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

Indian River Bay, North Atlantic Strand and Rehoboth Bay Watersheds

Submitted to:

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July 23, 2012

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CHAPTER 1: INTRODUCTION AND METHODS

Setting of Delaware Seashore State Park

Delaware Seashore State Park is located in southeastern Sussex County, Delaware (Figure 1.1) on the Atlantic Strand. No formal tracts exist for the state park. Because of its size, discussion purposes, and for mapping, the park was divided into three sections. These sections include the Middle Section (399 acres), North Section (1,589 acres), and the South Section (762 acres) for a total of 2,750 acres. The North Section is located north of Indian River Inlet, while the other two sections are south of Indian River Inlet.

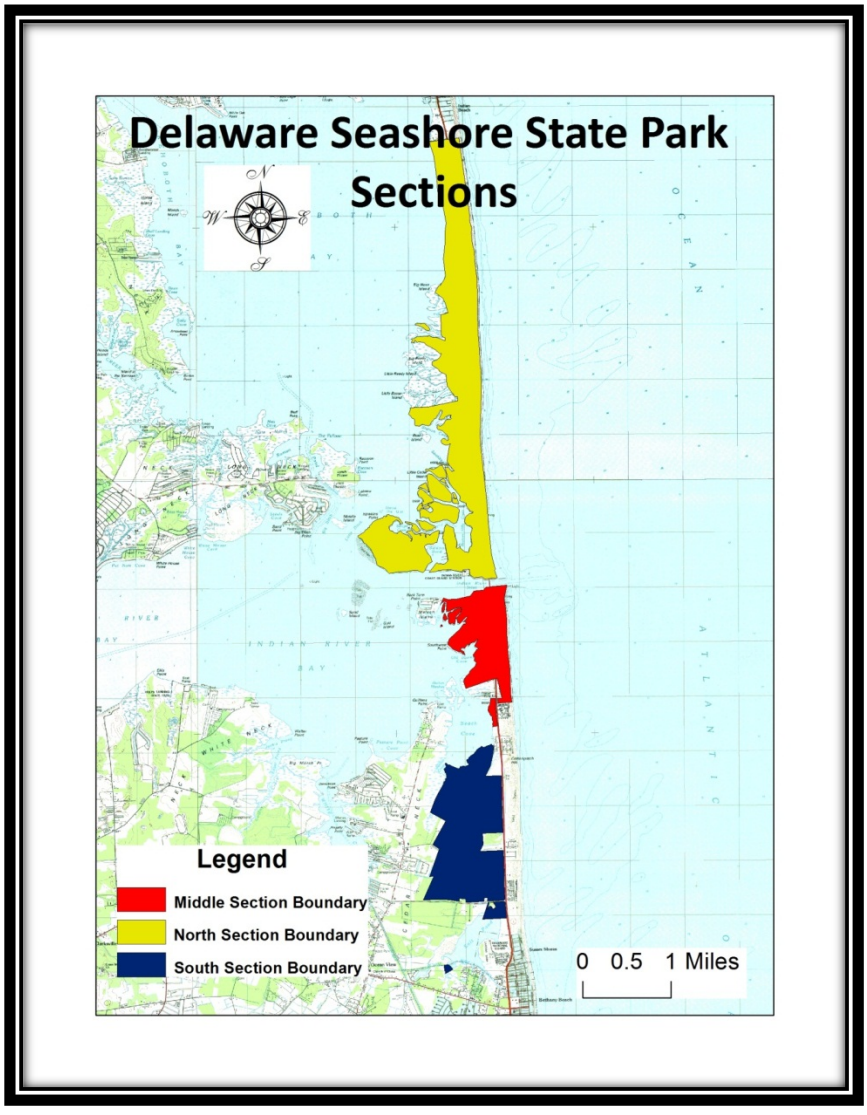

Figure 1.1. Delaware Seashore State Park Sections

Soils and Geology of Delaware Seashore State Park

Underlying Geology

The geology of Delaware Seashore State Park is composed of Holocene and Late Pleistocene sediments throughout except for Burton Island which is composed of Pliocene Sediments[1].

The Holocene sediments are composed of Barrier Washover Deposits, Dune Deposits, Marsh Deposits, Nearshore Deposits, and Shoreline Deposits[2]. Barrier Washover Deposits as described as "white to gray, very coarse to fine sand with scattered laminae of pebbles and heavy mineral laminae." Dune Deposits are described as "white to light-yellow, well-sorted, medium to fine sand" and dates from the late Pleistocene to Holocene. Shoreline deposits are composed of medium to coarse quartz sand with pebbles and cobbles and dates from the Holocene Period. The interior of the park is composed of spit deposits which are composed of fine to coarse sand, gravelly sand, silty sand, and sandy silt and dates from the Holocene. Scattered around the two formations above are swamp deposits that are composed of quartz sand with organic rich silt and dates from the Holocene.

Soils

Four main soils, Acquango-Beaches Complex (728 acres), Brockatonorton-Urban Land Complex (282 acres), Klej Loamy Sand (202 acres), and Mullica Berryland Complex (134 acres) are prominent in uplands of the park. Two soils, Purnell Peat (524 acres) and Saltpond Mucky Sand (415 acres) are prominent in the lowlands of the park. Other minor soils include Acquango-Urban Land Complex, Askecksy Loamy Sand, Ingleside Loamy Sand, and Runclint Loamy Sand.

[1] Ramsey, Kelvin W. and William S. Schenck. 1990. Geologic Map of Southern Delaware. Delaware Geologic Survey, Open File Report No. 32.

[2] Ramsey, Kelvin W. 2011. Geologic Map of the Fairmount and Rehoboth Beach Quadrangles, Delaware. Delaware Geologic Survey, Geologic Map Series No. 16.

Middle Section Soils

Two soils are prominent in the Middle Section and include Purnell Peat (151 acres) and Acquango-Beaches Complex (129 acres). Other minor soils include Brockatonorton Urban Land Complex (58 acres) and Saltpond Mucky Sand (45 acres).

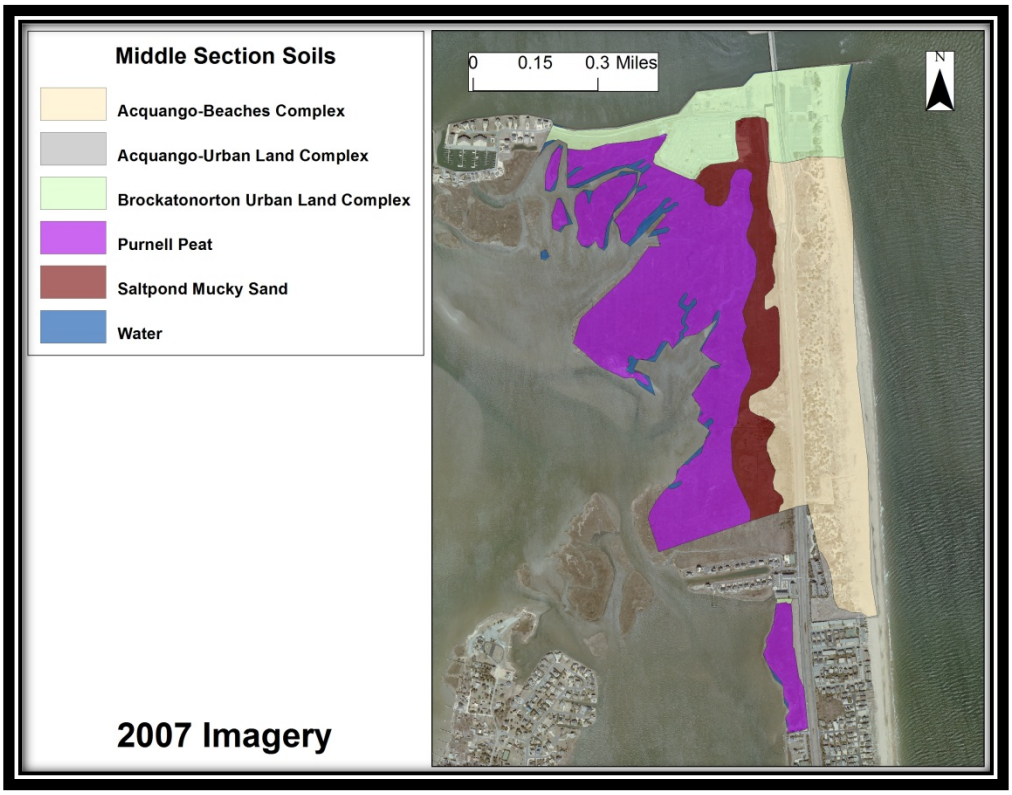

Figure 1.2. Middle Section Soil Map

North Section Soils

Three soils are prominent in the North Section and include Acquango-Beaches Complex (599 acres), Saltpond Mucky Sand (370 acres), and Purnell Peat (324 acres). Other minor soils include Brockatonorton-Urban Land Complex (132 acres) and Klej Loamy Sand (56 acres).

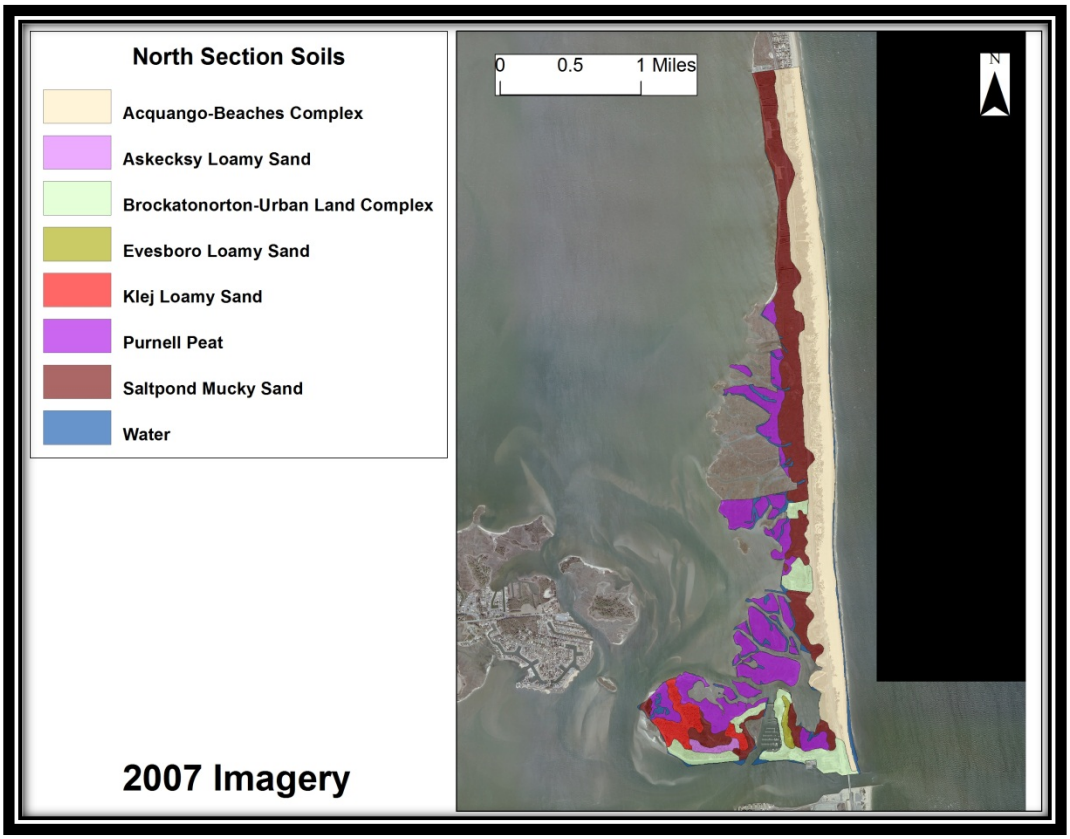

Figure 1.3. North Section Soil Map

South Section Soils

Two soils are prominent in the South Section and include Klej Loamy Sand (146 acres) and Mullica-Berryland Complex (134 acres). Other minor soils include Brockatonorton-Urban Land Complex (92 acres) and Runclint Loamy Sand (91 acres).

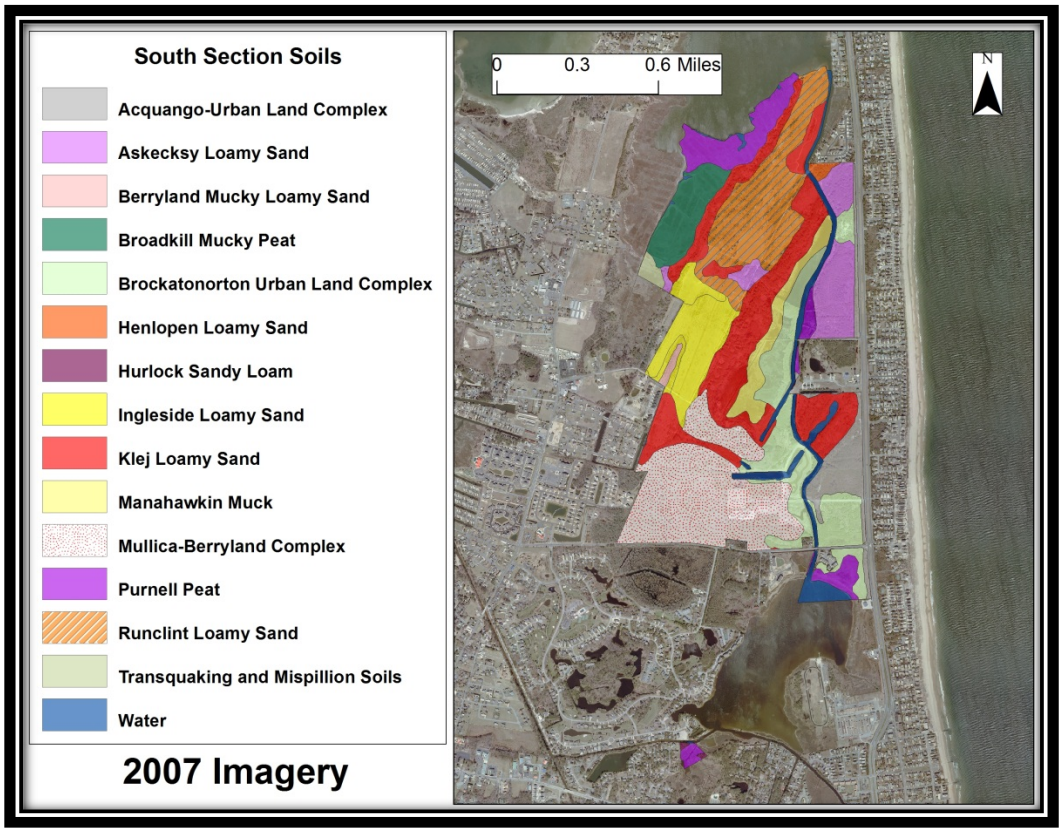

Figure 1.4. South Section Soil Map

Elevation

Elevation of the park ranges from sea level at the Atlantic Ocean and bays to about 6 feet at Burton Island. Some of the elevations of the higher dunes may be more than 6 feet but these are usually temporary.

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 Delaware Seashore 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 stated in elsewhere in the Mid-Atlantic [7],[8], [9]. The rising rate of rise may factor into the difference

[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.
[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).

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.

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

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[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.

[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

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.

[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.

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 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= Eustastic (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

[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.
[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.

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 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.

[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
[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.

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 Delaware Seashore State Park based on 1997, 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 ranked S2 or higher.

Surveys were conducted during 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).

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 1997, 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 5 and of the land covers in Chapter 6. A crosswalk to the Delaware Wildlife Action Plan (DEWAP) and the Northeast Habitat Classification (NHC) are provided at the top of each individual description.

Analysis of Historical Imagery

Historical imagery of Delaware Seashore State Park from 1997, 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 changes over a 10 and 5 year time frame. Changes in the respective vegetation communities and land covers are discussed in the descriptions while broader changes are discussed in the state park discussion. There is more imagery available (1937, 1954, 1961, 1968, and 1992) but these sets were not used due to geo-registration problems in the image tiles or poor image quality.

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 Delaware Seashore 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. 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 currently old field

[35] Coxe, Robert. 2010. Guide to Delaware Vegetation Communities-Summer 2010 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.

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 whole, the sections, and the vegetation communities/land covers using the DNREC Sea Level Rise Scenarios. Acreage lost in the various scenarios is estimated for each.

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 the study

1. **Vegetation Communities:** Thirty-two vegetation communities and ten land covers were found at Delaware Seashore State Park. North Atlantic Low Salt Marsh (728 acres) is the largest vegetation community, followed by Beachgrass-Panicgrass Dune Grassland with 202 acres. Water (284 acres) is the largest land cover, followed by Impervious Surface with 128 acres.

2. **Rare Plants:** Four rare plants are known to exist in Delaware Seashore State Park (Table 2.1).

Scientific Name	Common Name	Rank	Last Observed
Amaranthus pumilus	Seabeach Amaranth	S1	2011
Carex silicea	Seabeach Sedge	S2	???
Polygonum glaucum	Seabeach Knotweed	S2	???
Spiranthes vernalis	Twisted Ladies'-tresses	S2	1993

Table 2.1 Rare Plants at Delaware Seashore State Park

3. **Rare Animals:** Nine rare animals are known to exist in Delaware Seashore State Park (Table 2.2).

Scientific Name	Common Name	Rank	Last Observed
Charadrius melodus	Piping Plover	S1B	
Chordeiles minor	Common Nighthawk	S2B	1996
Circus cyaneus	Northern Harrier	S1B, S4N	1983
Haematopus palliatus	American Oystercatcher	S1B	1999
Photuris bethaniensis	A Firefly	S1	2000
Rynchops niger	Black Skimmer	S1B	1988
Sitta pusilla	Brown-headed Nuthatch	S2	1996
Sterna antillarum	Least Tern	S1B	1990
Sterna hirundo	Common Tern	S1B	1996

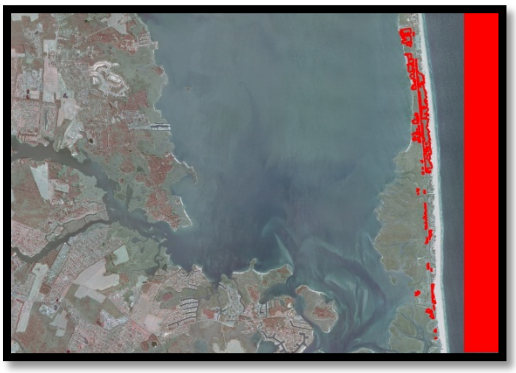
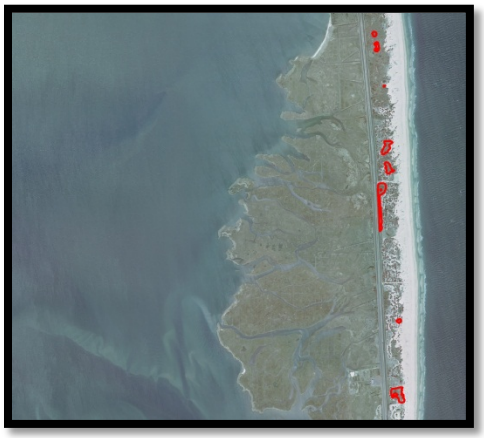
Table 2.2 Rare Animals at Delaware Seashore State Park

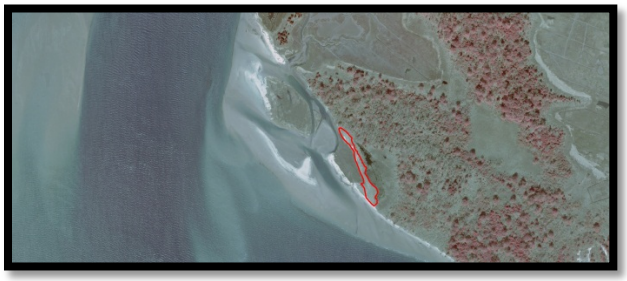
Ecological Integrity Assessment (EIA)

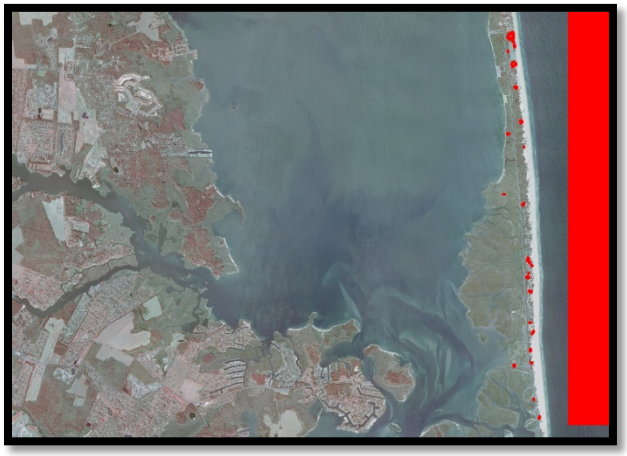
Seventeen vegetation communities are ranked S2 or higher (Table 2.3). These include Atlantic Coast Interdune Swale, Barrier Island Bog, Beachgrass-Panicgrass Dune Grassland, Central Coast Beach Heather Dune Shrubland, Chesapeake Bay Non-riverine Wet Hardwood Forest, Chesapeake Bay Maritime Shrubland, Forked Rush Dune Swale, Loblolly Pine Dune Woodland, Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland, Maritime Red Cedar Woodland, Mid-Atlantic Coast Backdune Grassland, Needlerush High Marsh, Southern Red Maple-Blackgum Swamp, Successional Maritime Forest, and Wax-Myrtle Shrub Swamp.

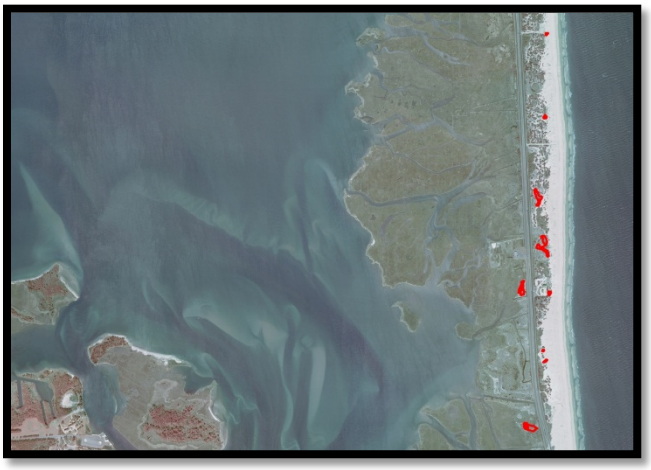
Table 2.3. EIA Vegetation Communities located in Delaware Seashore State Park

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 1a** **Atlantic Coast Interdune Swale (8.3 acres)** **EIA = 3.4 (C rank)**	This interdunal swale community is located in the middle section south of Indian River Inlet.
	**Delaware Seashore 1b** **Atlantic Coast Interdune Swale (0.1 acres)** **EIA = 2.3 (C rank)**	This interdunal swale community is located at the south end of the north section.

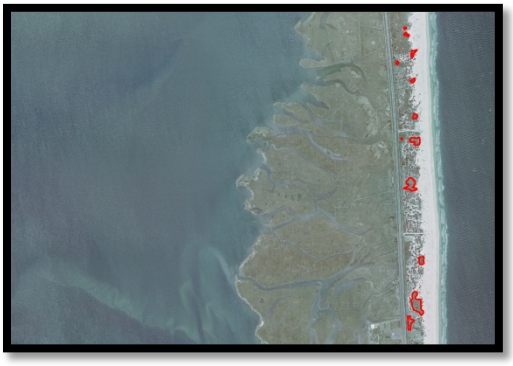
Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 1c** **Atlantic Coast Interdune Swale (108.2 acres)** **EIA = 3.69 (B rank)**	This interdunal swale is located on the strand in the north section.
	**Delaware Seashore 2a** **Barrier Island Bog (3 acres)** **EIA = 3.58 (B rank)**	This interdunal shrubland is located just to the west of DE 1 north of Indian River Inlet.
	**Delaware Seashore 2b** **Barrier Island Bog (5.6 acres)** **EIA = 3.69 (B rank)**	This interdunal swale community is located at the north end of the north section.
	**Delaware Seashore 3a** **Beachgrass-Panicgrass Dune Grassland (0.4 acres)** **EIA = 3.49 (B- rank)**	This maritime grassland is located in the southwestern end of the park north of Fred Hudson Road.

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 3b** **Beachgrass-Panicgrass Dune Grassland (200.7 acres)** **EIA = 4.15 (B rank)**	This maritime grassland is located on the strand north of Indian River inlet.
	**Delaware Seashore 3c** **Beachgrass-Panicgrass Dune Grassland (0.7 acres)** **EIA = 4.22 (B rank)**	This maritime grassland is located on the southwestern side of Burton Island.
	**Delaware Seashore 4a** **Central Coast Beach Heather Dune Shrubland (4.6 acres)** **EIA = 3.82 (B rank)**	This maritime shrubland is located on the strand south of Indian River Inlet.

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 4b** **Central Coast Beach Heather Dune Shrubland (0.2 acres)** **EIA = 3.93 (B rank)**	This maritime shrubland is located in the area of the Delaware Seashore marina and Burton Island.
	**Delaware Seashore 4c** **Central Coast Beach Heather Dune Shrubland (6.6 acres)** **EIA = 4.09 (B rank)**	This maritime shrubland is located on the strand north of Indian River Inlet.
	**Delaware Seashore 5** **Chesapeake Bay Non-riverine Wet Hardwood Forest (24 acres)** **EIA = 3.91 (B rank)**	This wetland forest is located north of Fred Hudson Road between Fresh Pond and Indian River Bay.

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 6a** **Chesapeake Bay Maritime Shrubland (6.4 acres)** **EIA = 4.20 (B+ rank)**	This maritime shrubland is located on the strand south of Indian River inlet and by the marina.
	**Delaware Seashore 6b** **Chesapeake Bay Maritime Shrubland (2.3 acres)** **EIA = 4.0 (B rank)**	This maritime shrubland is located north of Indian River Inlet north of the marina in the middle of north end of the park.

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 6c** **Chesapeake Bay Maritime Shrubland (2.5 acres)** **EIA = 3.93 (B rank)**	This shrub community is located on the strand north of Indian River Inlet at the most northern end of the park.
	**Delaware Seashore 7** **Chesapeake Bay Tall Maritime Shrubland (68.5 acres)** **EIA = 4.04 (B rank)**	This maritime forest community is located on Burton Island and the grounds of the marina.
	**Delaware Seashore 8a** **Forked Rush Dune Swale (1.8 acres)** **EIA = 3.4 (C rank)**	Interdunal swale community that is located on the north side of Indian River Inlet.
	**Delaware Seashore 8b** **Forked Rush Dune Swale (0.6 acres)** **EIA = 3.93 (B rank)**	This interdunal swale community is located at the north end of the north section.

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 8c** **Forked Rush Dune Swale (5.3 acres)** **EIA = 3.73 (B- rank)**	Interdunal swale community that is located in the middle of the north section north of Indian River Inlet.
	**Delaware Seashore 8d** **Forked Rush Dune Swale (1 acre)** **EIA = 3.66 (B rank)**	This interdunal swale community is located at the south end of the north section.
	**Delaware Seashore 8e** **Forked Rush Dune Swale (1 acre)** **EIA = 3.46 (C rank)**	This interdunal swale community is located at the south end of the middle section.
	**Delaware Seashore 9a** **Loblolly Pine Dune Woodland (0.4 acres)** **EIA = 3.87 (B rank)**	This woodland community is located at the northeast end of Burtons Island.

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 9b** **Loblolly Pine Dune Woodland (0.3 acres)** **EIA = 2.73 (C rank)**	This woodland community is located in the middle of the north section.
	**Delaware Seashore 9c** **Loblolly Pine Dune Woodland (1 acre)** **EIA = 3.4 (C rank)**	This woodland community is located at the north end of the middle section just south of Indian River Inlet.
	**Delaware Seashore 10a** **Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland (0.9 acres)** **EIA = 3.26 (C rank)**	Maritime woodland that is located on the south side of Indian River Bay west of Bethany Beach, DE.

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 10b** **Loblolly Pine-Wax-myrtle-Salt Meadow Cordgrass Woodland (1.1 acres)** **EIA = 3.93 (B rank)**	Maritime woodland that is located at the southern end of the park north of Fred Hudson Road.
	**Delaware Seashore 11** **Maritime Red Cedar Woodland (0.3 acres)** **EIA = 3.4 (C rank)**	This maritime woodland is located in the north section.
	**Delaware Seashore 12a** **Mid-Atlantic Coast Backdune Grassland (5.4 acres)** **EIA = 3.53 (B rank)**	This maritime grassland is located in the south section.

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 12b** **Mid-Atlantic Coast Backdune Grassland (107.2 acres)** **EIA = 4.06 (B rank)**	This maritime grassland is located on the strand of both the north and middle sections.
	**Delaware Seashore 13** **Mid-Atlantic Maritime Forest (0.7 acres)** **EIA = 4.2 (B rank)**	This maritime forest is located at the western end of Burtons Island.
	**Delaware Seashore 14a** **Needlerush High Marsh (3 acres)** **EIA = 3.86 (B rank)**	This high marsh community is located just south of the Bethany Beach cross-cut canal.
	**Delaware Seashore 14b** **Needlerush High Marsh (2.5 acres)** **EIA = 3.86 (B rank)**	This high marsh community is located in the south section, south of Fred Hudson Road at the north end of Fresh Pond.

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 14c** **Needlerush High Marsh (0.03 acres)** **EIA = 3.73 (B rank)**	This high marsh community is located in the south section of the park.
	**Delaware Seashore 15** **Southern Red Maple-Blackgum Swamp (85.4 acres)** **EIA = 3.75 (B rank)**	This swamp community is located in the south section of the park north of Fred Hudson Road.
	**Delaware Seashore 16a** **Successional Maritime Forest (16 acres)** **EIA = 3.63 (B rank)**	This maritime forest community is located in the south section of the park.
	**Delaware Seashore 16b** **Successional Maritime Forest (1.5 acres)** **EIA = 3.3 (C rank)**	This maritime forest community is located in the Burtons Island area of the north section.

Community Map	Community Name/EIA Score	Description
	**Delaware Seashore 16c** **Successional Maritime Forest (0.4 acres)** **EIA = 3.84 (B rank)**	This maritime forest community is located in the north section north of Indian River Inlet and west of DE 1.
	**Delaware Seashore 17a** **Wax-Myrtle Shrub Swamp (0.5 acres)** **EIA = 3.23 (B rank)**	This shrubland is located in the roadside ditches of DE 1 in the south section of the park.
	**Delaware Seashore 17b** **Wax-Myrtle Shrub Swamp (0.7 acres)** **EIA = 4.37 (B+ rank)**	This shrubland is located on Burtons Island.

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 Delaware Seashore State Park

One forest block is present that are more than 100 acres in size and are located in whole or part in Delaware Seashore State Park (Table 2.4 and Figure 2.1). 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.

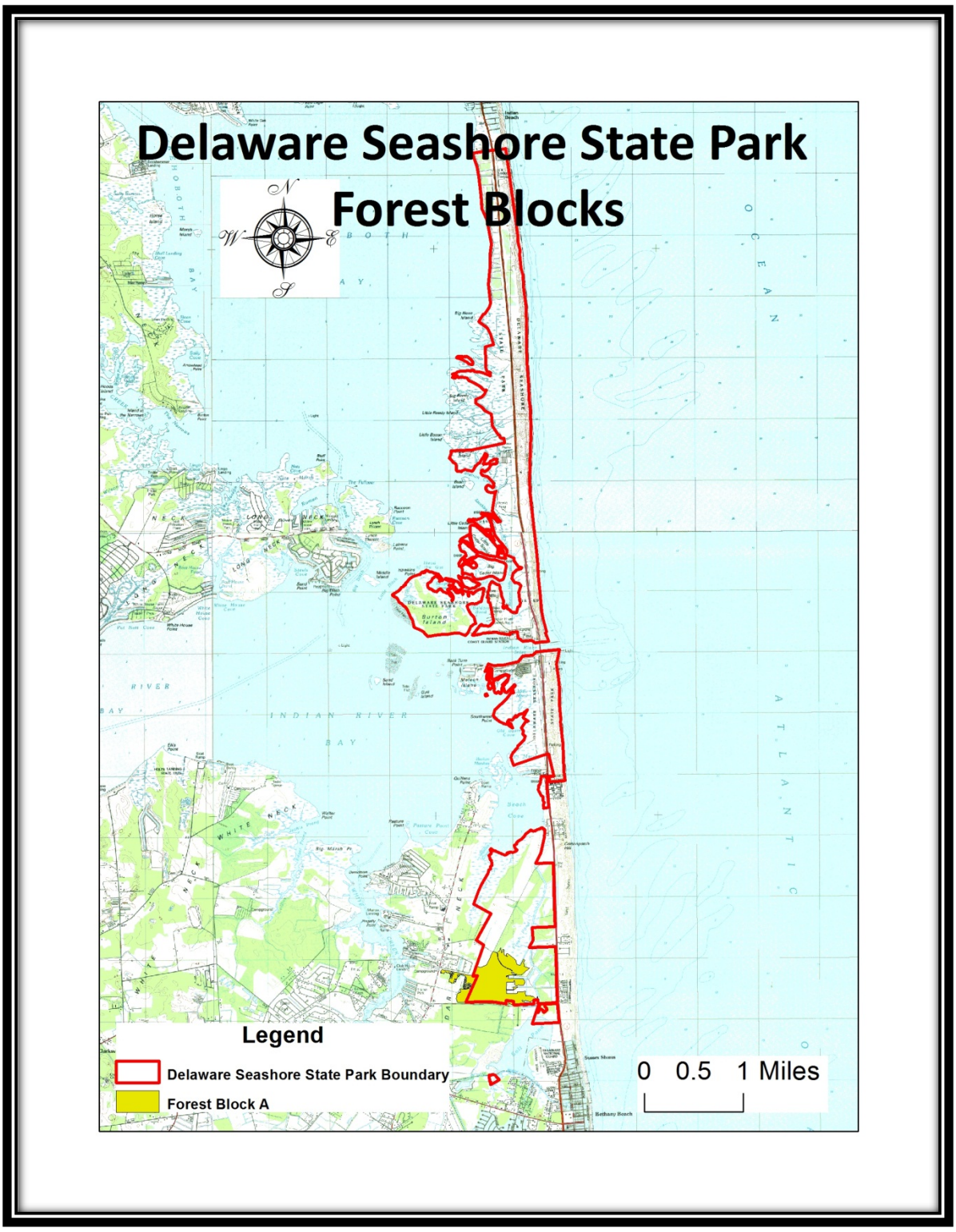


Figure 2.1. Forest Blocks in Delaware Seashore State Park

Table 2.4. Forest Blocks located in whole or part in Delaware Seashore State Park

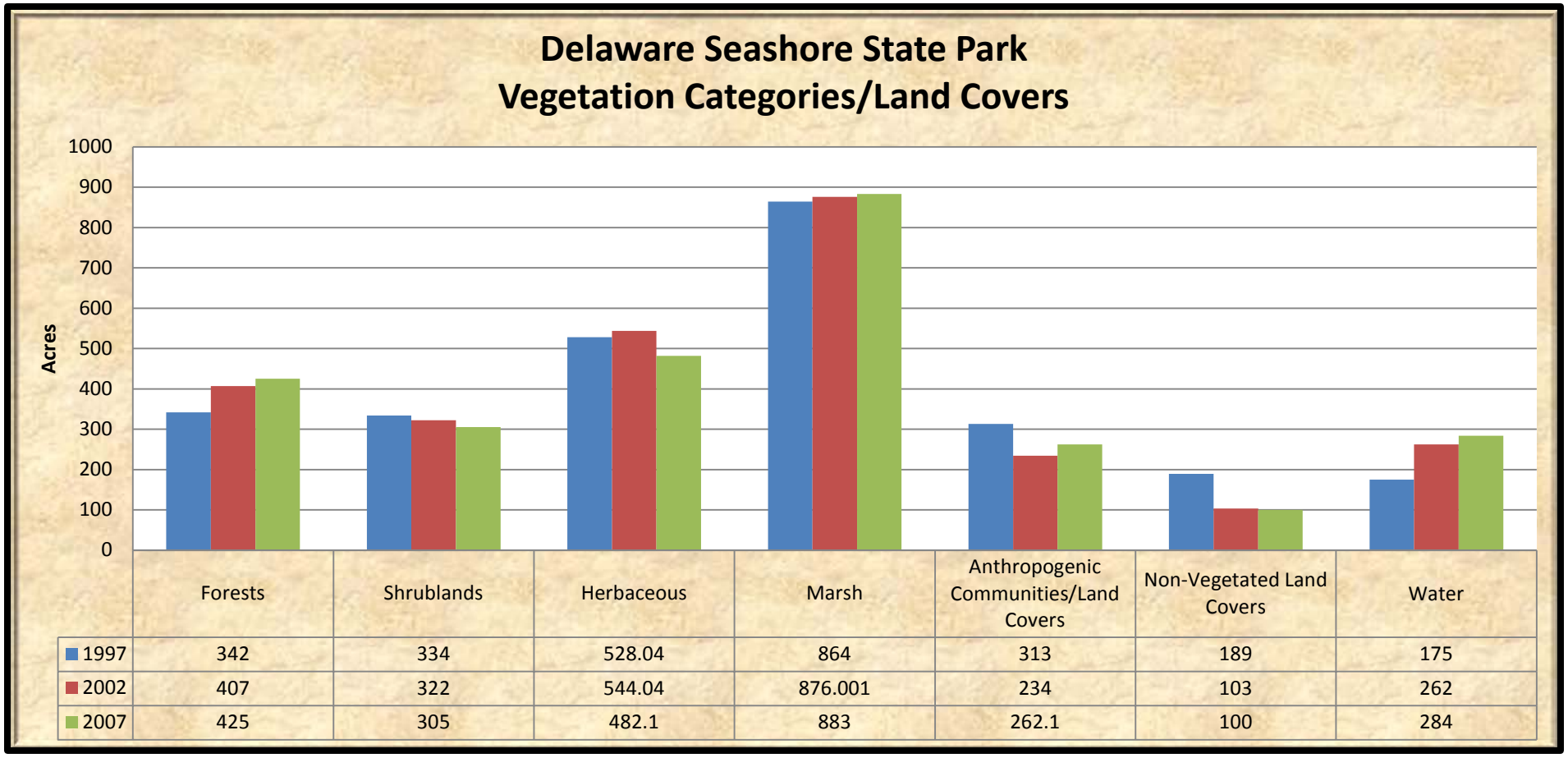
Forest Block Map	Block Name/Acreage	Description
	**Delaware Seashore A** **Current Block = 164 acres (40 acres interior)** **Potential Block = 747 acres (243 acres interior)**	Delaware Seashore A is located west of a canal between Fresh Pond and Indian River Bay. It is bounded by field area on the north, the canal on the east, Fred Hudson Road on the south, and developed area on the west. Three vegetation communities are located within this block and include Chesapeake Bay Non-riverine Wet Hardwood Forest, Early to Mid-Successional Loblolly Pine Forest, and Southern Red Maple-Blackgum Swamp. Indian River Bay is the drainage for this block. Currently this block contains 40 acres of interior habitat. Potentially this block could be 747 acres in size and contain 243 acres of interior habitat.

The Natural Progression of vegetation communities on the shores of the Inland Bays

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.

At Delaware Seashore State Park it was observed in places that the marsh is coming into the forested areas and appears to be largely skipping over the shrubland stage, though not as much as Assawoman Wildlife Area[39]. The amount of North Atlantic High Salt Marsh has decreased markedly from 1937 levels and has converted to North Atlantic Low Salt Marsh or water. Ditching in the marshes 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.

[39] Coxe, Robert. 2012. Vegetation Community and Land Use Change Analysis of Assawoman Wildlife Area Sussex County, Delaware. Unpublished Delaware Natural Heritage and Endangered Species Report.



	Forests	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1997	342	334	528.04	864	313	189	175
2002	407	322	544.04	876.001	234	103	262
2007	425	305	482.1	883	262.1	100	284

Figure 3.1. Delaware Seashore State Park Vegetation Categories/Land Covers (1997, 2002, and 2007)

Delaware Seashore State Park Broad Trends (Figure 3.1): Marshland has been increasing in the Park and remains the dominant vegetation community category in the park. Herbaceous communities are the next largest category and have been decreasing over the study period. Forests and water have increased the most.

DNREC Sea Level Rise Analysis (Table 3.1)

At 1.5 m of sea level rise, about 87% of the park will be inundated with water. More than half of the park will be flooded with 0.5 m of rise.

Table 3.1. Projected acres of Delaware Seashore State Park Impacted by Sea Level Rise

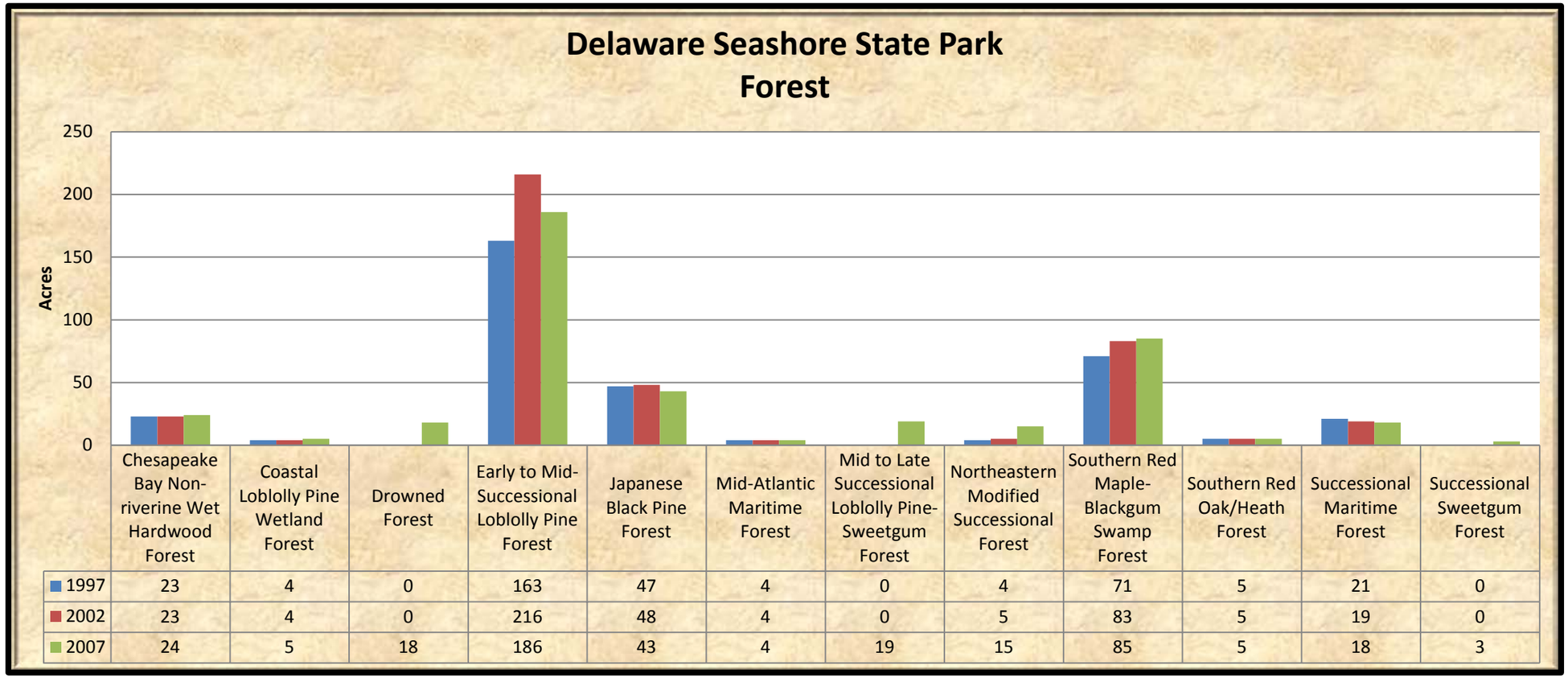
Rise	Acres
0.5 m	1,724 acres
1 m	2,167 acres
1.5 m	2,405 acres

Natural Capital (Table 3.2)

Natural capital of Delaware Seashore State Park has been going up with reforestation and sea level rise increasing the amount of water.

Table 3.2. Natural Capital of Delaware Seashore State Park

Year	Natural Capital (in 2012 dollars)
1997	$11,133,150/year
2002	$11,338,613/year
2007	$11,967,056/year



	Chesapeake Bay Non-riverine Wet Hardwood Forest	Coastal Loblolly Pine Wetland Forest	Drowned Forest	Early to Mid-Successional Loblolly Pine Forest	Japanese Black Pine Forest	Mid-Atlantic Maritime Forest	Mid to Late Successional Loblolly Pine-Sweetgum Forest	Northeastern Modified Successional Forest	Southern Red Maple-Blackgum Swamp Forest	Southern Red Oak/Heath Forest	Successional Maritime Forest	Successional Sweetgum Forest
1997	23	4	0	163	47	4	0	4	71	5	21	0
2002	23	4	0	216	48	4	0	5	83	5	19	0
2007	24	5	18	186	43	4	19	15	85	5	18	3

Figure 3.2. Forest at Delaware Seashore State Park (197, 2002, and 2007)

Delaware Seashore State Park Forest (Figure 3.2): Early to Mid-Successional Loblolly Pine Forest is the most common forested community in the park and has driven a lot of the gains in forest area. Southern Red Maple-Blackgum Swamp Forest is the next most common and has gained area as other forests mature into this type. Japanese Black Pine Forest has been decreasing in the park.

DNREC Sea Level Rise Analysis (Table 3.3)

Forest will be heavily impacted by sea level rise in Delaware Seashore State Park. A lot of the forestland is located in the South Section and on Burton Island. At 1.5 m of rise, almost 90% of the current forestland will be inundated.

Table 3.3. Projected acres of Delaware Seashore State Park Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	275 acres
1 m	339 acres
1.5 m	379 acres

Natural Capital (Table 3.4)

Capital of forestland has been going up as the park is reforested, especially in the South Section.

Table 3.4. Natural Capital of Delaware Seashore State Park Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,250,707/year
2002	$1,408,228/year
2007	$1,665,801/year

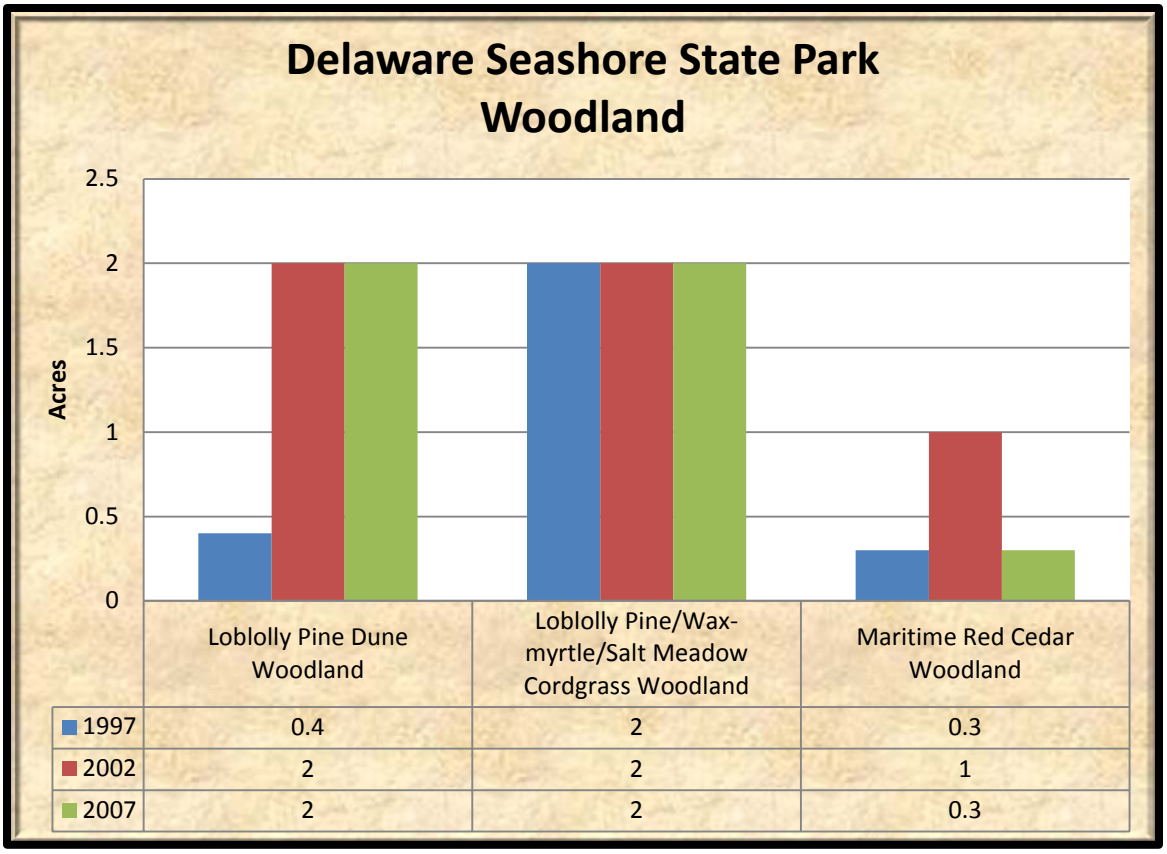


Figure 3.3. Woodland at Delaware Seashore State Park (1997, 2002, and 2007)

Delaware Seashore State Park Woodland (Figure 3.3): Few woodland types are present in the park and mainly consist of Loblolly Pine Dune Woodland and Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland.

DNREC Sea Level Rise Analysis (Table 3.5)

Woodland will be practically eliminated at 0.5 m of sea level rise. An additional 0.5 m of rise will seal its fate.

Table 3.5. Projected acres of Delaware Seashore State Park Woodland Impacted by Sea Level Rise

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

Natural Capital (Table 3.6)

Capital of woodland has oscillated over the study period with increases and losses of Maritime Red Cedar Woodland.

Table 3.6. Natural Capital of Delaware Seashore State Park Woodland	
Year	**Natural Capital (in 2012 dollars)**
1997	$529/year
2002	$946/year
2007	$813/year

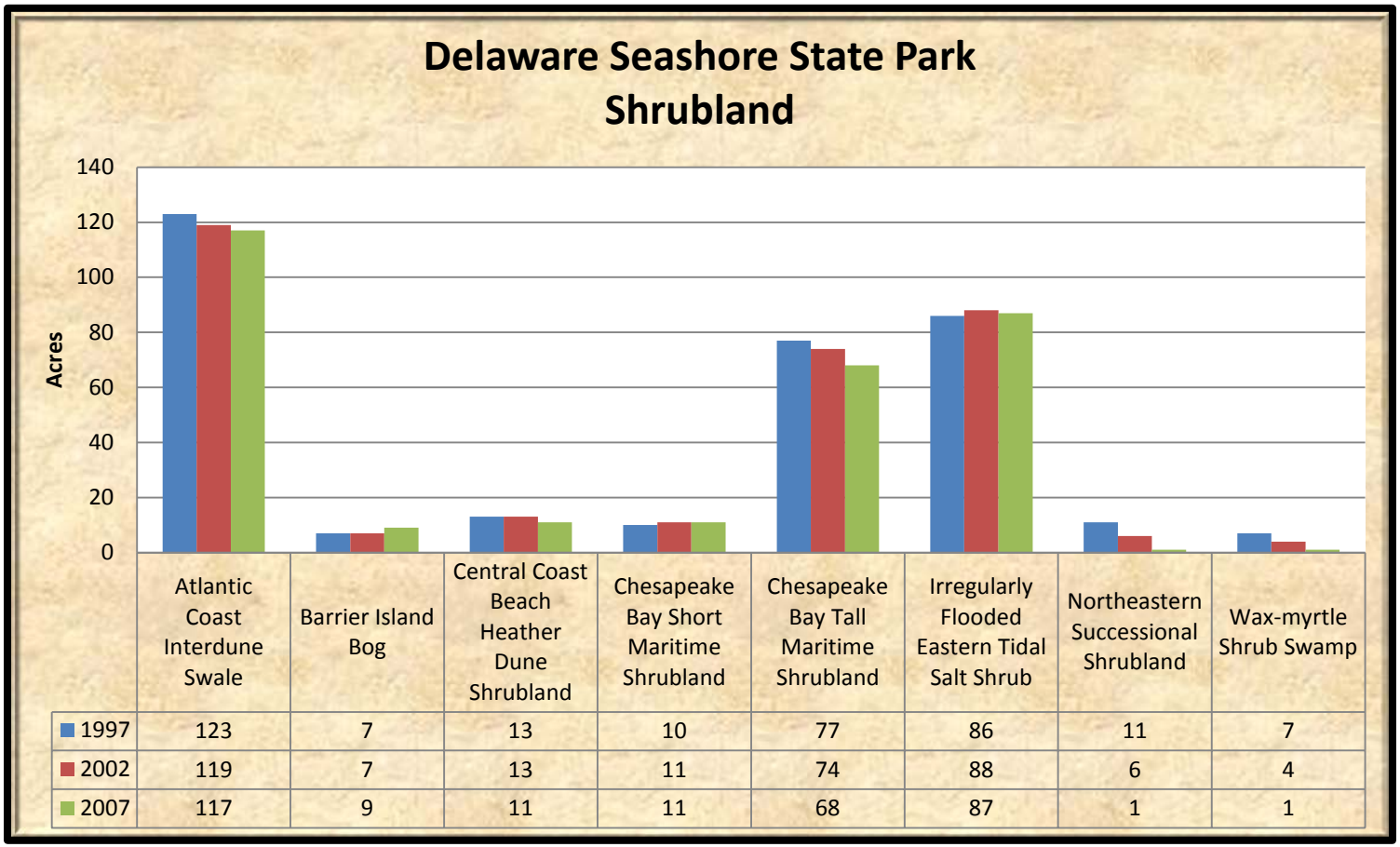


Figure 3.4. Shrubland at Delaware Seashore State Park (1997, 2002, and 2007)

Delaware Seashore State Park Shrubland (Figure 3.4): Atlantic Coast Interdune Swale is the most common shrubland in the park and covers large areas of the depressions between the dunes. Irregularly Flooded Eastern Tidal Salt Shrub is the next most common shrubland and has

remained steady in amount. A lot of these communities have fluctuated due to the fact that they are continually covered and uncovered by sand in the dunes.

DNREC Sea Level Rise Analysis (Table 3.7)

More than half of the current acreage of shrubland will be flooded with 0.5 m of sea level rise and almost be eliminated at 1.5 m of sea level rise.

Table 3.7. Projected acres of Delaware Seashore State Park Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	157 acres
1 m	264 acres
1.5 m	287 acres

Natural Capital (Table 3.8)

Capital of shrubland has been decreasing as shrubland succeed into more mature forests or are eliminated from sea level rise.

Table 3.8. Natural Capital of Delaware Seashore State Park Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,815,212/year
2002	$1,778,246/year
2007	$1,737,560/year

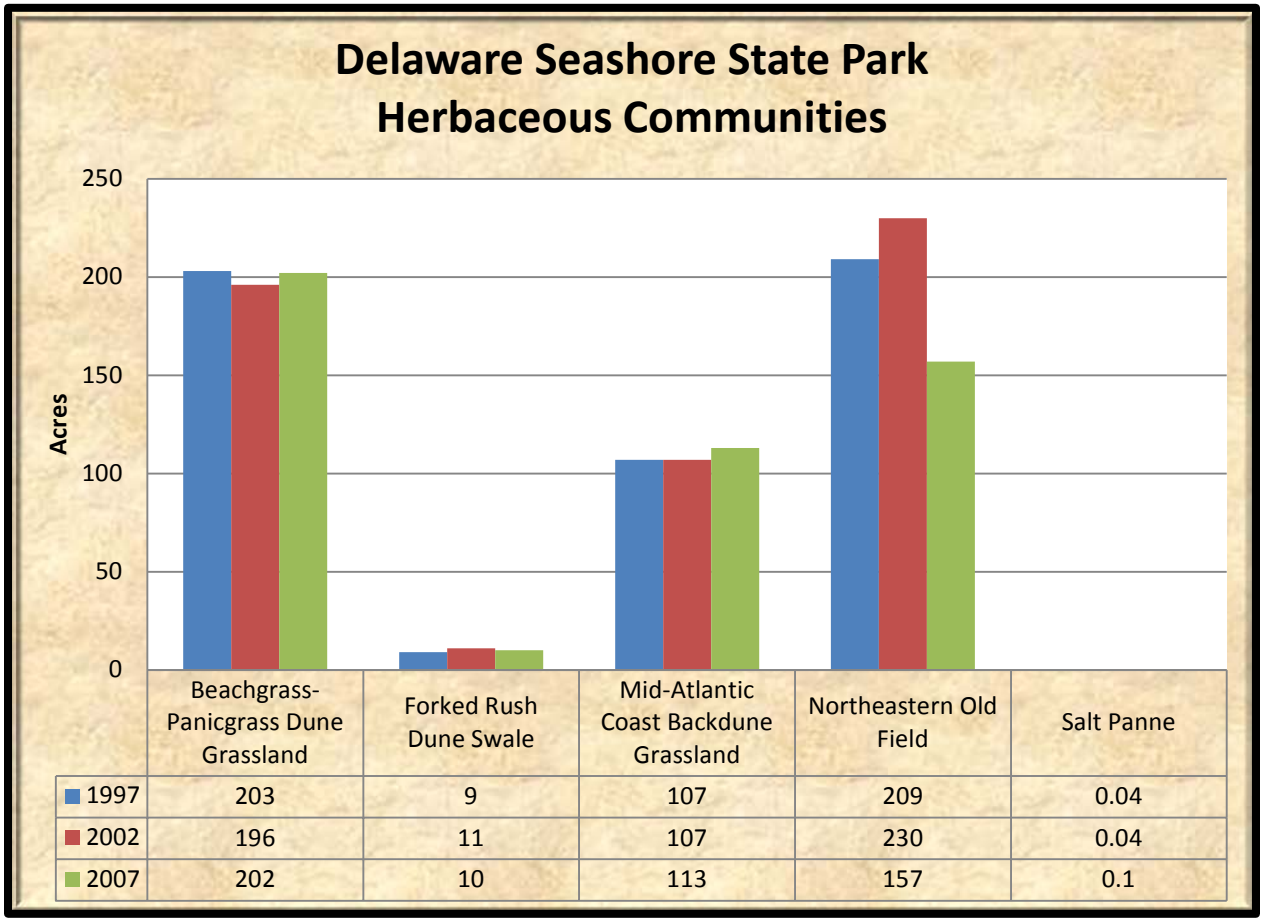


Figure 3.5. Herbaceous Communities at Delaware Seashore State Park (1997, 2002, and 2007)

Delaware Seashore State Park Herbaceous Communities (Figure 3.5): Beachgrass-Panicgrass Dune Grassland is the most common grassland in the park and covers most of the primary dunes in the park. Northeastern Old Field is the next most common and covers most of an abandoned agricultural field.

DNREC Sea Level Rise Analysis (Table 3.9)

A little more than half of the current acreage of herbaceous communities will be flooded with 1.5 m of sea level rise. Most of these communities are located in places of higher elevation on the tops of dunes.

Table 3.9. Projected acres of Delaware Seashore State Park Herbaceous Communities Impacted by Sea Level Rise

Rise	Acres
0.5 m	77 acres
1 m	157 acres
1.5 m	249 acres

Natural Capital (Table 3.10)

Capital of herbaceous communities has been transferred to more mature communities as these communities succeed.

Table 3.10. Natural Capital of Delaware Seashore State Park Herbaceous Communities

Year	Natural Capital (in 2012 dollars)
1997	$84,900/year
2002	$87,085/year
2007	$77,964/year

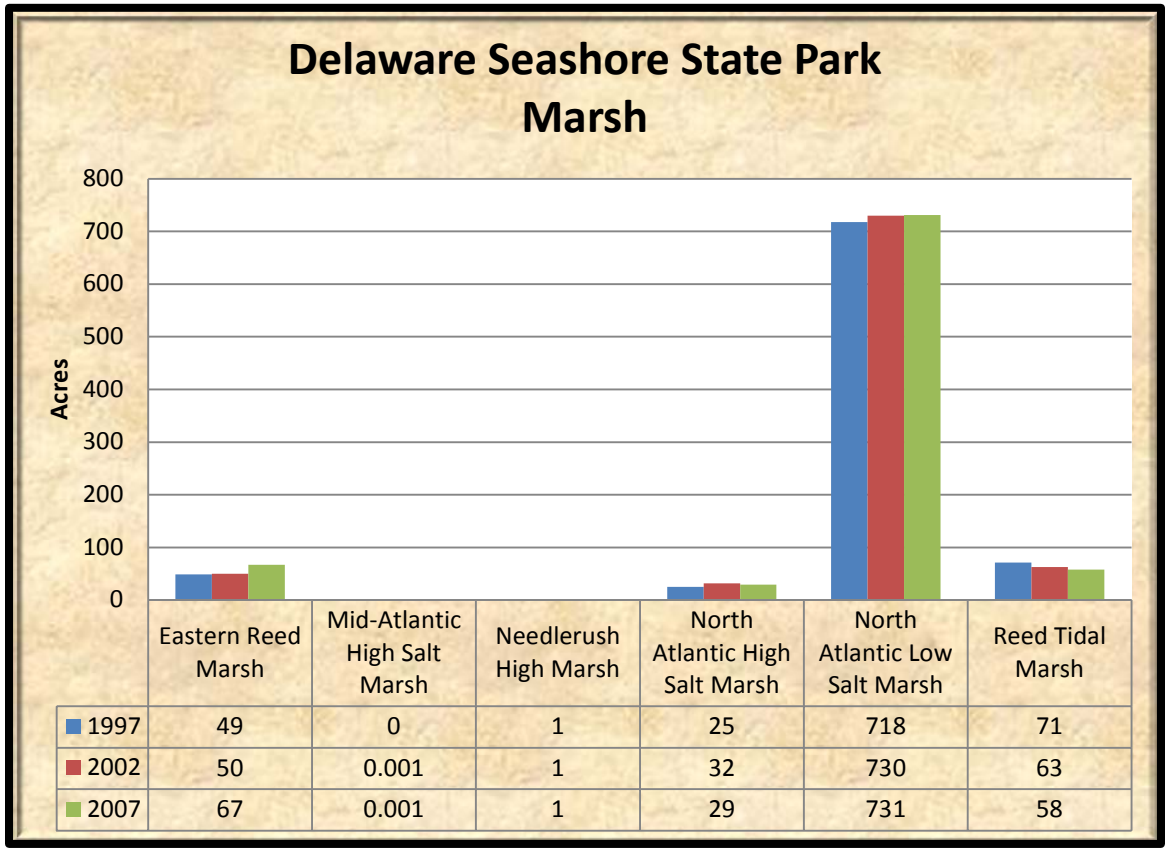


Figure 3.7. Marsh at Delaware Seashore State Park (1997, 2002, and 2007)

Delaware Seashore State Park Marsh (Figure 3.7): North Atlantic Low Salt Marsh is the largest marsh community in the park followed by Eastern Reed Marsh. Marshes in general have increased in area over the study period.

DNREC Sea Level Rise Analysis (Table 3.11)

Most of the marshland will be flooded with 0.5 m of sea level rise and will be completely inundated with 1 m of rise.

Table 3.11. Projected acres of Delaware Seashore State Park Marsh Impacted by Sea Level Rise

Rise	Acres
0.5 m	874 acres
1 m	883 acres
1.5 m	883 acres

Natural Capital (Table 3.12)

Capital of marshland has been rising as marsh converts adjacent communities. Marshland capital accounts for almost half of the total natural capital in the park.

Table 3.12. Natural Capital of Delaware Seashore State Park Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$5,550,345/year
2002	$5,631,396/year
2007	$5,742,019/year

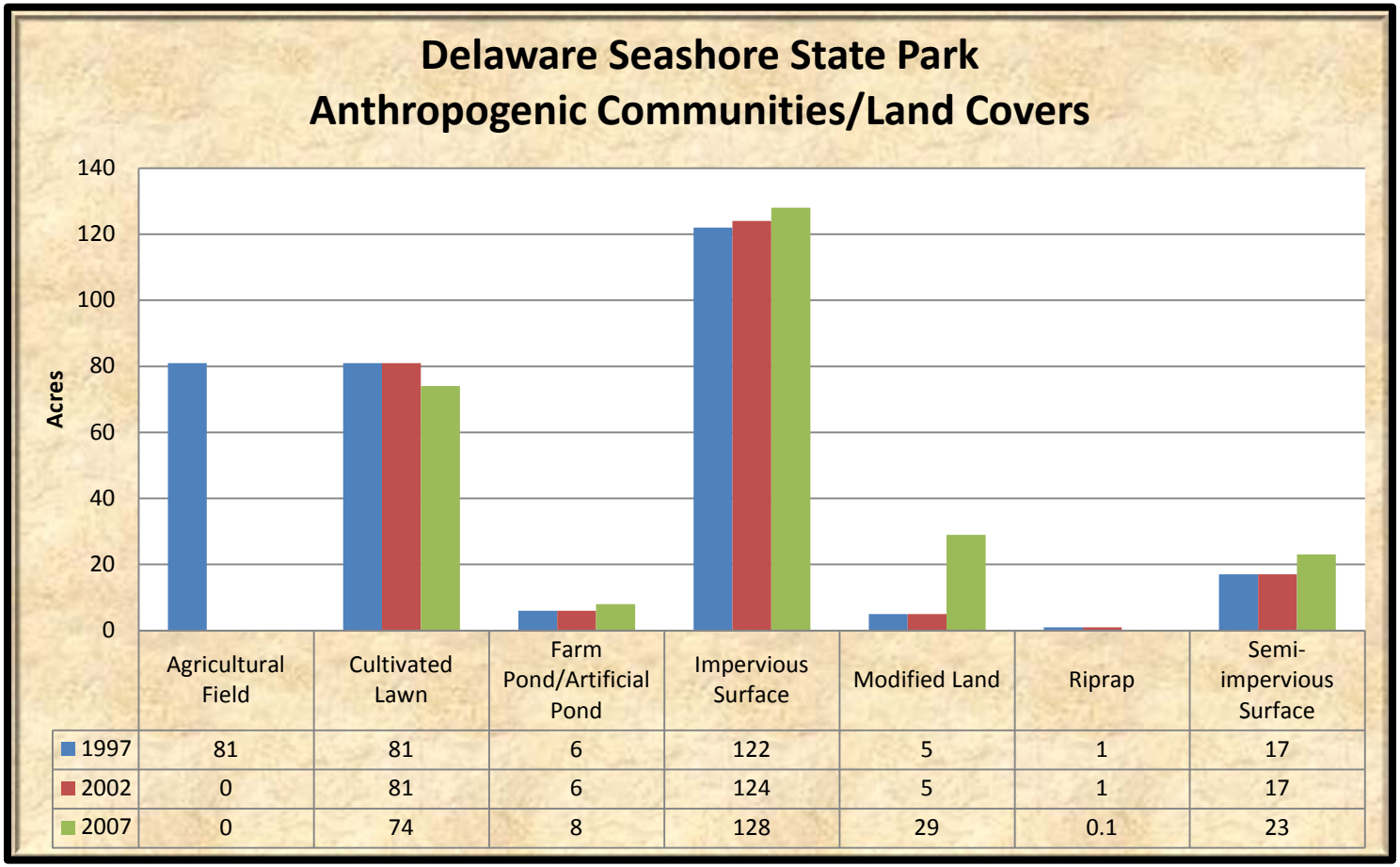


Figure 3.8. Anthropogenic Communities/land covers at Delaware Seashore State Park (1997, 2002, and 2007)

Delaware Seashore State Park Anthropogenic Communities/Land Covers (Figure 3.8): Impervious surface in the form of roads and parking lots is the largest anthropogenic community/ land cover followed by the closely associated cultivated lawn. A former agricultural field that was present in 1997 is now a Northeastern Old Field.

DNREC Sea Level Rise Analysis (Table 3.13)

A little less than a quarter of the anthropogenic communities/land covers will be inundated by 0.5 m of sea level rise. However, over 90% will be covered with 1.5 m of sea level rise resulting in infrastructure losses and expense.

Table 3.13. Projected acres of Delaware Seashore State Park Anthropogenic Communities/Land Covers Impacted by Sea Level Rise

Rise	Acres
0.5 m	62 acres
1 m	199 acres
1.5 m	239 acres

Natural Capital (Table 3.14)

Capital of anthropogenic communities/land covers has gone up with an increase in artificial ponds.

Table 3.14. Natural Capital of Delaware Seashore State Park Anthropogenic Communities/Land Covers

Year	Natural Capital (in 2012 dollars)
1997	$36,666/year
2002	$32,011/year
2007	$42,681/year

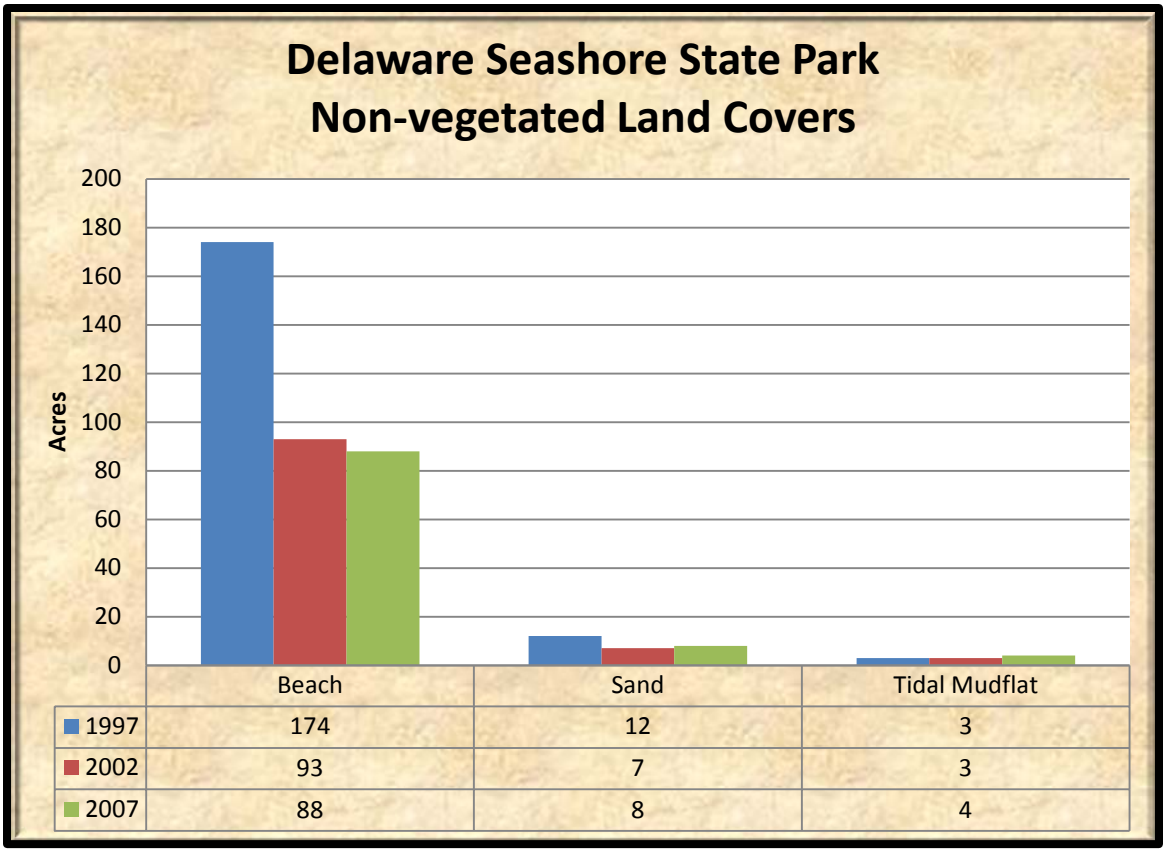


Figure 3.9. Non-vegetated Land Covers at Delaware Seashore State Park (1997, 2002, and 2007)

Delaware Seashore State Park Non-vegetated Land Covers (Figure 3.9): Beach is the most common non-vegetated community and has decreased a little more than half through the study period.

DNREC Sea Level Rise Analysis (Table 3.15)

About 20% of the Non-vegetated Land Covers will be flooded with 0.5 m of sea level rise and at 1.5 m of rise; about 70% will be inundated.

Table 3.15. Projected acres of Delaware Seashore State Park Non-vegetated Land Covers Impacted by Sea Level Rise

Rise	Acres
0.5 m	20 acres
1 m	38 acres
1.5 m	70 acres

Natural Capital (Table 3.16)

Tidal mudflat is the only non-vegetated land cover with any natural capital value in the park and has gone up recently with more acreage.

Table 3.16. Natural Capital of Delaware Seashore State Park Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1997	$12,543/year
2002	$6,271/year
2007	$18,814/year

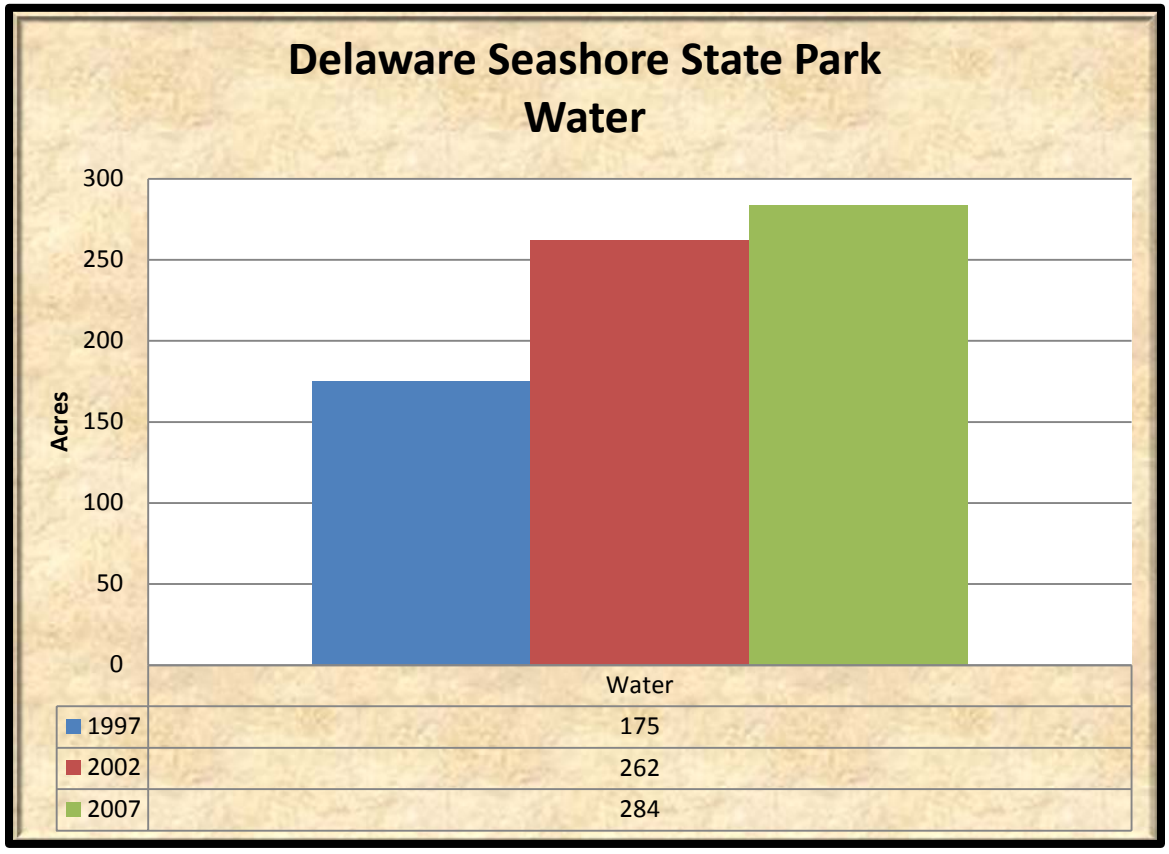


Figure 3.10. Water coverage (non-impoundment) at Delaware Seashore State Park (1997, 2002, and 2007)

Delaware Seashore State Park Water (Figure 3.10): Water coverage has been increasing over the study period and presumably driven by sea level rise and maybe erosion.

Natural Capital (Table 3.4)

As might be expected the capital of water has been going up with an increase in water. Most of the increases have been happening on the bay side adding to the overall capital of the park.

Table 3.4. Natural Capital of Delaware Seashore State Park Water	
Year	**Natural Capital (in 2012 dollars)**
1997	$2,382,257/year
2002	$2,394,431/year
2007	$2,681,404/year

CHAPTER 4: VEGETATION COMMUNITIES BY SECTION

1. Middle Section

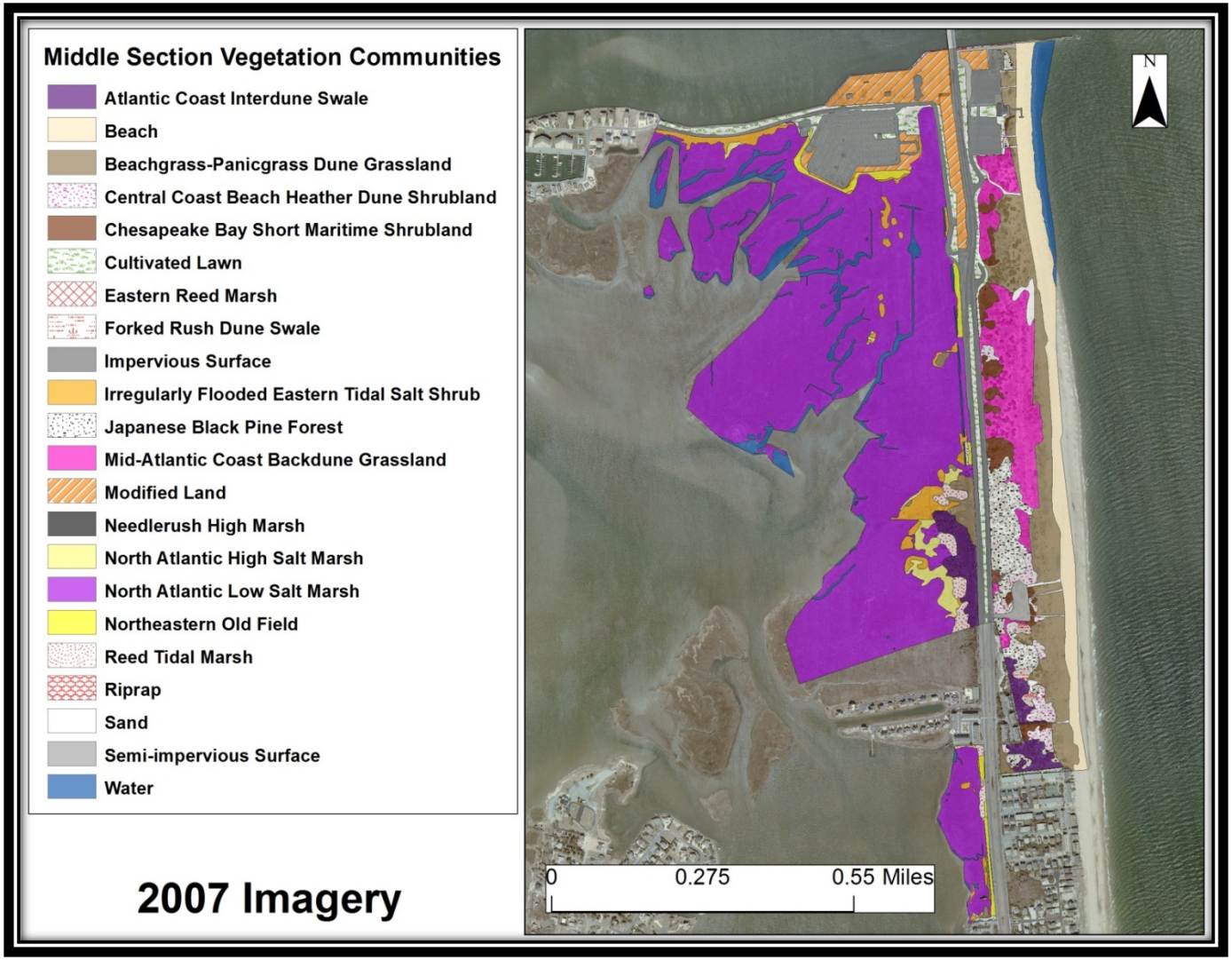


Figure 4-1.1. 2007 Vegetation Community map of the Middle Section

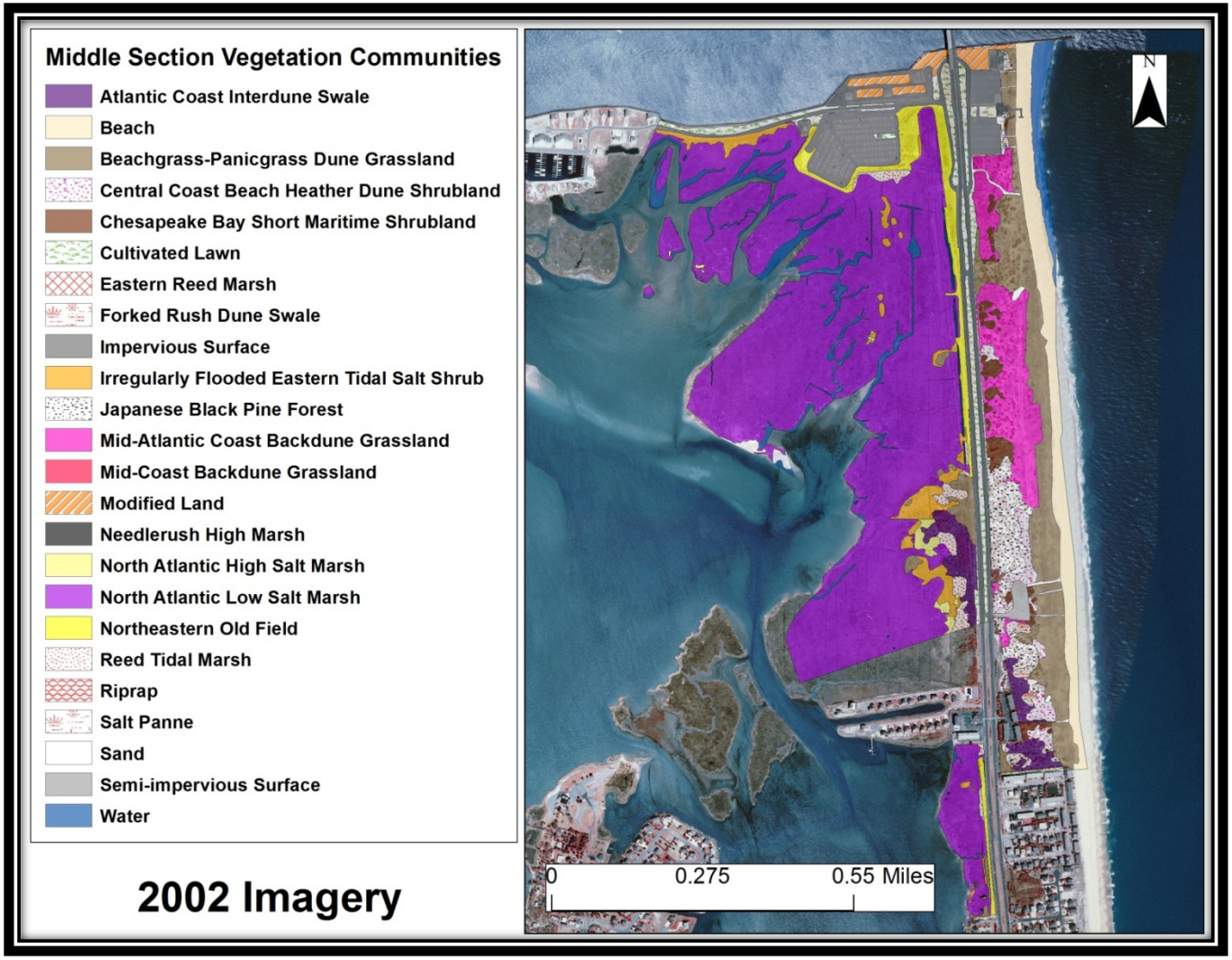


Figure 4-1.2. 2002 Vegetation Community map of the Middle Section

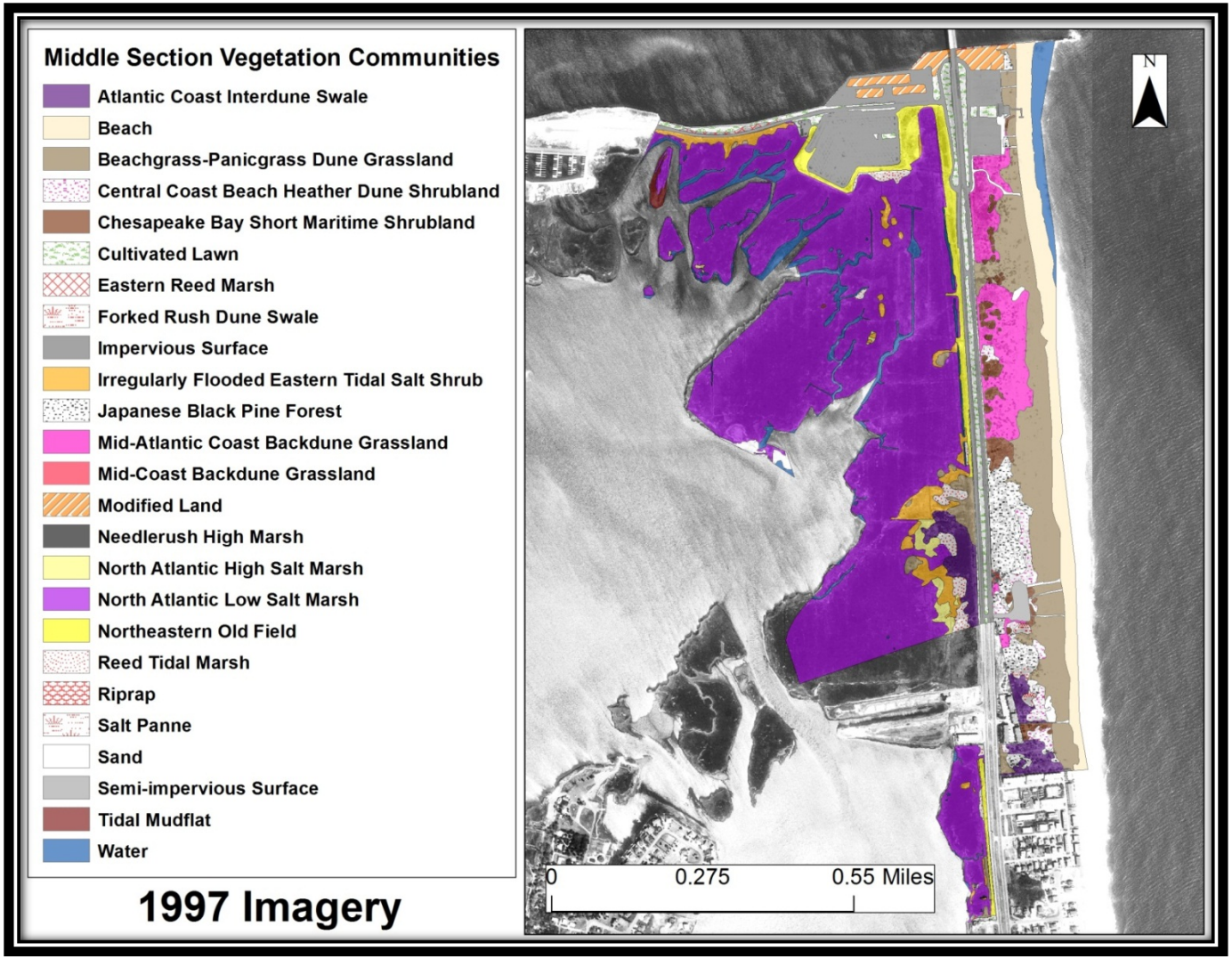


Figure 4-1.3. 1997 Vegetation Community map of the Middle Section

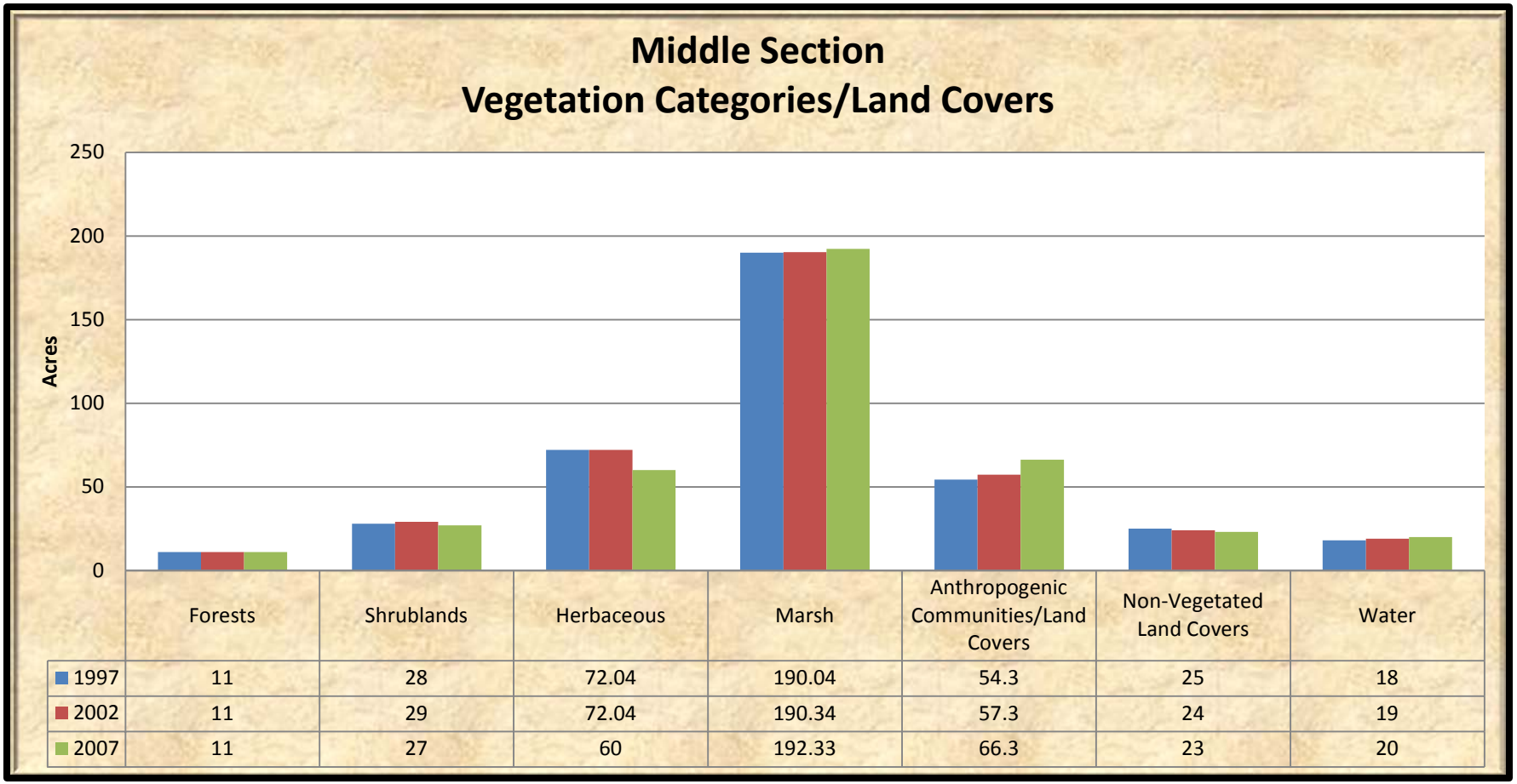


Figure 4-1.4. Middle Section Vegetation Categories/Land Covers (1997, 2002, and 2007)

Middle Section Broad Trends (Figure 4-1.4): The middle section is primarily covered in marsh and secondarily in herbaceous communities. Anthropogenic communities cover a fairly significant area as compared to the size of the area.

DNREC Sea Level Rise Analysis (Table 4-1.1)

More than ¾ of the Middle Section will be inundated with 1.5 m of sea level rise and more than half will be flooded with 0.5 m of rise.

Table 4-1.1. Projected acres of the Middle Section Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	255 acres
1 m	286 acres
1.5 m	315 acres

Natural Capital (Table 4-1.2)

Natural capital of the Middle Section has been going up with increases in marsh and water acreage.

Table 4-1.2. Natural Capital of the Middle Section	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,544,809/year
2002	$1,565,187/year
2007	$1,568,636/year

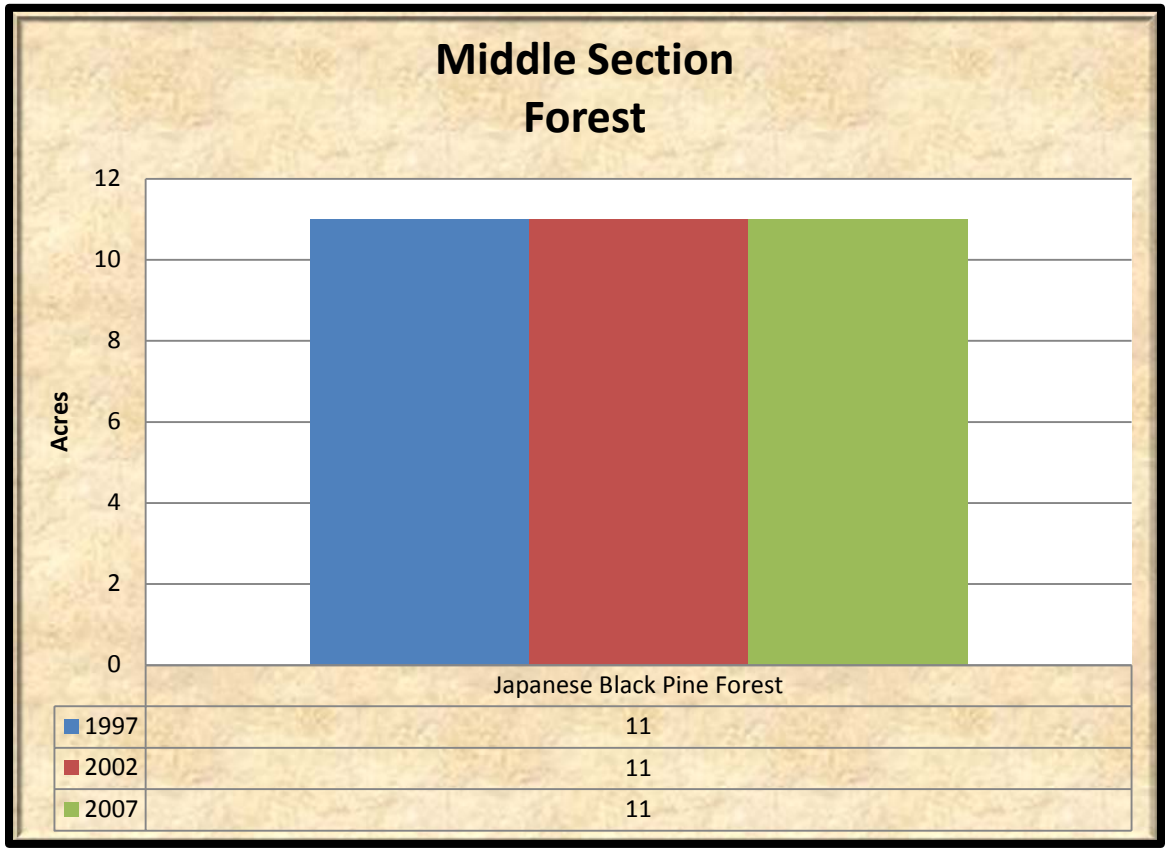


Figure 4-1.5. Middle Section Forest (1997, 2002, and 2007)

Middle Section Forest (Figure 4-1.5): Japanese Black Pine Forest is the largest and only forested community present in the middle section. It has remained at the same amount through the study period.

DNREC Sea Level Rise Analysis (Table 4-1.3)

About 2/3 of the forestland in the Middle Section will be flooded with 1.5 m of sea level rise. No effects will be seen with 0.5 m of rise.

Table 4-1.3. Projected acres of Middle Section Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	1 acre
1.5 m	7 acres

Natural Capital (Table 4-1.4)

The capitalization of Middle Section forest has remained at the same through the study period.

Table 4-1.4. Natural Capital of Middle Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$2,080/year
2002	$2,080/year
2007	$2,080/year

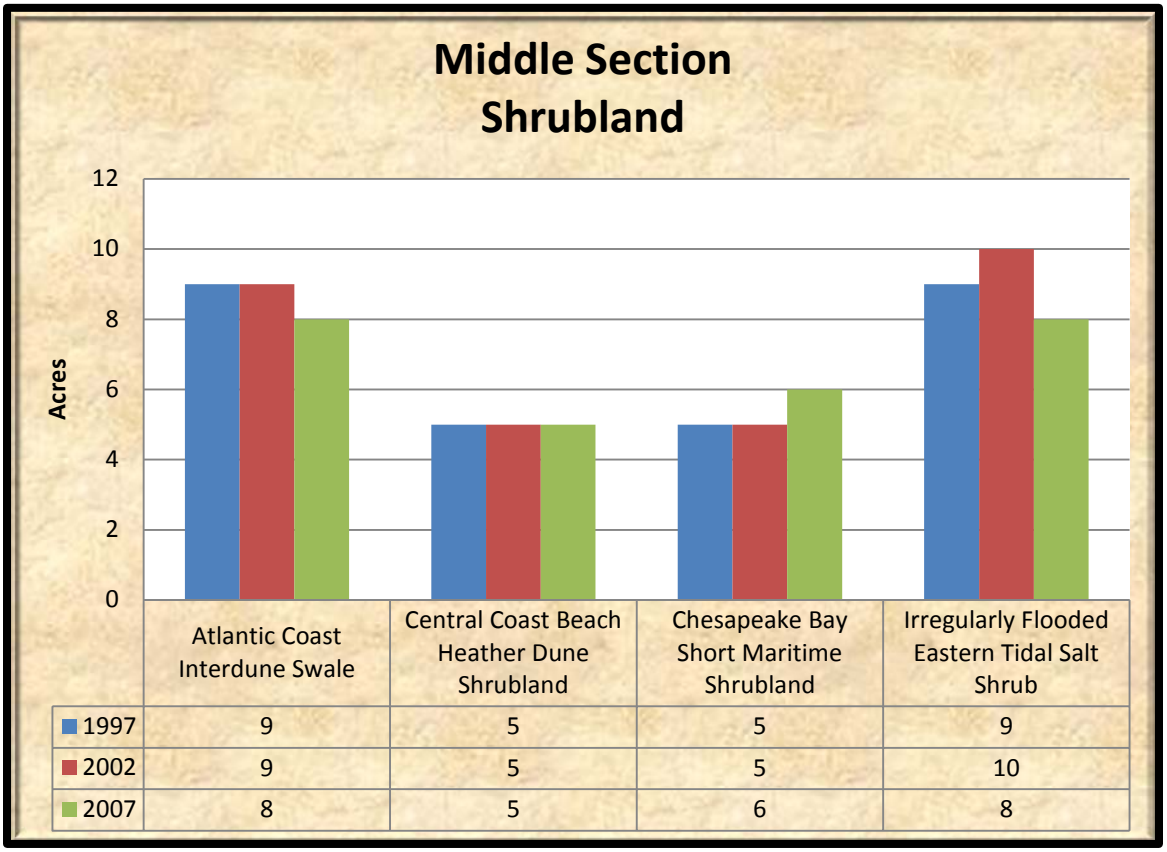


Figure 4-1.6. Middle Section Shrubland (1997, 2002, and 2007)

Middle Section Shrubland (Figure 4-1.6): Irregularly Flooded Eastern Tidal Salt Shrub and Atlantic Coast Interdune Swale are the most common shrublands in the middle section.

DNREC Sea Level Rise Analysis (Table 4-1.5)

A little less than ¾ of the current shrubland in the Middle Section will be inundated with 1.5 m of sea level rise.

Table 4-1.5. Projected acres of Middle Section Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	11 acres
1 m	13 acres
1.5 m	19 acres

Natural Capital (Table 4-1.6)

Capital in shrubland has been going down due to losses in swales and Irregularly Flooded Eastern Tidal Salt Shrub.

Table 4-1.6. Natural Capital of Middle Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$141,428/year
2002	$147,699/year
2007	$126,021/year

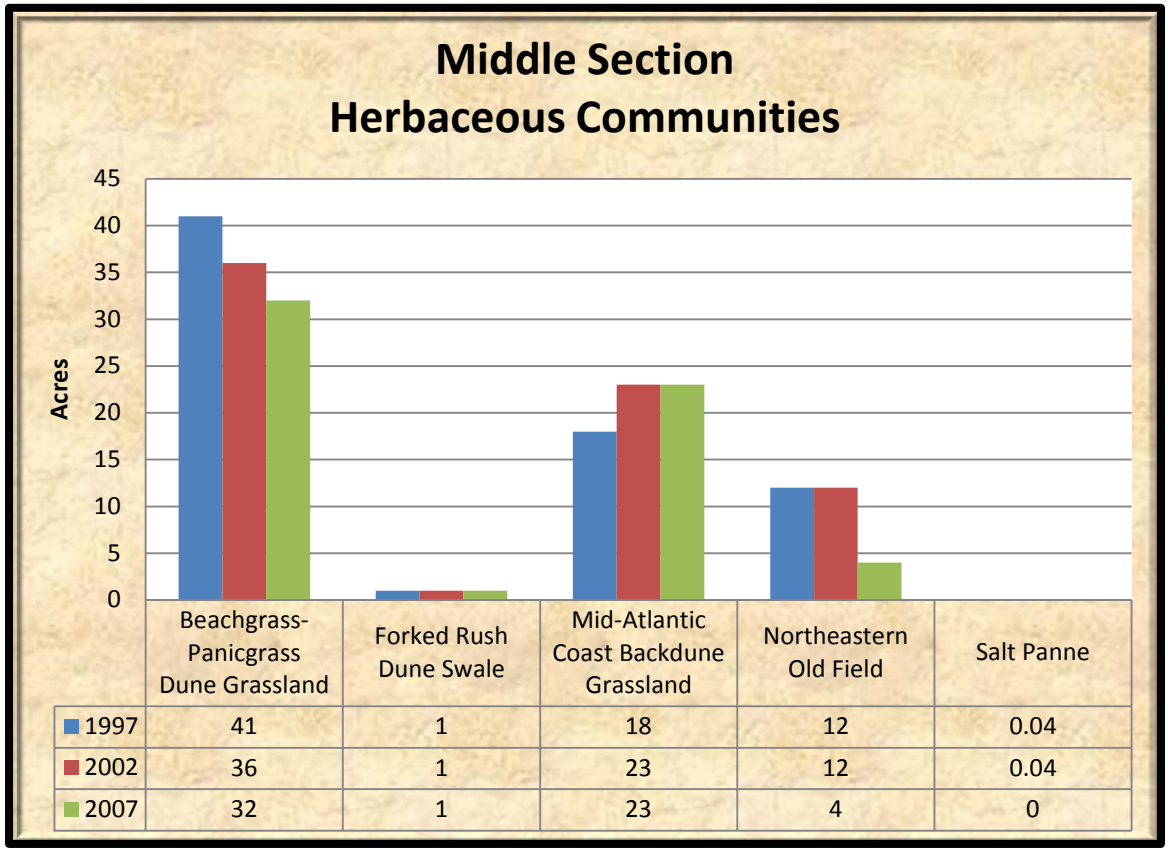


Figure 4-1.7. Middle Section Herbaceous Communities (1997, 2002, and 2007)

Middle Section Herbaceous Communities (Figure 4-1.7): Beachgrass-Panicgrass Dune Grassland is the most common herbaceous community, followed by Mid-Atlantic Coast Backdune Grassland.

DNREC Sea Level Rise Analysis (Table 4-1.7)

Less than ¼ of the current acreage of herbaceous communities in the Middle Section will be affected by sea level rise. Most of these communities are located at the tops of dunes at higher elevations.

Table 4-1.7. Projected acres of Middle Section Herbaceous Communities Impacted by Sea Level Rise

Rise	Acres
0.5 m	5 acres
1 m	8 acres
1.5 m	12 acres

Natural Capital (Table 4-1.8)

Natural capital of herbaceous communities has been falling with decreases in Beachgrass-Panicgrass Dune Grassland.

Table 4-1.8. Natural Capital of Middle Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1997	$19,626/year
2002	$19,626/year
2007	$17,878/year

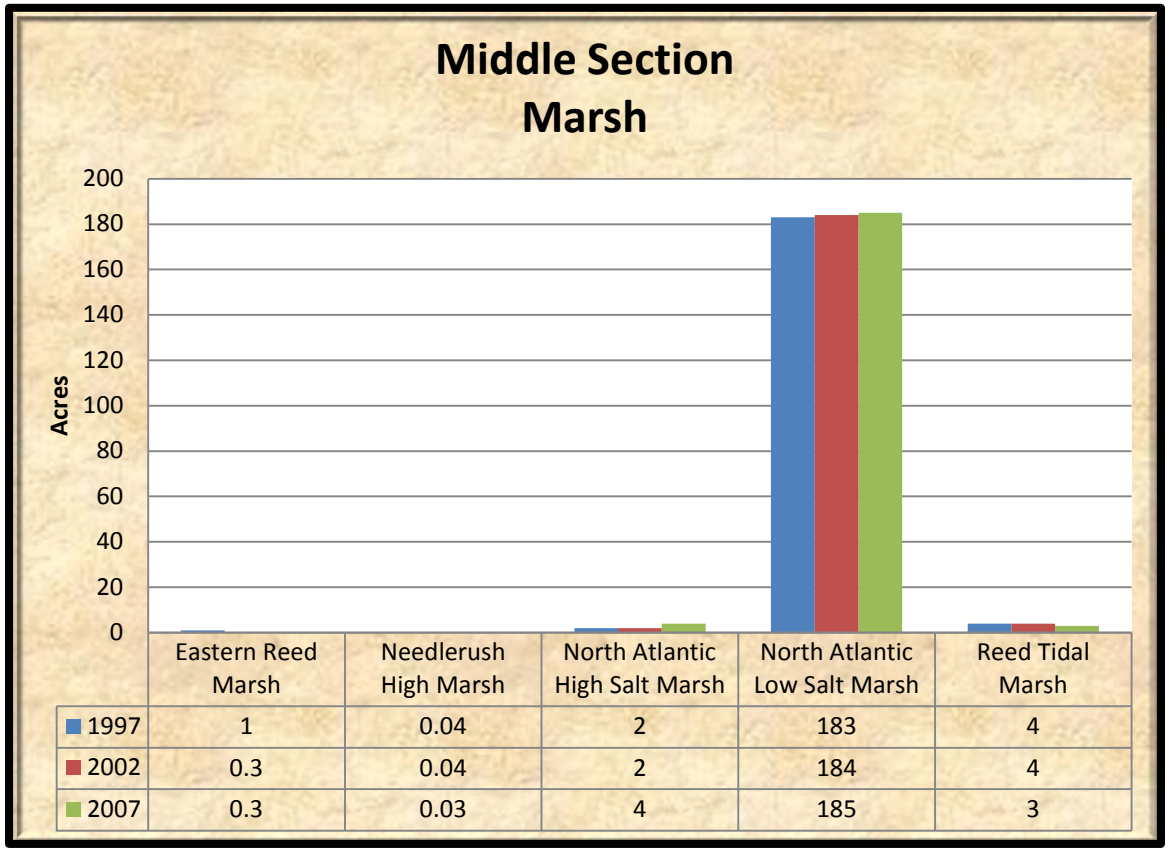


Figure 4-1.8. Middle Section Marsh (1997, 2002, and 2007)

Middle Section Marsh (Figure 4-1.8): North Atlantic Low Salt Marsh is by far the most marsh community in the middle section. North Atlantic High Salt Marsh, bucking a trend seen in other areas, has increased. Other marshes have seen decreases except for the North Atlantic Low Salt Marsh which has increased.

DNREC Sea Level Rise Analysis (Table 4-1.9)

Marsh in the Middle Section will be inundated with 0.5 m of sea level rise.

Table 4-1.9. Projected acres of Middle Section Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	193 acres
1 m	193 acres
1.5 m	193 acres

Natural Capital (Table 4-1.10)

Marsh has been going up in capital overall in the Middle Section.

Table 4-1.10. Natural Capital of Middle Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,194,557/year
2002	$1,194,331/year
2007	$1,206,874/year

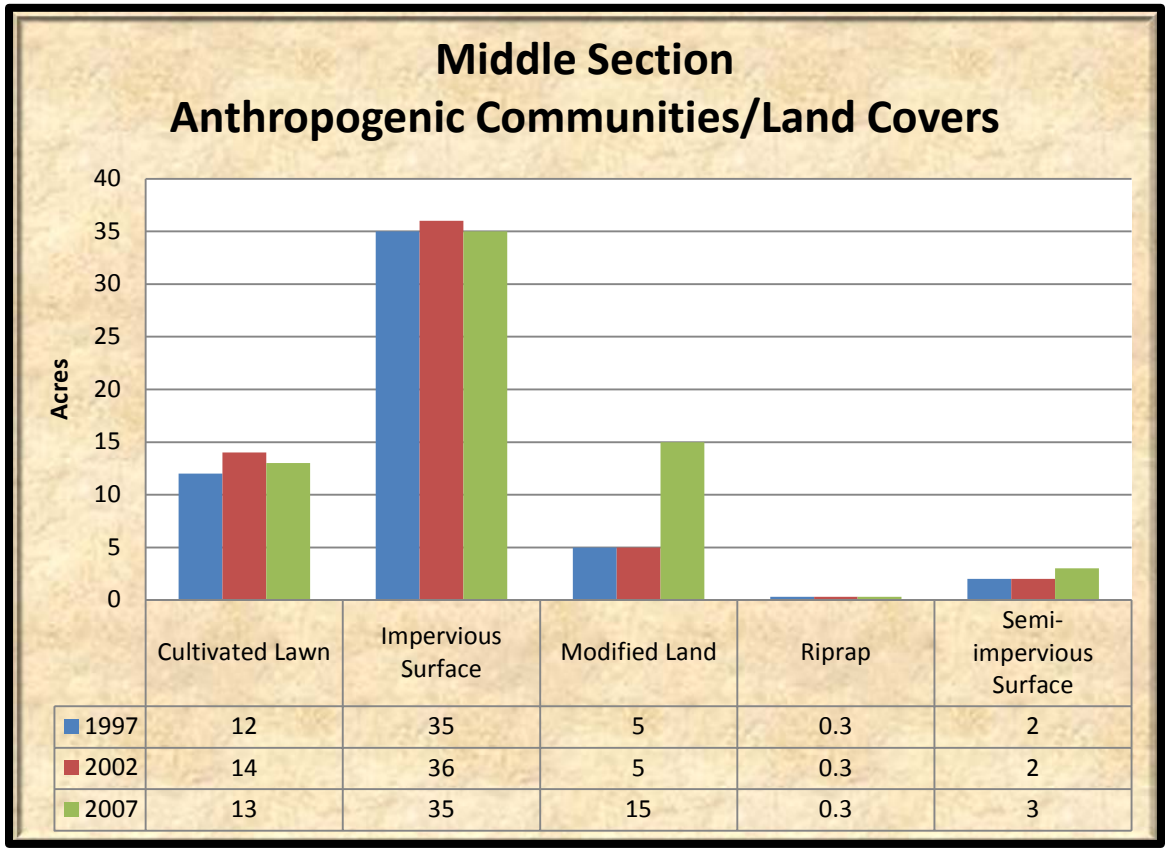


Figure 4-1.9. Middle Section Anthropogenic Communities/Land Covers (1997, 2002, and 2007)

Middle Section Anthropogenic Communities/Land Covers (Figure 4-1.9): Impervious surface is the largest anthropogenic community/land cover, followed by the associated cultivated lawn. All these types have remained in about the same amount except for modified land which has greatly increased with the construction of the new Indian River Inlet Bridge.

DNREC Sea Level Rise Analysis (Table 4-1.11)

More than ¾ of the anthropogenic communities/land covers in the Middle Section will be inundated with 1.5 m of sea level rise. More than 1/3 will be inundated with 0.5 m of rise.

Table 4-1.11. Projected acres of Middle Section Anthropogenic Communities/Land Covers Impacted by Sea Level Rise

Rise	Acres
0.5 m	23 acres
1 m	46 acres
1.5 m	56 acres

Natural Capital

None of the Anthropogenic Communities/Land Covers in the Middle Section have any natural capital value.

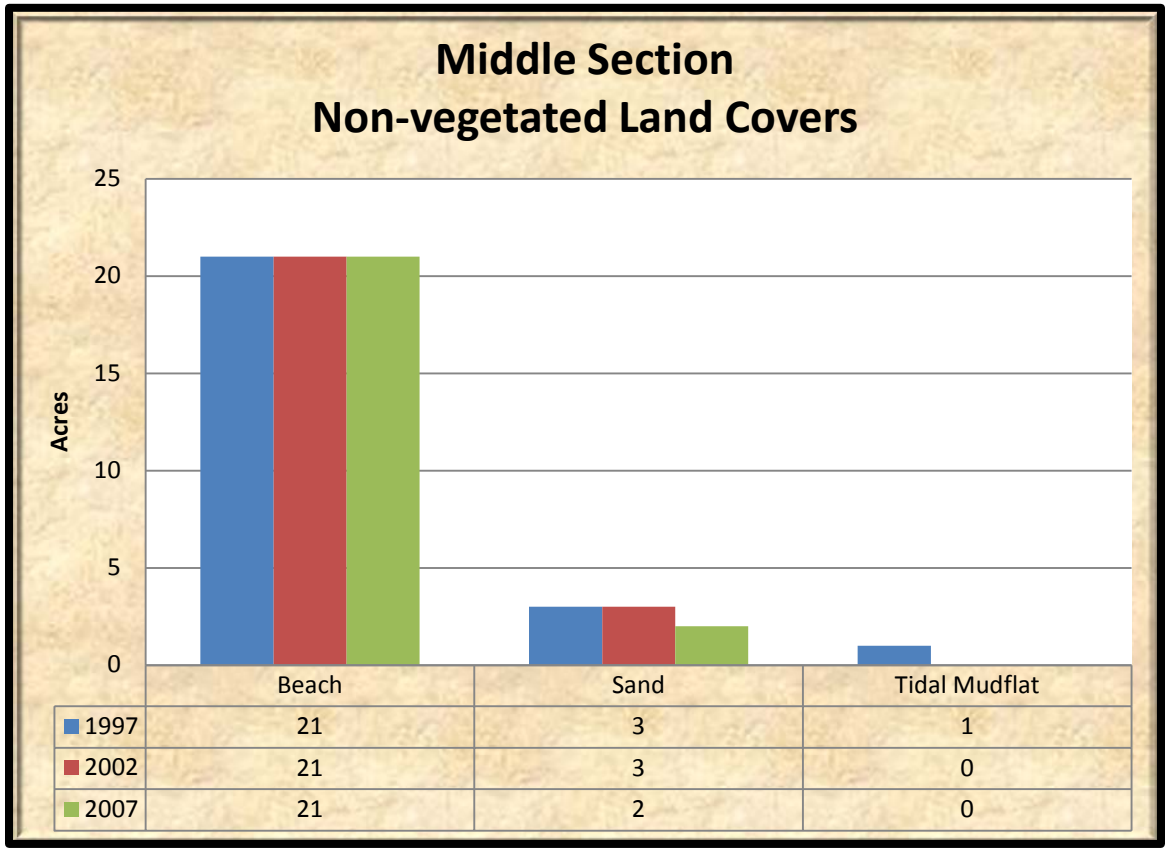


Figure 4-1.10. Middle Section Non-vegetated Land Covers (1997, 2002, and 2007)

Middle Section Non-vegetated Land Covers (Figure 4-1.10): Beach is main non-vegetated land cover in the middle section.

DNREC Sea Level Rise Analysis (Table 4-1.12)

Approximately 1/3 of the current acreage of non-vegetated land covers will be inundated with 1.5 m of sea level rise. The beach community has a tendency to move up with the rise so the effects could be even less with this land cover.

Table 4-1.12. Projected acres of Middle Section Non-vegetated Land Covers Impacted by Sea Level Rise

Rise	Acres
0.5 m	4 acres
1 m	6 acres
1.5 m	8 acres

Natural Capital

None of the Non-vegetated land covers have any natural capital value in the Middle Section.

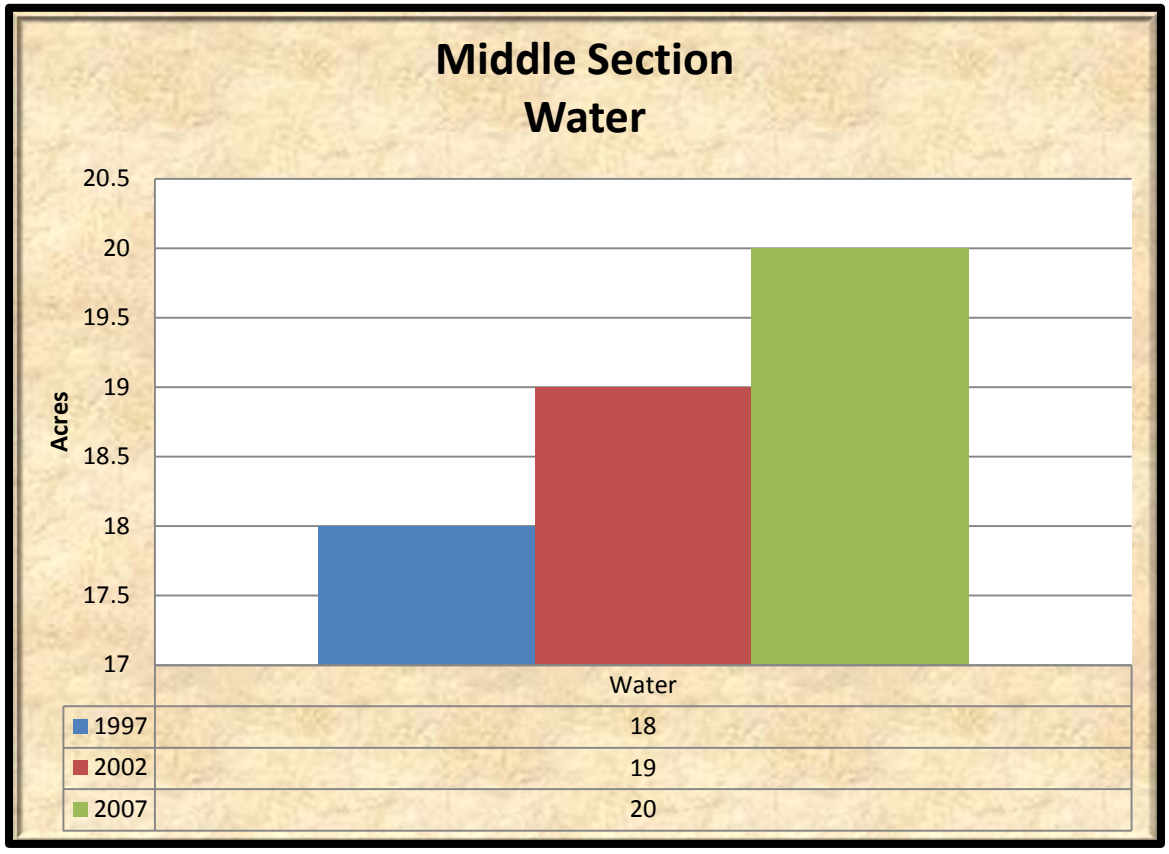


Figure 4-1.11. Middle Section water coverage (1997, 2002, and 2007)

Middle Section water coverage (Figure 4-1.11): Water has steadily increased in the middle section presumably due to sea level rise or erosion along the beach area.

Natural Capital (Table 4-1.13)

Water capital in the Middle Section has been increasing with sea level rise, a trend that is expected to continue.

Table 4-1.13. Natural Capital of Middle Section Water	
Year	**Natural Capital (in 2012 dollars)**
1997	$187,118/year
2002	$201,450/year
2007	$215,783/year

2. North Section

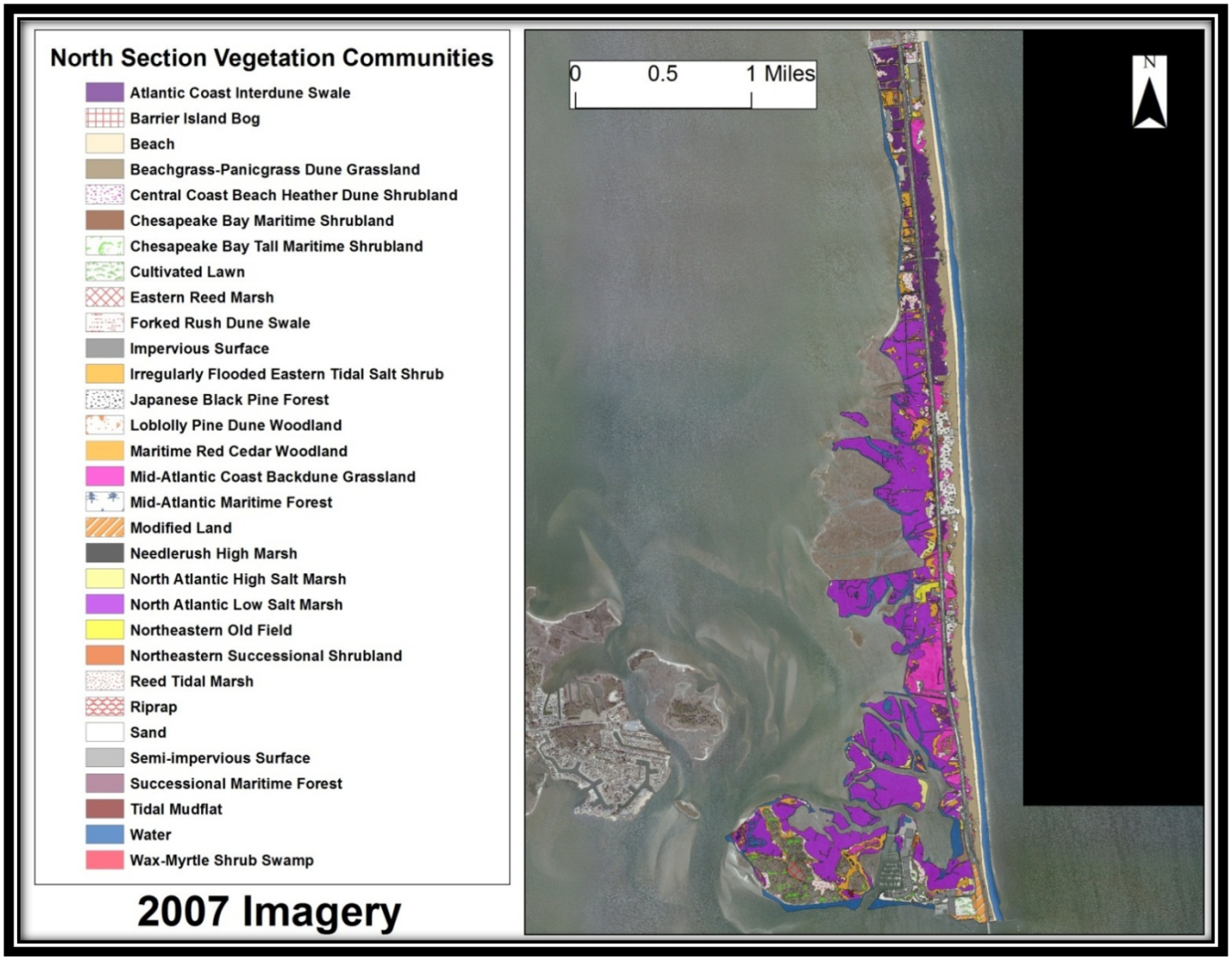


Figure 4-2.1. 2007 Vegetation Community map of the North Section

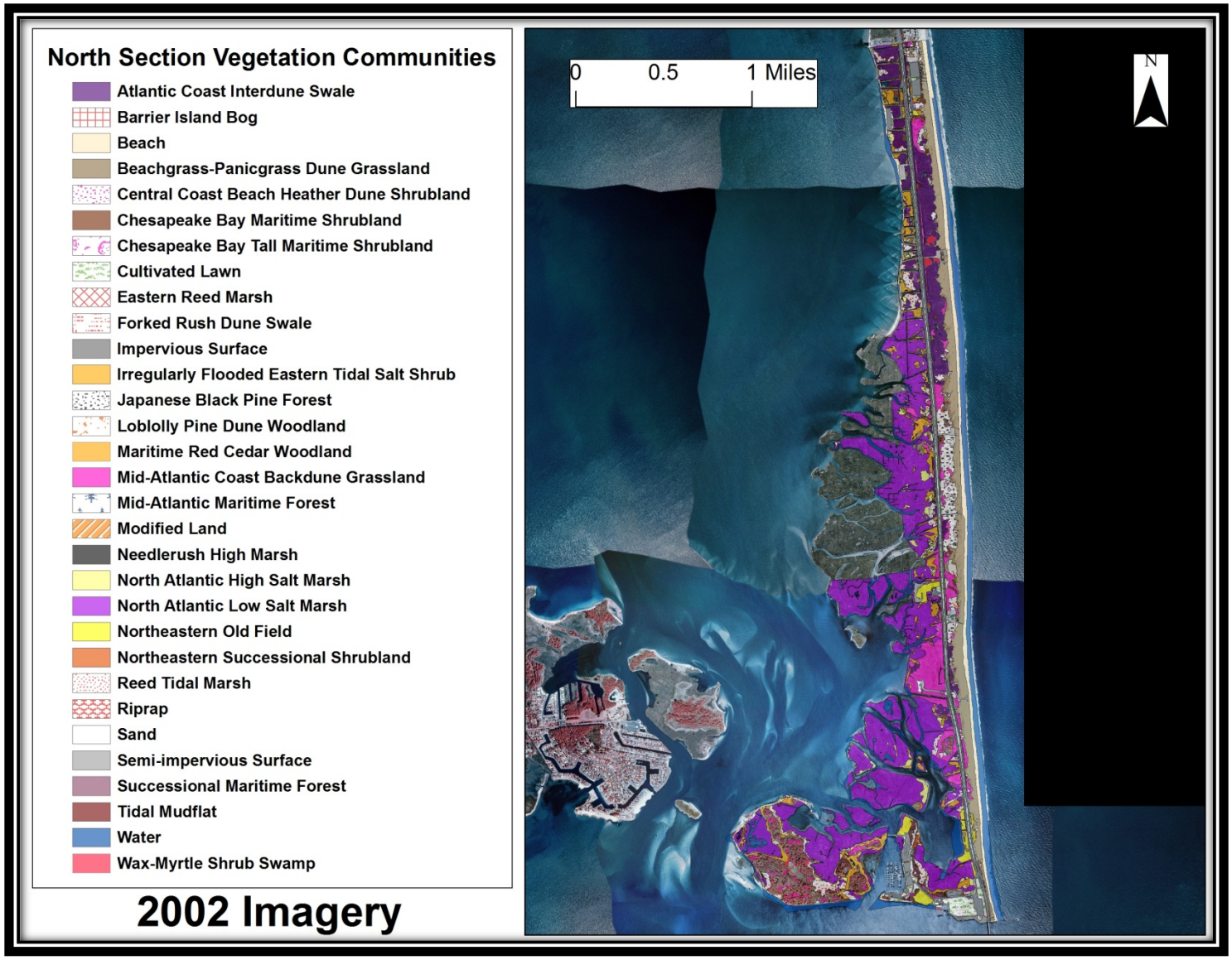


Figure 4-2.2. 2002 Vegetation Community map of the North Section

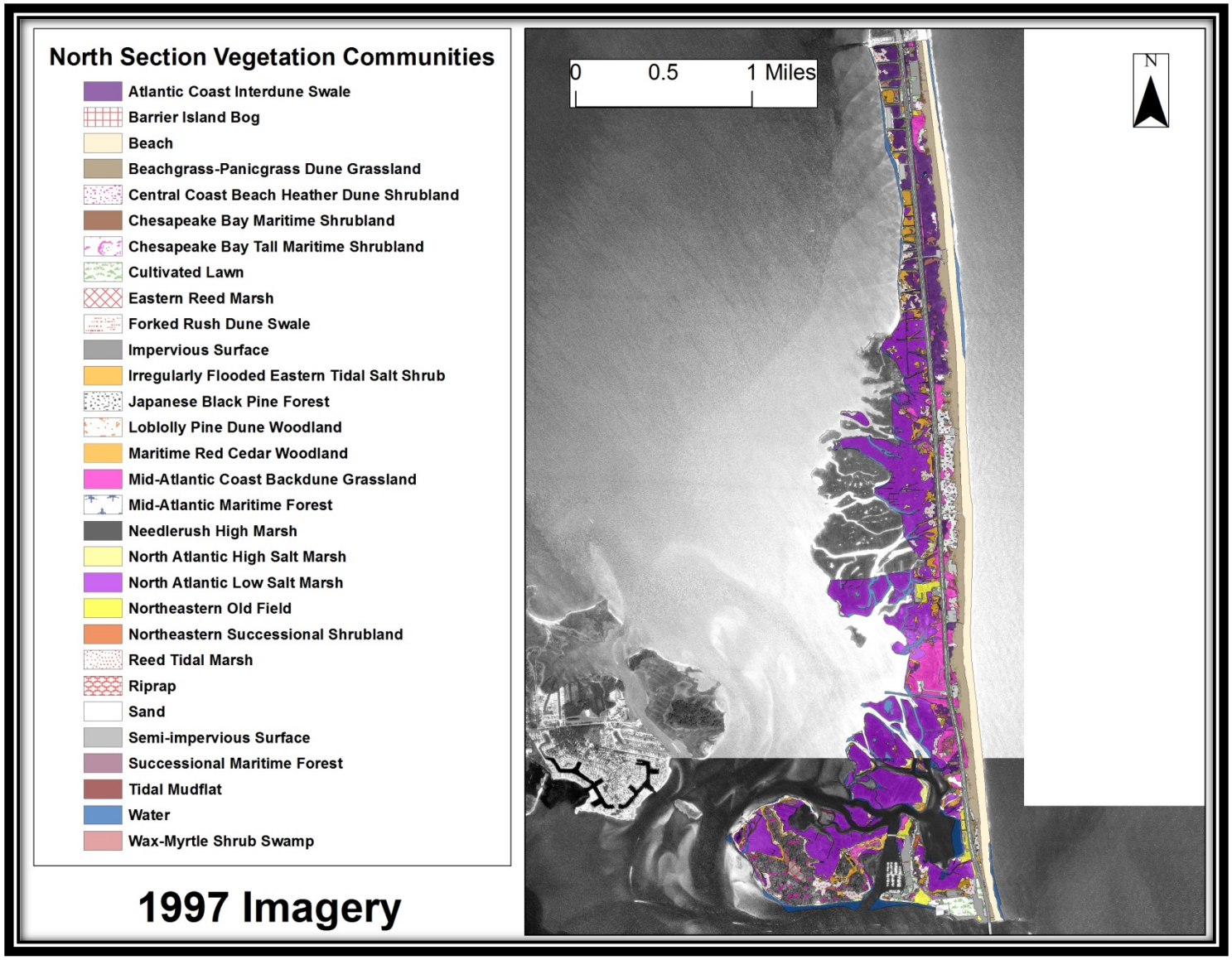


Figure 4-2.3. 1997 Vegetation Community map of the North Section

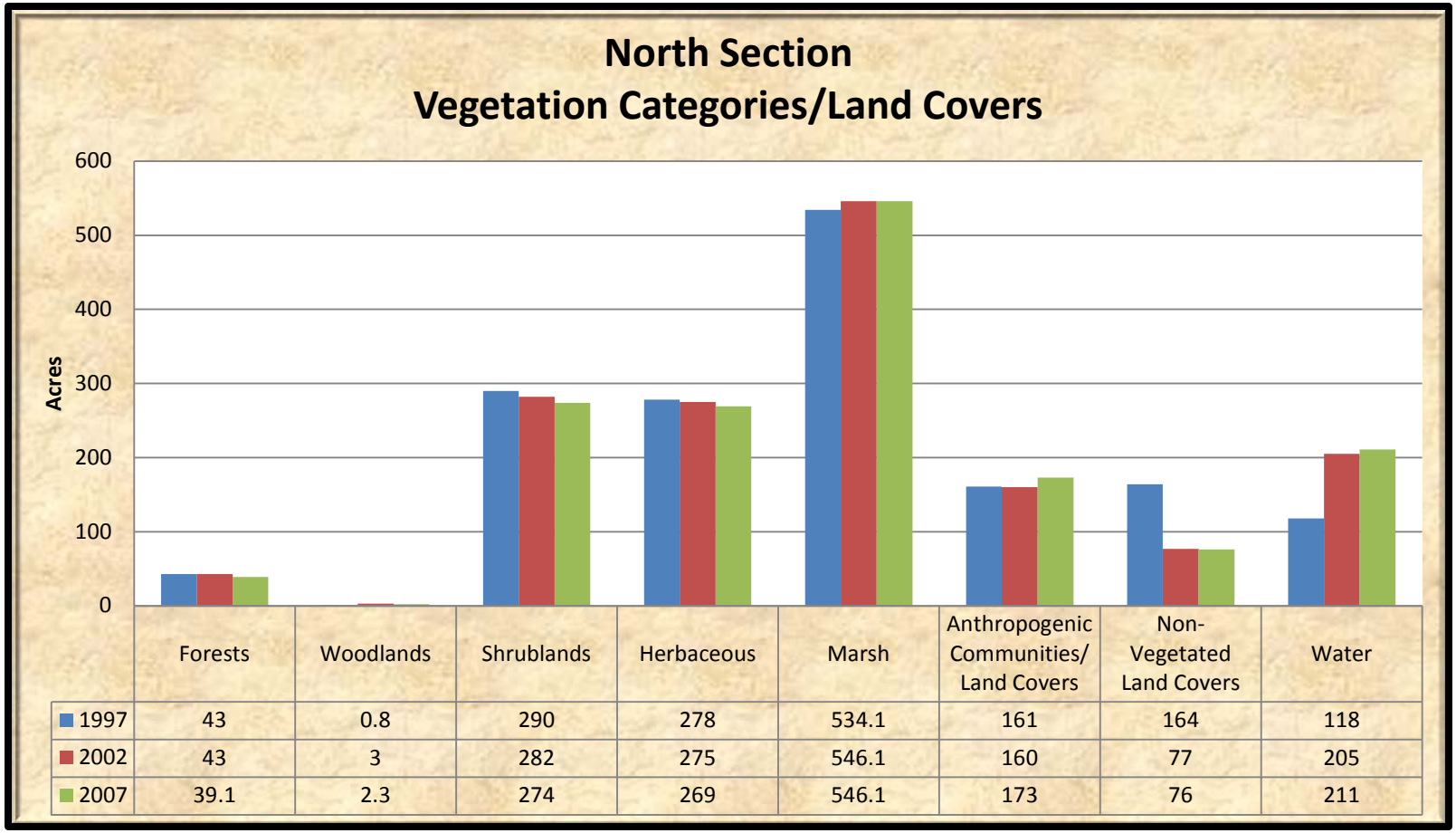


Figure 4-2.4. North Section Vegetation Community/Land Cover Categories (1997, 2002, and 2007)

North Section Broad Trends (Figure 4-2.4): The North Section is mostly covered by marshland and shrubland in the form of Atlantic Coast Interdune Swale. Herbaceous communities make up a significant portion of the area as well.

DNREC Sea Level Rise Analysis (Table 4-2.1)

Almost 90% of the North Section will be inundated by 1.5 m of sea level. This will come at the cost of replacement of DE 1 and lost access to points further south on the coast.

Table 4-2.1. Projected acres of the North Section Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	982 acres
1 m	1,300 acres
1.5 m	1,424 acres

Natural Capital (Table 4-2.2)

Natural capital of the North Section has been increasing with increases in marshland and water with sea level rise.

Table 4-2.2. Natural Capital of the North Section	
Year	**Natural Capital (in 2012 dollars)**
1997	$6,796,089/year
2002	$6,842,382/year
2007	$6,891,642/year

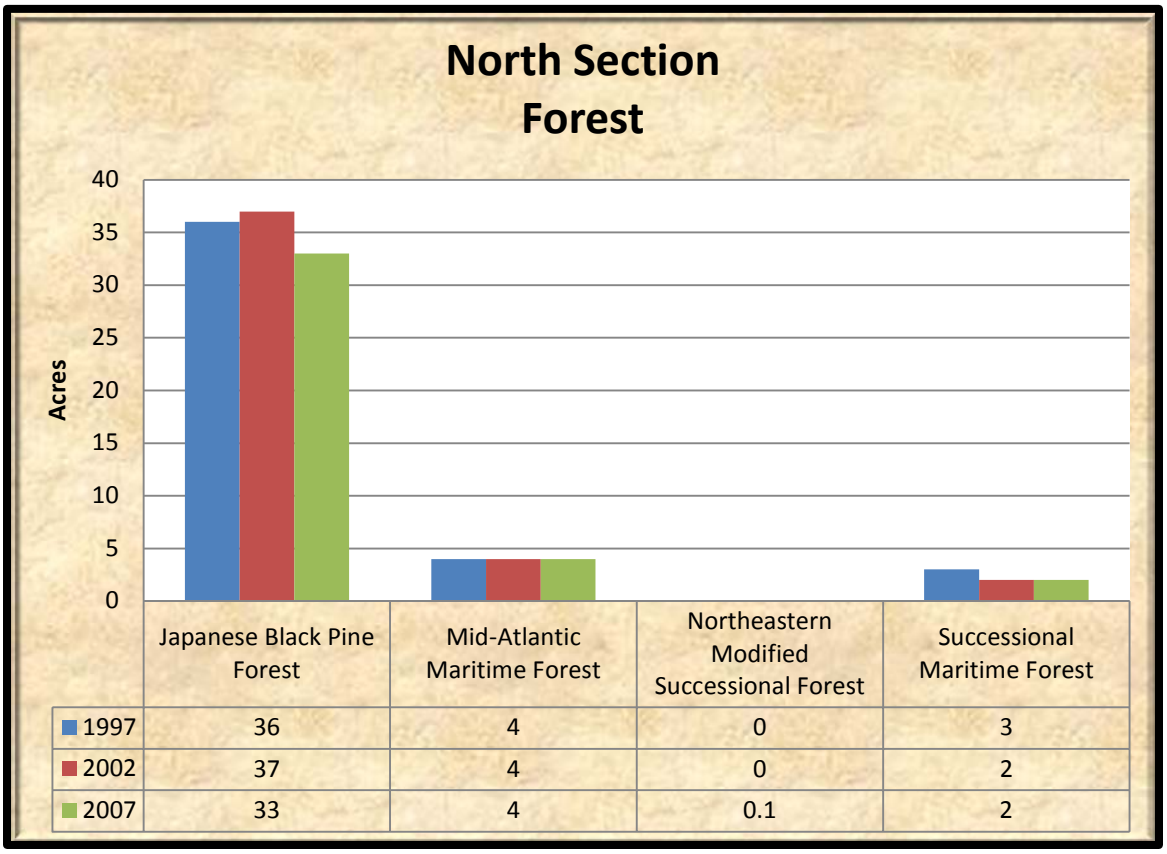


Figure 4-2.5. North Section Forest (1997, 2002, and 2007)

North Section Forest (Figure 4-2.5): Japanese Black Pine Forest is the largest forest type in the North Section of Delaware Seashore State Park, followed distantly by Mid-Atlantic Maritime Forest. Forest area has been roughly stable in amount through the study in the North Section.

DNREC Sea Level Rise Analysis (Table 4-2.3)

More than ¾ of the forestland in the North Section will be flooded by 1.5 m of sea level rise; however, this forestland will come out well with just 0.5 m of rise.

Table 4-2.3. Projected acres of North Section Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	22 acres
1.5 m	33 acres

Natural Capital (Table 4-2.4)

Natural capital of North Section forest has gone down between 2002 and 2007 with the loss of Japanese Black Pine Forest.

Table 4-2.4. Natural Capital of North Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$8,131/year
2002	$8,131/year
2007	$7,394/year

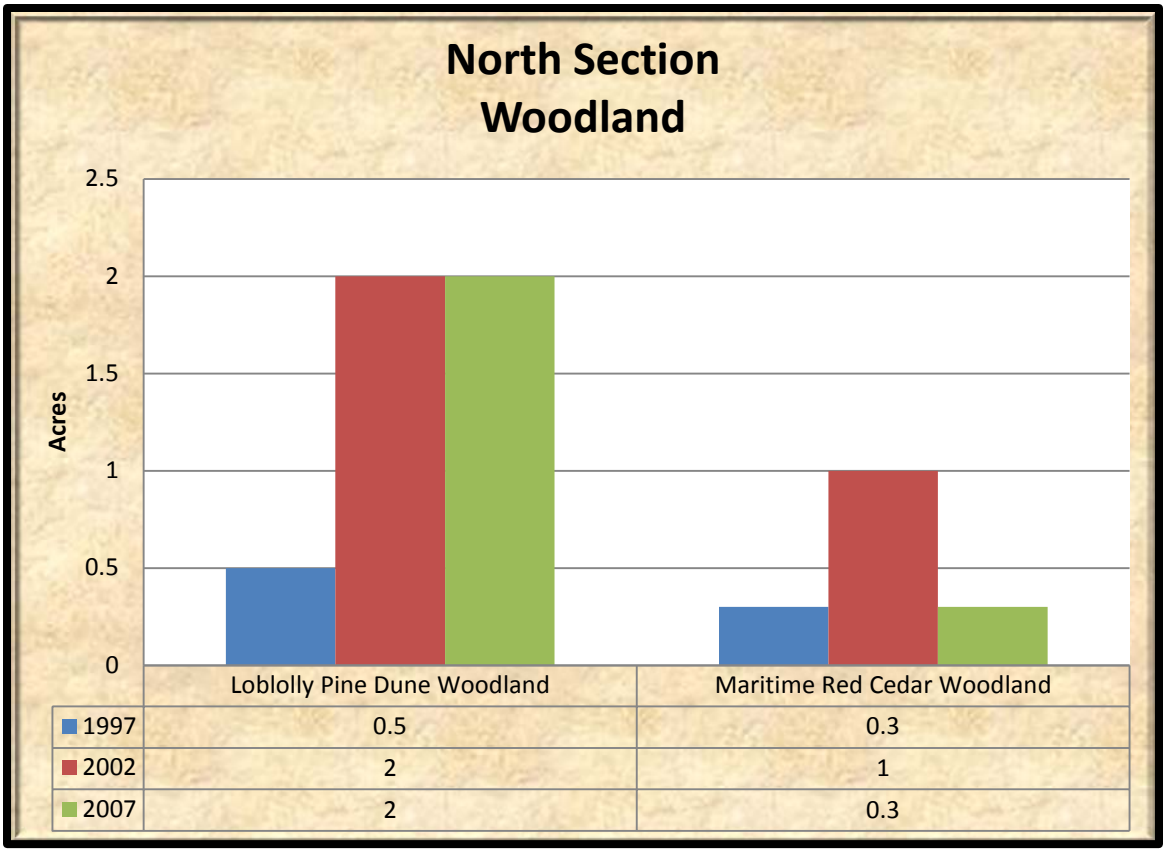


Figure 4-2.6. North Section Woodland (1997, 2002, and 2007)

North Section Woodland (Figure 4-2.6): Woodlands cover a small portion of the North Section and are mostly Loblolly Pine Dune Woodland.

DNREC Sea Level Rise Analysis (Table 4-2.5)

A little less than half of the woodland in the park will be inundated under the highest amount (1.5 m) of sea level rise.

Table 4-2.5. Projected acres of North Section Woodland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0.5 acres
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 4-2.6)

Natural capital of woodland has oscillated with changes in the acreage of Maritime Red Cedar Woodland.

Table 4-2.6. Natural Capital of North Section Woodland	
Year	**Natural Capital (in 2012 dollars)**
1997	$151/year
2002	$567/year
2007	$435/year

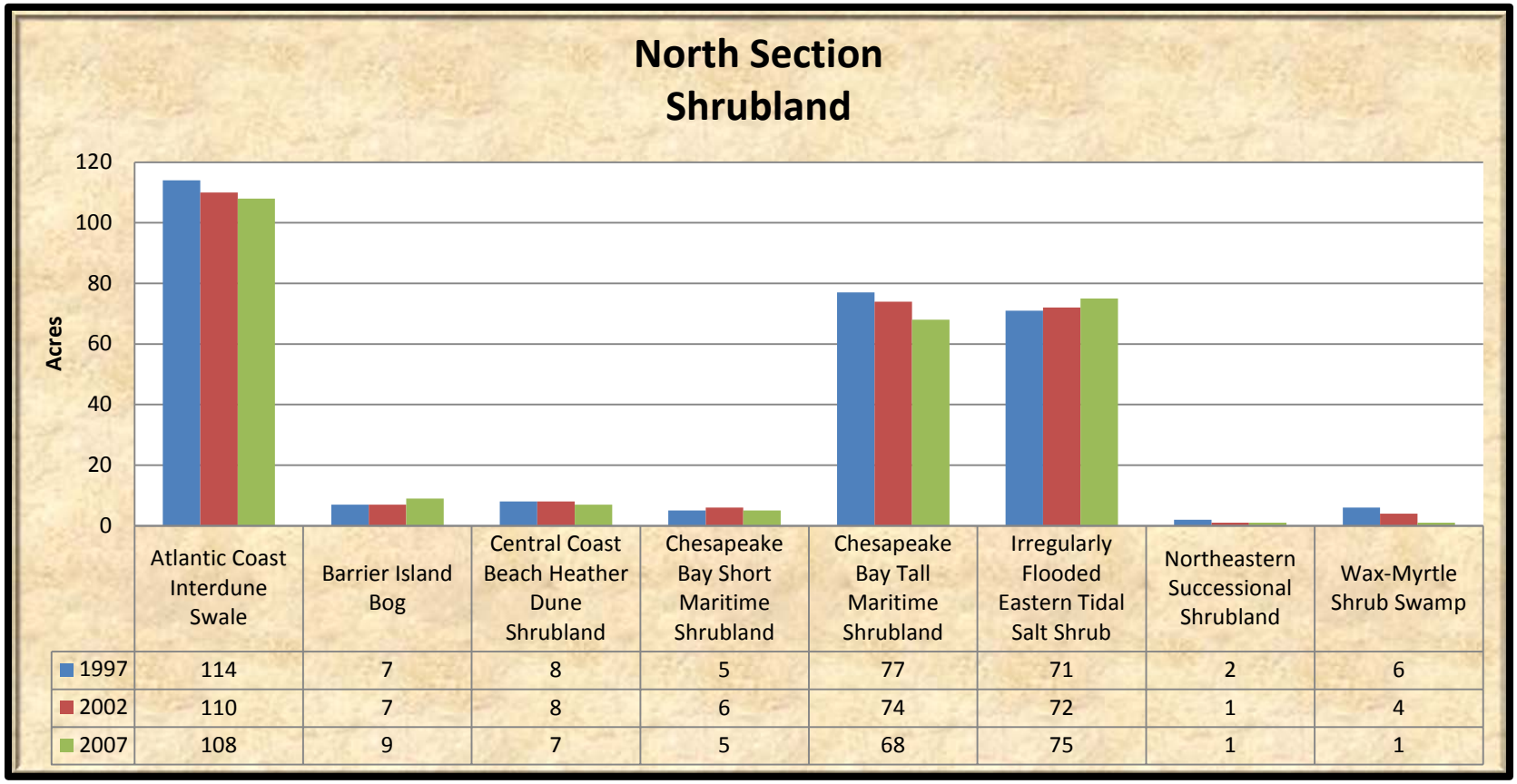


Figure 4-2.7. North Section Shrubland (1997, 2002, and 2007)

North Section Shrubland (Figure 4-2.7): Shrubland covers a significant portion of the North Section. Atlantic Coast Interdune Swale is the most common shrubland followed by Irregularly Flooded Eastern Tidal Salt Shrub.

DNREC Sea Level Rise Analysis (Table 4-2.7)

Shrubland in the North Section will be practically eliminated with 1.5 m of sea level rise and will be flooded by almost half with 0.5 m of rise.

Table 4-2.7. Projected acres of North Section Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	140 acres
1 m	246 acres
1.5 m	263 acres

Natural Capital (Table 4-2.8)

Shrubland capital has decreased recently due to the loss of some of the maritime communities to erosion and sea level rise.

Table 4-2.8. Natural Capital of North Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,637,354/year
2002	$1,587,502/year
2007	$1,577,307/year

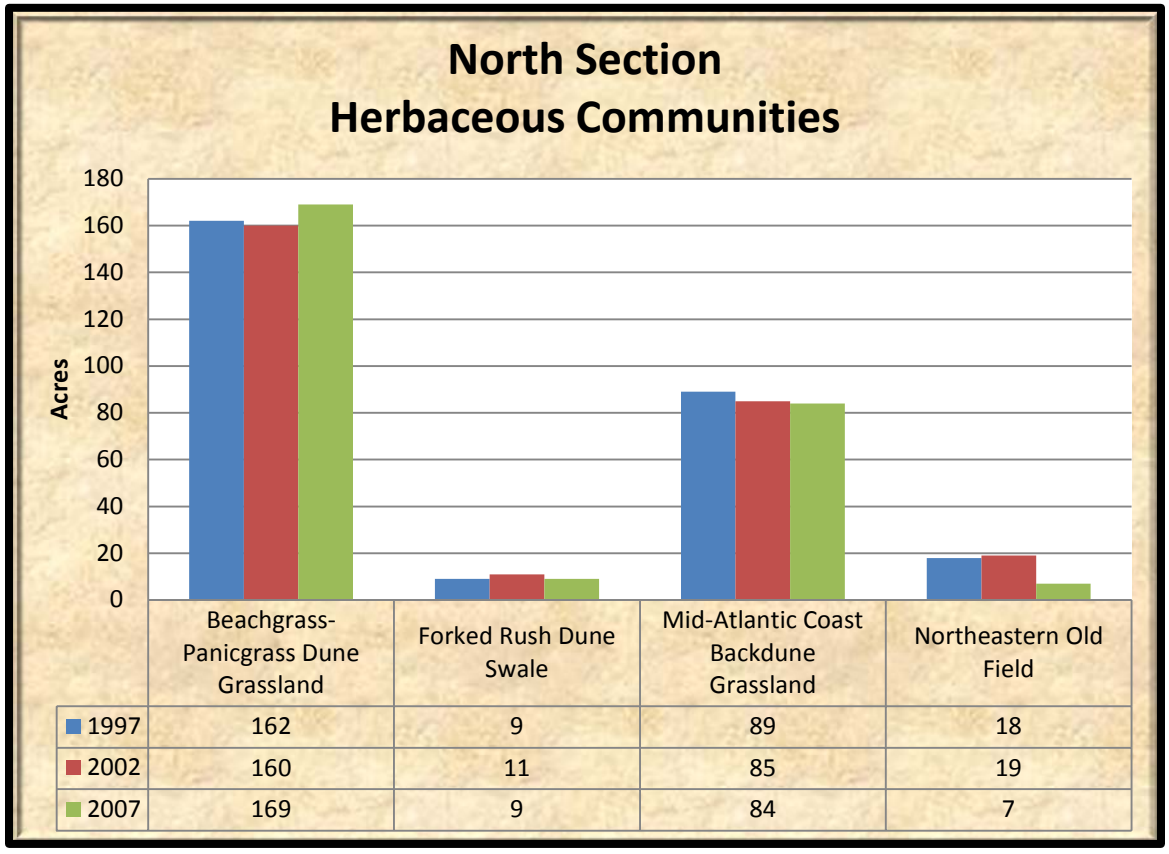


Figure 4-2.8. North Section Herbaceous Communities (1997, 2002, and 2007)

North Section Herbaceous Communities (Figure 4-2.8): Beachgrass-Panicgrass Dune Grassland is the most common herbaceous community in the North Section followed by Mid-Atlantic Coast Backdune Grassland.

DNREC Sea Level Rise Analysis (Table 4-2.9)

About half of the herbaceous communities in the North Section will be inundated with 1.5 m of sea level rise.

Table 4-2.9. Projected acres of North Section Herbaceous Communities Impacted by Sea Level Rise

Rise	Acres
0.5 m	55 acres
1 m	114 acres
1.5 m	150 acres

Natural Capital (Table 4-2.10)

Capital in herbaceous communities has gone down with maturation of the Northeastern Old Field into more mature communities. This capital was transferred to these other communities.

Table 4-2.10. Natural Capital of North Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1997	$122,726/year
2002	$140,560/year
2007	$121,414/year

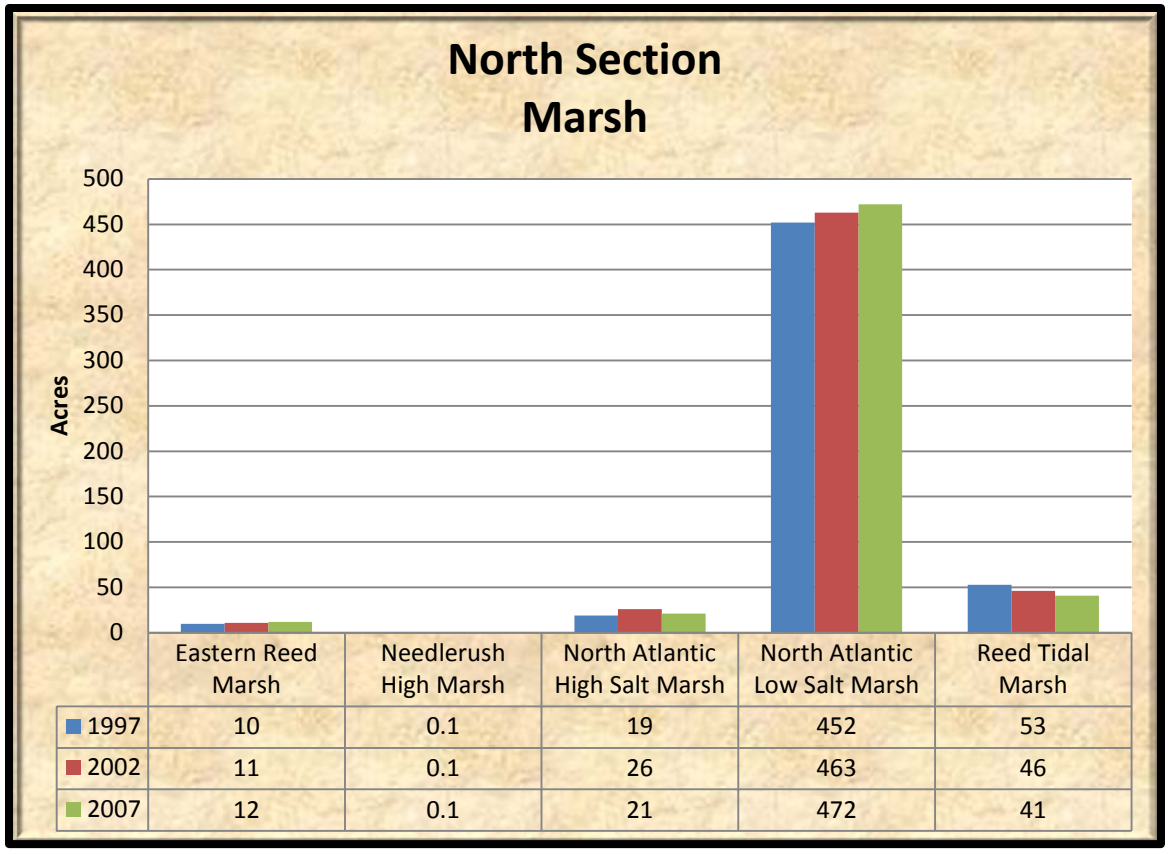


Figure 4-2.9. North Section Marsh (1997, 2002, and 2007)

North Section Marsh (Figure 4-2.9): North Atlantic Low Salt Marsh is the most common marsh community followed by Reed Tidal Marsh. North Atlantic Low Salt Marsh has been increasing while Reed Tidal Marsh has decreased.

DNREC Sea Level Rise Analysis (Table 4-2.11)

Marsh will be essentially eliminated with 0.5 m of sea level rise. An additional 0.5 m of rise will inundate the remaining Eastern Reed Marsh.

Table 4-2.11. Projected acres of North Section Marsh Impacted by Sea Level Rise

Rise	Acres
0.5 m	540 acres
1 m	546 acres
1.5 m	547 acres

Natural Capital (Table 4-2.12)

Capital of marshland has been going up as more land is converted to marsh with sea level rise.

Table 4-2.12. Natural Capital of North Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$3,378,975/year
2002	$3,450,970/year
2007	$3,460,251/year

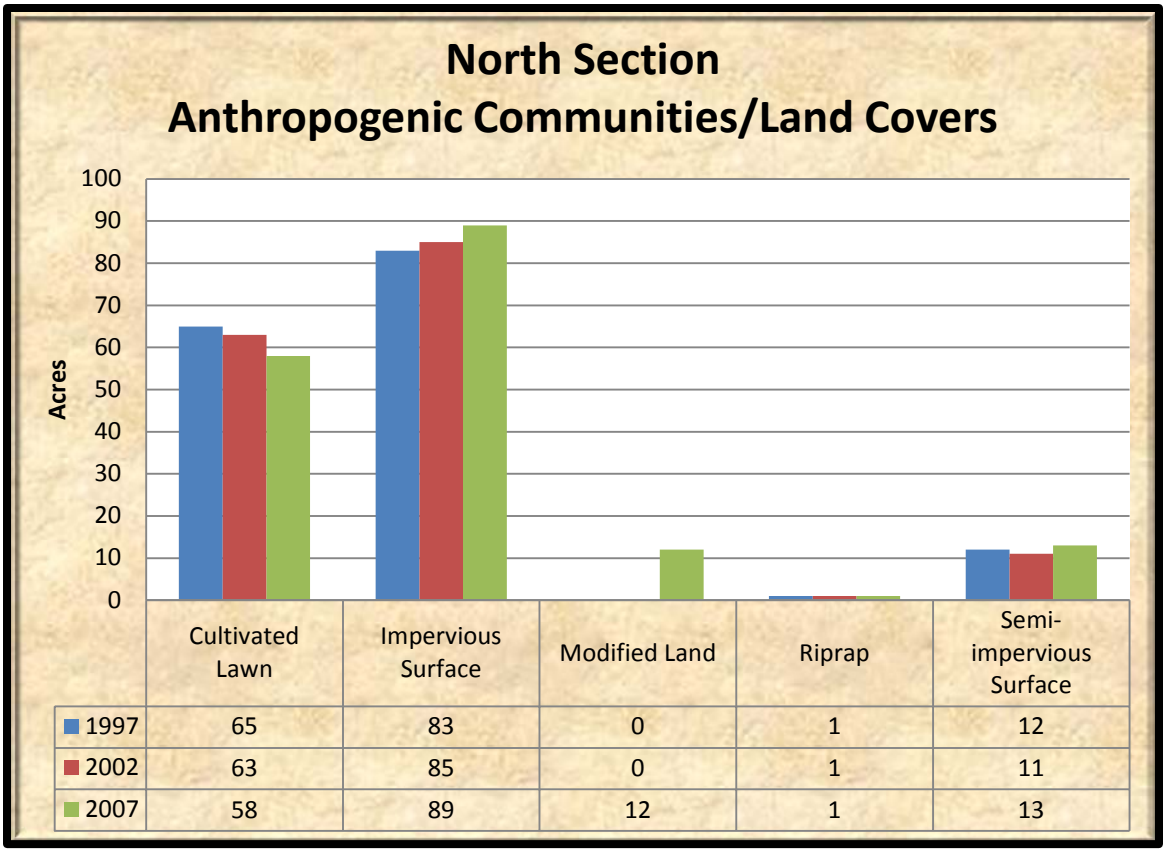


Figure 4-2.10. North Section Anthropogenic Communities/Land Covers (1997, 2002, and 2007)

North Section Anthropogenic Communities/Land Covers (Figure 4-2.10): Impervious surface is the most common anthropogenic community/land cover followed by the associated Cultivated Lawn. Impervious surface has grown as more land is developed while some cultivated lawn was eliminated in the development.

DNREC Sea Level Rise Analysis (Table 4-2.13)

Anthropogenic Communities/Land Covers will be lightly impacted with 0.5 m of sea level rise, but will be greatly impacted with 1.5 m of sea level rise. Since these land covers are associated with human infrastructure there will be additional economic costs other than the ecosystem services.

Table 4-2.13. Projected acres of North Section Anthropogenic Communities/Land Covers Impacted by Sea Level Rise

Rise	Acres
0.5 m	28 acres
1 m	131 acres
1.5 m	159 acres

Natural Capital

None of the Anthropogenic Communities/Land Covers in the North Section have any natural capital value.

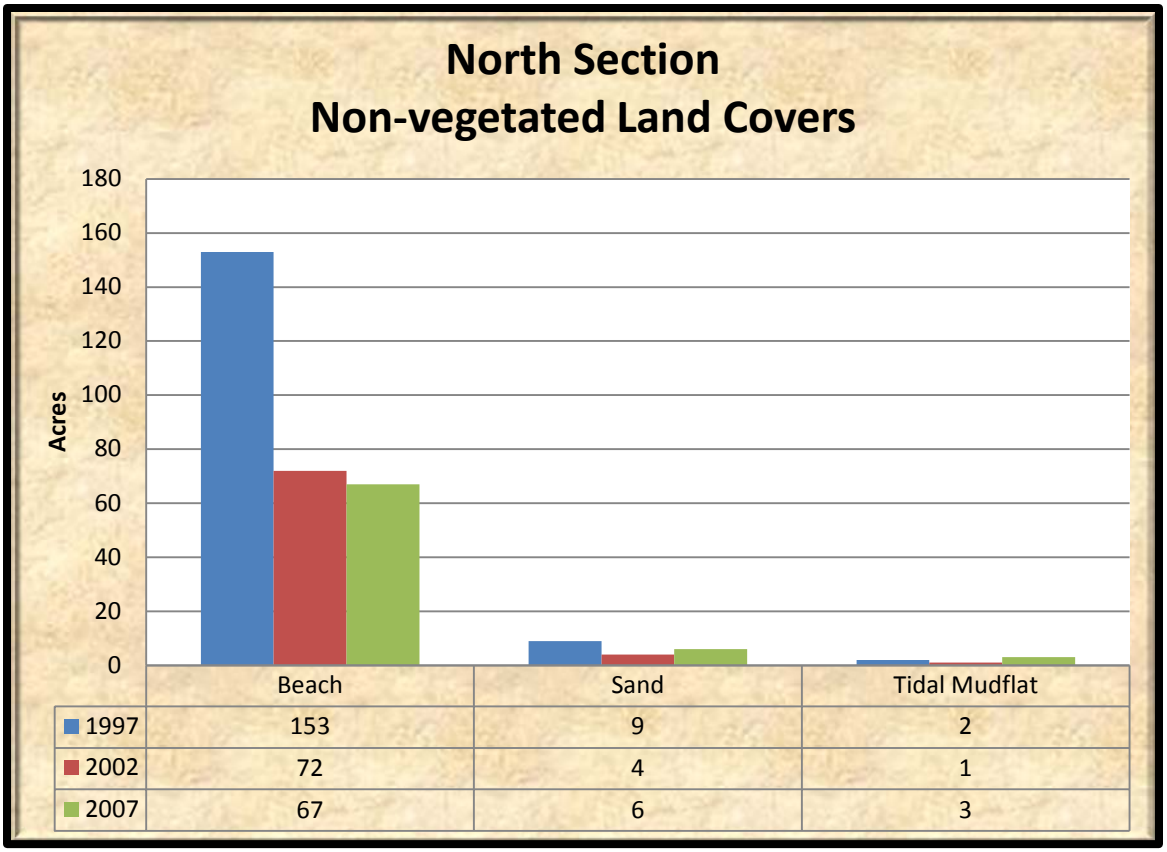


Figure 4-2.11. North Section Non-vegetated Land Covers (1997, 2002, and 2007)

North Section Non-vegetated Land Covers (Figure 4-2.11): Beach has historically been and still is the largest non-vegetated land cover in the North Section.

DNREC Sea Level Rise Analysis (Table 4-2.14)

A little more than ¾ of the non-vegetated land covers present in the North Section will be inundated with 1.5 m of sea level rise.

Table 4-2.14. Projected acres of North Section Non-vegetated Communities Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	14 acres
1 m	31 acres
1.5 m	60 acres

Natural Capital (Table 4-2.15)

Tidal mudflat is the only non-vegetated community with any natural capital value. It has increased overall since 1997 with some oscillation between 1997 and 2007.

Table 4-2.15. Natural Capital of North Section Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1997	$12,543/year
2002	$6,271/year
2007	$18,814/year

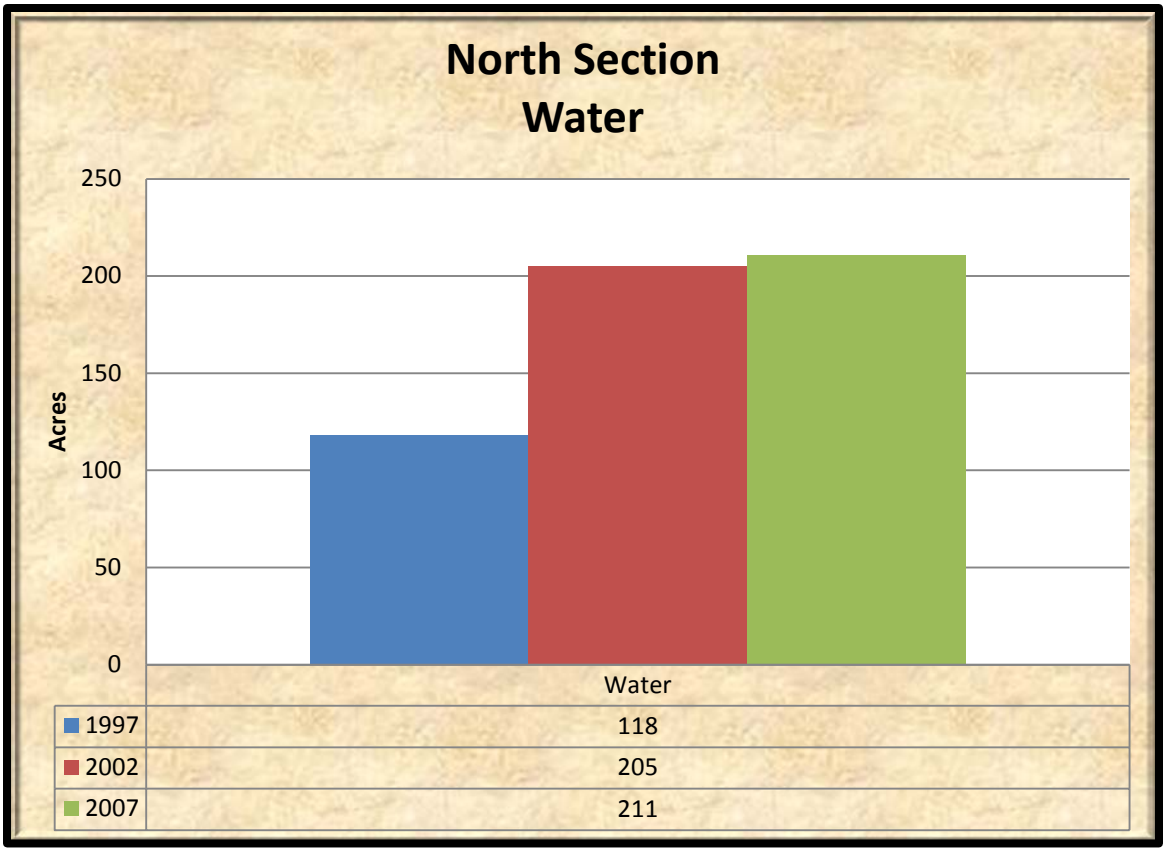


Figure 4-2.12. North Section Water (1997, 2002, and 2007)

North Section Water (Figure 4-2.12): As would be expected with sea level rise, water has been increasing in the North Section. However, some of this increase could be due to beach erosion on the ocean side.

Natural Capital (Table 4-2.16)

Capital of water has been going up as more land is inundated by sea level rise or eroded by storms.

Table 4-2.16. Natural Capital of North Section Water	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,636,158/year
2002	$1,648,332/year
2007	$1,705,980/year

3. South Section

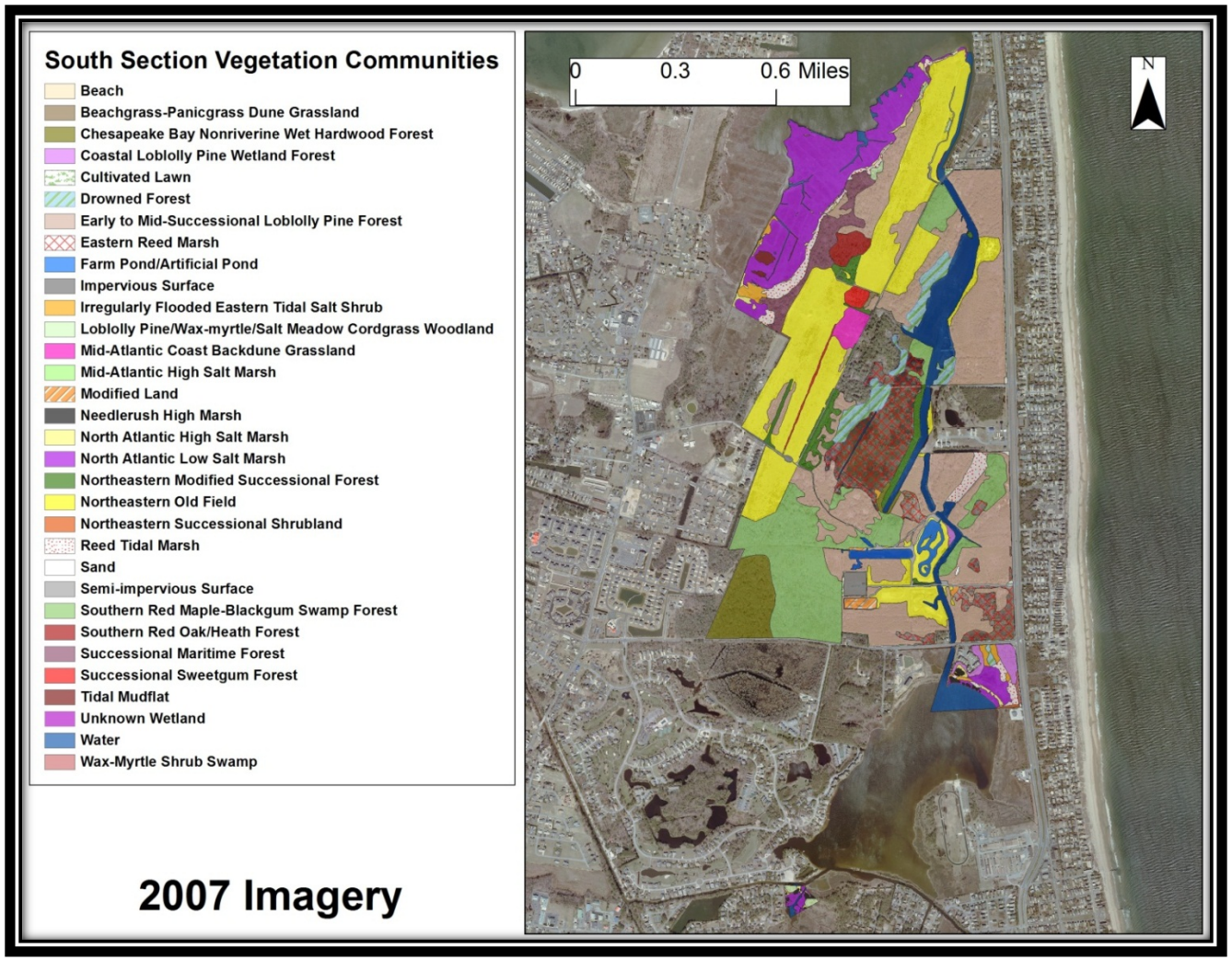


Figure 4-3.1. 2007 Vegetation Community map of the South Section

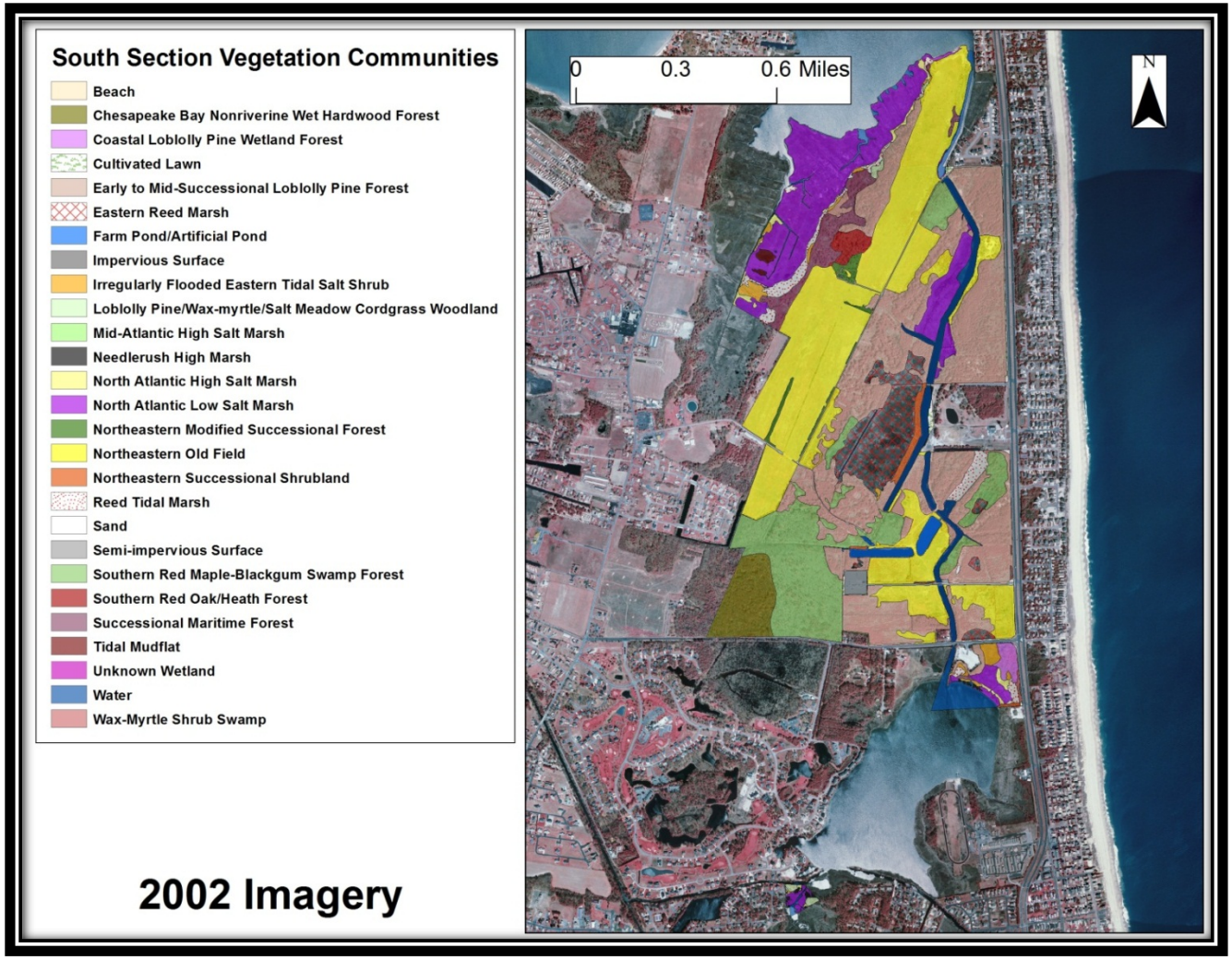


Figure 4-3.2. 2002 Vegetation Community map of the South Section

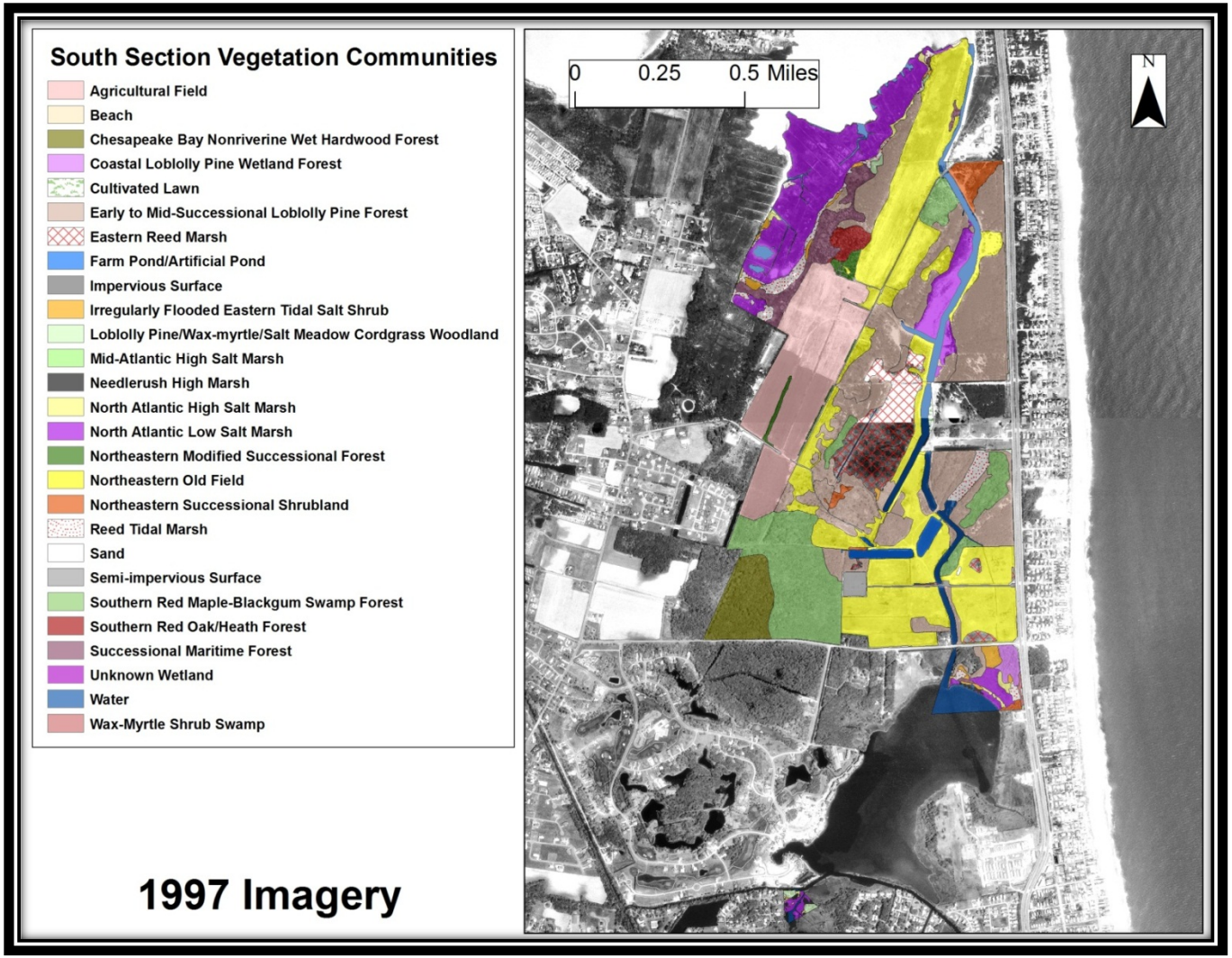
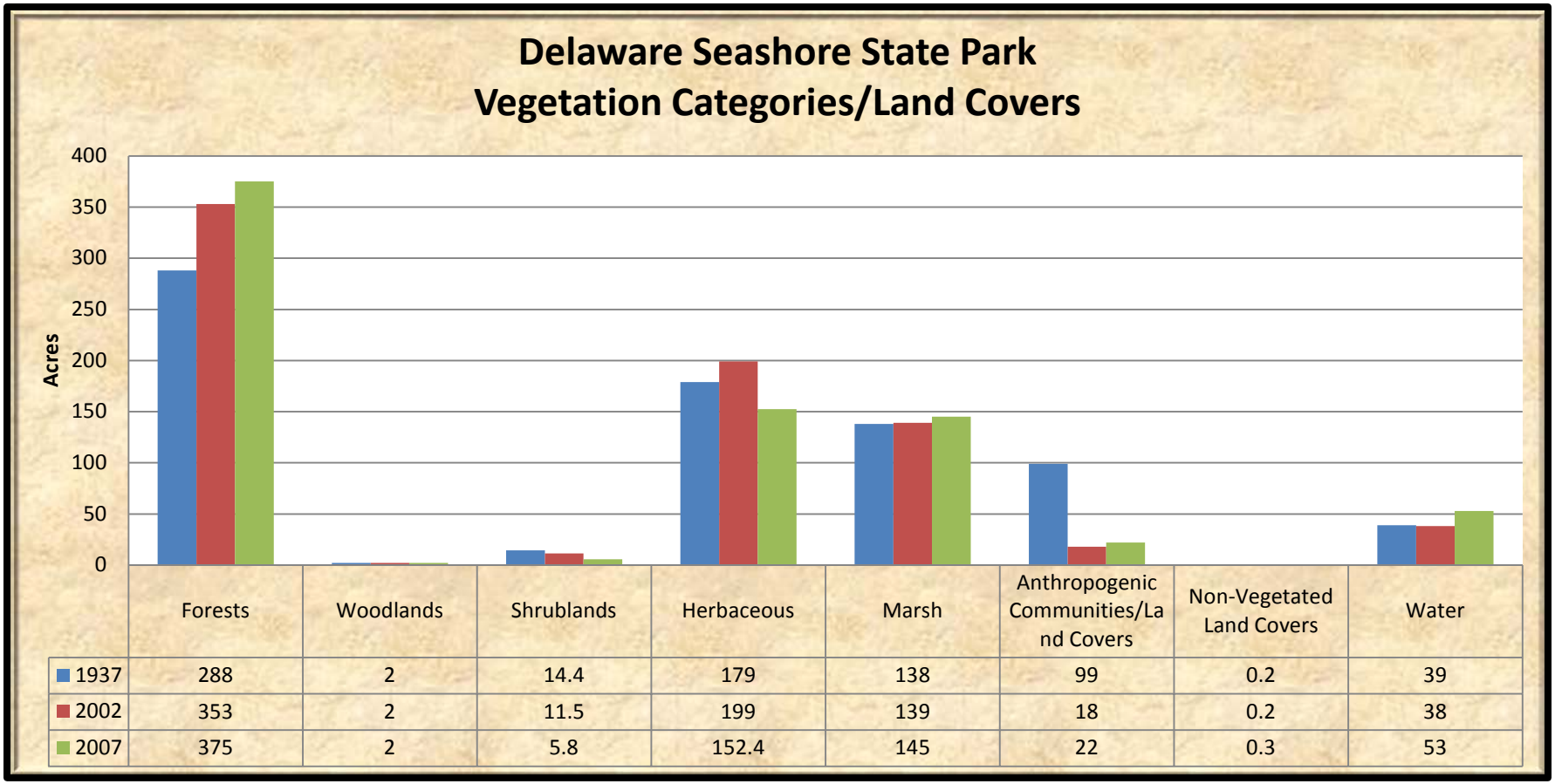


Figure 4-3.3. 1997 Vegetation Community map of the South Section



	Forests	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1937	288	2	14.4	179	138	99	0.2	39
2002	353	2	11.5	199	139	18	0.2	38
2007	375	2	5.8	152.4	145	22	0.3	53

Figure 4-3.4. South Section Vegetation Communities/Land Covers (1997, 2002, and 2007)

South Section Broad Trends (Figure 4-3.4): The South Section is roughly split between forestland and open areas (Herbaceous and Marsh) communities. Forests have greatly increased through succession during the study period at the expense of some of the herbaceous communities.

DNREC Sea Level Rise Analysis (Table 4-3.1)

Almost 90% of the South Section will be flooded with 1.5 m of sea level rise and almost 2/3 will be flooded with just 0.5 m of rise.

Table 4-3.1. Projected acres of the South Section Impacted by Sea Level Rise

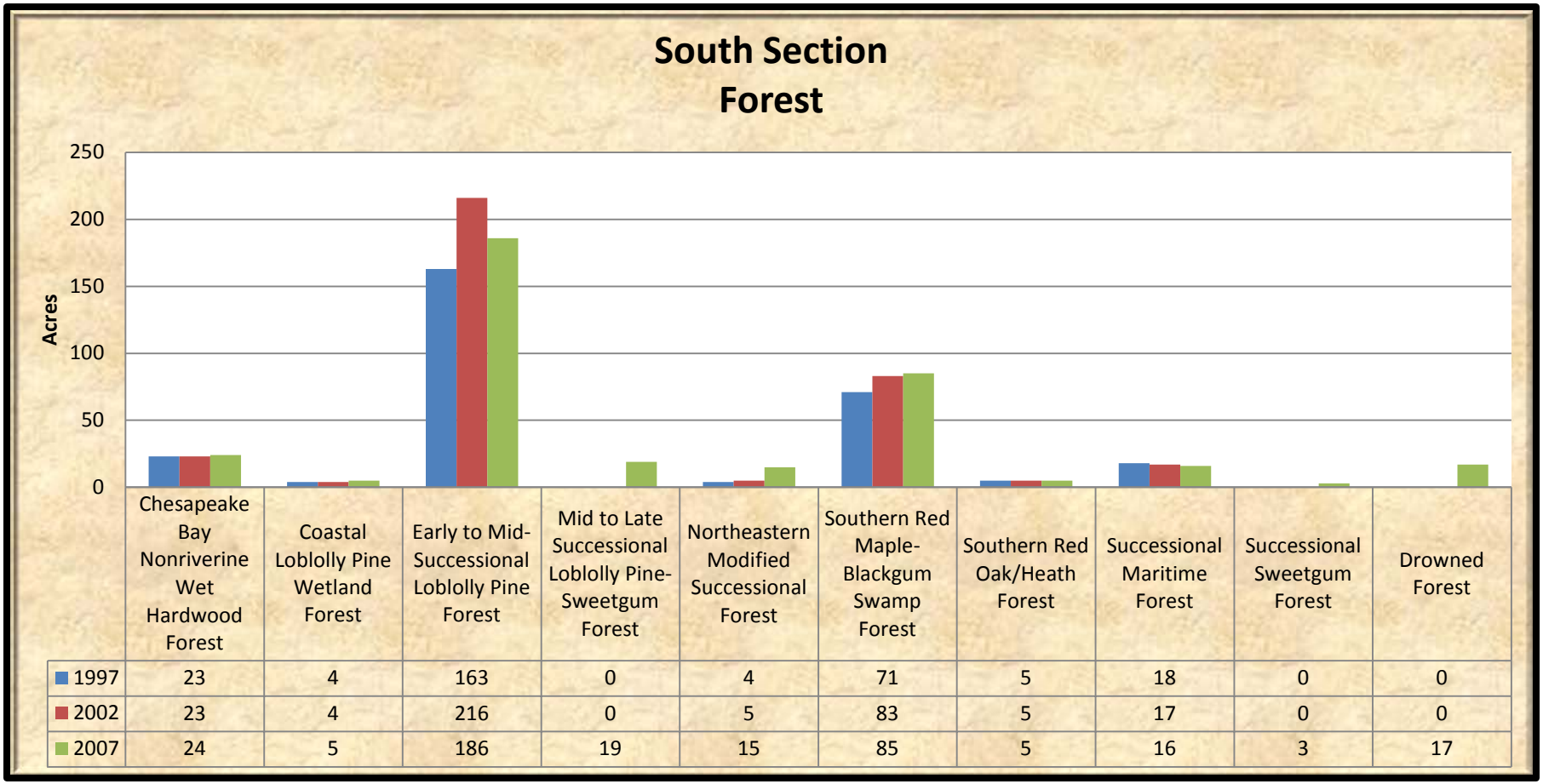
Rise	Acres
0.5 m	487 acres
1 m	580 acres
1.5 m	668 acres

Natural Capital (Table 4-3.2)

Capital of the South Section has been increasing with maturation of the forest communities and increasing water from sea level rise.

Table 4-3.2. Natural Capital of the South Section

Year	Natural Capital (in 2012 dollars)
1997	$2,839,129/year
2002	$3,001,128/year
2007	$3,523,445year



	Chesapeake Bay Nonriverine Wet Hardwood Forest	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 Forest	Southern Red Oak/Heath Forest	Successional Maritime Forest	Successional Sweetgum Forest	Drowned Forest
1997	23	4	163	0	4	71	5	18	0	0
2002	23	4	216	0	5	83	5	17	0	0
2007	24	5	186	19	15	85	5	16	3	17

Figure 4-3.5. South Section Forest (1997, 2002, and 2007)

South Section Forest (Figure 4-3.5): Early to Mid-Successional Forest is the largest forested community in the South Section, followed by Southern Red Maple-Blackgum Swamp.

DNREC Sea Level Rise Analysis (Table 4-3.3)

Over 2/3 of the forestland will be inundated with 0.5 m of sea level rise and over 90% will be flooded with 1.5 m of rise.

Table 4-3.3. Projected acres of South Section Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	257 acres
1 m	317 acres
1.5 m	350 acres

Natural Capital (Table 4-3.4)

Capital of forest has been increasing with efforts to reforest former fields and agricultural field.

Table 4-3.4. Natural Capital of South Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,240,496/year
2002	$1,398,016/year
2007	$1,656,327/year

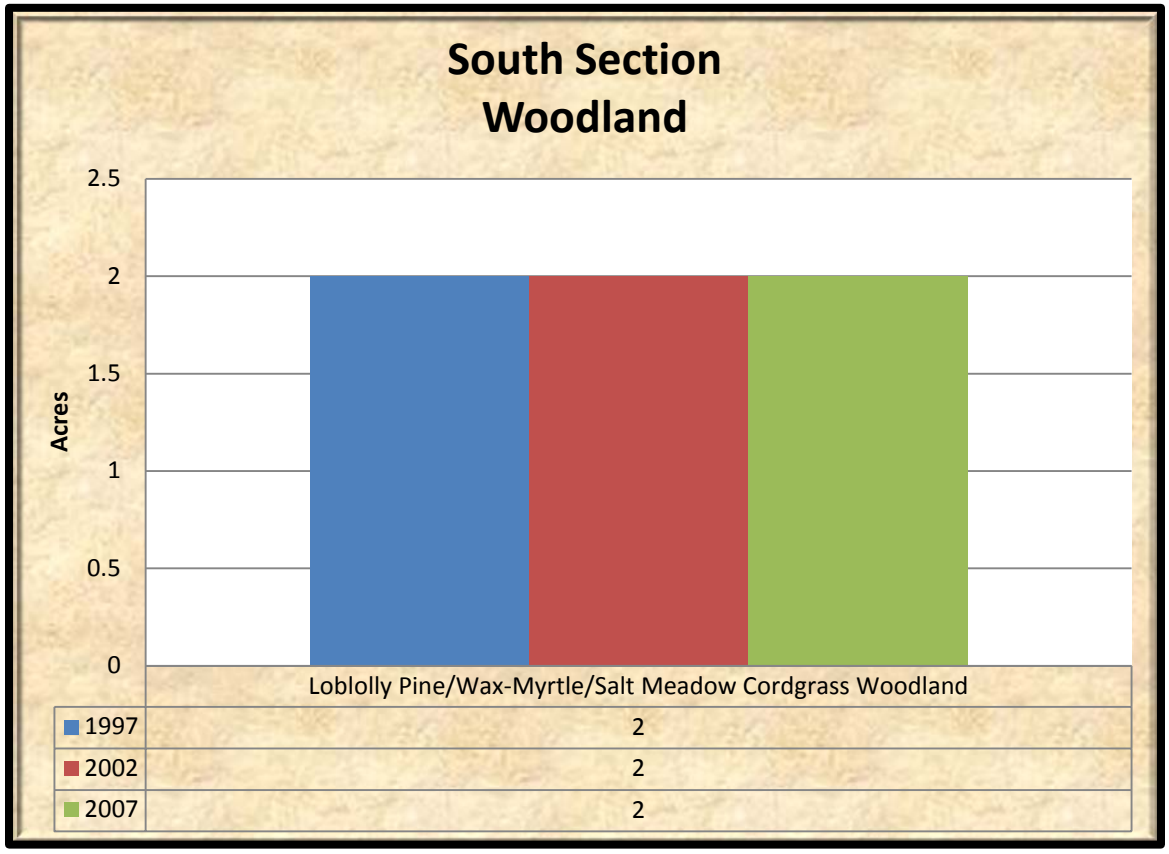


Figure 4-3.6. South Section Woodland (1997, 2002, and 2007)

South Section Woodland (Figure 4-3.6): Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland is the only woodland present in the South Section. It has remained at the same acreage through the study period.

DNREC Sea Level Rise Analysis (Table 4-3.5)

Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland will be completely inundated with 1m of sea level rise.

Table 4-3.5. Projected acres of South Section Woodland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 4-3.6)

Capital of woodland has stayed the same over the study period.

Table 4-3.6. Natural Capital of South Section Woodland	
Year	**Natural Capital (in 2012 dollars)**
1997	$378/year
2002	$378/year
2007	$378/year

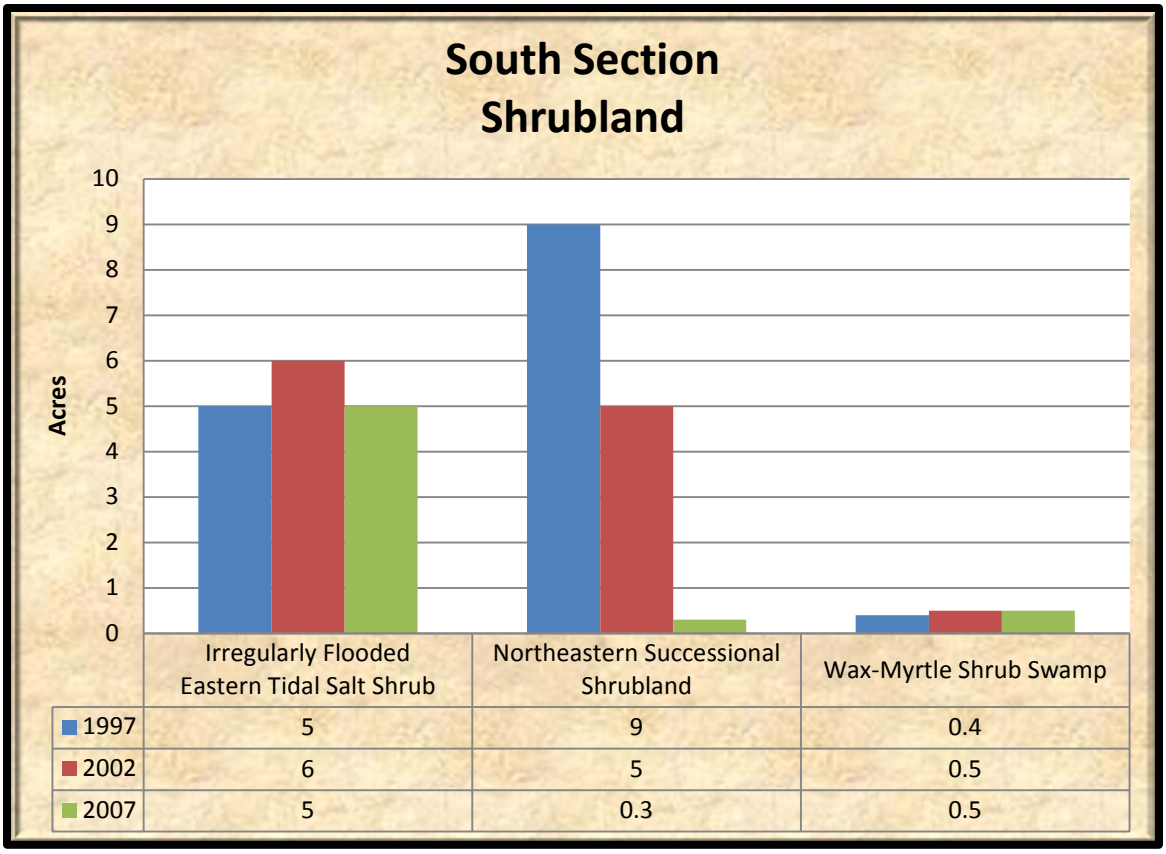


Figure 4-3.7. South Section Shrubland (1997, 2002, and 2007)

South Section Shrubland (Figure 4-3.7): Irregularly Flooded Eastern Tidal Salt Shrub is the most common shrubland in the South Section. Other shrublands cover an insignificant amount of acreage. Northeastern Successional Shrubland has succeeded to forest communities over the time of the study period.

DNREC Sea Level Rise Analysis (Table 4-3.7)

Shrubland will be completely inundated with 0.5 m of sea level rise in the South Section.

Table 4-3.7. Projected acres of South Section Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	5 acres
1.5 m	5 acres

Natural Capital (Table 4-3.8)

Natural capital of shrubland has decreased overall with maturation of Northeastern Successional Shrubland and loss of Irregularly Flooded Eastern Tidal Salt Shrub.

Table 4-3.8. Natural Capital of South Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$36,380/year
2002	$42,997/year
2007	$34,185/year

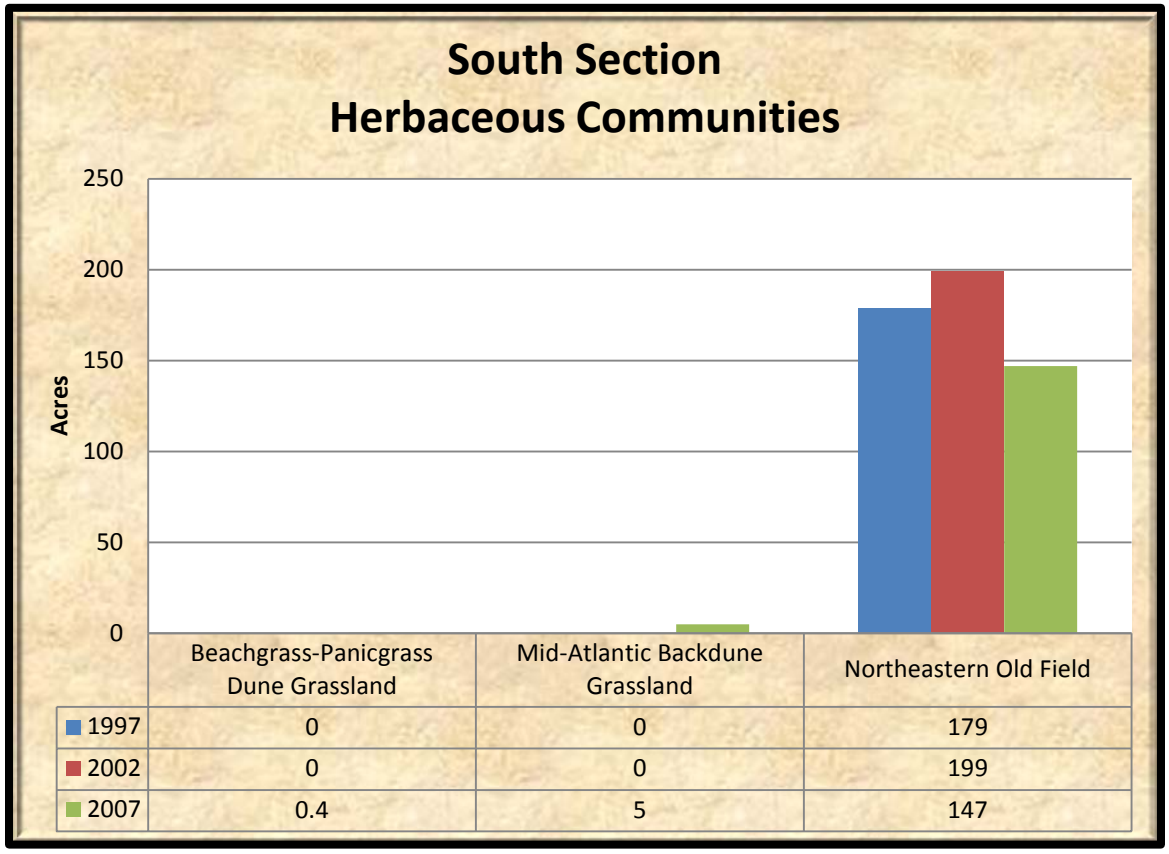


Figure 4-3.8. South Section Herbaceous Communities (1997, 2002, and 2007)

South Section Herbaceous Communities (Figure 4-3.8): Northeastern Old Field is the largest herbaceous community in the south section with Mid-Atlantic Coast Backdune Grassland and Beachgrass-Panicgrass Dune Grassland both newcomers who have populated an abandoned agricultural field. Northeastern Old Field has decreased in size due to succession to more mature communities.

DNREC Sea Level Rise Analysis (Table 4-3.9)

A lot of the herbaceous communities in the South Section are located at the western end of the section and away from effects of sea level rise. Despite this, with 1.5 m of sea level rise, 87 acres will be inundated or more than half of the total.

Table 4-3.9. Projected acres of South Section Herbaceous Communities Impacted by Sea Level Rise

Rise	Acres
0.5 m	16 acres
1 m	35 acres
1.5 m	87 acres

Natural Capital (Table 4-3.10)

Capital of herbaceous communities has been declining as these communities succeed into more mature communities.

Table 4-3.10. Natural Capital of South Section Herbaceous Communities

Year	Natural Capital (in 2012 dollars)
1997	$26,080/year
2002	$28,994/year
2007	$22,205/year

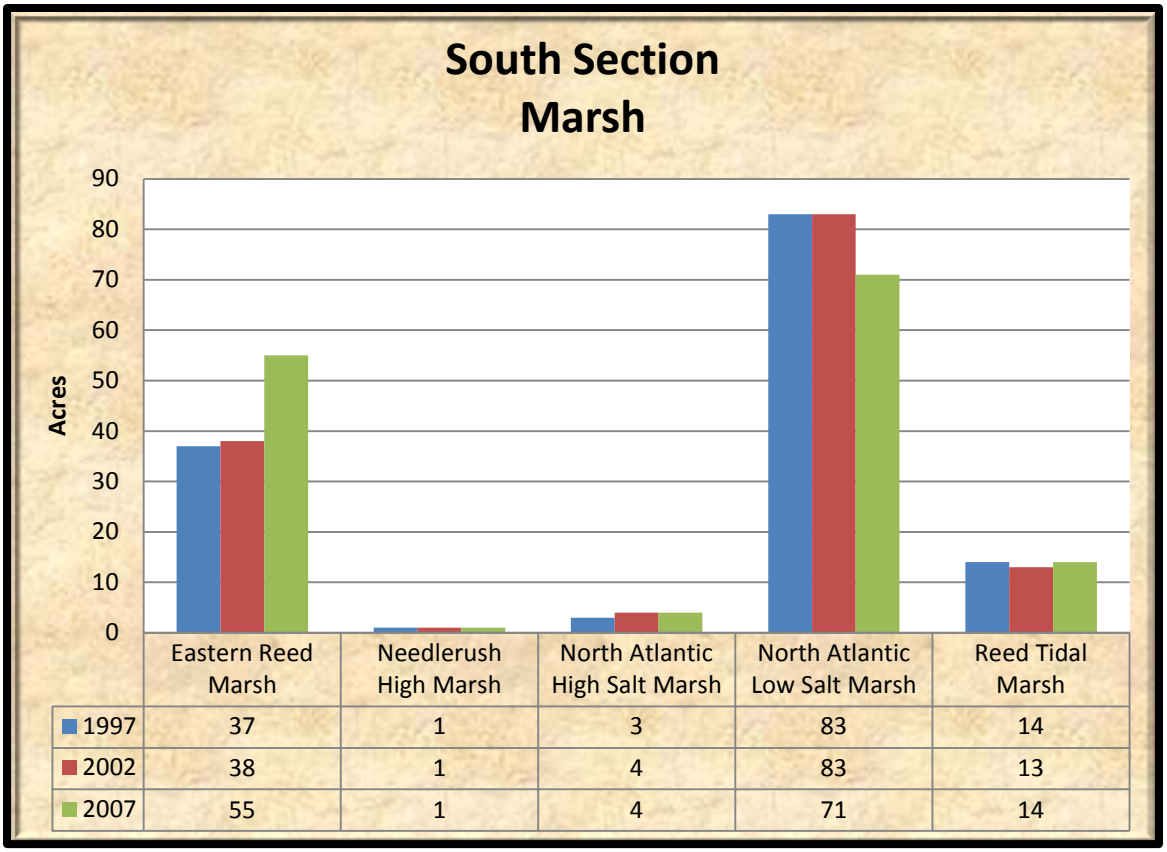


Figure 4-3.9. South Section Marsh (1997, 2002, and 2007)

South Section Marsh (Figure 4-3.9): North Atlantic Low Salt Marsh is the most common marsh followed by Eastern Reed Marsh. North Atlantic Low Salt has decreased over time while Eastern Reed Marsh has increased.

DNREC Sea Level Rise Analysis (Table 4-3.11)

Marsh will be eliminated from the South Section with 0.5 m of sea level rise.

Table 4-3.11. Projected acres of South Section Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	145 acres
1 m	145 acres
1.5 m	145 acres

Natural Capital (Table 4-3.12)

Capital of marshland has been going up with increases in Eastern Reed Marsh.

Table 4-3.12. Natural Capital of South Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$976,813/year
2002	$986,095/year
2007	$1,074,894/year

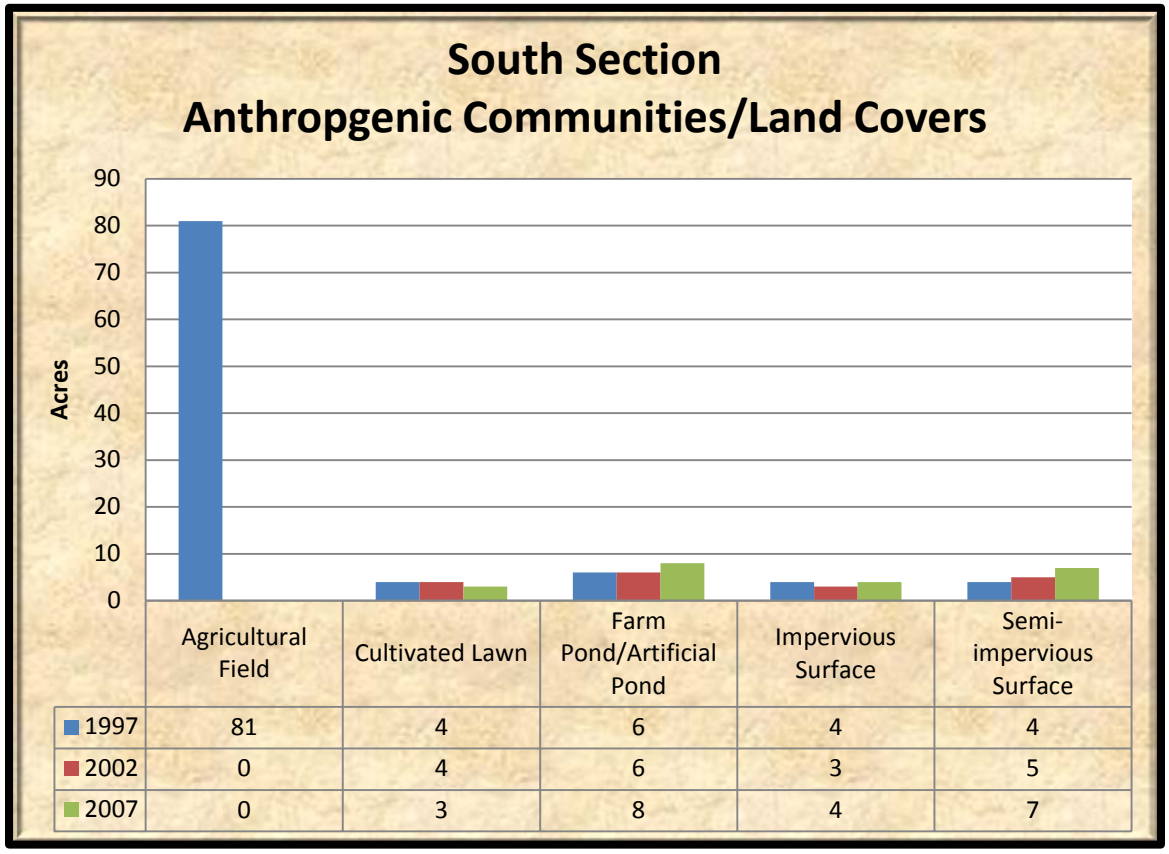


Figure 4-3.10. South Section Anthropogenic Communities/Land Covers (1997, 2002, and 2007)

South Section Anthropogenic Communities/Land Covers (Figure 4-3.10): In 2007 Anthropogenic Communities/Land Covers do not cover the acreage they once did. Land that was formerly agricultural field has converted to Northeastern Old Field. Farm Pond/Artificial Pond is now the most common anthropogenic community.

DNREC Sea Level Rise Analysis (Table 4-3.13)

Anthropogenic Communities/Land Covers will be completely inundated with 1 m of sea level rise. There will be additional economic effects because of the loss of infrastructure.

Table 4-3.13. Projected acres of South Section Anthropogenic Communities/Land Covers Impacted by Sea Level Rise

Rise	Acres
0.5 m	12 acres
1 m	22 acres
1.5 m	22 acres

Natural Capital (Table 4-3.14)

Capital of anthropogenic communities/land covers has been going up with an increase in Farm Pond/Artificial Ponds.

Table 4-3.14. Natural Capital of South Section Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1997	$36,656/year
2002	$32,011/year
2007	$42,681/year

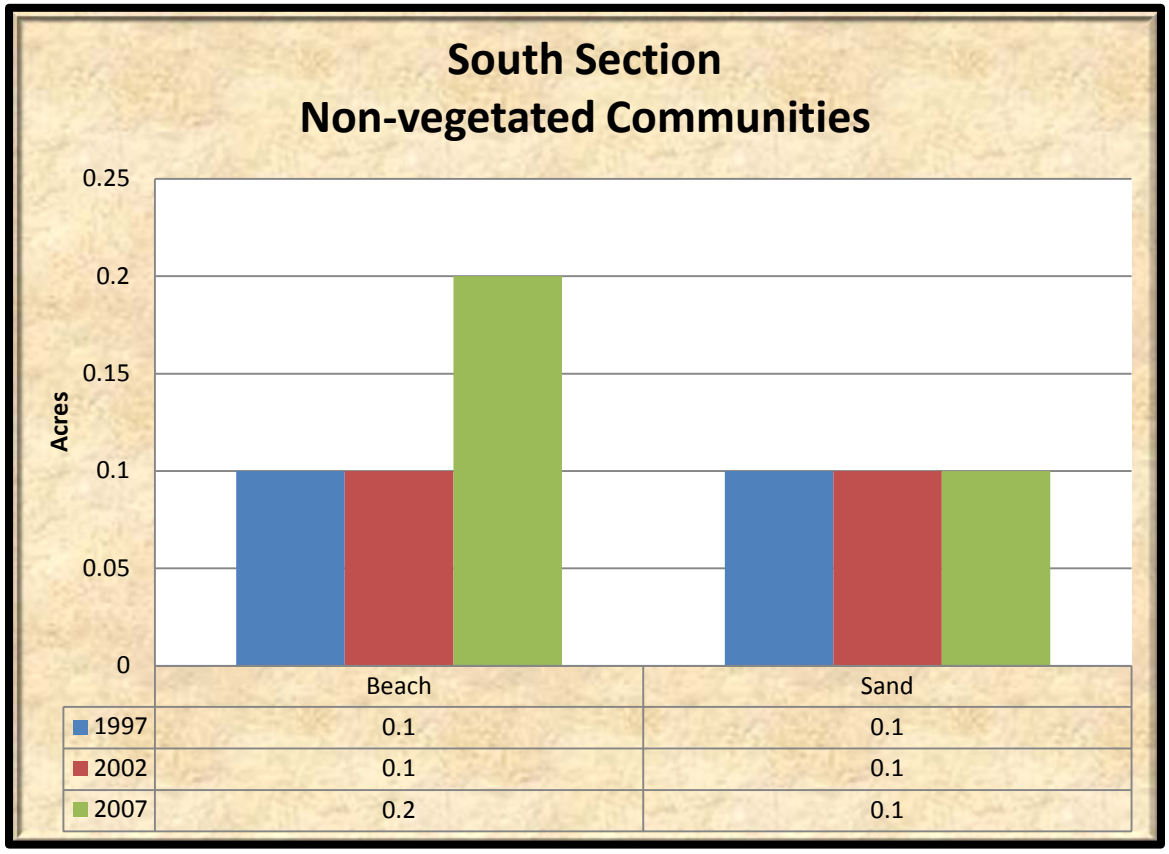


Figure 4-3.11. South Section Non-vegetated Land Covers (1997, 2002, and 2007)

South Section Non-vegetated Land Covers (Figure 4-3.11): Non-vegetated communities cover a very small amount of the South Section with beach being the largest.

DNREC Sea Level Rise Analysis (Table 4-3.15)

Non-vegetated land covers will be completely inundated with 0.5 m of sea level rise in the South Section.

Table 4-3.15. Projected acres of South Section Non-vegetated Land Covers Impacted 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

None of the Non-vegetated land covers in the South Section have any natural capital value.

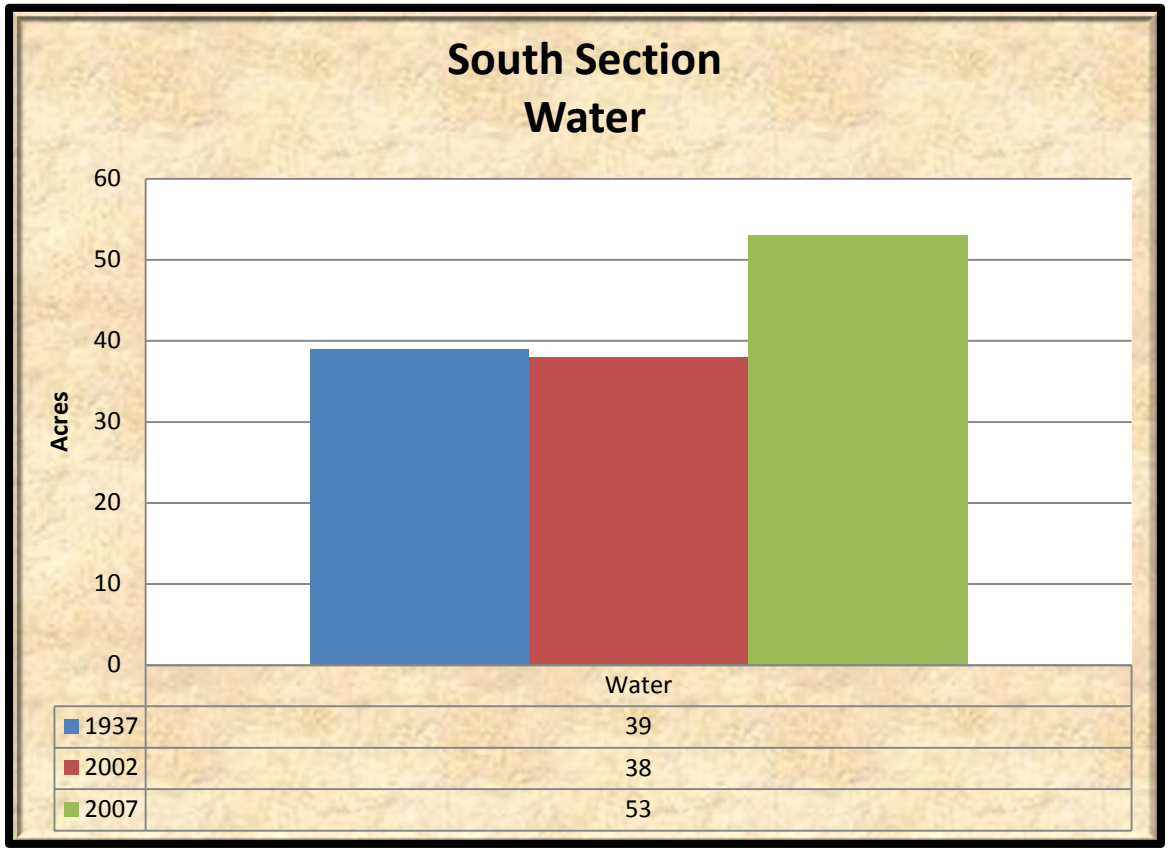


Figure 4-3.12. South Section Water Coverage (1997, 2002, and 2007)

South Section Water Coverage (Figure 4-3.12): Water is has been gradually increasing over the study period. In this area it appears to be driven by sea level rise and possibly groundwater rise driven by sea level rise.

Natural Capital (Table 4-3.16)

Natural capital of water has been going up with sea level rise and is expected to continue.

Table 4-3.16. Natural Capital of South Section Water	
Year	**Natural Capital (in 2012 dollars)**
1997	$558,981/year
2002	$544,648/year
2007	$759,641/year

CHAPTER 5: DESCRIPTIONS AND ANALYSIS OF THE VEGETATION COMMUNITIES

Thirty-two vegetation communities and ten land covers were noted in the survey (Figures 4-1.1-1.3, 2.1-2.3, 3.1-3.3). Below are the descriptions of the vegetation communities. The National Vegetation Classification (NVC) 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 NVC and the Guide to Delaware Vegetation Communities.

An analysis of the change over time is provided for those communities that are considered to be affected most immediately by sea level rise. For Delaware Seashore State Park these include the Irregularly Flooded Eastern Tidal Salt Shrub, Needlerush High Marsh, and North Atlantic High Salt Marsh.

The vegetation communities include:

1. Atlantic Coast Interdune Swale (CEGL003839)—117 acres
2. Barrier Island Bog (CEGL003906)—9 acres
3. Beachgrass-Panicgrass Dune Grassland (CEGL004043)—202 acres
4. Central Coast Beach Heather Dune Shrubland (CEGL003950)—11 acres
5. Chesapeake Bay Maritime Shrubland (CEGL003881)—11 acres
6. Chesapeake Bay Non-riverine Wet Hardwood Forest (CEGL004644)—24 acres
7. Chesapeake Bay Tall Maritime Shrubland (CEGL006319)—68 acres
8. Coastal Loblolly Pine Wetland Forest (CEGL006137)—5 acres
9. Cultivated Lawn (CEGL008462)—74 acres
10. Early to Mid-Successional Loblolly Pine Forest (CEGL006011)—186 acres
11. Eastern Reed Marsh (CEGL004141)—67 acres
12. Forked Rush Dune Swale (CEGL004111)—10 acres
13. Irregularly Flooded Eastern Tidal Salt Shrub (CEGL003921)—87 acres
14. Japanese Black Pine Forest (CEGL006012)—43 acres
15. Loblolly Pine Dune Woodland (CEGL006052)—2 acres
16. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland (CEGL006849)—2 acres
17. Maritime Red Cedar Woodland (CEGL006212)—0.2 acres
18. Mid-Atlantic Coast Backdune Grassland (CEGL004240)—113 acres
19. Mid to Late Successional Loblolly Pine-Sweetgum Forest (CEGL008462)—19 acres
20. Needlerush High Marsh (CEGL004186)—1 acre
21. North Atlantic High Salt Marsh (CEGL006006)—29 acres
22. North Atlantic Low Salt Marsh (CEGL004192)—728 acres
23. Northeastern Modified Successional Forest (CEGL006599)—15 acres
24. Northeastern Old Field (CEGL006107)—157 acres
25. Northeastern Successional Shrubland (CEGL006451)—1 acre
26. Reed Tidal Marsh (CEGL004187)—58 acres
27. Salt Panne (CEGL004308)—0.05 acres
28. Southern Red Maple-Blackgum Swamp (CEGL006238)—85 acres
29. Southern Red Oak/Heath Forest (CEGL006269)—5 acres
30. Successional Maritime Forest (CEGL006154)—18 acres

31. Successional Sweetgum Forest (CEGL007216)—3 acres
32. Wax-Myrtle Shrub Swamp (CEGL003840)—1 acre

Atlantic Coast Interdune Swale **[117 acres (Figure 5.1, Tables 5.1-5.4)] G3G4 S2**

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

Description

This community is found in depressions between the dunes throughout the park. 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 Delaware Seashore State Park

This community has gradually decreased over the study period from 123 acres to 116 acres, with 105 acres remaining of the original acres. Most of the losses have gone to Reed Tidal Marsh, Beachgrass-Panicgrass Dune Grassland, Japanese Black Pine Forest, and North Atlantic Low Salt Marsh (Table 5.1).

In spite of the losses this community has managed to convert 3 acres of Wax-Myrtle Shrub Swamp and 2 acres each of Cultivated Lawn and Reed Tidal Marsh (Table 5.2). However, the conversions are not keeping up with the losses resulting in a net loss of acreage.

This community may persist into the long term future but with reduced acreage.

Table 5.1. What was once Atlantic Coast Interdune Swale in 1997 has become X in 2007	
X	**Acreage**
Atlantic Coast Interdune Swale	105 acres
Reed Tidal Marsh	4 acres
Beachgrass-Panicgrass Dune Grassland	4 acres
Japanese Black Pine Forest	2 acres
North Atlantic Low Salt Marsh	2 acres
Other communities/land covers	6 acres

Table 5.2. Atlantic Coast Interdune Swale has migrated into X since 1997	
X	**Acreage**
Atlantic Coast Interdune Swale	105 acres
Wax-Myrtle Shrub Swamp	3 acres
Cultivated Lawn	2 acres
Reed Tidal Marsh	2 acres
Beachgrass-Panicgrass Dune Grassland	1 acre
Other communities/land covers	4 acres

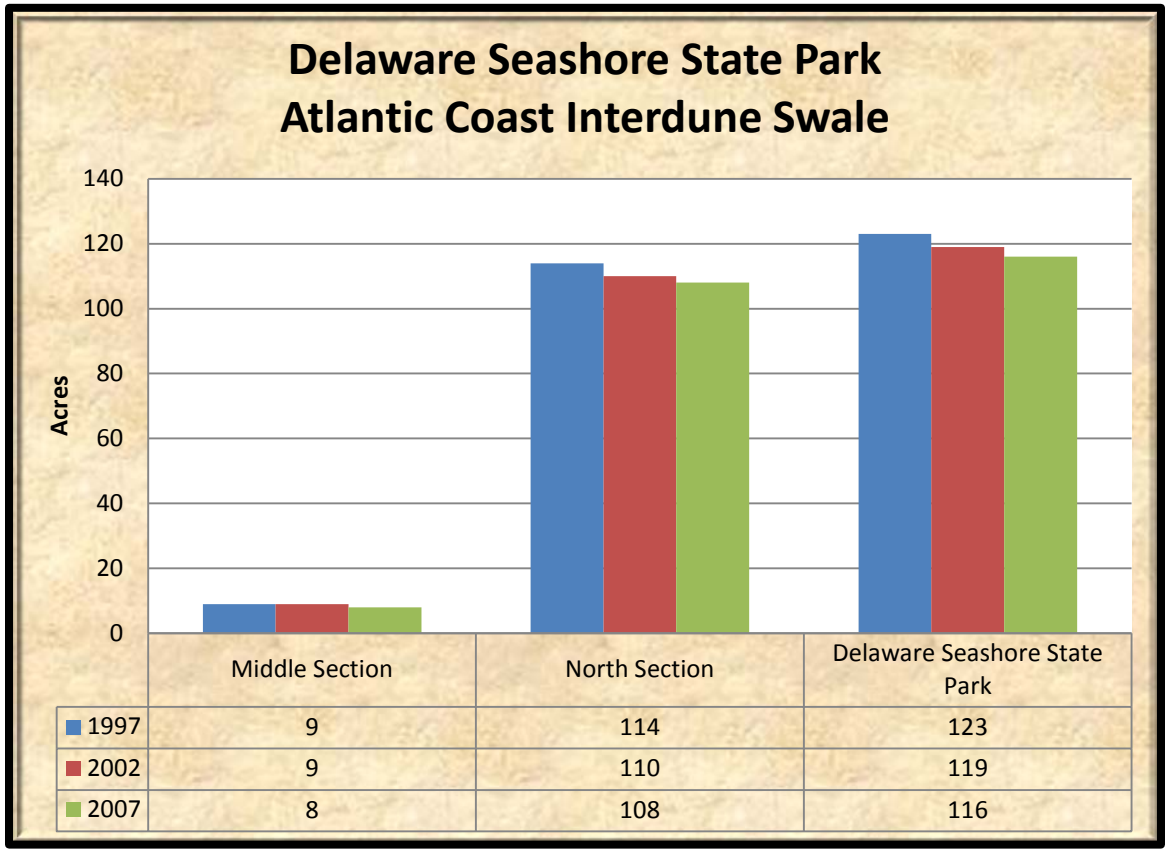


Figure 5.1. Atlantic Coast Interdune Swale at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.3)

Atlantic Coast Interdune Swale will lose a little more 1/3 of its current acreage with 0.5 m of sea level rise and will lose almost all of its acreage at 1 m of sea level rise.

Table 5.3. Projected acres of Atlantic Coast Interdune Swale Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	46 acres
1 m	112 acres
1.5 m	115 acres

Natural Capital (Table 5.4)

Capital of Atlantic Coast Interdune Swale has been decreasing with losses in acreage.

Table 5.4. Natural Capital of Atlantic Coast Interdune Swale	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,141,612/year
2002	$1,104,487/year
2007	$1,076,642/year

Barrier Island Bog **[9 acres (Figures 5.2-5.3, Tables 5.5-5.8)] G2G4 S1**

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

Description

Figure 5.2. Barrier Island Bog (Middle Section)

This community was determined through aerial imagery and records that are on file with the Natural Heritage Program. This community is typically found in depressions between the dunes. This community is dominated by southern bayberry (*Morella cerifera*) and highbush blueberry (*Vaccinium corymbosum*) and associated by inkberry (*Ilex glabra*). Common herbs include yellow-eyed grass (*Xyris torta*), royal fern (*Osmunda regalis* var. *spectabilis*), spoon-leaved sundew (*Drosera intermedia*), and switchgrass (*Panicum virgatum*).

Analysis of Condition at Delaware Seashore State Park

This community is only found in the North Section of the park and has increased by 2 acres over the study period. All of the original 7 acres are still present (Table 5.5). The additional acreage has come from Forked Rush Dune Swale, Cultivated Lawn, and Mid-Atlantic Coast Backdune Grassland (Table 5.6). Considering the increases this community appears to be stable over the short and long term and does not appear to be invaded by common reed (*Phragmites australis*), a fate common to other interdunal community.

Table 5.5. What was once Barrier Island Bog in 1997 has become X in 2007	
X	**Acreage**
Barrier Island Bog	7 acres

Table 5.6. Barrier Island Bog has migrated into X since 1997	
X	**Acreage**
Barrier Island Bog	7 acres
Forked Rush Dune Swale	1 acre
Cultivated Lawn	0.3 acres
Mid-Atlantic Coast Backdune Grassland	0.1 acres

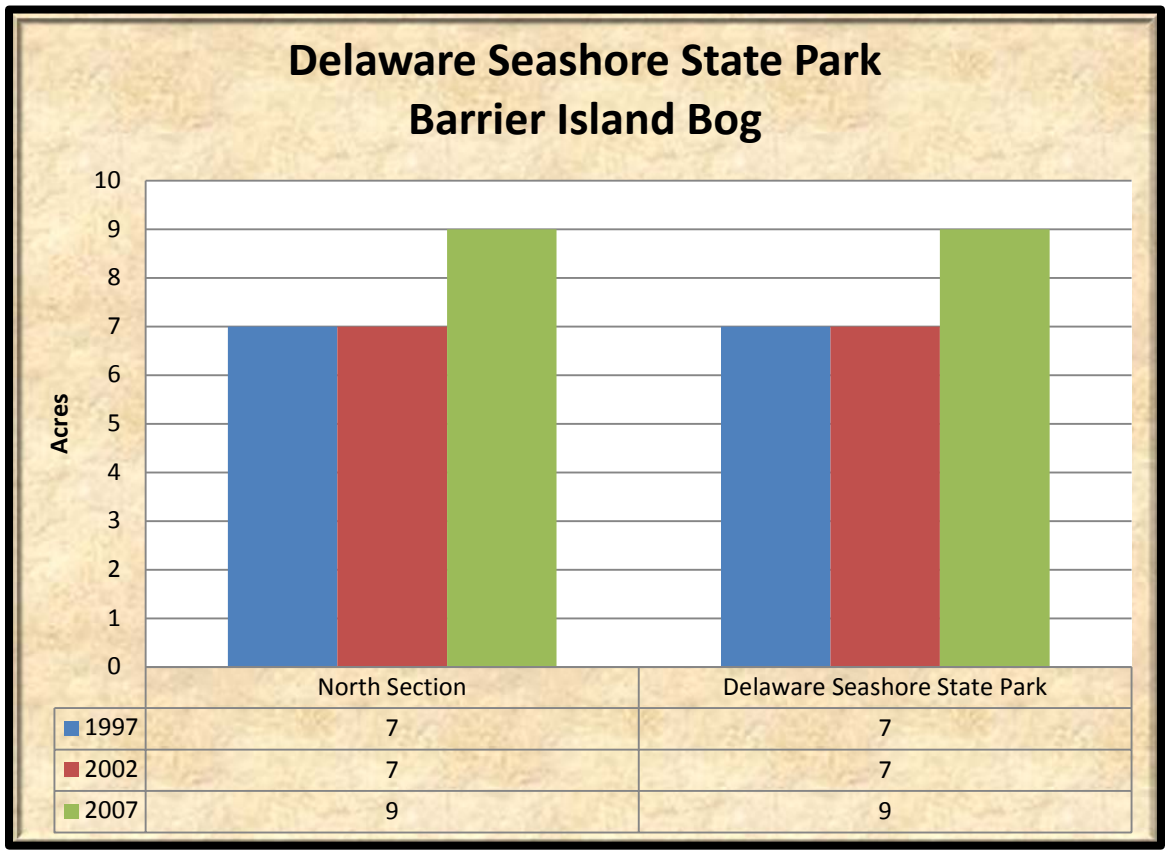


Figure 5.3. Barrier Island Bog at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.7)

About 1/3 of the current acreage of Barrier Island Bog will be inundated by 0.5 m of sea level rise and this community will be completely flooded with 1 m of rise.

Table 5.7. Projected acres of Barrier Island Bog Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	3 acres
1 m	8 acres
1.5 m	8 acres

Natural Capital (Table 5.8)

Capital of Barrier Island Bog has increased with an increase in acreage.

Table 5.8. Natural Capital of Barrier Island Bog	
Year	**Natural Capital (in 2012 dollars)**
1997	$64,970/year
2002	$64,970/year
2007	$83,533/year

Beachgrass-Panicgrass Dune Grassland **[202 acres (Figures 5.4-5.5, Tables 5.9-5.11)]**
G2 S2

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

Description

Figure 5.4. Beachgrass-Panicgrass Dune Grassland (Middle Section)

Beachgrass-Panicgrass Dune Grasslands are one of the native grasslands in the State of Delaware. These grasslands are co-dominated by beachgrass (*Ammophila breviligulata*) and panicgrass (*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 Delaware Seashore State Park

Although Beachgrass-Panicgrass appears to be at roughly the same acreage in 2007 as it was in 1997, it has moved around some. Of the original 203 acres, only 175 remain in the same place. The other acreage has converted to Mid-Atlantic Coast Backdune Grassland, Irregularly Flooded Eastern Tidal Salt Shrub, Water, and Sand (Table 5.9).

Since 1997, 8 acres of former Japanese Black Pine Forest have become this community, along with 4 acres of Atlantic Coast Interdune Swale that likely was covered over by sand. Three acres of Mid-Atlantic Coast Backdune Grassland and 2 acres of Northeastern Old Field converted to this community (Table 5.10).

Since the park is protected, it is expected that this community will survive in both the short and the long term. The acreage has been roughly stable and appears to be in balance with losses and gains. Since there is no discernible trend the survival prospects appear to be good.

Table 5.9. What was once Beachgrass-Panicgrass Dune Grassland in 1997 has become X in 2007	
X	**Acreage**
Beachgrass-Panicgrass Dune Grassland	175 acres
Mid-Atlantic Coast Backdune Grassland	8 acres
Irregularly Flooded Eastern Tidal Salt Shrub	3 acres
Water	3 acres
Sand	3 acres
Other communities/land covers	11 acres

Table 5.10. Beachgrass-Panicgrass Dune Grassland has migrated into X since 1997	
X	**Acreage**
Beachgrass-Panicgrass Dune Grassland	175 acres
Japanese Black Pine Forest	8 acres
Atlantic Coast Interdune Swale	4 acres
Mid-Atlantic Coast Backdune Grassland	3 acres
Northeastern Old Field	2 acres
Other communities/land covers	9 acres

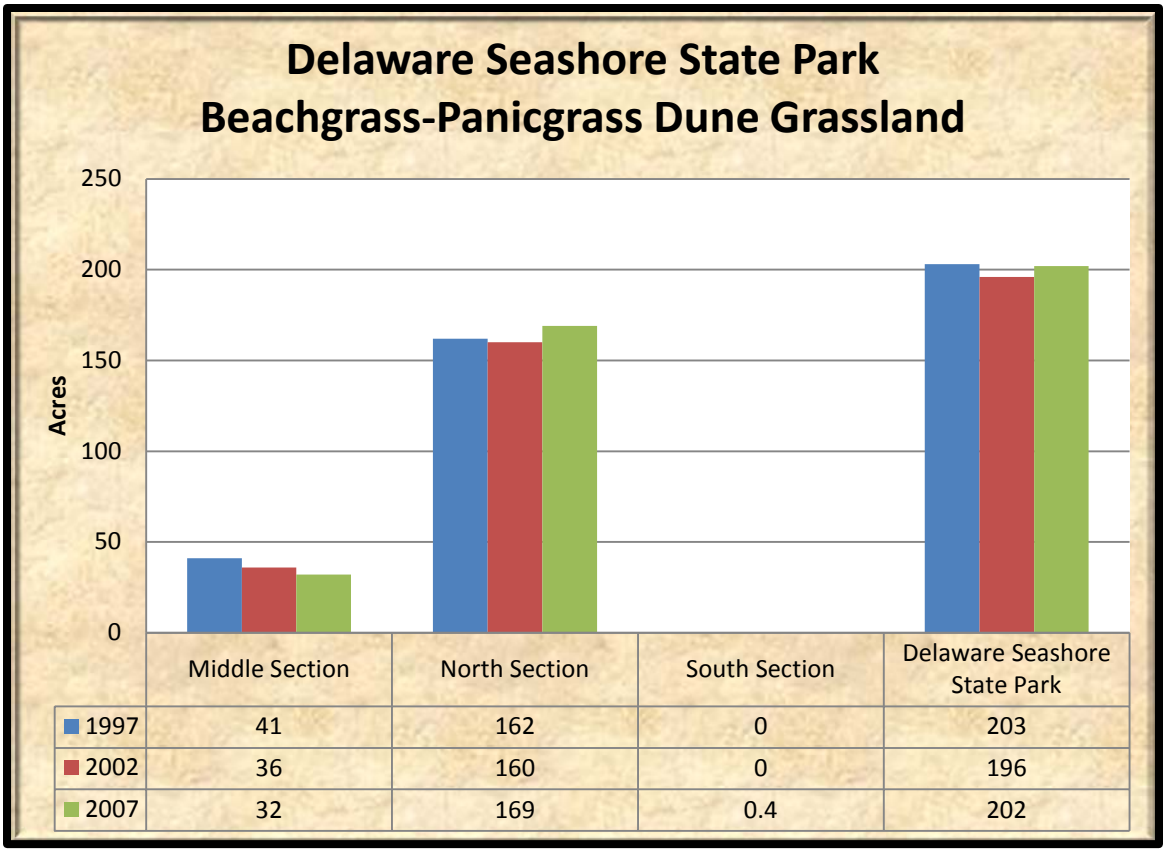


Figure 5.5. Beachgrass-Panicgrass Dune Grassland at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.11)

Most of the Beachgrass-Panicgrass Dune Grassland community is located above the height that will be affected by sea level rise. As such, less than 1/3 of this community will be flooded by a rise 1.5 m.

Table 5.11. Projected acres of Beachgrass-Panicgrass Dune Grassland Impacted by Sea Level Rise

Rise	Acres
0.5 m	17 acres
1 m	34 acres
1.5 m	61 acres

Natural Capital (Table 5.12)

Beachgrass-Panicgrass Dune Grassland capital went down between 1997 and 2002, but has increased in the 2002-2007 period. These numbers are likely cyclical because of storms and other events.

Table 5.12. Natural Capital of Beachgrass-Panicgrass Dune Grassland	
Year	**Natural Capital (in 2012 dollars)**
1997	$29,577/year
2002	$28,557/year
2007	$29,431/year

Central Coast Beach Heather Dune Shrubland **[11 acres (Figures 5.6-5.7, Tables 5.13-5.16)]**
G2 S2

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

Description

Figure 5.6. Central Coast Beach Heather Dune Shrubland (Middle 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*).

Analysis of Condition at Delaware Seashore State Park

This dwarf-shrub community tends to be ephemeral, appearing and reappearing as sand moves around in the maritime area. It has been increasing over time as it fills in former bare sand areas. This community appears to be secure in the park because of this increase in area.

Eight acres of the original thirteen acres from 1997 were still present in 2007. Since 1997 2 acres each have converted to Beachgrass-Panicgrass Dune Grassland and Mid-Atlantic Coast Backdune Grassland presumably from being covered by sand. A minor amount of this community has been converted to Atlantic Coast Interdune Swale (0.4 acres) and Chesapeake Bay Maritime Shrubland (0.2 acres) (Table 5.13).

In spite of losing acreage over the study period this community has converted 1 acre of Beachgrass-Panicgrass Dune Grassland and colonized one acre of sand. A minor amount of Chesapeake Bay Maritime Shrubland (0.2 acres) and Irregularly Flooded Eastern Tidal Salt Shrub (0.2 acres) was also converted (Table 5.14).

This community has declined slightly over the study period and given that this community tends to be ephemeral a trend cannot be discerned. This community could easily start to recover acreage given the right conditions. Because of this a projection on this community cannot be made with the data available.

Table 5.13. What was once Central Coast Beach Heather Dune Shrubland in 1997 has become X in 2007	
X	**Acreage**
Central Coast Beach Heather Dune Shrubland	8 acres
Beachgrass-Panicgrass Dune Grassland	2 acres
Mid-Atlantic Coast Backdune Grassland	2 acres
Atlantic Coast Interdune Swale	0.4 acres
Chesapeake Bay Short Maritime Shrubland	0.2 acres
Other communities/land covers	0.1 acres

Table 5.14. Central Coast Beach Heather Dune Shrubland has migrated into X since 1997	
X	**Acreage**
Central Coast Beach Heather Dune Shrubland	8 acres
Beachgrass-Panicgrass Dune Grassland	1 acre
Sand	1 acre
Chesapeake Bay Maritime Shrubland	0.2 acres
Irregularly Flooded Eastern Tidal Salt Shrub	0.2 acres
Other communities/land covers	0.4 acres

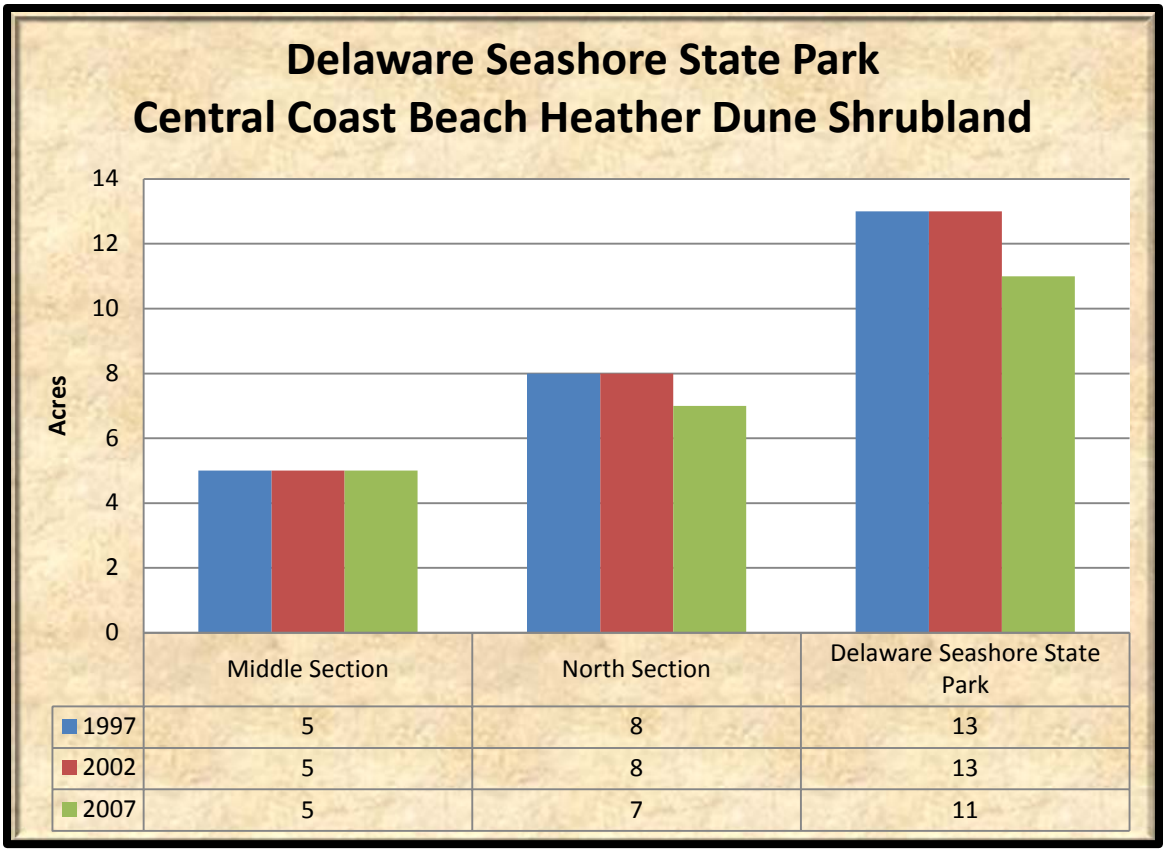


Figure 5.7. Central Coast Beach Heather Dune Shrubland at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.15)

A little more than half of the current acreage of Central Coast Beach Heather Dune Shrubland will be flooded under the highest amount of rise (1.5 m).

Table 5.15. Projected acres of Central Coast Beach Heather Dune Shrubland Impacted by Sea Level Rise

Rise	Acres
0.5 m	0.5 acres
1 m	3 acres
1.5 m	6 acres

Natural Capital (Table 5.16)

Capital of Central Coast Beach Heather Dune Shrubland has gone down recently with a loss in acreage.

Table 5.16. Natural Capital of Central Coast Beach Heather Dune Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,894/year
2002	$1,894/year
2007	$1,603/year

Chesapeake Bay Maritime Shrubland **[11 acres (Figures 5.8-5.9, Tables 5.17-5.20)]**
G2 S1

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

Description

Figure 5.8. Chesapeake Bay Maritime Shrubland (Middle Section)

This shrub community is composed primarily of beach plum (*Prunus maritima*) and associated by seaside goldenrod (*Solidago sempervirens*) and beachgrass (*Ammophila breviligulata*). It is generally found in the dunes around Central Coast Beach Heather Dune Shrubland and Beachgrass-Panicgrass Dune Grassland.

Analysis of Condition at Delaware Seashore State Park

Chesapeake Bay Maritime Shrubland has been roughly steady in acreage over the study period. Eight of the original ten 1997 acres were still present in 2007. Since 1997 1 acre has converted to Beachgrass-Panicgrass Dune Grassland and 0.5 acres to Mid-Atlantic Coast Backdune Grassland. A small amount, 0.2 acres, converted to Central Coast Beach Heather Dune Shrubland and to sand (0.1 acres) (Table 5.17).

While some acres converted to other communities, this community also converted other communities such as Mid-Atlantic Coast Backdune Grassland (1 acre), Beachgrass-Panicgrass Dune Grassland (1 acre), Northeastern Old Field (0.4 acres), and Atlantic Coast Interdune Swale (0.2 acres) (Table 5.18).

This community has been stable in acreage over the study period and as such a trend cannot be identified will the data available. Overall all of the coastal communities stand some chance of either decreasing in area or being eliminated due to sea level rise.

Table 5.17. What was once Chesapeake Bay Maritime Shrubland in 1997 has become X in 2007	
X	**Acreage**
Chesapeake Bay Maritime Shrubland	8 acres
Beachgrass-Panicgrass Dune Grassland	1 acre
Mid-Atlantic Coast Backdune Grassland	0.5 acres
Central Coast Beach Heather Dune Shrubland	0.2 acres
Sand	0.1 acres

Table 5.18. Chesapeake Bay Maritime Shrubland has migrated into X since 1997	
X	**Acreage**
Chesapeake Bay Maritime Shrubland	8 acres
Mid-Atlantic Coast Backdune Grassland	1 acre
Beachgrass-Panicgrass Dune Grassland	1 acre
Northeastern Old Field	0.4 acres
Atlantic Coast Interdune Swale	0.2 acres
Other communities/land covers	0.4 acres

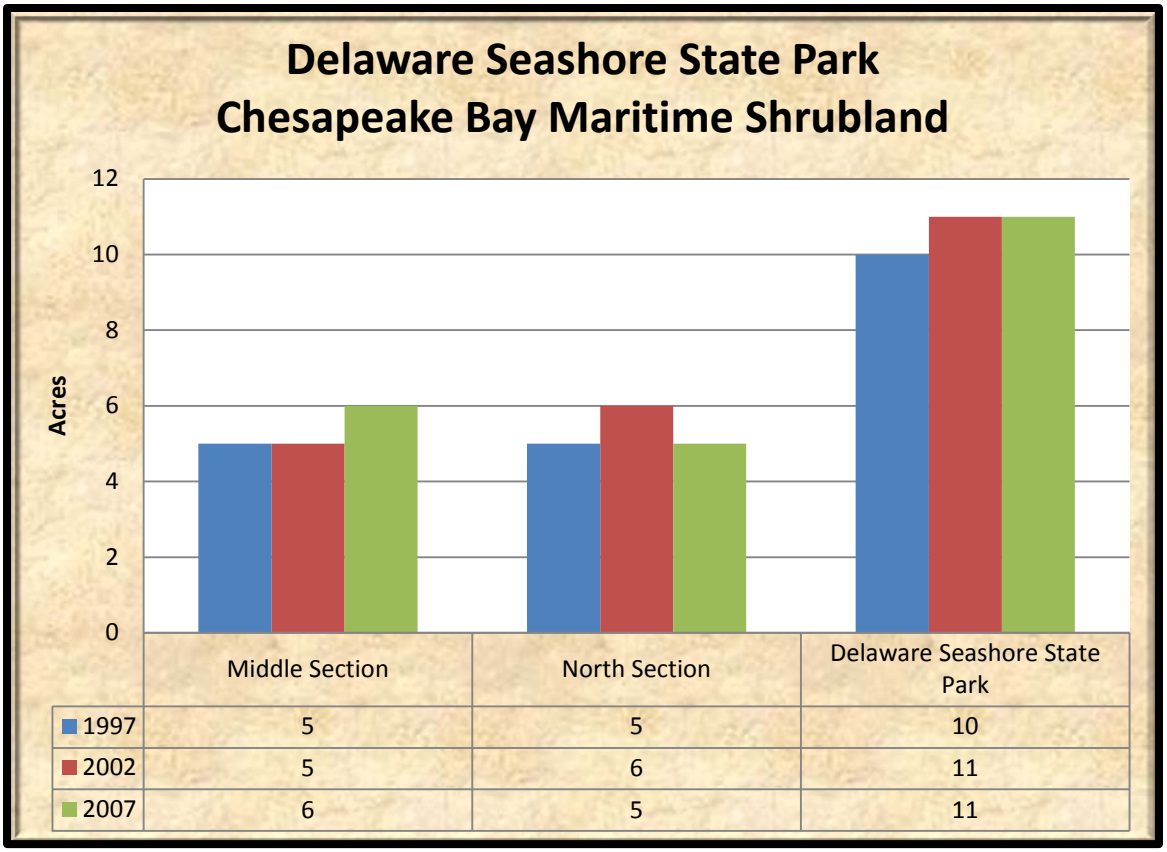


Figure 5.9. Chesapeake Bay Maritime Shrubland at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.19)

A little more than half of the current acreage of Chesapeake Bay Maritime Shrubland will be lost with 1.5 m of sea level rise.

Table 5.19. Projected acres of Chesapeake Bay Maritime Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	2 acres
1.5 m	6 acres

Natural Capital (Table 5.20)

Natural capital has increased with acreage for Chesapeake Bay Maritime Shrubland.

Table 5.20. Natural Capital of Chesapeake Bay Maritime Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,457/year
2002	$1,603/year
2007	$1,603/year

Chesapeake Bay Non-riverine Wet Hardwood Forest **[24 acres (Figures 5.10-5.11, Tables 5.21-5.24)] G2? S4 (Provisional)**

DEWAP: Coastal Plain Forested Floodplains and Riparian Swamps
NHC: Northern Atlantic Coastal Plain Basin Swamp and Wet Hardwood Forest

Description

This community is located adjacent to a Southern Red Maple-Blackgum Swamp Forest in an area where the soil is slightly less saturated. The canopy is dominated by red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), and southern red oak (*Quercus falcata*). The understory, which is thick in places, is composed of American holly (*Ilex opaca*), wild black cherry (*Prunus serotina*), and sassafras (*Sassafras albidum*). Common greenbrier (*Smilax rotundifolia*) is thick in places. Common herbs include netted chain fern (*Woodwardia areolata*), speargrass (*Chasmanthium laxum*), thicket sedge (*Carex abscondita*), partridgeberry (*Mitchella repens*), royal fern (*Osmunda regalis*), and cinnamon fern (*Osmunda cinnamomea*).

Figure 5.10. Chesapeake Bay Non-riverine Wet Hardwood Forest (South Section)

The examples located at Delaware Seashore State Park are in the late successional stage, with some thick areas of understory and still developing layers. Diameters-at-breast height ranged from 0.8 feet to 1.5 feet.

Analysis of Condition at Delaware Seashore State Park

All of the original 23 acres from 1997 were still present in 2007 with a gain of one acre from Early to Mid-Successional Loblolly Pine Forest. An additional 0.4 acres was gained from Northeastern Old Field, but this is in the rounding error and not counted as a gain (Tables 5.21 and 5.22).

By the numbers this community appears secure with a modest gain in acreage over the 10 years. However, it is located in an area that apparently flooding from groundwater making the prospects for the long term survival of this community uncertain. Because of this I would rate the long term survival of this community as fair.

Table 5.21. What was once Chesapeake Bay Non-riverine Wet Hardwood Forest in 1997 has become X in 2007	
X	**Acreage**
Chesapeake Bay Non-riverine Wet Hardwood Forest	23 acres

Table 5.22. Chesapeake Bay Non-riverine Wet Hardwood Forest has migrated into X since 1997	
X	**Acreage**
Chesapeake Bay Non-riverine Wet Hardwood Forest	23 acres
Early to Mid-Successional Loblolly Pine Forest	1 acre
Northeastern Old Field	0.4 acres

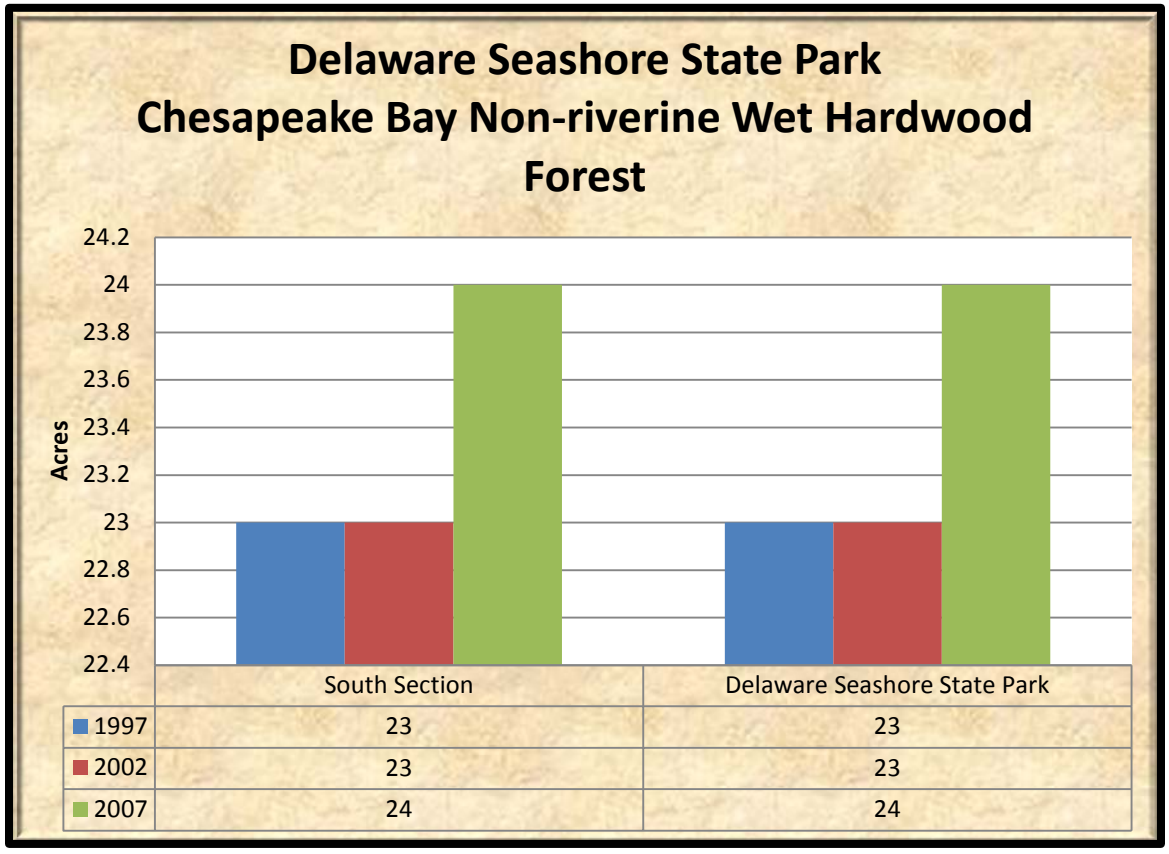


Figure 5.11. Chesapeake Bay Non-riverine Wet Hardwood Forest at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.23)

Most of this community will be lost with 0.5 m of sea level rise and it will be inundated completely with 1 m of sea level rise.

Table 5.23. Projected acres of Chesapeake Bay Non-riverine Wet Hardwood Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	18 acres
1 m	23 acres
1.5 m	23 acres

Natural Capital (Table 5.24)

Capital of Chesapeake Bay Non-riverine Wet Hardwood Forest has increased recently with additional acreage.

Table 5.24. Natural Capital of Chesapeake Bay Non-riverine Wet Hardwood Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$282,705/year
2002	$282,705/year
2007	$294,996/year

Chesapeake Bay Tall Maritime Shrubland **[68 acres (Figures 5.12-5.13, Tables 5.25-5.28)]**
G1G2 S1

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

Description

Figure 5.12. Chesapeake Bay Tall Maritime Shrubland (North Section)

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*).

Despite the name this community is similar to a stunted forest. The example located at Burton Island appeared to be mature with the ones near the marina being in a successional state.

Analysis of Condition at Delaware Seashore State Park

Chesapeake Bay Tall Maritime Shrubland is a globally rare community that is found on Burtons Island. Over the study period it has gradually decreased in acreage.

Of the original 77 acres in 1997, only 68 survive in 2007. About 2 acres converted to Irregularly Flooded Eastern Tidal Salt Shrub and about two acres were lost to development around the area of the marina (impervious surface (1 acre) and Cultivated Lawn (1 acre)). Another acre was lost to beach area via erosion on the shoreline of Burtons Island (Table 5.25).

This community has had very little success converting other communities or having communities mature into it. Sand, Wax-Myrtle Shrub Swamp, Irregularly Flooded Eastern Tidal Salt Shrub, Eastern Reed Marsh have all converted to this community in 0.2 acre increments (Table 5.26).

Given the losses of this community, poor recruitment, and vulnerability to sea level rise the long term prospects for this community are fair to poor. Chesapeake Bay Tall Maritime Shrubland will likely suffer large losses but some may continue to persist in the highest areas of the dunes.

Table 5.25. What was once Chesapeake Bay Tall Maritime Shrubland in 1997 has become X in 2007	
X	**Acreage**
Chesapeake Bay Tall Maritime Shrubland	68 acres
Irregularly Flooded Eastern Tidal Salt Shrub	2 acres
Impervious Surface	1 acre
Beach	1 acre
Cultivated Lawn	1 acre
Other communities/land covers	3 acres

Table 5.26. Chesapeake Bay Tall Maritime Shrubland has migrated into X since 1997	
X	**Acreage**
Chesapeake Bay Tall Maritime Shrubland	68 acres
Sand	0.2 acres
Wax-Myrtle Shrub Swamp	0.2 acres
Irregularly Flooded Eastern Tidal Salt Shrub	0.2 acres
Eastern Reed Marsh	0.2 acres
Other communities/land covers	0.1 acres

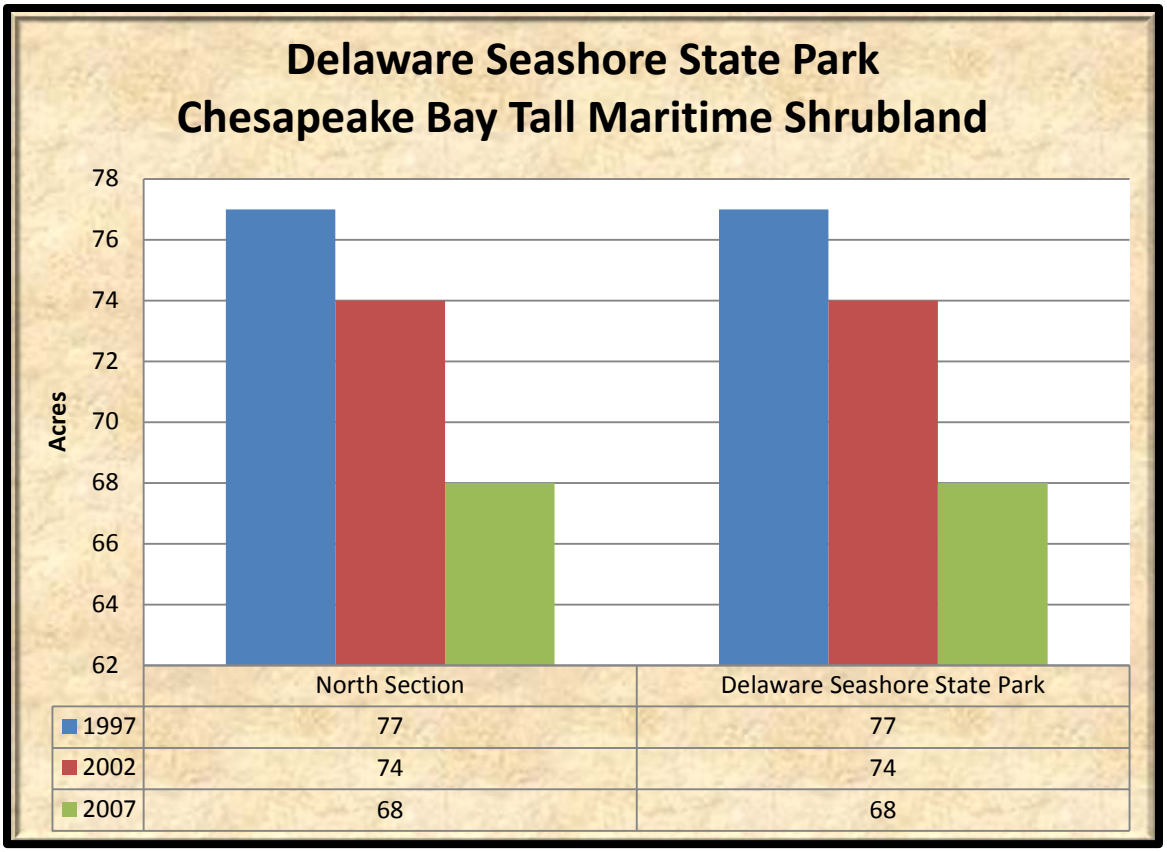


Figure 5.13. Chesapeake Bay Tall Maritime Shrubland at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.27)

Chesapeake Bay Tall Maritime Shrubland will also be completely inundated at 1.5 m of sea level rise and will be greatly impacted at 0.5 m of rise.

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

Rise	Acres
0.5 m	22 acres
1 m	51 acres
1.5 m	63 acres

Natural Capital (Table 5.28)

Capital of Chesapeake Bay Tall Maritime Shrubland has been decreasing because of development and encroachment of the nearby marsh.

Table 5.28. Natural Capital of Chesapeake Bay Tall Maritime Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$11,219/year
2002	$10,782/year
2007	$9,908/year

Coastal Loblolly Pine Wetland Forest **[5 acres (Figure 5.14, Tables 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 found in a canal north of and around Fresh Pond between the pond and DE 1. The location was determined from aerial interpretation, but generally Loblolly pine (*Pinus taeda*) dominates the canopy and is associated by red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), and sometimes southern red oak (*Quercus falcata*). Understory associates generally include American holly (*Ilex opaca*), southern red oak (*Quercus falcata*), and sassafras (*Sassafras albidum*). The shrub and vine layer is usually 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.

Most of the examples of this community appeared to late successional to mature. Large loblolly pines with diameters-at-breast height of 1.5 feet to 2 feet were occasionally seen. Other trees ranged from 0.8 feet up to 1.5 feet. Layering was chaotic in some places.

Analysis of Condition at Delaware Seashore State Park

Overall this community does not cover much acreage in the park and has increased by one acre over the study period. Three of the original 4 acres persist into 2007 with one acre going to Reed Tidal Marsh, likely at the edge of the marsh. Two acres of Early to Mid-Successional Loblolly Pine Forest have matured into this forest accounting for the acreage gain (Tables 4.23 and 4.24).

Since forest communities tend to long lived and the potential for some acres still present of Early to Mid-Successional Loblolly Pine Forest to mature to this community the prospects for this community appear to be good. However, because of the low location of the community there may be losses due to conversion to marsh and sea level rise.

Table 5.29. What was once Coastal Loblolly Pine Wetland in 1997 has become X in 2007	
X	**Acreage**
Coastal Loblolly Pine Wetland Forest	3 acres
Reed Tidal Marsh	1 acre

Table 5.30. Coastal Loblolly Pine Wetland Forest has migrated into X since 1997	
X	**Acreage**
Coastal Loblolly Pine Wetland Forest	3 acres
Early to Mid-Successional Loblolly Pine Forest	2 acres

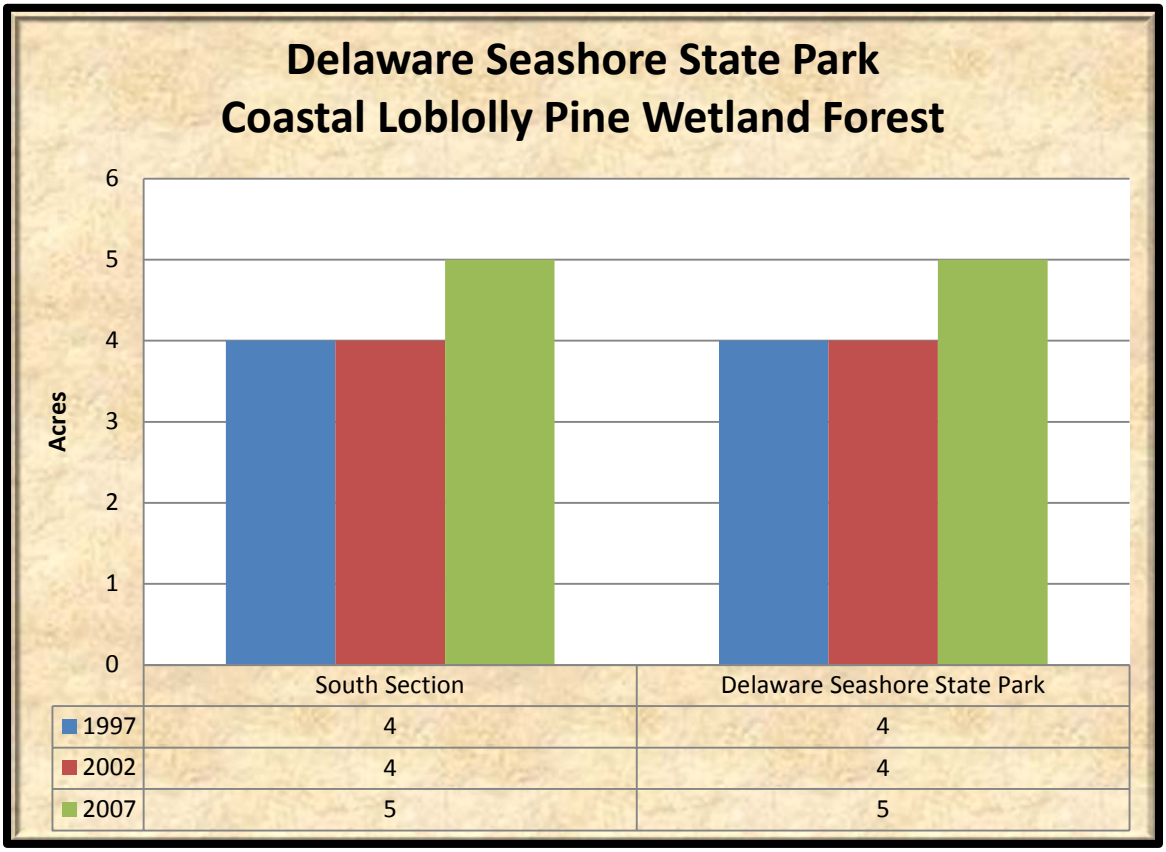


Figure 5.14. Coastal Loblolly Pine Wetland Forest at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.31)

This community will be completely inundated with just 0.5 m of sea level rise.

Table 5.31. Projected acres of Coastal Loblolly Pine Wetland Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	5 acres
1.5 m	5 acres

Natural Capital (Table 5.32)

Capital in Coastal Loblolly Pine Wetland Forest has gone up recently due to Early to Mid-Successional Loblolly Pine maturing into it. The capital from the previous community was transferred to this community.

Table 5.32. Natural Capital of Coastal Loblolly Pine Wetland Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$49,166/year
2002	$49,166/year
2007	$61,458/year

Cultivated Lawn **[74 acres (Figure 5.15, Tables 5.33-5.35)] 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 Delaware Seashore State Park

Cultivated lawn is often associated with development (Impervious surface and semi-impervious surface), and is a man-made community. Since 1997 this community has decreased in acreage due in part to further development of the new Indian River Inlet Bridge and conversion to wetlands with only 58 of the original 81 1997 acres still present in 2007. Nine acres were lost to impervious surface and 5 acres to modified land. Two acres each were lost to Atlantic Coast Interdune Swale and Irregularly Flooded Eastern Tidal Salt Shrub (Table 5.33).

Cultivated lawns also took over 6 acres of Northeastern Old Field and 2 acres of former impervious surface and 2 acres of Beachgrass-Panicgrass Dune Grassland. About one acre of sand was also converted to cultivated lawn (Table 5.34).

This community is man-made and is of little wildlife value. Perhaps the park can look for ways to convert the "lawns" to a more wildlife friendly habitat such as a meadow (Northeastern Old Field) or other more natural habitat providing a food and cover source.

Table 5.33. What was once Cultivated Lawn in 1997 has become X in 2007

X	Acreage
Cultivated Lawn	58 acres
Impervious Surface	9 acres
Modified Land	5 acres
Atlantic Coast Interdune Swale	2 acres
Irregularly Flooded Eastern Tidal Salt Shrub	2 acres
Other communities/land covers	4 acres

Table 5.34. Cultivated Lawn has migrated into X since 1997	
X	**Acreage**
Cultivated Lawn	58 acres
Northeastern Old Field	6 acres
Impervious Surface	2 acres
Beachgrass-Panicgrass Dune Grassland	2 acres
Sand	1 acre
Other communities/land covers	5 acres

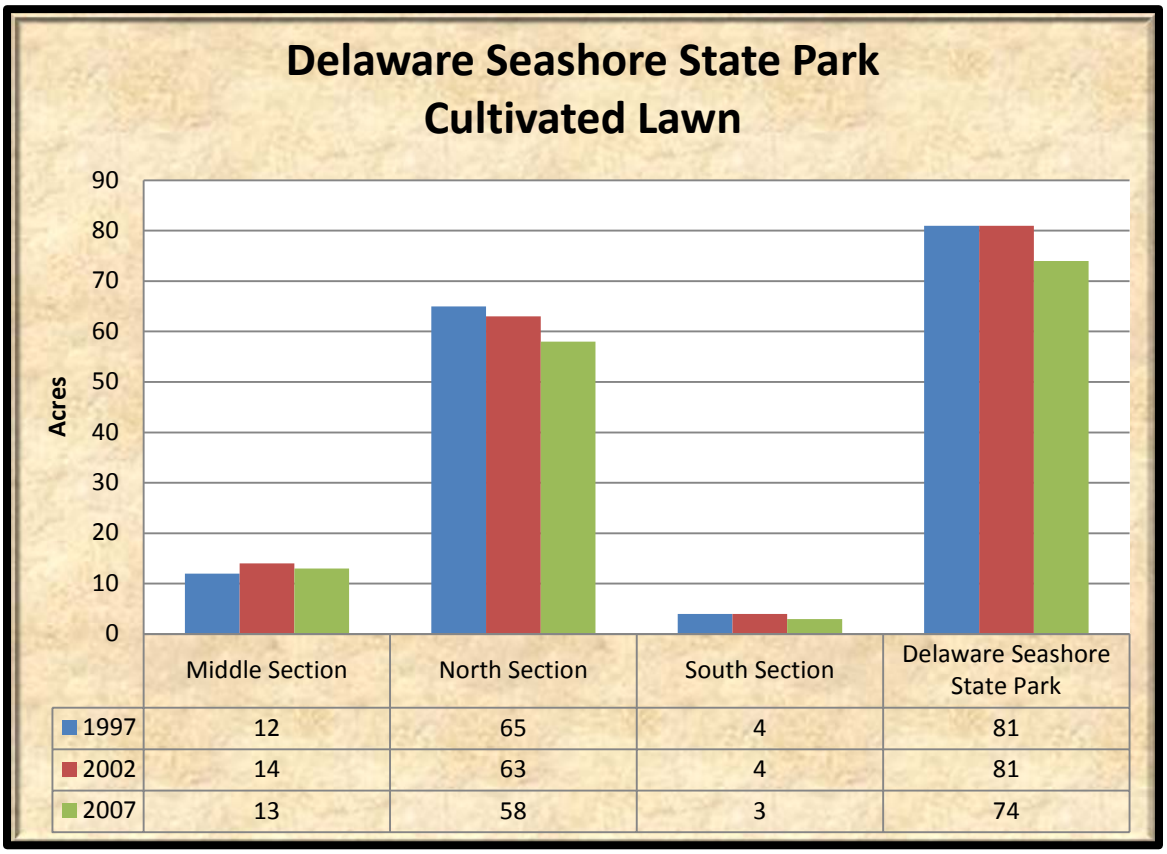


Figure 5.15. Cultivated Lawn at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.35)

Almost all of the acreage of cultivated lawn will be flooded with 1.5 m of sea level rise.

Table 5.35. Projected acres of Cultivated Lawn Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	19 acres
1 m	59 acres
1.5 m	69 acres

Natural Capital

This community does not have any natural capital.

Early to Mid-Successional Loblolly Pine Forest **[186 acres (Figures 5.16-5.17, Tables 5.36-5.39)]**
GNA SNA

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

Description

This forest community covers a large part of the south section near DE 1. Loblolly pine (*Pinus taeda*) is the lone species in a canopy that overtops red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), wild black cherry (*Prunus serotina*), and southern red oak (*Quercus falcata*). Wax-myrtle (*Morella cerifera*) and common greenbrier (*Smilax rotundifolia*) are common shrubs and vines. Herbs include speargrass (*Chasmanthium laxum*), short beach panicgrass (*Panicum amarum*), Eaton's Witchgrass (*Dichanthelium spretum*), and switchgrass (*Panicum virgatum*).

Figure 5.16. Early to Mid-Successional Loblolly Pine Forest (South Section)

Analysis of Condition at Delaware Seashore State Park

The acreage of Early to Mid-Successional Loblolly Pine Forest often varies with the amount of land that is taken out of agricultural production and the speed of succession. At Delaware Seashore State Park some of this community was eliminated when it drowned from water coming from sea level rise or from groundwater. The increase from 1997 to 2002 came from the abandonment of an agricultural field.

Because of the successional nature of this community it tends to come and go and can have large swings in acreage amounts as it succeeds to other communities and develops from other communities such as Northeastern Old Field, Northeastern Successional Shrubland, and agricultural field. In 2007 only 122 of the original 163 acres from 1997 remained. The remainder of the acres converted to more mature communities or drowned by water. These communities include Mid to Late Successional Loblolly Pine-Sweetgum Forest (16 acres), drowned forest (13 acres), Southern Red Maple-Blackgum Swamp Forest (6 acres), and Coastal Loblolly Pine Wetland Forest (2 acres) (Table 5.36).

Since 1997 a number of early successional communities have matured to this community but still there was a net loss in acreage. These communities include Northeastern Old Field (54 acres), Northeastern Successional Shrubland (6 acres), and Agricultural Field (4 acres) (Table 5.37).

This community may in time (50 years or so) succeed to more mature communities and cease to exist in the park. All of the agricultural fields, which are substrate for this community, have converted to Northeastern Old Field or other communities and once they succeed to Early to Mid-Successional Loblolly Pine Forest it will only be a matter of time before these new forests will become mature forestland.

Table 5.36. What was once Early to Mid-Successional Loblolly Pine Forest in 1997 has become X in 2007	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	122 acres
Mid to Late Successional Loblolly Pine-Sweetgum Forest	16 acres
Drowned Forest	13 acres
Southern Red Maple-Blackgum Forest	6 acres
Coastal Loblolly Pine Wetland Forest	2 acres
Other communities/land covers	4 acres

Table 5.37. Early to Mid-Successional Loblolly Pine Forest has migrated into X since 1997	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	122 acres
Northeastern Old Field	54 acres
Northeastern Successional Shrubland	6 acres
Agricultural Field	4 acres

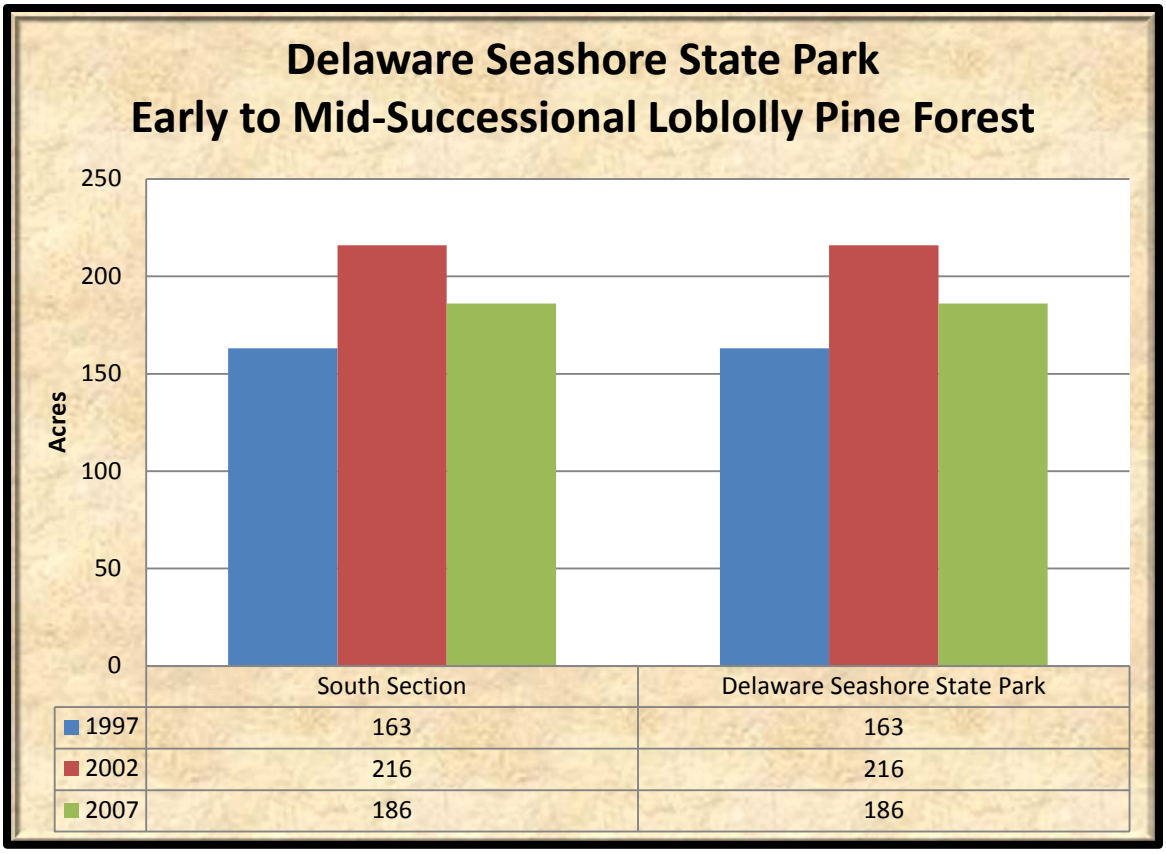


Figure 5.17. Early to Mid-Successional Loblolly Pine Forest at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.38)

Most of this community will be flooded at 1.5 m of sea level rise. This is problematic since this community serves as an "incubator" for future forest communities. This makes the likelihood of retreat less so.

Table 5.38. Projected acres of Early to Mid-Successional Loblolly Pine Forest Impacted by Sea Level Rise

Rise	Acres
0.5 m	128 acres
1 m	160 acres
1.5 m	176 acres

Natural Capital (Table 5.39)

The capital of Early to Mid-Successional Loblolly Pine Forest has oscillated as communities have matured into it and it has matured into other more mature communities.

Table 5.39. Natural Capital of Early to Mid-Successional Loblolly Pine Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$30,823/year
2002	$40,846/year
2007	$35,173/year

Eastern Reed Marsh **[67 acres (Figure 5.18, Tables 5.40-5.43)] GNA SNA**

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

Description

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

Analysis of Condition at Delaware Seashore State Park

The acreage of Eastern Reed Marsh has been steadily increasing through the study period with a marked increase from 2002 to 2007 in the South Section. Since this community is dominated by an aggressive exotic plant species it is hoped that it will be eliminated in the future.

Eastern Reed Marsh has greatly increased its acreage but only 46 of the original 49 acres from 1997 remains. About 1 acre each was converted to Cultivated Lawn and Atlantic Coast Interdune Swale. A small amount (0.4 acres) became tidal as North Atlantic Low Salt Marsh and about 0.3 acres gained more water and became a Farm Pond/Artificial Pond (Table 5.40).

Eastern Reed Marsh has colonized a number of communities since 1997 resulting in a net gain of acreage for the community. Northeastern Old Field had the most converted (13 acres) along with 2 acres each of Southern Red Maple-Blackgum Swamp and Early to Mid-Successional Loblolly Pine Forest. One acre of Beachgrass-Panicgrass Dune Grassland became this community likely as a result of increased water presence in the dune communities (Table 5.41).

Table 5.40. What was once Eastern Reed Marsh in 1997 has become X in 2007

X	Acreage
Eastern Reed Marsh	46 acres
Cultivated Lawn	1 acre
Atlantic Coast Interdune Swale	1 acre
North Atlantic Low Salt Marsh	0.4 acres
Farm Pond/Artificial Pond	0.3 acres
Other communities/land covers	1 acre

Table 5.41. Eastern Reed Marsh has migrated into X since 1997	
X	**Acreage**
Eastern Reed Marsh	46 acres
Northeastern Old Field	13 acres
Southern Red Maple-Blackgum Swamp	2 acres
Early to Mid-Successional Loblolly Pine Forest	2 acres
Beachgrass-Panicgrass Dune Grassland	1 acre
Other communities/land covers	2 acres

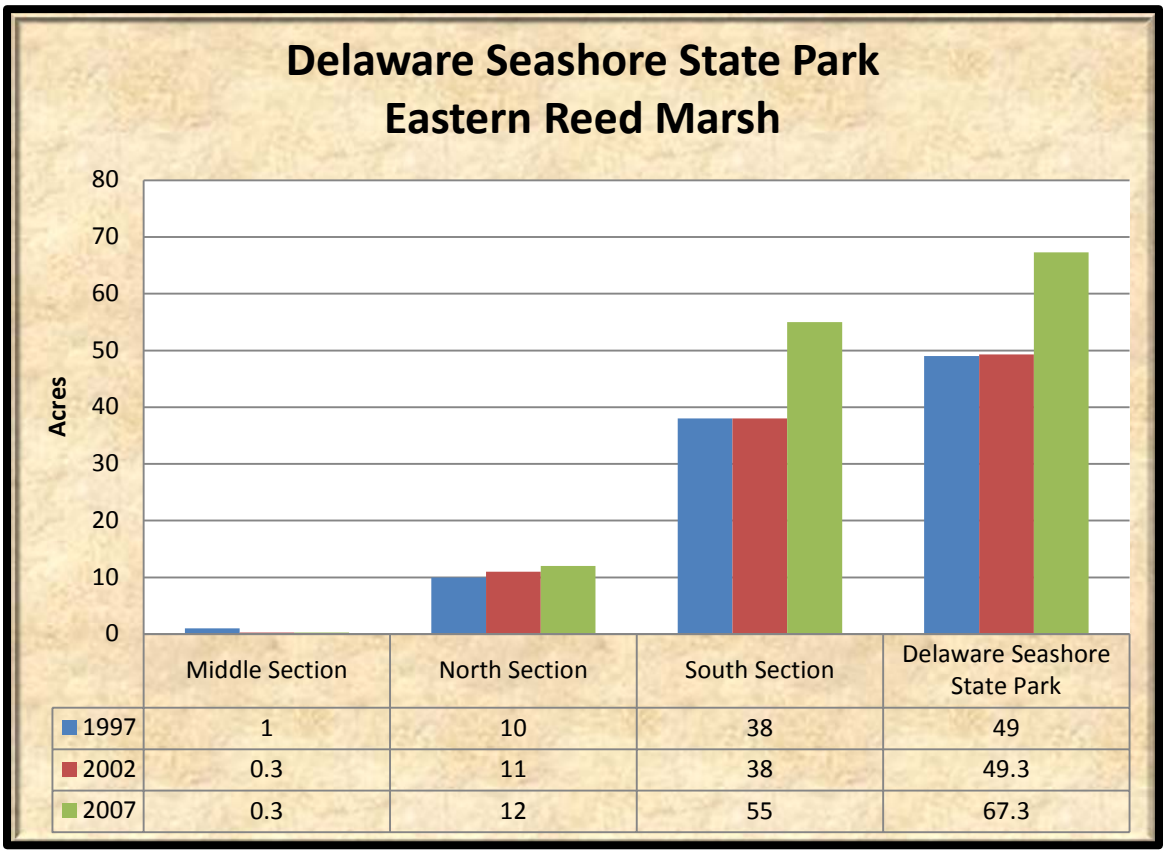


Figure 5.18. Eastern Reed Marsh at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.42)

Most of this community will be flooded at 1.5 m of sea level rise. This is problematic since this community serves as an "incubator" for future forest communities. This makes the likelihood of retreat less so.

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

Rise	Acres
0.5 m	128 acres
1 m	160 acres
1.5 m	176 acres

Natural Capital (Table 5.43)

The capital of Early to Mid-Successional Loblolly Pine Forest has oscillated as communities have matured into it and it has matured into other more mature communities.

Table 5.43. Natural Capital of Early to Mid-Successional Loblolly Pine Forest

Year	Natural Capital (in 2012 dollars)
1997	$30,823/year
2002	$40,846/year
2007	$35,173/year

Forked Rush Dune Swale **[10 acres (Figure 5.19, Tables 5.44-5.47)] G2 S2**

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

Description

Forked Rush Dune Swales are herbaceous depressions in the dunes between the Atlantic Ocean and DE 1. Most of these areas were identified from previous reports and field observations, most of which, unfortunately, appeared to be invaded by common reed (*Phragmites australis*). These swales are populated by round head rush (*Juncus scirpoides*), Canada rush (*Juncus canadensis*), forked rush (*J. dichotomus*), marsh St. John's Wort (*Triadenum virginicum*), beach panic grass (*Panicum amarum*), warty panicgrass (*P. verrucosum*), Eaton's witchgrass (*Dichanthelium spretum*), and redtop panicgrass (*P. rigidulum*). Occasionally there may also be cranberry (*Vaccinium macrocarpon*), and salt meadow cordgrass (*Spartina patens*).

Analysis of Condition at Delaware Seashore State Park

Forked Rush Dune Swale has oscillated up and down in acreage over the ten years as depressions are covered and uncovered by sand. Only seven of the original ten acres from 1997 were still present in 2007 with the remainder succeeded to a Barrier Island Bog (1 acre), and the rest being covered in sand and a Beachgrass-Panicgrass Dune Grassland (Table 5.44).

Despite the losses above this community did manage to break even in acreage colonizing 2 acres of Atlantic Coast Interdune Swale and 1 acre of Reed Tidal Marsh. Another 0.2 acres of Beachgrass-Panicgrass Dune Grassland converted as sand was removed from a depression (Table 5.45).

A similar study at Cape Henlopen State Park (Coxe 2012) has shown that this community is declining overall as habitat, common reed (*Phragmites australis*), and sand cover over the community. Forked Rush Dune Swale appears to be holding its own in Delaware Seashore State Park but it is unknown for how long it can do this. Aggressive management of common reed can help this community remain for the long term and appears to have done precisely this with the one acre acquired from the Reed Tidal Marsh.[40]

Table 5.44. What was once Forked Rush Dune Swale in 1997 has become X in 2007

X	Acreage
Forked Rush Dune Swale	7 acres
Barrier Island Bog	1 acre
Beachgrass-Panicgrass Dune Grassland	0.4 acres
Japanese Black Pine Forest	0.4 acres

[40] Coxe, Robert. 2012. Vegetation Community and land use change analysis of Cape Henlopen State Park, Sussex County, De. Unpublished Natural Heritage and Endangered Species Program report.

Table 5.45. Forked Rush Dune Swale has migrated into X since 1997	
X	**Acreage**
Forked Rush Dune Swale	7 acres
Atlantic Coast Interdune Swale	2 acres
Reed Tidal Marsh	1 acre
Beachgrass-Panicgrass Dune Grassland	0.2 acres
Sand	0.1 acres

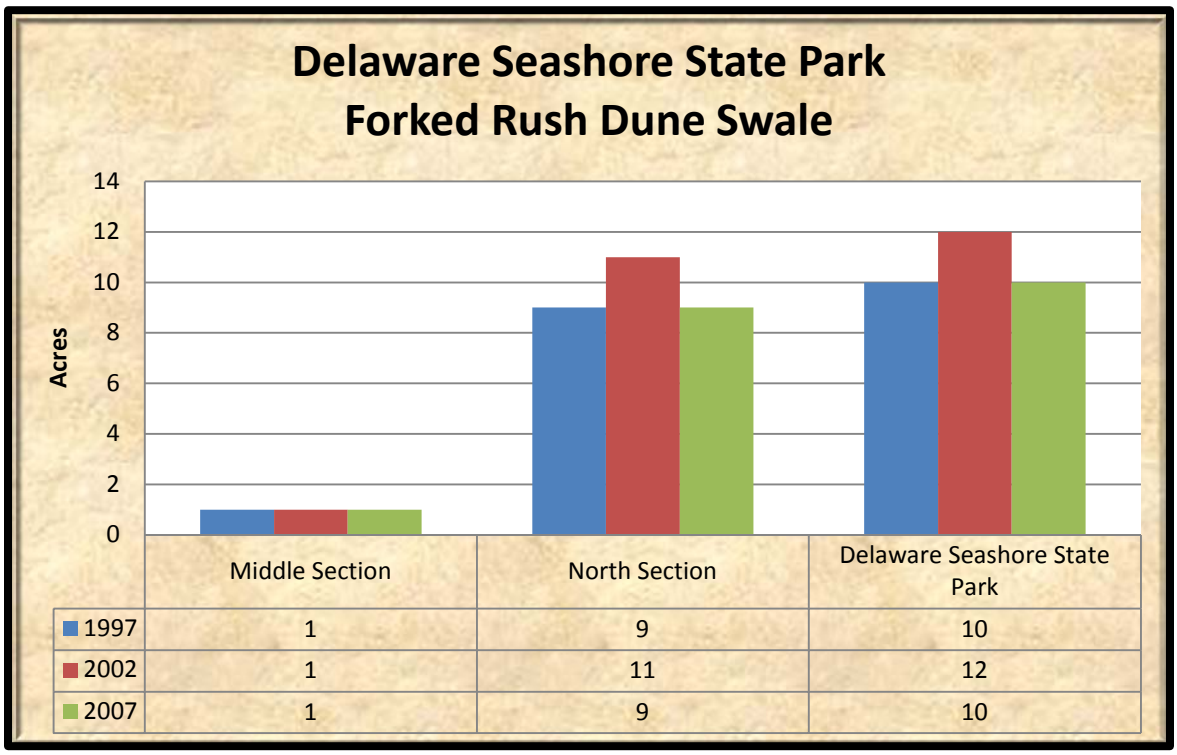


Figure 5.19. Forked Rush Dune Swale at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.46)

All of the current acreage of Forked Rush Dune Swale will be eliminated with 1.5 m of sea level rise. It will be greatly impacted at 1 m of rise.

Table 5.46. Projected acres of Forked Rush Dune Swale Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	6 acres
1.5 m	10 acres

Natural Capital (Table 5.47)

Forked Rush Dune Swale capital has oscillated due to forming and then being recovered by sand making the capital go up and down over time.

Table 5.47. Natural Capital of Forked Rush Dune Swale	
Year	**Natural Capital (in 2012 dollars)**
1997	$92,814/year
2002	$111,377/year
2007	$92,814/year

Irregularly Flooded Eastern Tidal Salt Shrub **[87 acres (Figures 5.20-5.22, Tables 5.48-5.51)]**
G5 S5

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

Description

Figure 5.20. Irregularly Flooded Eastern Tidal Salt Shrub (North 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 Delaware Seashore State Park

Irregularly Flooded Eastern Tidal Salt Shrub can be an ephemeral community moving from one area to another depending on elevation and the landward progress of the adjacent marsh. Historically this community has been gaining acreage each year, but in the most recent period it has not gained or lost acreage (Figure 5.21).

Only 61 acres of the original 85 from 1997 were still present in 2007. Of the remainder, about 9 acres became North Atlantic Low Salt Marsh, 7 acres as Reed Tidal Marsh, 5 acres as North Atlantic High Salt Marsh, and 1 acre as Beachgrass-Panicgrass Dune Grassland (Table 5.48).

This shrubland has had a net gain of acreage since 1997 going into about 6 acres of Reed Tidal Marsh, 3 acres of Beachgrass-Panicgrass Dune Grassland, 3 acres of Successional Maritime Forest and 2 acres of Chesapeake Bay Tall Maritime Shrubland (Table 5.49).

This community is located at the border of the marsh and forestland that is higher. As such it can serve as a bellwether of whether landward succession of the marsh is proceeding normally. In the case of Delaware Seashore State Park, the progression does seem to be proceeding normally with the caveat of North Atlantic High Salt losing ground in the process. It is expected that this shrub community will be present in the long term but could have some reduction in its acreage with greater sea level rise rates.

Table 5.48. What was once Irregularly Flooded Eastern Tidal Salt Shrub in 1997 has become X in 2007	
X	**Acreage**
Irregularly Flooded Eastern Tidal Salt Shrub	61 acres
North Atlantic Low Salt Marsh	9 acres
Reed Tidal Marsh	7 acres
North Atlantic High Salt Marsh	5 acres
Beachgrass-Panicgrass Dune Grassland	1 acre
Other communities/land covers	3 acres

Table 5.49. Irregularly Flooded Eastern Tidal Salt Shrub has migrated into X since 1997	
X	**Acreage**
Irregularly Flooded Eastern Tidal Salt Shrub	61 acres
Reed Tidal Marsh	6 acres
Beachgrass-Panicgrass Dune Grassland	3 acres
Successional Maritime Forest	3 acres
Chesapeake Bay Tall Maritime Shrubland	2 acres
Other communities/land covers	12 acres

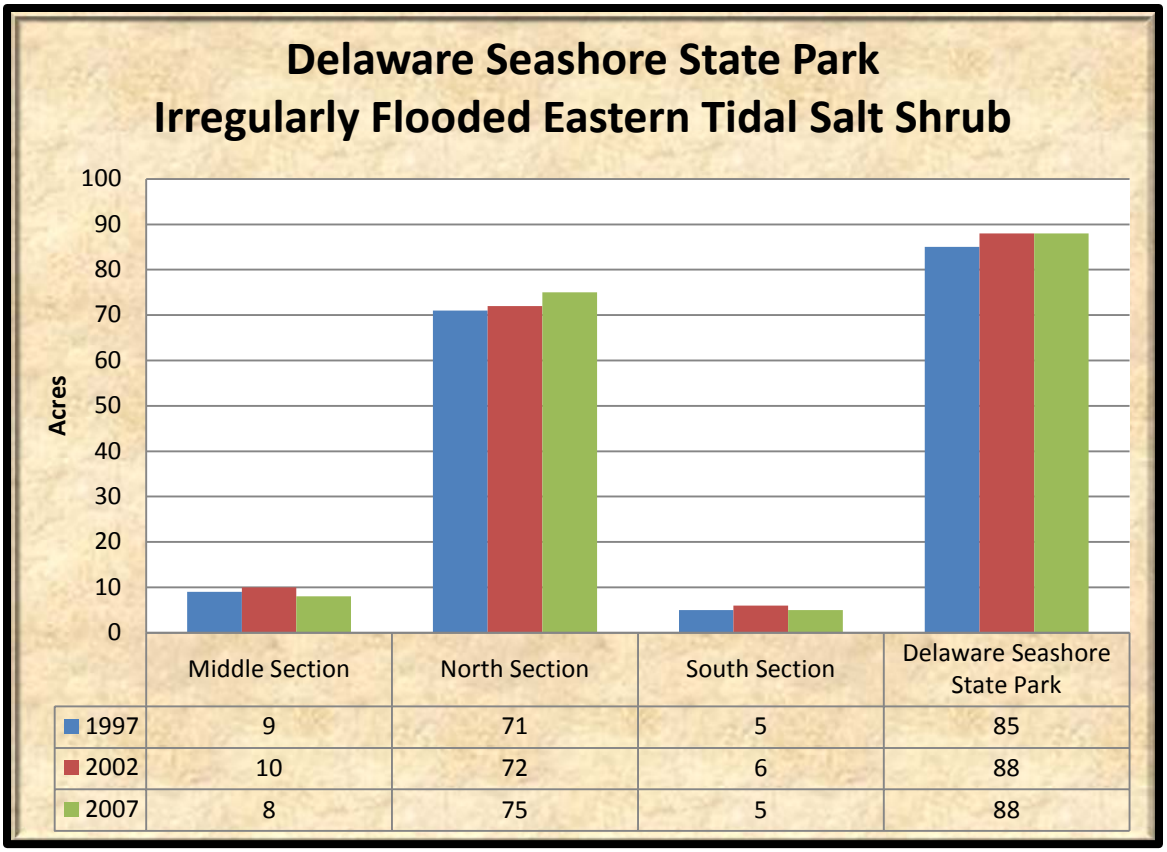


Figure 5.21. Irregularly Flooded Eastern Tidal Salt Shrub at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.50)

Irregularly Flooded Eastern Tidal Salt Shrub will be greatly impacted with 0.5 m of sea level rise and will be completely inundated with 1 m of rise.

Table 5.50. Projected acres of Irregularly Flooded Eastern Tidal Salt Shrub Impacted by Sea Level Rise

Rise	Acres
0.5 m	83 acres
1 m	87 acres
1.5 m	87 acres

Natural Capital (Table 5.51)

Bucking a trend seen in other places, Irregularly Flooded Eastern Tidal Salt Shrub has increased its capital over the study period.

Table 5.51. Natural Capital of Irregularly Flooded Eastern Tidal Salt Shrub	
Year	**Natural Capital (in 2012 dollars)**
1997	$533,061/year
2002	$551,874/year
2007	$551,874/year

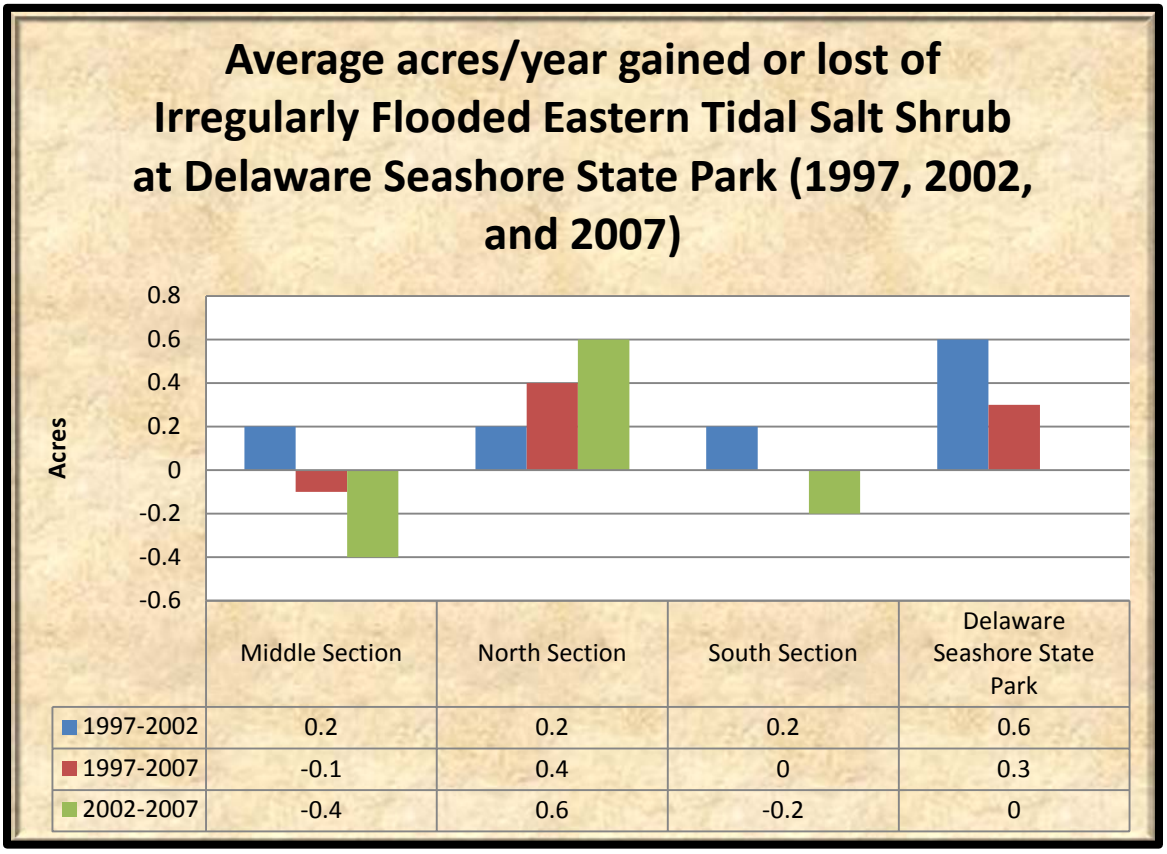


Figure 5.22. Average acres/year gained or lost of Irregularly Flooded Eastern Tidal Salt Shrub at Delaware Seashore State Park (1997-2007)

Japanese Black Pine Forest **[43 acres (Figures 5.23-5.24, Tables 5.52-5.55)] GNA SNA**

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

Description

Figure 5.23. Japanese Black Pine Forest (Middle 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 Delaware Seashore State Park

Japanese Black Pine was planted in the 1950's, the progeny of which became this forest community. The amount of this essentially man-made forest has been going down in recent years as part of an effort to get rid of the pine. As of 2007, 38 acres of the original 47 acres present in 1997 remained. Efforts to rid the park of the pine have resulted in 8 acres going to Beachgrass-Panicgrass Dune Grassland and 1 acre each going to Atlantic Coast Interdune Swale and Eastern Reed Marsh. In one location, about 0.3 acres was made into a beach access (Table 5.52).

In spite of the efforts to control this forest, it has spread into about 2 acres each of Atlantic Coast Interdune Swale and Mid-Atlantic Coast Backdune Grassland. One acre has been converted to Cultivated Lawn and 0.4 acres was reclaimed to a Forked Rush Dune Swale (Table 5.53).

In time it is hoped that the park will be rid of this species which is exotic to the park. Most of the reclaimed acreage is going to Beachgrass-Panicgrass Dune Grassland which the natural community for the area where the pines were planted.

Table 5.52. What was once Japanese Black Pine Forest in 1997 has become X in 2007	
X	**Acreage**
Japanese Black Pine Forest	38 acres
Beachgrass-Panicgrass Dune Grassland	8 acres
Atlantic Coast Interdune Swale	1 acre
Eastern Reed Marsh	1 acre
Semi-impervious Surface	0.3 acres
Other communities/land covers	0.3 acres

Table 5.53. Japanese Black Pine Forest has migrated into X since 1997	
X	**Acreage**
Japanese Black Pine Forest	38 acres
Atlantic Coast Interdune Swale	2 acres
Mid-Atlantic Coast Backdune Grassland	2 acres
Cultivated Lawn	1 acre
Forked Rush Dune Swale	0.4 acres
Other communities/land covers	1 acre

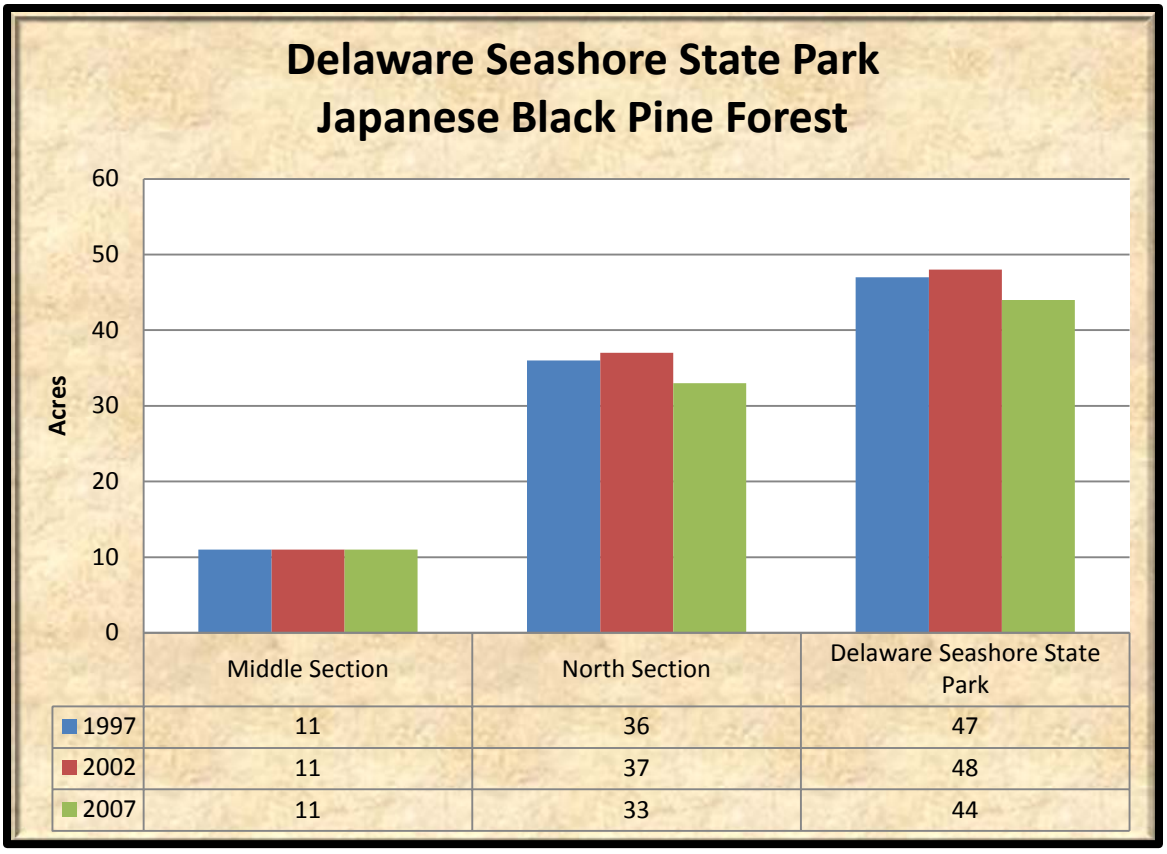


Figure 5.23. Japanese Black Pine Forest at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.54)

Some amount this forest will remain with 1.5 m of sea level rise if it is eradicated before.

Table 5.54. Projected acres of Japanese Black Pine Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0.3 acres
1 m	17 acres
1.5 m	34 acres

Natural Capital (Table 5.55)

Capital in Japanese Black Pine Forest has oscillated over time in Delaware Seashore State Park.

Table 5.55. Natural Capital of Japanese Black Pine Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$8,888/year
2002	$9,077/year
2007	$8,320/year

Loblolly Pine Dune Woodland **[2 acres (Figures 5.24-5.25, Tables 5.56-5.59)] G1G2 S1**

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

Description

The occurrences of this community are located in the north section primarily on Burton's Island. Loblolly pine (*Pinus taeda*) and a few red maple (*Acer rubrum*) dominate the canopy. The understory is composed of eastern red cedar (*Juniperus virginiana*), wild black cherry (*Prunus serotina*), hackberry (*Celtis occidentalis*), persimmon (*Diospyros virginiana*), sassafras (*Sassafras albidum*), and winged sumac (*Rhus copallina*). Common shrubs and vines include common greenbrier (*Smilax rotundifolia*), wax-myrtle (*Morella cerifera*), poison ivy (*Toxicodendron radicans*), blackberry (*Rubus* sp.), and white-leaf greenbrier (*Smilax glauca*). Herbs include switchgrass (*Panicum virgatum*), seaside bluestem (*Schizachyrium littorale*), horseweed (*Conyza canadensis*), deer-tongue grass (*Dichanthelium clandestinum*), Virginia creeper (*Parthenocissus quinquefolia*), and small-fruited witchgrass (*Dichanthelium dichotomum*).

Figure 5.24. Loblolly Pine Dune Woodland (South Section)

The woodlands at Delaware Seashore State Park appear to be in the late successional stage or maybe mature. Given the extreme site conditions it is sometimes hard to tell.

Analysis of Condition at Delaware Seashore State Park

Loblolly Pine Dune Woodland has managed to keep all of its acreage from 1997 into 2007 (Table 4.45) and gain some acreage from Mid-Atlantic Backdune Grassland (1 acre) and Irregularly Flooded Eastern Tidal Salt Shrub (Table 4.46). Given the net gain in acreage and the fact that none of the original were lost bodes well for this community in the future. It is expected that it will survive into the long term future.

Table 5.56. What was once Loblolly Pine Dune Woodland in 1997 has become X in 2007	
X	**Acreage**
Loblolly Pine Dune Woodland	0.4 acres

Table 5.57. Loblolly Pine Dune Woodland has migrated into X since 1997	
X	**Acreage**
Mid-Atlantic Coast Backdune Grassland	1 acre
Loblolly Pine Dune Woodland	0.4 acres
Irregularly Flooded Eastern Tidal Salt Shrub	0.1 acres

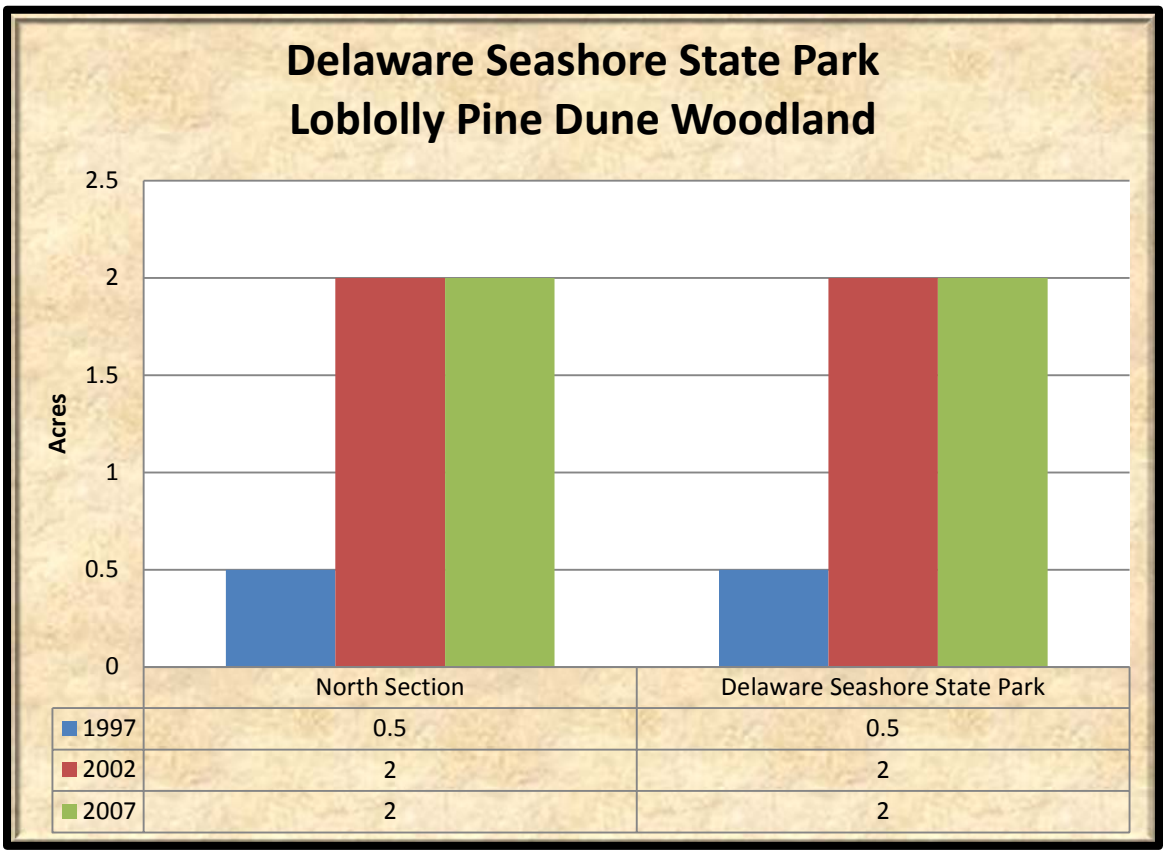


Figure 5.25. Loblolly Pine Dune Woodland at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.58)

About half of this community would be inundated under 1.5 m of sea level rise.

Table 5.58. Projected acres of Loblolly Pine Dune Woodland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0.2 acres
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 5.59)

This woodland community does not have much capital but it has increased over the study period.

Table 5.59. Natural Capital of Loblolly Pine Dune Woodland	
Year	**Natural Capital (in 2012 dollars)**
1997	$95/year
2002	$378/year
2007	$378/year

Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland **[2 acres (Figure 5.26, Tables 5.60-5.63)] GNR S3**

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

Description

The occurrences of this community are located at the north end of the south section. Occurrences were determined through aerial imager analysis and generally Loblolly pine (*Pinus taeda*) is dominates a scattered canopy overtopping a small layer of eastern red cedar (*Juniperus virginiana*) and southern red oak (*Quercus falcata*). Wax-myrtle (*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*).

Analysis of Condition at Delaware Seashore State Park

This woodland community that is generally lower in elevation than the Loblolly Pine Dune Woodland has been stable throughout the study period with no losses or gains in acreage (Tables 5.60 and 5.61). Given the data and the short time period studied, a specific projection cannot be made. However given the low elevation there will likely be some sea level rise effects with this community losing some acreage and the Loblolly Pine Dune Woodland converting to this community.

Table 5.60. What was once Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland in 1997 has become X in 2007	
X	**Acreage**
Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	2 acres

Table 5.61. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has migrated into X since 1997	
X	**Acreage**
Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	2 acres

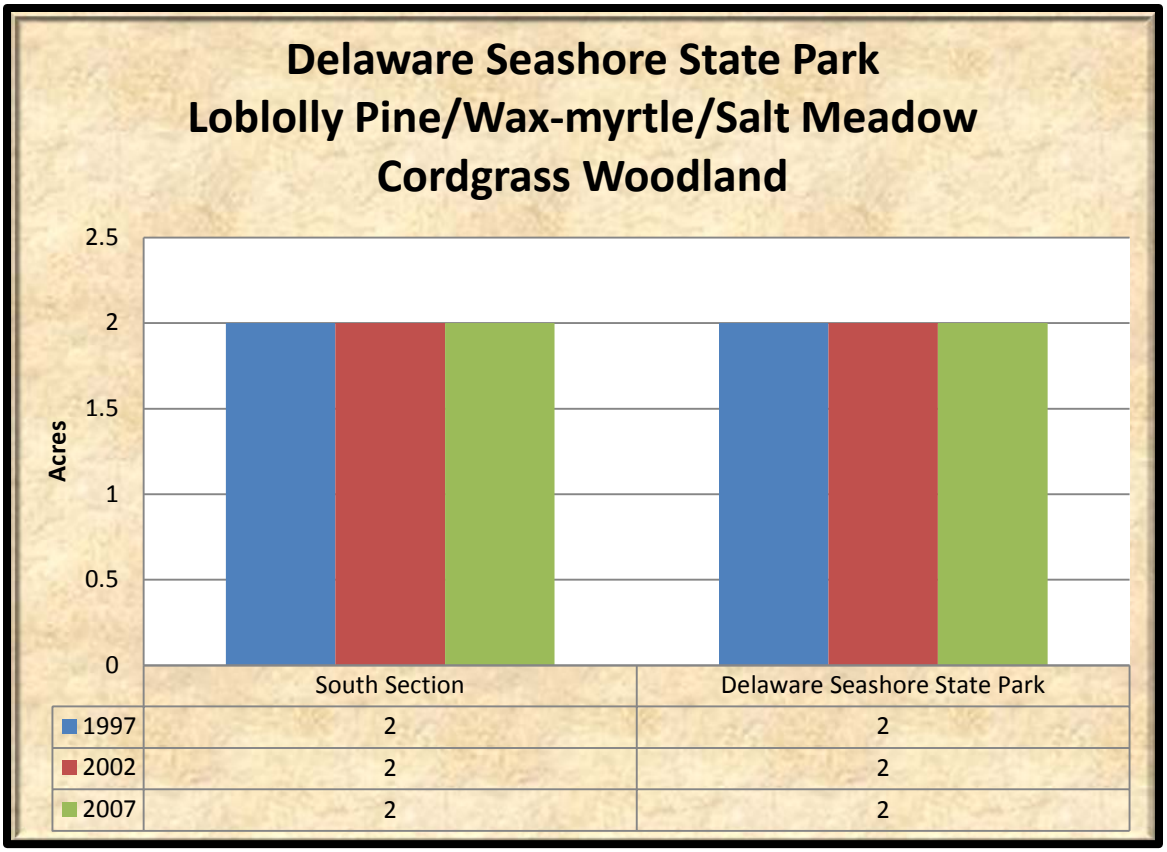


Figure 5.26. Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.62)

Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland will be completely inundated with 1 m of sea level rise.

Table 5.62. Projected acres of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 5.63)

The capital of this community has not changed over the study period.

Table 5.63. Natural Capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	
Year	**Natural Capital (in 2012 dollars)**
1997	$378/year
2002	$378/year
2007	$378/year

Maritime Red Cedar Woodland **[0.2 acres (Figure 5.27, Tables 5.64-5.67)] G2 S2**

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

Description

This woodland was aerially interpreted and a specific species list cannot be made. Generally this community is a woodland of eastern red cedar (*Juniperus virginiana*) that is associated by scattered southern red oak (*Quercus falcata*), sassafras (*Sassafras albidum*), loblolly pine (*Pinus taeda*), persimmon (*Diospyros virginiana*), and wild black cherry (*Prunus serotina*). The shrubby understory is composed of northern bayberry (*Morella pensylvanica*), southern bayberry (*Morella cerifera*), and highbush blueberry (*Vaccinium corymbosum*). The vine layer may be dense with common greenbrier (*Smilax rotundifolia*), poison ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), and trumpet creeper (*Campsis radicans*). The herb layer is composed of the dry loving species such as prickly pear cactus (*Opuntia humifusa*), tall beach panic grass (*Panicum amarum* var. *amarulum*), Gray's flatsedge (*Cyperus grayi*), seaside goldenrod (*Solidago caesia*), and little bluestem (*Schizachyrium scoparium*).

Analysis of Condition at Delaware Seashore State Park

This community covers very little of the park and has been stable in extent through the study period. It has neither gained nor lost acreage, other than a slight bump up in 2002 (Tables 5.64 and 5.65). It is projected to stay around in the short term and long term prospects cannot be given based on the data.

Table 5.64. What was once Maritime Red Cedar Woodland in 1997 has become X in 2007	
X	**Acreage**
Maritime Red Cedar Woodland	0.3 acres

Table 5.65. Maritime Red Cedar Woodland has migrated into X since 1997	
X	**Acreage**
Maritime Red Cedar Woodland	0.3 acres

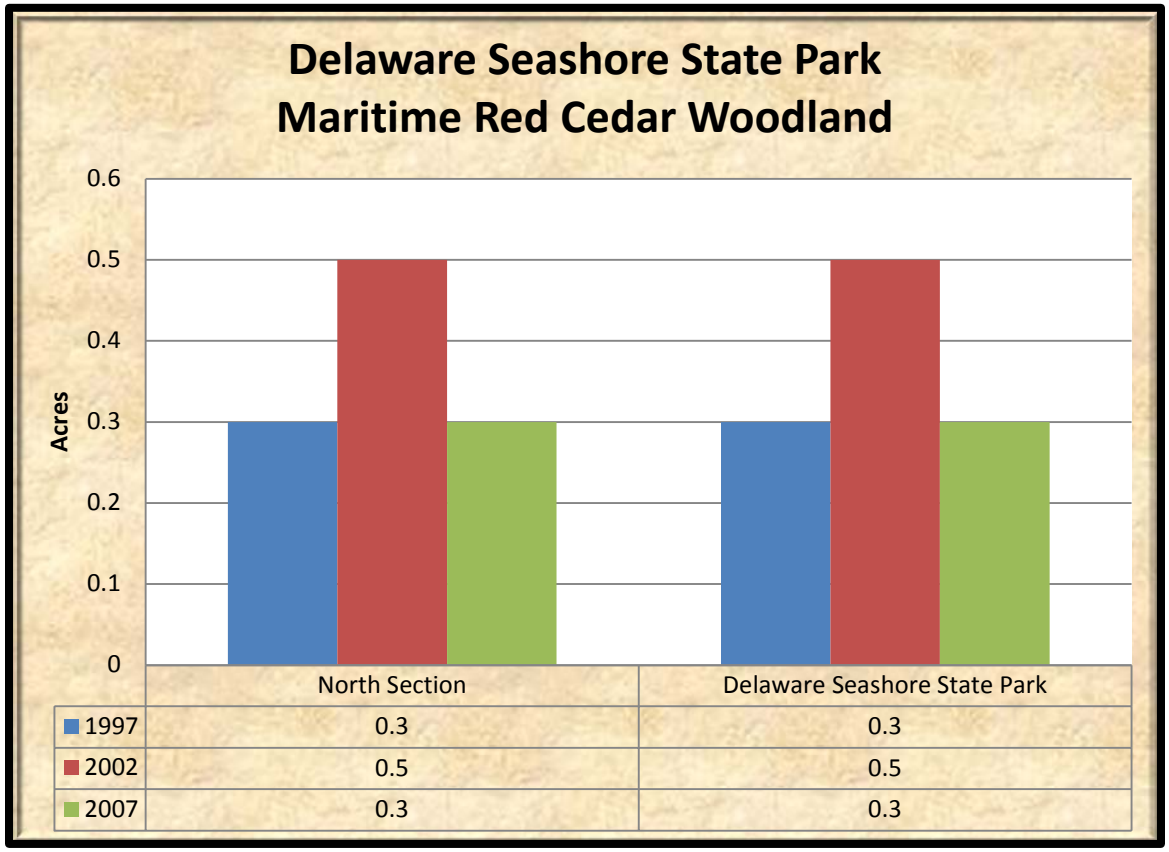


Figure 5.27. Maritime Red Cedar Woodland at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.66)

Maritime Red Cedar Woodland will be completely inundated with 1 m of sea level rise.

Table 5.66. Projected acres of Maritime Red Cedar Woodland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0.2 acres
1 m	0.3 acres
1.5 m	0.3 acres

Natural Capital (Table 5.67)

This is probably the least capitalized community in the park and it has oscillated through the study period.

Table 5.67. Natural Capital of Maritime Red Cedar Woodland	
Year	**Natural Capital (in 2012 dollars)**
1997	$57/year
2002	$95/year
2007	$57/year

Mid-Atlantic Coast Backdune Grassland **[112 acres (Figures 5.28-5.29, Tables 5.68-5.71)]**
G2 S1

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

Description

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 5.28. Mid-Atlantic Coast Backdune Grassland (South Section)

Analysis of Condition at Delaware Seashore State Park

Mid-Atlantic Coast Backdune Grassland is generally located in the backdunes landward of the fore dunes. It has increased in acreage during the study period helped by an increase from an abandoned agricultural field located near a marsh. Only 93 acres of the original 107 1997 acres were still present in 2007. The remaining acres converted to Beachgrass-Panicgrass Dune Grassland (3 acres) and 2 acres each to Irregularly Flooded Eastern Tidal Salt Shrub and Japanese Black Pine Forest. Chesapeake Bay Maritime Shrubland gained one acre from this community (Table 5.68).

Since 1997 this community has converted 8 acres of Beachgrass-Panicgrass Dune Grassland, 5 acres of agricultural field, 2 acres of Central Coast Beach Heather Dune Shrubland, and colonized 1 acre of sand (Table 5.69).

Given the recruitment and net gain in acreage this community appears to be stable for the long term in the park.

Table 5.68. What was once Mid-Atlantic Coast Backdune Grassland in 1997 has become X in 2007	
X	**Acreage**
Mid-Atlantic Coast Backdune Grassland	93 acres
Beachgrass-Panicgrass Dune Grassland	3 acres
Irregularly Flooded Eastern Tidal Salt Shrub	2 acres
Japanese Black Pine Forest	2 acres
Chesapeake Bay Maritime Shrubland	1 acre
Other communities/land covers	6 acres

Table 5.69. Mid-Atlantic Coast Backdune Grassland has migrated into X since 1997	
X	**Acreage**
Mid-Atlantic Coast Backdune Grassland	93 acres
Beachgrass-Panicgrass Dune Grassland	8 acres
Agricultural Field	5 acres
Central Coast Beach Heather Dune Shrubland	2 acres
Sand	1 acre
Other communities/land covers	3 acres

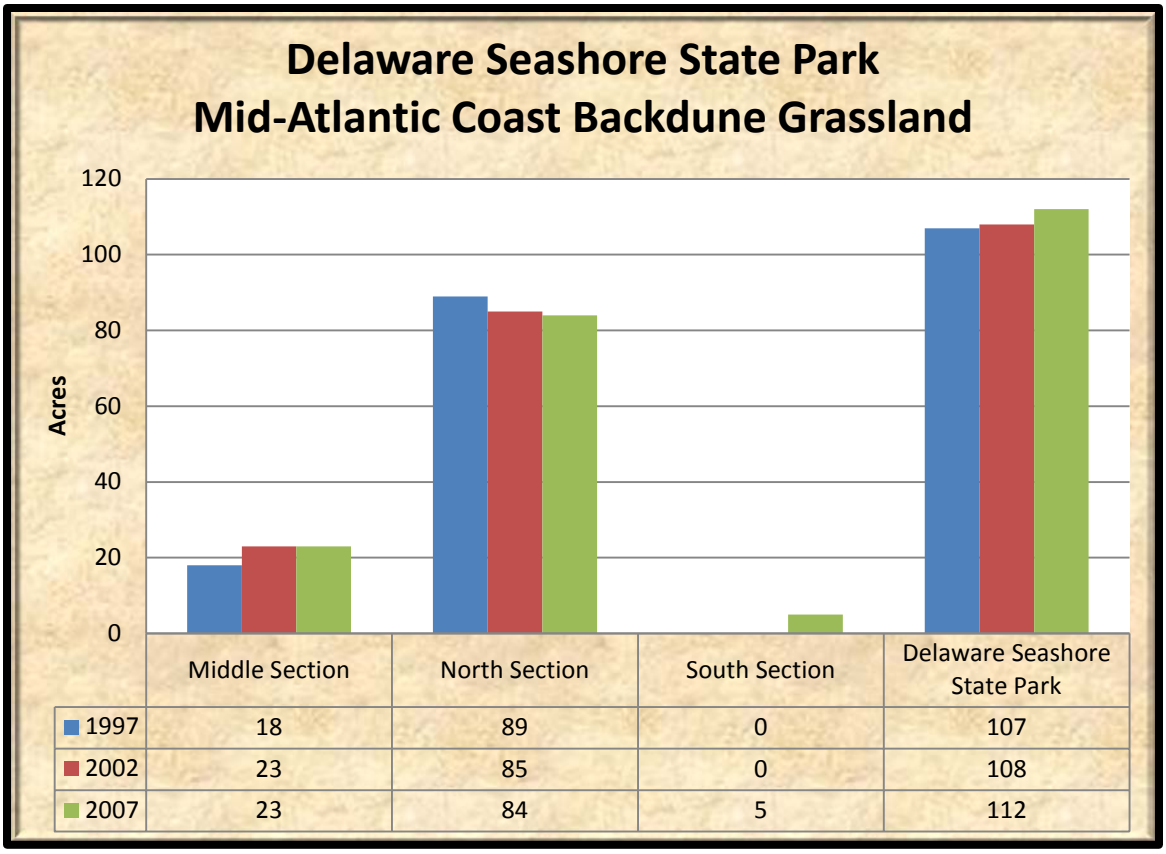


Figure 5.29. Mid-Atlantic Coast Backdune Grassland at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.70)

About ¾ of the current acreage of this community will be inundated with 1.5 m of sea level rise.

Table 5.70. Projected acres of Mid-Atlantic Coast Backdune Grassland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	36 acres
1 m	73 acres
1.5 m	84 acres

Natural Capital (Table 5.71)

Mid-Atlantic Coast Backdune Grassland has gradually increased in capitalization as it populates an abandoned agricultural field.

Table 5.71. Natural Capital of Mid-Atlantic Coast Backdune Grassland	
Year	**Natural Capital (in 2012 dollars)**
1997	$15,590/year
2002	$15,736/year
2007	$16,318/year

Mid to Late Successional Loblolly Pine-Sweetgum Forest **[19 acres (Figure 5.30, Tables 5.72-5.74)] GNA SNA**

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

Description

The one example of this community in Delaware Seashore State Park is similar to the Early to Mid-Successional Loblolly Pine Forest, with the exception of being older and having other hardwood species such as red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), southern red oak (*Quercus falcata*), and white oak (*Quercus alba*) present in the canopy with loblolly pine (*Pinus taeda*).

Analysis of Condition at Delaware Seashore State Park

Some of the Early to Mid-Successional Loblolly Pine Forest (16 acres) and Northeastern Old Field (3 acres) has matured to this community (Table 5.72), which was not present in 1997. As time goes on more pine forest will succeed to this community.

Table 5.72. Mid to Late Successional Loblolly Pine-Sweetgum Forest has migrated into X since 1997

X	Acreage
Early to Mid-Successional Loblolly Pine Forest	16 acres
Northeastern Old Field	3 acres

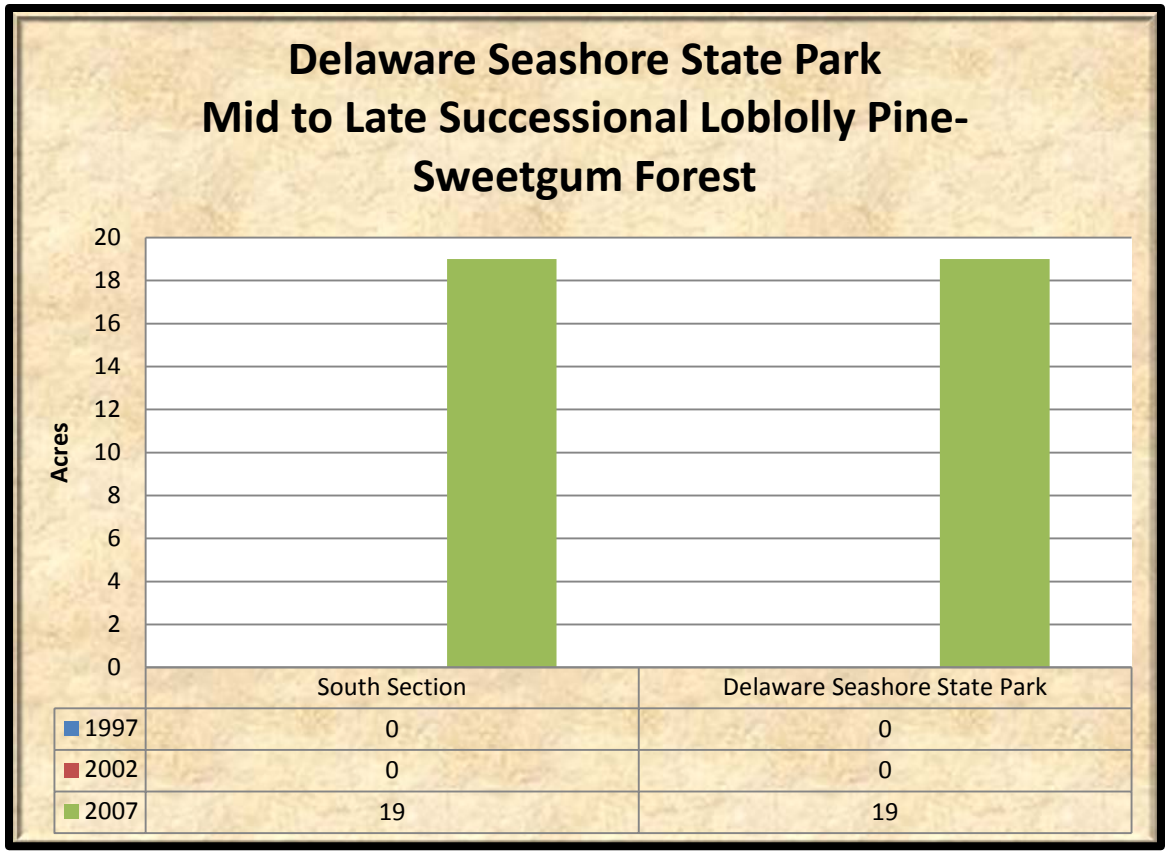


Figure 5.30. Mid to Late Successional Loblolly Pine-Sweetgum Forest at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.73)

All of the current acreage of this community will be inundated with 1.5 m of sea level rise.

Table 5.73. Projected acres of Mid to Late Successional Loblolly Pine-Sweetgum Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	11 acres
1 m	16 acres
1.5 m	19 acres

Natural Capital (Table 5.74)

This community has arisen from the maturation of an Early to Mid-Successional Loblolly Pine Forest. The capital from the earlier community was transferred to this community.

Table 5.74. Natural Capital of Mid to Late Successional Loblolly Pine-Sweetgum Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$0/year (not present)
2002	$0/year (not present)
2007	$3,593/year

Needlerush High Marsh **[1 acre (Figures 5.31-5.33, Tables 5.75-5.78)] G5 S2**

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

Description

Figure 5.31. Needlerush High Marsh (South 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 Delaware Seashore State Park

Needlerush High Marsh is very common south of the Maryland state line in the Ocean City, Maryland area but becomes quite rare north of the line. This is a potential climate change community but given the fact that it inhabits the same ecological niche and position as the North Atlantic High Salt Marsh which is declining things needlerush may not move north as easily as expected.

The one acre of Needlerush High Marsh that was present in 1997 was still present in 2007. Needlerush did manage to expand into Reed Tidal Marsh and North Atlantic Low Salt Marsh but it is within the rounding error so it does not show.

Given the fate of the North Atlantic High Salt Marsh, it would appear that this community may not expand as projected even with climate change. Time will tell but the prospects do not look good. More research in Maryland or Virginia where this marsh is more common may shed some light on how this marsh is reacting to sea level rise.

Table 5.75. What was once Needlerush High Marsh in 1997 has become X in 2007	
X	**Acreage**
Needlerush High Marsh	1 acre

Table 5.76. Needlerush High Marsh has migrated into X since 1997	
X	**Acreage**
Needlerush High Marsh	1 acre
Reed Tidal Marsh	0.3 acres
North Atlantic Low Salt Marsh	0.3 acres

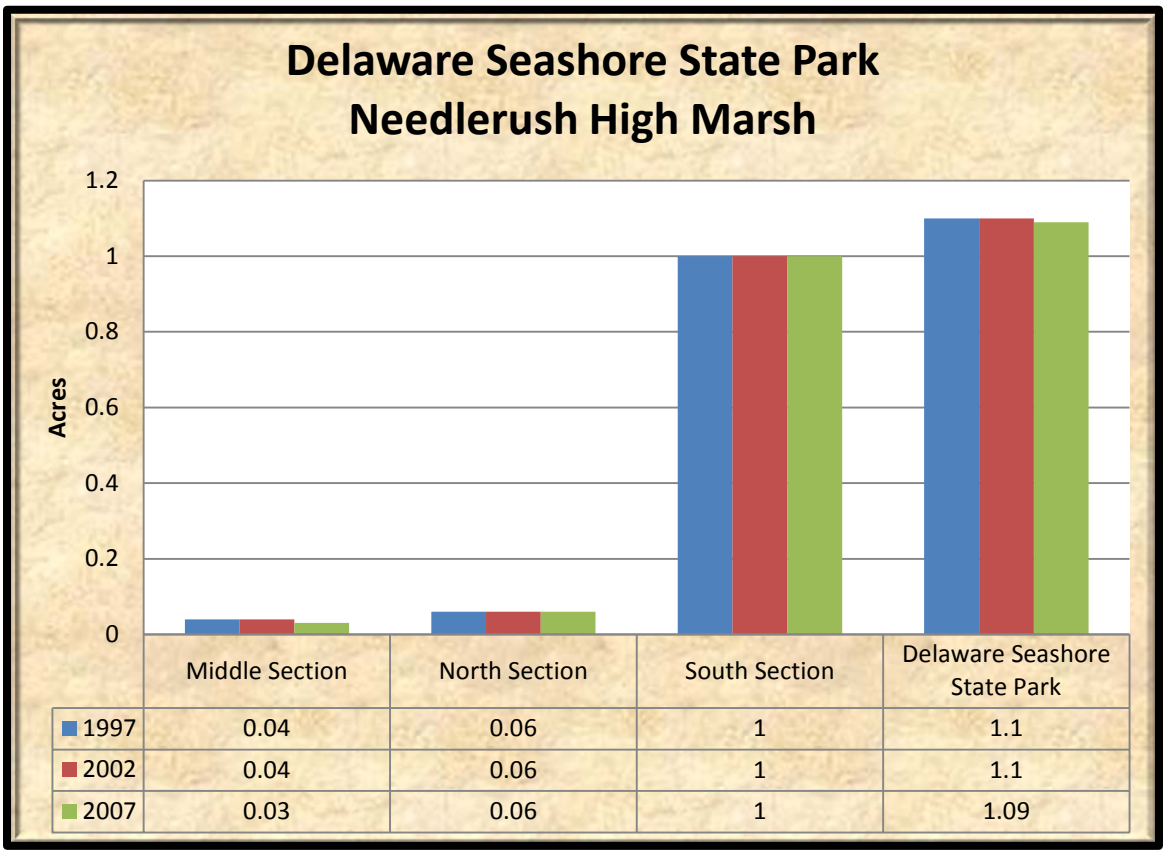


Figure 5.32. Needlerush High Marsh at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.77)

All of the current acreage of this community will be inundated with 0.5 m of sea level rise.

Table 5.77. Projected acres of Needlerush High Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 5.78)

Needlerush High Marsh has lost a small amount of capitalization with a loss in acreage.

Table 5.78. Natural Capital of Needlerush High Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$6,898/year
2002	$6,898/year
2007	$6,836/year

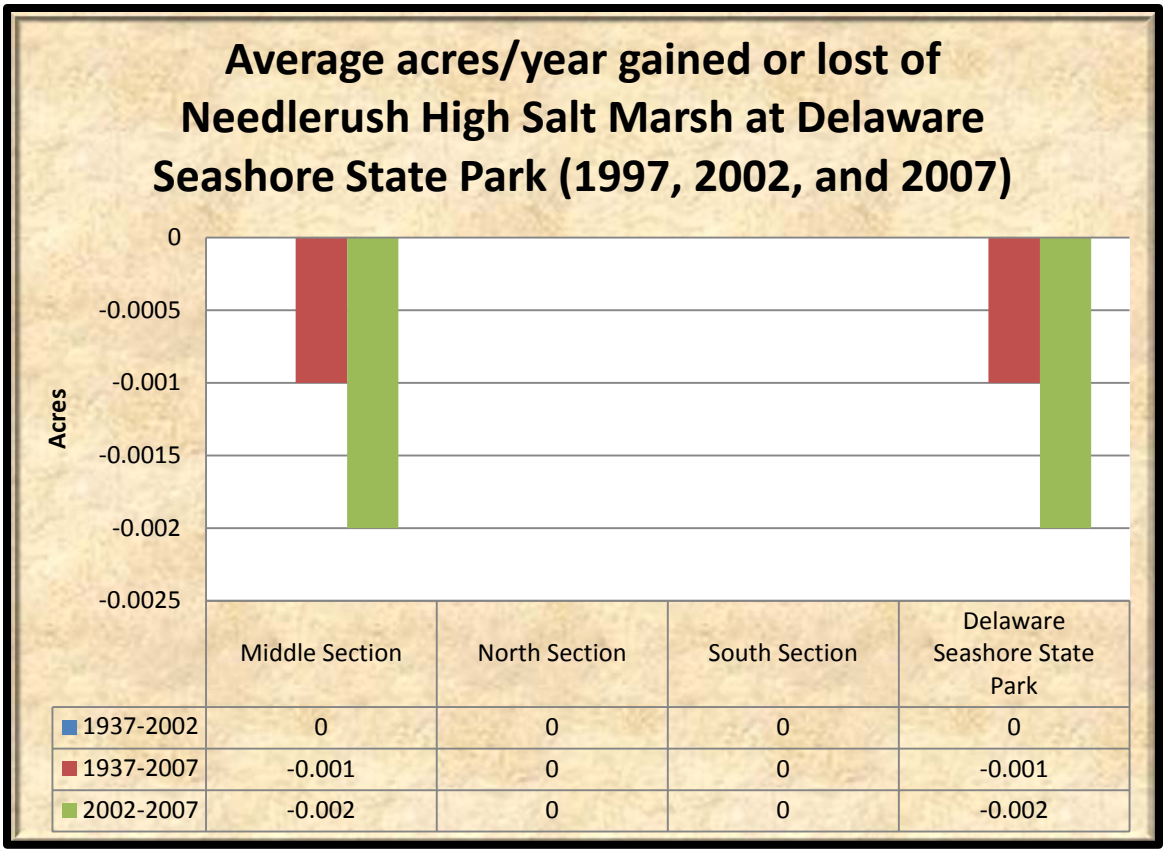


Figure 5.33. Average acres/year gained or lost of Needlerush High Marsh at Delaware Seashore State Park (1997, 2002, 0r 2007)

North Atlantic High Salt Marsh **[29 acres (Figures 5.34-5.36, Tables 5.79-5.82)] G5 S4**

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

Description

Figure 5.34. North Atlantic High Salt Marsh (North 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 Delaware Seashore State Park

After a bump up in acreage from 1997 to 2002 and a decline from 2002 to 2007 North Atlantic High Salt Marsh has still managed to have a net gain in acreage. This bucks a trend seen in other localities where this marsh is declining rapidly. These gains are likely from *Phragmites* control efforts, an effect which has also been seen at Little Creek Wildlife Area (Coxe 2012). [41]However there is a lot of change happening with only 15 of the original 1997 acres still existing in 2007. The remaining acres went primarily to North Atlantic Low Salt Marsh (9 acres) and 1 acre each went to Irregularly Flooded Eastern Tidal Salt Shrub and water. It is also lost 0.2 acres to Reed Tidal Marsh (Table 5.79).

In the gains category, North Atlantic High Salt Marsh converted 6 acres of Reed Tidal Marsh, likely through *Phragmites* control efforts. Five acres of Irregularly Flooded Eastern Tidal Salt Shrub converted to high marsh showing increased water in the system. Three acres of North Atlantic Low Salt Marsh were converted to North Atlantic High Salt Marsh likely from piles of dead common reed stems. A scant amount of Beachgrass-Panicgrass Dune Grassland (0.4 acres) was converted to North Atlantic High Salt Marsh (Table 5.80).

With *Phragmites* control efforts, at least in Delaware Seashore State Park, this community may be stable in the short term. In the long term, however, it may be in peril from the increasing rates of sea level rise.

[41] Coxe, Robert. 2012. Vegetation Community and Land Use Change Analysis of the Little Creek Wildlife Area, Kent County, De. Unpublished Delaware Natural Heritage and Endangered Species Report.

Table 5.79. What was once North Atlantic High Salt Marsh in 1997 has become X in 2007	
X	**Acreage**
North Atlantic High Salt Marsh	15 acres
North Atlantic Low Salt Marsh	9 acres
Irregularly Flooded Eastern Tidal Salt Shrub	1 acre
Water	1 acre
Reed Tidal Marsh	0.2 acres
Other communities/land covers	0.1 acres

Table 5.80. North Atlantic High Salt Marsh has migrated into X since 1997	
X	**Acreage**
North Atlantic High Salt Marsh	15 acres
Reed Tidal Marsh	6 acres
Irregularly Flooded Eastern Tidal Salt Shrub	5 acres
North Atlantic Low Salt Marsh	3 acres
Beachgrass-Panicgrass Dune Grassland	0.4 acres
Other communities/land covers	0.2 acres

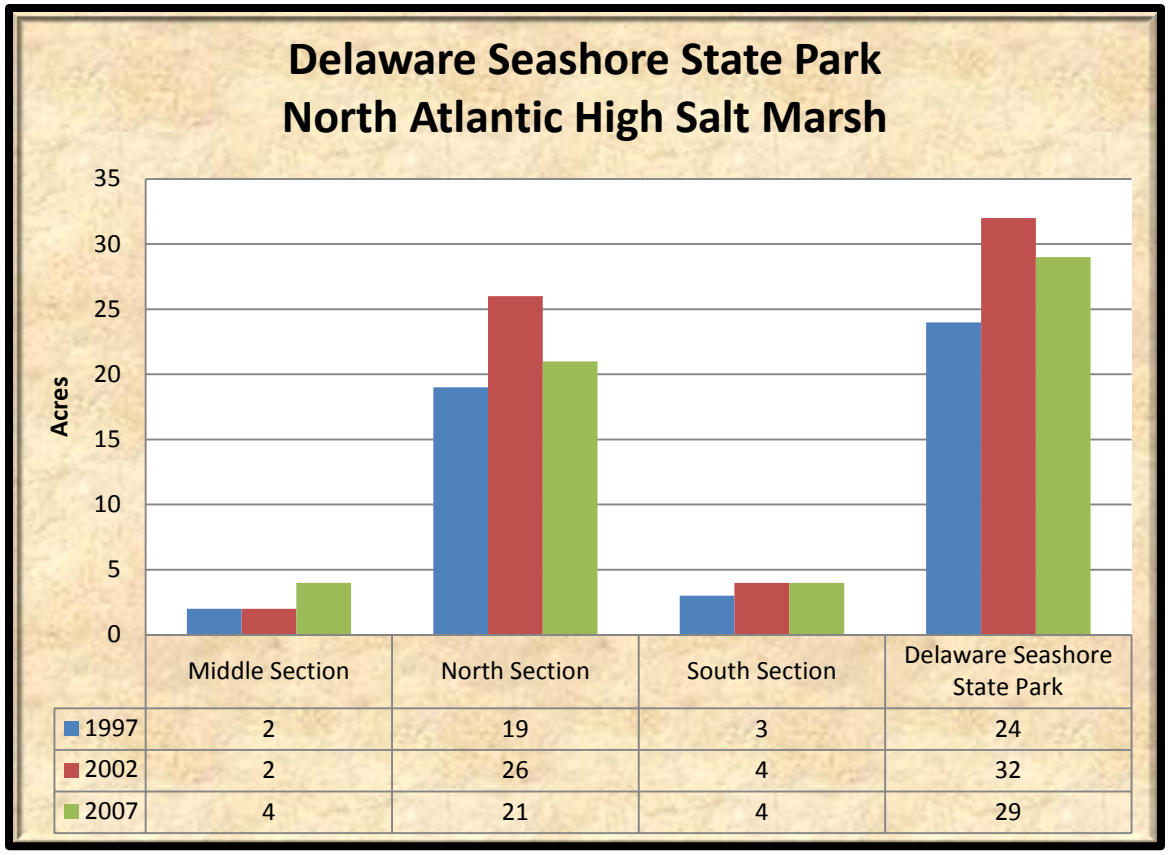


Figure 5.35. North Atlantic High Salt Marsh at Delaware Seashore State Park (1997, 2002, and 2007)

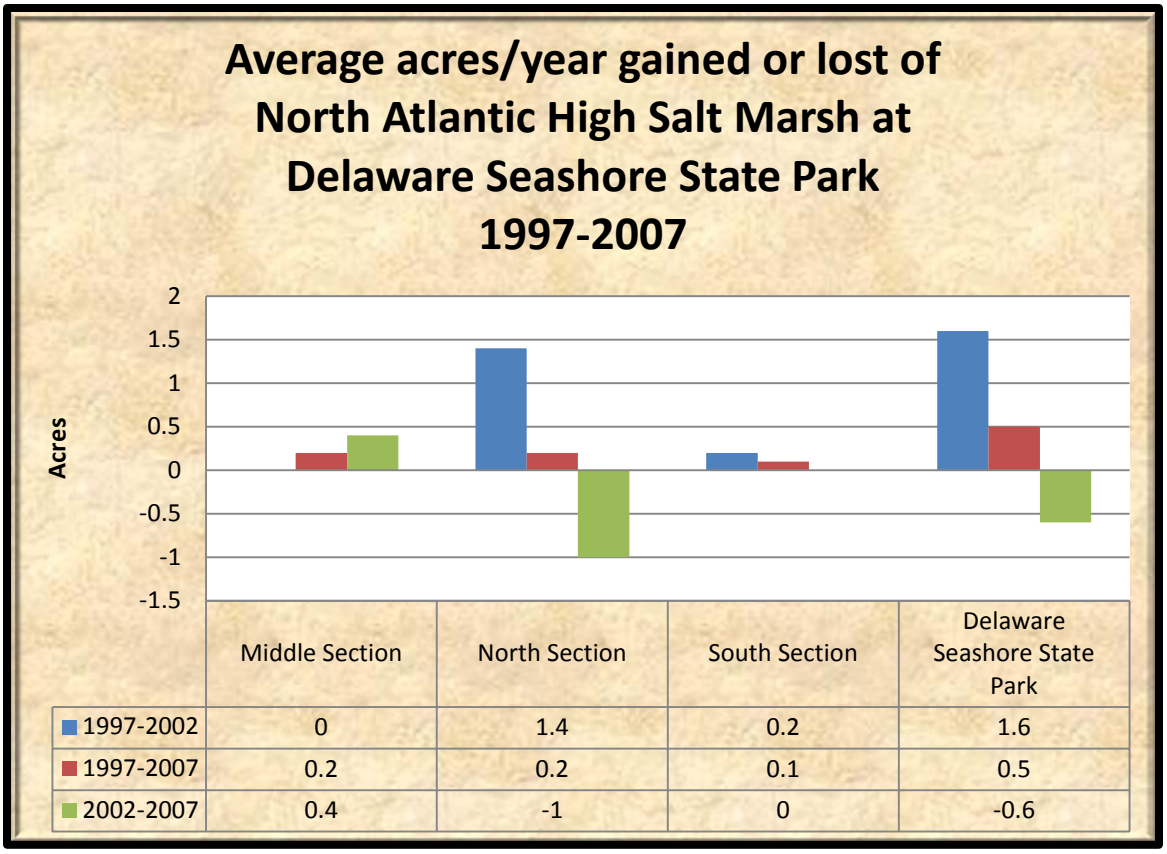


Figure 5.36. Average acres/year gained or lost of North Atlantic High Salt Marsh at Delaware Seashore State Park (1997-2007)

DNREC Sea Level Rise Analysis (Table 5.81)

All of the current acreage of this community will be inundated with 0.5 m of sea level rise.

Table 5.81. Projected acres of North Atlantic High Salt Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	29 acres
1 m	29 acres
1.5 m	29 acres

Natural Capital (Table 5.82)

North Atlantic High Salt Marsh has been generally stable in capitalization bucking a trend of losing capital seen in other areas. Inputs of sand may be contributing to the stability in this area.

Table 5.82. Natural Capital of North Atlantic High Salt Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$150,511/year
2002	$200,682/year
2007	$181,868/year

***North Atlantic Low Salt Marsh* [728 acres (Figures 5.37-5.39, Tables 5.83-5.86)] G5 S5**

DEWAP: Tidal Low Marshes
NHC: Northern Atlantic Coastal Plain Low Salt Marshes

Description

Figure 5.37. North Atlantic Low Salt Marsh (North 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 the marsh and is associated by sea lavender (*Limonium carolinianum*), glasswort (*Salicornia* sp.), hastate orache (*Atriplex prostrata*), sweetscent (*Pluchea odorata*), and salt meadow hay (*Spartina patens*).

Analysis of Condition at Delaware Seashore State Park

North Atlantic Low Salt Marsh is increasing in acreage and appears to be a trend throughout the coast of Delaware. This is at the expense of a lot of the high salt marsh communities and shrublands, though a little bit has come from accretion and sedimentation.

There is some change in that only 687 acres of the original 718, 1997 acres remained in 2007. The remaining acres converted to water (23 acres) showing that is some loss of low marsh happening in spite of the fact that it is gaining in the uplands. Three acres converted to North Atlantic High Salt Marsh and two acres to Irregularly Flooded Eastern Tidal Salt Shrub. Sand incursion likely provided substrate for about 0.4 acres of Mid-Atlantic Coast Backdune Grassland (Table 5.83).

Since 1997 North Atlantic has converted 11 acres of Reed Tidal Marsh, 9 acres each of Irregularly Flooded Eastern Tidal Salt Shrub and North Atlantic High Salt Marsh, and 7 acres of water through sedimentation (Table 5.84).

The short term prospects of this community appear to be assured. The long term prospects are more in question. Some questions to ask include: 1. What will happen when the North Atlantic Low Salt Marsh does not have any more high marsh or freshwater marshes to convert?; 2. What will happen when it hits a topographic high which it cannot surmount? Will the marsh start to disappear at a rapid rate once these things happen? Until these questions can be answered the long term future of low marsh and the marshes as we know them is in doubt. This could have massive impacts in fisheries and productivity on the coast.

Table 5.83. What was once North Atlantic Low Salt Marsh in 1997 has become X in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	687 acres
Water	23 acres
North Atlantic High Salt Marsh	3 acres
Irregularly Flooded Eastern Tidal Salt Shrub	2 acres
Mid-Atlantic Coast Backdune Grassland	0.4 acres
Other communities/land covers	2 acres

Table 5.84. North Atlantic Low Salt Marsh has migrated into X since 1997	
X	**Acreage**
North Atlantic Low Salt Marsh	687 acres
Reed Tidal Marsh	11 acres
Irregularly Flooded Eastern Tidal Salt Shrub	9 acres
North Atlantic High Salt Marsh	9 acres
Water	7 acres
Other communities/land covers	8 acres

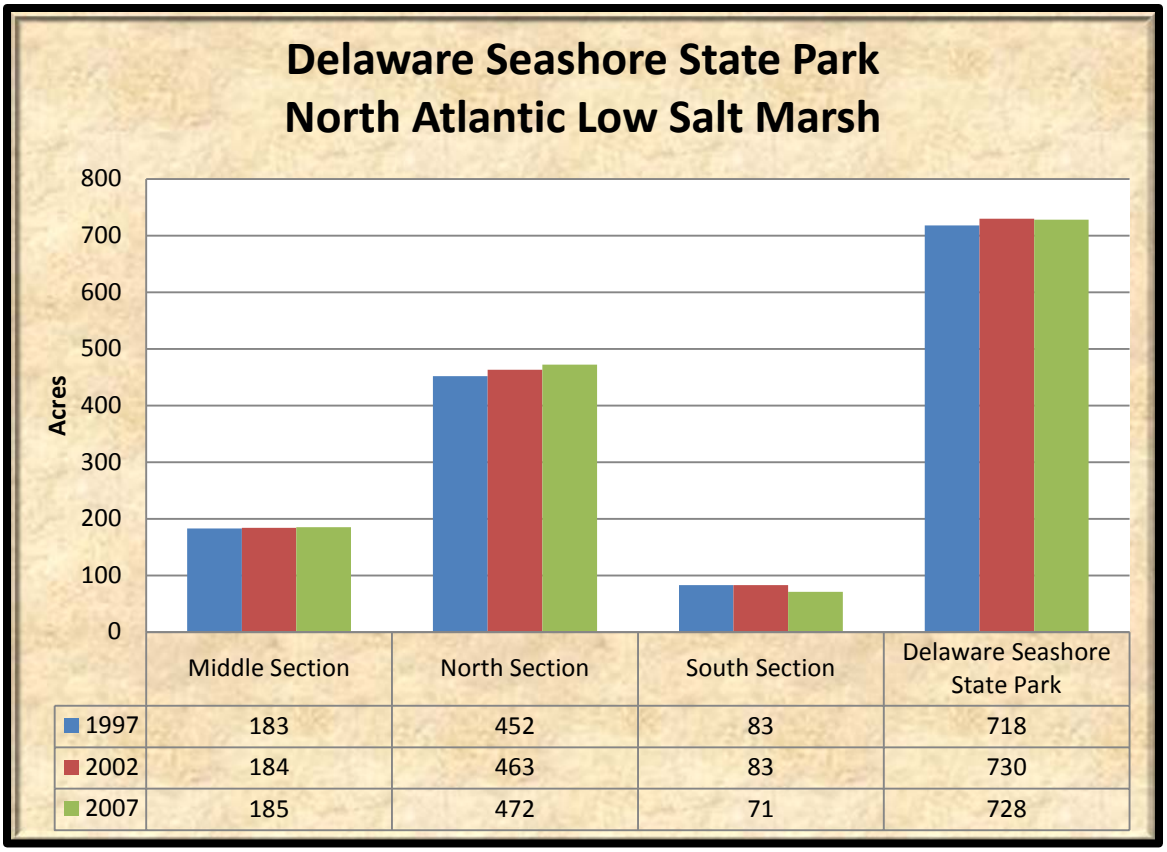


Figure 5.38. North Atlantic Low Salt Marsh at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.85)

All of the current acreage of this community will be inundated with 0.5 m of sea level rise.

Table 5.85. Projected acres of North Atlantic Low Salt Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	730 acres
1 m	730 acres
1.5 m	730 acres

Natural Capital (Table 5.86)

North Atlantic Low Salt Marsh has gradually been increasing capital as it gains acreage. This may continue in the short-term, but may go down in the long-term.

Table 5.86. Natural Capital of North Atlantic Low Salt Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$4,502,793/year
2002	$4,578,049/year
2007	$4,584,320/year

Northeastern Modified Successional Forest **[15 acres (Figure 5.39-5.40, Tables 5.87-5.90)]**
GNA SNA

DEWAP: Coastal Plain Upland Forest
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

This community is characterized by human disturbance and has a canopy that is not dissimilar to nearby more natural forests but has an understory and shrub/vine layer composed of exotic invasive plant species. Common canopy species include southern red oak (*Quercus falcata*), wild black cherry (*Prunus serotina*), white oak (*Quercus alba*), and eastern red cedar (*Juniperus virginiana*). The understory is composed of smaller members of the canopy and red maple, sassafras (*Sassafras albidum*), and American holly (*Ilex opaca*). The vine layer is trumpet creeper (*Campsis radicans*), Japanese honeysuckle (*Lonicera japonica*). Speargrass (*Chasmanthium laxum*) was the only herb noted.

Figure 5.39. Northeastern Modified Successional Forest (South Section)

The examples of this community are in a perpetually late successional state because of the exotic invasive plants that are present.

Analysis of Condition at Delaware Seashore State Park

Northeastern Modified Successional Forest has increased markedly since 1997 and has experienced no losses since this time. Gains have come from the maturation of 9 acres of Northeastern Old Field and 1 acre of Early to Mid-Successional Loblolly Pine Forest. A minor amount of semi-impervious surface (0.2 acres) and Northeastern Successional Shrubland (0.1 acres) was converted as well.

Since this community is composed primarily of exotic invasive plant species in the understory it is hoped that this community can be eliminated through exotic plant control efforts. Otherwise this community may continue to spread in the park.

Table 5.87. What was once Northeastern Modified Successional Forest in 1997 has become X in 2007	
X	**Acreage**
Northeastern Modified Successional Forest	4 acres

Table 5.88. Northeastern Modified Successional Forest has migrated into X since 1997	
X	**Acreage**
Northeastern Old Field	9 acres
Northeastern Modified Successional Forest	4 acres
Early to Mid-Successional Loblolly Pine Forest	1 acre
Semi-impervious Surface	0.2 acres
Northeastern Successional Shrubland	0.1 acres
Other communities/land covers	0.2 acres

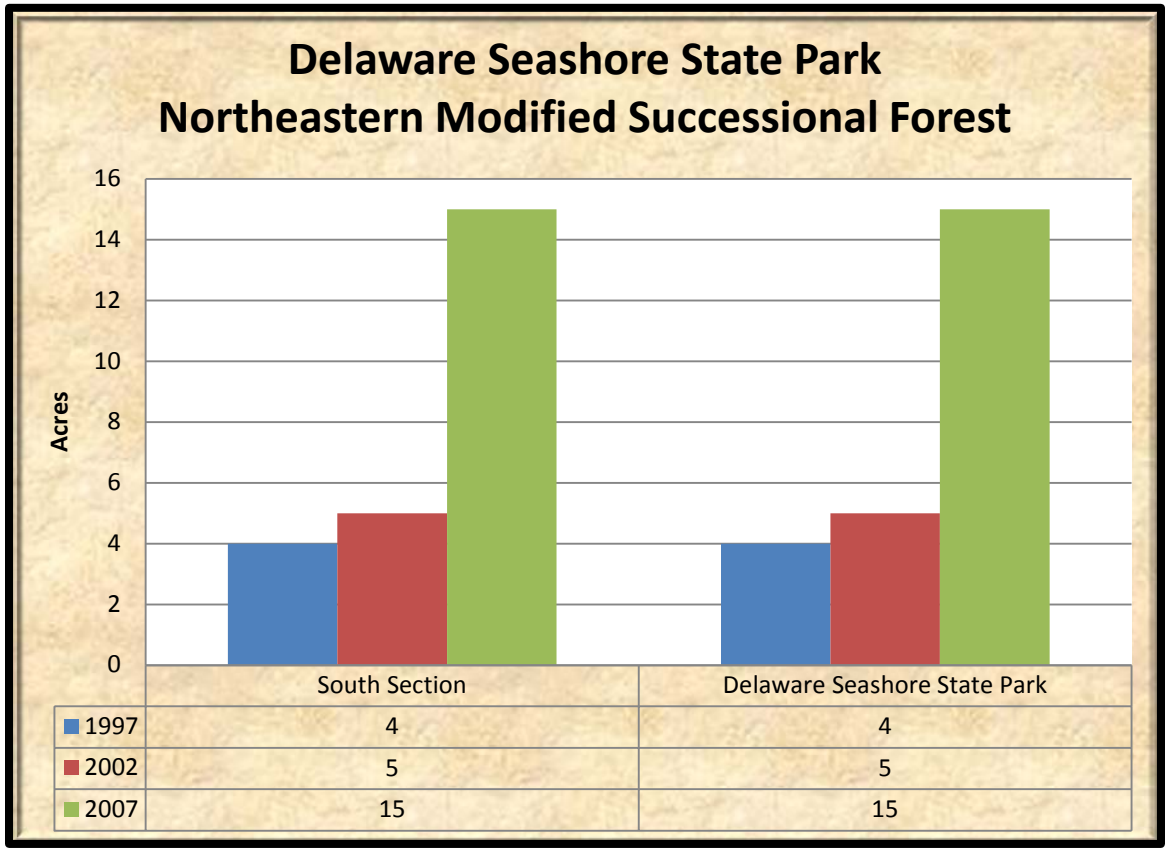


Figure 5.40. Northeastern Modified Successional Forest at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.89)

Most of the current acreage of this community will be inundated with 1.5 m of sea level rise.

Table 5.89. Projected acres of Northeastern Modified Successional Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	6 acres
1 m	10 acres
1.5 m	13 acres

Natural Capital (Table 5.90)

Capitalization of Northeastern Modified Successional Forest has increased quite a bit because of the invasive characteristics of the members of the community.

Table 5.90. Natural Capital of Northeastern Modified Successional Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$756/year
2002	$946/year
2007	$2,837/year

Northeastern Old Field **[157 acres (Figures 5.41-5.42, Tables 5.91-5.94)]** **GNA SNA**

DEWAP: Early Successional Upland Habitat
NHC: Semi-natural/Altered vegetation and Conifer Plantations

Description

Figure 5.41. Northeastern Old Field (South Section)

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. Species in this community include tall fescue (*Festuca rubra*), broom-sedge (*Andropogon virginicus*), trumpet-creeper (*Campsis radicans*), timothy (*Phleum pratense*), and orchard grass (*Dactylis glomerata*).

Analysis of Condition at Delaware Seashore State Park

A lot of the original 209 1997 acres of this community matured to other communities leaving 86 acres still present. Some of the communities maturing from it include Early to Mid-Successional Loblolly Pine Forest (54 acres), Southern Red Maple-Blackgum Swamp Forest (11 acres), and Northeastern Modified Successional Forest (9 acres). Eastern Reed Marsh also came into 13 acres of Northeastern Old Field (Table 5.91).

Since 1997 about 67 acres of agricultural field have become this community reducing the net loss of this community. One acre each of Farm Pond/Artificial Pond, Reed Tidal Marsh, and Cultivated Lawn have become this community (Table 5.92).

Northeastern Old Fields may continue to decline in the park as there are no more agricultural fields for it to convert. The only way it may maintain acreage is if they are maintained this way through management. In this way the short and long term prospects for this community will depend on management.

Table 5.91. What was once Northeastern Old Field in 1997 has become X in 2007	
X	**Acreage**
Northeastern Old Field	86 acres
Early to Mid-Successional Loblolly Pine Forest	54 acres
Eastern Reed Marsh	13 acres
Southern Red Maple-Blackgum Swamp Forest	11 acres
Northeastern Modified Successional Forest	9 acres
Other communities/land covers	36 acres

Table 5.92. Northeastern Old Field has migrated into X since 1997	
X	**Acreage**
Northeastern Old Field	86 acres
Agricultural Field	67 acres
Farm Pond/Artificial Pond	1 acre
Reed Tidal Marsh	1 acre
Cultivated Lawn	1 acre
Other communities/land covers	2 acres

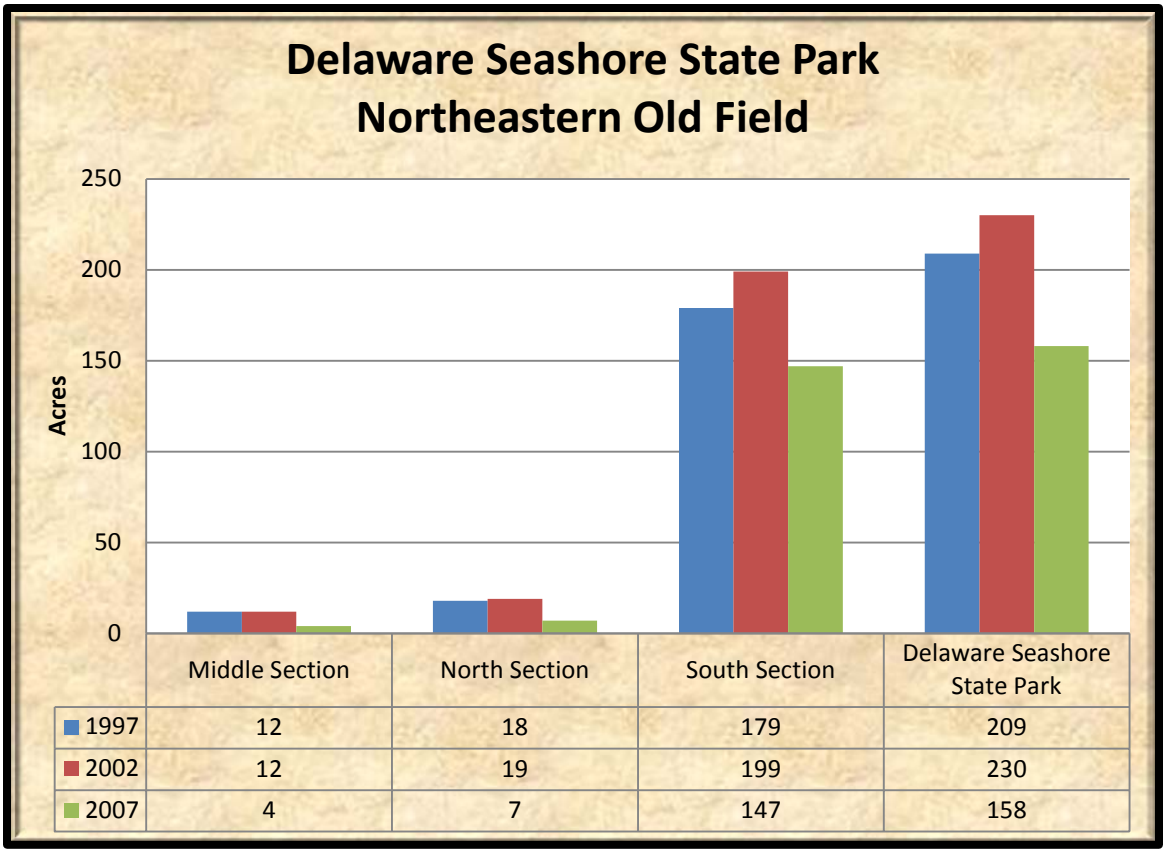


Figure 5.42. Northeastern Old Field at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.93)

Less than 2/3 of the current acreage of Northeastern Old Field will be inundated with 1.5 m of sea level rise.

Table 5.93. Projected acres of Northeastern Old Field Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	23 acres
1 m	44 acres
1.5 m	94 acres

Natural Capital (Table 5.94)

Northeastern Old Field is variable in capital since these communities are short lived and mature to shrubland and forests. Overall it has decreased in capital over the study period.

Table 5.94. Natural Capital of Northeastern Old Field	
Year	**Natural Capital (in 2012 dollars)**
1997	$30,451/year
2002	$33,511/year
2007	$23,021/year

Northeastern Successional Shrubland **[1 acre (Figure 5.43, Tables 5.95-5.98)] GNA SNA**

DEWAP: Early Successional Upland Habitat
NHC: Semi-natural/Altered vegetation and Conifer Plantations

Description

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 Delaware Seashore State Park

Like the Northeastern Old Field, Northeastern Successional Shrubland has decreased and in this case almost to elimination. Northeastern Successional Shrubland is often an intermediate step between Northeastern Old Field and a more mature forest community.

Only 1 acre of the original 11 1997 acres was still present in 2007. The remaining acres have matured to Early to Mid-Successional Loblolly Pine Forest (6 acres) and Southern Red Maple-Blackgum Swamp Forest (1 acre). A minor amount has converted to modified land (0.4 acres) and Reed Tidal Marsh (0.4 acres) (Table 5.95).

Since 1997 Northeastern Successional Shrubland has not made any gains, only losses. This fact gives this community poor prospects for surviving in either the short or long term (Table 5.96).

Table 5.95. What was once Northeastern Successional Shrubland in 1997 has become X in 2007

X	Acreage
Early to Mid-Successional Loblolly Pine Forest	6 acres
Southern Red Maple-Blackgum Swamp Forest	1 acre
Northeastern Successional Shrubland	1 acre
Modified Land	0.4 acres
Reed Tidal Marsh	0.4 acres
Other communities/land covers	1 acre

Table 5.96. Northeastern Successional Shrubland has migrated into X since 1997

X	Acreage
Northeastern Successional Shrubland	1 acre

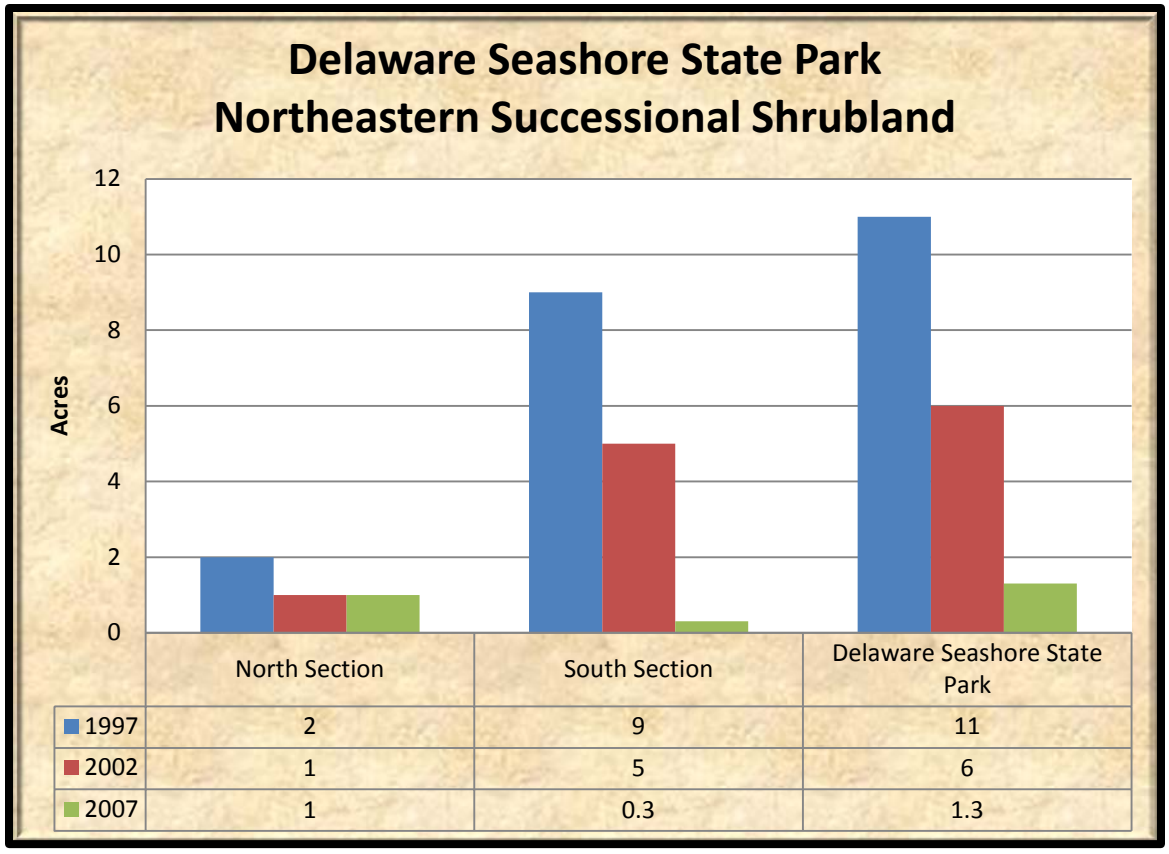


Figure 5.43. Northeastern Successional Shrubland at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.97)

All of the current acreage of this community will be inundated with 0.5 m of sea level rise.

Table 5.97. Projected acres of Northeastern Successional Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 5.98)

Capitalization of Northeastern Successional Shrubland has decreased as it has matured to forest.

Table 5.98. Natural Capital of Northeastern Successional Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,603/year
2002	$874/year
2007	$189/year

Reed Tidal Marsh **[58 acres (Figures 5.44-5.45, Tables 5.99-5.102)] GNA SNA**

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

Description

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.

Figure 5.44. Reed Tidal Marsh (South Section)

Analysis of Condition at Delaware Seashore State Park

Reed Tidal Marsh expanded in size up to 2002 and then decreased in the 2002 to 2007 with eradication efforts. Since this community is composed of an exotic invasive species it is hoped that eradication efforts continue and this community is further reduced.

Reed Tidal Marsh has decreased overall in acreage, likely through *Phragmites* control efforts. Only 42 acres of the original 71 1997 acres remained in 2007. Since this time 11 acres have converted to North Atlantic Low Salt Marsh, 6 acres each have gone to Irregularly Flooded Eastern Tidal Salt Shrub and North Atlantic High Salt Marsh, contributing to high marshes gains. Two acres went to Atlantic Coast Interdune Swale (Table 5.99)

In spite of efforts to control it, reed has managed to expand into 7 acres of Irregularly Flooded Eastern Tidal Salt Shrub, 4 acres of Atlantic Coast Interdune Swale, and 1 acre each of Wax-Myrtle Shrub Swamp and Beach (Table 5.100).

Table 5.99. What was once Reed Tidal Marsh in 1997 has become X in 2007	
X	**Acreage**
Reed Tidal Marsh	42 acres
North Atlantic Low Salt Marsh	11 acres
Irregularly Flooded Eastern Tidal Salt Shrub	6 acres
North Atlantic High Salt Marsh	6 acres
Atlantic Coast Interdune Swale	2 acres
Other communities/land covers	4 acres

Table 5.100. Reed Tidal Marsh has migrated into X since 1997	
X	**Acreage**
Reed Tidal Marsh	42 acres
Irregularly Flooded Eastern Tidal Salt Shrub	7 acres
Atlantic Coast Interdune Swale	4 acres
Wax-Myrtle Shrub Swamp	1 acre
Beach	1 acre
Other communities/land covers	4 acres

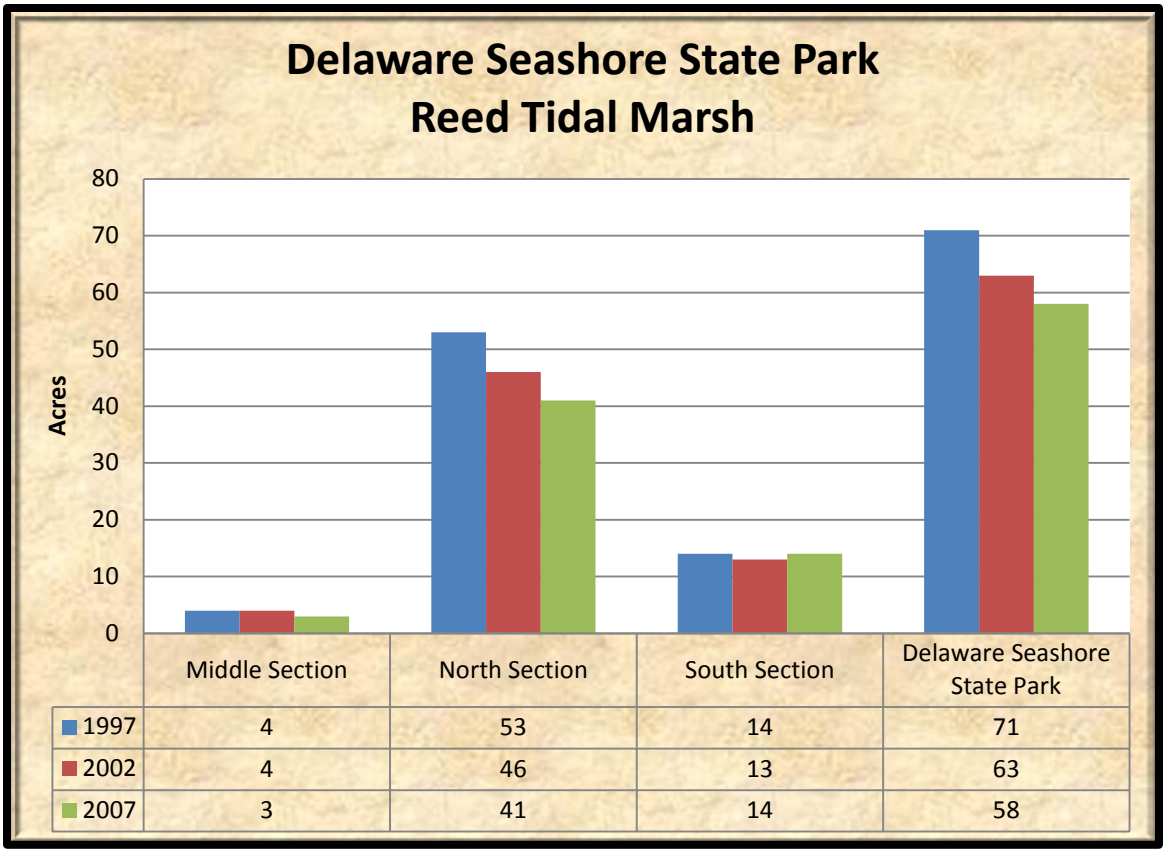


Figure 5.45. Reed Tidal Marsh at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.101)

Most of the current acreage of Reed Tidal Marsh will be flooded with 0.5 m of sea level rise and all of it will be inundated with 1 m of rise.

Table 5.101. Projected acres of Reed Tidal Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	56 acres
1 m	58 acres
1.5 m	58 acres

Natural Capital (Table 5.102)

Capitalization of Reed Tidal Marsh has been going down with its acreage.

Table 5.102. Natural Capital of Reed Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$445,262/year
2002	$395,092/year
2007	$363,735/year

Salt Panne **[0.05 acres (Figure 5.46-5.47, Tables 5.103-5.104)] 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 is dominated by saltwort (*Salicornia virginica*) and associated by sea lavender (*Limonium carolinianum*), and halbeard-leaf orache (*Atriplex patula*).

Figure 5.46. Salt Panne (North Section)

Analysis of Condition at Delaware Seashore State Park

Salt Pannes cover such a small amount of the park that an analysis was not completed. It has gained 0.01 acres during the study period and given the available a trend cannot be established to determine the prospects.

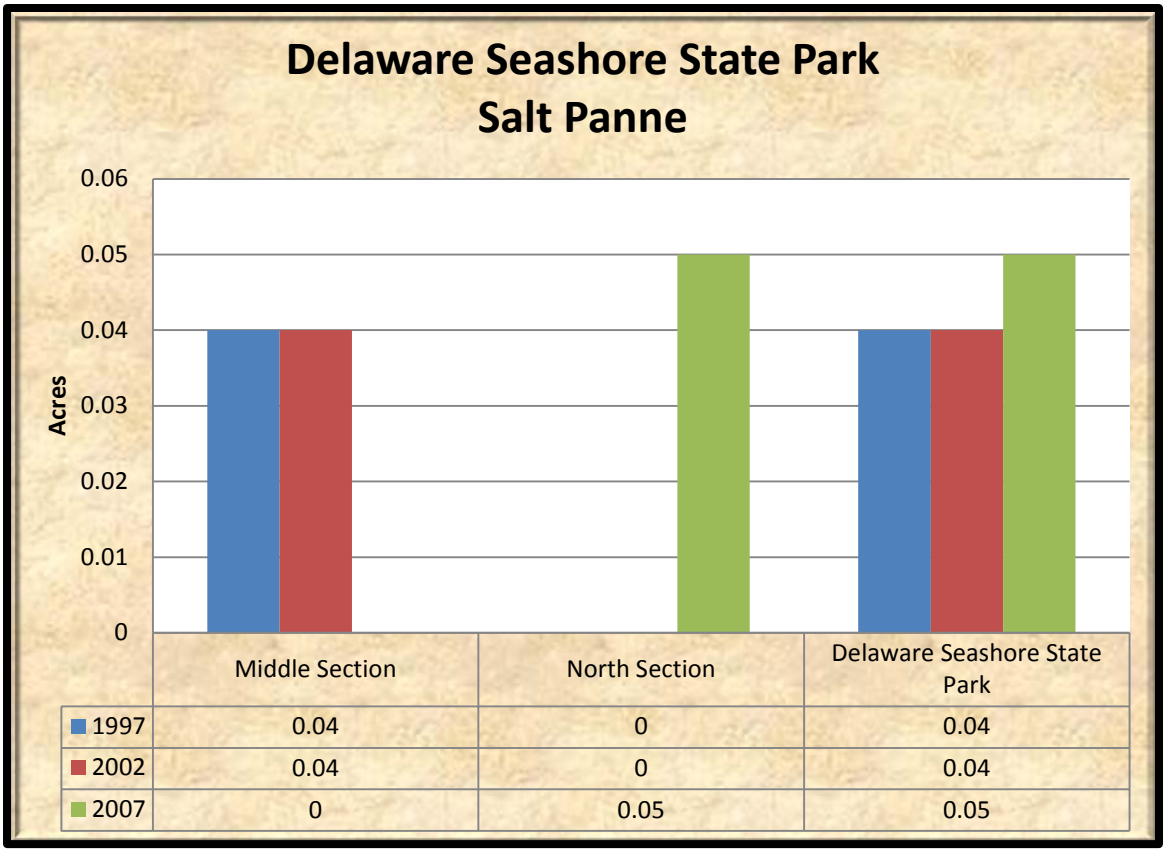


Figure 5.47. Salt Panne at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.103)

Salt Pannes are already inundated as a community, but they will be joined with open water at 0.5 m of sea level rise.

Table 5.103. Projected acres of Salt Panne Impacted 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 (Table 5.104)

Capitalization of Salt Panne has increased in the 2002 to 2007 period with an increase in acreage.

Table 5.104. Natural Capital of Salt Panne	
Year	**Natural Capital (in 2012 dollars)**
1997	$251/year
2002	$251/year
2007	$314/year

Southern Red Maple-Blackgum Swamp **[85 acres (Figures 5.48-5.49, Tables 5.105-5.108)]**
G3? S1

DEWAP: Coastal Plain Forested Floodplain and Riparian Forest
NHC: Northern Atlantic Coastal Plain Stream and River

Description

This community is found generally just north of Fred Hudson Road in the South Section. Red maple (*Acer rubrum*) is the dominant species in the canopy and is associated by loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), and black gum (*Nyssa sylvatica*). Understory species include sweetbay (*Magnolia virginiana*), winged sumac (*Rhus copallina*), American holly (*Ilex opaca*), and willow oak (*Quercus phellos*). Vines include common greenbrier (*Smilax rotundifolia*) and summer grape (*Vitis aestivalis*). Speargrass (*Chasmanthium laxum*) was the only herb noted in this community.

Figure 5.48. Southern Red Maple-Blackgum Swamp (South Section)

Analysis of Condition at Delaware Seashore State Park

Southern Red Maple-Blackgum Swamp Forest seems to be one of the more stable communities in the park with 68 acres of the original 71 1997 acres remaining. Two acres converted to Eastern Reed Marsh and 1 acre was drowned from water incursion (Table 5.105).

Since 1997 this community has gained acreage through maturation of primarily Northeastern Old Field (11 acres) and Early to Mid-Successional Loblolly Pine Forest (6 acres). Northeastern Successional Shrubland has converted 1 acre (Table 5.106).

By the numbers this community would appear secure but it is in an area that has been observed to be flooding. Some of this community has already been flooded and more may be flooded as the water seems to be increasing. It is unknown how fast this will happen making the prospects for this community uncertain.

Table 5.105. What was once Southern Red Maple-Blackgum Swamp Forest in 1997 has become X in 2007	
X	**Acreage**
Southern Red Maple-Blackgum Swamp Forest	68 acres
Eastern Reed Marsh	2 acres
Drowned Forest	1 acre

Table 5.106. Southern Red Maple-Blackgum Swamp Forest has migrated into X since 1997	
X	**Acreage**
Southern Red Maple-Blackgum Swamp Forest	68 acres
Northeastern Old Field	11 acres
Early to Mid-Successional Loblolly Pine Forest	6 acres
Northeastern Successional Shrubland	1 acre

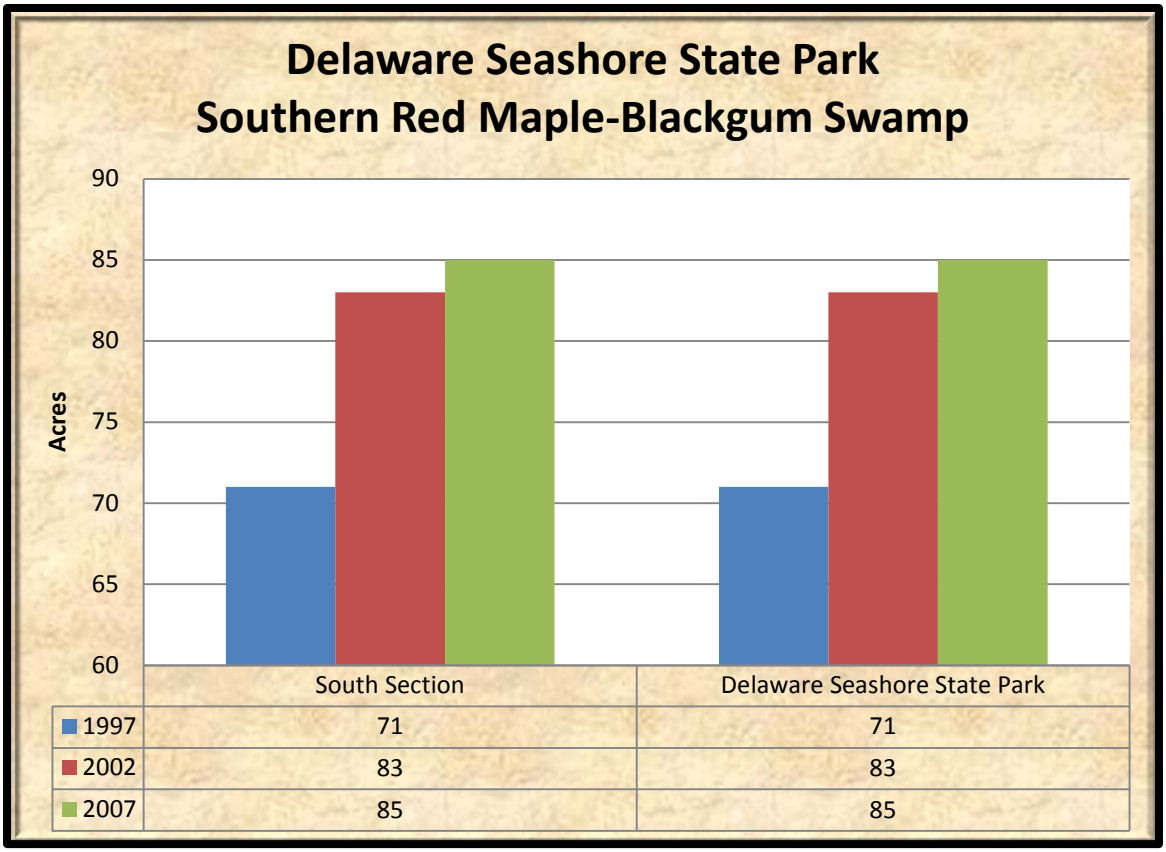


Figure 5.49. Southern Red Maple-Blackgum Swamp at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.107)

Southern Red Maple-Blackgum Swamp will have all of its current acreage inundated with 1.5 m of sea level rise.

Table 5.107. Projected acres of Southern Red Maple-Blackgum Swamp Impacted by Sea Level Rise

Rise	Acres
0.5 m	67 acres
1 m	78 acres
1.5 m	85 acres

Natural Capital (Table 5.108)

Capitalization of Southern Red Maple-Blackgum Swamp has been increasing as other communities mature into it. In the near future, however, this community may start to lose capitalization to water or marsh.

Table 5.108. Natural Capital of Southern Red Maple-Blackgum Swamp	
Year	**Natural Capital (in 2012 dollars)**
1997	$872,697/year
2002	$1,020,195/year
2007	$1,044,778/year

Southern Red Oak/Heath Forest **[5 acres (Figures 5.50-5.51, Tables 5.109-5.112)]**
G4G5 S5

DEWAP: Coastal Plain Upland Forests
NHC: Northern Coastal Plain Hardwood Forest

Description

This dry forest community is located just to the north of an old barn in the South Section. Southern red oak (*Quercus falcata*), wild black cherry (*Prunus serotina*), white oak (*Quercus alba*), and mockernut hickory (*Carya alba*) compose the canopy. The understory is composed of younger members of the canopy plus sassafras (*Sassafras albidum*), sand hickory (*Carya pallida*), and hercule's club (*Aralia spinosa*). No shrub layer was observed but common vines included common greenbrier (*Smilax rotundifolia*), Japanese honeysuckle (*Lonicera japonica*), white-leaf greenbrier (*Smilax glauca*), and summer grape (*Vitis aestivalis*). Deer tongue grass (*Dichanthelium clandestinum*) and speargrass (*Chasmanthium laxum*) were the only herbs present.

Figure 5.50. Southern Red Oak/Heath Forest (South Section)

The only example of this community in the park is a young to medium age example that share a lot of traits with a Successional Maritime Forest. The canopy and thick understory are also similar in height.

Analysis of Condition at Delaware Seashore State Park

Southern Red Oak/Heath Forest has not changed in acreage or location during the study period. All 5 acres from 1997 persisted into 2007 with only 0.3 acres going to Successional Maritime Forest (within the rounding error). On the flip side this community converted 0.5 acres of Successional Maritime Forest (also within the rounding error).

This is a long-lived dry climax community and is expected to persist into the long-term future.

Table 5.109. What was once Southern Red Oak/Heath Forest in 1997 has become X in 2007	
X	**Acreage**
Southern Red Oak/Heath Forest	5 acres
Successional Maritime Forest	0.3 acres

Table 5.110. Southern Red Oak/Heath Forest has migrated into X since 1997	
X	**Acreage**
Southern Red Oak/Heath Forest	5 acres
Successional Maritime Forest	0.5 acres

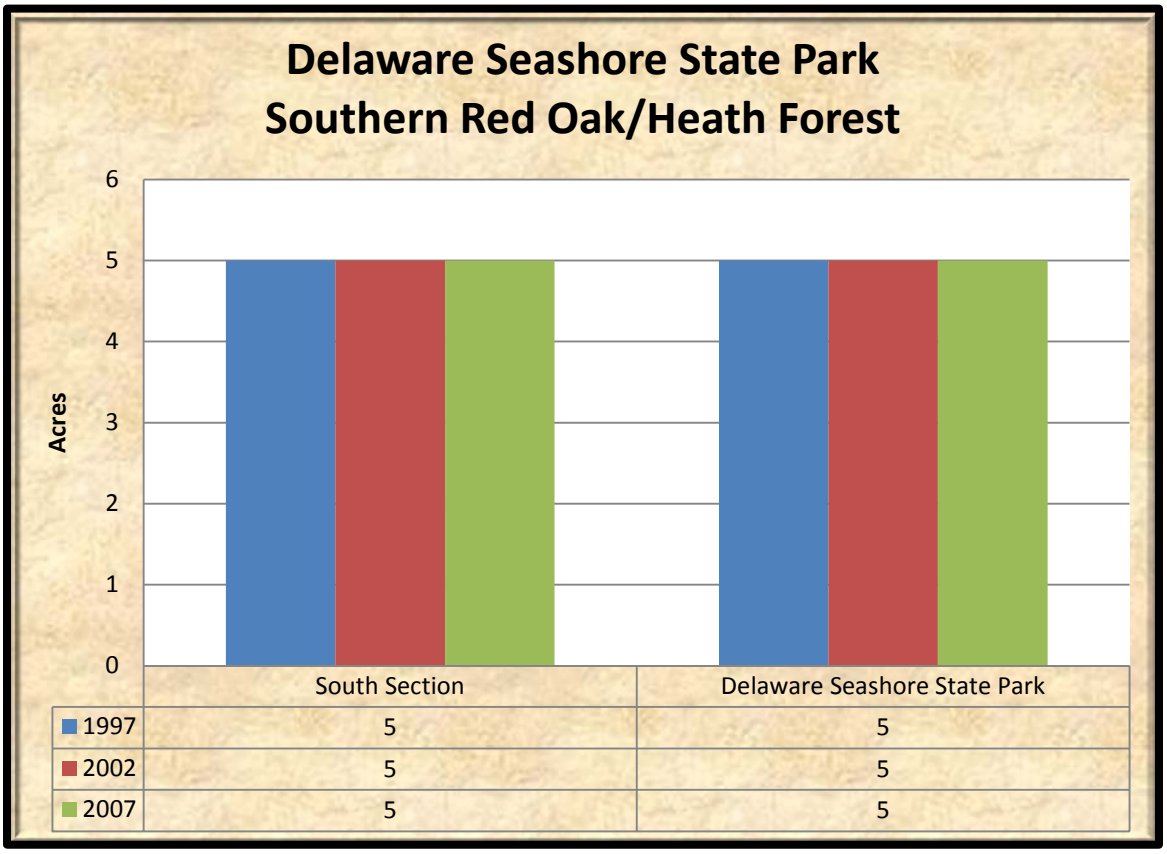


Figure 5.51. Southern Red Oak/Heath Forest at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.111)

Southern Red Oak/Heath Forest will be barely nicked by sea level rise inundation with 1.5 m of rise. These communities are drier and tend to be in higher places. It is unknown if these communities might convert to something else with water being so close.

Table 5.111. Projected acres of Southern Red Oak/Heath Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	0.01 acres

Natural Capital (Table 5.112)

Southern Red Oak/Heath Forest has not changed in capitalization over the study period. These communities tend to be long-lived and mature and do not change much.

Table 5.112. Natural Capital of Southern Red Oak/Heath Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$946/year
2002	$946/year
2007	$946/year

Successional Maritime Forest **[18 acres (Figures 5.52-5.53, Tables 5.113-5.116)] G2G3 S3**

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

Description

Successional Maritime Forest is scattered around the park in the North and South Sections around the edges of marshes and tidal water. Canopy species include wild black cherry (*Prunus serotina*), southern red oak (*Quercus falcata*), white oak (*Quercus alba*), and eastern red cedar (*Juniperus virginiana*). Smaller members of the canopy plus sassafras (*Sassafras albidum*), sand hickory (*Carya pallida*), and American holly (*Ilex opaca*) make up the understory. The shrub and vine layer is composed of Japanese honeysuckle (*Lonicera japonica*), common greenbrier (*Smilax rotundifolia*), summer grape (*Vitis rotundifolia*), trumpet creeper (*Campsis radicans*), and white-leaf greenbrier (*Smilax glauca*). Deer-tongue grass (*Dichanthelium clandestinum*) and speargrass (*Chasmanthium laxum*) were

Figure 5.52. Successional Maritime Forest (North Section)

Analysis of Condition at Delaware Seashore State Park

The position of Successional Maritime Forest makes this community very changeable and subject to disturbance. Seventeen acres of the original 21 1997 acres remained in 2007. Since 1997 3 acres have gone to Irregularly Flooded Eastern Tidal Salt Shrub and one acre to Northeastern Old Field. About a half-acre matured to Southern Red Oak/Heath Forest and 0.1 acre became semi-impervious surface in a trail (Table 5.113).

This community in spite of decreasing over time managed to colonize 0.4 acres of agricultural field and convert 0.2 acres of Chesapeake Bay Tall Maritime Shrubland (Table 5.114).

This community appears secure in the short term but is increasingly being squeezed by the marsh and landward communities as it is not converting fast enough with the rising water. Given this the long term prospects are fair.

Table 5.113. What was once Successional Maritime Forest in 1997 has become X in 2007	
X	**Acreage**
Successional Maritime Forest	17 acres
Irregularly Flooded Eastern Tidal Salt Shrub	3 acres
Northeastern Old Field	1 acre
Southern Red Oak/Heath Forest	0.5 acres
Semi-impervious Surface	0.1 acres
Other communities/land covers	0.1 acres

Table 5.114. Successional Maritime Forest has migrated into X since 1997	
X	**Acreage**
Successional Maritime Forest	17 acres
Agricultural Field	0.4 acres
Southern Red Oak/Heath Forest	0.3 acres
Chesapeake Bay Tall Maritime Shrubland	0.2 acres

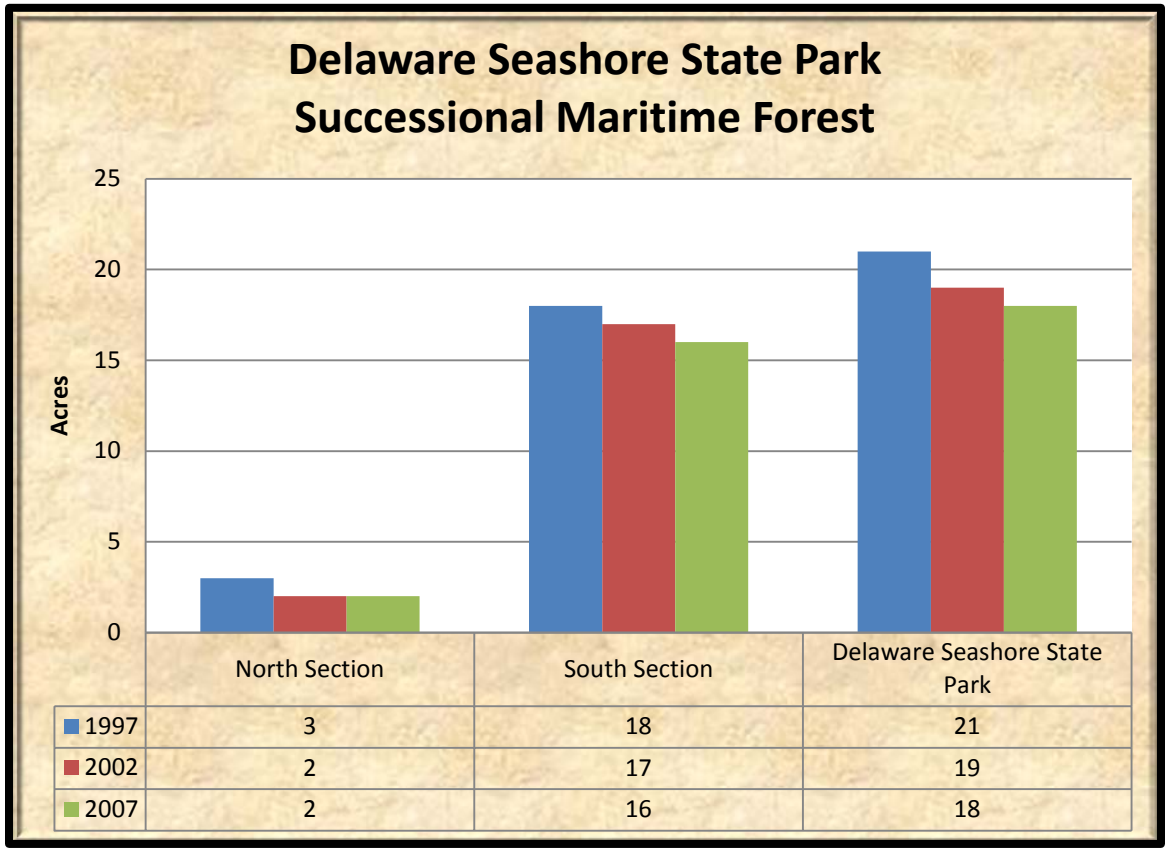


Figure 5.53. Successional Maritime Forest at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.115)

About 2/3 of this community will be inundated by 1.5 m of sea level rise.

Table 5.115. Projected acres of Successional Maritime Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	4 acres
1 m	8 acres
1.5 m	12 acres

Natural Capital (Table 5.116)

Successional Maritime Forest has been decreasing in capitalization as it converts to salt shrub and marshland.

Table 5.116. Natural Capital of Successional Maritime Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$3,971/year
2002	$3,593/year
2007	$3,404/year

Successional Sweetgum Forest **[3 acres (Figure 5.54, Tables 5.117-5.119)] GNA SNA**

DEWAP: Coastal Plain Upland Forest
NHC: Semi-natural/Altered vegetation and Conifer Plantations

Description

This successional forested community is composed of a thick mass of sweetgum (*Liquidambar styraciflua*) with an occasional loblolly pine (*Pinus taeda*) mixed in. Herbs present include horseweed (*Conyza canadensis*), broom-sedge (*Andropogon virginicus*), and nightshade (*Solanum nigrum*).

Analysis of Condition at Delaware Seashore State Park

Successional Sweetgum Forest arose out an abandoned agricultural field between 2002 and 2007. It covers 3 acres of the agricultural field and 0.1 acres of Northeastern Old Field. Since it is successional it will likely mature into another more mature community over the long term.

Table 5.117. Successional Sweetgum Forest has migrated into X since 1997

X	**Acreage**
Agricultural Field	3 acres
Northeastern Old Field	0.1 acres

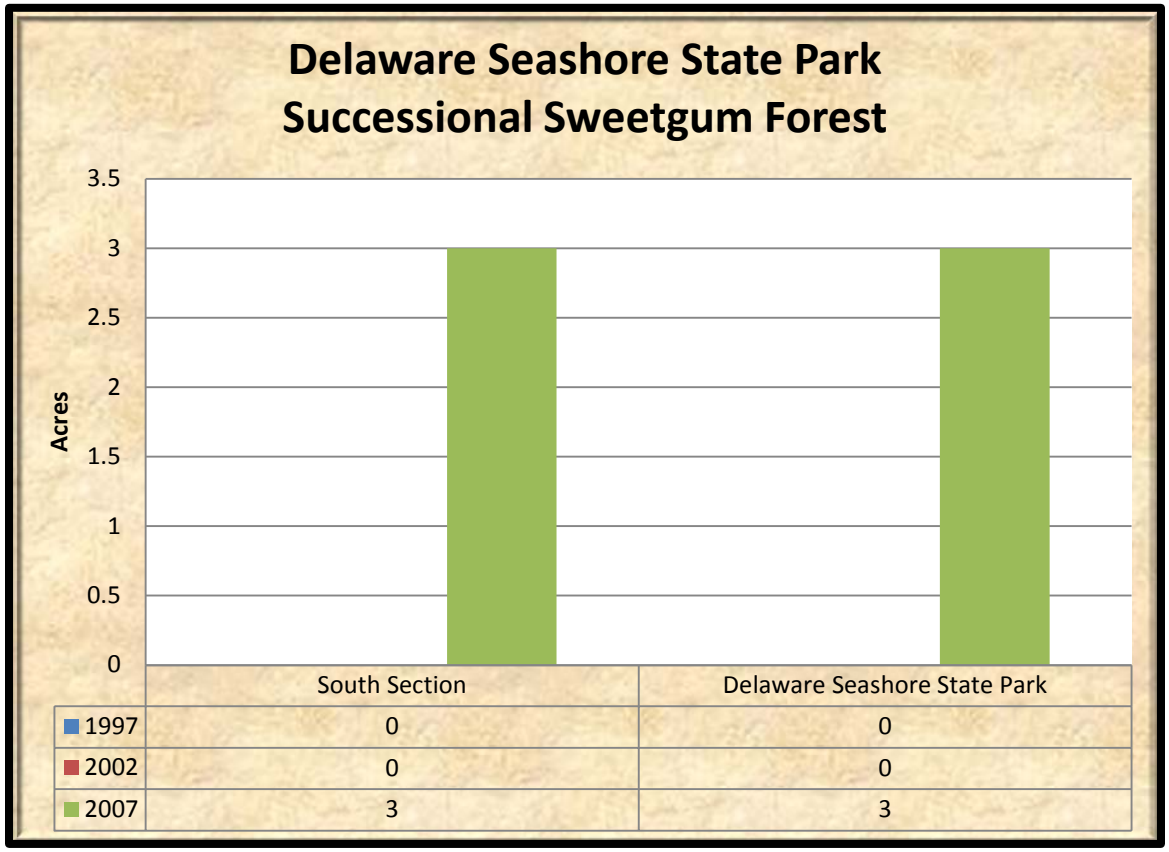


Figure 5.54. Successional Sweetgum Forest at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.118)

About 2/3 of this community will be inundated by 1.5 m of sea level rise, but will not be affected with 0.5 m of rise.

Table 5.118. Projected acres of Successional Sweetgum Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	1 acre
1.5 m	2 acres

Natural Capital (Table 5.119)

Successional Sweetgum Forest has only recently developed in the park.

Table 5.119. Natural Capital of Successional Sweetgum Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$0/year
2002	$0/year
2007	$567/year

***Wax-Myrtle Shrub Swamp* [2 acres (Figure 5.55, Tables 5.120-5.124)] G2G3 S2**

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

Description

Wax-myrtle Shrub Swamp is often found at the interface between brackish marshes and fresher to fresh tributaries. Wax-myrtle (*Morella cerifera*) is the dominant species if not the only species in this community.

Analysis of Condition at Delaware Seashore State Park

Wax-Myrtle Shrub Swamp has changed a lot since 1997 with only 2 acres of the original 6 1997 acres remaining in 2007. Most of the acreage converted to Atlantic Coast Interdune Swale (3 acres) and 1 acre each went to Irregularly Flooded Eastern Tidal Salt Shrub and Reed Tidal Marsh. Small amount (0.2 acres) went to Chesapeake Bay Tall Maritime Shrubland (Table 5.120).

Wax-Myrtle Shrub Swamp only recruited about 0.1 acres of Northeastern Old Field during the study period (Table 5.121). Given this small recruitment and the losses it appears that the prospects for this community surviving into the long term are poor.

Table 5.120. What was once Wax-Myrtle Shrub Swamp in 1997 has become X in 2007	
X	**Acreage**
Atlantic Coast Interdune Swale	3 acres
Irregularly Flooded Eastern Tidal Salt Shrub	1 acre
Reed Tidal Marsh	1 acre
Wax-Myrtle Shrub Swamp	1 acre
Chesapeake Bay Tall Maritime Shrub Swamp	0.2 acres

Table 5.121. Wax-Myrtle Shrub Swamp has migrated into X since 1997	
X	**Acreage**
Wax-Myrtle Shrub Swamp	1 acres
Northeastern Old Field	0.1 acres

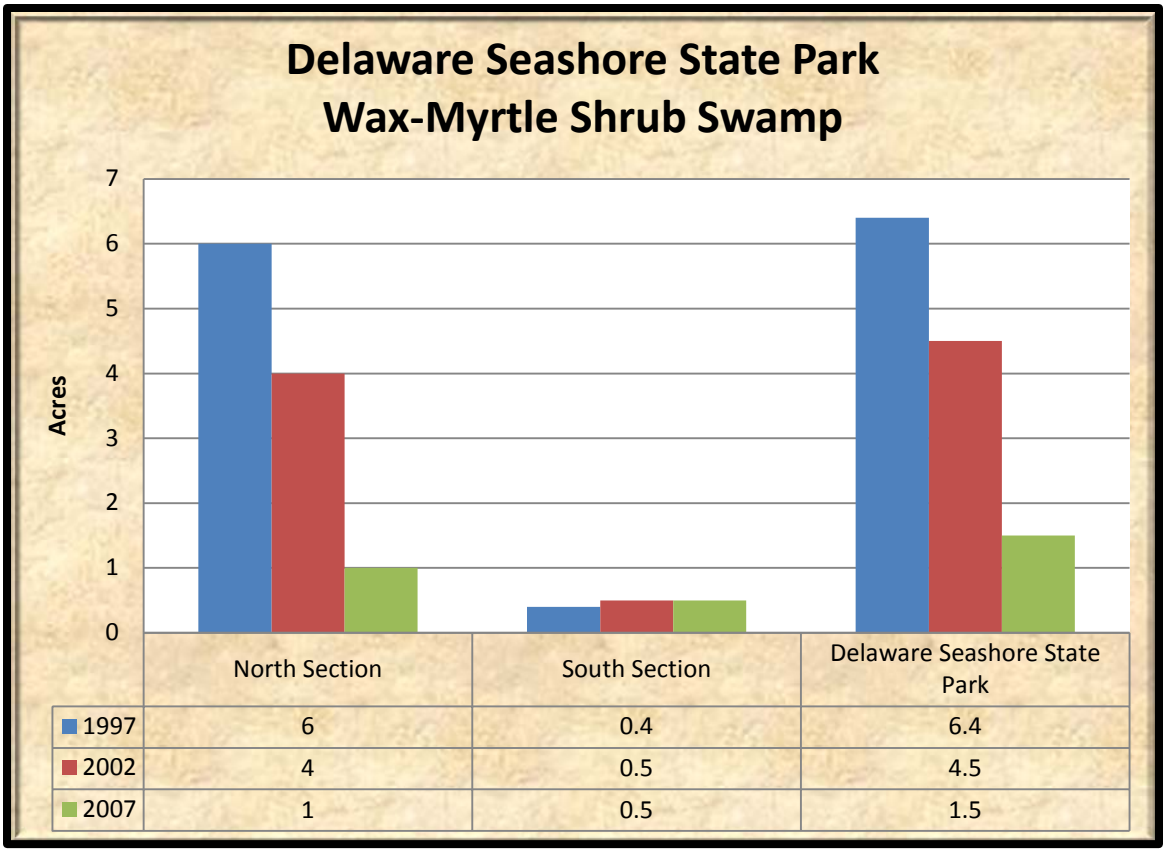


Figure 5.55. Wax-Myrtle Shrub Swamp at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.122)

All of this community will be flooded by 0.5 m of sea level rise.

Table 5.122. Projected acres of Wax-Myrtle Shrub Swamp Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 5.123)

Capital of Wax-Myrtle Shrub Swamp has been decreasing as it is being taken over by marsh and brackish shrub habitats.

Table 5.123. Natural Capital of Wax-Myrtle Shrub Swamp	
Year	**Natural Capital (in 2012 dollars)**
1997	$59,401/year
2002	$41,766/year
2007	$13,922/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. Beach—88 acres
2. Drowned Forest—17 acres
3. Farm Pond/Artificial Pond—8 acres
4. Impervious Surface—128 acres
5. Modified Land—29 acres
6. Riprap—2 acres
7. Sand—8 acres
8. Semi-impervious Surface—23 acres
9. Tidal Mudflat—4 acres
10. Water—284 acres

***Beach* [88 acres, (Figure 6.1, Tables 6.1-6.3)]**

DEWAP: Beach and Dune Habitats
NHC: No Equivalent Classification

Description

This land cover includes those places where there is a sandy interface between the land and water.

Analysis of Condition at Delaware Seashore State Park

The amount of beach area has markedly decreased since 1997. Most of the former beach has moved north across Rehoboth Beach to the Cape at Cape Henlopen. Without beach re-nourishment this trend will likely continue. In 2007 only 85 acres of the original 174 acres remained. The rest went to water (84 acres), North Atlantic Low Salt Marsh (2 acres), Tidal Mudflat (1 acre), and Reed Tidal Marsh (1 acre).

Since 1997 beach has migrated into 1 acre of Chesapeake Bay Tall Maritime Shrubland at Burtons Island, 1 acre of Beachgrass-Panicgrass Dune Grassland, 0.4 acres of North Atlantic Low Salt Marsh, and 0.1 acres of Reed Tidal Marsh.

Table 6.1. What was once Beach in 1997 has become X in 2007	
X	**Acreage**
Beach	85 acres
Water	84 acres
North Atlantic Low Salt Marsh	2 acres
Tidal Mudflat	1 acre
Reed Tidal Marsh	1 acre
Other communities/land covers	1 acre

Table 6.2. Beach has migrated into X since 1997	
X	**Acreage**
Beach	85 acres
Chesapeake Bay Tall Maritime Shrubland	1 acre
Beachgrass-Panicgrass Dune Grassland	1 acre
North Atlantic Low Salt Marsh	0.4 acres
Reed Tidal Marsh	0.1 acres
Other communities/land covers	0.3 acres

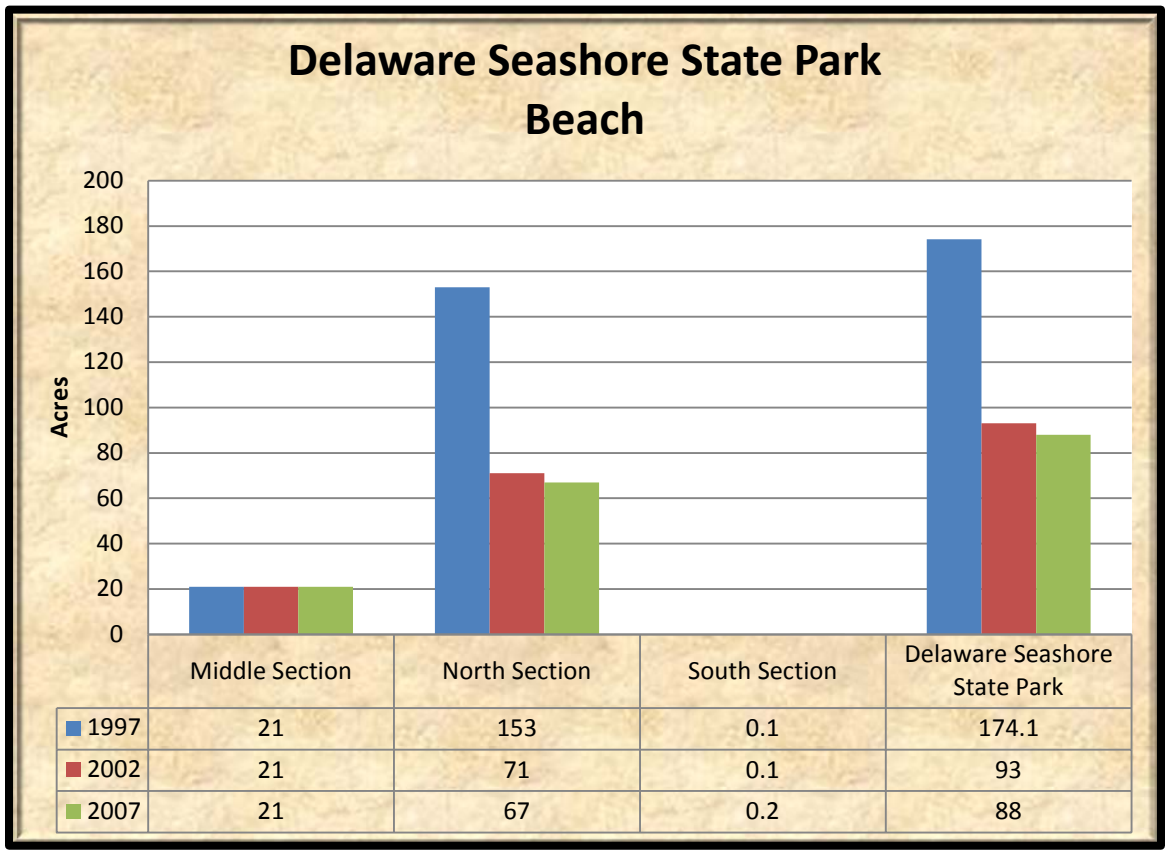


Figure 6.1. Beach at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.3)

A little less than ¾ of this community will be inundated by 1.5 m of sea level rise.

Table 6.3. Projected acres of Beach Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	14 acres
1 m	31 acres
1.5 m	62 acres

Natural Capital

This land cover does not have any natural capital value.

***Drowned Forest* [17 *acres* (Figure 6.2, Tables 6.4-6.7)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

This land cover is located in area where forestland has been inundated by water leaving dead trees and flooded vegetation.

Analysis of Condition at Delaware Seashore State Park

This land cover only presented itself in the 2007 aerial imagery and represents an area in which the woodland is being inundated from water. The water appears to be coming from groundwater as there is no connection to a water body. The primary community being affected is Early to Mid-Successional Loblolly Pine Forest (13 acres) along with Northeastern Old Field (3 acres), Southern Red Maple-Blackgum Swamp Forest (1 acre), and Irregularly Flooded Eastern Tidal Salt Shrub (1 acre) (Table 6.4). In the future there may be more Southern Red Maple-Blackgum Swamp Forest affected.

Table 6.4. Drowned Forest has migrated into X since 1997

X	Acreage
Early to Mid-Successional Loblolly Pine Forest	13 acres
Northeastern Old Field	3 acres
Southern Red Maple-Blackgum Swamp Forest	1 acre
Irregularly Flooded Eastern Tidal Salt Shrub	1 acre

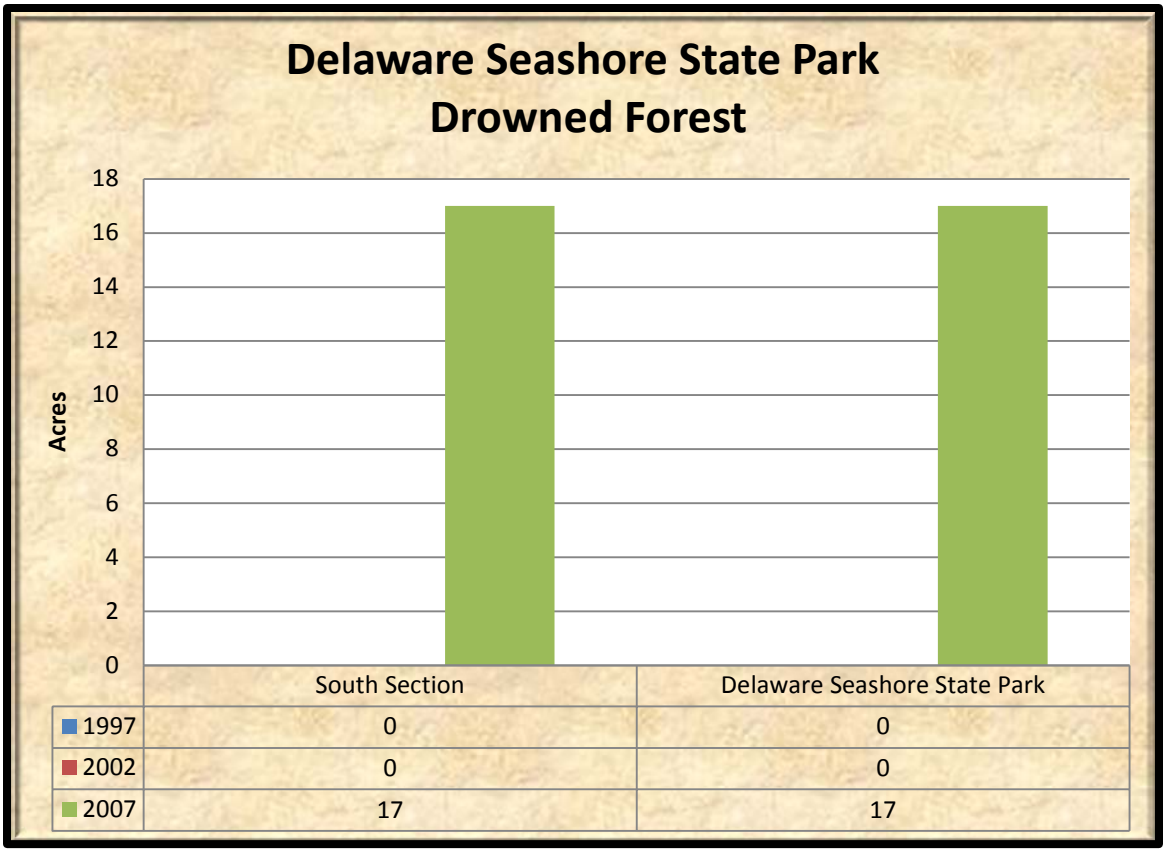


Figure 6.2. Drowned Forest at Delaware Seashore State Park

DNREC Sea Level Rise Analysis (Table 6.5)

All of this land cover will be flooded by 0.5 m of sea level rise.

Table 6.5. Projected acres of Drowned Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	17 acres
1 m	17 acres
1.5 m	17 acres

Natural Capital (Table 6.6)

I am currently including this land cover as having natural capital value, but this change with the new imagery set (2012).

Table 6.6. Natural Capital of Drowned Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$0/year (not present)
2002	$0/year (not present)
2007	$3,215/year

Farm Pond/Artificial Pond **[8 acres, (Figure 6.3, Tables 6.7-6.10)]**

DEWAP: Impoundment
NHC: No Equivalent Classification

Description

This land cover includes water bodies that are less than 5 acres in size.

Analysis of Condition at Delaware Seashore State Park

There are only a few ponds present in the park and all are located in the South Section away from the coastline. Northeastern Old Field and Eastern Reed Marsh are the only communities impacted by the development of ponds (Tables 6.7-6.8).

Table 6.7. What was once Farm Pond/Artificial Pond in 1997 has become X in 2007	
X	**Acreage**
Farm Pond/Artificial Pond	6 acres
Northeastern Old Field	1 acre

Table 6.8. Farm Pond/Artificial Pond has migrated into X since 1997	
X	**Acreage**
Farm Pond/Artificial Pond	6 acres
Northeastern Old Field	2 acres
Eastern Reed Marsh	0.3 acres

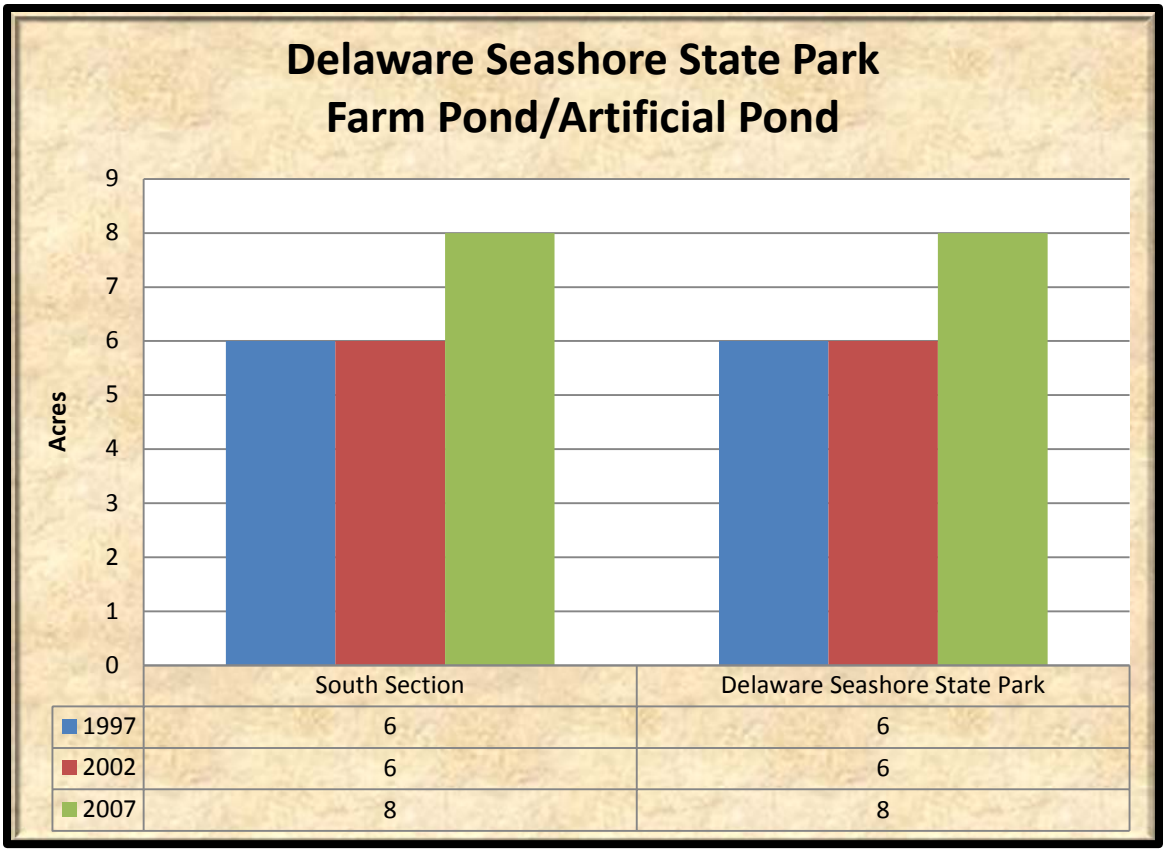


Figure 6.3. Farm Pond/Artificial Pond at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.9)

All of this land cover will be flooded by 1.5 m of sea level rise.

Table 6.9. Projected acres of Farm Pond/Artificial Pond Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	6 acres
1 m	7 acres
1.5 m	8 acres

Natural Capital (Table 6.10)

Farm Pond/Artificial Pond natural capital has been going up with the development of additional ponds.

Table 6.10. Natural Capital of Farm Pond/Artificial Pond	
Year	**Natural Capital (in 2012 dollars)**
1997	$32,011/year
2002	$32,011/year
2007	$42,681/year

Impervious Surface **[128 acres, (Figure 6.4, Tables 6.11-6.13)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

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 Delaware Seashore State Park

Impervious surface has increased with development in the park and construction of the new Indian River Inlet Bridge. This trend is likely to continue as the park gains more facilities.

Between 2002 and 2007 a lot of previous impervious surface area was eliminated temporarily by the construction of the new Indian River Inlet Bridge. By 2007 only 104 acres of the original 122 acres in 1997 were present with 14 acres going to modified land associated with the bridge. An additional 2 acres each went to Cultivated Lawn and Semi-impervious Surface (Table 6.11).

Since 1997 a net gain of impervious surfaces have been placed on 9 acres of Cultivated Lawn, 5 acres of Northeastern Old Field, 4 acres of Semi-impervious Surface, and 1 acre of Chesapeake Bay Tall Maritime Shrubland (Table 6.12).

Table 6.11. What was once Impervious Surface in 1997 has become X in 2007	
X	**Acreage**
Impervious Surface	104 acres
Modified Land	14 acres
Cultivated Lawn	2 acres
Semi-impervious Surface	2 acres
Irregularly Flooded Eastern Tidal Salt Shrub	0.1 acres
Other communities/land covers	0.2 acres

Table 6.12. Impervious Surface has migrated into X since 1997	
X	**Acreage**
Impervious Surface	104 acres
Cultivated Lawn	9 acres
Northeastern Old Field	5 acres
Semi-impervious Surface	4 acres
Chesapeake Bay Tall Maritime Shrubland	1 acre
Other communities/land covers	4 acres

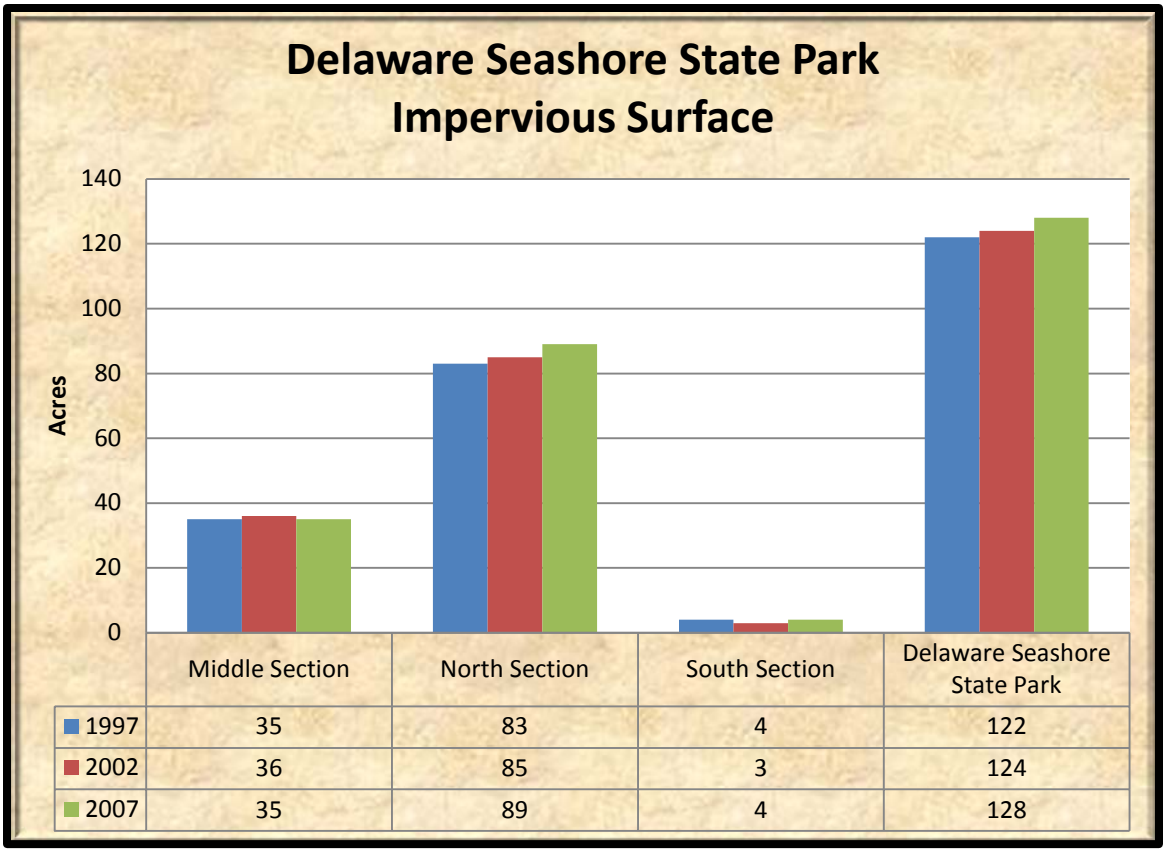


Figure 6.4. Impervious surface at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.13)

Impervious Surface will be heavily impacted, especially with rise above 1 m. Since this land cover includes man-made structures there will ultimately be economic effects, not only to natural capital, but on the expense side as well.

Table 6.13. Projected acres of Impervious Surface Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	22 acres
1 m	94 acres
1.5 m	116 acres

Natural Capital

This land cover does not have any natural capital value.

Modified Land **[29 acres, (Figure 6.5, Tables 6.14-6.16)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

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 Delaware Seashore State Park

This land cover had a major uptick in acreage between 2002 and 2007 with the building of the new Indian River Inlet Bridge. Communities affected by the increase include Impervious Surface (14 acres) in a former parking lot, Cultivated Lawn (5 acres), Northeastern Old Field (5 acres), and Northeastern Successional Shrubland (0.4 acres) (Tables 6.14-6.15). This land cover is often the precursor of development in the park and elsewhere.

Table 6.14. What was once Modified Land in 1997 has become X in 2007	
X	**Acreage**
Modified Land	4 acres
Impervious Surface	1 acre
Semi-impervious Surface	1 acre

Table 6.15. Modified Land has migrated into X since 1997	
X	**Acreage**
Impervious Surface	14 acres
Cultivated Lawn	5 acres
Northeastern Old Field	5 acres
Modified Land	4 acres
Northeastern Successional Shrubland	0.4 acres
Other communities/land covers	0.3 acres

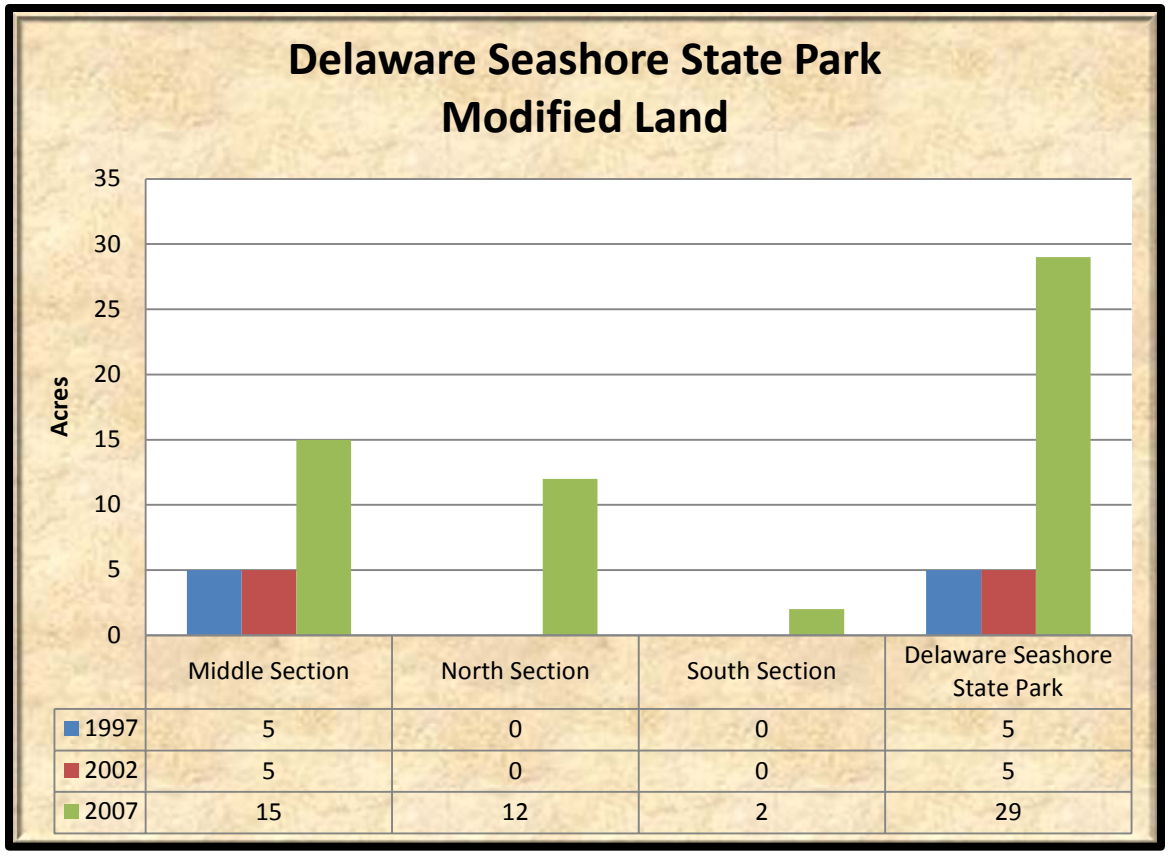


Figure 6.5. Modified Land at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.16)

The amount of acreage of this land cover that will be inundated is alarming in that these developments that are currently underway will be inundated with 0.5 m up to 1.5 m of rise. These are developments will be nearly new when they built and then will be flooded.

Table 6.16. Projected acres of Modified Land Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	9 acres
1 m	24 acres
1.5 m	26 acres

Natural Capital

This land cover does not have any natural capital value.

***Riprap* [2 acres, (Figure 6.6, Tables 6.17-6.19)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

Riprap is often used as a berm to prevent erosion on the beach. Most riprap in the park is present around the marina and the Indian River Inlet Bridge.

Analysis of Condition at Delaware Seashore State Park

The acreage in riprap has not changed over the study period but it has covered an additional 0.1 acres of sand since 1997 (Table 6.17-6.18).

Table 6.17. What was once Riprap in 1997 has become X in 2007	
X	**Acreage**
Riprap	1 acre

Table 6.18. Riprap has migrated into X since 1997	
X	**Acreage**
Riprap	1 acre
Sand	0.1 acres

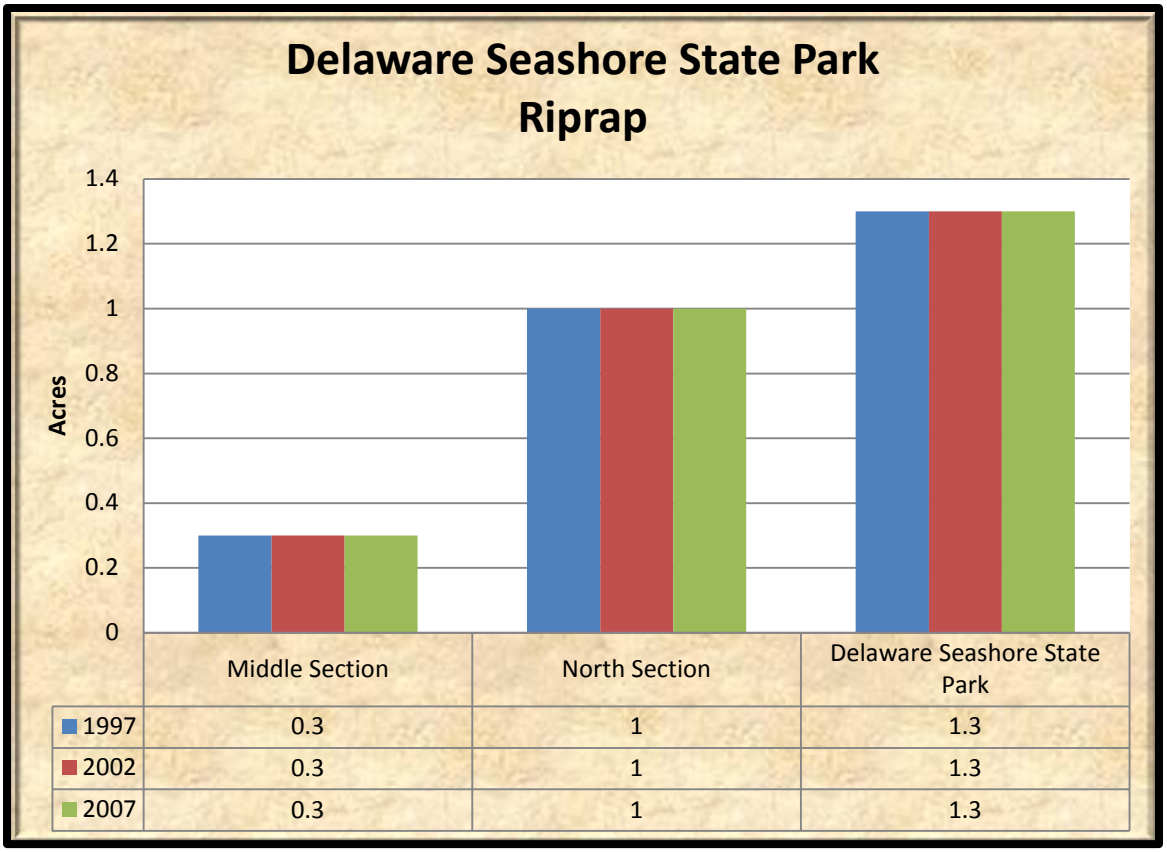


Figure 6.6. Riprap at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.19)

All of the current acreage of this land cover will be inundated with 0.5 m of sea level rise.

Table 6.19. Projected acres of Riprap Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital

This land cover does not have any natural capital value.

***Sand* [8 acres, (Figure 6.7, Tables 6.20-6.22)]**

DEWAP: Beach and Dune Habitats
NHC: No Equivalent Classification

Description

This land cover includes bare sand areas with no vegetation present.

Analysis of Condition at Delaware Seashore State Park

The amount of sand present in the park oscillates as plants are covered and then plants recolonize bare patches. There has been a rough trend of less sand as communities mature and sand is eroded from the shoreline.

The fact that there are only 4 acres in 2007 of the original 12 acres present in 1997 shows the movement of the sand. Areas that were once sand are now Cultivated Lawn (1 acre), Mid-Atlantic Coast Backdune Grassland (1 acre), Central Coast Beach Heather Dune Shrubland (1 acre), and water (1 acre) (Table 6.20).

Since 1997 sand has covered 3 acres of Beachgrass-Panicgrass Dune Grassland, 0.2 acres each of Atlantic Coast Interdune Swale, Semi-impervious Surface, and Cultivated Lawn (Table 6.21).

Table 6.20. What was once Sand in 1997 has become X in 2007	
X	**Acreage**
Sand	4 acres
Cultivated Lawn	1 acre
Mid-Atlantic Coast Backdune Grassland	1 acre
Central Coast Beach Heather Dune Shrubland	1 acre
Water	1 acre
Other communities/land covers	3 acres

Table 6.21. Sand has migrated into X since 1997	
X	**Acreage**
Sand	4 acres
Beachgrass-Panicgrass Dune Grassland	3 acres
Atlantic Coast Interdune Swale	0.2 acres
Semi-impervious Surface	0.2 acres
Cultivated Lawn	0.2 acres
Other communities/land covers	0.4 acres

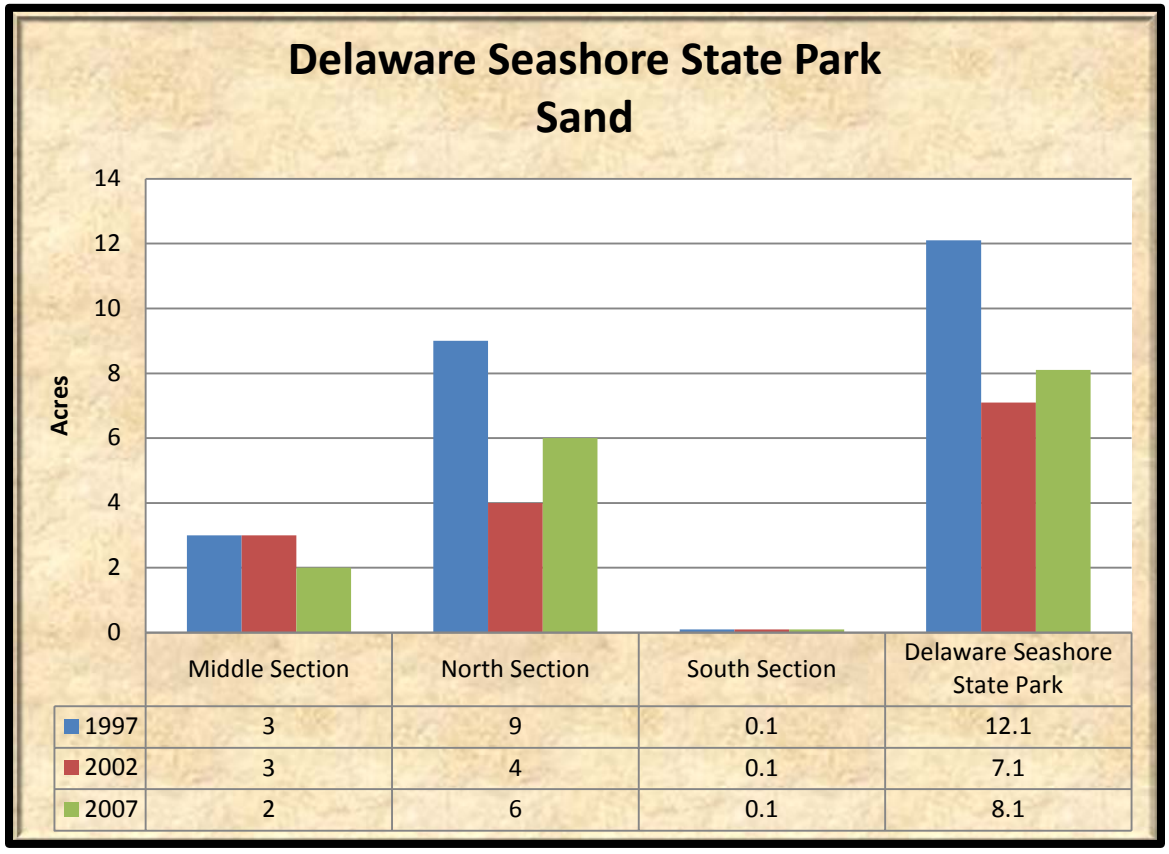


Figure 6.7. Sand at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.22)

About half of the current acres of this land cover will inundated with 1.5 m of sea level rise.

Table 6.22. Projected acres of Sand Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	3 acres
1.5 m	4 acres

Natural Capital

This land cover does not have any natural capital value.

Semi-impervious Surface **[23 acres, (Figure 6.8, Tables 6.23-6.25)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

This land cover most often includes compacted sand around beach access areas and trails.

Analysis of Condition at Delaware Seashore State Park

A number of the former semi-impervious surface areas in the park from 1997 have been paved over leaving only 11 acres of the original 18 acres. These former semi-impervious Surface areas have gone on to Impervious Surface (4 acres) and Cultivated Lawn (1 acre) (Table 6.23).

Since 1997, Semi-impervious Surface has gone into 6 acres of Northeastern Old Field, and 2 acres of Impervious Surface and 1 acre each of Chesapeake Bay Tall Maritime Shrubland and Cultivated Lawn (Table 6.24).

Table 6.23. What was once Semi-impervious Surface in 1997 has become X in 2007	
X	**Acreage**
Semi-impervious Surface	11 acres
Impervious Surface	4 acres
Cultivated Lawn	1 acre
Atlantic Coast Interdune Swale	0.3 acres
Northeastern Modified Successional Forest	0.2 acres
Other communities/land covers	1 acre

Table 6.24. Semi-impervious Surface has migrated into X since 1997	
X	**Acreage**
Semi-impervious Surface	11 acres
Northeastern Old Field	6 acres
Impervious Surface	2 acres
Chesapeake Bay Tall Maritime Shrubland	1 acre
Cultivated Lawn	1 acre
Other communities/land covers	2 acres

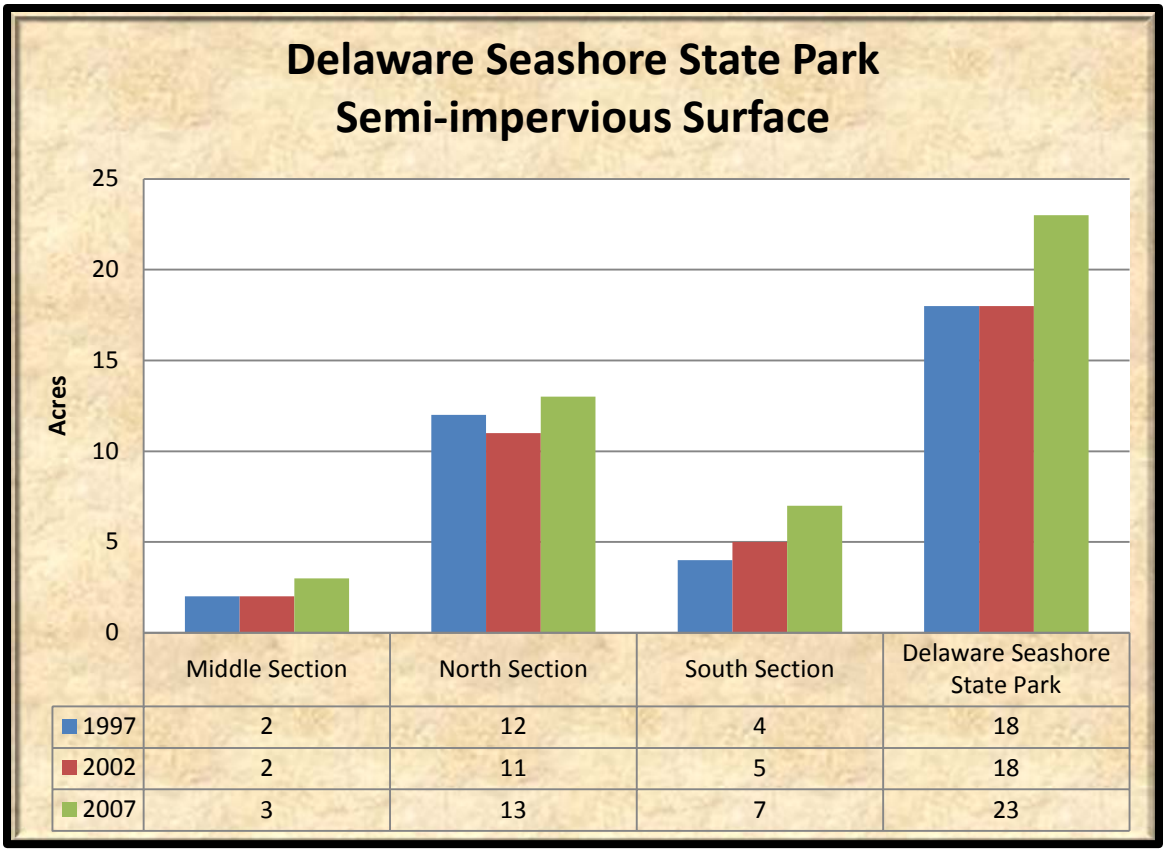


Figure 6.8. Semi-impervious Surface at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.25)

A little more than ¾ of this land cover will be inundated by 1.5 m of sea level rise.

Table 6.25. Projected acres of Semi-impervious Surface Impacted by Sea Level Rise

Rise	Acres
0.5 m	7 acres
1 m	14 acres
1.5 m	19 acres

Natural Capital

This land cover does not have any natural capital value.

Tidal Mudflat **[4 acres, (Figure 6.9, Tables 6.26-6.28)]**

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

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. These areas are often the intermediate stage between a marshland and open water.

Analysis of Condition at Delaware Seashore State Park

By 2007, only 0.5 acres of the original 3 acres in mudflat in 1997 were still present. The rest had gone to water (3 acres) (Table 6.26). Since 1997 1 acre of water, 1 acre of beach, and 1 acre of Reed Tidal Marsh has become tidal mudflat (Table 6.27). 0.4 acres of North Atlantic Low Salt Marsh has also become tidal mudflat.

Tidal mudflats may become more common as the rate of sea level rise increases. These increases in mudflats have already been seen in Assawoman Wildlife Area[42].

Table 6.26. What was once Tidal Mudflat in 1997 has become X in 2007	
X	**Acreage**
Water	3 acres
Tidal Mudflat	0.5 acres

Table 6.27. Tidal Mudflat has migrated into X since 1997	
X	**Acreage**
Water	1 acre
Beach	1 acre
Reed Tidal Marsh	1 acre
Tidal Mudflat	0.5 acres
North Atlantic Low Salt Marsh	0.4 acres
Other communities/land covers	0.3 acres

[42] Coxe, Robert. 2012. Vegetation Community and Land Use Change Analysis of Assawoman Wildlife Area in Sussex County, De. Unpublished Delaware Natural Heritage and Endangered Species Program report.

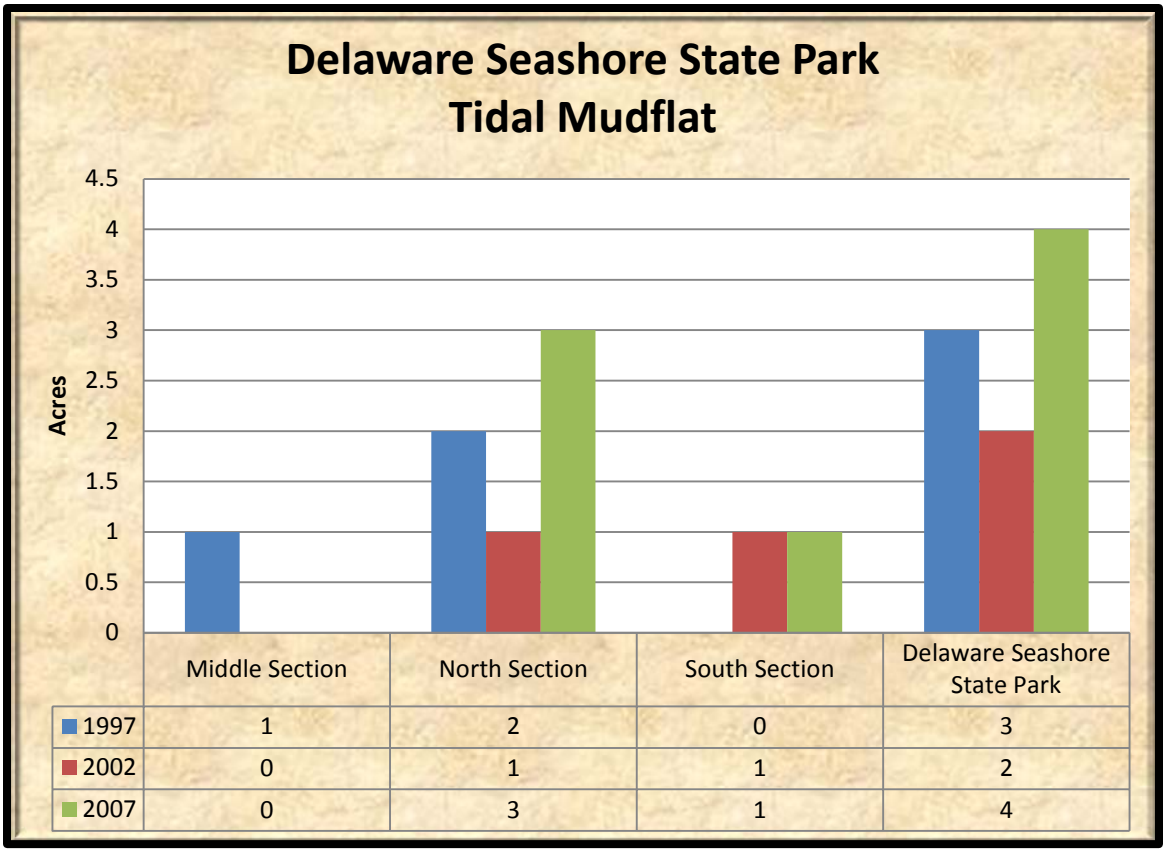


Figure 6.9. Tidal Mudflat at Delaware Seashore State Park (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.25)

All of this land cover will be inundated by 0.5 m of sea level rise.

Table 6.25. Projected acres of Semi-impervious Surface Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	4 acres
1 m	4 acres
1.5 m	4 acres

Natural Capital (Table 6.26)

Farm Pond/Artificial Pond natural capital has been going up with the development of additional ponds.

Table 6.26. Natural Capital of Tidal Mudflat	
Year	**Natural Capital (in 2012 dollars)**
1997	$18,814/year
2002	$12,543/year
2007	$25,085/year

***Water* [284 acres (Figures 6.10-6.11, Tables 6.27-6.30)]**

DEWAP: Nearshore Habitats
NHC: No Equivalent Classification

Description

This land cover includes water which not impounded as a pond or impoundment.

Analysis of Condition at Delaware Seashore State Park

As sea level rise increases the amount of water present in the park has been increasing also. In 2007, 162 acres of the original 175 acres from 1997 were still as water. The remaining acres became 7 acres of North Atlantic Low Salt Marsh, 2 acres each of Beachgrass-Panicgrass Dune Grassland and Irregularly Flooded Eastern Tidal Salt Shrub, and 1 acre of tidal mudflat (Table 6.27).

Since 1997 there has been a more than 100 acre net gain of water acreage. Communities and land covers inundated by water include 84 acres of beach, 23 acres of North Atlantic Low Salt Marsh, 3 acres of Beachgrass-Panicgrass Dune Grassland, and 3 acres of Tidal Mudflat (Table 6.28).

Table 6.27. What was once Water in 1997 has become X in 2007	
X	**Acreage**
Water	162 acres
North Atlantic Low Salt Marsh	7 acres
Beachgrass-Panicgrass Dune Grassland	2 acres
Irregularly Flooded Eastern Tidal Salt Shrub	2 acres
Tidal Mudflat	1 acre
Other communities/land covers	2 acres

Table 6.28. Water has migrated into X since 1997	
X	**Acreage**
Water	162 acres
Beach	84 acres
North Atlantic Low Salt Marsh	23 acres
Beachgrass-Panicgrass Dune Grassland	3 acres
Tidal Mudflat	3 acres
Other communities/land covers	6 acres

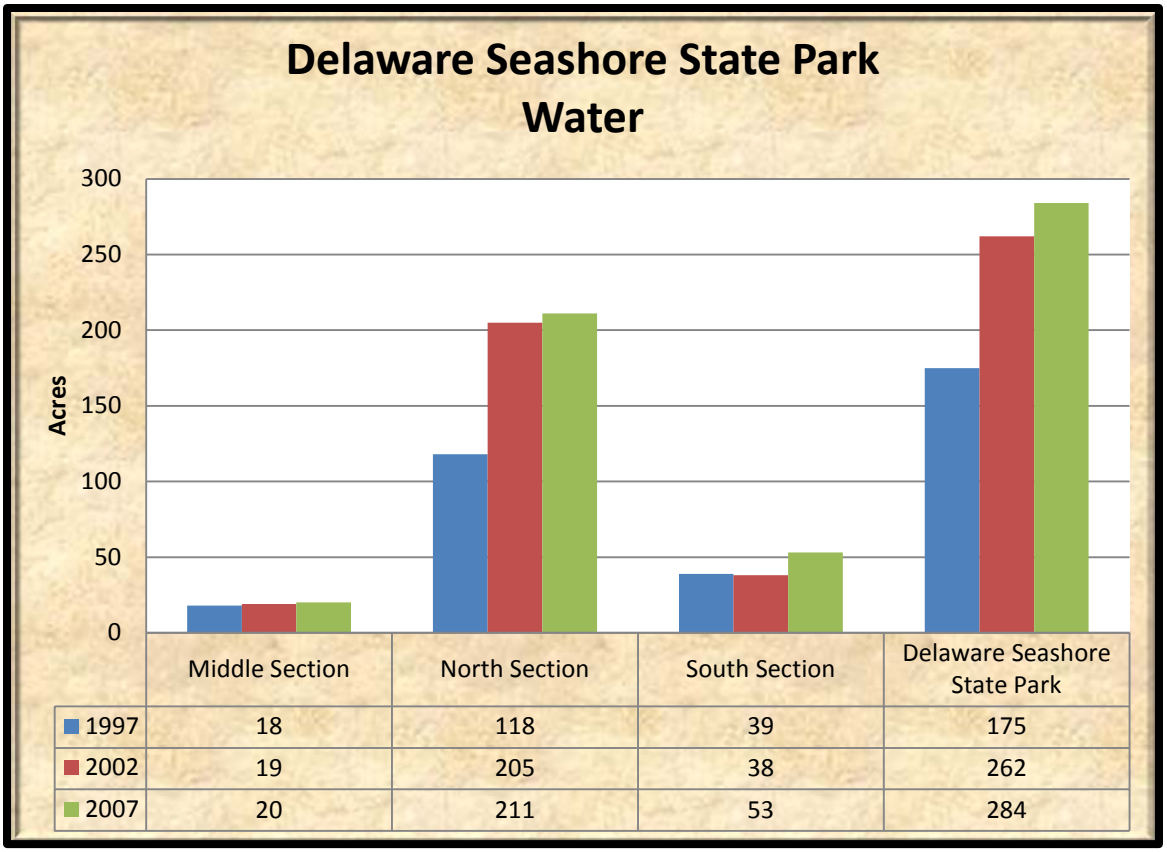


Figure 6.10. Water at Delaware Seashore State Park (1997, 2002, and 2007)

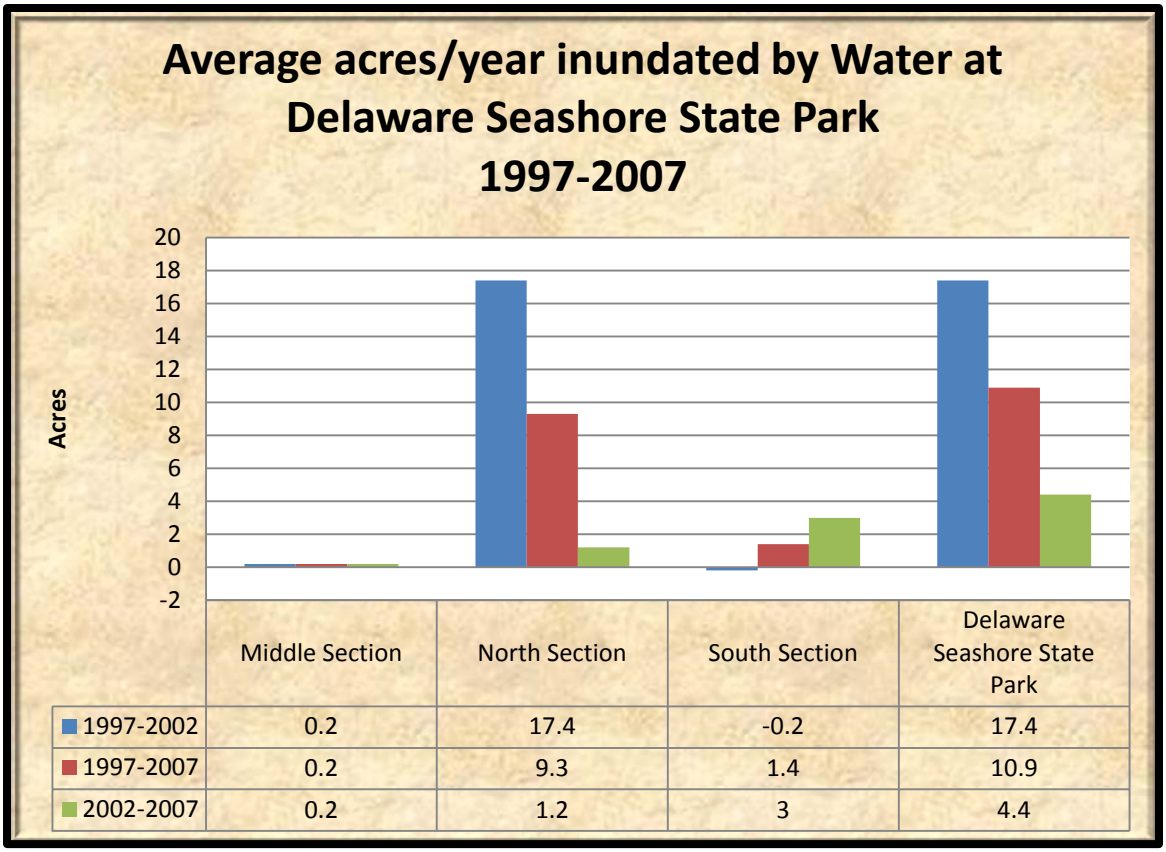


Figure 6.11. Average acres/year inundated by water at Delaware Seashore State Park

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 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	Baltimore 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 Impoundments			
Species	**Common Name**	**Class**	**Tier**
Podilymbus podiceps	Pied-billed grebe	Bird	1
Branta canadensis	Canada goose (migratory)	Bird	1
Anas rubripes	American black duck	Bird	1
Pandion haliaetus	Osprey	Bird	1
Actittis macularia	Spotted sandpiper	Bird	1
Cygnus columbianus	Tundra swan	Bird	2
Anas platyrhynchos	mallard	Bird	2
Anas clypeata	Northern shoveler	Bird	2
Aythya valisneria	canvasback	Bird	2
Aythya marila	Greater scaup	Bird	2
Aythya affinis	Lesser scaup	Bird	2
Bucephala albeola	bufflehead	Bird	2
Lophodytes cucullatttus	Hooded merganser	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

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
Rhynchops 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