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

Cedar Creek, Mispillion River, and Murderkill River Watersheds

Submitted to:

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Chapter 1: Introduction and Methods

Setting of Milford Neck Wildlife Area

Milford Neck Wildlife Area is located in southeastern Kent County, Delaware (Figure 1.1). The wildlife area is comprised of ten tracts comprising a total of 5,038 acres. Five tracts; Coverdale Tract (153 acres), Gray Farm Tract (211 acres), Hall Tract (263 acres), Hollager Tract (74 acres) and Penuel Tract (741 acres) are located in the Murderkill River drainage. Four tracts; Dickerson Tract (808 acres), Jester Tract (551 acres), Masten Tract (459 acres), Rawley's Island Tract (1,115 acres) are located in the Mispillion River drainage and one tract, the Cedar Creek Unit (664 acres), is located in the Cedar Creek drainage.

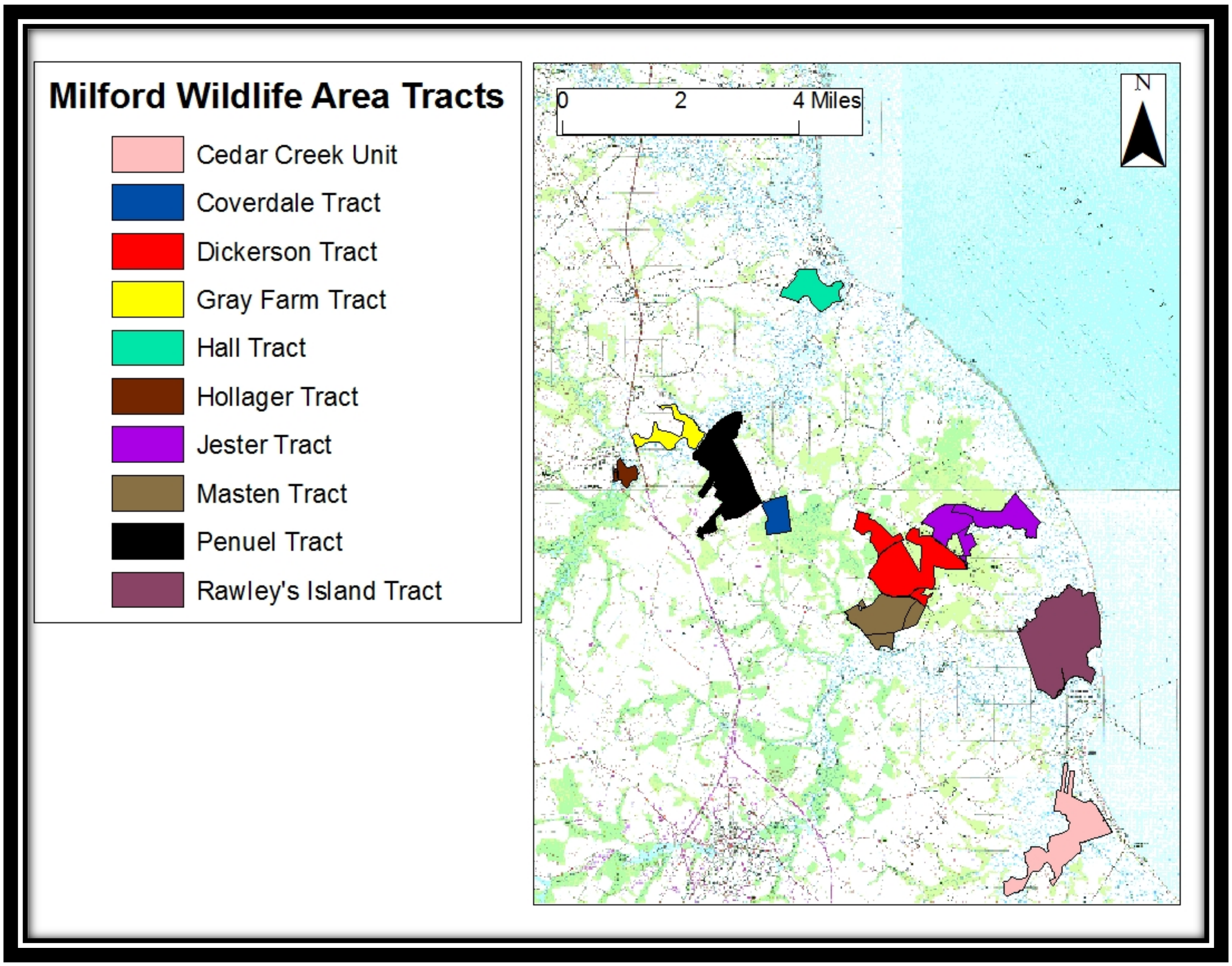

Figure 1.1. Tracts at Milford Neck Wildlife Area

History and Formation of Milford Neck Wildlife Area

Early History of the Land

Not much has been written on the history of Milford Neck. About the only work produced was a self-published work in 1990 by Roland Beebe called Milford Neck: a short history[1]. In this work he states that Milford Neck was at the then Paradise Point, now called Clark's Point was the site of the first landing of the Kalmar Nyckel before proceeding on to "The Rocks." Another is about the legend of Tory's Cave that is located on the land of William Herring, Esq. This legend states that there is a cave-like structure in which Tory's hid during the Revolutionary War.

Formation of Milford Neck Wildlife Area

No information has been located as to the origin of Milford Neck Wildlife Area other than the Division of Fish and Wildlife acquired these lands at some point.

Soils and Geology of Milford Neck Wildlife Area

Underlying Geology

As best as can be told all of the tracts of the Milford Neck Wildlife Area are underlain mostly by the Scott Corners Formation, a geological formation common to the eastern edge of Kent and northeastern Sussex counties. The Scott Corners Formation is described as "a heterogeneous unit of 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."[2]

Soils

Three soils are prominent in Milford Neck Wildlife Area including Transquaking and Mispillion Soils (in salt marshes), Carmichael Loam, and Sunken mucky loam. Other minor soils include Woodstown Sandy Loam, Fallsington Sandy Loam, Ingleside Sandy Loam and Piney Neck Loam. Milford Neck Wildlife Area ranges from sea level at Delaware Bay and the rivers to about 25 feet above mean sea level (msl) at the Penuel and Coverdale tracts.

1 Beebe, Roland. 1990. Milford Neck: a short history.

2 Ramsey, Kelvin. 2007. Geologic Map of Kent County, Delaware, Geologic Map Series, No. 14.

Cedar Creek Unit Soils

Transquaking and Mispillion Soils (590 acres) are the most common soil in the Cedar Creek Unit. These soils are found in the marsh. Other minor soils include Sunken Mucky Silt Loam (40 acres) and Downer Sandy Loam (17 acres).

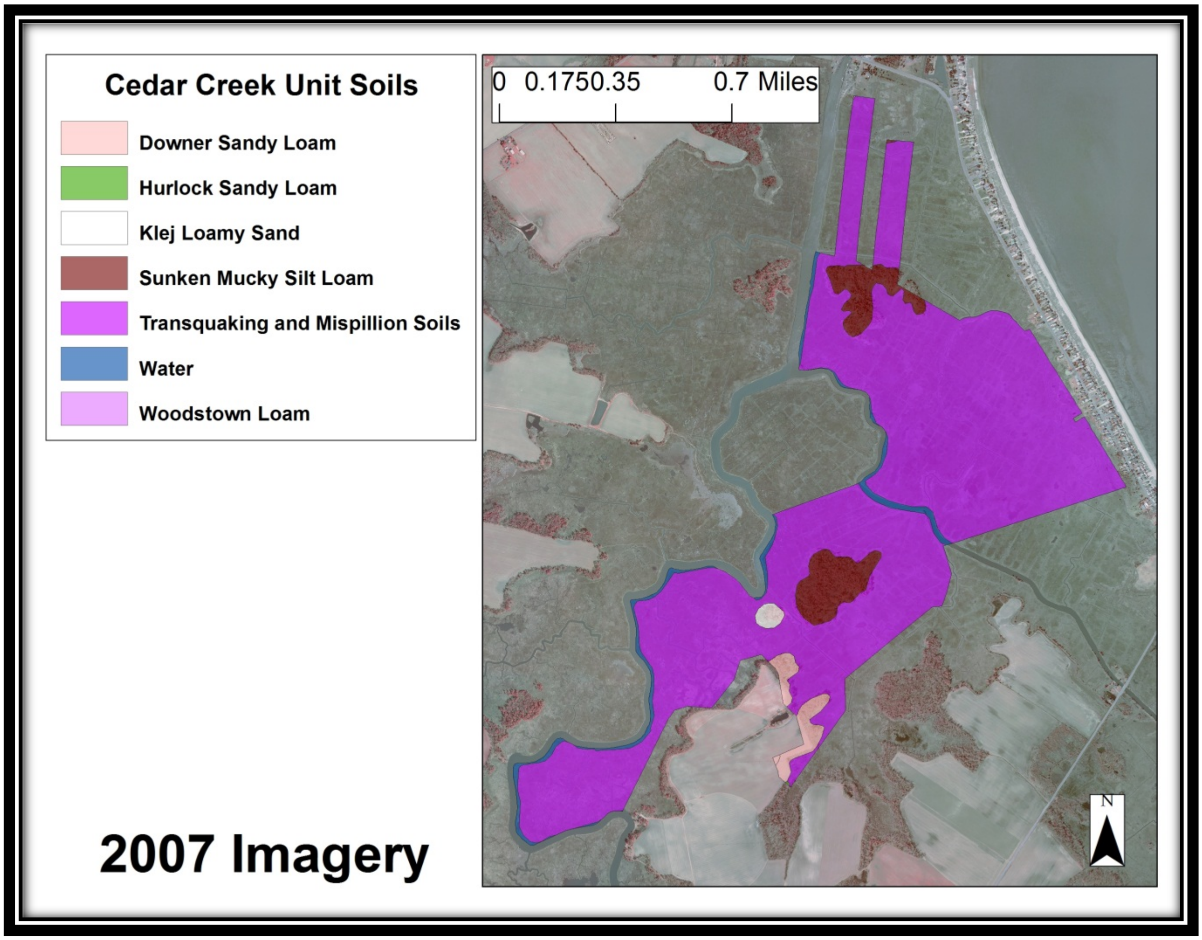

Figure 1.2. Soil Map of the Cedar Creek Unit

Coverdale Tract Soils

Carmichael Loam (80 acres) is the most common soil in the Coverdale Tract. Other minor soils include Fallsington Sandy Loam (48 acres) and Corsica Mucky Loam (11 acres).

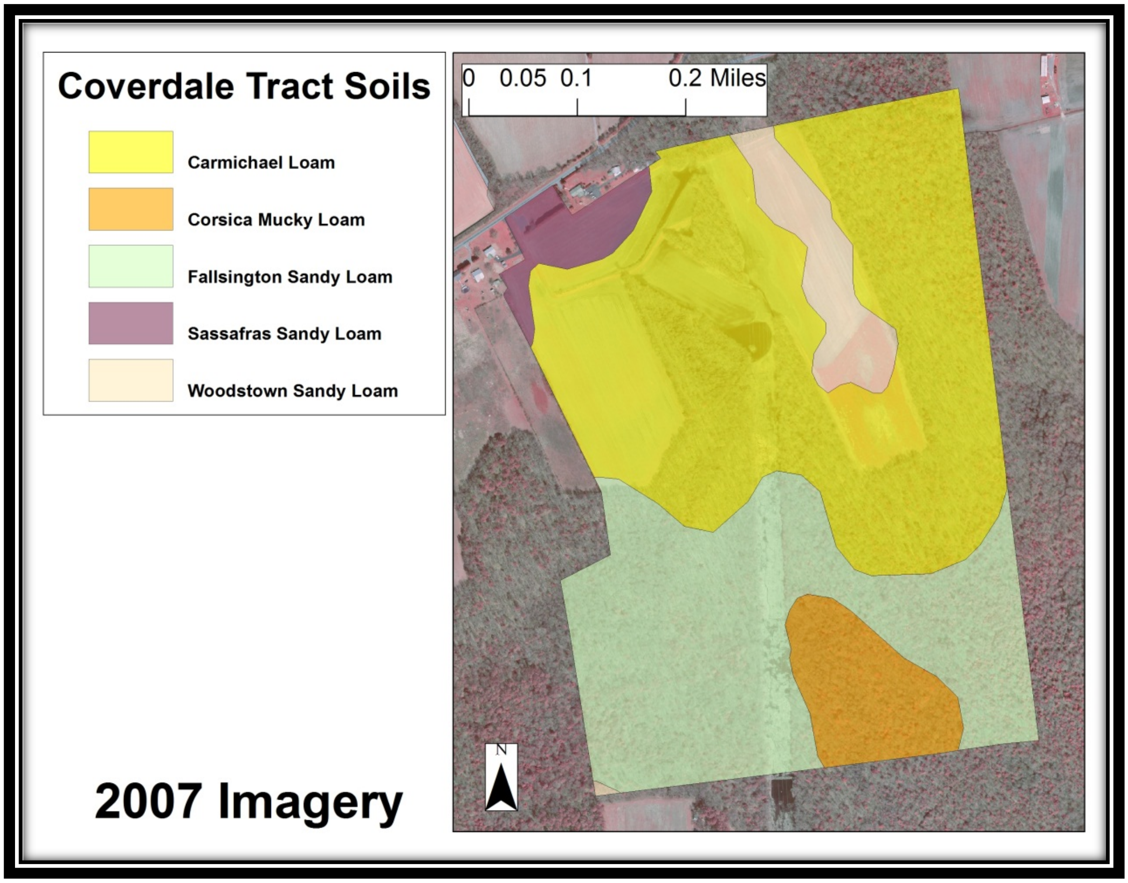

Figure 1.3. Soil Map of the Coverdale Tract

Dickerson Tract Soils

The most common soil in the Dickerson Tract is Carmichael Loam (390 acres). Other minor soils include Woodstown Sandy Loam (155 acres), Fallsington Sandy Loam (72 acres), Pineyneck Loam (50 acres), and Fallsington Loam (37 acres).

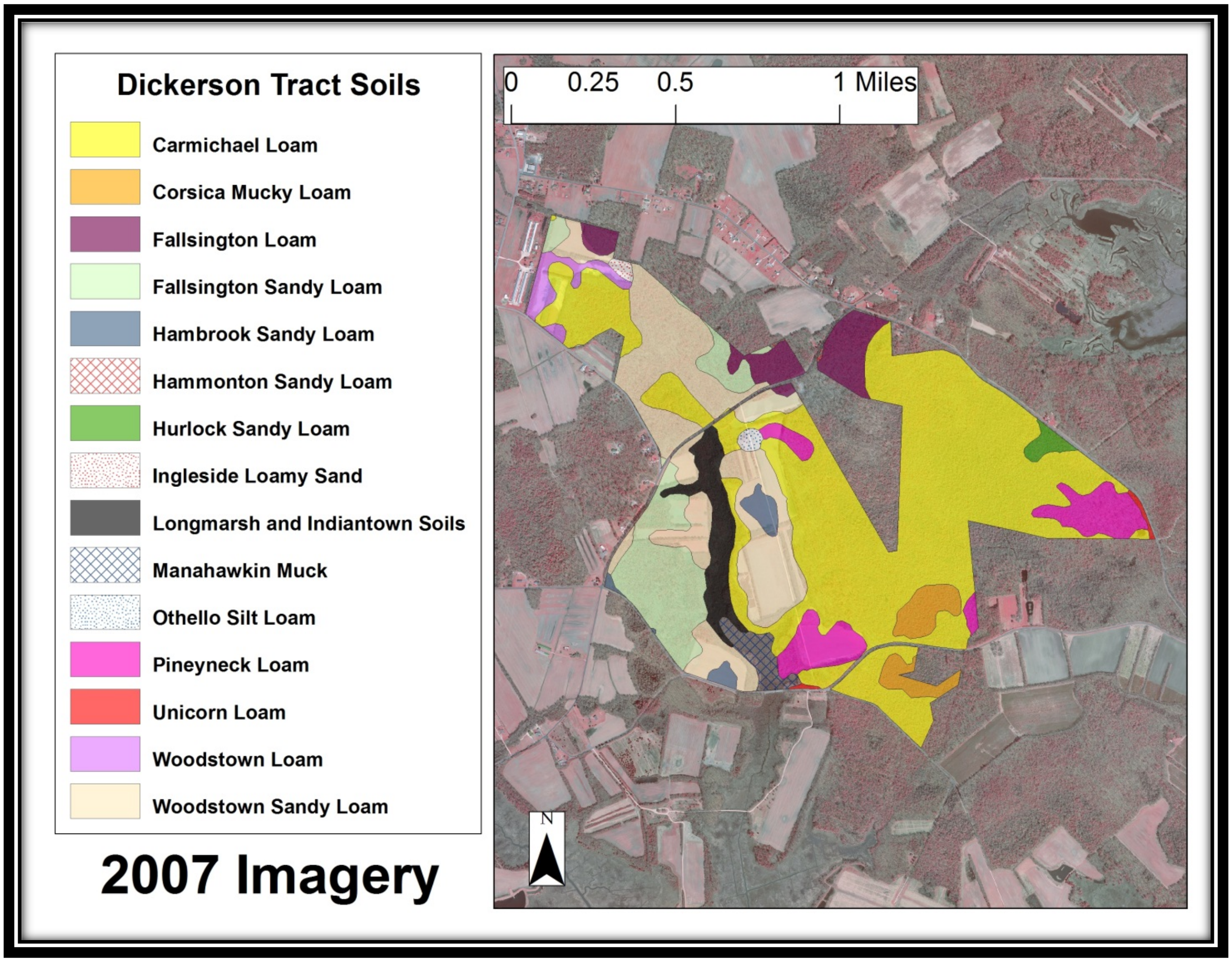

Figure 1.4. Soil Map of the Dickerson Tract

Gray Farm Soils

Transquaking and Mispillion Soils (124 acres), which underlie the marsh, is the most common soil in the Gray Farm Tract. Other soils found on the uplands include Downer Sandy Loam (24 acres), Ingleside Loamy Sand (22 acres), and Lenape Mucky Peat (19 acres).

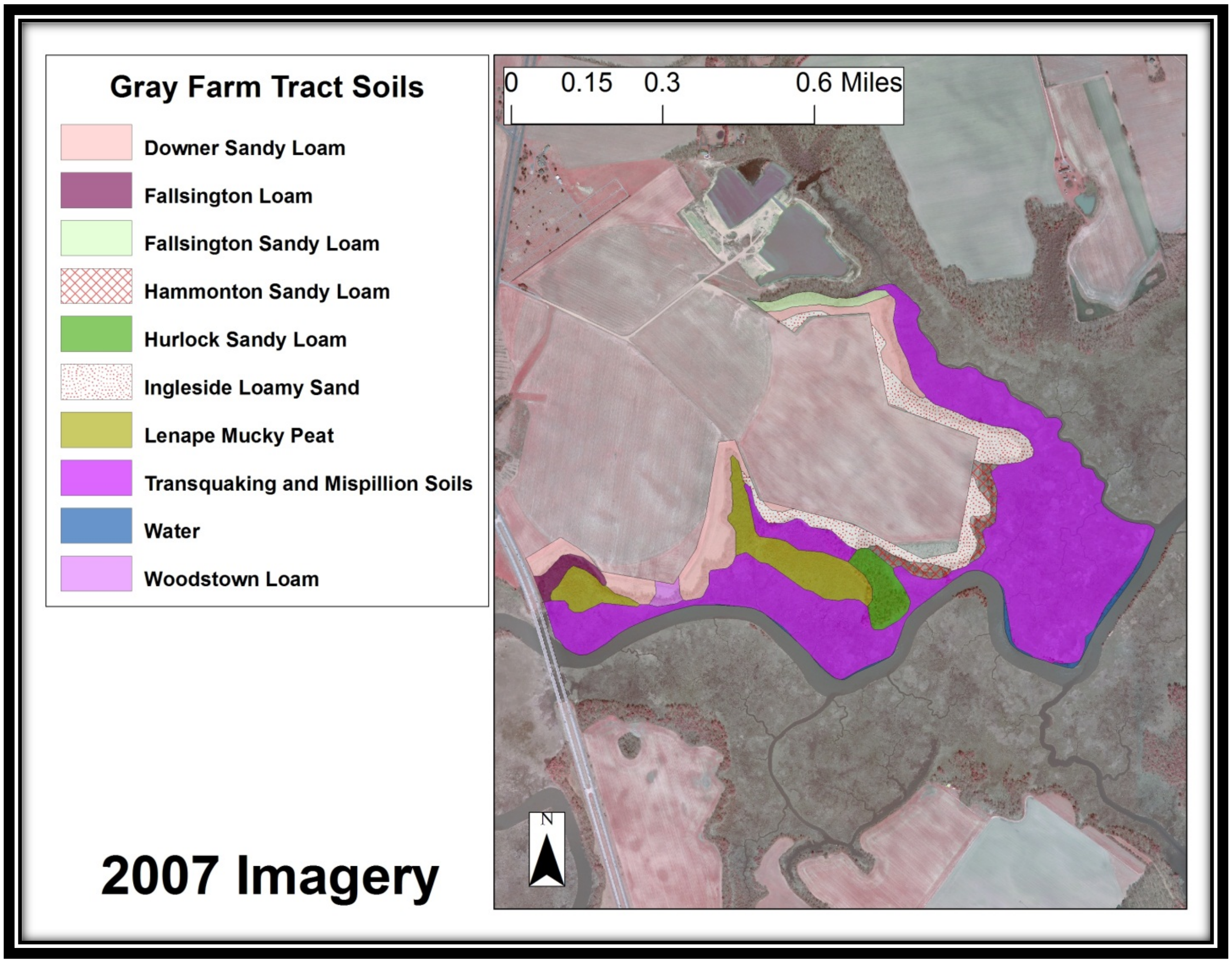

Figure 1.6. Soil Map of the Gray Farm Tract

Hall Tract Soils

Transquaking and Mispillion Soils (260 acres), which underlie the marsh, is the most common soil type in the Hall Tract. The only other soils are Hurlock Sandy Loam (2 acres) and Fallsington-Urban Land Complex (0.2 acres).

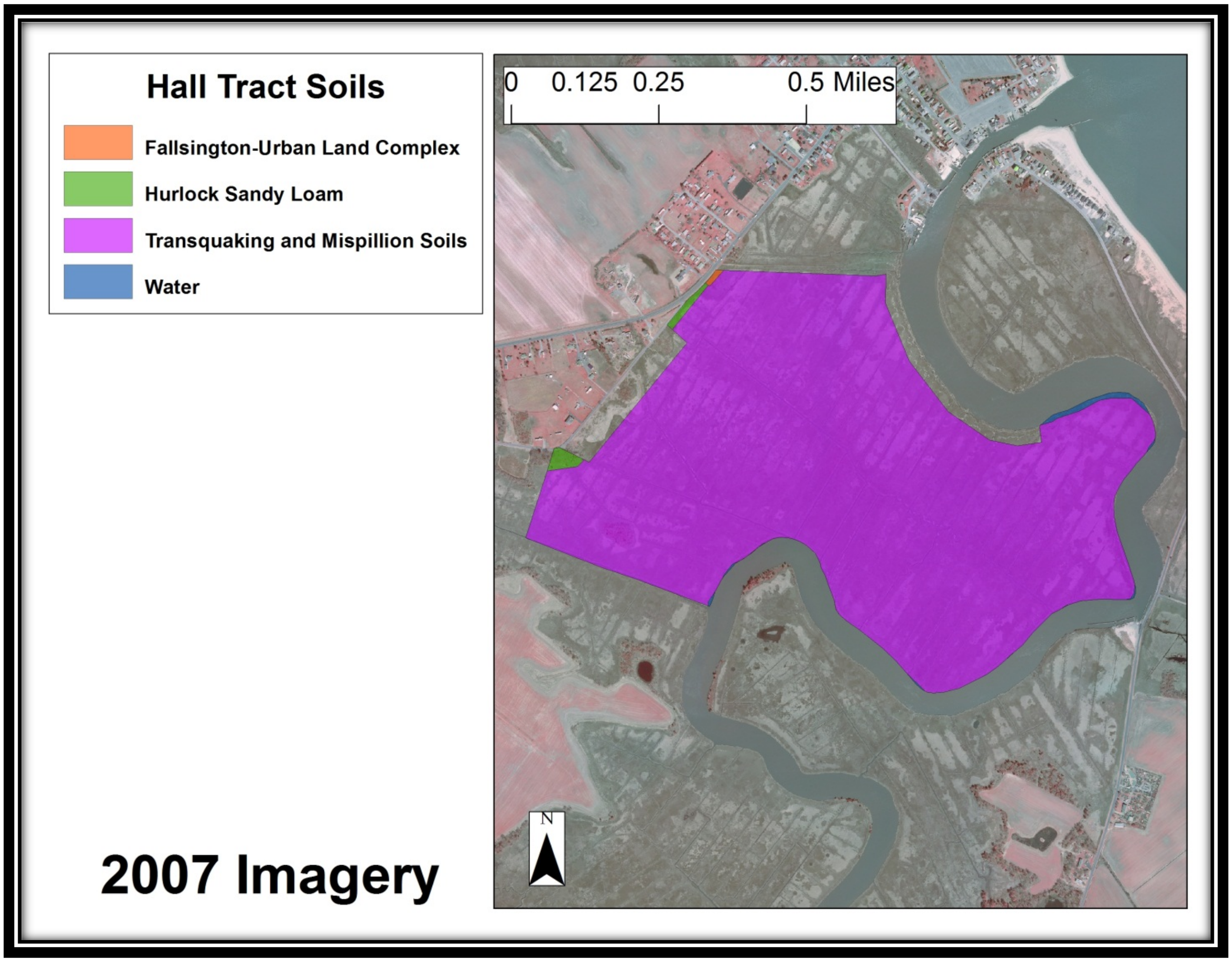

Figure 1.7. Soil Map of the Hall Tract

Hollager Tract Soils

Transquaking and Mispillion Soils (55 acres), which underlie the marsh, is the most common soil in the Hollager Tract. The only other soils are Hurlock Sandy Loam (14 acres) and Greenwich-Urban Land Complex (0.4 acres).

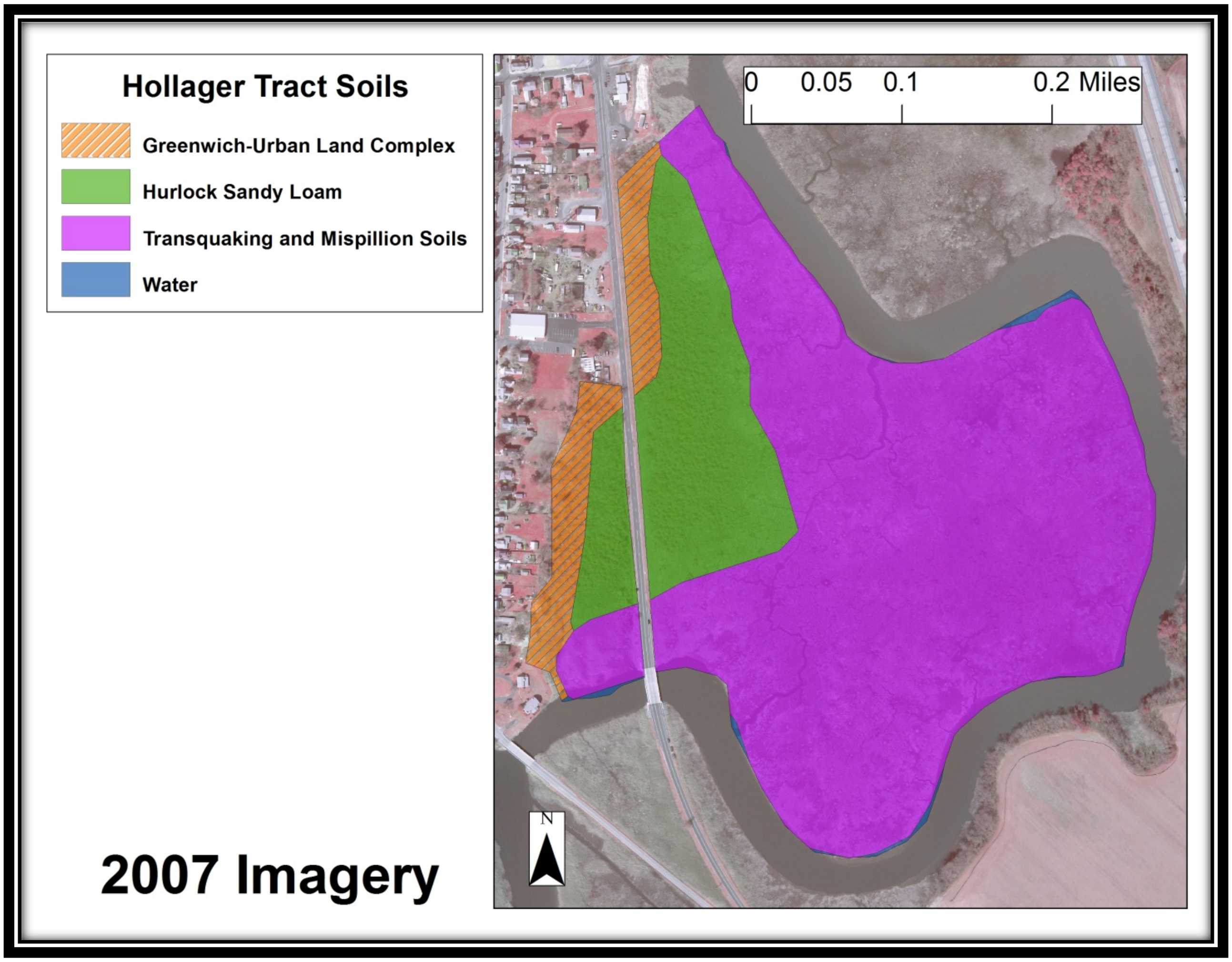

Figure 1.8. Soil Map of the Hollager Tract

Jester Tract Soils

The most common soils in the Jester Tract include Sunken Mucky Silt Loam (131 acres), Carmichael Loam (122 acres), and Transquaking and Mispillion Soils (101 acres). One minor soil, Pineyneck Loam (49 acres) is also present.

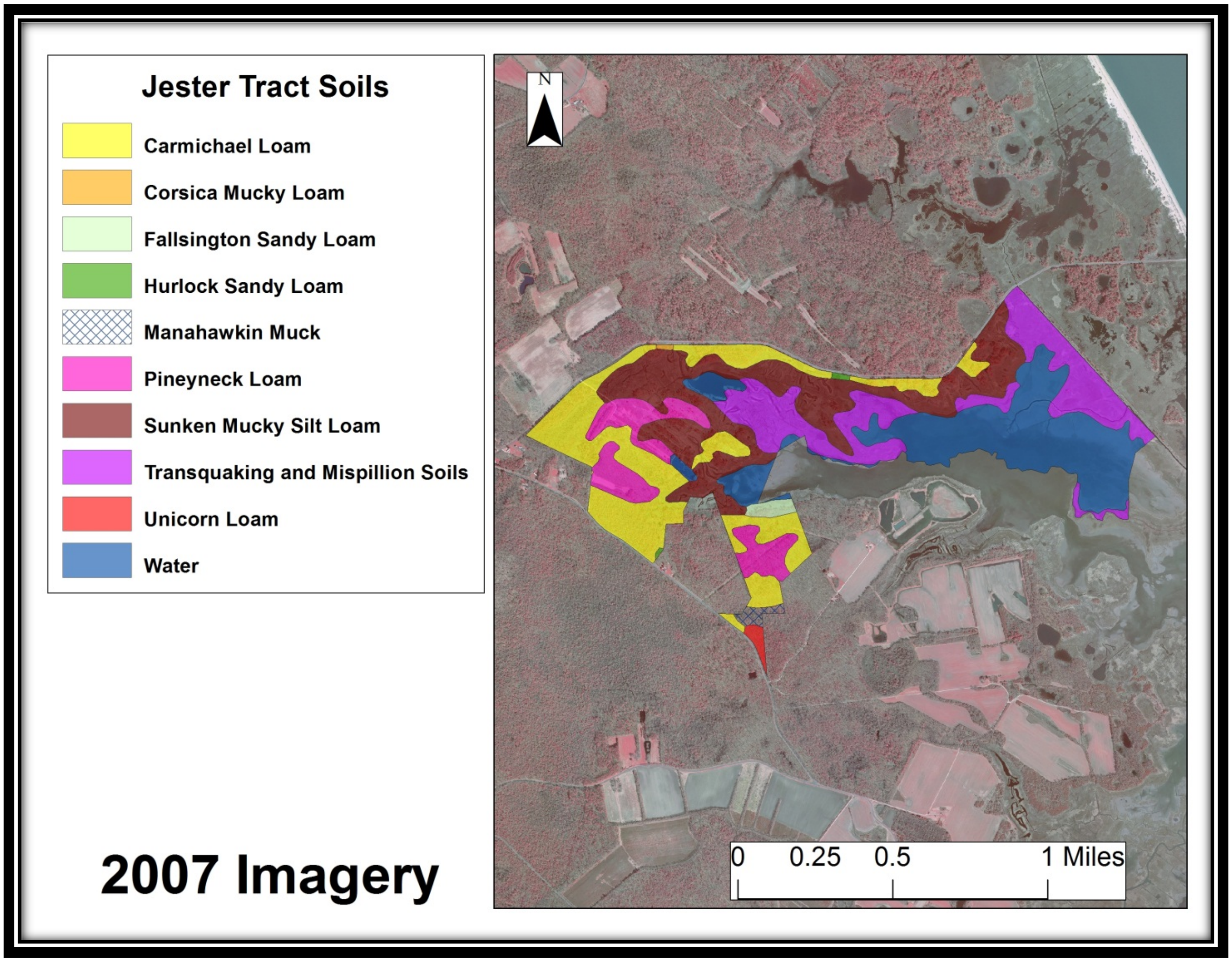

Figure 1.9. Soil Map of the Jester Tract

Penuel Tract Soils

Transquaking and Mispillion Soils (217 acres), which underlie the marsh, and Ingleside Sandy Loam (149 acres) that underlie the uplands are the most common soils in the Penuel Tract. Minor soils include Runclint Loamy Sand (94 acres) and Sunken Mucky Peat (71 acres).

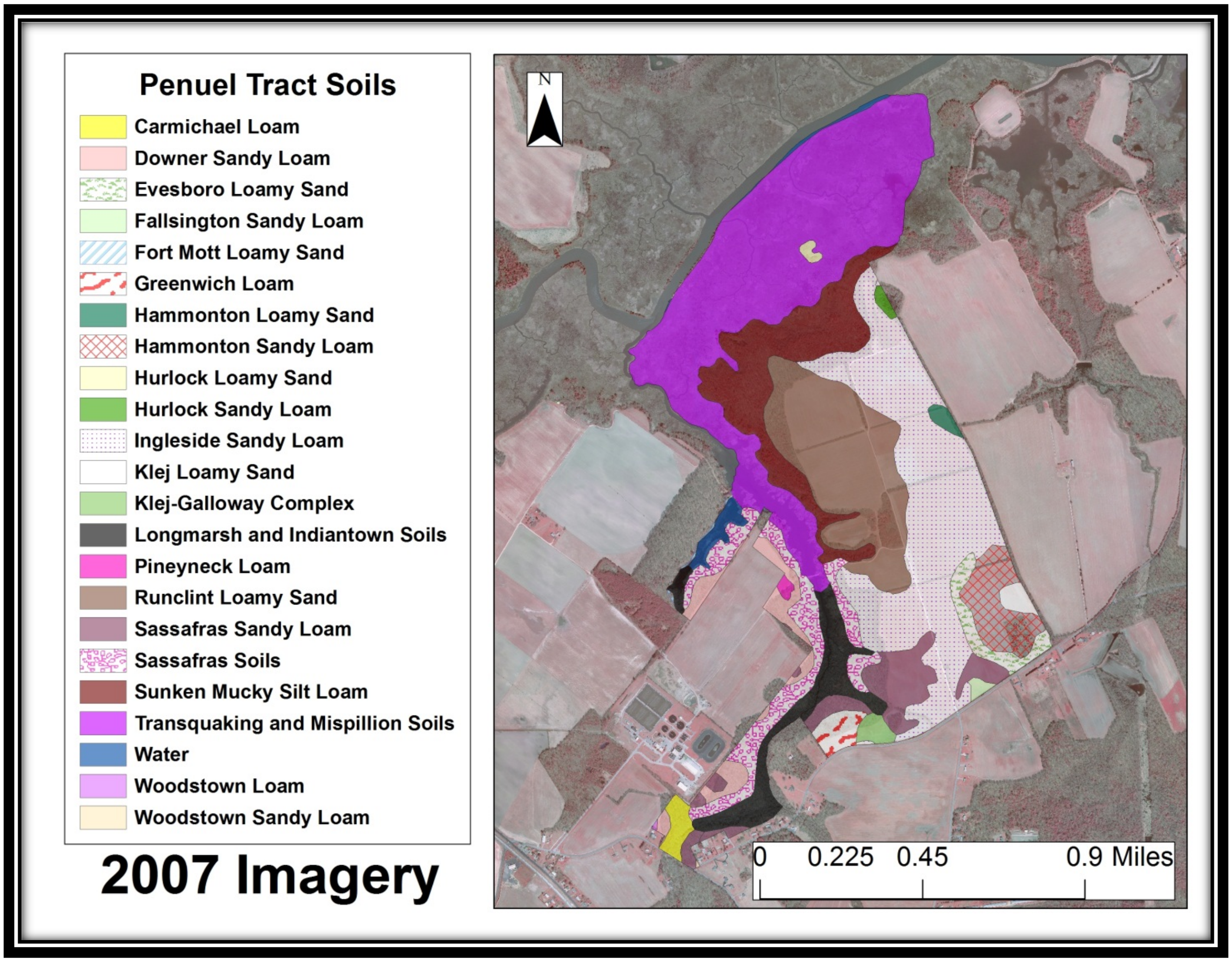

Figure 1.10. Soil Map of the Penuel Tract

Rawley's Island Tract Soils

Transquaking and Mispillion Soils (813 acres), underlying the marsh, is the most common soil type in the Rawley's Island Tract. Two other minor soils, Sunken Mucky Peat Loam (186 acres) and Carmichael Loam (55 acres) are also present.

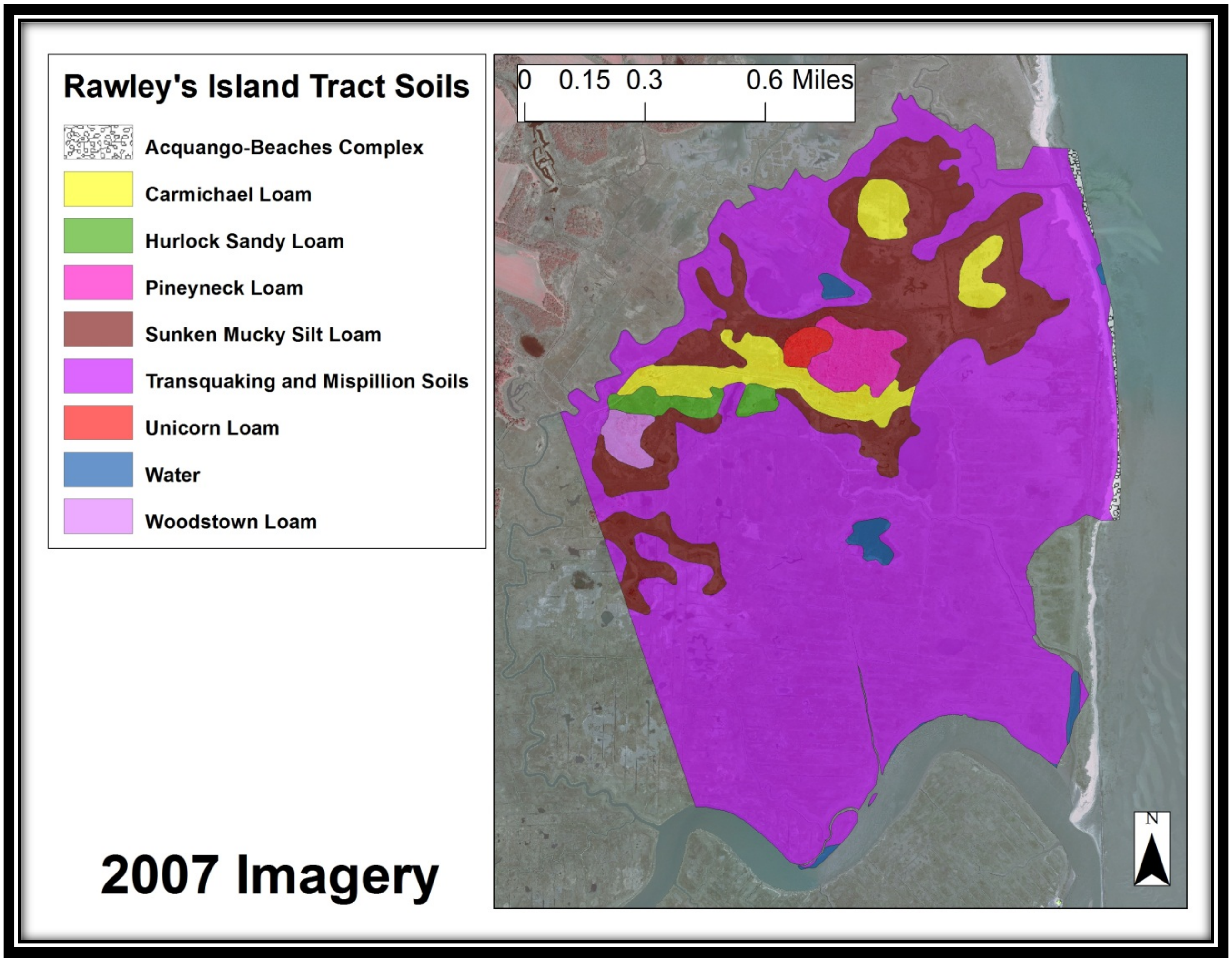

Figure 1.11. Soil Map of the Rawley's Island Tract

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 Milford Neck 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)[3]. 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.[4] 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.[5] 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.[6] Sea-level rise can also cause water tables to rise, water logging swamps away from the coast, a fact that has been stated in elsewhere in

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3 Belknap, D.F. and J.C. Kraft 1977. Holocene relative sea-level changes and coastal stratigraphic units on the northwest flank of the Baltimore Canyon geosyncline. Journal of Sedimentary Petrology 47 (2): 610-629 in Custer (1989).

4 Data from Permanent Service for Mean Sea Level website (www.psmsl.org)

5 NASA Global Climate Change Website (http://climate.nasa.gov/keyindicators) December 12, 2010 update.

6 Custer, Jay F. 1989. Prehistoric cultures of the Delmarva Peninsula: archaeological study. (Cranbury, NJ: Associated University Presses, Inc.), 447 pp.

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

Other sources have stated the rise on the Mid-Atlantic Coast to be 3-4 mm/year, while the global average is 1.8 mm/year[10], the difference of which is caused by geological subsidence from the glaciers of the last ice age. The rate 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[11], 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.[12] 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.[13] 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.[14] These changes would also impact the fisheries and economy related to it in the area.

Components of Sea Level Rise

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

Eustatic Rise

Most people think of this factor when they talk about sea level rise. This is the contribution of increased water volume coming from the melting of glaciers, snowpack, and groundwater extraction. Using the figure for Indian River Inlet above, these inputs account for about 1.2 mm/year of the rise when subtracted from the other factors[15]. Added to this is newer research that shows groundwater

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7 Rappleye, L. and W. M. Gardner. 1979. A cultural resources reconnaissance and impact assessment of the Great Dismal Swamp National Wildlife Refuge, City of Suffolk, Chesapeake, and Nansemond Counties, Virginia. Manuscript on file. Department of Anthropology, Catholic University, Washington, DC in Custer (1989).
8 Whitehead, D.R. 1972. Developmental and environmental history of the Dismal Swamp. Ecological Monographs 42: 301-15 in Custer (1989).
9 Gardner, W.M. 1978. Comparison of Ridge and Valley, Blue Ridge, Piedmont, and Coastal Plain Archaic Period Site Distribution: An idealized transect (preliminary model). Paper presented at the 1978 Middle Atlantic Archeological Conference, Rehoboth Beach, Delaware in Custer (1989).
10 Johnson, Zoe Pfahl. 2000. A Sea Level Rise Response Strategy for the State of Maryland. Maryland Department of Natural Resources.
11 Nikitina, Daria L., James E. Pizzuto, Reed A. Schwimmer, and Kelvin W. Ramsey. 2000. An updated Holocene sea-level curve for the Delaware Coast. Marine Geology 171 (1-4): 7-20.
12 Barth, M.C. and J.G. Titus. 1984. Greenhouse Effect and Sea Level Rise: A Challenge for this Generation. (New York: Van Nostrand Reinhold Co., Inc.) 238 pp.
13 Kraft, John C. and Md. Khalequzzaman. 1992. Geologic and human factors in the decline of the tidal salt marsh lithesome: the Delaware Estuary and Atlantic coastal zone. Sedimentary Geology 80 (3-4): 233-246.
14 Larson, C.E. and I. Clark. 2006. A search for scale in the sea-level studies. Journal of Coastal Research 22 (4): 788-800.
15 Davis, George H. 1987. Land Subsidence and Sea Level Rise on the Atlantic Coastal Plain of the United States. Environmental Geology 10 (2): 67-80.

depletion is adding 0.8 mm/year to sea level rise[16]. From this you have to subtract the amount of water that has been impounded on land. Chao, et al. states that about 10,800 cubic kilometers has been impounded in the last half century which subtracts about 0.55 mm/year from the rise[17]. When added together, eustatic factors account for 1.45 mm/year of the rise.

Stearic Rise

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

Isostatic Rise

Geological land subsidence adds the most to the rise currently accounting for about 1.6 mm/year[22] in the Mid-Atlantic region. Another study has given an amount ranging from 1.02 to 1.53 mm/year[23]. Liu, et al gives a similar for New York City stating a sea level rise of 2-4 mm/year to which glacio-isostatic factors account for about 40%[24].

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

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

18 Ditto

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

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

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

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

23 Englehart, S.E., B.P. Horton, B.C. Douglas, W.R. Peltier, T.E. Tornqvist. 2008. Spatial variability in the 20th century record of sea level rise along the US Atlantic Coast. American Gophysical Union, Fall 2008 Meeting.

24 Liu, J., R. Horton. 2007. Impacts of combined sea level rise and coastal subsidence, New York City Metropolitian Area. American Geophysical Union. Fall 2007 Meeting.

All of these factors added together

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

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

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

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

More recent studies looking at both changes in tidal marshes[30] and coastal forests[31] have shown that both can suffer effects of a rising sea level. Matthew Kirwan states that a tidal marsh can keep up with sea level rise through accretion if the amount of sediment is adequate, but that reforestation and dam building has restricted the sediment inflows[32]. Shirley and Battaglia come roughly to the same conclusion on the Gulf of Mexico coast, stating that they do not believe the marshes are keeping pace with the aquatic to terrestrial transition, but it is hard to map in the Coastal Plain because of major land use changes[33]. Kimberlyn Williams states that some of the factors leading to forest decline in coastal

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25 Klemas, Vytautas. 1972. Use of remote sensing to determine natural and man-made changes in the coastal zone. Transactions of the Delaware Academy of Science. 2: 13-34.
26 Vytautas, Klemas. 1972. Use of remote sensing and to determine natural and man-made changes in the coastal zone. Transactions of the Delaware Academy of Science 2:13-34.
27 Kadmon, R. and R. Harari-Kremer. 1999. Studying the long term vegetation dynamics using digital processing of historical aerial photographs. Remote Sensing of the Environment 68:164-176.
28 Smith, Carrie, Merryl Alber, and Alice Chalmers. 2001. Linking shifts in historic estuarine vegetation to salinity changes using a GIS. Proceedings of the 2001 Georgia Water Resources Conference.
29 Earle, J.C. and K.A. Kershaw. 1988. Vegetation patterns in James Bay coastal marshes. III. Salinity and elevation as factors influencing plant zonations. Canadian Journal of Botany 67: 2967-2974.
30 Kirwan, Matthew L. and A. Brad Murray. 2007. A coupled geomorphic and ecological model of tidal marsh evolution. Proceedings of the National Academy of Science 104(15):6118-6122.
31 Williams, Kimberlyn, et al. 1999. Sea-level rise and coastal forest retreat on the west coast of Florida, USA Ecology
32 Kirwan, Matthew L. and A. Brad Murray. 2007. A coupled geomorphic and ecological model of tidal marsh evolution. Proceedings of the National Academy of Science 104(15):6118-6122.
33 Shirley, Laura and Lorretta L. Battaglia. 2006. Assessing vegetation change in coastal landscapes of the northern Gulf of Mexico. Wetlands 26(4): 1057-1070.

areas result from; soil flooding—resulting in low oxygen availability and reducing conditions, elevated soil and groundwater salinity, and saltwater intrusion.

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

Purpose of the Study

This study was conducted with the following goals in mind:

1. Classify and map vegetation communities, land covers, and asses habitat conditions for Species of Greatest Conservation Need (SGCN)[as defined in the Delaware Wildlife Action Plan (DEWAP)] for Milford Neck Wildlife Area based on 1937, 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 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).

34 Orson, Richard A., Robert L. Simpson, and Ralph E. Good. 1992. The Paleoecological development of a late Holocene, Tidal Freshwater Marsh of the Upper Delaware River Estuary. Estuaries and Coasts 15(2): 130-146.

Vegetation Community and Land Cover Surveys

Vegetation communities and land covers were determined by qualitative analysis using observations made in the field and aerial photo-interpretation using 1937, 2002 and 2007 aerial imagery. Vegetation communities are named according to the *Guide to Delaware Vegetation Communities* 35which 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 communities are provided.

Analysis of Historical Imagery

Historical imagery of Milford Neck Wildlife Area from 1937 and 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, 65, and 70 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 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 Milford Neck Wildlife Area included in the EIA analysis are listed in Table 2.2 and depicted in Figures 2.1-2.7.

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 2.3 and Figure 2.8). A block is defined as contiguous forest habitat that is contained with 30 feet of non-forested and is the method used by the Maryland's Strategic Forest Lands Assessment.36 Forest interior is forested area that is 100m from a forest edge. Potential blocks were extended out to areas of noncontiguous habitat (such as roads, powerline right-of-ways, and developed areas) that were considered to be immovable. Most of the area that could be reverted to forest is currently old field habitat or in agricultural use. These blocks were determined for future planning in regards to improving and increasing forest interior habitat.

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35 Coxe, Robert. 2010. Guide to Delaware Vegetation Communities-Summer 2010 Edition. Unpublished report.

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

Sea Level Rise Analysis

An analysis was performed for the wildlife area as whole, the sections, and the vegetation communities/land covers using the DNREC Sea Level Rise Scenarios. An estimate of the 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.[37] The values from the table were calculated per acre of the vegetation community and then adjusted using an inflation calculator (DollarTimes.com) from 1994 values to 2012 values. Using these methods the following values were obtained:

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

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

Wetlands

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

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

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

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

Cropland: $37/acre/year

Grassland/fields: $94/acre/year

Open Ocean: $102/acre/year

Values were rounded off to the nearest whole dollar.

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

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

Summary of Findings from this study

1. **Vegetation Communities:** Thirty-seven vegetation communities and eleven land covers were found at Milford Neck Wildlife Area. North Atlantic Low Salt Marsh (2,014 acres) is the largest vegetation community followed by Chesapeake Bay Non-riverine Wet Hardwood Forest with 821 acres.

2. **Rare Plants:** Three rare plants are known to exist in Milford Neck Wildlife Area (Table 2.1).

Scientific Name	Common Name	Rank	Last Observed
Isotria verticillata	Large Whorled Pogonia	S2	???
Polygala cruciata	Crossleaf Milkwort	S2	???
Agastache nepetoides	Yellow Giant Hyssop	S2	1994

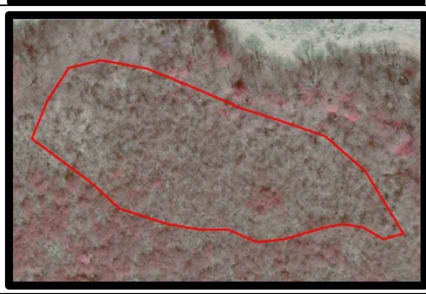
Table 2.1. Rare Plants at Milford Neck Wildlife Area

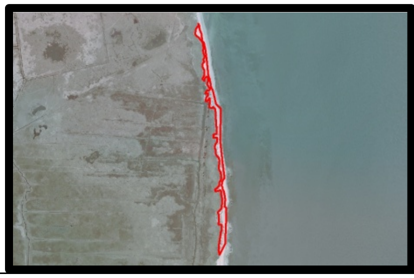
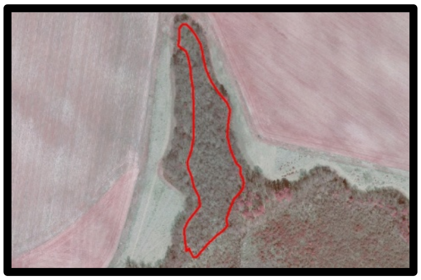
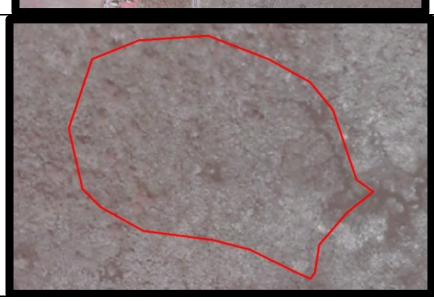
3. **Rare Animals:** No rare animals are currently known to exist in Milford Neck Wildlife Area.

Ecological Integrity Assessment (EIA)

Seven vegetation communities are ranked S2 or higher. These include Freshwater Tidal Mixed High Marsh, Freshwater Tidal Woodland, Northeastern Dry Oak-Hickory Forest, Northern Coastal Plain/Piedmont Basic Mesic Mixed Hardwood Forest, Overwash Dune Grassland, Southern Red Maple-Blackgum Swamp, and Wax-Myrtle Shrub Swamp.

Table 2.2. EIA Vegetation Communities located in Milford Neck Wildlife Area

Community Map	Community Name/EIA Score	Description
	**Milford Neck 1** **Freshwater Tidal Mixed High Marsh (0.32 acres)** **EIA = 3.08 (C rank)**	This marsh community is located in a cove that is edged by Atlantic Coast Wild Rice Tidal Marsh. It is located in the Penuel Tract.
	**Milford Neck 2** **Freshwater Tidal Woodland (1.34 acres)** **EIA = 2.66 (C rank)**	This woodland community comes about through the inundation of Southern Red Maple-Blackgum Swamps in a tidal situation. It is located at the edge of tide on the Murderkill River in the Gray Farm Tract.
	**Milford Neck 3** **Northeastern Dry Oak-Hickory Forest (7.74 acres)** **EIA = 2.66 (C rank)**	This forest community is located on an area of drier ground in the Coverdale Tract.
	**Milford Neck 4** **Northern Coastal Plain/Piedmont Basic Mesic Forest (6.67 acres)** **EIA= 3.02 (C rank)**	This forest community contains the highest diversity of herbs of any in the Milford Neck Wildlife Area and is found in places where the geology is circumneutral. It is located in the Penuel Tract.

Community Map	Community Name/EIA Score	Description
	**Milford Neck 5** **Overwash Dune Grassland (2.52 acres)** **EIA=4.15 (B rank)**	This grassland community forms from overwash over beach areas at the shore of the Delaware Bay. It is located on the Rawley's Island Tract.
	**Milford Neck 6** **Southern Red Maple-Blackgum Swamp Forest (3.61 acres)** **EIA=2.49 (C rank)**	This forest community is located in a saturated valley at the edge of tide. It is located on the Gray's Farm Tract.
	**Milford Neck 7** **Wax-myrtle Shrub Swamp (4.06 acres)** **EIA=2.59 (C rank)**	This shrubland community is part of the transition from forest to marsh in freshwater tidal situations. It is often found on the edge of tide. This example is located in the Hollager Tract.
	**Milford Neck 8** **Wax-Myrtle Shrub Swamp (8.44 acres)** **EIA=2.92 (C rank)**	This shrubland community is part of the transition from forest to marsh in freshwater tidal situations. It is often found on the edge of tide. This example is located in the Hollager Tract.
	**Milford Neck 9** **Wax-myrtle Shrub Swamp (0.92 acres)** **EIA=3.3 (C rank)**	This shrubland community is part of the transition from forest to marsh in freshwater tidal situations. It is often found on the edge of tide. This example is found in the Hollager Tract.

Community Map	Community Name/EIA Score	Description
	**Milford Neck 10** **Wax-myrtle Shrub Swamp (9.67 acres)** **EIA=3.82 (B rank)**	This shrubland community is part of the transition of forest to marsh in freshwater tidal situations. This example is located in the Gray Farm Tract and is backed by a Freshwater Tidal Woodland.
	**Milford Neck 11** **Wax-myrtle Shrub Swamp (1.89 acres)** **EIA=3.44 (C rank)**	This shrubland community is part of the transition of forest to marsh in freshwater tidal situations. This example is located in the Gray Farm Tract.
	**Milford Neck 12** **Wax-myrtle Shrub Swamp (29.95 acres)** **EIA=4.18 (B rank)**	This shrubland community is part of the transition of forest to marsh in freshwater tidal situations. Analysis of historical imagery reveals that it has transitioned from possibly Freshwater Tidal Woodland to this community. This example is located in the Dickerson Tract.
	**Milford Neck 13** **Wax-myrtle Shrub Swamp (3.82 acres)** **EIA=3.8 (B rank)**	This shrubland community is part of the transition of forest to marsh in freshwater tidal situations. This example is located in the Masten Tract.
	**Milford Neck 14** **Wax-myrtle Shrub Swamp (9.34 acres)** **EIA=3.8 (B rank)**	This shrubland community is part of the transition of forest to marsh in freshwater tidal situations. This example is located in the Masten Tract.

Coverdale Tract EIAs

The Coverdale Tract contains one occurrence of a Northeastern Dry Oak-Hickory Forest.

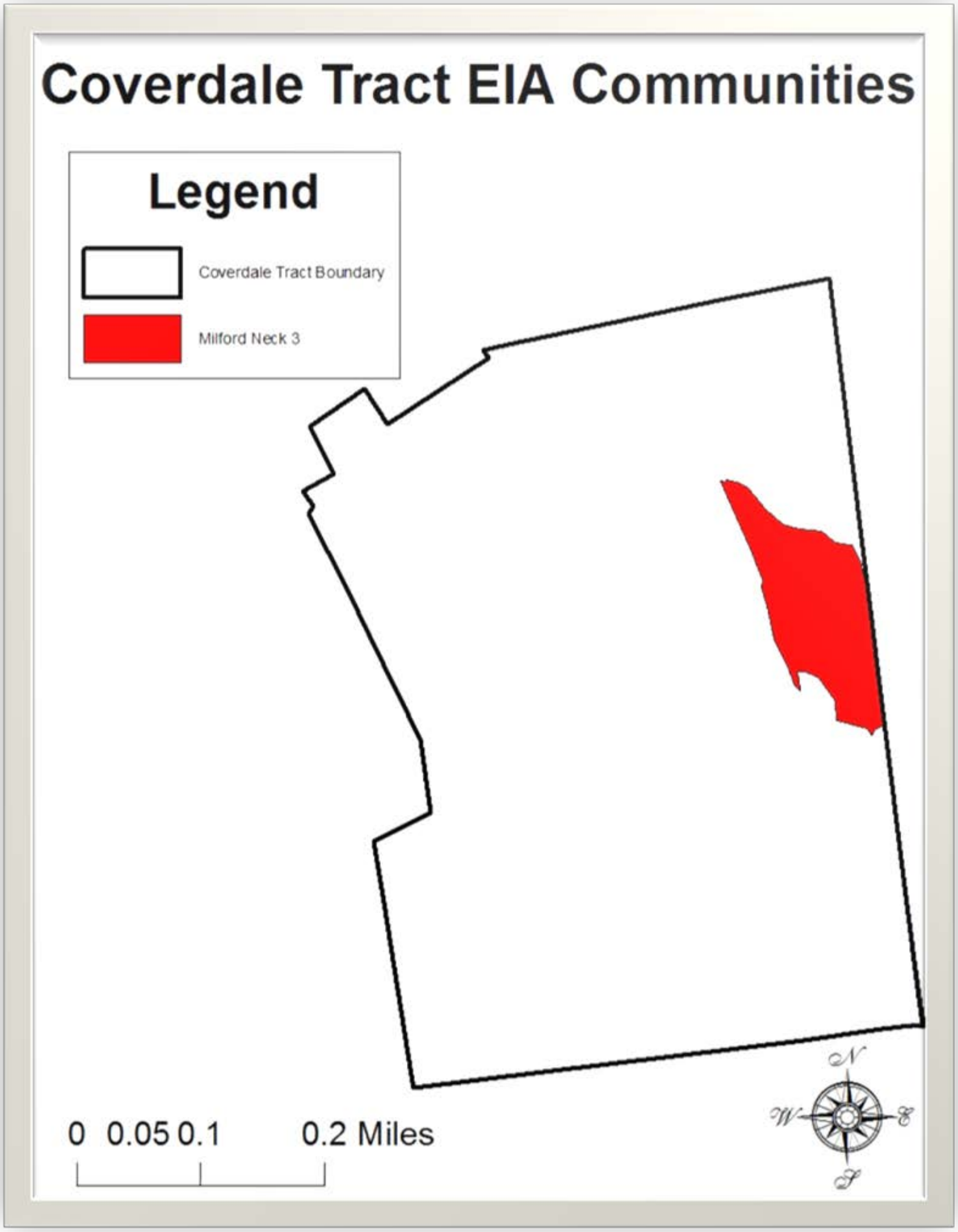


Figure 2.1. Coverdale Tract EIA Communities

Dickerson Tract EIAs

The Dickerson Tract contains one occurrence of a Wax-Myrtle Shrub Swamp.

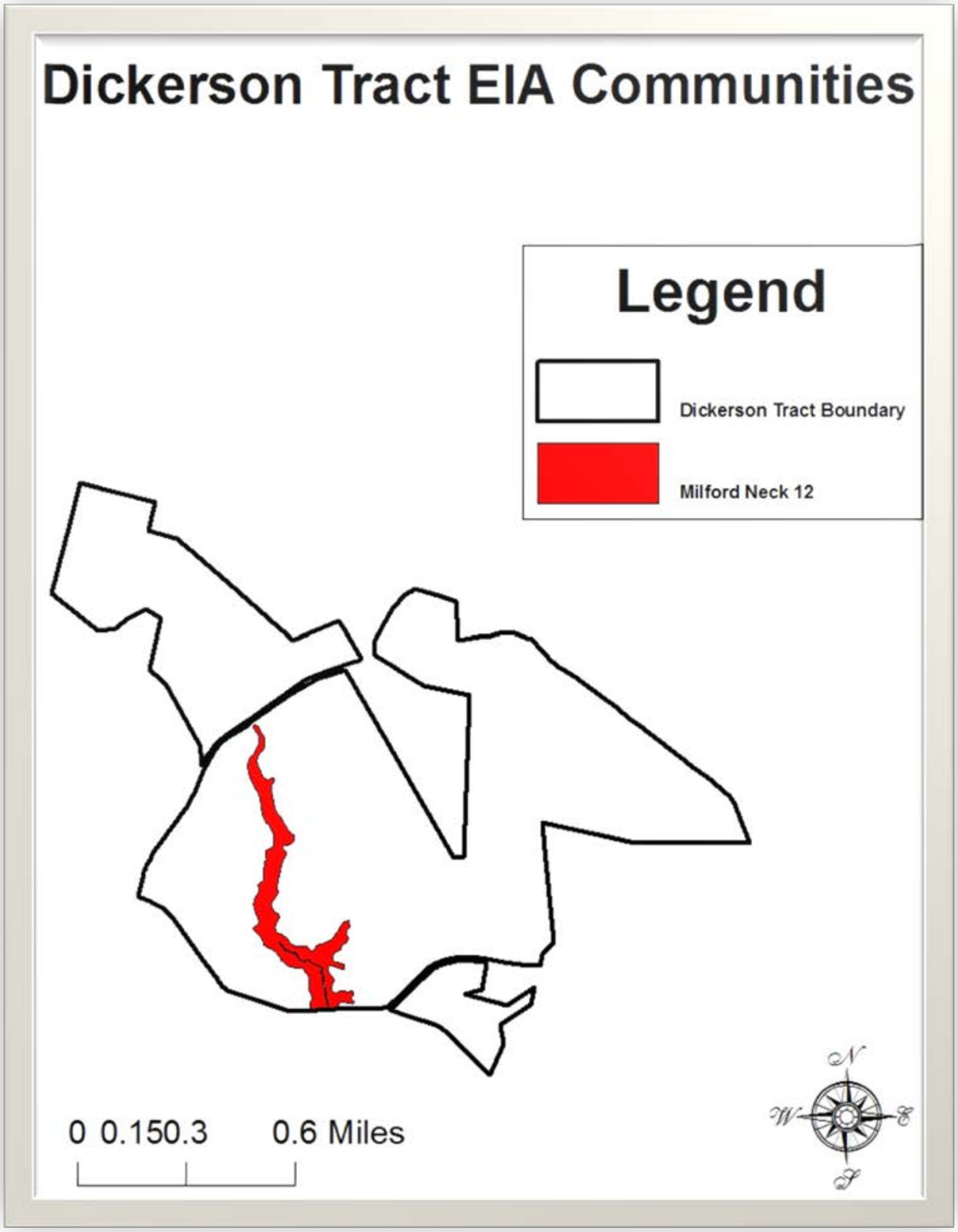


Figure 2.2. Dickerson Tract EIA Communities

Gray Farm Tract EIAs

The Gray Farm contains one occurrence each of two EIA communities, Freshwater Tidal Woodland, Southern Red Maple-Blackgum Swamp, and two occurrences of Wax-Myrtle Shrub Swamp.

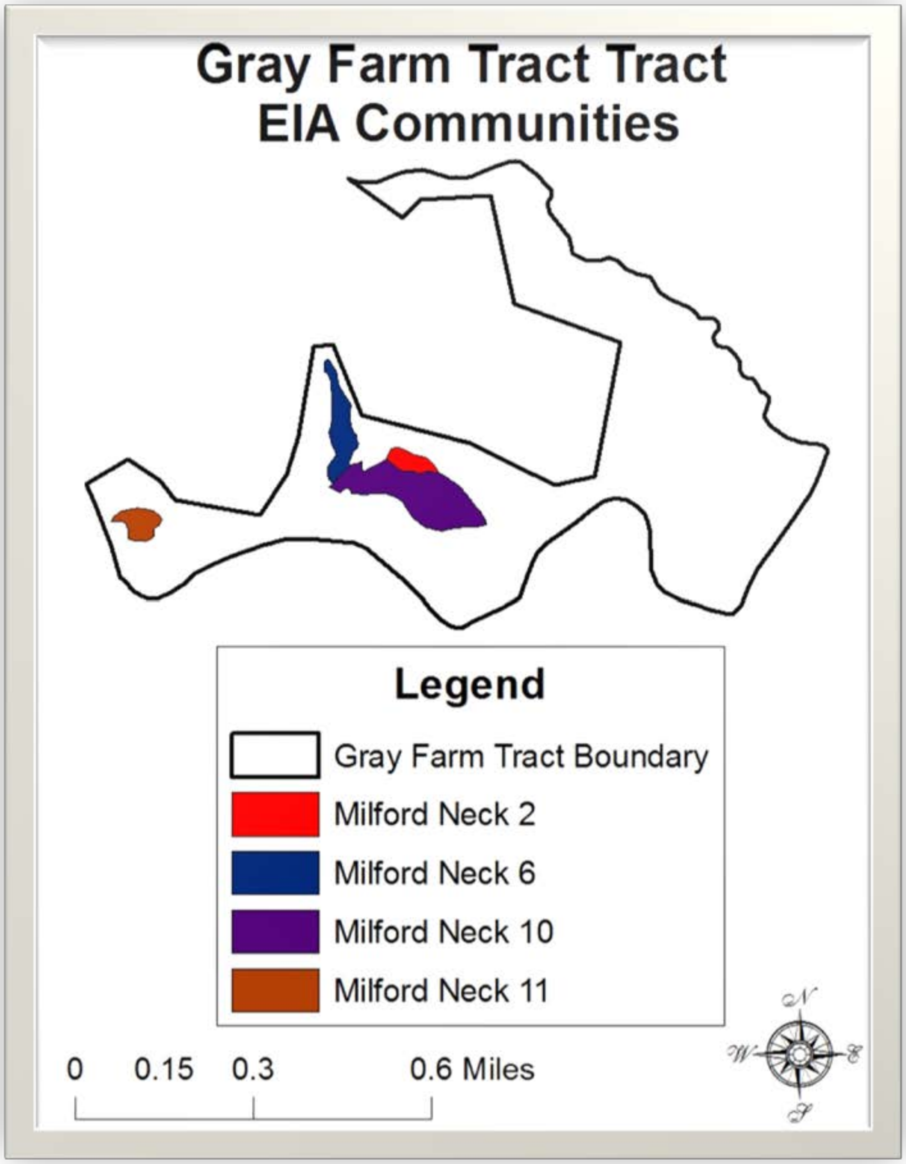


Figure 2.3. Gray Farm Tract EIA Communities

Hollager Tract EIAs

The Hollager Tract contains three occurrences of Wax-Myrtle Shrub Swamp.

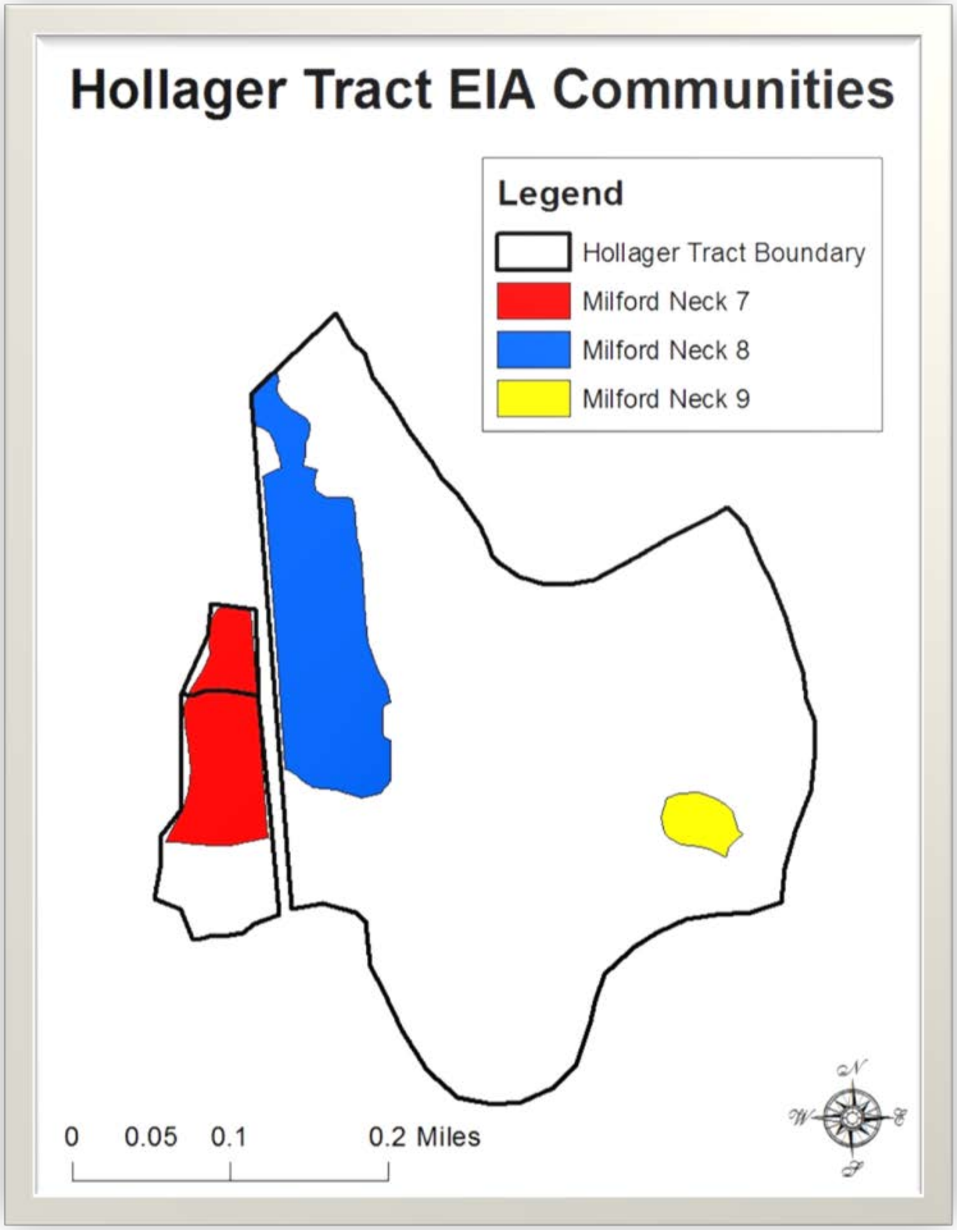


Figure 2.4. Hollager Tract EIA Communities

Masten Tract EIAs

The Masten Tract contains two occurrences of Wax-Myrtle Shrub Swamp.

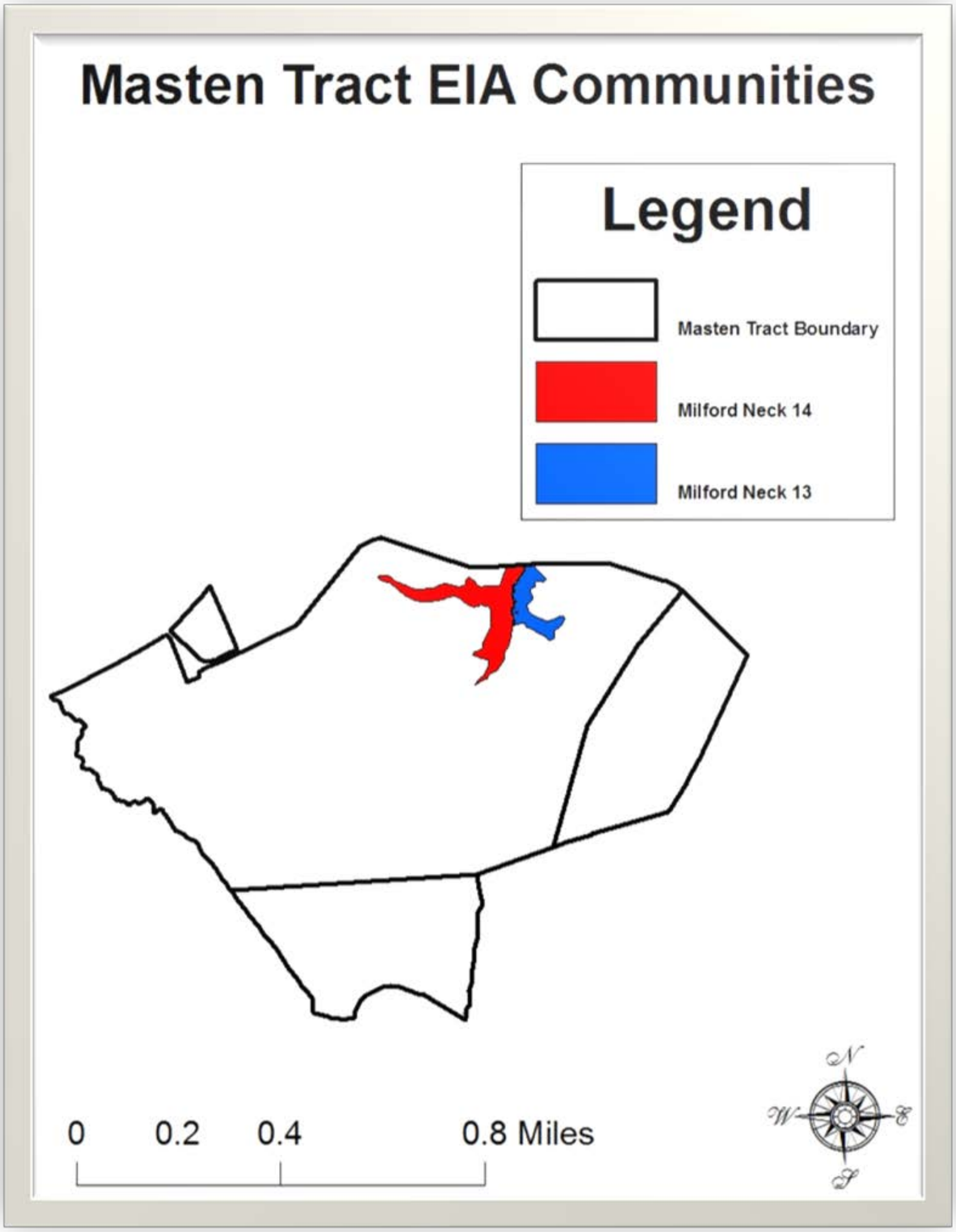


Figure 2.5. Masten Tract EIA Communities

Penuel Tract EIAs

The Penuel Tract contains one occurrence each of Freshwater Tidal Woodland and Northern Coastal Plain/Piedmont Basic Hardwood Forest.

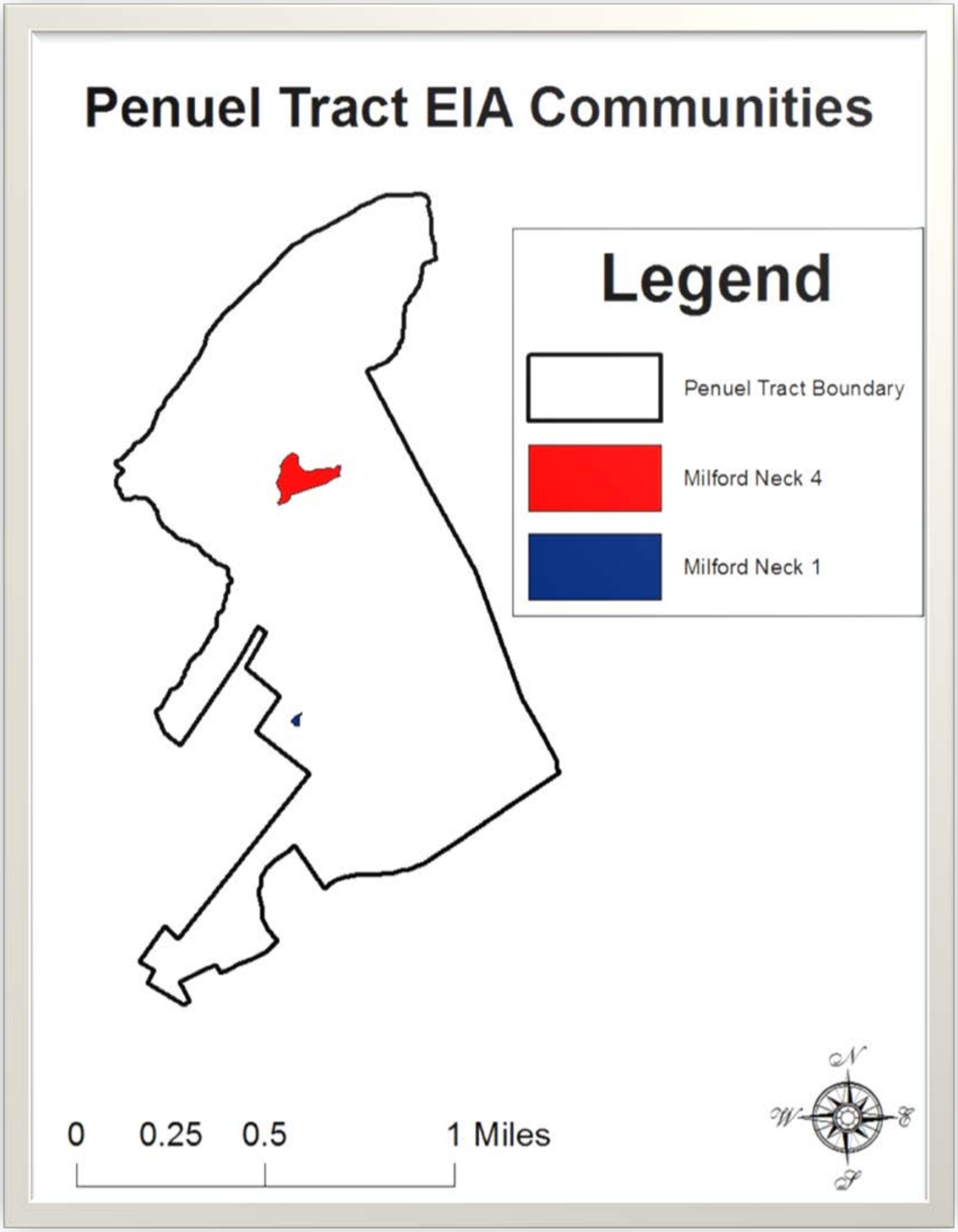


Figure 2.6. Penuel Tract EIA Communities

Rawley's Island EIAs

The Rawley's Island Tract contains one occurrence of an Overwash Dune Grassland.

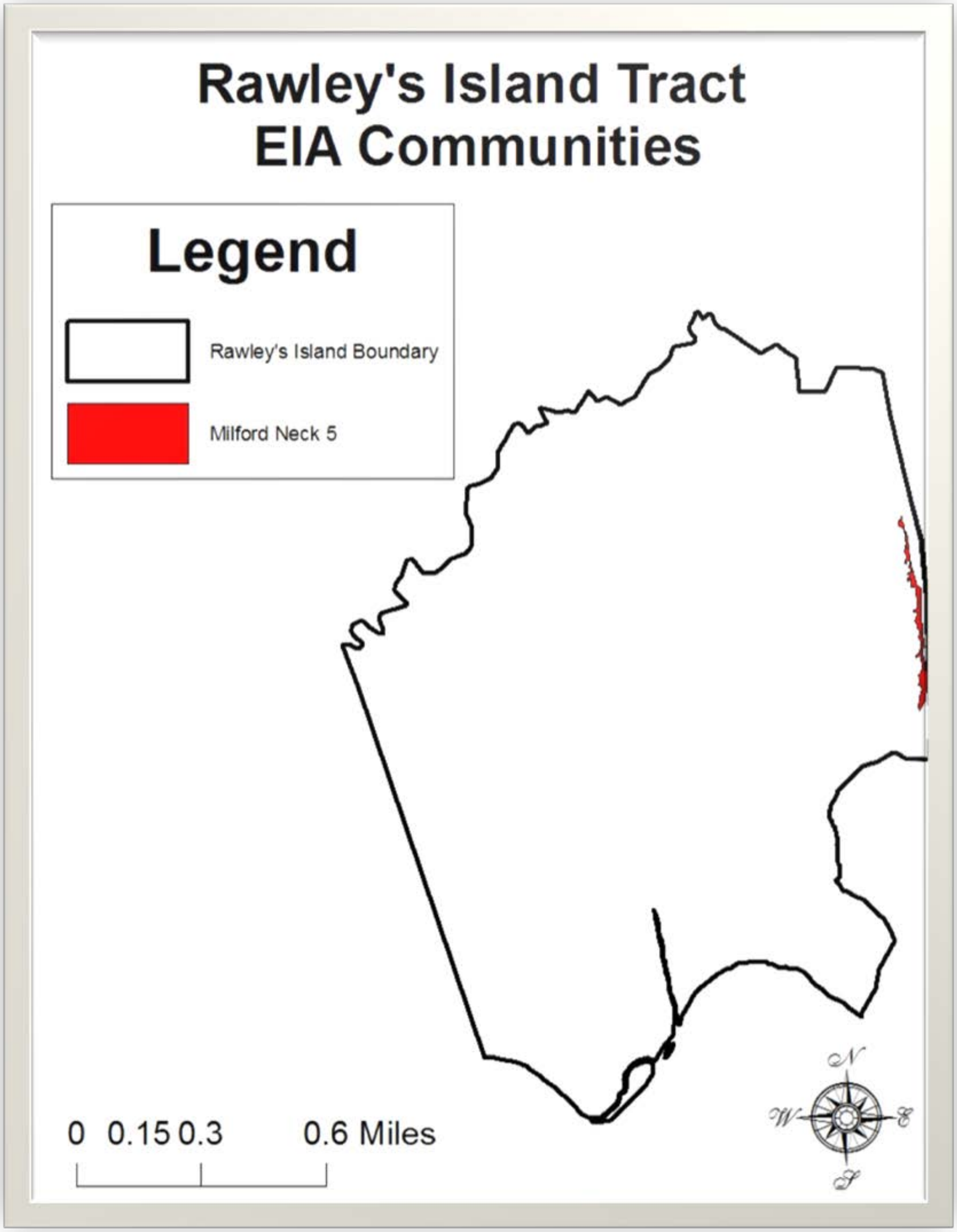


Figure 2.7. Rawley's Island Tract Vegetation Communities

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[38]. Nests in interior forests are less susceptible to predation and are not taken over by cowbirds, which is another hazard on edge habitats. Examples of birds that may be affected by a lack of large forest tracts include Barred Owl, Black and White Warbler, Worm-Eating Warbler, Acadian Flycatcher, Ovenbird, Kentucky Warbler, Red-Shouldered Hawk and many others.

Management of wildlife areas has traditionally favored forest game species such as wild turkey, ruffed grouse and American woodcock, which require old fields and edges running counter to the habitat needed for forest interior birds. Protecting forest interior birds runs contrary to the idea that artificially created edges creates more diversity. While this technique creates more diversity of some aggressive species it diminishes the populations of other species.

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

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

Analysis of Forest Blocks at Milford Neck Wildlife Area

Seven forest blocks are present that are more than 100 acres in size and are located in whole or part in the wildlife area (Table 2.2 and Figure 2.8). All forest blocks are bounded by a road, agricultural field, or other non-forested habitat. These areas are considered to be barriers to the passage of forest dwelling wildlife. Descriptions are provided for each forest block.

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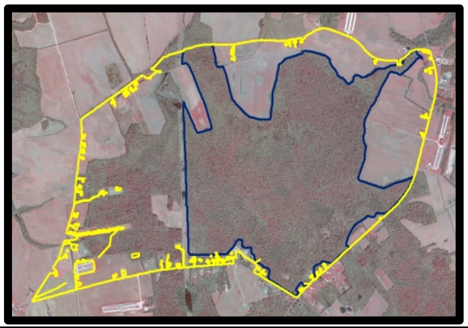
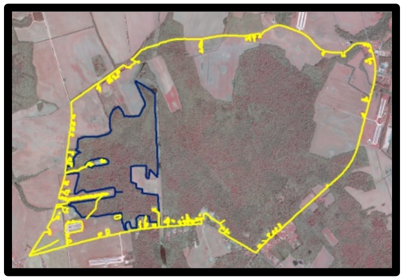
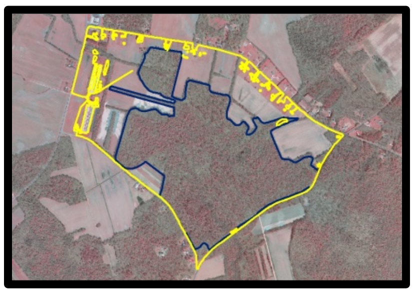
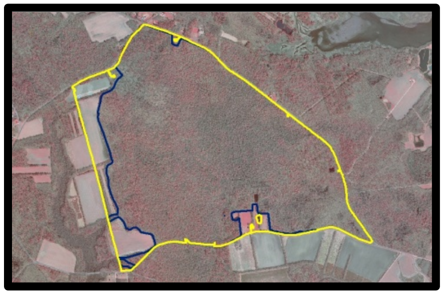
38 Ontario Landowner Resource Centre. 2000. Conserving the Forest Interior: A threatened wildlife habitat. Ontario Ministry of Natural Resources.

Table 2.2. Forest Blocks located in whole or part in Milford Neck Wildlife Area

Forest Block Map	Block Name/Acreage	Description
	**Milford Neck A** **Current Block = 289 acres (16 acres interior)** **Potential Block = 2,306 acres (1,193 acres interior)**	Milford Neck A encompasses nearly all of the wooded area in the Penuel Tract. It is bounded by agricultural field on the west and east, Milford Neck Road on the south, and tidal marsh on the north. Four vegetation communities are located within this block and include Chesapeake Bay Non-riverine Wet Hardwood Forest, Early to Mid-Successional Loblolly Pine Forest, Mid-Atlantic Mesic Mixed Hardwood Forest, and Northern Coastal Plain/Piedmont Basic Mesic Forest. The Murderkill River and a tributary is the drainage for this block. Currently this block contains 16 acres of interior habitat. Potentially this block could be 2,306 acres in size, and contain 1,193 acres of interior habitat.
	**Milford Neck B** **Current Block = 526 acres (326 acres interior)** **Potential Block = 1,100 acres (772 acres interior)**	Milford Neck B covers the eastern end of the Coverdale Tract. It is bounded by on the north by Milford Neck Road, on the east by Thompsonville Road, on the south by Torbert Road, and on the west by a powerline right-of-way. Two vegetation communities are located within this block and include, Chesapeake Bay Non-riverine Wet Hardwood Forest, and Northeastern Dry Oak-Hickory Forest. Brockenbridge Gut, a tributary to the Murderkill River, is the drainage for this block. Currently this block contains 526 acres of interior habitat. Potentially this block could be 772 acres in size and contain 1,100 acres of interior habitat.

Forest Block Map	Block Name/Acreage	Description
	**Milford Neck C** **Current Block = 150 acres (22 acres interior)** **Potential Block = 1,100 acres (772 acres interior)**	Milford Neck C is located on the west side of the Coverdale Tract. It is bounded by Torbert Road on the south, Road 423 on the west, agricultural field on the north, and a powerline right-of-way on the east. One vegetation community, Chesapeake Bay Non-riverine Wet Hardwood Forest is located within this block. The source of Brockenbridge Gut, a tributary to the Murderkill River, is located in this block. Currently this block contains 22 acres of interior habitat. Potentially this block could be 1,100 acres in size and contain 772 acres of interior habitat.
	**Milford Neck D** **Current Block = 179 acres (72 acres interior)** **Potential Block = 319 acres (172 acres interior)**	Milford Neck D is located at the northern end of the Dickerson Tract. It is bounded on the west by Gobbler Road, agricultural fields on the north and east, and on the south by Road 124. Three vegetation communities are located within this block and include Chesapeake Bay Non-riverine Wet Hardwood Forest, Mid-Atlantic Mesic Mixed Hardwood Forest, and Northeastern Modified Successional Forest. Kings Causeway, a tributary to the Mispillion River, drains this block. Currently this block contains 72 acres of interior habitat. Potentially this block could be 319 acres in size and contain 172 acres of interior habitat.

Forest Block Map	Block Name/Acreage	Description
	**Milford Neck E** **Current Block = 522 acres (360 acres interior)** **Potential Block = 589 acres (416 acres interior)**	Milford Neck E covers the northeastern end of the Dickerson Tract. It is bounded by Road 123 on the east, Stratham Lane on the south, agricultural field on the west, and Road 124 on the north. Three vegetation communities are located within this block and include Chesapeake Bay Non-riverine Wet Hardwood Forest, Mid-Atlantic Mesic Mixed Hardwood Forest, and Mid to Late Successional Loblolly Pine-Sweetgum Forest. Kings Causeway drains the block. Currently this block contains 360 acres of interior habitat. Potentially this block could be 589 acres in size and contain 416 acres of interior habitat.
	**Milford Neck F** **Current Block = 135 acres (27 acres interior)** **Potential Block = 209 acres (124 acres interior)**	Milford Neck F covers the western end of the Dickerson Tract. It is bounded by Road 124 on the west and north, fields on the east, and Stratham Lane on the south. Four vegetation communities are located within this block and include Chesapeake Bay Non-riverine Wet Hardwood Forest, Mid to Late Successional Loblolly Pine-Sweetgum Forest, Successional Tuliptree Forest, and Wax-myrtle Shrub Swamp. Kings Causeway drains the block. Currently this block contains 27 acres of interior habitat. Potentially this block could be 209 acres in size and contain 124 acres of interior habitat.
	**Milford Neck G** **Current Block = 231 acres (71 acres interior)** **Potential Block = 1,360 acres (549 acres interior)**	Milford Neck G covers the western end of the Jester Tract. It is bounded by Scotts Corner Road on the west and south, and marsh on the north and east. Three vegetation communities are located within this block and include Chesapeake Bay Non-riverine Wet Hardwood Forest, Early to Mid-Successional Loblolly Pine Forest, and Northeastern Modified Successional Forest. A tributary to Delaware Bay drains this block. Currently this block contains 71 acres of interior habitat. Potentially this block could be 1,360 acres and contain 549 acres of interior habitat.

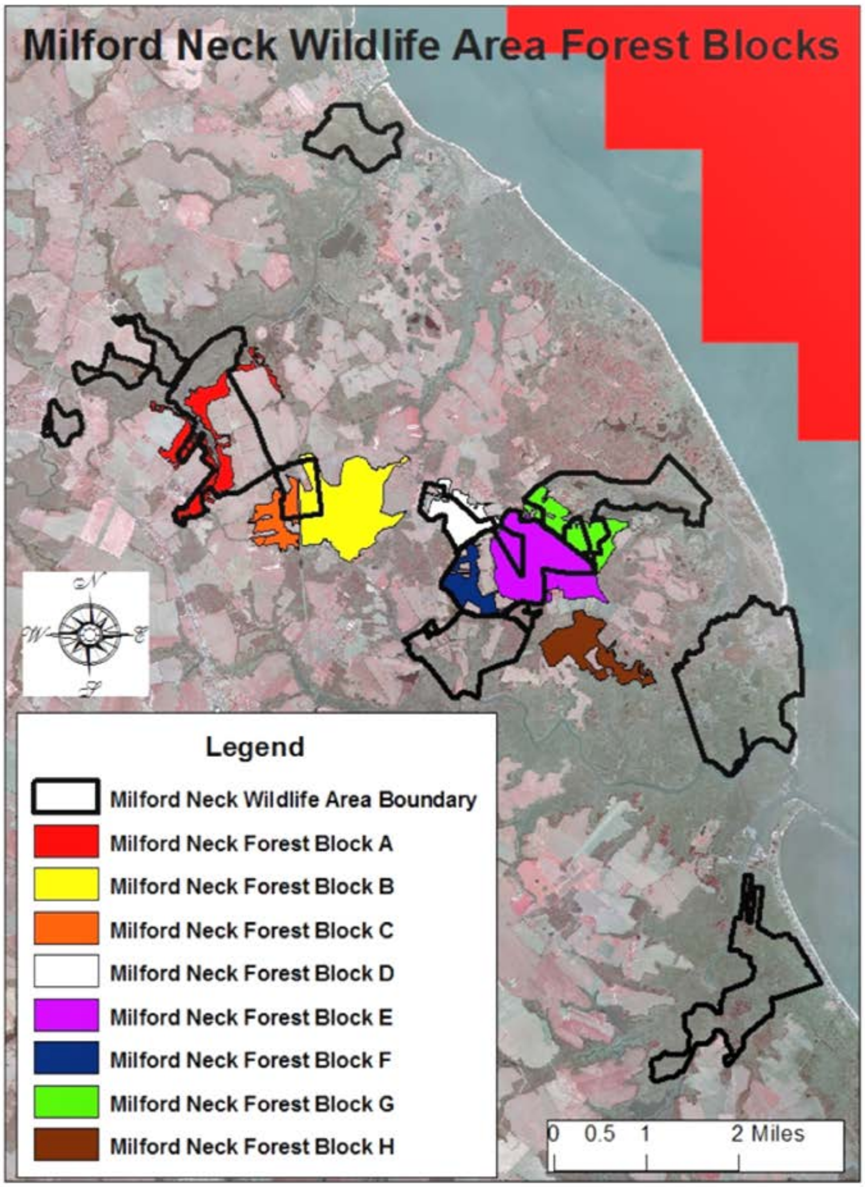
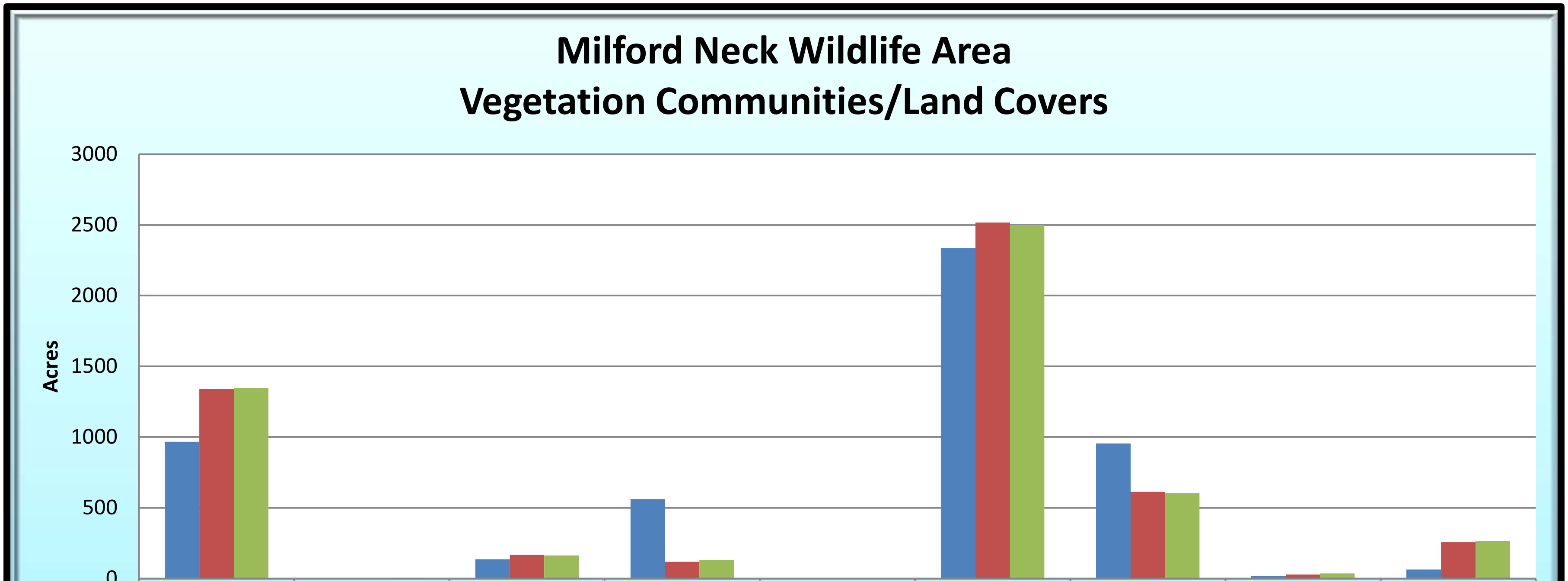


Figure 2.8. Milford Neck Wildlife Are Forest Blocks

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

Vegetation communities located adjacent to the shore of Delaware Bay or the Inland Bays go through a 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	Woodlands	Shrublands	Herbaceous	Coastal Plain Ponds	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1937	967	0	136.05	561.2	2	2336.17	954.36	18	64
2002	1340.7	3.1	166.4	117.7	1	2516.48	613.34	29.04	257
2007	1347.1	5	163.7	129.44	1	2498.68	602.4	36.7	264

Figure 3.1. Vegetation Community/Land Cover Categories at Milford Neck Wildlife Area (1937, 2002, and 2007)

Milford Neck Broad Trends (Figure 3.1): Forestland has increased throughout Milford Neck WA as Agricultural fields have succeeded to forest. Woodlands were not present in 1937 and have a very slight presence in 2007. Shrublands increased slightly to 2002 and then decreased from 2002 to 2007 reflecting a decrease in Eastern Tidal Salt Shrub. Herbaceous communities have decreased markedly from 1937 as Northeastern Old Fields have converted to shrubland and forest. Marsh increased modestly from 1937 to 2002 and then decreased slightly. This decrease could be from sea-level rise increasing. Time will tell if this trend continues but it is likely. Anthropogenic communities have decreased overall as Agricultural fields have gone fallow. Non-vegetated land, including tidal mudflats are increasing from the die-off of marsh through inundation, salt marsh die back, and other factors. Water has increased markedly from sea level rise.

DNREC Sea Level Rise Analysis (Table 3.1)

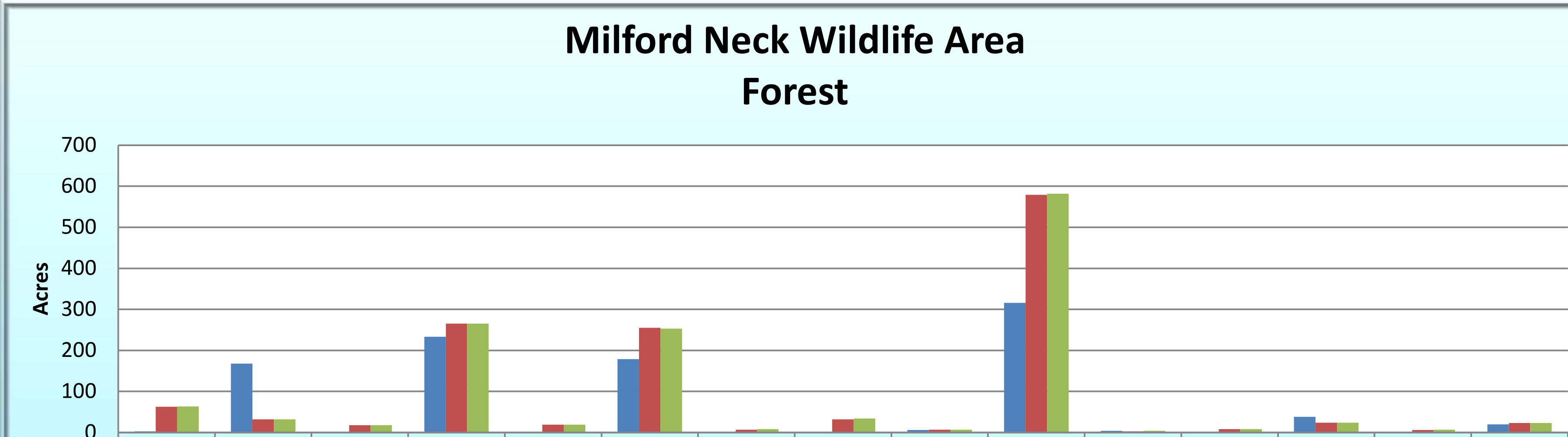
About 64% of Milford Neck Wildlife Area will be under water with 0.5 m of sea level rise. An additional 1m of rise increases it to 75% of the wildlife area.

Table 3.1. Projected acres of the Milford Neck Wildlife Area Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	3,232 acres
1 m	3,412 acres
1.5 m	3,764 acres

Natural Capital (Table 3.2)

Natural capital of Milford Neck Wildlife Area has gradually risen as forests mature and more estuary is formed within the wildlife area with sea level rise. This may be a short-term trend, however, since the quality of the estuary may decline with decreases in marsh acreage.

Table 3.2. Natural Capital of the Milford Neck Wildlife Area	
Year	**Natural Capital (in 2012 dollars)**
1937	$23,139,930/year
2002	$31,323,658/year
2007	$31,719,063/year



	Coastal Loblolly Pine Wetland Forest	Early to Mid-Successional Loblolly Pine Forest	Loblolly Pine-Tuliptree Upland Forest	Mesic Coastal Plain Oak Forest	Mid to Late Successional Loblolly Pine-Sweetgum Forest	Mid-Atlantic Mesic Mixed Hardwood Forest	Northeastern Dry Oak-Hickory Forest	Northeastern Modified Successional Forest	Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest	Red Maple-Sweetgum Swamp	Southern Red Maple-Blackgum Forest	Southern Red Oak/Heath Forest	Successional Maritime Forest	Successional Sweetgum Forest	Successional Tuliptree Forest
1937	3	168	0	233	0	179	0	0	6	316	4	0	38	0	20
2002	63	32	18	265	19	255	7	32	7	579	3	8	23.7	6	23
2007	63.4	32	18	265	19	253	8	34	7	582	4	8	23.7	7	23

Figure 3.2. Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

Milford Neck Wildlife Area Forest (Figure 3.2): Forests have increased overall from 1937 to 2007 in Milford Neck Wildlife Area. Chesapeake Bay Non-riverine Wet Hardwood Forest, Coastal Loblolly Pine Wetland Forest, and Mid-Atlantic Mesic Mixed Hardwood Forest have driven the bulk of the gains. Two forests, Northeastern Modified Successional Forest and Northeastern Dry Oak-Hickory Forest, have developed in the wildlife area since 1937. Two forests, Successional Maritime Forest and Early to Mid-Successional Loblolly Pine Forest have declined in the wildlife area.

DNREC Sea Level Rise Analysis (Table 3.3)

A little less than half of the current forestland in Milford Neck Wildlife Area will be flooded with 1.5 m of sea level rise.

Table 3.3. Projected acres of Milford Neck Wildlife Area Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	258 acres
1 m	372 acres
1.5 m	660 acres

Natural Capital (Table 3.4)

Forest land has been increasing in the wildlife area since 1937 leading to an almost doubling of the capital of forest.

Table 3.4. Natural Capital of Milford Neck Wildlife Area Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$6,924,086/year
2002	$11,303,585/year
2007	$11,473,208/year

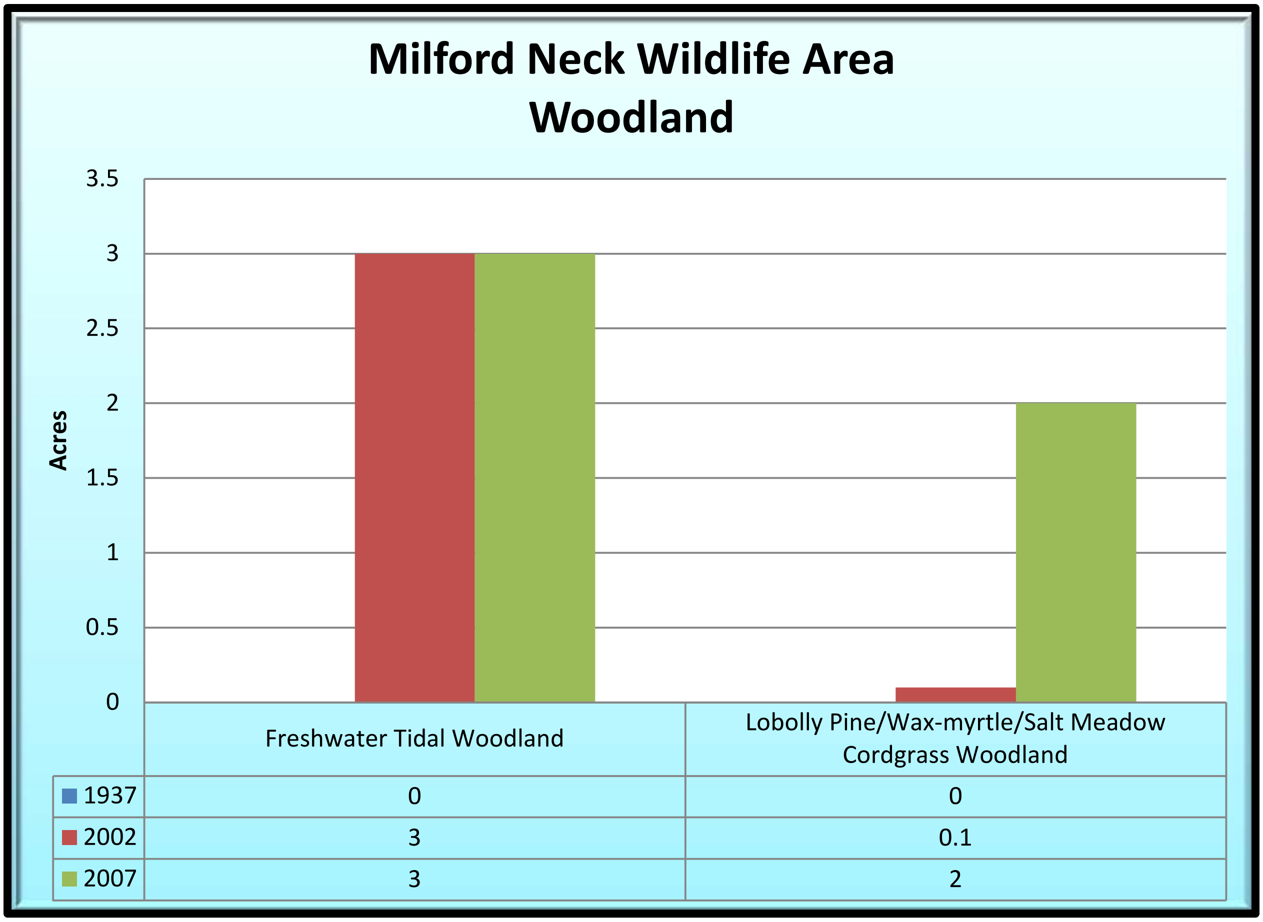


Figure 3.3. Woodland at Milford Neck Wildlife Area (1937, 2002, 2007)

Milford Neck Wildlife Area Woodland (Figure 3.3): No woodlands were present in 1937. By 2002 two types of woodlands appeared in the wildlife area, likely due to sea level rise flooding adjacent forested areas. The Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland is likely coming from excess salinity in a Coastal Loblolly Pine Wetland Forest. The Freshwater Tidal Woodland likely arises from flooding of Southern Red Maple-Blackgum Swamps. These Freshwater Tidal Woodlands seem to eventually succeed into Wax-Myrtle Shrub Swamps as the salinity increases.

DNREC Sea Level Rise Analysis (Table 3.5)

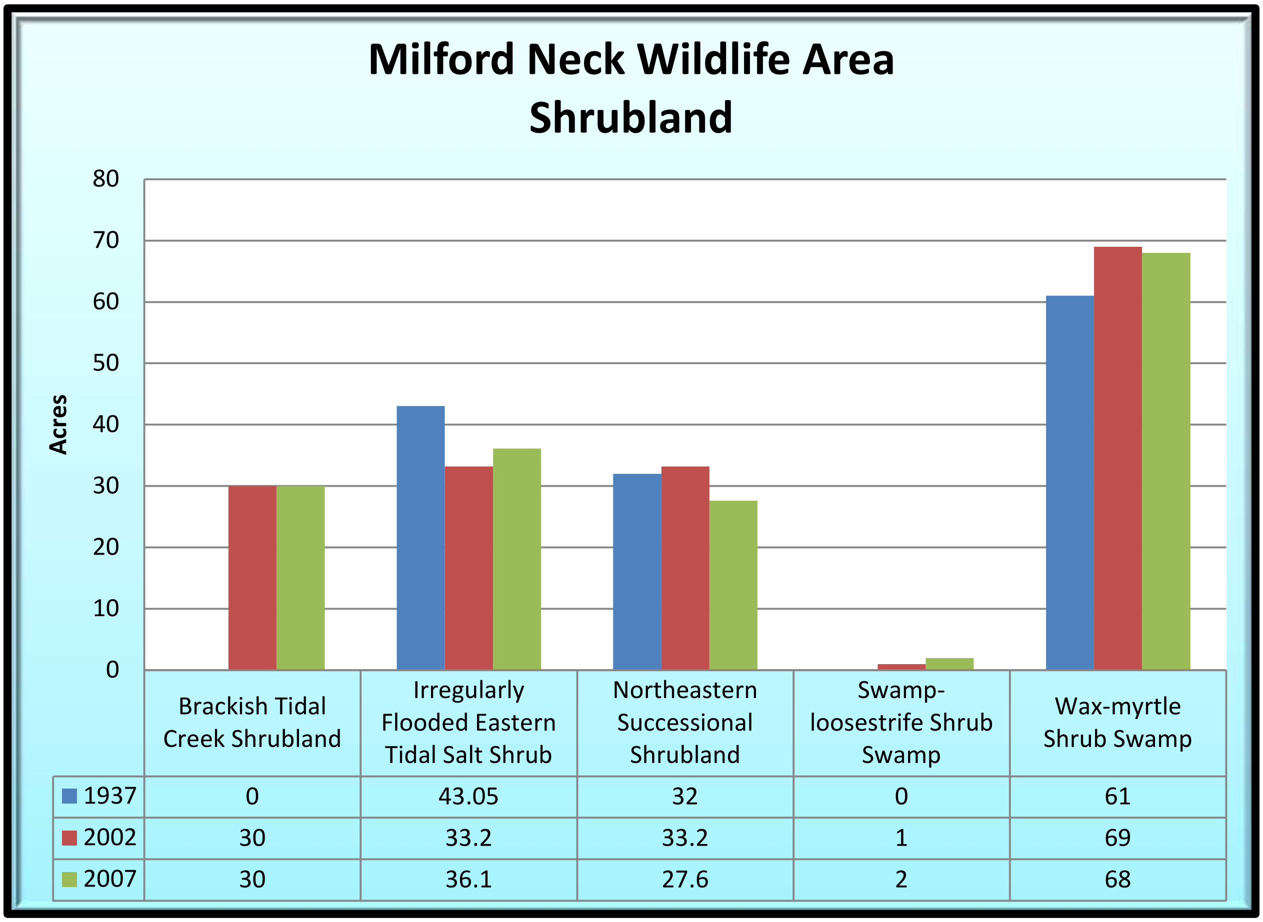
All of the woodland present in Milford Neck Wildlife Area will be inundated by water with 1 m of sea level rise. Most of the woodlands will be affected in some way with 0.5 m of sea level rise.

Table 3.5. Projected acres of Milford Neck Wildlife Area Woodland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	4 acres
1 m	5 acres
1.5 m	5 acres

Natural Capital (Table 3.6)

Woodlands were not present in 1937 in the wildlife area. Since this time two woodlands that appear come from the conversion of other communities, Coastal Plain Oak Floodplain Swamp to Freshwater Tidal Woodland and Coastal Loblolly Wetland Forest to Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland, have appeared in the wildlife area. One of these, Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland, has increased in acreage in the recent period (2002-2007) causing the capital to increase.

Table 3.6. Natural Capital of Milford Neck Wildlife Area Woodland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$25,812/year
2007	$49,166/year



	Brackish Tidal Creek Shrubland	Irregularly Flooded Eastern Tidal Salt Shrub	Northeastern Successional Shrubland	Swamp-loosestrife Shrub Swamp	Wax-myrtle Shrub Swamp
1937	0	43.05	32	0	61
2002	30	33.2	33.2	1	69
2007	30	36.1	27.6	2	68

Figure 3.4. Shrubland at Milford Neck Wildlife Area (1937, 2002, and 2007)

Milford Neck Wildlife Area Shrubland (Figure 3.4): The amount of shrubland has shown an overall increase from 1937 to 2007, but a slight decrease from 2002 to 2007. Brackish Tidal Creek Shrubland has increased the most as forests have converted to shrubland from sea level rise and rising water. Irregularly Flooded Eastern Tidal Salt Shrub has decreased overall but is showing a recent increase. Wax-Myrtle Shrub Swamp has increased slightly overall, but has decreased slightly recently.

DNREC Sea Level Rise Analysis (Table 3.7)

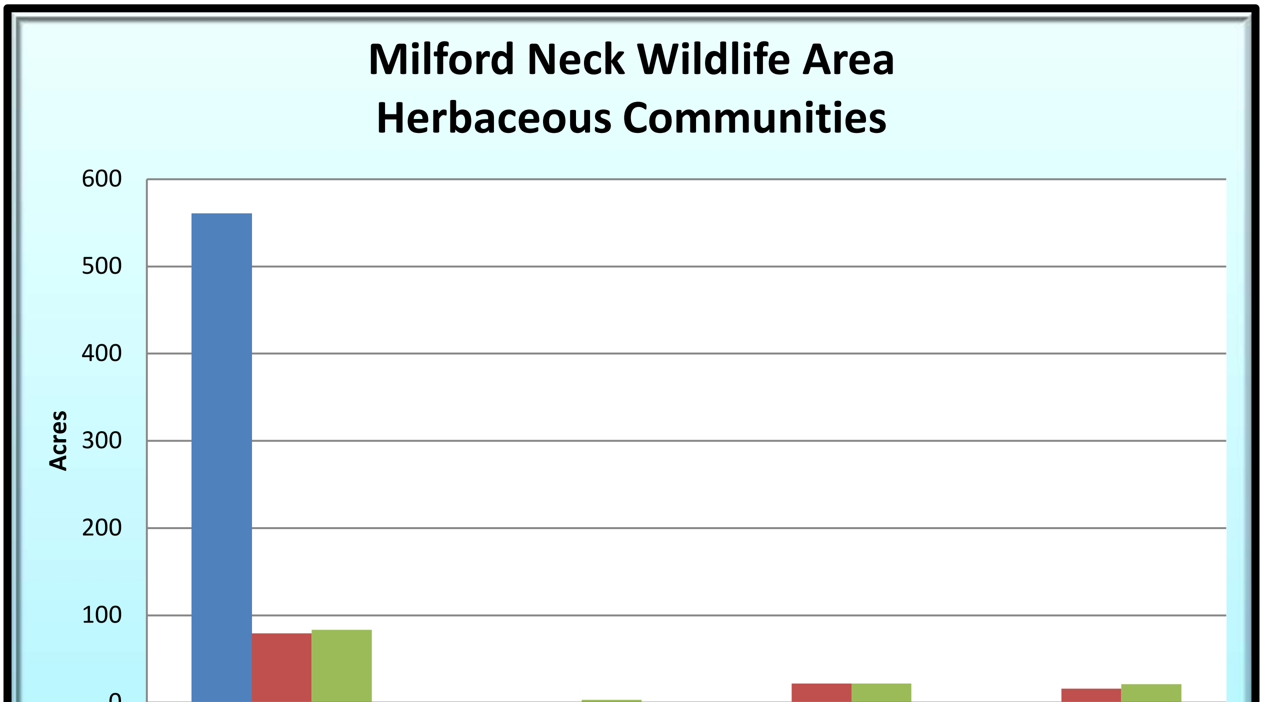
Almost all of the shrubland currently present in Milford Neck Wildlife Area will be inundated by water with 1.5 m of sea level rise.

Table 3.7. Projected acres of Milford Neck Wildlife Area Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	133 acres
1 m	141 acres
1.5 m	145 acres

Natural Capital (Table 3.8)

The capital of shrubland has increased due to the appearance of Swamp-loosestrife Shrub Swamp and the relative stability of Irregularly Flooded Eastern Tidal Salt Shrub. This is different from the losses seen in other wildlife areas of this community.

Table 3.8. Natural Capital of Milford Neck Wildlife Area Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$543,801/year
2002	$791,063/year
2007	$820,653/year



	Northeastern Old Field	Overwash Dune Grassland	Salt Panne	Upland Switchgrass Vegetation
1937	561.2	0	0	0
2002	79.4	0.3	22	16
2007	83.4	3	22.04	21

Figure 3.5. Herbaceous Communities at Milford Neck Wildlife Area (1937, 2002, and 2007)

Milford Neck Wildlife Area Herbaceous Communities (Figure 3.5): Northeastern Old Field was the only herbaceous community present in 1937 and has posted significant decreases from succession to forests. Since 1937, three new herbaceous communities have appeared. One, Upland Switchgrass Vegetation, is a result of restoration efforts in the wildlife area.

DNREC Sea Level Rise Analysis (Table 3.9)

About 40% of the herbaceous communities in Milford Neck Wildlife Area will be inundated by water with 1.5 m of sea level rise.

Table 3.9. Projected acres of Milford Neck Wildlife Area Herbaceous Communities Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	28 acres
1 m	40 acres
1.5 m	54 acres

Natural Capital (Table 3.10)

Northeastern Old Field and Upland Switchgrass Vegetation has been going up in the wildlife area increasing the capital of herbaceous communities.

Table 3.10. Natural Capital of Milford Neck Wildlife Area Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1937	$81,621/year
2002	$151,766/year
2007	$153,617/year

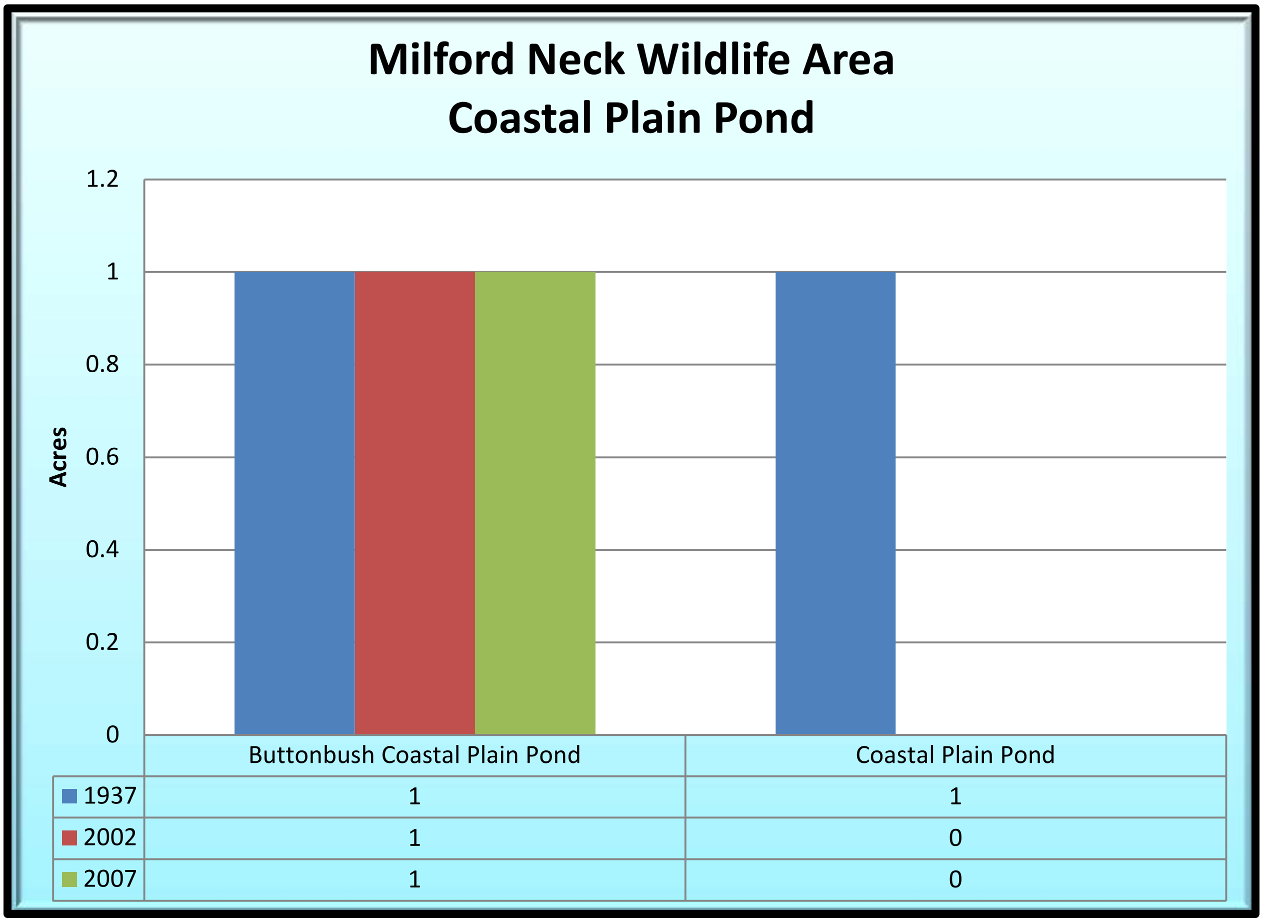


Figure 3.6. Coastal Plain Pond at Milford Neck Wildlife Area (1937, 2002, and 2007)

Milford Neck Wildlife Area Coastal Plain Pond (Figure 3.6): In 1937, two coastal plain pond types were present in the wildlife area. One, which was un-definable in 1937, has converted to Eastern Reed Marsh in later imagery. The other, a Buttonbush Coastal Plain Pond, has appeared stable over the years.

DNREC Sea Level Rise Analysis (Table 3.11)

The one remaining coastal plain pond present in Milford Neck Wildlife Area will not be affected by sea level rise until 1.5 m of rise is achieved.

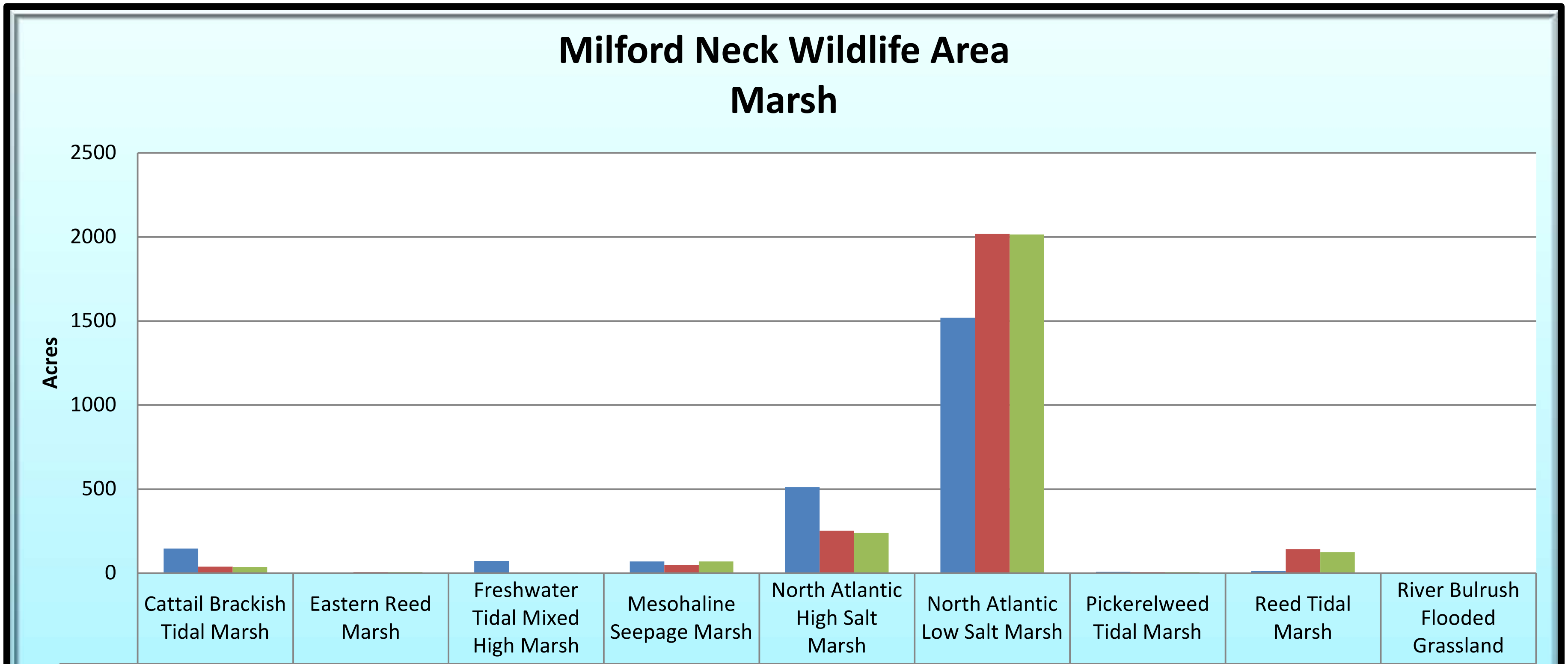
Table 3.11. Projected acres of Milford Neck Wildlife Area Coastal Plain Pond Inundated by Sea Level Rise

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

Natural Capital (Table 3.12)

Only one occurrence of a coastal plain pond still exists in the wildlife area. The loss of another pond reduced the capital of this category by half.

Table 3.12. Natural Capital of Milford Neck Wildlife Area Coastal Plain Pond	
Year	**Natural Capital (in 2012 dollars)**
1937	$18,563/year
2002	$9,281/year
2007	$9,281/year



	Cattail Brackish Tidal Marsh	Eastern Reed Marsh	Freshwater Tidal Mixed High Marsh	Mesohaline Seepage Marsh	North Atlantic High Salt Marsh	North Atlantic Low Salt Marsh	Pickerelweed Tidal Marsh	Reed Tidal Marsh	River Bulrush Flooded Grassland
1937	145.07	0	72.1	69	510	1519	8	12	1
2002	38	6.28	4	49	252.2	2018	6	143	0
2007	37	5.28	4	69	239.4	2014	5	125	0

Figure 3.7. Marsh at Milford Neck Wildlife Area (1937, 2002, and 2007)

Milford Neck Wildlife Area Marsh (Figure 3.7): Marshes have increased overall since 1937 as more shrublands and maritime forests have converted to marsh. North Atlantic Low Salt Marsh has gained the most with 499 acres added followed by Reed Tidal Marsh with 131 acres. Other marshes have declined such as North Atlantic High Salt Marsh and Freshwater Tidal Mixed High Marsh. The recent decline in North Atlantic Low Salt Marsh coupled with a decrease in the rate of water inundation could be a precursor to an eminent increase in the rate of marsh decline.

DNREC Sea Level Rise Analysis (Table 3.13)

Most of the marshland in Milford Neck Wildlife Area will be affected in some way by sea level rise with 0.5 m of rise. At 1 m of rise practically all of the marshland will be flooded by water.

Table 3.13. Projected acres of Milford Neck Wildlife Area Marsh Inundated by Sea Level Rise

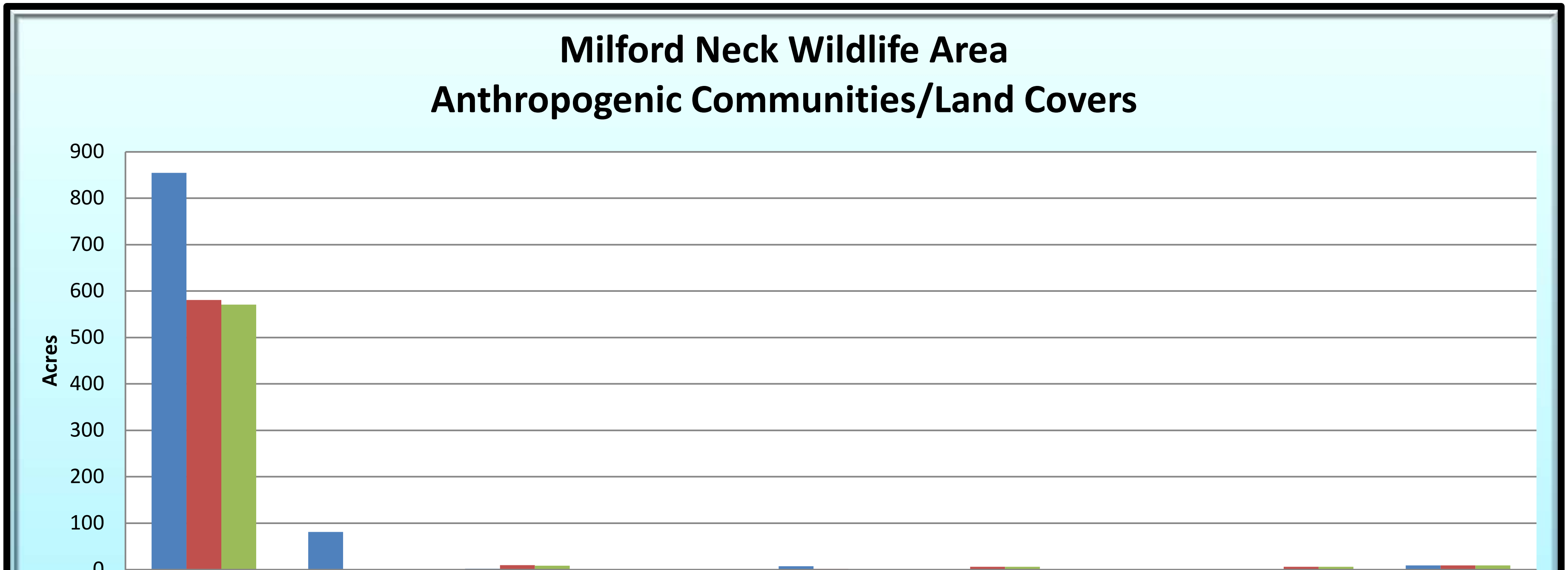
Rise	Acres
0.5 m	2,490 acres
1 m	2,497 acres
1.5 m	2,498 acres

Natural Capital (Table 3.14)

The capital of marshland has gradually increased due to gains in tidal marsh acreage.

Table 3.14. Natural Capital of Milford Neck Wildlife Area Marsh

Year	Natural Capital (in 2012 dollars)
1937	$14,298,564/year
2002	$15,198,158/year
2007	$15,246,322/year



	Agricultural Field	Clear-cut	Cultivated Lawn	Farm Pond/Artificial Pond	Impervious Surface	Impoundment	Modified Land	Powerline R-O-W	Semi-impervious Surface
1937	855	81	2.21	0	7.15	0	0	0	9
2002	581	0	9.9	0	1.34	6	0.1	6	9
2007	571	0	8.53	1	0.77	6	0.1	6	9

Figure 3.8. Anthropogenic Communities at Milford Neck Wildlife Area (1937, 2002, and 2007)

Anthropogenic Communities/Land Covers (Figure 3.8): This category which includes agricultural fields has been steadily decreasing over time as more land is converted to forest. Clear-cuts that were once prevalent in 1937 are now gone, but covers such as Farm Pond/Artificial Pond, Impoundments, and powerline R-O-Ws are now present. Impervious surface has actually decreased with the abandonment of a farm that was present on the Penuel Tract.

DNREC Sea Level Rise Analysis (Table 3.15)

About 16% of the current anthropogenic communities/land covers will be affected by sea level rise of 1.5 m.

Table 3.15. Projected acres of Milford Neck Wildlife Area Anthropogenic Communities/Land Covers Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	19 acres
1 m	55 acres
1.5 m	99 acres

Natural Capital (Table 3.16)

Agricultural fields and ponds/impoundments are the only anthropogenic communities/land covers with any natural capital value. They have increased due to the new impoundment and a farm pond.

Table 3.16. Natural Capital of Milford Neck Wildlife Area Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$49,034/year
2002	$70,666/year
2007	$75,370/year

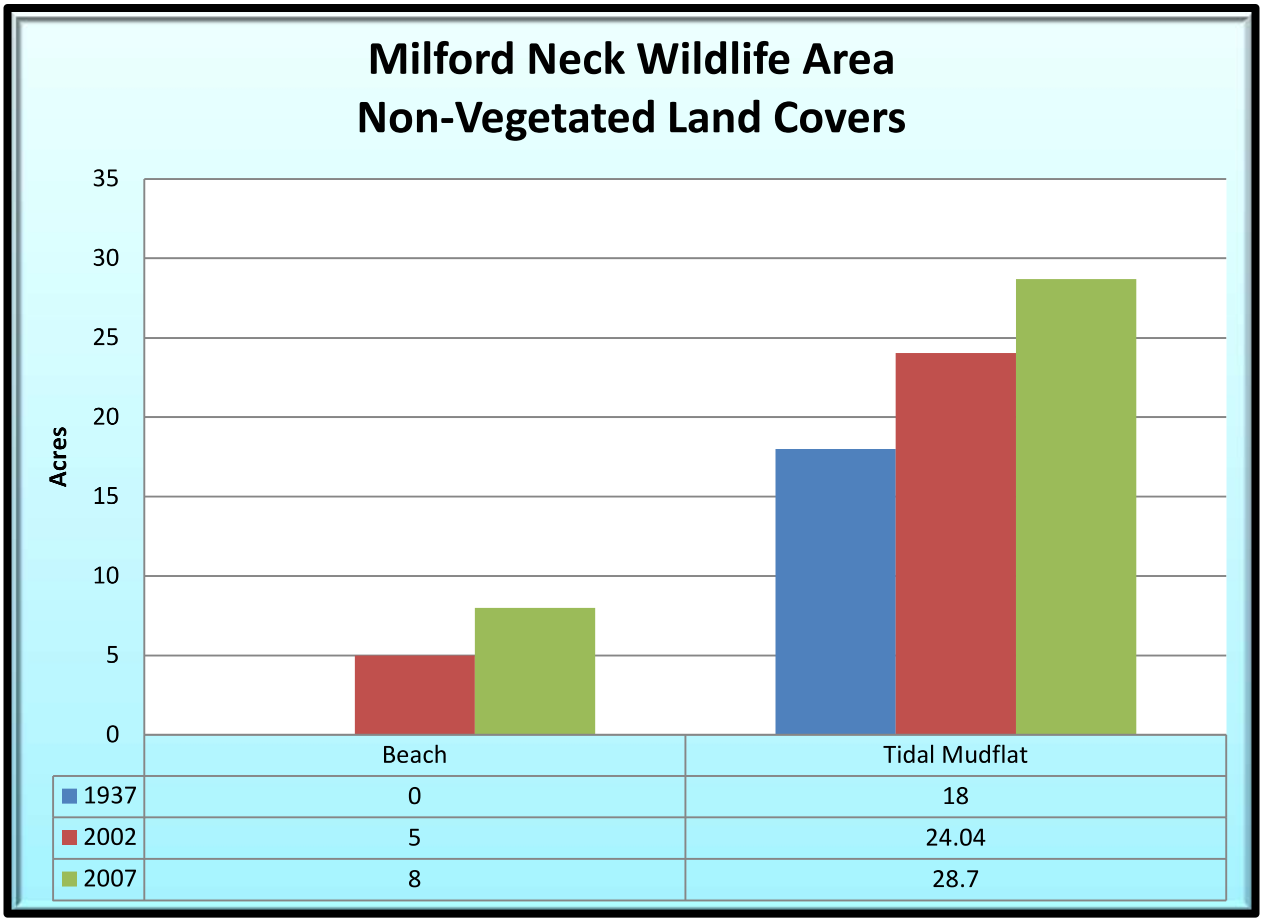


Figure 3.9. Non-vegetated Land Covers at Milford Neck Wildlife Area (1937, 2002, and 2007)

Milford Neck Wildlife Area Non-vegetated Land Covers (Figure 3.9): This category has gained in acres due to the increase in tidal mudflats which could be due to salt marsh dieback (prevalent at the time of the 2007 imagery), sea level rise, or a combination of both. Beach has been increasing and could be due to sediments being liberated from erosion.

DNREC Sea Level Rise Analysis (Table 3.17)

Practically all of the Non-vegetated Land Covers in Milford Neck Wildlife Area will be flooded by a sea level rise of 0.5 m.

Table 3.17. Projected acres of Milford Neck Wildlife Area Non-vegetated Land Covers Inundated by Sea Level Rise

Rise	Acres
0.5 m	36 acres
1 m	38 acres
1.5 m	38 acres

Natural Capital (Table 3.18)

Tidal mudflats have been increasing in the wildlife area causing an increase in the capital. It is not certain whether this is due to sea level rise or some other factor such as marsh dieback or erosion.

Table 3.18. Natural Capital of Milford Neck Wildlife Area Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$338,650/year
2002	$344,922/year
2007	$359,973/year

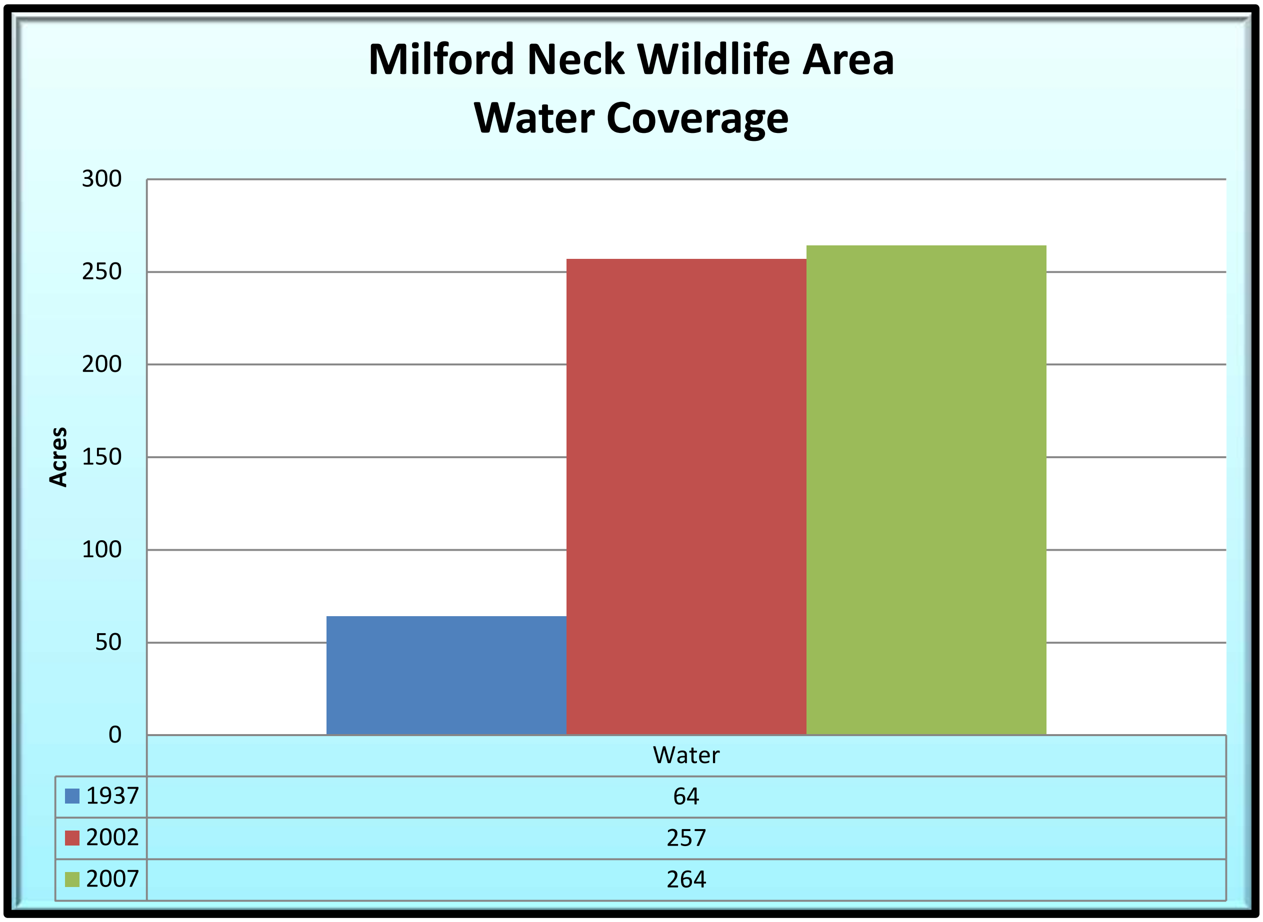


Figure 3.10. Water coverage (non-impoundment) at Milford Neck Wildlife Area (1937, 2002, and 2007)

Milford Neck Wildlife Area Water Coverage (Figure 3.10): This category includes tidal water which is subject to sea level rise. This category has risen greatly in the 1937 to 2007 period, but appears to be slowing in the 2002-2007 period. The historical average rates of rise (1937 to 2002) = 2.97 acres/year and (1937-2007) = 2.86 acres/year. The recent rate (2002 to 2007) shows a continued decrease with 1.4 acres/year lost to water but at about half the historical rate. The slowing to the inundation rate may be causing by higher topographic features and could indicate an eminent increase in the loss of marsh.

Natural Capital (Table 3.19)

Water has been increasing in Milford Neck Wildlife Area as sea level rises and hence increasing the capital.

Table 3.19. Natural Capital of Milford Neck Wildlife Area Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$885,611/year
2002	$3,428,404/year
2007	$3,531,474/year

CHAPTER 4: VEGETATION COMMUNITIES BY TRACT

1. Cedar Creek Unit

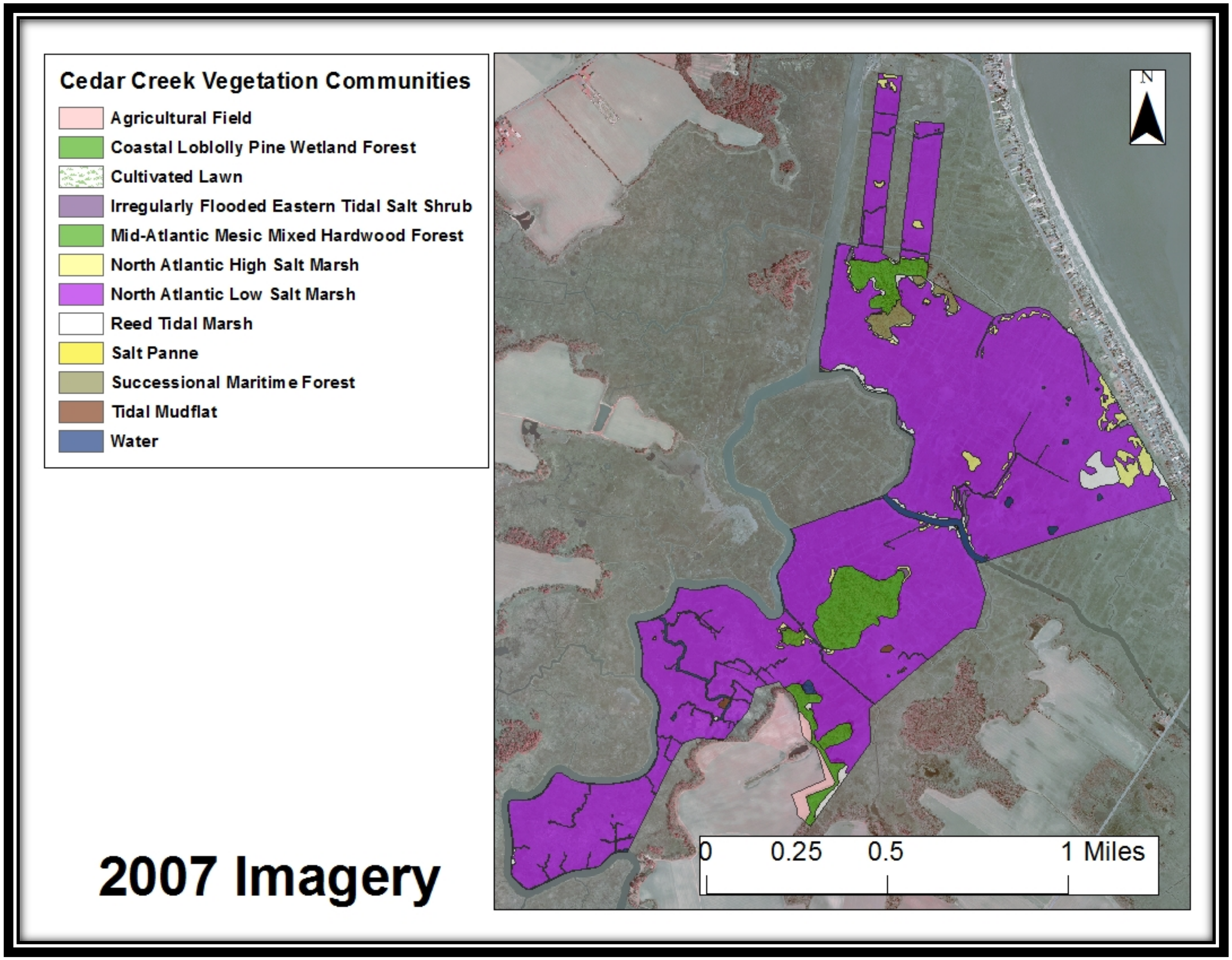


Figure 4-1.1. 2007 Vegetation Community Map of the Cedar Creek Unit

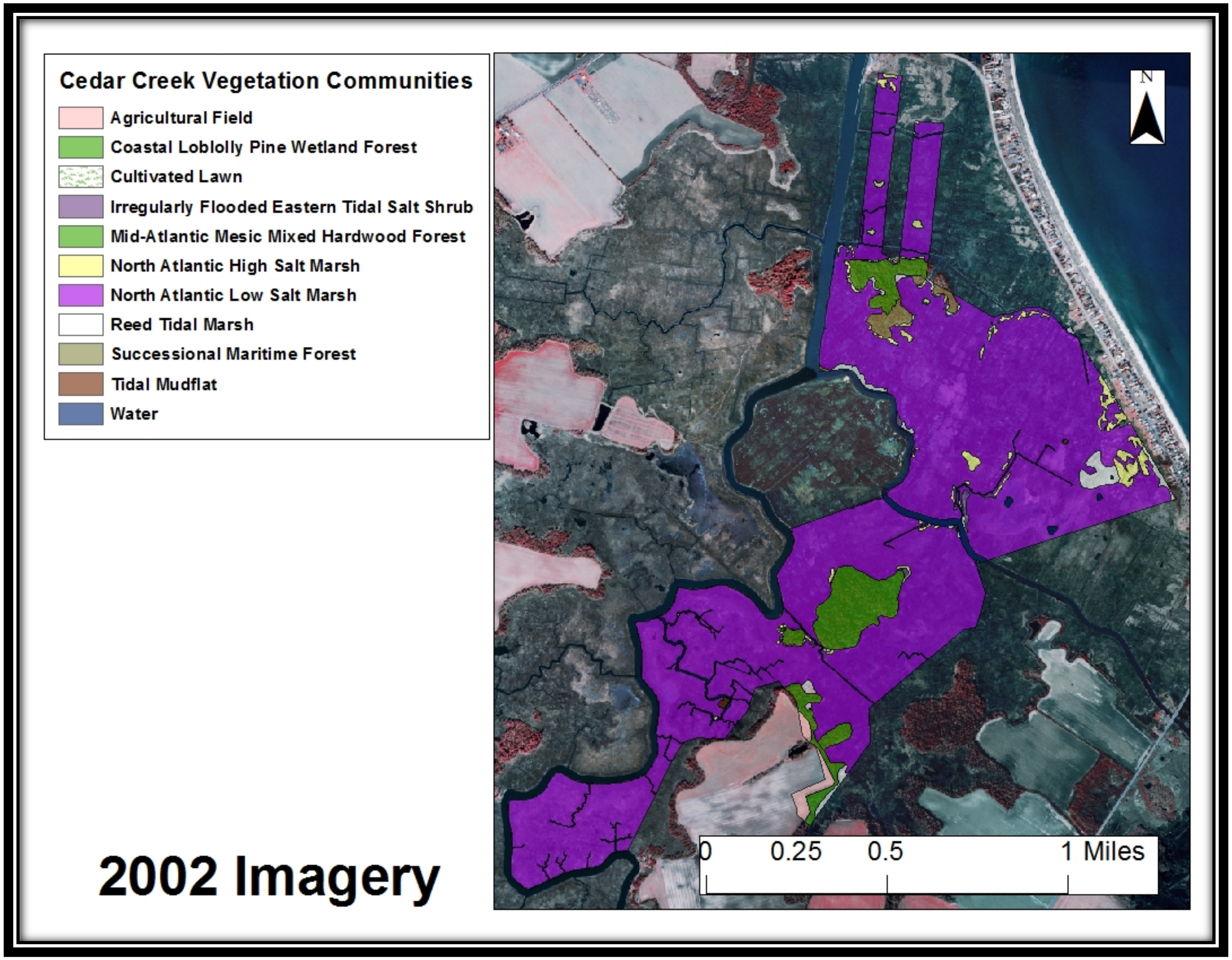


Figure 4-1.2. 2002 Vegetation Community of the Cedar Creek Unit

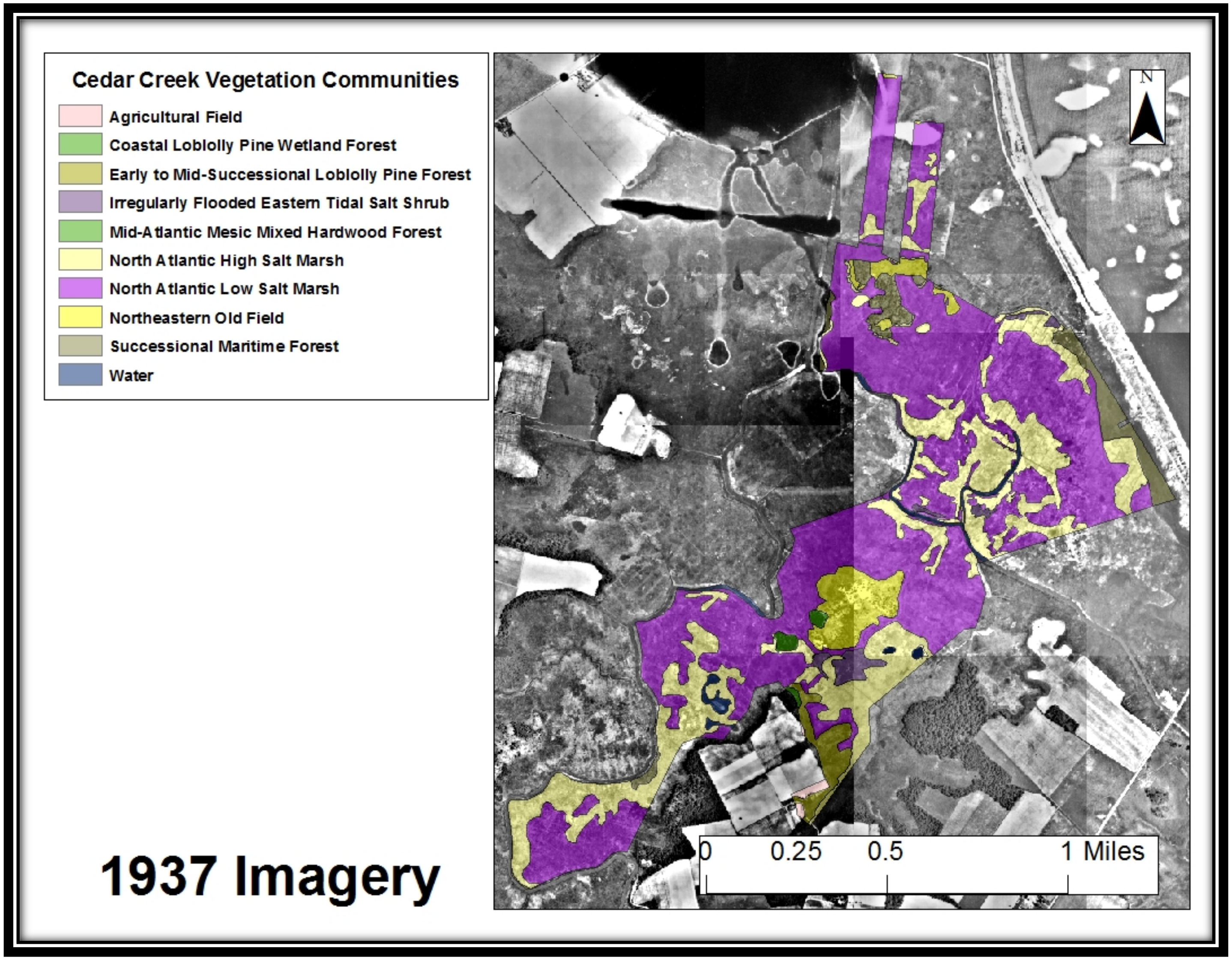
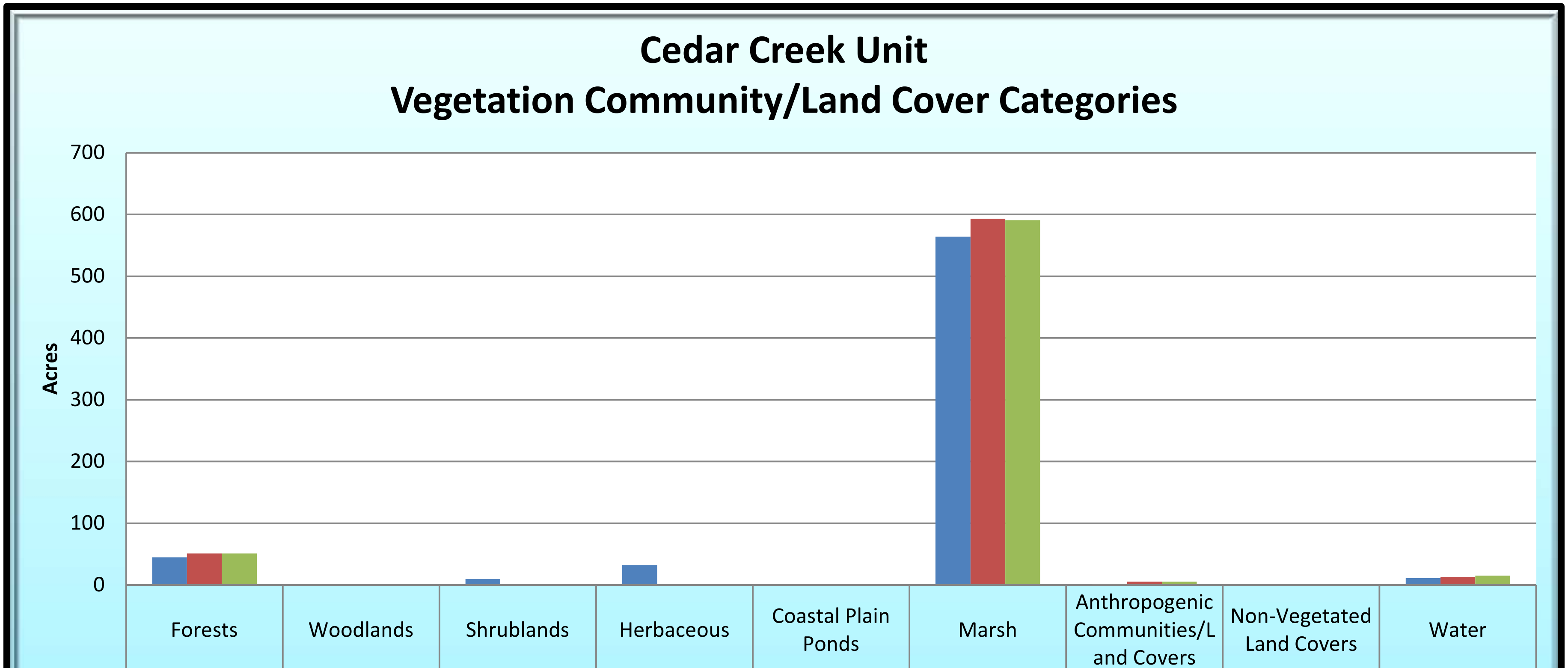


Figure 4-1.3. 1937 Vegetation Community Map of the Cedar Creek Unit



	Forests	Woodlands	Shrublands	Herbaceous	Coastal Plain Ponds	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1937	45	0	10	32	0	564	2	0	11
2002	51	0	1	0	0	593	5.3	1	13
2007	51	0	1	0.04	0	591	5.3	1	15

Figure 4-1.4. Cedar Creek Unit Vegetation Communities/Land Covers (1937, 2002, and 2007)

Cedar Creek Unit Broad Trends (Figure 4-1.4): Marshes are the predominant vegetation community in the Cedar Creek Unit, followed very distantly by forests and has been this way for the duration of the study period. The amount of marsh has gained slightly over time and forest coverage has increased as herbaceous communities converted to this type. Water coverage has gradually increased over time in the unit, most likely caused by sea level rise.

DNREC Sea Level Rise Analysis (Table 4-1.1)

The Cedar Creek Unit is mostly marsh that flows into Cedar Creek and is especially vulnerable to sea level rise. Most of the unit will be flooded with just 0.5 m of sea level rise and the entire unit will be inundated by water with 1.5 m of sea level rise.

Table 4-1.1. Projected acres of the Cedar Creek Unit Inundated by Sea Level Rise

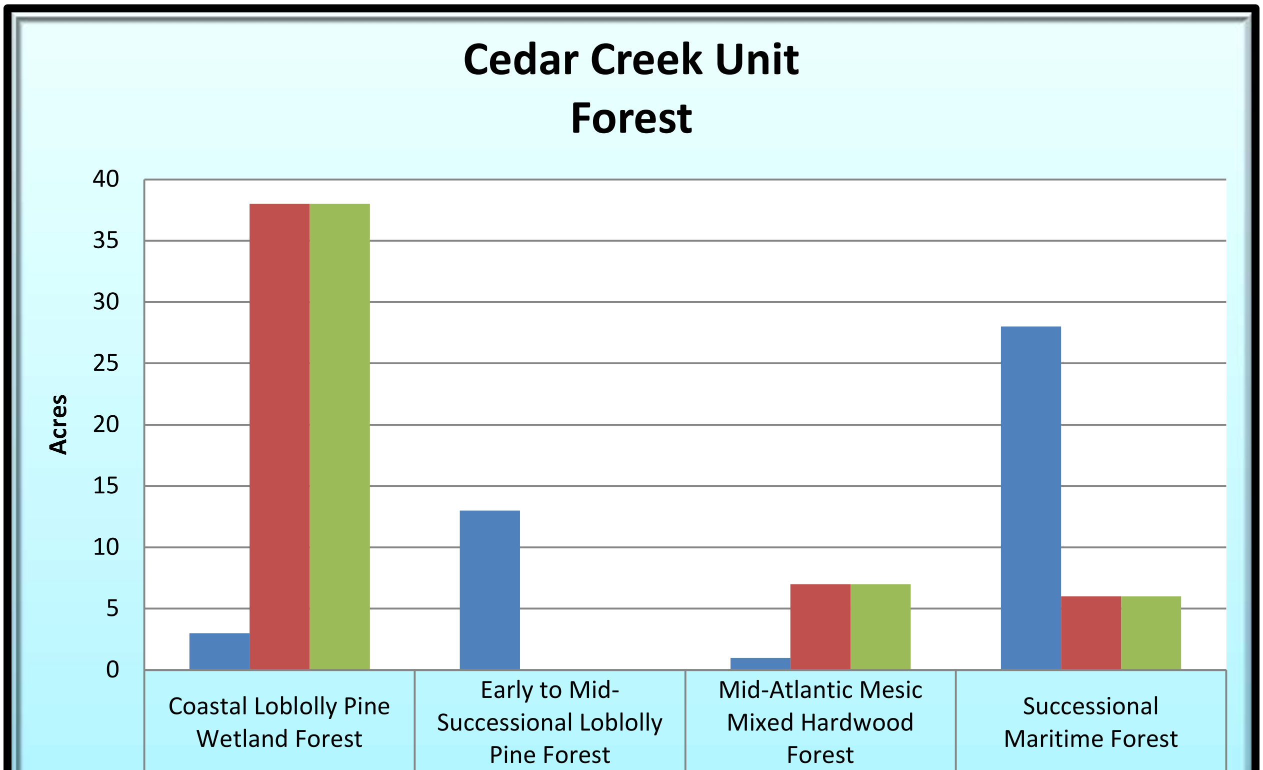
Rise	Acres
0.5 m	654 acres
1 m	662 acres
1.5 m	664 acres

Natural Capital (Table 4-1.2)

Natural capital has been gradually increasing in the Cedar Creek Unit with increases in marshland and water.

Table 4-1.2. Natural Capital of the Cedar Creek Unit

Year	Natural Capital (in 2012 dollars)
1937	$3,806,981/year
2002	$4,387,573/year
2007	$4,418,029/year



	Coastal Loblolly Pine Wetland Forest	Early to Mid-Successional Loblolly Pine Forest	Mid-Atlantic Mesic Mixed Hardwood Forest	Successional Maritime Forest
1937	3	13	1	28
2002	38	0	7	6
2007	38	0	7	6

Figure 4-1.5. Forest in the Cedar Creek Unit (1937, 2002, and 2007)

Cedar Creek Unit Forest (Figure 4-1.5): Since 1937, Coastal Loblolly Pine Wetland Forest has increased to become the dominant forest type in the Cedar Creek Unit and is remainly stable. Most of the gains were from the Early to Mid-Successional Loblolly Pine Forest which was present in 1937 and matured to Coastal Loblolly Pine Wetland Forest in part. Mid-Atlantic Mesic Mixed Hardwood Forest may have also originated from some of the Early to Mid-Successional Loblolly Pine and some areas that were Northeastern Old Field. Successional Maritime Forest was most common forest in 1937 but has declined markedly likely succeeding to Irregularly Flooded Eastern Tidal Salt Shrub or marsh with sea level rise, but has stabilized in recent years.

DNREC Sea Level Rise Analysis (Table 4-1.3)

Most of the forestland in the Cedar Creek Unit will be flooded with 0.5 m of sea level rise and will progressively flood until at 1.5 of rise they will entirely inundated.

Table 4-1.3. Projected acres of Cedar Creek Unit Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	43 acres
1 m	49 acres
1.5 m	51 acres

Natural Capital (Table 4-1.4)

Capital of the forest in the Cedar Creek Unit has matured from successional forests increasing the capital. The capital has been steady in the recent period (2002-2007) and will likely remain so until sea level rise starts to convert the forests.

Table 4-1.4. Natural Capital of Cedar Creek Unit Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$44,817/year
2002	$469,535/year
2007	$469,535/year

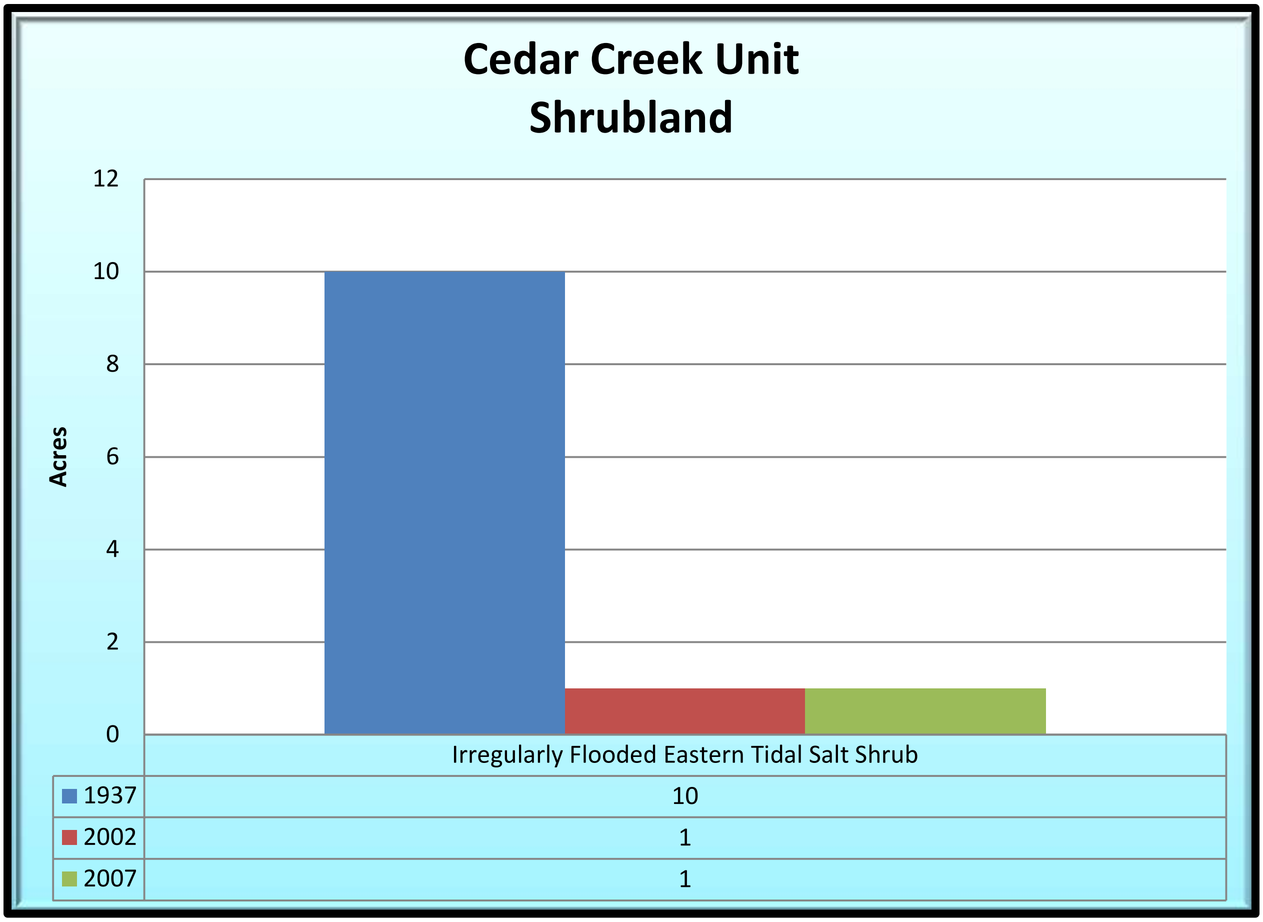


Figure 4-1.6. Shrubland in the Cedar Creek Unit (1937, 2002, and 2007)

Cedar Creek Unit Shrubland (Figure 4-1.6): Irregularly Flooded Eastern Tidal Salt Shrub is the only shrubland located within the Cedar Creek Unit. Through the years it has declined almost to the point of non-existence. With constant amounts of sea level rise at the historical level it would be expected to maintain its amounts as forests succeeded to it. Increases in the rate of sea level rise recently seem to be too fast for this community to develop and this serial stage be even skipped as forest succeed directly to marsh. This is supported by the standing dead trees that are present at the edges of the marsh.

Other factors possibly contributing to the loss of this community are topographic features. A lot of the marshes in Milford Neck Wildlife Area are rimmed by higher topography. This higher topography may constrain the maritime shrublands and the marshes. This same factor may be also showing in the slowing of the rate of water inundation.

DNREC Sea Level Rise Analysis (Table 4-1.5)

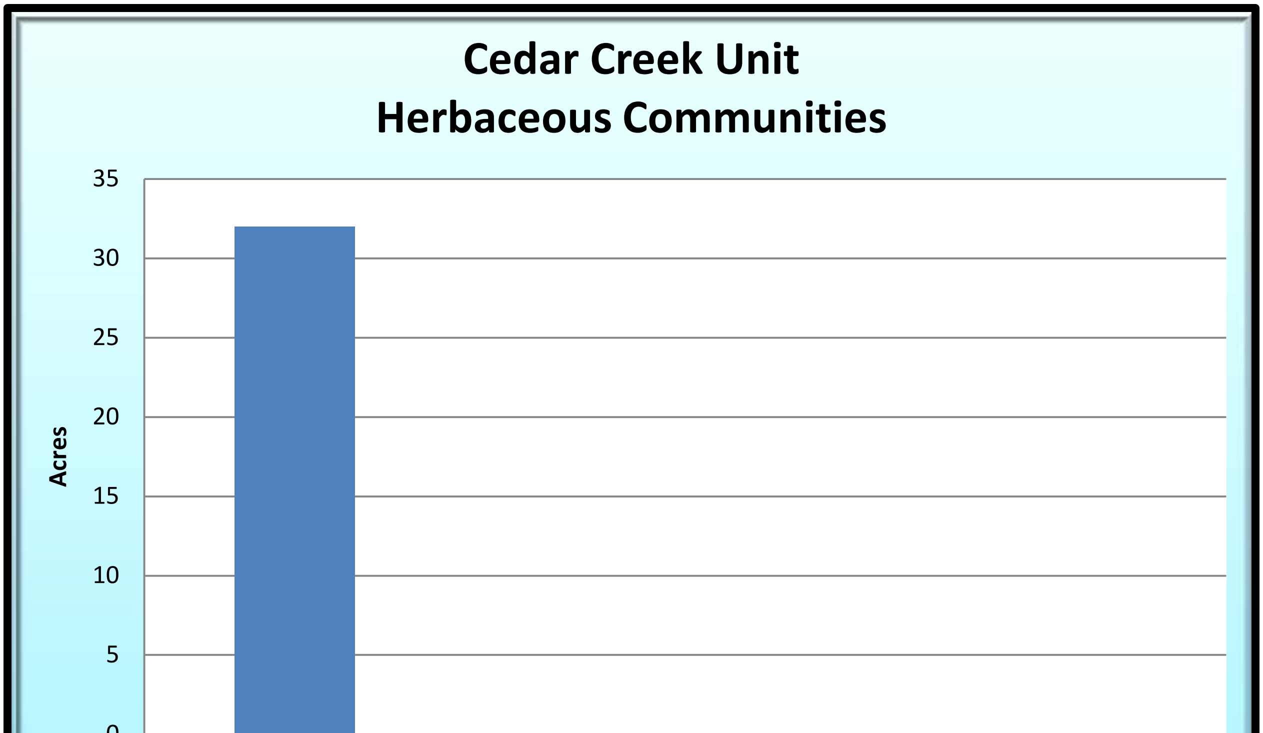
All of the shrubland present in the Cedar Creek Unit will be inundated by water with 0.5 m of sea level rise.

Table 4-1.5. Projected acres of Cedar Creek Unit Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 4-1.6)

Capital of shrubland has declined because of the loss of Irregularly Flooded Eastern Tidal Salt Shrub. While the amount has been steady in the recent period (2002-2007) it is uncertain if this will remain so with degradation of the marsh.

Table 4-1.6. Natural Capital of Cedar Creek Unit Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$62,713/year
2002	$6,271/year
2007	$6,271/year



	Northeastern Old Field	Salt Panne
1937	32	0
2002	0	0
2007	0	0.04

Figure 4-1.7. Herbaceous Communities in Cedar Creek Unit (1937, 2002, and 2007)

Cedar Creek Unit Herbaceous Communities (Figure 4-1.7): In 1937, a lot of the upland areas of the Cedar Creek Unit were open as Northeastern Old Field as pastureland or the abandonment of agricultural fields. These former fields have grown into the Coastal Loblolly Pine Wetland Forest and Mid-Atlantic Mesic Mixed Hardwood Forests of today eliminating this type from the tract. Salt Panne is an ephermal community in North Atlantic Low Salt Marsh and has only come about in 2007. These "pannes" develop in marsh depressions where water salt water has evaporated out creating an environment that is saltier than the one around it.

DNREC Sea Level Rise Analysis (Table 4-1.7)

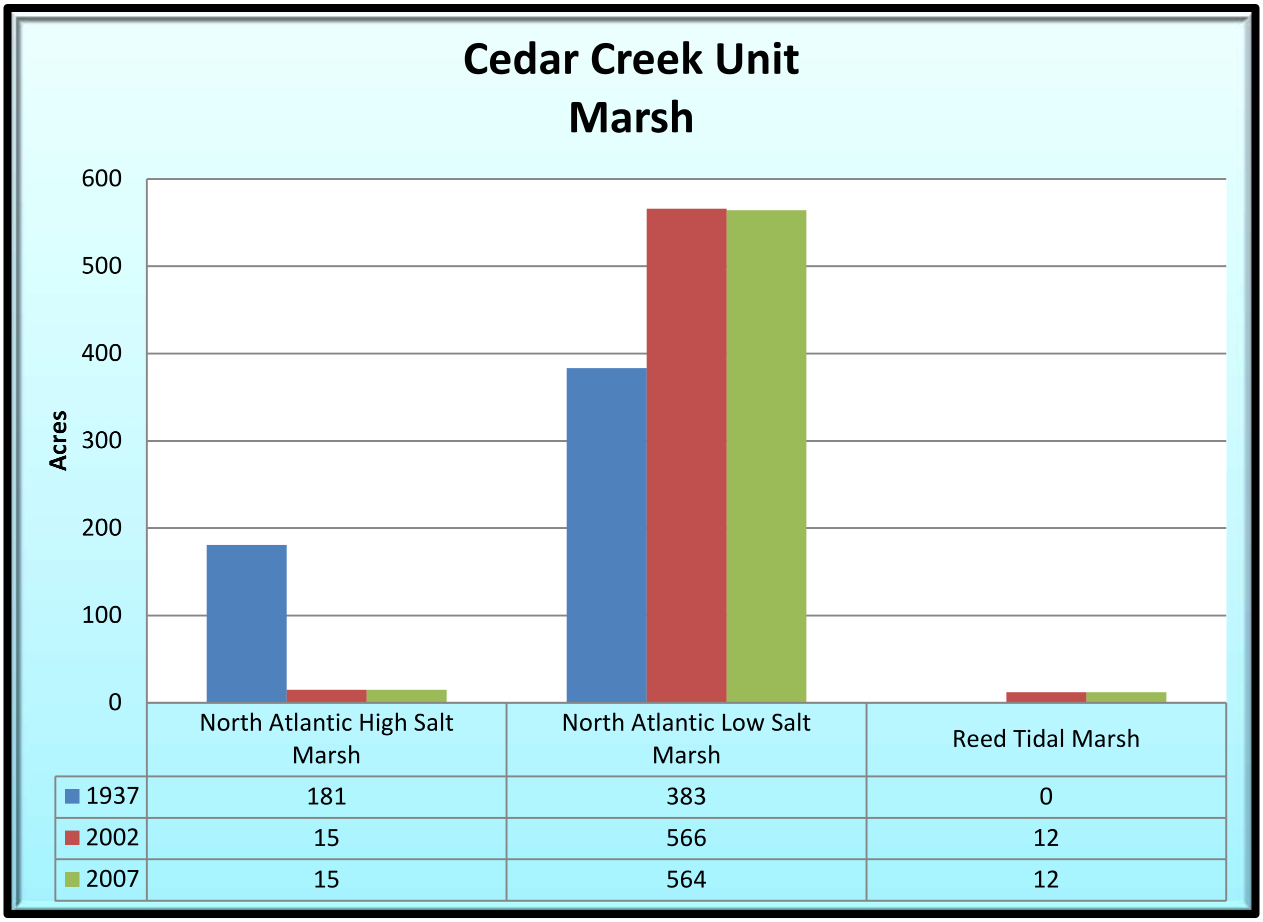
All of the herbaceous communities in the Cedar Creek Unit will be flooded with 0.5 m of sea level rise.

Table 4-1.7. Projected acres of Cedar Creek Unit Herbaceous Communities Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0.4 acres
1 m	0.4 acres
1.5 m	0.4 acres

Natural Capital (Table 4-1.8)

All of the Northeastern Old Field that was present in 1937 has matured to other communities. Salt Panne has only recently come into this unit and has added to the herbaceous community capital, barely.

Table 4-1.8. Natural Capital of Cedar Creek Unit Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1937	$4,662/year
2002	$0/year
2007	$251/year



	North Atlantic High Salt Marsh	North Atlantic Low Salt Marsh	Reed Tidal Marsh
1937	181	383	0
2002	15	566	12
2007	15	564	12

Figure 4-1.8. Marsh in the Cedar Creek Unit (1937, 2002, and 2007)

Cedar Creek Unit Marsh (Figure 4-1.8): North Atlantic Low Salt Marsh has been the most prominent marsh type in the Cedar Creek Unit since 1937. It has gained a lot of acreage likely at the expense of the North Atlantic High Salt Marsh which has lost almost all of its acreage since 1937. It appears that the amount of North Atlantic High Salt Marsh has stablized recently, but it is unknown it this is a long-term trend or a bump on the way down. Reed Tidal Marsh composed of common reed (*Phragmites australis*) is a recent arrival to the marshes. It has likely also taken some of the acreage formerly covered by the high marsh and some of the Irregularly Flooded Eastern Tidal Salt Shrub. Efforts at controlling this species appear to have stopped the spread in the short-term.

DNREC Sea Level Rise Analysis (Table 4-1.9)

All of the marshland in the Cedar Creek Unit will be flooded with 0.5 m of sea level rise.

Table 4-1.9. Projected acres of Cedar Creek Unit Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	590 acres
1 m	590 acres
1.5 m	590 acres

Natural Capital (Table 4-1.10)

Capital of marsh in the Cedar Creek Unit has increased with an increase in marsh acreage. This could be the precursor to sea level rise with more marsh developing and then will crash when inundated.

Table 4-1.10. Natural Capital of Cedar Creek Unit Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$3,537,013/year
2002	$3,718,881/year
2007	$3,706,338/year

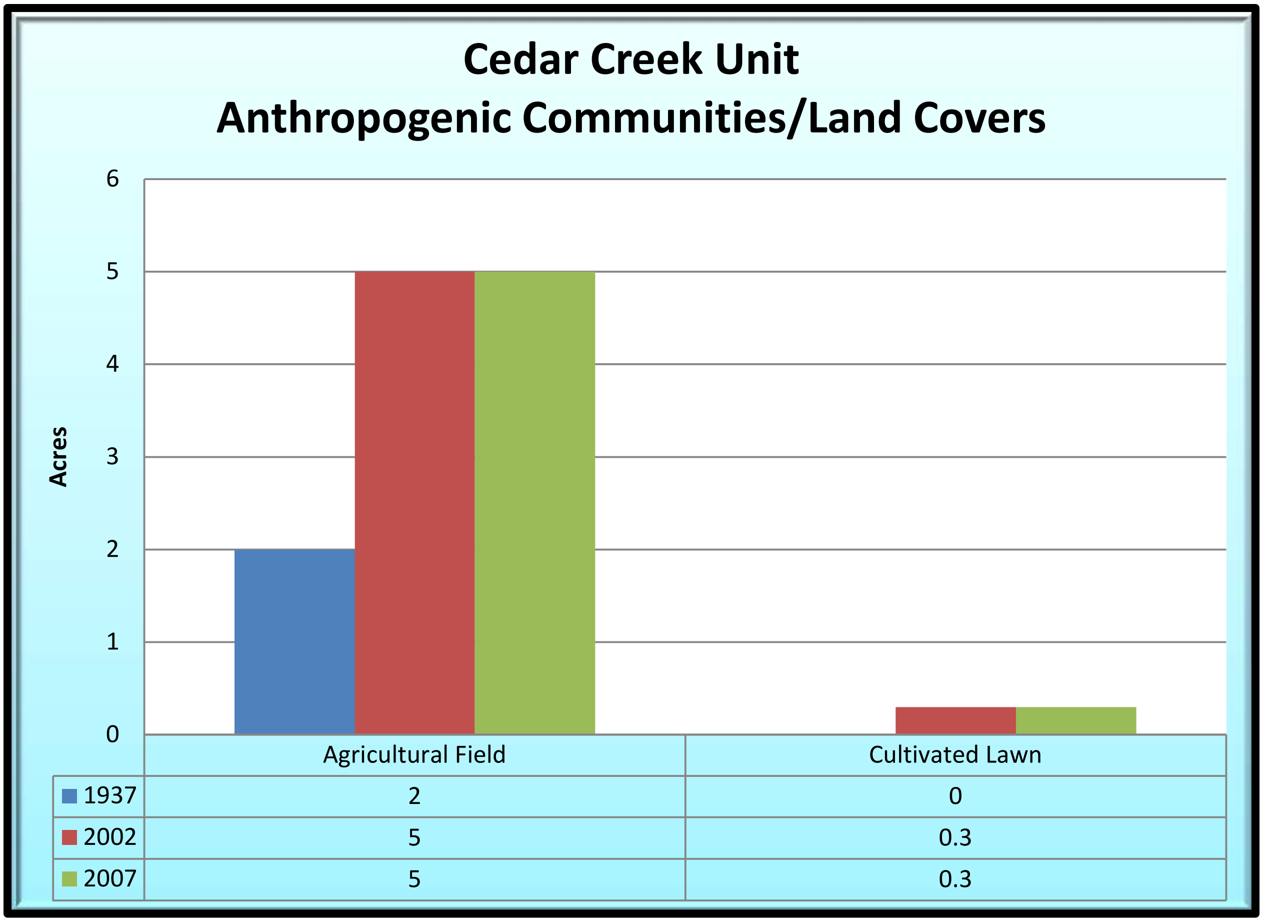


Figure 4-1.10. Anthropogenic Communities/Land Covers in the Cedar Creek Unit (1937, 2002, and 2007)

Cedar Creek Unit Anthropogenic Communities (Figure 4-1.10): Anthropogenic communities have covered very little of the Cedar Creek Unit since 1937 and still cover a small amount. The low elevation of the land and the tendency to flood during storms likely keeps this tract restricted from human uses.

DNREC Sea Level Rise Analysis (Table 4-1.11)

All of the anthropogenic communities/land covers will be flooded by water with 1 m of sea level rise.

Table 4-1.11. Projected acres of Cedar Creek Unit Anthropogenic Communities/Land Covers Inundated by Sea Level Rise

Rise	Acres
0.5 m	3 acres
1 m	5 acres
1.5 m	5 acres

Natural Capital (Table 4-1.12)

Agricultural field is the only anthropogenic community/land cover with any natural capital value in the Cedar Creek Unit. It has increased with an increase in acreage in the recent period (2002-2007).

Table 4-1.12. Natural Capital of Cedar Creek Unit Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$115/year
2002	$287/year
2007	$287/year

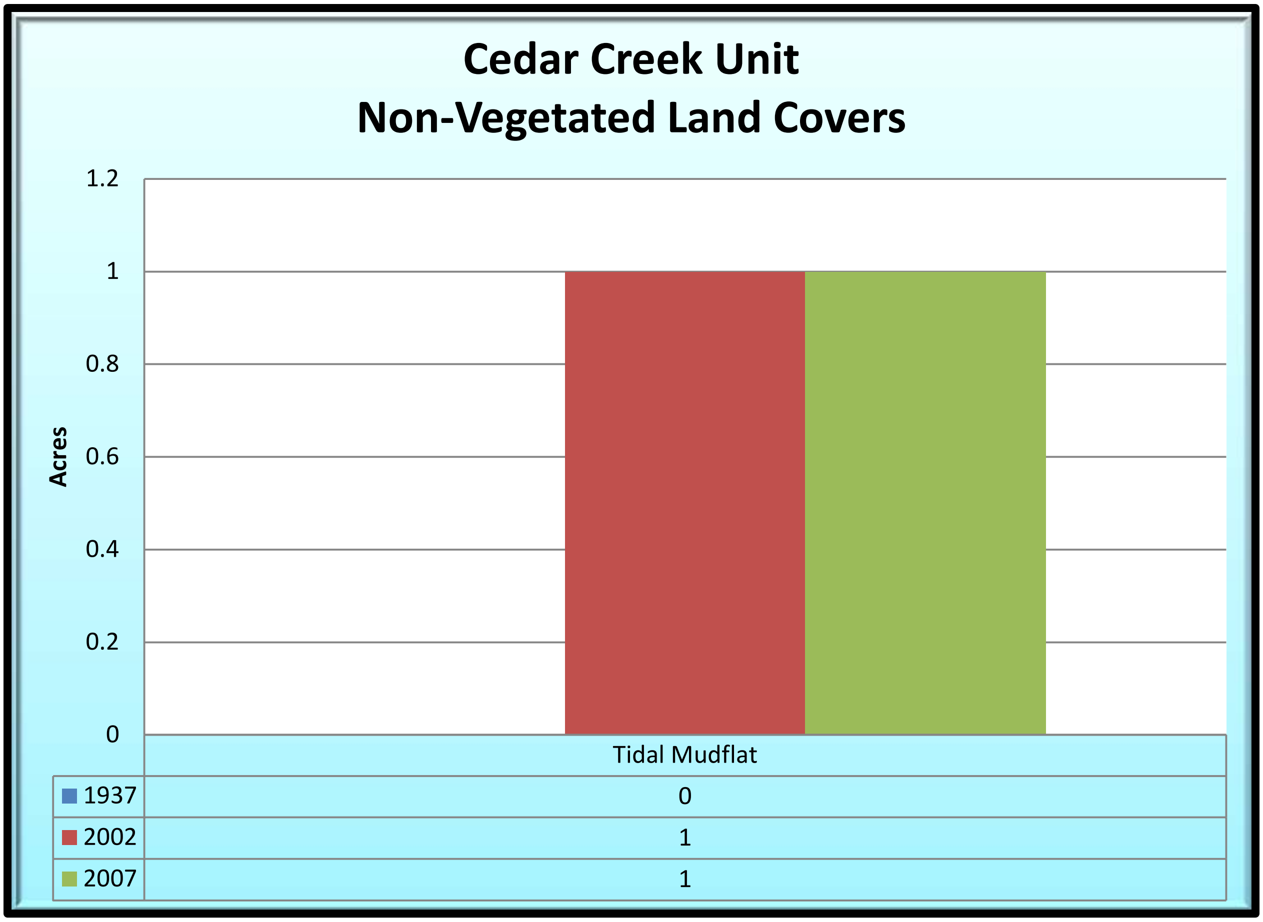


Figure 4-1.11. Non-vegetated Land Covers in the Cedar Creek Unit (1937, 2002, and 2007)

Cedar Creek Unit Non-vegetated Communities (Figure 4-1.11): Tidal mudflats are created in places where salt marsh vegetation has been cleared either to due to dieback, currents which have swept it away, or are former Salt Pannes that have breached. These areas where not present in 1937 and are minimally here today. They have been increasing in a relative sense (still do not cover much acreage) and can be indirectly a sign of sea level rise since they are often an intermediate step in a marsh converting to open water.

DNREC Sea Level Rise Analysis (Table 4-1.13)

All of the non-vegetated land covers in the Cedar Creek Unit will be inundated by water with 0.5 m of sea level rise.

Table 4-1.13. Projected acres of Cedar Creek Unit Non-vegetated Land Covers Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 4-1.14)

Tidal mudflat was not present in 1937, or at least not discernible. Since this time about an acre of mudflat has developed giving capital to this category.

Table 4-1.14. Natural Capital of Cedar Creek Unit Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$6,271/year
2007	$6,271/year

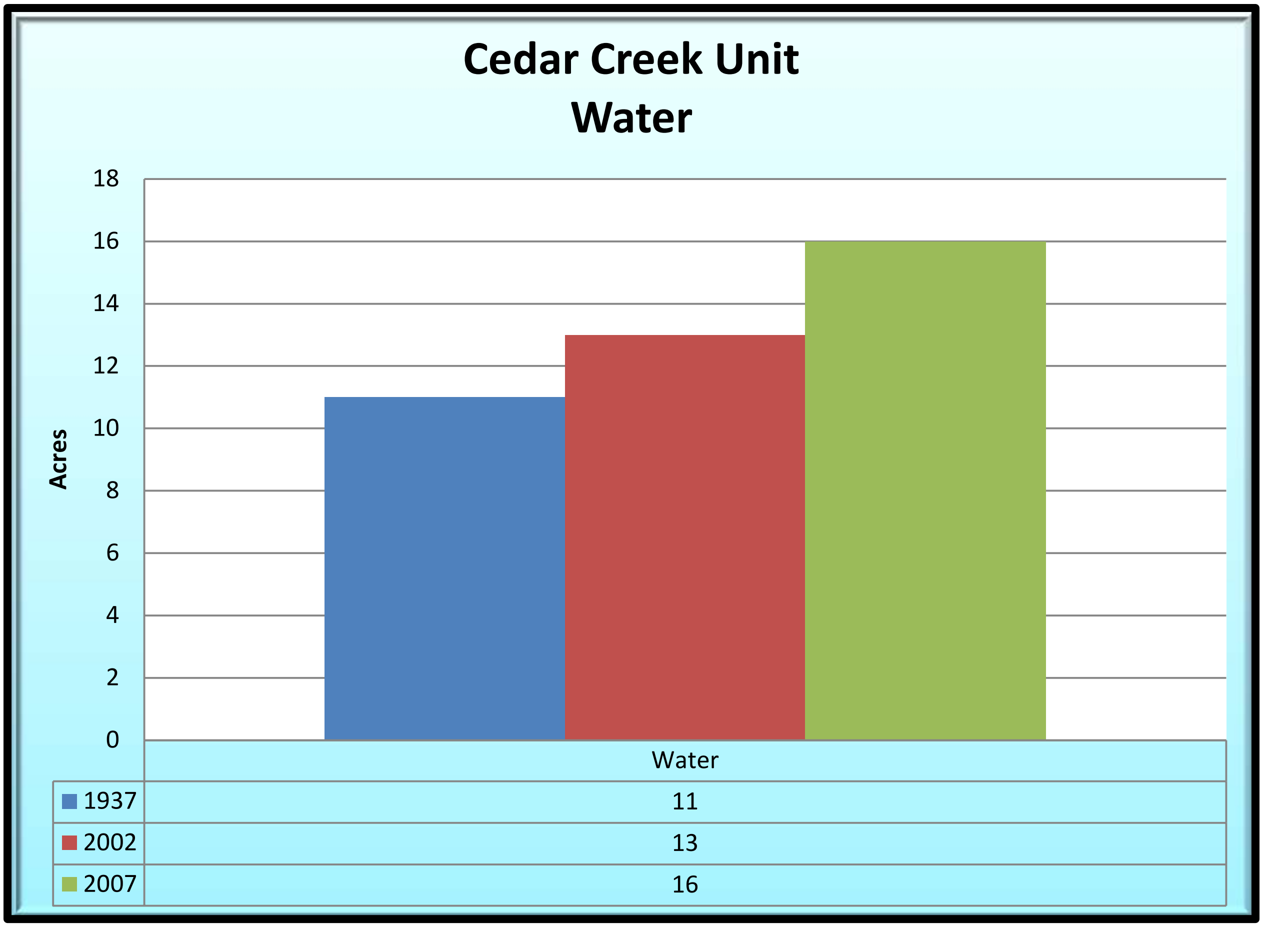


Figure 4-1.12. Water in the Cedar Creek Unit (1937, 2002, and 2007)

Cedar Creek Unit Water Coverage (Figure 4-1.12): Water coverage has made a steady increase in this unit since 1937. The water coverage is due in part to sea level rise, but other factors such as ditches holding back water is also a factor (Kevin Kalasz, personal communication). In the Cedar Creek Unit the historical rate of water inundation (1937-2002) = 0.03 acres/year and (1937-2007) = 0.06 acres/year. The recent rate (2002-2007) is 0.4 acres/year showing a rate increase for this tract.

Natural Capital (Table 4-1.15)

Water has increased in the Cedar Creek Unit leading to an increase in the capital as well.

Table 4-1.15. Natural Capital of Cedar Creek Unit Water

Year	**Natural Capital (in 2012 dollars)**
1937	$157,661/year
2002	$186,327/year
2007	$229,326/year

2. Coverdale Tract

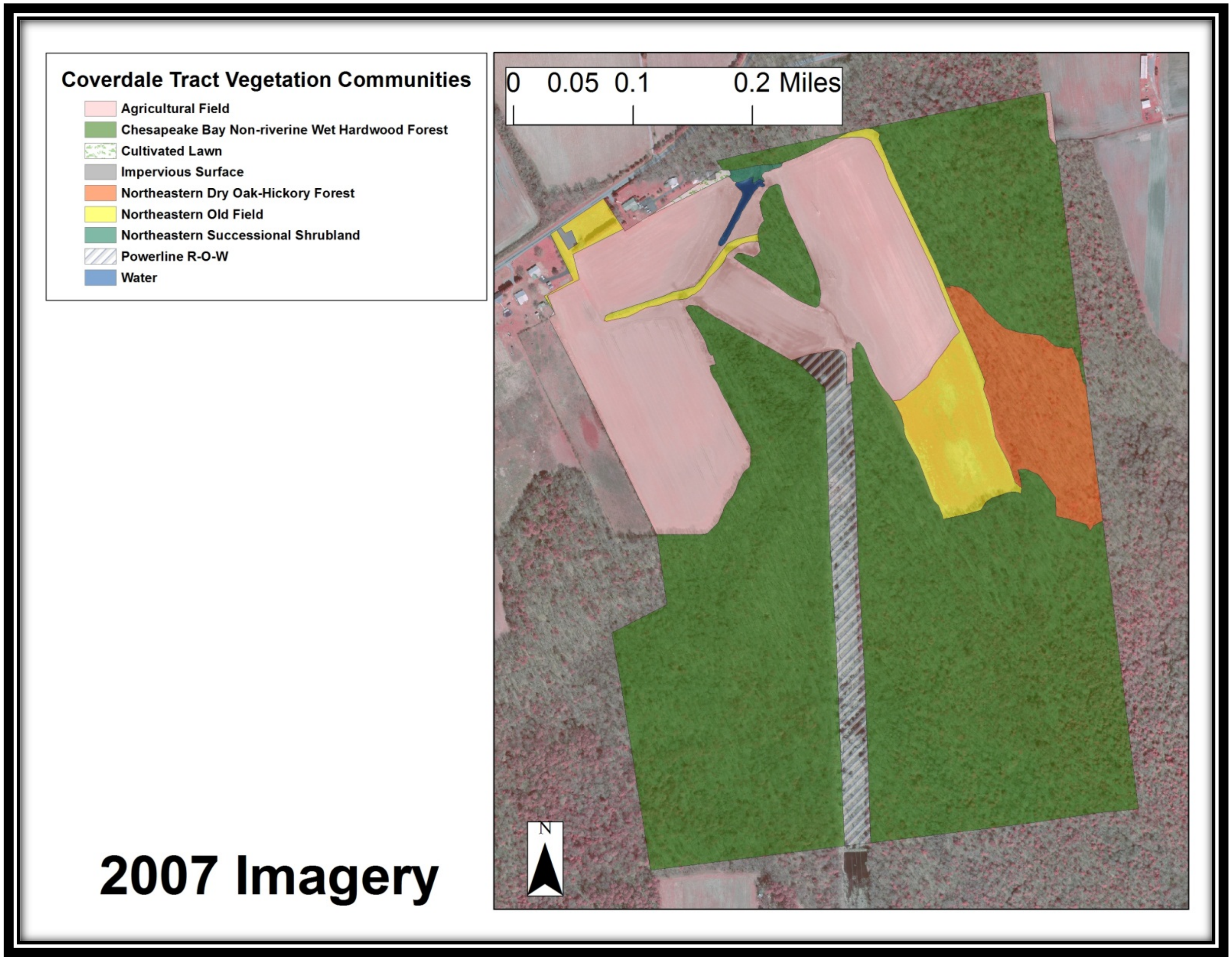


Figure 4-2.1. 2007 Vegetation Community map of the Coverdale Tract

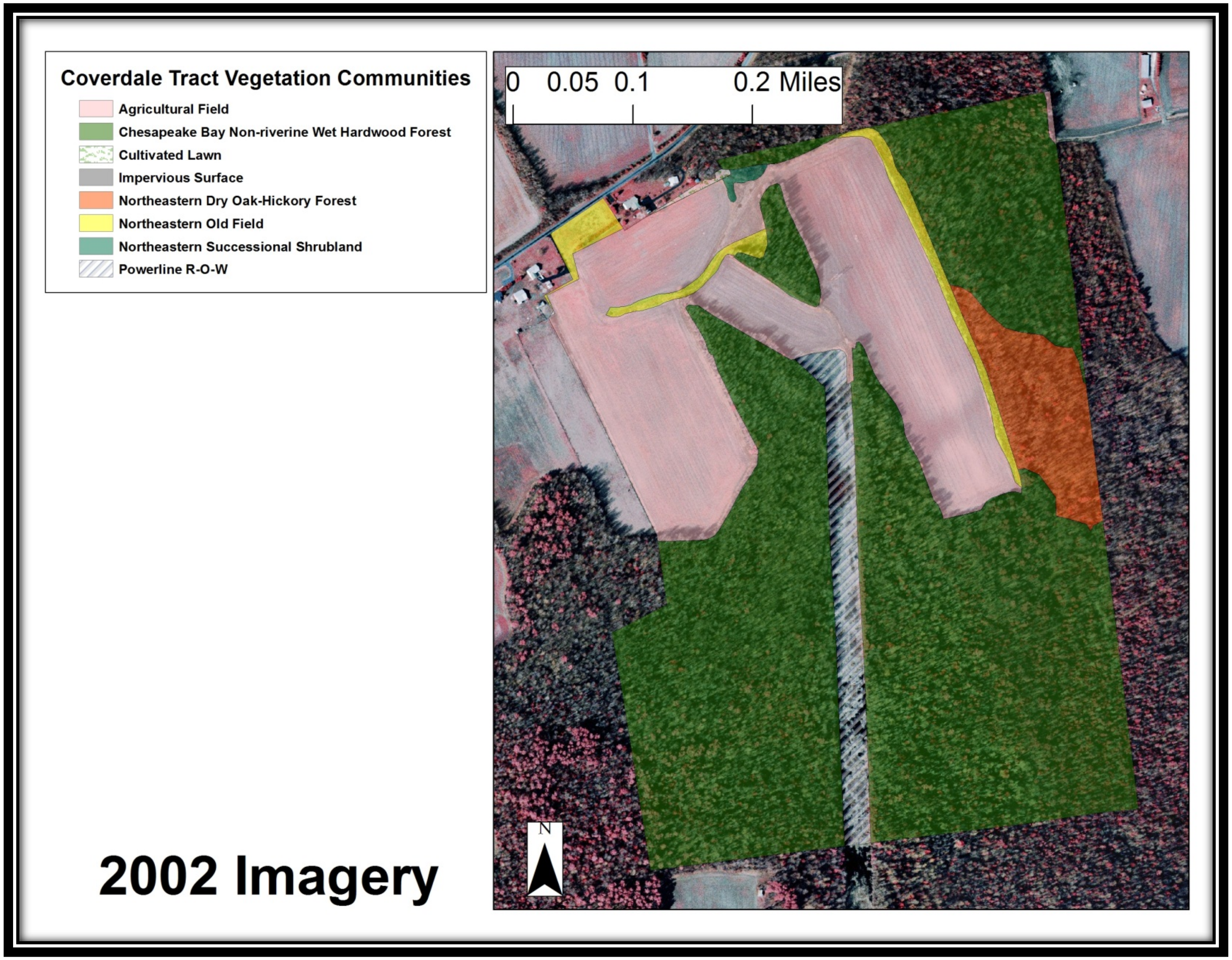


Figure 4-2.2. 2002 Vegetation Community map of the Coverdale Tract

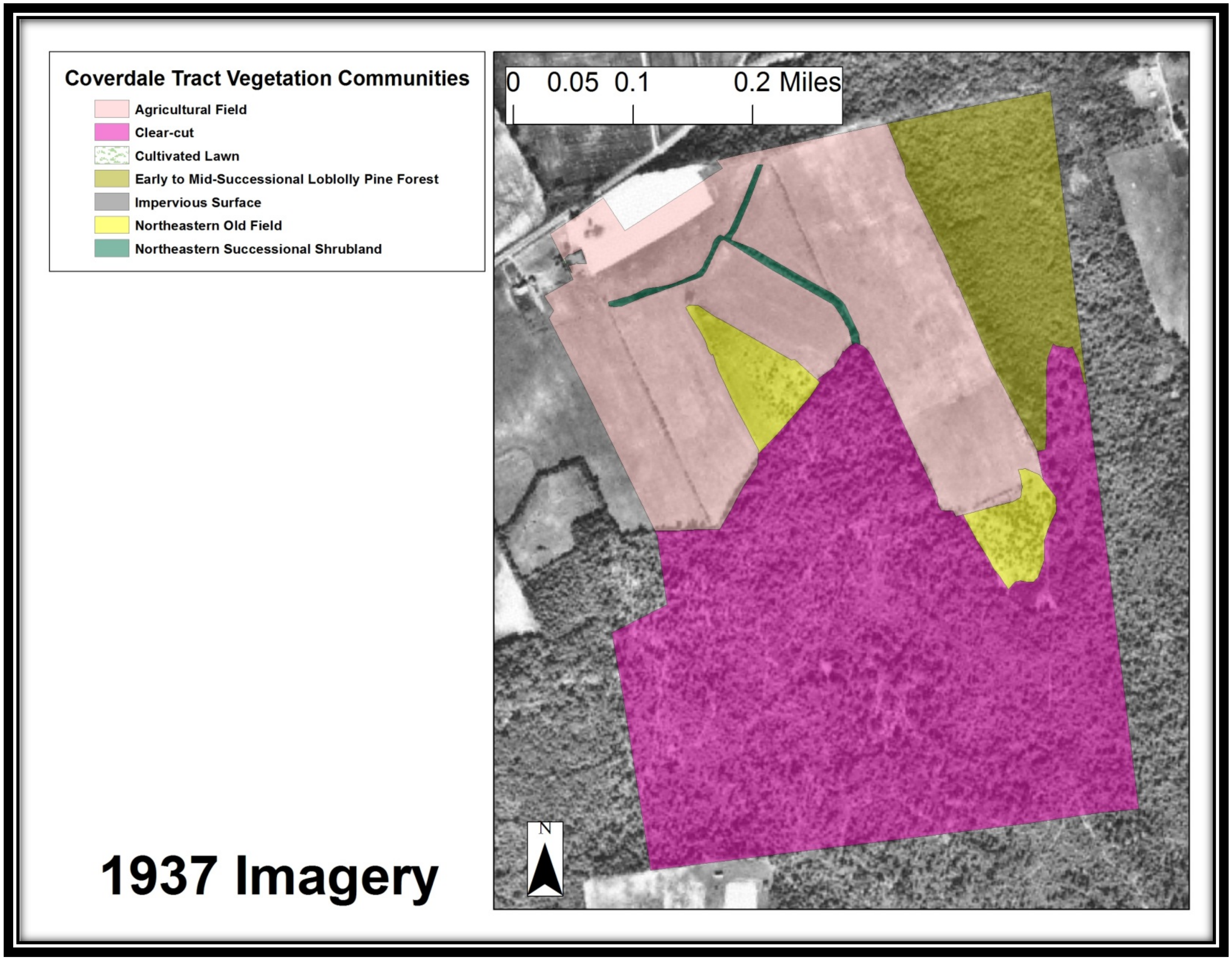
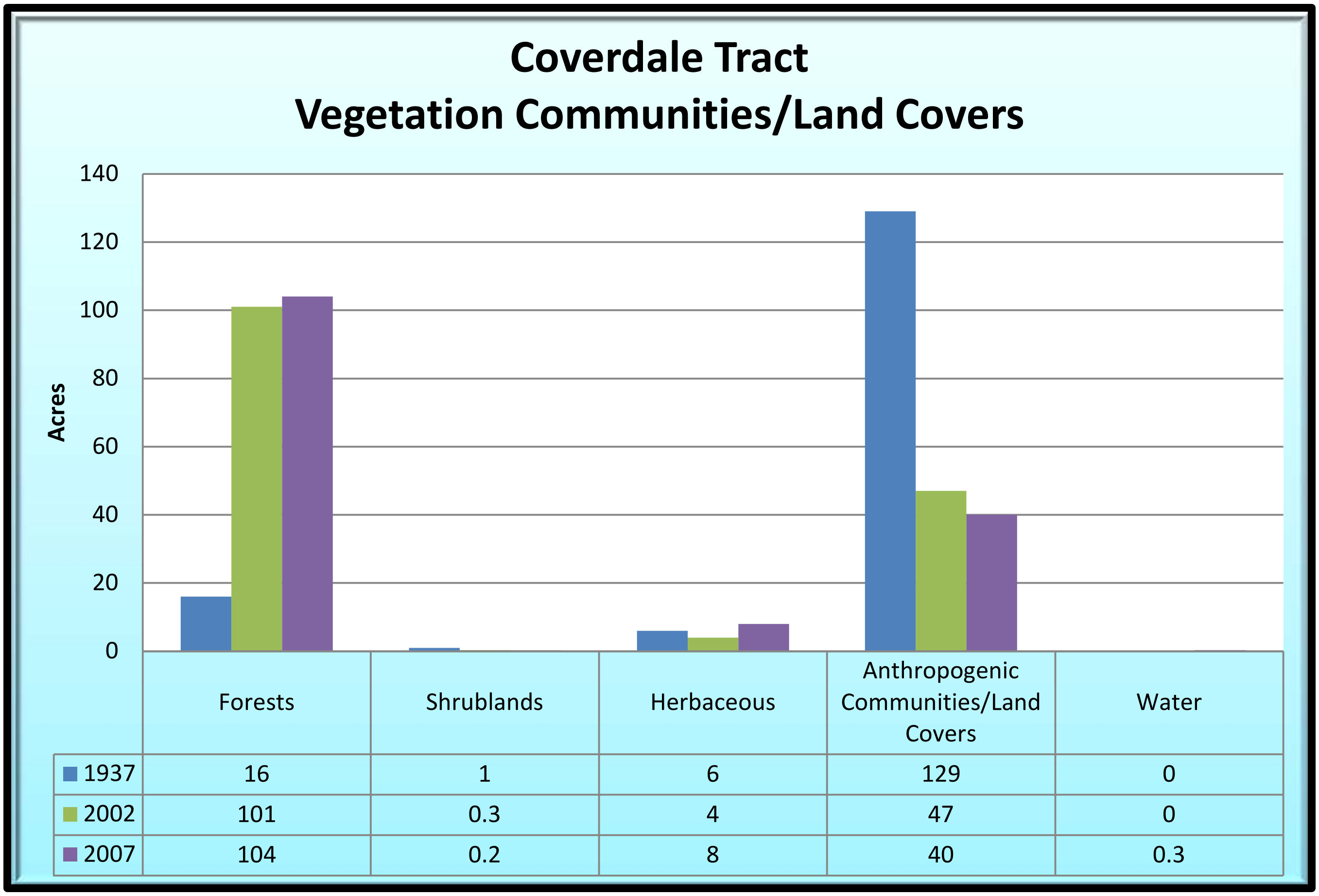


Figure 4-2.3. 1937 Vegetation Community map of the Coverdale Tract



	Forests	Shrublands	Herbaceous	Anthropogenic Communities/Land Covers	Water
1937	16	1	6	129	0
2002	101	0.3	4	47	0
2007	104	0.2	8	40	0.3

Figure 4-2.4. Vegetation Community/Land Cover Categories at the Coverdale Tract (1937, 2002, and 2007)

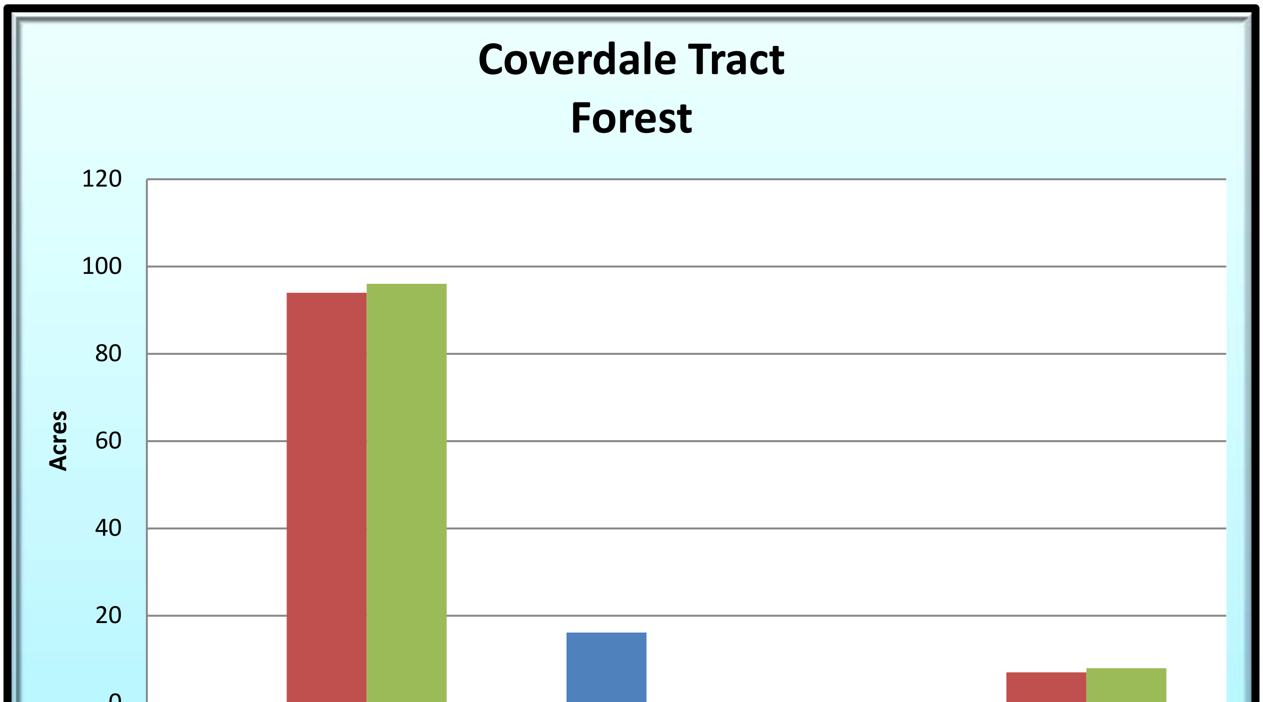
Coverdale Tract Broad Trends (Figure 4-2.4): The Coverdale Tract is located in the Murderkill River Drainage and is one the only tract that is not currently subject to sea level rise, having no exposure to tidal water. Forests have increased dramatically since 1937 with succession of agricultural fields and shrubland. Other categories are little changed. The Coverdale Tract is not affected by sea level rise under any of the scenarios so the sea rise analysis was not completed for this tract.

Natural Capital (Table 4-2.1)

The Coverdale Tract probably has one of the greatest increases of natural capital of any tract in the wildlife area system. This is primary due to the fact that the tract was mostly clear-cut in the 1937 aerial imagery, which does not have natural capital value, and agricultural field, which has very little value. These areas have since grown into forest and a wetland forest at that, which carries a lot of value. The value of the tract continues its increase even in the recent period (2002-2007).

Table 4-2.1. Natural Capital of the Coverdale Tract

Year	**Natural Capital (in 2012 dollars)**
1937	$6,798/year
2002	$1,159,703/year
2007	$1,186,242/year



	Chesapeake Bay Non-riverine Wet Hardwood Forest	Early to Mid-Successional Loblolly Pine Forest	Northeastern Dry Oak-Hickory Forest
1937	0	16	0
2002	94	0	7
2007	96	0	8

Figure 4-2.5. Forest at the Coverdale Tract (1937, 2002, and 2007)

Coverdale Tract Forest (Figure 4-2.5): Forests at the Coverdale Tract have transitioned from one early successional community (Early to Mid-Successional Loblolly Pine Forest) in 1937 to two mature forest types in 2007. These forests have arisen from maturation of the Early to Mid-Successional Loblolly Pine Forest and the clear-cut (in anthropogenic category) present in 1937. Both of the currently present forest types are on a trend of increasing acreage, with Chesapeake Bay Non-riverine Wet Hardwood Forest being the largest.

Natural Capital (Table 4-2.2)

Natural capital of forest has increased with acreage over the years. A lot of capital is from successional communities that have matured into forest.

Table 4-2.2. Natural Capital of Coverdale Tract Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$3,026/year
2002	$1,156,725/year
2007	$1,181,497/year

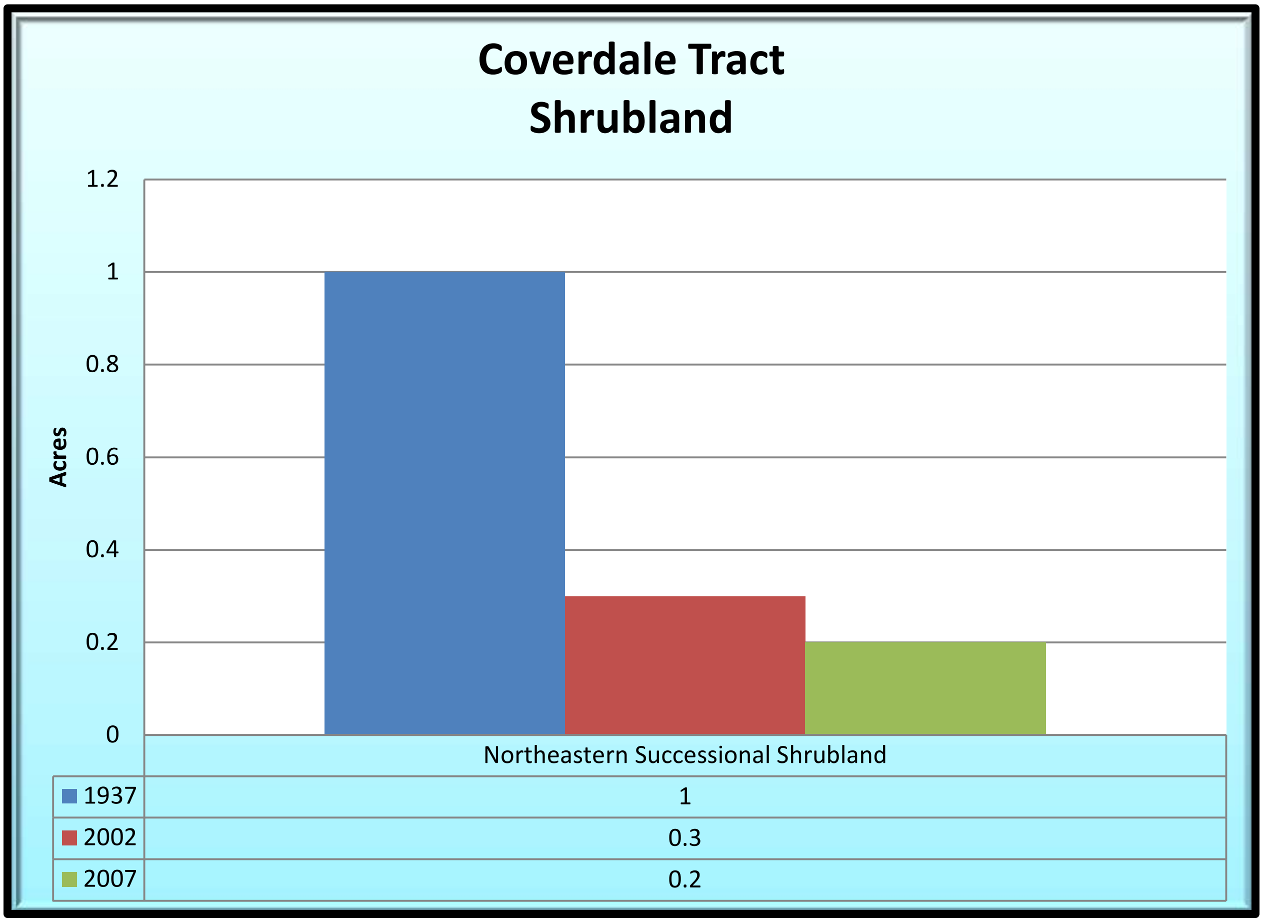


Figure 4-2.6. Shrubland at the Coverdale Tract (1937, 2002, and 2007)

Coverdale Tract Shrubland (Figure 4-2.6): Northeastern Successional Shrubland is the only shrubland community located in the Coverdale Tract. This community is successional and is found at the edges of forests and agricultural fields. They have decreased in time with the maturation to forests.

Natural Capital (Table 4-2.3)

Capital in shrubland has been declining the one community in this category, Northeastern Successional Shrubland, matures into other communities.

Table 4-2.3. Natural Capital of Coverdale Tract Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$146/year
2002	$44/year
2007	$29/year

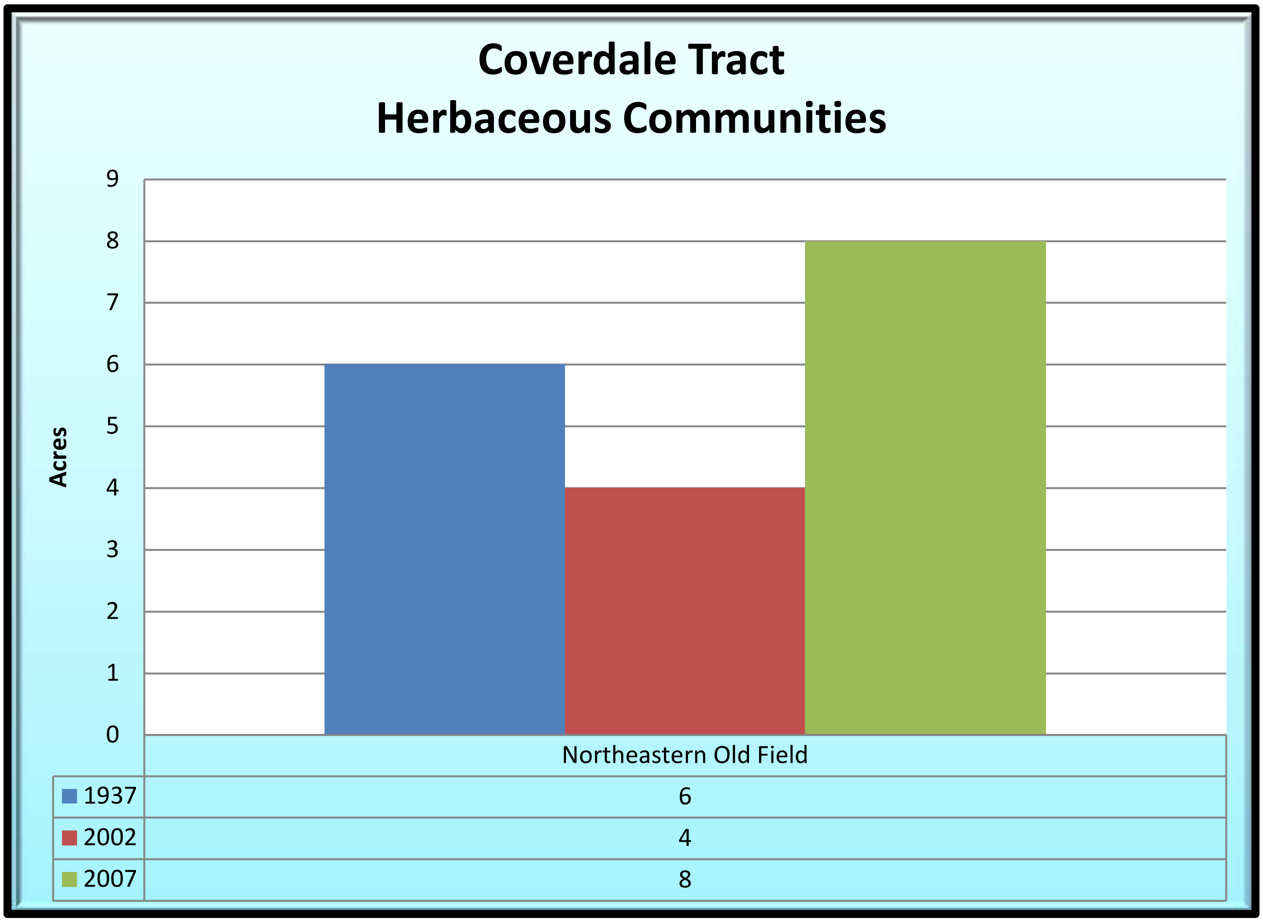


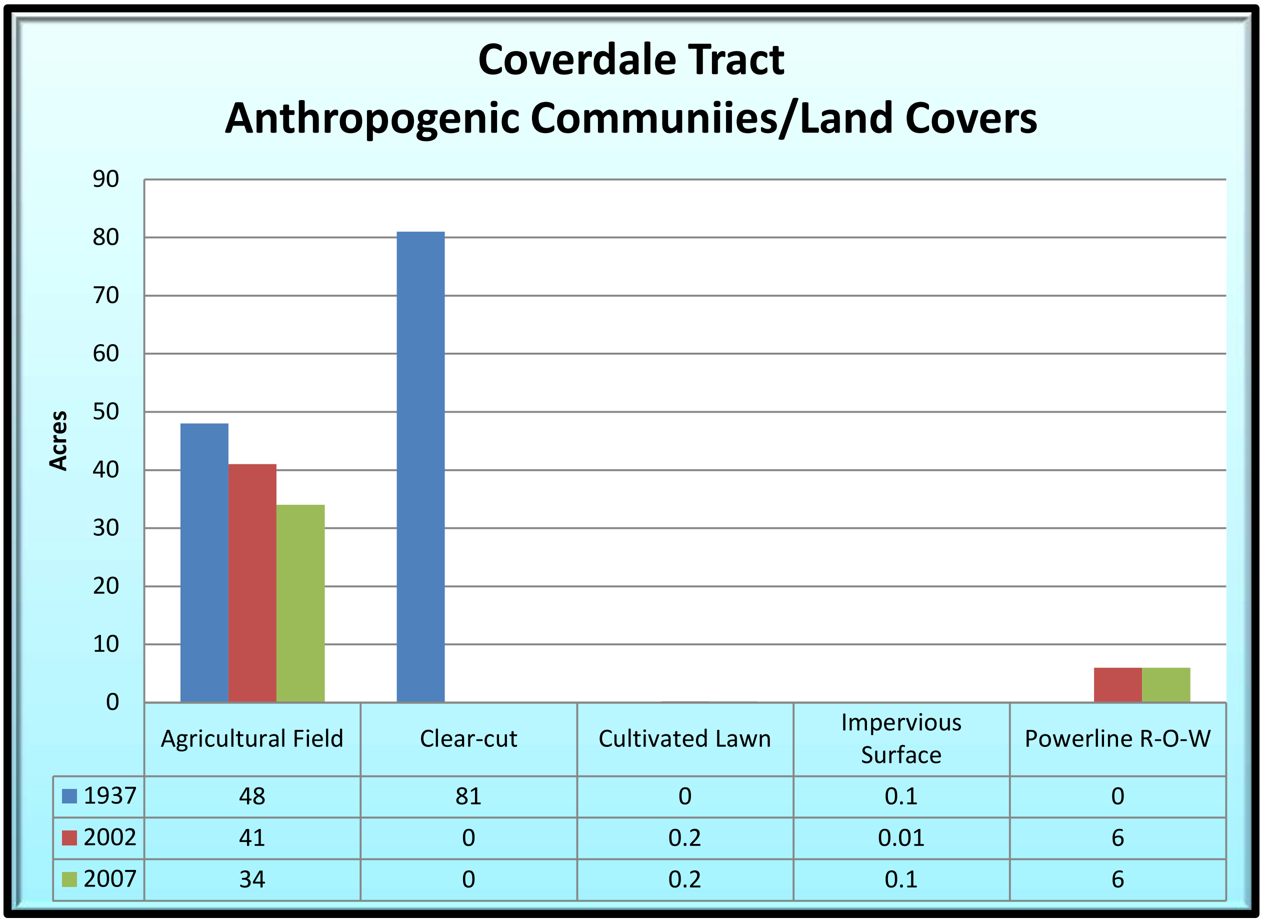
Figure 4-2.7. Herbaceous Communities at the Coverdale Tract (1937, 2002, and 2007)

Coverdale Tract Herbaceous Communities (Figure 4-2.7): Northeastern Old Field is the only herbaceous community located at the Coverdale Tract. This community often arises through the abandonment of agricultural use and eventually succeeds to a Northeastern Successional Shrubland or directly to a successional forest type. A slight dip in amount occurred during 2002 when agricultural field coverage was constant. This type can be short-lived or long-lived depending on site conditions and management.

Natural Capital (Table 4-2.4)

Herbaceous community capital has increased with an increase in Northeastern Old Field from the abandonment of agricultural field.

Table 4-2.4. Natural Capital of Coverdale Tract Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1937	$874/year
2002	$583/year
2007	$1,166/year



	Agricultural Field	Clear-cut	Cultivated Lawn	Impervious Surface	Powerline R-O-W
1937	48	81	0	0.1	0
2002	41	0	0.2	0.01	6
2007	34	0	0.2	0.1	6

Figure 4-2.8. Anthropogenic Communities/Land Covers at the Coverdale Tract (1937, 2002, and 2007)

Coverdale Tract Anthropogenic Communities (Figure 4-2.8): A recent clear-cut was the prominent anthropogenic community in 1937 with agricultural field following a distant second. Maturation of the clear-cut into forest makes agricultural field the predominant anthropogenic community in the Coverdale Tract in 2007. Since 1937, a powerline R-O-W covering a little more than six acres, was cut through the tract.

Natural Capital (Table 4-2.5)

Agricultural field is the only anthropogenic community/land cover with any natural capital value in the Coverdale Tract. The amount has been declining and is being transferred to herbaceous communities as the fields are abandoned.

Table 4-2.5. Natural Capital of Coverdale Tract Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$2,753/year
2002	$2,351/year
2007	$1,950/year

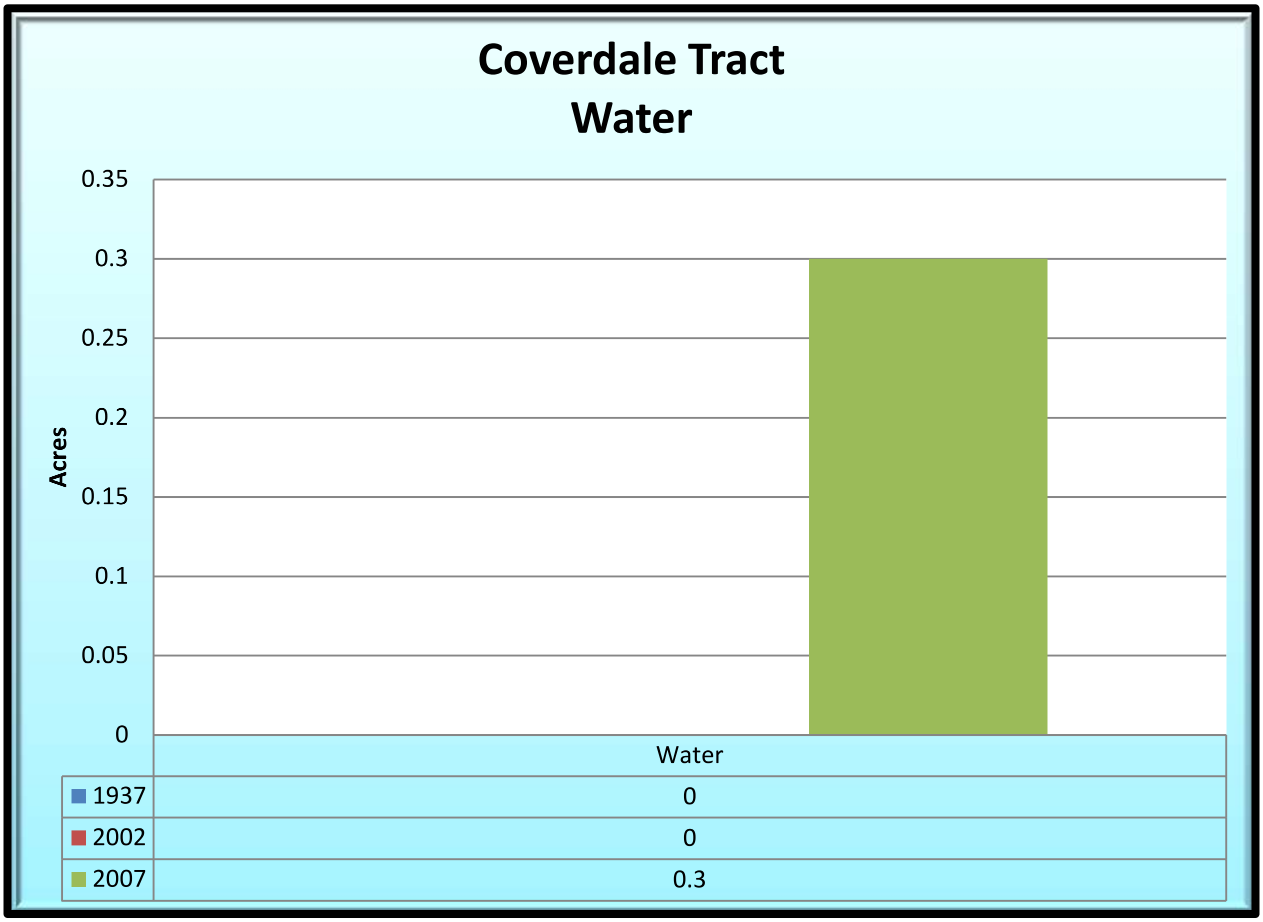


Figure 4-2.9. Water at the Coverdale Tract (1937, 2002, and 2007)

Coverdale Tract Water Coverage (Figure 4-2.9): The Coverdale Tract does not contain any tidal streams. As a result water coverage is minimal and only collects in low places. It is thought that the amount of water seen in 2007 is a result of water ponding from rain and is not a regular part of the tract.

Natural Capital (Table 4-2.6)

One small area of water is located in the Coverdale Tract that is not part of an impoundment.

Table 4-2.6. Natural Capital of Coverdale Tract Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$0/year (not present)
2007	$1,601/year

3. Dickerson Tract

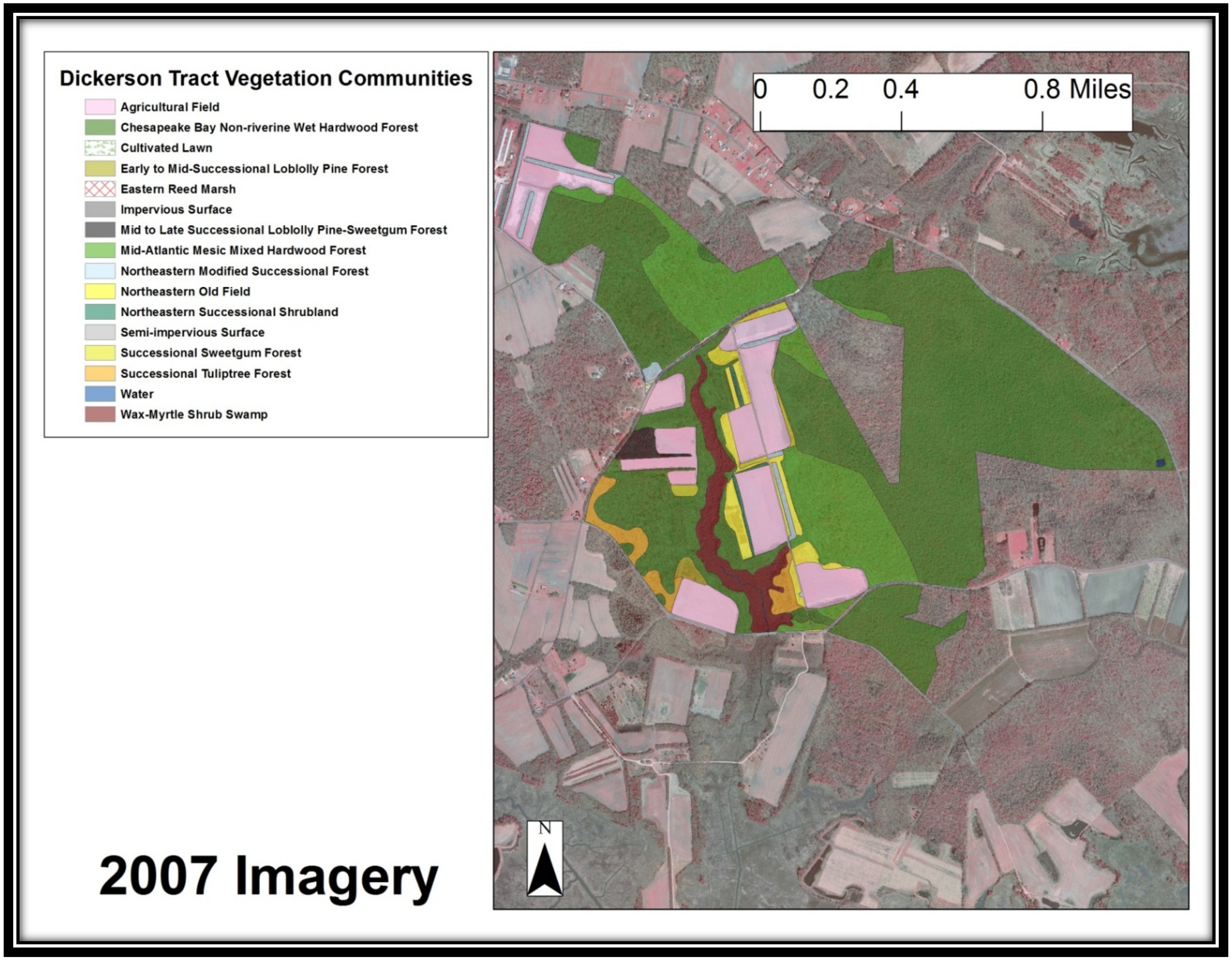


Figure 4-3.1. 2007 Vegetation Community Map of the Dickerson Tract

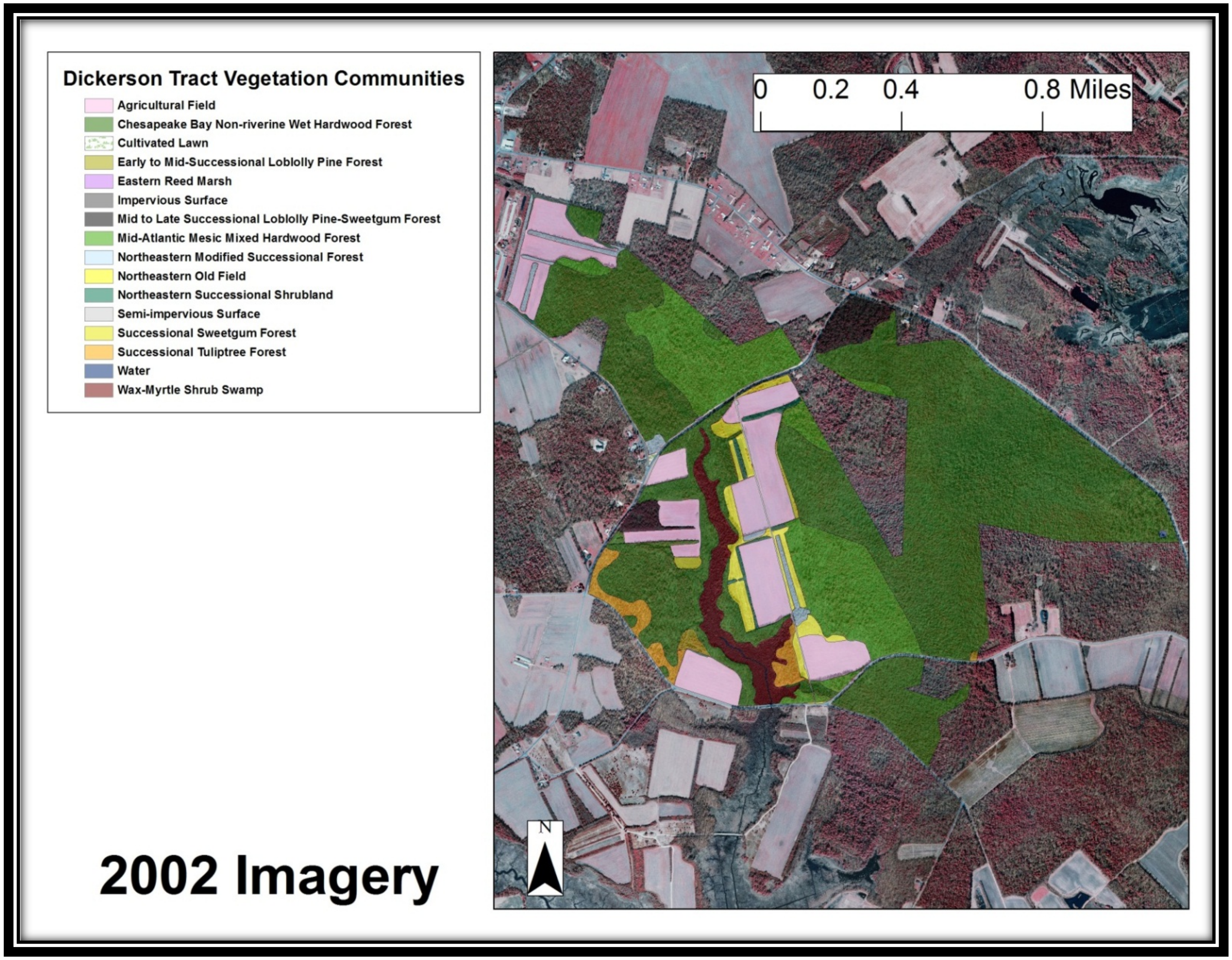


Figure 4-3.2. 2002 Vegetation Community Map of the Dickerson Tract

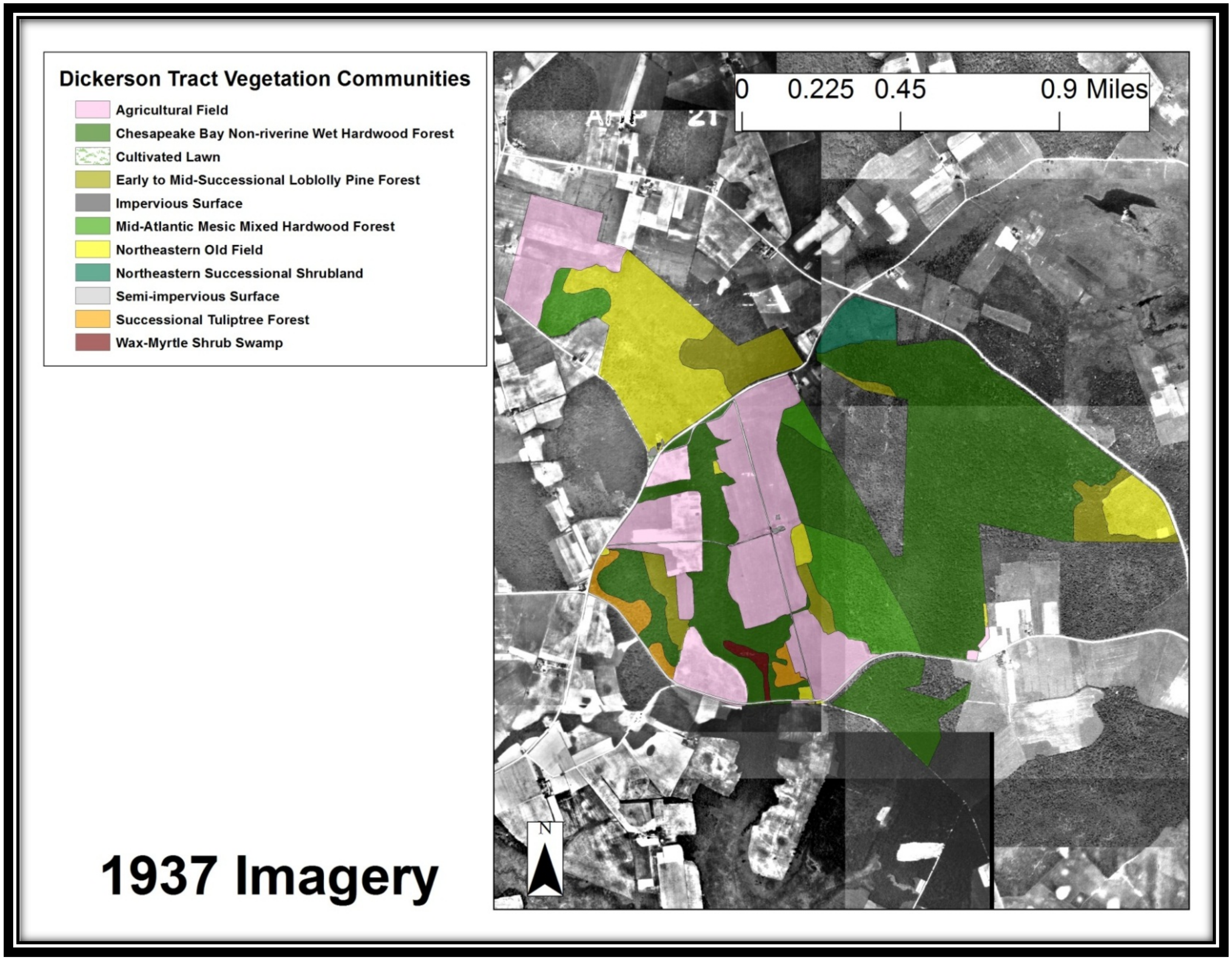
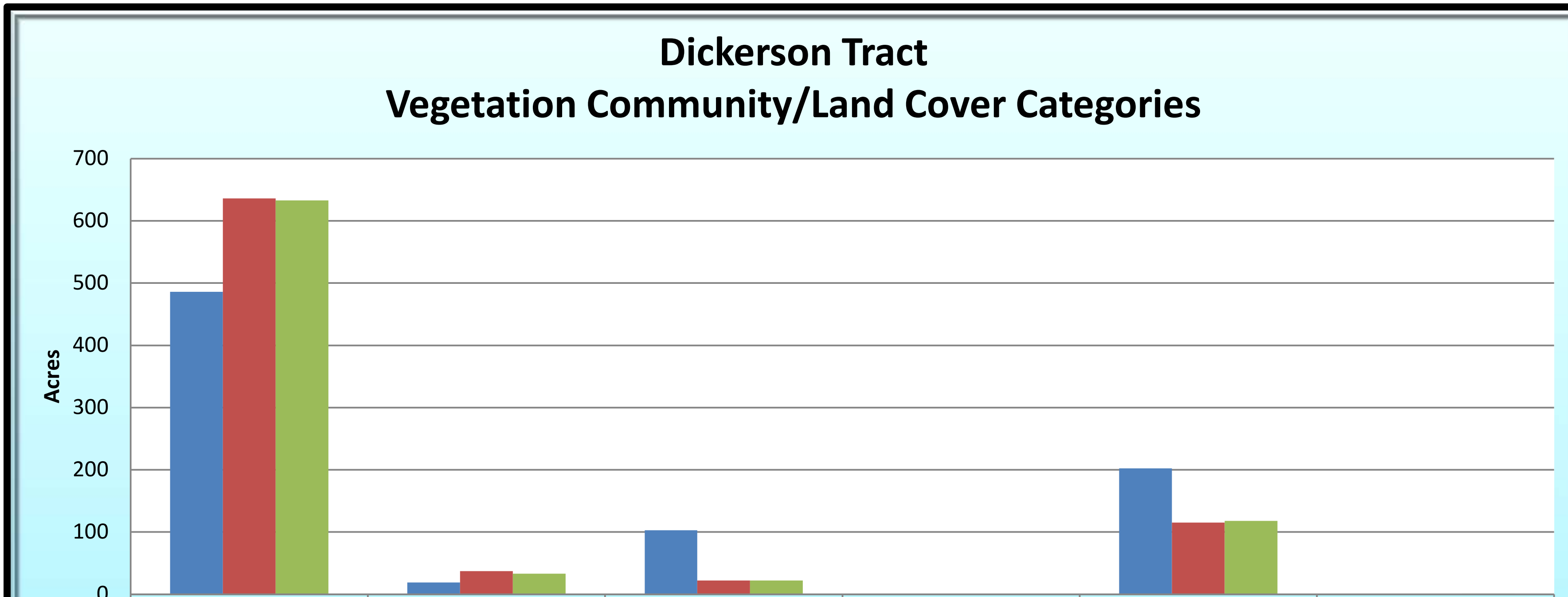


Figure 4-3.3. 1937 Vegetation Community Map of the Dickerson Tract



	Forests	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Water
1937	486	19	103	0	202.2	0
2002	636	37	22	0.08	115.02	0.4
2007	633	33	22	0.08	118.02	1

Figure 4-3.4. Vegetation Community/Land Covers at the Dickerson Tract (1937, 2002, and 2007)

Dickerson Tract Broad Trends (Figure 4-3.4): Forests, agricultural fields (anthropogenic), and Northeastern Old Field (herbaceous) were large parts of the Dickerson tract in 1937. By 2007, these areas had mostly succeeded to forest which is by far the most dominant category.

DNREC Sea Level Rise Analysis (Table 4-3.1)

About 34% of the Dickerson Tract will be inundated with 1.5 m of sea level rise.

Table 4-3.1. Projected acres of the Dickerson Tract Inundated by Sea Level Rise

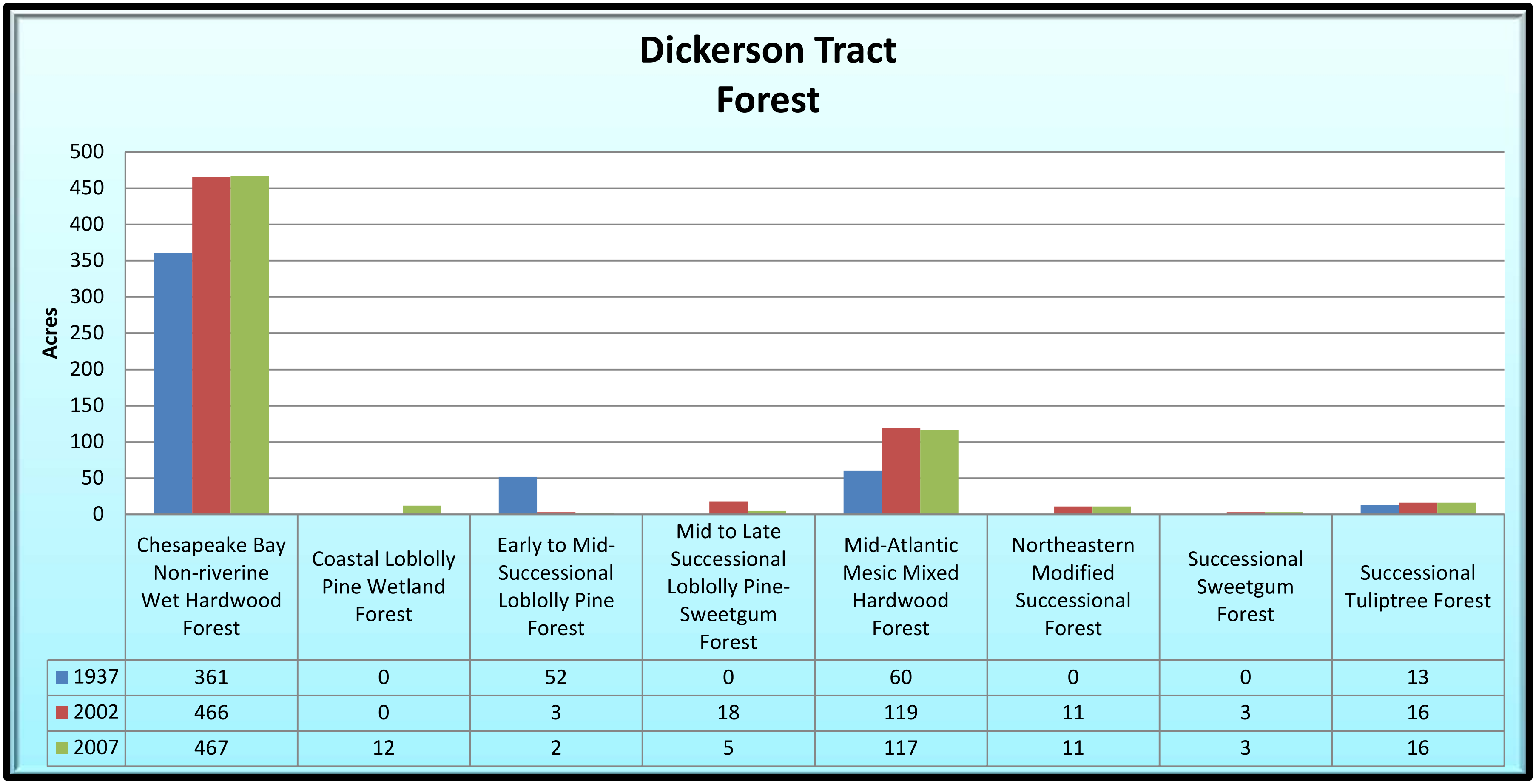
Rise	Acres
0.5 m	36 acres
1 m	62 acres
1.5 m	276 acres

Natural Capital (Table 4-3.2)

Like a lot of the other tracts in the wildlife area, capital has been increasing with time owing to increases in forest and in this case a small amount of agricultural field.

Table 4-3.2. Natural Capital of the Dickerson Tract

Year	Natural Capital (in 2012 dollars)
1937	$4,526,254/year
2002	$6,051,884/year
2007	$6,207,818/year



	Chesapeake Bay Non-riverine Wet Hardwood Forest	Coastal Loblolly Pine Wetland Forest	Early to Mid-Successional Loblolly Pine Forest	Mid to Late Successional Loblolly Pine-Sweetgum Forest	Mid-Atlantic Mesic Mixed Hardwood Forest	Northeastern Modified Successional Forest	Successional Sweetgum Forest	Successional Tuliptree Forest
1937	361	0	52	0	60	0	0	13
2002	466	0	3	18	119	11	3	16
2007	467	12	2	5	117	11	3	16

Figure 4-3.5. Forest at the Dickerson Tract (1937, 2002, and 2007)

Dickerson Tract Forest (Figure 4-3.5): Chesapeake Bay Non-riverine Wet Hardwood Forest has been the prominent forest at the Dickerson Tract since 1937 and remains so in 2007. Mid-Atlantic Mesic Mixed Hardwood Forest has gained more prominence over time and has ranked second highest since 1937. Since 1937, the tract has gained four additional forest types, and nearly lost one successional forest to maturation.

DNREC Sea Level Rise Analysis (Table 4-3.3)

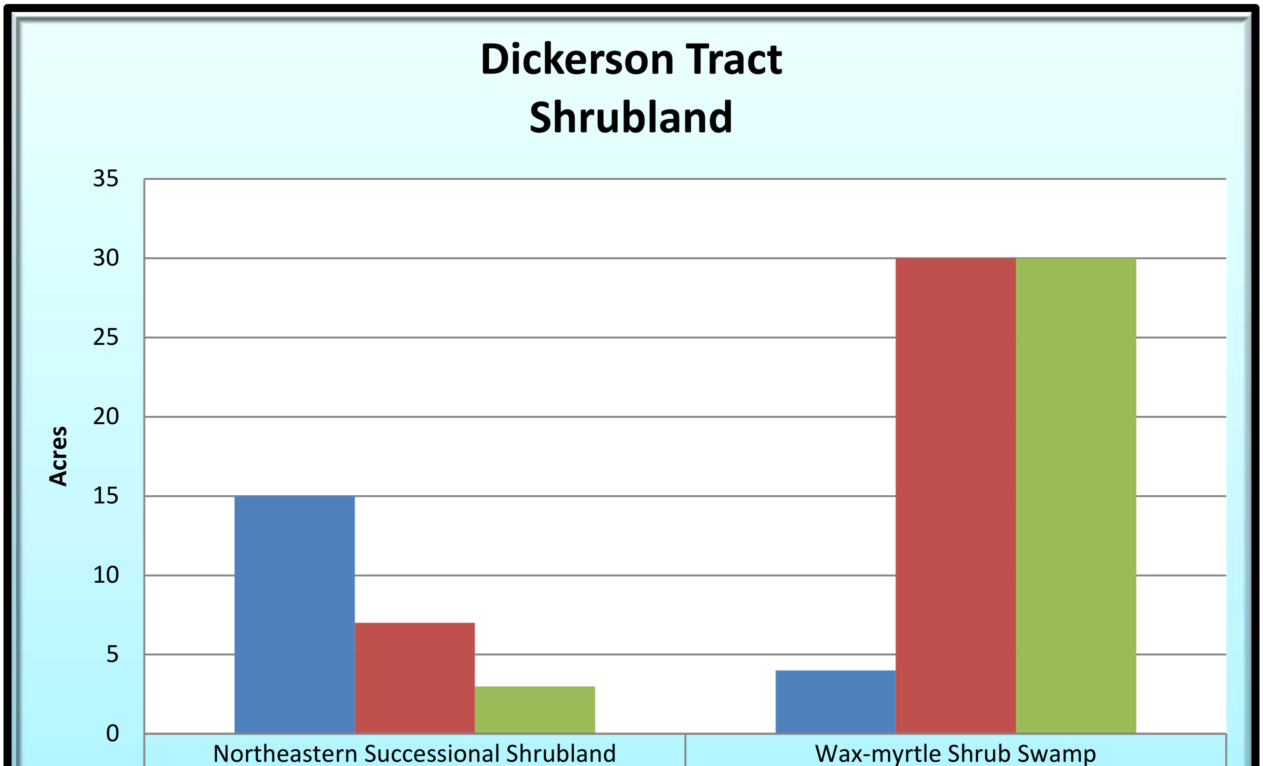
About 35% of the forestland in the Dickerson Tract will be flooded by water under the highest sea level rise scenario (1.5m).

Table 4-3.3. Projected acres of Dickerson Tract Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	8 acres
1 m	29 acres
1.5 m	225 acres

Natural Capital (Table 4-3.4)

Capital of forestland in the Dickerson Tract has been gradually increasing as forest mature. A lot of the increases are coming from the increase of wetland forest communities (Chesapeake Bay Non-riverine Wet Hardwood Forest and Coastal Loblolly Pine Wetland Forest).

Table 4-3.4. Natural Capital of Dickerson Tract Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$4,460,869/year
2002	$5,759,986/year
2007	$5,916,750/year



	Northeastern Successional Shrubland	Wax-myrtle Shrub Swamp
1937	15	4
2002	7	30
2007	3	30

Figure 4-3.6. Shrubland at the Dickerson Tract (1937, 2002, and 2007)

Dickerson Tract Shrubland (Figure 4-3.6): In 1937, Northeastern Successional Shrubland, located on the edges of agricultural fields was the primary shrubland type. These shrublands have gradually matured out of existence and recently a new shrubland, Wax-myrtle Shrub Swamp, has gained prominence with additional water from sea level rise on Kings Causeway (stream). The amount of Wax-Myrtle Shrub Swamp has remained stable in the 2002-2007 period.

DNREC Sea Level Rise Analysis (Table 4-3.5)

All of the Wax-myrtle Shrub Swamp will be inundated with 1 m of sea level rise. A scant amount of the Northeastern Successional Shrubland will be affected with 1.5 m of rise.

Table 4-3.5. Projected acres of Dickerson Tract Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	27 acres
1 m	30 acres
1.5 m	30 acres

Natural Capital (Table 4-3.6)

Capital in shrubland is up overall but has declined recently as Northeastern Successional Shrubland matures to forest communities.

Table 4-3.6. Natural Capital of Dickerson Tract Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$39,310/year
2002	$279,450/year
2007	$278,867/year

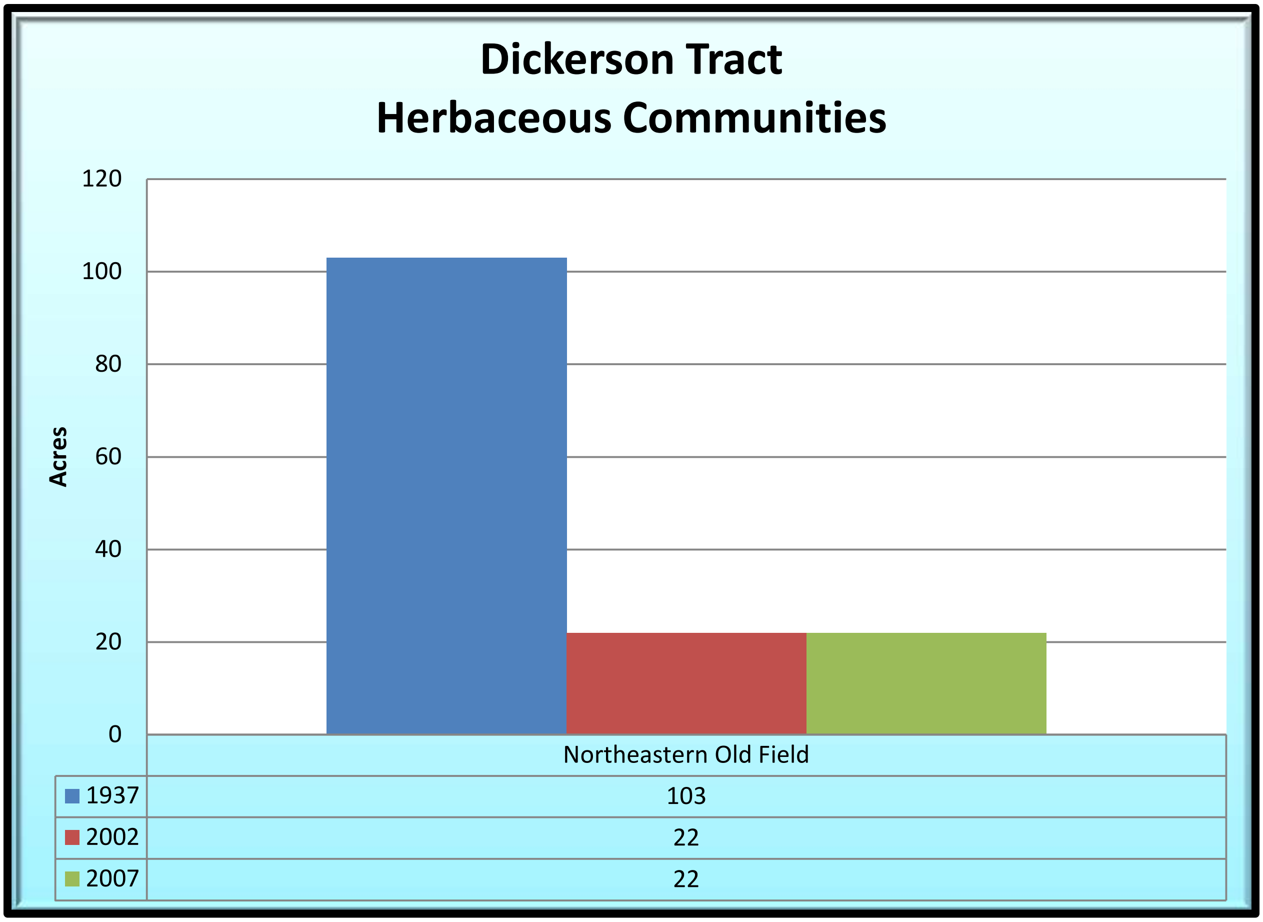


Figure 4-3.7. Herbaceous Communities at the Dickerson Tract (1937, 2002, and 2007)

Dickerson Tract Herbaceous Communities (Figure 4-3.7): Northeastern Old Field is the only herbaceous community present in the Dickerson Tract and has decreased with maturation to shrubland and on to forest.

DNREC Sea Level Rise Analysis (Table 4-3.7)

About 1/3 of the herbaceous communities in the Dickerson Tract will be flooded with 1.5 m of sea level rise.

Table 4-3.7. Projected acres of Dickerson Tract Herbaceous Communities Inundated by Sea Level Rise

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

Natural Capital (Table 4-3.8)

Herbaceous community capital has decreased with the maturation of the communities to shrubland and forest.

Table 4-3.8. Natural Capital of Dickerson Tract Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1937	$15,007/year
2002	$3,205/year
2007	$3,205/year

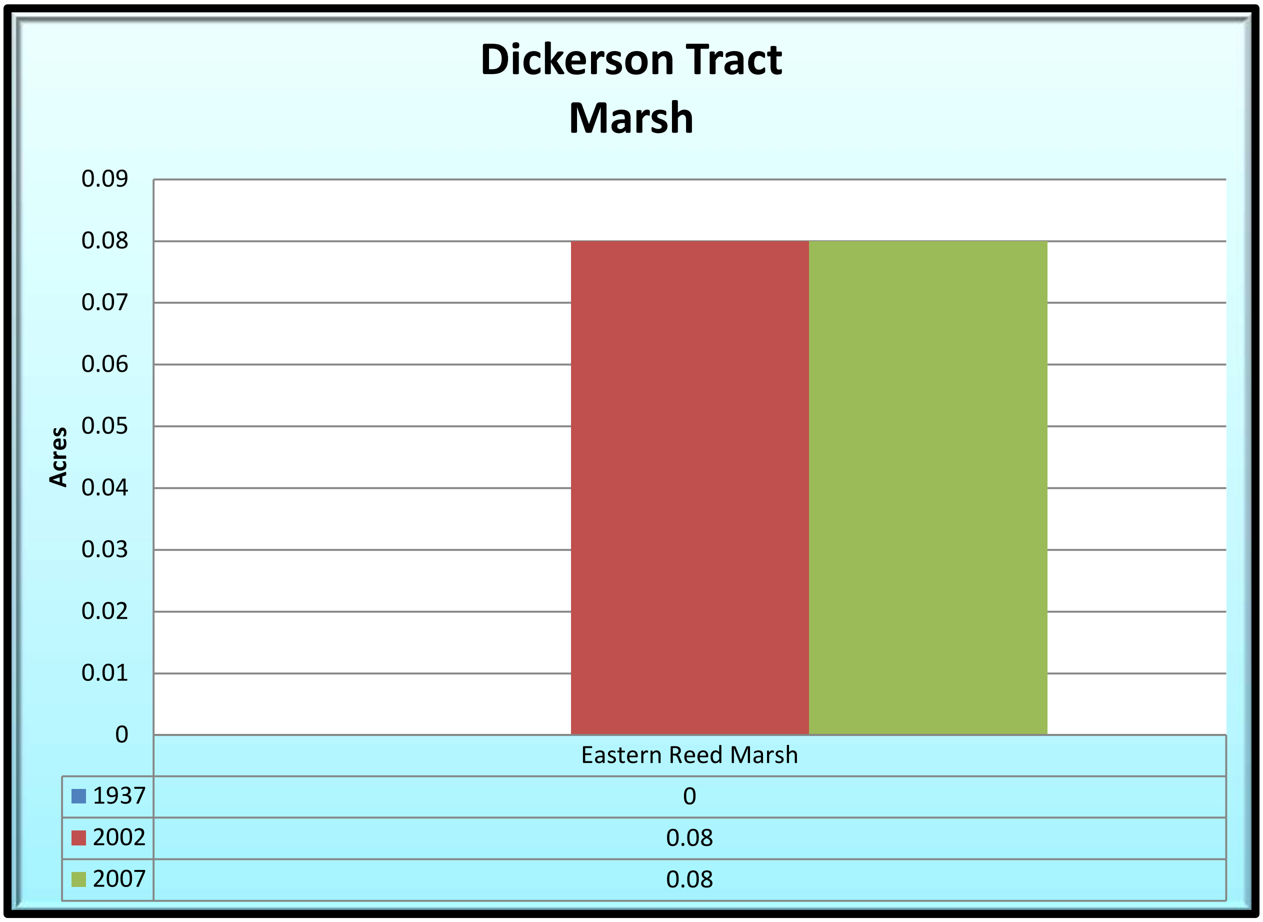


Figure 4-3.8. Dickerson Tract Marsh (1937, 2002, and 2007)

Dickerson Tract Marsh (Figure 4-3.8): Only one small speck of marsh is present in the Dickerson Tract. Since this type of marsh sometimes difficult to tell on 1937 imagery it is unknown whether it was present in 1937 or not.

DNREC Sea Level Rise Analysis (Table 4-3.9)

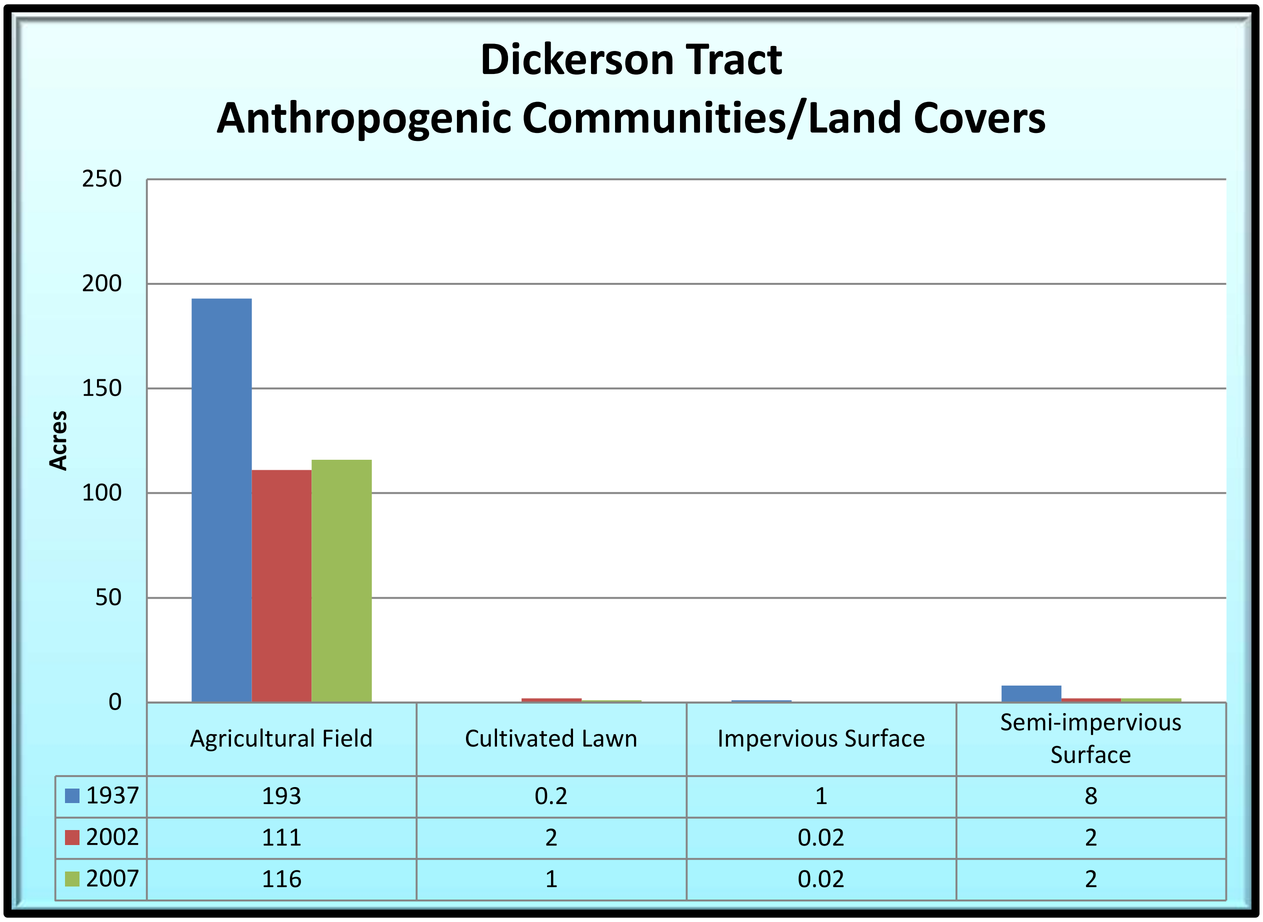
All of the marshland in the Dickerson Tract will be inundated by water with 1 m of sea level rise.

Table 4-3.9. Projected acres of Dickerson Tract Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0.08 acres
1.5 m	0.08 acres

Natural Capital (Table 4-3.10)

Eastern Reed Marsh has appeared in the Dickerson Tract since 1937 giving capital to the marsh category.

Table 4-3.10. Natural Capital of Dickerson Tract Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$743/year
2007	$743/year



	Agricultural Field	Cultivated Lawn	Impervious Surface	Semi-impervious Surface
1937	193	0.2	1	8
2002	111	2	0.02	2
2007	116	1	0.02	2

Figure 4-3.9. Dickerson Tract Anthropogenic Communities/Land Covers (1937, 2002, and 2007)

Dickerson Tract Anthropogenic Communities (Figure 4-3.9): Agricultural field has been the most prominent anthropogenic community through time. It has gradually decreased through abandonment and maturation with a small tick upward in the short term (2002-2007). Other anthropogenic communities have mostly decreased through time.

DNREC Sea Level Rise Analysis (Table 4-3.11)

Anthropogenic communities/land covers will be barely affected with even 1.5 m of sea level rise in the Dickerson Tract.

Table 4-3.11. Projected acres of Dickerson Tract Anthropogenic Communities/Land Covers Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0.1 acres
1 m	2 acres
1.5 m	14 acres

Natural Capital (Table 4-3.12)

Agricultural field is the only anthropogenic community/land cover that has any natural capital value in the Dickerson Tract. The capital of it has been going down as agricultural fields are abandoned and they revert to herbaceous communities (Northeastern Old Field). This transfer increases the overall capital in the tract and wildlife area.

Table 4-3.12. Natural Capital of Dickerson Tract Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$11,069/year
2002	$6,366/year
2007	$6,653/year

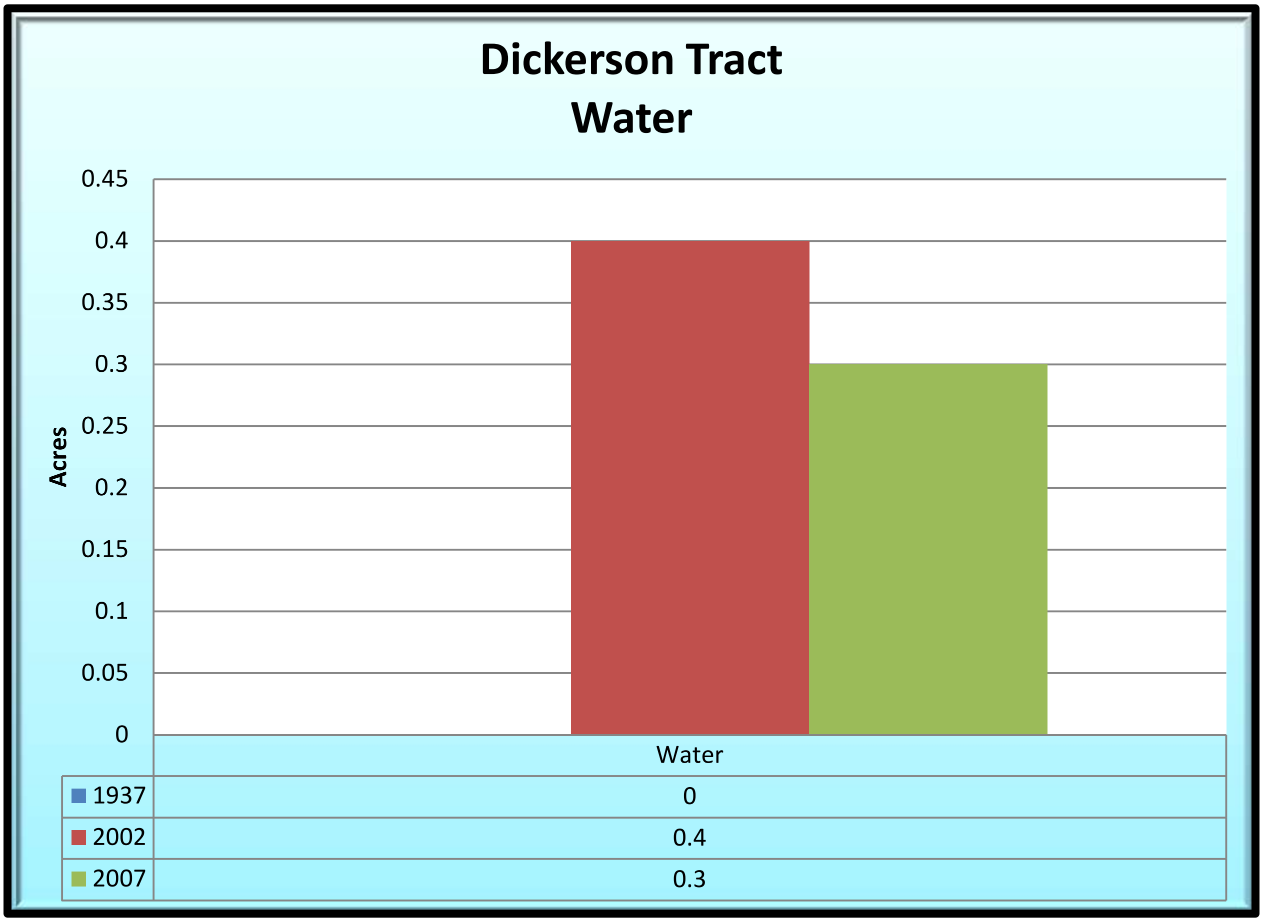


Figure 4-3.10. Dickerson Tract Water (1937, 2002, and 2007)

Dickerson Tract Water Coverage (Figure 4-3.10): Water covers a very small amount of the Dickerson Tract on an upstream part of Kings Causeway. This could change in time as more tidal water comes into the tract. . The historic rate of inundation in this tract has been (1937-2002 = 0.006 acres/year) and (1937-2007 = 0.004 acres/year). The recent rate (2002-2007), however has been positive with 0.02 acres/year. This same slowing of the rate has been seen in the Hall Tract and it is unknown whether it is from sedimentation or another factor.

Natural Capital (Table 4-3.13)

Capital of water increased up to 2002 but then decreased in the 2002 to 2007 period.

Table 4-3.13. Natural Capital of Dickerson Tract Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$2,134/year
2007	$1,601/year

4. Gray Farm Tract

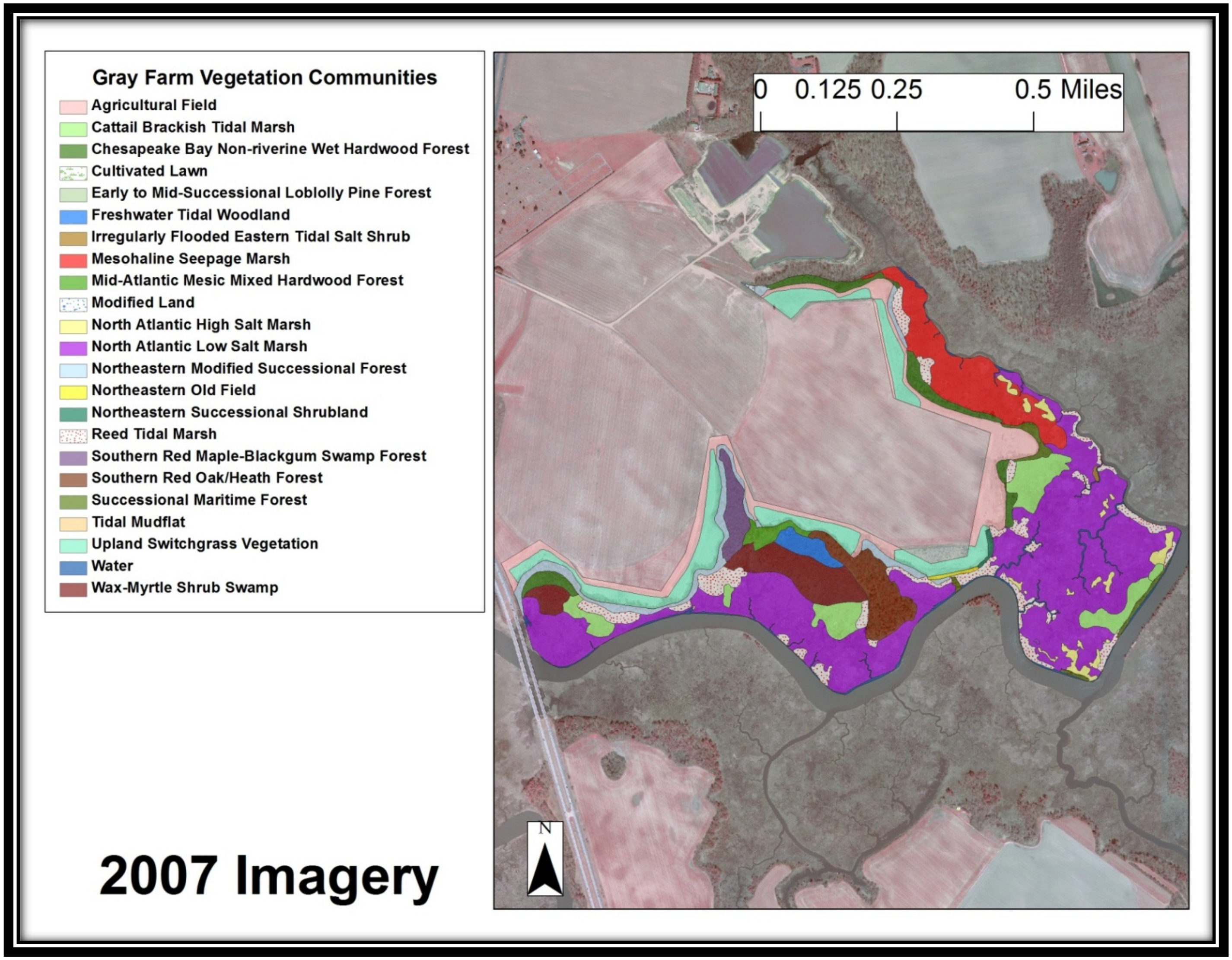


Figure 4-4.1. 2007 Vegetation Community Map of the Gray Farm Tract

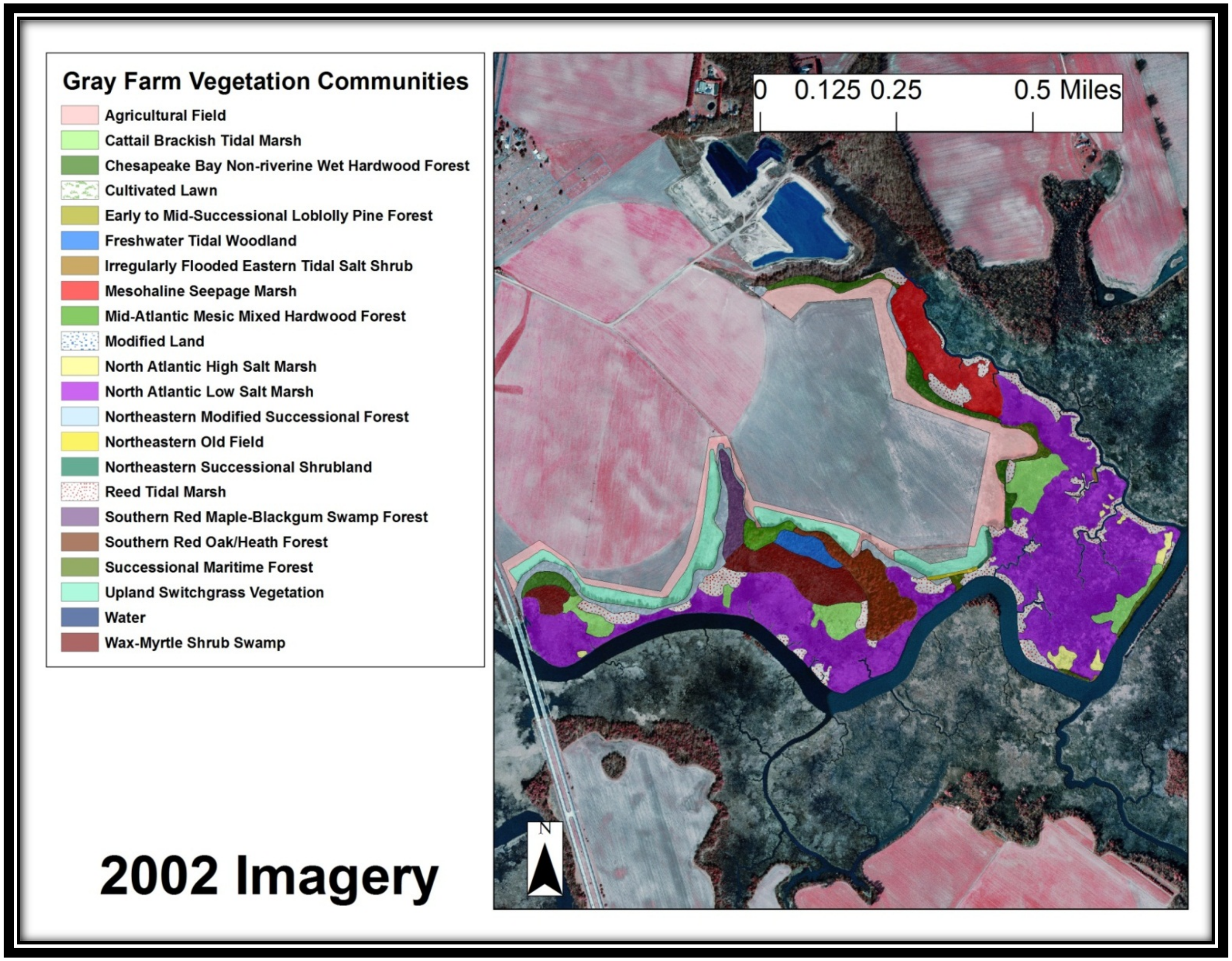


Figure 4-4.2. 2002 Vegetation Community Map of the Gray Farm Tract

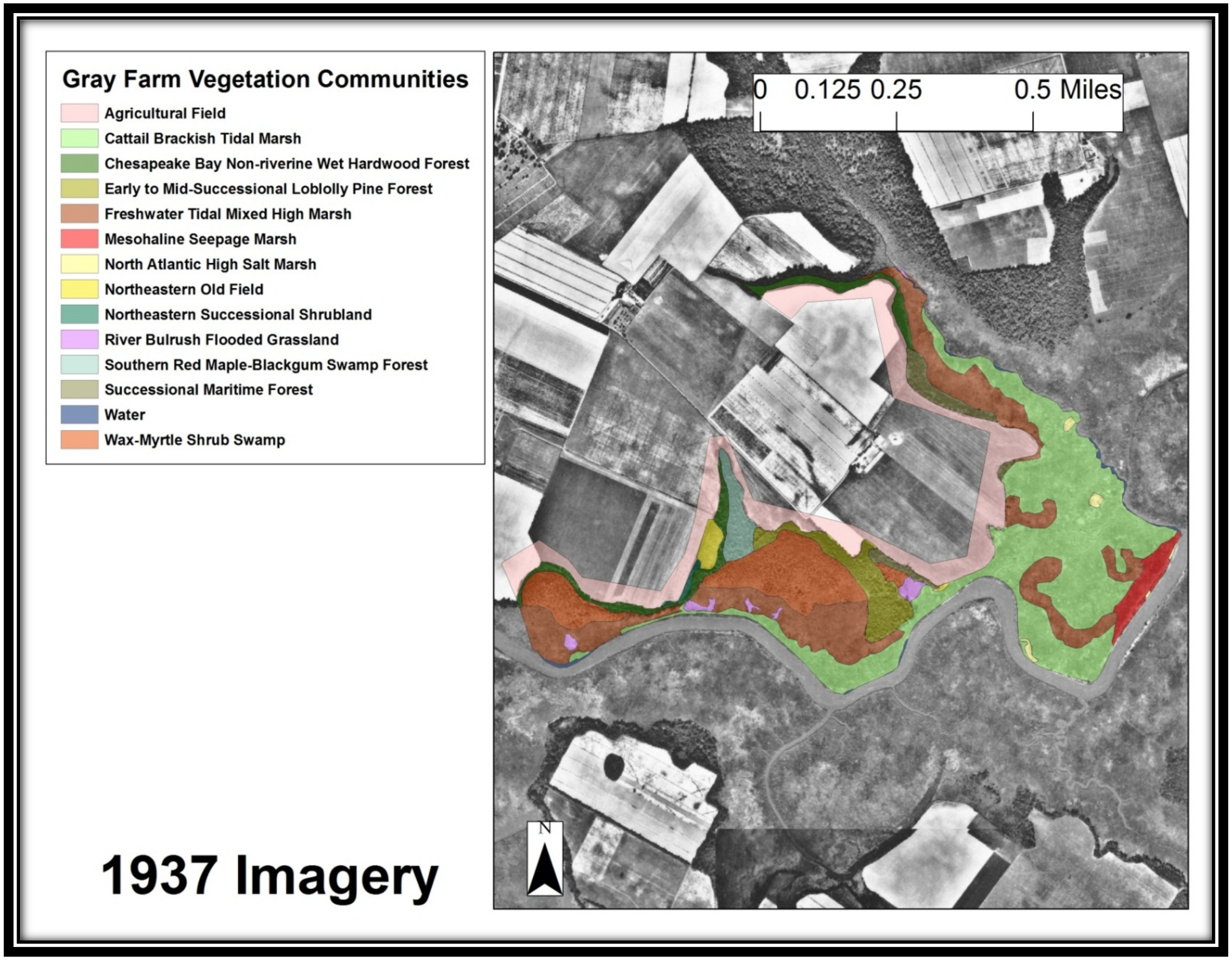
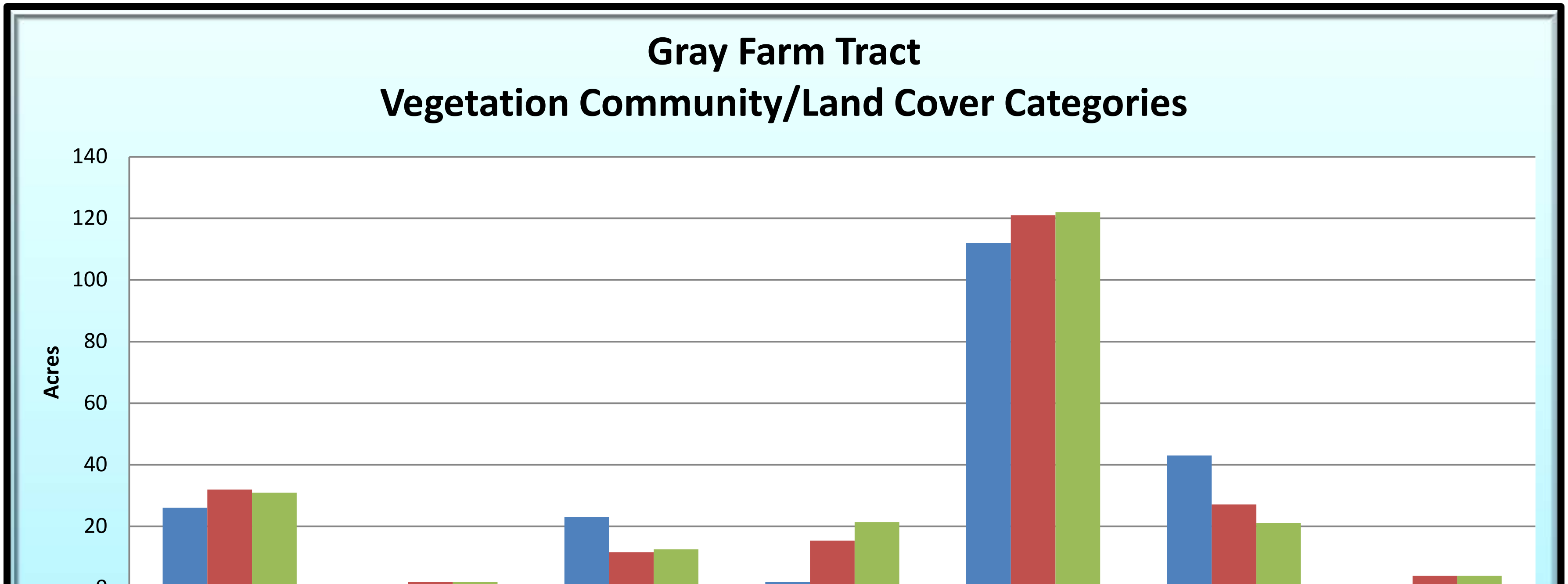


Figure 4-4.3. 1937 Vegetation Community Map of the Gray Farm Tract



	Forests	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Water
1937	26	0	23	2	112	43	1
2002	32	2	11.6	15.4	121	27.1	4
2007	31	2	12.5	21.4	122	21.1	4

Figure 4-4.4. Gray Farm Tract Vegetation Community/Land Cover Categories (1937, 2002, and 2007)

Gray Farm Tract Broad Trends (Figure 4-4.4): The Gray Farm Tract includes mostly agricultural fields that are edged by a narrow wooded buffer and marshes on the north side of the Murderkill River. Marsh has been and remains the most common category and has increased over time. Forests and woodlands have also made modest increases as agricultural fields (anthropogenic) have converted and water coverage has encroached into former forest.

DNREC Sea Level Rise Analysis (Table 4-4.1)

About ¾ of the Gray Farm Tract will flooded with 0.5 m of sea level rise. An additional 1 m of rise will inundated about 85% of the tract with water.

Table 4-4.1. Projected acres of the Gray Farm Tract Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	163 acres
1 m	173 acres
1.5 m	182 acres

Natural Capital (Table 4-4.2)

The total capital of the Gray Farm Tract has increased overall with a dip in 2002 and has remained within a narrow range. The amount of capital may continue to increase as upland communities are converted to wetland communities.

Table 4-4.2. Natural Capital of the Gray Farm Tract	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,064,960/year
2002	$1,063,231/year
2007	$1,066,395/year

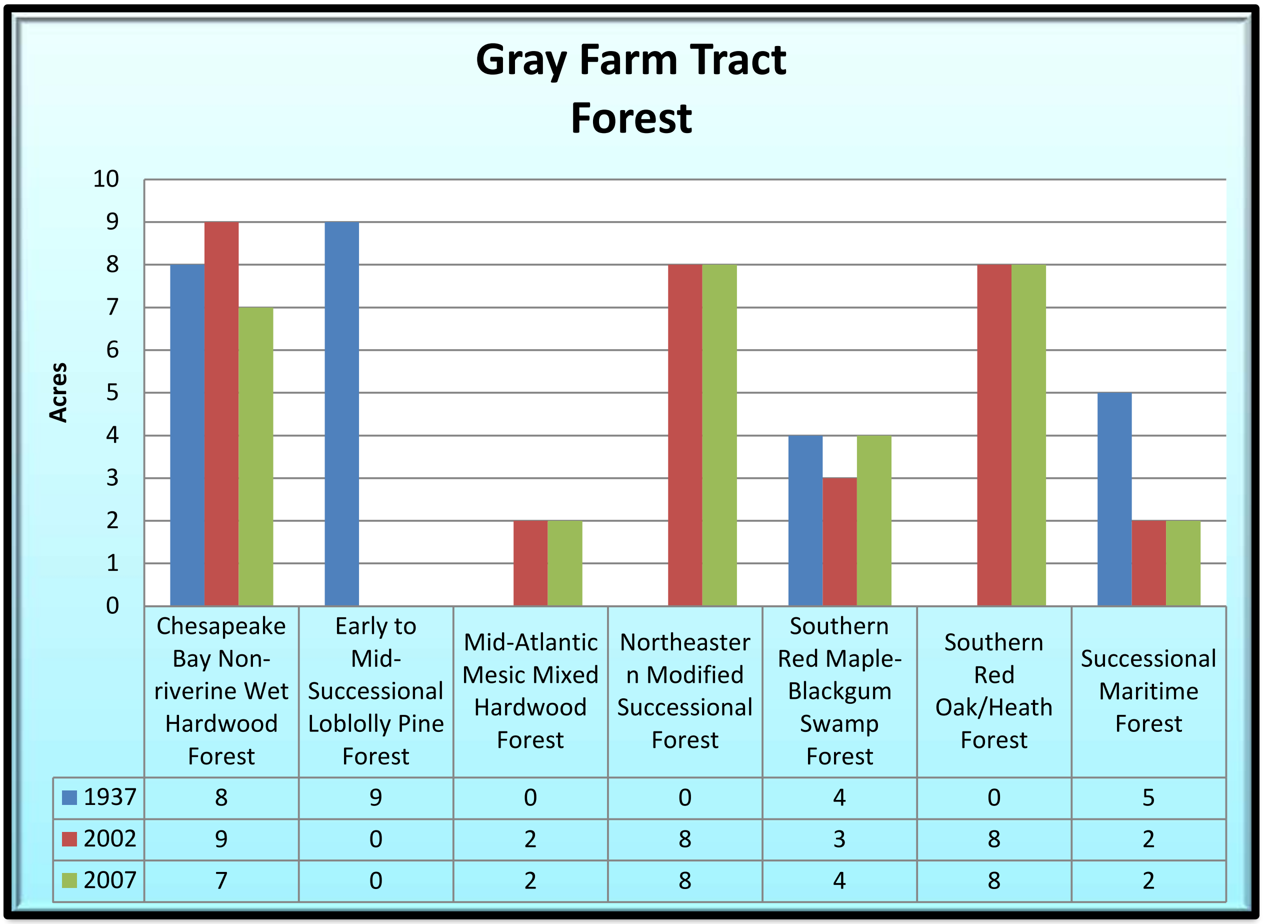


Figure 4-4.5. Gray Farm Tract Forest (1937, 2002, and 2007)

Gray Farm Tract Forest (Figure 4-4.5): Forest exists as a narrow buffer on this tract and for the most part has been decreasing as the march of sea level rise continues converting it to woodland and shrubland. Only one, Northeastern Modified Successional Forest, has increased and is likely a result of the edge effects of the agricultural fields. Early to Mid-Successional Loblolly Pine Forest has matured into other forest types and no longer exists on the tract.

DNREC Sea Level Rise Analysis (Table 4-4.3)

A little more than half of the forestland in the Gray Farm Tract will be inundated with 0.5 m of sea level rise. At 1.5 m of rise about ¾ of the forest area will be flooded by water.

Table 4-4.3. Projected acres of Gray Farm Tract Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	17 acres
1 m	21 acres
1.5 m	24 acres

Natural Capital (Table 4-4.4)

Overall the capital of forests in the Gray Farm Tract has declined since 1937 with a peak in capital at 2002. The amount of capital may increase if adjacent upland forests are converted to wetland forests, which have more capital than dry forests.

Table 4-4.4. Natural Capital of Gray Farm Tract Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$150,145/year
2002	$151,280/year
2007	$138,989/year

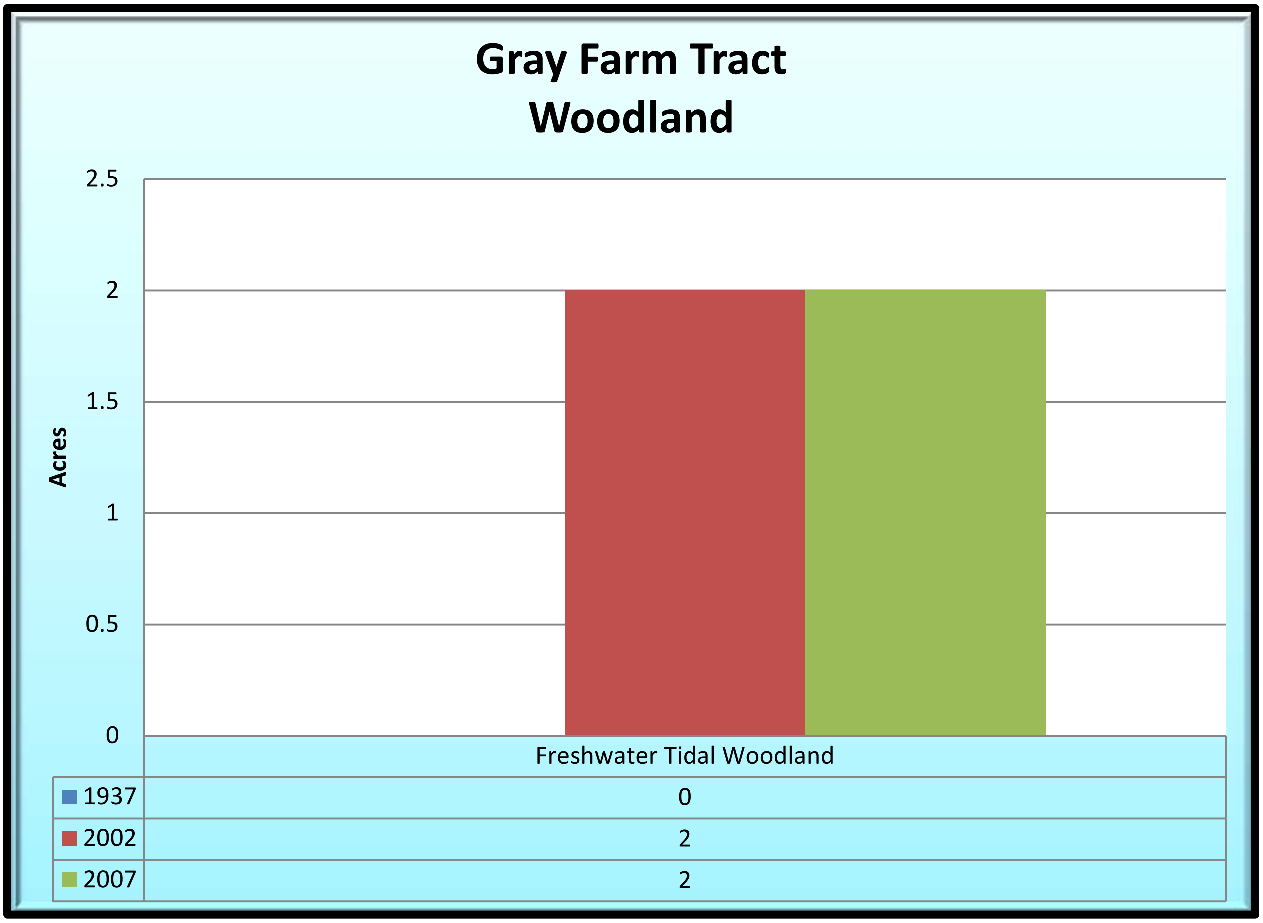


Figure 4-4.6. Gray Farm Tract Woodland (1937, 2002, and 2007)

Gray Farm Tract Woodland (Figure 4-4.6): Freshwater Tidal Woodland is the only woodland present in the Gray Farm tract. It seems to arise from the flooding of Chesapeake Bay Non-riverine Wet Hardwood Forest, which kills the sweetgum but leaves the red maple creating a woodland canopy. Analysis of aerials and field observation shows that this community gradually converts to shrubland (Wax-Myrtle Shrub Swamp) and then to marsh. This community may decline in the near future due to the tidal water hitting a topographic high and stopping its horizontal progression.

DNREC Sea Level Rise Analysis (Table 4-4.5)

All of the current acreage of Freshwater Tidal Woodland will be inundated with 0.5 m of sea level rise.

Table 4-4.5. Projected acres of Gray Farm Tract Woodland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 4-4.6)

Freshwater Tidal Woodland has been stable in amount in the recent period (2002-2007). It was not present in 1937.

Table 4-4.6. Natural Capital of Gray Farm Tract Woodland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$24,583/year
2007	$24,583/year

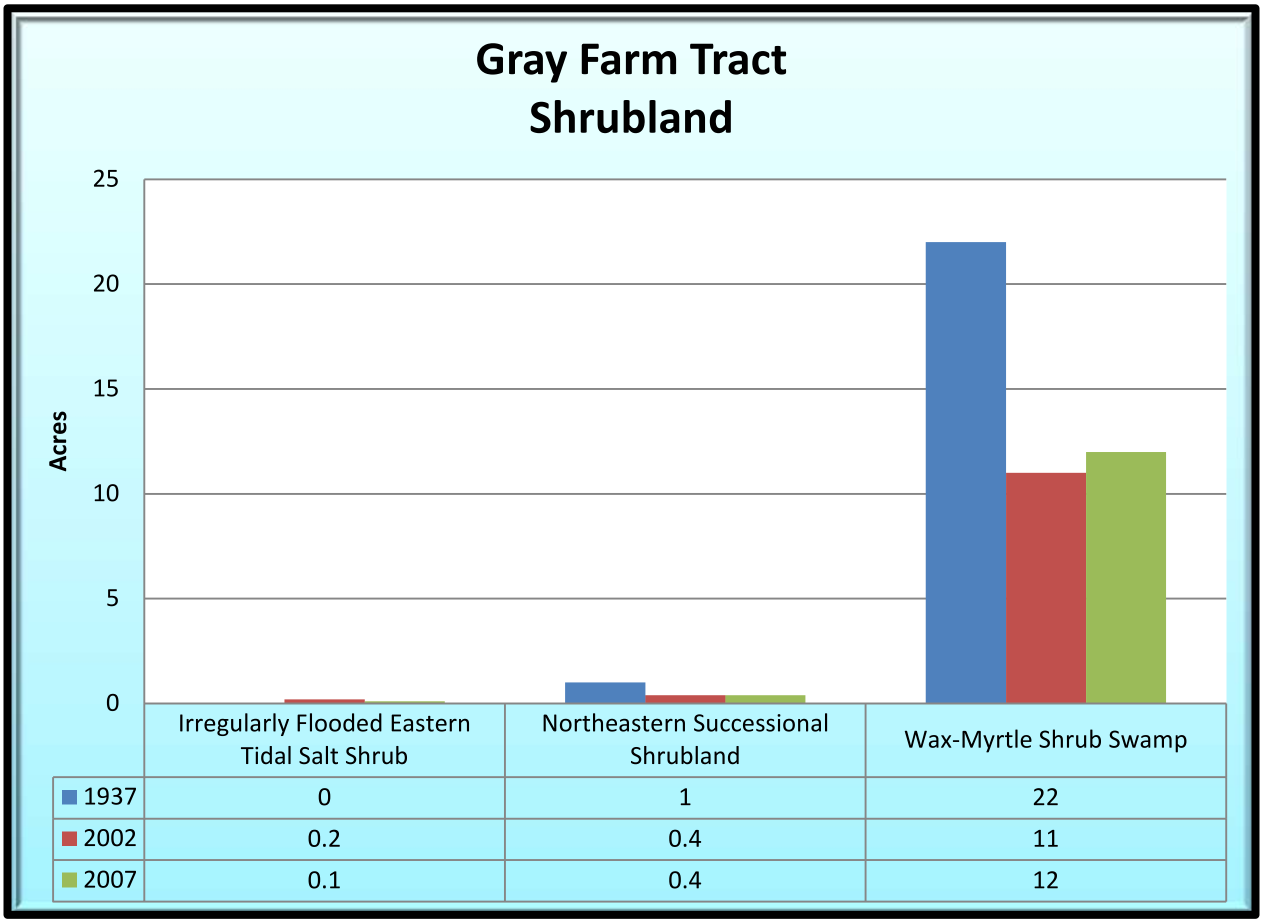


Figure 4-4.7. Gray Farm Tract Shrubland (1937, 2002, and 2007)

Gray Farm Tract Shrubland (Figure 4-4.7): Wax-Myrtle Shrub Swamp is the predominant shrubland of three in this tract and has been in decline. This may be caused by the lack of conversion of the Freshwater Tidal Woodland which is rimmed by a topographic high area at the rivers edge. The other two shrublands compose a small amount of the tract and have been relatively stable in amount.

DNREC Sea Level Rise Analysis (Table 4-4.7)

All of the shrubland currently present in the Gray Farm Tract will be inundated with 0.5 m.

Table 4-4.7. Projected acres of Gray Farm Tract Shrubland Inundated by Sea Level Rise

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

Natural Capital (Table 4-4.8)

A large loss of the Wax-Myrtle Shrub Swamp from saline water has contributed to a loss of capital in shrubland. Recently the amount has come up some due to an increase in Wax-Myrtle Shrub Swamp.

Table 4-4.8. Natural Capital of Gray Farm Tract Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$204,337/year
2002	$103,408/year
2007	$112,062/year

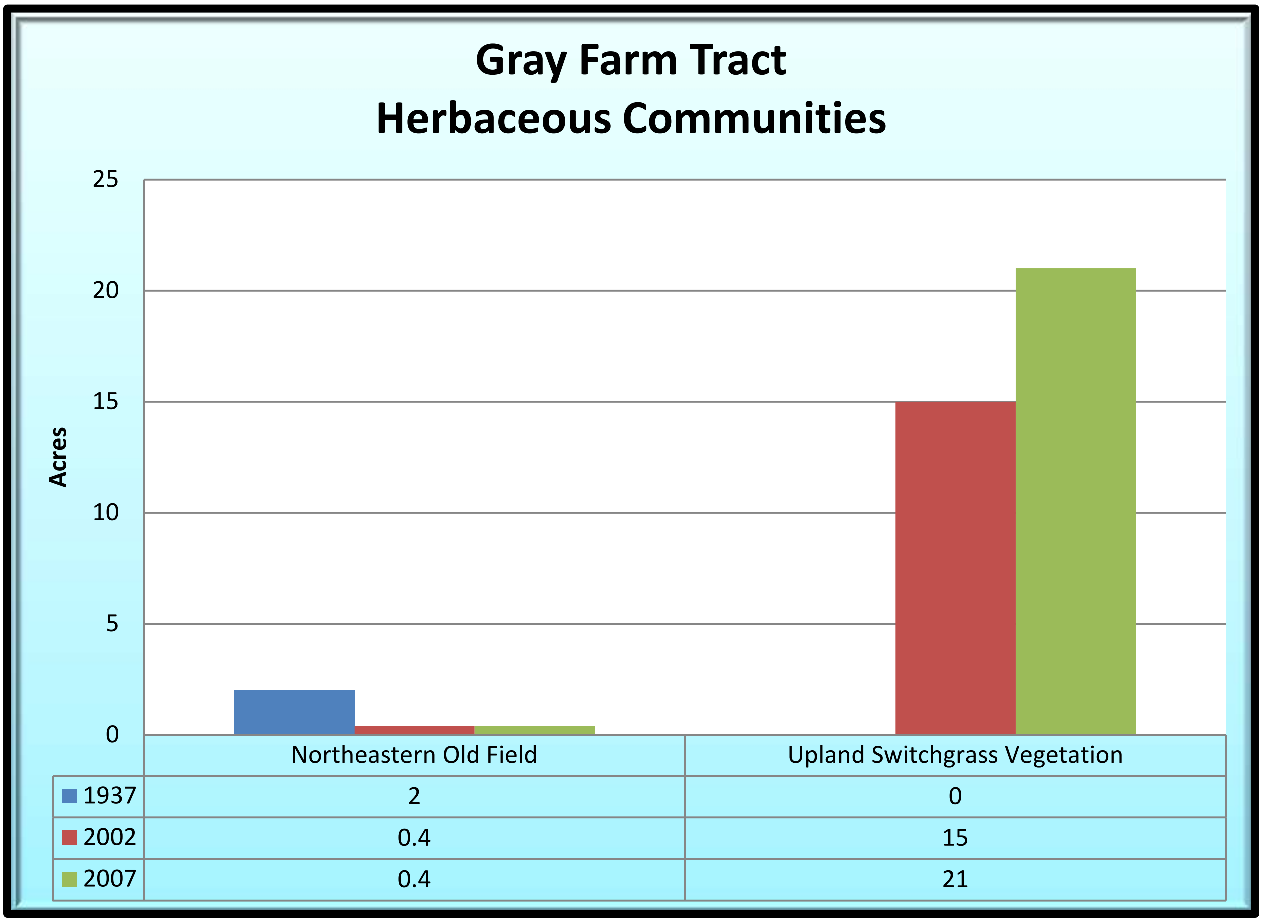


Figure 4-4.8. Gray Farm Tract Herbaceous Communities (1937, 2002, and 2007)

Gray Farm Tract Herbaceous Communities (Figure 4-4.8): Two herbaceous communities, Northeastern Old Field and Upland Switchgrass Vegetation, are present on the Gray Tract. Northeastern Old field has decreased as it has matured into likey Northeastern Modified Successional Forest. Upland Switchgrass Vegetation has come about through restoration efforts on the edges of agricultural fields.

DNREC Sea Level Rise Analysis (Table 4-4.9)

All of the Northeastern Old Field will be inundated with 1.5 m of sea level rise leaving a fairly large amount of Upland Switchgrass Vegetation remaining.

Table 4-4.9. Projected acres of Gray Farm Tract Herbaceous Communities Inundated by Sea Level Rise

Rise	Acres
0.5 m	3 acres
1 m	5 acres
1.5 m	7 acres

Natural Capital (Table 4-4.10)

Herbaceous communities have been increasing mainly being driven by the increase in Upland Switchgrass Vegetation.

Table 4-4.10. Natural Capital of Gray Farm Tract Herbaceous Communities

Year	Natural Capital (in 2012 dollars)
1937	$291/year
2002	$2,244/year
2007	$3,118/year

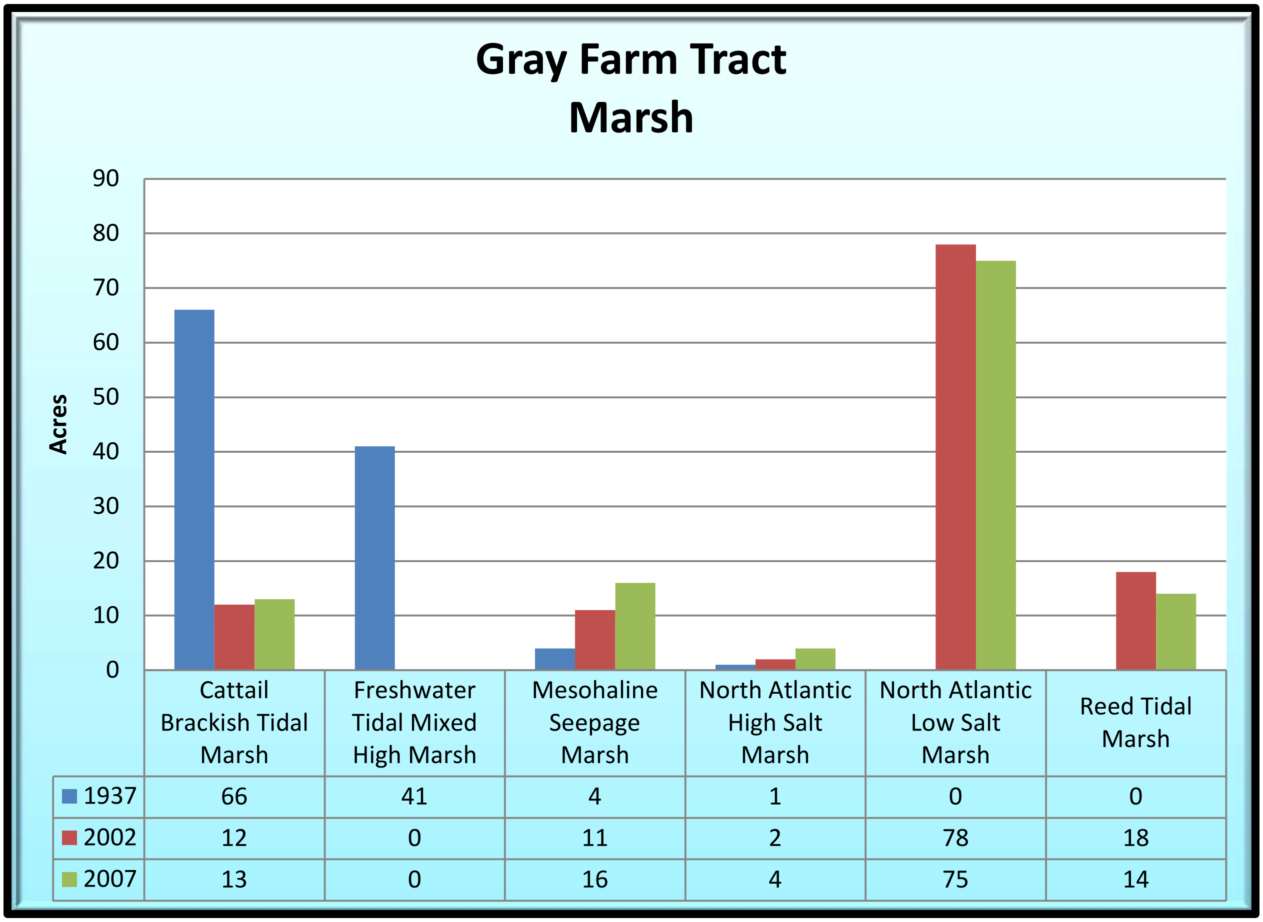


Figure 4-4.9. Gray Farm Tract Marsh (1937, 2002, and 2007)

Gray Farm Tract Marsh (Figure 4-4.9): In 1937, Cattail Brackish Tidal Marsh and Freshwater Tidal Mixed High Marsh were the most common marshes in the Gray Farm Tract. Over time as salinity has increased these have changed into marshes that more brackish (Mesohaline Seepage Marsh) and saline (North Atlantic Low Salt Marsh). Reed Tidal Marsh has come about since 1937 but has declined in the recent period due to eradication efforts and maybe also increased water.

DNREC Sea Level Rise Analysis (Table 4-4.11)

All of the current marshland will be inundated with water with 0.5 m of sea level rise.

Table 4-4.11. Projected acres of Gray Farm Tract Marsh Inundated by Sea Level Rise

Rise	Acres
0.5 m	121 acres
1 m	121 acres
1.5 m	121 acres

Natural Capital (Table 4-4.12)

The marshland in the Gray Farm Tract has changed in community type, but has also changed in amount leading to an increase in capital. This increase is still happening the recent period (2002-2007).

Table 4-4.12. Natural Capital of Gray Farm Tract Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$702,386/year
2002	$758,827/year
2007	$765,099/year

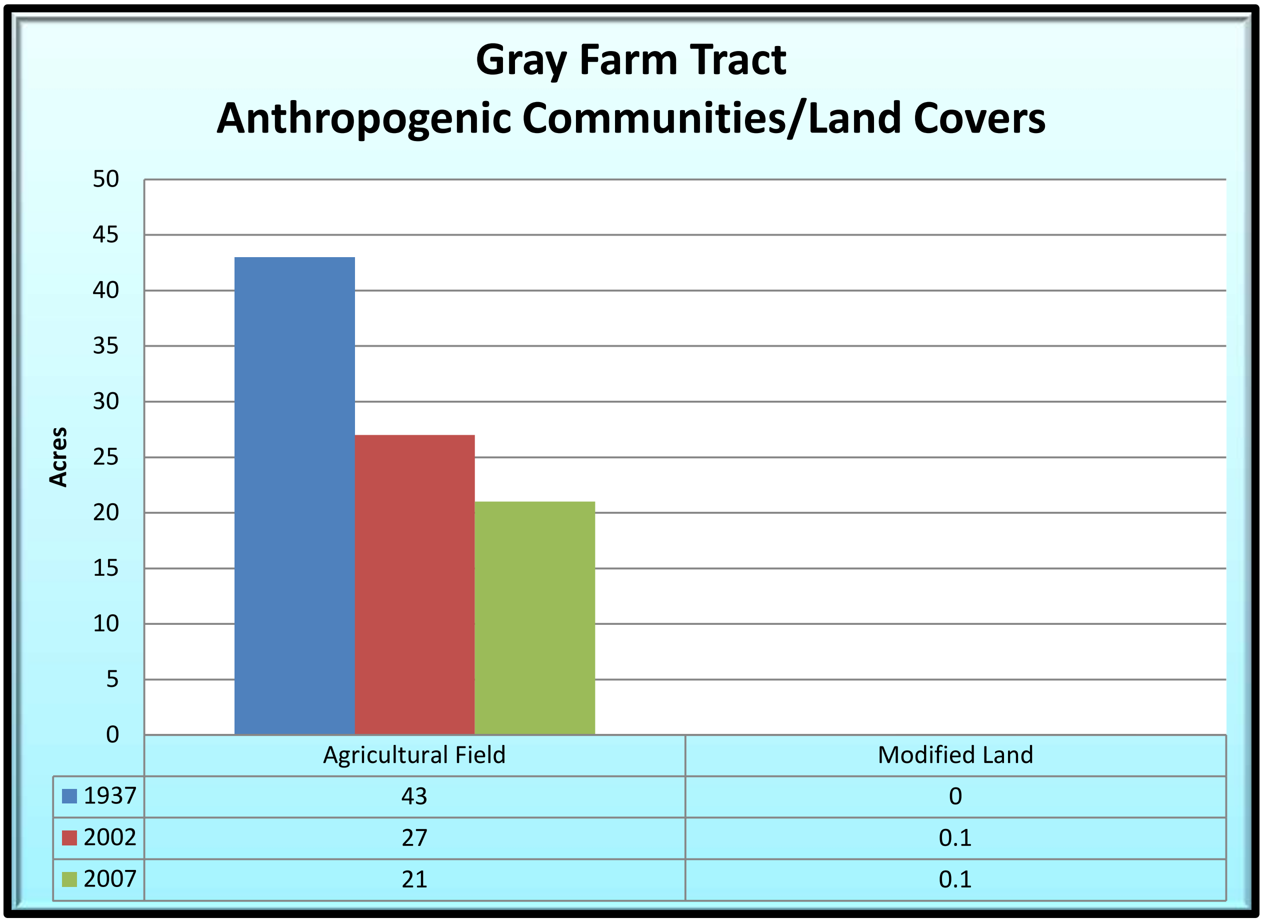


Figure 4-4.10. Gray Farm Tract Anthropogenic Communities/Land Covers (1937, 2002, and 2007)

Gray Farm Tract Anthropogenic Communities (Figure 4-4.10): Agricultural field is the most common anthropogenic community but has declined with conversion to shrubland and forest.

DNREC Sea Level Rise Analysis (Table 4-4.13)

A little more than half of the anthropogenic communities/land covers will be inundated with 1.5 m of sea level rise.

Table 4-4.13. Projected acres of Gray Farm Tract Anthropogenic Communities/Land Covers Inundated by Sea Level Rise

Rise	Acres
0.5 m	4 acres
1 m	8 acres
1.5 m	12 acres

Natural Capital (Table 4-4.14)

Agricultural field is the only anthropogenic community/land cover that has any natural capital value in the Gray Farm Tract. The capital of it has been going down as agricultural fields are abandoned and they revert to herbaceous communities (Northeastern Old Field). This transfer increases the overall capital in the tract and wildlife area.

Table 4-4.14. Natural Capital of Gray Farm Tract Anthropogenic Communities/Land Covers

Year	**Natural Capital (in 2012 dollars)**
1937	$2,466/year
2002	$1,548/year
2007	$1,204/year

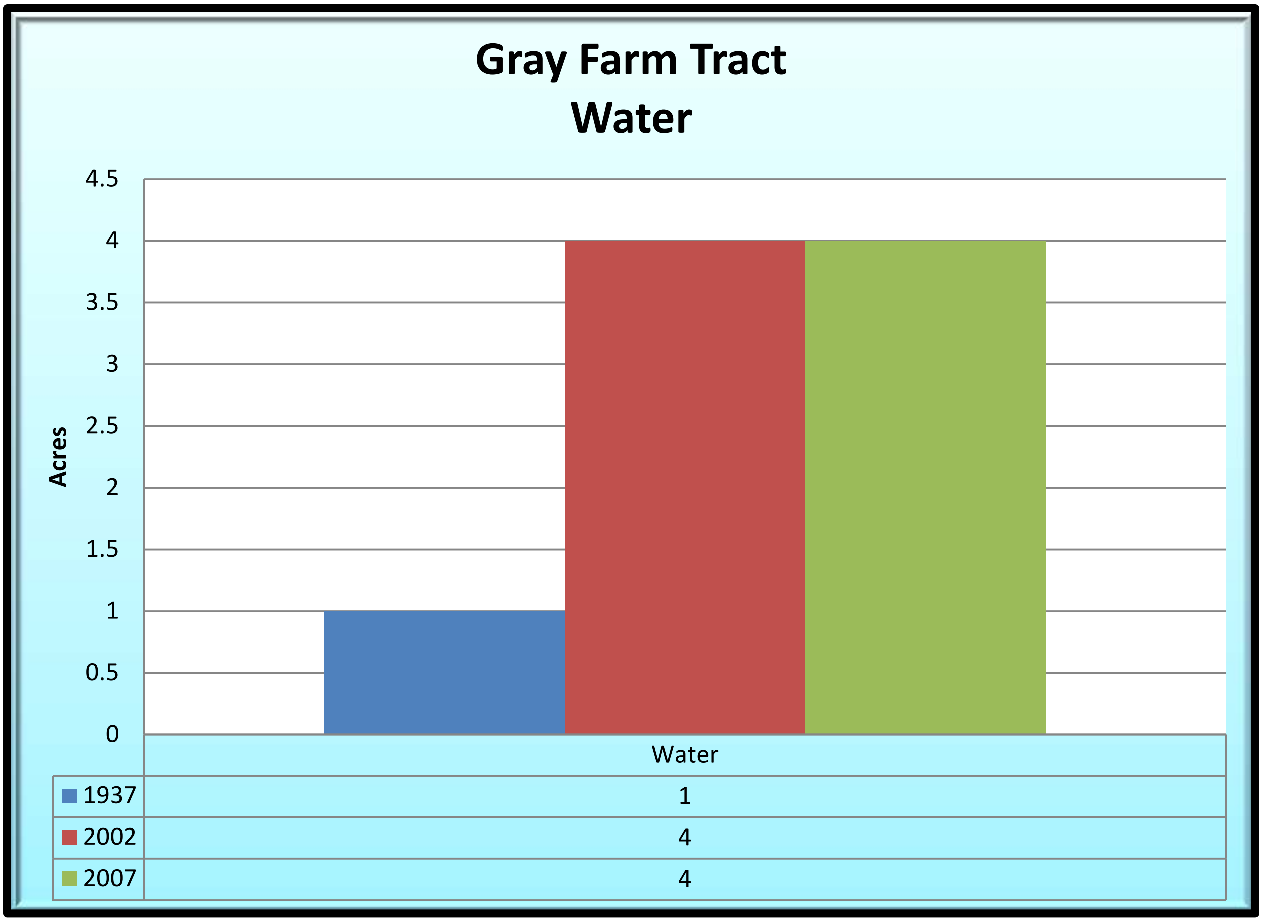


Figure 4-4.11. Gray Farm Tract Water (1937, 2002, and 2007)

Gray Farm Tract Water Coverage (Figure 4-4.11): As with a lot of the tracts, water has increased with the relentless march of sea level rise. Since the other tidal vegetation communities are showing indications of hitting a topographic high as they are not increasing, namely the Freshwater Tidal Woodland, water may become more common and marsh the woodlands and shrublands may disappear at a faster rate. A similar fate may befall the marshland. The historic rate of iniundation in this tract has been (1937-2002 = 0.05 acres/year) and (1937-2007 = 0.05 acres/year). The recent rate (2002-2007), however has been stable with 0 acres/year.

Natural Capital (Table 4-4.16)

Agricultural field is the only anthropogenic community/land cover that has any natural capital value in the Dickerson Tract. The capital of it has been going down as agricultural fields are abandoned and they revert to herbaceous communities (Northeastern Old Field). This transfer increases the overall capital in the tract and wildlife area.

Table 4-4.16. Natural Capital of Gray Farm Tract Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$5,335/year
2002	$21,340/year
2007	$21,340/year

5. Hall Tract

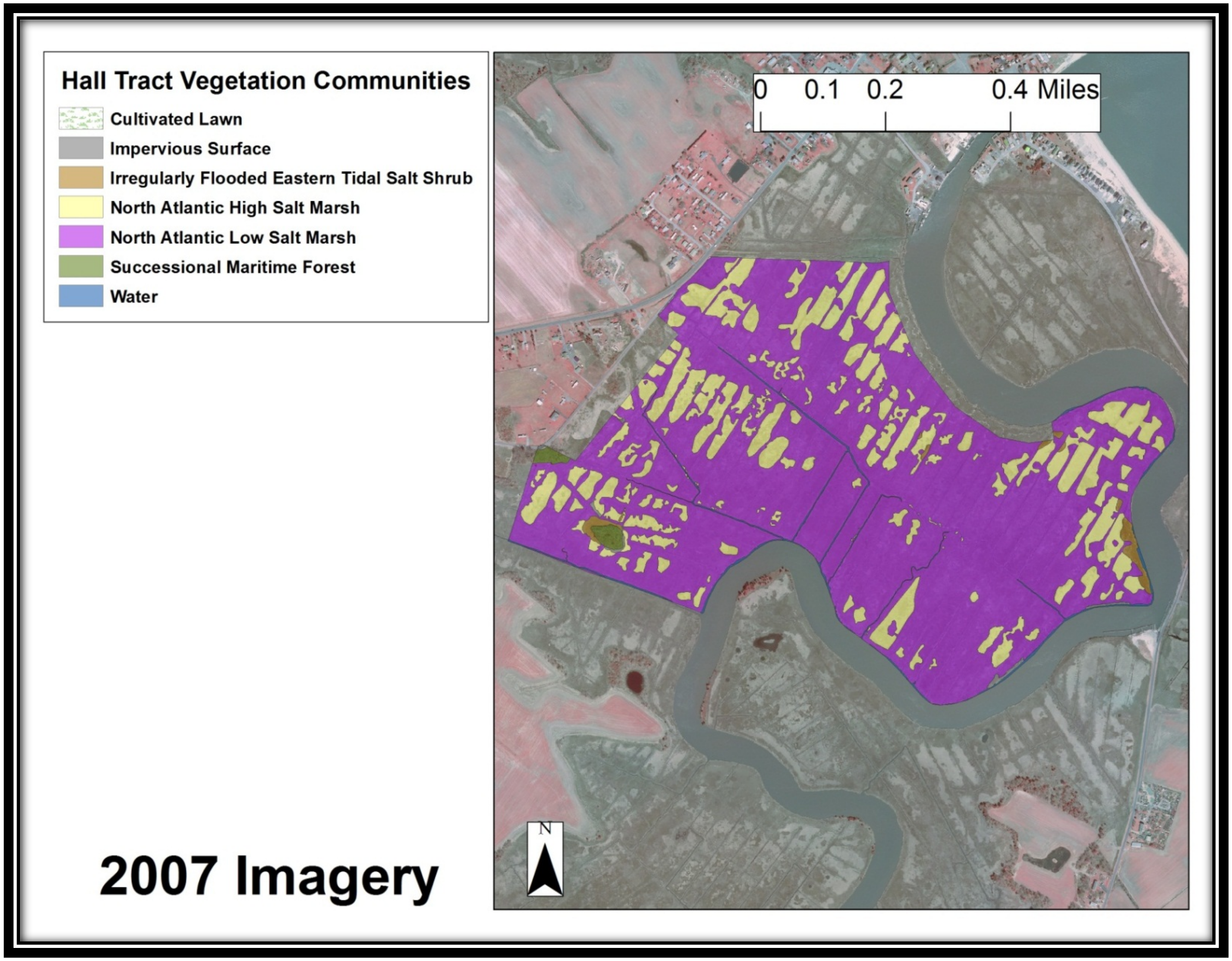


Figure 4-5.1. 2007 Vegetation Communty Map of the Hall Tract

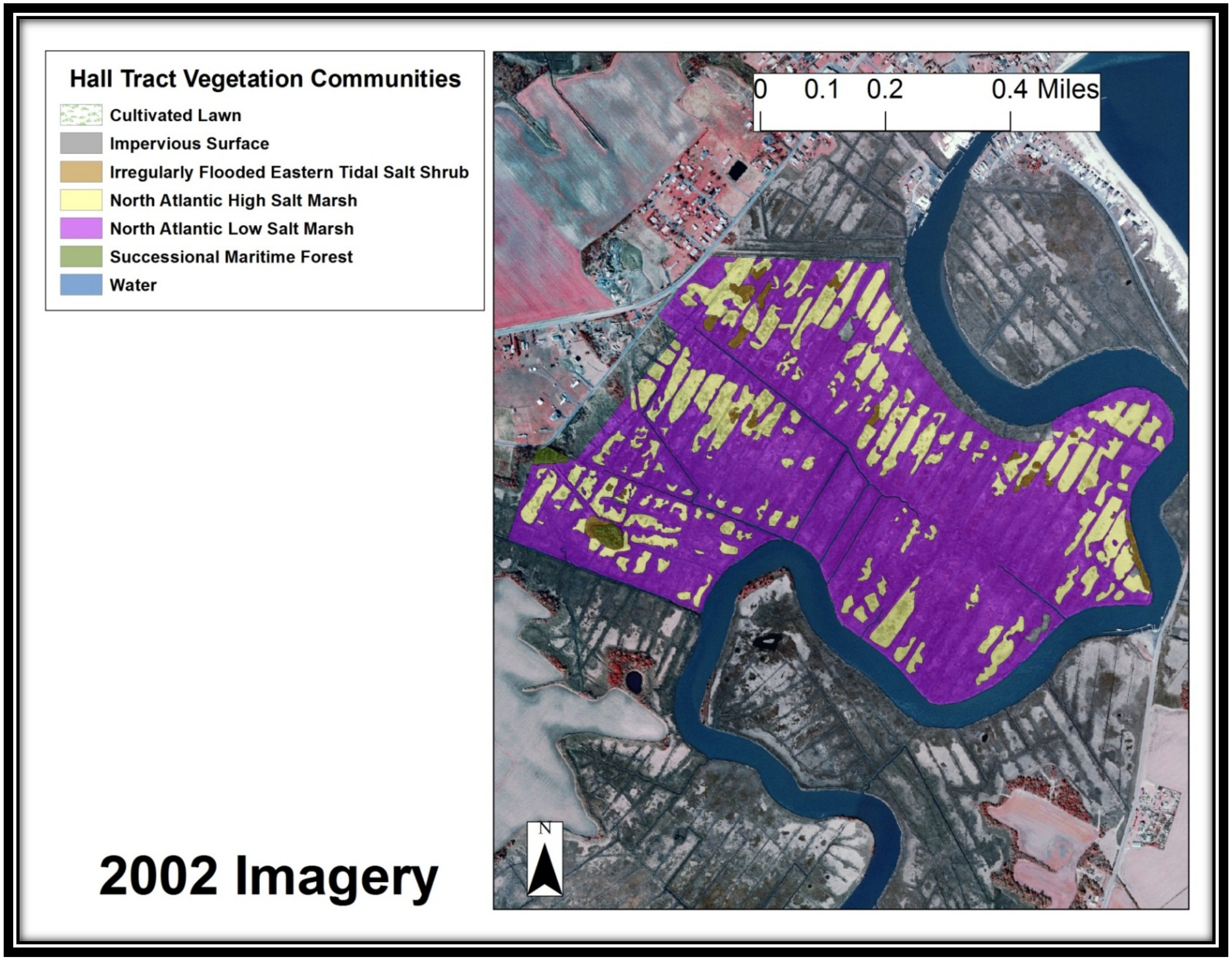


Figure 4-5.2. 2002 Vegetation Community map of the Hall Tract

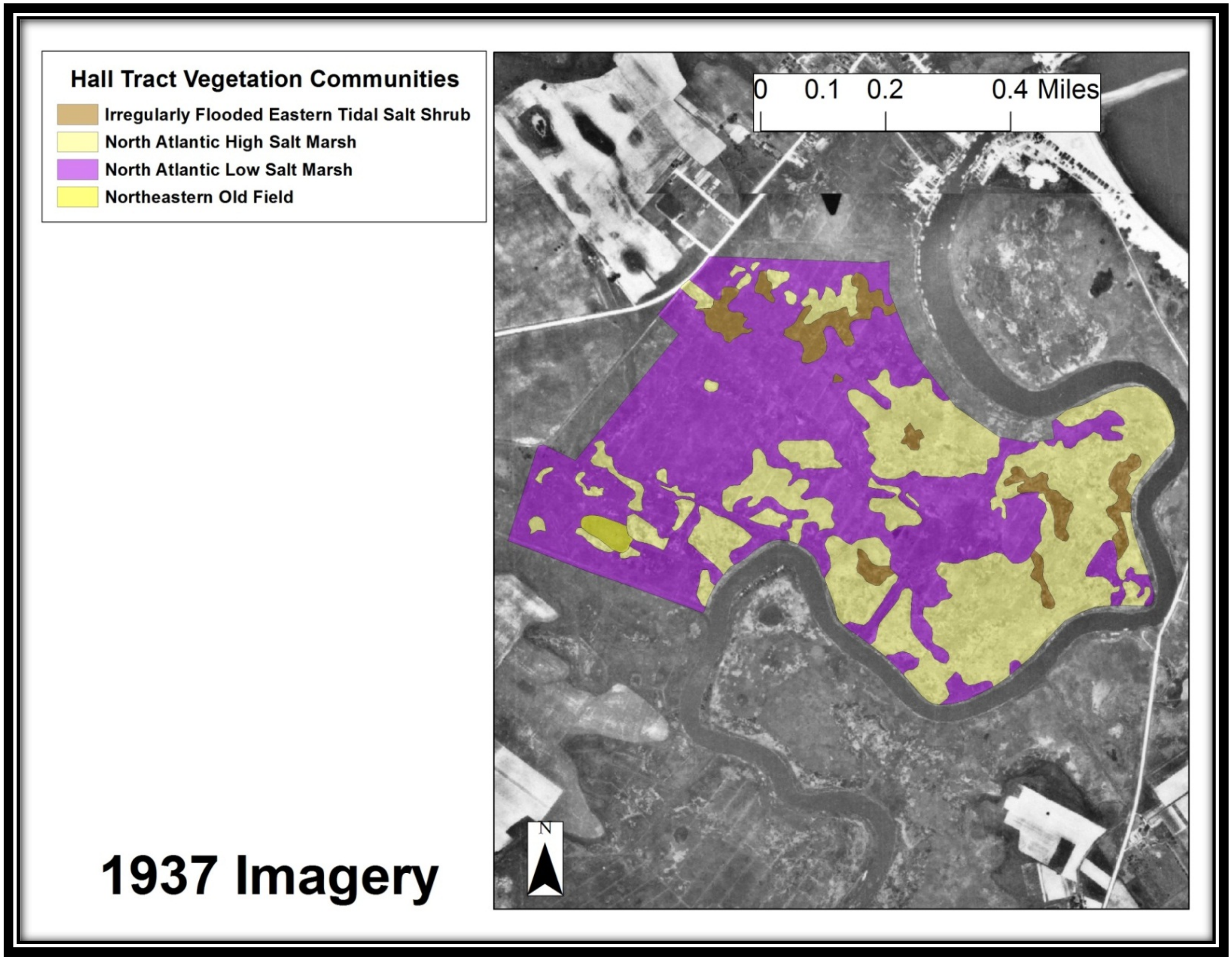
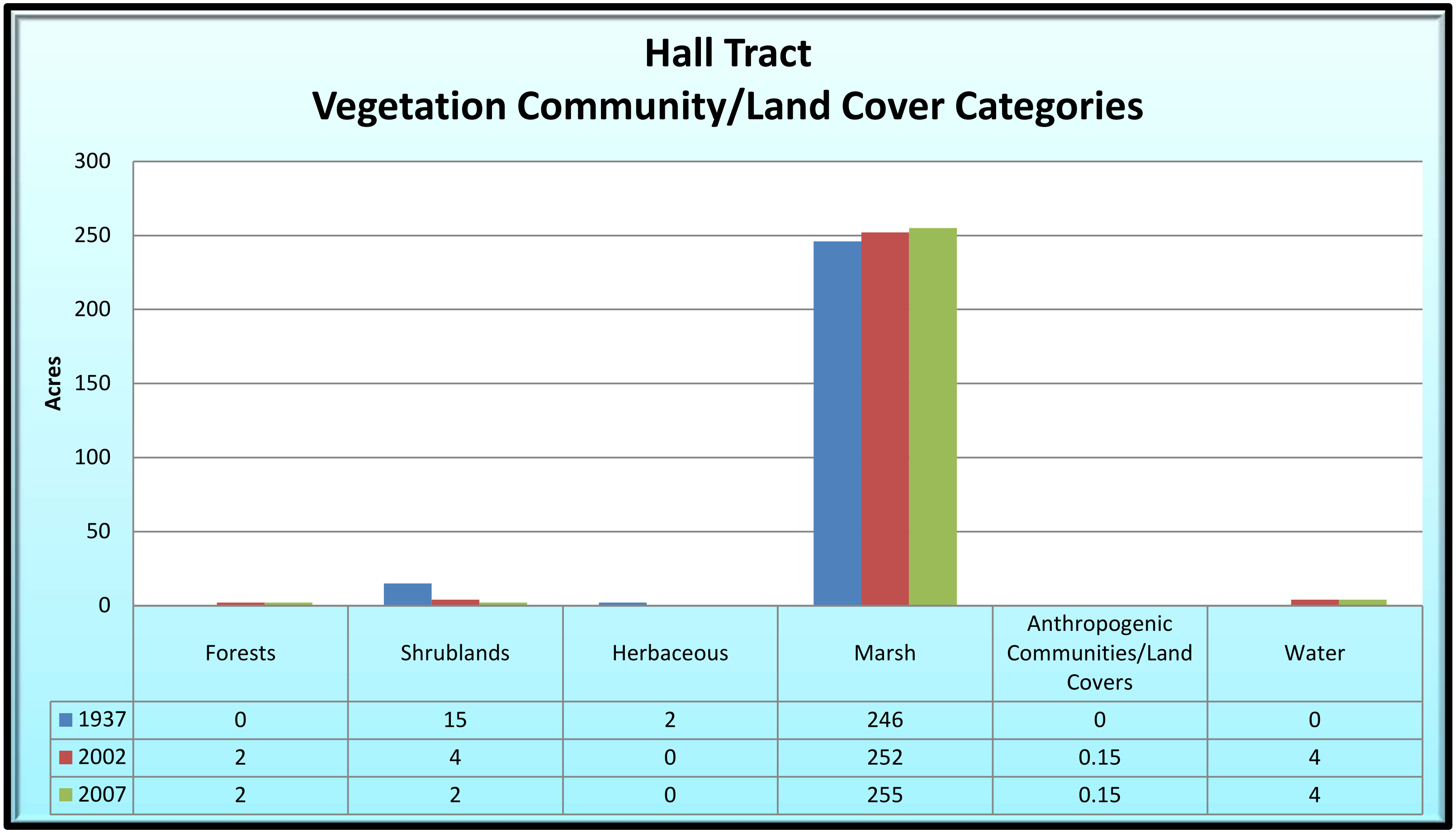


Figure 4-5.3. 1937 Vegetation Community Map of the Hall Tract



	Forests	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Water
1937	0	15	2	246	0	0
2002	2	4	0	252	0.15	4
2007	2	2	0	255	0.15	4

Figure 4-5.4. Hall Tract Vegetation Community/Land Cover Categories (1937, 2002, and 2007)

Hall Tract Broad Trends (Figure 4-5.4): The Hall Tract is a small tract that is located on the northern floodplain of the Murderkill River near Bowers Beach. Most of the tract is subject to tides and as a result marshland is the main vegetation type. Some small areas of forest and shrubland are located on the higher parts of the site.

DNREC Sea Level Rise Analysis (Table 4-5.1)

Practically all of the Hall Tract will be inundated by 0.5 m of sea level rise. For this reason a change analysis will not be done for the vegetation categories.

Table 4-5.1. Projected acres of the Hall Tract Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	263 acres
1 m	263 acres
1.5 m	263 acres

Natural Capital (Table 4-5.2)

Capital in the Hall Tract has increased overall from marsh and shrubland acreage with a dip in the 2002 to 2007 period.

Table 4-5.2. Natural Capital of the Hall Tract	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,637,101/year
2002	$1,663,162/year
2007	$1,663,162/year

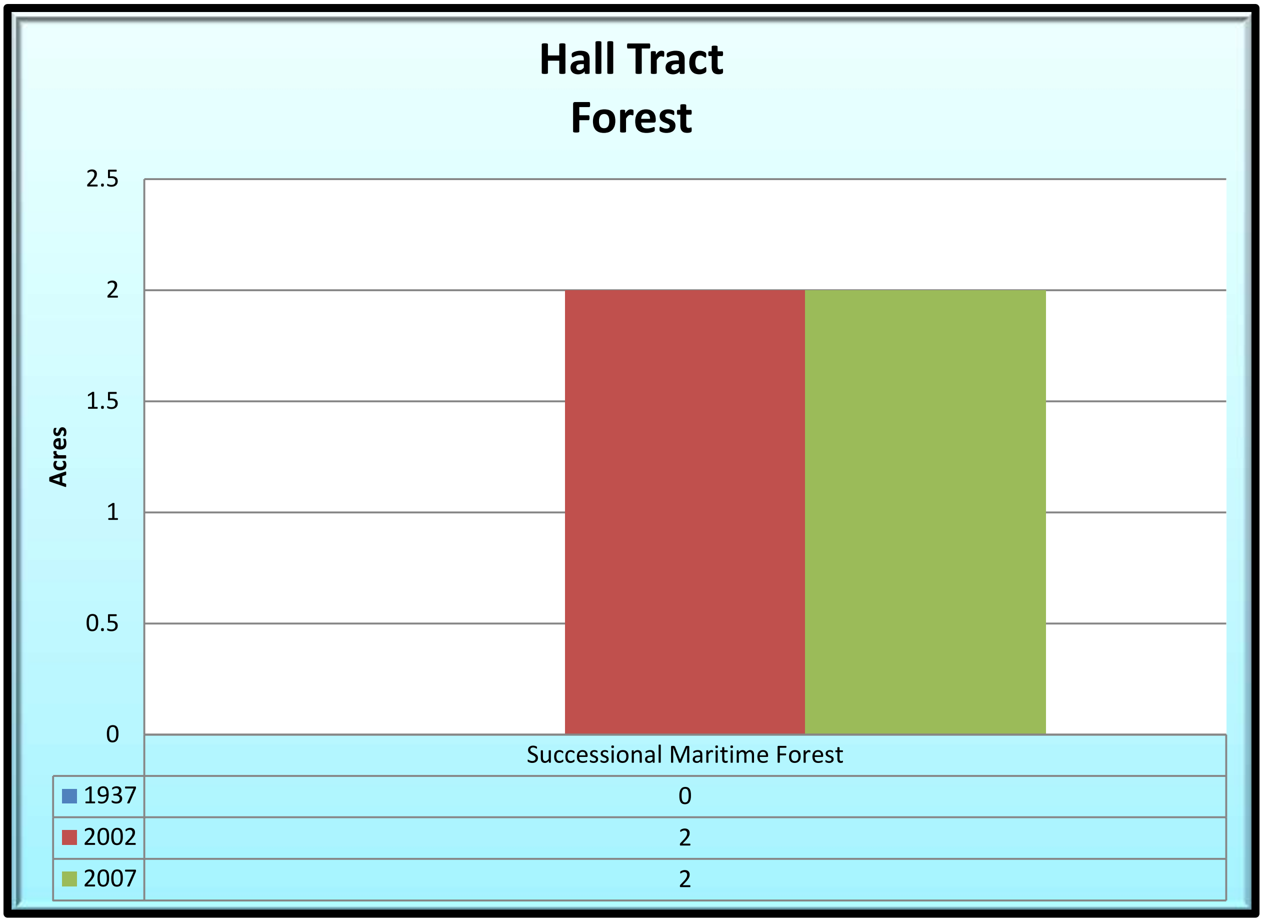


Figure 4-5.5. Hall Tract Forest (1937, 2002, and 2007)

Hall Tract Forest (Figure 4-5.5): Successional Martime Forest is the only forest located on the lowlands of the Hall Tract. It arised from a former Northeastern Old Field that may have been pastureland or agricultural field.

Natural Capital (Table 4-5.3)

Successional Maritime Forest occupies 2 acres in the Hall Tract and has been stable in amount in the recent period (2002-2007). It was not present in 1937.

Table 4-5.3. Natural Capital of Hall Tract Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$378/year
2007	$378/year

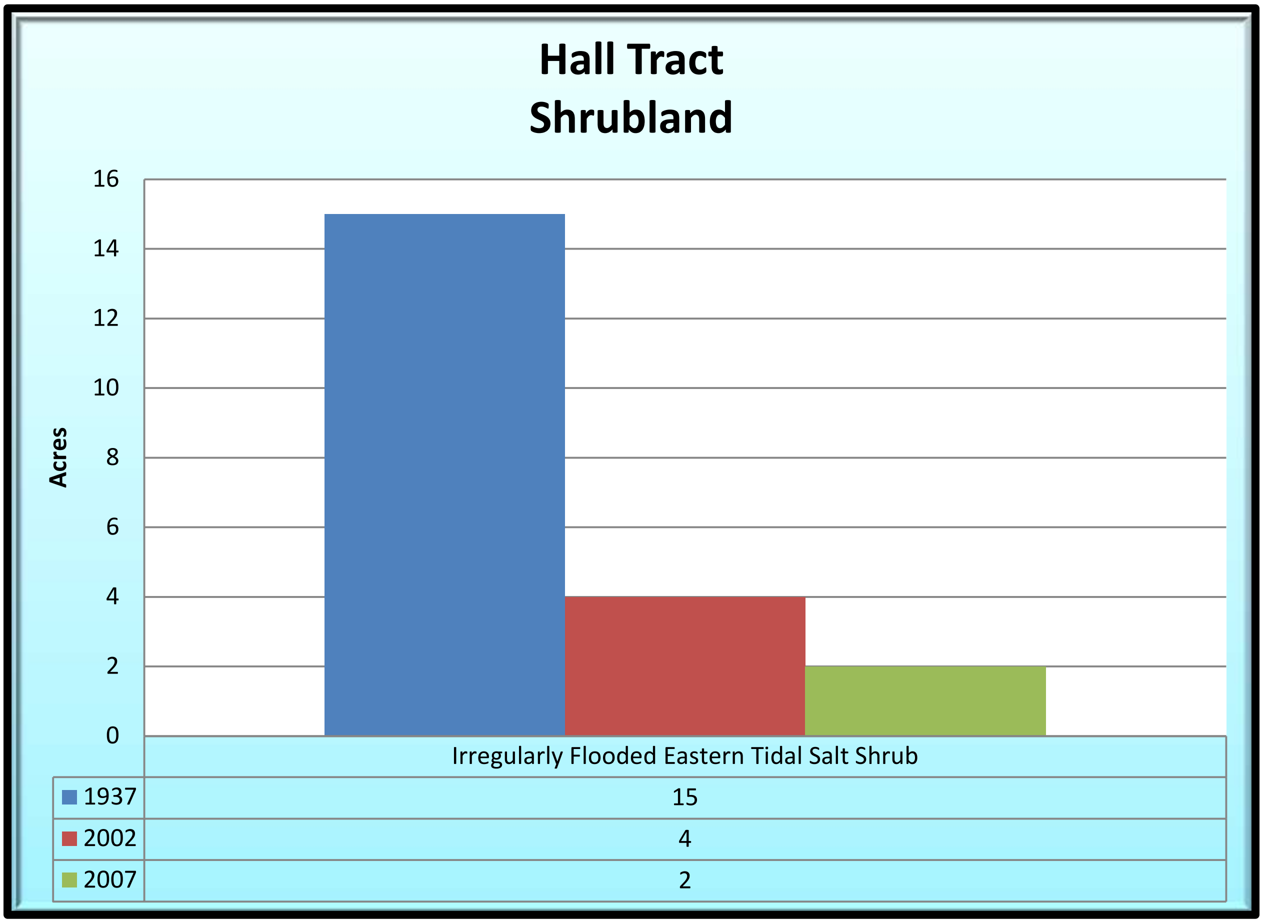


Figure 4-5.6. Hall Tract Shrubland (1937, 2002, and 2007)

Hall Tract Shrubland (Figure 4-5.6): One shrubland, Irregularly Flooded Eastern Tidal Salt Shrub, is present on the Hall Tract. Since 1937 it has decreased but has recently gained some ground, bucking a trend observed in other places. It is uknown what the future prospects are for this community but it may disappear at some point with greater rates of sea level rise.

Natural Capital (Table 4-5.4)

A decline in the amount of Irregularly Flooded Eastern Tidal Salt Shrub has led to a decline in shrubland capital. Recently the amount has resurged with an increase in acreage.

Table 4-5.4. Natural Capital of Hall Tract Shrubland

Year	Natural Capital (in 2012 dollars)
1937	$94,070/year
2002	$25,085/year
2007	$12,543/year

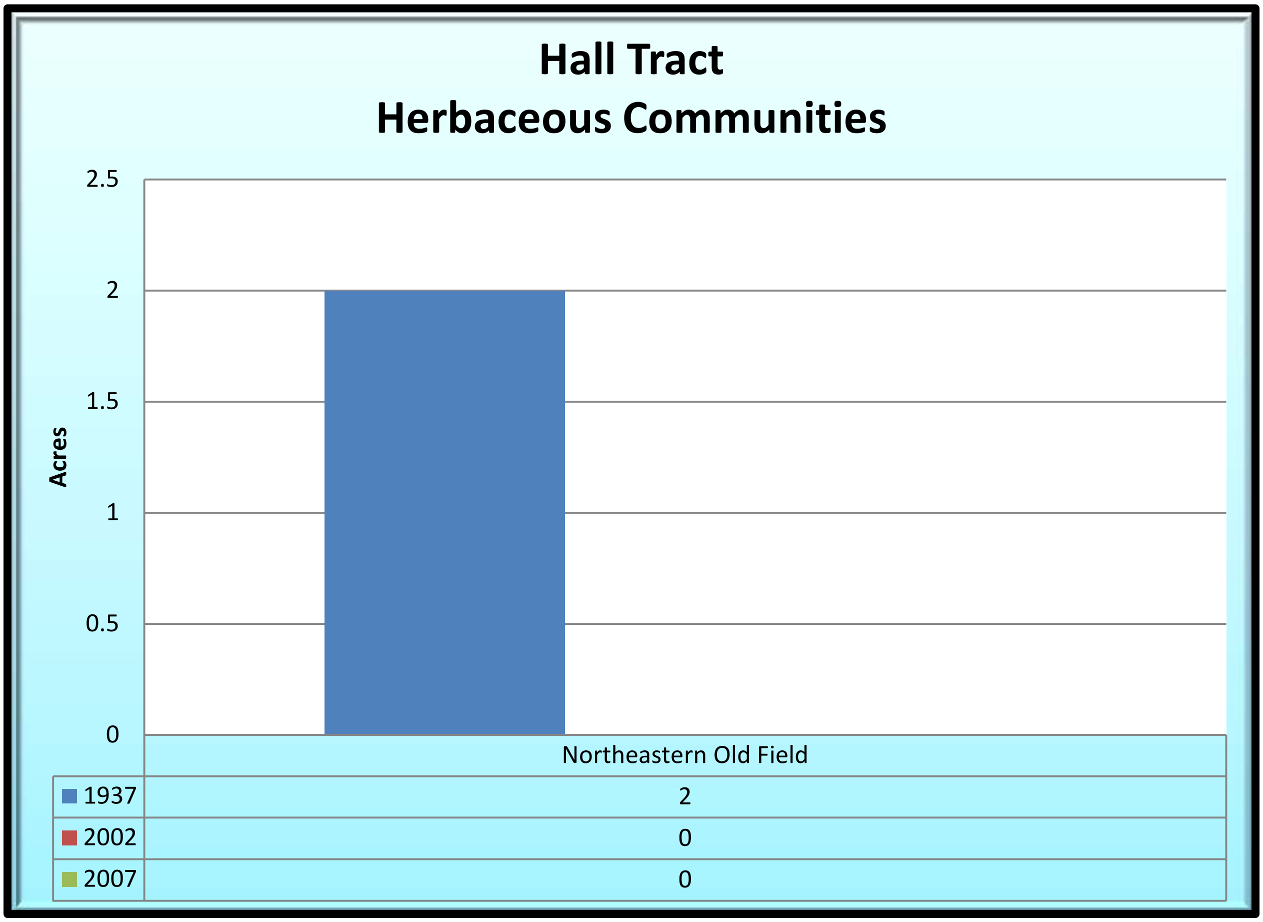


Figure 4-5.7. Hall Tract Herbaceous Communities (1937, 2002, and 2007)

Hall Tract Herbaceous Communities (Figure 4-5.7): Northeastern Old Field was present in 1937 but no longer remains on the tract. This community succeeded into Successional Maritime Forest at some point between 1937 and 2002.

Natural Capital (Table 4-5.5)

Northeastern Old Field that used to be in the tract is now forest and is no longer present.

Table 4-5.5. Natural Capital of Hall Tract Herbaceous Communities

Year	Natural Capital (in 2012 dollars)
1937	$291/year
2002	$0/year (not present)
2007	$0/year (not present)

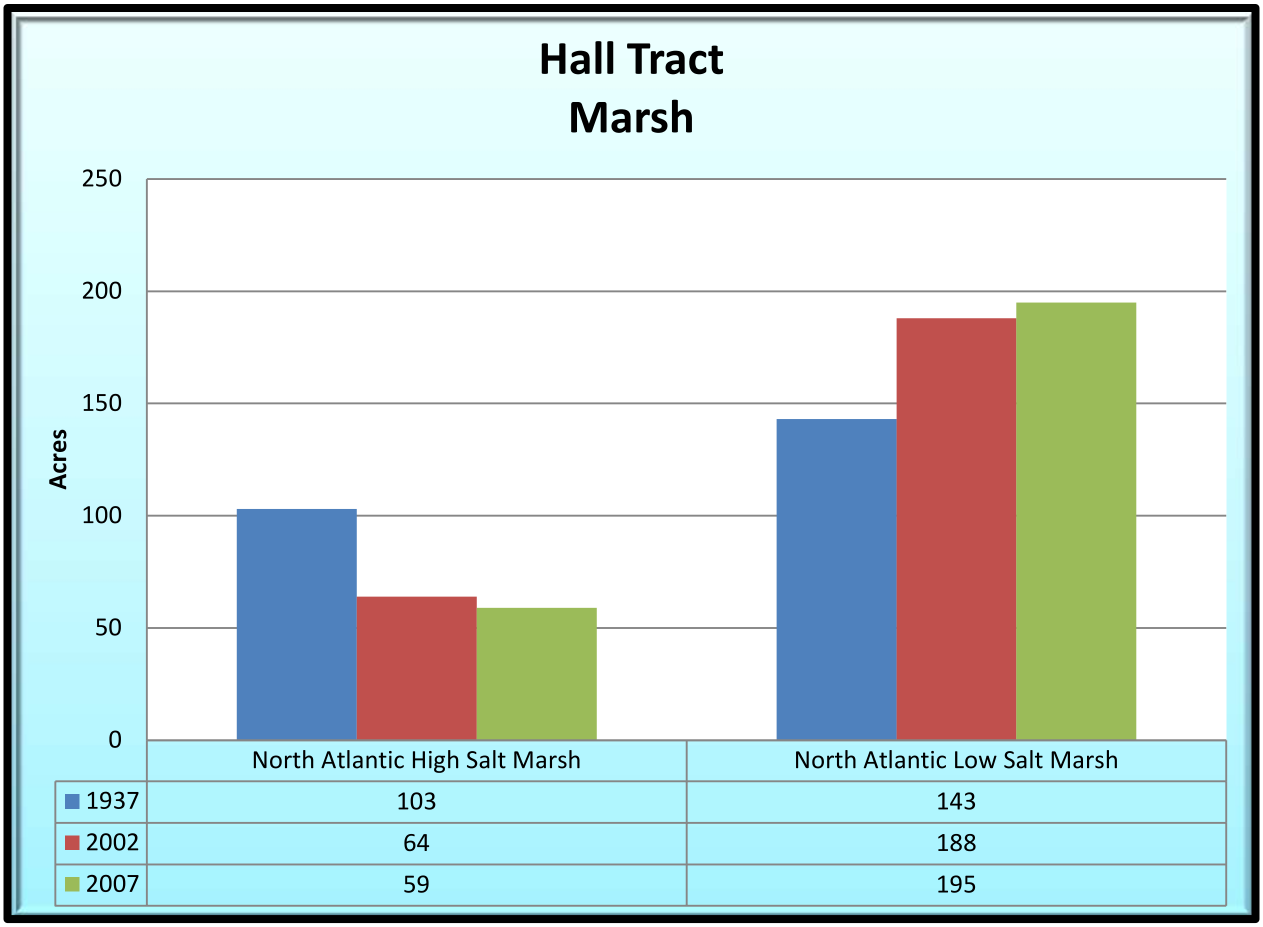


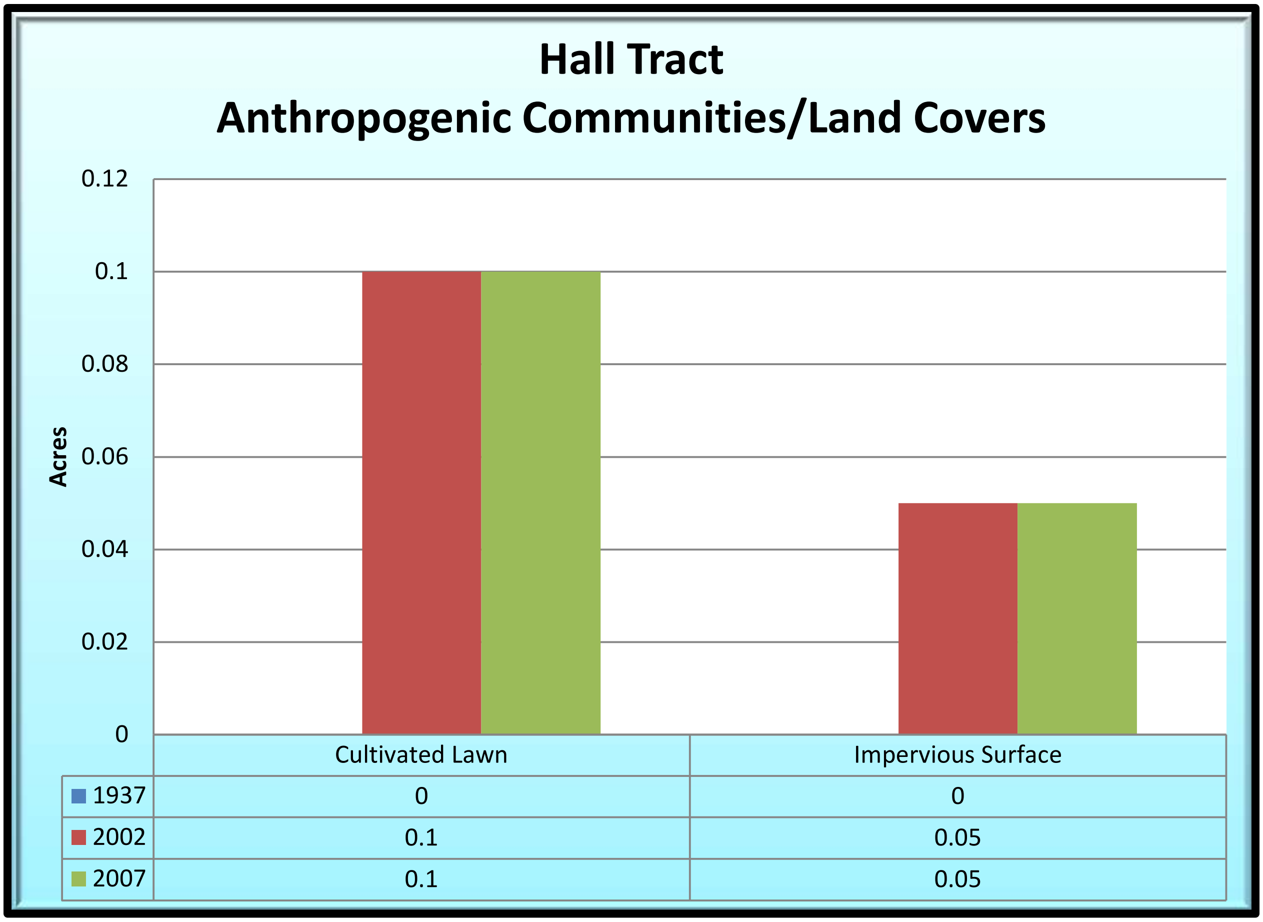
Figure 4-5.8. Hall Tract Marsh (1937, 2002, and 2007)

Hall Tract Marsh (Figure 4-5.8): North Atlantic Low Salt Marsh has been the most common marsh over time and has been increasing likely at the expense of the North Atlantic High Salt Marsh which has likely converted to this type. North Atlantic High Salt Marsh is essentially unchanged in amount from 2002 to 2007 but it is currently unknown if this is long-term trend or a bump on the road to decline. Judging from other locations the prognosis for this community is poor.

Natural Capital (Table 4-5.6)

North Atlantic High Salt Marsh has been declining while North Atlantic Low Salt Marsh has been increasing. Since the increases of North Atlantic Low Salt Marsh have been more than the North Atlantic High Salt Marsh the overall capital has increased over the study period.

Table 4-5.6. Natural Capital of Hall Tract Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,542,740/year
2002	$1,580,368/year
2007	$1,592,910/year



	Cultivated Lawn	Impervious Surface
1937	0	0
2002	0.1	0.05
2007	0.1	0.05

Figure 4-5.9. Hall Tract Anthropogenic Communities/Land Covers (1937, 2002, and 2007)

Hall Tract Anthropogenic Communities (Figure 4-5.9): Due to the low elevation and exposure to tidal flooding, Anthropogenic Communities are very minor part of the tract. Both Cultivated Lawn and Impervious Surface have come about since 1937 and are stable currently.

Natural Capital

None of the anthropogenic communities/land covers have any natural capital value in the Hall Tract.

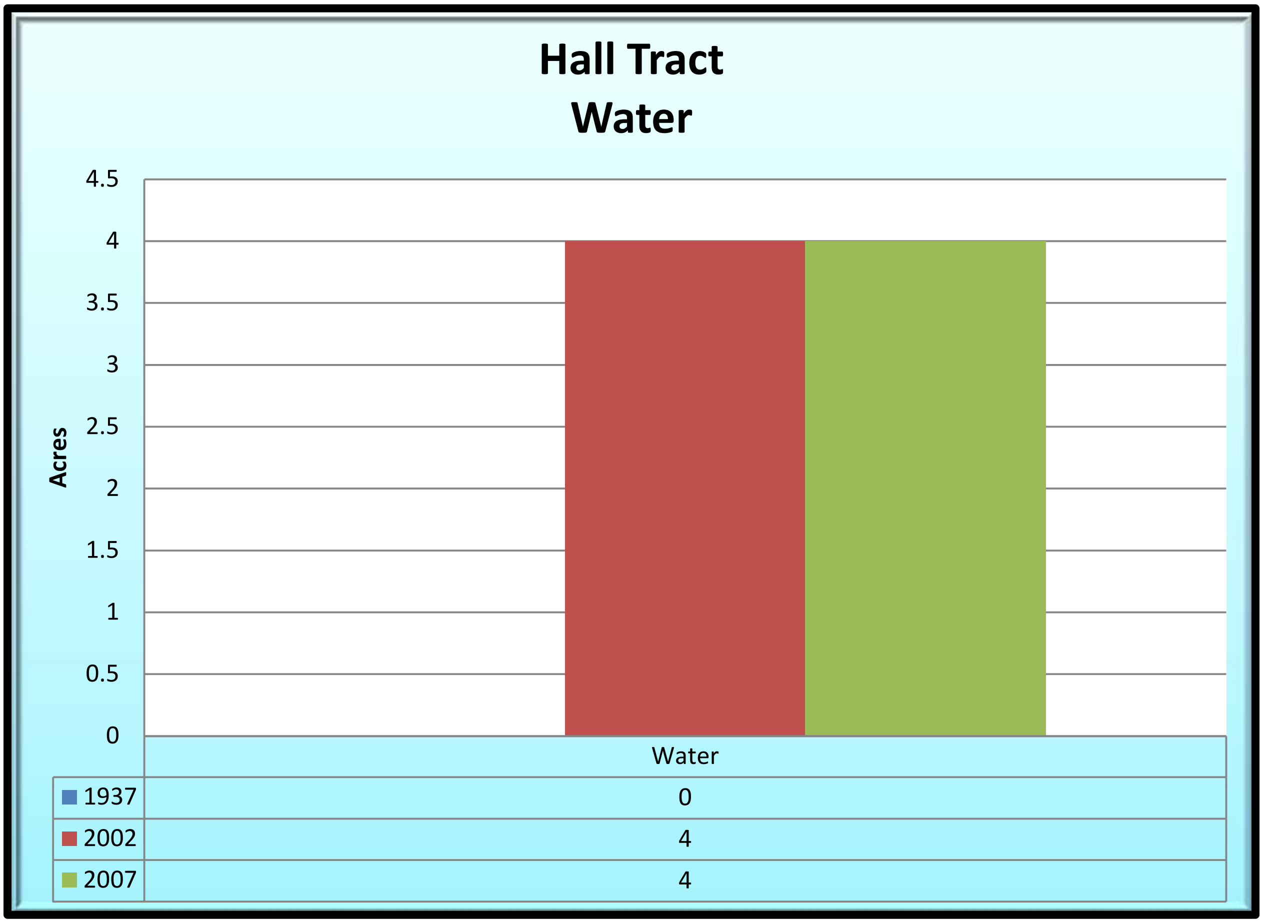


Figure 4-5.10. Hall Tract Water (1937, 2002, and 2007)

Hall Tract Water Coverage (Figure 4-5.10): Water that is subject to sea level rise is has appeared since 1937 when there was no coverage and has increased since. Between 2002 and 2007 the amount of coverage has decreased. I am unable to tell if this is fluctuation in an upward trend but this same pattern has been seen in other marsh areas (Hollager Tract) within the wildlife area. Some of the loss of water coverage may be due to accretion in the marsh. Increasing rates of sea level rise may erase the gains of accretion eventually. Other factors could be the DE 1 bridge over the Murderkill River which is nearby to both this tract and the Hollager Tract. . The historic rate of inundation in this tract has been (1937-2002 = 0.06 acres/year) and (1937-2007 = 0.04 acres/year). The recent rate (2002-2007) has been positive with 0.2 acres/year. It is unknown if this is long or short term slowing.

Natural Capital (Table 4-5.7)

No water was present within the boundaries of the Hall Tract in 1937. Since 1937, the amount of water has oscillated but has increased overall over the period.

Table 4-5.7. Natural Capital of Hall Tract Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$57,331/year
2007	$57,331/year

6. Hollager Tract

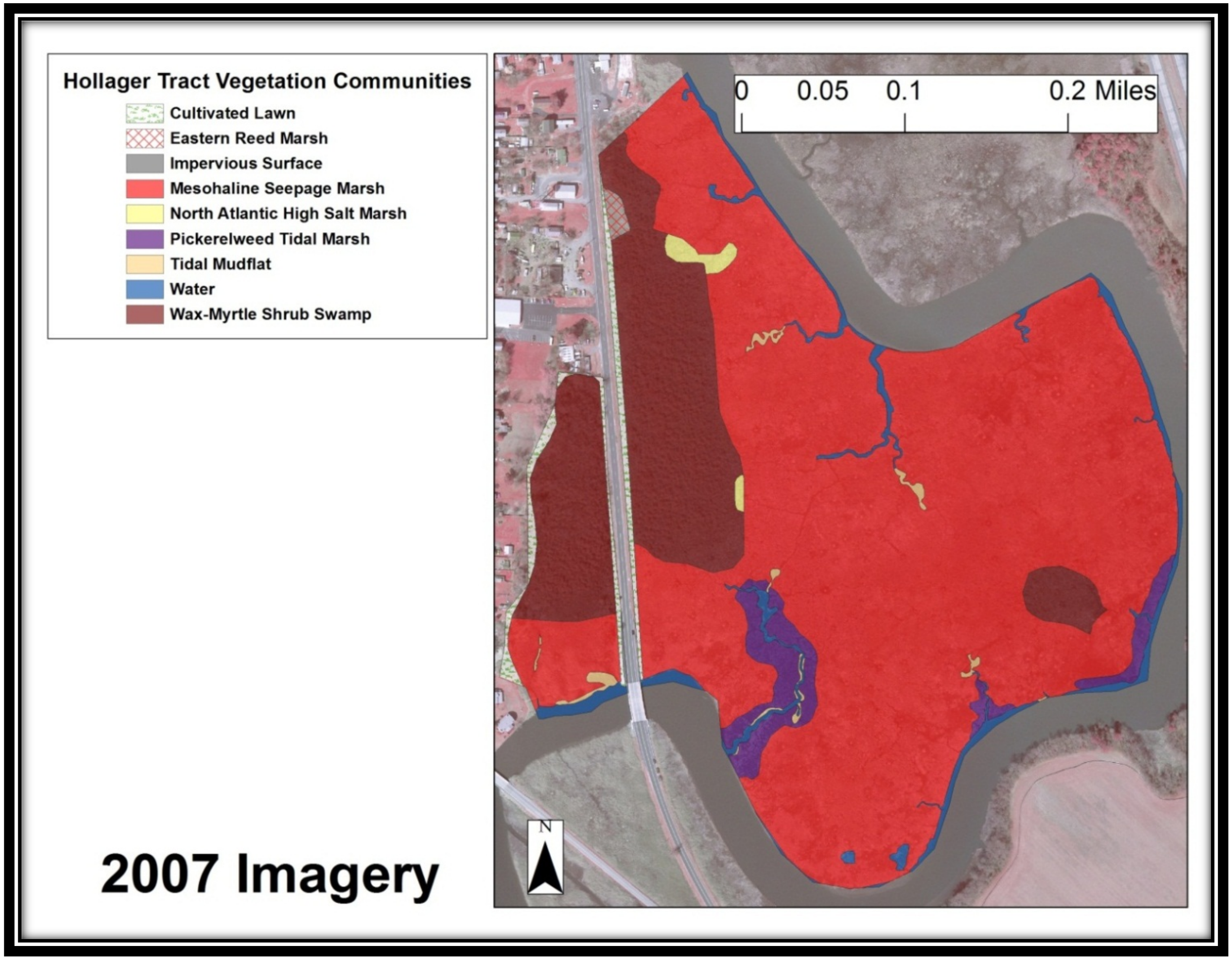


Figure 4-6.1. 2007 Vegetation Community Map of the Hollager Tract

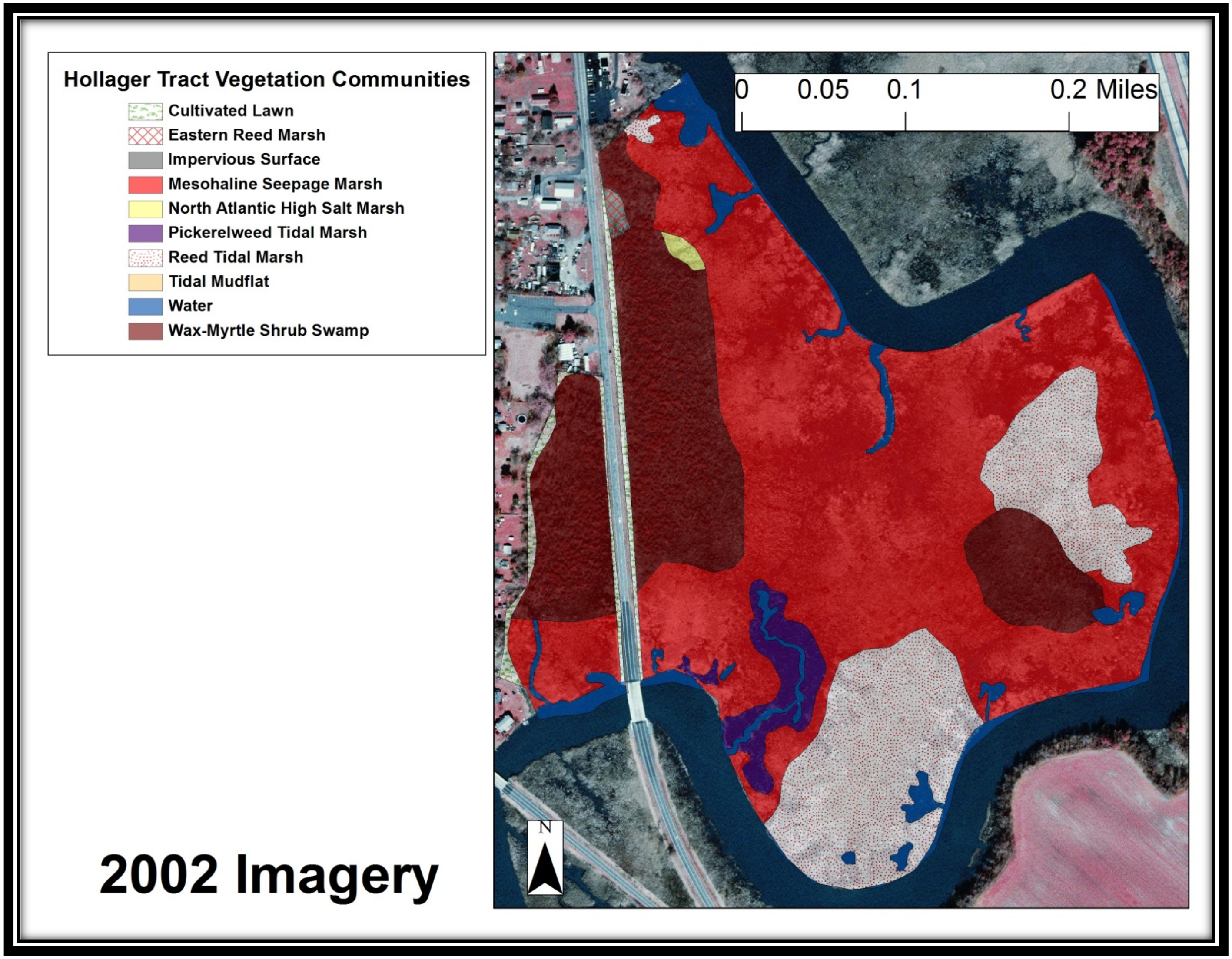
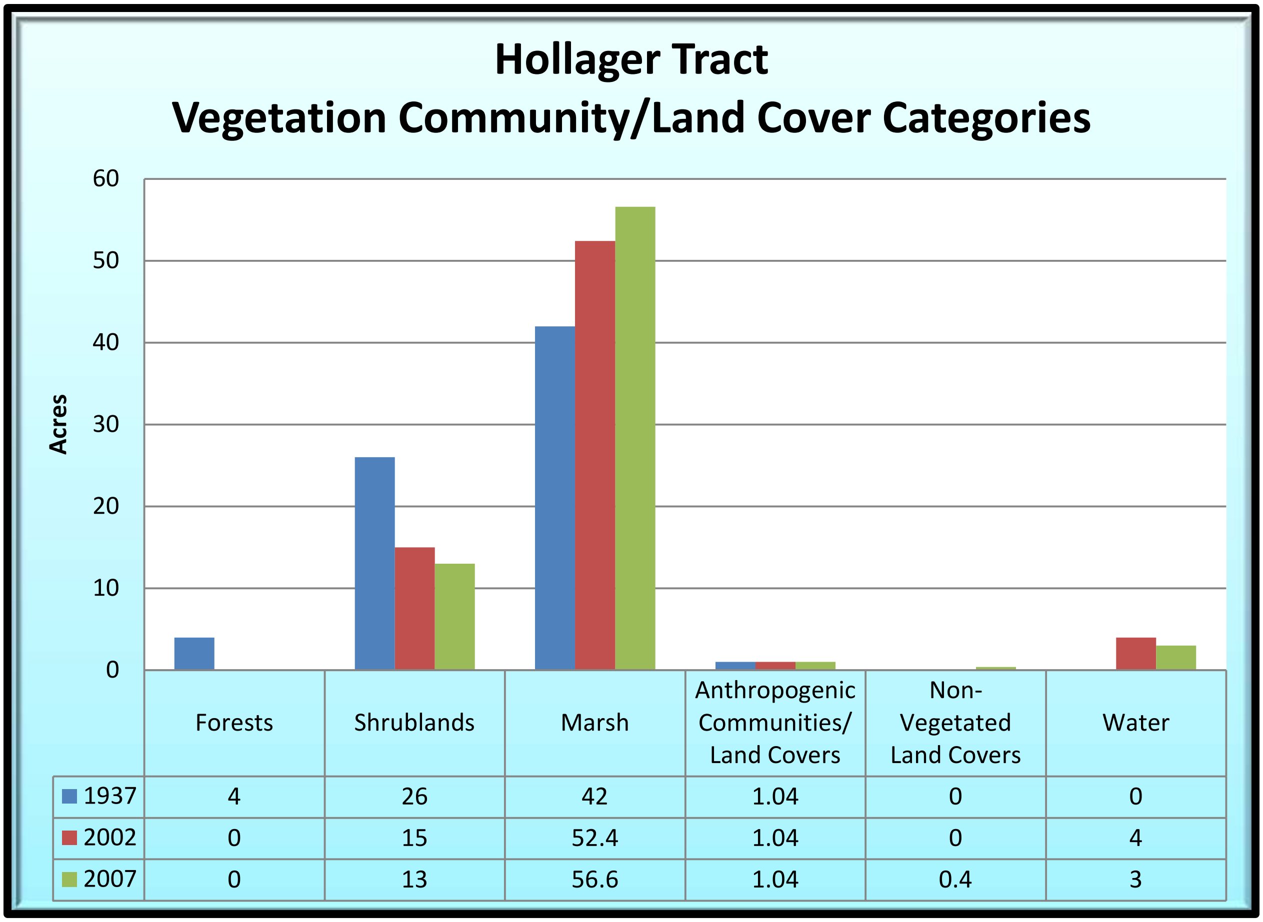


Figure 4-6.2. 2002 Vegetation Community Map of the Hollager Tract

Figure 4-6.3. 1937 Vegetation Community Map of the Hollager Tract



	Forests	Shrublands	Marsh	Anthropogenic Communities/ Land Covers	Non-Vegetated Land Covers	Water
1937	4	26	42	1.04	0	0
2002	0	15	52.4	1.04	0	4
2007	0	13	56.6	1.04	0.4	3

Figure 4-6.4. Hollager Tract Vegetation Community/Land Cover Categories (1937, 2002, and 2007)

Hollager Tract Broad Trends (Figure 4-6.4): The Hollager Tract is located to the southeast of the town of Frederica, Delaware on the north floodplain of the Murderkill River. Like the Hall Tract, it is mostly composed of marshland but also contains some shrublands in upland sections. Marsh is most common community historically and now with some increase in area. Shrubland has been on a decline with rises in sea level and increasing salinity. In 1937 some forest was present but no longer exists. Anthropogenic communities have increased on the edge of Frederica.

DNREC Sea Level Rise Analysis (Table 4-6.1)

The Hollager Tract will essentially be flooded in its entirety with 0.5 m of sea level rise. Because of this, a change analysis was not completed for the vegetation community categories.

Table 4-6.1. Projected acres of the Hollager Tract Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	73 acres
1 m	74 acres
1.5 m	74 acres

Natural Capital (Table 4-6.2)

Capital in the Hollager Tract is being driven mainly by the amount of marsh and water. Since the acreages of these two categories have been fluctuating the capital amounts have as well.

Table 4-6.2. Natural Capital of the Hollager Tract	
Year	**Natural Capital (in 2012 dollars)**
1937	$505,467/year
2002	$489,780/year
2007	$494,730/year

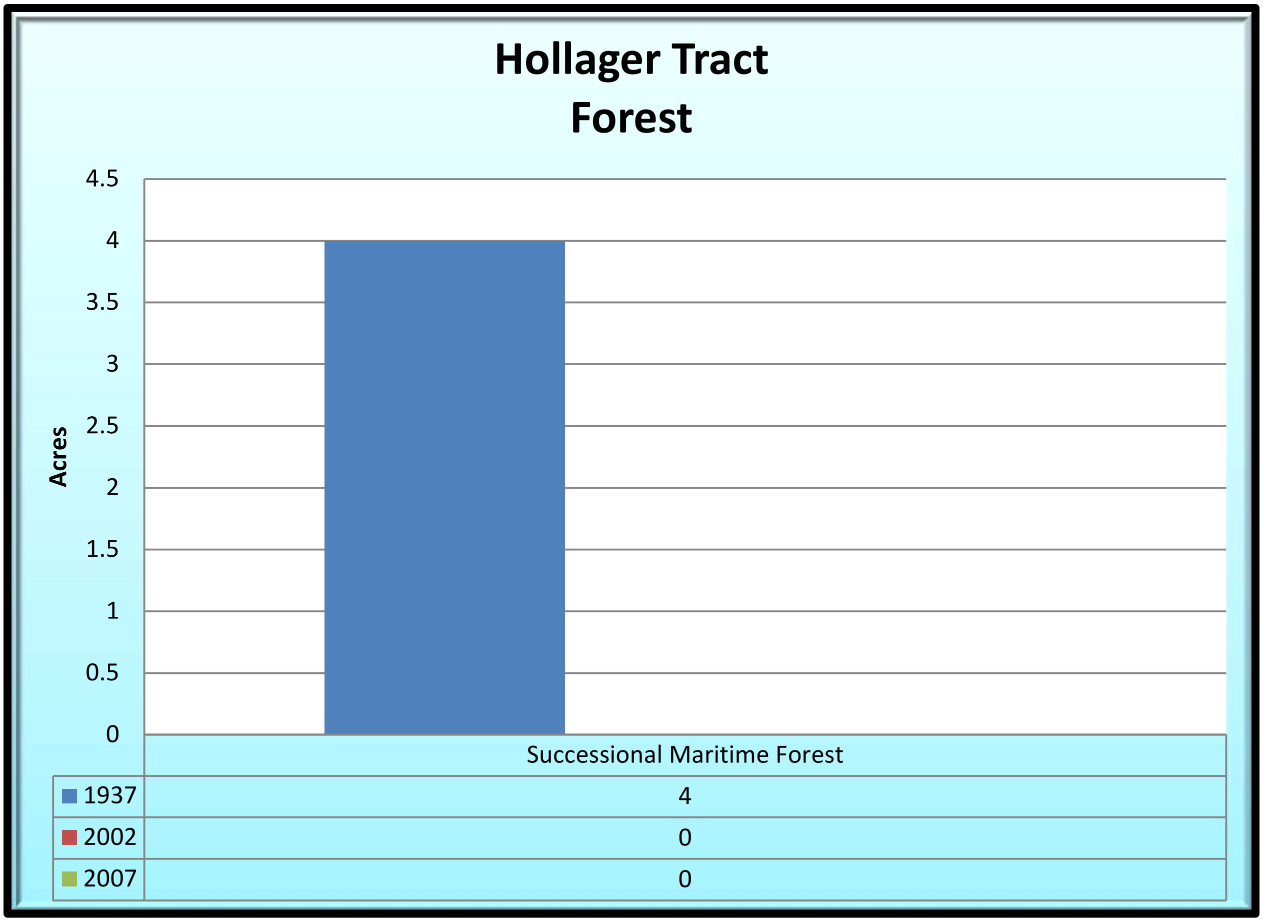


Table 4-6.5. Hollager Tract Forest (1937, 2002, and 2007)

Hollager Tract Forest (Figure 4-6.5): In 1937, one forest type, Successional Maritime Forest, was present in the Hollager Tract. Since this time, the forest has succeeded to shrubland with increasing amounts of water.

Natural Capital (Table 4-6.3)

Successional Maritime Forest is not present anymore in the Hollager Tract. The capital of forest was transferred to a wetland shrubland resulting in an increase in capital for the tract and wildlife area.

Table 4-6.3. Natural Capital of Hollager Tract Forest

Year	Natural Capital (in 2012 dollars)
1937	$756/year
2002	$0/year (not present)
2007	$0/year (not present)

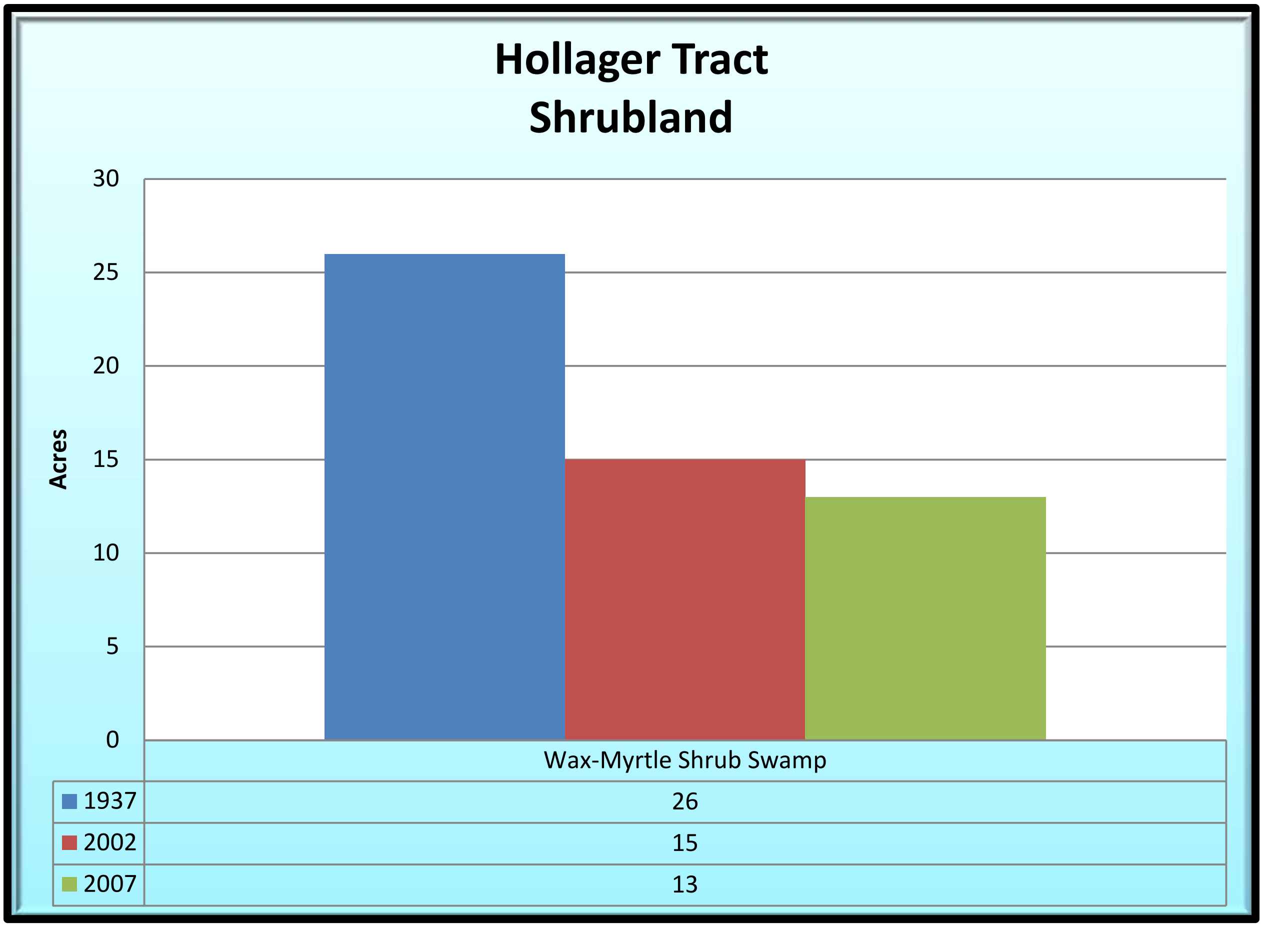


Figure 4-6.6. Hollager Tract Shrubland (1937, 2002, and 2007)

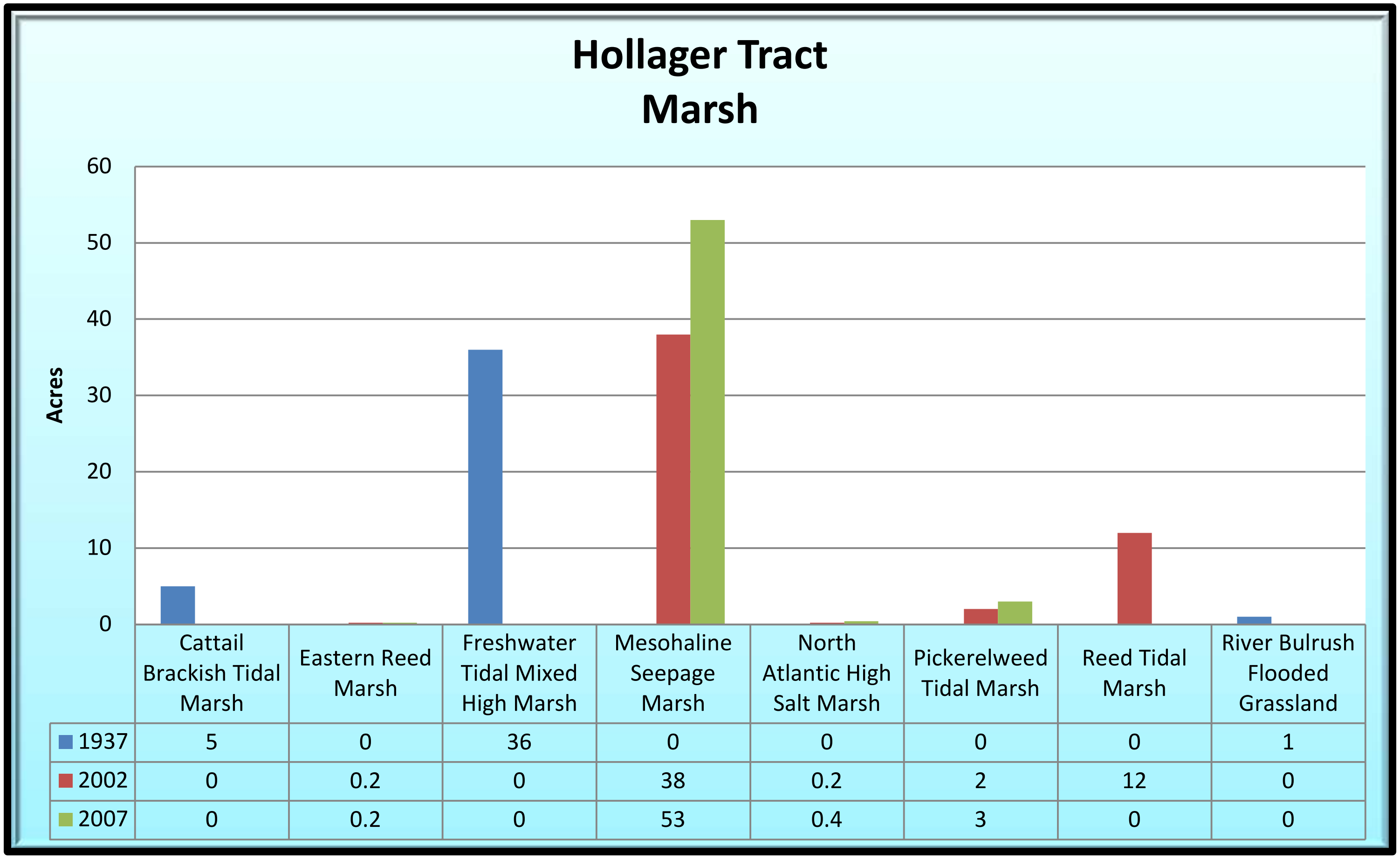
Hollager Tract Shrubland (Figure 4-6.6): Wax-Myrtle Shrub Swamp is the only shrubland in the Hollager Tract and has been declining over time as it likely converts to marsh. This decline is predicted to continue as there is no more undisturbed high ground for it to retreat.

Natural Capital (Table 4-6.4)

Shrubland in the Hollager Tract has gradually decreased as sea level rise converts the shrubland to marsh and transfers its capital to marsh.

Table 4-6.4. Natural Capital of Hollager Tract Shrubland

Year	**Natural Capital (in 2012 dollars)**
1937	$241,316/year
2002	$139,221/year
2007	$120,658/year



	Cattail Brackish Tidal Marsh	Eastern Reed Marsh	Freshwater Tidal Mixed High Marsh	Mesohaline Seepage Marsh	North Atlantic High Salt Marsh	Pickerelweed Tidal Marsh	Reed Tidal Marsh	River Bulrush Flooded Grassland
1937	5	0	36	0	0	0	0	1
2002	0	0.2	0	38	0.2	2	12	0
2007	0	0.2	0	53	0.4	3	0	0

Figure 4-6.7. Hollager Tract Marsh (1937, 2002, and 2007)

Hollager Tract Marsh (Figure 4-6.7): The Hollager Tract is located at the interface between freshwater and brackish water on the Murderkill River. Mesohaline Seepage Marsh is increasing on this tract with increasing salinities and North Atlantic High Salt Marsh is just making an appearance (North Atlantic High Salt Marsh is often the pioneer community before North Atlantic Low Salt Marsh starts to colonize). Pickerelweed Tidal Marsh is still persisting in some of the more sheltered areas of the site. Reed Tidal Marsh has been eliminated possibly due to eradication efforts.

Natural Capital (Table 4-6.5)

Marsh capital has been increasing due to increases in Mesohaline Seepage Marsh. This trend is expected to continue as the remaining shrubland is converted to marsh.

Table 4-6.5. Natural Capital of Hollager Tract Marsh

Year	**Natural Capital (in 2012 dollars)**
1937	$263,395/year
2002	$329,218/year
2007	$355,558/year

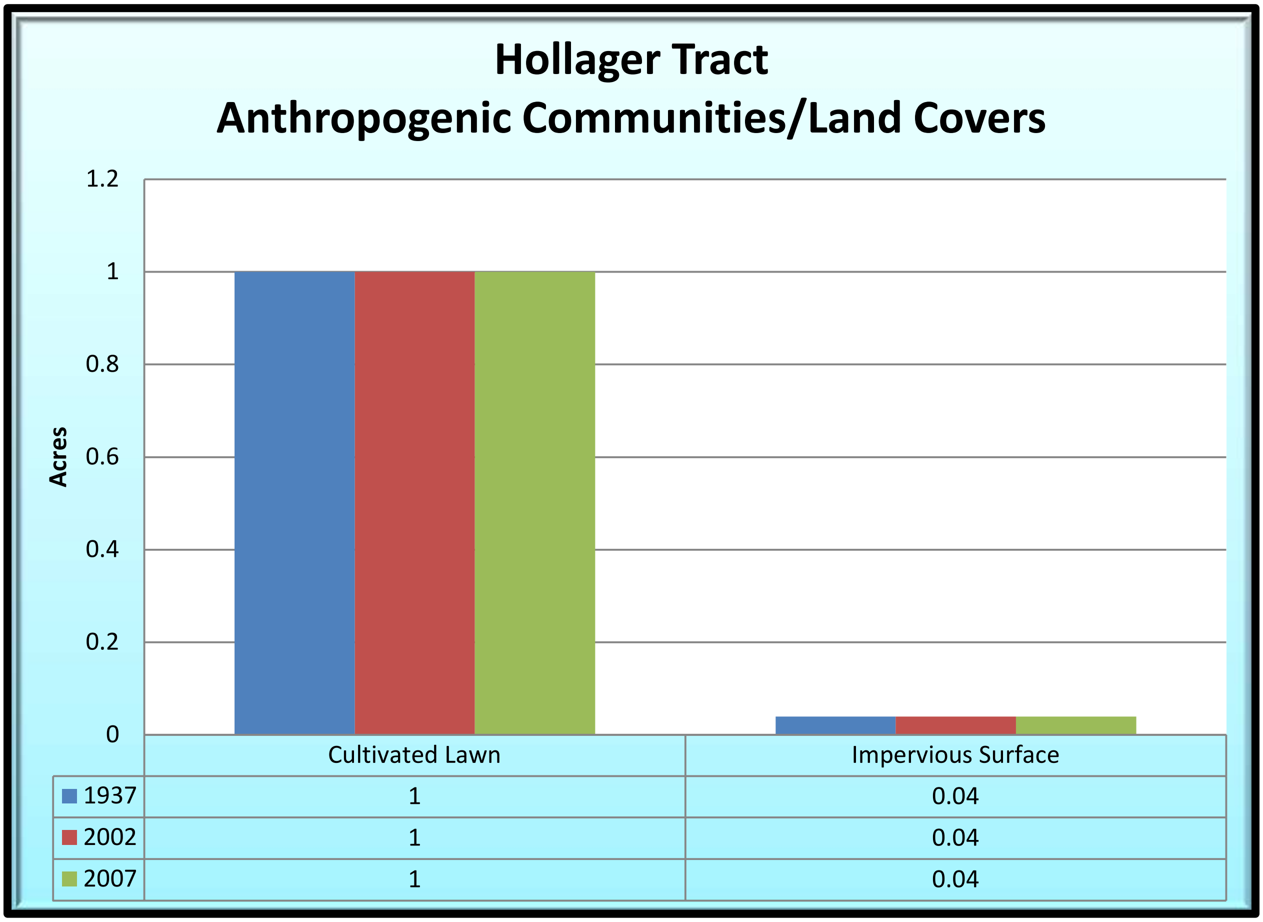


Figure 4-6.8. Hollager Tract Anthropogenic Communities/Land Covers (1937, 2002, and 2007)

Hollager Tract Anthropogenic Communities/Land Covers (Figure 4-6.8): Cultivated lawn is most common anthropogenic community in the Hollager Tract. Both the cultivated lawn and impervious surface are associated with DE 12 which runs through the middle of the tract.

Natural Capital

None of the anthropogenic communities/land covers in the Hollager Tract have any natural capital value.

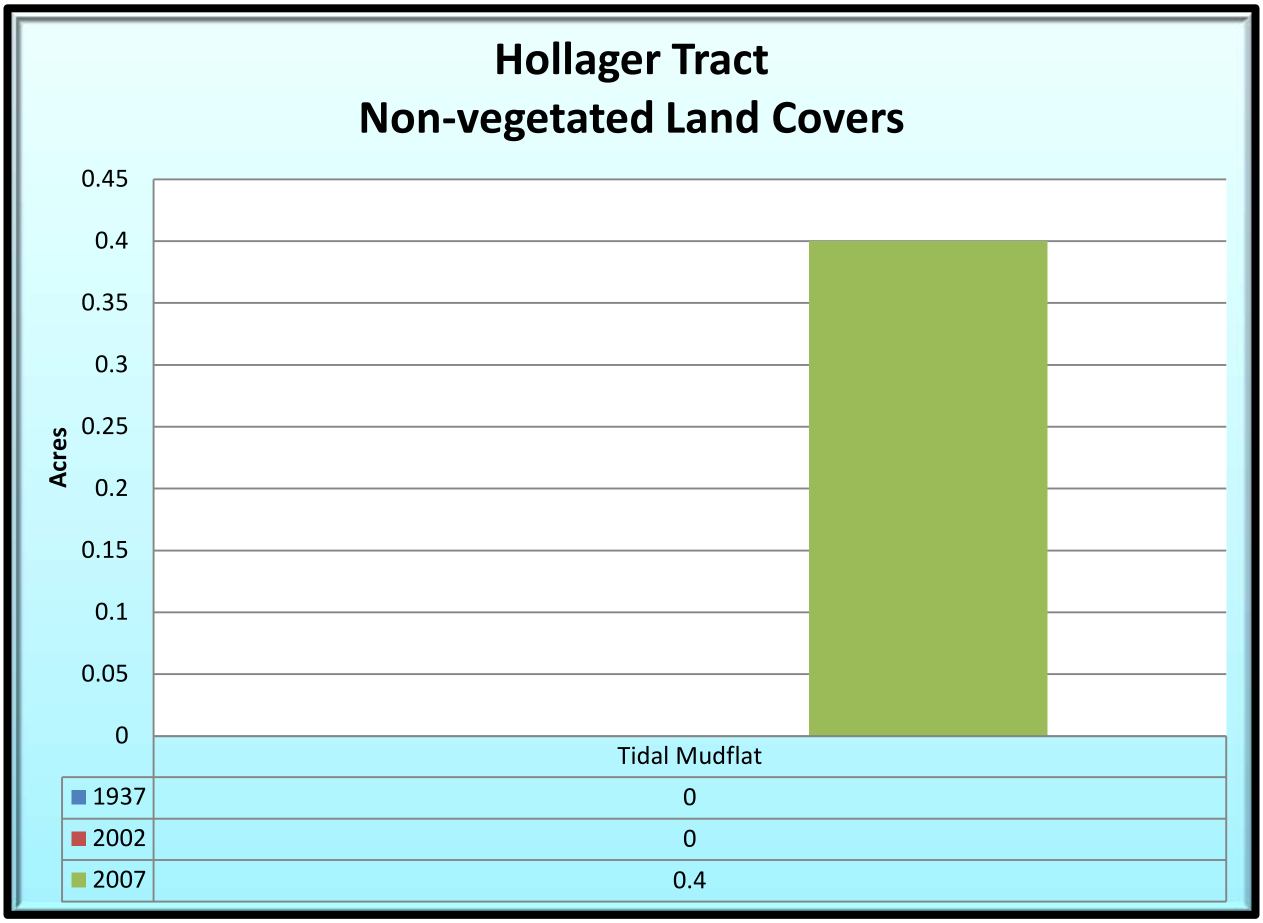


Figure 4-6.9. Hollager Tract Non-vegetated Land Covers (1937, 2002, and 2007)

Hollager Tract Non-vegetated Land Covers (Figure 4-6.9): Tidal mudflat is a very minor part of the Hollager Tract and is the only non-vegetated land cover. This community comes and goes as salt marsh dies, is eaten, or is converting to open water.

Natural Capital (Table 4-6.6)

Tidal mudflats tend to be ephemeral and oscillate in amount over time, resulting in an oscillation of the capital.

Table 4-6.6. Natural Capital of Hollager Tract Non-vegetated Land Covers

Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$0/year (not present)
2007	$2,509/year

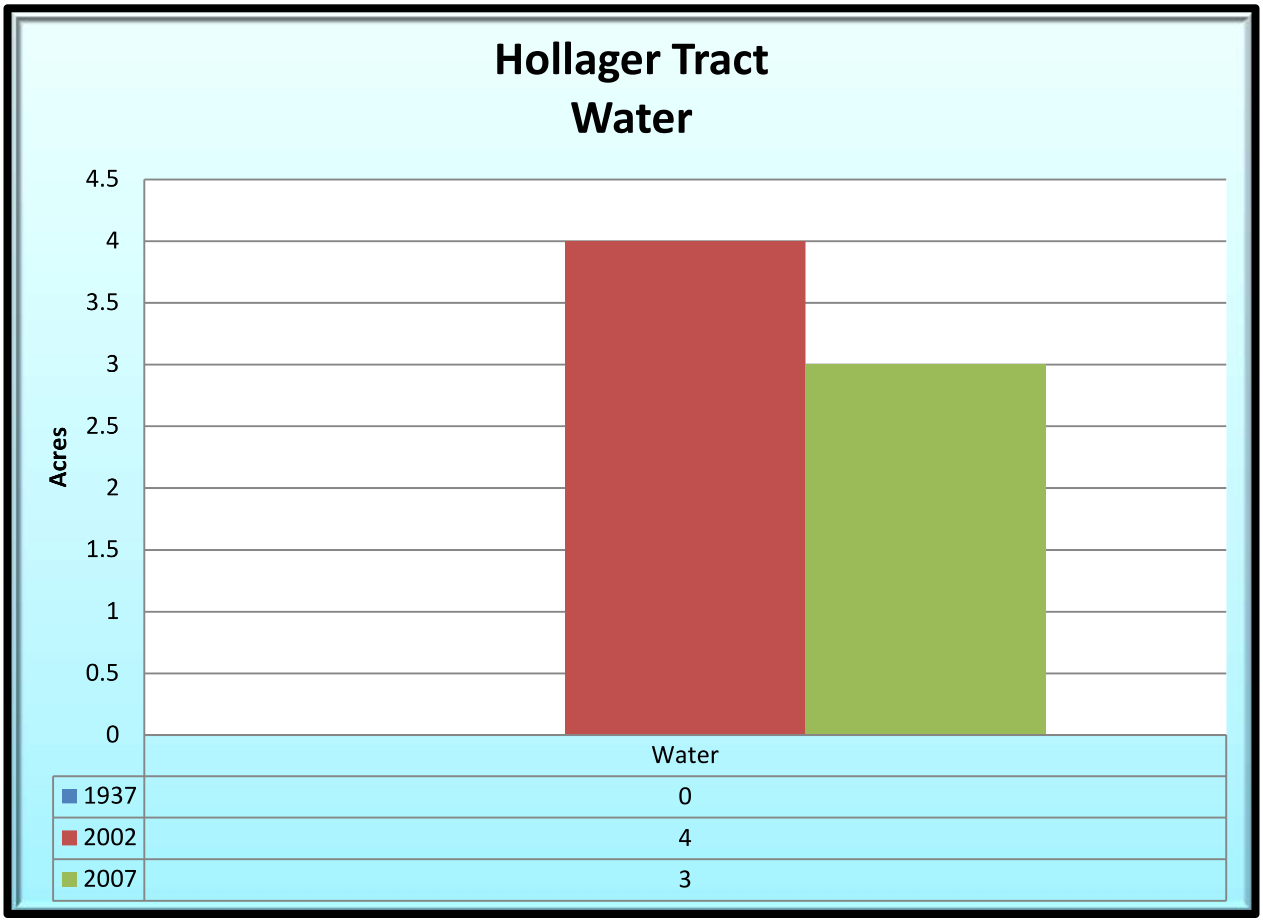


Figure 4-6.10. Hollager Tract Water (1937, 2002, and 2007)

Hollager Tract Water Coverage (Figure 4-6.10): Water has shown an overall increase but has declined recently. This could be due to accretion or sedimentation in the river. Sea level rise may be a factor in the overall increase. Like the Hall tract the increase in land could be due to sedimentation collecting from the DE 1 bridge over the Murderkill River constraining flow in the river. The historic rate of inundation in this tract has been (1937-2002 = 0.06 acres/year) and (1937-2007 = 0.04 acres/year). The recent rate (2002-2007), however has been positive with 0.2 acres/year. These same trends were seen in both the Hall Tract and in lesser amount in the Dickerson Tract.

Natural Capital (Table 4-6.7)

No water coverage was present in the Hollager Tract in 1937. Since 1937, the amount of water has increased overall but has fluctuated some.

Table 4-6.7. Natural Capital of Hollager Tract Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$21,340/year
2007	$16,005/year

7. Jester Tract

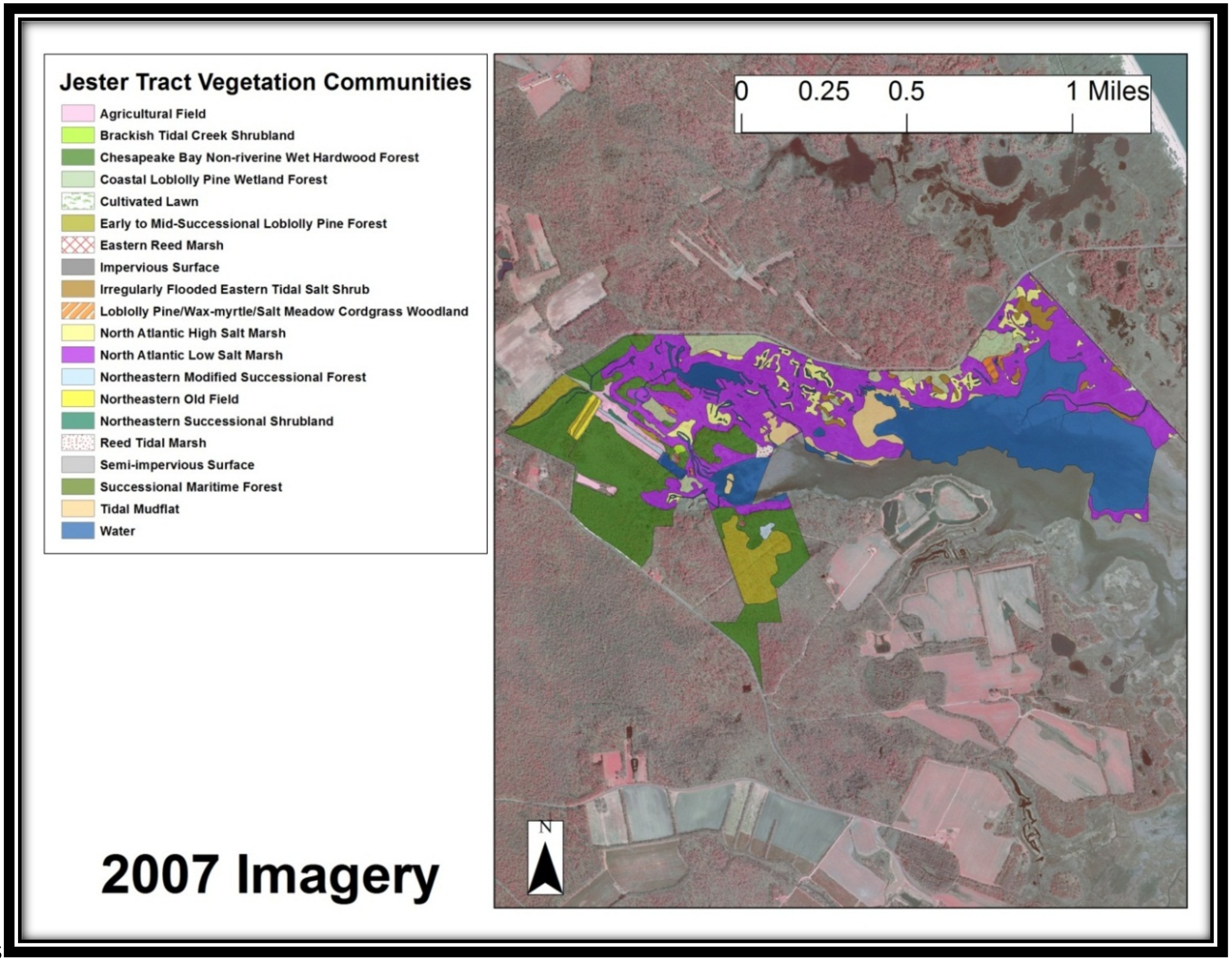


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Figure 4-7.1. 2007 Vegetation Community Map of the Jester Tract

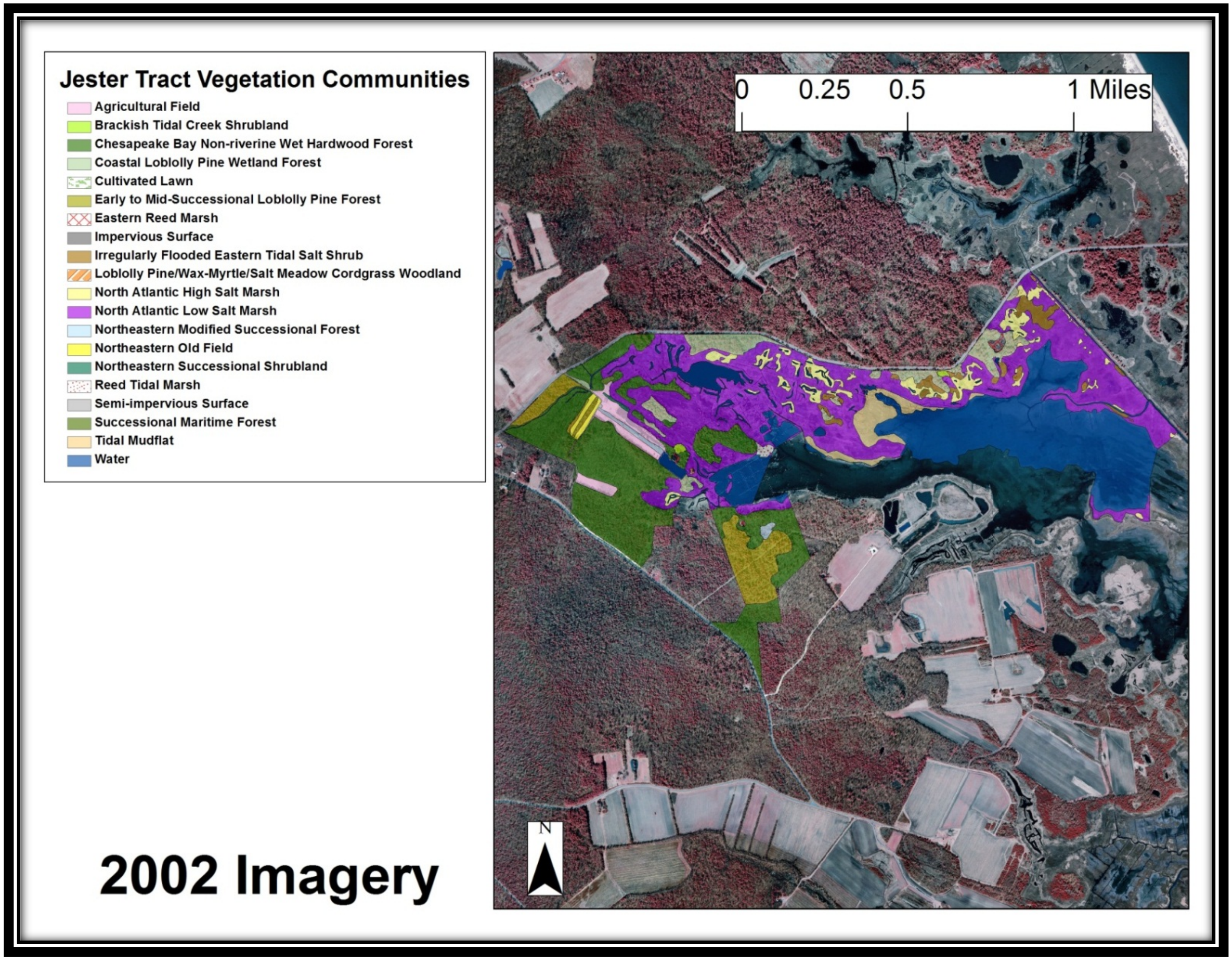


Figure 4-7.2. 2002 Vegetation Community Map of the Jester Tract

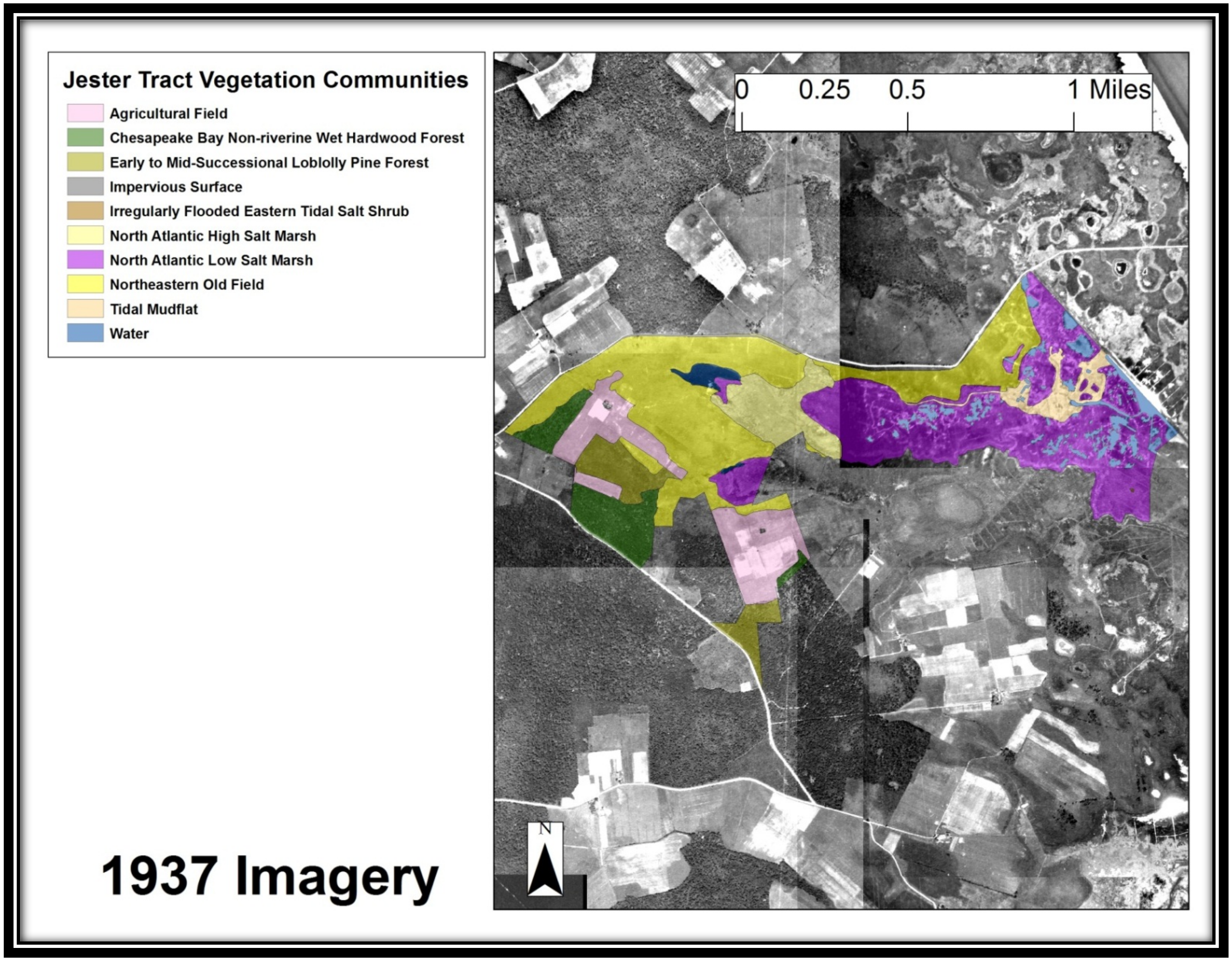
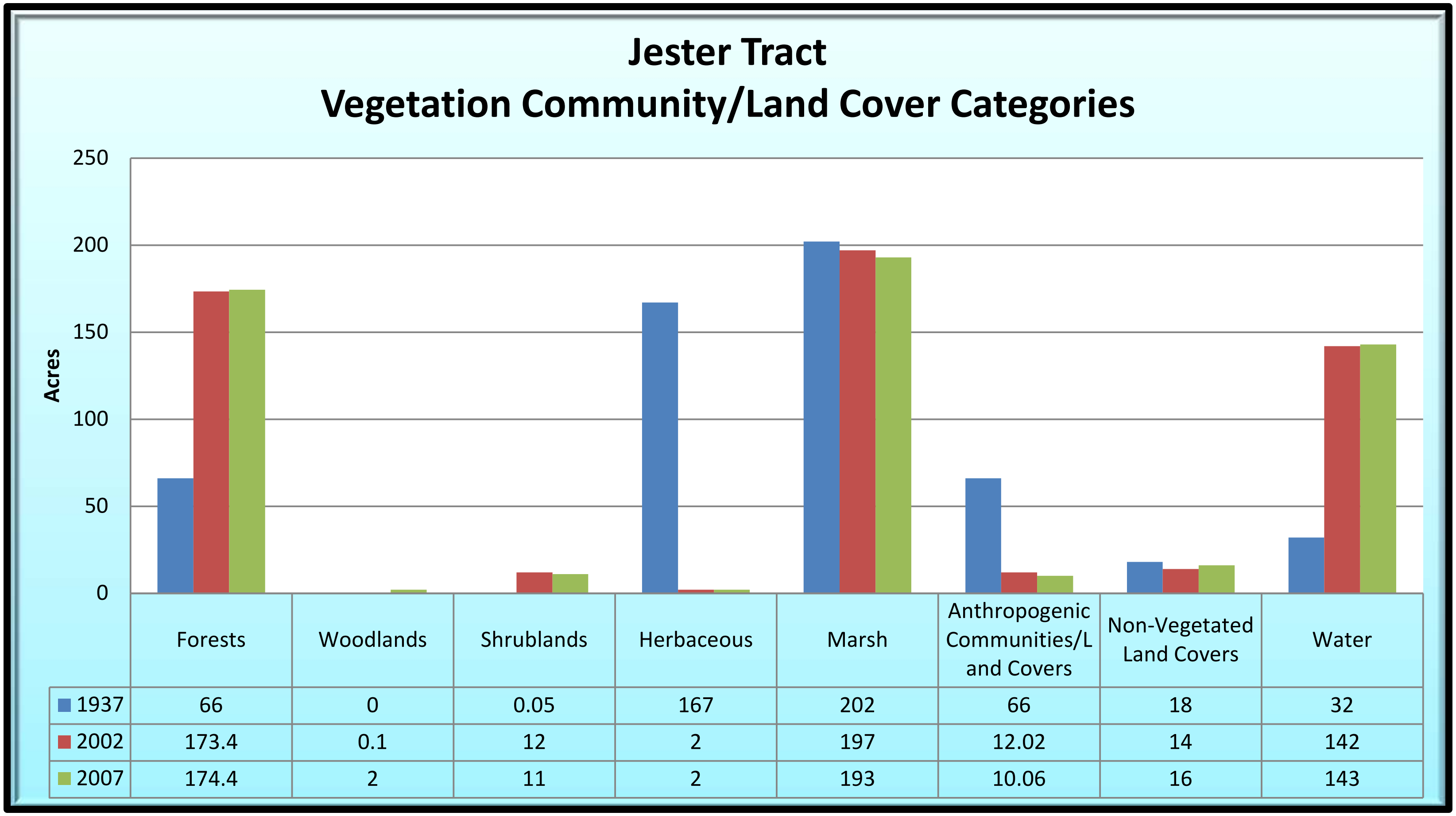


Figure 4-7.3. 1937 Vegetation Community Map of the Jester Tract



	Forests	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/L and Covers	Non-Vegetated Land Covers	Water
1937	66	0	0.05	167	202	66	18	32
2002	173.4	0.1	12	2	197	12.02	14	142
2007	174.4	2	11	2	193	10.06	16	143

Figure 4-7.4 Jester Tract Vegetation Community/Land Cover Categories (1937, 2002, and 2007)

Jester Tract Broad Trends (Figure 4-7.4): In 1937, herbaceous communities and marsh were most common vegetation categories in the Jester Tract. Later in 2007, the herbaceous communities have succeeded into forests and the marshes are still prevalent. Water coverage has also increased partly from mosquito control activities and from sea level inundation.

DNREC Sea Level Rise Analysis (Table 4-7.1)

Nearly the entire Jester Tract will be inundated by water with 1.5 m of sea level rise.

Table 4-7.1. Projected acres of the Jester Tract Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	441 acres
1 m	492 acres
1.5 m	546 acres

Natural Capital (Table 4-7.2)

Capital in the Jester Tract has been increasing with maturation of the forests, increases in marshland, and an increase in the amount of water.

Table 4-7.2. Natural Capital of the Jester Tract	
Year	**Natural Capital (in 2012 dollars)**
1937	$2,326,922/year
2002	$5,213,519/year
2007	$5,200,602/year

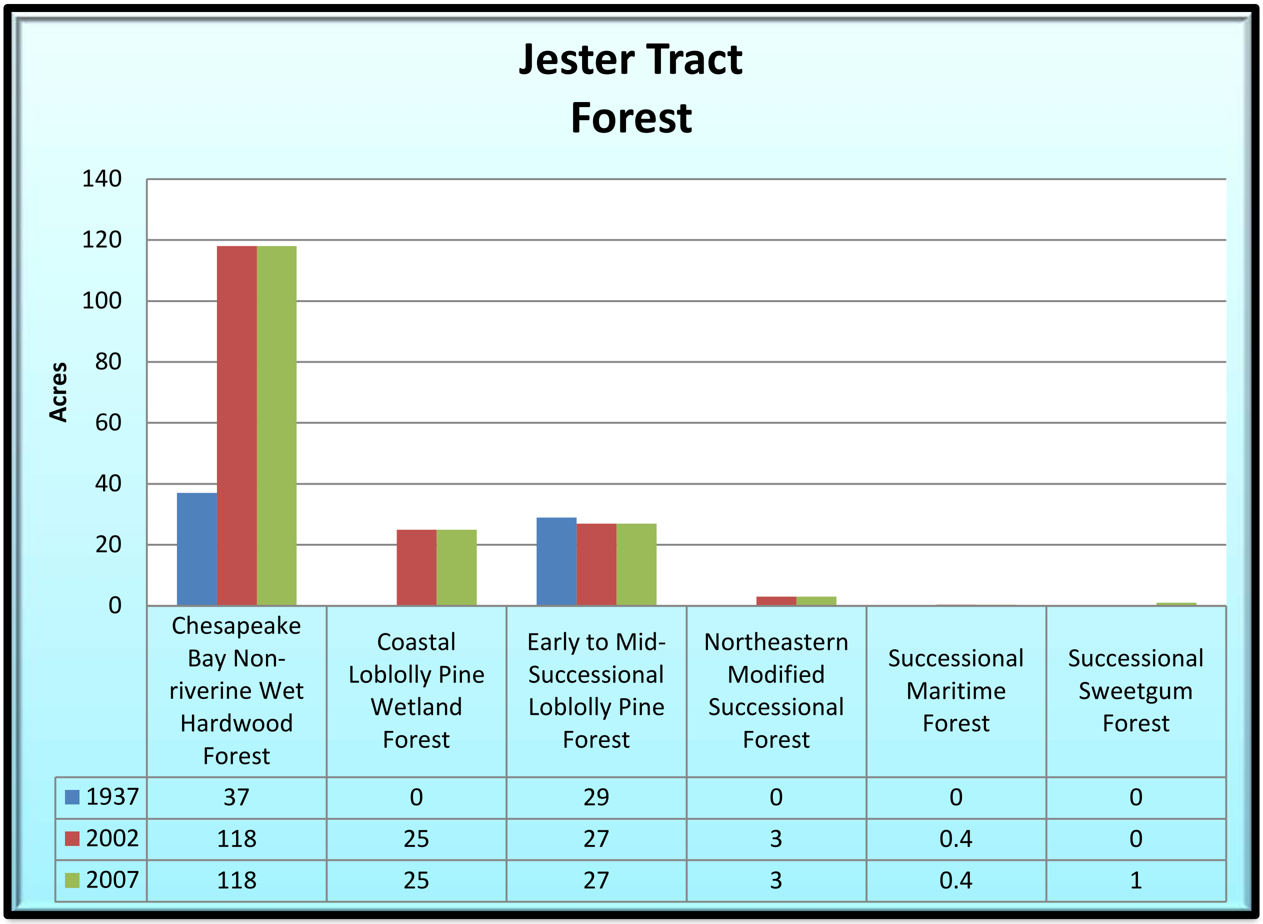


Figure 4-7.5. Jester Tract Forest (1937, 2002, and 2007)

Jester Tract Forest (Figure 4-7.5): Chesapeake Bay Non-riverine Wet Hardwood Forest has been and remains the most common forest type, with Coastal Loblolly Pine Wetland Forest and Early to Mid-Successional Loblolly Pine Forest following.

DNREC Sea Level Rise Analysis (Table 4-7.3)

Nearly all of the forestland currently present in the Jester Tract will be inundated by water at 1.5 m of sea level rise.

Table 4-7.3. Projected acres of Jester Tract Forest Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	80 acres
1 m	87 acres
1.5 m	171 acres

Natural Capital (Table 4-7.4)

Forestland capital has increased greatly since 1937 with maturation of forest from fields.

Table 4-7.4. Natural Capital of Jester Tract Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$460,269/year
2002	$1,763,433/year
2007	$1,763,433/year

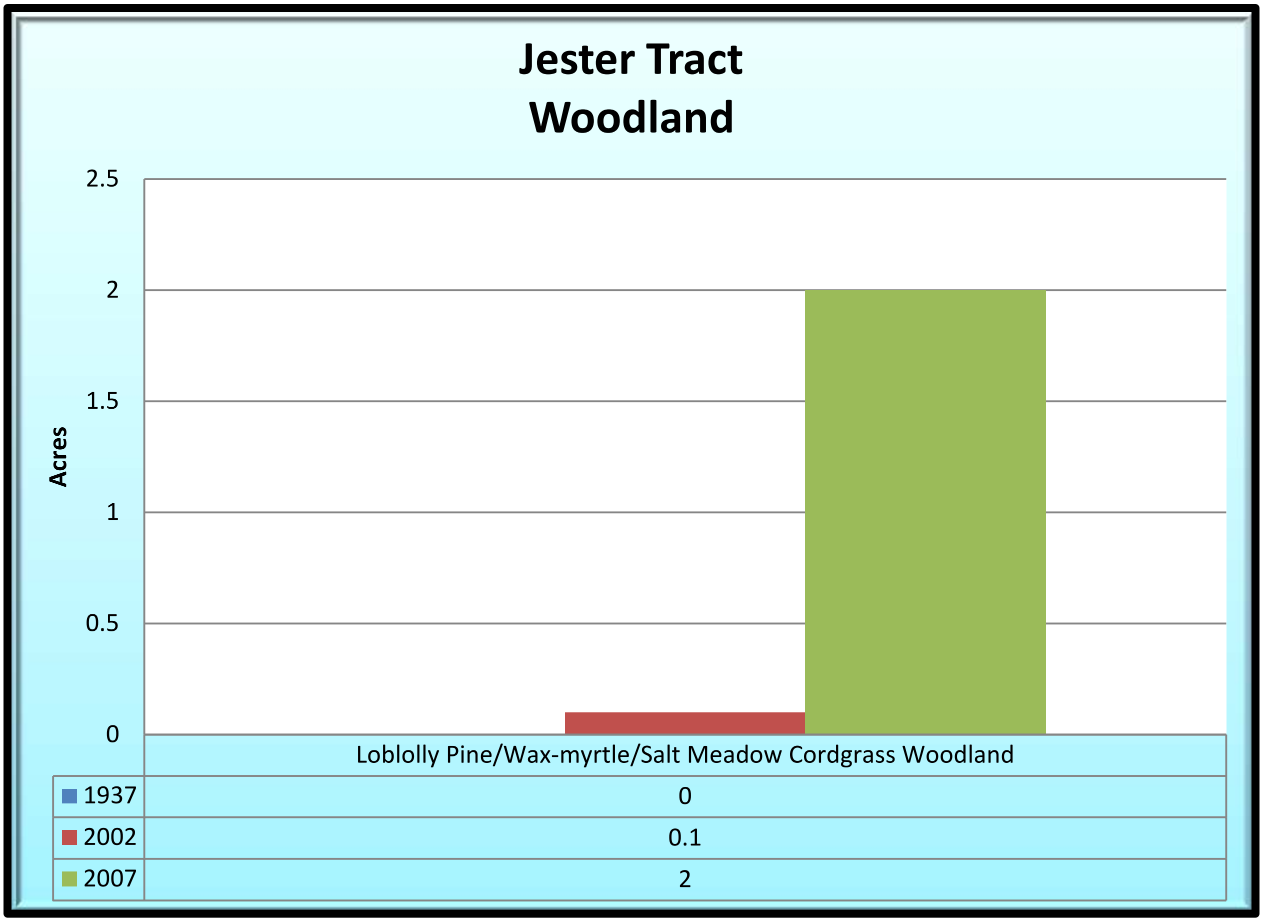


Figure 4-7.6. Jester Tract Woodland (1937, 2002, and 2007)

Jester Tract Woodland (Figure 4-7.6): Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland is the only woodland present in the Jester Tract. This woodland appears to be the result of sea level rise into Coastal Loblolly Pine Wetland Forest and the increase in this community may show that salinity and water is creeping into this community.

DNREC Sea Level Rise Analysis (Table 4-7.5)

All of the woodland currently present in the Jester Tract will be flooded with 0.5 m of sea level rise.

Table 4-7.5. Projected acres of Jester Tract Woodland Inundated by Sea Level Rise

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

Natural Capital (Table 4-7.6)

Woodland was not present in the Jester Tract in 1937 and has since gained capital from former fields.

Table 4-7.6. Natural Capital of Jester Tract Woodland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year
2002	$1,229/year
2007	$24,583/year

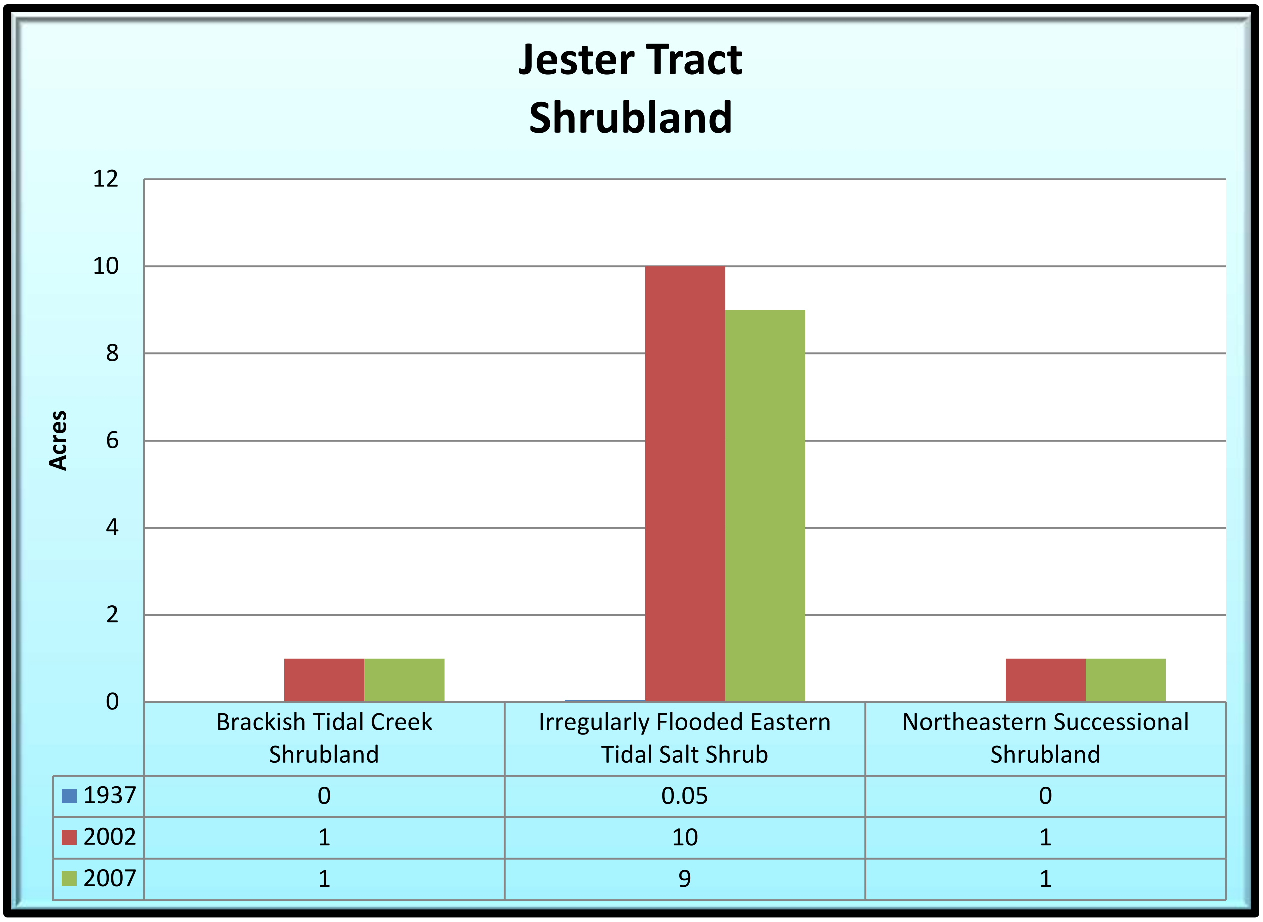


Figure 4-7.7. Jester Tract Shrubland (1937, 2002, and 2007)

Jester Tract Shrubland (Figure 4-7.7): Three shrublands are located in the Jester Tract, all of which have increased in amount overall. Two of the shrublands, Brackish Tidal Creek Shrubland and Northeastern Successional Shrubland have increased in the recent period (2002-2007), while Irregularly Flooded Eastern Tidal Salt Shrub has decreased slightly.

DNREC Sea Level Rise Analysis (Table 4-7.7)

All of the shrubland currently present in the Jester Tract will be inundated by water with 1 m of sea level rise.

Table 4-7.7. Projected acres of Jester Tract Shrubland Inundated by Sea Level Rise

Rise	Acres
0.5 m	10 acres
1 m	11 acres
1.5 m	11 acres

Natural Capital (Table 4-7.8)

Shrubland capital has increased since 1937, but has recently decreased due to a loss of acreage from Irregularly Flooded Eastern Tidal Salt Shrub.

Table 4-7.8. Natural Capital of Jester Tract Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$314/year
2002	$69,130/year
2007	$62,859/year

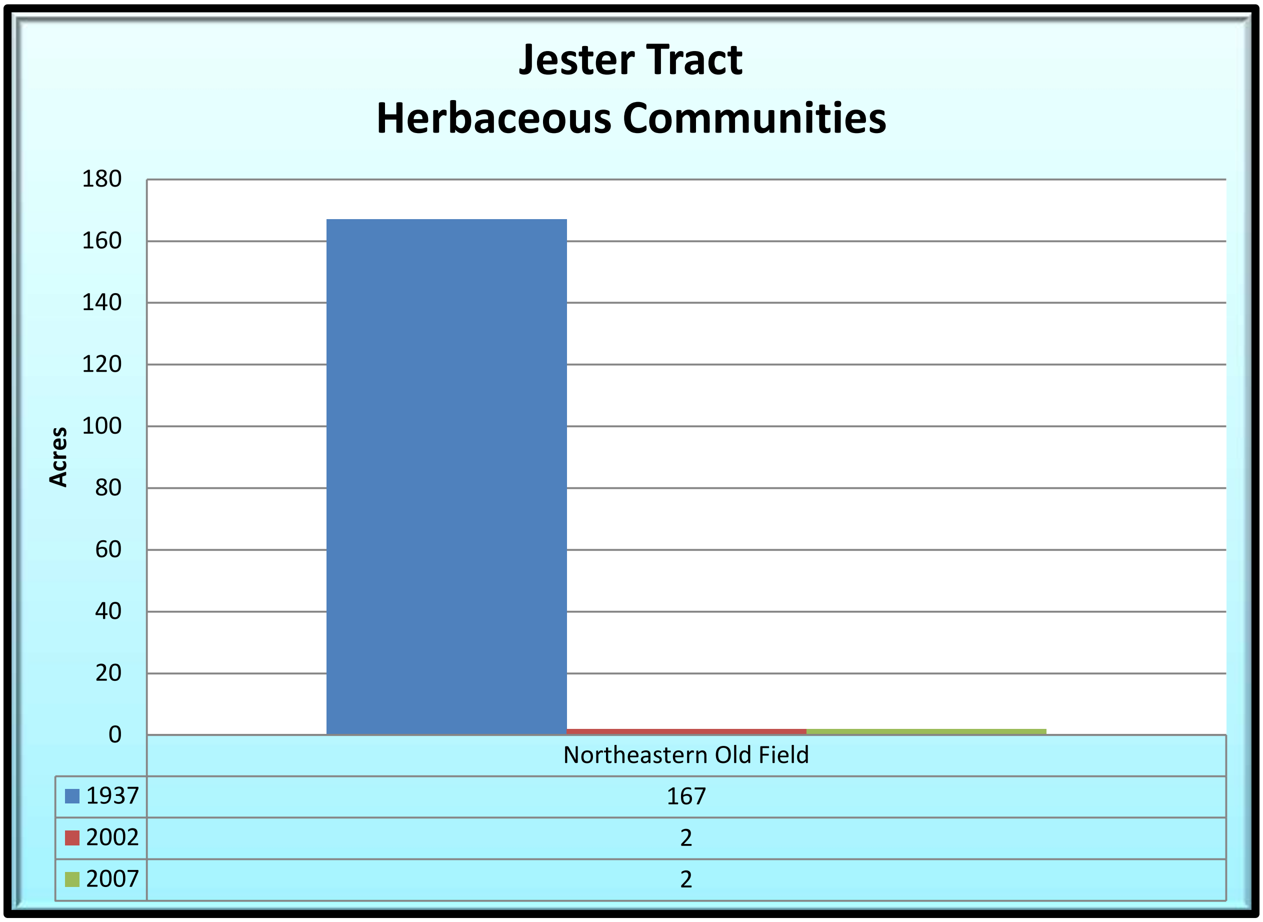


Figure 4-7.8. Jester Tract Herbaceous Communities (1937, 2002, and 2007)

Jester Tract Herbaceous Communities (Figure 4-7.8): Northeastern Old Field is the only herbaceous community and has decreased significantly over time. This community forms from the abandonment of agricultural fields or clearing.

DNREC Sea Level Rise Analysis (Table 4-7.9)

All of the herbaceous communities currently in the Jester Tract will be inundated by water with 1 m of sea level rise.

Table 4-7.9. Projected acres of Jester Tract Herbaceous Communities Inundated by Sea Level Rise

Rise	Acres
0.5 m	0.2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 4-7.10)

The Herbaceous communities (Northeastern Old Field) present in the Jester Tract in 1937 have matured into other communities transferring its capital to shrubland and forest.

Table 4-7.10. Natural Capital of Jester Tract Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1937	$24,332/year
2002	$291/year
2007	$291/year

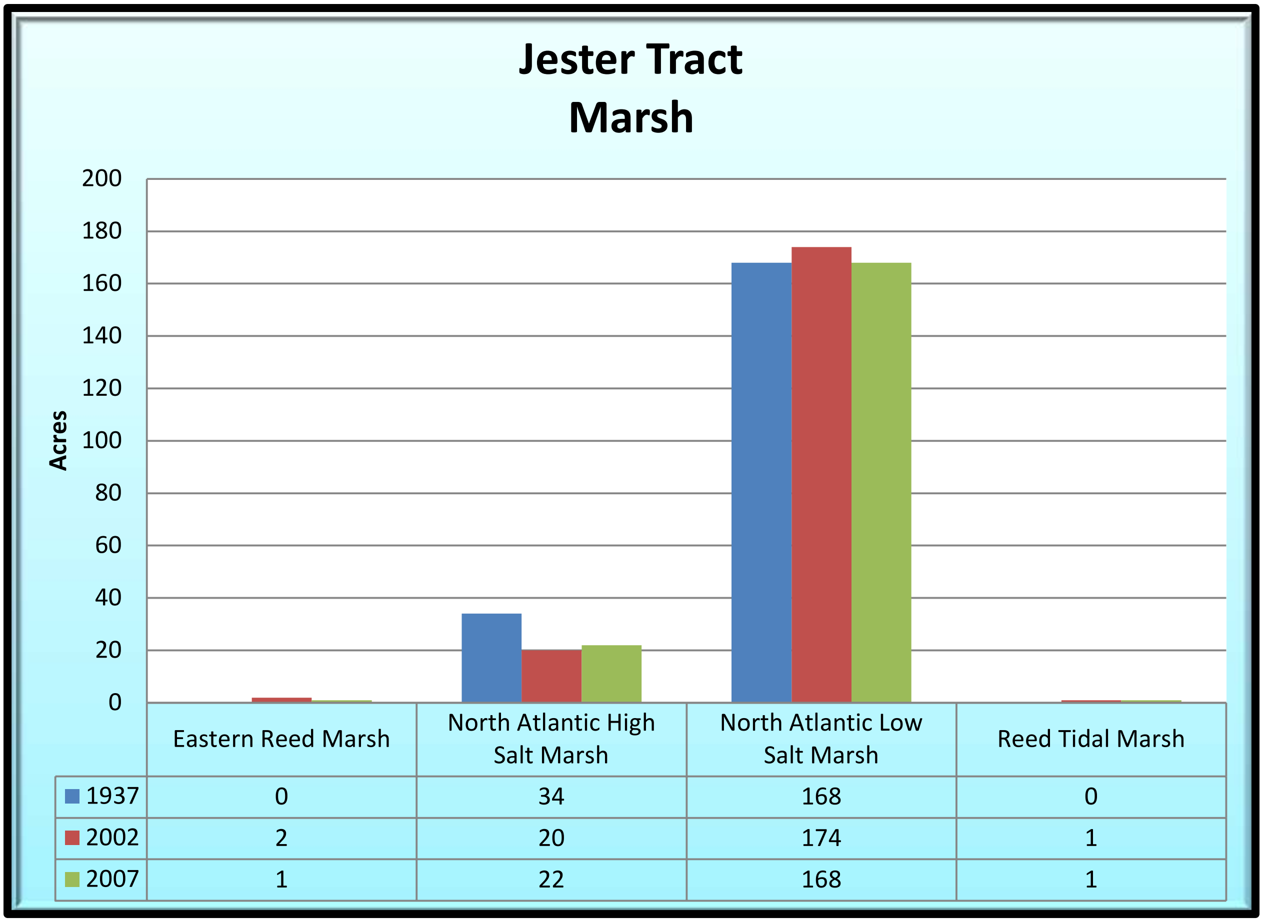


Figure 4-7.9. Jester Tract Marsh (1937, 2002, and 2007)

Jester Tract Marsh (Figure 4-7.9): Marsh overall has decreased with North Atlantic High Marsh losing the most. Two new marshes, Eastern Reed Marsh and Reed Tidal Marsh entered the tract since 1937 as eastern reed (*Phragmites australis*) gains more of a foothold.

DNREC Sea Level Rise Analysis (Table 4-7.11)

Most of the marshland in the Jester Tract will be flooded with 0.5 m of sea level rise and will be completely inundated by water with 1 m of rise.

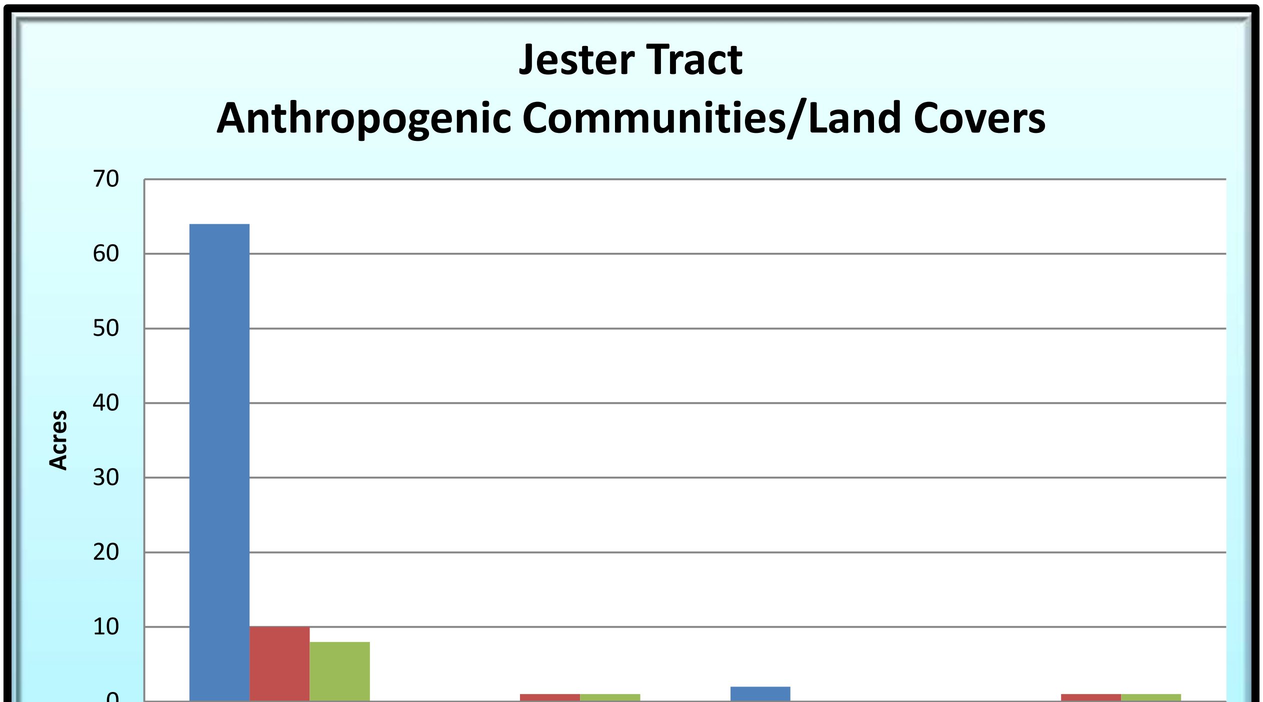
Table 4-7.11. Projected acres of Jester Tract Marsh Inundated by Sea Level Rise

Rise	Acres
0.5 m	189 acres
1 m	192 acres
1.5 m	192 acres

Natural Capital (Table 4-7.12)

Marsh has been declining overall since 1937 leading to a decrease in capital.

Table 4-7.12. Natural Capital of Jester Tract Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,266,803/year
2002	$1,241,466/year
2007	$1,213,371/year



	Agricultural Field	Cultivated Lawn	Impervious Surface	Semi-impervious Surface
1937	64	0	2	0
2002	10	1	0.02	1
2007	8	1	0.06	1

Figure 4-7.10. Jester Tract Anthropogenic Communities/Land Covers (1937, 2002, and 2007)

Jester Tract Anthropogenic Communities (Figure 4-7.10): Agricultural field has been and remains the largest anthropogenic community in the Jester Tract. Other anthropogenic communities and land covers have gained ground over time.

DNREC Sea Level Rise Analysis (Table 4-7.13)

Most of the anthropogenic communities/land covers in the Jester Tract will be inundated with 1.5 m of sea level rise.

Table 4-7.13. Projected acres of Jester Tract Anthropogenic Communities/Land Covers Inundated by Sea Level Rise

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

Natural Capital (Table 4-7.14)

Agricultural field is the only anthropogenic communities/land cover with natural capital value in the Jester Tract. Its capital has been going down with reductions in agricultural field.

Table 4-7.14. Natural Capital of Jester Tract Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$3,670/year
2002	$574/year
2007	$459/year

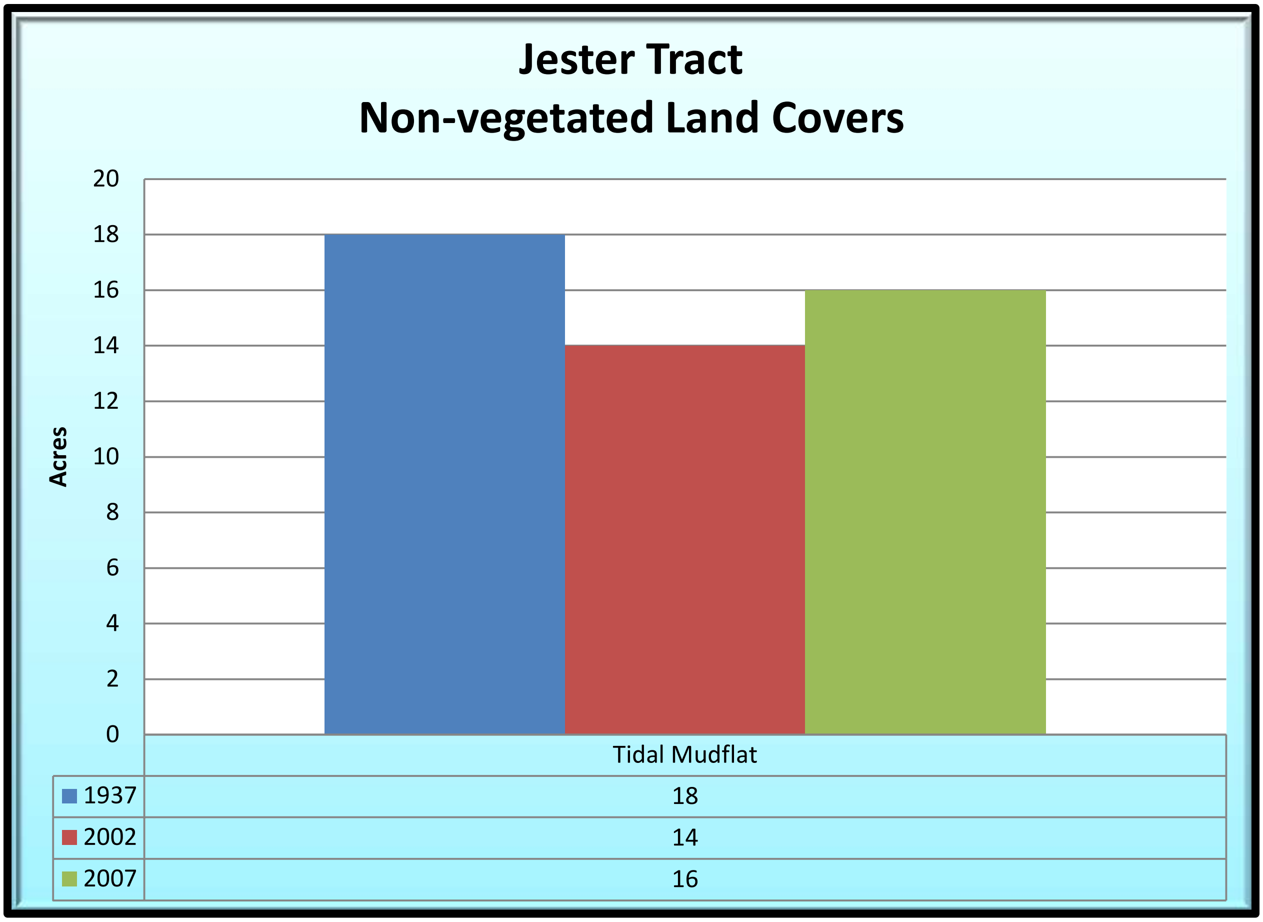


Figure 4-7.11. Jester Tract Non-vegetated Land Covers (1937, 2002, and 2007)

Jester Tract Non-vegetated Land Covers (Figure 4-7.11): Tidal mudflat is the only non-vegetated land cover in the Jester Tract and it has oscillated in amount over the period studied.

DNREC Sea Level Rise Analysis (Table 4-7.15)

All of the Non-vegetated Land Covers in the Jester Tract will be lost with 0.5 m of sea level rise.

Table 4-7.15. Projected acres of Jester Tract Non-vegetated Land Covers Inundated by Sea Level Rise

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

Natural Capital (Table 4-7.16)

Tidal mudflats tend to be ephemeral and oscillate in amount leading to the capital going up and down as well.

Table 4-7.16. Natural Capital of Jester Tract Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$112,883/year
2002	$87,798/year
2007	$100,341/year

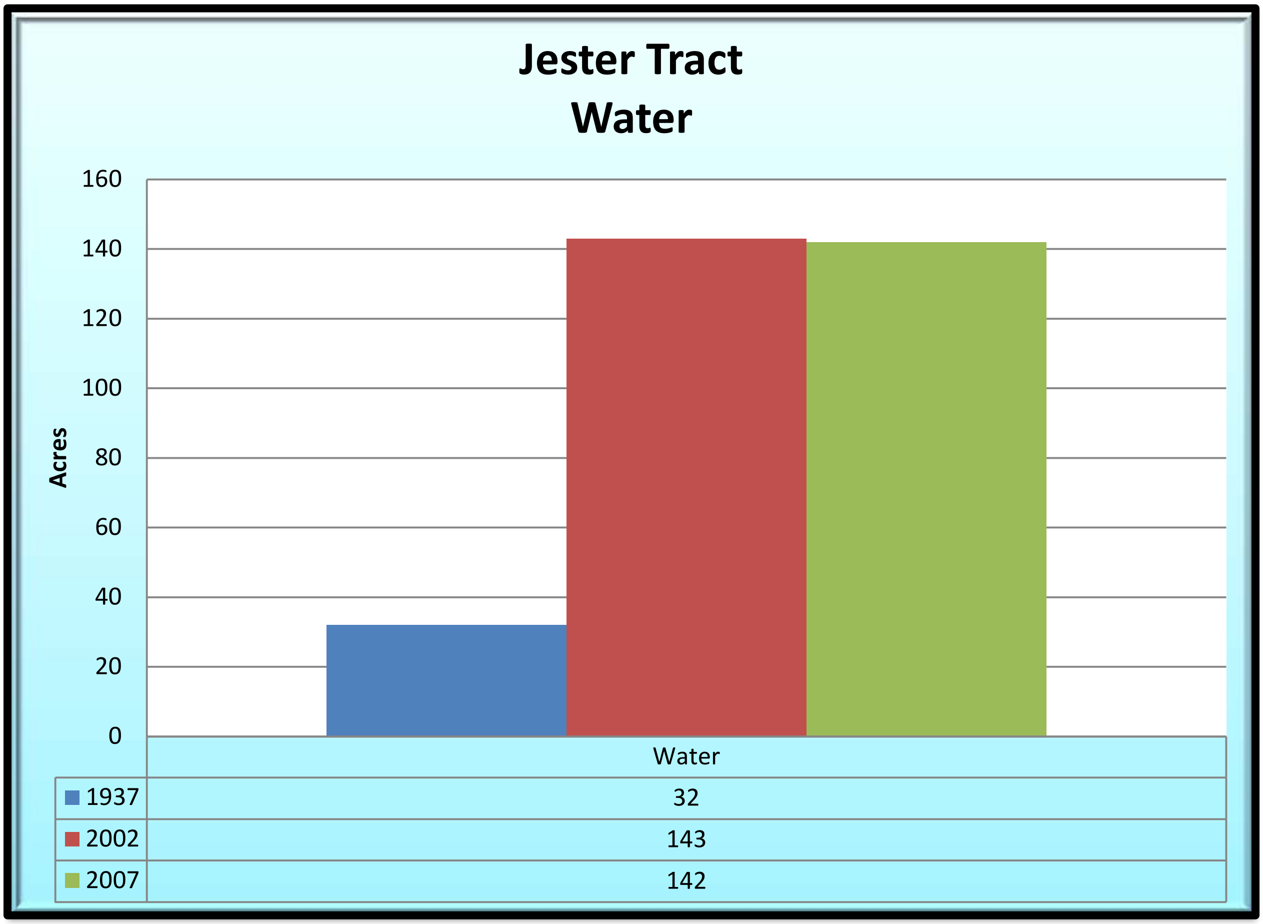


Figure 4-7.12. Jester Tract Water (1937, 2002, and 2007)

Jester Tract Water Coverage (Figure 4-7.12): Water coverage in the Jester Tract increased markedly in the 1937 to 2002 period and then has slowed its rate of increase for the 2002 to 2007 period. Historical rates (1937-2002 = 1.69 acres/year) and (1937-2007 = 1.59 acres/year) point to a decrease in the rate of inundation. Recent rates (2002-2007 = 0.2 acres/year) are even lower showing that the water could have filled a basin and is encountering topographic highs.

Natural Capital (Table 4-7.17)

Water capital has gradually increased in the Jester Tract, presumably from sea level rise and maybe erosion.

Table 4-7.17. Natural Capital of Jester Tract Water

Year	**Natural Capital (in 2012 dollars)**
1937	$458,651/year
2002	$2,049,598/year
2007	$2,035,265/year

8. Masten Tract

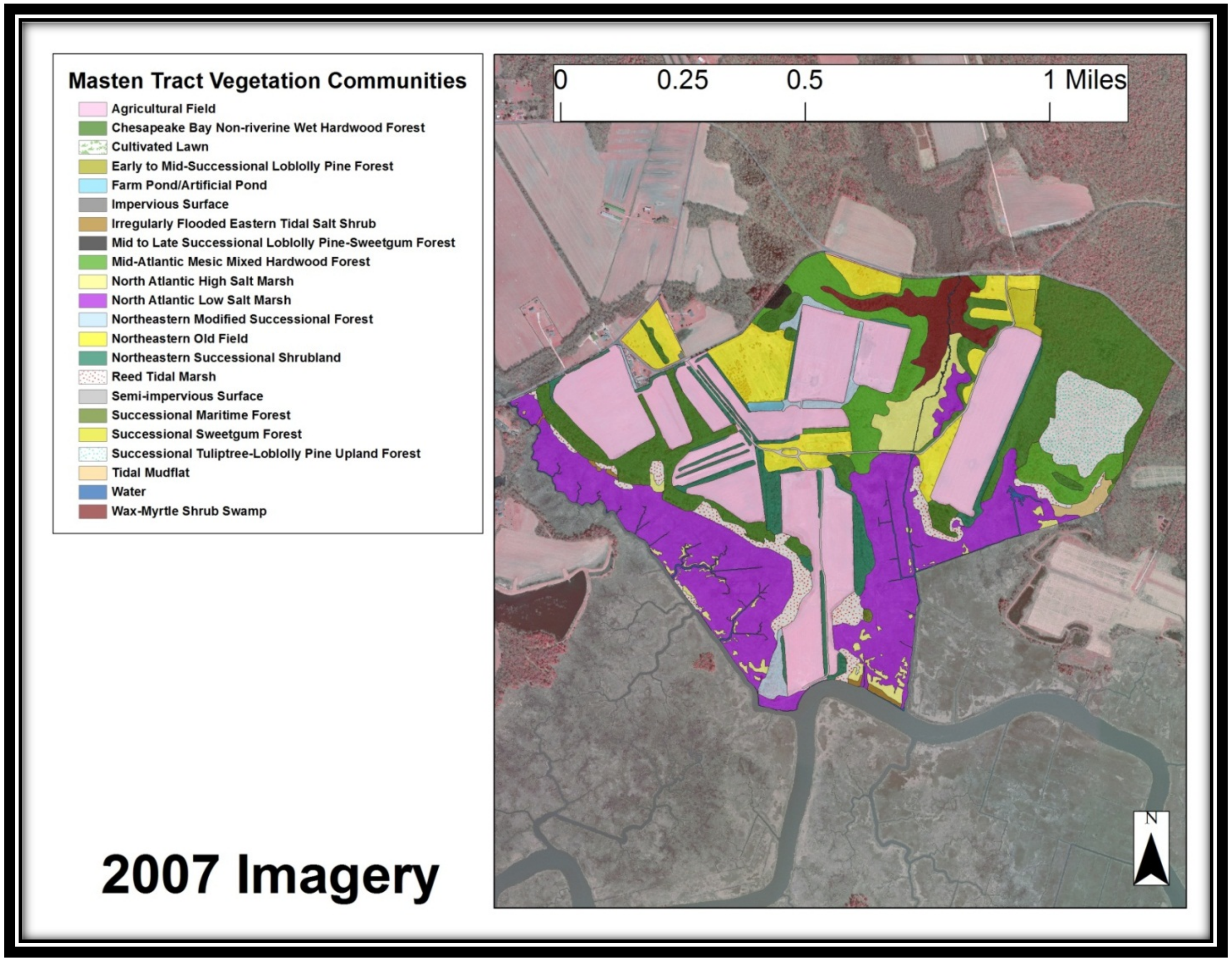


Figure 4-8.1. 2007 Vegetation Community Map of the Masten Tract

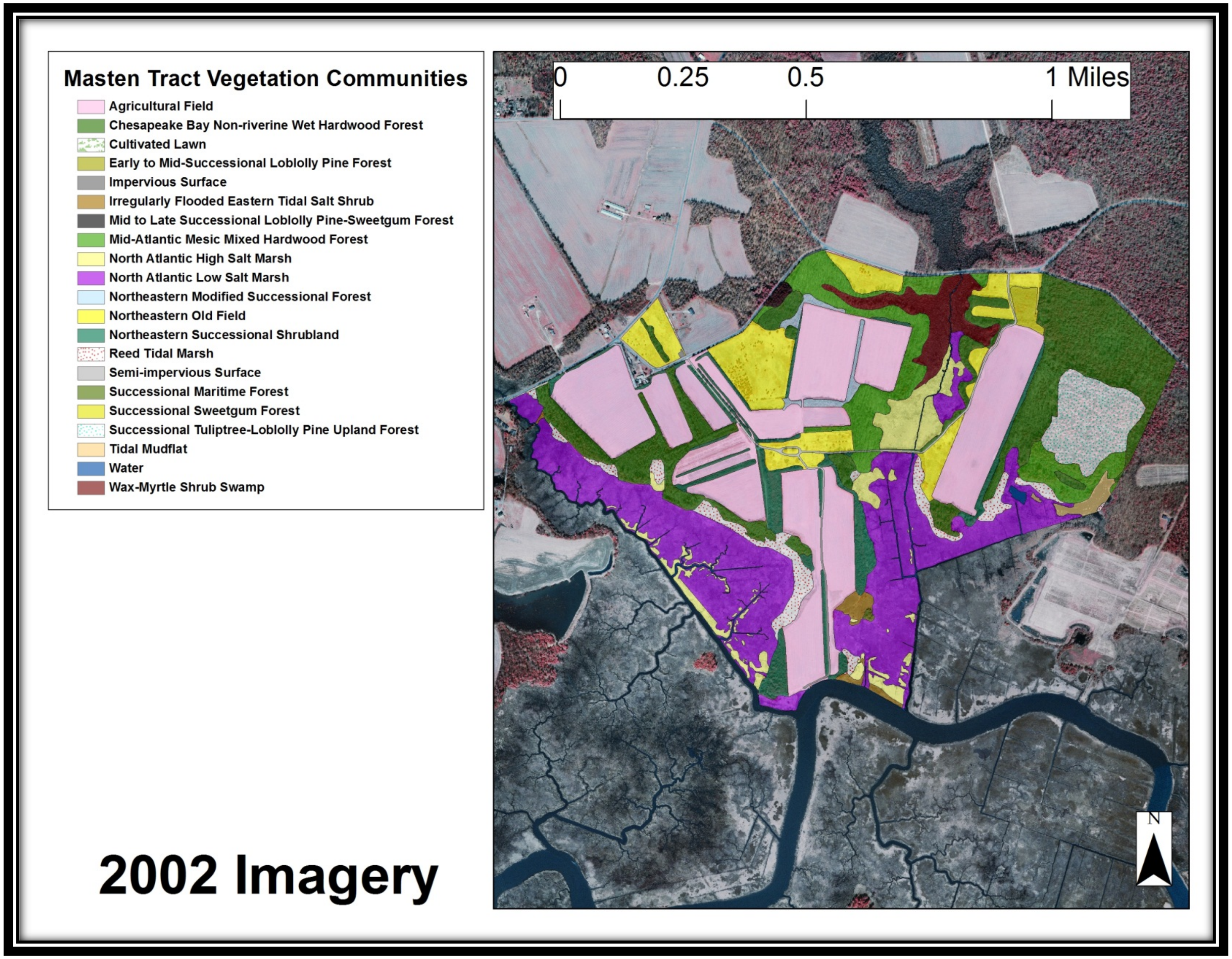


Figure 4-8.2. 2002 Vegetation Community Map of the Masten Tract

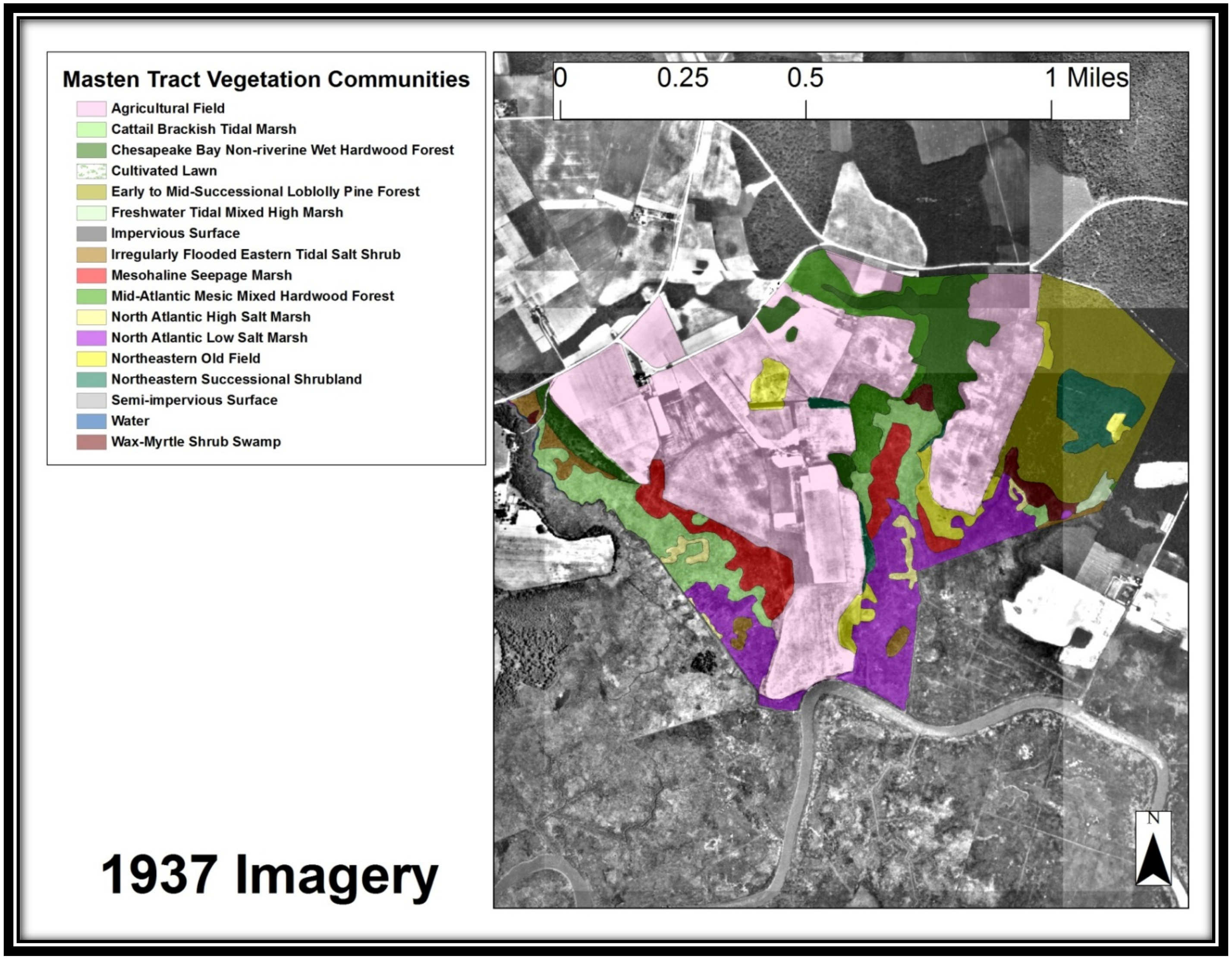
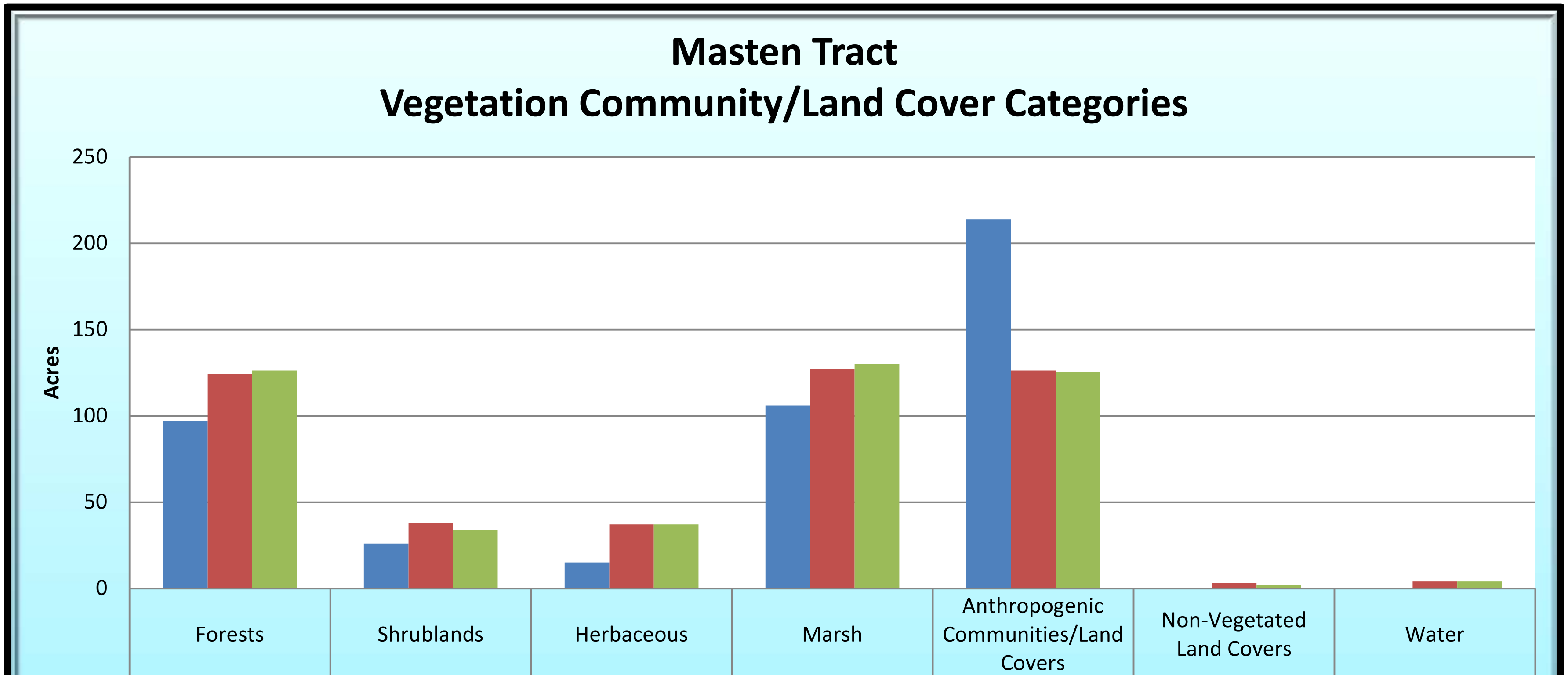


Figure 4-8.3. 1937 Vegetation Community Map of the Masten Tract



	Forests	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1937	97	26	15	106	214.02	0	0.3
2002	124.3	38	37	127	126.3	3	4
2007	126.3	34	37	130	125.5	2	4

Figure 4-8.4. Masten Tract Vegetation Community/Land Cover Categories (1937, 2002, and 2007)

Masten Tract Broad Trends (Figure 4-8.4): Forests, shrublands, herbaceous communities, marsh, non-vegetated land covers, and water have increased in the Masten Tract since 1937. Only anthropogenic communities/land covers have posted a decrease driven by agricultural fields.

DNREC Sea Level Rise Analysis (Table 4-8.1)

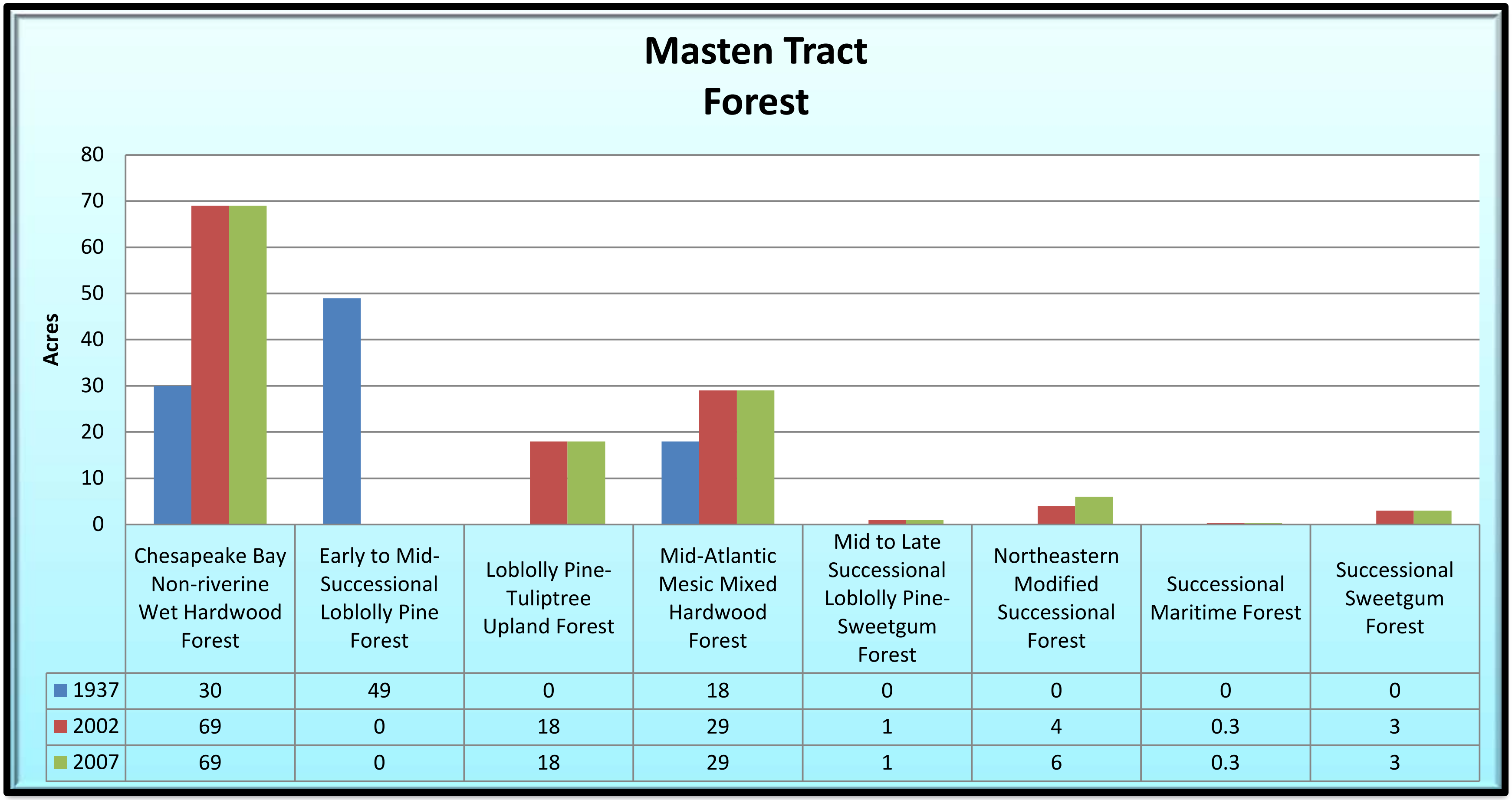
A little less than 2/3 of the Masten Tract will be inundated by water with 1.5 m of sea level rise. Most of the impacts will take place along the immediate stream corridors.

Table 4-8.1. Projected acres of the Masten Tract Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	196 acres
1 m	239 acres
1.5 m	284 acres

Natural Capital (Table 4-8.2)

Capital in the Masten Tract has gradually increased with gains in forest and marsh.

Table 4-8.2. Natural Capital of the Masten Tract	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,110,812/year
2002	$1,765,578/year
2007	$1,770,943/year



	Chesapeake Bay Non-riverine Wet Hardwood Forest	Early to Mid-Successional Loblolly Pine Forest	Loblolly Pine-Tuliptree Upland Forest	Mid-Atlantic Mesic Mixed Hardwood Forest	Mid to Late Successional Loblolly Pine-Sweetgum Forest	Northeastern Modified Successional Forest	Successional Maritime Forest	Successional Sweetgum Forest
1937	30	49	0	18	0	0	0	0
2002	69	0	18	29	1	4	0.3	3
2007	69	0	18	29	1	6	0.3	3

Figure 4-8.5. Masten Tract Forest (1937, 2002, and 2007)

Masten Tract Forest (Figure 4-8.5): In 1937, Chesapeake Bay Non-riverine Wet Hardwood Forest, Early to Mid-Successional Loblolly Pine Forest, and Mid-Atlantic Mesic Mixed Hardwood Forest were the only forests present on the tract. Later in 2007, the Early to Mid-Successional Loblolly Pine Forest has succeeded to add to the other two forests and Mid to Late Successional Loblolly Pine-Sweetgum Forest. In addition, three other forests have appeared.

DNREC Sea Level Rise Analysis (Table 4-8.3)

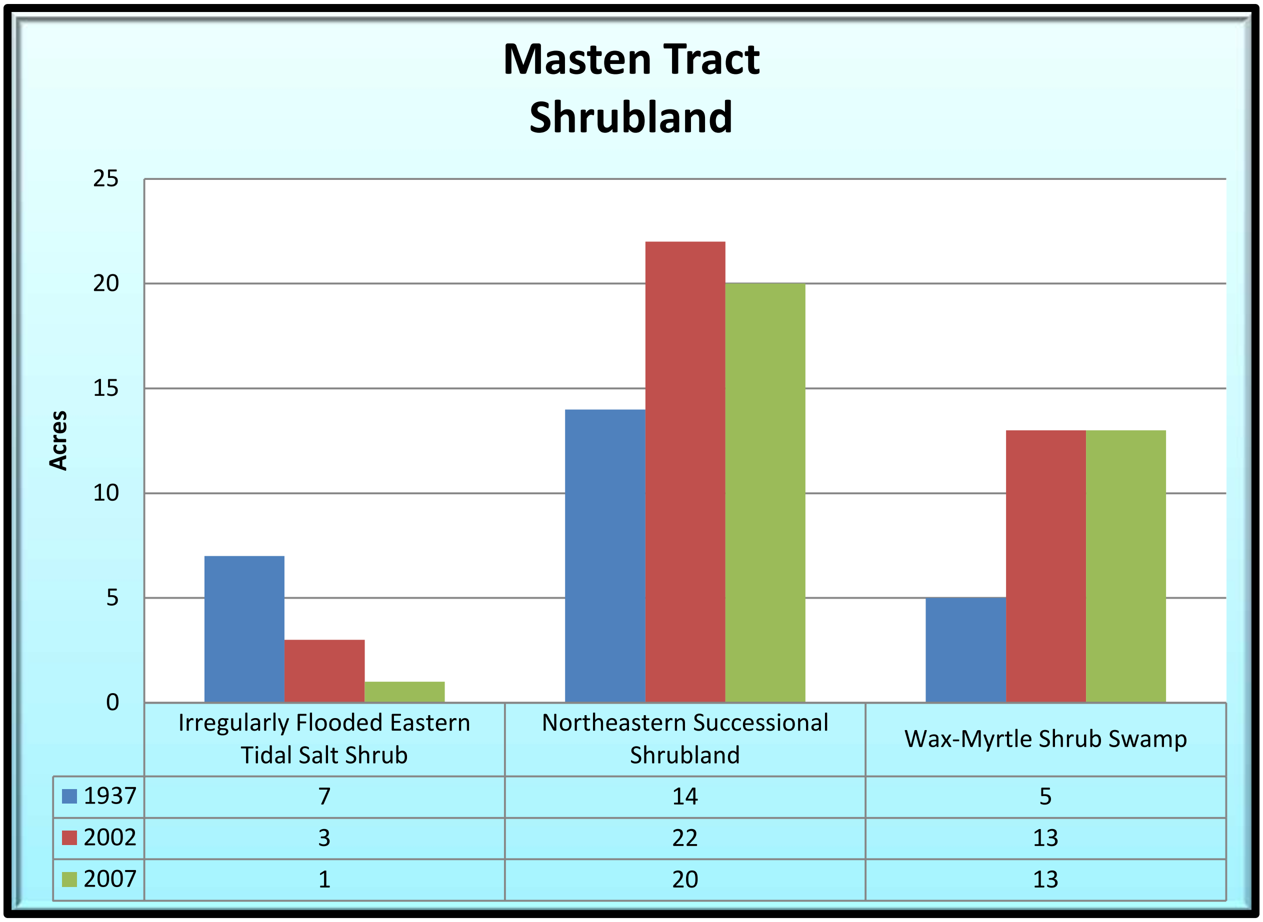
A little more than half of the forestland in the Masten Tract will be inundated by water with 1.5 m of sea level rise.

Table 4-8.3. Projected acres of Masten Tract Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	30 acres
1 m	47 acres
1.5 m	66 acres

Natural Capital (Table 4-8.4)

Forest capital has been increasing with an increase in the amount of forest. The recent increase was from a gain in Northeastern Modified Successional Forest, which has grown from Northeastern Successional Shrubland increasing the capital in the tract and the wildlife area.

Table 4-8.4. Natural Capital of Masten Tract Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$381,415/year
2002	$858,571/year
2007	$858,949/year



	Irregularly Flooded Eastern Tidal Salt Shrub	Northeastern Successional Shrubland	Wax-Myrtle Shrub Swamp
1937	7	14	5
2002	3	22	13
2007	1	20	13

Figure 4-8.6. Masten Tract Shrubland (1937, 2002, and 2007)

Masten Tract Shrubland (Figure 4-8.6): Shrublands have increased overall in the Masten Tract. Only one shrubland, Irregularly Flooded Eastern Tidal Salt Shrub, has decreased in amount and is likely a result of sea level rise or an increase in salinity in the marshes.

DNREC Sea Level Rise Analysis (Table 4-8.5)

About 2/3 of the current shrubland in the Masten Tract will be flooded by water with 1.5 m of sea level rise.

Table 4-8.5. Projected acres of Masten Tract Shrubland Inundated by Sea Level Rise

Rise	Acres
0.5 m	17 acres
1 m	21 acres
1.5 m	24 acres

Natural Capital (Table 4-8.6)

Shrubland capital has been decreasing with losses in Irregularly Flooded Eastern Tidal Salt Shrub and maturation of Northeastern Successional Shrubland to forest.

Table 4-8.6. Natural Capital of Masten Tract Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$45,939/year
2002	$22,019/year
2007	$9,185/year

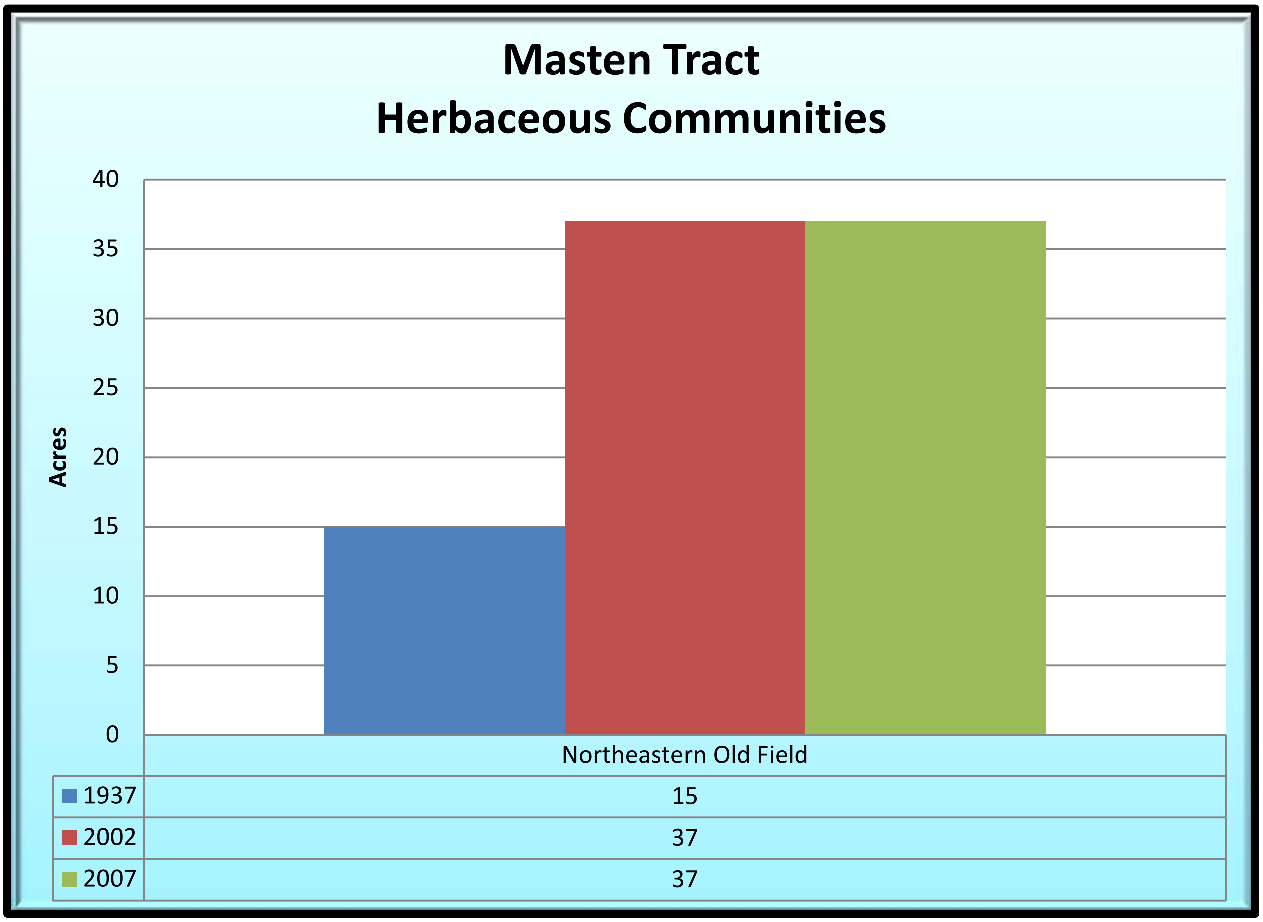


Figure 4-8.7. Masten Tract Herbaceous Communities (1937, 2002, and 2007)

Masten Tract Herbaceous Communities (Figure 4-8.7): Northeastern Old Field is the only herbaceous community present in the Masten Tract and fluctuates mainly on the amount of agricultural field that is taken out of production.

DNREC Sea Level Rise Analysis (Table 4-8.7)

A little more than ¼ of the herbaceous communities in the Masten Tract will be affected by 1.5 m of sea level rise.

Table 4-8.7. Projected acres of Masten Tract Herbaceous Communities Inundated by Sea Level Rise

Rise	Acres
0.5 m	3 acres
1 m	7 acres
1.5 m	10 acres

Natural Capital (Table 4-8.8)

Herbaceous communities have increased with the abandonment of agricultural field leading to an increase in capital for the tract and the wildlife area.

Table 4-8.8. Natural Capital of Masten Tract Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1937	$2,186/year
2002	$5,391/year
2007	$5,391/year

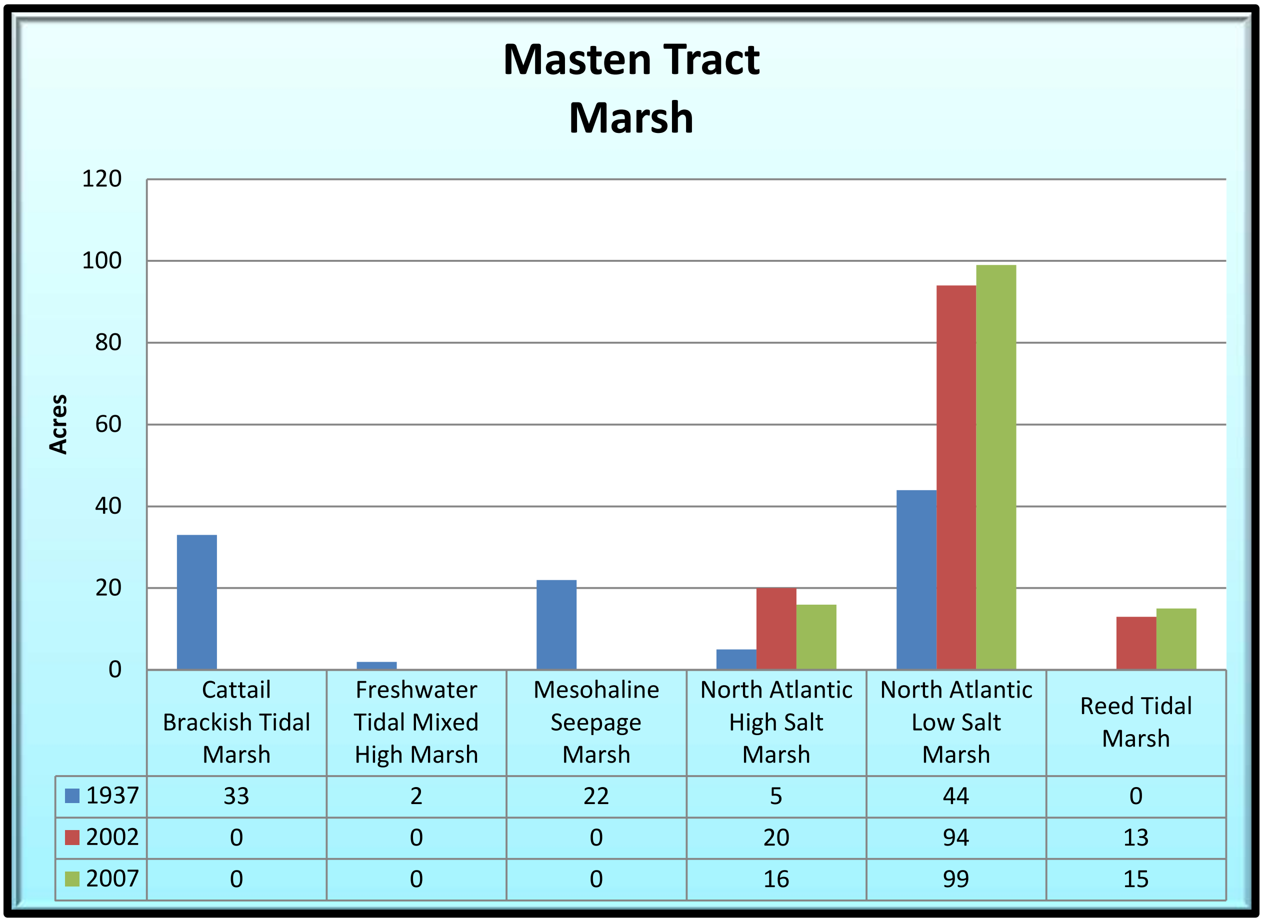


Figure 4-8.8. Masten Tract Marsh (1937, 2002, and 2007)

Masten Tract Marsh (Figure 4-8.8): In 1937, three marshes were prominent in the Masten Tract including Cattail Brackish Tidal Marsh, Mesohaline Seepage Marsh, and North Atlantic Low Salt Marsh. Also at this time a remnant (2 acres) of the former freshwater marshes was present. Since these two marshes, Cattail Brackish Tidal Marsh and Mesohaline Seepage Marsh, have disappeared and have been replaced by North Atlantic Low Salt Marsh as the salinities have risen. Reed Tidal Marsh is a recent arrival to the marshes and has likely taken over some the area covered by North Atlantic High Marsh.

DNREC Sea Level Rise Analysis (Table 4-8.9)

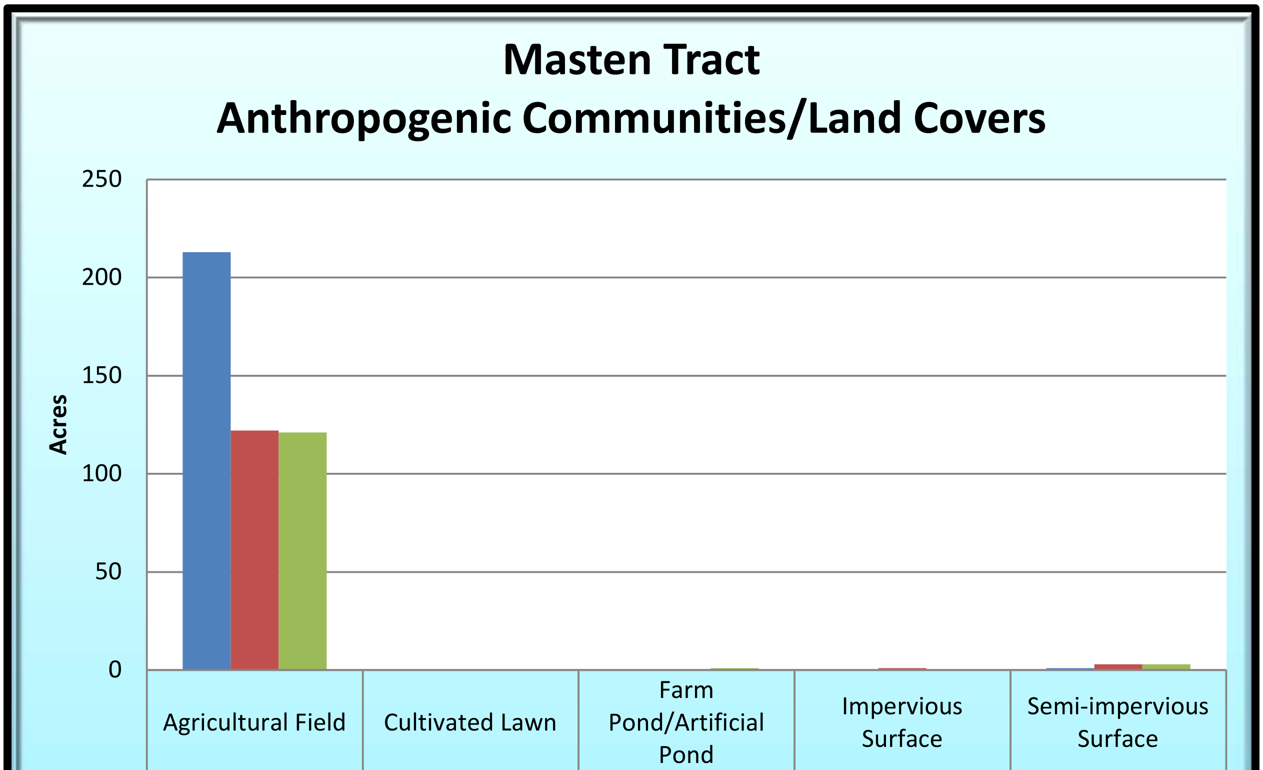
All of the marshland currently present in the Masten Tract will be inundated by water with 0.5 m of sea level rise.

Table 4-8.9. Projected acres of Masten Tract Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	130 acres
1 m	130 acres
1.5 m	130 acres

Natural Capital (Table 4-8.10)

Capital of marshland has increased, being driven by gains in North Atlantic Low Salt Marsh.

Table 4-8.10. Natural Capital of Masten Tract Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$664,758/year
2002	$796,455/year
2007	$815,269/year



	Agricultural Field	Cultivated Lawn	Farm Pond/Artificial Pond	Impervious Surface	Semi-impervious Surface
1937	213	0.01	0	0.01	1
2002	122	0.3	0	1	3
2007	121	0.2	1	0.3	3

Figure 4-8.9. Masten Tract Anthropogenic Communities/Land Covers (1937, 2002, and 2007)

Masten Tract Anthropogenic Communities/Land Covers (Figure 4-8.9): Agricultural field is the predominant anthropogenic community in the Masten Tract and has been declining since 1937 fueling the rise of Northeastern Old Field. Other anthropogenic types are minor to the tract.

DNREC Sea Level Rise Analysis (Table 4-8.11)

A little more than 1/3 of the anthropogenic communities/land covers will be flooded by water with 1.5 m of sea level rise in the Masten Tract.

Table 4-8.11. Projected acres of Masten Tract Anthropogenic Communities/Land Covers Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	10 acres
1 m	29 acres
1.5 m	47 acres

Natural Capital (Table 4-8.12)

Agricultural field and ponds are the only anthropogenic communities and land covers with natural capital value in the Masten Tract. Agricultural fields have been declined as they are abandoned, the addition of a pond and caused an overall increase in the capital from 1937.

Table 4-8.12. Natural Capital of Masten Tract Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$12,216/year
2002	$6,997/year
2007	$12,274/year

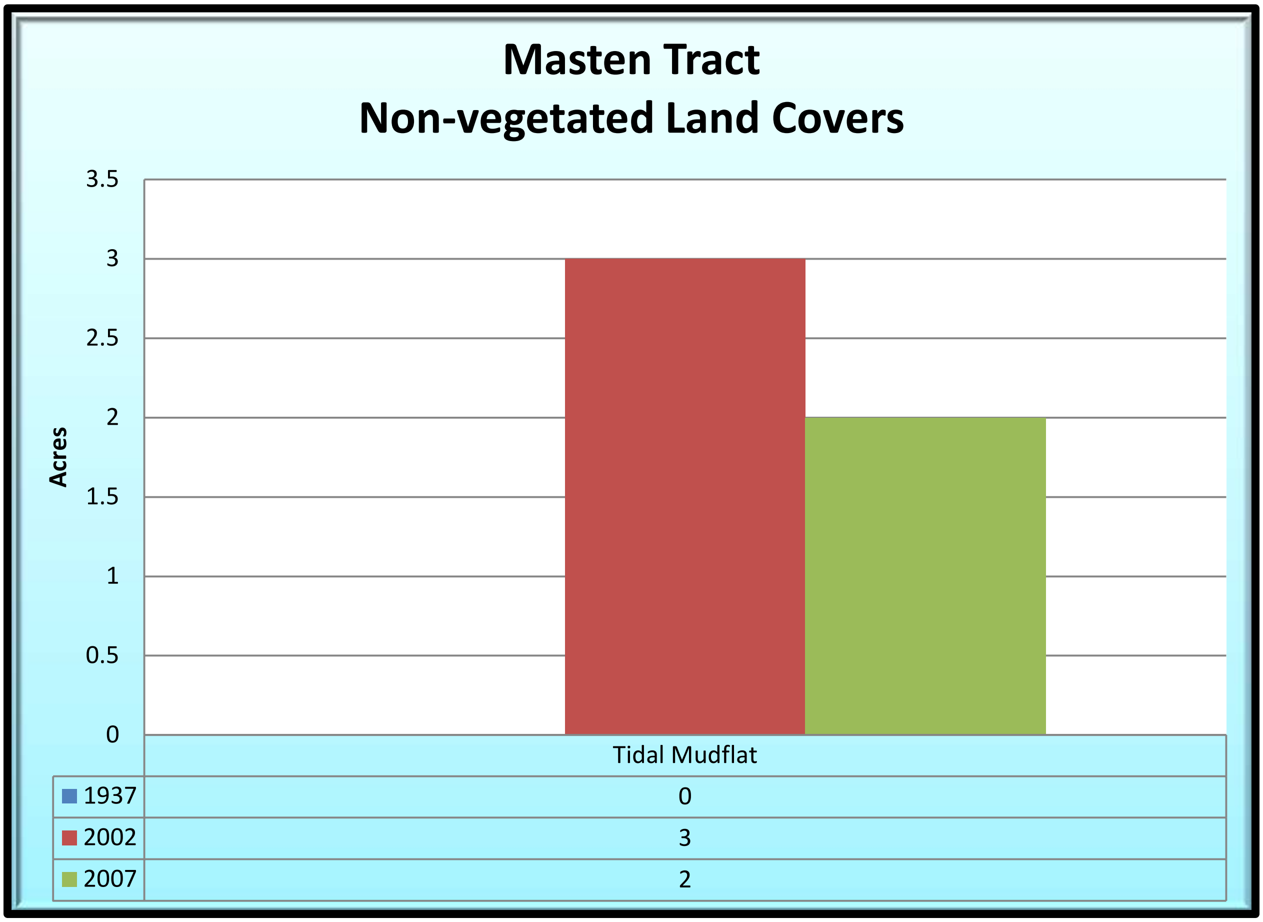


Figure 4-8.10. Masten Tract Non-vegetated Land Covers (1937, 2002, and 2007)

Masten Tract Non-vegetated Land Covers (Figure 4-8.10): Tidal mudflat has come about recently in the Masten Tract and has been roughly stable in amount.

DNREC Sea Level Rise Analysis (Table 4-8.13)

All of the Non-vegetated Land Covers in the Masten Tract will be inundated by water with 0.5 m of sea level rise.

Table 4-8.13. Projected acres of Masten Tract Non-vegetated Land Covers Inundated by Sea Level Rise

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

Natural Capital (Table 4-8.14)

Tidal mudflats are ephemeral and come and go with storms and disturbance to the marsh. As such the capital tends to fluctuate and this is the case in the Masten Tract.

Table 4-8.14. Natural Capital of Masten Tract Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$18,814/year
2007	$12,543/year

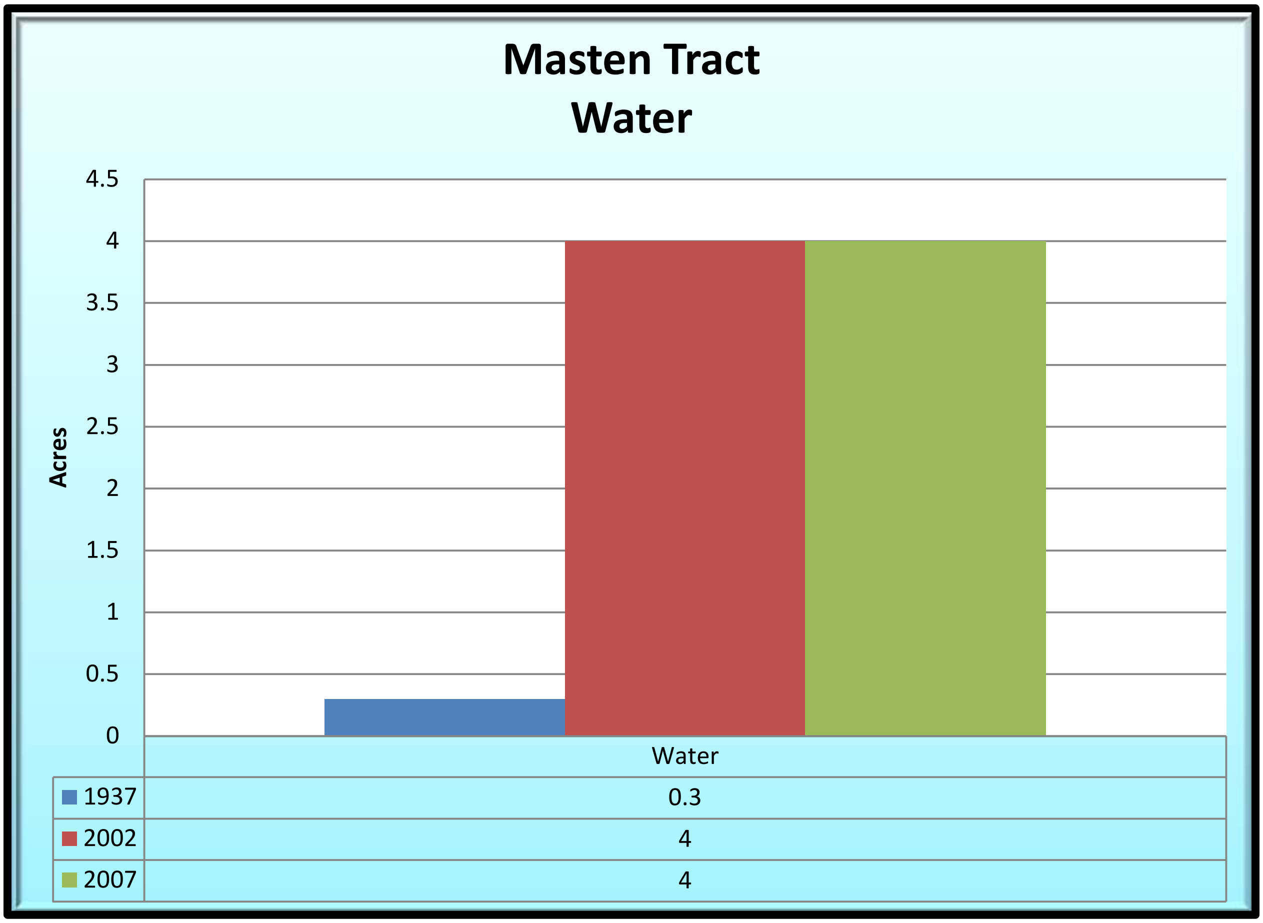


Figure 4-8.11. Masten Tract Water (1937, 2002, and 2007)

Masten Tract Water Coverage (Figure 4-8.11): Rates of water inundation in the Masten Tract mirror those in the Hall Tract and the Hollager Tract. The historic rate of inundation in this tract has been (1937-2002 = 0.06 acres/year) and (1937-2007 = 0.04 acres/year). The recent rate (2002-2007), however has been negative with- 0.2 acres/year.Topographical effects could be one of the factors among other unknown factors.

Natural Capital (Table 4-8.16)

Water has increased overall since 1937 in the Masten Tract. Recently, however, it has decreased in acreage and capital.

Table 4-8.16. Natural Capital of Masten Tract Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$4,300/year
2002	$57,331/year
2007	$57,331/year

9. Penuel Tract

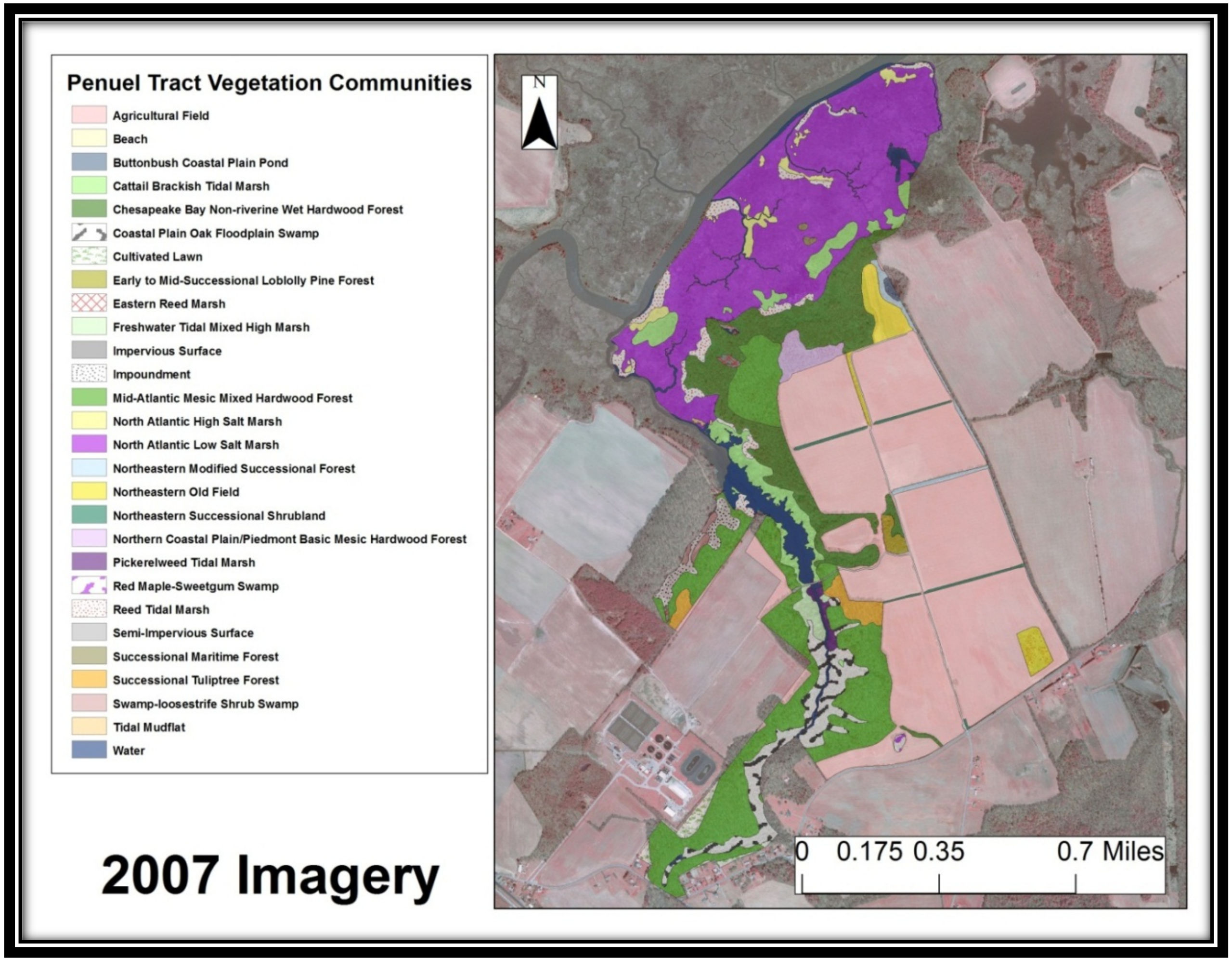


Figure 4-9.1. 2007 Vegetation Community Map of the Penuel Tract

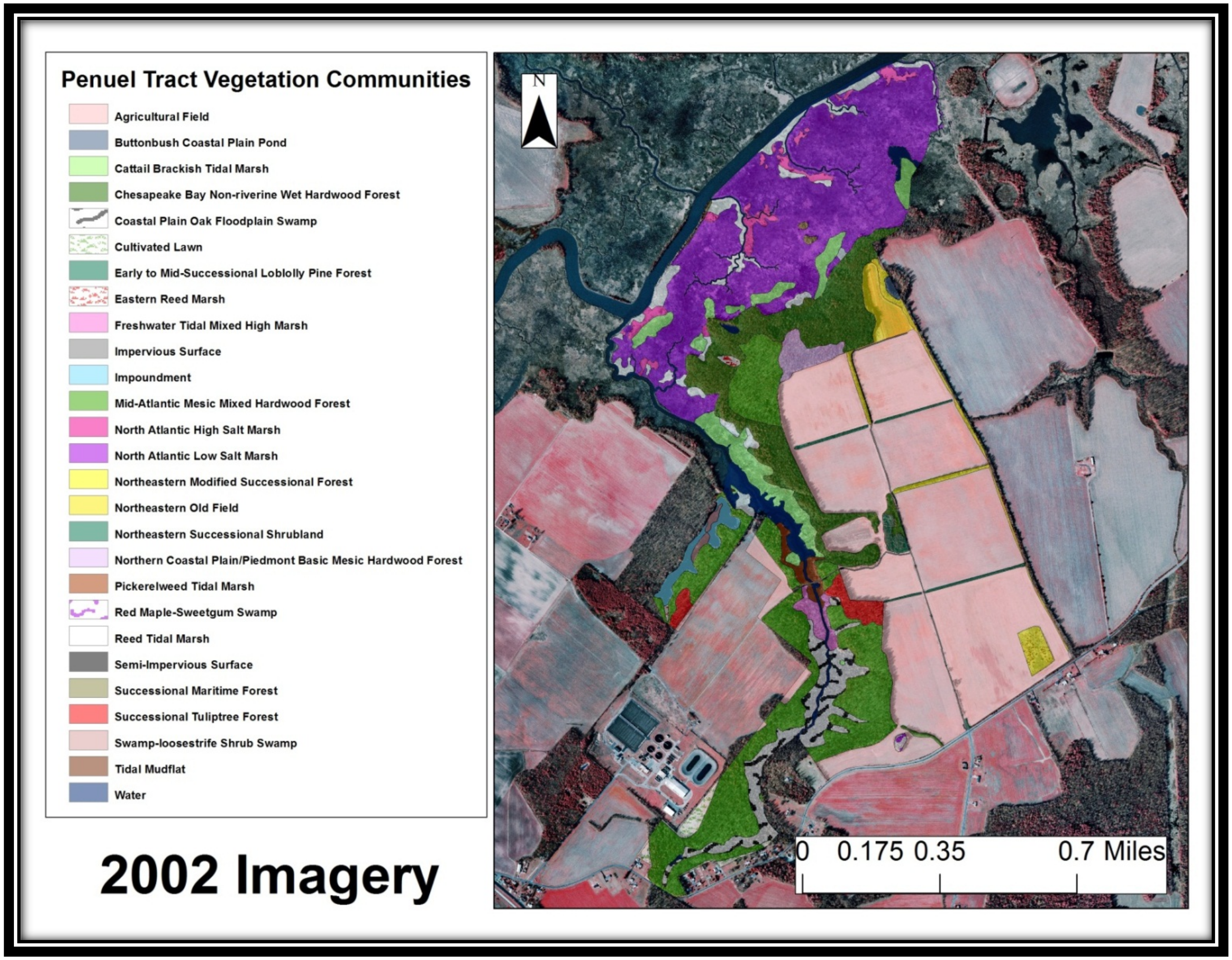


Figure 4-9.2. 2002 Vegetation Community Map of the Penuel Tract

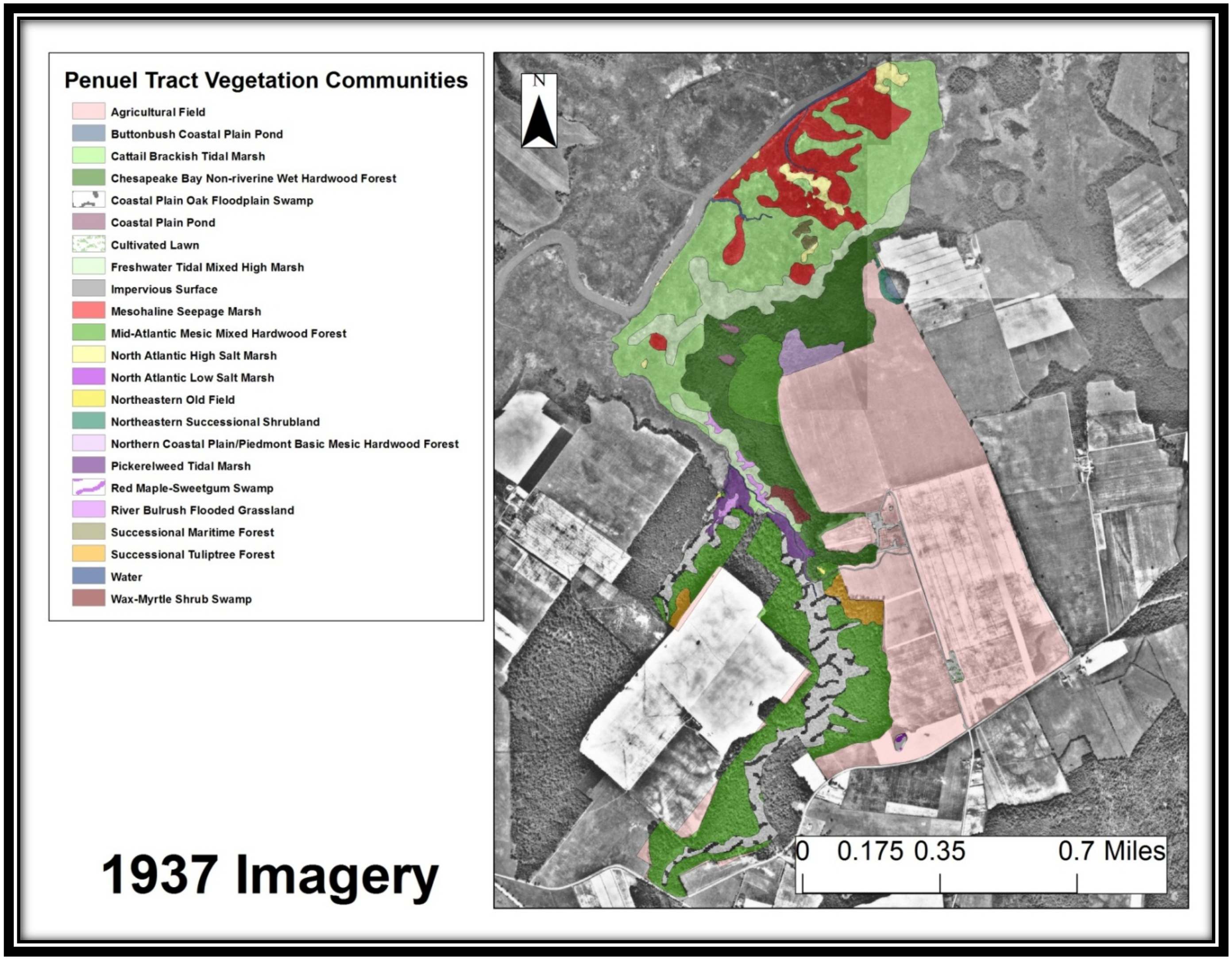
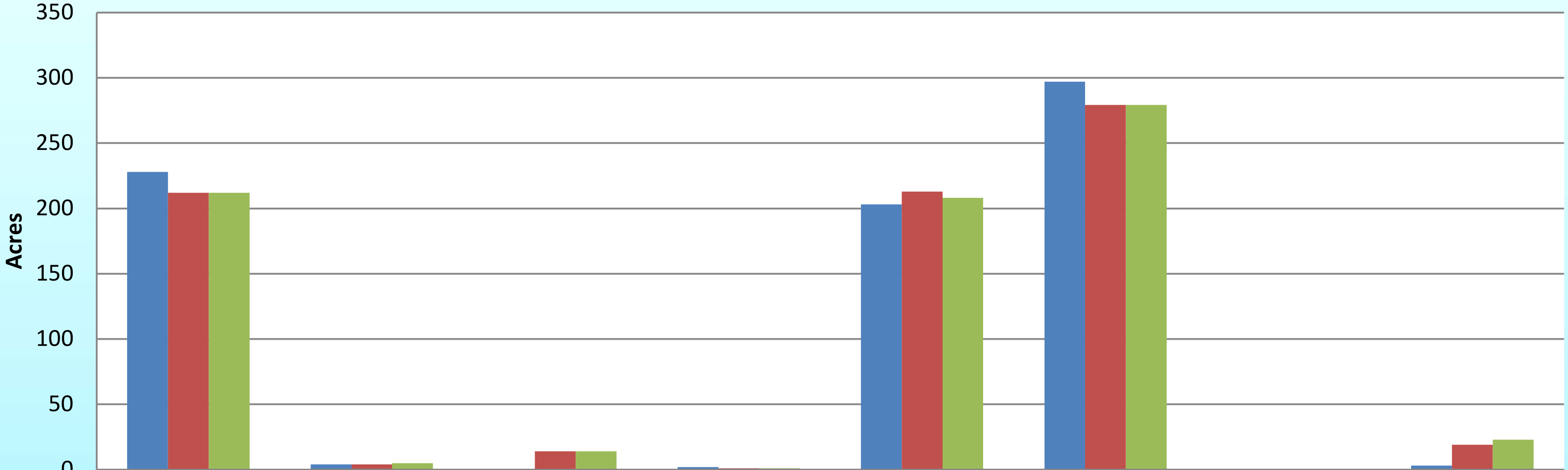


Figure 4-9.3. 1937 Vegetation Community Map of the Penuel Tract



	Forests	Shrublands	Herbaceous	Coastal Plain Ponds	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1937	228	4	0.2	2	203	297	0	3
2002	212	4	14	1	213	279.2	0.04	19
2007	212	5	14	1	208	279.2	0.3	23

Figure 4-9.4. Penuel Tract Vegetation Community/Land Cover Categories (1937, 2002, and 2007)

Penuel Tract Broad Trends (Figure 4-9.4): The Penuel Tract is located on the south side of the Murderkill River and contains a tributary that flows north into the river. In 1937, Forests, Marsh, and Anthropogenic communities (Agricultural field) are the predominant vegetation types. Since this time two, Forest and Anthropogenic communities have declined, while marsh has increased in area. Other vegetation types have increased as well.

DNREC Sea Level Rise Analysis (Table 4-9.1)

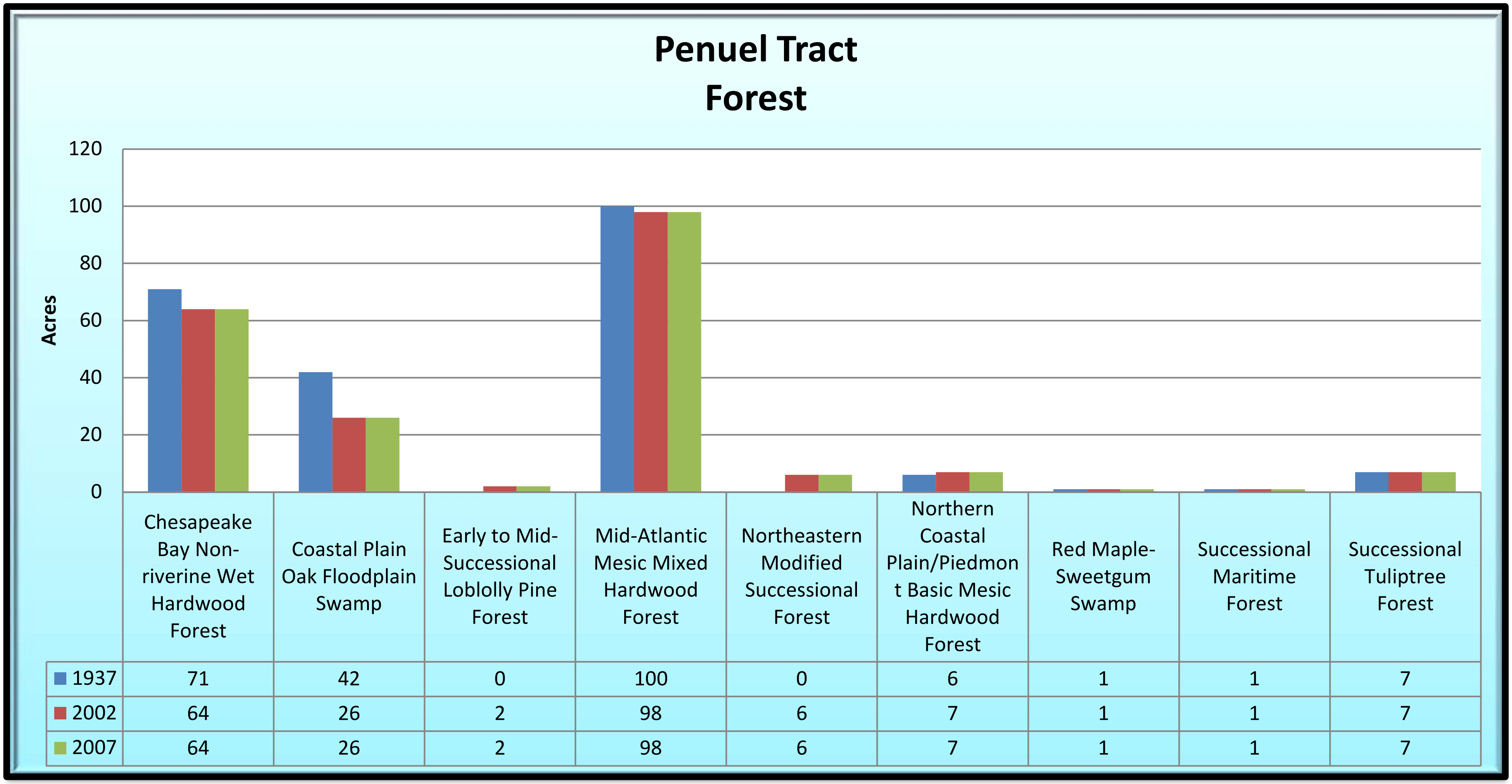
A little less than half of the Penuel Tract will be inundated by water with 1.5 m of sea level rise.

Table 4-9.1. Projected acres of the Penuel Tract Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	298 acres
1 m	330 acres
1.5 m	358 acres

Natural Capital (Table 4-9.2)

Capital in the Penuel Tract has decreased overall with a reduction in the amount of forestland. These losses have been mitigated by an increase in marsh.

Table 4-9.2. Natural Capital of the Penuel Tract	
Year	**Natural Capital (in 2012 dollars)**
1937	$2,775,196/year
2002	$2,655,406/year
2007	$2,656,301/year



	Chesapeake Bay Non-riverine Wet Hardwood Forest	Coastal Plain Oak Floodplain Swamp	Early to Mid-Successional Loblolly Pine Forest	Mid-Atlantic Mesic Mixed Hardwood Forest	Northeastern Modified Successional Forest	Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest	Red Maple-Sweetgum Swamp	Successional Maritime Forest	Successional Tuliptree Forest
1937	71	42	0	100	0	6	1	1	7
2002	64	26	2	98	6	7	1	1	7
2007	64	26	2	98	6	7	1	1	7

Figure 4-9.5. Penuel Tract Forest (1937, 2002, and 2007)

Penuel Tract Forest (Figure 4-9.5): Mid-Atlantic Mesic Mixed Hardwood Forest and Chesapeake Bay Non-riverine Wet Hardwood Forest have been the most common forest types in the Penuel Tract. Both have suffered declines since 1937. One rare forest type, Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest, has remained at nearly the same amount during the study period.

DNREC Sea Level Rise Analysis (Table 4-9.3)

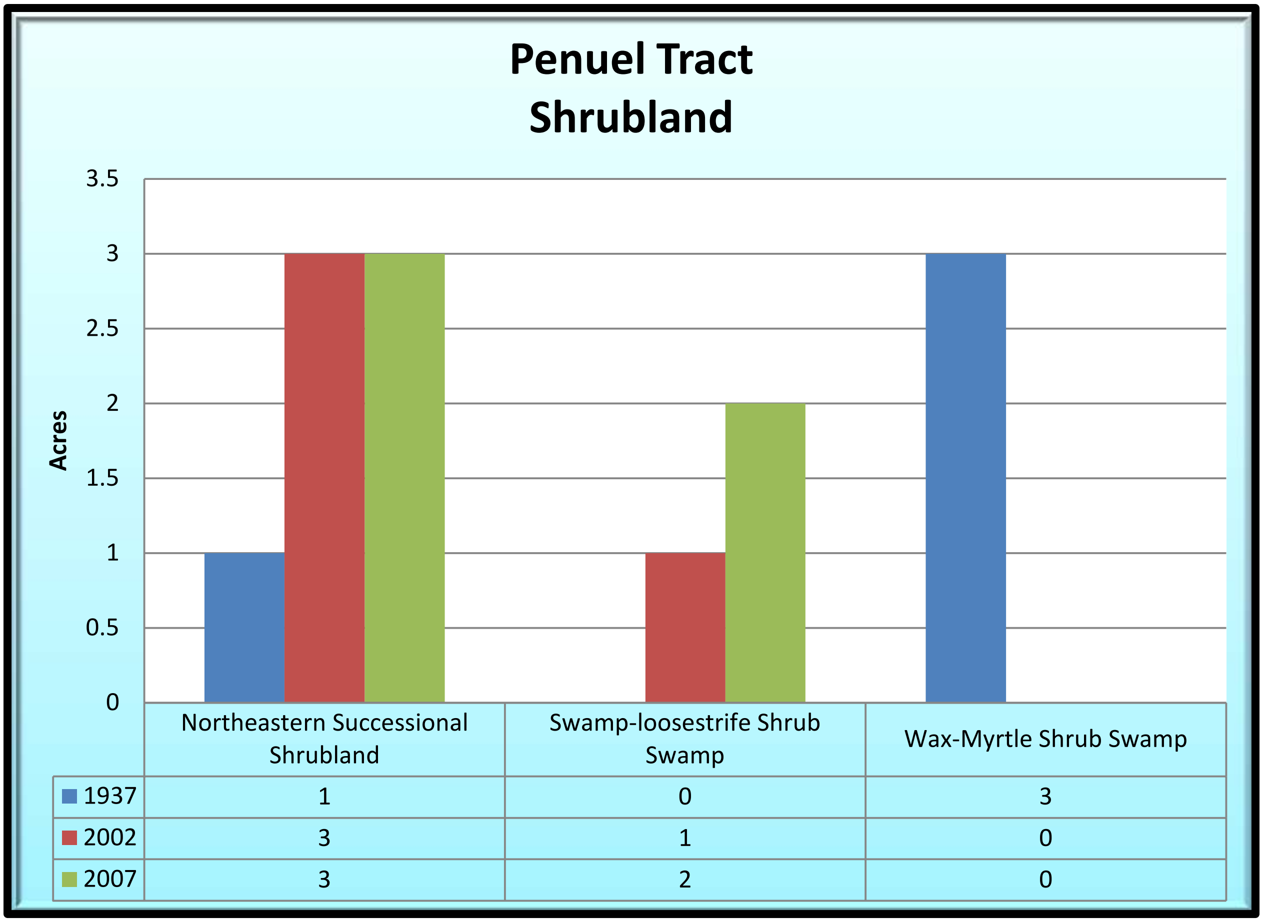
All of the Non-vegetated Land Covers in the Masten Tract will be inundated by water with 0.5 m of sea level rise.

Table 4-9.3. Projected acres of Penuel Tract Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	66 acres
1 m	89 acres
1.5 m	109 acres

Natural Capital (Table 4-9.4)

Capital of forest has decreased with losses of forest due to water immersion on the tributary to the Murderkill River and the development of an Impoundment.

Table 4-9.4. Natural Capital of Penuel Tract Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,422,788/year
2002	$1,141,408/year
2007	$1,141,408/year



	Northeastern Successional Shrubland	Swamp-loosestrife Shrub Swamp	Wax-Myrtle Shrub Swamp
1937	1	0	3
2002	3	1	0
2007	3	2	0

Figure 4-9.6. Penuel Tract Shrubland (1937, 2002, and 2007)

Penuel Tract Shrubland (Figure 4-9.6): Wax-Myrtle Shrub Swamp has been replaced by Northeastern Successional Shrubland as the most common shrubland in the Penuel Tract. Swamp-loosestrife Shrub Swamp is an apparent newcomer to the tract and is located in an impoundment that formed in the 1950's to 1960's.

DNREC Sea Level Rise Analysis (Table 4-9.5)

Swamp-loosestrife Shrub Swamp is eliminated from the Penuel Tract with 1 m of sea level rise.

Table 4-9.5. Projected acres of Penuel Tract Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 4-9.6)

Shrubland capital has decreased with the loss of Wax-Myrtle Shrub Swamp. It has increased recently, however, from a gain in acreage from Swamp-loosestrife Shrub Swamp.

Table 4-9.6. Natural Capital of Penuel Tract Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$27,990/year
2002	$9,719/year
2007	$19,000/year

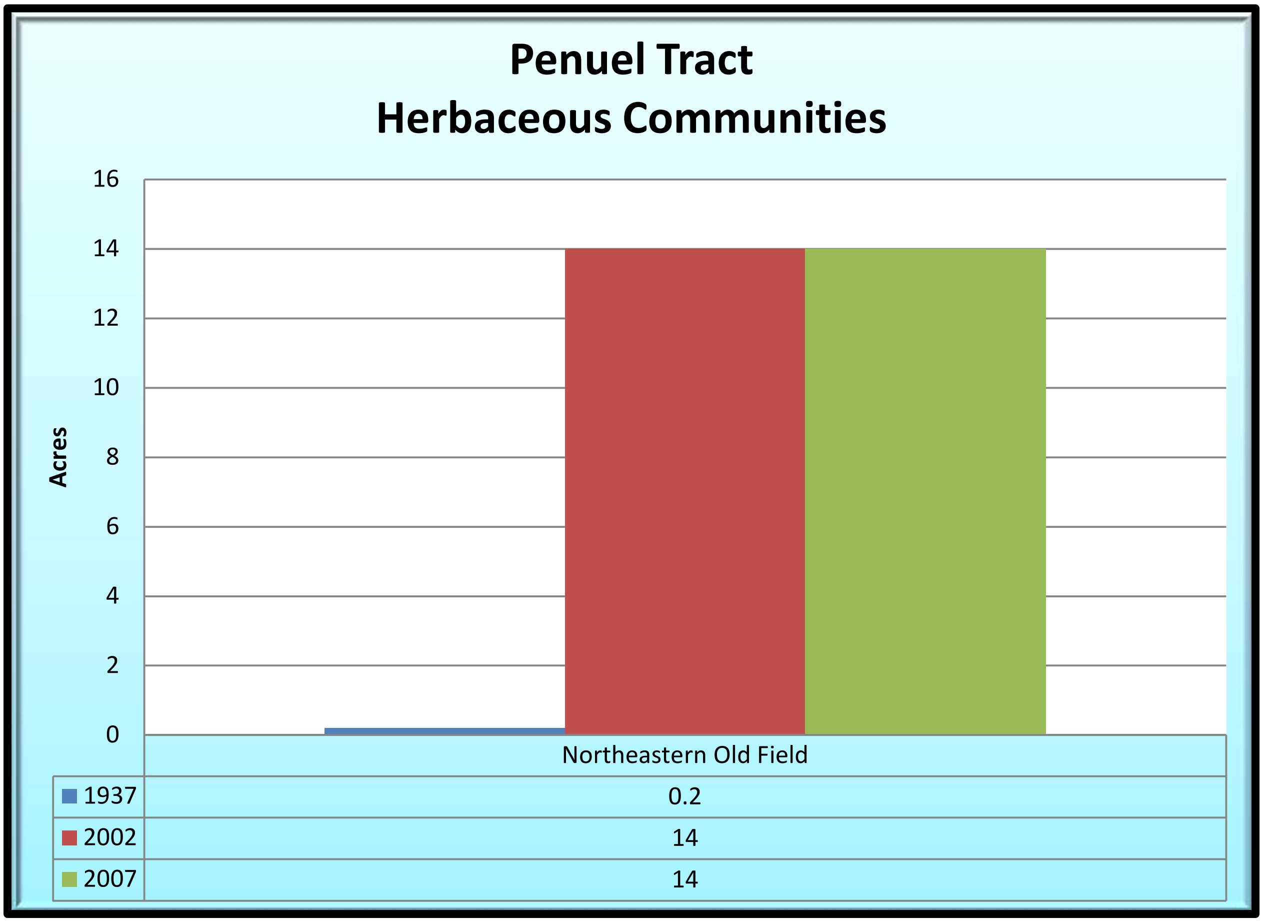


Figure 4-9.7. Penuel Tract Herbaceous Communities (1937, 2002, and 2007)

Penuel Tract Herbaceous Communities (Figure 4-9.7): Northeastern Old Field has increased since 1937 with the addition of wildlife food plots in the Penuel Tract and the abandonment of agriculture.

DNREC Sea Level Rise Analysis (Table 4-9.7)

A little less than ¼ of the current herbaceous community acreage will be affected with 1.5 m of sea level rise.

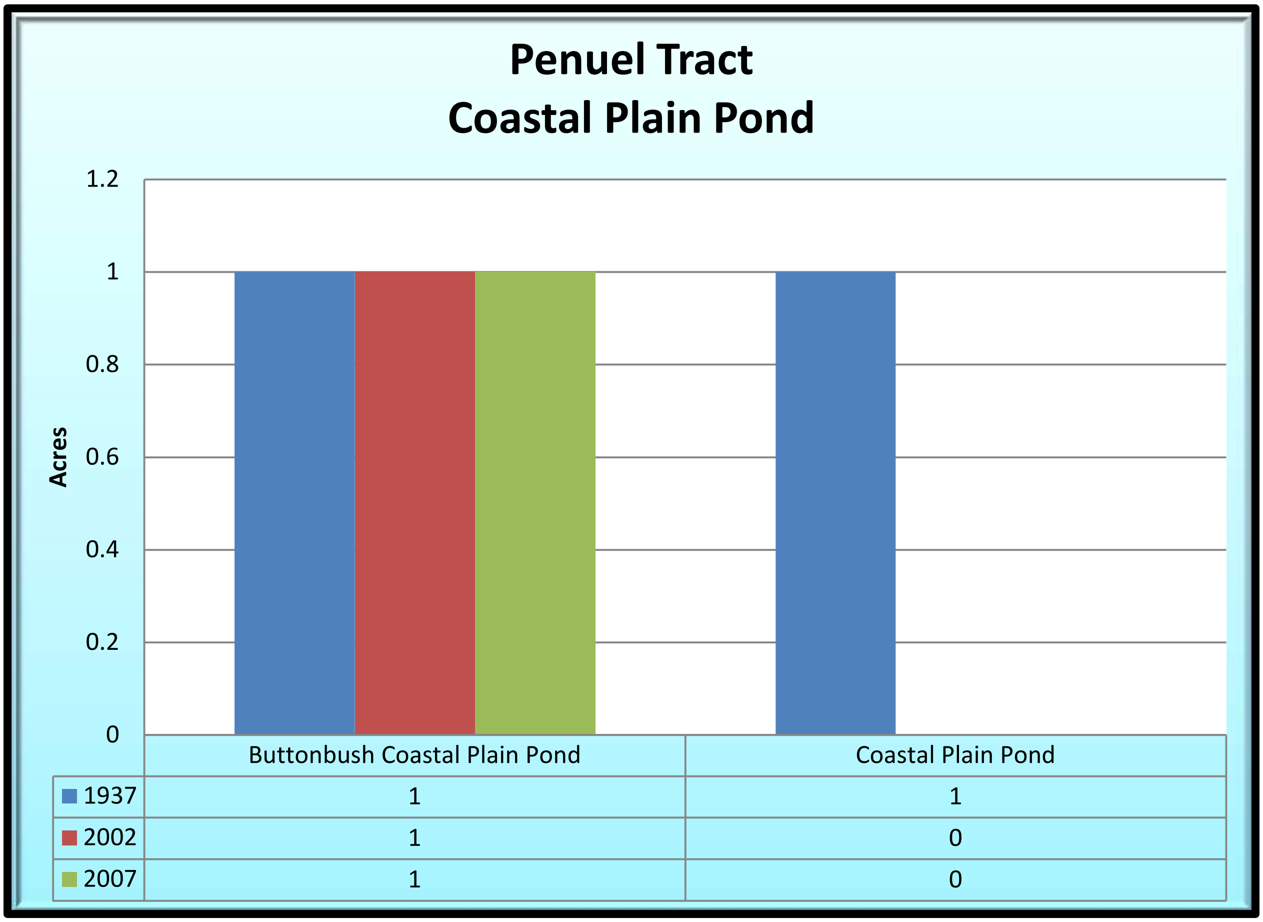
Table 4-9.7. Projected acres of Penuel Tract Herbaceous Communities Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	2 acres
1.5 m	3 acres

Natural Capital (Table 4-9.8)

Northeastern Old Field has increased in the recent period with abandonment of agricultural fields causing the capital to increase for both the tract and the wildlife area.

Table 4-9.8. Natural Capital of Penuel Tract Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1937	$29/year
2002	$2,040/year
2007	$2,040/year



	Buttonbush Coastal Plain Pond	Coastal Plain Pond
1937	1	1
2002	1	0
2007	1	0

Figure 4-9.8. Penuel Tract Coastal Plain Pond (1937, 2002, and 2007)

Penuel Tract Coastal Plain Pond (Figure 4-9.8): In 1937 there were two locations of Coastal Plain Ponds in the Penuel Tract. One pond could be identified and one pond is unknown. The pond that was unknown in 1937 has been converted to an Eastern Reed Marsh in recent times resulting in its elimination.

DNREC Sea Level Rise Analysis (Table 4-9.9)

The remaining coastal plain pond in the Penuel Tract will be "captured" by tidal water with 1.5 m of sea level rise.

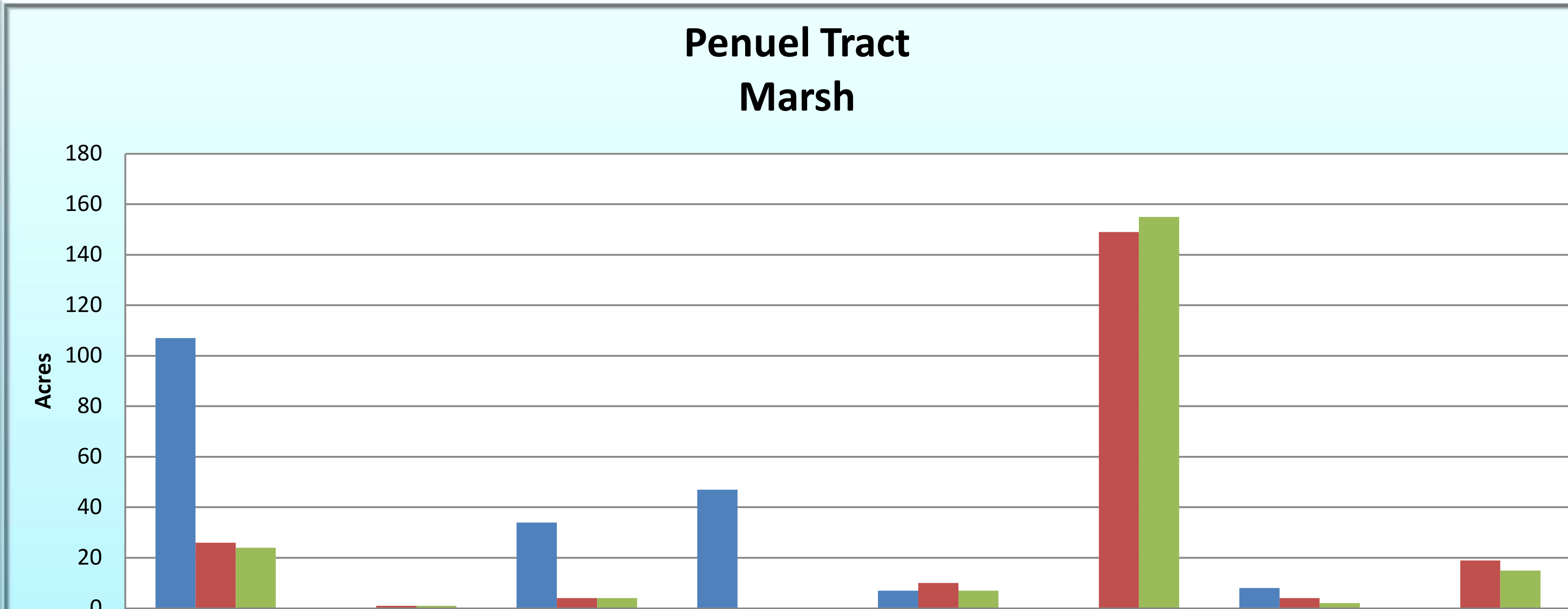
Table 4-9.9. Projected acres of Penuel Tract Coastal Plain Pond Inundated by Sea Level Rise

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

Natural Capital (Table 4-9.10)

The amount of coastal plain pond acreage has been reduced by half from its 1937 level causing the capital to decrease.

Table 4-9.10. Natural Capital of Penuel Tract Coastal Plain Pond	
Year	**Natural Capital (in 2012 dollars)**
1937	$18,563/year
2002	$9,281/year
2007	$9,281/year



	Cattail Brackish Tidal Marsh	Eastern Reed Marsh	Freshwater Tidal Mixed High Marsh	Mesohaline Seepage Marsh	North Atlantic High Salt Marsh	North Atlantic Low Salt Marsh	Pickerelweed Tidal Marsh	Reed Tidal Marsh
1937	107	0	34	47	7	0	8	0
2002	26	1	4	0	10	149	4	19
2007	24	1	4	0	7	155	2	15

Figure 4-9.9. Penuel Tract Marsh (1937, 2002, and 2007)

Penuel Tract Marsh (Figure 4-9.9): The marshes of the Penuel Tract are an interesting study as they have changed markedly since 1937. In 1937 the marshes present on this tract were freshwater marshes whereas today they are mostly brackish to salt marshes. In 1937 Cattail Brackish Tidal Marsh was the most common marsh with Freshwater Tidal Mixed High Marsh occupying the tributaries. In 2007 North Atlantic Low Salt Marsh is the most common marsh with 160 acres, showing a marked change in the salinity of the marsh.

DNREC Sea Level Rise Analysis (Table 4-9.11)

All of the marshland in the Penuel Tract will be inundated with 0.5 m of sea level rise.

Table 4-9.11. Projected acres of Penuel Tract Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	208 acres
1 m	208 acres
1.5 m	358 acres

Natural Capital (Table 4-9.12)

Marsh capital has increased overall with a reduction in the recent period (2002-2007) with losses in Cattail Brackish Tidal Marsh and Reed Tidal Marsh.

Table 4-9.12. Natural Capital of Penuel Tract Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,273,074/year
2002	$1,338,797/year
2007	$1,307,441/year

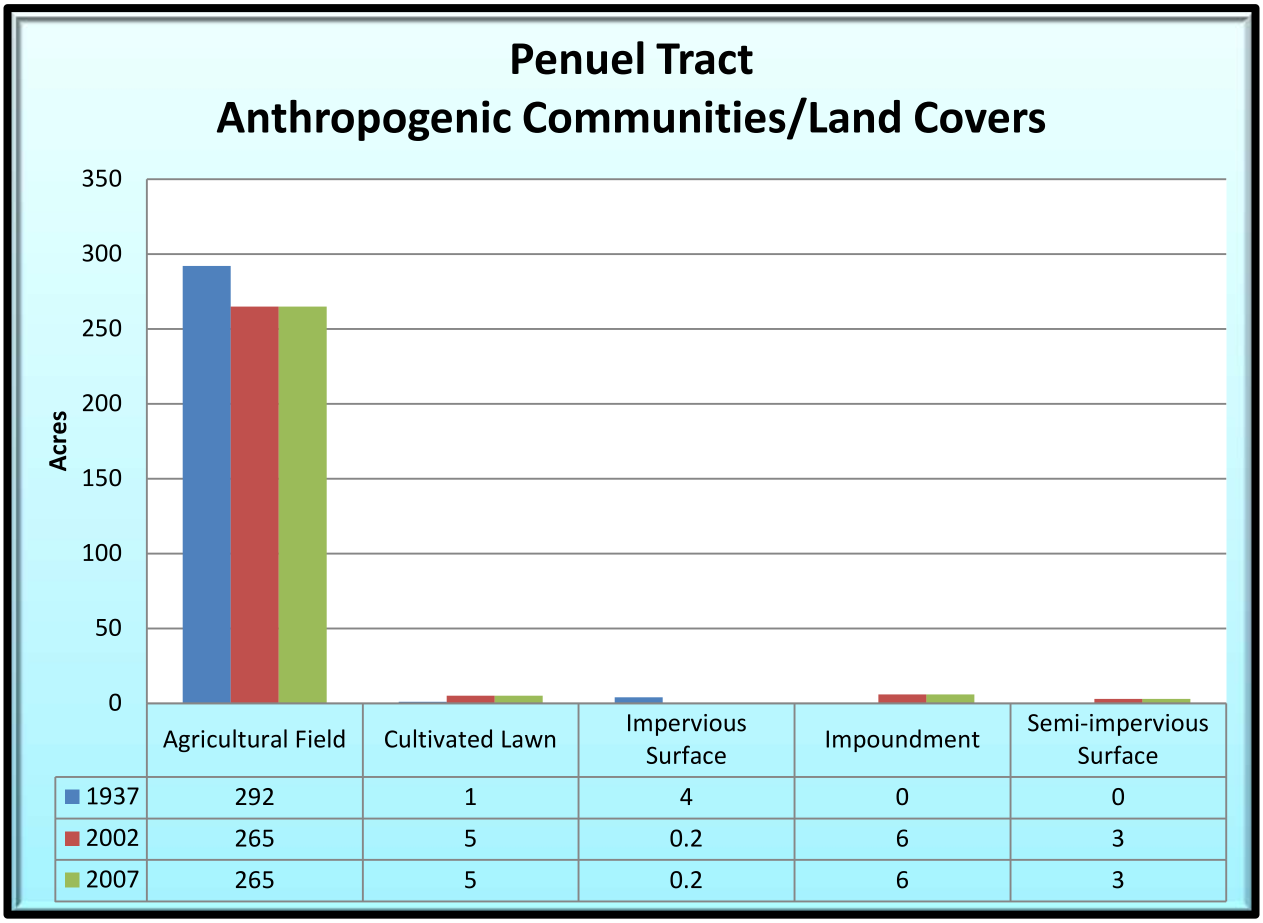


Figure 4-9.10. Penuel Tract Anthropogenic Communities/Land Covers (1937, 2002, and 2007)

Penuel Tract Anthropogenic Communities/Land Covers (Figure 4-9.10): Like some of the other tracts, agricultural field is the most prominent anthropogenic community. Impervious surface decreased with the abandonment of farmhouse that was present in 1937.

DNREC Sea Level Rise Analysis (Table 4-9.13)

Anthropogenic communities/land covers will be barely touched as compared to its acreage with 1.5 m of sea level rise.

Table 4-9.13. Projected acres of Penuel Tract Anthropogenic Communities/Land Covers Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0.3 acres
1 m	6 acres
1.5 m	11 acres

Natural Capital (Table 4-9.14)

Agricultural field and impoundments are the only anthropogenic communities/land covers with any natural capital value in the Penuel Tract. An increase in impoundment area has caused the capital to increase in this tract and the wildlife area as a whole.

Table 4-9.14. Natural Capital of Penuel Tract Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$16,746/year
2002	$52,543/year
2007	$52,543/year

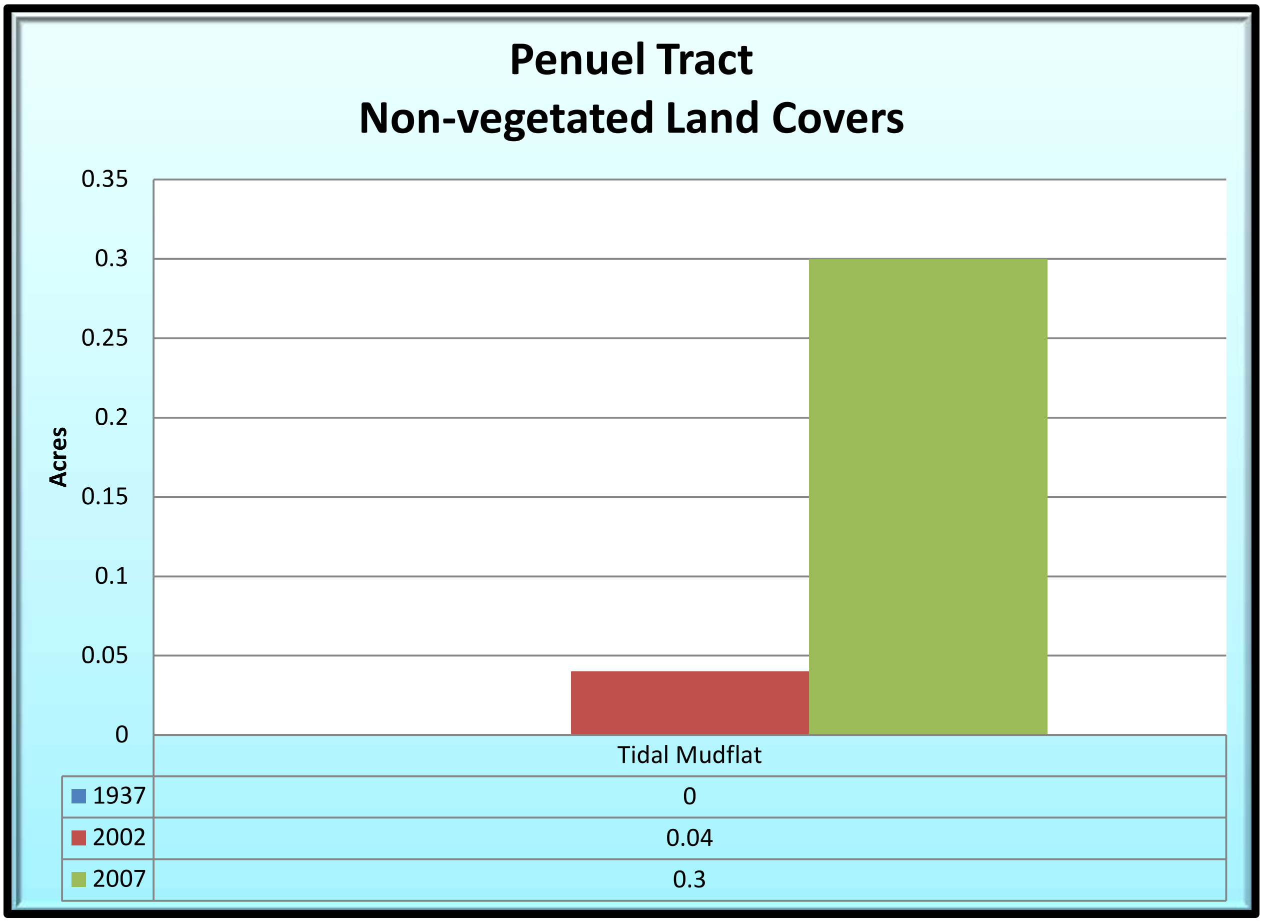


Figure 4-9.11. Penuel Tract Non-vegetated Land Covers (1937, 2002, and 2007)

Penuel Tract Non-vegetated Land Covers (Figure 4-9.11): Tidal mudflats have gradually increased in the Penuel Tract over time. In spite of the increase they still do not cover much area.

DNREC Sea Level Rise Analysis (Table 4-9.15)

All of the Non-vegetated Land Covers in the Penuel Tract will be inundated by water with 0.5 m of sea level rise.

Table 4-9.15. Projected acres of Penuel Tract Non-vegetated Land Covers Inundated by Sea Level Rise

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

Natural Capital (Table 4-9.16)

An increase in tidal mudflat area has increased the capital of Non-vegetated Land Covers.

Table 4-9.16. Natural Capital of Penuel Tract Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$251/year
2007	$1,881/year

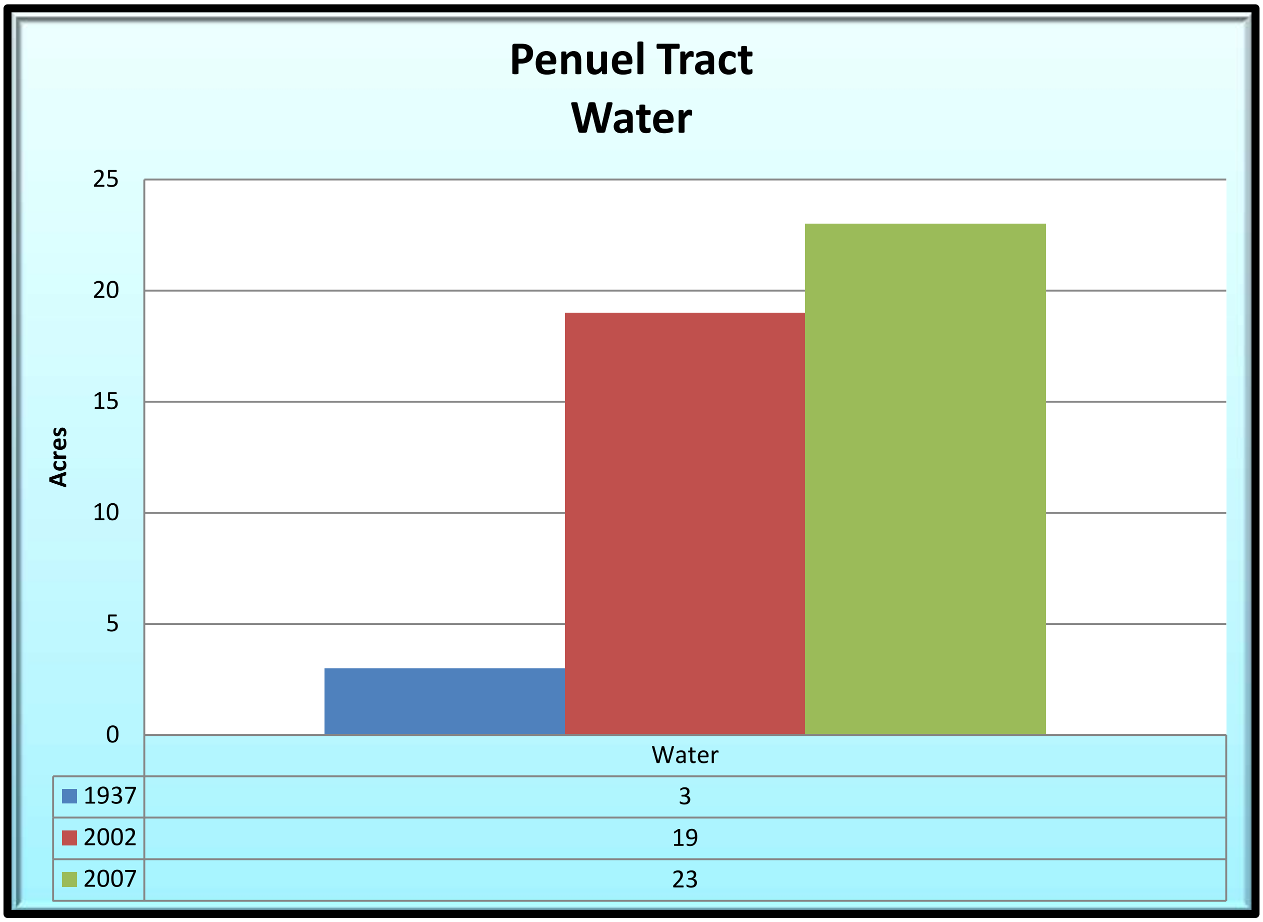


Figure 4-9.12. Penuel Tract Water (1937, 2002, and 2007)

Penuel Tract Water Coverage (Figure 4-9.12): Water has increased steadily since 1937 and the rate appears to be increasing. The historic rate (1937-2002 = 0.25 acres/year) and (1937-2007 = 0.29 acres/year) shows a slight increase. The recent rate (2002-2007 = 0.8 acres/year) confirms an increase in the rate of water inundation.

Natural Capital (Table 4-9.17)

Water has been increasing in the Penuel Tract raising its capital. The increase in the Penuel Tract appears to be from sea level rise.

Table 4-9.17. Natural Capital of Penuel Tract Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$16,005/year
2002	$101,367/year
2007	$122,707/year

10. Rawley's Island Tract

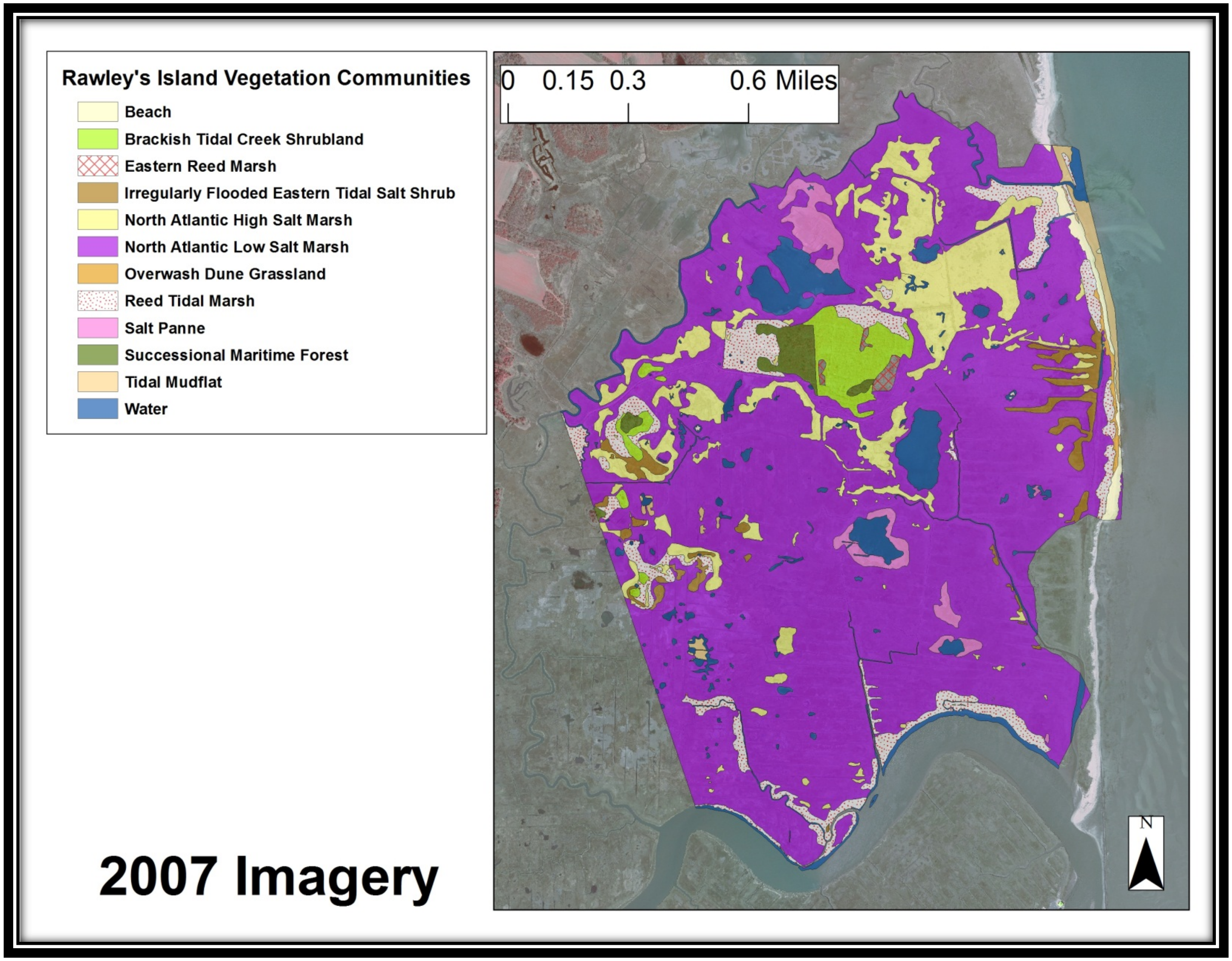


Figure 4-10.1. 2007 Vegetation Community Map of the Rawley's Island Tract

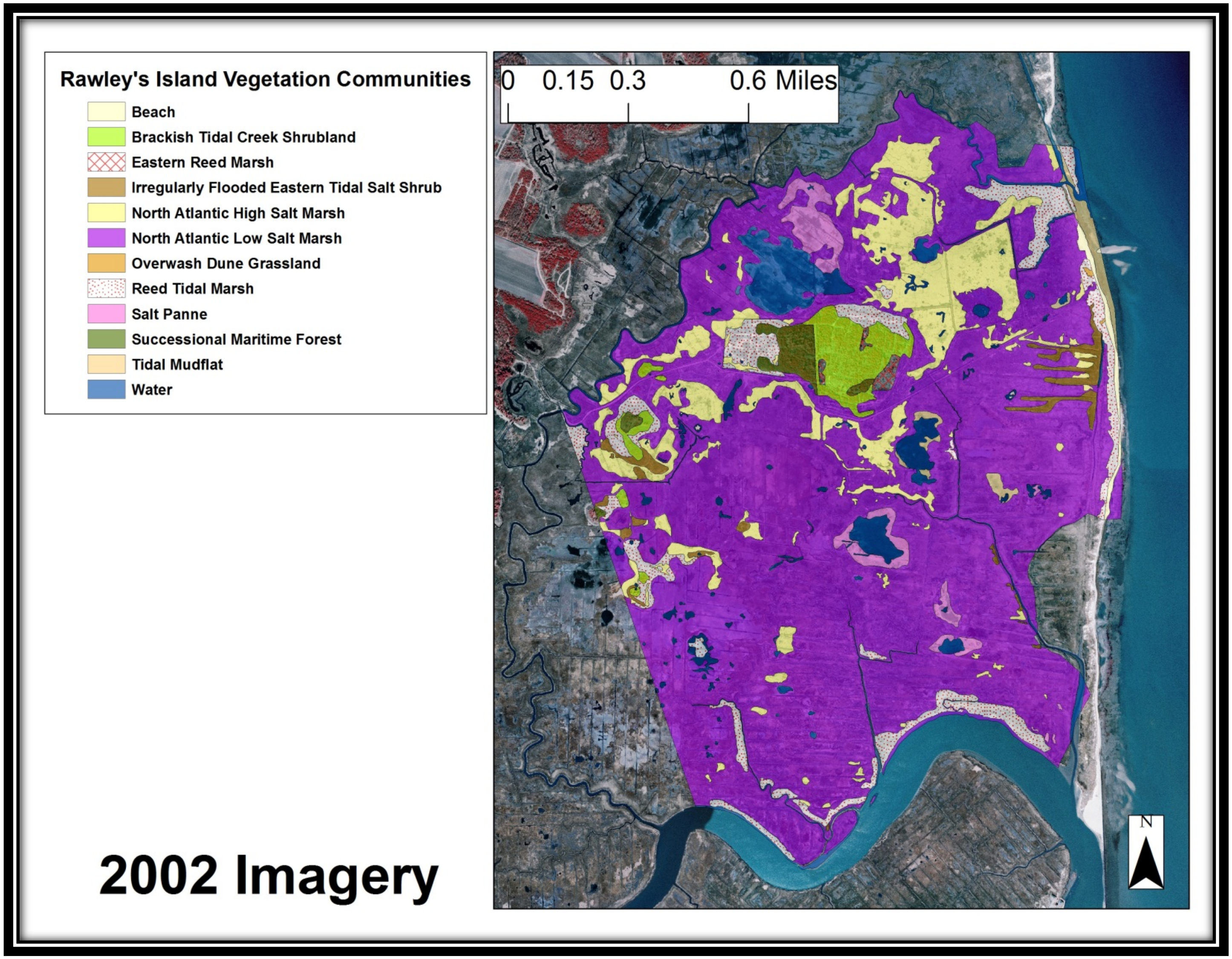


Figure 4-10.2. 2002 Vegetation Community Map of the Rawley's Island Tract

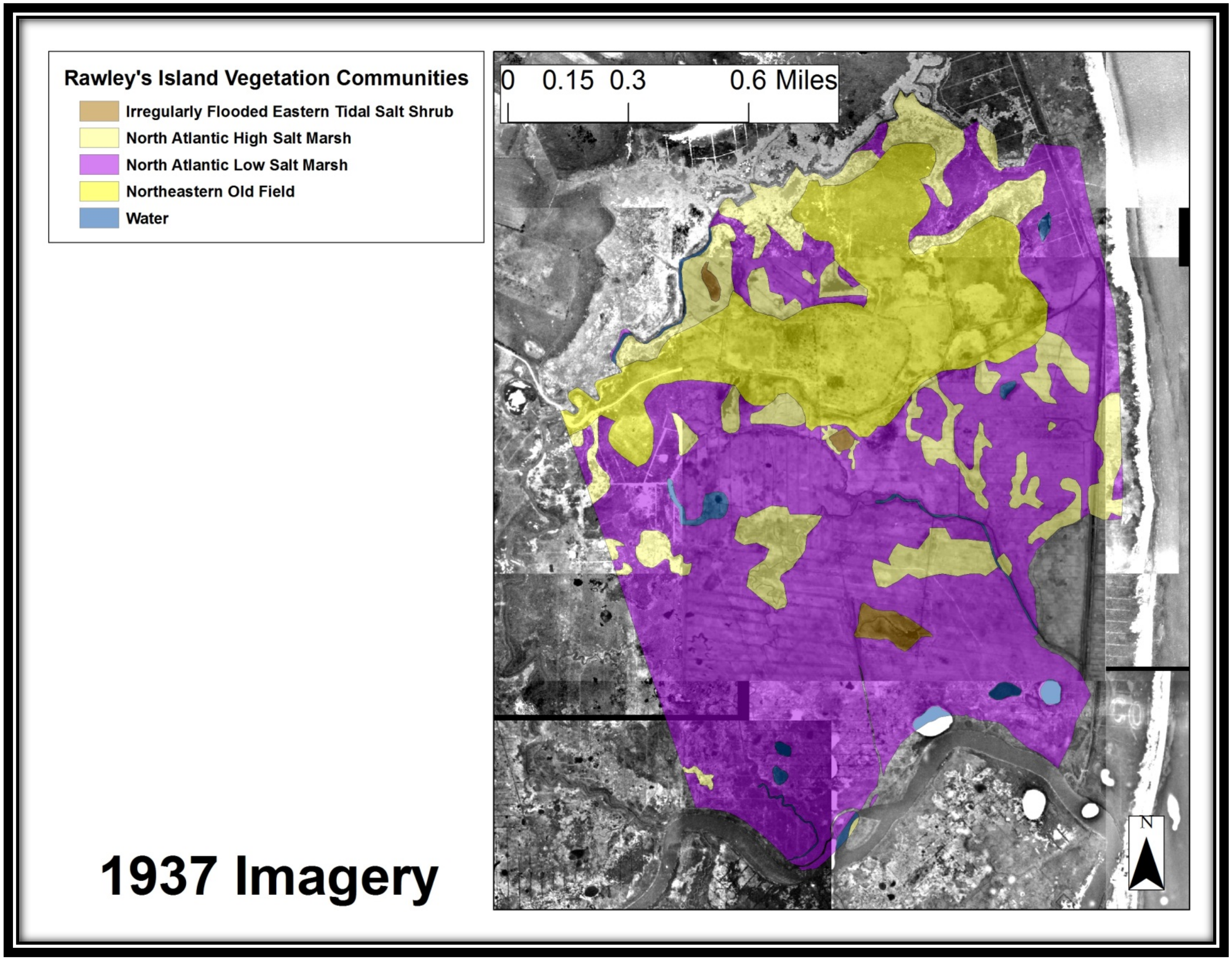
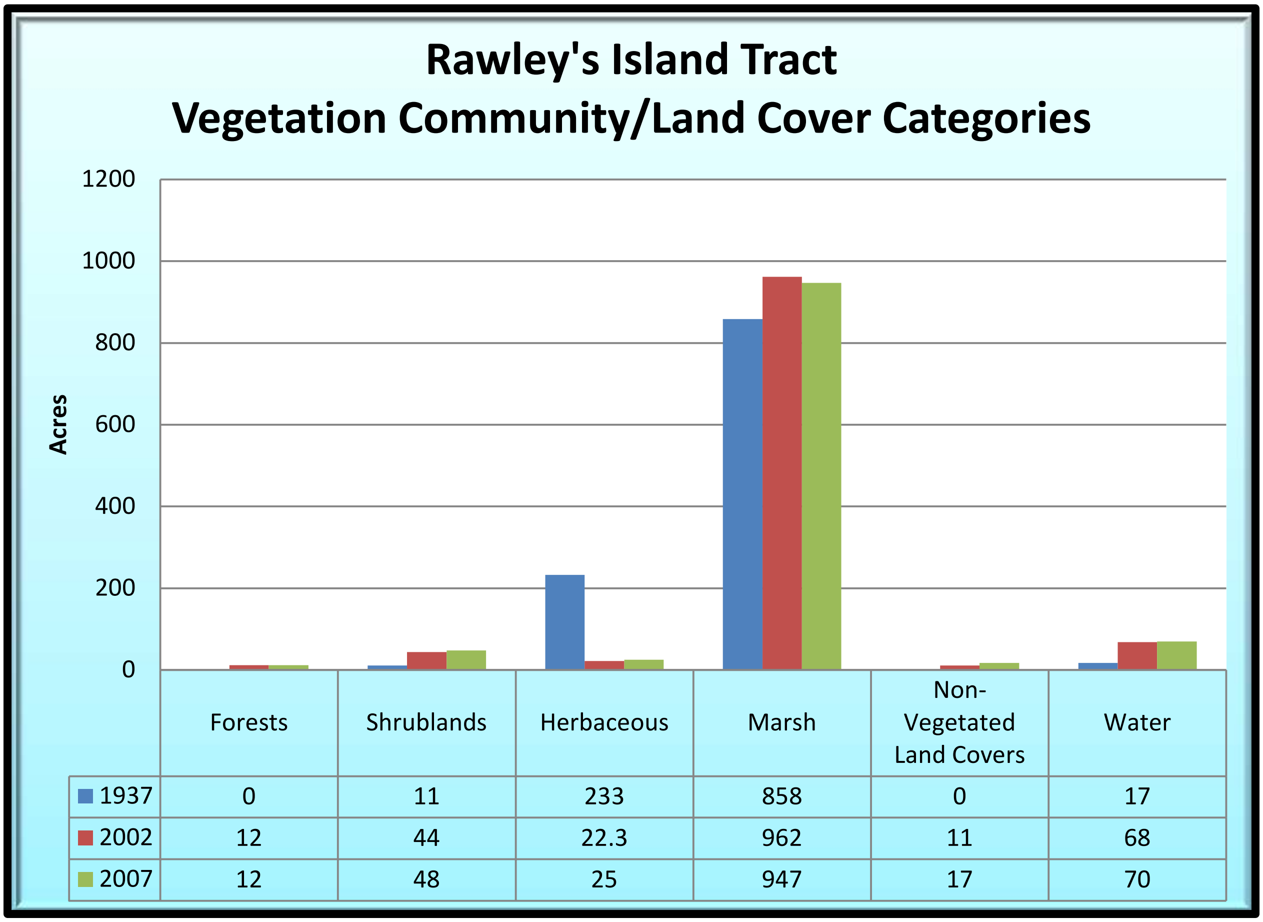


Figure 4-10.3. 1937 Vegetation Community Map of the Rawley's Island Tract



	Forests	Shrublands	Herbaceous	Marsh	Non-Vegetated Land Covers	Water
1937	0	11	233	858	0	17
2002	12	44	22.3	962	11	68
2007	12	48	25	947	17	70

Figure 4-10.4. Rawley's Island Tract Vegetation Community/Land Cover Categories (1937, 2002, and 2007)

Rawley's Island Tract Broad Trends (Figure 4-10.4): In 1937, Marsh and Herbaceous Communities were the most common in the Rawley's Island Tract. Since this time Marsh remains common while Shrublands have taken the second spot from herbaceous communities through succession. Water has also increased during the study period.

DNREC Sea Level Rise Analysis (Table 4-10.1)

The Rawley's Island Tract will essentially be flooded by sea level rise at 0.5 m and will be completely inundated at 1 m of rise. Because of this no sea level rise analyzes were conducted for the vegetation categories.

Table 4-10.1. Projected acres of the Rawley's Island Tract Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	1,109 acres
1 m	1,117 acres
1.5 m	1,118 acres

Natural Capital (Table 4-10.2)

Natural capital of the Rawley's Island Tract has increased overall since 1937 with a small decrease in the 2002 to 2007 period.

Table 4-10.2. Natural Capital of the Rawley's Island Tract	
Year	**Natural Capital (in 2012 dollars)**
1937	$5,727,366/year
2002	$7,452,588/year
2007	$7,460,142/year

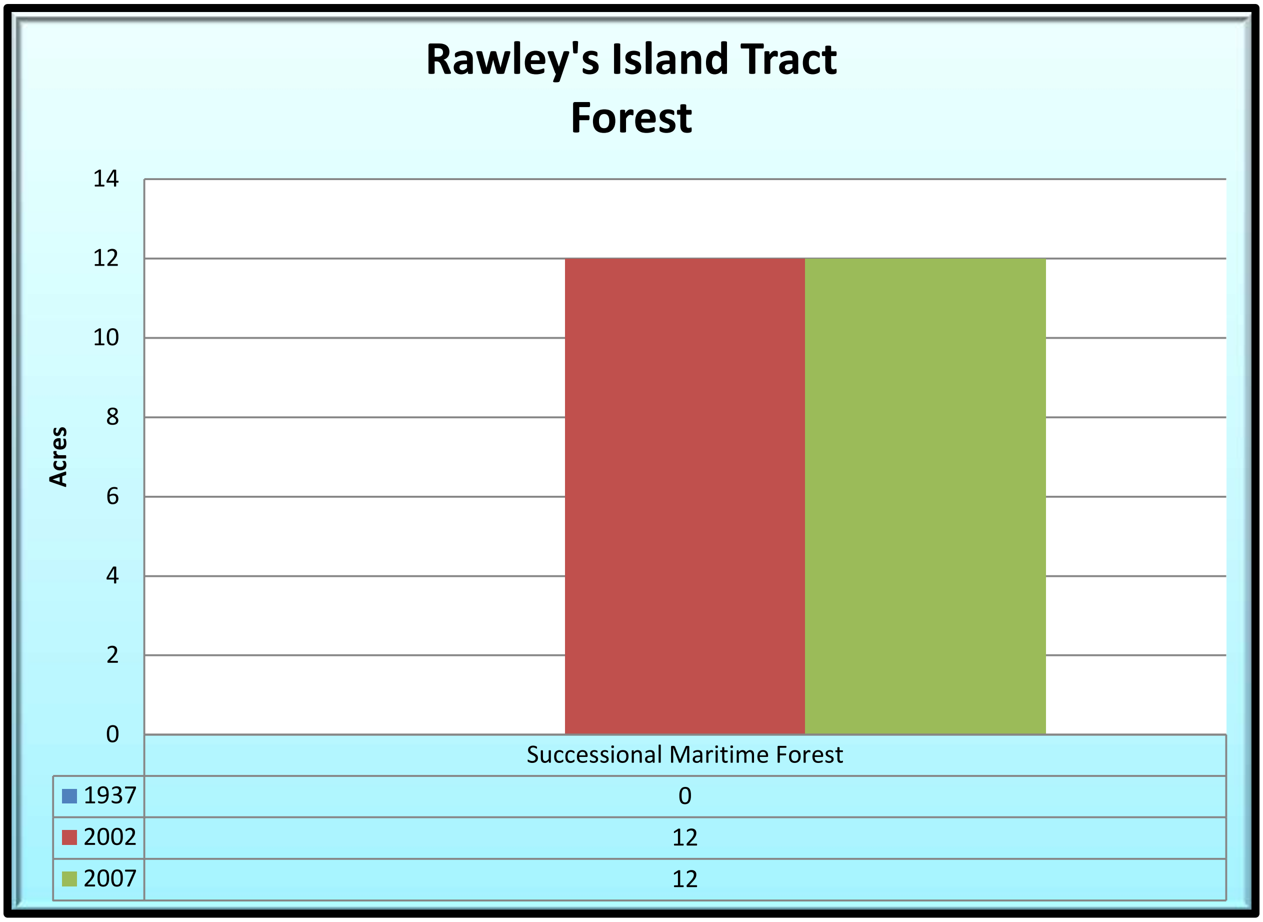


Figure 4-10.5. Rawley's Island Forest (1937, 2002, and 2007)

Rawley's Island Tract Forest (Figure 4-10.5): Successional Maritime Forest is the only forest type present on the Rawley's Island Tract. It is found on Rawley's Island that was present as Northeastern Old Field in 1937.

Natural Capital (Table 4-10.3)

Successional Maritime Forest was not present in 1937 and has gained $2,269 in capital. It has stayed the same since 2002.

Table 4-10.3. Natural Capital of Rawley's Island Tract Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$2,269/year
2007	$2,269/year

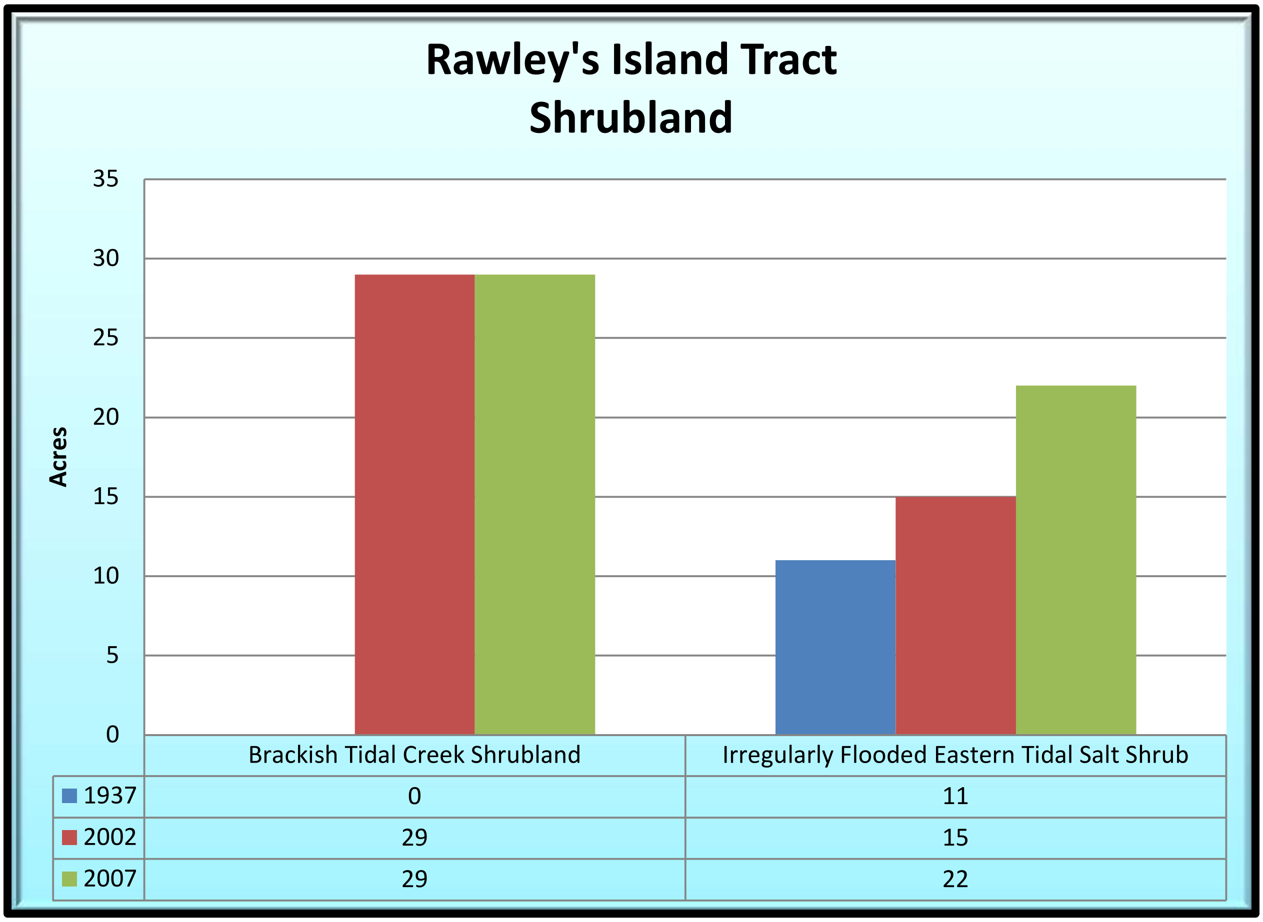


Figure 4-10.6. Rawley's Island Tract Shrubland (1937, 2002, and 2007)

Rawley's Island Tract Shrubland (Figure 4-10.6): In 1937, Irregularly Flooded Eastern Tidal Salt Shrub was the most common shrubland located on the Rawley's Island Tract. Over time it has increased but a newcomer, Brackish Tidal Creek Shrubland, has taken over the top position.

Natural Capital (Table 4-10.4)

Shrubland capital has increased with increases in Irregularly Flooded Eastern Tidal Salt Shrub.

Table 4-10.4. Natural Capital of Rawley's Island Tract Shrubland

Year	Natural Capital (in 2012 dollars)
1937	$68,984/year
2002	$275,937/year
2007	$319,836/year

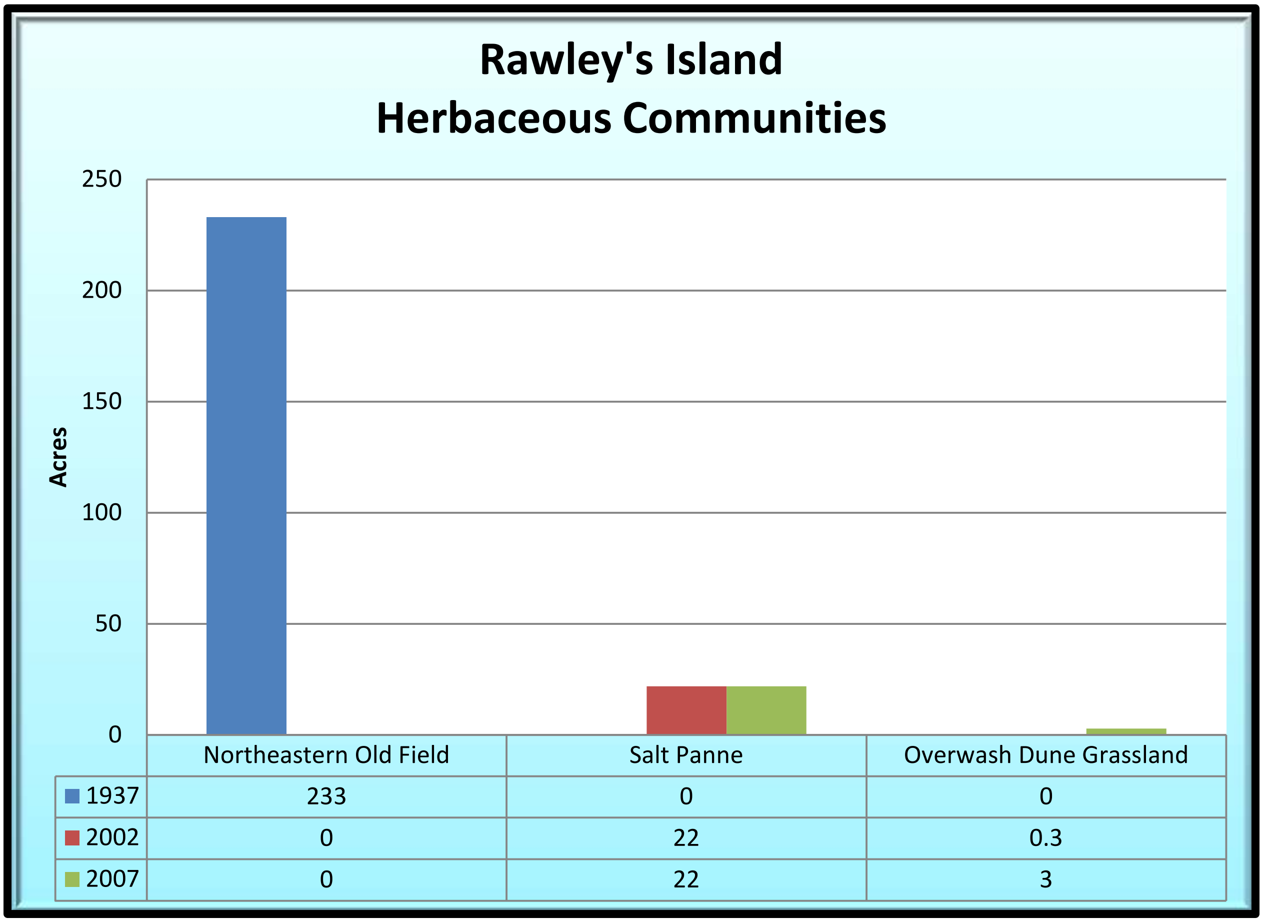


Figure 4-10.7. Rawley's Island Herbaceous Communities (1937, 2002, and 2007)

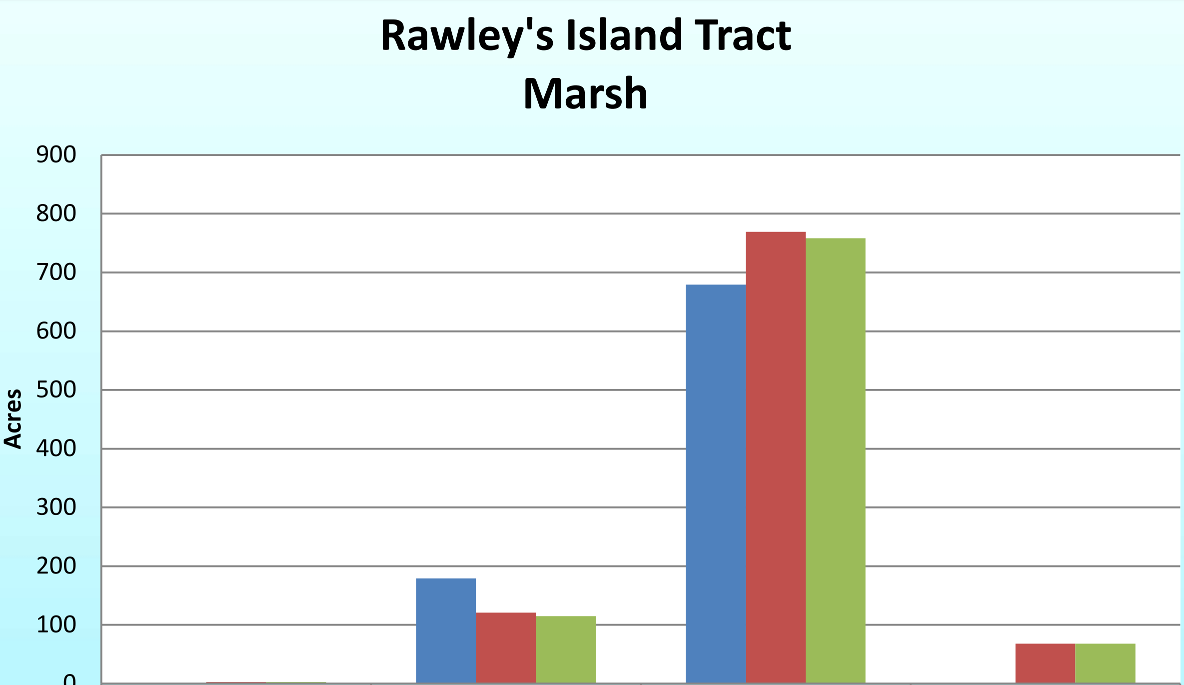
Rawley's Island Tract Herbaceous Communities (Figure 4-10.7): Northeastern Old Field was the predominant herbaceous community in 1937. It has since succeeded to other communities. Salt Panne and Overwash Dune Grassland have appeared since 1937 and together cover about 25 acres.

Natural Capital (Table 4-10.5)

Natural capital of herbaceous communities has increased due to an increase in Overwash Dune Grassland acreage and the appearance of salt panne.

Table 4-10.5. Natural Capital of Rawley's Island Tract Herbaceous Communities

Year	Natural Capital (in 2012 dollars)
1937	$33,948/year
2002	$138,012/year
2007	$138,406/year



	Eastern Reed Marsh	North Atlantic High Salt Marsh	North Atlantic Low Salt Marsh	Reed Tidal Marsh
1937	0	179	679	0
2002	3	121	769	68
2007	3	115	758	68

Figure 4-10.8. Rawley's Island Tract Marsh (1937, 2002, and 2007)

Rawley's Island Tract Marsh (Figure 4-10.8): North Atlantic Low Salt Marsh is the most common marsh community followed by North Atlantic High Salt Marsh throughout the study period. Following a trend seen in other tracts, North Atlantic High Salt Marsh has decreased throughout the study period. Since 1937, marshes dominated by eastern reed (*Phragmites australis*), including Eastern Reed Marsh and Reed Tidal Marsh have appeared. Reed Tidal Marsh has decreased in the 2002 to 2007 period perhaps because of eradication efforts.

Natural Capital (Table 4-10.6)

Overall capital of marsh has increased since 1937 with dip in the 2002 to 2007 period due to losses in North Atlantic High Salt Marsh.

Table 4-10.6. Natural Capital of Rawley's Island Tract Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$5,380,775/year
2002	$6,042,021/year
2007	$5,947,951/year

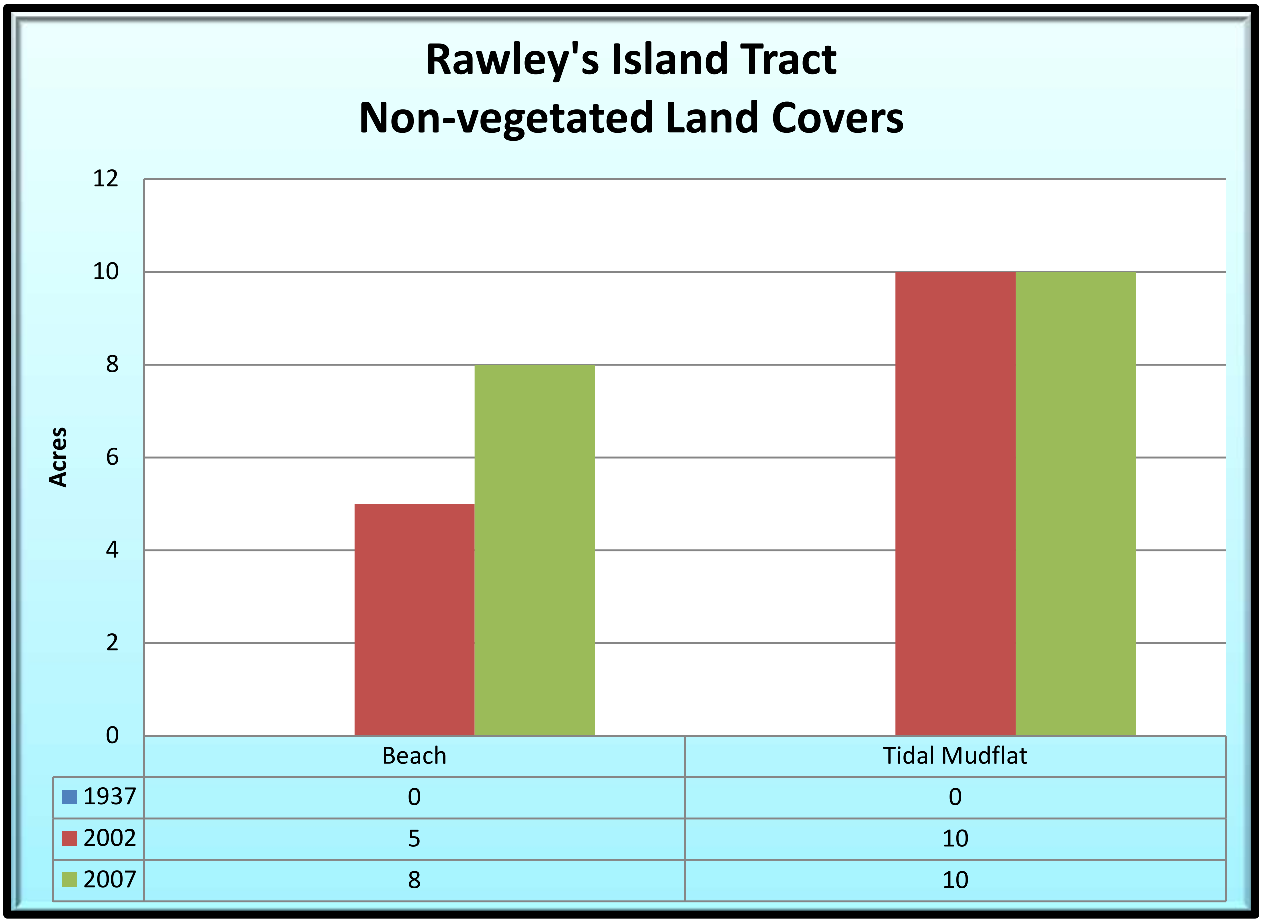


Figure 4-10.9. Rawley's Island Non-vegetated Land Covers (1937, 2002, and 2007)

Rawley's Island Tract Non-vegetated Land Covers (Figure 4-10.9): There were no non-vegetated land covers present in 1937. Since two have appeared and have increased in the 2002 to 2007 period.

Natural Capital (Table 4-10.7)

An increase in tidal mudflat area has increased the capital of Non-vegetated Land Covers.

Table 4-10.7. Natural Capital of Rawley's Island Tract Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$62,713/year
2007	$62,713/year

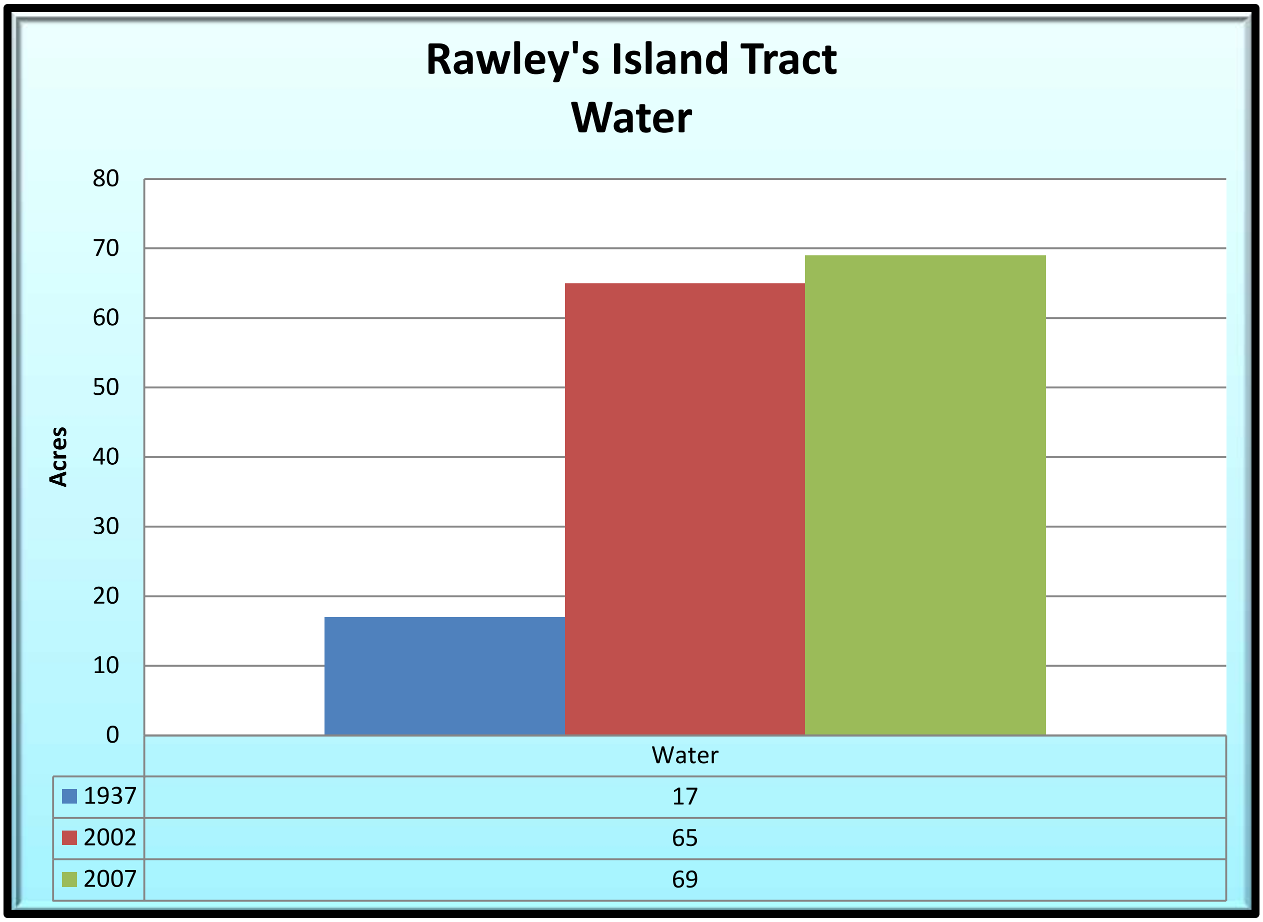


Figure 4-10.10. Rawley's Island Water Coverage (1937, 2002, and 2007)

Rawley's Island Tract Water Coverage (Figure 4-10.10): Water has steadily increased over the study period from 17 acres in 1937 to almost 70 acres in 2007. This tract has shown the most increase in water over the study period for Milford Neck Wildlife Area. A historical rate comparison (1937-2002 = 0.78 acres/year) and (1937-2007 = 0.76 acres/year) shows a slight decrease in the rate of immersion. The recent rate (2002-2007 = 0.4 acres/year) confirms the slowing of the rate. The change may be due to topographic factors or some other unknown factor.

Natural Capital (Table 4-10.8)

An increase in tidal mudflat area has increased the capital of Non-vegetated Land Covers.

Table 4-10.8. Natural Capital of Rawley's Island Tract Water

Year	Natural Capital (in 2012 dollars)
1937	$243,659/year
2002	$931,635/year
2007	$988,967/year

CHAPTER 5: DESCRIPTIONS OF THE VEGETATION COMMUNITIES

Thirty-seven vegetation communities and eleven land covers were noted in the surveys. 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 NVCS and the *Guide to Delaware Vegetation Communities*.

The vegetation communities include:

1. Brackish Tidal Creek Shrubland (CEGL006846)—29 acres
2. Buttonbush Coastal Plain Pond (CEGL006242)—1 acre
3. Cattail Brackish Tidal Marsh (CEGL004201)—33 acres
4. Chesapeake Bay Non-riverine Wet Hardwood Forest (CEGL004644)—821 acres
5. Coastal Loblolly Pine Wetland Forest (CEGL006137)—75 acres
6. Coastal Plain Oak Floodplain Swamp (CEGL006605)—26 acres
7. Cultivated Lawn (CEGL006486)—9 acres
8. Early to Mid-Successional Loblolly Pine Forest (CEGL006011)—32 acres
9. Eastern Reed Marsh (CEGL004141)—5 acres
10. Freshwater Tidal Mixed High Marsh (CEGL006325)—4 acres
11. Freshwater Tidal Woodland (CEGL006165)—1 acre
12. Irregularly Flooded Eastern Tidal Salt Shrub (CEGL003921)—35 acres
13. Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland (CEGL006849)—2 acres
14. Mesohaline Seepage Marsh (CEGL006418)—70 acres
15. Mid-Atlantic Mesic Mixed Hardwood Forest (CEGL006075)—253 acres
16. Mid to Late Successional Loblolly Pine-Sweetgum Forest (CEGL008462)—19 acres
17. North Atlantic High Salt Marsh (CEGL006006)—242 acres
18. North Atlantic Low Salt Marsh (CEGL004192)—2,014 acres
19. Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest (CEGL006055)—7 acres
20. Northeastern Dry Oak-Hickory Forest (CEGL006336)—8 acres
21. Northeastern Modified Successional Forest (CEGL006599)—34 acres
22. Northeastern Old Field (CEGL006107)—83 acres
23. Northeastern Successional Shrubland (CEGL006451)—28 acres
24. Overwash Dune Grassland (CEGL004097)—3 acres
25. Pickerelweed Tidal Marsh (CEGL004706)—5 acres
26. Red Maple-Sweetgum Swamp (CEGL006110)—1 acre
27. Reed Tidal Marsh (CEGL004187)—125 acres
28. Salt Panne (CEGL004308)—22 acres
29. Southern Red Maple-Blackgum Swamp Forest (CEGL006238)—4 acres
30. Southern Red Oak/Heath Forest (CEGL006269)—8 acres
31. Successional Maritime Forest (CEGL006145)—23 acres
32. Successional Sweetgum Forest (CEGL007216)—7 acres
33. Successional Tuliptree Forest (CEGL007220)—23 acres
34. Successional Tuliptree-Loblolly Pine Upland Forest (CEGL007521)—18 acres
35. Swamp-loosestrife Shrub Swamp (CEGL005089)—2 acres
36. Upland Switchgrass Vegetation (CEGL006616)—21 acres

37. Wax-myrtle Shrub Swamp (CEGL003840)—68 acres

The land covers include:

1. Agricultural Field—569 acres
2. Beach—8 acres
3. Clear-cut—0 acres
4. Farm Pond/Artificial Pond—1 acre
5. Impervious Surface—1 acre
6. Impoundment—6 acres
7. Modified Land—0.1 acres
8. Powerline R-O-W—6 acres
9. Semi-impervious Surface—9 acres
10. Tidal Mudflat—30 acres
11. Water—266 acres

***Brackish Tidal Creek Shrubland* [29 acres (Figures 5.1 and 5.2, Tables 5.1-5.3)] GNR S2**

DEWAP: Tidal High Marshes
NHC: North Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh

Description

This shrubland community is composed primarily of southern bayberry (*Morella cerifera*), which is associated by salt shrub (*Baccharis halimifolia*). Other possible species include red maple (*Acer rubrum*), poison ivy (*Toxicodendron radicans*), and seashore mallow (*Kostelezkya virginica*). Herbs may include narrow-leaf cattail (*Typha angustifolia*), dotted smartweed (*Polygonum punctatum*), slender flatsedge (*Cyperus filicinus*), switchgrass (*Panicum virgatum*), and others. The community and its delineations were determined through aerial imagery interpretation and therefore an exact species list cannot be provided.

Analysis of Condition at Milford Neck Wildlife Area

Brackish Tidal Creek Shrubland has come about since 1937 and has populated 28 acres of Northeastern Old Field and 2 acres of North Atlantic Low Salt Marsh (Table 5.1).

Table 5.1. Brackish Tidal Creek Shrubland has migrated into X since 1954

X	**Acreage**
Northeastern Old Field	28 acres
North Atlantic Low Salt Marsh	2 acres

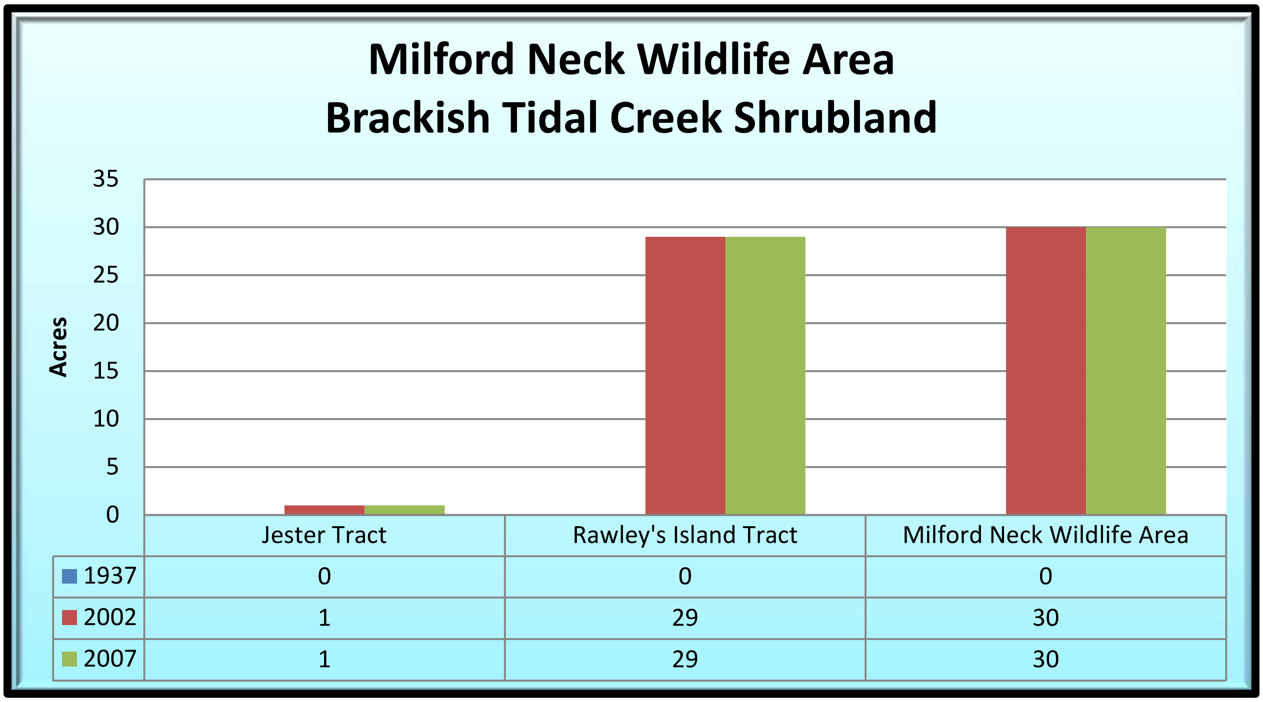


Figure 5.1. Brackish Tidal Creek Shrubland at Milford Neck Wildlife Area (1937, 2002, and 2007)

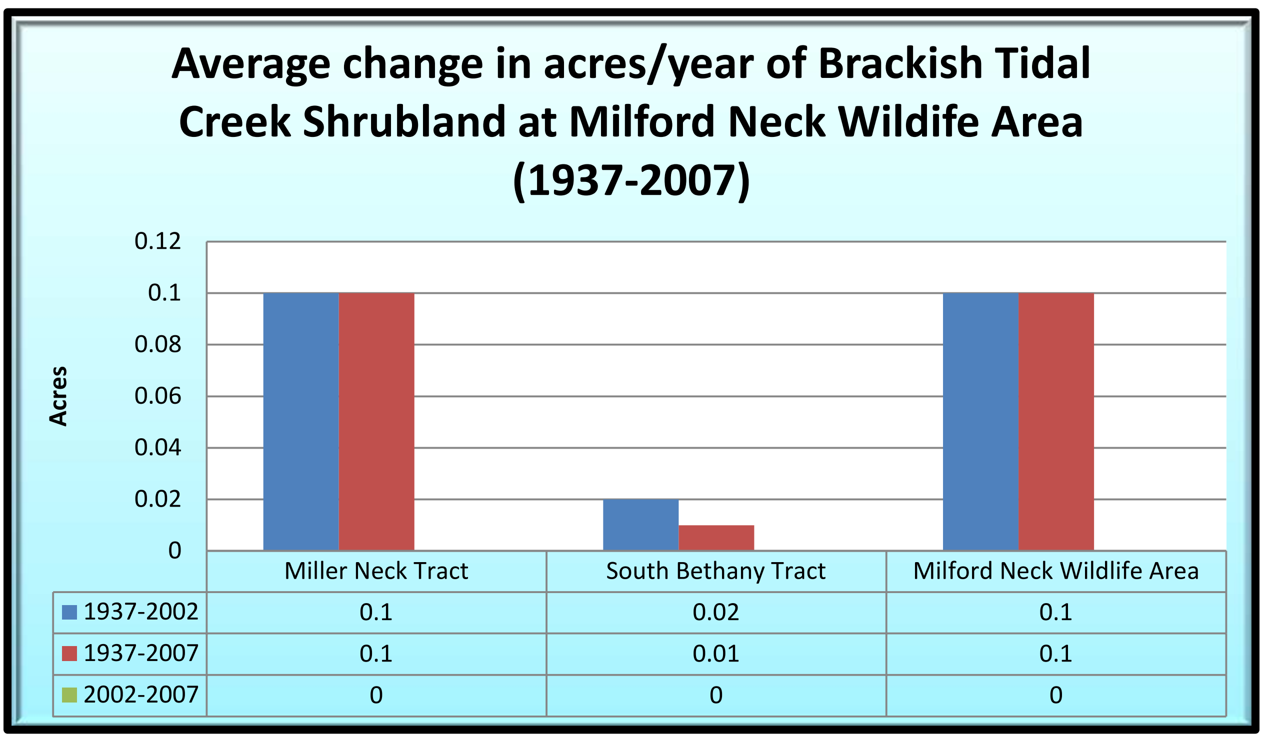


Figure 5.2. Average change in acres/year of Brackish Tidal Creek Shrubland at Milford Neck Wildlife Area (1937-2007)

DNREC Sea Level Rise Analysis (Table 5.2)

All of the current extent of Brackish Tidal Creek Shrubland will be inundated with 0.5 m of sea level rise.

Table 5.2. Projected acres of Brackish Tidal Creek Shrubland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	29 acres
1 m	29 acres
1.5 m	29 acres

Natural Capital (Table 5.3)

Brackish Tidal Creek Shrubland was not present in 1937 and has since grown to include $278,442/year in capital.

Table 5.3. Natural Capital of Brackish Tidal Creek Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$278,442/year
2007	$278,442/year

Buttonbush Coastal Plain Pond **[1 acre (Figures 5.3-5.4, Tables 5.4-5.5)]   G3?   S3**

DEWAP: Shrub Swamps
NHC: Northern Atlantic Coastal Plain Pond

Description

Figure 5.3. Buttonbush Coastal Plain Pond—in background (Penuel Tract)

One occurrence of this community is located on the Penuel Tract and has changed little since 1937. The middle of the pond is dominated by buttonbush (*Cephalanthus occidentalis*), with an edge of red maple (*Acer rubrum*) and wild black cherry (*Prunus serotina*). The edge understory is composed of common greenbrier (*Smilax rotundifolia*), Japanese honeysuckle (*Lonicera japonica*), highbush blueberry (*Vaccinium corymbosum*), and poison ivy (*Toxicodendron radicans*). Duckweed (*Lemna minor*) was floating in the water and Virginia creeper (*Parthenocissus quinquefolia*) was present in the herbaceous layer.

Analysis of Condition at Milford Neck Wildlife Area

This community is rather long lived and has been unchanged since 1937. Because of this no change analysis has happened. Since it fairly high above the tide, the prospects for this community's existence are fairly good.

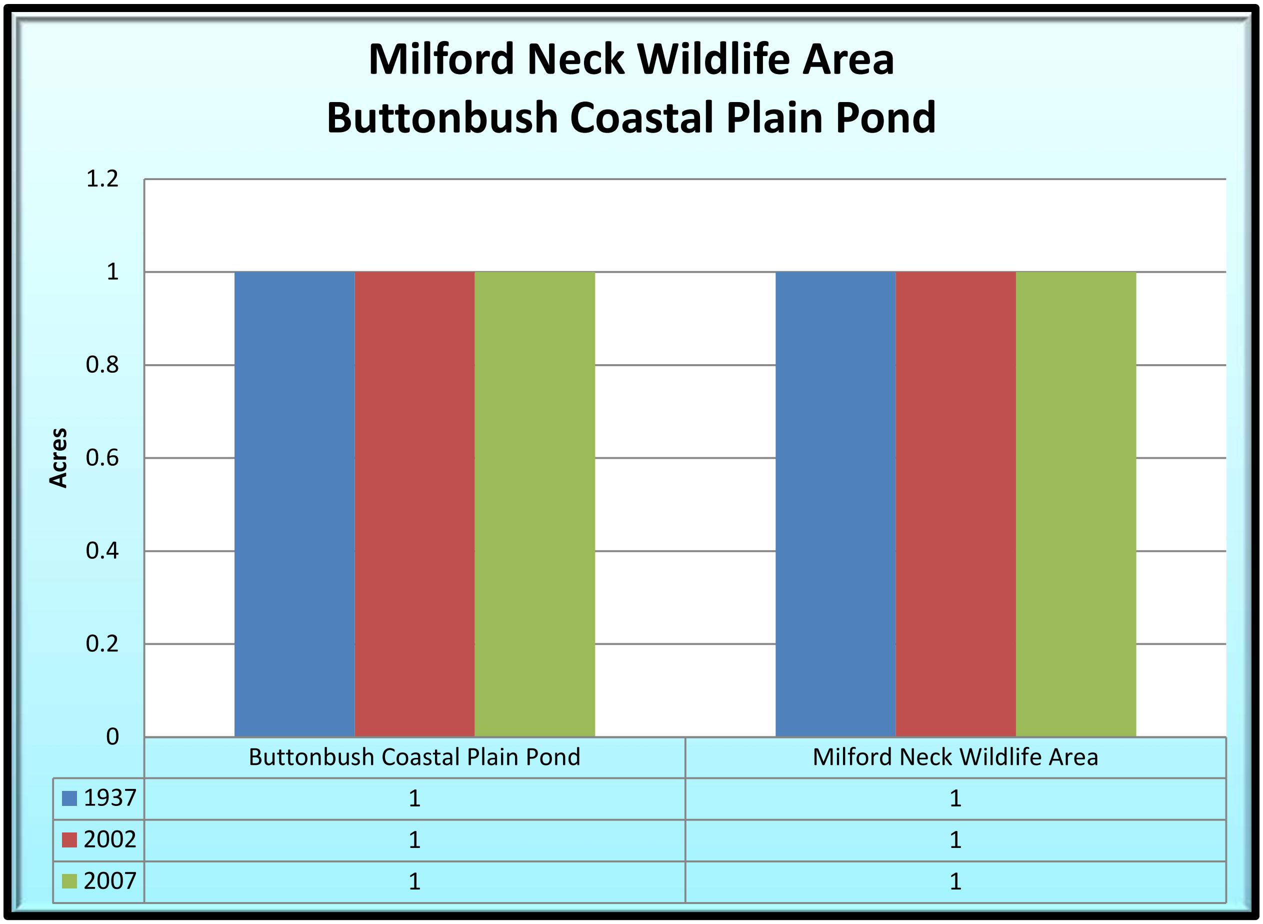


Figure 5.4. Buttonbush Coastal Plain Pond at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.4)

This community will be "captured" by tidal water with 1.5 m of sea level rise.

Table 5.4. Projected acres of Buttonbush Coastal Plain Pond Inundated by Sea Level Rise

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

Natural Capital (Table 5.5)

Buttonbush Coastal Plain Pond has been stable in capital throughout the study period.

Table 5.5. Natural Capital of Buttonbush Coastal Plain Pond	
Year	**Natural Capital (in 2012 dollars)**
1937	$9,281/year
2002	$9,281/year
2007	$9,281/year

***Cattail Brackish Tidal Marsh* [33 acres (Figures 5.5-5.7, Tables 5.6-5.9)] G4G5 S2**

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

<u>Description</u>

Figure 5.5. Cattail Brackish Tidal Marsh (Penuel Tract)

This brackish marsh community is prominent in the Gray Farm and Penuel Tracts on the edges of the Murderkill River and a tributary. Wide-leaved cattail (*Typha latifolia*) dominates nearly to totality but may be joined by salt meadow cordgrass (*Spartina alternifolia*) and pickerelweed (*Sagittaria latifolia*).

<u>Analysis of Condition at Milford Neck Wildlife Area</u>

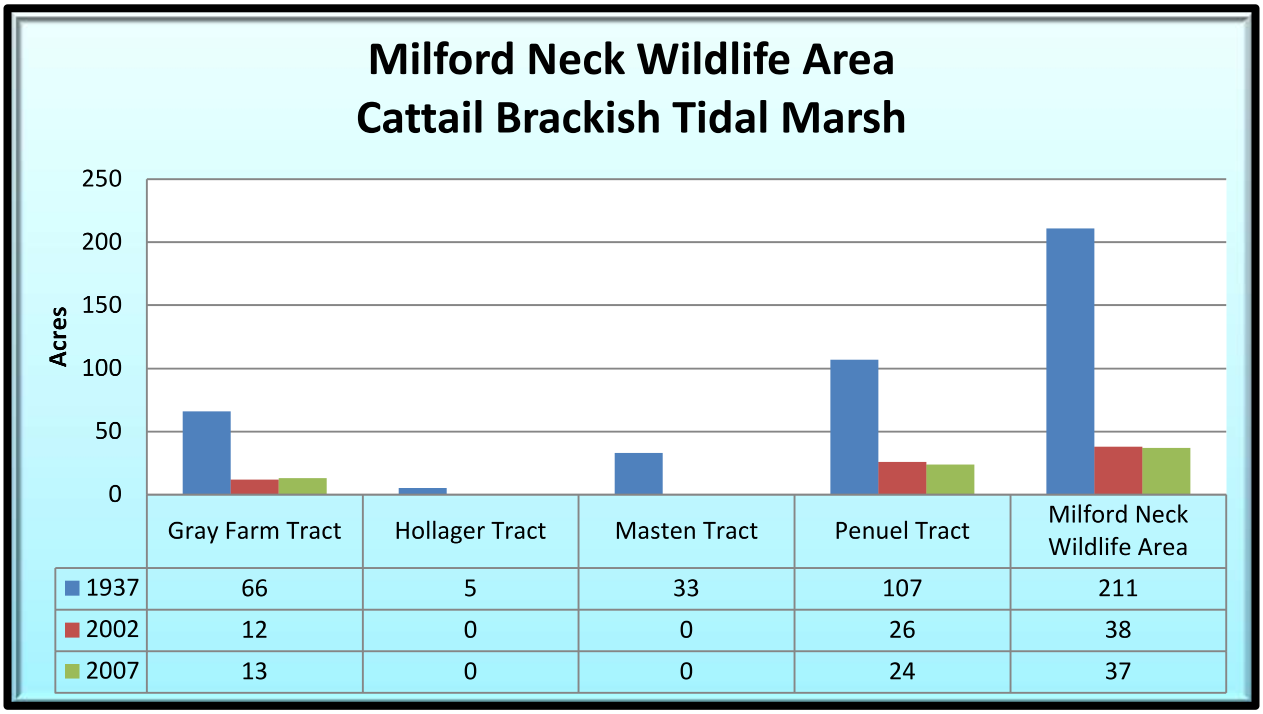
This community has declined markedly since 1937 as more brackish water moves into the Murderkill River system. The Cattail Brackish Tidal Marsh is finding few places in which to move and neighboring shrub and forest ecosystems are not converting fast enough to provide refuge.

Only 9 acres of the original 211 acres present in 1937 remained in 2007. The rest of the acreage has become 155 acres of North Atlantic Low Salt Marsh, 14 acres of Reed Tidal Marsh, 13 acres of North Atlantic High Salt Marsh, 10 acres of water, and 9 acres of Mesohaline Seepage Marsh (Table 5.6). The conversion to North Atlantic Low Salt Marsh and High Marsh and Mesohaline Seepage Marsh shows an increasing amount of salinity in the marshes of the wildlife area.

This community has increased overall since 1937, but has declined in the Gray Farm Tract, where the marsh has run out of room to move landward. Cattail marsh is increasing though on a tributary to the Murderkill River in the Penuel Tract. This marsh community has converted 14 acres of Freshwater Tidal Mixed High Marsh, 4 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 3 acres of Wax-Myrtle Shrub Swamp, and 3 acres of Mesohaline Seepage Marsh (Table 5.7). The prospects for continued survival are poor in the Gray Farm Tract, but it may continue to thrive in the Penuel Tract depending on the rate of sea level rise.

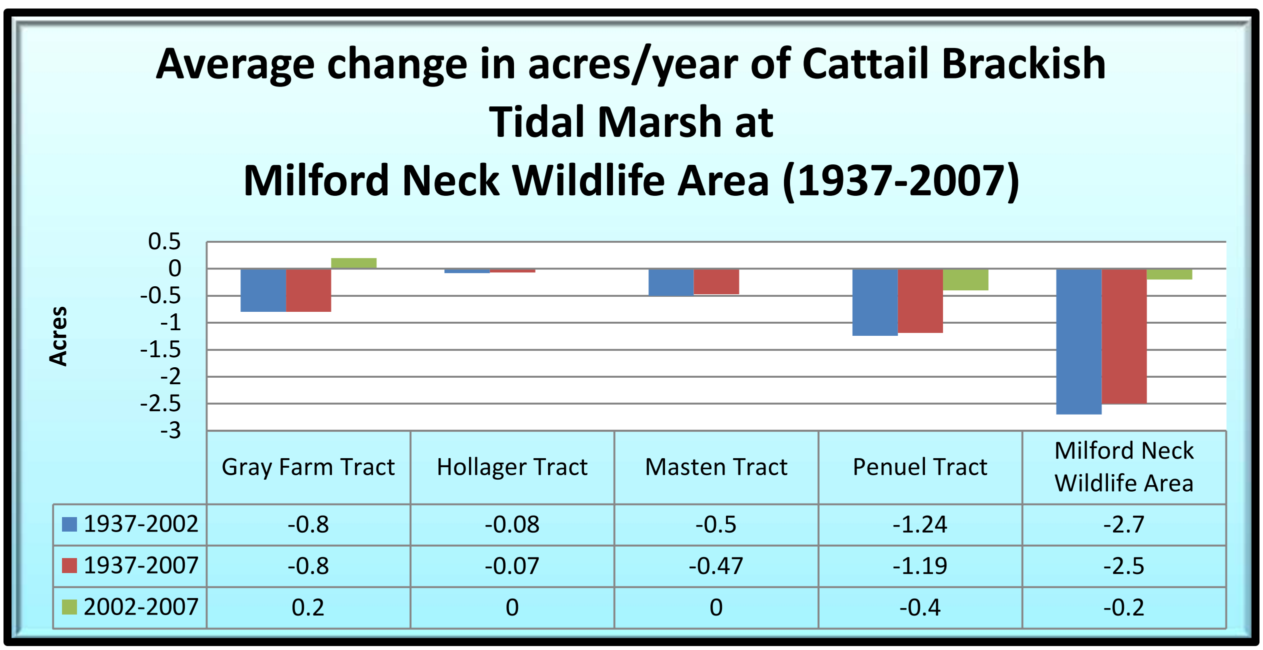
Table 5.6. What was once Cattail Brackish Tidal Marsh in 1937 has become X in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	155 acres
Reed Tidal Marsh	14 acres
North Atlantic High Salt Marsh	13 acres
Water	10 acres
Mesohaline Seepage Marsh	9 acres
Other communities/land covers	11 acres

Table 5.7. Cattail Brackish Tidal Marsh has migrated into X since 1937	
X	**Acreage**
Freshwater Tidal Mixed High Marsh	14 acres
Cattail Brackish Tidal Marsh	9 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	4 acres
Wax-Myrtle Shrub Swamp	3 acres
Mesohaline Seepage Marsh	3 acres
Other communities/land covers	3 acres



	Gray Farm Tract	Hollager Tract	Masten Tract	Penuel Tract	Milford Neck Wildlife Area
1937	66	5	33	107	211
2002	12	0	0	26	38
2007	13	0	0	24	37

Figure 5.6. Cattail Brackish Tidal Marsh at Milford Neck Wildlife Area (1937, 2002, and 2007)



	Gray Farm Tract	Hollager Tract	Masten Tract	Penuel Tract	Milford Neck Wildlife Area
1937-2002	-0.8	-0.08	-0.5	-1.24	-2.7
1937-2007	-0.8	-0.07	-0.47	-1.19	-2.5
2002-2007	0.2	0	0	-0.4	-0.2

Figure 5.7. Average change in acres/year of Cattail Brackish Tidal Marsh at Milford Neck Wildlife Area (1937-2007)

DNREC Sea Level Rise Analysis (Table 5.8)

This community will be eliminated with 0.5 m of sea level rise in its current extent.

Table 5.8. Projected acres of Cattail Brackish Tidal Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	37 acres
1 m	0 acres
1.5 m	1 acre

Natural Capital (Table 5.9)

Capital of Cattail Brackish Tidal Marsh has been gradually decreasing as acreage is lost.

Table 5.9. Natural Capital of Cattail Brackish Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,323,244/year
2002	$238,309/year
2007	$232,038/year

***Chesapeake Bay Non-riverine Wet Hardwood Forest* [821 acres (Figures 5.8-5.9, Tables 5.10-5.13)]**
G3 S3

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

Description

Chesapeake Bay Non-riverine Wet Hardwood Forest is the most common forested community in Milford Neck Wildlife Area. It is found in flat to nearly flat wet areas. Red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*) are often the main co-dominants and are associated by loblolly pine (*Pinus taeda*), pin oak (*Quercus palustris*), white oak (*Quercus alba*), and in places of higher elevation, northern red oak (*Quercus rubra*), and southern red oak (*Quercus falcata*). Understory associates can include smaller members of the canopy plus American holly (*Ilex opaca*), willow oak (*Quercus phellos*), wild black cherry (*Prunus serotina*), and blackgum (*Nyssa sylvatica*). Common greenbrier (*Smilax rotundifolia*), highbush blueberry (*Vaccinium corymbosum*), arrow-wood (*Viburnum dentatum*), pinxter flower (*Rhododendron periclymenoides*), sweet pepperbush (*Clethra alnifolia*), wax-myrtle (*Morella cerifera*), and one location, wisteria (*Wisteria sinensis*) compose the shrub and vine layer. Herbs noted in this community include Japanese stiltgrass (*Microstegium vimineum*), pink ladies slipper (*Cypripedium acaule*), partridge-berry (*Mitchella repens*), cinnamon fern (*Osmunda cinnamomea*), netted chain fern (*Woodwardia areolata*), and a few deer-tongue grass (*Dichanthelium clandestinum*) and swan's sedge (*Carex swanii*).

Figure 5.8. Chesapeake Bay Non-riverine Wet Hardwood Forest (Coverdale Tract)

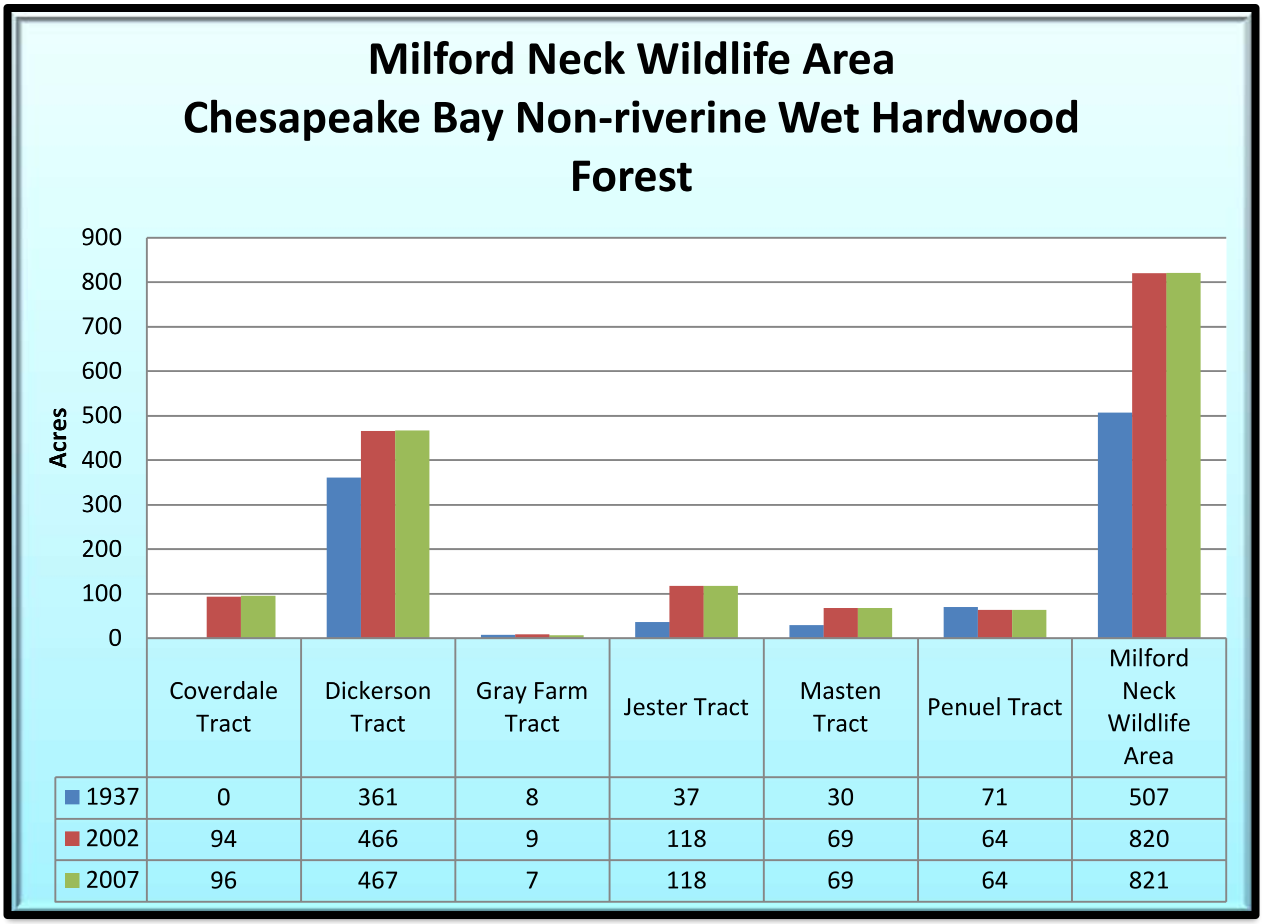
All of the examples of this community are at least in the late successional stage with a few being mature. DBH's range from 1 foot up to 2.5 feet and some examples have a thick understory showing a younger age.

Analysis of Condition at Milford Neck Wildlife Area

In 2007, 439 acres of the 507 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest from 1937 were still present. The rest of the acreage had become 39 acres of Wax-Myrtle Shrub Swamp, 6 acres of North Atlantic Low Salt Marsh, 5 acres of Reed Tidal Marsh, and 4 acres of Northeastern Modified Successional Forest (Table 5.10). Most of these conversions show the gradual rise in sea level and salinity in the wildlife area. Since 1937, the acreage of this community has increased by over 300 acres by growing into 109 acres of Northeastern Old Field, 100 acres of Early to Mid-Successional Loblolly Pine Forest, 74 acres of agricultural field, and 71 acres of clear-cut (Table 5.11).

Table 5.10. What was once Chesapeake Bay Non-riverine Wet Hardwood Forest in 1937 has become X in 2007	
X	**Acreage**
Chesapeake Bay Non-riverine Wet Hardwood Forest	439 acres
Wax-Myrtle Shrub Swamp	39 acres
North Atlantic Low Salt Marsh	6 acres
Reed Tidal Marsh	5 acres
Northeastern Modified Successional Forest	4 acres
Other communities/land covers	13 acres

Table 5.11. Chesapeake Bay Non-riverine Wet Hardwood Forest has migrated into X since 1937	
X	**Acreage**
Chesapeake Bay Non-riverine Wet Hardwood Forest	439 acres
Northeastern Old Field	109 acres
Early to Mid-Successional Loblolly Pine Forest	100 acres
Agricultural Field	74 acres
Clear-cut	71 acres
Other communities/land covers	26 acres



	Coverdale Tract	Dickerson Tract	Gray Farm Tract	Jester Tract	Masten Tract	Penuel Tract	Milford Neck Wildlife Area
1937	0	361	8	37	30	71	507
2002	94	466	9	118	69	64	820
2007	96	467	7	118	69	64	821

Figure 5.9. Chesapeake Bay Non-riverine Wet Hardwood Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.12)

About half of the acreage of Chesapeake Bay Non-riverine Wet Hardwood Forest will be flooded with 1.5 m of sea level rise.

Table 5.12. Projected acres of Chesapeake Bay Non-riverine Wet Hardwood Forest Inundated by Sea Level Rise

Rise	Acres
0.5 m	121 acres
1 m	192 acres
1.5 m	401 acres

Natural Capital (Table 5.13)

Capital of Chesapeake Bay Non-riverine Wet Hardwood Forest has been increasing as more successional communities mature to it.

Table 5.13. Natural Capital of Chesapeake Bay Non-riverine Wet Hardwood Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$6,231,791/year
2002	$10,079,030/year
2007	$10,091,322/year

***Coastal Loblolly Pine Wetland Forest* [75 acres (Figure 5.10, Tables 5.14-5.17)] G3 S3**

DEWAP: Isolated Wetlands
NHC: Northern Atlantic Coastal Plain Maritime Forest

Description

This is the mature wetland pine forest of the wildlife area and of the coastal areas. Since the localities of this community were aerially interpreted based on localities just to the north of the wildlife area exact species lists cannot be given. Generally Loblolly pine (*Pinus taeda*) dominates the canopy and is associated by red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*). The understory and shrub and vine layer is dominated by common greenbrier (*Smilax rotundifolia*), poison ivy (*Toxicodendron radicans*), southern bayberry (*Morella cerifera*), and highbush blueberry (*Vaccinium corymbosum*). Common herbs include Virginia creeper (*Parthenocissus quinquefolia*), netted chain fern (*Woodwardia areolata*), royal fern (*Osmunda regalis* var. *spectabilis*), cinnamon fern (*Osmunda cinnamomea*), and Pennsylvania smartweed (*Polygonum pensylvanicum*).

Analysis of Condition at Milford Neck Wildlife Area

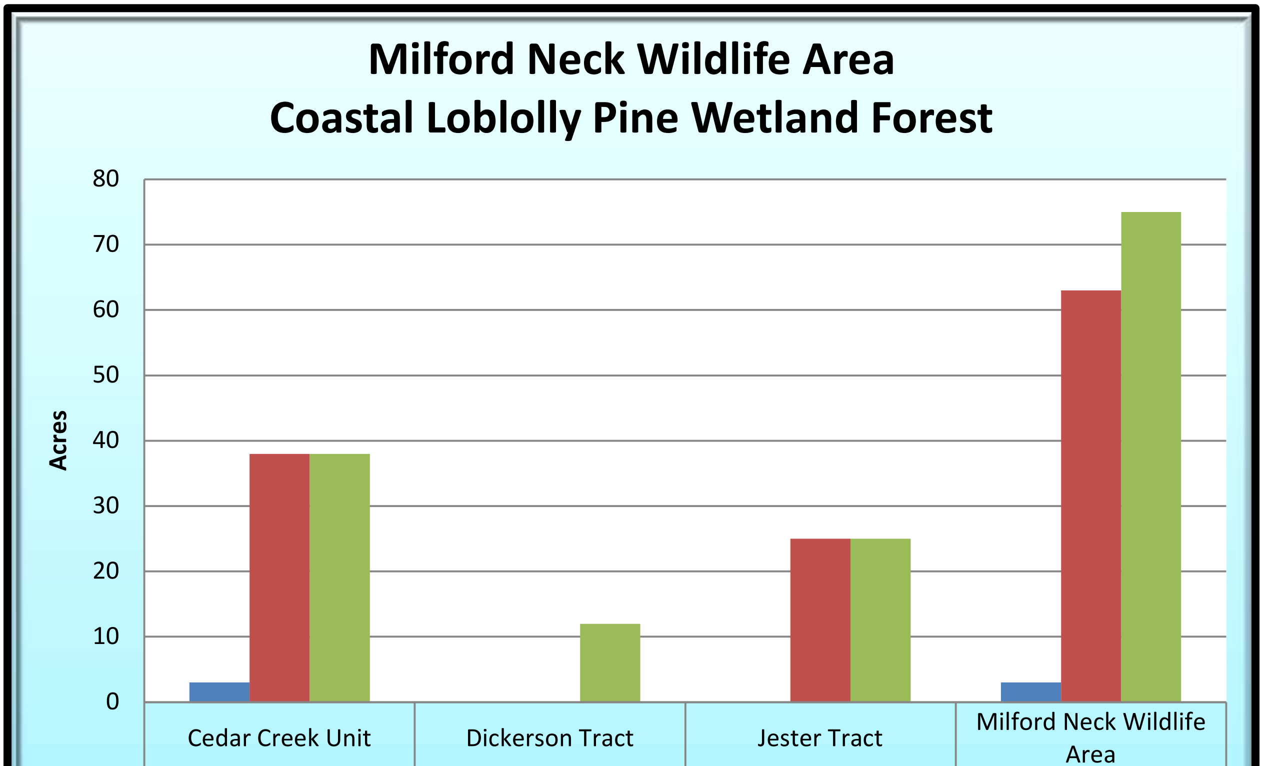
Coastal Loblolly Pine Wetland Forest has increased since 1937 in the wildlife area as a whole in the Cedar Creek Unit and the Jester Tract. In the short-term the amount has been stable and is projected to stay this way in the near term.

In 2007 about 2 acres of the original 3 acres from 1937 still existed. The other acre had converted to 1 acre of North Atlantic Low Salt Marsh and 0.1 acres of North Atlantic High Salt Marsh (Table 5.14). Since 1937, this community has grown into 51 acres of Northeastern Old Field, 12 acres of Northeastern Successional Shrubland, 5 acres of Successional Maritime Forest, and 2 acres of Early to Mid-Successional Loblolly Pine Forest (Table 5.15).

Table 5.14. What was once Coastal Loblolly Pine Wetland Forest in 1937 has become X in 2007

X	Acreage
Coastal Loblolly Pine Wetland Forest	2 acres
North Atlantic Low Salt Marsh	1 acre
North Atlantic High Salt Marsh	0.1 acres

Table 5.15. Coastal Loblolly Pine Wetland Forest has migrated into X since 1937	
X	**Acreage**
Northeastern Old Field	51 acres
Northeastern Successional Shrubland	12 acres
Successional Maritime Forest	5 acres
Early to Mid-Successional Loblolly Pine Forest	2 acres
Coastal Loblolly Pine Wetland Forest	2 acres
Other communities/land covers	3 acres



	Cedar Creek Unit	Dickerson Tract	Jester Tract	Milford Neck Wildlife Area
1937	3	0	0	3
2002	38	0	25	63
2007	38	12	25	75

Figure 5.10. Coastal Loblolly Pine Wetland Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.16)

Almost all of the Coastal Loblolly Pine Wetland Forest in Milford Neck Wildlife Area will be inundated with 1.5 m of sea level rise.

Table 5.16. Projected acres of Coastal Loblolly Pine Wetland Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	52 acres
1 m	62 acres
1.5 m	73 acres

Natural Capital (Table 5.17)

Capital of Coastal Loblolly Pine Wetland Forest has been increasing as more forest communities mature to it or are converted to it.

Table 5.17. Natural Capital of Coastal Loblolly Pine Wetland Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$36,875/year
2002	$774,365/year
2007	$921,862/year

Coastal Plain Oak Floodplain Swamp [26 acres (Figures 5.11-5.12, Tables 5.18-5.21)] G3 S3

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

Description

This riparian forested community is located on a tributary to the Murderkill River in the Penuel Tract. The canopy is composed of red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), and tuliptree (*Liriodendron tulipifera*) that overtops an understory of the same. Common greenbrier (*Smilax rotundifolia*), blackberry (*Rubus* sp.), wisteria (*Wisteria sinensis*), and multiflora rose (*Rosa multiflora*) compose the shrub and vine layer. Herbs include cinnamon fern (*Osmunda cinnamomea*), royal fern (*O. regalis*), arrow-leaf tearthumb (*Polygonum arifolium*), and orange-spotted jewelweed (*Impatiens capensis*).

Figure 5.11. Coastal Plain Oak Floodplain Swamp (Penuel Tract)

The examples of this this community at Milford Neck Wildlife Area vary from late successional to mature. Diameters of canopy trees range from 1 foot to 2 feet. The shrub layers can be thick in this community.

Analysis of Condition at Milford Neck Wildlife Area

Coastal Plain Oak Floodplain Swamp has decreased since 1937 as it has not migrated upstream and as it is eaten away by sea level rise and increased salinity. In 2007, only 26 acres of the 42 acres in 1937 were still present. The rest of the acreage had become 5 acres of impoundment, 3 acres of Freshwater Tidal Mixed High Marsh, 3 acres of water, and 2 acres of Pickerelweed Tidal Marsh (Table 5.18). Since 1937, this forest has not migrated at all leading to the reduced acreage (Table 5.19).

Table 5.18. What was once Coastal Plain Oak Floodplain Swamp in 1937 has become X in 2007

X	Acreage
Coastal Plain Oak Floodplain Swamp	26 acres
Impoundment	5 acres
Freshwater Tidal Mixed High Marsh	3 acres
Water	3 acres
Pickerelweed Tidal Marsh	2 acres
Other communities/land covers	3 acres

Table 5.19. Coastal Plain Oak Floodplain Swamp has migrated into X since 1937	
X	**Acreage**
Coastal Plain Oak Floodplain Swamp	26 acres

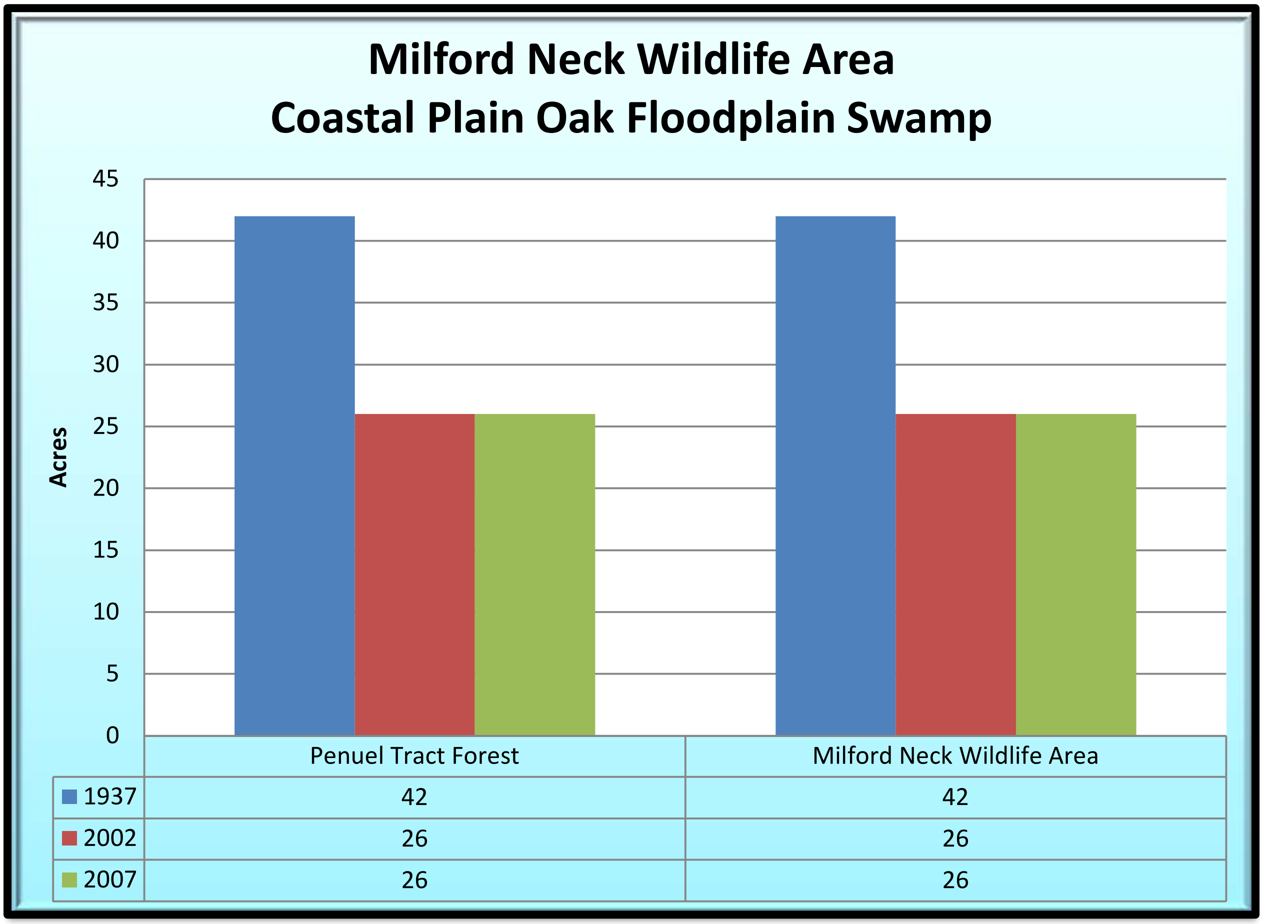


Figure 5.12. Coastal Plain Oak Floodplain Swamp at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.20)

Essentially all of acreage of Coastal Plain Oak Floodplain Swamp will be inundated with 0.5 m of sea level rise and all will be inundated with 1.5 m of rise.

Table 5.20. Projected acres of Coastal Plain Oak Floodplain Swamp Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	24 acres
1 m	25 acres
1.5 m	26 acres

Natural Capital (Table 5.21)

Capital of Coastal Plain Oak Floodplain Forest has decreased with sea level rise eating into it. IN the case of marsh community conversions this leads to a reduction of capital for the wildlife area.

Table 5.21. Natural Capital of Coastal Plain Oak Floodplain Swamp	
Year	**Natural Capital (in 2012 dollars)**
1937	$516,243/year
2002	$319,579/year
2007	$319,579/year

***Cultivated Lawn* [9 acres (Figure 5.13, Tables 5.22-5.24)]   GNA   SNA**

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

Description

This community is located primarily on the roadsides in the wildlife area. Cultivated lawns are generally composed of tall fescue (*Festuca arundinacea*).

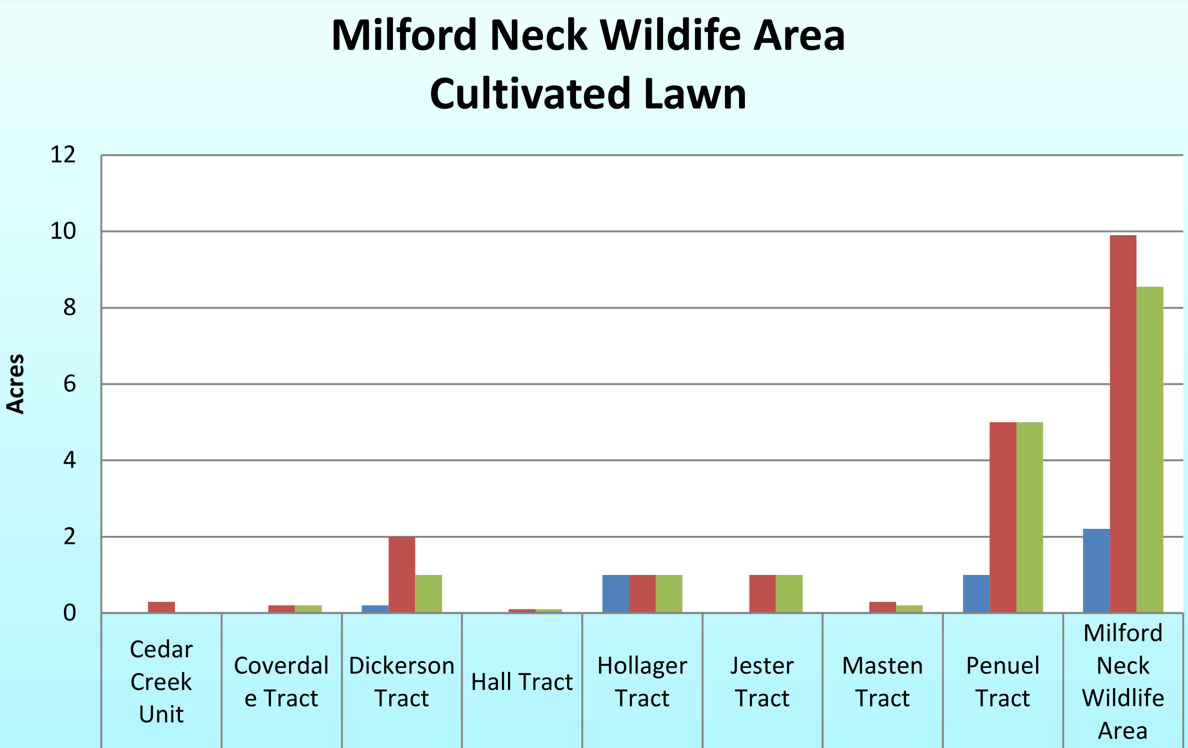
Analysis of Condition at Milford Neck Wildlife Area

This community has increased through time with an increase in roads and impervious surface area, which it is related. Given the management in the wildlife area it will likely remain around the same amount.

One acre of the original 2 acres present in 1937 was still present in 2007. The other acre has become an agricultural field (Table 5.22). Since 1937, 5 acres of agricultural field, 1 acre of Chesapeake Bay Non-riverine Wet Hardwood Forest, and 1 acre of Northeastern Old Field have been developed into cultivated lawn (Table 5.23).

Table 5.22. What was once Cultivated Lawn in 1937 has become X in 2007	
X	**Acreage**
Agricultural Field	1 acre
Cultivated Lawn	1 acre

Table 5.23. Cultivated Lawn has migrated into X since 1937	
X	**Acreage**
Agricultural Field	5 acres
Cultivated Lawn	1 acre
Chesapeake Bay Non-riverine Wet Hardwood Forest	1 acre
Northeastern Old Field	1 acre



	Cedar Creek Unit	Coverdale Tract	Dickerson Tract	Hall Tract	Hollager Tract	Jester Tract	Masten Tract	Penuel Tract	Milford Neck Wildlife Area
1937	0	0	0.2	0	1	0	0.01	1	2.21
2002	0.3	0.2	2	0.1	1	1	0.3	5	9.9
2007	0.03	0.2	1	0.1	1	1	0.2	5	8.55

Figure 5.13. Cultivated Lawn at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.24)

About 1/3 of the total cultivated lawn in Milford Neck Wildlife Area will be inundated by water with 1.5 m of sea level rise.

Table 5.24. Projected acres of Cultivated Lawn Inundated by Sea Level Rise

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

Natural Capital

Cultivated lawn does not have any natural capital value.

***Early to Mid-Successional Loblolly Pine Forest* [32 acres (Figures 5.14-5.15, Tables 5.25-5.28)] GNA SNA**

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

<u>*Description*</u>

This early to mid-successional community is dominated by loblolly pine (*Pinus taeda*) in the canopy with other hardwoods composing the understory such as red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), white oak (*Quercus alba*), willow oak (*Quercus phellos*), sassafras (*Sassafras albidum*), and American holly (*Ilex opaca*). The shrub and vine layer includes common greenbrier (*Smilax rotundifolia*), highbush blueberry (*Vaccinium corymbosum*), poison ivy (*Toxicodendron radicans*), Japanese honeysuckle (*Lonicera japonica*), and multiflora rose (*Rosa multiflora*). Thicket sedge (*Carex abscondita*), pink ladies slipper (*Cypripedium acaule*), ground pine (*Lycopodium obscurum*), partridgeberry (*Mitchella repens*), and Virginia creeper (*Parthenocissus quinquefolia*) compose the herbaceous layer.

Figure 5.14. Early to Mid-Successional Loblolly Pine Forest (Penuel Tract)

<u>*Analysis of Condition at Milford Neck Wildlife Area*</u>

This community was once more prominent in the wildlife area as clear-cuts around the turn of the 20th century grew into more mature forest communities. As these remaining pine forests grow into hardwood forests or coastal forests this community will gradually decline through time. Only 0.4 acres of the 168 acres in 1937 still existed in 2007. The rest of the acreage had become 100 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 44 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, 7 acres of Southern Red Oak/Heath Forest, 5 acres of Successional Tuliptree-Loblolly Pine Upland Forest, and 3 acres of agricultural field (Table 5.25). Since 1937, Early to Mid-Successional Loblolly Pine Forest has grown into 25 acres of agricultural field, 6 acres of Northeastern Old Field, and 1 acre of impervious surface (Table 5.26).

Table 5.25. What was once Early to Mid-Successional Loblolly Pine Forest in 1937 has become X in 2007	
X	**Acreage**
Chesapeake Bay Non-riverine Wet Hardwood Forest	100 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	44 acres
Southern Red Oak/Heath Forest	7 acres
Successional Tuliptree-Loblolly Pine Upland Forest	5 acres
Agricultural Field	3 acres
Other communities/land covers	9 acres

Table 5.26. Early to Mid-Successional Loblolly Pine Forest has migrated into X since 1937	
X	**Acreage**
Agricultural Field	25 acres
Northeastern Old Field	6 acres
Impervious Surface	1 acre
Early to Mid-Successional Loblolly Pine Forest	0.4 acres

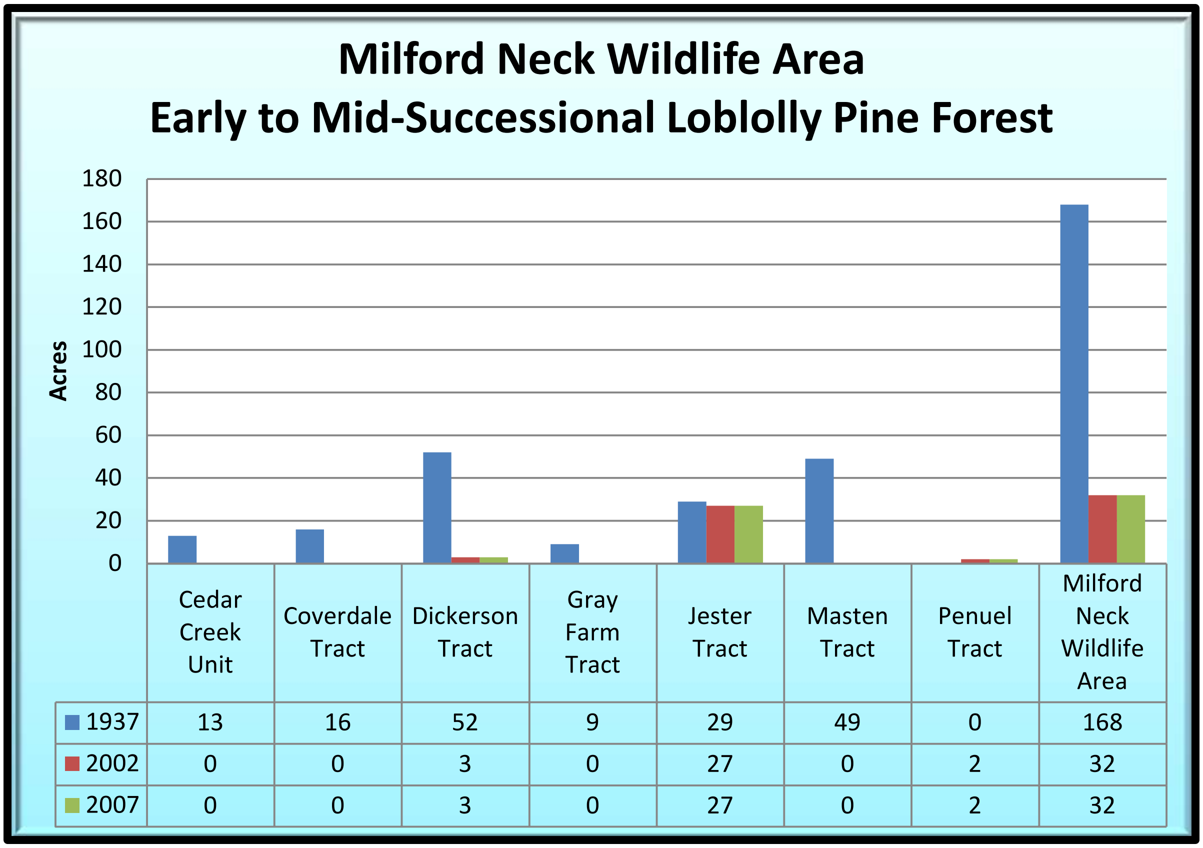


Figure 5.15. Early to Mid-Successional Loblolly Pine Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.27)

Most of the Early to Mid-Successional Loblolly Pine Forest will be inundated with 1.5 m of sea level. However, it will be lightly impacted with 0.5 m of rise.

Table 5.27. Projected acres of Early to Mid-Successional Loblolly Pine Forest Inundated by Sea Level Rise

Rise	**Acres**
0.5 m	2 acres
1 m	10 acres
1.5 m	28 acres

Natural Capital (Table 5.28)

Capital of Early to Mid-Successional Loblolly Pine Forest has declined rapidly with maturation to more mature forest communities.

Table 5.28. Natural Capital of Early to Mid-Successional Loblolly Pine Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$31,769/year
2002	$6,051/year
2007	$6,051/year

***Eastern Reed Marsh* [5 acres (Figure 5.16-5.17, Tables 5.29-5.31)] GNA SNA**

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

Description

Figure 5.16. Eastern Reed Marsh (Jester Tract)

This community does not appear to be present in the 1937 aerial imagery and has come about since. It is scatted in depressions throughout the wildlife area. It is characterized by the near total or total dominance of common reed (*Phragmites australis*).

Analysis of Condition at Milford Neck Wildlife Area

This community is composed of an invasive exotic species, common reed. It is scattered throughout the wildlife area and without targeted elimination efforts it will likely be present in the future. It was not present in 1937 and has since come into 4 acres of Northeastern Old Field, 1 acre of Coastal Plain Pond, and 0.2 acres each of Coastal Plain Oak Floodplain Swamp, Chesapeake Bay Non-riverine Wet Hardwood Forest, and Successional Maritime Forest (Table 5.29).

Table 5.29. Eastern Reed Marsh has migrated into X since 1937

X	**Acreage**
Northeastern Old Field	4 acres
Coastal Plain Pond	1 acre
Coastal Plain Oak Floodplain Swamp	0.2 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.2 acres
Successional Maritime Forest	0.2 acres
Other communities/land covers	0.2 acres

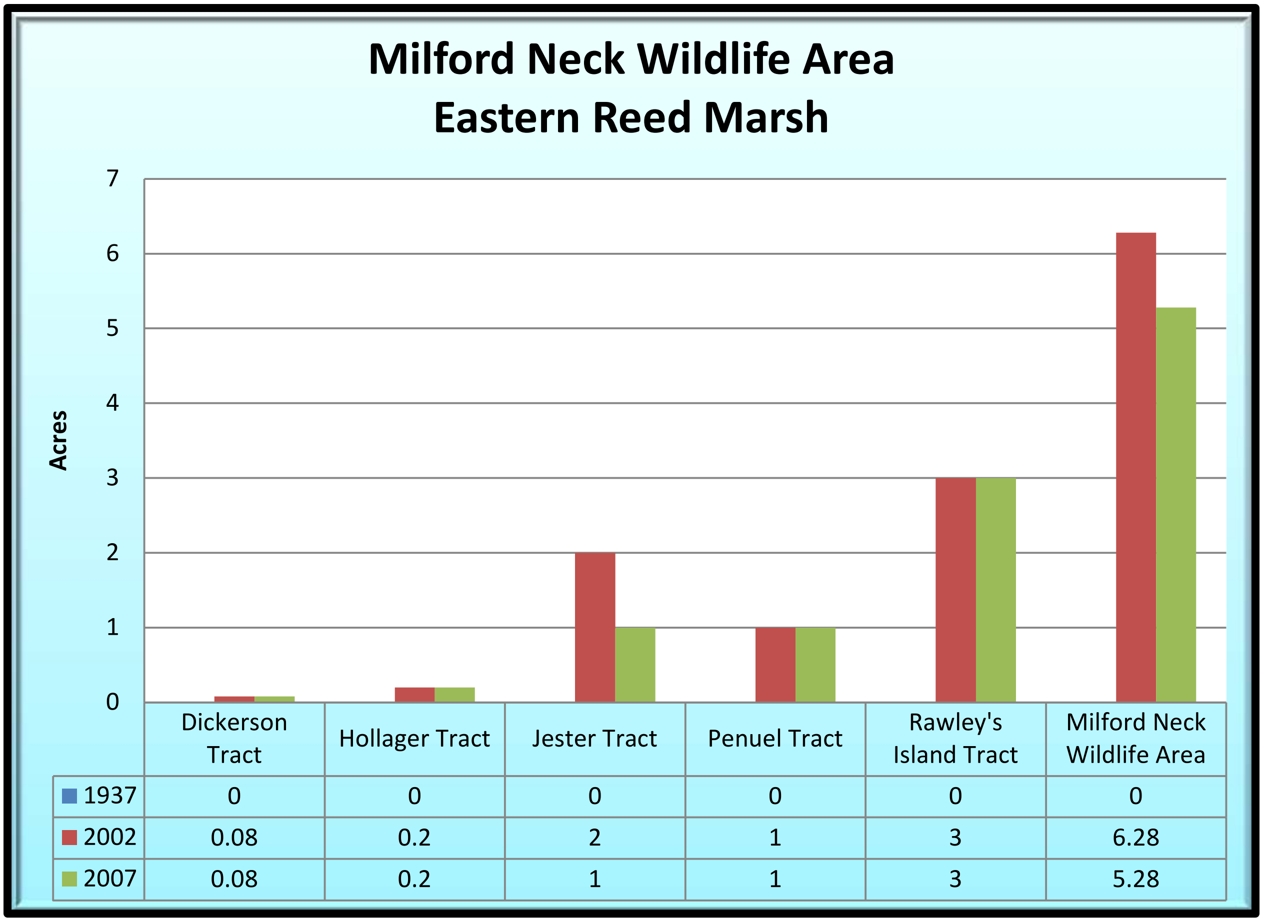


Figure 5.17. Eastern Reed Marsh at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.30)

All of the current acreage of Eastern Reed Marsh in Milford Neck Wildlife Area will be inundated with 0.5 m of sea level rise.

Table 5.30. Projected acres of Eastern Reed Marsh Inundated by Sea Level Rise

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

Natural Capital (Table 5.31)

Eastern Reed Marsh was not present in 1937 and peaked out at $58,287 of capital and has declined to $49,006/year since 2002.

Table 5.31. Natural Capital of Eastern Reed Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$58,287/year
2007	$49,006/year

***Freshwater Tidal Mixed High Marsh* [0.3 acres (Figures 5.18-5.20, Tables 5.32-5.35)] GNR S1**

DEWAP: Freshwater Tidal Marshes
NHC: Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh

Description

Figure 5.18. Freshwater Tidal Mixed High Marsh (Penuel Tract)

This freshwater marsh is currently located in small amount in the Penuel Tract and was once located on three other tracts. It is located in freshwater tidal situations and is composed of arrow-leaf tearthumb (*Polygonum arifolium*), hemlock water-parsnip (*Sium suave*), rice cutgrass (*Leersia oryzoides*), orange-spotted jewelweed (*Impatiens capensis*), pickerelweed (*Sagittaria latifolia*), cinnamon fern (*Osmunda cinnamomea*), Virginia creeper (*Parthenocissus quinquefolia*), jack-in-the-pulpit (*Arisaema triphyllum*), royal fern (*Osmunda regalis*), and netted chain fern (*Woodwardia areolata*).

Analysis of Condition at Milford Neck Wildlife Area

This community will likely be eliminated from the wildlife area in the not too distant future. The encroachment of saline water in the Penuel Tract, where this community is located, is moving too fast for enough new freshwater marshes to form. None of the Freshwater Tidal Mixed High Marsh from 1937 still existed in 2007. By 2007 all of this marsh had become 43 acres of North Atlantic Low Salt Marsh, 40 acres of Mesohaline Seepage Marsh, 14 acres of Cattail Brackish Tidal Marsh, 5 acres of water, and 3 acres of Reed Tidal Marsh (Table 5.32). Since 1937, Freshwater Tidal Mixed High Marsh has managed to convert 3 acres of Coastal Plain Oak Floodplain Swamp and 0.2 acres of Mid-Atlantic Mesic Mixed Hardwood Forest (Table 5.33), but not enough to equal the losses.

Table 5.32. What was once Freshwater Tidal Mixed High Marsh in 1937 has become X in 2007

X	Acreage
North Atlantic Low Salt Marsh	43 acres
Mesohaline Seepage Marsh	40 acres
Cattail Brackish Tidal Marsh	14 acres
Water	5 acres
Reed Tidal Marsh	3 acres
Other communities/land covers	7 acres

Table 5.33. Freshwater Tidal Mixed High Marsh has migrated into X since 1937	
X	**Acreage**
Coastal Plain Oak Floodplain Swamp	3 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	0.2 acres

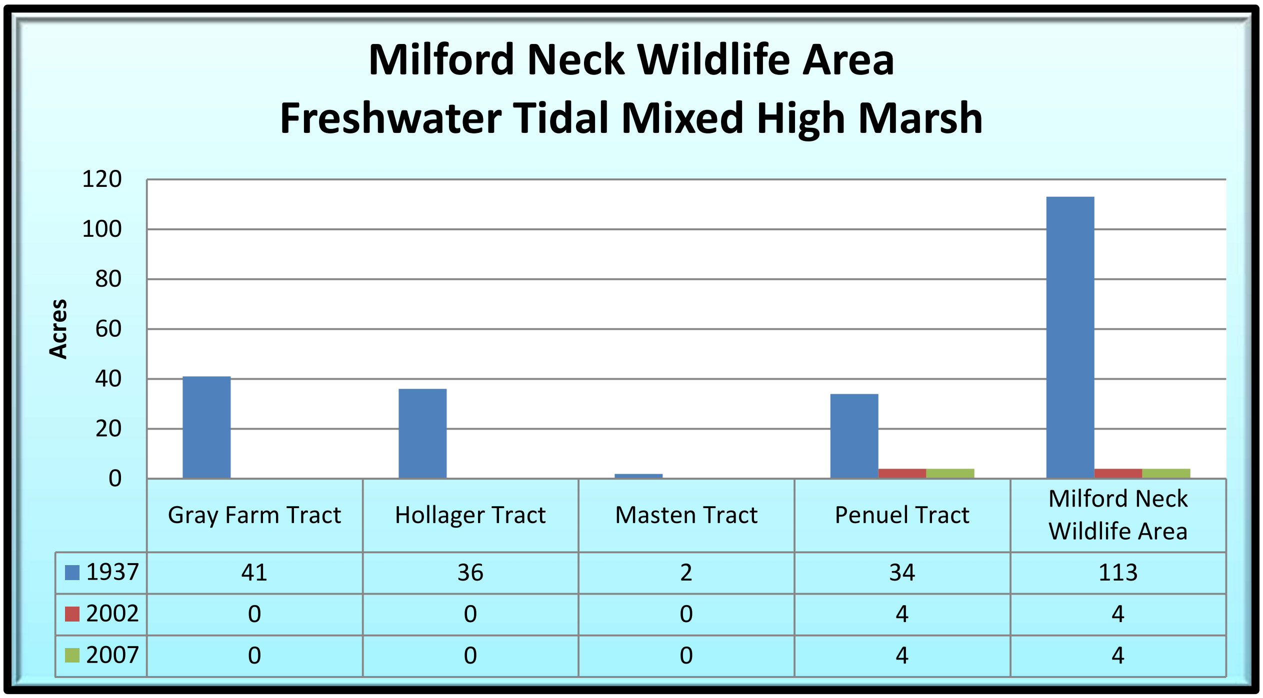


Figure 5.19. Freshwater Tidal Mixed High Marsh at Milford Neck Wildlife Area (1937, 2002, and 2007)

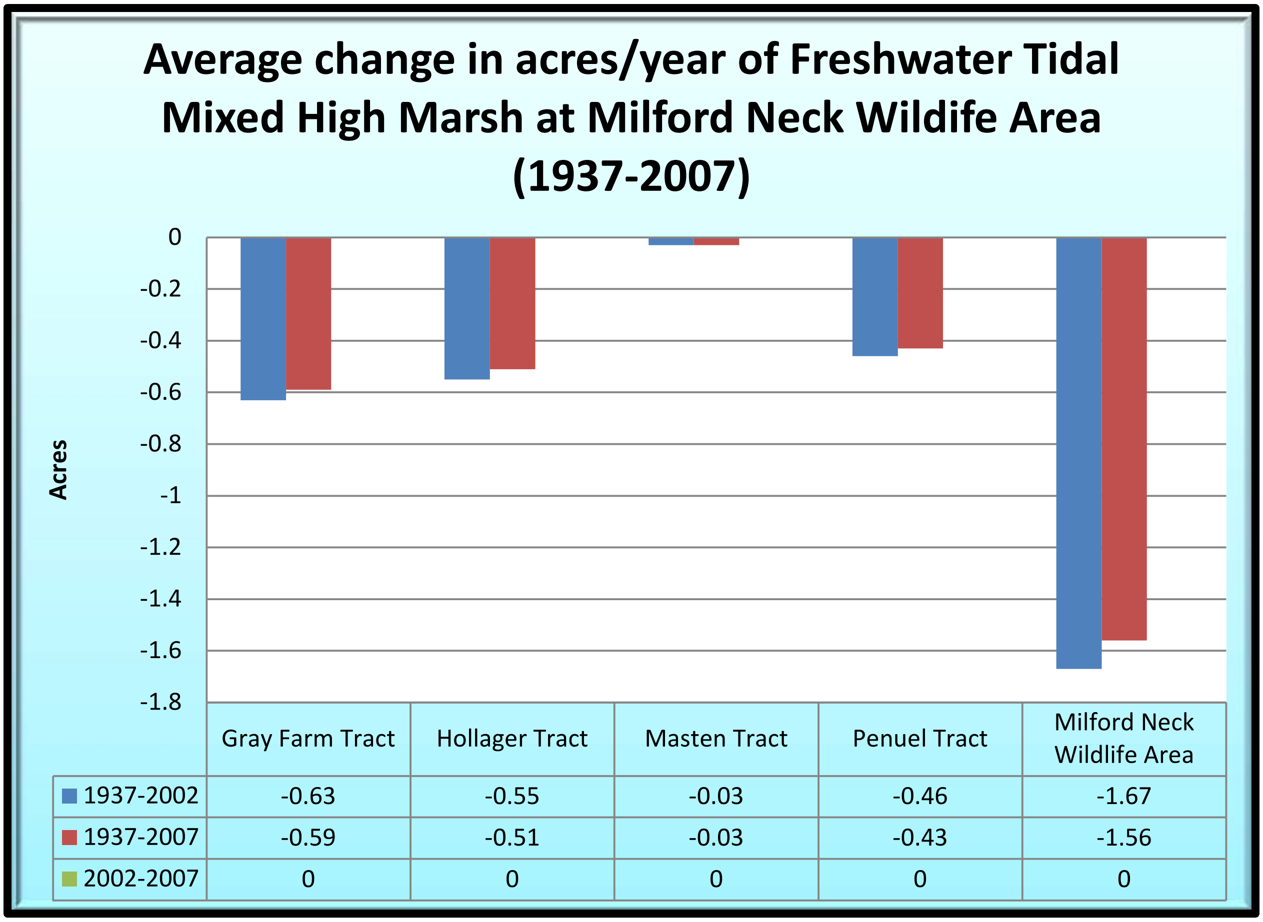


Figure 5.20. Average changes in acres/year of Freshwater Tidal Mixed High Marsh at Milford Neck Wildlife Area (1937-2007)

DNREC Sea Level Rise Analysis (Table 5.34)

All of the current acreage of Freshwater Tidal Mixed High Marsh in Milford Neck Wildlife Area will be inundated with 0.5 m of sea level rise.

Table 5.34. Projected acres of Freshwater Tidal Mixed High Marsh Inundated by Sea Level Rise

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

Natural Capital (Table 5.35)

Natural capital of Freshwater Tidal Mixed High Marsh is just a remnant of its former value with conversion to other more saline marshes and water.

Table 5.35. Natural Capital of Freshwater Tidal Mixed High Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$708,657/year
2002	$25,085/year
2007	$25,085/year

***Freshwater Tidal Woodland* [1 acre (Figure 5.21-5.22, Tables 5.36-5.38)]   G2   S2**

DEWAP: Freshwater Tidal Forested Wetlands
NHC: Northern Atlantic Coastal Plain Tidal Swamp

Description

This woodland community seems to arise from Southern Red Maple-Blackgum Swamps that have been flooded through tidal inundation. Red maple (*Acer rubrum*) is the only canopy member in the sparse canopy, with some wax-myrtle (*Morella cerifera*) reaching the canopy. Understory associates include sweetbay (*Magnolia virginiana*), wax-myrtle, multiflora rose (*Rosa multiflora*), and common greenbrier (*Smilax rotundifolia*). Wax-myrtle was the only shrub observed and herbaceous species include orange-spotted jewelweed (*Impatiens capensis*), wide-leaved cattail (*Typha latifolia*), climbing hempweed (*Mikania scandens*), nodding tick-seed (*Bidens cernua*), water-pepper smartweed (*Polygonum hydropiperiodes*), royal fern (*Osmunda regalis*), and American water-pennywort (*Hydrocotyle americana*).

Figure 5.21. Freshwater Tidal Woodland (Gray Farm Tract)

The Freshwater Tidal Woodland in Milford Neck appears to be Middle to Late Successional but it hard to tell since this community often comes about through the conversion of a previous forest type. The conversion often leads to some regrowth making it look younger.

Analysis of Condition at Milford Neck Wildlife Area

This community does not appear to be present in 1937 and has come about since. In 2007 it covered acres which came from 2 acres of Wax-Myrtle Shrub Swamp and 0.3 acres of Early to Mid-Successional Loblolly Pine Forest (Table 5.36).

Table 5.36. Freshwater Tidal Woodland has migrated into X since 1937	
X	**Acreage**
Wax-Myrtle Shrub Swamp	2 acres
Early to Mid-Successional Loblolly Pine Forest	0.3 acres

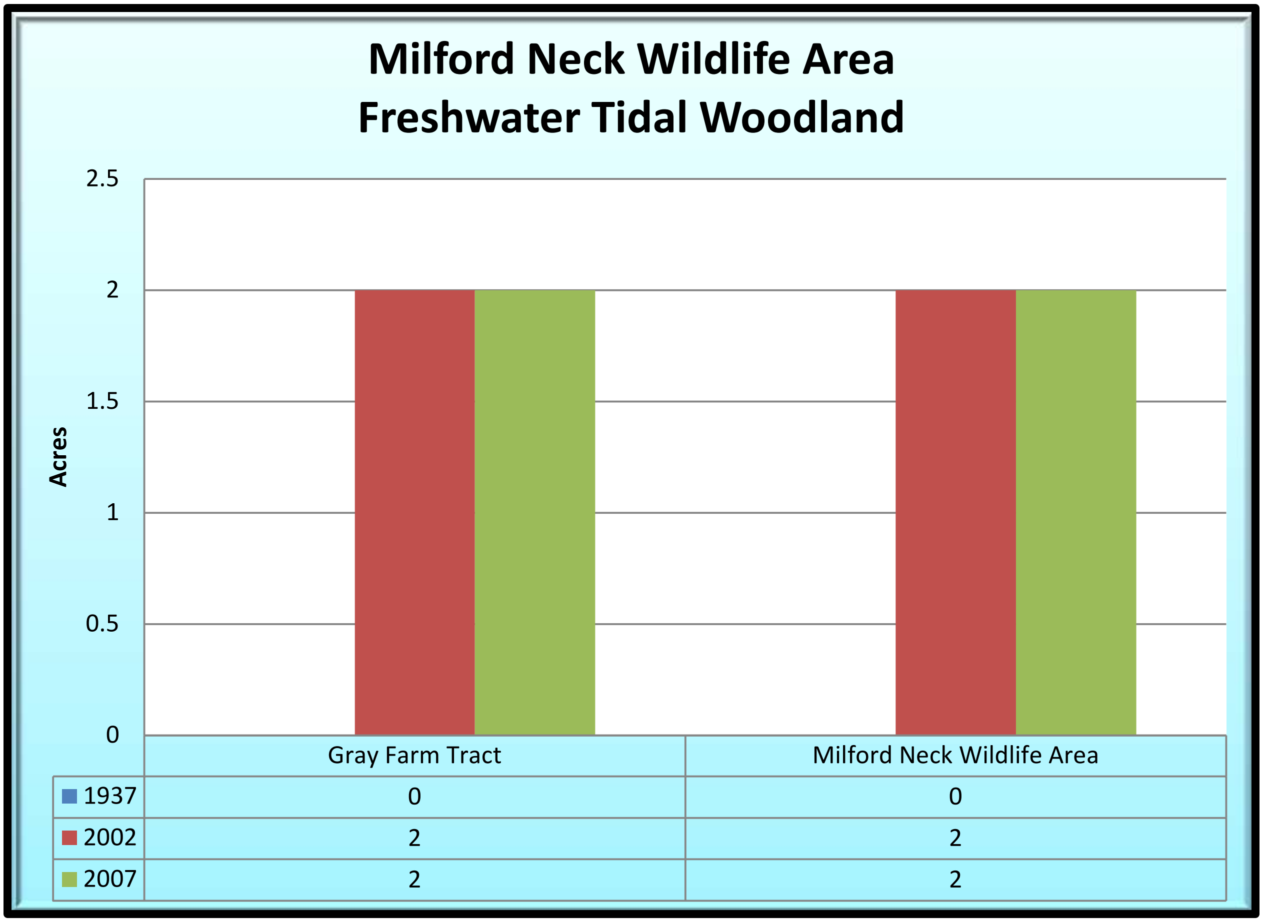


Figure 5.22. Freshwater Tidal Woodland at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.37)

All of the current acreage of Freshwater Tidal Woodland in Milford Neck Wildlife Area will be inundated with 0.5 m of sea level rise.

Table 5.37. Projected acres of Freshwater Tidal Woodland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 5.38)

Freshwater Tidal Woodland was not present in 1937 and has since converted some shrubland and forest to acquire $24,583 in capital, resulting in a capital gain for the wildlife area.

Table 5.38. Natural Capital of Freshwater Tidal Mixed High Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$24,583/year
2007	$24,583/year

Irregularly Flooded Eastern Tidal Salt Shrub **[36 acres (Figure 5.23-5.24, Tables 5.39-)] G5 S5**

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

Description

This shrub community is dominated by salt shrub (*Baccharis halimifolia*), which is associated by salt grass (*Distichlis spicata*) and salt meadow hay (*Spartina patens*). It is generally located on the interface of salt marshes and more upland habitats. It is located in most of the tracts of Milford Neck Wildlife Area and is one of the more widely distributed communities.

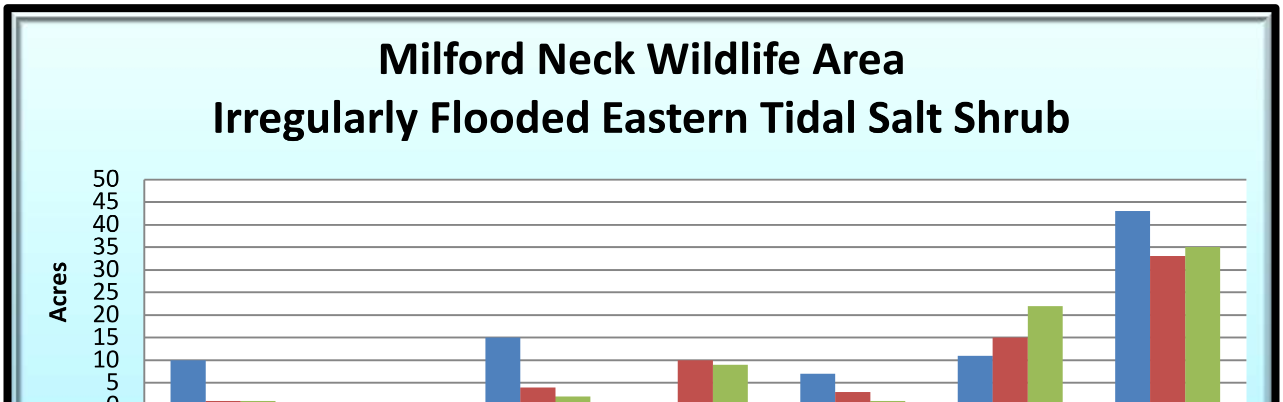
Analysis of Condition at Milford Neck Wildlife Area

This community, likely due to sea level rise, is being compressed by encroachment of the marsh and terrestrial communities in the uplands. Overall it has declined in amount in the wildlife area with some gains being realized in the Rawley's Island Tract. The long term prognosis for this community is not good as the marsh continues to advance landward. Only 0.5 acres of the 43 acres from 1937 were still present in 2007. The rest of the shrubland had become 36 acres of North Atlantic Low Salt Marsh, 6 acres of North Atlantic High Salt Marsh, 0.5 acres of Irregularly Flooded Eastern Tidal Salt Shrub, 0.5 acres of water, and 0.4 acres of Tidal Mudflat (Table 5.39). Since 1937, this community has migrated into 23 acres of North Atlantic Low Salt Marsh, 6 acres of North Atlantic High Salt Marsh, 5 acres of Northeastern Old Field, and 1 acre of water (Table 5.40).

Table 5.39. What was once Irregularly Flooded Eastern Tidal Salt Shrub in 1937 has become X in 2007

X	Acreage
North Atlantic Low Salt Marsh	36 acres
North Atlantic High Salt Marsh	6 acres
Irregularly Flooded Eastern Tidal Salt Shrub	0.5 acres
Water	0.5 acres
Tidal Mudflat	0.4 acres
Other communities/land covers	0.3 acres

Table 5.40. Irregularly Flooded Eastern Tidal Salt Shrub has migrated into X since 1937	
X	**Acreage**
North Atlantic Low Salt Marsh	23 acres
North Atlantic High Salt Marsh	6 acres
Northeastern Old Field	5 acres
Water	1 acre
Irregularly Flooded Eastern Tidal Salt Shrub	0.5 acres
Other communities/land covers	0.5 acres



	Cedar Creek Unit	Gray Farm Tract	Hall Tract	Jester Tract	Masten Tract	Rawley's Island Tract	Milford Neck Wildlife Area
1937	10	0	15	0.05	7	11	43.05
2002	1	0.1	4	10	3	15	33.1
2007	1	0.1	2	9	1	22	35.1

Figure 5.23. Irregularly Flooded Eastern Tidal Salt Shrub at Milford Neck Wildlife Area (1937, 2002, and 2007)

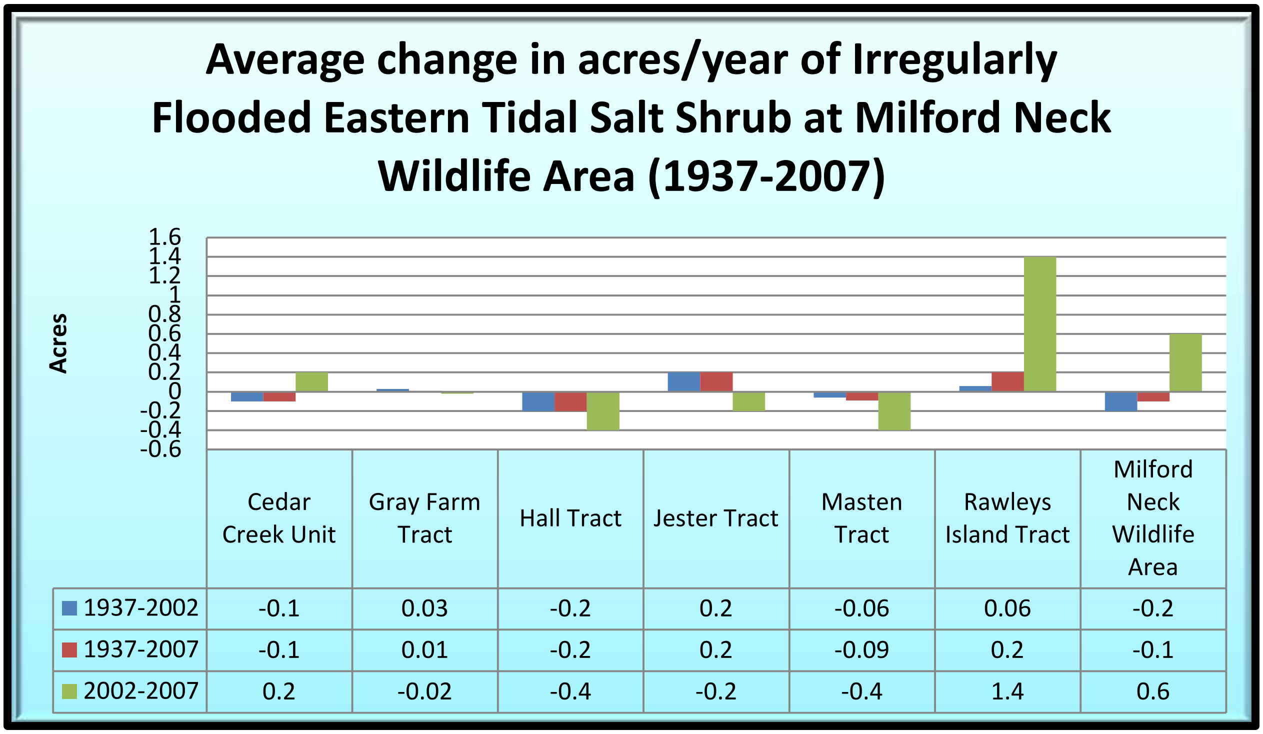


Figure 5.24. Average change in acres/year of Irregularly Flooded Eastern Tidal Salt Shrub at Milford Neck Wildlife Area (1937-2007)

DNREC Sea Level Rise Analysis (Table 5.41)

All of the current acreage of Irregularly Flooded Eastern Tidal Salt Shrub in Milford Neck Wildlife Area will be inundated with 0.5 m of sea level rise.

Table 5.41. Projected acres of Irregularly Flooded Eastern Tidal Salt Shrub Inundated by Sea Level Rise

Rise	Acres
0.5 m	36 acres
1 m	36 acres
1.5 m	36 acres

Natural Capital (Table 5.42)

Natural capital of Irregularly Flooded Eastern Tidal Salt Shrub has declined overall but has recently increased in the 2002-2007 period with an acreage increase in the Rawley's Island Tract.

Table 5.42. Natural Capital of Irregularly Flooded Eastern Tidal Salt Shrub	
Year	**Natural Capital (in 2012 dollars)**
1937	$269,979/year
2002	$207,580/year
2007	$220,123/year

***Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland* [2 acres (Figure 5.25-5.27, Tables 5.43-5.44)] GNR S3**

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

<u>*Description*</u>

Figure 5.25. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland (Jester Tract)

This community was determined through aerial image analysis in both the Jester and Rawley's Island Tracts. Loblolly pine (*Pinus taeda*) is dominates the canopy with overtopping an understory of wax-myrtle (*Morella cerifera*) and salt shrub (*Baccharis halimifolia*). Salt meadow cordgrass (*Spartina patens*) dominates the herbaceous layer underneath.

The examples of this community appear to be late successional. Most canopy trees are around 1.0 to 1.2 feet in diameter.

<u>*Analysis of Condition at Milford Neck Wildlife Area*</u>

All of the current acreage of this community grew in from Northeastern Old Field. It appears to be increasing as sea level converts the growth of the pine.

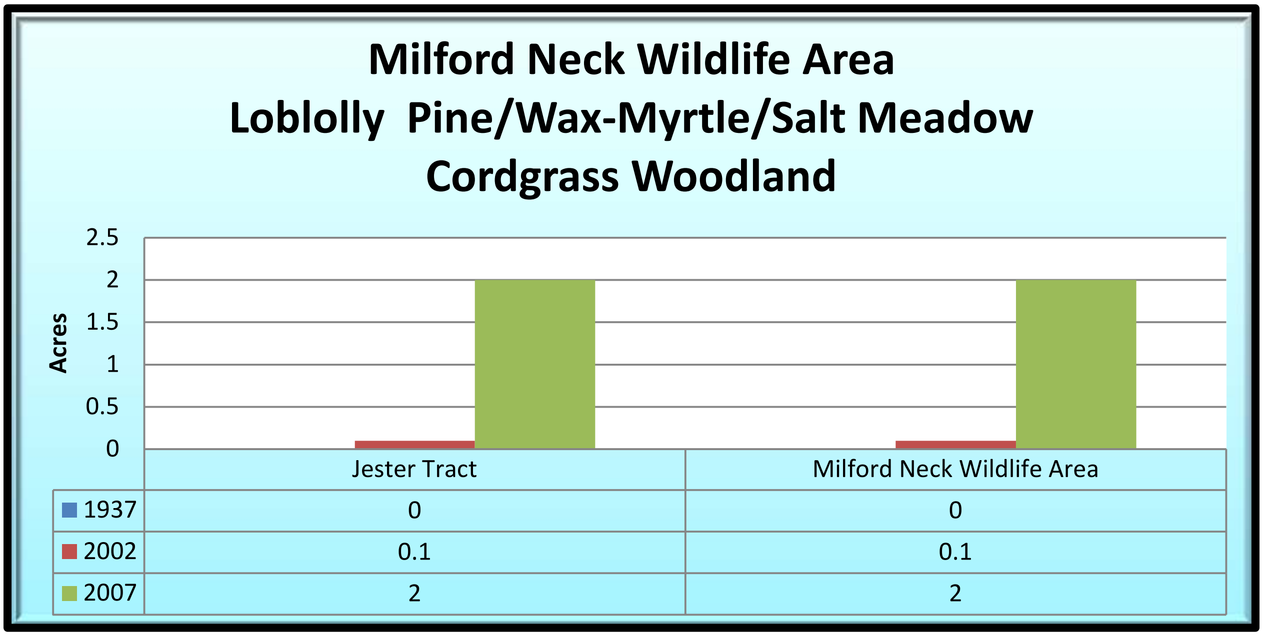


Figure 5.26. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland at Milford Neck Wildlife Area (1937, 2002, and 2007)

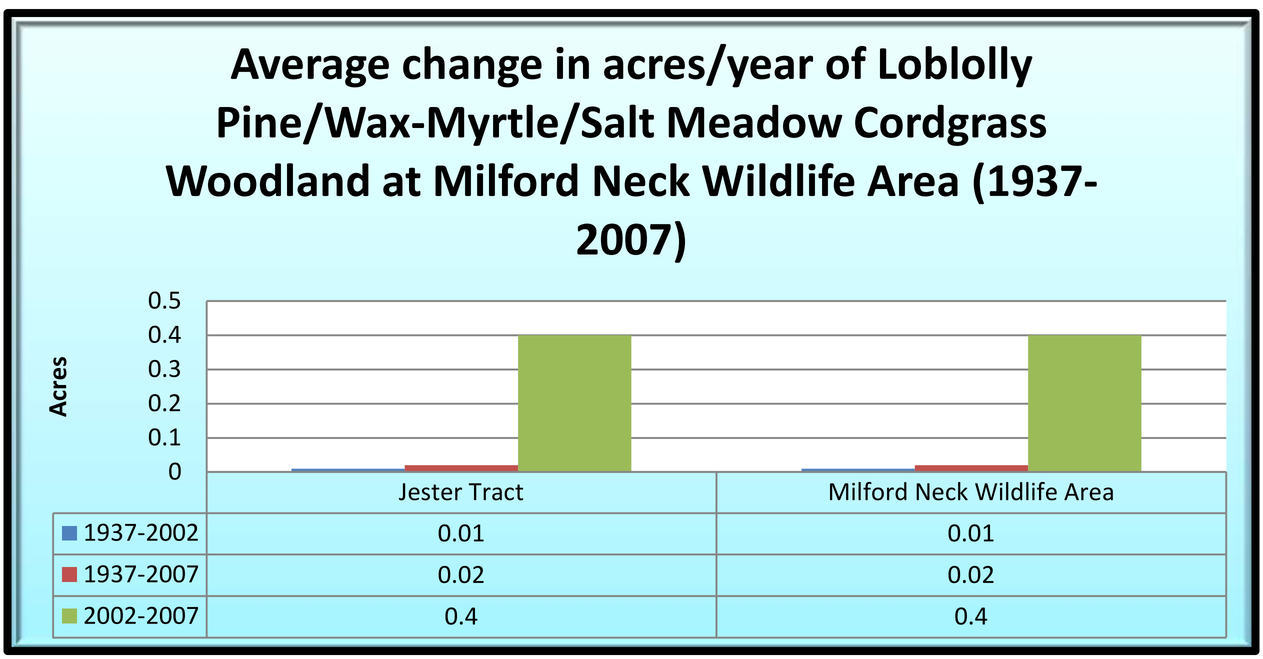


Figure 5.27. Average change in acres/year of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland at Milford Neck Wildlife Area (1937-2007)

DNREC Sea Level Rise Analysis (Table 5.44)

All of the current acreage of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland in Milford Neck Wildlife Area will be inundated with 0.5 m of sea level rise.

Table 5.44. Projected acres of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 5.45)

Natural capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has been increasing as the acreage increases. Overall this has resulted in a capital increase for the wildlife area.

Table 5.45. Natural Capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$19/year
2007	$378/year

***Mesohaline Seepage Marsh* [70 acres (Figures 5.28-5.30, Table 5.46-5.49)]** **GNR** **S2**

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

Description

Figure 5.28. Mesohaline Seepage Marsh (Gray Farm Tract)

This marsh is present in both the Gray Farm and Hollager Tract. It is composed of salt marsh fleabane (*Pluchea odorata*), Pickerelweed (*Sagittaria latifolia*), wide-leaved cattail (*Typha latifolia*), waterhemp amaranth (*Amaranthus cannabinus*), salt meadow cordgrass (*Spartina alternifolia*), marsh mallow (*Hibiscus moscheutos*), white snakeroot (*Ageratina altissima*), salt shrub (*Baccharis halimifolia*), and climbing hempweed (*Mikania scandens*).

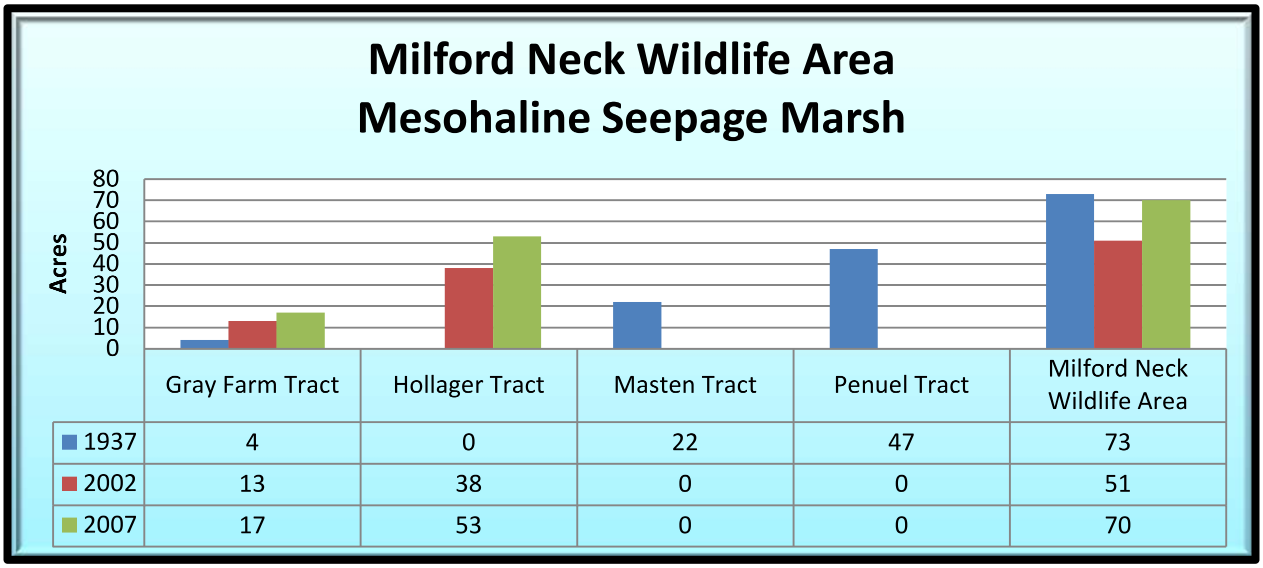
Analysis of Condition at Milford Neck Wildlife Area

None of the Mesohaline Seepage Marsh from 1937 was still present in 2007. All of the marsh had become 60 acres of North Atlantic Low Salt Marsh, 8 acres of North Atlantic High Salt Marsh, 3 acres of Reed Tidal Marsh, 3 acres of Cattail Brackish Tidal Marsh, and 2 acres of water (Table 5.46). Since 1937, this marsh has converted 40 acres of Freshwater Tidal Mixed High Marsh, 17 acres of Wax-myrtle Shrub Swamp, 9 acres of Cattail Brackish Tidal Marsh, and 1 acre each of Successional Maritime Forest and River Bulrush Flooded Grassland (Table 5.47).

Table 5.46. What was once Mesohaline Seepage Marsh in 1937 has become X in 2007

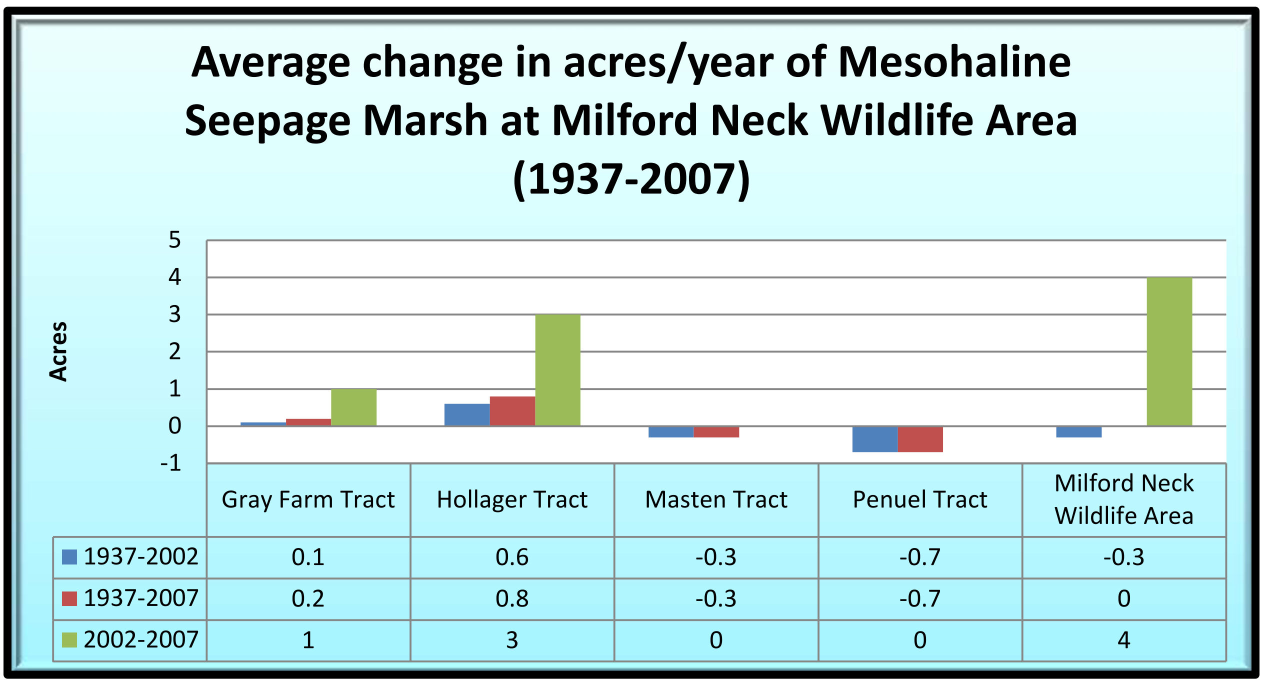
X	Acreage
North Atlantic Low Salt Marsh	60 acres
North Atlantic High Salt Marsh	8 acres
Reed Tidal Marsh	3 acres
Cattail Brackish Tidal Marsh	3 acres
Water	2 acres
Other communities/land covers	1 acre

Table 5.47. Mesohaline Seepage Marsh has migrated into X since 1937	
X	**Acreage**
Freshwater Tidal Mixed High Marsh	40 acres
Wax-Myrtle Shrub Swamp	17 acres
Cattail Brackish Tidal Marsh	9 acres
Successional Maritime Forest	1 acre
River Bulrush Flooded Grassland	1 acre
Other communities/land covers	1 acre



	Gray Farm Tract	Hollager Tract	Masten Tract	Penuel Tract	Milford Neck Wildlife Area
1937	4	0	22	47	73
2002	13	38	0	0	51
2007	17	53	0	0	70

Figure 5.29. Mesohaline Seepage Marsh at Milford Neck Wildlife Area (1937, 2002, and 2007)



	Gray Farm Tract	Hollager Tract	Masten Tract	Penuel Tract	Milford Neck Wildlife Area
1937-2002	0.1	0.6	-0.3	-0.7	-0.3
1937-2007	0.2	0.8	-0.3	-0.7	0
2002-2007	1	3	0	0	4

Figure 5.30. Average change in acres/year of Mesohaline Seepage Marsh at Milford Neck Wildlife Area (1937-2007)

DNREC Sea Level Rise Analysis (Table 5.48)

All of the current acreage of Mesohaline Seepage Marsh in Milford Neck Wildlife Area will be inundated with 0.5 m of sea level rise.

Table 5.48. Projected acres of Mesohaline Seepage Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	69 acres
1 m	69 acres
1.5 m	69 acres

Natural Capital (Table 5.49)

Mesohaline Seepage Marsh capital has declined overall since 1937 with large dip in 2002. Since 2002, this marsh has gone further downstream a tributary in the Gray Farm Tract and could be due to increased rainfall in the 2002 to 2007 period. This expansion added to the capital.

Table 5.49. Natural Capital of Mesohaline Seepage Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$457,805/year
2002	$319,836/year
2007	$438,991/year

***Mid-Atlantic Mesic Mixed Hardwood Forest* [253 acres (Figures 5.31-5.32, Tables 5.50-5.53)] G5 S5**

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

Description

This is one of the more common forested communities behind Chesapeake Bay Non-riverine Wet Hardwood Forest in the wildlife area. Mid-Atlantic Mesic Mixed Hardwood Forest often contains more oaks and American beech (*Fagus grandifolia*) in the canopy or understory than the latter community. The examples in the wildlife area are composed of white oak (*Quercus alba*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), pignut hickory (*Carya glabra*), American beech (*Fagus grandifolia*), tuliptree (*Liriodendron tulipifera*), northern red oak (*Quercus rubra*), black oak (*Quercus velutina*), and loblolly pine (*Pinus taeda*). The understory contains smaller members of the canopy plus American holly (*Ilex opaca*), blackgum (*Nyssa sylvatica*), mockernut hickory (*Carya alba*), and a few chestnut oaks (*Quercus prinus*) in one location. The shrub layer contains multiflora rose (*Rosa multiflora*), mountain laurel (*Kalmia latifolia*), low-bush blueberry (*Vaccinium pallidum*), pinxter flower (*Rhododendron periclymenoides*), and strawberry-bush (*Euonymus americana*). The vine layer contains common greenbrier (*Smilax rotundifolia*), white-leaf greenbrier (*Smilax glauca*), and a few Japanese honeysuckle (*Lonicera japonica*). Not all sites have an herbaceous layer, but when present includes perfoliate bellwort (*Uvularia perfoliata*), pokeweed (*Phytolacca americana*), jack-in-the-pulpit (*Arisaema triphyllum*), mayapple (*Podophyllum peltatum*), and false solomon's seal (*Maianthemum racemosum*).

Figure 5.31. Mid-Atlantic Mesic Mixed Hardwood Forest (Penuel Tract)

The examples at Milford Neck Wildlife Area are generally in mature condition with a small amount that are late successional. Diameters of canopy trees range from 1.5 feet to 2.5 feet for larger trees. Definition between layers is good and exotic invasive plants are few.

Analysis of Condition at Milford Neck Wildlife Area

Most of the acreage from 1937 was still present in 2007 (173 acres vs. 160 acres). The remaining acreage had become 14 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 5 acres of agricultural field, and 0.2 acres each of Freshwater Tidal Mixed High Marsh and cultivated lawn (Table 5.50). Since 1937, Mid-Atlantic Mesic Mixed Hardwood Forest has grown from 44 acres of Early to Mid-Successional Loblolly Pine Forest, 31 acres of Northeastern Old Field, 14 acres of agricultural field, and 2 acres of semi-impervious surface (Table 5.51).

Table 5.50. What was once Mid-Atlantic Mesic Mixed Hardwood Forest in 1937 has become X in 2007	
X	**Acreage**
Mid-Atlantic Mesic Mixed Hardwood Forest	160 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	14 acres
Agricultural Field	5 acres
Freshwater Tidal Mixed High Marsh	0.2 acres
Cultivated Lawn	0.2 acres
Other communities/land covers	0.4 acres

Table 5.51. Mid-Atlantic Mesic Mixed Hardwood Forest has migrated into X since 1937	
X	**Acreage**
Mid-Atlantic Mesic Mixed Hardwood Forest	160 acres
Early to Mid-Successional Loblolly Pine Forest	44 acres
Northeastern Old Field	31 acres
Agricultural Field	14 acres
Semi-impervious Surface	2 acres
Other communities/land covers	2 acres

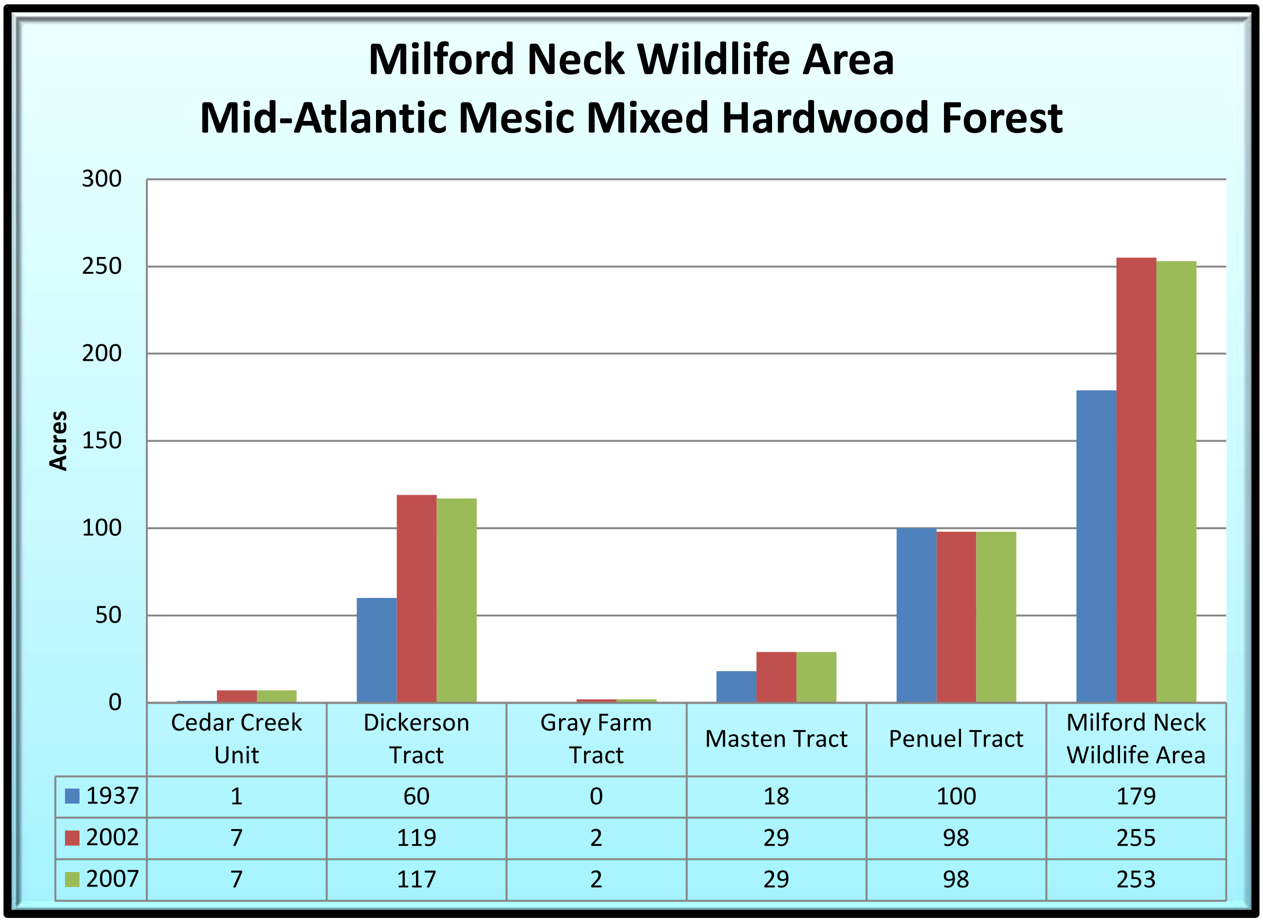


Figure 5.32. Mid-Atlantic Mesic Mixed Hardwood Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.52)

A little less than a third of the current acreage of Mid-Atlantic Mesic Mixed Hardwood Forest would be inundated with 1.5 m of sea level rise.

Table 5.52. Projected acres of Mid-Atlantic Mesic Mixed Hardwood Forest Inundated by Sea Level Rise

Rise	Acres
0.5 m	23 acres
1 m	40 acres
1.5 m	72 acres

Natural Capital (Table 5.53)

Capital of Mid-Atlantic Mesic Mixed Hardwood has increased overall since 1937. Recently some capital was lost due to a loss in acreage.

Table 5.53. Natural Capital of Mid-Atlantic Mesic Mixed Hardwood Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$33,849/year
2002	$48,221/year
2007	$47,842/year

Mid to Late Successional Loblolly Pine-Sweetgum Forest **[19 acres (Figures 5.33-5.34, Tables 5.54-5.56)] GNA SNA**

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

Description

This mid to late successional pine community is characterized by having other associates in the canopy with loblolly pine (*Pinus taeda*) rather than just loblolly pine as in the Early to Mid-Successional Loblolly Pine Forest. The associates include red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*) and a few willow oaks (*Quercus phellos*). The understory is more diverse with likely future canopy species and includes white oak (*Quercus alba*), blackgum (*Nyssa sylvatica*), mockernut hickory (*Carya alba*), wild black cherry (*Prunus serotina*), and American holly (*Ilex opaca*). The shrub and vine layer is composed of poison ivy (*Toxicodendron radicans*), common greenbrier (*Smilax rotundifolia*), Japanese honeysuckle (*Lonicera japonica*), blackhaw viburnum (*Viburnum prunifolium*), multiflora rose (*Rosa multiflora*), and highbush blueberry (*Vaccinium corymbosum*). Common herbs include partridge-berry (*Mitchella repens*), Virginia creeper (*Parthenocissus quinquefolia*), cinnamon fern (*Osmunda cinnamomea*), New York Fern (*Thelypteris novaboracensis*), wild licorice (*Galium circaezans*), ebony spleenwort (*Asplenium platyneuron*), Japanese stiltgrass (*Microstegium vimineum*), common blue violet (*Viola sororia*), enchanter's nightshade (*Circaea lutetiana*), swan's sedge (*Carex swanii*), false solomon's seal (*Maianthemum racemosum*), and mayapple (*Podophyllum peltatum*).

Figure 5.33. Mid to Late Successional Loblolly Pine-Sweetgum Forest

Analysis of Condition at Milford Neck Wildlife Area

Mid to Late Successional Loblolly Pine-Sweetgum Forest was not present in 1937 and has since had a high of 18 acres and currently has 6 acres of which 6 acres grew from agricultural field and 0.1 acres came from Chesapeake Bay Non-riverine Wet Hardwood Forest (Table 5.54).

Table 5.51. Mid to Late Successional Loblolly Pine-Sweetgum Forest has migrated into X since 1937

X	Acreage
Agricultural Field	6 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.1 acres

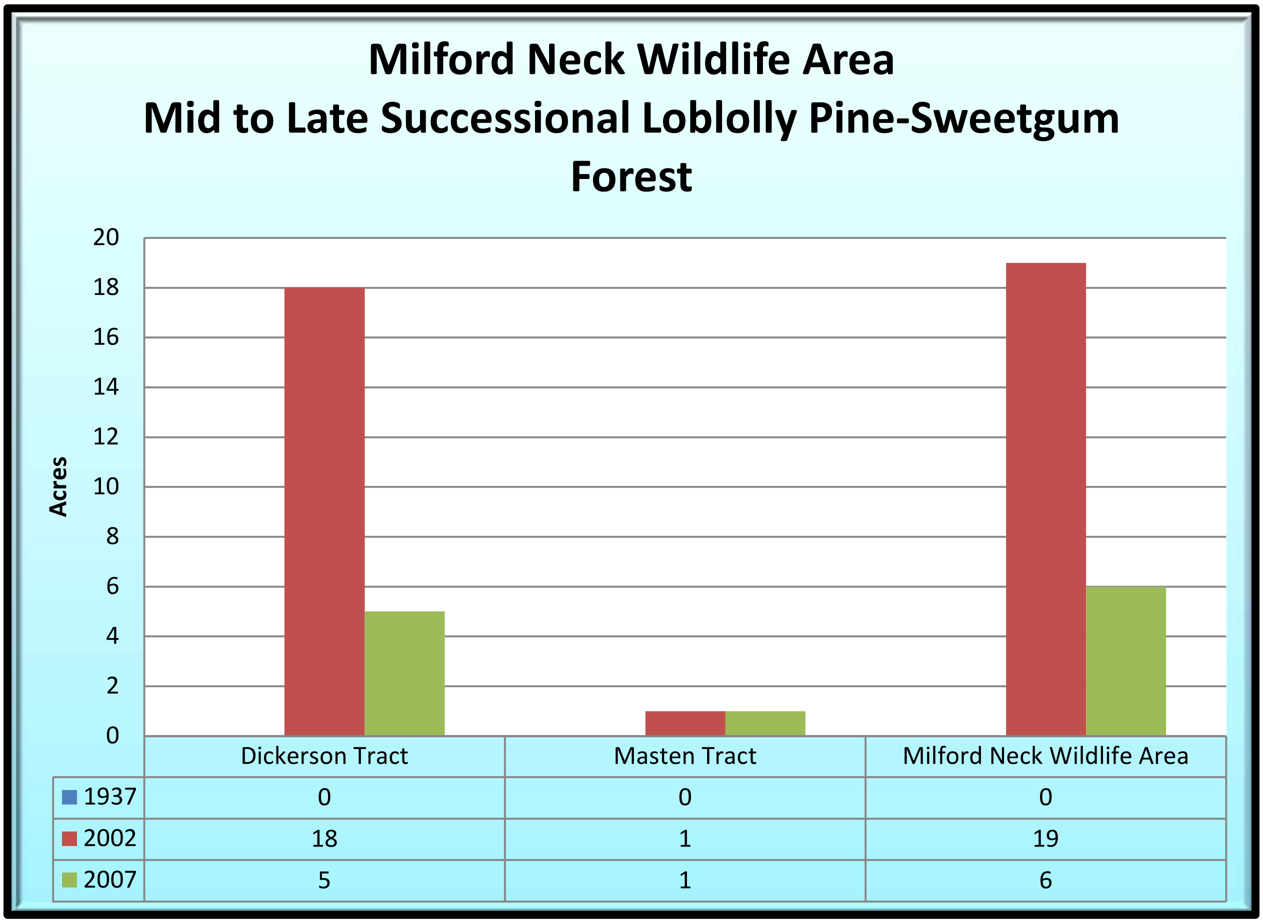


Figure 5.34. Mid to Late Successional Loblolly Pine-Sweetgum Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.55)

Mid to Late Successional Loblolly Pine-Sweetgum Forest will be barely touched with 1.5 m of sea level rise.

Table 5.55. Projected acres of Mid-Atlantic Mesic Mixed Hardwood Forest Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	0 acres
1.5 m	0.1 acres

Natural Capital (Table 5.56)

Capital of Mid to Late Successional Loblolly Pine-Sweetgum Forest has oscillated as this forest matures to other forest communities and other forests mature to it.

Table 5.56. Natural Capital of Mid to Late Successional Loblolly Pine-Sweetgum Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$3,593/year
2007	$1,135/year

***North Atlantic High Salt Marsh* [242 acres (Figures 5.35-5.36 and Tables 5.57-5.60)] G5 S4**

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

Description

This community is located just above the elevation of the North Atlantic Low Salt Marsh where it receives only occasional tidal effects. Salt meadow cordgrass (*Spartina patens*) is the dominant species and is associated sometimes by salt grass (*Distichlis spicata*) and salt marsh fleabane (*Pluchea odorata*).

Analysis of Condition at Milford Neck Wildlife Area

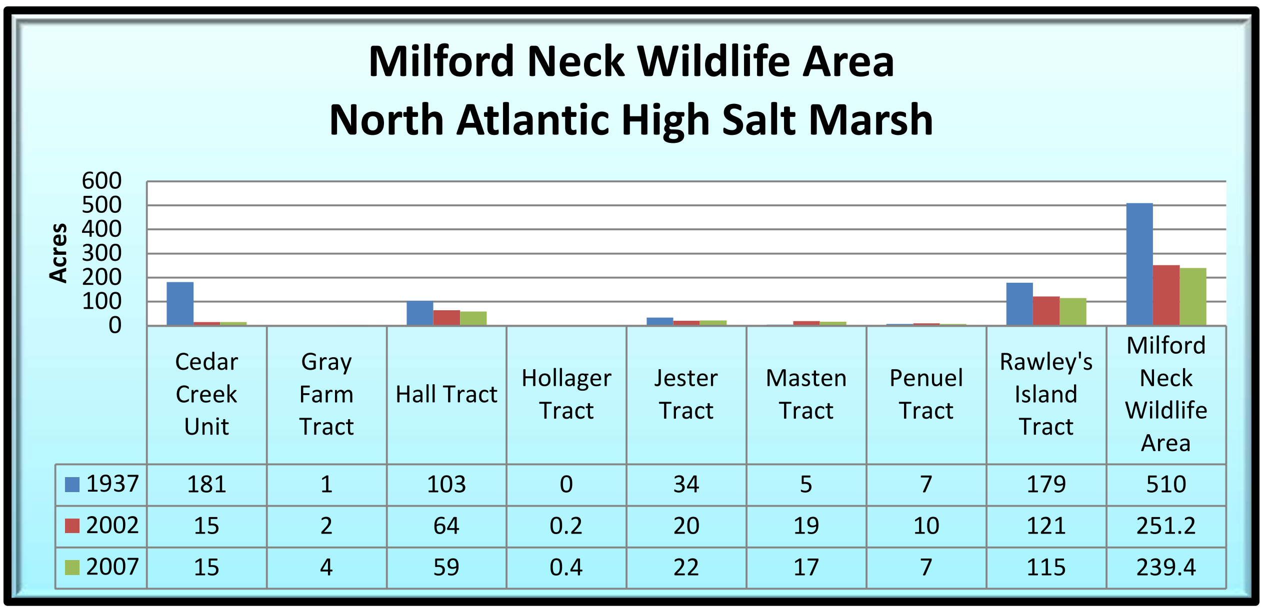
North Atlantic High Salt Marsh has experienced significant declines since 1937, however, it is unknown if the 1937 amounts were artificially high due to salt hay farming. Whatever the cause, the decline continues and the cause is unknown at this point. The prognosis for this community given the declines observed is not good; however the rate of decline in Milford Neck Wildlife Area appears to be slowing (Figure 5.36).

In 2007, only 43 acres of the 510 acres of North Atlantic High Salt Marsh from 1937 was still present. The rest had become 410 acres of North Atlantic Low Salt Marsh, 26 acres of water, 13 acres of Reed Tidal Marsh, and 6 acres of Irregularly Flooded Eastern Tidal Salt Shrub (Table 5.57). Since 1937, North Atlantic High Salt Marsh has converted 86 acres of Northeastern Old Field, 77 acres of North Atlantic Low Salt Marsh, 13 acres of Cattail Brackish Tidal Marsh, and 6 acres of Irregularly Flooded Eastern Tidal Salt Shrub (Table 5.58). Both of these observations show some landward migration of the marsh and cutting into the marsh by water.

Table 5.57. What was once North Atlantic High Salt Marsh in 1937 has become X in 2007

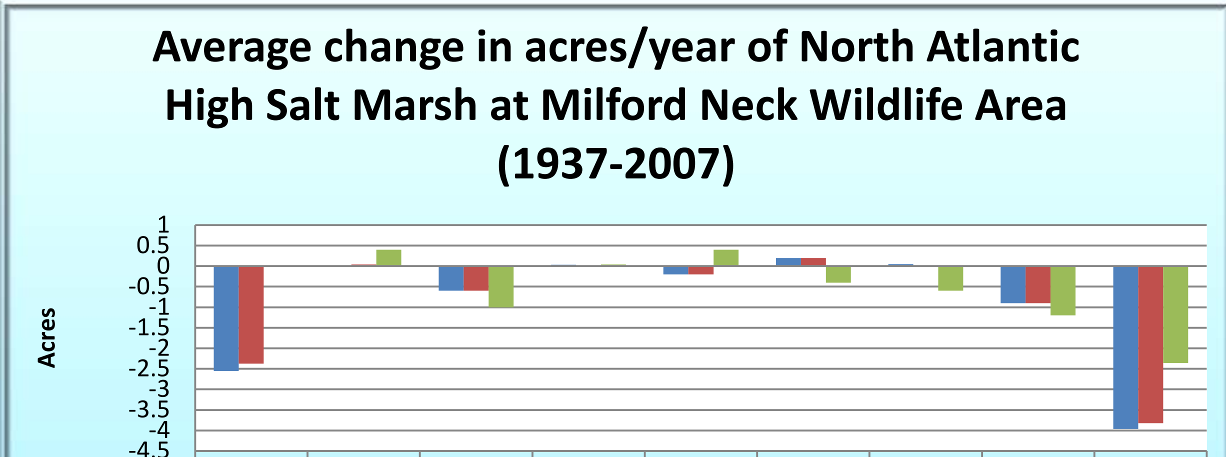
X	Acreage
North Atlantic Low Salt Marsh	410 acres
North Atlantic High Salt Marsh	43 acres
Water	26 acres
Reed Tidal Marsh	13 acres
Irregularly Flooded Eastern Tidal Salt Shrub	6 acres
Other communities/land covers	13 acres

Table 5.58. North Atlantic High Salt Marsh has migrated into X since 1937	
X	**Acreage**
Northeastern Old Field	86 acres
North Atlantic Low Salt Marsh	77 acres
North Atlantic High Salt Marsh	43 acres
Cattail Brackish Tidal Marsh	13 acres
Irregularly Flooded Eastern Tidal Salt Shrub	6 acres
Other communities/land covers	14 acres



	Cedar Creek Unit	Gray Farm Tract	Hall Tract	Hollager Tract	Jester Tract	Masten Tract	Penuel Tract	Rawley's Island Tract	Milford Neck Wildlife Area
1937	181	1	103	0	34	5	7	179	510
2002	15	2	64	0.2	20	19	10	121	251.2
2007	15	4	59	0.4	22	17	7	115	239.4

Figure 5.35. North Atlantic High Salt Marsh at Milford Neck Wildlife Area (1937, 2002, and 2007)



	Cedar Creek Unit	Gray Farm Tract	Hall Tract	Hollager Tract	Jester Tract	Masten Tract	Penuel Tract	Rawley's Island Tract	Milford Neck Wildlife Area
1937-2002	-2.55	0.01	-0.6	0.03	-0.2	0.2	0.05	-0.9	-3.96
1937-2007	-2.37	0.04	-0.6	0.01	-0.2	0.2	0	-0.9	-3.82
2002-2007	0	0.4	-1	0.04	0.4	-0.4	-0.6	-1.2	-2.36

Figure 5.36. Average change in acres/year of North Atlantic High Salt Marsh at Milford Neck Wildlife Area (1937-2007)

DNREC Sea Level Rise Analysis (Table 5.59)

All of the current acreage of North Atlantic High Salt Marsh will be inundated with 0.5 m of sea level rise.

Table 5.59. Projected acres of North Atlantic High Salt Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	239 acres
1 m	239 acres
1.5 m	239 acres

Natural Capital (Table 5.60)

Capital of North Atlantic High Salt Marsh has been decreasing along with its acreage. Most of the losses have been through transfers to North Atlantic Low Salt Marsh.

Table 5.60. Natural Capital of North Atlantic High Salt Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$3,198,363/year
2002	$1,575,351/year
2007	$1,501,349/year

***North Atlantic Low Salt Marsh* [2,014 acres (Figures 5.37-5.38, Tables 5.61-5.64)] G5 S5**

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

<u>Description</u>

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

<u>Analysis of Condition at Milford Neck Wildlife Area</u>

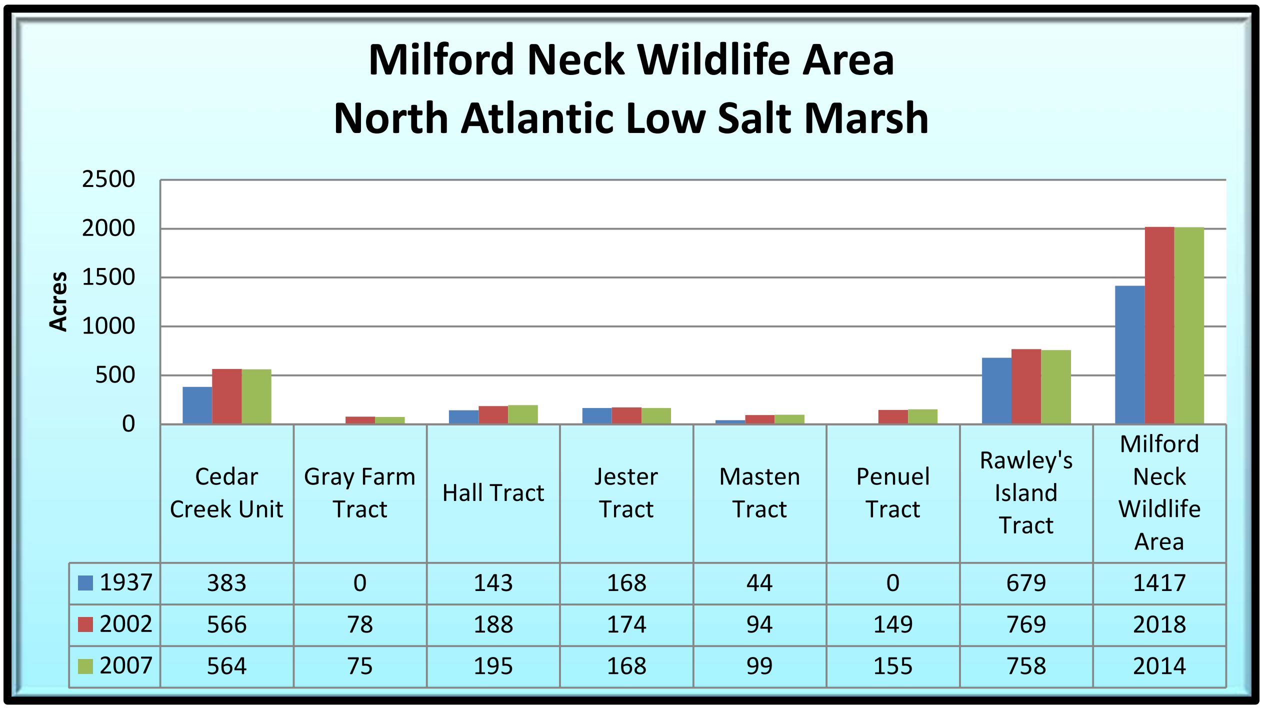
Currently North Atlantic Low Salt Marsh has been increasing in the wildlife area and appears to be keeping pace with sea level rise. Some of the increases though have come at the cost of fresher communities such Freshwater Tidal Mixed High Marsh, Mesohaline Seepage Marsh, and Cattail Brackish Tidal Marsh. These communities are now few in the wildlife area and with increasing rates of sea level rise this community may start to decrease. The short-term prospects appear to be fair to good for the community but the long-term outlook is only fair.

In 2007, 1,066 acres of the 1,417 acres from 1937 of North Atlantic Low Salt Marsh still existed. The remaining acreage had become 157 acres of water, 77 acres of North Atlantic High Salt Marsh, 47 acres of Reed Tidal Marsh, and 23 acres if Irregularly Flooded Eastern Tidal Salt Shrub (Table 5.61). Since 1937, North Atlantic Low Salt Marsh has converted 410 acres of North Atlantic High Salt Marsh, 170 acres of Northeastern Old Field, 155 acres of Cattail Brackish Tidal Marsh, and 60 acres of Mesohaline Seepage Marsh (Table 5.62). All of these observations show the influx of brackish water into the system.

Table 5.61. What was once North Atlantic Low Salt Marsh in 1937 has become X in 2007

X	**Acreage**
North Atlantic Low Salt Marsh	1,067 acres
Water	157 acres
North Atlantic High Salt Marsh	77 acres
Reed Tidal Marsh	47 acres
Irregularly Flooded Eastern Tidal Salt Shrub	23 acres
Other communities/land covers	44 acres

Table 5.62. North Atlantic Low Salt Marsh has migrated into X since 1937	
X	**Acreage**
North Atlantic Low Salt Marsh	1,066 acres
North Atlantic High Salt Marsh	410 acres
Northeastern Old Field	170 acres
Cattail Brackish Tidal Marsh	155 acres
Mesohaline Seepage Marsh	60 acres
Other communities/land covers	151 acres



	Cedar Creek Unit	Gray Farm Tract	Hall Tract	Jester Tract	Masten Tract	Penuel Tract	Rawley's Island Tract	Milford Neck Wildlife Area
1937	383	0	143	168	44	0	679	1417
2002	566	78	188	174	94	149	769	2018
2007	564	75	195	168	99	155	758	2014

Figure 5.37. North Atlantic Low Salt Marsh at Milford Neck Wildlife Area (1937, 2002, and 2007)

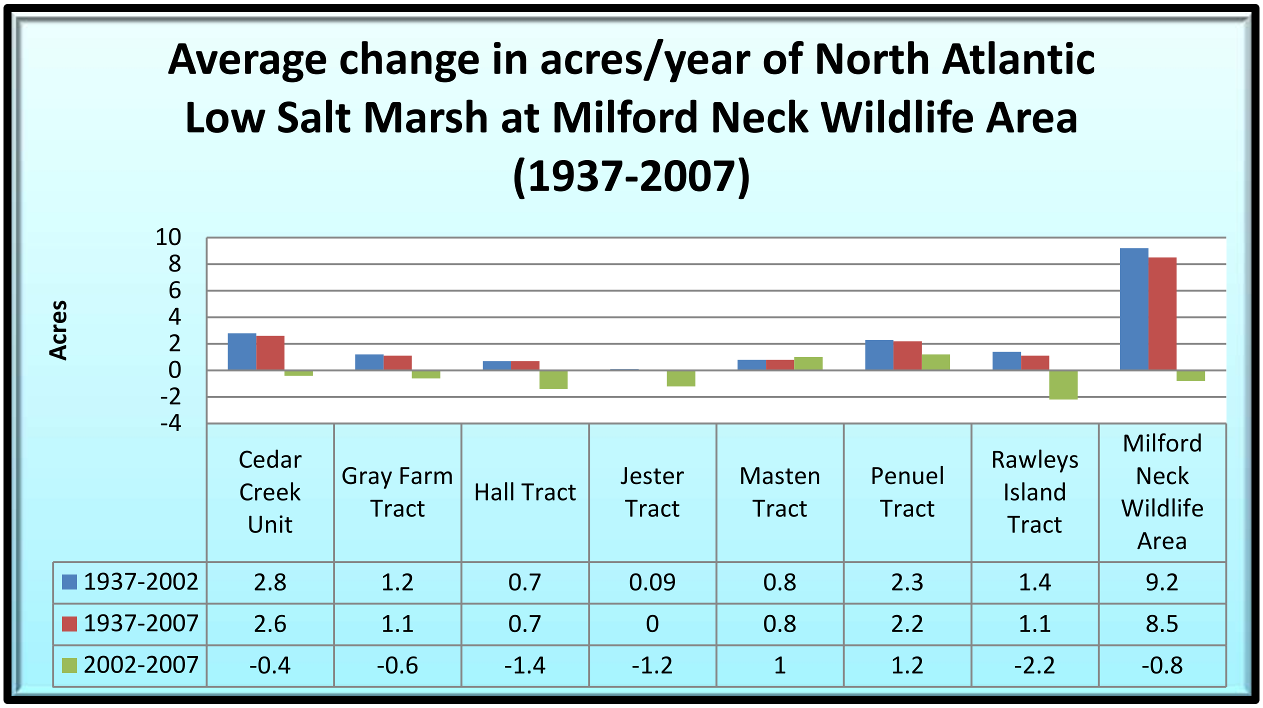


Figure 5.38. Average change in acres/year of North Atlantic Low Salt Marsh at Milford Neck Wildlife Area (1937-2007)

DNREC Sea Level Rise Analysis (Table 5.63)

Essentially all of the current acreage of North Atlantic Low Salt Marsh will be inundated with 0.5 m of sea level rise.

Table 5.63. Projected acres of North Atlantic Low Salt Marsh Inundated by Sea Level Rise

Rise	Acres
0.5 m	2,010 acres
1 m	2,013 acres
1.5 m	2,013 acres

Natural Capital (Table 5.64)

Capital of North Atlantic Low Salt Marsh has increased overall since 1937 with a decrease in the 2002 to 2007 period. It is unknown whether this decrease is short-term or not.

Table 5.64. Natural Capital of North Atlantic Low Salt Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$8,886,432/year
2002	$12,655,483/year
2007	$12,630,398/year

***Northeastern Dry Oak-Hickory Forest* [8 acres (Figures 5.39-5.40, Tables 5.65-5.66)] G4G5 S1**

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

<u>*Description*</u>

A late successional to mature Northeastern Dry-Oak Hickory forest occurs in one location on the Coverdale tract. Pignut hickory (*Carya glabra*) is present in large amount and associated by southern red oak (*Quercus falcata*), northern red oak (*Quercus rubra*), white oak (*Quercus alba*), tuliptree (*Liriodendron tulipifera*), and a few black walnut (*Juglans nigra*). The understory is composed of smaller members of the canopy plus wild black cherry (*Prunus serotina*), American holly (*Ilex opaca*), flowering dogwood (*Cornus florida*), water oak (*Quercus nigra*), red maple (*Acer rubrum*), and American beech (*Fagus grandifolia*). Common greenbrier (*Smilax rotundifolia*), blackberry (*Rubus* sp.), Japanese honeysuckle (*Lonicera japonica*), wisteria (*Wisteria sinensis*), and low-bush blueberry (*Vaccinium pallidum*) compose the shrub and vine layer. Herbs present include ebony spleenwort (*Asplenium platyneuron*), common blue violet (*Viola sororia*), Virginia creeper (*Parthenocissus quinquefolia*), swan's sedge (*Carex swanii*), wood sorrel (*Oxalis stricta*), cinquefoil (*Potentilla canadensis*), wild licorice (*Galium circaezans*), Japanese stiltgrass (*Microstegium vimineum*), and pokeweed (*Phytolacca americana*).

Figure 5.39. Northeastern Dry Oak-Hickory Forest (Penuel Tract)

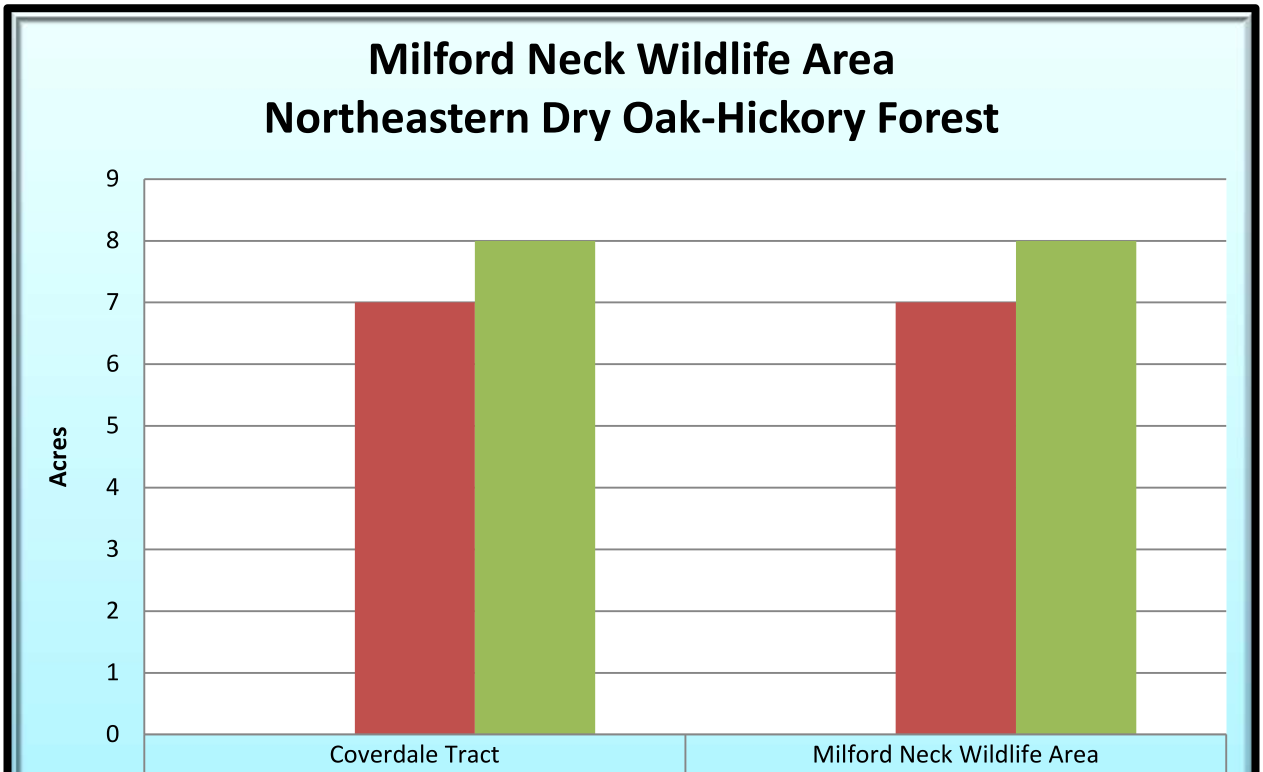
The one example of this community in the Coverdale Tract appears to be late successional with diameters of canopy trees ranging from 1 foot to 1.5 feet and a somewhat thick understory.

<u>*Analysis of Condition at Milford Neck Wildlife Area*</u>

Only one example of this community is located in the wildlife area which puts this community at risk. Japanese stiltgrass and wisteria are both present in the occurrence and threaten to wipe out the unique for the area, herbaceous layer. The canopy should remain intact though and at least in the short-term the success of this community is promising.

Northeastern Dry Oak-Hickory Forest was not present in 1937 and has since grown into 3 acres of clear-cut, 3 acres of Early to Mid-Successional Loblolly Pine Forest, and 2 acres of agricultural field (Table 5.65).

Table 5.65. Northeastern Dry Oak-Hickory Forest has migrated into X since 1937	
X	**Acreage**
Clear-cut	3 acres
Early to Mid-Successional Loblolly Pine Forest	3 acres
Agricultural Field	2 acres



	Coverdale Tract	Milford Neck Wildlife Area
1937	0	0
2002	7	7
2007	8	8

Figure 5.40. Northeastern Dry Oak-Hickory Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis

Northeastern Dry Oak-Hickory Forest is located on the Coverdale Tract and is not affected by 1.5 m of sea level rise.

Natural Capital (Table 5.66)

Capital of Northeastern Dry Oak-Hickory Forest has gradually increased through the study period.

Table 5.66. Natural Capital of Northeastern Dry Oak-Hickory Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$1,324/year
2007	$1,513/year

Northeastern Modified Successional Forest **[34 acres (Figures 5.41-5.42, Tables 5.67-5.69)] GNA SNA**

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

Description

This community, which was not present in 1937, is located in a little more than half of the tracts of the wildlife area. It is of scattered distribution in places of disturbance. The canopy compositions and maturity varies with the location, amount of disturbance, and the successional origin of the forest. Canopy species can include sweetgum (*Liquidambar styraciflua*), black walnut (*Juglans nigra*), red maple (*Acer rubrum*), willow oak (*Quercus phellos*), wild black cherry (*Prunus serotina*), quaking aspen (*Populus tremuloides*), blackgum (*Nyssa sylvatica*), and loblolly pine (*Pinus taeda*). Understories are composed of a mixture of the canopy associates. The shrub and vine layers of these communities are typically thick with exotic and native aggressive species, a distinguishing characteristic of the community. Species here can include thick areas of multiflora rose (*Rosa multiflora*), Japanese honeysuckle (*Lonicera japonica*), common greenbrier (*Smilax rotundifolia*), summer grape (*Vitis aestivalis*), arrow-wood (*Viburnum dentatum*), and in case a few elderberry (*Sambucus canadensis*). Herb compositions can range from sparse due to a thick canopy or diverse due to availability of nutrients. Species can include Japanese stiltgrass (*Microstegium vimineum*), spikerush (*Juncus effusus*), deer-tongue grass (*Dichanthelium clandestinum*), Virginia creeper (*Parthenocissus quinquefolia*), lady's thumb smartweed (*Polygonum persicaria*), Cinnamon fern (*Osmunda cinnamomea*), sensitive fern (*Onoclea sensibilis*), pokeweed (*Phytolacca americana*), enchanter's nightshade (*Circaea lutetiana*), jack-in-the-pulpit (*Arisaema triphyllum*), and crown vetch (*Coronilla varia*).

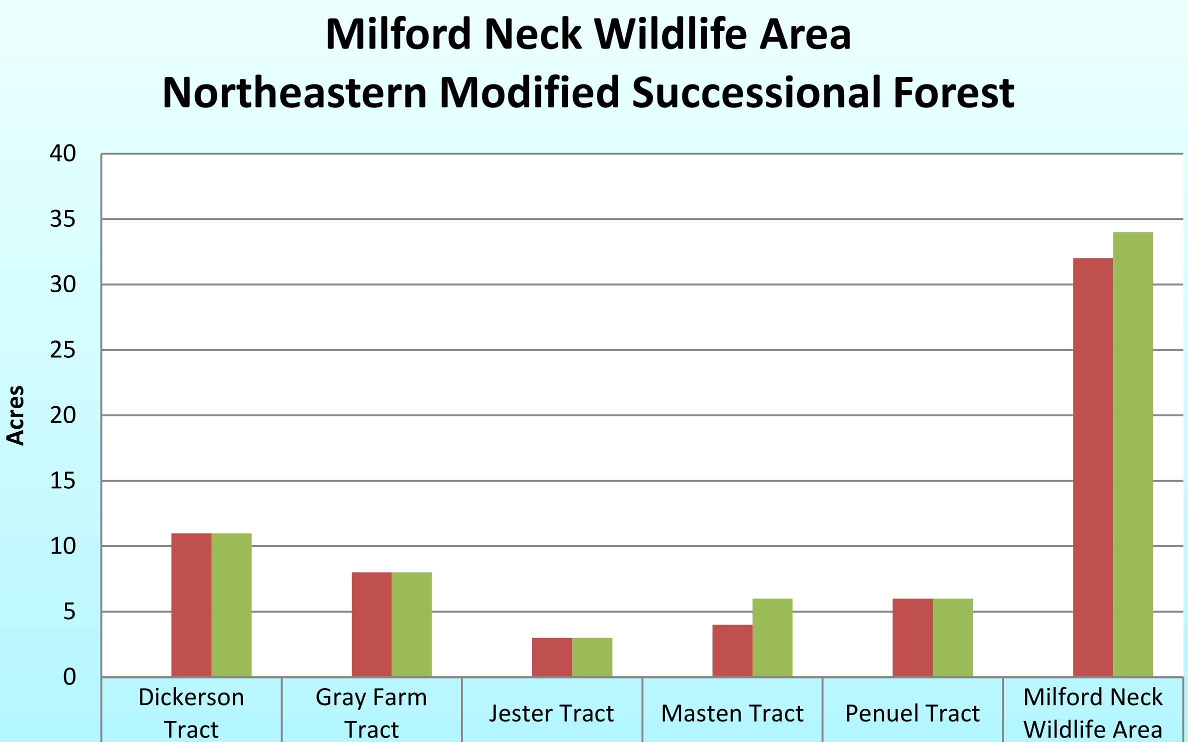
Figure 5.41. Northeastern Modified Successional Forest (Jester Tract)

Analysis of Condition at Milford Neck Wildlife Area

These communities often arise from disturbance or in places where there is a high availability of nutrients. Efforts to remove the invasive species present may restore these communities to a more natural state to in some cases Mid-Atlantic Mesic Mixed Hardwood Forest, Successional Tuliptree Forest, and Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest. These communities have increased in the 2002 to 2007, but without more data it is unknown if this is an upward trend.

Northeastern Modified Successional Forest was not present in 1937 and has since grown into 24 acres of agricultural field, invaded 4 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, grown from 2 acres of Northeastern Successional Shrubland and 1 acre each of Northeastern Old Field and Successional Maritime Forest (Table 5.67).

Table 5.65. Northeastern Modified Successional Forest has migrated into X since 1937	
X	**Acreage**
Agricultural Field	24 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	4 acres
Northeastern Successional Shrubland	2 acres
Northeastern Old Field	1 acre
Successional Maritime Forest	1 acre
Other communities/land covers	1 acre



	Dickerson Tract	Gray Farm Tract	Jester Tract	Masten Tract	Penuel Tract	Milford Neck Wildlife Area
1937	0	0	0	0	0	0
2002	11	8	3	4	6	32
2007	11	8	3	6	6	34

Figure 5.42. Northeastern Modified Successional Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.68)

About a third of the current acreage of Northeastern Modified Successional Forest will be inundated with 1.5 m of sea level rise.

Table 5.68. Projected acres of Northeastern Modified Successional Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	6 acres
1 m	9 acres
1.5 m	13 acres

Natural Capital (Table 5.69)

Capital of Northeastern Modified Successional Forest has been increasing as more successional communities grow to this community and as exotic invasive species invade other intact forests.

Table 5.69. Natural Capital of Northeastern Modified Successional Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$6,051/year
2007	$6,429/year

***Northeastern Old Field* [83 acres (Figures 5.43-5.44, Tables 5.70-5.74)] GNR S5**

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

Description

Figure 5.43. Northeastern Old Field (Masten Tract)

This community is often includes wildlife fields or recently abandoned agricultural fields. Tall fescue (*Festuca arundinacea*) is often the dominant species and is associated by Japanese honeysuckle (*Lonicera japonica*), poison ivy (*Toxicodendron radicans*), milkweed (*Asclepias* sp.), autumn olive (*Elaeagnus umbellata*), and foxtail barley (*Hordeum jubatum*).

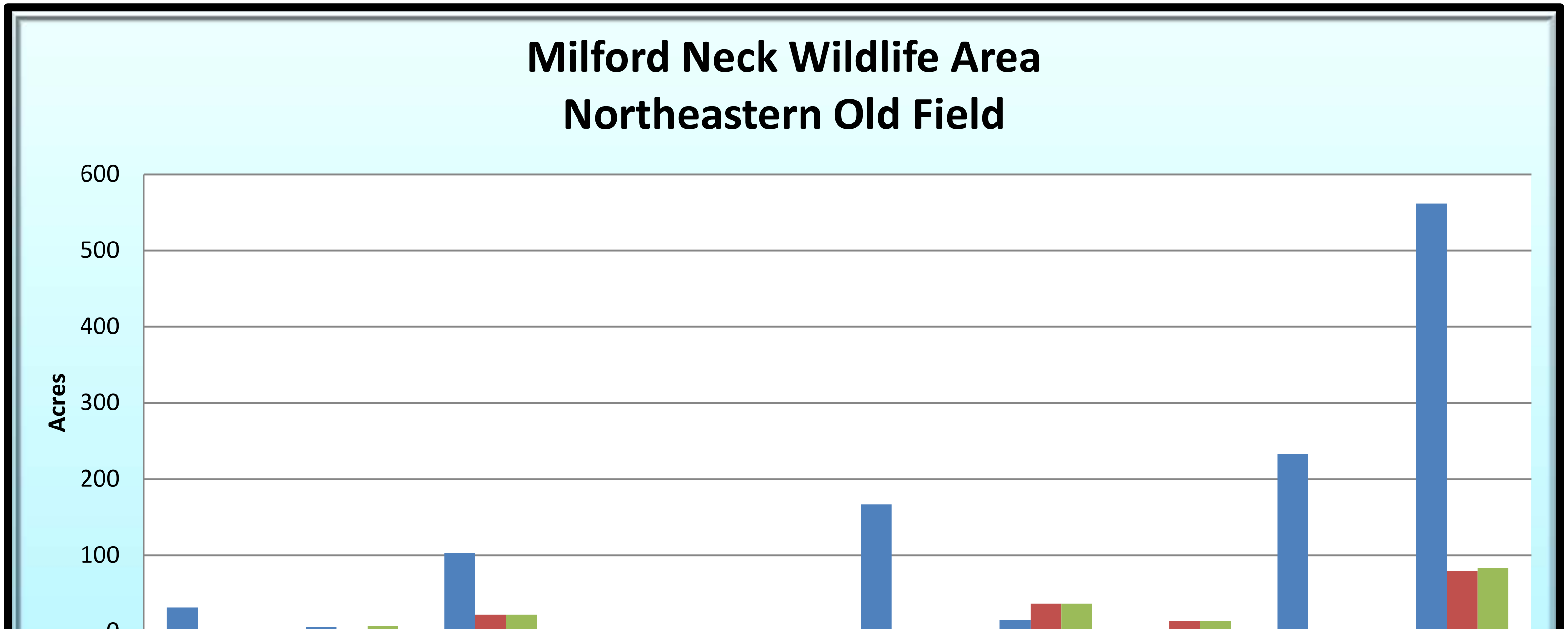
Analysis of Condition at Milford Neck Wildlife Area

This once prominent community in the wildlife area is being maintained for wildlife habitat as wildlife food plots. It will likely remain in the wildlife area for some time into the future as part of the wildlife focus of the wildlife area.

In 2007, about 5 acres of the 561 acres of Northeastern Old Field from 1937 was still present. The rest of the acreage had become 170 acres of North Atlantic Low Salt Marsh, 109 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 86 acres of North Atlantic High Salt Marsh, 51 acres of Coastal Loblolly Pine Wetland Forest, and 31 acres of Mid-Atlantic Mesic Mixed Hardwood Forest (Table 5.70). Since 1937, Northeastern Old Field has decreased in acreage but has still grown into 77 acres of agricultural field, 0.5 acre of Semi-impervious Surface, 0.3 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, and 0.2 acres of Impervious Surface (Table 5.71).

Table 5.61. What was once Northeastern Old Field in 1937 has become X in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	170 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	109 acres
North Atlantic High Salt Marsh	86 acres
Coastal Loblolly Pine Wetland Forest	51 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	31 acres
Other communities/land covers	113 acres

Table 5.62. Northeastern Old Field has migrated into X since 1937	
X	**Acreage**
Agricultural Field	77 acres
Northeastern Old Field	5 acres
Semi-impervious Surface	0.5 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.3 acres
Impervious Surface	0.2 acres
Other communities/land covers	0.3 acres



	Cedar Creek Unit	Coverdale Tract	Dickerson Tract	Gray Farm Tract	Hall Tract	Jester Tract	Masten Tract	Penuel Tract	Rawley's Island Tract	Milford Neck Wildlife Area
1937	32	6	103	2	2	167	15	0.2	233	561.2
2002	0	4	22	0.4	0	2	37	14	0	79.4
2007	0	8	22	0.4	0	2	37	14	0	83.4

Figure 5.44. Northeastern Old Field at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.73)

About 23 acres of Northeastern Old Field will be affected by 1.5 m of sea level rise.

Table 5.73. Projected acres of Northeastern Old Field Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	3 acres
1 m	11 acres
1.5 m	23 acres

Natural Capital (Table 5.74)

Capital of Northeastern Old Field has fallen from its high in 1937, but has recently rebounded somewhat between 2002 and 2007.

Table 5.74. Natural Capital of Northeastern Old Field	
Year	**Natural Capital (in 2012 dollars)**
1937	$81,767/year
2002	$11,569/year
2007	$12,151/year

Northeastern Successional Shrubland **[28 acres (Figures 5.45-5.46, Tables 5.75-5.78)] GNA SNA**

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

Description

This community is located primarily in the Masten tract though it once covered a good part of the Dickerson tract as well. It is present a lot as hedgerows between wildlife and agricultural fields. Wild black cherry (*Prunus serotina*) dominates the canopy if present, otherwise a shrub layer of autumn olive (*Elaeagnus umbellata*), multiflora rose (*Rosa multiflora*), tree-of-heaven (*Ailanthus altissima*), smooth sumac (*Rhus glabra*), summer grape (*Vitis aestivalis*), and blackberry (*Rubus* sp.) is present. Few herbs are present in these communities due to the thickness of the shrub canopies. Some of the few noted include pokeweed (*Phytolacca americana*) and Japanese honeysuckle (*Lonicera japonica*).

Figure 5.45. Northeastern Successional Shrubland (Jester Tract)

Analysis of Condition at Milford Neck Wildlife Area

This community is often present wherever there is disturbance or a hedgerow. If not composed heavily of exotic invasive species it will often succeed to a forested community. However, if a lot of invasive species as present it will likely perpetuate itself or succeed into a Northern Modified Successional Forest. This community is currently in decline as it succeeds into forested communities. Some will likely be around in the future as more agricultural land succeeds to forest.

Showing the successional nature of this community, only 1 acre of 32 acres from 1937 was still present in 2007. The rest of the acreage had become 12 acres of Coastal Loblolly Pine Wetland Forest, 12 acres of Successional Tuliptree-Loblolly Pine Upland Forest, 3 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, and 2 acres of Northeastern Modified Successional Forest (Table 5.75). Since 1937, this community has lost acreage but it still grew into 26 acres of agricultural field and 1 acre of Northeastern Old Field (Table 5.76).

Table 5.75. What was once Northeastern Successional Shrubland in 1937 has become X in 2007	
X	**Acreage**
Coastal Loblolly Pine Wetland Forest	12 acres
Successional Tuliptree-Loblolly Pine Upland Forest	12 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	3 acres
Northeastern Modified Successional Forest	2 acres
Northeastern Successional Shrubland	1 acre
Other communities/land covers	2 acres

Table 5.76. Northeastern Successional Shrubland has migrated into X since 1937	
X	**Acreage**
Agricultural Field	26 acres
Northeastern Successional Shrubland	1 acre
Northeastern Old Field	1 acre

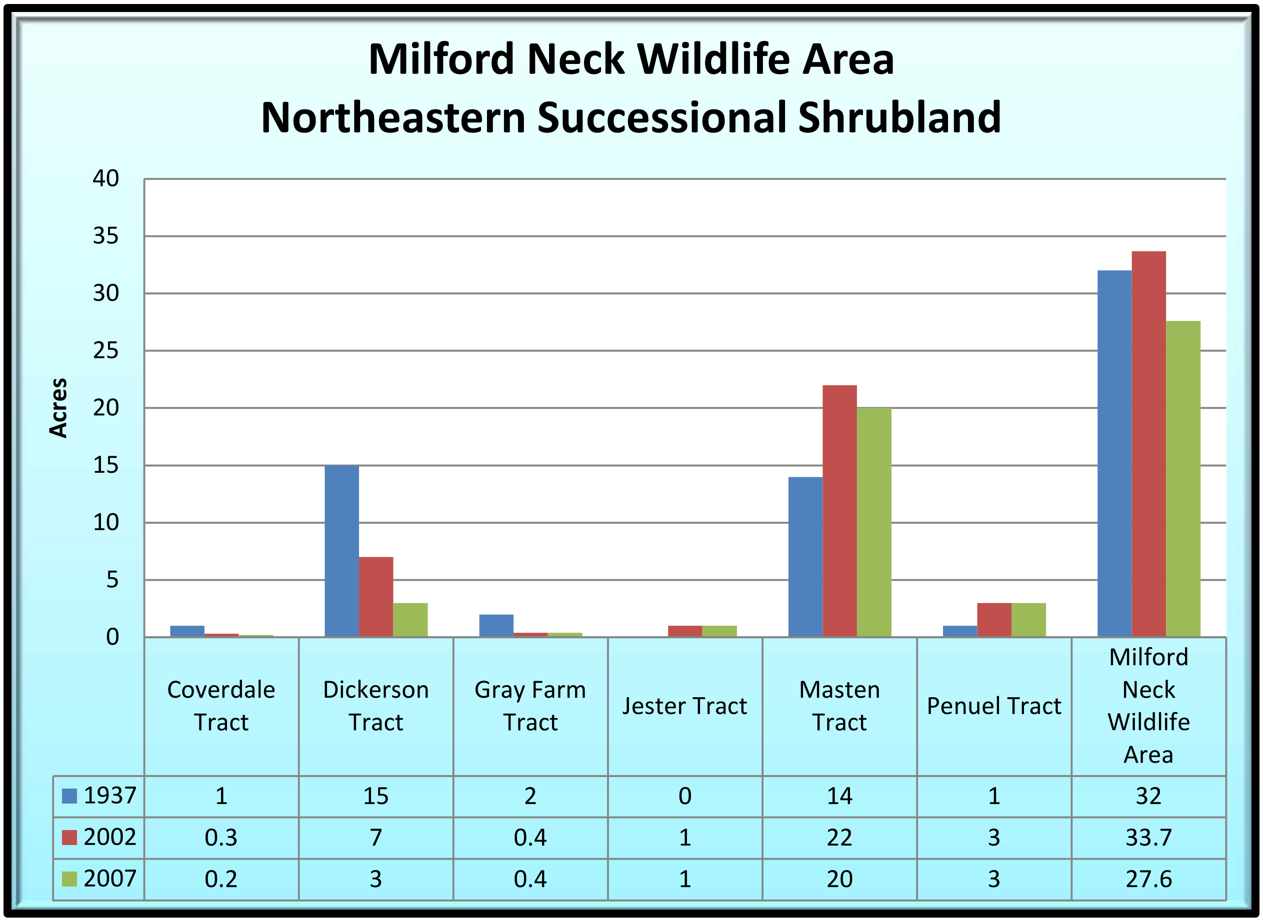


Figure 5.46. Northeastern Successional Shrubland at Milford Wildlife Neck Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.73)

About 40% of the current acreage of Northeastern Successional Shrubland will be inundated with 1.5 m of sea level rise in Milford Neck Wildlife Area.

Table 5.77. Projected acres of Northeastern Successional Shrubland Inundated by Sea Level Rise

Rise	Acres
0.5 m	4 acres
1 m	7 acres
1.5 m	11 acres

Natural Capital (Table 5.78)

Overall Northeastern Successional Shrubland has declined in capital since 1937. However, the decline has been slight and it was actually higher in 2002 than in 1937.

Table 5.78. Natural Capital of Northeastern Successional Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$4,662/year
2002	$4,910/year
2007	$4,021/year

Northern Coastal Plain/Piedmont Basic Mesic Forest **[7 acres (Figures 5.47-5.48, Tables 5.79-5.80)]**
G4? S2

DEWAP: Coastal Plain Upland Forest
NHC: Northern Atlantic Coastal Plain Calcareous Ravine

Description

This community type is known to have the richest herb layers in Delaware along with the Successional Tuliptree Forest, which is a more successional version of this community. It is found in places where the soil is circumneutral or above in pH providing an abundance of nutrients. In some locations this community is thought to occupy former marl banks, reefs, and shell middens.

The location on the Penuel tract is in very mature condition. Tuliptree (*Liriodendron tulipifera*) and white oak (*Quercus alba*) co-dominate the canopy associated by a few southern red oaks (*Quercus falcata*). The understory is diverse with mockernut hickory (*Carya alba*), American holly (*Ilex opaca*), wild black cherry (*Prunus serotina*), flowering dogwood (*Cornus florida*), and a few red maple (*Acer rubrum*), American beech (*Fagus grandifolia*), spicebush (*Lindera benzoin*), and eastern red cedar (*Juniperus virginiana*) in some of the canopy openings where there is abundant light. The shrub is not as diverse and is composed of blackberry (*Rubus* sp.), autumn olive (*Elaeagnus umbellata*), summer grape (*Vitis aestivalis*), and poison ivy (*Toxicodendron radicans*). The herbaceous layer is diverse with some of the more common species being enchanter's nightshade (*Circaea lutetiana*), Virginia creeper (*Parthenocissus quinquefolia*), jack-in-the-pulpit (*Arisaema triphyllum*), Swan's sedge (*Carex swanii*), thicket sedge (*C. abscondita*), Christmas fern (*Polystichum acrostichoides*), golden ragwort (*Senecio aureus*), and deer-tongue grass (*Dichanthelium clandestinum*).

The one example of this community in the Penuel Tract has been here at least since 1937 and is in mature condition. It has some of the largest trees in the wildlife area with diameters of canopy trees ranging from 1.5 feet up to 3.5 feet with some tuliptree. Layering definition is good and exotic invasive plants are present but are not disruptive.

Figure 5.47. Northern Coastal Plain/Piedmont Basic Mesic Forest (Penuel Tract)

Analysis of Condition at Milford Neck Wildlife Area

This community has been roughly stable in coverage over time with a slight increase in area as maturation of the surrounding forest to this community has occurred. Absent human disturbance and higher elevation of the community, it is expected that this forest will continue for some time into the future. Because of the stability and lack of change an analysis was not conducted.

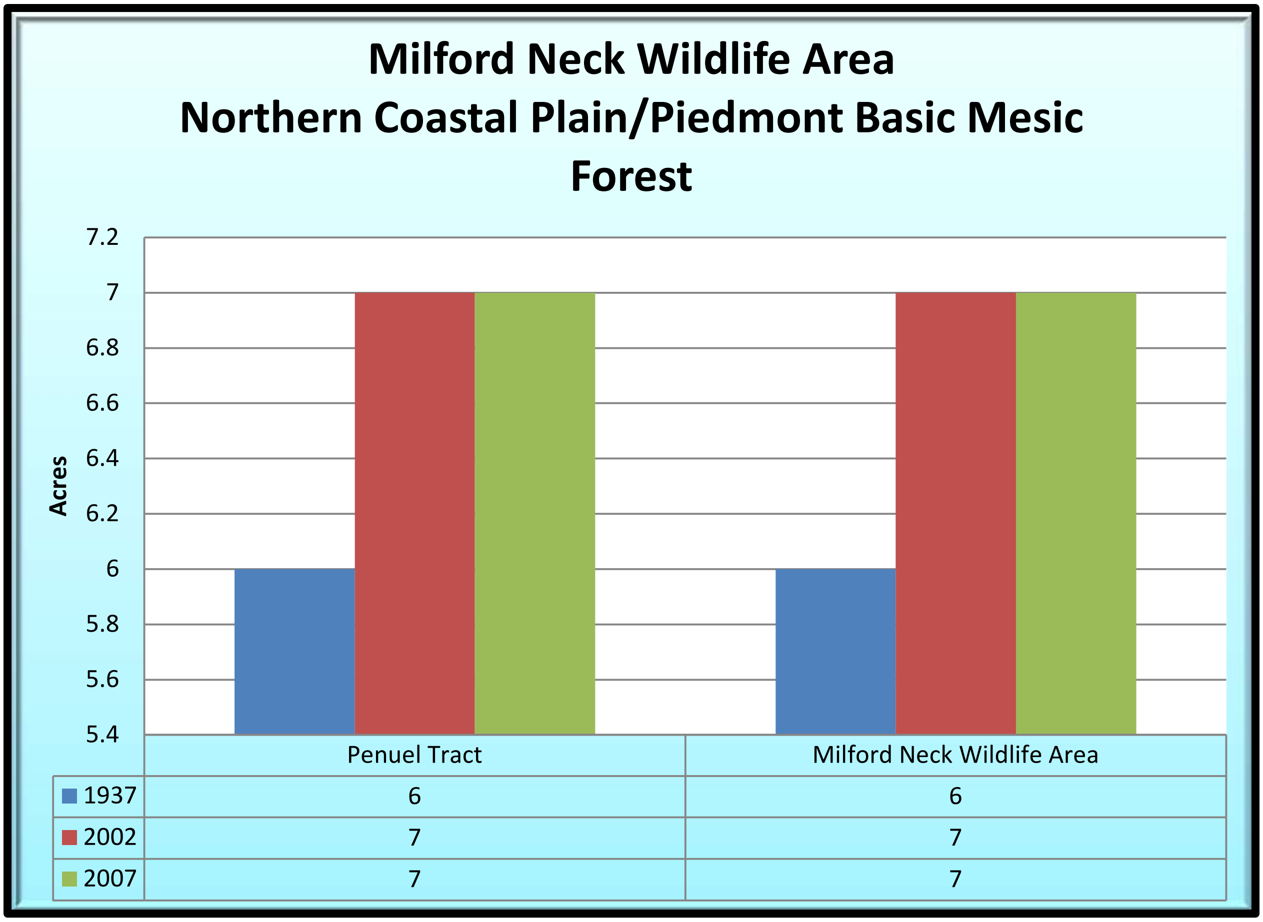


Figure 5.48. Northern Coastal Plain/Piedmont Basic Mesic Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.79)

Most of this community is located in a place of higher elevation. At 1.5 m of sea level rise, about 2 acres will be impacted.

Table 5.79. Projected acres of Northern Coastal Plain/Piedmont Basic Mesic Forest Inundated by Sea Level Rise

Rise	Acres
0.5 m	0.2 acres
1 m	0.5 acres
1.5 m	2 acres

Natural Capital (Table 5.80)

Capital of Northern Coastal Plain/Piedmont Basic Mesic Forest has increased slightly since 1937. It will likely stay stable into the near future.

Table 5.80. Natural Capital of Northern Coastal Plain/Piedmont Basic Mesic Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,135/year
2002	$1,324/year
2007	$1,324/year

***Overwash Dune Grassland* [3 acres (Figure 5.49, Tables 5.81-5.83)]   G2G3   S2S3?**

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

Description

This herbaceous community is located in places where dunes have been overrun by storm tides. This community was determined through aerial imagery so an exact species list cannot be given. Typically salt meadow cordgrass (*Spartina patens*) and/or olney's three square bulrush (*Schoenoplectus pungens*) are dominant in this community. Other associates may include seaside goldenrod (*Solidago sempervirens*), dune sandbur (*Cenchrus tribuloides*), bristly foxtail (*Setaria parviflora*), and seashore saltgrass (*Distichlis spicata*).

Analysis of Condition at Milford Neck Wildlife Area

Overwash Dune Grassland was not present in 1937 and has since covered 1 acre each of North Atlantic Low Salt Marsh and North Atlantic High Salt Marsh (Table 5.81).

Table 5.81. Overwash Dune Grassland has migrated into X since 1937	
X	**Acreage**
North Atlantic Low Salt Marsh	1 acre
North Atlantic High Salt Marsh	1 acre

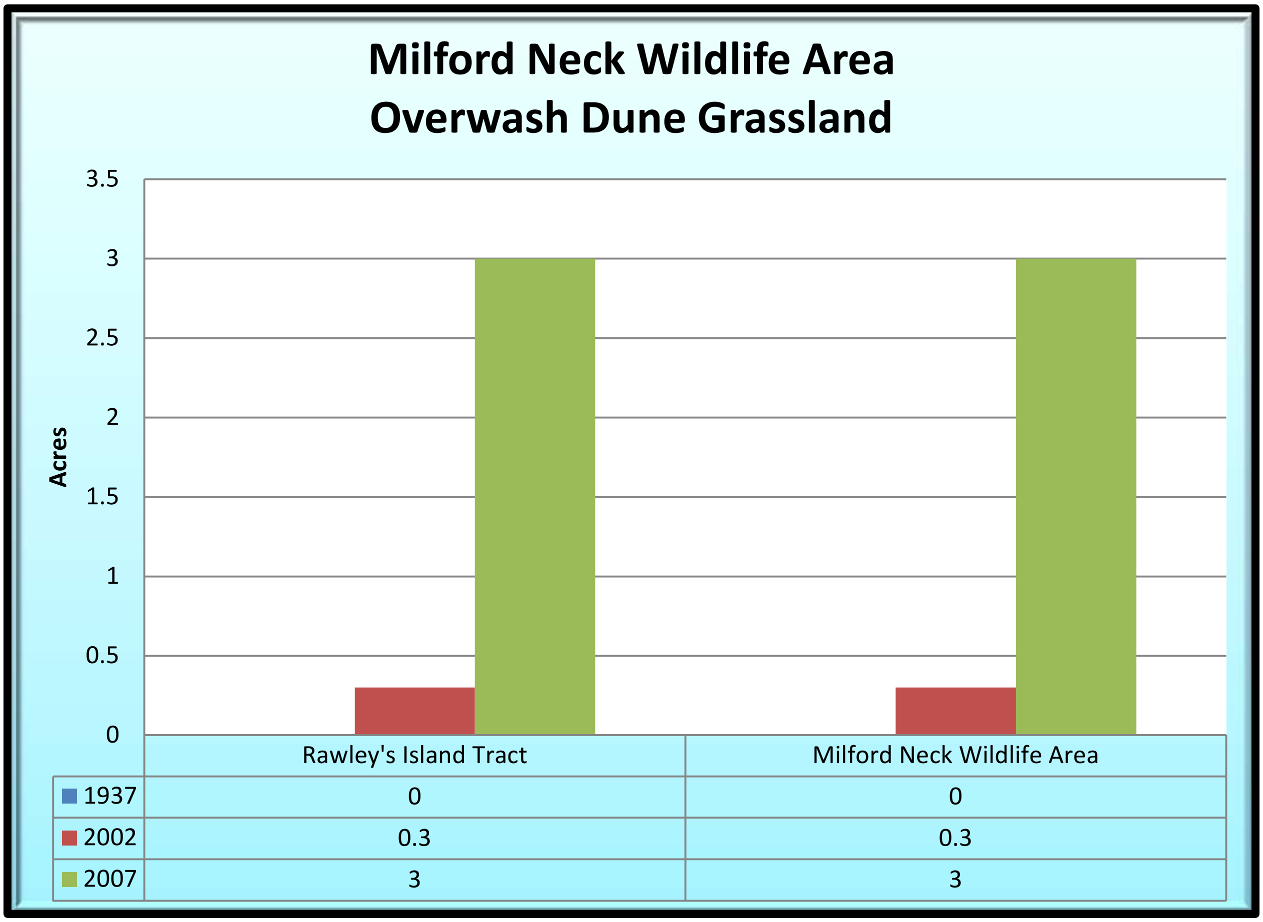


Figure 5.49. Overwash Dune Grassland at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.82)

All of the current acreage of Overwash Dune Grassland will be inundated with 0.5 m of sea level rise.

Table 5.82. Projected acres of Overwash Dune Grassland Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	3 acres
1 m	3 acres
1.5 m	3 acres

Natural Capital (Table 5.83)

Capital of Overwash Dune Grassland has been increasing with its acreage.

Table 5.83. Natural Capital of Overwash Dune Grassland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$44/year
2007	$437/year

***Pickerelweed Tidal Marsh* [5 acres (Figures 5.50-5.53, Tables 5.84-5.87)] G3G4 S4**

DEWAP: Tidal Low Marshes
NHC: Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh

Description

Figure 5.50. Pickerelweed Tidal Marsh (Penuel Tract)

This tidal freshwater marsh can occur concurrently with the Atlantic Coast Wild Rice Tidal Marsh, depending on the season. Since the marsh in this case was a distance away in the water, direct inspection was not possible. The list below is general to the type in Delaware. This marsh is best seen in the spring and is dominated by arrow-arum (*Peltandra virginica*), and pickerelweed (*Pontederia cordata*). Other associates include broadleaf arrowhead (*Sagittaria latifolia*), mild water pepper (*Polygonum hydropiperoides*), and later in the year wild rice (*Zizania aquatica*).

Analysis of Condition at Milford Neck Wildlife Area

This freshwater marsh type has grown to 2002 from its 1937 level and then declined from 2002 to 2007. Research conducted after Hurricane Katrina in Louisiana showed that freshwater marshes have a harder time recovering after storm surge events or sea level rise39. Another study on the Chesapeake Bay has shown that freshwater tidal marshes are converting to brackish marshes40. With increased sea level rise this community may face diminishing prospects in the long term as it hits up against the adjoining forest.

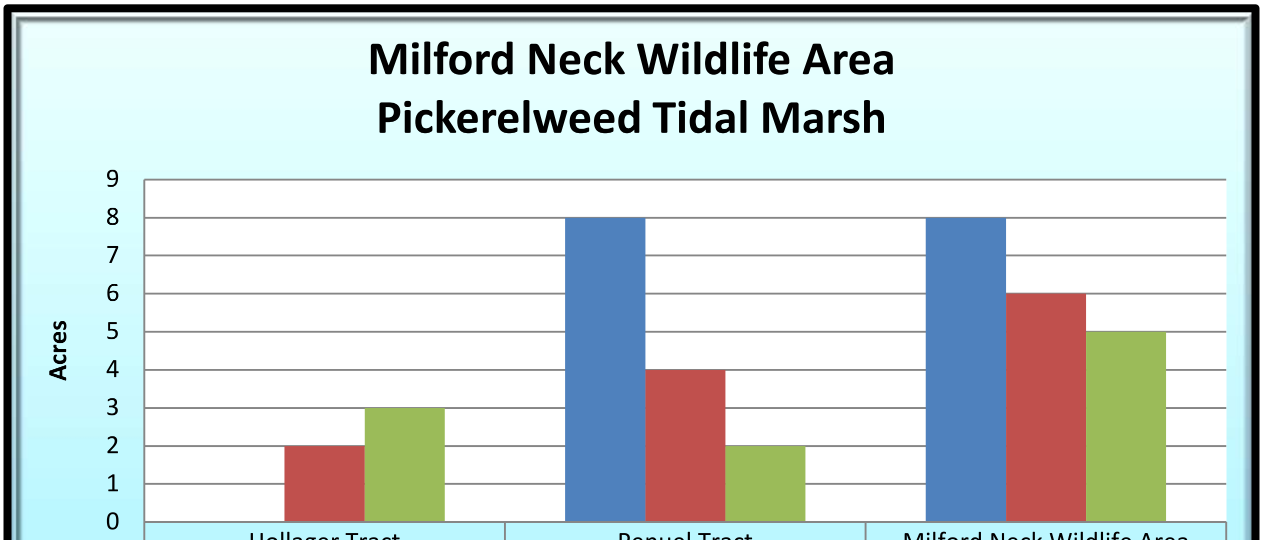
In 2007, virtually none of the 8 acres of Pickerelweed Tidal Marsh from 1937 still existed. The acreage that was once this marsh had become 5 acres of water, 1 acre of impoundment, 1 acre of Reed Tidal Marsh, 1 acre of Cattail Brackish Tidal Mars, and 0.2 acres of Mid-Atlantic Mesic Mixed Hardwood Forest (Table 5.84). Since 1937, this community has converted 2 acres each of Coastal Plain Oak Floodplain Swamp and Freshwater Tidal Mixed High Marsh and 1 acre of Cattail Brackish Tidal Marsh (Table 5.85).

39 Middleton, Beth A. 2009. Regeneration of coastal marsh vegetation impacted by hurricanes Katrina and Rita. Wetlands 29(1): 54-65.

40 Perry, James E. and Carl H. Hershner. 1999. Temporal changes in the vegetation pattern in a tidal freshwater marsh. Wetands 19(1): 90-99.

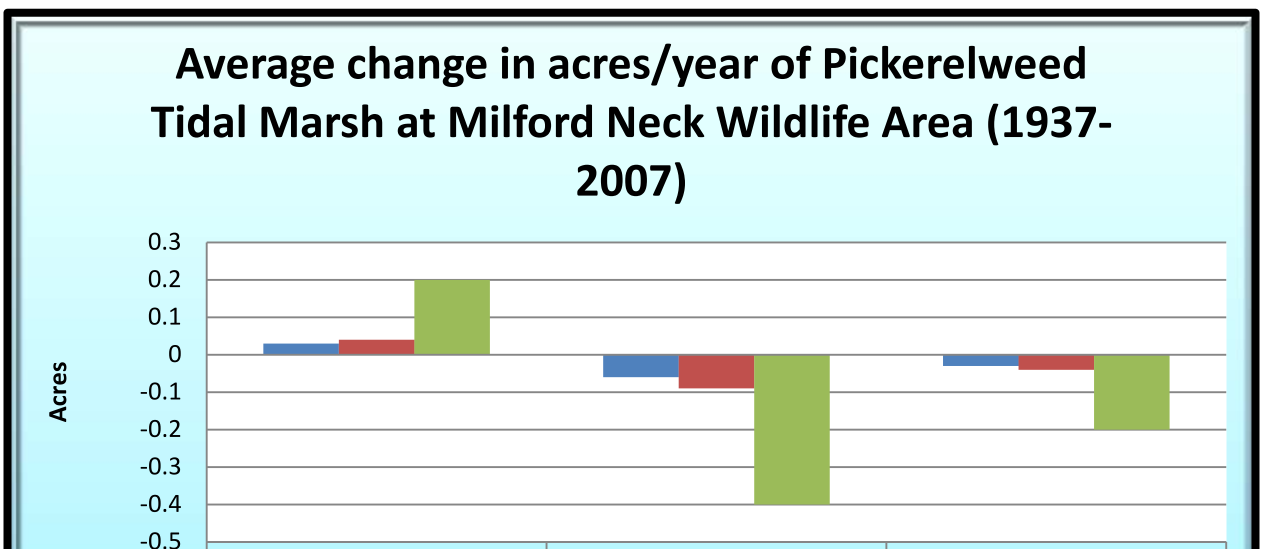
Table 5.84. What was once Pickerelweed Tidal Marsh in 1937 has become X in 2007	
X	**Acreage**
Water	5 acres
Impoundment	1 acre
Reed Tidal Marsh	1 acre
Cattail Brackish Tidal Marsh	1 acre
Mid-Atlantic Mesic Mixed Hardwood Forest	0.2 acres
Other communities/land covers	0.2 acres

Table 5.85. Pickerelweed Tidal Marsh has migrated into X since 1937	
X	**Acreage**
Coastal Plain Oak Floodplain Swamp	2 acres
Freshwater Tidal Mixed High Marsh	2 acres
Cattail Brackish Tidal Marsh	1 acre



	Hollager Tract	Penuel Tract	Milford Neck Wildlife Area
1937	0	8	8
2002	2	4	6
2007	3	2	5

Figure 5.51. Pickerelweed Tidal Marsh at Milford Neck Wildlife Area (1937, 2002, and 2007)



	Hollager Tract	Penuel Tract	Milford Neck Wildlife Area
1937-2002	0.03	-0.06	-0.03
1937-2007	0.04	-0.09	-0.04
2002-2007	0.2	-0.4	-0.2

Figure 5.52. Average change in acres/year of Pickerelweed Tidal Marsh at Milford Neck Wildlife Area (1937-2007)

DNREC Sea Level Rise Analysis (Table 5.86)

All of the current acreage of Pickerelweed Tidal Marsh will be flooded with 0.5 m of sea level rise. It does appear that is converting enough communities to last long.

Table 5.86. Projected acres of Pickerelweed Tidal Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	5 acres
1.5 m	2 acres

Natural Capital (Table 5.87)

Capital of Pickerelweed Tidal Marsh has been decreasing along with its acreage.

Table 5.87. Natural Capital of Pickerelweed Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$50,170/year
2002	$37,628/year
2007	$31,357/year

***Red Maple-Sweetgum Swamp* [1 acre (Figure 5.53, Table 5.88)]   G4G5   S5**

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

Description

This forested depression community is found in the Penuel Tract in a remnant Coastal Plain Pond. Red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*) co-dominate the canopy in the depression with smaller members of the canopy plus American holly (*Ilex opaca*) and blackgum (*Nyssa sylvatica*) in the understory. Common greenbrier (*Smilax rotundifolia*), highbush blueberry (*Vaccinium corymbosum*), Japanese honeysuckle (*Lonicera japonica*), and poison ivy (*Toxicodendron radicans*) are found in the shrub and vine layer. No herbs were noted in this community.

Analysis of Condition at Milford Neck Wildlife Area

The Red Maple-Sweetgum Swamp in the depression has not changed in acreage or extent since 1937. Therefore an analysis was not completed.

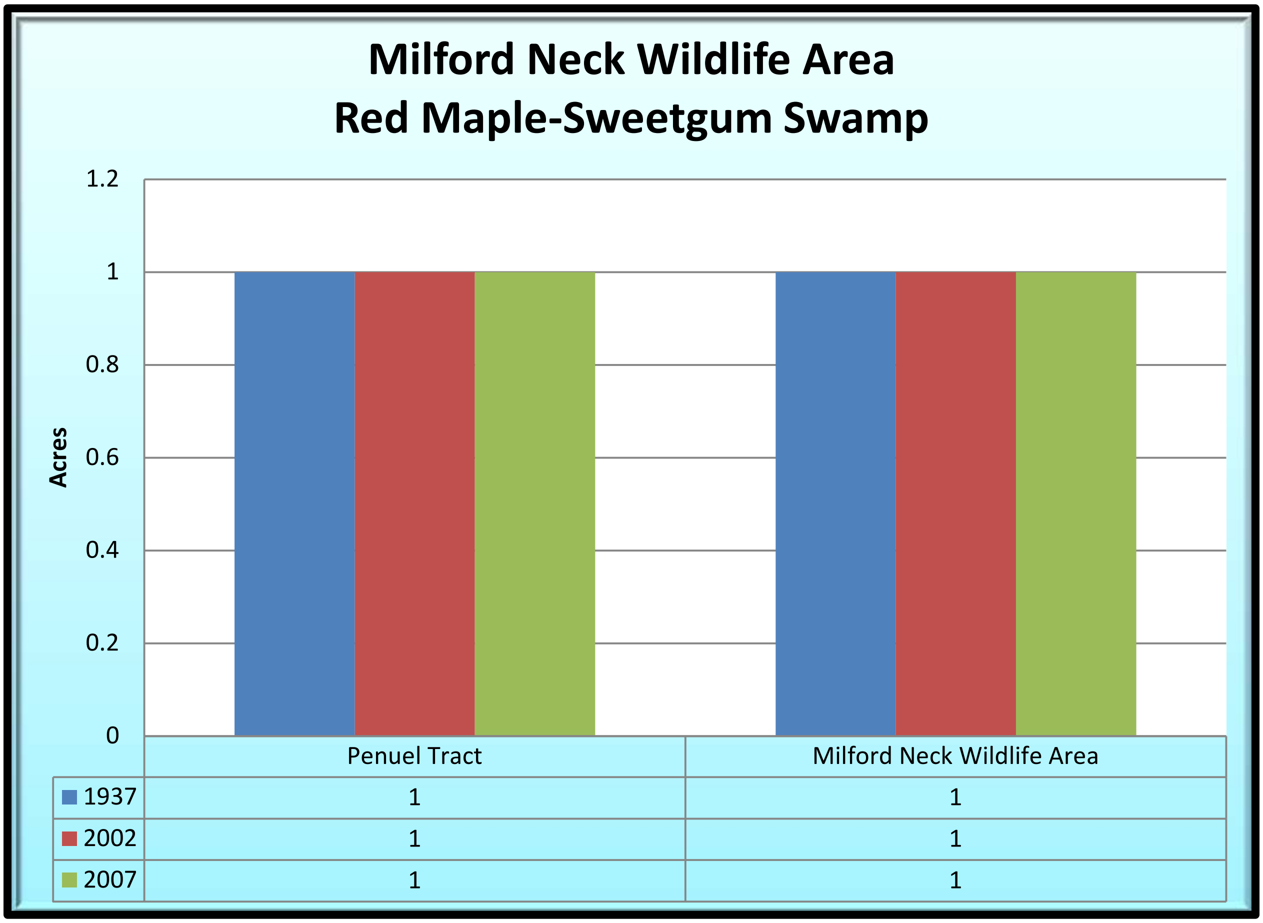


Figure 5.53. Red Maple-Sweetgum Swamp at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis

This community will not be affected by sea level rise in its current extent.

Natural Capital (Table 5.88)

Capital of Red Maple-Sweetgum Swamp has stayed the same since 1937.

Table 5.88. Natural Capital of Red Maple-Sweetgum Swamp	
Year	**Natural Capital (in 2012 dollars)**
1937	$9,143/year
2002	$9,143/year
2007	$9,143/year

***Reed Tidal Marsh* [125 acres (Figures 5.54-5.56, Tables 5.89-5.91)]** **GNA** **SNA**

DEWAP: Tidal Low Marshes
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Figure 5.54. Reed Tidal Marsh (Jester Tract)

This community is composed nearly entirely of reed grass (*Phragmites australis*) in a tidal situation.

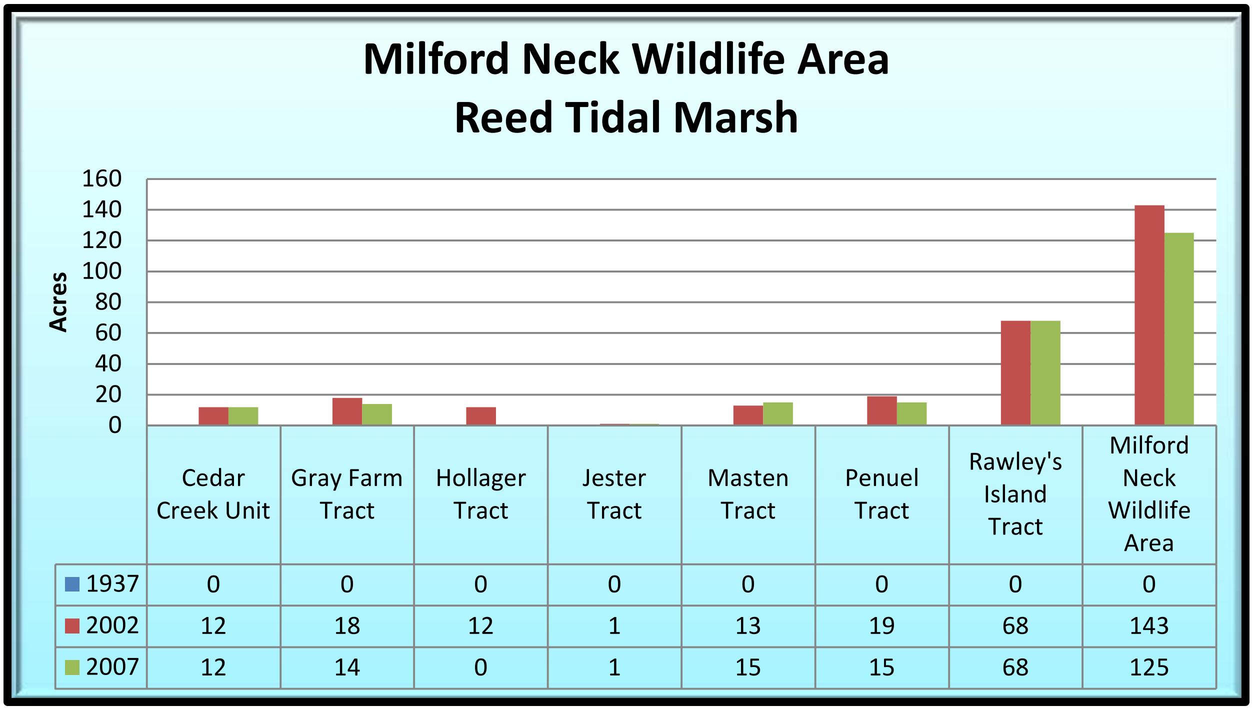
Analysis of Condition at Milford Neck Wildlife Area

This marsh community was not present in 1937, but has since grown to cover a large area. It reached its highest amount in 2002, but efforts to eradicate the primary species have decreased the coverage. Continuing eradication efforts may further decrease the amount of coverage of this community.

Since 1937 this community has converted 47 acres of North Atlantic Low Salt Marsh, 23 acres of Northeastern Old Field, 14 acres of Cattail Brackish Tidal Marsh, 13 acres of North Atlantic High Salt Marsh, and 8 acres of Agricultural Field (Table 5.89).

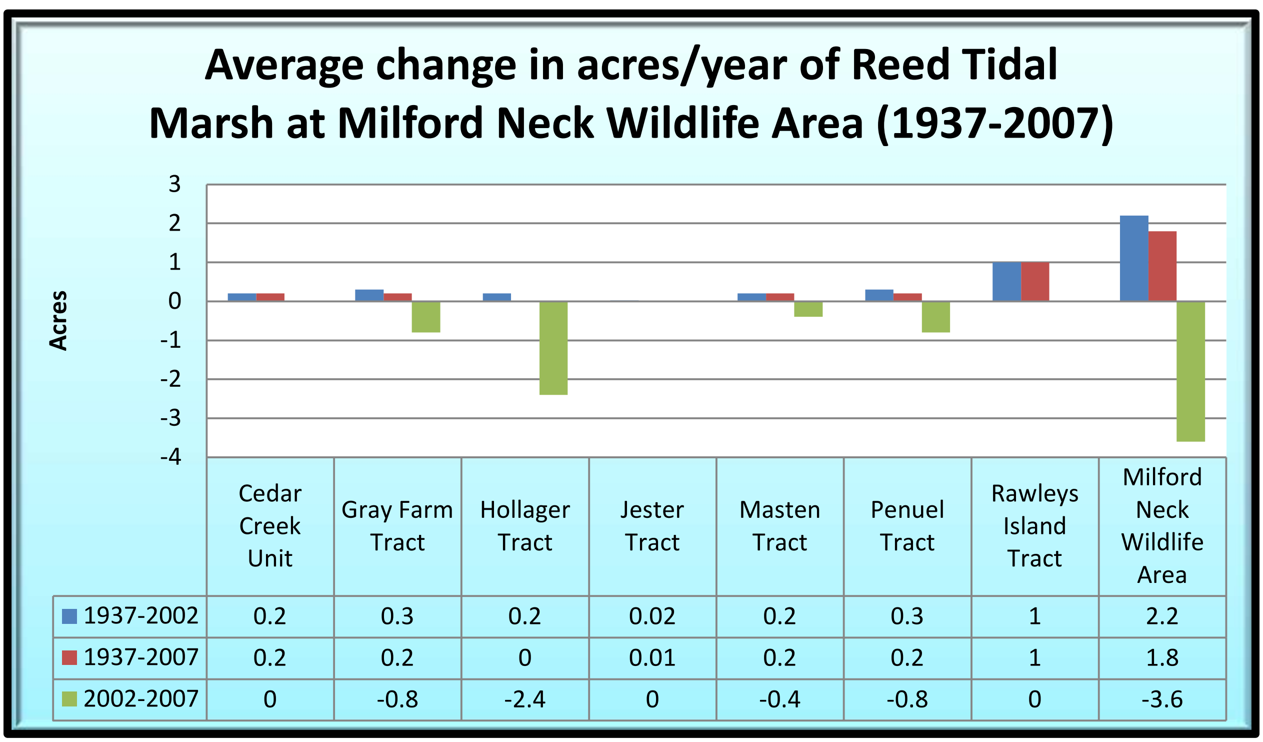
Table 5.89. Reed Tidal Marsh has migrated into X since 1937

X	Acreage
North Atlantic Low Salt Marsh	47 acres
Northeastern Old Field	23 acres
Cattail Brackish Tidal Marsh	14 acres
North Atlantic High Salt Marsh	13 acres
Agricultural Field	8 acres
Other communities/land covers	22 acres



	Cedar Creek Unit	Gray Farm Tract	Hollager Tract	Jester Tract	Masten Tract	Penuel Tract	Rawley's Island Tract	Milford Neck Wildlife Area
1937	0	0	0	0	0	0	0	0
2002	12	18	12	1	13	19	68	143
2007	12	14	0	1	15	15	68	125

Figure 5.55. Reed Tidal Marsh at Milford Neck Wildlife Area (1937, 2002, and 2007)



	Cedar Creek Unit	Gray Farm Tract	Hollager Tract	Jester Tract	Masten Tract	Penuel Tract	Rawleys Island Tract	Milford Neck Wildlife Area
1937-2002	0.2	0.3	0.2	0.02	0.2	0.3	1	2.2
1937-2007	0.2	0.2	0	0.01	0.2	0.2	1	1.8
2002-2007	0	-0.8	-2.4	0	-0.4	-0.8	0	-3.6

Figure 5.56. Average change in acres/year of Reed Tidal Marsh at Milford Neck Wildlife Area (1937-2007)

DNREC Sea Level Rise Analysis (Table 5.90)

All of the current acreage of Reed Tidal Marsh will be inundated by 1 m of sea level rise.

Table 5.90. Projected acres of Pickerelweed Tidal Marsh Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	123 acres
1 m	126 acres
1.5 m	127 acres

Natural Capital (Table 5.91)

Capital of Reed Tidal Marsh peaked in 2002, but has since declined because of eradication efforts.

Table 5.91. Natural Capital of Reed Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$896,796/year
2007	$783,913/year

River Bulrush Flooded Grassland **[0 acres (Figure 5.57, Tables 5.92-5.93)]   GNR   S1.1**

DEWAP: Freshwater Tidal Marshes
NHC: Laurentian-Acadian Freshwater Marsh

Description

This community was present in small amount in 1937, but has since been extirpated from the wildlife area by increasing salinities. It is characterized by a monoculture marsh of river bulrush (*Scirpus fluviatilis*) and is found in the freshest of marshes having less than 1 ppt salinity.

Analysis of Condition at Milford Neck Wildlife Area

River Bulrush Flooded Grassland is no longer present in the wildlife area, being extirpated at some point between 1937 and 2002. The likely cause is increasing salinity further up the river and conversion to brackish marsh. What was once this community has become 2 acres of North Atlantic Low Salt Marsh, 1 acre of water, 1 acre of Cattail Brackish Tidal Marsh, 1 acre of Mesohaline Seepage Marsh, and 0.4 acres of impoundment (Table 5.92). The communities that it became lend credence to the increasing salinities of the waters around the wildlife area.

Table 5.92. What was once River Bulrush Flooded Grassland in 1937 has become X in 2007

X	Acreage
North Atlantic Low Salt Marsh	2 acres
Water	1 acre
Cattail Brackish Tidal Marsh	1 acre
Mesohaline Seepage Marsh	1 acre
Impoundment	0.4 acres
Other communities/land covers	0.3 acres

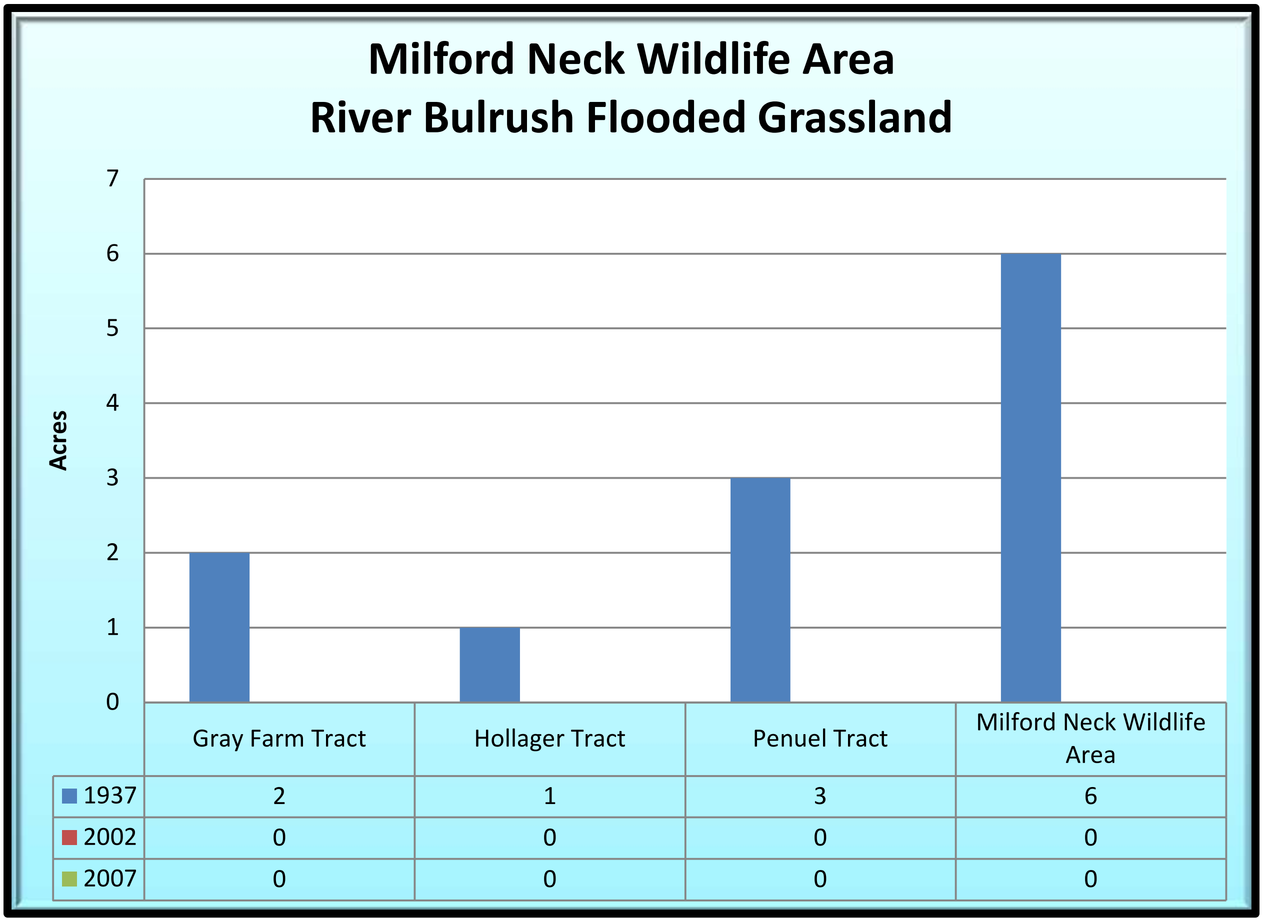


Figure 5.57. River Bulrush Flooded Grassland at Milford Neck Wildlife Area (1937, 2002, and 2007)

Natural Capital (Table 5.93)

Capital of River Bulrush Flooded Grassland has been transferred to marsh communities with the disappearance of this community.

Table 5.93. Natural Capital of River Bulrush Flooded Grassland

Year	Natural Capital (in 2012 dollars)
1937	$37,628/year
2002	$0/year (not present)
2007	$0/year (not present)

***Salt Panne* [22 acres (Figure 5.58, Tables 5.94-5.96)] G5 S3**

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

Description

All of the occurrences of this community were obtained through aerial imagery analysis due to the locations in the deep marsh. These areas a pools of saline water in the North Atlantic Low or high salt marshes that serve as evaporation basins making them saltier than the surrounding environment. Glasswort (*Salicornia virginica*) is often dominant in the pannes and is associated by sea lavender (*Limonium carolinianum*) and halbeard-leaf orache (*Atriplex patula*).

Analysis of Condition at Milford Neck Wildlife Area

Nearly all of the salt pannes located within Milford Neck Wildlife Area are located in the Rawley's Island tract. The coverage appears stable in the recent period (2002-2007) and without more data; a projection on the continuation of this community cannot be made. In other areas they are known to be ephemeral in nature.

This community has come about since 1937 and has converted 11 acres of North Atlantic Low Salt Marsh, 7 acres of Northeastern Old Field, and 5 acres of North Atlantic High Salt Marsh (Table 5.94).

Table 5.94. Salt Panne has migrated into X since 1937

X	Acreage
North Atlantic Low Salt Marsh	11 acres
Northeastern Old Field	7 acres
North Atlantic High Salt Marsh	5 acres

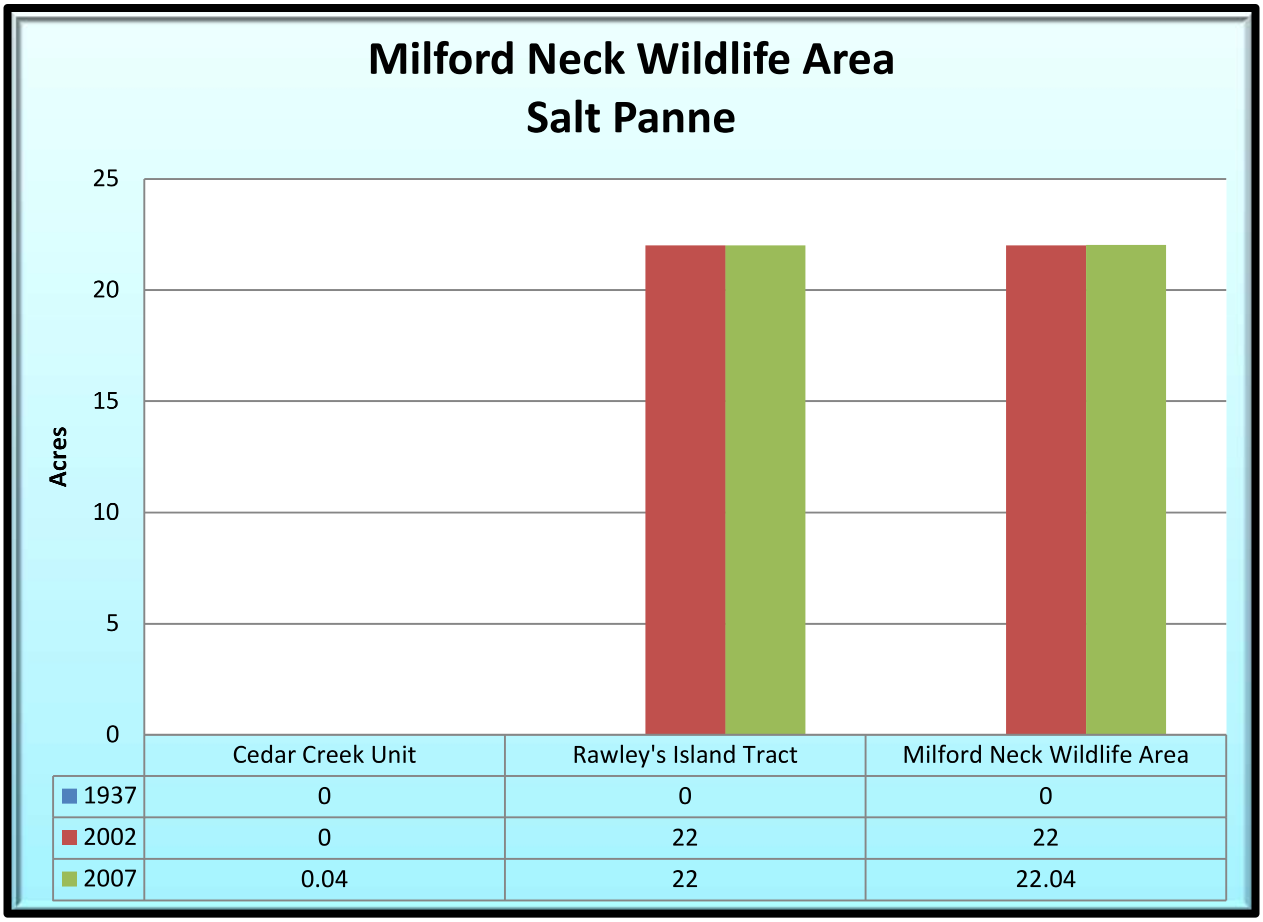


Figure 5.58. Salt Panne at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.95)

All of the current acreage of Salt Panne will be captured by 0.5 m of sea level rise.

Table 5.95. Projected acres of Salt Panne Inundated by Sea Level Rise

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

Natural Capital (Table 5.96)

Capital of Salt Panne has increased slight from 2002 to 2007. It was not present in 1937 and gained capital from fields and other marsh types.

Table 5.96. Natural Capital of Salt Panne	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$137,969/year
2007	$138,219/year

***Southern Red Maple-Blackgum Swamp Forest* [4 acres (Figures 5.59-5.60, Tables 5.97-5.100)] G3? S2**

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

Description

All of the occurrences in Milford Neck Wildlife Area are nearly at the edge of tide but not in the tidal zone. It is not known conclusively how these communities form but they may come about in place whether the progress of tidal water is slower than that found in the Freshwater Tidal Woodland. Causal observation points to Freshwater Tidal Woodland forming in places where the tidal progress is faster killing off the sweetgum (*Liquidambar styraciflua*) and leaving a "woodland" of red maple (*Acer rubrum*). In the case of the Southern Red Maple-Blackgum Swamp Forest, the die off of the sweetgum may be more gradual allowing blackgum (*Nyssa sylvatica*), a more water tolerant species, to its place. In time as more water is present, over more time, these communities may also revert to a Freshwater Tidal Woodland, which in time revert to a shrubbier situation such as Wax-Myrtle Shrub Swamp.

The community in the Gray Farm tract is composed of red maple and blackgum in the canopy. The sparse understory is mainly smaller members of the canopy plus sweetbay (*Magnolia virginiana*) and a small amount of tuliptree (*Liriodendron tulipifera*). Shrub species include highbush blueberry (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), possum-haw viburnum (*Viburnum nudum*), arrow-wood (*Viburnum dentatum*), and Japanese honeysuckle (*Lonicera japonica*). Cinnamon fern (*Osmunda cinnamomea*), hemlock water-parsnip (*Sium suave*), Canadian clearweed (*Pilea pumila*), salt marsh fleabane (*Pluchea odorata*), netted chainfern (*Woodwardia areolata*), stinging nettle (*Urtica dioica*), sensitive fern (*Oncolea sensibilis*), jack-in-the-pulpit (*Arisaema triphyllum*), and orange-spotted jewelweed (*Impatiens capensis*) compose the herb layer.

Figure 5.59. Southern Red Maple-Blackgum Swamp (Gray Farm Tract)

The example in the Gray Farm Tract could be considered late successional to mature but it undergoing change due to water input making an exact conclusion hard. The understory is thick and may be due to the changes.

Analysis of Condition at Milford Neck Wildlife Area

This community has remained relatively stable during the study period (1937-2007) with 3 acres of 4 acres surviving to 2007 and is projected to remain so in the near future. The rest of the acreage had become 0.5 acres of Wax-Myrtle Shrub Swamp, 0.4 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, and 0.2 acres of Northeastern Modified Successional Forest (Table 5.97). Since 1937 this community has converted 0.3 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest (Table 5.98). With sea level rise and this community's presence in a low ravine, the long term prospects are uncertain.

Table 5.97. What was once Southern Red Maple-Blackgum Swamp in 1937 has become X in 2007	
X	**Acreage**
Southern Red Maple-Blackgum Swamp	3 acres
Wax-Myrtle Shrub Swamp	0.5 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	0.4 acres
Northeastern Modified Successional Forest	0.2 acres

Table 5.98. Southern Red Maple-Blackgum Swamp has migrated into X since 1937	
X	**Acreage**
Southern Red Maple-Blackgum Swamp	3 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.3 acres

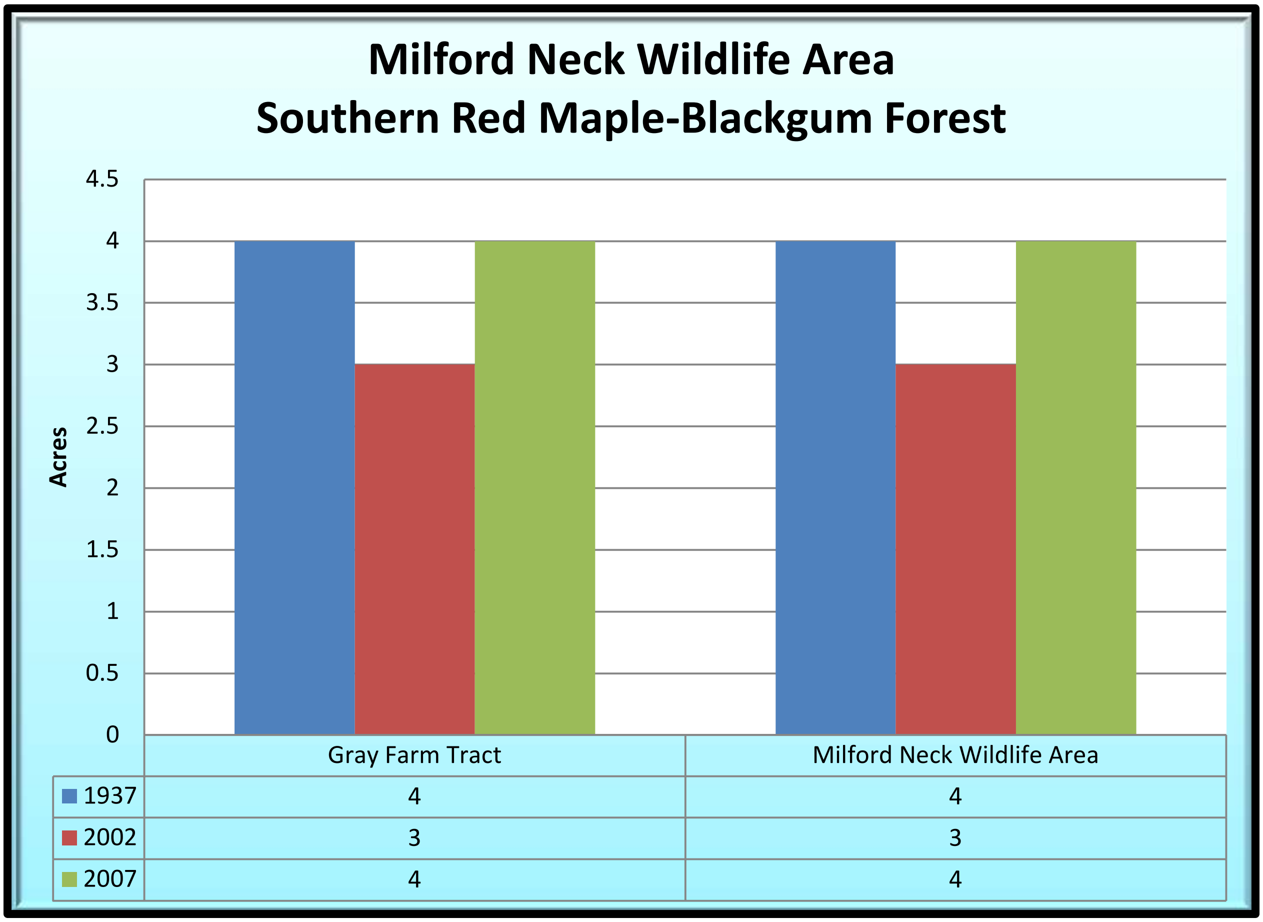


Figure 5.60. Southern Red Maple-Blackgum Swamp Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.99)

Essentially all of this community will be flooded with 0.5 m of sea level rise.

Table 5.99. Projected acres of Southern Red Maple-Blackgum Swamp Inundated by Sea Level Rise

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

Natural Capital (Table 5.100)

Capital of Southern Red Maple-Blackgum Swamp has oscillated over the study period as this community is exposed to the effects of sea level rise. It is projected there will be more losses in the near future.

Table 5.100. Natural Capital of Southern Red Maple-Blackgum Swamp	
Year	**Natural Capital (in 2012 dollars)**
1937	$756/year
2002	$567/year
2007	$756/year

***Southern Red Oak/Heath Forest* [8 acres (Figures 5.61-5.62, Tables 5.101-5.103)]** **G4G5 S5**

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

<u>*Description*</u>

This community occupies a small portion of the Gray Farm tract and is an apparently a recent arrival to the wildlife area. It is of a young to mid-successional age and does not express the characteristics of this community very well but in time it may better express them. Currently southern red oak (*Quercus falcata*), white oak (*Quercus alba*), tuliptree (*Liriodendron tulipifera*), loblolly pine (*Pinus taeda*), and a few willow oak (*Quercus phellos*) and blackgum (*Nyssa sylvatica*) compose the canopy. Understory associates include American holly (*Ilex opaca*), wild black cherry (*Prunus serotina*), flowering dogwood (*Cornus florida*), and smaller members of the canopy. A shrub layer of low-bush blueberry (*Vaccinium pallidum*) and huckleberry (*Gaylussacia frondosa*) is present along with common greenbrier (*Smilax rotundifolia*), highbush blueberry (*Vaccinium corymbosum*), and Japanese honeysuckle (*Lonicera japonica*). Black scale speargrass (*Chasmanthium laxum*) was the only herb noted in this community.

Figure 5.61. Southern Red Oak/Heath Forest (Gray Farm)

The example of this this community in the Gray Farm Tract is middle to late successional as evidenced by the small diameters of the canopy trees (0.8 to 1.2 feet) and the thick understory. Layers such as the understory and shrubs have still yet to sort out well.

<u>*Analysis of Condition at Milford Neck Wildlife Area*</u>

There is not enough data on this community in the wildlife area to draw a conclusion on the status of this community. Imagery coming in 2012 may possibly give a trend in order to draw conclusion.

This community was not present in 1937 and has since grown from 7 acres of Early to Mid-Successional Forest, 0.2 acres of Wax-Myrtle Shrub Swamp, 0.2 acres of Successional Maritime Forest, and 0.2 acres of Cattail Brackish Marsh (Table 5.101). The last three may have been due to mapping error.

Table 5.101. Southern Red Oak/Heath Forest has migrated into X since 1937	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	7 acres
Wax-Myrtle Shrub Swamp	0.2 acres
Successional Maritime Forest	0.2 acres
Cattail Brackish Tidal Marsh	0.1 acres

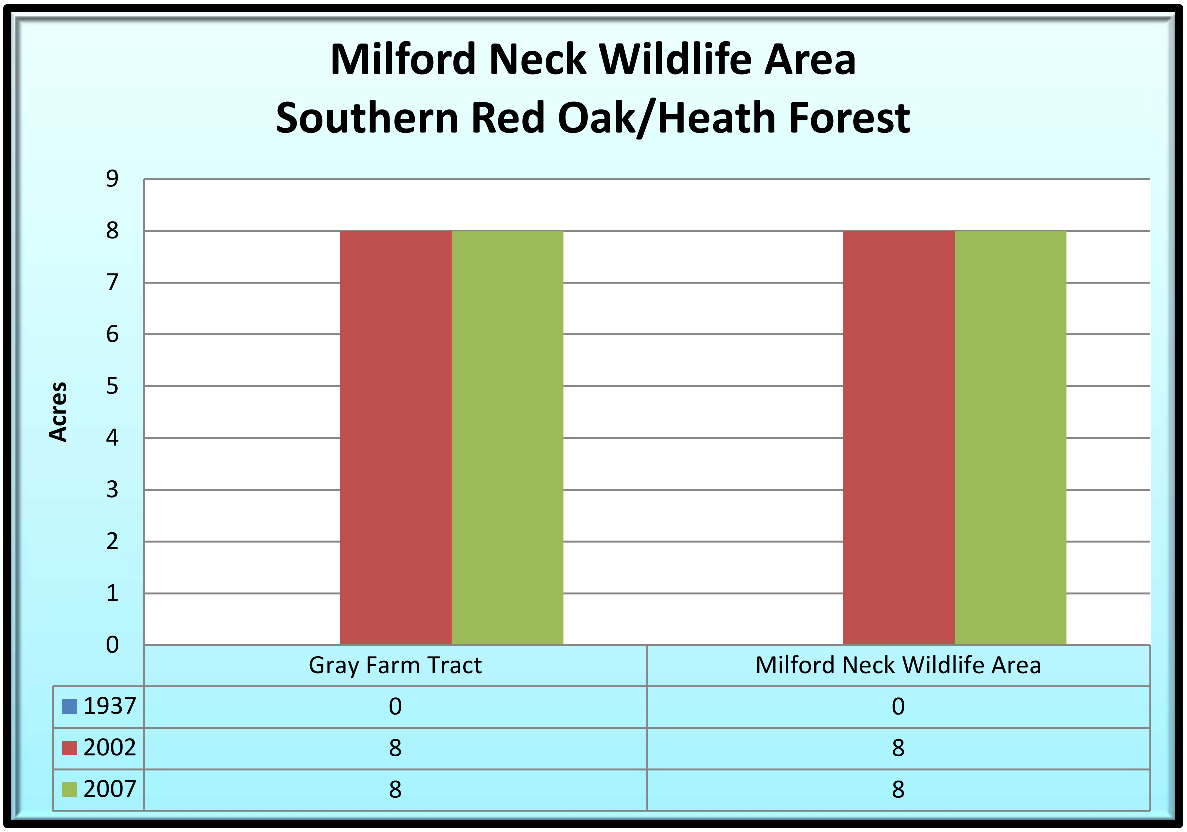


Figure 5.62. Southern Red Oak/Heath Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.102)

About ¾ of this community will be impacted by 1.5 m of sea level rise. The occurrences of this community are located towards the edge of the marsh which is unusual for it.

Table 5.102. Projected acres of Southern Red Oak/Heath Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	3 acres
1 m	4 acres
1.5 m	6 acres

Natural Capital (Table 5.103)

Capital of Southern Red Oak/Heath Forest has stayed the same since 2002. Most of its capital has come from other forest types.

Table 5.103. Natural Capital of Southern Red Oak/Heath Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$1,513/year
2007	$1,513/year

***Successional Maritime Forest* [24 acres (Figure 5.63, Tables 5.104-)] G2G3 S3**

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

Description

This community is located at the interface between the upland forests and the brackish shrub and marsh communities where it receives occasional salt spray and storm tides. Most of the locations of this community in the wildlife area were aerially interpreted. It is composed of a stunted canopy of red maple (*Acer rubrum*), sassafras (*Sassafras albidum*), wild black cherry (*Prunus serotina*), and sweetgum (*Liquidambar styraciflua*). The understory is mainly smaller members of the canopy plus persimmon (*Diospyros virginiana*). Common greenbrier (*Smilax rotundifolia*) is found in the vine layer. No herbs were noted in the one example visited in the Jester Tract.

Analysis of Condition at Milford Neck Wildlife Area

This community has decreased from its extent in 1937 mainly from losses in the Cedar Creek Unit. These losses may possibly be due to increasing rates of sea level inundation which is reducing the ability of the more upland forests to transition to this forest or not giving the forests enough time to become this type of forest. In the recent period (2002-2007) this community has been stable but it is unknown at this point whether this is a long-term plateau.

In 2007, 5 acres of the 38 acres from 1937 still existed. The rest of the acreage had become 13 acres of North Atlantic Low Salt Marsh, 5 acres of Coastal Loblolly Pine Wetland Forest, 4 acres of North Atlantic High Salt Marsh, and 4 acres of Wax-Myrtle Shrub Swamp (Table 5.104). Since 1937 Successional Maritime Forest has grown into 14 acres of Northeastern Old Field, 1 acre of North Atlantic Low Salt Marsh, 1 acre of Freshwater Tidal Mixed High Marsh, and 1 acre of Cattail Brackish Tidal Marsh (Table 5.105)

Table 5.104. What was once Successional Maritime Forest in 1937 has become X in 2007

X	Acreage
North Atlantic Low Salt Marsh	13 acres
Coastal Loblolly Pine Wetland Forest	5 acres
Successional Maritime Forest	5 acres
North Atlantic High Salt Marsh	4 acres
Wax-Myrtle Shrub Swamp	4 acres
Other communities/land covers	11 acres

Table 5.105. Successional Maritime Forest has migrated into X since 1937	
X	**Acreage**
Northeastern Old Field	14 acres
Successional Maritime Forest	5 acres
North Atlantic Low Salt Marsh	1 acre
Freshwater Tidal Mixed High Marsh	1 acre
Cattail Brackish Tidal Marsh	1 acre
Other communities/land covers	1 acre

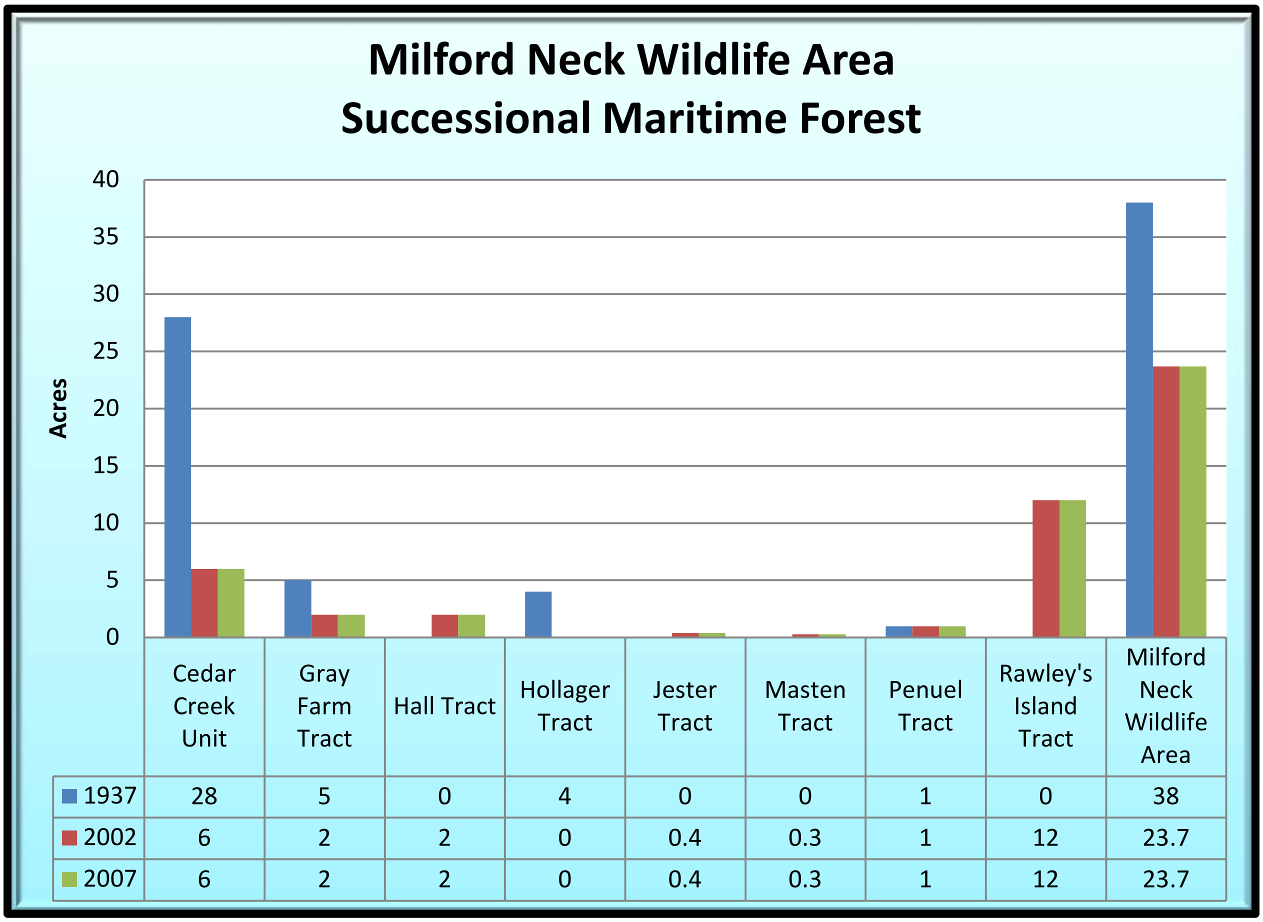


Figure 5.63. Successional Maritime Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.106)

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

Table 5.106. Projected acres of Successional Maritime Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	23 acres
1 m	23 acres
1.5 m	23 acres

Natural Capital (Table 5.107)

Capital of Successional Maritime Forest has decreased along with its acreage since 1937.

Table 5.107. Natural Capital of Successional Maritime Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$7,186/year
2002	$4,482/year
2007	$4,482/year

***Successional Sweetgum Forest* [7 acres (Figures 5.64-5.65, Tables 5.108-5.109)] GNA SNA**

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

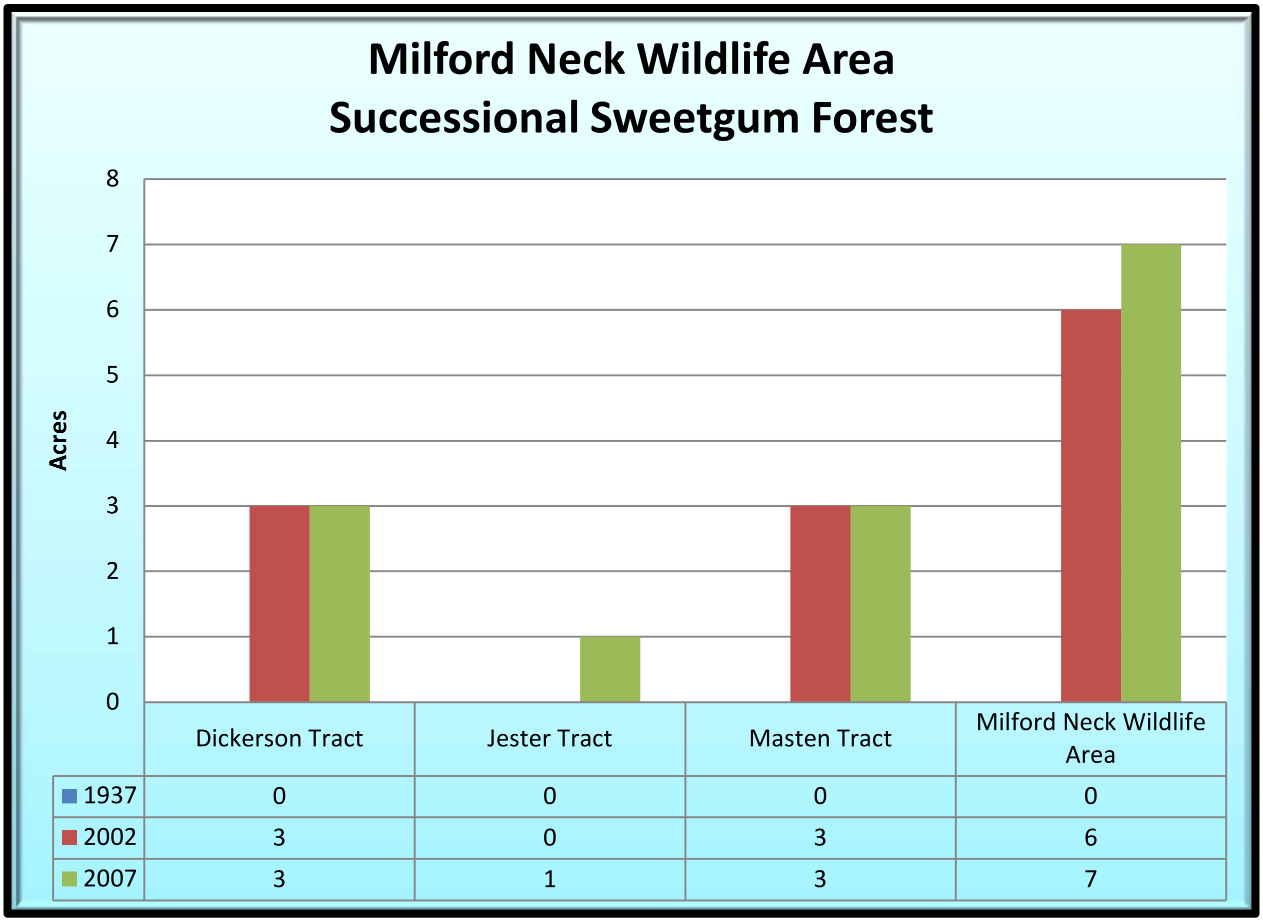
Description

Figure 5.64. Successional Sweetgum Forest (Masten Tract)

In Milford Neck Wildlife Area this community presents as a young thick forested community with a successional low canopy. Sweetgum (*Liquidambar styraciflua*) is the dominant species with some red maple (*Acer rubrum*) mixed in. Underneath the canopy, a low shrub and vine layer of highbush blueberry (*Vaccinium corymbosum*) and common greenbrier (*Smilax rotundifolia*) can be found. In one example on the Masten tract, spikerush (*Juncus effusus*) was found.

Analysis of Condition at Milford Neck Wildlife Area

This is a successional community that will likely succeed to a Chesapeake Bay Non-riverine Wet Hardwood Forest in time. It is appearing in places that have been abandoned from agricultural use and wildlife fields that have been allowed to revert to forest. In the recent period (2002-2007), there has been an increase in this community. This community will likely be present in the wildlife as long as there are fields reverting to forest. All of the acreage in Milford Neck Wildlife Area came from agricultural fields.



	Dickerson Tract	Jester Tract	Masten Tract	Milford Neck Wildlife Area
1937	0	0	0	0
2002	3	0	3	6
2007	3	1	3	7

Figure 5.65. Successional Sweetgum Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.108)

A little less than half of the current acreage of Successional Sweetgum Forest will be inundated by 1.5 m of sea level rise.

Table 5.108. Projected acres of Successional Sweetgum Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	1 acre
1.5 m	3 acres

Natural Capital (Table 5.109)

Capital of Successional Sweetgum Forest has been going up as more agricultural fields are abandoned.

Table 5.109. Natural Capital of Successional Sweetgum Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$1,135/year
2007	$1,324/year

***Successional Tuliptree Forest* [23 acres (Figures 5.56-5.57, Tables 5.110-)]   GNA   SNA**

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

<u>*Description*</u>

This community type is second only to the Northern Coastal Plain/Piedmont Basic Mesic Hardwood forest in the herbaceous species diversity in the wildlife area. Tuliptree (*Liriodendron tulipifera*) dominates a canopy that overtops an understory of blackgum (*Nyssa sylvatica*), American beech (*Fagus grandifolia*), and wild black cherry (*Prunus serotina*). The shrub and vine layer is thick in places with exotics such as multiflora rose (*Rosa multiflora*), Japanese honeysuckle (*Lonicera japonica*), autumn olive (*Elaeagnus umbellata*), and other natives such as summer grape (*Vitis aestivalis*) that take advantage of high nutrient situations. Herbs include Virginia creeper (*Parthenocissus quinquefolia*), enchanter's nightshade (*Circaea lutetiana*), mayapple (*Podophyllum peltatum*), Jack-in-the-pulpit (*Arisaema triphyllum*), and pokeweed (*Phytolacca americana*).

Figure 5.56. Successional Tuliptree Forest (Penuel Tract)

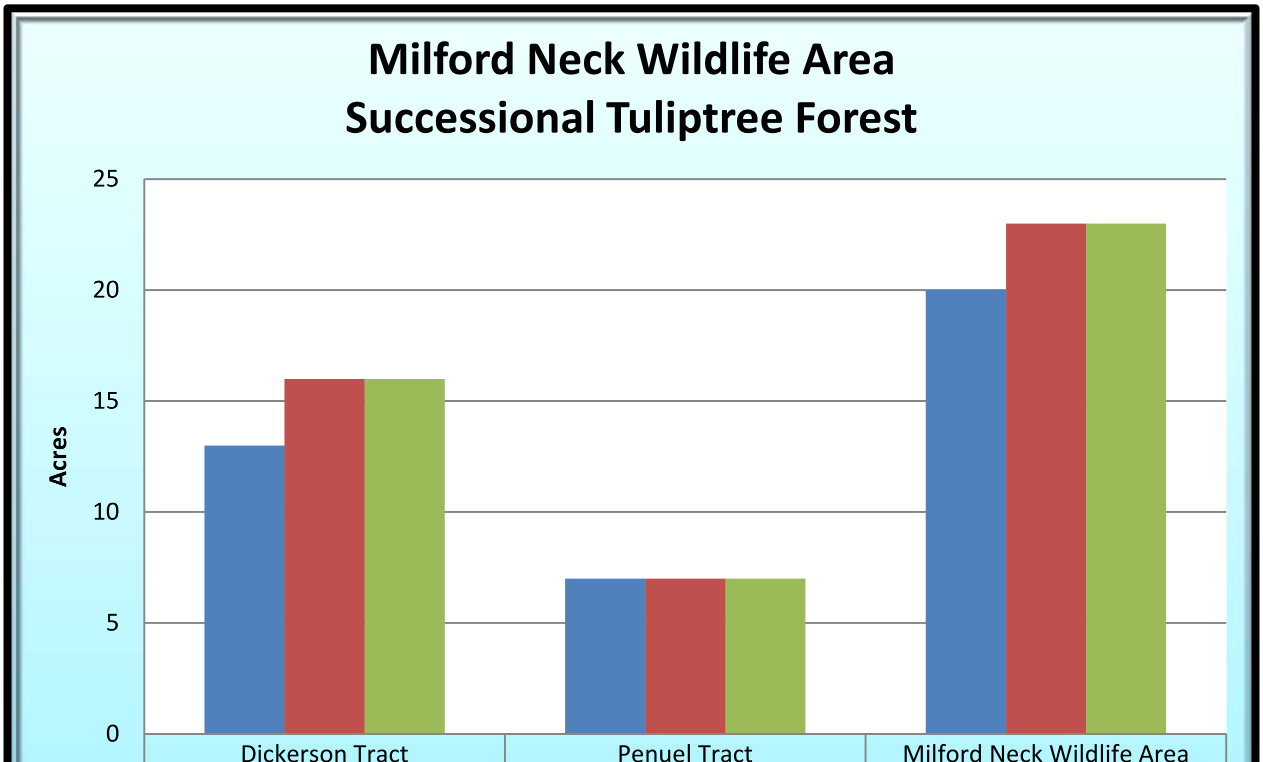
<u>*Analysis of Condition at Milford Neck Wildlife Area*</u>

This community appears to be relatively stable in the wildlife area as most of the acreage present in 1937 was still present in 2007 (19 acres vs. 20 acres). The remaining acre converted to Chesapeake Bay Non-riverine Wet Hardwood Forest (Table 5.110). Since 1937, this community has grown into 2 acres of agricultural field, 1 acre of semi-impervious surface, 0.2 acres of Northeastern Old Field, and converted 0.2 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest (Table 5.111).

Table 5.110. What was once Successional Tuliptree Forest in 1937 has become X in 2007

X	Acreage
Successional Tuliptree Forest	19 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	1 acre

Table 5.111. Successional Tuliptree Forest has migrated into X since 1937	
X	**Acreage**
Successional Tuliptree Forest	19 acres
Agricultural Field	2 acres
Semi-impervious Surface	1 acre
Northeastern Old Field	0.2 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.2 acres



	Dickerson Tract	Penuel Tract	Milford Neck Wildlife Area
1937	13	7	20
2002	16	7	23
2007	16	7	23

Figure 5.57. Successional Tuliptree Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.112)

About ¼ of the current acreage of Successional Tuliptree Forest will be impacted by 1.5 m of sea level rise.

Table 5.112. Projected acres of Successional Tuliptree Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	3 acres
1.5 m	6 acres

Natural Capital (Table 5.113)

Capital of Successional Tuliptree Forest has been going up as more agricultural fields are abandoned.

Table 5.113. Natural Capital of Successional Tuliptree Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$3,782/year
2002	$4,349/year
2007	$4,349/year

***Successional Tuliptree-Loblolly Pine Upland Forest* [18 acres (Figures 5.58-5.59, Tables 5.114-5.116)]**
GNA SNA

DEWAP: Coastal Plain Upland Forest
NHC: No Equivalent Classification

Description

The only known occurrence of Successional Tuliptree-Loblolly Pine Upland Forest is found in a mesic flatwood just above the elevation of the Mispillion River in Milford Neck Wildlife Area. It is similar to the Successional Tuliptree Forest (**CEGL007220**) but is co-dominated by loblolly pine (*Pinus taeda*). Other associates in the canopy include red maple (*Acer rubrum*) and willow oak (*Quercus phellos*). The understory is composed of smaller members of the canopy plus white oak (*Quercus alba*), sweetgum (*Liquidambar styraciflua*), blackgum (*Nyssa sylvatica*), mockernut hickory (*Carya alba*), American holly (*Ilex opaca*), and wild black cherry (*Prunus serotina*). The shrub and vine layer is composed of poison ivy (*Toxicodendron radicans*), common greenbrier (*Smilax rotundifolia*), Japanese honeysuckle (*Lonicera japonica*), blackhaw viburnum (*Viburnum prunifolium*), multiflora rose (*Rosa multiflora*), and arrowwood (*Viburnum dentatum*). Common herbs in the rich herbaceous layer include partridge-berry (*Mitchella repens*), Virginia creeper (*Parthenocissus quinquefolia*), New York fern (*Thelypteris novaboracensis*), ebony spleenwort (*Asplenium platyneuron*), Japanese stiltgrass (*Microstegium vimineum*), enchanter's nightshade (*Circaea lutetiana*), swan's sedge (*Carex swanii*), and grape fern (*Botrychium virginianum*).

Figure 5.58. Successional Tuliptree-Loblolly Pine Upland Forest (Dickerson Tract)

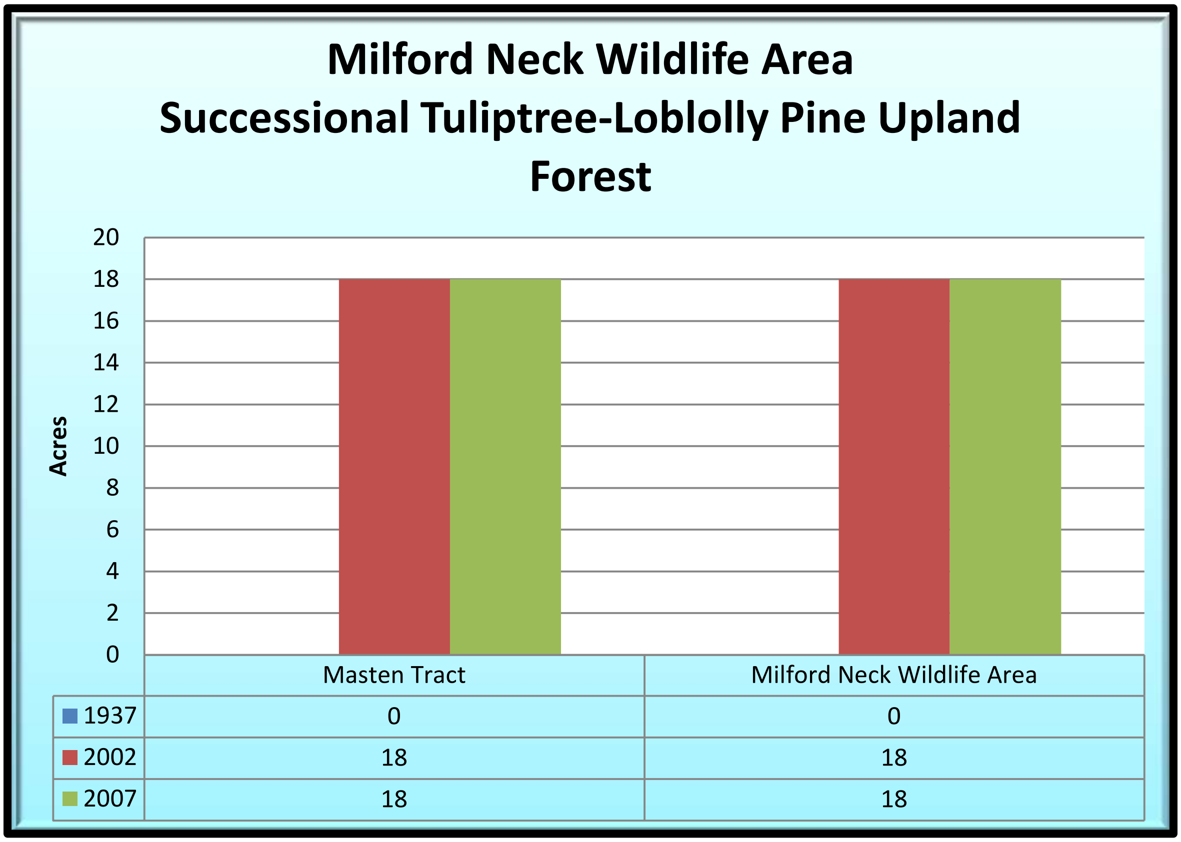
The example of this community appears to be Middle to Late Successional. Diameters of canopy trees range from 1.0 to 1.5 feet. Layering of the understory and shrubs is nearly complete and the understory is not too thick.

Analysis of Condition at Milford Neck Wildlife Area

This is new community for Delaware and so far is the only known location for this community in the state. Since the two dominants in the community are known from other successional forests is likely that this community will likely grow into another community such as a Mid-Atlantic Mesic Mixed Hardwood Forest or a Chesapeake Bay Non-riverine Wet Hardwood Forest if the hydrology becomes wetter.

Since 1937, this community has originated from 12 acres of Northeastern Successional Shrubland, 5 acres of Early to Mid-Successional Loblolly Pine Forest, and 1 acre of Northeastern Old Field (Table 5.114).

Table 5.114. Successional Tuliptree-Loblolly Pine Upland Forest has migrated into X since 1937	
X	**Acreage**
Northeastern Successional Shrubland	12 acres
Early to Mid-Successional Loblolly Pine Forest	5 acres
Northeastern Old Field	1 acre



	Masten Tract	Milford Neck Wildlife Area
1937	0	0
2002	18	18
2007	18	18

Table 4.43. Loblolly Pine-Tuliptree Upland Forest at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.115)

A little than ¼ of the current acreage of Successional Tuliptree-Loblolly Pine Upland Forest will be inundated by 1.5 m of sea level rise.

Table 5.115. Projected acres of Successional Tuliptree-Loblolly Pine Upland Forest Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	1 acre
1.5 m	5 acres

Natural Capital (Table 5.116)

This community was not preset in 1937 and has since grown to acquire $3,404 in capital.

Table 5.116. Natural Capital of Successional Tuliptree-Loblolly Pine Upland Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$3,404/year
2007	$3,404/year

***Swamp-loosestrife Shrub Swamp* [2 acres (Figures 5.60-5.61, Tables 5.117-5.119)] GNR S3**

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

Description

Figure 5.60. Swamp-loosestrife Shrub Swamp (Penuel Tract)

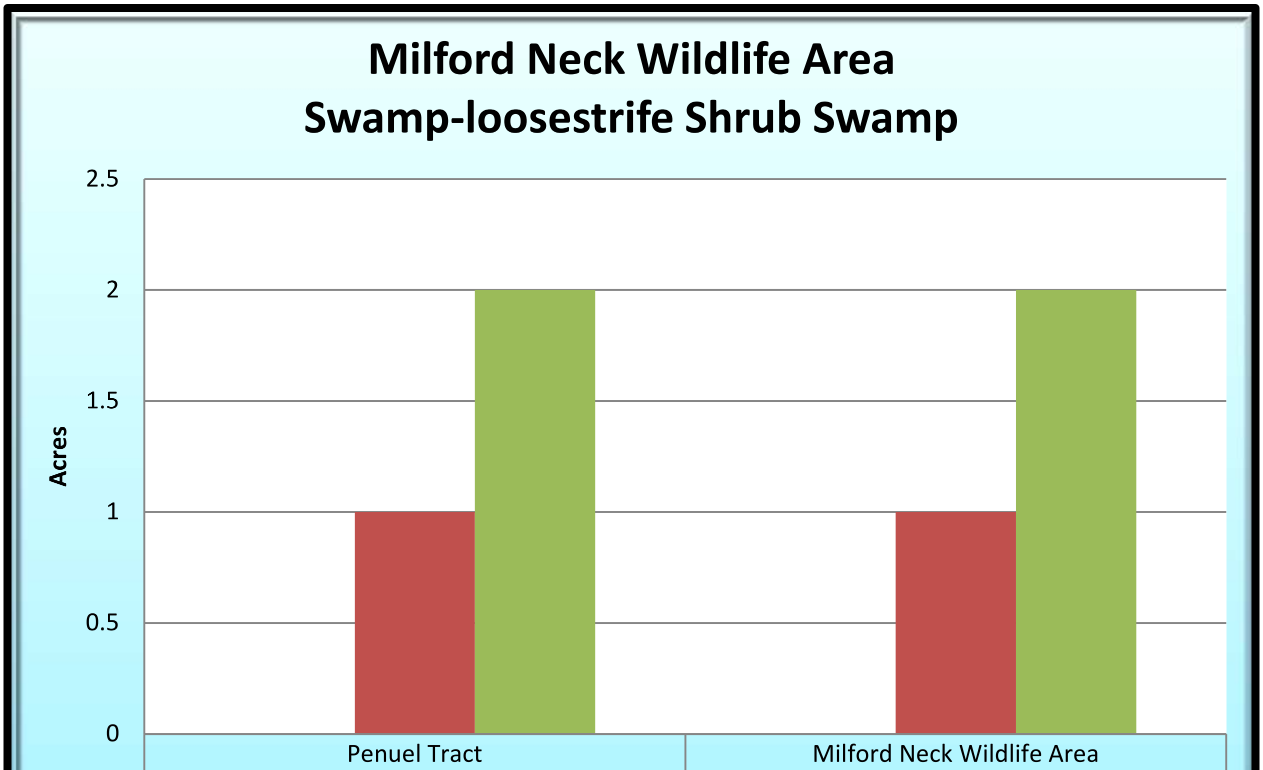
Swamp-loosestrife Shrub Swamp is located in an impoundment in the Penuel tract. It often grows in dense tangles in the water of impoundments and other bodies of water. The location at the Penuel tract is no different being a dense monoculture of swamp-loosestrife (*Decodon verticillata*).

Analysis of Condition at Milford Neck Wildlife Area

This community will likely be a feature of the Penuel tract as long as the impoundment remains. It has been at the same coverage in the recent period (2002-2007) and is projected to remain so. This is community is located where 1 acre of Coastal Plain Oak Floodplain Swamp and 0.2 acres of Pickerelweed Tidal Marsh used to be in 1937 (Table 5.117).

Table 5.117. Swamp-loosestrife Shrub Swamp has migrated into X since 1937

X	Acreage
Coastal Plain Oak Floodplain Swamp	1 acre
Pickerelweed Tidal Marsh	0.2 acres



	Penuel Tract	Milford Neck Wildlife Area
1937	0	0
2002	1	1
2007	2	2

Figure 5.61. Swamp-loosestrife Shrub at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.118)

The current acreage of Swamp-loosestrife will be exposed to tidal water at 1 m of sea level rise.

Table 5.118. Projected acres of Swamp-loosestrife Shrub Swamp Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 5.119)

Capital of Swamp-loosestrife Shrub Swamp has been increasing as it expands in the impoundment.

Table 5.119. Natural Capital of Swamp-loosestrife Shrub Swamp	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$9,281/year
2007	$18,563/year

***Upland Switchgrass Vegetation* [21 acres (Figures 5.62-5.63, Tables 5.120-)] GNR SNA**

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

Description

Figure 5.62. Upland Switchgrass Vegetation (Gray Farm Tract)

Upland Switchgrass Vegetation is located on the edges of fields that have been either reclaimed from agriculture or are partially reclaimed. Switchgrass (*Panicum virgatum*) is the dominant species and is joined by Canada goldenrod (*Solidago canadensis*), autumn olive (*Elaeagnus umbellata*), wild black cherry (*Prunus serotina*), salt shrub (*Baccharis halimifolia*), and blackberry (*Rubus* sp.).

Analysis of Condition at Milford Neck Wildlife Area

This is community is planted as a vegetated buffer between agricultural fields and wooded areas in the wildlife area. Since 1937, it has been planted in 19 acres of agricultural field, 2 acres of Northeastern Old Field, 1 acre of Northeastern Successional Shrubland, and 0.2 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest via another community (Table 5.120).

Table 5.120. Swamp-loosestrife Shrub Swamp has migrated into X since 1937

X	Acreage
Agricultural Field	19 acres
Northeastern Old Field	2 acres
Northeastern Successional Shrubland	1 acre
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.2 acres

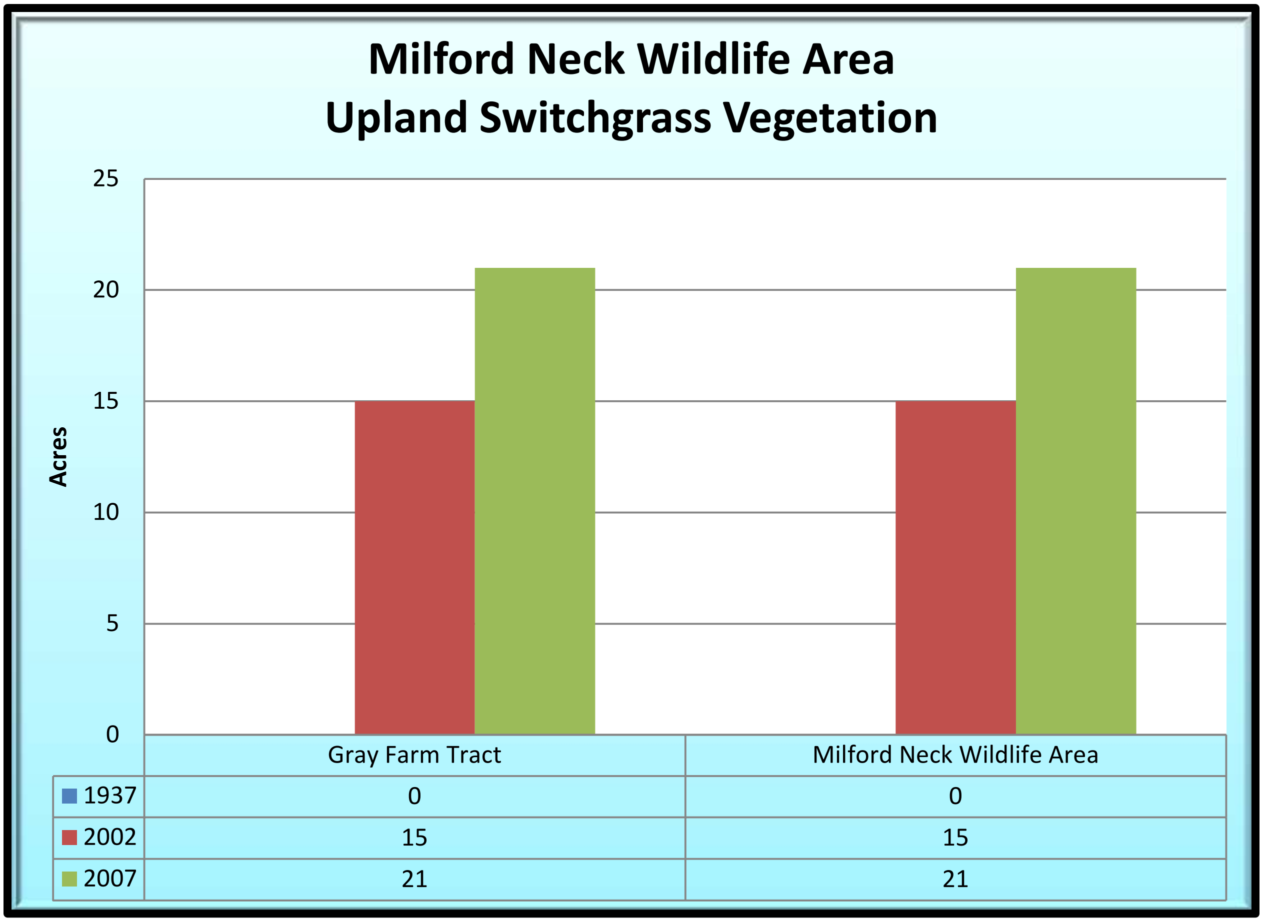


Figure 5.63. Upland Switchgrass Vegetation at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.121)

About 1/3 of the current acreage of Upland Switchgrass Vegetation will be inundated by 1.5 m of sea level rise.

Table 5.121. Projected acres of Upland Switchgrass Vegetation Inundated by Sea Level Rise

Rise	Acres
0.5 m	2 acres
1 m	4 acres
1.5 m	7 acres

Natural Capital (Table 5.122)

Capital of Upland Switchgrass Vegetation has been increasing as this community is planted around the wildlife area.

Table 5.122. Natural Capital of Upland Switchgrass Vegetation	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$2,186/year
2007	$3,060/year

***Wax-Myrtle Shrub Swamp* [68 acres (Figures 5.64-5.65, Tables 5.123-)] G2G3 S2**

DEWAP: Shrub Swamps
NHC: Northern Atlantic Coastal Plain Dune and Swale

Description

Figure 5.64. Wax-Myrtle Shrub Swamp (Gray Farm Tract)

This community is composed, often entirely, of wax-myrtle (*Morella cerifera*) and bayberry (*Morella pennsylvanica*). Some scattered stems of red maple (*Acer rubrum*) and loblolly pine (*Pinus taeda*) may be present.

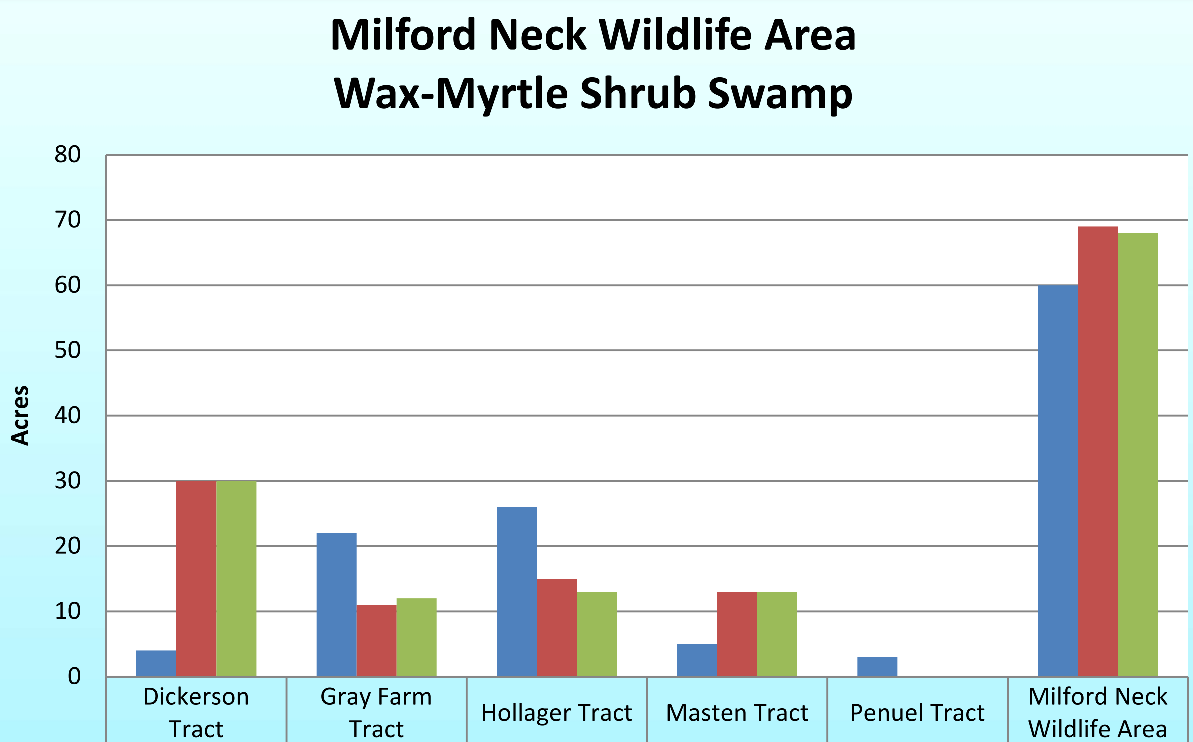
Analysis of Condition at Milford Neck Wildlife Area

This community is often intermediate between forests and brackish marshes and can be found at the interface between fresh tidal woodlands and brackish marsh. This community has increased overall in the wildlife area as the marshes have regressed landward. However these gains have taken place in the flatter areas of the Dickerson and Masten Tracts along Kings Causeway. This community has decreased in other tracts as it has encountered topographic barriers to its progression. In time it may decrease in the Dickerson and Masten tracts resulting in an overall decrease in the wildlife area.

In 2007, about 23 acres of 60 acres in 1937 were still present as this community. The rest of the acreage had become 17 acres of Mesohaline Seepage Marsh, 7 acres of North Atlantic Low Salt Marsh, 4 acres of Reed Tidal Marsh, and 3 acres of Cattail Brackish Tidal Marsh (Table 5.123). Since 1937, this community has converted 39 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 4 acres of Successional Maritime Forest, 1 acre of Freshwater Tidal Mixed High Marsh, and 0.5 acres of Southern Red Maple-Blackgum Swamp (Table 5.124).

Table 5.123. What was once Wax-Myrtle Shrub Swamp in 1937 has become X in 2007	
X	**Acreage**
Wax-Myrtle Shrub Swamp	23 acres
Mesohaline Seepage Marsh	17 acres
North Atlantic Low Salt Marsh	7 acres
Reed Tidal Marsh	4 acres
Cattail Brackish Tidal Marsh	3 acres
Other communities/land covers	7 acres

Table 5.124. Wax-Myrtle Shrub Swamp has migrated into X since 1937	
X	**Acreage**
Chesapeake Bay Non-riverine Wet Hardwood Forest	39 acres
Wax-Myrtle Shrub Swamp	23 acres
Successional Maritime Forest	4 acres
Freshwater Tidal Mixed High Marsh	1 acre
Southern Red Maple-Blackgum Swamp	0.5 acres
Other communities/land covers	1 acre



	Dickerson Tract	Gray Farm Tract	Hollager Tract	Masten Tract	Penuel Tract	Milford Neck Wildlife Area
1937	4	22	26	5	3	60
2002	30	11	15	13	0	69
2007	30	12	13	13	0	68

Figure 5.65. Wax-Myrtle Shrub Swamp at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.125)

Wax-Myrtle Shrub Swamp will essentially be inundated with 0.5 m of sea level rise.

Table 5.125. Projected acres of Wax-Myrtle Shrub Swamp Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	64 acres
1 m	67 acres
1.5 m	67 acres

Natural Capital (Table 5.126)

Capital of Wax-Myrtle Shrub Swamp has increased overall since 1937 with a slight decrease from 2002 to 2007.

Table 5.126. Natural Capital of Wax-Myrtle Shrub Swamp	
Year	**Natural Capital (in 2012 dollars)**
1937	$556,884/year
2002	$640,417/year
2007	$631,135/year

CHAPTER 6: DESCRIPTIONS 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 its effects can also be seen in the impoundments, resulting in increased size of the impoundments from groundwater.

***Agricultural Field* [569 acres (Figure 6.1, Tables 6.1-6.4)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

In 1937 there were 855 acres in agricultural use. This has since decreased to 581 acres in 2002 and 569 acres in 2007. Most of these fields are planted in either corn or soybeans.

Analysis of Condition at Milford Neck Wildlife Area

Overall agricultural has been declining within the wildlife area, as it has with most wildlife areas. In 2007, 556 acres of 855 acres in 1937 still existed as agricultural field. The rest of the acreage had become 77 acres of Northeastern Old Field, 74 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 26 acres of Northeastern Successional Shrubland, and 25 acres of Early to Mid-Successional Loblolly Pine Forest (Table 6.1). Since 1937, agricultural field has been developed in 5 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, 3 acres of Early to Mid-Successional Loblolly Pine Forest, 2 acres of Semi-impervious Surface, and 1 acre of cultivated lawn (Table 6.2).

Table 6.1. What was once Agricultural Field in 1937 has become X in 2007

X	Acreage
Agricultural Field	556 acres
Northeastern Old Field	77 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	74 acres
Northeastern Successional Shrubland	26 acres
Early to Mid-Successional Loblolly Pine Forest	25 acres
Other communities/land covers	97 acres

Table 6.2. Agricultural Field has migrated into X since 1937	
X	**Acreage**
Agricultural Field	556 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	5 acres
Early to Mid-Successional Loblolly Pine Forest	3 acres
Semi-impervious Surface	2 acres
Cultivated Lawn	1 acre
Other communities/land covers	3 acres

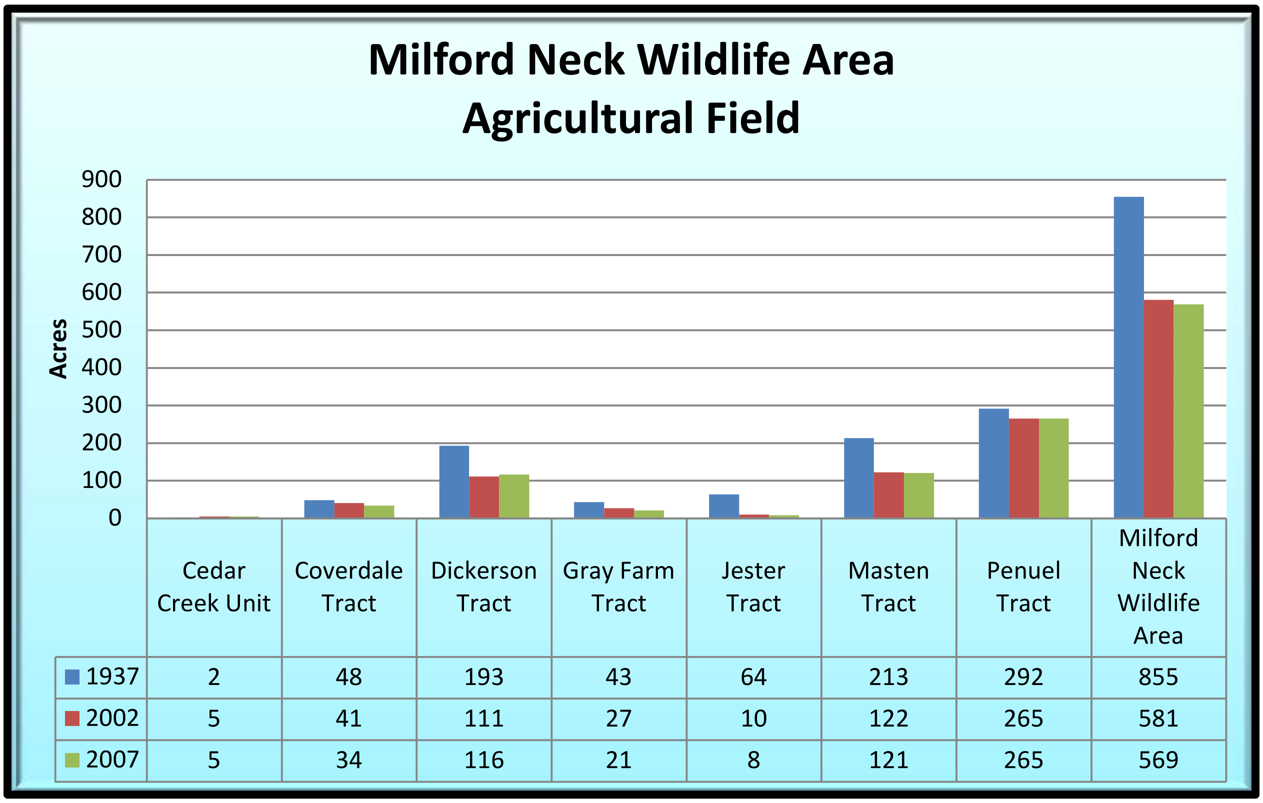


Figure 6.1. Agriculture Fields at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.3)

Only about 15% of the current acreage of agricultural field will be impacted by 1.5 m of sea level rise.

Table 6.3. Projected acres of Agricultural Field Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	17 acres
1 m	45 acres
1.5 m	87 acres

Natural Capital (Table 6.4)

Capital of agricultural field has been declining as more and more fields are abandoned.

Table 6.4. Natural Capital of Agricultural Field	
Year	**Natural Capital (in 2012 dollars)**
1937	$49,034/year
2002	$33,320/year
2007	$32,632/year

Beach **[8 acres (Figure 6.2, Tables 6.5-6.6)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

Beaches include the bare sandy areas that are adjacent to water in the bays. They can form in areas of high erosion.

Analysis of Condition at Milford Neck Wildlife Area

Beaches have been increasing in amount in the recent period and could indicate rising rates of erosion freeing sediments in the marsh and elsewhere. It is unknown whether this trend will continue. Beach was not present in 1937 and has since covered 6 acres of North Atlantic Low Salt Marsh and 2 acres of North Atlantic High Salt Marsh (Table 6.5).

Table 6.5. Beach has migrated into X since 1937

X	Acreage
North Atlantic Low Salt Marsh	6 acres
North Atlantic High Salt Marsh	2 acres

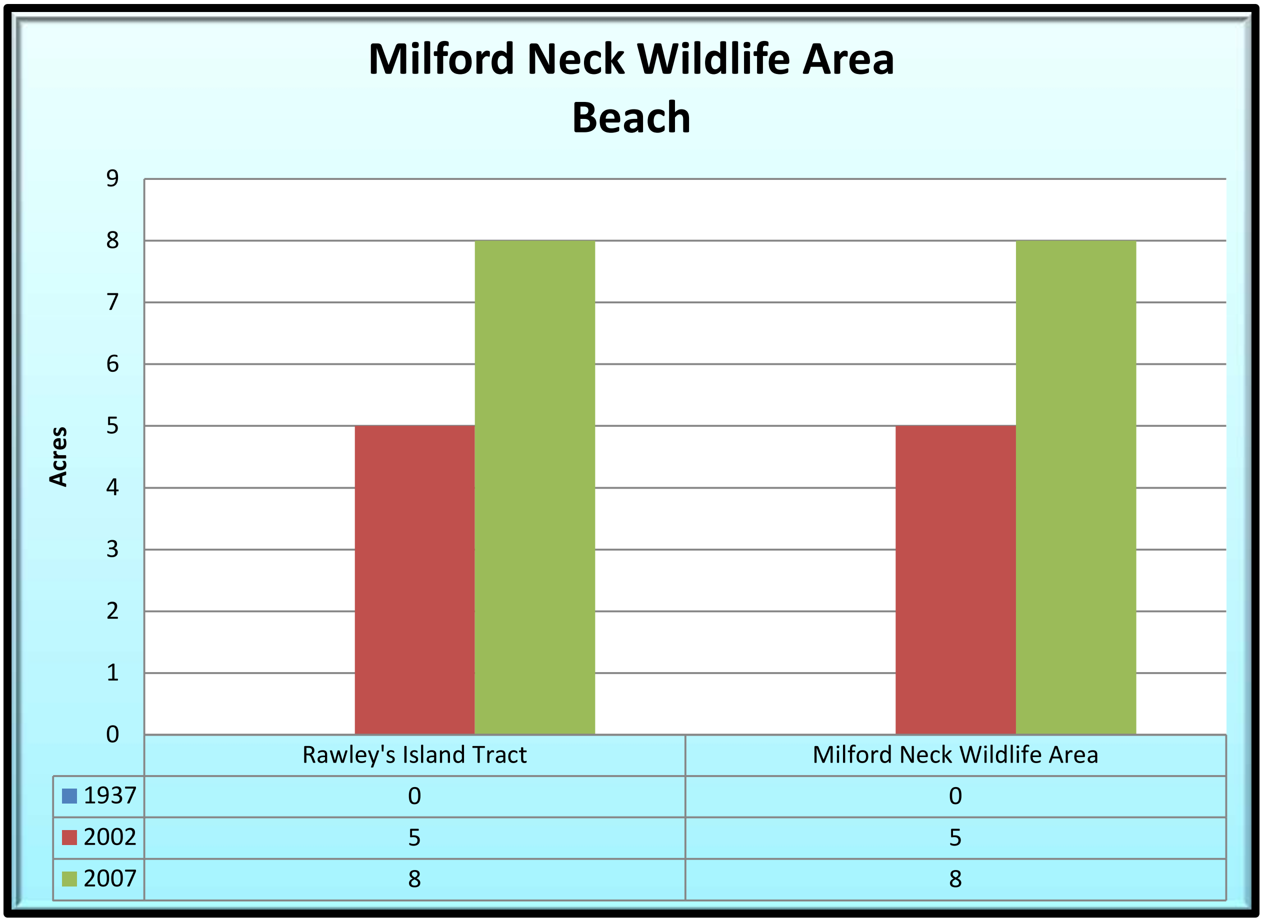


Figure 6.2. Beach at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.6)

All of the current acreage of Beach will be flooded by 1 m of sea level rise.

Table 6.3. Projected acres of Agricultural Field Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	8 acres
1.5 m	8 acres

Natural Capital

Beach does not have any natural capital value.

***Clear-cut* [0 acres (Figure 6.3, Table 6.7)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

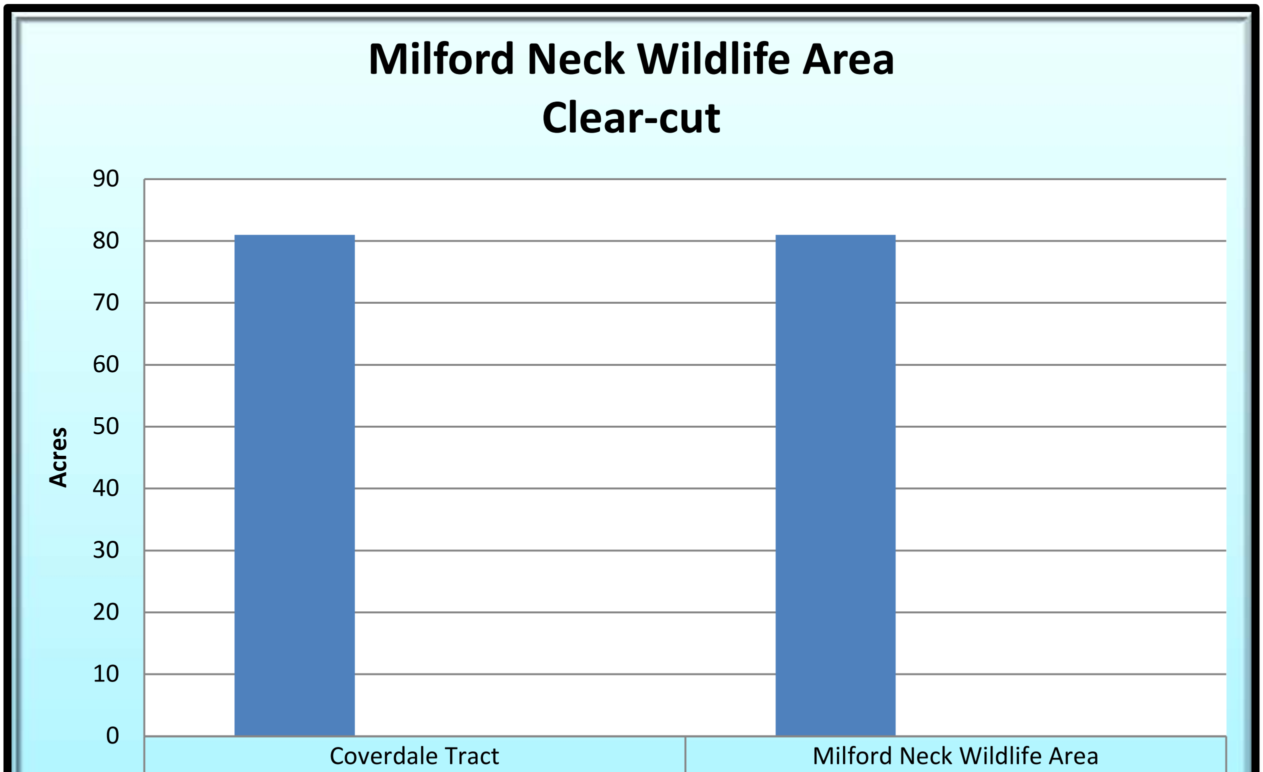
Clear-cuts include those areas that have been cut for timber but have not regenerated enough to become a distinct vegetation community again.

Analysis of Condition at Milford Neck Wildlife Area

Clear-cut was present in 1937 and is no longer present in the wildlife area. What was once clear-cut has become 71 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 6 acres of Powerline R-O-W, 3 acres of Northeastern Dry Oak-Hickory Forest, 0.3 acres of Agricultural Field, and 0.1 acres of Northeastern Old Field (Table 6.7).

Table 6.7. What was once Clear-cut in 1937 has become X in 2007

X	Acreage
Chesapeake Bay Non-riverine Wet Hardwood Forest	71 acres
Powerline R-O-W	6 acres
Northeastern Dry Oak-Hickory Forest	3 acres
Agricultural Field	0.3 acres
Northeastern Old Field	0.1 acres



	Coverdale Tract	Milford Neck Wildlife Area
1937	81	81
2002	0	0
2007	0	0

Figure 6.3. Clear-cut at Milford Neck Wildlife Area (1937, 2002, and 2007)

***Farm Pond/Artificial Pond* [1 acre (Figure 6.4, Tables 6.8-6.10)]**

DEWAP: Impoundment
NHC: No Equivalent Classification

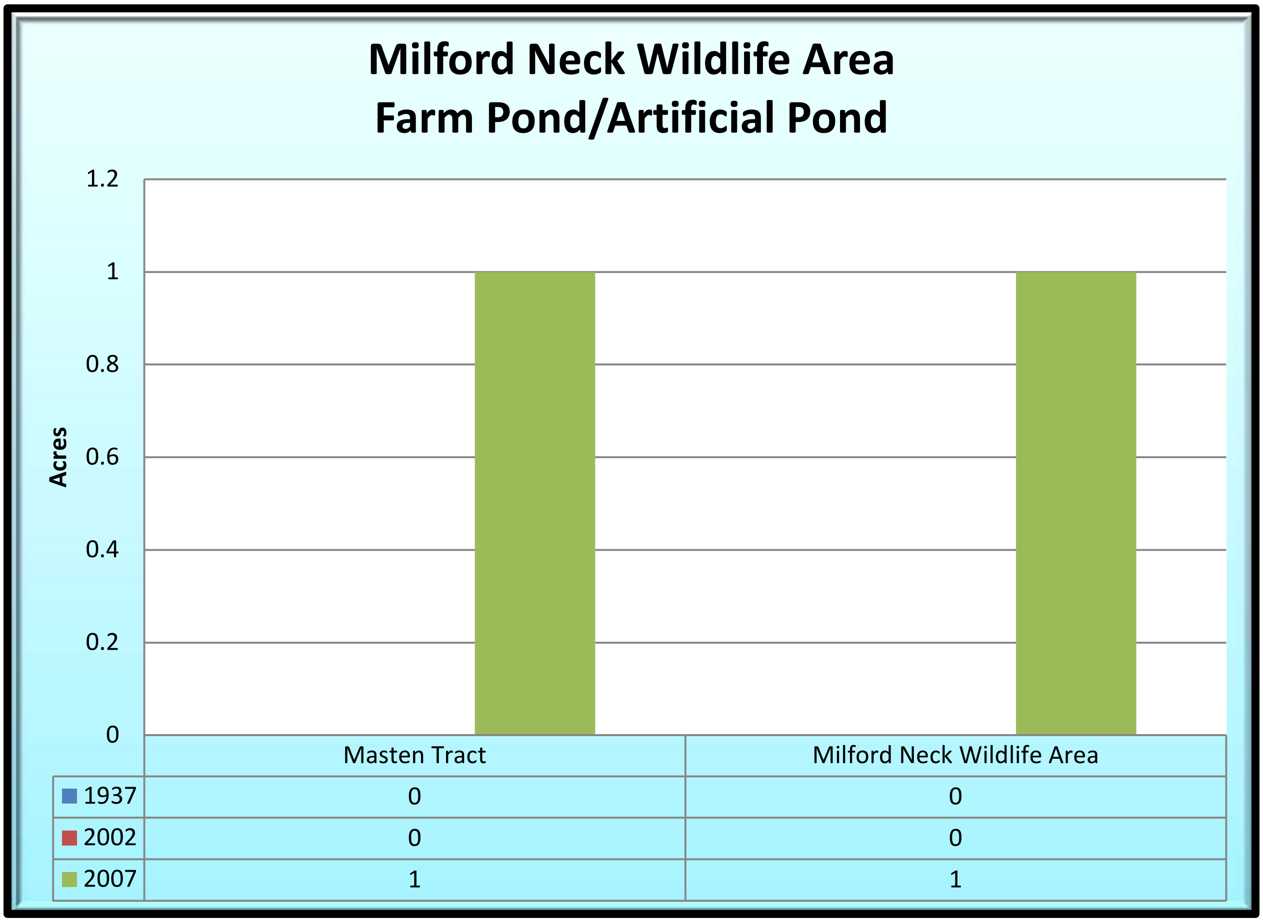
Description

Farm Ponds and Artificial Ponds are impoundments that are smaller than 5 acres. There is only one artificial pond in Milford Neck Wildlife which was created between 2002 and 2007.

Analysis of Condition at Milford Neck Wildlife Area

All of the current Farm Pond/Artificial Pond acreage in the wildlife area has come from 1 acre of Northeastern Old Field (Table 6.8).

Table 6.8. Farm Pond/Artificial Pond has migrated into X since 1937	
X	**Acreage**
Northeastern Old Field	1 acre



	Masten Tract	Milford Neck Wildlife Area
1937	0	0
2002	0	0
2007	1	1

Figure 6.4. Farm Pond/Artificial Pond at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.9)

None of the current Farm Pond/Artificial Pond acreage will be impacted by up to 1.5 m of sea level rise in the wildlife area.

Table 6.9. Projected acres of Farm Pond/Artificial Pond Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	0 acres

Natural Capital (Table 6.10)

Farm Pond/Artificial Pond was developed between 2002 and 2007 resulting in a capital increase for the wildlife area from Northeastern Old Field.

Table 6.10. Natural Capital of Farm Pond/Artificial Pond	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$0/year (not present)
2007	$5,335/year

***Impervious Surface* [1 acre (Figure 6.5, Tables 6.11-6.13)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

<u>*Description*</u>

Impervious surfaces have largely decreased in Milford Neck Wildlife Area with farming operations and associated structures disappearing.

<u>*Analysis of Condition at Milford Neck Wildlife Area*</u>

Impervious surface has decreased dramatically in the wildlife area since 1937, mostly stemming from the abandonment of a farm that was once present on the Penuel Tract. In 2007, only 0.2 acres of the 7 acres of impervious surface from 1937 was still present. The rest of the acreage had become 2 acres of Semi-impervious Surface, 1 acre of Chesapeake Bay Non-riverine Wet Hardwood Forest, 1 acre of agricultural field, 1 acre of Coastal Loblolly Pine Wetland Forest, and 1 acre of Northeastern Modified Successional Forest (Table 6.11). Since 1937, impervious surface has been developed in 0.3 acres of agricultural field, 0.1 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, and 0.1 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest (Table 6.12).

Table 6.11. What was once Impervious Surface in 1937 has become X in 2007

X	**Acreage**
Semi-impervious Surface	2 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	1 acre
Agricultural Field	1 acre
Coastal Loblolly Pine Wetland Forest	1 acre
Northeastern Modified Successional Forest	1 acre
Other communities/land covers	2 acres

Table 6.12. Impervious Surface has migrated into X since 1937

X	**Acreage**
Agricultural Field	0.3 acres
Impervious Surface	0.2 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	0.1 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	0.1 acres

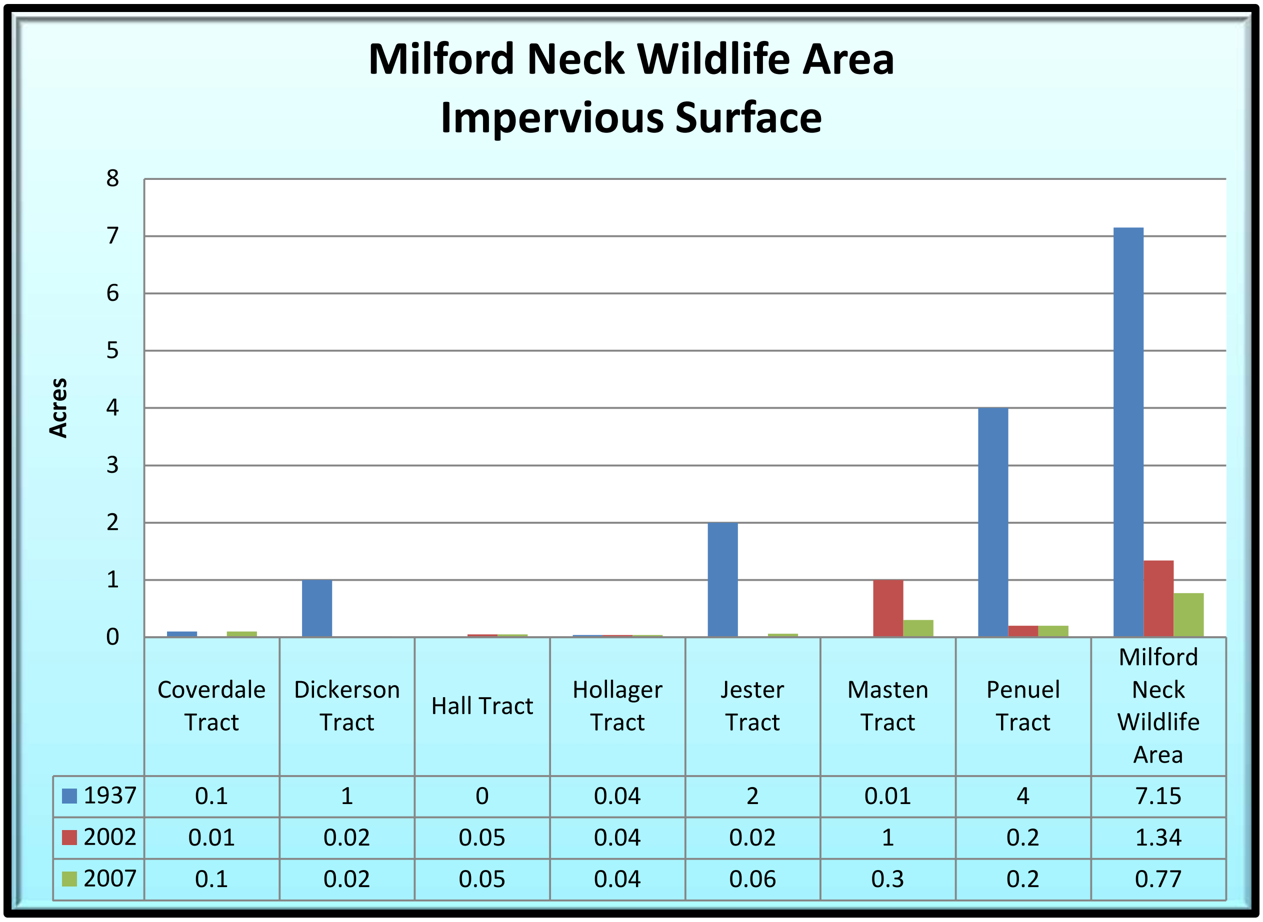


Figure 6.5. Impervious surface at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.13)

None of the current acreage of impervious surface will be impacted with 0.5 m of sea level rise. However 0.2 acres will be flooded with 1.5 m of rise.

Table 6.13. Projected acres of Impervious Surface Inundated by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	0.1 acres
1.5 m	0.2 acres

Natural Capital

Impervious Surface does not contain any natural capital value.

***Impoundment* [6 acres (Figure 6.6, Tables 6.14-6.16)]**

DEWAP: Impoundment
NHC: No Equivalent Classification

Description

Impoundments are man-made reservoirs that are greater than 5 acres in size. The only impoundment at Milford Neck Wildlife Area is in the Penuel Tract which was created between 1954 and 1961. It is location of Swamp-loosestrife Shrub Swamp, which is the only location for this community in the wildlife area.

Analysis of Condition at Milford Neck Wildlife Area

This artificially created community occupies a former tributary to a larger tributary flowing into the Murderkill River. To create it, 5 acres of Coastal Plain Oak Floodplain Swamp, 1 acre of Pickerelweed Tidal Marsh, and 0.4 acres of River Bulrush Flooded Grassland were flooded (Table 6.14).

Table 6.14. Impoundment has migrated into X since 1937

X	Acreage
Coastal Plain Oak Floodplain Swamp	5 acres
Pickerelweed Tidal Marsh	1 acre
River Bulrush Flooded Grassland	0.4 acres

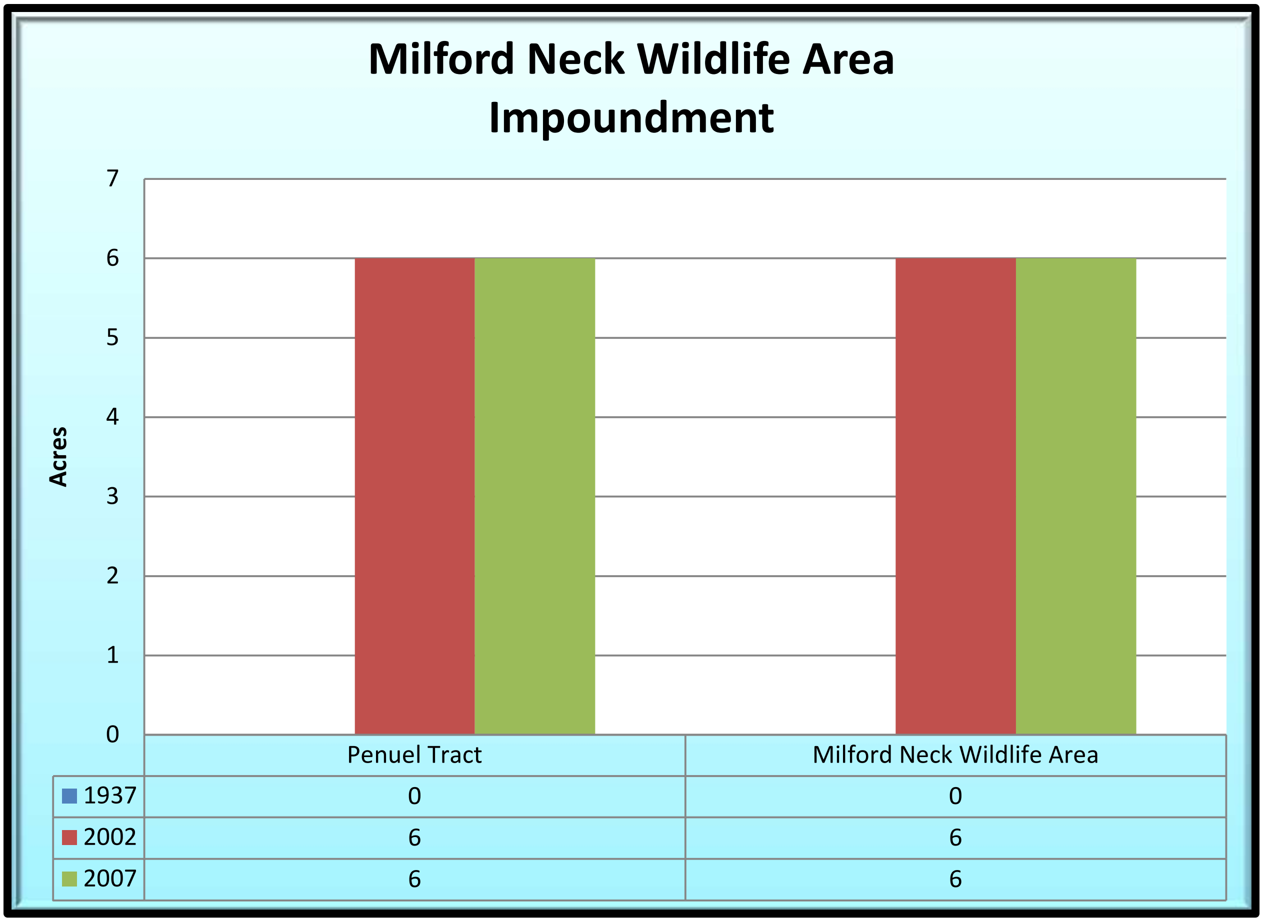


Figure 6.6. Impoundment at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.15)

The current impoundment in the wildlife area will be captured by 1 m of sea level rise.

Table 6.15. Projected acres of Impoundment Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	6 acres
1.5 m	6 acres

Natural Capital (Table 6.16)

Capital of impoundment equals $32,011/year and was gained through transfers from forest and marsh communities. Mostly this resulted in a capital gain for the wildlife area.

Table 6.16. Natural Capital of Impoundment	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$32,011/year
2007	$32,011/year

***Modified Land* [0.1 acres (Figure 6.7, Table 6.17)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

<u>Description</u>

Modified Lands are disturbed areas without any vegetation or very little vegetation.

<u>*Analysis of Condition at Milford Neck Wildlife Area*</u>

All of the Modified Land present in the wildlife area came from Chesapeake Bay Non-riverine Wet Hardwood Forest.

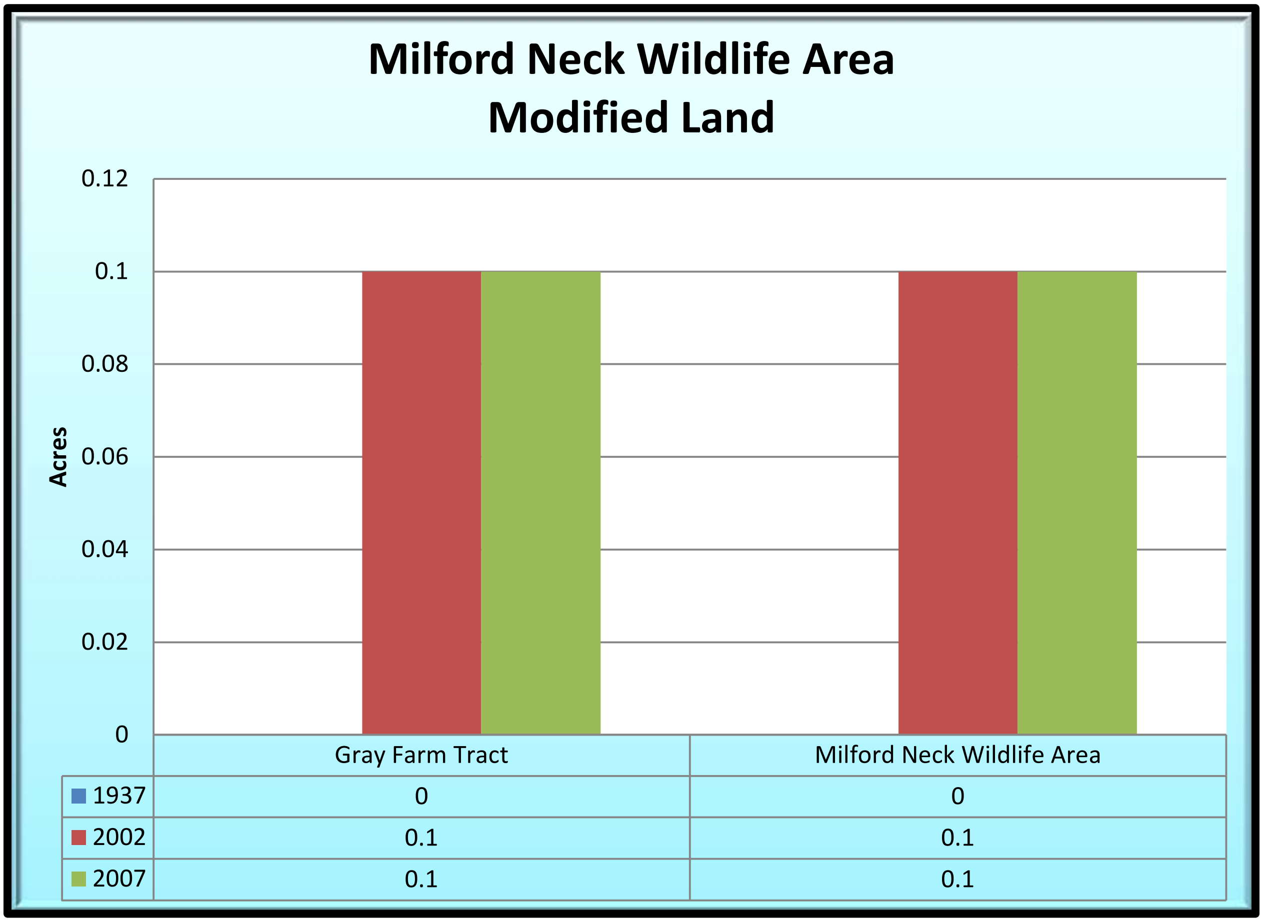


Figure 6.7. Modified Land at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.17)

None of the current modified land in the wildlife area will be impacted by up to 1.5 m of sea level rise.

Table 6.17. Projected acres of Modified Land Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	0 acres

Natural Capital

Modified Land does not contain any natural capital value.

***Powerline R-O-W* [6 acres (Figure 6.8, Tables 6.18-6.19)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

Powerline R-O-Ws often share a lot of the characteristics of the Northeastern Old Field and the Northeastern Successional Shrubland. They are found in the cleared areas underneath powerline R-O-Ws.

Analysis of Condition at Milford Neck Wildlife Area

The only powerline R-O-W in the wildlife area is located at the Coverdale Tract and was placed between 1937 and 2002 displacing 6 acres of clear-cut and 0.3 acres of agricultural field (Table 6.18)

Table 6.18. Powerline R-O-W has migrated into X since 1937

X	Acreage
Clear-cut	6 acres
Agricultural Field	0.3 acres

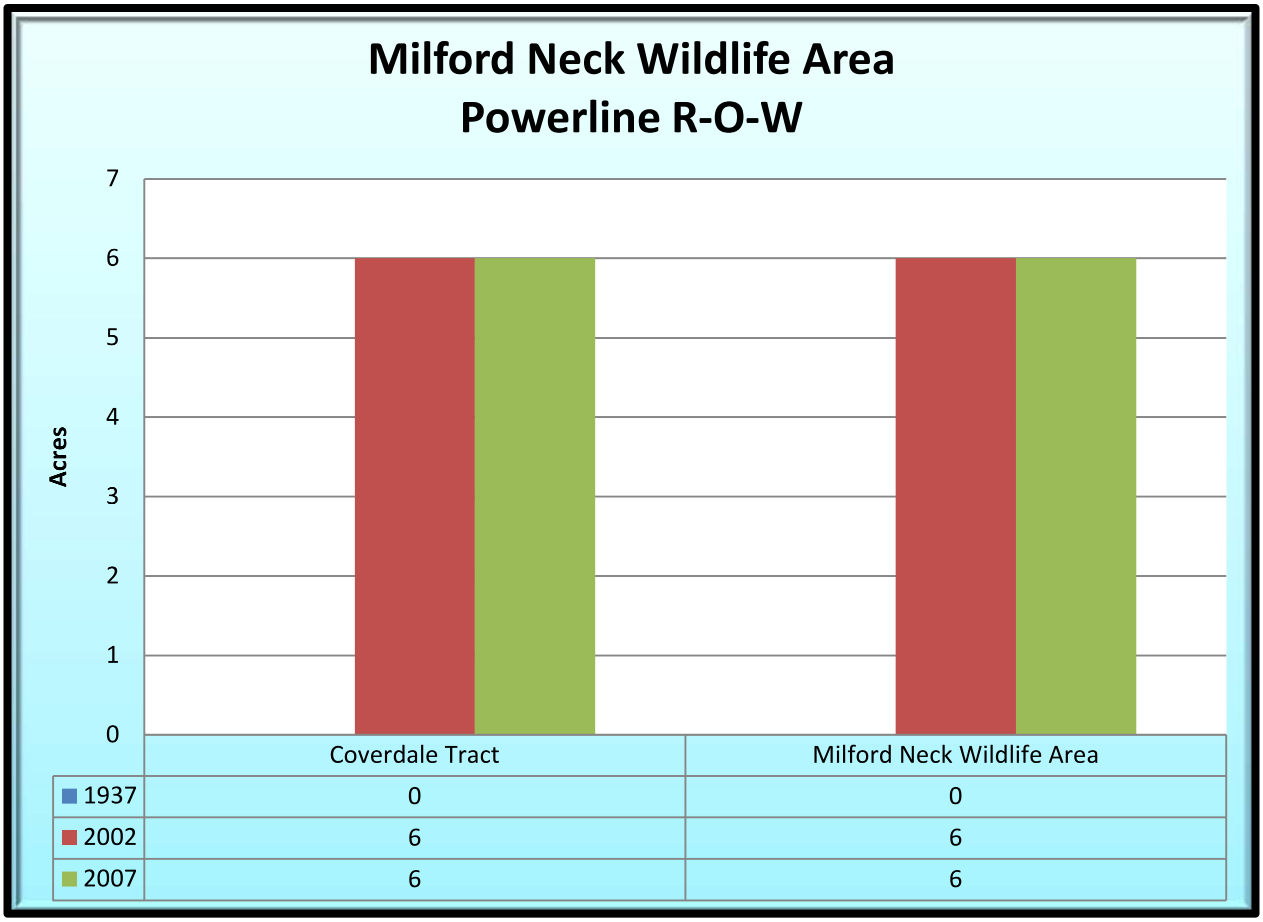


Figure 6.8. Powerline R-O-W at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.19)

None of the current Powerline R-O-W in the wildlife area will be impacted by up to 1.5 m of sea level rise.

Table 6.19. Projected acres of Powerline R-O-W Inundated by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	0 acres

Natural Capital

Powerline R-O-W does not contain any natural capital value.

Semi-impervious Surface **[9 acres (Figure 6.9, Tables 6.20-6.22)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

Most of the roads going through the wildlife area are dirt or semi-impervious area. A number of these roads have gone out of use with the abandonment of local farms leading to a decrease in the total amount of area.

Analysis of Condition at Milford Neck Wildlife Area

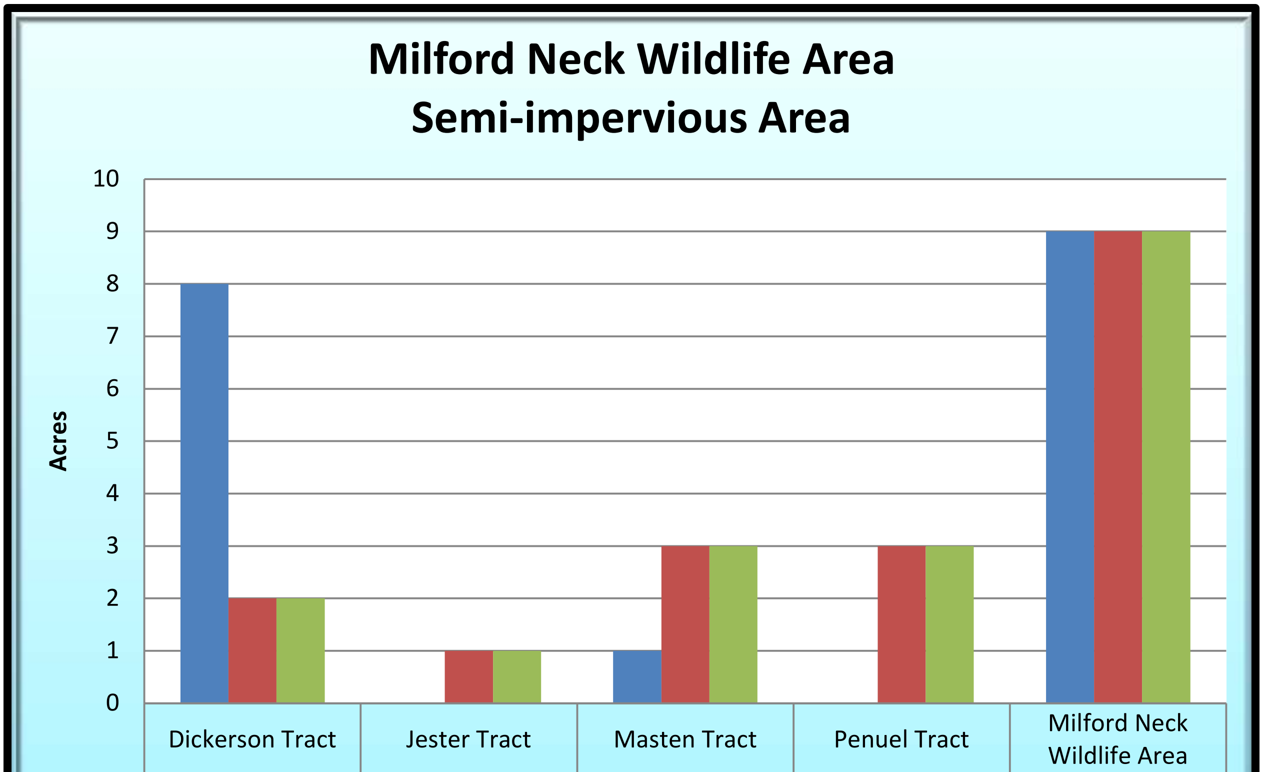
Semi-impervious Surface has remained at the same amount of acreage even though it has changed places over the years. In 2007, about 1 acre of the 9 acres from 1937 was still present as this land cover. The rest had become 2 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 2 acres of agricultural field, 2 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, and 1 acre of Successional Tuliptree Forest (Table 6.20). Since 1937, Semi-impervious Surface has been developed in 6 acres of agricultural field, 2 acres of impervious surface, 0.2 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, and 0.2 acres of Northeastern Old Field (Table 6.21).

Table 6.20. What was once Semi-impervious Surface in 1937 has become X in 2007

X	Acreage
Chesapeake Bay Non-riverine Wet Hardwood Forest	2 acres
Agricultural Field	2 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	2 acres
Successional Tuliptree Forest	1 acre
Semi-impervious Surface	1 acre
Other communities/land covers	1 acre

Table 6.21. Semi-impervious Surface has migrated into X since 1937

X	Acreage
Agricultural Field	6 acres
Impervious Surface	2 acres
Semi-impervious Surface	1 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	0.2 acres
Northeastern Old Field	0.2 acres
Other communities/land covers	0.3 acres



	Dickerson Tract	Jester Tract	Masten Tract	Penuel Tract	Milford Neck Wildlife Area
1937	8	0	1	0	9
2002	2	1	3	3	9
2007	2	1	3	3	9

Figure 6.9. Semi-impervious Surface at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.22)

About 1/3 of the current acreage of Semi-impervious surface will be inundated with 1.5 m of sea level rise.

Table 6.22. Projected acres of Semi-impervious Surface Inundated by Sea Level Rise

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

Natural Capital

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

***Tidal Mudflat* [30 acres (Figure 6.10, Tables 6.23-6.26)]**

DEWAP: Nearshore Habitats
NHC: No Equivalent Classification

Description

Tidal mudflats are ephemeral and go up and down in amount as marsh converts to water.

Analysis of Condition at Milford Neck Wildlife Area

In 2007, 0.1 acres of 18 acres of Tidal Mudflat from 1937 still existed. The rest of the acreage had become 10 acres of North Atlantic Low Salt Marsh, 8 acres of Water, 0.1 acres of Irregularly Flooded Eastern Tidal Salt Shrub, and 0.1 acres of North Atlantic High Salt Marsh (Table 6.23).

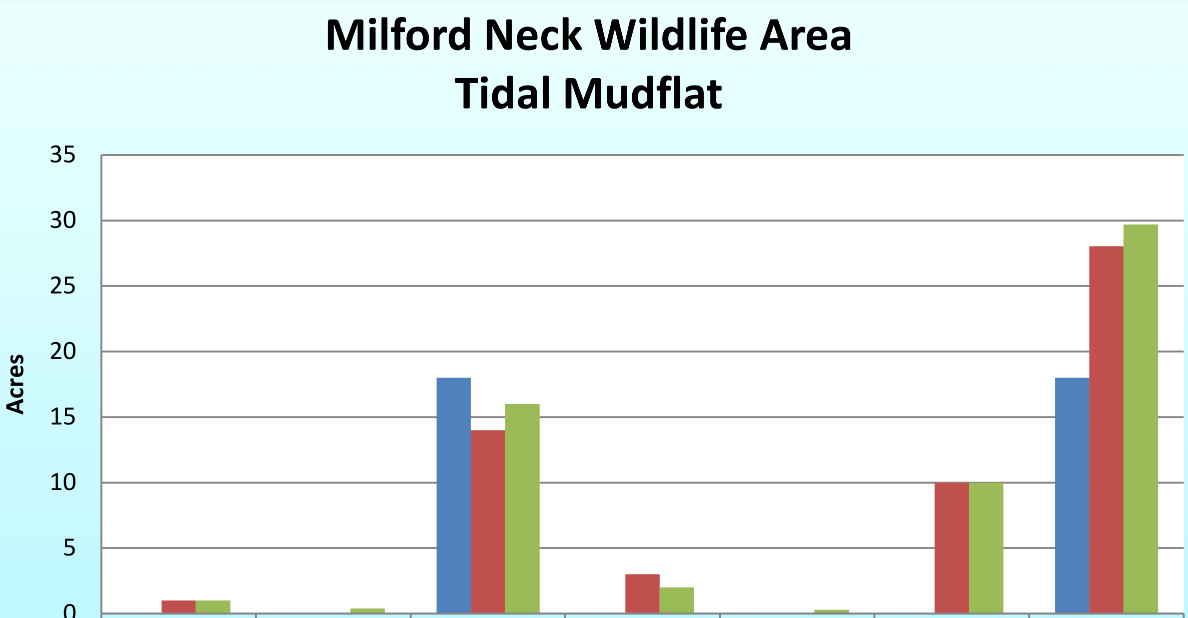
Since 1937, tidal mudflat consumed 21 acres of North Atlantic Low Salt Marsh, 5 acres of North Atlantic High Salt Marsh, 2 acres of Freshwater Tidal Mixed High Marsh, 1 acre of water, and 1 acre of Wax-Myrtle Shrub Swamp (Table 6.24).

Table 6.23. What was once Tidal Mudflat in 1937 has become X in 2007

X	**Acreage**
North Atlantic Low Salt Marsh	10 acres
Water	8 acres
Tidal Mudflat	0.1 acres
Irregularly Flooded Eastern Tidal Salt Shrub	0.1 acres
North Atlantic High Salt Marsh	0.1 acres

Table 6.24. Tidal Mudflat has migrated into X since 1937

X	**Acreage**
North Atlantic Low Salt Marsh	21 acres
North Atlantic High Salt Marsh	5 acres
Freshwater Tidal Mixed High Marsh	2 acres
Water	1 acre
Wax-Myrtle Shrub Swamp	1 acre
Other communities/land covers	1 acre



	Cedar Creek Unit	Hollager Tract	Jester Tract	Masten Tract	Penuel Tract	Rawley's Island Tract	Milford Neck Wildlife Area
1937	0	0	18	0	0	0	18
2002	1	0	14	3	0.04	10	28.04
2007	1	0.4	16	2	0.3	10	29.7

Figure 6.10. Tidal Mudflat at Milford Neck Wildlife Area (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 6.25)

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

Table 6.25. Projected acres of Tidal Mudflat Inundated by Sea Level Rise

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

Natural Capital (Table 6.26)

Capital of mudflats has been gradually increasing through time. It is unknown whether this is caused by sea level rise or not.

Table 6.26. Natural Capital of Tidal Mudflat	
Year	**Natural Capital (in 2012 dollars)**
1937	$112,883/year
2002	$175,847/year
2007	$186,258/year

***Water* [266 acres (Figure 6.11, Tables 6.27-6.29)]**

DEWAP: Nearshore Habitats
NHC: No Equivalent Classification

Description

Water includes water areas that are subject to tide, streams, and other water areas that are not part of a Farm Pond/Artificial Pond or impoundment.

Analysis of Condition at Milford Neck Wildlife Area

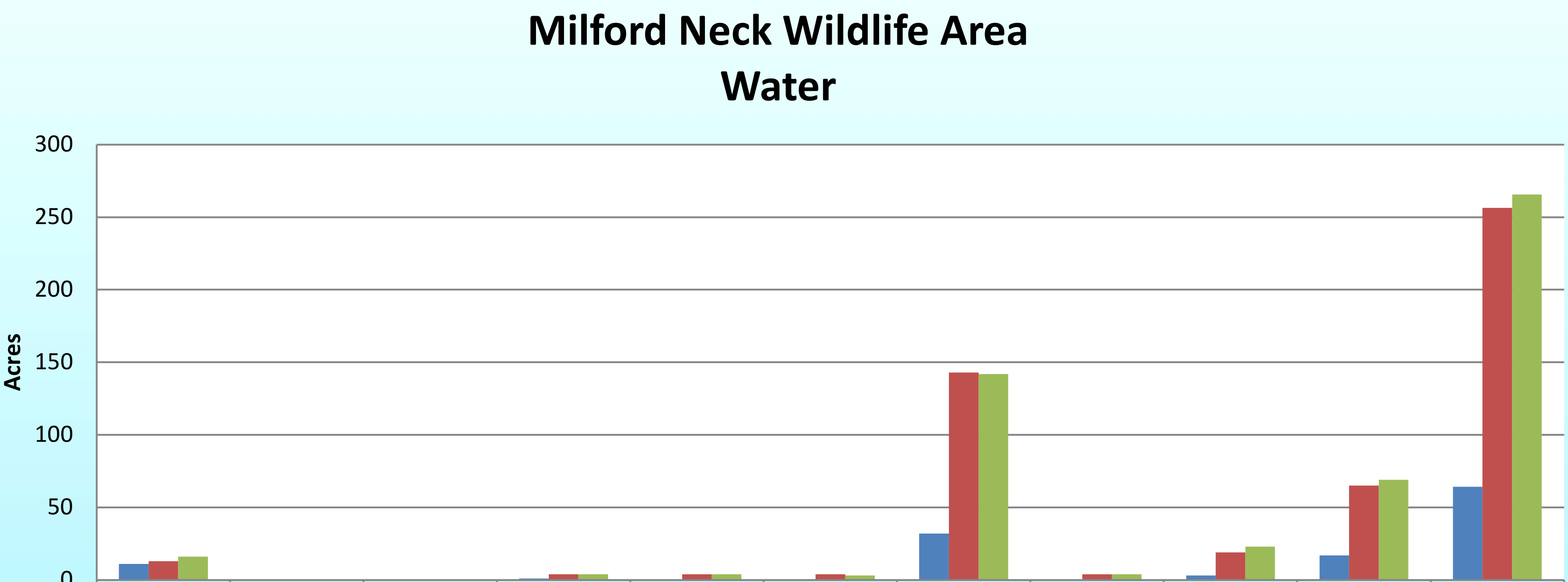
About 27 acres of the 64 acres of water present in 1937 still existed in 2007. The rest of the acreage had become 30 acres of North Atlantic Low Salt Marsh, 4 acres of Reed Tidal Marsh, 1 acre of Irregularly Flooded Eastern Tidal Salt Shrub, and 1 acre of North Atlantic High Salt Marsh (Table 6.27). Since 1937, water has covered 157 acres of North Atlantic Low Salt Marsh, 26 acres of North Atlantic High Salt Marsh, 14 acres of Northeastern Old Field, and 10 acres of Cattail Brackish Tidal Marsh (Table 6.28).

Table 6.27. What was once Water in 1937 has become X in 2007

X	Acreage
North Atlantic Low Salt Marsh	30 acres
Water	27 acres
Reed Tidal Marsh	4 acres
Irregularly Flooded Eastern Tidal Salt Shrub	1 acre
North Atlantic High Salt Marsh	1 acre
Other communities/land covers	1 acre

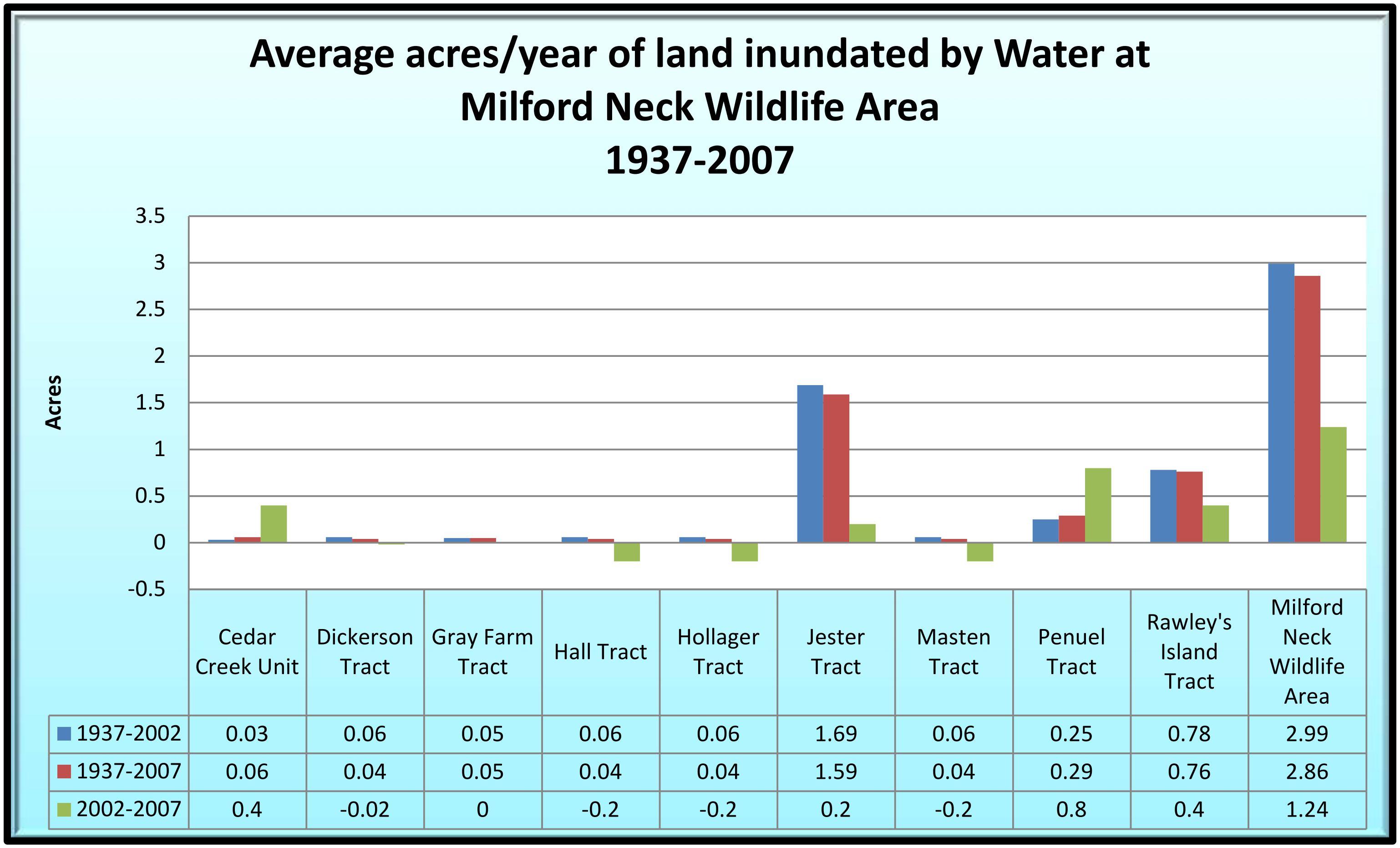
Table 6.28. Water has migrated into X since 1937

X	Acreage
North Atlantic Low Salt Marsh	157 acres
Water	27 acres
North Atlantic High Salt Marsh	26 acres
Northeastern Old Field	14 acres
Cattail Brackish Tidal Marsh	10 acres
Other communities/land covers	31 acres



	Cedar Creek Unit	Coverdale Tract	Dickerson Tract	Gray Farm Tract	Hall Tract	Hollager Tract	Jester Tract	Masten Tract	Penuel Tract	Rawley's Island Tract	Milford Neck Wildlife Area
1937	11	0	0	1	0	0	32	0.3	3	17	64.3
2002	13	0	0.4	4	4	4	143	4	19	65	256.4
2007	16	0.3	0.3	4	4	3	142	4	23	69	265.6

Figure 6.11. Water at Milford Neck Wildlife Area (1937, 2002, and 2007)



	Cedar Creek Unit	Dickerson Tract	Gray Farm Tract	Hall Tract	Hollager Tract	Jester Tract	Masten Tract	Penuel Tract	Rawley's Island Tract	Milford Neck Wildlife Area
1937-2002	0.03	0.06	0.05	0.06	0.06	1.69	0.06	0.25	0.78	2.99
1937-2007	0.06	0.04	0.05	0.04	0.04	1.59	0.04	0.29	0.76	2.86
2002-2007	0.4	-0.02	0	-0.2	-0.2	0.2	-0.2	0.8	0.4	1.24

Figure 6.12. Acres of land per year converted to water at Milford Neck Wildlife Area (1937, 2002, and 2007)

Natural Capital (Table 6.29)

Capital of mudflats has been gradually increasing through time. It is unknown whether this is caused by sea level rise or not.

Table 6.29. Natural Capital of Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$885,611/year
2002	$3,428,404/year
2007	$3,531,474/year

Appendix I: State rare vegetation ranking criteria

Ranks are based on a system developed by The Nature Conservancy and Natureserve to measure the relative rarity of vegetation communities within a given state. State rarity ranks are used to prioritize conservation and protection efforts so that the rarest of vegetation communities receive immediate attention. The primary criteria for ranking vegetation communities are the total number of documented occurrences with consideration given to the total number of occurrences and total amount of acreage in the state. Ranks for vegetation communities are updated annually and are based on current knowledge and mapping being done for the Guide to Delaware Vegetation Communities.

State Rank

S1 Extremely rare (i.e., typically 5 or fewer occurrences statewide), or may be susceptible to extirpation because of other threats to its existence.

S1.1 Only a single occurrence or population of the species is known to occur. (this rank is only applied to plants.)

S2 Very rare, (i.e., typically 6 to 20 occurrences statewide), or may be susceptible to extirpation because other threats to its existence.

S3 Rare to uncommon, not yet susceptible to extirpation but may be if additional populations are destroyed. Approximately 21 to 100 occurrences statewide.

S4 Common, apparently secure in the state under present conditions.

S5 Very common, secure in the state under present conditions.

SH Historically known, but not verified for an extended period (usually 15+ years); there are expectations that the species may be rediscovered.

SX Extirpated or presumed extirpated from the state. All historical locations and/or potential habitat have been surveyed.

SU Status uncertain within the state. Usually an uncommon species which is believed to be of conservation concern, but there is inadequate data to determine the degree of rarity.

SNR Unranked

SNA Not Applicable

SW Weedy vegetation or vegetation dominated by invasive alien species (this rank is only applied to natural communities).

SM Vegetation resulting from management or modification of natural vegetation. It is readily restorable by management or time and/or the restoration of original ecological processes (this rank is only applied to natural communities).

APPENDIX II: SGCN SPECIES EXPECTED FOR KEY WILDLIFE HABITATS

SGCN Species expected in Beach and Dune Habitats			
Species	**Common Name**	**Class**	**Tier**
Cincindela dorsalis media	white tiger beetle	Insect	1
Cincindela lepida	little white tiger beetle	Insect	1
Malaclemys terrapin terrapin	Northern diamondback terrapin	Reptile	1
Charadrius melodus	Piping plover	Bird	1
Haematopus palliatus	American Oystercatcher	Bird	1
Arenaria interpres	ruddy turnstone	Bird	1
Calidris canutus	Red knot	Bird	1
Calidrius alba	sanderling	Bird	1
Sterna hirundo	common tern	Bird	1
Sterna antillarum	least tern	Bird	1
Rynchops niger	black skimmer	Bird	1
Chordeiles minor	common nighthawk	Bird	1
Cincindela dorsalis	Eastern beach tiger beetle	Bird	2
Cincindela hirticolis	beach-dune tiger beetle	Bird	2
Melitara prodenialis	a snout-moth	Bird	2
Drasteria graphica atlantica	Atlantic graphic moth	Bird	2
Schinia spinosae	a noctuid moth	Bird	2
Falco peregrinus	peregrine falcon	Bird	2
Pluvialis squatarola	black-bellied plover	Bird	2
Catoptrophorus semipalmatus	willet	Bird	2
Calidris pusilla	semi-palmated sandpiper	Bird	2
Calidris maritima	purple sandpiper	Bird	2
Calidris alpina	dunlin	Bird	2
Larus marinus	great black-backed gull	Bird	2
Piplio erythrophthalmus	Eastern towhee	Bird	2
Passerculus sandwichensis	savannah sparrow	Bird	2

SGCN Species expected in 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 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 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 Freshwater Tidal Marshes			
Paones massasoit chermockii	Chermock's Mulberry Wine	Insect	1
Nannothemis bella	Elfin Skimmer	Insect	1
Clemmys guttata	Spotted Turtle	Reptile	1
Podilymbus podiceps	Pied-billed grebe	Bird	1
Nycticorax nycticorax	Black-crowned night heron	Bird	1
Nyctanassa violacea	Yellow-crowned night heron	Bird	1
Pandion haliaetus	osprey	Bird	1
Lycaena hyllus	Bronze copper	Insect	2
Papaipema birdii	Umbellifer borer moth	Insect	2
Libellula axilena	Bar-winged skimmer	Insect	2
Argia bipunctulata	Seepage dancer	Insect	2
Nehalennia gracilis	Sphagnum sprite	Insect	2
Botaurus lentiginosus	American bittern	Bird	2
Ixobrychus exilis	Least Bittern	Bird	2
Ardea herodias	Great blue heron	Bird	2
Casmeridius albus	Great egret	Bird	2
Egretta thula	Snowy egret	Bird	2
Egretta caerulea	Little blue heron	Bird	2
Egretta tricolor	Tricolored heron	Bird	2
Bubulcus ibis	Cattle egret	Bird	2
Anas platyrhynchos	mallard	Bird	2
Rallus elegans	King rail	Bird	2
Porzana carolina	sora	Bird	2
Dolichonyx oryzivorus	bobolink	Bird	2

SGCN Species expected in 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 Nearshore Habitats			
Species	**Common Name**	**Class**	**Tier**
Callinectes sapidus	Blue crab	Crustaceans	1
Limulus polyphemus	Horseshoe crab	Arachinids	1
Pristis pectinata	Smalltooth sawfish	Fish	1
Acipenser brevirostrum	Shortnose sturgeon	Fish	1
Acipenser oxyrinchus	Atlantic sturgeon	Fish	1
Caretta caretta	Loggerhead sea turtle	Reptile	1
Chelonia mydas	Atlantic green turtle	Reptile	1
Lepidochelys kempii	Kemp's Ridley sea turtle	Reptile	1
Branta canadensis	Canada goose (migratory)	Bird	1
Pandion haliaetus	Osprey	Bird	1
Phocoena phocoena	Harbor porpoise	Mammal	1
Balaenoptera physalus	Fin whale	Mammal	1
Megaptera novaeangliae	Humpback whale	Mammal	1
Balaena glacialis	Northern right whale	Mammal	1
Cetorhinus maximus	Basking shark	Fish	2
Carcharodon carcharias	White shark	Fish	2
Carcharhinus obscurus	Dusky shark	Fish	2
Squatina dumeril	Atlantic angel shark	Fish	2
Alosa mediocris	Hickory shad	Fish	2
Apeltes quadracus	Fourspine stickleback	Fish	2
Eretmochelys imbricata imbricate	Hawksbill	Reptile	2
Pelecanus occidentalis	Brown pelican	Bird	2
Phalacrocorax carbo	great cormorant	Bird	2
Phalacrocorax auritus	Double-crested cormorant	Bird	2
Cygnus columbianus	Tundra swan	Bird	2
Branta bemicla	brant	Bird	2
Aythya valisineria	Canvasback	Bird	2
Aythya americana	Redhead	Bird	2
Aythya marila	Greater scaup	Bird	2
Aythya affinis	Lesser scaup	Bird	2
Clangula hyemalis	Oldsquaw	Bird	2
Melanitta nigra	Black scoter	Bird	2
Melanitta perspicillata	Surf scoter	Bird	2
Melanitta fusca	White-winged scoter	Bird	2

Bucephala albeola	bufflehead	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