Chapter Three: Watershed Characteristics

The combination of Atlantic coastal plain, maritime, and boreal influences on the Cape provide a unique environment. This once unforested area has given way to forests of pitch pine and heathlands, a rare ecosystem, wooded swamps and freshwater marshes in the riparian areas, and grasslands on the dunes. Areas of vegetation that are not directly influenced by tides or salt water and are well elevated above ground water are referred to as uplands (Godfrey et al., 1978). The upland communities described by Godfrey et al. (1978) include grasslands and meadows, shrublands and thickets, woodlands and forests.

VEGETATION

Forests

The forests, which cover approximately half of the Cape (Figure 3.1a-c), are predominantly pitch pine (*Pinus rigida*), a principal species in the maritime forests and an invader of old fields previously dominated by hardwoods (Brownlow, 1979). Other tree species (Table 3.1) include black oak (*Quercus velutina*) and white oak (*Quercus alba*) which along with the pitch pine, grow in the podzoic soils (Brownlow, 1979) and eventually succeed the pine woodland with suppression of fire (Godfrey et al., 1978). The understory of the pitch pine forests includes several species of shrubs including low bush blueberry (*Vaccinium vacillans*), bear oak (*Quercus ilicifolia*), and black huckleberry (*Gaylussacia baccata*) (Godfrey et al., 1978).

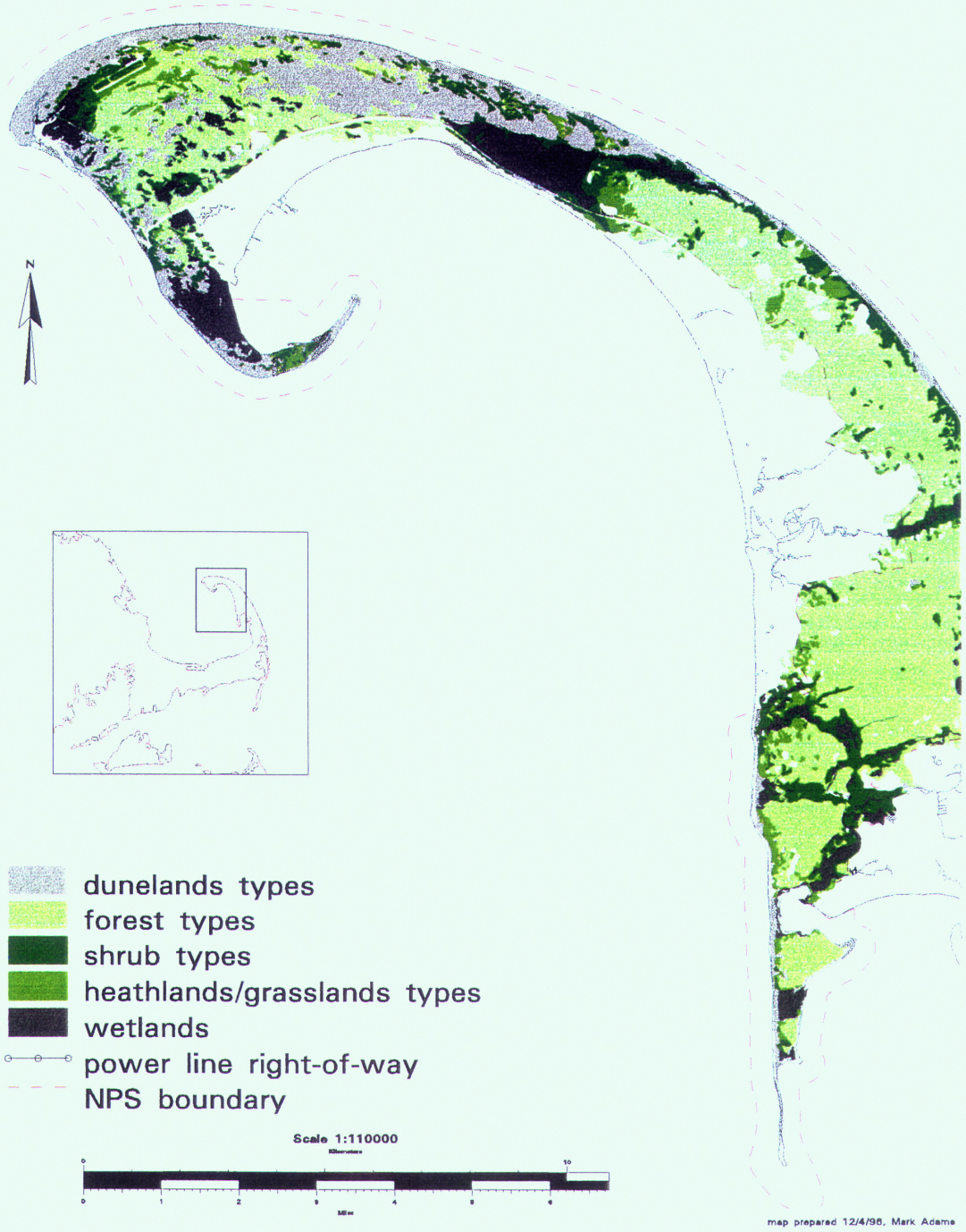
Heathlands

Multi-stemmed, woody plants that dominate open areas are classified as shrublands or thickets if the growth of the shrubs is fairly dense (Godfrey et al., 1978). Godfrey et al. describe heathlands, dominated by members of the heath family (Ericaceae), as one of the most distinctive shrub communities on the Cape (Table 3.1). Bearberry heath (*Arctostaphylos*), beach heather heath (*Hudsonia*), and huckleberry- blueberry heath (*Gaylussacia-Vaccinium*) are the dominant subtypes of heathlands on the Cape (Figure 3.1a-c). Due to increased natural succession of pine and oak, heath communities are decreasing in size. The Cape Cod National Seashore classifies the heathlands as a "Special Status Plant Community" (Carlson et al., 1991). Besides heathlands, mixed coastal shrubs (occurring on the dunes) and lowland shrubs (occurring on the border of wetlands) are also established shrub communities within the National Seashore (Godfrey et al., 1978).

Water Resources Management Plan

Figure 3.1a: Generalized Vegetation within Cape Cod National Seashore Boundary

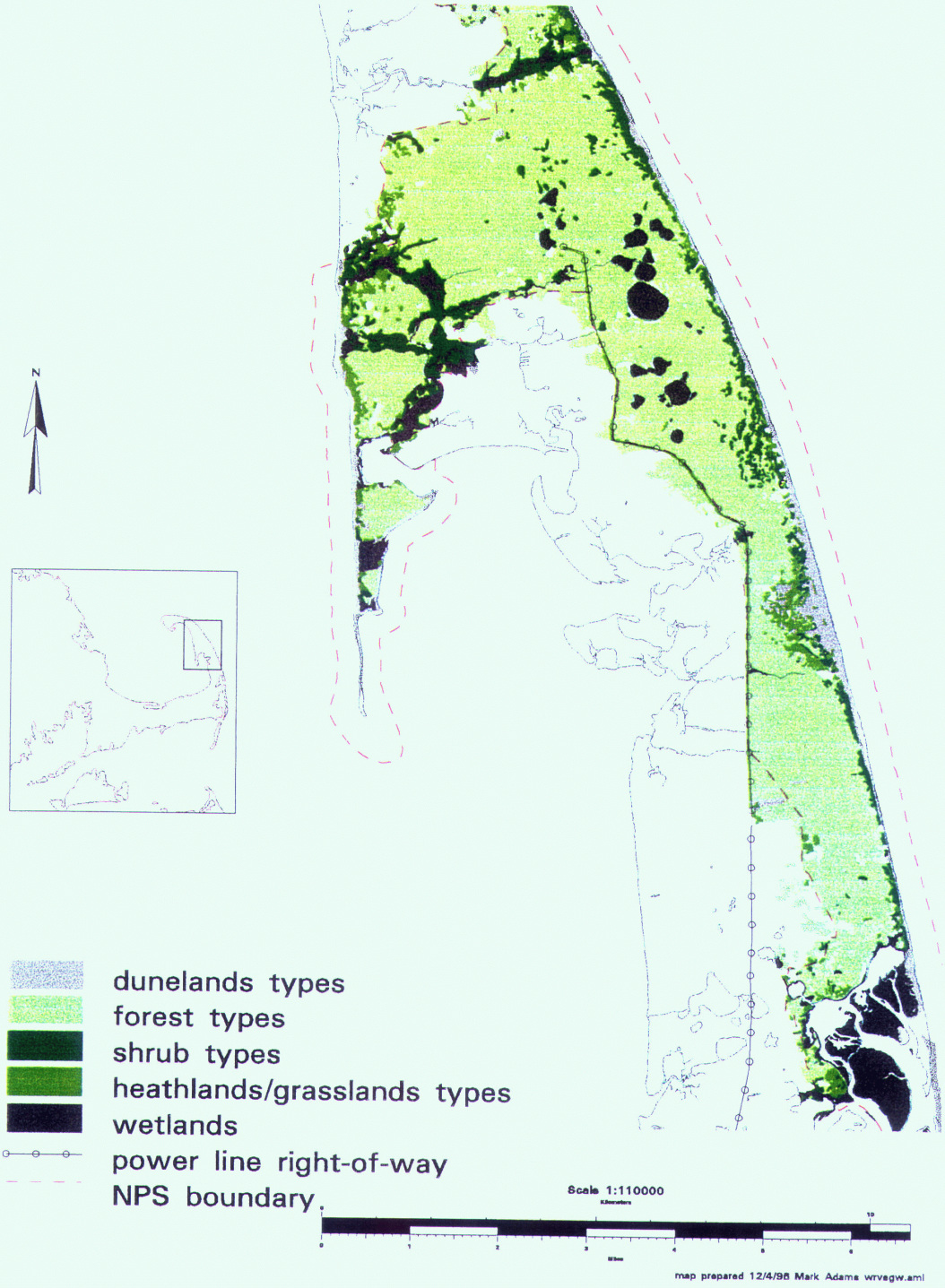
Sources: Vegetation interpreted from 1991 aerial photos by NPS staff.



Water Resources Management Plan

Figure 3.1b: Generalized Vegetation within Cape Cod National Seashore Boundary

Sources: Vegetation interpreted from 1991 aerial photos by NPS staff.



Water Resources Management Plan

Figure 3.1c: Generalized Vegetation within Cape Cod National Seashore Boundary

Sources: Vegetation interpreted from 1991 aerial photos by NPS staff.

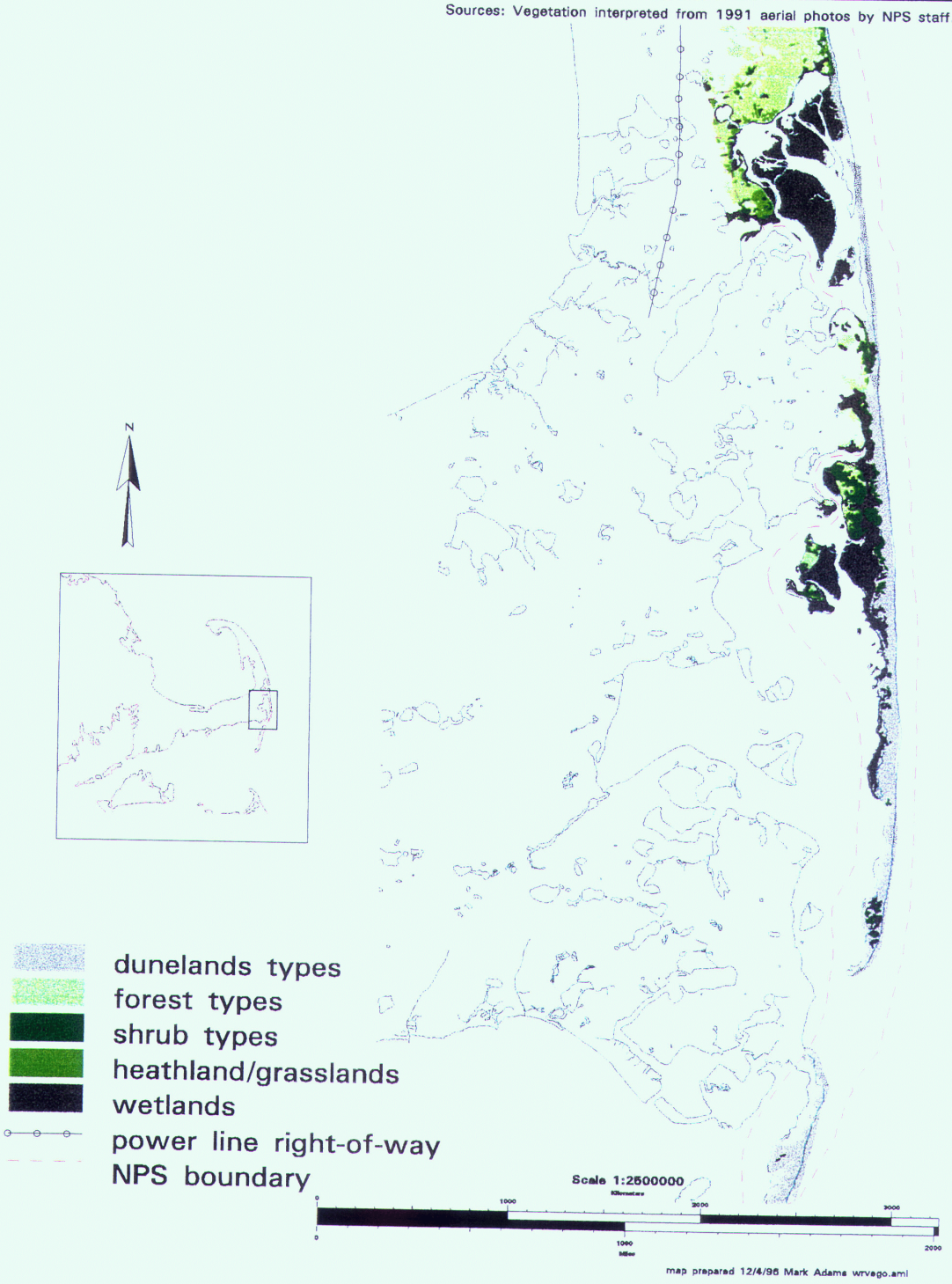


Table 3.1. Summary of characteristic plants by habitat.

Forests

Pitch pine	*Pinus rigida*
Black oak	*Quercus velutina*
White oak	*Quercus alba*
Low bush blueberry	*Vaccinium vacillans*
Bear oak	*Quercus ilicifolia*
Black huckleberry	*Gaylussacia baccata*

Heathlands *(Ericaceae)*

Bearberry	*Arctostaphylos uva-ursi*
Beach heather	*Hudsonia tomentosa and H. ericoides*
Huckleberry	*Gaylussacia baccata*
Blueberry	*Vaccinium* spp.

Tree Swamps

Atlantic white cedar	*Chamaecyparis thyoides*
Virginia chain fern	*Woodwardia virginica*
Red maple	*Acer rubrum*
Black gum	*Nyssa sylvatica*
Star flower	*Trientalis borealis*
Gooseberry	*Ribes grossularia*
Swamp azalea	*Rhododendron viscosum*

Freshwater Marshes

Narrowleaf cattail	*Typha angustifolia*
Common reed grass	*Phragmites australis*
Blue flag iris	*Iris versicolor*
Royal fern	*Osmunda regalis*
Virginia rose	*Rosa virginiana*
Narrowleaf meadow-sweet	*Spirea alba*
Wrinkled goldenrod	*Solidago rugosa*

Grasslands

American beach grass	*Ammophila breviligulata*
Dusty miller	*Artemesia caudata*
Beach pea	*Lathyrus maritima*
Seaside goldenrod	*Lathyrus maritima*
Beach heather	*Hudsonia tomentosa and H. ericoides*
Hairgrass	*Deschampsia flexuosa*
Velvet grass	*Holcus Ianatus*
Beardgrass	*Andropogon* spp.

Bogs

Cranberry	*Vaccinium macrocarpon*
Sphagnum	*Spagnum* spp.
Bog club moss	*Lycopodium inumdatum*
Round leafed sundew	*Drosera rotundifolia*
Pitcher plant	*Sarracenia purpurea*
Bladderwort	*Utricularia* spp.

Kettle Ponds

Dwarf umbrella grass	*Fuirena pumila*
Bladderwort	*Utricularia resupinata*
Floating heart	*Nymphoides cordata*
Sweet flag	*Acorus calamus*

Seasonally-flooded Wetlands

Red maple	*Acer rubrum*
Pitch pine	*Pinus rigida*

Province Lands Dune Ponds

Fragrant water lily	*Nymphaea odorata*

Pilgrim Lake

Widgeon grass	*Ruppia maritima*
Pond weeds	*Potamageton* spp.
Common reed	*Phragmites australis*
Narrowleaf cattail	*Typha angustifolia*
Wide leaf cattail	*Typha latifolia*

Rivers and Streams

Pondweed	*Potomageton* spp.
Bladderwort	*Utricularia* spp.
Duck weed	*Lemna minor*
Manna grass	*Glyceria* spp.

Coastal Salt Marshes

Cordgrass	*Spartina alterniflora*
Glasswort	*Salicornia virginica*
Macroalgae	*Fucus and Ascophyllum* spp.
Salt marsh hay	*Spartina patens*
Spike grass	*Distichlis spicata*
Seaside goldenrod	*Solidago sempervirens*
Sea lavender	*Limonium nashii*
Eelgrass	*Zostera marina*

Tree Swamps

The Atlantic white cedar (*Chamaecyparis thyoides*) community (Table 3.1) is a tree swamp that establishes itself under very specific conditions that are rare in New England (Godfrey et al., 1978; Motzkin, 1990). Only a few stands remain on the Cape (Brownlow, 1979); one of which is an 80-acre swamp in Wellfleet on National Seashore property. The dense canopy of the white cedar creates a dark, cool, humid microclimate that supports many bog plant species as well as Virginia chain fern (*Woodwardia virginica*) and moss covered hummocks. Traditionally these trees were cut for their decay-resistant properties (Brownlow, 1979).

Red maple (*Acer rubrum*) exists in moist lowland swamps and is often found in the company of white cedar. Red maple swamps and their deep rich humus soils support many members of the tupelo (*Nyssa sylvatica*) plant community such as the star flower (*Trientalis borealis*), gooseberry (*Ribes grossularia*), and swamp azalea (*Rhododendron viscosum*) (Godfrey et al., 1978).

Freshwater Marshes

Freshwater marshes on the National Seashore occur in river drainages, pond shores, and areas that were once salt water, but are now fresh water due to the placement of dikes and tide gates that prohibit tidal influences in the marsh (Godfrey et al., 1978). Saturated with standing water most of the year, these marshes support grasses, sedges, rushes, cattails, and forbs (Godfrey et al., 1978). Many of the freshwater marshes on the Cape are dominated by narrowleaf cattails (*Typha angustifolia*) and common reed grass (*Phragmites australis*). While these two vegetation types occupy the same habitat, they are usually found separately, growing in pure stands. Other plants (Table 3.1) found in the freshwater marshes are blue flag iris (*Iris versicolor*), royal fern (*Osmunda regalis*), and rose (*Rosa virginiana*) (Godfrey et al., 1978). Upslope of the cattails, marshes have wet to moist deep loam soil and are dominated by narrowleaf meadow-sweet (*Spiraea alba*) and wrinkled goldenrod (*Solidago rugosa*) (Godfrey et al., 1978). The freshwater marshes all support valuable habitat for a wide variety of wildlife such as waterfowl, raccoons (*Procyon lotor*), and great blue herons (*Ardea herodias*) as well as a variety of fish species.

Grasslands

The primary grasslands on the seashore are the beachgrass dunes located in the Province Lands, Great Island, Coast Guard Beach, and Nauset Beach (Figure 3.1a-c) (Godfrey et al., 1978). The dunes are dynamic, and their shape and direction of movement depend on prevailing winds, which are a constant force on dune formation (Brownlow, 1979). Godfrey et al. (1978) state that the dunes are stabilized primarily by American beach grass (*Ammophila breviligulata*) which can grow through 10 to 12 inches (.25 to .30m) of newly deposited sands. Other vegetation (Table 3.1) on the dunes includes dusty miller (*Artemesia caudata*), beach pea (*Lathyrus maritima*), seaside goldenrod (*Solidago sempervirens*), and beach heather (*Hudsonia tomentosa* and *H. ericoides*). Hairgrass (*Deschampsia*) dunes, mixed meadows, velvet-grass (*Holcus*) meadows, and beardgrass (*Andropogon*) grasslands are also upland communities located on the National Seashore (Godfrey et al., 1978).

SURFACE FRESHWATER RESOURCES

Bogs

Bogs are poorly drained wetlands that have a floating mat of vegetation on their surface made up of sphagnum moss, cranberries, insectivorous plants, or sedges to name a few (Godfrey et al., 1978). Bogs, typically acidic and low in nutrients, are often found in surface depressions that have accumulated thick layers of peat (Godfrey et al., 1978). There are several types of bogs that occur on the Cape (Figure 3.2a-c) as classified by the U.S. Fish & Wildlife Service Cowardin classification system (Cowardin et al., 1979). The predominant type is the cranberry bog which occurs in the interdune swales of the Province Lands (Brownlow, 1979). The cranberries (*Vaccinium macrocarpon*) thrive in saturated sandy loam soils that are acidic and nutrient poor (Brownlow, 1979). Once referred to as "red gold" by residents of Cape Cod, cranberry bogs are an integral part of the cultural landscape on Cape Cod. In the upper reaches of the Pamet River valley is an abandoned commercial cranberry bog that once served as a cranberry farm for a Cape Cod family from the 1800s through the 1950s.

Plants (Table 3.1) in the bogs include sphagnum (*Sphagnum spp.*), bog club moss (*Lycopodium inundatum*), round leafed sundew (*Drosera rotundifolia*), and insectivorous plants such as the pitcher plant (*Sarracenia purpurea*) and bladderwort (*Utricularia spp.*). Shankpainter Pond is a quaking bog located in the Province Lands, outside of the National Seashore (Figure3.1a-c). Quaking bogs are rare in southern New England and are vegetated mostly with sphagnum moss which floats a few feet above a loose bed of peat (Brownlow, 1979).

Kettle Ponds

Many of the surface freshwater resources on the Cape are kettle ponds, permanently flooded water bodies formed in ice-block depressions left in the landscape after the last glaciers melted about 12,000 years ago (Portnoy, 1995). There are 20 permanently flooded kettle ponds (Figure 3.2a-c) (Table 3.2) within the National Seashore that range from 3 to 90 acres and 60 feet (10 to 21 meters) deep (Portnoy, 1995); all of which occur in the towns of Wellfleet and Truro (Godfrey et al., 1978).

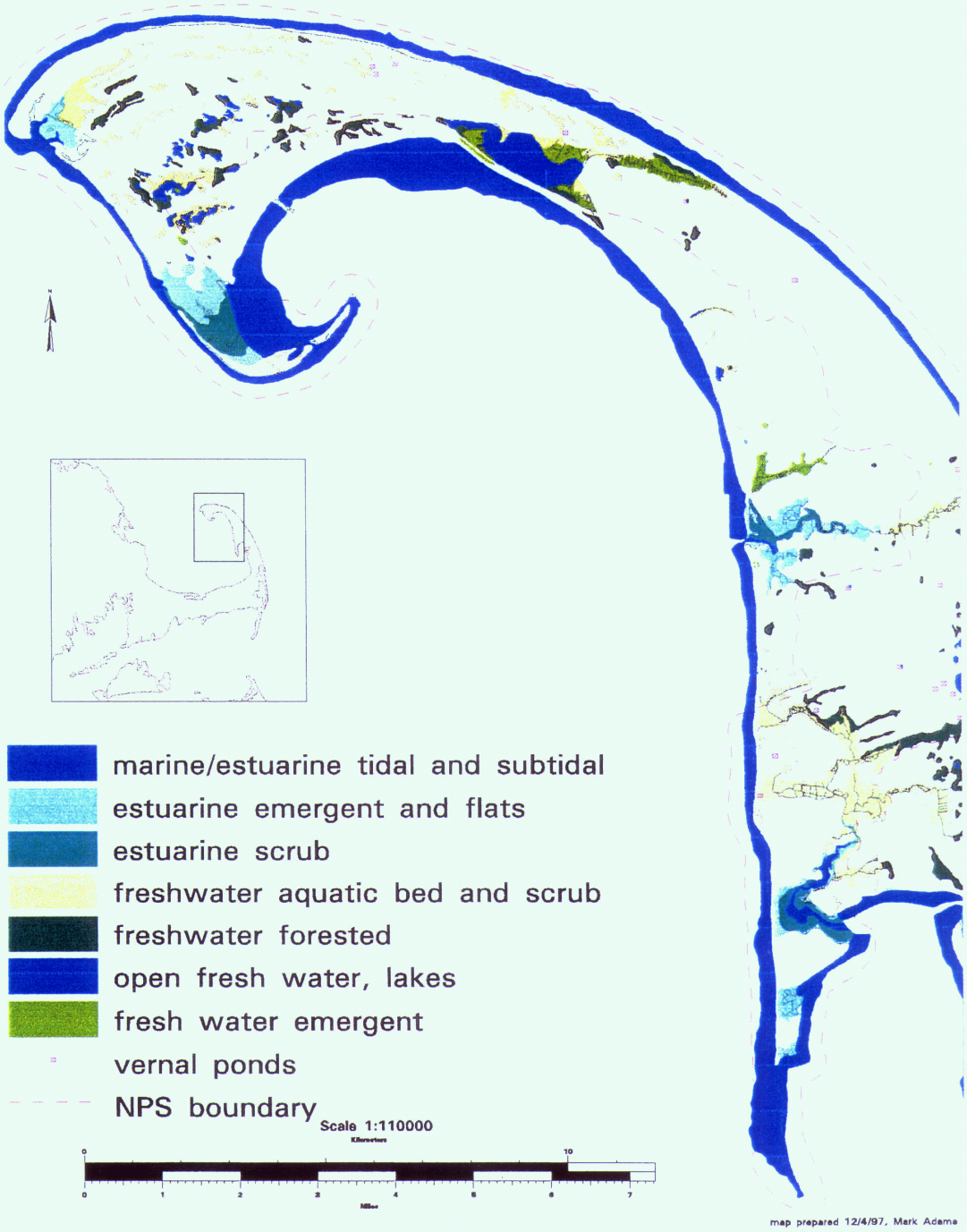
Table 3.2. Kettle ponds in Cape Cod National Seashore.

Kettle Pond	Location
Duck Pond	Wellfleet
Dyer Pond	Wellfleet
Great Pond	Truro
Great Pond	Wellfleet
Gull Pond	Wellfleet
Herring Pond	Wellfleet
Higgins Pond	Wellfleet
Horseleech Pond	Truro
Kinnacum Pond	Wellfleet
Long Pond	Wellfleet
Northeast Pond	Wellfleet
Round Pond-East	Truro
Round Pond-West	Truro
Ryder Pond	Truro
Slough Pond	Truro
Snow Pond	Truro
Southeast Pond	Wellfleet
Spectacle Pond	Wellfleet
Turtle Pond	Wellfleet
Williams Pond	Wellfleet

Water Resources Management Plan

Figure 3.2a: Wetlands Provincetown/North Truro Quad

Sources: USFWS National Wetlands Inventory, digitized by NPS Denver Service Center.

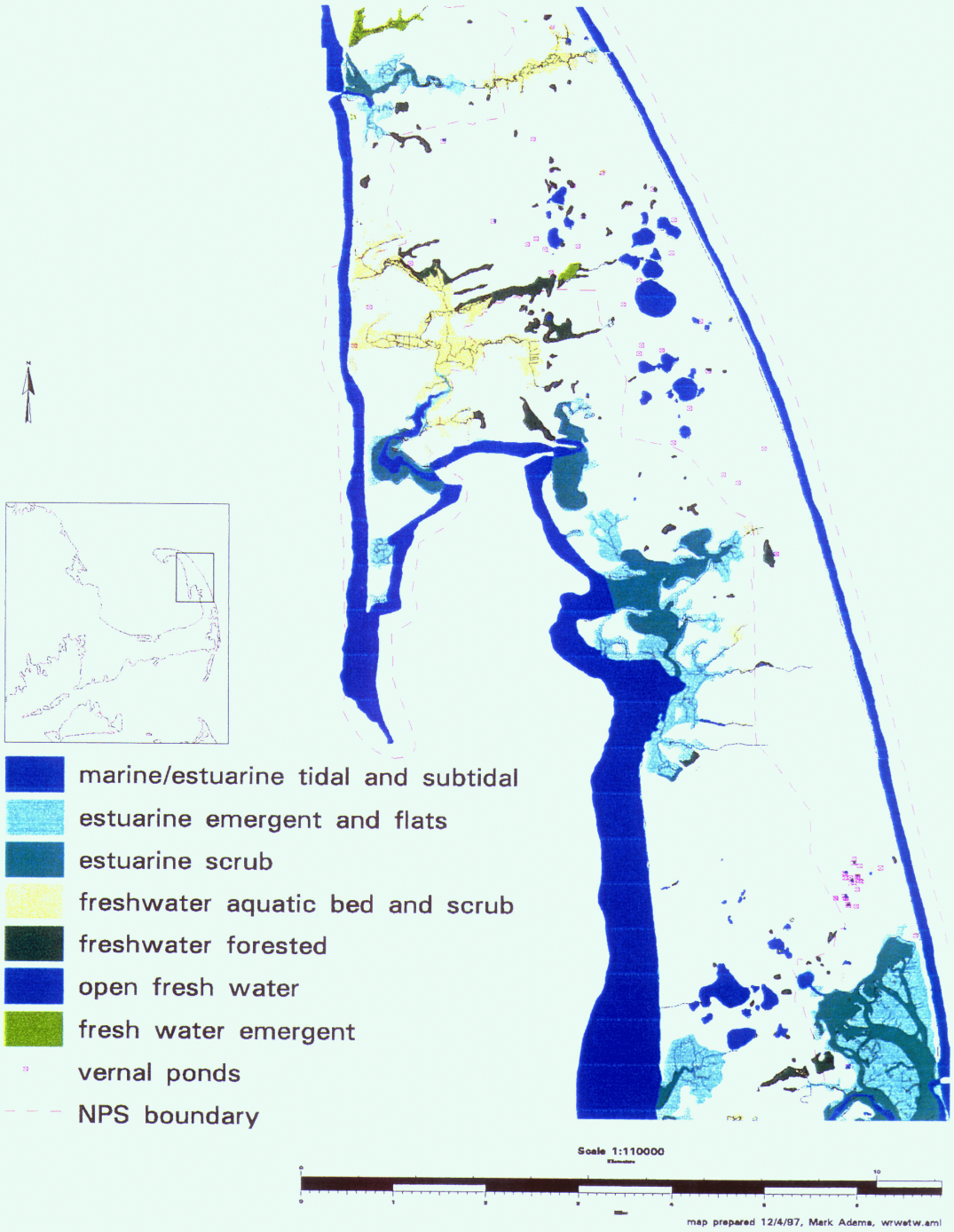


map prepared 12/4/97, Mark Adams

Water Resources Management Plan

Figure 3.2b: Wetlands Wellfleet Quad

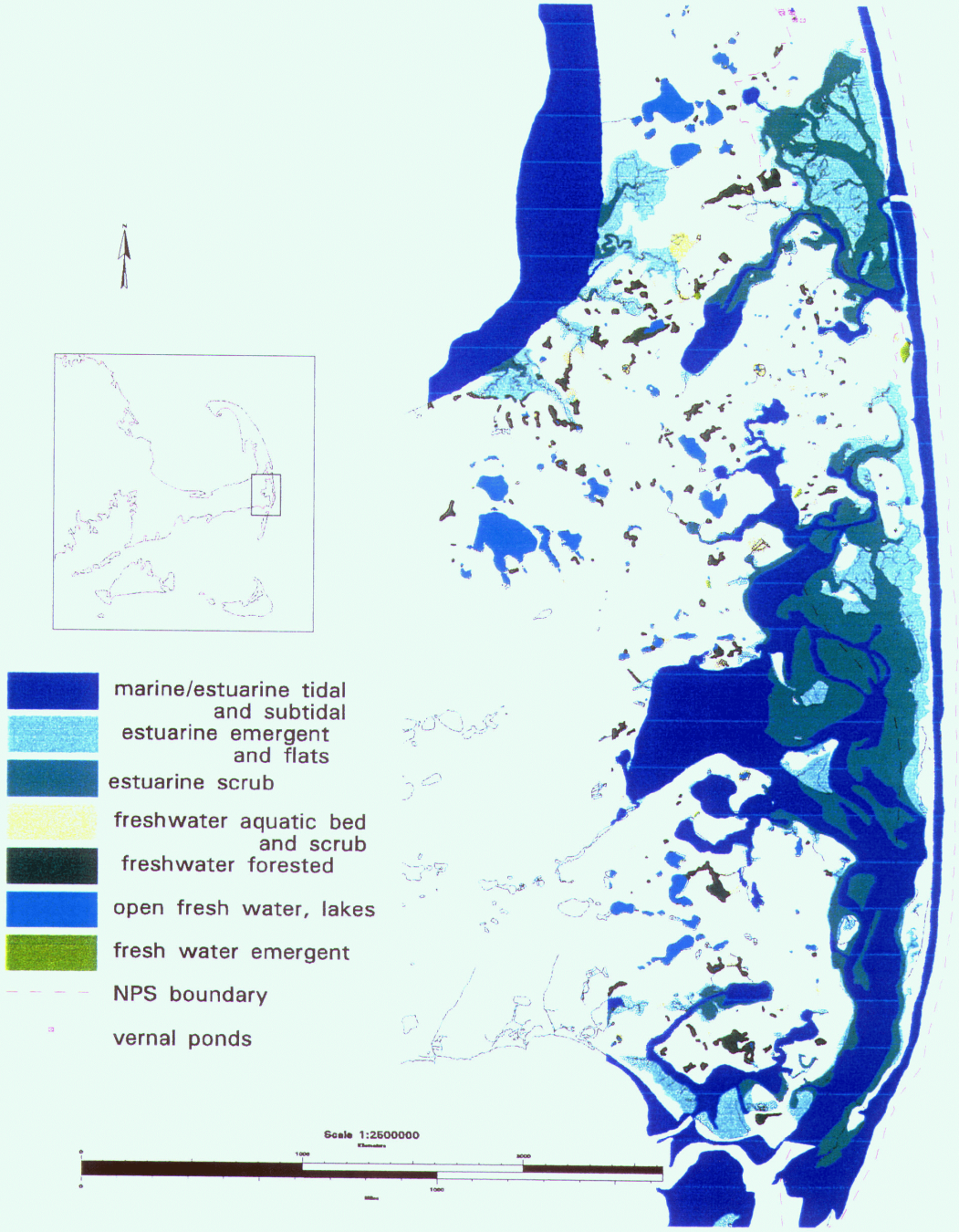
Sources: USFWS National Wetlands Inventory, digitized by NPS Denver Service Center.



Water Resources Management Plan

Figure 3.2c: Wetlands Orleans Quad

Sources: USFWS National Wetlands Inventory, digitized by NPS Denver Service Center.



map prepared 12/4/97, Mark Adams

The kettle ponds on the lower Cape are either oligotrophic or mesotrophic (Martin et al., 1992). The landlocked, oligotrophic ponds are highly acidic (pH 4 to 5) and set in non-calcareous, non-weathering, crystalline outwash sands. The kettle pond waters have a low specific conductance, low alkalinity, and low buffering capacity (Table 3.3) which makes them sensitive to acid deposition (Godfrey et al., 1996; Samora, 1988; Winkler, 1985). Mesotrophic ponds, such as the interconnected Gull, Higgins, Williams, and Herring Ponds (Figure 3.1a-c), show a greater marine or ground water influence than the oligotrophic ponds. The mesotrophic ponds are more productive and have a greater alkalinity (Table 3.4) and conductivity than the oligotrophic ponds (Martin et al., 1992).

Some species found in the pond ecosystem are found nowhere else on the Cape (Table 3.1) (Samora, 1988). The Massachusetts Natural Heritage Program designated kettle ponds on the Cape Cod National Seashore as a "Massachusetts Natural Area for a Coastal Plain Pondshore" because of many rare plants found there (Samora, 1988). Dwarf umbrella grass (*Fuirena pumila*), bladderwort (*Utricularia resupinata*), floating heart (*Nymphoides cordata*), and sweet flag (*Acornus calamus*) are all plant species found in various locations within the kettle pond community (Godfrey et al., 1978). In addition to their designation by the Natural Heritage Program, all of the National Seashore kettle ponds have been designated as “Outstanding Resource Waters of Massachusetts” (Rojko and Kimball, 1995). This designation highlights the socio-economic, recreational, ecological, and aesthetic values of the ponds while placing them in a strict regulatory classification meant to preserve the integrity of the water quality.

Seasonally-flooded Freshwater Wetlands

There are 55 documented seasonally-flooded wetlands within the National Seashore that vary in size from small habitats (15 to 100 feet; 5 to 30 meters in diameter) to larger systems that occupy several acres. Since 1985, seasonally-flooded wetlands within the National Seashore have been mapped and their vegetation and water chemistry has been described. Half of the 55 wetlands are immediately surrounded by mixed heathlands or ericaceous shrubs, 31 percent are surrounded by red maple (*Acer rubrum)*, and 13 percent are surrounded by pitch pine forest *(Pinus rigida)*. The predominance of coniferous and ericaceous vegetation (Table 3.1) in combination with the low alkalinity outwash soils causes most seasonally-flooded wetlands in the National Seashore to be acidic (median pH = 4.82) (Portnoy, 1986). Most of the wetlands function as “vernal pools” where annual dewatering affects the aquatic community providing habitat for a distinct group of animals. Vernal pool dependent fauna of the outer Cape include wood frogs, spotted salamanders, and many species of invertebrates, including state-listed species.

Dune Ponds

The Province Lands ponds are young ponds which developed in the last 1,000 years (Figure 3.1a-c). They are small, shallow depressions of less than 3 feet (1 meter), that form between dunes on barrier spits and extend below the water table (Godfrey et al., 1978). These ponds are part of a larger wetlands complex that includes bogs, marshes, and floating peat islands (Table 3.1). Some of the ponds are ephemeral and were designated as wetlands, not as open water, on old maps (Winkler, 1994).

Table 3.3. Acid rain monitoring project data for 16 Cape Cod National Seashore kettle ponds, averages from 1983 to 1993.

Abbreviations are as follows: ANC (acid neutrality capacity); TP (total phosphorus); SO_4 (sulfate); Cl (chloride); NO_3 (nitrate); Na (sodium); Ca (calcium); K (potassium); Mg (magnesium); Mn (manganese); Fe (iron); Al (alumium); Si (silica).

Lake	pH	ANC	TP	SO_4	Cl	NO_3	Color	Na	Ca	K	Mg	Mn	Fe	Al	Si
Duck Pond	4.70	-0.77	2.7	7.93	24.43	0.01	14.96	14.97	1.10	1.00	1.72	0.06	0.09	0.05	0.08
Dyer Pond	4.70	-0.83		8.41	26.10	0.00	3.00	14.93	1.12	0.84	1.90	0.11	0.06	0.04	0.19
Great Pond (T)	6.08	1.77		7.55	29.09	0.02	32.60	16.96	2.65	0.79	1.70	0.02	0.23	0.06	0.17
Great Pond (W)	4.81	-0.64	0.0	6.42	19.68	0.00	5.42	11.12	0.99	0.70	1.40	0.06	0.07	0.04	0.04
Gull Pond	6.63	3.18		8.43	30.49	0.01	4.47	18.41	1.81	1.03	2.48	0.01	0.05	0.01	0.06
Herring Pond	6.54	4.28	15.4	7.40	31.37	0.01	13.38	18.32	2.02	0.91	2.52	0.03	0.22	0.01	1.08
Higgins Pond	6.51	3.03	10.8	7.94	30.07	0.02	10.29	18.31	1.68	0.99	2.53	0.02	0.11	0.01	0.55
Horseleech Pond	5.79	0.67		10.56	38.31	0.04	9.20	22.60	1.56	1.11	3.33	0.17	0.27	0.01	0.67
Kinnacum Pond	4.47	-1.83		6.98	19.15	0.03	11.52	11.13	0.72	0.61	1.39	0.03	0.08	0.10	0.06
Long Pond	4.64	-0.98	3.9	7.54	20.67	0.01	4.00	11.71	1.20	0.78	1.41	0.05	0.05	0.08	0.04
Round Pond	4.81	-0.56	7.1	6.29	16.03	0.01	12.16	9.10	0.97	0.52	1.29	0.05	0.22	0.04	0.08
Ryder Pond	5.18	-0.39		9.17	31.85	0.03	5.80	19.94	1.52	0.84	1.91	0.05	0.10	0.10	0.17
Slough Pond	4.78	-0.66		10.29	27.91	0.02	9.64	16.57	1.35	0.84	2.25	0.04	0.06	0.06	0.08
Snow Pond	5.64	0.65		5.48	20.86	0.00	14.15	12.02	0.96	0.72	1.61	0.04	0.35	0.03	0.11
Spectacle Pond	5.01	-0.11	3.9	8.12	29.04	0.03	8.33	16.39	0.81	0.83	2.18	0.03	0.02	0.03	0.09
Williams Pond	5.92	1.69		8.71	31.54	0.02	51.08	19.43	1.78	1.08	2.52	0.06	0.61	0.04	0.25

Average consists of a minimum of 23 measurements and maximum of 45 measurements, except for Pilgrim Lake (1 measurement).
All units in mg/l except pH (pH units) and Color (PCUs).
Total Phosphorus (ug/l) only for April 1993.

Table 3.4. General characteristics of the kettle ponds of Cape Cod National Seashore. (J. Portnoy, 1998, personal communication, Cape Cod National Seashore). Conductivity data are from April 1998, showing general increases since 1982. pH and alkalinity data are from April 1998; chlorophyll *a* data are from August 1997.

Pond	Maximum Depth (m)	Area (ha)	Conductivity (uS/cm)	pH	Alkalinity (ppm)	Chl *a* mg/m^3	Shore Dwellings	Public Beach	Land-locked
Duck	18	5.1	112	4.76	-0.50	0.8	1	Yes	Yes
Dyer	10	4.8	92	4.85	-0.50	1.7	3	Yes	Yes
Great (W)	15	17.8	123	4.96	-0.25	1.1	8	Yes	Yes
Long	15	15.0	99	4.97	-0.25	2.1	22	Yes	Yes
Turtle	2	1.6	94	4.59	-1.00	3.1	2	No	Yes
Northeast	4	1.7	81	5.16	0.50	1.5	3	No	Yes
Southeast	4	1.1	107	5.03	0.00	1.1	1	No	Yes
Spectacle	7	0.5	145	5.22	0.00	2.2	0	Yes	Yes
Kinnacum	2	0.8	96	4.78	-0.50	1.2	1	No	Yes
Gull	19	44.0	145	6.81	3.25	0.4	21	Yes	No
Higgins	6	11.3	144	6.58	3.25	0.4	7	No	No
Herring	4	8.1	143	6.50	2.75	1.4	2	No	No
Williams	2	3.6	159	5.65	0.50	7.6	3	No	No
Slough	8	11.9	134	5.04	-0.25	1.0	9	No	Yes
Horseleech	5	10.0	171	5.66	0.50	0.3	4	No	Yes
Round (E)	8	2.6	111	5.02	0.00	1.0	1	No	Yes
Round (W)	9	0.8	76	4.89	-0.50	1.4	0	No	Yes
Ryder	10	8.3	143	4.72	-1.00	0.5	7	No	Yes
Snow	8	2.3	95	5.70	0.25	0.1	0	Yes	Yes
Great (T)	11	7.0	126	5.78	-0.25	0.2	6	No	Yes

Rivers and Streams

Despite the fact that Cape Cod has no major river system that serves as drainage for the entire area, it has been classified as a river basin under the Massachusetts River Basin Planning Program (Massachusetts Department of Environmental Management, 1994). The Herring and Pamet rivers represent the two major stream systems on the lower Cape (Figure 3.2a-c). The lack of a significant elevation gradient on the Cape coupled with highly permeable soils prevent extensive surface water runoff and stream development. However, both the Herring and Pamet rivers follow channels cut by catastrophic drainage of lakes by the melting of the glacier (Oldale, 1992; Mitchell and Soukup, 1981).

The Herring River estuary is greatly altered by diking and drainage that started during the early 1900s and, perhaps as early as the 1600s for the purpose of mosquito control, flood protection, and improved travel corridors. It has a discharge of 1.8 to 7.1 cubic feet/second (cfs) (50 to 200 liters/second) (J. Portnoy, 1997, pers. comm., National Park Service).

The Upper Pamet River, located in Truro, east of Route 6, was a salt marsh estuary until it was diked around 1860. It now is a freshwater wetland and stream system (Geise et al., 1993) that extends 1.6 miles (2.5 km) in length (Godfrey et al., 1978). Discharge varies from 1.4 to 3.9 cfs (40 to 110 liters/sec) (Marine Research Inc., 1986). Tide gates located at Castle Road prevent the estuarine Lower Pamet from influencing the freshwater environment of the Upper Pamet (Livingston, 1996). Plants (Table 3.1) found along the Upper Pamet River include pondweeds (*Potomageton*), bladderworts (*Utricularia*), floating duck weeds (*Lemna minor*) and many other species (Godfrey et al., 1978).

SURFACE BRACKISH RESOURCES

Brackish Lakes

Pilgrim Lake (Figure 3.2a), once a coastal lagoon, is the only water body within the National Seashore large enough to warrant designation as a lake (Godfrey et al., 1978; Mitchell and Soukup, 1981). Natural processes accompanied by anthropogenic alterations have transformed this body of water from a salt water bay to the present 344 acre (139 ha) brackish, shallow, eutrophic lake (Mozgala, 1974; Applebaum and Brenninkmeyer, 1988). Subjected to diking, midge control, fish kills, eutrophication, and infilling from dune migration (Portnoy, 1991), this water body is subject to several management options discussed in Chapter 10.

SURFACE BRACKISH RESOURCES

Waterbodies	Location
Blackfish Creek	Wellfleet
Hatches Harbor	Provincetown
Herring River	Wellfleet
Little Pamet River	Truro
Pamet River	Truro
Nauset Marsh	Eastham
Salt Meadow/Pilgrim Lake	Truro

In addition to the prominent cyanobacteria and midges, common plant species (Table 3.1) found here are widgeon grass (*Ruppia maritima*), pond weeds (*Potamageton* spp.), common reed (*Phragmites australis*), and narrowleaf and wide leaf cattails (*Typha angustifolia and T. latifolia*) (Godfrey et al., 1978).

Estuaries

Estuaries are coastal waters influenced by a mixture of marine salt water and inland fresh water and are commonly located where fresh water rivers empty into salt water environments, primarily oceans and bays. Estuaries are one of the most valuable and productive ecosystems found anywhere, providing important nursery habitat to fish and shellfish (Mitchell and Soukup, 1981; Roman and Manski, 1993). Almost all of the estuarine systems on the National Seashore (Figure 3.2a-c) have been altered to some extent by dikes and tide gates, reducing their productivity and habitat values (Mitchell and Soukup, 1981). Cape Cod National Seashore has developed proposals for the restoration of the diked Hatches Harbor and Herring River estuary (Roman and Manski, 1993).

Coastal Salt Marshes

Salt marshes are productive systems, providing large amounts of nutrients and organic matter to marine food chains (Brownlow, 1979). The marsh system combines regular tidal submersion and wave protection for the vegetation to create a stable accreting marsh (Godfrey et al., 1978). Coastal salt marshes support a diverse variety of plants (Table 3.1) including mud flat pioneer species (Brownlow, 1979) such as cordgrass (*Spartina alterniflora*), glassworts (*Salicornia virginica*), and algae (*Fucus and Ascophyllum* spp.) as well as plants typically found in stable, interior salt marshes, including salt marsh hay (*Spartina patens*), spike grass (*Distichlis spicata*), seaside goldenrod (*Solidago sempervirens*), and sea lavender (*Limonium nashii*). Salt marshes on the lower Cape are located at Hatches Harbor (east of Race Point Light) (Figure 10.2), Pamet River (west of Route 6) (Figure 10.3), Nauset Marsh, Provincetown's West End (Figure 9.1a), and the lower Herring River (Wellfleet) (Figure 10.1) (Godfrey et al., 1978).

Eelgrass beds occur in the saline and brackish water environments on the Cape. Eelgrass (*Zostera marina*) is found below the level of low tide, in bays and estuaries, growing in dense stands as high as 4 feet (Brownlow, 1979). These beds provide food and shelter to a wide range of organisms such as shellfish (e.g., scallops), crustaceans (e.g., lobsters), and small fish. Benthic algae such as *Laminaria*, *Desmerestia*, *Chorda*, *Chondrus*, and *Codium* are associated with this environment (Brownlow, 1979), which occurs in several places on the Cape including Nauset Marsh (Roman et al., 1990).

WILDLIFE

Freshwater Fish

Water bodies such as Gull Pond and the Herring River support populations of largemouth bass (*Micropterus salmoides*), American eel (*Anguilla rostrata*), chain pickerel (*Esox niger*), sunfish (*Lepomis* spp.), white perch (*Morone americana*), yellow perch (*Perca flavescens*), brown bullheads (*Ameiurus nebulosus*), and shiners (*Notropis* spp.) (Table 3.5 and 3.6). The Pamet River also supports resident and migratory brook trout (Massachusetts Department of Environmental Management, 1994). According to Steve Hurley of the Massachusetts Division of Fisheries and Wildlife, brook, brown, and rainbow trout are stocked two to four times a year in Great Pond (Truro), four to eight times a year in Gull Pond (Wellfleet), and brook trout only once a year in the Pamet River. In 1995 the Massachusetts Division of Fisheries and Wildlife stocked 450 fish in Great Pond, 3,351 fish in Gull Pond,

and 400 in the Pamet River. All stocking occurs in the spring only (S. Hurley, 1996, pers. comm., Massachusetts Division of Fisheries and Wildlife). Historical stocking records are summarized in Table 3.7.

Reptiles and Amphibians

Freshwater wetlands, ponds, and estuaries of the National Seashore are habitat for a variety of reptiles and amphibians, though fewer species occur on the outer Cape peninsula than on the Massachusetts mainland (Lazell, 1972). The National Seashore was recently (ca 1993 to 1996) included in Massachusetts Audubon's "Herp Atlas," documenting presence/absence by topographic quadrangle.

Reptiles common to wetland habitats include the eastern ribbon snake (*Thamnophis sauritus*), eastern painted turtle (*Chrysemys picta*), and eastern box turtle (*Terrapene carolina*). Painted turtles occur in seasonally-flooded wetlands, kettle ponds and low-salinity zones of estuaries. Although generally considered terrestrial, box turtles spend long periods in freshwater ponds and bogs during the summer. Spotted turtles (*Clemmys guttata*), of State Special Concern, are apparently more rare but widely distributed in swamps and emergent wetlands. A disjunct population of *C. guttata* occurs in the Provincetown ponds. Diamondback terrapins (*Malaclemys terrapin*), of State Threatened Status, are restricted to Wellfleet Harbor with Great Island serving as the northernmost nesting site on the Atlantic coast. The northern water snake (*Nerodia sipedon*), though common elsewhere in the state, is rare on the outer Cape.

Common wetland-dependent amphibians include spotted salamander (*Ambystoma maculatum*), bullfrog (*Rana catesbeiana*), green frog (*Rana clamitans*), spring peeper (*Pseudacris crucifer*) and Fowler's toad (*Bufo woodhousii fowleri*). Although rarely seen except during spawning after heavy rain, spadefoot toads (*Scaphiopus holbrookii*) appear to be widely distributed from Eastham to the tip of the Cape. The spotted salamander is the only mole salamander within the National Seashore and breeds in some of the National Seashore's most acidic vernal ponds, along with wood frogs (*Rana sylvatica*) and spring peepers (Portnoy, 1990c). Wood frogs are a recent arrival from the south; breeding has been documented only as far north as Eastham. Bullfrogs have apparently extended their range to permanent waters throughout the National Seashore (J. Portnoy, 1997, personal observation, National Park Service), except for Pronvincetown, following their introduction in South Wellfleet in the early 1970s (Lazell, 1972). Green frogs are most common in seasonally-flooded ponds and emergent wetlands. Fowler's toads range throughout the National Seashore's upland, but breed only in the kettle ponds and interdunal ponds; these waters have higher alkalinity than the vernal ponds used by most other amphibian species for spawning.

There are insufficient data to evaluate whether National Seashore anurans (frogs and toads) are threatened with the kind of anuran decline observed in many other parts of the world, particularly the American northwest (Sarkar, 1996). Frequently cited possible causes include the effects of El Niño, increased solar ultraviolet radiation (UV-B) from diminished stratospheric ozone, and bacterial infections. The need is for long-term ecological studies.

Table 3.5. List of fish species that occur on the Cape Cod National Seashore. (Massachusetts Division of Fisheries & Wildlife).

Family	Common Name	Scientific Name	Occurrence
Anguillidae- freshwater eels	American eel	*Anguilla rostrata*	Ponds, streams Catadromous
Clupeidae- herrings	Blueback herring	*Alosa aestivalis*	Ponds, streams, Anadromous
	Alewife	*Alosa pseudoharengus*	Ponds, streams, Anadromous
Salmonidae- trouts	Rainbow trout	*Oncorhynchus mykiss*	Stocked
	Brown trout	*Salmo trutta*	Stocked
	Brook trout	*Salvelinus fontinalis*	Stocked
Esocidae- pikes	Redfin pickerel	*Esox americanus*	Streams
	Chain pickerel	*Esox niger*	Ponds
Cyprinidae- carps and minnows	Common carp	*Cyprinus carpio*	Pilgrim Lake
	Golden shiner	*Notemigonus crysoleucas*	Ponds, streams
	Bridled shiner	*Notropis bifrenatus*	Pamet River
Ictaluridae - bullhead catfishes	Brown bullhead	*Ameiurus nebulosus*	Ponds
Catostomidae- suckers	White Sucker	*Catostomus commersoni*	Ponds, streams
Cyprinodontidae- killifishes	Banded killfish	*Fundulus diaphanus*	Ponds
	Mummichog	*Fundulus heteroclitus*	Estuarine
	Striped killfish	*Fundulus majalis*	Estuarine
Gasterosteidae- sticklebacks	Fourspine stickleback	*Apeltes quadracus*	Estuarine
	Threespine stickleback	*Gasterosteus aculeatus*	Estuarine
Percichthyidae- temperate basses	White perch	*Morone americana*	Ponds, Anadromous
	Striped bass	*Morone saxatillis*	Estuarine
Centrarchidae- sunfishes	Banded sunfish	*Enneacanthus obesus*	Suspected
	Pumpkinseed	*Lepomis gibbosus*	Ponds
	Smallmouth bass	*Micropterus dolomieui*	Ponds
	Largemouth bass	*Micropterus salmoides*	Ponds
Percidae- perches	Tesselated darter	*Etheostoma olmstedi*	Ponds, streams
	Yellow perch	*Perca flavescens*	Ponds

Table 3.6. Freshwater fish species in National Seashore ponds (S. Hurley, 1996, personal communication, Massachusetts Division of Fisheries & Wildlife, Southeast District).

	Clapps	Duck	Dyer	Great (T)	Great (W)	Turtle	Gull	Horseleech	Long	Pilgrim	Round	Ryder	Slough	Snow Pond
Last Survey Fish Species	**81**	**85**	**65**	**90**	**88**	**88**	**82**	**67**	**85**	**66**	**67**	**86**	**52**	**91**
American eel							C			E		O		
Blueback herring							R							
Alewife							C							
Rainbow trout							S							
Brown trout							S							
Brook trout				S			S							
Redfin pickerel									C					
Chain pickerel	C				C				C			C		
Golden shiner							C					C		
Common carp										O				
White sucker							C					C	C	
Brown bullhead	C			C					C			C	C	
Banded killifish				C			C				C	C	C	
White perch							C			C		C		
Pumpkinseed	C			C		O		C	C			C	C	R
Smallmouth bass				C			C					C		
Largemouth bass	C						C							R
Yellow perch		C	C	C	C		C	C	C		C	C	C	

Abbreviations are: O - observed R - reported E - expected C - Collected S - stocked

Table 3.7. Fish species and years stocked in National Seashore ponds (S. Hurley, 1997, personal communication, Massachusetts Division of Fisheries & Wildlife).

POND	AW	BK	BT	Chinook	CP	EST	GS	LMB	RT	SMB	WP	Walleye	YP	Smelt
Great (T)			1960-61 1985-89			1958-59 1961--64 1966-67 1970-72 1977 1979-1982 1985 1990-97			1958-62 1966-82 1987-89	1958 1980	1934			
Great (W)										1933 1940			1934	
Gull			1949 1964-82 1985-97			1949 1979-83 1984 1986 1990-96			1950 1964-97	1925 1935	1922		1935	1917-18
Horseleech											1927			
Kinnacum	1957-58							1956		1972- 73				
Long	1954-57 1959 1967	1973		1914-17	1966		1967	1954-56	1902 1917		1938			1916-18
Pilgrim	1969													
Round (West)			1962			1961-64 1966-67			1960 1962					
Slough										1914	1939	1914		
Snow										1970				
RIVERS	**AW**	**BK**	**BT**	**Chinook**	**CPP**	**EST**	**GS**	**LMB**	**RT**	**SMB**	**WP**	**Walleye**	**YP**	**Smelt**
Pamet			1964-65 1971-72 1974-75 1987-88			1986 1988-97			1976 1978-82 1989					

Abbreviations are as follows:

AW	Alewife	LMB	Largemouth Bass
BK	Banded Killifish	RT	Rainbow Trout
BT	Brown Trout	SMB	Smallmouth Bass
CP	Chain Pickerel	WP	White Perch
Chinook	Chinook Salmon	Smelt	Rainbow Smelt
EST	Eastern Brook Trout	YP	Yellow Perch
GS	Golden Shiner		

Table 3.8. Summary of state-listed species on Cape Cod National Seashore according to the Massachusetts Division of Fisheries & Wildlife. Plants.

PLANTS **Scientific Name**	**Common Name**	**State Rank**
Aristida purpurascens	**Purple needlegrass**	**Threatened**
Carex oligosperma	**Few-fruit sedge**	**Threatened**
Carex striata var brevis	**Walter's sedge**	**Endangered**
Corema conradii	**Broom crowberry**	**Special Concern**
Dichanthelium commonsianum	**Commons' panic-grass**	**Special Concern**
Drosera filiformis	**Thread-leaved sundew**	**Watch Listed**
Eleocharis obtusa var ovata	**Ovate spike-sedge**	**Endangered**
Fuirena pumila	**Umbrella-grass**	**Watch Listed**
Helianthemum dumosum	**Bushy rockrose**	**Special Concern**
Juncus debilis	**Weak rush**	**Endangered**
Mertensia maritima	**Oysterleaf**	**Endangered**
Opuntia humifusa	**Prickly pear**	**Threatened**
Orontium aquaticum	**Golden club**	**Threatened**
Rhynchospora scirpoides	**Long-beaked bald-sedge**	**Special Concern**
Sabatia kennedyana	**Plymouth Gentian**	**Special Concern**
Sagittaria teres	**Terete arrowhead**	**Special Concern**
Sphenopholis pensylvanica	**Swamp oats**	**Threatened**
Utricularia fibrosa	**Fibrous bladderwort**	**Threatened**
Utricularia subulata	**Subulate bladderwort**	**Special Concern**

Table 3.8 Summary of state-listed species on Cape Cod National Seashore according to the Massachusetts Division of Fisheries & Wildlife. Animals.

ANIMALS **Scientific Name**	**Common Name**	**State Rank**
Accipiter striatus	**Sharp-shinned hawk**	**Special Concern**
Asio flammeus	**Short-eared owl**	**Endangered**
Calidris canutus	**Red knot**	**Watch Listed**
Charadrius melodus	**Piping plover**	**Threatened, Federal List**
Circus cyaneus	**Northern harrier**	**Threatened**
Clemmys guttata	**Spotted turtle**	**Special Concern**
Hemidactylium scutatum	**Four-toed salamander**	**Special Concern**
Larus atricilla	**Laughing gull**	**Watch Listed**
Malaclemys terrapin	**Diamondback terrapin**	**Threatened**
Pandion haliaetus	**Osprey**	**Watch Listed**
Pooecetes gramineus	**Vesper sparrow**	**Threatened**
Rynchops niger	**Black skimmer**	**Watch Listed**
Scaphiopus holbrookii	**Eastern spadefoot**	**Threatened**
Sterna antillarum	**Least tern**	**Special Concern**
Sterna dougallii	**Roseate tern**	**Endangered, Federal List**
Sterna hirundo	**Common tern**	**Special Concern**
Sterna paradisaea	**Arctic tern**	**Special Concern**
Terrapene carolina	**Eastern box turtle**	**Special Concern**
Abagrotis crumbi benjamini	**Coastal heathland cutworm**	**Special Concern**
Apharetra purpurea	**Blueberry sallow**	**Special Concern**
Catocala herodias gerhardi	**Gerhard's underwing moth**	**Threatened**
Cingilia catenaria	**Chain dot geometer**	**Special Concern**
Enallagma laterale	**New England bluet**	**Special Concern**
Enallagma recurvatum	**Barrens bluet**	**Threatened**
Ferrissia walkeri	**Walker's limpet**	**Special Concern**
Fixsenia favonius ontario	**Northern hairstreak**	**Special Concern**

RARE, THREATENED AND ENDANGERED SPECIES

Currently no federally listed plant species have been identified in the National Seashore (S. Hurley, 1996, personal communication, Massachusetts Division of Fisheries and Wildlife). The Division does however identify 19 state listed plants and 28 state listed animals and insects, summarized in Table 3.8. There are two federally listed threatened and endangered animal species breeding on the National Seashore, the piping plover (*Charadrius melodus*) (threatened) and the roseate tern (*Steina dougallii*) (endangered).

Cape Cod National Seashore is home to several species of beach nesting seabirds and shorebirds. Barrier islands and spits, in particular, provide important nesting habitat for common and least terns, piping plovers, and a few roseate and Arctic terns. Roseate terns are a federal and state listed endangered species, piping plovers are federal and state listed as threatened, and all of the other terns are state listed as of special concern. Roseate terns nest on New Island in Nauset Marsh, and formerly nested on Plover Island, which is now attached to Coast Guard Beach. A colony of nearly 3,000 least and common terns, which nested on Plover Island in 1995, has moved to other lower Cape Cod nesting areas. Piping plovers show a marked preference for nesting areas with both ocean and estuarine foraging habitats, such as those found on barrier beaches. Although many plovers nest successfully on Cape Cod's ocean beaches without estuarine habitat, they are more concentrated on the barrier beaches, such as Coast Guard Beach, Nauset Heights Beach, Jeremy Point, and the Wood End.

The threatened northeastern beach tiger beetle (*Cincindela dorsalis dorsalis*) was formerly found on Cape Cod beaches as far north as Nauset Light. Coast Guard Beach has been identified as one of the best sites in the northeast for re-establishment of this species, which is currently found on only two other beaches north of the Chesapeake Bay (K. Jones, 1996, pers. comm., National Park Service).

At least two species of freshwater mussel, a group threatened throughout North America, occur in the more alkaline kettle ponds. These bivalves are important indicators of water quality.