

**Supporting Information:** Species-specific functional morphology of four US Atlantic Coast dune grasses: biogeographic implications for dune shape and coastal protection. By Sally D. Hacker, Katya R. Jay, Nicholas Cohn, Evan B. Goldstein, Paige Hovenga, Michael Itzkin, Laura J. Moore, Rebecca S. Mostow, Elsemarie V. Mullins, and Peter Ruggiero.

**Table S1.** Transect locations, north to south, used to survey the distribution and abundance of vegetation along foredunes of the Outer Banks islands from False Cape, Virginia, to Bogue Banks, North Carolina, USA (see Figure 2).

Island	Transect Name	Latitude	Longitude	Distance to Neighboring Transect (km; S or W)
False Cape	FAC_4	36.6276652	-75.889766	3
	FAC_3	36.6017811	-75.879916	1.8
	FAC_2	36.5860808	-75.875638	3.8
	FAC_1	36.5524759	-75.868308	3.6
Bodie Island	BOD_10	36.5201078	-75.8620715	4.5
	BOD_9	36.4800983	-75.8529037	8.9
	BOD_8	36.4021958	-75.83065	13.6
	BOD_7	36.282266	-75.7938133	11.4
	BOD_6	36.1854457	-75.7521485	0.7
	BOD_5	36.1792965	-75.749355	11.6
	BOD_4	36.0828711	-75.7003949	10
	BOD_3	36.002747	-75.6486079	20.4
	BOD_2	35.8344112	-75.5582271	4.6
	BOD_1	35.7958095	-75.540219	3.5
Pea Island	PEA_3	35.768445	-75.5204608	3.2
	PEA_2	35.7431869	-75.5042115	3.5
	PEA_1	35.7131589	-75.4913202	5
Hatteras Island	HAT_13	35.6698157	-75.4777052	5.1
	HAT_12	35.6242763	-75.4683802	9.8
	HAT_11	35.5365675	-75.4669414	7.3
	HAT_10	35.4729693	-75.481195	7.4
	HAT_9	35.40673	-75.4858532	5
	HAT_8	35.3622823	-75.4971147	5
	HAT_7	35.3181785	-75.5080946	4.9
	HAT_6	35.2747138	-75.5174755	5.4
	HAT_5	35.226518	-75.5284563	4.5
	HAT_4	35.2346899	-75.5768313	4.8
	HAT_3	35.2277451	-75.6286256	5.1
	HAT_2	35.2123191	-75.6816534	4.4
	HAT_1	35.1972224	-75.7268737	5
Ocracoke Island	OCR_5	35.1816654	-75.7779723	8.3
	OCR_4	35.1510415	-75.8608008	5.6
	OCR_3	35.1267793	-75.9147228	4.5
	OCR_2	35.1049833	-75.9559919	4
	OCR_1	35.0826812	-75.9899732	6
North Core Banks	NCB_22	35.0530517	-76.0447896	5.2
	NCB_21	35.0270573	-76.0916687	0.9

	NCB_20	35.0216145	-76.0989634	1
	NCB_19	35.015843	-76.1066362	1.2
	NCB_18	35.0085828	-76.1167294	0.8
	NCB_17	35.0040006	-76.123335	1.1
	NCB_16	34.9969761	-76.131801	0.9
	NCB_15	34.9912825	-76.1391699	1.1
	NCB_14	34.9843826	-76.1478347	1
	NCB_13	34.9781301	-76.1559868	1
	NCB_12	34.972267	-76.163924	1
	NCB_11	34.9663064	-76.1720108	0.9
	NCB_10	34.9606305	-76.1794134	1.1
	NCB_9	34.95371	-76.1881125	1.1
	NCB_8	34.9470608	-76.1962458	0.9
	NCB_7	34.9411404	-76.2033866	1
	NCB_6	34.9346253	-76.2111514	2
	NCB_5	34.9220592	-76.2261748	2.1
	NCB_4	34.9087018	-76.2422395	2.1
	NCB_3	34.896227	-76.2588123	0.9
	NCB_2	34.8912641	-76.2658907	1
	NCB_1	34.8857374	-76.2738852	9
South Core Banks	SCB_20	34.8306836	-76.3454967	1.5
	SCB_19	34.8193753	-76.3545105	1.9
	SCB_18	34.8062837	-76.3675944	2.1
	SCB_17	34.7922181	-76.3822877	2
	SCB_16	34.7785368	-76.3956676	1.6
	SCB_15	34.7665769	-76.405443	2.4
	SCB_14	34.7495076	-76.4213716	2.1
	SCB_13	34.7344208	-76.4350908	1.9
	SCB_12	34.7201798	-76.4472372	2.1
	SCB_11	34.7048951	-76.4605842	2
	SCB_10	34.6898346	-76.4734951	1.9
	SCB_9	34.6755438	-76.4850783	2
	SCB_8	34.6607904	-76.4970186	2.1
	SCB_7	34.6443710	-76.5071979	2
	SCB_6	34.6281112	-76.5170870	2.1
	SCB_5	34.6115026	-76.5274718	2
	SCB_4	34.5945781	-76.5343936	0.4
	SCB_3	34.5927095	-76.5375693	1.8
	SCB_2	34.6065351	-76.5473031	1.9
	SCB_1	34.6222448	-76.5542065	1
	SCB_0	34.6306684	-76.5554503	1.75
Shackleford Banks	SHB_12	34.6340256	-76.5369748	1.1
	SHB_11	34.6417083	-76.5437355	1
	SHB_10	34.6485386	-76.5512356	1
	SHB_9	34.6537058	-76.5604061	1.1
	SHB_8	34.658427	-76.5706677	1
	SHB_7	34.6621783	-76.5799107	1.1
	SHB_6	34.6657629	-76.5906425	1
	SHB_5	34.6688427	-76.601124	1
	SHB_4	34.6717272	-76.6115413	1
	SHB_3	34.6742112	-76.6224491	1.1

	SHB_2	34.6765883	-76.6335074	1
	SHB_1	34.6792183	-76.643726	3.6
Bogue Banks	BGB_22	34.6937681	-76.6791235	0.9
	BGB_21	34.69372	-76.6894279	1
	BGB_20	34.6944136	-76.7002502	0.6
	BGB_19	34.6950673	-76.7063912	2
	BGB_18	34.6969735	-76.7285541	2
	BGB_17	34.6974806	-76.749723	2
	BGB_16	34.6971152	-76.7715031	2
	BGB_15	34.6959009	-76.7934497	2
	BGB_14	34.6942997	-76.8147773	2.1
	BGB_13	34.6920085	-76.8376368	1.9
	BGB_12	34.689642	-76.8576913	2.3
	BGB_11	34.686544	-76.8819837	1.9
	BGB_10	34.6837044	-76.9020641	1.9
	BGB_9	34.6807421	-76.9219194	2.2
	BGB_8	34.6770714	-76.945784	1.8
	BGB_7	34.673964	-76.9653633	2.1
	BGB_6	34.6700276	-76.987871	2
	BGB_5	34.6660888	-77.0087279	2
	BGB_4	34.661501	-77.0294428	2.1
	BGB_3	34.6561629	-77.0519749	2.2
	BGB_2	34.6505467	-77.093451	1.9
	BGB_1	34.6443328	-77.0935954	0

**Table S2.** List of the 53 plant species found in foredune surveys of the Outer Banks islands from False Cape, Virginia, to Bogue Banks, North Carolina, USA. Plants are classified by functional group. Eleven plant species are listed as unknowns with their basic defining characteristics.

	<b>Species</b>	
Grasses	<i>Ammophila breviligulata</i> (AMBR)	<i>Spartina cynosuroides</i>
	<i>Andropogon littoralis</i>	<i>Spartina patens</i> (SPPA)
	<i>Cenchrus tribuloides</i>	<i>Uniola paniculata</i> (UNPA)
	<i>Digitaria</i> sp.	Unknown 3 (small grass)
	<i>Panicum amarum</i> (PAAM)	Unknown 4 (small grass)
	<i>Panicum virgatum</i>	Unknown 9 (tall grass)
Sedges	<i>Carex</i> sp.	
Forbs	<i>Achillea millefolium</i>	<i>Krigia virginica</i>
	<i>Aster subulatus</i>	<i>Lactuca canadensis</i>
	<i>Borrichia frutescens</i>	<i>Lepidium virginicum</i>
	<i>Cakile edentula</i>	<i>Oenothera humifusa</i>
	<i>Centella asiatica</i>	<i>Rumex acetosella</i>
	<i>Conyza canadensis</i>	<i>Solidago sempervirens</i>
	<i>Commelina erecta</i>	<i>Trichostema</i> sp.
	<i>Croton punctatus</i>	Unknown 1 (small fuzzy herb)
	<i>Diodia teres</i>	Unknown 5 (small herb)
	<i>Euphorbia polygonifolia</i>	Unknown 6 (aster)
	<i>Gaillardia pulchella</i>	Unknown 7 (fuzzy aster)
	<i>Gnaphalium obtusifolium</i>	Unknown 8 (small herb)
	<i>Heterotheca subaxillaris</i>	Unknown 11 (small fuzzy herb)
<i>Hydrocotyle bonariensis</i>		
Vines	<i>Ipomoea sagittata</i>	<i>Smilax auriculata</i>
	<i>Ipomoea stolonifera</i>	<i>Smilax bona-nox</i>
	<i>Lonicera sempervirens</i>	<i>Strophostyles helvola</i>
	<i>Parthenocissus quinquefolia</i>	Unknown 2 (thorny vine)
Shrubs	<i>Iva imbricata</i>	<i>Opuntia drummondii</i>
	<i>Myrica cerifera</i>	Unknown 10 (small shrub)
Trees	<i>Quercus geminata</i>	

**Table S3.** One-way ANOVAs and associated Tukey's post hoc tests ( $p \leq 0.05$  in bold) for the abundance of (A) plant functional groups (grasses, forbs, vines, and shrubs) on different islands (abbreviations in Table S1), (B) dune grass species (abbreviations in Table S2) on different islands, and (C) dune grass species across the dune profile (toe/face, crest, and heel/back) in foredunes of the Outer Banks islands from Virginia to North Carolina, USA.

<b>A.</b>	<b>Effect</b>	<b>DF</b>	<b>SS</b>	<b>MS</b>	<b>F</b>	<b><i>p</i></b>	<b>Post hoc</b>
<b>Grasses</b>	Island	8	1.37	0.17	3.94	<b>0.0004</b>	NCB=FAC=HAT>PEA=SHB=BGB=BOD=SCB=OCR
	Residual	103	4.47	0.04			
<b>Forbs</b>	Island	8	0.17	0.02	1.53	0.1573	
	Residual	103	1.42	0.01			
<b>Vines</b>	Island	8	0.91	0.11	7.68	<b>0.0001</b>	BGB>BOD=SCB=OCR=PEA=HAT>NCB=FAC=SHB
	Residual	103	1.52	0.01			
<b>Shrubs</b>	Island	8	0.45	0.06	3.76	<b>0.0007</b>	OCR=PEA=BOD=SCB>HAT=BGB=SHB=NCB=FAC
	Residual	103	1.52	0.01			
<b>B.</b>	<b>Effect</b>	<b>DF</b>	<b>SS</b>	<b>MS</b>	<b>F</b>	<b><i>p</i></b>	<b>Post hoc</b>
<b>AMBR</b>	Island	8	1.83	0.23	4.30	<b>0.0002</b>	OCR=FAC=BOD>BGB=HAT=SCB=PEA=NCB=SHB
	Residual	103	5.51	0.05			
<b>PAAM</b>	Island	8	0.66	0.08	3.01	<b>0.0045</b>	OCR=FAC>NCB=OCR=HAT=PEA=BGB=SCB=SHB
	Residual	103	2.83	0.03			
<b>SPPA</b>	Island	8	0.49	0.06	1.37	0.2195	
	Residual	103	4.62	0.05			
<b>UNPA</b>	Island	8	3.02	0.38	3.78	<b>0.0006</b>	SHB=BGB=SCB=NCB=HAT=PEA>OCR=FAC=BOD
	Residual	103	10.30	0.10			
<b>C.</b>	<b>Effect</b>	<b>DF</b>	<b>SS</b>	<b>MS</b>	<b>F</b>	<b><i>p</i></b>	<b>Post hoc</b>
<b>AMBR</b>	Island	2	0.12	0.06	0.06	0.6407	
	Residual	24	2.33	0.09			
<b>PAAM</b>	Island	2	0.02	0.01	0.17	0.8461	
	Residual	24	1.13	0.05			

<b>SPPA</b>	Island	2	1.26	0.63	8.28	<b>0.0018</b>	Heel>Crest=Toe
	Residual	24	1.83	0.07			
<b>UNPA</b>	Island	2	0.27	0.14	1.02	0.3773	
	Residual	24	3.21	0.13			

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**Table S4.** Mean ( $\pm$  95% CI) growth form and morphological differences of the four dominant dune grass species (abbreviations in Table S2) in foredunes of the Outer Bank islands, USA. Sample sizes are in the first parentheses and significant differences are represented by different letters in the second parentheses.

<b>Traits</b>	<b>AMBR</b>	<b>PAAM</b>	<b>SPPA</b>	<b>UNPA</b>
Plant density (number per 0.25 m <sup>2</sup> )	5.3 $\pm$ 1 (184)(a)	5.1 $\pm$ 0.6 (274)(a)	2.2 $\pm$ 0.5 (108)(b)	5.2 $\pm$ 0.2 (949)(a)
Total shoot density (number per 0.25 m <sup>2</sup> )	14.4 $\pm$ 2.7 (180)(b)	7.1 $\pm$ 1.4 (157)(c)	19.7 $\pm$ 4.4 (48)(a)	8.3 $\pm$ 0.4 (407)(c)
Total aboveground biomass (g per 0.25 m <sup>2</sup> )	36.5 $\pm$ 6.8 (180)(b)	19.6 $\pm$ 3.9 (157)(c)	12.3 $\pm$ 2.8 (48)(c)	51.7 $\pm$ 2.3 (407)(a)
Plant height (cm)	74.7 $\pm$ 2.6 (180)(b)	49.7 $\pm$ 3 (153)(d)	60.3 $\pm$ 4.4 (48)(c)	85.1 $\pm$ 2.6 (403)(a)
Plant weight (g per aboveground plant)	7.1 $\pm$ 1.2 (180)(b)	3.4 $\pm$ 0.5 (157)(d)	5.6 $\pm$ 1.1 (48)(c)	8.7 $\pm$ 0.6 (407)(a)
Shoot number (per plant)	2.7 $\pm$ 0.3 (180)(b)	1.4 $\pm$ 0.2 (157)(c)	9 $\pm$ 1.5 (48)(a)	1.6 $\pm$ 0.1 (407)(c)
Shoot weight (g per shoot)	2.5 $\pm$ 0.3 (180)(b)	2.7 $\pm$ 0.4 (157)(b)	0.6 $\pm$ 0.1 (48)(c)	6.2 $\pm$ 0.5 (407)(a)
Leaf number (per shoot)	5.8 $\pm$ 0.3 (180)(b)	8.7 $\pm$ 0.6 (153)(a)	4.7 $\pm$ 0.4 (48)(c)	8.5 $\pm$ 0.4 (407)(a)
Leaf width (mm)	5.5 $\pm$ 0.2 (180)(c)	7.6 $\pm$ 0.4 (155)(a)	2.0 $\pm$ 0.4 (48)(d)	6.3 $\pm$ 0.2 (405)(b)
Ligule length (mm)	1.6 $\pm$ 0.1 (180)(b)	2.3 $\pm$ 0.1 (152)(a)	0.8 $\pm$ 0.1 (47)(c)	2.2 $\pm$ 0.1 (394)(a)
Rhizome internode length (cm)	1.9 $\pm$ 0.1 (147)(b)	2.4 $\pm$ 0.3 (123)(a)	2.0 $\pm$ 0.3 (15)(ab)	2.4 $\pm$ 0.3 (272)(ab)
Root number (per node)	2.7 $\pm$ 0.9 (180)(b)	1.6 $\pm$ 0.6 (159)(c)	7.2 $\pm$ 1.8 (47)(a)	1.8 $\pm$ 0.3 (410)(c)