BOEM/New Hampshire Cooperative Agreement (Contract M14ACOOO10) Technical Report

New Hampshire Beaches: Sediment Characterization

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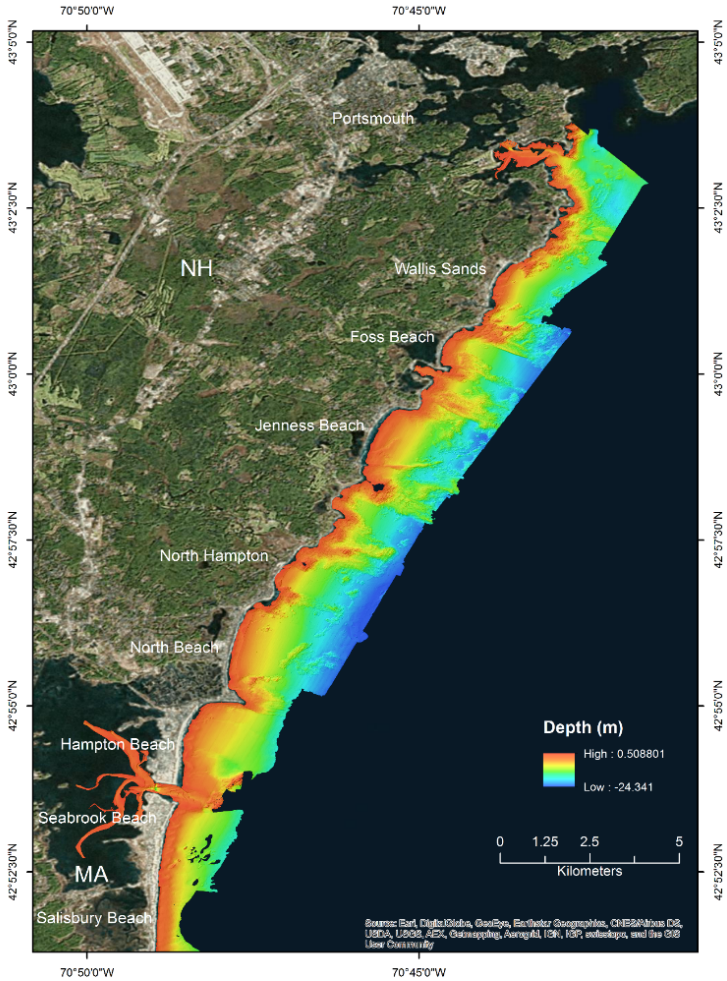
University of New Hampshire Center for Coastal and Ocean Mapping/Joint Hydrographic Center



Acknowledgements

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We gratefully acknowledge Dr. Thomas Lippmann for the use of the GNSS Rover and accessories, as well as helping process and verify the data. A number of colleagues at the UNH CCOM/JHC provided scientific and technical support, advice, and insight including the IT Group (Will Fessenden and Jordan Chadwick) and Data Management (Paul Johnson and Erin Nagel). Jon Hunt provided valuable help in use of the GPS rover and processing the data. Diamond Tachera, Alexandra Padilla and Stephanie Ward provided help in the field. Their efforts are greatly appreciated.

Map Projections

All maps are projected in Mercator Auxiliary Sphere, horizontal datum is GCS WGS 1984; vertical datum is MLLW.

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Table of Contents

Tables

List of Figures

Appendices

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Abstract

The grain size of the natural sediment composing the major New Hampshire beaches under summer equilibrium conditions were determined as a first step in assessing the optimal sediment size that would be needed for beach nourishment. In summer, 2015, seven major beaches including Wallis Sands, Foss Beach, Jenness Beach, North Hampton Beach, North Beach, Hampton Beach, and Seabrook Beach were sampled along three to five transects extending from the dunes or engineering structures (e.g., seawalls) to the low water line. In addition, the beach cross-section was profiled using a rover GPS system or the Emery method (profile rods and the horizon). Results indicate that during the low energy conditions of summer 2015, many of the sandy beaches appeared to vary between fine to medium sands with granular sediments and scattered pebbles. Two of the beaches (North Hampton and Seabrook) were somewhat coarser with medium to coarse sands with granular material and scattered pebbles. However, the gravel fractions tended to be under-sampled due to the methodology used. Also, higher energy conditions were not sampled. Therefore, additional studies are needed to fully understand the seasonal changes or changes related to calm (low energy) versus stormy (high energy) conditions in sediment size and characteristics and verification of results presented here.

Introduction

The New Hampshire (NH) coastline is extremely diverse ranging from rocky shorelines in the north to sandy barriers at the Massachusetts border to the south (Figure 1). The beaches range in size from ~1.3 km (Foss Beach) to over ~2.7 km (North Beach). However, Seabrook Beach (~2.2 km), along with Salisbury Beach which is part of the same barrier island, extends ~7.9 km from Hampton Inlet to the Merrimack River, Massachusetts. The total length of beaches in NH is ~13.5 km. Most of the beaches, with the exception of Hampton and Seabrook barriers, are separated by rocky headlands or glacial features (e.g., Great Boars Head is an eroding drumlin). Furthermore, the bedrock or glacial features extend offshore into the subtidal, essentially segmenting the beaches (Figure 2). It is likely these nearshore bathymetric highs interrupt the longshore transport of sediment between beaches, which has major implications to the beach sediment sources. The composition of the beaches varies over a wide range from sand to granule or fine to medium gravel (pebbles and cobbles).

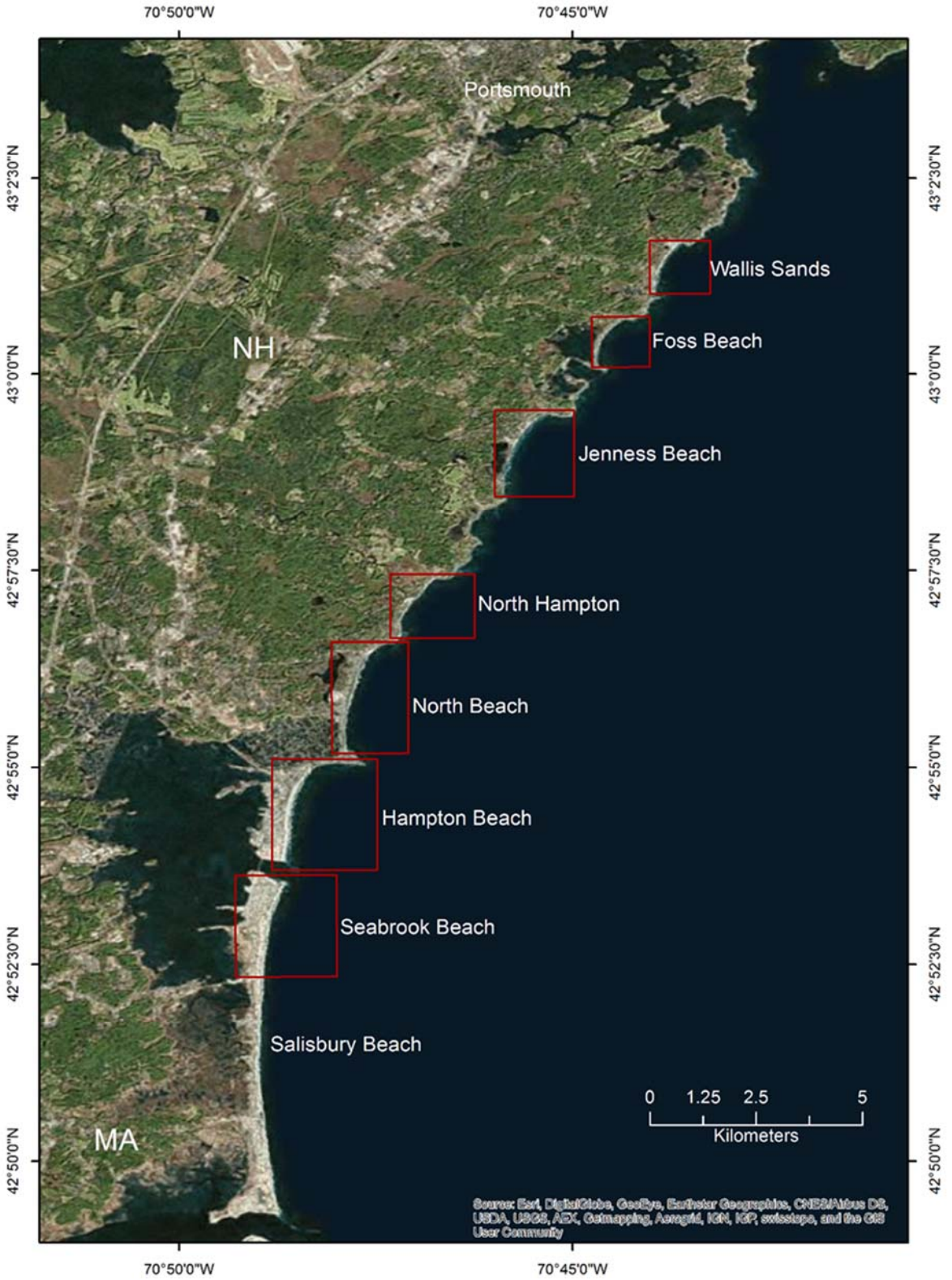

Figure 1. Location of New Hampshire beaches profiled and sampled (outlined in red) during this study.

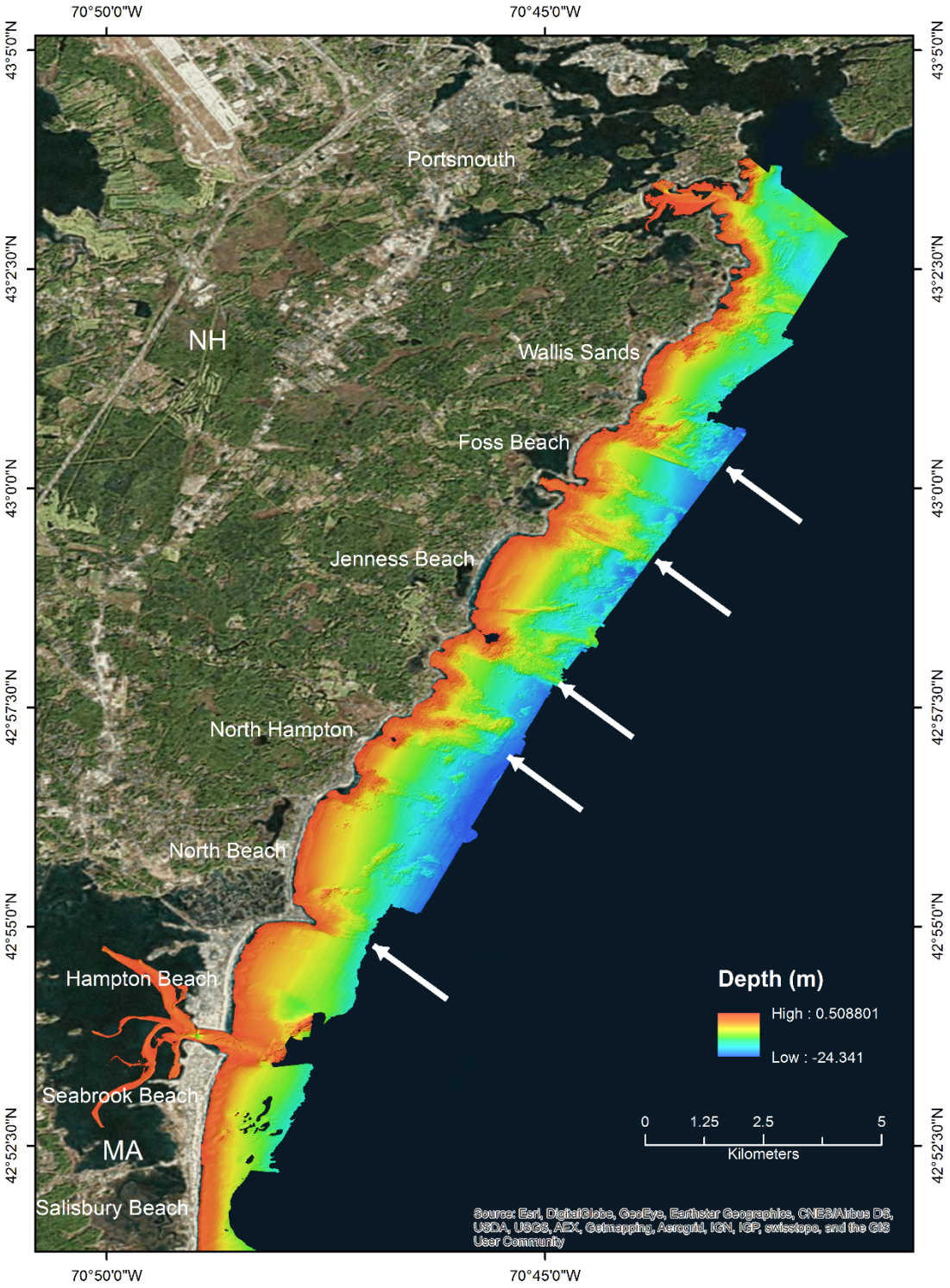

Figure 2. Nearshore bathymetry of the New Hampshire shelf. Note that many of the major beaches are separated by rocky or gravelly topographic/bathymetric highs which extend offshore, essentially segmenting the intervening beaches (see white arrows).

Historically, the NH coastline has undergone a slow retreat or has been relatively stable (Himmelstoss et al., 2010; Olsen and Chormann, in review) as a result of a relatively low rate of relative sea-level rise, bedrock outcrops that help to anchor the shoreline, and extensive engineering structures. Most of the beaches are highly modified by seawalls, riprap, berms, groins, jetties, and other coastal defense structures. Due to these structures, the beaches likely undergo large volumetric changes and have narrowed in width in many areas. This is especially true of the coast north of Great Boars Head where the beaches are smaller and lower elevation than the beaches to the south (Olson and Chormann, in review). Hampton Beach and Seabrook Beach tend to be wider and have higher elevations. Nevertheless, both Hampton and Seabrook are periodically nourished with sand, as are some of the other beaches in the state such as Wallis Sands (Haddad and Pilkey, 1998). And it is very likely that the need to nourish the NH beaches will become greater in the future as the rate of sea-level rise continues to increase and storms become more intensive (IPCC, 2014).

Essential to nourishing any beach is a thorough understanding of the natural sediments that compose the beach including the grain size distribution. It is also important to understand the grain size distribution under low energy conditions (typically summer), when the beaches tend to be accretional, and during high energy conditions (typically winter and stormy periods), when the beaches erode and finer sediments are winnowed. Prior to the work presented in this report, no systematic study of the beach morphology or sediments had been done in NH since the late 1990s (Leo, 2000). Most of the previous work was focused on a subset of the beaches and did not include all of the major systems. Overall, little is known of the mineralogy, sediment grain size distribution, or how the grain size varies over the year from the calmer summer conditions to the stormier winter periods.

Therefore, to address this major gap in our understanding, the seven major beaches in NH were sampled in summer, 2015 to determine grain size distributions during low energy conditions. In addition, the beaches were resampled in fall, 2015 for grain size analysis. The summer samples have been analyzed and the results are reported here. The fall samples have been archived and will be analyzed at a later date. Future work calls for the beaches to be sampled in late winter or early spring to observe the impact of the high energy conditions that occurred during winter storms.

Collectively, these studies will provide the baseline data needed to determine the size of sediment needed for beach nourishment. In addition, determination of the sediment grain size of the NH beaches is needed to determine the suitability of offshore sand and gravel deposits to be used for beach nourishment.

Methods

Field Procedures

The summer 2015 beach sediment sampling utilized the following protocol. First, a beach profile (cross-section) was run at the sampling transect to determine the major features and help asses if the beach was in an accretional, equilibrium, or erosional phase based on the morphology. The beach profile was run using either the Emery profile method or a GNSS rover unit (described below). Second, the beach profile was paced to determine sampling positions approximately ¼, ½, and ¾ the distance across the beach profile. The actual position was frequently shifted landward or seaward to account for beach morphologic features. A fourth sample was added if there were dunes present or to assure the upper beach was adequately sampled. The sediment sample was collected at each site using a ~22 cm long PVC tube with an inside diameter of 5 cm. The tube was inserted into the sediment between 8 -12 cm, retrieved assuring no sediment was lost out of the bottom, and stored in a Whirl-Pak or Ziplock baggy. The position of each sampled site was determine with a Garmin 76Cx hand held GPS unit with an accuracy <10 m. Finally, each sampling site and the overall beach was photographed. In total, 81 sediment samples were collected and analyzed from 24 profile locations distributed between the 7 beaches along the NH coast (Figure 1). The sampling was done between June 10 and August 17, 2015. The sampling sites are shown for each beach in Figures 5-27 in the Results section.

A second sampling was conducted during fall, 2015 using the same procedures described above, but using primarily the GNSS Rover to measure the beach profile. In total, 96 sediment samples were collected from 28 profile locations distributed between the 7 beaches. The sampling was done from October 10 to November 21, 2015. These samples have been archived for analysis at a future date. Summer and fall, 2015 sampling represents primarily low energy, constructional beach conditions.

The procedures described above worked well for unimodal, sandy beaches that did not have an appreciable gravel component. However, it was noted at several beaches that the core tube encountered a fine gravel layer underlying the sandy surface. In addition, some beaches had pebble to cobble berms close to the seawall or had scattered pebbles across the beach. Consequently, use of the core tube limited the sampling of the larger clasts (pebbles and cobbles). In addition, if the beach sediments were stratified with finer sediments overlying gravelly sediments the core tube tended to under-sample the coarser material.

To assure that all sediment populations are being sampled, the field procedure will be modified for subsequent field sampling of bimodal beaches. Changes will include sampling all sediment populations present, increasing the overall size of the sample volume, and documenting all layering via notes and photographs.

Laboratory Analysis

Grain size was determined using standard sieve and pipette analytical techniques (after Folk 1980). The grain size data was analyzed in “Gradistat” (Blott and Pye, 2001), with the major

statistics based on the log-normal distribution of phi sizes as recommended in Folk (1954). Organic content was estimated by loss-on-ignition (% LOI) after ~4 hours at 450°C.

Sediment grain size statistics and classifications presented in this report include: the "textural group" based on the relative gravel, sand, and mud content of the sample; the "sediment name" which adds more detail to the textural group by giving the modal grain size for each of the fractions of the sample (gravel, sand or mud); and the "Wentworth" classification (Wentworth, 1922) based solely on the mean grain size in phi units.

Two of the grain size parameters (mean and sorting) are expressed in phi units, a geometric conversion used in geologic studies to place equal importance on small differences in fine-grained sediments and large differences in coarse-grained sediments (Blott and Pye, 2001). Typically, the Wentworth scale is used that separates size classes by a factor of two (doubling as size increases or halving a size decreases) (Appendix 1). The transformation between phi (ϕ) units and mm is $\phi = -\log_2 dmm$ or $dmm = -\phi 2$ where dmm is the diameter of a particle in mm. Sorting, a measure of the spread of the sizes about the mean or standard deviation of the sample, is also expressed in phi units. Skewness and kurtosis are dimensionless. Skewness is a measure of the symmetry about the mean with positive values indicating skewing towards fines and negative values skewing towards coarse sediments. Kurtosis is concentration of the grains about the mean (see Blott and Pye, 2001 or Folk, 1980 for further information).

Beach Profiling

Emery Method. A very simple and widely used method to survey the beach profile was utilized during the initial sampling in summer, 2015 (Emery, 1961). The beach profile or topographic cross-section was determined by spacing two 1.5 m calibrated staffs a known distance apart (usually 1 to 3 m) and creating a level line-of-sight with the horizon (Figure 3). Ignoring a very small error introduced due to the curvature of the earth over wide beaches, the relative change in elevation between the staffs was the topographic change in elevation on the beach. Summing the changes in elevations and distance between the staffs provided the beach cross-section from a landward reference point, often a point on a seawall or rip rap to the low water line. The profile was measured from the reference point each time it is run. Since the reference points locations and elevations were determined by GNSS, the profile lines are referenced to each other and have absolute elevations. Each profile is run perpendicular to the beach based on at least two line of sight markers.

GPS Rover. Beach profiles were also run in summer, 2015 with a GNSS Rover which consisted of a three-wheeled dolly with a central fixed height antenna and water resistant housing storing an Ashtech receiver (Proflex 500) (Figure 4). The GNSS log was corrected during post-processing using Continuously Operating Reference Stations (CORS) located in either Salisbury, Massachusetts or Durham, New Hampshire. The elevations were determined in reference to the ellipsoid (WGS84) and adjusted to Mean Lower Low Water (MLLW) referenced to NAD83 (1986) using VDatum 3.5 (NOAA; http://vdatum.noaa.gov/; downloaded February 2016).

Figure 3. Measuring a beach profile using the Emery method at Hampton Beach on June 18, 2015.

Figure 4. Measuring a beach profile at Wallis Sands using the GNSS Rover system on August 3, 2016.

Results

The results of the study of the beach sediment grain size conducted during summer 2015 is presented in this report as a series of figures, photographs, and tables for each of the seven major beaches in NH. The results for the beaches are presented in a sequence running from north to south (Figures 5-27 and Tables 1-14). At present there has not been a synthesis and interpretation of the data as complete seasonal sampling has not been done.

Wallis Sands, New Hampshire

Figure 5. Location map of profile stations and beach sediment sampling locations during summer, 2015 at Wallis Sands, New Hampshire. The results of the grain size analyses are given in Tables 1 and 2.

Figure 6. Wallis Sands State Park, New Hampshire. View looking south on June 10, 2015.

Figure 7. Wallis Sands beach on June 10, 2015 looking south from near profile WS_02.

Figure 8. Wallis Sands beach on January 14, 2016 looking south from near profile WS_02. Note scattered pebbles on surface of beach during the higher energy winter period.

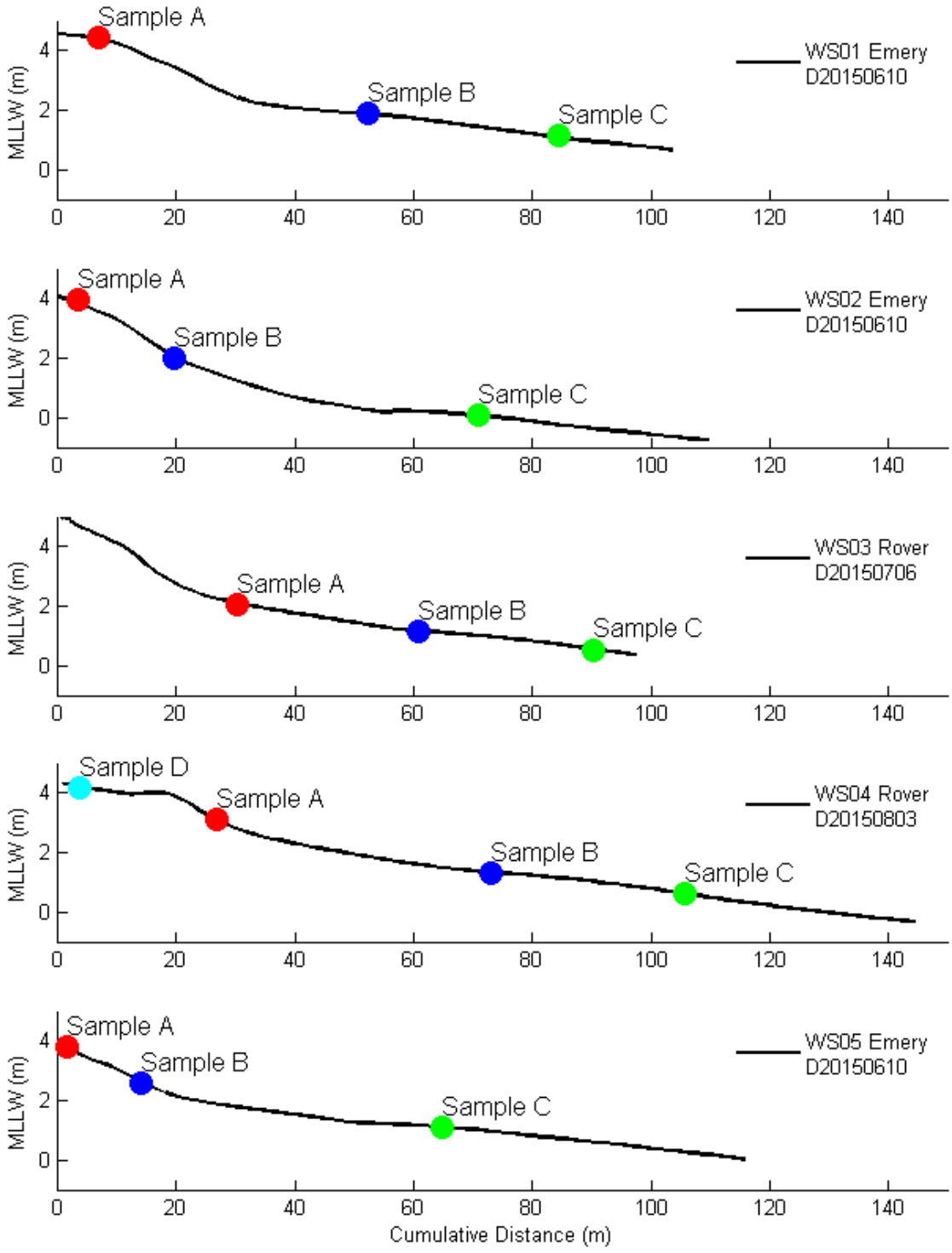

Figure 9. Beach profiles and sediment sample locations for Wallis Sands, New Hampshire in summer, 2015. The method used to measure the beach profile (Emery or Rover) is also given in the legend. The results of the grain size analyses are given in Tables 1 and 2.

Table 1. Location, textural group, sediment name, and sorting of samples from Wallis Sands, New Hampshire. Abbreviations used in this table include *Sl* for Slightly and *Mod* for Moderately.

Station Number	Latitude	Longitude	Sample Collecte	Textural Group %GSM from Gradistat	Abbrev	Sediment Name %GSM and Mode in Wentworth Scale	Abbrev	Classification Mean Phi Size	Abbrev	Sorting from Gradistat	Abbrev
WS_01_A	43.027650	-70.728350	20150610	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Medium Sand	mdS	Poorly Sorted	PS
WS_01_B	43.027350	-70.727967	20150610	Sl Gravelly Sand	(g)S	Sl GranularMedium Sand	(gr)mdS	Medium Sand	mdS	Mod Sorted	MS
WS_01_C	43.027167	-70.727667	20150610	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Medium Sand	mdS	Mod Sorted	MS
WS_02_A	43.024817	-70.730817	20150610	Sl Gravelly Sand	(g)S	Sl GranularMedium Sand	(gr)mdS	Medium Sand	mdS	Mod Well Sorted	MWS
WS_02_B	43.024733	-70.730650	20150610	Sl Gravelly Sand	(g)S	Sl Granular Coarse Sand	slgmS	Medium Sand	mdS	Mod Well Sorted	MWS
WS_02_C	43.024500	-70.730100	20150610	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Sorted	MS
WS_03_A	43.022817	-70.731617	20150706	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Fine Sand	fS	Mod Well Sorted	MWS
WS_03_B	43.022733	-70.731267	20150706	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Sorted	MS
WS_03_C	43.022633	-70.730917	20150706	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Medium Sand	mdS	Mod Well Sorted	MWS
WS_04_A	43.021633	-70.731983	20150803	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Well Sorted	MWS
WS_04_B	43.021533	-70.731433	20150803	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Fine Sand	fS	Mod Well Sorted	MWS
WS_04_C	43.021467	-70.731050	20150803	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Well Sorted	MWS
WS_04_D	43.021683	-70.732267	20150803	Sl Gravelly Sand	(g)S	Sl Pebbly Medium Sand	(p)mdS	Medium Sand	mdS	Mod Well Sorted	MWS
WS_05_A	43.020667	-70.732483	20150610	Sand	S	Medium Sand	mdS	Medium Sand	mdS	Mod Well Sorted	MWS
WS_05_B	43.020683	-70.732300	20150610	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Well Sorted	MWS
WS_05_C	43.020600	-70.731683	20150610	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Well Sorted	MWS

Table 2. Statistics and size distribution of samples from Wallis Sands, New Hampshire. The definition of the abbreviations are given in Table 1.

Wallis Sands		D20150610 WS_01			D20150610 WS_02			D20150706 WS_03			D20150803 WS_04				D20150610 WS_05		
		A	B	C	A	B	C	A	B	C	A	B	C	D	A	B	C
Textural Group		(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	S	(g)S	(g)S
Sediment Name		(vfg)fS	(vfg)mdS	(vfg)fS	(vfg)mdS	(vfg)cS	(vfg)mdS	(vfg)fS	(vfg)mdS	(vfg)fS	(vfg)mdS	(vfg)fS	(vfg)mdS	(fg)mdS	mdS	(vfg)mdS	(vfg)mdS
Sed Name (Wentworth)		(gr)fS	(gr)mdS	(gr)fS	(gr)mdS	slgmS	(gr)mdS	(gr)fS	(gr)mdS	(gr)fS	mdS	fS	mdS	mdS	mdS	(gr)mdS	(gr)mdS
Sorting		PS	MS	MS	MWS	MWS	MS	MWS	MS	MWS	MWS	MWS	MWS	MWS	MWS	MWS	MWS
Modes		Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni
%G		3.5	1.0	1.0	0.0	0.1	1.5	0.1	1.2	0.6	0.0	0.2	0.4	0.4	0.0	0.0	O.2
%S		96.0	98.6	98.8	99.7	99.5	98.2	99.8	98.7	99.3	100.0	99.8	99.5	99.6	100.0	100.0	99.5
%M		0.5	0.4	0.2	0.2	0.4	0.3	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.3
Mean - phi		1.5	1.6	1.6	1.1	1.1	1.4	2.0	1.7	1.9	1.8	2.0	1.7	1.7	1.6	1.8	1.3
Mean mm		0.363	0.340	0.319	0.475	0.472	0.379	0.245	0.315	0.270	0.293	0.246	0.311	0.299	0.337	0.291	0.397
Sorting - phi		1.149	0.872	0.869	0.560	0.688	0.840	0.56	0.75	0.61	0.63	0.52	0.66	0.53	0.50	0.56	0.63
Skewness		-0.234	-0.171	-0.255	0.018	0.156	-0.120	-0.316	-0.281	-0.252	-0.267	-0.177	-0.101	-0.142	-0.110	-0.148	-0.075
Kurtosis		0.909	0.893	0.929	0.98	0.91	0.897	1.373	1.165	1.241	1.027	1.147	1.024	1.192	1.033	0.969	1.009
D10 - phi		-0.2	0.3	0.4	0.3	0.2	0.2	1.1	0.6	1.0	0.8	1.3	0.7	1.0	0.9	1.0	0.5
D50 - phi		1.6	1.7	1.8	1.1	1.0	1.4	2.1	1.8	2.0	1.9	2.1	1.7	1.8	1.6	1.8	1.4
D90 - phi		2.8	2.6	2.7	1.8	2.0	2.4	2.6	2.4	2.5	2.4	2.7	2.4	2.4	2.2	2.4	2.1
D10 - microns		0.872	1.265	1.349	1.252	1.167	1.133	2.188	1.472	2.018	1.766	2.397	1.670	2.040	1.865	2.049	1.456
D50 - microns		3.054	3.150	3.475	2.076	2.005	2.632	4.357	3.430	3.923	3.670	4.225	3.314	3.402	3.042	3.547	2.570
D90 - microns		6.842	5.916	6.303	3.525	3.984	5.112	6.216	5.363	5.599	5.384	6.345	5.411	5.151	4.654	5.345	4.298
Total Sample Wt - gms		61.3	84.8	98.5	55.4	49.3	57.2	61.8	90.4	73.4	59.1	66.3	97.9	53.3	46.1	97.8	108.8
Class (ϕ)	-3.0																
	-2.5																
Gravel	-2.0	0.2		0.2					0.1	0.2			0.1	0.2			
	-1.5	1.3	0.4	0.1		0.2	0.8	0.1	0.5	0.2		0.1	0.1	0.1			
	-1.0	2.0	0.5	0.7	0.0	0.0	0.6	0.1	0.6	0.2	0.0	0.1	0.2	0.0		0.0	0.2
	-0.5	3.3	1.2	1.2	0.2	0.3	1.6	0.2	1.2	0.4	0.1	0.1	0.2	0.1	0.0	0.1	0.5
	0.0	5.4	2.9	2.7	2.1	2.5	3.7	0.6	2.0	0.8	0.6	0.2	0.8	0.2	0.1	0.2	1.6
	0.5	8.8	7.3	5.9	11.7	15.7	9.0	2.2	4.5	2.3	3.2	0.9	3.3	1.5	1.5	1.1	5.9
	1.0	13.5	14.9	13.1	32.4	31.2	18.7	5.1	8.8	5.6	9.4	3.7	10.8	6.8	10.5	7.2	19.5
Sand	1.5	12.4	16.6	14.4	32.3	21.8	19.5	6.7	13.6	10.8	14.0	9.1	18.8	16.6	28.6	19.2	30.5
	2.0	13.9	19.4	19.5	17.6	18.6	21.7	22.4	33.3	31.2	30.0	28.7	33.9	45.2	42.3	33.7	29.5
	2.5	20.9	25.0	27.8	3.0	8.6	19.3	48.7	28.5	38.1	36.1	42.3	23.8	24.8	15.1	32.2	10.6
	3.0	14.6	10.2	12.8	0.3	0.7	4.3	13.0	6.0	9.3	6.1	13.2	6.5	3.7	1.7	5.9	1.4
	3.5	2.2	1.1	1.4	0.1	0.1	0.5	0.9	0.8	0.7	0.4	1.6	1.4	0.5	0.2	0.3	0.1
	4.0	1.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Mud	<4.0	0.5	0.4	0.2	0.2	0.4	0.3	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.3

Foss Beach, New Hampshire

Figure 10. Location map of profile stations and beach sediment sampling locations during summer, 2015 at Foss Beach, New Hampshire. The results of the grain size analyses are given in Tables 3 and 4.

Figure 11. Photograph of Foss Beach taken on July 18, 2015 looking north from near profile FB_04.

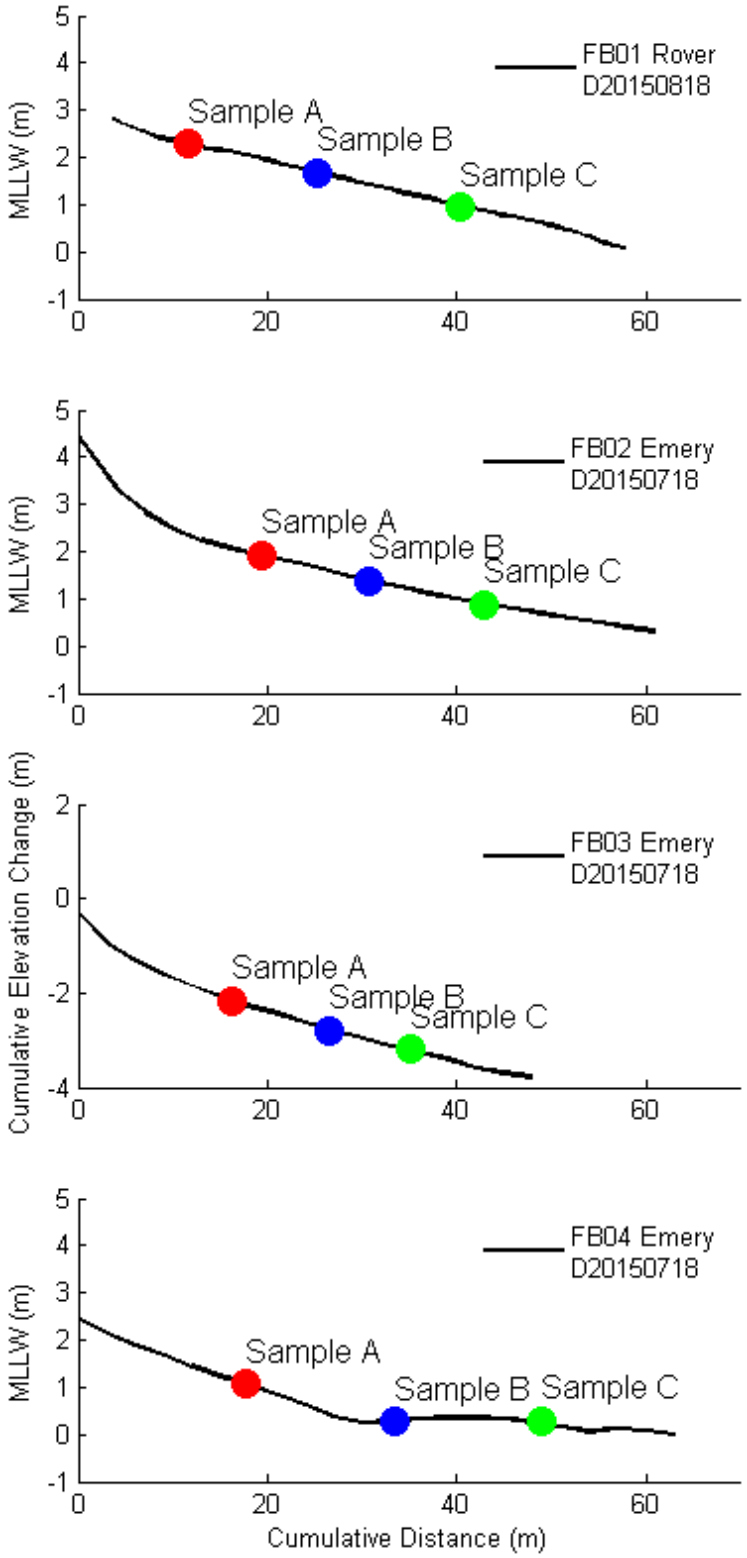

Figure 12. Beach profiles and sediment sample locations for Foss Beach, New Hampshire in summer, 2015. The method used to measure the beach profile (Emery or Rover) is also given in the legend. The results of the grain size analyses are given in Tables 3 and 4.

Table 3. Location, textural group, sediment name, and sorting of samples from Foss Beach, New Hampshire. Abbreviations used in this table include *Sl* for Slightly and *Mod* for Moderately.

Station Number	Latitude	Longitude	Sample Collecte	Textural Group %GSM from Gradistat	Abbrev	Sediment Name %GSM and Mode in Wentworth Scale	Abbrev	Classification Mean Phi Size	Abbrev	Sorting from Gradistat	Abbrev
FB_02_A	43.00769	-70.74386	20150718	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Fine Sand	fS	Well Sorted	WS
FB_02_B	43.00765	-70.74373	20150718	Sand	S	Fine Sand	fS	Fine Sand	fS	Well Sorted	WS
FB_02_C	43.00759	-70.74360	20150718	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Fine Sand	fS	Well Sorted	WS
FB_03_A	43.00580	-70.74470	20150718	Gravelly Sand	gS	Pebbly fine Sand	pfS	Fine Sand	fS	Mod Sorted	MS
FB_03_B	43.00577	-70.74458	20150718	Gravelly Sand	gS	Pebbly fine Sand	pfS	Coarse Sand	cS	Poorly Sorted	PS
FB_03_C	43.00579	-70.74447	20150718	Gravelly Sand	gS	Pebbly fine Sand	pfS	Medium Sand	mdS	Poorly Sorted	PS
FB_04_A	43.00352	-70.74486	20150718	Gravelly Sand	gS	Pebbly fine Sand	pfS	Medium Sand	mdS	Poorly Sorted	PS
FB_04_B	43.00351	-70.74466	20150718	Sand	S	Fine Sand	fS	Fine Sand	fS	Very Well Sorted	VWS
FB_04_C	43.00355	-70.74447	20150718	Sand	S	Fine Sand	fS	Fine Sand	fS	Very Well Sorted	VWS

Table 4. Statistics and size distribution of samples from Foss Beach, New Hampshire. The definition of the abbreviations are given in Table 3.

Foss Beach		D20150718 FB_02			D20150718 FB_03			D20150718 FB_04		
		A	B	C	A	B	C	A	B	C
Textural Group		(g)S	S	(g)S	gS	gS	gS	gS	S	S
Sediment Name		(vfg)fS	fS	(vfg)fS	fgfS	fgfS	fgfS	fgfS	fS	fS
Sed Name (Wentworth)		(gr)fS	fS	(gr)fS	pfS	pfS	pfS	pfS	fS	fS
Sorting		WS	WS	WS	MS	PS	PS	PS	VWS	VWS
Modes		Uni	Uni	Uni	Uni	Bi	Bi	Bi	Uni	Uni
%G		0.1	0.0	0.3	6.1	27.2	20.0	14.6	0.0	0.0
%S		99.9	99.9	99.5	93.7	72.7	79.9	85.3	99.8	99.8
%M		0.0	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.2
Mean - phi		2.5	2.3	2.5	2.2	0.8	1.1	1.5	2.3	2.3
Mean mm		0.174	0.197	0.181	0.218	0.564	0.452	0.346	0.197	0.199
Sorting - phi		0.49	0.388	0.44	0.84	1.97	1.84	1.54	0.33	0.33
Skewness		0.274	0.143	0.114	-0.425	-0.780	-0.732	-0.722	0.220	0.178
Kurtosis		0.928	1.486	1.05	4.78	0.53	0.816	4.722	1.385	1.43
D10 - phi		2.0	1.8	2.0	0.9	-2.3	-2.1	-1.8	2.0	2.0
D50 - phi		2.4	2.3	2.4	2.2	2.2	2.2	2.2	2.3	2.3
D90 - phi		3.2	2.9	3.0	2.7	2.7	2.9	2.8	2.8	2.8
D10 - microns		0.247	0.278	0.247	0.527	4.872	4.205	3.598	0.247	0.248
D50 - microns		0.189	0.205	0.187	0.213	0.225	0.218	0.211	0.204	0.206
D90 - microns		0.107	0.136	0.126	0.151	0.151	0.139	0.141	0.139	0.142
Total Sample Wt - gms		68.7	84.6	70.7	66.9	144.3	89.5	63.8	85.0	95.0
Class (ϕ)	-3.0									
	-2.5									
Gravel	-2.0				3.3	24.2	11.7	9.3		
	-1.5	0.1		0.3	1.6	1.5	4.1	2.5		
	-1.0	0.0		0.0	1.2	1.6	4.2	2.9		
Sand	-0.5	0.1	0.2	0.1	1.7	1.4	3.8	1.2	0.0	
	0.0	0.2	0.3	0.2	1.2	1.0	1.9	0.5	0.0	0.0
	0.5	0.3	0.4	0.4	0.6	0.4	0.6	0.2	0.0	0.0
	1.0	0.4	0.6	0.5	0.5	0.2	0.3	0.2	0.2	0.2
	1.5	0.9	1.2	1.0	0.7	0.3	0.5	0.6	0.6	0.5
	2.0	6.2	10.4	5.9	8.1	3.8	4.5	5.0	6.2	7.9
	2.5	49.7	61.6	47.2	63.5	49.2	43.5	52.9	69.3	69.4
	3.0	23.0	20.1	35.1	15.6	13.4	20.8	22.2	19.2	18.4
	3.5	19.1	5.0	8.8	1.7	3.0	3.9	2.4	3.8	3.3
	4.0	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.3	0.1
Mud	<4.0	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.2

Jenness Beach, New Hampshire

Figure 13. Location map of profile stations and sediment sampling sites during summer, 2015 at Jenness Beach, New Hampshire.

Figure 14. Photograph of Jenness Beach taken on June 11, 2015 looking north from near profile JB_02.

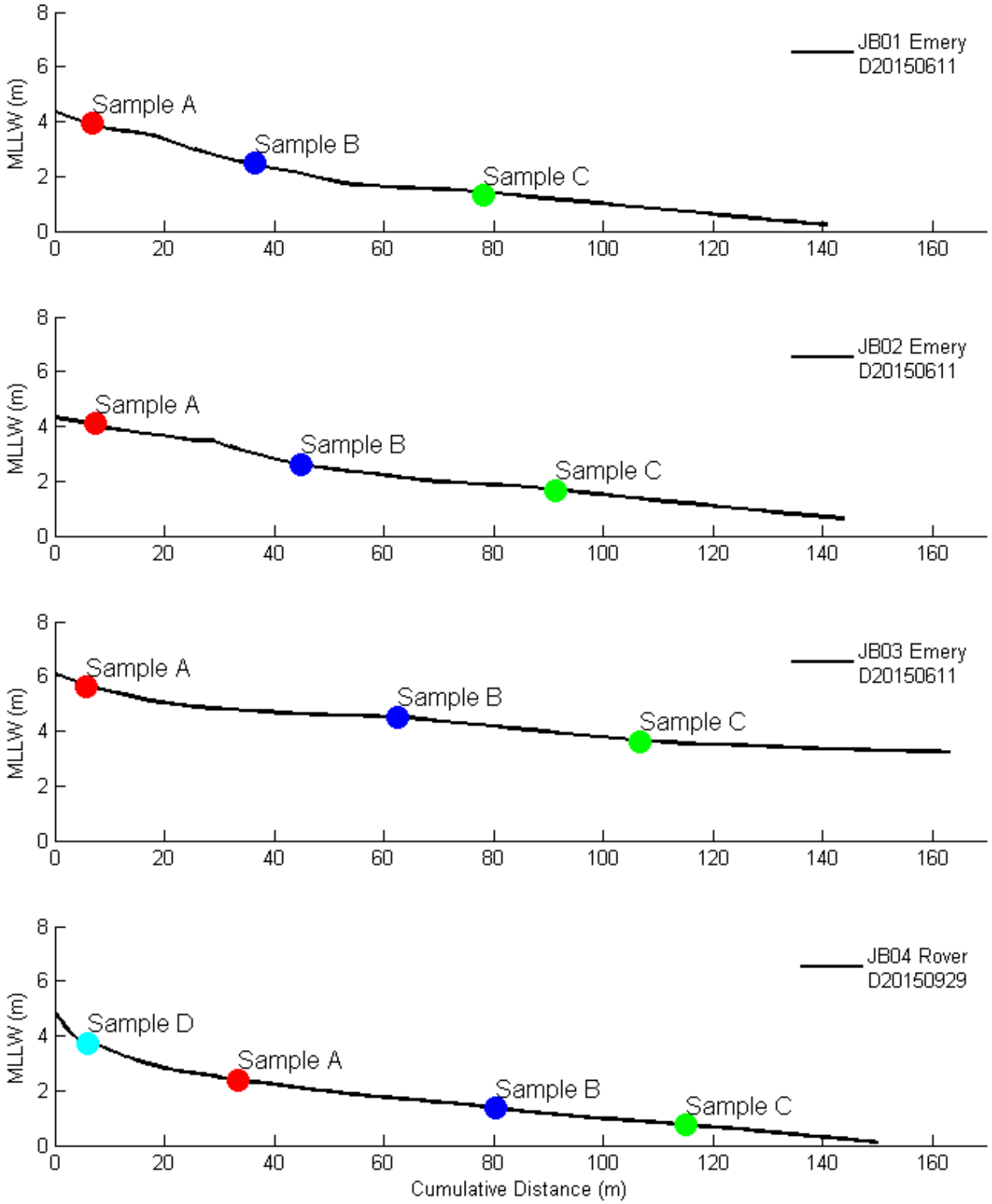

Figure 15. Beach profiles and sediment sample locations for Jenness Beach, New Hampshire in summer, 2015. The method used to measure the beach profile (Emery or Rover) is also given in the legend. The results of the grain size analyses are given in Tables 5 and 6.

Table 5. Location and grain size classifications for Jenness Beach, New Hampshire. Abbreviations used in this table include *Sl* for Slightly and *Mod* for Moderately.

Station Number	Latitude	Longitude	Sample Collecte	Textural Group %GSM from Gradistat	Abbrev	Sediment Name %GSM and Mode in Wentworth Scale	Abbrev	Classification Mean Phi Size	Abbrev	Sorting from Gradistat	Abbrev
JB_01_A	42.988683	-70.760167	20150611	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mS	Medium Sand	**mdS**	Mod Well Sorted	MWS
JB_01_B	42.988550	-70.759850	20150611	Sandy Gravel	sG	Sandy Granular Gravel	sgrG	Very Coarse Sand	**vcS**	Poorly Sorted	PS
JB_01_C	42.988350	-70.759433	20150611	Slighjtly Gravelly Sand	(g)S	Sl Pebbly Fine Sand	(p)fS	Fine Sand	fS	Poorly Sorted	PS
JB_02_A	42.985750	-70.762333	20150611	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Fine Sand	fS	Well Sorted	WS
JB_02_B	42.985617	-70.761900	20150611	Sandy Gravel	sG	Sandy Pebbly Gravel	spG	Coarse Sand	cS	Poorly Sorted	PS
JB_02_C	42.985467	-70.761367	20150611	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Fine Sand	fS	Mod Sorted	MS
JB_03_A	42.982833	-70.763433	20150611	Sandy Gravel	sG	Sandy Pebbly Gravel	spG	Granular Gravel	**grS**	Very Poorly Sorted	VPS
JB_03_B	42.982717	-70.762767	20150611	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Fine Sand	**fS**	Well Sorted	WS
JB_03_C	42.982567	-70.762250	20150611	Sl Gravelly Sand	(g)S	Sl Pebbly Fine Sand	(p)fS	Medium Sand	**mdS**	Poorly Sorted	PS
JB_04_A	42.980433	-70.764167	20150803	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(g)fS	Fine Sand	fS	Mod Well Sorted	MWS
JB_04_B	42.980333	-70.763600	20150803	Sl Gravelly Sand	(g)S	Sl Pebbly Fine Sand	(p)fS	Fine Sand	fS	Mod Well Sorted	MWS
JB_04_C	42.980267	-70.763183	20150803	Sl Gravelly Sand	(g)S	Sl Pebbly Fine Sand	(p)fS	Fine Sand	fS	Well Sorted	WS
JB_04_D	42.980467	-70.764517	20150803	Gravelly sand	gS	Pebbly Fine Sand	pfS	Medium sand	mdS	Poorly Sorted	PS

Table 6. Statistics and size distribution of samples from Jenness Beach, New Hampshire. The definition of the abbreviations are given in Table 5.

Jenness Beach		D20150611 JB_01			D20150611 JB_02			D20150611 JB_03			D20150803 JB_04			
		A	B	C	A	B	C	A	B	C	A	B	C	D
Textural Group		(g)S	sG	(g)S	(g)S	sG	(g)S	sG	(g)S	(g)S	(g)S	(g)S	(g)S	gS
Sediment Name		(vfg)mdS	svfgfS	(fg)fS	(vfg)fS	sfG	(vfg)fS	smdG	(vfg)fS	(fg)fS	(vfg)fS	(fg)fS	(fg)fS	vfgS
Sed Name (Wentworth)		(gr)mS	sgrG	(p)fS	(gr)fS	spG	(gr)fS	spG	(gr)fS	(p)fS	(g)fS	(p)fS	(p)fS	pfS
Sorting		MWS	PS	PS	WS	PS	MS	VPS	WS	PS	MWS	MWS	WS	PS
Modes		Uni	Bi	Uni	Uni	Bi	Uni	Bi	Uni	Bi	Uni	Uni	Uni	Uni
%G		0.1	52.8	5.0	0.0	37.4	1.8	60.7	0.0	1.7	0.2	1.5	1.3	14.3
%S		99.7	47.1	95.0	99.8	62.4	98.0	39.3	99.5	98.1	99.7	98.5	98.6	85.7
%M		0.2	0.1	0.0	0.2	0.1	0.2	0.0	0.5	0.2	0.1	0.0	0.1	0.0
Mean - phi		1.3	-0.9	2.1	2.0	0.0	2.1	-1.6	2.3	1.9	2.4	2.4	2.5	1.9
Mean mm		0.395	1.839	0.228	0.244	0.994	0.240	3.076	0.200	0.272	0.195	0.186	0.180	0.265
Sorting - phi		0.690	1.141	1.071	0.435	1.674	0.816	2.606	0.433	1.046	0.504	0.520	0.047	1.056
Skewness		0.023	0.346	-0.572	0.031	-0.384	-0.340	0.672	-0.057	-0.503	-0.028	-0.084	0.017	-0.555
Kurtosis		0.948	1.280	1.901	1.008	0.531	1.089	0.498	1.029	1.449	1.137	1.206	1.112	2.971
D10 - phi		0.5	-2.0	0.2	1.5	-2.3	0.8	-4.2	1.7	0.3	1.7	1.7	1.9	-1.5
D50 - phi		1.3	-1.1	2.4	2.0	0.6	2.2	-3.1	2.3	2.3	2.3	2.4	2.4	2.1
D90 - phi		2.3	0.8	3.0	2.6	1.9	2.9	2.4	2.9	2.9	2.9	3.0	3.0	2.6
D10 - microns		0.701	3.954	0.896	0.344	5.060	0.557	18.095	0.311	0.829	0.318	0.308	0.260	2.819
D50 - microns		0.400	2.077	0.186	0.243	0.661	0.219	8.441	0.201	0.203	0.197	0.184	0.184	0.235
D90 - microns		0.207	0.568	0.128	0.161	0.271	0.134	0.192	0.138	0.130	0.130	0.126	0.126	0.162
Total Sample Wt - gms		60.0	62.4	100.1	106.2	152.3	91.0	135.4	90.8	127.9	84.8	82.6	87.4	87.6
Class (ϕ)	-4.0							15.8						
	-3.5							25.2						
	-3.0							10.7						
Gravel	-2.5							5.8						
	-2.0		9.4	2.6		33.2	0.8	1.2		0.9		1.2	0.7	5.9
	-1.5		18.5	0.8		2.6	0.4	1.4		0.4		0.1	0.4	4.2
	-1.0	0.1	24.9	1.6	0.0	1.7	0.6	0.6	0.0	0.4	0.2	0.2	0.2	4.2
	-0.5	0.4	16.2	2.2	0.0	2.0	0.9	0.8	0.1	0.4	0.3	0.1	0.2	1.1
	0.0	1.6	11.8	2.1	0.0	2.7	1.3	0.7	0.2	0.4	0.3	0.2	0.2	0.0
	0.5	7.2	6.9	2.3	0.1	5.5	2.2	0.8	0.3	13.7	0.4	0.4	0.3	0.0
	1.0	22.1	3.7	3.5	0.5	11.8	5.5	1.1	0.9	1.2	1.1	1.1	0.7	0.1
Sand	1.5	28.7	2.1	4.7	5.8	19.3	10.7	2.5	3.0	2.5	3.5	2.8	1.6	1.0
	2.0	22.7	1.8	7.0	39.8	14.6	15.9	10.0	14.8	7.6	13.3	9.2	6.4	24.5
	2.5	12.9	2.3	25.9	40.1	5.4	28.8	16.7	46.0	35.1	43.0	36.9	42.0	45.8
	3.0	3.4	1.8	40.4	11.5	0.8	28.6	5.9	34.2	30.8	31.3	38.4	37.8	10.5
	3.5	0.8	0.4	6.9	1.8	0.3	4.1	0.8	0.0	6.2	6.5	8.9	9.1	2.4
	4.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.3	0.4	0.1
Mud	<4.0	0.2	0.1	0.0	0.2	0.2	0.2	0.0	0.5	0.2	0.1	0.0	0.1	0.0

North Hampton Beach, New Hampshire

Figure 16. Location map of profile stations and sediment sampling sites during summer 2015 at North Hampton Beach, New Hampshire.

Figure 17. North Hampton Beach on August 17, 2015 looking south from near profile NH_02.

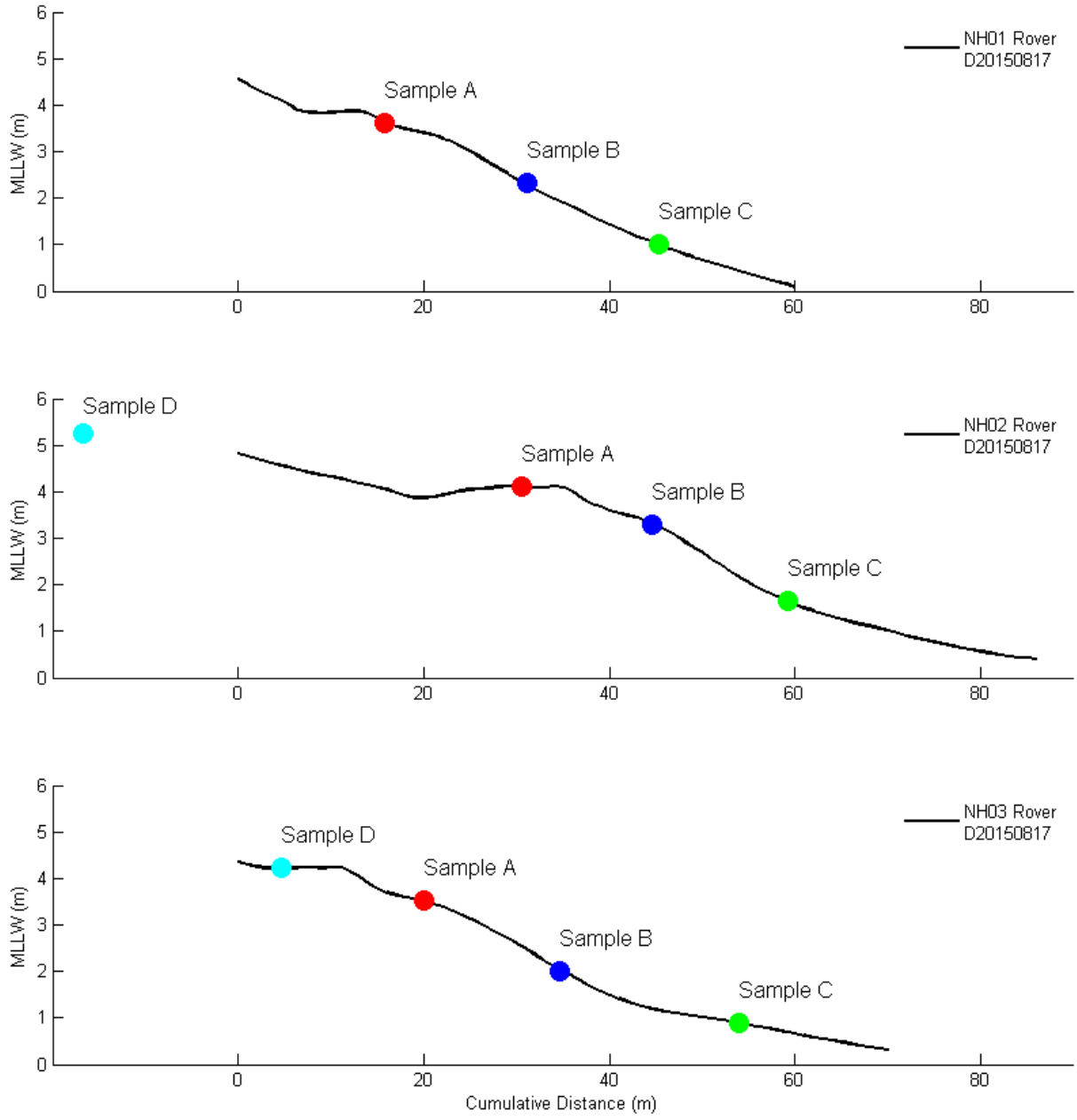

Figure 18. Beach profiles and sediment sample locations for North Hampton Beach, New Hampshire in summer, 2015. The method used to measure the beach profile (Emery or Rover) is also given in the legend. The results of the grain size analyses are given in Tables 7 and 8.

Table 7. Location and grain size classifications for North Hampton Beach, New Hampshire. Abbreviations used in this table include *Sl* for Slightly and *Mod* for Moderately.

Station Number	Latitude	Longitude	Sample Collecte	Textural Group %GSM from Gradistat	Abbrev	Sediment Name %GSM and Mode in Wentworth Scale	Abbrev	Classification Mean Phi Size	Abbrev	Sorting from Gradistat	Abbrev
NH_01_A	42.955620	-70.781110	20150817	Sand	S	Medium Sand	mdS	Medium Sand	mdS	Well Sorted	WS
NH_01_B	42.955560	-70.780940	20150817	Sand	S	Medium Sand	mdS	Medium Sand	mdS	Mod Sorted	MS
NH_01_C	42.955470	-70.780810	20150817	Gravelly Sand	gS	Pebbly Medium Sand	pmdS	Coarse Sand	cS	Poorly Sorted	PS
NH_02_A	42.950500	-70.785600	20150817	Sl Gravelly Sand	(g)S	Sl Pebbly Medium Sand	(p)mdS	Medium Sand	mdS	Well Sorted	WS
NH_02_B	42.950440	-70.785440	20150817	Sl Gravelly sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Sorted	MS
NH_02_C	42.950370	-70.785220	20150817	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Sorted	MS
NH_02_D	42.950550	-70.785770	20150817	Sand	S	Medium Sand	mdS	Medium Sand	mdS	Mod Well Sorted	MWS
NH_03_A	42.952170	-70.784310	20150817	Sand	S	Medium Sand	mdS	Medium Sand	mdS	Well Sorted	WS
NH_03_B	42.952100	-70.784170	20150817	Gravelly sand	gS	Granular Medium Sand	grmdS	Coarse Sand	cS	Poorly Sorted	PS
NH_03_C	42.951990	-70.784050	20150817	Gravelly Sand	gS	Granular Medium Sand	grmdS	Coarse Sand	cS	Poorly Sorted	PS
NH_03_D	42.952360	-70.784820	20150817	Sl Gravelly Sand	(g)S	Sl Pebbly Medium Sand	(p)mdS	Medium Sand	mdS	Mod Well Sorted	MWS

Table 8. Statistics and size distribution of samples from North Hampton Beach, New Hampshire. The definition of the abbreviations are given in Table 7.

North Hampton		D20150817 NH_01			D20150817 NH_02				D20150817 NH_03			
		A	B	C	A	B	C	D	A	B	C	D
Textural Group		S	S	gS	(g)S	(g)S	(g)S	S	S	gS	gS	(g)S
Sediment Name		mdS	mdS	fgmdS	(fg)mdS	(vfg)mdS	(vfg)mdS	mdS	mdS	vfgmdS	vfgmdS	(vfg)mdS
Sed Name (Wentworth)		mdS	mdS	pmdS	(p)mdS	(gr)mdS	(gr)mdS	mdS	mdS	grmdS	grmdS	(p)mdS
Sorting		WS	MS	PS	WS	MS	MS	MWS	WS	PS	PS	MWS
Modes		Uni	Uni	Bi	Uni	Uni	Uni	Uni	Uni	Bi	Uni	Uni
%G		0.0	0.0	25.7	0.8	4.3	4.3	0.0	0.0	14.2	12.9	2.1
%S		100.0	100.0	74.3	99.2	95.7	95.7	100.0	100.0	85.8	87.1	97.9
%M		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean - phi		1.7	1.6	0.6	1.5	1.4	1.5	1.2	1.7	0.8	0.8	1.3
Mean mm		0.302	0.328	0.674	0.346	0.377	0.343	0.425	0.301	0.593	0.578	0.394
Sorting - phi		0.455	0.796	1.821	0.495	0.790	0.737	0.627	0.387	1.346	1.309	0.597
Skewness		-0.072	-0.260	-0.620	-0.190	-0.048	-0.436	-0.005	-0.054	-0.479	-0.512	-0.185
Kurtosis		1.376	1.348	0.668	1.108	1.660	1.942	0.992	1.361	0.944	0.996	1.181
D10 - phi		1.1	0.4	-2.2	0.8	0.1	0.5	0.5	1.2	-1.4	-1.4	0.6
D50 - phi		1.7	1.7	1.5	1.6	1.6	1.7	1.2	1.7	1.2	1.2	1.4
D90 - phi		2.3	2.4	2.4	2.1	2.1	2.2	2.0	2.3	2.1	2.0	2.0
D10 - microns		0.463	0.733	4.625	0.568	0.904	0.709	0.717	0.443	2.690	2.557	0.682
D50 - microns		0.299	0.306	0.344	0.332	0.332	0.317	0.425	0.299	0.439	0.429	0.380
D90 - microns		0.201	0.186	0.192	0.236	0.236	0.215	0.253	0.210	0.240	0.254	0.256
Total Sample Wt - gms		82.3	80.1	117.5	66.1	84.0	101.6	62.8	87.2	106.5	129.7	81.3
Class (ϕ)	-3.0											
	-2.5											
Gravel	-2.0			17.6	0.5	1.6	2.0			5.4	5.9	1.5
	-1.5			4.1	0.2	1.3	1.1			4.0	3.0	0.3
	-1.0			4.0	0.1	1.4	1.2			4.8	4.0	0.3
	-0.5	0.0	2.8	4.1	0.4	1.9	1.4	0.2	0.0	5.8	6.1	0.7
	0.0	0.2	3.5	3.0	0.6	2.6	1.7	1.8	0.2	6.6	6.3	1.3
	0.5	0.9	4.2	2.9	2.2	4.0	2.6	8.3	0.6	7.3	7.3	4.2
	1.0	5.0	8.3	4.2	9.3	8.6	6.5	24.5	3.8	10.6	10.6	14.7
Sand	1.5	17.4	15.2	7.5	27.7	19.9	17.0	32.1	15.4	14.7	15.0	33.9
	2.0	54.5	37.9	29.1	47.0	46.8	50.4	24.1	61.1	29.6	33.1	35.4
	2.5	18.1	20.5	16.7	10.7	10.5	13.3	7.1	17.0	10.1	7.3	7.0
	3.0	3.4	6.7	5.6	1.0	1.1	2.5	1.7	1.8	1.1	1.1	0.7
	3.5	0.5	1.0	1.1	0.2	0.2	0.3	0.3	0.1	0.1	0.1	0.1
	4.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mud	<4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

North Beach, New Hampshire

Figure 19. Location map of profile stations and sediment sampling sites during summer, 2015 at North Beach, New Hampshire.

Figure 20. North Beach on June 20, 2015 looking south from near profile NB_01.

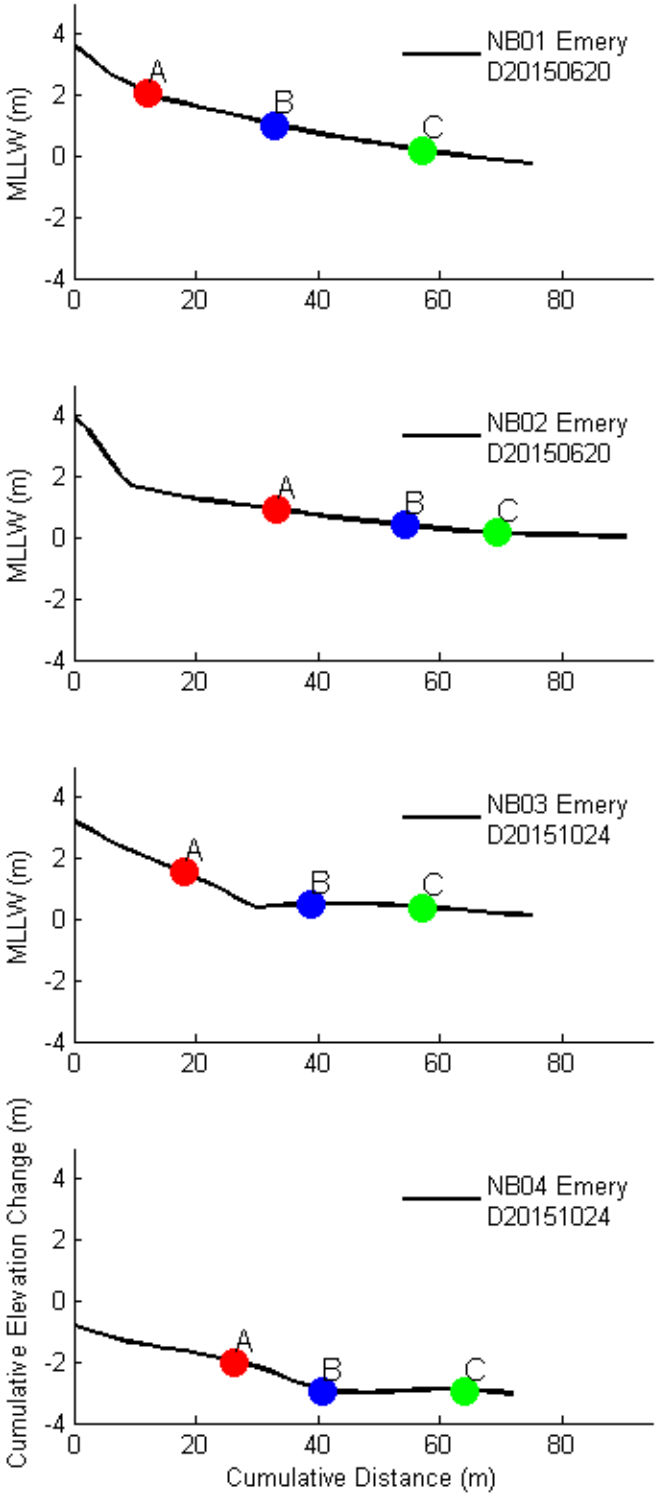

Figure 21. Beach profiles and sediment sample locations for North Beach, New Hampshire in summer 2015. The method used to measure the beach profile (Emery or Rover) is also given in the legend. The results of the grain size analyses are given in Tables 9 and 10.

Table 9. Location and grain size classifications for North Beach, New Hampshire. Abbreviations used in this table include *Sl* for Slightly and *Mod* for Moderately.

Station Number	Latitude	Longitude	Sample Collecte	Textural Group %GSM from Gradistat	Abbrev	Sediment Name %GSM and Mode in Wentworth Scale	Abbrev	Classification Mean Phi Size	Abbrev	Sorting from Gradistat	Abbrev
NB_01_A	42.939483	-70.794500	20150620	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Well Sorted	MWS
NB_01_B	42.939400	-70.794250	20150620	Gravelly Sand	gS	Pebbly Sand	pS	Medium Sand	mdS	Poorly Sorted	PS
NB_01_C	42.939350	-70.793983	20150620	Gravelly Sand	gS	Pebbly Fine Sand	pfS	Medium Sand	mdS	Poorly Sorted	PS
NB_02_A	42.931767	-70.797183	20150620	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Fine Sand	fS	Mod Well Sorted	MWS
NB_02_B	42.931733	-70.796983	20150620	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Fine Sand	fS	Mod Well Sorted	MWS
NB_02_C	42.931683	-70.796750	20150620	Gravelly Sand	gS	Pebbly Fine Sand	pfS	Medium Sand	mdS	Poorly Sorted	PS
NB_03_A	42.928550	-70.798017	20150620	Gravelly Sand	gS	Pebbly Fine Sand	pfS	Fine Sand	fS	Mod Sorted	MS
NB_03_B	42.928500	-70.797767	20150620	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Fine Sand	fS	Well Sorted	WS
NB_03_C	42.928500	-70.797517	20150620	Gravelly Sand	gS	Pebbly Fine Sand	pfS	Coarse Sand	cS	Poorly Sorted	PS

Table 10. Statistics and size distribution of samples from North Beach, New Hampshire. The definition of the abbreviations are given in Table 9.

North Beach		D20150620 NB_01			D20150620 NB_02			D20150620 NB_03		
		A	B	C	A	B	C	A	B	C
Textural Group		(g)S	gS	gS	(g)S	(g)S	gS	gS	(g)S	gS
Sediment Name		(vfg)mdS	mdgS	fgfS	(vfg)fS	(vfg)fS	fgfS	fgfS	(vfg)fS	fgfS
Sed Name (Wentworth)		(gr)mdS	pS	pfS	(gr)fS	(gr)fS	pfS	pfS	(gr)fS	pfS
Sorting		MWS	PS	PS	MWS	MWS	PS	MS	WS	PS
Modes		Uni	Uni	Uni	Uni	Uni	Bi	Uni	Uni	Bi
%G		0.1	6.5	9.2	2.2	1.3	12.3	5.9	2.1	17.6
%S		99.9	93.2	90.9	97.2	98.2	87.6	94.1	97.6	82.4
%M		0.0	0.3	0.0	0.6	0.5	0.1	0.0	0.3	0.0
Mean - phi		1.8	1.5	1.3	2.1	2.1	1.2	2.0	2.1	0.9
Mean mm		0.282	0.349	0.395	0.237	0.234	0.422	0.247	0.238	0.539
Sorting - phi		0.534	1.195	1.352	0.632	0.621	1.466	0.881	0.489	1.790
Skewness		-0.103	-0.488	-0.541	-0.248	-0.230	-0.556	-0.376	-0.243	-0.777
Kurtosis		1.123	1.511	1.326	1.524	1.483	1.367	2.423	1.453	2.601
D10 - phi		1.1	-0.2	-0.891	1.2	1.262	-1.369	0.8	1.5	-2.2
D50 - phi		1.8	1.8	1.780	2.1	2.138	1.762	2.1	2.1	2.0
D90 - phi		2.4	2.5	2.536	2.8	2.775	2.580	2.7	2.6	2.5
D10 - microns		0.467	1.140	1.855	0.431	0.417	2.582	0.594	0.347	4.502
D50 - microns		0.278	0.291	0.291	0.229	0.227	0.295	0.238	0.227	0.247
D90 - microns		0.186	0.181	0.172	0.147	0.146	0.167	0.152	0.167	0.183
Total Sample Wt - gms		74.9	119.1	109.8	88.7	77.0	91.9	72.4	77.5	52.8
Class (ϕ)	-3.0		2.5							
	-2.5		1.3	3.0						
Gravel	-2.0		1.1	1.8	0.5	0.3	7.4	3.0	1.0	15.4
	-1.5	0.0	0.8	1.5	0.8	0.4	1.9	1.4	0.7	1.1
	-1.0	0.0	0.9	2.9	1.0	0.7	3.0	1.5	0.4	1.0
	-0.5	0.0	1.6	4.0	0.7	1.3	3.4	1.2	0.7	1.5
	0.0	0.2	3.0	4.1	0.9	1.0	3.0	1.0	0.6	0.8
	0.5	1.1	5.8	4.6	1.3	1.2	3.4	1.1	0.6	0.6
	1.0	5.6	8.7	5.8	2.4	2.4	6.0	1.7	1.1	1.2
Sand	1.5	14.8	10.0	7.9	5.6	5.1	9.9	4.7	3.2	3.0
	2.0	40.2	25.5	25.6	25.2	25.2	22.8	28.7	26.1	23.5
	2.5	31.3	29.4	27.8	42.9	42.8	27.2	39.4	53.6	43.7
	3.0	5.8	8.2	9.4	15.6	16.8	9.9	13.9	9.4	7.5
	3.5	0.9	0.9	1.7	2.4	2.3	1.9	2.4	2.1	0.5
	4.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Mud	<4.0	0.0	0.3	0.0	0.5	0.5	0.1	0.0	0.3	0.0

Hampton Beach, New Hampshire

Figure 22. Location map of profile stations and sediment sampling sites during summer, 2015 at Hampton Beach, New Hampshire.

Figure 23. Hampton Beach on July 7, 2015 looking south from near profile HB_01. Note beach has been graded in preparation for the visitors that day.

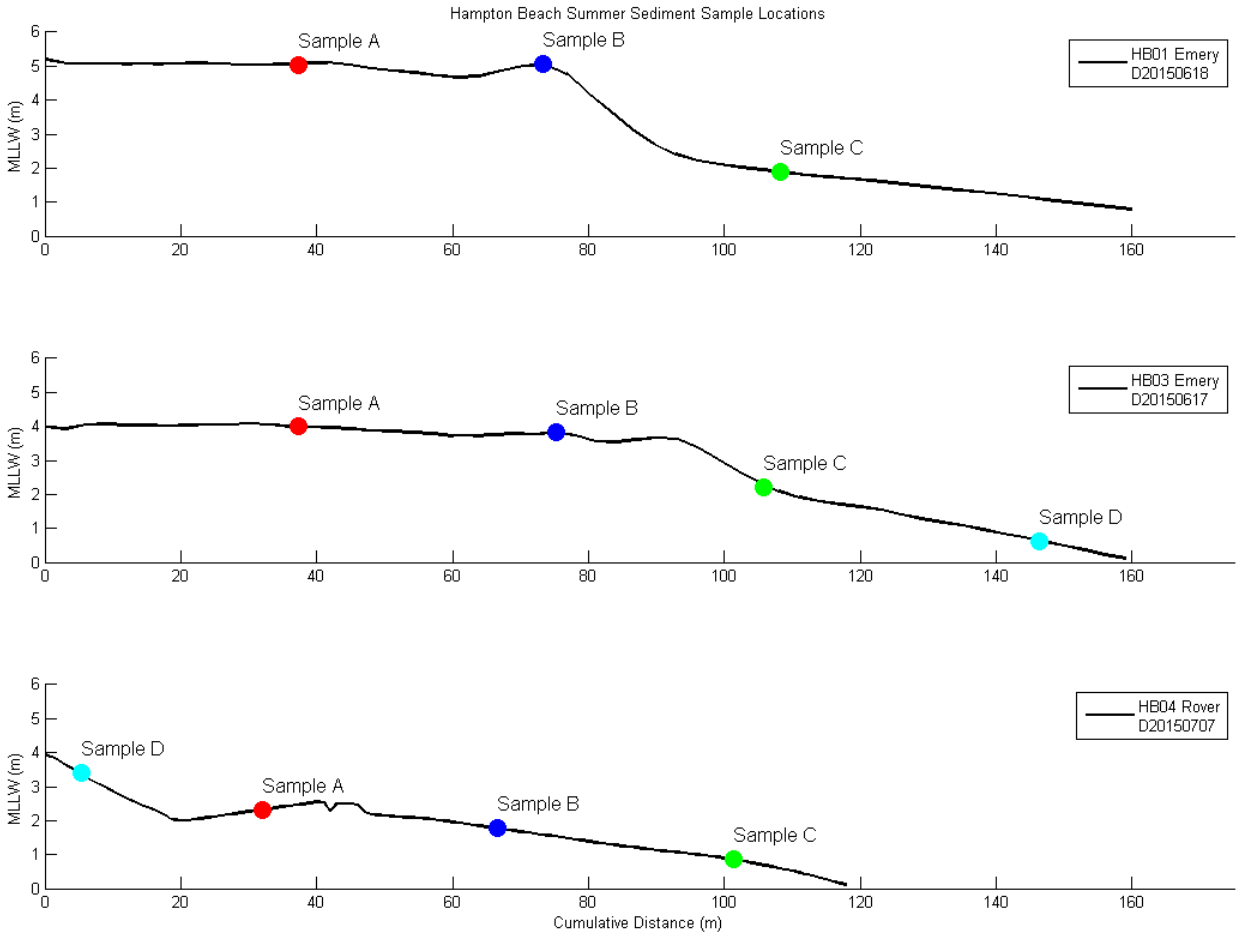

Figure 24. Beach profiles and sediment sample locations for Hampton Beach, New Hampshire in summer 2015. The method used to measure the beach profile (Emery or Rover) is also given in the legend. The results of the grain size analyses are given in Tables 11 and 12.

Table 11. Location and grain size classifications for Hampton Beach, New Hampshire. Abbreviations used in this table include *Sl* for Slightly and *Mod* for Moderately.

Station Number	Latitude	Longitude	Sample Collecte	Textural Group %GSM from Gradistat	Abbrev	Sediment Name %GSM and Mode in Wentworth Scale	Abbrev	Classification Mean Phi Size	Abbrev	Sorting from Gradistat	Abbrev
HB_01_A	42.912933	-70.808400	20150618	Sl Gravelly Sand	(g)S	Sl Granular Coarse Sand	(vfg)cS	Coarse Sand	cS	Mod Sorted	MS
HB_01_B	42.912800	-70.808000	20150618	Sl Gravelly Sand	(g)S	Sl GranularMediumSand	(gr)mdS	Medium Sand	mdS	Mod Well Sorted	MWS
HB_01_C	42.912650	-70.807617	20150618	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Medium Sand	mdS	Mod Sorted	MS
HB_03_A	42.905483	-70.809417	20150618	Sl Gravelly Sand	(g)S	Sl Granular Coarse Sand	(gr)cS	Medium Sand	mdS	Poorly Sorted	PS
HB_03_B	42.905500	-70.809917	20150618	Sl Gravelly Sand	(g)S	Sl Granular Coarse Sand	(gr)cS	Coarse sand	cS	Mod Sorted	MS
HB_03_C	42.905517	-70.810283	20150618	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Sorted	MS
HB_03_D	42.905533	-70.810750	20150618	Sand	S	Medium Sand	mdS	Medium Sand	mdS	Mod Well Sorted	MWS
HB_04_A	42.900000	-70.810450	20150707	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Medium Sand	mdS	Poorly Sorted	PS
HB_04_B	42.899950	-70.810050	20150707	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Sorted	MS
HB_04_C	42.899917	-70.809617	20150707	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Sorted	MS
HB_04_D	42.900033	-70.810783	20150707	Sand	S	Fine Sand	fS	Fine Sand	fS	Well Sorted	WS

Table 12. Statistics and size distribution of samples from Hampton Beach, New Hampshire. The definition of the abbreviations are given in Table 11.

Hampton Beach		D20150618 HB_01			D20150618 HB_03				D20150707 HB_04			
		A	B	C	A	B	C	D	A	B	C	D
Textural Group		(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	S	(g)S	(g)S	(g)S	S
Sediment Name		(vfg)cS	(vfg)mdS	(vfg)fS	(vfg)cS	(vfg)cS	(vfg)mdS	mdS	(vfg)fS	(vfg)mdS	(vfg)mdS	fS
Sed Name (Wentworth)		(gr)cS	(gr)mdS	(gr)fS	(gr)cS	(gr)cS	(gr)mdS	mdS	(gr)fS	(gr)mdS	(gr)mdS	fS
Sorting		MS	MWS	MS	PS	MS	MS	MWS	PS	MS	MS	WS
Modes		Uni	Uni	Uni	Bi	Uni	Bi	Uni	Uni	Uni	Uni	Uni
%G		1.1	0.3	0.2	0.6	4.7	0.1	0.0	1.1	0.5	2.0	0.0
%S		98.3	99.7	99.6	99.1	95.3	90.1	99.8	98.9	99.4	97.9	99.9
%M		0.6	0.0	0.2	0.3	0.0	9.8	0.2	0.0	0.1	0.1	0.1
Mean - phi		0.7	1.0	1.8	1.2	0.5	1.6	1.6	1.6	1.4	1.3	2.1
Mean mm		1.576	2.024	3.375	2.342	1.376	2.992	2.965	2.973	2.715	2.454	4.196
Sorting - phi		0.797	0.671	0.806	1.028	0.910	0.925	0.647	1.068	0.773	0.960	0.482
Skewness		0.080	-0.082	-0.281	-0.007	0.062	0.306	0.012	-0.244	0.027	-0.072	-0.091
Kurtosis												
D10 - phi		-0.3	0.1	0.6	-0.1	-0.7	0.7	0.7	0.0	0.5	0.0	1.5
D50 - phi		0.6	1.0	1.9	1.2	0.4	1.5	1.6	1.7	1.4	1.3	2.1
D90 - phi		1.8	1.9	2.7	2.5	1.7	3.3	2.4	2.8	2.4	2.4	2.7
D10 - microns		1.267	0.919	0.675	1.072	1.624	0.599	0.612	0.971	0.701	0.976	0.350
D50 - microns		0.652	0.485	0.267	0.426	0.744	0.345	0.336	0.299	0.373	0.399	0.232
D90 - microns		0.293	0.276	0.155	0.178	0.309	0.104	0.191	0.144	0.188	0.185	0.150
Total Sample Wt - gms		71.1	71.6	117.0	113.1	72.2	77.8	69.3	73.6	69.3	86.0	73.5
Class (ϕ)	-3.0											
	-2.5											
Gravel	-2.0								0.3		0.8	
	-1.5	0.4		0.0	0.1	0.9	0.1		0.2	0.2	0.5	
	-1.0	0.8	0.3	0.2	0.5	3.9	0.0		0.6	0.3	0.7	
	-0.5	4.3	1.9	0.6	3.1	9.0	0.0	0.1	2.2	0.6	2.0	0.0
	0.0	15.5	3.8	2.3	8.0	17.1	0.2	0.5	5.9	1.8	5.2	0.2
	0.5	23.9	16.0	5.5	14.4	22.0	2.6	3.7	9.7	6.5	10.7	0.4
	1.0	21.5	25.4	9.3	17.7	22.0	14.7	13.6	13.7	18.1	17.5	1.9
Sand	1.5	17.5	28.7	13.9	13.5	12.0	29.9	27.1	11.7	26.4	18.9	6.2
	2.0	11.5	19.1	22.3	16.4	7.6	31.1	32.4	11.8	23.1	19.6	31.3
	2.5	3.1	4.0	30.3	16.1	4.1	9.7	15.5	22.6	15.1	15.3	43.7
	3.0	0.7	0.5	13.2	8.0	1.1	1.6	4.9	18.3	6.3	6.9	12.8
	3.5	0.3	0.2	2.0	1.9	0.3	0.3	1.8	2.9	1.5	1.6	3.2
	4.0	0.1	0.0	0.1	0.1	0.0	0.0	0.2	0.1	0.1	0.1	0.2

Seabrook Beach, New Hampshire

Figure 25. Location map of profile stations and sediment sampling sites during summer 2015 at Seabrook Beach, New Hampshire.

Figure 26. Seabrook Beach July 19, 2015 looking south from near profile SB_02.

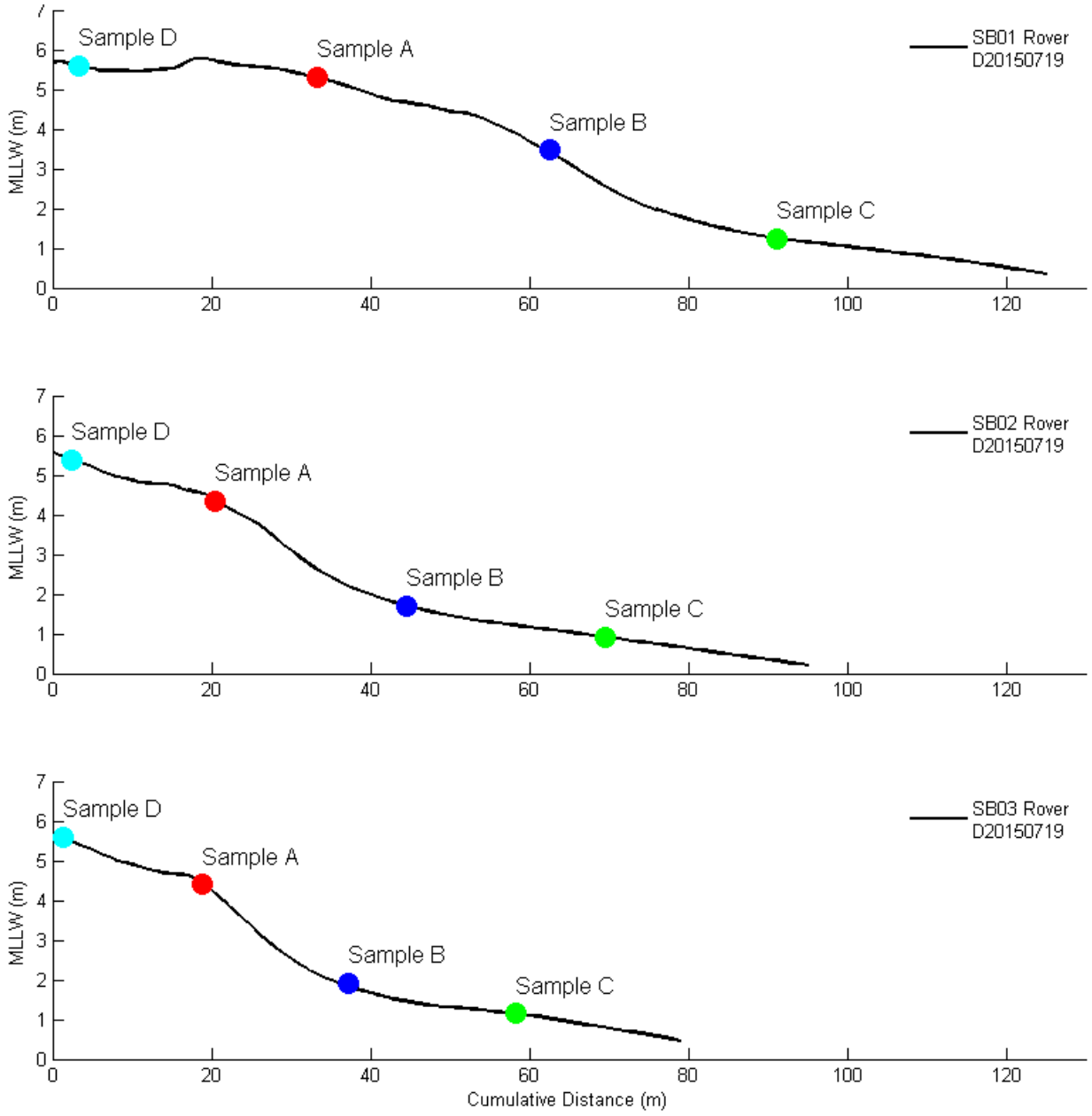

Figure 27. Beach profiles and sediment sample locations for Seabrook Beach, New Hampshire in summer 2015. The method used to measure the beach profile (Emery or Rover) is also given in the legend. The results of the grain size analyses are given in Tables 13 and 14.

Table 13. Location and grain size classifications for Seabrook Beach, New Hampshire. Abbreviations used in this table include *Sl* for Slightly and *Mod* for Moderately.

Station Number	Latitude	Longitude	Sample Collecte	Textural Group %GSM from Gradistat	Abbrev	Sediment Name %GSM and Mode in Wentworth Scale	Abbrev	Classification Mean Phi Size	Abbrev	Sorting from Gradistat	Abbrev
SB_01_A	42.887483	-70.813650	20150719	Sand	S	Medium Sand	mdS	Medium Sand	mdS	Mod Well Sorted	MWS
SB_01_B	42.887400	-70.813300	20150719	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Well Sorted	MWS
SB_01_C	42.887333	-70.812967	20150719	Sl Gravelly sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Sorted	MS
SB_01_D	42.887567	-70.814000	20150719	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Sorted	MS
SB_02_A	42.884833	-70.814233	20150719	Sl Gravelly Sand	(g)S	Sl Granular Coarse Sand	(gr)cS	Coarse Sand	cS	Mod Sorted	MS
SB_02_B	42.884783	-70.813950	20150719	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Medium Sand	mdS	Mod Sorted	MS
SB_02_C	42.884750	-70.813633	20150719	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Well Sorted	MWS
SB_02_D	42.884883	-70.814450	20150719	Sl Gravelly Sand	(g)S	Sl Granular Coarse Sand	(gr)cS	Coarse Sand	cS	Mod Well Sorted	MWS
SB_03_A	42.882917	-70.814683	20150719	Sl Gravelly Sand	(g)S	Sl Granular Coarse Sand	(gr)cS	Coarse Sand	cS	Mod Sorted	MS
SB_03_B	42.882917	-70.814450	20150719	Sl Gravelly Sand	(g)S	Sl Granular Fine Sand	(gr)fS	Medium Sand	mdS	Poorly Sorted	PS
SB_03_C	42.882883	-70.814200	20150719	Sl Gravelly Sand	(g)S	Sl Granular Medium Sand	(gr)mdS	Medium Sand	mdS	Mod Well Sorted	MWS
SB_03_D	42.882950	-70.814900	20150719	Sl Gravelly Sand	(g)S	Sl Granular Coarse Sand	(gr)cS	Coarse Sand	cS	Mod Well Sorted	MWS

Table 14. Statistics and size distribution of samples from Seabrook Beach, New Hampshire. The definition of the abbreviations are given in Table 13.

Seabrook Beach		D20150719 SB_01				D20150719 SB_02				D20150719 SB_03			
		A	B	C	D	A	B	C	D	A	B	C	D
Textural Group		S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S	(g)S
Sediment Name		mdS	(vfg)mdS	(vfg)mdS	(vfg)mdS	(vfg)cS	(vfg)fS	(vfg)mdS	(vfg)cS	(vfg)cS	(vfg)fS	(vfg)mdS	(vfg)cS
Sed Name (Wentworth)		mdS	mdS	mdS	mdS	cS	mdS	mdS	cS	cS	mdS	mdS	cS
Sorting		MWS	MWS	MS	MS	MS	MS	MWS	MWS	MS	PS	MWS	MWS
Modes		Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni	Uni
%G		0.0	0.1	0.3	0.2	1.4	0.9	0.0	0.1	1.0	0.8	0.2	0.0
%S		100.0	99.9	99.6	99.8	98.6	99.1	100.0	99.9	99.0	99.2	99.8	100.0
%M		0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Mean - phi		1.3	1.0	1.5	1.7	0.8	1.8	1.8	0.8	0.7	1.3	1.8	0.7
Mean mm		2.544	2.014	2.912	3.322	1.689	3.470	3.494	1.765	1.647	2.505	3.413	1.579
Sorting - phi		0.563	0.654	0.743	0.756	0.913	0.844	0.602	0.631	0.907	1.092	0.621	0.601
Skewness		0.052	0.007	-0.339	-0.163	-0.033	-0.476	-0.106	0.068	0.076	-0.296	-0.114	0.076
Kurtosis		0.888	0.977	1.220	1.035	0.842	1.570	1.135	0.981	0.863	0.752	1.131	1.070
D10 - phi		0.6	0.1	0.4	0.7	-0.4	0.2	1.0	0.1	-0.4	-0.3	1.0	0.0
D50 - phi		1.3	1.0	1.7	1.8	0.8	2.0	1.8	0.8	0.7	1.6	1.8	0.6
D90 - phi		2.1	1.9	2.3	2.6	1.9	2.6	2.5	1.7	1.9	2.5	2.5	1.4
D10 - microns		0.640	0.904	0.782	0.635	1.328	0.845	0.487	0.955	1.308	1.200	0.515	1.035
D50 - microns		0.393	0.501	0.313	0.288	0.585	0.246	0.280	0.575	0.628	0.334	0.286	0.646
D90 - microns		0.233	0.275	0.199	0.162	0.269	0.168	0.181	0.307	0.265	0.173	0.183	0.370
Total Sample Wt - gms		52.0	52.9	65.6	96.6	83.3	89.0	68.0	61.4	65.3	45.6	75.1	57.1
Class (ϕ)	-3.0												
	-2.5												
Gravel	-2.0						0.2						
	-1.5				0.1	0.2	0.2			0.1	0.2		
	-1.0		0.1	0.3	0.0	1.2	0.5	0.0	0.1	1.0	0.6	0.2	0.0
	-0.5	0.1	0.8	1.2	0.7	6.2	2.4	0.3	0.5	5.6	4.4	0.2	1.2
	0.0	0.6	4.7	4.3	2.2	15.2	4.5	0.8	6.4	16.5	10.6	0.9	9.8
	0.5	1.9	14.9	5.9	4.0	17.1	4.4	1.8	22.6	20.1	11.0	2.3	29.8
	1.0	25.1	29.6	8.5	9.5	18.3	4.3	5.7	34.0	19.2	10.4	6.9	33.9
Sand	1.5	31.7	27.3	15.8	18.1	18.7	7.8	17.0	21.7	15.8	10.0	17.0	17.4
	2.0	28.3	17.3	39.1	25.9	16.5	23.7	35.7	11.5	13.9	16.3	36.4	6.3
	2.5	10.3	4.5	21.8	26.2	5.5	39.9	29.2	2.5	6.6	25.6	27.2	1.1
	3.0	1.5	0.6	2.8	11.8	0.8	11.0	8.5	0.5	1.0	9.9	8.1	0.3
	3.5	0.3	0.2	0.3	1.5	0.3	1.0	0.8	0.2	0.1	1.0	0.7	0.1
	4.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Mud	<4.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Summary

Sampling stations were established at the major beaches along the NH coast, the beach cross-sections were profiled, and sediment samples collected for summer, 2015. These sediment samples were analyzed for grain size and the results presented within this report. Initial results indicate that during the low energy conditions of summer 2015, many of the sandy beaches appeared to vary between fine to medium sands with granular sediments and scattered pebbles. However, North Hampton and Seabrook Beach were somewhat coarser with medium to coarse sands with granular material and scattered pebbles. However, the gravel fractions at all of the beaches tended to be under-sampled due to the methodology used. In addition, high energy conditions (storms) were not sampled.

This initial study of the beaches revealed modifications of the procedures used during summer and fall, 2015 are needed to fully characterize NH beaches with bimodal sediment populations. These modifications will be implemented in subsequent samplings of the beaches as necessary. However, the additional sampling for winter (or high energy conditions) and verification of summer (or low energy conditions) are beyond the scope of the present study and will be conducted during new projects. Additional research is recognized as a high priority as this study has shown that seasonal studies are needed to fully understand the sediment characteristics of the beaches under varying energy conditions. This work is essential before beach nourishment is conducted and for informed coastal management.

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Appendix 1. Relationship between phi size, Wentworth Size Class and Gradistat Modified Class

Size	Size	Size	Wentworth Size Class	Gradistat Modified Class
> -10.0 ϕ	> 1024 mm	--------	Boulder Gravel	Very Large Boulder
-9.0 to -10.0 ϕ	512 to 1024 mm	--------	Boulder Gravel	Large Boulder
-8.0 to -9.0 ϕ	256 to 512 mm	--------	Boulder Gravel	Medium Boulder
-7.0 to -8.0 ϕ	128 to 256 mm	--------	Cobble Gravel	Small Boulder
-6.0 to -7.0 ϕ	64 to 128 mm	--------	Cobble Gravel	Very Small Boulder
-5.0 to -6.0 ϕ	32 to 64 mm	--------	Pebble Gravel	Very Coarse Gravel
-4.0 to -5.0 ϕ	16 to 32 mm	--------	Pebble Gravel	Coarse Gravel
-3.0 to -4.0 ϕ	8.0 to 16 mm	--------	Pebble Gravel	Medium Gravel
-2.0 to -3.0 ϕ	4.0 to 8.0 mm	--------	Pebble Gravel	Fine Gravel
-1.0 to -2.0 ϕ	2.0 to 4.0 mm	--------	Granule Gravel	Very Fine Gravel
0.0 to -1.0 ϕ	1.0 to 2.0 mm	---------	Very Coarse Sand	Very Coarse Sand
1.0 to 0.0 ϕ	0.5 to 1.0 mm	--------	Coarse Sand	Coarse Sand
2.0 to 1.0 ϕ	0.25 to 0.5 mm	500 µ	Medium Sand	Medium Sand
3.0 to 2.0 ϕ	0.125 to 0.25 mm	250 µ	Fine Sand	Fine Sand
4.0 to 3.0 ϕ	0.0625 to .125 mm	125 µ	Very Fine Sand	Very Fine Sand
5.0 to 4.0 ϕ	0.031 to .0625 mm	63 µ	Coarse Silt	Very Coarse Silt
6.0 to 5.0 ϕ	0.0156 to 0.031 mm	31 µ	Medium Silt	Coarse Silt
7.0 to 6.0 ϕ	0.0078 to 0.0156 mm	15.6 µ	Fine Silt	Medium Silt
8.0 to 7.0 ϕ	0.0039 to 0.0078 mm	7.8 µ	Very Fine Silt	Fine Silt
9.0 to 8.0 ϕ	0.0002 to 0.0039 mm	3.9 µ	Clay	Very Fine Silt
< 9.0 ϕ	< 0.0002 mm	2.0 µ	Clay	Clay
14.0 ϕ	.00006 mm	0.06 µ	Clay	Clay