Historical Analysis and Map of Vegetation Communities, Land Covers, and Habitats of Little Creek Wildlife Area Kent County, Delaware

Simons River and Little Creek Watersheds

Submitted to:

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CHAPTER 1: INTRODUCTION AND METHODS

Setting of Little Creek Wildlife Area

Little Creek Wildlife Area is located in eastern Kent County, Delaware (Figure 1.1). The wildlife area is divided into three sections for ease of description. These three sections include a North Section (359 acres), Middle Section (2,125 acres), and the South Section (2,166 acres), which in total comprise 4,649 acres. The North Section is located in the Simons River watershed, while the other sections are located in the Little Creek watershed.

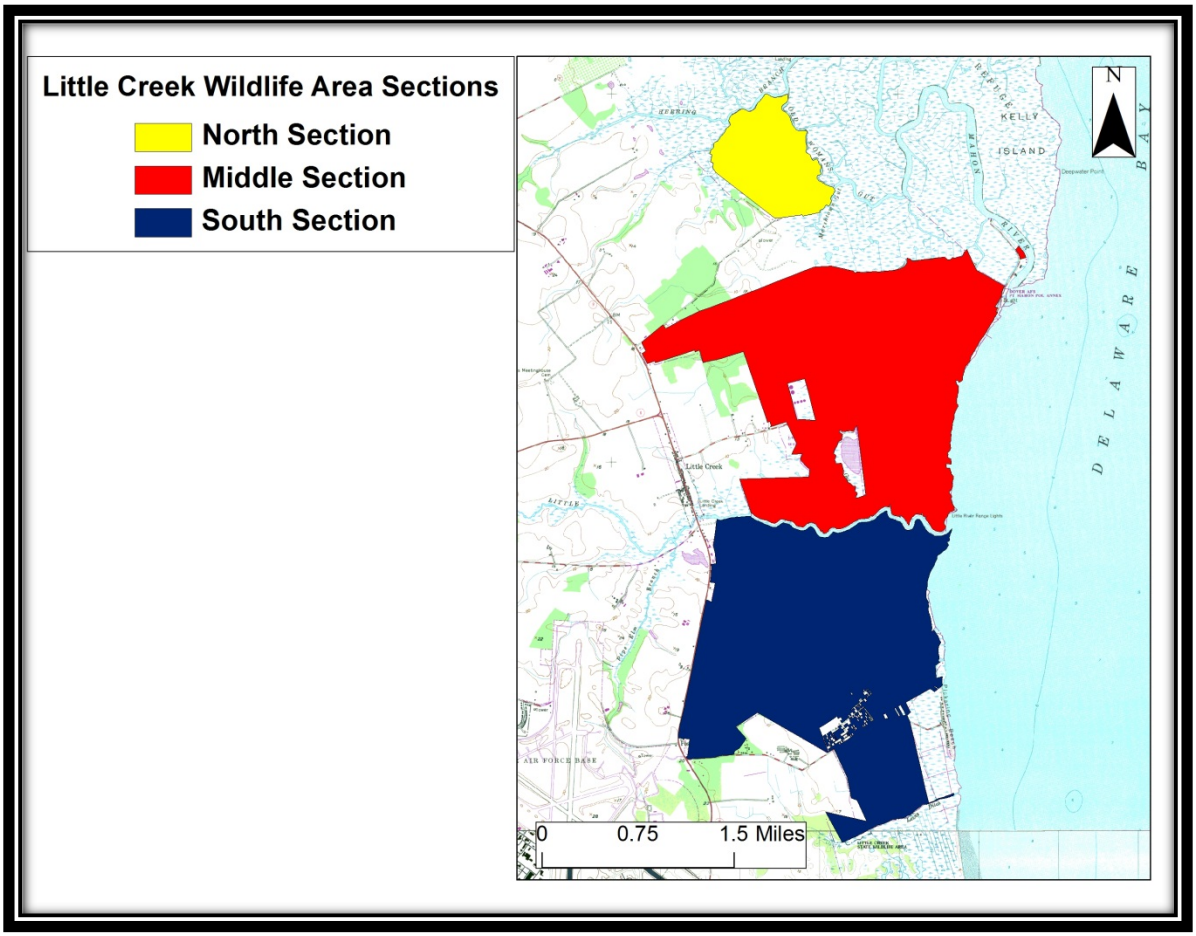

Figure 1.1. Sections at Little Creek Wildlife Area

History and Formation of Little Creek Wildlife Area

Early History of the Land[1]

The land that is now Little Creek Wildlife Area was used in the 1800's for a thriving oyster industry in the town of Little Creek. Many oyster shucking shacks were located on the road going to Port Mahon. Little Creek was also used as the commercial shipping hub for the City of Dover. This industry eventually faded by the start of the 20th century and later the land was acquired by the Delaware Division of Fish and Wildlife.

Formation of Little Creek Wildlife Area[2]

In 1957, a federal aid procurement grant was used to purchase the first tract in Little Creek Wildlife. Shortly after this time, an additional 1,200 acres was acquired. This land was acquired to provide continuous protection along the coast from Woodland Beach Wildlife Area through Bombay Wildlife National Wildlife Refuge to Milford Neck Wildlife Area. In 1961, the first impoundment was constructed followed by another in 1966.

Soils and Geology of Little Creek Wildlife Area

Underlying Geology[3]

Little Creek Wildlife Area is underlain by marsh deposits in the east and the Scotts Corners Formation in the west (those places that are not marsh). Marsh deposits are described as "structureless to finely laminated, black to dark gray, organic-rich silty clay to clayey silt with discontinuous beds of peat and rare shells." The Scotts Corners Formation is described as a "heterogeneous unit to light-gray to brown to light yellowish-brown, coarse to fine sand, gravelly sand and pebble gravel with rare discontinuous beds of organic-rich clayey silt, clayey silt, and pebble gravel."

Soils

Major soils in Little Creek Wildlife Area include Broadkill-Appoquinimink Complex (1,983 acres) and Transquaking and Mispillion Soils (633 acres) in the tidal marsh, and Carmichael Loam (524 acres) in the uplands. Minor soils include Pineyneck Loam (186 acres), Othello Silt Loam (138 acres), Corsica Mucky Loam (89 acres), Hurlock Sandy Loam (68 acres), Tent Silt Loam (67 acres), and Kentuck Mucky Silt Loam (63 acres).

[1] Thank You Delaware Bay.org. ??? Spotlight on Little Creek, Delaware!!!
[2] Florio, A.J. 1969. Little Creek Wildlife Area Management Plan. Delaware Division of Fish and Wildlife, unpublished report.
[3] Ramsey, Kelvin W. 2007. Geologic Map of Kent County, Delaware. Delaware Geologic Survey, Geologic Map Series No. 14.

Middle Section Soils

Broadkill-Appoquinimink Complex (1,449 acres) is the most prominent soil in the Middle Section. Other minor soils include Carmichael Loam (297 acres) and Pineyneck Loam (98 acres).

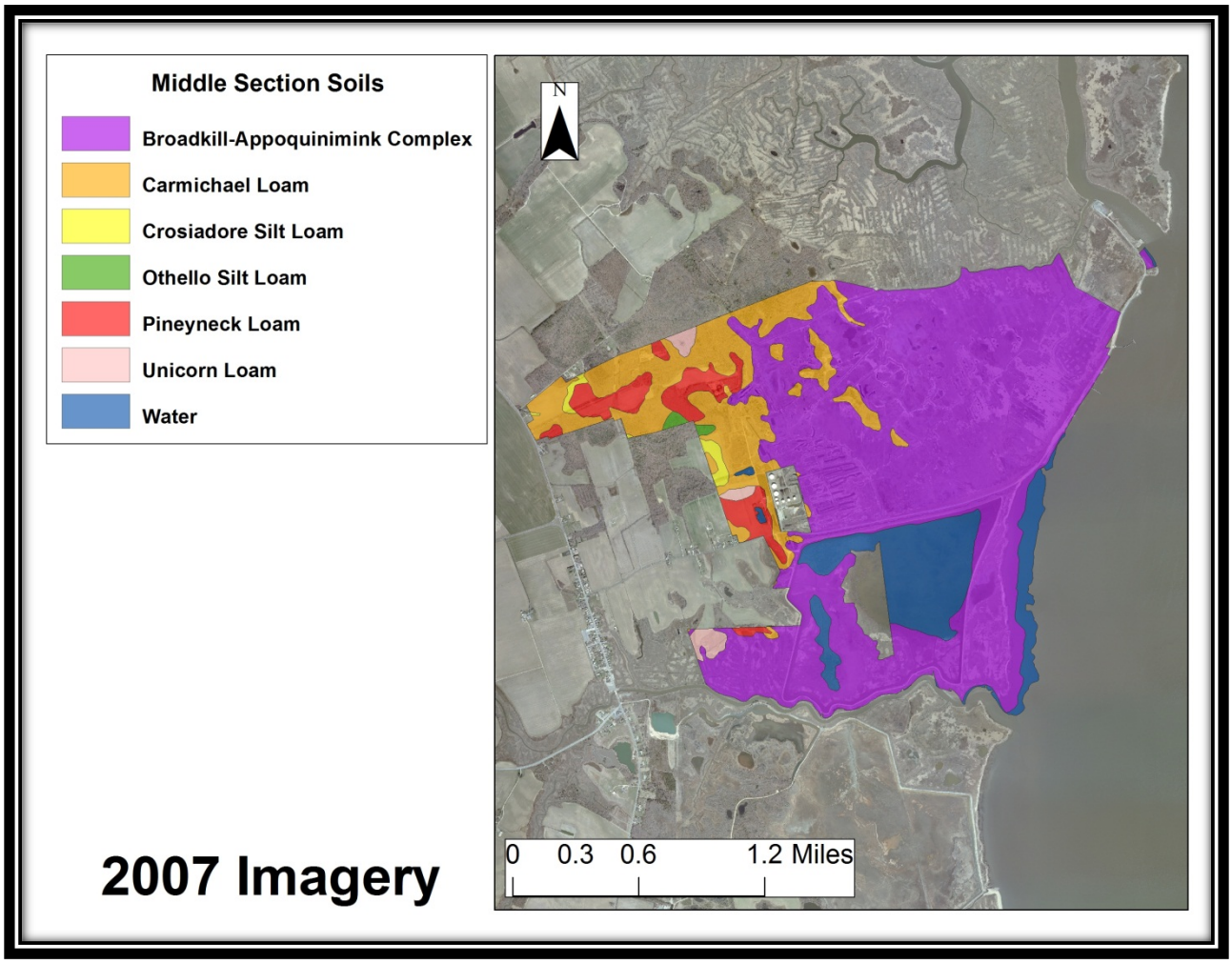

Figure 1.2. Middle Section Soil Map

North Section Soils

Broadkill-Appoquinimink Complex (324 acres) is the most prominent soil in the North Section followed by Othello Silt Loam (28 acres).

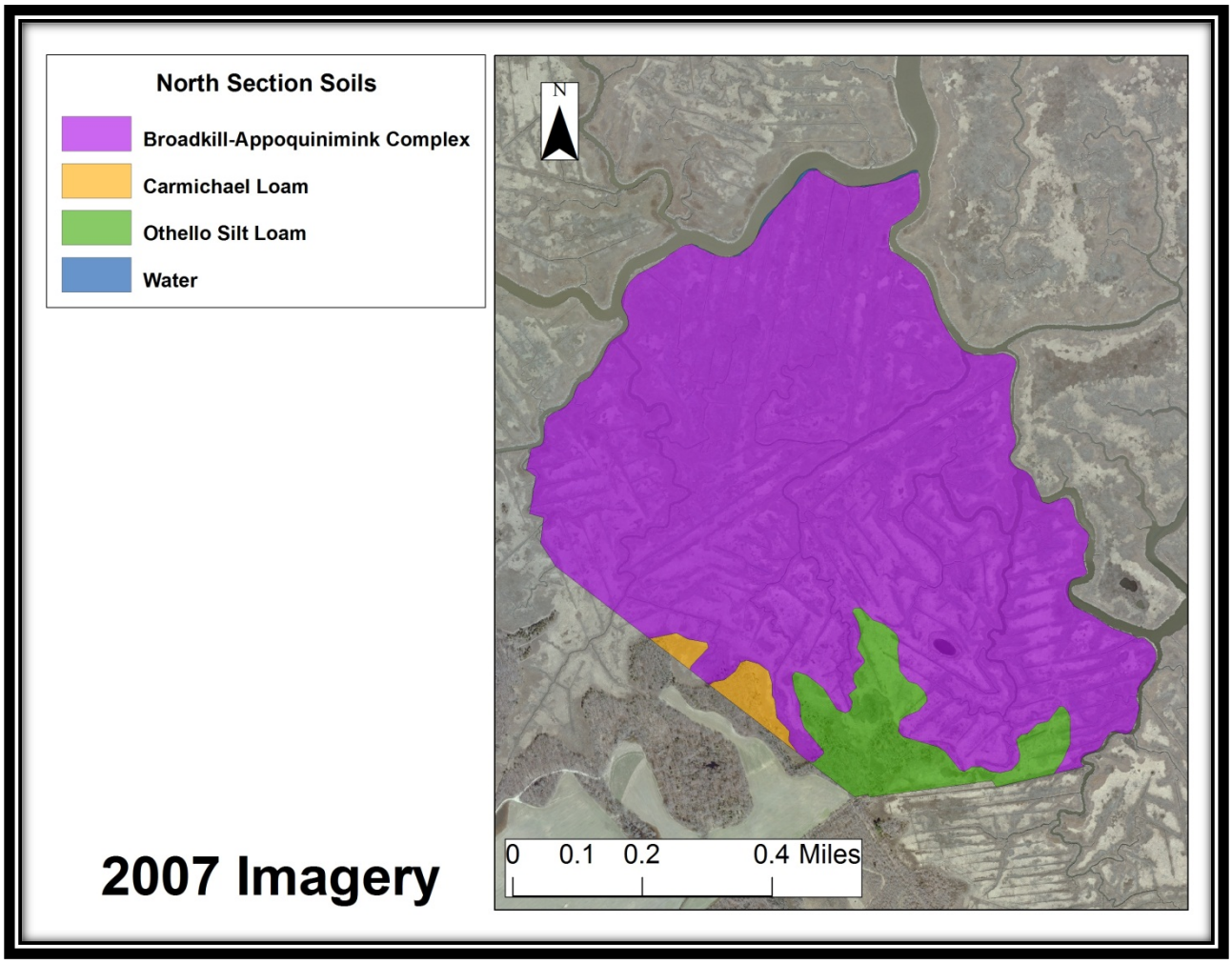

Figure 1.3. North Section Soil Map

South Section Soils

Transquaking and Mispillion Soils (633 acres) are prominent in the South Section. Other minor soils include Carmichael Loam (221 acres), Broadkill-Appoquinimink Complex (209 acres), and Othello Silt Loam (103 acres).

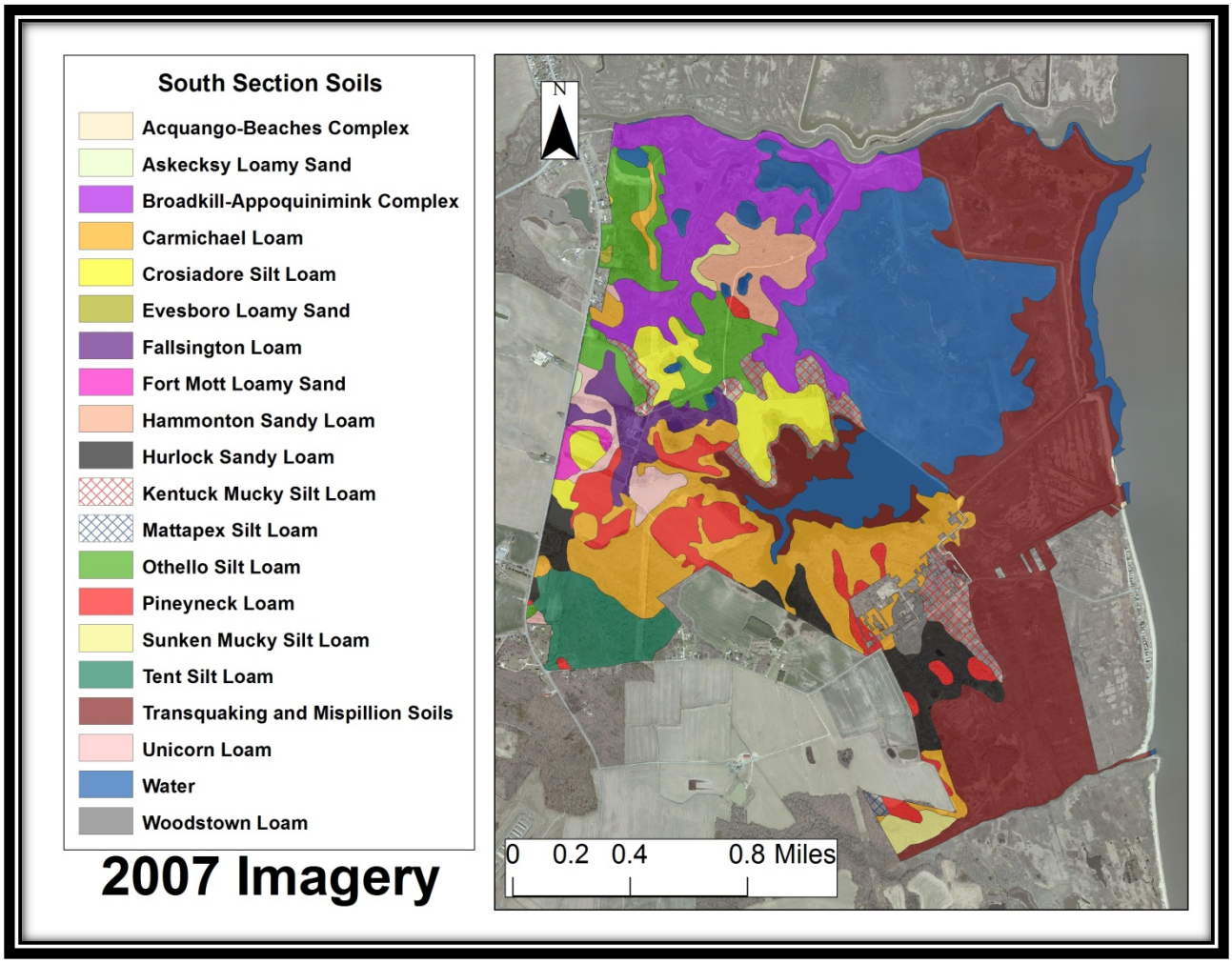

Figure 1.4. South Section Soil Map

Elevation

Elevations in the wildlife area range from sea level at Delaware Bay to 20 feet at Postles Corner in the southwest.

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 Little Creek Wildlife Area

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 was about 3 cm/decade (30 cm/100 years). From 3,000 years to the present time it has been rising 1 cm/decade (10 cm/100 years)[4]. Data from the Reedy Point tidal station (1985-2009) shows the average rate of rise to be 5.4 cm/year and at Lewes (1919-2009), 3.24 mm/year.[5] 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 rise to 3.28 mm/year or 3.3 cm/decade.[6] This is above the fast rate 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.[7] Sea-level rise can also cause water tables to rise, water logging swamps away from the coast, a fact that has been stated in

[4] 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).
[5] Data from Permanent Service for Mean Sea Level website (www.psmsl.org)
[6] NASA Global Climate Change Website (http://climate.nasa.gov/keyindicators) December 12, 2010 update.
[7] Custer, Jay F. 1989. Prehistoric cultures of the Delmarva Peninsula: archaeological study. (Cranbury, NJ: Associated University Presses, Inc.), 447 pp.

elsewhere in the Mid-Atlantic.[8],[9],[10] The rising rate of rise may factor into the difference between the Indian River Inlet and Lewes tidal stations. The Lewes station has been operating longer and has a more complete data set than the Indian River Inlet Station.

Other sources have stated the rise on the Mid-Atlantic Coast to be 3-4 mm/year, while the global average is 1.8 mm/year[11], the difference of which is caused by geological subsidence from the glaciers of the last ice age. The rate of sea-level rise is now 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[12], but the current rate of sea level rise is above the accretion rate resulting in losses. The rate is projected to go much higher with rates of 10 cm/decade (1 m/100 years) as a median.[13] Kraft and Khalequzzaman project that most of the fringing salt marshes in Delaware will be eliminated in 200-300 years and be extinct in 1,500 to 1,700 years.[14] Other investigators have pointed out that there is a lack of temporal scale to a lot of the studies and that there may a significant time lag between sea level rise and anthropogenic inputs of carbon dioxide.[15] 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[16]. Added to this is newer research that shows groundwater depletion

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[8] 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).

[9] Whitehead, D.R. 1972. Developmental and environmental history of the Dismal Swamp. Ecological Monographs 42: 301-15 in Custer (1989).

[10] 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).

[11] Johnson, Zoe Pfahl. 2000. A Sea Level Rise Response Strategy for the State of Maryland. Maryland Department of Natural Resources.

[12] 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.

[13] 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.

[14] 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.

[15] Larson, C.E. and I. Clark. 2006. A search for scale in the sea-level studies. Journal of Coastal Research 22 (4): 788-800.

[16] 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.

is adding 0.8 mm/year to sea level rise[17]. From this you have to subtract the amount of water that has been impounded on land. Chao, et al. states that about 10,800 cubic kilometers has been impounded in the last half century which subtracts about 0.55 mm/year from the rise[18]. When added together, eustatic factors account for 1.45 mm/year of the rise.

Stearic Rise

This factor comes from thermal expansion of ocean water and salinity currents. This factor contributes about 0.9 mm/year of the observed rise[19]. 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[20], 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[21]. 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[22].

Isostatic Rise

Geological land subsidence adds the most to the rise currently accounting for about 1.6 mm/year[23] in the Mid-Atlantic region. Another study has given an amount ranging from 1.02 to 1.53 mm/year[24]. 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%[25].

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)

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[17] 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

[18] 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.

[19] Ditto

[20] 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.

[21] 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.

[22] 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.

[23] 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.

[24] 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.

[25] 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.

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[26]. Victor compared aerial imagery from 1954 and 1968 on a qualitative basis and looked at changes in the marshes and other man-made features. He incorporated some multispectral analysis to determine some of the vegetation types. Though he did not refer to specific vegetation communities as we know them now, he did look at vegetation assemblages (Low marsh, high marsh, and salt shrub) that are very similar to the groupings now. No figures were given in his paper regarding the overall changes. He did note, however, that the shoreline at Cape Henlopen had receded 4 to 21 feet per year from 1843 to 1939[27]. Other papers have also used historical aerial imagery to map vegetation change[28],[29] and salinity factors can impact on those changes[30].

More recent studies looking at both changes in tidal marshes[31] and coastal forests[32] 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[33]. 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[34]. 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[35] in areas where the coast was submerging. The freshwater marshes help produce the environmental conditions later needed by the more saline marshes.

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[26] 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.

[27] 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.

[28] 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.

[29] 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.

[30] 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.

[31] 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.

[32] Williams, Kimberlyn, et al. 1999. Sea-level rise and coastal forest retreat on the west coast of Florida, USA Ecology

[33] 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.

[34] Shirley, Laura and Lorretta L. Battaglia. 2006. Assessing vegetation change in coastal landscapes of the northern Gulf of Mexico. Wetlands 26(4): 1057-1070.

[35] 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 asses habitat conditions for Species of Greatest Conservation Need (SGCN)[as defined in the Delaware Wildlife Action Plan (DEWAP)] for Little Creek Wildlife Area 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 wildlife area.
3. Determine the forest blocks located within or partially within the wildlife area.
4. Produce Ecological Integrity Assessments (EIAs) for vegetation communities that ranked S2 or higher.

Surveys were conducted during 2010, 2011, and 2012 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* [36]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 Northeast Habitat Classification (NHC) is provided at the top of each individual description.

Analysis of Historical Imagery

Historical imagery of Little Creek Wildlife Area 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 change over a 5 and 10 year time frame. Changes in the respective vegetation communities and land covers are discussed in the descriptions while broader changes are discussed in the wildlife area discussion. There is more imagery available but these sets (1937, 1954, 1961, 1968, 1992) were not used due to registration problems in the image tiles.

Ecological Integrity Assessment (EIA)

An EIA was conducted for those communities in the wildlife area 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 Little Creek Wildlife included in the EIA analysis are listed in Table 2.3 and depicted in Figures 2.1-2.2.

Forest Block Analysis

Current forest blocks within or partially within the wildlife area 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 and Figure 2.3). 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.[37] 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, powerline right-of-ways, and developed areas) that were considered to be immovable. Most of the area that could be reverted to forest is

[36] Coxe, Robert. 2010. Guide to Delaware Vegetation Communities-Summer 2010 Edition. Unpublished report.
[37] Maryland Department of Natural Resources. 2003. Strategic Forest Lands Assessment. Co-op Project between Maryland Department of Natural Resources, Watershed Services, and Maryland Forest Service. 40 p.

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

Sea Level Rise Analysis

An analysis was performed for the wildlife area as whole, sections, and vegetation communities/land covers using the DNREC Sea Level Rise Scenarios. Estimates of acreage lost under the various scenarios is provided for each.

Natural Capital Analysis

The natural capital of each vegetation community was determined using a table in Costanza, et al.[38] 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.

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

CHAPTER 2: RESULTS OF EIAS, FOREST BLOCKS, AND GENERAL OBSERVATIONS

Summary of Findings from this study

1. **Vegetation Communities:** Twenty-nine vegetation communities and twelve land covers are currently found at Little Creek Wildlife Area. North Atlantic Low Salt Marsh (1,695 acres) and Reed Tidal Marsh (563 acres) are the prominent vegetation communities in the wildlife area. Impoundment (420 acres) and Agricultural Field (269 acres) are prominent land covers.

2. **Rare Plants:** One rare plant is known to exist in Little Creek Wildlife Area and it is unknown whether the wildlife area has been extensively surveyed for rare plants.

Scientific Name	Common Name	Rank	Last Observed
Listera australis	Southern Twayblade	S3	?

Table 2.1. Rare plants located at Little Creek Wildlife Area

3. **Rare Animals:** Three rare animals are known to occur in Little Creek Wildlife Area

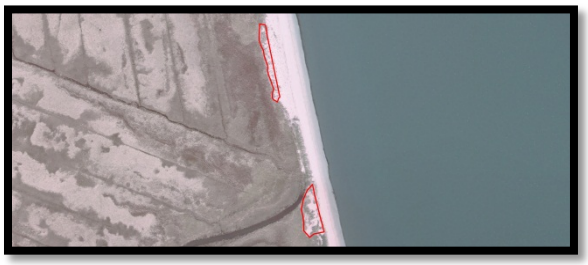
Scientific Name	Common Name	Rank	Last Observed
Botaurus lentiginosus	American Bittern	S1B	1994
Callophrys irus	Frosted Elfin	S1	1971
Fulica americana	American Coot	S1B	1964
Himantopus mexicanus	Black-necked Stilt	S2B	1996
Sterna antillarum	Least Tern	S1B	1991
Sterna hirundo	Common Tern	S1B	1991

Table 2.2. Rare animals located at Little Creek Wildlife Area

Ecological Integrity Assessment (EIA)

Three vegetation communities, Brackish Tidal Creek Shrubland, Overwash Dune Grassland, and Wax-Myrtle Shrub Swamp , are ranked S2 or higher.

Table 2.3. EIA Vegetation Communities located in Little Creek Wildlife Area

Community Map	Community Name/EIA Score	Description
	**Little Creek 1a** **Brackish Tidal Creek Shrubland (0.3 acres)** **EIA = 3.4 (C rank)**	This shrubland is located just north of Little Creek in the middle section.
	**Little Creek 1b** **Brackish Tidal Creek Shrubland (0.5 acres)** **EIA = 3.4 (C rank)**	This shrubland is located at the south end of the south section.
	**Little Creek 2** **Overwash Dune Grassland (0.4 acres)** **EIA = 3.53 (B rank)**	This grassland is located on the beach of Delaware Bay in the south section.
	**Little Creek 3a** **Wax-Myrtle Shrub Swamp (4.0 acres)** **EIA= 3.91 (B rank)**	This shrubland is located at the west end of the middle section.

Community Map	Community Name/EIA Score	Description
	**Little Creek 3b** **Wax-Myrtle Shrub Swamp (0.9 acres)** **EIA= 3.4 (C rank)**	This shrubland is located at the west end of the middle section.

Middle Section EIAs

The Middle Creek Section contains one occurrence of Brackish Tidal Creek Shrubland and two occurrences of Wax-Myrtle Shrub Swamp.

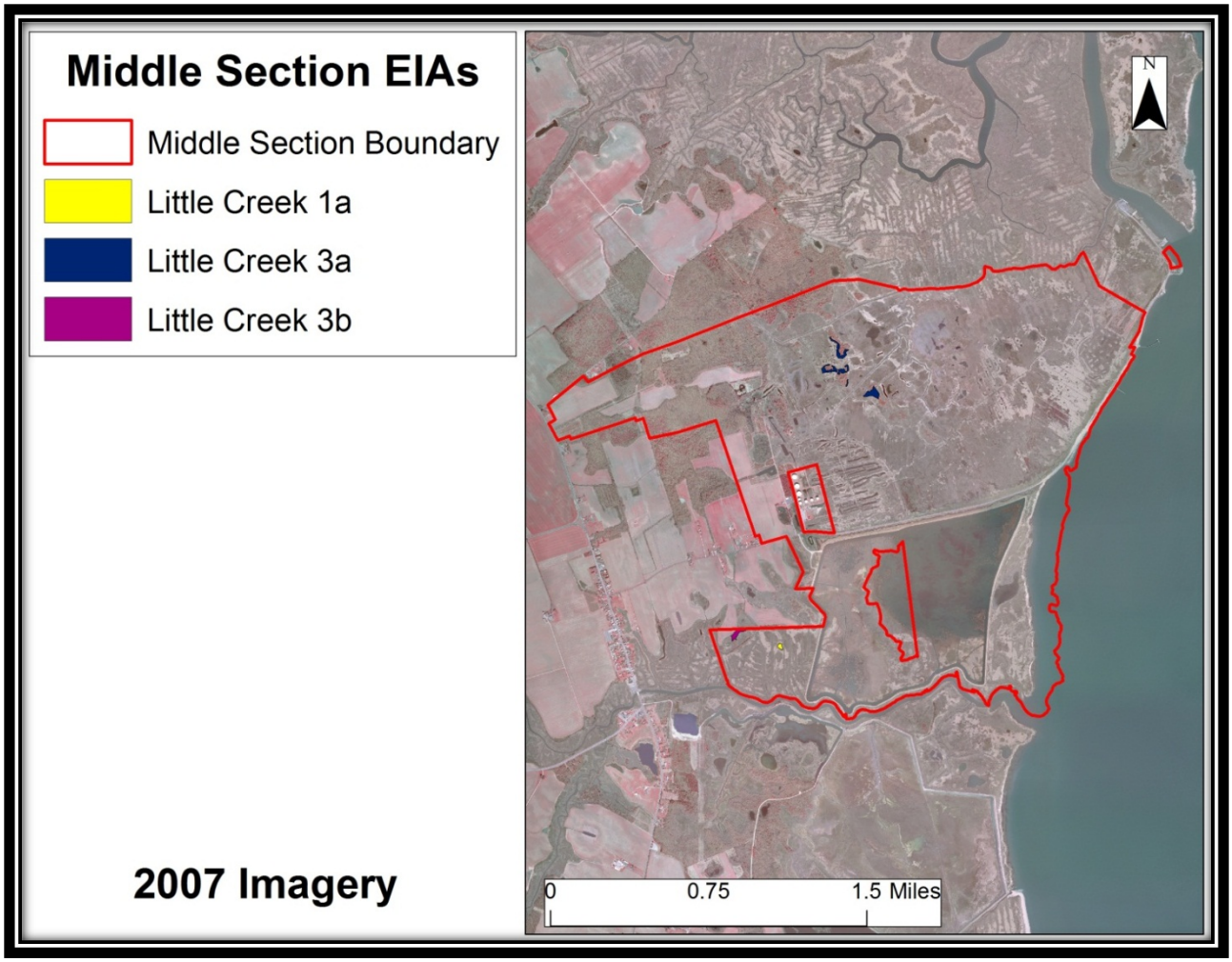


Figure 2.1. Middle Section EIA Communities

South Section EIAs

The South Section has one occurrence each of Brackish Tidal Creek Shrubland and Overwash Dune Grassland.

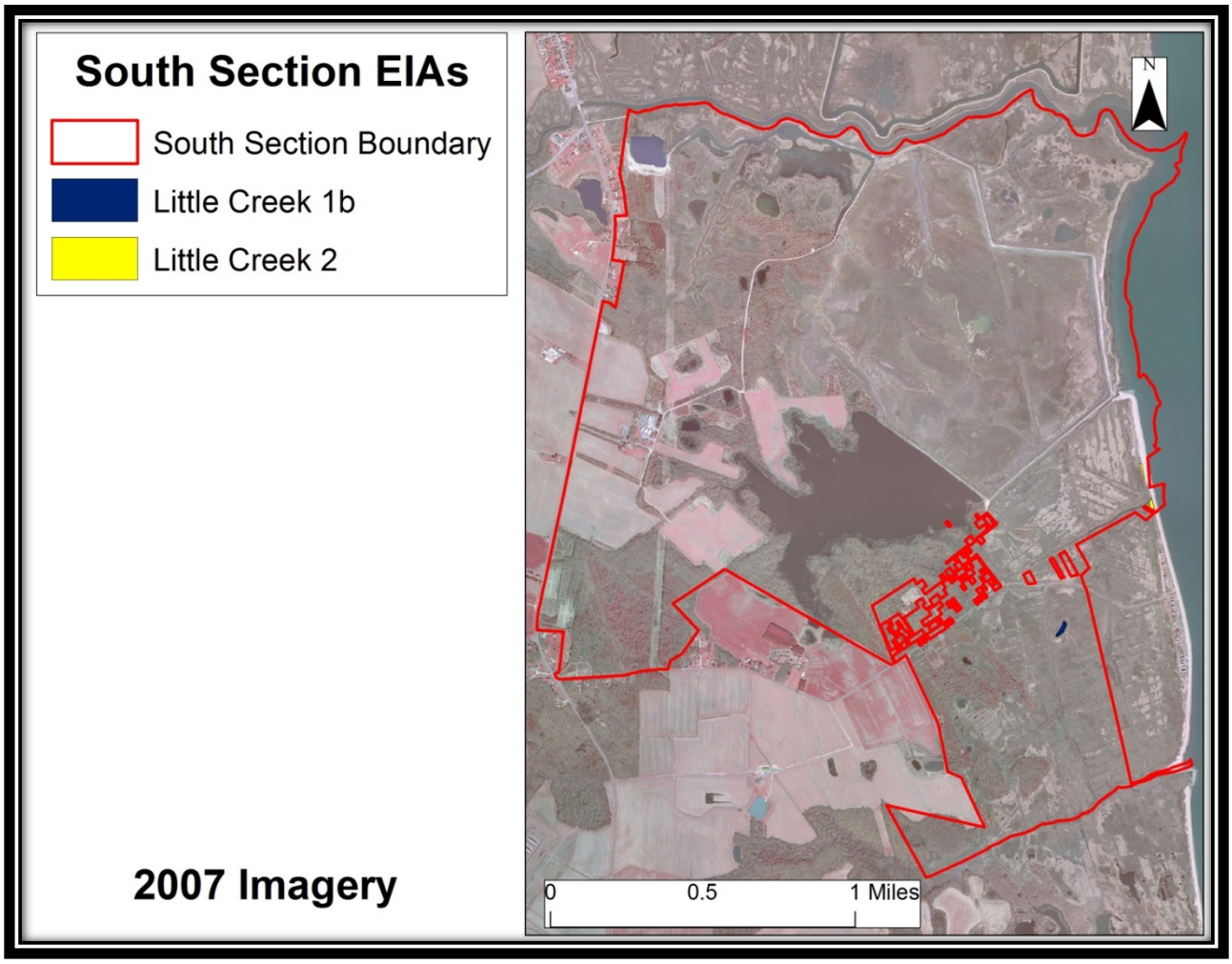


Figure 2.2. South Section EIA Communities

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[39]. 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 wildlife areas has traditionally favored wildlife management, which requires open fields for foraging habitat as compared to the interior 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 Little Creek Wildlife Area

Two forest blocks are present that are more than 100 acres in size and are located in whole or part in the state park (Table 2.4 and Figure 2.3). 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.

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

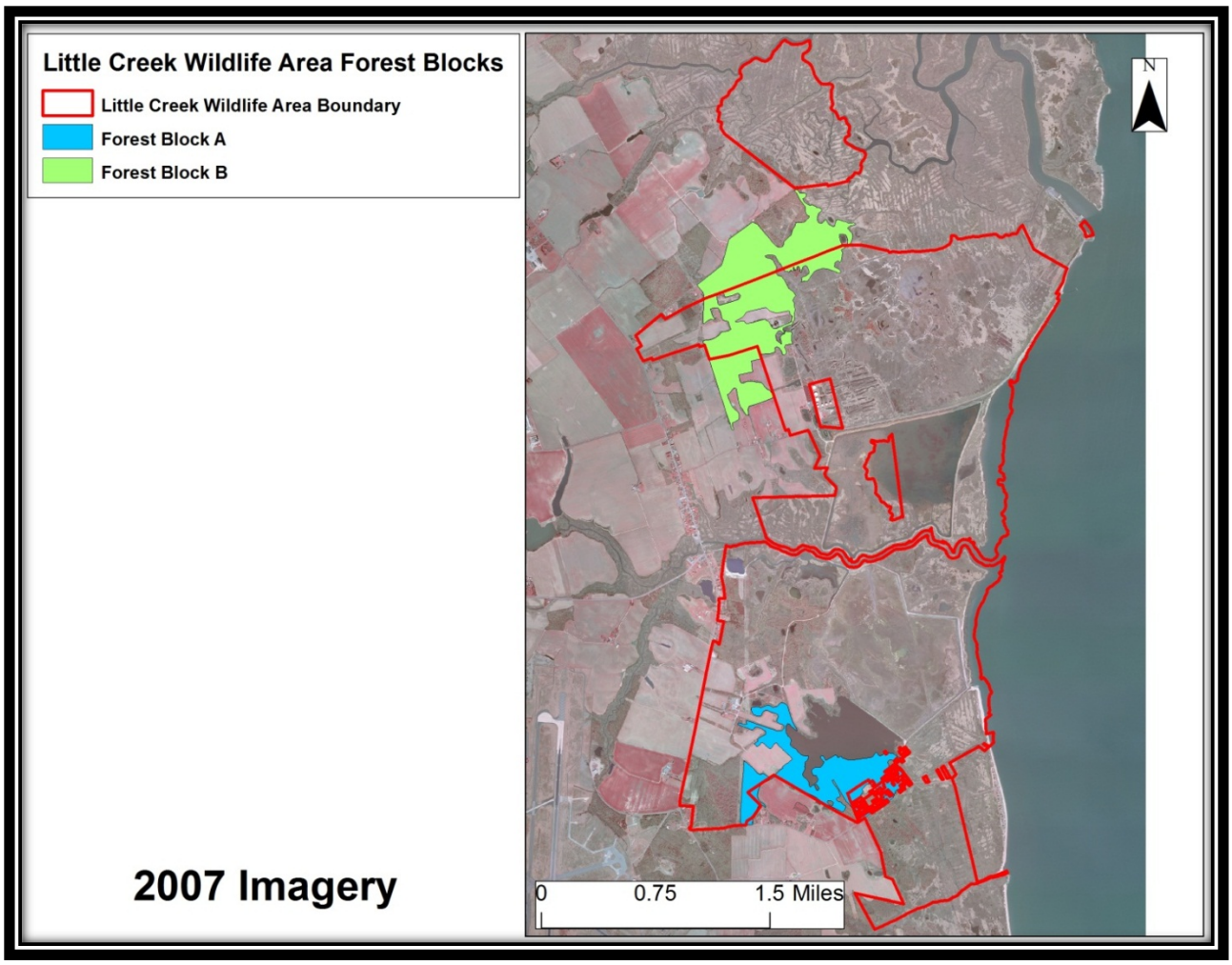
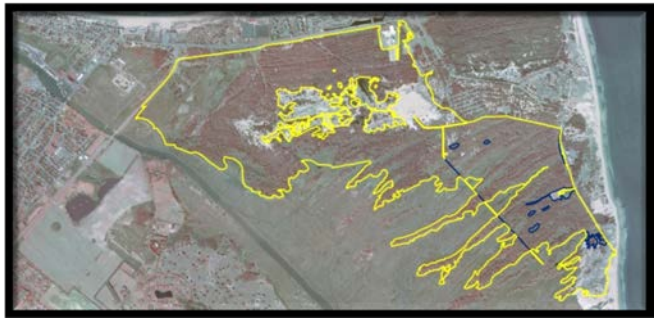


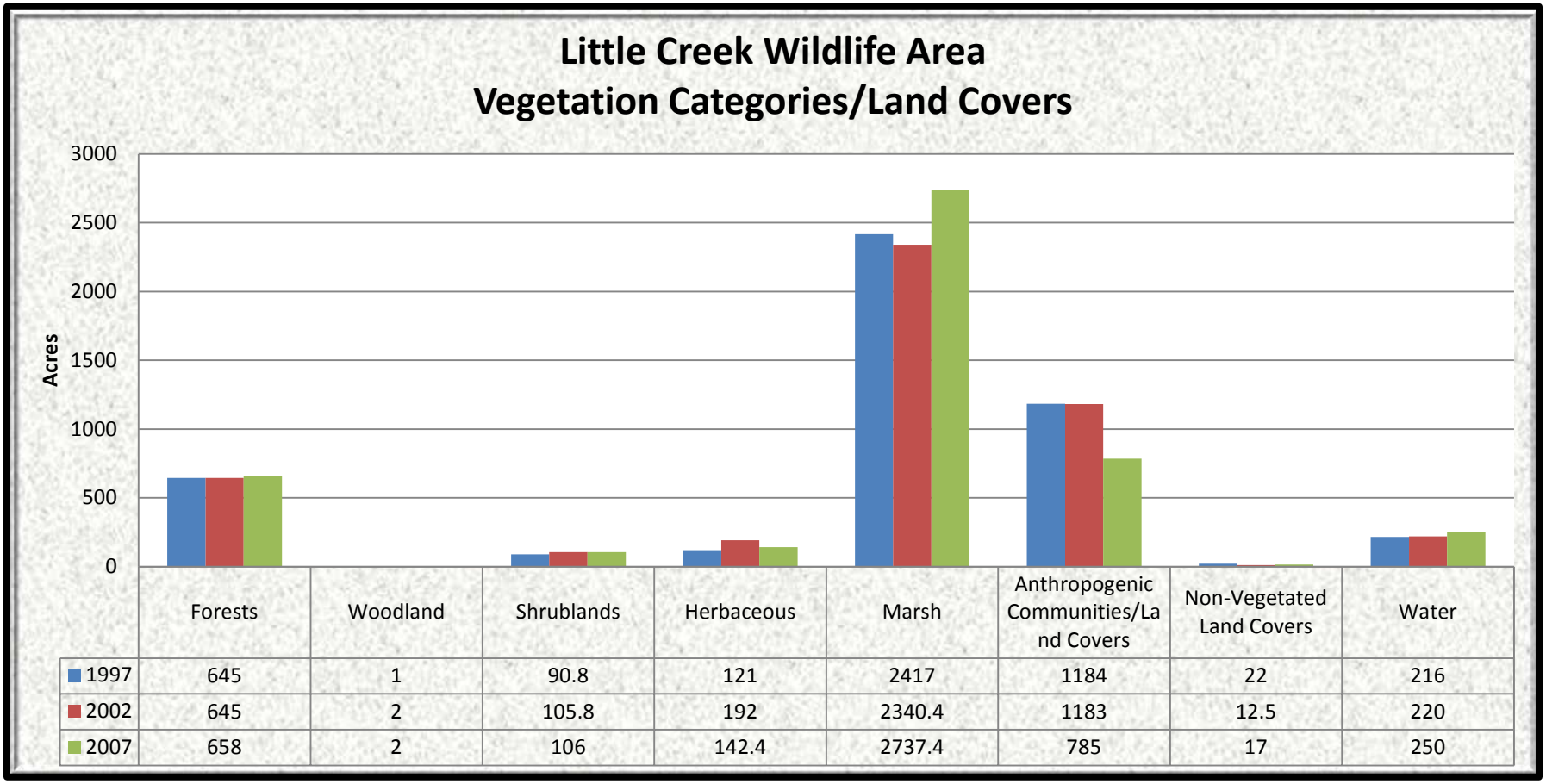
Figure 2.3. Little Creek Wildlife Area Forest Blocks

Table 2.4. Forest Blocks located in whole or part in Little Creek Wildlife Area

Forest Block Map	Block Name/Acreage	Description
	**Little Creek A** **Current Block = 181 acres (17 acres interior)** **Potential Block = 636 acres (333 acres interior)**	Little Creek A is located at the southwest end of the south section. It is bounded by DE 9 (Bayside Drive) on the west, a dirt access road on the north, impoundment and marsh on the east, and County Road 349 on the south. Five vegetation communities are located within this block and include Chesapeake Bay Non-riverine Wet Hardwood Forest, Coastal Plain Oak Floodplain Swamp, Mid-Atlantic Mesic Mixed Hardwood Forest, Northeastern Modified Successional Forest, and Successional Sweetgum Forest. Little Creek and Simons River are the drainages for this block. Currently this block contains 17 acres of interior habitat. Potentially this block could be 636 acres in size and contain 333 acres of interior habitat.
	**Little Creek B** **Current Block = 362 acres (114 acres interior)** **Potential Block = 1,710 acres (1,113 acres interior)**	Little Creek B is located in the western part of the Middle Section. It is bounded on the north by County Road 89, on the east by marsh, on the south by Port Mahon Road, and on the west by DE 9 (Bayside Drive). Four vegetation communities are located within this block and include Chesapeake Bay Non-riverine Wet Hardwood Forest, Northeastern Modified Successional Forest, Successional Maritime Forest, and Virginia Pine Successional Forest. Little Creek is the drainage for this block. Currently this block contains 114 acres of interior habitat. Potentially this block could be 1,710 acres in size and contain 1,113 acres of interior habitat.

The Natural Progression of vegetation communities on the shores of Delaware Bay

Vegetation communities located adjacent to the shore of Delaware Bay 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.



	Forests	Woodland	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1997	645	1	90.8	121	2417	1184	22	216
2002	645	2	105.8	192	2340.4	1183	12.5	220
2007	658	2	106	142.4	2737.4	785	17	250

Figure 3.1. Vegetation Community/Land Cover Categories at Little Creek Wildlife Area (1997, 2002, and 2007)

Little Creek Wildlife Area Vegetation Communities/Land Covers (Figure 3.1): Marsh, followed by anthropogenic communities, is the most prominent vegetation communities and land covers throughout the entire wildlife area. Herbaceous communities have increased along with forest as agricultural fields are taken out of service.

DNREC Sea Level Rise Analysis (Table 3.1)

More than ¾ of Little Creek Wildlife Area will be inundated with just 0.5 m of sea level rise. An additional 0.5 m of rise will flood another 335 acres and 1.5 m of rise will flood 4,122 acres or about 89% of the wildlife area. Little Creek Wildlife Area is one of the most exposed wildlife areas to sea level rise.

Table 3.1. Projected acres of Little Creek Wildlife Area Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	4,122 acres
1 m	3,952 acres
1.5 m	3,617 acres

Natural Capital (Table 3.2)

Overall the natural capital for Little Creek Wildlife Area has increased with dip in capital when some marshland was lost in an impoundment.

Table 3.2. Natural Capital of Little Creek Wildlife Area	
Year	**Natural Capital (in 2012 dollars)**
1997	$29,092,401/year
2002	$28,921,749/year
2007	$29,491,329/year

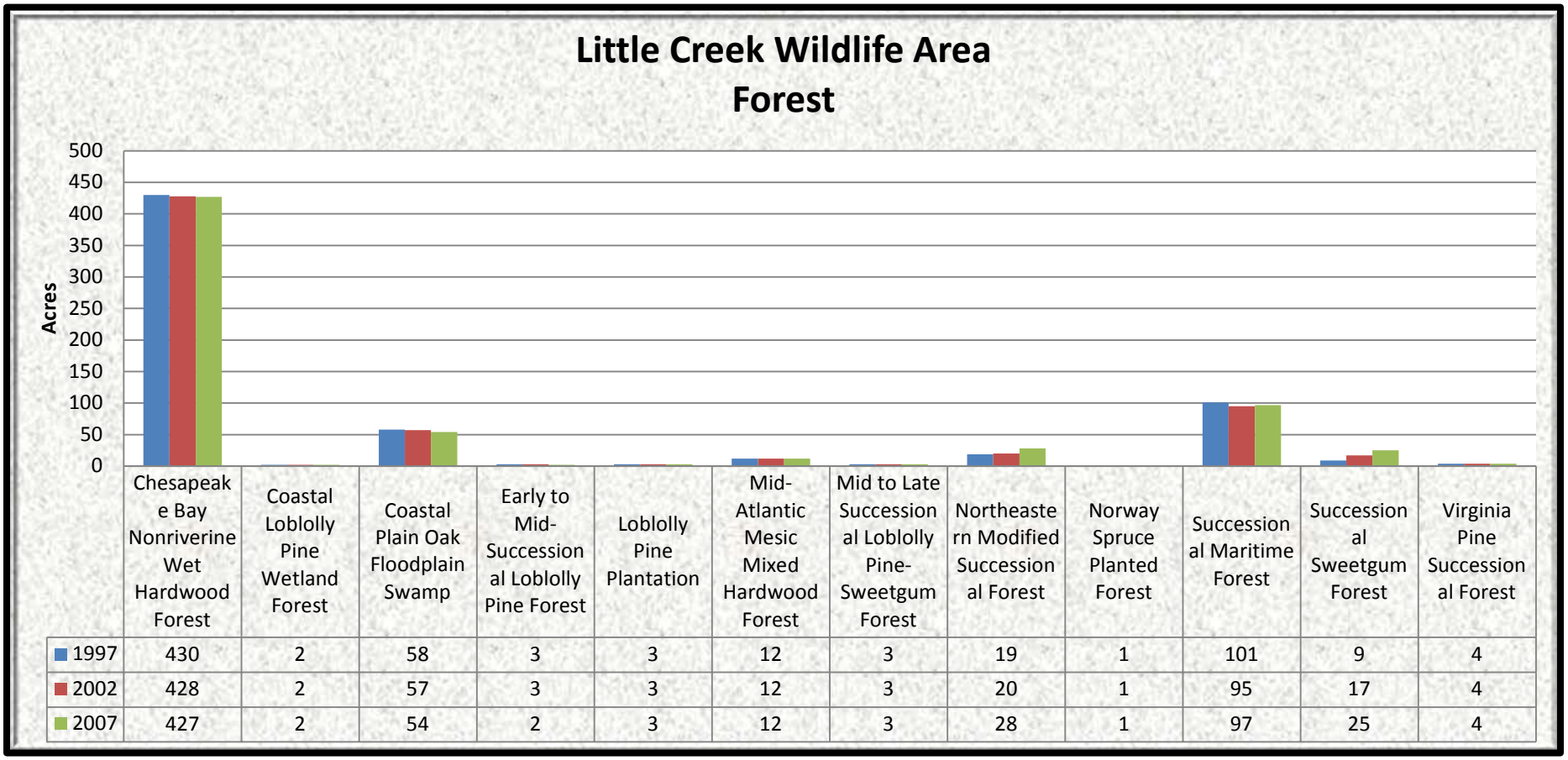


Figure 3.2. Little Creek Wildlife Area Forest (1997, 2002, and 2007)

Little Creek Wildlife Area Forest (Figure 3.2): Little Creek Wildlife Area probably has the most diverse assemblage of forests of any wildlife area. Chesapeake Bay Non-riverine Wet Hardwood Forest is the most common, follow distantly by Successional Maritime Forest. Most forested areas have lost a small amount of acreage with a few gaining a few acres.

DNREC Sea Level Rise Analysis (Table 3.3)

About 2/3 of the forestland in Little Creek Wildlife Area will be flooded with 1.5 m of sea level rise.

Table 3.3. Projected acres of Little Creek Wildlife Area Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	168 acres
1 m	329 acres
1.5 m	414 acres

Natural Capital (Table 3.4)

Capital of forests has been declined as forest is lost on the edges of the impoundments and the coastal areas.

Table 3.4. Natural Capital of Little Creek Wildlife Area Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$6,076,729/year
2002	$6,015,838/year
2007	$5,969,698/year

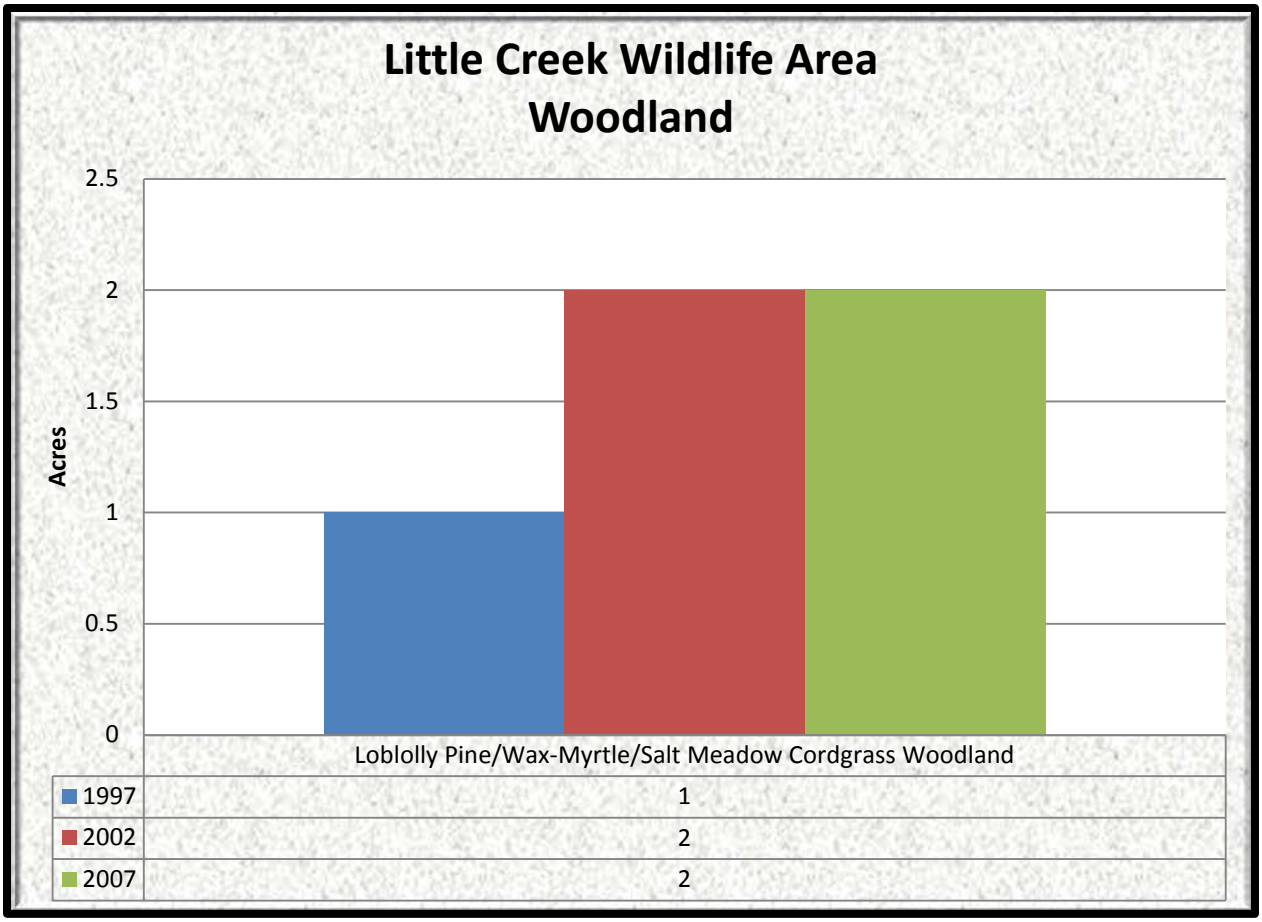


Figure 3.3. Little Creek Wildlife Area Woodland (1997, 2002, and 2007)

Little Creek Wildlife Area Woodland (Figure 3.3): Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland is the only woodland present in Little Creek Wildlife Area. It has been gaining acreage from the conversion of an adjacent pine forest at the marsh edge.

DNREC Sea Level Rise Analysis (Table 3.5)

All of the woodland in the wildlife area will be inundated with 0.5 m of sea level rise.

Table 3.5. Projected acres of Little Creek Wildlife Area Woodland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 3.6)

Capital of woodland has increased with conversion of forest on the edges of the marsh.

Table 3.6. Natural Capital of Little Creek Wildlife Area Woodland	
Year	**Natural Capital (in 2012 dollars)**
1997	$189/year
2002	$378/year
2007	$378/year

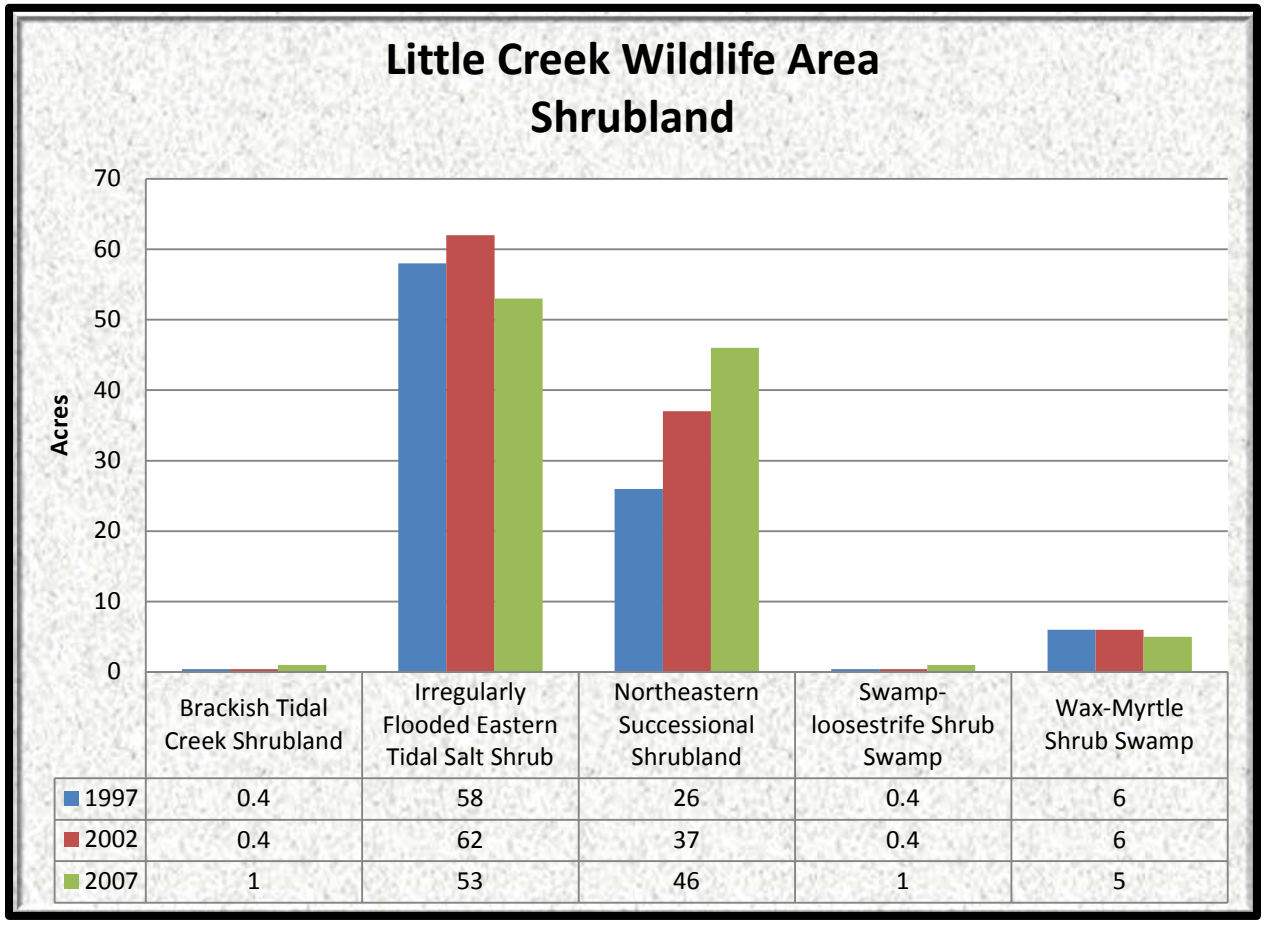


Figure 3.4. Shrubland at Little Creek Wildlife Area (1997, 2002, and 2007)

Little Creek Wildlife Area Shrubland (Figure 3.4): Irregularly Flooded Eastern Tidal Salt Shrub used to be the most prominent shrubland in the wildlife area by a wide margin, but it has declined while Northeastern Successional Shrubland has increased. A decline in Irregularly Flooded Eastern Tidal Salt Shrub has been seen in other wildlife areas including Assawoman and Milford Neck. Wax-myrtle Shrub Swamp has experienced a slight decline, which along with Irregularly Flooded Eastern Tidal Salt Shrub, could be due to brackish water effects and water inundation from sea level rise. Brackish Tidal Creek Shrubland has increased slightly during the study period.

DNREC Sea Level Rise Analysis (Table 3.7)

More than half of the shrubland located in Little Creek Wildlife Area will be flooded with 0.5 m of sea level rise driven mainly by the inundation of Irregularly Flooded Eastern Tidal Salt Shrub. At 1.5 m of rise about 80% of the shrubland will be inundated by water.

Table 3.7. Projected acres of Little Creek Wildlife Area Shrubland Impacted by Sea Level Rise

Rise	Acres
0.5 m	57 acres
1 m	71 acres
1.5 m	85 acres

Natural Capital (Table 3.8)

The natural capital of shrubland in Little Creek Wildlife Area has oscillated with losses in Irregularly Flooded Eastern Tidal Salt Shrub and gains in Northeastern Successional Shrubland.

Table 3.8. Natural Capital of Little Creek Wildlife Area Shrubland

Year	Natural Capital (in 2012 dollars)
1997	$423,876/year
2002	$450,419/year
2007	$399,653/year

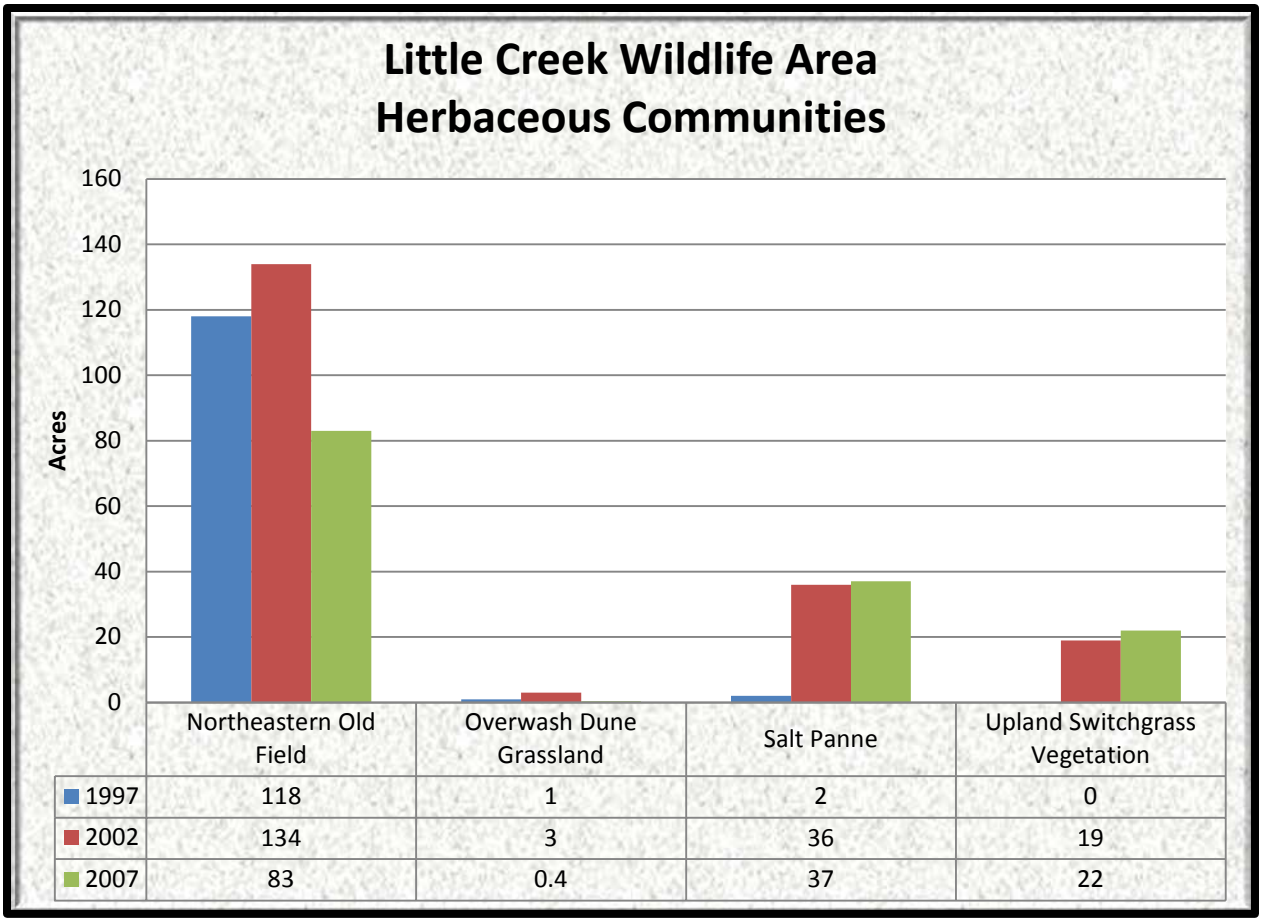


Figure 3.5. Herbaceous Communities at Little Creek Wildlife Area (1997, 2002, and 2007)

Little Creek Wildlife Area Herbaceous Communities (Figure 3.5): Northeastern Old Field is the most common herbaceous community in the wildlife area and has declined during the study period along with Overwash Dune Grassland. The former is likely declining due to succession to more mature communities. Salt Panne and Upland Switchgrass Vegetation have increased.

DNREC Sea Level Rise Analysis (Table 3.9)

Only about half of the herbaceous communities will be affected by sea level rise at 1.5 m of rise.

Table 3.9. Projected acres of Little Creek Wildlife Area Herbaceous Communities Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	48 acres
1 m	60 acres
1.5 m	76 acres

Natural Capital (Table 3.10)

Herbaceous community capital has oscillated based on the acreage of Northeastern Old Field, which has varied quite a bit over the study period.

Table 3.10. Natural Capital of Little Creek Wildlife Area Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1997	$17,484/year
2002	$22,729/year
2007	$15,065/year

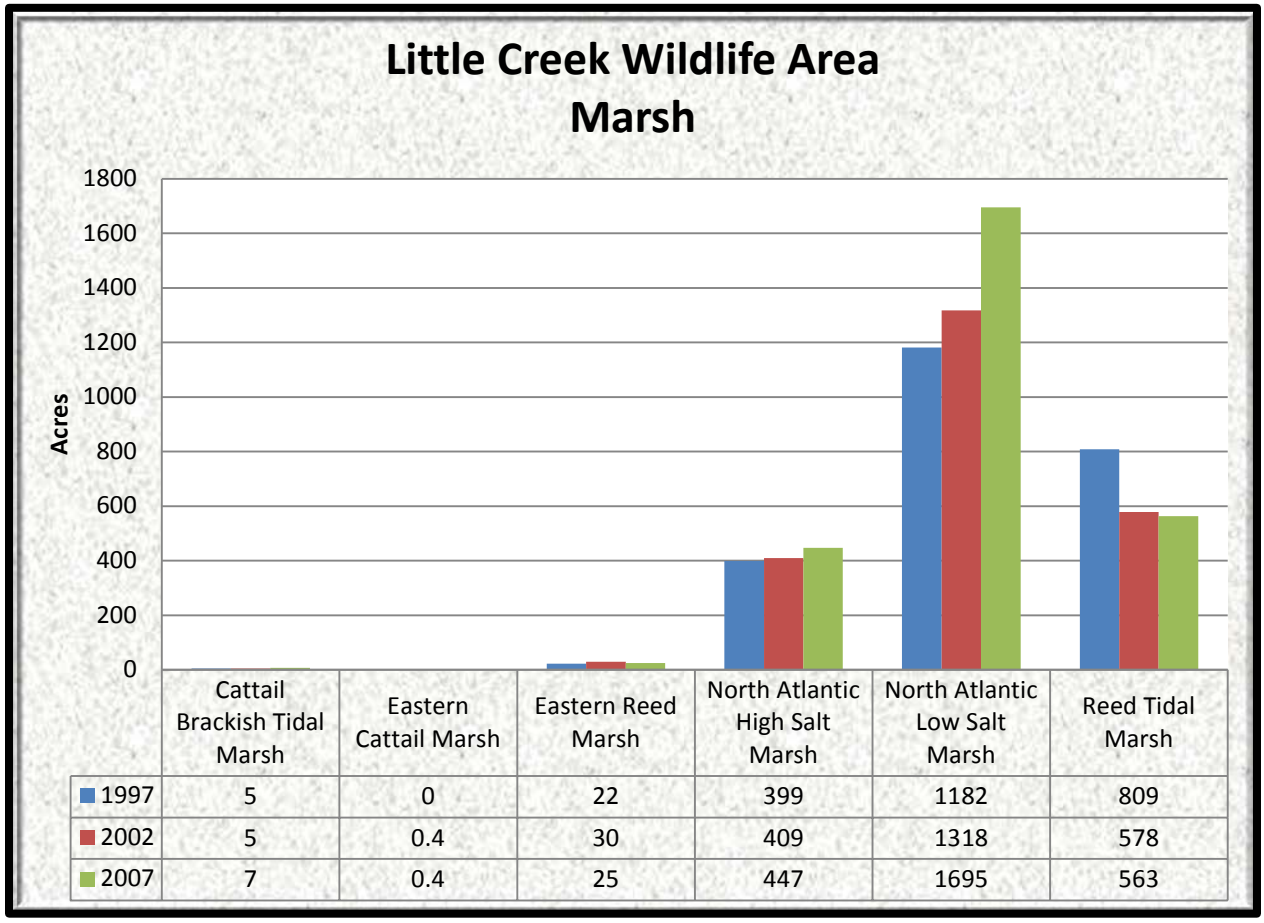


Figure 3.6. Marsh at Little Creek Wildlife Area (1997, 2002, and 2007)

Little Creek Wildlife Area Marsh (Figure 3.6): North Atlantic Low Salt Marsh is by far the most common marsh in the wildlife area. North Atlantic High Marsh, once the second largest marsh, has experienced declines, reflecting a trend seen throughout the coastal area. Eastern Reed Marsh has come into prominence in recent years and Reed Tidal Marsh has slightly declined, presumably through eradication efforts.

DNREC Sea Level Rise Analysis (Table 3.11)

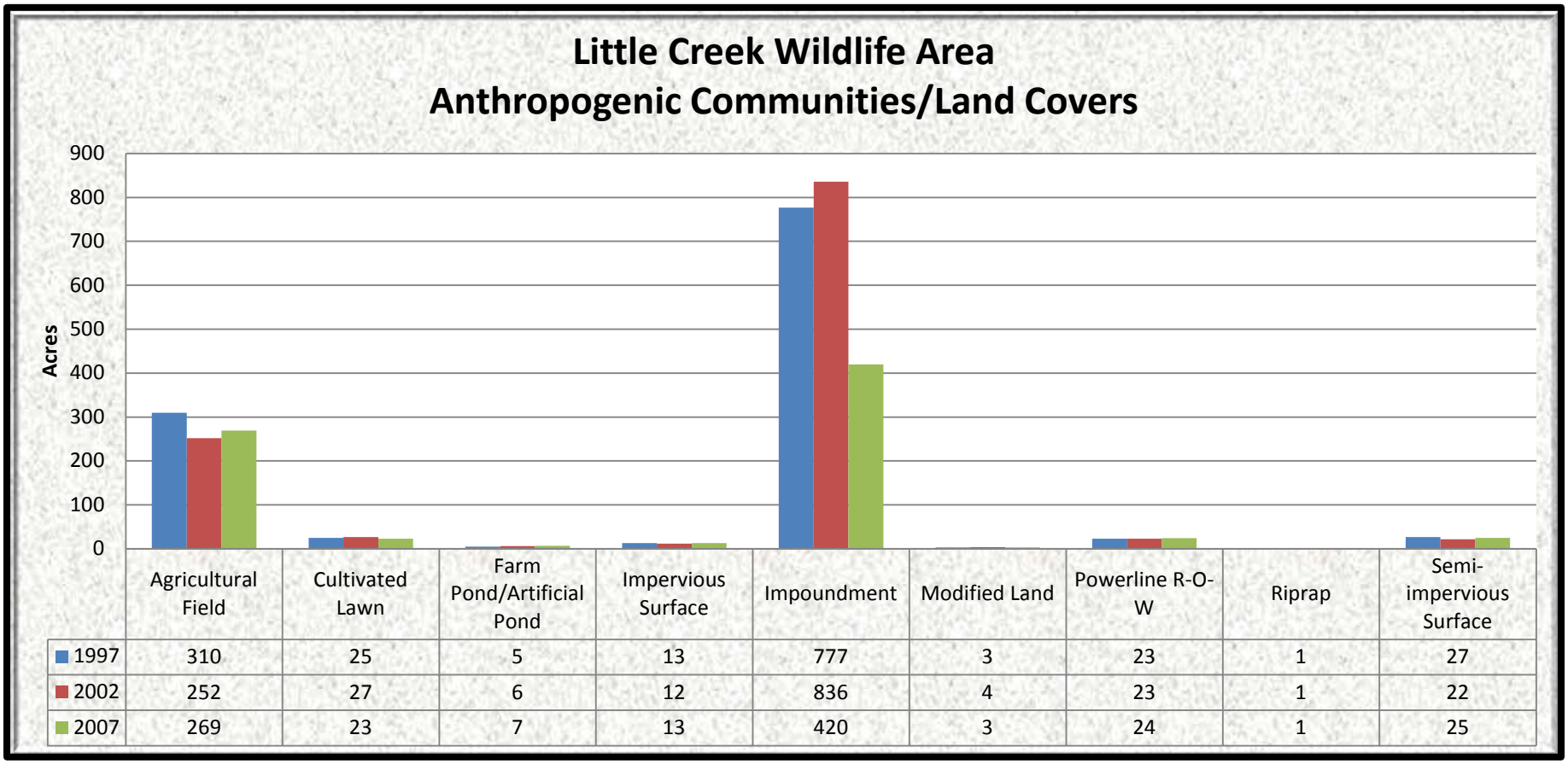
Most of the marshland in the wildlife area will be inundated in its current extent at 0.5 m of sea level rise and will essentially totally flood at 1.5 m of rise.

Table 3.11. Projected acres of Little Creek Wildlife Area Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	2,735 acres
1 m	2,729 acres
1.5 m	2,654 acres

Natural Capital (Table 3.12)

Capital of marsh has been increasing with increases in North Atlantic Low Salt Marsh.

Table 3.12. Natural Capital of Little Creek Wildlife Area Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$15,223,954/year
2002	$14,771,868/year
2007	$17,237,242/year



	Agricultural Field	Cultivated Lawn	Farm Pond/Artificial Pond	Impervious Surface	Impoundment	Modified Land	Powerline R-O-W	Riprap	Semi-impervious Surface
1997	310	25	5	13	777	3	23	1	27
2002	252	27	6	12	836	4	23	1	22
2007	269	23	7	13	420	3	24	1	25

Figure 3.7. Anthropogenic Communities at Little Creek Wildlife Area (1997, 2002, and 2007)

Little Creek Wildlife Area Anthropogenic Communities/Land Covers (Figure 3.7): Impoundment is the most common anthropogenic community, followed by agricultural field. As can be seen in the table, impoundment area fluctuates wildly depending on the management scheme being employed at the time of the imagery and rainfall.

DNREC Sea Level Rise Analysis (Table 3.13)

About 70% of the anthropogenic communities/land covers will be impacted by sea level rise at 1.5 m of rise.

Table 3.13. Projected acres of Little Creek Wildlife Area Anthropogenic Communities/Land Covers Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	428 acres
1 m	493 acres
1.5 m	544 acres

Natural Capital (Table 3.14)

Capital of anthropogenic communities/land covers is driven by the acreage in the impoundments. Since one of the impoundments was breached in the 2007 imagery, the capital went down. If the impoundment is restored the capital will likely go back up in this category.

Table 3.14. Natural Capital of Little Creek Wildlife Area Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1997	$4,189,769/year
2002	$4,506,664/year
2007	$2,293,515/year

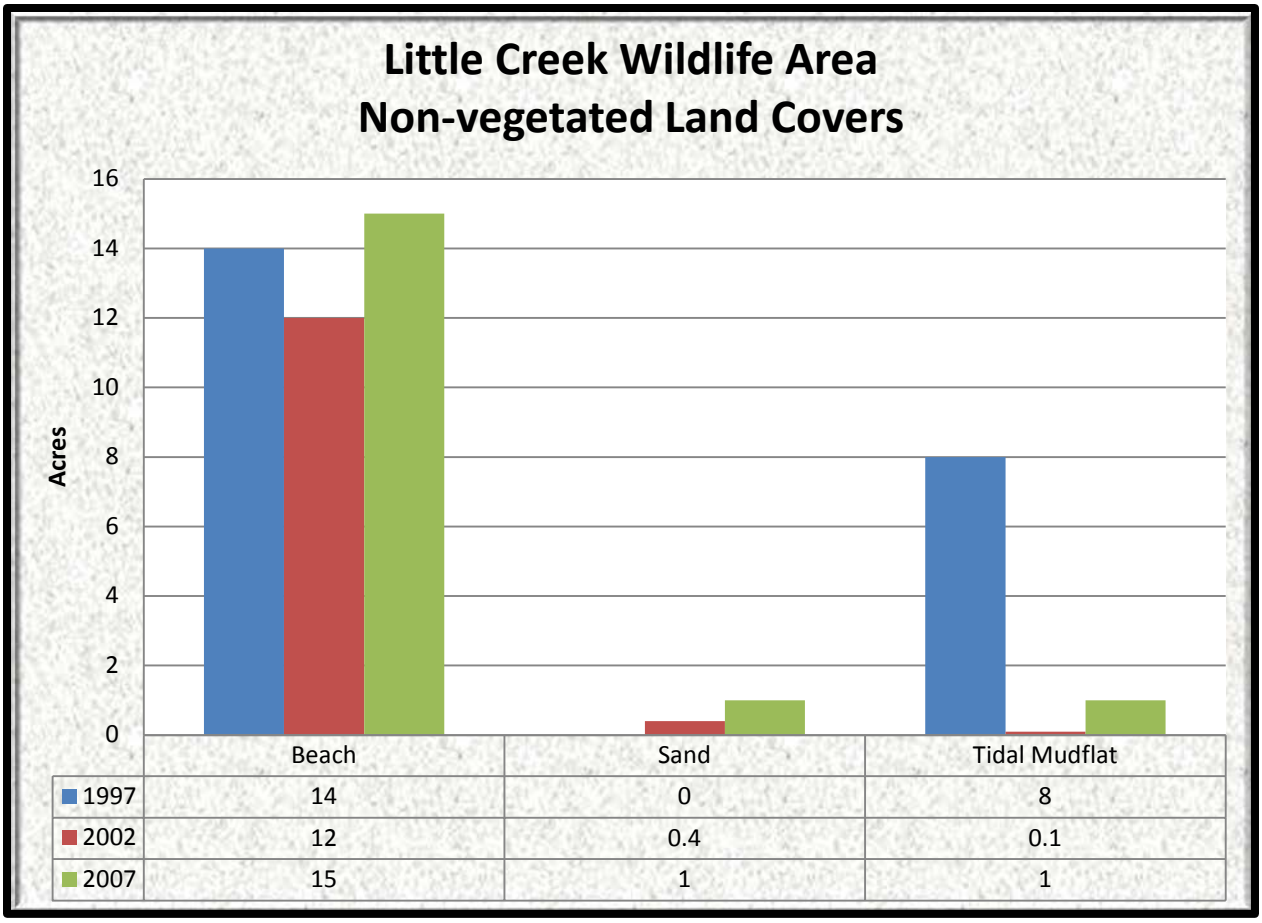


Figure 3.8. Non-vegetated Land Covers at Little Creek Wildlife Area (1997, 2002, and 2007)

Little Creek Wildlife Area Non-vegetated Land Covers (Figure 3.8): Beach is the most prominent non-vegetated community at Little Creek Wildlife Area followed distantly by sand and tidal mudflat, which each cover 1 acre.

DNREC Sea Level Rise Analysis (Table 3.15)

Almost all of the Non-vegetated land covers will be inundated at 1 m of sea level rise.

Table 3.15. Projected acres of Little Creek Wildlife Area Non-vegetated Land Covers Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	12 acres
1 m	16 acres
1.5 m	16 acres

Natural Capital (Table 3.16)

Tidal mudflat is the only Non-vegetated land cover with any natural capital value. Because of its ephemeral nature, its capital tends to oscillate through any given time period.

Table 3.16. Natural Capital of Little Creek Wildlife Area Non-vegetated Land Covers

Year	Natural Capital (in 2012 dollars)
1997	$50,170/year
2002	$627/year
2007	$6,898/year

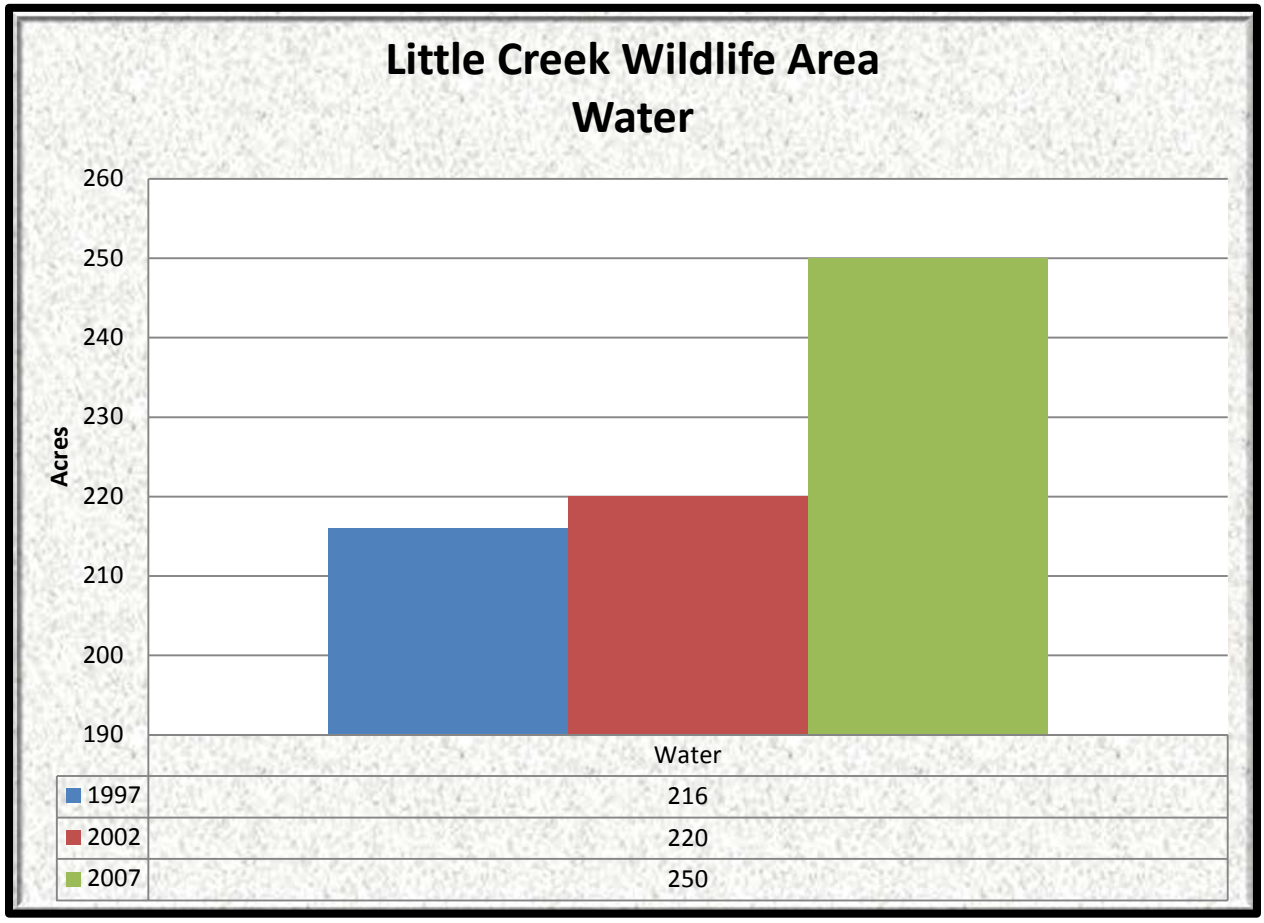


Figure 3.8. Water coverage (non-impoundment) at Little Creek Wildlife Area (1997, 2002, and 2007)

Little Creek Wildlife Area Water Coverage (Figure 3.8): This category includes tidal water which is subject to sea level rise and not contained in impoundments. This category has increased overall in the wildlife area as whole but not as much as that seen in other wildlife areas such Assawoman or Milford Neck.

Natural Capital (Table 3.17)

Estuarine water has been increasing with sea level rise causing the capital to increase.

Table 3.17. Natural Capital of Little Creek Wildlife Area Water	
Year	**Natural Capital (in 2012 dollars)**
1997	$3,110,228/year
2002	$3,153,227/year
2007	$3,568,880/year

CHAPTER 4: VEGETATION COMMUNITIES BY SECTION

1. North Section

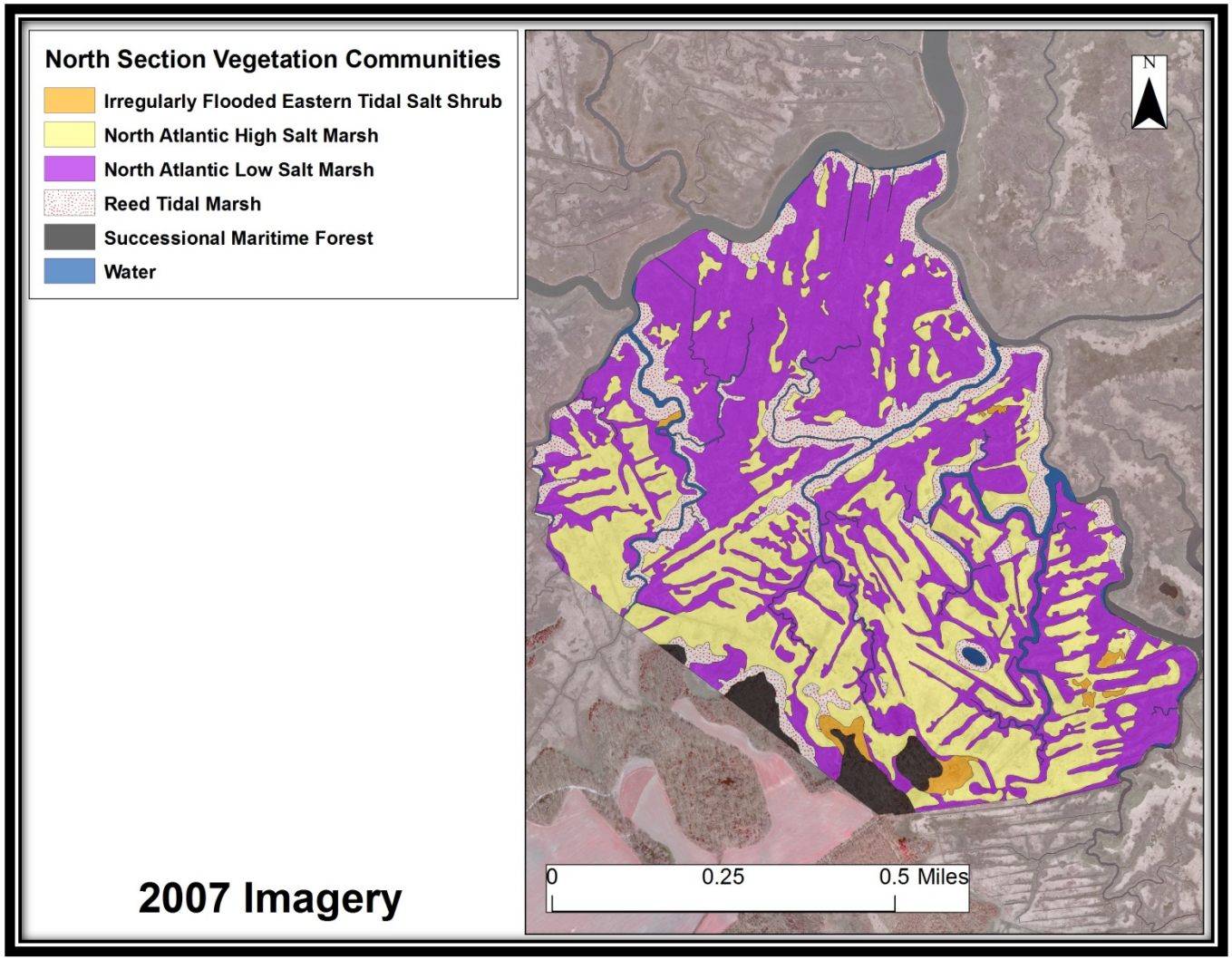


Figure 4-1.1. 2007 Vegetation Community map of the North Section

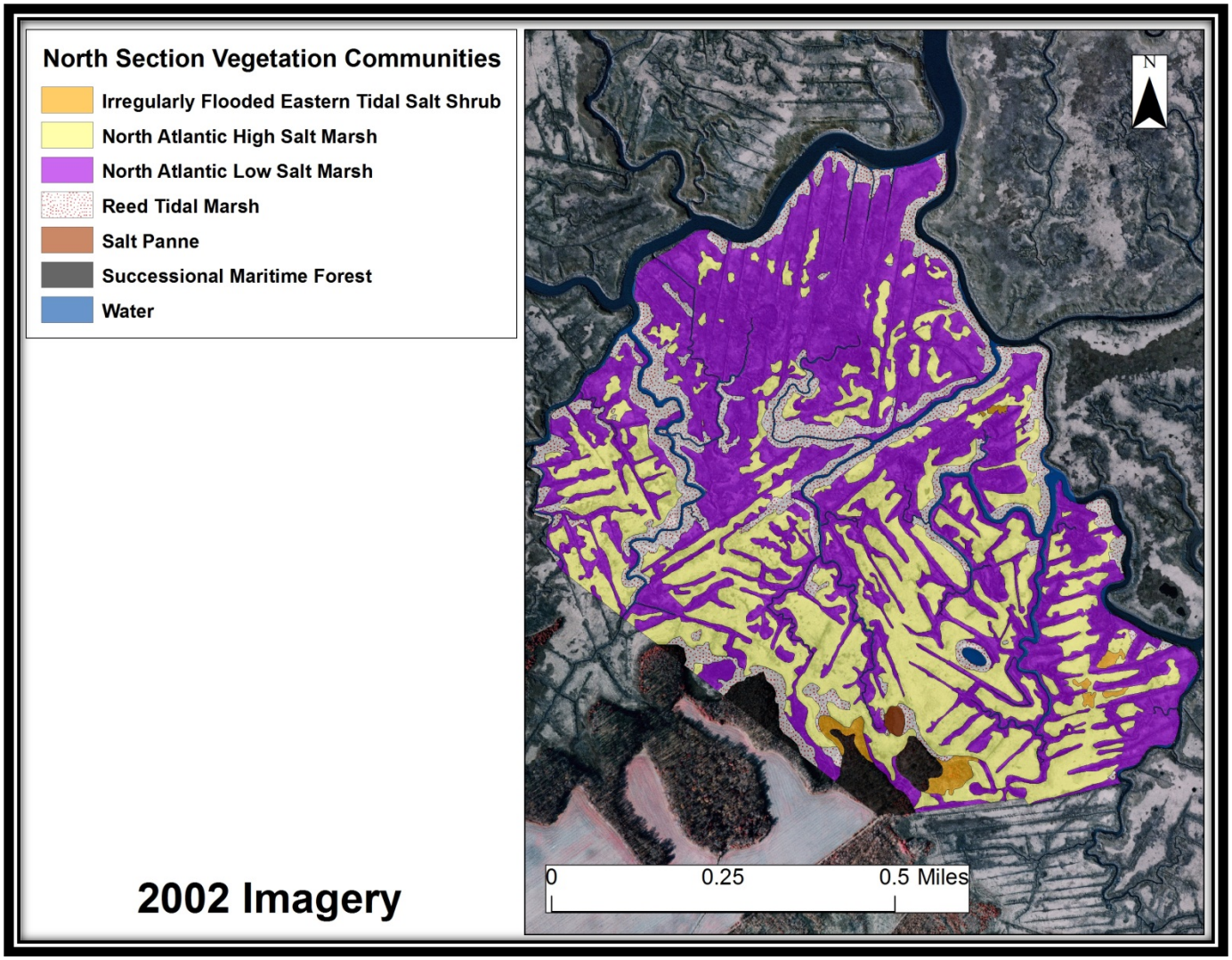


Figure 4-1.2. 2002 Vegetation Community map of the North Section

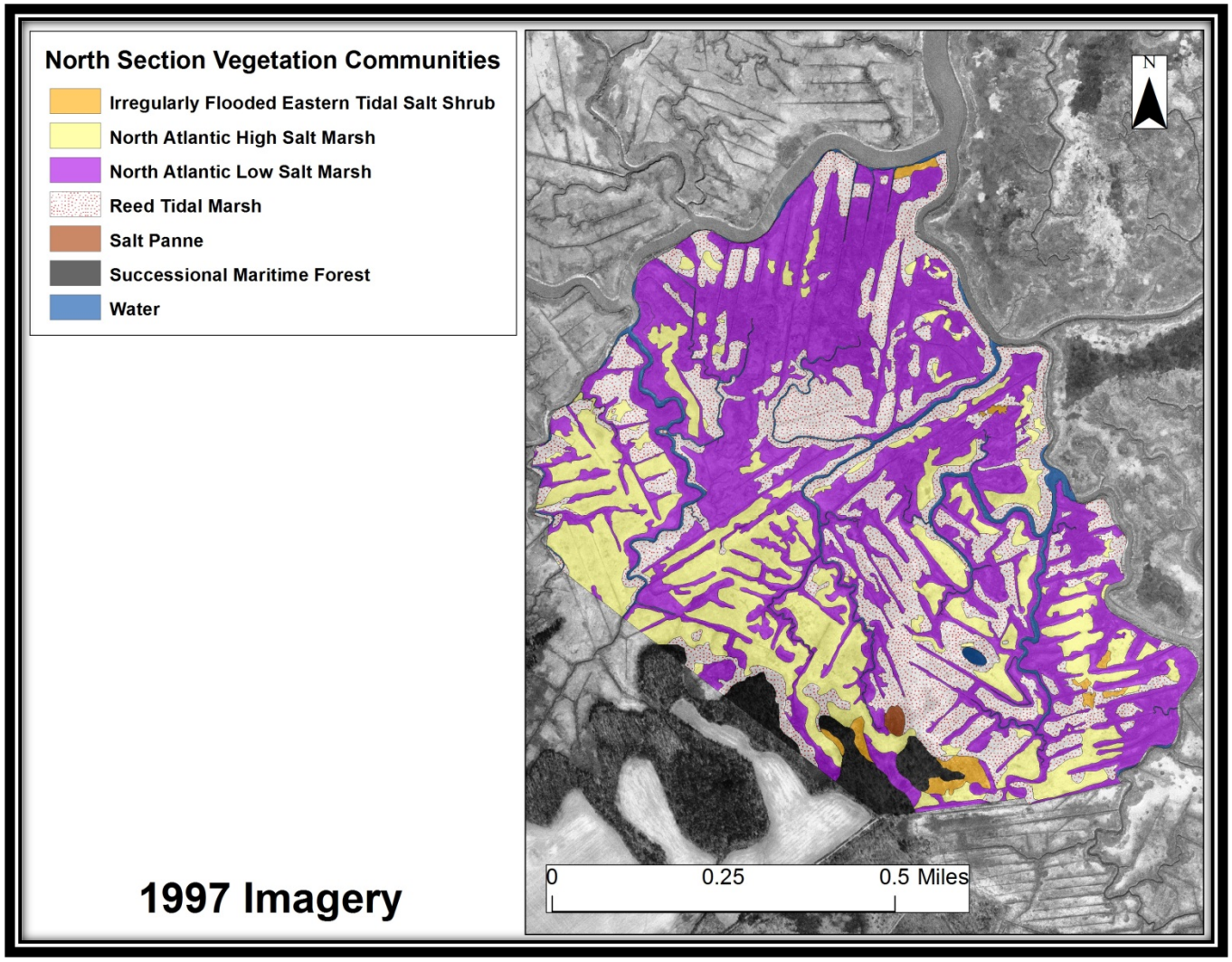


Figure 4-1.3. 1997 Vegetation Community map of the North Section

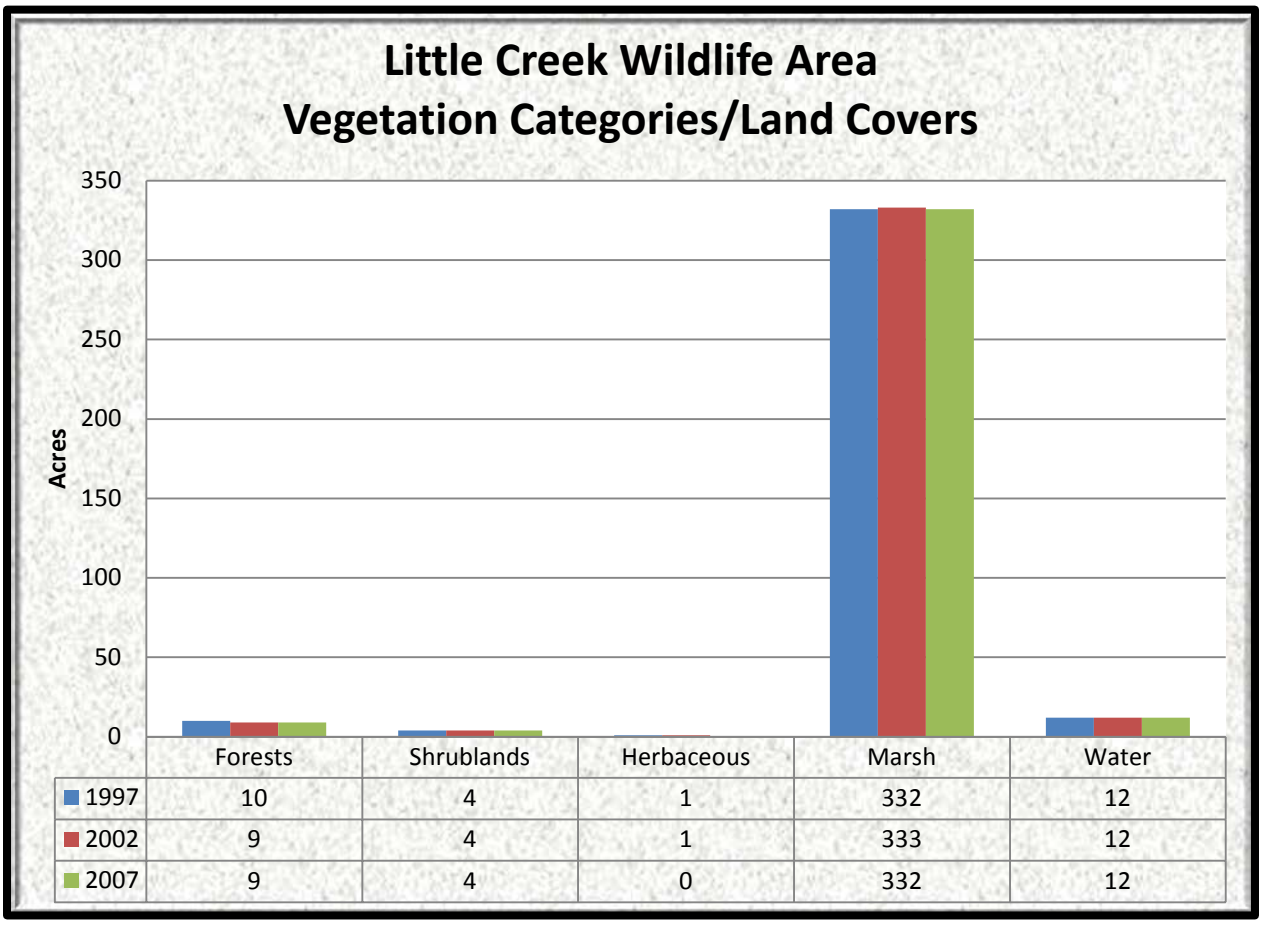


Figure 4-1.4. North Section Vegetation Community/Land Cover Categories (1997, 2002, and 2007)

North Section Vegetation Categories/Land Covers (Figure 4-1.4): Marshland is the most prominent vegetation community in the North Section, followed distantly by anthropogenic communities and forests.

DNREC Sea Level Rise Analysis (Table 4-1.1)

Most of the North Section will be inundated with 0.5 m of sea level rise and it will be entirely flooded with 1 m of rise.

Table 4-1.1. Projected acres of the North Section Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	353 acres
1 m	357 acres
1.5 m	357 acres

Natural Capital (Table 4-1.2)

Natural capital in the North Section has decreased overall with a slight uptick in 2002. It is unknown if this trend will continue.

Table 4-1.2. Natural Capital of the North Section

Year	Natural Capital (in 2012 dollars)
1997	$2,287,313/year
2002	$2,293,396/year
2007	$2,280,853/year

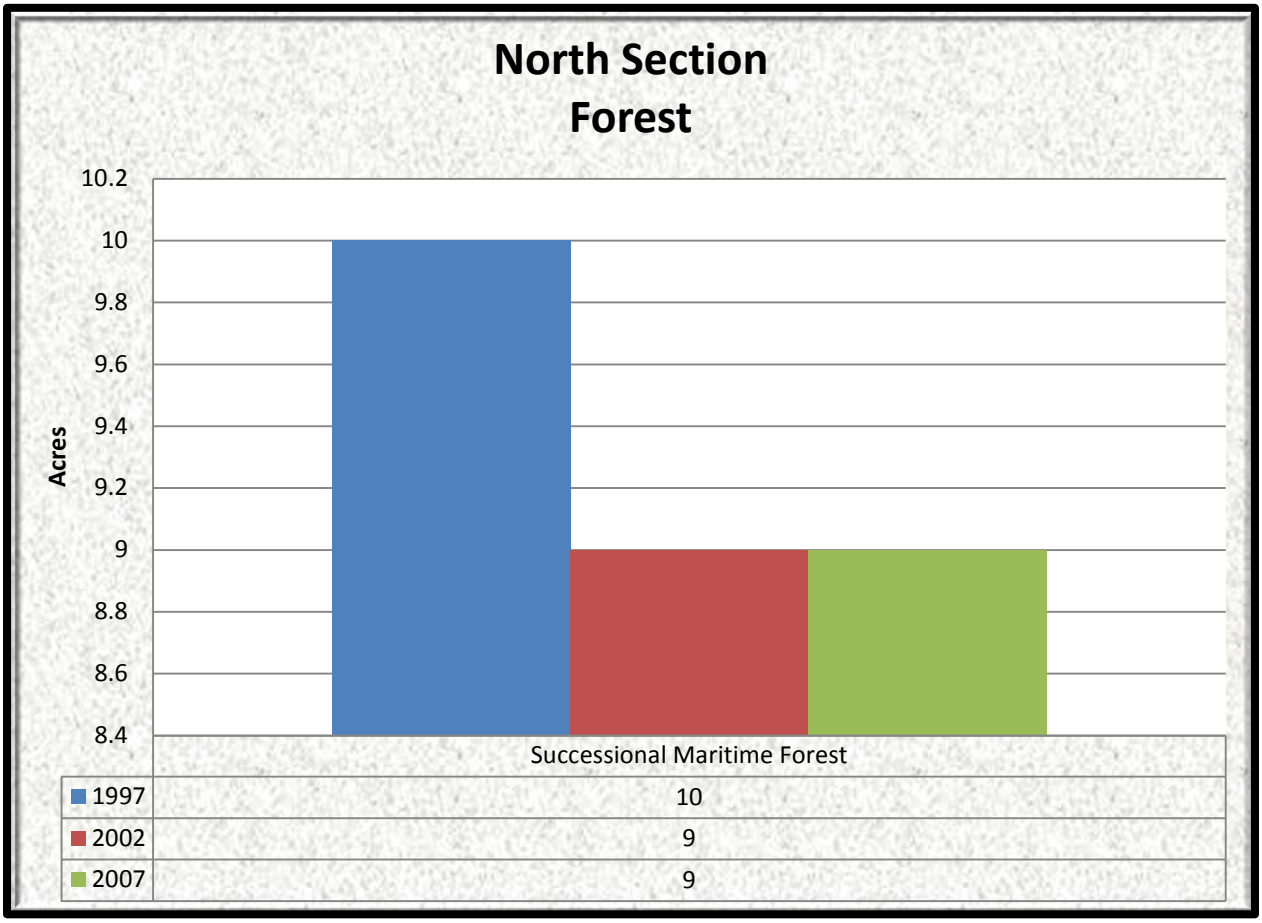


Figure 4-1.5. North Section Forest (1997, 2002, and 2007)

North Section Forests (Figure 4-1.5): The North Section is located mostly in a marshy area with some upland to the west. On these uplands is found Successional Maritime Forest which has lost an acre in the 10 year study period.

DNREC Sea Level Rise Analysis (Table 4-1.3)

All of the forestland in the North Section will be inundated with 1 m of sea level rise. About half will be flooded with 0.5 m of rise.

Table 4-1.3. Projected acres of North Section Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	4 acres
1 m	9 acres
1.5 m	9 acres

Natural Capital (Table 4-1.4)

Forest capital of the North Section has decreased slightly due a loss in acreage presumably from sea level rise conversion.

Table 4-1.4. Natural Capital of North Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,891/year
2002	$1,702/year
2007	$1,702/year

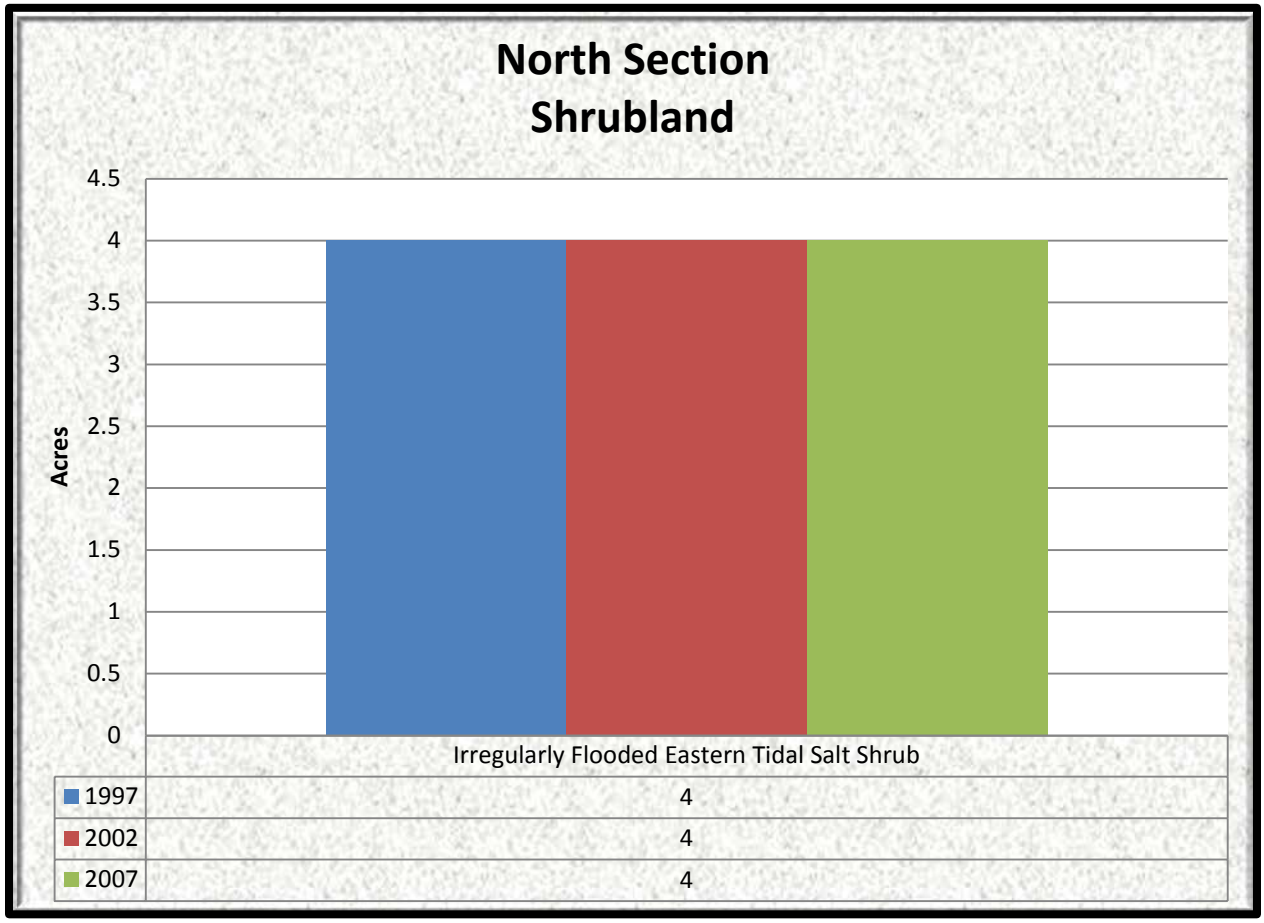


Figure 4-1.6. North Section Shrubland (1997, 2002, and 2007)

North Section Shrubland (Figure 4-1.6): Irregularly Flooded Eastern Tidal Salt Shrub is the only shrubland located in the North Section. In this section the amount has been stable through the 10 year study period.

DNREC Sea Level Rise Analysis (Table 4-1.5)

All of the shrubland present in the North Section will be inundated with 0.5 m of sea level rise.

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

Natural Capital (Table 4-1.6)

Capital of shrubland for the North Section has remained the same through the study period.

Table 4-1.6. Natural Capital of North Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$25,085/year
2002	$25,085/year
2007	$25,085/year

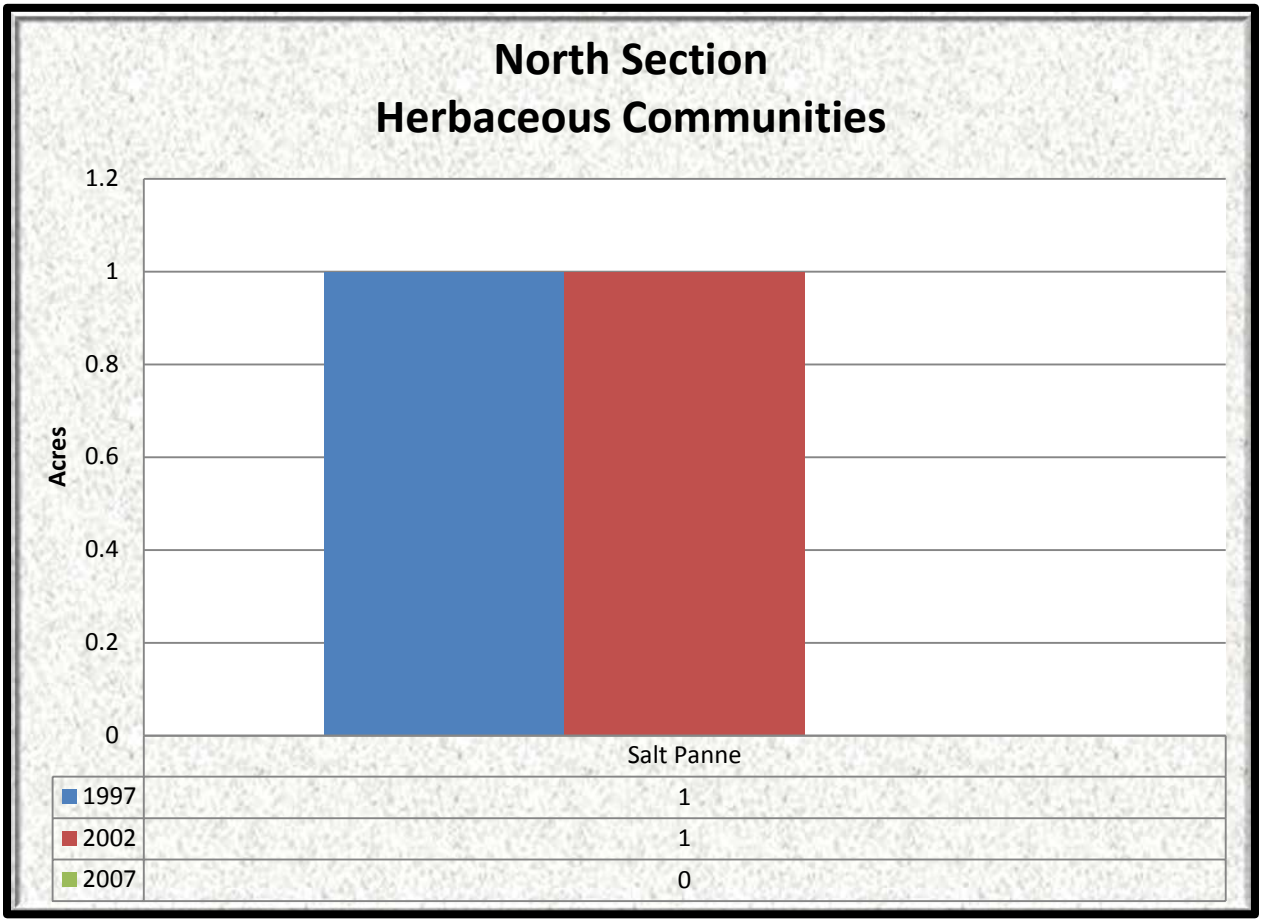


Figure 4-1.7. North Section Herbaceous Communities (1997, 2002, and 2007)

North Section Herbaceous Communities (Figure 4-1.7): Salt Panne has the only herbaceous community present in the North Section during the 10 year study period. It has since disappeared from the section. This community tends to be ephemeral and comes and goes as depressions form in the North Atlantic Low Salt Marsh and then they succeed to open water or tidal mudflat.

Natural Capital (Table 4-1.7)

Herbaceous communities are no longer present in the North Section. The capital was likely transferred to water.

Table 4-1.7. Natural Capital of North Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1997	$6,271/year
2002	$6,271/year
2007	$0/year

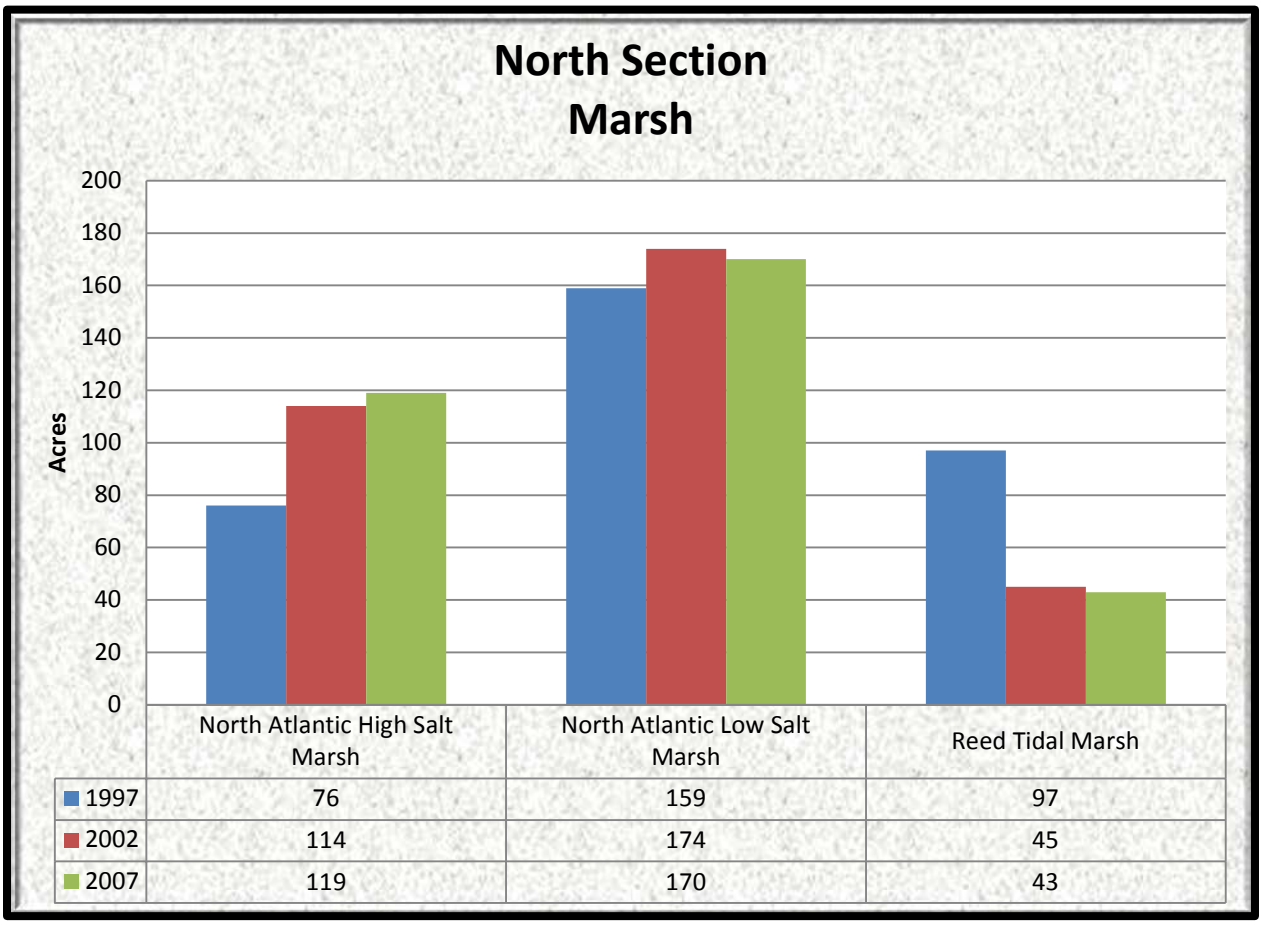


Figure 4-1.8. North Section Marsh (1997, 2002, and 2007)

North Section Marsh (Figure 4-1.8): North Atlantic Low Salt Marsh is and has been the most common marsh in the North Section and shows a trend of increasing over time. North Atlantic High Salt Marsh, bucking a trend seen in other wildlife areas (Coxe 2010a, Coxe 2010b, and Coxe 2010c) has increased. This increase in area could be the result of *Phragmites* spraying efforts opening up habitat for the main species salt meadow hay (*Spartina patens*) to colonize.

DNREC Sea Level Rise Analysis (Table 4-1.8)

All of the marshland in the North Section will be flooded with 0.5 m of sea level rise.

Table 4-1.8. Projected acres of North Section Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	333 acres
1 m	333 acres
1.5 m	333 acres

Natural Capital (Table 4-1.9)

Capital in marshland has been pretty much the same with a small increase in 2002.

Table 4-1.9. Natural Capital of North Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$2,082,072/year
2002	$2,088,343/year
2007	$2,082,072/year

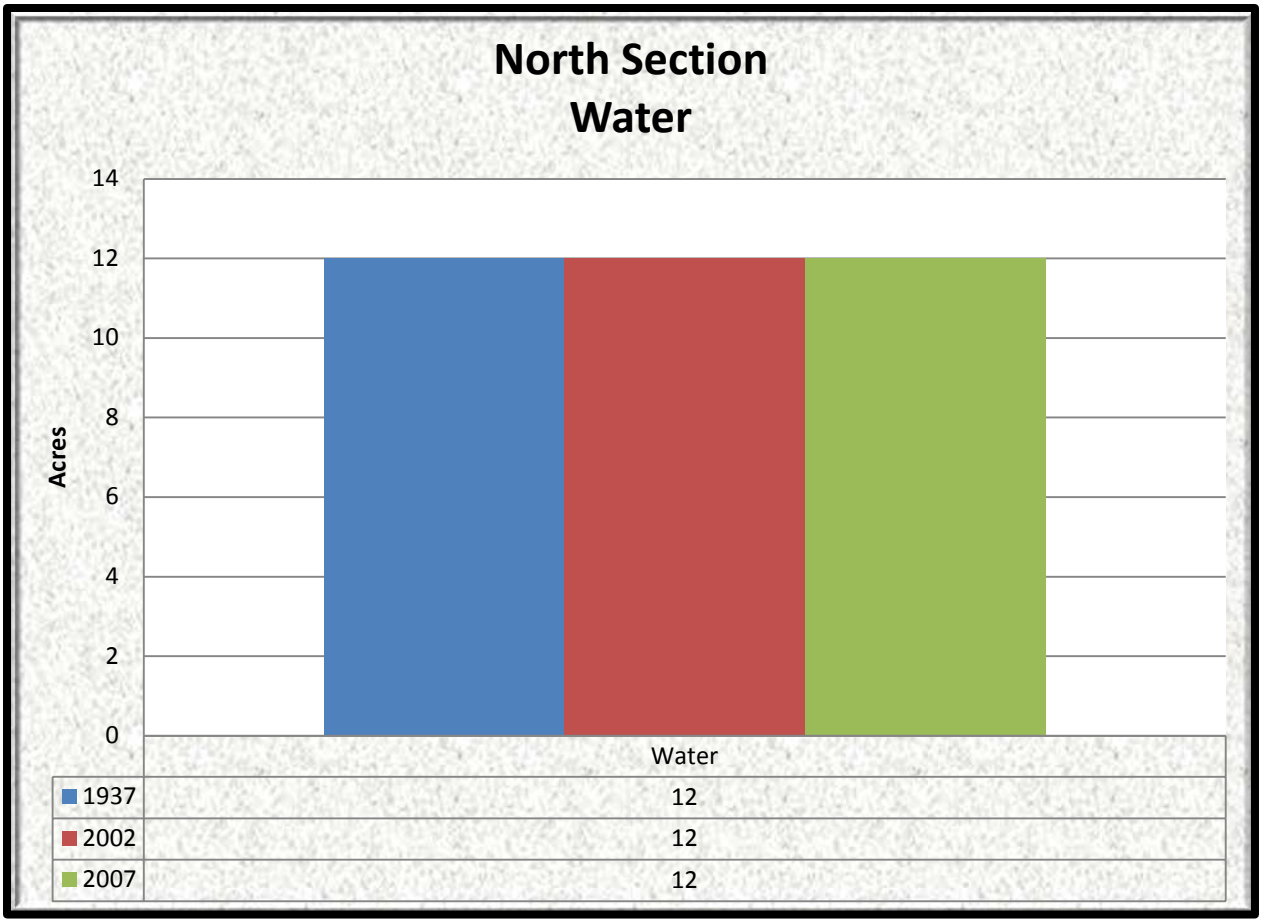


Figure 4-1.9. North Section Water coverage (1997, 2002, and 2007)

North Section Water Coverage (Figure 4-1.9): The amount of water coverage in the North Section has remained stable throughout the study period.

Natural Capital (Table 4-1.10)

Capital of water in the North Section has stayed the same through the study period.

Table 4-1.10. Natural Capital of North Section Water	
Year	**Natural Capital (in 2012 dollars)**
1997	$171,994/year
2002	$171,994/year
2007	$171,994/year

2. Middle Section

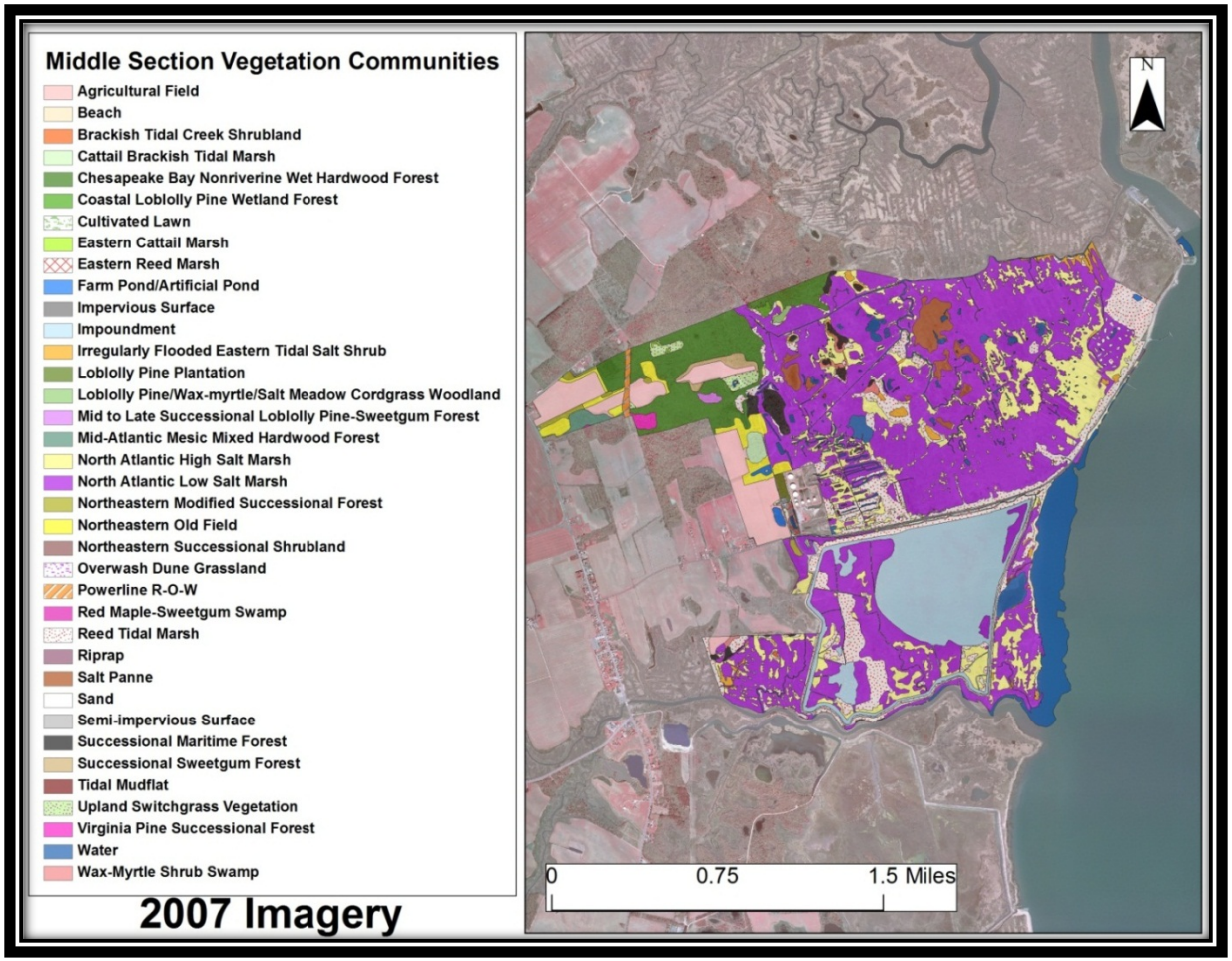


Figure 4-2.1. 2007 Vegetation Community map of the Middle Section

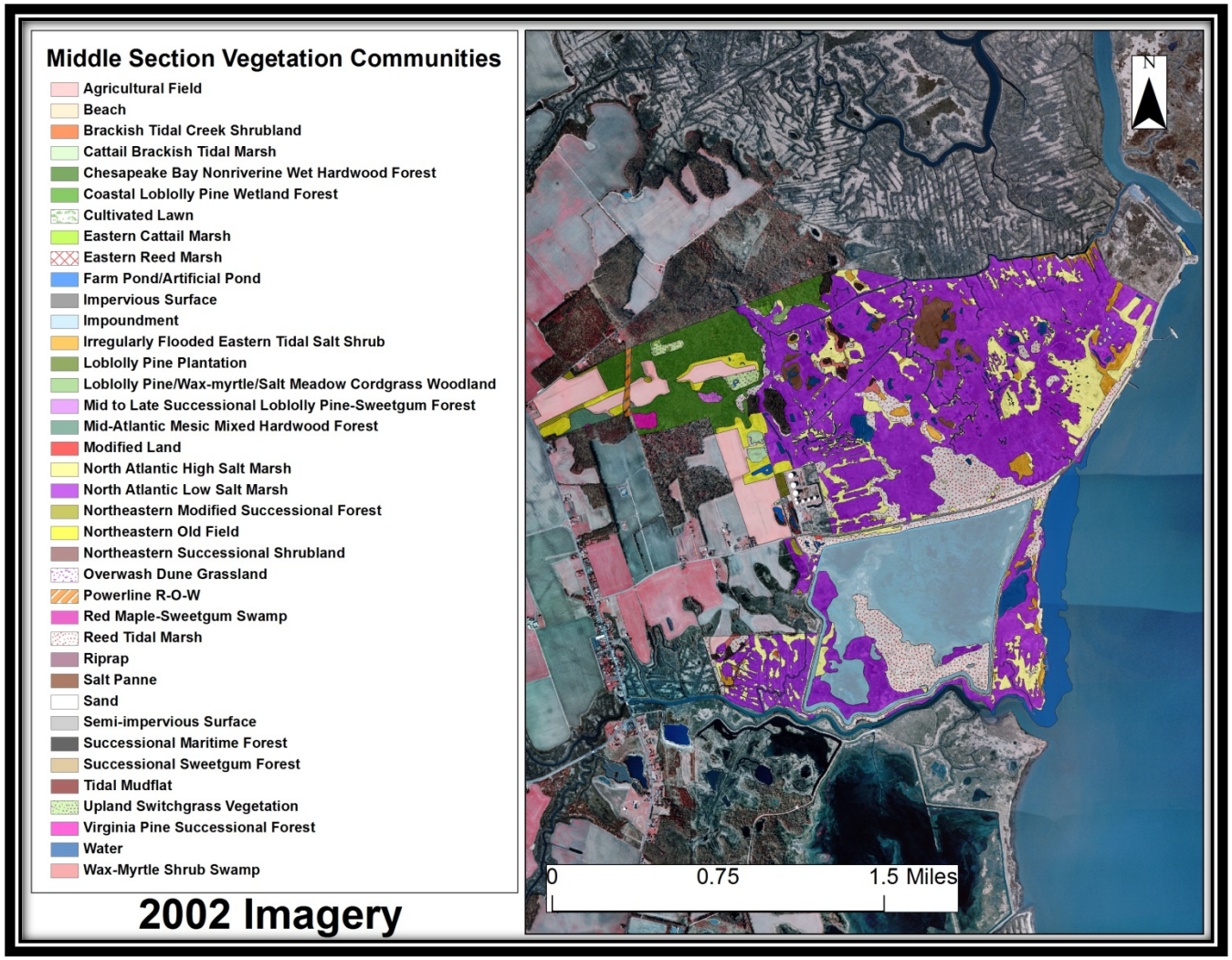


Figure 4-2.2. 2002 Vegetation Community map of the Middle Section

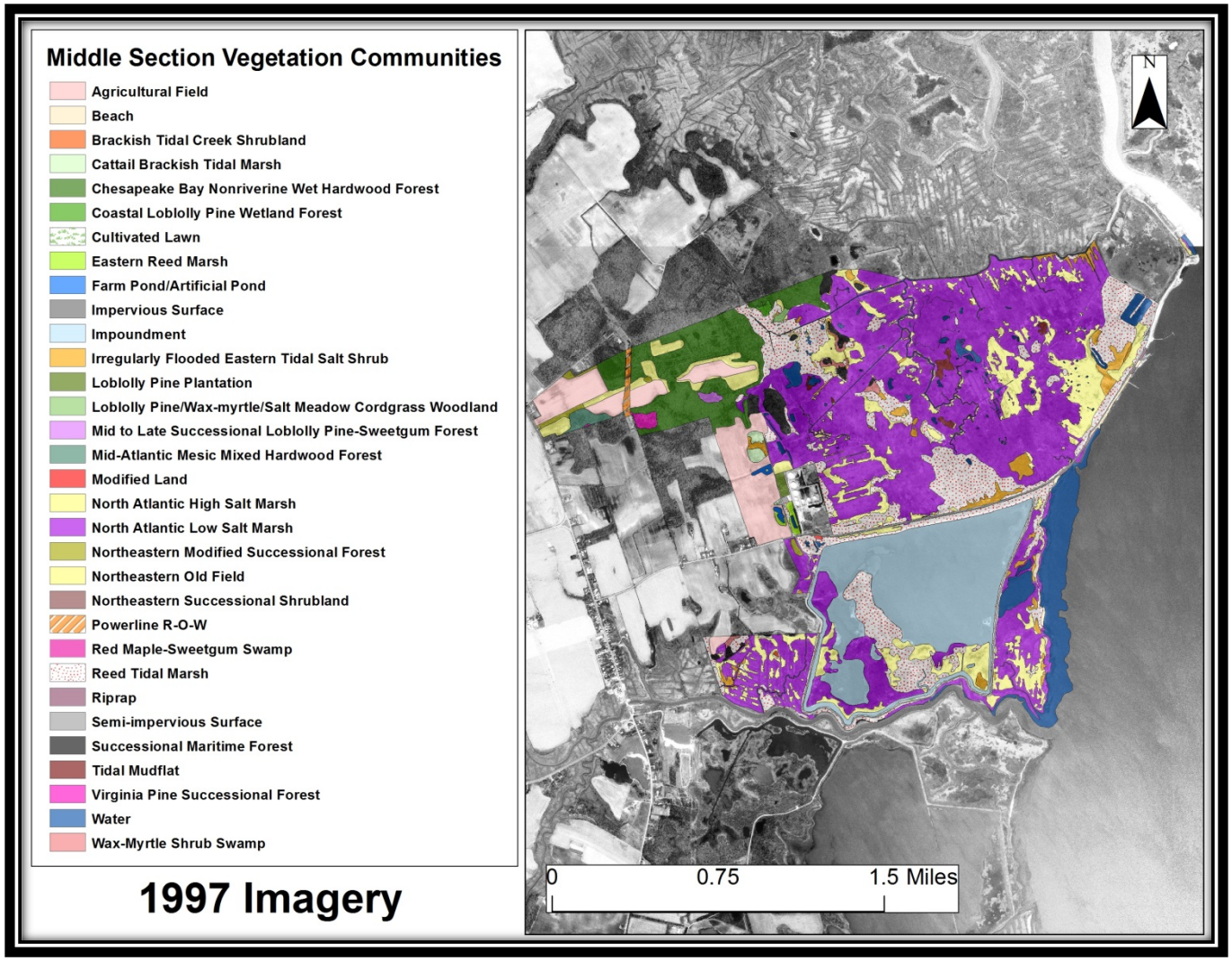
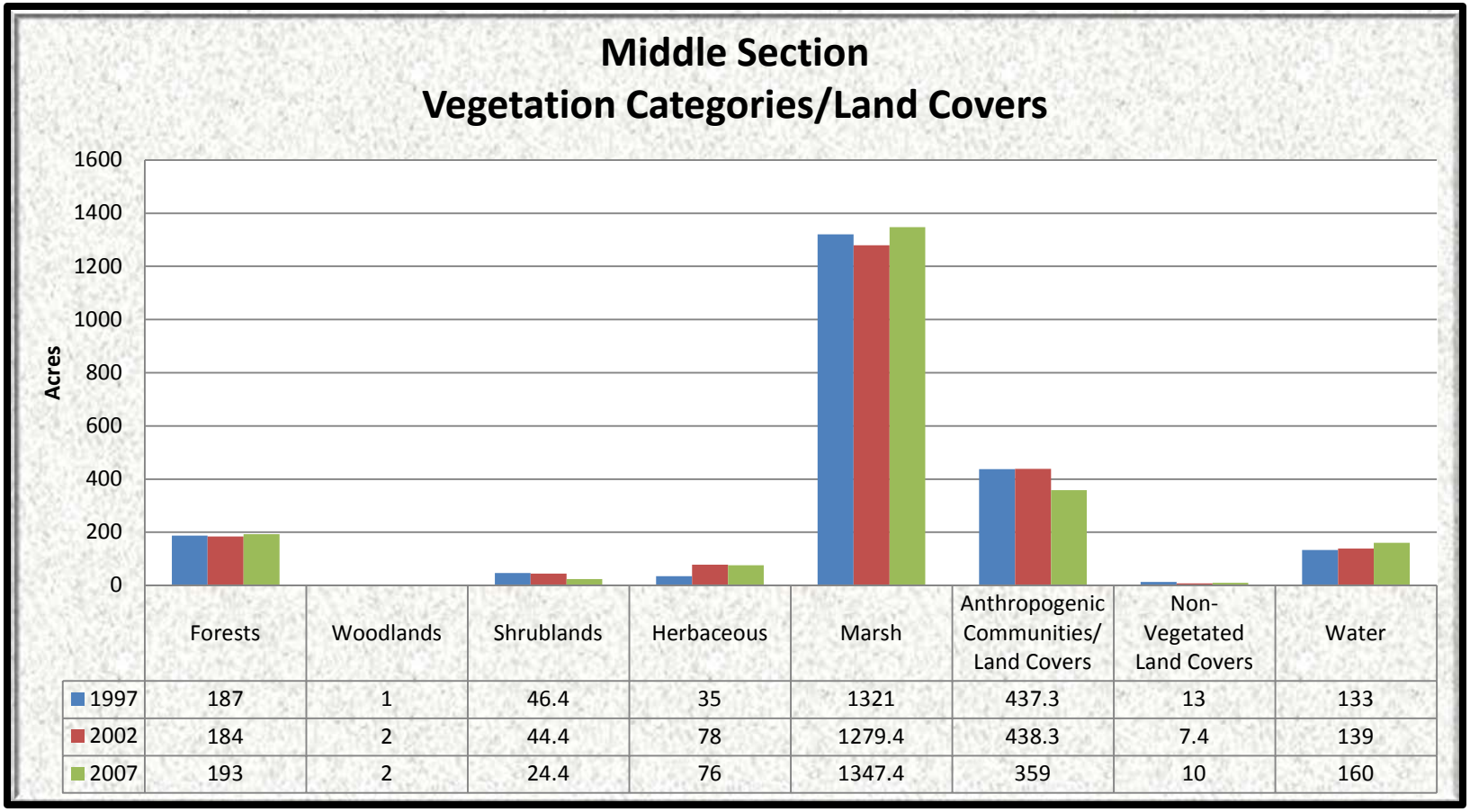


Figure 4-2.3. 1997 Vegetation Community map of the Middle Section



	Forests	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/ Land Covers	Non-Vegetated Land Covers	Water
1997	187	1	46.4	35	1321	437.3	13	133
2002	184	2	44.4	78	1279.4	438.3	7.4	139
2007	193	2	24.4	76	1347.4	359	10	160

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

Middle Section Vegetation Community/Land Covers (Figure 4-2.4): Marshland is the most prominent vegetation community in the Middle Section followed by Anthropogenic Communities/Land Covers.

DNREC Sea Level Rise Analysis (Table 4-2.1)

About 89% of the Middle Section will be flooded by water with 1.5 m of sea level rise. About 84% will be inundated with 0.5 m of rise.

Table 4-2.1. Projected acres of the Middle Section Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1,813 acres
1 m	1,884 acres
1.5 m	1,929 acres

Natural Capital (Table 4-2.2)

Middle Section capital has been going up with increases in forest and water.

Table 4-2.2. Natural Capital of the Middle Section	
Year	**Natural Capital (in 2012 dollars)**
1997	$13,859,722/year
2002	$13,661,761/year
2007	$13,887,439/year

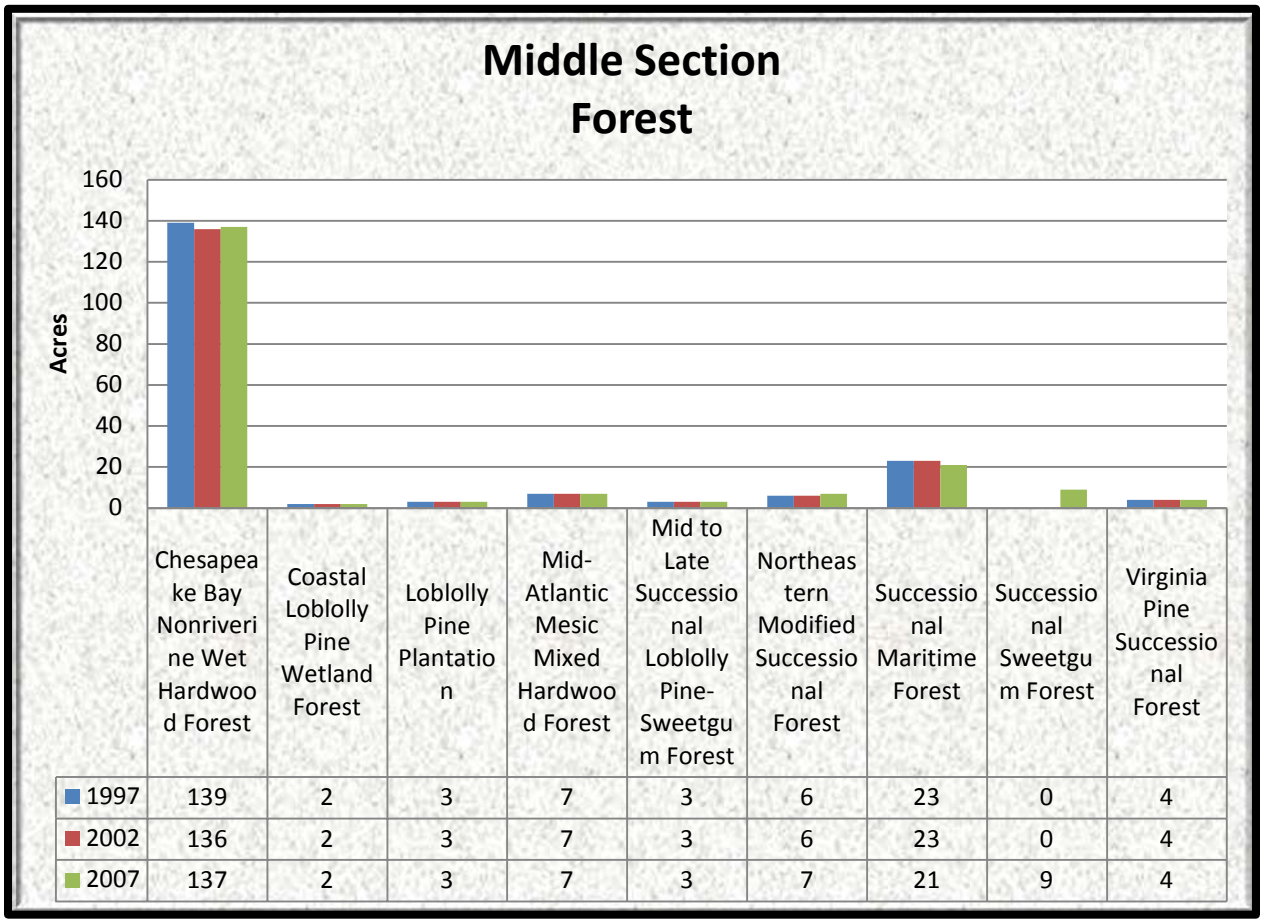


Figure 4-2.5. Middle Section Forest (1997, 2002, and 2007)

Middle Section Forest (Figure 4-2.5): Chesapeake Bay Non-riverine Wet Hardwood Forest is the most common forest type in the middle section covering more acreage than all others combined. Successional Maritime Forest is the next most common.

DNREC Sea Level Rise Analysis (Table 4-2.3)

A little more than half of the current forestland acreage in the Middle Section will be inundated with 1.5 m of sea level rise.

Table 4-2.3. Projected acres of Middle Section Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	57 acres
1 m	81 acres
1.5 m	100 acres

Natural Capital (Table 4-2.4)

Capital in forest has decreased overall with a slight increase in the recent period (2002-2007) due to the appearance of a Successional Sweetgum Forest.

Table 4-2.4. Natural Capital of Middle Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,741,800/year
2002	$1,704,926/year
2007	$1,718,730/year

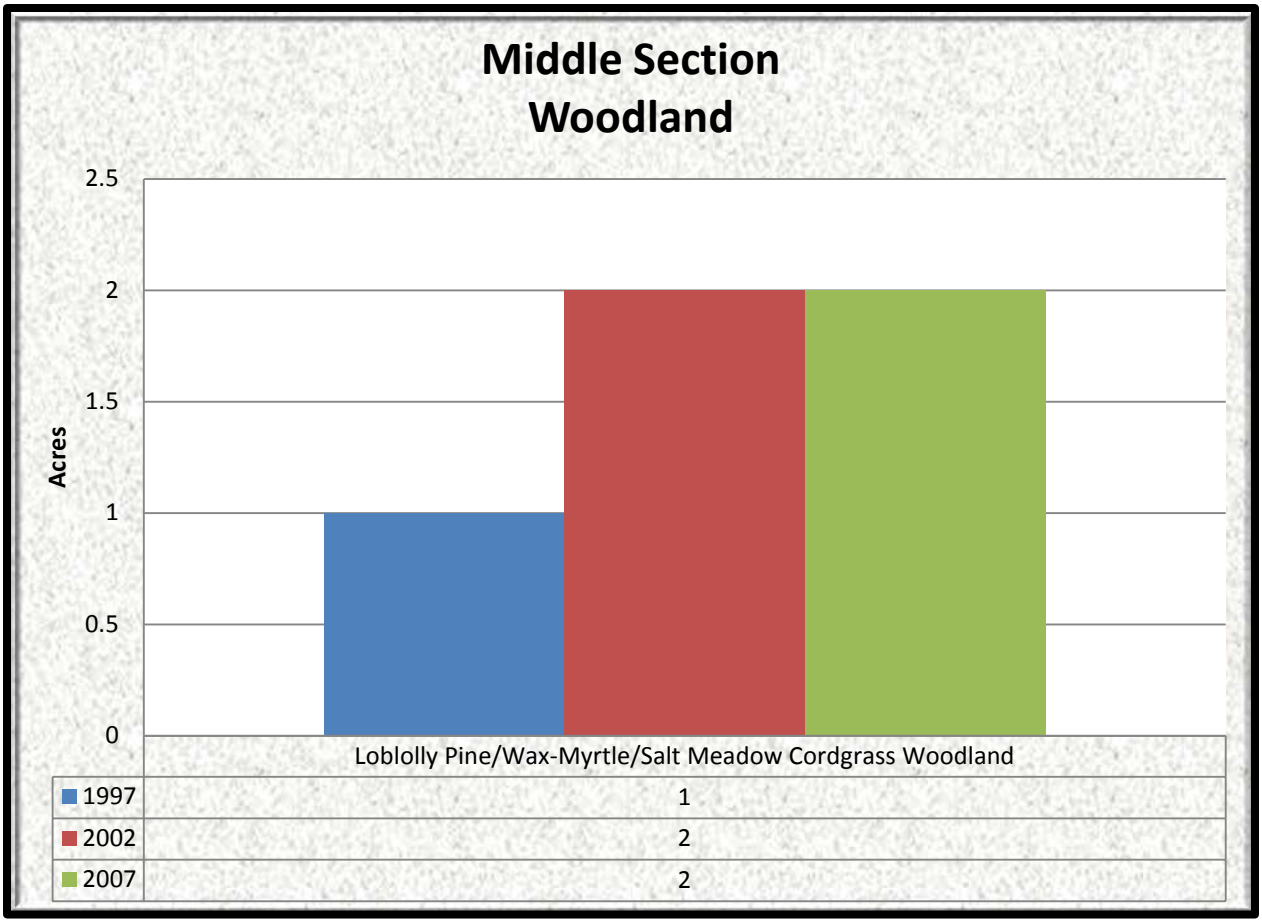


Figure 4-2.6. Middle Section Woodland (1997, 2002, and 2007)

Middle Section Woodland (Figure 4-2.6): Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass is the only woodland present in the middle section. It has increased by one acre during the 10 year study period and may be increasing as a result of sea level rise encroaching into the upland forests adjacent to the marsh.

DNREC Sea Level Rise Analysis (Table 4-2.5)

All of the woodland in the Middle Section will be flooded with 0.5 m of sea level rise.

Table 4-2.5. Projected acres of Middle Section Woodland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 4-2.6)

Capital in woodland has increased in the study period with an increase in acreage.

Table 4-2.6. Natural Capital of Middle Section Woodland	
Year	**Natural Capital (in 2012 dollars)**
1997	$189/year
2002	$378/year
2007	$378/year

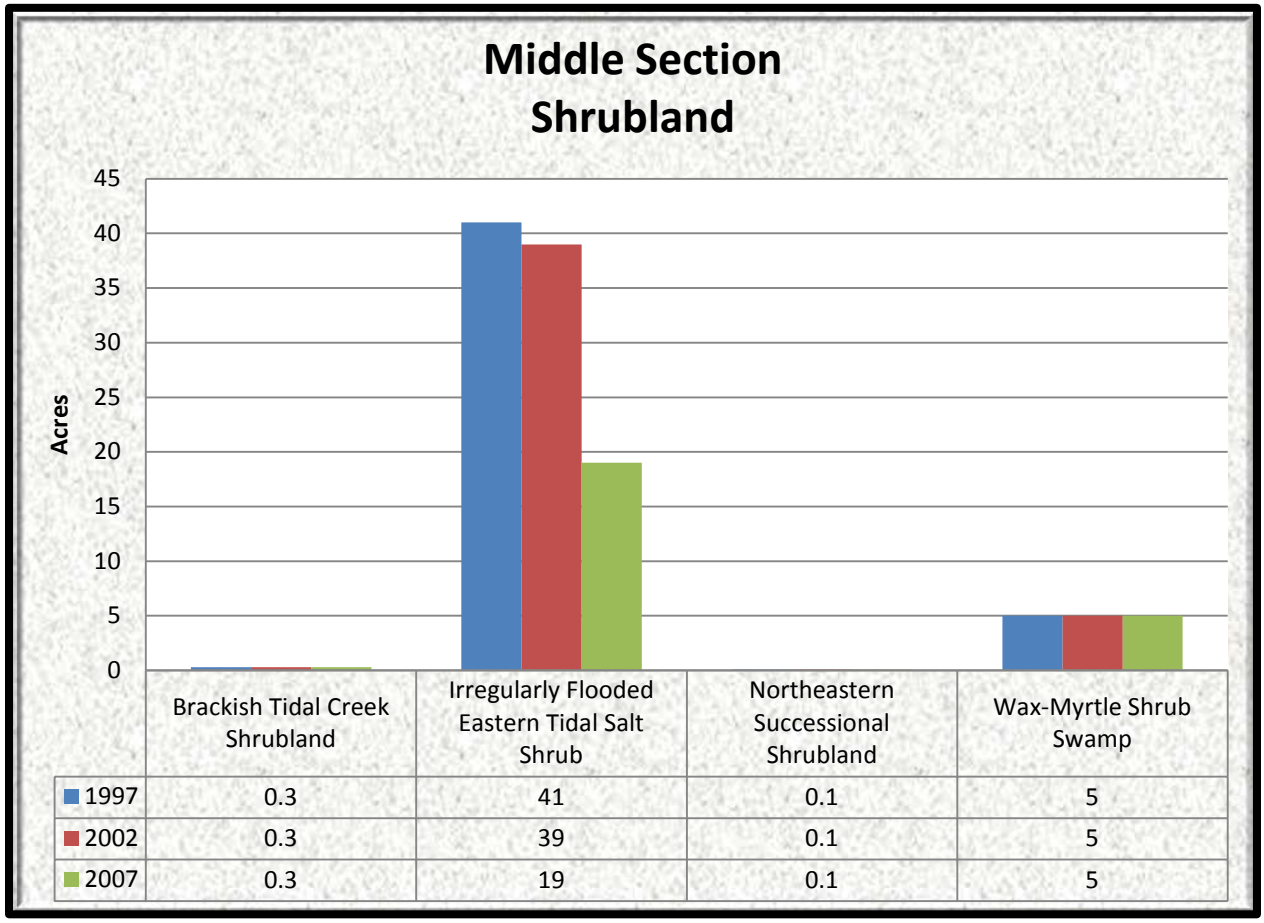


Figure 4-2.7. Middle Section Shrubland (1997, 2002, and 2007)

Middle Section Shrubland (Figure 4-2.7): Irregularly Flooded Eastern Tidal Salt Shrub is the most common shrubland in the middle section but has declined by more than half in 10 years. This observation along with the increase in woodland lends support to saline water encroaching into the uplands. Wax-Myrtle Shrub Swamp is the next common shrubland and has not lost any acreage in 10 years.

DNREC Sea Level Rise Analysis (Table 4-2.7)

All of the shrubland in the Middle Section will be flooded with 0.5 m of sea level rise.

Table 4-2.7. Projected acres of Middle Section Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	24 acres
1 m	24 acres
1.5 m	24 acres

Natural Capital (Table 4-2.8)

Capital in shrubland has been declining with losses in Irregularly Flooded Eastern Tidal Salt Shrub.

Table 4-2.8. Natural Capital of Middle Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$305,424/year
2002	$292,882/year
2007	$167,456/year

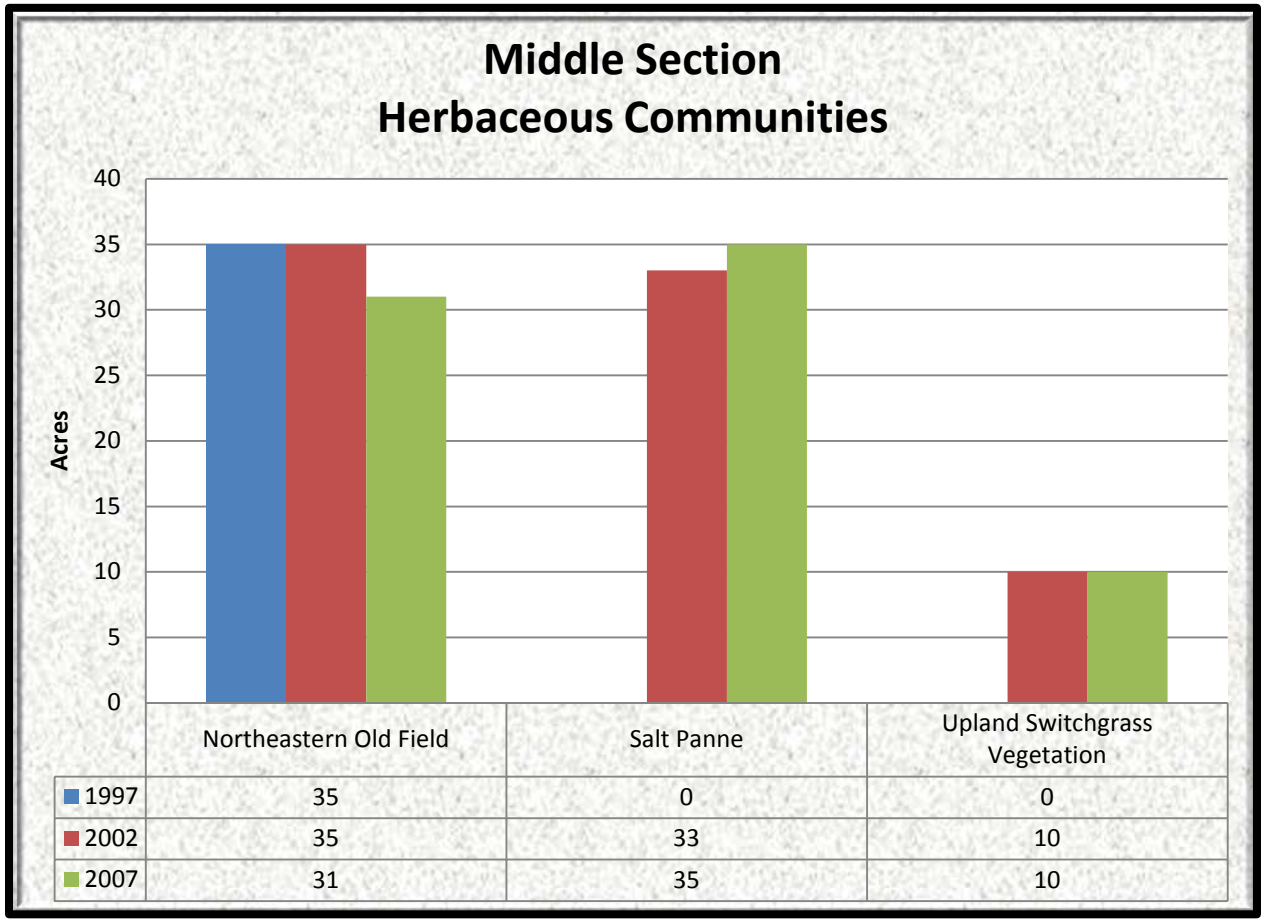


Figure 4-2.8. Middle Section Herbaceous Communities (1997, 2002, and 2007)

Middle Section Herbaceous Communities (Figure 4-2.8): Salt Panne is the most common herbaceous community and has only come about recently with depressions in the North Atlantic Low Salt Marsh. Northeastern Old Field is the next most common herbaceous community resulting mostly from the abandonment of agricultural fields and wildlife fields that are kept open through management. Northeastern Old Field has lost some acreage through succession to Northeastern Successional Shrubland.

DNREC Sea Level Rise Analysis (Table 4-2.9)

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

Table 4-2.9. Projected acres of Middle Section Herbaceous Communities Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	43 acres
1 m	50 acres
1.5 m	55 acres

Natural Capital (Table 4-2.10)

Herbaceous community capital has increased overall with Upland Switchgrass Vegetation acreage and increases in Salt Panne.

Table 4-2.10. Natural Capital of Middle Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1997	$5,100/year
2002	$6,557/year
2007	$5,974/year

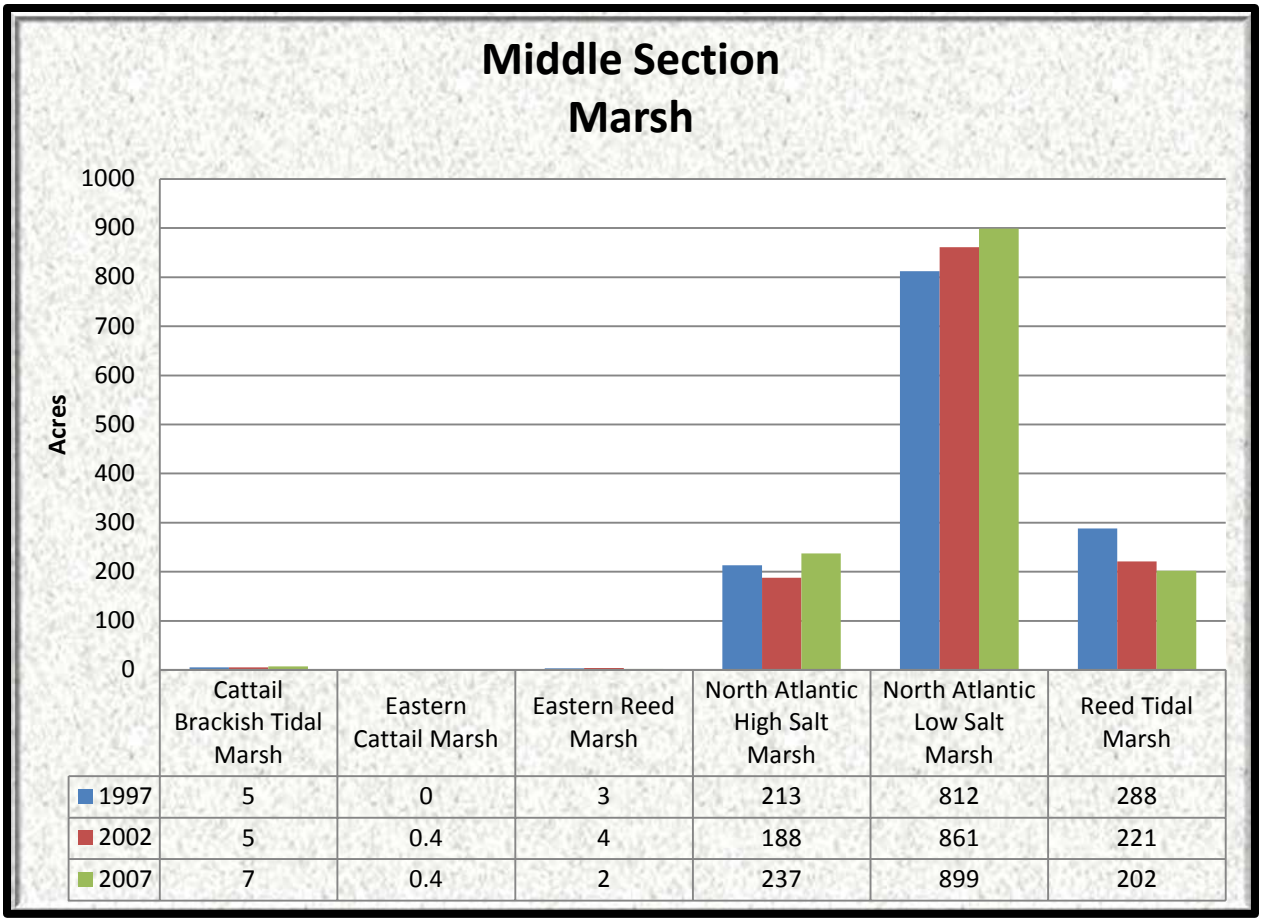


Figure 4-2.9. Middle Section Marsh (1997, 2002, and 2007)

Middle Section Marsh (Figure 4-2.9): North Atlantic Low Salt Marsh is the most common marsh type in the middle section. As more land is converted to marsh it has been increasing through the study period. North Atlantic High Salt Marsh, like the North Section, has bucked a trend seen in other areas and has increased in area. In tandem, Reed Tidal Marsh has decreased, pointing to *Phragmites* spraying efforts providing habitat for the main species in North Atlantic High Salt Marsh, salt meadow hay (*Spartina patens*) to colonize. One small area of Cattail Brackish Tidal Marsh has gradually spread within the confines of a backchannel.

DNREC Sea Level Rise Analysis (Table 4-2.11)

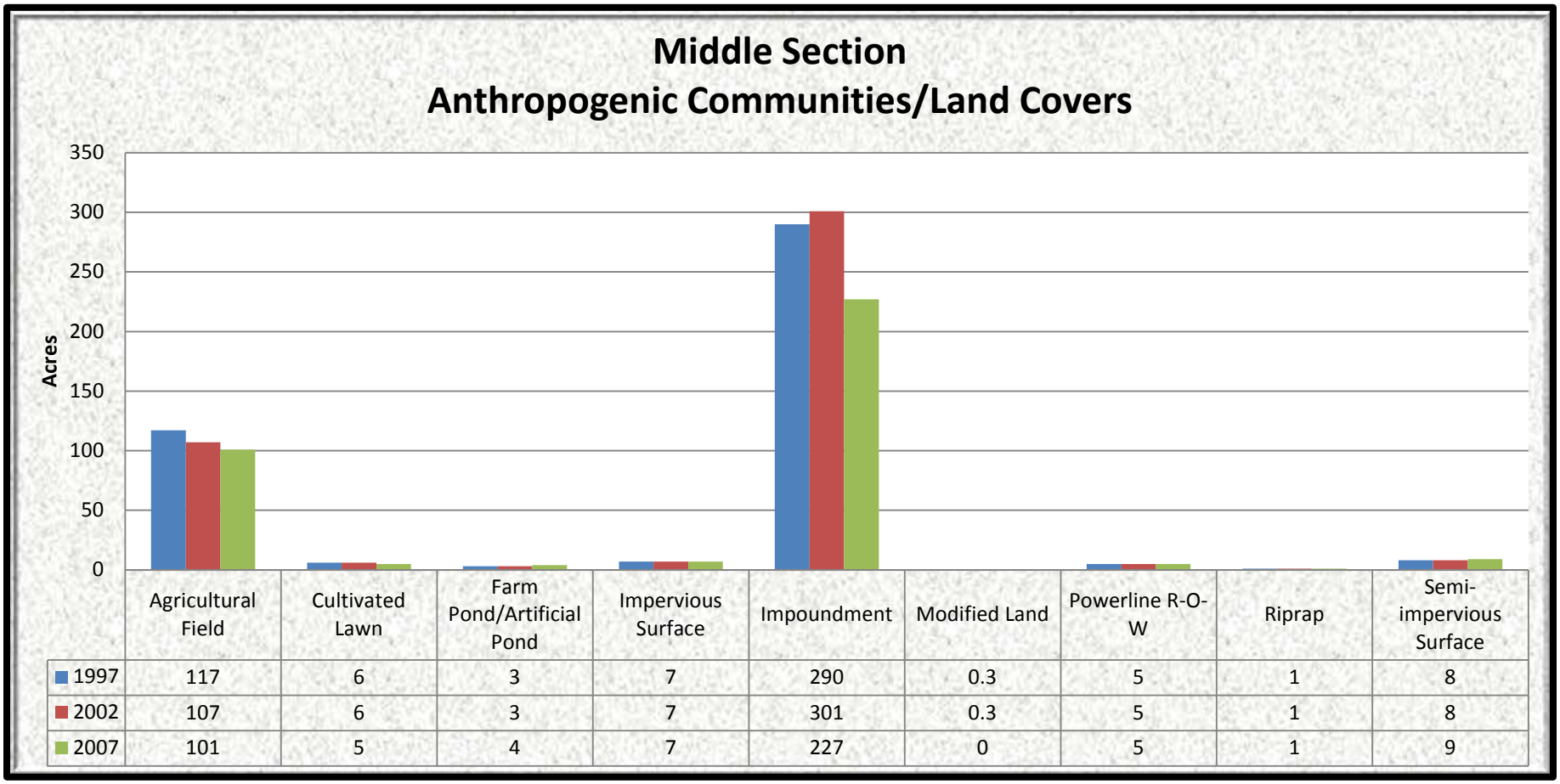
Essentially all of the marshland in the Middle Section will be flooded with 1 m of sea level rise.

Table 4-2.11. Projected acres of Middle Section Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1,321 acres
1 m	1,344 acres
1.5 m	1,346 acres

Natural Capital (Table 4-2.12)

Capital in marshland has going up through the study period with increases in North Atlantic Low Salt Marsh and North Atlantic High Salt Marsh.

Table 4-2.12. Natural Capital of Middle Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$8,293,418/year
2002	$8,036,746/year
2007	$8,457,174/year



	Agricultural Field	Cultivated Lawn	Farm Pond/Artificial Pond	Impervious Surface	Impoundment	Modified Land	Powerline R-O-W	Riprap	Semi-impervious Surface
1997	117	6	3	7	290	0.3	5	1	8
2002	107	6	3	7	301	0.3	5	1	8
2007	101	5	4	7	227	0	5	1	9

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

Middle Section Anthropogenic Communities/Land Covers (Figure 4-2.10): Impoundment is the most common anthropogenic community in the middle section and is the result of providing wading bird habitat. The amount of area in impoundment fluctuates depending on the management scheme in place at the time the amount of precipitation. Agricultural fields are the next most common and have been gradually decreasing as more land is put into wildlife use or succeeds to forest.

DNREC Sea Level Rise Analysis (Table 4-2.13)

A little more than ¾ of the current anthropogenic communities/land covers in the Middle Section will be inundated with 1.5 m of sea level rise.

Table 4-2.13. Projected acres of Middle Section Anthropogenic Communities/Land Covers Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	245 acres
1 m	260 acres
1.5 m	273 acres

Natural Capital (Table 4-2.14)

Agricultural fields and impoundments are the only land covers with any natural capital value in this category. The capital of them has been going down with acreage losses in both land covers.

Table 4-2.14. Natural Capital of Middle Section Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,569,894/year
2002	$1,628,007/year
2007	$1,238,200/year

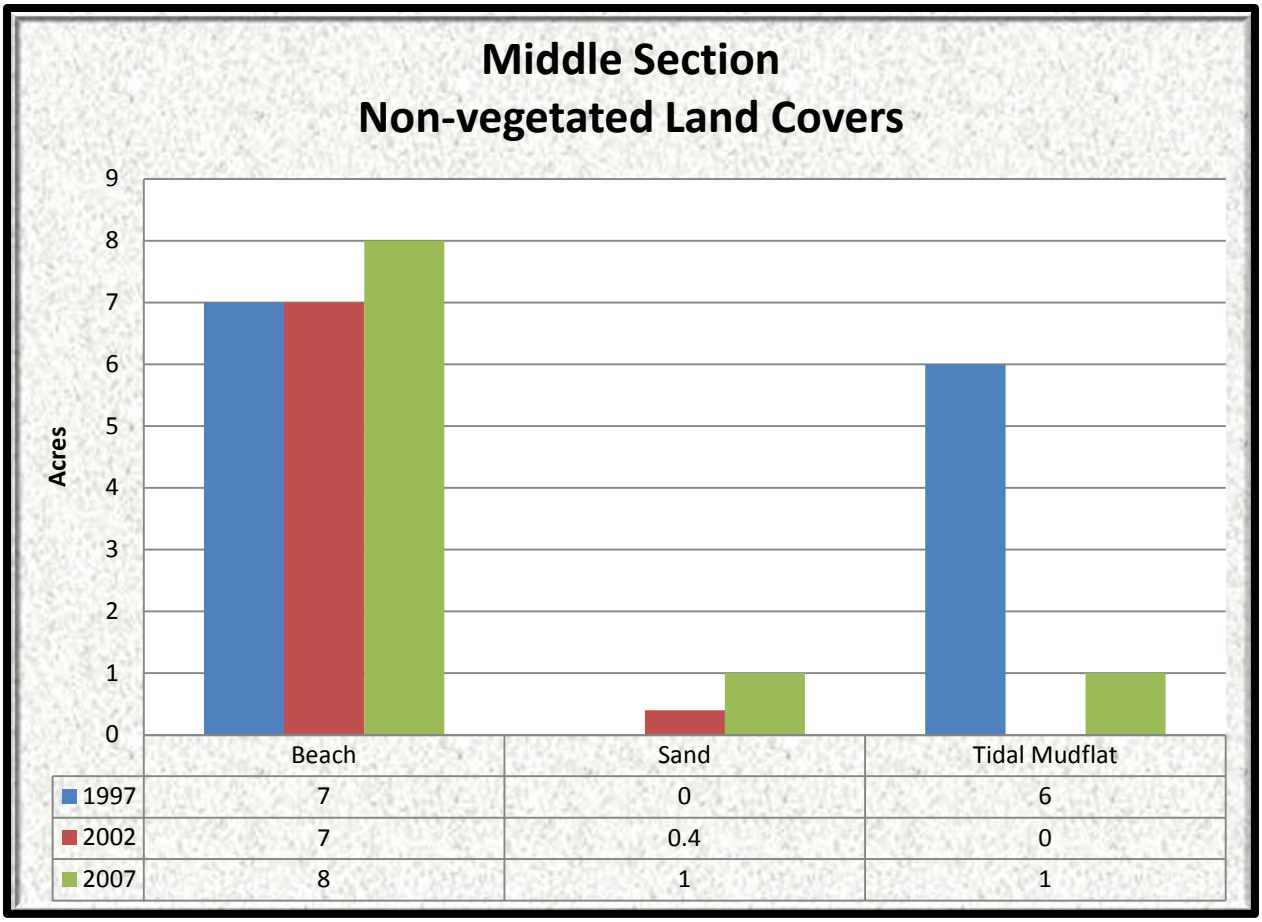


Figure 4-2.11. Middle Section Non-vegetated Communities (1997, 2002, and 2007)

Middle Section Non-vegetated Communities (Figure 4-2.11): Beach is the most common non-vegetated land cover in the middle section. Most of these fluctuate over time in this dynamic system.

DNREC Sea Level Rise Analysis (Table 4-2.15)

All of the Non-vegetated land covers in the Middle Section will be flooded with 1 m of sea level rise and will be mostly flooded with 0.5 m of rise.

Table 4-2.15. Projected acres of Middle Section Non-vegetated Land Covers Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	8 acres
1 m	10 acres
1.5 m	10 acres

Natural Capital (Table 4-2.16)

Tidal mudflat is the only non-vegetated land cover with natural capital value in the Middle Section. The capital has oscillated with the appearance and disappearance of mudflats underscoring the ephemeral nature of this land cover.

Table 4-2.16. Natural Capital of Middle Section Non-vegetated Land Covers

Year	Natural Capital (in 2012 dollars)
1997	$37,628/year
2002	$0/year (not present)
2007	$6,271/year

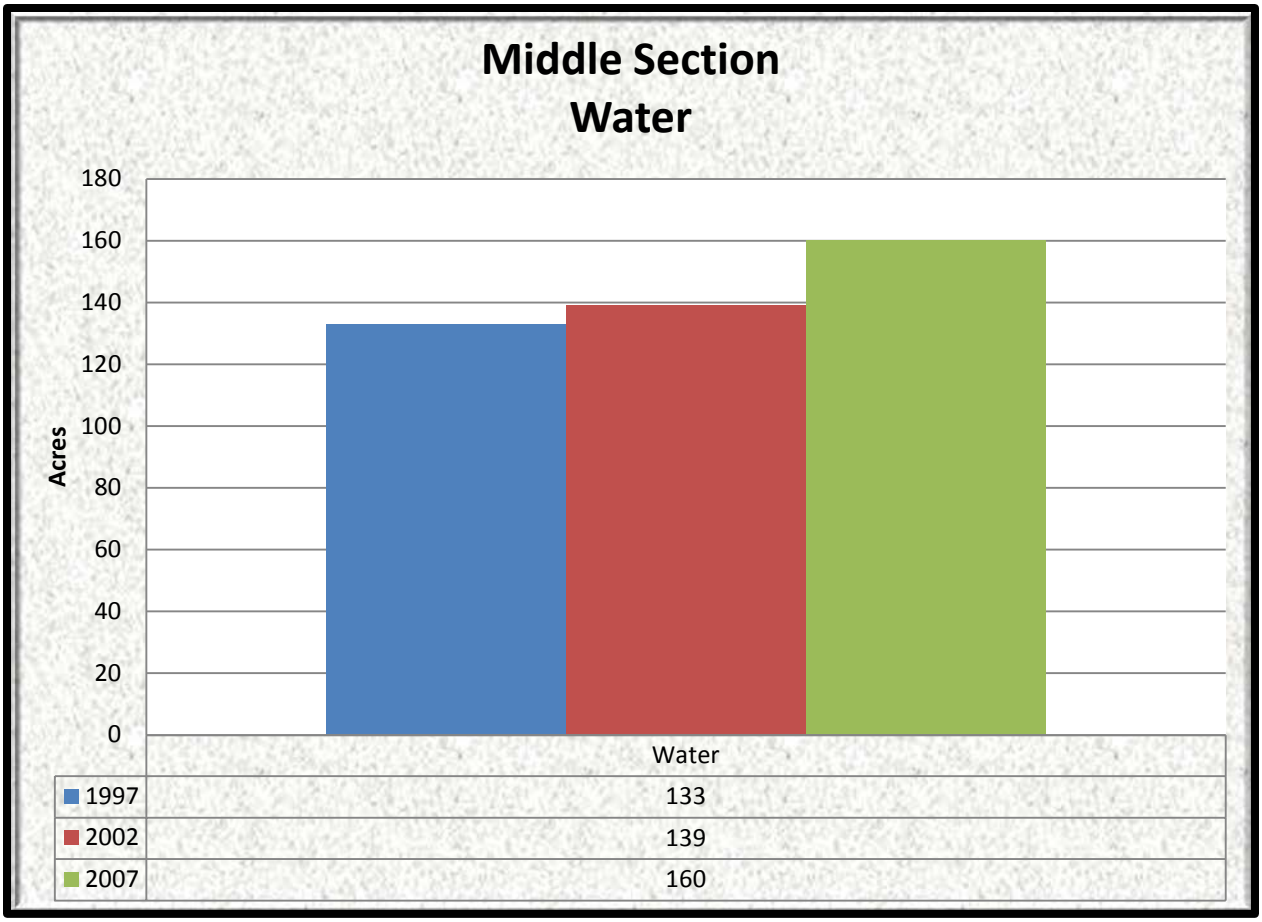


Figure 4-2.11. Middle Section Water Coverage (1997, 2002, and 2007)

Middle Section Water Coverage (Figure 4-2.11): The amount of area in water has greatly increased in the middle section. This large increase may be responsible for some of the increase in woodland and decrease in shrubland.

Natural Capital (Table 4-2.17)

Water capital has been increasing with sea level rise and erosion in the marsh.

Table 4-2.17. Natural Capital of Middle Section Water	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,906,269/year
2002	$1,992,266/year
2007	$2,293,256/year

3. South Section

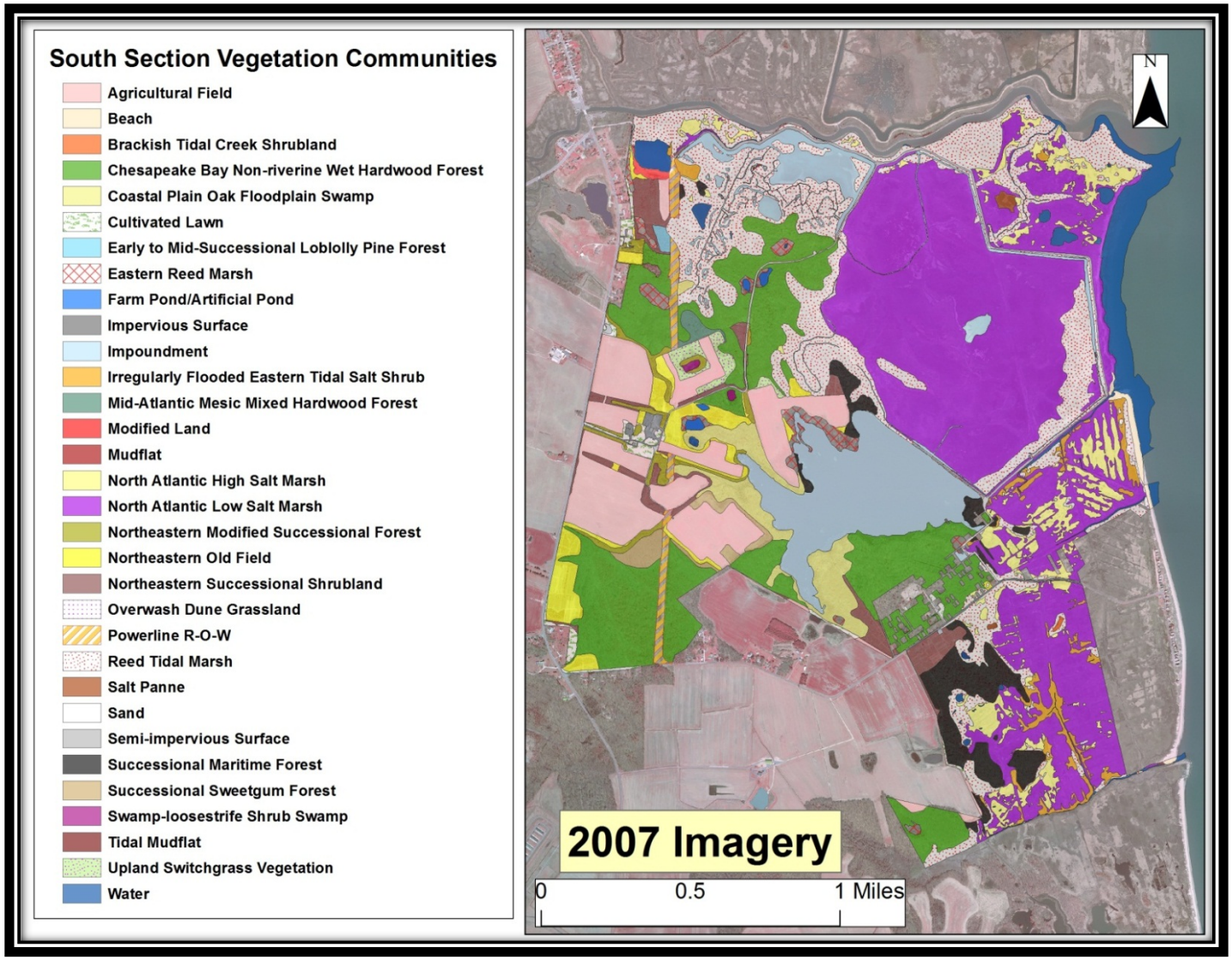


Figure 4-3.1. 2007 Vegetation Community map of the South Section

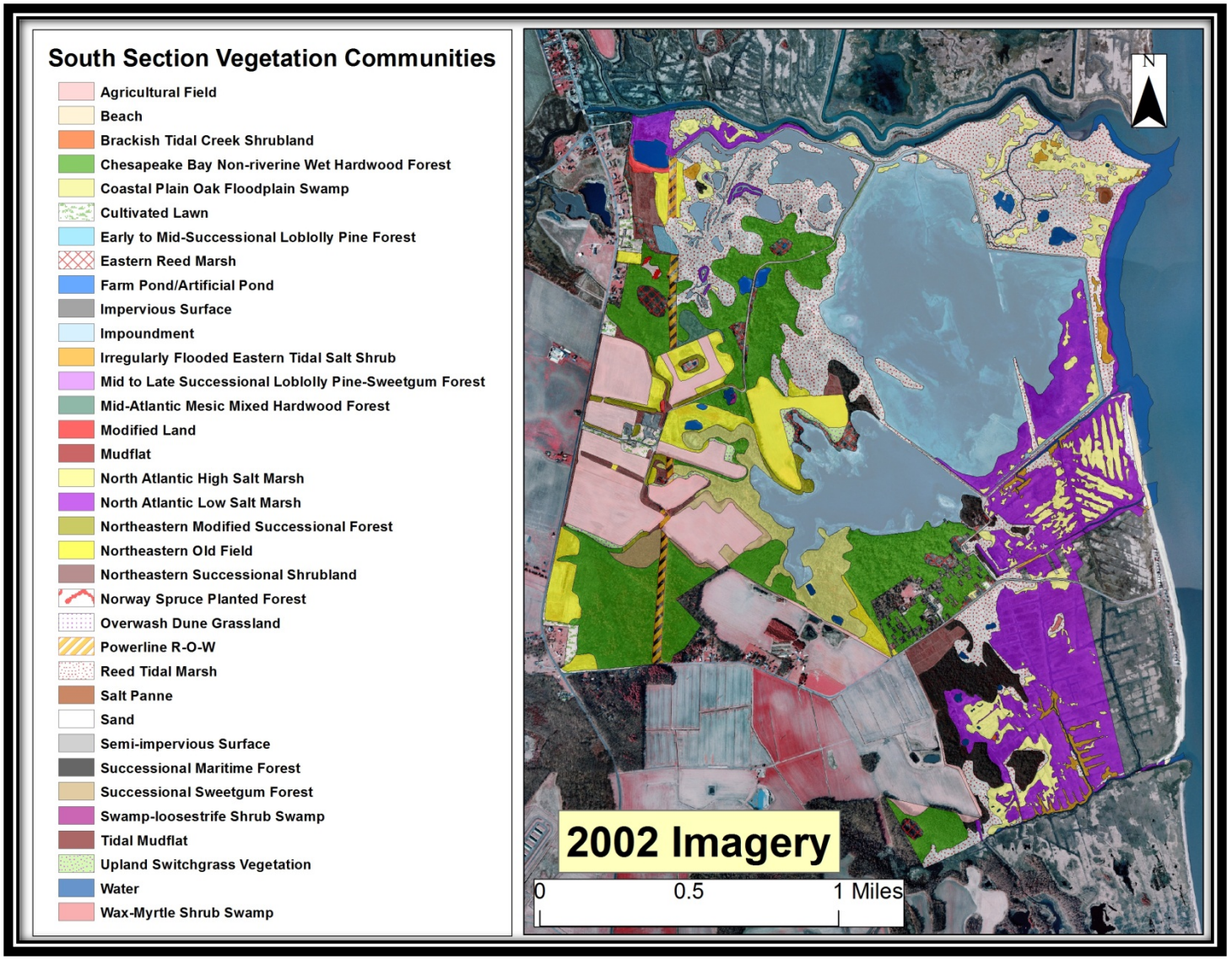


Figure 4-3.2. 2002 Vegetation Community map of the South Section

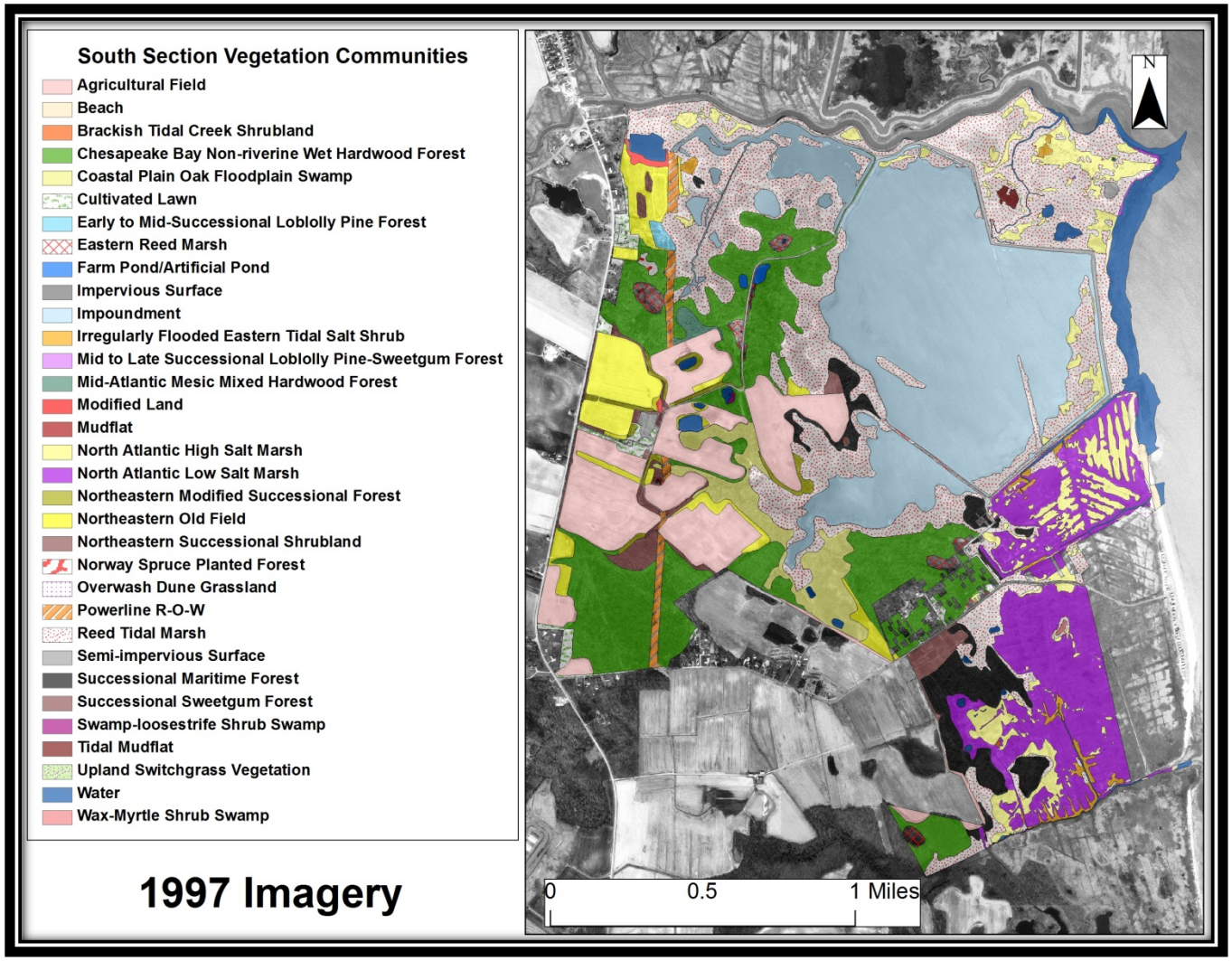


Figure 4-3.3. 1997 Vegetation Community map of the South Section

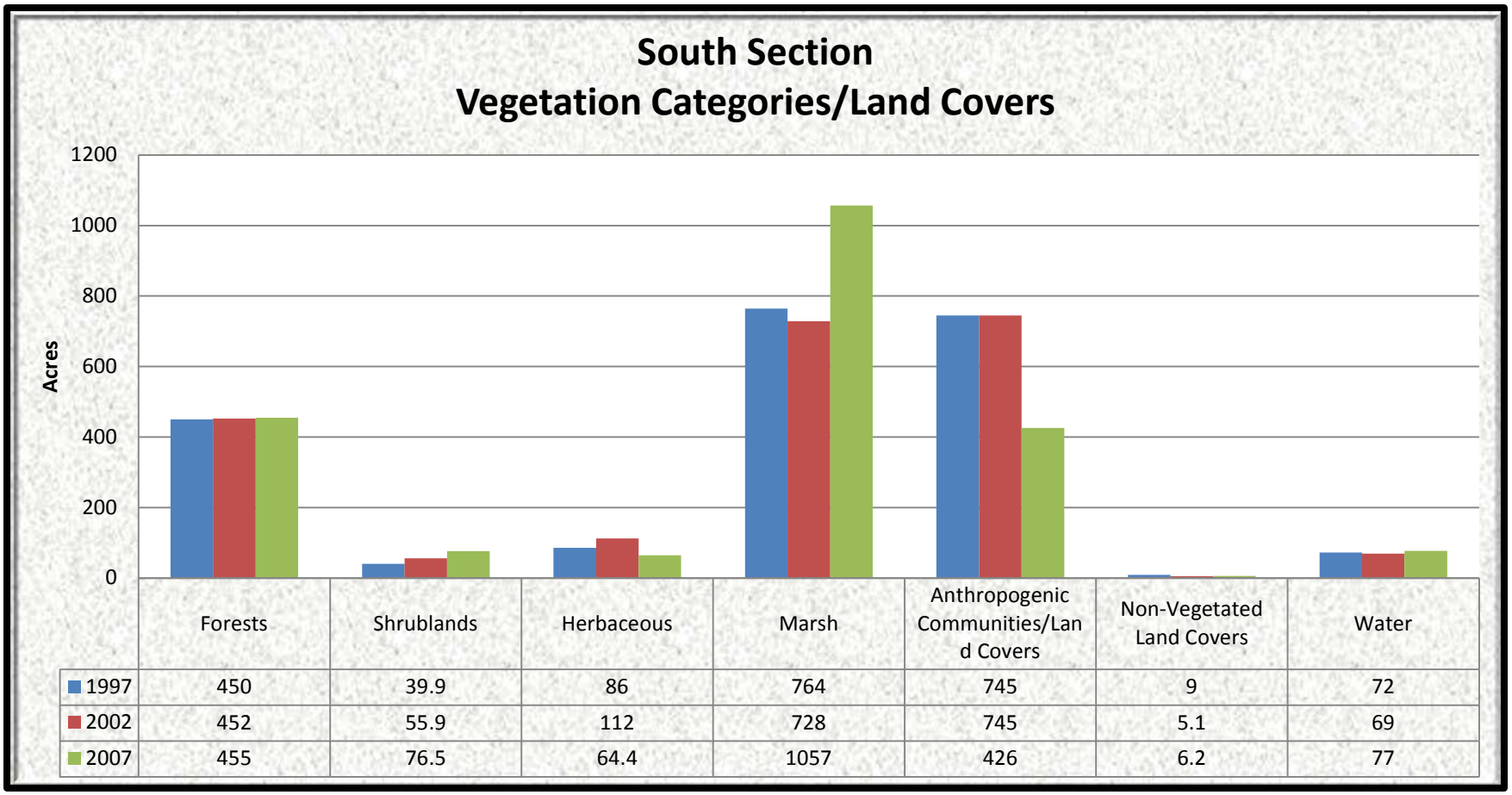


Figure 4-3.4. South Section Vegetation Community/Land Cover Categories (1997, 2002, and 2007)

South Section Vegetation Community/Land Covers (Figure 4-3.4): Marsh is the largest vegetation community/land cover type in the South Section followed by Forest and Anthropogenic communities/land covers. Forest and marsh have increased while anthropogenic communities have decreased.

DNREC Sea Level Rise Analysis (Table 4-3.1)

About 83% of the South Section will be inundated with 1.5 m of sea level rise.

Table 4-3.1. Projected acres of the South Section Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1,402 acres
1 m	1,662 acres
1.5 m	1,787 acres

Natural Capital (Table 4-3.2)

Capital of the South Section has increased with increases in acreages of marsh.

Table 4-3.2. Natural Capital of the South Section	
Year	**Natural Capital (in 2012 dollars)**
1997	$12,957,908/year
2002	$12,979,136/year
2007	$13,335,580/year

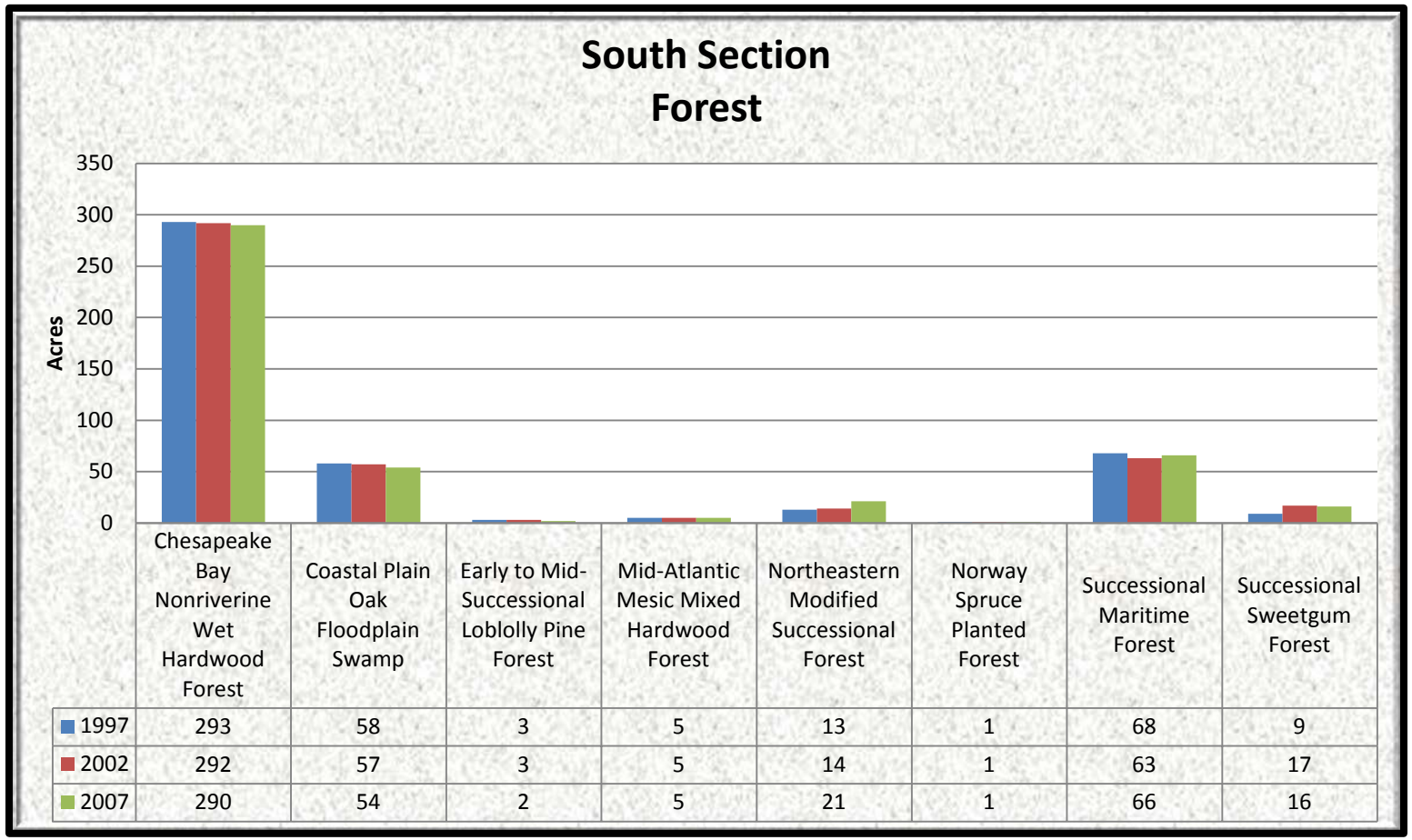


Figure 4-3.5. South Section Forest (1997, 2002, and 2007)

South Section Forest (Figure 4-3.5): Chesapeake Bay Non-riverine Wet Hardwood Forest is the most common forested community in the South Section of Little Creek Wildlife Area. Along with a lot of other forests it is gradually declining in acreage.

DNREC Sea Level Rise Analysis (Table 4-3.3)

About 2/3 of the current forestland will be inundated with 1.5 m of sea level rise.

Table 4-3.3. Projected acres of South Section Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	106 acres
1 m	242 acres
1.5 m	304 acres

Natural Capital (Table 4-3.4)

Capital in forest has been decreasing with deceases in wetland forest acreage.

Table 4-3.4. Natural Capital of South Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$4,333,037/year
2002	$4.309,211/year
2007	$4,249,266/year

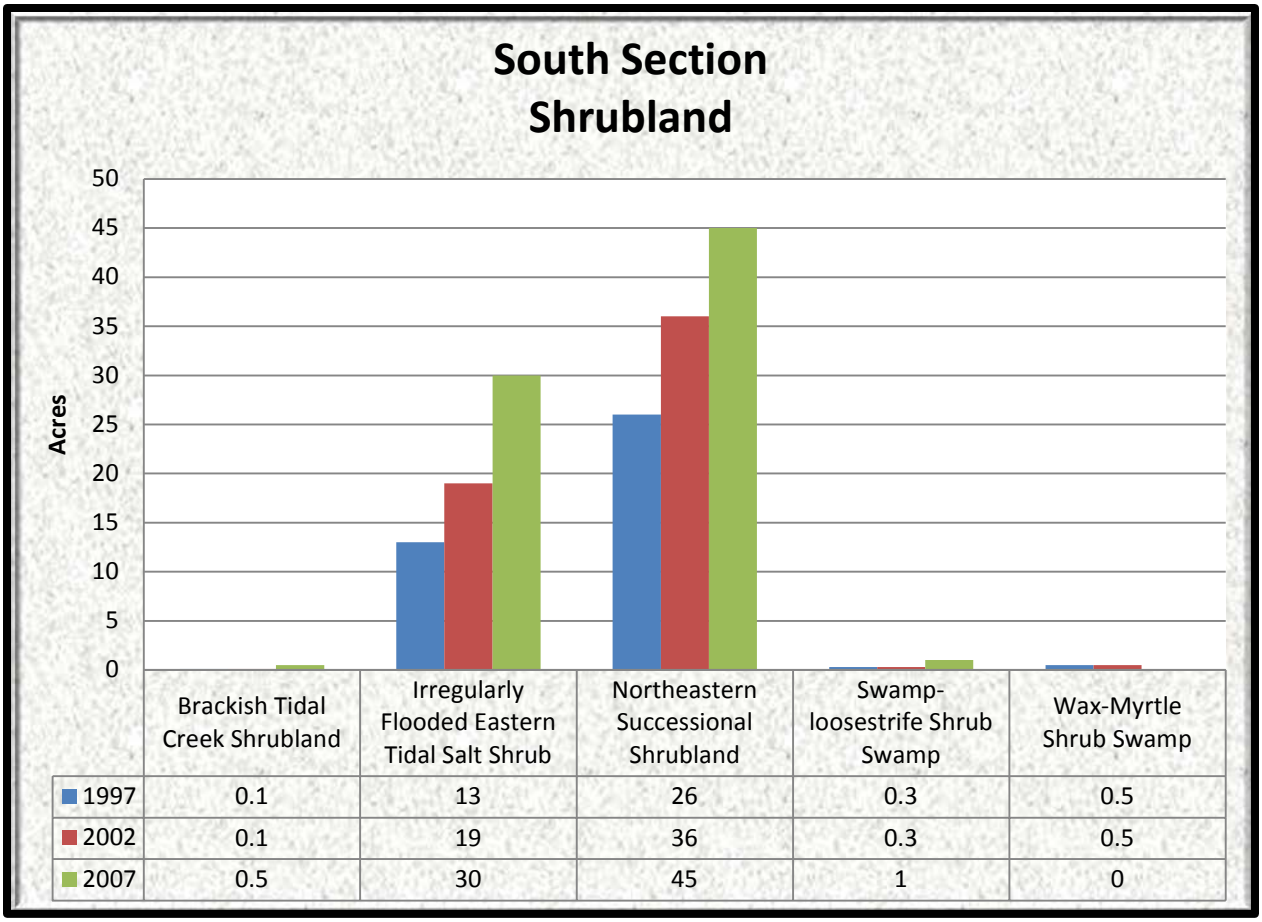


Figure 4-3.6. South Section Shrubland (1997, 2002, and 2007)

South Section Shrubland (Figure 4-3.6): Northeastern Successional Shrubland is the most prominent shrubland in the south section, followed by Irregularly Flooded Eastern Tidal Salt Shrub. Both of these communities are increasing for different reasons. Northeastern Successional Shrubland is developing in older Northeastern Old Fields and Irregularly Flooded Eastern Tidal Salt Shrub is taking over land reclaimed by *Phragmites* control and regression of the salt marsh.

DNREC Sea Level Rise Analysis (Table 4-3.5)

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

Table 4-3.5. Projected acres of South Section Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	28 acres
1 m	42 acres
1.5 m	56 acres

Natural Capital (Table 4-3.6)

Capital in shrubland has been increasing due to increases in Irregularly Flooded Eastern Tidal Salt Shrub and Northeastern Successional Shrubland.

Table 4-3.6. Natural Capital of South Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$93,367/year
2002	$132,452/year
2007	$207,112/year

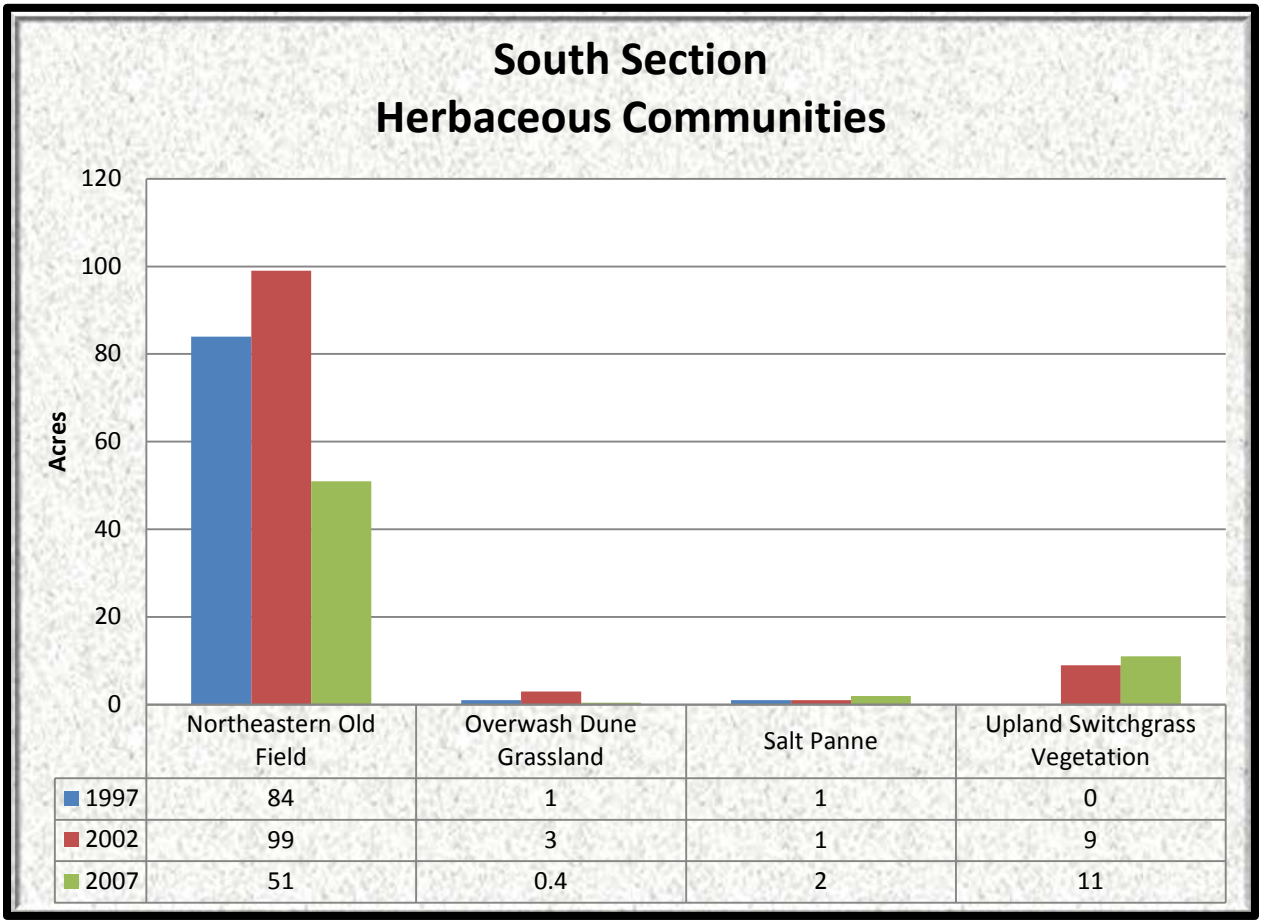


Figure 4-3.7. South Section Herbaceous Communities (1997, 2002, and 2007)

South Section Herbaceous Communities (Figure 4-3.7): Northeastern Old Field is the most prominent herbaceous community and has declined over time as it has matured into shrubland and forest. Upland Switchgrass Vegetation has been planted on the edges of fields and has appeared and increased during the study period.

DNREC Sea Level Rise Analysis (Table 4-3.7)

About 1/3 of the current herbaceous communities in the South Section would be inundated by 1.5 m of sea level rise.

Table 4-3.7. Projected acres of South Section Herbaceous Communities Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	10 acres
1.5 m	22 acres

Natural Capital (Table 4-3.8)

Herbaceous community capital has increased overall from 1997, but has decreased recently (2002-2007) with a loss in Northeastern Old Field acreage.

Table 4-3.8. Natural Capital of South Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1997	$18,656/year
2002	$22,444/year
2007	$21,634/year

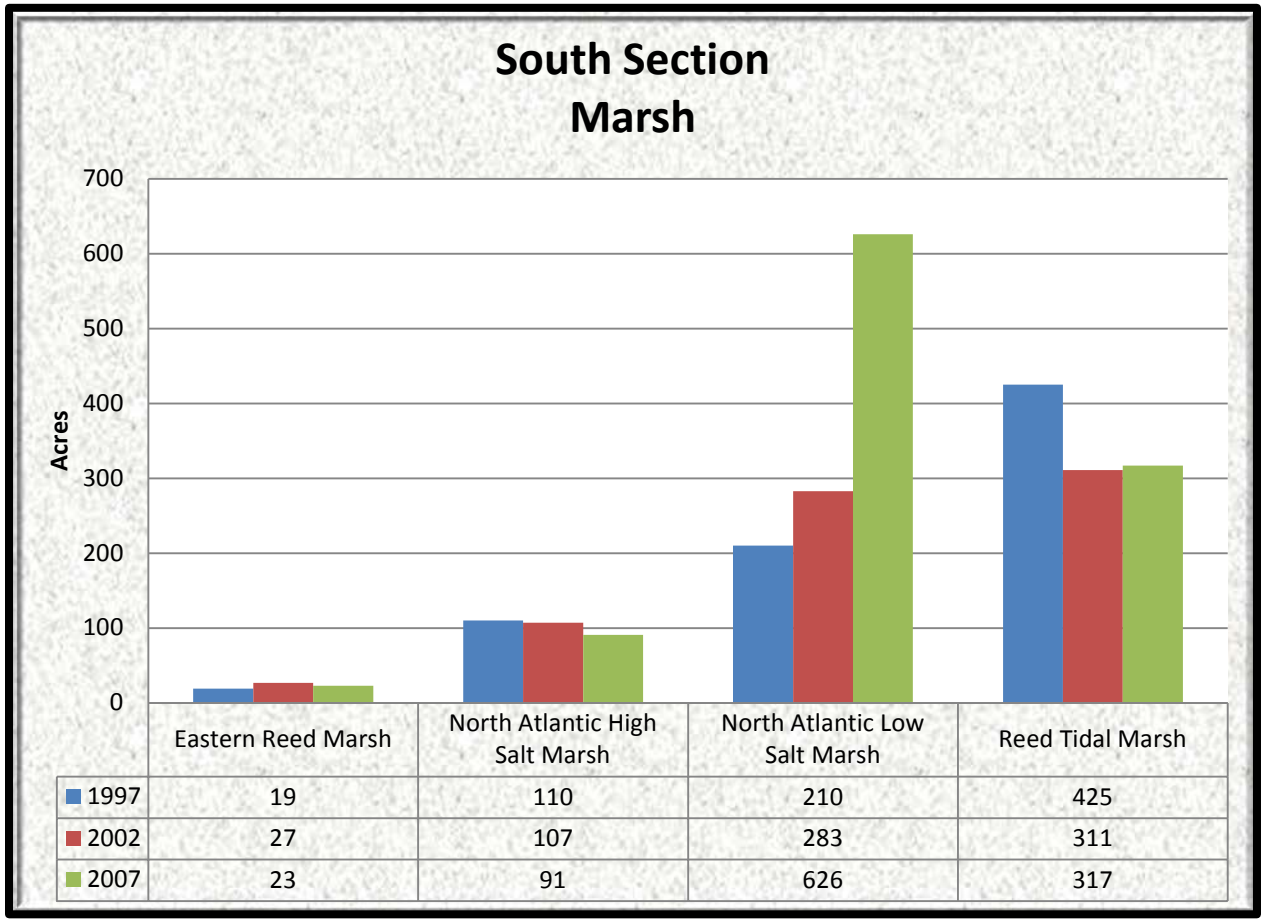


Figure 4-3.8. South Section Marsh (1997, 2002, and 2007)

South Section Marsh (Figure 4-3.8): North Atlantic Low Salt Marsh is the dominant marsh community followed by Reed Tidal Marsh. Reed Tidal Marsh has been declining with control efforts. North Atlantic High Salt Marsh unlike the two other sections is declining.

DNREC Sea Level Rise Analysis (Table 4-3.9)

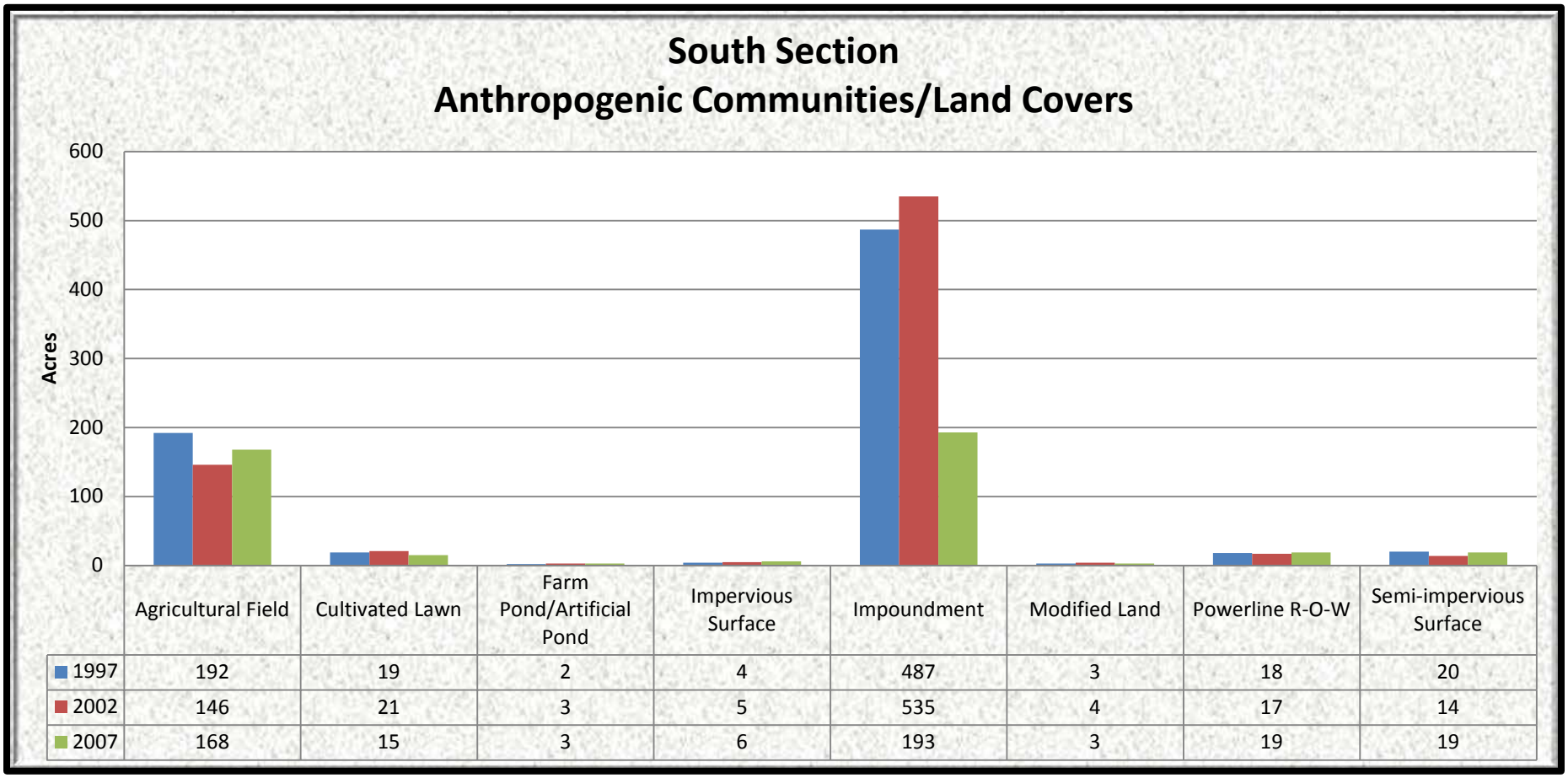
All of the marshland will be essentially inundated with 1 m of sea level rise in the South Section.

Table 4-3.9. Projected acres of South Section Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1,000 acres
1 m	1,052 acres
1.5 m	1,056 acres

Natural Capital (Table 4-3.10)

Capital in marshland has gone up markedly with an increase in North Atlantic Low Salt Marsh in an impoundment. It is unknown whether this condition is temporary or not.

Table 4-3.10. Natural Capital of South Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$4,848,465/year
2002	$4,646,779/year
2007	$6,697,996/year



	Agricultural Field	Cultivated Lawn	Farm Pond/Artificial Pond	Impervious Surface	Impoundment	Modified Land	Powerline R-O-W	Semi-impervious Surface
1997	192	19	2	4	487	3	18	20
2002	146	21	3	5	535	4	17	14
2007	168	15	3	6	193	3	19	19

Figure 4-3.9. South Section Anthropogenic Communities/Land Covers (1997, 2002, and 2007)

South Section Anthropogenic Communities/Land Covers (Figure 4-3.9): Impoundment is the most common anthropogenic community followed by agricultural field. Impoundment area varies widely depending on management. Other anthropogenic communities are minor to the major land covers.

DNREC Sea Level Rise Analysis (Table 4-3.11)

A little less than 2/3 of the anthropogenic communities/land covers in the South Section will be inundated with 1.5 m of sea level rise.

Table 4-3.11. Projected acres of South Section Anthropogenic Communities/Land Covers Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	182 acres
1 m	233 acres
1.5 m	264 acres

Natural Capital (Table 4-3.12)

Capital in anthropogenic communities/land cover has been reduced by more than half because of the drying of an impoundment. The capital was transferred to marsh.

Table 4-3.12. Natural Capital of South Section Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1997	$2,619,875/year
2002	$2,878,657/year
2007	$1,055,314/year

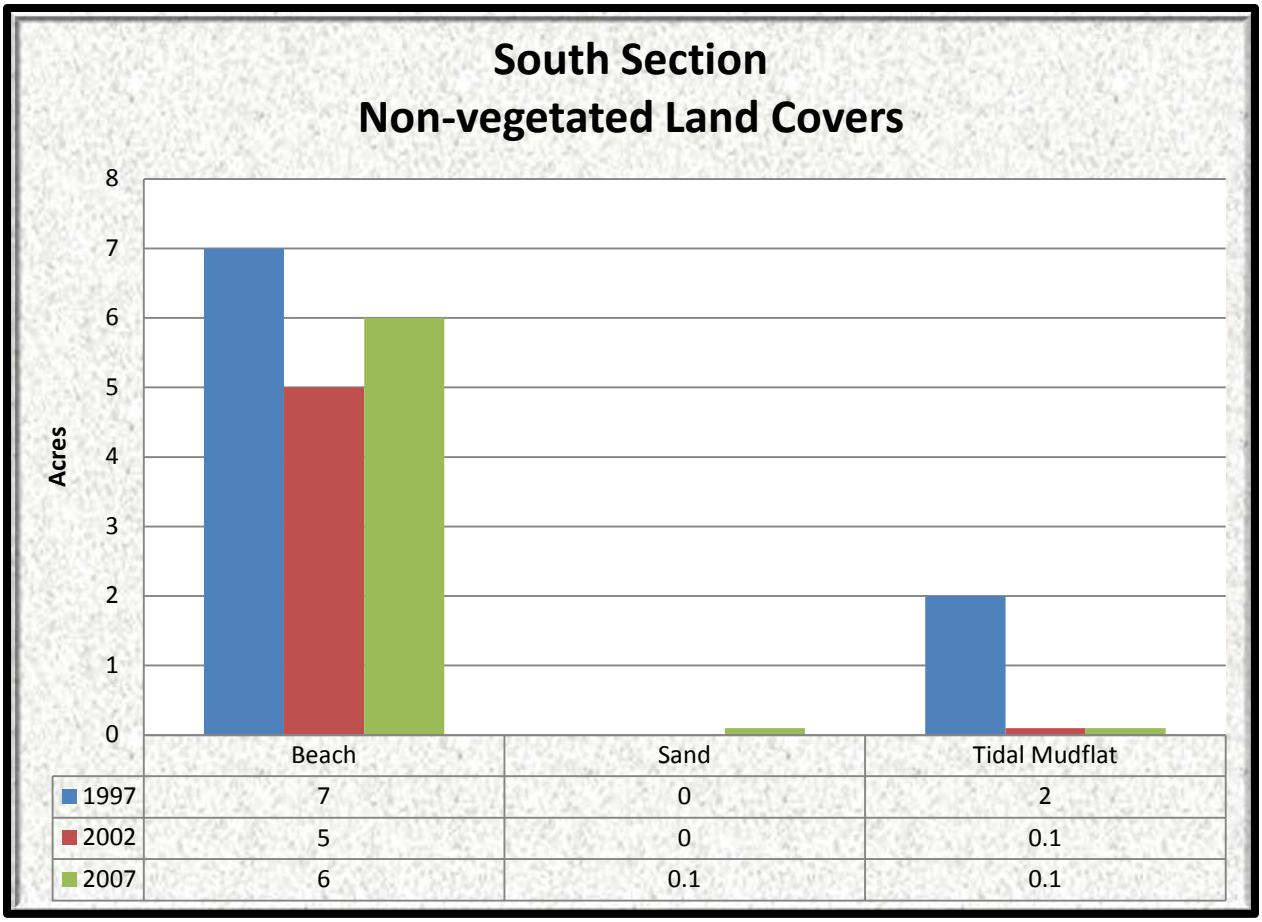


Figure 4-3.10. South Section Non-vegetated Covers (1997, 2002, and 2007)

South Section Non-vegetated Land Covers (Figure 4-3.10): Non-vegetated communities cover a small amount of the south section with beach area on Delaware Bay being the most prominent.

DNREC Sea Level Rise Analysis (Table 4-3.13)

All of the Non-vegetated Land Covers in the South Section will be inundated with 1 m of sea level rise.

Table 4-3.13. Projected acres of the South Section Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	4 acres
1 m	6 acres
1.5 m	6 acres

Natural Capital (Table 4-3.14)

Tidal mudflat is the only Non-vegetated land cover with any natural capital value. The capital has declined due to a loss in acreage during the study period.

Table 4-3.14. Natural Capital of the South Section

Year	Natural Capital (in 2012 dollars)
1997	$12,543/year
2002	$627/year
2007	$627/year

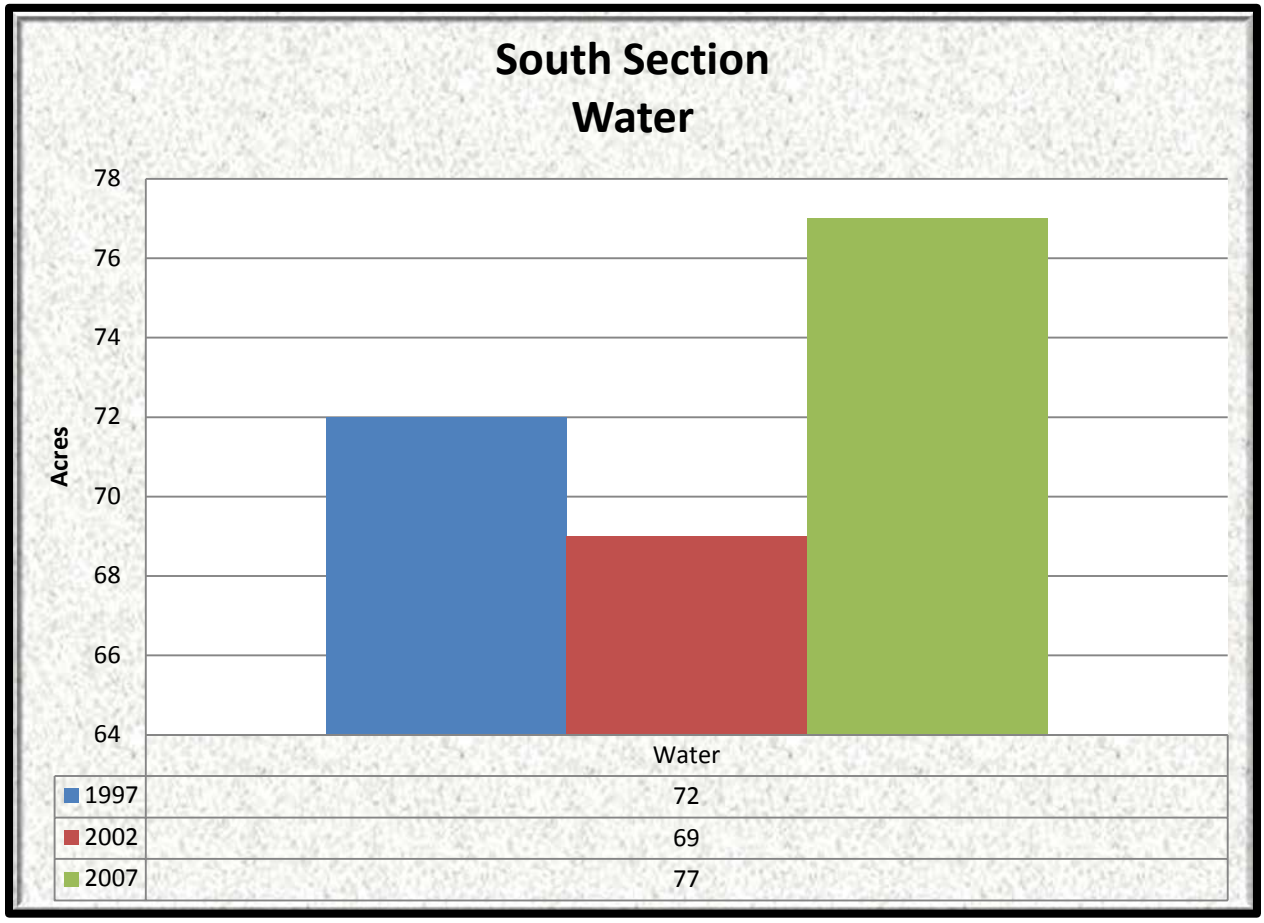


Figure 4-3.11. South Section Water Coverage (1997, 2002, and 2007)

South Section Water Coverage (Figure 4-3.11): Water coverage overall has increased in the south section being driven by erosion on the Delaware bayshore and sea level rise. A small decrease was seen in the 1997 to 2002 period but the increase continued in the 2002 to 2007 period.

Natural Capital (Table 4-3.15)

Capital in water has largely increased over the study period due an overall increase in acreage.

Table 4-3.15. Natural Capital of South Section Water	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,031,965/year
2002	$988,967/year
2007	$1,103,629/year

CHAPTER 5: DESCRIPTIONS OF THE VEGETATION COMMUNITIES

Twenty-nine vegetation communities were noted in the survey (Figures 4-1.1-1.3, 4-2.1-2.3, 4-3.1-3.3). 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.

Current Vegetation Communities (2007):

1. Brackish Tidal Creek Shrubland (CEGL006846)—1 acre
2. Cattail Brackish Tidal Marsh (CEGL004201)—7 acres
3. Chesapeake Bay Non-riverine Wet Hardwood Forest (CEGL004644)—405 acres
4. Coastal Loblolly Pine Wetland Forest (CEGL006137)—2 acres
5. Coastal Plain Oak Floodplain Swamp (CEGL006605)—54 acres
6. Cultivated Lawn (CEGL008462)—20 acres
7. Early to Mid-Successional Loblolly Pine Forest (CEGL006011)—2 acres
8. Eastern Cattail Marsh (CEGL006153)—0.5 acres
9. Eastern Reed Marsh (CEGL004141)—25 acres
10. Irregularly Flooded Eastern Tidal Salt Shrub (CEGL003921)—53 acres
11. Loblolly Pine Plantation (CEGL007179)—3 acres
12. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland (CEGL006849)—2 acres
13. Mid-Atlantic Mesic Mixed Hardwood Forest (CEGL006075)—34 acres
14. Mid to Late Successional Loblolly Pine-Sweetgum Forest (CEGL008462)—3 acres
15. North Atlantic High Salt Marsh (CEGL006006)—447 acres
16. North Atlantic Low Salt Marsh (CEGL004192)—1,695 acres
17. Northeastern Modified Successional Forest (CEGL006599)—27 acres
18. Northeastern Old Field (CEGL006107)—83 acres
19. Northeastern Successional Shrubland (CEGL006451)—47 acres
20. Norway Spruce Planted Forest (CEGL007167)—1 acre
21. Overwash Dune Grassland (CEGL004097)—0.4 acres
22. Reed Tidal Marsh (CEGL004187)—563 acres
23. Salt Panne (CEGL004308)—37 acres
24. Successional Maritime Forest (CEGL006154)—97 acres
25. Successional Sweetgum Forest (CEGL007216)—25 acres
26. Swamp-loosestrife Shrub Swamp (CEGL005089)—1 acre
27. Upland Switchgrass Vegetation (CEGL006616)—22 acres
28. Virginia Pine Successional Forest (CEGL002591)—4 acres
29. Wax-Myrtle Shrub Swamp (CEGL003840)—5 acres

Brackish Tidal Creek Shrubland **[1 acre (Figure 5.1, Tables 5.1-5.4] GNR S3**

DEWAP: Shrub Swamps
NHC: Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh

Description

This shrubland community is found in two locations, both of which are on islands in the marsh. From all appearances this shrubland came about through the gradually flooding of a forest area as the salt marsh encroached on an island. This occurrence was not directly observed in the field due to the location and an exact species cannot be given. However, most of these communities are dominated by southern bayberry (*Morella cerifera*), and associated by salt shrub (*Baccharis halimifolia*). The communities at Little Creek Wildlife Area also likely have common reed (*Phragmites australis*) on the edges since they are surrounded by Reed Tidal Marsh.

Analysis of Condition at Little Creek Wildlife Area

Existing Brackish Tidal Creek Shrubland has not changed much over the study period with 0.3 acres still remaining from 1997 in 2007. About 0.1 acres matured into Successional Maritime Forest since 1997 (Table 5.1).

Since 1997, this shrubland has increased in acreage and has converted 0.5 acres of Wax-Myrtle Shrub Swamp. This acreage along with the 0.3 acres still remaining brings the total to 0.8 acres in 2007 (Table 5.2).

Table 5.1. What was once Brackish Tidal Creek Shrubland in 1997 has become X in 2007	
X	**Acreage**
Brackish Tidal Creek Shrubland	0.3 acres
Successional Maritime Forest	0.1 acres

Table 5.2. Brackish Tidal Creek Shrubland has migrated into X since 1997	
X	**Acreage**
Wax-Myrtle Shrub Swamp	0.5 acres
Brackish Tidal Creek Shrubland	0.3 acres

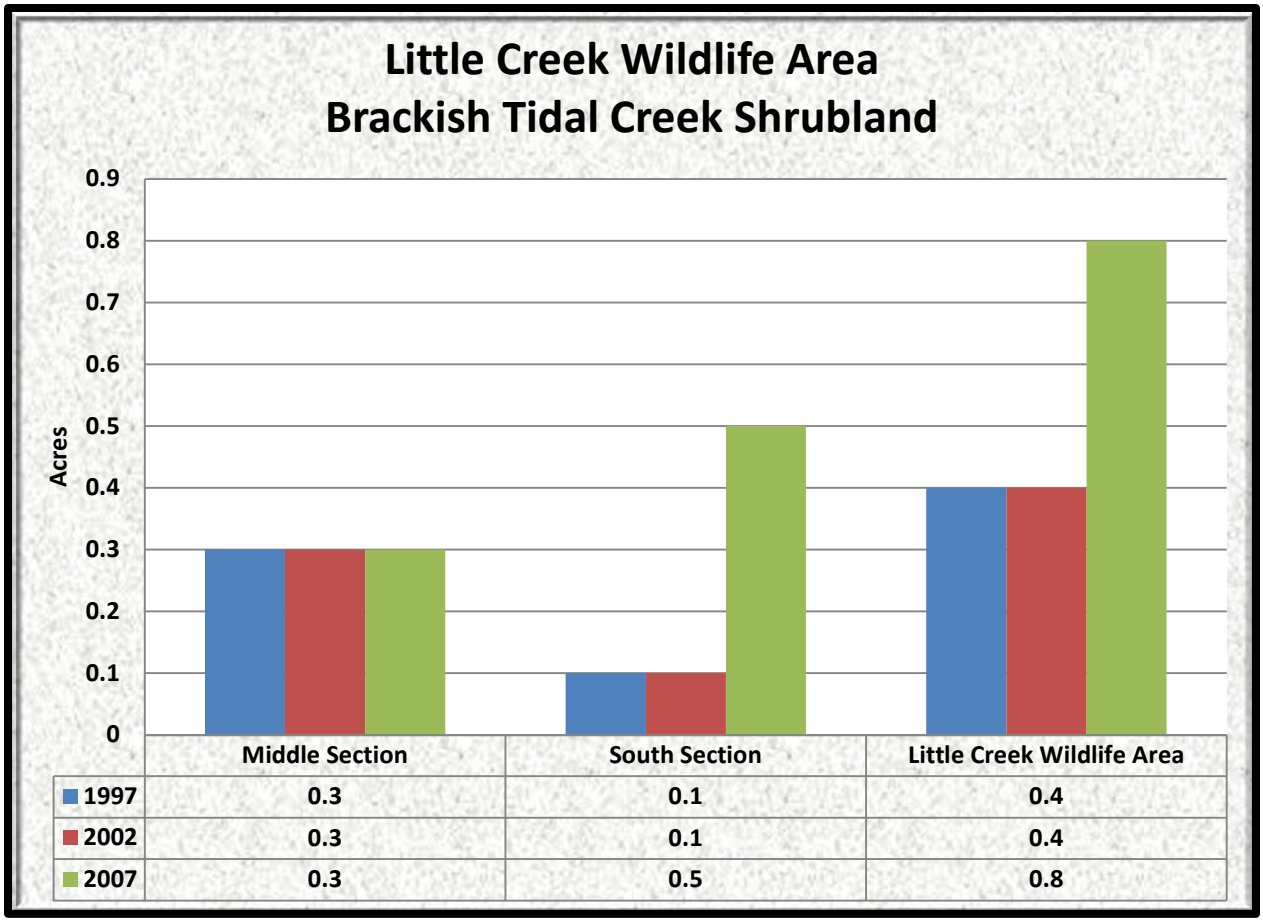


Figure 5.1. Brackish Tidal Shrubland at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.3)

Essentially all of the Brackish Tidal Creek Shrubland present in Little Creek Wildlife Area will be inundated with 0.5 m and the rest at 1 m of sea level rise.

Table 5.3. Projected acres of Brackish Tidal Creek Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0.6 acres
1 m	0.7 acres
1.5 m	0.7 acres

Natural Capital (Table 5.4)

Capital in Brackish Tidal Creek Shrubland has increased with acreage over the study period.

Table 5.4. Natural Capital of Brackish Tidal Creek Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$2,509/year
2002	$2,509/year
2007	$5,017/year

***Cattail Brackish Tidal Marsh* [7 acres (Figure 5.2, Tables 5.5-5.8)] G4G5 S3**

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

Description

This community is composed of wide-leaf cattail (*Typha latifolia*) and narrow leaf cattail (*Typha angustifolia*) in a tidal situation.

Analysis of Condition at Little Creek Wildlife Area

Cattail Brackish Tidal Marsh has increased from 1997 to 2007 with all of the acres from 1997 present in 2007 (Table 5.5). Since 1997 this community has converted 2 acres of Irregularly Flooded Eastern Tidal Salt Shrub for a net gain of 2 acres (Table 5.6).

Table 5.5. What was once Cattail Brackish Tidal Marsh in 1997 has become X in 2007	
X	**Acreage**
Cattail Brackish Tidal Marsh	5 acres

Table 5.6. Cattail Brackish Tidal Marsh has migrated into X since 1997	
X	**Acreage**
Cattail Brackish Tidal Marsh	5 acres
Irregularly Flooded Eastern Tidal Salt Shrub	2 acres

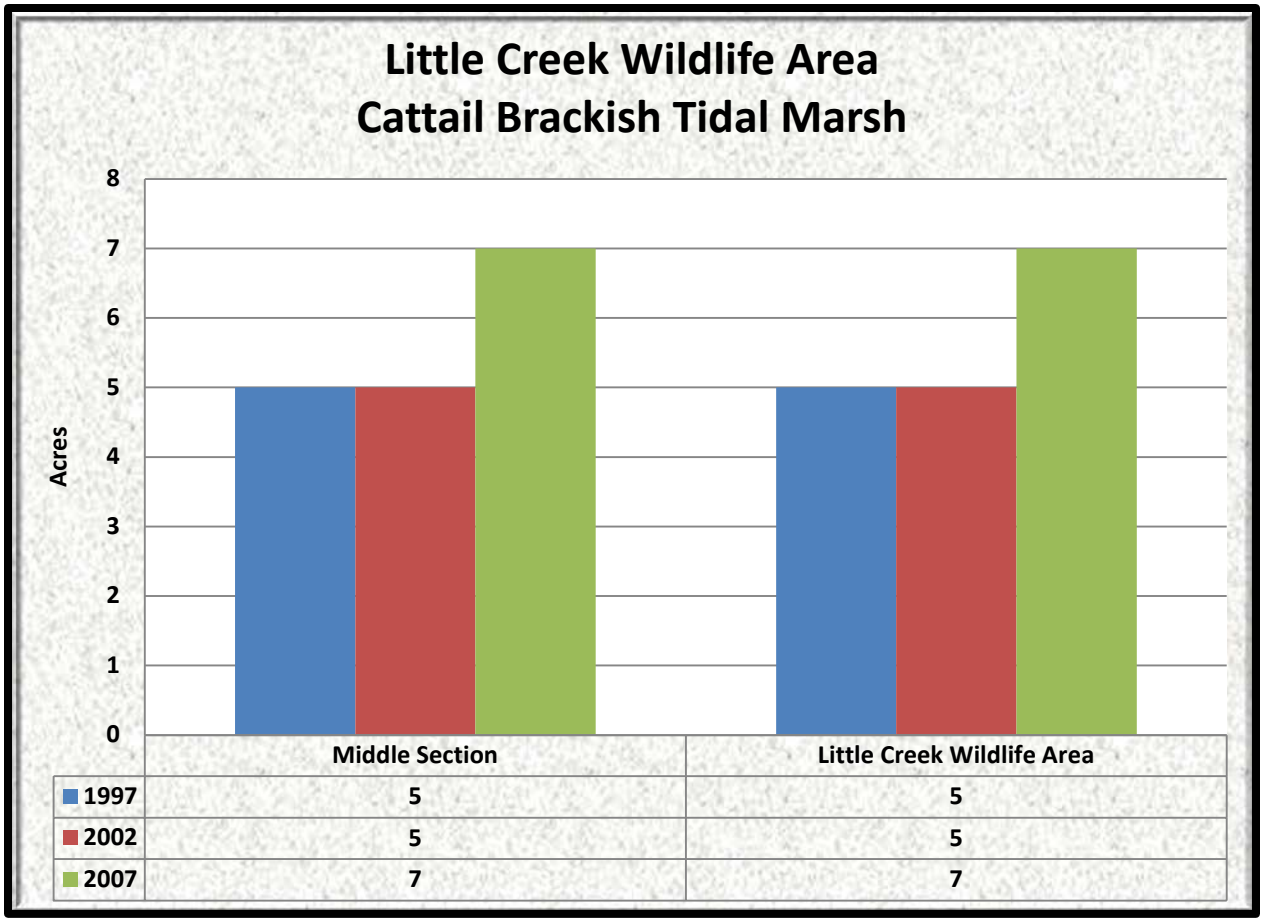


Figure 5.2. Cattail Brackish Tidal Marsh at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.7)

All of the Cattail Brackish Tidal Marsh present in Little Creek Wildlife Area will be inundated with 0.5 m of sea level rise.

Table 5.7. Projected acres of Cattail Brackish Tidal Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	7 acres
1 m	7 acres
1.5 m	7 acres

Natural Capital (Table 5.8)

Capital in Cattail Brackish Tidal Marsh has increased during the study period with gains from Irregularly Flooded Eastern Tidal Salt Shrub. This could be due to sea level rise converting the shrubland to marsh. The Cattail Brackish Tidal Marsh may in time be converted to North Atlantic Low Salt Marsh.

Table 5.8. Natural Capital of Cattail Brackish Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$31,357/year
2002	$31,357/year
2007	$43,899/year

Chesapeake Bay Non-riverine Wet Hardwood Forest **[404 acres (Figures 5.3-5.4, Tables 5.9-5.12)] G3? S3**

DEWAP: Isolated Forested Wetlands
NHC: Northern Atlantic Coastal Plain Basin Swamp and Wet Hardwood Swamp

Description

This is the most forested community in the wildlife area and is widespread in the lowlands. Common canopy species include red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), black gum (*Nyssa sylvatica*), willow oak (*Quercus phellos*), southern red oak (*Quercus falcata*), and white oak (*Quercus alba*). The understory is composed of eastern red cedar (*Juniperus virginiana*), American holly (*Ilex opaca*), sweetbay (*Magnolia virginiana*), pin oak (*Quercus palustris*), and sweetgum (*Liquidambar styraciflua*). The shrub and vine layer include highbush blueberry (*Vaccinium corymbosum*), common greenbrier (*Smilax rotundifolia*), lowbush blueberry (*Vaccinium pallidum*), poison ivy (*Toxicodendron radicans*), and Japanese honeysuckle (*Lonicera japonica*). Speargrass (*Chasmanthium laxum*), royal fern (*Osmunda regalis*), thicket sedge (*Carex abscondita*), onion (*Allium* sp.), ground pine (*Lycopodium obscurum*), partridgeberry (*Mitchella repens*), and Atlantic sedge (*Carex atlantica*) are among the herbs noted.

Figure 5.3. Chesapeake Bay Non-riverine Wet Hardwood Forest

The examples located at Little Creek Wildlife Area are in a late successional state. Most forest layers are intact but canopy trees are still of small size. Except for the edges near marshes exotics in this community are few.

Analysis of Condition at Little Creek Wildlife Area

This lowland forested community has decreased steadily throughout the study period. Most of the losses have come from the spread of exotic invasive plant species which have converted the forest to Northeastern Modified Successional Forest (6 acres). Other places have converted to Coastal Plain Oak Swamp (2 acres), and one acre each of Reed Tidal Marsh and Impoundment. Only 393 acres of the original 408 acres present 1997 still existed in 2007 (Table 5.9).

Since 1997 this forest has still migrated in spite of the losses into 6 acres of Eastern Reed Marsh, 2 acres of Successional Maritime Forest, and 1 acre of cultivated lawn (Table 5.10).

Table 5.9. 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	414 acres
Northeastern Modified Successional Forest	6 acres
Coastal Plain Oak Floodplain Swamp	2 acres
Reed Tidal Marsh	1 acre
Impoundment	1 acre
Other communities/land covers	4 acres

Table 5.10. Chesapeake Bay Non-riverine Wet Hardwood Forest has migrated into X since 1997	
X	**Acreage**
Chesapeake Bay Non-riverine Wet Hardwood Forest	414 acres
Eastern Reed Marsh	6 acres
Successional Maritime Forest	2 acres
Cultivated Lawn	1 acre
Agricultural Field	1 acre
Other communities/land covers	2 acres

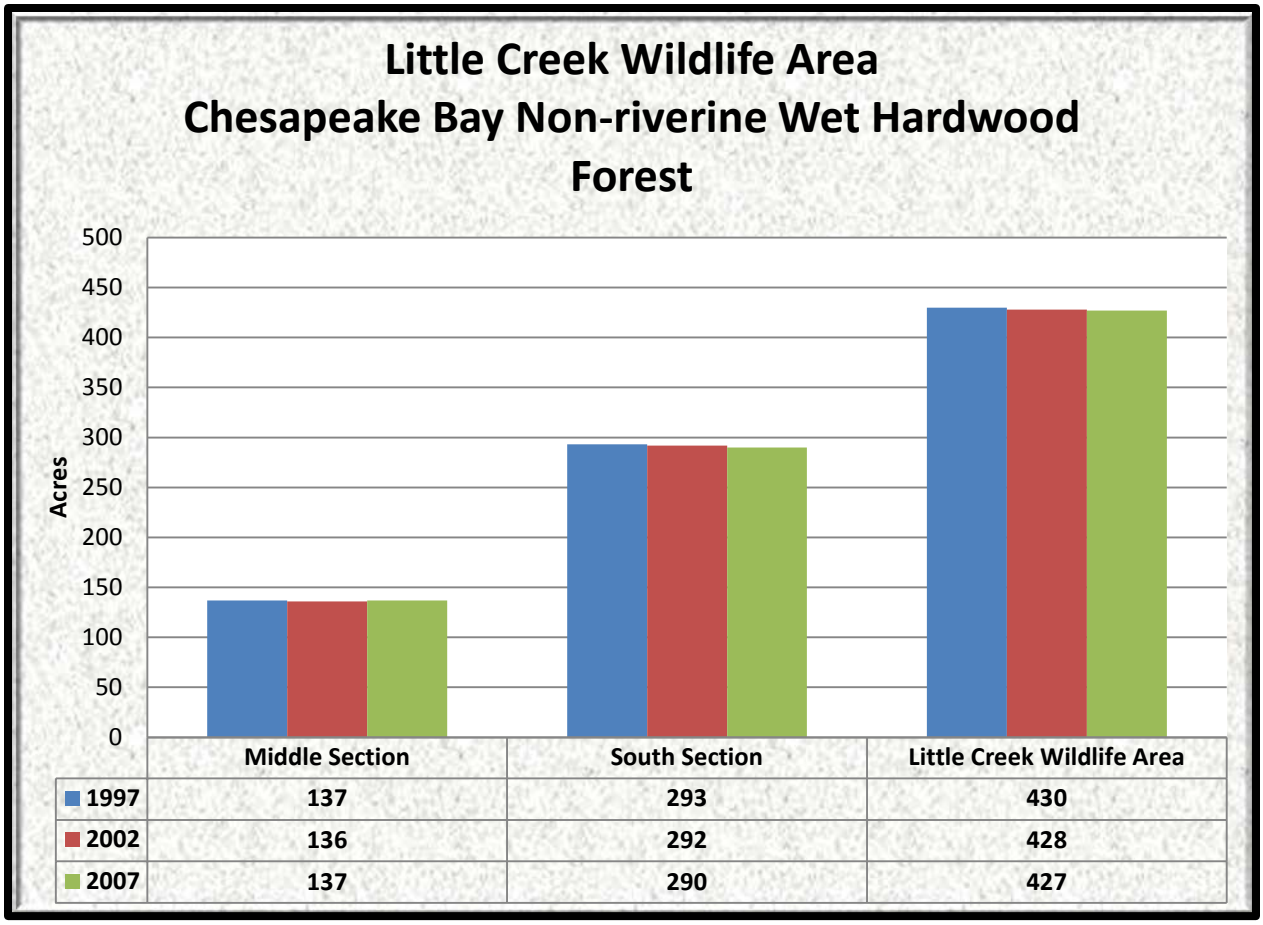


Figure 5.4. Chesapeake Bay Non-riverine Wet Hardwood Forest at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.11)

More than half of the current acreage of Chesapeake Bay Non-riverine Wet Hardwood Forest will be inundated with 1.5 m of sea level rise.

Table 5.11. Projected acres of Chesapeake Bay Non-riverine Wet Hardwood Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	114 acres
1 m	195 acres
1.5 m	247 acres

Natural Capital (Table 5.12)

Capital in Chesapeake Bay Non-riverine Wet Hardwood Forest has been decreasing with acreage during the study period. Most of the lost acreage and capital has been to Northeastern Modified Successional Forest with the spread of exotic invasive plant species.

Table 5.12. Natural Capital of Chesapeake Bay Non-riverine Wet Hardwood Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$5,285,345/year
2002	$5,260,762/year
2007	$5,248,471/year

Coastal Loblolly Pine Wetland Forest **[2 acres (Figures 5.5-5.6, Tables 5.13-5.14)]**
G3 S3

DEWAP: Isolated Forested Wetlands
NHC: Northeastern Atlantic Coastal Plain Maritime Forest

Description

This community is located at the north end of the Middle Section on the northern edge of the marsh. Loblolly Pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), and red maple (*Acer rubrum*) compose a canopy that overtops an understory of American holly (*Ilex opaca*), eastern red cedar (*Juniperus virginiana*), and persimmon (*Diospyros virginiana*). The shrub layer includes highbush blueberry (*Vaccinium corymbosum*). Common herbs include speargrass (*Chasmanthium laxum*), switchgrass (*Panicum virgatum*), and Japanese stiltgrass (*Microstegium vimineum*).

Figure 5.5. Coastal Loblolly Pine Wetland Forest (Middle Section)

Like the Chesapeake Bay Non-riverine Wet Hardwood Forest, the examples of this community are in a late successional state and are likely of the same age and have the same characteristics. Canopy trees overall are still of small size.

Analysis of Condition at Little Creek Wildlife Area

Coastal Loblolly Pine Wetland Forest has remained at the same location and amount through the study period. Because of this no change analysis was conducted.

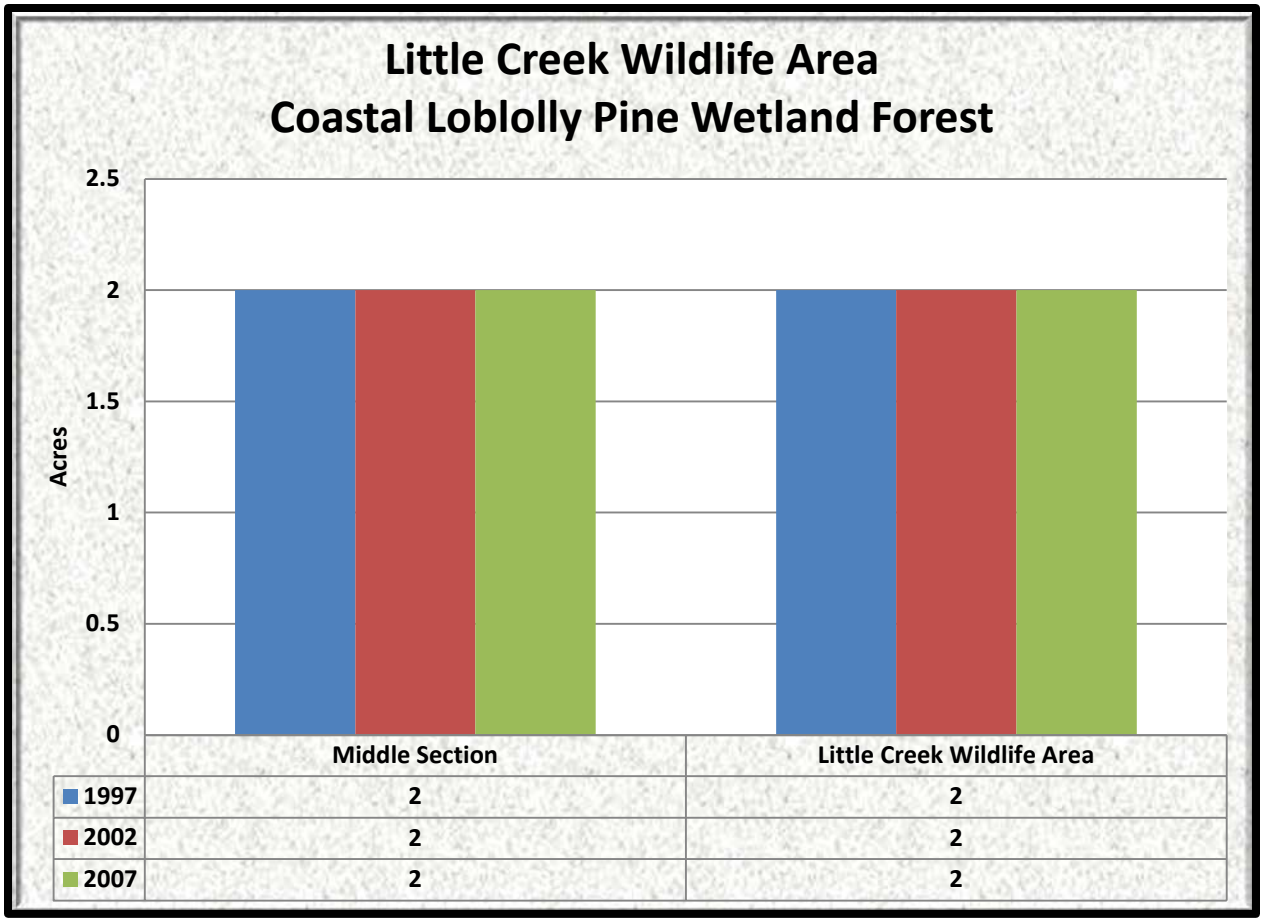


Figure 5.6. Coastal Loblolly Pine Wetland Forest at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.13)

All of the current acreage of Coastal Loblolly Pine Forest will be inundated with 0.5 m of sea level rise.

Table 5.13. Projected acres of Coastal Loblolly Pine Wetland Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 5.14)

The capital of Coastal Loblolly Pine Wetland Forest has not changed during the study period.

Table 5.14. Natural Capital of Coastal Loblolly Pine Wetland Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$24,583/year
2002	$24,583/year
2007	$24,583/year

Coastal Plain Oak Floodplain Swamp **[54 acres (Figures 5.7-5.8, Tables 5.15-5.18)] GNR S2**

DEWAP: Forested Floodplains and Riparian Swamps
NHC: Northern Atlantic Coastal Stream and River

Description

This forested community is found on the edge of an impoundment in the South Section. A lot of oaks are found in the canopy and include swamp white oak (*Quercus bicolor*), white oak (*Quercus alba*), and southern red oak (*Quercus falcata*). Other canopy species include black gum (*Nyssa sylvatica*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), mockernut hickory (*Carya alba*), and tuliptree (*Liriodendron tulipifera*). The understory is composed of American holly (*Ilex opaca*), eastern red cedar (*Juniperus virginiana*), and wild black cherry (*Prunus serotina*). The shrub and vine layer includes common greenbrier (*Smilax rotundifolia*), Japanese honeysuckle (*Lonicera japonica*), and highbush blueberry (*Vaccinium corymbosum*). Speargrass (*Chasmanthium laxum*) was the only herbaceous species noted in this community.

Figure 5.7. Coastal Plain Oak Floodplain Swamp

The examples of this community are overall in the late successional state, with a small amount approaching the mature state. Canopy trees are slightly larger than other communities and layers are intact.

Analysis of Condition at Little Creek Wildlife Area

Forty-eight acres of the original 58 acres were present in 2007, with the rest becoming part of the Impoundment (9 acres) and water (1 acre). A very small amount has become Northeastern Modified Successional Forest (0.2 acres) and Chesapeake Bay Non-riverine Wet Hardwood Forest (0.2 acres) (Table 5.15).

Coastal Plain Oak Floodplain Swamp has lost 4 acres since 1997 but has managed to convert some communities in spite of this. These include Chesapeake Bay Non-riverine Wet Hardwood Forest (2 acres), Agricultural Field (2 acres), Northeastern Modified Successional Forest (1 acre), and Water (0.3 acres) (Table 5.16).

Table 5.15. What was once Coastal Plain Oak Floodplain Swamp in 1997 has become X in 2007	
X	**Acreage**
Coastal Plain Oak Floodplain Swamp	48 acres
Impoundment	9 acres
Water	1 acre
Northeastern Modified Successional Forest	0.2 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.2 acres
Other communities/land covers	0.1 acres

Table 5.16. Coastal Plain Oak Floodplain Swamp has migrated into X since 1997	
X	**Acreage**
Coastal Plain Oak Floodplain Swamp	48 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	2 acres
Agricultural Field	2 acres
Northeastern Modified Successional Forest	1 acre
Water	0.3 acres
Other communities/land covers	0.1 acres

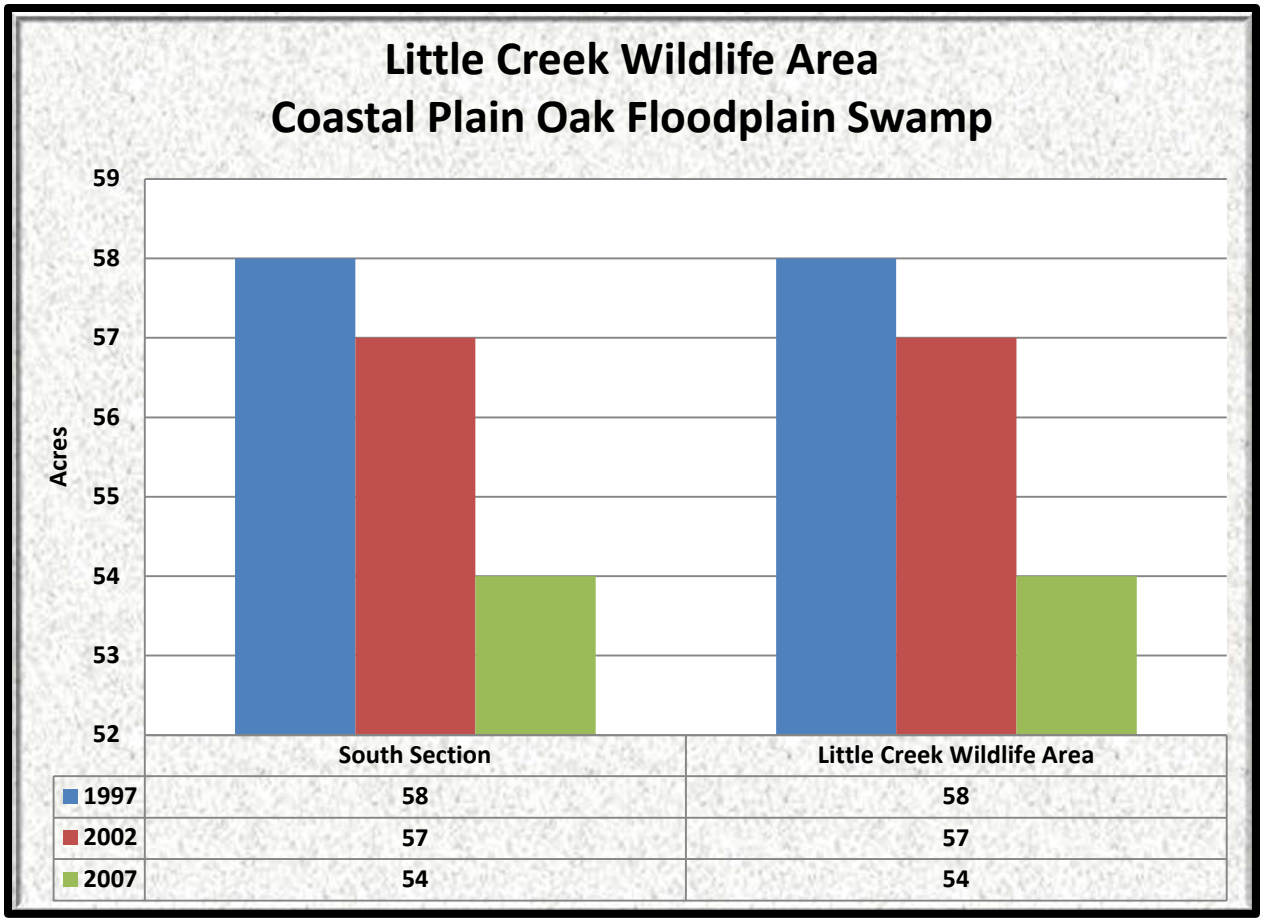


Figure 5.8. Coastal Plain Oak Floodplain Swamp at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.17)

Most of the current acreage of Coastal Plain Oak Floodplain Swamp will be inundated with 1.5 m of sea level rise.

Table 5.17. Projected acres of Coastal Plain Oak Floodplain Swamp Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	35 acres
1.5 m	46 acres

Natural Capital (Table 5.18)

Coastal Plain Oak Floodplain Swamp has decreased in capital overall during the study period, due to losses in acreage to impoundment inundation.

Table 5.18. Natural Capital of Coastal Plain Oak Floodplain Swamp	
Year	**Natural Capital (in 2012 dollars)**
1997	$712,907/year
2002	$700,616/year
2007	$663,741/year

Cultivated Lawn **[45 acres (Figure 5.8, Tables 5.19-5.21)]** **GNA SNA**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

This community is located adjacent to the roadsides and buildings in the wildlife area. It is dominated by tall fescue (*Festuca arundinacea*) with other ornamental grasses and plants. It is mowed more than once a year.

Analysis of Condition at Little Creek Wildlife Area

This community is artificially created and maintained and is not judged by condition. However, the amount of this community in the wildlife area has gradually trended downward over time.

In 2007, sixteen of the original 25 acres were still present. The rest of the acreage has changed to Reed Tidal Marsh (3 acres), Northeastern Modified Successional Forest (3 acres), Chesapeake Bay Non-riverine Wet Hardwood Forest (1 acre), and Northeastern Old Field (1 acre) (Table 4.15).

Cultivated Lawn has declined over the study period but has still managed to convert some other communities including Agricultural Field (3 acres), Reed Tidal Marsh (2 acres), Northeastern Old Field (1 acre), and Northeastern Successional Shrubland (1 acre) (Table 4.16).

Table 5.19. What was Cultivated Lawn in 1997 has become X in 2007

X	Acreage
Cultivated Lawn	16 acres
Reed Tidal Marsh	3 acres
Northeastern Modified Successional Forest	3 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	1 acre
Northeastern Old Field	1 acre
Other communities/land covers	2 acres

Table 5.20. Cultivated Lawn has migrated into X since 1997	
X	**Acreage**
Cultivated Lawn	16 acres
Agricultural Field	3 acres
Reed Tidal Marsh	2 acres
Northeastern Old Field	1 acre
Northeastern Successional Shrubland	1 acre
Other communities/land covers	1 acre

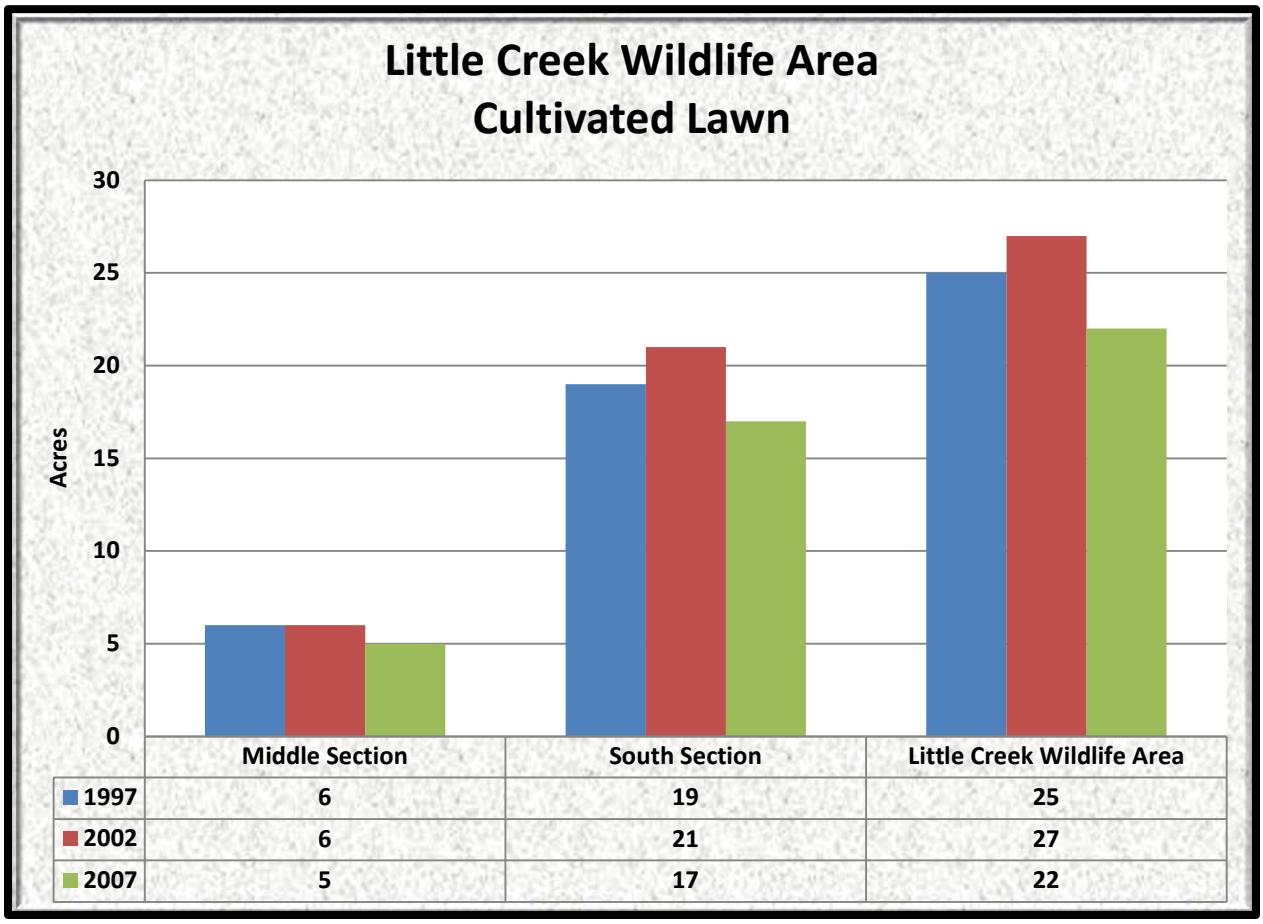


Figure 5.9. Cultivated Lawn at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.21)

Half of the cultivated lawn currently present in Little Creek Wildlife Area will be inundated by water with 1.5 m of sea level rise.

Table 5.21. Projected acres of Cultivated Lawn Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	8 acres
1.5 m	11 acres

Natural Capital

Cultivated lawn does not have any natural capital value.

Early to Mid-Successional Loblolly Pine Forest **[2 acres (Figure 5.10, Tables 5.22-5.25)] GNA SNA**

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

Description

This community is typified by having loblolly pine (*Pinus taeda*) as the only species in the canopy. Species in the understory include red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), and other hardwood species. Some scattered vines of common greenbrier (*Smilax rotundifolia*) may be present. The herbaceous layer in these communities is usually non-existent due to the shading of the canopy. Note this community was not directly observed in the wildlife area and was aerially interpreted.

Analysis of Condition at Little Creek Wildlife Area

This community has declined by one acre over the study period with the one acre going to powerline R-O-W (Table 5.22). This community only recruited 0.1 acres of Northeastern Old Field (Table 5.23).

Table 5.22. What was Early to Mid-Successional Loblolly in 1997 has become X in 2007	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	2 acres
Powerline R-O-W	1 acre

Table 5.23. Early to Mid-Successional Loblolly Pine Forest has migrated into X since 1997	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	2 acres
Northeastern Old Field	0.1 acres

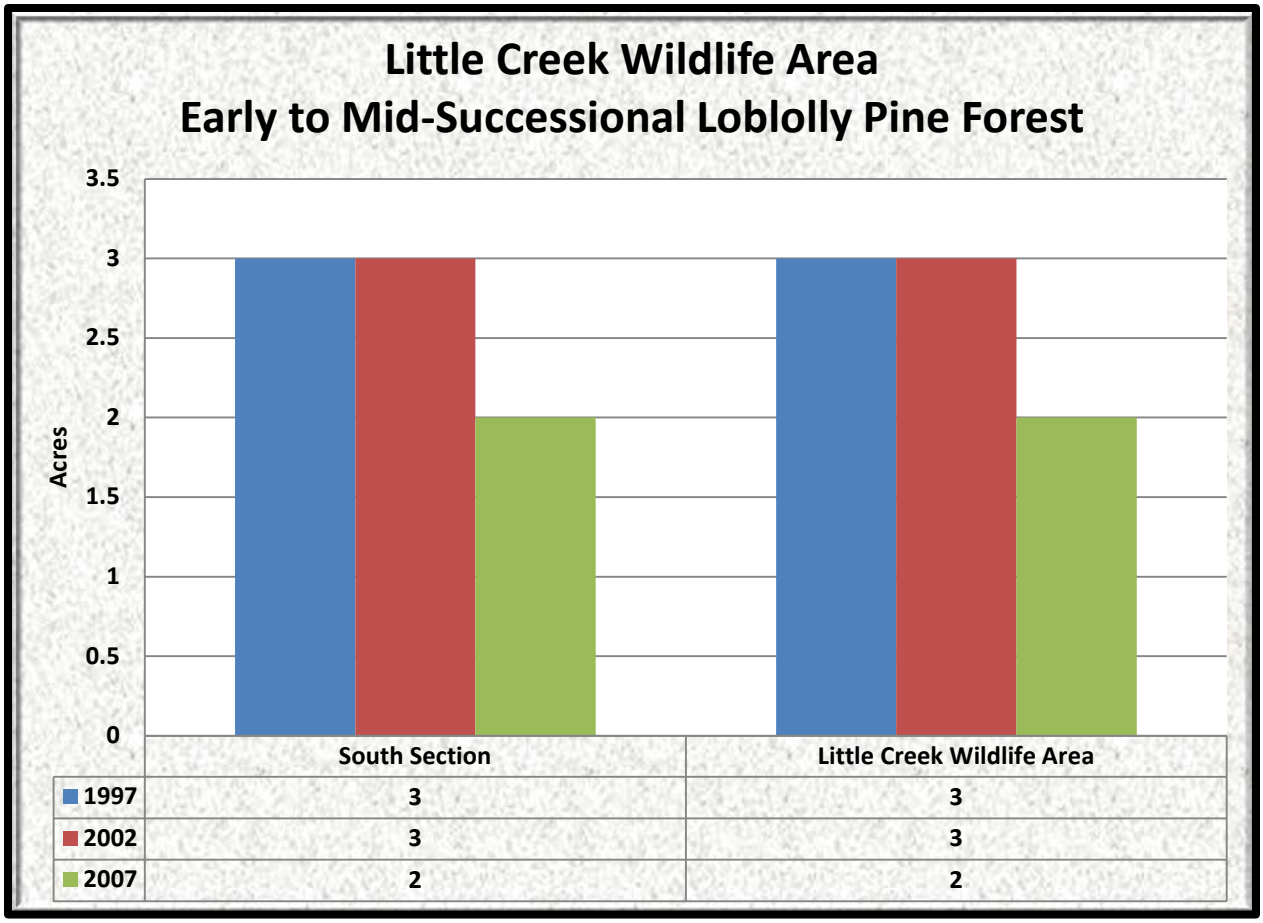


Figure 5.10. Early to Mid-Successional Loblolly Pine Forest at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.24)

Half of the current acreage of Early to Mid-Successional Loblolly Pine Forest will be inundated with 1.5 m of sea level rise. This community will be barely affected with 0.5 m of sea level rise. The effects of the rise could be more far reaching since this community matures into other forested communities.

Table 5.24. Projected acres of Early to Mid-Successional Loblolly Pine Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0.4 acres
1.5 m	1 acre

Natural Capital (Table 5.25)

Capital of Early to Mid-Successional Loblolly Pine Forest declined with the placement of a powerline between 2002 and 2007.

Table 5.25. Natural Capital of Early to Mid-Successional Loblolly Pine Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$567/year
2002	$567/year
2007	$378/year

Eastern Cattail Marsh **[0.4 acres (Figure 5.11, Tables 5.26-5.28)] G5 S4**

DEWAP: Streamside Herbaceous Wetlands
NHC: Laurentian-Acadian Freshwater Marsh

Description

Eastern Cattail Marsh is a non-tidal marsh that is totally dominated by wide-leaf cattail (*Typha latifolia*) and narrow-leaf cattail (*Typha angustifolia*). They are often found in depressions where there is water.

Analysis of Condition at Little Creek Wildlife Area

Eastern Cattail Marsh has come into the wildlife area via a wildlife restoration in a Northeastern Old Field (Table 5.26). It currently covers about 0.4 acres.

Table 5.26. Eastern Cattail Marsh has migrated into X since 1997	
X	**Acreage**
Northeastern Old Field	0.4 acres

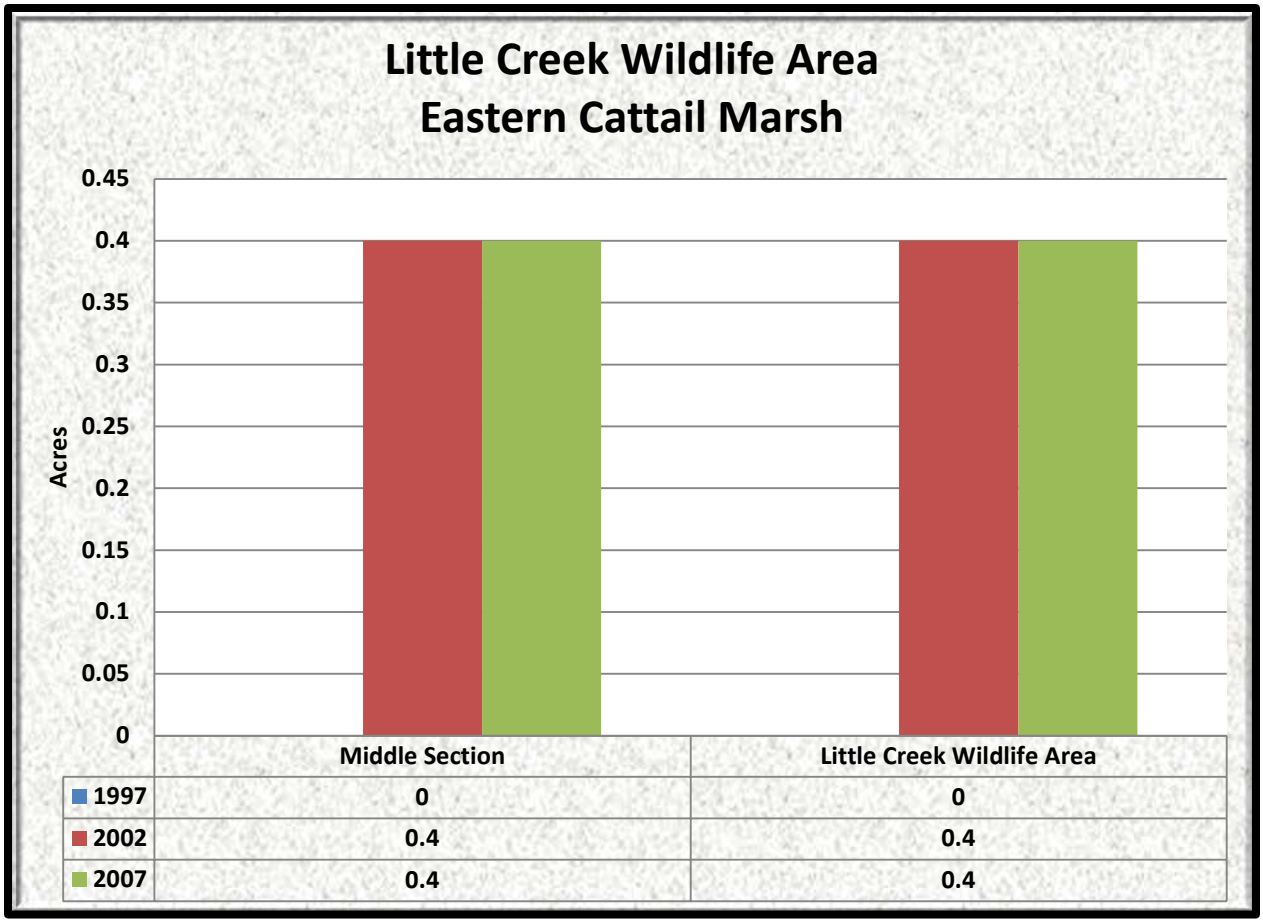


Figure 5.11. Eastern Cattail Marsh at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.27)

Eastern Cattail Marsh will not affected by sea level rise in its current extent.

Table 5.27. Projected acres of Eastern Cattail Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	0 acres

Natural Capital (Table 5.28)

Eastern Cattail Marsh was not present in 1997 and has since grown into a reclamation site in a Northeastern Old Field. The capital has been the same in the recent period (2002-2007).

Table 5.28. Natural Capital of Eastern Cattail Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$0/year (not present)
2002	$3,713/year
2007	$3,713/year

Eastern Reed Marsh **[85 acres (Figures 5.12.-5.13, Tables 5.29-5.32)]** **GNA SNA**

DEWAP: Streamside Herbaceous Wetlands
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Figure 5.12. Eastern Reed Marsh (Middle Section)

This community is dominated to totality by eastern reed (*Phragmites australis*) in non-tidal wetland situations.

Analysis of Condition at Little Creek Wildlife Area

Eastern Reed Marsh has increased overall over the study period with a few ups and downs. Aggressive control efforts have likely been affecting the acreage and the community has been moving around a lot as evidenced by the fact that only 10 acres of the original 22 acres from 1997 still existed in 2007. The rest of the acres became Chesapeake Bay Non-riverine Wet Hardwood Forest (6 acres), Reed Tidal Marsh (2 acres), Northeastern Successional Shrubland (2 acres), and Farm Pond/Artificial Pond (1 acre) (Table 5.29).

Since 1997 this community has migrated into agricultural field (5 acres), Successional Maritime Forest (4 acres), Northeastern Old Field (3 acres), and water (1 acre) (Table 5.30).

Table 5.29. What was Eastern Reed Marsh in 1997 has become X in 2007	
X	**Acreage**
Eastern Reed Marsh	10 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	6 acres
Reed Tidal Marsh	2 acres
Northeastern Successional Shrubland	2 acres
Farm Pond/Artificial Pond	1 acre
Other communities/land covers	1 acre

Table 5.30. Eastern Reed Marsh has migrated into X since 1997	
X	**Acreage**
Eastern Reed Marsh	10 acres
Agricultural Field	5 acres
Successional Maritime Forest	4 acres
Northeastern Old Field	3 acres
Water	1 acre
Other communities/land covers	2 acres

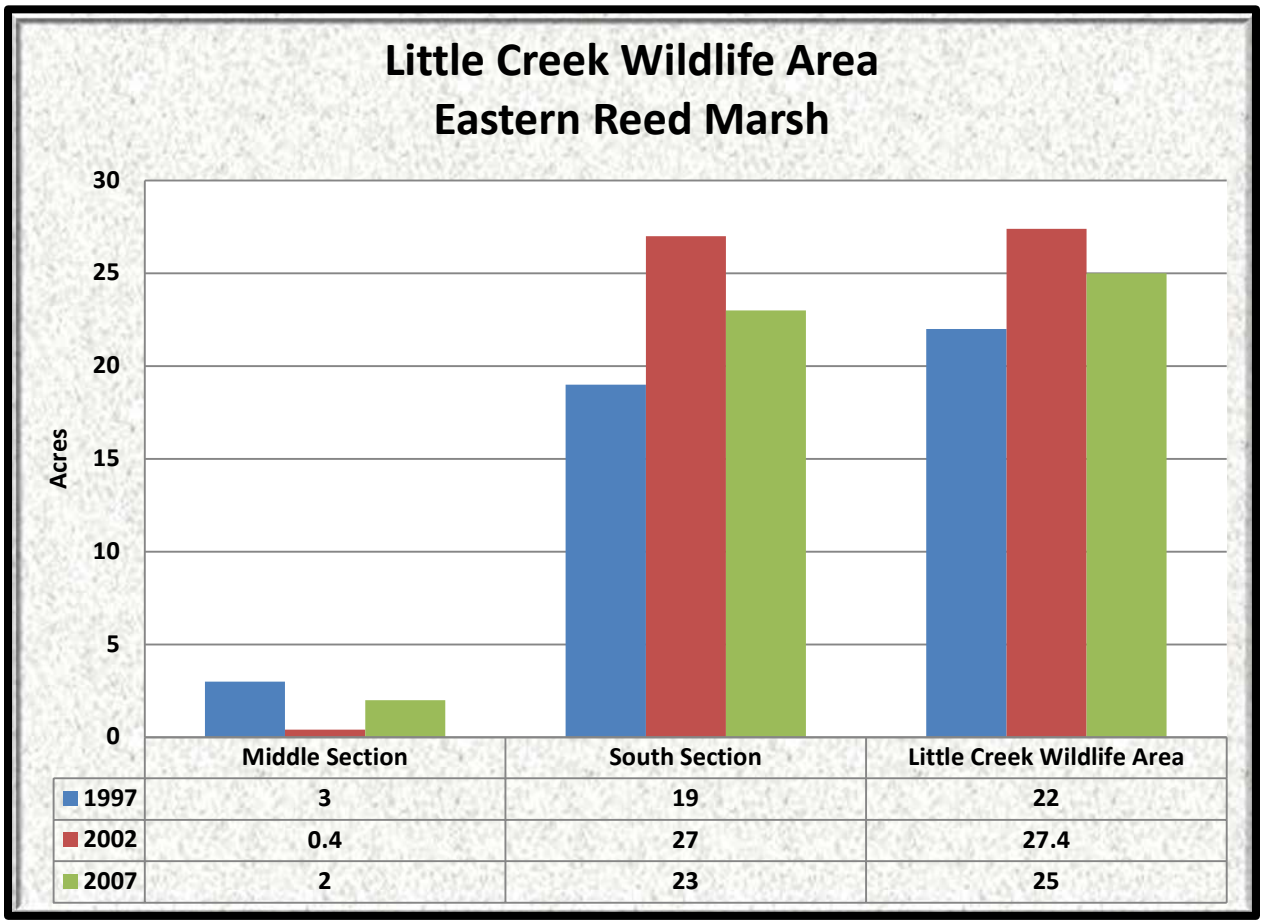


Figure 5.13. Eastern Reed Marsh at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.31)

Most of the Eastern Reed Marsh present in Little Creek Wildlife Area will be flooded with 1.5 m of sea level rise. Since this community most often grows on the edge of the impoundments, this means the impoundments will be flooded as well. However, the impoundments may be protected from the rise making the losses less.

Table 5.31. Projected acres of Eastern Reed Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	11 acres
1 m	22 acres
1.5 m	24 acres

Natural Capital (Table 5.32)

Eastern Reed Marsh has increased overall during the study period with a slight uptick in 2002.

Table 5.32. Natural Capital of Eastern Reed Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$204,191/year
2002	$254,310/year
2007	$232,035/year

Irregularly Flooded Eastern Tidal Salt Shrub **[12 acres (Figures 5.14-5.15, Tables 5.33-5.36)]**
G5 S5

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

Description

This brackish shrub community is found just above the elevation of the North Atlantic High Salt Marsh and just below other forested communities such as the Successional Maritime Forest. At Ted Harvey Wildlife Area it is composed primarily of salt shrub (*Baccharis halimifolia*) with a small amount of elderbush (*Iva frutuscens*). Some salt meadow hay (*Spartina alterniflora*) may be mixed in underneath the shrubs.

Analysis of Condition at Little Creek Wildlife Area

Irregularly Flooded Eastern Tidal Salt Shrub has decreased overall in acreage between 1997 and 2007 and has moved around quite a bit with only 24 acres original 1997 acres remaining in 2007. The other areas have become North Atlantic Low Salt Marsh (16 acres), Reed Tidal Marsh (8 acres), North Atlantic High Salt Marsh (5 acres), and Cattail Brackish Tidal Marsh (2 acres) (Table 5.33). A lot of these conversions indicate more salinity and water being present.

Since 1997, in spite of declining, this community has migrated into 16 acres of North Atlantic Low Salt Marsh, presumably on the piles created by dead *Phragmites* stems, North Atlantic High Salt Marsh (6 acres) for the same reason, Reed Tidal Marsh (4 acres), and 1 acre of Successional Maritime Forest (Table 5.34).

Table 5.33. What was Irregularly Flooded Eastern Tidal Salt Shrub in 1997 has become X in 2007

X	Acreage
Irregularly Flooded Eastern Tidal Salt Shrub	24 acres
North Atlantic Low Salt Marsh	16 acres
Reed Tidal Marsh	8 acres
North Atlantic High Salt Marsh	5 acres
Cattail Brackish Tidal Marsh	2 acres
Other communities/land covers	3 acres

Table 5.34. Irregularly Flooded Eastern Tidal Salt Shrub has migrated into X since 1997	
X	**Acreage**
Irregularly Flooded Eastern Tidal Salt Shrub	24 acres
North Atlantic Low Salt Marsh	16 acres
North Atlantic High Salt Marsh	6 acres
Reed Tidal Marsh	4 acres
Successional Maritime Forest	1 acre
Other communities/land covers	1 acre

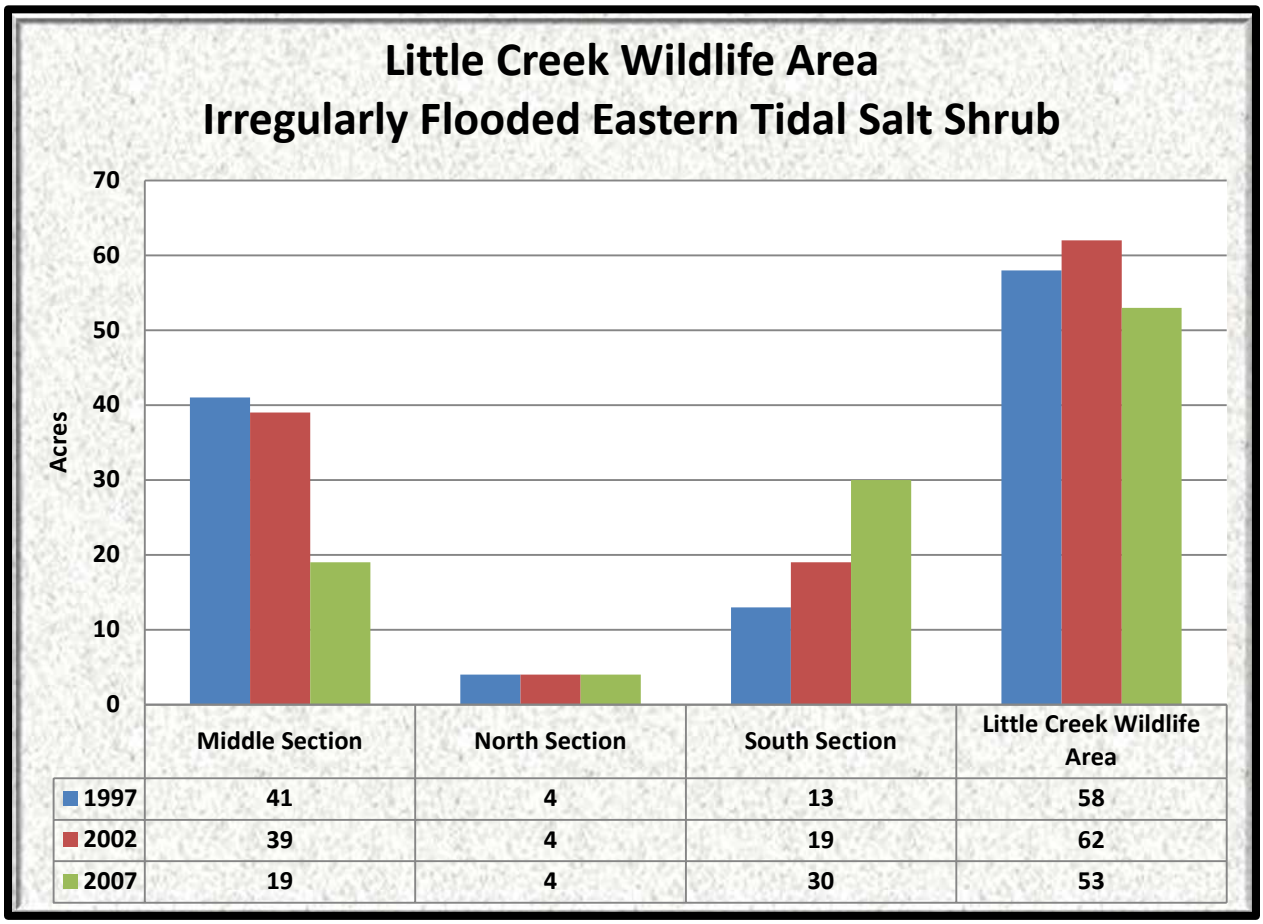


Figure 5.14. Irregularly Flooded Eastern Tidal Salt Shrub at Little Creek Wildlife Area (1997, 2002, and 2007)

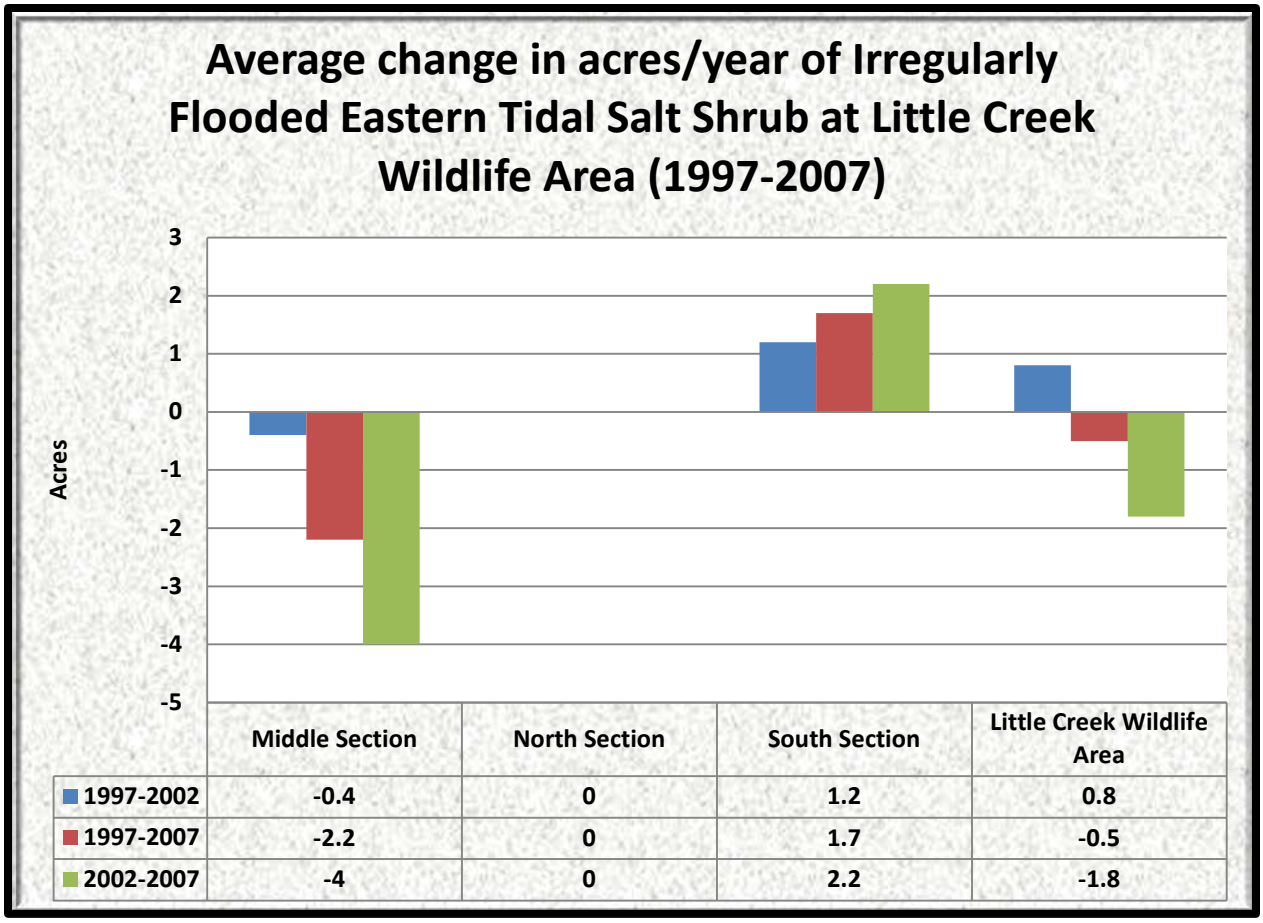


Figure 5.15. Average change in acres/year of Irregularly Flooded Eastern Tidal Salt Shrub at Little Creek Wildlife Area (1997-2007)

DNREC Sea Level Rise Analysis (Table 5.35)

Most of the Irregularly Flooded Eastern Tidal Salt Shrub will be inundated with 0.5 m of sea level rise and the rest will be flooded with 1 m of rise.

Table 5.35. Projected acres of Irregularly Flooded Eastern Tidal Salt Shrub Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	50 acres
1 m	53 acres
1.5 m	53 acres

Natural Capital (Table 5.36)

Irregularly Flooded Eastern Tidal Salt Shrub experienced a gain in capital in 2002, likely as a result of *Phragmites* control spraying. Since 2002, it has lost capital as sea level rise continues its march.

Table 5.36. Natural Capital of Irregularly Flooded Eastern Tidal Salt Shrub	
Year	**Natural Capital (in 2012 dollars)**
1997	$363,735/year
2002	$388,821/year
2007	$332,379/year

Loblolly Pine Plantation **[3 acres (Figure 5.16, Tables 5.37-5.40)] GNA SNA**

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

Description

Since the one stand of this community was aerially interpreted an exact species cannot be given. Loblolly Pine Plantations are planted stands of loblolly pine (*Pinus taeda*) that are in rows. The rest of the community is very similar in species to the Early to Mid-Successional Loblolly Pine Forest.

Analysis of Condition at Little Creek Wildlife Area

This community has not changed during the study period (Table 5.37). All of the original acreage is present and there has been some migration into Reed Tidal Marsh (0.3 acres) (Table 5.38).

Table 5.37. What was Loblolly Pine Plantation in 1997 has become X in 2007	
X	**Acreage**
Loblolly Pine Plantation	3 acres

Table 5.38. Loblolly Pine Plantation has migrated into X since 1997	
X	**Acreage**
Loblolly Pine Plantation	3 acres
Reed Tidal Marsh	0.3 acres

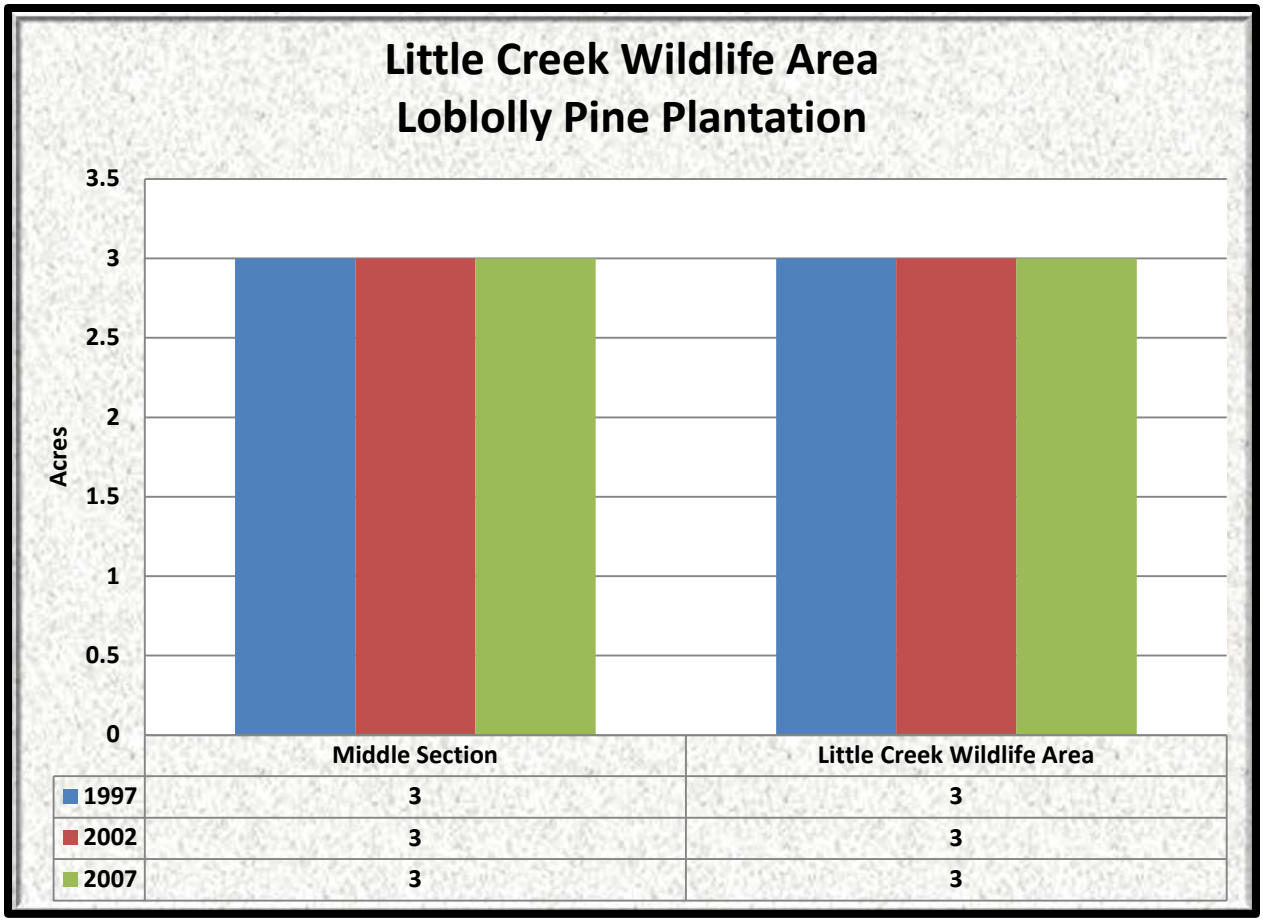


Figure 5.16. Loblolly Pine Plantation at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.39)

About 2/3 of the current acreage of Loblolly Pine Plantation will be flooded with 1.5 m of sea level rise.

Table 5.39. Projected acres of Loblolly Pine Plantation Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0.1 acres
1 m	0.5 acres
1.5 m	2 acres

Natural Capital (Table 5.40)

The capital of Loblolly Pine Plantation has remained the same throughout the study period.

Table 5.40. Natural Capital of Loblolly Pine Plantation	
Year	**Natural Capital (in 2012 dollars)**
1997	$567/year
2002	$567/year
2007	$567/year

Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland **[2 acres (Figures 5.17-5.18, Tables 5.41-5.44)] GNR S3**

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

Description

This community is located in small cove off of the marsh and is adjacent to Coastal Plain Loblolly Pine Wetland Forest. Loblolly pine (*Pinus taeda*) dominates a canopy that overtops red maple (*Acer rubrum*), eastern red cedar (*Juniperus virginiana*), and sweetgum (*Liquidambar styraciflua*). The shrub layer is composed of wax-myrtle (*Morella cerifera*), and highbush blueberry (*Vaccinium corymbosum*). Common herbs include salt meadow hay (*Spartina patens*), switchgrass (*Panicum virgatum*), Sweetscent (*Pluchea odorata*), common reed (*Phragmites australis*), and cinnamon fern (*Osmunda cinnamomea*).

Figure 5.17. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland (Middle Section)

The examples of this community in the wildlife area appear to be in the mid to late successional state. It is likely that they may be converted Early to Mid-Successional Loblolly Pine Forest that predates the 1997 imagery.

Analysis of Condition at Little Creek Wildlife Area

This woodland has increased by one acre as it cuts into adjacent forested communities. The one acre of woodland present in 1997 still survives in 2007 (Table 5.41) and the increase was into a Chesapeake Bay Non-riverine Wet Hardwood Forest (Table 5.42).

Table 5.41. What was 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	1 acre

Table 5.42. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has migrated into X since 1997	
X	**Acreage**
Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	1 acre
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.4 acres

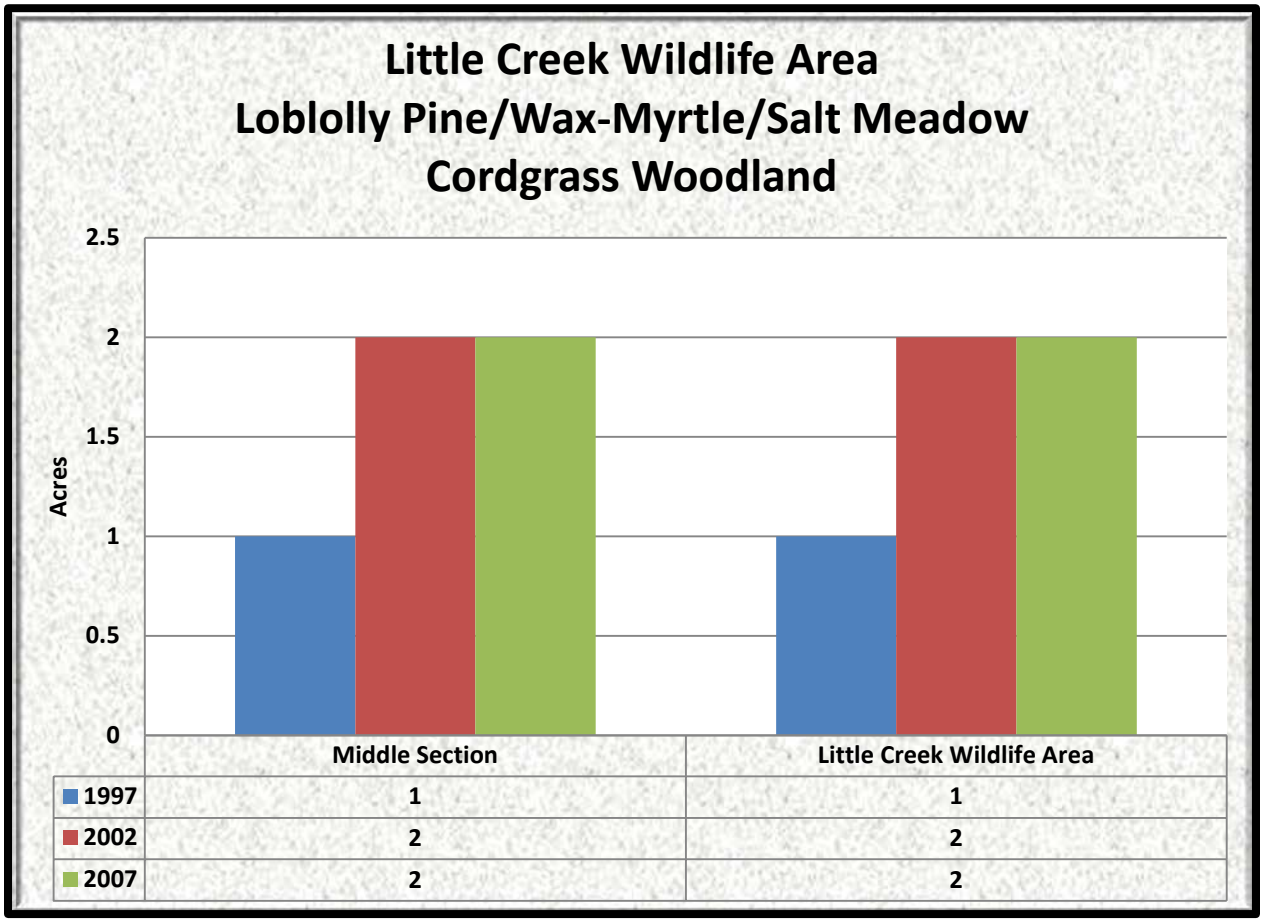


Figure 5.18. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.43)

All of the current acreage of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland will be flooded with 0.5 m of sea level rise.

Table 5.43. Projected acres of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 5.44)

The capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has doubled with its acreage.

Table 5.44. Natural Capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	
Year	**Natural Capital (in 2012 dollars)**
1997	$12,292/year
2002	$24,583/year
2007	$24,583/year

Mid-Atlantic Mesic Mixed Hardwood Forest **[12 acres (Figure 5.19, Tables 5.45-5.46)] G5 S5**

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

Description

Both of the occurrences of this community were aerially interpreted and not directly observed. This community is similar to a lot of the mixed hardwood forest communities with the exception of a large amount of American beech (*Fagus grandifolia*). The understory and layers below it are similar to that found in the Chesapeake Bay Non-riverine Wet Hardwood Forest in this area.

The examples of this community, like a lot of other forested communities in the wildlife area, are in a late successional to barely mature state. Layering is developed but canopy tree overall are still small. Exotic invasive plant species are few in this community.

Analysis of Condition at Little Creek Wildlife Area

This community has not changed during the study period and therefore a change analysis has not been completed.

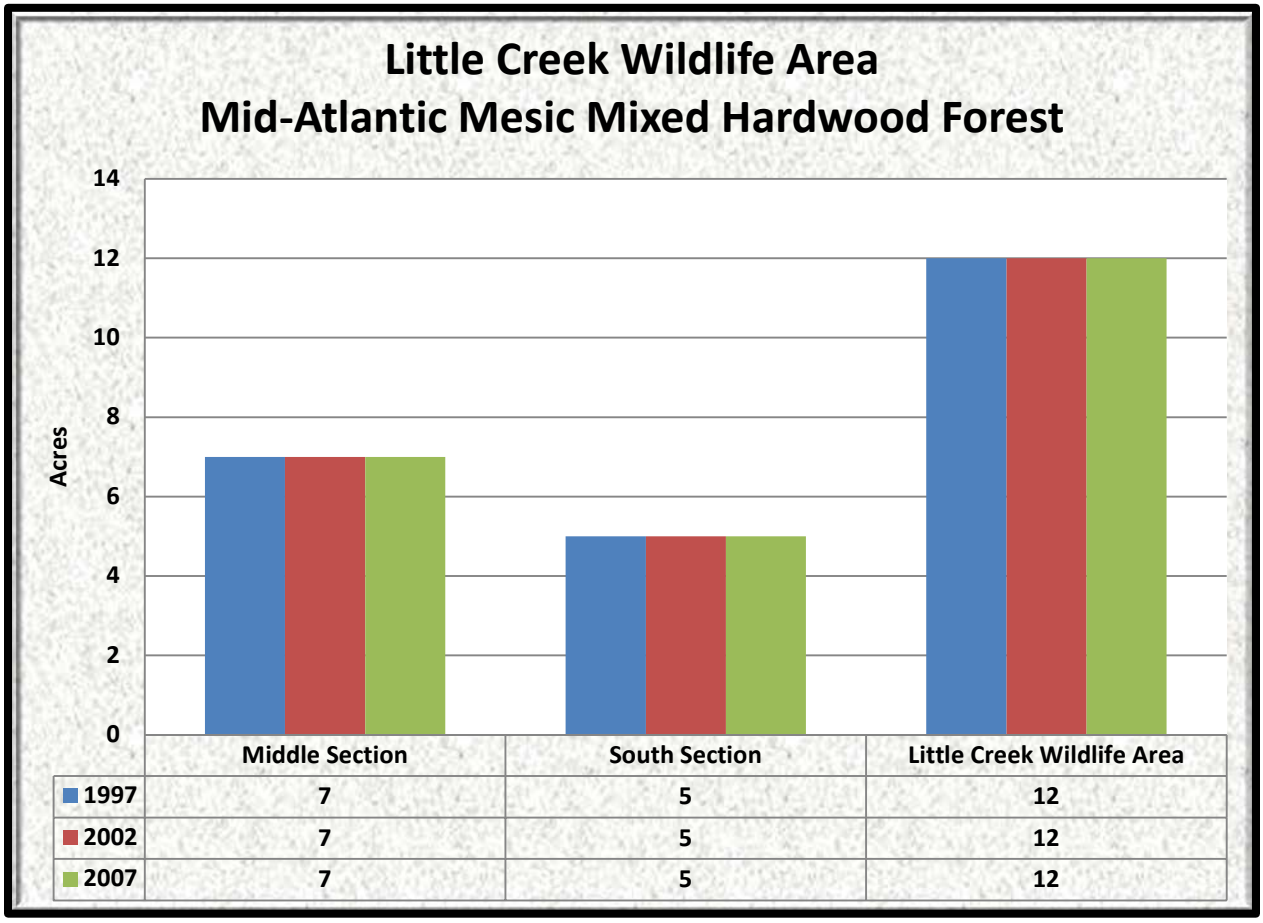


Figure 5.19. Mid-Atlantic Mesic Mixed Hardwood Forest at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.45)

About 40% of the current acreage of Mid-Atlantic Mesic Mixed Hardwood Forest will be flooded with 1.5 m of sea level rise.

Table 5.45. Projected acres of Mid-Atlantic Mesic Mixed Hardwood Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	4 acres
1.5 m	5 acres

Natural Capital (Table 5.46)

Capital of Mid-Atlantic Mesic Mixed Hardwood Forest has been stable throughout the study period.

Table 5.46. Natural Capital of Mid-Atlantic Mesic Mixed Hardwood Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$2,269/year
2002	$2,269/year
2007	$2,269/year

Mid to Late Successional Loblolly Pine-Sweetgum Forest **[3 acres (Figure 5.20, Tables 5.47-5.48)] GNA SNA**

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

Description

This mid to late successional forest contains a high amount of loblolly pine (*Pinus taeda*), but also is composed of other species in the canopy. Other canopy associates include red maple (*Acer rubrum*), southern red oak (*Quercus falcata*), blackgum (*Nyssa sylvatica*), willow oak (*Quercus phellos*), and sweetgum (*Liquidambar styraciflua*). The understory is composed of American holly (*Ilex opaca*), eastern red cedar (*Juniperus virginiana*), and pin oak (*Quercus palustris*). The shrub and vine layer includes highbush blueberry (*Vaccinium corymbosum*), lowbush blueberry (*V. pallidum*), wax-myrtle (*Morella cerifera*), and common greenbrier (*Smilax rotundifolia*). The herbaceous layer is composed of partridge-berry (*Mitchella repens*), Atlantic sedge (*Carex atlantica*), ground pine (*Lycopodium obscurum*), switchgrass (*Panicum virgatum*), and speargrass (*Chasmanthium laxum*).

Analysis of Condition at Little Creek Wildlife Area

This community has changed very little during the study period. Because of the lack of changes, a change analysis was not completed.

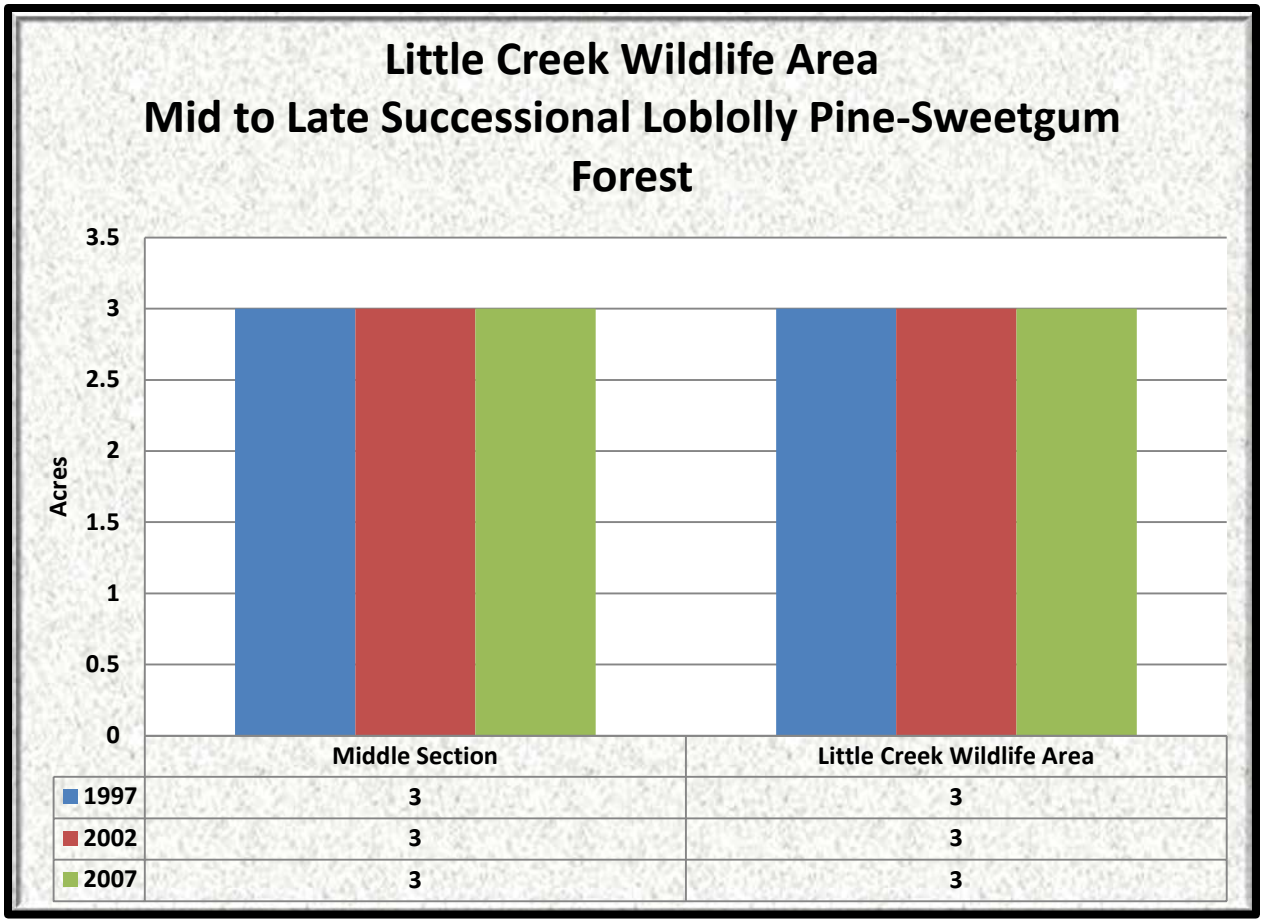


Figure 5.20. Mid to Late Successional Loblolly Pine-Sweetgum Forest at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.47)

Essentially all of the acreage of Mid to Late Successional Loblolly Pine-Sweetgum Forest will be inundated with 1.5 m of sea level rise.

Table 5.47. Projected acres of Mid to Late Successional Loblolly Pine-Sweetgum Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 5.48)

The capital of Mid to Late Successional Loblolly Pine-Sweetgum Forest has been stable throughout the study period.

Table 5.48. Natural Capital of Mid to Late Successional Loblolly Pine-Sweetgum Forest

Year	Natural Capital (in 2012 dollars)
1997	$567/year
2002	$567/year
2007	$567/year

North Atlantic High Salt Marsh **[447 acres (Figures 5.21-5.22, Tables 5.49-5.52)] G5 S4**

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

Description

Figure 5.21. North Atlantic High Salt Marsh (Middle Section)

This marsh community occurs at a slightly higher elevation than the North Atlantic Low Salt Marsh and is dominated by salt meadow cordgrass (*Spartina patens*). Other associates include salt grass (*Distichlis spicata*), sea lavender (*Limonium carolinianum*), and salt marsh fleabane (*Pluchea odorata*).

Analysis of Condition at Little Creek Wildlife Area

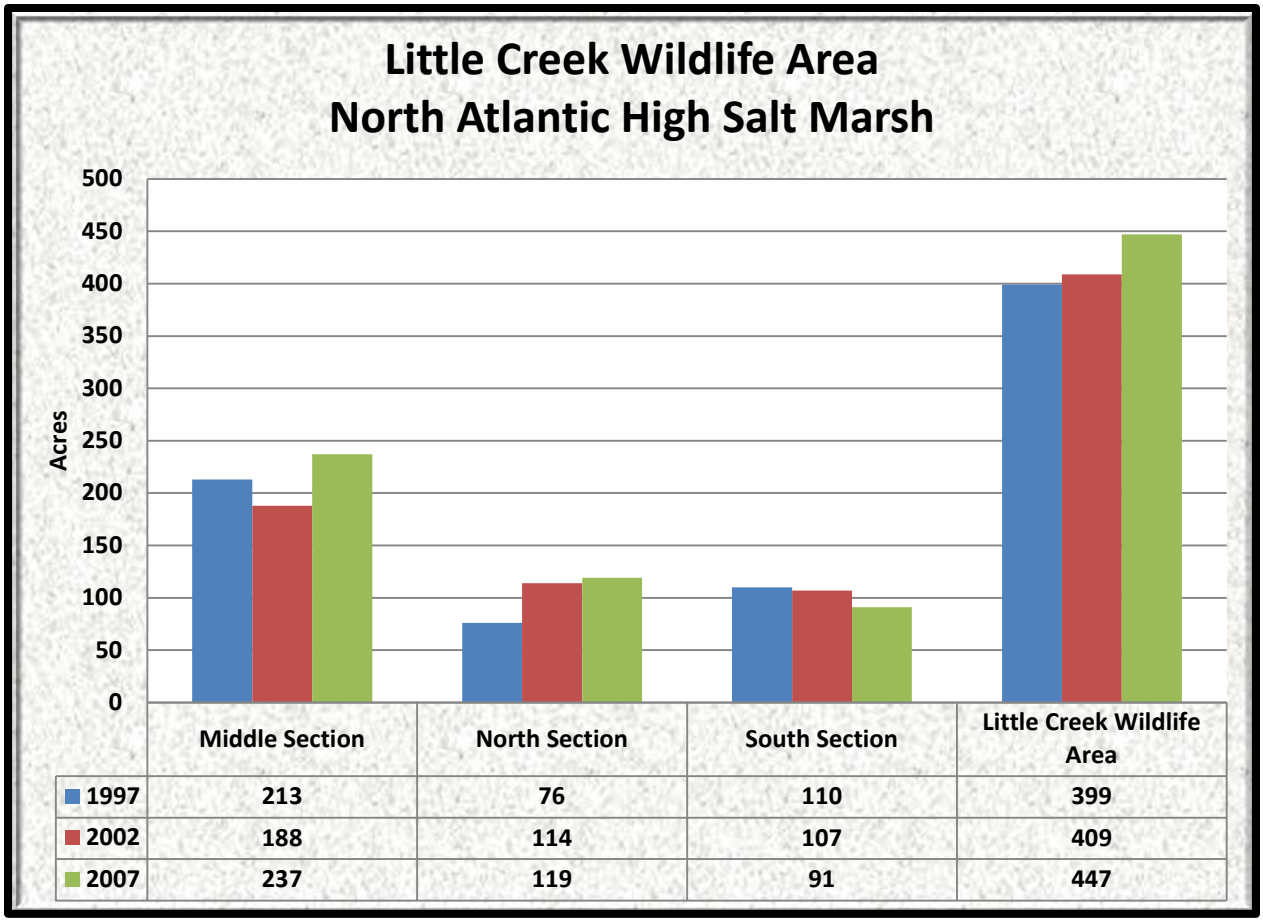
Little Creek Wildlife Area is one of the few places on the Delaware Coast where North Atlantic High Salt Marsh is increasing in acreage. All other places have seen dramatic declines. A lot of the increases at Little Creek Wildlife Area can likely be attributed to efforts to control *Phragmites* in the marsh. Once the *Phragmites* is removed, Salt Meadow Cordgrass (*Spartina patens*) can then move in and colonize the same area.

In 2007, 297 acres of the high marsh from 1997 remained. The rest became North Atlantic Low Salt Marsh (53 acres), Reed Tidal Marsh (35 acres), Irregularly Flooded Eastern Tidal Salt Shrub (6 acres), and water (4 acres) (Table 5.49).

Since 1997, North Atlantic High Salt Marsh has been able to migrate into Reed Tidal Marsh (72 acres, a figure higher than the loss, resulting in a net gain of high marsh), North Atlantic Low Salt Marsh (71 acres), Irregularly Flooded Eastern Tidal Salt Shrub (5 acres), and Impoundment (2 acres) (Table 5.50).

Table 5.49. What was North Atlantic High Salt Marsh in 1997 has become X in 2007	
X	**Acreage**
North Atlantic High Salt Marsh	297 acres
North Atlantic Low Salt Marsh	53 acres
Reed Tidal Marsh	35 acres
Irregularly Flooded Eastern Tidal Salt Shrub	6 acres
Water	4 acres
Other communities/land covers	3 acres

Table 5.50. North Atlantic High Salt Marsh has migrated into X since 1997	
X	**Acreage**
North Atlantic High Salt Marsh	297 acres
Reed Tidal Marsh	72 acres
North Atlantic Low Salt Marsh	71 acres
Irregularly Flooded Eastern Tidal Salt Shrub	5 acres
Impoundment	2 acres
Other communities/land covers	1 acre



	Middle Section	North Section	South Section	Little Creek Wildlife Area
1997	213	76	110	399
2002	188	114	107	409
2007	237	119	91	447

Figure 5.22. North Atlantic High Salt Marsh at Little Creek Wildlife Area (1997, 2002, and 2007)

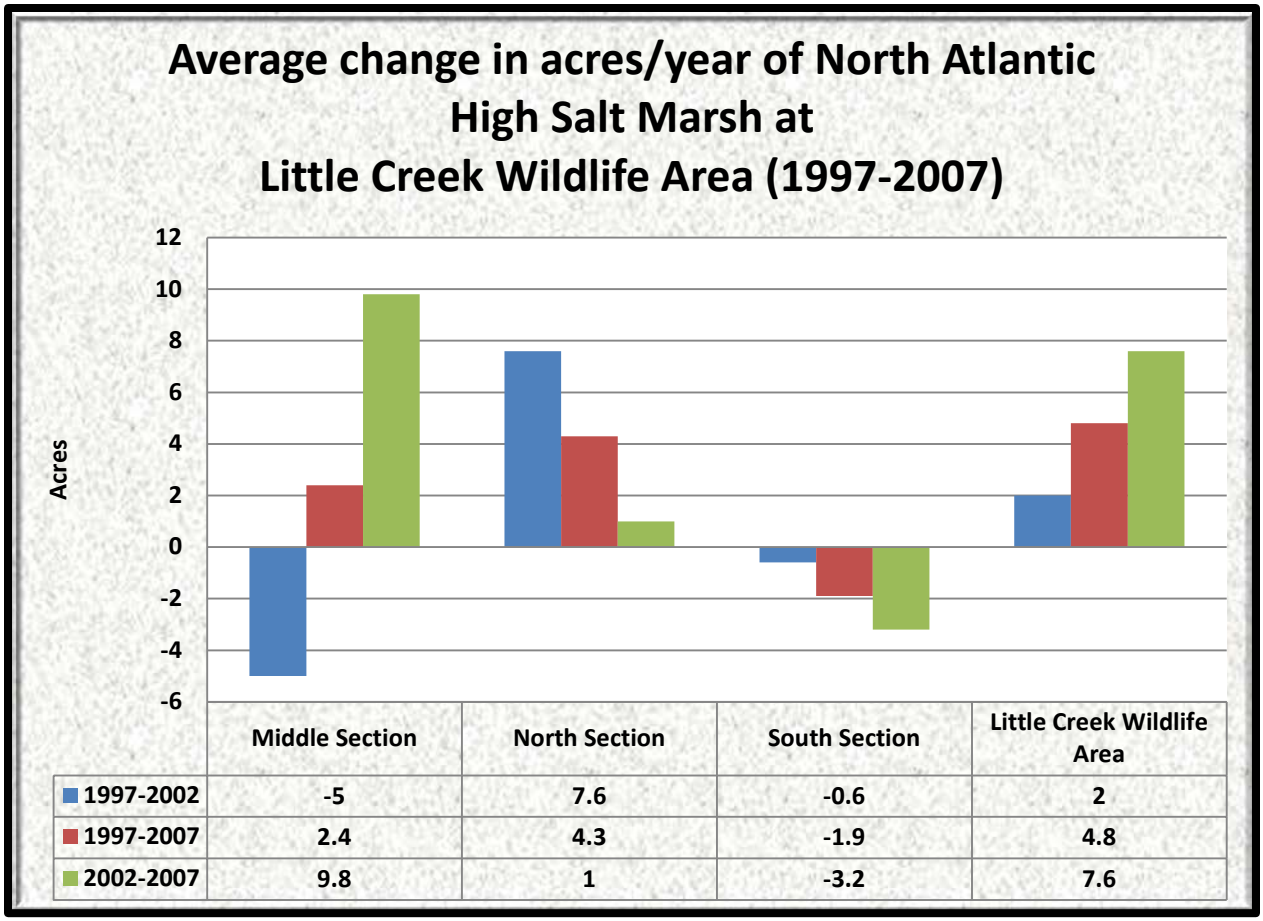


Figure 5.23. Average change in acres/year of North Atlantic High Salt Marsh at Little Creek Wildlife Area (1997-2007)

DNREC Sea Level Rise Analysis (Table 5.51)

Essentially all of the acreage of North Atlantic High Salt Marsh will be inundated with 0.5 m of sea level rise, and an additional 0.5 m will finish the rest.

Table 5.51. Projected acres of North Atlantic High Salt Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	446 acres
1 m	447 acres
1.5 m	447 acres

Natural Capital (Table 5.52)

Bucking a trend seen in other wildlife areas and state parks, the capital and acreage of North Atlantic High Salt Marsh has increased during the study period. This increase may be due to *Phragmites* control spraying, which is opening the high marsh habitat for colonization by salt meadow cordgrass (*Spartina patens*).

Table 5.52. Natural Capital of North Atlantic High Salt Marsh

Year	Natural Capital (in 2012 dollars)
1997	$2,502,249/year
2002	$2,564,962/year
2007	$2,803,271/year

North Atlantic Low Salt Marsh **[1,695 acres (Figure 5.24-5.26, Tables 5.53-5.56)] G5 S5**

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

Description

Figure 5.24. North Atlantic Low Salt Marsh (Middle Section)

This is the most common marsh community in the wildlife area. It is the lowest elevation marsh, receives diurnal tide and is dominated nearly entirely by salt marsh cordgrass (*Spartina alterniflora*).

Analysis of Condition at Little Creek Wildlife Area

North Atlantic Low Salt Marsh has increased over the study period, a number which is skewed somewhat by the effects of Impoundment management. While it is likely that low marsh has increased somewhat the actual gains are probably less than what the numbers would lead one to believe.

In 2007, 965 acres of the 1997 acres were still present. The rest of the marsh became Reed Tidal Marsh (72 acres), North Atlantic High Salt Marsh (71 acres), Water (33 acres), and salt panne (21 acres) (Table 5.53).

Since 1997, North Atlantic Low Salt Marsh has been able to colonize 414 acres of impoundment, leading to the skewed numbers, 241 acres of Reed Tidal Marsh (likely from *Phragmites* management), 53 acres of North Atlantic High Salt Marsh, and 16 acres of Irregularly Flooded Eastern Tidal Salt Shrub (Table 5.54).

Table 5.53. What was North Atlantic Low Salt Marsh in 1997 has become X in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	965 acres
Reed Tidal Marsh	72 acres
North Atlantic High Salt Marsh	71 acres
Water	33 acres
Salt Panne	21 acres
Other communities/land covers	20 acres

Table 5.54. North Atlantic Low Salt Marsh has migrated into X since 1997	
X	**Acreage**
North Atlantic Low Salt Marsh	965 acres
Impoundment	414 acres
Reed Tidal Marsh	241 acres
North Atlantic High Salt Marsh	53 acres
Irregularly Flooded Eastern Tidal Salt Shrub	16 acres
Other communities/land covers	7 acres

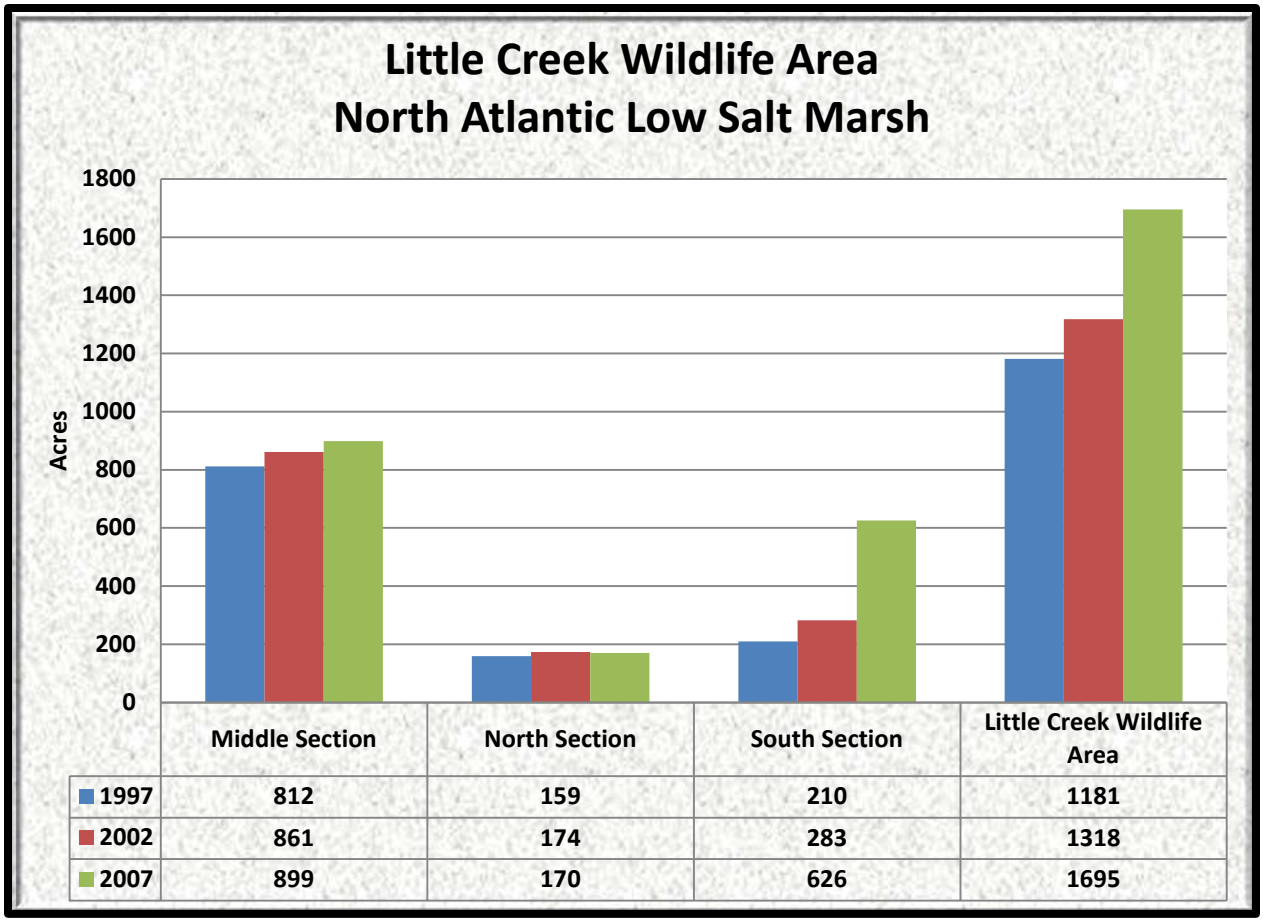


Figure 5.25. North Atlantic Low Salt Marsh at Little Creek Wildlife Area (1997, 2002, and 2007)

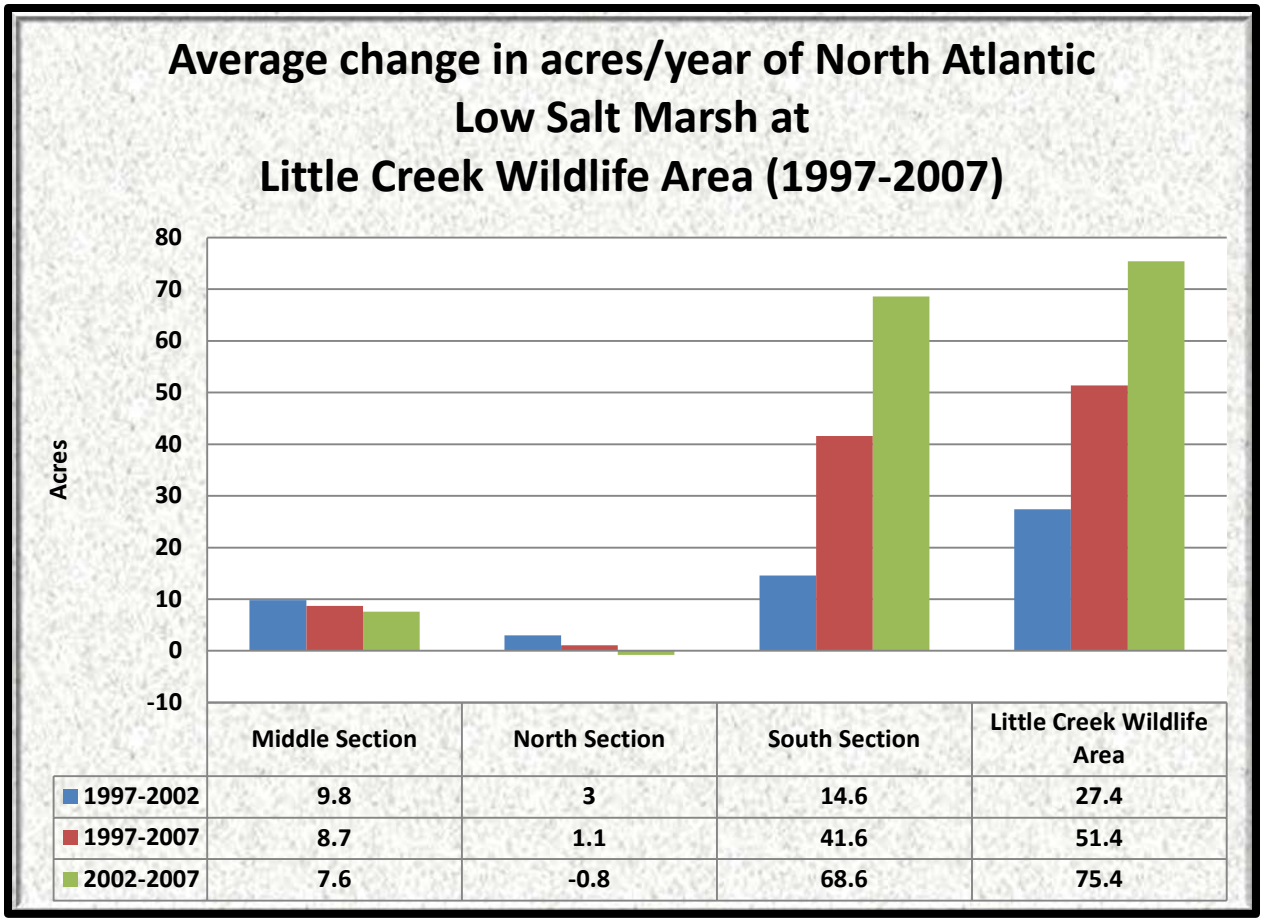


Figure 5.26. Average change in acres/year of North Atlantic Low Salt Marsh at Little Creek Wildlife Area (1997-2007)

DNREC Sea Level Rise Analysis (Table 5.55)

North Atlantic Low Salt Marsh will be essentially eliminated with 0.5 m of sea level rise.

Table 5.55. Projected acres of North Atlantic Low Salt Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1,682 acres
1 m	1,695 acres
1.5 m	1,695 acres

Natural Capital (Table 5.56)

Capital in North Atlantic Low Salt Marsh has been going up at the expense of other marsh communities and shrublands.

Table 5.56. Natural Capital of North Atlantic Low Salt Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$7,406,405/year
2002	$8,265,573/year
2007	$10,629,854/year

Northeastern Modified Successional Forest **[27 acres (Figures 5.27-5.28, Tables 5.57-5.60)]**
GNA SNA

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

Description

This disturbed forest community that is often from agricultural field origin is scattered around the wildlife area. Red maple (*Acer rubrum*) and wild black cherry (*Prunus serotina*) often compose the canopy with an understory of American holly (*Ilex opaca*) and sassafras (*Sassafras albidum*). The shrub layer is composed of highbush blueberry (*Vaccinium corymbosum*) and thick Japanese honeysuckle (*Lonicera japonica*). The only herb noted was American pokeweed (*Phytolacca americana*).

Figure 5.27. Northeastern Modified Successional Forest (Middle Section)

The examples of this community are in a perpetual late successional state due to the inhibiting influence of the exotic invasive species.

Analysis of Condition at Little Creek Wildlife Area

This forested community comes about through the invasion of exotic invasive plant species and disturbance. It has been increasing in the wildlife area as exotics gain a foothold in the wildlife area.

In 2007, 11 acres of the original 19 acres remained from 1997. The other acres became Northeastern Successional Shrubland (3 acres), Coastal Plain Oak Floodplain Swamp (1 acre), Successional Maritime Forest (1 acre), and Impoundment (1 acre) (Table 5.57).

Since 1997, this forest has migrated into 6 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, matured into 3 acres of Northeastern Successional Shrubland, 3 acres of Cultivated Lawn, and 1 acre of Northeastern Old Field (Table 5.58).

Table 5.57. What was Northeastern Modified Successional Forest in 1997 has become X in 2007	
X	**Acreage**
Northeastern Modified Successional Forest	12 acres
Northeastern Successional Shrubland	3 acres
Coastal Plain Oak Floodplain Swamp	1 acre
Successional Maritime Forest	1 acre
Impoundment	1 acre
Other communities/land covers	0.4 acres

Table 5.58. Northeastern Modified Successional Forest has migrated into X since 1997	
X	**Acreage**
Northeastern Modified Successional Forest	12 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	6 acres
Northeastern Successional Shrubland	4 acres
Cultivated Lawn	3 acres
Northeastern Old Field	1 acre
Other communities/land covers	2 acres

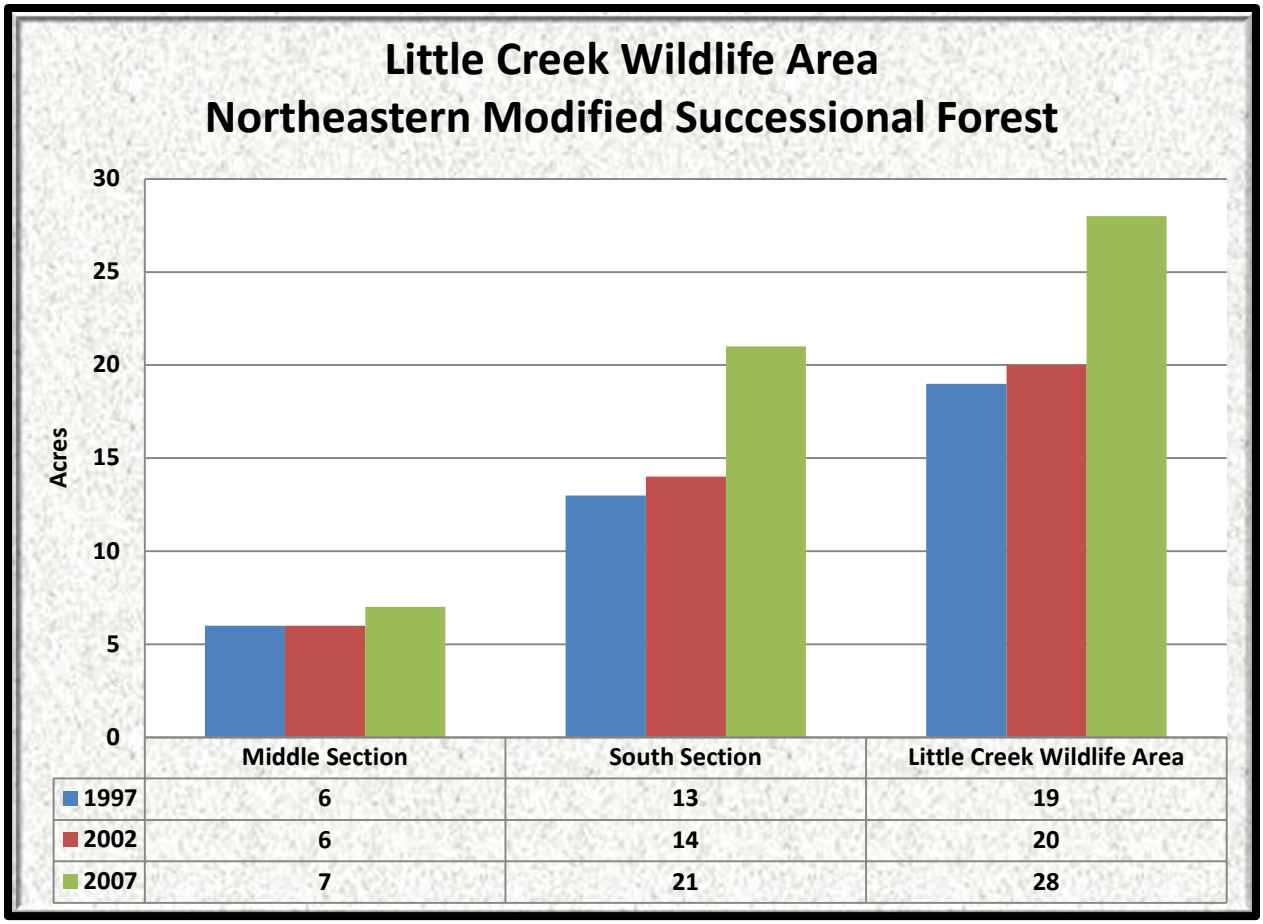


Figure 5.28. Northeastern Modified Successional Forest at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.59)

About ¼ of the current acreage of Northeastern Modified Successional Forest in Little Creek Wildlife Area will be impacted by water from sea level rise.

Table 5.59. Projected acres of Northeastern Modified Successional Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	4 acres
1.5 m	8 acres

Natural Capital (Table 5.60)

Capital of Northeastern Modified Successional Forest has been increasing as the exotic invasive plant species within it spread through other forest communities.

Table 5.60. Natural Capital of Northeastern Modified Successional Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$3,593/year
2002	$3,782/year
2007	$5,295/year

Northeastern Old Field **[83 acres (Figure 5.29, Tables 5.61-5.64)] GNR S5**

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

Description

This herbaceous community is composed of tall fescue (*Festuca rubra*), orchard grass (*Dactylis glomerata*), white clover (*Trifolium arvense*), red clover (*Trifolium pratense*), blackberry (*Rubus* sp.), salt shrub (*Baccharis halimifolia*), and milkweed (*Asclepias* sp.).

Analysis of Condition at Little Creek Wildlife Area

The amount of Northeastern Old Field tends to oscillate depending on management and the amount agricultural fields in use. Overall this community seems to be decreasing at Little Creek Wildlife Area with an uptick in acreage in the 1997-2002 period.

In 2007, 28 acres of the 119 acres remained as Northeastern Old Field. The rest of the fields became agricultural field (36 acres), Northeastern Successional Shrubland (19 acres), Successional Sweetgum Forest (14 acres), and Upland Switchgrass Vegetation (11 acres) (Table 5.61).

Since 1997, 52 acres of agricultural fields, 1 acre of Northeastern Successional Shrubland, 1 acre of Cultivated Lawn, and 0.5 acres of Modified Land have become Northeastern Old Field (Table 5.62).

Table 5.61. What was Northeastern Old Field in 1997 has become X in 2007

X	Acreage
Agricultural Field	36 acres
Northeastern Old Field	28 acres
Northeastern Successional Shrubland	19 acres
Successional Sweetgum Forest	14 acres
Upland Switchgrass Vegetation	11 acres
Other communities/land covers	10 acres

Table 5.62. Northeastern Old Field has migrated into X since 1997	
X	**Acreage**
Agricultural Field	52 acres
Northeastern Old Field	28 acres
Northeastern Successional Shrubland	1 acre
Cultivated Lawn	1 acre
Modified Land	0.5 acres
Other communities/land covers	1 acre

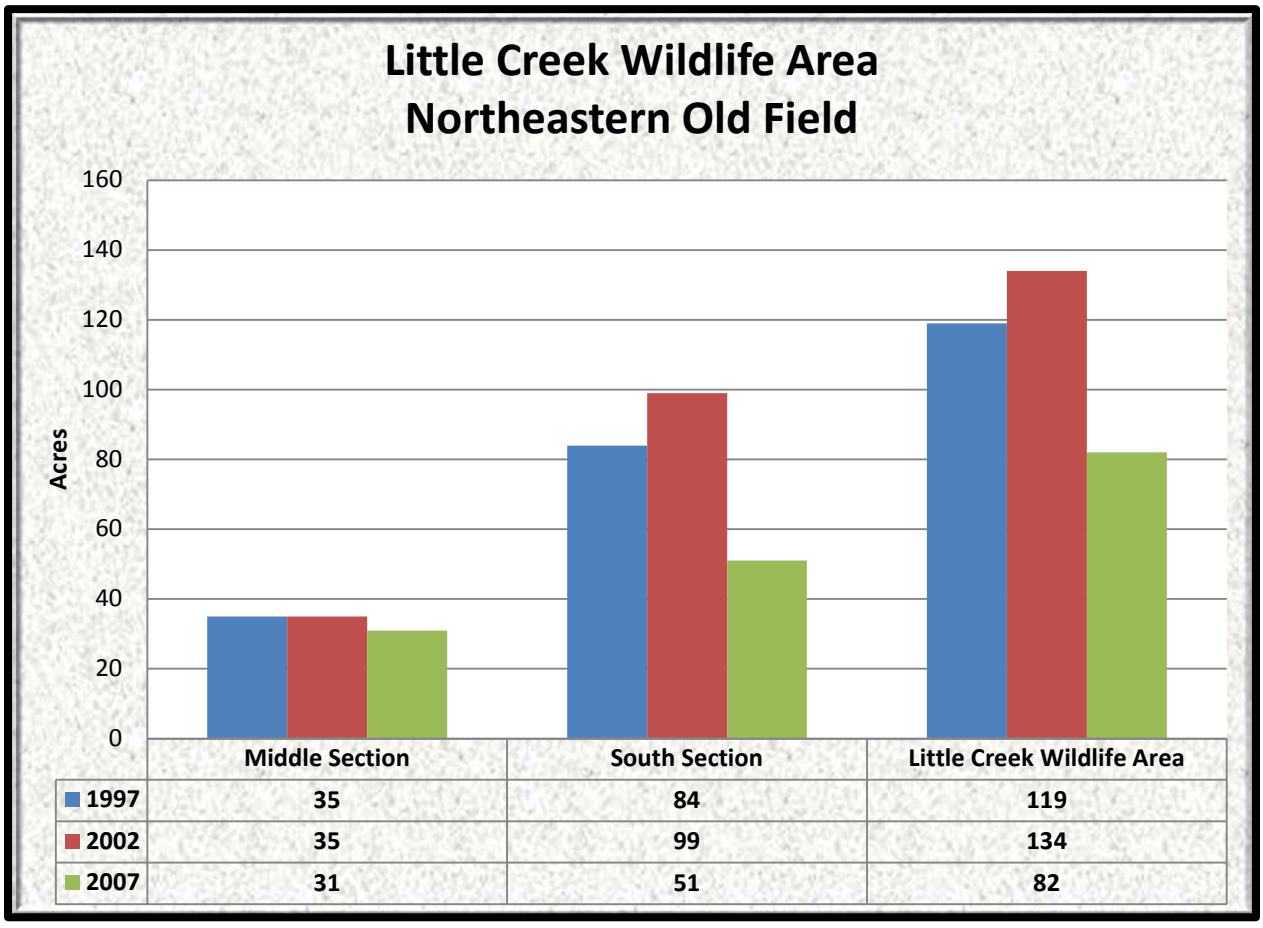


Figure 5.29. Northeastern Old Field at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.63)

Less than 1/3 of the current acreage of Northeastern Old Field will be impacted by 1.5 m of sea level rise.

Table 5.63. Projected acres of Northeastern Old Field Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	10 acres
1 m	19 acres
1.5 m	26 acres

Natural Capital (Table 5.64)

Northeastern Old Field has largely been decreasing as it matures to Northeastern Successional Shrubland and Successional Sweetgum Forest.

Table 5.64. Natural Capital of Northeastern Old Field	
Year	**Natural Capital (in 2012 dollars)**
1997	$17,338/year
2002	$19,524/year
2007	$11,947/year

Northeastern Successional Shrubland **[47 acres (Figure 5.30, Tables 5.65-5.68)] GNA SNA**

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

Description

This shrubland community is often located on the edges of roads and agricultural fields. Most expressions of it are composed of multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), wild black cherry (*Prunus serotina*), Japanese honeysuckle (*Lonicera japonica*), tuliptree (*Liriodendron tulipifera*), timothy (*Phleum pratense*), and poison ivy (*Toxicodendron radicans*).

Analysis of Condition at Little Creek Wildlife Area

Northeastern Successional Shrubland has increased in acreage during the study period. This is largely the result of Northeastern Old Fields maturing into this community.

In 2007, 18 acres of the original 26 acres from 1997 were still present. The rest of the acreage matured into Northeastern Modified Successional Forest (4 acres), became agricultural field (1 acre), Northeastern Old Field (1 acre) or cultivated lawn (1 acre) (Table 5.65).

Since 1997, Northeastern Successional Shrubland has migrated into 19 acres of Northeastern Old Field, 3 acres of Northeastern Modified Successional Forest, 2 acres of Eastern Reed Marsh, and 2 acres of agricultural field (Table 5.66).

Table 5.65. What was Northeastern Successional Shrubland in 1997 has become X in 2007

X	Acreage
Northeastern Successional Shrubland	18 acres
Northeastern Modified Successional Forest	4 acres
Agricultural Field	1 acre
Northeastern Old Field	1 acre
Cultivated Lawn	1 acre
Other communities/land covers	1 acre

Table 5.66. Northeastern Successional Shrubland has migrated into X since 1997	
X	**Acreage**
Northeastern Old Field	19 acres
Northeastern Successional Shrubland	18 acres
Northeastern Modified Successional Forest	3 acres
Eastern Reed Marsh	2 acres
Agricultural Field	2 acres
Other communities/land covers	2 acres

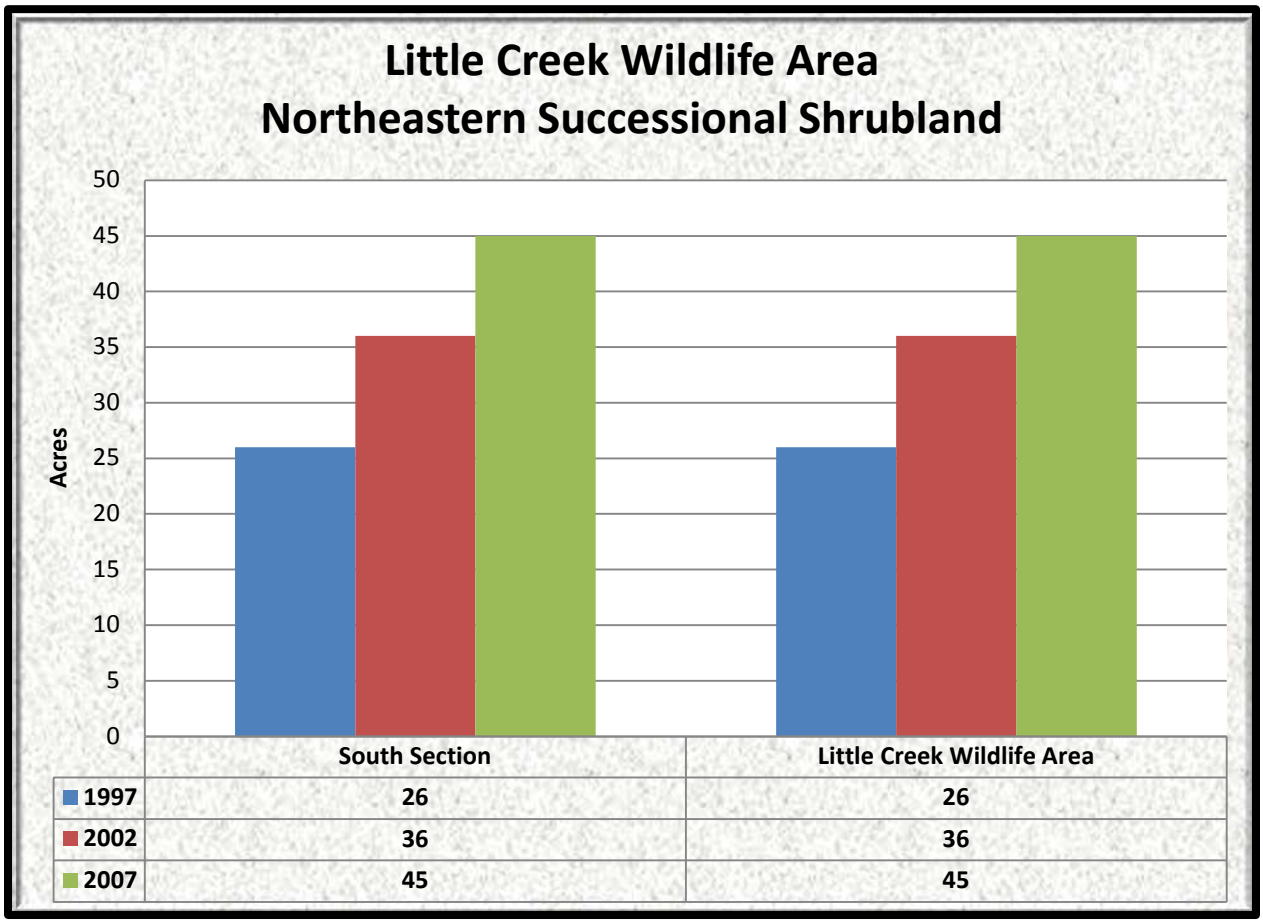


Figure 5.30. Northeastern Successional Shrubland at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.67)

A little more than half of the current Northeastern Successional Shrubland will be inundated will 1.5 m of sea level rise.

Table 5.67. Projected acres of Northeastern Successional Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	12 acres
1.5 m	25 acres

Natural Capital (Table 5.68)

Northeastern Successional Shrubland has been increasing as it populates Northeastern Old Fields.

Table 5.68. Natural Capital of Northeastern Successional Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1997	$3,788/year
2002	$5,245/year
2007	$6,557/year

Norway Spruce Planted Forest **[1 acre (Figure 5.31, Tables 5.69-5.72)] GNA SNA**

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

Description

This community consists entirely of planted Norway spruce (*Picea abies*). Because of the acidity of the needles and the shading of the trees very little if anything grows underneath.

Analysis of Condition at Little Creek Wildlife Area

This is an artificial, man-made community that has not changed during the study period, however part of this community has converted to a Chesapeake Bay Non-riverine Wet Hardwood Forest (Table 5.69).

This community has not been planted in any other areas since 1997 (Table 5.70).

Table 5.69. What was Norway Spruce Planted Forest in 1997 has become X in 2007	
X	**Acreage**
Norway Spruce Planted Forest	1 acre
Chesapeake Bay Non-riverine Wet Hardwood Forest	1 acre

Table 5.70. Norway Spruce Planted Forest has migrated into X since 1997	
X	**Acreage**
Norway Spruce Planted Forest	1 acre

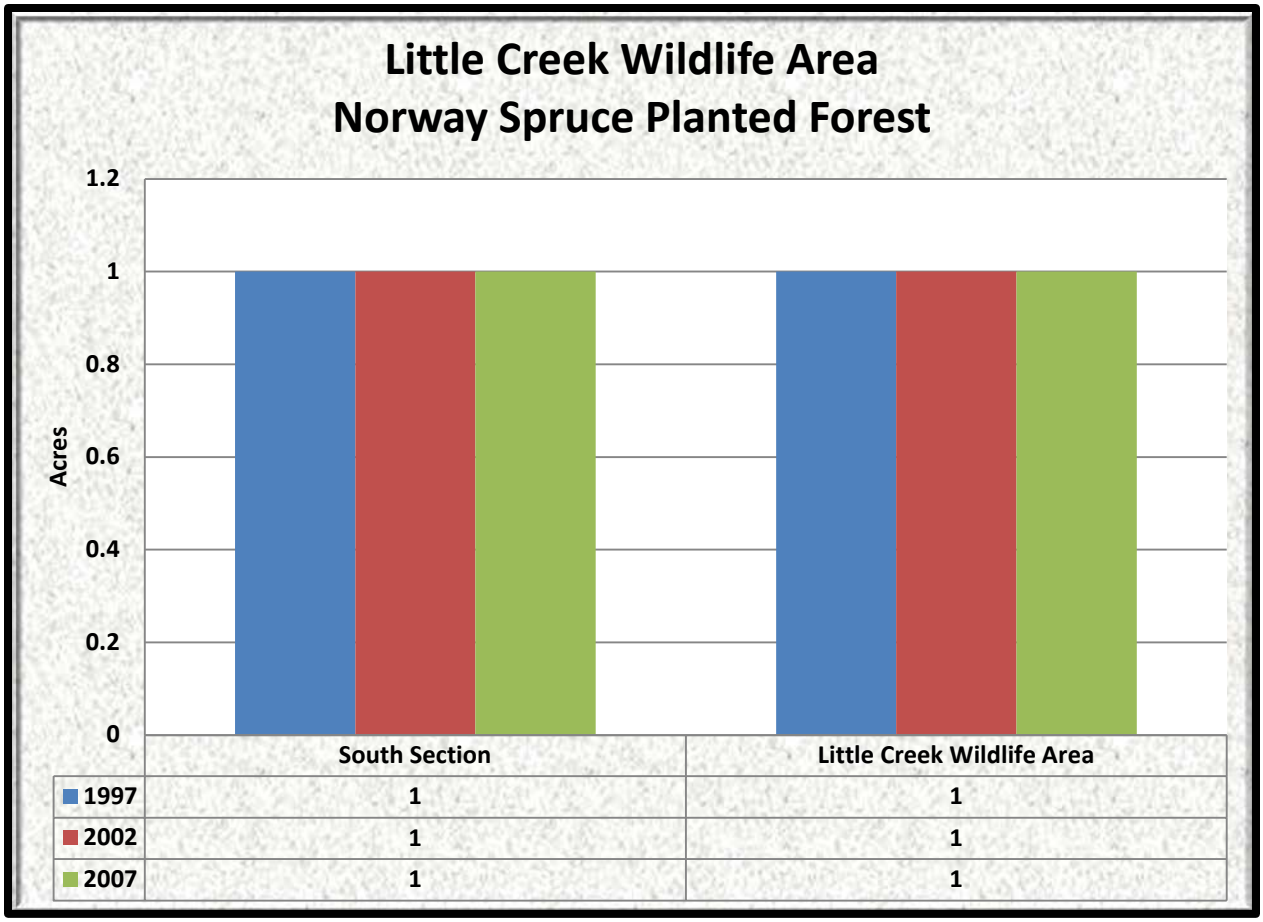


Figure 5.31. Norway Spruce Planted Forest at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.71)

Norway Spruce Planted Forest will be impacted by water at 1 m of sea level rise.

Table 5.71. Projected acres of Norway Spruce Planted Forest Impacted by Sea Level Rise

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

Natural Capital (Table 5.72)

Capital of Norway Spruce Planted Forest has remained the same throughout the study period.

Table 5.72. Natural Capital of Norway Spruce Planted Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$189/year
2002	$189/year
2007	$189/year

Overwash Dune Grassland **[0.4 acres (Figure 5.32, Tables 5.73-5.76)] G2G3 S2S3?**

DEWAP: Beach and Dune Habitats
NHC: Northern Atlantic Coastal Dune and Maritime Grassland

Description

This grassland community is located just behind the beach and dune areas on the Delaware Bay at the eastern end of the Logan Lane Tract. It is formed when sand is pushed over the beach during storms forming a fan configuration behind the beach. Some of the newer overwashes are un-vegetated but others can contain salt meadow hay (*Spartina patens*), olney's three square bulrush (*Schoenoplectus pungens*), seaside goldenrod (*Solidago sempervirens*), dune sandbur (*Cenchrus tribuloides*), and seashore saltgrass (*Distichlis spicata*).

Analysis of Condition at Little Creek Wildlife Area

Overwash Dune Grassland tends to be an ephemeral community that comes and goes depending on the amount of storms and sedimentation. In 1997 there was 1 acre of this community but by 2007 only 0.3 acres of the original acres remained. The rest of the acreage became Reed Tidal Marsh (Table 5.73). There was a threefold increase in 2002 and then decrease showing the changeable nature of this community.

Since 1997 this community has covered 0.1 acres of North Atlantic Low Salt Marsh (Table 5.74).

Table 5.73. What was Overwash Dune Grassland in 1997 has become X in 2007	
X	**Acreage**
Reed Tidal Marsh	1 acre
Overwash Dune Grassland	0.3 acres

Table 5.74. Overwash Dune Grassland has migrated into X since 1997	
X	**Acreage**
Overwash Dune Grassland	0.3 acres
North Atlantic Low Salt Marsh	0.1 acres

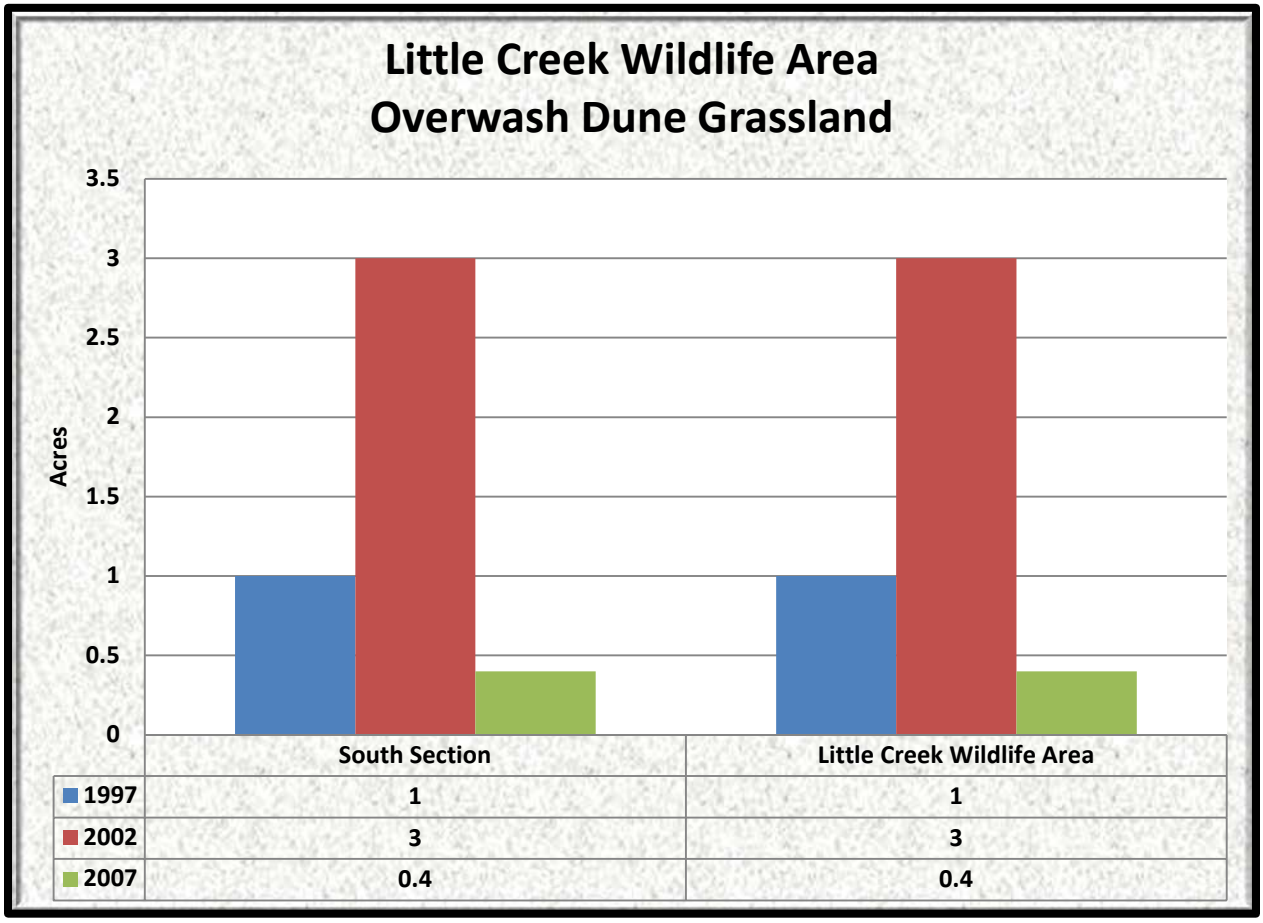


Figure 5.32. Overwash Dune Grassland at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.75)

Overwash Dune Grassland will be impacted by water at 1 m of sea level rise in Little Creek Wildlife Area.

Table 5.75. Projected acres of Overwash Dune Grassland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0.4 acres
1.5 m	0.4 acres

Natural Capital (Table 5.76)

Overwash Dune Grassland is an ephemeral community that comes and goes according to storm events. As such, the capital of the community oscillated during the study period.

Table 5.76. Natural Capital of Overwash Dune Grassland	
Year	**Natural Capital (in 2012 dollars)**
1997	$146/year
2002	$437/year
2007	$58/year

Reed Tidal Marsh **[563 acres (Figures 5.33-5.34, Tables 5.77-5.80)] GNA SNA**

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

Description

Figure 5.33. Reed Tidal Marsh (Middle Section)

Reed Tidal Marsh is a tidal marsh that is dominated nearly or completely by common reed (*Phragmites australis*).

Analysis of Condition at Little Creek Wildlife Area

Reed Tidal Marsh has experienced marked decreases in acreage since 1997, due to aggressive control efforts in the wildlife area. In 1997 there were 810 acres of this community in the wildlife area but by 2007 only 394 of the original acreage remained. The rest became North Atlantic Low Salt Marsh (241 acres), Impoundment (75 acres), North Atlantic High Salt Marsh (72 acres), and water (12 acres) (Table 5.77).

Since 1997, this community has continued to spread in spite of the control efforts. Communities that have been converted include 72 acres of North Atlantic Low Salt Marsh, 35 acres of North Atlantic High Salt Marsh (still, there was a net gain for this community), 29 acres of Impoundment, and 8 acres of Irregularly Flooded Eastern Tidal Salt Shrub (Table 5.78).

Table 5.77. What was Reed Tidal Marsh in 1997 has become X in 2007	
X	**Acreage**
Reed Tidal Marsh	394 acres
North Atlantic Low Salt Marsh	241 acres
Impoundment	75 acres
North Atlantic High Salt Marsh	72 acres
Water	12 acres
Other communities/land covers	16 acres

Table 5.78. Reed Tidal Marsh has migrated into X since 1997	
X	**Acreage**
Reed Tidal Marsh	394 acres
North Atlantic Low Salt Marsh	72 acres
North Atlantic High Salt Marsh	35 acres
Impoundment	29 acres
Irregularly Flooded Eastern Tidal Salt Shrub	8 acres
Other communities/land covers	24 acres

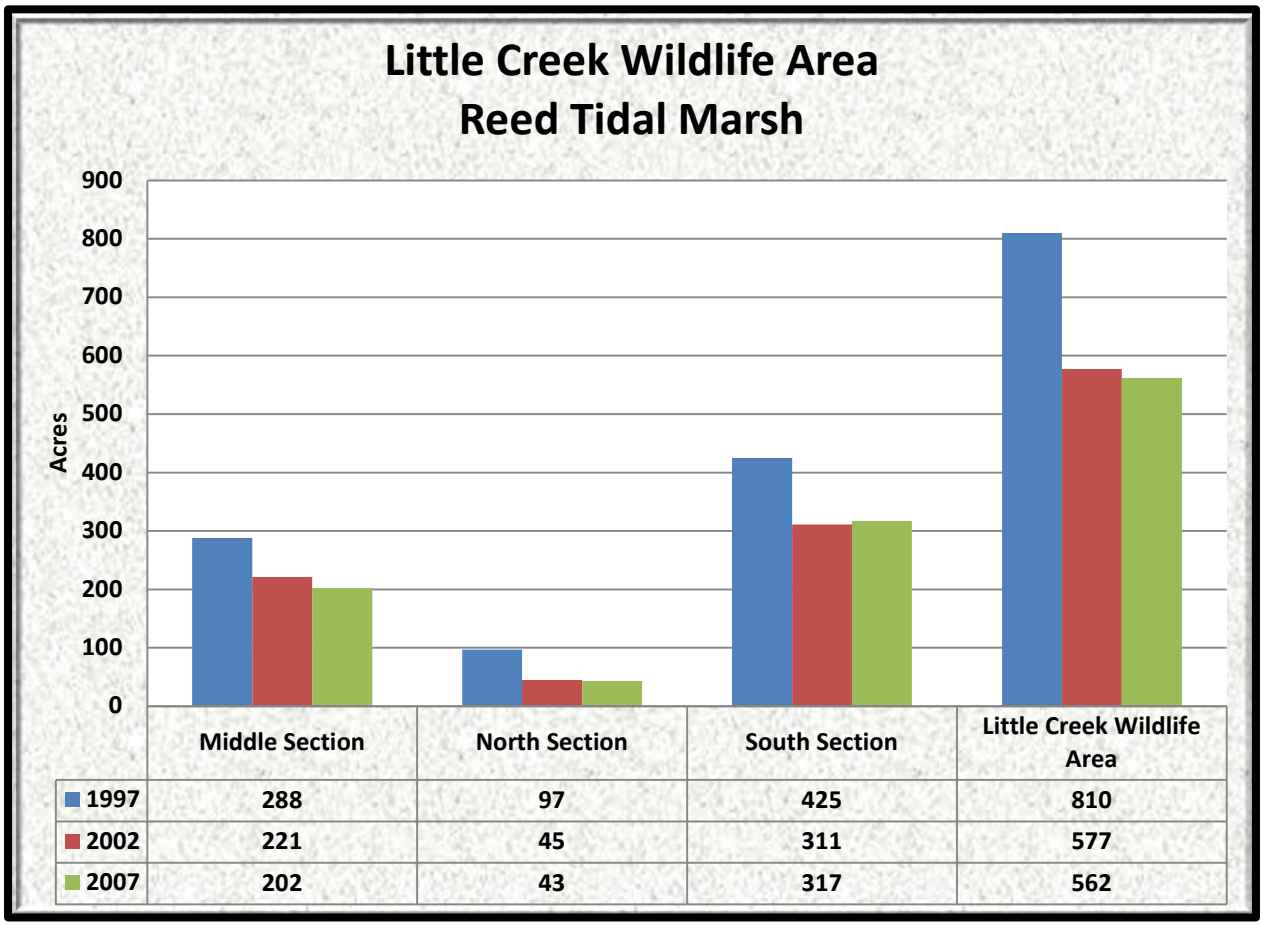


Figure 5.35. Reed Tidal Marsh at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.79)

All of the Reed Tidal Marsh acreage will be inundated with 1.5 m of sea level rise.

Table 5.79. Projected acres of Reed Tidal Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	508 acres
1 m	559 acres
1.5 m	562 acres

Natural Capital (Table 5.80)

Capital of Reed Tidal Marsh has been decreasing, mainly because of *Phragmites* control efforts.

Table 5.80. Natural Capital of Reed Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1997	$5,079,753/year
2002	$3,618,540/year
2007	$3,524,471/year

***Salt Panne* [37 acres (Figure 5.36, Tables 5.81-5.84)] G5 S3**

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

Description

Salt pannes are located in small depressions in North Atlantic Low Salt Marsh. Because of the combination of impounded saline water and evaporation, these habitats can be saltier than the surrounding area. All of the occurrences of this community were aerially interpreted because of their location. Typical species in salt pannes include glasswort (*Salicornia virginica*), dwarf glasswort (*Salicornia bigelovii*), sea lavender (*Limonium carolinianum*), and halbeard-leaf orache (*Atriplex patula*).

Analysis of Condition at Little Creek Wildlife Area

Salt Pannes can be ephemeral like the Overwash Dune Grassland, coming and going as depressions are made then filled. Since 1997 this community has increased more than most and it is uncertain if this may be a precursor of sea level rise as water takes over the marsh. None of the 1997 acreage of 2 acres was present in 2007 (Table 5.81).

Since 1997, this community has appeared in 21 acres of North Atlantic Low Salt Marsh, 7 acres of water, 7 acres of tidal mudflat, 1 acre of Reed Tidal Marsh, and 0.4 acres of North Atlantic High Salt Marsh (Table 5.82).

Table 5.81. What was Salt Panne in 1997 has become X in 2007	
X	**Acreage**
Water	1 acre
North Atlantic Low Salt Marsh	1 acre

Table 5.82. Salt Panne has migrated into X since 1997	
X	**Acreage**
North Atlantic Low Salt Marsh	21 acres
Water	7 acres
Tidal Mudflat	7 acres
Reed Tidal Marsh	1 acre
North Atlantic High Salt Marsh	0.4 acres

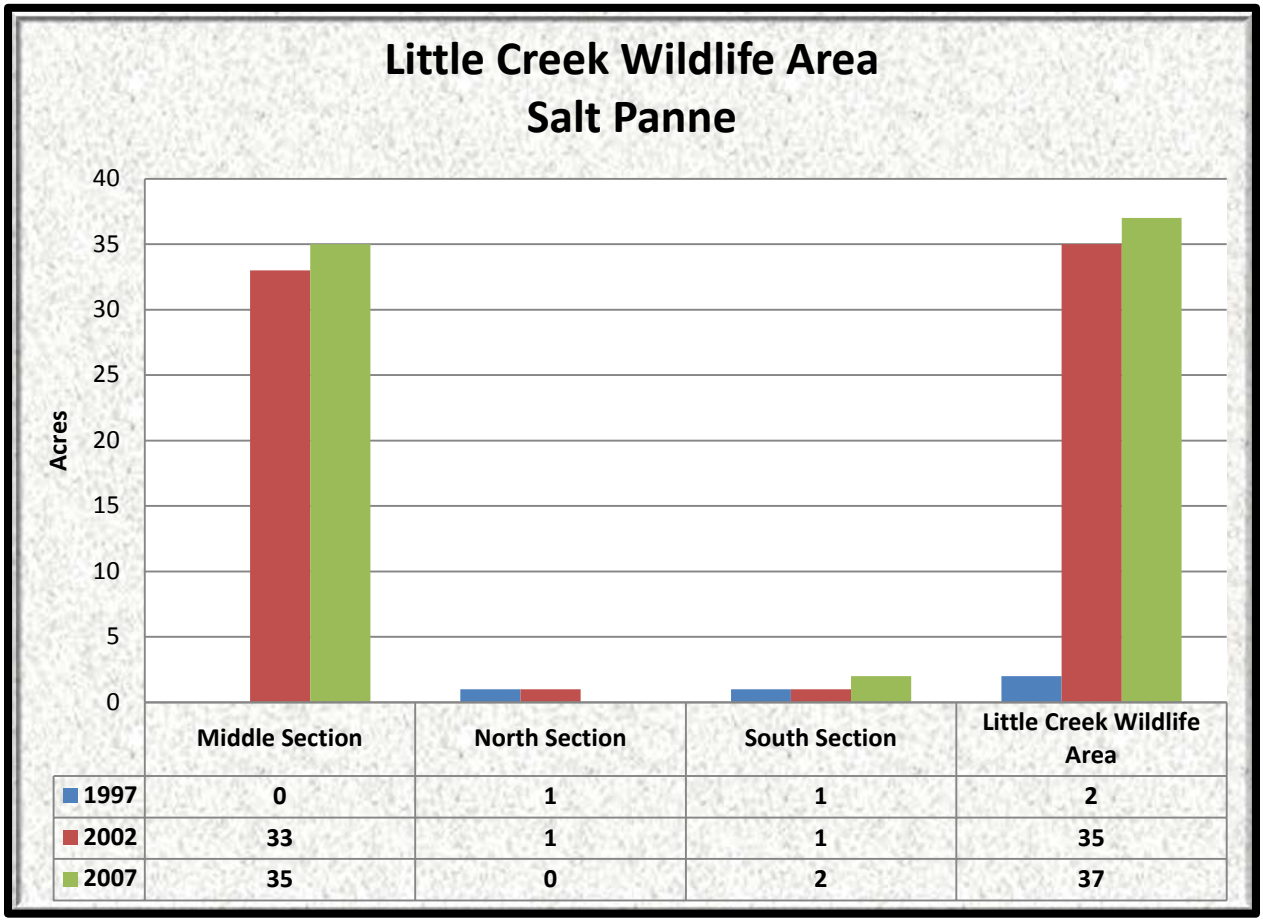


Figure 5.36. Salt Panne at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.83)

All of the current Salt Panne acreage will be inundated with 0.5 m of sea level rise.

Table 5.83. Projected acres of Salt Panne Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	37 acres
1 m	37 acres
1.5 m	37 acres

Natural Capital (Table 5.84)

Capital of Salt Panne has gone up likely as a result of sea level rise degrading the North Atlantic Low Salt Marsh and invading tidal mudflats.

Table 5.84. Natural Capital of Salt Panne	
Year	**Natural Capital (in 2012 dollars)**
1997	$12,543/year
2002	$219,496/year
2007	$232,038/year

Successional Maritime Forest **[101 acres (Figures 5.37-5.38, Tables 5.85-5.88)] G2G3 S3**

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

Description

This forested community is located near the edges of the marsh and has a stunted canopy composed of sweetgum (*Liquidambar styraciflua*), wild black cherry (*Prunus serotina*), persimmon (*Diospyros virginiana*), and eastern red cedar (*Juniperus virginiana*). The understory is composed of smaller members of the canopy plus southern bayberry (*Morella cerifera*). No shrubs or vines were observed and the only herbaceous species is common reed (*Phragmites australis*).

Figure 5.37. Successional Maritime Forest (Middle Section)

Being at the upper end of Delaware Bay, the examples of this community at Little Creek do not receive the high salt inputs that communities further down the bay get. As a result these forests are larger in stature than a typical Successional Maritime Forest.

Analysis of Condition at Little Creek Wildlife Area

In 2007, 92 of the original 101 acres from 1997 still existed. The rest of the acreage became eastern reed marsh (4 acres), Chesapeake Bay Non-riverine Wet Hardwood Forest (2 acres), Impoundment (1 acre), and Reed Tidal Marsh (1 acre) (Table 5.85).

Since 1997, this community has converted 1 acre of Northeastern Modified Successional Forest, 1 acre of Reed Tidal Marsh, 0.5 acres of Agricultural Field, and 0.4 acres of North Atlantic Low Salt Marsh (Table 5.86).

Table 5.85. What was Successional Maritime Forest in 1997 has become X in 2007	
X	**Acreage**
Successional Maritime Forest	92 acres
Eastern Reed Marsh	4 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	2 acres
Impoundment	1 acre
Reed Tidal Marsh	1 acre
Other communities/land covers	1 acre

Table 5.86. Successional Maritime Forest has migrated into X since 1997	
X	**Acreage**
Successional Maritime Forest	92 acres
Northeastern Modified Successional Forest	1 acre
Reed Tidal Marsh	1 acre
Agricultural Field	0.5 acres
North Atlantic Low Salt Marsh	0.4 acres
Other communities/land covers	1 acre

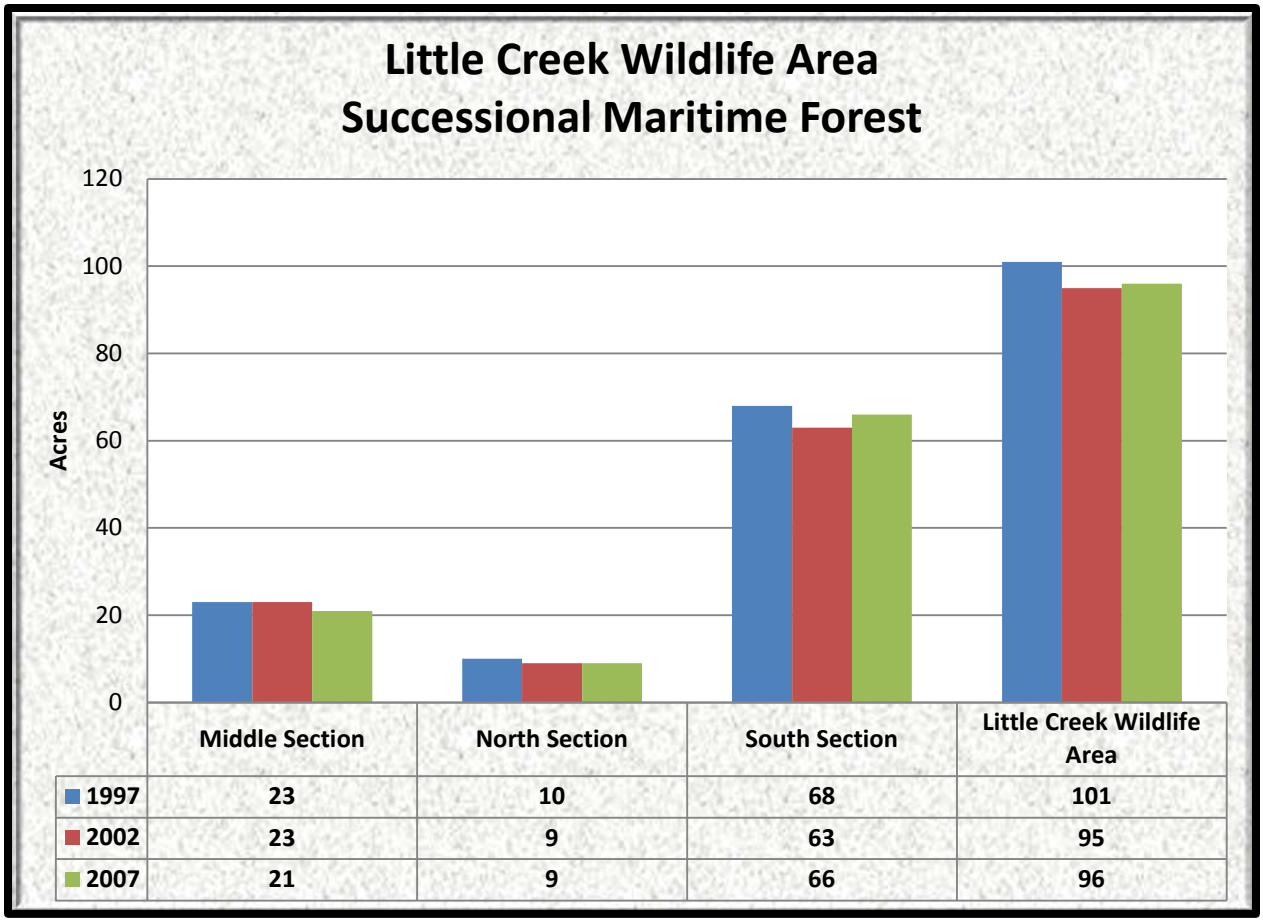


Figure 5.38. Successional Maritime Forest at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.87)

All of the current Successional Maritime Forest acreage will be inundated by water with 0.5 m of sea level rise.

Table 5.87. Projected acres of Successional Maritime Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	45 acres
1 m	86 acres
1.5 m	96 acres

Natural Capital (Table 5.88)

Capital of Successional Maritime Forest has decreased because of conversion to marsh, but has come back up some in the recent period (2002-2007).

Table 5.88. Natural Capital of Successional Maritime Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$19,099/year
2002	$17,965/year
2007	$18,154/year

Successional Sweetgum Forest **[25 acres (Figures 5.39-5.40, Tables 5.89-5.91)] GNA SNA**

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

Description

Successional Sweetgum Forest is found on the edges of agricultural fields in the wildlife area. This successional forest community is a near monoculture of young sweetgum (*Liquidambar styraciflua*), with an occasional eastern red cedar (*Juniperus virginiana*), and red maple (*Acer rubrum*). No herbs or shrubs were noted for this community.

Figure 5.39. Successional Sweetgum Forest (Middle Section)

Analysis of Condition at Little Creek Wildlife Area

All nine acres from 1997 were still present in 2007. Since 1997, Successional Sweetgum Forest has grown into 14 acres of Northeastern Old Field, and 1 acre each of agricultural field and Chesapeake Bay Non-riverine Wet Hardwood Forest (Table 5.89).

Table 5.89. Successional Sweetgum Forest has migrated into X since 1997	
X	**Acreage**
Northeastern Old Field	14 acres
Successional Sweetgum Forest	9 acres
Agricultural Field	1 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	1 acre

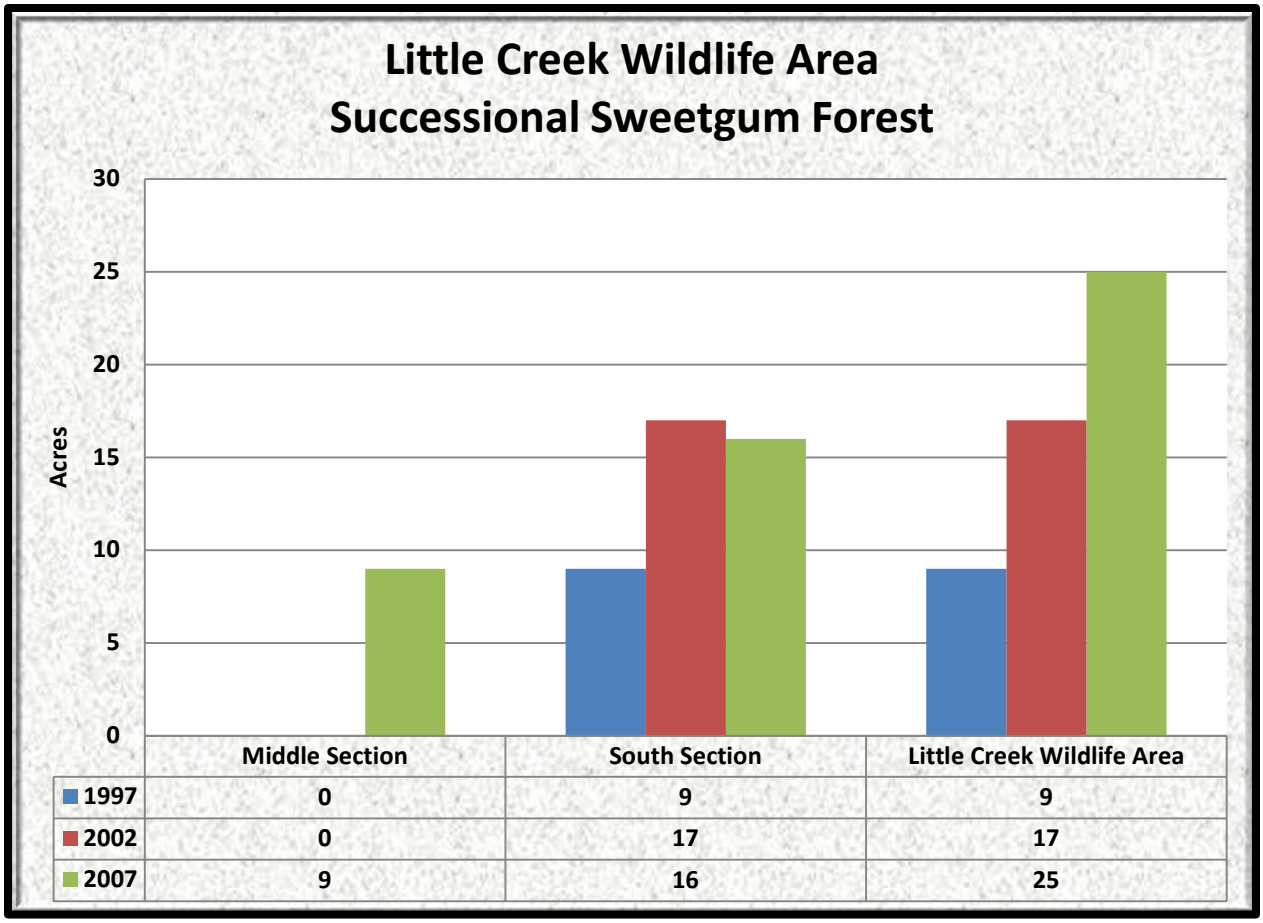


Figure 5.40. Successional Sweetgum Forest at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.90)

About 1/5 of the current acreage of Successional Sweetgum Forest will be impacted by 1.5 m of sea level rise.

Table 5.90. Projected acres of Successional Sweetgum Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	3 acres
1.5 m	5 acres

Natural Capital (Table 5.91)

Capital of Successional Sweetgum Forest has been increasing as it populates Northeastern Old Field and agricultural fields.

Table 5.91. Natural Capital of Successional Sweetgum Forest	
Year	**Natural Capital (in 2012 dollars)**
1997	$1,702/year
2002	$3,215/year
2007	$4,728/year

***Swamp-loosestrife Shrub Swamp* [1 acre (Figures 5.41-5.42, Tables 5.91-5.94)] GNR S3**

DEWAP: Shrub Swamps
NHC: Northern Atlantic Coastal Plain Stream and River

Description

Figure 5.41. Swamp-loosestrife Shrub Swamp (Middle Section)

These shrub communities are often found in ponds and impoundments where there is deep water. Swamp-loosestrife (*Decodon verticillatus*) is the dominant species and sometimes the only species which is case in Little Creek Wildlife area. This community is growing in a pond near the Fisheries Building.

Analysis of Condition at Little Creek Wildlife Area

About 0.1 acres of the 0.3 acres present in 1997 still existed in 2007. The rest of the acreage had become Chesapeake Bay Non-riverine Wet Hardwood Forest (Table 5.91). Since 1997, Swamp-loosestrife Shrub Swamp has populated 1 acre of water increasing its size (Table 5.92).

Table 5.91. What was Swamp-loosestrife Shrub Swamp in 1997 has become X in 2007	
X	**Acreage**
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.3 acres
Swamp-loosestrife Shrub Swamp	0.1 acres

Table 5.92. Swamp-loosestrife Shrub Swamp has migrated into X since 1997	
X	**Acreage**
Water	1 acre
Swamp-loosestrife Shrub Swamp	0.1 acres

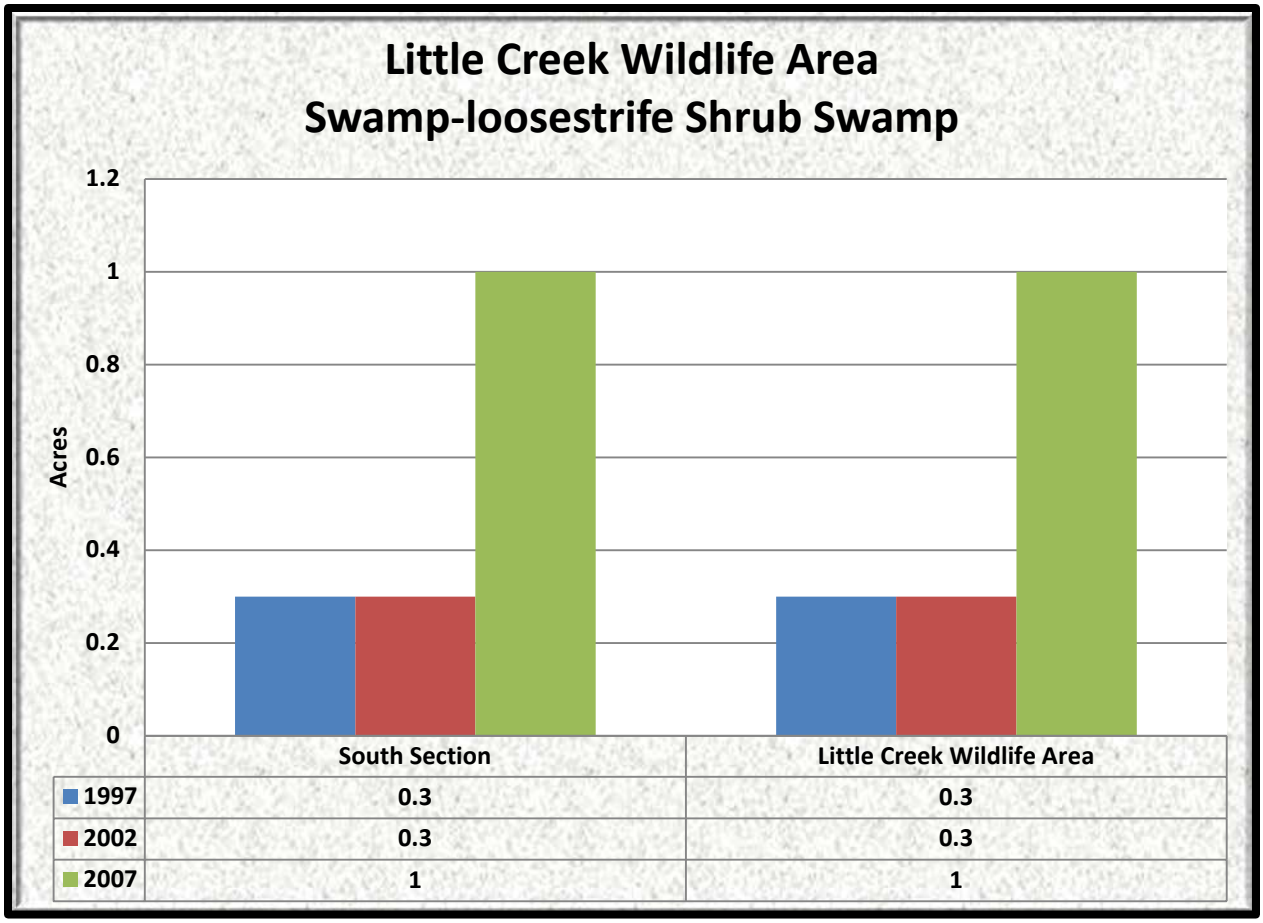


Figure 5.42. Swamp-loosestrife Shrub Swamp at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.93)

All of the Swamp-loosestrife Shrub Swamp acreage will be inundated with 1.5 m of sea level rise.

Table 5.93. Projected acres of Swamp-loosestrife Shrub Swamp Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	1 acre

Natural Capital (Table 5.94)

Capital of Swamp-loosestrife Shrub Swamp has increased with its growing acreage.

Table 5.94. Natural Capital of Swamp-loosestrife Shrub Swamp	
Year	**Natural Capital (in 2012 dollars)**
1997	$2,784/year
2002	$2,784/year
2007	$9,281/year

Upland Switchgrass Vegetation **[22 acres (Figures 5.43-5.44, Tables 5.95-5.97)] GNA SNA**

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

Description

Figure 5.43. Upland Switchgrass Vegetation (Middle Section)

This community is planted as a buffer around wildlife fields and agricultural fields in the wildlife area. Switchgrass (*Panicum virgatum*) is generally the only species in these communities, but sometimes a sapling of red maple (*Acer rubrum*) or sweetgum (*Liquidambar styraciflua*) can be found in them.

Analysis of Condition at Little Creek Wildlife Area

This community, which has been planted on the edges of Northeastern Old Fields and agricultural fields, was not present in 1997. Since 1997 it has been planted on 11 acres of Northeastern Old Field and 10 acres of Agricultural Field to cover 21 acres in total (Table 5.95)

Table 5.95. Upland Switchgrass Vegetation has been planted into X since 1997	
X	**Acreage**
Northeastern Old Field	11 acres
Agricultural Field	10 acres

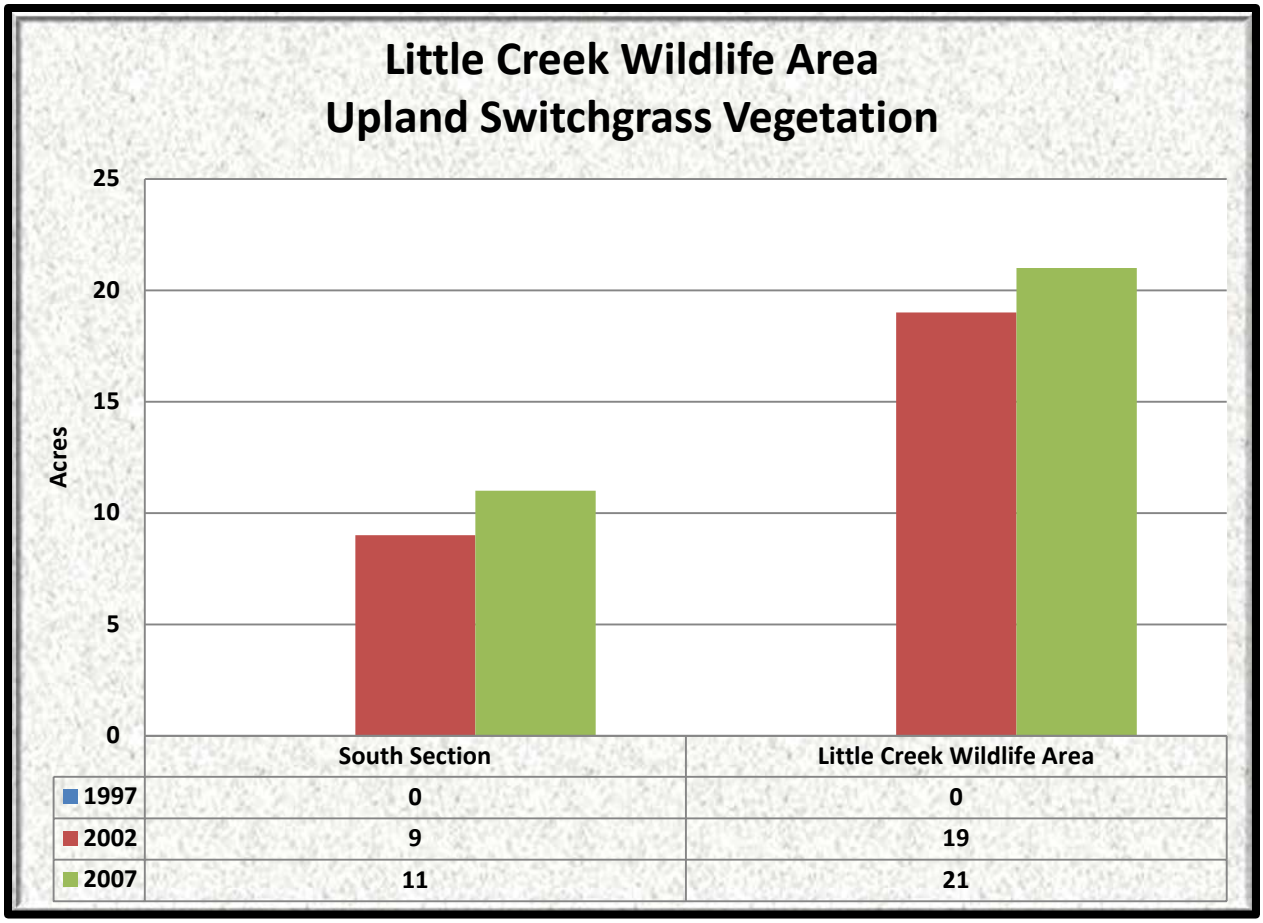


Figure 5.44. Upland Switchgrass Vegetation at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.96)

About 2/3 of the current acreage of Upland Switchgrass Vegetation will be flooded with 1.5 m of sea level rise.

Table 5.96. Projected acres of Upland Switchgrass Vegetation Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	4 acres
1.5 m	13 acres

Natural Capital (Table 5.97)

Increasing amounts of switchgrass (*Panicum virgatum*) have been planted in the wildlife area causing a rise in capital through transfers.

Table 5.97. Natural Capital of Upland Switchgrass Vegetation	
Year	**Natural Capital (in 2012 dollars)**
1997	$0/year (not present)
2002	$2,768/year
2007	$3,060/year

Wax-Myrtle Shrub Swamp **[5 acres (Figure 5.45, Tables 5.98-5.99)] G2G3 S2**

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

Description

This community was noted through aerial interpretation. Typically this community is dominated by wax-myrtle (*Morella cerifera*), and associated by salt shrub (*Baccharis halimifolia*) and red maple (*Acer rubrum*). Common herbs include speargrass (*Chasmanthium laxum*), netted chain fern (*Woodwardia areolata*), royal fern (*Osmunda regalis* var. *spectabilis*), false nettle (*Boehmeria cylindrica*), and Pennsylvania smartweed (*Polygonum pensylvanicum*).

Analysis of Condition at Little Creek Wildlife Area

During the study period, this community has only lost 0.5 acres, but has otherwise not changed. Because of this no change analysis was conducted.

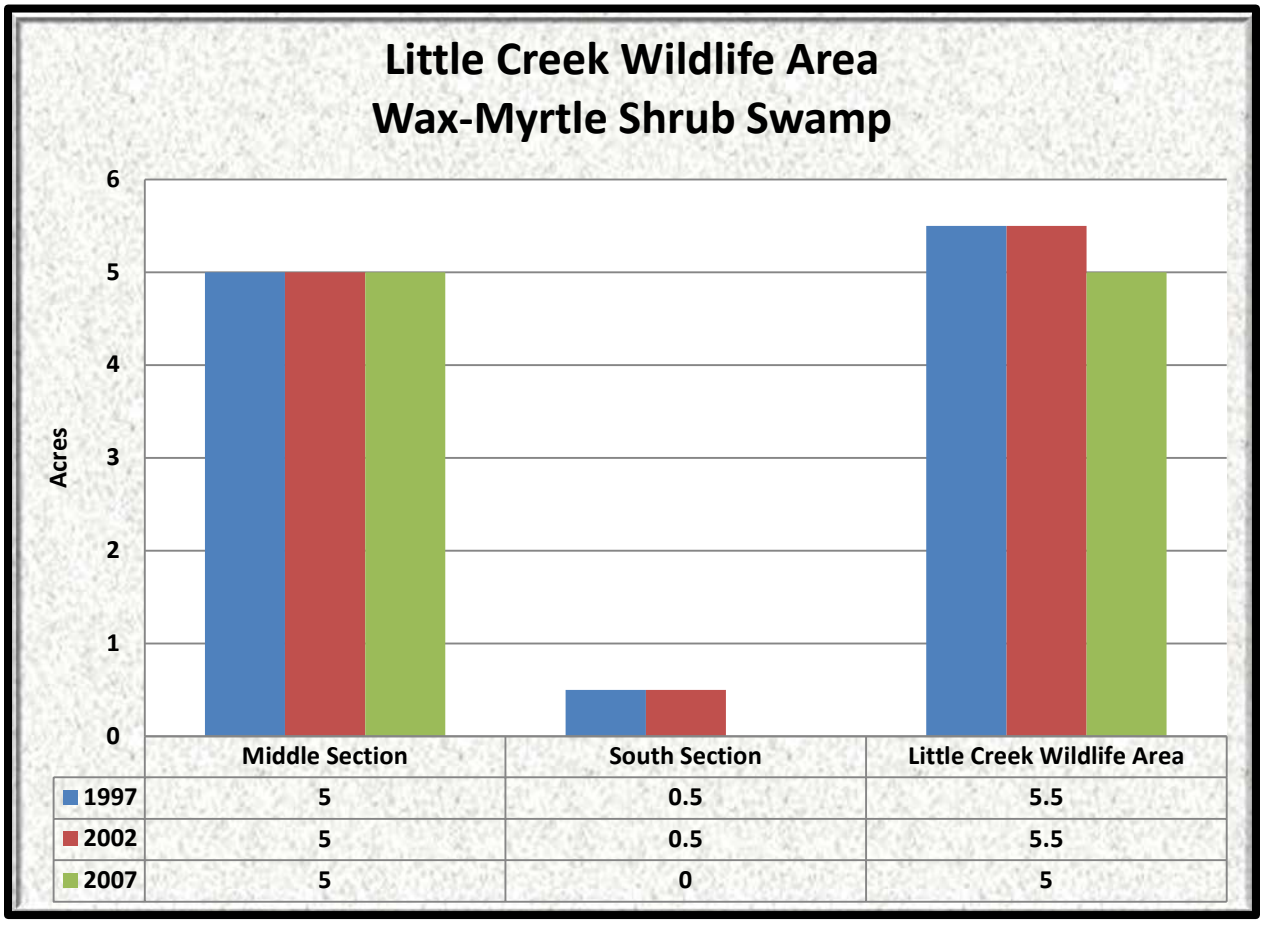


Figure 5.45. Wax-Myrtle Shrub Swamp at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.98)

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

Table 5.98. Projected acres of Wax-Myrtle Shrub Swamp Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	5 acres
1.5 m	5 acres

Natural Capital (Table 5.99)

The loss of 0.5 acres of Wax-Myrtle Shrub Swamp has resulted in a loss of capital from 2002 to 2007.

Table 5.99. Natural Capital of Wax-Myrtle Shrub Swamp	
Year	**Natural Capital (in 2012 dollars)**
1997	$51,048/year
2002	$51,048/year
2007	$46,407/year

CHAPTER 6: DESCRIPTION AND ANALYSIS OF THE LAND COVERS

Land covers are those areas that are not vegetation communities but still cover ground surface. In terms of sea-level rise, water is most important but it effects can also be seen in the impoundments.

The land covers include:

1. Agricultural Field—269 acres
2. Beach—15 acres
3. Farm Pond/Artificial Pond—7 acres
4. Impervious Surface—13 acres
5. Impoundment—420 acres
6. Modified Land—3 acres
7. Powerline R-O-W—24 acres
8. Riprap—1 acre
9. Sand—1 acre
10. Semi-impervious Surface—28 acres
11. Tidal Mudflat—1 acre
12. Water—249 acres

Agricultural Field **[269 acres (Figure 6.1, Tables 6.1-6.4)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

In 1997, 309 acres were planted in crops. Since this time the number of acres has been reduced to 269 acres, most of which have become Northeastern Old Fields.

Analysis of Condition at Little Creek Wildlife Area

Agricultural fields have been declining in the wildlife area as the fields are converted to wildlife use and open land. In 2007, only 232 acres of the original 309 acres in 1997 were still in agricultural use. The former fields have become Northeastern Old Field (52 acres), Upland Switchgrass Vegetation (10 acres), Eastern Reed Marsh (5 acres), and Cultivated Lawn (3 acres) (Table 6.1).

Since 1997, agricultural field has been created from 36 acres of Northeastern Old Field, 1 acre of shrubland and 0.1 acres of Northeastern Modified Successional Forest (Table 6.2).

Table 6.1. What was once Agricultural Field in 1997 has become X in 2007	
X	**Acreage**
Agricultural Field	232 acres
Northeastern Old Field	52 acres
Upland Switchgrass Vegetation	10 acres
Eastern Reed Marsh	5 acres
Cultivated Lawn	3 acres
Other communities/land covers	8 acres

Table 6.2. Agricultural Field has migrated into X since 1997	
X	**Acreage**
Agricultural Field	232 acres
Northeastern Old Field	36 acres
Northeastern Successional Shrubland	1 acre
Northeastern Modified Successional Forest	0.1 acres

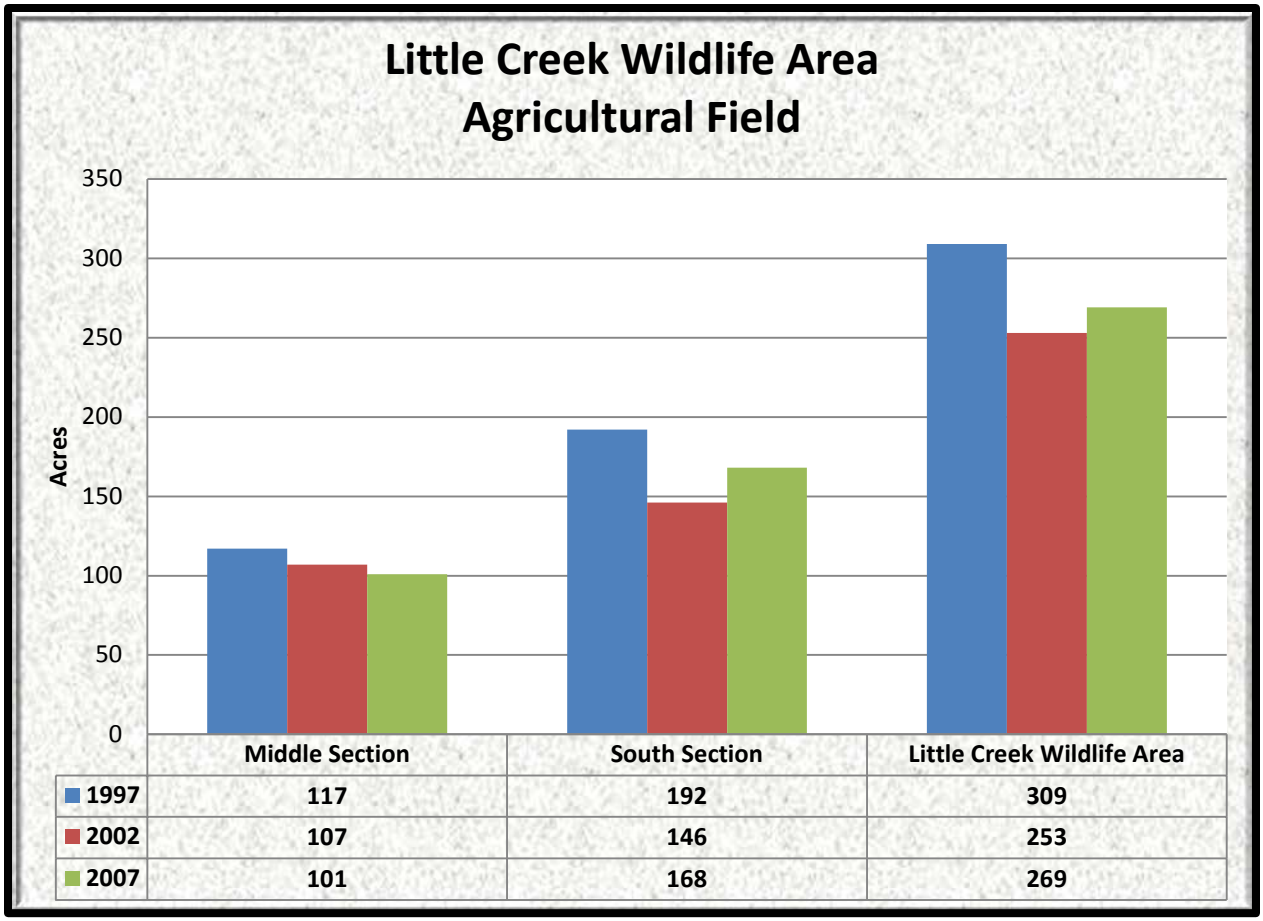


Figure 6.1. Agricultural Fields at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.3)

Less than ¼ of the current acreage of agricultural field will be impacted by 1.5 m of sea level rise in Little Creek Wildlife Area.

Table 6.3. Projected acres of Agricultural Field Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	7 acres
1 m	26 acres
1.5 m	64 acres

Natural Capital (Table 6.4)

Natural capital in agricultural fields has gone down with the acreage of the fields. More and more fields are being abandoned and reclaimed to natural habitat.

Table 6.4. Natural Capital of Agricultural Field	
Year	**Natural Capital (in 2012 dollars)**
1997	$17,721/year
2002	$14,510/year
2007	$15,427/year

***Beach* [15 acres (Figure 6.2, Tables 6.5-6.7)]**

DEWAP: Un-vegetated Sandy Beach
NHC: No Equivalent Classification

Description

This land cover is located on edges of Delaware Bay and the St. Jones River. It is characterized by an un-vegetated stretch of sand.

Analysis of Condition at Little Creek Wildlife Area

This land cover tends to be ephemeral and comes and goes with storms and overwashes. In 2007, 5 acres of the original 14 acres of beach present in 1997 still existed. Of the rest, 6 acres have been inundated by water, 2 acres have become Reed Tidal Marsh, and 0.2 acres have been covered in Riprap (Table 6.5).

Since 1997, beach area has covered 3 acres of Reed Tidal Marsh, 2 acres of water, and 2 acres of North Atlantic Low Salt Marsh (Table 6.6).

Table 6.5. What was once Beach in 1997 has become X in 2007	
X	**Acreage**
Water	6 acres
Beach	5 acres
Reed Tidal Marsh	2 acres
Riprap	0.2 acres
North Atlantic Low Salt Marsh	0.1 acres

Table 6.6. Beach has migrated into X since 1997	
X	**Acreage**
Beach	5 acres
Reed Tidal Marsh	3 acres
Water	2 acres
North Atlantic Low Salt Marsh	2 acres
Other communities/land covers	2 acres

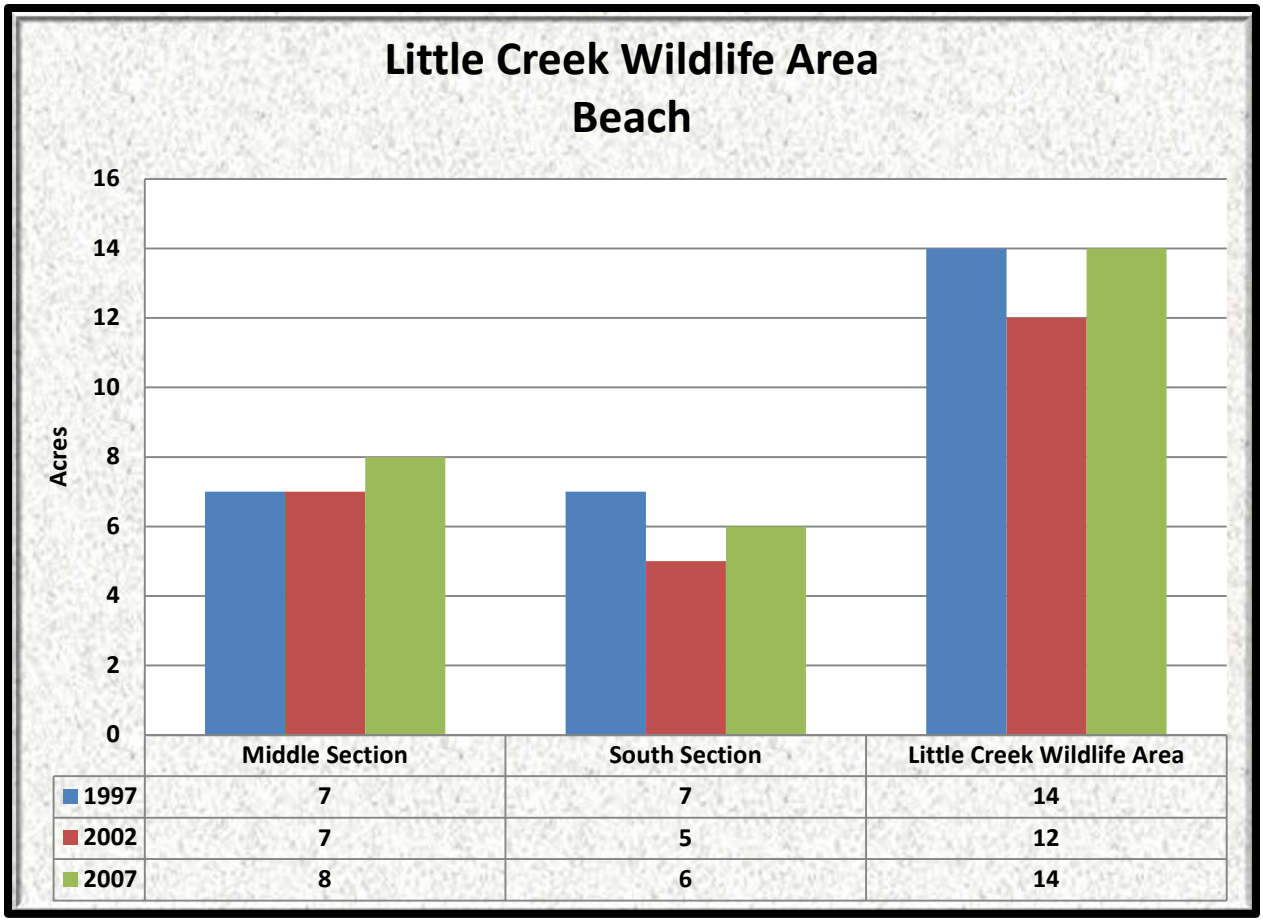


Figure 6.2. Beach at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.7)

All of the current beach acreage will be inundated with 1 m of sea level rise.

Table 6.7. Projected acres of Beach Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	11 acres
1 m	14 acres
1.5 m	14 acres

Natural Capital

Beach does have any natural capital value.

Farm Pond/Artificial Pond **[7 acres, (Figure 6.3, Tables 6.8-6.11)]**

DEWAP: Impoundments
NHC: No Equivalent Classification

Description

This land cover refers to bodies of water that are artificially created and less than five acres in size.

Analysis of Condition at Little Creek Wildlife Area

These water bodies are artificial in nature and not subject to natural changes. Only one acre of pond from 1997 changed and went to an Eastern Reed Marsh (Table 6.8). Since 1997, ponds have been developed from 2 acres of water, 1 acre of Eastern Reed Marsh, and 0.3 acres of Northeastern Old Field (Table 6.9).

Table 6.8. What was Farm Pond/Artificial Pond in 1997 has become X in 2007	
X	**Acreage**
Farm Pond/Artificial Pond	4 acres
Eastern Reed Marsh	1 acre

Table 6.9. Farm Pond/Artificial Pond has migrated into X since 1997	
X	**Acreage**
Farm Pond/Artificial Pond	4 acres
Water	2 acres
Eastern Reed Marsh	1 acre
Northeastern Old Field	0.3 acres

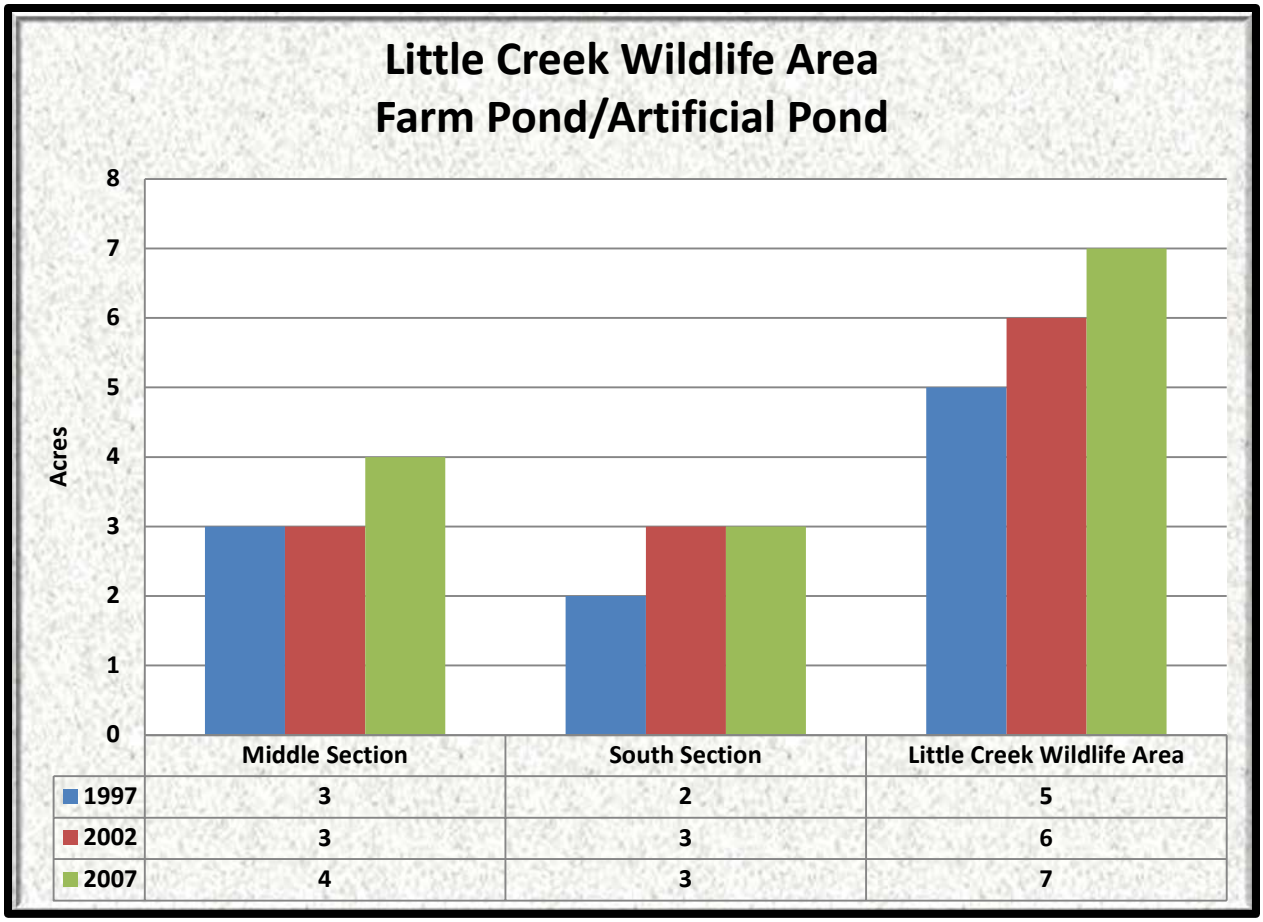


Figure 6.3. Farm Pond/Artificial Pond at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.10)

Essentially all of the farm pond/artificial pond present in the wildlife area will be "captured" at 1 m of sea level rise.

Table 6.10. Projected acres of Farm Pond/Artificial Pond Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	3 acres
1 m	6 acres
1.5 m	6 acres

Natural Capital (Table 6.11)

More ponds have been developed in the wildlife area since 1997, causing the capital to increase.

Table 6.11. Natural Capital of Farm Pond/Artificial Pond	
Year	**Natural Capital (in 2012 dollars)**
1997	$26,676/year
2002	$32,011/year
2007	$37,346/year

Impervious Surface **[13 acres, (Figure 6.4, Tables 6.12-6.14)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

This land cover includes those surfaces that are impermeable to water.

Analysis of Condition at Little Creek Wildlife Area

All of the impervious surface from 1997 was still present in 2007 and about 0.4 acres is now cultivated lawn (Table 6.12). Since 1997, impervious surfaces have been developed on 1 acre of Northeastern Old Field and 0.2 acres of Semi-impervious Surface (Table 6.13).

Table 6.12. What was Impervious Surface in 1997 has become X in 2007	
X	**Acreage**
Impervious Surface	12 acres
Cultivated Lawn	0.4 acres

Table 6.13. Impervious Surface has migrated into X since 1997	
X	**Acreage**
Impervious Surface	12 acres
Northeastern Old Field	1 acre
Semi-impervious Surface	0.2 acres

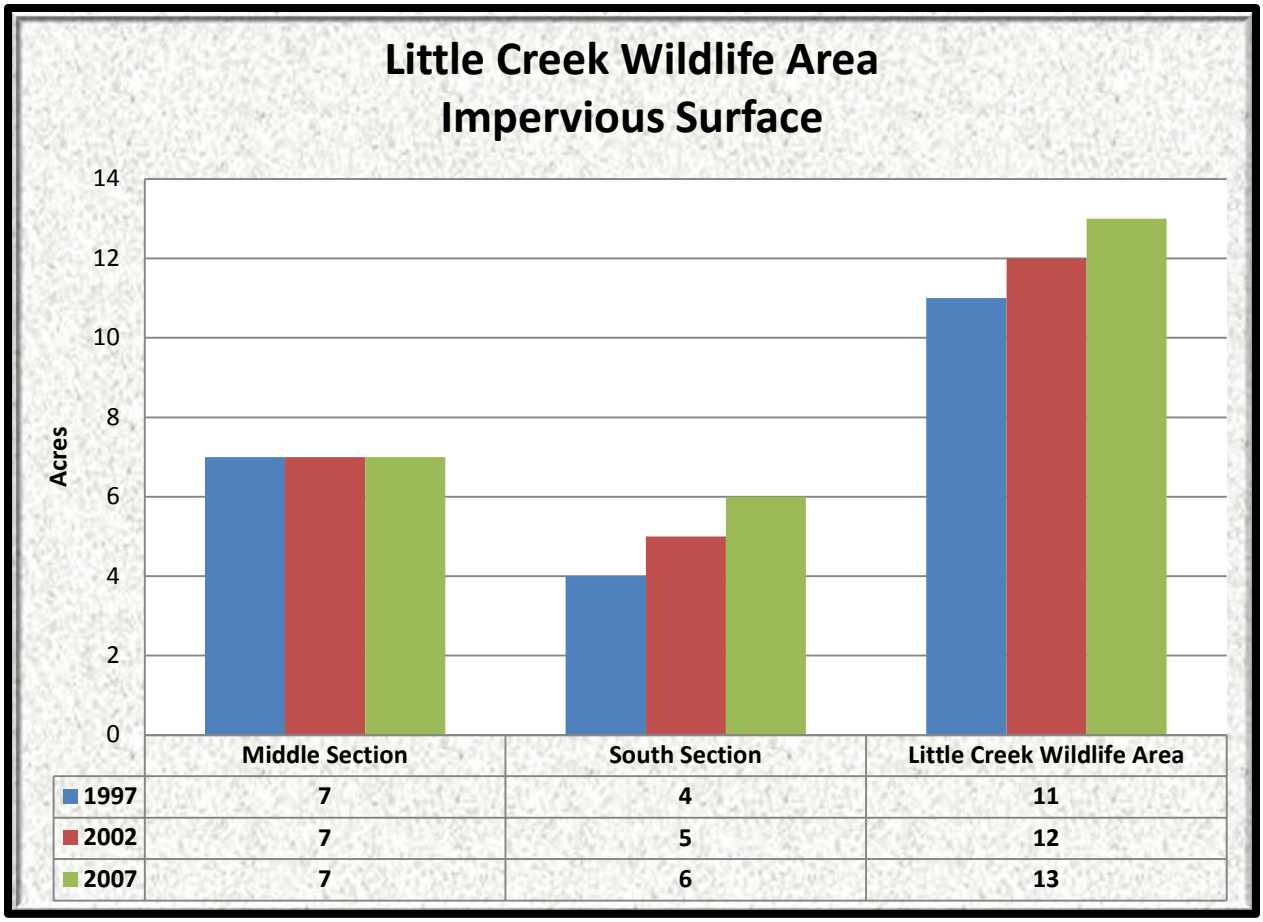


Figure 6.4. Impervious surface at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.14)

About 70% of the current impervious surfaces will be flooded with 1.5 m of sea level rise.

Table 6.14. Projected acres of Impervious Surface Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	8 acres
1.5 m	9 acres

Natural Capital

Impervious surface does not have any natural capital value.

***Impoundment* [420 acres (Figure 6.5, Tables 6.14-6.17)]**

DEWAP: Impoundments
NHC: No Equivalent Classification

Description

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

Analysis of Condition at Little Creek Wildlife Area

About 330 acres of the 777 acres present in 1997 were still present in 2007. The rest of the acreage had become 414 acres of North Atlantic Low Salt Marsh, 29 acres of Reed Tidal Marsh, 2 acres of water, and 2 acres of North Atlantic High Salt Marsh (Table 6.14).

Since 1997, impoundments have flooded 75 acres of Reed Tidal Marsh, 9 acres of Coastal Plain Oak Floodplain Swamp, 1 acre of Chesapeake Bay Non-riverine Wet Hardwood Forest, and 1 acre of North Atlantic Low Salt Marsh (Table 6.15).

Table 6.14. What was Impoundment in 1997 has become X in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	414 acres
Impoundment	330 acres
Reed Tidal Marsh	29 acres
Water	2 acres
North Atlantic High Salt Marsh	2 acres
Other communities/land covers	0.1 acres

Table 6.15. Impoundment has migrated into X since 1997	
X	**Acreage**
Impoundment	330 acres
Reed Tidal Marsh	75 acres
Coastal Plain Oak Floodplain Swamp	9 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	1 acre
North Atlantic Low Salt Marsh	1 acre
Other communities/land covers	4 acres

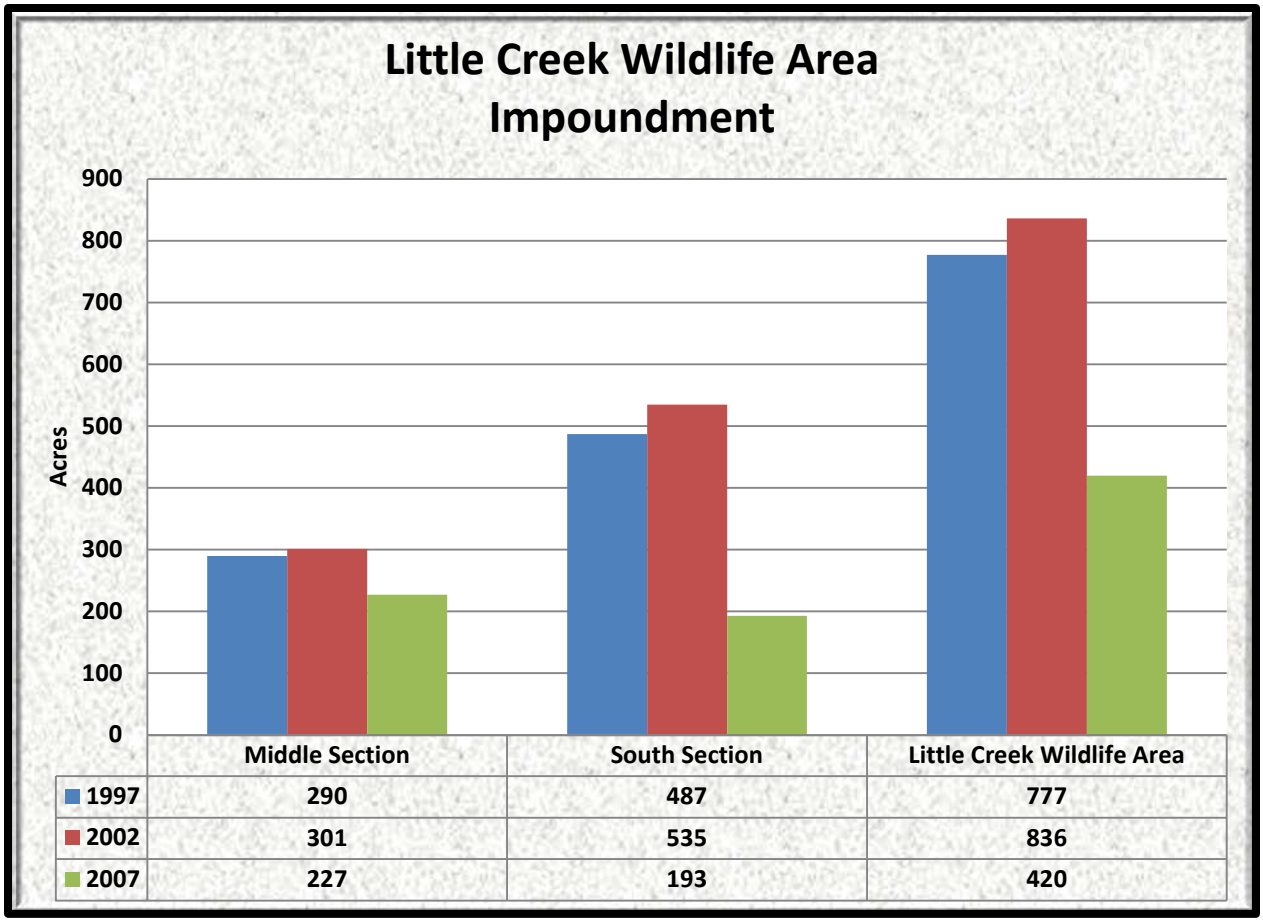


Figure 6.5. Impoundments at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.16)

Most of the impoundment area in Little Creek Wildlife Area will be "captured" with 0.5 m of sea level rise.

Table 6.16. Projected acres of Impoundment Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	397 acres
1 m	420 acres
1.5 m	420 acres

Natural Capital (Table 6.17)

Impoundments have lost a lot of capital due to the water structures being undermined and the tidal flow being established. Most of the capital has transferred to marsh.

Table 6.17. Natural Capital of Impoundment	
Year	**Natural Capital (in 2012 dollars)**
1997	$4,145,372/year
2002	$4,460,144/year
2007	$2,240,742/year

Modified Land **[3 acres (Figure 6.6, Tables 6.18-6.20)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

This land cover includes those areas where the land has been disturbed and there is not plant cover. They are often present as bare dirt.

Analysis of Condition at Little Creek Wildlife Area

One acre of the original three acres present in 1997 was present in 2007. The rest of the acreage had become 1 acre of water, 0.5 acres of Northeastern Old Field, 0.3 acres of North Atlantic Low Salt Marsh, and 0.2 acres of Powerline R-O-W (Table 6.18).

Since 1997, modified land has been developed in 2 acres of Northeastern Old Field (Table 6.19).

Table 6.18. What was Modified Land in 1997 has become X in 2007

X	Acreage
Water	1 acre
Modified Land	1 acre
Northeastern Old Field	0.5 acres
North Atlantic Low Salt Marsh	0.3 acres
Powerline R-O-W	0.2 acres

Table 6.19. Modified Land has migrated into X since 1997

X	Acreage
Northeastern Old Field	2 acres
Modified Land	1 acre

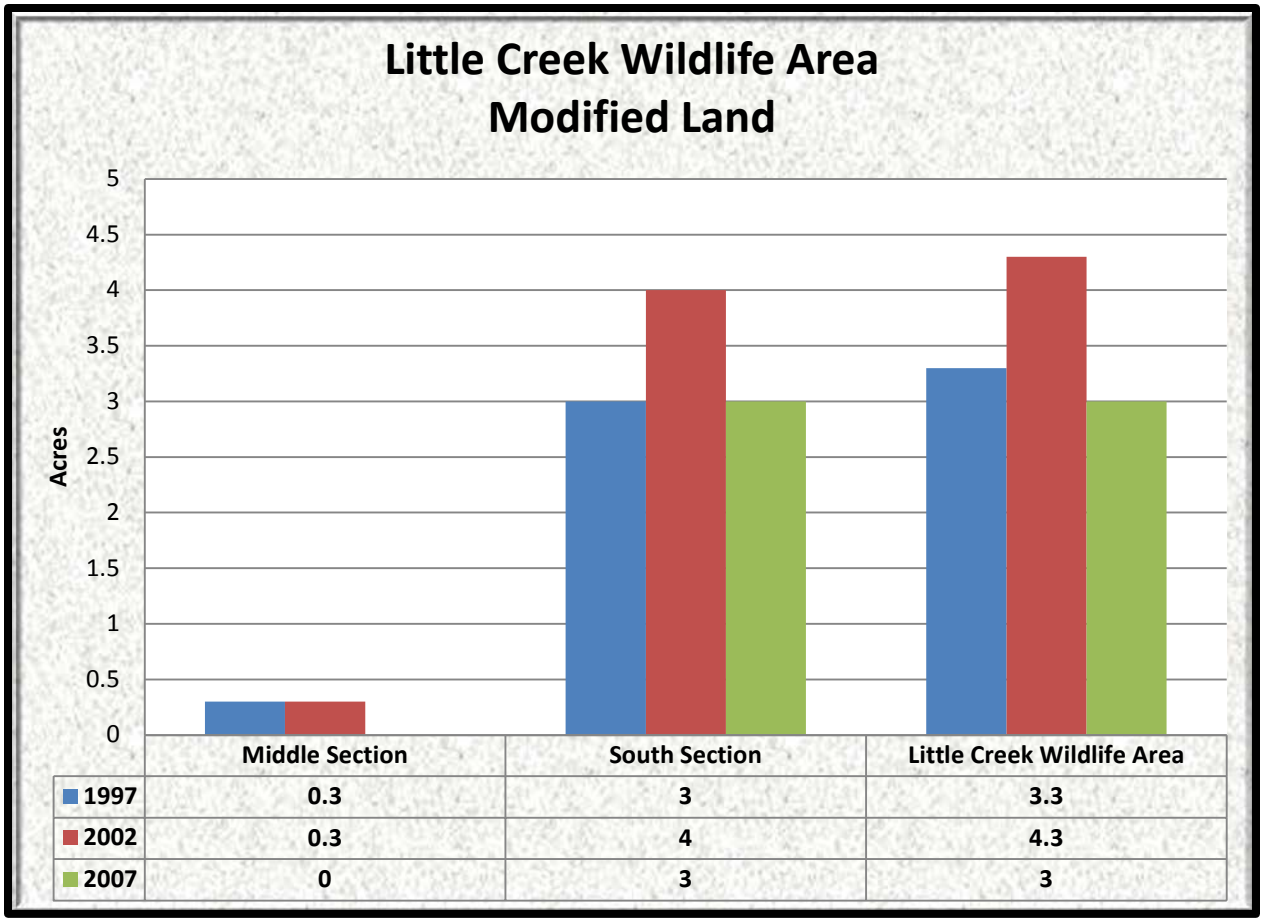


Figure 6.6. Modified Land at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.20)

All of the current modified land will be inundated with 1.5 m of sea level rise.

Table 6.20. Projected acres of Modified Land Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0.2 acres
1 m	2 acres
1.5 m	3 acres

Natural Capital

Modified land does not have any natural capital value.

***Powerline R-O-W* [24 acres (Figure 6.7, Tables 6.21-6.23)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

This land cover is located underneath powerline R-O-Ws. These areas are often similar to Northeastern Old Fields and Northeastern Successional Shrublands but are intensively managed to keep vegetation low.

Analysis of Condition at Little Creek Wildlife Area

About 22 acres of the original 23 acres from 1997 were still present in 2007. The rest of the acreage had become 1 acre each of Irregularly Flooded Eastern Tidal Salt Shrub and Reed Tidal Marsh, 0.3 acres of Successional Maritime Forest, and 0.1 acres of Northeastern Modified Successional Forest (Table 6.21).

Since 1997, powerline has been developed on one acre each of Northeastern Old Field, Early to Mid-Successional Loblolly Pine Forest, and agricultural field, and 0.2 acres of modified land (Table 6.22).

Table 6.21. What was Powerline R-O-W in 1997 has become X in 2007

X	Acreage
Powerline R-O-W	22 acres
Irregularly Flooded Eastern Tidal Salt Shrub	1 acre
Reed Tidal Marsh	1 acre
Successional Maritime Forest	0.3 acres
Northeastern Modified Successional Forest	0.1 acres
Other communities/land covers	0.2 acres

Table 6.22. Powerline R-O-W has migrated into X since 1997

X	Acreage
Powerline R-O-W	22 acres
Northeastern Old Field	1 acre
Early to Mid-Successional Loblolly Pine Forest	1 acre
Agricultural Field	1 acre
Modified Land	0.2 acres
Other communities/land covers	0.5 acres

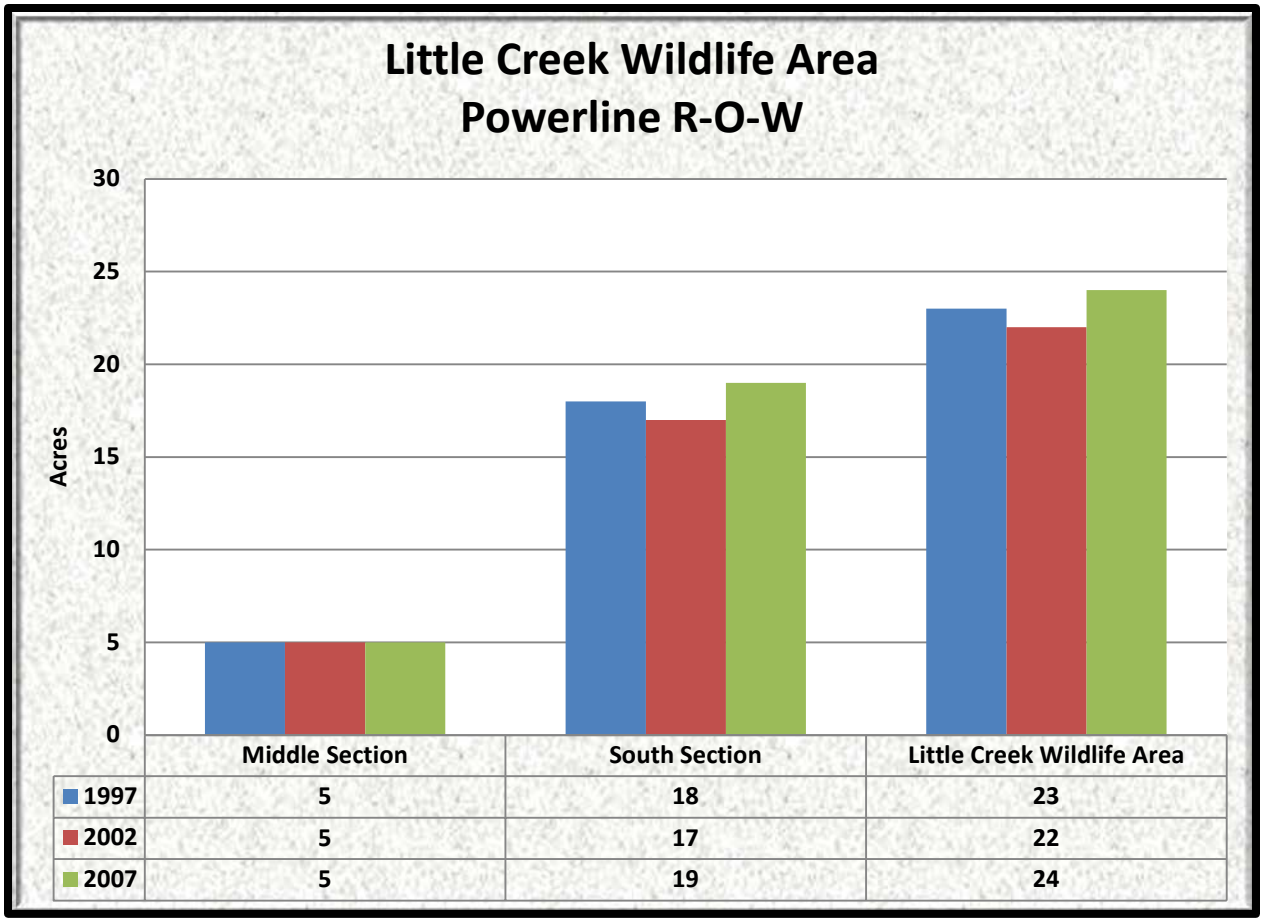


Figure 6.7. Powerline R-O-W at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.23)

Powerline will be impacted to some extent with sea level rise. While the actual may not be flooded, the bases of the towers will be in the water and could be undermined. With 1.5 m of sea level rise about 1/3 of the acreage in the R-O-W's will be subjected to tidal water.

Table 6.23. Projected acres of Powerline R-O-W Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	4 acres
1 m	7 acres
1.5 m	9 acres

Natural Capital

Powerline R-O-W's do not have any natural capital value.

***Riprap* [1 acre (Figure 6.8, Tables 6.24-6.26)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

This land cover is located underneath powerline R-O-Ws. These areas are often similar to Northeastern Old Fields and Northeastern Successional Shrublands but are intensively managed to keep vegetation low.

Analysis of Condition at Little Creek Wildlife Area

The same amount of riprap was present 2007 as it was in 1997 with the addition of about 0.2 acres of beach (Table 6.24).

Since 1997, riprap has been placed on 0.2 acres of former beach area (Table 6.25).

Table 6.24. What was Riprap in 1997 has become X in 2007	
X	**Acreage**
Riprap	1 acre
Beach	0.2 acres

Table 6.25. Riprap has migrated into X since 1997	
X	**Acreage**
Riprap	1 acre
Beach	0.2 acres

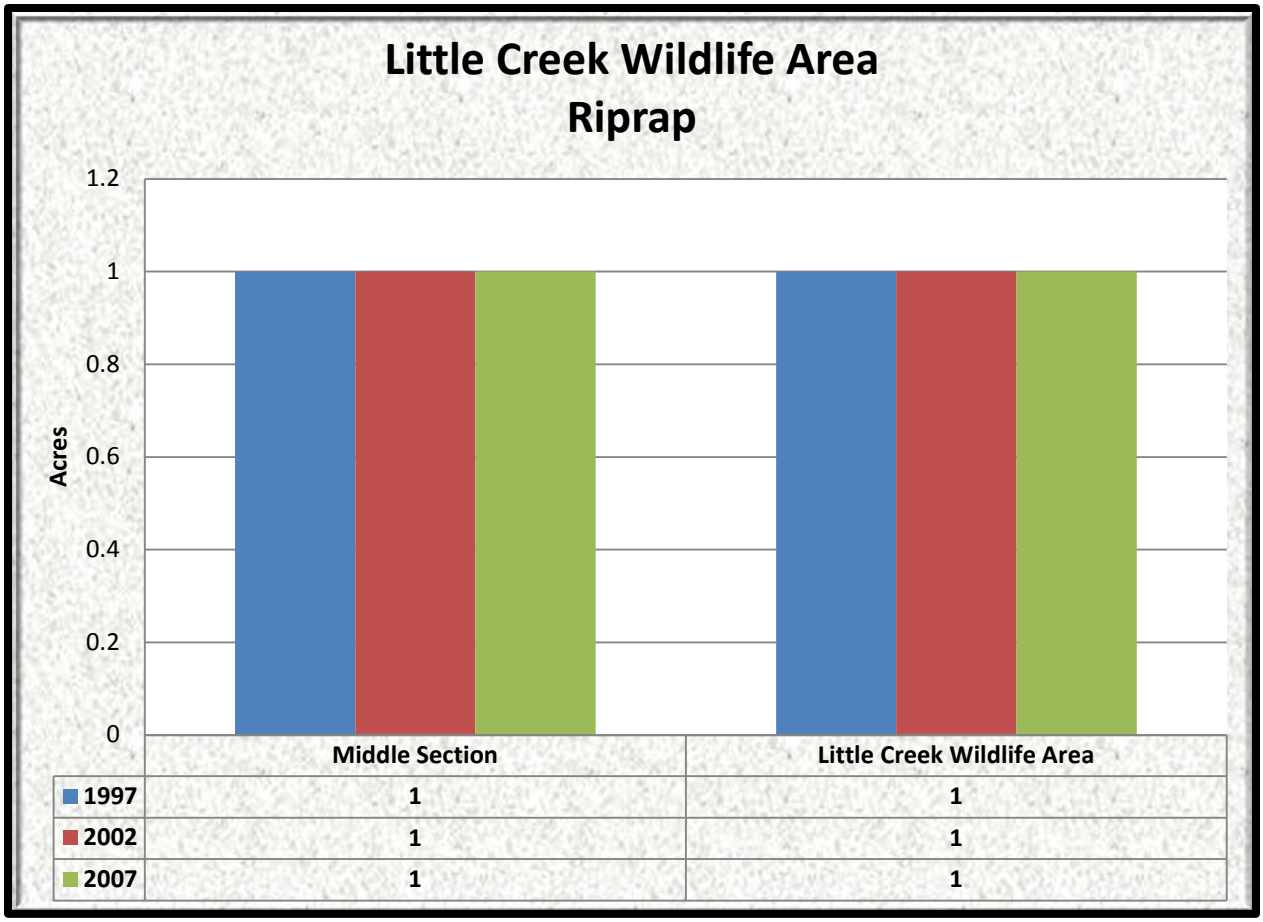


Figure 6.8. Riprap at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.26)

All of the current riprap area will be flooded with 0.5 m of sea level rise.

Table 6.26. 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

Riprap does not have any natural capital value.

***Sand* [1 acre (Figure 6.9, Tables 6.27-6.28)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

Sand is located in places where there is no vegetated cover and therefore bare sand.

Analysis of Condition at Little Creek Wildlife Area

Sand was not present as a land cover in 1997 and has since occupied 1 acre of former Reed Tidal Marsh and 0.1 acres of cultivated lawn (Table 6.27).

Table 6.27. Sand has migrated into X since 1997	
X	**Acreage**
Reed Tidal Marsh	1 acre
Cultivated Lawn	0.1 acres

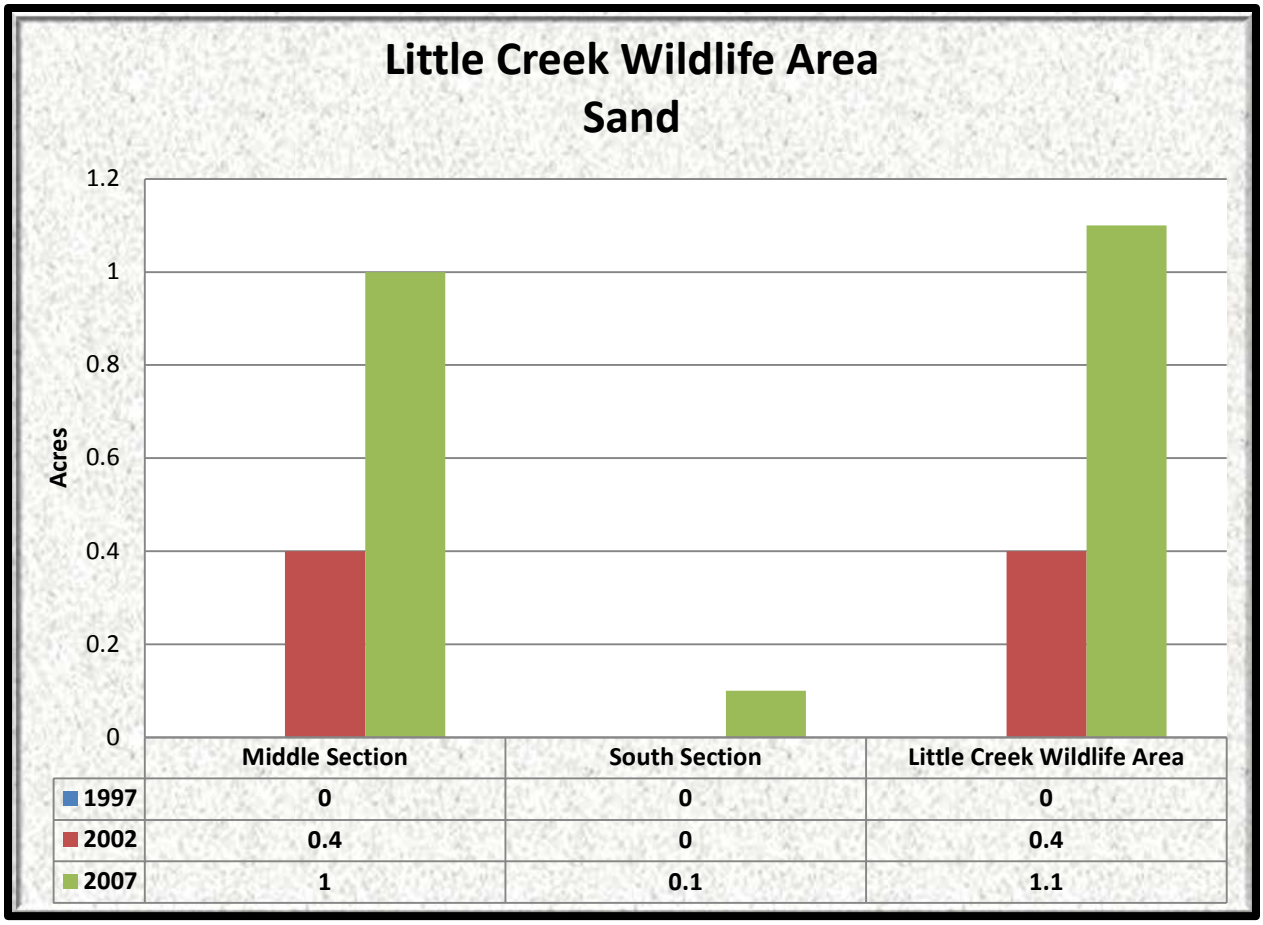


Figure 6.9. Sand at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.28)

All of the sand coverage will be inundated with 1 m of sea level rise.

Table 6.28. Projected acres of Sand Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0.1 acres
1 m	1 acre
1.5 m	1 acre

Natural Capital

Sand does not have any natural capital value.

Semi-impervious Surface **[28 acres (Figure 6.10, Tables 6.29-6.31)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

This land cover includes the numerous dirt roads that go through the wildlife area. All of the roads are underlain by the sandy substrate that is common in the wildlife area. Most of the additional roads in the wildlife area have been dirt roads.

Analysis of Condition at Little Creek Wildlife Area

In 2007, 22 of the original 28 acres from 1997 still existed. The rest of the acres of Semi-impervious Surface had become 4 acres of Reed Tidal Marsh, 0.2 acres of impervious Surface, 0.1 acres of cultivated lawn, and 0.1 acres of North Atlantic Low Salt Marsh (Table 6.29).

Since 1997, semi-impervious surface has been developed in 3 acres of Reed Tidal Marsh, 0.5 acres of cultivated lawn, 0.2 acres of Northeastern Successional Shrubland, and 0.1 acres of Chesapeake Bay non-riverine Wet Hardwood Forest (Table 6.30).

Table 6.29. What was Semi-impervious Surface in 1997 has become X in 2007	
X	**Acreage**
Semi-impervious Surface	22 acres
Reed Tidal Marsh	4 acres
Impervious Surface	0.2 acres
Cultivated Lawn	0.1 acres
North Atlantic Low Salt Marsh	0.1 acres
Other communities/land covers	0.2 acres

Table 6.30. Semi-impervious Surface has migrated into X since 1997	
X	**Acreage**
Semi-impervious Surface	22 acres
Reed Tidal Marsh	3 acres
Cultivated Lawn	0.5 acres
Northeastern Successional Shrubland	0.2 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.1 acres
Other communities/land covers	0.2 acres

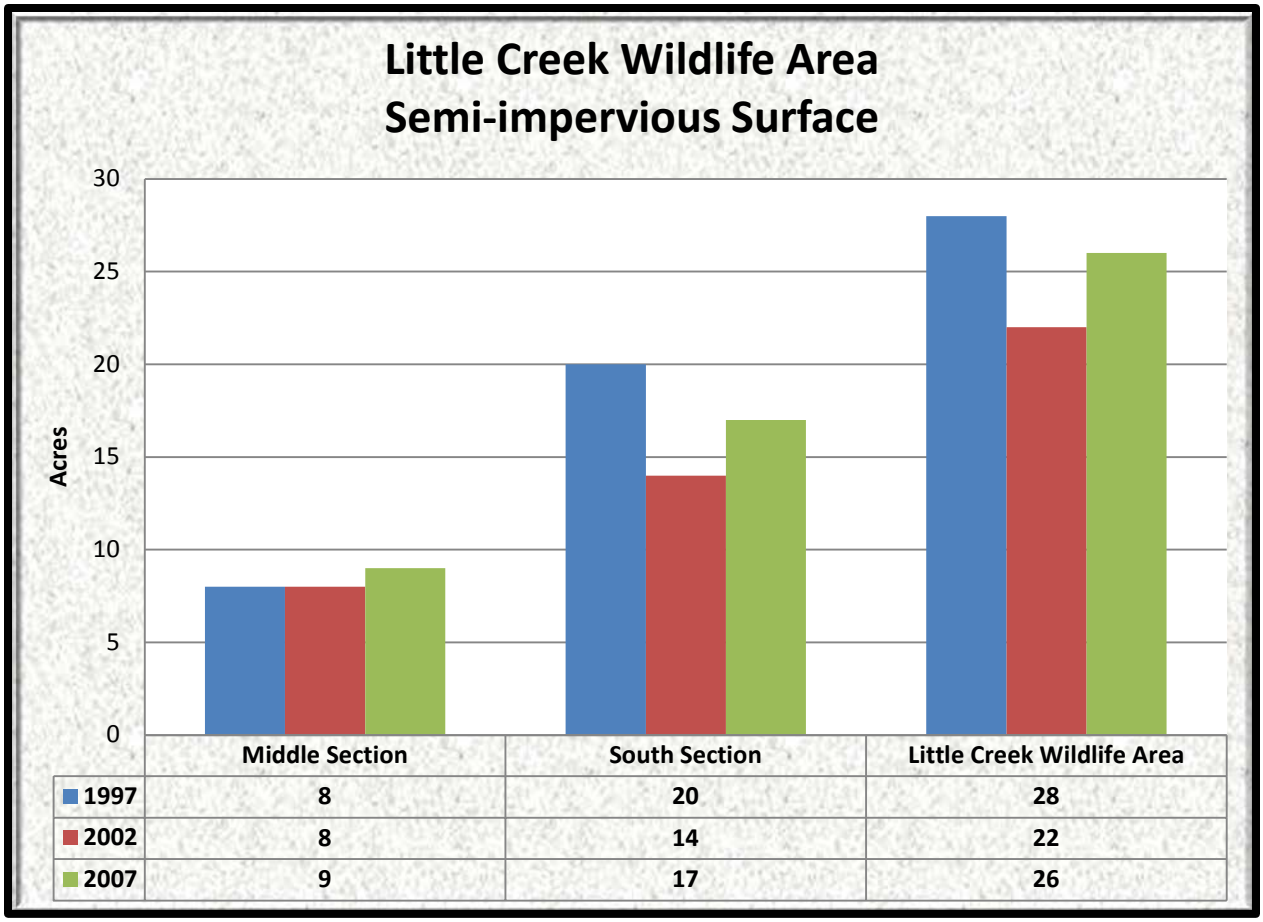


Figure 6.10. Semi-impervious Surface at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.31)

Most of the semi-impervious surface area in the wildlife area will be inundated by water at 1.5 m of sea level rise.

Table 6.31. Projected acres of Semi-impervious Surface Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	15 acres
1.5 m	22 acres

Natural Capital

Semi-impervious Surface does not have any natural capital value.

Tidal Mudflat **[1 acre (Figure 6.11, Tables 6.32-6.AAA)]**

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

Description

This land cover includes non-vegetated areas in marshlands that are subjected to tidal influence. They are often ephemeral and re-vegetate or convert to open water.

Analysis of Condition at Little Creek Wildlife Area

None of the tidal mudflat from 1997 still existed in 2007. What was tidal mudflat had become 7 acres of salt panne, 1 acre of water, 0.4 acres of North Atlantic Low Salt Marsh, and 0.1 acres of North Atlantic High Salt Marsh (Table 6.32). Since 1997, tidal mudflat has formed in 1 acre of water and 0.1 acres of North Atlantic Low Salt Marsh (Table 6.33).

Table 6.32. What was Tidal Mudflat in 1997 has become X in 2007	
X	**Acreage**
Salt Panne	7 acres
Water	1 acre
North Atlantic Low Salt Marsh	0.4 acres
North Atlantic High Salt Marsh	0.1 acres

Table 6.33. Tidal Mudflat has migrated into X since 1997	
X	**Acreage**
Water	1 acre
North Atlantic Low Salt Marsh	0.1 acres

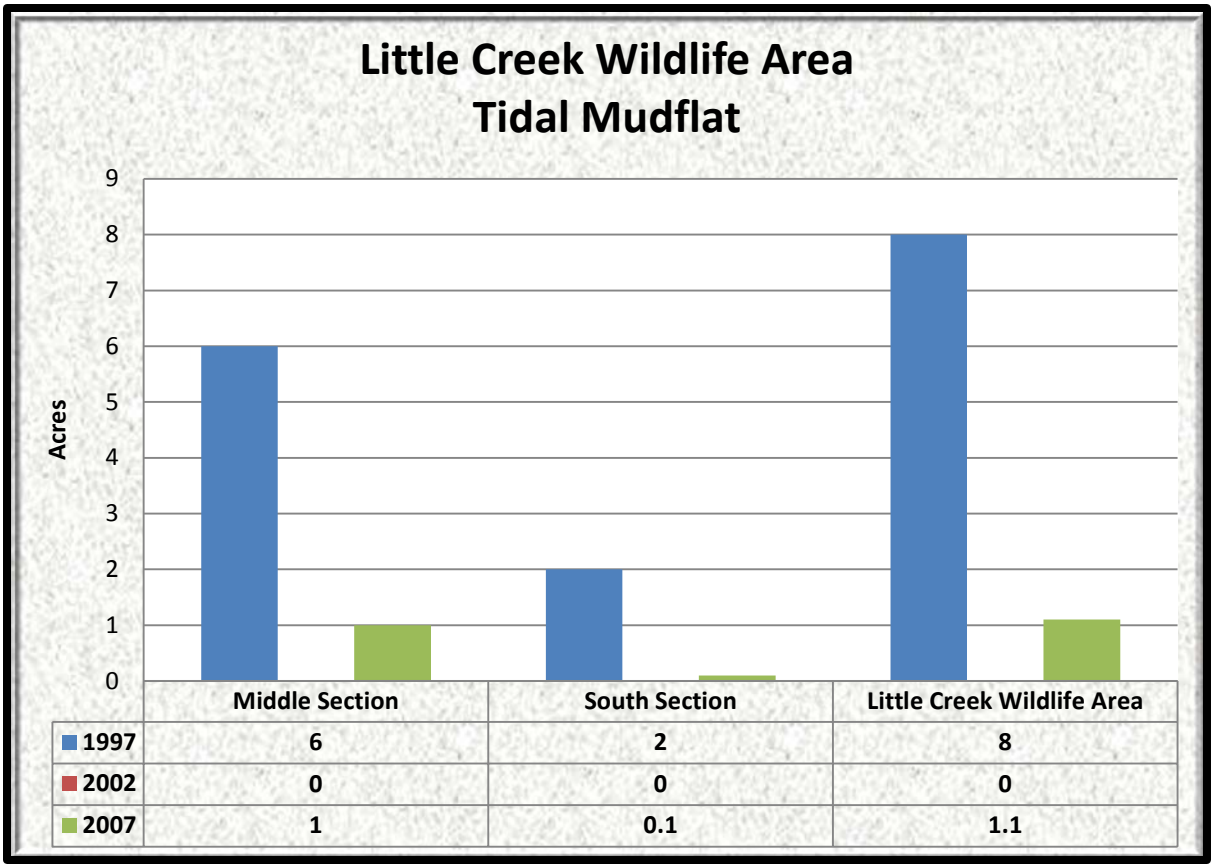


Figure 6.11. Tidal Mudflat at Little Creek Wildlife Area (1997, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.34)

All of the current acreage of tidal mudflat will be inundated with 0.5 m of sea level rise.

Table 6.34. Projected acres of Tidal Mudflat Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 6.35)

Tidal mudflat capital has decreased from its high in 1997. In 2002, it was not present and in 2007, it had regained $6,898/year of capital.

Table 6.35. Natural Capital of Tidal Mudflat	
Year	**Natural Capital (in 2012 dollars)**
1997	$50,170/year
2002	$0/year (not present)
2007	$6,898/year

***Water* [249 acres (Figures 6.12-6.13, Tables 6.36-6.38)]**

DEWAP: Nearshore Habitats
NHC: No Equivalent Classification

Description

Water includes all of the non-impounded water present in the wildlife area.

Analysis of Condition at Little Creek Wildlife Area

About 186 acres of the water present in 1997 was still present in 2007. The rest had become 8 acres of Reed Tidal Marsh, 7 acres of Salt Panne, 5 acres of North Atlantic Low Salt Marsh, and 2 acres of Farm Pond/Artificial Pond (Table 6.36). Since 1997, water has inundated 33 acres of North Atlantic Low Salt Marsh, 12 acres of Reed Tidal Marsh, 6 acres of beach, and 4 acres of North Atlantic High Salt Marsh (Table 6.37).

Almost 6 acres of Little Creek Wildlife Area is being inundated each year by water in the 2002-2007 period. This is almost ten times the 1997-2002 rate of inundation (Figure 6.13).

Table 6.36. What was Water in 1997 has become X in 2007	
X	**Acreage**
Water	186 acres
Reed Tidal Marsh	8 acres
Salt Panne	7 acres
North Atlantic Low Salt Marsh	5 acres
Farm Pond/Artificial Pond	2 acres
Other vegetation communities/land covers	8 acres

Table 6.37. Water has inundated X since 1997	
X	**Acreage**
Water	186 acres
North Atlantic Low Salt Marsh	33 acres
Reed Tidal Marsh	12 acres
Beach	6 acres
North Atlantic High Salt Marsh	4 acres
Other vegetation communities/land covers	8 acres

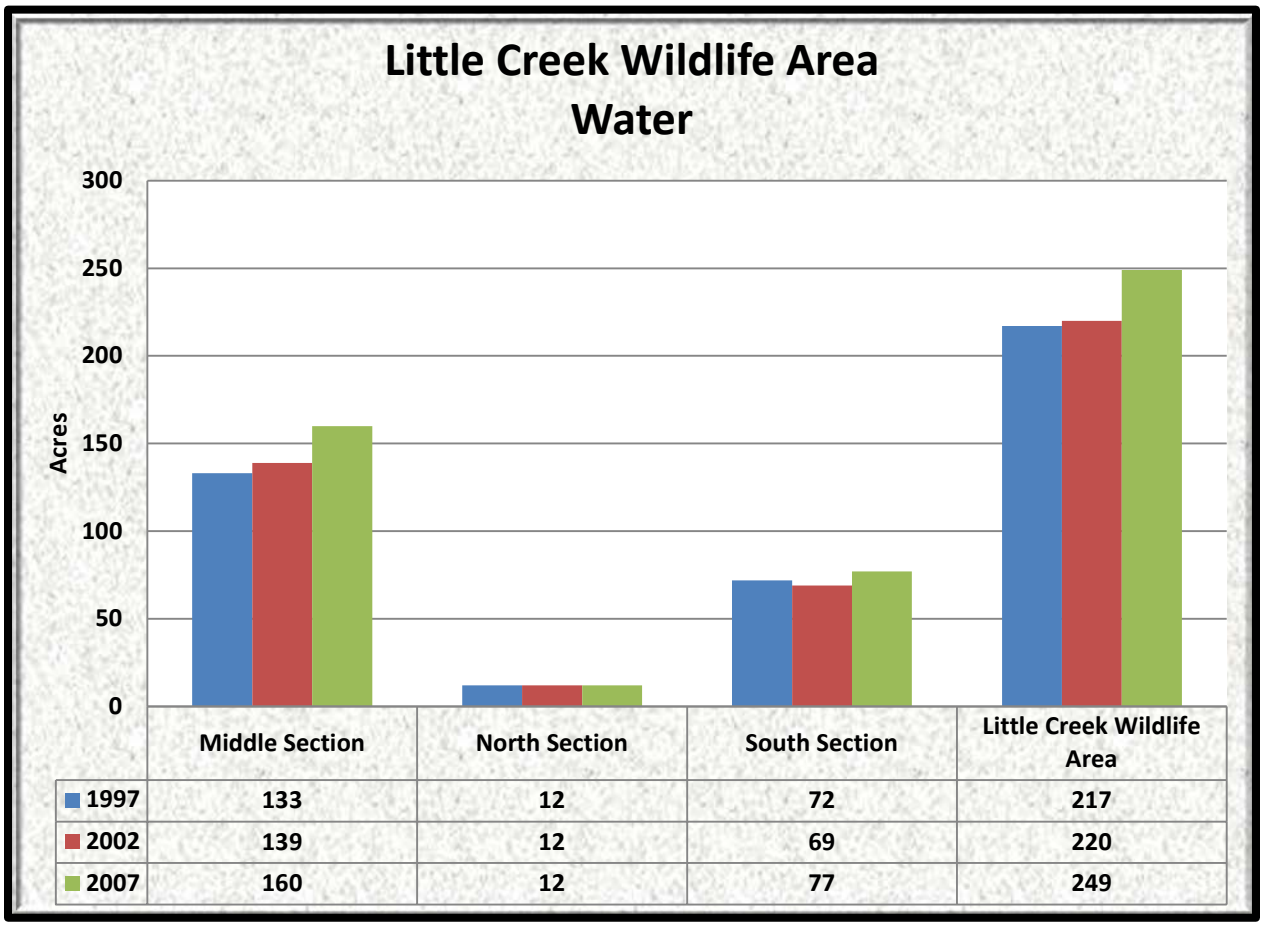
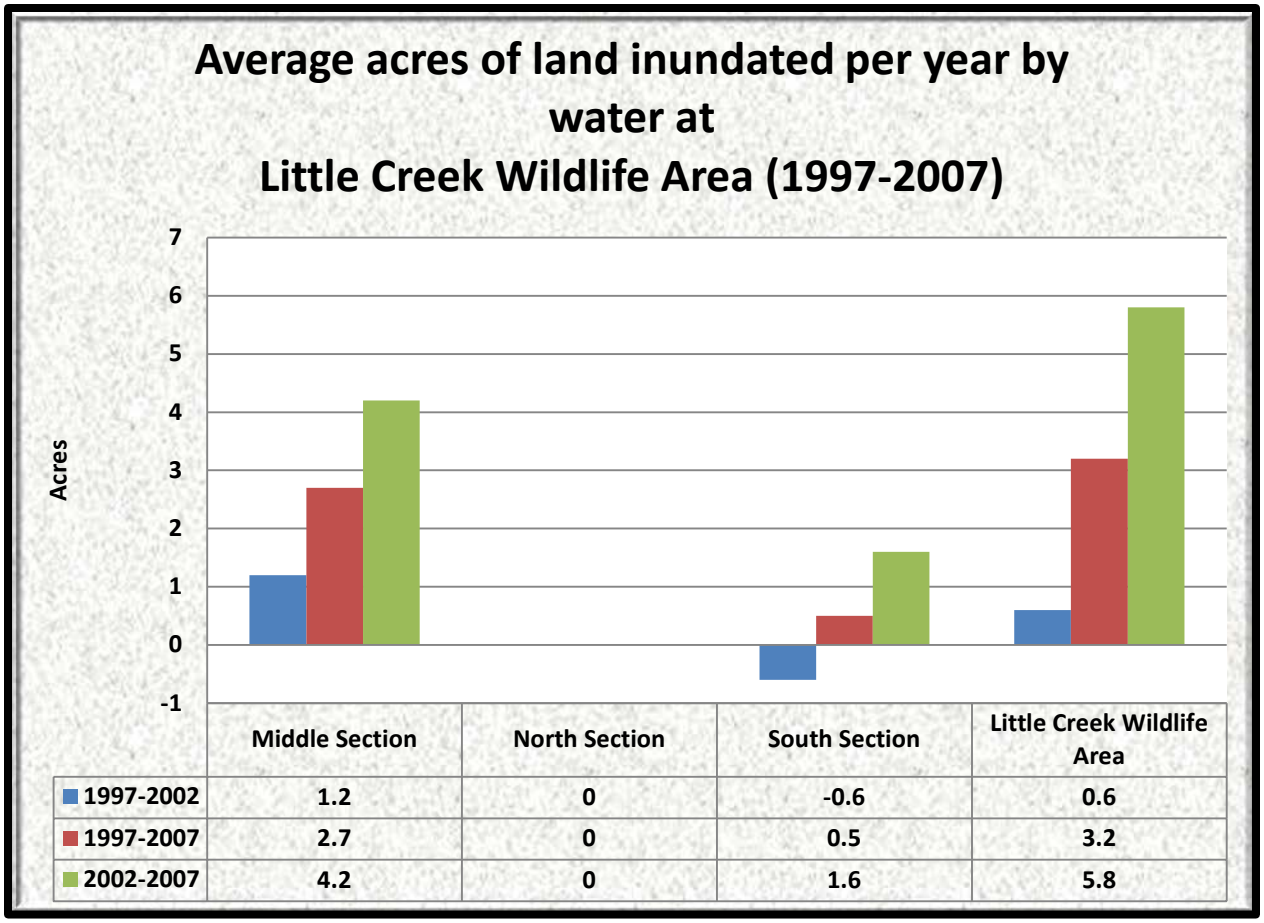


Figure 6.12. Water at Little Creek Wildlife Area (1997, 2002, and 2007)

Natural Capital (Table 6.38)

Capital of water has continued to creep upward as more water enters the wildlife area.

Table 6.38. Natural Capital of Water	
Year	**Natural Capital (in 2012 dollars)**
1997	$3,110,228/year
2002	$3,153,227/year
2007	$3,568,880/year



	Middle Section	North Section	South Section	Little Creek Wildlife Area
1997-2002	1.2	0	-0.6	0.6
1997-2007	2.7	0	0.5	3.2
2002-2007	4.2	0	1.6	5.8

Figure 6.13. Average acres of land inundated per year by water at Little Creek Wildlife Area (1997-2007)

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	Baltimora oriole	Bird	2
Lasionycteris noctivagans	Silver-haired bat	Mammal	2
Lasiurus borealis	Eastern red bat	Mammal	2
Lasiurus cinereus	Hoary bat	Mammal	2
Canis latrans	coyote	Mammal	2

SGCN Species expected in Early Successional Upland Habitats			
Species	**Common Name**	**Class**	**Tier**
Nicrophorus americanus	American burying beetle	Insect	1
Callophrys irus	frosted elfin	Insect	1
Papaipema maritima	maritime sunflower borer moth	Insect	1
Terrapene carolina	Eastern box turtle	Reptile	1
Lampropeltis triangulum	milk snake	Reptile	1
Branta canadensis	Canada goose (migratory)	Bird	1
Circus cyaneus	Northern harrier	Bird	1
Bartramia longicauda	upland sandpiper	Bird	1
Scolopax minor	American woodcock	Bird	1
Asio flammeus	short-eared Owl	Bird	1
Chordeiles minor	common nighthawk	Bird	1
Lanius ludovicianus	loggerhead shrike	Bird	1
Dendroica discolor	prairie warbler	Bird	1
Ammodramus henslowii	Henslow's sparrow	Bird	1
Cincindela scutellaris	festive tiger beetle	Insect	2
Atrytonopsis hianna	dusted skipper	Insect	2
Satyrium liparops	striped hairstreak	Insect	2
Satyrium liparops strigosum	stiped hairstreak	Insect	2
Callophrys gryneus	juniper hairstreak	Insect	2
Speyeria aphrodite	aphrodite fritillary	Insect	2
Speyeria idalia	regal fritillary	Insect	2
Boloria bellona	meadow fritillary	Insect	2

Paratrea plebeja	trumpet vine sphinx	Insect	2
Calyptra canadensis	Canadian owlet	Insect	2
Acronicta rubricoma	a dagger moth	Insect	2
Papaipema rigida	rigid sunflower borer moth	Insect	2
Cirrhophanus triangulifer	a noctuid moth	Insect	2
Schina septentrionalis	a noctuid moth	Insect	2
Plegadis falcinellus	glossy ibis	Bird	2
Cygnus columbianus	tundra swan	Bird	2
Coragyps atratus	black vulture	Bird	2
Colinus virginianus	Northern bobwhite	Bird	2
Pluvialis squatarola	black-bellied plover	Bird	2
Coccyzus erythropthalmus	black-billed cuckoo	Bird	2
Chaetura pelagica	chimney swift	Bird	2
Colaptes auratus	Northern flicker	Bird	2
Empidonax minimus	least flycatcher	Bird	2
Tyrannus tyrannus	Eastern kingbird	Bird	2
Toxostoma rufum	Brown thrasher	Bird	2
Dendroica pensylvanica	Chestnut-sided warbler	Bird	2
Icteria virens	Yellow-breasted chat	Bird	2
Piplio erythrophthalmus	Eastern towhee	Bird	2
Spizella pusilla	field sparrow	Bird	2
Pooecetes gramineus	vesper sparrow	Bird	2
Passerculus sandwichensis	savannah sparrow	Bird	2
Ammodramus savannarum	grasshopper sparrow	Bird	2
Dolichonyx oryzivorus	bobolink	Bird	2
Cryptotis parva	least shrew	Bird	2

SGCN Species expected in 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
Actitus 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 cucullatus	Hooded merganser	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 Tidal High Marsh Habitats			
Species	**Common Name**	**Class**	**Tier**
Problema bulenta	rare skipper	Insect	1
Pero zalissaria	a geometer moth	Insect	2
Acontia delecta	a noctuid moth	Insect	2
Papaipema birdi	umbellifer borer moth	Insect	2
Brachymesia gravida	four-spotted pennant	Insect	2
Nycticorax nycticorax	black-crowned night-heron	Bird	1
Nyctanassa violacea	yellow-crowned night-heron	Bird	1
Anas rubripes	American black duck	Bird	1
Circus cyaneus	northern harrier	Bird	1
Laterallus jamaicensis	black rail	Bird	1
Asio flammeus	short-eared owl	Bird	1
Cistothorus platensis	sedge wren	Bird	1
Ammodramus caudacutus	saltmarsh sharp-tailed sparrow	Bird	1
Ammodramus maritimus	seaside sparrow	Bird	1
Botaurus lentiginosus	American bittern	Bird	2
Ixobrychus exilis	least bittern	Bird	2
Ardea herodias	great blue heron	Bird	2
Casmerodius albus	great egret	Bird	2
Egretta thula	snowy egret	Bird	2
Egretta caerulea	little blue heron	Bird	2
Egretta tricolor	tricolored heron	Bird	2
Bubulcus ibis	Cattle egret	Bird	2
Porzana carolina	sora	Bird	2
Fulica americana	American coot	Bird	2
Tyto alba	barn owl	Bird	2
Cistothorus palustris	marsh wren	Bird	2

SGCN Species expected in Tidal Low Marsh Habitats			
Species	**Common Name**	**Class**	**Tier**
Problema bulenta	rare skipper	Insect	1
Malaclemys terrapin terrapin	Northern diamondback terrapin	Reptile	1
Podilymbus podiceps	Pied-billed grebe	Bird	1
Nycticorax nycticorax	Black-crowned night-heron	Bird	1
Branta canadensis	Canada goose (migratory)	Bird	1
Anas rubripes	American black duck	Bird	1
Nyctanassa violacea	yellow-crowned night-heron	Bird	1
Circus cyaneus	northern harrier	Bird	1
Arenaria interpres	Ruddy turnstone	Bird	1
Asio flammeus	short-eared owl	Bird	1
Calidris canutus	Red knot	Bird	1
Sterna hirundo	Common tern	Bird	1

Sterna forsteri	Forster's tern	Bird	1
Rhnchops niger	Black skimmer	Bird	1
Ammodramus caudacutus	Saltmarsh sharp-tailed sparrow	Bird	1
Ammodramus maritimus	Seaside sparrow	Bird	1
Cicindela marginata	Margined tiger beetle	Insect	2
Pero zalissaria	A geometer moth	Insect	2
Acontia delecta	A noctuid moth	Insect	2
Brachymesia gravida	Four-spotted pennant	Insect	2
Pelecanus occidentalis	Brown pelican	Bird	2
Phalacrocorax carbo	Great cormorant	Bird	2
Phalacrocorax auritus	Double-crested cormorant	Bird	2
Ardea herodias	Great blue heron	Bird	2
Casmerodius albus	Great egret	Bird	2
Egretta thula	Snowy egret	Bird	2
Egretta caerulea	Little blue heron	Bird	2
Egretta tricolor	Tricolored heron	Bird	2
Bubulcus ibis	Cattle egret	Bird	2
Plegadis falcinellus	Glossy ibis	Bird	2
Anas platyrhynchos	mallard	Bird	2
Falco peregrinus	Peregrine falcon	Bird	2
Rallus elegans	King rail	Bird	2
Fulica americana	American coot	Bird	2
Pluvialis squatarola	Black-bellied plover	Bird	2
Himantopus mexicanus	Black-necked stilt	Bird	2
Catoptrophorus semipalmatus	Willet	Bird	2
Calidris pusilla	Semipalmated sandpiper	Bird	2
Calidris alpina	dunlin	Bird	2
Sterna nilotica	Gull-billed tern	Bird	2
Tyto alba	Barn owl	Bird	2
Cistothorus palustris	Marsh wren	Bird	2