Historical Analysis and Map of Vegetation Communities, Land Covers, and Habitats of Cape Henlopen State Park
Sussex County, Delaware

Breakwater Harbor, Broadkill River, Lewes-Rehoboth Canal, North Atlantic Strand, and Rehoboth Bay Watersheds

Submitted to:

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CHAPTER 1: INTRODUCTION AND METHODS

Setting of Cape Henlopen State Park

Cape Henlopen State Park is located in southeastern Sussex County, Delaware (Figure 1.1). No formal tracts exist for the state park. Because of its size, for discussion purposes and mapping, the park is divided into eight sections. These sections include Cape Point (378 acres), Church Woods (33 acres), Fort Miles (405 acres), Gordons Pond (738 acres), Great Dune (1,906 acres), Holland Glade (582 acres), Red Mill (15 acres), and Wolfe Neck (1,311 acres) for a total size of 5,338 acres. Cape Point Section, Fort Miles Section, Gordons Pond Section, and Great Dune Section are all located east of Lewes and Rehoboth Canal. Church Woods Section, Holland Glade Section, and Wolfe Neck Section are located west of the Lewes and Rehoboth Canal. Red Mill Section is located west of the Town of Lewes and is separate from the others.

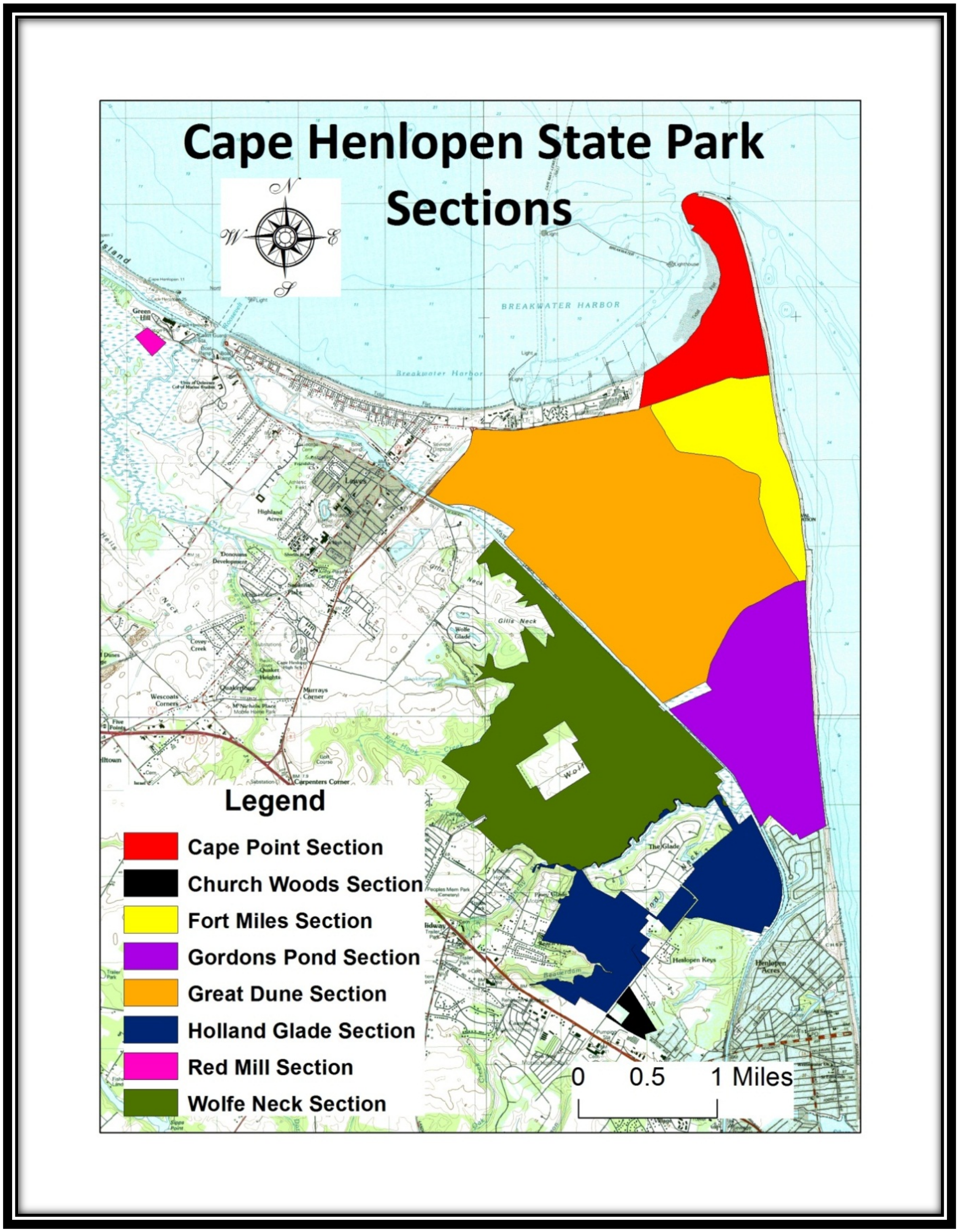

Figure 1.1. Cape Henlopen State Park Sections

History and Formation of Cape Henlopen State Park[1]

Early History of the Land

In 1498, John Cabot became the first European to view Cape Henlopen. Starting in 1610 the Cape received many names including Cape La Warre for Lord de la Warre, Cape Cornelius, and the last Cape Hindlopen, later changed to Cape Henlopen. The name Cape Hindlopen (Cape Henlopen) was first applied at Fenwick Island and created some confusion to mappers, giving Delaware a lot more land to the south than it would have otherwise gotten.

Formation of Cape Henlopen State Park

The area that is now Cape Henlopen State Park was once used as an army base during WWII called Fort Miles. In 1964 part of this land was transferred to the State of Delaware and became Cape Henlopen State Park. Subsequent additions were made in 1973, 1975, 1976, 1980, 1982, 1983, 1989, and 1991 bringing the park up to its current size of 5,338 acres.

Soils and Geology of Cape Henlopen State Park[2]

Underlying Geology

The geology of Cape Henlopen State Park is generally composed of Holocene sediments east of Lewes and Rehoboth Canal and Late Pleistocene sediments west of the canal. Shoreline deposits are located in the cape point area and beaches along the strand and are composed of medium to coarse quartz sand with pebbles and cobbles dating from the Holocene Period. The park interior is composed of spit deposits that are composed of fine to coarse sand, gravelly sand, silty sand, and sandy silt dating from the Holocene Period. Scattered around the two deposits above are swamp deposits that are composed of quartz sand with organic rich silt dating from the Holocene Period.

Sediments west of Lewes and Rehoboth Canal are composed of the Scotts Corners and Lynch Heights Formation, both of which date from the Late Pleistocene Period. The Scotts Corner formation is described as "a heterogeneous unit of light gray to brown to light yellowish brown coarse fine sand, gravelly sand, and pebble gravel with rare discontinuous beds of organic-rich clayey silt and clayey silt." The Lynch Heights Formation is described as "a heterogeneous unit of light gray to brown to light yellowish brown medium to fine sand with discontinuous beds of coarse sand, gravel, silt, fine, to very fine sand, and organic rich clayey silt to silty sand." It is considered to be of fluvial origin.

[1] Pearson, Eric A. 1995. Bits and Pieces on Fabulous Cape Henlopen. Self-published.
[2] Ramsey, Kelvin. 2003. Geological Map of the Lewes and Cape Henlopen Quadrangles. Delaware Geological Survey, Geologic Map Series No.12.

Soils

Two main soils, Acquango-Beaches Complex (1,924 acres) found in uplands and Broadkill Mucky Peat (1,051 acres) found in marshes, are prominent east of the Lewes and Rehoboth Canal. West of the canal, Downer Sandy Loam (524 acres), Downer Loamy Sand (238 acres), and Greenwich Loam (155 acres) are prominent. Elevations of Cape Henlopen State Park range from sea level at the Atlantic Ocean to 50 feet at the top of Great Dune.

Cape Point Section Soils

Acquango-Beaches Complex is the prominent soil in the Cape Point Section (350 acres). The other soil present in the tract, Acquango-Urban Land Complex, occupies 27 acres.

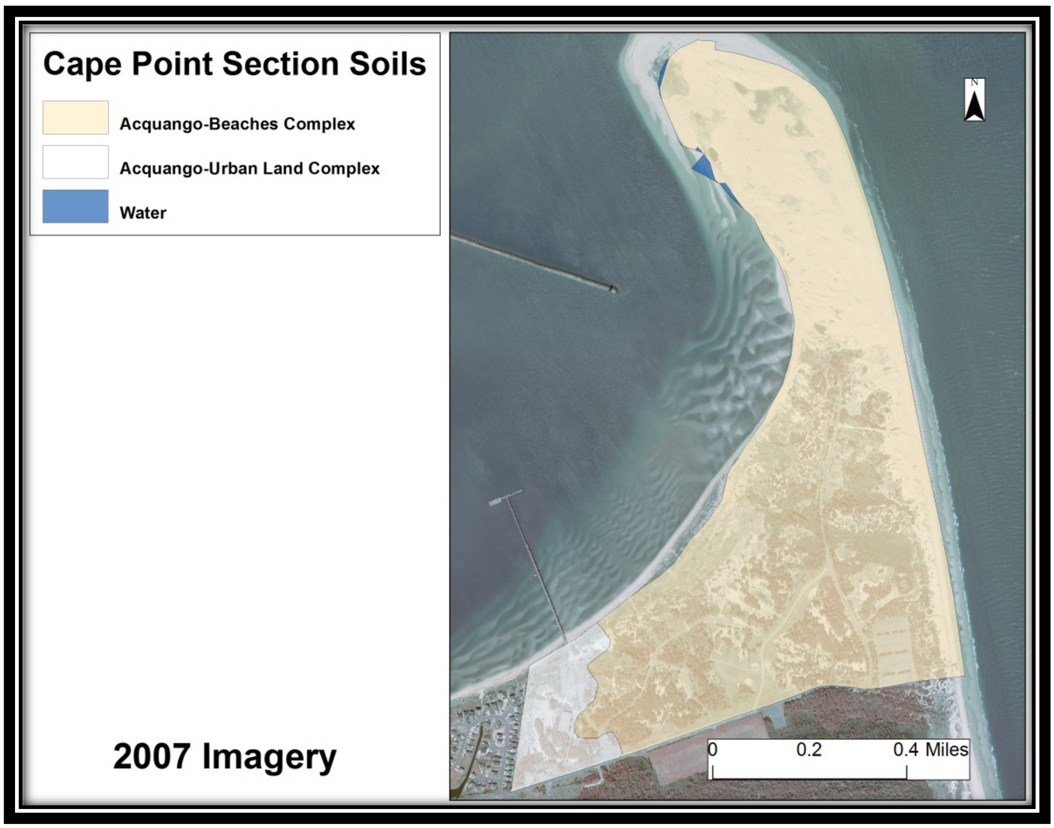

Figure 1.2. Cape Point Section Soil Map

Church Woods Section Soils

Greenwich Loam (32 acres) is the prominent soil the Church Woods Section with a small amount of Greenwich-Urban Land Complex (1 acre).

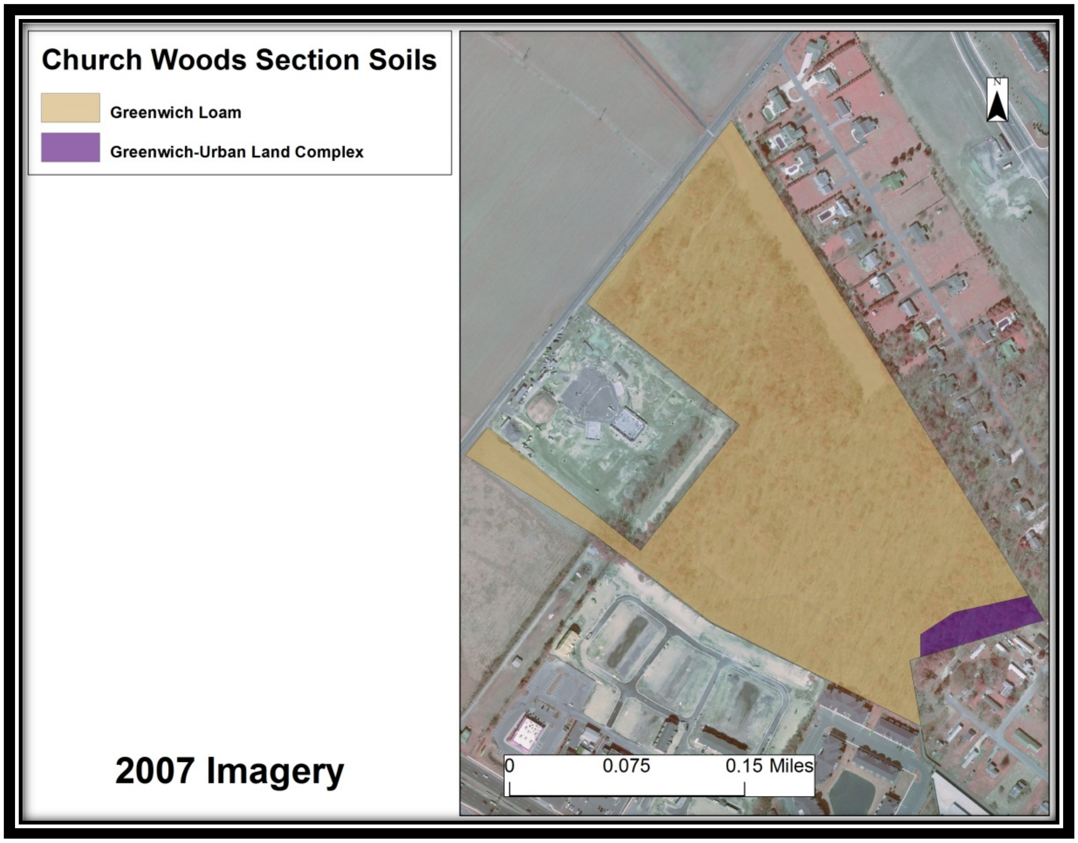

Figure 1.3. Church Woods Section Soil Map

Fort Miles Section Soils

Acquango-Beaches Complex (403 acres) is the most prominent soil in the Fort Miles Section. Acquango-Urban Land Complex, the other soil present, covers about 2 acres.

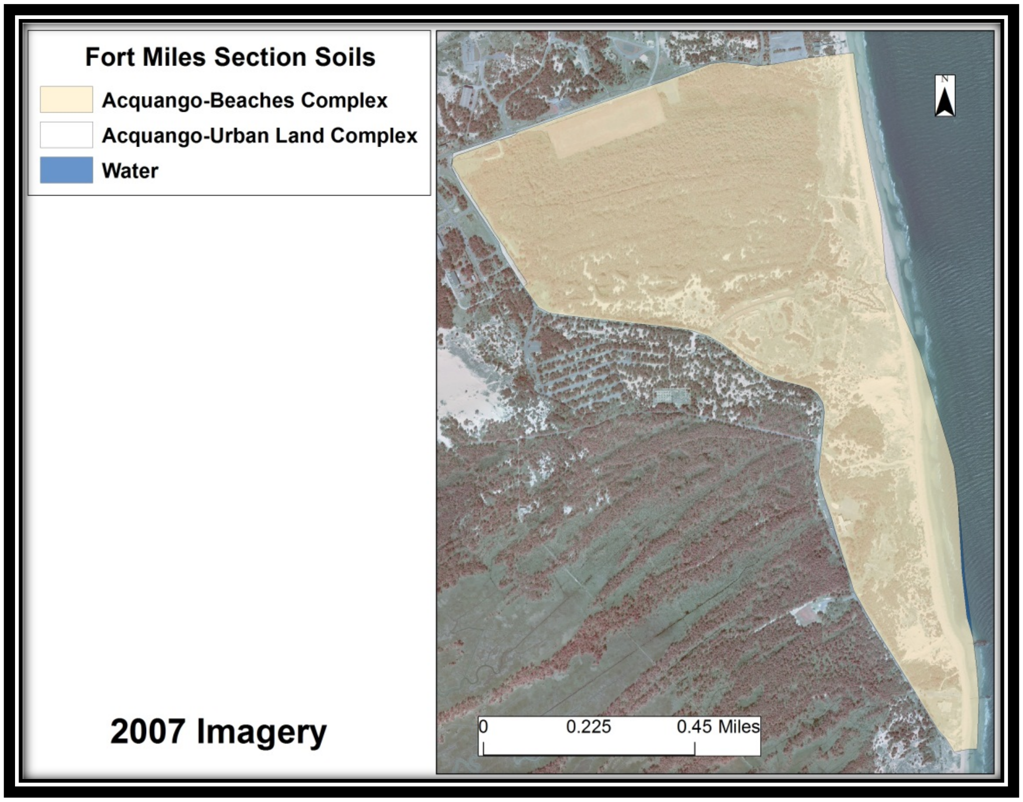

Figure 1.4. Fort Miles Section Soil Map

Gordons Pond Section Soils

Two prominent soils, Acquango-Beaches Complex (194 acres) and Broadkill Mucky Peat (176 acres), are present in the Gordons Pond Section. Other minor soils include Saltpond Mucky Sand (59 acres) and Brockotonorton-Urban Land Complex (42 acres).

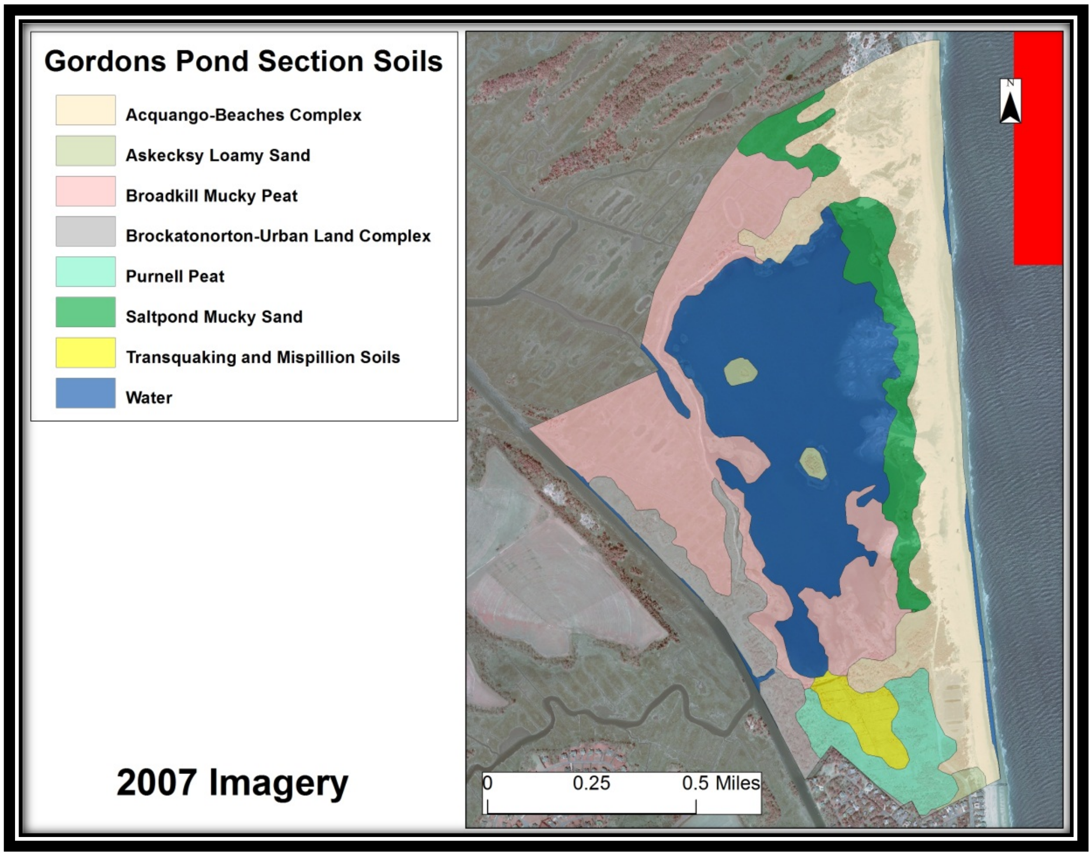

Figure 1.5. Gordons Pond Section Soil Map

Great Dune Section Soils

Like the Gordons Pond Section, the Great Dune Section is composed primarily of Acquango-Beaches Complex (967 acres) and Broadkill Mucky Peat (612 acres). Other minor soils include Saltpond Mucky Sand (146 acres) and Udorthents (106 acres).

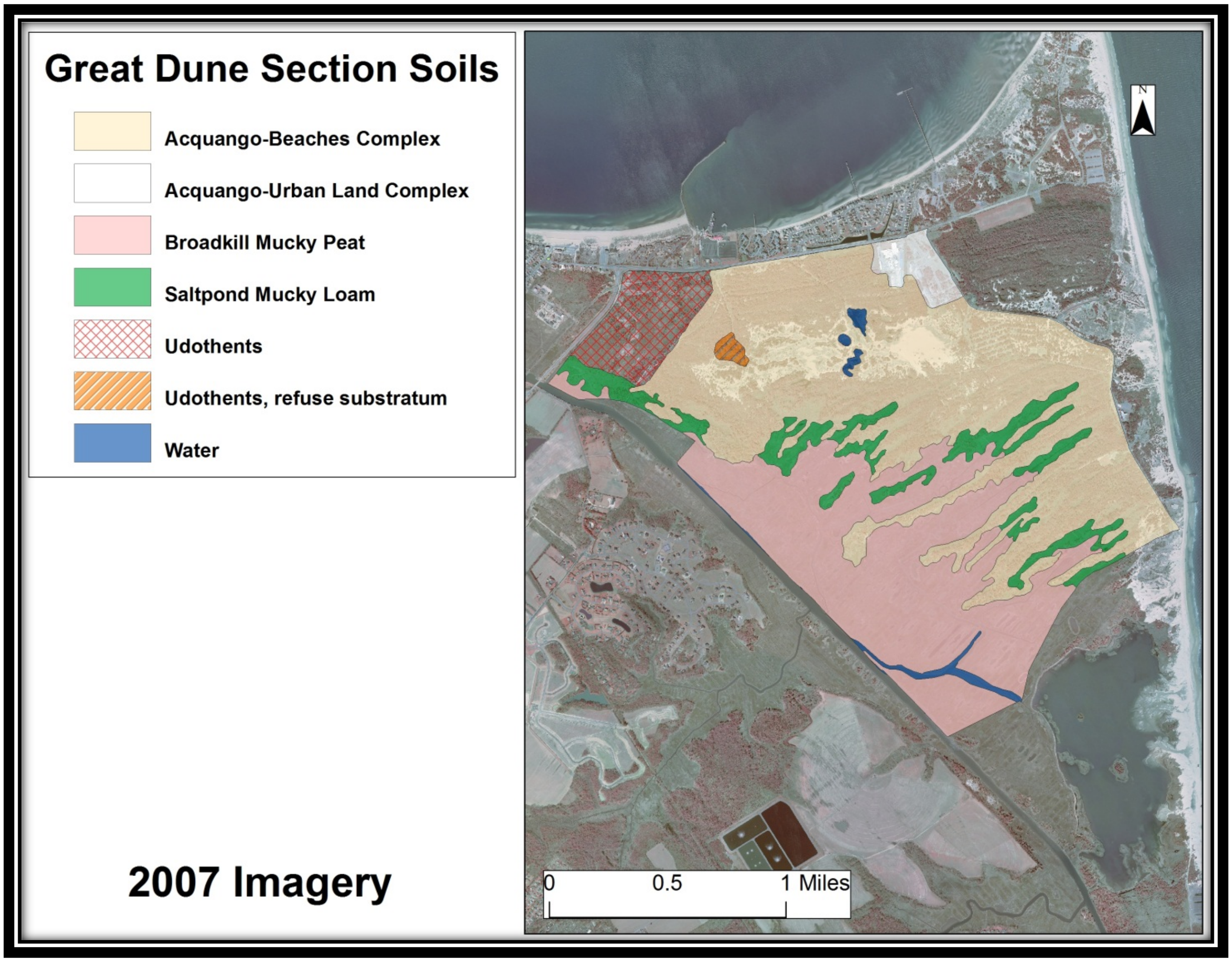

Figure 1.6. Great Dune Section Soil Map

Holland Glade Section Soils

Two soils, Downer Sandy Loam (131 acres) and Greenwich Loam (124 acres), are prominent in the Holland Glade Section. Other minor soils include Fort Mott Loamy Sand (76 acres), Downer Loamy Sand (57 acres), and Broadkill Mucky Peat (47 acres).

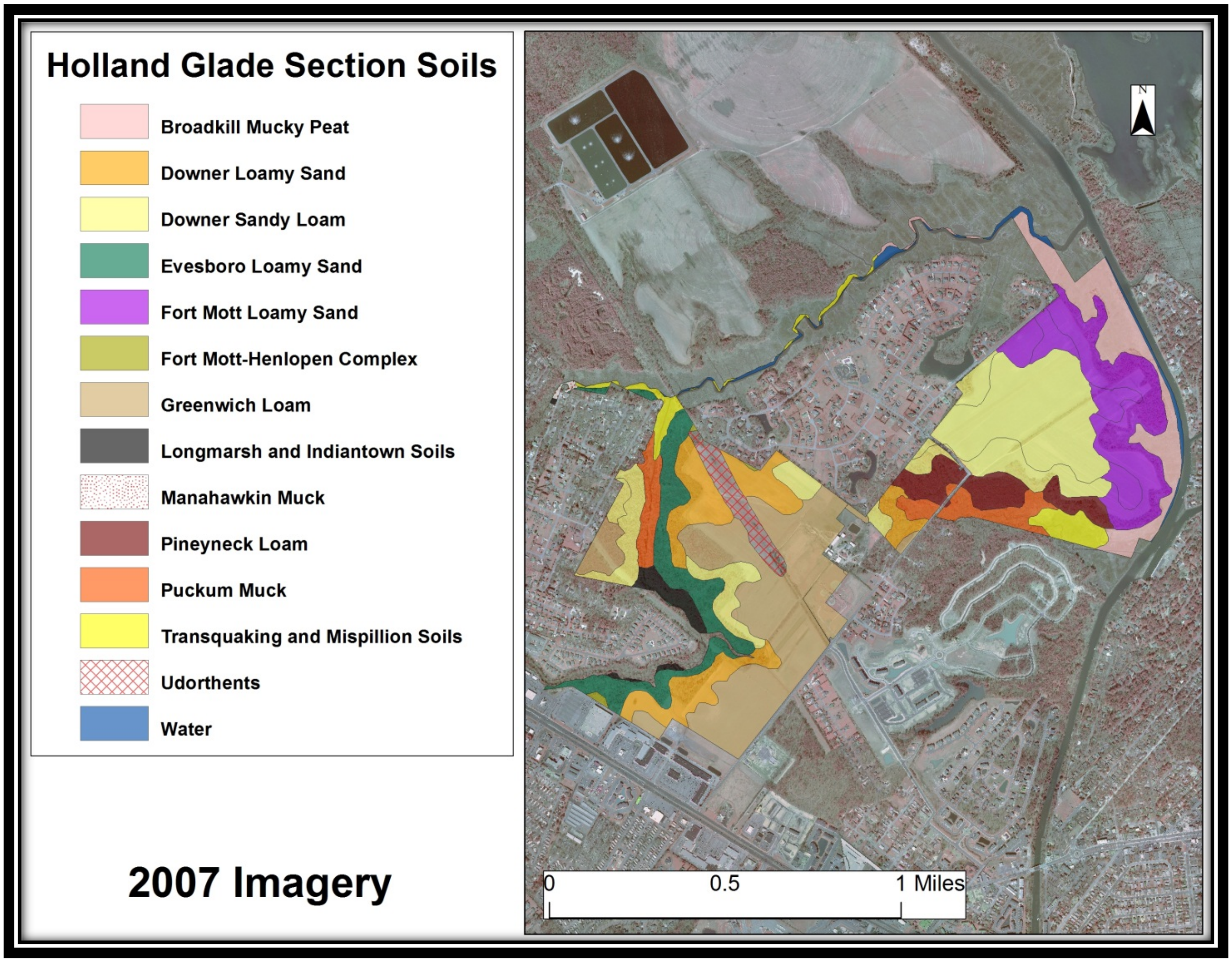

Figure 1.7. Holland Glade Section Soil Map

Red Mill Section Soils

Only two soils, Purnell Peat (11 acres) and Askecksy Loamy Sand (4 acres), are present in the Red Mill Section.

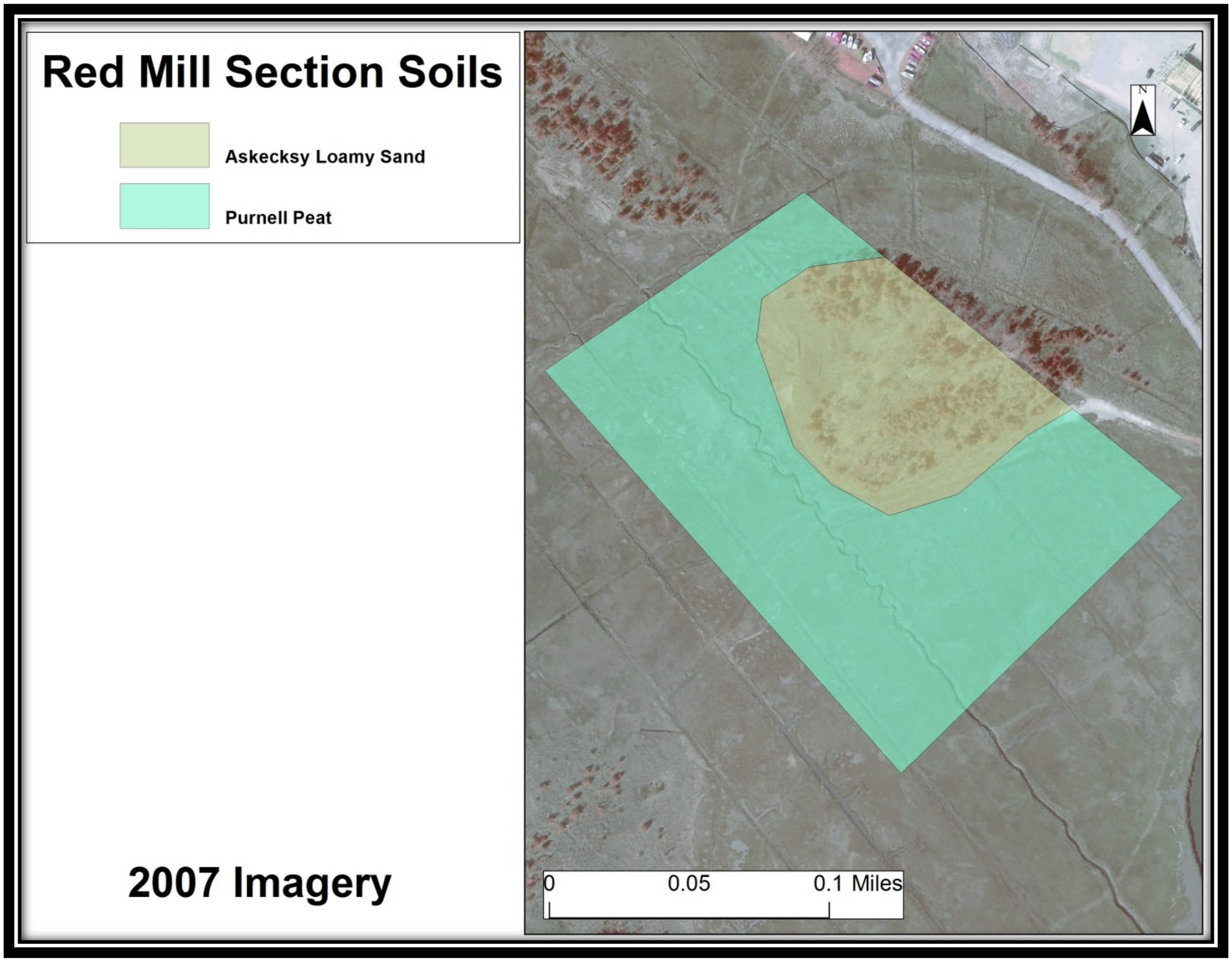

Figure 1.8. Red Mill Section Soil Map

Wolfe Neck Section Soils

Three soils, Downer Sandy Loam (394 acres), Broadkill Peat (216 acres), and Downer Sandy Loam (181 acres), are prominent in the Wolfe Neck Section. Other soils include Transquaking and Mispillion Soils (113 acres), Hammonton Sandy Loam (99 acres), Hurlock Sandy Loam (67 acres), and Brockatonorton-Urban Land Complex (51 acres).

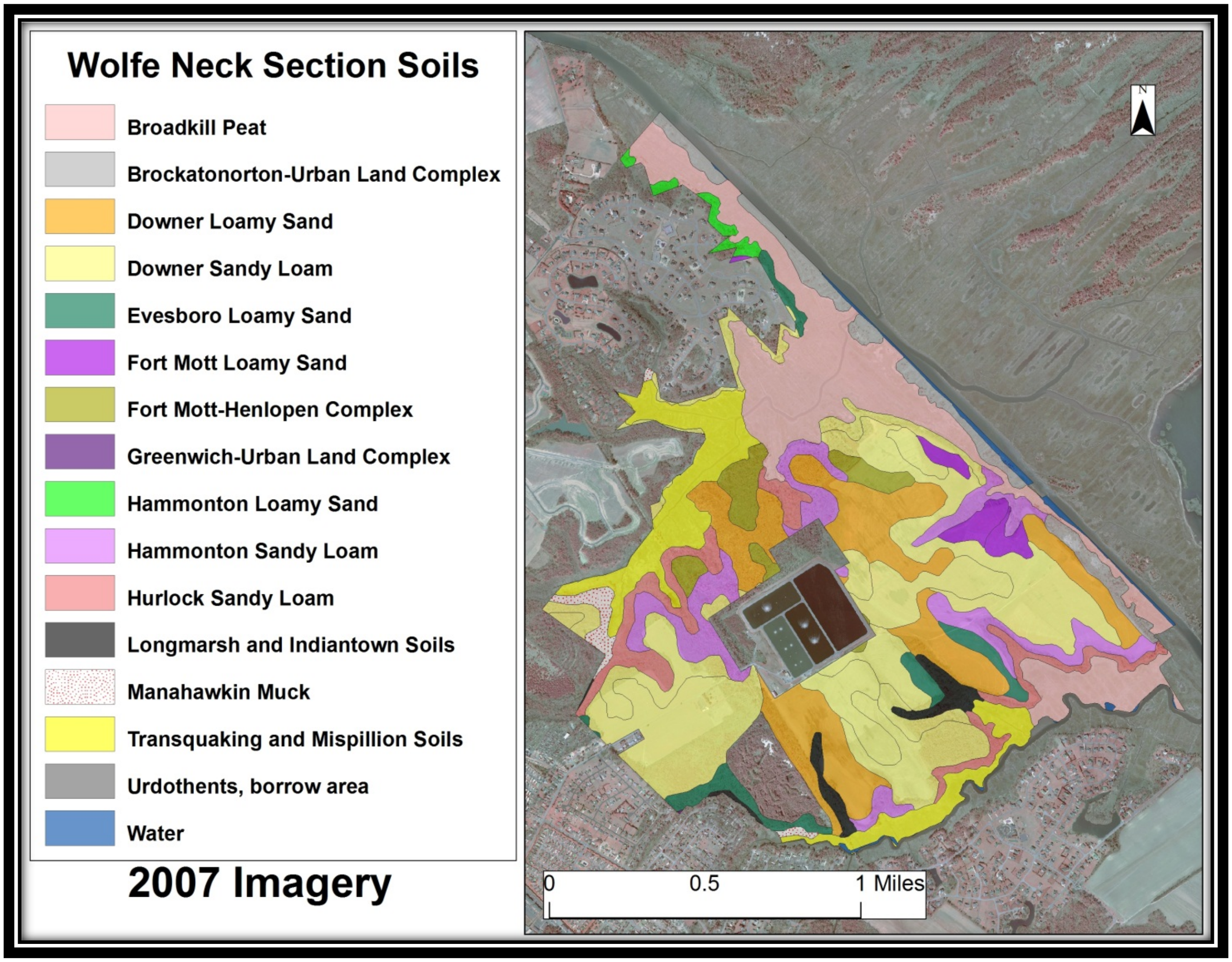

Figure 1.9. Wolfe Neck Section Soil Map

Discussion of vegetation communities in general and why they are important in management

While Natural Communities provide the optimal habitats and structure that are needed for animals to exist, vegetation communities provide an approximation of natural communities. The differences in the vegetation communities are governed by non-biotic factors and biotic factors. Non-biotic factors include things such as geology (soil type, availability of moisture, and exposure), climate, and fire regime. Biotic factors include: number and amount of predators and prey, biodiversity of the community and presence and absence of contributors to ecosystem health such as ants, fungi and bacteria and size of forest blocks. Historically these factors have not changed much other than changes brought about by larger climate shifts. Since the time of modern European settlement of Eastern North America (i.e. from about 1600 A.D.), physical factors such as fire regime and moisture availability have changed and nearly all of the biotic factors have changed resulted in a markedly different landscape today than what the original settlers saw. Today, instead of having Natural Communities, we have Vegetation Communities, which only approximate Natural Communities and are essentially artificial shells of what they could be.

Discussion of Sea-Level Rise and why it may affect the vegetation communities at Cape Henlopen State Park

To understand the effects of sea-level rise on vegetation communities near the coast one can look at what has happened historically. From the late Pleistocene period to 5,000 years ago, sea-level rise in Delaware was about 3 cm/decade (30 cm/100 years). From 3,000 years to the recent past it has been rising 1 cm/decade (10 cm/100 years).[3] More recent data from the Indian River Inlet (1972-1983) shows the rate of rise to be 3.73 mm/year and at Lewes (1919-2009), 3.24 mm/year[4]. More recent historical ground data from the National Aeronautics and Space Administration (NASA) from 1870 to 2000 has shown a sea level rise of 1.7 mm/year or 1.7 cm/decade. Even more recent data from the Jason satellites (1993-present) has shown an increase in the rise to 3.28 mm/year or 3.3 cm/decade.[5] This is above the fast rate of rise seen from the Late Pleistocene to 5,000 years ago. Jay Custer in his book Prehistoric cultures of the Delmarva Peninsula states that "Rising sea-level had three major effects on the environments of the Delmarva Peninsula: changes in the availability and distribution of coastal resources, changes in interior water tables, and potential changes in local air mass distributions and weather patterns. Changing availability of coastal resources with sea-level is related both to the rate of sea-level rise and changing shoreline topography. Before 3,000 years ago the rate of sea-level rise was so great that stable estuarine environments did not have time to develop". The slower sea-level rise after this time has allowed estuaries and marshes to increase in size, by lateral erosion.[6] Sea-level rise can also cause water tables to rise, water logging swamps away from the coast, a fact that has been

[3] Belknap, D.F. and J.C. Kraft. 1977. Holocene relative sea-level changes and coastal stratigraphic units on the northwest flank of the Baltimore Canyon geosyncline. Journal of Sedimentary Petrology 47(2): 610-629 in Custer (1989).
[4] Data from Permanent Service for Mean Sea Level website (www.psmsl.org)
[5] NASA Global Climate Change Website (http://climate.nasa.gov/keyindicators) December 12, 2010 update.
[6] Custer, Jay F. 1989. Prehistoric cultures of the Delmarva Peninsula: archaeological study. (Cranbury, NJ: Associated University Presses, Inc.), 447 pp.

stated in elsewhere in the Mid-Atlantic [7],[8], [9]. The rising rate of rise may factor into the difference between the Indian River Inlet and Lewes tidal stations. The Lewes station has been operating longer and has a more complete data set than the Indian River Inlet station.

Other sources have stated the rise on the Mid-Atlantic Coast to be 3-4 mm/year, while the global average is 1.8 mm/year[10] , the difference of which is caused by geological subsidence from the glaciers of the last ice age. The rate sea-level rise now is equal to the time historically when estuaries and marshes did not have time to develop. Marshes have been accreting about 3 mm/year for the past 100 years [11], but the current rate of sea level rise is above the accretion rate resulting in losses. It is projected to go much higher with rates of 10 cm/decade (1 m/100 years) as a median[12]. Kraft and Khalequzzaman project that most of the fringing salt marshes in Delaware will be eliminated in 200-300 years and by extinct in 1,500 to 1,700 years.[13] Other investigators have pointed out that there is a lack of temporal scale to a lot of the studies and that there may be a significant time lag between sea level rise and anthropogenic inputs of carbon dioxide. [14] These changes would also impact the fisheries and economy related to it in the area.

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[7] Rappleye, L. and W.M. Gardner. 1979. A cultural resources reconnaissance and impact assessment of the Great Dismal Swamp National Wildlife Refuge, City of Suffolk, Chesapeake, and Nansemond Counties, Virginia. Manuscript on file. Department of Anthropology, Catholic University, Washington, DC in Custer (1989).
[8] Whitehead, D.R. 1972. Developmental and environmental history of the Dismal Swamp. Ecological Monographs 42:301-15 in Custer (1989).
[9] Gardner, W.M. 1978. Comparison of Ridge and Valley, Blue Ridge, Piedmont, and Coastal Plain Archaic Period Site Distribution: An idealized transect (preliminary model). Paper presented at the 1978 Middle Atlantic Archeological Conference, Rehoboth Beach, Delaware in Custer (1989).
[10] Johnson, Zoe Pfahl. 2000. A Sea Level Rise Response Strategy for the State of Maryland. Maryland Department of Natural Resources.
[11] Nikitina, Daria L., James E. Pizzuto, Reed A. Schwimmer, and Kelvin W. Ramsey. 2000. An updated Holocene sea-level curve for the Delaware Coast. Marine Geology 171 (1-4): 7-20.
[12] Barth, M.C. and J.G. Titus. 1984. Greenhouse Effect and Sea Level Rise: A Challenge for this Generation. (New York: Van Nostrand Reinhold Co., Inc.) 238 pp.
[13] Kraft, John C. and Md. Khalequzzaman. 1992. Geologic and human factors in the decline of the tidal salt marsh lithesome: the Delaware Estuary and Atlantic coastal zone. Sedimentary Geology 80 (3-4): 233-246.
[14] Larsen, C.E. and I. Clark. 2006. A search for scale in sea-level studies. Journal of Coastal Research 22(4): 788-800.

Components of Sea Level Rise

There are many factors that all come together to produce the observed rise above. These include Eustatic (rise due to increased water volume), stearic (rise due to increased temperature and salinity), and isostatic (rise due to geological subsidence).

Eustatic Rise

Most people think of this factor when they talk about sea level rise. This is the contribution of increased water volume coming from the melting of glaciers, snowpack, and groundwater extraction. Using the figure for Indian River Inlet above this accounts for about 1.2 mm/year of the rise when subtracted from the other factors[15]. Added to this is newer research that shows groundwater depletion is adding 0.8 mm/year to sea level rise[16]. From this you have to subtract the amount of water that has been impounded on land. Chao, et al. states that about 10,800 cubic kilometers has been impounded in the last half century which subtracts about 0.55 mm/year from the rise[17]. When added together, eustatic factors account for 1.45 mm/year of the rise.

Stearic Rise

This factor comes from thermal expansion of ocean water and salinity currents. This factor contributes about 0.9 mm/year of the observed rise[18]. Yin et al states that this factor could account for more than the global mean in the future through a weakening of the meridional overturning circulation in the Atlantic[19], accounting for much more rise than in earlier studies. They go further to say that these contributions in New York City could result in a rise of 15 cm, 20 cm, or 21 cm, under low, medium, and high rates of emissions, respectively[20]. Other studies have pointed out that variations in rise in the Mid-Atlantic can be 20 cm and persist for years due to the North Atlantic Subtropical Gyre[21].

Isostatic Rise

Geological land subsidence adds the most to the rise currently accounting for about 1.6 mm/year[22] in the Mid-Atlantic region. Another study has given an amount ranging from 1.02 to 1.53

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[15] Davis, George H. 1987. Land Subsidence and Sea Level Rise on the Atlantic Coastal Plain of the United States. Environmental Geology 10 (2): 67-80.

[16] Wada, Y., L.P.H. van Beek, C.M. van Kempen. J.W.T. Reckman, S. Vasak, and M.F.P. Bierkens. 2010. Global depletion of groundwater resources. Geophysical Research Letters 37

[17] Chao, B.F., Y.H. Wu, and Y.S. Li. 2008. Impact of Artificial Reservoir Water Impoundment on Global Sea Level. Science 320(5873): 212-214.

[18] Ditto

[19] Yin, Jianjun., S.M. Griffies, M. Schlesinger, R.J. Stouffer. 2010. Regional Sea Level Rise Projections on the Northeast Coast of the United States. American Geophysical Union, Fall 2010 meeting.

[20] Yin, Jianjun, M.E. Schlesinger, R.J. Stouffer. 2009. Model Projections of Rapid Sea Level Rise on the Northeast Coast of the United States. Nature Geoscience 2(4): 262-266.

[21] Hong, Byung-Gi. 1998. Decadal variability in the North Atlantic Subtropical Gyre: Can it explain variability in sea level along the East Coast of the United States. Ph.D. Thesis, The Florida State University, 77 pp.

[22] Davis, George H. 1987. Land Subsidence and Sea Level Rise on the Atlantic Coastal Plain of the United States. Environmental Geology 10(2): 67-80.

mm/year[23]. Liu, et al gives a similar for New York City stating a sea level rise of 2-4 mm/year to which glacio-isostatic factors account for about 40%[24].

All of these factors added together

If we add all of these factors together using the data above we get a range of 3.15 mm to 3.95 mm/year.

E= Eustatic (1.45 mm/yr.)
S= Stearic (0.9 mm/yr.)
I= Isostatic (1.6 mm/yr.-Davis, 1.02-1.53 mm/yr.-Engelhart, et al., 0.8 mm-1.6 mm/yr.-Liu)

Using vegetation communities to map sea level rise and changes in the landscape

One of the first studies in Delaware to use vegetation communities to map human induced changes in the landscape was done by a Victor Klemas at the University of Delaware in the early 1970s[25]. Victor compared aerial imagery from 1954 and 1968 on a qualitative basis and looked at changes in the marshes and other man-made features. He incorporated some multispectral analysis to determine some of the vegetation types. Though he did not refer to specific vegetation communities as we know them now, he did look at vegetation assemblages (Low marsh, high marsh, and salt shrub) that are very similar to the groupings now. No figures were given in his paper regarding the overall changes. He did note, however, that the shoreline at Cape Henlopen had receded 4 to 21 feet per year from 1843 to 1939[26]. Other papers have also used historical aerial imagery to map vegetation change[27],[28] and salinity factors can impact on those changes[29].

More recent studies looking at both changes in tidal marshes[30] and coastal forests[31] have shown that both can suffer effects of a rising sea level. Matthew Kirwan states that a tidal marsh can keep up with sea level rise through accretion if the amount of sediment is adequate, but that reforestation and

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[23] Englehart, S.E., B.P. Horton, B.C. Douglas, W.R. Peltier, T.E. Tornqvist. 2008. Spatial variability in the 20th century record of sea level rise along the US Atlantic Coast. American Gophysical Union, Fall 2008 Meeting.
[24] Liu, J., R. Horton. 2007. Impacts of combined sea level rise and coastal subsidence, New York City Metropolitian Area. American Geophysical Union. Fall 2007 Meeting.
[25] Klemas, Vytautas. 1972. Use of remote sensing to determine natural and man-made changes in the coastal zone. Transactions of the Delaware Academy of Science. 2: 13-34.
[26] Vytautas, Klemas. 1972. Use of remote sensing and to determine natural and man-made changes in the coastal zone. Transactions of the Delaware Academy of Science 2:13-34.
[27] Kadmon, R. and R. Harari-Kremer. 1999. Studying the long term vegetation dynamics using digital processing of historical aerial photographs. Remote Sensing of the Environment 68:164-176.
[28] Smith, Carrie, Merryl Alber, and Alice Chalmers. 2001. Linking shifts in historic estuarine vegetation to salinity changes using a GIS. Proceedings of the 2001 Georgia Water Resources Conference.
[29] Earle, J.C. and K.A. Kershaw. 1988. Vegetation patterns in James Bay coastal marshes. III. Salinity and elevation as factors influencing plant zonations. Canadian Journal of Botany 67: 2967-2974.
[30] Kirwan, Matthew L. and A. Brad Murray. 2007. A coupled geomorphic and ecological model of tidal marsh evolution. Proceedings of the National Academy of Science 104(15):6118-6122.
[31] Williams, Kimberlyn, et al. 1999. Sea-level rise and coastal forest retreat on the west coast of Florida, USA Ecology

dam building has restricted the sediment inflows[32]. Shirley and Battaglia come roughly to the same conclusion on the Gulf of Mexico coast, stating that they do not believe the marshes are keeping pace with the aquatic to terrestrial transition, but it is hard to map in the Coastal Plain because of major land use changes[33]. Kimberlyn Williams states that some of the factors leading to forest decline in coastal areas result from; soil flooding—resulting in low oxygen availability and reducing conditions, elevated soil and groundwater salinity, and saltwater intrusion.

One study in the Delaware River Estuary stipulated that freshwater tidal marshes are needed to help the development of brackish and salt marshes[34] in areas where the coast was submerging. The freshwater marshes help produce the environmental conditions later needed by the more saline marshes.

Purpose of the Study

This study was conducted with the following goals in mind:

1. Classify and map vegetation communities, land covers, and assess habitat conditions for Species of Greatest Conservation Need (SGCN)[as defined in the Delaware Wildlife Action Plan (DEWAP)] for Cape Henlopen State Park based on 1954, 2002, and 2007 aerial imagery and field observations.
2. Use the maps above to determine changes in the vegetation communities and the effects of sea level rise and to determine the relative rate of sea level rise in the park.
3. Determine the forest blocks located within or partially within the park.
4. Produce Ecological Integrity Assessments (EIAs) for vegetation communities that are ranked S2 or higher.

Surveys were conducted during 2010 and 2011 by Robert Coxe, an Environmental Scientist with the Delaware Natural Heritage and Endangered Species Program (DNHESP) within the Delaware Division of Fish and Wildlife, Department of Natural Resources and Environmental Control (DNREC).

[32] Kirwan, Matthew L. and A. Brad Murray. 2007. A coupled geomorphic and ecological model of tidal marsh evolution. Proceedings of the National Academy of Science 104(15):6118-6122.
[33] Shirley, Laura and Lorretta L. Battaglia. 2006. Assessing vegetation change in coastal landscapes of the northern Gulf of Mexico. Wetlands 26(4): 1057-1070.
[34] Orson, Richard A., Robert L. Simpson, and Ralph E. Good. 1992. The Paleoecological development of a late Holocene, Tidal Freshwater Marsh of the Upper Delaware River Estuary. Estuaries and Coasts 15(2): 130-146.

Vegetation Community and Land Cover Surveys

Vegetation communities and land covers were determined by qualitative analysis using observations made in the field and aerial photo-interpretation using 1954, 2002, and 2007 imagery. Vegetation communities are named according to the *Guide to Delaware Vegetation Communities* [35]which follows the National Vegetation Classification System (NVCS). The NVCS classifies vegetation on a national scale for the United States and is linked to international vegetation classification. The NVCS helps provide a uniform name and description of vegetation communities found throughout the country and helps determine relative rarity. Descriptions of the vegetation communities are provided in Chapter 4, and of the land covers in Chapter 5. A crosswalk to the Delaware Wildlife Action Plan (DEWAP) and the Northeast Habitat Classification (NHC) is provided at the top of each individual description.

Analysis of Historical Imagery

Historical imagery of Cape Henlopen State Park from 1954, 2002 and current imagery from 2007 were examined. A vegetation community map was produced for each year in order to compare vegetation and land cover change over a 5, 48, and 53 year time frame. Changes in the respective vegetation communities and land covers in the entire park are discussed in Chapter 3 while changes in the sections are discussed in Chapter 4. There is more imagery available (1937, 1961, 1968, 1992, and 1997) but these sets were not used due to geo-registration problems in the image tiles or image quality issues.

Ecological Integrity Assessment (EIA)

An EIA was conducted for those communities in the state park that are ranked S2 or higher in Delaware. EIAs are an analysis being developed by Natureserve to determine the relative quality of vegetation communities across North America. Using Natural Heritage methodology, communities are ranked according to rarity (Appendix I). The vegetation communities at Cape Henlopen State Park included in the EIA analysis are listed in Table 2.3.

Forest Block Analysis

Current forest blocks within or partially within the state park that are greater than 100 acres were mapped (Figure 2.8) and described. Each current block is described for current total acres and current forest interior habitat, potential acres, potential forest interior habitat, vegetation communities currently present, and major drainage (Table 2.4). A block is defined as contiguous forest habitat that is contained with 30 feet of non-forested and is the method used by the Maryland's Strategic Forest Lands Assessment.[36] Forest interior is forested area that is 100m from a forest edge. Potential blocks were extended out to areas of noncontiguous habitat (such as roads, power line right-of-ways, and developed areas) that were considered to be immovable. Most of the area that could be reverted to forest is

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[35] Coxe, Robert. 2012. Guide to Delaware Vegetation Communities-Winter 2012 Edition. Unpublished report.

[36] Maryland Department of Natural Resources. 2003. Strategic Forest Lands Assessment. Co-op Project between Maryland Department of Natural Resources, Watershed Services, and Maryland Forest Service. 40 p.

currently old field habitat or in agricultural use. These blocks were determined for future planning in regards to improving and increasing forest interior habitat.

Sea Level Rise Analysis

An analysis was performed for the State Park as a whole and for the various sections using the DNREC Sea Level Rise Scenarios. An estimate of the projected acre lost under the various scenarios is provided for the park as whole, the sections, and the vegetation communities and land covers.

Natural Capital Analysis

The natural capital of each vegetation community was determined using a table in Costanza, et al.[37] The values from the table were calculated per acre of the vegetation community and then adjusted using an inflation calculator (DollarTimes.com) from 1994 values to 2012 values. Using these methods the following values were obtained:

Estuaries (water): $9,247/acre/year

Temperate Forest (Upland forests): $122/acre/year

Wetlands

-General (not as below): $5,988/acre/year

-Tidal Marsh: $4,046/acre/year

-Swamps/floodplains: $7,930/acre/year

Lakes (Impoundments): $3,442/acre/year

Cropland: $37/acre/year

Grassland/fields: $94/acre/year

Open Ocean: $102/acre/year

Values were rounded off to the nearest whole dollar. Calculating the natural capital provides a consistent way to compare wildlife areas and state parks as far as value. Even if you do not agree with the values, it still provides a relative measure of the areas.

[37] Costanza, Robert, et al. 1997. The value of the world's ecosystem services and natural capital. Nature 387:253-260.

Chapter 2: Results of EIAs, Forest Blocks and General Observations

Summary of Findings from this study

1. **Vegetation Communities:** Forty vegetation communities and twelve land covers were found at Cape Henlopen State Park. North Atlantic Low Salt Marsh (1,095 acres) is the largest vegetation community, followed by Pitch Pine Dune Woodland with 911 acres. Agricultural Field (759 acres) is the largest land cover, followed by water with 390 acres.

2. **Rare Plants:** Thirty rare plants are known to exist in Cape Henlopen State Park (Table 2.1).

Scientific Name	Common Name	Rank	Last Observed
Amaranthus pumilus	Seabeach Amaranth	S1	???
Actostaphylos uva-ursi	Bearberry	SX	2001
Calopogon tuberosus	Grass-pink Orchid	S1	2001
Carex exilis	Coast Sedge	S1	2003
Carex mitchelliana	Mitchell's Sedge	S2	1997
Carex silicea	Seabeach Sedge	S2	???
Commelina erecta	Slender Dayflower	S2	1990
Drosera rotundifolia	Roundleaf Sundew	S2	2003
Eriocaulon decangulare	Ten-angle Pipewort	S1	2003
Eriophorum virginicum	Tawny Cotton-grass Sedge	S1	1997
Fimbristylis caroliniana	Carolina Fimbry	S2	???
Fuirena squarrosa	Hairy Umbrella-sedge	S3	???
Hudsonia ericoides	Golden-heather	S1	1997
Juncus coriaceus	Northern St. John's Wort	S2	???
Juncus pelocarpus	Brown-fruited Rush	S2	1997
Liatris graminifolia	Grassleaf Gayfeather		1997
Minuartia caroliniana	Pine Barren Sandwort	S1.1	1997
Platanthera blephariglottis	White-fringe Orchid	S1	1997
Platanthera flava var. *herbiola*	Southern Rein Orchid	S1	???
Pogonia ophioglossoides	Rose Pogonia	S2	2001
Polygala cruciate	Cross-leaved Milkwort	S2	???
Rhynchospora alba	White Beak-rush	S2	1993
Rhynchospora scirpoides	Long-beaked Bald-rush	S2	1997
Sagittaria engelmanniana	Engelmann's Arrowhead	S2	1983
Sideroxylon lycioides	Buckthorn Bumelia	S1.1	1997
Smilax bona-nox	Saw Greenbrier	S1	1997
Spiranthes vernalis	Twisted Ladies'-tresses	S2	1993
Sporobolus clandestinus	Rough Dropseed	S1	1997
Utricularia fibrosa	Fibrous Bladderwort	S3	1991
Utricularia juncea	Southern Bladderwort	S2	1995

Table 2.1 Rare Plants at Cape Henlopen State Park

3. **Rare Animals:** Fourteen rare animals are known to exist in Cape Henlopen State Park (Table 1.2).

Scientific Name	Common Name	Rank	Last Observed
Brachymesia gravida	Four-spotted Pennant	S1	???
Charadrius melodus	Piping Plover	S1B	2011
Chordeiles minor	Common Nighthawk	S2B	1996
Cincindela lepida	Little White Tiger Beetle	S1	2001
Cincindela scutellaris	A Tiger Beetle	S1?	???
Cistothorus platensis	Sedge Wren	S1B	1991
Elaphe guttata	Corn Snake	S1	1997
Haematopus palliatus	American Oystercatcher	S1B	2001
Libellula deplanata	Blue Corporal	S2	1993
Nycticorax nycticorax	Black-crowned Night-heron	S1B	1989
Rhynchops niger	Black Skimmer	S1B	1988
Sitta pusilla	Brown-headed Nuthatch	S2	1997
Sterna antillarum	Least Tern	S1B	1997
Sterna hirundo	Common Tern	S1B	1994

Table 2.2 Rare Animals at Cape Henlopen State Park

Ecological Integrity Assessment (EIA)

Eighteen vegetation communities are ranked S2 or higher. These areas are mapped by section in Figures 2.1-2.6 and summarized in Table 2.3. The vegetation communities in the EIAs are listed in the section descriptions.

Cape Point Section EIAs (Figure 2.1)

The Cape Point Section contains seven EIA communities, Barrier Island Bog, Beachgrass-Panicgrass Dune Grassland, Central Coast Beach Heather Dune Shrubland, Chesapeake Bay Maritime Shrubland, Chesapeake Bay Tall Maritime Shrubland, Mid-Atlantic Coast Backdune Grassland, and Pitch Pine Dune Woodland.

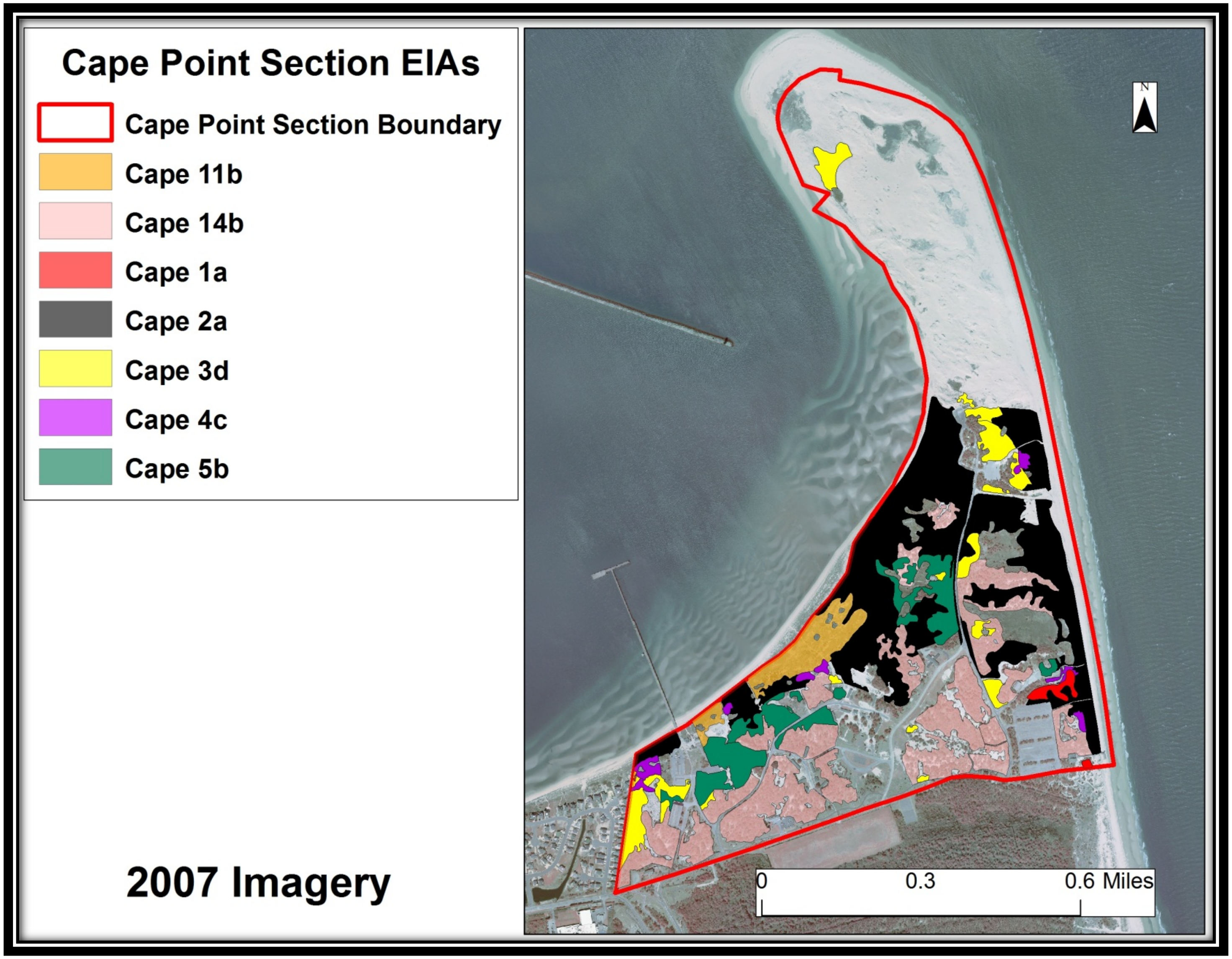


Figure 2.1. Cape Point Section EIA Communities

Fort Miles Section EIAs (Figure 2.2)

The Fort Miles Section contains eight EIA communities that include Barrier Island Bog, Beachgrass-Panicgrass Dune Grassland, Central Coast Beach Heather Dune Shrubland, Chesapeake Bay Maritime Shrubland, Mid-Atlantic Coast Backdune Grassland, Pitch Pine Dune Woodland, Pitch Pine Lowland, and Pitch Pine/Cranberry Interdunal Swale .

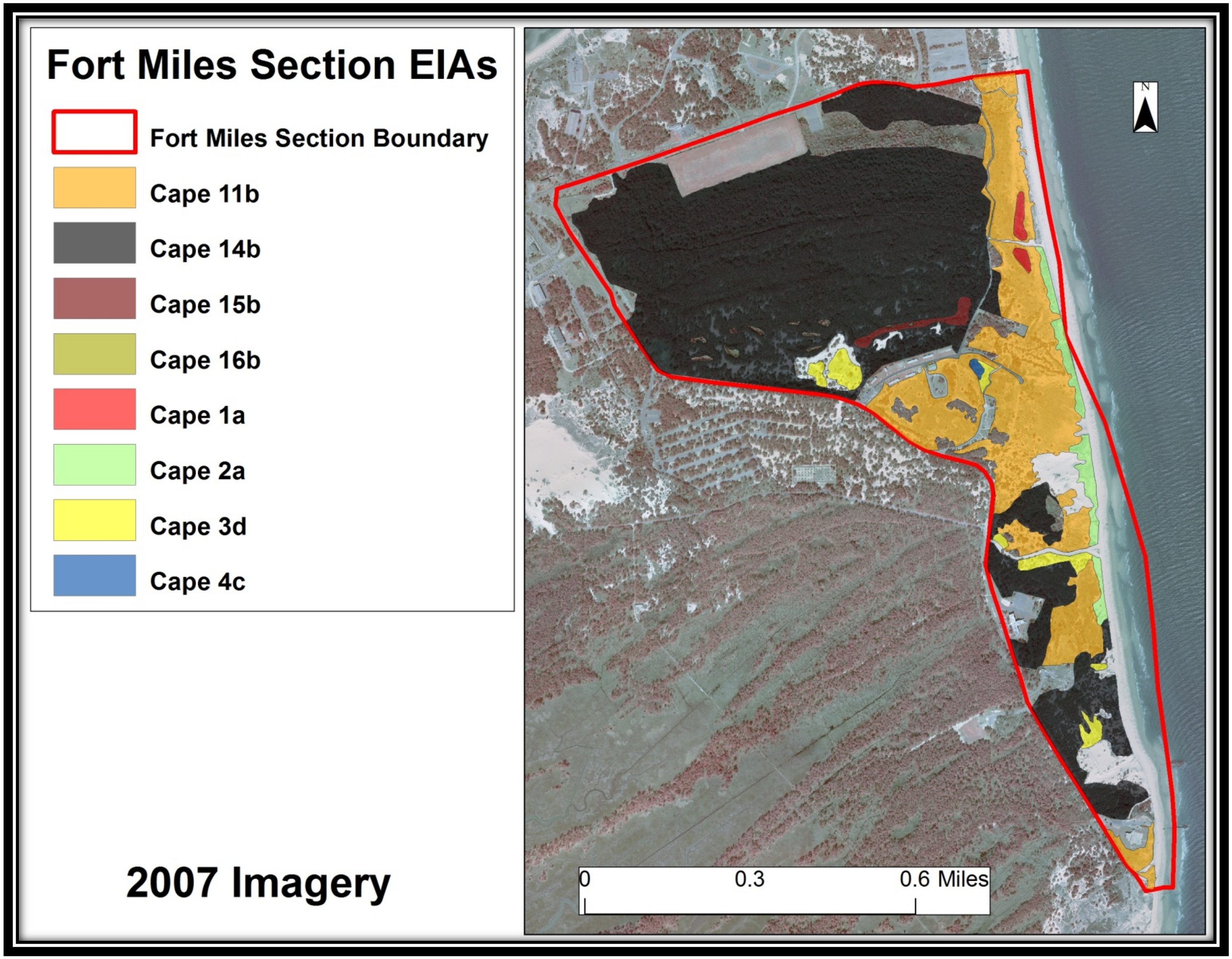


Figure 2.2. Fort Miles Section EIA Communities

Gordons Pond Section EIAs (Figure 2.3)

The Gordons Pond Section contains ten EIA communities that include Barrier Island Bog, Beachgrass-Panicgrass Dune Grassland, Central Coast Beach Heather Dune Shrubland (2 occurrences), Chesapeake Bay Maritime Shrubland (2 occurrences), Forked Rush Dune Swale, Loblolly Pine Dune Woodland, Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Meadow, Mid-Atlantic Backdune Grassland, Overwash Dune Grassland, Pitch Pine Dune Woodland, and Wax-Myrtle Shrub Swamp. This section contains the only occurrence of Forked Rush Dune Swale in the park.

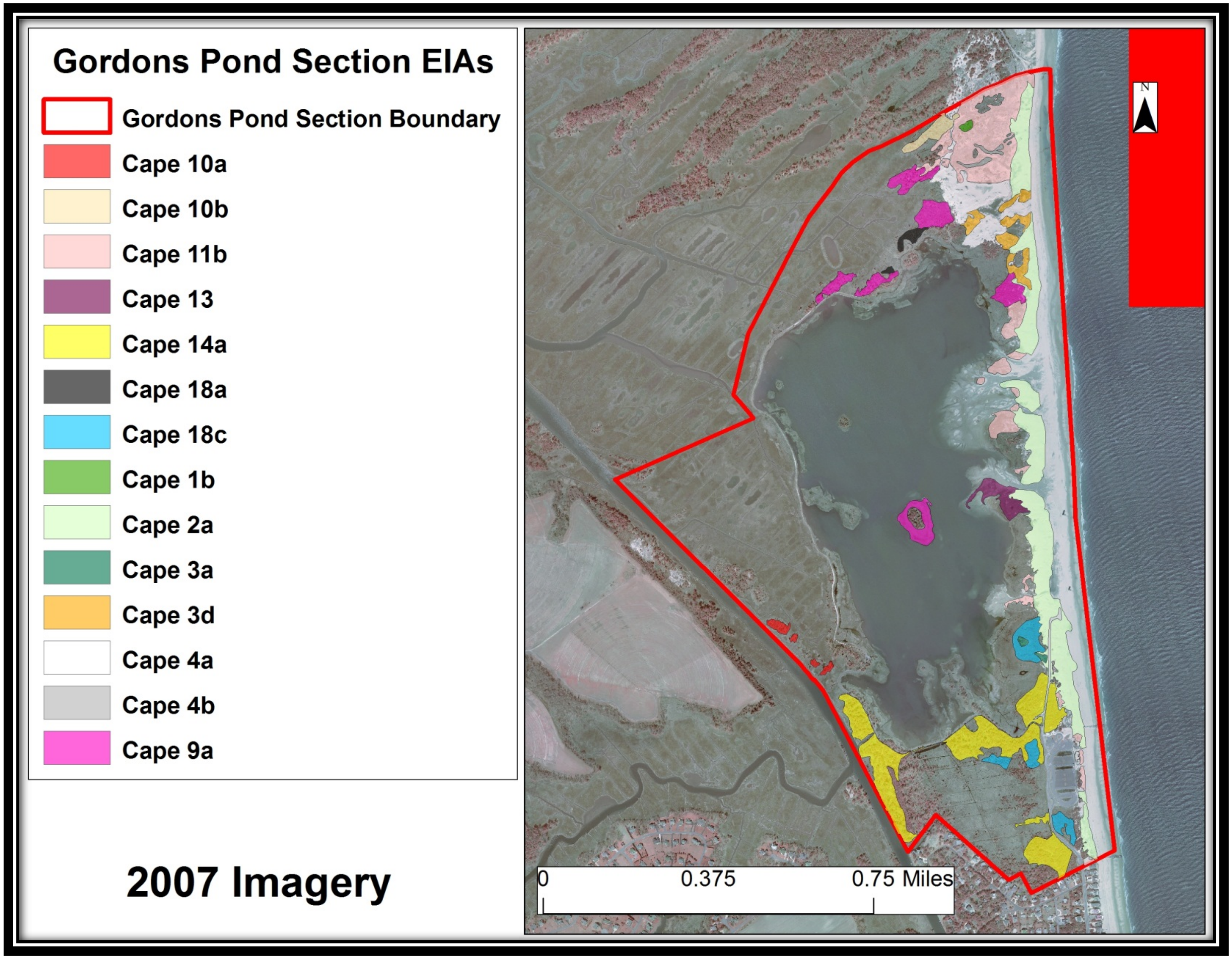


Figure 2.3. Gordons Pond Section EIA Communities

Great Dune Section EIAs (Figure 2.4)

The Great Dune Section contains eleven EIA communities, that include Beachgrass-Panicgrass Dune Grassland, Central Coast Beach Heather Dune Shrubland, Chesapeake Bay Tall Maritime Shrubland, Coastal Plain Pond, Freshwater Tidal Woodland, Loblolly Pine Dune Woodland (2 occurrences), Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland, Mid-Atlantic Coast Backdune Grassland, Overwash Dune Grassland, Pitch Pine Dune Woodland, and Wax-Myrtle Shrub Swamp. This section contains the only occurrence of Coastal Plain Pond in the park.

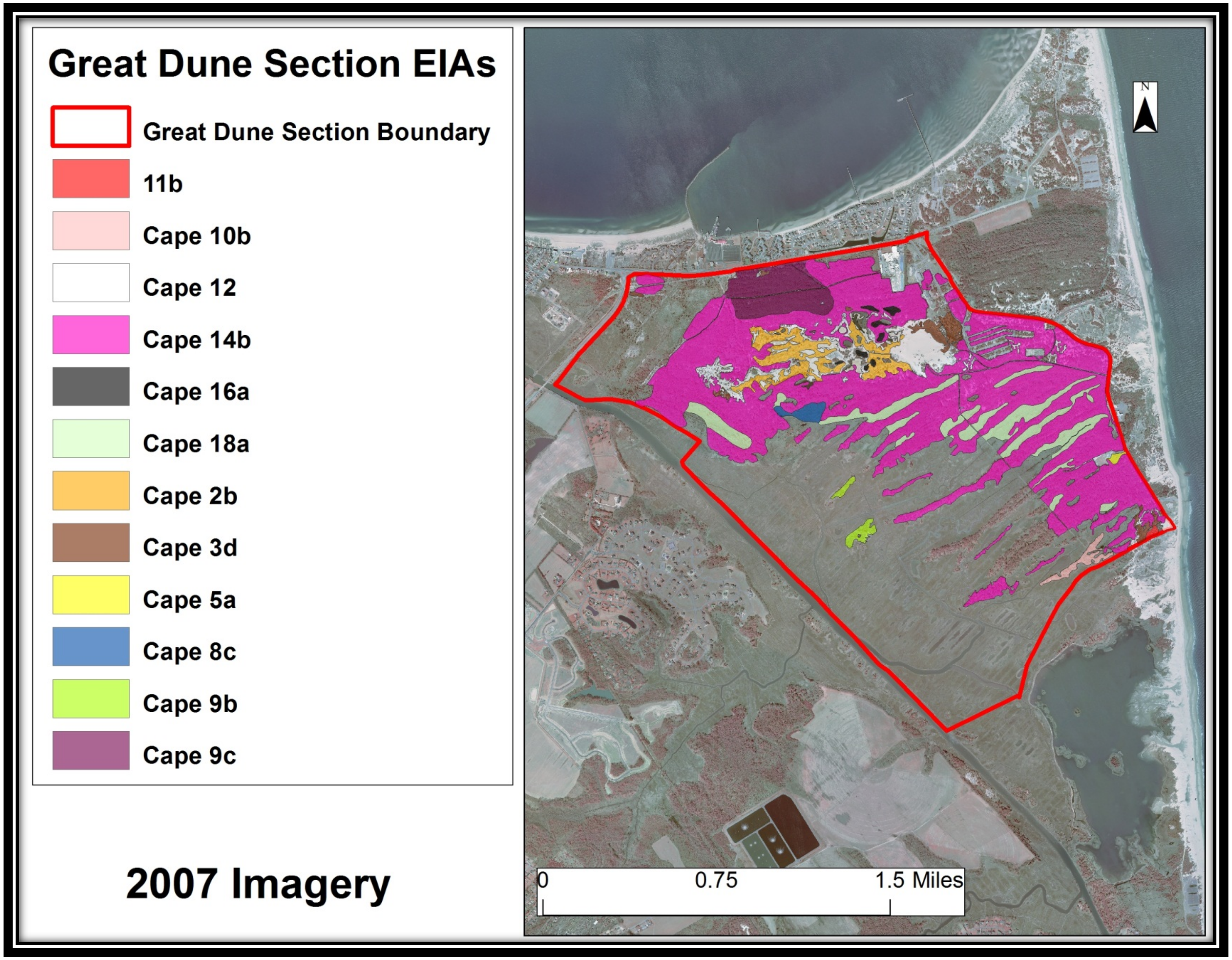


Figure 2.4. Great Dune Section EIA Communities

Holland Glade Section EIAs (Figure 2.5)

Freshwater Tidal Woodland and Wax-Myrtle Shrub Swamp are the only EIA communities present in the Holland Glade Section.

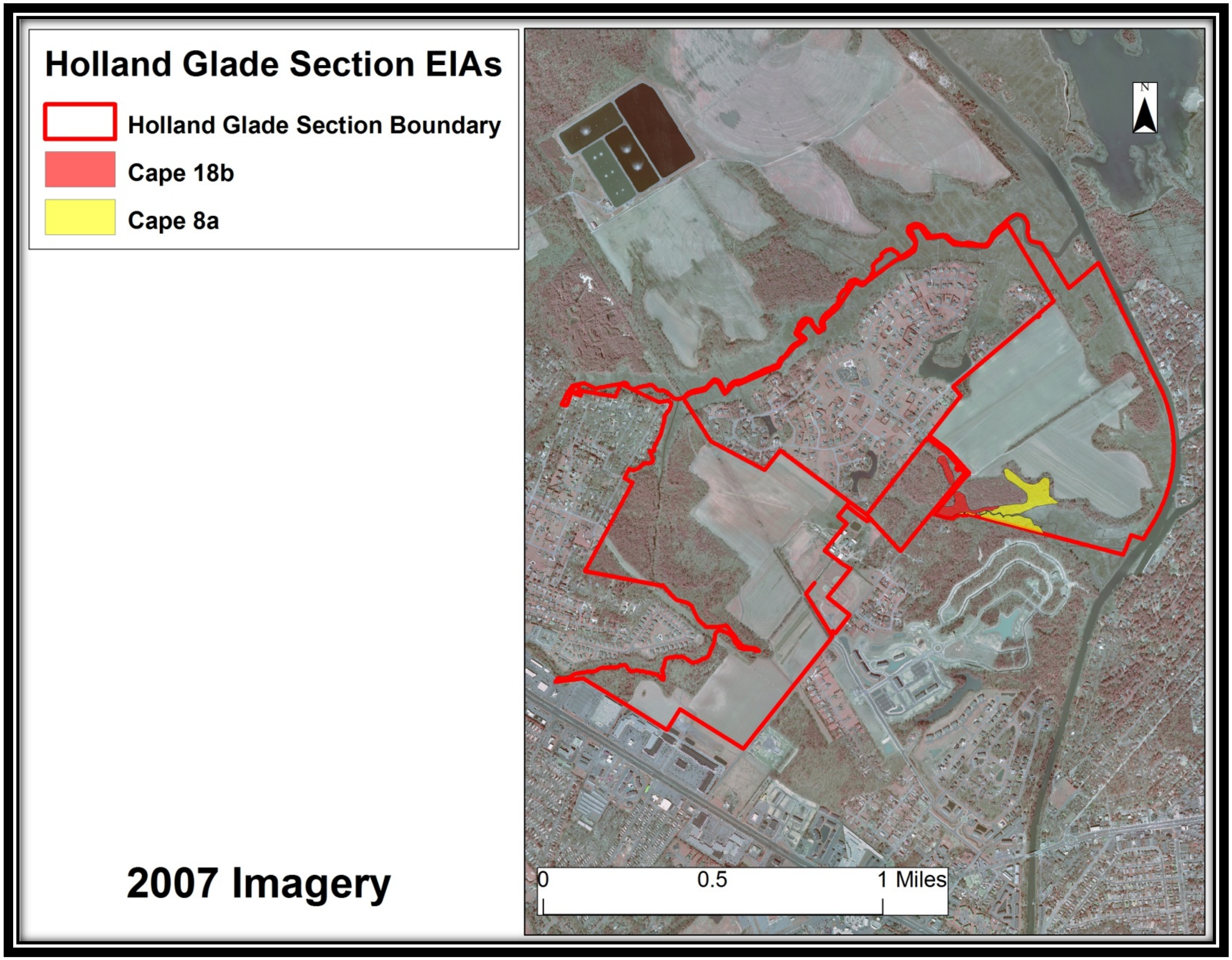


Figure 2.5. Holland Glade Section EIA Communities

Wolfe Neck Section EIAs (Figure 2.6)

The Wolfe Neck Section contains four EIA communities, Central Coast Beach Heather Dune Shrubland, Freshwater Tidal Woodland, Mid-Atlantic Coast Backdune Grassland, and Wax-Myrtle Shrub Swamp.

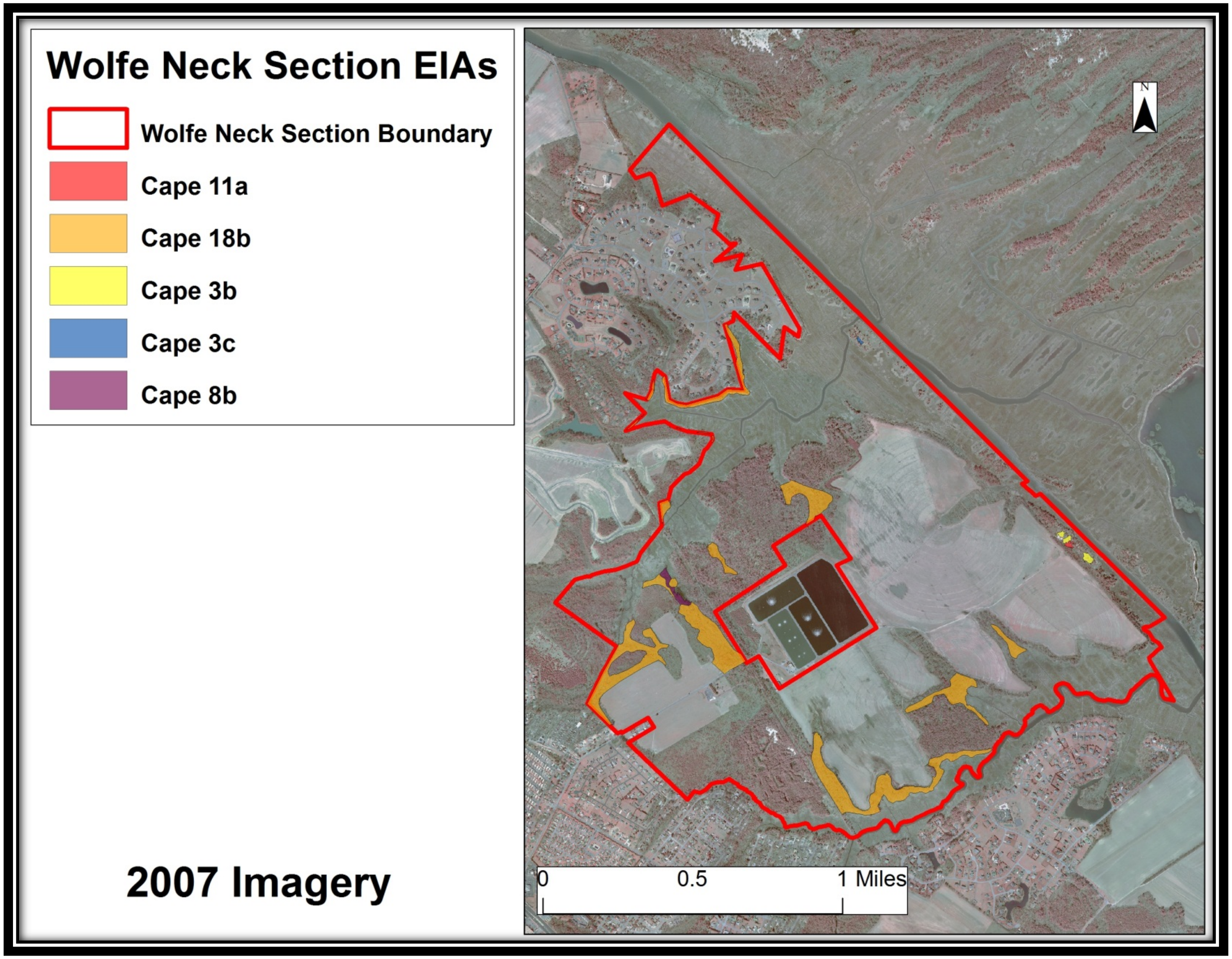
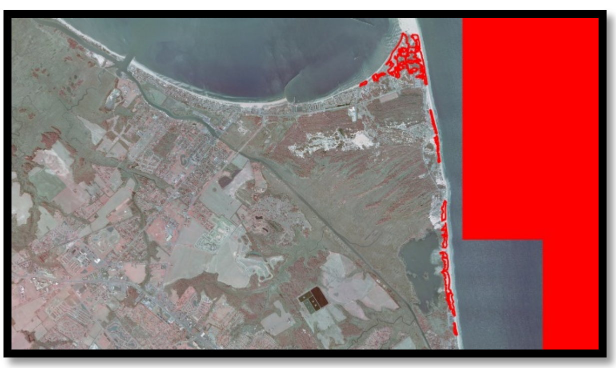
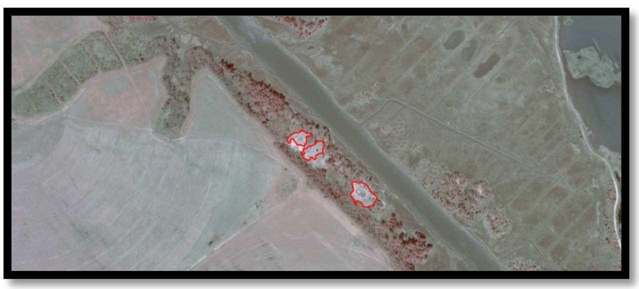
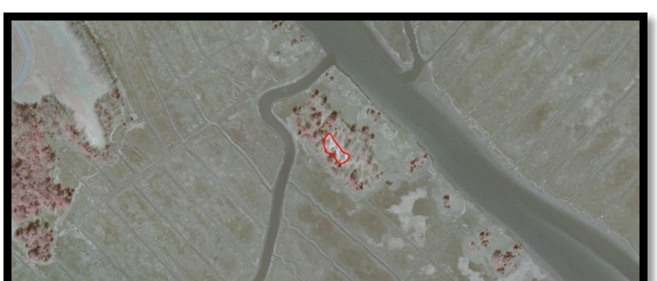
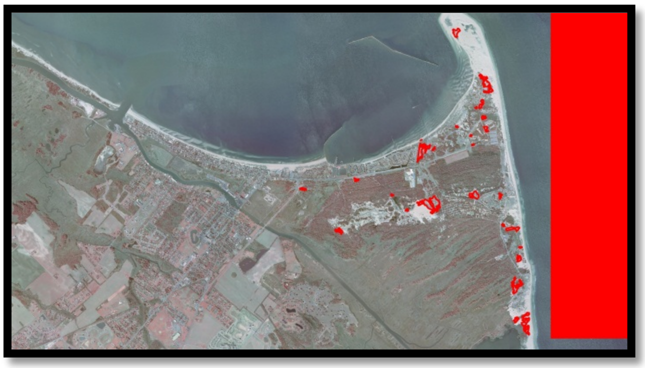
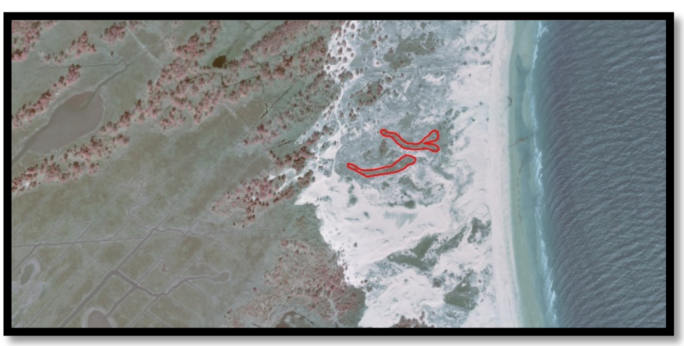


Figure 2.6. Wolfe Neck Section EIA Communities

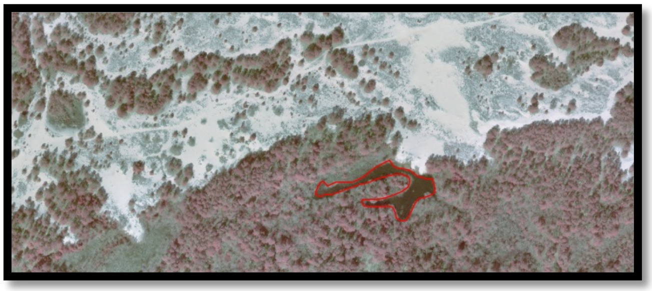
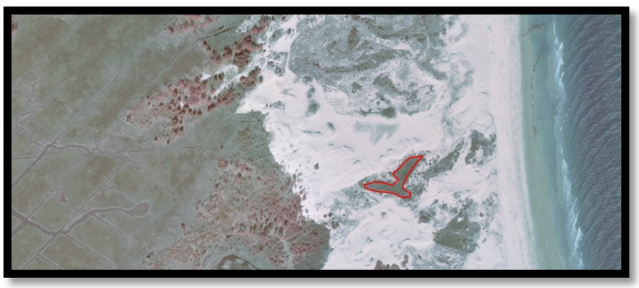
Table 2.3. EIA Vegetation Communities located in Cape Henlopen State Park

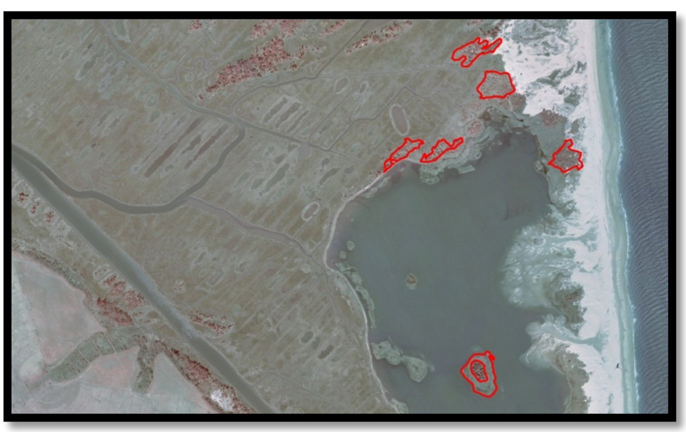
Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 1a** **Barrier Island Bog (3 acres)** **EIA = 4 (B rank)**	This Barrier Island Bog is located in depressions between dunes on the Atlantic Ocean shore.
	**Cape Henlopen 1b** **Barrier Island Bog (0.3 acres)** **EIA = 4.24 (B rank)**	This Barrier Island Bog is located in an interdunal depression south of the Herring Beach parking area.
	**Cape Henlopen 2a** **Beachgrass-Panicgrass Dune Grassland (114.7 acres)** **EIA = 4.42 (AB rank)**	This occurrence of Beachgrass-Panicgrass Dune Grassland is located on dunes fronting the Atlantic Ocean from Cape Point south to Gordons Pond.
	**Cape Henlopen 2b** **Beachgrass-Panicgrass Dune Grassland (43.5 acres)** **EIA = 4.41 (AB rank)**	This occurrence of Beachgrass-Panicgrass Dune Grassland is scattered around Walking Dune in the center of Cape Henlopen State Park.

Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 3a** **Central Coast Beach Heather Dune Shrubland (0.4 acres)** **EIA = 4.02 (B rank)**	This occurrence of Central Coast Beach Heather Dune Shrubland is located between Gordon's Pond and the Atlantic Ocean southeast of Gordons Pond.
	**Cape Henlopen 3b** **Central Coast Beach Heather Dune Shrubland (1.1 acres)** **EIA = 3.5 (B rank)**	This occurrence of Central Coast Beach Heather Dune Shrubland is located on piles of sand left from the dredging of the Lewes-Rehoboth Canal and old shell mittens.
	**Cape Henlopen 3c** **Central Coast Beach Heather Dune Shrubland (0.2 acres)** **EIA = 3.24 (C rank)**	This occurrence of Central Coast Beach Heather Dune Shrubland is located on an island in the marsh just south of the Lewes-Rehoboth Canal.

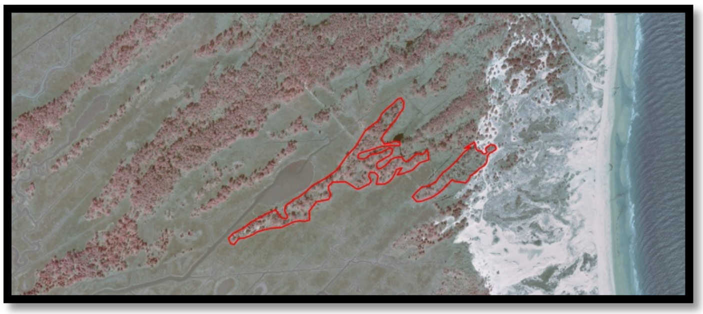
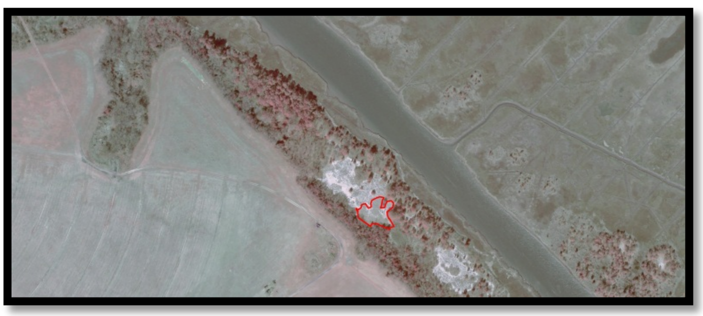
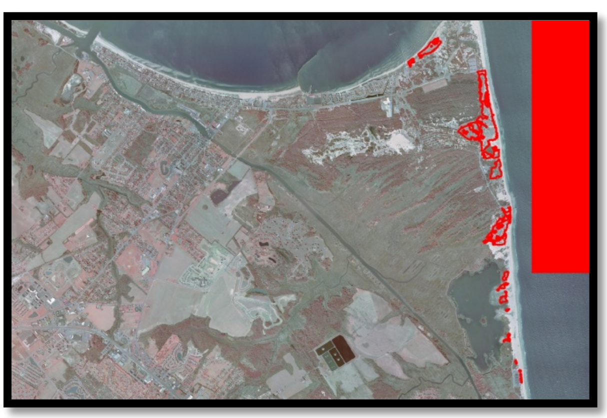
Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 3d** **Central Coast Beach Heather Dune Shrubland (41.5 acres)** **EIA = 3.84 (B rank)**	This occurrence of Central Coast Beach Heather Dune Shrubland is scattered on dunes and sand at the north end of Cape Henlopen State Park between Cape Point and Herring Point.
	**Cape Henlopen 4a** **Chesapeake Bay Maritime Shrubland (0.3 acres)** **EIA= 3.21 (C rank)**	This occurrence of Chesapeake Bay Maritime Shrubland is located around the Gordons Pond parking lot at the south entrance to the park.
	**Cape Henlopen 4b** **Chesapeake Bay Maritime Shrubland (0.8 acres)** **EIA= 4.24 (B rank)**	This occurrence of Chesapeake Bay Maritime Shrubland is located to the south of the Herring Point parking lot and north of Gordons Pond.

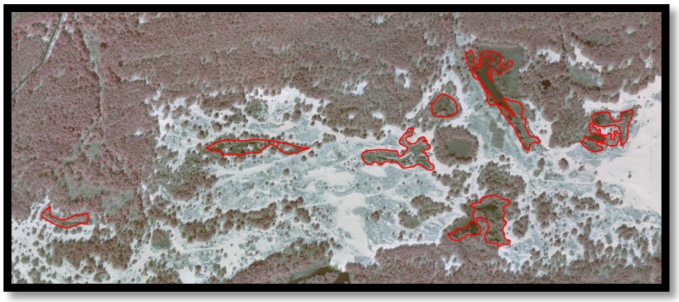
Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 4c** **Chesapeake Bay Maritime Shrubland (3.4 acres)** **EIA= 4.17 (B rank)**	This occurrence of Chesapeake Bay Maritime Shrubland is located on the north side of Cape Henlopen State Park in the Cape Point area.
	**Cape Henlopen 5a** **Chesapeake Bay Tall Maritime Shrubland (1.3 acres)** **EIA = 3.61 (B rank)**	This occurrence of Chesapeake Bay Tall Maritime Shrubland is located just south of the Biden Center.
	**Cape Henlopen 5b** **Chesapeake Bay Tall Maritime Shrubland (17.9 acres)** **EIA = 4.1 (B rank)**	This occurrence of Chesapeake Bay Tall Maritime Shrubland is in scattered locations on the north end of the park near Cape Point.

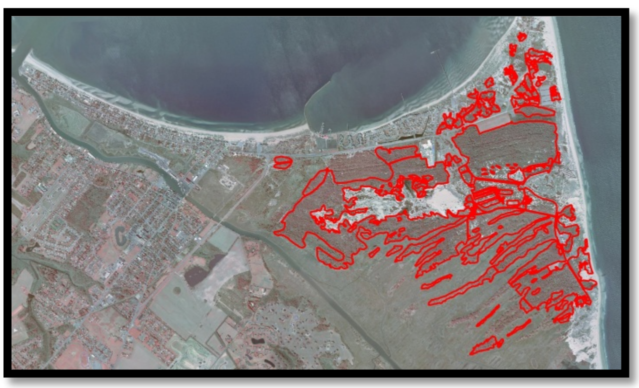
Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 6** **Coastal Plain Pond (0.6 acres)** **EIA = 4.26 (B rank)**	This occurrence of Coastal Plain Pond is located in a seasonally flooded depression south of Walking Dune.
	**Cape Henlopen 7** **Forked Rush Dune Swale (0.3 acres)** **EIA = 4.24 (B rank)**	This occurrence of Forked Rush Dune Swale is located south of the Herring Beach parking lot and north of Gordons Pond.
	**Cape Henlopen 8a** **Freshwater Tidal Woodland (9.0 acres)** **EIA = 3.83 (B rank)**	This occurrence of Freshwater Tidal Woodland is located just north of a development in the Wolfe Glade section.

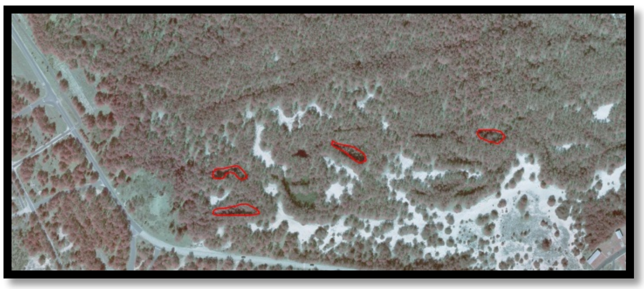
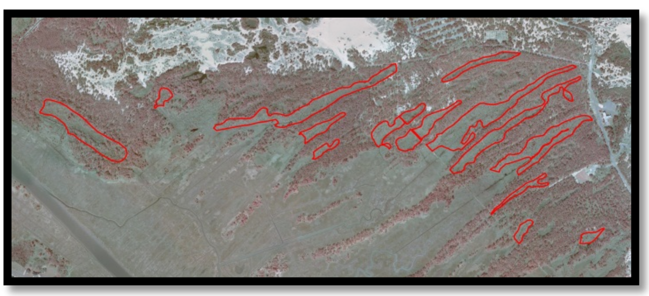
Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 8b** **Freshwater Tidal Woodland (1.6 acres)** **EIA = 3.88 (B rank)**	This occurrence of Freshwater Tidal Woodland is located on a small tributary to Wolfe Glade in the Wolfe Glade section.
	**Cape Henlopen 8c** **Freshwater Tidal Woodland (6.8 acres)** **EIA = 4.28 (B rank)**	This occurrence of Freshwater Tidal Woodland fronts the marsh just south of Walking Dune.
	**Cape Henlopen 9a** **Loblolly Pine Dune Woodland (12.5 acres)** **EIA = 4.06 (B rank)**	This occurrence of Loblolly Pine Dune Woodland is located in scattered places around and on an island in Gordons Pond.

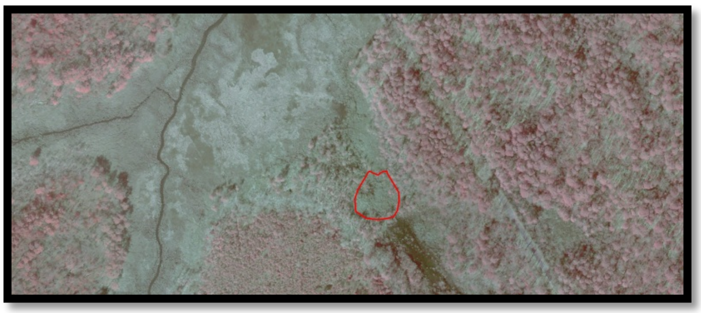
Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 9b** **Loblolly Pine Dune Woodland (6.6 acres)** **EIA = 4.37 (B rank)**	This occurrence of Loblolly Pine Dune Woodland is located on two islands in the marsh west and south of the Walking Dune.
	**Cape Henlopen 9c** **Loblolly Pine Dune Woodland (6.8 acres)** **EIA = 4.19 (B rank)**	This occurrence of Loblolly Pine Dune Woodland is located south of the ferry landing.
	**Cape Henlopen 10a** **Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland (1.3 acres)** **EIA = 4.06 (B rank)**	This occurrence of Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland is located on islands in the marsh southwest of Gordons Pond at the south end of the park.

Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 10b** **Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland (9.8 acres)** **EIA = 4.39 (B rank)**	This occurrence of Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland is located southwest of the Herring Point parking lot.
	**Cape Henlopen 11a** **Mid-Atlantic Coast Backdune Grassland (0.3 acres)** **EIA= 3.10 (C rank)**	This occurrence of Mid-Atlantic Coast Backdune Grassland is located on an old shell mitten next to the Lewes-Rehoboth Canal.
	**Cape Henlopen 11b** **Mid-Atlantic Coast Backdune Grassland (111.5 acres)** **EIA= 3.95 (B rank)**	This occurrence of Mid-Atlantic Backdune Grassland is scattered behind the primary dune between Cape Point and Gordons Pond.

Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 12** **Northern Cranberry Interdunal Swale (7.7 acres)** **EIA= 4.62 (A rank)**	This occurrence of Northern Cranberry Interdunal Swale is located in depression areas of Walking Dune and in an impounded pond.
	**Cape Henlopen 13** **Overwash Dune Grassland (3.1 acres)** **EIA = 4.28 (B rank)**	This occurrence of Overwash Dune Grassland is located between Gordons Pond and the Atlantic Ocean.
	**Cape Henlopen 14a** **Pitch Pine Dune Woodland (27 acres)** **EIA = 3.67 (B rank)**	This occurrence of Pitch Pine Dune Woodland is located south of Gordons Pond.
	**Cape Henlopen 14b** **Pitch Pine Dune Woodland (849.2 acres)** **EIA = 4.18 (B rank)**	This occurrence of Pitch Pine Dune Woodland is located between Cape Point and Herring Point.

Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 13** **Overwash Dune Grassland (3.1 acres)** **EIA = 4.28 (B rank)**	This occurrence of Overwash Dune Grassland is located between Gordons Pond and the Atlantic Ocean.
	**Cape Henlopen 14a** **Pitch Pine Dune Woodland (27 acres)** **EIA = 3.67 (B rank)**	This occurrence of Pitch Pine Dune Woodland is located south of Gordons Pond.
	**Cape Henlopen 14b** **Pitch Pine Dune Woodland (849.2 acres)** **EIA = 4.18 (B rank)**	This occurrence of Pitch Pine Dune Woodland is located between Cape Point and Herring Point.
	**Cape Henlopen 15a** **Pitch Pine Lowland (4.5 acres)** **EIA = 4.22 (B rank)**	This occurrence of Pitch Pine Lowland is located in depressions at the north end of Walking Dune.

Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 15b** **Pitch Pine Lowland (2.2 acres)** **EIA = 3.95 (B rank)**	This occurrence of Pitch Pine Lowland is located in a depression created by a ditch north of Fort Miles.
	**Cape Henlopen 16** **Pitch Pine/Cranberry Interdunal Swale (0.6 acres)** **EIA = 4.62 (A rank)**	This occurrence of Pitch Pine/Cranberry Interdunal Swale is located in depressions north of Fort Miles.
	**Cape Henlopen 17a** **Southern Red Maple-Blackgum Swamp (77.6 acres)** **EIA = 4.2 (B rank)**	This occurrence of Southern Red Maple-Blackgum Swamp is located in low drainages between "pine peninsulas" west of the road going to Herring Point.
	**Cape Henlopen 17b** **Southern Red Maple-Blackgum Swamp (72.7 acres)** **EIA = 3.67 (B rank)**	This occurrence of Southern Red Maple-Blackgum Swamp is located at the upper ends of tributaries west of Lewes-Rehoboth Canal.

Community Map	Community Name/EIA Score	Description
	**Cape Henlopen 18a** **Wax-Myrtle Shrub Swamp (1.1 acres)** **EIA = 3.66 (B rank)**	This occurrence of Wax-Myrtle Shrub Swamp is located northwest of Gordons Pond.
	**Cape Henlopen 18b** **Wax-Myrtle Shrub Swamp (0.4 acres)** **EIA = 4.14 (B rank)**	This occurrence of Wax-Myrtle Shrub Swamp is located at the upper end of a tributary to Wolfe Glade and downstream of a former sea level fen.
	**Cape Henlopen 18c** **Wax-Myrtle Shrub Swamp (6.1 acres)** **EIA = 3.73 (B rank)**	This occurrence of Wax-Myrtle Shrub Swamp is located southeast of Gordons Pond near the south entrance.

Forest Block Analysis

Importance of Forest Blocks

Forest blocks are important for a number of animals such as bobcat and neo-tropical migratory birds which nest in forest interiors (those places that are 100 meters from the edge of a forest). Many neotropical migratory birds are considered to be breeders in forest interior areas. Due to development, road building, which causes fragmentation, agricultural fields and other non-forest land uses, habitats for these birds are increasingly being eliminated leading to reductions in populations. Predators are better able to get the birds in small woodlands and edge habitats. In Ontario it was found that 80% of the neo-tropical bird nests in small woodlands (<100 ha) were lost to predators[38]. Nests in interior forests are less susceptible to predation and are not taken over by cowbirds, which is another hazard on edge habitats. Examples of birds that may be affected by a lack of large forest tracts include Barred Owl, Black and White Warbler, Worm-Eating Warbler, Acadian Flycatcher, Ovenbird, Kentucky Warbler, Red-Shouldered Hawk and many others.

Management of state parks has traditionally favored recreational uses, which require cultivated lawns and edges running counter to the habitat needed for forest interior birds. Protecting forest interior birds runs contrary to the idea that artificially created edges creates more diversity. While this technique creates more diversity of some aggressive species it diminishes the populations of other species.

In protecting forest blocks, those blocks which are circular contain the most interior area per unit area. The next best shape is a square and linear configurations produce the least forest interior due to shape.

A study by Robbins et al. (1989) showed that most forest interior species require a forest of at least 150 ha (370 acres) in size. Very few forest tracts in Delaware are at least this size, one of the more notable being the Great Cypress Swamp.

Analysis of Forest Blocks at Cape Henlopen State Park

Six forest blocks are present that are more than 100 acres in size and are located in whole or part in the state park (Table 2.4 and Figure 2.8). All forest blocks are bounded by a road, agricultural field, or other non-forested habitat. These areas are considered to be barriers to the passage of forest dwelling wildlife. Descriptions are provided for each forest block.

[38] Ontario Landowner Resource Centre. 2000. Conserving the Forest Interior: A threatened wildlife habitat. Ontario Ministry of Natural Resources.

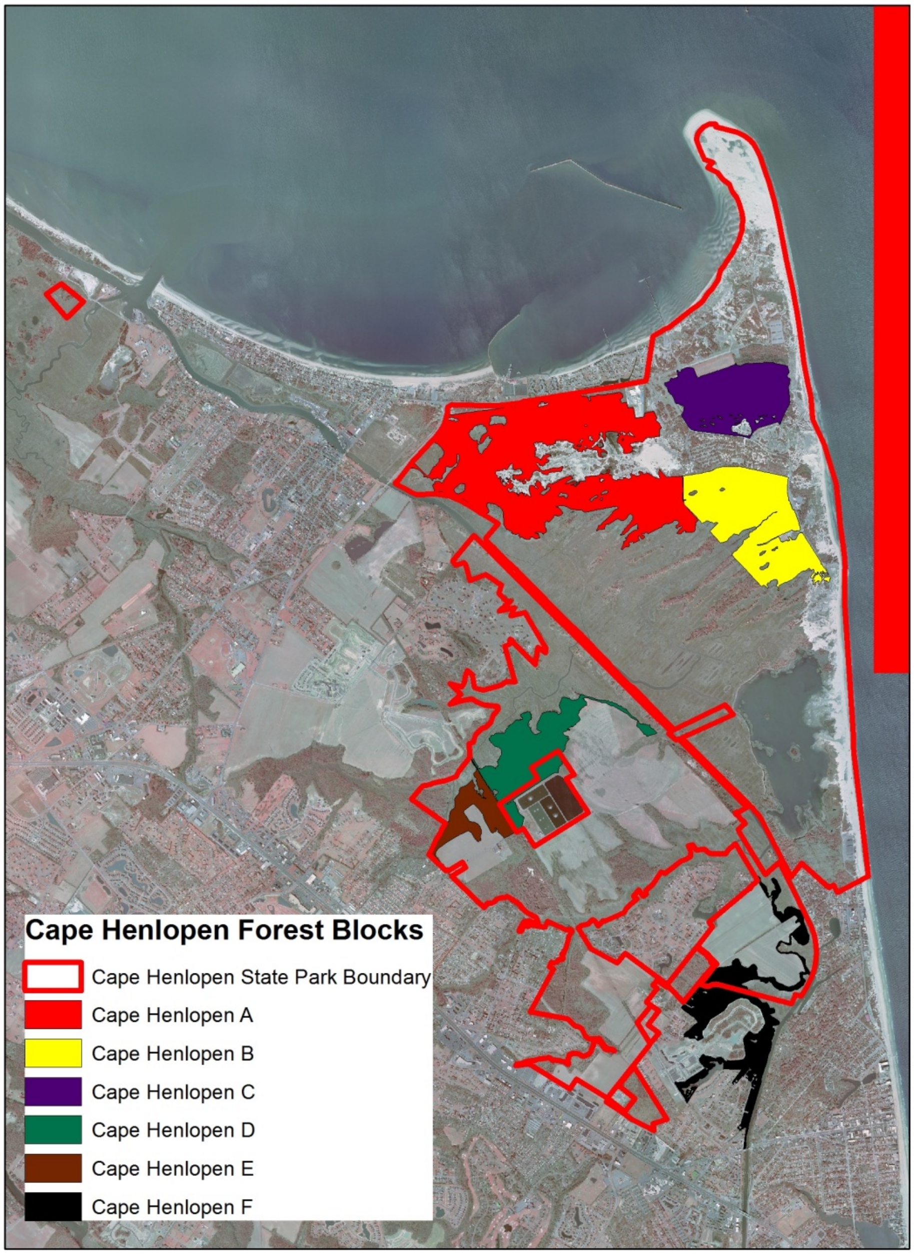


Figure 2.8. Forest Blocks in Cape Henlopen State Park

Table 2.4. Forest Blocks located in whole or part in Cape Henlopen State Park

Forest Block Map	Block Name/Acreage	Description
	**Cape Henlopen A** **Current Block = 492 acres (111 acres interior)** **Potential Block = 934 acres (575 acres interior)**	Cape Henlopen A covers the western end of Great Dune. It is bounded by US 9 on the west, Cape Henlopen Drive on the north, developed area and Walking Dune Trail on the east, and salt marsh on the south. Five vegetation communities are located within this block and include Freshwater Tidal Woodland, Loblolly Pine Dune Woodland, Northeastern Modified Successional Forest, Pitch Pine Dune Woodland, and Southern Red Maple-Blackgum Swamp. Lewes-Rehoboth Canal is the drainage for this block. Currently this block contains 111 acres of interior habitat. Potentially this block could be 934 acres in size and contain 575 acres of interior habitat. Cape Henlopen A shares a potential forest block with Cape Henlopen B.
	**Cape Henlopen B** **Current Block = 224 acres (56 acres interior)** **Potential Block = 934 acres (575 acres interior)**	Cape Henlopen B covers the woodland and forest east of Walking Dune Trail, which is a former access road for the army. It is bounded on the north by a road just south of the campground, on the east by Dune Road, on the south by Walking Dune Trail and salt marsh, and on the west by Walking Dune Trail. Two vegetation communities are located within this block and include Pitch Pine Dune Woodland and Southern Red Maple-Blackgum Swamp. Lewes-Rehoboth Canal is the drainage for this block. Currently this block contains 56 acres of interior habitat. Potentially this block could be 934 acres in size and contain 575 acres of interior habitat. Cape Henlopen B shares a potential forest block with Cape Henlopen A.

Forest Block Map	Block Name/Acreage	Description
	**Cape Henlopen C** **Current Block = 158 acres (60 acres interior)** **Potential Block = 205 acres (121 acres interior)**	Cape Henlopen C is located at the northeast end of Cape Henlopen State Park south of Cape Point. It is bounded by Dune Road and Fort Miles on the south, Post Lane on the north and east, Dune Road on the west. One vegetation community, Pitch Pine Dune Woodland is located within this block. This black is drained by the Atlantic Ocean via a ditch. Currently this block contains 60 acres of interior habitat. Potentially this block could be 205 acres in size and contain 121 acres of interior habitat.
	**Cape Henlopen D** **Current Block = 142 acres (39 acres interior)** **Potential Block = 1,247 acres (593 acres interior)**	Cape Henlopen D is located at the north end of Wolfe Neck east of Breakwater and Junction Trail. It is bounded on the north by Wolfe Glade, east by agricultural field, south by a spray irrigation facility and agricultural field, and on the west by the Junction and Breakwater Trail. Four vegetation communities are located within this block and include Early to Mid-Successional Loblolly Pine Forest, Mid to Late Successional Loblolly Pine-Sweetgum Forest, Southern Red Maple-Blackgum Swamp, and Southern Red Oak/Heath Forest. Lewes-Rehoboth Canal drains this block. Currently this block contains 39 acres of interior habitat. Potentially this block could be 1,247 acres in size and contain 593 acres of interior habitat. Cape Henlopen D shares a potential forest block with Cape Henlopen E.

<table>
<tr><th>Forest Block Map</th><th>Block Name/Acreage</th><th>Description</th></tr>
<tr><td></td><td>Cape Henlopen E

Current Block =
59 acres
(0 acres interior)

Potential Block =
1,247 acres
(593 acres interior)</td><td>Cape Henlopen E is located at the north end of Wolfe Neck west of the Junction and Breakwater Trail. It is bounded by Wolfe Glade on the north, Junction and Breakwater Trail on the east, Wolfe Neck Road and agricultural field on the south, and Wolfe Glade on the west. Four vegetation communities are located within this block and include Early to Mid-Successional Loblolly Pine Forest, Freshwater Tidal Woodland, Southern Red Maple-Blackgum Swamp, Successional Tuliptree Forest. Wolfe Glade which runs into Lewes and Rehoboth Canal is the main drainage for the block. Currently this block contains no interior habitat. Potentially this block could be 1,247 acres in size, and contain 593 acres of interior habitat. Cape Henlopen E shares a potential forest block with Cape Henlopen D.</td></tr>
<tr><td></td><td>Cape Henlopen F

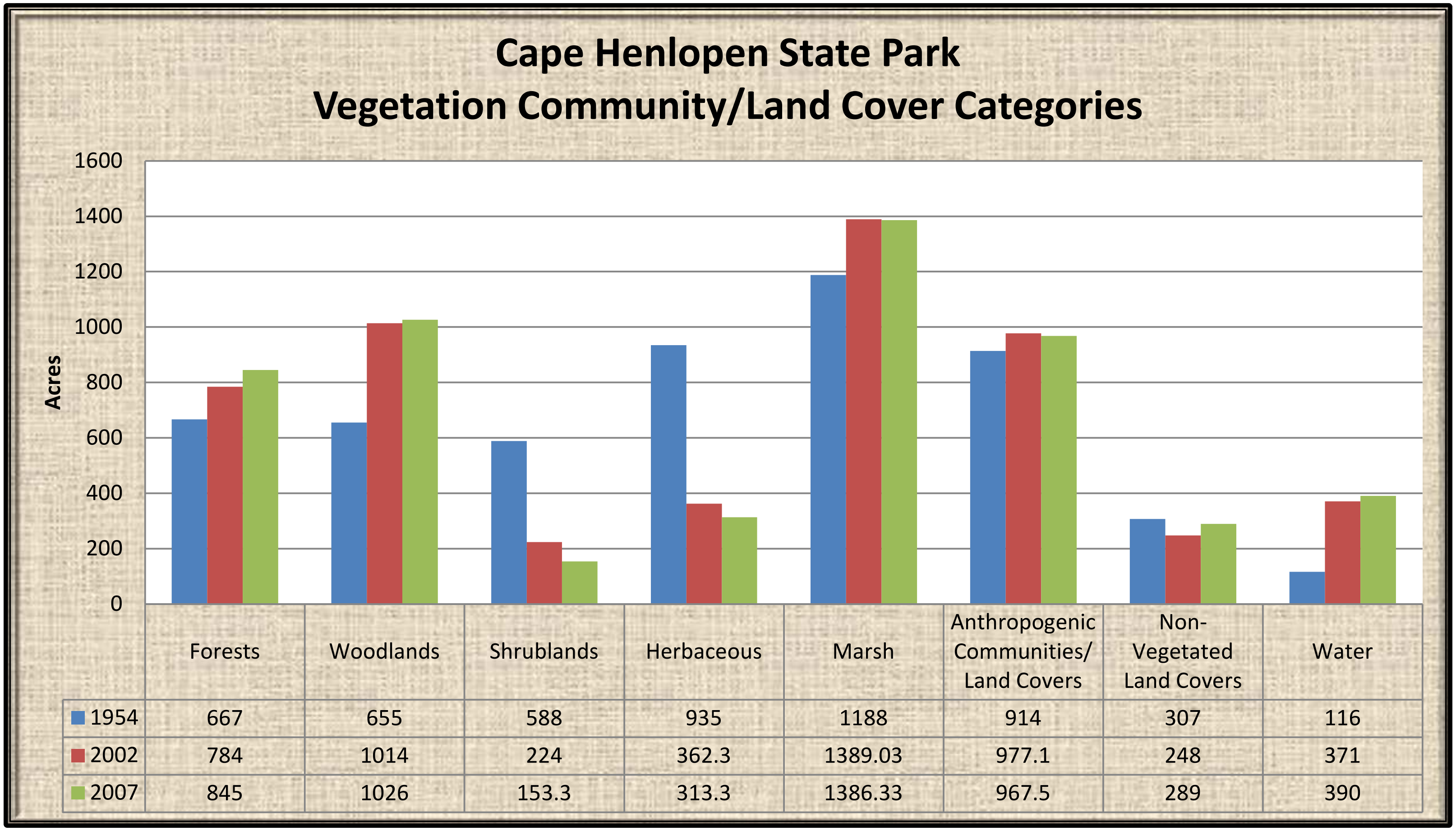
Current Block=
155 acres
(1 acre interior)

Potential Block=
350 acres
(254 acres interior)</td><td>Cape Henlopen F is located north of Holland Glade. This block bounded by development and salt marsh on the north, salt marsh on the east, development on the south, and Road 273 on the west. Seven vegetation communities are located this block and include Early to Mid-Successional Loblolly Pine Forest, Freshwater Tidal Woodland, Mid to Late Successional Loblolly Pine-Sweetgum Forest, Northeastern Modified Successional Forest, Southern Red Maple-Blackgum Swamp, Southern Red Oak/Heath Forest, and Successional Maritime Forest. The Lewes and Rehoboth Canal is the major drainage for this block. Currently this block contains 1 acre of interior habitat. Potentially this block could be 350 acres in size and contain 254 acres of interior habitat.</td></tr>
</table>

The Natural Progression of vegetation communities on the shores of the Cape Henlopen Area

Vegetation communities located adjacent to the shore of Delaware Bay or the Inland Bays go through natural progression of retreating backwards as sea level rises. For centuries this has meant that as sea level rises the forested communities will progress into shrubland, the shrubland will progress into marsh, and then the marsh will convert to open water, perhaps with a brief period as a mudflat. Further gradations can be noticed via different forests, shrublands, and marshes (high and low), and can be used to map out the effects of sea level rise and increasing salinity in the area. In the recent past (70 years) this natural progression appears to be eroding because of sea levels which are rising too fast for the natural progression to continue. In addition some communities reach a hardened shoreline, rip-rap or some other artificial barrier which prevents the progression.

The amount of North Atlantic High Salt Marsh has decreased markedly from 1954 levels and has converted largely to North Atlantic Low Salt Marsh. Marsh ditching conducted in the early to middle part of the 20th century is helping to convert more marsh to water by acting as a direct injection mechanism into the marsh for high water events and for sea level rise.



	Forests	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/ Land Covers	Non-Vegetated Land Covers	Water
1954	667	655	588	935	1188	914	307	116
2002	784	1014	224	362.3	1389.03	977.1	248	371
2007	845	1026	153.3	313.3	1386.33	967.5	289	390

Figure 3.1. Cape Henlopen State Park Vegetation Categories/Land Covers (1954, 2002, and 2007)

Cape Henlopen State Park Broad Trends (Figure 3.1): Most of Cape Henlopen State Park is covered in marshland followed by woodland. Anthropogenic communities in the form of agricultural fields come in a close third. Forest area has been gaining ground as former fields succeed into more mature communities.

DNREC Sea Level Rise Analysis (Table 3.1)

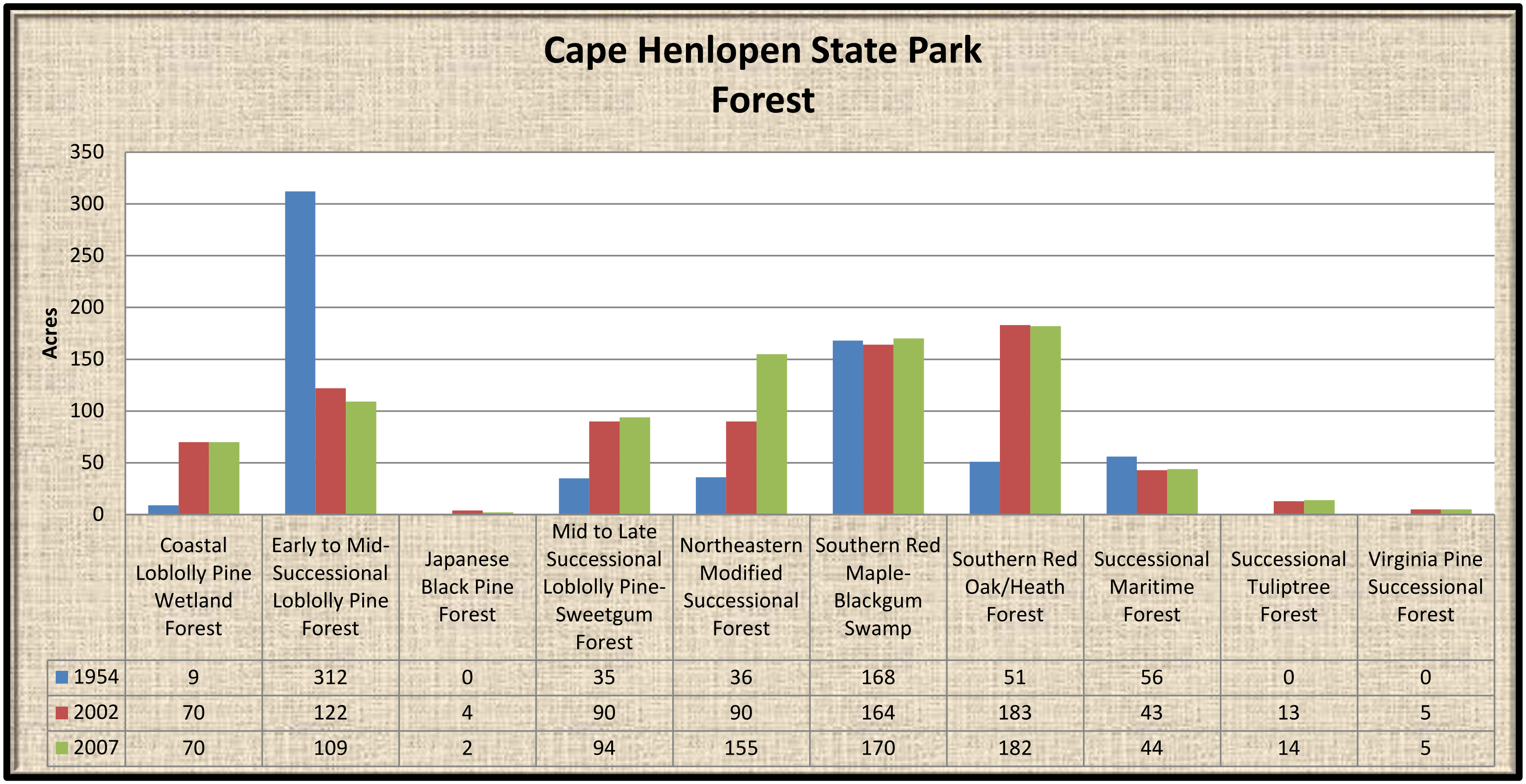
Almost half of Cape Henlopen State Park will be flooded with 0.5 m of sea level rise. About 65% will be inundated with 1.5 m of sea level rise.

Table 3.1. Projected acres of Cape Henlopen State Park Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	2,417 acres
1 m	3,071 acres
1.5 m	3,512 acres

Natural Capital (Table 3.2)

The capital value of Cape Henlopen State Park has gradually been going up as woodland and water cover increases.

Table 3.2. Natural Capital of Cape Henlopen State Park	
Year	**Natural Capital (in 2012 dollars)**
1954	$13,325,096/year
2002	$15,019,759/year
2007	$15,050,926/year



	Coastal Loblolly Pine Wetland Forest	Early to Mid-Successional Loblolly Pine Forest	Japanese Black Pine Forest	Mid to Late Successional Loblolly Pine-Sweetgum Forest	Northeastern Modified Successional Forest	Southern Red Maple-Blackgum Swamp	Southern Red Oak/Heath Forest	Successional Maritime Forest	Successional Tuliptree Forest	Virginia Pine Successional Forest
1954	9	312	0	35	36	168	51	56	0	0
2002	70	122	4	90	90	164	183	43	13	5
2007	70	109	2	94	155	170	182	44	14	5

Figure 3.2. Forest at Cape Henlopen State Park (1954, 2002, and 2007)

Cape Henlopen State Park Forest (Figure 3.2): Southern Red Oak/Heath Forest found in the westerns sections (Holland Glade and Wolfe Neck) is the most common forest type in the park. Southern Red Maple-Blackgum Swamp found in between fingers of Pitch Pine Dune Woodland follows a close second, with Northeastern Modified Successional Forest coming in third. Early to Mid-Successional Loblolly Pine Forest has been declining the park as this community succeeds to more mature community types such as Southern Red Oak/Heath Forest.

DNREC Sea Level Rise Analysis (Table 3.3)

A little more than half of the forestland at Cape Henlopen State Park will be flooded with 1.5 m of sea level rise.

Table 3.3. Projected acres of Cape Henlopen State Park Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	236 acres
1 m	355 acres
1.5 m	442 acres

Natural Capital (Table 3.4)

The capitalization of forestland has been increasing with its acreage through the years as it repopulates former bare sand areas.

Table 3.4. Natural Capital of Cape Henlopen State Park Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$2,170,301/year
2002	$3,435,380/year
2007	$3,506,462/year

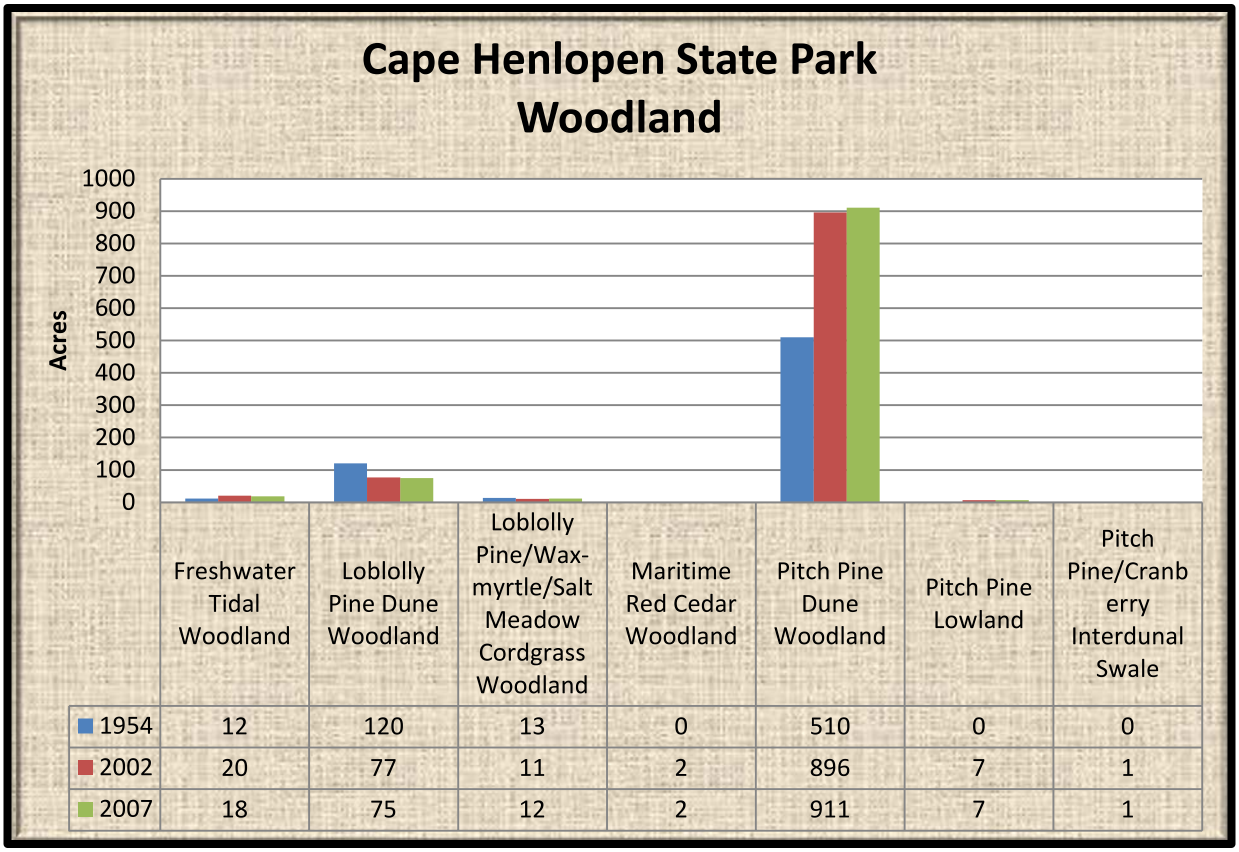


Figure 3.3. Woodland at Cape Henlopen State Park(1954, 2002, and 2007)

Cape Henlopen State Park Woodland (Figure 3.3): Pitch Pine Dune Woodland is by far the most common woodland in the park and found mostly in the Great Dune Section. The next most common is woodland is Loblolly Pine Dune Woodland found in the Gordons Pond Section. All other woodlands are fairly minor in area.

DNREC Sea Level Rise Analysis (Table 3.5)

A little more than ¾ of the current woodland in the park will be inundated with 1.5 m of sea level rise.

Table 3.5. Projected acres of Cape Henlopen State Park Woodland Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	308 acres
1 m	645 acres
1.5 m	799 acres

Natural Capital (Table 3.6)

The capitalization of woodland has increased overall since 1954 with a decrease in the 2002 to 2007 period.

Table 3.6. Natural Capital of Cape Henlopen State Park Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$426,421/year
2002	$676,411/year
2007	$653,530/year

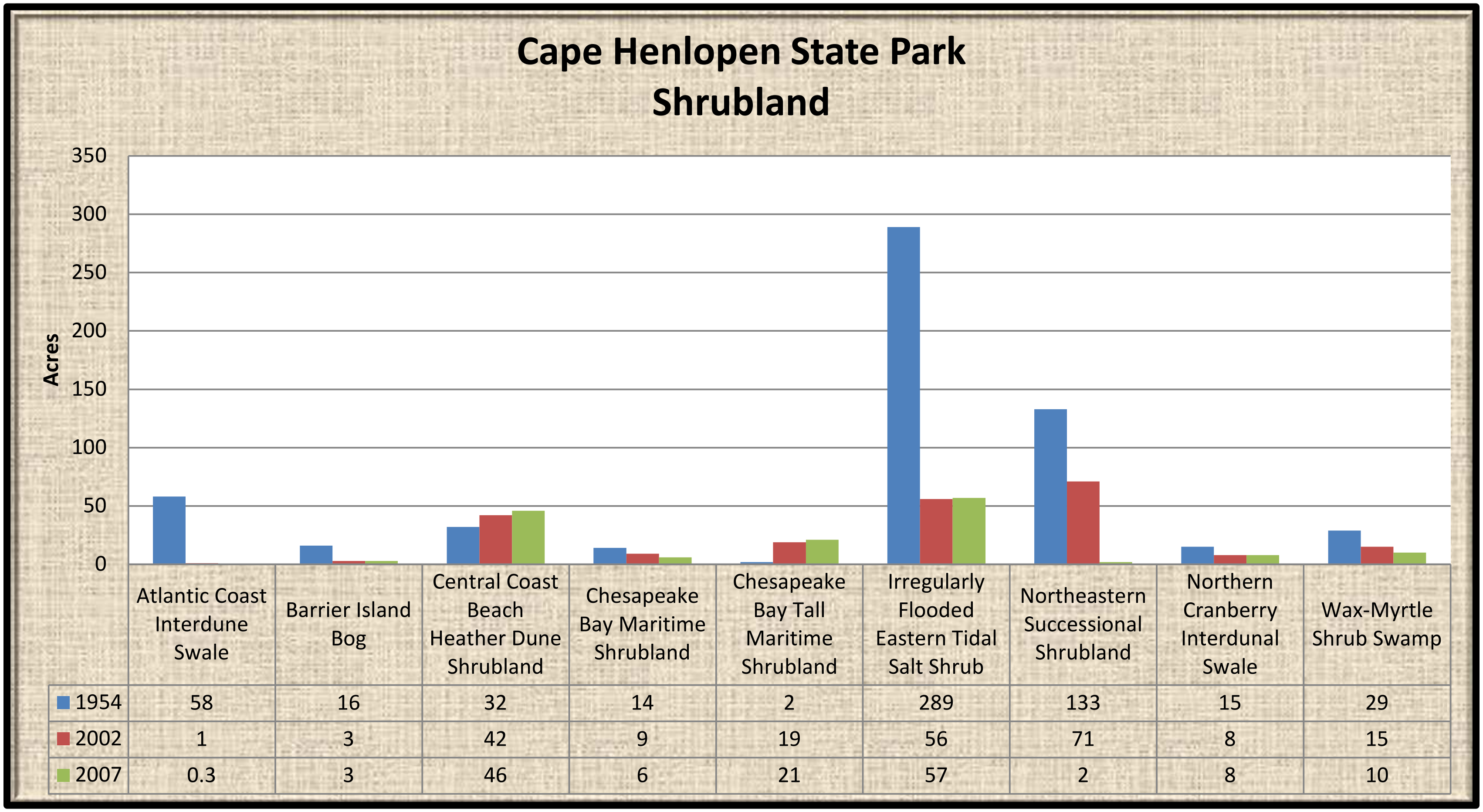


Figure 3.4. Shrubland at Cape Henlopen State Park (1954, 2002, and 2007)

Cape Henlopen State Park Shrubland (Figure 3.4): Irregularly Flooded Eastern Tidal Salt Shrub is the most common shrubland with Central Coast Beach Heather Dune Shrubland following in second. Chesapeake Bay Tall Maritime Shrubland comes in third and this occurrence is the second largest known in the state.

DNREC Sea Level Rise Analysis (Table 3.7)

A little less than ¾ of the shrubland at Cape Henlopen State Park will be inundated with 1.5 m of sea level rise.

Table 3.7. Projected acres of Cape Henlopen State Park Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	67 acres
1 m	88 acres
1.5 m	110 acres

Natural Capital (Table 3.8)

Capital in shrubland has greatly decreased with losses in Irregularly Flooded Eastern Tidal Salt Shrub and Barrier Island Bog.

Table 3.8. Natural Capital of Cape Henlopen State Park Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$2,146,781/year
2002	$229,857/year
2007	$226,327/year

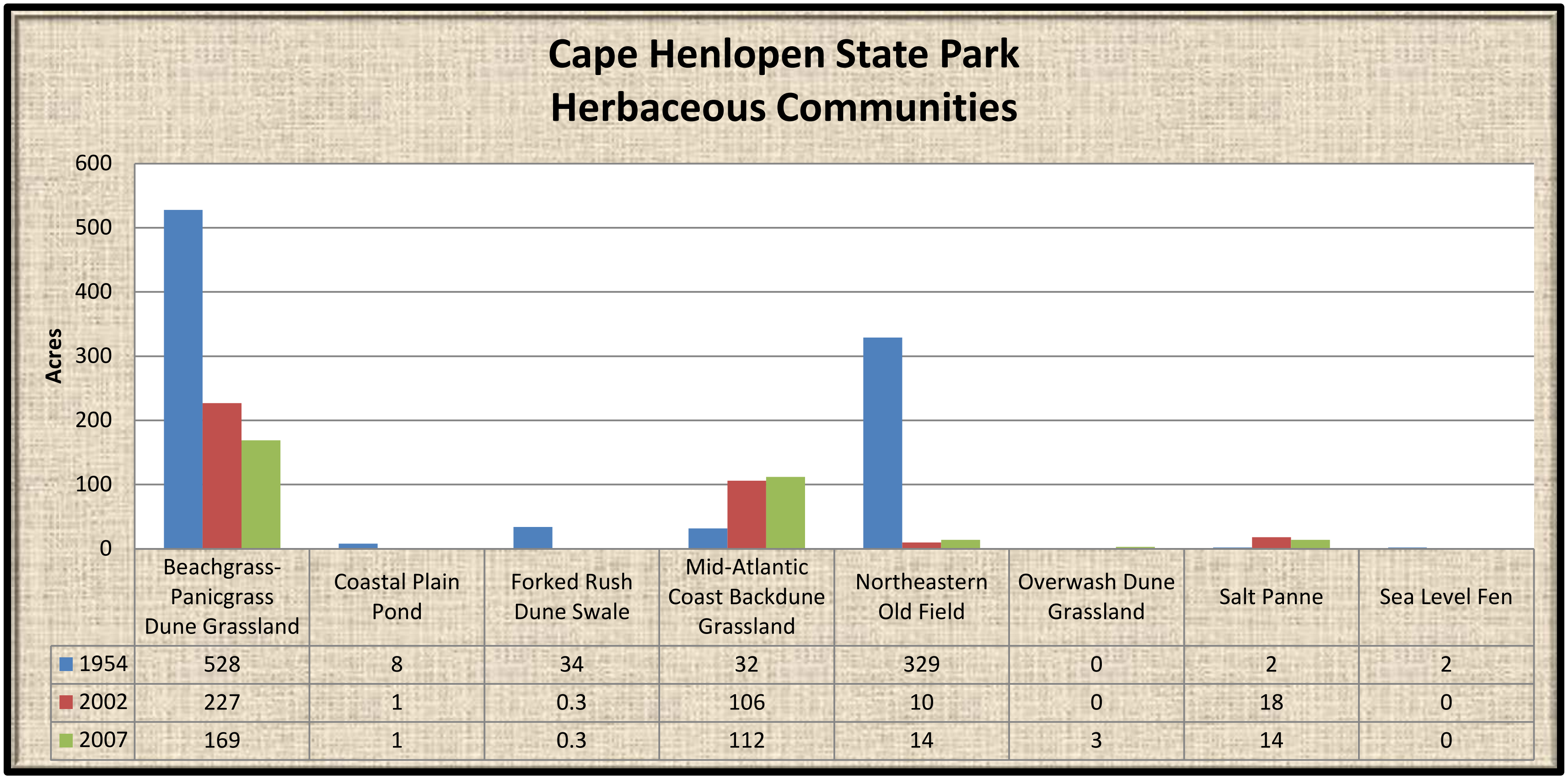


Figure 3.5. Herbaceous Communities at Cape Henlopen State Park (1954, 2002, and 2007)

Cape Henlopen State Park Herbaceous Communities (Figure 3.5): Beachgrass-Panicgrass Dune Grassland and the related Mid-Atlantic Coast Backdune Grassland are the most common herbaceous communities in the park. The others are fairly minor in area.

DNREC Sea Level Rise Analysis (Table 3.9)

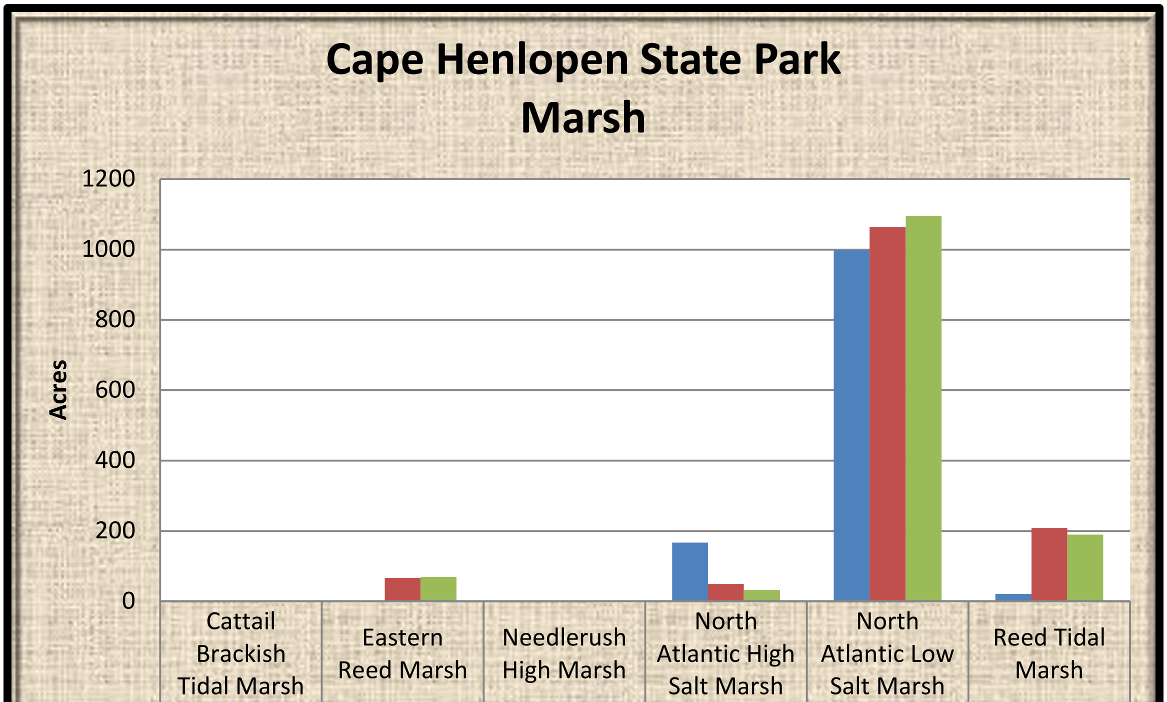
About 41% of the herbaceous communities in the park will be flooded with 1.5 m of sea level rise. Only about 7% will be flooded with 0.5 m of rise.

Table 3.9. Projected acres of Cape Henlopen State Park Herbaceous Communities Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	23 acres
1 m	66 acres
1.5 m	130 acres

Natural Capital (Table 3.10)

Capital in herbaceous communities has been going down with losses in Beachgrass-Panicgrass Dune Grassland and succession of Northeastern Old Field.

Table 3.10. Natural Capital of Cape Henlopen State Park Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$274,918/year
2002	$162,864/year
2007	$131,266/year



	Cattail Brackish Tidal Marsh	Eastern Reed Marsh	Needlerush High Marsh	North Atlantic High Salt Marsh	North Atlantic Low Salt Marsh	Reed Tidal Marsh
1954	0	1	0	167	999	21
2002	1	67	0.03	49	1063	209
2007	0.3	69	0.03	32	1095	190

Figure 3.7. Marsh at Cape Henlopen State Park (1954, 2002, and 2007)

Cape Henlopen State Park Marsh (Figure 3.7): North Atlantic Low Salt Marsh is by far the most common marsh with Reed Tidal Marsh following a distant second. North Atlantic High Salt Marsh is the third most common marsh and has suffers significant declines.

DNREC Sea Level Rise Analysis (Table 3.11)

About 95% of the marshland in the park will be flooded with 0.5 m of rise. An additional 1 m of rise brings the figure to 98%.

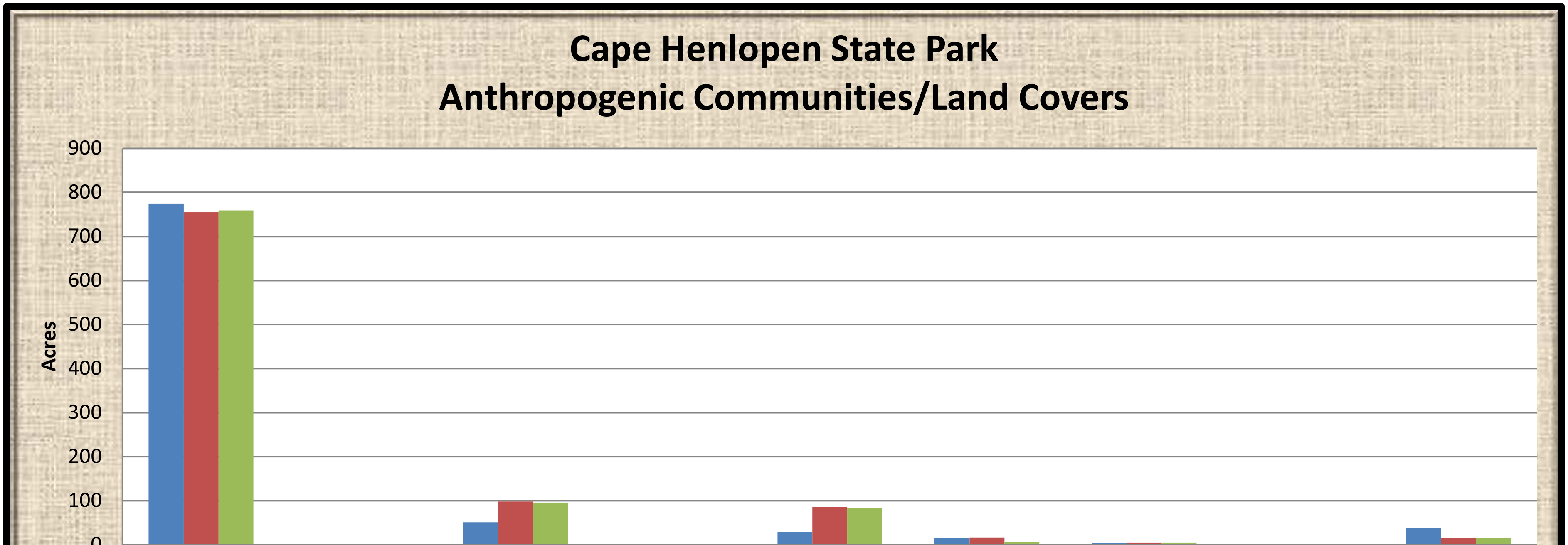
Table 3.11. Projected acres of Cape Henlopen State Park Marsh Inundated by Sea Level Rise

Rise	Acres
0.5 m	1,320 acres
1 m	1,351 acres
1.5 m	1,363 acres

Natural Capital (Table 3.12)

Capitalization of marshland has increased overall since 1954, but has decreased in the 2002 to 2007 period, likely because of declines in North Atlantic High Salt Marsh.

Table 3.12. Natural Capital of Cape Henlopen State Park Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$7,459,586/year
2002	$8,913,955/year
2007	$8,897,022/year



	Agricultural Field	Clear-cut	Cultivated Lawn	Farm Pond/Artificial Pond	Impervious Surface	Modified Land	Powerline R-O-W	Riprap	Semi-impervious Surface
1954	775	0	51	0	29	16	4	0	39
2002	755	0	98	1	86	17	5	0.1	15
2007	759	0.4	96	1	83	7	5	0.1	16

Figure 3.8. Anthropogenic Communities at Cape Henlopen State Park (1954, 2002, and 2007)

Cape Henlopen State Park Anthropogenic Communities/Land Covers (Figure 3.8): Agricultural field is the most common anthropogenic community and is found in the western sections (Holland Glade and Wolfe Neck) of the park. Cultivated Lawn and the related impervious surface makes up a fairly significant part of the anthropogenic communities present at Cape Henlopen State Park.

DNREC Sea Level Rise Analysis (Table 3.13)

Relatively little of the anthropogenic community/land covers in the park will be impacted by even 1.5 m of sea level rise (13%).

Table 3.13. Projected acres of Cape Henlopen State Park Anthropogenic Communities/Land Covers Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	10 acres
1 m	61 acres
1.5 m	125 acres

Natural Capital (Table 3.14)

Agricultural fields and Farm Pond/Artificial Ponds are the only anthropogenic communities/land covers with any capital value. While the agricultural fields have decreased a pond has been developed which increased the capital. However the amount is declining in 2002 to 2007 period with reduction in agricultural fields.

Table 3.14. Natural Capital of Cape Henlopen State Park Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1954	$44,504/year
2002	$48,790/year
2007	$49,077/year

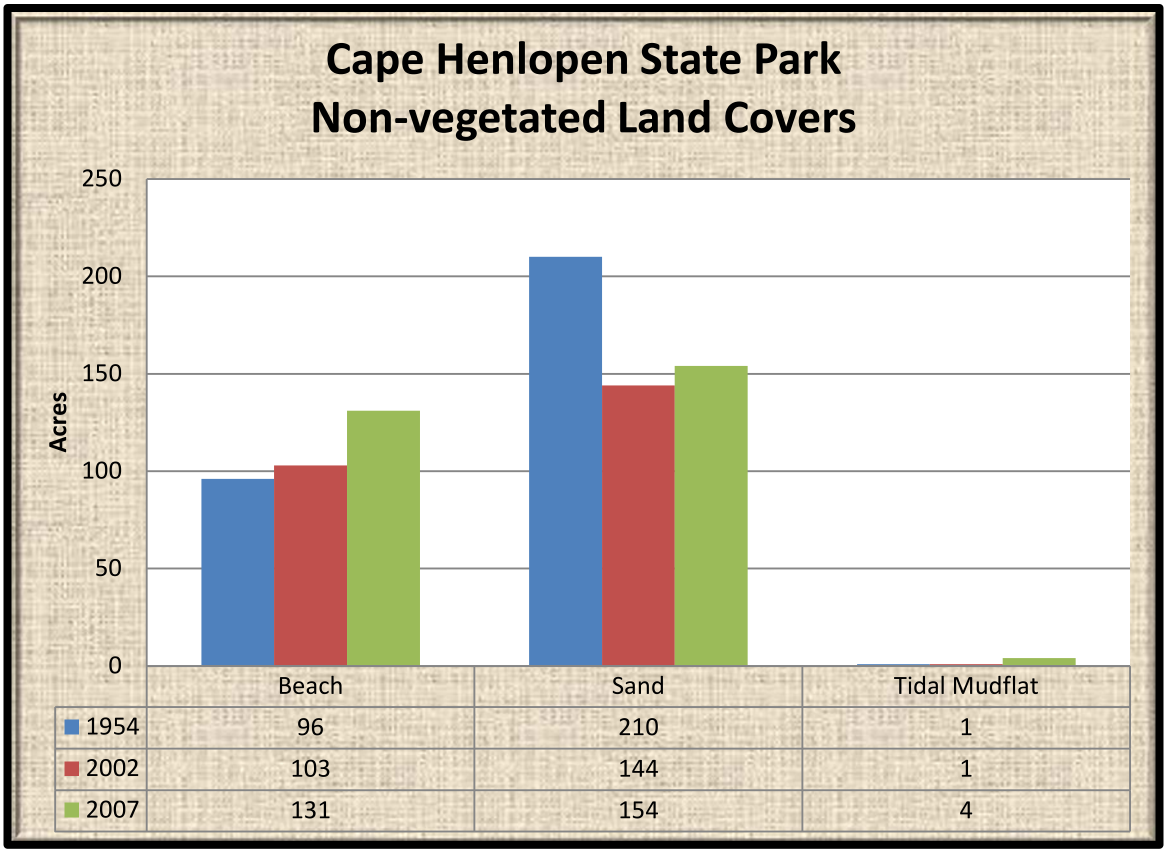


Figure 3.9. Non-vegetated Land Covers at Cape Henlopen State Park (1954, 2002, and 2007)

Cape Henlopen State Park Non-vegetated Land Covers (Figure 3.9): Sand and the related beach immediate to the water are the most common non-vegetated communities.

DNREC Sea Level Rise Analysis (Table 3.15)

A little more 50% of the Non-vegetated land covers will be inundated with 1.5 m of sea level rise.

Table 3.15. Projected acres of Cape Henlopen State Park Non-vegetation Land Covers Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	65 acres
1 m	115 acres
1.5 m	155 acres

Natural Capital (Table 3.16)

Capital of non-vegetated land covers in Cape Henlopen State Park has increased with increasing acreage in tidal mudflats, which is the only land cover with capital value.

Table 3.16. Natural Capital of Cape Henlopen State Park Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1954	$6,271/year
2002	$7,526/year
2007	$25,085/year

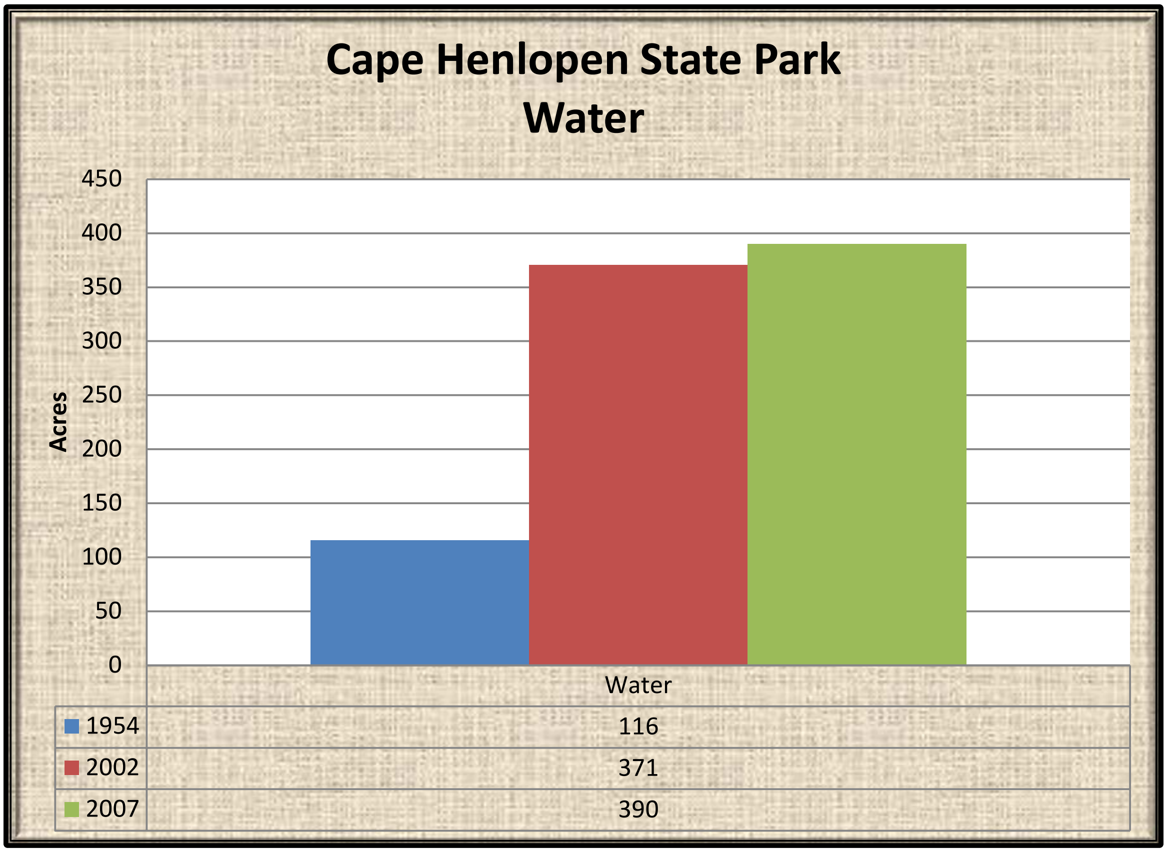


Figure 3.10. Water coverage (non-impoundment) at Cape Henlopen State Park (1954, 2002, and 2007)

Cape Henlopen State Park Water (Figure 3.10): Water has been increasing overall in the park and experienced a significant surge in the 1954-2002 as Gordons Pond filled with water.

Natural Capital (Table 3.17)

Water has been increasing with sea level rise and as a result has increased the capital.

Table 3.7. Natural Capital of Cape Henlopen State Park Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$728,336/year
2002	$1,535,696/year
2007	$1,552,874/year

CHAPTER 4: VEGETATION COMMUNITIES BY SECTION

1. Cape Point Section

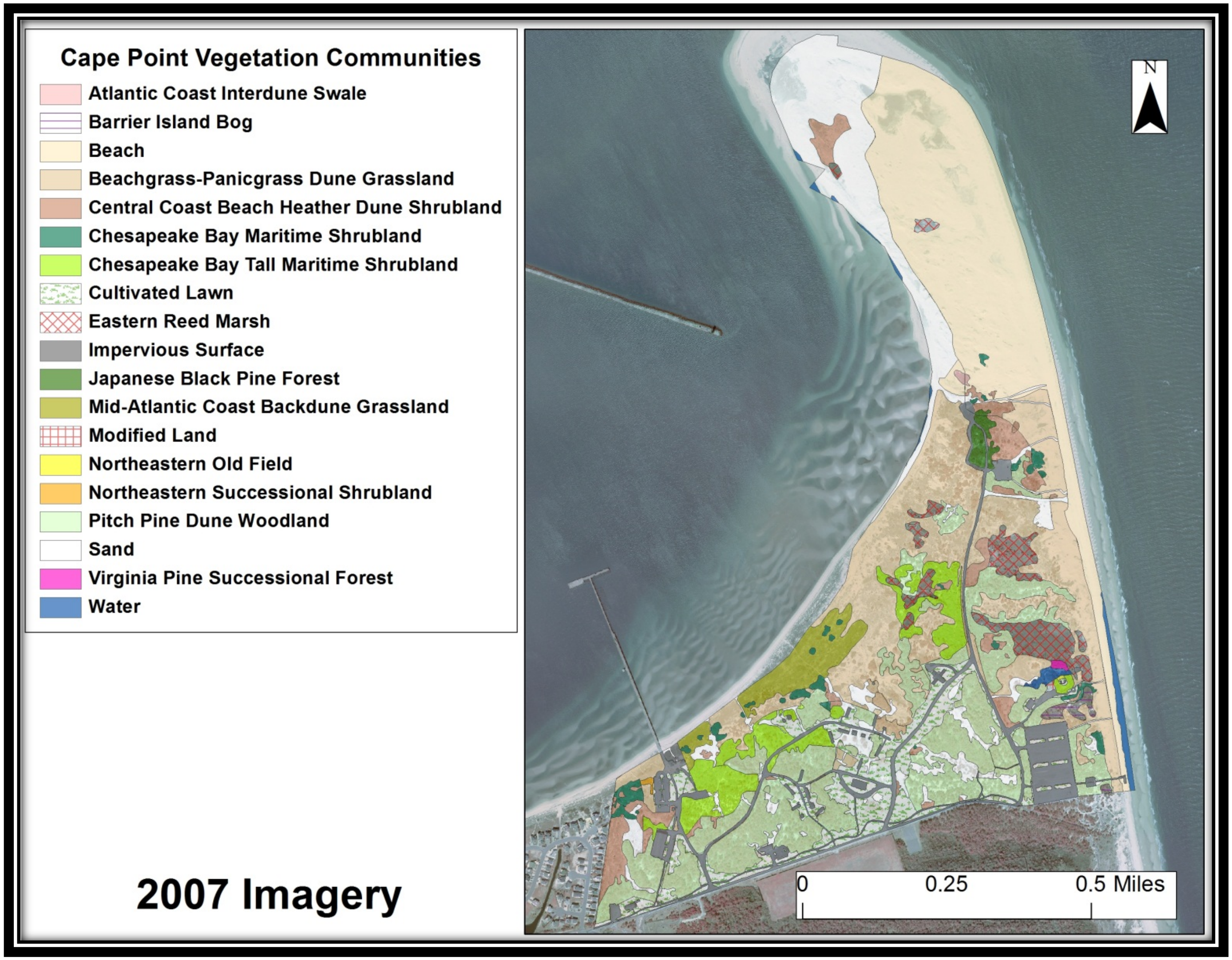


Figure 4-1.1. 2007 Vegetation Community map of Cape Point Section

Figure 4-1.2. 2002 Vegetation Community map of Cape Point Section

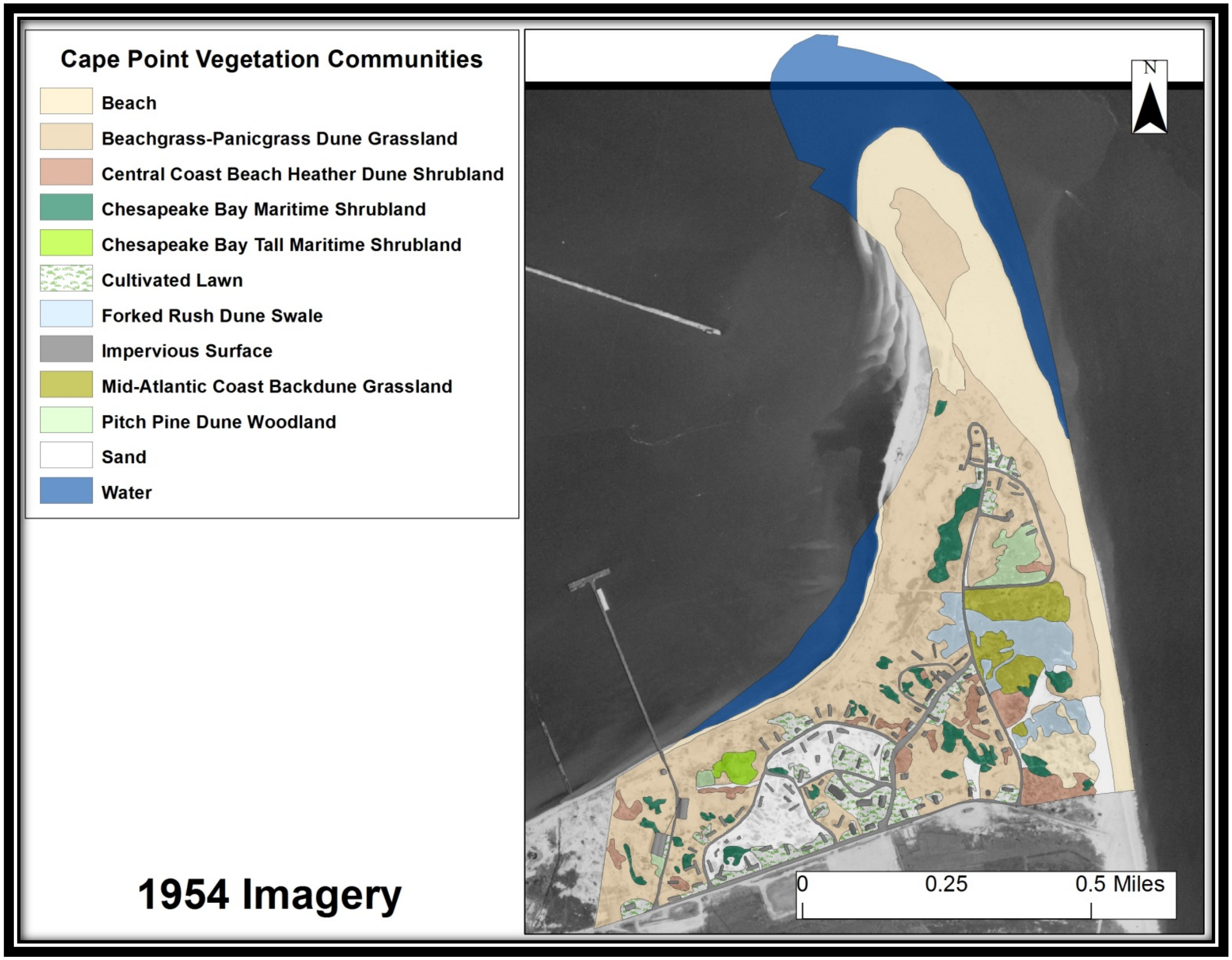
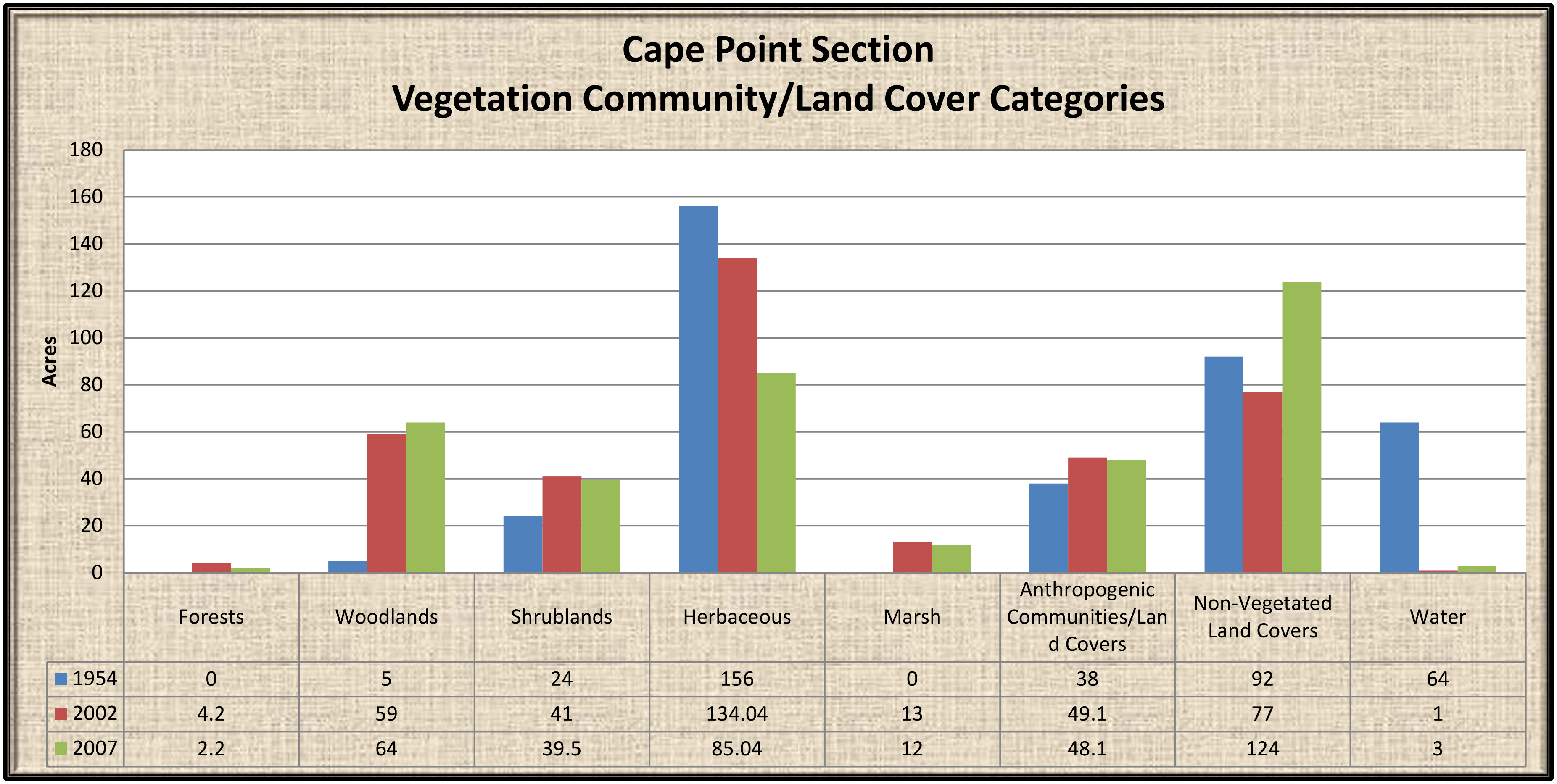


Figure 4-1.3. 1954 Vegetation Community map of Cape Point Section



	Forests	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1954	0	5	24	156	0	38	92	64
2002	4.2	59	41	134.04	13	49.1	77	1
2007	2.2	64	39.5	85.04	12	48.1	124	3

Figure 4-1.4. Cape Point Section Vegetation Categories/Land Covers (1954, 2002, and 2007)

Cape Point Section Broad Trends (Figure 4-1.4): Because of its proximity and exposure to the bay and ocean, the Cape Point Section is composed mainly of herbaceous communities (grasslands) and non-vegetated land covers (sand and beach). In 1954 the herbaceous communities were more common owing to the use of the military. Since this time some of the open areas have succeeded into forests and woodlands. Some of the water coverage that was present in 1954 has been filled by sand from further south as the point is more developed and larger than it was in 1954. Part of this increase may be due to sand re-nourishment projects in areas to the south such as Rehoboth Beach.

DNREC Sea Level Rise Analysis (Table 4-1.1)

A lot of the Cape Point area is composed of raised sand dunes that tower above the ocean and bay. At 0.5 m of sea level rise, only 21 acres of this section will be inundated. An additional 0.5 m of rise will flood 90 more acres and 1.5 m will inundate a little more than half of the section.

Table 4-1.1. Projected acres of the Cape Point Section Inundated by Sea Level Rise

Rise	Acres
0.5 m	21 acres
1 m	111 acres
1.5 m	230 acres

Natural Capital (Table 4-1.2)

The capitalization of woodland has consistently been transferred to other communities as the amount of woodland has gone down.

Table 4-1.2. Natural Capital of the Cape Point Section

Year	Natural Capital (in 2012 dollars)
1954	$156,054/year
2002	$185,677/year
2007	$163,526/year

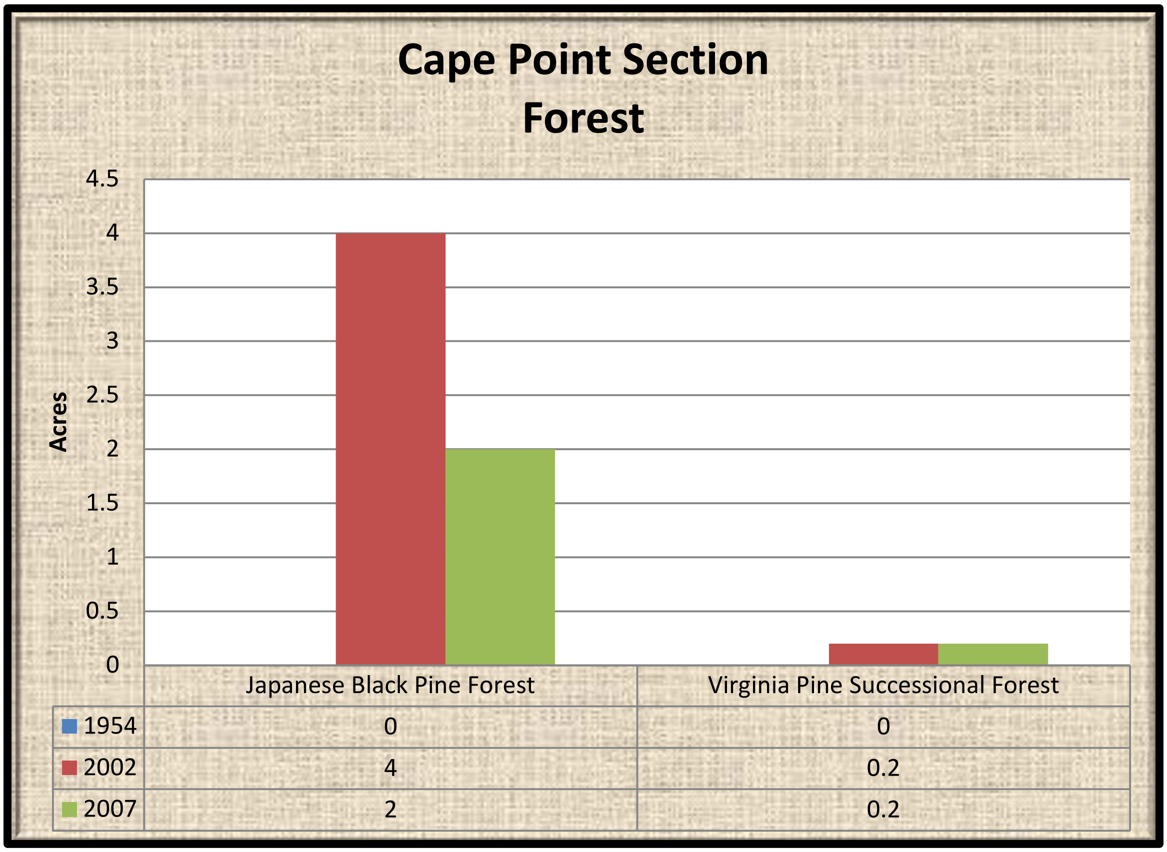


Figure 4-1.5. Cape Point Section Forest (1954, 2002, and 2007)

Cape Point Section Forest (Figure 4-1.5): Japanese Black Pine Forest is the most common forest in the Cape Point Section and has declined in the recent past with eradication efforts. Virginia Pine forest as best as can be told was not present in 1954 and has come about in very small amount since. Overall forests make up a very small amount of the area of the Cape Point Section.

DNREC Sea Level Rise Analysis (Table 4-1.3)

The sea level rise scenarios as they are now project a very slight inundation of the forestland at Cape Point. At 1.5 m of rise, only 0.1 acres will be impacted.

Table 4-1.3. Projected acres of Cape Point Section Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0.1 acres
1.5 m	0.1 acres

Natural Capital (Table 4-1.4)

Natural capital of Cape Point section forests increased up to 2002 and then decreased in the 2002-2007 period. There were no forested communities in 1954.

Table 4-1.4. Natural Capital of Cape Point Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$794/year
2007	$416/year

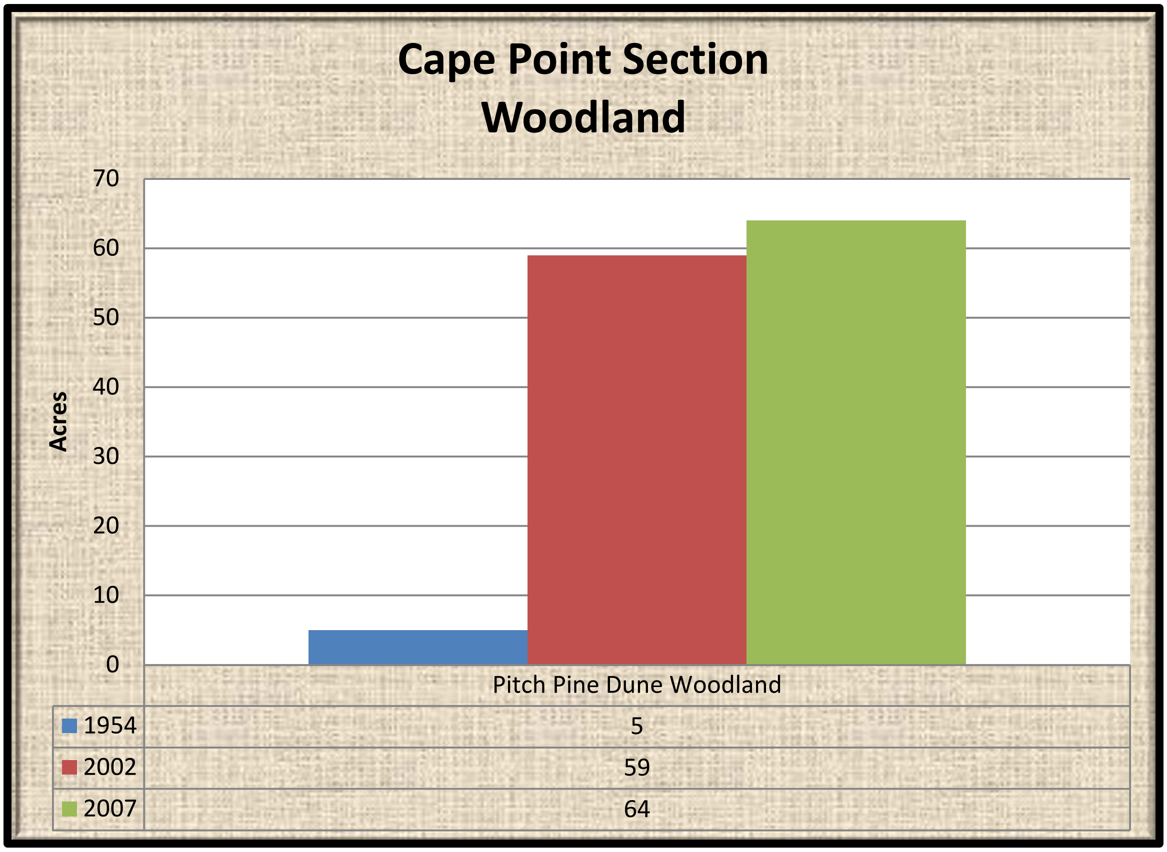


Figure 4-1.6. Cape Point Section Woodland (1954, 2002, and 2007)

Cape Point Section Woodland (Figure 4-1.6): Pitch Pine Dune Woodland is the woodland present in the Cape Point Section. It has increased since 1954 as more former open land has succeeded to woodland.

DNREC Sea Level Rise Analysis (Table 4-1.5)

None of the woodland present at Cape Point would affected with 0.5 m of sea level rise. However, with 1.5 m of sea level rise a little less than ¾ of the current acreage would inundated.

Table 4-1.5. Projected acres of Cape Point Section Woodland Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	14 acres
1.5 m	44 acres

Natural Capital (Table 4-1.6)

The capitalization of woodland has consistently been transferred to other communities as the amount of woodland has gone down.

Table 4-1.6. Natural Capital of Cape Point Section Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$946/year
2002	$11,157/year
2007	$12,102/year

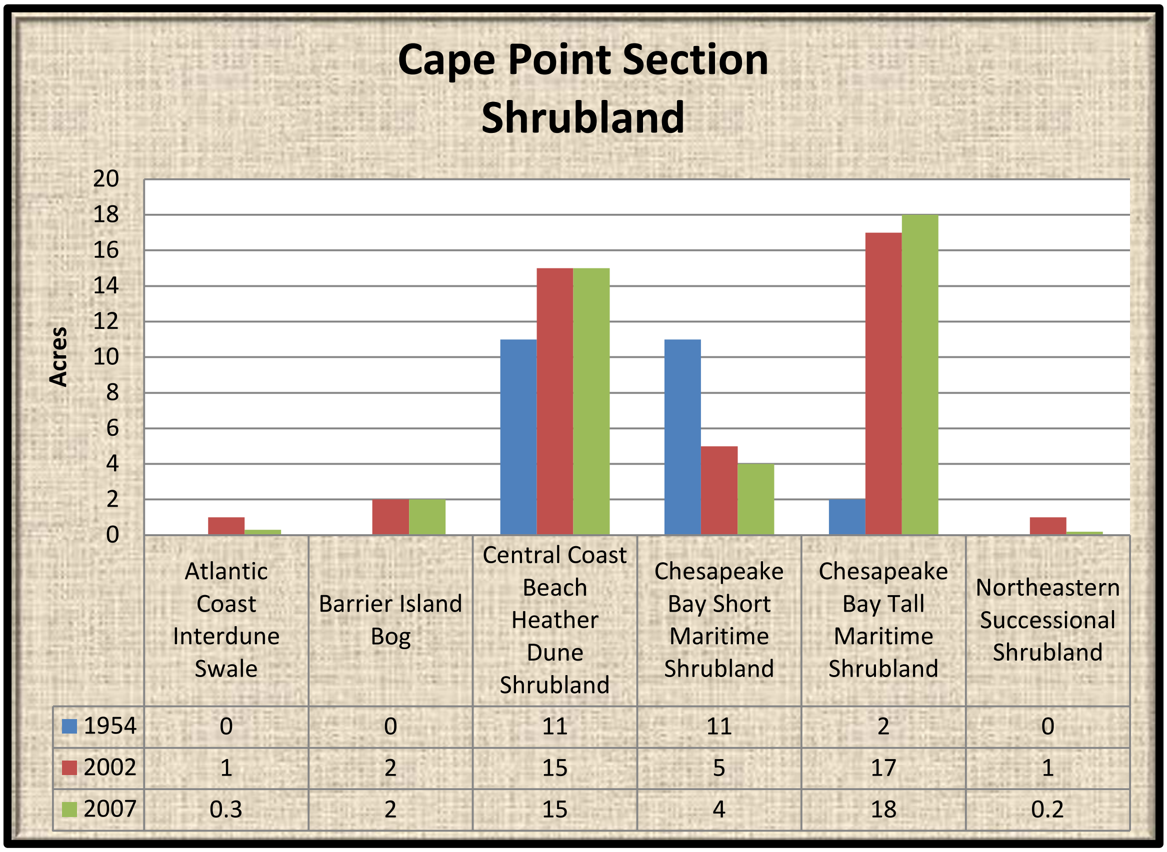


Figure 4-1.7. Cape Point Section Shrubland (1954, 2002, and 2007)

Cape Point Section Shrubland (Figure 4-1.7): Chesapeake Bay Tall Maritime Shrubland is the most common "shrubland" and is technically a stunted forest. It has continued to increase through time. Central Coast Beach Heather Dune Shrubland is the second most common shrubland and has increased overall, though it tends to be ephemeral. Chesapeake Bay Short Maritime Shrubland comes in third and has been declined presumably from the influx of sand from further south though the exact cause is unknown.

DNREC Sea Level Rise Analysis (Table 4-1.7)

None of the shrubland present at Cape Point would be impacted by 0.5 m of sea level rise. But at 1 m of rise and beyond 12 acres will be flooded and it rapidly goes up from there.

Table 4-1.7. Projected acres of Cape Point Section Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	12 acres
1.5 m	21 acres

Natural Capital (Table 4-1.8)

Capitalization of shrubland at Cape Point has increased from 1954, but has recently decreased from its 2002 high. Losses in Atlantic Coast Interdune Swale and Northeastern Successional Shrubland are main drivers.

Table 4-1.8. Natural Capital of Cape Point Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$3,497/year
2002	$33,380/year
2007	$26,766/year

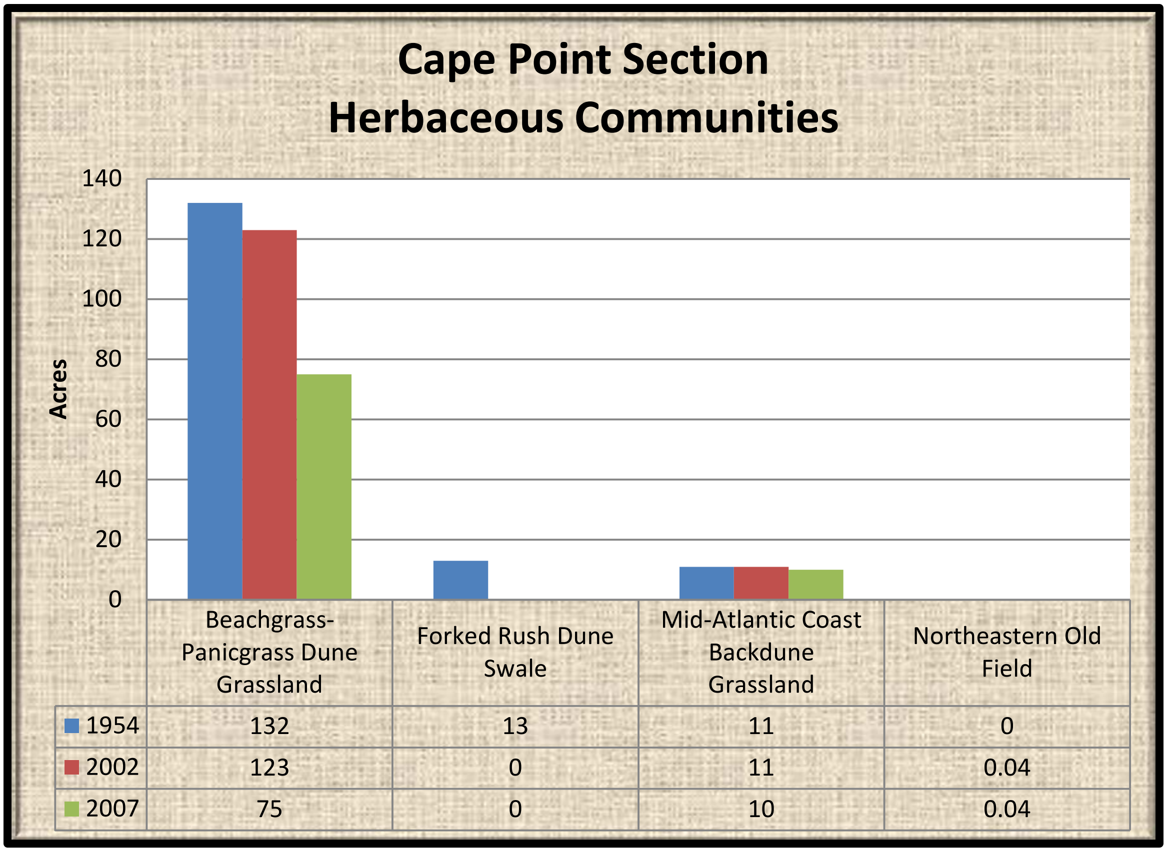


Figure 4-1.8. Cape Point Section Herbaceous Communities (1954, 2002, and 2007)

Cape Point Section Herbaceous Communities (Figure 4-1.8): Beachgrass-Panicgrass Dune Grassland is the most common herbaceous community in the Cape Point Section and has declined through time, especially during the recent period. Forked Rush Dune Swale was present in 1954 but has since disappeared from this section. Mid-Atlantic Coast Backdune Grassland, located landward of the Beachgrass-Panicgrass Dune Grassland, has remained at about the same amount through time.

DNREC Sea Level Rise Analysis (Table 4-1.9)

At the highest scenario for sea level rise (1.5 m), about half of the herbaceous communities would be inundated. Only 0.2 acres would be impacted with 0.5 m of rise.

Table 4-1.9. Projected acres of Cape Point Section Herbaceous Communities Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0.2 acres
1 m	23 acres
1.5 m	48 acres

Natural Capital (Table 4-1.10)

Herbaceous communities have gradually gone down in value, due mainly to losses in Beachgrass-Panicgrass Dune Grassland.

Table 4-1.10. Natural Capital of Cape Point Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$141,493/year
2002	$19,530/year
2007	$12,390/year

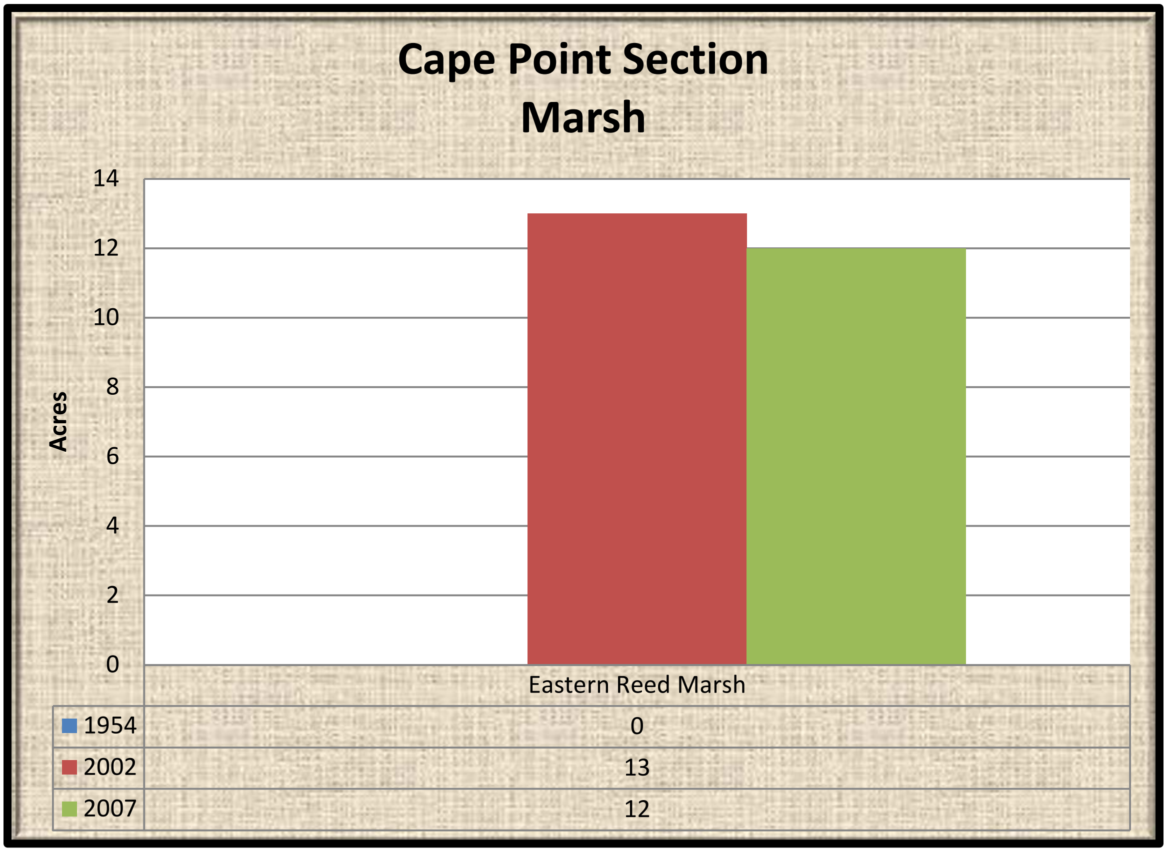


Figure 4-1.9. Cape Point Section Marsh (1954, 2002, and 2007)

Cape Point Section Marsh (Figure 4-1.9): Eastern Reed Marsh is the only marsh type in the Cape Point Section and is located in interdunal depressions. Some of these depressions were once home to Forked Rush Dune Swale and Atlantic Coast Interdune Swale which have been taken over by this community. It may be possible through eradication of the reed (*Phragmites australis*) to bring these communities back.

DNREC Sea Level Rise Analysis (Table 4-1.11)

Most of the marshland at Cape Point would be flooded with 1 m of rise and all of it at 1.5 m of rise. None of the current acreage would be affected by 0.5 m of rise.

Table 4-1.11. Projected acres of Cape Point Section Marsh Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	10 acres
1.5 m	12 acres

Natural Capital (Table 4-1.12)

Eastern Reed Marsh is the only marsh present at Cape Point. This community occurs in depressions and is often covered by sand, especially during wind events. The capital has been going down because of sand covering the community.

Table 4-1.12. Natural Capital of Cape Point Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$120,658/year
2007	$111,376/year

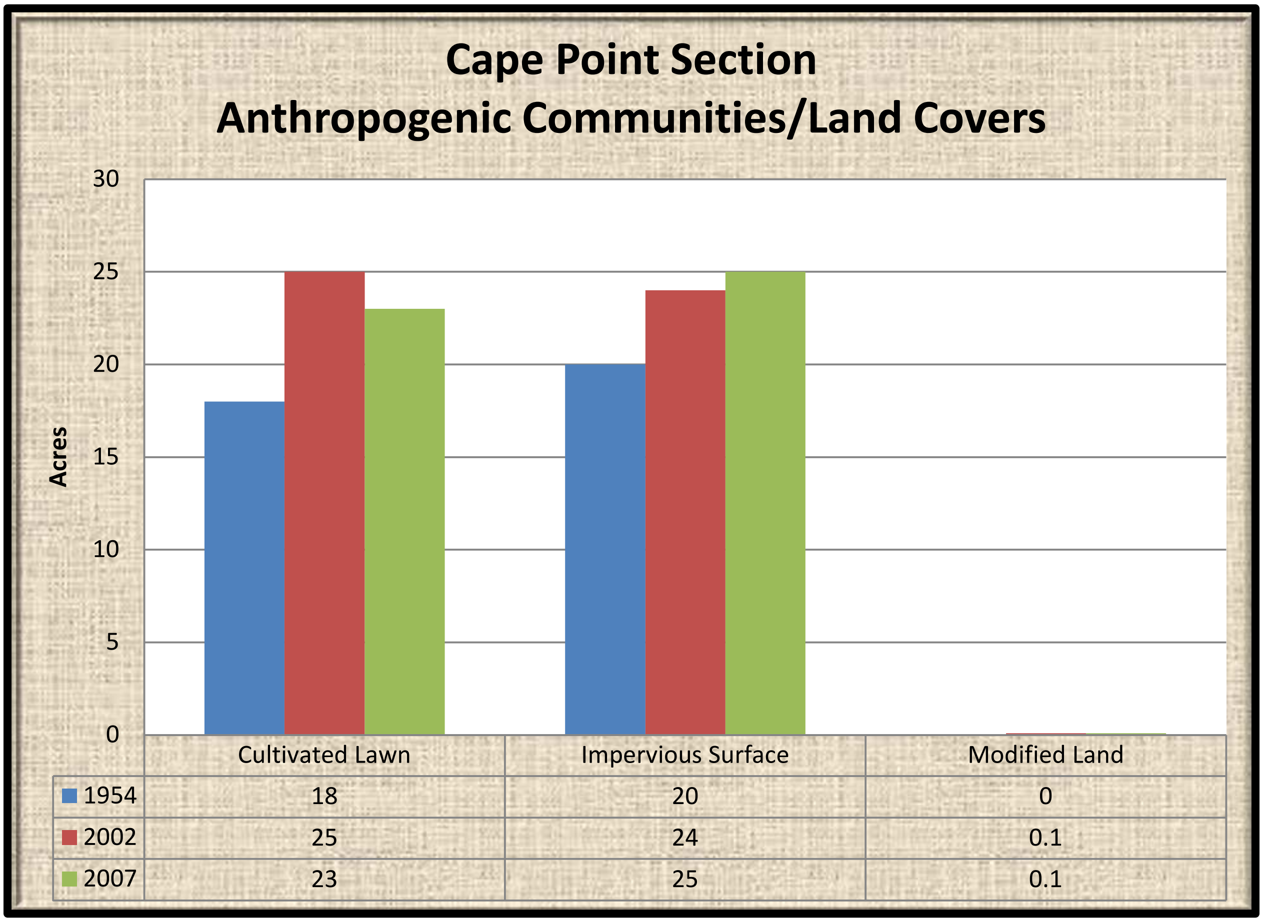


Figure 4-1.10. Cape Point Section Anthropogenic Communities/Land Covers (1954, 2002, and 2007)

Cape Point Section Anthropogenic Communities/Land Covers (Figure 4-1.10): Impervious surface and cultivated lawn are the prominent anthropogenic communities in the Cape Point Section. Most of the buildings and roads present here were built during this area's use by the military.

DNREC Sea Level Rise Analysis (Table 4-1.13)

None of the man-made communities or land covers would be affected with 0.5 m of sea level rise. At 1 m about 5 acres would be inundated and at 1.5 m about ¾ of them would be flooded.

Table 4-1.13. Projected acres of Cape Point Section Anthropogenic Communities/Land Covers Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	0 acres
1 m	5 acres
1.5 m	36 acres

Natural Capital

None of the Anthropogenic Communities/Land Covers at Cape Point have any natural capital value.

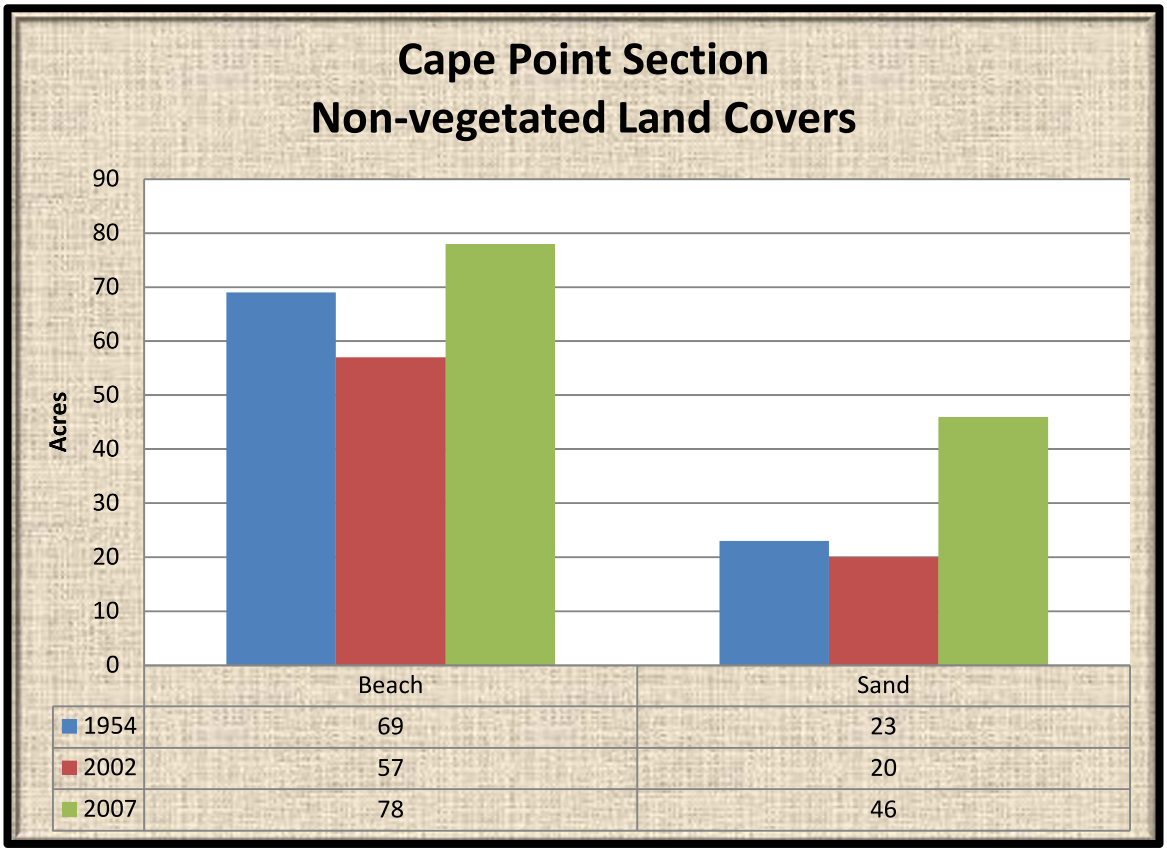


Figure 4-1.11. Cape Point Section Non-vegetated Land Covers (1954, 2002, and 2007)

Cape Point Section Non-vegetated Land Covers (Figure 4-1.11): Beach area is the most common non-vegetated land cover followed by non-vegetated sand.

DNREC Sea Level Rise Analysis (Table 4-1.14)

A lot of the Cape Point area is composed of raised sand dunes that tower above the ocean and bay. At 0.5 m of sea level rise, only 21 acres of this section will be inundated. An additional 0.5 m of rise will flood 90 more acres and 1.5 m will inundate a little more than half of the section.

Table 4-1.14. Projected acres of Cape Point Section Non-vegetated Land Covers Inundated by Sea Level Rise

Rise	Acres
0.5 m	18 acres
1 m	44 acres
1.5 m	63 acres

Natural Capital

None of the non-vegetated land covers have any capital value at Cape Point.

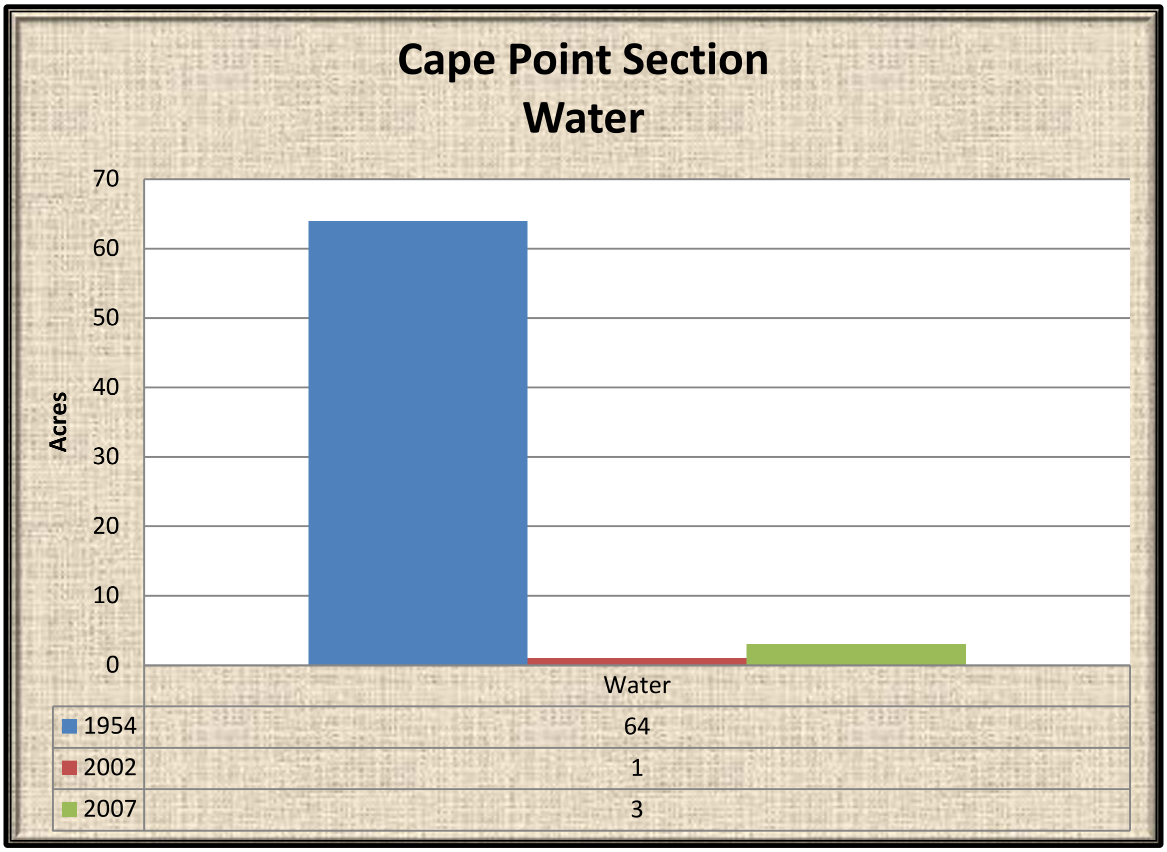


Figure 4-1.12. Cape Point Section water coverage (1954, 2002, and 2007)

Cape Point Section water coverage (Figure 4-1.12): The amount of water coverage in the Cape Point Section is an interesting study in how nearshore areas are dynamic and rise with sea level. In 1954, the "Cape" of Cape Henlopen was a lot shorter being produced by a nearshore current flowing northward. Beach nourishment projects and sand additions have caused the Cape to become longer filling in places that were once open water. At the current time there is little water coverage within the same boundaries.

Natural Capital (Table 4-1.15)

The water coverage at Cape Point is composed of ocean, which has a lower value than an estuarine environment. Cape Point is in a zone of dune building, so water coverage has been going down. As a result the capital has been going down and reducing the overall capital in the park.

Table 4-1.15. Natural Capital of Cape Point Section Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$10,118/year
2002	$158/year
2007	$474/year

2. Church Woods Section

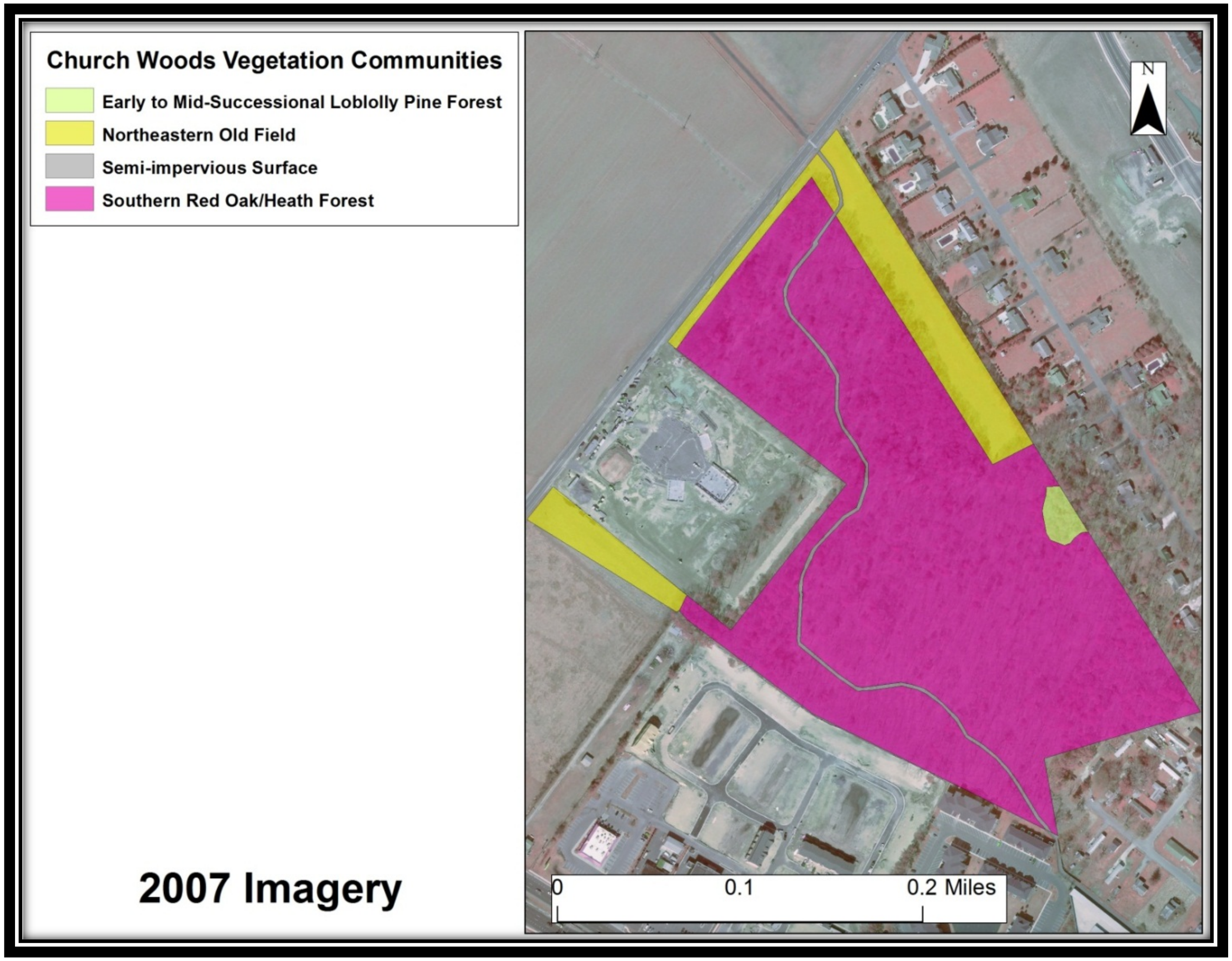


Figure 4-2.1. 2007 Vegetation Community map of Church Woods Section

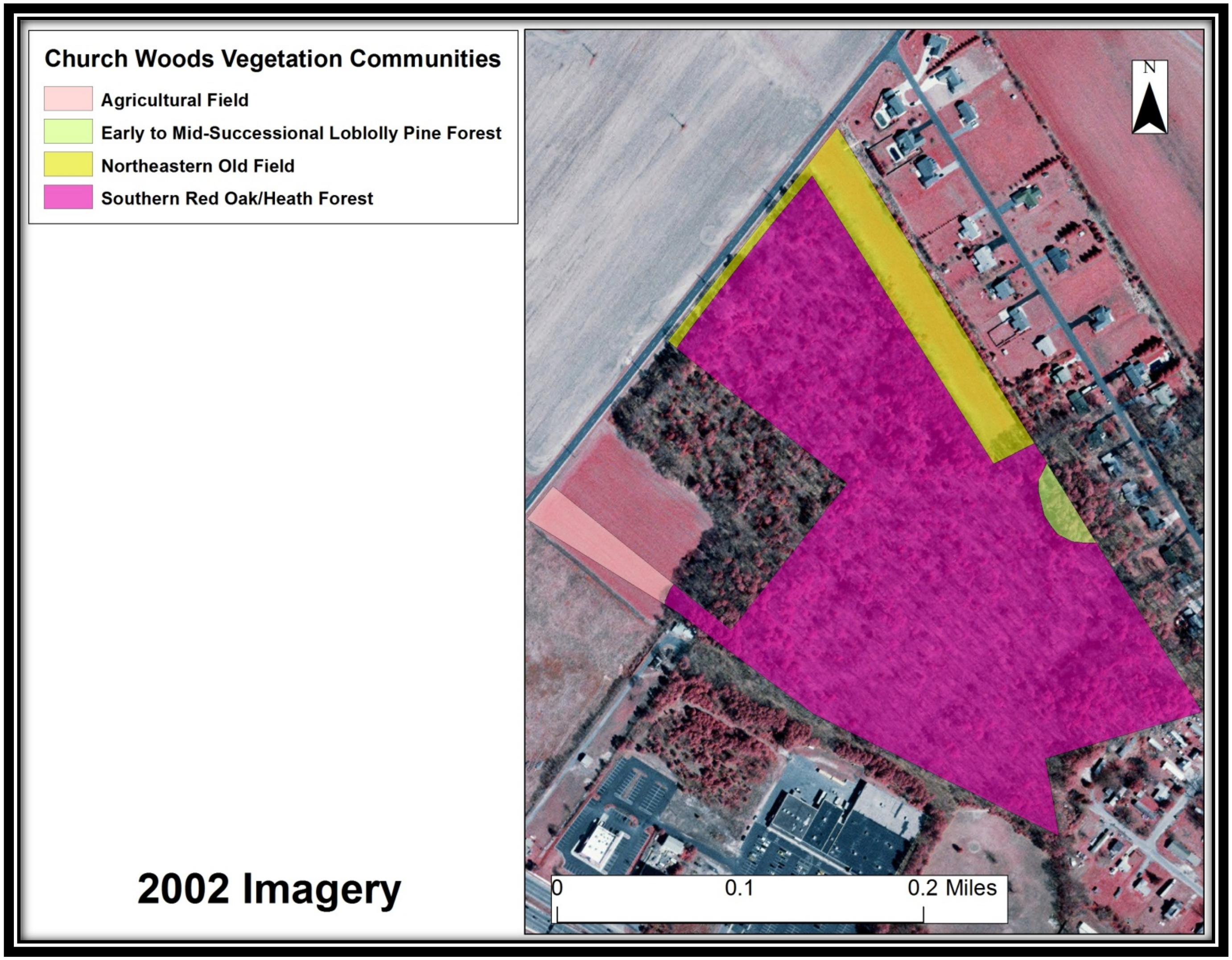


Figure 4-2.2. 2002 Vegetation Community map of Church Woods Section

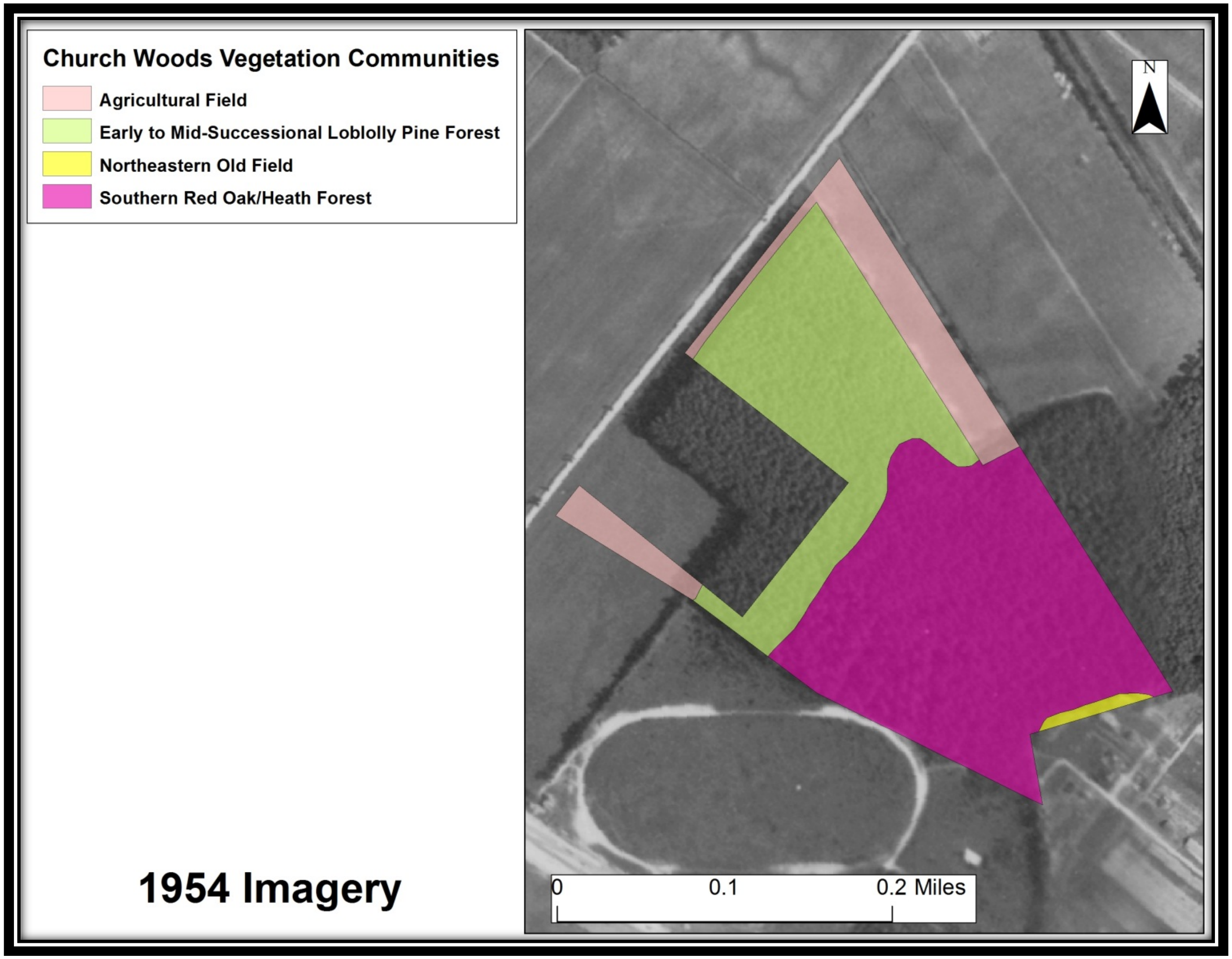


Figure 4-2.3. 1954 Vegetation Community map of Church Woods Section

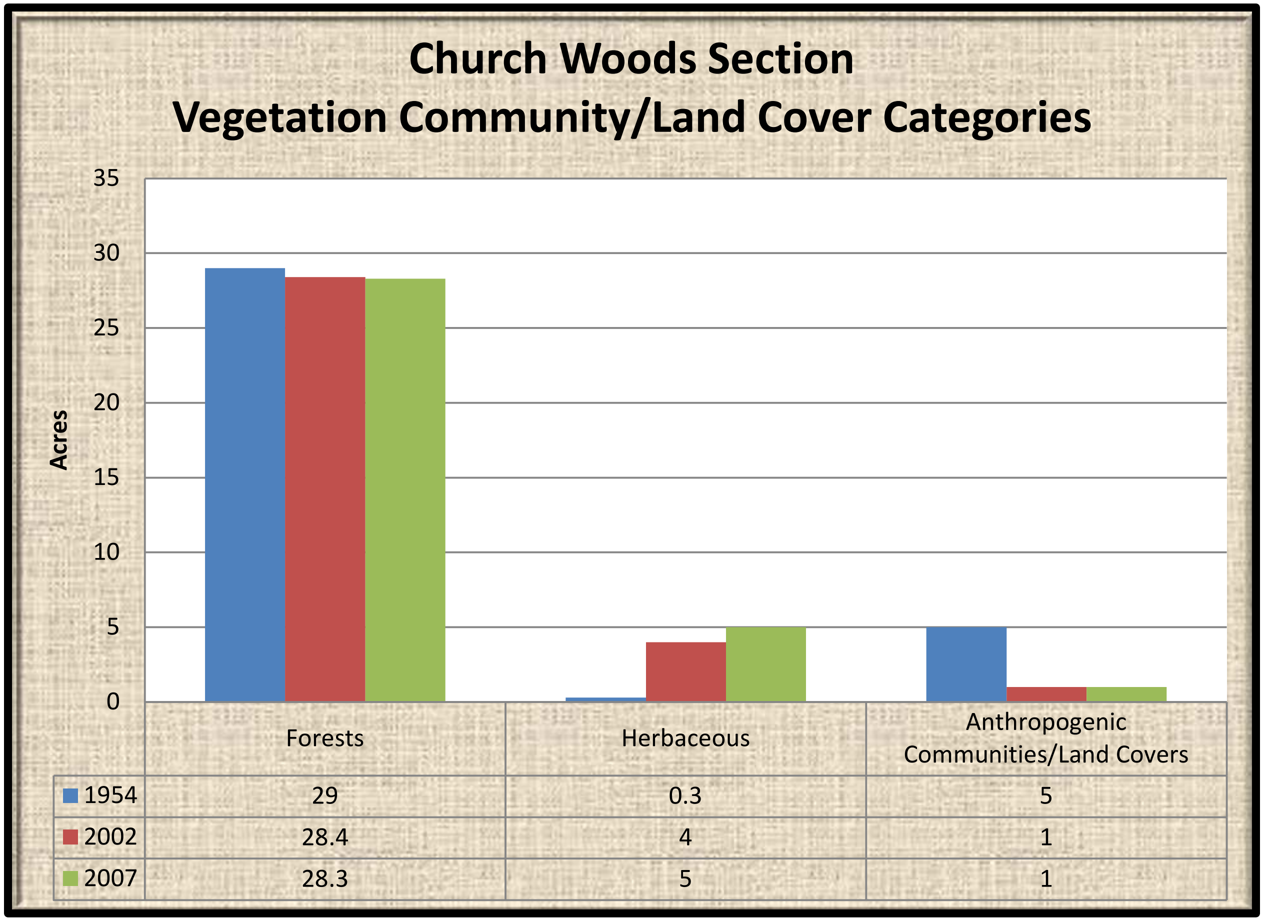


Figure 4-2.4. Church Woods Section Vegetation Community/Land Cover Categories (1954, 2002, and 2007)

Church Woods Section Broad Trends (Figure 4-2.4): This section is located west of Lewes-Rehoboth Canal and is adjacent to a recently built church, hence the name "Church Woods." This section is mostly forested with small amount of herbaceous area (Northeastern Old Field) in former agricultural land. The entirety of the Church Woods Section is not impacted by any of the current sea level rise scenarios, there no analysis sea level rise analysis was completed for this section.

Natural Capital (Table 4-2.1)

Natural capital in the Church Woods Section has been increasing trend, mainly driven by an increase in herbaceous communities.

Table 4-2.1. Natural Capital of the Church Woods Section	
Year	**Natural Capital (in 2012 dollars)**
1954	$5,815/year
2002	$6,111/year
2007	$6,080/year

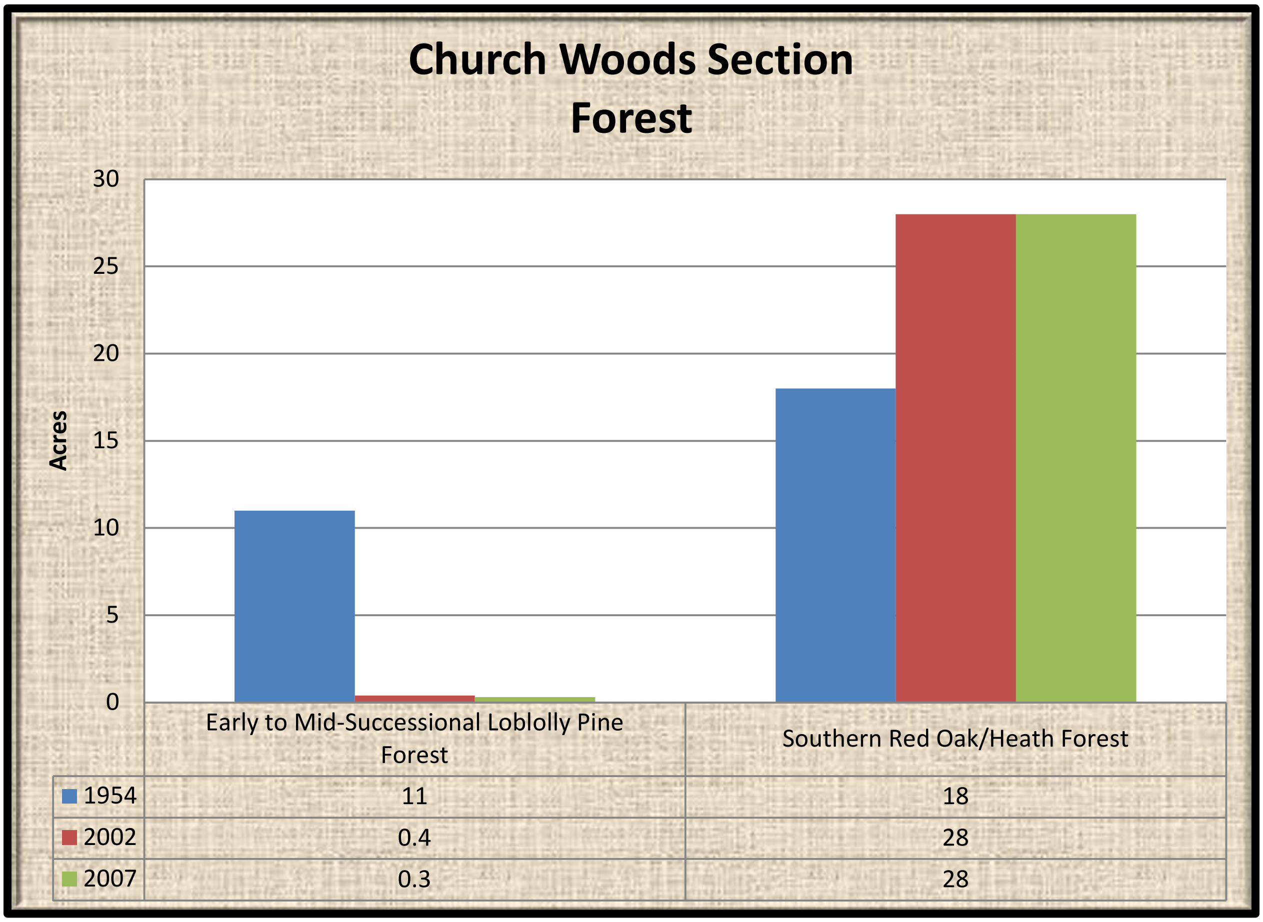


Figure 4-2.5. Church Woods Section Forest (1954, 2002, and 2007)

Church Woods Section Forest (Figure 4-2.5): Southern Red Oak/Heath Forest is the most common forested community and has succeeded in part from a former Early to Mid-Successional Loblolly Pine Forest present in 1954. A very small amount of the pine forest still persists and may increase a little with succession of the Northeastern Old Field.

Natural Capital (Table 4-2.2)

The natural capital of the Church Woods forest has declined slightly as part of the forest areas were converted to cultivated lawn and semi-impervious surface.

Table 4-2.2. Natural Capital of Church Woods Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$5,484/year
2002	$5,370/year
2007	$5,352/year

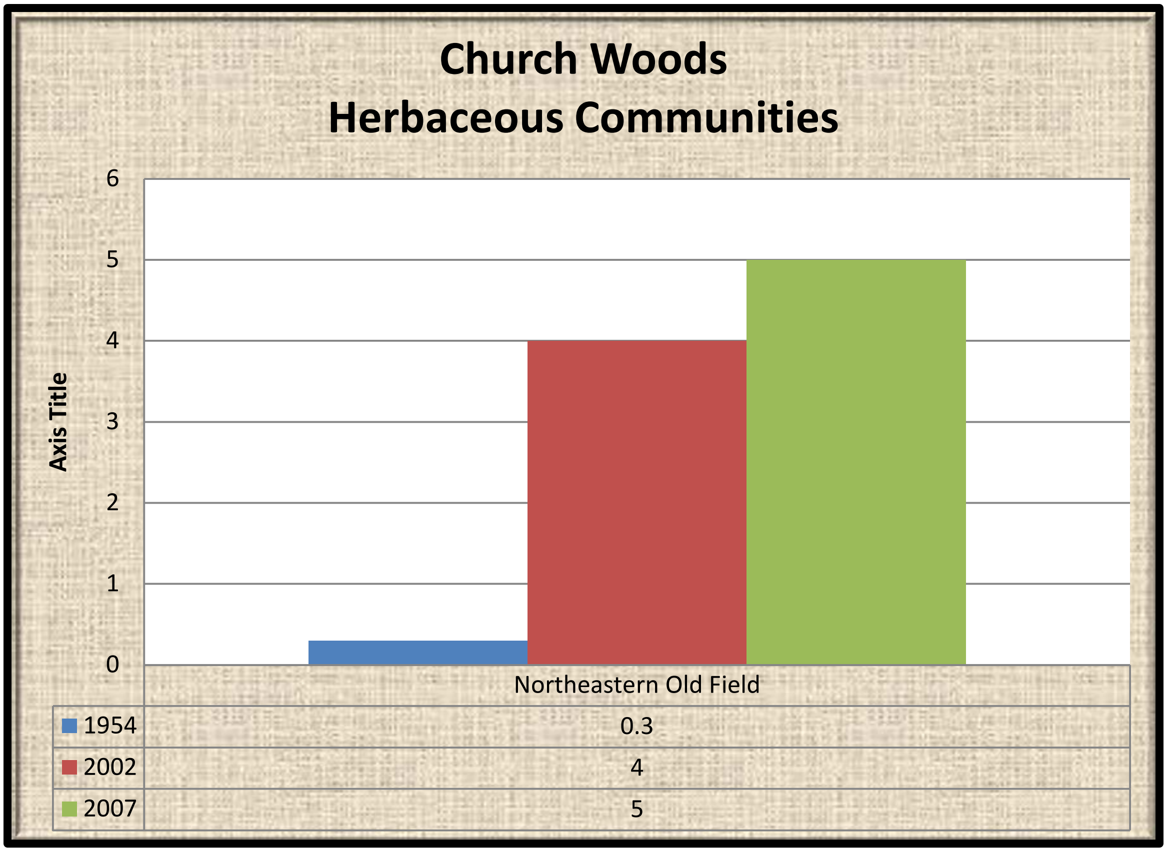


Figure 4-2.6. Church Woods Section Herbaceous Communities

Church Woods Section Herbaceous Communities (Figure 4-2.6): Northeastern Old Field is the only herbaceous community in this section and has arisen from former agricultural field.

Natural Capital (Table 4-2.3)

The capital of herbaceous communities has increased as more fields are developed. Some of these fields have come from more valuable communities resulting in an overall loss for the section and the park.

Table 4-2.3. Natural Capital of Church Woods Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$44/year
2002	$583/year
2007	$729/year

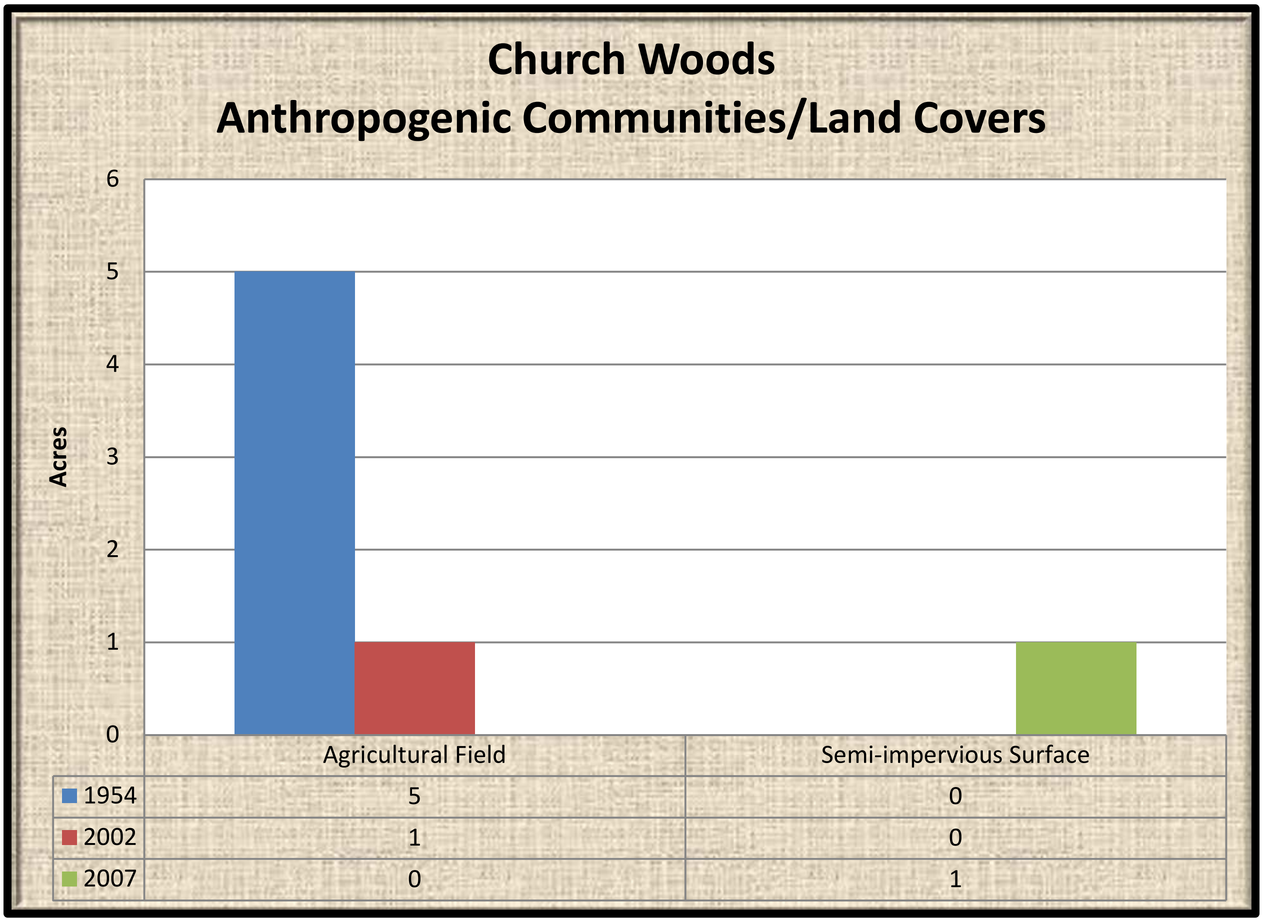


Figure 4-2.7. Church Woods Section Anthropogenic Communities/Land Covers (1954, 2002, and 2007)

Church Woods Section Anthropogenic Communities/Land Covers (Figure 4-2.7): Semi-impervious surface in the form of a walking/biking trail is the only anthropogenic community present in the Church Woods Section. The former agricultural field has been abandoned to become a Northeastern Old Field.

Natural Capital (Table 4-2.4)

Agricultural field is the only Anthropogenic Community/land cover with any capital value. Its value has been transferred to other communities and is now $0/year.

Table 4-2.4. Natural Capital of Church Woods Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1954	$287/year
2002	$57/year
2007	$0/year (not present)

3. Fort Miles Section

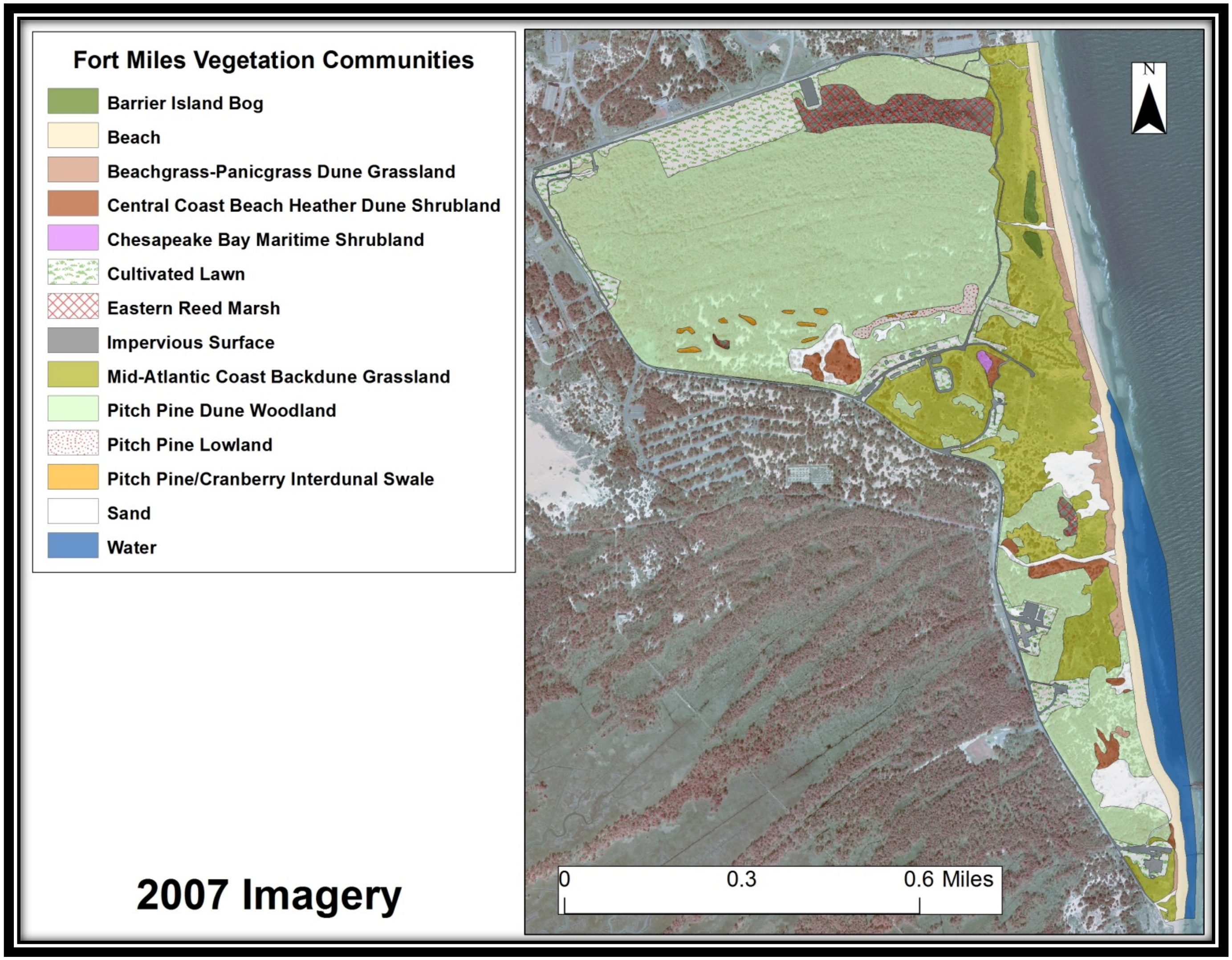


Figure 4-3.1. 2007 Vegetation Community map of Fort Miles Section

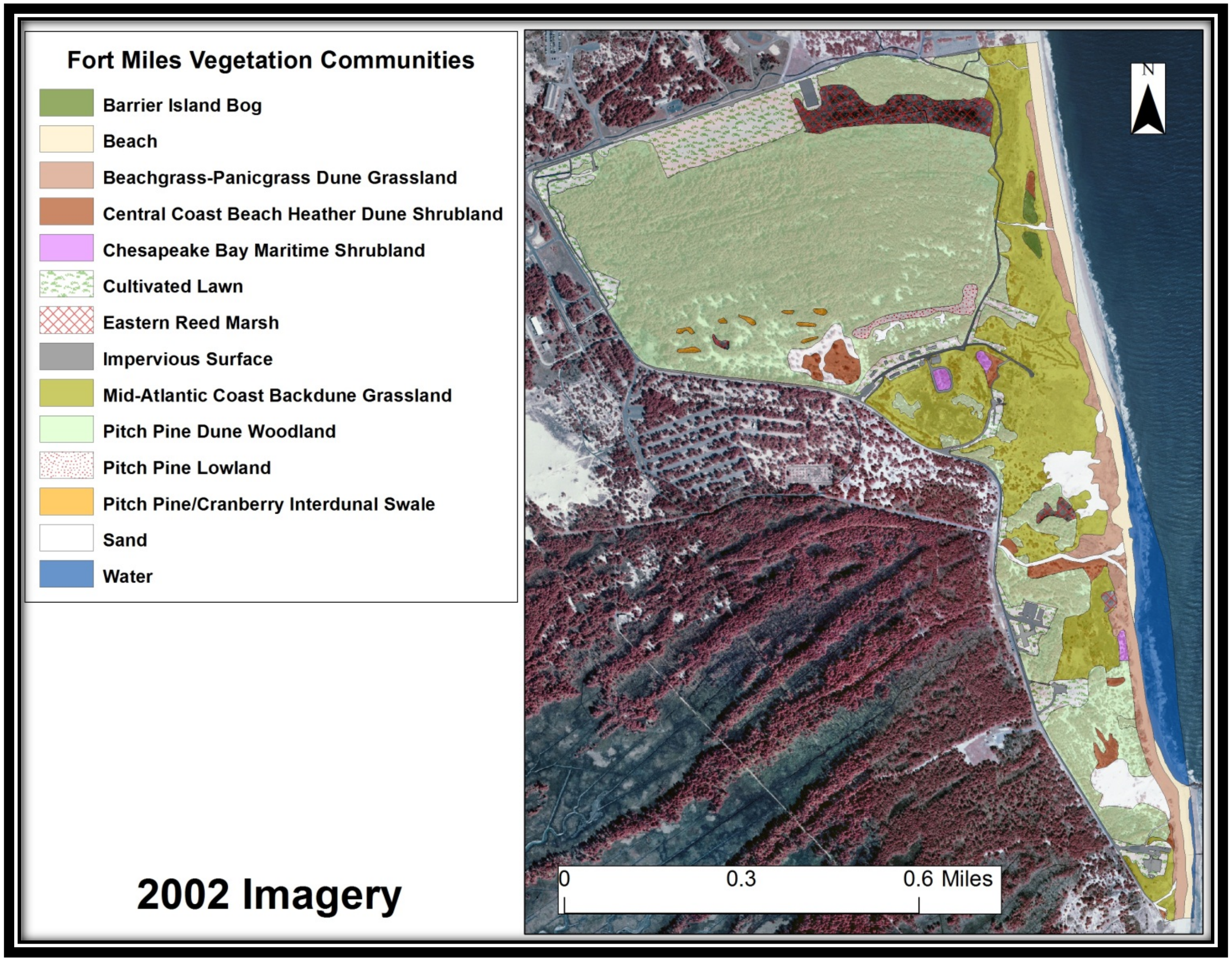


Figure 4-3.2. 2002 Vegetation Community map of Fort Miles Section

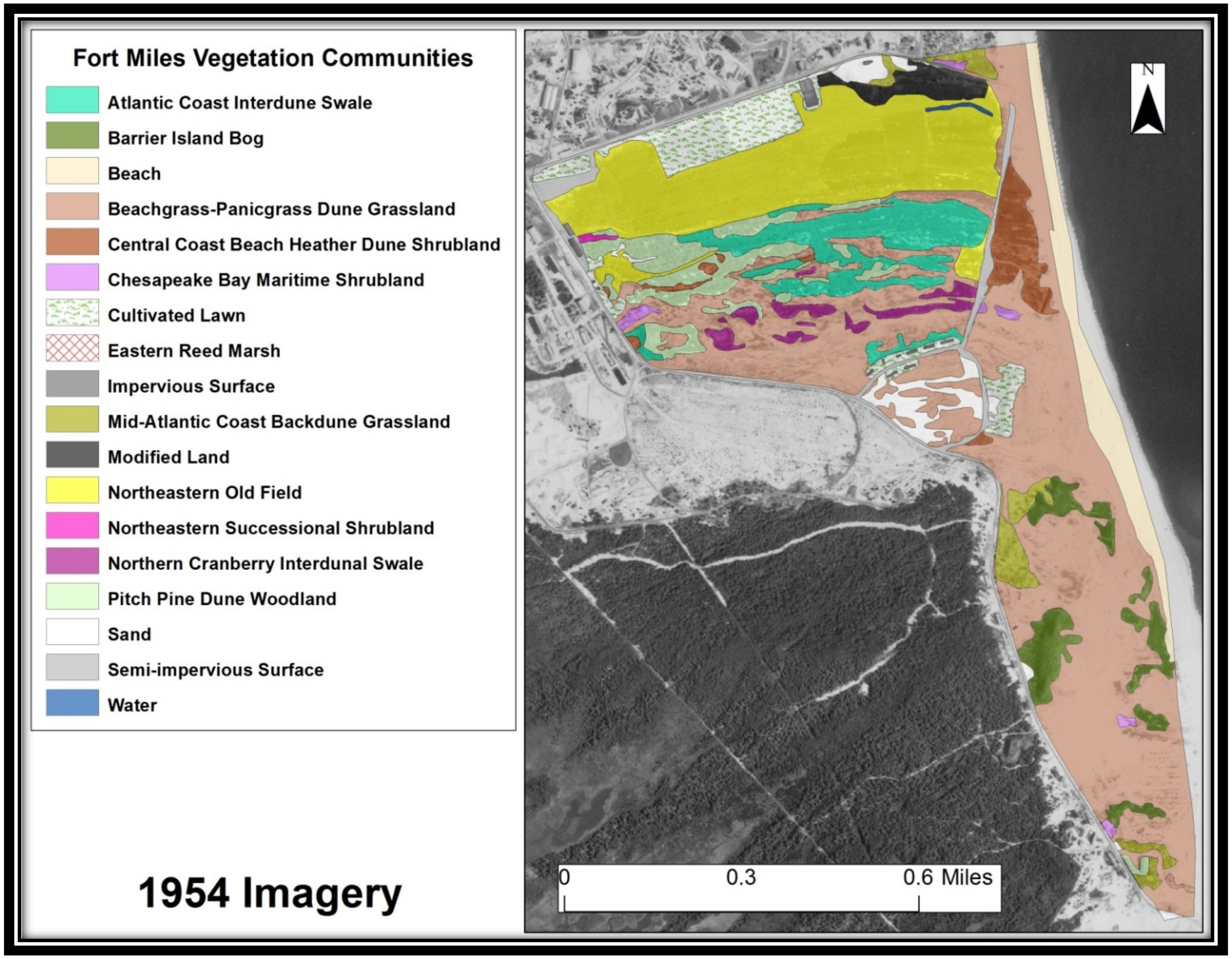
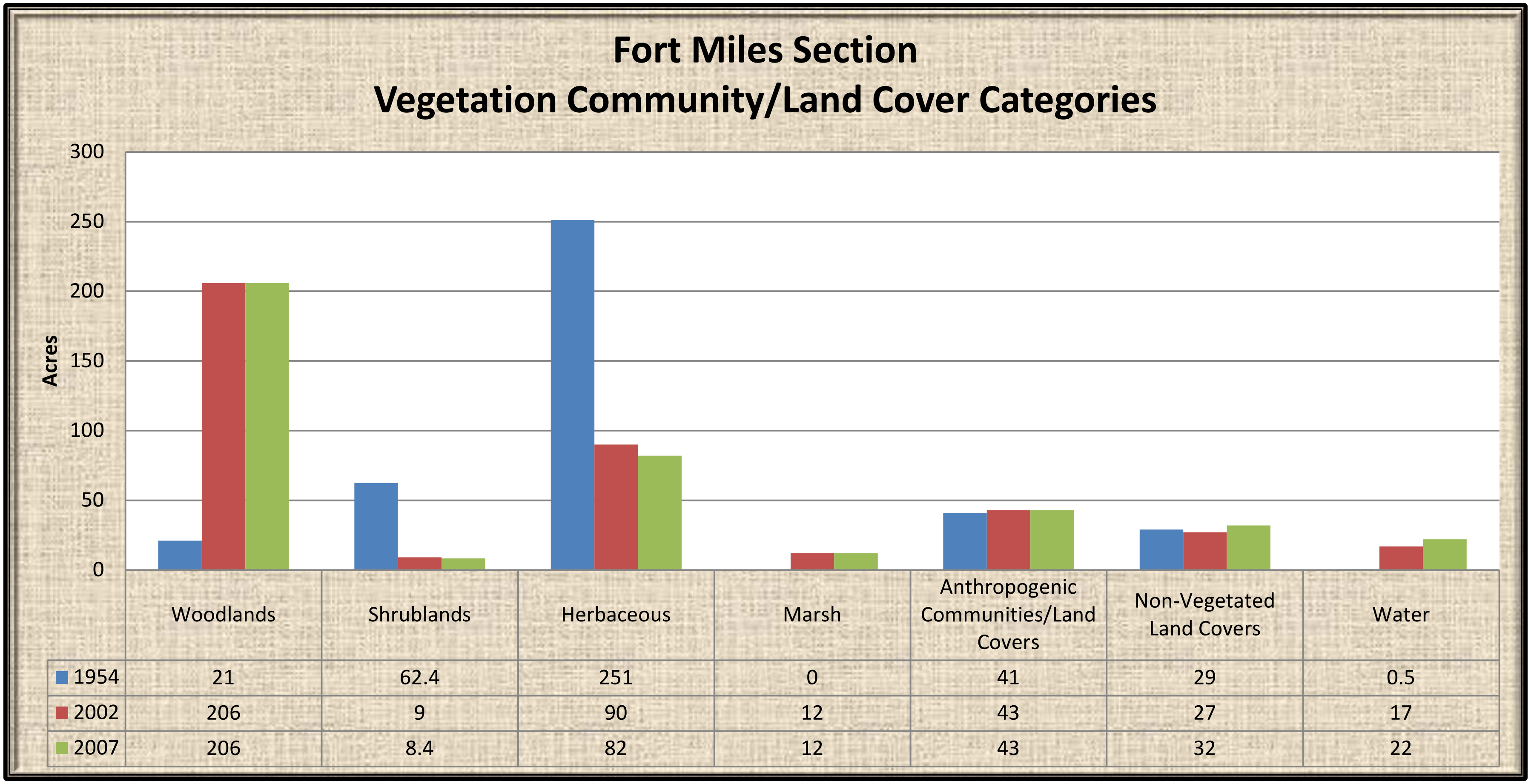


Figure 4-3.3. 1954 Vegetation Community map of Fort Miles Section



	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1954	21	62.4	251	0	41	29	0.5
2002	206	9	90	12	43	27	17
2007	206	8.4	82	12	43	32	22

Figure 4-3.4. Fort Miles Section Vegetation Communities/Land Covers (1954, 2002, and 2007)

Fort Miles Section Broad Trends (Figure 4-3.4): Fort Miles Section is exposed to the Atlantic Ocean on the east and contains some more inland areas to the west that are not exposed. This section contains a lot of the former Army structures present in the park leading to a high amount of anthropogenic communities. In 1954 most of the section was composed of herbaceous communities having been cleared for use by the Army in the early 1940's. Since this time the former herbaceous communities have grown into woodlands. Water has made a steady increase in the section during the study period. No forests are present in this section.

DNREC Sea Level Rise Analysis (Table 4-3.1)

About 28 acres of the Fort Miles Section would be inundated with 0.5 m of sea level rise. At 1 m of rise, about half of the section would be underwater and at 1.5 m of rise, a little more than half would be flooded.

Table 4-3.1. Projected acres of the Fort Miles Section Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	28 acres
1 m	192 acres
1.5 m	234 acres

Natural Capital (Table 4-3.2)

Capital in the Fort Miles Section has decreased since 1954 and is driven by losses in some of the wetland swale communities.

Table 4-3.2. Natural Capital of the Fort Miles Section

Year	**Natural Capital (in 2012 dollars)**
1954	$497,362/year (not present)
2002	$176,620/year
2007	$176,116/year

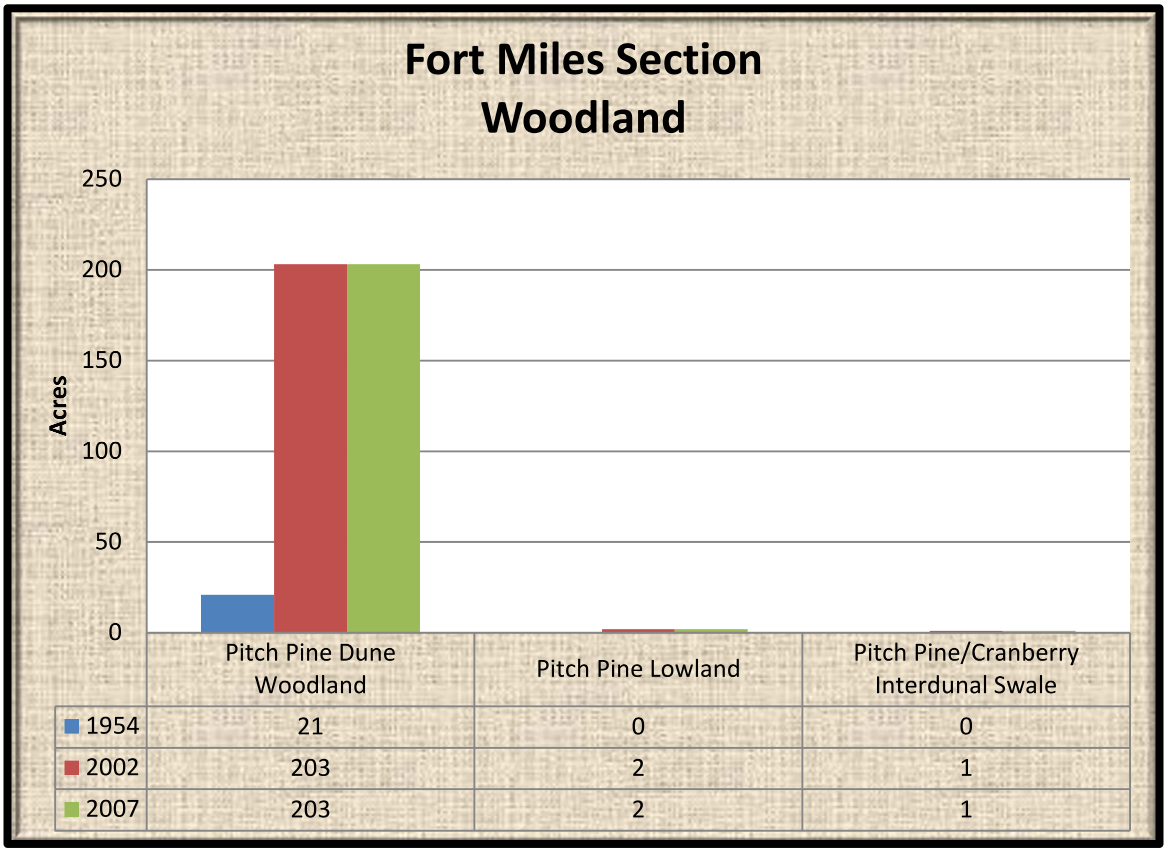


Figure 4-3.5. Fort Miles Section Woodland (1954, 2002, and 2007)

Fort Miles Section Woodland (Figure 4-3.5): Pitch Pine Dune Woodland is the prominent woodland type in the Fort Miles Section and has greatly increased in acreage in the uplands since 1954. In lowland areas, Pitch Pine Lowland and Pitch Pine/Cranberry Interdunal Swale can be found in small amount.

DNREC Sea Level Rise Analysis (Table 4-3.3)

None of the woodlands of the Fort Miles Section will be impacted with 0.5 m of sea level rise. However, at 1 m of rise a little more than half will be inundated and at 1.5 m about ¾ of the current acreage will be flooded.

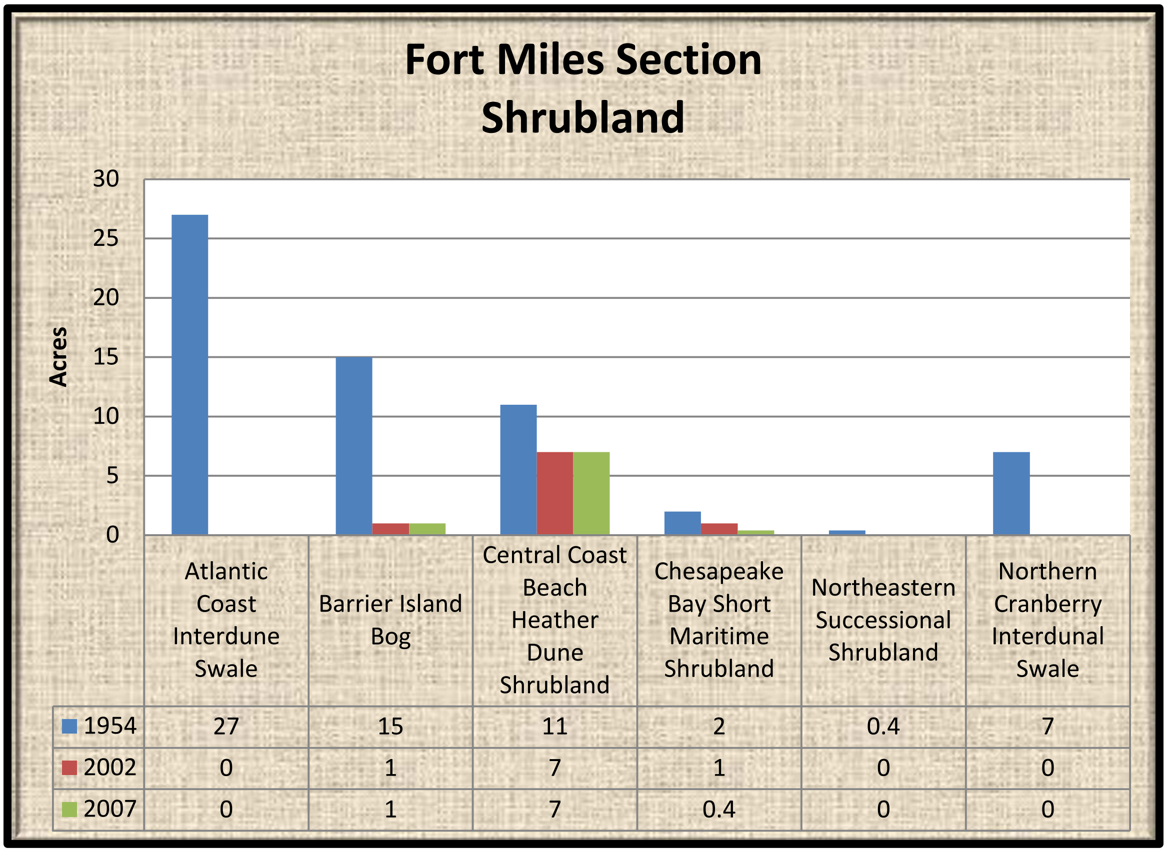
Table 4-3.3. Projected acres of the Fort Miles Section Woodland Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	0 acres
1 m	129 acres
1.5 m	153 acres

Natural Capital (Table 4-3.4)

Capital in woodland has increased markedly with increases in Pitch Pine Dune Woodland over the years.

Table 4-3.4. Natural Capital of Fort Miles Section Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$3,971/year (not present)
2002	$75,262/year
2007	$75,262/year



	Atlantic Coast Interdune Swale	Barrier Island Bog	Central Coast Beach Heather Dune Shrubland	Chesapeake Bay Short Maritime Shrubland	Northeastern Successional Shrubland	Northern Cranberry Interdunal Swale
1954	27	15	11	2	0.4	7
2002	0	1	7	1	0	0
2007	0	1	7	0.4	0	0

Figure 4-3.6. Fort Miles Section Shrubland (1954, 2002, and 2007)

Fort Miles Section Shrubland (Figure 4-3.6): Central Coast Beach Heather Dune Shrubland is the most common shrubland in the section and is located close to the Atlantic Ocean. In 1954, however, there were more depressions in which Atlantic Coast Interdunal Swale was found that have now succeeded to lowland woodland. Two other shrubland communities, Northeastern Successional Shrubland and Northern Cranberry Interdunal Swale, have disappeared since the 1950's. Barrier Island Bog has been reduced to one acre from its former 15 acres. The cause of this disappearance is unknown.

DNREC Sea Level Rise Analysis (Table 4-3.5)

Only one acre of shrubland would be impacted by sea level rise under the highest amount of 1.5 m.

Table 4-3.5. Projected acres of Fort Miles Section Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	1 acre

Natural Capital (Table 4-3.6)

Capital of Shrubland has greatly decreased with losses in swale communities.

Table 4-3.6. Natural Capital of Fort Miles Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$456,741/year
2002	$10,447/year
2007	$10,359/year

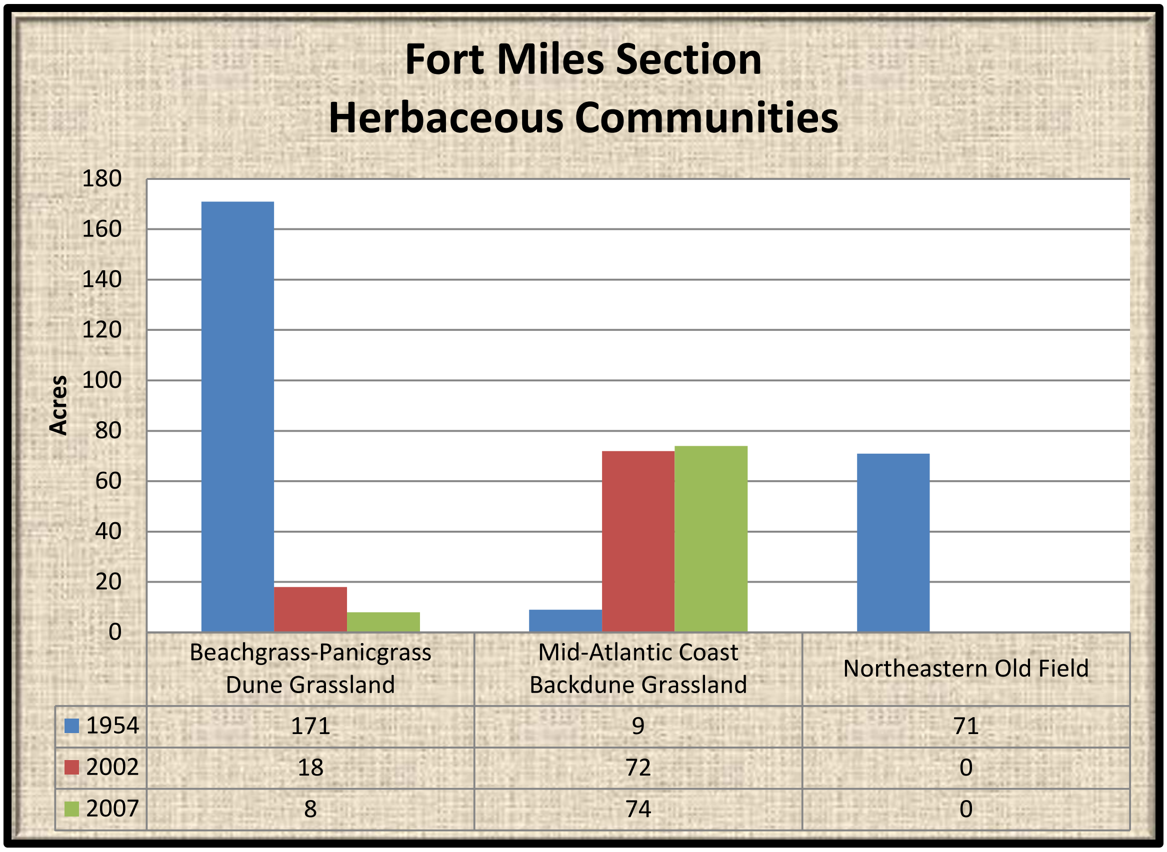


Figure 4-3.7. Fort Miles Section Herbaceous Communities (1954, 2002, and 2007)

Fort Miles Section Herbaceous Communities (Figure 4-3.7): Beachgrass-Panicgrass Dune Grassland was once prominent in the open areas that were cleared during the use of the area by the Army. Since this time the open areas have succeeded to woodland, while Mid-Atlantic Coast Backdune Grassland has taken over the area behind the first line of dunes. All of the Northeastern Old Field has succeeded to a more mature community.

DNREC Sea Level Rise Analysis (Table 4-3.7)

Herbaceous communities will only be slightly affected by the highest sea level rise. At 1 m of rise 2 acres will be flooded and at 1.5 m of rise 11 acres will be inundated.

Table 4-3.7. Projected acres of Fort Miles Section Herbaceous Communities Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	2 acres
1.5 m	11 acres

Natural Capital (Table 4-3.8)

Capital of herbaceous communities has been decreasing with losses in Northeastern Old Field and Beachgrass-Panicgrass Dune Grassland.

Table 4-3.8. Natural Capital of Fort Miles Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$36,571/year
2002	$13,113/year
2007	$11,947/year

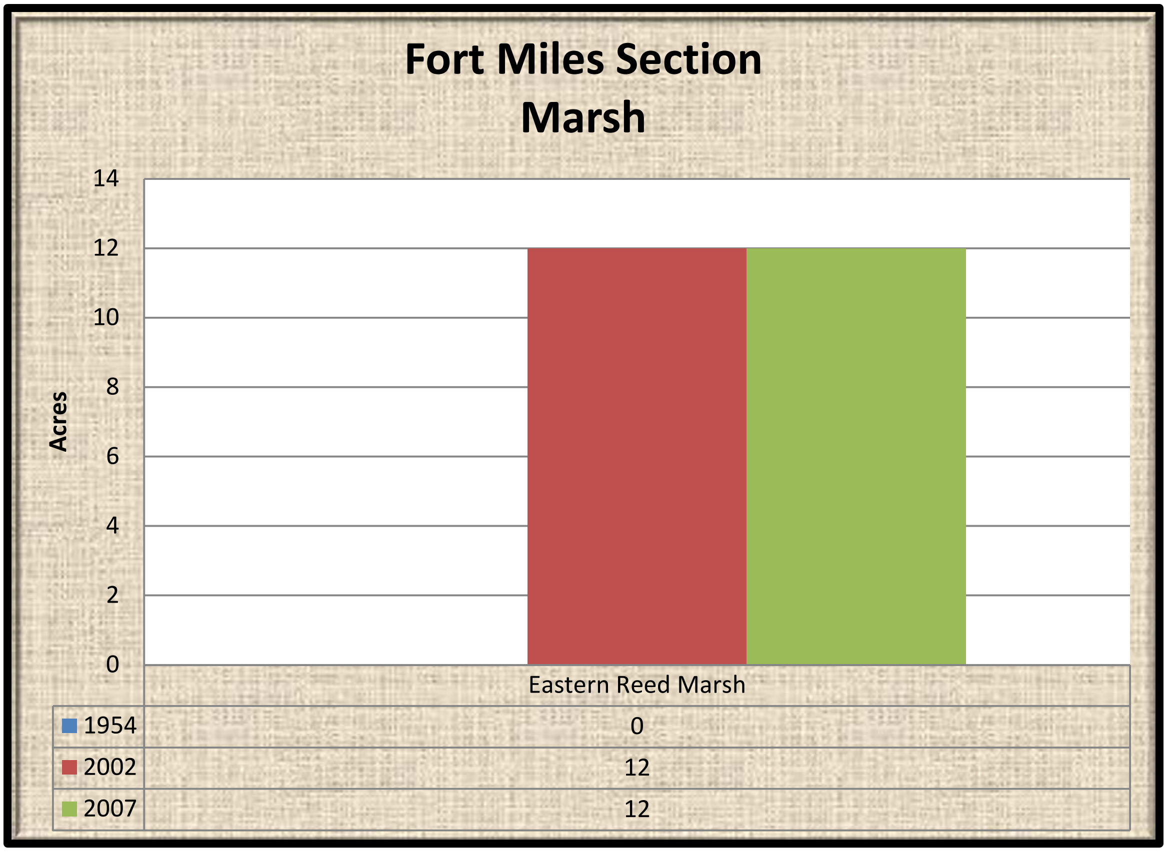


Figure 4-3.8. Fort Miles Section Marsh (1954, 2002, and 2007)

Fort Miles Section Marsh (Figure 4-3.8): Eastern Reed Marsh is the only marsh and is occupying areas that were once Barrier Island Bog and Atlantic Coast Interdune Swale.

DNREC Sea Level Rise Analysis (Table 4-3.9)

All of the marshland present in the Fort Miles Tract will be inundated with 1 m of sea level rise. A lot of these communities are occupying places that used to be interdunal swales.

Table 4-3.9. Projected acres of Fort Miles Section Marsh Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	0 acres
1 m	11 acres
1.5 m	11 acres

Natural Capital (Table 4-3.10)

Eastern Reed Marsh is the only marsh present at Cape Point. This community occurs in depressions and is often covered by sand, especially during wind events. The capital has been going down because of sand covering the community.

Table 4-3.10. Natural Capital of Fort Miles Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$111,377/year
2007	$111,377/year

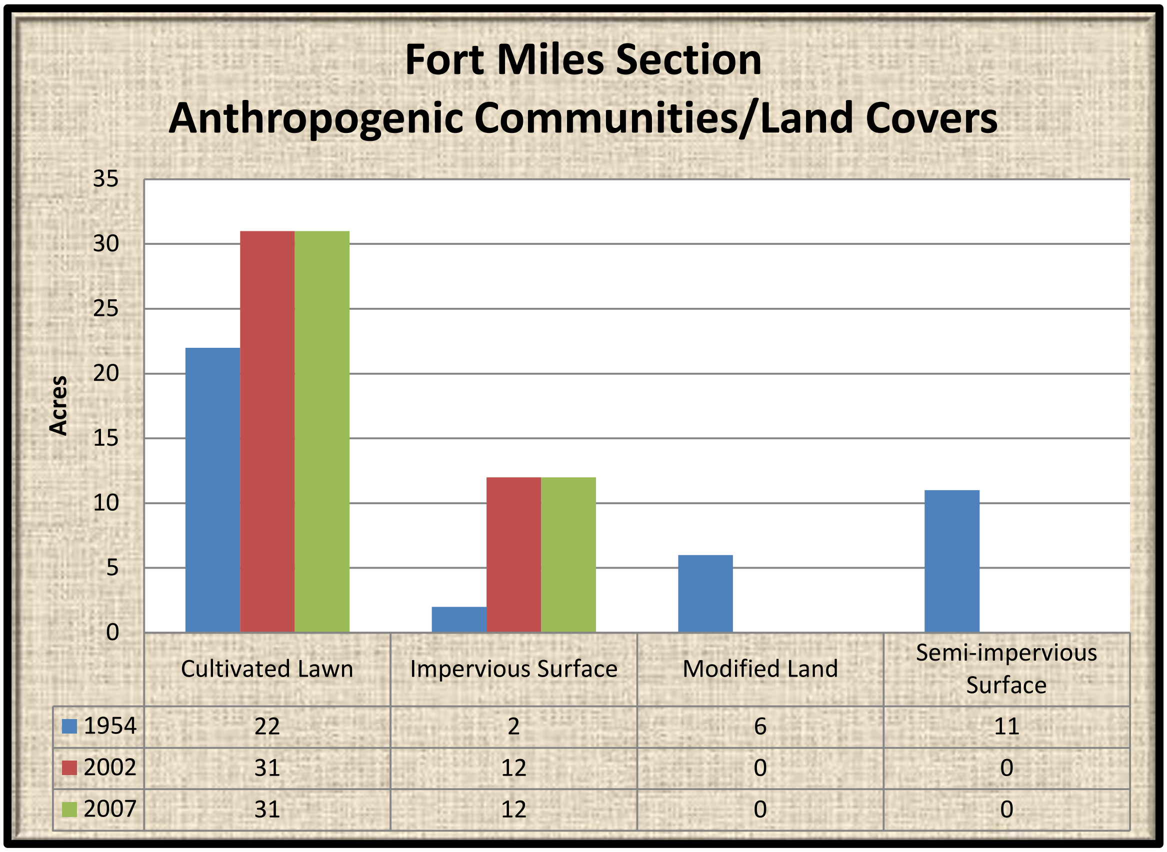


Figure 4-3.9. Fort Miles Section Anthropogenic Communities/Land Covers (1954, 2002, and 2007)

Fort Miles Section Anthropogenic Communities/Land Covers (Figure 4-3.9): Cultivated Lawn has increased along with Impervious Surface area in the section. Modified Land and Semi-impervious Surface have disappeared over time.

DNREC Sea Level Rise Analysis (Table 4-3.11)

Anthropogenic Communities/Land Covers will be impacted (19 acres) with 1 m of sea level rise. At 1.5 m of rise, about 24 acres will be impacted.

Table 4-3.11. Projected acres of the Fort Miles Section Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	19 acres
1.5 m	24 acres

Natural Capital

None of the Anthropogenic Communities/Land Covers in the Fort Miles Section have any capital value.

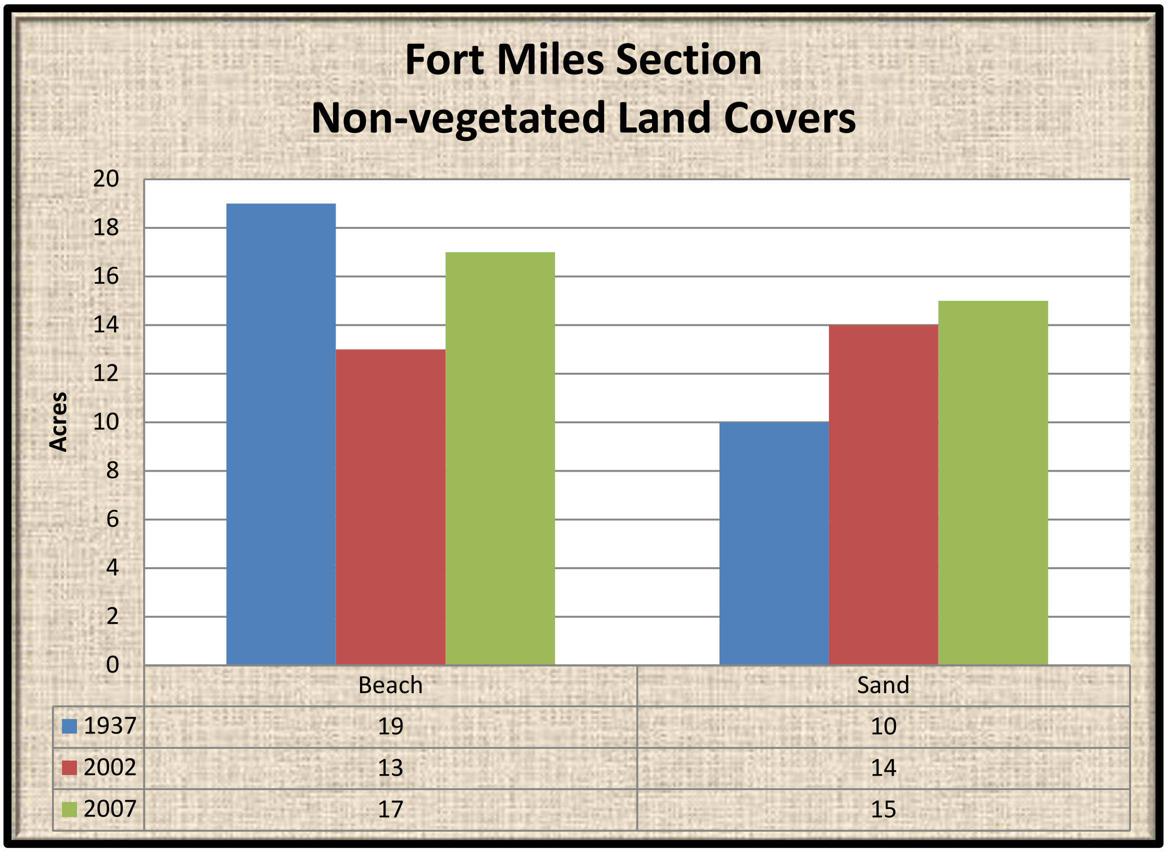


Figure 4-3.10. Fort Miles Section Non-vegetated Land Covers (1954, 2002, and 2007)

Fort Miles Section Non-vegetated Land Covers (Figure 4-3.10): The amount of Beach and Sand has remained relatively constant over the study period.

DNREC Sea Level Rise Analysis (Table 4-3.12)

Non-vegetated Land Covers will have some impacts under all of the sea level rise scenarios. At 0.5 m of rise, 6 acres will be flooded. At 1 m of rise, 9 acres will be inundated and at 1.5 m, 12 acres will be impacted. Both of these land covers will likely rise with the sea level.

Table 4-3.12. Projected acres of Fort Miles Section Non-vegetated Land Covers Inundated by Sea Level Rise

Rise	Acres
0.5 m	6 acres
1 m	9 acres
1.5 m	12 acres

Natural Capital

None of the non-vegetated land covers in the Fort Miles Section have any capital value.

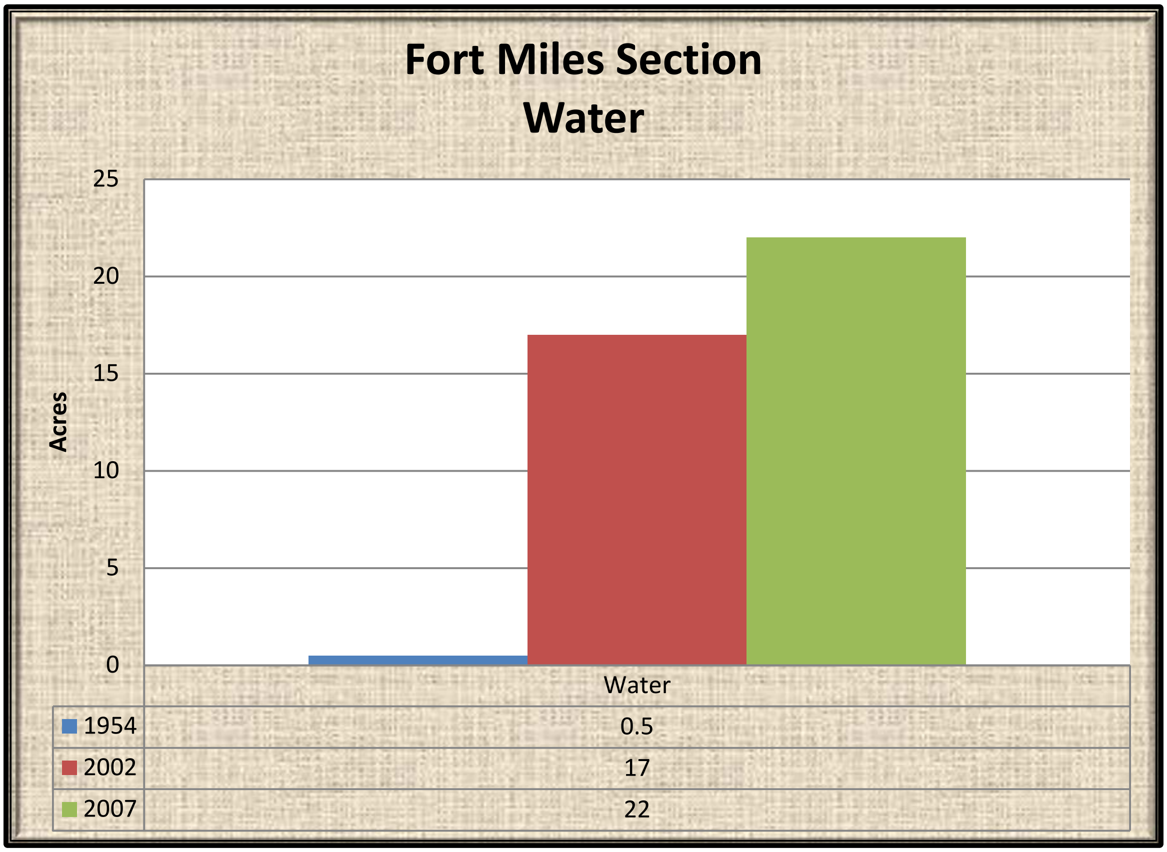


Figure 3-3.11. Fort Miles Section Water Coverage (1954, 2002, and 2007)

Fort Miles Section Water Coverage (Figure 3-3.11): The amount of water in the section has gradually increased over the study period. This could possibly be due to erosion of Great Dune.

Natural Capital (Table 4-3.13)

The capital of water in the Fort Miles Section has been increasing with its acreage.

Table 4-3.13. Natural Capital of Fort Miles Section Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$79/year (not present)
2002	$2,688/year
2007	$3,478/year

4. Gordons Pond Section

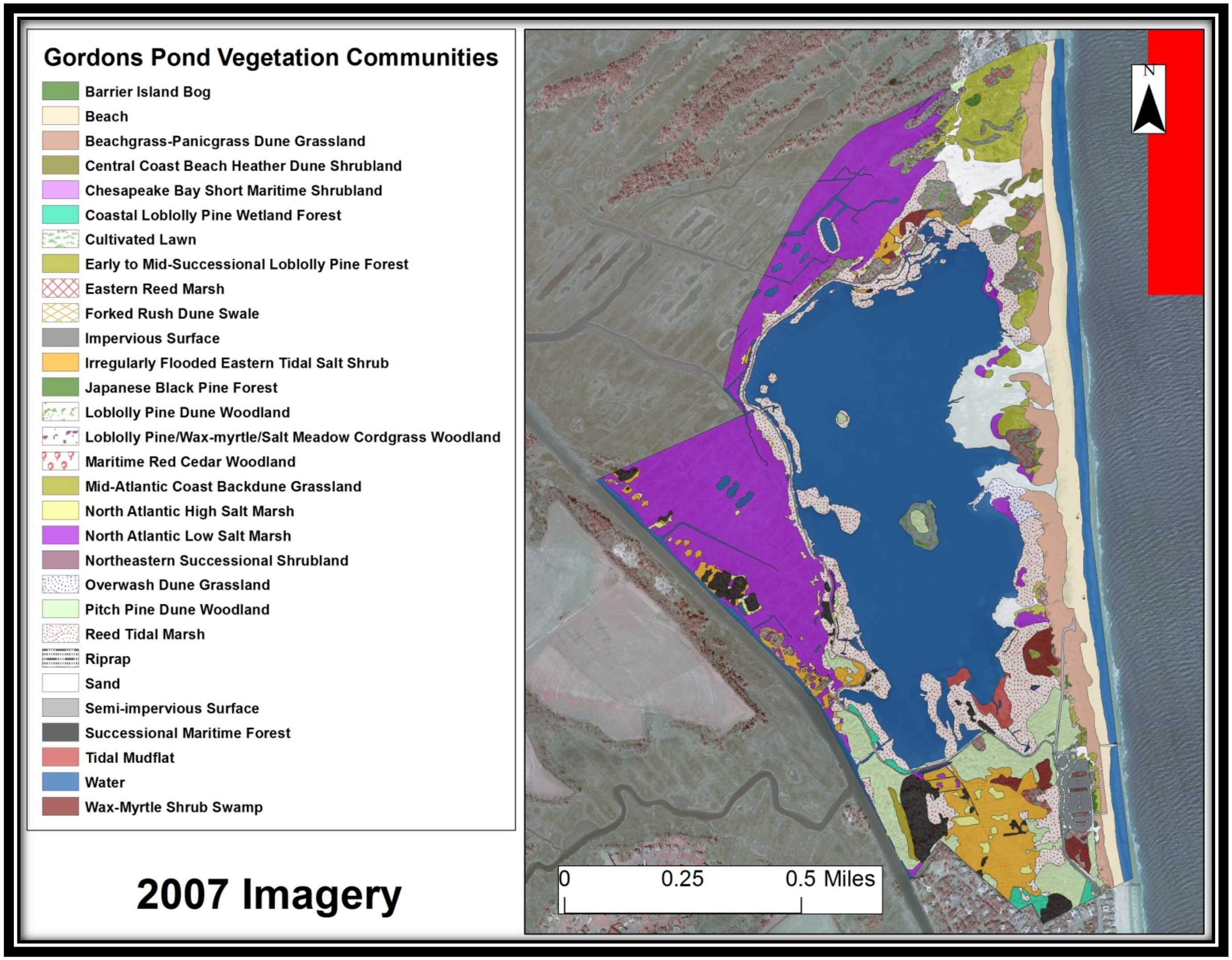


Figure 4-4.1. 2007 Vegetation Community map of Gordons Pond Section

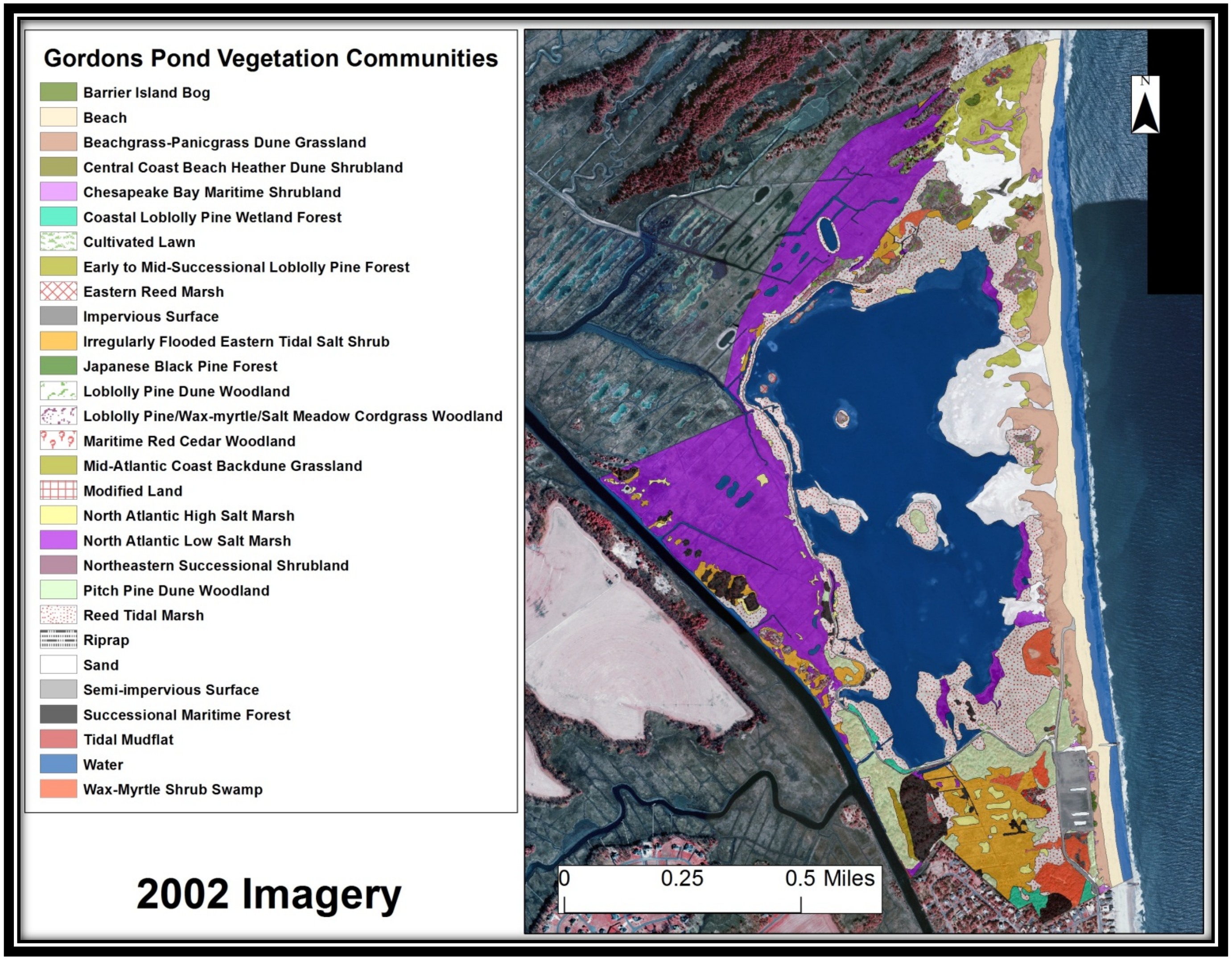


Figure 4-4.2. 2002 Vegetation Community map of Gordons Pond Section

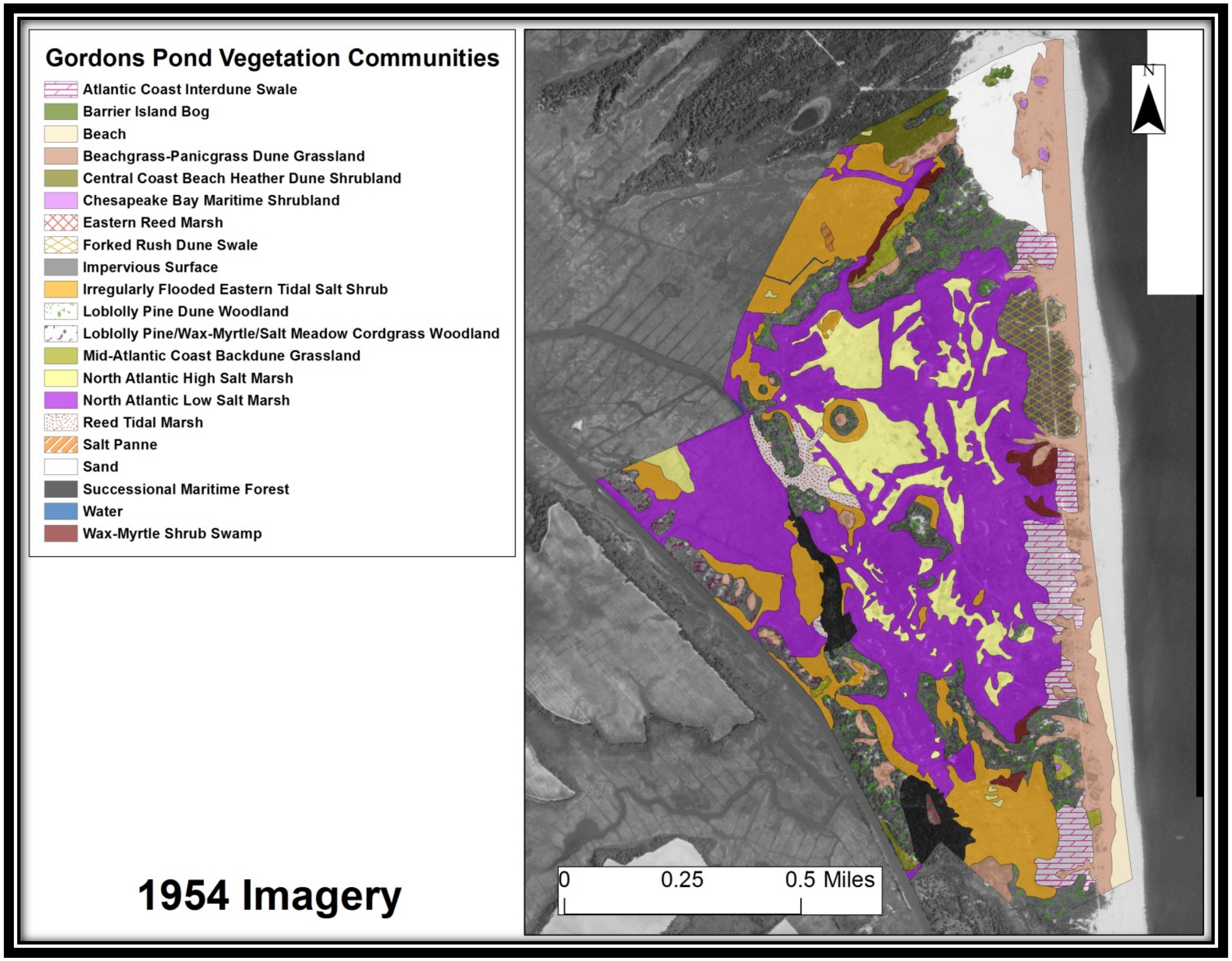
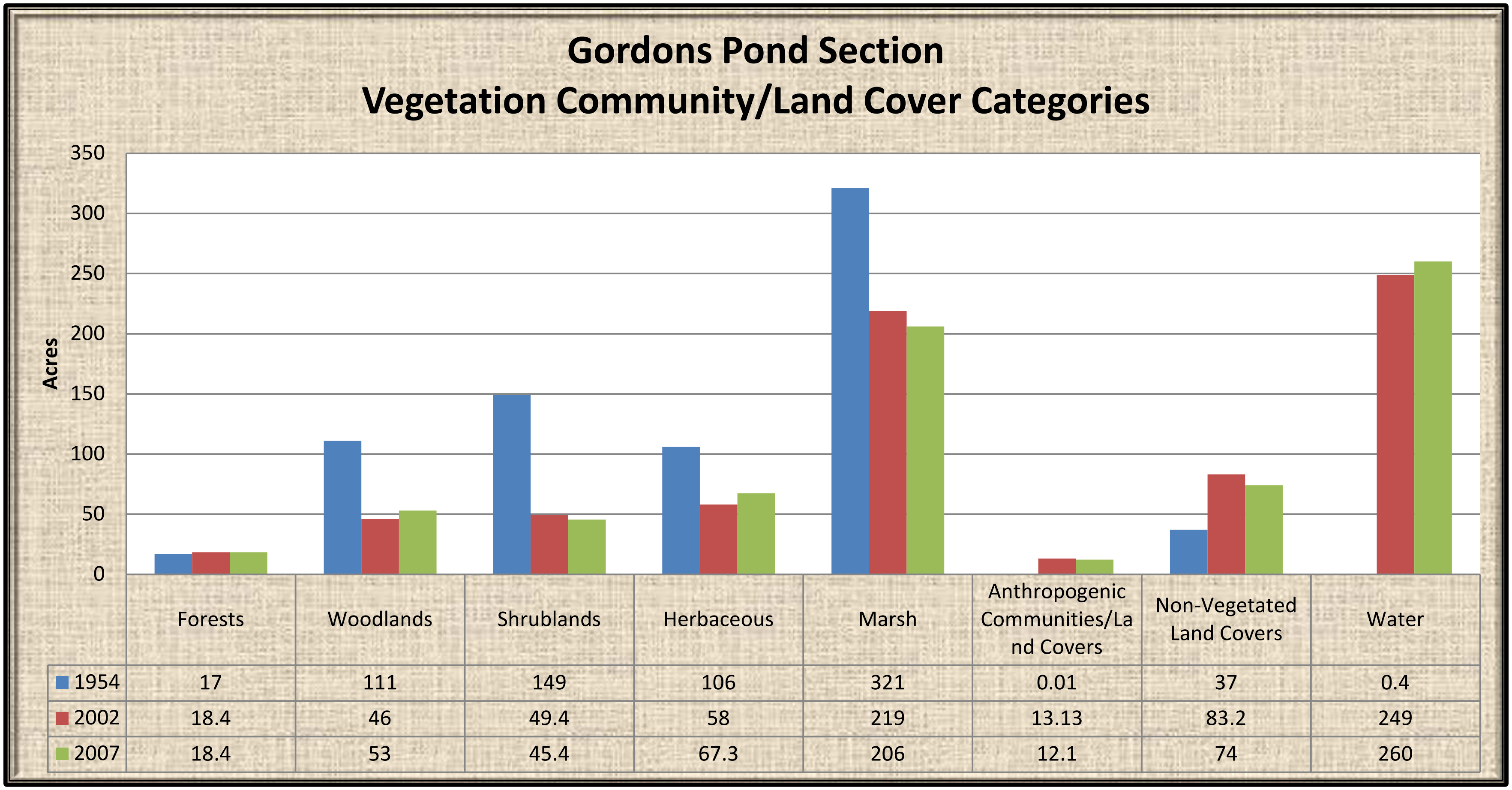


Figure 4-4.3. 1954 Vegetation Community Map of Gordons Pond Section



	Forests	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1954	17	111	149	106	321	0.01	37	0.4
2002	18.4	46	49.4	58	219	13.13	83.2	249
2007	18.4	53	45.4	67.3	206	12.1	74	260

Figure 4-4.4. Gordons Pond Section Vegetation Communities/Land Covers (1954, 2002, and 2007)

Gordons Pond Section Broad Trends (Figure 4-4.4): Gordons Pond is perhaps the section that has seen the most amount of change over the years. In 1954, what is now the pond was a large depression covered in North Atlantic Low Salt Marsh. Since 1954 the depression has filled with water and is semi-tidal with a tidal control structure. The filling in of the depression has greatly increased the amount of water within the park. Other communities have generally decreased over time owned to the amount of water increasing, exposure to erosion, sea level rise, and conversion to other communities.

DNREC Sea Level Rise Analysis (Table 4-4.1)

About 28 acres of the Fort Miles Section would be inundated with 0.5 m of sea level rise. At 1 m of rise, about half of the section would be underwater and at 1.5 m of rise, a little more than half would be flooded.

Table 4-4.1. Projected acres of the Gordons Pond Section Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	606 acres
1 m	653 acres
1.5 m	685 acres

Natural Capital (Table 4-4.2)

Eastern Reed Marsh is the only marsh present at Cape Point. This community occurs in depressions and is often covered by sand, especially during wind events. The capital has been going down because of sand covering the community.

Table 4-4.2. Natural Capital of the Gordons Pond Section	
Year	**Natural Capital (in 2012 dollars)**
1954	$3,021,035/year (not present)
2002	$1,726,390/year
2007	$1,660,671/year

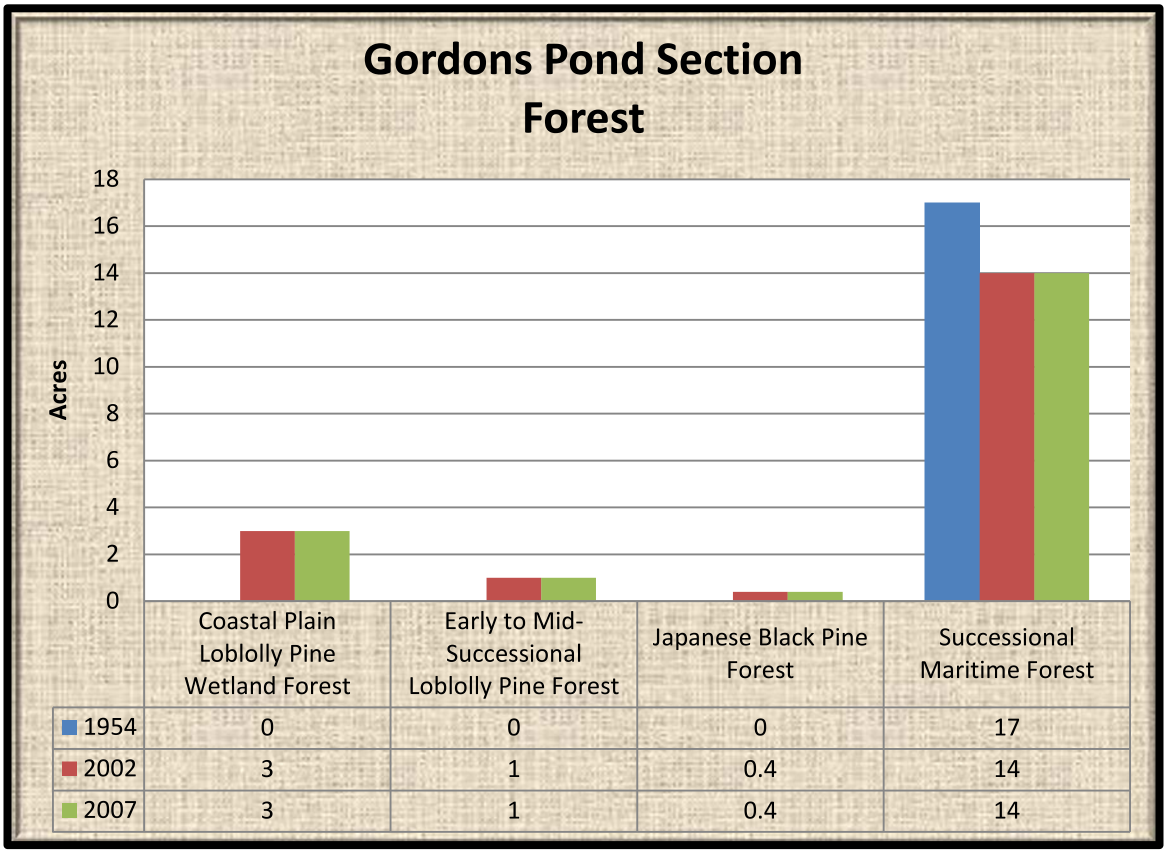


Figure 4-4.5. Gordons Pond Section Forest (1954, 2002, and 2007)

Gordons Pond Section Forest (Figure 4-4.5): Successional Maritime Forest is the most common forest with the Gordons Pond Section. Other forest types are minor to the section and have come about since 1954.

DNREC Sea Level Rise Analysis (Table 4-4.3)

Most of the forests in the Gordons Pond Section will be inundated with 0.5 m of rise. At 1 m and greater all of the forests will be flooded.

Table 4-4.3. Projected acres of Gordons Pond Section Forest Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	16 acres
1 m	18 acres
1.5 m	18 acres

Natural Capital (Table 4-4.4)

Eastern Reed Marsh is the only marsh present at Cape Point. This community occurs in depressions and is often covered by sand, especially during wind events. The capital has been going down because of sand covering the community.

Table 4-4.4. Natural Capital of Gordons Pond Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$3,215/year (not present)
2002	$39,787/year
2007	$39,787/year

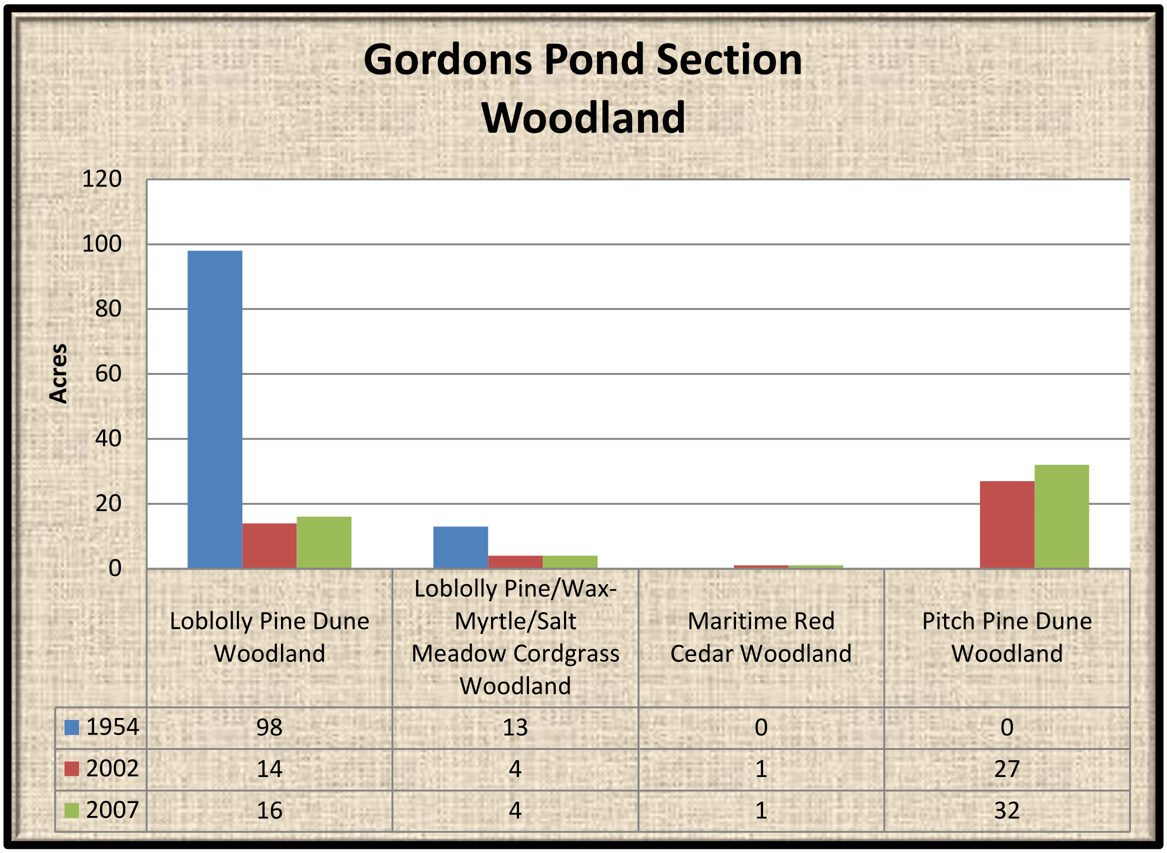


Figure 4-4.6. Gordons Pond Section Woodland (1954, 2002, and 2007)

Gordons Pond Section Woodland (Figure 4-4.6): Loblolly Pine Dune Woodland was once prominent in this section existing around the edges of the former marsh in 1954. Since this time it has been reduced to a small fringed around the pond and islands in the pond. Pitch Pine Dune Woodland coming from the north have also come about since 1954. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has been reduced as habitat has converted to marsh or shrubland.

DNREC Sea Level Rise Analysis (Table 4-4.5)

Most of the woodland in the Gordons Pond Section will be inundated with 0.5 m of sea level rise and they will be essentially totally flooded with 1 m and greater sea level rise.

Table 4-4.5. Projected acres of Gordons Pond Section Woodland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	41 acres
1 m	51 acres
1.5 m	52 acres

Natural Capital (Table 4-4.6)

Woodland capital has decreased since 1954 with losses in Loblolly Pine Dune Woodland. Recently (2002-2007) there has been a slight uptick with an increase in Loblolly Pine Dune Woodland.

Table 4-4.6. Natural Capital of Gordons Pond Section Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$178,321/year
2002	$57,108/year
2007	$58,432/year

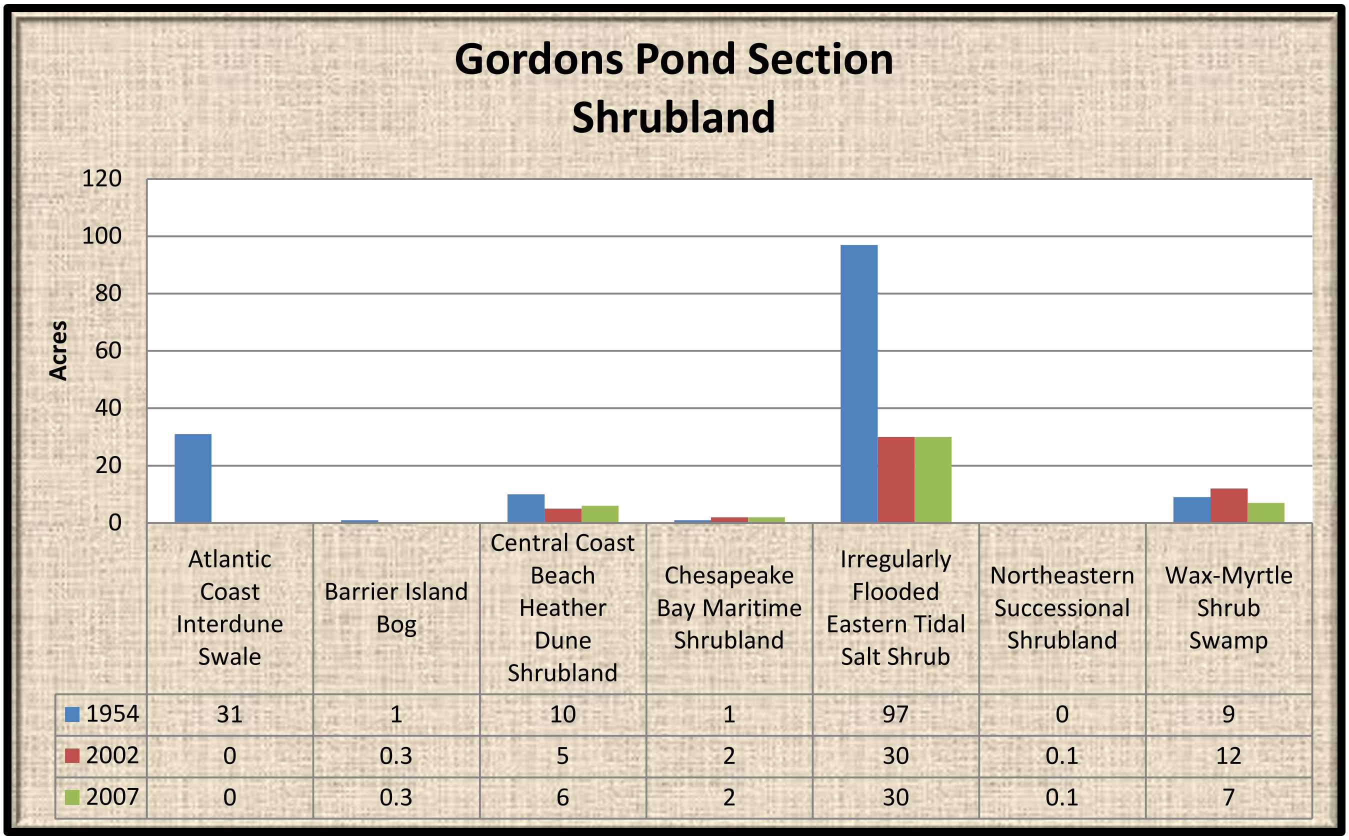


Figure 4-4.7. Gordons Pond Section Shrubland (1954, 2002, and 2007)

Gordons Pond Section Shrubland (Figure 4-4.7): Irregularly Flooded Eastern Tidal Salt Shrub is the most prominent shrubland today but has like almost every other shrubland been reduced from its amount in 1954. Chesapeake Bay Maritime Shrubland has increased by one acre over the study period and is now relatively stable in amount over the recent period (2002-2007).

DNREC Sea Level Rise Analysis (Table 4-4.7)

About 2/3 of the existing shrubland would be inundated with 0.5 m of sea level rise. At 1 m of rise an additional acre would be flooded and at 1.5 m 34 total acres would be inundated.

Table 4-4.7. Projected acres of Gordons Pond Section Shrubland Inundated by Sea Level Rise

Rise	Acres
0.5 m	30 acres
1 m	31 acres
1.5 m	34 acres

Natural Capital (Table 4-4.8)

Capital of shrubland has gone down markedly from its high in 1954. Since 2002, it has come up slightly on an increase in acreage from Central Coast Beach Heather Dune Shrubland.

Table 4-4.8. Natural Capital of Gordons Pond Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$609,919/year
2002	$189,174/year
2007	$189,319/year

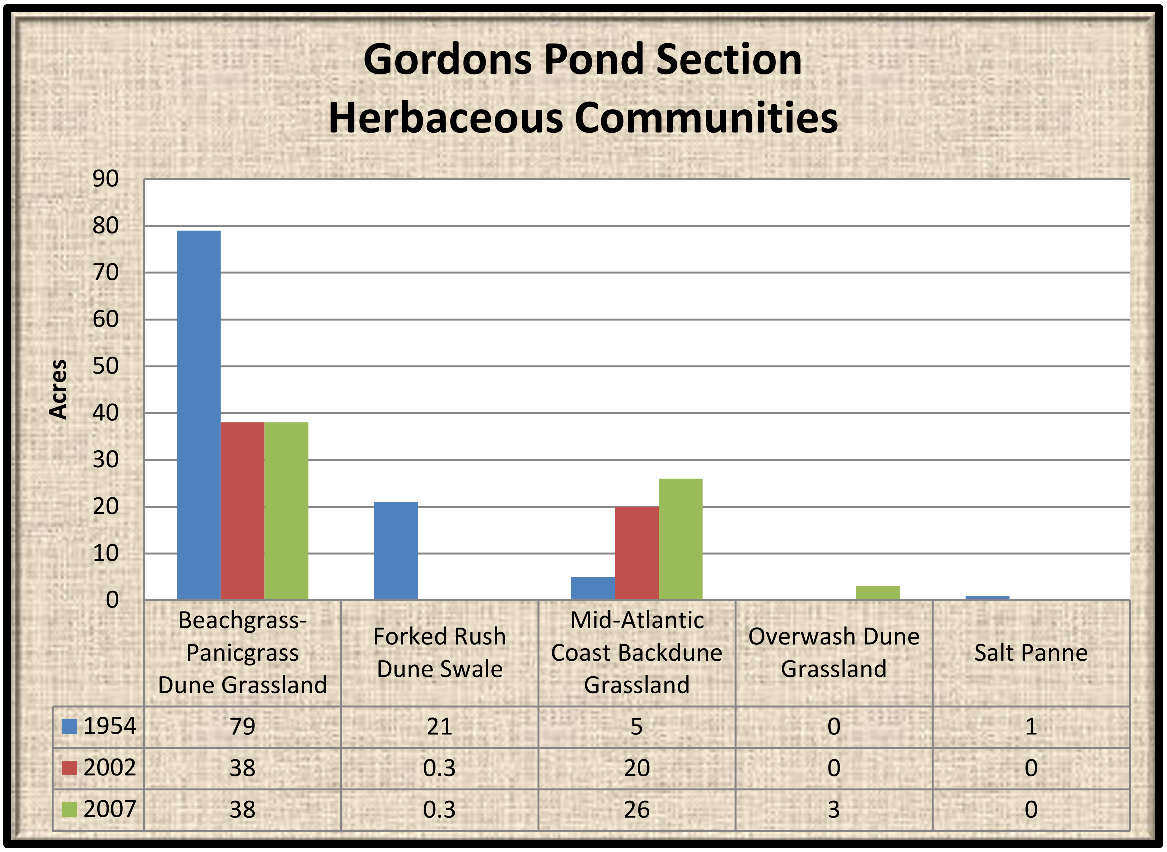


Figure 4-4.8. Gordons Pond Section Herbaceous Communities (1954, 2002, and 2007)

Gordons Pond Section Herbaceous Communities (Figure 4-4.8): Beachgrass-Panicgrass Dune Grassland is located on the ocean ward dunes and is the most prominent herbaceous community. Mid-Atlantic Coast Backdune Grassland is located between the first line of dunes and the pond. Forked Rush Dune Swale was once common in the section but has since declined or has been taken over by Eastern Reed Marsh.

DNREC Sea Level Rise Analysis (Table 4-4.9)

A lot of the herbaceous communities in the Gordons Pond Section are located at the tops of dunes reducing their exposure to sea level rise. At the greatest amount of the rise in the scenarios (1.5 m) only about half of the existing acreage will be inundated.

Table 4-4.9. Projected acres of Gordons Pond Section Herbaceous Communities Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	7 acres
1 m	15 acres
1.5 m	34 acres

Natural Capital (Table 4-4.10)

Capitalization of herbaceous communities, like the shrub communities, has gone down since 1954 but has also experienced a slight uptick from 2002 with an increase in Overwash Dune Grassland.

Table 4-4.10. Natural Capital of Gordons Pond Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$213,420/year
2002	$11,235/year
2007	$12,546/year

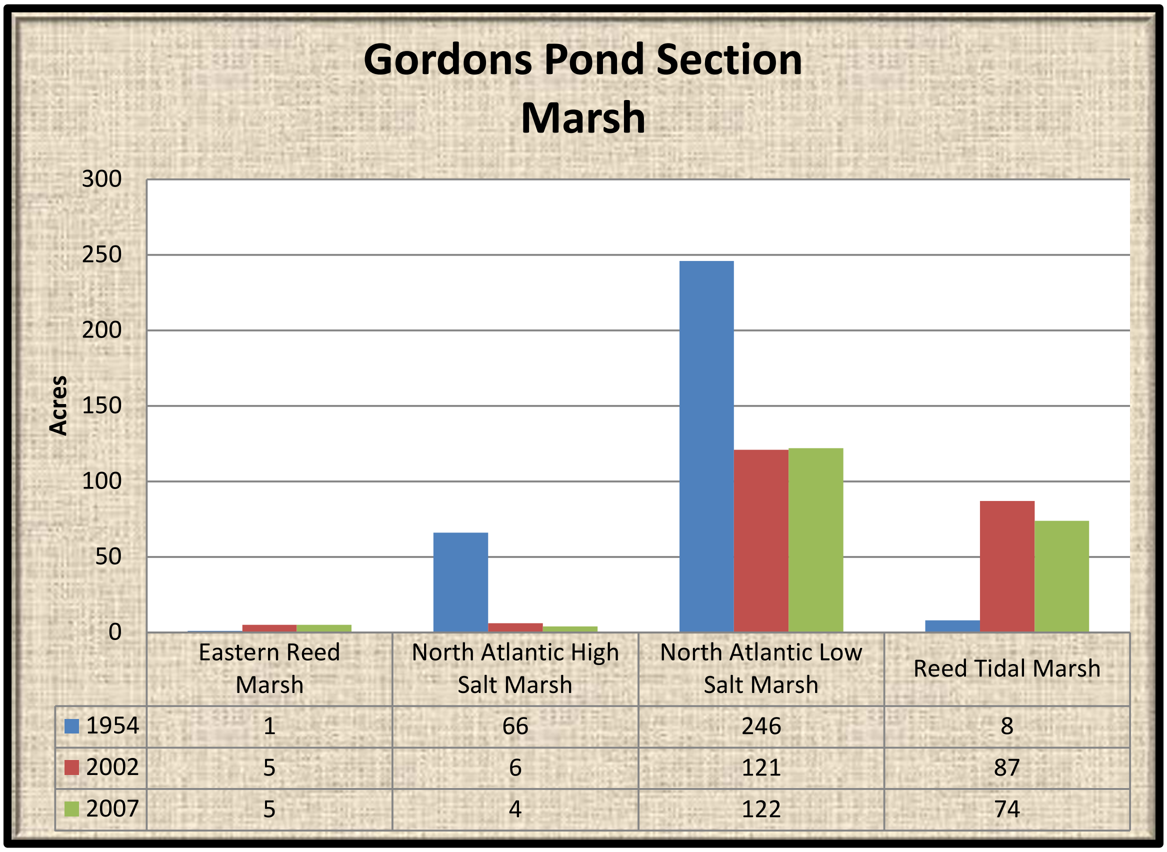


Figure 4-4.9. Gordons Pond Section Marsh (1954, 2002, and 2007)

Gordons Pond Section Marsh (Figure 4-4.9): North Atlantic Low Salt Marsh is common in the land areas of the former depression along with Reed Tidal Marsh. North Atlantic High Salt Marsh was once common on the more upland parts of the depression but has declined to 4 acres and continues to decline. Eastern Reed Marsh has taken over some of the smaller depressions occupied by interdune swales.

DNREC Sea Level Rise Analysis (Table 4-4.11)

A lot of the herbaceous communities in the Gordons Pond Section are located at the tops of dunes reducing their exposure to sea level rise. At the greatest amount of the rise in the scenarios (1.5 m) only about half of the existing acreage will be inundated.

Table 4-4.11. Projected acres of Gordons Pond Section Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	7 acres
1 m	15 acres
1.5 m	34 acres

Natural Capital (Table 4-4.12)

Capital of marshland has decreased with losses in North Atlantic High Salt Marsh and North Atlantic Low Salt Marsh.

Table 4-4.12. Natural Capital of Gordons Pond Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$2,016,097/year
2002	$1,388,465/year
2007	$1,300,667/year

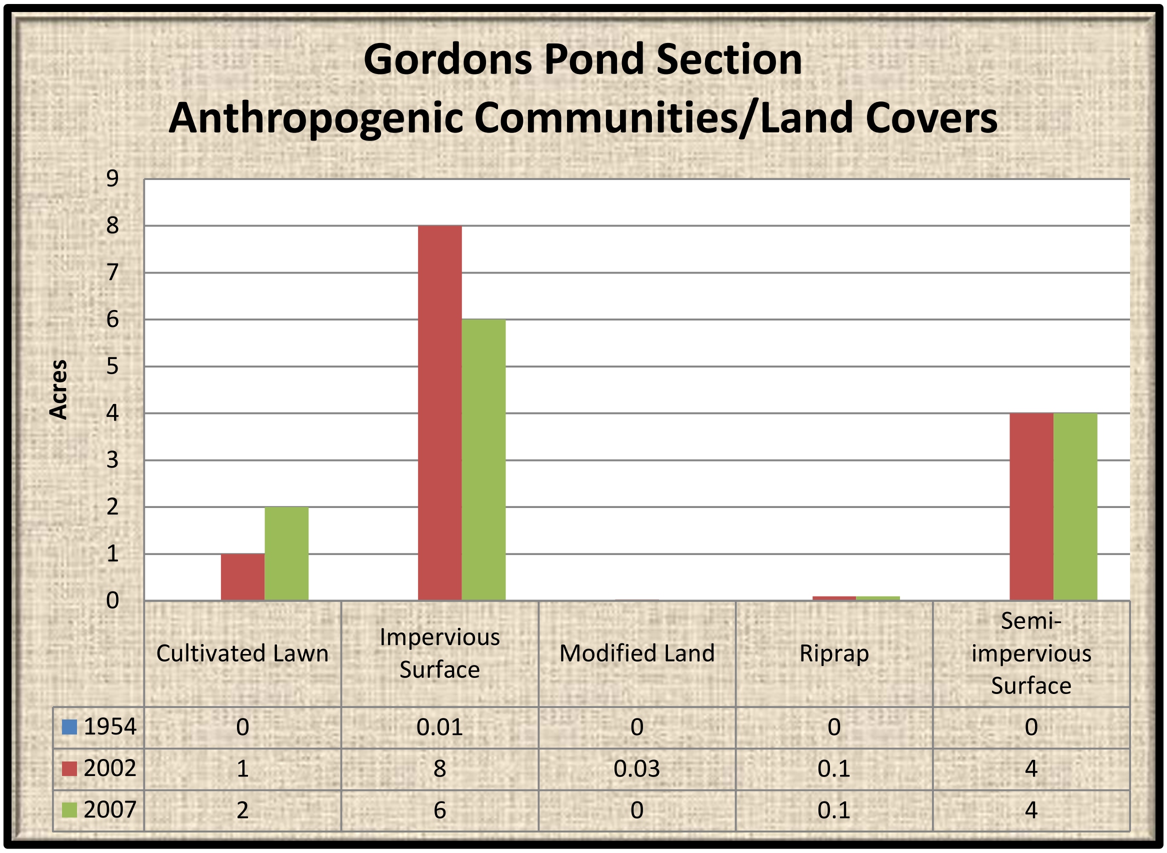


Figure 4-4.10. Gordons Pond Section Anthropogenic Communities/Land Covers (1954, 2002, and 2007)

Gordons Pond Section Anthropogenic Communities/Land Covers (Figure 4-4.10): Impervious Surface has increased in the section with the addition of a paved parking lot at the south end. Most of the semi-impervious surface is composed of the trail that goes around the pond.

DNREC Sea Level Rise Analysis (Table 4-4.13)

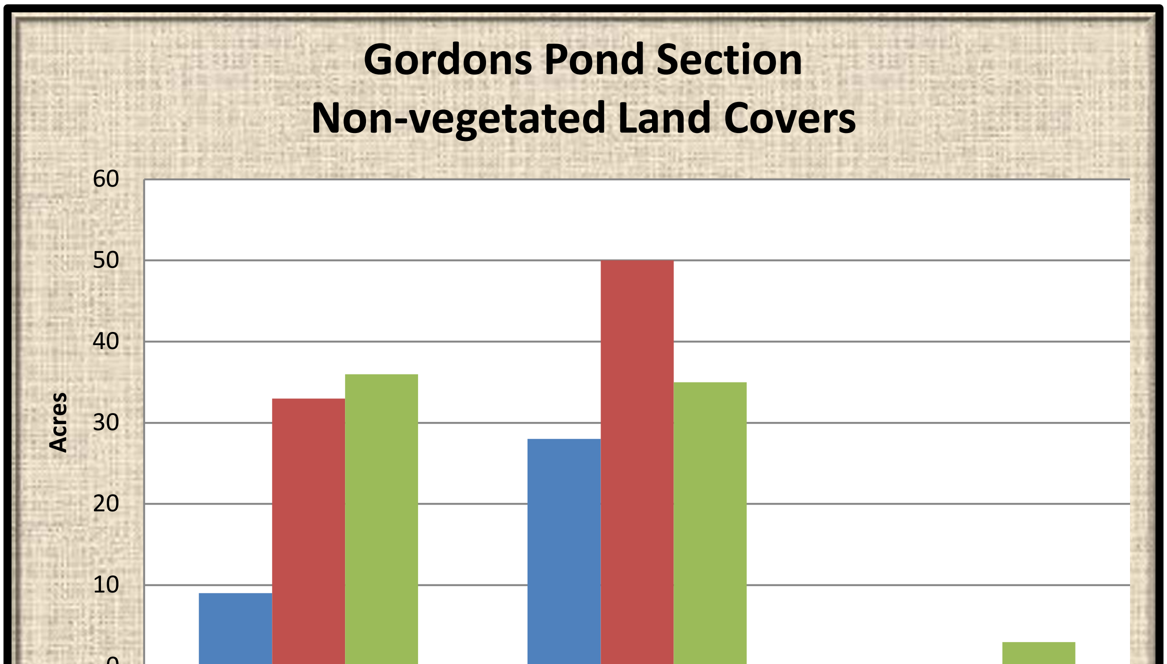
Anthropogenic Communities/Land Covers will gradually be inundated by sea level rise and at the greatest amount of rise will be totally covered by water.

Table 4-4.13. Projected acres of Gordons Pond Section Anthropogenic Communities/Land Covers Inundated by Sea Level Rise

Rise	Acres
0.5 m	4 acres
1 m	9 acres
1.5 m	12 acres

Natural Capital (Table 4-4.14)

None of the Anthropogenic Communities/Land Covers in the Gordons Pond Section have any capital value.



	Beach	Sand	Tidal Mudflat
1954	9	28	0
2002	33	50	0.2
2007	36	35	3

Figure 4-4.11. Gordons Pond Section Non-vegetated Land Covers (1954, 2002, and 2007)

Gordons Pond Section Non-vegetated Land Covers (Figure 4-4.11): The amount of beach in the section has increased over the years and could be due to renourishment projects happening to the south in Rehoboth Beach, DE. The amount of sand, however, has remained relatively constant. Tidal mudflats have increased in the Lewes and Rehoboth Canal area.

DNREC Sea Level Rise Analysis (Table 4-4.15)

Beach and Tidal Mudflat are the most vulnerable non-vegetated communities in the Gordons Pond Section. Some of the sand coverage is located at the tops of dunes where it is protected from the rise. At the greatest amount of rise (1.5 m), about 62 acres will be flooded.

Table 4-4.15. Projected acres of Gordons Pond Section Non-vegetated Land Covers Inundated by Sea Level Rise

Rise	Acres
0.5 m	40 acres
1 m	57 acres
1.5 m	62 acres

Natural Capital (Table 4-4.16)

Tidal Mudflat is the only non-vegetated community with capital in the Gordons Pond Section. It was not present in 1954 and has since risen to $18,814/year mainly from losses in the tidal marsh.

Table 4-4.16. Natural Capital of Gordons Pond Section Non-vegetated Communities

Year	Natural Capital (in 2012 dollars)
1954	$0/year (not present)
2002	$1,254/year
2007	$18,814/year

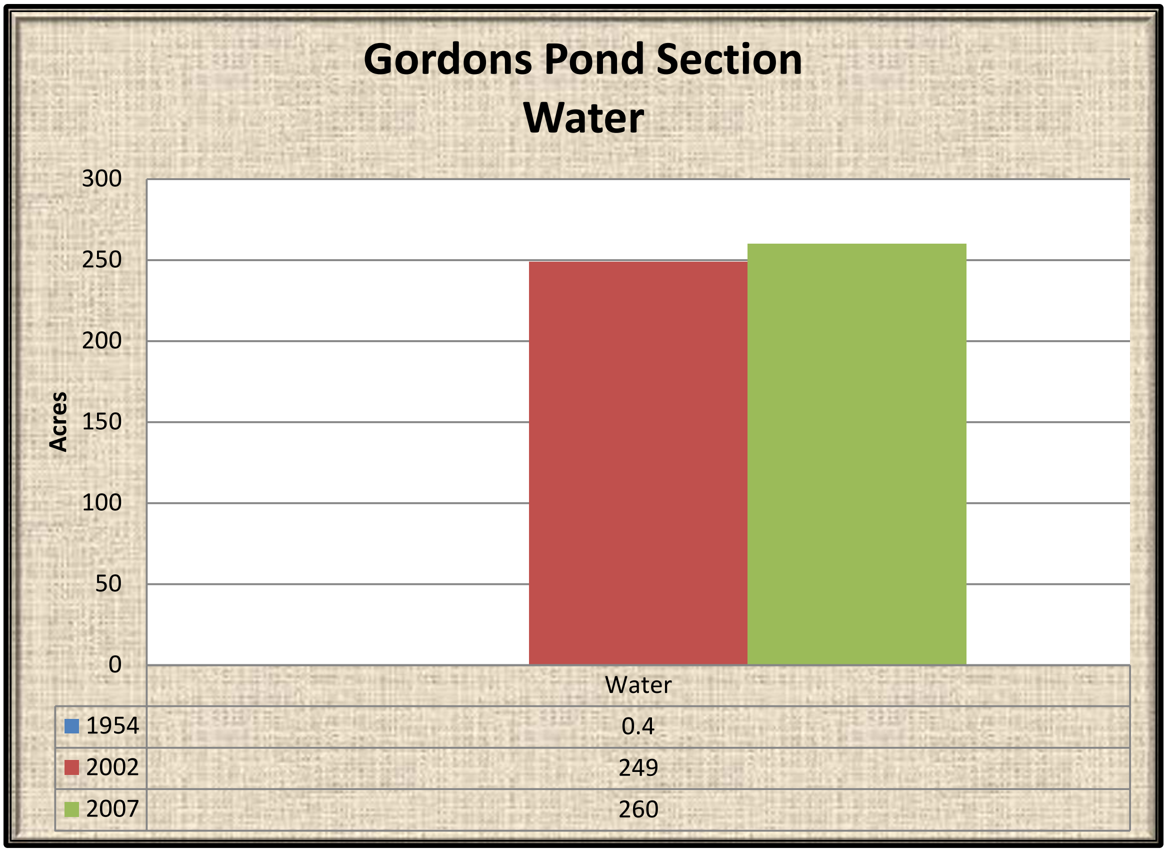


Figure 4-4.12. Gordons Pond Section Water Coverage (1954, 2002, and 2007)

Gordons Pond Section Water Coverage (Figure 4-4.12): The amount of water has greatly increased with the filling in of the depression that is now Gordons Pond. This increase continues into the recent period (2002-2007).

Natural Capital (Table 4-4.17)

Most, if not all, of the capital from water comes from the filling of Gordons Pond when it breached at some point between 1954 and 2002. The amount continues to increase as the pond gets bigger.

Table 4-4.17. Natural Capital of Gordons Pond Section Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$63/year
2002	$39,367/year
2007	$41,106/year

5. Great Dune Section

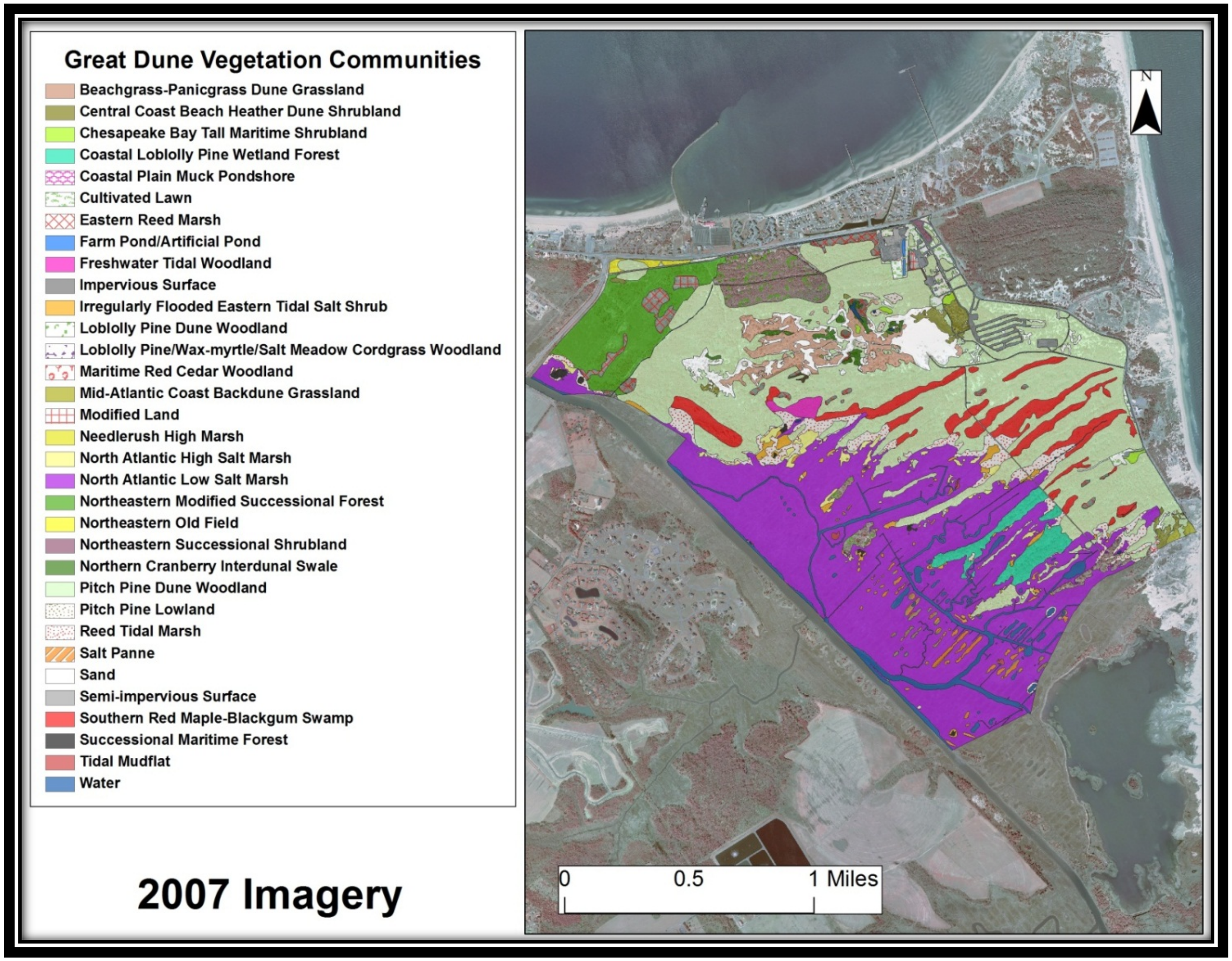


Figure 4-5.1. 2007 Vegetation Community Map of Great Dune Section

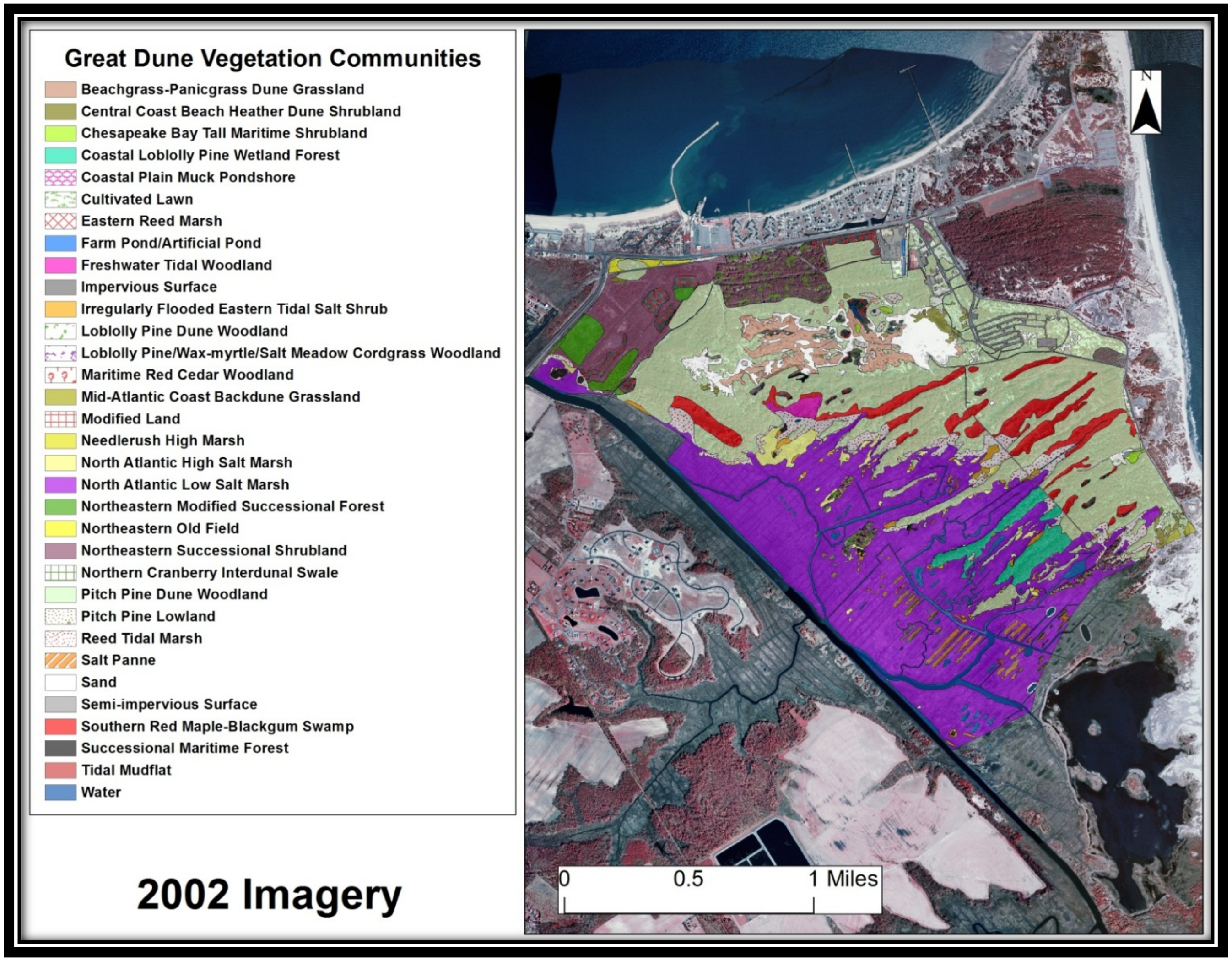


Figure 4-4.2. 2002 Vegetation Community Map of Great Dune Section

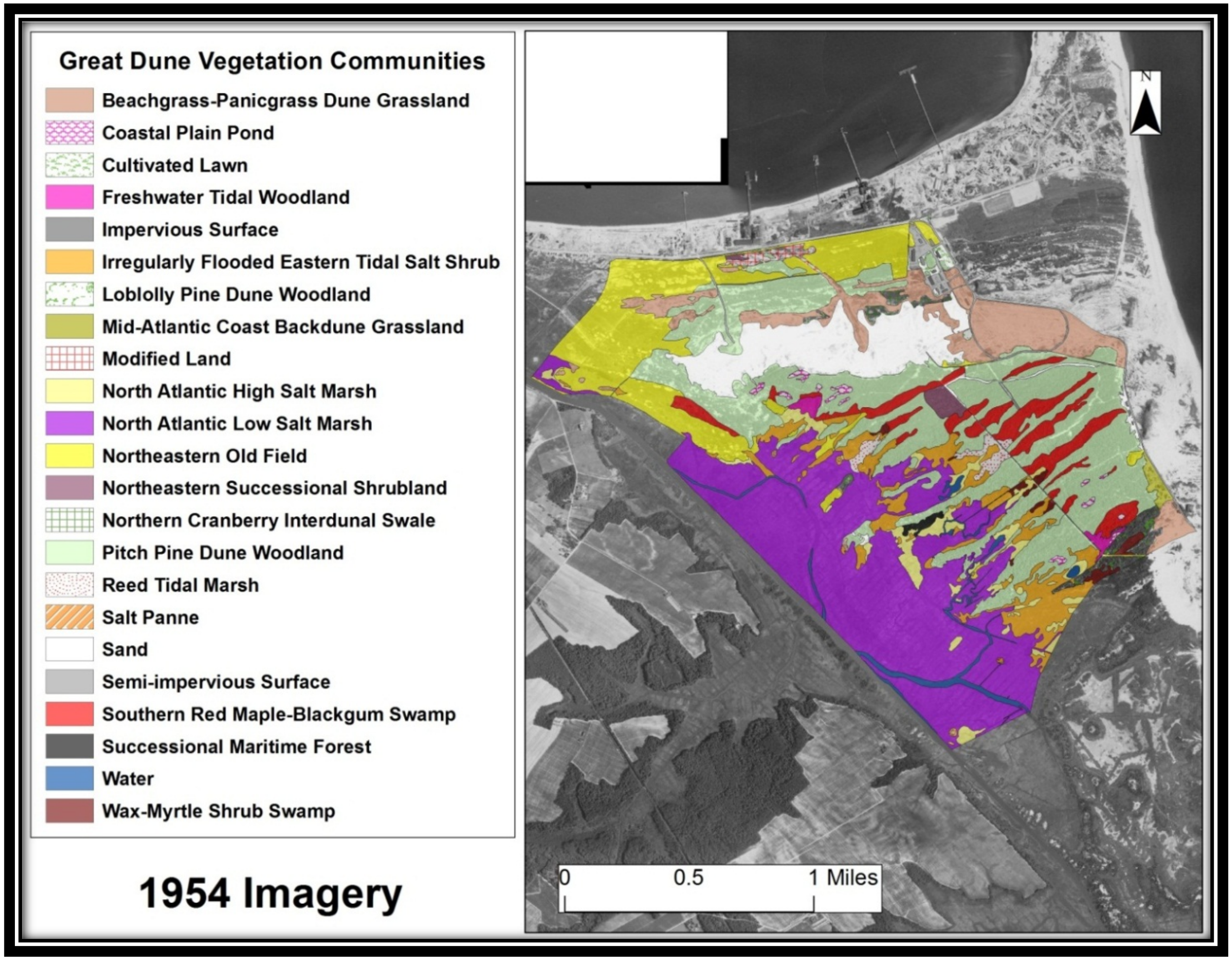
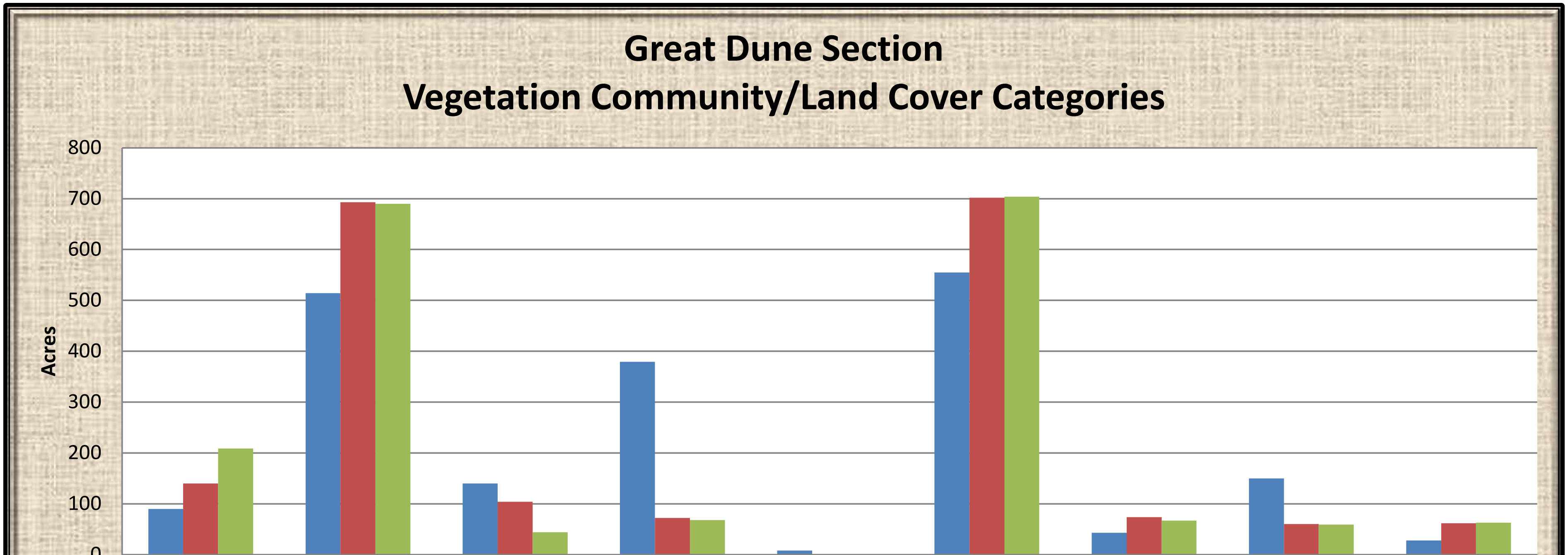


Figure 4-4.3. 1954 Vegetation Community Map of Great Dune Section



	Forests	Woodlands	Shrublands	Herbaceous	Coastal Plain Ponds	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1954	90	514	140	379	8	555	43	150	28
2002	140	693	104	72	1	702.03	74	60	62
2007	209	690	44	68	1	704.03	67	59	63

Figure 4-5.4. Great Dune Section Vegetation Communities/Land Covers (1954, 2002, and 2007)

Great Dune Section Broad Trends (Figure 4-5.4): The Great Dune Section covers most of the west section of the park east of the Lewes and Rehoboth Canal. It composed primarily of marshland adjacent to the Lewes and Rehoboth Canal, Woodland in long fingers going into the marsh, and forests between the arms of the woodland fingers. All of the water coverage in this section comes from the canal side and increases in water coverage are likely due to sea level rise, which has led to an increase in water over time.

DNREC Sea Level Rise Analysis (Table 4-5.1)

Despite the high dunes present in this section, there is still a lot of marshland that is vulnerable to sea level rise. At 0.5 m of sea level more than half of the section is inundated. At 1 m of rise an additional 282 acres is flooded. At 1.5 m about 1,600 acres will be flooded or more than ¾ of the section.

Table 4-5.1. Projected acres of the Great Dune Section Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	1,139 acres
1 m	1,421 acres
1.5 m	1,597 acres

Natural Capital (Table 4-5.2)

Natural capital of the Great Dune Section has been going up with maturation of the forests and additions of estuarine water in the western marshes.

Table 4-5.2. Natural Capital of the Great Dune Section	
Year	**Natural Capital (in 2012 dollars)**
1954	$5,960,630/year
2002	$7,374,949/year
2007	$7,432,046/year

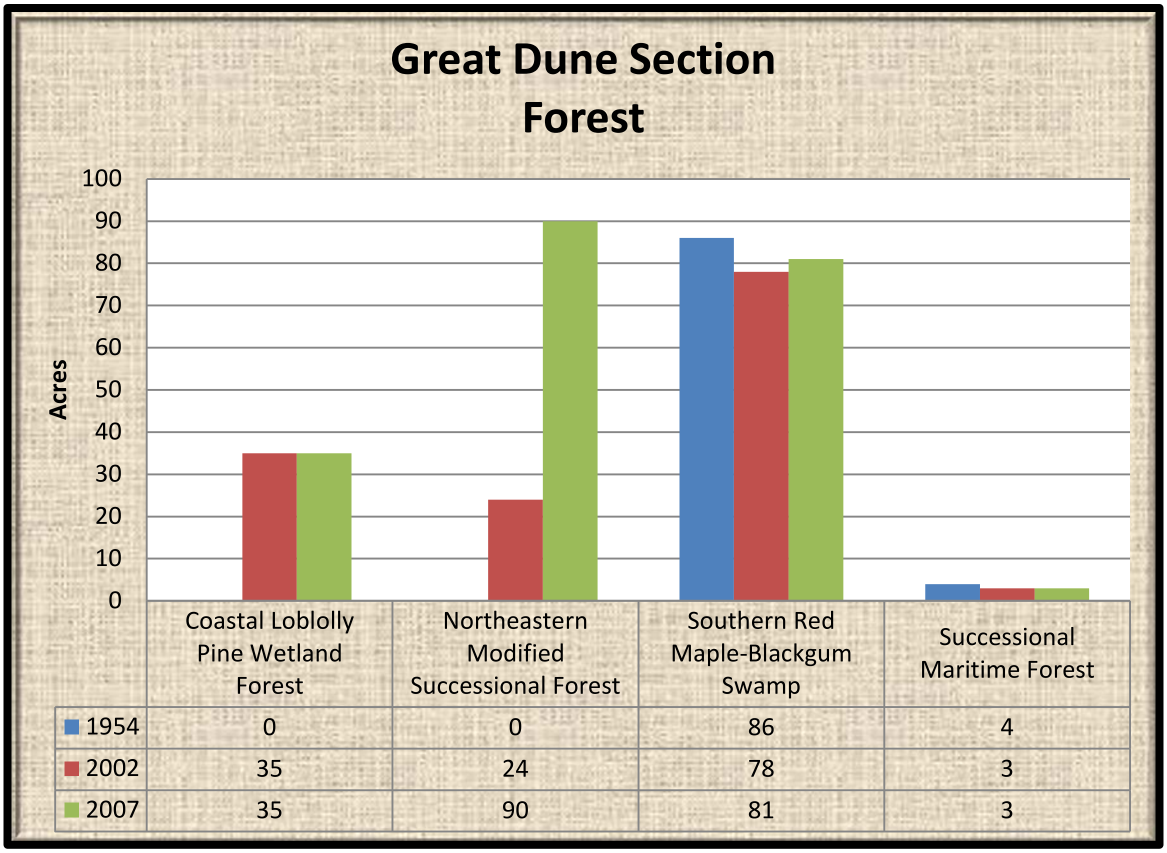


Figure 4-5.5. Great Dune Section Forest (1954, 2002, and 2007)

Great Dune Section Forest (Figure 4-5.5): Northeastern Modified Successional Forest that is located in an old sand mine area and Southern Red Maple-Blackgum Swamp in between the woodland fingers are most common forest types in the Great Dune Section. Coastal Loblolly Pine Wetland Forest is located just to the south of Great Dune near the edge of the marsh.

DNREC Sea Level Rise Analysis (Table 4-5.3)

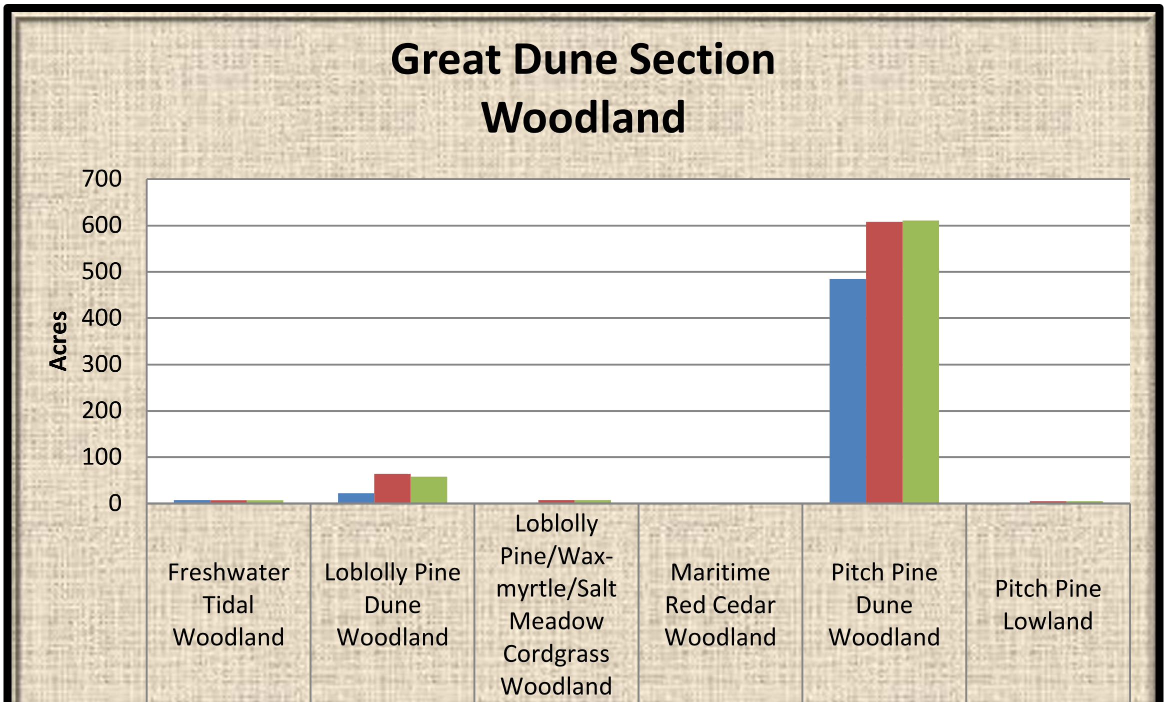
Coastal Loblolly Pine Wetland Forest and Southern Red Maple-Blackgum Swamp are the most vulnerable forests in the Great Dune Section. At the greatest amount of rise more than ¾ of the forest will be inundated.

Table 4-5.3. Projected acres of Great Dune Section Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	96 acres
1 m	150 acres
1.5 m	178 acres

Natural Capital (Table 4-5.4)

Capitalization of forest land in the Great Dune Section has increased with increasing acreage. A lot of gains were made from the maturation of a shrubland in an old quarry area between 2002 and 2007.

Table 4-5.4. Natural Capital of Great Dune Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,057,825/year
2002	$1,394,045/year
2007	$1,443,400/year



	Freshwater Tidal Woodland	Loblolly Pine Dune Woodland	Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland	Maritime Red Cedar Woodland	Pitch Pine Dune Woodland	Pitch Pine Lowland
1954	8	22	0	0	484	0
2002	7	64	8	1	608	5
2007	7	58	8	1	611	5

Figure 4-5.6. Great Dune Section Woodland (1954, 2002, and 2007)

Great Dune Section Woodland (Figure 4-5.6): Pitch Pine Dune Woodland is by far the most common woodland in this section with a small amount of Loblolly Pine Dune Woodland present in the northwestern section and in the southern parts of Great Dune. Some smaller woodlands, Freshwater Tidal Woodland, Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland, Maritime Red Cedar Woodland, and Pitch Pine Lowland, are scattered around the section.

DNREC Sea Level Rise Analysis (Table 4-5.5)

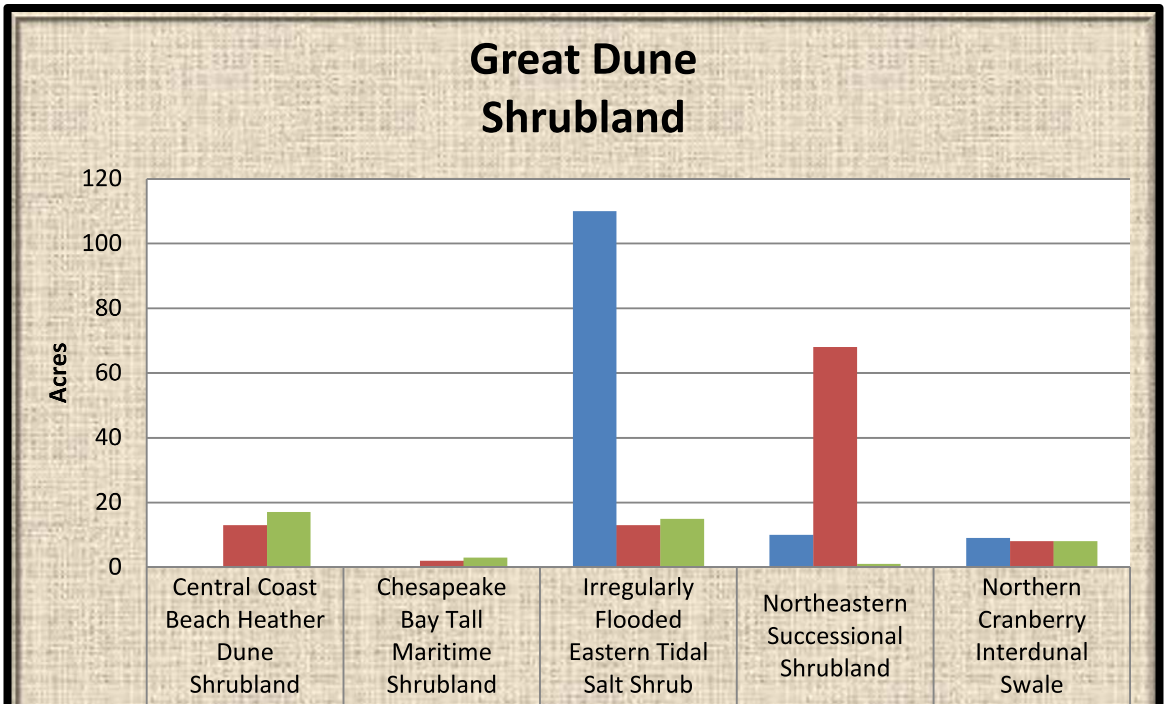
Most of the woodlands that will be impacted by sea level in the Great Dune Section are located on the peninsular "fingers" that go into the marsh. At 0.5 m of rise 257 acres will be flooded. At 1.5 m of rise, 540 acres will be inundated.

Table 4-5.5. Projected acres of Great Dune Section Woodland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	257 acres
1 m	442 acres
1.5 m	540 acres

Natural Capital (Table 4-5.6)

Capitalization of woodland has gone up overall with a slight decline in the recent period (2002-2007) due to a loss of Loblolly Pine Dune Woodland.

Table 4-5.6. Natural Capital of Great Dune Section Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$194,017/year
2002	$373,094/year
2007	$372,527/year



	Central Coast Beach Heather Dune Shrubland	Chesapeake Bay Tall Maritime Shrubland	Irregularly Flooded Eastern Tidal Salt Shrub	Northeastern Successional Shrubland	Northern Cranberry Interdunal Swale
1954	0	0	110	10	9
2002	13	2	13	68	8
2007	17	3	15	1	8

Figure 4-5.7. Great Dune Shrubland (1954, 2002, and 2007)

Great Dune Section Shrubland (Figure 4-5.7): Central Coast Beach Heather Dune Shrubland located on sandy areas of Great Dune and Irregularly Flooded Eastern Tidal Salt Shrub located on the edges of the marsh are the most common shrublands. This section has the most acreage of Northern Cranberry Interdunal Swale in the park. One small area of Chesapeake Bay Tall Maritime Shrubland is located in a sheltered area on the north end of Great Dune.

DNREC Sea Level Rise Analysis (Table 4-5.7)

Coastal Loblolly Pine Wetland Forest and Southern Red Maple-Blackgum Swamp are the most vulnerable forests in the Great Dune Section. At the greatest amount of rise more than ¾ of the forest will be inundated.

Table 4-5.7. Projected acres of Great Dune Section Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	96 acres
1 m	150 acres
1.5 m	178 acres

Natural Capital (Table 4-5.8)

Shrubland capital is has decreased since 1954 mainly from a decrease in Irregularly Flooded Eastern Tidal Salt Shrub. However, the amount has recently increased from a slight uptick in acreage from this same community.

Table 4-5.8. Natural Capital of Great Dune Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$691,300/year
2002	$93,620/year
2007	$97,129/year

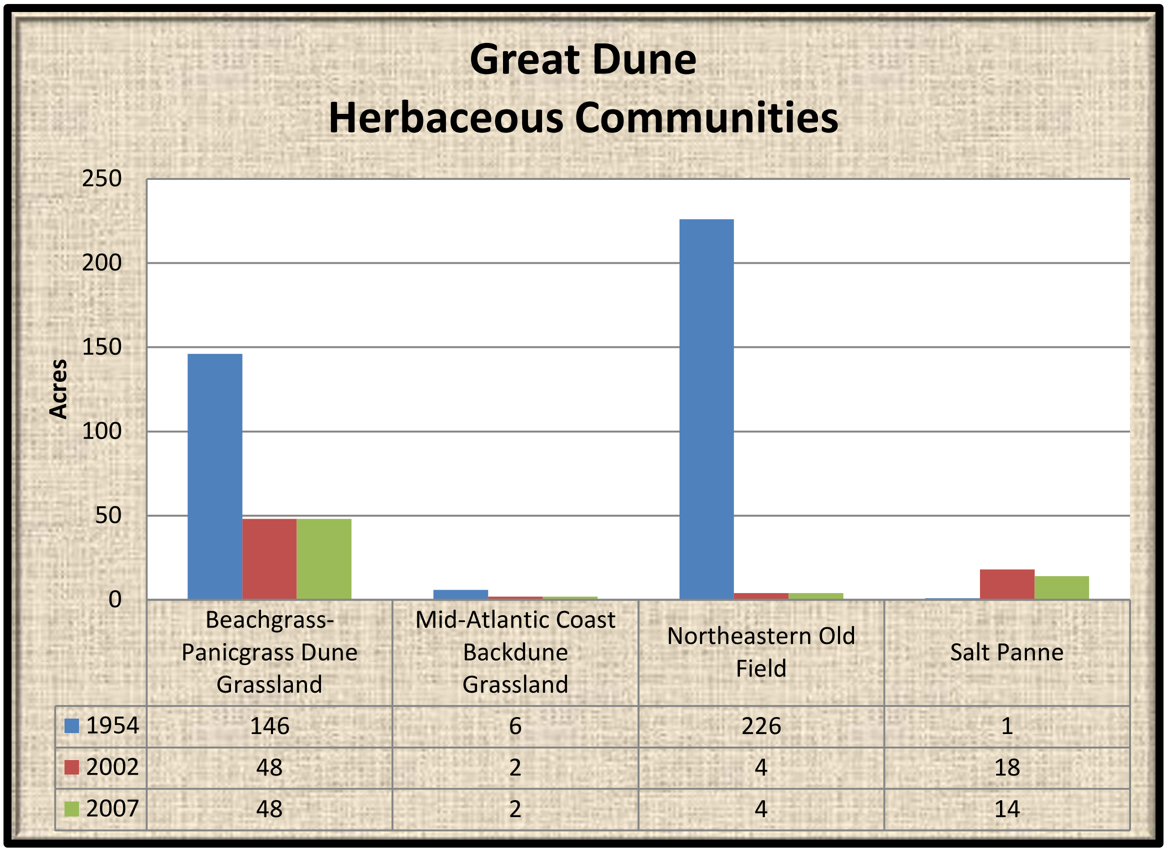


Figure 4-5.8. Great Dune Herbaceous Communities (1954, 2002, and 2007)

Great Dune Herbaceous Communities (Figure 4-5.8): Beachgrass-Panicgrass Dune Grassland is found on the some of the higher areas of Great Dune. Other herbaceous communities are minor in this section.

DNREC Sea Level Rise Analysis (Table 4-5.9)

A little less than half of the current acreage of herbaceous communities will be inundated with 1.5 m of sea level rise. Most of these communities are grasslands that are located at the tops of dunes and away from the immediate effects.

Table 4-5.9. Projected acres of Great Dune Section Herbaceous Communities Inundated by Sea Level Rise

Rise	Acres
0.5 m	15 acres
1 m	24 acres
1.5 m	35 acres

Natural Capital (Table 4-5.10)

Herbaceous community capitalization has oscillated with maturation of these communities into shrubland or forest. A recent decrease is due to a loss of salt panne acreage.

Table 4-5.10. Natural Capital of Great Dune Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$61,346/year
2002	$120,751/year
2007	$95,666/year

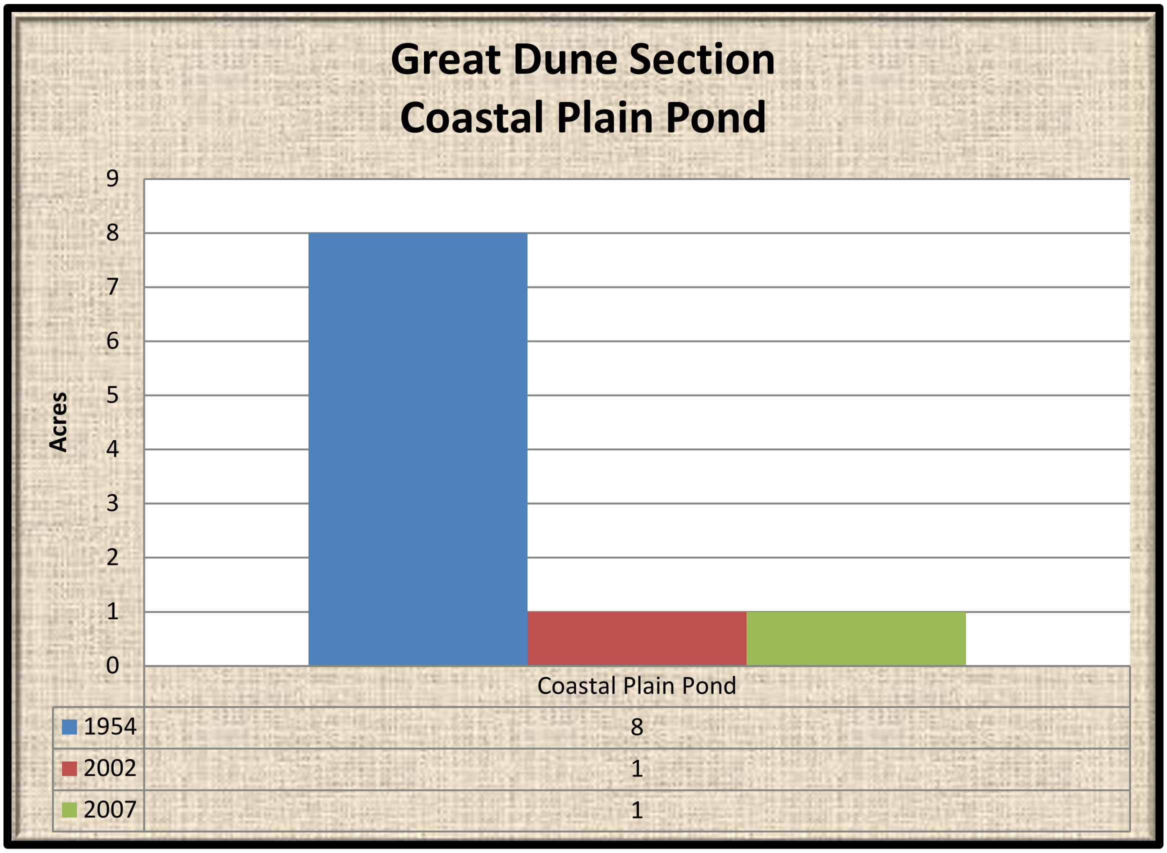


Figure 4-5.9. Great Dune Section Coastal Plain Pond (1954, 2002, and 2007)

Great Dune Section Coastal Plain Pond (Figure 4-5.9): Only one coastal plain pond is present in this section, while there were several present in 1954.

DNREC Sea Level Rise Analysis (Table 4-5.11)

Even though this community is protected by a high sand dune on all sides, rising groundwater from sea level rise will flood the Coastal Plain Pond permanently with 0.5 m of sea level rise.

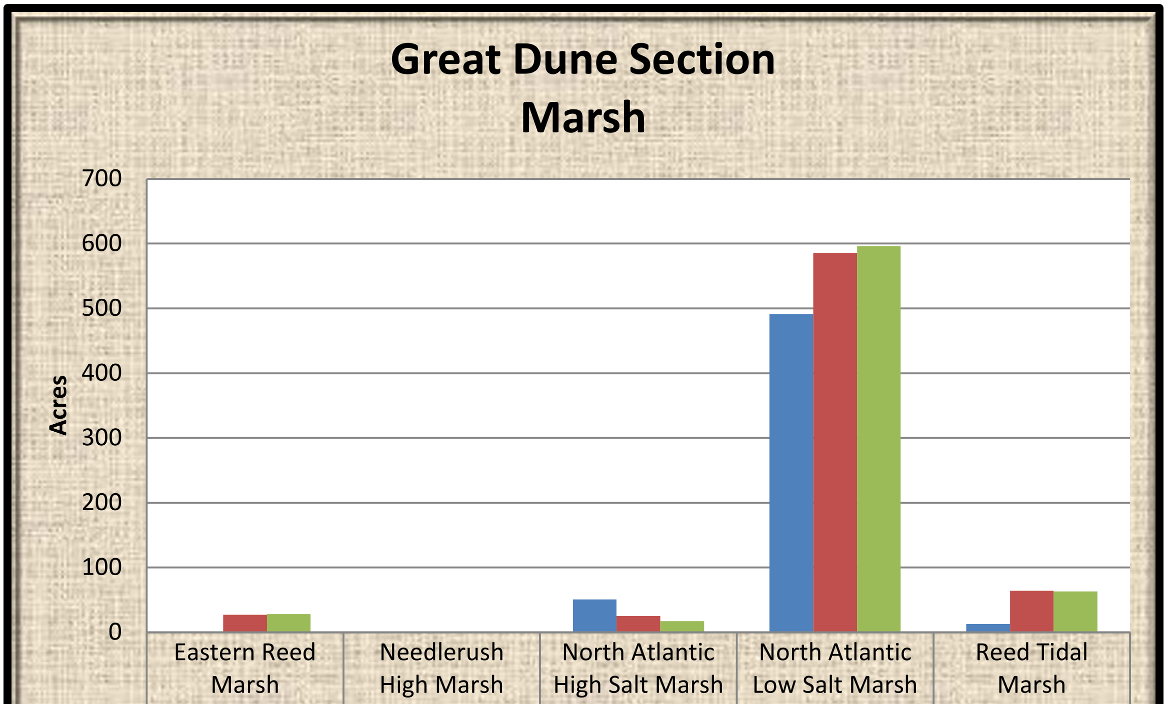
Table 4-5.11. Projected acres of Great Dune Section Coastal Plain Pond Inundated by Sea Level Rise

Rise	Acres
0.5 m	1 acres
1 m	1 acres
1.5 m	1 acres

Natural Capital (Table 4-5.12)

Like a lot of other communities, Coastal Plain Pond has decreased in capital since 1954. It has been stable in the recent period.

Table 4-5.12. Natural Capital of Great Dune Section Coastal Plain Pond	
Year	**Natural Capital (in 2012 dollars)**
1954	$74,251/year
2002	$9,281/year
2007	$9,281/year



	Eastern Reed Marsh	Needlerush High Marsh	North Atlantic High Salt Marsh	North Atlantic Low Salt Marsh	Reed Tidal Marsh
1954	0	0	51	491	13
2002	27	0.03	25	586	64
2007	28	0.03	17	596	63

Figure 4-5.10. Great Dune Section Marsh (1954, 2002, and 2007)

Great Dune Section Marsh (Figure 4-5.10): North Atlantic Low Salt Marsh is the most prominent marsh in the Great Dune Section and has increased over the study period. Reed Tidal Marsh has also increased likely at the expense of North Atlantic High Salt Marsh which has decreased markedly.

DNREC Sea Level Rise Analysis (Table 4-5.14)

Most of the marshland present in the Great Dune Section will be inundated with just 0.5 m or greater of sea level rise.

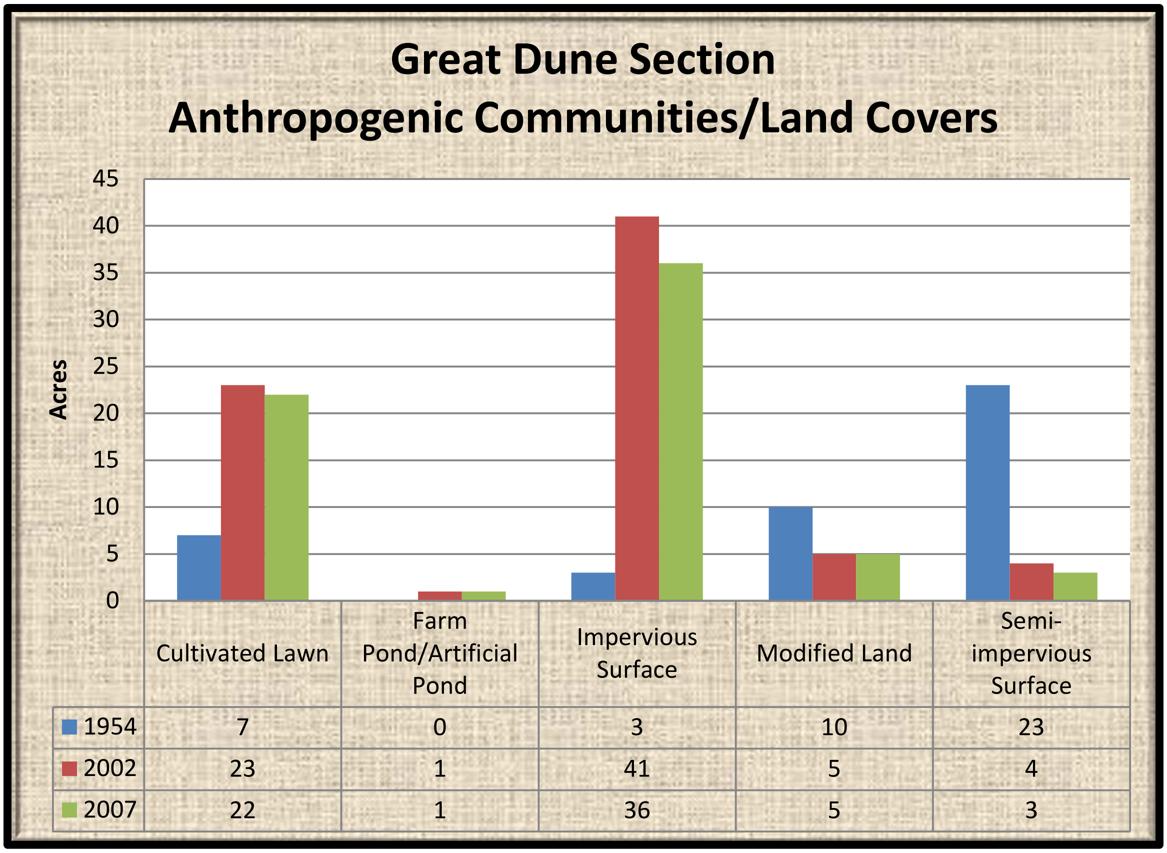
Table 4-5.14. Projected acres of the Great Dune Section Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	687 acres
1 m	692 acres
1.5 m	698 acres

Natural Capital (Table 4-5.15)

Marsh has increased through the years in the Great Dune Section, adding to the overall capital of the park.

Table 4-5.15. Natural Capital of Great Dune Section Marsh

Year	Natural Capital (in 2012 dollars)
1954	$3,480,572/year
2002	$4,483,913/year
2007	$4,499,466/year



	Cultivated Lawn	Farm Pond/Artificial Pond	Impervious Surface	Modified Land	Semi-impervious Surface
1954	7	0	3	10	23
2002	23	1	41	5	4
2007	22	1	36	5	3

Figure 4-5.11. Great Dune Section Anthropogenic Communities/Land Covers (1954, 2002, and 2007)

Great Dune Section Anthropogenic Communities/Land Covers (Figure 4-5.11): Impervious surface is the most common anthropogenic community followed by cultivated lawn.

DNREC Sea Level Rise Analysis (Table 4-5.14)

A little more than half of the Anthropogenic Communities/Land Covers will be impacted by the greatest (1.5 m) scenario of sea level rise.

Table 4-5.14. Projected acres of Great Dune Section Anthropogenic Communities/Land Covers Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	5 acres
1 m	24 acres
1.5 m	38 acres

Natural Capital (Table 4-5.15)

Only one land cover, Farm Pond/Artificial Pond, has any capital value in the Great Dune Section. No ponds were present in 1954, but have been developed since.

Table 4-5.15. Natural Capital of Great Dune Section Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$5,335/year
2007	$5,335/year

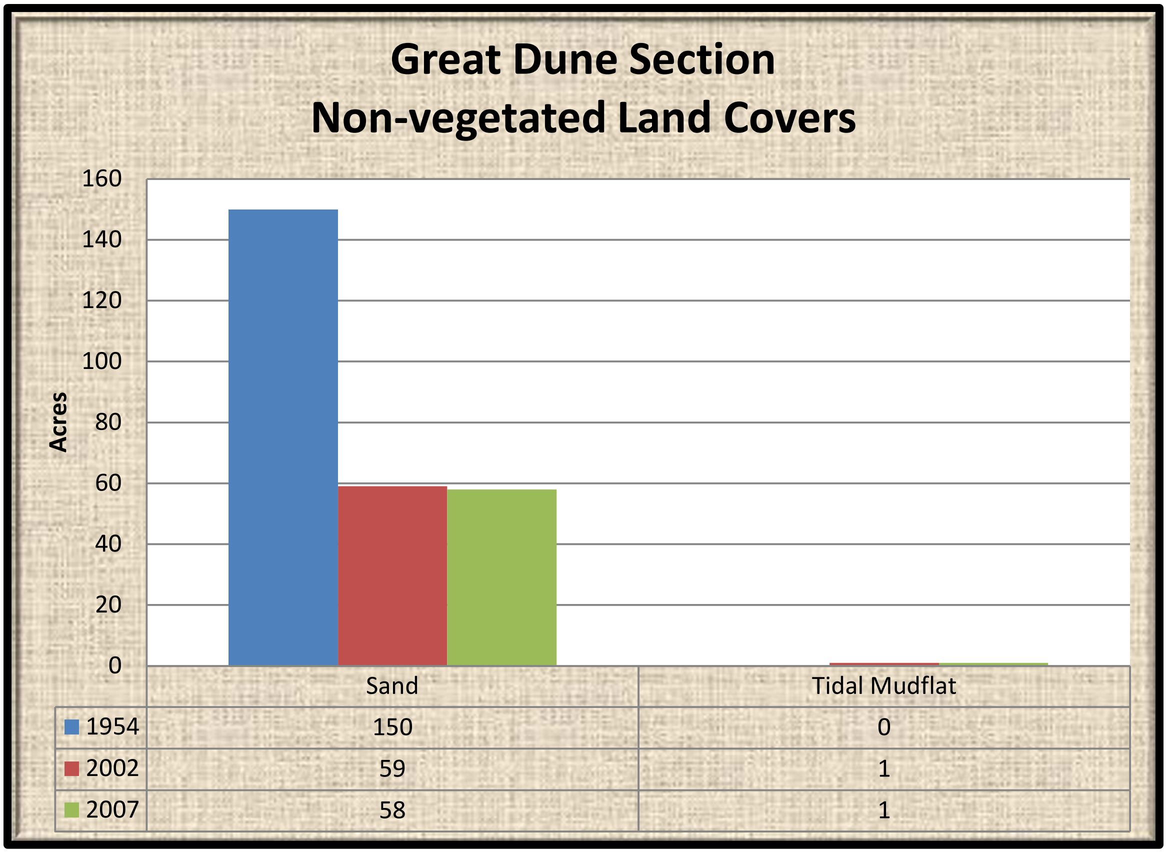


Figure 4-5.12. Great Dune Section Non-vegetated Land Covers (1954, 2002, and 2007)

Great Dune Section Non-vegetated Land Covers (Figure 4-5.12): Sand that is part of Great Dune is the most common non-vegetated land cover.

DNREC Sea Level Rise Analysis (Table 4-5.16)

Tidal Mudflats will be eliminated with 0.5 m of sea level rise. Sand which makes up the bulk of Great Dune and Walking Dune will only slightly be affected by the greatest sea level rise scenario (1.5 m). A lot the dune grassland communities may find refuge here.

Table 4-5.16. Projected acres of Great Dune Section Non-vegetated Land Covers Inundated by Sea Level Rise

Rise	Acres
0.5 m	1 acres
1 m	4 acres
1.5 m	17 acres

Natural Capital (Table 4-5.17)

Tidal Mudflat is the only non-vegetated community with any capital in the Great Dune Section. It appeared in 2002 and has remained at $6,271/year.

Table 4-5.17. Natural Capital of Great Dune Section Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$6,271/year
2007	$6,271/year

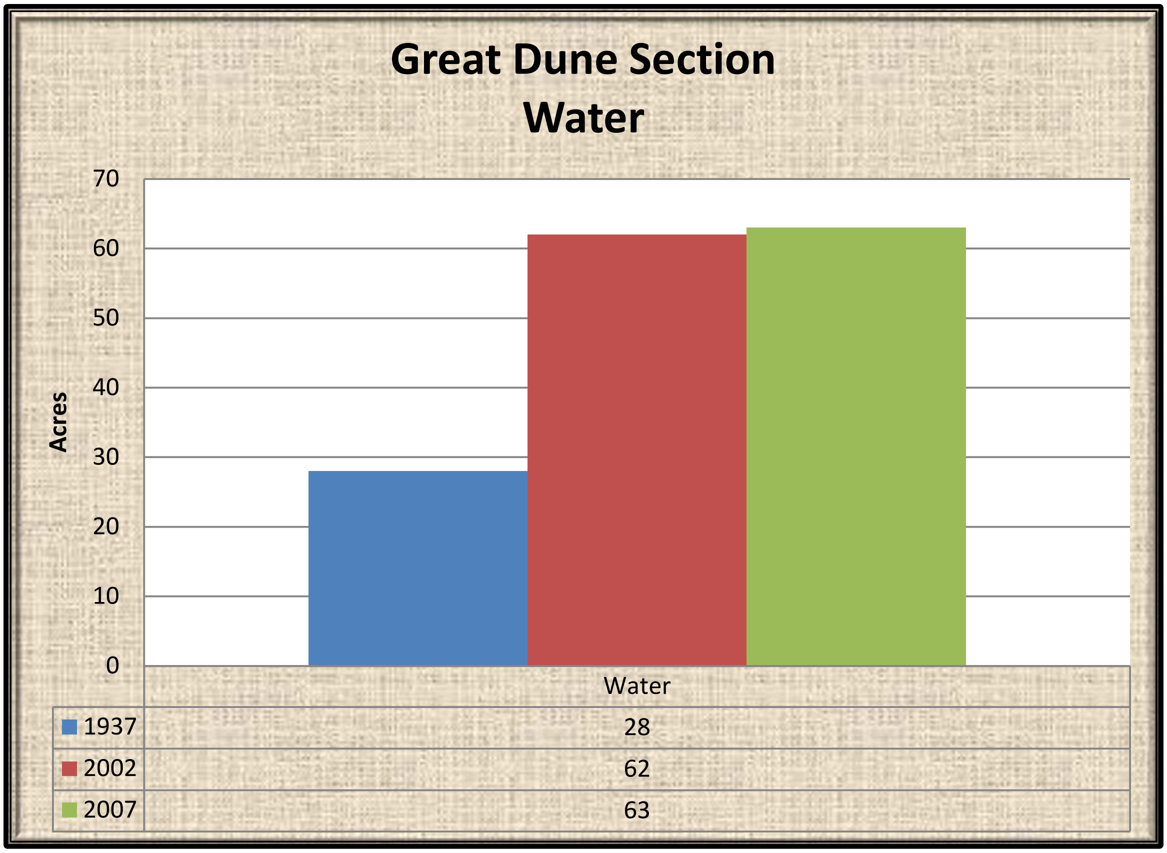


Figure 4-5.12. Great Dune Section Water Coverage (1954, 2002, and 2007)

Great Dune Section Water Coverage (Figure 4-5.12): The amount of area covered by water has increased over time likely due to sea level rise since this section does have any ocean beach area.

Natural Capital (Table 4-5.18)

Capitalization of water has increased with acreage over the years.

Table 4-5.18. Natural Capital of Great Dune Section Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$401,320/year
2002	$888,637/year
2007	$902,970/year

6. Holland Glade Section

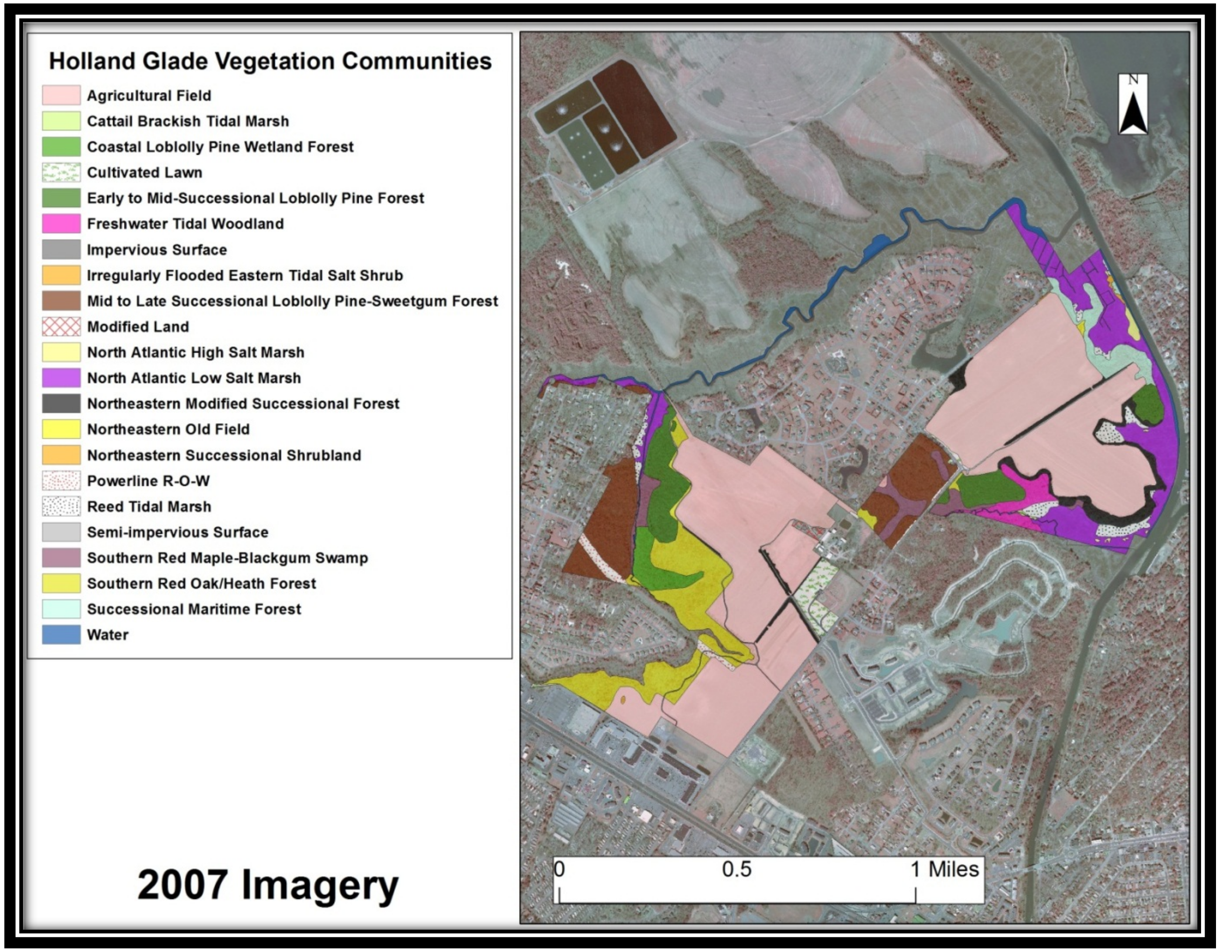


Figure 4-6.1. 2007 Vegetation Community Map of Holland Glade Section

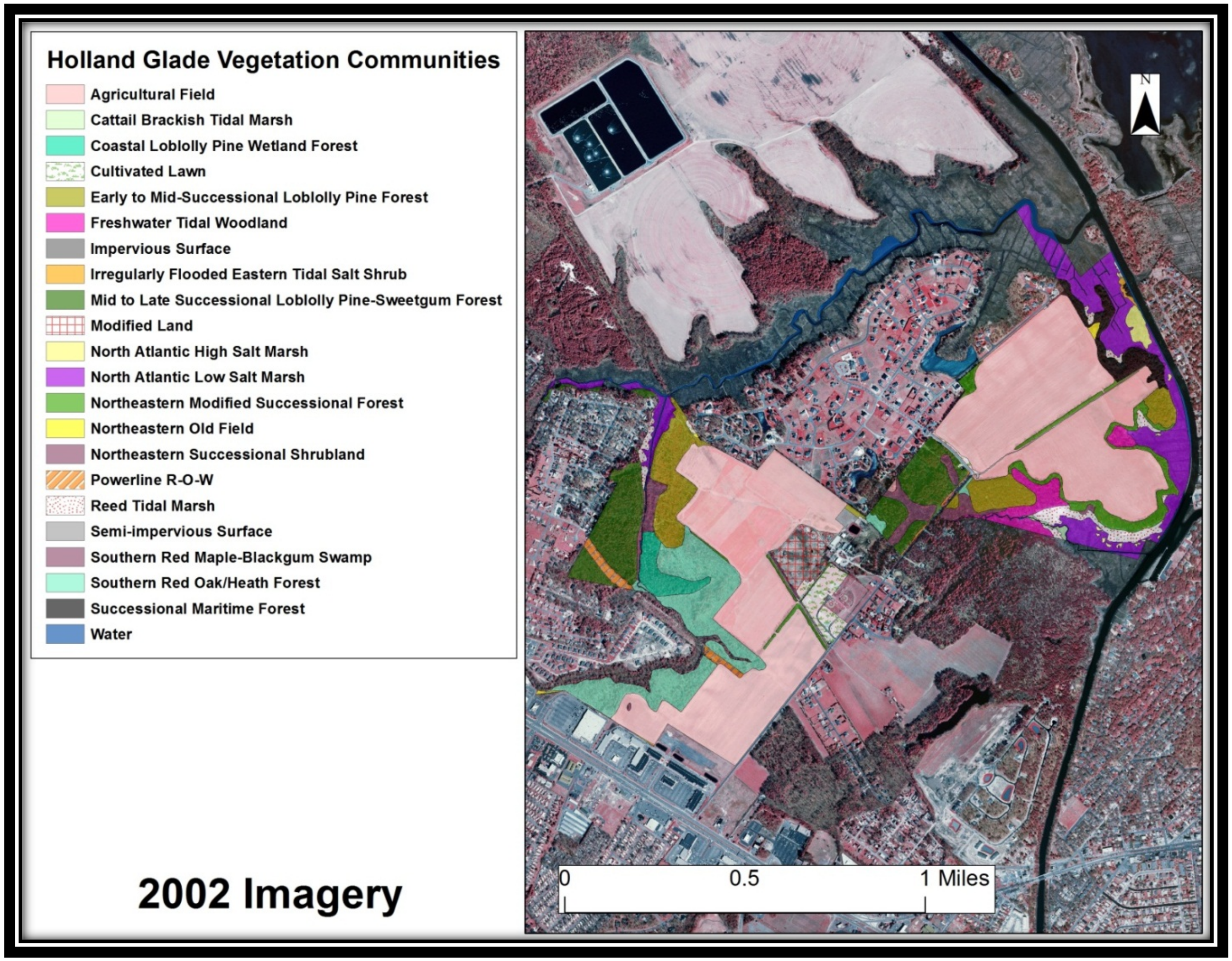


Figure 4-6.2. 2002 Vegetation Community Map of Holland Glade Section

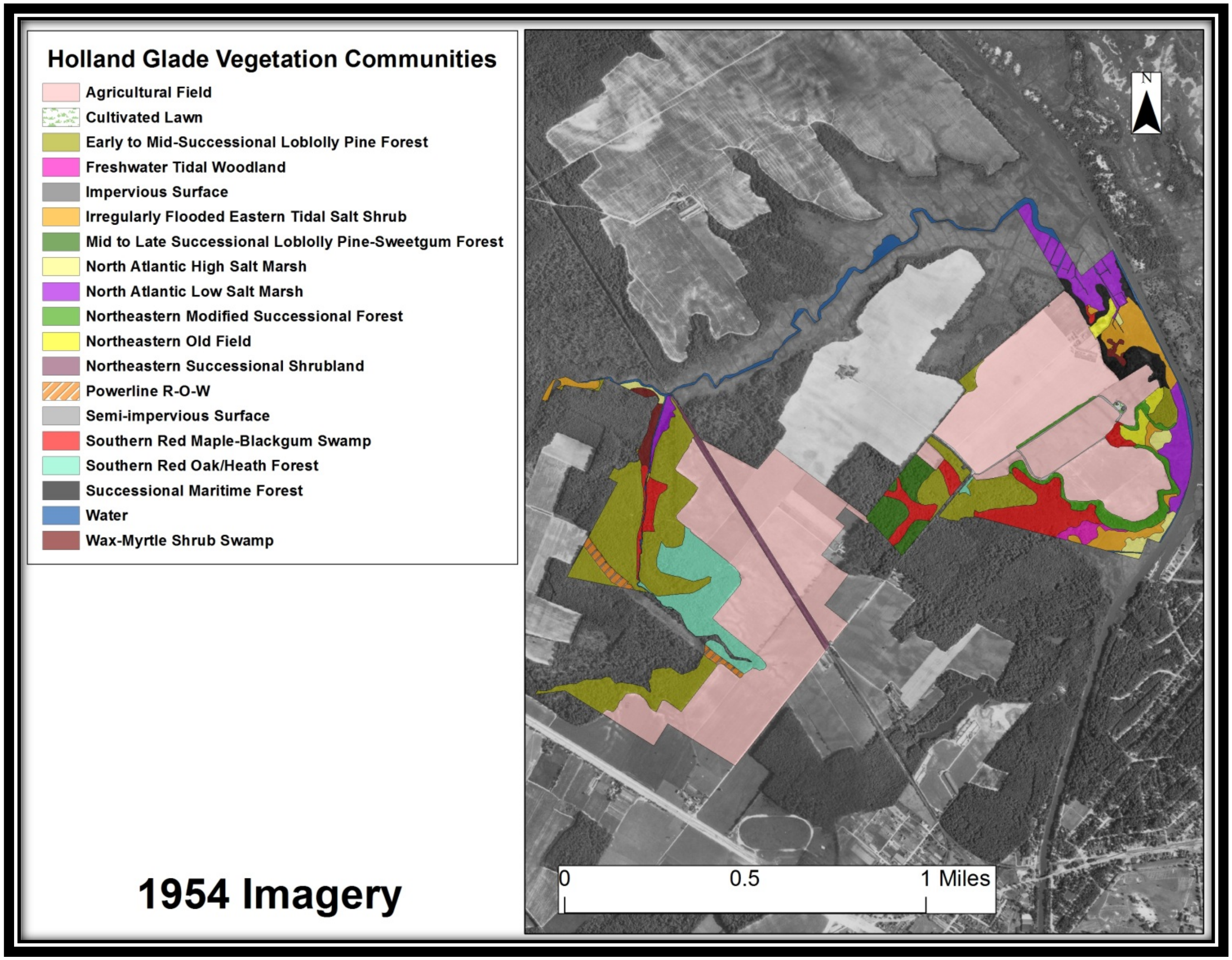
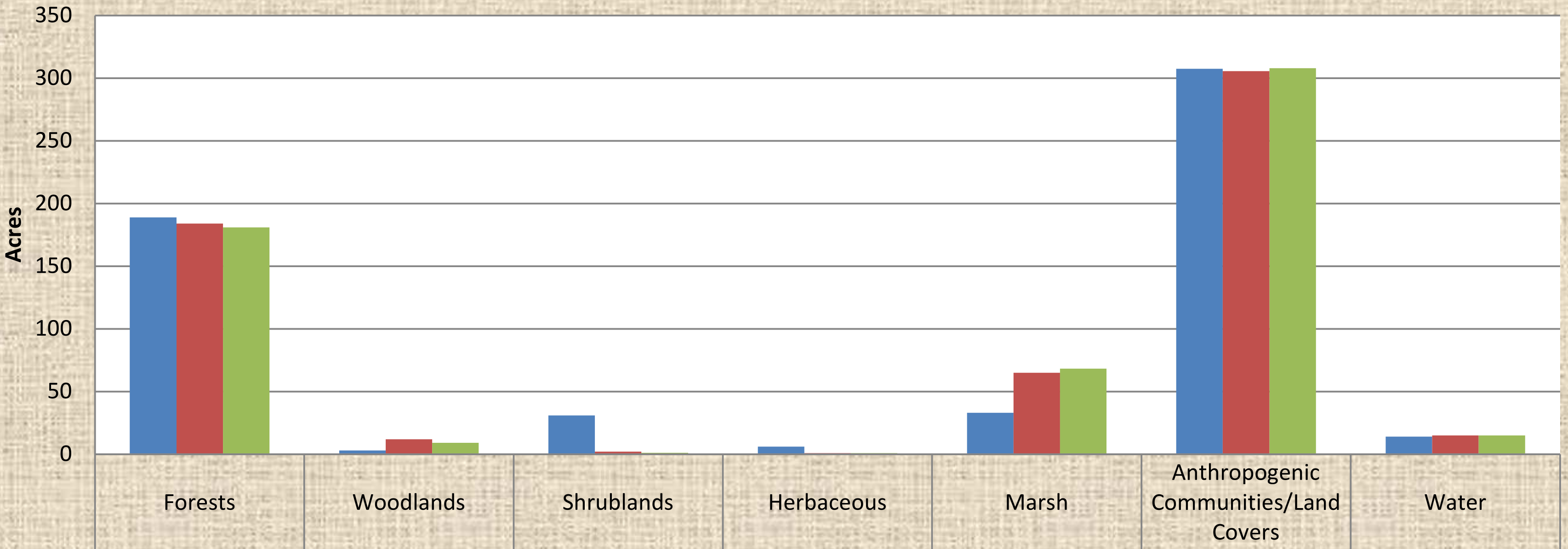


Figure 4-6.3. 1954 Vegetation Community Map of Holland Glade Section



	Forests	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Water
1954	189	3	31	6	33	307.4	14
2002	184	12	2	1	65	305.5	15
2007	181	9	1.2	1	68.3	308	15

Figure 4-6.4. Holland Glade Section Vegetation Communities/Land Covers (1954, 2002, and 2007)

Holland Glade Section Broad Trends (Figure 4-6.4): Holland Glade is located to the west of the Lewes and Rehoboth Canal and is composed mostly of forest and agricultural field (Anthropogenic communities). Other uses are minor to these.

DNREC Sea Level Rise Analysis (Table 4-6.1)

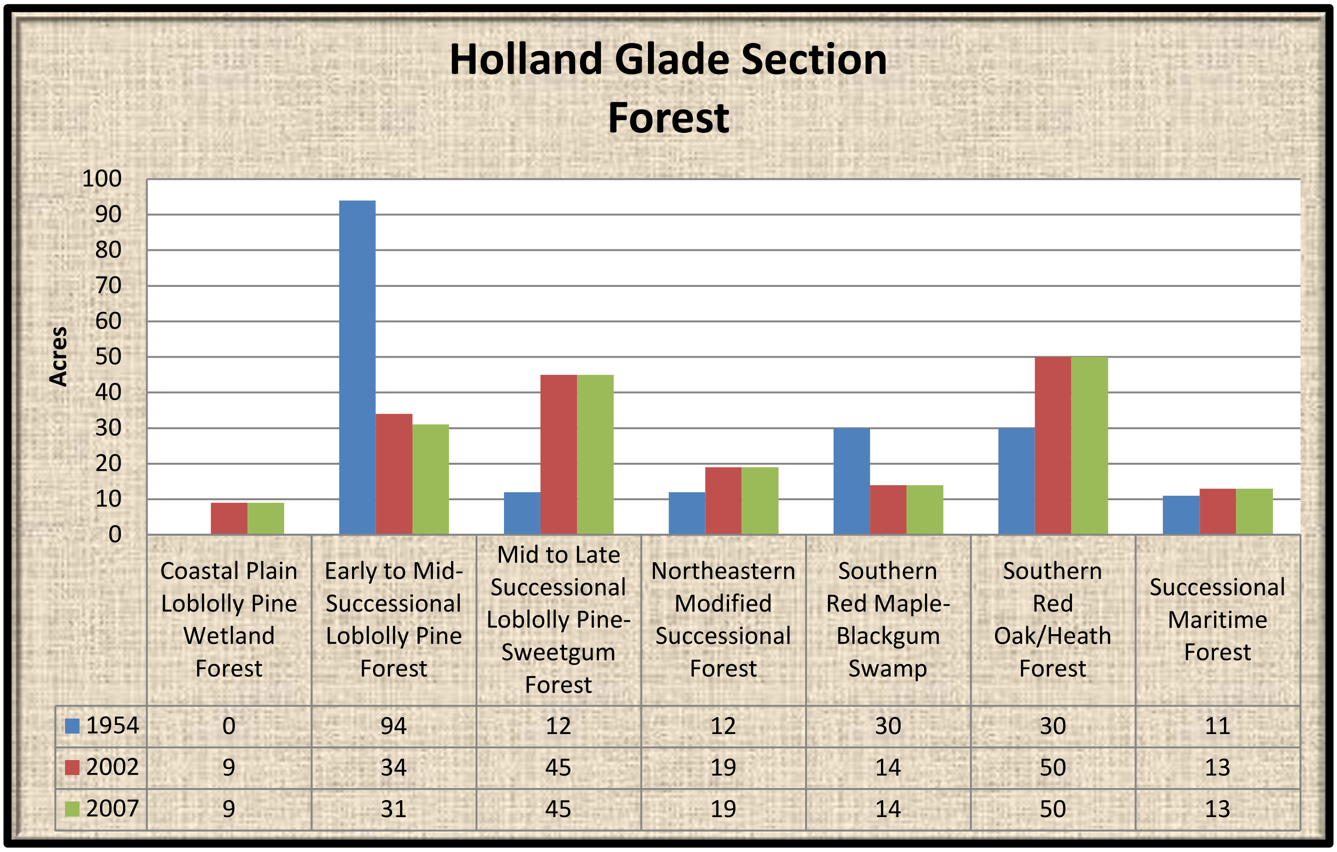
About ¼ of the Holland Glade Section will be inundated by 1.5 m of sea level rise.

Table 4-6.1. Projected acres of the Holland Glade Section Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	116 acres
1 m	133 acres
1.5 m	146 acres

Natural Capital (Table 4-6.2)

Overall capitalization in the Holland Glade has increased since 1954 with more forests being present. Recently, however, the amount has gone down slightly.

Table 4-6.2. Natural Capital of the Holland Glade Section	
Year	**Natural Capital (in 2012 dollars)**
1954	$975,485/year
2002	$1,548,160/year
2007	$1,531,928/year



	Coastal Plain Loblolly Pine Wetland Forest	Early to Mid-Successional Loblolly Pine Forest	Mid to Late Successional Loblolly Pine-Sweetgum Forest	Northeastern Modified Successional Forest	Southern Red Maple-Blackgum Swamp	Southern Red Oak/Heath Forest	Successional Maritime Forest
1954	0	94	12	12	30	30	11
2002	9	34	45	19	14	50	13
2007	9	31	45	19	14	50	13

Figure 4-6.5. Holland Glade Section Forest (1954, 2002, and 2007)

Holland Glade Section Forest (Figure 4-6.2): Southern Red Oak/Heath Forest located on the uplands is the most common forest type followed by Mid to Late Successional Loblolly Pine-Sweetgum Forest, which may succeed to Southern Red Oak/Heath Forest. Early to Mid-Successional Loblolly Pine Forest is also fairly common.

DNREC Sea Level Rise Analysis (Table 4-6.3)

Forestland in the Holland Glade section will gradually be inundated by sea level rise, but at its greatest level (1.5 m) only about ¼ of the total acreage will be inundated.

Table 4-6.3. Projected acres of Holland Glade Section Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	27 acres
1 m	40 acres
1.5 m	53 acres

Natural Capital (Table 4-6.4)

Capitalization of the forest land in the Holland Glade section has been going up with the maturation of the forest. It has generally been stable in the recent period (2002-2007).

Table 4-6.4. Natural Capital of Holland Glade Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$398,812/year
2002	$755,644/year
2007	$755,076/year

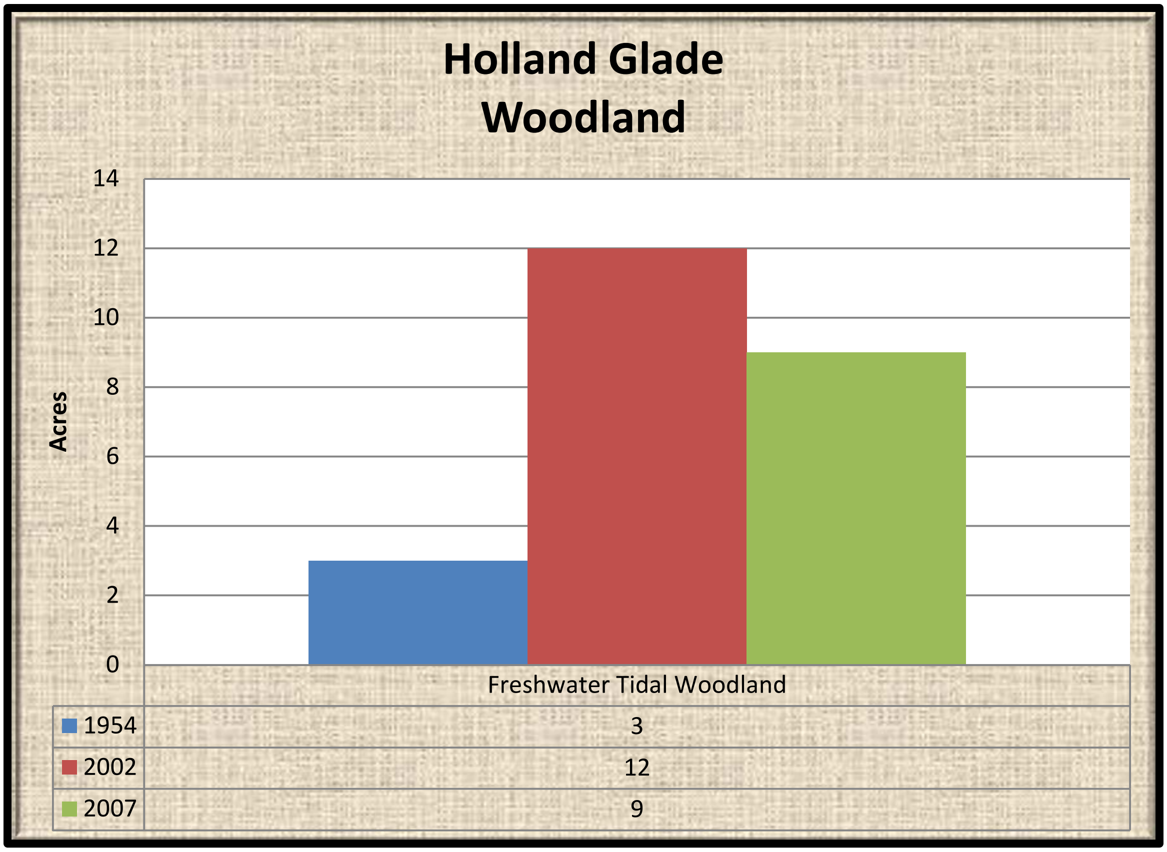


Figure 4-6.6. Holland Glade Section Woodland (1954, 2002, and 2007)

Great Dune Section Woodland (Figure 4-6.6): One woodland is present in this section and is located at the upper end of a tributary to the Lewes and Rehoboth Canal.

DNREC Sea Level Rise Analysis (Table 4-6.5)

Woodland in the Holland Glade section will be totally inundated with 1 m or greater of sea level rise.

Table 4-6.5. Projected acres of Holland Glade Section Woodland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	8 acres
1 m	9 acres
1.5 m	9 acres

Natural Capital (Table 4-6.6)

Overall the capitalization of woodland is has increased since 1954, however in the recent period the woodland category has lost value due to conversion to marsh.

Table 4-6.6. Natural Capital of Holland Glade Section Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$36,875/year
2002	$147,498/year
2007	$110,624/year

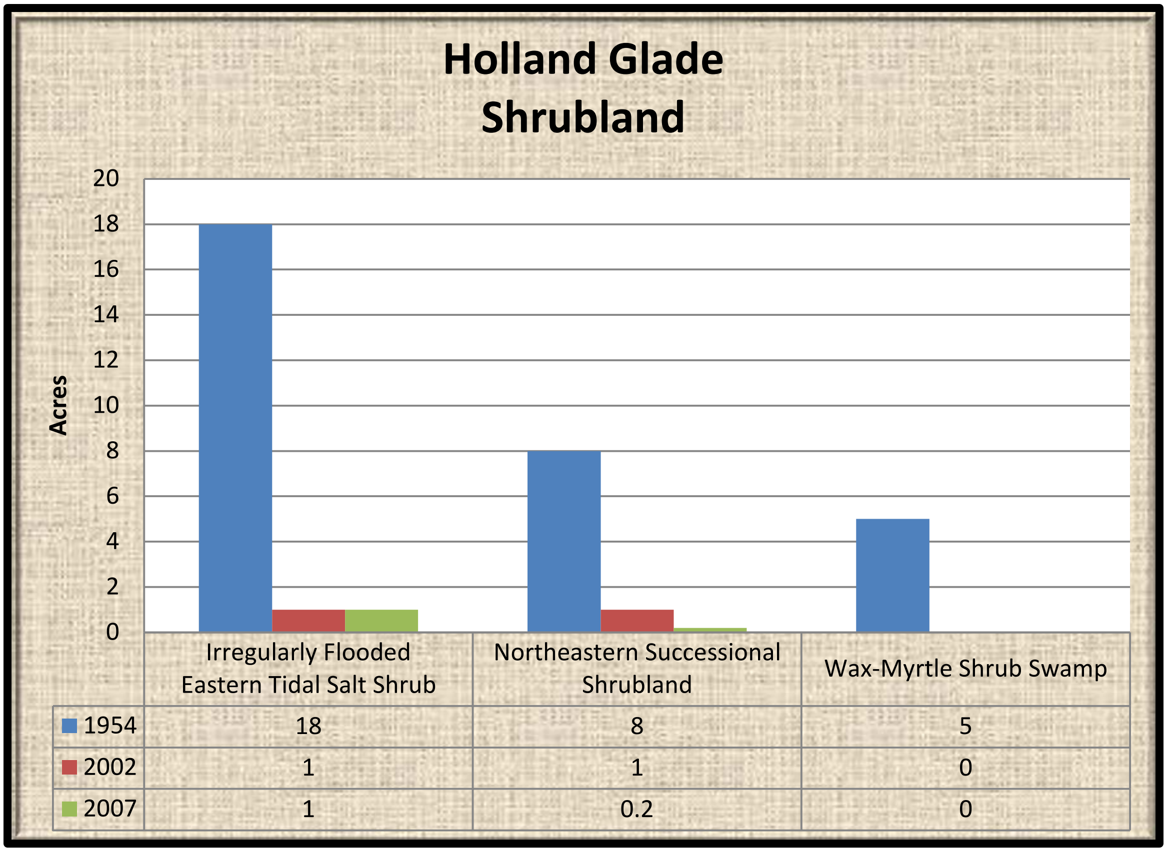


Figure 6-6.7. Holland Glade Shrubland (1954, 2002, and 2007)

Holland Glade Section Shrubland (Figure 4-6.4): Shrublands are not very common in this section with Irregularly Flooded Eastern Tidal Salt Shrub being the most common.

DNREC Sea Level Rise Analysis (Table 4-6.7)

Shrubland in the Holland Glade section will be completely inundated with 0.5 m of sea level rise.

Table 4-6.7. Projected acres of Holland Glade Section Shrubland Inundated by Sea Level Rise

Rise	Acres
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 4-6.8)

Capitalization of shrubland has greatly decreased due to losses in Irregularly Flooded Eastern Tidal Salt Shrub and Wax-Myrtle Shrub Swamp.

Table 4-6.8. Natural Capital of Holland Glade Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$114,049/year
2002	$6,417/year
2007	$6,300/year

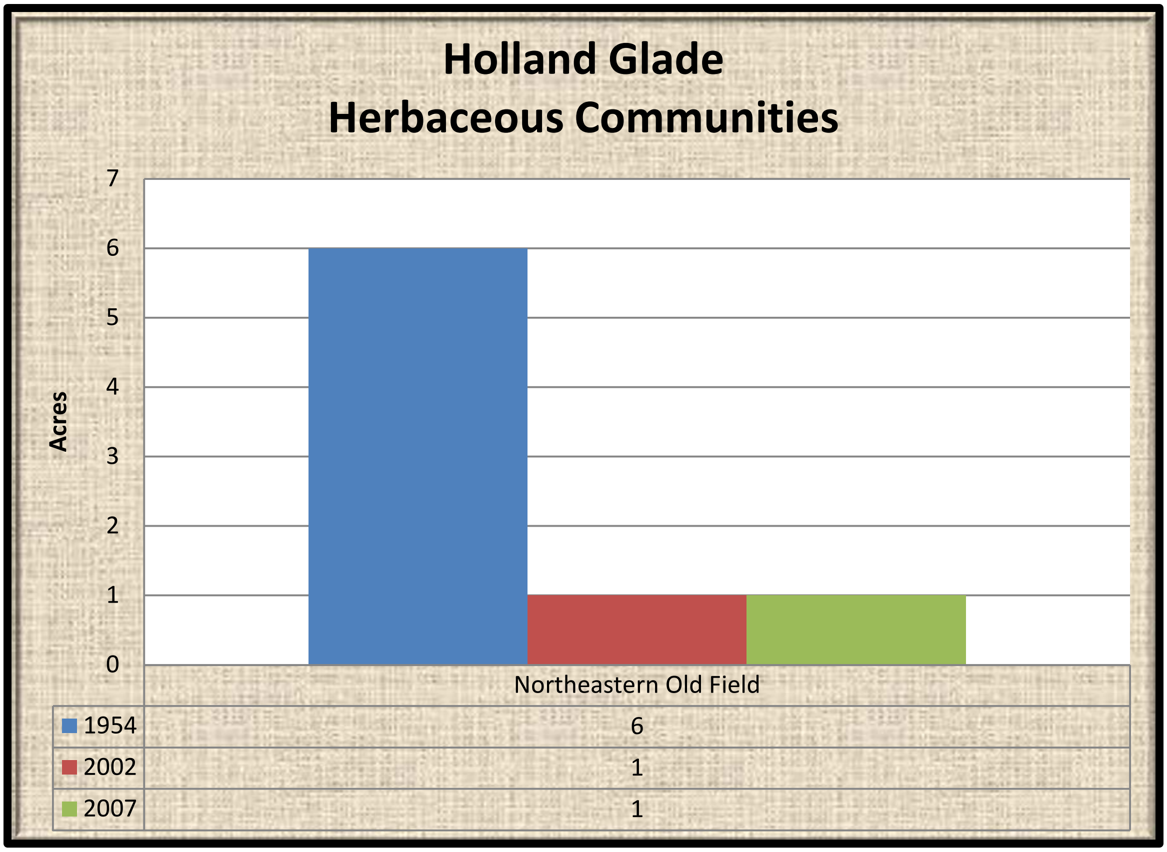


Figure 4-6.8. Holland Glade Herbaceous Communities (1954, 2002, and 2007)

Holland Glade Herbaceous Communities (Figure 4-6.8): Northeastern Old Field is the most common herbaceous community, but only covers one acre.

DNREC Sea Level Rise Analysis (Table 4-6.9)

Northeastern Old Field will only be slightly affected by the highest amount of sea level rise at 1.5 m.

Table 4-6.9. Projected acres of Holland Glade Section Herbaceous Communities Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	0.03 acres

Natural Capital (Table 4-6.10)

The amount of herbaceous community capitalization has gone down with maturation of the communities to shrubland or forest.

Table 4-6.10. Natural Capital of Holland Glade Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$875/year
2002	$146/year
2007	$146/year

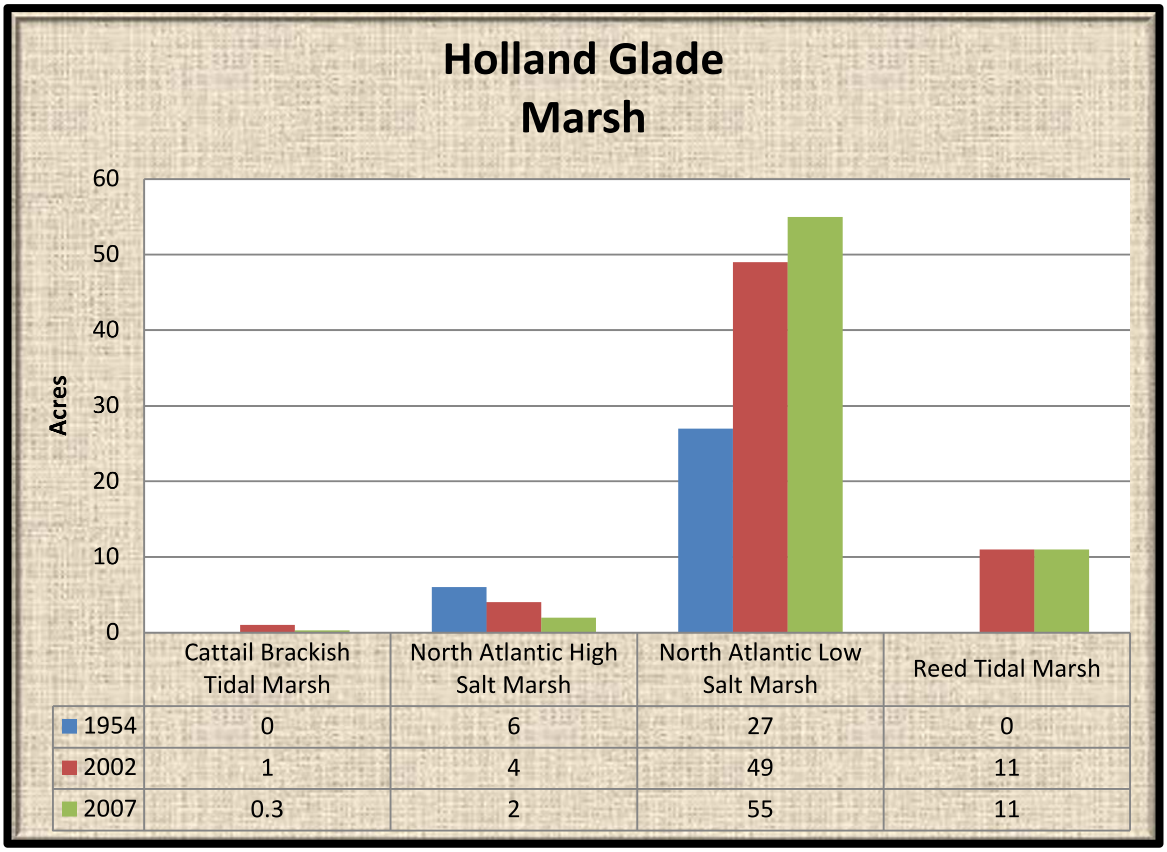


Figure 4-6.9. Holland Glade Section Marsh (1954, 2002, and 2007)

Holland Glade Section Marsh (Figure 4-6.9): North Atlantic Low Salt Marsh is the most common marsh followed by Reed Tidal Marsh, which is a newcomer to the section.

DNREC Sea Level Rise Analysis (Table 4-6.11)

Marsh will be completely inundated with 0.5 m of sea level rise in the Holland Glade Section.

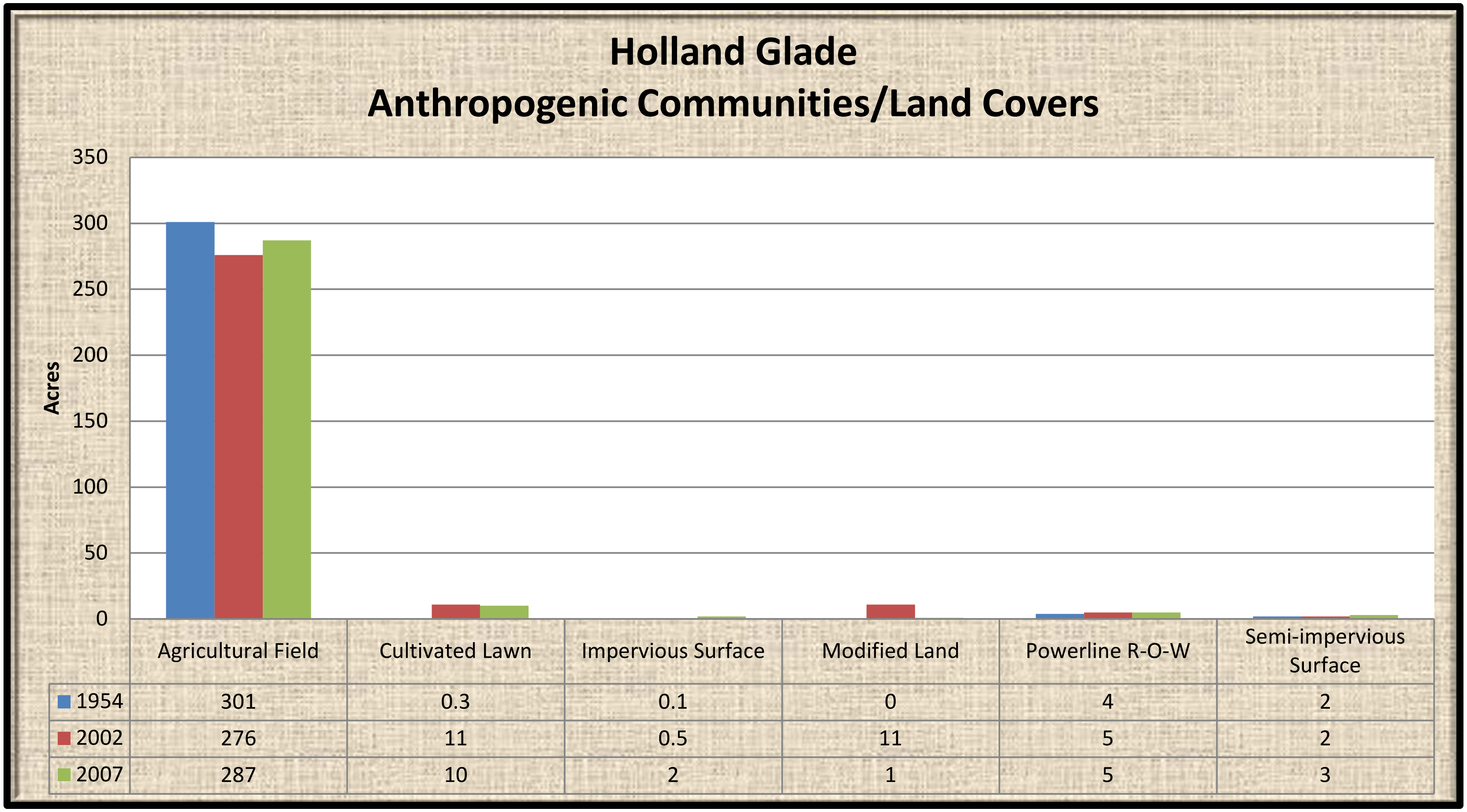
Table 4-6.11. Projected acres of Holland Glade Section Marsh Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	66 acres
1 m	66 acres
1.5 m	66 acres

Natural Capital (Table 4-6.12)

Marsh capitalization has been going up being driven by increases in North Atlantic Low Salt Marsh. This increase is coming at the cost to other communities that adjacent to the marsh.

Table 4-6.12. Natural Capital of Holland Glade Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$206,953/year
2002	$407,635/year
2007	$428,330/year



	Agricultural Field	Cultivated Lawn	Impervious Surface	Modified Land	Powerline R-O-W	Semi-impervious Surface
1954	301	0.3	0.1	0	4	2
2002	276	11	0.5	11	5	2
2007	287	10	2	1	5	3

Figure 4-6.10. Holland Glade Section Anthropogenic Communities/Land Covers (1954, 2002, and 2007)

Holland Glade Section Anthropogenic Communities/Land Covers (Figure 4-6.10): Agricultural field is by far the most common anthropogenic community in the section followed by small amount of cultivated lawn along some of the trails.

DNREC Sea Level Rise Analysis (Table 4-6.13)

Even at 1.5 m of sea level rise, only 1 acre of Anthropogenic Communities/Land Covers will be affected in the Holland Glade Section.

Table 4-6.13. Projected acres of Holland Glade Section Anthropogenic Communities/Land Covers Inundated by Sea Level Rise

Rise	Acres
0.5 m	0.2 acres
1 m	0.3 acres
1.5 m	1 acre

Natural Capital (Table 4-6.14)

Agricultural field is the only land cover with any capital value and has gone up and down with changes in agricultural field acreage and use.

Table 4-6.14. Natural Capital of Holland Glade Section Anthropogenic Communities/Land Covers

Year	Natural Capital (in 2012 dollars)
1954	$17,262/year
2002	$15,829/year
2007	$16,459/year

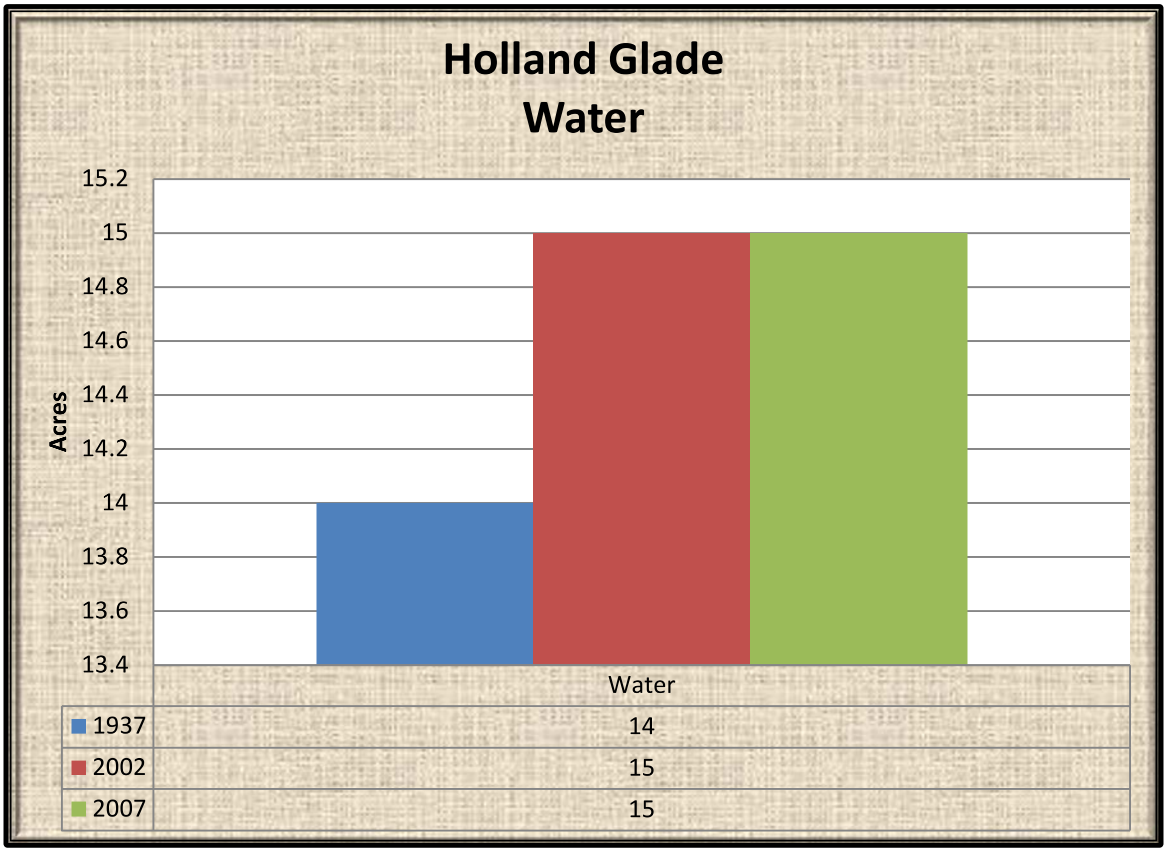


Figure 4-6.11. Holland Glade Section Water Coverage (1954, 2002, and 2007)

Holland Glade Section Water Coverage (Figure 4-6.11): Water has increased slightly over the study period but has been stable in the recent period (2002-2007).

Natural Capital (Table 4-6.15)

The amount of water present has increased due to sea level rise and other factors causing the overall capitalization to increase. In the recent period, it has been stable.

Table 4-6.15. Natural Capital of Holland Glade Section Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$200,660/year
2002	$214,993/year
2007	$214,993/year

7. Red Mill Section

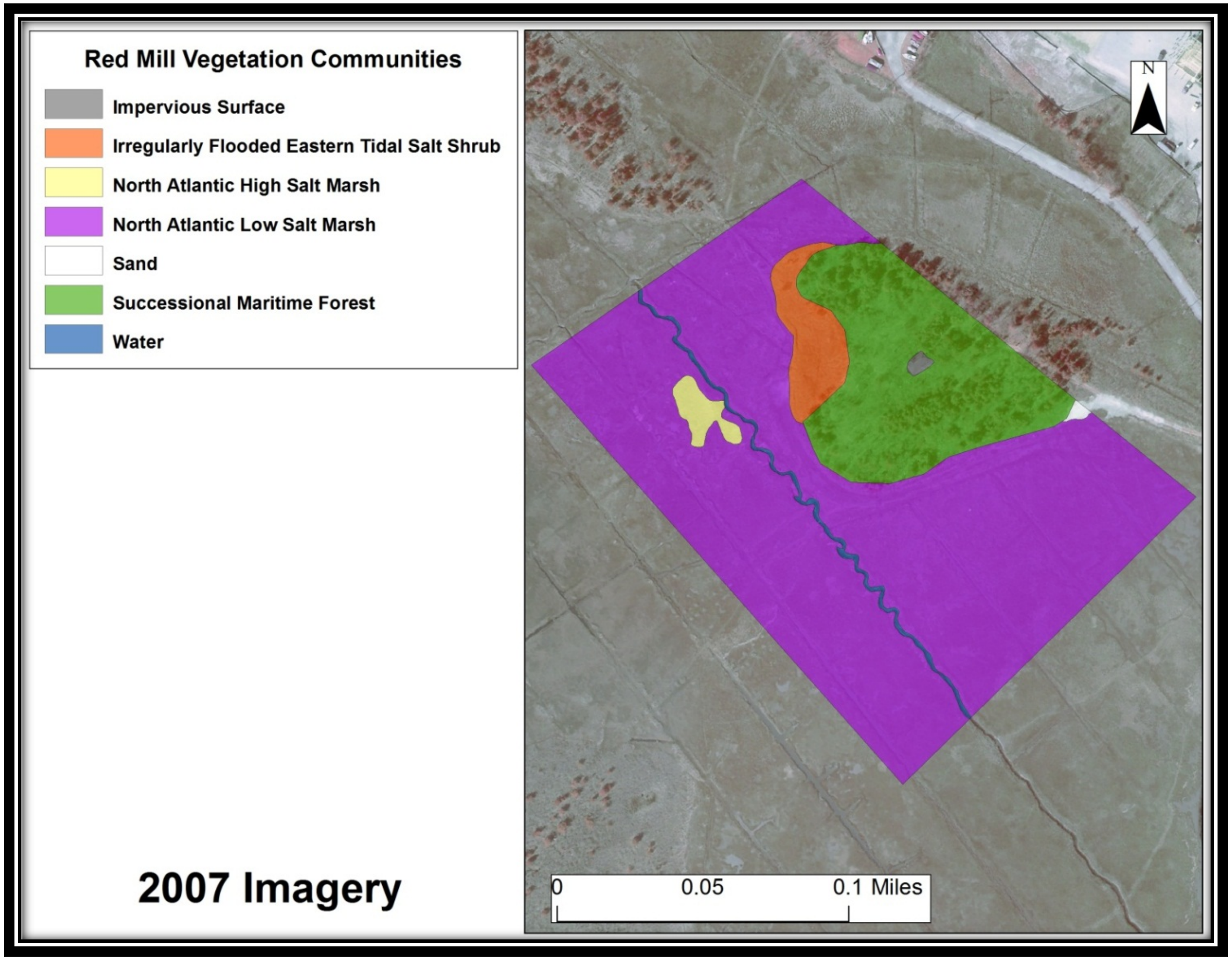


Figure 4-7.1. 2007 Vegetation Community Map of Red Mill Section

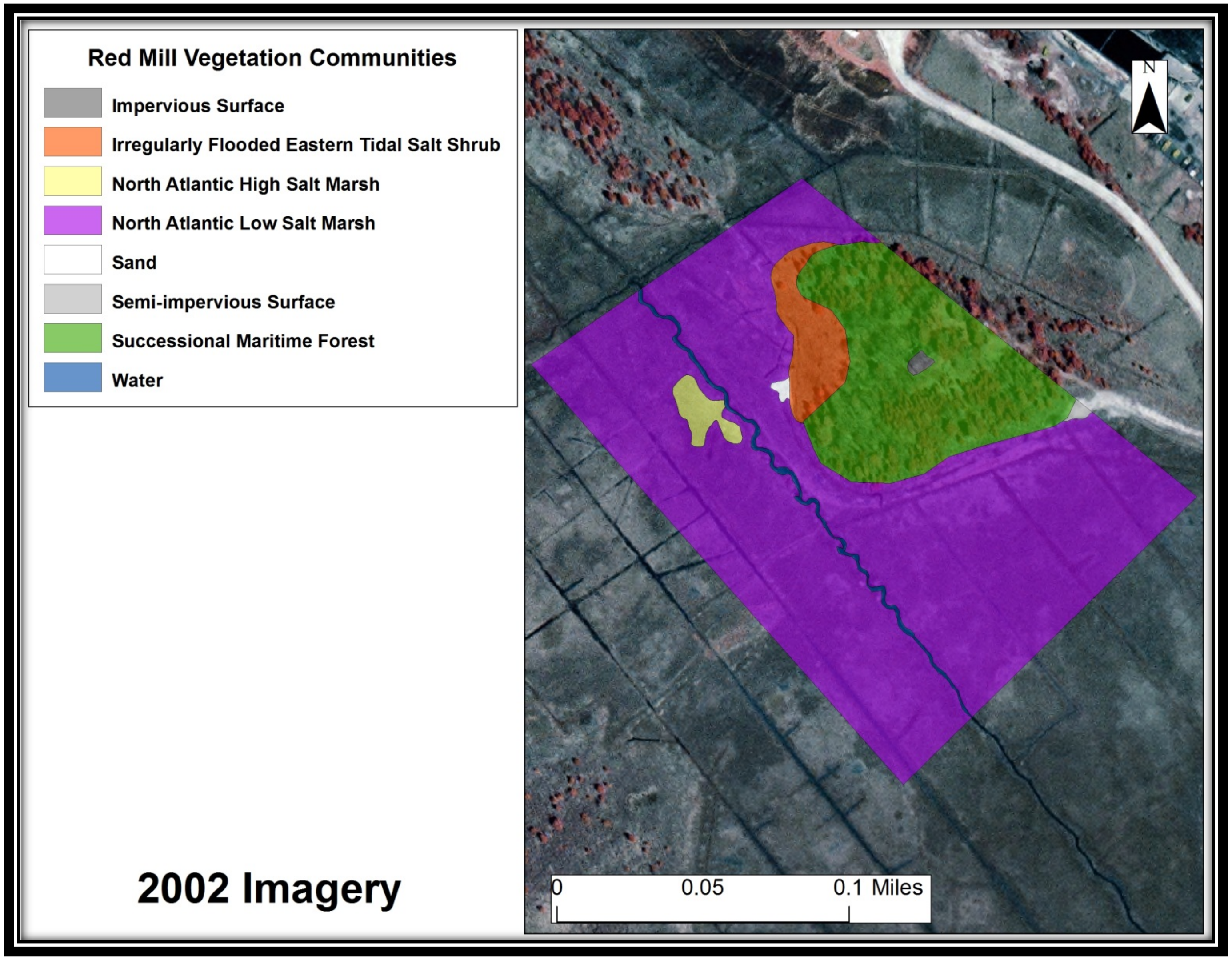


Figure 4-7.2. 2002 Vegetation Community Map of Red Mill Section

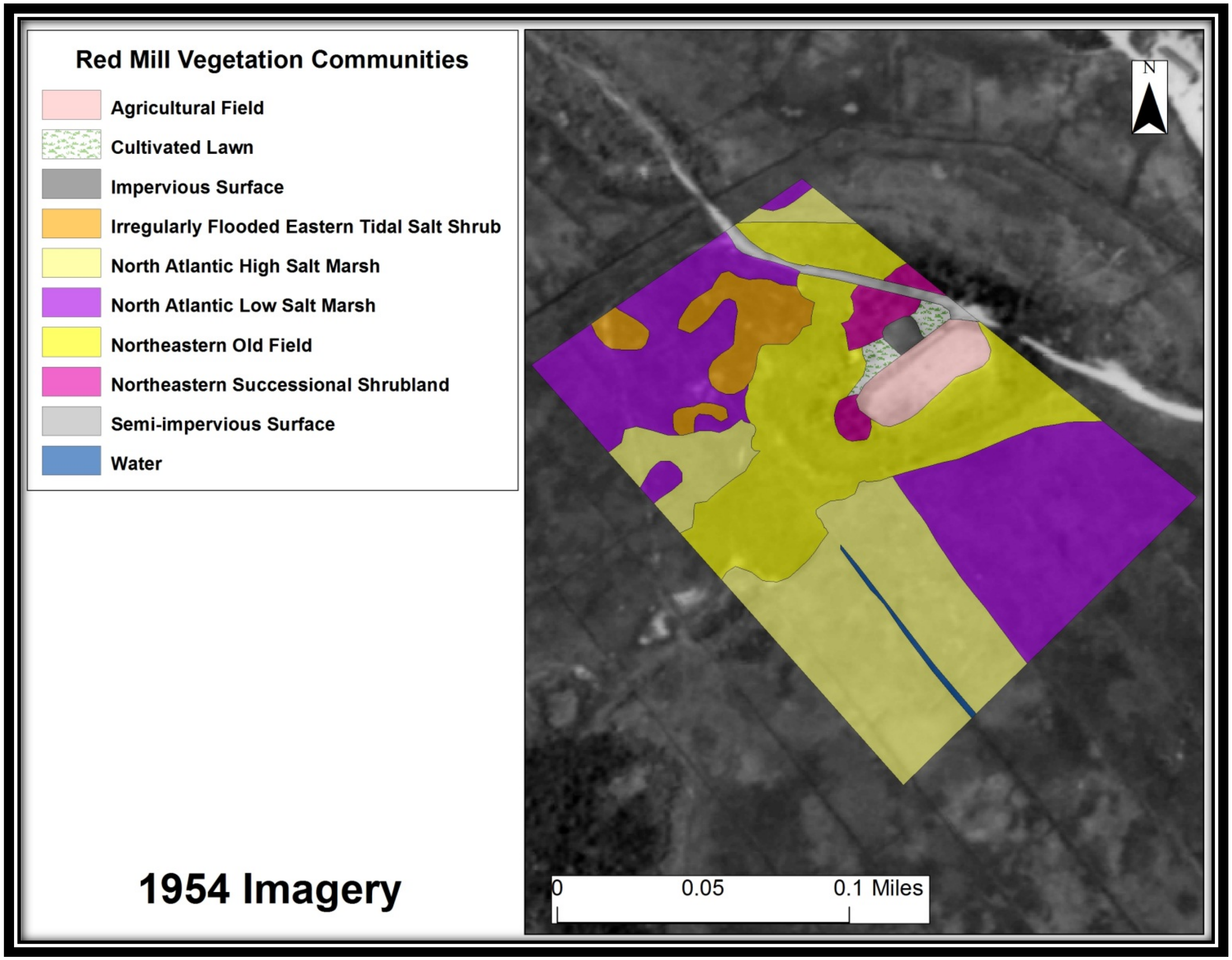
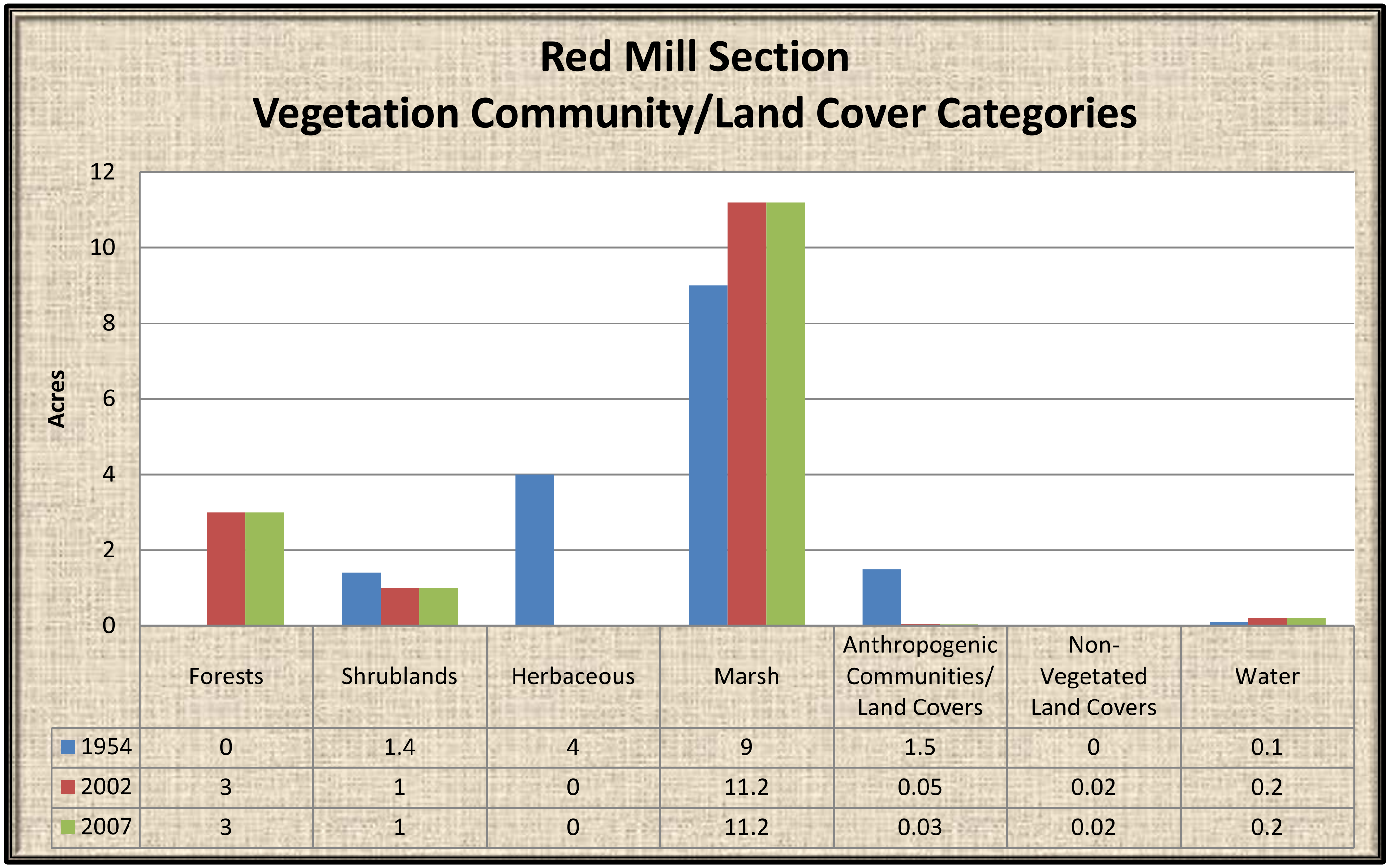


Figure 4-7.3. 1954 Vegetation Community Map of Red Mill Section



	Forests	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/ Land Covers	Non-Vegetated Land Covers	Water
1954	0	1.4	4	9	1.5	0	0.1
2002	3	1	0	11.2	0.05	0.02	0.2
2007	3	1	0	11.2	0.03	0.02	0.2

Figure 4-7.4. Red Mill Section Vegetation Communities/Land Covers (1954, 2002, and 2007)

Red Mill Section Broad Trends (Figure 4-7.4): The Red Mill is a small isolated section of the park that is located in the Red Mill watershed west of Lewes. Marsh is and has been the most prominent community in the section with a small upland that was once the site of home and small garden.

DNREC Sea Level Rise Analysis (Table 4-7.1)

The Red Mill section will be greatly reduced with just 0.5 m of sea level rise. Additions in the amount of rise to 1.5 m will complete inundate this section.

Table 4-7.1. Projected acres of the Red Mill Section Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	13 acres
1 m	14 acres
1.5 m	15 acres

Natural Capital (Table 4-7.2)

The capitalization of the Red Mill section has gone up with an increase in marsh and water since 1954.

Table 4-7.2. Natural Capital of the Red Mill Section	
Rise	**Natural Capital (in 2012 dollars)**
1954	$64,845/year
2002	$79,944/year
2007	$79,944/year

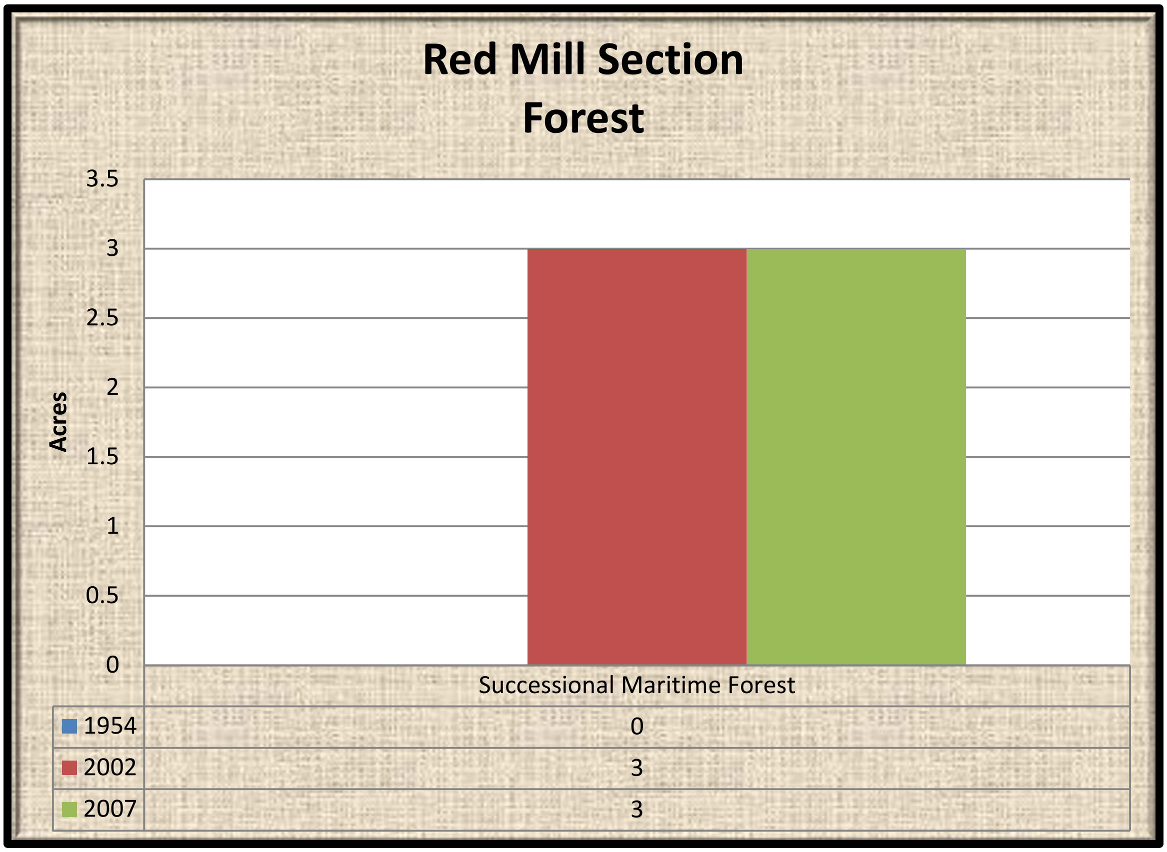


Figure 4-7.5. Red Mill Section Forest (1954, 2002, and 2007)

Red Mill Section Forest (Figure 4-7.5): Successional Maritime Forest has grown up where in the old garden plot that was next to the house in 1954.

DNREC Sea Level Rise Analysis (Table 4-7.3)

Successional Maritime Forest will be inundated with 1 m of rise or greater and will be impacted greatly with just 0.5 m of rise.

Table 4-7.3. Projected acres of Red Mill Section Forest Inundated by Sea Level Rise

Rise	Acres
0.5 m	2 acres
1 m	3 acres
1.5 m	3 acres

Natural Capital (Table 4-7.4)

Capitalization of the forest land in the Red Mill section has been going up with the maturation of the forest. It has generally been stable in the recent period (2002-2007).

Table 4-7.4. Natural Capital of Red Mill Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$567/year
2007	$567/year

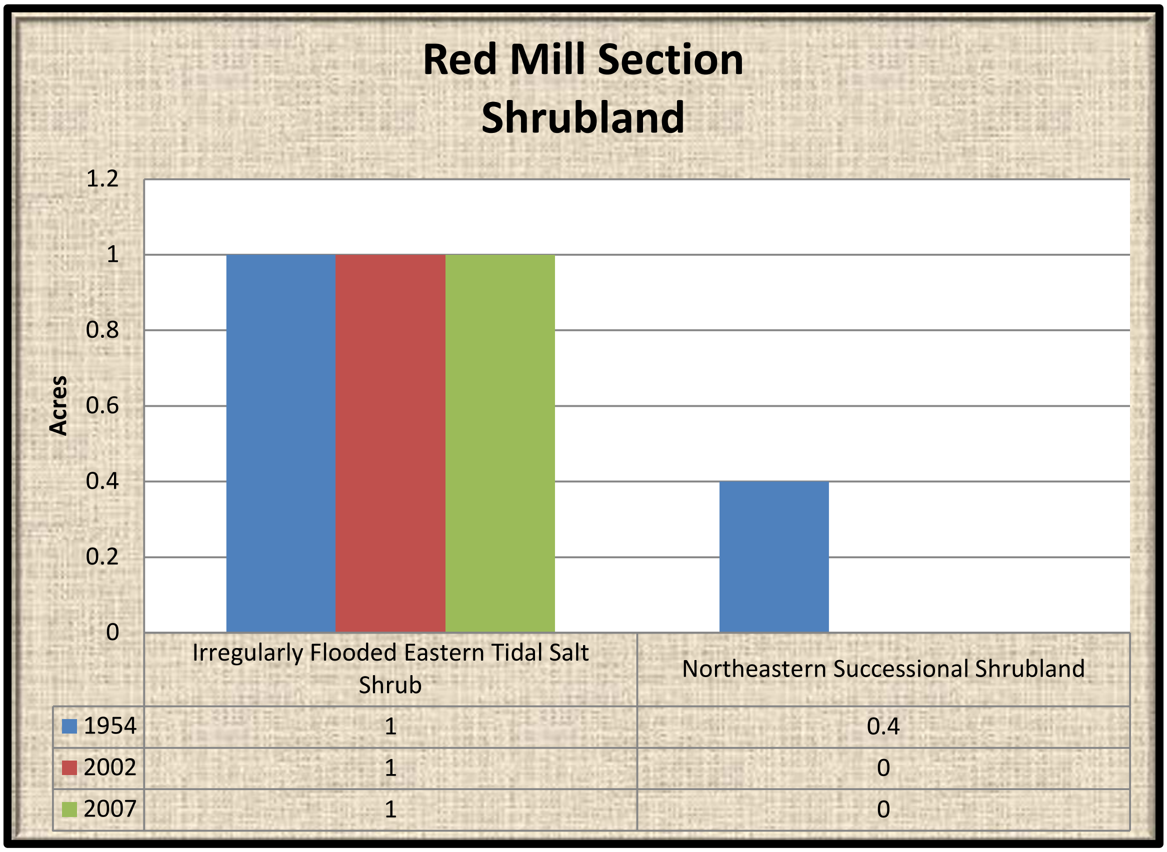


Figure 3-7.6. Red Mill Shrubland (1954, 2002, and 2007)

Red Mill Section Shrubland (Figure 3-7.6): Some Irregularly Flooded Eastern Tidal Salt Shrub fringes the marsh around the island.

DNREC Sea Level Rise Analysis (Table 4-7.5)

Irregularly Flooded Eastern Tidal Salt Shrub will be flooded completely with 0.5 m of sea level rise.

Table 4-7.5. Projected acres of Red Mill Section Shrubland Inundated by Sea Level Rise

Rise	Acres
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 4-7.6)

Capitalization of shrubland has gone down slightly with the maturation of Northeastern Successional Shrubland from 1954.

Table 4-7.6. Natural Capital of Red Mill Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$6,330/year (not present)
2002	$6,271/year
2007	$6,271/year

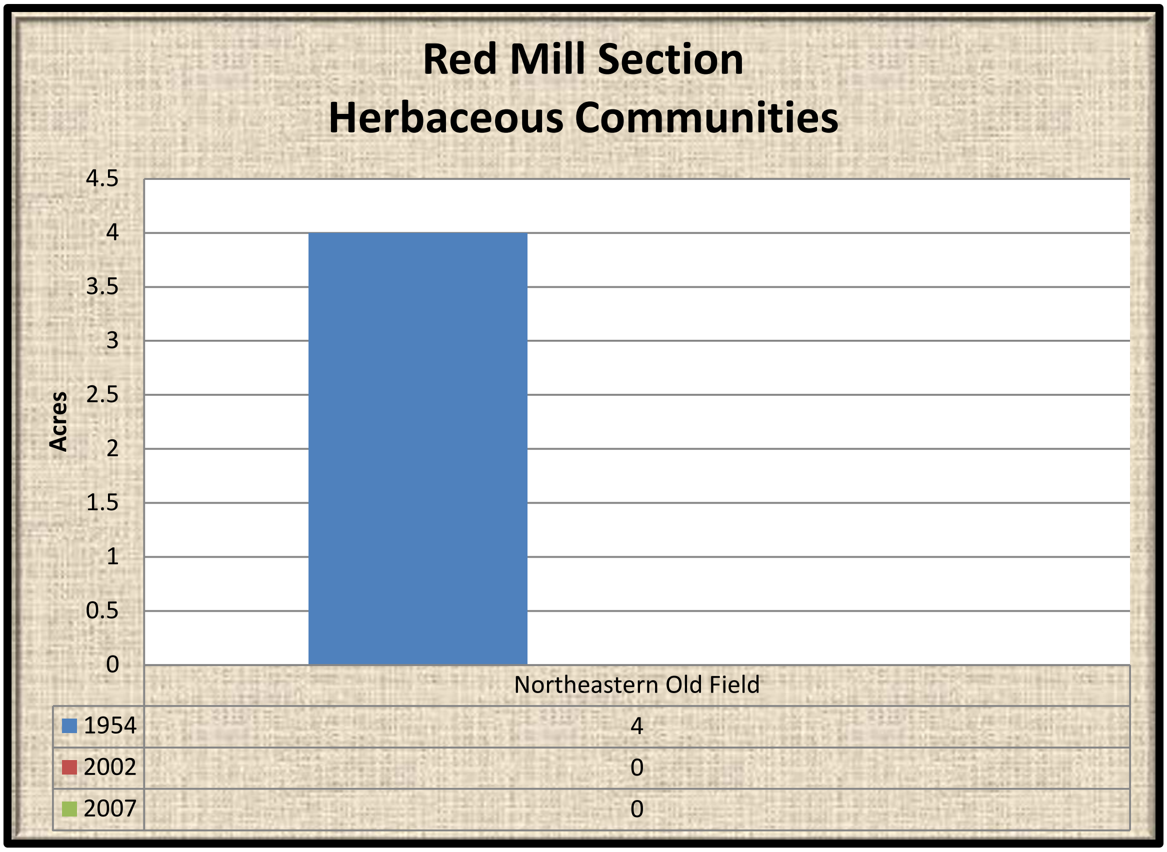


Figure 4-7.7. Red Mill Herbaceous Communities (1954, 2002, and 2007)

Red Mill Section Herbaceous Communities (Figure 4-7.7): A large part of the island was covered in Northeastern Old Field in 1954 and was associated with the house. It has since succeeded into today's Successional Maritime Forest

Natural Capital (Table 4-7.7)

The former capital of Northeastern Old Field has been transferred to a more mature community.

Table 4-7.7. Natural Capital of Red Mill Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$583/year (not present)
2002	$0/year (not present)
2007	$0/year (not present)

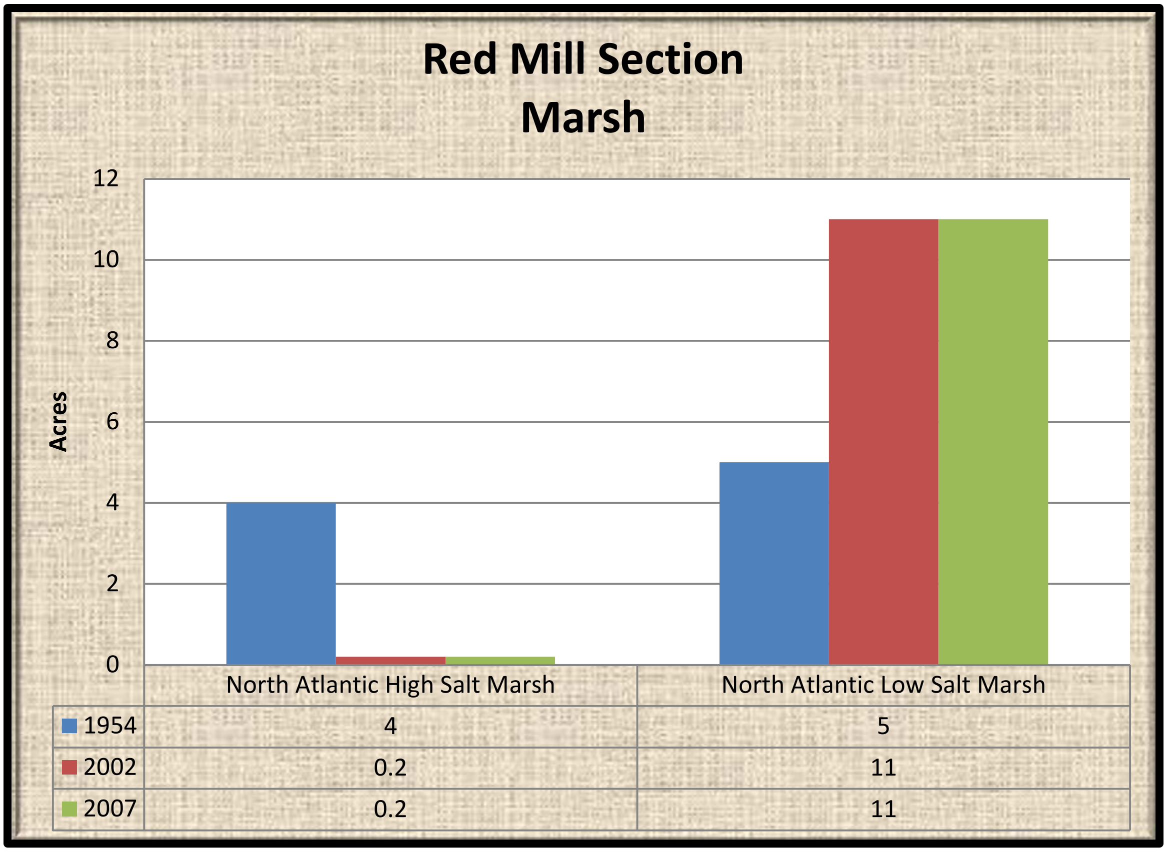


Figure 4-7.8. Red Mill Section Marsh (1954, 2002, and 2007)

Red Mill Section Marsh (Figure 4-7.8): North Atlantic Low Salt Marsh has been increasing in the section as more land surface is subjected to tide with sea level rise. North Atlantic High Salt Marsh, which used to closely follow North Atlantic Low Salt Marsh in acreage, is almost extirpated from the section.

DNREC Sea Level Rise Analysis (Table 4-7.8)

All of the marsh present in the Red Mill Section will be inundated with 0.5 m of sea level rise.

Table 4-7.8. Projected acres of Red Mill Section Marsh Inundated by Sea Level Rise

Rise	Acres
0.5 m	11 acres
1 m	11 acres
1.5 m	11 acres

Natural Capital (Table 4-7.9)

Marsh capital has gone up with an increase in North Atlantic Low Salt Marsh and has been stable in the recent period (2002-2007).

Table 4-7.9. Natural Capital of Red Mill Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$56,442/year
2002	$70,239/year
2007	$70,239/year

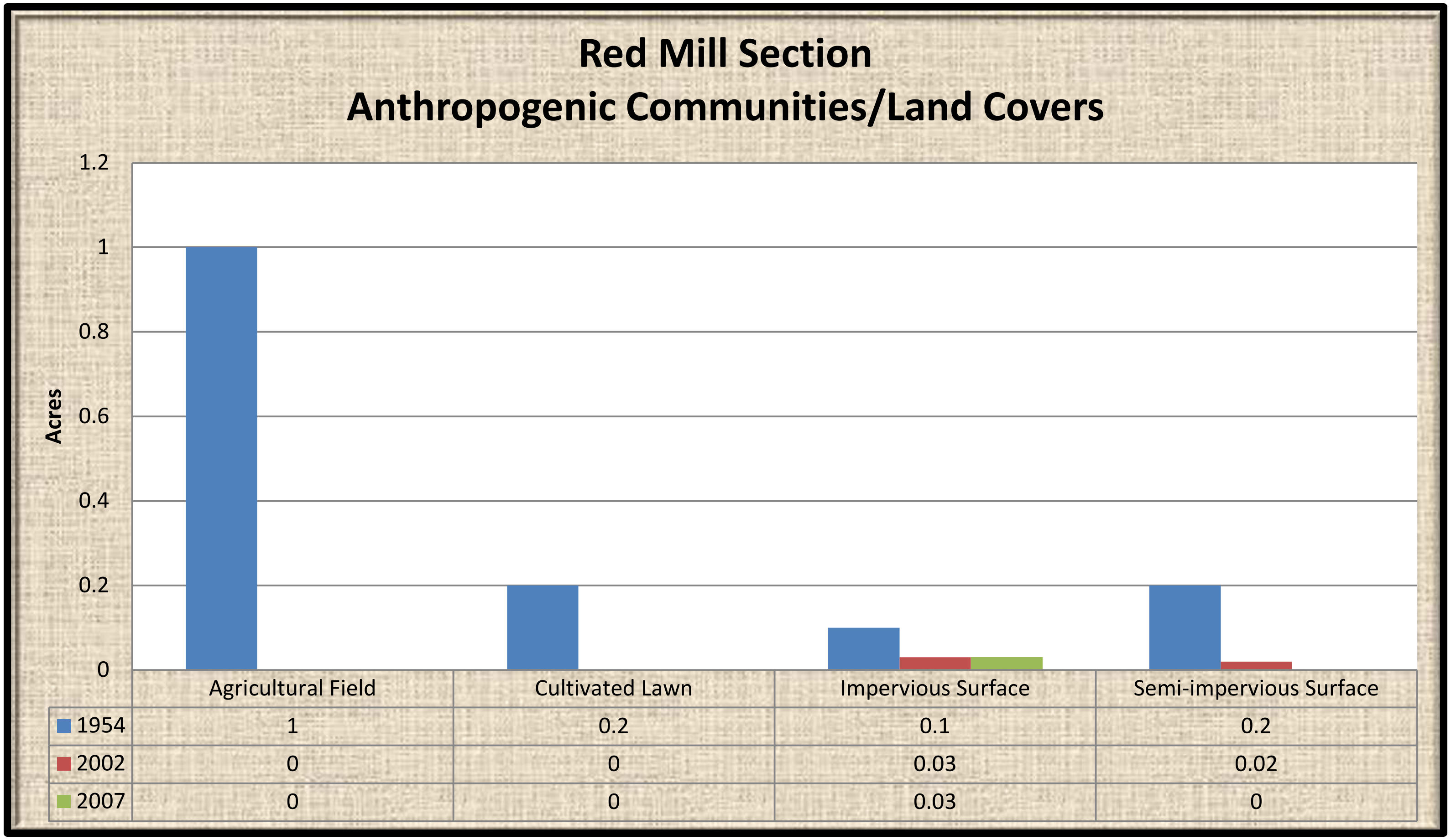


Figure 4-7.9. Red Mill Section Anthropogenic Communities/Land Covers (1954, 2002, and 2007)

Red Mill Section Anthropogenic Communities/Land Covers (Figure 4-7.9): Anthropogenic communities are almost totally absent from the section with the abandonment of the farm and house.

DNREC Sea Level Rise Analysis (Table 4-7.10)

All of the impervious surface left in the Red Mill section will be inundated with 1.5 m of sea level rise.

Table 4-7.10. Projected acres of Red Mill Section Anthropogenic Communities/Land Covers Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	0.03 acres

Natural Capital (Table 4-7.11)

Since agricultural field is no longer present, the Red Mill section does not have any more capital value in Anthropogenic Communities/Land Covers.

Table 4-7.11. Natural Capital of Red Mill Section Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1954	$57/year
2002	$0/year (not present)
2007	$0/year (not present)

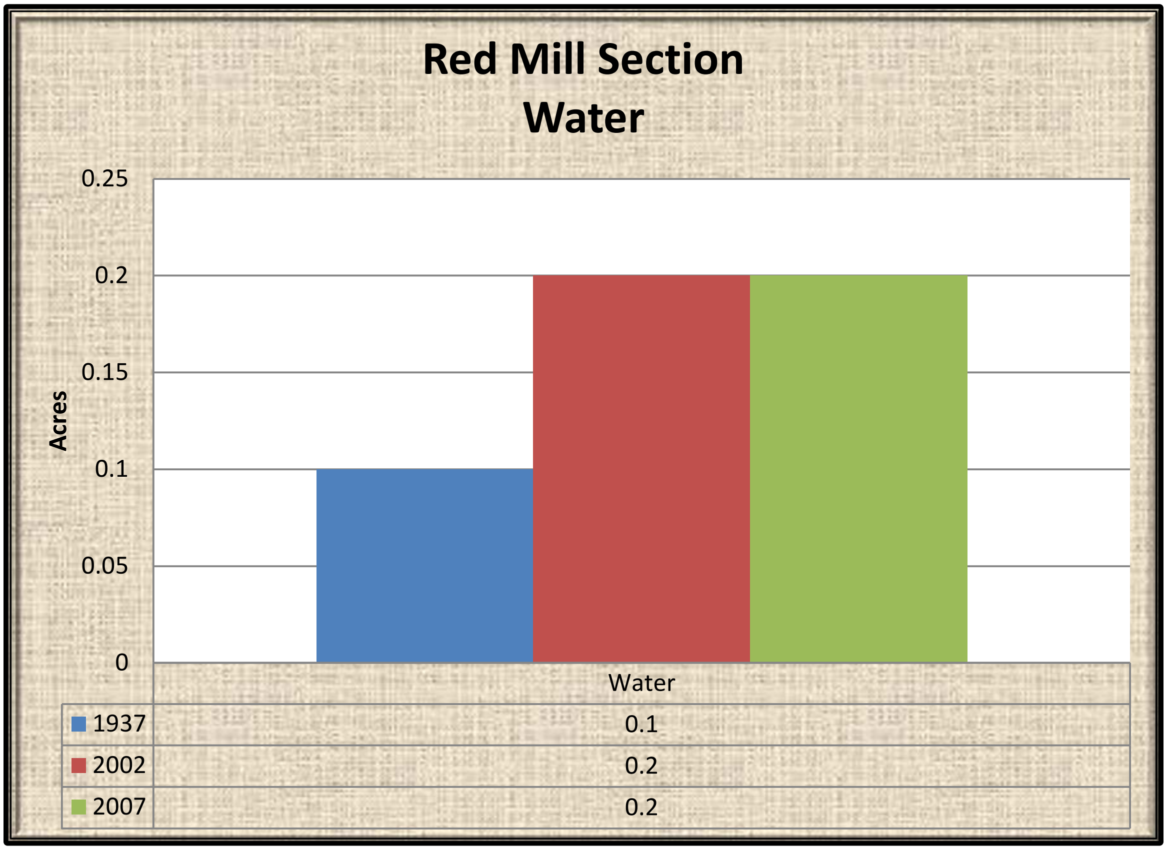


Figure 4-7.7. Red Mill Section Water Coverage (1954, 2002, and 2007)

Red Mill Section Water Coverage (Figure 4-7.7): Water has increased very slightly over time and has been stable in the recent period (2002-2007).

Natural Capital (Table 4-7.12)

Capitalization of the forest land in the Red Mill section has been going up with the maturation of the forest. It has generally been stable in the recent period (2002-2007).

Table 4-7.12. Natural Capital of Red Mill Section Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,433/year
2002	$2,867/year
2007	$2,877/year

8. Wolfe Neck Section

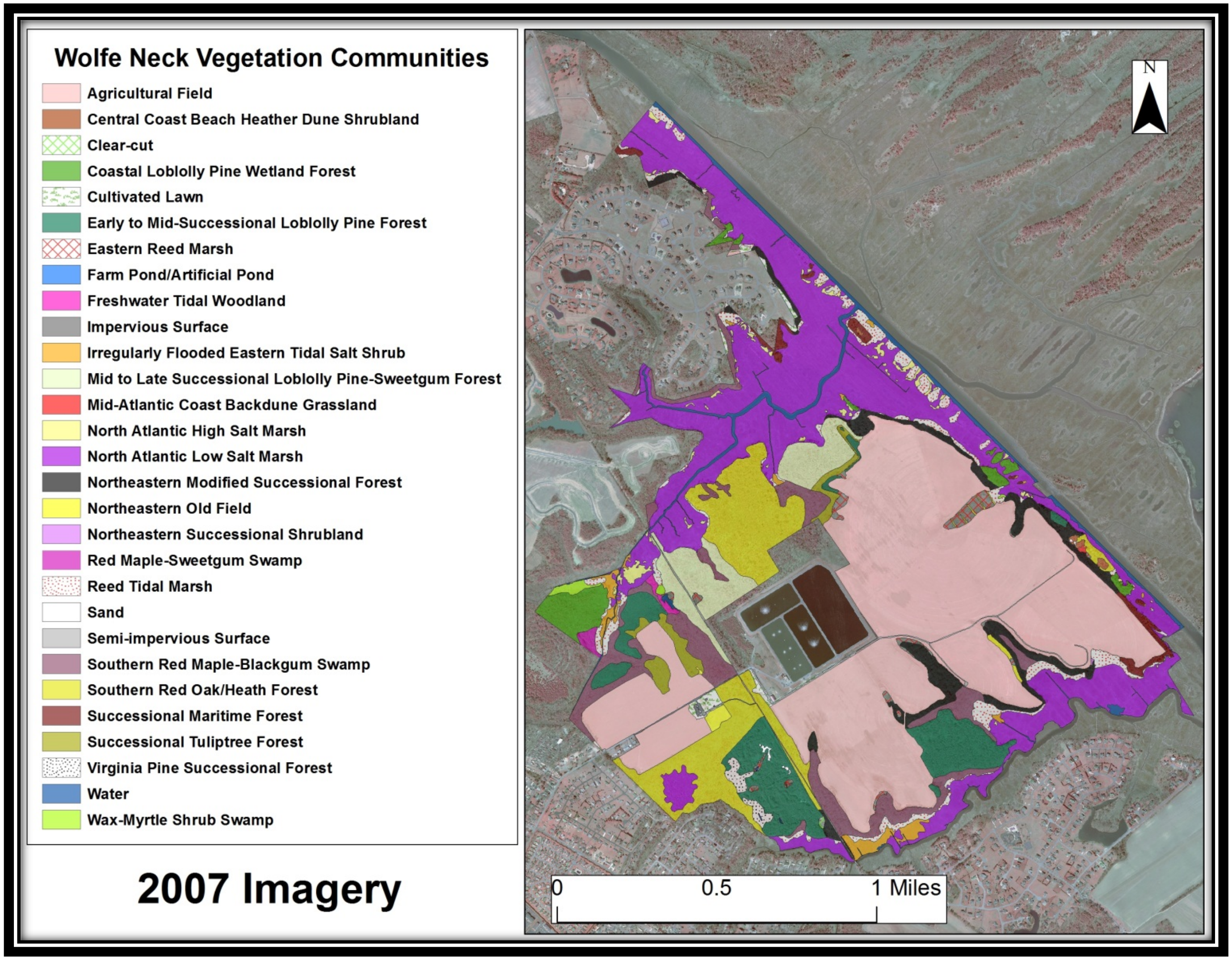


Figure 4-8.1. 2007 Vegetation Community Map of Wolfe Neck Section

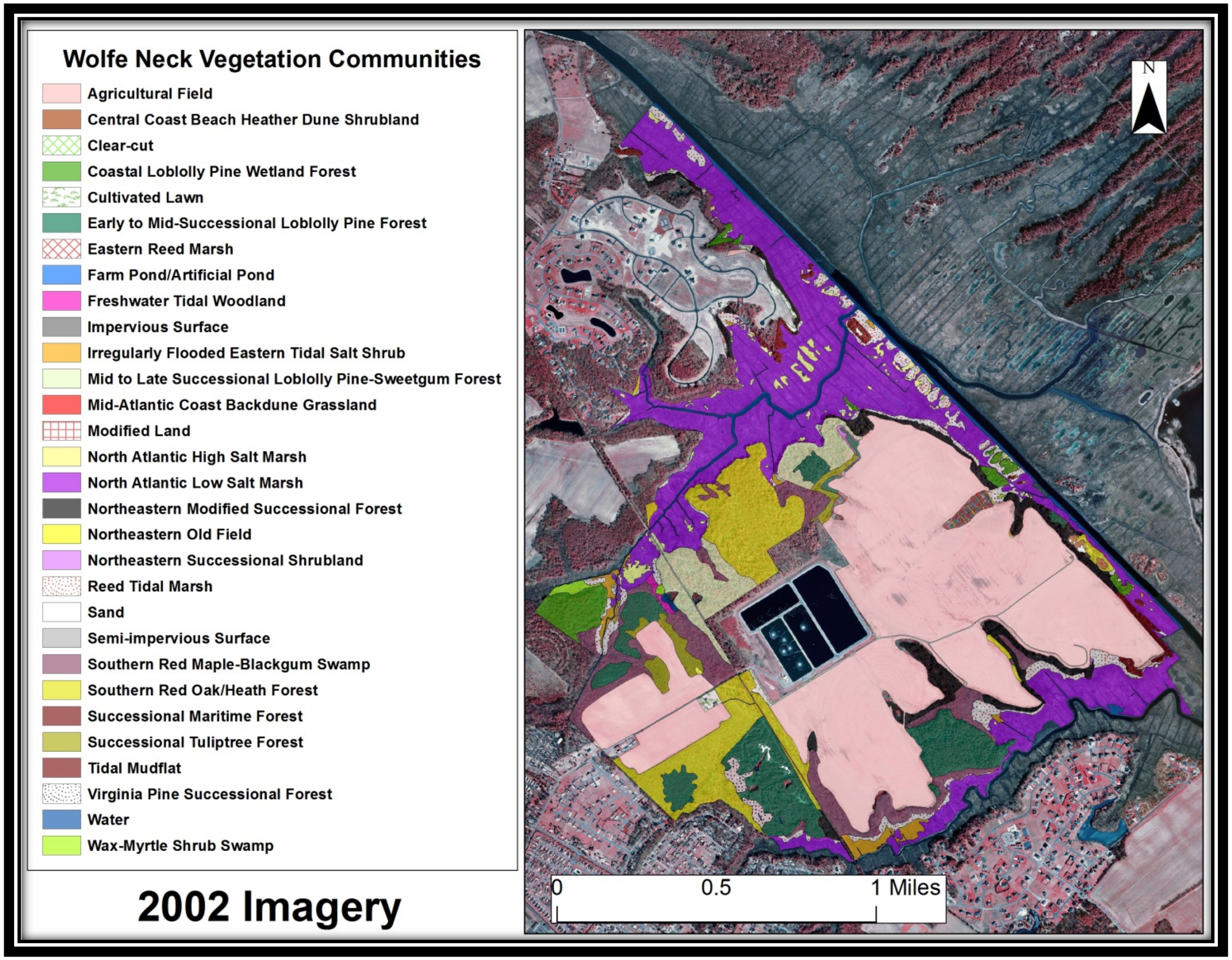


Figure 4-8.2. 2002 Vegetation Community of Wolfe Neck Section

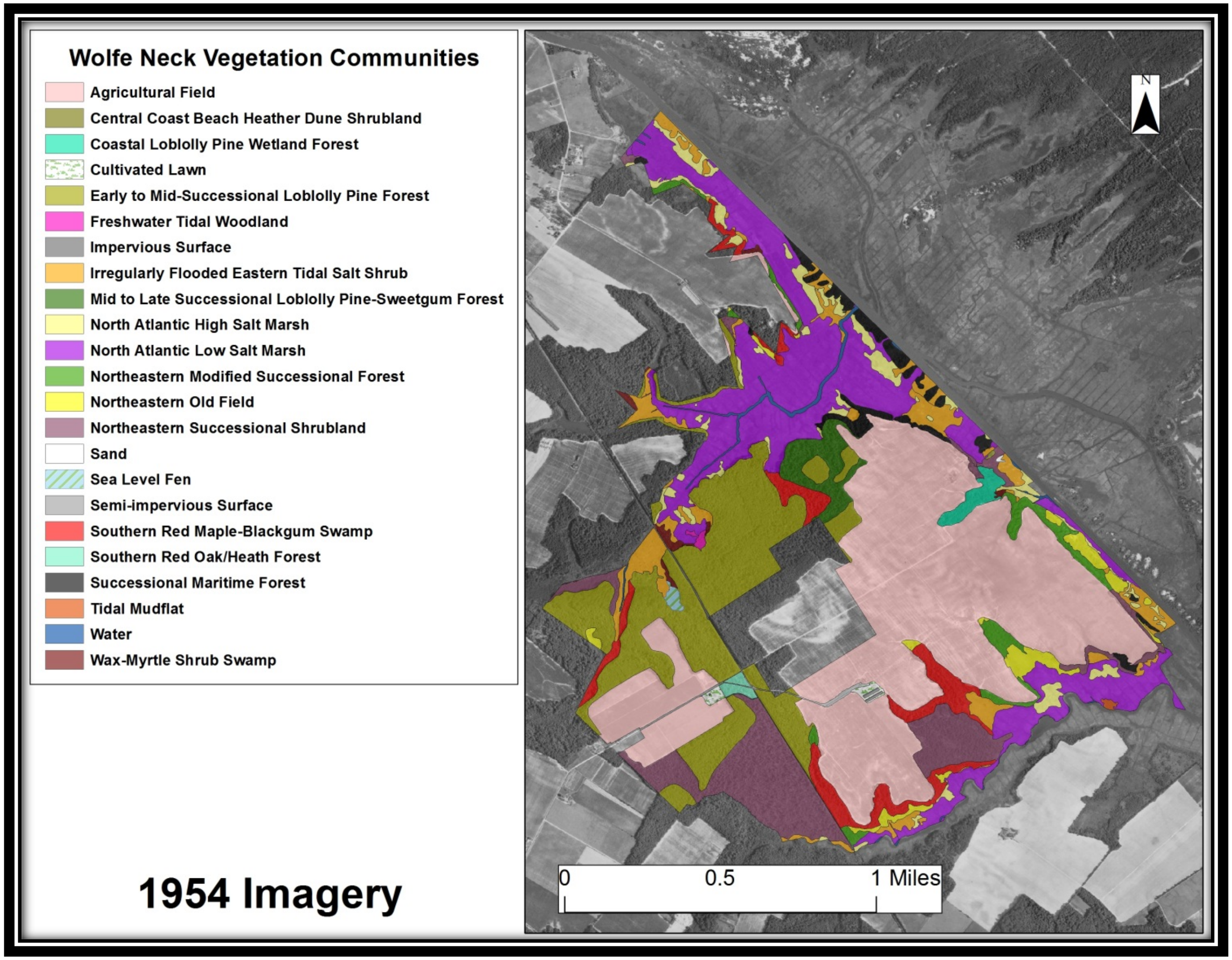
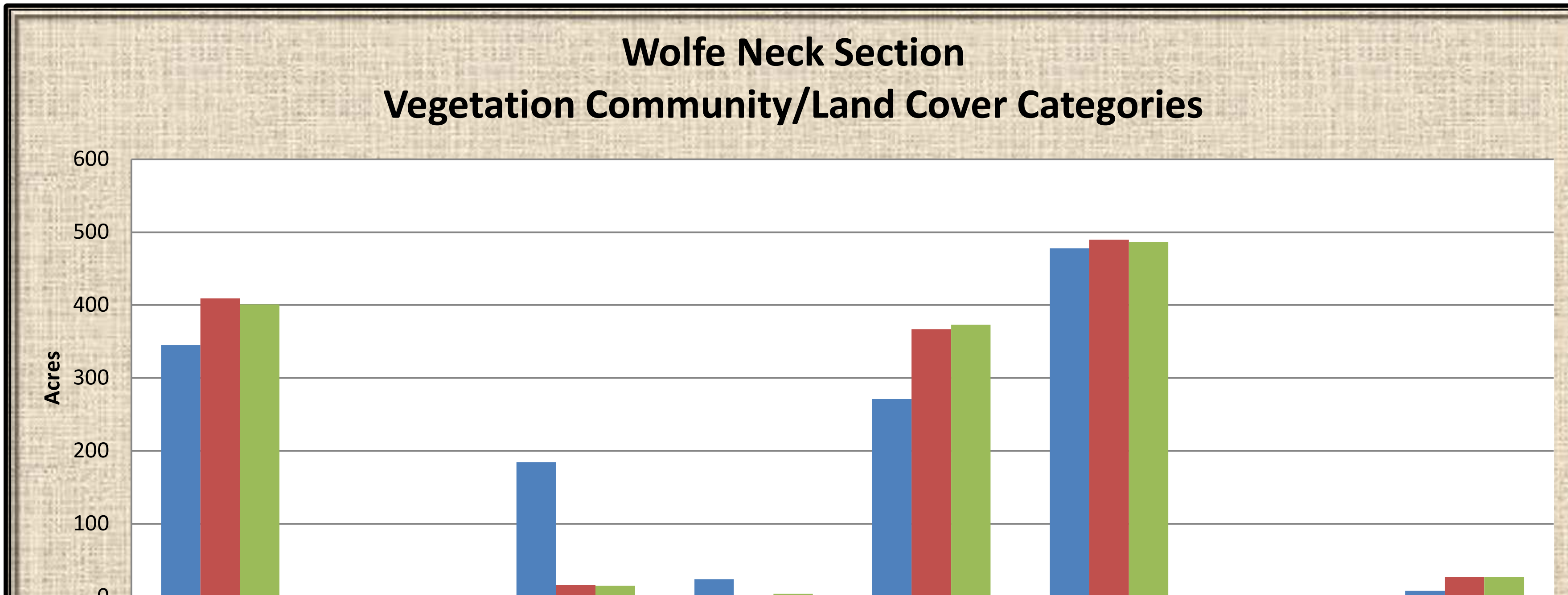


Figure 4-8.3. 1954 Vegetation Community Map of Wolfe Neck Section



	Forests	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1954	345	1	184.3	24	271	478	1.2	8
2002	409	1	16	2	367	489.54	1.3	27
2007	401	2	15.08	4.3	373	486.44	1	27

Figure 4-8.4. Wolfe Neck Section Vegetation Communities/Land Covers (1954, 2002, and 2007)

Wolfe Neck Section Broad Trends (Figure 4-8.4): The Wolfe Neck Section is located west of the Lewes and Rehoboth Canal and composed of anthropogenic communities (agricultural field), forest, and marsh.

DNREC Sea Level Rise Analysis (Table 4-8.1)

Most of the Wolfe Neck section is located in higher elevations. Under the highest sea level rise scenario (1.5 m), a little less than half of the section will be inundated.

Table 4-8.1. Projected acres of the Wolfe Neck Section Inundated by Sea Level Rise

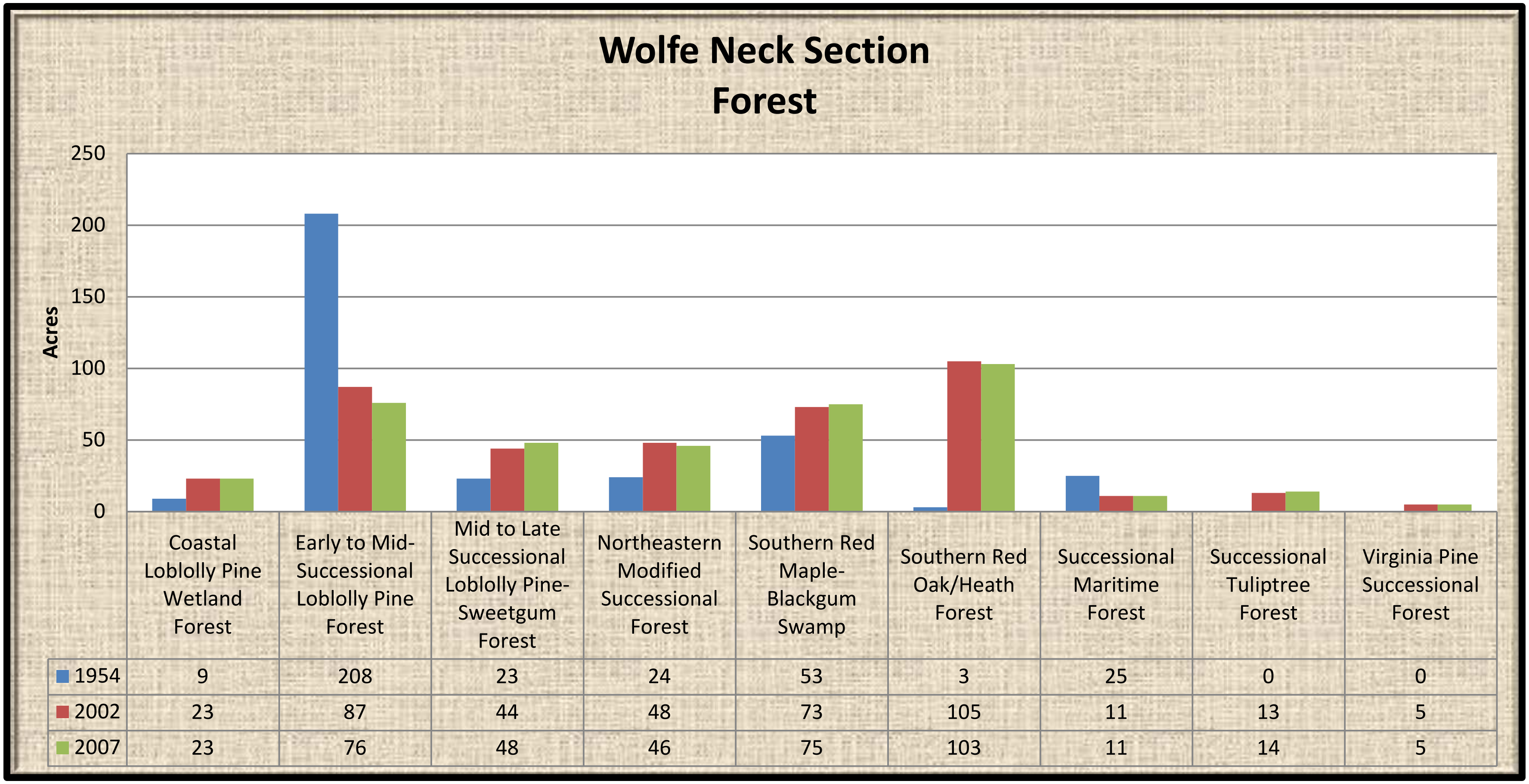
Rise	Acres
0.5 m	494 acres
1 m	547 acres
1.5 m	606 acres

Natural Capital (Table 4-8.2)

The capital of the Wolfe Neck Section has gradually increased, being driven mainly by increases in marshland.

Table 4-8.2. Natural Capital of the Wolfe Neck Section

Year	Natural Capital (in 2012 dollars)
1954	$2,998,269/year
2002	$4,067,255/year
2007	$4,146,052/year



	Coastal Loblolly Pine Wetland Forest	Early to Mid-Successional Loblolly Pine Forest	Mid to Late Successional Loblolly Pine-Sweetgum Forest	Northeastern Modified Successional Forest	Southern Red Maple-Blackgum Swamp	Southern Red Oak/Heath Forest	Successional Maritime Forest	Successional Tuliptree Forest	Virginia Pine Successional Forest
1954	9	208	23	24	53	3	25	0	0
2002	23	87	44	48	73	105	11	13	5
2007	23	76	48	46	75	103	11	14	5

Figure 4-8.5. Wolfe Neck Section Forest (1954, 2002, and 2007)

Wolfe Neck Section Forest (Figure 4-8.5): Southern Red Oak/Heath Forest is the most common forest type in Wolfe Neck Section, followed by Early to Mid-Successional Loblolly Pine Forest which is declining as it succeeds into more mature types. Southern Red Maple-Blackgum Swamp is the most lowland forest. Mid to Late Successional Loblolly Pine-Sweetgum Forest is also common in the section. Other forest types are fairly minor to the section.

DNREC Sea Level Rise Analysis (Table 4-8.3)

Less than half of the forested area in the Wolfe Neck section will be inundated with 1.5 m of sea level rise.

Table 4-8.3. Projected acres of Wolfe Neck Section Forest Inundated by Sea Level Rise

Rise	Acres
0.5 m	95 acres
1 m	142 acres
1.5 m	189 acres

Natural Capital (Table 4-8.4)

Capital in forestland has increased. This is being driven in part by increases in Southern Red Maple-Blackgum Swamp.

Table 4-8.4. Natural Capital of Wolfe Neck Section Forest

Year	Natural Capital (in 2012 dollars)
1954	$704,965/year
2002	$1,239,172/year
2007	$1,261,864/year

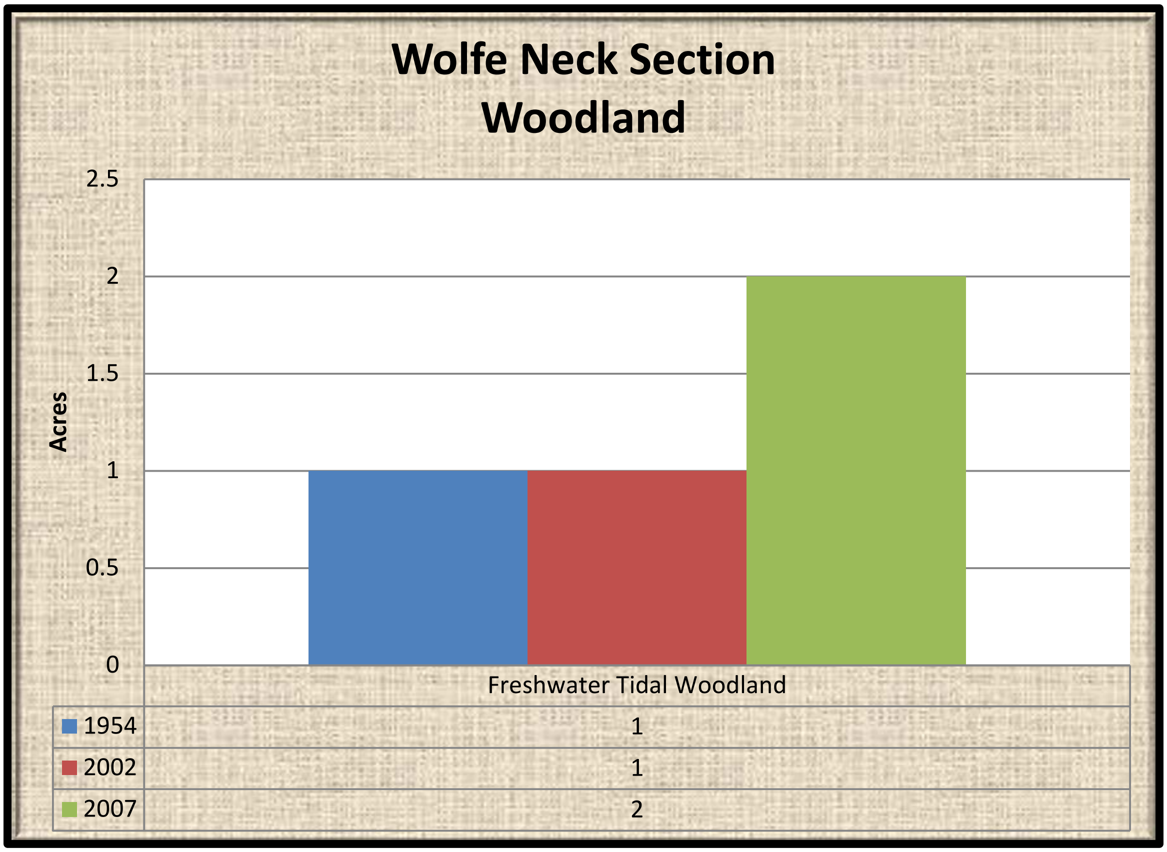


Figure 4-8.6. Wolfe Neck Woodland (1954, 2002, and 2007)

Wolfe Neck Section Woodland (Figure 4-8.6): Freshwater Tidal Woodland is the only woodland present in the section. It is located in a place where Southern Red Maple-Blackgum Swamp is being inundated by sea level rise.

DNREC Sea Level Rise Analysis (Table 4-8.3)

All of the current woodland located in the Wolfe Neck section will be inundated with 0.5 m of sea level rise.

Table 4-8.5. Projected acres of Wolfe Neck Section Woodland Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 4-8.6)

The capitalization of woodland has doubled in recent period with an increase in the amount of woodland.

Table 4-8.6. Natural Capital of Wolfe Neck Section Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$12,292/year
2002	$12,292/year
2007	$24,583/year

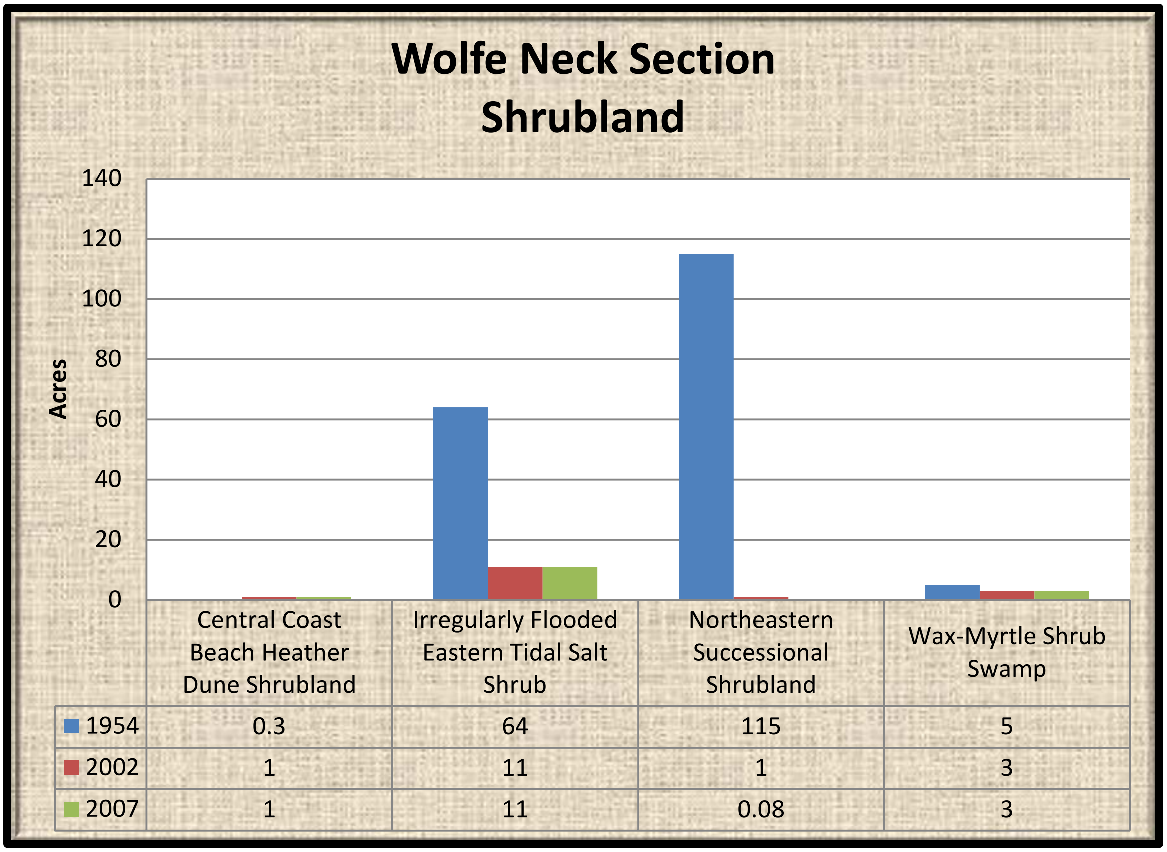


Figure 4-8.7. Wolfe Neck Section Shrubland (1954, 2002, and 2007)

Wolfe Neck Section Shrubland (Figure 4-8.7): Irregularly Flooded Eastern Tidal Salt Shrub is the most common shrubland in the Wolfe Neck Section. It has declined from its 1954 high.

DNREC Sea Level Rise Analysis (Table 4-8.7)

Shrubland in the Wolfe Neck section will essentially be eliminated with 0.5 m of sea level rise.

Table 4-8.7. Projected acres of Wolfe Neck Section Shrubland Inundated by Sea Level Rise

Rise	Acres
0.5 m	14 acres
1 m	14 acres
1.5 m	15 acres

Natural Capital (Table 4-8.8)

Capital of shrublands has been declining with declines in Northeastern Successional Shrubland as it matures to forest.

Table 4-8.8. Natural Capital of Wolfe Neck Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$418,162/year
2002	$69,276/year
2007	$69,142/year

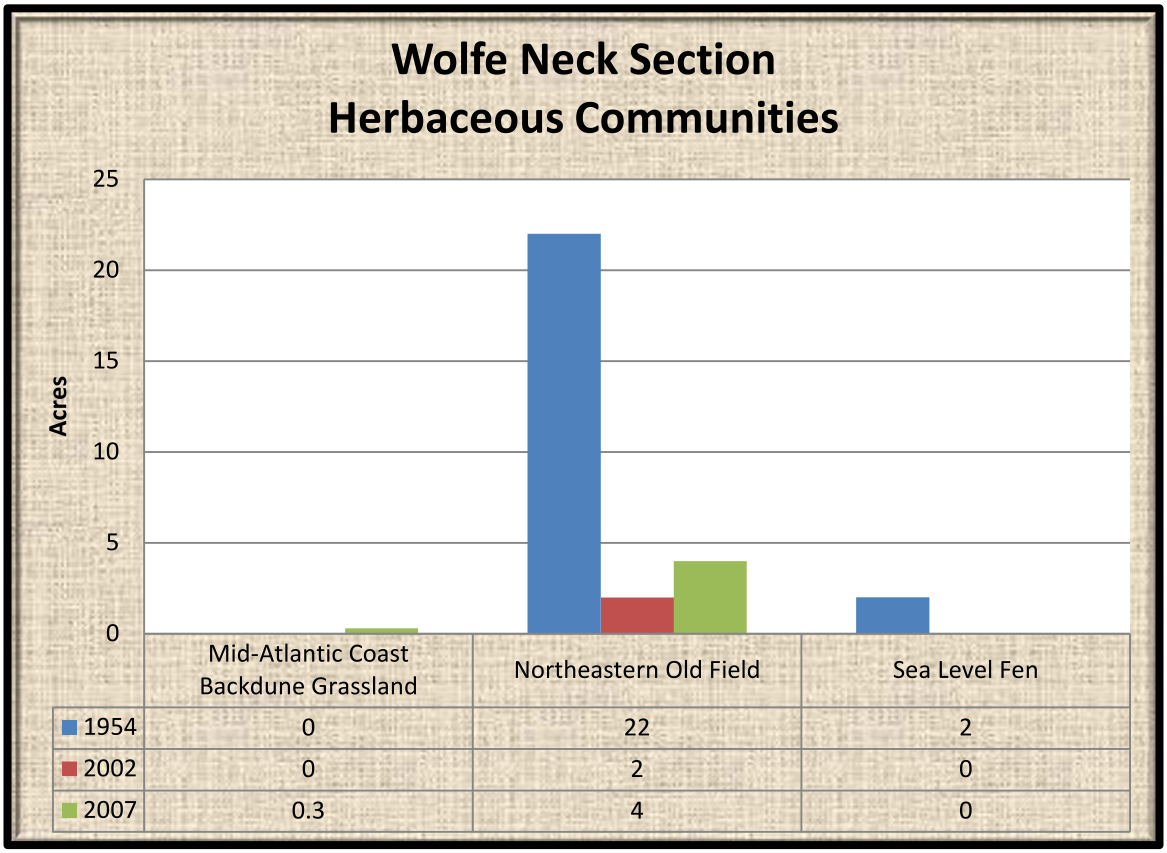


Figure 4-8.8. Wolfe Neck Section Herbaceous Communities (1954, 2002, and 2007)

Wolfe Neck Section Herbaceous Communities (Figure 4-8.8): Herbaceous communities are a very minor part of the Wolfe Neck Section. Northeastern Old Field is the most common herbaceous community but is declining as it succeeds to more mature communities. A sea level fen used to be a part of this section, but has since disappeared with sea level rise.

DNREC Sea Level Rise Analysis (Table 4-8.9)

About ¼ of the herbaceous communities in the Wolfe Neck Tract will be impacted by 1.5 m of sea level rise.

Table 4-8.9. Projected acres of Wolfe Neck Section Herbaceous Communities Inundated by Sea Level Rise

Rise	Acres
0.5 m	0.1 acres
1 m	0.5 acres
1.5 m	1 acre

Natural Capital (Table 4-8.10)

Herbaceous community capital has gone down with maturation of Northeastern Old Field into more mature communities.

Table 4-8.10. Natural Capital of Wolfe Neck Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$21,768/year
2002	$291/year
2007	$627/year

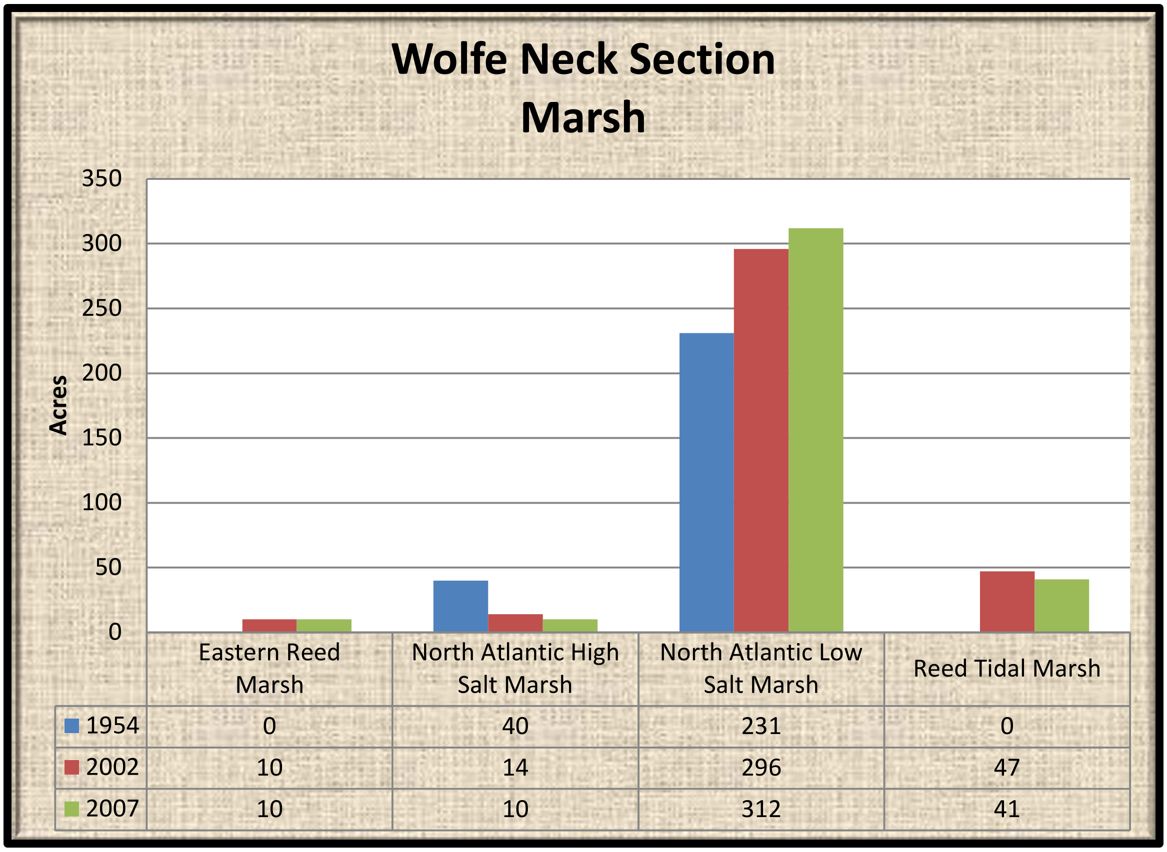


Figure 4-8.9. Wolfe Neck Section Marsh (1954, 2002, and 2007)

Wolfe Neck Section Marsh (Figure 4-8.9): North Atlantic Low Salt Marsh is the most common marsh type in the Wolfe Neck Section and has been increasing through time. North Atlantic High Salt Marsh has been decreasing long with Reed Tidal Marsh.

DNREC Sea Level Rise Analysis (Table 4-8.11)

Marsh will essentially be eliminated in its current extent with 0.5 m or greater of sea level rise.

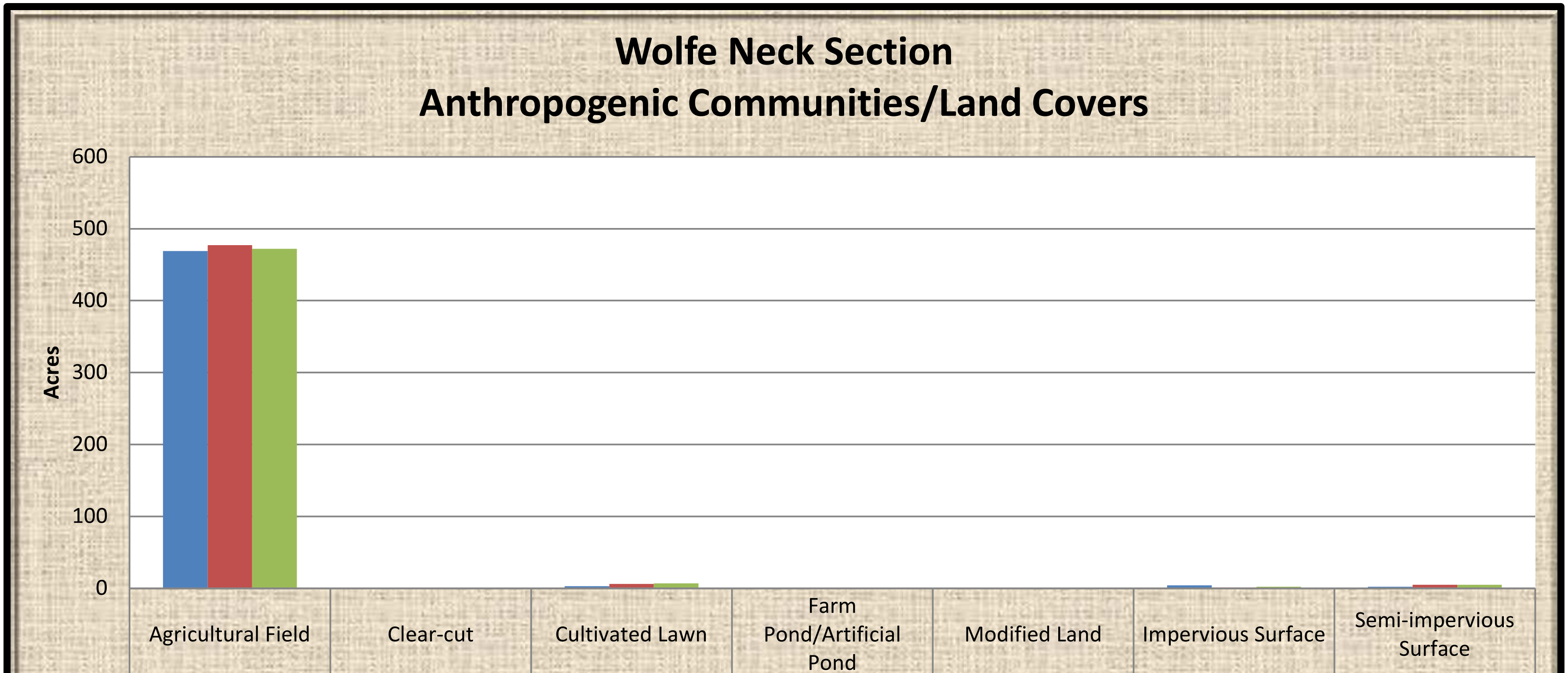
Table 4-8.11. Projected acres of Wolfe Neck Section Marsh Inundated by Sea Level Rise

Rise	Acres
0.5 m	355 acres
1 m	357 acres
1.5 m	358 acres

Natural Capital (Table 4-8.12)

Marsh capital has been going up as North Atlantic Low Salt Marsh increases. This may eventually fall with sea level rise.

Table 4-8.12. Natural Capital of Wolfe Neck Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,699,522/year
2002	$2,331,668/year
2007	$2,375,567/year



	Agricultural Field	Clear-cut	Cultivated Lawn	Farm Pond/Artificial Pond	Modified Land	Impervious Surface	Semi-impervious Surface
1954	469	0	3	0	0	4	2
2002	477	0	6	0.04	0.5	1	5
2007	472	0.4	7	0.04	0	2	5

Figure 4-8.10. Wolfe Neck Section Anthropogenic Communities/Land Covers (1954, 2002, and 2007)

Wolfe Neck Section Anthropogenic Communities/Land Covers (Figure 4-8.10): Agricultural field is the most common anthropogenic community with all other types minor to it.

DNREC Sea Level Rise Analysis (Table 4-8.13)

Anthropogenic Communities/Land Covers will be slightly affected by sea level rise. Most of this category is located in areas of high elevation.

Table 4-8.13. Projected acres of Wolfe Neck Section Anthropogenic Communities/Land Covers Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	3 acres
1.5 m	13 acres

Natural Capital (Table 4-8.14)

Agricultural field and Farm Pond/Artificial Ponds are the only land covers that have capital value. Overall the amount has been going up but oscillating with the amount of agricultural acreage.

Table 4-8.14. Natural Capital of Wolfe Neck Section Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1954	$26,897/year
2002	$27,569/year
2007	$27,283/year

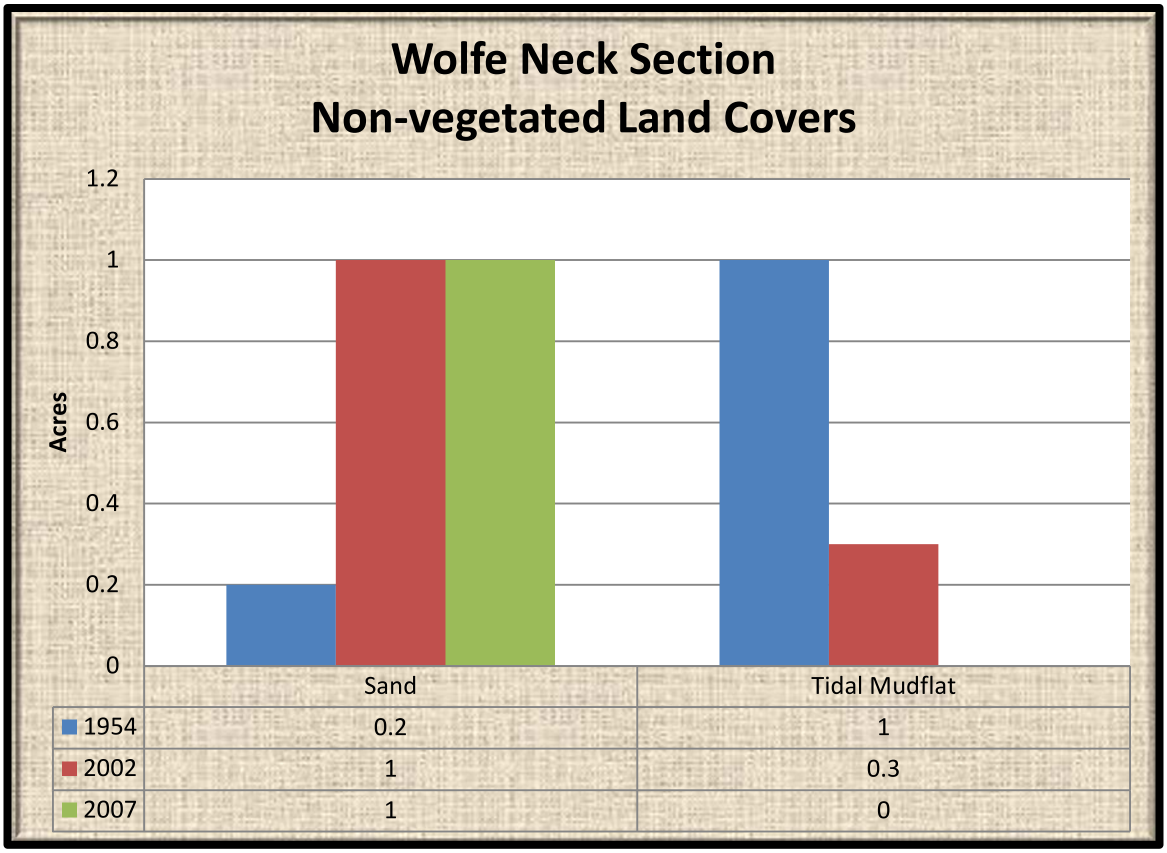


Figure 4-8.11. Wolfe Neck Section Non-vegetated Land Covers (1954, 2002, and 2007)

Wolfe Neck Section Non-vegetated Land Covers (Figure 4-8.11): Non-vegetated Land Covers only cover 1 acre in the section with sand being the only one.

DNREC Sea Level Rise Analysis (Table 4-8.15)

The one area of sand in the Wolfe Neck section is located in an area of higher elevation.

Table 4-8.15. Projected acres of Wolfe Neck Section Non-vegetated Land Covers Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	0 acres
1.5 m	0 acres

Natural Capital

None of the existing non-vegetated land covers have any capital value in the Wolfe Neck section.

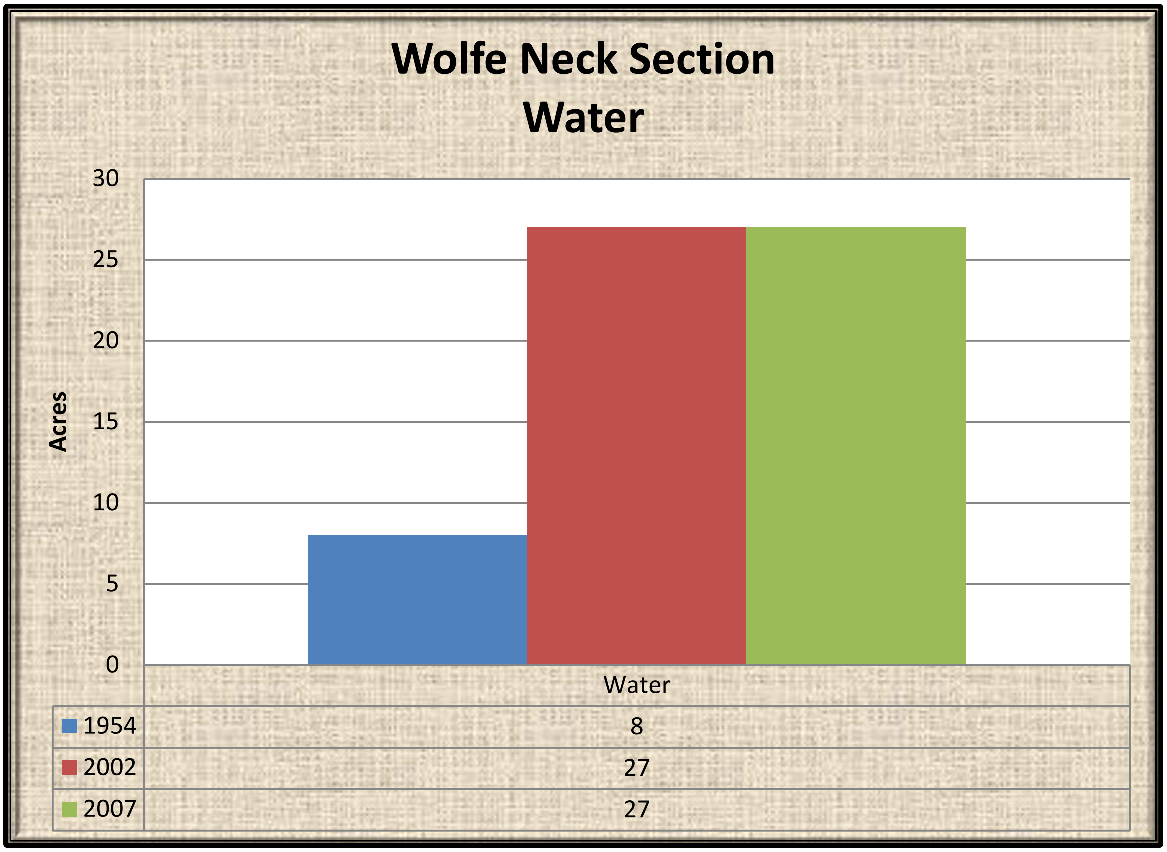


Figure 4-8.12. Wolfe Neck Section Water Coverage (1954, 2002, and 2007)

Wolfe Neck Section Non-vegetated Land Covers (Figure 4-8.12): Water coverage has increased since 1954 and has been stable in the recent period (2002-2007).

Natural Capital (Table 4-8.17)

Water capital in the estuary has been increasing with the increasing amount of water in the section.

Table 4-8.17. Natural Capital of Wolfe Neck Section Marsh

Year	Natural Capital (in 2012 dollars)
1954	$114,663/year
2002	$386,987/year
2007	$386,987/year

Chapter 5: Descriptions and Analysis of the Vegetation Communities

Forty vegetation communities and twelve land covers were noted in the survey (Figures 9-32). Below are the descriptions of the vegetation communities. The National Vegetation Classification System (NVCS) Association number is given with the vegetation community and their approximate acreage in the project area. Names of communities correspond with the common names as given in the NVCS and the Guide to Delaware Vegetation Communities. The crosswalk to the Key Wildlife Habitat (KWH) from the Delaware Wildlife Action Plan (DEWAP) and the Northeast Habitat Classification (NHC) are given below the title.

An analysis of the sea level rise rate over time is provided for those communities that are considered to be affected most immediately by sea level rise. For Cape Henlopen State Park these include the Cattail Brackish Tidal Marsh, Freshwater Tidal Woodland, Irregularly Flooded Eastern Tidal Salt Shrub, Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland, Needlerush High Marsh, North Atlantic High Salt Marsh, North Atlantic Low Salt Marsh, and Reed Tidal Marsh.

The vegetation communities include:

1. Atlantic Coast Interdune Swale (CEGL003839)—0.3 acres
2. Barrier Island Bog (CEGL003906)—3 acres
3. Beachgrass-Panicgrass Dune Grassland (CEGL004043)—169 acres
4. Cattail Brackish Tidal Marsh (CEGL004201)—0.3 acres
5. Central Coast Beach Heather Dune Shrubland (CEGL003950)—46 acres
6. Chesapeake Bay Maritime Shrubland (CEGL003881)—6 acres
7. Chesapeake Bay Tall Maritime Shrubland (CEGL006319)—21 acres
8. Coastal Loblolly Pine Wetland Forest (CEGL006137)—70 acres
9. Coastal Plain Pond (CEGL006086)—1 acre
10. Cultivated Lawn (CEGL008462)—96 acres
11. Early to Mid-Successional Loblolly Pine Forest (CEGL006011)—109 acres
12. Eastern Reed Marsh (CEGL004141)—69 acres
13. Forked Rush Dune Swale (CEGL004111)—0.3 acres
14. Freshwater Tidal Woodland (CEGL006165)—18 acres
15. Irregularly Flooded Eastern Tidal Salt Shrub (CEGL003921)—57 acres
16. Japanese Black Pine Forest (CEGL006012)—2 acres
17. Loblolly Pine Dune Woodland (CEGL006052)—75 acres
18. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland (CEGL006849)—12 acres
19. Maritime Red Cedar Woodland (CEGL006212)—2 acres
20. Mid-Atlantic Coast Backdune Grassland (CEGL004240)—112 acres
21. Mid to Late Successional Loblolly Pine-Sweetgum Forest (CEGL008462)—94 acres
22. Needlerush High Marsh (CEGL004186)—0.03 acres
23. North Atlantic High Salt Marsh (CEGL006006)—32 acres
24. North Atlantic Low Salt Marsh (CEGL004192)—1095 acres
25. Northeastern Modified Successional Forest (CEGL006599)—155 acres
26. Northeastern Old Field (CEGL006107)—14 acres
27. Northeastern Successional Shrubland (CEGL006451)—2 acres

28. Northern Interdunal Cranberry Swale (CEGL006141)—8 acres
29. Overwash Dune Grassland (CEGL004097)—3 acres
30. Pitch Pine Dune Woodland (CEGL006117)—911 acres
31. Pitch Pine Lowland (CEGL006195)—7 acres
32. Pitch Pine/Cranberry Interdunal Swale (CEGL006127)—1 acre
33. Reed Tidal Marsh (CEGL004187)—190 acres
34. Salt Panne (CEGL004308)—14 acres
35. Southern Red Maple-Blackgum Swamp (CEGL006238)—170 acres
36. Southern Red Oak/Heath Forest (CEGL006269)—182 acres
37. Successional Maritime Forest (CEGL006145)—44 acres
38. Successional Tuliptree Forest (CEGL007220)—14 acres
39. Virginia Pine Successional Forest (CEGL002591)—5 acres
40. Wax-Myrtle Shrub Swamp (CEGL003840)—10 acres

***Atlantic Coast Interdune Swale* [0.3 acres (Figure 5.1, Tables 5.1-5.4)] G3G4 S2**

DEWAP: Interdunal Wetlands
NHC: Northern Atlantic Coastal Plain Dune and Swale

Description

This community is found in depressions near the cape. Wax-myrtle (*Morella cerifera*) often dominates the shrub layer and associated by blackberry (*Rubus* sp.) and by beach plum (*Prunus maritima*) on the edge. Common reed (*Phragmites australis*) and broom-sedge (*Andropogon virginicus*) co-dominate the herbaceous layer.

Analysis of Condition at Cape Henlopen State Park

Atlantic Coast Interdune Swale is only found in the Cape Point Section and has come into the park since 1954. In the recent period (2002-2007) it has declined from 1 acre to 0.3 acres in size.

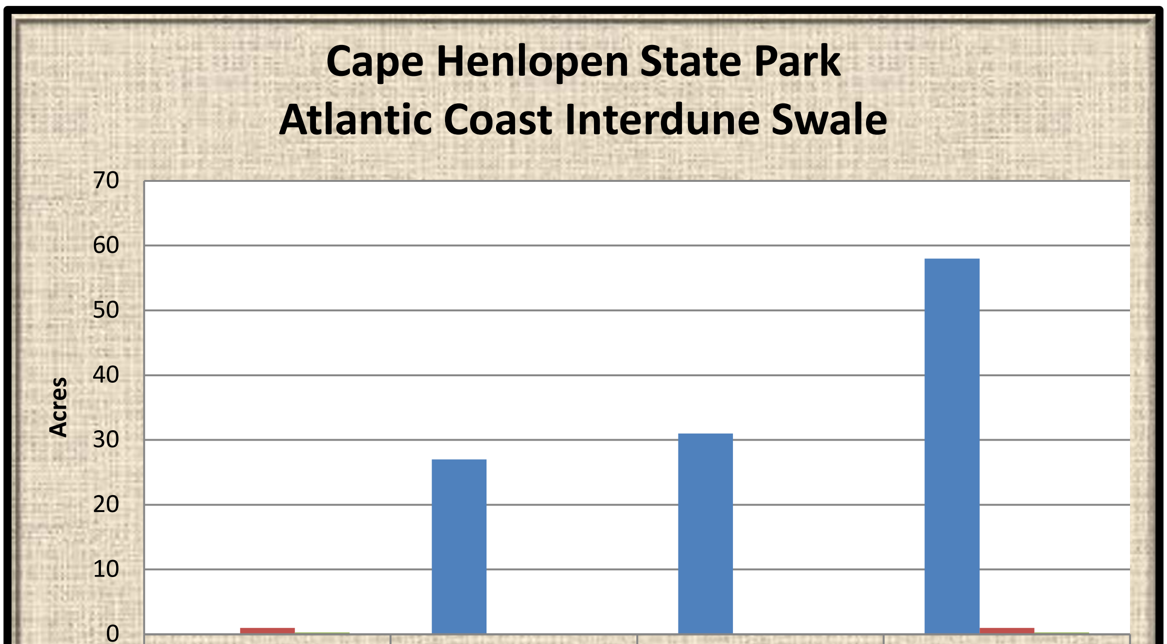
None of the acreage present in 1954 as this community exists in 2007. What was this community has become mostly Pitch Pine Dune Woodland (30 acres), Beachgrass-Panicgrass Dune Grassland (9 acres), Beach (6 acres), Reed Tidal Marsh (4 acres), and Impervious Surface (2 acres) (Table 5.1).

Since 1954 this community has migrated into 0.2 acres of Beach and 0.1 acres of Beachgrass-Panicgrass Dune Grassland (Table 5.2).

Given the tenuous amount of acreage that this community is currently found in and the lack of recruitment the prospects for the survival of this community are poor.

Table 5.1. What was once Atlantic Coast Interdune Swale in 1954 has become X in 2007	
X	**Acreage**
Pitch Pine Dune Woodland	30 acres
Beachgrass-Panicgrass Dune Grassland	9 acres
Beach	6 acres
Reed Tidal Marsh	4 acres
Impervious Surface	2 acres
Other communities/land covers	6 acres

Table 5.2. Atlantic Coast Interdune Swale has migrated into X since 1954	
X	**Acreage**
Beach	0.2 acres
Beachgrass-Panicgrass Dune Grassland	0.1 acres



	Cape Point Section	Fort Miles Section	Gordons Pond Section	Cape Henlopen State Park
1954	0	27	31	58
2002	1	0	0	1
2007	0.3	0	0	0.3

Figure 5.1. Atlantic Coast Interdune Swale at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.3)

Atlantic Coast Interdune Swale will not be affected with 0.5 m of rise but will be virtually eliminated with 1.5 m of rise.

Table 5.3. Projected acres of Atlantic Coast Interdune Swale Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0.1 acres
1.5 m	0.2 acres

Natural Capital (Table 5.4)

This community has matured into other communities resulting in a capital loss for the park. This loss continues in the recent period (2002-2007).

Table 5.4. Natural Capital of Atlantic Coast Interdune Swale	
Year	**Natural Capital (in 2012 dollars)**
1954	$538,321/year
2002	$9,281/year
2007	$2,784/year

Barrier Island Bog **[3 acres (Figure 5.2, Tables 5.5-5.8)] G2G4 S1**

DEWAP: Interdunal Wetlands
NHC: Northern Atlantic Coastal Plain Dune and Swale

Description

This community is scattered around the immediate coastal areas of the park. The shrub canopy is dominated by southern bayberry (*Morella cerifera*) and highbush blueberry (*Vaccinium corymbosum*) and associated by inkberry (*Ilex glabra*). Herbs in these depressions include yellow-eyed grass (*Xyris torta*), royal fern (*Osmunda regalis*), and spoon-leaved sundew (*Drosera intermedia*).

Analysis of Condition at Cape Henlopen State Park

Barrier Island Bog has been declining since 1954 but seems to be stable in acreage in the recent period (2002-2007). A lot of what was once Barrier Island Bog has become more upland communities (Table 5.5) such as Pitch Pine Dune Woodland, Mid-Atlantic Coast Backdune Grassland, and Cultivated Lawn potentially showing a build-up of sand and sediment. However some areas losses are attributable to invasion by Eastern Reed Marsh and have been inundated by water. Since 1954 this community has migrated (Table 5.6) into Beachgrass-Panicgrass Dune Grassland, Forked Rush Dune Swale, and Central Coast Beach Heather Dune Shrubland. The Forked Rush Dune Swale community has likely succeeded to this community as shrubs get more established while the other communities may have become wetter over time allowing this community to come in. What is left of this community is found in three sections. Given the data it is unknown what the short-term prospects for this community are but the long-term prospects do not look good for its continued survival, but eradication of reed grass (*Phragmites australis*) may help.

Table 5.5. What was once Barrier Island Bog in 1954 has become X in 2007	
X	**Acreage**
Pitch Pine Dune Woodland	5 acres
Water	3 acres
Cultivated Lawn	2 acres
Mid-Atlantic Coast Backdune Grassland	1 acre
Eastern Reed Marsh	1 acre
Other communities/land covers	3 acres

Table 5.6. Barrier Island Bog has migrated into X since 1954	
X	**Acreage**
Beachgrass-Panicgrass Dune Grassland	1 acre
Forked Rush Dune Swale	1 acre
Sand	1 acre
Central Coast Beach Heather Dune Shrubland	1 acre
Beach	0.1 acres
Other communities/land covers	0 acres

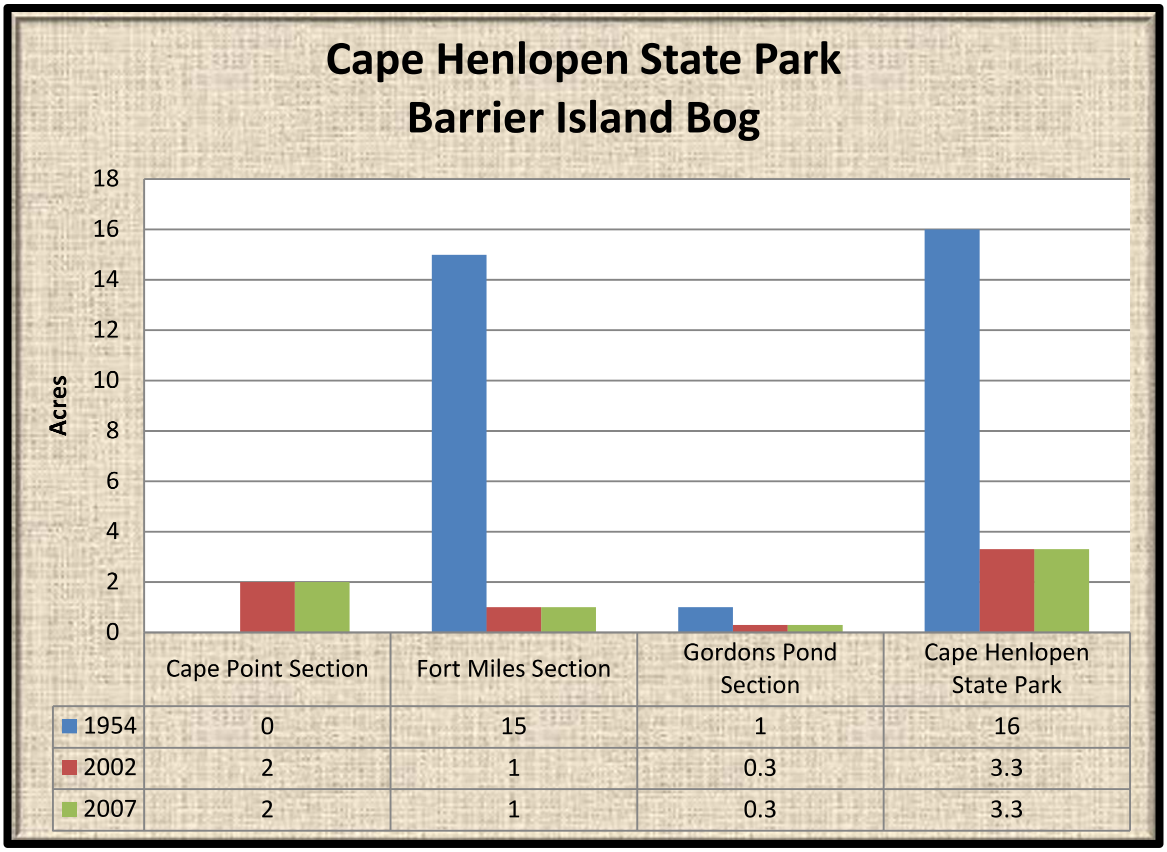


Figure 5.2. Barrier Island Bog at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.7)

Barrier Island Bog will not be affected at 0.5 m of sea level rise. About 1/3 of the current acreage will be impacted at 1 m and it will be eliminated at 1.5 m of rise in its current extent.

Table 5.7. Projected acres of Barrier Island Bog Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	1 acre
1.5 m	3 acres

Natural Capital (Table 5.8)

The capital of Barrier Island Bog has dropped with decreasing acreage from successional to Pitch Pine Dune Woodland and invasion by common reed (*Phragmites australis*). The succession to Pitch Pine Dune Woodland resulted in a capital loss to the park.

Table 5.8. Natural Capital of Barrier Island Bog	
Year	**Natural Capital (in 2012 dollars)**
1954	$148,502/year
2002	$30,629/year
2007	$30,629/year

***Beachgrass-Panicgrass Dune Grassland* [169 acres (Figures 5.3-5.4, Tables 5.9-5.12, Figure 33)]**
G2 S2

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Dune and Swale

Description

Figure 5.3. Beachgrass-Panicgrass Dune Grassland (Gordons Pond Section)

Beachgrass-Panicgrass Dune Grasslands are one of the native grasslands in the State of Delaware. These grasslands are co-dominated by beach grass (*Ammophila breviligulata*) and panic grass (*Panicum amarum*) and associated by scattered individuals of seaside goldenrod (*Solidago sempervirens*), purple sand grass (*Triplasis purpurea*), sand dune sandbur (*Cenchrus tribuloides*), and seaside sandmat (*Chamaesyce polygonifolia*).

Analysis of Condition at Cape Henlopen State Park

Beachgrass-Panicgrass Dune Grassland has been declining in the park, largely driven by area that once harbored this community becoming woodland. In the recent period (2002-2007) large losses were seen around the point area likely due to storms pushing up sand.

Seventy-two of the original 528 acres from 1954 still existed in 2007. The remaining acres have converted to Pitch Pine Dune Woodland (181 acres), Mid-Atlantic Coast Backdune Grassland (59 acres), Beach (38 acres), and sand (33 acres) (Table 5.9).

Since 1954 this community has colonized 41 acres of Sand and 14 acres of Beach. Nine acres of Atlantic Coast Interdune Swale has been converted along with 7 acres of Forked Rush Dune Swale likely from being covered by shifting sand (Table 5.10).

This community has been decreasing in the park. While it is likely to be around in the short term the long term prospects are less certain unless colonizes a lot of the Walking Dunes area.

Table 5.9. What was once Beachgrass-Panicgrass Dune Grassland in 1954 has become X or remained in 2007	
X	**Acreage**
Pitch Pine Dune Woodland	181 acres
Beachgrass-Panicgrass Dune Grassland	72 acres
Mid-Atlantic Coast Backdune Grassland	59 acres
Beach	38 acres
Sand	33 acres
Other communities/land covers	144 acres

Table 5.10. Beachgrass-Panicgrass Dune Grassland has migrated into X or remained since 1954	
X	**Acreage**
Beachgrass-Panicgrass Dune Grassland	72 acres
Sand	41 acres
Beach	14 acres
Atlantic Coast Interdune Swale	9 acres
Forked Rush Dune Swale	7 acres
Other communities/land covers	27 acres

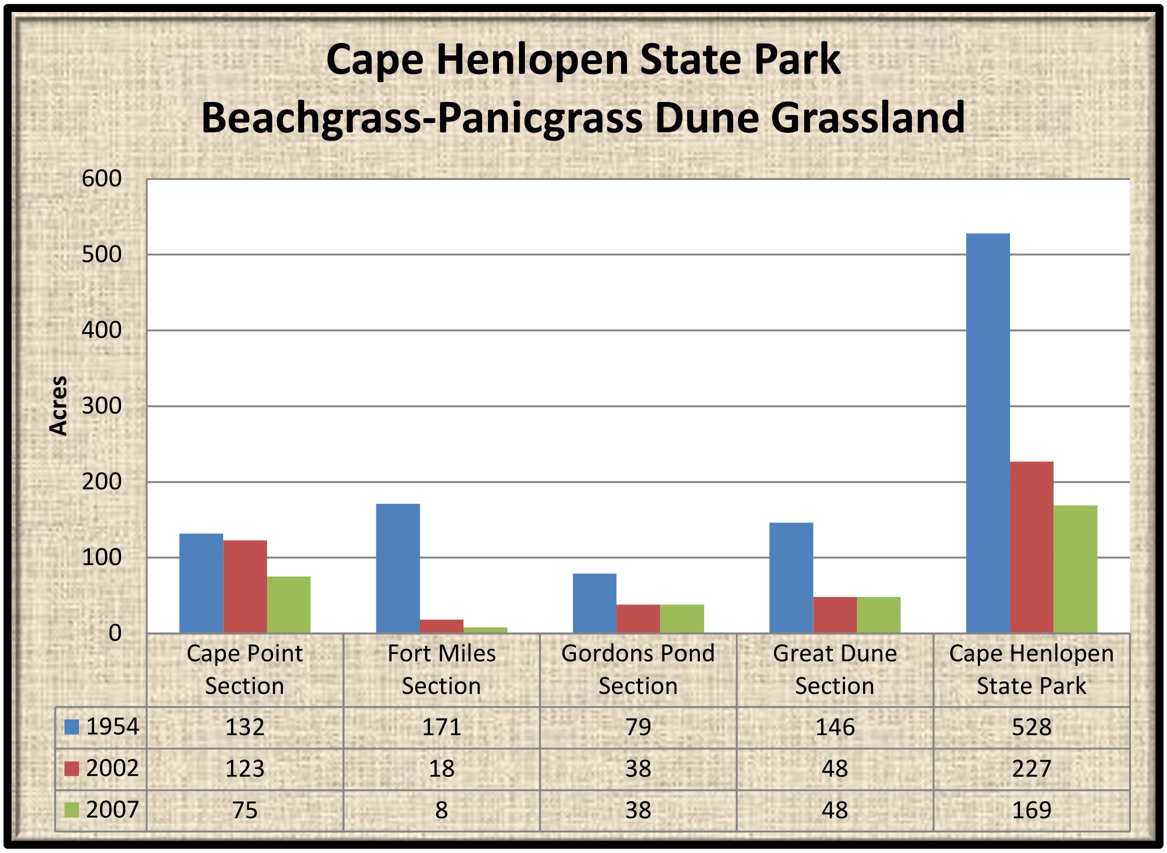


Figure 5.4. Beachgrass-Panicgrass Dune Grassland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.11)

This grassland community is often found in higher elevation places on dunes and will be barely affected at 0.5 m of rise and a little less than half of the acreage will be inundated with 1.5 m of rise.

Table 5.11. Projected acres of Beachgrass-Panicgrass Dune Grassland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	26 acres
1.5 m	68 acres

Natural Capital (Table 5.12)

Beachgrass-Panicgrass Dune Grassland capital has been going down as the community matures into other communities such as Pitch Pine Dune Woodland. This is happening mostly to the interior occurrences of the community.

Table 5.12. Natural Capital of Beachgrass-Panicgrass Dune Grassland	
Year	**Natural Capital (in 2012 dollars)**
1954	$76,930/year
2002	$33,074/year
2007	$24,623/year

***Cattail Brackish Tidal Marsh* [0.3 acres (Figure 5.5, Tables 5.13-5.16)] G4G5 S3**

DEWAP: Tidal Low Marshes
NHC: Northern Atlantic Coastal Plain Brackish Tidal Marsh

Description

This brackish marsh community is located at the marsh woodland interface of tributary to the Lewes and Rehoboth Canal in the Holland Glade Section. It dominated nearly entirely by wide-leaved cattail (*Typha latifolia*) in a tidal situation.

Analysis of Condition at Cape Henlopen State Park

Cattail Brackish Tidal Marsh had entered the park by 2002, but was not present in 1954. Arising from former Freshwater Tidal Woodland and Southern Red Maple/Blackgum Swamp the conversion of a wooded community to a marsh shows an increase of water into the system and in the case of this community an increase of salinity. Since 2002 this community has lost acreage to North Atlantic Low Salt Marsh showing a further increase of salinity and is not replacing itself. This community could be just a short lived feature on the landscape where a wooded community succumbed to water inundation or it could re-arise somewhere in the park. It is unknown is this community will resurge again as the woodland upstream dies or if the Reed Tidal Marsh nearby is eradicated.

Cattail Brackish Tidal Marsh was not present in the park in 1954 and has come into the park between this time and 2002. Out of the original 1 acre present in 2002, only 0.3 acres were present in 2007. The rest (0.5 acres) had converted to North Atlantic Low Salt Marsh (Table 5.13).

Since 2002 this community has converted 0.5 acres of Southern Red Maple-Blackgum Swamp Forest and 0.2 acres of Freshwater Tidal Woodland. These conversions along with the conversion of it to North Atlantic Low Salt Marsh above, shows the progression of higher salinity water into the system and more water in general (Table 5.14).

This community has a tenuous hold in the park and the long term prospects look sketchy unless it can convert more wooded communities, a feat which is unlikely with increasing rates of sea level rise.

Table 5.13. What was once Cattail Brackish Tidal Marsh in 2002 has become X or remained in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	0.5 acres
Cattail Brackish Tidal Marsh	0.3 acres

Table 5.14. Cattail Brackish Tidal Marsh has migrated into X (2002) or remained since 1954	
X (2002)	**Acreage**
Southern Red Maple-Blackgum Swamp	0.5 acres
Freshwater Tidal Woodland	0.2 acres

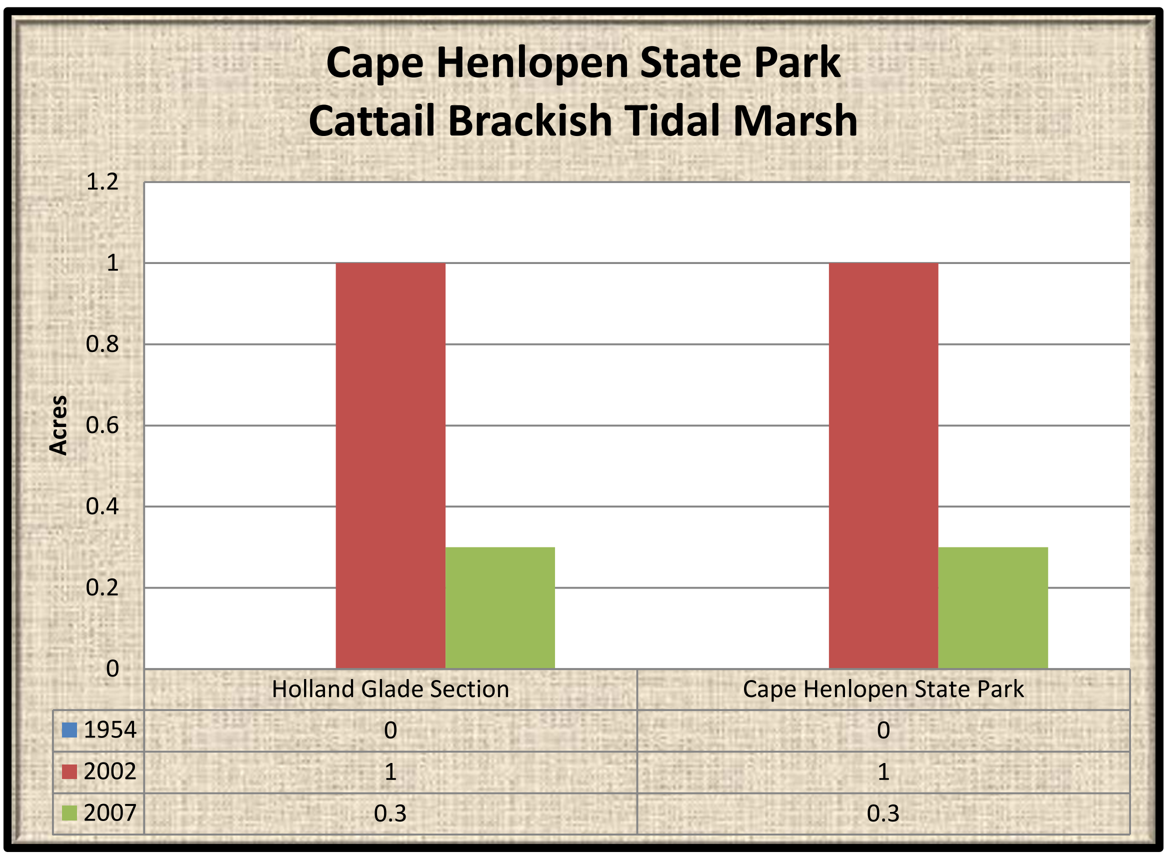


Figure 5.5. Cattail Brackish Tidal Marsh at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.15)

Cattail Brackish Tidal Marsh will be inundated completely by 0.5 m of sea level rise in its current extent.

Table 5.15. Projected acres of Cattail Brackish Tidal Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0.3 acres
1 m	0.3 acres
1.5 m	0.3 acres

Natural Capital (Table 5.16)

Cattail Brackish Tidal Marsh was not present in 1954 but has converted some former wooded communities resulting in an increase in the overall capital for the park. Recently, however, the acreage has gone down resulting in a decrease of capital.

Table 5.16. Natural Capital of Cattail Brackish Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$6,271/year
2007	$1,881/year

Central Coast Beach Heather Dune Shrubland **[46 acres (Figures 5.6-5.7, Tables 5.17-5.20)]**
G2 S2

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Dune and Swale

<u>Description</u>

Figure 5.6. Central Coast Beach Heather Dune Shrubland (Fort Miles Section)

Central Coast Beach Heather Dune Shrubland is a dwarf shrub community that is dominated by beach heather (*Hudsonia tomentosa*). Other species that may occur in scattered numbers around the beach heather include seaside bluestem (*Schizachyrium scoparium* ssp. *littorale*), poison ivy (*Toxicodendron radicans*), seaside goldenrod (*Solidago sempervirens*), and rough buttonweed (*Diodia teres*).

<u>Analysis of Condition at Cape Henlopen State Park</u>

Central Coast Beach Heather Dune Shrubland has been increasing in acreage through the study period. This is likely being driven by an increase in sand and sediment in the area since 1954. This same trend has been seen in the Barrier Island Bog. This idea is furthered by some of this community becoming Pitch Pine Dune Woodland and Mid-Atlantic Coast Backdune Grassland showing the advancement of more sand between what was formerly this community and the ocean.

On the other hand, this community has migrated into Beachgrass-Panicgrass Dune Grassland and has colonized former bare sand which is to be expected. Likely in the Gordons Pond area this community has taken over some Loblolly Pine Dune Woodland showing the increase of water in the pond area. This community will likely survive well in the long-term and the short term and appears to be secure.

In 1954 32 acres of this Central Coast Beach Heather Dune Shrubland were present in the park, but in 2007 only 1 acre of those original acres was still present. The remaining acres have converted to Pitch Pine Dune Woodland (8 acres), Mid-Atlantic Coast Backdune Grassland (7 acres), North Atlantic Low Salt Marsh (6 acres), and 2 acres of Impervious Surface (Table 5.17).

Since 1954 this community has converted 23 acres of Beachgrass-Panicgrass Dune Grassland, colonized 11 acres of sand, converted 2 acres of Loblolly Pine Dune Woodland, and 2 acres of Northeastern Old Field resulting in a net gain in acreage for the community (Table 5.18).

Table 5.17. What was once Central Coast Beach Heather Dune Shrubland in 1954 has become X or remained in 2007	
X	**Acreage**
Pitch Pine Dune Woodland	8 acres
Mid-Atlantic Coast Backdune Grassland	7 acres
North Atlantic Low Salt Marsh	6 acres
Impervious Surface	2 acres
Central Coast Beach Heather Dune Shrubland	1 acre
Other communities/land covers	6 acres

Table 5.18. Central Coast Beach Heather Dune Shrubland has migrated into X or remained since 1954	
X	**Acreage**
Beachgrass-Panicgrass Dune Grassland	23 acres
Sand	11 acres
Loblolly Pine Dune Woodland	2 acres
Northeastern Old Field	2 acres
Central Coast Beach Heather Dune Shrubland	1 acre
Other communities/land covers	4 acres

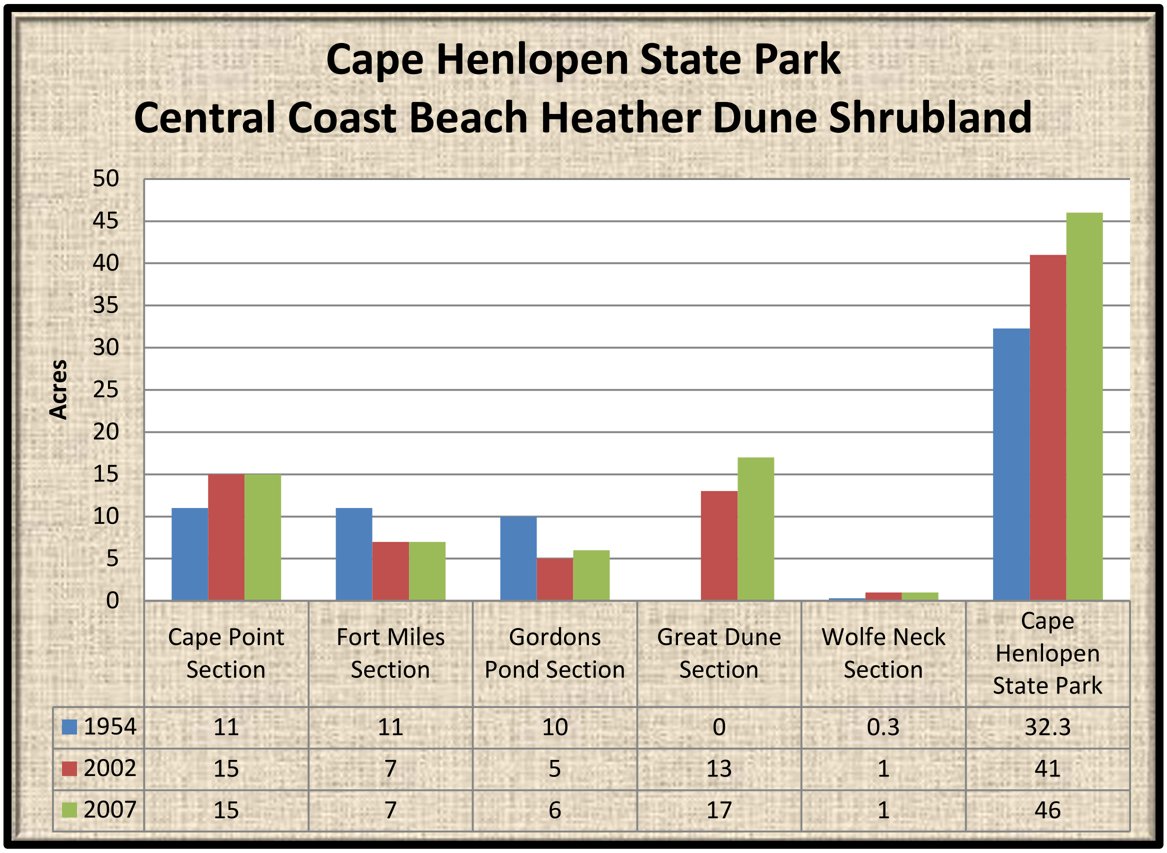


Figure 5.7. Central Coast Beach Heather Dune Shrubland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.19)

Like the Beachgrass-Panicgrass Dune Grassland, this community is often located in higher elevation parts of the dunes. As such only about ¼ of the current acreage will be affected by the highest sea level rise scenario (1.5 m).

Table 5.19. Projected acres of Central Coast Beach Heather Dune Shrubland Inundated by Sea Level Rise

Rise	Acres
0.5 m	0.4 acres
1 m	5 acres
1.5 m	13 acres

Natural Capital (Table 5.20)

Capital of Central Coast Beach Heather Dune Shrubland has been going up as it populates former areas of bare sand. This results in an overall increase in capital for the park.

Table 5.20. Natural Capital of Central Coast Beach Heather Dune Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$4,706/year
2002	$5,974/year
2007	$6,702/year

***Chesapeake Bay Maritime Shrubland* [6 acres (Figure 5.8, Tables 5.21-5.24)] G2 S1**

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Dune and Swale

Description

This shrub community is composed primarily of beach plum (*Prunus maritima*) and associated by seaside goldenrod (*Solidago sempervirens*) and beach grass (*Ammophila breviligulata*).

Analysis of Condition at Cape Henlopen State Park

Like some other communities, what was once Chesapeake Bay Maritime Shrubland has become woodland or another upland type community. In addition, impervious surface and cultivated lawn has taken some of this community. Chesapeake Bay Maritime Shrubland has migrated into mostly Beachgrass-Panicgrass Dune Grassland and bare sand since 1954, with only 0.4 acres remaining in the same place over the study period. With the declines the survival of this community in the park is uncertain given the data.

None of the original acreage of this community from 1954 still existed in 2007 showing its ephemeral nature. The acreage that did exist has been converted to 5 acres of Pitch Pine Dune Woodland, 3 acres of Beachgrass-Panicgrass Dune Grassland, 1 acre each of Chesapeake Bay Tall Maritime Shrubland, and Impervious Surface, and 0.4 acres of Cultivated Lawn (Table 5.21).

Since 1954 this community has migrated into 4 acres of Beachgrass-Panicgrass Dune Grassland, 1 acre of sand, 0.4 acres of Central Coast Beach Heather Dune Shrubland, 0.3 acres of water, and 0.2 acres of Beach (Table 5.22). Still this community has suffered a net loss in acreage.

Chesapeake Bay Maritime Shrubland will likely continue to decrease in acreage as overall dune acreage decreases. Like the other dune communities it will likely be around in some amount as long as the habitat persists.

Table 5.21. What was once Chesapeake Bay Maritime Shrubland in 1954 has become X or remained in 2007

X	Acreage
Pitch Pine Dune Woodland	5 acres
Beachgrass-Panicgrass Dune Grassland	3 acres
Chesapeake Bay Tall Maritime Shrubland	1 acre
Impervious Surface	1 acre
Cultivated Lawn	0.4 acres
Other communities/land covers	1 acre

Table 5.22. Chesapeake Bay Maritime Shrubland has migrated into X or remained since 1954	
X	**Acreage**
Beachgrass-Panicgrass Dune Grassland	4 acres
Sand	1 acre
Central Coast Beach Heather Dune Shrubland	0.4 acres
Water	0.3 acres
Beach	0.2 acres
Other communities/land covers	0.3 acres

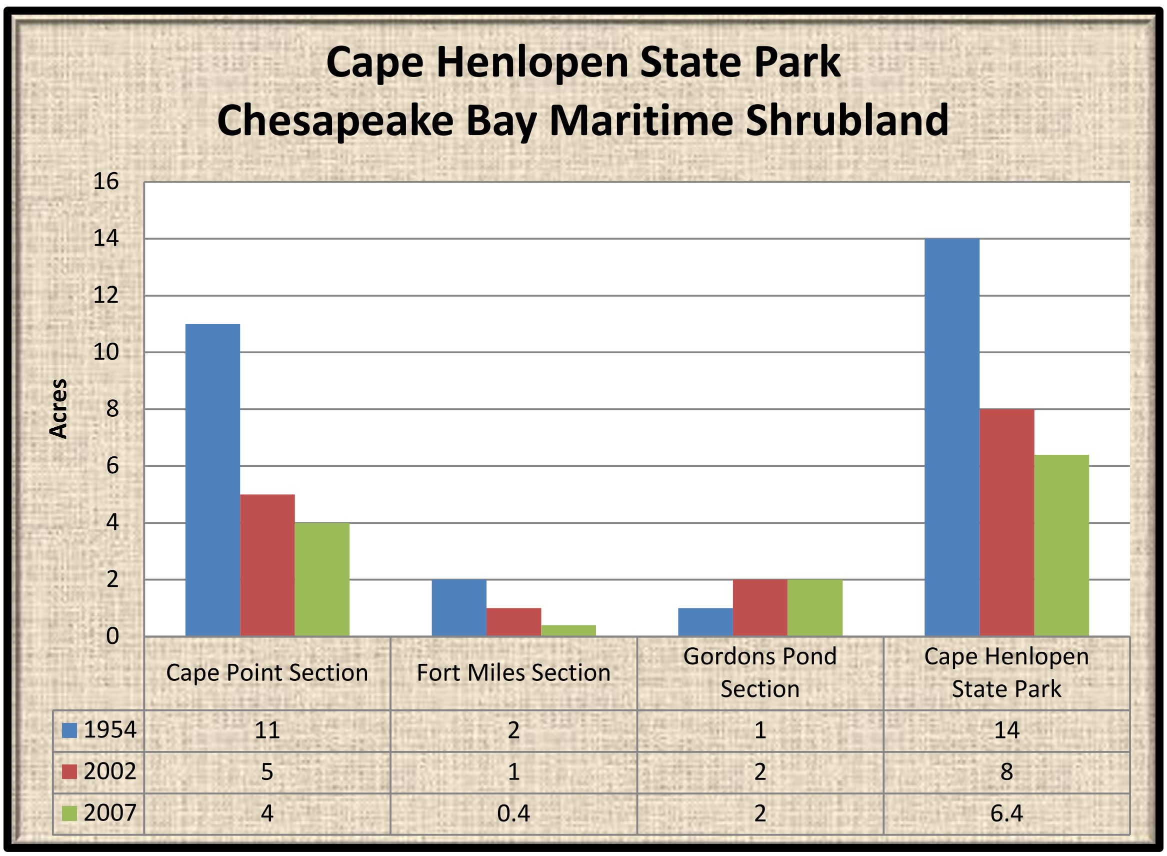


Figure 5.8. Chesapeake Bay Maritime Shrubland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.23)

Chesapeake Bay Short Maritime Shrubland is often found in the dunes but often at a lower elevation than other communities. As such it will be more affected by sea level rise. At 0.5 m of rise, it will not be affected and barely impacted at 1 m of rise. At 1.5 m of rise, about 2/3 of the current acreage will be inundated.

Table 5.23. Projected acres of Chesapeake Bay Maritime Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	1 acre
1.5 m	4 acres

Natural Capital (Table 5.24)

Capital of Chesapeake Bay Maritime Shrubland has going down as it matures to other communities or is taken over by changing conditions. Most of the capital is in the form of transfers to other communities.

Table 5.24. Natural Capital of Chesapeake Bay Maritime Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$2,040/year
2002	$1,166/year
2007	$932/year

***Chesapeake Bay Tall Maritime Shrubland* [21 acres (Figures 5.9-5.10, Tables 5.25-5.28)]**
G1G2 S1

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Maritime Forest

<u>*Description*</u>

This community is located south of the fishing pier on the bayside of the park. Wild black cherry (*Prunus serotina*) dominates a canopy that is associated by a few eastern red cedar (*Juniperus virginiana*). The understory is very similar to that found in the Successional Maritime Forest with sassafras (*Sassafras albidum*), slippery elm (*Ulmus rubra*), and persimmon (*Diospyros virginiana*). The shrub and vine layer is composed of trumpet-vine (*Campsis radicans*), wax-myrtle (*Morella cerifera*), American holly (*Ilex opaca*), common greenbrier (*Smilax rotundifolia*), and hog-peanut (*Apios americana*). Herbs include speargrass (*Chasmanthium laxum*), switchgrass (*Panicum virgatum*), and horseweed (*Conyza canadensis*).

Figure 5.9. Chesapeake Bay Tall Maritime Shrubland (Cape Point Section)

<u>*Analysis of Condition at Cape Henlopen State Park*</u>

A lot of the remains of the quarantine hospital and the army base are present within this community. When walking through you can see old concrete pads and other structures.

In 1954 only two acres of this community were present in the park. Today only 1 acre of the original acreage remains as this community with the other acre becoming Pitch Pine Dune Woodland (Table 5.25). As it has increased it has migrated into Beachgrass-Panicgrass Dune Grassland, Forked Rush Dune Swale, and bare sand (Table 5.26). Given the increases in this community it appears that it has a secure future in the park.

Table 5.25. What was once Chesapeake Bay Tall Maritime Shrubland in 1954 has become X or remained in 2007

X	Acreage
Chesapeake Bay Tall Maritime Shrubland	1 acre
Pitch Pine Dune Woodland	1 acre

Table 5.26. Chesapeake Bay Tall Maritime Shrubland has migrated into X or remained since 1954	
X	**Acreage**
Beachgrass-Panicgrass Dune Grassland	10 acres
Forked Rush Dune Swale	2 acres
Sand	2 acres
Chesapeake Bay Tall Maritime Shrubland	1 acre
Northeastern Old Field	1 acre
Other communities/land covers	4 acres

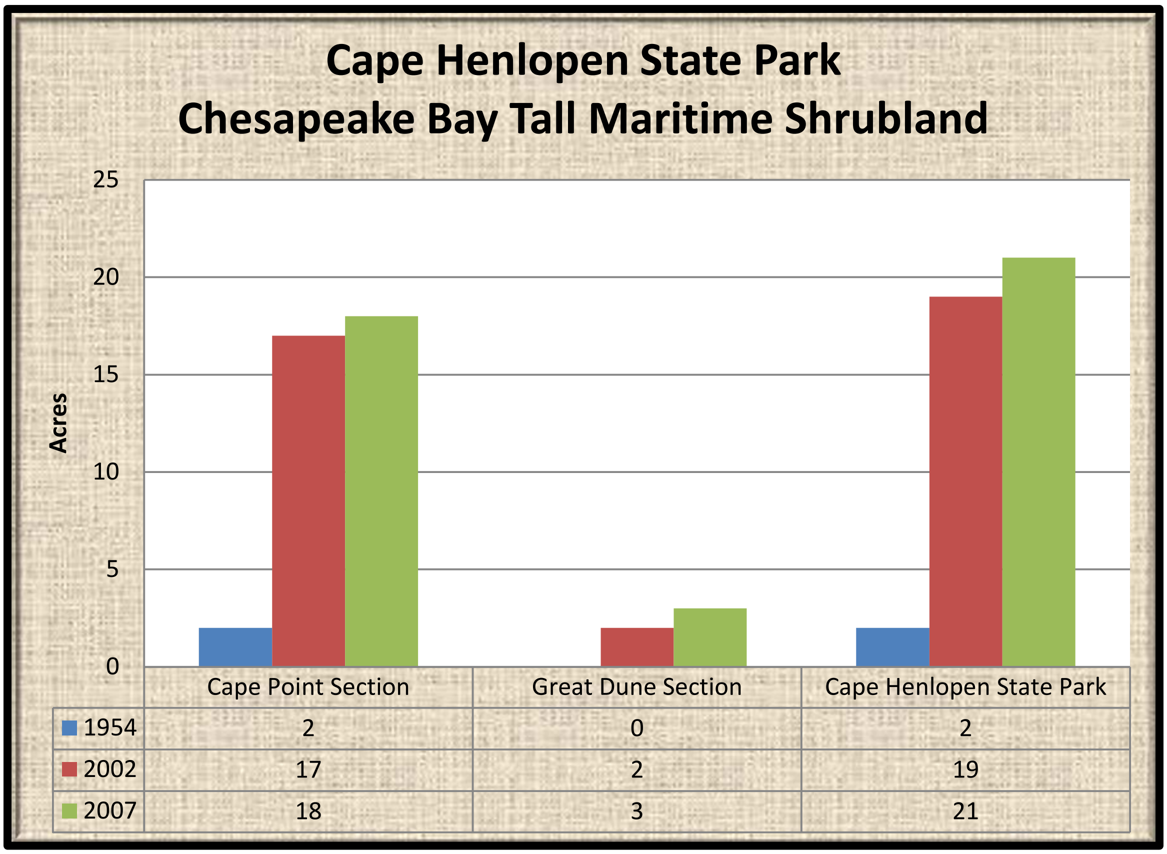


Figure 5.10. Chesapeake Bay Tall Maritime Shrubland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.27)

Chesapeake Bay Short Maritime Shrubland is often found in the dunes but often at a lower elevation than other communities. As such it will be more affected by sea level rise. At 0.5 m of rise, it will not be affected and barely impacted at 1 m of rise. At 1.5 m of rise, about 2/3 of the current acreage will be inundated.

Table 5.27. Projected acres of Chesapeake Bay Tall Maritime Shrubland Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	7 acres
1.5 m	12 acres

Natural Capital (Table 5.28)

The natural capital of Chesapeake Bay Tall Maritime Shrubland has been going up with acreage and is resulting in an increase in the overall capital of the park.

Table 5.28. Natural Capital of Chesapeake Bay Tall Maritime Shrubland

Year	Natural Capital (in 2012 dollars)
1954	$378/year
2002	$3,593/year
2007	$3,971/year

***Coastal Loblolly Pine Wetland Forest* [70 acres (Figure 5.11, Table 5.29-5.32)] G3 S3**

DEWAP: Coastal Plain Forested Floodplains and Riparian Swamps
NHC: Northern Atlantic Coastal Plain Maritime Forest

Description

This community is often found on the edges of the marshes in the behind the maritime areas. Loblolly pine (*Pinus taeda*) dominates the canopy and is associated by a few pitch pine (*Pinus rigida*) reflecting the pine composition on peninsulas nearby. Understory associates include American holly (*Ilex opaca*), southern red oak (*Quercus falcata*), and sassafras (*Sassafras albidum*). The shrub and vine layer is composed of common greenbrier (*Smilax rotundifolia*), lowbush blueberry (*Vaccinium pallidum*), highbush blueberry (*Vaccinium corymbosum*), white-leaf greenbrier (*Smilax glauca*), and wax-myrtle (*Morella cerifera*). Speargrass (*Chasmanthium laxum*) and bracken fern (*Pteridium aquilinium*) were the herbs noted in this community.

Analysis of Condition at Cape Henlopen State Park

This community has greatly increased since 1954 and appears to be stable in the recent period (2002-2007). It appears to be secure in the short-term but may suffer losses in the long-term due to sea level rise.

Two acres of the original nine acres from 1954 still remain in 2007. Since 1954, this forest has become Eastern Reed Marsh (3 acres), Agricultural Field (2 acres), Reed Tidal Marsh (1 acre), and Northeastern Modified Successional Forest (1 acre) (Table 5.29).

This forest has gained a lot of acreage since 1954 from the conversion of Pitch Pine Dune Woodland (35 acres) and the succession of Early to Mid-Successional Loblolly Pine Forest (23 acres) to this community. Other communities that have been converted include Loblolly Pine Dune Woodland (2 acres) and Southern Red Maple-Blackgum Swamp (2 acres) (Table 5.30).

Table 5.29. What was once Coastal Loblolly Pine Wetland Forest in 1954 has become X or remained in 2007

X	Acreage
Eastern Reed Marsh	3 acres
Coastal Loblolly Pine Wetland Forest	2 acres
Agricultural Field	2 acres
Reed Tidal Marsh	1 acre
Northeastern Modified Successional Forest	1 acre
Other communities/land covers	0.3 acres

Table 5.30. Coastal Loblolly Pine Wetland Forest has migrated into X or remained since 1954	
X	**Acreage**
Pitch Pine Dune Woodland	35 acres
Early to Mid-Successional Loblolly Pine Forest	24 acres
Loblolly Pine Dune Woodland	2 acres
Coastal Loblolly Pine Wetland Forest	2 acres
Southern Red Maple-Blackgum Swamp	2 acres
Other communities/land covers	6 acres

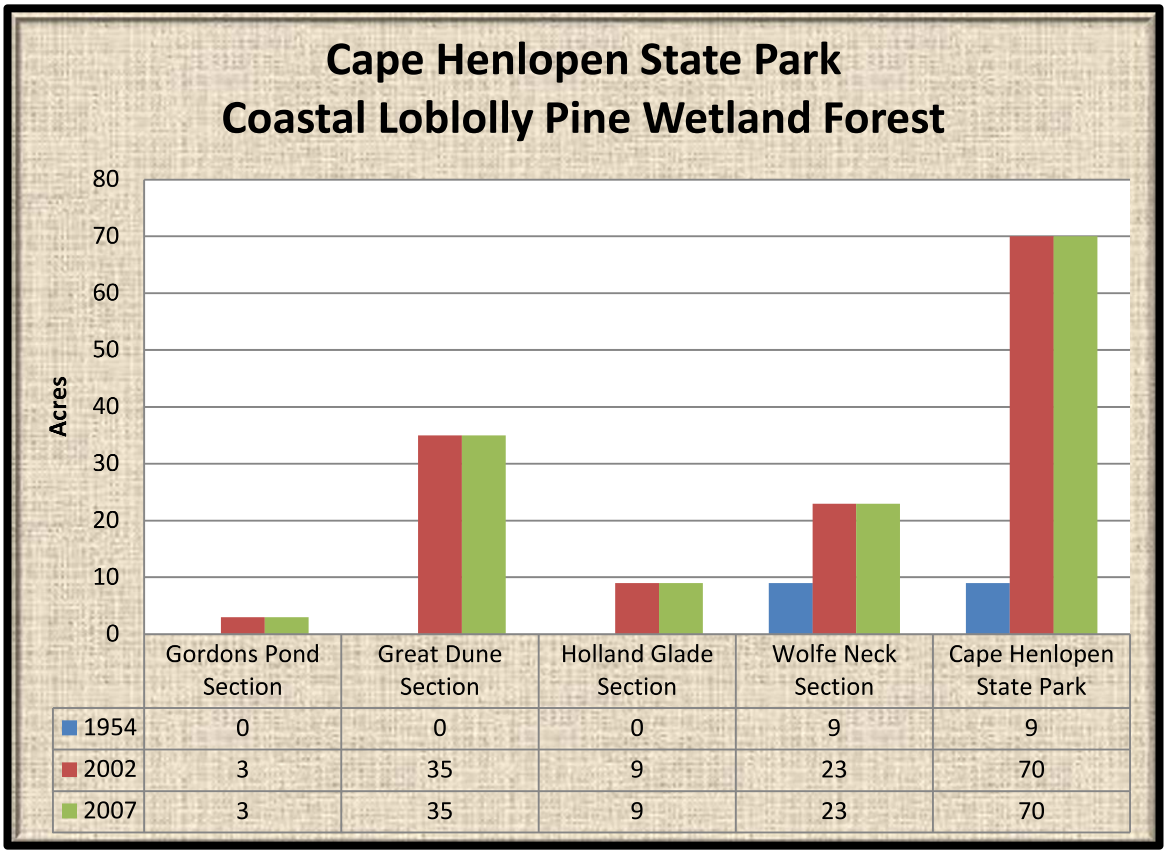


Figure 5.11. Coastal Loblolly Pine Wetland Forest at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.31)

This community is located in lowland areas and as such is vulnerable to sea level rise. At 0.5 m of sea level rise, almost half of the current acreage will be inundated. At 1.5 m of rise, a little more than ¾ of the acreage will be flooded.

Table 5.31. Projected acres of Coastal Loblolly Pine Wetland Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	32 acres
1 m	48 acres
1.5 m	57 acres

Natural Capital (Table 5.32)

The capital of Coastal Loblolly Pine Wetland Forest has been going up as it converts Pitch Pine Dune Woodland from lack of fire and Early to Mid-Successional Loblolly Pine Forest matures into it. Most of the gained capital is through transfers and is does not result in an overall park capital increase.

Table 5.32. Natural Capital of Coastal Loblolly Pine Wetland Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,702/year
2002	$13,237/year
2007	$13,237/year

Coastal Plain Pond **[1 acre (Figure 5.12, Tables 5.33-5.36)]** **G3** **S3**

DEWAP: Coastal Plain Seasonal Ponds
NHC: Northern Atlantic Coastal Plain Pond

Description

This community (called Horseshoe Bog), while not a true Coastal Plain Pond as the name may imply, is located in a depression at the south end of Great Dune and is the only relatively undisturbed example known to exist in the state. Another relic community occurrence is located to the south of this one. A lot of the former locations of this community have been taken over by reed grass (*Phragmites australis*) and are no longer this community.

This community is co-dominated by waterlily (*Nymphaea odorata*) and Robbin's spikerush (*Eleocharis robbinsii*) and associated by little floating heart (*Nymphoides cordata*), reticulated nutrush (*Scleria reticularis*), cranberry (*Vaccinium macrocarpon*), and twig rush (*Cladium mariscoides*).

Analysis of Condition at Cape Henlopen State Park

The Coastal Plain Pond community used have many occurrences in the park, but has been taken over by reed grass (*Phragmites australis*) becoming Eastern Reed Marsh (4 acres) or covered by sand and thence succeeding into Pitch Pine Dune Woodland (2 acres) since 1954 or has been taken over sea level rise and becoming North Atlantic Low Salt Marsh (1 acre) (Table 5.33).

A lot of the areas that are now Eastern Reed Marsh might be able to be reclaimed if the reed grass (*Phragmites australis*) is eradicated. Since 1954, the one remaining location, covering 1 acre, has not migrated (Horseshoe Bog above) (Table 5.34). It may be only a matter of time before this one remaining community is taken over by reed grass. Monitoring of the site can prevent this.

Table 5.33. What was once Coastal Plain Pond in 1954 has become X or remained in 2007

X	Acreage
Eastern Reed Marsh	4 acres
Pitch Pine Dune Woodland	2 acres
North Atlantic Low Salt Marsh	1 acre
Coastal Plain Pond	1 acre
Sand	0.3 acres
Other communities/land covers	0.2 acres

Table 5.34. Coastal Plain Pond has migrated into X or remained since 1954	
X	**Acreage**
Coastal Plain Pond	1 acre

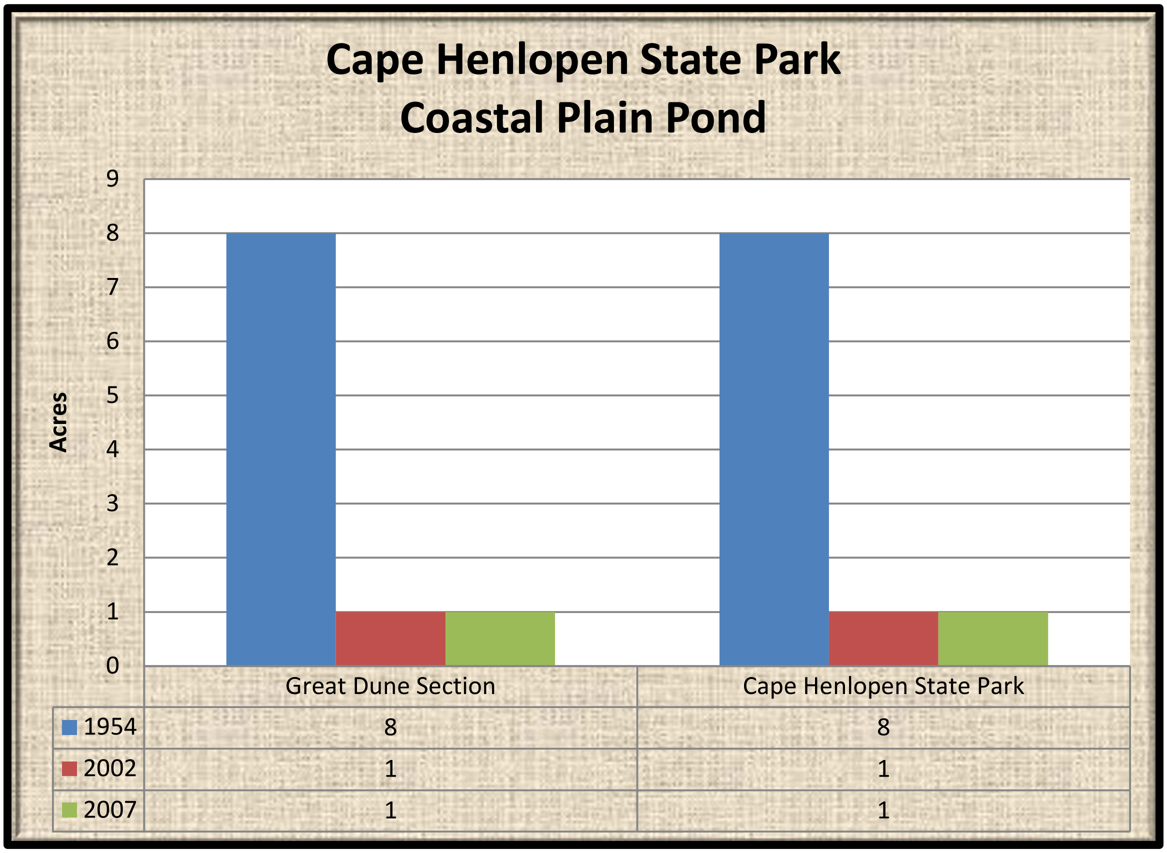


Figure 5.12. Coastal Plain Pond at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.35)

This community will be eliminated by inundation with 0.5 m of sea level rise.

Table 5.35. Projected acres of Coastal Plain Pond Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 5.36)

Natural capital of Coastal Plain Pond has decreased from invasion of Eastern Reed Marsh and sea level rise taking over other occurrences. Eradication of the Eastern Reed Marsh may increase the capital of this community.

Table 5.36. Natural Capital of Coastal Plain Pond	
Year	**Natural Capital (in 2012 dollars)**
1954	$74,251/year
2002	$9,281/year
2007	$9,281/year

***Cultivated Lawn* [96 acres (Figure 5.13, Tables 5.37-5.40)] GNA SNA**

DEWAP: No Equivalent Classification
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Cultivated lawns are found around the buildings and roadsides of the park. Most often lawns are composed of tall fescue (*Festuca arundinacea*) and that is true around the buildings, but on the roadsides, weeping lovegrass (*Eragrostis curvula*) is planted.

Analysis of Condition at Cape Henlopen State Park

Cultivated lawns are generally associated with developed areas and tend to rise and fall with them. Development in the park has increased since 1954 resulting in an increase in cultivated lawn area to the recent period. Some of the former cultivated lawns have succeeded into Pitch Pine Dune Woodland where there are abandoned structures (Table 5.37). Since 1954 cultivated lawns have been emplaced in Beachgrass-Panicgrass Dune Grassland and other anthropogenic communities/land covers (Table 5.38).

Table 5.37. What was once Cultivated Lawn in 1954 has become X or remained in 2007	
X	**Acreage**
Cultivated Lawn	33 acres
Pitch Pine Dune Woodland	6 acres
Impervious Surface	4 acres
Mid-Atlantic Coast Backdune Grassland	2 acres
Agricultural Field	2 acres
Other communities/land covers	4 acres

Table 5.38. Cultivated Lawn has migrated into X or remained since 1954	
X	**Acreage**
Cultivated Lawn	33 acres
Beachgrass-Panicgrass Dune Grassland	14 acres
Agricultural Field	13 acres
Northeastern Old Field	8 acres
Semi-impervious Surface	7 acres
Other communities/land covers	22 acres

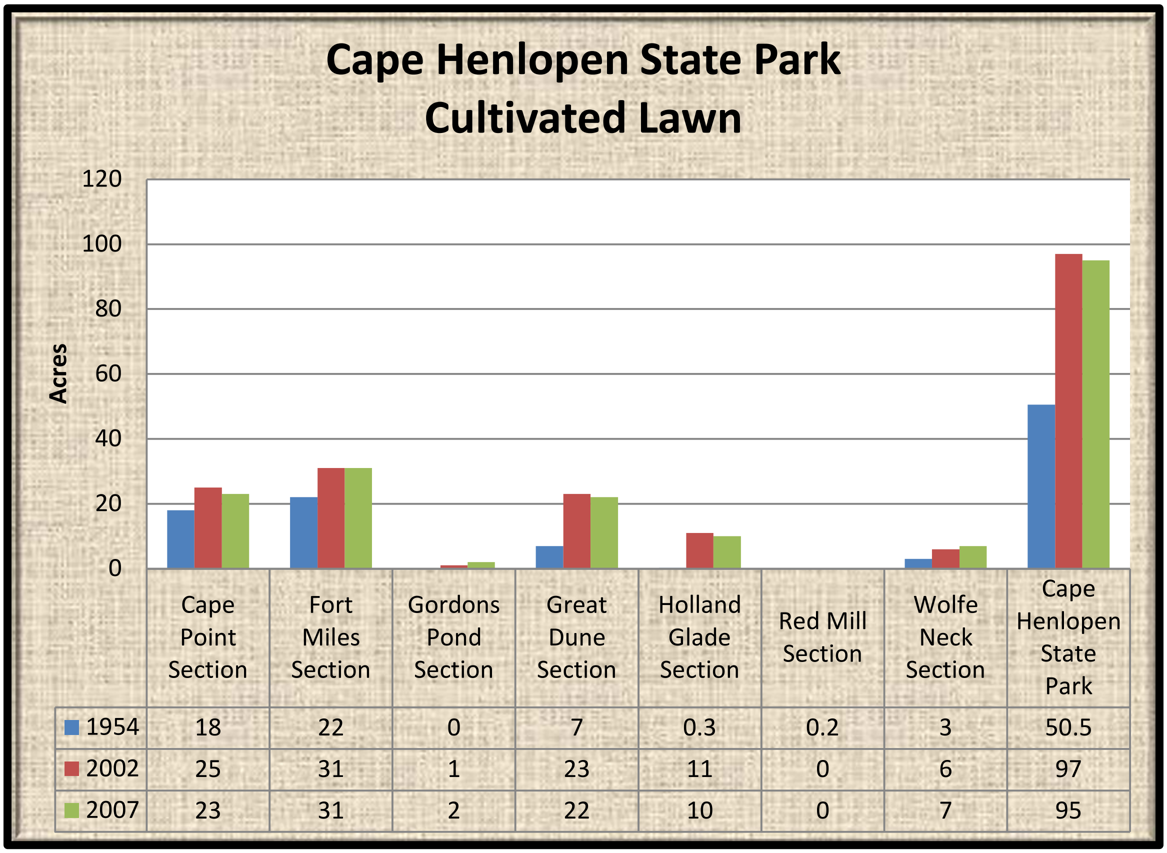


Figure 5.13. Cultivated Lawn at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.39)

A little more than half of the current acreage of Cultivated Lawn will be inundated by 1.5 m of sea level rise. These areas are often associated with impervious surface and man-made structures so these places may incur damage.

Table 5.39. Projected acres of Cultivated Lawn Inundated by Sea Level Rise

Rise	Acres
0.5 m	3 acres
1 m	31 acres
1.5 m	57 acres

Natural Capital

Cultivated Lawn does not have any capital value.

***Early to Mid-Successional Loblolly Pine Forest* [109 acres (Figure 5.14-5.15, Tables 5.40-5.43)]**
GNA SNA

DEWAP: Early Successional Upland Habitats
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

<u>*Description*</u>

Figure 5.14. Early to Mid-Successional Loblolly Pine Forest (Wolfe Neck Section)

This early successional forest is located in the Wolfe Glade area north of the parking lot. Loblolly pine (*Pinus taeda*) is the species in the canopy that overtops an understory of tuliptree (*Liriodendron tulipifera*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), American holly (*Ilex opaca*), sweetbay (*Magnolia virginiana*), and bigtooth aspen (*Populus grandidentata*). Common greenbrier (*Smilax rotundifolia*) dominates the shrub and vine layer with some highbush blueberry (*Vaccinium corymbosum*) on the edge. No herbs were seen in this community.

<u>*Analysis of Condition at Cape Henlopen State Park*</u>

In 1954 former field areas were reforesting as this community and hence there was a large amount of this community. Since 1954, this community has matured into Southern Red Oak/Heath Forest (109 acres), Mid to Late Successional Loblolly Pine-Sweetgum Forest (62 acres), Southern Red Maple-Blackgum Swamp (36 acres), and Coastal Loblolly Pine Wetland Forest (23 acres) (Table 5.40). This community has also expanded, but not enough to maintain its acreage as it succeeds. Most of the new acreage has come from Northeastern Successional Shrubland (59 acres), with a very small amount coming from Northeastern Old Field (2 acres), Loblolly Pine Dune Woodland (1 acre), and Agricultural Field (1 acre) (Table 5.41). This community will likely continue to decline, due to succession, unless more agricultural field is taken out of service.

Table 5.40. What was once Early to Mid-Successional Loblolly Pine Forest in 1954 has become X or remained in 2007	
X	**Acreage**
Southern Red Oak/Heath Forest	109 acres
Mid to Late Successional Loblolly Pine Forest	62 acres
Early to Mid-Successional Loblolly Pine Forest	43 acres
Southern Red Maple-Blackgum Swamp	36 acres
Coastal Loblolly Pine Wetland Forest	23 acre
Other communities/land covers	40 acres

Table 5.41. Early to Mid-Successional Loblolly Pine Forest has migrated into X or remained since 1954	
X	**Acreage**
Northeastern Successional Shrubland	59 acres
Early to Mid-Successional Loblolly Pine Forest	43 acres
Northeastern Old Field	2 acres
Loblolly Pine Dune Woodland	1 acre
Agricultural Field	1 acre
Other communities/land covers	2 acres

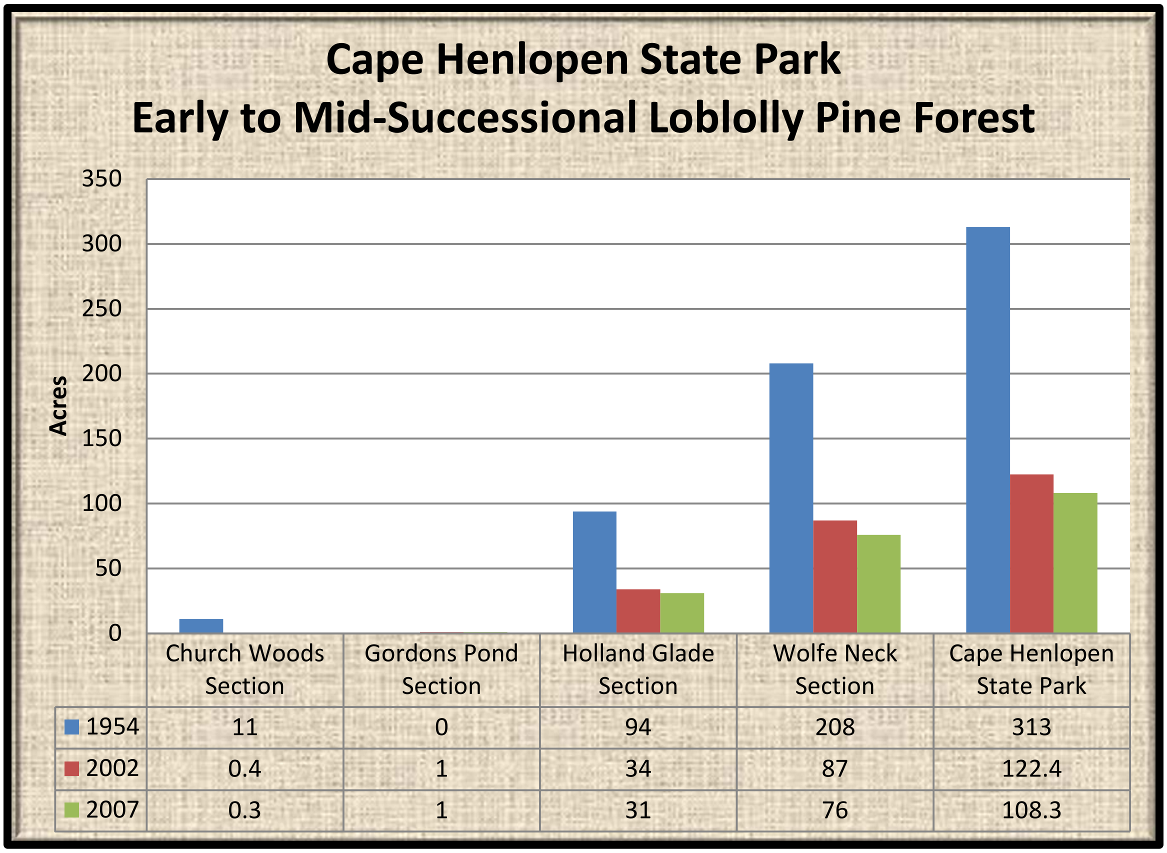


Figure 5.15. Early to Mid-Successional Loblolly Pine Forest at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.42)

At the greatest amount of rise, a little less than 1/3 of the current acreage will be inundated of this community.

Table 5.42. Projected acres of Early to Mid-Successional Loblolly Pine Forest Inundated by Sea Level Rise

Rise	Acres
0.5 m	8 acres
1 m	19 acres
1.5 m	32 acres

Natural Capital (Table 5.43)

Capital of Early to Mid-Successional Loblolly Pine Forest has been decreasing as this community matures into other forest types. Most of capital is being transferred to other communities.

Table 5.43. Natural Capital of Early to Mid-Successional Loblolly Pine Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$59,188/year
2002	$23,146/year
2007	$20,480/year

Eastern Reed Marsh **[69 acres (Figures 5.16-5.17, Tables 5.44-5.47)] GNA SNA**

DEWAP: No Equivalent Classification
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Figure 5.16. Eastern Reed Marsh (Holland Glade)

Eastern reed marsh is a non-tidal marsh that is dominated nearly entirely by common reed (*Phragmites australis*).

Analysis of Condition at Cape Henlopen State Park

In 1954 only 1-2 acres of this community was present in the area of what would become the park, and has since become Reed Tidal Marsh as tidal water has reached it (Table 5.44). Since 1954, it has expanded to 68 acres filling in Northeastern Old Field (25 acres), Beachgrass-Panicgrass Dune Grassland (11 acres), Forked Rush Dune Swale (5 acres), Pitch Pine Dune Woodland (4 acres), and Coastal Plain Pond (4 acres), among others (Table 5.45). The acreage of this community has been more or less steady in the recent period (2002-2007). This community has been responsible for the elimination of a lot of the interdunal communities in the park, especially Forked Rush Dune Swale and Coastal Plain Pond. Aggressive eradication efforts can help restore some the communities back.

Table 5.44. What was once Eastern Reed Marsh in 1954 has become X or remained in 2007	
X	**Acreage**
Reed Tidal Marsh	2 acres

Table 5.45. Eastern Reed Marsh has migrated into X or remained since 1954	
X	**Acreage**
Northeastern Old Field	25 acres
Beachgrass-Panicgrass Dune Grassland	11 acres
Forked Rush Dune Swale	5 acres
Pitch Pine Dune Woodland	4 acres
Coastal Plain Pond	4 acres
Other communities/land covers	19 acres

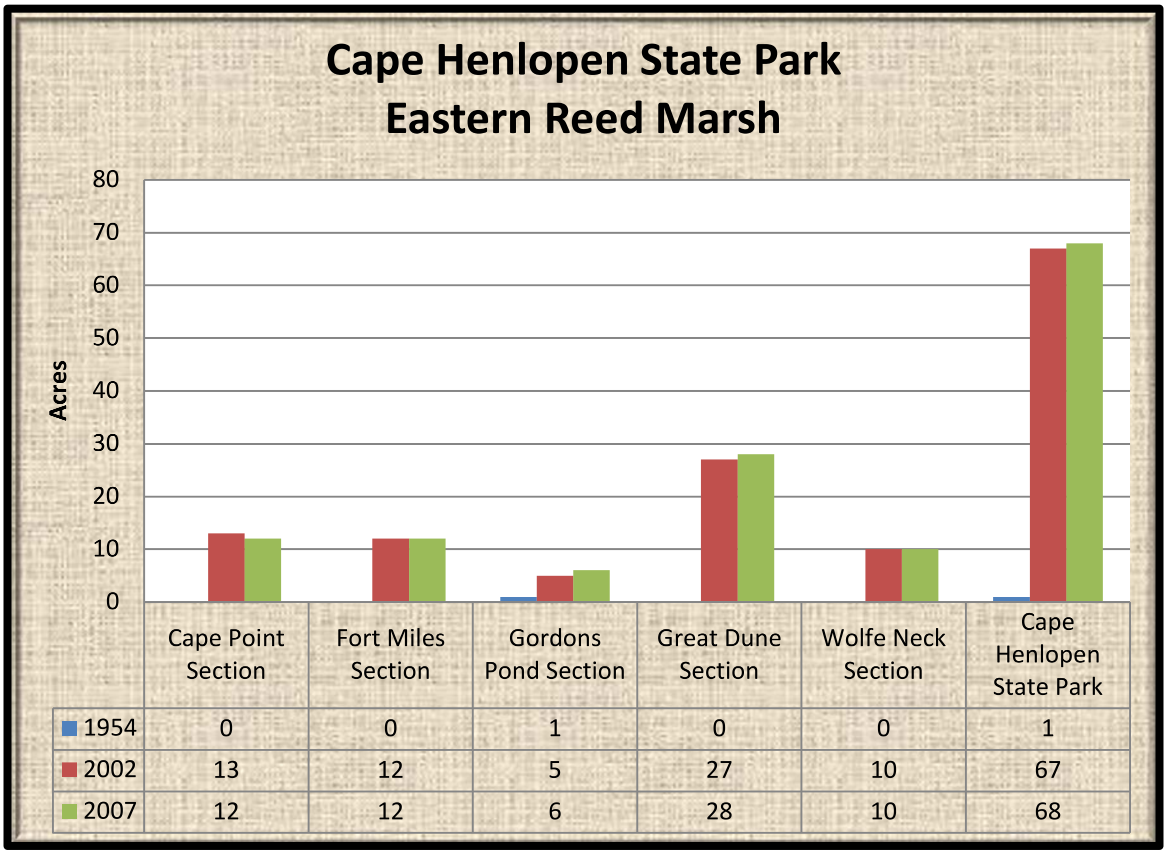


Figure 5.17. Eastern Reed Marsh at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.46)

At the greatest amount of rise (1.5 m), a little less than 1/2 of the current acreage will be inundated of this community.

Table 5.46. Projected acres of Eastern Reed Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	8 acres
1 m	19 acres
1.5 m	32 acres

Natural Capital (Table 5.47)

Capital of Eastern Reed Marsh has been increasing as it invades more communities, especially in wetlands. Despite being composed of an exotic invasive species, there communities are still wetlands which provide some filtering benefit. However, a native wetland is preferable and the capital would transfer to the native wetland.

Table 5.47. Natural Capital of Eastern Reed Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$9,281/year
2002	$621,854/year
2007	$631,135/year

***Forked Rush Dune Swale* [0.3 acres (Figures 5.18-5.19, Tables 5.48-5.50)] G2 S2**

DEWAP: Interdunal Wetlands
NHC: Northern Atlantic Coastal Plain Dune and Swale

Description

This interdune swale herbaceous community is located south of the Herring Point parking lot. This particular swale was seen from a distance and a specific species list was not made. In these communities, Olney's three square bulrush (*Schoenoplectus pungens*) is co-dominant with round head rush (*Juncus scirpoides*). Associates that can be found the dominants include Canada rush (*Juncus canadensis*), forked rush (*Juncus dichotomus*), marsh St. John's Wort (*Triadenum virginicum*), beach panic grass (*Panicum amarum*), Eaton's witchgrass (*Dichanthelium spretum*), and cranberry (*Vaccinium macrocarpon*).

Figure 5.18. Forked Rush Dune Swale (Gordons Pond Section)

Analysis of Condition at Cape Henlopen State Park

Forked Dune Swales have declined from their highs in 1954 mainly because of conversion to other communities, invasion by reed grass (*Phragmites australis*) and a lack of migration and expansion. Since 1954, this community has been converted to Beach (7 acres), Beachgrass-Panicgrass Dune Grassland (7 acres), Eastern Reed Marsh (5 acres), Pitch Pine Dune Woodland (3 acres), and Chesapeake Bay Tall Maritime Shrubland (2 acres) (Table 5.48). The conversion and the fact that it has not expanded at all (Table 5.49), has meant that it has almost been eliminated in the park. The remaining swale south of Herring Point is located near two other swales that are invaded by reed grass. This swale may in time also be invaded.

Table 5.48. What was once Forked Rush Dune Swale in 1954 has become X or remained in 2007	
X	Acreage
Beach	7 acres
Beachgrass-Panicgrass Dune Grassland	7 acres
Eastern Reed Marsh	5 acres
Pitch Pine Dune Woodland	3 acres
Chesapeake Bay Tall Maritime Shrubland	2 acres
Other communities/land covers	9 acres

Table 5.49. Forked Rush Dune Swale has migrated into X or remained since 1954	
X	Acreage
Forked Rush Dune Swale	0.3 acres

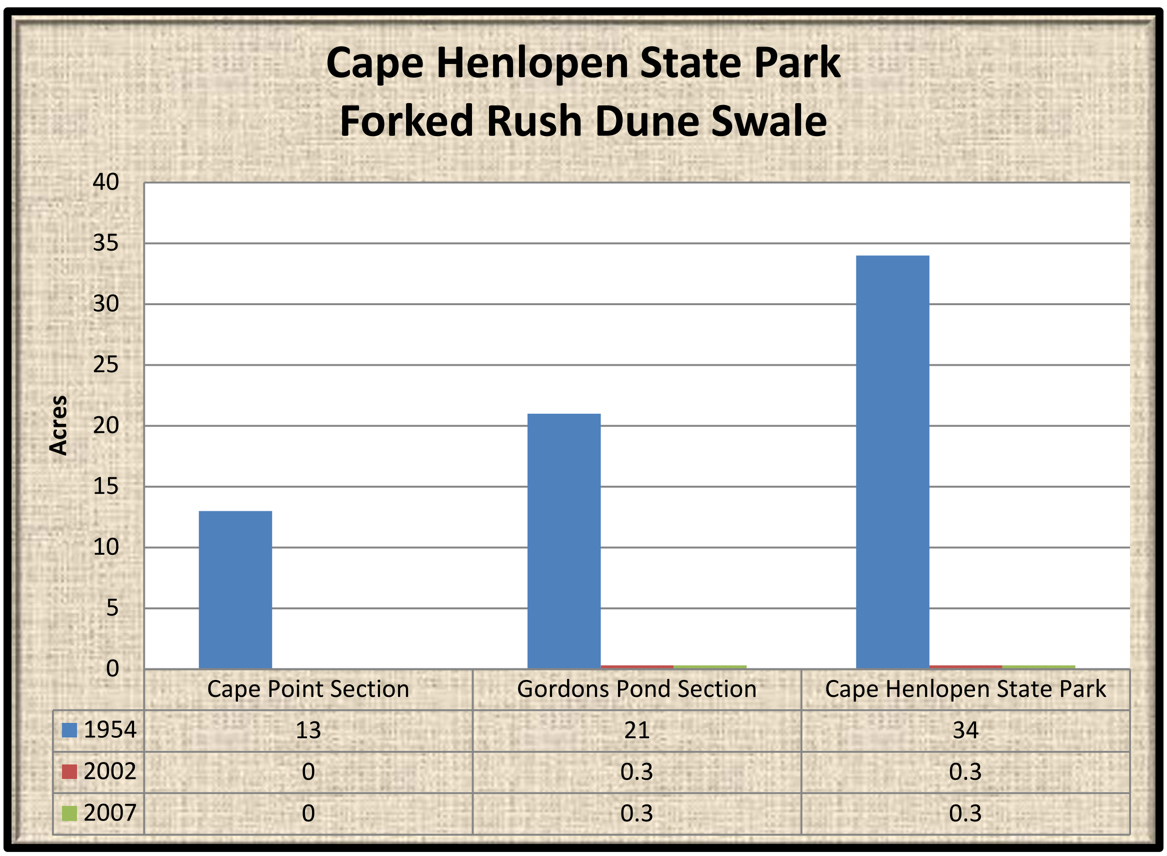


Figure 5.19 Forked Rush Dune Swale at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis

This community will not be affected by sea level in any of the scenarios.

Natural Capital (Table 5.50)

Fork Rush Dune Swale has lost a lot of its 1954 capital to Eastern Reed Marsh, which been taking over the wet depressions and interdunal wetlands in the park.

Table 5.50. Natural Capital of Forked Rush Dune Swale

Year	Natural Capital (in 2012 dollars)
1954	$315,568/year
2002	$1,796/year
2007	$1,796/year

***Freshwater Tidal Woodland* [18 acres (Figures 5.20-5.21, Tables 5.51-5.54)] G2 S2**

DEWAP: Freshwater Tidal Forested and Scrub-shrub Wetlands
NHC: Northern Atlantic Coastal Plain Tidal Swamp

<u>*Description*</u>

Figure 5.20. Freshwater Tidal Woodland (Holland Glade Section)

This community is found in coves on the edges of marshes in Wolfe Glade and some of the tributaries to Lewes-Rehoboth Canal. These communities may result from tidal influence in the adjacent and higher Southern Red Maple-Blackgum Swamps. Red maple (*Acer rubrum*) forms a scattered canopy over water-willow (*Decodon verticillatus*) and highbush blueberry (*Vaccinium corymbosum*). Skunk cabbage (*Symplocarpus foetidus*) and reed grass (*Phragmites australis*) were the only herbs noted in this community.

<u>*Analysis of Condition at Cape Henlopen State Park*</u>

Freshwater Tidal Woodland appears to come from the inundation of Southern Red Maple-Blackgum swamps as sea level rises. With general reforestation of the park this community has increased over the long-term. Recently though it has shown a slight decrease in the Holland Glade Section resulting in an overall decrease throughout the park.

In spite of the overall increase in acreage, only 4 acres from 1954 remain in 2007. The rest have become North Atlantic Low Salt Marsh (6 acres), Reed Tidal Marsh (1 acre), Pitch Pine Dune Woodland (0.4 acres), and Irregularly Flooded Eastern Tidal Salt Shrub (0.2 acres) (Table 5.51). These conversions show an environment that increasing in salinity and tidal elevation.

As stated above Freshwater Tidal Woodland has migrated into Southern Red Maple-Blackgum Swamp (9 acres) as tidal water rises into the community. Other communities it has converted include North Atlantic High Salt Marsh (1 acre), Northeastern Old Field (1 acre), and a sea-level fen (1 acre) that was present in the Wolfe Neck part of the park (Table 5.52).

Table 5.51. What was once Freshwater Tidal Woodland in 1954 has become X or remained in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	6 acres
Freshwater Tidal Woodland	4 acres
Reed Tidal Marsh	1 acre
Pitch Pine Dune Woodland	0.4 acres
Irregularly Flooded Eastern Tidal Salt Shrub	0.2 acres
Other communities/land covers	0.1 acres

Table 5.52. Freshwater Tidal Woodland has migrated into X or remained since 1954	
X	**Acreage**
Southern Red Maple-Blackgum Swamp	9 acres
Freshwater Tidal Woodland	4 acres
North Atlantic High Salt Marsh	1 acre
Northeastern Old Field	1 acre
Sea-level Fen	1 acre
Other communities/land covers	1 acre

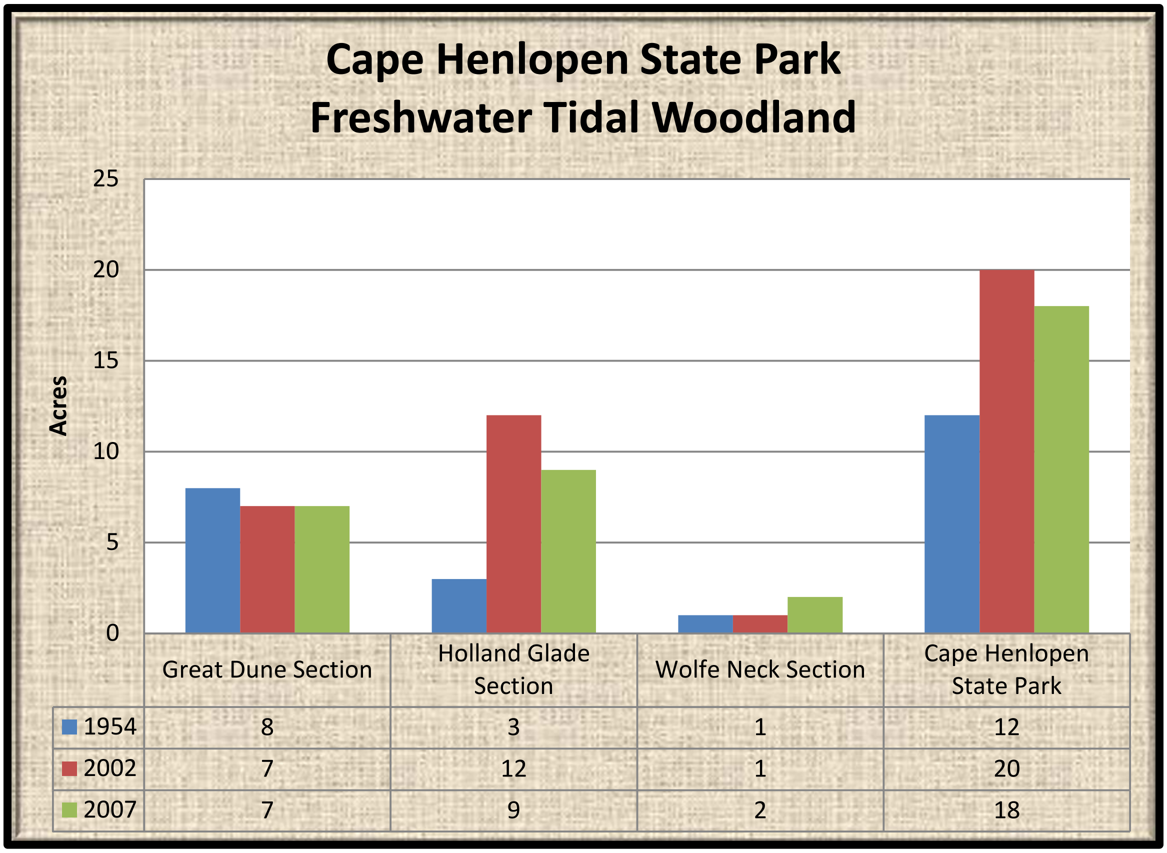


Figure 5.21. Freshwater Tidal Woodland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.53)

Freshwater Tidal Woodland will essentially be eliminated by inundation with 0.5 m of sea level rise. Additional rise will guarantee the flooding.

Table 5.53. Projected acres of Freshwater Tidal Woodland Inundated by Sea Level Rise

Rise	Acres
0.5 m	16 acres
1 m	17 acres
1.5 m	18 acres

Natural Capital (Table 5.54)

Overall the capital of Freshwater Tidal Woodland has increased and could be the result of sea level rise converting Southern Red Maple-Blackgum Swamp. The acreage has dropped somewhat in the recent period with conversion to marsh.

Table 5.54. Natural Capital of Freshwater Tidal Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$147,498/year
2002	$245,830/year
2007	$221,247/year

***Irregularly Flooded Eastern Tidal Salt Shrub* [57 acres (Figures 5.22-5.24, Tables 5.55-5.58)]**
G5 S5

DEWAP: Tidal High Marshes
NHC: Northern Atlantic Coastal Plain Tidal Salt Marsh

Description

Figure 5.22. Irregularly Flooded Eastern Tidal Salt Shrub (Gordons Pond Section)

This shrub community receives occasional storm tides and is composed of two main species, salt shrub (*Baccharis halimifolia*) and marsh elder (*Iva frutescens*). Other herbaceous species that may be present include salt meadow hay (*Spartina patens*), sea lavender (*Limonium carolinianum*), seaside goldenrod (*Solidago sempervirens*), and marsh fleabane (*Pluchea odorata*).

Analysis of Condition at Cape Henlopen State Park

Irregularly Flooded Eastern Tidal Salt Shrub declined markedly between 1954 and 2002 and has increased slightly from 2002 to 2007. Most of the former acreage has converted to North Atlantic Low Salt Marsh, showing an increase in water, and Reed Tidal Marsh. Of the remaining acreage, 28 acres have remained as salt shrub, while some has migrated into North Atlantic Low Salt Marsh, Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland, Pitch Pine Dune Woodland, and Successional Maritime Forest.

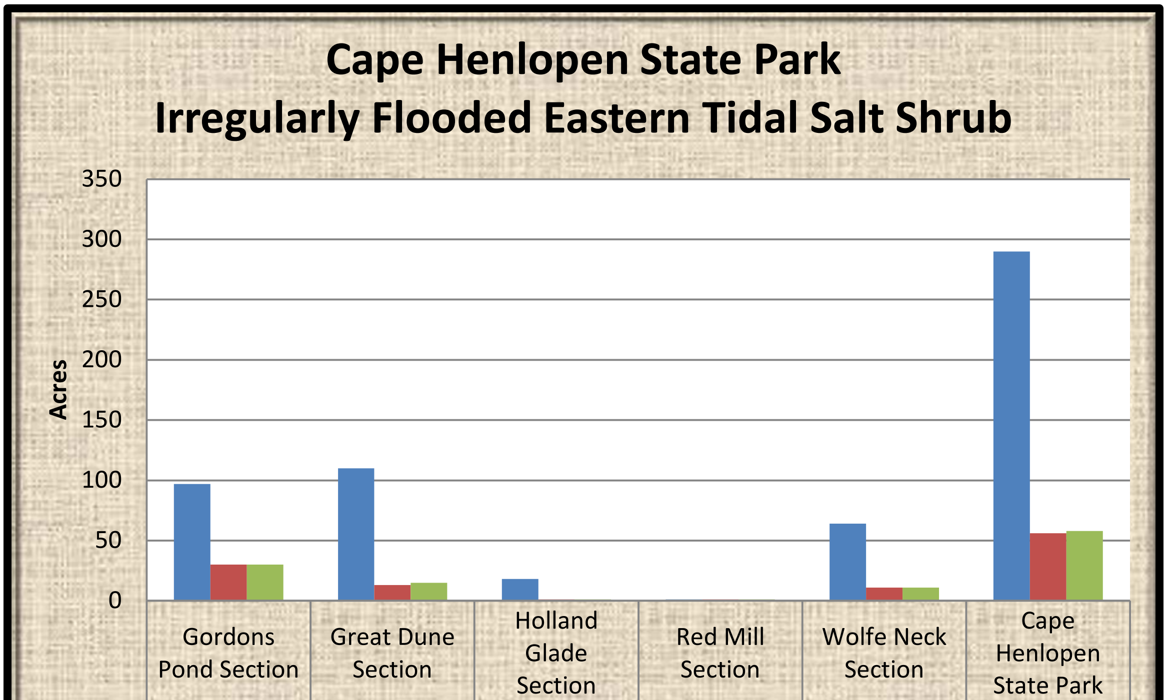
This community has suffered large declines since 1954 with only 28 acres of the original 290 acres from 1954 still present in 2007. Most of the acreage has converted to North Atlantic Low Salt Marsh (171 acres) with a lesser amount going to Reed Tidal Marsh (38 acres), Irregularly Flooded Eastern Tidal Salt Shrub (28 acres), Water (24 acres), and North Atlantic High Salt Marsh (13 acres) (Table 5.55).

In spite of the declines this community has expanded into a few areas such as North Atlantic Low Salt Marsh (5 acres), likely on the piles of reed grass (*Phragmites australis*) present on the edges of the marsh, Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland (3 acres), Pitch Pine Dune Woodland (3 acres), and Successional Maritime Forest (2 acres) (Table 5.56).

Given the decline in the 1954 to 2002 period and the slight increase in 2002 to 2007 period it would appear that this community is on shaky ground for its continued existence.

Table 5.55. What was once Irregularly Flooded Eastern Tidal Salt Shrub in 1954 has become X or remained in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	171 acres
Reed Tidal Marsh	38 acres
Irregularly Flooded Eastern Tidal Salt Shrub	28 acres
Water	24 acres
North Atlantic High Salt Marsh	13 acres
Other communities/land covers	15 acres

Table 5.56. Irregularly Flooded Eastern Tidal Salt Shrub has migrated into X or remained since 1954	
X	**Acreage**
Irregularly Flooded Eastern Tidal Salt Shrub	28 acres
North Atlantic Low Salt Marsh	5 acres
Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	3 acres
Pitch Pine Dune Woodland	3 acres
Successional Maritime Forest	2 acres
Other communities/land covers	15 acres



	Gordons Pond Section	Great Dune Section	Holland Glade Section	Red Mill Section	Wolfe Neck Section	Cape Henlopen State Park
1954	97	110	18	1	64	290
2002	30	13	1	1	11	56
2007	30	15	1	1	11	58

Figure 5.23. Irregularly Flooded Eastern Tidal Salt Shrub (1954, 2002, and 2007)

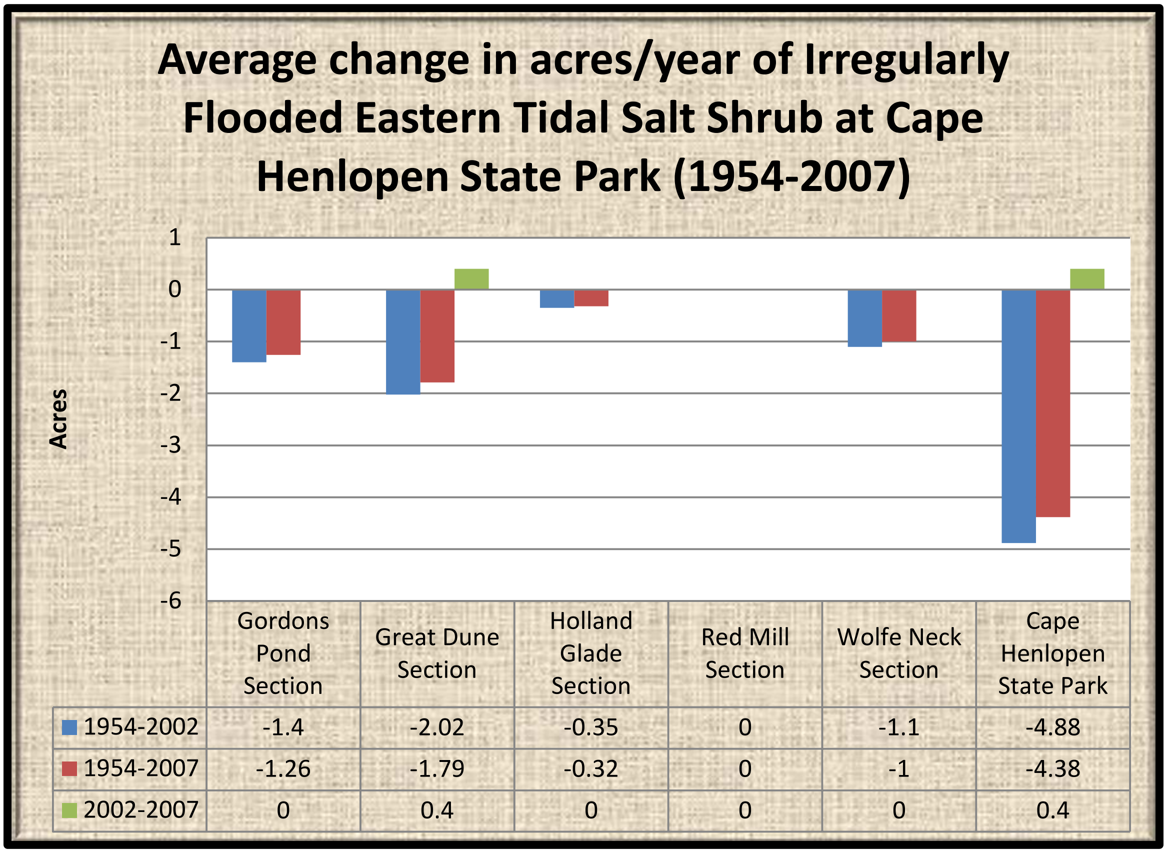


Figure 5.24. Average change in acres/year of Irregularly Flooded Eastern Tidal Salt Shrub at Cape Henlopen State Park (1954-2007)

DNREC Sea Level Rise Analysis (Table 5.57)

Irregularly Flooded Eastern Tidal Salt Shrub will be eliminated due to flooding after 0.5 m of sea level rise.

Table 5.57. Projected acres of Irregularly Flooded Eastern Tidal Salt Shrub Inundated by Sea Level Rise

Rise	Acres
0.5 m	57 acres
1 m	57 acres
1.5 m	57 acres

Natural Capital (Table 5.58)

Capital of Irregularly Flooded Eastern Tidal Salt Shrub has gone down greatly from its 1954 high, but has experienced a recent uptick with an increase in acreage in the recent period (2002-2007).

Table 5.58. Natural Capital of Irregularly Flooded Eastern Tidal Salt Shrub	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,818,677/year
2002	$351,193/year
2007	$363,735/year

***Japanese Black Pine Forest* [2 acres (Figures 5.25-5.26, Tables 5.59-5.61)] GNA SNA**

DEWAP: Beach and Dune Habitats
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Figure 5.25. Japanese Black Pine Forest (Cape Point Section)

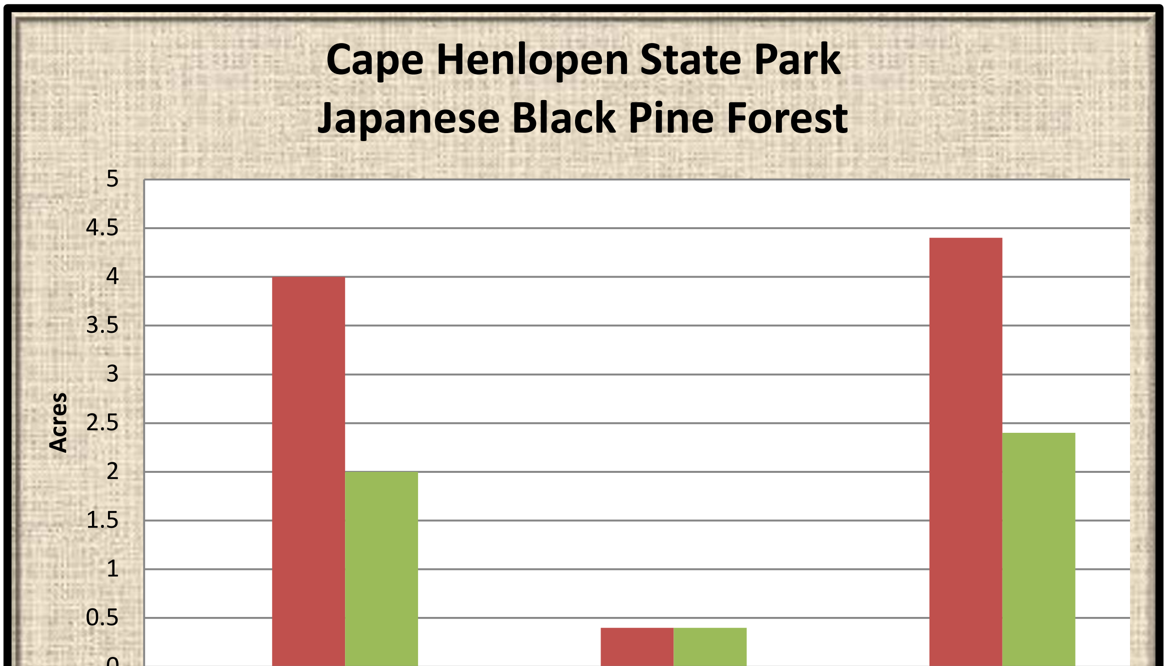
Japanese Black Pine Forests are dominated by an introduced species of pine, Japanese Black pine (*Pinus thunbergiana*) that is able to handle the near coastal habitats. These communities may have some beach heather (*Hudsonia tomentosa*) growing underneath.

Analysis of Condition at Cape Henlopen State Park

In 1954, Japanese Black Pine Forest was not detected in park either because it was not present yet or was two small to pick up as a discrete forest community. It is known that this species was planted in the 1950's as part of a reforestation project from the times that this area was in use by the US Army. Japanese Black Pine Forest was mostly planted in what was then Beachgrass-Panicgrass Dune Grassland, a community that included most of the open area present in the Cape Point section. Other land covers and communities that this forest took over include impervious surface (some of the old buildings and roads), cultivated lawn, Atlantic Coast Interdune Swale, and Mid-Atlantic Coast Backdune Grassland (Table 5.59).

The dominant species of this community, Japanese Black Pine, is currently being actively eradicated with herbicide. It is hoped that the habitat opened will revert to either Beachgrass-Panicgrass Dune Grassland or Pitch Pine Dune Woodland depending on location.

Table 5.59. Japanese Black Pine Forest has migrated into X or remained since 1954	
X	**Acreage**
Beachgrass-Panicgrass Dune Grassland	2 acres
Impervious Surface	0.4 acres
Cultivated Lawn	0.2 acres
Atlantic Coast Interdune Swale	0.1 acres
Mid-Atlantic Coast Backdune Grassland	0.1 acres
Other communities/land covers	0 acres



	Cape Point Section	Gordons Pond Section	Cape Henlopen State Park
1954	0	0	0
2002	4	0.4	4.4
2007	2	0.4	2.4

Figure 5.26. Japanese Black Pine Forest at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.60)

Japanese Black Pine Forest will not be affected until 1.5 m of sea level rise and then only barely.

Table 5.60. Projected acres of Japanese Black Pine Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	0.05 acres

Natural Capital (Table 5.61)

Japanese Black Pine Forest was not present in 1954 and has since gained up to $832/year in capital. Since 2002 it has lost almost half of its capital from a loss in acreage.

Table 5.61. Natural Capital of Japanese Black Pine Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$832/year
2007	$454/year

***Loblolly Pine Dune Woodland* [75 acres (Figures 5.27-5.28, Tables 5.62-5.65)]   G1G2   S1**

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Maritime Forest

Description

Figure 5.27. Loblolly Pine Dune Woodland (Gordons Pond Section)

Loblolly Pine Dune Woodland is found in the Gordon's Pond area and has loblolly pine (*Pinus taeda*) as the dominant species in the canopy. American holly (*Ilex opaca*), northern bayberry (*Morella cerifera*), common greenbrier (*Smilax rotundifolia*), eastern red cedar (*Juniperus virginiana*), an d wild black cherry (*Prunus serotina*) are found underneath in the understory. Panicgrass (*Panicum amarum*), seaside bluestem (*Schizachyrium littorale*), and reed grass (*Phragmites australis*) were the only herbs noted.

Analysis of Condition at Cape Henlopen State Park

Loblolly Pine Dune Woodland has steadily declined through the years with most of the community either converting to Reed Tidal Marsh, Pitch Pine Dune Woodland, or water. Only about 9 acres of the original 120 acres of Loblolly Pine Dune Woodland from 1954 still exists. About nine acres of the community has converted to Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland which is an intermediate community between this community and salt shrub (Table 5.62). This conversion shows the increasing presence of water and salinity into the community and active conversion taking place.

Even though this community is declining it has migrated and converted about 33 acres of Pitch Pine Dune Woodland, likely in those places that have not received fire in a long time retarding the regeneration of the pitch pine (*Pinus rigida*). This community has also populated about 12 acres of Northeastern Old Field and 8 acres of former modified land (Table 5.63).

Given the fairly large amount of acreage still present in the park and the repopulation in other areas this community will likely persist in the short-term and may possibly in the long term future as well.

Table 5.62. What was once Loblolly Pine Dune Woodland in 1954 has become X or remained in 2007	
X	**Acreage**
Reed Tidal Marsh	37 acres
Pitch Pine Dune Woodland	22 acres
Water	15 acres
Loblolly Pine Dune Woodland	9 acres
Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland	9 acres
Other communities/land covers	28 acres

Table 5.63. Loblolly Pine Dune Woodland has migrated into X or remained since 1954	
X	**Acreage**
Pitch Pine Dune Woodland	33 acres
Northeastern Old Field	12 acres
Loblolly Pine Dune Woodland	9 acres
Modified Land	8 acres
Beachgrass-Panicgrass Dune Grassland	5 acres
Other communities/land covers	7 acres

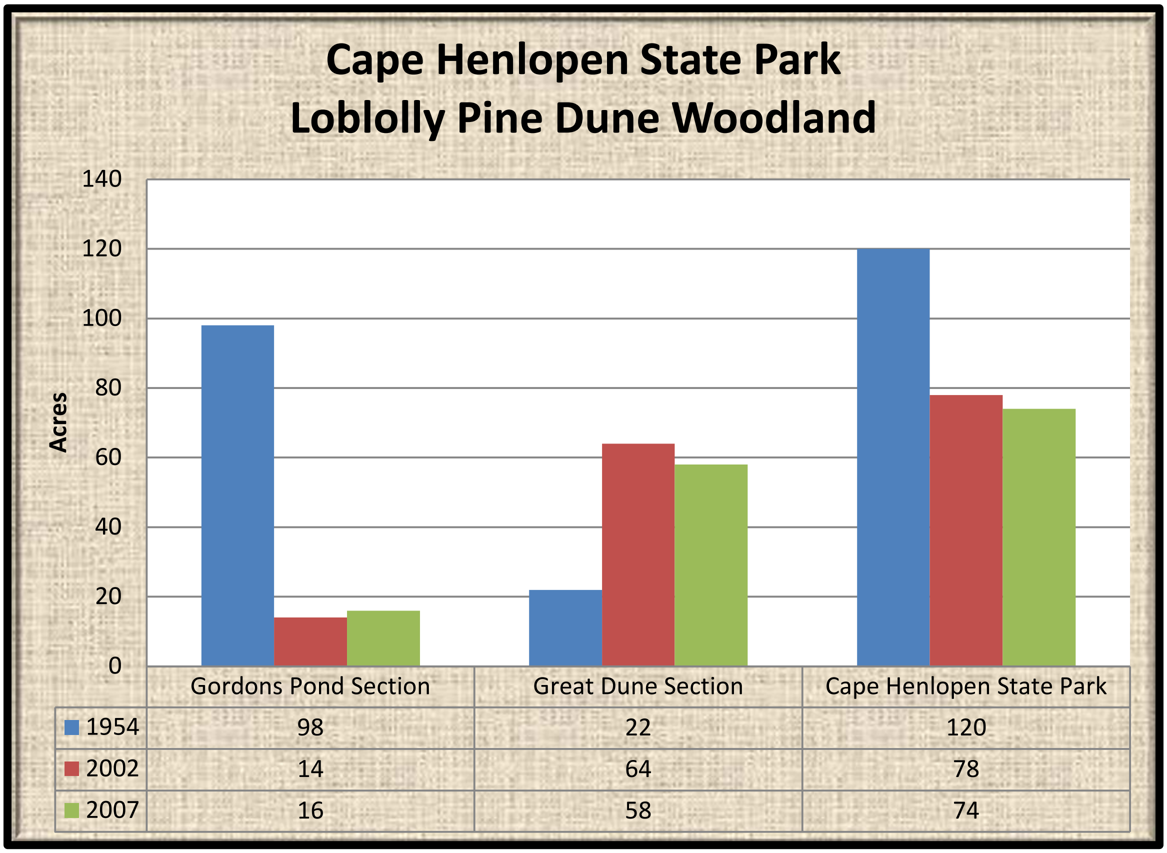


Figure 5.28. Loblolly Pine Dune Woodland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.64)

Loblolly Pine Dune Woodland in Cape Henlopen State Park will be heavily impacted by sea level rise, likely because it is so close to Gordons Pond. At 0.5 m of sea level rise, 50 acres will be flooded and at 1 m of rise nearly the entire community will be inundated in its current extent. Another 0.5 m of rise will flood the entire community. This community does have anywhere to retreat to since it is on an upland island and surrounded by marsh and pond on all sides.

Table 5.64. Projected acres of Loblolly Pine Dune Woodland Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	50 acres
1 m	72 acres
1.5 m	74 acres

Natural Capital (Table 5.65)

Capital of Loblolly Pine Dune Woodland has been going down with losses in acreage to Reed Tidal Marsh and Pitch Pine Dune Woodland through transfers.

Table 5.65. Natural Capital of Loblolly Pine Dune Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$22,692/year
2002	$14,750/year
2007	$13,993/year

***Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland* [12 acres (Figures 5.29-5.30, Tables 5.66-5.69)]   GNR   S3**

DEWAP: No Equivalent Classification
NHC: Northern Atlantic Coastal Plain Maritime Forest

<u>*Description*</u>

This woodland community is found to the west of Gordon's pond on islands in the marsh. Loblolly pine (*Pinus taeda*) is dominates the scattered canopy overtopping a small layer of eastern red cedar (*Juniperus virginiana*) and southern red oak (*Quercus falcata*). Northern bayberry (*Morella cerifera*) and salt shrub (*Baccharis halimifolia*) are found in the shrub layer. Herbs include salt meadow hay (*Spartina patens*), switchgrass (*Panicum virgatum*), seaside bluestem (*Schizachyrium littorale*), seaside goldenrod (*Solidago sempervirens*), rush (*Juncus* sp.), and Eaton's witchgrass (*Panicum spretum*).

Figure 5.29. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland (Gordons Pond Section)

<u>*Analysis of Condition at Cape Henlopen State Park*</u>

Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has declined very slightly be appears to be stable in the recent period (2002-2007). Over the years about 5 acres have converted to North Atlantic Low Salt Marsh and 3 acres each have gone to Irregularly Flooded Eastern Tidal Salt Shrub and Successional Maritime Forest. Only about one acre has gone to North Atlantic High Salt Marsh. Generally the progression of this community goes from this community to Irregularly Flooded Eastern Tidal Salt Shrub to North Atlantic High Salt Marsh to North Atlantic Low Salt Marsh, and then to open water (Table 5.66). The low amount of North Atlantic High Salt Marsh compared to the other communities shows the imperiled state that it is in.

This community has converted about nine acres of Loblolly Pine Dune Woodland and has grown into about an acre of Beachgrass-Panicgrass Dune Grassland. Only about 0.4 acres of the original acreage of 13 acres remains present showing the changeable and short-lived nature of this community (Table 5.67).

Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland has overall declined slightly but has come into the Great Dune section since 1954, while the Gordons Pond section has lost about 2/3 of its acreage since 1954. This community may possibly decline in the future since there are not many loblolly pine communities to convert to this type.

Table 5.66. What was once Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass in 1954 has become X or remained in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	5 acres
Irregularly Flooded Eastern Tidal Salt Shrub	3 acres
Successional Maritime Forest	3 acres
Water	1 acre
North Atlantic High Salt Marsh	1 acre
Other communities/land covers	0.5 acres

Table 5.67. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has migrated into X or remained since 1954	
X	**Acreage**
Loblolly Pine Dune Woodland	9 acres
Beachgrass-Panicgrass Dune Grassland	1 acre
Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	0.4 acres
Sand	0.3 acres
Central Coast Beach Heather Dune Shrubland	0.3 acres
Other communities/land covers	1 acre

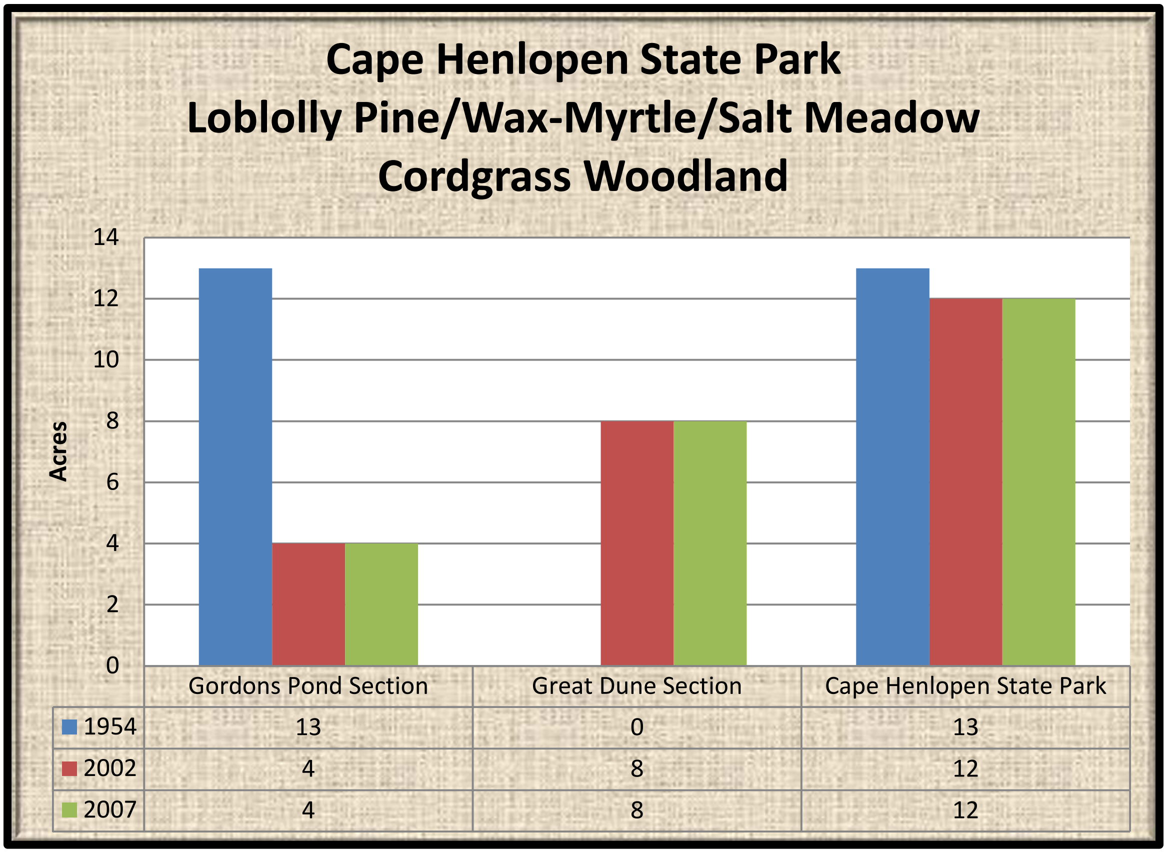


Figure 5.30. Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.68)

Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland will be essentially totally inundated with 0.5 m of sea level rise.

Table 5.68. Projected acres of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland Inundated by Sea Level Rise

Rise	Acres
0.5 m	10 acres
1 m	11 acres
1.5 m	11 acres

Natural Capital (Table 5.69)

The capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has declined slightly since 1954 with a decrease in acreage.

Table 5.69. Natural Capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$81,527/year
2002	$75,256/year
2007	$75,256/year

***Maritime Red Cedar Woodland* [2 acres (Figure 5.31, Tables 5.70-5.73)]** **G2** **S2**

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Maritime Forest

Description

This woodland is dominated by eastern red cedar (*Juniperus virginiana*) and is one of the driest maritime communities. Since this occurrence was determined via aerial imagery analysis a specific species list cannot be given. Typical associates for this community include southern red oak (*Quercus falctata*), pitch pine (*Pinus rigida*), sassafras (*Sassafras albidum*), loblolly pine (*Pinus taeda*), persimmon (*Diospyros virginiana*), and wild black cherry (*Prunus serotina*). The shrub layer may include northern bayberry (*Morella pensylvanica*), southern bayberry (*Morella cerifera*), salt shrub (*Baccharis halimifolia*), and highbush blueberry (*Vaccinium corymbosum*). A somewhat thick vine layer of poison ivy (*Toxicodendron radicans*), common greenbrier (*Smilax rotundifolia*), and Virginia creeper (*Parthenocissus quinquefolia*) may exist. Common herbs include prickly pear (*Opuntia humifusa*), egg-leaf witchgrass (*Dichanthelium ovale*), switchgrass (*Panicum virgatum*), salt meadow cordgrass (*Spartina patens*), and seaside goldenrod (*Solidago sempervirens*).

Analysis of Condition at Cape Henlopen State Park

Maritime Red Cedar Woodland was not present or detectable in 1954 and has grown into 2 acres of 1 acre each of Irregularly Flooded Eastern Tidal Salt Shrub and Northeastern Old Field (Table 5.70). Since this community is located in so few acres in the park is hard state that it is secure for the future.

Table 5.70. Maritime Red Cedar Woodland has migrated into X or remained since 1954	
X	**Acreage**
Irregularly Flooded Eastern Tidal Salt Shrub	1 acre
Northeastern Old Field	1 acre

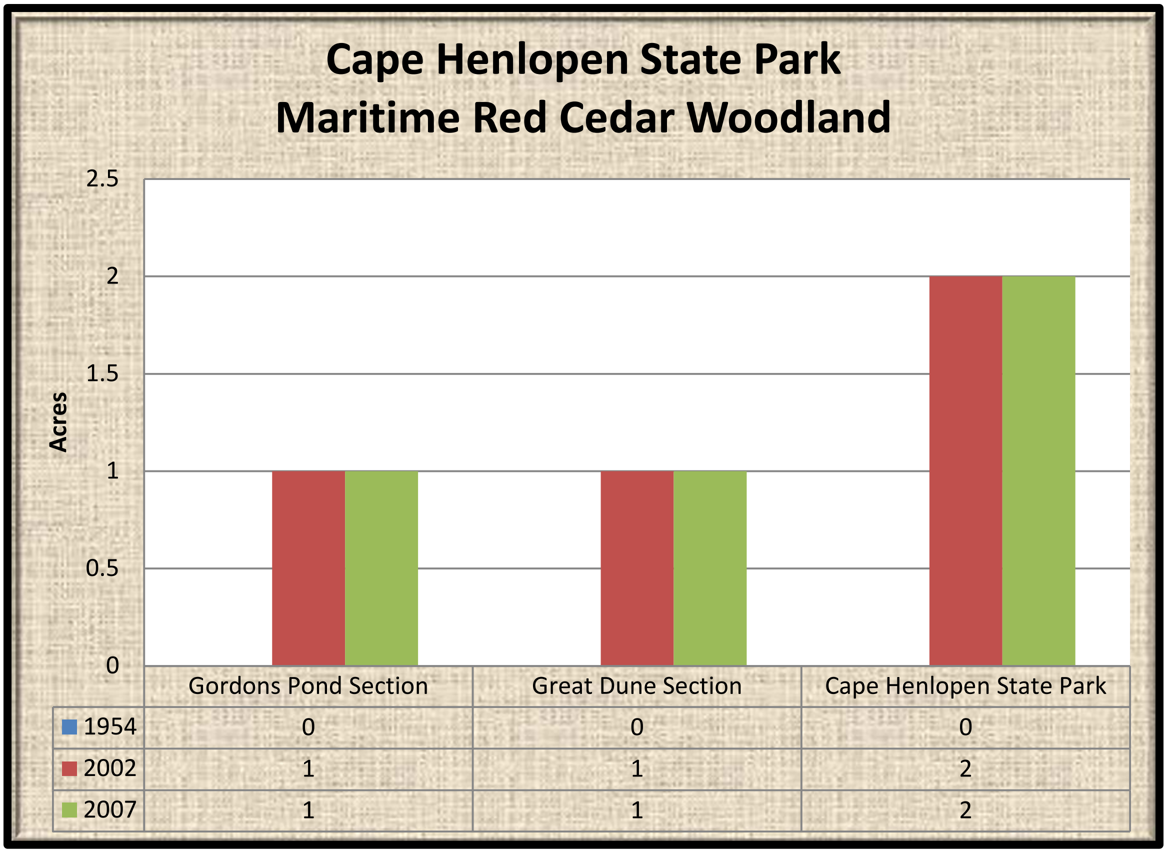


Figure 5.31. Maritime Red Cedar Woodland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.71)

Maritime Red Cedar Woodland will be totally inundated with 0.5 m of sea level rise.

Table 5.71. Projected acres of Maritime Red Cedar Woodland Inundated by Sea Level Rise

Rise	Acres
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 5.72)

This woodland was not present in 1954 and has been stable in capital in the recent period (2002-2007).

Table 5.72. Natural Capital of Maritime Red Cedar Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$378/year
2007	$378/year

***Mid-Atlantic Coast Backdune Grassland* [112 acres (Figures 5.32-5.33, Tables 5.73-5.76)]**
G2 S1

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Dune and Swale

<u>*Description*</u>

Mid-Atlantic Coast Backdune Grasslands are often located behind the first line of dunes on the coastal strand but can in some cases occur out of the maritime area in sandy areas. It typified by the presence of seaside bluestem (*Schizachyrium littorale*) that is associated by broom-sedge (*Andropogon virginicus*), tall beach panicgrass (*Panicum amarum*), yarrow (*Achillea millefolium*), Eaton's witchgrass (*Panicum spretum*), northern beach pinweed (*Lechea maritima*), and seaside goldenrod (*Solidago sempervirens*). Scattered stems of wild black cherry (*Prunus serotina*), beach plum (*Prunus maritima*), eastern red cedar (*Juniperus virginiana*), wax-myrtle (*Morella cerifera*), and beach heather (*Hudsonia tomentosa*) may be mixed in the grassland.

Figure 5.32. Mid-Atlantic Backdune Grassland (Fort Miles Section)

<u>*Analysis of Condition at Cape Henlopen State Park*</u>

Mid-Atlantic Coast Backdune Grassland has greatly expanded since being cleared during the time of US Army use. Only about 2 acres of the original 31 acres present in 1954 are still present showing the short-lived nature of this community. About 16 acres of it matured into Pitch Pine Dune Woodland and about 5 acres converted to Beachgrass-Panicgrass Dune Grassland with the ocean getting closer. Impervious surface gobbled up 2 acres in the form of a parking lot and 2 acres matured to Irregularly Flooded Eastern Tidal Salt Shrub (Table 5.73).

Expansion of this community has converted 59 acres of Beachgrass-Panicgrass Dune Grassland, and 20 acres of bare sand. About 7 acres each went to Central Coast Beach Heather Dune Shrubland and Water and 3 acres went to North Atlantic Low Salt Marsh (Table 5.74).

Given the expansion it is likely that this community will remain in the short and long term futures of the park.

Table 5.73. What was once Mid-Atlantic Coast Backdune Grassland in 1954 has become X or remained in 2007	
X	**Acreage**
Pitch Pine Dune Woodland	16 acres
Beachgrass-Panicgrass Dune Grassland	5 acres
Mid-Atlantic Coast Backdune Grassland	2 acres
Impervious Surface	2 acres
Irregularly Flooded Eastern Tidal Salt Shrub	2 acres
Other communities/land covers	5 acres

Table 5.74. Mid-Atlantic Coast Backdune Grassland has migrated into X or remained since 1954	
X	**Acreage**
Beachgrass-Panicgrass Dune Grassland	59 acres
Sand	20 acres
Central Coast Beach Heather Dune Shrubland	7 acres
Water	7 acres
North Atlantic Low Salt Marsh	3 acres
Other communities/land covers	15 acres

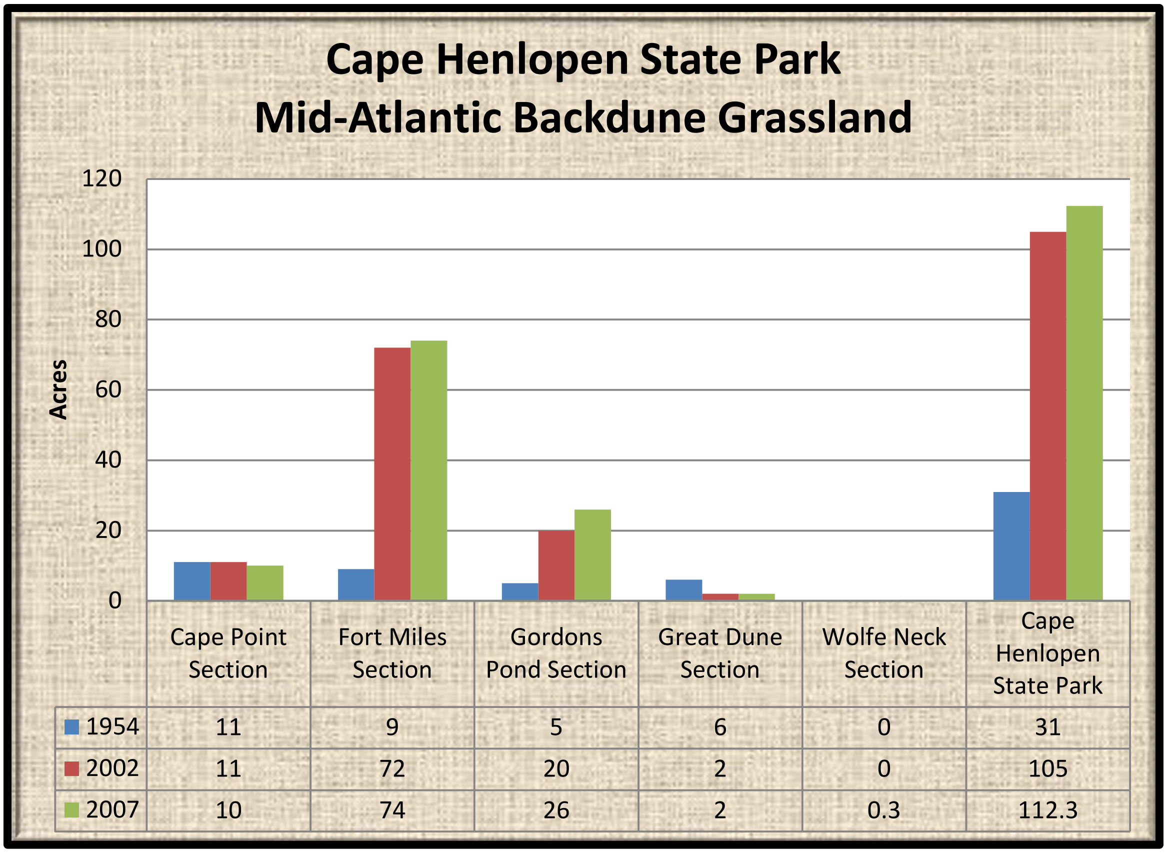


Figure 5.33. Mid-Atlantic Backdune Grassland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.75)

Only about 39 acres of Mid-Atlantic Backdune Grassland will be inundated by sea level rise with 1.5 m of rise.

Table 5.75. Projected acres of Mid-Atlantic Backdune Grassland Inundated by Sea Level Rise

Rise	Acres
0.5 m	4 acres
1 m	18 acres
1.5 m	39 acres

Natural Capital (Table 5.76)

Capital of Mid-Atlantic Backdune Grassland has gradually been going up as the community expands.

Table 5.76. Natural Capital of Mid-Atlantic Backdune Grassland	
Year	**Natural Capital (in 2012 dollars)**
1954	$4,517/year
2002	$15,299/year
2007	$16,362/year

***Mid to Late Successional Loblolly Pine-Sweetgum Forest* [94 acres (Figures 5.34-5.35, Tables 5.77-5.80)] GNA SNA**

DEWAP: Coastal Plain Upland Forests
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

This late successional forest is found south of lower Wolfe Glade west of Lewes-Rehoboth Canal. The example in this area is right at the cusp of transitioning from this forest type to a Southern Red Oak/Heath Forest. The canopy is nearly mature with loblolly pine (*Pinus taeda*), red maple (*Acer rubrum*), white oak (*Quercus alba*) , northern red oak (*Quercus rubra*), southern red oak (*Quercus falcata*), and Virginia pine (*Pinus virginiana*). The understory is well developed, but thick in some places and is composed of smaller members of the canopy plus American holly (*Ilex opaca*), mockernut hickory (*Carya alba*), pignut hickory (*Carya* glabra), sassafras (*Sassafras albidum*), and a few sweetbay (*Magnolia virginiana*). The shrub and vine layer is composed of common greenbrier (*Smilax rotundifolia*), highbush blueberry (*Vaccinium corymbosum*), white-leaf greenbrier (*Smilax glauca*), and lowbush blueberry (*Vaccinium pallidum*). Slender spikegrass (*Chasmanthium laxum*) was the only herb noted in this community.

Figure 5.34. Mid to Late Successional Loblolly Pine-Sweetgum Forest (Holland Glade Section)

Analysis of Condition at Cape Henlopen State Park

This community has gained acreage over the years as Early to Mid-Successional Loblolly Pine Forest has matured into this community. About 24 acres of the original 35 are still present in 2007. The rest have converted to Successional Tuliptree Forest (3 acres), Agricultural Field (3 acres), Eastern Reed Marsh (1 acre), and North Atlantic Low Salt Marsh (1 acre) (Table 5.77). Since this time 62 acres of Early to Mid-Successional Loblolly Pine Forest have matured into this type. Only about 9 acres of this community have been converted with 3 acres maturing into Successional Tuliptree Forest and 3 acres being cleared for Agricultural Field (Table 5.78). About one acre each went to Eastern Reed Marsh and North Atlantic Low Salt Marsh.

Table 5.77. What was once Mid to Late Successional Loblolly Pine-Sweetgum Forest in 1954 has become X or remained in 2007	
X	**Acreage**
Mid to Late Successional Loblolly Pine-Sweetgum Forest	24 acres
Successional Tuliptree Forest	3 acres
Agricultural Field	3 acres
Eastern Reed Marsh	1 acre
North Atlantic Low Salt Marsh	1 acre
Other communities/land covers	2 acres

Table 5.78. Mid-Atlantic Coast Backdune Grassland has migrated into X or remained since 1954	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	62 acres
Mid to Late Successional Loblolly Pine-Sweetgum Forest	24 acres
Agricultural Field	2 acres
Wax-Myrtle Shrub Swamp	2 acres
Southern Red Maple-Blackgum Swamp	1 acre
Other communities/land covers	2 acres

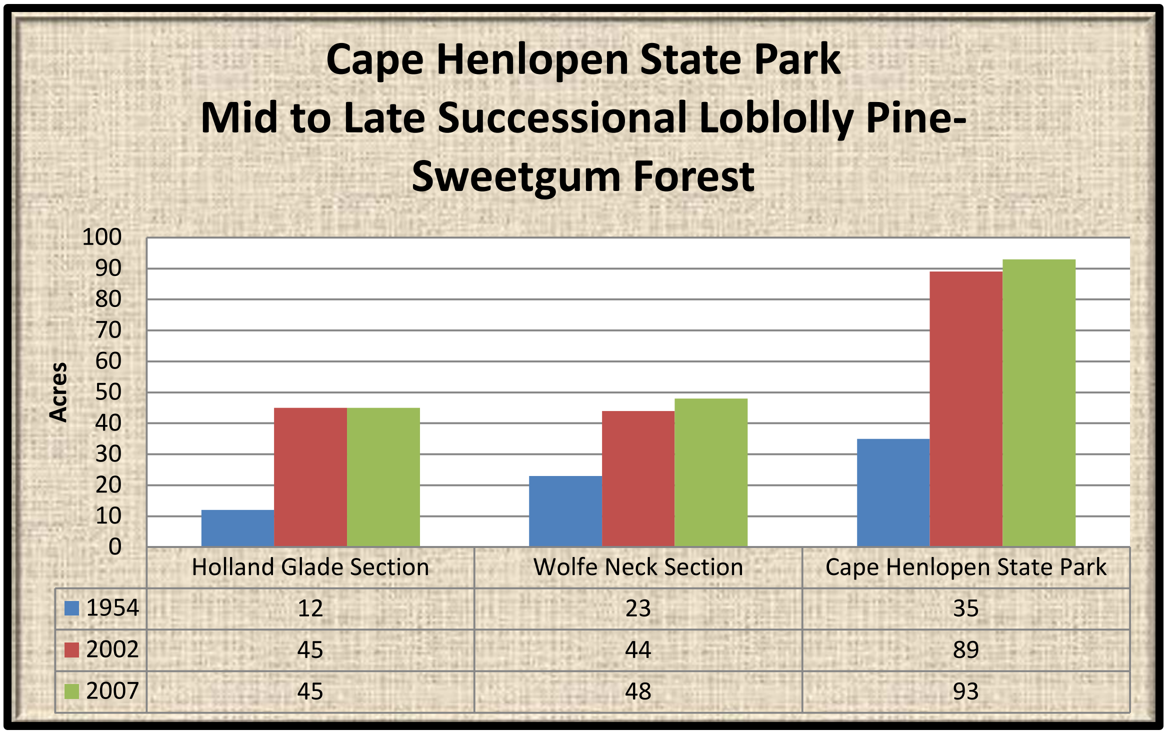


Figure 5.35. Mid to Late Successional Loblolly Pine-Sweetgum Forest at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.79)

Most of the examples of this community are located in places of higher elevation. At 1.5 m of sea level only 39 acres of this community will be inundated or about 1/3 of it.

Table 5.79. Projected acres of Mid to Late Successional Loblolly Pine-Sweetgum Forest Inundated by Sea Level Rise

Rise	Acres
0.5 m	16 acres
1 m	26 acres
1.5 m	39 acres

Natural Capital (Table 5.80)

This community has been gaining acreage as Early to Mid-Successional Loblolly Pine Forest matures into it.

Table 5.80. Natural Capital of Mid to Late Successional Loblolly Pine-Sweetgum Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$6,619/year
2002	$16,830/year
2007	$17,586/year

Needlerush High Marsh **[0.03 acres (Figures 5.36-5.37, Tables 5.81-5.82)] G5 S2**

DEWAP: Tidal High Marshes
NHC: Northern Atlantic Coastal Plain Tidal Salt Marsh

Description

Figure 5.36. Needlerush High Marsh (Great Dune Section)

This marsh community is found in clumps on higher ground in North Atlantic Low Salt Marsh. Needlerush (*Juncus roemerianus*) dominates the marsh nearly completely. Some stems of salt meadow hay (*Spartina patens*) may be found in places.

Analysis of Condition at Cape Henlopen State Park

It is not known at what point this marsh came into the park but it was sometime between 1954 and 2002. At the current time it barely has a foothold in the park and has not gotten larger in the 2002 to 2007 period. It developed in North Atlantic Low Salt Marsh that was present in 1954.

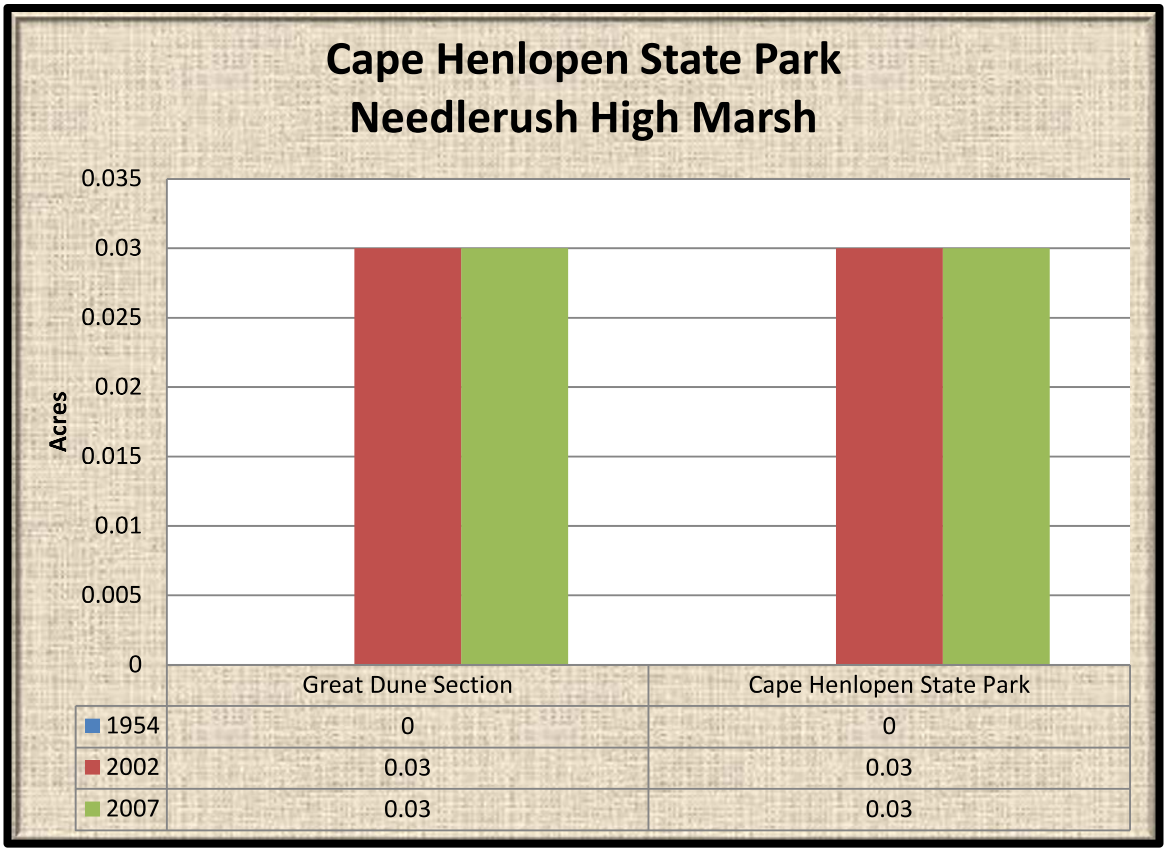


Figure 5.37. Needlerush High Marsh at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.81)

All of the acreage of Needlerush High Marsh will be inundated with 0.5 m of sea level rise. This is northernmost occurrence of this community in Delaware making a dim outlook for this community to expand north with climate change.

Table 5.81. Projected acres of Needlerush High Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0.03 acres
1 m	0.03 acres
1.5 m	0.03 acres

Natural Capital (Table 5.82)

Needlerush High Marsh has apparently come into Cape Henlopen State Park since 1954 and before 2002. Since 2002 it has remained at a stable amount.

Table 5.82. Natural Capital of Needlerush High Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$188/year
2007	$188/year

***North Atlantic High Salt Marsh* [32 acres (Figures 5.38-5.39, Tables 5.83-5.86)] G5 S4**

DEWAP: Tidal High Marshes
NHC: North Atlantic Coastal Plain Tidal Salt Marsh

Description

Figure 5.38. North Atlantic High Salt Marsh (Holland Glade Section)

This marsh is found in areas of higher ground in the North Atlantic Low Salt Marsh. Salt meadow hay (*Spartina patens*) dominates the marsh and may be associated with marsh fleabane (*Pluchea odorata*), salt meadow cordgrass (*Spartina alternifolia*), and salt grass (*Distichlis spicata*).

Analysis of Condition at Cape Henlopen State Park

North Atlantic High Salt Marsh has been found to be one of the most imperiled vegetation communities in Delaware. The marsh at Cape Henlopen State Park is no exception, where this marsh has lost 134 acres since 1954 and 16 acres in the recent period (2002-2007). Among the causes for the decline may be sea level rise and invasion by common reed (*Phragmites australis*). If the loses continue at the 2002-2007 rate this marsh may extirpated from the park in 15 to 20 years.

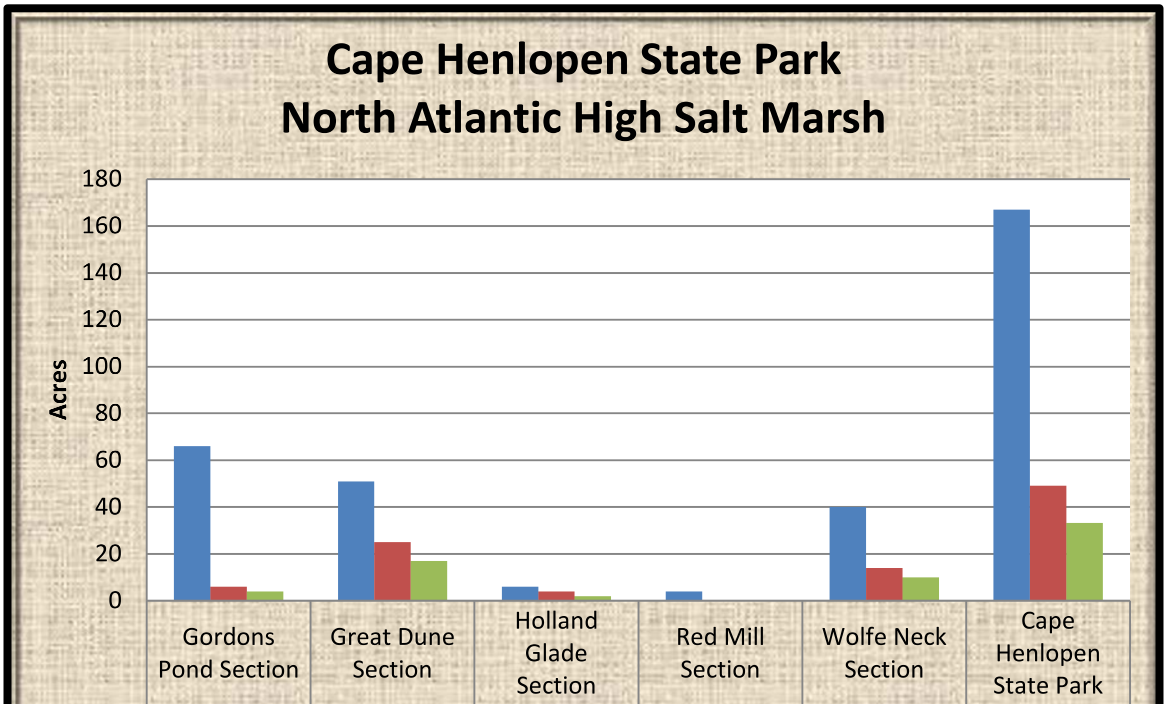
Showing the imperiled nature of the marsh, only 4 acres of the original 167 acres present at Cape Henlopen State Park in 1954 remained in 2007. The rest of the acreage has converted to North Atlantic Low Salt Marsh (83 acres) and water (59 acres) with a smaller amount going to Reed Tidal Marsh (9 acres), and sand (5 acres) (Table 5.83).

Despite the losses, this community has been able to make an anemic expansion into Irregularly Flooded Eastern Tidal Salt Shrub (13 acres), North Atlantic Low Salt Marsh (7 acres), Reed Tidal Marsh (2 acres), and Northeastern Old Field (2 acres) (Table 5.84).

The continued existence of this community in the park over the long term is in doubt. Restoration efforts might be questionable given the general lack of natural expansion. It could be that sea level rise is currently going too fast for this community to expand or colonize new ground.

Table 5.83. What was once North Atlantic High Salt Marsh in 1954 has become X or remained in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	83 acres
Water	59 acres
Reed Tidal Marsh	9 acres
Sand	5 acres
North Atlantic High Salt Marsh	4 acres
Other communities/land covers	2 acres

Table 5.84. North Atlantic High Salt Marsh has migrated into X or remained since 1954	
X	**Acreage**
Irregularly Flooded Eastern Tidal Salt Shrub	13 acres
North Atlantic Low Salt Marsh	7 acres
North Atlantic High Salt Marsh	4 acres
Reed Tidal Marsh	2 acres
Northeastern Old Field	2 acres
Other communities/land covers	5 acres



	Gordons Pond Section	Great Dune Section	Holland Glade Section	Red Mill Section	Wolfe Neck Section	Cape Henlopen State Park
1954	66	51	6	4	40	167
2002	6	25	4	0.2	14	49.2
2007	4	17	2	0.2	10	33.2

Figure 5.39. North Atlantic High Salt Marsh at Cape Henlopen State Park (1954, 2002, and 2007)

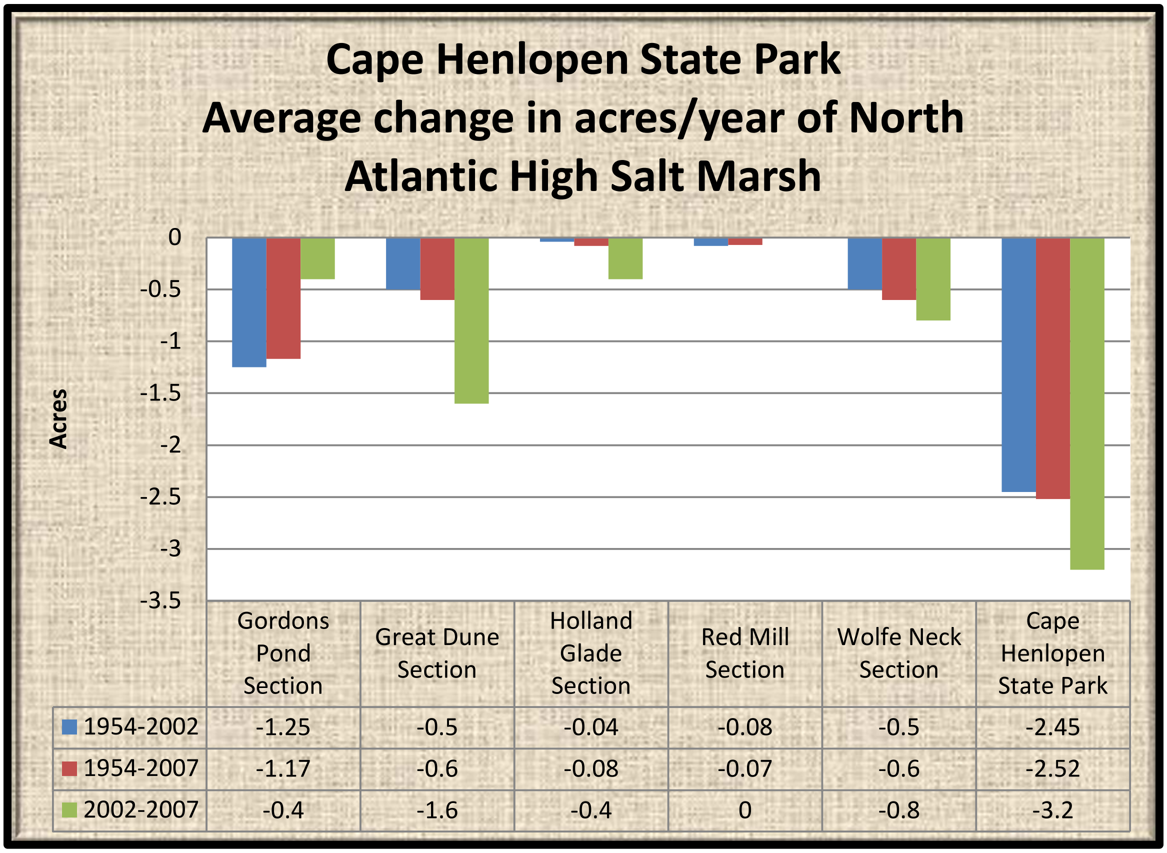


Figure 5.40. Average change in acres/year of North Atlantic High Salt Marsh at Cape Henlopen State Park

DNREC Sea Level Rise Analysis (Table 5.85)

All of this community will be flooded in its current extent with 0.5 m of sea level rise.

Table 5.85. Projected acres of North Atlantic High Salt Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	32 acres
1 m	32 acres
1.5 m	32 acres

Natural Capital (Table 5.86)

Capital of North Atlantic High Salt Marsh has declined greatly with its loss in acreage. These declines will likely continue into the future.

Table 5.86. Natural Capital of North Atlantic High Marsh Salt Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,047,307/year
2002	$308,548/year
2007	$208,207/year

North Atlantic Low Salt Marsh **[1,095 acres (Figures 5.41-5.43, Tables 5.87-5.90)] G5 S5**

DEWAP: Tidal Low Marshes
NHC: North Atlantic Coastal Plain Tidal Salt Marsh

Description

Figure 5.41. North Atlantic Low Salt Marsh (Great Dune Section)

North Atlantic Low Salt Marsh lies at the lowest elevation of the marsh communities and receives diurnal tides. Salt meadow cordgrass (*Spartina alternifolia*) is dominates this marsh and is associated by sea lavender (*Limonium carolinianum*), glasswort (*Salicornia* spp.), hastate orache (*Atriplex prostrata*), tidal marsh amaranth (*Amaranthus cannabinus*), sweetscent (*Pluchea odorata*), and salt meadow hay (*Spartina patens*).

Analysis of Condition at Cape Henlopen State Park

North Atlantic Low has increased by almost one hundred acres since 1954 in the park with about 729 acres of the original 1954 acreage remaining. Of the remaining acres from 1954, 184 acres have converted to water, 25 acres to Reed Tidal Marsh, 14 acres have gone to sand, and 13 acres have become salt pannes (Table 5.87).

Expansion of the marsh has taken over 171 acres of Irregularly Flooded Eastern Tidal Salt Shrub and 83 acres of North Atlantic High Salt Marsh. In addition there has been some landward progression of the marsh going into 14 acres of Pitch Pine Dune Woodland and 13 acres of Wax-Myrtle Shrub Swamp (Table 5.88).

Given the sheer size of the marsh it would be easy to say that this community is secure in both the short and long term futures. This may be true for the short term but the long term is more uncertain has sea level rise will become more rapid outstripping the ability of the marsh to keep up.

Table 5.87. What was once North Atlantic Low Salt Marsh in 1954 has become X or remained in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	729 acres
Water	184 acres
Reed Tidal Marsh	25 acres
Sand	14 acres
Salt Panne	13 acres
Other communities/land covers	36 acres

Table 5.88. North Atlantic Low Salt Marsh has migrated into X or remained since 1954	
X	**Acreage**
North Atlantic Low Salt Marsh	729 acres
Irregularly Flooded Eastern Tidal Salt Shrub	171 acres
North Atlantic High Salt Marsh	83 acres
Pitch Pine Dune Woodland	13 acres
Wax-Myrtle Shrub Swamp	13 acres
Other communities/land covers	84 acres

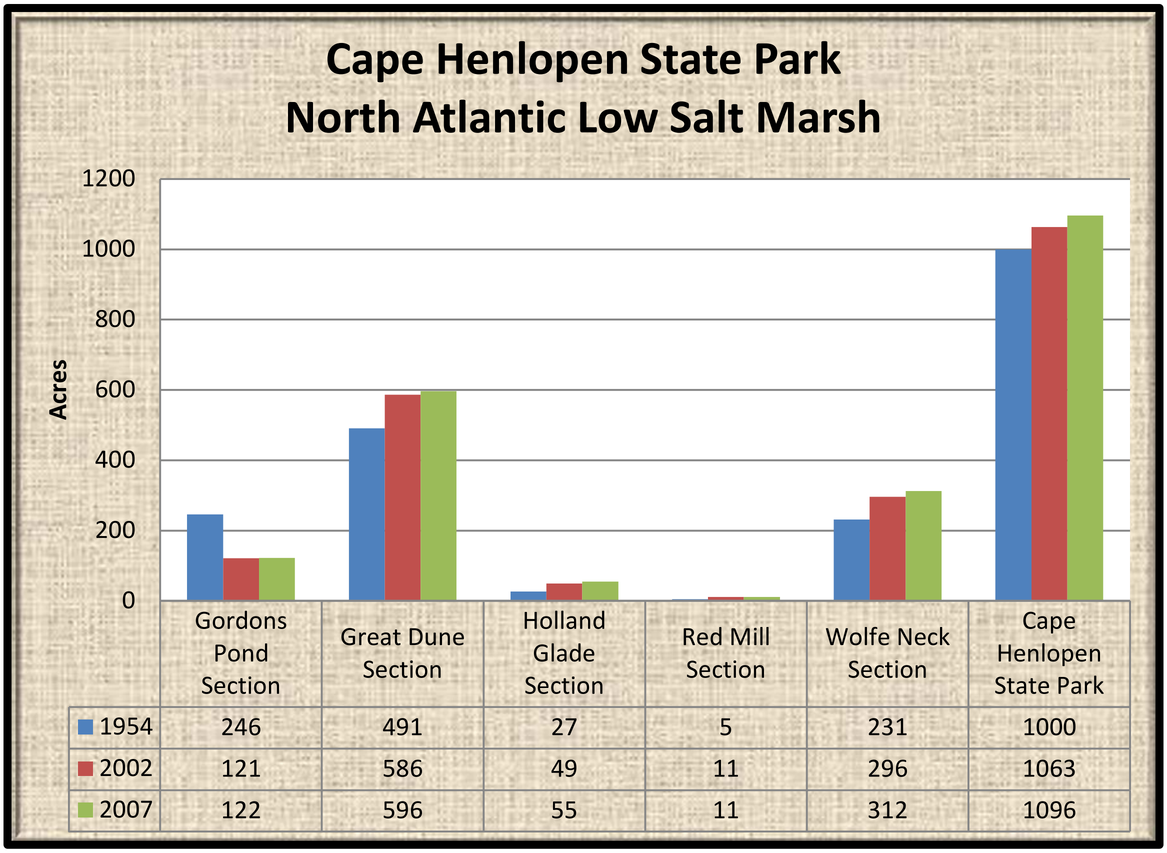


Figure 5.42. North Atlantic Low Salt Marsh at Cape Henlopen State Park (1954, 2002, and 2007)

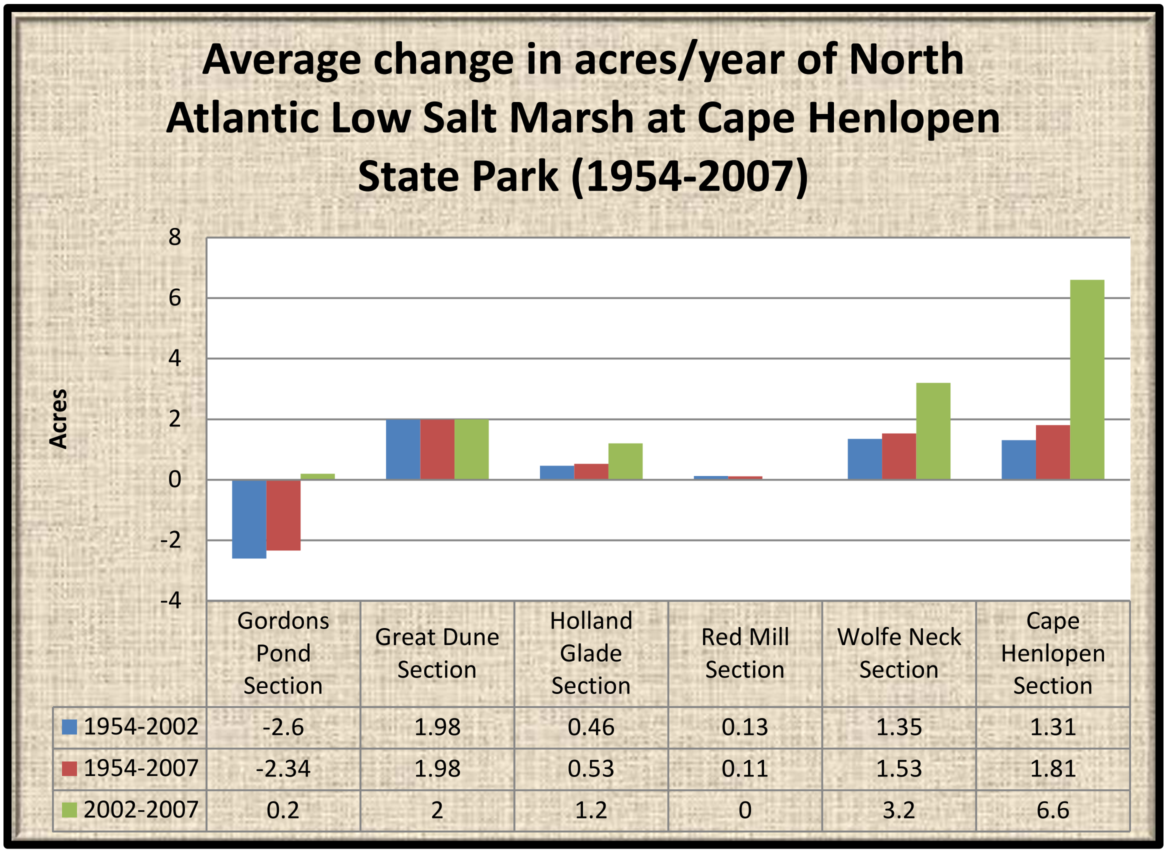


Figure 5.43. Average in acres/year of North Atlantic Low Salt Marsh at Cape Henlopen State Park (1954-2007)

DNREC Sea Level Rise Analysis (Table 5.89)

North Atlantic Low Salt Marsh will be eliminated with 0.5 m of sea level rise.

Table 5.89. Projected acres of North Atlantic Low Salt Marsh Inundated by Sea Level Rise

Rise	Acres
0.5 m	1,088 acres
1 m	1,088 acres
1.5 m	1,088 acres

Natural Capital (Table 5.90)

Capital of North Atlantic Low Salt Marsh has been increasing with increasing acreage. Considering the sea level rise scenarios these may start to fall in the near future.

Table 5.90. Natural Capital of North Atlantic Low Marsh Salt Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$6,271,300/year
2002	$6,666,392/year
2007	$6,873,345/year

***Northeastern Modified Successional Forest* [155 acres (Figures 5.44-5.45, Tables 5.91—5.94)]**
GNA SNA

DEWAP: Coastal Plain Upland Forest
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

This community is mainly located in the Wolfe Neck area. It is characterized by human disturbance and has a canopy that is not dissimilar to nearby more natural forests. The examples here have a canopy of tuliptree (*Liriodendron tulipifera*), loblolly pine (*Pinus taeda*), red maple (*Acer rubrum*), and white oak (*Quercus alba*). The understory is composed of red maple, sassafras (*Sassafras albidum*), and American holly (*Ilex opaca*). The vine layer is thick with summer grape (*Vitis aestivalis*) and Japanese honeysuckle (*Lonicera japonica*). Skunk cabbage (*Symplocarpus foetidus*) and daffodil (*Narcissus pseudonarcissus*) were the only herbs noted.

Figure 5.44. Northeastern Modified Successional Forest (Holland Glade Section)

Analysis of Condition at Cape Henlopen State Park

This successional disturbed forest community still contains 32 acres of the original 36 that were present in 1954 showing a long lived community. The other 4 acres have converted to one acre each of Irregularly Flooded Eastern Tidal Salt Shrub, Agricultural Field, Northeastern Old Field, and Southern Red Maple-Blackgum Swamp (Table 5.91).

Since 1954 this community gained some acreage from maturing habitats including 87 acres of Northeastern Old Field and 8 acres of Agricultural Field. It has also invaded about 8 acres of Southern Red Maple-Blackgum Swamp (Table 5.92).

It is hoped that this community might be able to be restored to a more natural forest community with removal of the exotic invasive plant species. If eradication occurs this community could be reduced in the short term and eradicated in the long term.

Table 5.91. What was once Northeastern Modified Successional Forest in 1954 has become X or remained in 2007	
X	**Acreage**
Northeastern Modified Successional Forest	32 acres
Irregularly Flooded Eastern Tidal Salt Shrub	1 acre
Agricultural Field	1 acre
Northeastern Old Field	1 acre
Southern Red Maple-Blackgum Swamp	1 acre

Table 5.92. Northeastern Modified Successional Forest has migrated into X or remained since 1954	
X	**Acreage**
Northeastern Old Field	87 acres
Northeastern Modified Successional Forest	32 acres
Agricultural Field	8 acres
Southern Red Maple-Blackgum Swamp	8 acres
Beachgrass-Panicgrass Dune Grassland	6 acres
Other communities/land covers	13 acres

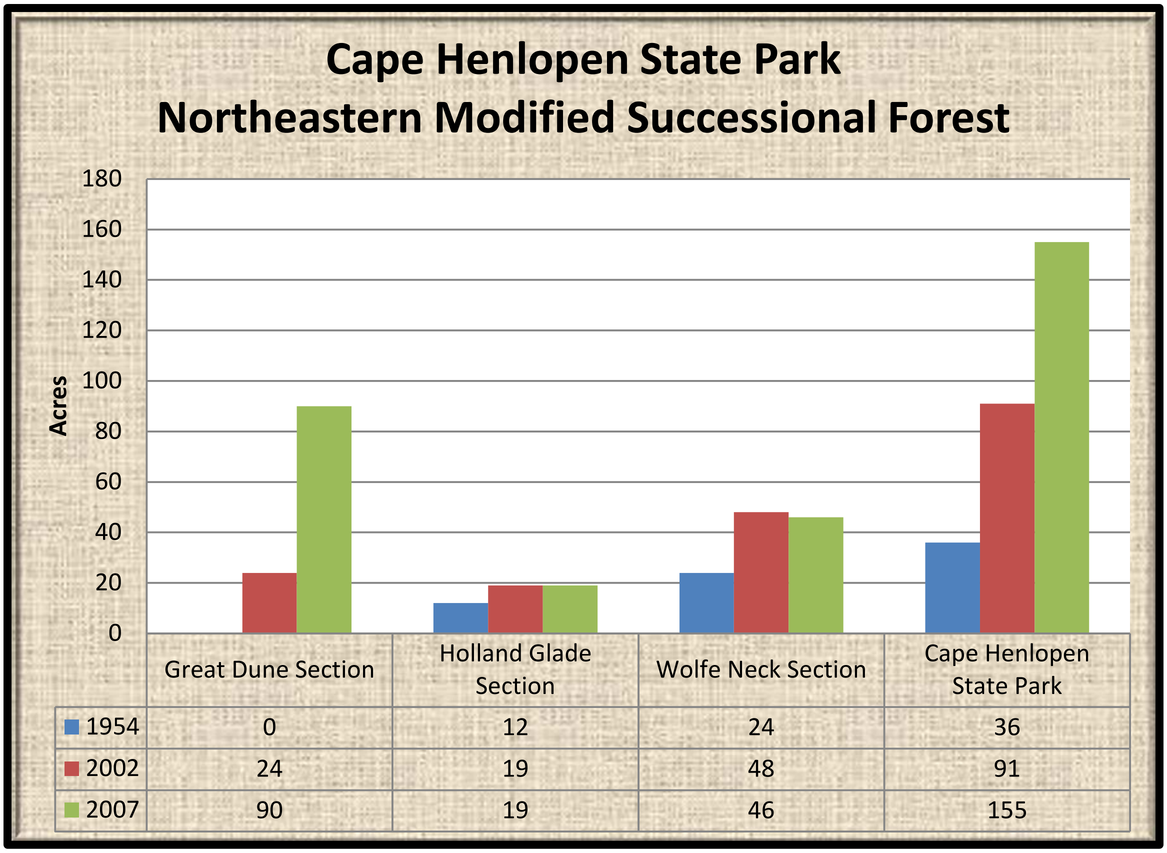


Figure 5.45. Northeastern Modified Successional Forest at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.93)

More than half of this community will be inundated with 1.5 m of sea level rise.

Table 5.93. Projected acres of Northeastern Modified Successional Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	29 acres
1 m	71 acres
1.5 m	101 acres

Natural Capital (Table 5.94)

Capital of Northeastern Modified Successional Forest has been increasing as exotic invasive plant species invade new forest communities. This community will be impacted by sea level rise reducing the capital.

Table 5.94. Natural Capital of Northeastern Modified Successional Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$6,808/year
2002	$17,208/year
2007	$29,311/year

***Northeastern Old Field* [14 acres (Figure 5.46, Tables 5.95-5.98)]** **GNA** **SNA**

DEWAP: Early Successional Upland Habitats
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Areas of field were once prevalent in what is now the park when the land was in Army use. These fields have since grown into woodland areas leaving small remnants of this community. Since the occurrences of this community were mostly mapped by aerial imagery analysis specific species list cannot be given.

Analysis of Condition at Cape Henlopen State Park

Only 4 acres of this community remains from 1954 and most (118 acres) has grown into Pitch Pine Dune Woodland and Northeastern Modified Successional Forest (87 acres). Some parts near wetlands have become Eastern Reed Marsh (25 acres) and Reed Tidal Marsh (15 acres). Loblolly Pine Dune Woodland has grown into about 12 acres (Table 5.95).

Even though it has declined significantly since maturing into other forest types it has managed to populate 8 acres of abandoned agricultural field and one acre of Northeastern Modified Successional Forest (Table 5.96).

Table 5.95. What was once Northeastern Old Field in 1954 has become X or remained in 2007	
X	**Acreage**
Pitch Pine Dune Woodland	118 acres
Northeastern Modified Successional Forest	87 acres
Eastern Reed Marsh	25 acres
Reed Tidal Marsh	15 acres
Loblolly Pine Dune Woodland	12 acres
Other communities/land covers	71 acres

Table 5.96. Northeastern Old Field has migrated into X or remained since 1954	
X	**Acreage**
Agricultural Field	8 acres
Northeastern Old Field	4 acres
Northeastern Modified Successional Forest	1 acre
Coastal Loblolly Pine Wetland Forest	0.3 acres
Early to Mid-Successional Loblolly Pine Forest	0.1 acres
Other communities/land covers	0 acres

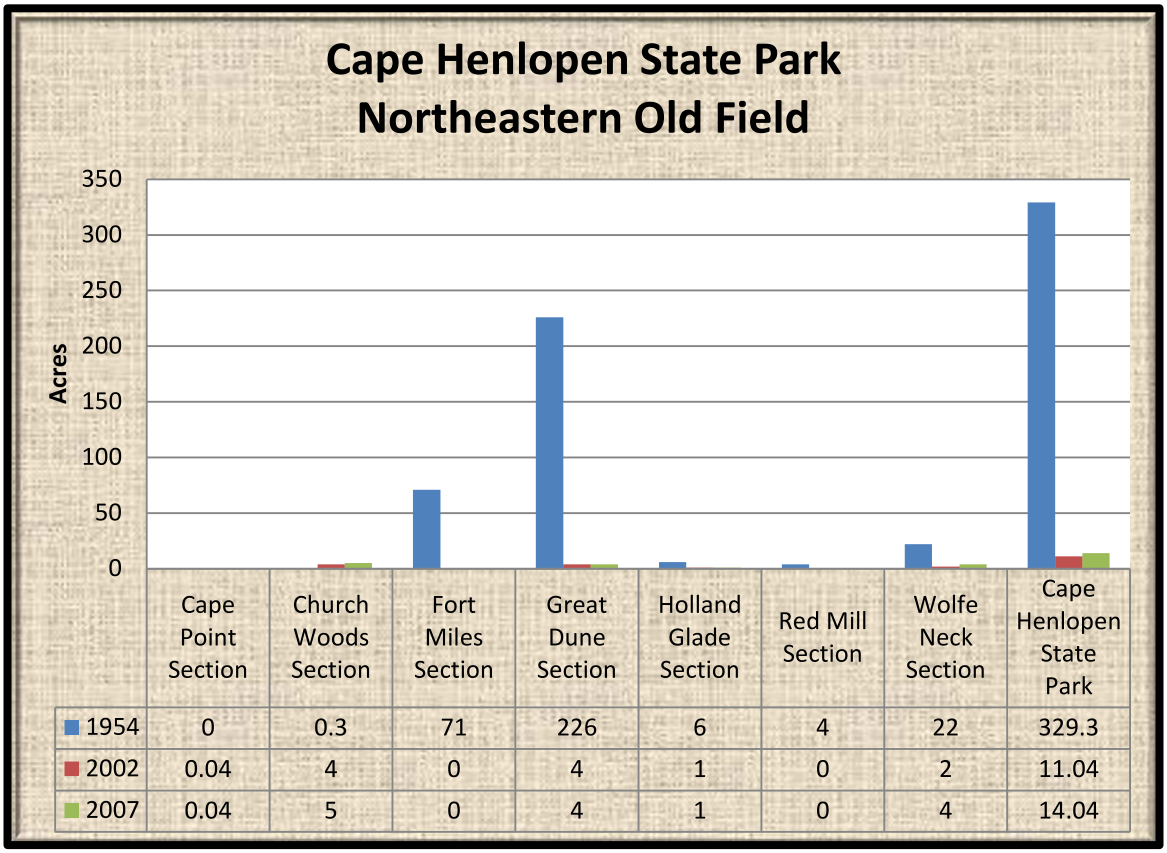


Figure 5.46. Northeastern Old Field at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.97)

A little more than 1/3 of the current acreage of this community will impacted with 1.5 m of sea level rise and will barely be affected by 0.5 m of rise.

Table 5.97. Projected acres of Northeastern Old Field Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	0.06 acres
1 m	4 acres
1.5 m	5 acres

Natural Capital (Table 5.98)

Capital of Northeastern Old Field has decreased as this community matures into shrubland and forest. Some reductions in agricultural field have caused this community to increase recently.

Table 5.98. Natural Capital of Northeastern Old Field	
Year	**Natural Capital (in 2012 dollars)**
1954	$47,979/year
2002	$1,609/year
2007	$2,046/year

***Northeastern Successional Shrubland* [2 acres (Figures 5.47-5.48, Tables 5.99-5.102)] GNA SNA**

DEWAP: Early Successional Upland Habitats
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Figure 5.48. Northeastern Successional Shrubland (Holland Glade Section)

This community is composed of shrubs in a successional situation. Woody species include eastern red cedar (*Juniperus virginiana*) and wild black cherry (*Prunus serotina*). Shrubs and vines include Japanese honeysuckle (*Lonicera japonica*), privet (*Ligustrum vulgare*), wineberry (*Rubus phoenocalasius*), multiflora rose (*Rosa multiflora*), and blackberry (*Rubus* sp.).

Analysis of Condition at Cape Henlopen State Park

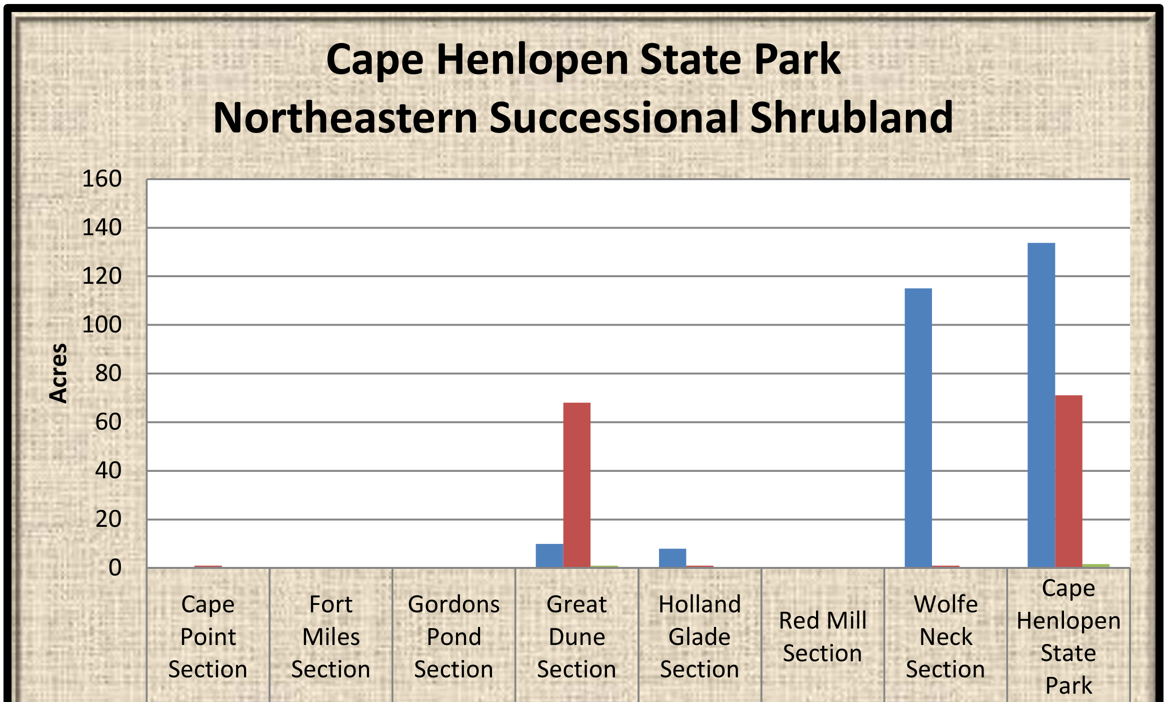
Less than 0.1 acres of this community still exist out of the original 134 acres in 1954. A large area of shrubland was located in the Wolfe Neck Section in 1954 has since grown into about 54 acres of Early to Mid-Successional Loblolly Pine Forest and 18 acres of Southern Red Oak/Heath Forest (Table 4.79). North Atlantic Low Salt Marsh claimed about 10 acres of this community and 6 acres were cleared for an agricultural field. Closer to the coast about 9 acres matured into Pitch Pine Dune Woodland.

Even though this community has been declined it has slightly expanded into about 1 acre of Northeastern Old Field and 0.2 acres each of agricultural field and cultivated lawn (Table 4.80).

With maturation this community may eventually disappear from the park but in the long term as it will likely be present in small amount in the short term.

Table 5.99. What was once Northeastern Successional Shrubland in 1954 has become X or remained in 2007	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	59 acres
Southern Red Oak/Heath Forest	18 acres
North Atlantic Low Salt Marsh	10 acres
Pitch Pine Dune Woodland	9 acres
Agricultural Field	6 acres
Other communities/land covers	30 acres

Table 5.100. Northeastern Successional Shrubland has migrated into X or remained since 1954	
X	**Acreage**
Northeastern Old Field	1 acre
Agricultural Field	0.2 acres
Cultivated Lawn	0.2 acres
Beachgrass-Panicgrass Dune Grassland	0.2 acres
Semi-impervious Surface	0.2 acres
Other communities/land covers	0.2 acres



	Cape Point Section	Fort Miles Section	Gordons Pond Section	Great Dune Section	Holland Glade Section	Red Mill Section	Wolfe Neck Section	Cape Henlopen State Park
1954	0	0.4	0	10	8	0.4	115	133.8
2002	1	0	0.1	68	1	0	1	71.1
2007	0.2	0	0.1	1	0.2	0	0.08	1.58

Figure 5.49. Northeastern Successional Shrubland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.101)

Northeastern Successional Shrubland will be completely inundated with 1 m of sea level rise in its current extent.

Table 5.101. Projected acres of Northeastern Successional Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0.1 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 5.102)

Capital for Northeastern Successional Shrubland has been gradually going down as it matures into forested communities or is eliminated.

Table 5.102. Natural Capital of Northeastern Successional Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$19,495/year
2002	$10,359/year
2007	$230/year

***Northern Interdunal Cranberry Swale* [8 acres (Figures 5.50-5.51, Tables 5.103-5.106)] G2G3 S1**

DEWAP: Interdunal Wetlands
NHC: Northern Atlantic Coastal Plain Dune and Swale

Description

Figure 5.50. Northern Interdunal Cranberry Swale (Great Dune Section)

These communities are found mainly in the Great Dune area and north of Fort Miles in seasonally flooded depressions. Cranberry (*Vaccinium macrocarpon*) is the dominant species and is associated by royal fern (*Osmunda regalis*), round-head rush (*Juncus scirpoides*), reed grass (*Phragmites australis*), and switchgrass (*Panicum virgatum*).

Analysis of Condition at Cape Henlopen State Park

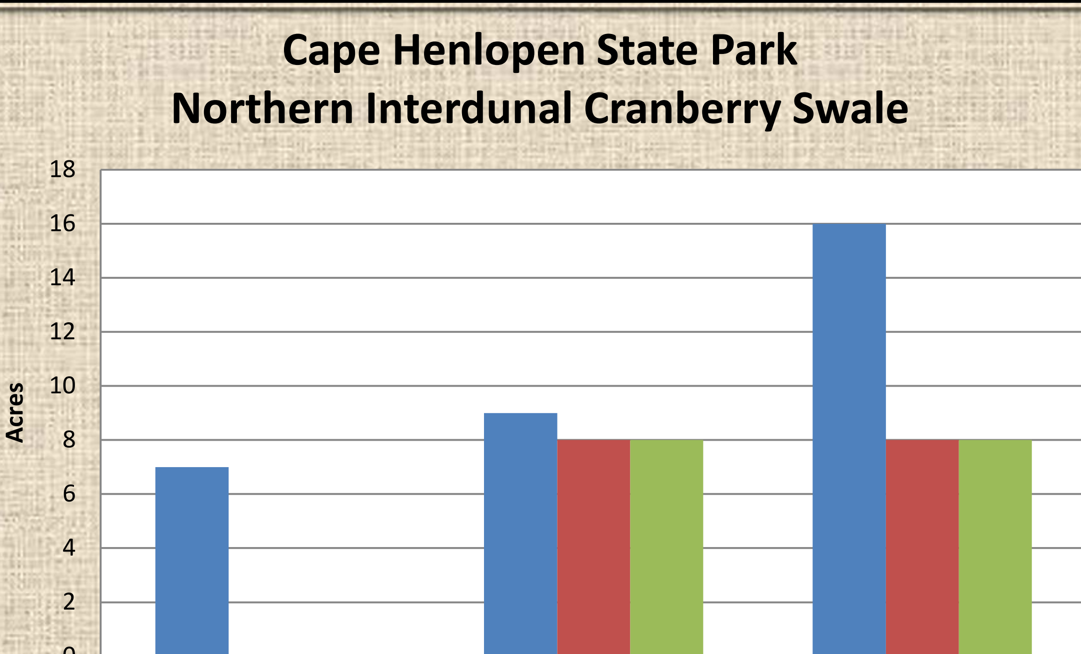
Only about 0.1 acres of the original 16 acres from 1954 still exist in the park and this community has declined by about half to 8 acres in 2007. Of these about 10 acres matured into Pitch Pine Dune Woodland and 3 acres matured into Pitch Pine Lowland. One acre matured into Pitch Pine/Cranberry Interdunal Swale, which is a related community with a pitch pine (*Pinus rigida*) overstory. Another acre went to Chesapeake Bay Tall Maritime Shrubland (Table 5.103).

This community migrated into other areas while it was losing ground including 7 acres of sand and one acre of Beachgrass-Panicgrass Dune Grassland (Table 5.104).

This community appears to be stable in the recent period (2002-2007). It is projected to remain healthy in the short term but eventually it may run out of places to migrate to and loss large amounts of acreage or be eradicated in the long term.

Table 5.103. What was once Northern Cranberry Interdunal Swale in 1954 has become X or remained in 2007	
X	**Acreage**
Pitch Pine Dune Woodland	10 acres
Pitch Pine Lowland	3 acres
Chesapeake Bay Tall Maritime Shrubland	1 acre
Pitch Pine/Cranberry Interdunal Swale	1 acre
Cultivated Lawn	0.4 acres
Other communities/land covers	1 acre

Table 5.104. Northern Cranberry Interdunal Swale has migrated into X or remained since 1954	
X	**Acreage**
Sand	7 acres
Beachgrass-Panicgrass Dune Grassland	1 acre
Northern Cranberry Interdunal Swale	0.1 acres



	Fort Miles Section	Great Dune Section	Cape Henlopen State Park
1954	7	9	16
2002	0	8	8
2007	0	8	8

Figure 5.51. Northern Cranberry Interdunal Swale at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.105)

About half this community will be inundated with 1 m of sea level and it will be completely inundated with 1.5 m of rise.

Table 5.105. Projected acres of Northern Interdunal Cranberry Swale Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	4 acres
1.5 m	8 acres

Natural Capital (Table 5.106)

Capital of Northern Interdunal Cranberry Swale has decreased by half as it matures to forested communities.

Table 5.106. Natural Capital of Northern Interdunal Cranberry Swale	
Year	**Natural Capital (in 2012 dollars)**
1954	$148,502/year
2002	$74,251/year
2007	$74,251/year

***Overwash Dune Grassland* [3 acres (Figure 5.52, Tables 5.107-5.109)] G2G3 S2S3**

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Dune and Swale

Description

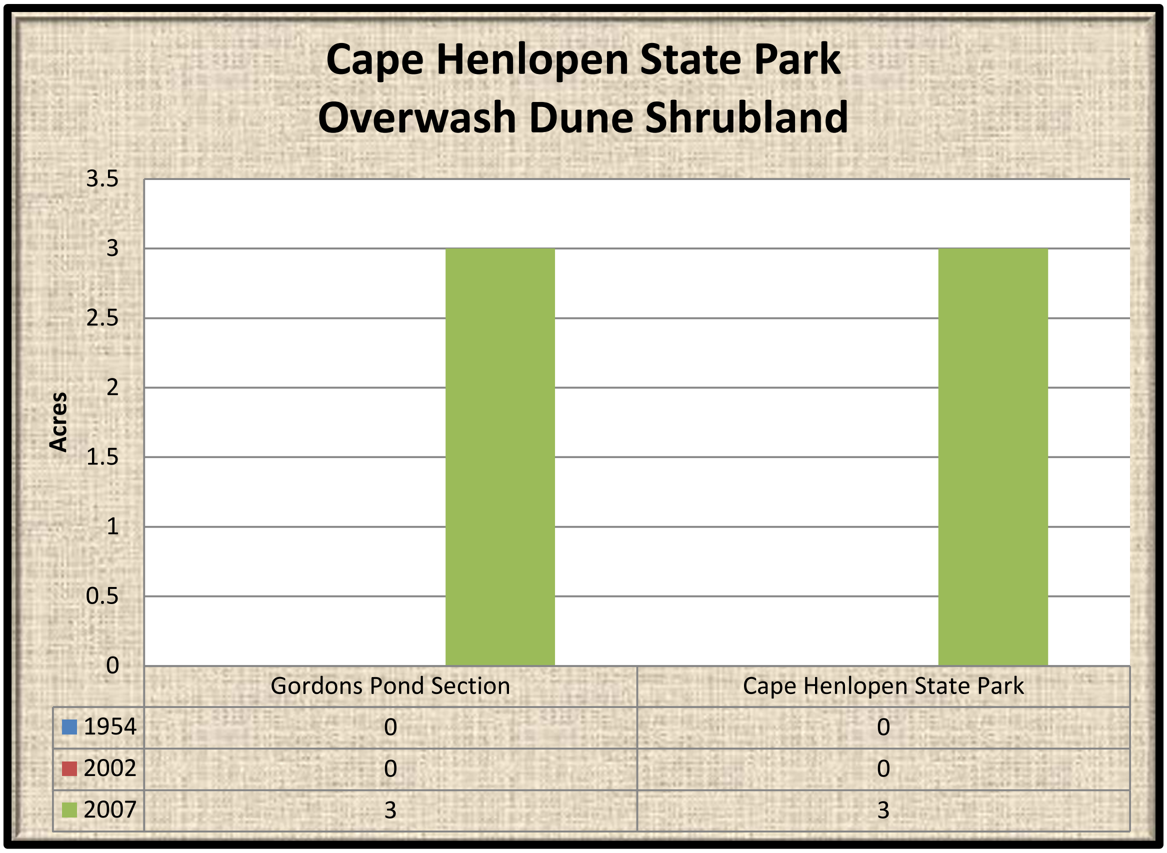
This grassland community is located in the Gordons Pond section in places where the land between Gordons Pond and the Atlantic Ocean has been breached. Most of the community at Gordons Pond resembles a Mid-Atlantic Coast Backdune Grassland with a lot of overwash and bare gravel and sand.

Analysis of Condition at Cape Henlopen State Park

This community comes and goes depending on storms and the availability of habitat and was not discernible present in 1954. Since this time it has come into 3 acres of North Atlantic Low Salt Marsh and 0.1 acres each of Wax-Myrtle Shrub Swamp and North Atlantic High Salt Marsh. It will likely continue this pattern for some time to come (Table 5.107).

Table 5.107. Overwash Dune Grassland has migrated into X or remained since 1954

X	Acreage
North Atlantic Low Salt Marsh	3 acres
Wax-Myrtle Shrub Swamp	0.1 acres
North Atlantic High Salt Marsh	0.1 acres



	Gordons Pond Section	Cape Henlopen State Park
1954	0	0
2002	0	0
2007	3	3

Figure 5.52. Overwash Dune Grassland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.108)

About half this community will be inundated with 1 m of sea level and it will be completely inundated with 1.5 m of rise.

Table 5.108. Projected acres of Overwash Dune Grassland Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	3 acres
1 m	3 acres
1.5 m	3 acres

Natural Capital (Table 5.109)

Overwash Dune Grassland has recently come into the park in the Gordons Pond Section. The capital is a transfer from North Atlantic Low Salt Marsh resulting in a loss for the park.

Table 5.109. Natural Capital of Overwash Dune Grassland	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$0/year (not present)
2007	$437/year

***Pitch Pine Dune Woodland* [911 acres (Figures 5.53-5.54, Tables 5.110-5.113)] G2G3 S1**

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Maritime Forest

Description

This woodland is found through the northern section of the park and is the most common. Pitch pine (*Pinus rigida*) dominates the canopy with a varying amount of loblolly pine (*Pinus taeda*), Virginia pine (*Pinus virginiana*), and hybrid pine mixed in. The understories vary and include wild black cherry (*Prunus serotina*), sassafras (*Sassafras albidum*), southern red oak (*Quercus falcata*), persimmon (*Diospyros virginiana*), eastern red cedar (*Juniperus virginiana*), and southern red oak (*Quercus falcata*). The shrub and vine layer is composed of white-leaf greenbrier (*Smilax glauca*), common greenbrier (*Smilax rotundifolia*), highbush blueberry (*Vaccinium corymbosum*), Pennsylvania bayberry (*Morella heterophylla*), ligustrum (*Ligustrum vulgare*), and laurel leaf greenbrier (*Smilax laurifolia*). Some examples at the northwestern end of the park near the ferry terminal have a coverage of Japanese honeysuckle (*Lonicera japonica*). Herbs are generally scattered in this community, likely owing to the acidity in the needles. Some of the herbs seen include woodland goldenrod (*Solidago caesia*), wintergreen (*Chimaphila maculata*), switchgrass (*Panicum virgatum*), seaside bluestem (*Schizachyrium littorale*), speargrass (*Chasmanthium laxum*), and Eaton's witchgrass (*Panicum spretum*).

Figure 5.53. Pitch Pine Dune Woodland (Great Dune Section)

Analysis of Condition at Cape Henlopen State Park

Pitch Pine Dune Woodland is the largest wooded community in the park and has grown into the fields and grasslands of 1954. This community is dependent on fires and with the absence of fire not much regeneration was observed during the field surveys. The mature pitch pine may survive for some time but controlled burns are needed for its continued survival over the long term.

Of the original 510 acres from 1954, about 396 acres remain with the other areas becoming 35 acres of Coastal Loblolly Pine Wetland Forest, 33 acres of Loblolly Pine Dune Woodland, 14 acres of North Atlantic Low Salt Marsh, and 8 acres of Southern Red Maple-Blackgum Swamp (Table 5.110).

This community has nearly doubled its acreage expanding into 181 acres of Beachgrass-Panicgrass Dune Grassland (the predominant open area in 1954), 118 acres of Northeastern Old Field, 58 acres of sand, and 30 acres of Atlantic Coast Interdune Swale (Table 5.111).

Efforts are underway to begin a program of controlled burns within the park especially in the Gordons Pond area where a lot of this community is converting to loblolly pine types. With these efforts this community will likely be secure in the short and long term future.

Table 5.110. What was once Pitch Pine Dune Woodland in 1954 has become X or remained in 2007	
X	**Acreage**
Pitch Pine Dune Woodland	396 acres
Coastal Loblolly Pine Wetland Forest	35 acres
Loblolly Pine Dune Woodland	33 acres
North Atlantic Low Salt Marsh	14 acres
Southern Red Maple-Blackgum Swamp	8 acres
Other communities/land covers	23 acres

Table 5.111. Pitch Pine Dune Woodland has migrated into X or remained since 1954	
X	**Acreage**
Pitch Pine Dune Woodland	396 acres
Beachgrass-Panicgrass Dune Grassland	181 acres
Northeastern Old Field	118 acres
Sand	58 acres
Atlantic Coast Interdune Swale	30 acres
Other communities/land covers	127 acres

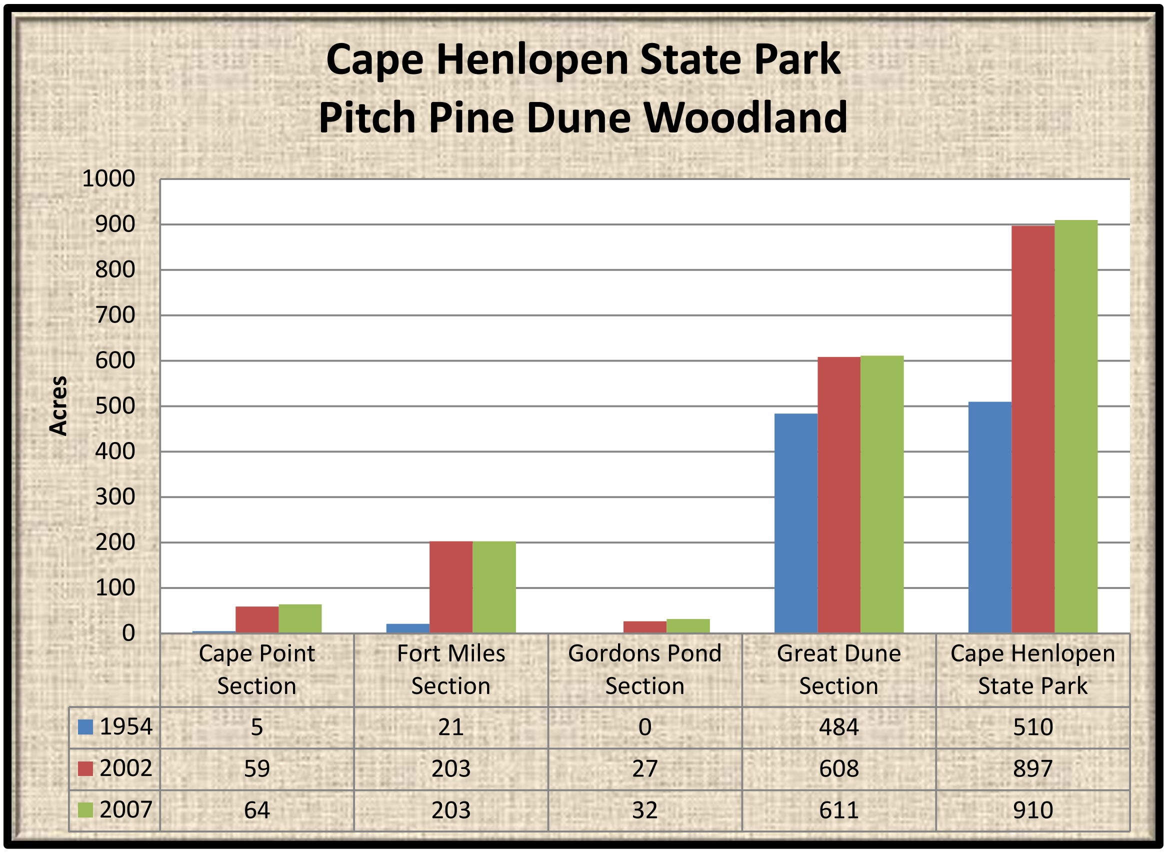


Figure 5.54. Pitch Pine Dune Woodland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.112)

This woodland community will be progressively affected by sea level with most affected happening after 1 m of sea level rise.

Table 5.112. Projected acres of Pitch Pine Dune Woodland Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	230 acres
1 m	538 acres
1.5 m	686 acres

Natural Capital (Table 5.113)

Capital of Pitch Pine Dune Woodland has been gradually going up as more communities mature into it and as it colonizes former open areas.

Table 5.113. Natural Capital of Pitch Pine Dune Woodland	
Year	**Natural Capital (in 2012 dollars)**
1954	$96,441/year
2002	$169,623/year
2007	$172,081/year

Pitch Pine Lowland **[7 acres, (Figures 5.55-5.56, Tables 5.114-5.116)]**

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Pitch Pine Lowland

Description

Figure 5.55. Pitch Pine Lowland (Fort Miles Section)

This community is similar to the Pitch Pine Dune Woodland with the exception of a thick understory of highbush blueberry (*Vaccinium corymbosum*) and other shrubs. Pitch pine (*Pinus rigida*) dominates the canopy overtopping a shrub layer of highbush blueberry, American holly (*Ilex opaca*), northern bayberry (*Morella cerifera*), southern bayberry (*Morella heterophylla*), huckleberry (*Gaylussacia frondosa*), and inkberry (*Ilex glabra*). Northern marsh St. John's Wort (*Triadenum fraseri*) was the only herb noted in this community.

Analysis of Condition at Cape Henlopen State Park

This community was not present as far as can be told in 1954. Since this time it has come about in 3 acres of Northern Cranberry Interdunal Swale, which matured to this community and 2 acres each of Beachgrass-Panicgrass Dune Grassland and sand (Table 5.114).

Like the Pitch Pine Dune Woodland this community requires occasional fire to ensure its continued success. It has been stable in the recent period (2002-2007) and is projected to remain that way over the short term. It is not known what the long term prospects for this community are.

Table 5.114. Pitch Pine Lowland has migrated into X or remained since 1954

X	Acreage
Northern Cranberry Interdunal Swale	3 acres
Beachgrass-Panicgrass Dune Grassland	2 acres
Sand	2 acres
Pitch Pine Dune Woodland	0.1 acres
Semi-impervious Surface	0.1 acres

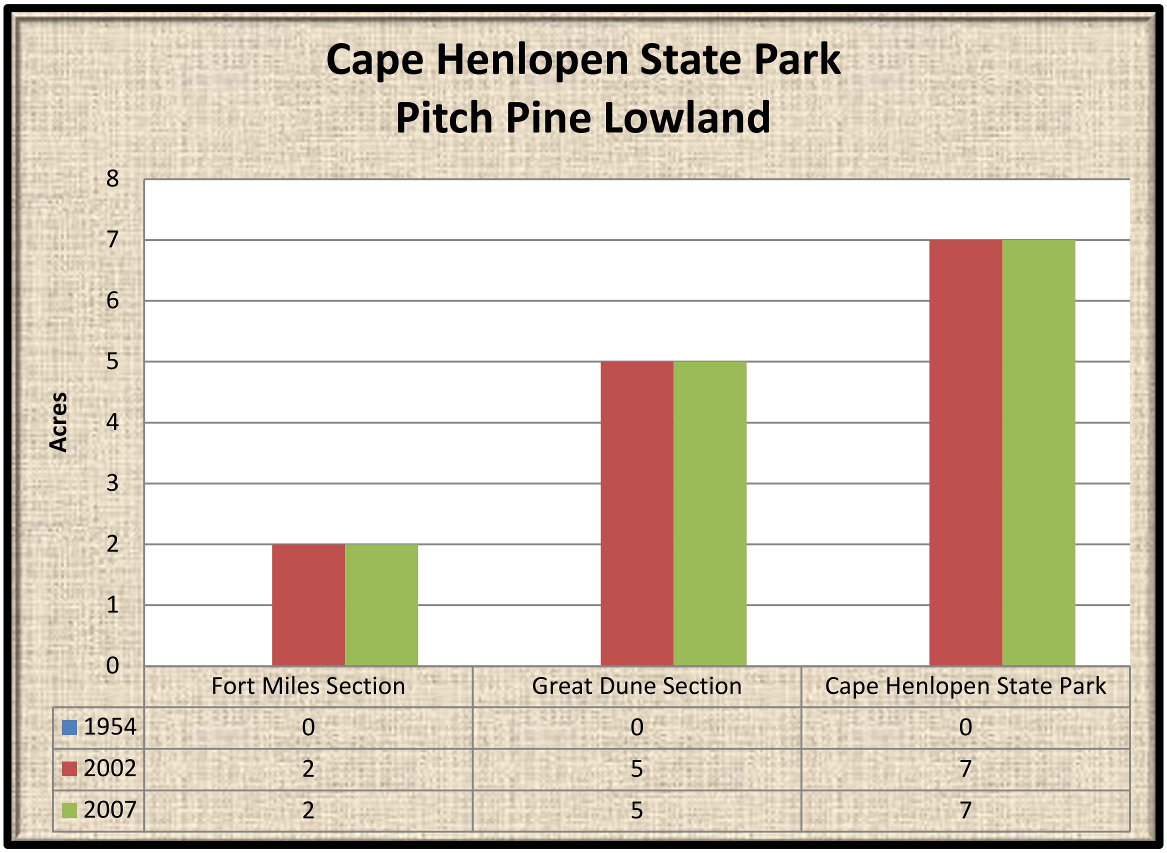


Figure 5.56. Pitch Pine Lowland at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.115)

This community will be completely inundated in its current extent with 1.5 m of sea level rise.

Table 5.115. Projected acres of Pitch Pine Lowland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	5 acres
1.5 m	7 acres

Natural Capital (Table 5.116)

Capital of Pitch Pine Dune Woodland has been gradually going up as more communities mature into it and as it colonizes former open areas.

Table 5.116. Natural Capital of Pitch Pine Lowland	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$1,324/year
2007	$1,324/year

Pitch Pine/Cranberry Interdunal Swale **[1 acre (Figures 5.57-5.58, Tables 5.117-5.119)] GNR S1**

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Dune and Swale

Description

Figure 5.57. Pitch Pine/Cranberry Interdunal Swale (Fort Miles Section)

These depression communities contain a scattered canopy of pitch pine (*Pinus rigida*) that overtops a shrub layer of cranberry (*Vaccinium macrocarpon*), highbush blueberry (*Vaccinium corymbosum*), southern bayberry (*Morella cerifera*), northern bayberry (*Morella pennsylvanica*), and inkberry (*Ilex glabra*). Northern marsh St. John's Wort (*Triadenum fraseri*) was the only herb observed.

Analysis of Condition at Cape Henlopen State Park

This community has formed in depressions north of Fort Miles that were once open land (bare sand) in 1954 converted to Northern Cranberry Interdunal Swale and then matured to this community. A small amount of the community migrated into existing Pitch Pine Dune Woodland which had matured from Northeastern Old Field (Table 5.117).

There are currently several small examples of this community in the park and all are small in size. This community has been stable in the recent period (2002-2007) and is projected to remain so in the short term. It is unknown what the long term prospects are for the community.

Table 5.117. Pitch Pine/Cranberry Interdunal Swale has migrated into X or remained since 1954	
X	**Acreage**
Northern Cranberry Interdunal Swale	1 acre
Pitch Pine Dune Woodland	0.3 acres

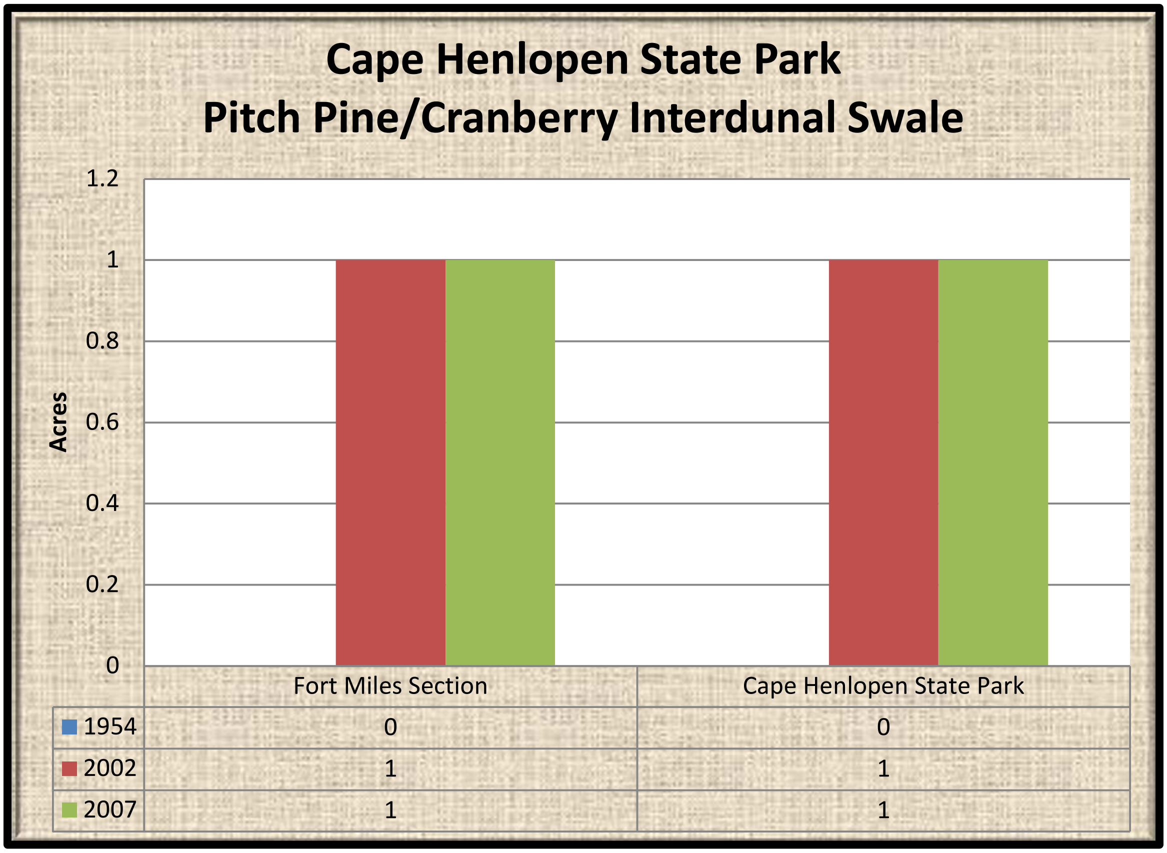


Figure 5.58. Pitch Pine/Cranberry Interdunal Swale at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.118)

Pitch Pine/Cranberry Interdunal Swale will be eliminated in its current extent by 1.5 m of sea level rise.

Table 5.118. Projected acres of Pitch Pine/Cranberry Interdunal Swale Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	0.5 acres
1.5 m	1 acre

Natural Capital (Table 5.119)

One acre of this community has grown into the park raising the overall capital.

Table 5.119. Natural Capital of Pitch Pine/Cranberry Interdunal Swale	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$9,281/year
2007	$9,281/year

***Reed Tidal Marsh* [190 acres (Figures 5.60-5.61, Tables 5.120-5.123)] GNA SNA**

DEWAP: Tidal High Marshes
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Figure 5.60. Reed Tidal Marsh (Great Dune Section)

This marsh community is often found on the edges of marshes throughout the park. Reed grass (*Phragmites australis*) dominates completely or nearly completely in this marsh.

Analysis of Condition at Cape Henlopen State Park

Reed Tidal Marsh expanded in acreage up to 2002 and then decreased in the 2002 to 2007 period with eradication efforts. In spite of this expansion only 7 acres of the original 21 acres from 1954 are still this community. The rest of the original 21 acres converted to North Atlantic Low Salt Marsh (6 acres), water (5 acres), and North Atlantic High Salt Marsh (2 acres) (Table 5.120).

In terms of expansion this community has displaced 38 acres of Irregularly Flooded Eastern Tidal Salt Shrub, 37 acres of Loblolly Pine Dune Woodland, 25 acres of North Atlantic Low Salt Marsh, 15 acres of Northeastern Old Field, and 13 acres of Southern Red Maple-Blackgum Swamp (Table 5.121).

Since this community is composed of an exotic invasive species it is hoped that eradication efforts continue and this community is further reduced.

Table 5.120. What was once Reed Tidal Marsh in 1954 has become X or remained in 2007	
X	**Acreage**
Reed Tidal Marsh	7 acres
North Atlantic Low Salt Marsh	6 acres
Water	5 acres
North Atlantic High Salt Marsh	2 acres
Irregularly Flooded Eastern Tidal Salt Shrub	0.3 acres
Other communities/land covers	0.02 acres

Table 5.121. Reed Tidal Marsh has migrated into X or remained since 1954	
X	**Acreage**
Irregularly Flooded Eastern Tidal Salt Shrub	38 acres
Loblolly Pine Dune Woodland	37 acres
North Atlantic Low Salt Marsh	25 acres
Northeastern Old Field	15 acres
Southern Red Maple-Blackgum Swamp	13 acres
Other communities/land covers	61 acres

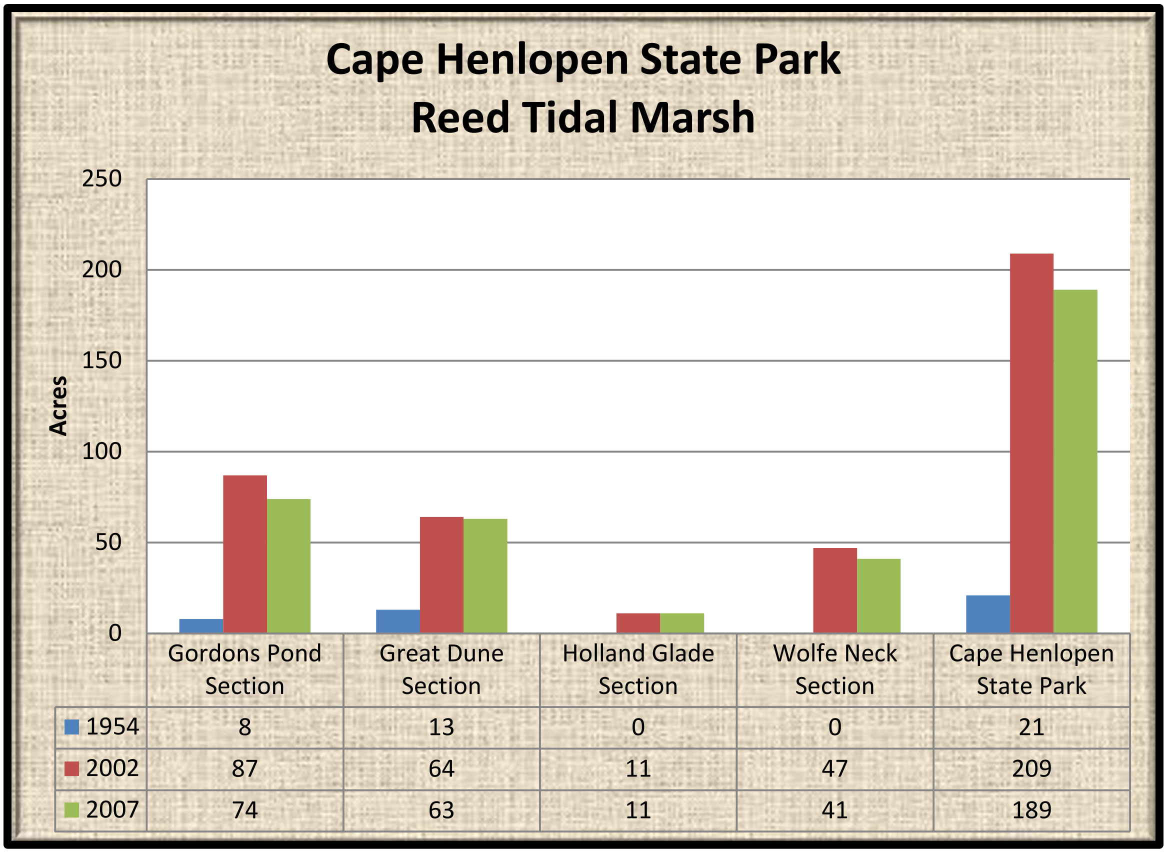


Figure 5.61. Reed Tidal Marsh at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.122)

Reed Tidal Marsh will mostly be inundated with 0.5 m of sea level rise and will be completely inundated with 1 m of rise.

Table 5.122. Projected acres of Reed Tidal Marsh Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	185 acres
1 m	188 acres
1.5 m	188 acres

Natural Capital (Table 5.123)

Reed Tidal Marsh has increased overall since 1954, but has decreased in acreage and capital in the recent period (2002-2007). The recent decrease has transferred capital to more native marshland.

Table 5.123. Natural Capital of Reed Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$131,697/year
2002	$1,310,702/year
2007	$1,185,276/year

***Salt Panne* [14 acres (Figure 5.62, Table 5.124-5.127)]   G5   S3**

DEWAP: Tidal Low Marshes
NHC: Northern Atlantic Coastal Plain Tidal Salt Marsh

Description

Occurrences of this community were obtained through aerial imagery interpretation and therefore there is no direct observation. A typical example of this community contains glasswort (*Salicornia virginica*), and dwarf glasswort (*Salicornia bigelovii*). Associates may include sea lavender (*Limonium carolinianum*) and halbeard-leaf orache (*Atriplex patula*).

Analysis of Condition at Cape Henlopen State Park

Salt pannes tend to come and go in the park as new areas are converted to this community and salt pannes convert to open water. These communities are so ephemeral that none of the original 2 acres from 1954 was still present in 2007 (Table 5.124). Those original acres have been converted to one acre each of North Atlantic Low Salt Marsh and water.

Since 1954 salt pannes have gained in overall acreage, likely a result of the increased water present as these communities can serve as an intermediate step between going from marsh to water. Thirteen acres of North Atlantic Low Salt Marsh have been converted to this community since 1954 along one acre each of Irregularly Flooded Eastern Tidal Salt Shrub and North Atlantic High Salt Marsh (Table 5.125). With more water coming into the system these communities may well continue to increase in amount as the marshes transition to water.

Table 5.124. What was once Salt Panne in 1954 has become X or remained in 2007

X	Acreage
North Atlantic Low Salt Marsh	1 acre
Water	1 acre
Tidal Mudflat	0.3 acres

Table 5.125. Salt Panne has migrated into X or remained since 1954

X	Acreage
North Atlantic Low Salt Marsh	13 acres
Irregularly Flooded Eastern Tidal Salt Shrub	1 acre
North Atlantic High Salt Marsh	1 acre
Water	0.2 acres

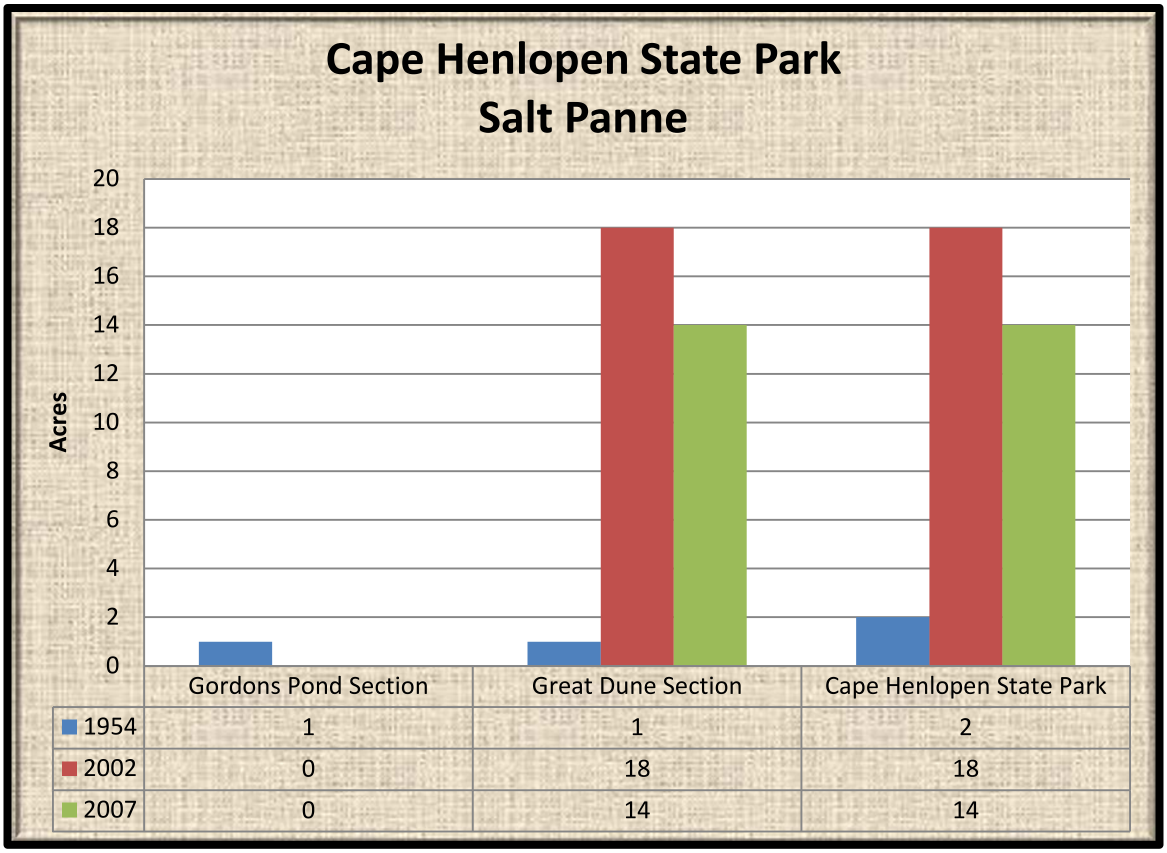


Figure 5.62. Salt Panne at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.126)

Salt Panne will be eliminated at the lowest amount (0.5 m) of sea level rise.

Table 5.126. Projected acres of Salt Panne Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	14 acres
1 m	14 acres
1.5 m	14 acres

Natural Capital (Table 5.127)

Salt Panne has increased overall since 1954, with a recent (2002-2007) decrease. Some of the decrease and development of the salt panne communities may be due to the inundation of the marsh.

Table 5.127. Natural Capital of Salt Panne	
Year	**Natural Capital (in 2012 dollars)**
1954	$12,543/year
2002	$112,883/year
2007	$87,798/year

***Southern Red Maple-Blackgum Swamp* [170 acres (Figures 5.63-5.64, Table 5.128-5.131)]**
G3? S1

DEWAP: Coastal Plain Forested Floodplains and Riparian Swamps
NHC: Northern Atlantic Coastal Plain Stream and River

<u>*Description*</u>

Southern Red Maple-Blackgum Swamps are found in the interior of the pine "arms" east of the marsh and in some of the upper reaches of tributaries in the Wolfe Neck area above Freshwater Tidal Woodlands. Red maple (*Acer rubrum*) is the most prominent canopy species and is associated by a few sweetgum (*Liquidambar styraciflua*), loblolly pine (*Pinus taeda*), and blackgum (*Nyssa sylvatica*). American holly (*Ilex opaca*), sweetbay (*Magnolia virginiana*), persimmon (*Diospyros virginiana*), and water oak (*Quercus nigra*) compose the understory. Common shrubs and vines include highbush blueberry (*Vaccinium corymbosum*), common greenbrier (*Smilax rotundifolia*) that is thick in places, white-leaf greenbrier (*Smilax glauca*), inkberry (*Ilex glabra*), and northern bayberry (*Morella cerifera*). Speargrass (*Chasmanthium laxum*), Eaton's witch grass (*Dichanthelium spretum*), cinnamon fern (*Osmunda cinnamomea*), reed grass (*Phragmites australis*), royal fern (*Osmunda regalis*), sallow sedge (*Carex lurida*), slender blue flag iris (*Iris prismatica*), Atlantic sedge (*Carex atlantica*), netted chainfern (*Woodwardia areolata*), partridgeberry (*Mitchella repens*), weak stellate sedge (*Carex seorsa*), lamp rush (*Scirpus cyperinus*), and wood reed (*Cinna arundinacea*) are some of the herbs in this community.

Figure 5.63. Southern Red Maple-Blackgum Swamp (Holland Glade Section)

<u>*Analysis of Condition at Cape Henlopen State Park*</u>

The acreage of this community has been roughly stable in acreage amount since 1954 with 114 of the original 169 acres remaining in 2007. About 13 acres were converted to Reed Tidal Marsh, 10 acres to Pitch Pine Dune Woodland, 9 acres to Freshwater Tidal Woodland, which is wetter than this community, and 8 acres became Northeastern Modified Successional Forest (Table 5.128).

Since 1954 about 36 acres of Early to Mid-Successional Loblolly Pine Forest has matured into this community, 8 acres of Pitch Pine Dune Woodland were converted to this community likely through increased water, and 8 acres of Northeastern Old Field matured to this community along with one acre of agricultural field (Table 5.129).

This community still has some area to migrate into but it eventually will encounter a barrier at Dune Road. At this point it will likely start to decline in acreage and would be expected in the long term future.

Table 5.128. What was once Southern Red Maple-Blackgum Swamp in 1954 has become X or remained in 2007	
X	**Acreage**
Southern Red Maple-Blackgum Swamp	114 acres
Reed Tidal Marsh	13 acres
Pitch Pine Dune Woodland	10 acres
Freshwater Tidal Woodland	9 acres
Northeastern Modified Successional Forest	8 acres
Other communities/land covers	14 acres

Table 5.129. Southern Red Maple-Blackgum Swamp has migrated into X or remained since 1954	
X	**Acreage**
Southern Red Maple-Blackgum Swamp	114 acres
Early to Mid-Successional Loblolly Pine Forest	36 acres
Pitch Pine Dune Woodland	8 acres
Northeastern Old Field	8 acres
Agricultural Field	1 acre
Other communities/land covers	3 acres

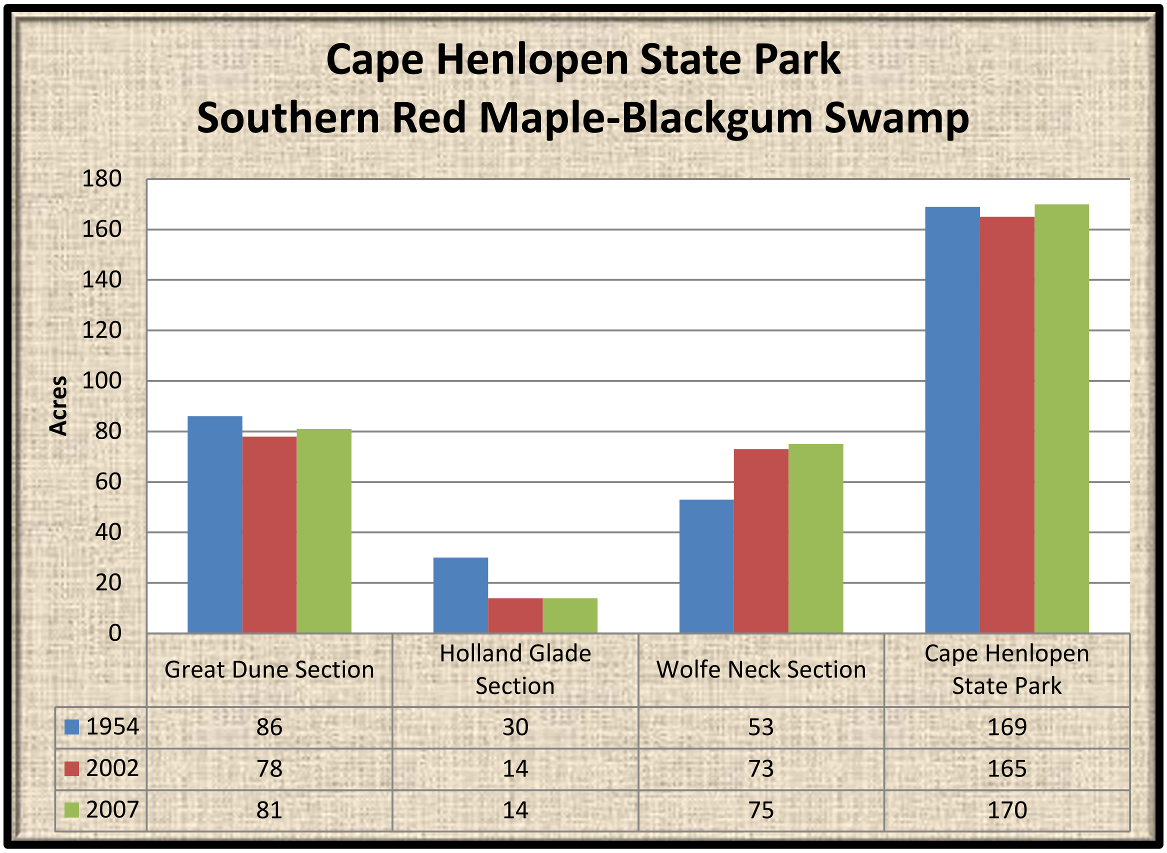


Figure 5.64. Southern Red Maple-Blackgum Swamp at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.130)

Southern Red Maple-Blackgum Swamp is located in places of low elevation and sometimes just above tidal areas. As such it will be heavily impacted by sea level rise. At 1.5 m of sea level rise, nearly 90% of the community will lost. However, this community shows some ability to migrate higher.

Table 5.130. Projected acres of Southern Red Maple-Blackgum Swamp Inundated by Sea Level Rise

Rise	Acres
0.5 m	109 acres
1 m	137 acres
1.5 m	150 acres

Natural Capital (Table 5.131)

This swamp community has gradually been increasing with some losses along the way due to conversion to marsh and woodland. It is unknown what the future prospects of this community are.

Table 5.131. Natural Capital of Southern Red Maple-Blackgum Swamp	
Year	**Natural Capital (in 2012 dollars)**
1954	$2,077,264/year
2002	$2,028,098/year
2007	$2,089,555/year

***Southern Red Oak/Heath Forest* [182 acres (Figures 5.65-5.66, Tables 5.132-5.135)] G4G5 S5**

DEWAP: Coastal Plain Upland Forest
NHC: Northern Atlantic Coastal Plain Hardwood Forest

Description

Figure 5.65. Southern Red Oak/Heath Forest (Holland Glade Section)

This forest community is located in the Wolfe Glade area and has a canopy composed of southern red oak (*Quercus falcata*), red maple (*Acer rubrum*), mockernut hickory (*Carya alba*), and white oak (*Quercus alba*). Smaller members of the canopy plus American holly (*Ilex opaca*) are located in the understory. Lowbush blueberry (*Vaccinium pallidum*) was noted in the understory and thicket sedge (*Carex abscondita*) was the only herb seen.

Analysis of Condition at Cape Henlopen State Park

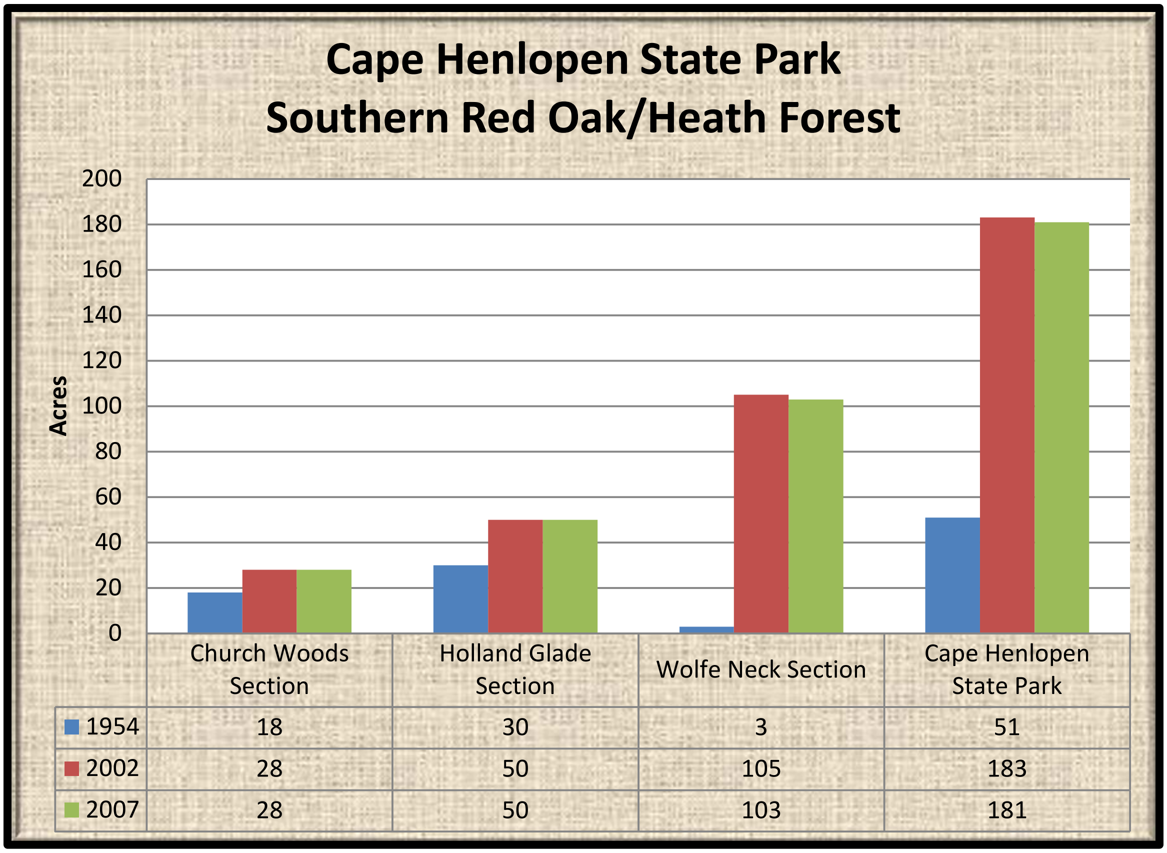
Southern Red Oak/Heath Forest is a relatively long lived forest and could be considered to be a climax forest for the drier more upland areas of the park. Bolstering this assertion is the fact that 50 acres of the original 51 acres from 1954 are still present in 2007. Since 1954 one acre was lost to Semi-impervious Surface (Table 5.132).

Since 1954, this community has greatly increased in acreage with 109 acres of Early to Mid-Successional Loblolly Pine Forest, 18 acres of Northeastern Successional Shrubland, 3 acres of Northeastern Old Field, and one acre of Mid to Late Successional Loblolly Pine-Sweetgum Forest maturing into this community (Table 5.133).

Because of the long-lived nature of this community, its position in upland areas, and protection of the park this community has a secure future through the long term.

Table 5.132. What was once Southern Red Oak/Heath Forest in 1954 has become X or remained in 2007	
X	**Acreage**
Southern Red Oak/Heath Forest	50 acres
Semi-impervious Surface	1 acre
Agricultural Field	0.4 acres
Early to Mid-Successional Loblolly Pine Forest	0.3 acres
Impervious Surface	0.1 acres

Table 5.133. Southern Red Oak/Heath Forest has migrated into X or remained since 1954	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	109 acres
Southern Red Oak/Heath Forest	50 acres
Northeastern Successional Shrubland	18 acres
Northeastern Old Field	3 acres
Mid to Late Successional Loblolly Pine-Sweetgum Forest	1 acre
Other communities/land covers	1 acre



	Church Woods Section	Holland Glade Section	Wolfe Neck Section	Cape Henlopen State Park
1954	18	30	3	51
2002	28	50	105	183
2007	28	50	103	181

Figure 5.66. Southern Red Oak/Heath Forest at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.134)

Southern Red Oak/Heath Forest is located in the higher elevation parts of the park and as such is not affected much by sea level rise. Even with the highest amount of rise (1.5 m), a little more than 10% of the community will be inundated.

Table 5.134. Projected acres of Southern Red Oak/Heath Forest Inundated by Sea Level Rise

Rise	Acres
0.5 m	12 acres
1 m	18 acres
1.5 m	23 acres

Natural Capital (Table 5.135)

Southern Red Oak/Heath Forest has generally been increasing in amount since 1954 as former successional forests mature into it.

Table 5.135. Natural Capital of Southern Red Maple-Blackgum Swamp	
Year	**Natural Capital (in 2012 dollars)**
1954	$9,644/year
2002	$34,605/year
2007	$34,227/year

***Successional Maritime Forest* [44 acres (Figure 5.67, Tables 5.136-5.139)] G2G3 S3**

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Maritime Forest

Description

Successional Maritime Forest is scattered around the park around the edges of marshes and tidal water. Wild black cherry (*Prunus serotina*), sassafras (*Sassafras albidum*), southern red oak (*Quercus falcata*), and red maple (*Acer rubrum*) are often associates in the canopy. The understory contains persimmon (*Diospyros virginiana*), which is characteristic of the community, along with smaller members of the canopy plus American holly (*Ilex opaca*), and serviceberry (*Amelanchier canadensis*). Common greenbrier (*Smilax rotundifolia*) often trails along the ground. Herbs are uncommon and typically include speargrass (*Chasmanthium laxum*) and partridgeberry (*Mitchella repens*).

Analysis of Condition at Cape Henlopen State Park

Successional Maritime Forest located at forest interface of shrubland and marsh along the coast. As such it is an ephemeral forest community that is subjected to continual change, flooding, and exposure to the elements. Only 20 acres of the original 57 in 1954 were still present in 2007. Since 1954 13 acres have converted to Reed Tidal Marsh, 10 acres to North Atlantic Low Salt Marsh, and 4 acres each went to Northeastern Modified Successional Forest and water (Table 5.136).

While experiencing a decline in acreage since 1954 this community this managed to colonize new ground. About 4 acres each of Northeastern Old Field and Northeastern Successional Shrubland, and 3 acres of Beachgrass-Panicgrass Dune Grassland matured into this community. Three acres of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland converted to this community likely as a result of the pine dying out (Table 5.137).

With increasing rates of sea level rise this community will likely continue to experience declines. It may be present in short term future but the long term prospects are not as good.

Table 5.136. What was once Successional Maritime Forest in 1954 has become X or remained in 2007

X	**Acreage**
Successional Maritime Forest	20 acres
Reed Tidal Marsh	13 acres
North Atlantic Low Salt Marsh	10 acres
Northeastern Modified Successional Forest	4 acres
Water	4 acres
Other communities/land covers	5 acres

Table 5.137. Successional Maritime Forest has migrated into X or remained since 1954	
X	**Acreage**
Successional Maritime Forest	20 acres
Northeastern Old Field	4 acres
Northeastern Successional Shrubland	4 acres
Beachgrass-Panicgrass Dune Grassland	3 acres
Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	3 acres
Other communities/land covers	10 acres

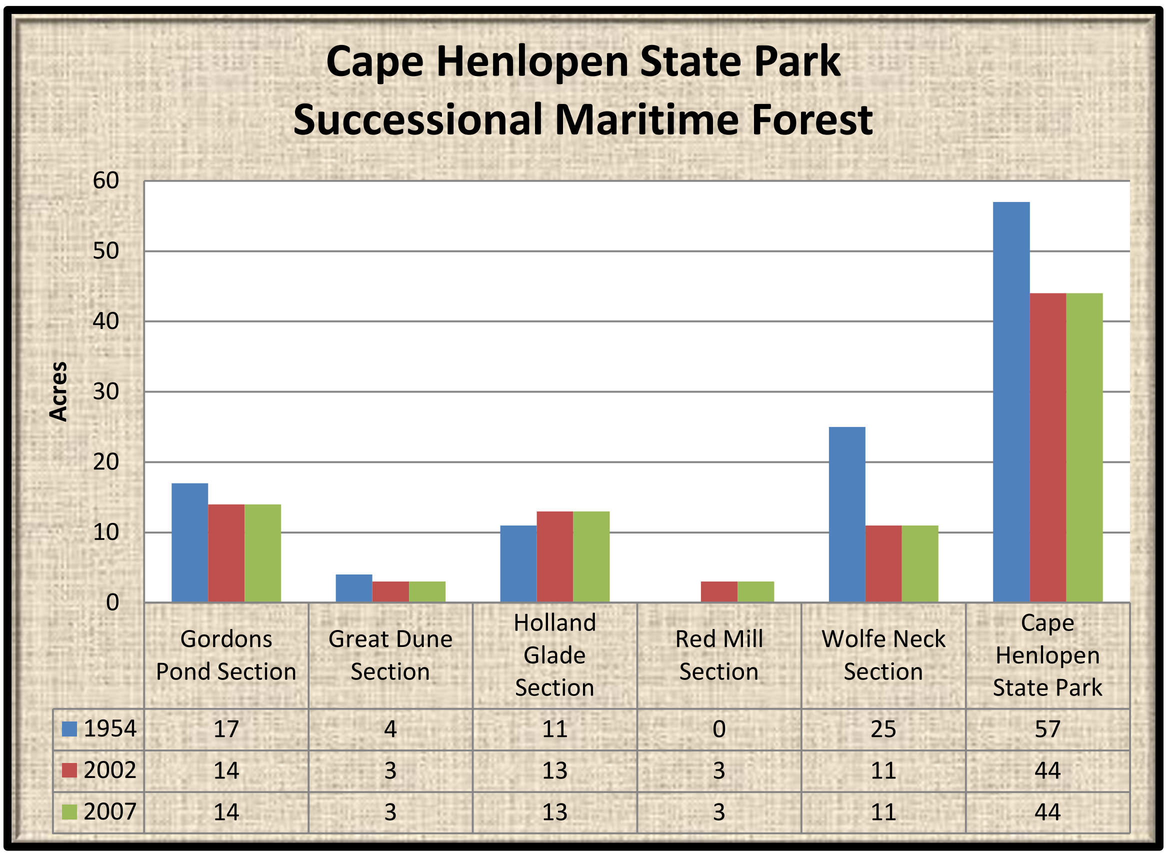


Figure 5.67. Successional Maritime Forest at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.138)

Successional Maritime Forest is located close to the edge of the tidal marsh and at low elevation. While not completely flooded at the highest sea level rise it is greatly impacted.

Table 5.138. Projected acres of Successional Maritime Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	31 acres
1 m	37 acres
1.5 m	38 acres

Natural Capital (Table 5.139)

Some of what was once Successional Maritime Forest has converted to Reed Tidal Marsh showing the progression of this community to marsh. The capital of the community was transferred to the marsh community.

Table 5.139. Natural Capital of Successional Maritime Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$10,779/year
2002	$8,320/year
2007	$8,320/year

***Successional Tuliptree Forest* [14 acres (Figures 5.68-5.69, Tables 5.140-5.142)] GNA SNA**

DEWAP: Coastal Plain Upland Forest
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Figure 5.68. Successional Tuliptree Forest (Wolfe Neck Section)

Successional Tuliptree Forest is located in the upper end of Wolfe Glade north of Wolfe Neck Road. Tuliptree (*Liriodendron tulipifera*) is the dominant species and is associated by red maple (*Acer rubrum*). No other layers were noted in this community and could be due to the density of the stems.

Analysis of Condition at Cape Henlopen State Park

This community was not present in 1954 and has since come about in the park as 11 acres of Early to Mid-Successional Loblolly Pine Forest and 3 acres of Mid to Late Successional Loblolly Pine-Sweetgum Forest matured to it. About one acre of agricultural field became this community (Table 5.140).

This community appears to be expanding in the short term but it will eventually transition to another community as it matures. Aggressive management of exotic invasive plant species can keep this community from becoming Northeastern Modified Successional Forest, a community that this type is prone to become.

Table 5.140. Successional Tuliptree Forest has migrated into X or remained since 1954

X	Acreage
Early to Mid-Successional Loblolly Pine Forest	11 acres
Mid to Late Successional Loblolly Pine-Sweetgum Forest	3 acres
Agricultural Field	1 acre

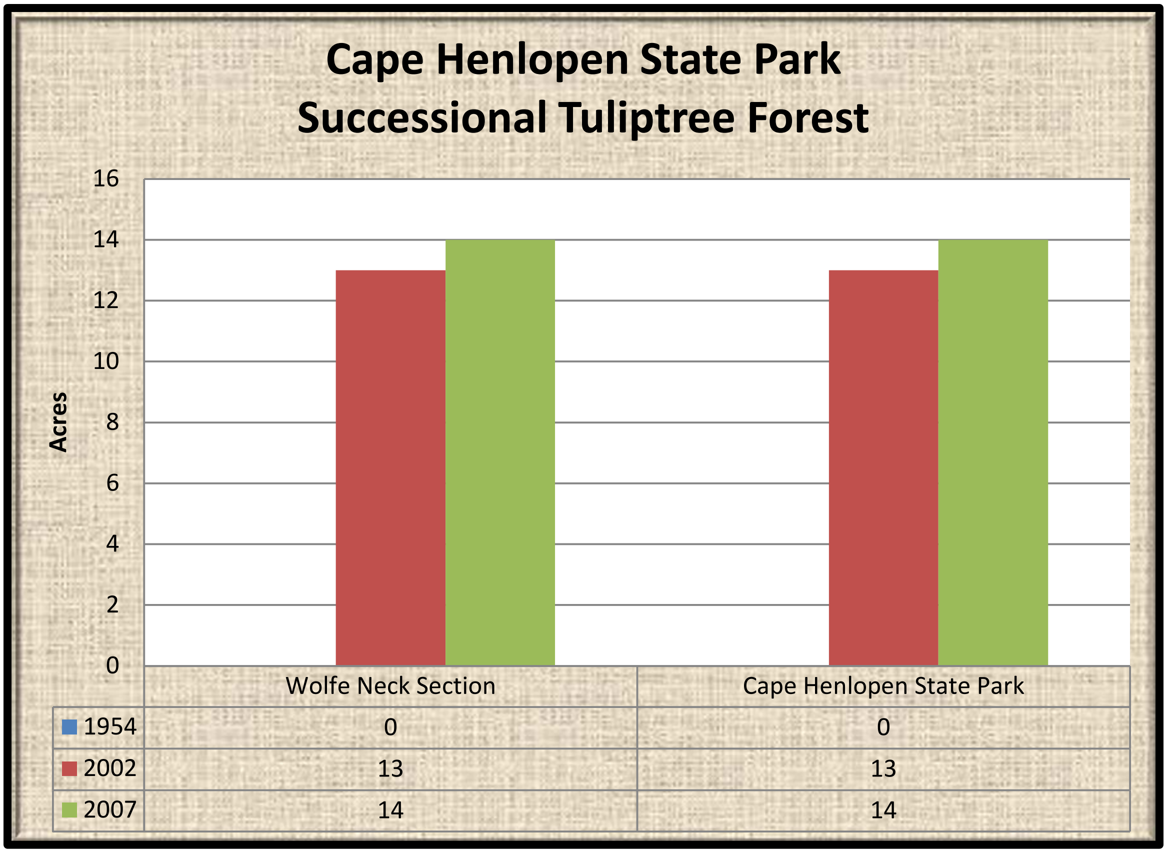


Figure 5.69. Successional Tuliptree Forest at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.141)

The occurrences of this community are located adjacent to an agricultural field in a place of high elevation. At 0.5 m of sea level rise, this community will not be affected and will only have 2 acres flooded with 1.5 m of sea level rise.

Table 5.141. Projected acres of Successional Tuliptree Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0.3 acres
1.5 m	2 acres

Natural Capital (Table 5.142)

This community has been gradually increasing in capital as more fields grow into forests.

Table 5.142. Natural Capital of Successional Tuliptree Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$2,458/year
2007	$2,647/year

***Virginia Pine Successional Forest* [5 acres (Figures 5.70-5.71, Tables 5.143-5.145)] GNA SNA**

DEWAP: Coastal Plain Upland Forest
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Virginia Pine Successional Forest is scattered in small amount around the park. The prominent location is an old sandpit area at the south end of Wolfe Neck. Virginia pine (*Pinus virginiana*) dominates the canopy and is associated by sassafras (*Sassafras albidum*), pitch pine (*Pinus rigida*), and loblolly pine (*Pinus taeda*). The understory is composed of the smaller members of the canopy in the sandpit location and wild black cherry (*Prunus serotina*), eastern red cedar (*Juniperus virginiana*), southern red oak (*Quercus falcata*) at other locations. Southern bayberry (*Morella heterophylla*) was the only shrub noted and switchgrass (*Panicum virgatum*) was the only herb noted in this community.

Figure 5.70. Virginia Pine Successional Forest (Wolfe Neck Section)

Analysis of Condition at Cape Henlopen State Park

Virginia Pine Successional Forest was not present as far as can told in 1954. Arising from an old sandpit and from 5 acres of matured Northeastern Successional Shrubland, this community has come into the park since 1954 (Table 5.143). Given the age of the community and the xeric conditions it is growing in, it will likely be present in the short term future and partially into the long term. Eventually it may mature into a Southern Red Oak/Heath Forest.

Table 5.143. Virginia Pine Successional Forest has migrated into X or remained since 1954

X	Acreage
Northeastern Successional Shrubland	5 acres
Forked Rush Dune Swale	0.1 acres
Sand	0.1 acres

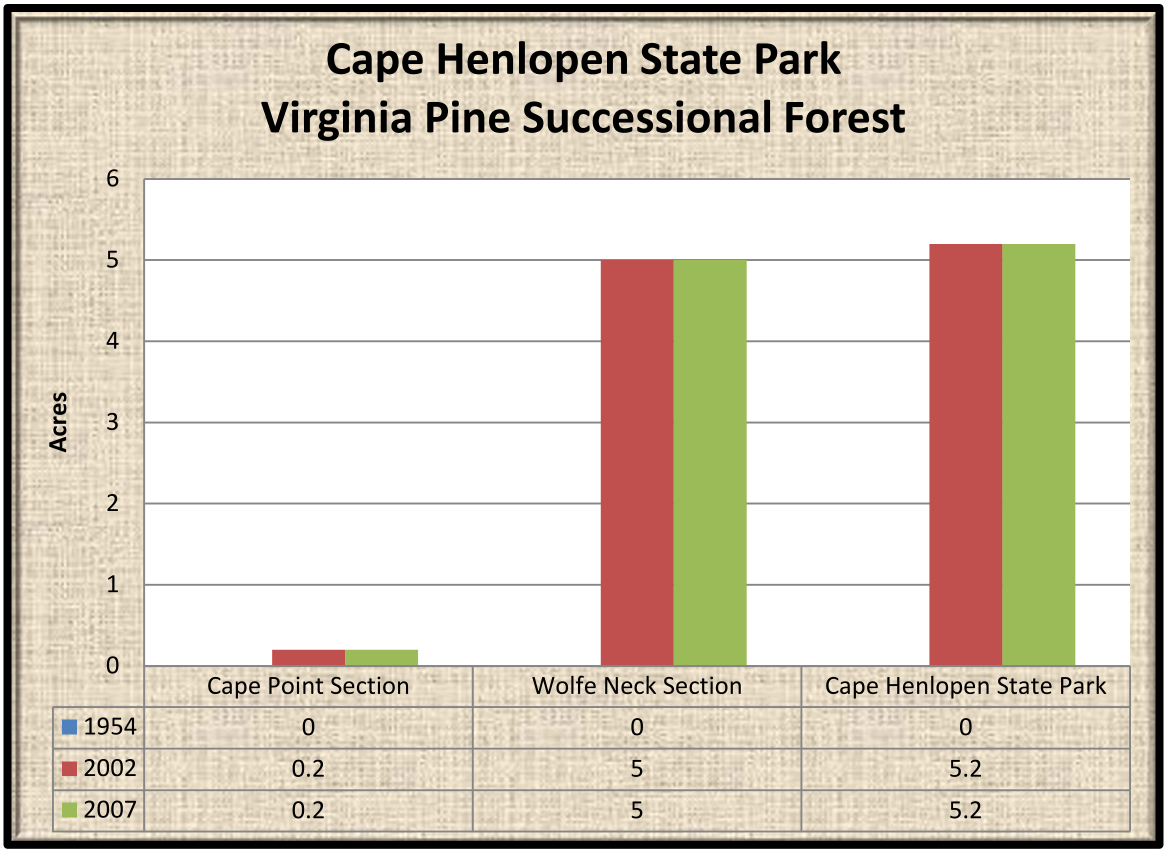


Figure 5.71. Virginia Pine Successional Forest at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.144)

This community is mostly located in an old sandpit that is protected from sea level rise. A little less than half of this community will be affected by sea level rise in its greatest extent.

Table 5.144. Projected acres of Virginia Pine Successional Forest Inundated by Sea Level Rise

Rise	Acres
0.5 m	0.02 acres
1 m	1 acre
1.5 m	2 acres

Natural Capital (Table 5.145)

Virginia Pine Successional Forest does not have much capital and has been stable in the recent period (2002-2007). When it grew into the sandpit it increased the overall capital for the park.

Table 5.145. Natural Capital of Virginia Pine Successional Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	\$0/year (not present)
2002	\$983/year
2007	\$983/year

***Wax-Myrtle Shrub Swamp* [10 acres (Figures 5.72-5.73, Tables 5.146-5.149)] G2G3 S2**

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Plain Dune and Swale

Description

Figure 5.72. Wax-Myrtle Shrub Swamp (Wolfe Neck Section)

Wax-myrtle Shrub Swamp is often found at the interface between brackish marshes and fresher to fresh tributaries. Northern bayberry (*Morella cerifera*) is the dominant species if not the only species in this community.

Analysis of Condition at Cape Henlopen State Park

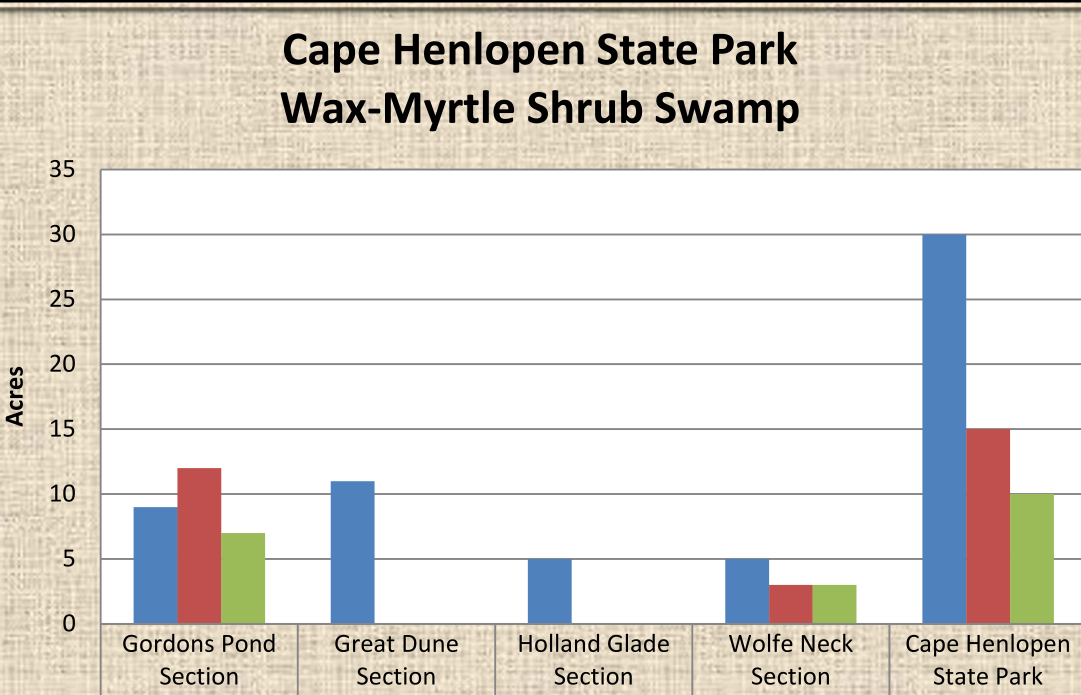
Wax-Myrtle Shrub Swamp is another ephemeral type shrubland, at least in maritime areas, with only one acre present in 2007 of the original 30 acres in 1954. Since 1954, 13 acres have converted to North Atlantic Low Salt Marsh, 7 acres to Reed Tidal Marsh, 3 acres to Beachgrass-Panicgrass Dune Grassland, likely as a result of sand covering the shrubland. Two acres and one acre matured to Mid to Late Successional Loblolly Pine-Sweetgum Forest and Pitch Pine Dune Woodland, respectively (Table 5.146).

In spite of this community's declines since 1954 it has managed to migrate into some other habitats including 3 acres of North Atlantic Low Salt Marsh at Gordons Pond, 2 acres of Northeastern Successional Shrubland, and one acre each of Atlantic Coast Interdune Swale, Irregularly Flooded Eastern Tidal Shrubland, and Loblolly Pine Dune Woodland (Table 5.147).

This community experience declines throughout the study period and does not appear to be spreading much. While it may be present in the short term it may fade out in the long term future.

Table 5.146. What was once Wax-Myrtle Shrub Swamp in 1954 has become X or remained in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	13 acres
Reed Tidal Marsh	7 acres
Beachgrass-Panicgrass Dune Grassland	3 acres
Mid to Late Successional Loblolly Pine-Sweetgum Forest	2 acres
Pitch Pine Dune Woodland	1 acre
Other communities/land covers	4 acres

Table 5.147. Wax-Myrtle Shrub Swamp has migrated into X or remained since 1954	
X	**Acreage**
North Atlantic Low Salt Marsh	3 acres
Northeastern Successional Shrubland	2 acres
Atlantic Coast Interdune Swale	1 acre
Irregularly Flooded Tidal Salt Shrub	1 acre
Loblolly Pine Dune Woodland	1 acre
Other communities/land covers	2 acres



	Gordons Pond Section	Great Dune Section	Holland Glade Section	Wolfe Neck Section	Cape Henlopen State Park
1954	9	11	5	5	30
2002	12	0	0	3	15
2007	7	0	0	3	10

Table 4.112. Wax-Myrtle Shrub Swamp at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.148)

Wax-Myrtle Shrub Swamp will be eliminated with 1 m of sea level rise in its current extent.

Table 5.148. Projected acres of Wax-Myrtle Shrub Swamp Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	9 acres
1 m	10 acres
1.5 m	10 acres

Natural Capital (Table 5.149)

Wax-Myrtle Shrub Swamp has been gradually decreasing in acreage and transferring its capital to marsh. This trend will likely continue with sea level rise rates increasing.

Table 5.149. Natural Capital of Wax-Myrtle Shrub Swamp	
Year	**Natural Capital (in 2012 dollars)**
1954	$278,442/year
2002	$139,221/year
2007	$92,814/year

CHAPTER 6: DESCRIPTIONS AND ANALYSIS OF THE LAND COVERS

Twelve land covers were noted during the survey. Land covers are those areas such as agricultural fields or places that do not contain vegetation communities but still cover ground surface. In terms of sea-level rise, water is most important but it effects can also be seen in the impoundments.

The land covers include:

1. Agricultural Field—759 acres
2. Beach—131 acres
3. Clear-cut—0.4 acres
4. Farm Pond/Artificial Pond—1 acres
5. Impervious Surface—83 acres
6. Modified Land—7 acres
7. Powerline R-O-W—5 acres
8. Riprap—0.1 acres
9. Sand—154 acres
10. Semi-impervious Surface—16 acres
11. Tidal Mudflat—4 acres
12. Water—390 acres

***Agricultural Field* [759 acres, (Figure 6.1, Tables 6.1-6.4)]**

Description

All of the agricultural fields in the park are found in the Wolfe Neck and Holland Glade sections. This land cover is composed of row crops namely corn and soybeans.

Analysis of Condition at Cape Henlopen State Park

A few large agricultural fields are present in the western sections (Holland Glade and Wolfe Neck). About 727 acres of the original 776 acres from 1954 are still in agricultural use. Since 1954 some of the acreage has been converted to other uses including 13 acres of cultivated lawn, 8 acres each of Northeastern Modified Successional Forest and Northeastern Old Field, and 5 acres of Semi-impervious Surface (Table 6.1).

While some of the previous agricultural fields have been taken out of use some new fields were developed from 13 acres of Early to Mid-Successional Loblolly Pine Forest, 6 acres of Northeastern Successional Shrubland, 3 acres of Semi-impervious Surface, and 3 acres of Mid to Late Successional Loblolly Pine-Sweetgum Forest since 1954 (Table 6.2).

Agricultural Fields are a man-made created land cover and are not subject to natural succession except when taken out of use. Since agriculture is vital to the economy and the fact that most of the fields are in upland areas these fields will likely be around through the long term future.

Table 6.1. What was once Agricultural Field in 1954 has become X or remained in 2007

X	Acreage
Agricultural Field	727 acres
Cultivated Lawn	13 acres
Northeastern Modified Successional Forest	8 acres
Northeastern Old Field	8 acres
Semi-impervious Surface	5 acres
Other communities/land covers	15 acres

Table 6.2. Agricultural Field has migrated into X or remained since 1954	
X	**Acreage**
Agricultural Field	727 acres
Early to Mid-Successional Loblolly Pine Forest	13 acres
Northeastern Successional Shrubland	6 acres
Semi-impervious Surface	3 acres
Mid to Late Successional Loblolly Pine-Sweetgum Forest	3 acres
Other communities/land covers	7 acres

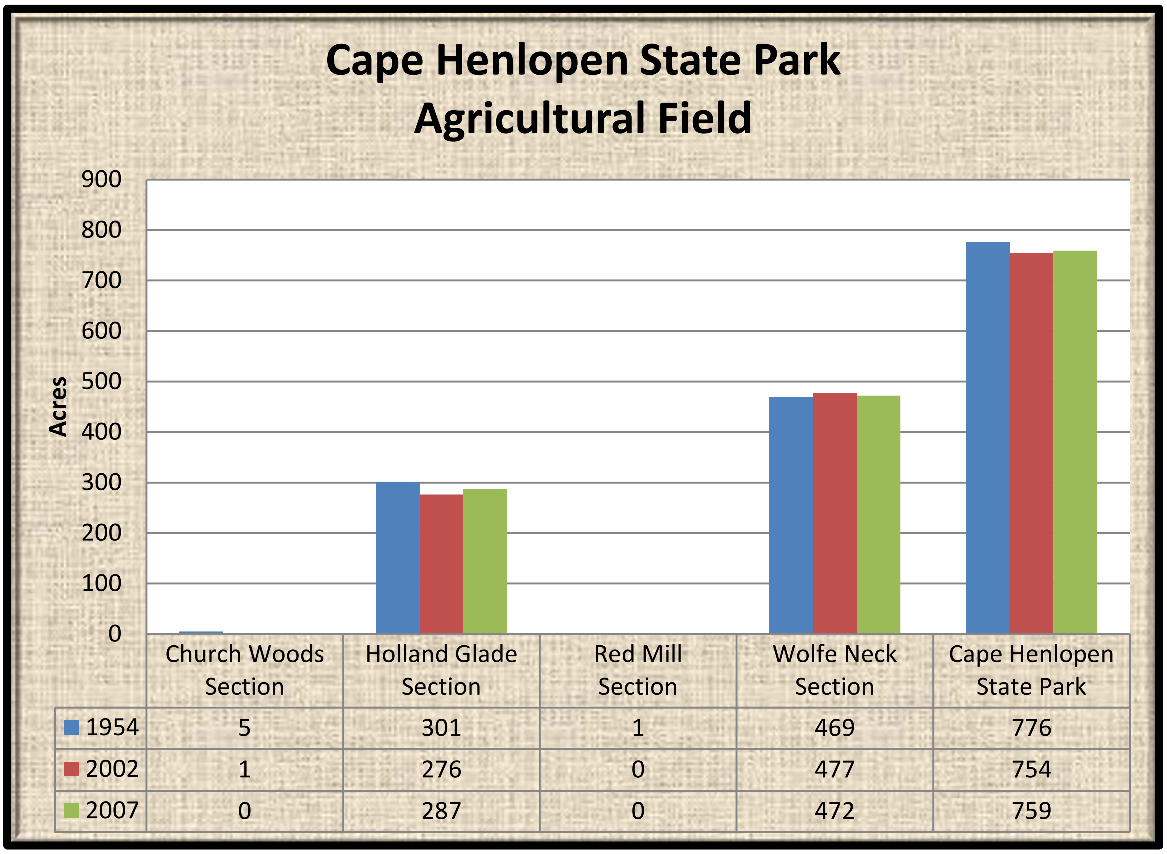


Figure 6.1. Agriculture Field at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.3)

Most of the agricultural fields in the park are located in places of higher elevation giving a low exposure to sea level rise.

Table 6.3. Projected acres of Agricultural Field Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0.2 acres
1 m	3 acres
1.5 m	12 acres

Natural Capital (Table 6.4)

Agricultural Field is one of three land covers with any capital value. The values have been roughly stable as most of the agricultural fields have stayed in service.

Table 6.4. Natural Capital of Agricultural Field	
Year	**Natural Capital (in 2012 dollars)**
1954	$44,504/year
2002	$43,242/year
2007	$43,529/year

Beach **[131 acres (Figure 6.2, Tables 6.5-6.7)]**

Description

This land cover includes those places between the dunes and the water of the bay or ocean.

Analysis of Condition at Cape Henlopen State Park

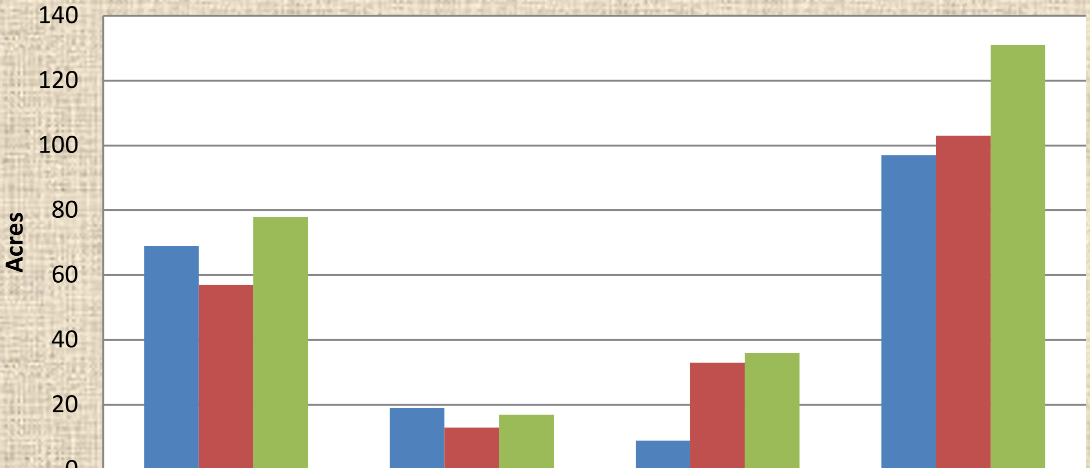
About 50 acres of the original 97 acres of beach from 1954 still exists. The rest have converted to water (15 acres), Beachgrass-Panicgrass Dune Grassland (14 acres), sand (10 acres), and impervious surface (3 acres) in the form of a parking lot (Table 6.5).

Beach has increased in acreage since 1954 largely due to renourishment projects happening to the south of the park in Rehoboth Beach, De. Showing the encroachment of the ocean landward, about 38 acres of Beachgrass-Panicgrass Dune Grassland has converted to beach since 1954. Twenty-eight acres of the beach has become water largely through erosion. Seven acres of Forked Rush Dune Swale has become beach area along with 6 acres of Atlantic Coast Interdune Swale (Table 6.6).

Beach area has been increasing as nourishment sand from southern beaches moves north. This has also caused the Cape to increase in area over the years. The renourishment of the beach will likely continue for some time to come.

Table 6.5. What was once Beach in 1954 has become X or remained in 2007	
X	**Acreage**
Beach	50 acres
Water	15 acres
Beachgrass-Panicgrass Dune Grassland	14 acres
Sand	10 acres
Impervious Surface	3 acres
Other communities/land covers	5 acres

Table 6.6. Beach has migrated into X or remained since 1954	
X	**Acreage**
Beach	50 acres
Beachgrass-Panicgrass Dune Grassland	38 acres
Water	28 acres
Forked Rush Dune Swale	7 acres
Atlantic Coast Interdune Swale	6 acres
Other communities/land covers	1 acre



	Cape Point Section	Fort Miles Section	Gordons Pond Section	Cape Henlopen State Park
1954	69	19	9	97
2002	57	13	33	103
2007	78	17	36	131

Figure 6.2. Beach at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.7)

Most of the agricultural fields in the park are located in places of higher elevation giving a low exposure to sea level rise.

Table 6.7. Projected acres of Beach Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	33 acres
1 m	72 acres
1.5 m	87 acres

Natural Capital

Beach does not have any natural capital associated with it.

***Clear-cut* [0.4 acres (Figure 6.3, Table 6.8)]**

Description

One small clear-cut is located in the Wolfe Neck section of the park.

Analysis of Condition at Cape Henlopen State Park

This clear-cut has only come about recently and is not likely to persist as it matures into an older forest. Because of the small size no trends and given for it since it will not persist.

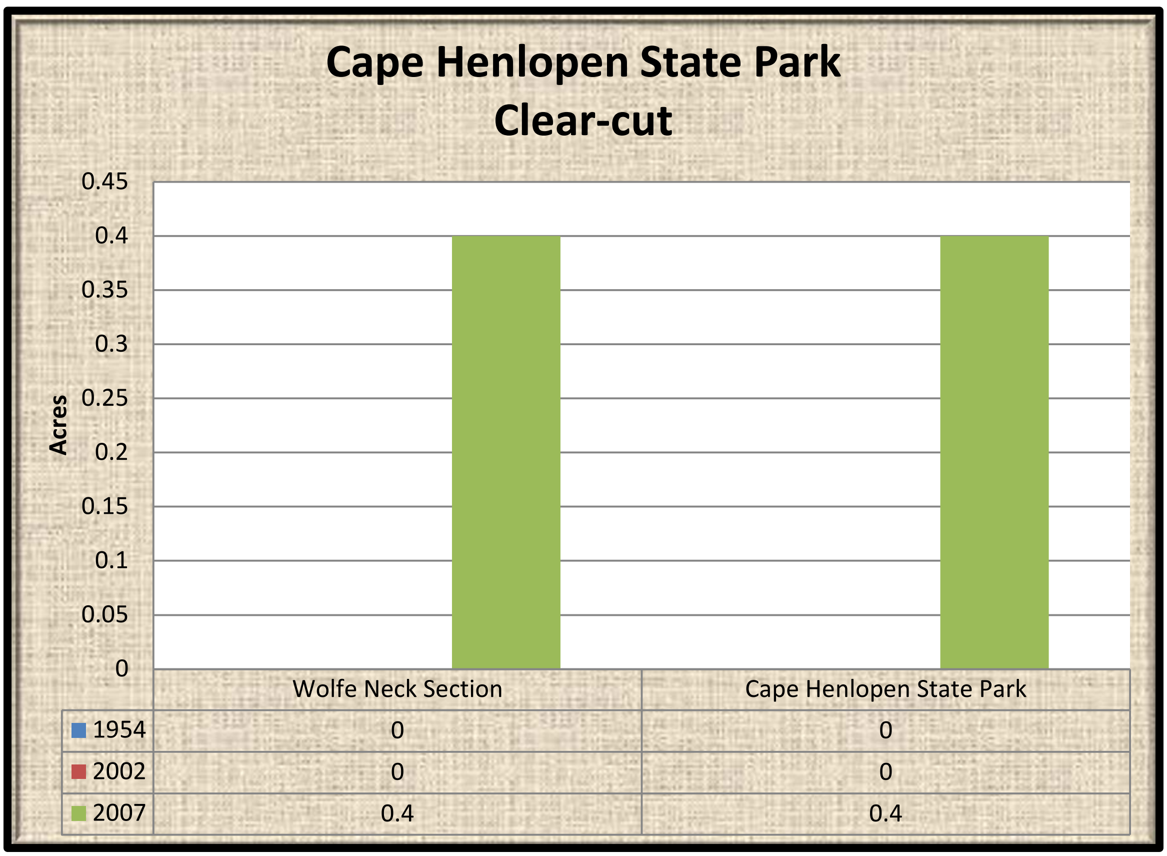


Figure 6.3. Clear-cut at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.8)

The clear-cut area will have very little area affected by sea level rise at the highest level.

Table 6.8. Projected acres of Clear-cut Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	0.02 acres

Natural Capital

The clear-cut area does not have any natural capital value.

***Farm Pond/Artificial Pond* [1 acre (Figure 6.4, Tables 6.9-6.10)]**

Description

This land cover includes water bodies that are less than 5 acres in size. One of the ponds present in the Great Dune Section contains cranberry (*Vaccinium macrocarpon*).

Analysis of Condition at Cape Henlopen State Park

There are only a few ponds present in the park. Both of the ponds present in the park have come about since 1954 and are not increasing in size. They all originate from Northeastern Old Field present in 1954 (Table 6.9).

Table 6.9. Farm Pond/Artificial Pond has migrated into X or remained since 1954	
X	**Acreage**
Northeastern Old Field	1 acre

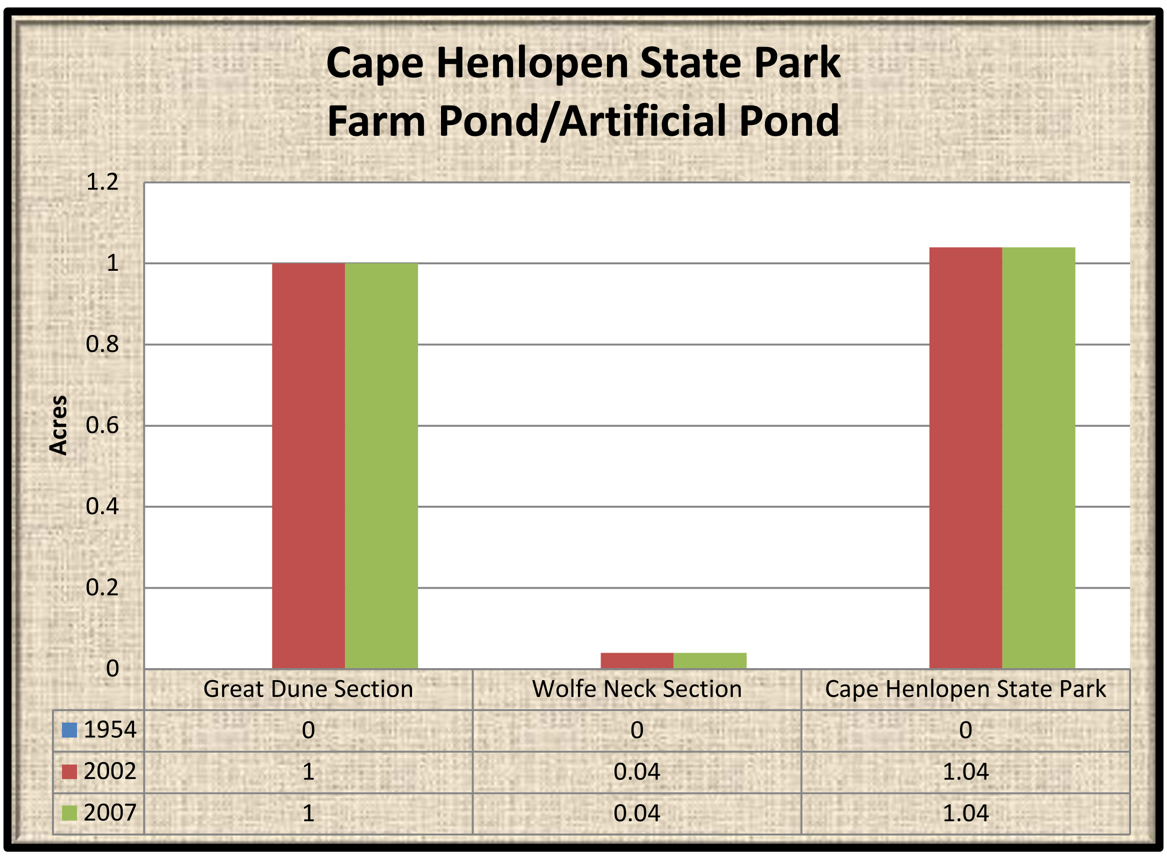


Figure 6.4. Farm Pond/Artificial Pond at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.10)

The ponds in Cape Henlopen State Park will be "captured" with 1 m of sea level rise.

Table 6.10. Projected acres of Farm Pond/Artificial Pond Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 6.11)

Farm Pond/Artificial Pond has a small capital value because there is not much acreage. It has remained at the same acreage in the recent (2002-2007) period.

Table 6.11. Natural Capital of Farm Pond/Artificial Pond	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$5,549/year
2007	$5,549/year

***Impervious Surface* [83 acres, (Figure 6.5, Tables 6.12-6.14)]**

Description

This land cover includes those areas that are impervious to the flow of water. They are most often the result of development as buildings, parking lots, or roads.

Analysis of Condition at Cape Henlopen State Park

In spite of the some of the US Army installation reverting back to natural uses the amount of the impervious surface has increased greatly since 1954. About 11 acres of the original 29 acres present in 1954 still exists. The rest of the former impervious surface has become 6 acres of cultivated lawn, 4 acres of Pitch Pine Dune Woodland, and one acre each of Agricultural field and Beachgrass-Panicgrass Dune Grassland (Table 6.12).

Since 1954 Impervious surface has covered over an increasing amount of area including 22 acres of Beachgrass-Panicgrass Dune Grassland, 14 acres of Semi-impervious surface which are mainly from dirt roads being paved, 11 acres of Northeastern Old Field, and 4 acres of cultivated lawn (Table 6.13).

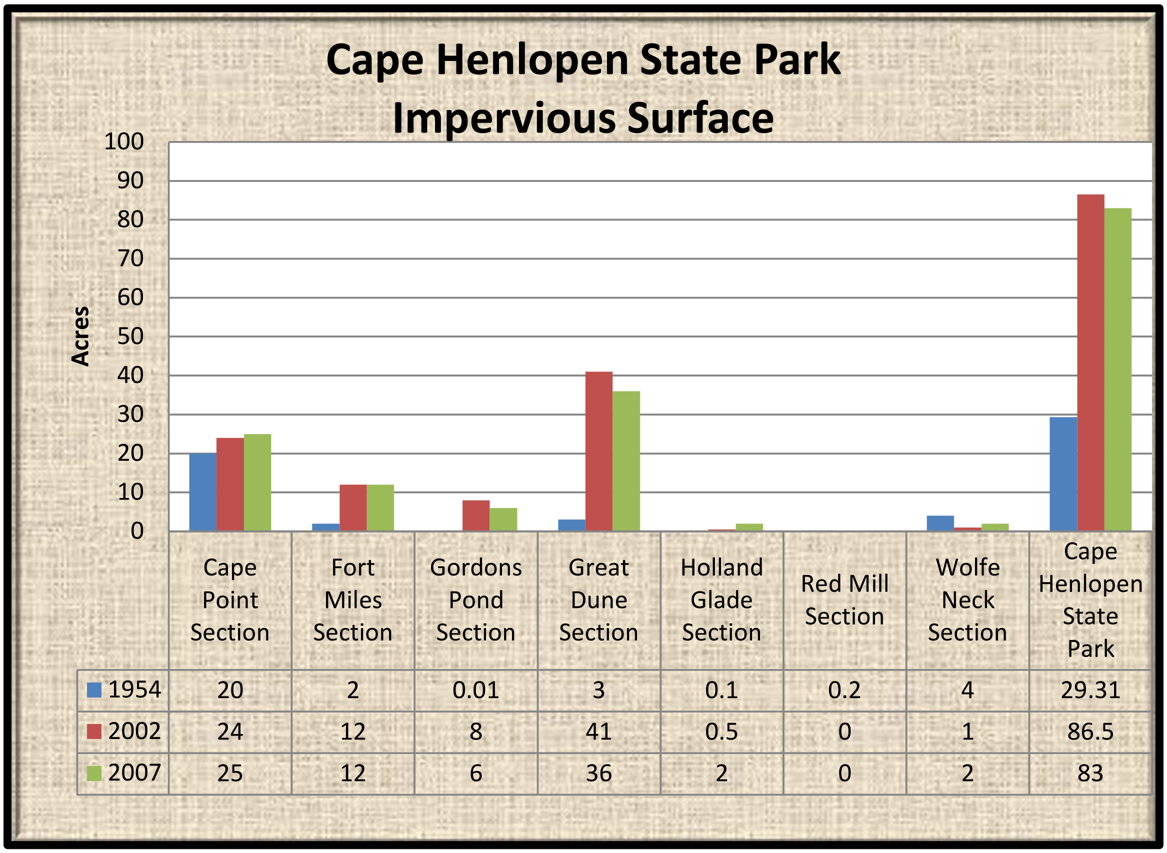
Impervious surface is a man-made land cover and will be around through the long term future.

Table 6.12. What was once Impervious Surface in 1954 has become X or remained in 2007

X	Acreage
Impervious Surface	11 acres
Cultivated Lawn	6 acres
Pitch Pine Dune Woodland	4 acres
Agricultural Field	1 acre
Beachgrass-Panicgrass Dune Grassland	1 acre
Other communities/land covers	5 acres

Table 6.13. Impervious Surface has migrated into X or remained since 1954

X	Acreage
Beachgrass-Panicgrass Dune Grassland	22 acres
Semi-impervious Surface	14 acres
Northeastern Old Field	11 acres
Impervious Surface	11 acres
Cultivated Lawn	4 acres
Other communities/land covers	21 acres



	Cape Point Section	Fort Miles Section	Gordons Pond Section	Great Dune Section	Holland Glade Section	Red Mill Section	Wolfe Neck Section	Cape Henlopen State Park
1954	20	2	0.01	3	0.1	0.2	4	29.31
2002	24	12	8	41	0.5	0	1	86.5
2007	25	12	6	36	2	0	2	83

Figure 6.5. Impervious surface at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.14)

More than half of the impervious surface area in the park will be inundated by 1.5 m of sea level rise. There will be a lot of costs involved in rebuilding roads or abandoning infrastructure.

Table 6.14. Projected acres of Impervious Surface Inundated by Sea Level Rise

Rise	Acres
0.5 m	1 acre
1 m	20 acres
1.5 m	44 acres

Natural Capital

Impervious surface does not have does not have any natural capital value.

***Modified Land* [6 acres, (Figure 6.6, Tables 6.15-6.17)]**

Description

This land cover includes those places where the land has been cleared of all vegetation but it not yet built upon or is perpetually bare of vegetation due to human activity.

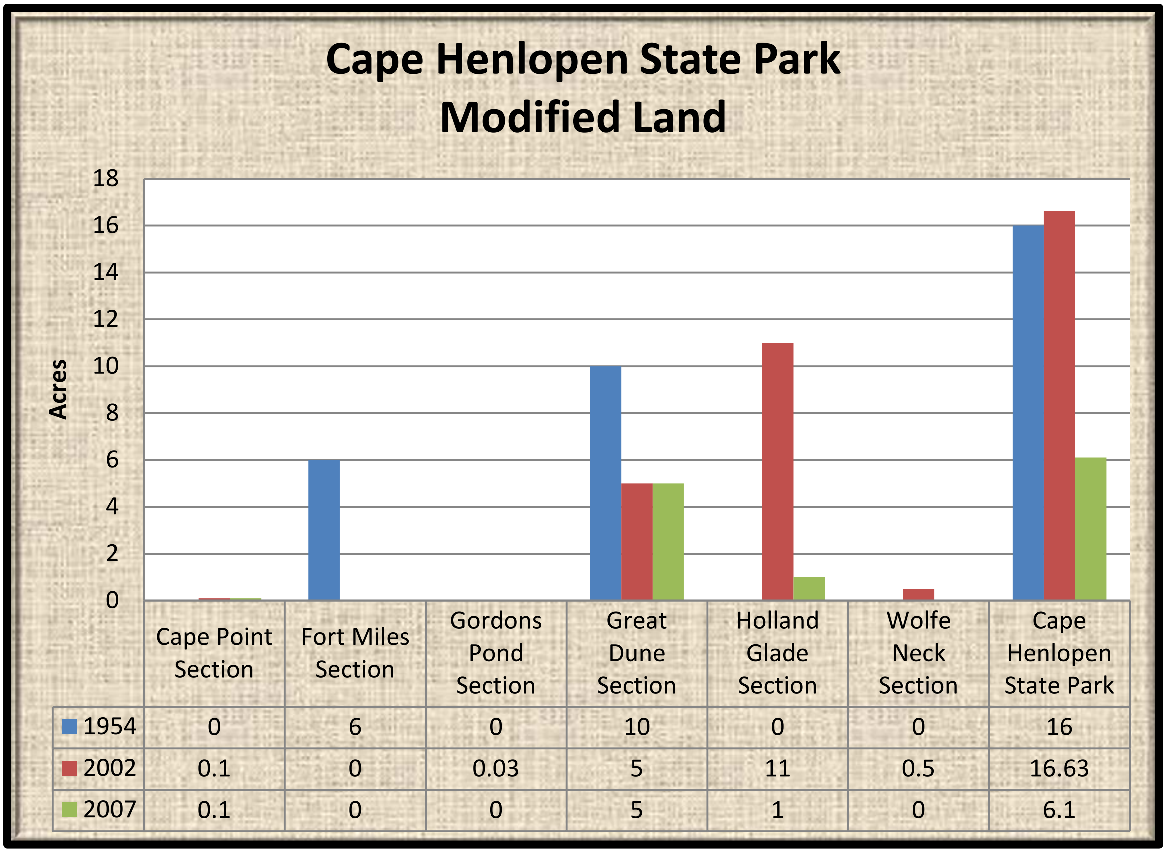
Analysis of Condition at Cape Henlopen State Park

Modified land is a transitional land cover between a natural area and development. As such, it comes and goes and none is still present from that which existed in 1954. Of the modified land that existed in 1954, 8 acres each have become Loblolly Pine Dune Woodland and Pitch Pine Dune Woodland (Table 6.15).

Since 1954 modified land has taken out 4 acres of Northeastern Old Field and one acre each of Semi-impervious surface area and agricultural field (Table 6.16).

Table 6.15. What was once Modified Land in 1954 has become X or remained in 2007	
X	**Acreage**
Loblolly Pine Dune Woodland	8 acres
Pitch Pine Dune Woodland	8 acres
Central Coast Beach Heather Dune Shrubland	0.4 acres
Cultivated Lawn	0.2 acres

Table 6.16. Modified Land has migrated into X or remained since 1954	
X	**Acreage**
Northeastern Old Field	4 acres
Semi-impervious Surface	1 acre
Agricultural Field	1 acre
Impervious Surface	0.3 acres



	Cape Point Section	Fort Miles Section	Gordons Pond Section	Great Dune Section	Holland Glade Section	Wolfe Neck Section	Cape Henlopen State Park
1954	0	6	0	10	0	0	16
2002	0.1	0	0.03	5	11	0.5	16.63
2007	0.1	0	0	5	1	0	6.1

Figure 6.6. Modified Land at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.17)

A little less than half of the current modified land will be inundated by 1.5 m of sea level rise.

Table 6.17. Projected acres of Modified Land Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	0 acres
1 m	0.3 acres
1.5 m	3 acres

Natural Capital

Modified Land does not have does not have any natural capital value.

***Powerline R-O-W* [5 acres (Figure 6.7, Table 6.18)]**

Description

This land cover is located underneath power lines and resembles the same habitat as found in a Northeastern Old Field or Northeastern Successional Shrubland.

Analysis of Condition at Cape Henlopen State Park

One powerline R-O-W is present in the Holland Glade Section and was present in 1954. Since it is in the same area, no change analysis was conducted for this type.

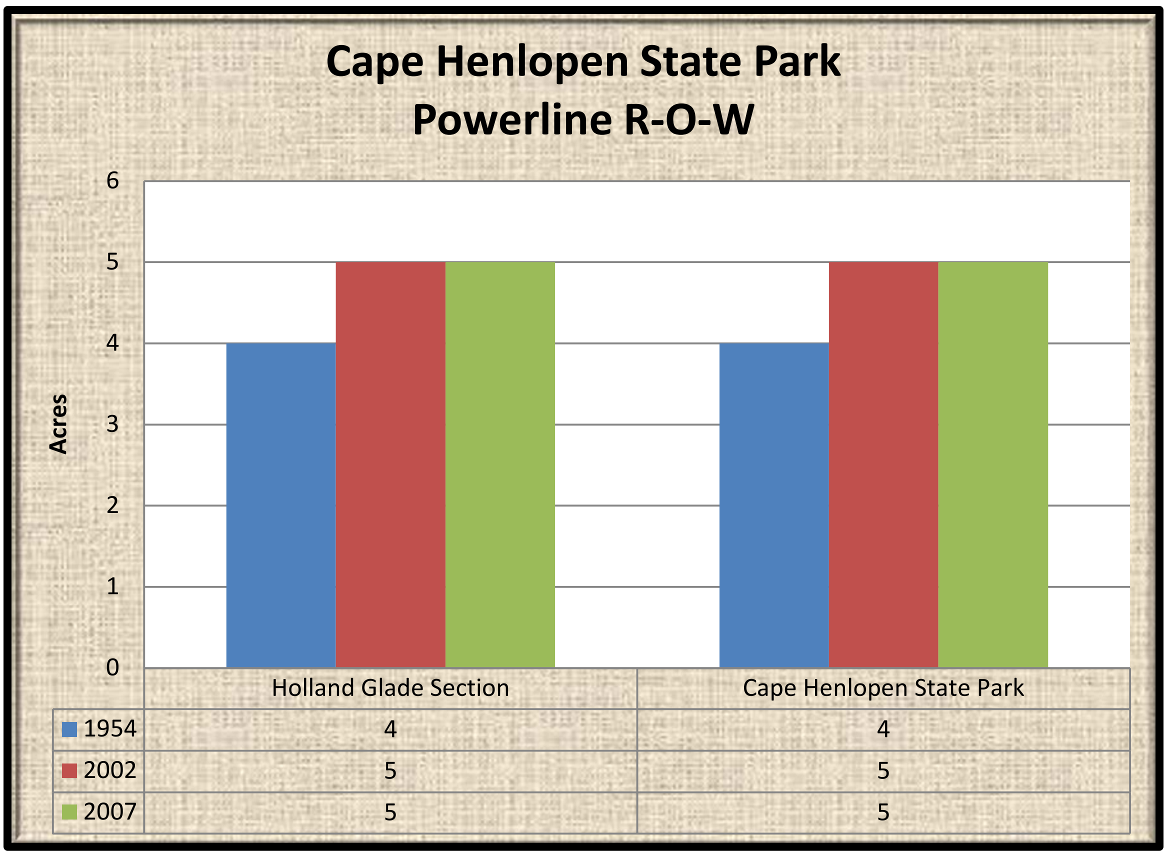


Figure 6.7. Powerline R-O-W at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.18)

Powerline R-O-W will only slightly by affected even under 1.5 m of sea level rise.

Table 6.18. Projected acres of Powerline R-O-W Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0.03 acre
1 m	0.07 acres
1.5 m	0.3 acres

Natural Capital

Powerline R-O-W does not have does not have any natural capital value.

Riprap **[0.1 acres (Figure 6.8, Table 6.19)]**

Description

Riprap is often used as a berm to prevent erosion on the beach. One jetty is present at the north end of Gordons Pond Section.

Analysis of Condition at Cape Henlopen State Park

Riprap has not been used that much in the past in the park. Since 1954, however a jetty was built at the north end of the Gordons Pond Section taking out 0.1 acres of beach. It is unknown if there are plans for any more riprap to be used in the park.

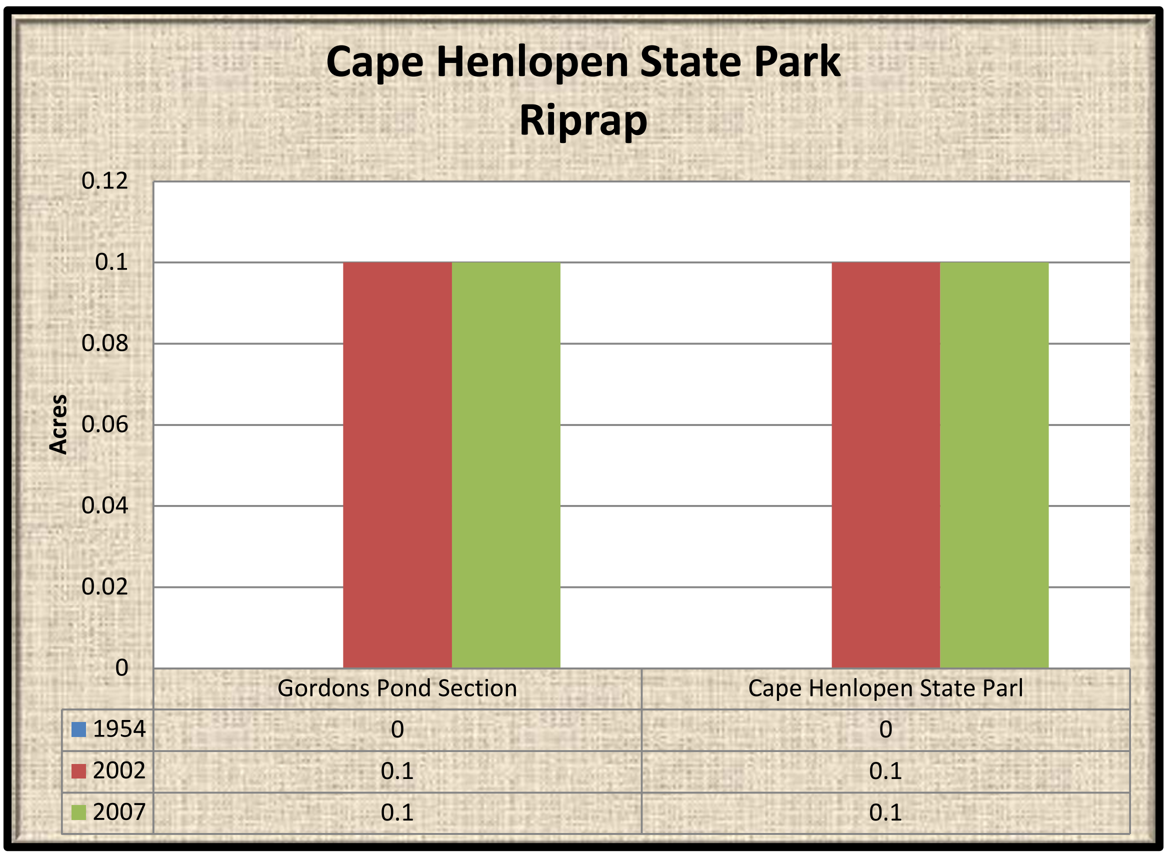


Figure 6.8. Riprap at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.19)

All of the current areas of riprap will be inundated with 0.5 m of sea level rise.

Table 6.19. Projected acres of Riprap Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0.1 acres
1 m	0.1 acres
1.5 m	0.1 acres

Natural Capital

Riprap does not have does not have any natural capital value.

Sand **[154 acres, (Figure 6.9, Tables 6.20-22)]**

Description

This land cover includes bare sand areas with no vegetation present.

Analysis of Condition at Cape Henlopen State Park

In 1954, sand was one of the larger open areas present in what would become the state park. Since this time 55 acres of the original 211 acres in sand are still sand. The rest has become or grown into 58 acres of Pitch Pine Dune Woodland, 41 acres of Beachgrass-Panicgrass Dune Grassland, 20 acres of Mid-Atlantic Coast Backdune Grassland, and 11 acres of Central Coast Beach Heather Dune Shrubland (Table 6.20).

As sand moves around the park it has taken over some other communities in spite of having an overall decrease over the study period. Some of the communities covered include 33 acres of Beachgrass-Panicgrass Dune Grassland, 22 acres of water and 14 acres of North Atlantic Low Salt Marsh, which both created new land area, and 10 acres of beach (Table 6.21).

Given the large volume of sand present in the park, this land cover will be around long into the future. The large amount of sand gives the park and coastal areas in general resiliency to sea level rise and as result these areas are not as affected by sea level rise as places further inland. For instance, Rehoboth Beach fairs much better in sea level rise scenarios, than does Wilmington or New Castle, Delaware because of the ability of sand to build up the land.

Table 6.20. What was once Sand in 1954 has become X or remained in 2007

X	**Acreage**
Pitch Pine Dune Woodland	58 acres
Sand	55 acres
Beachgrass-Panicgrass Dune Grassland	41 acres
Mid-Atlantic Coast Backdune Grassland	20 acres
Central Coast Beach Heather Dune Shrubland	11 acres
Other communities/land covers	24 acres

Table 6.21. Sand has migrated into X or remained since 1954	
X	**Acreage**
Sand	55 acres
Beachgrass-Panicgrass Dune Grassland	33 acres
Water	22 acres
North Atlantic Low Salt Marsh	14 acres
Beach	10 acres
Other communities/land covers	21 acres

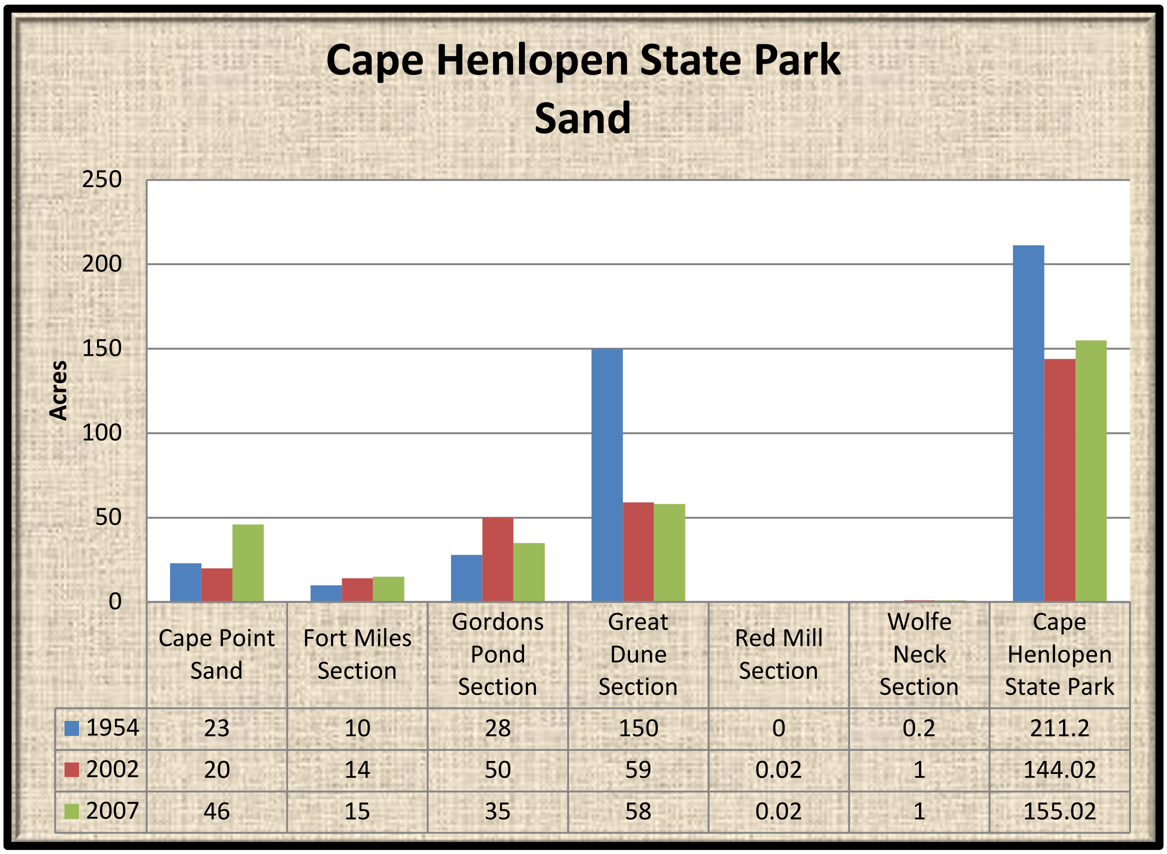


Figure 6.9. Sand at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.22)

A little less than half of the sand area will be flooded by 1.5 m of sea level rise.

Table 6.22. Projected acres of Riprap Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	28 acres
1 m	39 acres
1.5 m	63 acres

Natural Capital

Sand does not have does not have any natural capital value.

***Semi-impervious Surface* [16 acres (Figure 6.10, Tables 6.23--23)]**

Description

This land cover most often includes compacted sand around beach access areas and trails.

Analysis of Condition at Cape Henlopen State Park

In 1954 semi-impervious surface composed a lot of the roads in the army base. Since this time a lot of the former sand roads had been paved in the amount of 14 acres. In addition 7 acres each of semi-impervious surface had become Pitch Pine Dune Woodland and cultivated lawn. Three acres have become agricultural field (Table 5.22).

In spite of the decrease about 5 acres of agricultural field were covered in semi-impervious surface in the form of a bike and walking trail. Two acres each had become Loblolly Pine Dune Woodland and Early to Mid-Successional Loblolly Pine Forest (Table 5.23).

Table 6.23. What was once Semi-impervious Surface in 1954 has become X or remained in 2007	
X	**Acreage**
Impervious Surface	14 acres
Pitch Pine Dune Woodland	7 acres
Cultivated Lawn	7 acres
Agricultural Field	3 acres
Semi-impervious Surface	3 acres
Other communities/land covers	5 acres

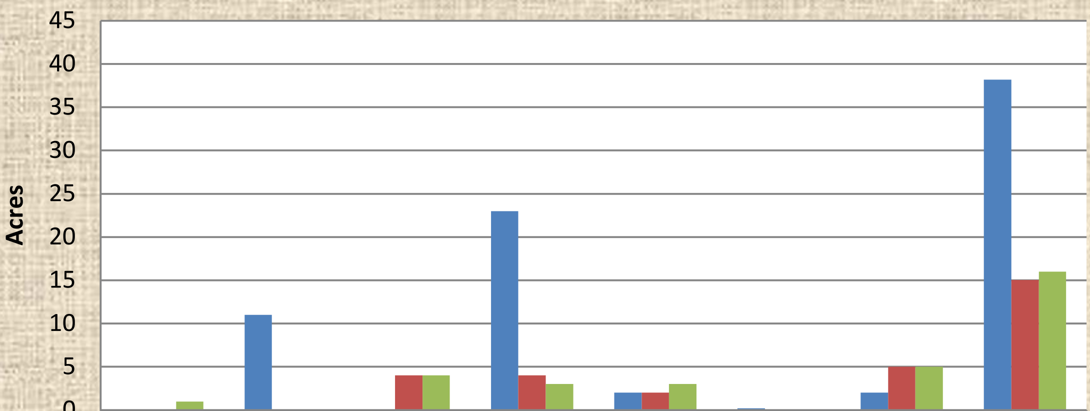
Table 6.24. Semi-impervious Surface has migrated into X or remained since 1954	
X	**Acreage**
Agricultural Field	5 acres
Semi-impervious Surface	3 acres
Loblolly Pine Dune Woodland	2 acres
Early to Mid-Successional Loblolly Pine Forest	2 acres
Beachgrass-Panicgrass Dune Grassland	1 acre
Other communities/land covers	4 acres

DNREC Sea Level Rise Analysis on current (2007) acreage

-0.5 m rise = 6 acres lost to water inundation

-1 m rise = 7 acres lost to water inundation

-1.5 m rise = 8 acres lost to water inundation



	Church Woods Section	Fort Miles Section	Gordons Pond Section	Great Dune Section	Holland Glade Section	Red Mill Section	Wolfe Neck Section	Cape Henlopen State Park
1954	0	11	0	23	2	0.2	2	38.2
2002	0	0	4	4	2	0.02	5	15.02
2007	1	0	4	3	3	0	5	16

Figure 6.10. Semi-impervious Surface at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.25)

About half of semi-impervious surface will be inundated by 1.5 m of sea level rise.

Table 6.25. Projected acres of Semi-impervious Surface Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	6 acres
1 m	7 acres
1.5 m	8 acres

Natural Capital

Semi-impervious Surface does not have does not have any natural capital value.

***Tidal Mudflat* [4 acres, (Figure 6.11, Tables 6.26-6.27)]**

Description

This land cover includes places where marsh vegetation has either died off or has been wiped clean from a storm leaving a non-vegetated mudflat.

Analysis of Condition at Cape Henlopen State Park

Mudflats have been increasing as the marsh is under assault from rising sea level and erosion. This is a trend that has been seen in other areas such as Assawoman Wildlife Area and Milford Neck Wildlife Area.

DNREC Sea Level Rise Analysis (Table 6.25)

All of the current Tidal Mudflats will be inundated with 0.5 m of sea level rise.

Table 6.25. Projected acres of Tidal Mudflat Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	4 acres
1 m	4 acres
1.5 m	4 acres

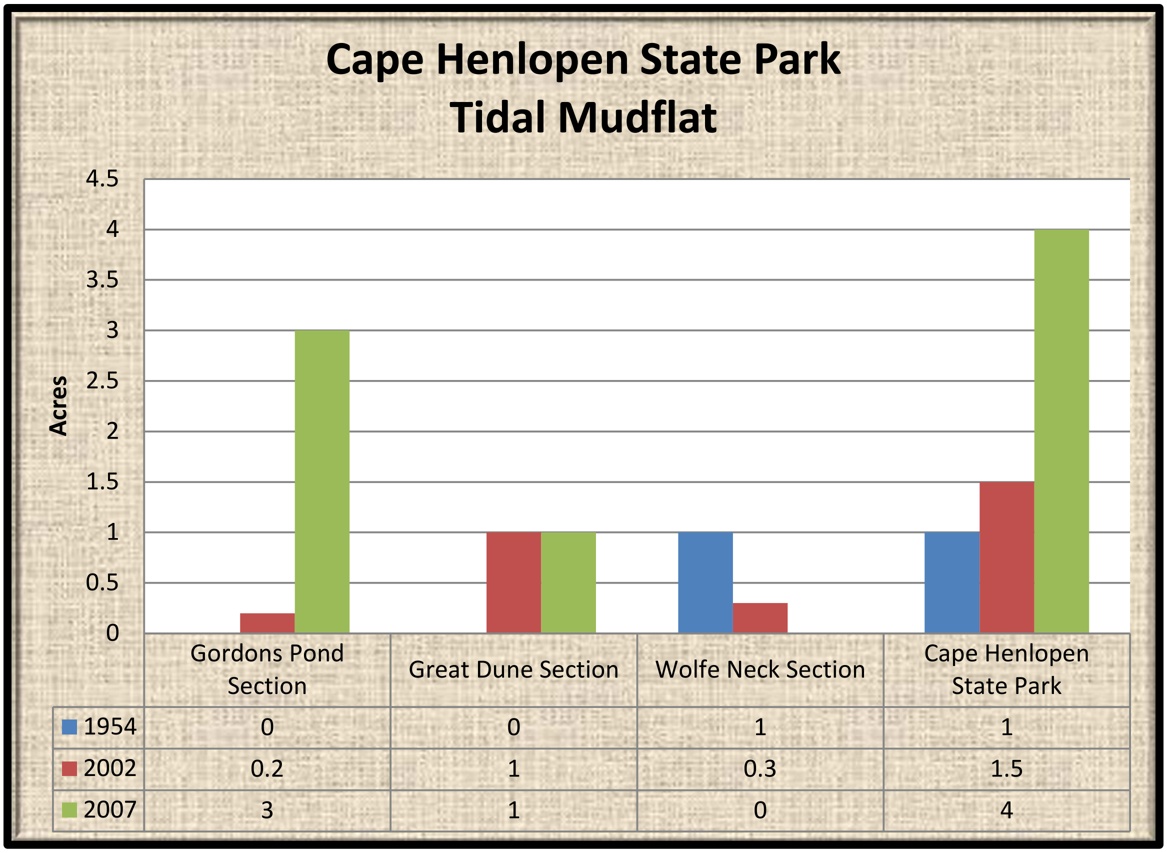


Figure 6.11. Tidal Mudflat at Cape Henlopen State Park (1954, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.26)

All of the current tidal mudflats will be inundated with 0.5 m of sea level rise.

Table 6.26. Projected acres of Tidal Mudflat Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	4 acres
1 m	4 acres
1.5 m	4 acres

Natural Capital (Table 6.27)

Tidal Mudflats have increased rapidly in the recent period (2002-2007) and could be due to sea level rise inundating the marsh.

Table 6.27. Natural Capital of Tidal Mudflat	
Year	**Natural Capital (in 2012 dollars)**
1954	$6,217/year
2002	$9,407/year
2007	$25,085/year

***Water* [390 acres (Figure 6.12, Tables 6.28-)]**

<u>*Description*</u>

This land cover includes water which not impounded as a pond or impoundment.

<u>*Analysis of Condition at Cape Henlopen State Park*</u>

Water coverage has been greatly increasing since 1954 and is a harbinger of sea level rise. However, of the 115 acres present as water in 1954 only 41 acres remain as water in the same place. Some of these areas were filled in as 27 acres of beach, 22 acres of sand, 10 acres of North Atlantic Low Salt Marsh, and 7 acres of Mid-Atlantic Coast Backdune Grassland (Table 5.26).

Since 1954 water has covered over 184 acres of North Atlantic Low Salt Marsh, but this did not result in a decrease in the marsh area since the marsh has converted large amounts of salt shrub and North Atlantic High Salt Marsh. Water has also covered 59 acres of North Atlantic High Salt Marsh, with this community taking a double whammy from the marsh conversion and water. Thirty-two acres of Beachgrass-Panicgrass Dune Grassland and 24 acres of Irregularly Flooded Eastern Tidal Salt Shrub were also flooded (Table 5.27).

The amount of water will likely continue to cover the park at an increasing rate with most losses occurring on the back side by Lewes-Rehoboth Canal.

Table 6.28. What was once Water in 1954 has become X or remained in 2007

X	**Acreage**
Water	41 acres
Beach	27 acres
Sand	22 acres
North Atlantic Low Salt Marsh	10 acres
Mid-Atlantic Coast Backdune Grassland	7 acres
Other communities/land covers	9 acres

Table 6.29. Water has migrated into X or remained since 1954

X	**Acreage**
North Atlantic Low Salt Marsh	184 acres
North Atlantic High Salt Marsh	59 acres
Water	41 acres
Beachgrass-Panicgrass Dune Grassland	32 acres
Irregularly Flooded Eastern Tidal Salt Shrub	24 acres
Other communities/land covers	51 acres

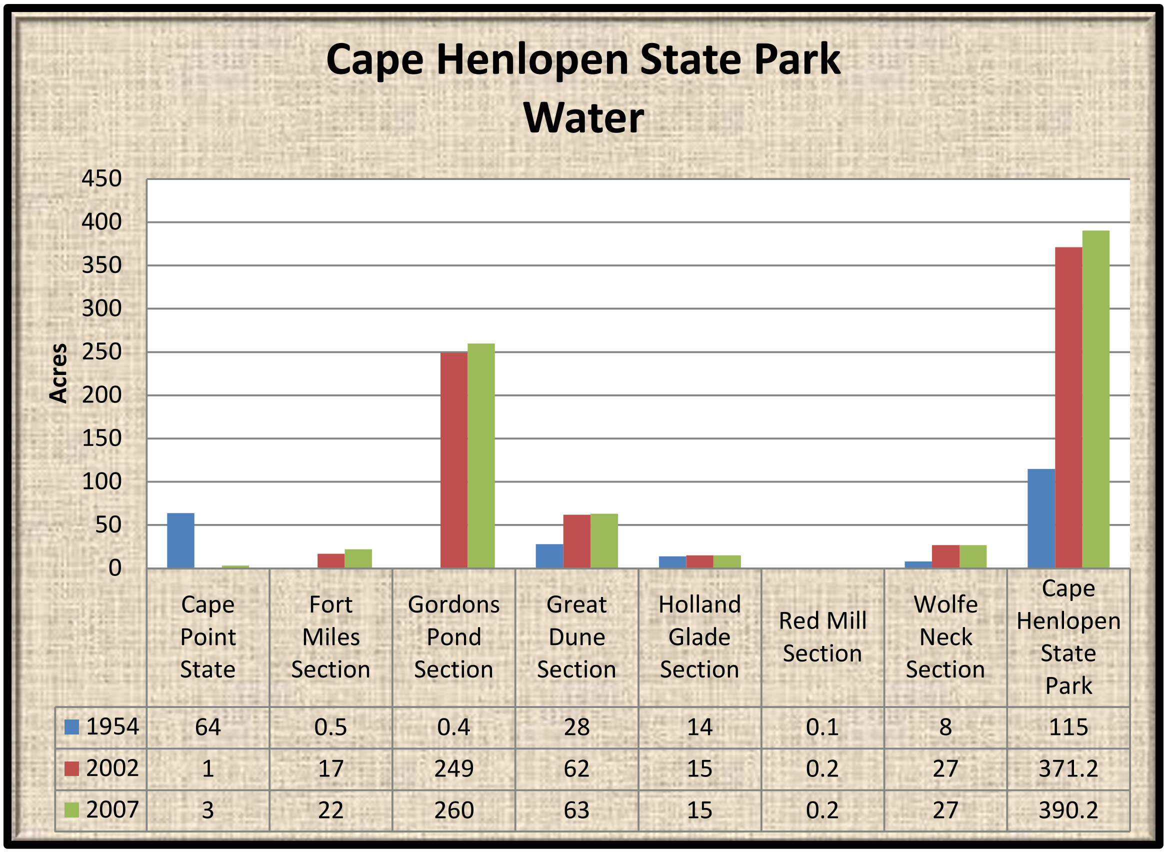


Figure 6.12. Water at Cape Henlopen State Park (1954, 2002, and 2007)

Natural Capital (Table 6.30)

The capital of water has been going up with sea level rise.

Table 6.27. Natural Capital of Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,648,278/year
2002	$5,320,354/year
2007	$5,592,678/year

Appendix I: State rare vegetation ranking criteria

Ranks are based on a system developed by The Nature Conservancy and Natureserve to measure the relative rarity of vegetation communities within a given state. State rarity ranks are used to prioritize conservation and protection efforts so that the rarest of vegetation communities receive immediate attention. The primary criteria for ranking vegetation communities are the total number of documented occurrences with consideration given to the total number of occurrences and total amount of acreage in the state. Ranks for vegetation communities are updated annually and are based on current knowledge and mapping being done for the Guide to Delaware Vegetation Communities.

State Rank

S1 Extremely rare (i.e., typically 5 or fewer occurrences statewide), or may be susceptible to extirpation because of other threats to its existence.

S1.1 Only a single occurrence or population of the species is known to occur. (this rank is only applied to plants.)

S2 Very rare, (i.e., typically 6 to 20 occurrences statewide), or may be susceptible to extirpation because other threats to its existence.

S3 Rare to uncommon, not yet susceptible to extirpation but may be if additional populations are destroyed. Approximately 21 to 100 occurrences statewide.

S4 Common, apparently secure in the state under present conditions.

S5 Very common, secure in the state under present conditions.

SH Historically known, but not verified for an extended period (usually 15+ years); there are expectations that the species may be rediscovered.

SX Extirpated or presumed extirpated from the state. All historical locations and/or potential habitat have been surveyed.

SU Status uncertain within the state. Usually an uncommon species which is believed to be of conservation concern, but there is inadequate data to determine the degree of rarity.

SNR Unranked

SNA Not Applicable

SW Weedy vegetation or vegetation dominated by invasive alien species (this rank is only applied to natural communities).

SM Vegetation resulting from management or modification of natural vegetation. It is readily restorable by management or time and/or the restoration of original ecological processes (this rank is only applied to natural communities).

APPENDIX II: SGCN SPECIES EXPECTED FOR KEY WILDLIFE HABITATS

SGCN Species expected in Beach and Dune Habitats			
Species	**Common Name**	**Class**	**Tier**
Cincindela dorsalis media	white tiger beetle	Insect	1
Cincindela lepida	little white tiger beetle	Insect	1
Malaclemys terrapin terrapin	Northern diamondback terrapin	Reptile	1
Charadrius melodus	Piping plover	Bird	1
Haematopus palliatus	American Oystercatcher	Bird	1
Arenaria interpres	ruddy turnstone	Bird	1
Calidris canutus	Red knot	Bird	1
Calidrius alba	sanderling	Bird	1
Sterna hirundo	common tern	Bird	1
Sterna antillarum	least tern	Bird	1
Rynchops niger	black skimmer	Bird	1
Chordeiles minor	common nighthawk	Bird	1
Cincindela dorsalis	Eastern beach tiger beetle	Bird	2
Cincindela hirticolis	beach-dune tiger beetle	Bird	2
Melitara prodenialis	a snout-moth	Bird	2
Drasteria graphica atlantica	Atlantic graphic moth	Bird	2
Schinia spinosae	a noctuid moth	Bird	2
Falco peregrinus	peregrine falcon	Bird	2
Pluvialis squatarola	black-bellied plover	Bird	2
Catoptrophorus semipalmatus	willet	Bird	2
Calidris pusilla	semi-palmated sandpiper	Bird	2
Calidris maritima	purple sandpiper	Bird	2
Calidris alpina	dunlin	Bird	2
Larus marinus	great black-backed gull	Bird	2
Piplio erythrophthalmus	Eastern towhee	Bird	2
Passerculus sandwichensis	savannah sparrow	Bird	2

SGCN Species expected in Coastal Plain Forested Floodplains and Riparian Swamps			
Species	**Common Name**	**Class**	**Tier**
Satyrium kingi	King's hairstreak	Insect	1
Clemmys guttata	Spotted turtle	Reptile	1
Terrapene carolina	Eastern box turtle	Reptile	1
Nerodia erythrogaster	Plainbelly water snake	Reptile	1
Nycticorax nyticorax	Black crowned night-heron	Bird	1
Nyctanassa violacea	yellow-crowned night-heron	Bird	1
Buteo platypterus	Broad-winged hawk	Bird	1
Melanerpes erythrocephalus	Red-headed woodpecker	Bird	1
Hylocichla mustelina	Wood thrush	Bird	1
Parula americana	Northern parula	Bird	1
Setophaga ruticella	American redstart	Bird	1
Limnothlypis swainsonii	Swainson's warbler	Bird	1
Amblyscirtes aesculapius	Lace-winged roadside-skipper	Insect	2

Libytheana carinenta	American snout	Insect	2
Anacamptodes pergracilis	Cypress looper	Insect	2
Chloropteryx tepperaria	Angle winged emerald moth	Insect	2
Manduca jasminearum	Ash sphinx	Insect	2
Dolba hyloeus	Black alder or pawpaw sphinx	Insect	2
Haploa colona	A tiger moth	Insect	2
Orgyia detrita	A tussock moth	Insect	2
Catocala unijuga	Once-married underwing	Insect	2
Catocala praeclara	Praeclara underwing	Insect	2
Parapamea buffaloensis	A borer moth	Insect	2
Papaipema stenocelis	Chain fern borer moth	Insect	2
Gomphaeschna antilope	Taper-tailed darner	Insect	2
Gomphaeschna furcillata	Harlequin darner	Insect	2
Sympetrum ambiguum	Blue-faced meadowhawk	Insect	2
Enallagma weewa	Blackwater bluet	Insect	2
Hemidactylum scutatum	Four-toed salamander	Amphibian	2
Pseudotriton montanus montanus	Mud salamander	Amphibian	2
Hyla chrysoscelis	Cope's gray treefrog	Amphibian	2
Rana virgatipes	Carpenter frog	Amphibian	2
Opheodrys aestivus	Rough green snake	Reptile	2
Thamnophis sauritus	Eastern ribbon snake	Reptile	2
Agkistrodon contortix	copperhead	Reptile	2
Ardea herodias	Great blue heron	Bird	2
Casmerodius albus	Great egret	Bird	2
Egretta thula	Snowy egret	Bird	2
Egretta caerulea	Little blue heron	Bird	2
Egretta tricolor	Tricolored heron	Bird	2
Bubulcus ibis	Cattle egret	Bird	2
Plegadis falcinellus	Glossy ibis	Bird	2
Buteo lineatus	Red-shouldered hawk	Bird	2
Strix varia	Barred owl	Bird	2
Vireo flavifrons	Yellow-throated vireo	Bird	2
Protonotaria citrea	Prothonotary warbler	Bird	2
Helmitheros vermivorus	Worm-eating warbler	Bird	2
Oporornis formosus	Kentucky warbler	Bird	2
Piranga olivacea	Scarlet tanager	Bird	2
Icterus galbula	Baltimore oriole	Bird	2
Lasionycteris noctivagans	Silver-haired bat	Mammal	2
Nycticeius humeralis	Evening bat	Mammal	2

SGCN Species expected in Coastal Plain Seasonal Ponds			
Species	**Common Name**	**Class**	**Tier**
Poanes massasoit	Mulberry wing	Insect	1
Ambystoma tigrinum tigrinum	Tiger salamander	Amphibian	1
Hyla gratiosa	Barking treefrog	Amphibian	1
Clemmys guttata	Spotted turtle	Reptile	1

Euphyes dion	Dion skipper	Insect	2
Aeshna tubercullifera	Black-tipped darner	Insect	2
Aeshna verticalis	Green-striped darner	Insect	2
Anax longipes	Comet darner	Insect	2
Gomphaeschna antilope	Taper-tailed darner	Insect	2
Tetragoneuria costalis	Stripe-winged baskettail	Insect	2
Celithemis verna	Double-ringed pennant	Insect	2
Leucorrhinia intacta	Dot-tailed whiteface	Insect	2
Libellula axilena	Bar-winged skimmer	Insect	2
Libellula deplanata	Blue corporal	Insect	2
Botaurus lentiginosus	American bittern	Insect	2
Sympetrum ambiguum	Blue-faced meadowhawk	Insect	2
Sympetrum semicinctum	Band-winged meadowhawk	Insect	2
Lestes eurinus	Amber-winged spreadwing	Insect	2
Enallagma dubium	Burgundy bluet	Insect	2
Enallagma durium	Big bluet	Insect	2
Enallagma pallidum	Pale bluet	Insect	2
Enallagma vesperum	Vesper bluet	Insect	2
Nehalennia irene	Sedge sprite	Insect	2
Gomphus villosipes	Unicorn clubtail	Insect	2
Ambystoma maculatum	Spotted salamander	Amphibian	2
Hemidactylum scutatum	Four-toed salamander	Amphibian	2
Hyla chrysocelis	Cope's gray treefrog	Amphibian	2
Scaphiopus holbrookii	Eastern spadefoot	Amphibian	2
Thamnophis sauritus	Eastern ribbon snake	Reptile	2

SGCN Species expected in Coastal Plain Upland Forest			
Species	**Common Name**	**Class**	**Tier**
Cicindela patruela consentanea	Northern barrens tiger beetle	Insect	1
Callophrys irus	frosted elfin	Insect	1
Catocala antinympha	sweetfern underwing	Insect	1
Catocala lacrymosa	tearful underwing	Insect	1
Terrapene carolina	Eastern box turtle	Reptile	1
Eumeces laticeps	broadhead skink	Reptile	1
Cemophora coccinea	scarlet snake	Reptile	1
Elaphe guttata	corn snake	Reptile	1
Lampropeltis triangulum	milk snake	Reptile	1
Haliaeetus leucocephalus	Bald eagle	Bird	1
Accipiter cooperii	Cooper's Hawk	Bird	1
Buteo platypterus	broad-winged hawk	Bird	1
Asio otus	long-eared owl	Bird	1
Melanerpes erythrocephalus	red-headed woodpecker	Bird	1
Certhia americana	brown creeper	Bird	1
Hylocichla mustelina	wood thrush	Bird	1
Wilsonia citrina	hooded warbler	Bird	1
Sciurus niger cinereus	Delmarva fox squirrel	Mammal	1
Discus catskillensis	angular disc	Gastropod	2

Cicindela patruela	Northern barrens tiger beetle	Insect	2
Cicindela unipunctata	one-spotted tiger beetle	Insect	2
Photuris frontalis	a firefly	Insect	2
Erynnis martialis	mottled duskywing	Insect	2
Erynnis baptisiae	wild indigo duskywing	Insect	2
Battus philenor	pipevine swallowtail	Insect	2
Polygonia progone	gray comma	Insect	2
Caripeta aretaria	a geometer moth	Insect	2
Tolype notialis	a lasiocampid moth	Insect	2
Hemileuca maia maia	the buckmoth	Insect	2
Cisthene kentuckiensis	Kentucky lichen moth	Insect	2
Cisthene tenuifascia	a lichen moth	Insect	2
Grammia phyllira	phyllira tiger moth	Insect	2
Zale metata	a noctuid moth	Insect	2
Catocala flebilis	mournful underwing	Insect	2
Catocala residua	residua underwing	Insect	2
Catocala cerogama	Yellow banded underwing	Insect	2
Acronicta exilis	Exiled dagger moth	Insect	2
Acronicta lithospila	Streaked dagger moth	Insect	2
Papaipema araliae	Aralia shoot borer moth	Insect	2
Papaipema baptisiae	Wild indigo borer moth	Insect	2
Lepipolys perscripta	A noctuid moth	Insect	2
Scincella lateralis	Ground skink	Reptile	2
Heterodon platirhinos	Eastern hognose snake	Reptile	2
Lampropeltis getula	Common kingsnake	Reptile	2
Storeria occipitomaculata	Redbelly snake	Reptile	2
Virginia valeriae	Smooth earth snake	Reptile	2
Agkistrodon contortix	Copperhead	Reptile	2
Coragyps atratus	Black vulture	Bird	2
Strix varia	Barred owl	Bird	2
Caprimulgus vociferus	whip-poor-will	Bird	2
Colaptes auratus	Northern flicker	Bird	2
Myiarchus crinitus	Great crested flycatcher	Bird	2
Sitta pusilla	Brown-headed nuthatch	Bird	2
Vireo flavifrons	Yellow-throated vireo	Bird	2
Dendroica dominca	Yellow-throated warbler	Bird	2
Mniotilta varia	Black-and-white warbler	Bird	2
Seiurus motacilla	Louisiana waterthrush	Bird	2
Oporornis formosus	Kentucky warbler	Bird	2
Piranga olivacea	Scarlet tanager	Bird	2
Piplio erythrophthalmus	Eastern towhee	Bird	2
Icterus galbula	Baltimora oriole	Bird	2
Lasionycteris noctivagans	Silver-haired bat	Mammal	2
Lasiurus borealis	Eastern red bat	Mammal	2
Lasiurus cinereus	Hoary bat	Mammal	2
Canis latrans	coyote	Mammal	2

SGCN Species expected in Early Successional Upland Habitats			
Species	**Common Name**	**Class**	**Tier**
Nicrophorus americanus	American burying beetle	Insect	1
Callophrys irus	frosted elfin	Insect	1
Papaipema maritima	maritime sunflower borer moth	Insect	1
Terrapene carolina	Eastern box turtle	Reptile	1
Lampropeltis triangulum	milk snake	Reptile	1
Branta canadensis	Canada goose (migratory)	Bird	1
Circus cyaneus	Northern harrier	Bird	1
Bartramia longicauda	upland sandpiper	Bird	1
Scolopax minor	American woodcock	Bird	1
Asio flammeus	short-eared Owl	Bird	1
Chordeiles minor	common nighthawk	Bird	1
Lanius ludovicianus	loggerhead shrike	Bird	1
Dendroica discolor	prairie warbler	Bird	1
Ammodramus henslowii	Henslow's sparrow	Bird	1
Cincindela scutellaris	festive tiger beetle	Insect	2
Atrytonopsis hianna	dusted skipper	Insect	2
Satyrium liparops	striped hairstreak	Insect	2
Satyrium liparops strigosum	stiped hairstreak	Insect	2
Callophrys gryneus	juniper hairstreak	Insect	2
Speyeria aphrodite	aphrodite fritillary	Insect	2
Speyeria idalia	regal fritillary	Insect	2
Boloria bellona	meadow fritillary	Insect	2
Paratrea plebeja	trumpet vine sphinx	Insect	2
Calyptra canadensis	Canadian owlet	Insect	2
Acronicta rubricoma	a dagger moth	Insect	2
Papaipema rigida	rigid sunflower borer moth	Insect	2
Cirrhophanus triangulifer	a noctuid moth	Insect	2
Schina septentrionalis	a noctuid moth	Insect	2
Plegadis falcinellus	glossy ibis	Bird	2
Cygnus columbianus	tundra swan	Bird	2
Coragyps atratus	black vulture	Bird	2
Colinus virginianus	Northern bobwhite	Bird	2
Pluvialis squatarola	black-bellied plover	Bird	2
Coccyzus erythropthalmus	black-billed cuckoo	Bird	2
Chaetura pelagica	chimney swift	Bird	2
Colaptes auratus	Northern flicker	Bird	2
Empidonax minimus	least flycatcher	Bird	2
Tyrannus tyrannus	Eastern kingbird	Bird	2
Toxostoma rufum	Brown thrasher	Bird	2
Dendroica pensylvanica	Chestnut-sided warbler	Bird	2
Icteria virens	Yellow-breasted chat	Bird	2
Piplio erythrophthalmus	Eastern towhee	Bird	2
Spizella pusilla	field sparrow	Bird	2
Pooecetes gramineus	vesper sparrow	Bird	2
Passerculus sandwichensis	savannah sparrow	Bird	2
Ammodramus savannarum	grasshopper sparrow	Bird	2

Dolichonyx oryzivorus	bobolink	Bird	2
Cryptotis parva	least shrew	Bird	2

SGCN Species expected in Freshwater Tidal Forested and Scrub-Shrub Wetlands			
Species	**Common Name**	**Class**	**Tier**
Poanes massasaoit chermockii	Chermock's mulberry wing	Insect	1
Nannothemis bella	Elfin skimmer	Insect	1
Clemmys guttata	Spotted Turtle	Reptile	1
Podilymbus podiceps	Pied-billed grebe	Bird	1
Nycticorax nyticorax	Black-crowned night-heron	Bird	1
Nyctanassa violacea	Yellow-crowned night-heron	Bird	1
Pandion haliatus	Osprey	Bird	1
Lycaena hyllus	Bronze copper	Insect	2
Papaipema birdi	Umbellifer borer moth	Insect	2
Libellula axilena	Bar-winged skimmer	Insect	2
Argia bipunctulata	Seepage dancer	Insect	2
Nehalerinia gracilis	Sphagnum sprite	Insect	2
Botaurus lentiginosus	American bittern	Bird	2
Ixobrychus exilis	Least bittern	Bird	2
Ardea herodias	Great blue heron	Bird	2
Casmerodius albus	Great egret	Bird	2
Egretta thula	Snowy egret	Bird	2
Egretta caerulea	Little blue heron	Bird	2
Egretta tricolor	Tricolored heron	Bird	2
Bubulcus ibis	Cattle egret	Bird	2
Anas platyrhynchos	mallard	Bird	2
Rallus elegans	King rail	Bird	2
Porzana carolina	Sora	Bird	2
Dolichonyx oryzivorus	Bobolink	Bird	2

SGCN Species expected in Interdunal Wetlands			
Species	**Common Name**	**Class**	**Tier**
Photuris bethaniensis	Bethany Beach firefly	Insect	1
Cicindela hirticolis	Beach-dune tiger beetle	Insect	2

SGCN Species expected in Tidal High Marsh Habitats			
Species	**Common Name**	**Class**	**Tier**
Problema bulenta	rare skipper	Insect	1
Pero zalissaria	a geometer moth	Insect	2
Acontia delecta	a noctuid moth	Insect	2
Papaipema birdi	umbellifer borer moth	Insect	2
Brachymesia gravida	four-spotted pennant	Insect	2
Nycticorax nycticorax	black-crowned night-heron	Bird	1
Nyctanassa violacea	yellow-crowned night-heron	Bird	1
Anas rubripes	American black duck	Bird	1
Circus cyaneus	northern harrier	Bird	1

Laterallus jamaicensis	black rail	Bird	1
Asio flammeus	short-eared owl	Bird	1
Cistothorus platensis	sedge wren	Bird	1
Ammodramus caudacutus	saltmarsh sharp-tailed sparrow	Bird	1
Ammodramus maritimus	seaside sparrow	Bird	1
Botaurus lentiginosus	American bittern	Bird	2
Ixobrychus exilis	least bittern	Bird	2
Ardea herodias	great blue heron	Bird	2
Casmerodius albus	great egret	Bird	2
Egretta thula	snowy egret	Bird	2
Egretta caerulea	little blue heron	Bird	2
Egretta tricolor	tricolored heron	Bird	2
Bubulcus ibis	Cattle egret	Bird	2
Porzana carolina	sora	Bird	2
Fulica americana	American coot	Bird	2
Tyto alba	barn owl	Bird	2
Cistothorus palustris	marsh wren	Bird	2

SGCN Species expected in Tidal Low Marsh Habitats			
Species	**Common Name**	**Class**	**Tier**
Problema bulenta	rare skipper	Insect	1
Malaclemys terrapin terrapin	Northern diamondback terrapin	Reptile	1
Podilymbus podiceps	Pied-billed grebe	Bird	1
Nycticorax nycticorax	Black-crowned night-heron	Bird	1
Branta canadensis	Canada goose (migratory)	Bird	1
Anas rubripes	American black duck	Bird	1
Nyctanassa violacea	yellow-crowned night-heron	Bird	1
Circus cyaneus	northern harrier	Bird	1
Arenaria interpres	Ruddy turnstone	Bird	1
Asio flammeus	short-eared owl	Bird	1
Calidris canutus	Red knot	Bird	1
Sterna hirundo	Common tern	Bird	1
Sterna forsteri	Forster's tern	Bird	1
Rhnchops niger	Black skimmer	Bird	1
Ammodramus caudacutus	Saltmarsh sharp-tailed sparrow	Bird	1
Ammodramus maritimus	Seaside sparrow	Bird	1
Cicindela marginata	Margined tiger beetle	Insect	2
Pero zalissaria	A geometer moth	Insect	2
Acontia delecta	A noctuid moth	Insect	2
Brachymesia gravida	Four-spotted pennant	Insect	2
Pelecanus occidentalis	Brown pelican	Bird	2
Phalacrocorax carbo	Great cormorant	Bird	2
Phalacrocorax auritus	Double-crested cormorant	Bird	2
Ardea herodias	Great blue heron	Bird	2
Casmerodius albus	Great egret	Bird	2
Egretta thula	Snowy egret	Bird	2
Egretta caerulea	Little blue heron	Bird	2

Egretta tricolor	Tricolored heron	Bird	2
Bubulcus ibis	Cattle egret	Bird	2
Plegadis falcinellus	Glossy ibis	Bird	2
Anas platyrhynchos	mallard	Bird	2
Falco peregrinus	Peregrine falcon	Bird	2
Rallus elegans	King rail	Bird	2
Fulica americana	American coot	Bird	2
Pluvialis squatarola	Black-bellied plover	Bird	2
Himantopus mexicanus	Black-necked stilt	Bird	2
Catoptrophorus semipalmatus	Willet	Bird	2
Calidris pusilla	Semipalmated sandpiper	Bird	2
Calidris alpina	dunlin	Bird	2
Sterna nilotica	Gull-billed tern	Bird	2
Tyto alba	Barn owl	Bird	2
Cistothorus palustris	Marsh wren	Bird	2