



CHAPTER 4.

Ecological Geography of the NBNERR

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Figure 4.1. Geographic setting of the NBNERR, including the extent of the 4,818 km² (1,853-square-mile) Narragansett Bay watershed. GIS data sources courtesy of *RIGIS* (www.edc.uri.edu/rigis/) and *Massachusetts GIS* (www.mass.gov/mgis/massgis.htm).



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Geographic Setting

Prudence Island is located roughly in the center of Narragansett Bay, R.I., bounded by 41°34.71'N and 41°40.02'N, and 71°18.16'W and 71°21.24'W. Metropolitan Providence lies 14.4 kilometers (km) (9 miles) to the north and the city of Newport lies 6.4 km (4 miles) to the south of Prudence (Fig 4.1). Because of its central location, Prudence Island is affected by numerous water masses in Narragansett Bay including nutrient-rich freshwaters flowing downstream from the Providence and Taunton rivers and oceanic tidal water masses moving upstream from Rhode Island Sound. Prudence Island is the third largest island in Narragansett Bay after Aquidneck and Conanicut islands, and is easily the largest island in the Reserve at 1,424 hectares (ha) (3,559 acres).

The other three smaller islands in the Reserve are all located in close proximity to Prudence Island. Patience Island sits 0.16 km (0.1 mile) off the northwest point of Prudence, while Hope Island and Dyer Island lie 2.4 km (1.5 miles) to the west and 1.1 (0.7 mile) km to the southeast of Prudence Island, respectively. In decreasing order, the sizes of these islands are 86 ha (214 acres) (Patience), 31 ha (78 acres) (Hope), and 14 ha (36 acres) (Dyer).

Climate and Weather

The temperate, maritime climate around the Reserve and surrounding mainland is heavily influenced and moderated by Narragansett Bay. Meteorological patterns on mainland Rhode Island are monitored by the NOAA National Weather Service (NWS) at T.F. Greene airport in Warwick, R.I. (on the west side of Narragansett Bay, approximately 16 km (10 miles) south of Providence). A more comprehensive suite of meteorological data is monitored on Prudence Island with a Campbell weather station located near Potter Cove (Figs. 2.5, 4.2). The weather station on Prudence Island was established in 1996 and began continually collecting weather data as part of the NERR System-Wide Monitoring



Program in 2001. Annual weather patterns on Prudence Island are similar to those on the mainland, at least when considering air temperature, wind speed, and barometric pressure (Figure 4.3).

Using recent data collected from the NBNERR weather station, some annual patterns are clear. For example, air temperature, relative humidity, and the amount of photosynthetically active radiation (PAR) all clearly peak during the summer months (Fig. 4.3). The total amount of precipitation is generally highest during spring and fall, but this pattern is not as strong as the former parameters based on these limited data. Wind speed is lowest during the summer and barometric pressure displays no strong annual pattern. Predominant wind directions vary by season (Fig. 4.4). In spring, winds are mostly from the southwest and northeast, but are primarily only from the southwest at lower velocities in the summer. In fall, high velocity northwest winds accompany the southwesterlies, and in winter a mix of northern, northwestern, and southwestern winds is common.

Geology

All of Rhode Island, including Prudence, Patience, Hope, and Dyer islands, has been intermittently buried under glacial ice sheets beginning as far back as the Pleistocene epoch, approximately 2.5 to 3 million years ago. The last of the glaciers retreated from the area during the Wisconsin glaciation, approximately 12,000 years ago. As the glaciers retreated from the area, they deposited vast amounts of till, sand, gravel, and unconsolidated rock over the bedrock (Fig. 4.5). Most of the land on the four islands is composed of thin glacial till over ancient bedrock, with smaller areas of adjacent outwash (Fig. 4.6). Like much of the Narragansett Bay coastline, the bedrock of Prudence, Patience, Hope, and Dyer islands is composed of stratified sedimentary rock from the Pennsylvanian age, while Narragansett Bay itself is an ancient drowned glacial river valley.

Figure 4.2. The NBNERR weather station on Prudence Island. *Photo from NBNERR photo library.*

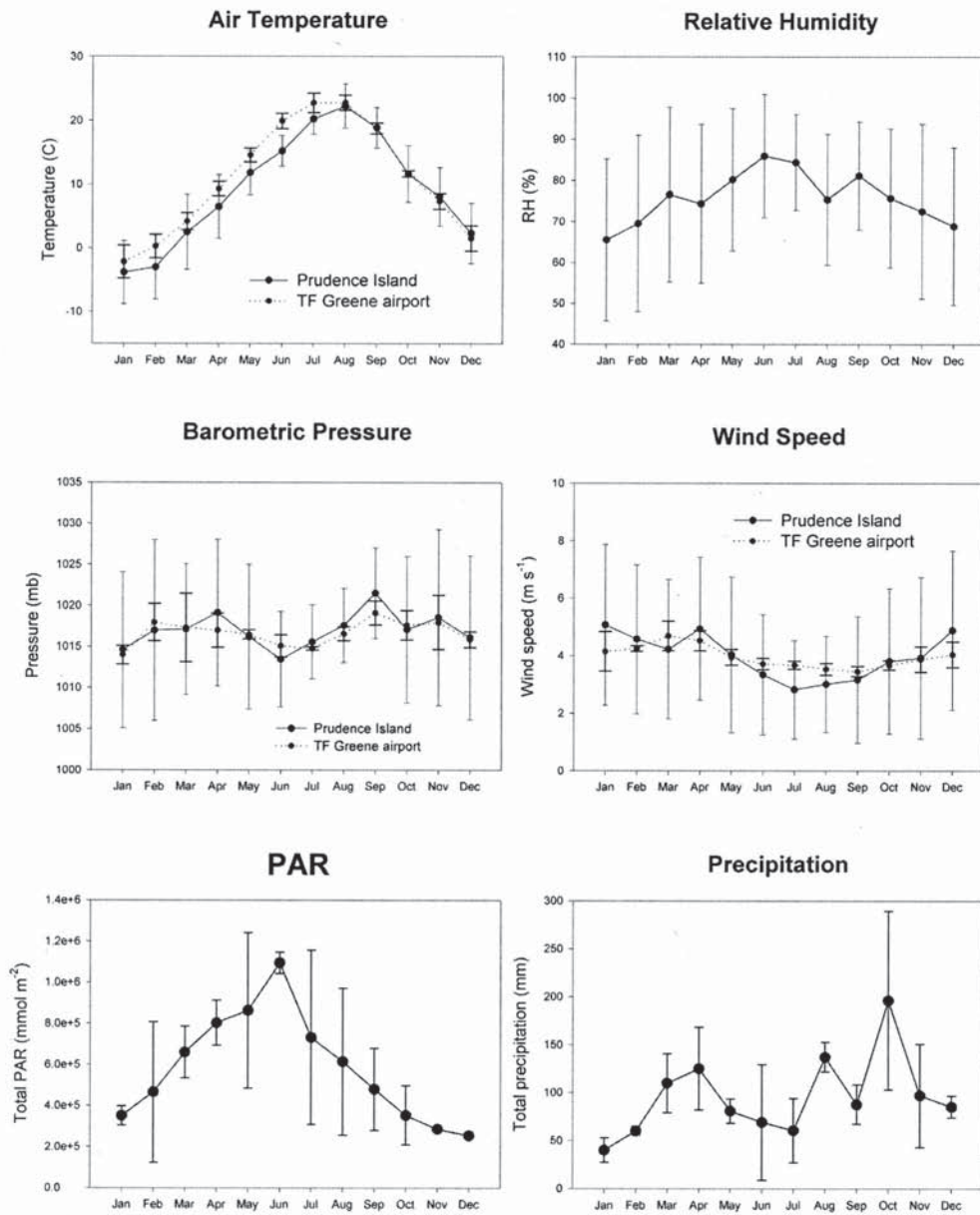
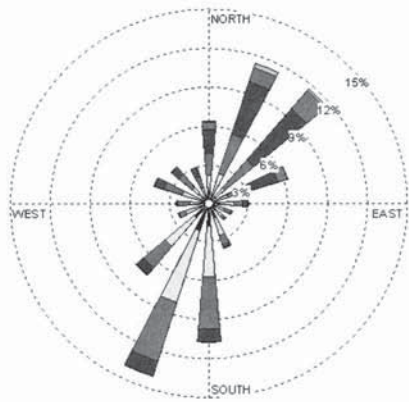
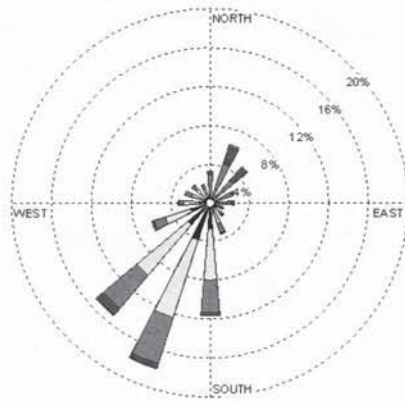


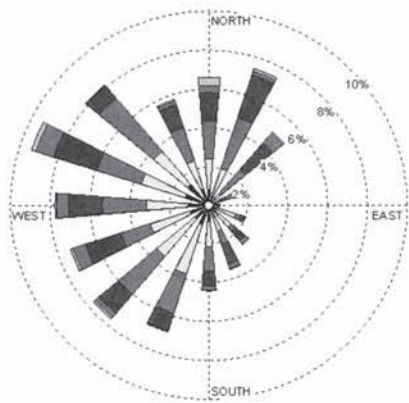
Figure 4.3. Meteorological patterns on Prudence Island and mainland, R.I. Prudence Island data are from 2003–05 from the NBNERR weather station near Potter Cove. Temperature, humidity, pressure, and wind speed plots are monthly averages from 15-minute samples. PAR and precipitation plots are monthly totals from 15-minute samples. Mainland temperature, pressure, and wind speed data were obtained from the NWS at T.F. Greene airport in Warwick, R.I. Temperature and wind speed data are monthly averages from 1999–2004; pressure data are monthly averages from 2001–04. Error bars for all data are standard deviations.



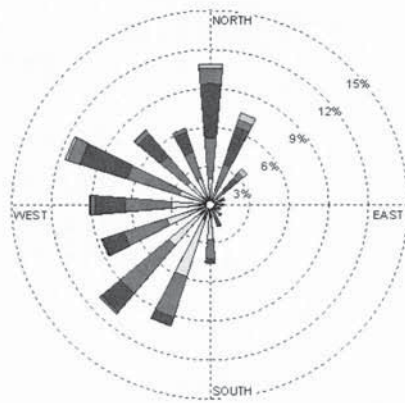
Spring



Summer



Fall



Winter

Figure 4.4. Seasonal wind roses from the NBNERR weather station located near Potter Cove on Prudence Island. Data are from 2003–05. All wind rose figures were created using the WRPLOT View software package (©1998–2004 Lakes Environmental Software).



Figure 4.5. Glacial erratics found on a Prudence Island beach. *Photo from NBNERR photo library.*

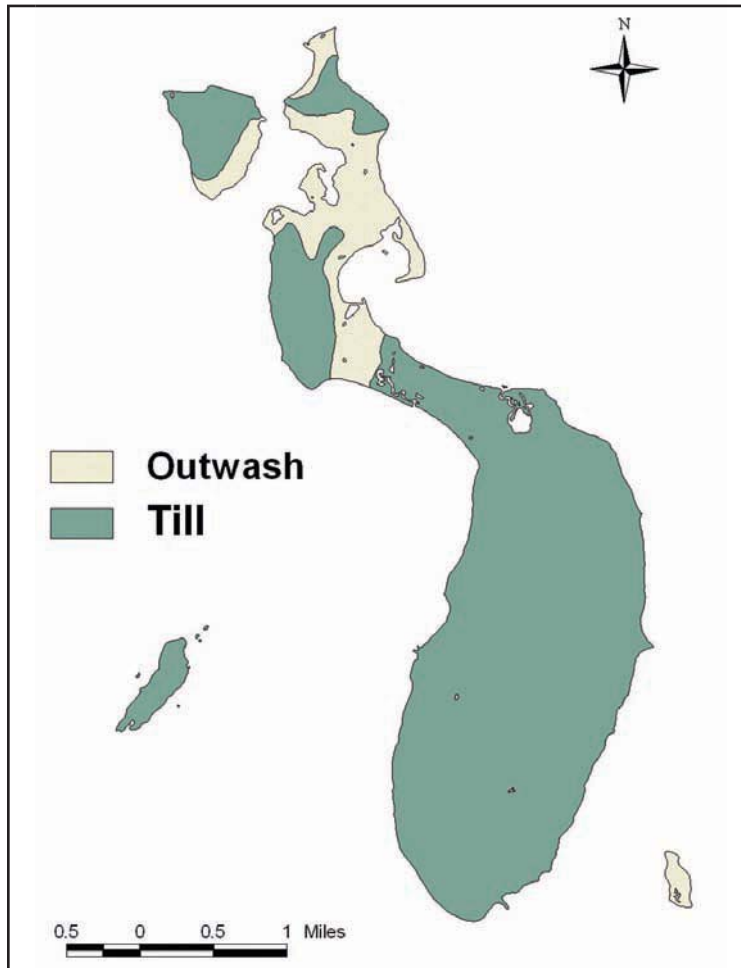


Figure 4.6. Glacial deposits overlying bedrock on Prudence, Patience, Hope, and Dyer islands. *GIS data sources courtesy of RIGIS.*



Figure 4.8. Sandy, well-drained Poquonock soils fronting and supporting pine barrens in the South Prudence Unit of the NBNERR. *Photo from NBNERR photo library.*



Soils

Much of the information on the soils of Prudence, Patience, Hope, and Dyer islands was obtained from the Soil Survey of Rhode Island (Rector, 1981). According to this survey, soils can be classified as soil series, complexes, undifferentiated groups, or miscellaneous areas. A soil series characterizes soils by their profiles. Each series can be further broken into different phases based on characteristics such as slope, wetness, or salinity, among others. For example, the Newport soil series on Prudence Island is present in three phases (A, B, and C phases) based on differences in slope (Table 4.1; Fig. 4.7). A soil complex is an area of at least two soils that are well mixed together or too small to be differentiated on a map. An example of this on Prudence Island is the rock outcrop—Canton complex (Rp). An undifferentiated group is also an area of two or more soils that are not separated simply because there is little value in doing so, and an example from Prudence is the Canton and Charlton fine sandy loams, zero to 3 percent slopes.

Based on this, 27 different soil types (including multiple phases of the same soil series) are found on Prudence, Patience, Hope, and Dyer islands (Table 4.1; Fig. 4.7). This includes features such as beaches around each of the islands and rocky outcrops along the shore of Hope Island. Based on acreage, the dominant soil types for each island (after summing multiple phases of the same soil series) are the

Newport series (Prudence and Patience islands), the Canton and Charlton complex (Hope), and the Merrimac series (Dyer).

Prudence Island is dominated by non-hydric soils, but approximately 24 percent of the soils on the island are hydric, supporting relatively large areas of wetlands. Although it is composed of a diverse array of soil types, Prudence is ultimately dominated by different phases of both the Newport and Poquonock soil series (856.7 acres and 775.4 acres, respectively). The Poquonock series is notable in that only 2,555 acres of this series are found in Rhode Island as a whole; thus over 30 percent of the statewide total (775 acres) is found on Prudence Island. It is these sandy, well-drained Poquonock soils (Fig. 4.8) that support two areas of globally rare pine barrens found on Prudence—one in the southwest corner of the island and the other directly south of Prudence neck (see Chapter 5).

Soils are even drier on Patience Island, where only 12 percent of the island (26 out of 210 acres) is composed of hydric soils. The hydric soils (Matunuck mucky peat and Stissing silt loam) are associated with a salt and brackish marsh found along the southeast side of the island. Hope Island is listed as being composed entirely of non-hydric soil types, although two small perched wetlands are known to exist. It is unique among the four islands in that it is overwhelmingly dominated by rocky outcrops and the Canton

Table 4.1. Acres of soil types found on Prudence, Patience, Hope, and Dyer Islands. Soil types include soil series (including different phases of the same series), complexes, undifferentiated groups, and miscellaneous areas, but not waterbodies (Rector, 1981). Acreages of Prudence Island soils are presented for different sections of the NBNERR, for the NBNERR as a whole, and for all of Prudence Island.

Soil Type	Prudence					Patience	Hope	Dyer
	North Prudence Unit	Mid Prudence Units	South Prudence Unit	Total NBNERR on Prudence	Total Prudence			
Ba – Beaches	59.37	7.82	11.22	78.41	124.79	12.68	3.27	8.75
Bc – Birchwood sandy loam		5.48	20.30	25.78	122.91			
CeC – Canton and Charlton fine sandy loams		14.02	1.22	15.24	59.00		39.44	
Dc – Deerfield loamy fine sand		1.11		1.11	28.40			
Du – dumps		0.48	3.63	4.11	4.62			
HkD – Hinckley gravelly sandy loam, hilly	15.23			15.23	15.23			
Ma – Mansfield mucky silt loam		36.99		36.99	44.55			
Mk – Matunuck mucky peat	104.33	53.48		157.81	212.14	10.79		5.54
MmA – Merrimac sandy loam	11.72			11.72	11.72			
MmB – Merrimac sandy loam	94.73	4.67		99.40	127.40			11.05
NeA – Newport silt loam		64.26	101.85	166.11	235.89	30.98		
NeB – Newport silt loam	181.52	93.86	66.07	341.45	542.08	47.50		
NeC – Newport silt loam		46.25	8.35	54.6	78.71	7.51		
PmA – Pittstown silt loam	23.96	50.84	24.99	99.79	114.43			
PmB – Pittstown silt loam		6.22	4.13	10.35	34.91			
PsA – Poquonock loamy fine sand, 0–3% slopes		36.51	234.07	270.58	444.96			
PsB – Poquonock loamy fine sand, 3–8% slopes		113.82	26.80	140.62	330.42	30.86		
QoC – Quonset gravelly sandy loam, rolling	132.53	14.21		146.74	208.99	38.07		
Rk – Rock outcrop							17.30	
Rp – Rock outcrop – Canton complex							13.39	
Sb – Scarboro mucky sandy loam	46.32	52.89	63.92	163.13	315.60			
Se – Stissing silt loam		38.98	213.26	252.24	267.43	15.40		
Ss – Sudbury sandy loam	23.59			23.59	23.59			
UAB – Udipsamments, undulating	1.95			1.95	1.95			
UD – Udorthents – Urban land complex			22.48	22.48	22.48			
W – Walpole sandy loam	14.22	2.71	2.87	19.8	35.82	14.55	15.15	15.10
WgA – Windsor sandy loam	7.79	22.84		30.63	112.61			
WgB – Windsor loamy sand	29.29	1.15		30.44	49.84	14.45		

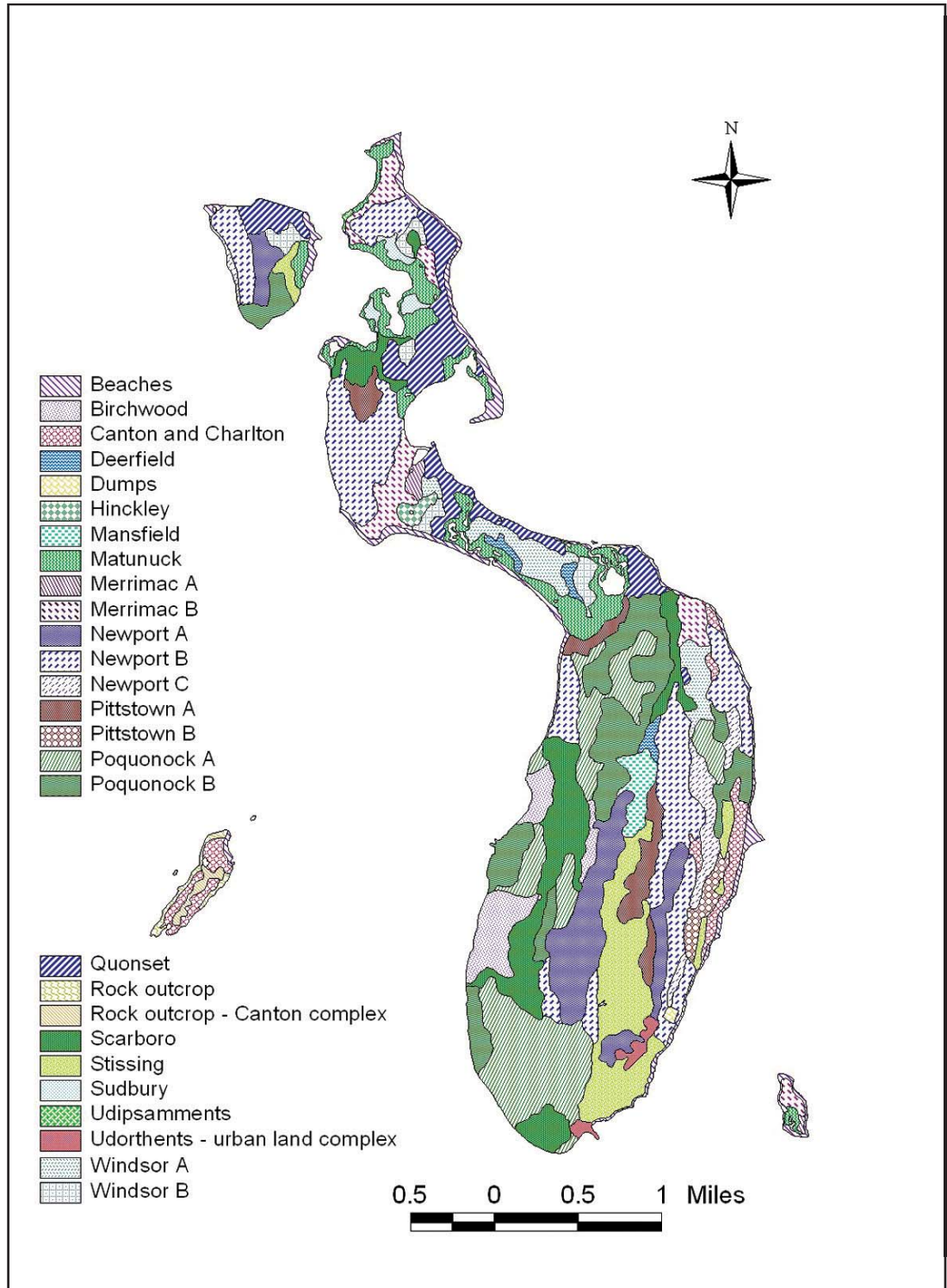


Figure 4.7. Soil types found on Prudence, Patience, Hope, and Dyer islands. GIS data sources courtesy of RIGIS.

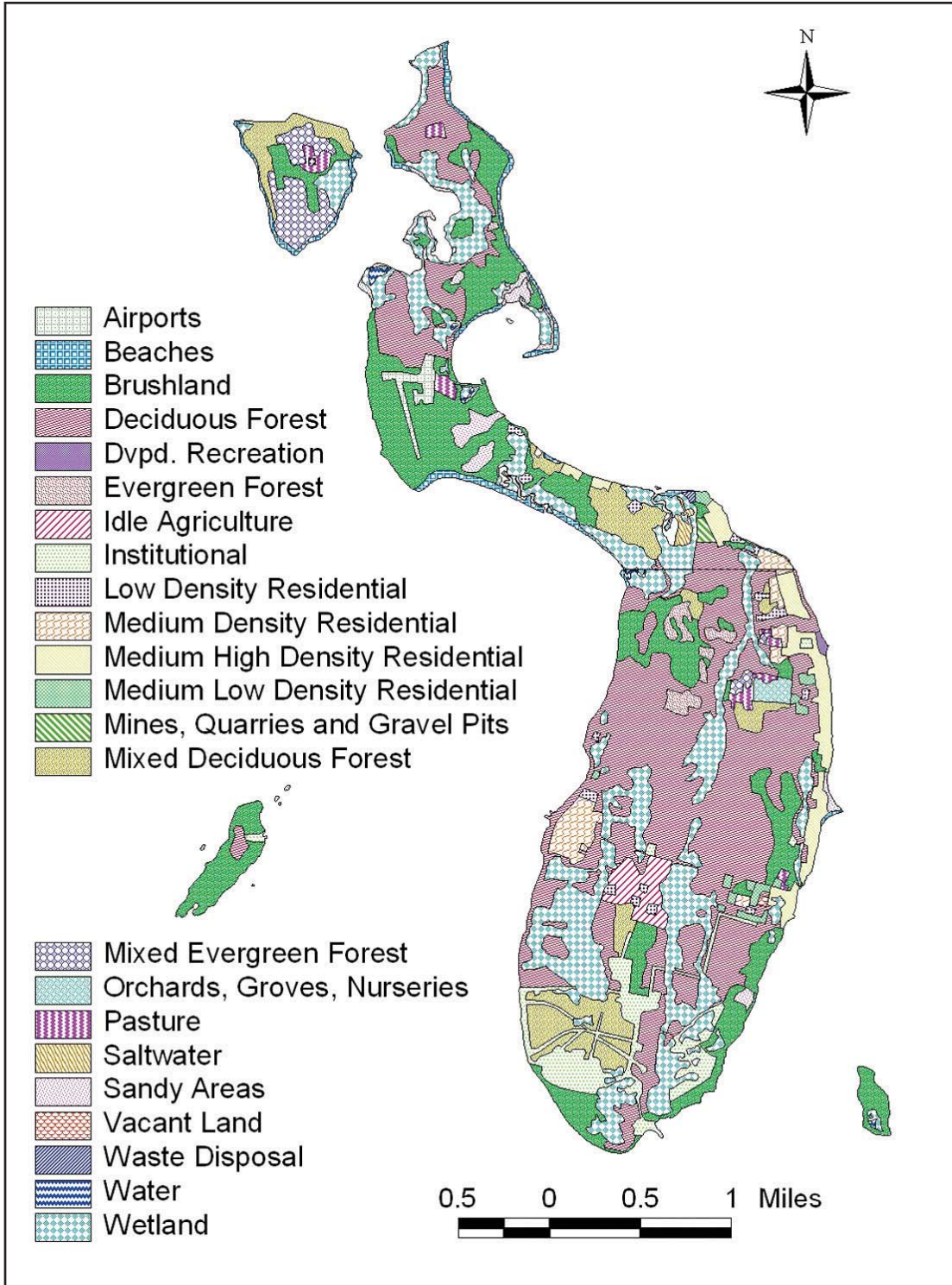


Figure 4.9. Land cover in 1995 on Prudence, Patience, Hope, and Dyer islands. GIS data sources courtesy of RIGIS.



a.



b.



c.

Figure 4.10. Examples of the dominant land cover classes on Prudence Island, including: (a) forest (pine-oak mixed forests are common on Prudence); (b) wetland (in this case, a salt marsh); and (c) brushland (dominated here by briar, *Smilax* spp.). Photos from NBNERR photo library.

Table 4.2. Acres of land cover types on Prudence, Patience, Hope, and Dyer islands based on RIGIS 1995 land-use/land cover coverage. Acreages of Prudence Island land cover classes are presented for different sections of the NBNERR, for the NBNERR as a whole, and for all of Prudence Island.

Land cover type	Prudence				Total Prudence	Patience	Hope	Dyer
	North Prudence Unit	Mid Prudence Units	South Prudence Unit	Total NBNERR on Prudence				
Airports	14.45			14.45	27.33			
Beaches	38.11	4.36		42.47	59.75	16.89		
Brushland	289.4	70.56	122.79	482.75	642.94	30.31	63.88	24.76
Deciduous forest	189.69	413.91	182.81	786.41	1207.65		7.51	
Developed recreation					3.29			
Evergreen forest	1.37	6.44		7.81	40.03			
Idle agriculture		0.1	11.83	11.93	52.14			
Institutional		0.16	163.2	163.36	176.04		2.94	
Low density residential		1.56	1.6	3.16	28.46	0.82		
Medium density residential		0.99		0.99	72.67			
Medium high density residential		2.62	0.03	2.65	120.37			
Medium low density residential		0.23	0.47	0.7	27.81			
Mines, quarries, and gravel pits		0.01		0.01	6.3			
Mixed deciduous forest		15.34	102.91	118.25	209.98	48.27		
Mixed evergreen forest		0.27		0.27	7.72	79.27		
Orchards, groves, nurseries					16.5			
Pasture	8.73	1		9.73	29.31	9.94		
Saltwater		1.52		1.52	10.77			
Sandy areas (not beaches)	49.67		4.71	54.38	60.14			
Vacant land					1.68			
Waste disposal					1.96			
Water	5.2	1.88		7.08	7.08			0.84
Wetland	144.14	142.79	212.34	499.27	743.02	22.91		2.97



and Charlton complex, characterized by a surface where stones and boulders cover between 2 and 10 percent, and where rock outcrops cover up to 10 percent (Rector, 1981). Because of these features, Hope Island resembles the rocky shorelines found in some areas along the southern coast of Rhode Island and along much of the northern New England coast. Dyer Island is also dominated by non-hydric soils (23 acres, compared to six acres of hydric soils). The six-acre hydric soil unit is Matunuck mucky peat that supports a small salt marsh on the southern end of the island.

Land Use and Land Cover

A diverse mosaic of land cover and habitat types exists on Prudence, Patience, Hope, and Dyer islands, in part due to over 300 years of extensive human modifications (see Chapter 3). Detailed land-use and land cover data for the islands (and all of Rhode Island) are available for the years of 1995 and 1998 in the form of GIS coverages that are coded according to the Anderson Level 3 land-use/land cover classification system (RIGIS, 2005). Based on the 1995 coverage, 23 land cover classes are found on the four NBNERR islands (Table 4.2; Fig. 4.9). All of these classes are present on Prudence, but not on Patience (seven land cover classes), Hope (three classes), or Dyer (three classes).

Prudence Island is dominated by secondary growth habitats. Deciduous forest is the largest land cover class (1,208 acres; 34 percent of the island), followed by wetlands (743 acres; 21 percent) and brushland (643 acres; 19 percent) (Fig. 4.10). In contrast, developed land cover classes (e.g., residential areas) comprise only 249 acres, or 7 percent of Prudence Island. Compared to the three other large islands in Rhode Island (Aquidneck, Conanicut, and Block), Prudence Island has by far the least amount of developed and agricultural land and the most forested and brushland, again illustrating the natural setting of Prudence (Rosenzweig et al., 2002).

When considering only the land within the NBNERR on Prudence Island, dominant land cover classes include deciduous forest (32 percent), brushland (23 percent), and wetlands (21 percent) (Table 4.2). However, only 17 land cover classes were identified in the Reserve, due to the absence of orchards and nurseries, mines and quarries, developed recreation areas, waste disposal, and vacant lands. At least 64 percent of the total acreage of each natural land cover class on Prudence Island was located inside Reserve boundaries, with the exception of evergreen forests (only 20 percent of this class

was found in the Reserve). Land cover differed among the units of the NBNERR, but most were again dominated by forest, wetland, and brushland (Table 4.2).

Patience Island is almost completely composed of natural land cover classes, including mixed evergreen forest (79 acres; 38 percent of the island), mixed deciduous forest (48 acres; 23 percent), brushland (30 acres; 14 percent), and wetlands (23 acres; 11 percent). A 0.8-acre of residential development remains on Patience Island due to a lone inholding remaining after the island was purchased by the state.

Hope and Dyer islands differ from both Patience and Prudence in that they are both overwhelmingly dominated by a single land cover class. There are 64 acres of brushland on Hope Island and 25 acres on Dyer, making up 85 percent and 86 percent of the two islands, respectively. The only other land cover classes on these islands are deciduous forest and institutional (remnants from Navy use) on Hope, and water and wetland on Dyer.

Three land cover classes grew by at least 37 acres between 1988 and 1995 on Prudence Island: Ninety-nine acres of mixed deciduous forest, 72 acres of brushland, and 37 acres of deciduous forest grew during this period. Virtually all of these habitat increases occurred on the South Prudence Unit where areas that were abandoned by the Navy began to revert back to a more natural state (Fig. 4.9).

Wetlands

Based on the RIGIS wetlands coverage maps, 10 types of wetlands are found on Prudence, Patience, Hope, and Dyer islands (Fig. 4.11), although most of these are either deciduous forested wetlands and estuarine emergent wetlands (i.e., salt marshes) (Table 4.3). Almost 70 percent of all wetlands occurring on the four islands are protected within the boundaries of the Reserve, including 76 percent of all salt marshes. Compared to Aquidneck, Conanicut, and Block islands, Prudence has by far the greatest proportion of wetlands relative to the total island area (Rosenzweig et al., 2002).

Surficial Hydrology

Surface water bodies that retain water throughout the year are scarce on the four islands in the Reserve. Prudence has a few small year-round ponds, although the exact number is unknown (six were present on the RIGIS ponds coverage, and six

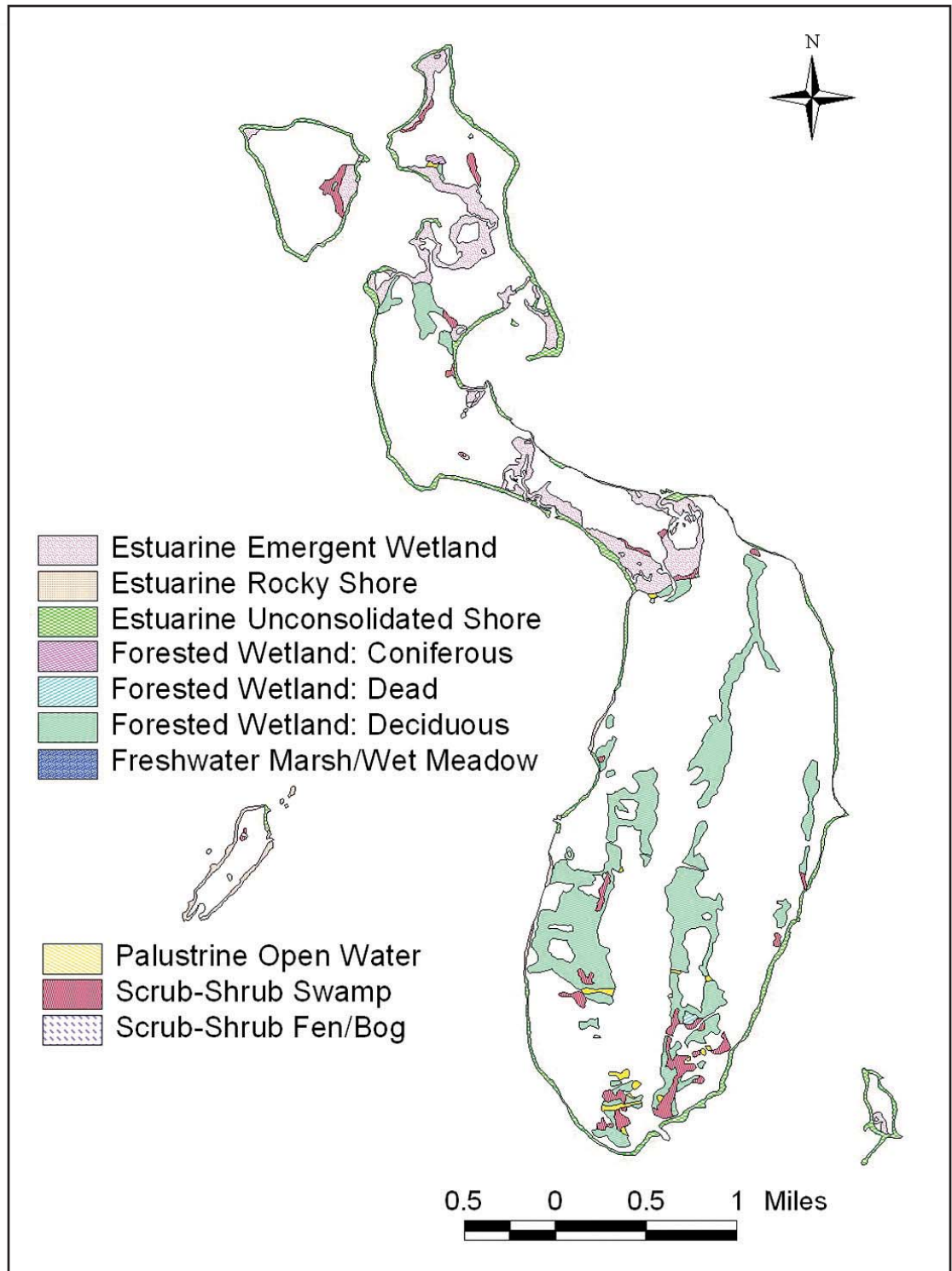


Figure 4.11. Wetlands on Prudence, Patience, Hope, and Dyer islands. GIS data sources courtesy of RIGIS.

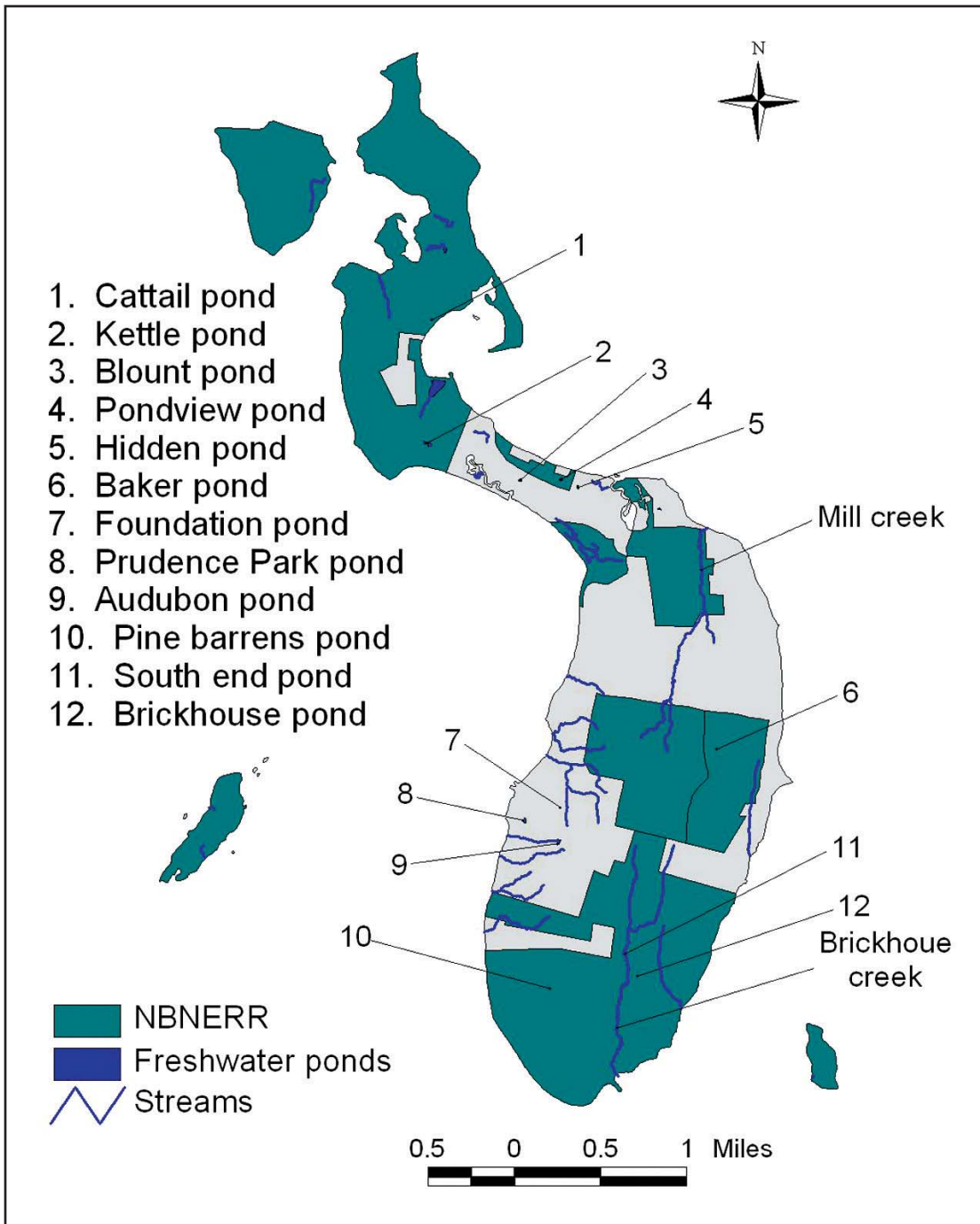
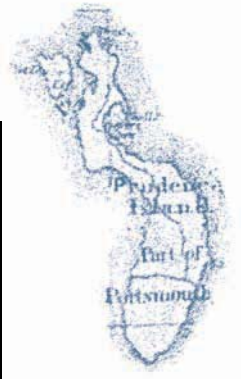


Figure 4.12. Freshwater ponds and streams on Prudence, Patience, Hope and Dyer islands. All pond names are colloquial; ponds were unofficially named by island residents or Reserve staff. GIS data sources courtesy of RIGIS.

Table 4.3. Acres of wetland types on Prudence, Patience, Hope, and Dyer islands based on RIGIS 1995 wetlands coverage. Acreages of Prudence Island wetland classes are presented for different sections of the NBNERR, for the NBNERR as a whole, and for all of Prudence Island.

Wetland class	Prudence					Patience	Hope	Dyer
	North Prudence Unit	Mid Prudence Units	South Prudence Unit	Total NBNERR on Prudence	Total Prudence			
Forested wetland: deciduous	28.55	87.44	156.31	272.30	448.82	0.44		
Estuarine emergent wetland	101.86	47.87		149.73	200.85	12.82		2.97
Estuarine unconsolidated shore	55.18	9.90	21.90	86.98	124.89	19.33	1.07	8.28
Scrub-shrub swamp	9.76	3.21	42.00	54.97	65.62	9.64	0.72	
Estuarine rocky shore			1.12	1.12	7.24		13.13	
Freshwater marsh/wet meadow	0.90	0.64	11.90	13.44	15.09			
Forested wetland: dead				2.57	2.57			
Palustrine open water	0.47		0.51	0.98	1.65		0.78	
Forested wetland: coniferous	2.36			2.36	2.36			
Scrub-shrub fen/bog	0.26			0.26	.26			
All wetlands	202.31	149.48	235.31	587.1	875.58	42.23	15.70	12.32

more were located based on personal observations; Fig. 4.12). Prudence also supports approximately 15.5 km (9.7 miles) of streams (based on the RIGIS streams coverage) and numerous, but unquantified vernal pools. Patience and Dyer islands do not support any standing freshwater ponds or streams (Fig. 4.12; the stream on Patience Island is actually a salt marsh tidal creek). Hope Island has two streams present on it according to the RIGIS coverage in addition to two small freshwater ponds that do not show up on the ponds coverage (personal observation). More detailed maps and information on ponds, vernal pools, and streams on the islands are needed, in part due to mapping inaccuracies on the RIGIS coverages.

Shoreline

Based on the RIGIS Narragansett Bay estuarine habitat coverage, the NBNERR encompasses approximately 29 km (18.2 miles) of estuarine shoreline on Prudence, Patience, Hope, and Dyer islands. The Reserve's shoreline is composed of five classes, including 15.5 km of beaches (mostly cobble, some sandy), 6.2 km of salt marsh (fringing and meadow marshes), 5.3 km of rocky shore, 1.9 km of upland, and 0.3 km of *Phragmites australis* (Fig. 4.13).

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Rector, D. 1981. Soil Survey of Rhode Island. U.S. Department of Agriculture, Soil Conservation Service. 200pp., plus maps.

Rosenzweig, L., R. Duhaime, A. Mandeville, and P. August. 2002. Ecological geography of Block Island. In: *The Ecology of Block Island*. Pp. 3–12. Edited by Paton, P.W., L.L. Gould, P.V. August, and A.O. Frost. Rhode Island Natural History Survey, Kingston, R.I.



a.

Figure 4.13. Examples of dominant shoreline types in the NBNERR, including: (a) sandy beach; (b) cobble beach; (c) fringing salt marsh; and (d) rock outcrop. Photos from NBNERR photo library.



b.



c.



d.