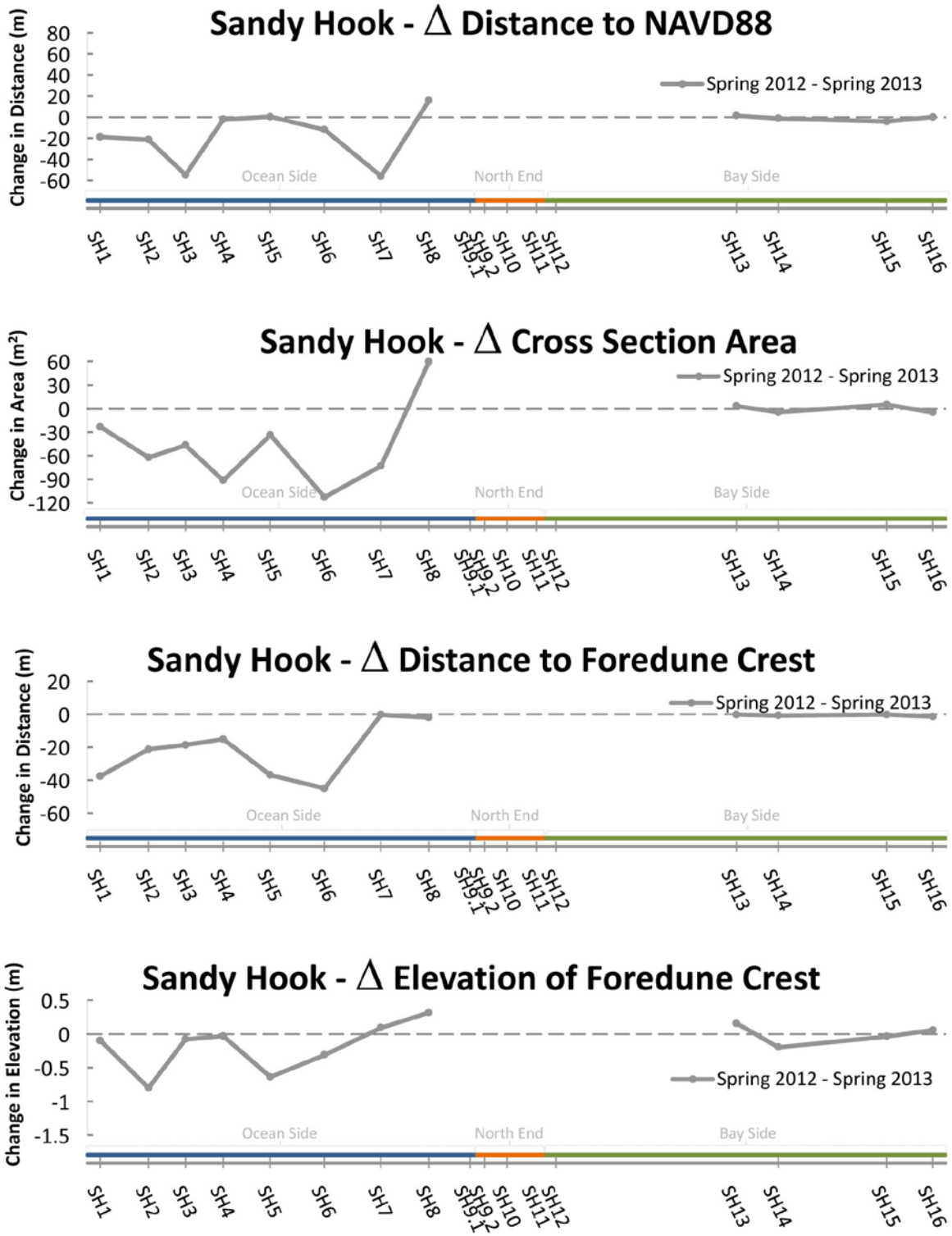


Figure 97. Alongshore annual difference of dimensions of selected topographical variables at Sandy Hook, Spring 2012 –Spring 2013, incorporating dune/beach profile sites along the ocean side, inlet, and bay side situations.

Breezy Point

The spatial association extends from the eastern margin, in Riis Park, continues through Fort Tilden, Breezy Point, beyond the jetty at Rockaway Inlet, and to the bayside as far as Roxbury Cove.

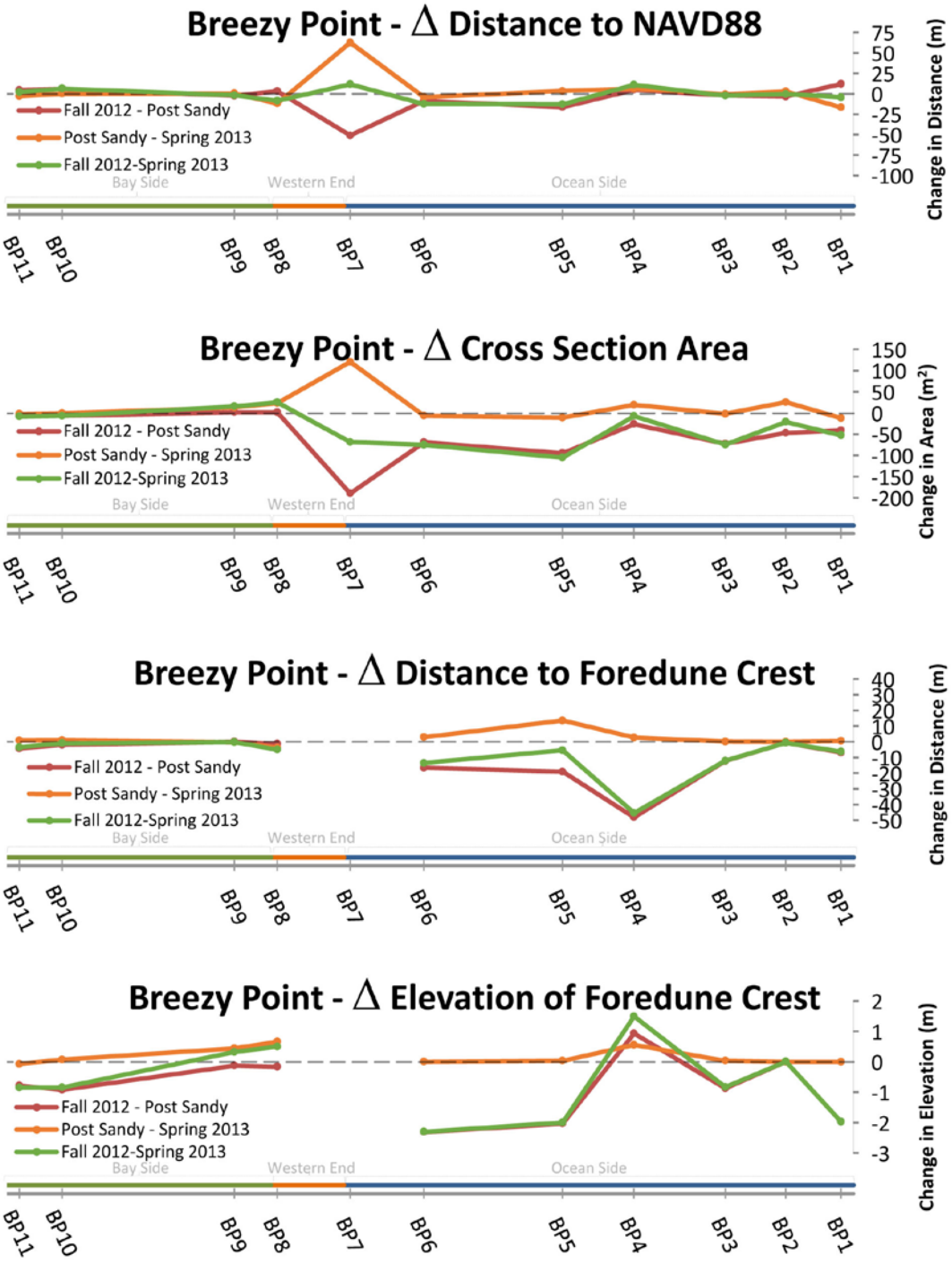


Figure 98. Alongshore seasonal differences in dimensions of selected topographical variables at Breezy Point, Fall 2012, post Sandy, and Spring 2013, incorporating dune/beach profile sites along the ocean side, inlet, and bay side situations.

Plumb Beach

The alongshore dimension of coastal features extends from the western margin near the jetty to the accreting spit at the eastern margin. A major episode of beach nourishment occurred during this report period.

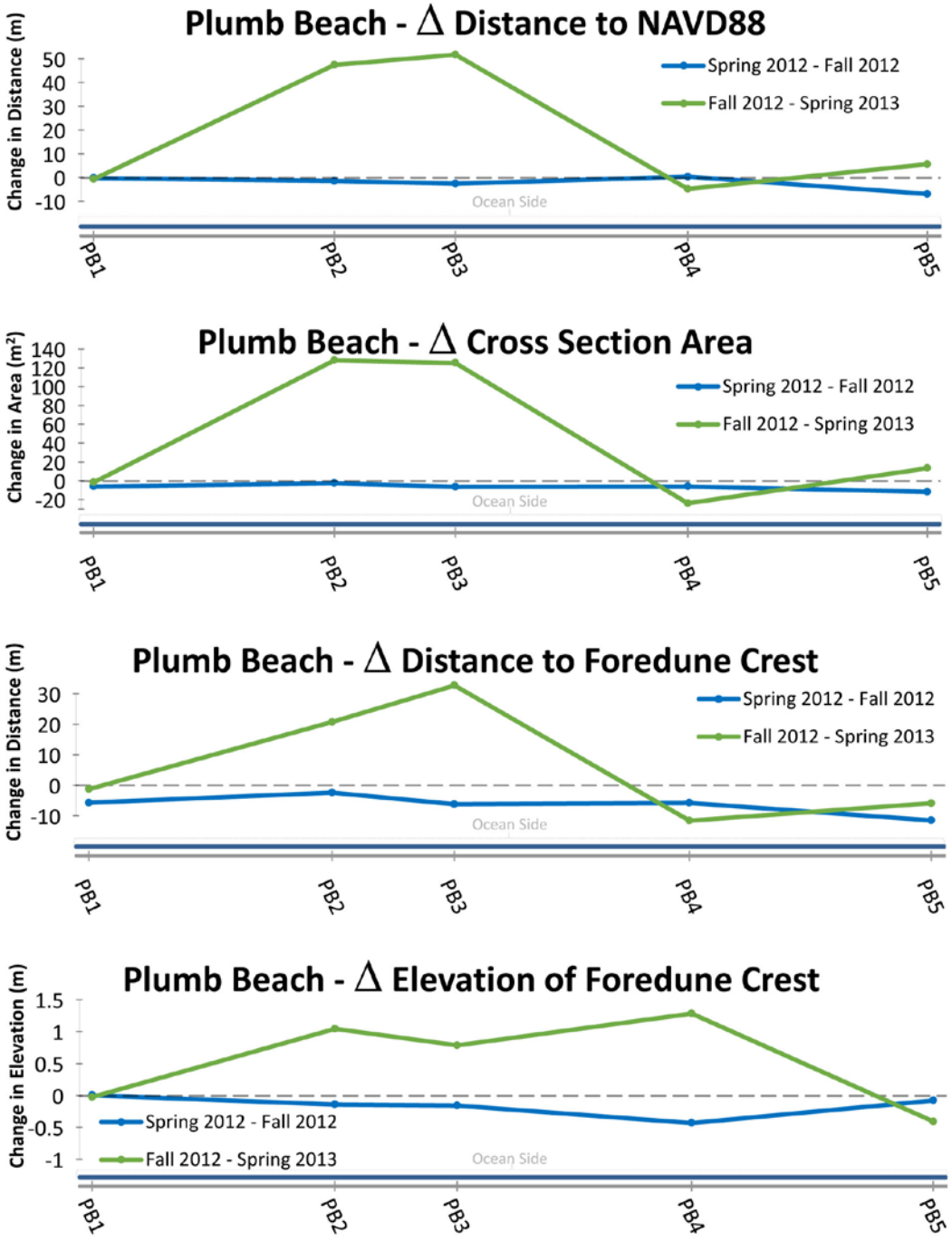


Figure 99. Alongshore seasonal differences in dimensions of selected topographical variables at Breezy Point, Spring 2012, Fall 2012, and Spring 2013.

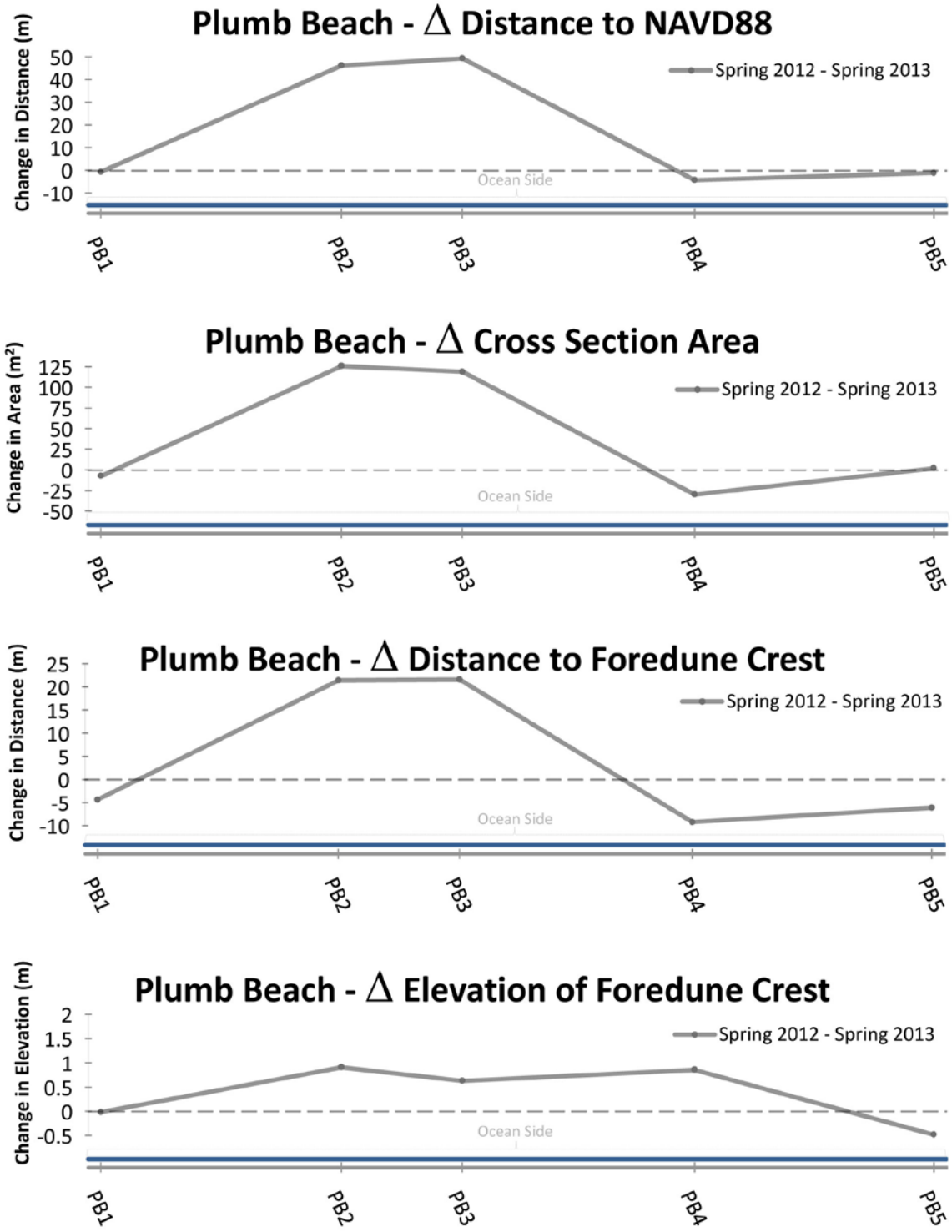


Figure 100. Alongshore annual differences of dimensions of selected topographical variables at Breezy Point, Spring 2012 –Spring 2013.

Great Kills

The spatial association extends from the eastern margin and continues through the jetty at Crooke's Point. It includes sites along the inlet margin and into the Great Kills Marina.

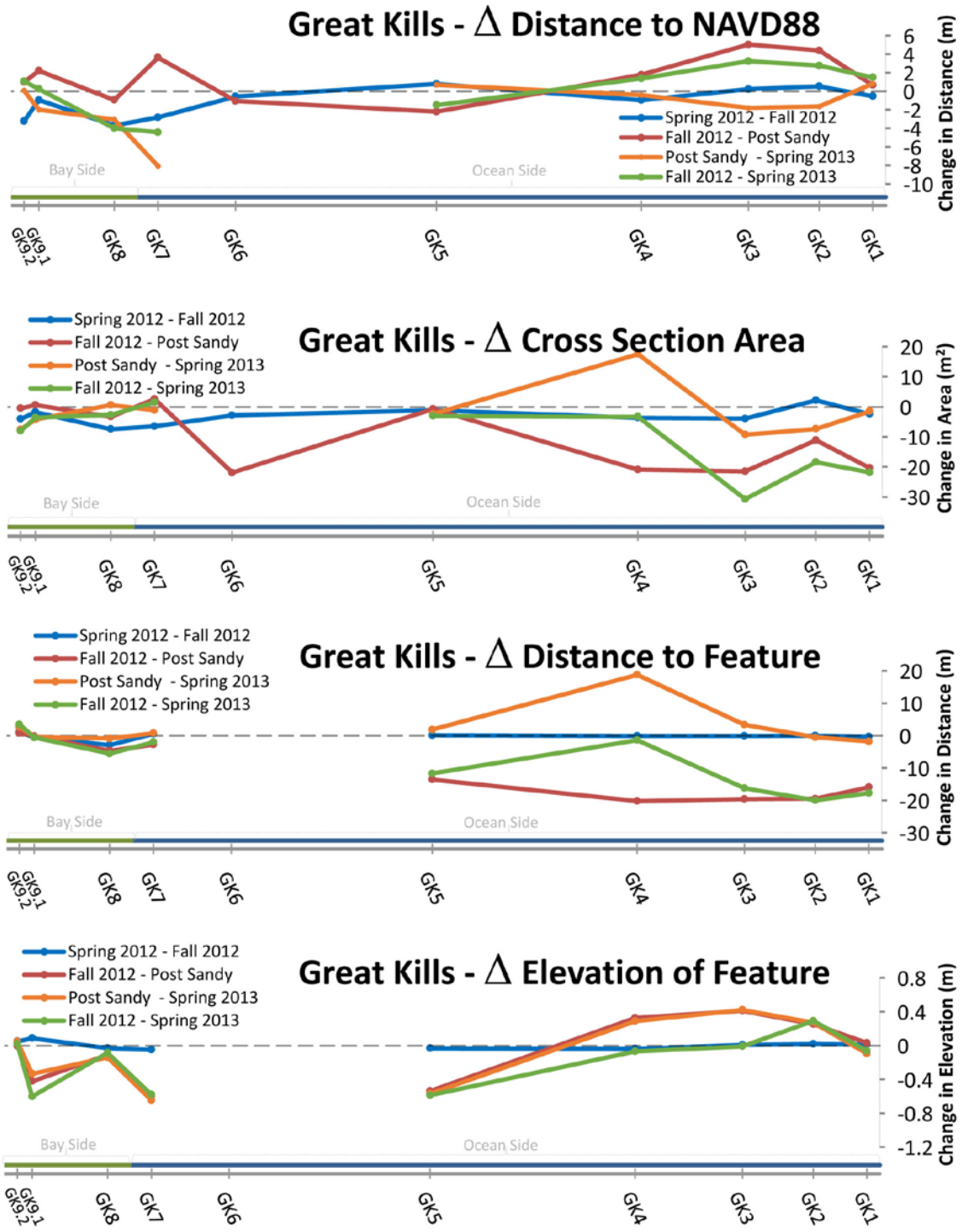


Figure 101. Alongshore seasonal differences of dimensions of selected topographical variables at Great Kills, Spring 2012, Fall 2012, post-Sandy, and Spring 2013.

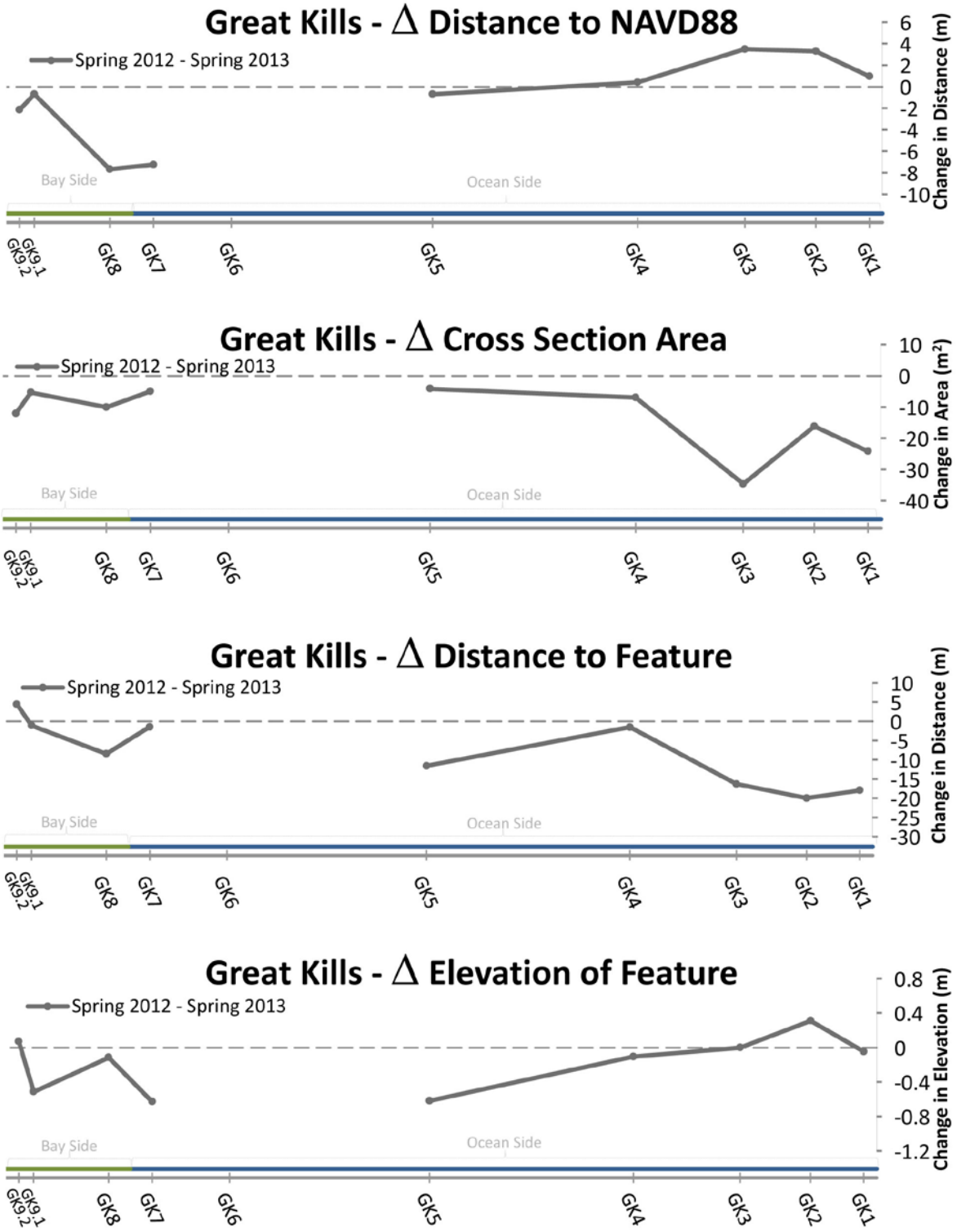


Figure 102. Alongshore annual differences in dimensions of selected topographical variables at Great Kills, Spring 2012 - Spring 2013.

Miller Field

The two Miller Field profiles represent the conditions near the groins at either alongshore margin of the ocean-facing shoreline. The groins create major restrictions of alongshore sediment input/output at the boundaries of this site.

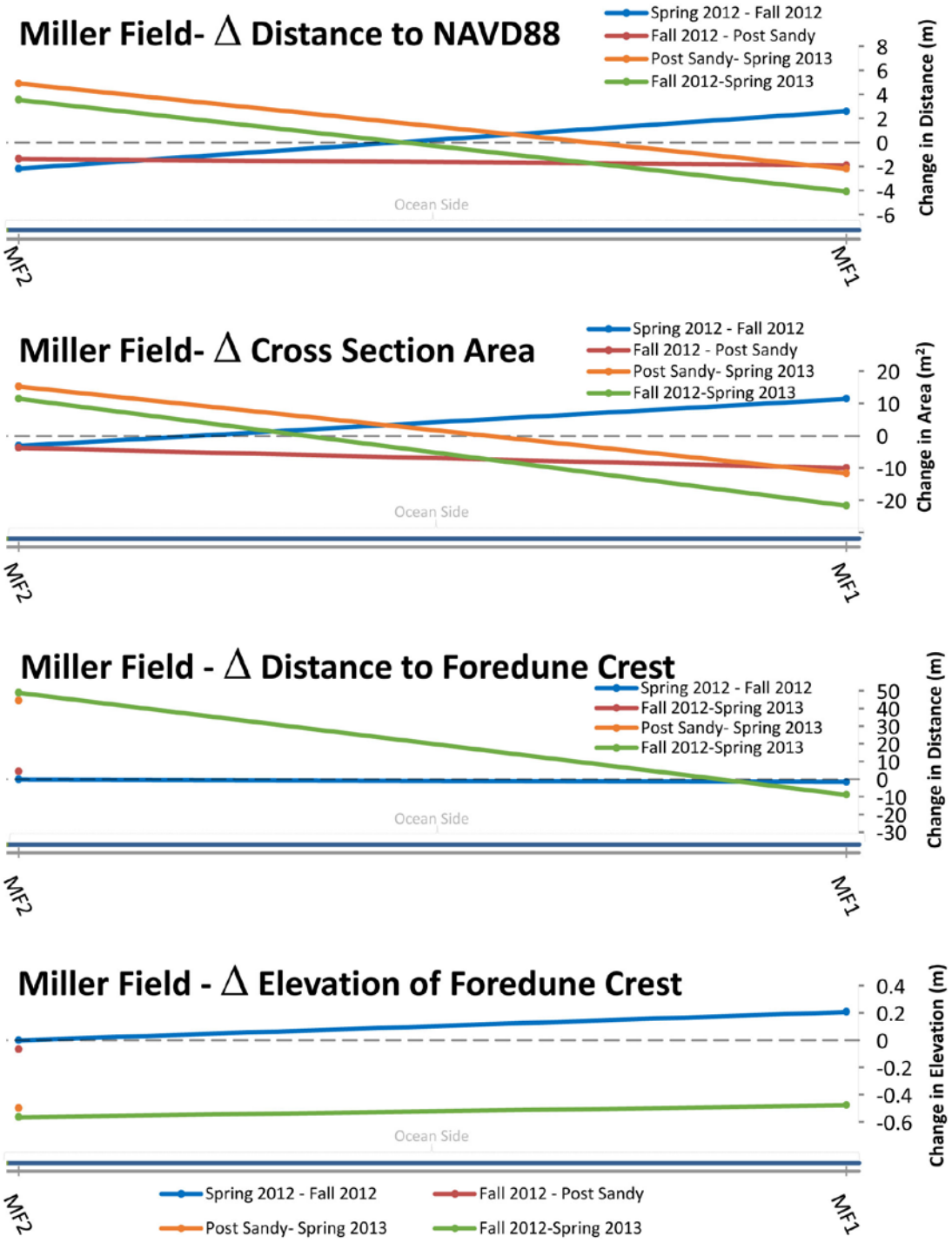


Figure 103. Alongshore seasonal differences of dimensions of selected topographical variables at Miller Field, Spring 2012, Fall 2012, post-Sandy, and Spring 2013.

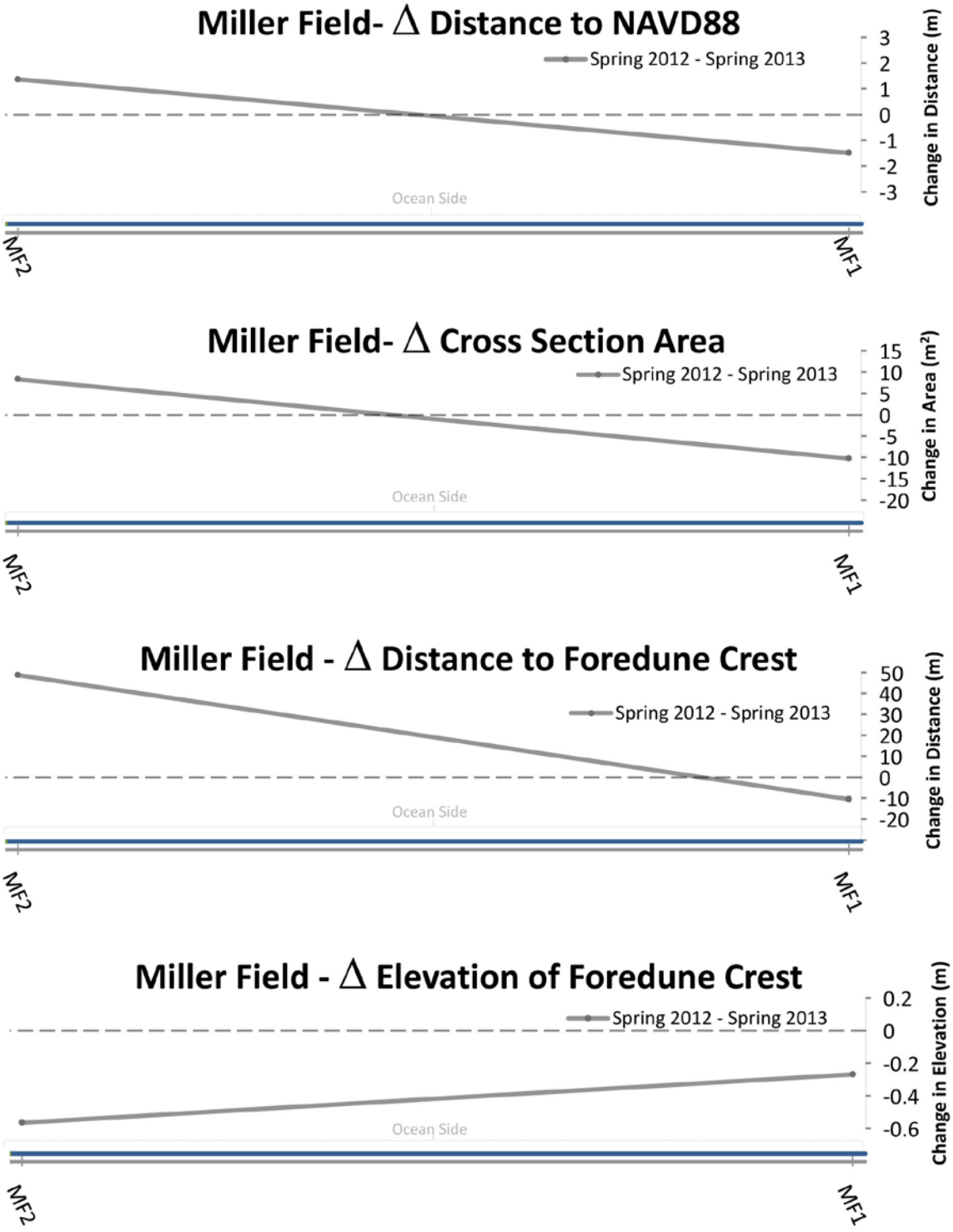


Figure 104. Alongshore annual differences of dimensions of selected topographical variables at Miller Field, Spring 2012 – Spring 2013.

Fort Wadsworth

The ocean-facing shoreline at Fort Wadsworth is constrained by a groin to the west and a terminal groin/jetty to the east. There is little sediment input to this section of the shoreline and the geomorphological features tend to depict gains and losses related to the alteration of alongshore transport direction.

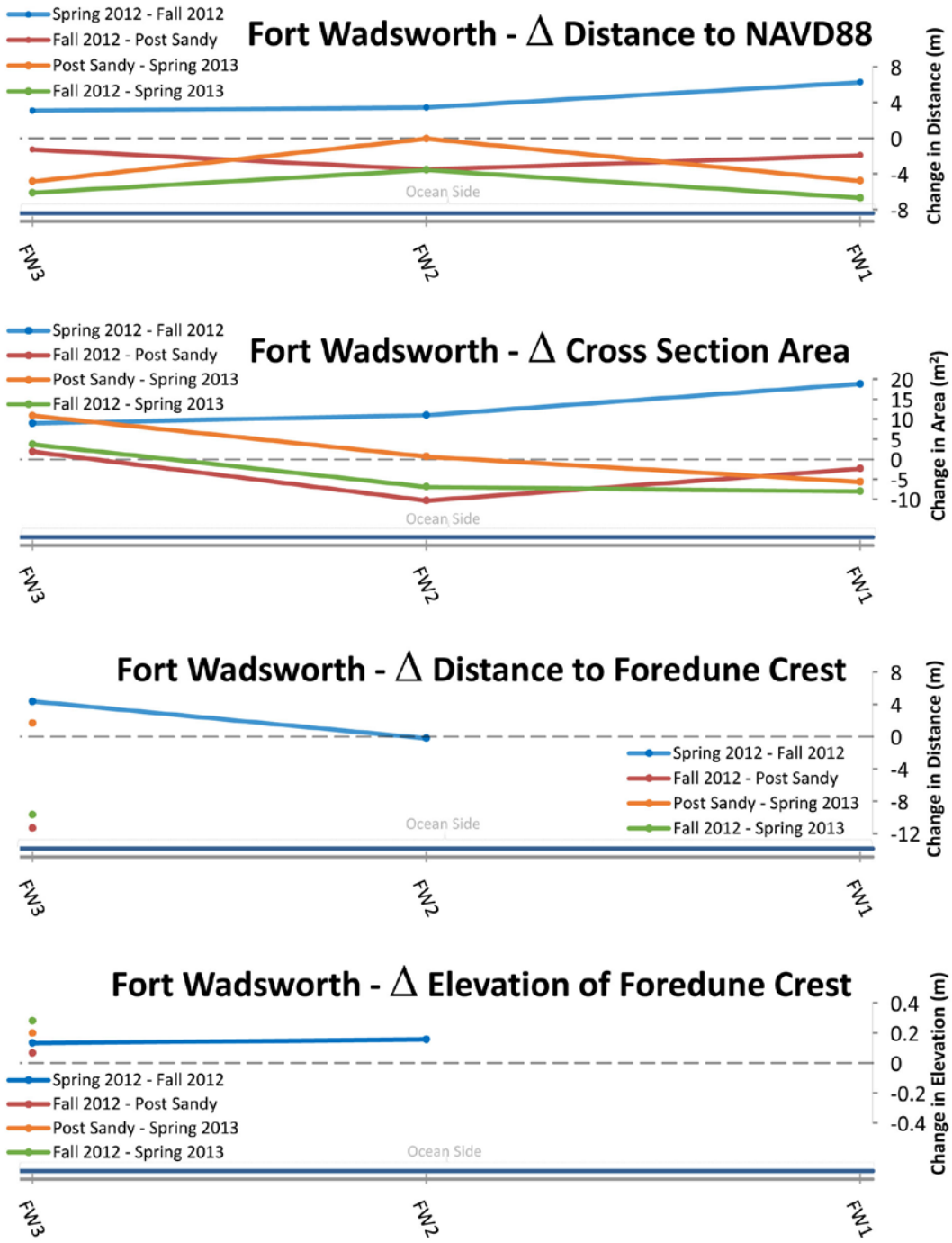


Figure 105. Alongshore seasonal differences of dimensions of selected topographical variables at Miller Field, Spring 2012, Fall 2012, post-Sandy, and Spring 2013.

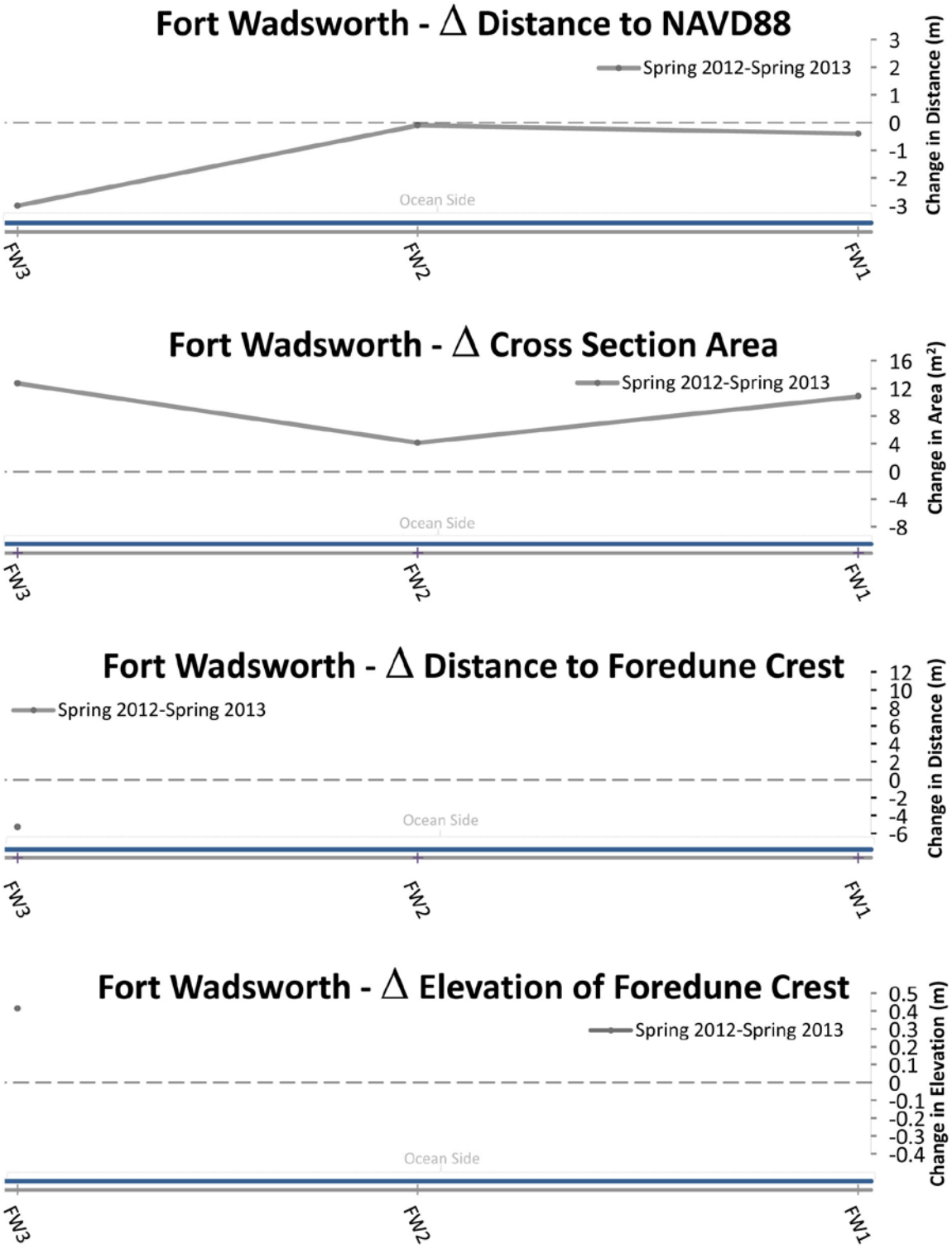


Figure 106. Alongshore annual differences of dimensions of selected topographical variables at Fort Wadsworth, Spring 2012 – Spring 2013.

Conclusions

A wealth of information is available from the seasonal topographical surveys conducted throughout the coastal areas of GATE. The changes are seen in the individual profiles and in the comparison of profiles within the several parts of GATE. More detailed analyses will be conducted in the Trend Report that will cover five years of data collection.

All of the profile data and the derived measures of change are compiled in a database for GATE and are deposited with the Data Manager of the Northeast Coastal and Barrier Network.

Literature Cited

Allen, J. R., 2000. Vital signs of northeast coastal park resource change: Shoreline monitoring group report. National Park Service Internal Report.

Psuty, N. P., P. Dennehy, T. Silveira, and N. Apostolou, 2010a. Coastal geomorphology of the ocean shoreline, Gateway National Recreation Area: natural evolution and cultural modifications, a synthesis. Natural Resource Report NPS/NER/NRR—2010/184. Fort Collins, Colorado.

Psuty, N. P., M. Duffy, J. F. Pace, D. E. Skidds, and T. M. Silveira, 2010b. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR—2010/185. National Park Service, Fort Collins, Colorado.

Psuty, N. P., A. Spahn, T. M. Silveira, and P. M. Dennehy, July 2010c. Breezy Point, Gateway National Recreation Area, spatial network of survey monuments, July 2010. Submitted to David Avrin, Chief, Division of Natural and Cultural Resources, Gateway National Recreation Area, NPS.

Psuty, N. P., A. Spahn, T. M. Silveira, and P. M. Dennehy, July 2010d. Great Kills, Gateway National Recreation Area, spatial network of survey monuments. Submitted to David Avrin, Chief, Division of Natural and Cultural Resources, Gateway National Recreation Area, NPS.

Psuty, N. P., A. Spahn, T. M. Silveira, and P. M. Dennehy, July 2010e. Miller Field & Fort Wadsworth, Gateway National Recreation Area, spatial network of survey monuments. Submitted to David Avrin, Chief, Division of Natural and Cultural Resources, Gateway National Recreation Area, NPS.

Psuty, N. P., A. Spahn, T. M. Silveira, and P. M. Dennehy, July 2010f. Plumb Beach, Gateway National Recreation Area, spatial network of survey monuments. Submitted to David Avrin, Chief, Division of Natural and Cultural Resources, Gateway National Recreation Area, NPS.

Psuty, N. P., A. Spahn, T. M. Silveira, and P. M. Dennehy, July 2010g. Sandy Hook, Gateway National Recreation Area, spatial network of survey monuments. Submitted to David Avrin, Chief, Division of Natural and Cultural Resources, Gateway National Recreation Area, NPS.

Psuty, N. P., T. M Silveira, A. Spahn, and D. Skidds, 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II – coastal topography. Natural Resource Report NPS/NCBN/NRR —2012/591. National Park Service, Fort Collins, Colorado.

Stevens, S., B. Milstead, M. Albert, and G. Entsminger, 2005. Northeast Coastal and Barrier Network vital signs monitoring plan. Technical Report NPS/NER/NRTR - 2005/025. National Park Service. Boston, Massachusetts.

Appendix A: Dimensions of Distance and Area, Spring 2012 – Spring 2013, GATE Profiles

- Spring 2012
- Fall 2012
- Post-Sandy 2012
- Spring 2013

Special Note for Dimensional Tables:

Values in brackets represent dimensions that are seaward of the benchmark, and are comparable to the 2011-2012 Annual Report. Metrics have been adjusted because of displacement of the inland point of origin (earlier starting position may have been compromised by erosion or deposition) to calculate the linear and areal measurements. Profile IDs with an asterisk indicate that the benchmark was relocated during the 2012-2013 survey season and is no longer comparable to previous reports.

Spring 2012

Sandy Hook

Survey Date: 03/20/12 | Low Tide: 1:06 PM | Height: 1.295 m

ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m²) Total		Beach		Dune		Cliff
SH1	126.13		43.46		-	3.25	-	278.78		265.17		13.61		-
SH2	208.73	*[203.72]*	102.13	*[97.12]*	-	3.48	-	423.96	*[402.37]*	381.92	*[369.91]*	42.03	*[32.46]*	-
SH3	234.77		64.12		-	3.71	-	511.92		425.22		86.69		-
SH4	152.42	*[127.41]*	48.33	*[23.32]*	-	4.65	-	456.67	*[341.61]*	319.89	*[259.87]*	136.78	*[81.74]*	-
SH5	111.27	*[58.78]*	52.53	*[0.04]*	-	3.95	-	268.15	*[100.59]*	221.36	*[96.11]*	46.79	*[4.48]*	-
SH6	178.11	*[112.85]*	90.74	*[25.48]*	-	4.12	-	443.79	*[214.53]*	337.55	*[181.04]*	106.24	*[33.49]*	-
SH7	456.13	*[373.19]*	83.04	*[0.10]*	-	4.81	-	971.13	*[643.72]*	808.45	*[609.43]*	162.68	*[34.29]*	-
SH8	366.79	*[301.42]*	94.32	*[28.95]*	-	4.59	-	824.20	*[612.64]*	690.24	*[534.96]*	133.97	*[77.68]*	-
SH9.1	-		-		-	-	-	-		-		-		-
SH9.2	-		-		-	-	-	-		-		-		-
SH10	-		-		-	-	-	-		-		-		-
SH11	-		-		-	-	-	-		-		-		-
SH12	-		-		-	-	-	-		-		-		-
SH13	85.07	*[22.05]*	66.35	*[3.33]*	-	1.77	-	90.36	*[22.47]*	89.47	*[21.78]*	0.89	*[0.69]*	-
SH14	50.54	*[27.21]*	27.41	*[4.08]*	-	2.12	-	42.82	*[24.61]*	41.22	*[23.01]*	1.60		-
SH15	62.09		1.70		-	3.79	-	77.68		65.67		12.01		-
SH16	34.23	*[17.96]*	22.14	*[5.87]*	-	3.88	-	97.17	*[36.22]*	43.37	*[18.98]*	53.80	*[17.24]*	-

Breezy Point

Survey Date: | Low Tide: | Height:

ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m²) Total		Beach		Dune		Cliff
BP1	-		-		-	-	-	-		-		-		-
BP2	-		-		-	-	-	-		-		-		-
BP3	-		-		-	-	-	-		-		-		-
BP4	-		-		-	-	-	-		-		-		-
BP5	-		-		-	-	-	-		-		-		-
BP6	-		-		-	-	-	-		-		-		-
BP7	-		-		-	-	-	-		-		-		-
BP8	-		-		-	-	-	-		-		-		-
BP9	-		-		-	-	-	-		-		-		-
BP10	-		-		-	-	-	-		-		-		-
BP11	-		-			-	-	-		-		-		-

Plumb Beach

Survey Date: 04/04/12 | Low Tide: 11:54 AM | Height: 0.17 m

ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m²) Total		Beach		Dune		Cliff
PB1	51.91	*[40.14]*	24.38	*[12.61]*	-	2.68	-	98.22	*[71.52]*	83.59	*[60.41]*	14.63	*[11.11]*	-
PB2	20.26		7.26		-	2.64	-	34.53		28.40		6.13		-
PB3	32.56		18.04		-	2.39	-	56.28		51.45		4.83		-
PB4	96.63	*[43.20]*	61.98	*[8.55]*	-	4.13	-	196.48	*[100.24]*	128.83	*[67.28]*	67.65	*[32.97]*	-
PB5	107.34	*[69.30]*	66.15	*[28.11]*	-	3.09	-	138.35	*[99.60]*	128.65	*[89.90]*	9.71		-

Great Kills

Survey Date: 03/21/12 | Low Tide: 1:18 PM | Height: -0.213 m

ID	Distance (m) NAVD88		Dune Crest		Cliff Edge		Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m²) Total		Beach		Dune		Cliff	
GK1	58.25	*[34.22]*	-		35.18	*[11.15]*	-	4.54	189.35	*[80.96]*	112.32	*[54.66]*	-		77.02	*[26.30]*
GK2	83.81		-		60.35		-	4.75	326.48		175.43		-		151.05	
GK3	48.82	*[28.20]*	-		23.14	*[2.52]*	-	5.38	172.20	*[55.89]*	93.63	*[44.15]*	-		78.57	*[11.75]*
GK4	61.49	*[37.78]*	-		35.37	*[11.66]*	-	3.71	179.93	*[83.45]*	121.34	*[64.43]*	-		58.60	*[19.03]*
GK5	83.33	*[71.50]*	31.08	*[19.25]*	-		3.91	-	185.61	*[152.89]*	162.83	*[134.44]*	22.79	*[18.45]*	-	
GK6	45.60		-		-		-	-	100.94		83.66		17.28		-	
GK7	67.64		19.53		-		3.35	-	99.54		72.30		27.24		-	
GK8	29.91		11.29		-		2.46	-	40.70		29.76		10.94		-	
GK9.1	36.83		8.72		-		3.06	-	58.54		42.08		16.46		-	
GK9.2	63.48		4.81		-		2.66	-	89.34		68.78		20.56		-	

Miller Field

Survey Date: 03/21/12 | Low Tide: 1:18 PM | Height: -0.213 m

ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m²) Total		Beach		Dune		Cliff
MF1	103.49		60.13		-	3.38	-	238.74		187.02		51.72		-
MF2*	107.71	*[65.99]*	23.72	*[-18.00]*	-	3.55	-	272.26	*[140.02]*	195.22	*[111.79]*	77.04	*[28.23]*	-

Fort Wadsworth

Survey Date: 03/21/12 | Low Tide: 1:18 PM | Height: -0.213 m

ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m²) Total		Beach		Dune		Cliff
FW1	37.89	*[34.06]*	-		-	-	-	46.92	*[38.04]*	46.92	*[38.04]*	1.23	*[0.00]*	-
FW2	41.12		0.26		-	2.78	-	64.10		60.14		3.97		-
FW3	69.14		13.96		-	3.02	-	135.19		129.84		5.35		-

* Tide elevation values are referenced to Mean Lower Low Water (MLLW)

Fall 2012

Sandy Hook					Survey Date 09/26/12		Low Tide 11:18 PM		Height -0.061 m			
ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m^2) Total		Beach		Dune		Cliff
SH1	124.52		42.87		-	3.37	-	293.14		278.46		14.68		-
SH2	213.33	[208.33]	101.35	[96.35]	-	3.61	-	447.74	[426.18]	405.41	[393.41]	42.33	[32.76]	-
SH3	243.64		63.07		-	3.77	-	534.82		449.06		85.75		-
SH4	157.64	[132.63]	47.36	[22.35]	-	4.62	-	481.19	[366.13]	342.11	[282.09]	139.08	[84.04]	-
SH5	109.39	[56.90]	52.49	[0.00]	-	4.30	-	283.22	[121.41]	231.51	[107.72]	51.71	[13.69]	-
SH6	176.64	[111.37]	90.60	[25.33]	-	4.17	-	469.45	[240.13]	361.70	[205.16]	107.75	[34.98]	-
SH7	452.71	[369.77]	82.94	[0.00]	-	4.92	-	994.55	[667.14]	831.55	[632.54]	163.00	[34.60]	-
SH8	382.31	[316.94]	91.40	[26.03]	-	4.68	-	882.12	[670.56]	743.04	[587.76]	139.08	[82.80]	-
SH9.1	50.72		-		-	-	-	87.65		87.60		0.04		-
SH9.2	349.46		-		-	-	-	715.93		703.04		12.88		-
SH10	346.20	[201.29]	235.51	[90.60]	-	2.10	-	589.85	[277.18]	405.46	[225.55]	184.39	[51.62]	-
SH11	160.67	[42.44]	82.58	[-35.65]	-	2.60	-	290.58	[51.43]	226.47	[49.13]	64.11	[2.30]	-
SH12	149.33	[54.37]	120.34	[25.38]	-	3.31	-	227.44	[82.70]	193.00	[67.26]	34.44	[15.44]	-
SH13	86.69	[23.67]	66.49	[3.47]	-	1.93	-	95.42	[27.53]	93.28	[25.59]	2.14	[1.94]	-
SH14	51.31	[28.00]	27.57	[4.26]	-	2.2	-	46.01	[32.15]	43.67	[29.81]	2.34		-
SH15	59.59		1.47		-	3.78	-	79.42		67.23		12.19		-
SH16	34.44	[18.17]	22.21	[5.94]	-	3.97	-	97.35	[36.40]	43.88	[19.49]	53.47	[16.91]	-

Breezy Point					Survey Date 10/22/12		Low Tide 8:18 PM		Height 0.05 m			
ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m^2) Total		Beach		Dune		Cliff
BP1	69.39		6.82		-	5.01	-	158.23		123.51		34.72		-
BP2	96.00		12.97		-	3.12	-	192.75		174.16		18.59		-
BP3	184.39	[84.43]	119.40	[19.44]	-	6.80	-	610.37	[259.92]	377.60	[147.72]	232.77	[112.20]	-
BP4	103.29	[69.29]	59.72	[25.72]	-	3.17	-	283.57	[152.22]	196.38	[118.18]	87.19	[34.04]	-
BP5	142.89		49.87		-	4.66	-	301.64		268.18		33.47		-
BP6	271.55	[136.66]	168.39	[33.50]	-	4.82	-	583.74	[270.61]	542.65	[246.77]	41.09	[23.84]	-
BP7	143.61		22.61		-	4.45	-	250.80		234.46		16.35		-
BP8	244.83	[174.28]	109.25	[38.70]	-	6.18	-	712.22	[470.46]	368.69	[248.75]	343.53	[221.71]	-
BP9	139.79	[114.22]	50.42	[24.85]	-	4.19	-	360.90	[261.80]	191.60	[148.14]	169.30	[113.66]	-
BP10	52.88	[16.84]	34.02	[-2.02]	-	2.71	-	66.13	[16.86]	61.60	[16.08]	4.53	[0.78]	-
BP11	29.61	[17.67]	11.94	[0.00]		3.15	-	47.55	[20.99]	36.98	[16.68]	10.57	[4.31]	-

Plumb Beach					Survey Date 09/19/12		Low Tide 4:12 PM		Height -0.028 m			
ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m^2) Total		Beach		Dune		Cliff
PB1	51.79	[40.06]	21.21	[9.48]	-	2.69	-	92.58	[66.02]	79.60	[56.52]	12.98	[9.50]	-
PB2	18.96		7.92		-	2.50	-	32.23		27.16		5.06		-
PB3	30.13		6.85		-	2.23	-	50.16		47.85		2.31		-
PB4	97.12	[43.69]	64.30	[10.38]	-	3.71	-	190.79	[94.56]	125.99	[64.44]	64.80	[30.12]	-
PB5	100.56	[62.57]	65.84	[27.85]	-	3.01	-	126.96	[88.37]	121.08	[82.50]	5.88		-

Great Kills						Survey Date 09/25/12		Low Tide 10:36 PM		Height -0.058 m				
ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m^2) Total		Beach		Dune		Cliff
GK1	57.73	[33.67]	-		34.93 [10.87]	-	4.56	186.98	[78.47]	110.30	[52.56]	-		76.68 [25.91]
GK2	84.35		-		60.34	-	4.77	328.71		176.31		-		152.40
GK3	49.06	[28.44]	-		23.07 [2.45]	-	5.39	168.31	[52.01]	90.82	[41.33]	-		77.49 [10.67]
GK4	60.53	[36.81]	-		35.28 [11.56]	-	3.67	176.32	[79.84]	118.67	[61.76]	-		57.64 [18.07]
GK5	84.13	[72.30]	31.18	[19.35]	-	3.88	-	184.52	[151.79]	163.78	[135.39]	20.74	[16.40]	-
GK6	45.05		-		-	-	-	98.14		82.06		16.09		-
GK7	64.83		20.10		-	3.3	-	93.09		69.13		23.96		-
GK8	26.22		8.39		-	2.43	-	33.32		24.98		8.34		-
GK9.1	35.89		8.22		-	3.15	-	56.84		42.01		14.83		-
GK9.2	60.25		5.80		-	2.71	-	85.33		67.03		18.30		-

Miller Field					Survey Date 10/03/12		Low Tide 3:48 PM		Height 0.265 m			
ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m^2) Total		Beach		Dune		Cliff
MF1	106.08		58.52		-	3.59	-	250.20		192.45		57.75		-
MF2	105.53	[63.81]	23.60	[-18.12]	-	3.55	-	269.14	[136.87]	191.15	[107.72]	77.99	[29.15]	-

Fort Wadsworth					Survey Date 10/03/12		Low Tide 3:48 PM		Height 0.265 m			
ID	Distance (m) NAVD88		Dune Crest		Cliff Edge	Elevation (m) Dune Crest	Cliff Edge	Cross Section Area (m^2) Total		Beach		Dune		Cliff
FW1*	44.17	[40.24]	-		-	-	-	65.77	[56.34]	63.33	[55.48]	2.44	[0.86]	-
FW2	44.57		0.06		-	2.93	-	75.13		67.91		7.22		-
FW3	72.24		18.34		-	3.15	-	144.19		136.65		7.54		-

* Tide elevation values are referenced to Mean Lower Low Water (MLLW)

Post Sandy 2012

Sandy Hook					Survey Date 11/13/12		Low Tide 1:10 PM		Height -0.27 m	
ID	Distance (m) NAVD88	Distance (m) Dune Crest	Distance (m) Cliff Edge	Elevation (m) Dune Crest	Elevation (m) Cliff Edge	Cross Section Area (m^2) Total	Cross Section Area (m^2) Beach	Cross Section Area (m^2) Dune	Cross Section Area (m^2) Cliff
SH1	120.59	0.00	-	3.26	-	226.49	214.85	11.64	-
SH2	203.16 *[198.17]*	82.95 *[77.96]*	-	2.66	-	382.21 *[360.89]*	350.78 *[338.80]*	31.43 *[22.09]*	-
SH3	214.68	38.42	-	3.57	-	453.37	376.57	76.81	-
SH4	167.61 *[142.48]*	0.01 *[-25.12]*	-	4.42	-	298.75 *[207.82]*	254.16 *[193.86]*	44.59 *[13.96]*	-
SH5	120.26 *[67.77]*	4.07 *[-48.42]*	-	3.10	-	230.60 *[107.23]*	217.41 *[107.23]*	13.18 *[0.00]*	-
SH6	173.34 *[107.94]*	45.44 *[-19.96]*	-	3.82	-	352.04 *[143.94]*	300.81 *[143.94]*	51.24 *[0.00]*	-
SH7	461.46 *[378.69]*	82.77 *[0.00]*	-	4.90	-	910.43 *[585.59]*	748.91 *[550.26]*	161.52 *[35.33]*	-
SH8	393.65 *[328.27]*	92.40 *[27.02]*	-	4.73	-	891.69 *[680.45]*	754.80 *[599.55]*	136.88 *[80.90]*	-
SH9.1	36.72	-	-	-	-	57.29	57.29	0.00	-
SH9.2	245.40	-	-	-	-	413.32	413.32	0.00	-
SH10	349.95 *[205.04]*	237.81 *[92.90]*	-	2.05	-	602.62 *[289.95]*	414.11 *[234.20]*	188.51 *[55.74]*	-
SH11	160.38 *[42.44]*	84.61 *[-33.33]*	-	2.60	-	289.75 *[51.43]*	226.03 *[49.13]*	63.72 *[2.30]*	-
SH12	151.25 *[56.01]*	116.84 *[21.60]*	-	2.59	-	217.45 *[73.06]*	188.07 *[62.01]*	29.38 *[11.05]*	-
SH13	86.18 *[23.10]*	63.41 *[0.33]*	-	1.87	-	92.68 *[25.53]*	90.01 *[23.27]*	2.68 *[2.27]*	-
SH14	47.36 *[24.06]*	24.71 *[1.41]*	-	1.82	-	36.64 *[22.88]*	35.96 *[22.20]*	0.67	-
SH15	59.06	2.29	-	3.77	-	82.61	69.37	13.24	-
SH16	35.31 *[19.33]*	20.50 *[4.52]*	-	3.89	-	94.73 *[34.81]*	44.13 *[20.16]*	50.61 *[14.66]*	-

Breezy Point					Survey Date 11/14/12		Low Tide 1:17 AM		Height -0.266 m	
ID	Distance (m) NAVD88	Distance (m) Dune Crest	Distance (m) Cliff Edge	Elevation (m) Dune Crest	Elevation (m) Cliff Edge	Cross Section Area (m^2) Total	Cross Section Area (m^2) Beach	Cross Section Area (m^2) Dune	Cross Section Area (m^2) Cliff
BP1	81.61	0.00	-	3.04	-	117.74	110.91	6.82	-
BP2	92.74	12.43	-	3.13	-	146.25	133.33	12.93	-
BP3	182.55 *[82.50]*	107.23 *[7.18]*	-	5.93	-	537.98 *[187.09]*	365.76 *[135.67]*	172.22 *[51.42]*	-
BP4	108.23 *[74.23]*	11.63 *[-22.37]*	-	4.10	-	257.64 *[130.43]*	200.98 *[122.78]*	56.67 *[7.65]*	-
BP5	126.68	30.92	-	2.64	-	207.51	197.09	10.42	-
BP6	263.16 *[128.27]*	151.89 *[17.00]*	-	2.51	-	515.16 *[180.18]*	476.55 *[175.87]*	38.60 *[4.31]*	-
BP7	92.70	-	-	-	-	61.63	61.63	0.00	-
BP8	248.29 *[177.74]*	108.07 *[37.52]*	-	6.01	-	714.36 *[472.60]*	380.50 *[260.56]*	333.86 *[212.04]*	-
BP9	137.45 *[111.88]*	50.52 *[24.95]*	-	4.07	-	363.39 *[258.81]*	195.57 *[152.10]*	167.82 *[106.71]*	-
BP10	59.17 *[22.98]*	32.06 *[-4.13]*	-	1.79	-	60.12 *[15.06]*	59.95 *[15.06]*	0.17 *[0.00]*	-
BP11	34.51 *[22.61]*	7.70 *[-4.20]*	-	2.37	-	41.80 *[17.35]*	37.44 *[17.22]*	4.36 *[0.13]*	-

Plumb Beach					Survey Date		Low Tide		Height	
ID	Distance (m) NAVD88	Distance (m) Dune Crest	Distance (m) Cliff Edge	Elevation (m) Dune Crest	Elevation (m) Cliff Edge	Cross Section Area (m^2) Total	Cross Section Area (m^2) Beach	Cross Section Area (m^2) Dune	Cross Section Area (m^2) Cliff
PB1	-	- -	-	-	-	-	-	-	-
PB2	-	- -	-	-	-	-	-	-	-
PB3	-	- -	-	-	-	-	-	-	-
PB4	-	- -	-	-	-	-	-	-	-
PB5	-	- -	-	-	-	-	-	-	-

Great Kills							Survey Date 11/12/12		Low Tide 12:17 PM		Height -0.187 m	
ID	Distance (m) NAVD88		Distance (m) Dune Crest		Distance (m) Cliff Edge		Elevation (m) Dune Crest	Elevation (m) Cliff Edge	Cross Section Area (m^2) Total	Cross Section Area (m^2) Beach	Cross Section Area (m^2) Dune	Cross Section Area (m^2) Cliff
GK1	58.41	*[34.40]*	-		19.02	*[-4.99]*	-	4.59	166.68 *[61.65]*	112.29 *[54.69]*	-	54.39 *[6.96]*
GK2	88.75		-		40.87		-	5.02	317.65	185.81	-	131.84
GK3	54.11	*[33.37]*	-		3.47	*[-17.27]*	-	5.81	146.85 *[55.79]*	102.40 *[52.72]*	-	44.45 *[3.07]*
GK4	62.31	*[38.67]*	-		15.07	*[-8.57]*	-	4.00	155.46 *[64.89]*	118.60 *[61.85]*	-	36.86 *[3.03]*
GK5	81.93	*[70.12]*	17.63	*[5.82]*	-		3.34	-	183.85 *[147.99]*	161.41 *[133.09]*	22.44 *[14.90]*	-
GK6	44.00		-		-		-	-	76.27	75.61	0.66	-
GK7	68.47		17.34		-		2.70	-	95.72	74.61	21.11	-
GK8	25.29		3.73		-		2.32	-	30.04	24.01	6.03	-
GK9.1	38.12		8.12		-		2.73	-	57.48	43.54	13.94	-
GK9.2	61.25		6.57		-		2.70	-	84.85	66.57	18.28	-

Miller Field					Survey Date 11/16/12		Low Tide 3:46 PM		Height -0.092 m	
ID	Distance (m) NAVD88	Distance (m) Dune Crest	Distance (m) Cliff Edge	Elevation (m) Dune Crest	Elevation (m) Cliff Edge	Cross Section Area (m^2) Total	Cross Section Area (m^2) Beach	Cross Section Area (m^2) Dune	Cross Section Area (m^2) Cliff
MF1	104.19	-	-	-	-	240.19	186.08	54.11	-
MF2	104.17 *[62.45]*	28.01 *[-13.71]*	-	3.49	-	265.39 *[129.88]*	185.22 *[101.79]*	80.17 *[28.09]*	-

Fort Wadsworth					Surevy Date 11/16/12		Low Tide 3:46 PM		Height -0.092 m	
ID	Distance (m) NAVD88	Distance (m) Dune Crest	Distance (m) Cliff Edge	Elevation (m) Dune Crest	Elevation (m) Cliff Edge	Cross Section Area (m^2) Total	Cross Section Area (m^2) Beach	Cross Section Area (m^2) Dune	Cross Section Area (m^2) Cliff
FW1	42.26 *[38.39]*	-	-	-	-	63.42 *[54.66]*	60.93 *[53.19]*	2.49 *[1.48]*	-
FW2	41.06	-	-	-	-	64.81	61.50	3.31	-
FW3	70.97	6.99	-	3.22	-	146.11	135.72	10.39	-

* Tide elevation values are referenced to Mean Lower Low Water (MLLW)

Spring 2013

Sandy Hook	Survey Date	Low Tide	Height
	04/05/13	9:53 AM	0.025 m

ID	Distance (m)					Elevation (m)		Cross Section Area (m²)							
	NAVD88		Dune Crest		Cliff Edge	Dune Crest	Cliff Edge	Total		Beach		Dune		Cliff	
SH1	107.36		5.88		-	3.16	-	255.74		243.66		12.08		-	
SH2	187.46	*[182.46]*	80.93	*[75.93]*	-	2.68	-	361.82	*[340.57]*	335.92	*[323.93]*	25.90	*[16.63]*	-	
SH3	180.06		45.49		-	3.63	-	465.57		393.93		71.64		-	
SH4	150.35	*[125.34]*	33.16	*[8.15]*	-	4.62	-	365.46	*[270.69]*	296.90	*[236.89]*	68.57	*[33.80]*	-	
SH5	111.74	*[59.26]*	15.60	*[-36.88]*	-	3.32	-	234.66	*[92.70]*	216.09	*[92.70]*	18.57	*[0.00]*	-	
SH6	166.35	*[100.38]*	45.78	*[-20.19]*	-	3.81	-	331.26	*[117.61]*	275.81	*[117.61]*	55.45	*[0.00]*	-	
SH7	400.24	*[317.44]*	82.80	*[0.00]*	-	4.90	-	898.28	*[571.39]*	734.59	*[535.86]*	163.69	*[35.53]*	-	
SH8	382.75	*[317.38]*	92.38	*[27.01]*	-	4.91	-	884.02	*[672.45]*	741.08	*[585.80]*	142.94	*[86.66]*	-	
SH9.1	27.81		-		-	-	-	38.44		37.56		0.88		-	
SH9.2	226.08		-		-	-	-	307.29		304.34		2.95		-	
SH10	360.97	*[216.06]*	237.81	*[92.90]*	-	2.05	-	608.68	*[296.01]*	420.24	*[240.33]*	188.44	*[55.68]*	-	
SH11	158.91	*[40.92]*	82.81	*[-35.18]*	-	2.76	-	294.90	*[48.27]*	221.59	*[44.60]*	73.31	*[3.67]*	-	
SH12	146.82	*[51.75]*	116.93	*[21.86]*	-	2.60	-	214.49	*[65.63]*	182.92	*[55.65]*	31.57	*[9.98]*	-	
SH13	86.63	*[23.58]*	66.16	*[3.11]*	-	1.93	-	93.84	*[25.10]*	91.18	*[22.92]*	2.66	*[2.18]*	-	
SH14	49.49	*[26.37]*	26.72	*[3.60]*	-	1.93	-	38.47	*[24.10]*	37.42	*[23.05]*	1.04		-	
SH15	58.19		1.54		-	3.76	-	82.91		70.08		12.82		-	
SH16	34.46	*[18.12]*	20.71	*[4.37]*	-	3.94	-	92.76	*[31.51]*	42.68	*[18.18]*	50.08	*[13.33]*	-	

Breezy Point	Survey Date	Low Tide	Height
	04/04/13	8:42 AM	-0.135 m

ID	Distance (m)					Elevation (m)		Cross Section Area (m²)							
	NAVD88		Dune Crest		Cliff Edge	Dune Crest	Cliff Edge	Total		Beach		Dune		Cliff	
BP1	65.14		0.59		-	3.04	-	105.94		97.50		8.44		-	
BP2	95.88		12.43		-	3.13	-	172.39		158.39		14.00		-	
BP3	182.19	*[82.23]*	107.43	*[7.47]*	-	5.97	-	536.32	*[185.85]*	364.18	*[134.29]*	172.14	*[51.56]*	-	
BP4	114.58	*[80.59]*	14.37	*[-19.62]*	-	4.67	-	277.03	*[140.11]*	209.75	*[131.58]*	67.28	*[8.53]*	-	
BP5	130.22		44.52		-	2.67	-	196.84		190.29		6.54		-	
BP6	259.17	*[124.29]*	154.91	*[20.03]*	-	2.52	-	509.03	*[174.13]*	471.98	*[171.32]*	37.04	*[2.82]*	-	
BP7	155.49		-		-	-	-	182.54		182.54		0.00		-	
BP8	236.47	*[165.91]*	104.33	*[33.77]*	-	6.68	-	738.09	*[496.32]*	373.62	*[253.67]*	364.47	*[242.64]*	-	
BP9	138.17	*[112.61]*	50.25	*[24.69]*	-	4.52	-	376.97	*[270.89]*	190.45	*[147.00]*	186.52	*[123.89]*	-	
BP10	59.50	*[23.50]*	33.15	*[-2.85]*	-	1.87	-	59.85	*[15.06]*	59.44	*[15.06]*	0.41	*[0.00]*	-	
BP11	31.81	*[19.93]*	8.57	*[-3.31]*		2.31	-	39.85	*[15.62]*	35.69	*[15.50]*	4.17	*[0.12]*	-	

Plumb Beach	Survey Date	Low Tide	Height
	04/10/13	1:42 AM	0.034 m

ID	Distance (m)					Elevation (m)		Cross Section Area (m²)							
	NAVD88		Dune Crest		Cliff Edge	Dune Crest	Cliff Edge	Total		Beach		Dune		Cliff	
PB1	51.27	*[39.39]*	20.06	*[8.18]*	-	2.67	-	91.21	*[63.35]*	79.46	*[56.13]*	11.75	*[7.23]*	-	
PB2	66.52		28.71		-	3.55	-	160.63		113.89		46.74		-	
PB3	81.97		39.67		-	3.02	-	175.59		140.95		34.64		-	
PB4	92.44	*[38.97]*	52.80	*[-0.67]*	-	5.00	-	167.14	*[71.76]*	119.69	*[56.91]*	47.45	*[14.85]*	-	
PB5	106.30	*[68.50]*	60.06	*[22.26]*	-	2.61	-	140.71	*[99.19]*	135.40	*[93.88]*	5.31		-	

Great Kills	Survey Date	Low Tide	Height
	04/08/13	12:19 PM	-0.153 m

ID	Distance (m)						Elevation (m)		Cross Section Area (m²)							
	NAVD88		Dune Crest		Cliff Edge		Dune Crest	Cliff Edge	Total		Beach		Dune		Cliff	
GK1	59.23	*[35.20]*	-		17.24	*[-6.79]*	-	4.50	165.23	*[60.36]*	112.24	*[54.58]*	-		52.99	*[5.78]*
GK2	87.12		-		40.39		-	5.06	310.36		179.99		-		130.37	
GK3	52.32	*[31.70]*	-		6.84	*[-13.78]*	-	5.38	137.64	*[48.08]*	95.91	*[46.43]*	-		41.72	*[1.64]*
GK4	61.91	*[38.19]*	-		33.89	*[10.17]*	-	3.60	173.04	*[77.56]*	119.44	*[62.51]*	-		53.60	*[15.05]*
GK5	82.64	*[70.80]*	19.51	*[7.67]*	-		3.29	-	181.52	*[145.72]*	161.04	*[132.64]*	20.49	*[13.08]*	-	
GK6	-		-		-		-	-	-		-		-		-	
GK7	60.41		18.11		-		2.72	-	94.64		72.65		22.00		-	
GK8	22.25		2.86		-		2.34	-	30.69		23.97		6.72		-	
GK9.1	36.14		7.65		-		2.55	-	53.27		39.79		13.48		-	
GK9.2	61.34		9.28		-		2.73	-	77.36		60.05		17.31		-	

Miller Field	Survey Date	Low Tide	Height
	05/30/13	6:00 AM	-0.105 m

ID	Distance (m)					Elevation (m)		Cross Section Area (m²)							
	NAVD88		Dune Crest		Cliff Edge	Dune Crest	Cliff Edge	Total		Beach		Dune		Cliff	
MF1	102.00		49.68		-	3.12	-	228.54		183.32		45.22		-	
MF2	109.08	*[67.37]*	72.52	*[30.81]*	-	2.99	-	280.64	*[147.55]*	194.22	*[110.81]*	86.42	*[36.74]*	-	

Fort Wadsworth	Survey Date	Low Tide	Height
	03/26/13	2:32 AM	-0.411 m

ID	Distance (m)					Elevation (m)		Cross Section Area (m²)							
	NAVD88		Dune Crest		Cliff Edge	Dune Crest	Cliff Edge	Total		Beach		Dune		Cliff	
FW1	37.49	*[33.59]*	-		-	-	-	57.78	*[48.41]*	52.74	*[44.96]*	5.03	*[3.45]*	-	
FW2	41.02		-		-	-	-	68.25		62.12		6.13		-	
FW3	66.14		8.68		-	3.43	-	147.93		134.87		13.06		-	

* Tide elevation values are referenced to Mean Lower Low Water (MLLW)

Appendix B: Dimensions of Seasonal and Annual Change on GATE Profiles

- Spring 2012 – Fall 2012
- Fall 2012 – Post-Sandy 2012
- Post-Sandy 2012 – Spring 2013
- Fall 2012 – Spring 2013
- Spring 2012 – Spring 2013

Spring 2012 - Fall 2012

Sandy Hook

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
SH1	-1.61	-0.59	-	0.12	-	14.36	13.29	1.07	-
SH2	4.60	-0.78	-	0.13	-	23.78	23.49	0.30	-
SH3	8.87	-1.05	-	0.06	-	22.90	23.84	-0.94	-
SH4	5.22	-0.97	-	-0.03	-	24.52	22.22	2.30	-
SH5	-1.88	-0.04	-	0.35	-	15.07	10.15	4.92	-
SH6	-1.47	-0.14	-	0.05	-	25.66	24.15	1.51	-
SH7	-3.42	-0.10	-	0.11	-	23.42	23.10	0.32	-
SH8	15.52	-2.92	-	0.09	-	57.92	52.80	5.11	-
SH9.1	-	-	-	-	-	-	-	-	-
SH9.2	-	-	-	-	-	-	-	-	-
SH10	-	-	-	-	-	-	-	-	-
SH11	-	-	-	-	-	-	-	-	-
SH12	-	-	-	-	-	-	-	-	-
SH13	1.62	0.14	-	0.16	-	5.06	3.81	1.25	-
SH14	0.77	0.16	-	0.08	-	3.19	2.45	0.74	-
SH15	-2.50	-0.23	-	-0.01	-	1.74	1.56	0.18	-
SH16	0.21	0.07	-	0.08	-	0.18	0.51	-0.33	-

Breezy Point

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
BP1	-	-	-	-	-	-	-	-	-
BP2	-	-	-	-	-	-	-	-	-
BP3	-	-	-	-	-	-	-	-	-
BP4	-	-	-	-	-	-	-	-	-
BP5	-	-	-	-	-	-	-	-	-
BP6	-	-	-	-	-	-	-	-	-
BP7	-	-	-	-	-	-	-	-	-
BP8	-	-	-	-	-	-	-	-	-
BP9	-	-	-	-	-	-	-	-	-
BP10	-	-	-	-	-	-	-	-	-
BP11	-	-	-	-	-	-	-	-	-

Plumb Beach

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
PB1	-0.12	-3.17	-	0.01	-	-5.64	-3.99	-1.65	-
PB2	-1.30	0.66	-	-0.14	-	-2.30	-1.24	-1.07	-
PB3	-2.43	-11.19	-	-0.15	-	-6.12	-3.60	-2.52	-
PB4	0.49	2.32	-	-0.42	-	-5.69	-2.84	-2.85	-
PB5	-6.78	-0.31	-	-0.07	-	-11.39	-7.57	-3.83	-

Great Kills

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
GK1	-0.52	-	-0.25	-	0.02	-2.37	-2.02	-	-0.34
GK2	0.54	-	-0.01	-	0.02	2.23	0.88	-	1.35
GK3	0.24	-	-0.07	-	0.01	-3.89	-2.81	-	-1.08
GK4	-0.96	-	-0.09	-	-0.04	-3.61	-2.67	-	-0.96
GK5	0.80	0.10	-	-0.03	-	-1.09	0.95	-2.05	-
GK6	-0.55	-	-	-	-	-2.80	-1.60	-1.19	-
GK7	-2.81	0.57	-	-0.05	-	-6.45	-3.17	-3.28	-
GK8	-3.69	-2.90	-	-0.03	-	-7.38	-4.78	-2.60	-
GK9.1	-0.94	-0.50	-	0.09	-	-1.70	-0.07	-1.63	-
GK9.2	-3.23	0.99	-	0.05	-	-4.01	-1.75	-2.26	-

Miller Field

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
MF1	2.59	-1.61	-	0.21	-	11.46	5.43	6.03	-
MF2	-2.18	-0.12	-	0.00	-	-3.12	-4.07	0.95	-

Fort Wadsworth

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
FW1*	6.28	-	-	-	-	18.85	16.41	2.44	-
FW2	3.45	-0.20	-	0.16	-	11.03	7.77	3.25	-
FW3	3.10	4.38	-	0.13	-	9.00	6.81	2.19	-

Fall 2012 - Post Sandy 2012

Sandy Hook

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
SH1	-3.93	-42.87	-	-0.11	-	-66.65	-63.61	-3.04	-
SH2	-10.17	-18.40	-	-0.95	-	-65.53	-54.63	-10.90	-
SH3	-28.96	-24.65	-	-0.20	-	-81.45	-72.49	-8.94	-
SH4	9.97	-47.35	-	-0.20	-	-182.44	-87.95	-94.49	-
SH5	10.87	-48.42	-	-1.20	-	-52.62	-14.10	-38.53	-
SH6	-3.30	-45.16	-	-0.34	-	-117.41	-60.89	-56.51	-
SH7	8.75	-0.17	-	-0.01	-	-84.12	-82.64	-1.48	-
SH8	11.34	1.00	-	0.05	-	9.57	11.76	-2.20	-
SH9.1	-14.00	-	-	-	-	-30.36	-30.31	-0.04	-
SH9.2	-104.06	-	-	-	-	-302.61	-289.72	-12.88	-
SH10	3.75	2.30	-	-0.04	-	12.77	8.65	4.12	-
SH11	-0.29	2.03	-	0.00	-	-0.83	-0.44	-0.39	-
SH12	1.92	-3.50	-	-0.72	-	-9.99	-4.93	-5.06	-
SH13	-0.51	-3.08	-	-0.07	-	-2.74	-3.27	0.54	-
SH14	-3.95	-2.86	-	-0.39	-	-9.37	-7.71	-1.67	-
SH15	-0.53	0.82	-	-0.01	-	3.19	2.14	1.05	-
SH16	0.87	-1.71	-	-0.08	-	-2.62	0.25	-2.86	-

Breezy Point

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
BP1	12.22	-6.82	-	-1.97	-	-40.49	-12.60	-27.90	-
BP2	-3.26	-0.54	-	0.01	-	-46.50	-40.83	-5.66	-
BP3	-1.84	-12.17	-	-0.87	-	-72.39	-11.84	-60.55	-
BP4	4.94	-48.09	-	0.94	-	-25.93	4.60	-30.52	-
BP5	-16.21	-18.95	-	-2.03	-	-94.13	-71.09	-23.05	-
BP6	-8.39	-16.50	-	-2.30	-	-68.58	-66.10	-2.49	-
BP7	-50.91	-	-	-	-	-189.17	-172.83	-16.35	-
BP8	3.46	-1.18	-	-0.16	-	2.14	11.81	-9.67	-
BP9	-2.34	0.10	-	-0.12	-	2.49	3.97	-1.48	-
BP10	6.29	-1.96	-	-0.92	-	-6.01	-1.65	-4.36	-
BP11	4.90	-4.24	-	-0.78	-	-5.75	0.46	-6.21	-

Plumb Beach

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
PB1	-	-	-	-	-	-	-	-	-
PB2	-	-	-	-	-	-	-	-	-
PB3	-	-	-	-	-	-	-	-	-
PB4	-	-	-	-	-	-	-	-	-
PB5	-	-	-	-	-	-	-	-	-

Great Kills

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
GK1	0.68	-	-15.91	-	0.03	-20.30	1.99	-	-22.29
GK2	4.40	-	-19.47	-	0.25	-11.06	9.50	-	-20.56
GK3	5.05	-	-19.60	-	0.41	-21.46	11.58	-	-33.04
GK4	1.78	-	-20.21	-	0.33	-20.86	-0.07	-	-20.78
GK5	-2.20	-13.55	-	-0.54	-	-0.67	-2.37	1.70	-
GK6	-1.05	-	-	-	-	-21.87	-6.45	-15.43	-
GK7	3.64	-2.76	-	-0.60	-	2.63	5.48	-2.85	-
GK8	-0.93	-4.66	-	-0.11	-	-3.28	-0.97	-2.31	-
GK9.1	2.23	-0.10	-	-0.42	-	0.64	1.53	-0.89	-
GK9.2	1.00	0.77	-	0.00	-	-0.48	-0.46	-0.02	-

Miller Field

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
MF1	-1.89	-	-	-	-	-10.01	-6.37	-3.64	-
MF2	-1.36	4.41	-	-0.07	-	-3.75	-5.93	2.18	-

Fort Wadsworth

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
FW1	-1.91	-	-	-	-	-2.35	-2.40	0.05	-
FW2	-3.51	-	-	-	-	-10.32	-6.41	-3.91	-
FW3	-1.27	-11.35	-	0.06	-	1.92	-0.93	2.85	-

Post Sandy 2012 - Spring 2013

Sandy Hook

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
SH1	-13.23	5.88	-	-0.10	-	29.25	28.81	0.44	-
SH2	-15.70	-2.02	-	0.02	-	-20.39	-14.86	-5.53	-
SH3	-34.62	7.07	-	0.06	-	12.20	17.36	-5.17	-
SH4	-17.26	33.15	-	0.20	-	66.71	42.74	23.98	-
SH5	-8.52	11.53	-	0.22	-	4.06	-1.32	5.39	-
SH6	-6.99	0.34	-	-0.02	-	-20.78	-25.00	4.21	-
SH7	-61.22	0.03	-	0.00	-	-12.15	-14.32	2.17	-
SH8	-10.90	-0.02	-	0.18	-	-7.67	-13.72	6.06	-
SH9.1	-8.91	-	-	-	-	-18.85	-19.73	0.88	-
SH9.2	-19.32	-	-	-	-	-106.03	-108.98	2.95	-
SH10	11.02	0.00	-	0.00	-	6.06	6.13	-0.07	-
SH11	-1.47	-1.80	-	0.16	-	5.15	-4.44	9.59	-
SH12	-4.43	0.09	-	0.01	-	-2.96	-5.15	2.19	-
SH13	0.45	2.75	-	0.07	-	1.16	1.17	-0.02	-
SH14	2.13	2.01	-	0.11	-	1.83	1.46	0.37	-
SH15	-0.87	-0.75	-	-0.01	-	0.30	0.71	-0.42	-
SH16	-0.85	0.21	-	0.05	-	-1.97	-1.45	-0.53	-

Breezy Point

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
BP1	-16.47	0.59	-	0.00	-	-11.80	-13.41	1.62	-
BP2	3.14	0.00	-	0.00	-	26.14	25.06	1.07	-
BP3	-0.36	0.20	-	0.04	-	-1.66	-1.58	-0.08	-
BP4	6.35	2.74	-	0.56	-	19.39	8.77	10.61	-
BP5	3.54	13.60	-	0.04	-	-10.67	-6.80	-3.88	-
BP6	-3.99	3.02	-	0.01	-	-6.13	-4.57	-1.56	-
BP7	62.79	-	-	-	-	120.91	120.91	0.00	-
BP8	-11.82	-3.74	-	0.67	-	23.73	-6.88	30.61	-
BP9	0.72	-0.27	-	0.45	-	13.58	-5.12	18.70	-
BP10	0.33	1.09	-	0.08	-	-0.27	-0.51	0.24	-
BP11	-2.70	0.87	-	-0.07	-	-1.95	-1.75	-0.19	-

Plumb Beach

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
PB1	-	-	-	-	-	-	-	-	-
PB2	-	-	-	-	-	-	-	-	-
PB3	-	-	-	-	-	-	-	-	-
PB4	-	-	-	-	-	-	-	-	-
PB5	-	-	-	-	-	-	-	-	-

Great Kills

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
GK1	0.82	-	-1.78	-	-0.09	-1.45	-0.05	-	-1.40
GK2	-1.63	-	-0.48	-	0.04	-7.29	-5.82	-	-1.47
GK3	-1.79	-	3.37	-	-0.42	-9.21	-6.49	-	-2.73
GK4	-0.40	-	18.82	-	-0.40	17.58	0.84	-	16.74
GK5	0.71	1.88	-	-0.05	-	-2.33	-0.37	-1.95	-
GK6	-	-	-	-	-	-	-	-	-
GK7	-8.06	0.77	-	0.02	-	-1.08	-1.96	0.89	-
GK8	-3.04	-0.87	-	0.02	-	0.65	-0.04	0.69	-
GK9.1	-1.98	-0.47	-	-0.18	-	-4.21	-3.75	-0.46	-
GK9.2	0.09	2.71	-	0.02	-	-7.49	-6.52	-0.97	-

Miller Field

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
MF1	-2.19	-	-	-	-	-11.65	-2.76	-8.89	-
MF2	4.91	28.01	-	-0.50	-	15.25	9.00	6.25	-

Fort Wadsworth

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
FW1	-4.77	-	-	-	-	-5.64	-8.19	2.54	-
FW2	-0.04	-	-	-	-	3.44	0.62	2.82	-
FW3	-4.83	1.69	-	0.22	-	1.82	-0.85	2.67	-

Fall 2012 - Spring 2013

Sandy Hook

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
SH1	-17.16	-36.99	-	-0.21	-	-37.40	-34.80	-2.60	-
SH2	-25.87	-20.42	-	-0.93	-	-85.92	-69.49	-16.43	-
SH3	-63.58	-17.58	-	-0.14	-	-69.25	-55.13	-14.11	-
SH4	-7.29	-14.20	-	0.00	-	-115.73	-45.21	-70.51	-
SH5	2.35	-36.89	-	-0.98	-	-48.56	-15.42	-33.14	-
SH6	-10.29	-44.82	-	-0.36	-	-138.19	-85.89	-52.30	-
SH7	-52.47	-0.14	-	-0.02	-	-96.27	-96.96	0.69	-
SH8	0.44	0.98	-	0.23	-	1.90	-1.96	3.86	-
SH9.1	-22.91	-	-	-	-	-49.21	-50.04	0.84	-
SH9.2	-123.38	-	-	-	-	-408.64	-398.70	-9.93	-
SH10	14.77	2.30	-	-0.04	-	18.83	14.78	4.05	-
SH11	-1.76	0.23	-	0.16	-	4.32	-4.88	9.20	-
SH12	-2.51	-3.41	-	-0.71	-	-12.95	-10.08	-2.87	-
SH13	-0.06	-0.33	-	0.00	-	-1.58	-2.10	0.52	-
SH14	-1.82	-0.85	-	-0.28	-	-7.54	-6.25	-1.30	-
SH15	-1.40	0.07	-	-0.02	-	3.49	2.85	0.63	-
SH16	0.02	-1.50	-	-0.03	-	-4.59	-1.20	-3.39	-

Breezy Point

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
BP1	-4.25	-6.23	-	-1.97	-	-52.29	-26.01	-26.28	-
BP2	-0.12	-0.54	-	0.01	-	-20.36	-15.77	-4.59	-
BP3	-2.20	-11.97	-	-0.83	-	-74.05	-13.42	-60.63	-
BP4	11.29	-45.35	-	1.50	-	-6.54	13.37	-19.91	-
BP5	-12.67	-5.35	-	-1.99	-	-104.80	-77.89	-26.93	-
BP6	-12.38	-13.48	-	-2.30	-	-74.71	-70.67	-4.05	-
BP7	11.88	-	-	-	-	-68.26	-51.92	-16.35	-
BP8	-8.36	-4.92	-	0.50	-	25.87	4.93	20.94	-
BP9	-1.62	-0.17	-	0.33	-	16.07	-1.15	17.22	-
BP10	6.62	-0.87	-	-0.84	-	-6.28	-2.16	-4.12	-
BP11	2.20	-3.37	-	-0.84	-	-7.70	-1.29	-6.40	-

Plumb Beach

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
PB1	-0.52	-1.15	-	-0.02	-	-1.37	-0.14	-1.23	-
PB2	47.56	20.79	-	1.05	-	128.40	86.73	41.68	-
PB3	51.84	32.82	-	0.79	-	125.43	93.10	32.33	-
PB4	-4.68	-11.50	-	1.29	-	-23.65	-6.30	-17.35	-
PB5	5.74	-5.78	-	-0.40	-	13.75	14.32	-0.57	-

Great Kills

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
GK1	1.50	-	-17.69	-	-0.06	-21.75	1.94	-	-23.69
GK2	2.77	-	-19.95	-	0.29	-18.35	3.68	-	-22.03
GK3	3.26	-	-16.23	-	-0.01	-30.67	5.09	-	-35.77
GK4	1.38	-	-1.39	-	-0.07	-3.28	0.77	-	-4.04
GK5	-1.49	-11.67	-	-0.59	-	-3.00	-2.74	-0.25	-
GK6	-	-	-	-	-	-	-	-	-
GK7	-4.42	-1.99	-	-0.58	-	1.55	3.52	-1.96	-
GK8	-3.97	-5.53	-	-0.09	-	-2.63	-1.01	-1.62	-
GK9.1	0.25	-0.57	-	-0.60	-	-3.57	-2.22	-1.35	-
GK9.2	1.09	3.48	-	0.02	-	-7.97	-6.98	-0.99	-

Miller Field

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
MF1	-4.08	-8.84	-	-0.48	-	-21.66	-9.13	-12.53	-
MF2	3.55	23.60	-	-0.56	-	11.50	3.07	8.43	-

Fort Wadsworth

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
FW1	-6.68	-	-	-	-	-7.99	-10.59	2.59	-
FW2	-3.55	-	-	-	-	-6.88	-5.79	-1.09	-
FW3	-6.10	-9.66	-	0.28	-	3.74	-1.78	5.52	-

Spring 2012 - Spring 2013

Sandy Hook

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
SH1	-18.77	-37.58	-	-0.10	-	-23.04	-21.51	-1.53	-
SH2	-21.27	-21.20	-	-0.80	-	-62.14	-46.00	-16.13	-
SH3	-54.71	-18.63	-	-0.08	-	-46.35	-31.29	-15.05	-
SH4	-2.07	-15.17	-	-0.03	-	-91.21	-22.99	-68.21	-
SH5	0.47	-36.93	-	-0.64	-	-33.49	-5.27	-28.22	-
SH6	-11.76	-44.96	-	-0.31	-	-112.53	-61.74	-50.79	-
SH7	-55.89	-0.24	-	0.09	-	-72.85	-73.86	1.01	-
SH8	15.96	-1.94	-	0.32	-	59.82	50.84	8.97	-
SH9.1	-	-	-	-	-	-	-	-	-
SH9.2	-	-	-	-	-	-	-	-	-
SH10	-	-	-	-	-	-	-	-	-
SH11	-	-	-	-	-	-	-	-	-
SH12	-	-	-	-	-	-	-	-	-
SH13	1.56	-0.19	-	0.16	-	3.48	1.71	1.77	-
SH14	-1.05	-0.69	-	-0.20	-	-4.35	-3.80	-0.56	-
SH15	-3.90	-0.16	-	-0.03	-	5.23	4.41	0.81	-
SH16	0.23	-1.43	-	0.06	-	-4.41	-0.69	-3.72	-

Breezy Point

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
BP1	-	-	-	-	-	-	-	-	-
BP2	-	-	-	-	-	-	-	-	-
BP3	-	-	-	-	-	-	-	-	-
BP4	-	-	-	-	-	-	-	-	-
BP5	-	-	-	-	-	-	-	-	-
BP6	-	-	-	-	-	-	-	-	-
BP7	-	-	-	-	-	-	-	-	-
BP8	-	-	-	-	-	-	-	-	-
BP9	-	-	-	-	-	-	-	-	-
BP10	-	-	-	-	-	-	-	-	-
BP11	-	-	-	-	-	-	-	-	-

Plumb Beach

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
PB1	-0.64	-4.32	-	-0.01	-	-7.01	-4.13	-2.88	-
PB2	46.26	21.45	-	0.91	-	126.10	85.49	40.61	-
PB3	49.41	21.63	-	0.64	-	119.31	89.50	29.81	-
PB4	-4.19	-9.18	-	0.86	-	-29.34	-9.14	-20.20	-
PB5	-1.04	-6.09	-	-0.48	-	2.36	6.75	-4.40	-

Great Kills

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
GK1	0.98	-	-17.94	-	-0.05	-24.12	-0.08	-	-24.03
GK2	3.31	-	-19.96	-	0.31	-16.12	4.56	-	-20.68
GK3	3.50	-	-16.30	-	0.00	-34.56	2.28	-	-36.85
GK4	0.42	-	-1.48	-	-0.11	-6.89	-1.90	-	-5.00
GK5	-0.69	-11.57	-	-0.62	-	-4.09	-1.79	-2.30	-
GK6	-	-	-	-	-	-	-	-	-
GK7	-7.23	-1.42	-	-0.63	-	-4.90	0.35	-5.24	-
GK8	-7.66	-8.43	-	-0.12	-	-10.01	-5.79	-4.22	-
GK9.1	-0.69	-1.07	-	-0.51	-	-5.27	-2.29	-2.98	-
GK9.2	-2.14	4.47	-	0.07	-	-11.98	-8.73	-3.25	-

Miller Field

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
MF1	-1.49	-10.45	-	-0.27	-	-10.20	-3.70	-6.50	-
MF2	1.37	-	-	-	-	8.38	-1.00	9.38	-

Fort Wadsworth

ID	Δ Distance (m)			Δ Elevation (m)		Δ Cross Section Area (m^2)			
	NAVD88	Dune Crest	Cliff Edge	Dune Crest	Cliff Edge	Total	Beach	Dune	Cliff
FW1*	-0.40	-	-	-	-	10.86	5.82	-	-
FW2	-0.10	-	-	-	-	4.15	1.98	2.16	-
FW3	-3.00	-5.28	-	0.41	-	12.74	5.03	7.71	-

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 646/130778, December 2015

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov