



Shoreline Change Monitoring at Gateway National Recreation Area

2010-2011 Annual Report

Natural Resource Technical Report NPS/NCBN/NRTR—2011/504



ON THE COVER

Bathhouse and beach, Riis Park, Jamaica Bay Unit, Gateway National Recreation Area
Photograph by: Norbert P. Psuty

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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado publishes a range of reports that address natural resource topics 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.

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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.

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Contents

	Page
Figures.....	v
Tables.....	xi
Executive Summary.....	xiii
Acknowledgements.....	xv
Introduction.....	1
Site and Situation.....	3
Timing of Shoreline Position Surveys.....	5
Natural and Cultural Events Affecting Shoreline Position.....	7
Natural Events.....	7
Artificial Emplacement of Sediment.....	10
Shoreline Position Data Sets.....	11
Gateway Segments.....	13
Sandy Hook.....	13
Great Kills Park.....	16
Great Kills Park, West End.....	18
Miller Field.....	19
Fort Wadsworth.....	21
Plumb Beach.....	23
Breezy Point.....	25
Breezy Point – Bayside.....	27
Spatial Evaluation.....	29
Summary Statistics and Tables of Change.....	31
Sandy Hook.....	31

Contents (continued)

	Page
Great Kills Park	33
Great Kills, West End	34
Miller Field	35
Fort Wadsworth	36
Plumb Beach	38
Breezy Point.....	39
Breezy Point – Bayside.....	41
Areas of Interest.....	43
Conclusions and Information for Management	43
Problems / Concerns	43
Literature Cited	45

Figures

	Page
Figure 1. Shoreline areas of Gateway National Recreation Area considered in this report; including the location of the National Ocean Data Center (NOAA) Water Level Station at Sandy Hook as well as other sites mentioned in this report.	1
Figure 2. Distribution of water levels (light blue) from January 2010 through April 2011, incorporating storm threshold water level elevation, storm events; timing of shoreline surveys, and storm surges (actual elevation minus predicted elevation) (dark blue line).	8
Figure 3. An example of surveyed shorelines intersecting with transects, and producing measures of distances from the baseline along each transect.	12
Figure 4. Net shoreline change at Sandy Hook Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010- (left panel) and Fall 2010 - Spring 2011 (right panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.	14
Figure 5. Net shoreline change at the Sandy Hook Unit, Gateway National Recreation Area for the period Spring 2010 - Spring 2011, incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation (all values in meters).	15
Figure 6. Net shoreline change at Great Kills Park, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010 (top panel), Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation (all values in meters).	16
Figure 7. Net annual shoreline change at Great Kills Park, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 - Spring 2011 incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/-1.0 standard deviation (all values in meters).	17
Figure 8. Net annual shoreline change at Great Kills Park, West End, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 - Spring 2011 incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/-1.0 standard deviation (all values in meters).	18

Figures (continued)

	Page
Figure 9. Net shoreline change at Miller Field, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010 (top panel), Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.....	19
Figure 10. Net annual shoreline change at Miller Field, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 - Spring 2011 incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/-1.0 standard deviation, all values in meters.	20
Figure 11. Net shoreline change at Fort Wadsworth, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 201- (top panel), Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.....	21
Figure 12. Net annual shoreline change at Fort Wadsworth, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 - Spring 2011 incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/-1.0 standard deviation, all values in meters.	22
Figure 13. Net shoreline change at Plumb Beach, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010 (top panel), Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.....	23
Figure 14. Net shoreline change at Plumb Beach, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Spring 2011, incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.	24
Figure 15. Net shoreline change at Breezy Point, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010 (top panel) and Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.....	25
Figure 16. Net shoreline change at Breezy Point, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Spring 2011, incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0standard deviation, all values in meters.	26

Figures (continued)

	Page
Figure 17. Net shoreline change at Breezy Point - Bayside, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010 (top panel) and Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.	27
Figure 18. Net shoreline change at Breezy Point - Bayside, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Spring 2011, incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.	28
Figure 19. Distribution of difference measurements at Sandy Hook Unit, Gateway National Recreation Area, for the seasonal shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value (12.7 m), standard deviation (16.56 m), maximum, and minimum values.	31
Figure 20. Distribution of difference measurements at Sandy Hook Unit, Gateway National Recreation Area, for the seasonal shoreline change between Fall 2010 and Spring 2011, incorporating the mean change value (-6.83 m), standard deviation (11.63 m), maximum, and minimum values.	32
Figure 21. Distribution of difference measurements at Sandy Hook Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value (5.53 m), standard deviation (18.23 m), maximum, and minimum.	32
Figure 22. Distribution of difference measurements at Great Kills Park, Staten Island Unit, Gateway National Recreation Area, for the seasonal shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value (-0.98 m), standard deviation (2.91 m), maximum, and minimum.	33
Figure 23. Distribution of difference measurements at Great Kills Park, Staten Island Unit, Gateway National Recreation Area, for the seasonal shoreline change between Fall 2010 and Spring 2011, incorporating the mean change value (-0.33 m), standard deviation (1.68 m), maximum, and minimum.	33
Figure 24. Distribution of difference measurements at Great Kills Park, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value, (-1.24 m) standard deviation (2.24 m), maximum, and minimum.	34

Figures (continued)

	Page
Figure 25. Distribution of difference measurements at Great Kills Park, West End, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value, (-0.24 m) standard deviation (3.88 m), maximum, and minimum.....	34
Figure 26. Distribution of difference measurements at Miller Field, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value, (-1.60 m) standard deviation (3.50 m), maximum, and minimum.	35
Figure 27. Distribution of difference measurements at Miller Field, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Fall 2010 and Spring 2011, incorporating the mean change value, (2.32 m) standard deviation (1.16 m), maximum, and minimum.	35
Figure 28. Distribution of difference measurements at Miller Field, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value, (0.72 m) standard deviation (3.79 m), maximum, and minimum.....	36
Figure 29. Distribution of difference measurements at Fort Wadsworth, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value, (-1.15 m) standard deviation (2.62 m), maximum, and minimum.	36
Figure 30. of difference measurements at Fort Wadsworth, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Fsl2010 and Spring 2011, incorporating the mean change value, (1.75 m) standard deviation (1.07 m), maximum, and minimum.	37
Figure 31. Distribution of difference measurements at Fort Wadsworth, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value, (0.68 m) standard deviation (2.04 m), maximum, and minimum.....	37
Figure 32. Distribution of difference measurements at Plumb Beach, Jamaica Bay Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value, (-3.17 m) standard deviation (2.24 m), maximum, and minimum.	38

Figures (continued)

	Page
Figure 33. Distribution of difference measurements at Plumb Beach, Jamaica Bay Unit, Gateway National Recreation Area, for the annual shoreline change between Fall 2010 and Spring 2010, incorporating the mean change value, (3.96 m) standard deviation (3.89 m), maximum, and minimum.	38
Figure 34. Distribution of difference measurements at Plumb Beach, Jamaica Bay Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2010, incorporating the mean change value, (0.64 m) standard deviation (4.26 m), maximum, and minimum.....	39
Figure 35. Distribution of difference measurements at Breezy Point, Jamaica Bay Unit, Gateway National Recreation Area, for the seasonal shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value (12.81 m), standard deviation (15.64 m), maximum, and minimum.	39
Figure 36. Distribution of difference measurements at Breezy Point, Jamaica Bay Unit, Gateway National Recreation Area, for the seasonal shoreline change between Fall 2010 and Spring 2011, incorporating the mean change value (2.26 m), standard deviation (7.27 m), maximum, and minimum.	40
Figure 37. Distribution of difference measurements at Breezy Point, Jamaica Bay Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value (14.55 m), standard deviation (15.67 m), maximum, and minimum.....	40
Figure 38. Distribution of difference measurements at Breezy Point– Bayside, Jamaica Bay Unit, Gateway National Recreation Area, for the seasonal shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value (-2.15 m), standard deviation (9.35 m), maximum, and minimum.	41
Figure 39. Distribution of difference measurements at Breezy Point– Bayside, Jamaica Bay Unit, Gateway National Recreation Area, for the seasonal shoreline change between Fall 2010 and Spring 2011, incorporating the mean change value (4.48 m), standard deviation (4.26 m), maximum, and minimum.....	41
Figure 40. Distribution of difference measurements at Breezy Point– Bayside, Jamaica Bay Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value (2.37 m), standard deviation (8.62 m), maximum, and minimum.....	42

Tables

	Page
Table 1. Date of shoreline survey and elevation of associated neap-tide, high-tide.	5
Table 2. Storm events - January 2010 through April 2011.	9
Table 3. Example of measured distances from the baseline for each transect on each survey, and comparative displacements of the shoreline between surveys.	12

Executive Summary

This annual report documents the collection of shoreline position data and describes the short-term variation that has occurred during the period from Spring 2010 to Spring 2011 in the Gateway National Recreation Area, as called for in the Northeast Coastal and Barrier Network's protocol on shoreline monitoring (Psuty, et al., 2010). The changes in shoreline position are generally descriptive of the seasonal contrasts (lower energetics in the summer period versus higher energetics in the winter period) that support sediment accumulation during summer and erosion during the winter. However, there are many natural variables and cultural events that affect the gains and losses of sediment and the displacements of the beach, especially along a coastal setting where sediment input and shoreline exposure are as varied as they are at Gateway National Recreation Area. This short-term annual report is just the first step in characterizing the Park's ocean shoreline by establishing a baseline of information for subsequent descriptions and analyses.

The ocean shoreline of the Sandy Hook Unit had an average seasonal variation of 12.7 m and ± 6.83 m, and an average annual variation of 5.53 m, with considerable gain in the Gunnison Beach area. Great Kills had mean seasonal changes ranging from -0.98 m to -0.33 m, with a mean annual loss of -1.24 m, with greatest losses in the vicinity of the old bathhouse location. The west end of Great Kills Park had an annual mean change of 0.24 m, with accumulation downdrift of the jetty, erosion along the inland shoreline, and accumulation at the entrance to the marina. Miller Field had an annual change of 0.72 m, with erosion to the west and gain in the middle and eastern portion. The change at Fort Wadsworth was modest, a mean of 0.68 m, with erosion at the western portion and accumulation to the east. Plumb Beach had an annual change of 0.64 m, with erosion at the western and central portions balancing larger accumulations at the eastern end of the spit. The annual net condition at Breezy Point was a mean gain of 14.55 m; with considerable accumulation along the western half of the spit and no net change along the eastern half. The area of Breezy Point beyond the terminal jetty and along the bayside margin had a net gain of 2.37 m, with most of the gain immediately downdrift of the jetty and small changes along the remainder of the bayside shoreline.

This annual report on shoreline position change of the Gateway ocean shoreline does offer some insight into the areas of coastal dynamics and sediment budget. However, it is a report on only one year of observations and does not establish a trend. The protocols for shoreline monitoring created a comparable geodatabase that will lead to efficiencies in data assembly and analysis.

Acknowledgements

The field survey team is a critical component in the gathering of the field data and the subsequent processing of the data sets. Particular recognition is given to Mark Christiano for his great assistance in both collecting shoreline position and in helping to orchestrate the data collection, Barry Shafer, Lauren Posillico, Mary Jo Marino, Bill Parker, and Amanda Rollizo ably assisted in the field survey efforts. The shoreline monitoring could not have occurred without the able logistical assistance of Park personnel: Bruce Lane and Jeannie McArthur were consistent contributors at Sandy Hook, providing assistance with vehicles and with logistical support in the field.

This project is supported by the Northeast Coastal and Barrier Network of the National Park Service Inventory and Monitoring Program (Sara Stevens, NCBN Program Manager). It is carried out under Cooperative Agreement CA4520-99-007, Task Order J4506040626/0005.

Introduction

This is part of a series of Annual Monitoring Reports of the change in shoreline position along the ocean facing shorelines in Gateway National Recreation Area (Fig. 1). This report is a product of the shoreline monitoring protocols described in Psuty, et al. (2010) that were applied consistently starting in the spring of 2006. Subsequent surveys conducted in the spring of 2008, the fall of 2008, and in the spring of 2009 provide the temporal span for this annual report.

The goal of the annual report is to document the collection of shoreline position data and to describe the short-term variation that has occurred, as called for in SOP #7 (Change Calculation, Data Analysis, and Reporting) (Psuty, et al., 2010). The changes in shoreline position are generally descriptive of the seasonal contrasts (lower energetics in the summer period versus higher energetics in the winter period) that support sediment accumulation during summer and erosion during the winter. However, there are many other variables that affect the gains and losses of sediment and the displacements of the beach, especially along a coastal setting where sediment input and shoreline exposure are as varied as they are at Gateway National Recreation Area. Therefore, the short-term annual report is just a step in understanding the conditions that characterize the Park's ocean shoreline and is meant to establish a baseline of information for subsequent characterization and analyses. Discussions and analyses of vectors of shoreline change and likely associations will be the theme of the longer-term (5 years) trend reports to be produced by the Northeast Coastal and Barrier Network.



Figure 1. Shoreline areas of Gateway National Recreation Area considered in this report; including the location of the National Ocean Data Center (NOAA) Water Level Station at Sandy Hook as well as other sites mentioned in this report.

Site and Situation

The primary geomorphological components of the Gateway National Recreation Area ocean shoreline are the pair of barrier islands, Sandy Hook and Breezy Point, extending towards and into New York Harbor (Fig. 1). In addition, the park incorporates several segments of an ocean facing shoreline on Staten Island, and a short segment of an ocean-facing shoreline at Plumb Beach. The segmentation of the shoreline, variable sediment input, and the wide range of exposure to the ambient wave and current conditions create differential responses to individual climatic events and to the net conditions at the shoreline.

The ocean shoreline position survey follows the Northeast Coastal and Barrier Network shoreline position monitoring protocol developed by Psuty, et al. (2010). Each survey records the position of the shoreline at that time, and subsequent surveys compare the changing position through time and space. The resulting data set is a measure of change for specific portions of the coast as well as for the segments of the Gateway ocean shoreline. In this report, the coastal segments areas follows: Sandy Hook Unit, Great Kills Park of Staten Island Unit, Plumb Beach of Jamaica Bay Unit, and the Riis Park-Fort Tilden-Breezy Point area of Jamaica Bay Unit (hereafter referred to as Breezy Point).

Timing of Shoreline Position Surveys

Three surveys of the neap-tide, high-tide swash-line are included in this annual report (Table 1). They represent the positions monitored from the spring of 2010 to the spring of 2011. The three surveys were run during the predicted neap-tide period and had similar water level elevations, grouping around 1.4 m MLLW.

Table 1. Date of shoreline survey and elevation of associated neap-tide, high-tide.

Season / Park	Date of survey	Previous High Tide	
		Height* (m)	Time
Spring 2010			
Sandy Hook	6 Apr 2010	1.510	01:06 AM
Great Kills	7 Apr 2010	1.541	01:30 AM
Miller Field	5 Apr 2010	1.507	12:36 AM
Fort Wadsworth	5 Apr 2010	1.507	12:36 AM
Plumb Beach	7 Apr 2010	1.541	01:30 AM
Breezy Point	8 Apr 2010	1.475	03:00 AM
Fall 2010			
Sandy Hook	18 Oct 2010	1.354	04:24 AM
Great Kills	15 Oct 2010	1.669	12:54 AM
Miller Field	15 Oct 2010	1.669	12:54 AM
Fort Wadsworth	15 Oct 2010	1.669	12:54 AM
Plumb Beach	14 Oct 2010	1.533	12:30 AM
Breezy Point	21 Oct 2010	1.747	06:12 AM
Spring 2011			
Sandy Hook	7 Apr 2011	1.396	10:12 AM
Great Kills	7 Apr 2011	1.396	10:12 AM
Miller Field	6 Apr 2011	1.242	09:30 AM
Fort Wadsworth	6 Apr 2011	1.242	09:30 AM
Plumb Beach	6 Apr 2011	1.242	09:30 AM
Breezy Point	8 Apr 2011	1.315	10:30 AM

There is a NOAA water level station located at the northern end of Sandy Hook (Fig. 1) (Station 8531680 (NOAA, 2009)). It is on the northern bay margin of Sandy Hook, but the entrance to New York harbor is so large that the station effectively records the water level in the adjacent ocean with very little elevational difference or temporal delay.

Natural and Cultural Events Affecting Shoreline Position

Natural Events

Storms are important elements of the environment that affect shoreline position by mobilizing and transporting beach and dune sediment. The existing protocol for shoreline monitoring is directed at identifying the seasonal, annual, and longer-term sediment balances at the ocean shoreline by recording changing positions of the water-land contact. Individual storms create short-term variations in the beach position and their occurrence and local effect can be accommodated by judicious planning of survey dates to avoid periods of short-term storm erosion and recovery, and to emphasize neap-tide swash positions independent of specific storms.

Storms are a condition at the ocean beach. They are important drivers of coastal change. The Sandy Hook water level station is a good resource for the determination of neap tide occurrence and elevation, as it responds to the full range of ambient wave directions and storm surges that approach and affect the Gateway National Recreation Area (NRA) ocean shoreline.

Wave data are often described by statistical values such as wave height, wave length, wave period, etc. These data are used in the calculation of wave dynamics in linear wave theory and they provide a basis for the establishment of local wave climatologies described by the U.S. Army Corps of Engineers in their Wave Information Studies (<http://frf.usace.army.mil/wis>). Another approach to describe storm dimension is the level of inundation on the beach profile and the effects on the upper beach. For Sandy Hook, storms that reach an elevation 2.0 m above mean low water affect the upper beach and cause changes to the berm and potentially to the foredune. Whereas the effects of a particular storm are subject to accompanying conditions, a seasonal grouping of storm frequency and intensity provide a comparative evaluation of storminess and aspects of beach response to the events.

Using this approach to event-driven inundation, 23 storms have been identified as occurring between the beginning of April 2010 surveys and the end of April 2011 surveys (Fig. 2). Further, durations of the storm events were established by noting consecutive high tides with elevations greater than 2.0 m (Table 2). The greater the number of consecutive high tides operating on the upper beach, the more likely will the shoreline position represent erosion and displacement of the shoreline.

The combination of data in Figure 2 and Table 2 portrays the spring of 2010, soon after the surveys, as with the highest storm surge of the survey period (April 25-27, elevation of 2.318 m, and a duration of 5 high tides). The summer was relatively mild, with small storms and short durations except for August 9-13 (2.136 water elevation and 6 high tides). The next major storm was October 4-10, water elevation of 2.276 and a duration of 8 high tides), a week or two prior to the fall survey. The remainder of the fall and winter saw a succession of storms that had modest water elevation and very short durations. Late March had the last major storm of the survey period (March 20-23, water elevation of 2.104, and duration of 4 high tides). Whereas the severity of the storms was not exceptional and storm surges were modest, the continuity of storm events throughout the year produced considerable mobilization of sediment and alongshore transport.

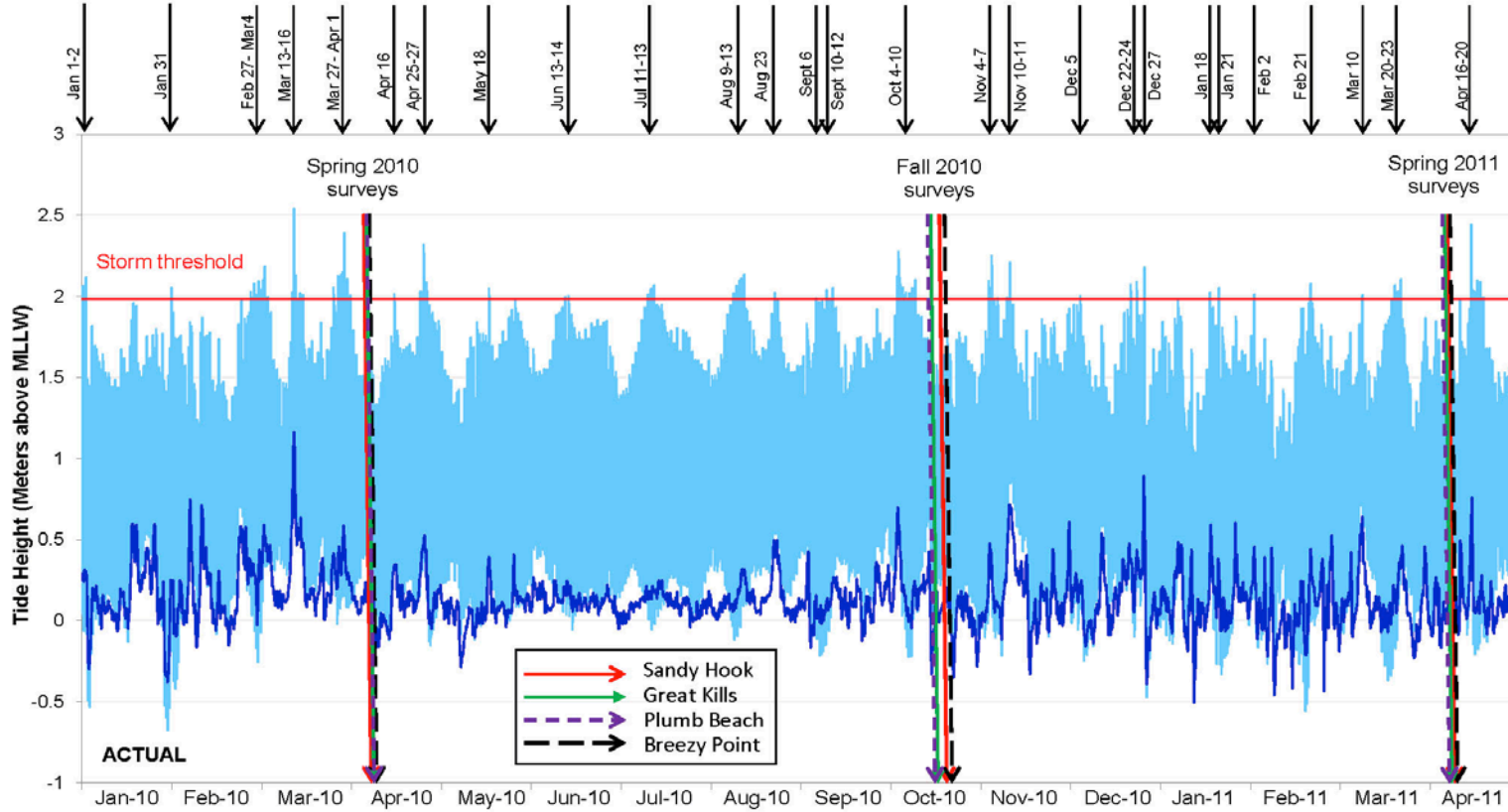


Figure 2. Distribution of water levels (light blue) from January 2010 through April 2011, incorporating storm threshold water level elevation, storm events; timing of shoreline surveys, and storm surges (actual elevation minus predicted elevation) (dark blue line). (Source: NOAA Ocean Data Center, Station 8531680).

Table 2. Storm events - January 2010 through April 2011. (NOAA,<http://tidesandcurrents.noaa.gov/>)

Storm	Number of tides higher than 2.0 m (Storm threshold)	Tide height (m)	Maximum Tide	
			Date	Measured surge (m)
January 1-2, 2010	2	2.117	1/2/2010	0.304
January 31, 2010	1	2.051	01/31/10	0.236
February 27 - March 4, 2010	9	2.182	03/03/10	0.472
March 13-16, 2010	6	2.541	03/13/10	1.164
March 27 - April 1, 2010	8	2.390	03/30/10	0.506
April 16, 2010	1	2.011	04/16/10	0.343
April 25-27, 2010	5	2.318	04/26/10	0.476
May 18, 2010	1	2.047	05/18/10	0.392
June 13-14, 2010	2	1.999	06/14/10	0.180
July 11-13, 2010	3	2.069	07/13/10	0.190
August 9-13, 2010	6	2.136	08/13/10	0.317
August 23, 2010	1	2.020	08/23/10	0.388
September 6, 2010	1	1.987	09/06/10	0.154
September 10-12, 2010	3	2.052	09/12/10	0.232
October 4-10, 2010	8	2.276	10/04/10	0.595
November 4-5, 2010	3	2.249	11/05/10	0.348
November 7, 2010	1	1.987	11/07/10	0.096
November 10-11, 2010	2	2.207	11/11/10	0.711
December 5, 2010	1	2.000	12/05/10	0.200
December 22, 2010	1	2.072	12/22/10	0.385
December 24, 2010	1	2.089	12/24/10	0.435
December 27, 2010	1	2.176	12/27/10	0.715
January 18, 2011	1	2.023	01/18/11	0.414
January 21, 2011	1	2.052	01/21/11	0.325
February 2, 2011	1	2.010	02/02/11	0.455
February 21, 2011	1	2.077	02/21/11	0.440
March 10, 2011	1	2.006	03/10/11	0.639
March 20-23, 2011	4	2.104	03/23/11	0.388
April 16-20, 2011	6	2.443	04/16/11	0.600

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

Because the shoreline position surveys are scheduled at six-month intervals, they are not meant to represent the outcomes of specific storms, but instead they provide insight into the comparison of times of high energy levels and considerable sediment transport relative to those times of lower energy levels and more opportunity for sediment retention. Yet, the results may not be so simple. There are other variables at work that affect the outcomes, such as the local sites of sediment accumulation and loss associated with structures at the inlets and along the shoreline; human manipulation of sediment; inshore circulation cells that add the dimensions of current patterns to the sediment mobility equation; alongshore transfers of pulses of sediment; etc. This report lays the foundation for the subsequent analyses of relationships but it is not intended to explore the relationships at this time. The analyses will be incorporated in the 5-year Trend Report of the Gateway shoreline.

Artificial Emplacement of Sediment

The period in this report included the emplacement of 104,000 m³ of sediment dredged from East Rockaway Inlet to the beach at Far Rockaway, during March-May 2010. Although the sediment was not applied directly to the shoreline within the Park, it does add to the sediment budget arriving at the Riis Park section and continuing to Breezy Point. It is not possible to ascribe any of the changes to this cultural event in this short time. But, it is an element of the factors affecting changes in shoreline position to be considered in subsequent analyses. There was also about 20,000 m³ deposited offshore of the Critical Zone of Sandy Hook during this survey period. This is a very small amount of material and it would be very difficult to trace its impact on the local sediment budget.

Shoreline Position Data Sets

Following application of the protocol, each surveyed shoreline is registered to a common base and distances are measured from an offshore baseline at 10 m intervals along the baseline following Digital Shoreline Analysis System (DSAS), a software program created and maintained by the U.S. Geological Survey (Thieler, et al., 2009) (see SOP # 7, Psuty et al., 2010) (Fig. 3). The product of the first part of the analysis is a plot of the shoreline positions, the offshore baseline, and transects (Fig. 3). The second part is a measure of the distances along the transects to each surveyed shoreline (Table 3). The complete table of 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 portrayal of the distribution of dimensions of change is created by an application called the Shoreline Change Mapper (Psuty, et al., 2010), 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 distance 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. A running bar graph depicts the relative difference in shoreline position between surveys. Differences of less than 10 m of seaward or landward displacement (+ 10 m to -10 m) are shown as gray, whereas seaward displacement (accretion) greater than 10 m is shown as shades of blue and landward displacement (erosion) in shades of red. The length of each line represents the magnitude of change between two chosen dates. Additionally, the bar-graph portrayal adds information about the mean change values. These data sets (differences between surveys) are portrayed spatially in a series of panels (Figs. 4 - 9) that depict the seasonal changes from Spring 2010 to Fall 2010, Fall 2010 to Spring 2011, and annual change from Spring 2010 to Spring 2011. The panels include the traces of the surveyed shorelines, a plot of the measured differences between pairs of shorelines, and a depiction of the value of the mean change and an accompanying one standard deviation for each comparison. Together, these panels incorporate essential information on the measures and distributions of change through the span of one year, the basis of this annual report. Although the intent of the survey is to document the change in shoreline position produced by gains or losses in sediment, the 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 three contributors to the variation in the estimate. Their character and dimension are: 1) the recording instrument is a GPS unit with sub-meter accuracy, its variation is about 0.3 m; 2) there is variation in the wave runup to create the neap high-tide swash line, it is 2-3 m; and 3) there is some small variation in the operator's tracking of the swash line on the beach face (0.25 m). Together, these contributors create an estimate in variation in position of ± 2.55 m. Therefore, any surveyed shoreline has an intrinsic estimation of ± 2.55 m. Further, any comparison between two survey lines would incorporate the estimates associated with each survey plus the variation in tidal level between the two surveys, up to 0.2 m, or an estimate of change of ± 5.66 m. However, the locations of the Great Kills Park and Plumb Beach shorelines are less exposed than Sandy Hook and Breezy Point, the beach face is steeper, and the wave run up is less, reducing the variation from this variable. For purposes of this monitoring effort, the estimation value for each of the surveys at Great Kills Park and Plumb Beach is judged to be ± 2.2 m; the comparison between any two surveys has an estimate of change of ± 4 m.

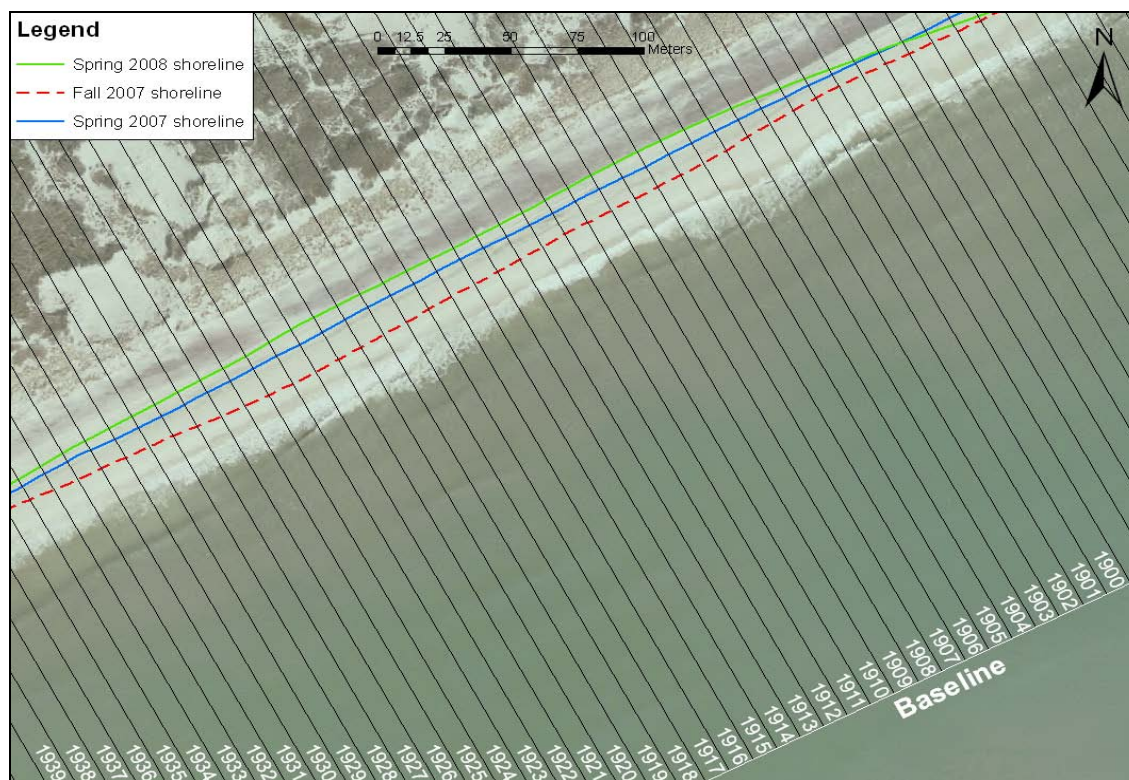


Figure 3. An example of surveyed shorelines intersecting with transects, and producing measures of distances from the baseline along each transect.

Table 3. Example of measured distances from the baseline for each transect on each survey, and comparative displacements of the shoreline between surveys.

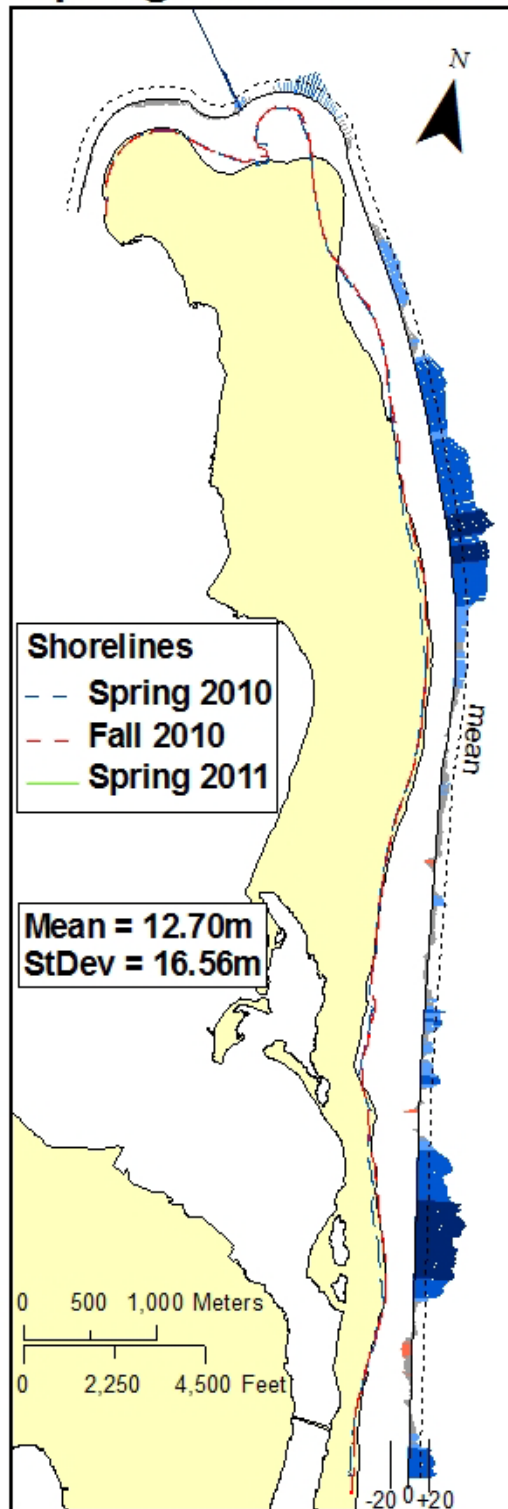
Transect Order	Distance to baseline (m)			Changes (m)		
	Spring 2007	Fall 2007	Spring 2008	Spring 2007 - Fall 2007	Fall 2007 - Spring 2008	Spring 2007 - Spring 2008
1900	241.78	235.92	244.99	5.86	-9.07	-3.22
1901	241.61	234.94	245.69	6.67	-10.75	-4.08
1902	241.39	234.07	246.34	7.32	-12.27	-4.95
1903	241.21	233.11	246.83	8.11	-13.72	-5.62
1904	241.03	231.96	247.05	9.07	-15.09	-6.02
1905	240.89	231.16	247.10	9.73	-15.94	-6.21
1906	240.43	230.50	247.12	9.94	-16.63	-6.69
1907	240.05	230.22	247.04	9.83	-16.82	-6.99
1908	239.78	229.77	246.78	10.01	-17.01	-7.00
1909	239.74	229.42	246.36	10.32	-16.93	-6.61
1910	239.32	229.10	245.76	10.22	-16.66	-6.44

Gateway Segments

Sandy Hook

The three seasonal surveys were conducted on April 6, 2010, October 18, 2010, and April 7, 2011. The shoreline change data indicate a general deposition along the shoreline during the first interval (Fig. 4, left panel) and general erosion during the second interval (Fig. 4, right panel). The net condition for the year (Fig. 5) had greatest change in the vicinity of Gunnison Beach, and modest to no changes over the remainder of Sandy Hook, with a mean accretion of 5.53 m.

Spring 2010-Fall 2010



Fall 2010-Spring 2011

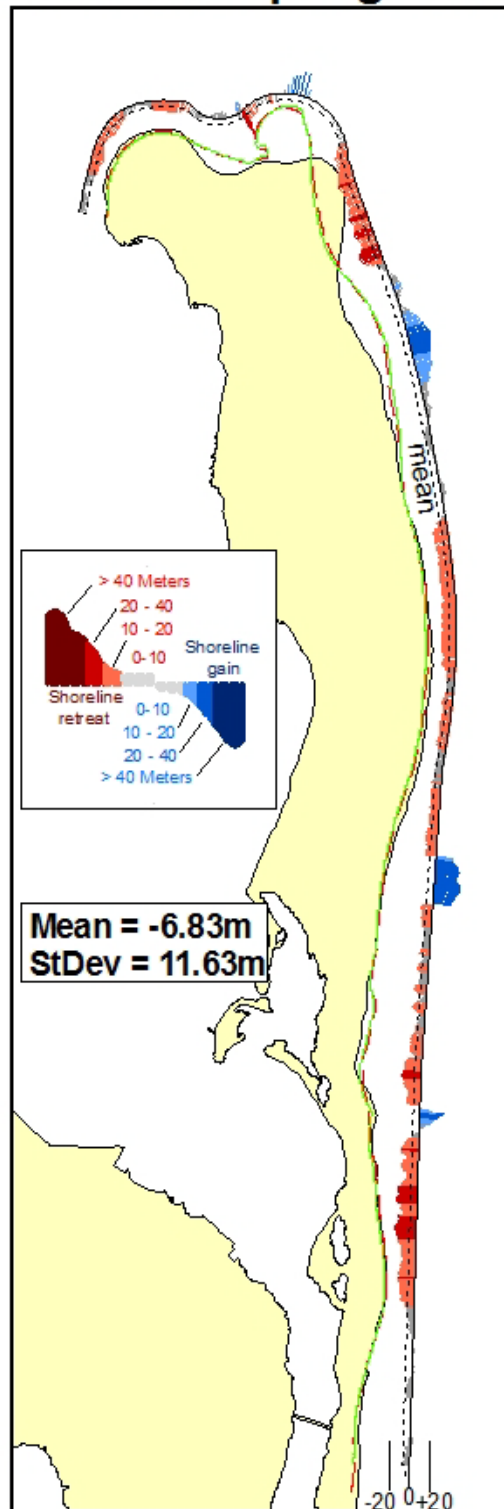


Figure 4. Net shoreline change at Sandy Hook Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010- (left panel) and Fall 2010 - Spring 2011 (right panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.

Spring 2010 - Spring 2011

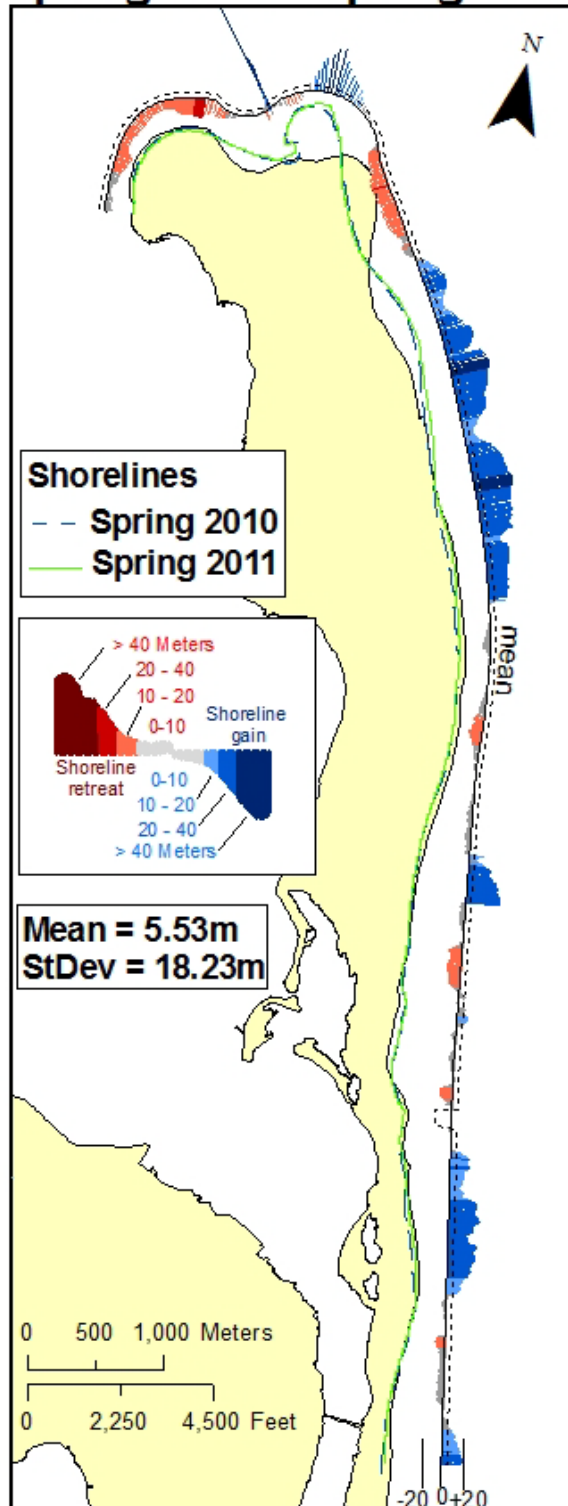


Figure 5. Net shoreline change at the Sandy Hook Unit, Gateway National Recreation Area for the period Spring 2010 - Spring 2011, incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation (all values in meters).

Great Kills Park

The three seasonal surveys were conducted on April 7, 2010, October 15, 2010, and April 7, 2011. The shoreline change data indicate that erosion occurred along a large portion of the shoreline during the first interval, with an average inland displacement of -0.98 m (Fig. 6, top panel). The Fall 2010 – Spring 2011 displacement had minor change, -0.33 m (Fig. 6, bottom panel). The net change during the year was an average inland displacement of -1.24 m (Fig. 7).

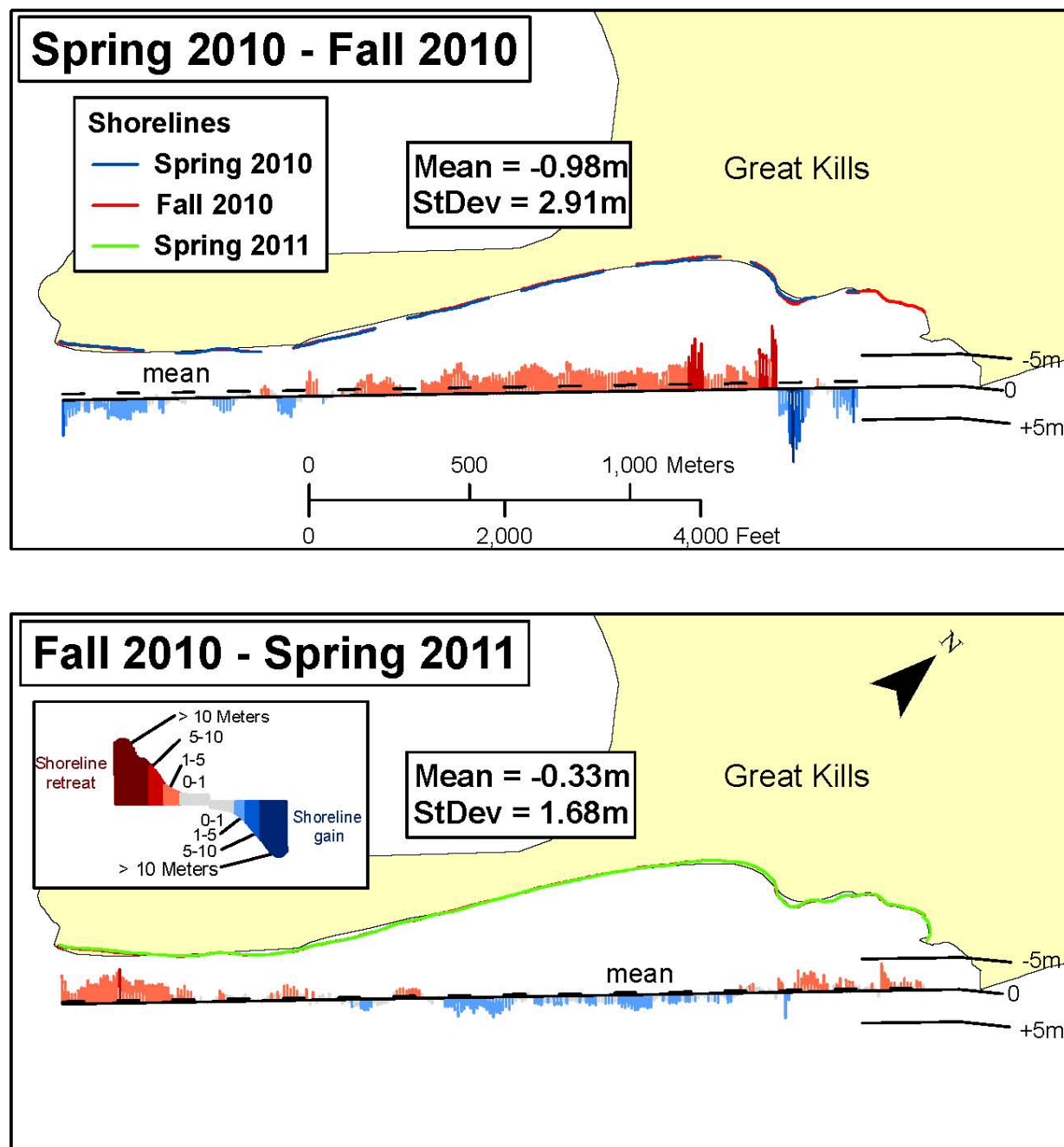


Figure 6. Net shoreline change at Great Kills Park, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010 (top panel), Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation (all values in meters).

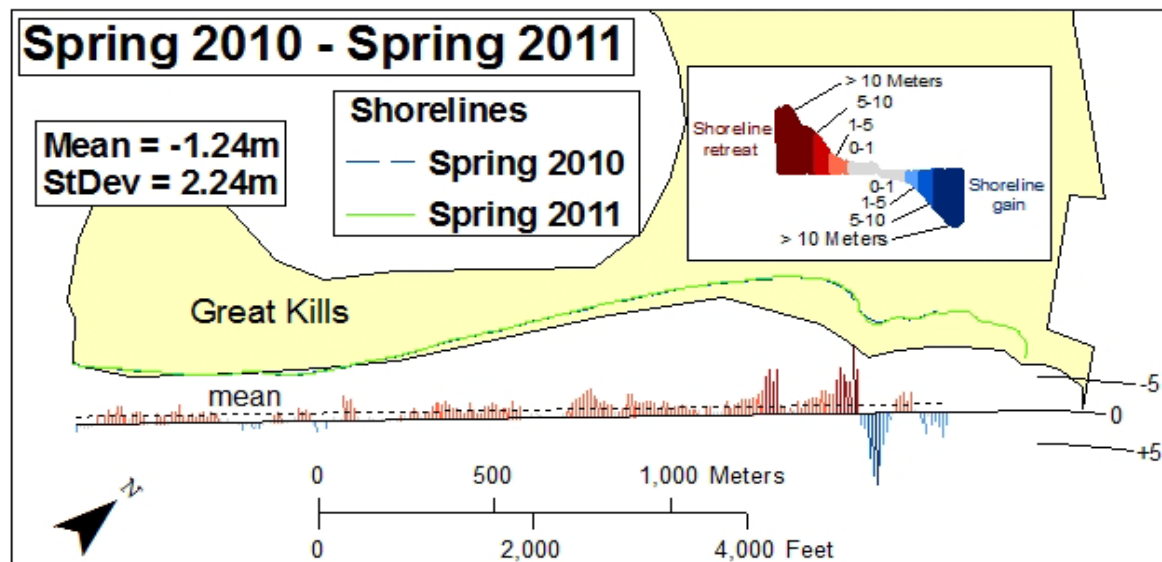


Figure 7. Net annual shoreline change at Great Kills Park, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 - Spring 2011 incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/-1.0 standard deviation (all values in meters).

Great Kills Park, West End

There were problems with signal reception during the fall survey and thus only the two spring surveys are reported here. The surveys were conducted on April 7, 2010 and April 7, 2011. The shoreline change is alternating sequence of loss and gain (Fig. 8), with an alongshore projection to the southwest (toward the dredged boat channel), erosion of the end of the spit, and accumulation leading toward the channel leading to the marina basin. Gains and losses cancel each other, with a net change of -0.24 m for the entire segment.

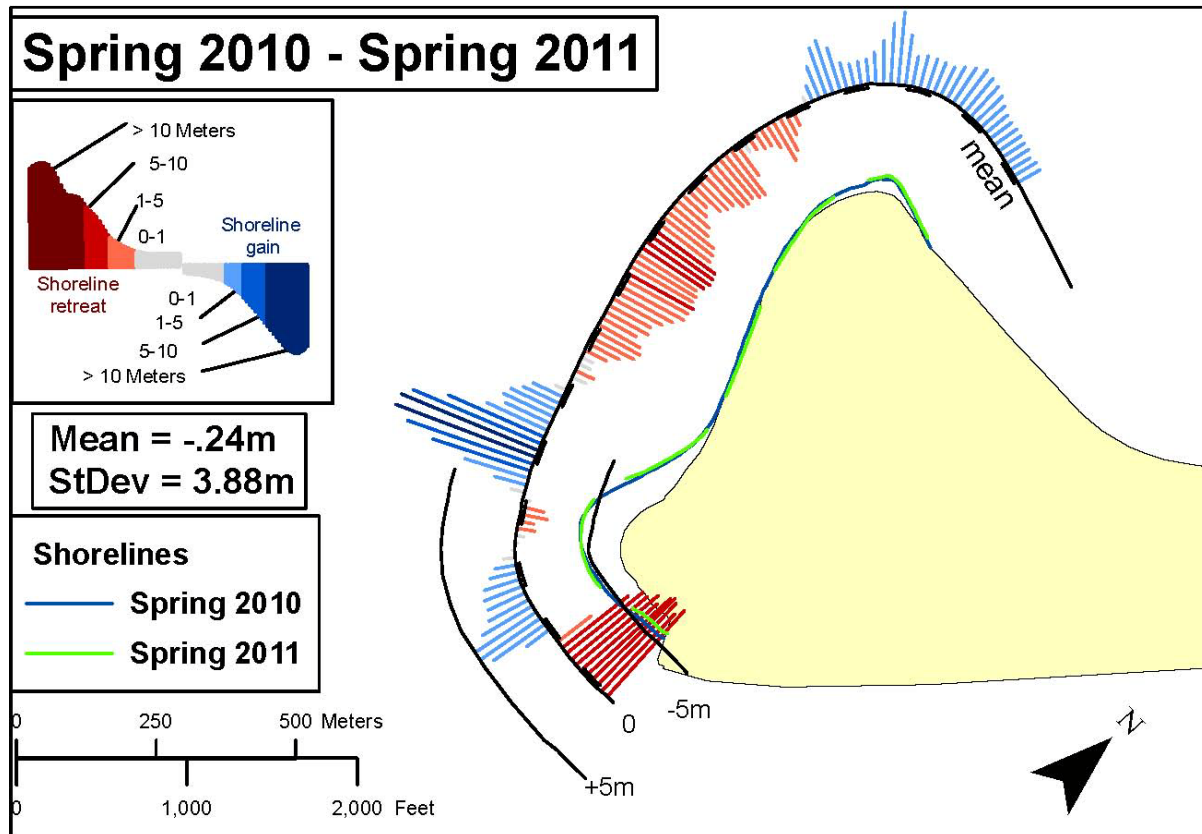
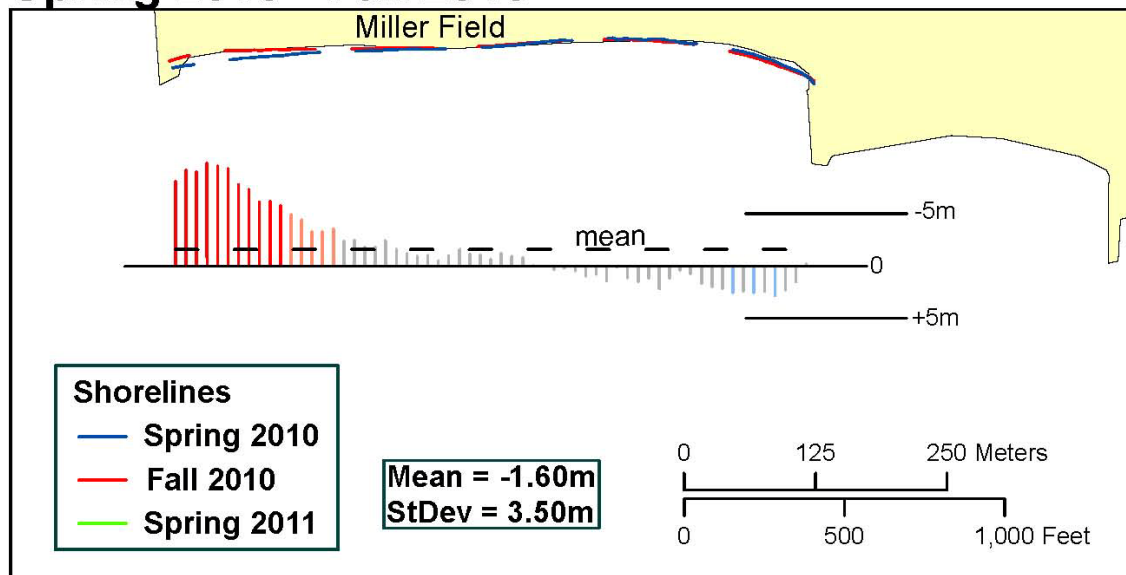


Figure 8. Net annual shoreline change at Great Kills Park, West End, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 - Spring 2011 incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/-1.0 standard deviation (all values in meters).

Miller Field

The surveys were conducted on April 5, 2010, October 15, 2010, and April 6, 2011. The short segment at this site is greatly affected by its alongshore neighbors and the effects of the bordering groins. The first period had erosion at the western end of the compartment and small gains at the eastern end (Fig. 9, top panel), with a mean loss of -1.60 m. In the second period, a small gain characterized the entire compartment (Fig. 9, bottom panel), a positive mean of 2.32 m. The annual net combined the two conditions to have a loss toward the west and modest gains in the remainder of the compartment (Fig. 10), and a net gain of 0.72 m.

Spring 2010 - Fall 2010



Fall 2010 - Spring 2011

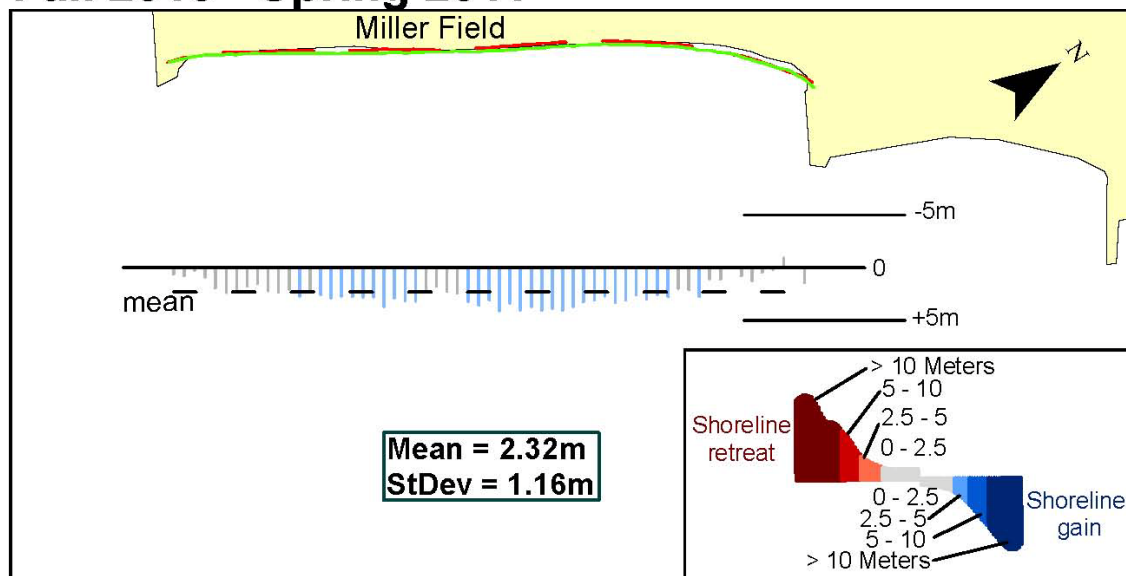


Figure 9. Net shoreline change at Miller Field, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010 (top panel), Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.

Spring 2010 - Spring 2011

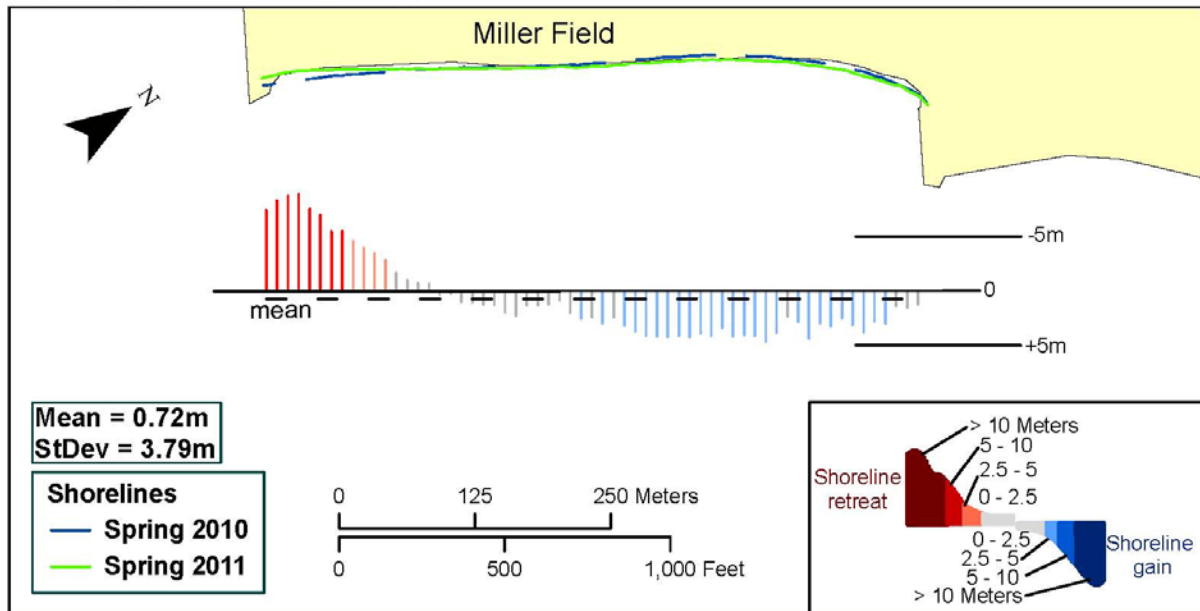
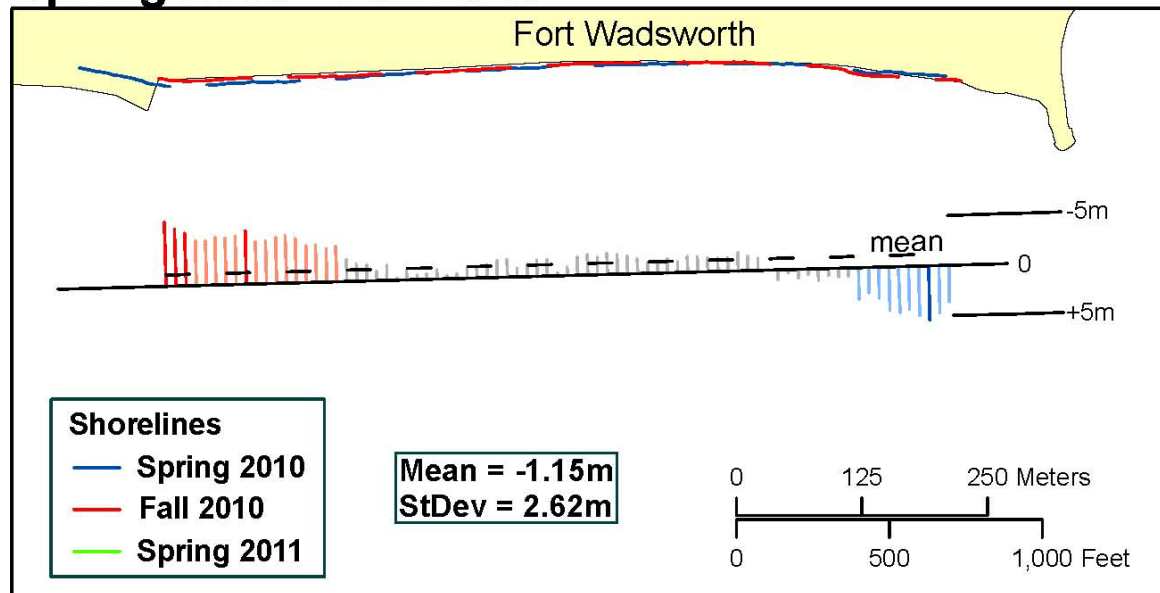


Figure 10. Net annual shoreline change at Miller Field, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 - Spring 2011 incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and ± 1.0 standard deviation, all values in meters.

Fort Wadsworth

The surveys were conducted on April 5, 2010, October 15, 2010, and April 6, 2011. The changes are affected by the structures to either end. The first survey period had erosion at the western end and deposition to the east (Fig. 11, top panel), with a net loss of -1.15 m. The second period had a modest gain along the entire compartment (Fig. 11, bottom panel), a mean gain of 1.75 m. For the year, there was slight erosion at the western end, modest gain at the east, and little change between (Fig. 12), achieving a mean gain of 0.68 m.

Spring 2010 - Fall 2010



Fall 2010 - Spring 2011

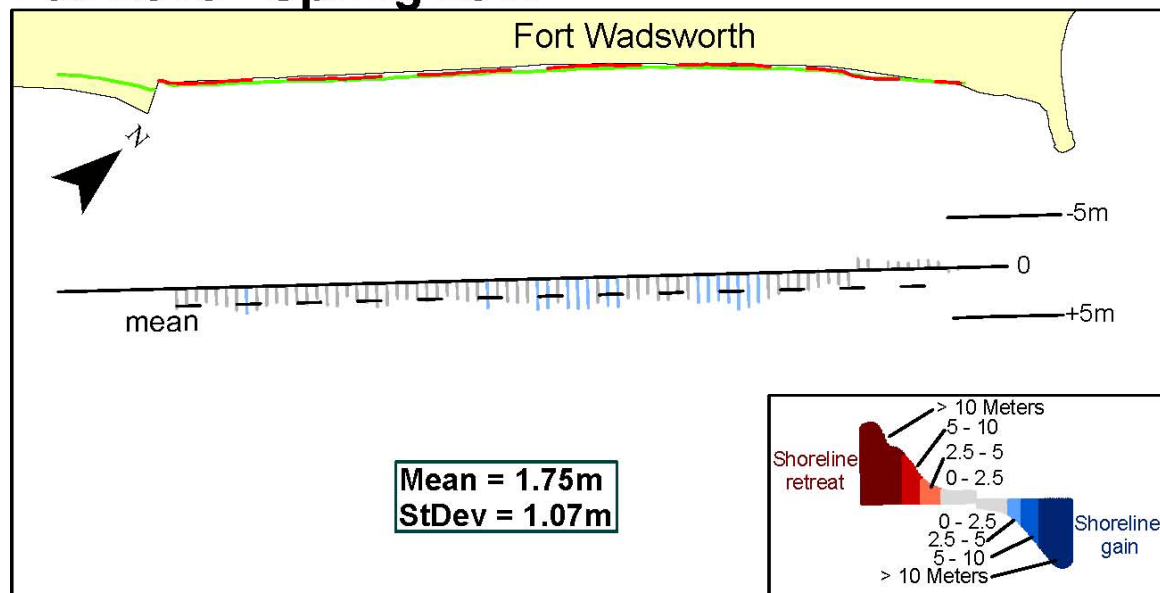


Figure 11. Net shoreline change at Fort Wadsworth, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2011 (top panel), Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.

Spring 2010 - Spring 2011

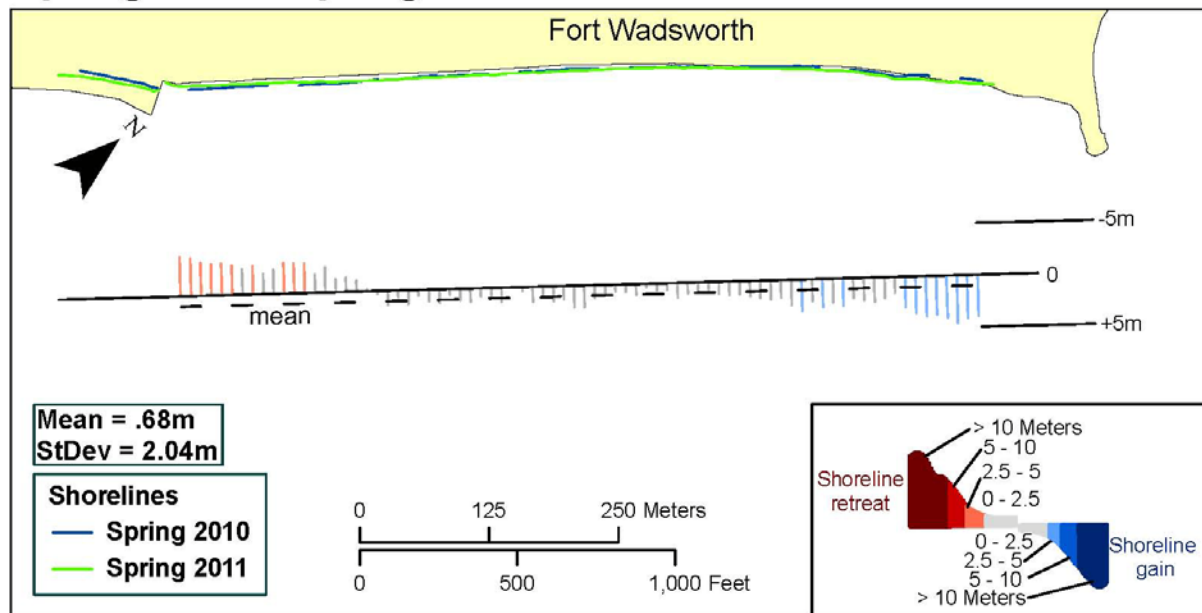
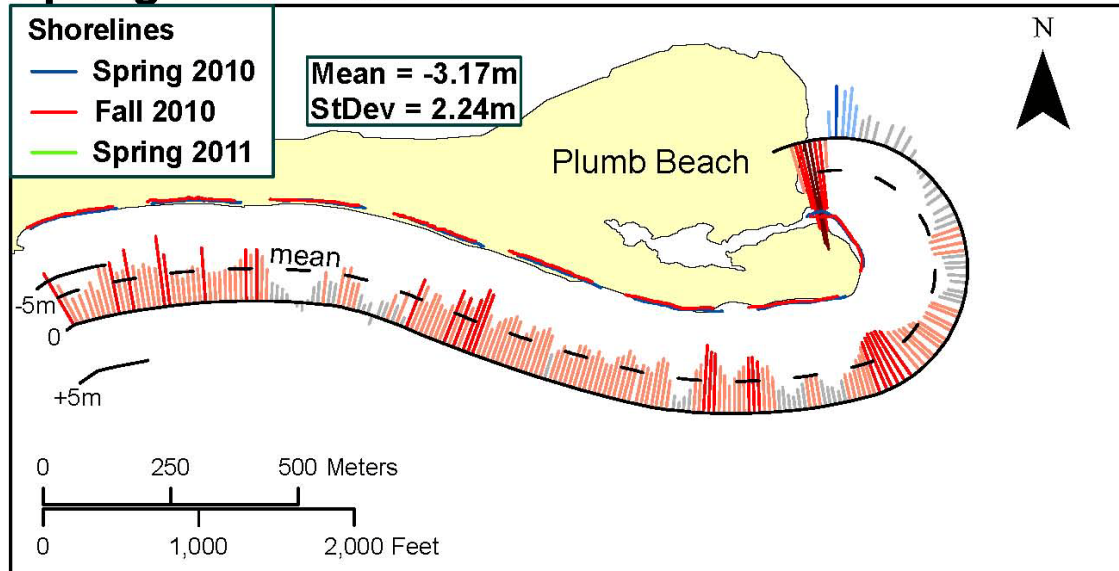


Figure 12. Net annual shoreline change at Fort Wadsworth, Staten Island Unit, Gateway National Recreation Area for the period Spring 2010 - Spring 2011 incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and ± 1.0 standard deviation, all values in meters.

Plumb Beach

The three seasonal surveys were conducted on April 7, 2010, October 14, 2010, and April 6, 2011. The Spring to Fall survey disclosed erosion along the entire shoreline (Fig. 13, top panel)), with a general displacement of -3.17 m. However, the Fall to Spring survey revealed little change in the western half of the area and a major accumulation downdrift to the east, creating a mean positive displacement of 3.96 m (Fig. 13, bottom panel). The net change from Spring to Spring (Fig. 14) has an erosional condition in the western and central portions, and an increasing positive displacement toward the eastern end of the spit.

Spring 2010 - Fall 2010



Fall 2010 - Spring 2011

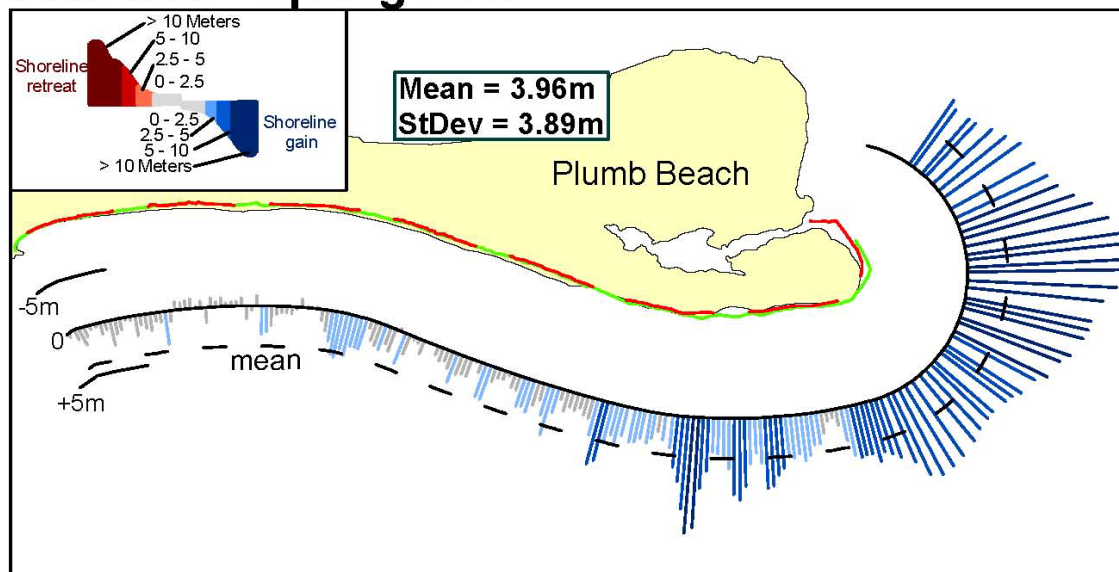


Figure 13. Net shoreline change at Plumb Beach, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010 (top panel), Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.

Spring 2010 - Spring 2011

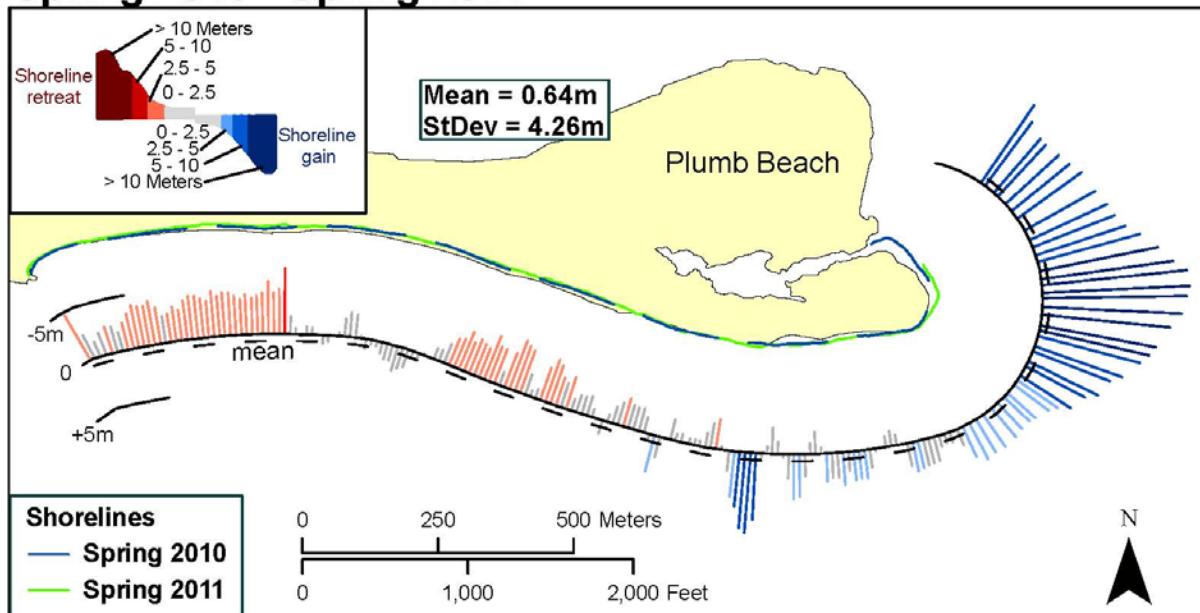


Figure 14. Net shoreline change at Plumb Beach, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Spring 2011, incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.

Breezy Point

The three seasonal surveys were conducted on April 8, 2010, October 21, 2010, and April 8, 2011. The shoreline change data indicate that accumulation occurred along the western portion of the shoreline during the Spring 2010 – Fall 2010 interval (Fig. 15, top panel), with an average seaward displacement of 12.81 m. The Fall 2010 – Spring 2011 displacement had modest changes throughout, with a modest gain (Fig. 15, bottom panel), averaging 2.26 m. The net change during the year (Fig. 16) was an average seaward displacement of 14.55 m. The pattern of summer loss and winter gain is similar to the sequence recorded at Sandy Hook. Maximum gain was in the western portion, in the vicinity of the Co-op, with almost no change at either end of the park area. The placement of sand on the beach updrift Breezy Point may have influenced the shoreline position in addition to the pattern of storm events.

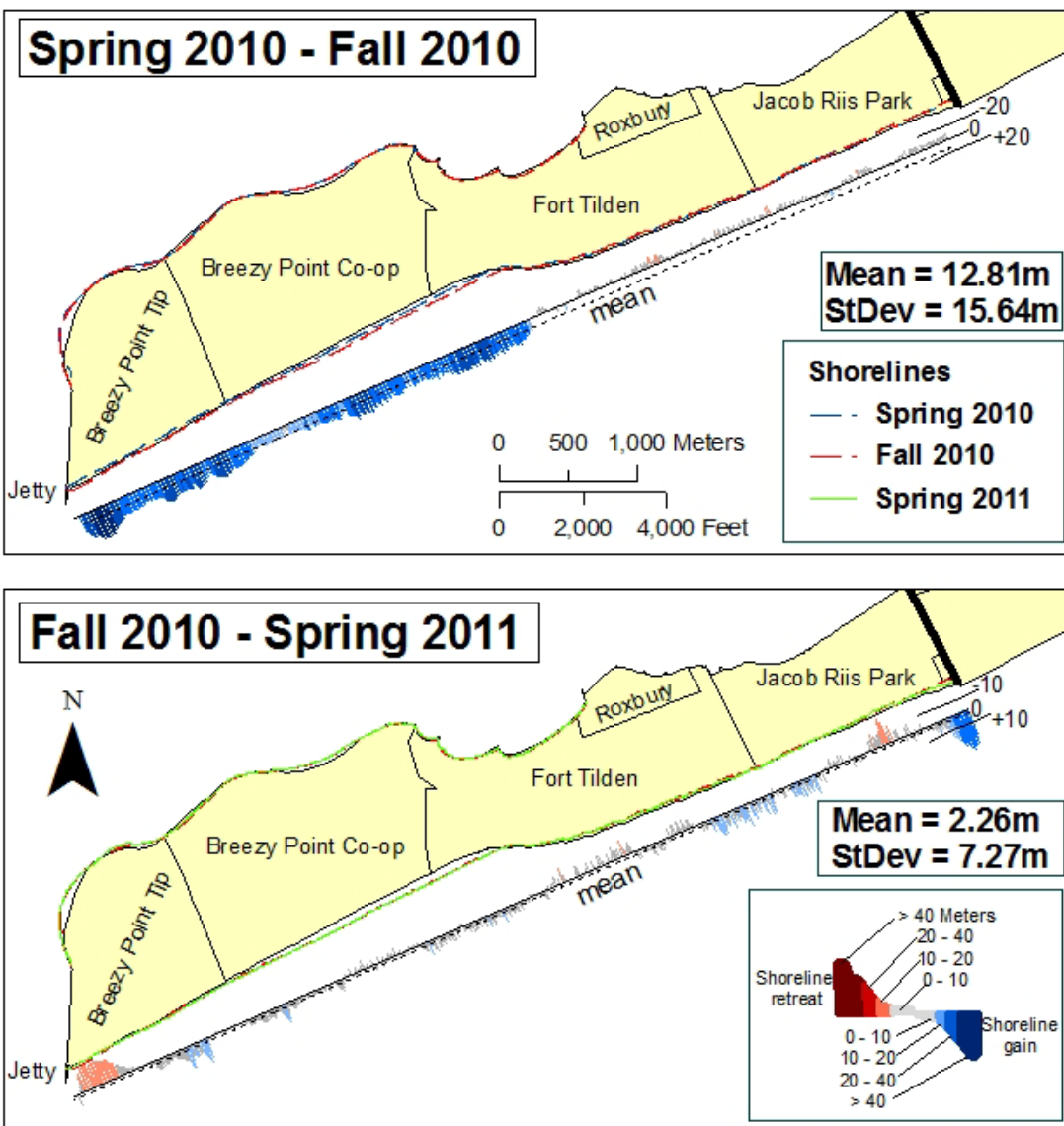


Figure 15. Net shoreline change at Breezy Point, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010 (top panel) and Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.

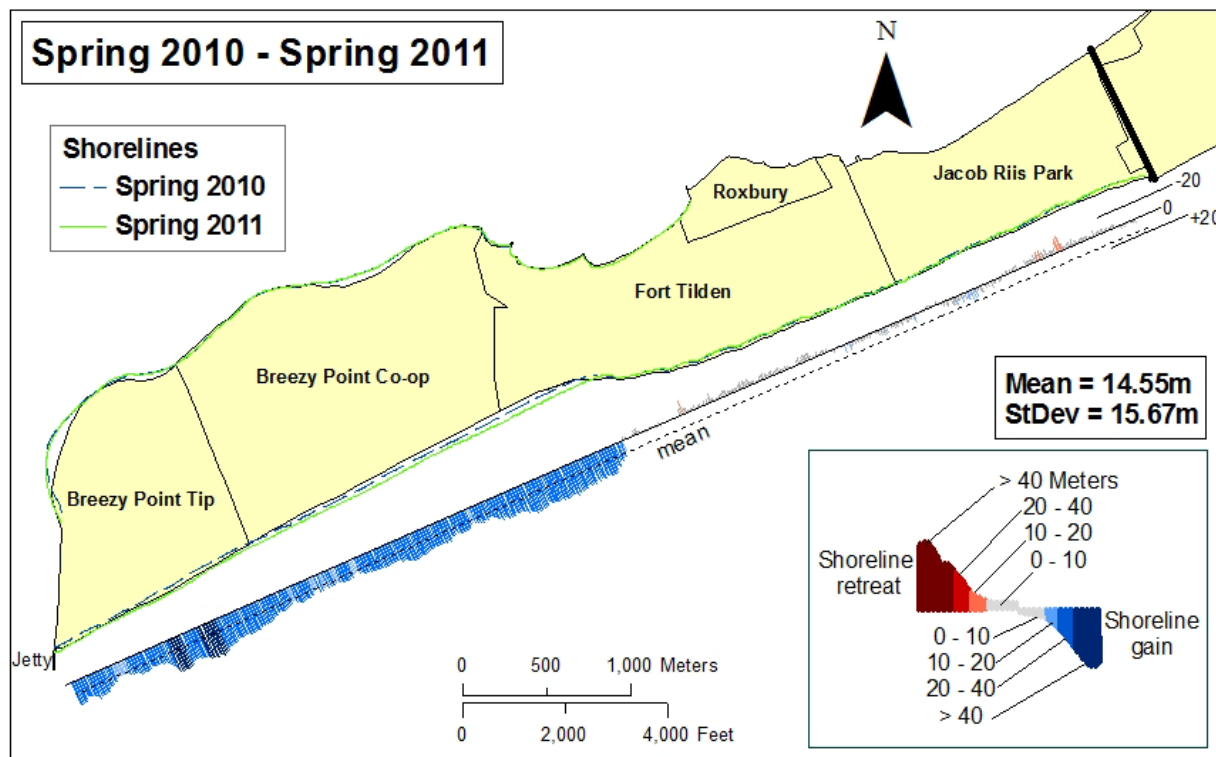


Figure 16. Net shoreline change at Breezy Point, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Spring 2011, incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.

Breezy Point – Bayside

The three seasonal surveys were conducted on April 8, 2010, October 21, 2010, and April 8, 2011. The shoreline changes are relatively modest because the wave and current energies reaching this site are low and the sediment supply consists of local mobilization and transport. The Spring 2010-Fall 2011 period had some accretion on the western extremity and general erosion along the bay shoreline (Fig. 17, top panel), with a mean inland displacement of -2.15 m. During Fall 2010-Spring 2011, the changes will largely accretionary (Fig. 17, bottom panel), with a positive mean of 4.48 m. The annual change was largely concentrated on the western margin of the spit (Fig. 18), with a positive mean of 2.37 m.

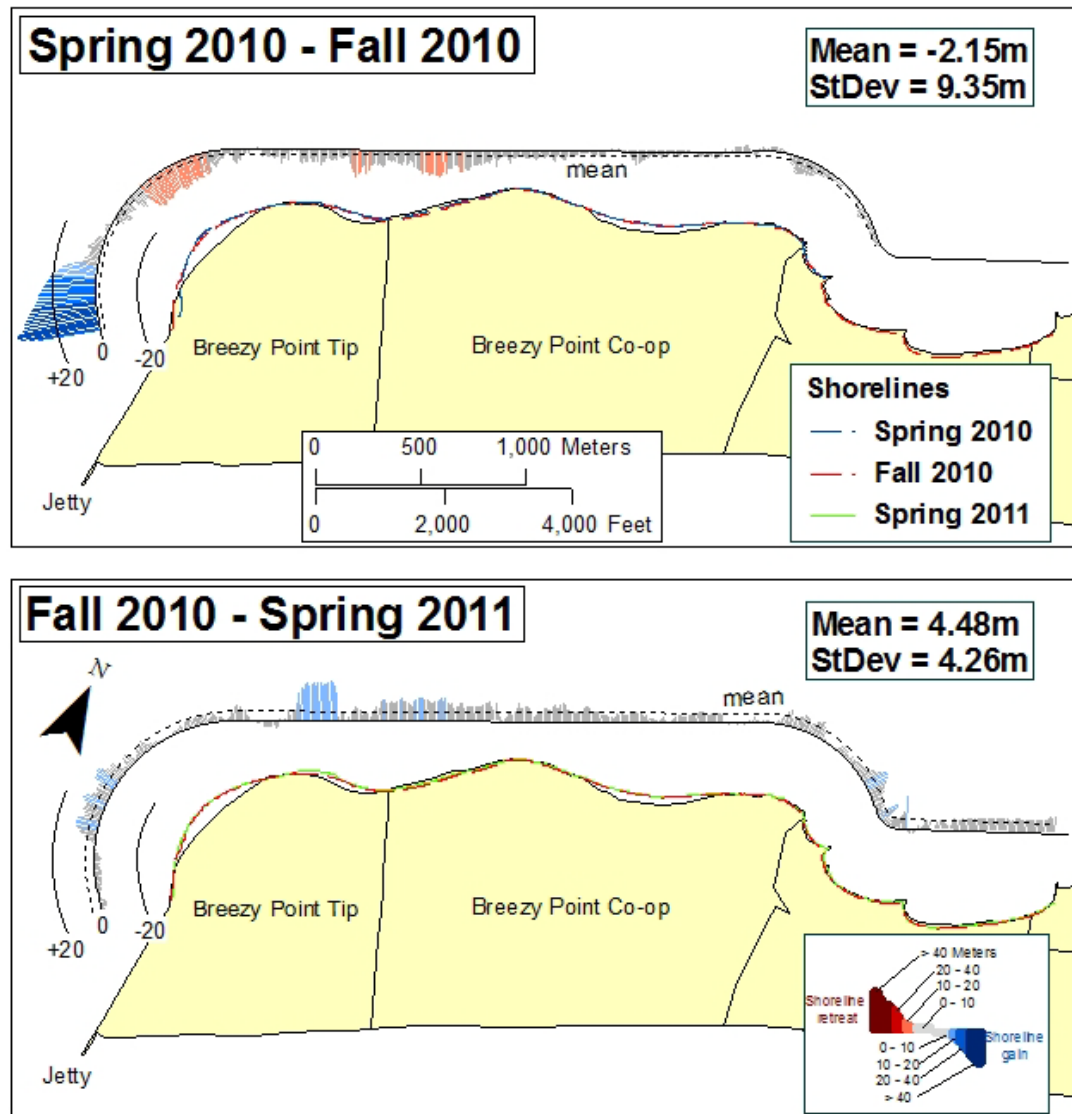


Figure 17. Net shoreline change at Breezy Point - Bayside, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Fall 2010 (top panel) and Fall 2010 - Spring 2011 (bottom panel), incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.

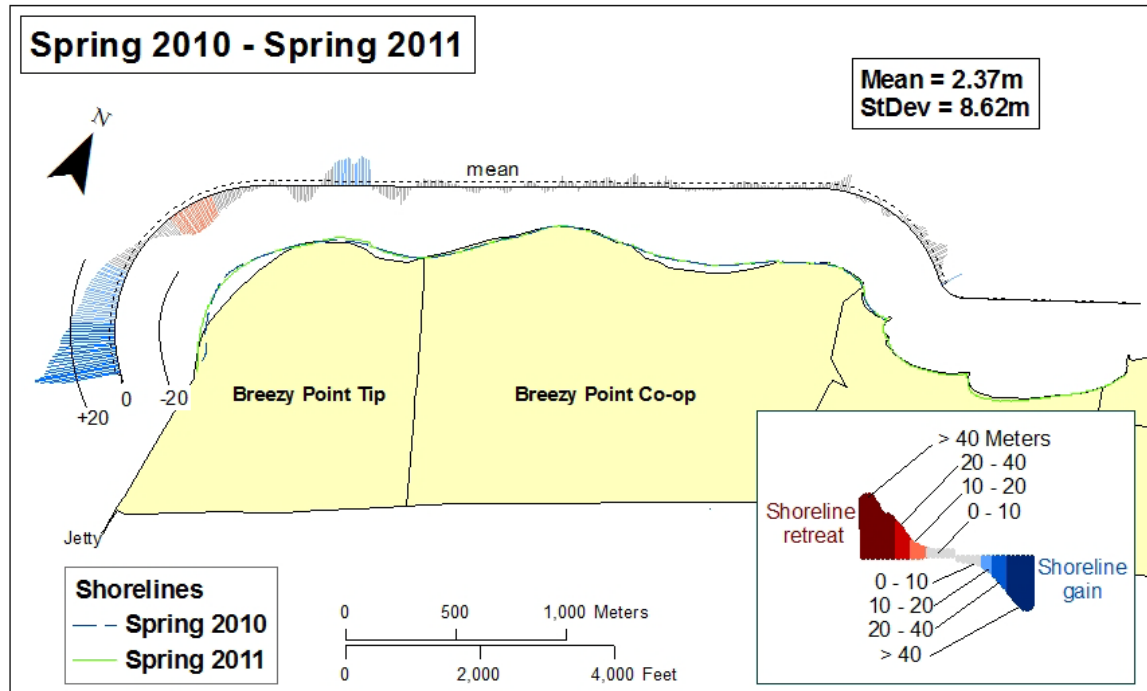


Figure 18. Net shoreline change at Breezy Point - Bayside, Jamaica Bay Unit, Gateway National Recreation Area for the period Spring 2010 – Spring 2011, incorporating surveyed shoreline positions, dimensions of shoreline change, mean change, mean change line, and +/- 1.0 standard deviation, all values in meters.

Spatial Evaluation

The totality of the difference measurements is also subjected to very simple statistical analysis to determine the mean and standard deviation values for the seasonal and annual comparisons. These outcomes are incorporated in Figures 4-18. Each of the panels in these figures has a dashed black line depicting the mean difference value, and a text box with the values of the mean change and the 1.0 standard deviation. Thus, through the incorporation of mean and standard deviation values, the spatial portrayal of change is reported relative to all other changes on the segment of Gateway NRA for the same temporal span. It is a means to provide a visual perspective on the magnitude and direction of the change (vectors) on a localized basis.

Summary Statistics and Tables of Change

The outcomes of the difference measurements are represented as histograms of the frequency of changes (Figs. 19-40). In the instances of the seasonal comparisons, there is a near normal distribution that depicts a marked central tendency in the assembled measurements and a general decline of frequency of change away from the mean values. Some of the annual comparisons have a bi-modal distribution of the change values because one of the seasonal trends was erosional whereas the other was depositional. Further, each of the comparisons is tempered by the uncertainty values that accompany the methodology of defining the shoreline (± 6 m). The uncertainty is low, but it exists and it is necessary to view all changes in the context of the accuracy of the defined shoreline position. However, this is one year and it is not prudent to ascribe longer-term changes and interpretations based on this limited data set. In general, the unimodal seasonal distributions have a smaller standard deviation value than the bimodal annual comparisons.

Sandy Hook

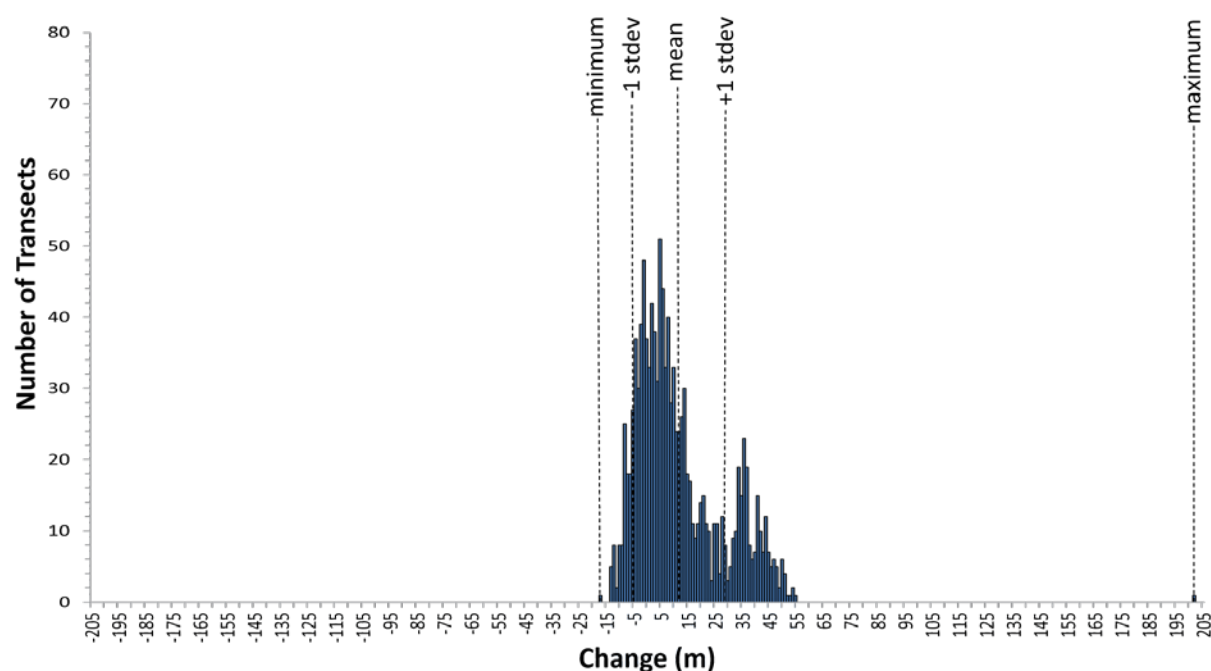


Figure 19. Distribution of difference measurements at Sandy Hook Unit, Gateway National Recreation Area, for the seasonal shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value (12.7 m), standard deviation (16.56 m), maximum, and minimum values.

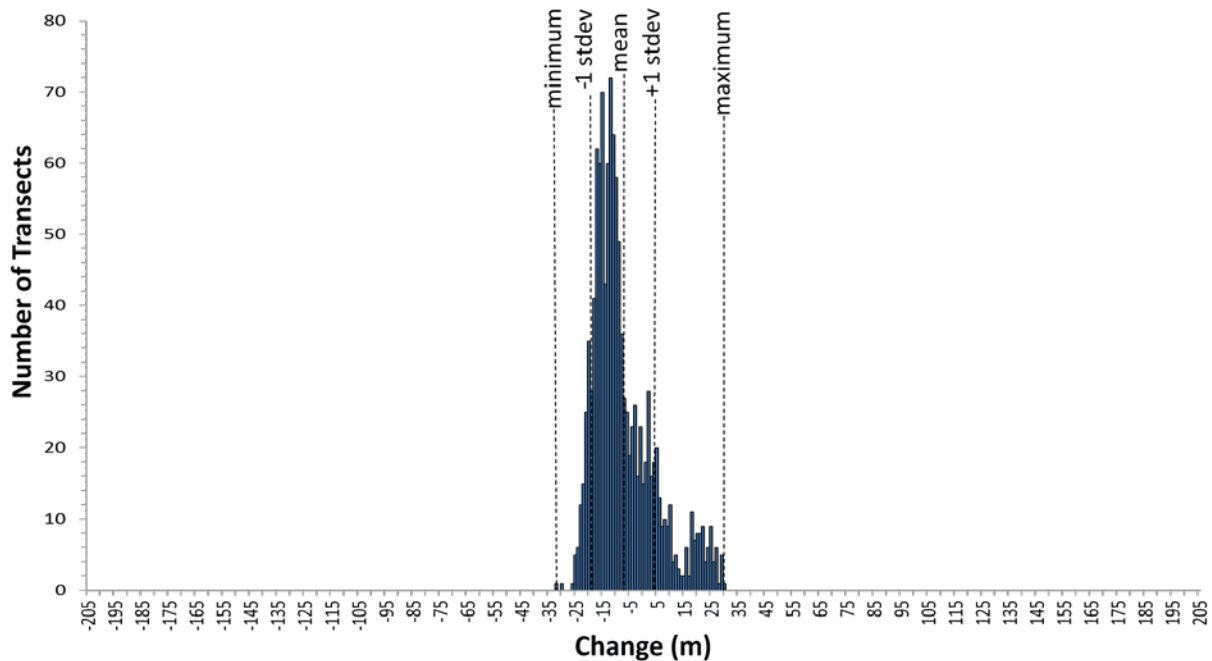


Figure 20. Distribution of difference measurements at Sandy Hook Unit, Gateway National Recreation Area, for the seasonal shoreline change between Fall 2010 and Spring 2011, incorporating the mean change value (-6.83 m), standard deviation (11.63 m), maximum, and minimum values.

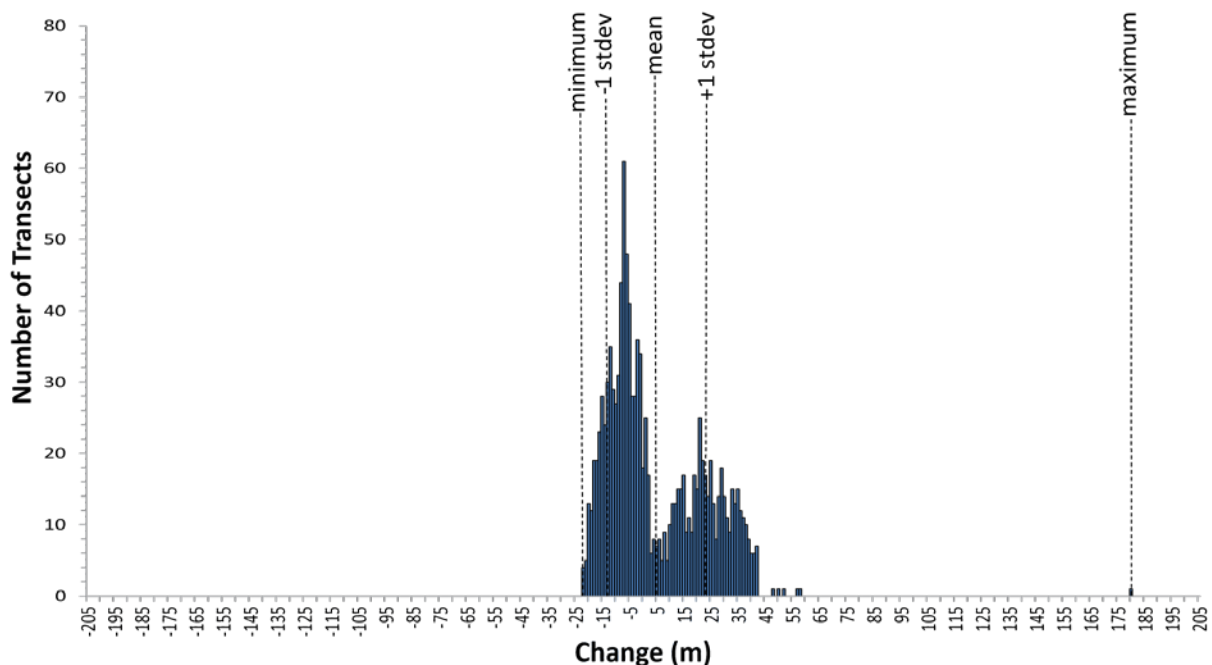


Figure 21. Distribution of difference measurements at Sandy Hook Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value (5.53 m), standard deviation (18.23 m), maximum, and minimum.

Great Kills Park

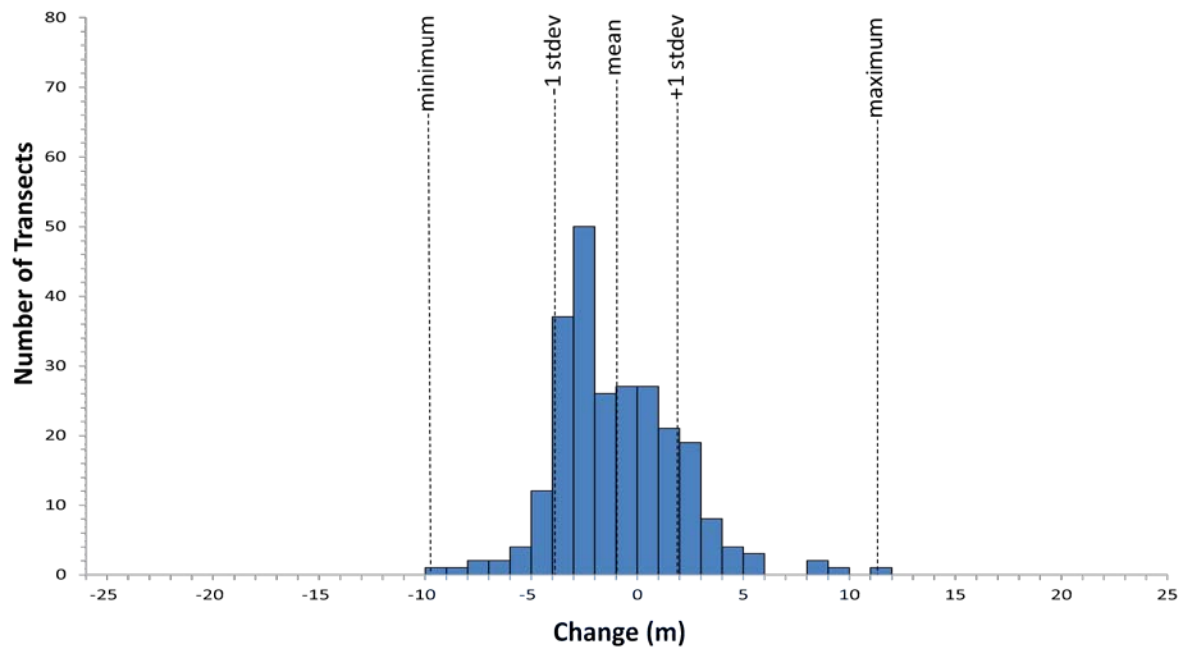


Figure 22. Distribution of difference measurements at Great Kills Park, Staten Island Unit, Gateway National Recreation Area, for the seasonal shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value (-0.98 m), standard deviation (2.91 m), maximum, and minimum.

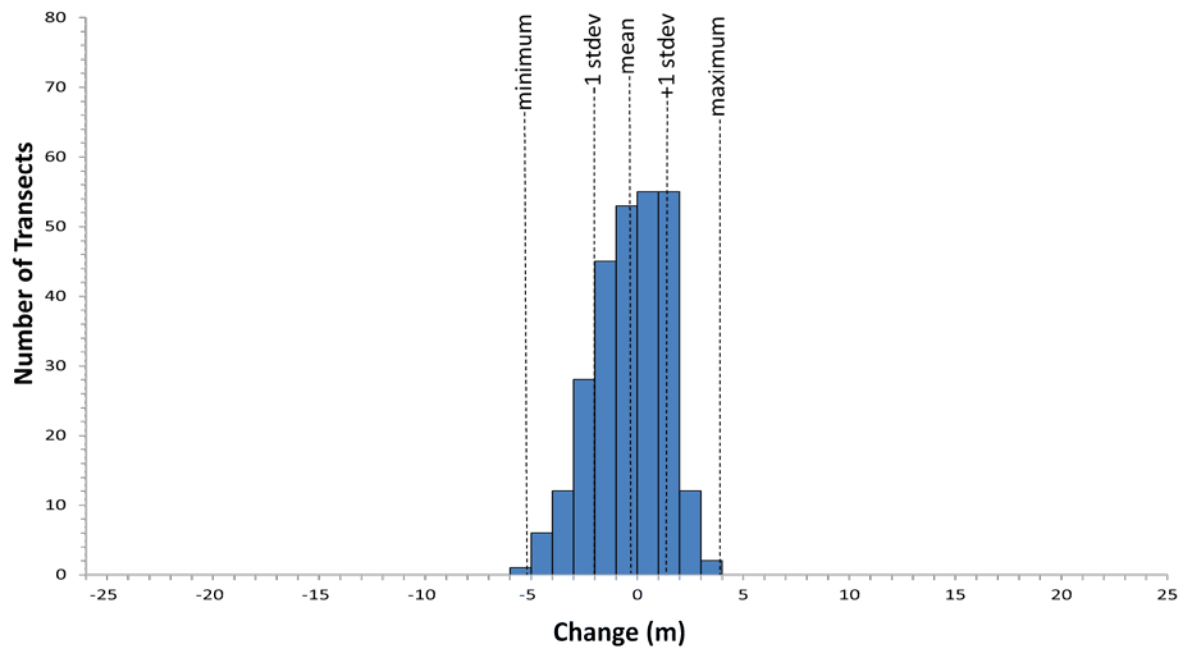


Figure 23. Distribution of difference measurements at Great Kills Park, Staten Island Unit, Gateway National Recreation Area, for the seasonal shoreline change between Fall 2010 and Spring 2011, incorporating the mean change value (-0.33 m), standard deviation (1.68 m), maximum, and minimum.

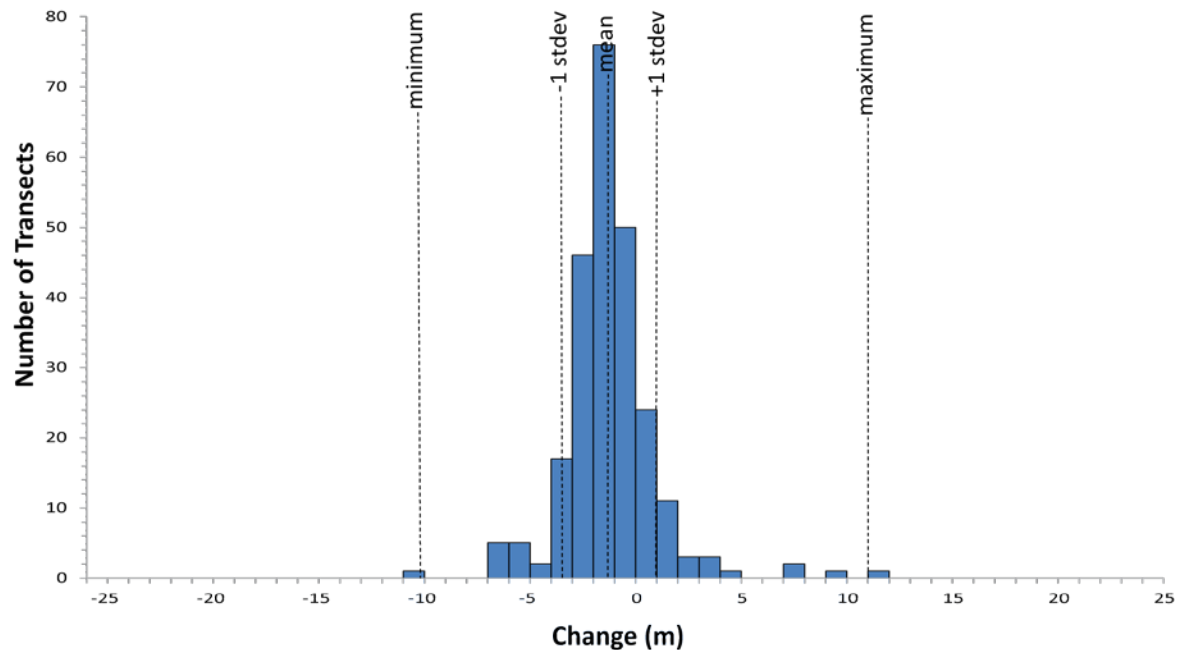


Figure 24. Distribution of difference measurements at Great Kills Park, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value, (-1.24 m) standard deviation (2.24 m), maximum, and minimum.

Great Kills, West End

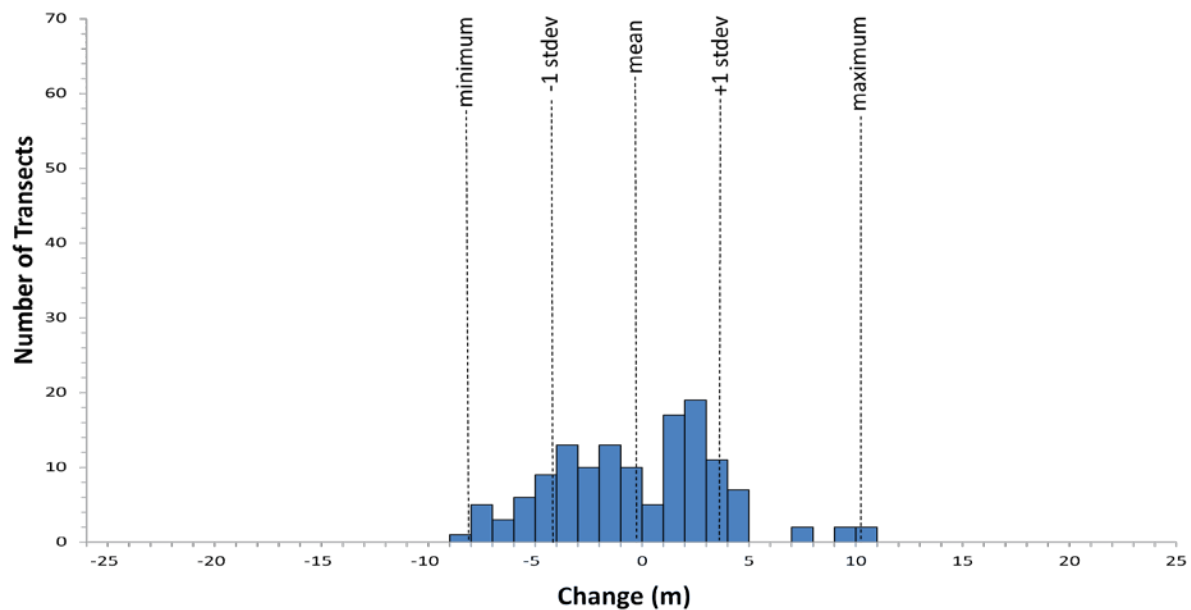


Figure 25. Distribution of difference measurements at Great Kills Park, West End, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value, (-0.24 m) standard deviation (3.88 m), maximum, and minimum.

Miller Field

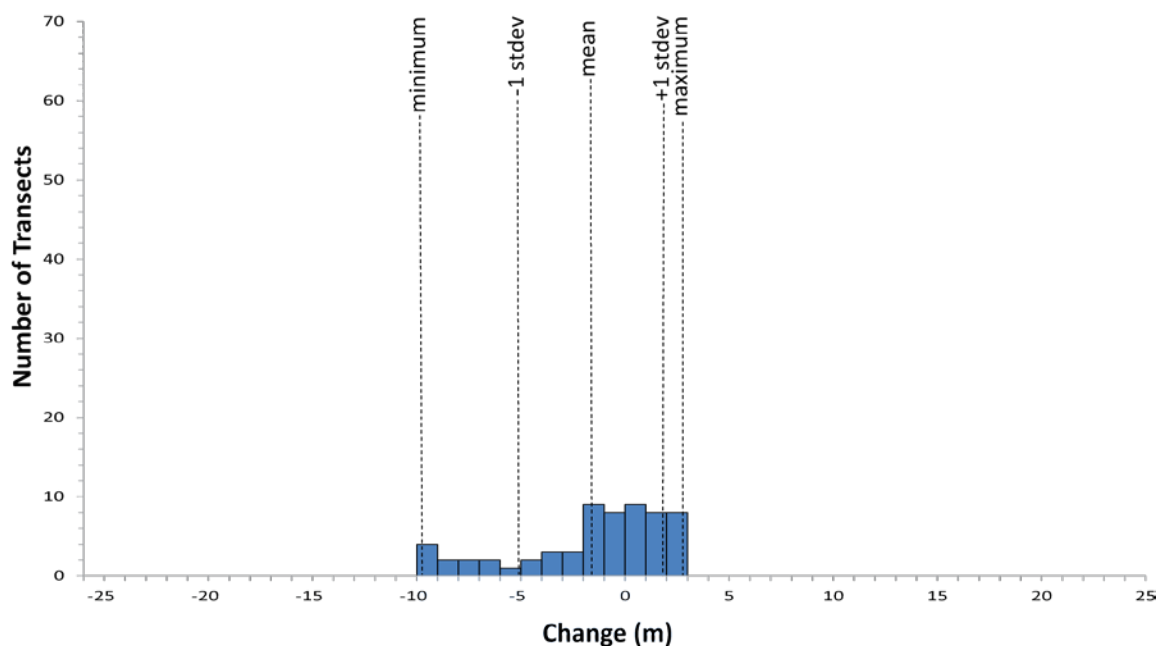


Figure 26. Distribution of difference measurements at Miller Field, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value, (-1.60 m) standard deviation (3.50 m), maximum, and minimum.

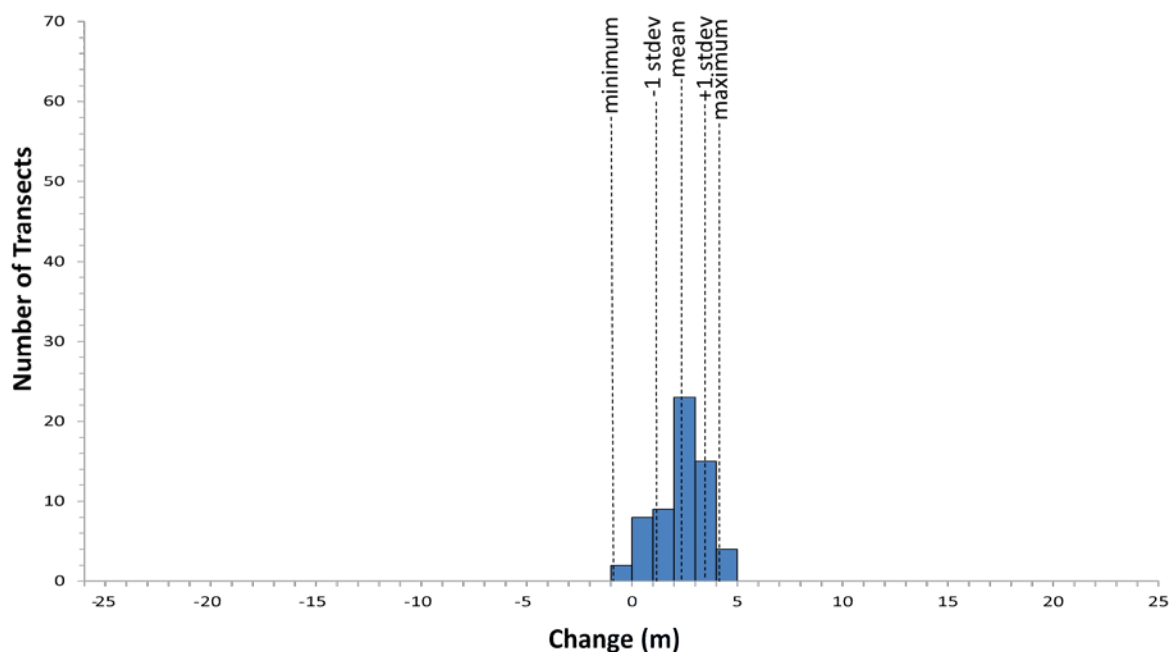


Figure 27. Distribution of difference measurements at Miller Field, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Fall 2010 and Spring 2011, incorporating the mean change value, (2.32 m) standard deviation (1.16 m), maximum, and minimum.

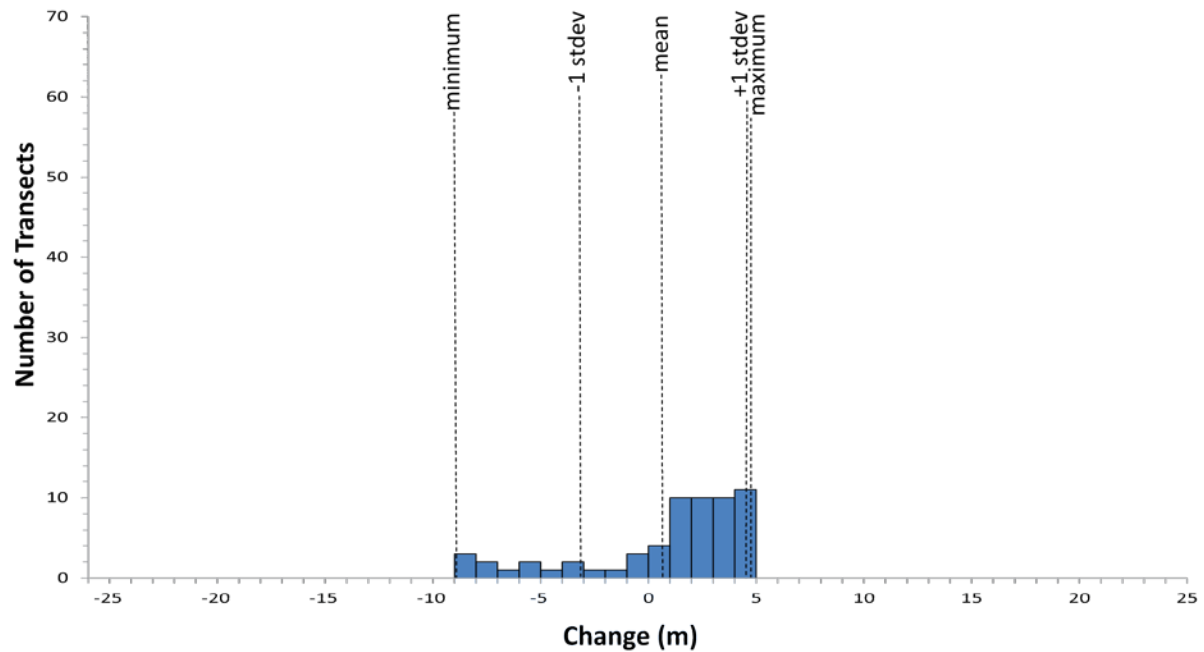


Figure 28. Distribution of difference measurements at Miller Field, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value, (0.72 m) standard deviation (3.79 m), maximum, and minimum.

Fort Wadsworth

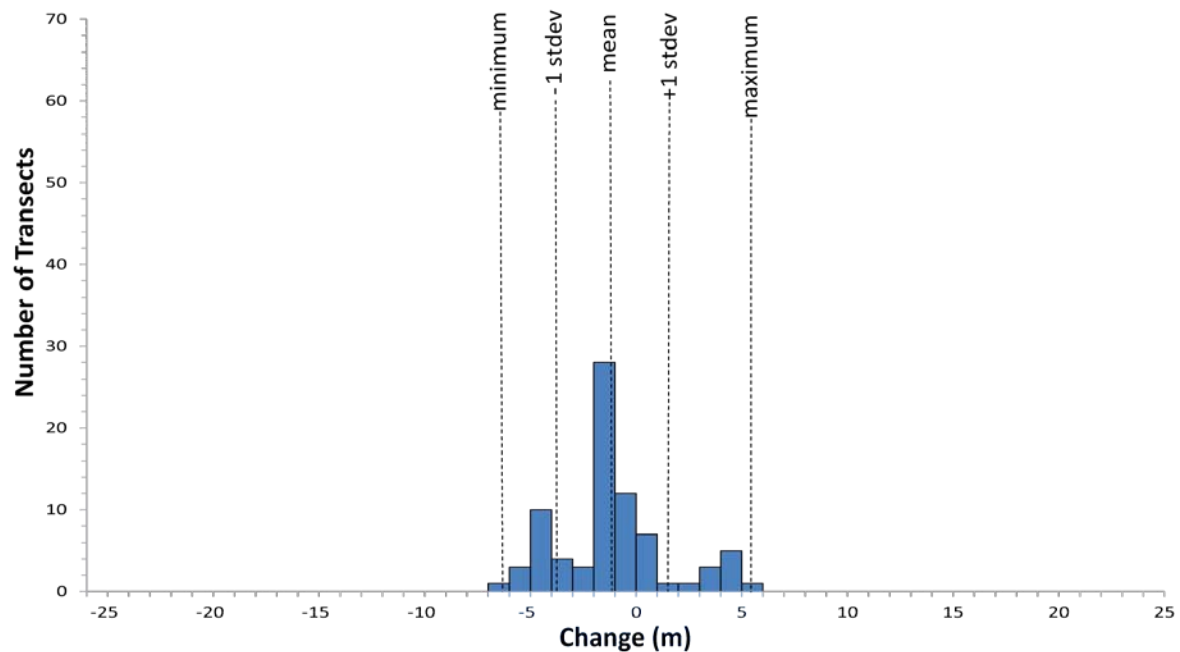


Figure 29. Distribution of difference measurements at Fort Wadsworth, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value, (-1.15 m) standard deviation (2.62 m), maximum, and minimum.

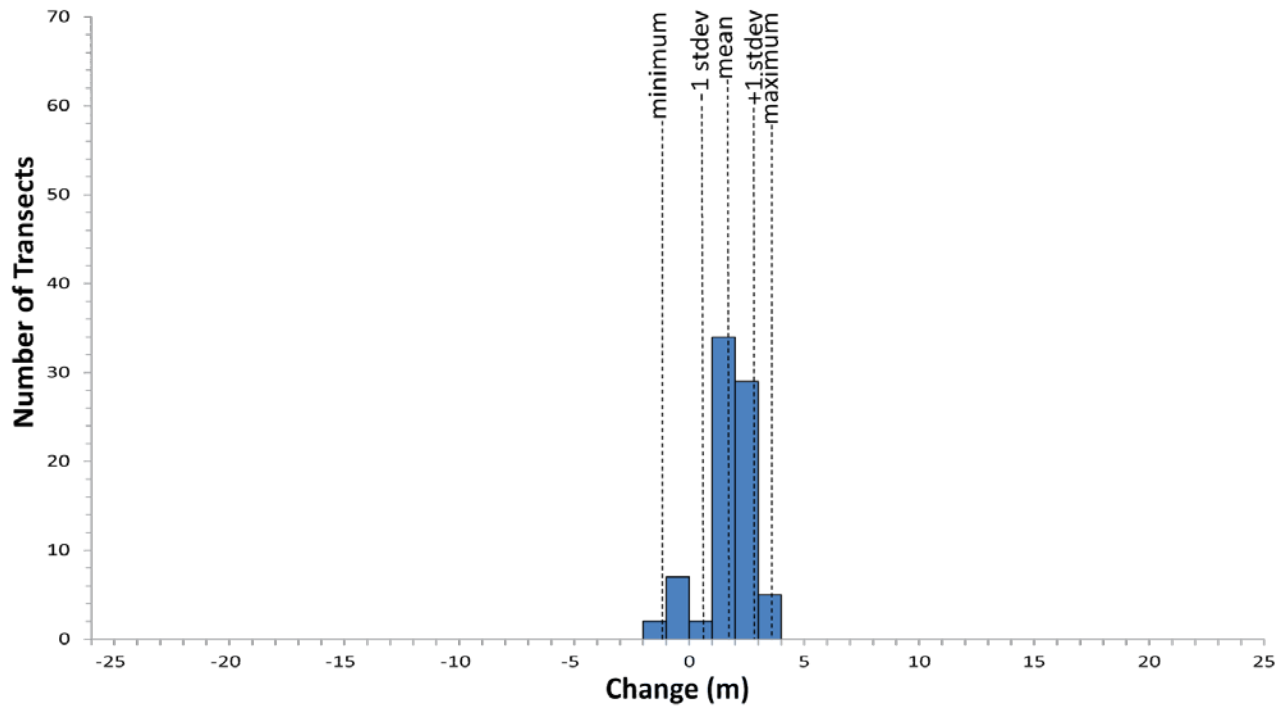


Figure 30. of difference measurements at Fort Wadsworth, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Fsl2010 and Spring 2011, incorporating the mean change value, (1.75 m) standard deviation (1.07 m), maximum, and minimum.

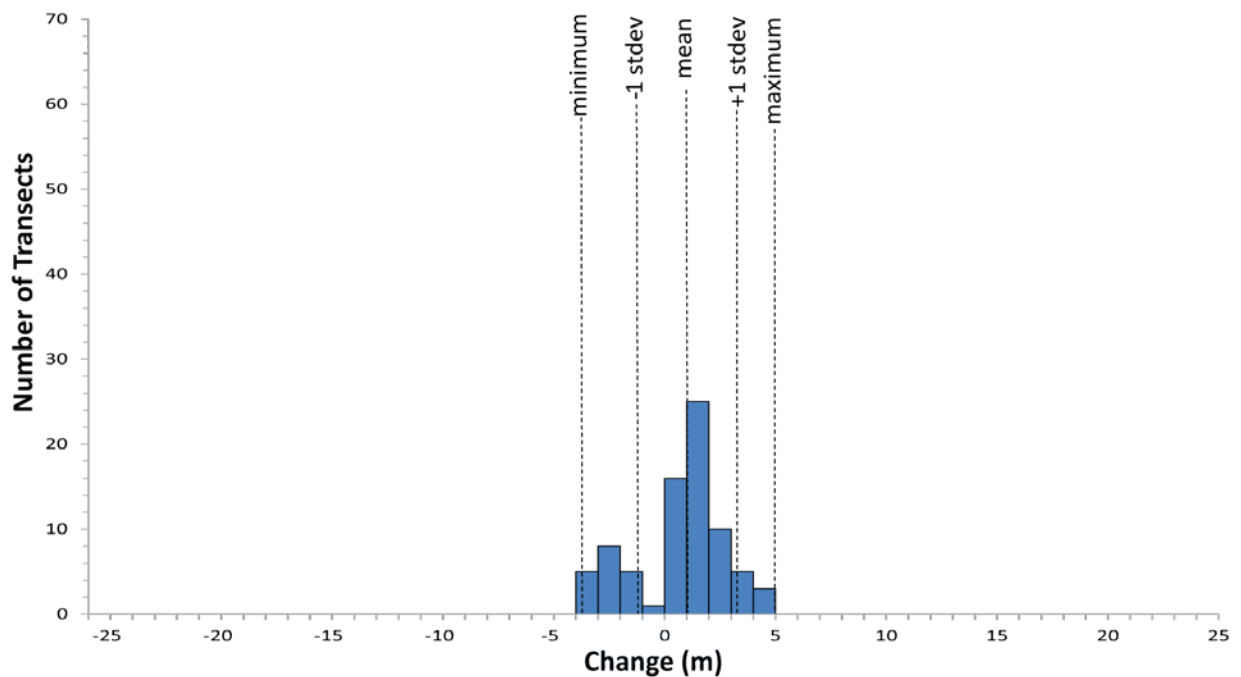


Figure 31. Distribution of difference measurements at Fort Wadsworth, Staten Island Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value, (0.68 m) standard deviation (2.04 m), maximum, and minimum.

Plumb Beach

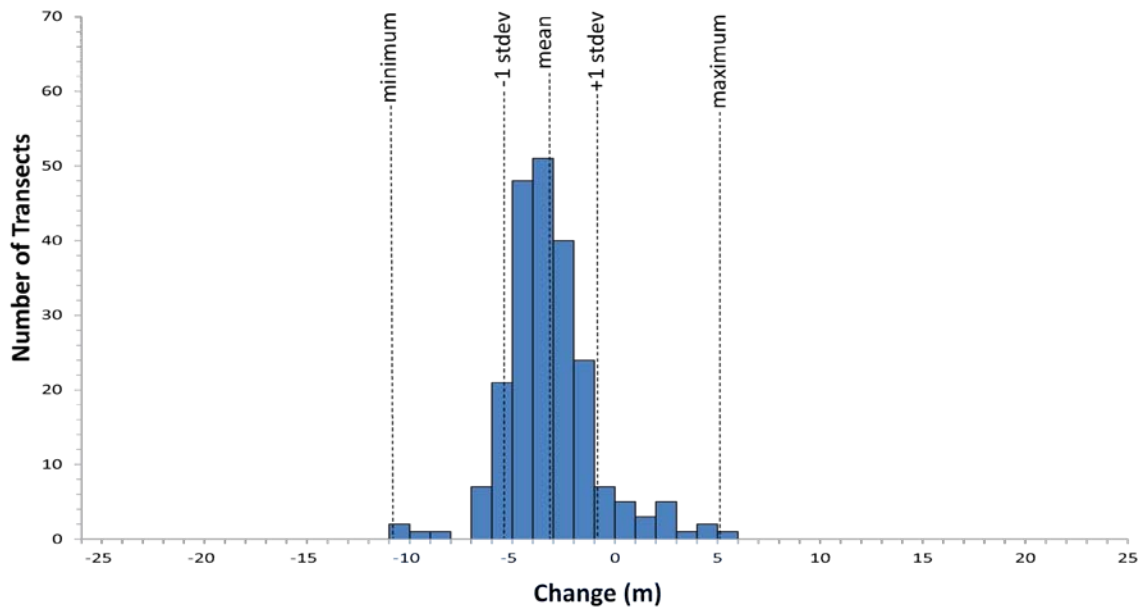


Figure 32. Distribution of difference measurements at Plumb Beach, Jamaica Bay Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value, (-3.17 m) standard deviation (2.24 m), maximum, and minimum.

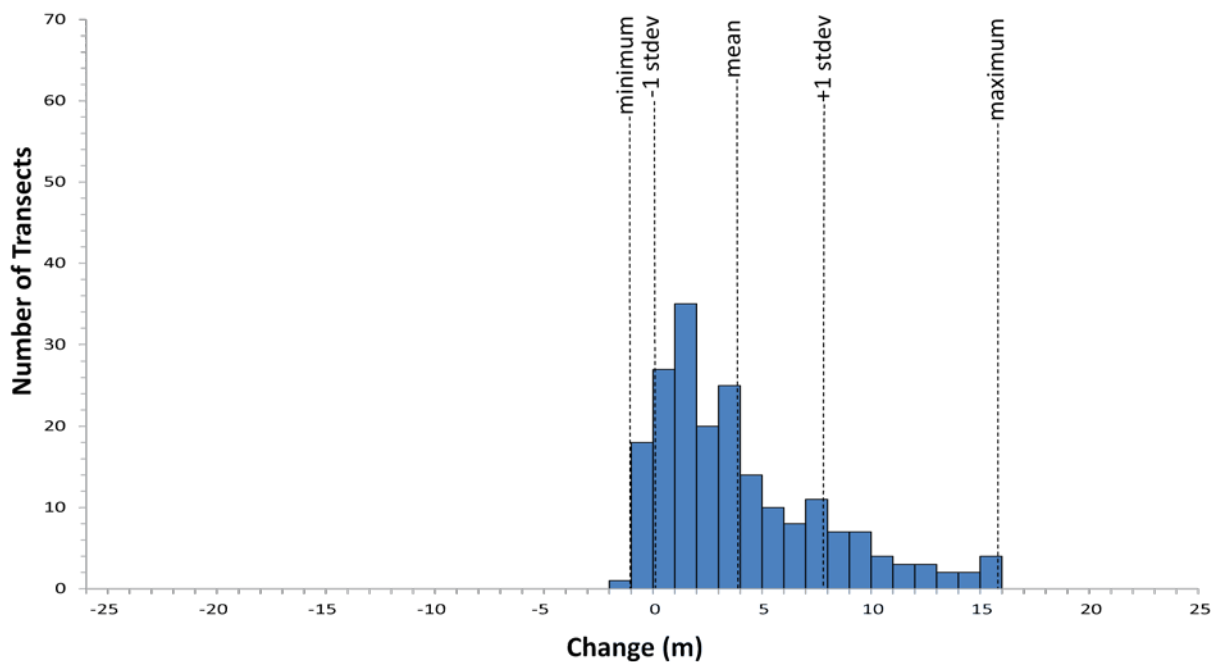


Figure 33. Distribution of difference measurements at Plumb Beach, Jamaica Bay Unit, Gateway National Recreation Area, for the annual shoreline change between Fall 2010 and Spring 2010, incorporating the mean change value, (3.96 m) standard deviation (3.89 m), maximum, and minimum.

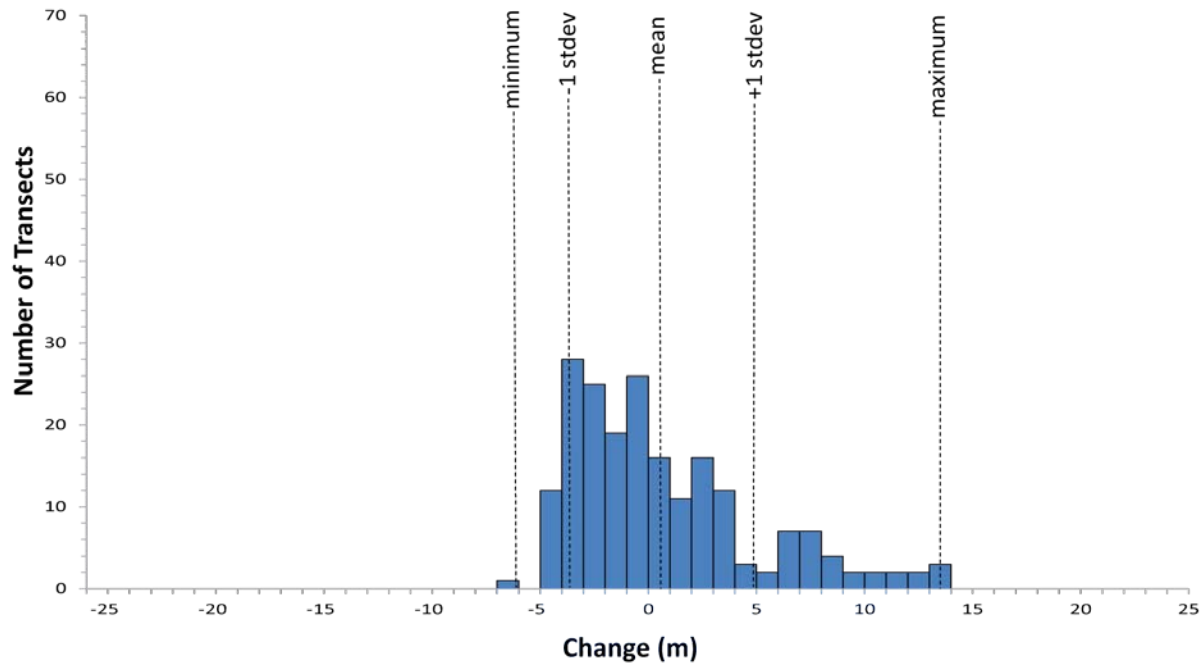


Figure 34. Distribution of difference measurements at Plumb Beach, Jamaica Bay Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2010, incorporating the mean change value, (0.64 m) standard deviation (4.26 m), maximum, and minimum.

Breezy Point

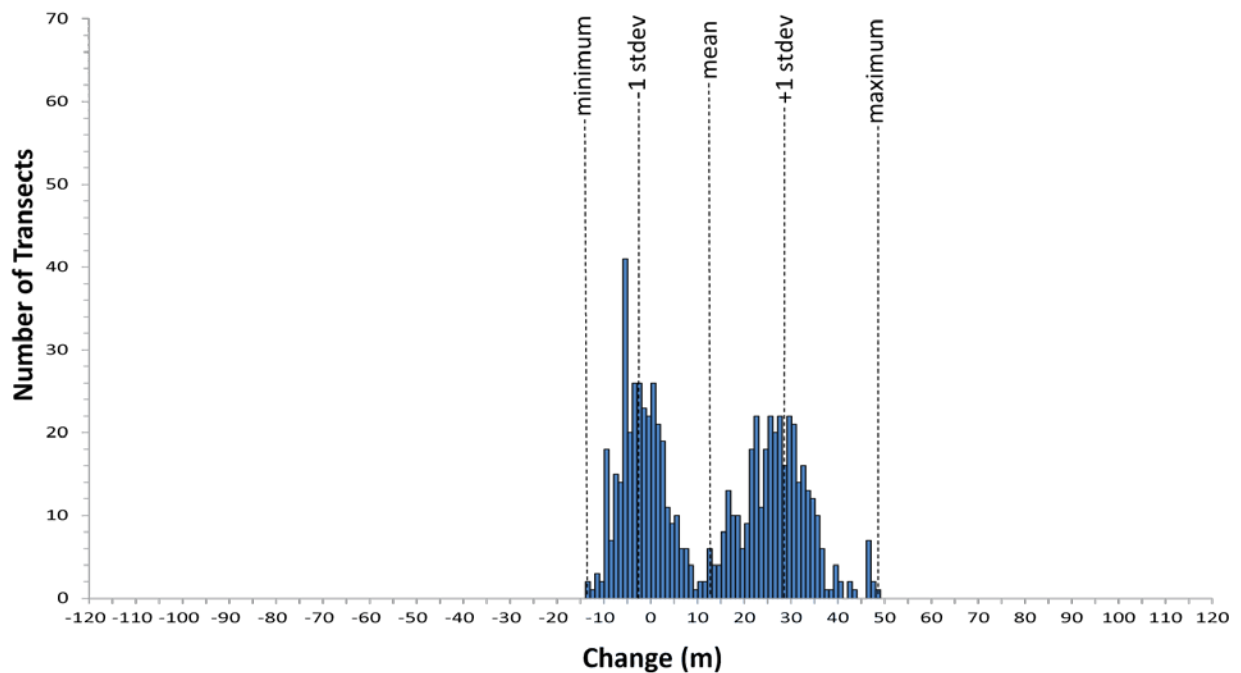


Figure 35. Distribution of difference measurements at Breezy Point, Jamaica Bay Unit, Gateway National Recreation Area, for the seasonal shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value (12.81 m), standard deviation (15.64 m), maximum, and minimum.

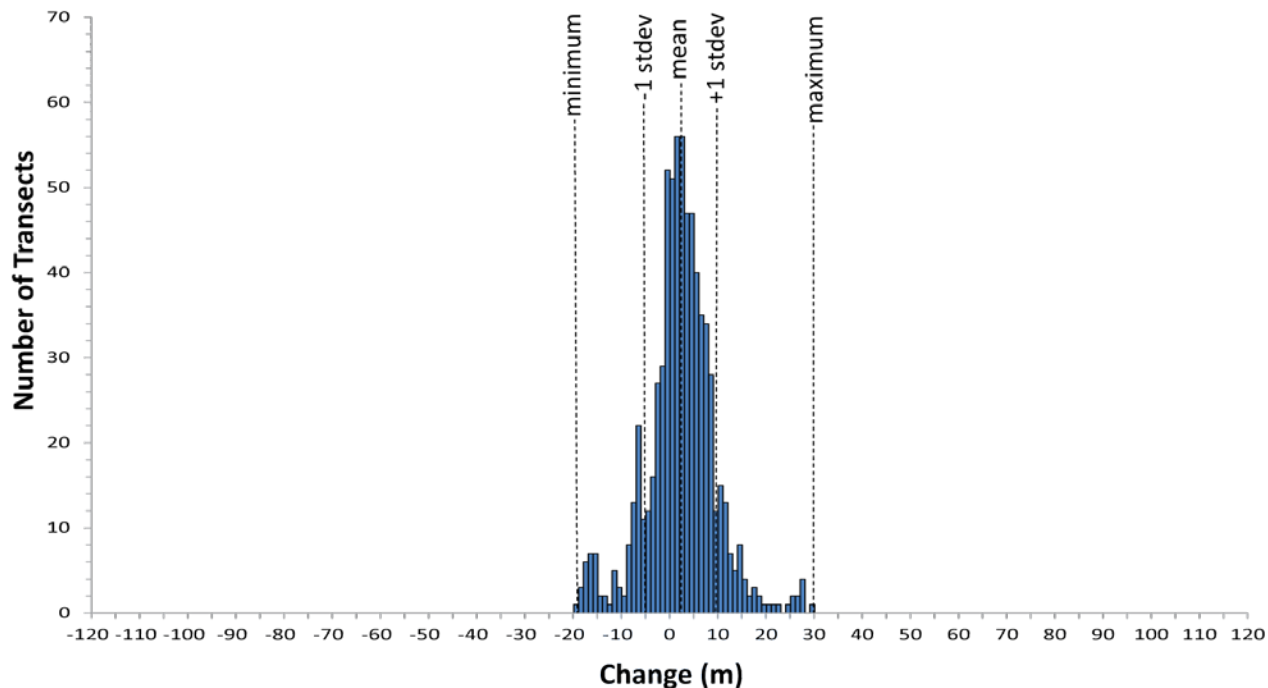


Figure 36. Distribution of difference measurements at Breezy Point, Jamaica Bay Unit, Gateway National Recreation Area, for the seasonal shoreline change between Fall 2010 and Spring 2011, incorporating the mean change value (2.26 m), standard deviation (7.27 m), maximum, and minimum.

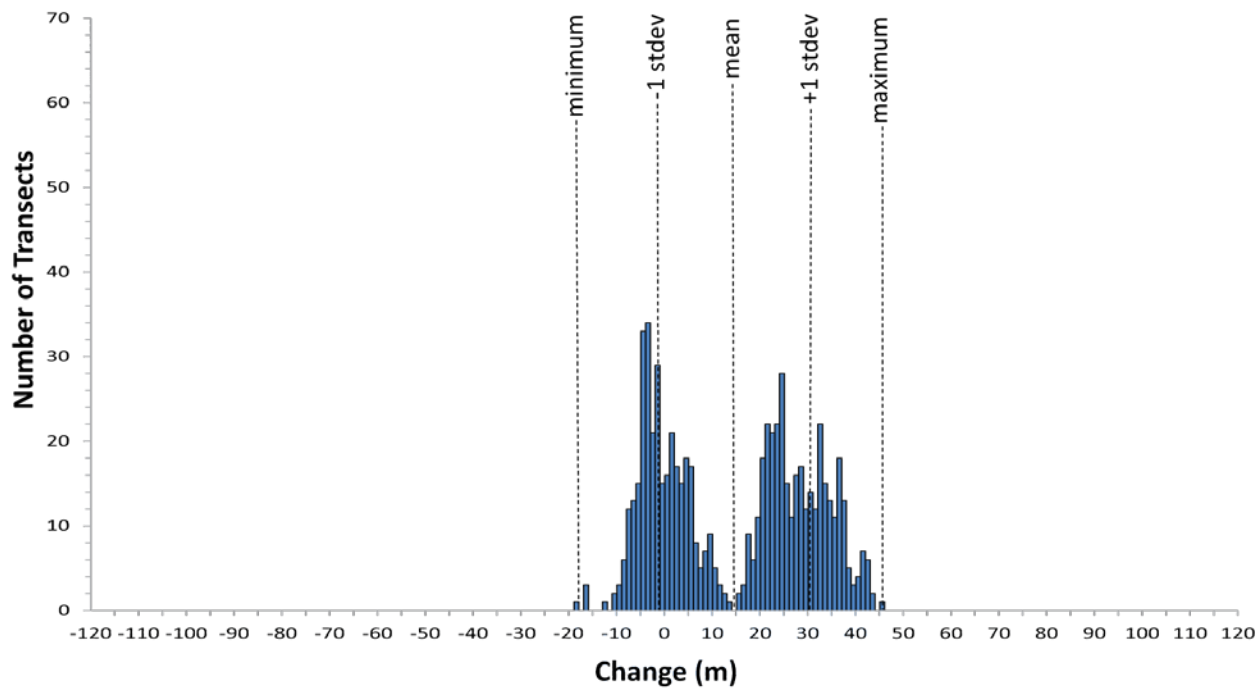


Figure 37. Distribution of difference measurements at Breezy Point, Jamaica Bay Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value (14.55 m), standard deviation (15.67 m), maximum, and minimum.

Breezy Point – Bayside

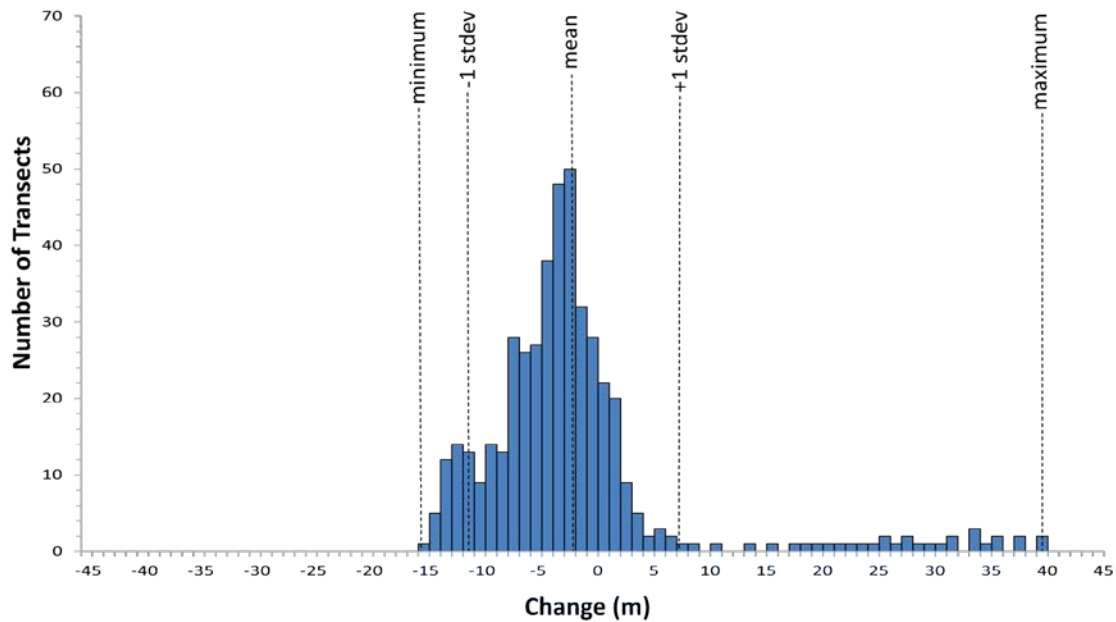


Figure 38. Distribution of difference measurements at Breezy Point– Bayside, Jamaica Bay Unit, Gateway National Recreation Area, for the seasonal shoreline change between Spring 2010 and Fall 2010, incorporating the mean change value (-2.15 m), standard deviation (9.35 m), maximum, and minimum.

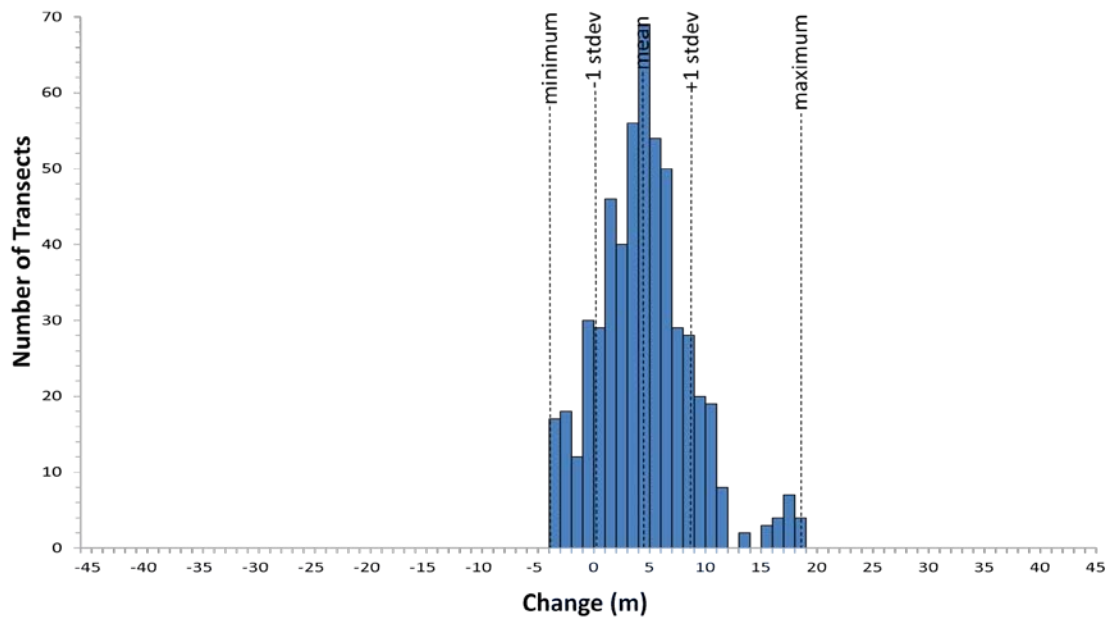


Figure 39. Distribution of difference measurements at Breezy Point– Bayside, Jamaica Bay Unit, Gateway National Recreation Area, for the seasonal shoreline change between Fall 2010 and Spring 2011, incorporating the mean change value (4.48 m), standard deviation (4.26 m), maximum, and minimum.

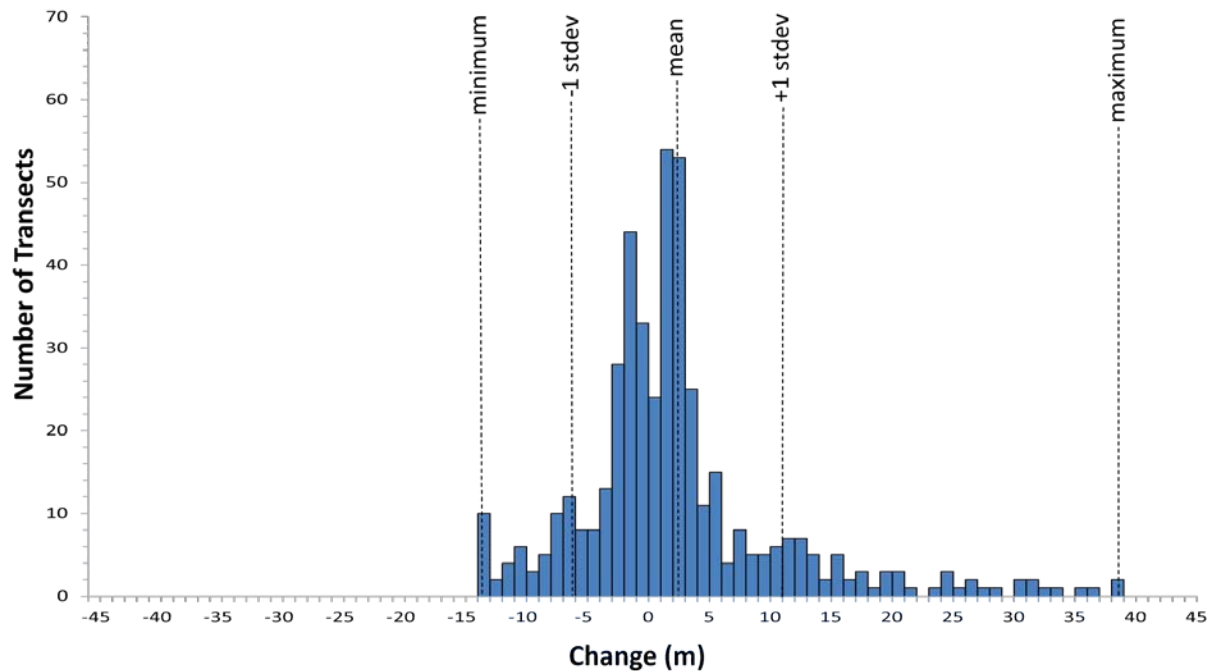


Figure 40. Distribution of difference measurements at Breezy Point– Bayside, Jamaica Bay Unit, Gateway National Recreation Area, for the annual shoreline change between Spring 2010 and Spring 2011, incorporating the mean change value (2.37 m), standard deviation (8.62 m), maximum, and minimum.

Areas of Interest

Specific areas of interest have not been highlighted in this annual report. The temporal scale is too short to describe a condition that may be influenced by a few storms or non-stormy period. The data will be incorporated in a longer term, trend report, where there is much more perspective on the sequence and vectors of change.

Conclusions and Information for Management

With the caveat that the data presented only apply to a one-year period, there are many locations that have changes greater than ± 10 m measure of uncertainty (± 6 m at Great Kills) and a few that are greater than the one-standard-deviation. It is difficult to determine whether these changes are local perturbations or some larger negative displacement with this limited data set. Longer-term tendencies of shoreline change will be analyzed and presented in the NCBN 5-year trend reports.

Problems / Concerns

There were no issues that arose in this period that constituted problems or concerns in the application of the protocol. One small matter was the potential for loss of satellite communication during the survey at the western end of Great Kills Park, probably because of dense tree cover.

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