

Supplementary Materials

Sediment Budget and Geomorphological Evolution of the Estuarine Dune-Beach System on Three Nourished Beaches, Delaware Bay, New Jersey

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Table S1. Volume of the Tidal Flat at Pierce's Point within each Compartment (Comp.). The asterisk indicates that uncertainty was not calculated because there were no points within that Compartment.

Zone	Comp.	Tidal Volume (m ³)			
		Pre-Fill 2013	Post-Fill 2014	April 2017	March 2018
Updrift	1	--	--	1953 ± 9	2047 ± 9
	2	--	--	2143 ± 7	2070 ± 7
Fill	3	3056 ± 27	3095 ± 27	3382 ± 7	3416 ± 7
	4	2071*	2174*	2550 ± 12	2591 ± 12
	5	1310*	1475*	1835 ± 8	1888 ± 8
	6	1399*	1649*	1850 ± 34	2066 ± 34
	7	1337 ± 34	1644 ± 34	1786 ± 8	2047 ± 8
	8	1415*	1572*	1835 ± 15	2023 ± 15
	9	1568*	1620*	1777 ± 9	2008 ± 9
	10	1707*	1684*	1843 ± 12	2042 ± 12
	11	1594 ± 33	1718 ± 33	1977 ± 10	2061 ± 10
	12	1414*	1737*	1942 ± 11	2121 ± 11
	13	1352*	1677*	1748 ± 8	1937 ± 8
	14	1400*	1730*	1913 ± 11	2017 ± 11
	15	1541 ± 40	1870 ± 40	2195 ± 11	2430 ± 11
Downdrift	16	2106*	2520*	2721 ± 17	3006 ± 17
	17	2380 ± 41	2898 ± 41	3105 ± 17	3250 ± 17
	18	2294*	2718*	2861 ± 15	3165 ± 15
	19	2275 ± 30	2603 ± 30	2787 ± 13	3075 ± 13
	20	2303*	2328*	2864 ± 10	2932 ± 10
	21	2271*	2200*	2639 ± 6	2673 ± 6
	22	1968*	1963*	1965*	1986*
	23	--	--	341*	360*

Table S2. Volume of the Beach at Pierce’s Point within each Compartment (Comp.). The asterisk indicates that uncertainty was not calculated because there were no points within that Compartment.

Zone	Comp.	Beach Volume (m ³)			
		Pre-Fill 2013	Post-Fill 2014	April 2017	March 2018
Updrift	1	--	--	2392 ± 5	2355 ± 5
	2	--	--	2211 ± 5	2205 ± 5
Fill	3	3825 ± 14	3685 ± 14	3599 ± 8	3820 ± 8
	4	2210 ± 13	2102 ± 13	1916 ± 7	1949 ± 7
	5	657*	960*	625 ± 6	520 ± 6
	6	833*	1297*	1022 ± 6	925 ± 6
	7	694 ± 10	1221 ± 10	829 ± 6	656 ± 6
	8	1210*	1196*	768 ± 6	554 ± 6
	9	1552*	1406*	1057 ± 5	949 ± 5
	10	1634*	1577*	1173 ± 5	1079 ± 5
	11	1326 ± 10	1654 ± 10	1253 ± 7	1114 ± 7
	12	1437*	1684*	1317 ± 5	1093 ± 5
	13	1452*	1677*	1213 ± 6	1000 ± 6
	14	1656*	1851*	1152 ± 6	1131 ± 6
	15	1944 ± 17	2103 ± 17	1469 ± 6	1494 ± 6
Downdrift	16	2355*	2591*	2558 ± 10	2597 ± 10
	17	2095 ± 21	2407 ± 21	3051 ± 12	3286 ± 12
	18	1796*	1895*	2459 ± 10	2592 ± 10
	19	1779 ± 26	1755 ± 26	2041 ± 14	2082 ± 14
	20	1831*	1666*	2230 ± 14	2182 ± 14
	21	2018*	1697*	2347 ± 13	2022 ± 13
	22	2020 ± 33	1594 ± 33	1736 ± 13	1576 ± 13
	23	--	--	114 ± 3	140 ± 3

Table S3. Volume of the Dunes at Pierce’s Point within each Compartment (Comp.). The asterisk indicates that uncertainty was not calculated because there were no points within that Compartment.

Zone	Comp.	Dune Volume (m ³)			
		Pre-Fill 2013	Post-Fill 2014	April 2017	March 2018
Updrift	1	--	--	408 ± 6	396 ± 6
	2	--	--	180 ± 5	193 ± 5
Fill	3	84 ± 4	13 ± 4	14 ± 6	91 ± 6
	4	53*	0*	77 ± 2	79 ± 2
	5	31*	0*	30 ± 0	11 ± 0
	6	56*	22*	71 ± 5	45 ± 5
	7	53 ± 7	108 ± 7	55 ± 1	7 ± 1
	8	31*	142*	86*	33*
	9	64*	152*	95 ± 3	72 ± 3
	10	66*	162*	87 ± 3	76 ± 3
	11	143 ± 15	165 ± 15	85 ± 4	87 ± 4
	12	162*	125*	39 ± 2	76 ± 2
	13	132*	77*	36 ± 3	45 ± 3
	14	105*	51*	14 ± 3	65 ± 3
	15	56 ± 7	34 ± 7	44 ± 4	128 ± 4
Downdrift	16	0*	0*	28 ± 8	129 ± 8
	17	5 ± 0	0 ± 0	20 ± 7	93 ± 7
	18	13*	0*	33 ± 7	86 ± 7
	19	32*	0*	51 ± 5	124 ± 5
	20	22*	0*	17 ± 2	46 ± 2
	21	4*	0*	1*	0*
	22	0*	0*	0*	0*
	23	--	--	2*	2*

Table S4. Volume of the Tidal Flat at Reeds Beach within each Compartment (Comp.). The asterisk indicates that uncertainty was not calculated because there were no points within that Compartment.

Zone	Comp.	Tidal Volume (m ³)			
		Pre-Fill 2013	Post-Fill 2014	April 2017	March 2018
Updrift	1	--	331*	331*	331*
	2	--	504*	504*	504*
	3	--	620*	620*	620*
	4	--	799 ± 3	809*	808*
	5	--	1066 ± 9	1094 ± 3	1048 ± 3
	6	--	1025 ± 6	993 ± 3	1011 ± 3
Fill	7	1700 ± 11	1644 ± 11	1493 ± 7	1659 ± 7
	8	1085 ± 13	1214 ± 13	1049 ± 8	1167 ± 8
	9	1275 ± 24	1346 ± 24	1614 ± 7	1408 ± 7
	10	1034*	949*	1429 ± 6	1168 ± 6
	11	997*	916*	1019 ± 4	1186 ± 4
	12	1023 ± 13	1003 ± 13	963 ± 16	1104 ± 16
	13	969*	969*	997 ± 2	984 ± 2
	14	859 ± 8	876 ± 8	890 ± 6	957 ± 6
	15	824*	908*	887 ± 6	978 ± 6
	16	789 ± 9	957 ± 9	909 ± 5	958 ± 5
	17	708*	883*	823 ± 4	842 ± 4
	18	592 ± 15	757 ± 15	649 ± 5	683 ± 5
	19	595*	738*	625 ± 4	646 ± 4
	20	603 ± 3	715 ± 3	614 ± 3	617 ± 3
Downdrift	21	--	--	261 ± 10	341 ± 10
	22	--	--	169 ± 6	287 ± 6

Table S5. Volume of the Beach at Reeds Beach within each Compartment (Comp.). The asterisk indicates that uncertainty was not calculated because there were no points within that Compartment.

Zone	Comp.	Beach Volume (m ³)			
		Pre-Fill 2013	Post-Fill 2014	April 2017	March 2018
Updrift	1	--	612 ± 2	524 ± 5	537 ± 5
	2	--	725 ± 3	808 ± 5	894 ± 5
	3	--	982 ± 6	1103 ± 5	911 ± 5
	4	--	755 ± 9	1125 ± 5	883 ± 5
	5	--	735 ± 9	1016 ± 5	926 ± 5
	6	--	717 ± 11	691 ± 5	787 ± 5
Fill	7	1039 ± 11	1152 ± 11	1050 ± 9	1057 ± 9
	8	701 ± 11	800 ± 11	941 ± 3	762 ± 3
	9	1118 ± 9	1176 ± 9	1592 ± 5	1443 ± 5
	10	894*	995*	1079 ± 6	1323 ± 6
	11	953*	1118*	1052 ± 4	1278 ± 4
	12	1133 ± 11	1308 ± 11	1343 ± 6	1359 ± 6
	13	1203*	1325*	1377 ± 3	1347 ± 3
	14	1146 ± 8	1228 ± 8	1286 ± 6	1245 ± 6
	15	1190*	1289*	1345 ± 4	1308 ± 4
	16	1188 ± 8	1337 ± 8	1374 ± 6	1325 ± 6
	17	1014*	1205*	1170 ± 3	1138 ± 3
	18	743 ± 8	969 ± 8	845 ± 5	825 ± 5
	19	735*	950*	810 ± 3	793 ± 3
	20	777 ± 4	921 ± 4	799 ± 3	806 ± 3
Downdrift	21	--	--	122 ± 6	270 ± 6
	22	--	--	26 ± 5	208 ± 5

Table S6. Volume of the Dunes at Reeds Beach within each Compartment (Comp.). The asterisk indicates that uncertainty was not calculated because there were no points within that Compartment.

Zone	Comp.	Dune Volume (m ³)			
		Pre-Fill 2013	Post-Fill 2014	April 2017	March 2018
Updrift	1	--	39 ± 2	21 ± 1	26 ± 1
	2	--	52 ± 2	48 ± 2	49 ± 2
	3	--	36 ± 2	52 ± 2	63 ± 2
	4	--	6 ± 1	59 ± 2	84 ± 2
	5	--	16 ± 2	62 ± 3	98 ± 3
	6	--	10 ± 4	65 ± 1	81 ± 1
Fill	7	28 ± 2	19 ± 2	94 ± 2	114 ± 2
	8	12*	19*	111 ± 1	97 ± 1
	9	5 ± 5	88 ± 5	215 ± 3	211 ± 3
	10	0*	62*	141 ± 4	156 ± 4
	11	9*	27*	127 ± 3	103 ± 3
	12	0*	2*	64 ± 3	103 ± 3
	13	0*	10*	80 ± 3	123 ± 3
	14	9 ± 6	46 ± 6	131 ± 2	98 ± 2
	15	49*	106*	191 ± 4	154 ± 4
	16	95 ± 8	152 ± 8	264 ± 9	216 ± 9
	17	71*	112*	220 ± 2	223 ± 2
	18	19 ± 5	55 ± 5	115 ± 2	127 ± 2
	19	33*	67*	79 ± 3	74 ± 3
	20	57 ± 6	94 ± 6	115 ± 2	122 ± 2
Downdrift	21	--	--	--	--
	22	--	--	--	--

Table S7. Volume of the Tidal Flat at Moore's Beach within each Compartment (Comp.). The asterisk indicates that uncertainty was not calculated because there were no points within that Compartment.

Zone	Comp.	Tidal Volume (m ³)			
		Pre-Fill 2013	Post-Fill 2014	April 2017	June 2018
Downdrift	1	--	--	296 ± 1	274 ± 1
	2	--	--	321 ± 1	286 ± 1
	3	--	--	363 ± 0	327 ± 0
	4	--	--	380 ± 2	350 ± 2
	5	--	--	370 ± 1	331 ± 1
	6	--	--	422 ± 2	384 ± 2
	7	--	--	422 ± 1	399 ± 1
Fill	8	459 ± 3	451 ± 3	407 ± 2	368 ± 2
	9	319*	295*	283 ± 2	268 ± 2
	10	403*	386*	368 ± 1	353 ± 1
	11	429*	423*	388 ± 1	369 ± 1
	12	409*	393*	359 ± 7	334 ± 7
	13	424*	405*	379 ± 2	344 ± 2
	14	409*	391*	361 ± 1	332 ± 1
	15	396 ± 3	384 ± 3	353 ± 2	314 ± 2
	16	401*	395*	353 ± 1	305 ± 1
	17	404*	403*	356*	307*
	18	422*	413*	357 ± 1	310 ± 1
	19	434 ± 3	425 ± 3	363 ± 2	306 ± 2
	20	588 ± 7	601 ± 7	420*	332*
	21	559 ± 4	567 ± 4	402*	316*
	22	417 ± 4	413 ± 4	325 ± 1	277 ± 1
	23	383*	391*	297 ± 0	250 ± 0
	24	381*	398*	295 ± 2	248 ± 2
	25	380 ± 3	390 ± 3	295 ± 1	250 ± 1
	26	358*	382*	283 ± 1	235 ± 1
	27	358 ± 4	387 ± 4	290 ± 1	247 ± 1

	28	371*	388*	301 ± 1	260 ± 1
	29	327*	336*	253*	224*
	30	272 ± 3	333 ± 3	261 ± 2	228 ± 2
	31	204*	268*	290 ± 19	250 ± 19
Updrift	32	221 ± 28	369 ± 28	454 ± 9	448 ± 9
	33	240 ± 30	373 ± 30	453 ± 9	473 ± 9
	34	341 ± 12	332 ± 12	321 ± 7	417 ± 7
	35	395 ± 39	426 ± 39	263 ± 12	511 ± 12
	36	428*	554*	314 ± 3	549 ± 3
	37	394*	453*	415*	516*
	38	300 ± 3	336 ± 3	376*	376*
	39	219*	220*	221*	220*

Table S8. Volume of the Beach at Moore’s Beach within each Compartment (Comp.). The asterisk indicates that uncertainty was not calculated because there were no points within that Compartment.

Zone	Comp.	Beach Volume (m³)			
		Pre-Fill 2013	Post-Fill 2014	April 2017	June 2018
Downdrift	1	--	--	1550 ± 2	1326 ± 2
	2	--	--	1485 ± 5	1277 ± 5
	3	--	--	1577 ± 3	1540 ± 3
	4	--	--	1592 ± 5	1543 ± 5
	5	--	--	1465 ± 4	1405 ± 4
	6	--	--	1655 ± 6	1526 ± 6
	7	--	--	1724 ± 5	1532 ± 5
Fill	8	1739 ± 18	1706 ± 18	1625 ± 7	1436 ± 7
	9	1070*	1114*	995 ± 6	832 ± 6
	10	1476 ± 16	1573 ± 16	1447 ± 5	1245 ± 5
	11	1690 ± 13	1775 ± 13	1629 ± 5	1453 ± 5
	12	1531*	1732*	1576 ± 7	1421 ± 7
	13	1457 ± 9	1945 ± 9	1685 ± 6	1558 ± 6
	14	1438*	1937*	1590 ± 4	1474 ± 4
	15	1539 ± 8	1928 ± 8	1517 ± 4	1380 ± 4
	16	1580 ± 14	1979 ± 14	1476 ± 3	1307 ± 3
	17	1566 ± 7	2003 ± 7	1439 ± 6	1265 ± 6
	18	1652*	1999*	1420 ± 3	1264 ± 3
	19	1687 ± 3	1848 ± 3	1384 ± 5	1179 ± 5
	20	2068 ± 7	2069 ± 7	1614 ± 6	1346 ± 6
	21	2029 ± 8	2030 ± 8	1609 ± 7	1360 ± 7
	22	1658 ± 12	1936 ± 12	1487 ± 4	1266 ± 4
	23	1408 ± 9	1937 ± 9	1391 ± 4	1180 ± 4
	24	1373*	1905*	1378 ± 3	1183 ± 3
	25	1511 ± 10	1876 ± 10	1343 ± 3	1186 ± 3
	26	1456*	1802*	1224 ± 5	1088 ± 5
	27	1505 ± 8	1847 ± 8	1284 ± 3	1135 ± 3
	28	1565 ± 15	1872 ± 15	1346 ± 5	1201 ± 5
	29	1254 ± 8	1559 ± 8	1045 ± 5	887 ± 5
	30	1035 ± 8	1541 ± 8	1058 ± 4	824 ± 4
	31	773 ± 8	1180 ± 8	780 ± 9	584 ± 9
Updrift	32	755 ± 12	1032 ± 12	689 ± 5	525 ± 5
	33	738 ± 23	859 ± 23	635 ± 7	563 ± 7
	34	956 ± 7	966 ± 7	859 ± 7	773 ± 7
	35	941 ± 11	947 ± 11	937 ± 10	897 ± 10
	36	1150 ± 14	1006 ± 14	1358 ± 10	1328 ± 10
	37	1785 ± 15	1644 ± 15	2128 ± 11	2054 ± 11
	38	1125 ± 14	1372 ± 14	1845 ± 6	1907 ± 6
	39	641 ± 11	699 ± 11	954 ± 11	989 ± 11

Table S9. Volume of the Dunes at Moore's Beach within each Compartment (Comp.). The asterisk indicates that uncertainty was not calculated because there were no points within that Compartment.

Zone	Comp.	Dune Volume (m ³)			
		Pre-Fill 2013	Post-Fill 2014	April 2017	June 2018
Downdrift	1	--	--	66 ± 3	140 ± 3
	2	--	--	110 ± 7	158 ± 7
	3	--	--	181 ± 4	232 ± 4
	4	--	--	225 ± 6	249 ± 6
	5	--	--	232 ± 3	254 ± 3
	6	--	--	233 ± 6	251 ± 6
	7	--	--	144 ± 4	183 ± 4
Fill	8	0*	0*	122 ± 8	162 ± 8
	9	0*	0*	115 ± 2	103 ± 2
	10	2*	13*	192 ± 5	165 ± 5
	11	37 ± 5	52 ± 5	219 ± 4	228 ± 4
	12	39*	88*	259 ± 5	266 ± 5
	13	19 ± 11	136 ± 11	280 ± 5	314 ± 5
	14	20*	124*	261 ± 6	339 ± 6
	15	72 ± 11	79 ± 11	233 ± 3	314 ± 3
	16	102*	118*	185 ± 4	222 ± 4
	17	126 ± 13	217 ± 13	188 ± 5	195 ± 5
	18	103*	200*	180 ± 4	205 ± 4
	19	110 ± 4	168 ± 4	164 ± 6	146 ± 6
	20	65 ± 3	65 ± 3	187 ± 3	173 ± 3
	21	40 ± 3	40 ± 3	194 ± 6	205 ± 6
	22	55 ± 9	66 ± 9	200 ± 5	165 ± 5
	23	56 ± 12	71 ± 12	212 ± 4	196 ± 4
	24	29*	27*	224 ± 4	207 ± 4
	25	103 ± 14	163 ± 14	238 ± 6	237 ± 6
	26	143*	230*	203 ± 4	208 ± 4
	27	182 ± 13	291 ± 13	218 ± 4	196 ± 4
	28	172 ± 18	282 ± 18	218 ± 5	210 ± 5
	29	129 ± 10	274 ± 10	181 ± 5	140 ± 5
	30	82 ± 11	387 ± 11	217 ± 3	130 ± 3
	31	63 ± 6	196 ± 6	93 ± 3	43 ± 3
Updrift	32	34 ± 7	54 ± 7	32 ± 1	7 ± 1
	33	41*	40*	49 ± 1	15 ± 1
	34	41 ± 2	28 ± 2	120 ± 2	71 ± 2
	35	84 ± 6	83 ± 6	224 ± 2	224 ± 2
	36	113 ± 5	101 ± 5	396 ± 4	269 ± 4
	37	94 ± 8	87 ± 8	364 ± 4	344 ± 4
	38	14 ± 2	10 ± 2	63 ± 5	135 ± 5
	39	2 ± 3	4 ± 3	10 ± 1	6 ± 1