Historical Analysis and Map of Vegetation Communities, Land Covers, and Habitats of Thompson Island Nature Preserve Sussex County, Delaware

Lewes and Rehoboth Canal and Rehoboth Bay Watersheds

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Table of Contents

Chapter 1: Introduction and Methods 4
Setting of Thompson Island Nature Preserve 4
Soils and Geology of Thompson Island Nature Preserve 5
Underlying Geology 5
Soils 5
Elevation 6
Discussion of vegetation communities in general and why they are important in management 6
Discussion of Sea-Level Rise and why it may affect the vegetation communities at Thompson Island Nature Preserve 6
Components of Sea Level Rise 8
Eustatic Rise 8
Stearic Rise 8
Isostatic Rise 8
All of these factors added together 9
Using vegetation communities to map sea level rise and changes in the landscape 9
Purpose of the Study 10
Vegetation Community and Land Cover Surveys 11
Analysis of Historical Imagery 11
Ecological Integrity Assessment (EIA) 11
Forest Block Analysis 11
Natural Capital Analysis 12
Chapter 2: Results, EIAs, and General Observations 13
Summary of Findings from this study 13
1. Vegetation Communities: 13
2. Rare Plants: 13
3. Rare Animals: 13
Ecological Integrity Assessment (EIA) 13
The Natural Progression of vegetation communities on the shores of the Inland Bays 14
Chapter 3: Broad Trends at Thompson Island Nature Preserve 15
Chapter 4: Descriptions and Analysis of the Vegetation Communities 35
Chapter 5: Descriptions and Analysis of the Land Covers 79

Appendix I: State rare vegetation ranking criteria 87
Appendix II: SGCN Species expected for Key Wildlife Habitats 88

CHAPTER 1: INTRODUCTION AND METHODS

Setting of Thompson Island Nature Preserve

Thompson Island Nature Preserve is located in southeastern Sussex County, Delaware (Figure 1.1). One tract, totaling 206 acres comprises the nature preserve. The preserve can roughly be divided into three sections with marshland between each section.

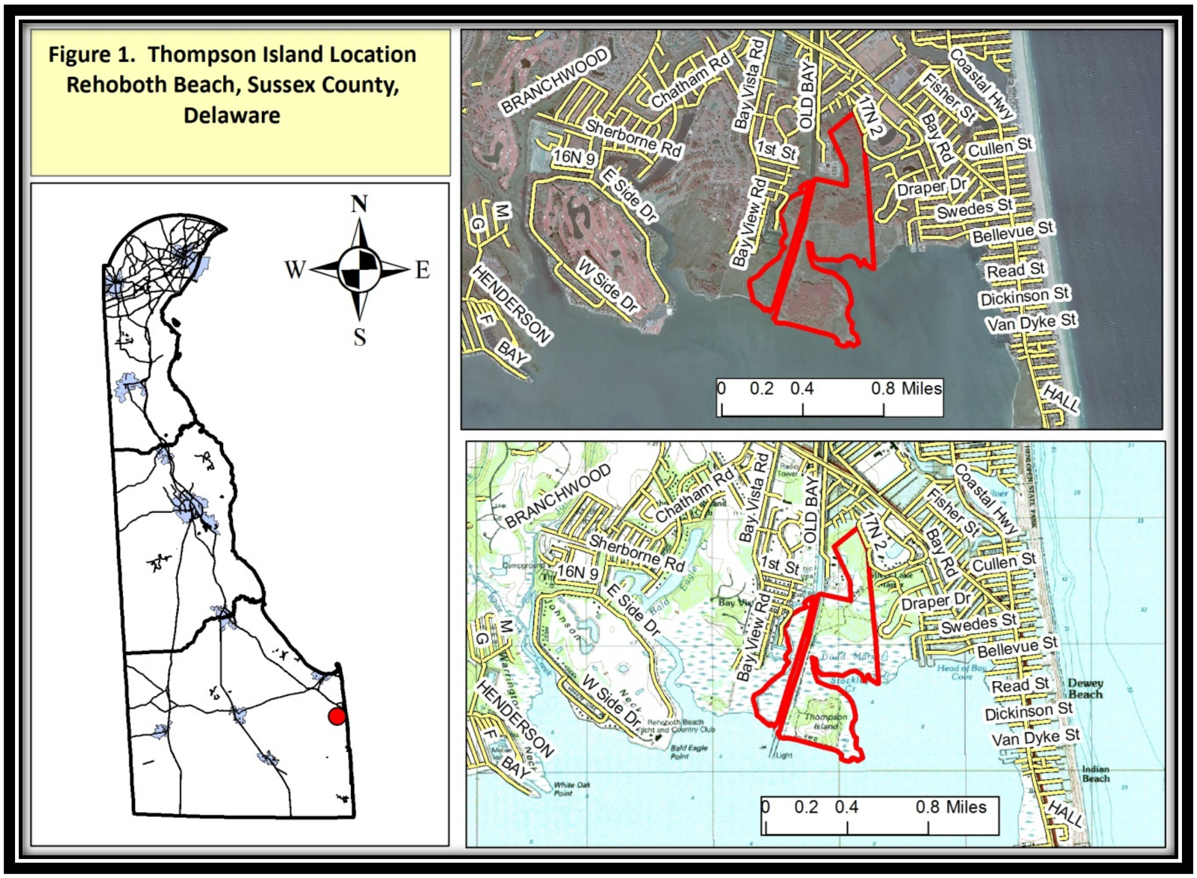

Figure 1.1. Thompson Island Location

Soils and Geology of Thompson Island Nature Preserve

Underlying Geology

The Thompson Island area is underlain presumably by either the Scotts Corners or Lynch Heights Formation, however, none of the published geologic maps directly cover this area. The marshes would be underlain by marsh deposits.

Soils

Fort Mott loamy sand, Transquaking and Mispillion soils, Broadkill mucky peat, and Hurlock loamy sand are the most common soils at Thompson Island Nature Preserve. Two minor soils including Evesboro loamy sand and Brockatonorton-Urban land complex are also present.

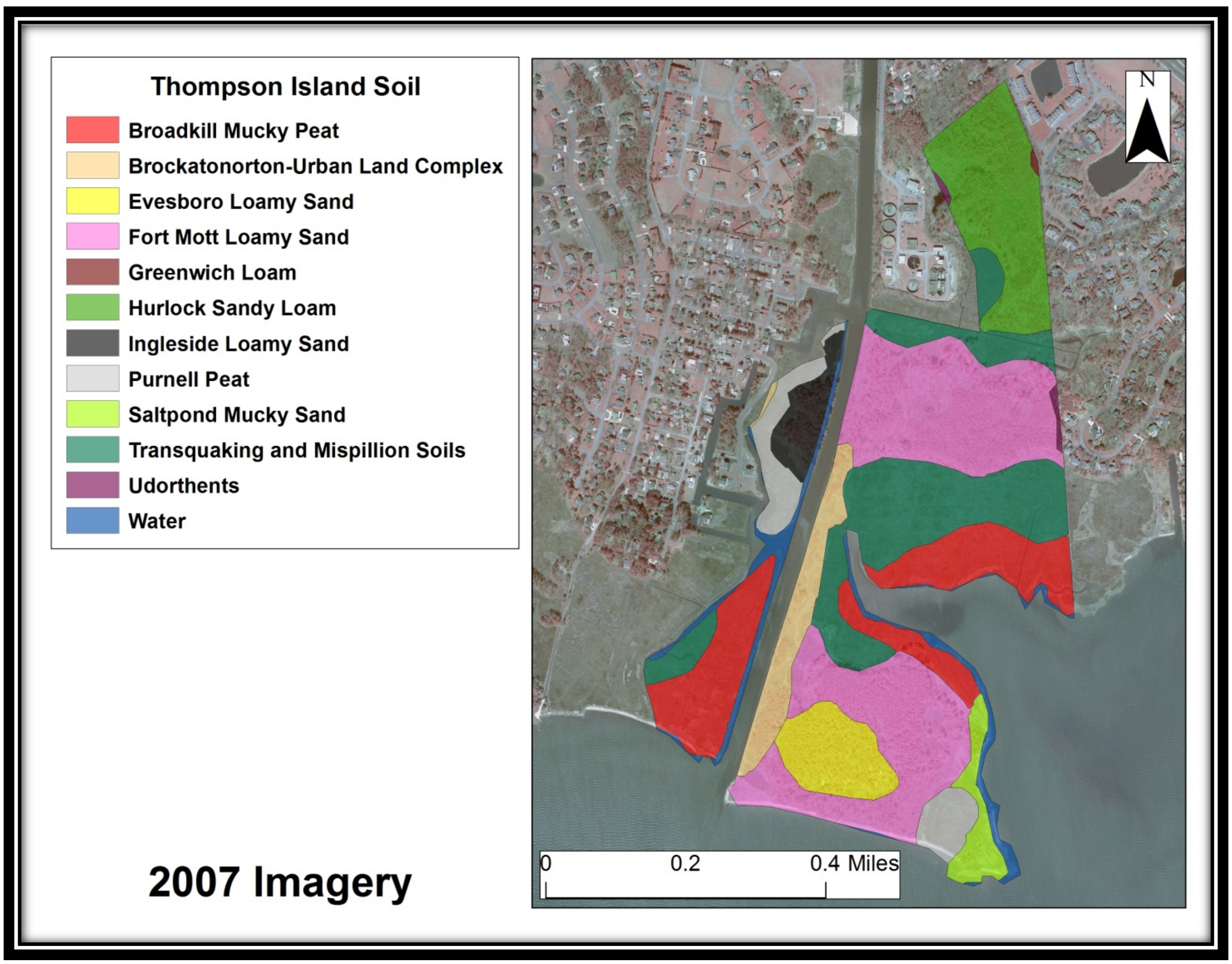

Figure 1.2. Thompson Island Soil Map

Elevation

Elevation of the site ranges from sea level at the bay and marshes to 20 feet at the center Thompson Island. The site is dissected by marshes and Thompson Island itself is highest at the center and slopes to all sides.

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 Thompson Island Nature Preserve

To understand the effects of sea-level rise on vegetation communities near the coast one can look at what has happened historically. From the late Pleistocene period to 5,000 years ago, sea-level rise in Delaware was about 3 cm/decade (30 cm/100 years). From 3,000 years to the recent past it has been rising 1 cm/decade (10 cm/100 years).[1] More recent data from the Indian River Inlet (1972-1983) shows the rate of rise to be 3.73 mm/year and at Lewes (1919-2009), 3.24 mm/year[2]. More recent historical ground data from the National Aeronautics and Space Administration (NASA) from 1870 to 2000 has shown a sea level rise of 1.7 mm/year or 1.7 cm/decade. Even more recent data from the Jason satellites (1993-present) has shown an increase in the rise to 3.28 mm/year or 3.3 cm/decade.[3] This is above the fast rate of rise seen from the Late Pleistocene to 5,000 years ago. Jay Custer in his book Prehistoric cultures of the Delmarva Peninsula states that "Rising sea-level had three major effects on the environments of the Delmarva Peninsula: changes in the availability and distribution of coastal resources, changes in interior water tables, and potential changes in local air mass distributions and weather patterns. Changing availability of coastal resources with sea-level is related both to the rate of sea-level rise and changing shoreline topography. Before 3,000 years ago the rate of sea-level rise was so great that stable estuarine environments did not have time to develop". The slower sea-level rise

[1] 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).
[2] Data from Permanent Service for Mean Sea Level website (www.psmsl.org)
[3] NASA Global Climate Change Website (http://climate.nasa.gov/keyindicators) December 12, 2010 update.

after this time has allowed estuaries and marshes to increase in size, by lateral erosion.[4] Sea-level rise can also cause water tables to rise, water logging swamps away from the coast, a fact that has been stated in elsewhere in the Mid-Atlantic [5],[6], [7]. 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[8] , the difference of which is caused by geological subsidence from the glaciers of the last ice age. The rate sea-level rise now is equal to the time historically when estuaries and marshes did not have time to develop. Marshes have been accreting about 3 mm/year for the past 100 years [9], but the current rate of sea level rise is above the accretion rate resulting in losses. It is projected to go much higher with rates of 10 cm/decade (1 m/100 years) as a median[10]. Kraft and Khalequzzaman project that most of the fringing salt marshes in Delaware will be eliminated in 200-300 years and by extinct in 1,500 to 1,700 years.[11] Other investigators have pointed out that there is a lack of temporal scale to a lot of the studies and that there may be a significant time lag between sea level rise and anthropogenic inputs of carbon dioxide. [12] These changes would also impact the fisheries and economy related to it in the area.

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

[5] 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).

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

[7] 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).

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

[9] 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.

[10] 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.

[11] 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.

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

Components of Sea Level Rise

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

Eustatic Rise

Most people think of this factor when they talk about sea level rise. This is the contribution of increased water volume coming from the melting of glaciers, snowpack, and groundwater extraction. Using the figure for Indian River Inlet above this accounts for about 1.2 mm/year of the rise when subtracted from the other factors[13]. Added to this is newer research that shows groundwater depletion is adding 0.8 mm/year to sea level rise[14]. 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[15]. 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[16]. 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[17], 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[18]. 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[19].

Isostatic Rise

Geological land subsidence adds the most to the rise currently accounting for about 1.6 mm/year[20] in the Mid-Atlantic region. Another study has given an amount ranging from 1.02 to 1.53

[13] 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.

[14] 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

[15] 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.

[16] Ditto

[17] 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.

[18] 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.

[19] 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.

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

mm/year[21]. 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%[22].

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[23]. 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[24]. Other papers have also used historical aerial imagery to map vegetation change[25],[26] and salinity factors can impact on those changes[27].

More recent studies looking at both changes in tidal marshes[28] and coastal forests[29] 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

[21] 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.
[22] 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.
[23] 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.
[24] 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.
[25] 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.
[26] 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.
[27] 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.
[28] 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.
[29] Williams, Kimberlyn, et al. 1999. Sea-level rise and coastal forest retreat on the west coast of Florida, USA Ecology

dam building has restricted the sediment inflows[30]. 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[31]. Kimberlyn Williams states that some of the factors leading to forest decline in coastal areas result from; soil flooding—resulting in low oxygen availability and reducing conditions, elevated soil and groundwater salinity, and saltwater intrusion.

One study in the Delaware River Estuary stipulated that freshwater tidal marshes are needed to help the development of brackish and salt marshes[32] in areas where the coast was submerging. The freshwater marshes help produce the environmental conditions later needed by the more saline marshes.

Purpose of the Study

This study was conducted with the following goals in mind:

1. Classify and map vegetation communities, land covers, and assess habitat conditions for Species of Greatest Conservation Need (SGCN)[as defined in the Delaware Wildlife Action Plan (DEWAP)] for Thompson Island Nature Preserve 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 nature preserve.
3. Determine the forest blocks located within or partially within the nature preserve.
4. Produce Ecological Integrity Assessments (EIAs) for vegetation communities that ranked S2 or higher.

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

[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] Shirley, Laura and Lorretta L. Battaglia. 2006. Assessing vegetation change in coastal landscapes of the northern Gulf of Mexico. Wetlands 26(4): 1057-1070.
[32] 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 imagery. Vegetation communities are named according to the *Guide to Delaware Vegetation Communities* [33]which follows the National Vegetation Classification System (NVCS). The NVCS classifies vegetation on a national scale for the United States and is linked to international vegetation classification. The NVCS helps provide a uniform name and description of vegetation communities found throughout the country and helps determine relative rarity. Descriptions of the vegetation communities are provided in Chapter 4 and of the land covers in Chapter 5. A crosswalk to the Delaware Wildlife Action Plan (DEWAP) and the Northeast Habitat Classification (NHC) is given at the top of each individual description.

Analysis of Historical Imagery

Historical imagery of Thompson Island Nature Preserve 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 (1954, 1961, 1968, 1992, and 1997) but these sets were not used due to geo-registration problems in the image tiles.

Ecological Integrity Assessment (EIA)

An EIA was conducted for those communities in the nature preserve 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 Thompson Island Nature Preserve included in the EIA analysis are listed in Table 2.3.

Forest Block Analysis

No forest blocks are present within Thompson Island Nature Preserve.

Sea Level Rise Analysis

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

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[33] Coxe, Robert. 2011. Guide to Delaware Vegetation Communities-Summer 2011 Edition. Unpublished report.

Natural Capital Analysis

The natural capital of each vegetation community was determined using a table in Costanza, et al.[34] The values from the table were calculated per acre of the vegetation community and then adjusted using an inflation calculator (DollarTimes.com) from 1994 values to 2012 values. Using these methods the following values were obtained:

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

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

Wetlands

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

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

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

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

Cropland: $37/acre/year

Grassland/fields: $94/acre/year

Open Ocean: $102/acre/year

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

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

Chapter 2: Results, EIAs, and General Observations

Summary of Findings from this study

1. **Vegetation Communities:** Fourteen vegetation communities and three land covers were found at Thompson Island Nature Preserve. North Atlantic Low Salt Marsh (86 acres) is the largest vegetation community, followed by Mid to Late Successional Loblolly Pine-Sweetgum Forest with 33 acres. Water (10 acres) is the largest land cover followed by beach with 1 acre.

2. **Rare Plants:** One rare plant is known to exist in Thompson Island Nature Preserve (Table 2.1).

Scientific Name	Common Name	Rank	Last Observed
Hierochloe odorata	Holy Grass	S1	1994

Table 2.1 Rare Plants at Thompson Island Nature Preserve

3. **Rare Animals:** One rare animal is known to exist in Thompson Island Nature Preserve (Table 2.2).

Scientific Name	Common Name	Rank	Last Observed
Cistothorus platensis	Sedge Wren	S1B	1994

Table 2.2 Rare Animals at Thompson Island Nature Preserve

Ecological Integrity Assessment (EIA)

One vegetation community, Chesapeake Bay Tall Maritime Shrubland is ranked S2 or higher.

Table 2.3. EIA Vegetation Communities located in Thompson Island Nature Preserve

Community Map	Community Name/EIA Score	Description
	**Thompson Island 1** **Chesapeake Bay Tall Maritime Shrubland (12.5 acres)** **EIA = 4.18 (B rank)**	This shrubland/forest community is located at the south end of the island fronting Rehoboth Bay.

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

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

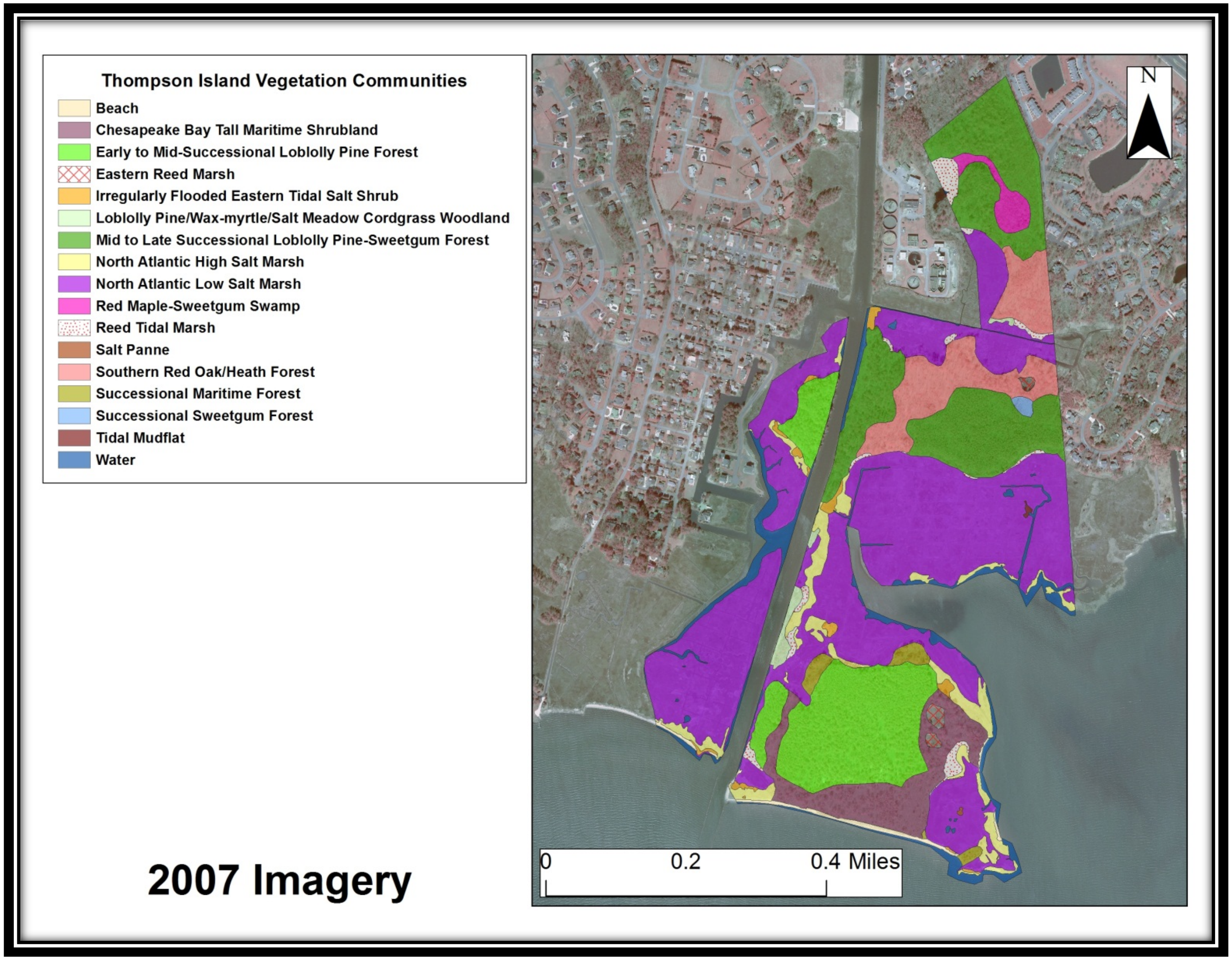


Figure 3.1. 2007 Vegetation Community of the Thompson Island Nature Preserve

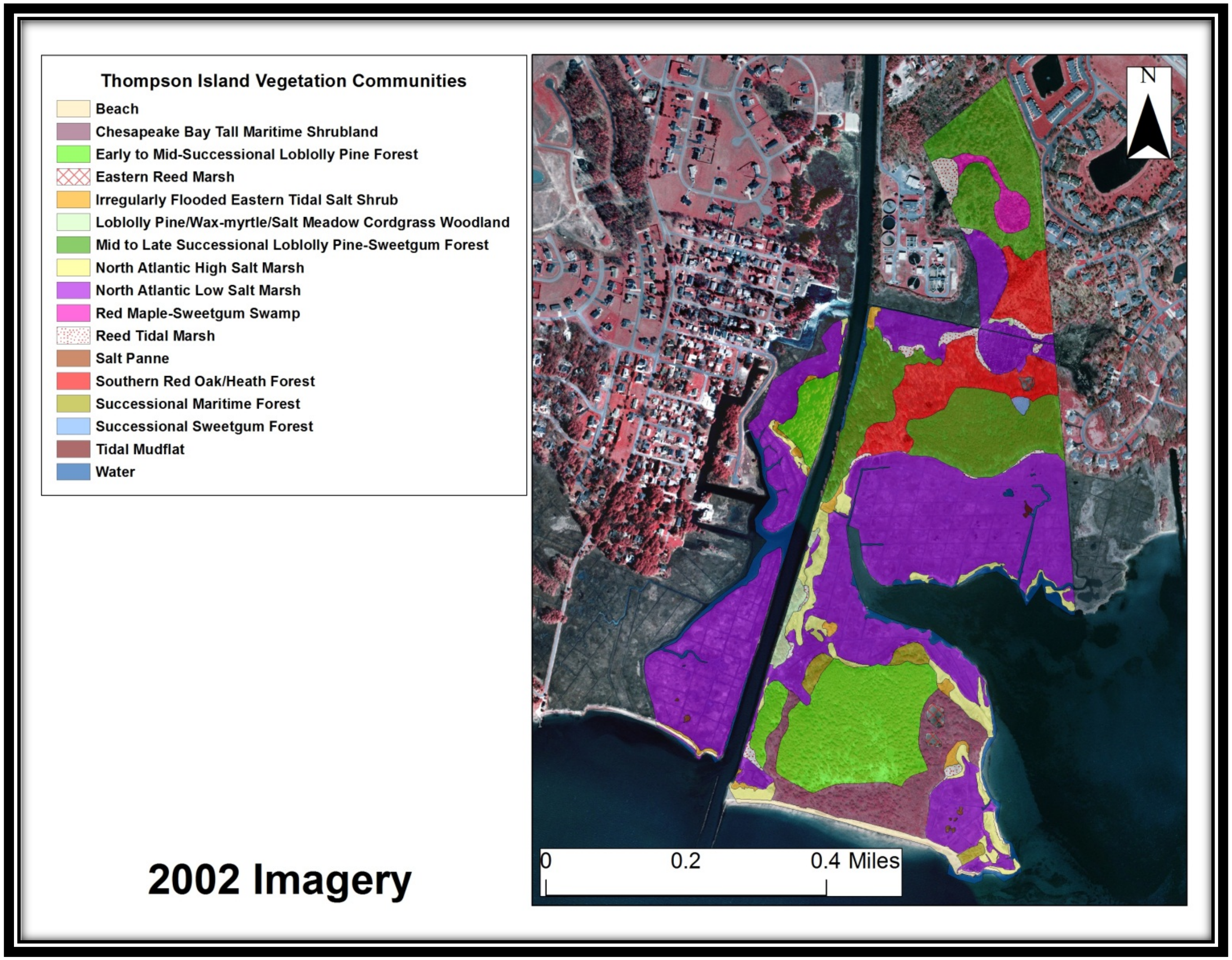


Figure 3.2. 2002 Vegetation Community Map of the Thompson Island Nature Preserve

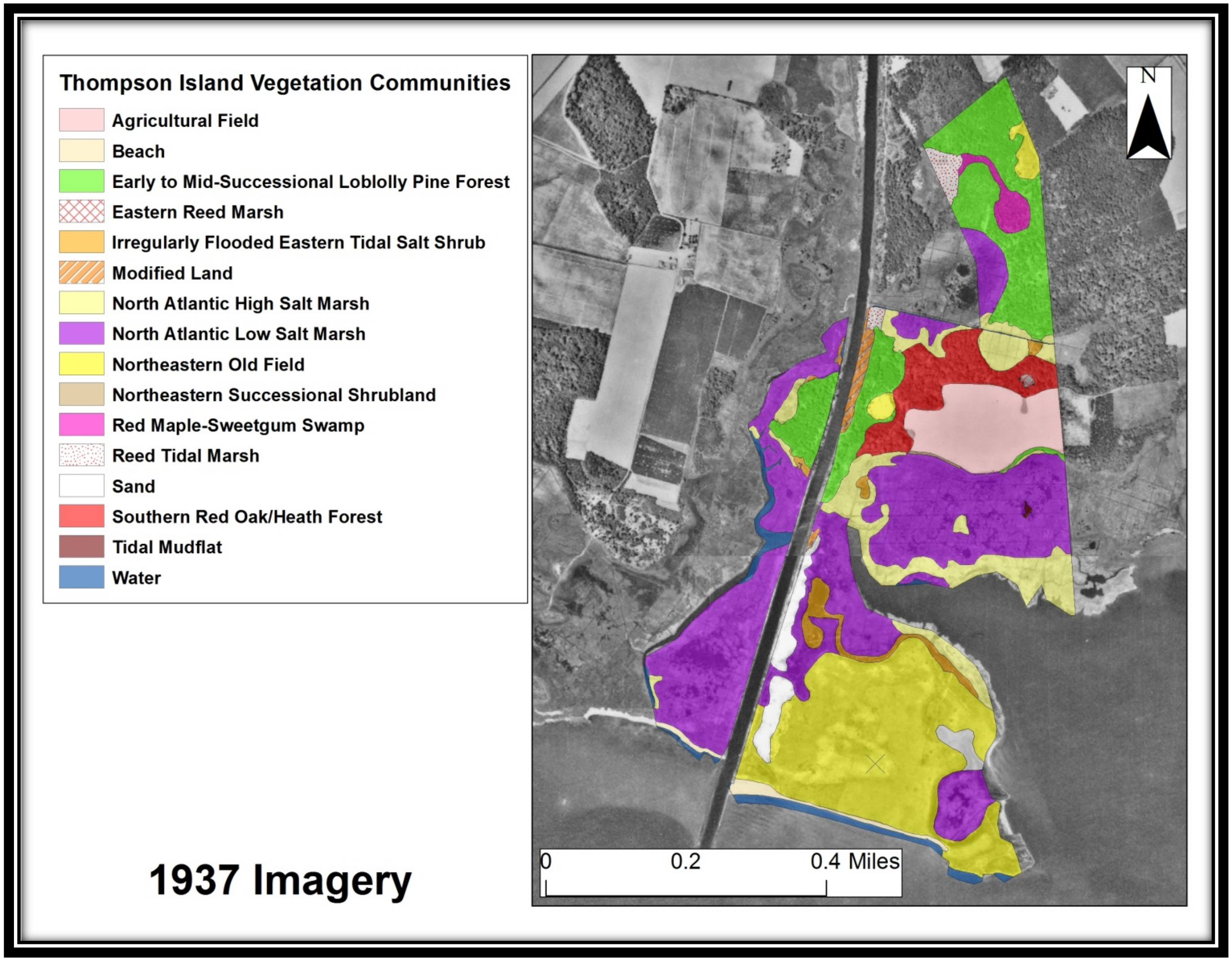
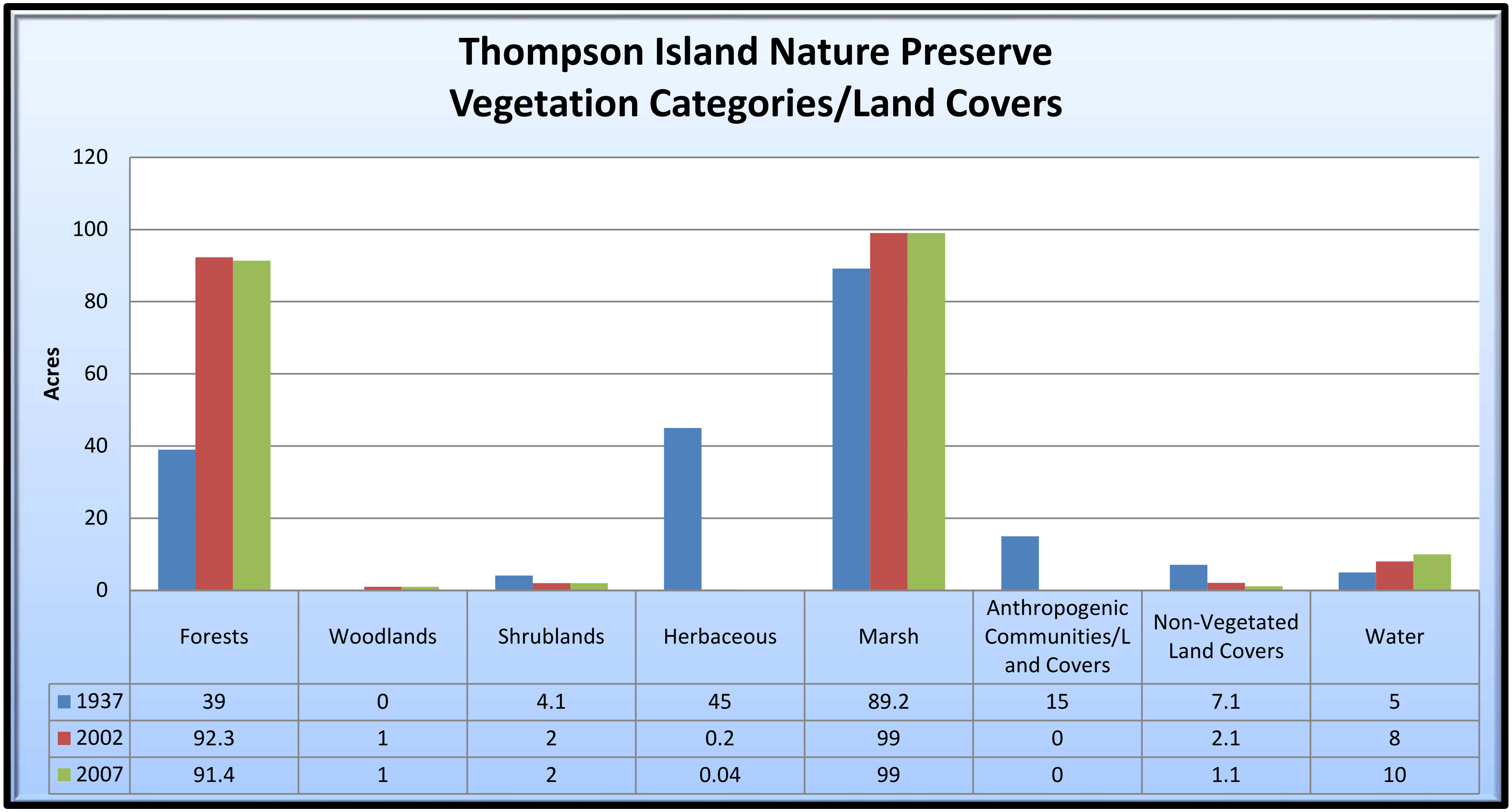


Figure 3.3. 1937 Vegetation Community Map of the Thompson Island Nature Preserve



	Forests	Woodlands	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Non-Vegetated Land Covers	Water
1937	39	0	4.1	45	89.2	15	7.1	5
2002	92.3	1	2	0.2	99	0	2.1	8
2007	91.4	1	2	0.04	99	0	1.1	10

Figure 3.4. Thompson Island Nature Preserve Vegetation Categories/Land Covers (1937, 2002, and 2007)

Thompson Island Nature Preserve Broad Trends (Figure 3.4): During the study period (1937-2007), forests, woodlands, marsh, and water all gained area, while all other categories lost ground. Most of the herbaceous communities (Northeastern Old Field) present in 1937 have succeeded into forests. Some areas of the herbaceous communities have succeeded into marsh.

DNREC Sea Level Rise Analysis (Table 3.1)

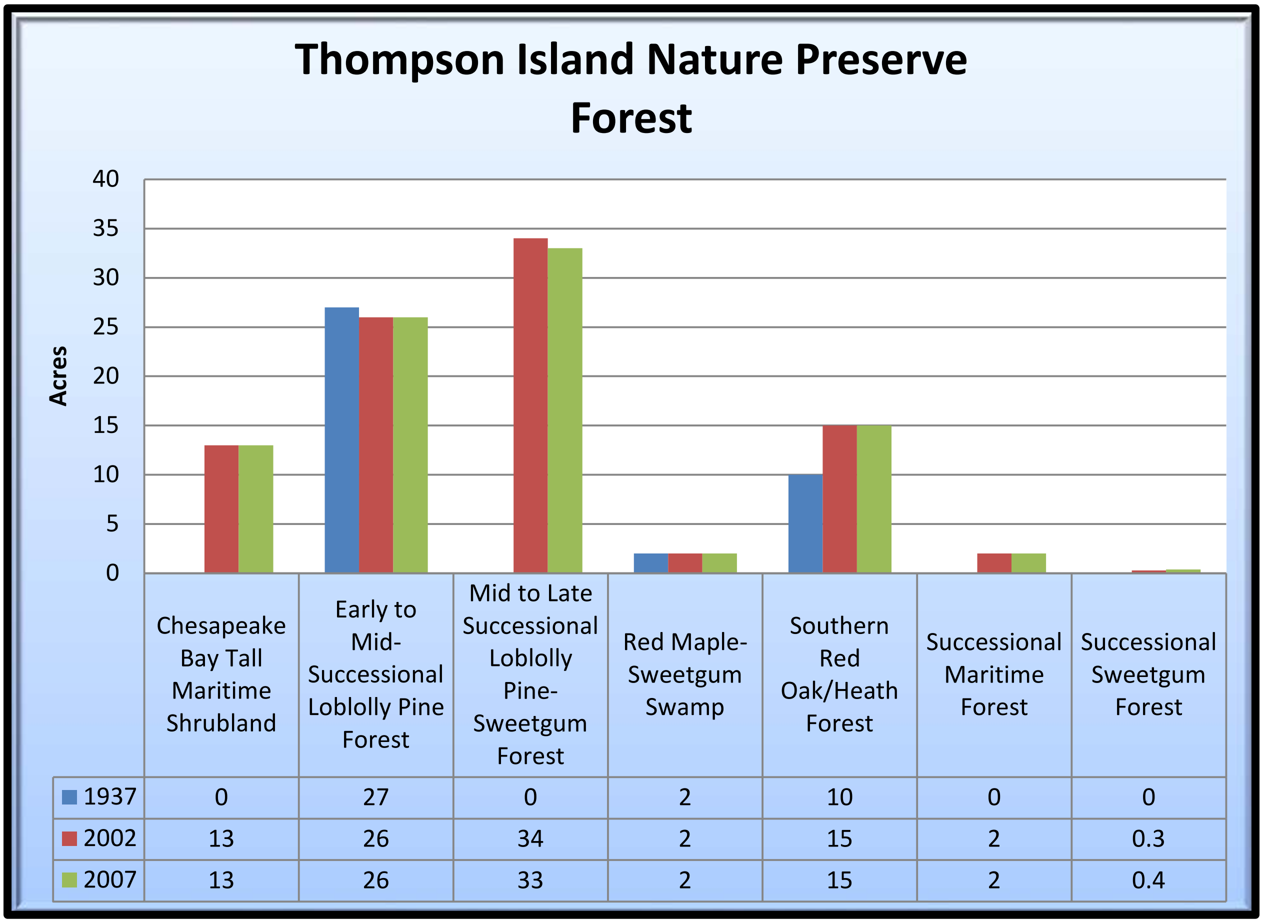
A little more than ¾ of the nature preserve will be flooded by water with 1.5 m of sea level rise. Essentially this will leave the middle part of the "island."

Table 3.1. Projected acres of Thompson Island Nature Preserve Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	129 acres
1 m	150 acres
1.5 m	164 acres

Natural Capital (Table 3.2)

Capital in the Thompson Island Nature Preserve has been increasing as the amount of water coverage increases.

Table 3.2. Natural Capital of Thompson Island Nature Preserve	
Year	**Natural Capital (in 2012 dollars)**
1937	$696,275/year
2002	$806,906/year
2007	$834,298/year



	Chesapeake Bay Tall Maritime Shrubland	Early to Mid-Successional Loblolly Pine Forest	Mid to Late Successional Loblolly Pine-Sweetgum Forest	Red Maple-Sweetgum Swamp	Southern Red Oak/Heath Forest	Successional Maritime Forest	Successional Sweetgum Forest
1937	0	27	0	2	10	0	0
2002	13	26	34	2	15	2	0.3
2007	13	26	33	2	15	2	0.4

Figure 3.5. Forest at Thompson Island Nature Preserve (1937, 2002, and 2007)

Thompson Island Forest (Figure 3.5): In 1937, Early to Mid-Successional Loblolly Pine Forest was the most common forested community, which has aged to become Mid to Late Successional Loblolly Pine-Sweetgum Forest, now (2007) the most common community, and Southern Red Oak/Heath Forest. Since 1937, more Early to Mid-Successional Loblolly Pine Forest has populated the preserve as well as Chesapeake B ay Tall Maritime Shrubland, a globally rare community.

DNREC Sea Level Rise Analysis (Table 3.3)

A little more than half of the forestland present in preserve will be flooded by water with 1.5 m of sea level rise.

Table 3.3. Projected acres of Thompson Island Natural Preserve Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	17 acres
1 m	36 acres
1.5 m	50 acres

Natural Capital (Table 3.4)

Forestland capital has increased since 1937 with the maturation of fields into forest communities. A small decrease recently was from the loss of one acre from Mid to Late Successional Loblolly Pine-Sweetgum Forest.

Table 3.4. Natural Capital of Thompson Island Nature Preserve Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$31,580/year
2002	$41,659/year
2007	$41,489/year

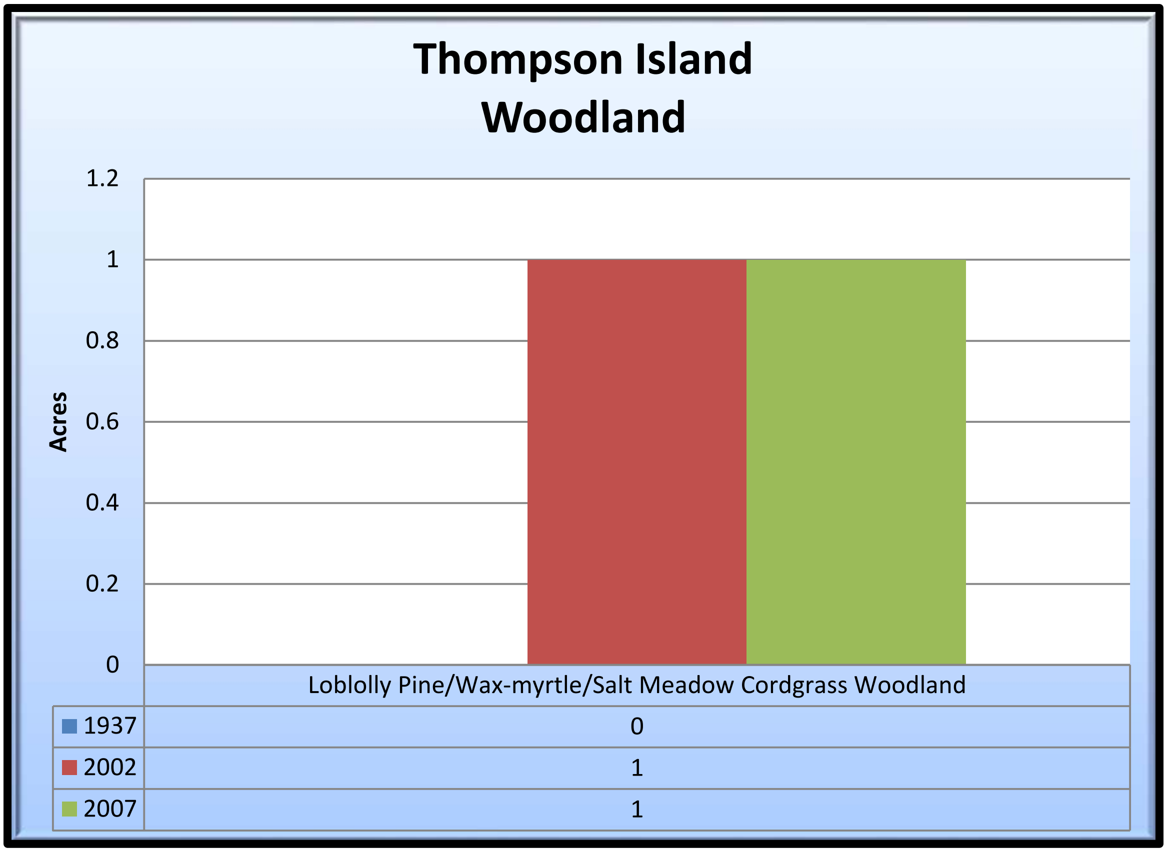


Figure 3.6. Woodland at Thompson Island Nature Preserve (1937, 2002, and 2007)

Thompson Island Woodland (Figure 3.6): Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass is the only woodland within the Nature Preserve. It has formed on old spoils from the dredging of the Lewes and Rehoboth Canal.

DNREC Sea Level Rise Analysis (Table 3.5)

All of the current acreage of woodland in the preserve will be eliminated with 0.5 m of sea level rise.

Table 3.5. Projected acres of Thompson Island Natural Preserve Woodland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 3.6)

Woodland was not present in 1937 and has since developed in the preserve. Since 2002 it has been stable in amount.

Table 3.6. Natural Capital of Thompson Island Nature Preserve Woodland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$12,292/year
2007	$12,292/year

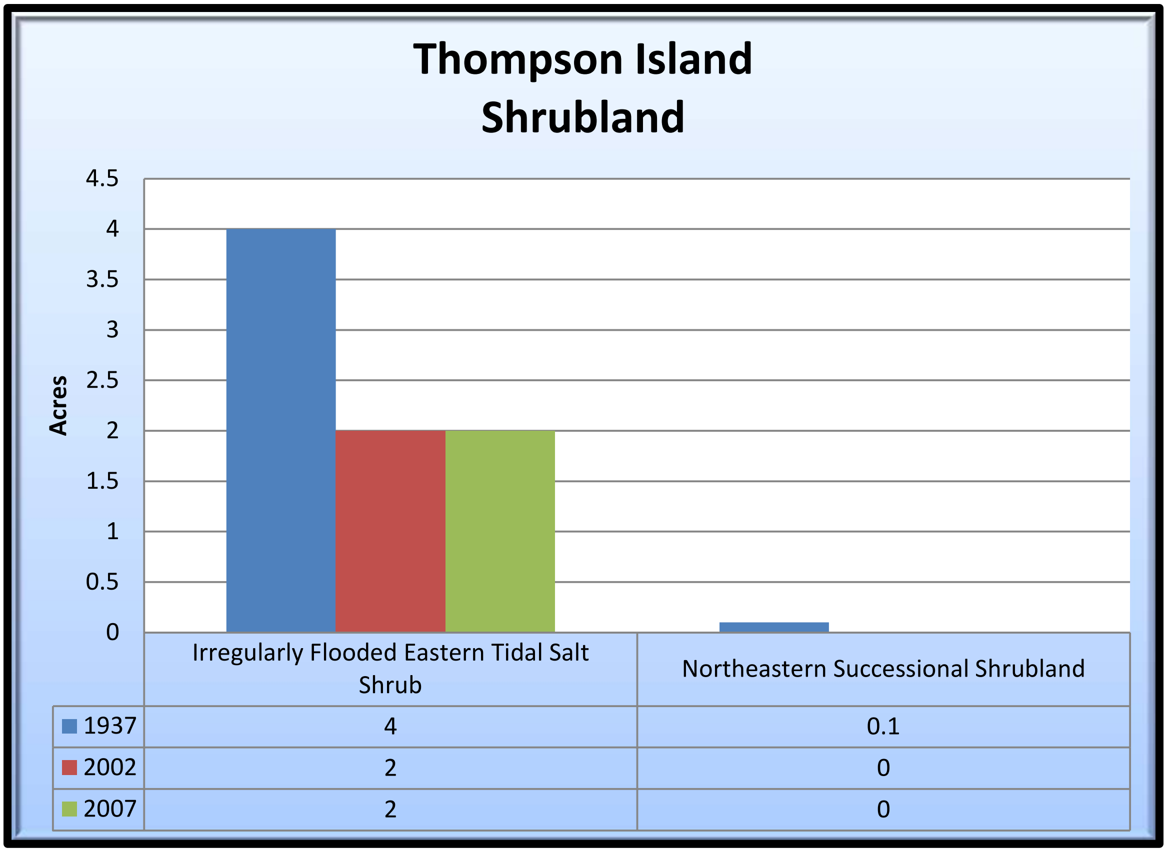


Figure 3.7. Shrubland at Thompson Island Nature Preserve (1937, 2002, and 2007)

Thompson Island Nature Preserve Shrubland (Figure 3.7): In 1937, two shrublands were present at Thompson Island Nature Preserve. Currently there only one, Irregularly Flooded Eastern Tidal Salt Shrub, which has declined since 1937.

DNREC Sea Level Rise Analysis (Table 3.7)

All of the shrubland in its current extent will be inundated by water with 0.5 m of sea level rise.

Table 3.7. Projected acres of Thompson Island Natural Preserve Shrubland Impacted by Sea Level Rise

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

Natural Capital (Table 3.8)

Shrubland capital has declined with the decline the amount of Irregularly Flooded Eastern Tidal Salt Shrub. It has been stable in amount in 2002-2007 period.

Table 3.8. Natural Capital of Thompson Island Nature Preserve Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$25,100/year
2002	$12,543/year
2007	$12,543/year

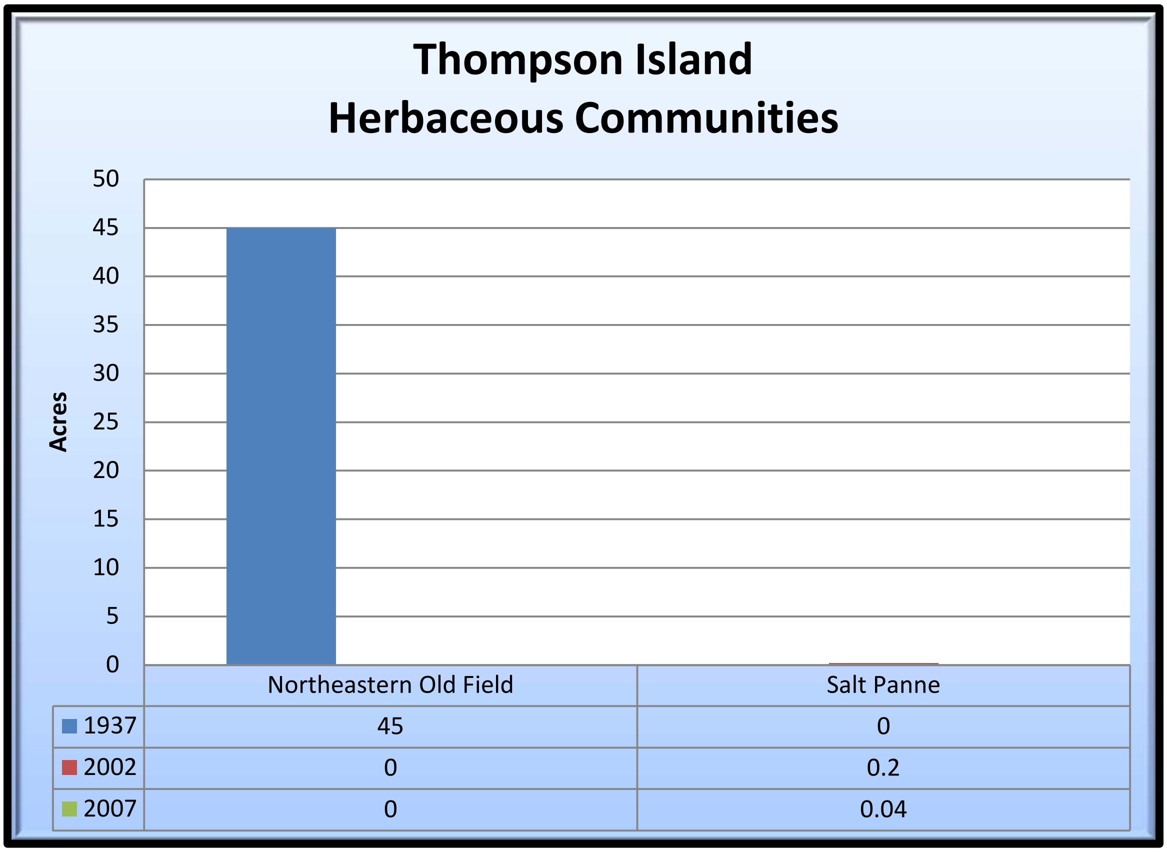


Figure 3.8. Herbaceous Communities at Thompson Island Nature Preserve (1937, 2002, and 2007)

Thompson Island Herbaceous Communities (Figure 3.8): In 1937, most of the lower island was covered by a Northeastern Old Field and was apparently the site of an indian burial mound. This field has now covered over in an Early to Mid-Successional Loblolly Pine Forest. Salt Panne is present in the marshes and comes and goes as areas open in the marsh.

DNREC Sea Level Rise Analysis (Table 3.9)

All of the current acreage of herbaceous communities will be eliminated with 0.5 m of sea level rise.

Table 3.9. Projected acres of Thompson Island Natural Preserve Herbaceous Communities Impacted by Sea Level Rise

Rise	Acres
0.5 m	0.04 acres
1 m	0.04 acres
1.5 m	0.04 acres

Natural Capital (Table 3.10)

Capital in herbaceous communities has gone since Northeastern Old Field has matured into shrubland and forest.

Table 3.10. Natural Capital of Thompson Island Nature Preserve Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1937	$6,557/year
2002	$1,254/year
2007	$251/year

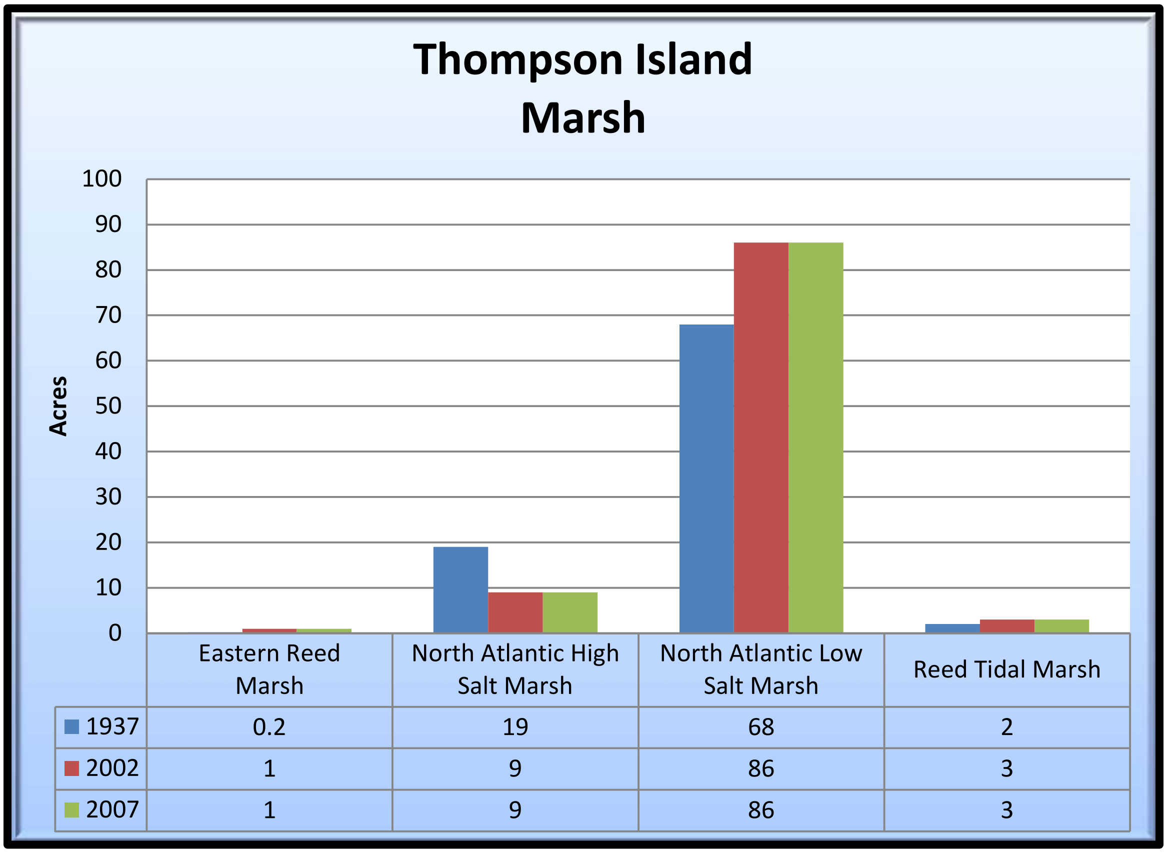


Figure 3.9. Marsh at Thompson Island Nature Preserve (1937, 2002, and 2007)

Thompson Island Marsh (Figure 3.9): North Atlantic Low Salt Marsh is the largest marsh community in Thompson Island Nature Preserve, followed distantly by North Atlantic High Salt Marsh. The amount of North Atlantic High Salt Marsh has been falling as it is converted to North Atlantic Low Salt Marsh.

DNREC Sea Level Rise Analysis (Table 3.11)

All of the current marshland present in the preserve will be flooded with 0.5 m of sea level rise.

Table 3.11. Projected acres of Thompson Island Natural Preserve Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	99 acres
1 m	99 acres
1.5 m	99 acres

Natural Capital (Table 3.12)

Marshland capital has increased, driven mainly by gains in North Atlantic Low Salt Marsh acreage.

Table 3.12. Natural Capital of Thompson Island Nature Preserve Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$560,002/year
2002	$623,869/year
2007	$623,869/year

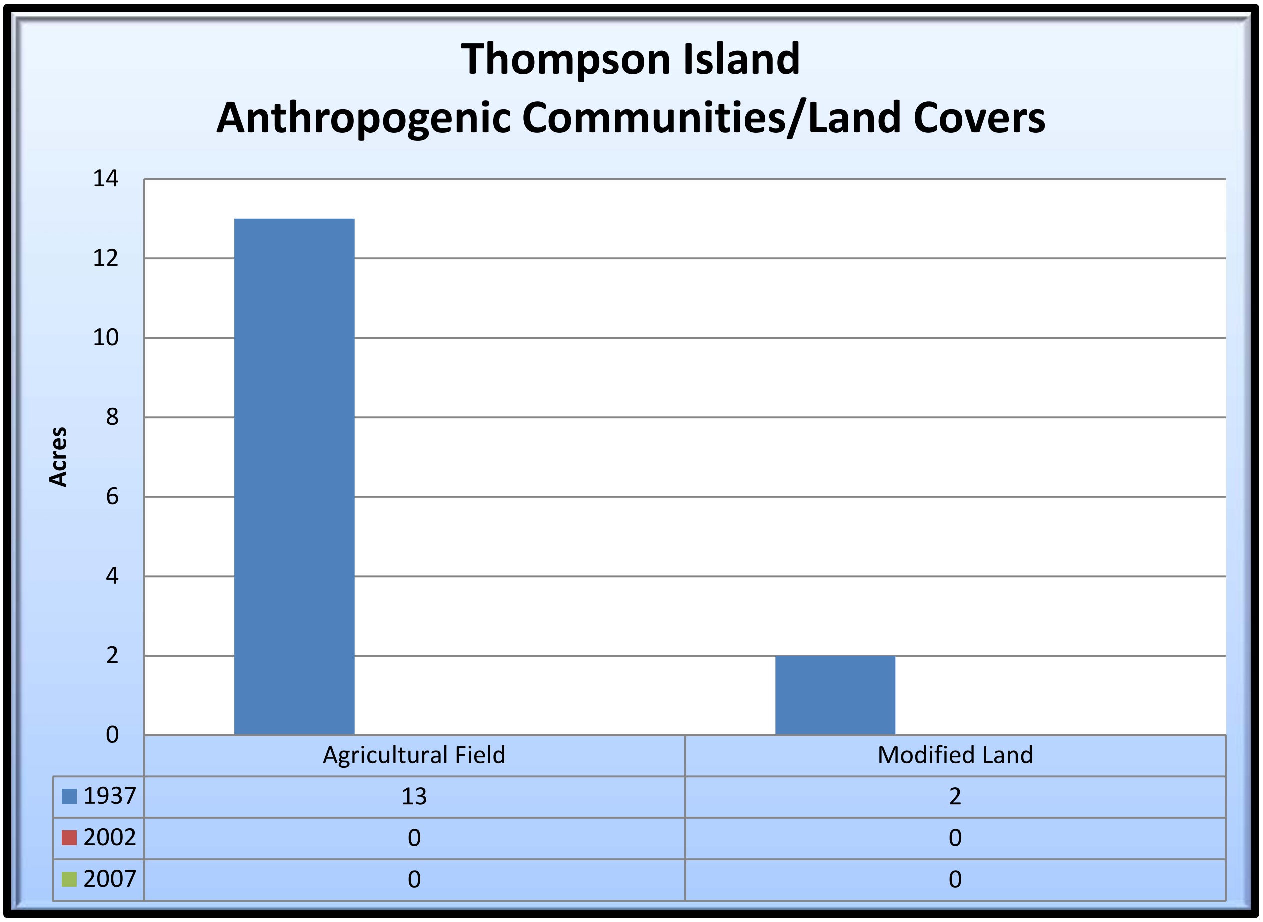


Figure 3.10. Anthropogenic Communities at Thompson Island Nature Preserve (1937, 2002, and 2007)

Thompson Island Anthropogenic Communities/Land Covers (Figure 3.10): No anthropogenic communities are currently located on the preserve. In 1937, an agricultural field covered a large of the middle island at the preserve. This has since succeeded to forest.

Natural Capital (Table 3.13)

Agricultural field is the only anthropogenic community/land cover with any natural capital value. It not present anymore in the preserve.

Table 3.13. Natural Capital of Thompson Island Nature Preserve Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$746/year
2002	$0/year (not present)
2007	$0/year (not present)

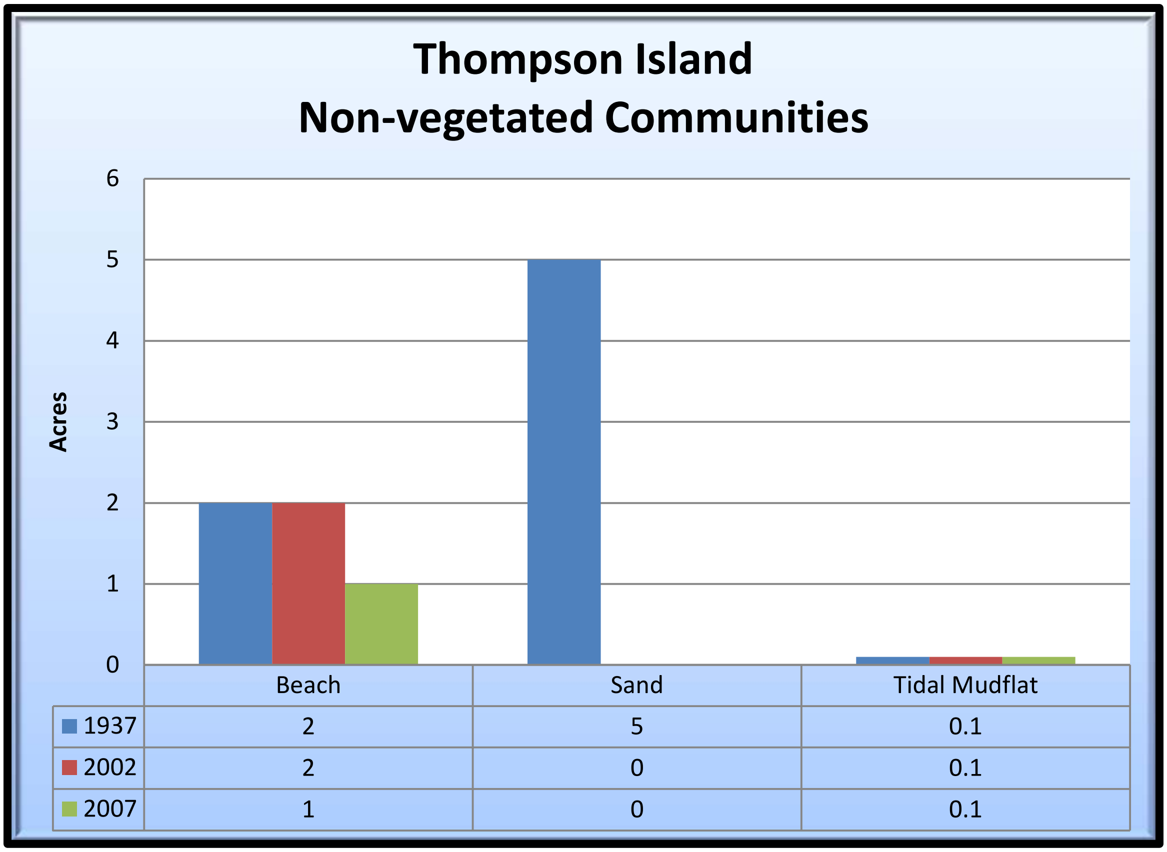


Figure 3.11. Non-vegetated Land Covers at Thompson Island Nature Preserve (1937, 2002, and 2007)

Thompson Island Non-vegetated Land Covers (Figure 3.11): This category has been declining due to sea level rise in the case of beach area or succession in the case of sand. Tidal mudflats have remained stable.

DNREC Sea Level Rise Analysis (Table 3.14)

All of the Non-vegetated Land Covers in the preserve will be inundated with 0.5 m of sea level rise.

Table 3.14. Projected acres of Thompson Island Natural Preserve Non-vegetated Land Covers Impacted by Sea Level Rise

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

Natural Capital (Table 3.15)

Tidal mudflat is the only non-vegetated land cover with any natural capital value in the preserve. It has been stable in amount through the study period.

Table 3.15. Natural Capital of Thompson Island Nature Preserve Non-vegetated Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$627/year
2002	$627/year
2007	$627/year

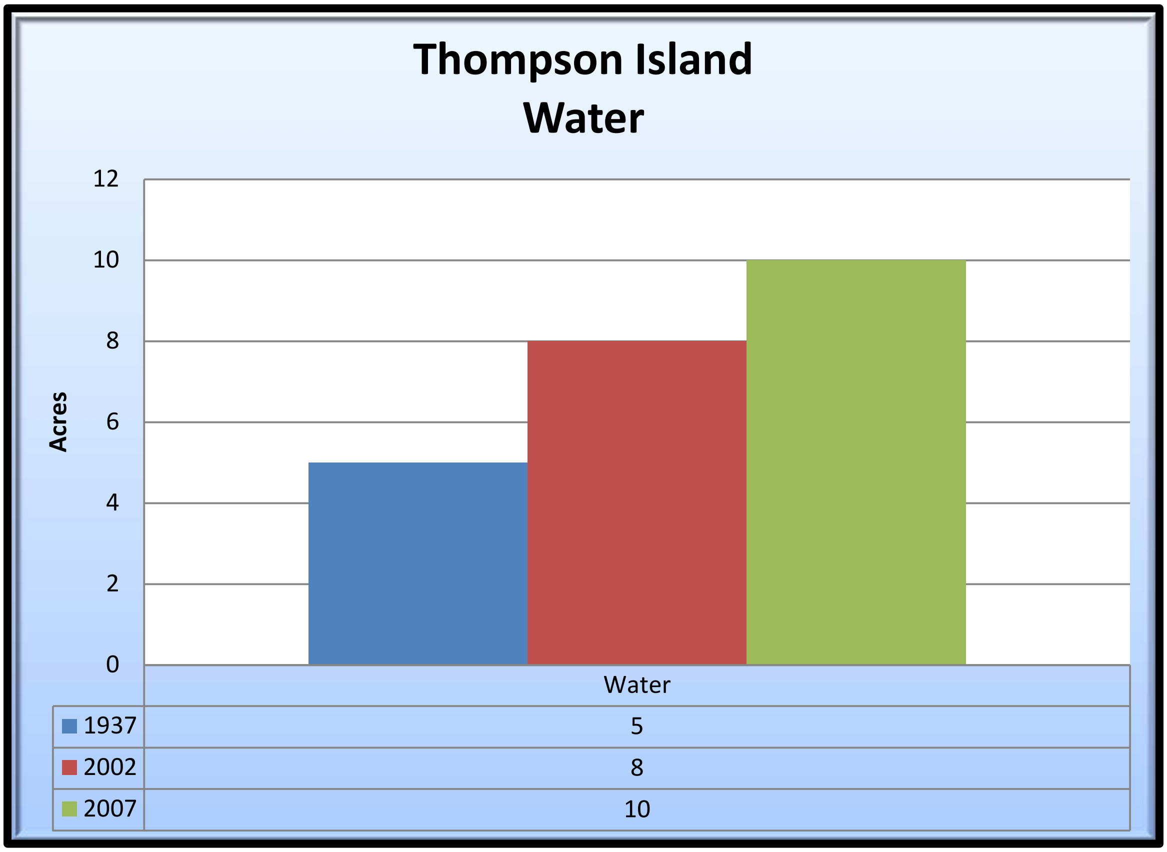


Figure 3.12. Water coverage (non-impoundment) at Thompson Island Nature Preserve (1937, 2002, and 2007)

Thompson Island Water (Figure 3.12): Water coverage has increased through the study period as sea level rise covers more area.

Natural Capital (Table 3.16)

Water capital has increased with its acreage and is presumably due to sea level rise.

Table 3.16. Natural Capital of Thompson Island Nature Preserve Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$71,664/year
2002	$114,663/year
2007	$143,329/year

Chapter 4: Descriptions and Analysis of the Vegetation Communities

Fourteen vegetation communities and three land covers were noted in the survey (Figures 8-19). Below are the descriptions of the vegetation communities. The National Vegetation Classification (NVC) Association number is given with the vegetation community and their approximate acreage in the project area. Names of communities correspond with the common names as given in the NVC and the Guide to Delaware Vegetation Communities.

An analysis of the change over time is provided for those communities that are considered to be affected most immediately by sea level rise. For Assawoman Wildlife Area these include the Brackish Tidal Creek Shrubland, Irregularly Flooded Eastern Tidal Salt Shrub, Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland, Needlerush High Marsh, North Atlantic Low Salt Marsh, North Atlantic High Salt Marsh, Successional Maritime Forest, and Water coverage.

The vegetation communities include:

1. Chesapeake Bay Tall Maritime Shrubland (CEGL006319)—13 acres
2. Early to Mid-Successional Loblolly Pine Forest (CEGL006011)—26 acres
3. Eastern Reed Marsh (CEGL004141)—1 acre
4. Irregularly Flooded Eastern Tidal Salt Shrub (CEGL003921)—2 acres
5. Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland (CEGL006849)—1 acre
6. Mid to Late Successional Loblolly Pine-Sweetgum Forest (CEGL008462)—33 acres
7. North Atlantic High Salt Marsh (CEGL006006)—9 acres
8. North Atlantic Low Salt Marsh (CEGL004192)—86 acres
9. Red Maple-Sweetgum Swamp (CEGL006110)—2 acres
10. Reed Tidal Marsh (CEGL004187)—3 acres
11. Salt Panne (CEGL004308)—0.04 acres
12. Southern Red Oak/Heath Forest (CEGL006269)—15 acres
13. Successional Maritime Forest (CEGL006145)—15 acres
14. Successional Sweetgum Forest (CEGL007216)—0.4 acres

The land cover types include:

1. Beach—1 acres
2. Tidal Mudflat—0.1 acres
3. Water—10 acres

Chesapeake Bay Tall Maritime Shrubland **[13 acres, (Figure 4.1; Tables 4.1-4.4)] G1G2 S1**

DEWAP: Dune Shrublands
NHC: Northern Atlantic Coastal Plain Maritime Forest

Description

Figure 4.1. Chesapeake Bay Tall Maritime Shrubland

This tall shrubland/stunted forest is located at the south end of Thompson Island where is receives moisture and salt spray from Rehoboth Bay. Wild black cherry (*Prunus serotina*) dominates a canopy that is associated by loblolly pine (*Pinus taeda*) and Virginia pine (*Pinus virginiana*). Sassafras (*Sassafras albidum*), southern red oak (*Quercus falcata*), and northern bayberry (*Morella pensylvanica*) compose a short understory. Speargrass (*Chasmanthium laxum*) and switchgrass (*Panicum virgatum*) were the only herbs noted.

Analysis of Condition at Thompson Island Nature Preserve

This community has come about at Thompson Island Nature Preserve since 1937 in 10 acres of former Northeastern Old Field, 1 acre of sand, 1 acre of beach, and 0.3 acres of water (Table 5.1). It has been stable in extent in the recent period (2002-2007) and is projected to remain this way in the short-term since it is located on a rise above the bay area. In the long term however, erosion of the cliffs adjacent to the bay may reduce the acreage of this community.

Table 4.1. Chesapeake Bay Tall Maritime Shrubland has migrated into X or remained since 1937

X	Acreage
Northeastern Old Field	10 acres
Sand	1 acre
Beach	1 acre
Water	0.3 acres

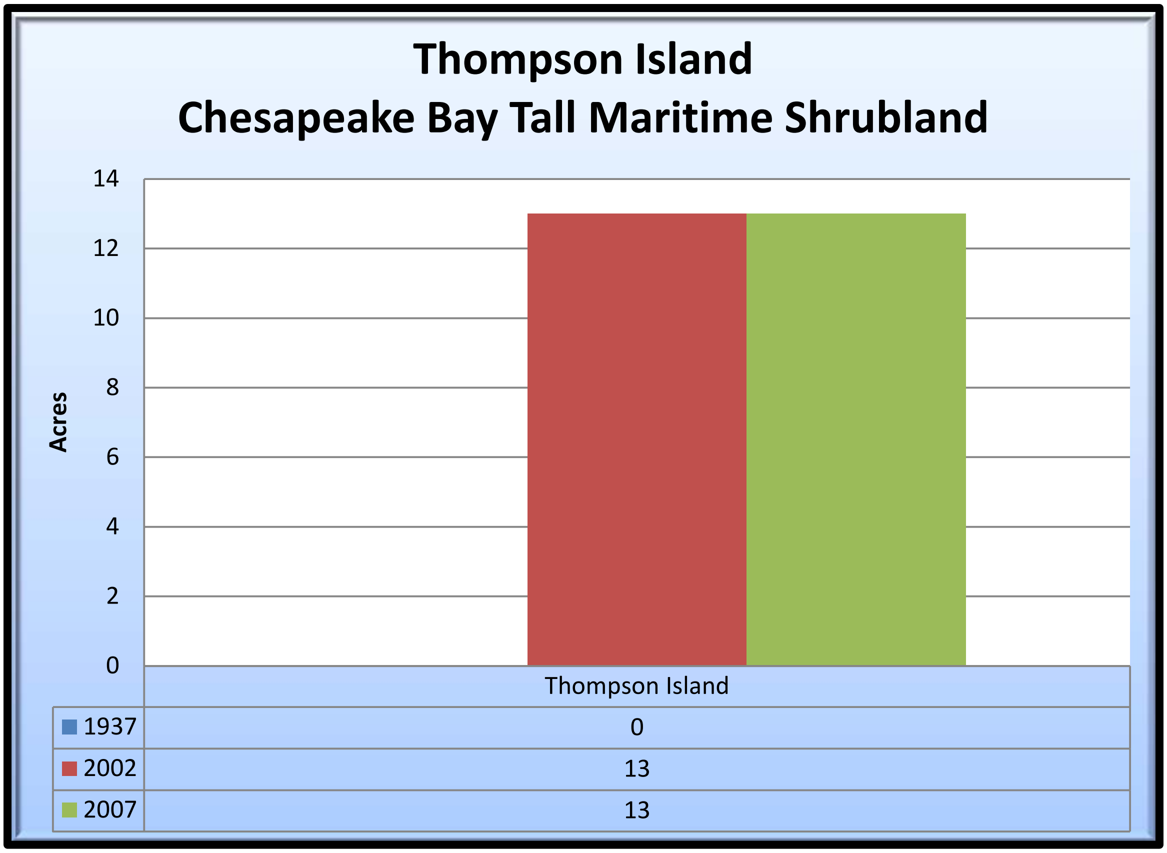


Figure 4.2. Chesapeake Bay Tall Maritime Shrubland at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.2)

A little more than half of the current acreage of Chesapeake Tall Maritime Shrubland will be inundated by water with 1.5 m of sea level rise.

Table 4.2. Projected acres of Chesapeake Bay Tall Maritime Shrubland Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	5 acres
1.5 m	7 acres

Natural Capital (Table 4.3)

Chesapeake Bay Tall Maritime Shrubland has stayed the same in the preserve since it appeared in 2002.

Table 4.3. Natural Capital of Chesapeake Bay Tall Maritime Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$627/year
2007	$627/year

***Early to Mid-Successional Loblolly Pine Forest* [26 acres, (Figures 4.3-4.4; Tables 4.4-4.7)]**
GNA SNA

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

Description

This successional pine community covers most of the center of Thompson Island. It is characterized by the total dominance of loblolly pine (*Pinus taeda*) in the overstory with no hardwoods in the canopy. The forest present on Thompson Island is at the mid-successional stage with hardwood trees almost to the height of the canopy. Understory associates include southern red oak (*Quercus falcata*), American holly (*Ilex opaca*), wild black cherry (*Prunus serotina*), eastern red cedar (*Juniperus virginiana*), sassafras (*Sassafras albidum*), and sweetgum (*Liquidambar styraciflua*). Highbush blueberry (*Vaccinium corymbosum*) was the only shrub noted with common greenbrier (*Smilax rotundifolia*) and white-leaf greenbrier (*Smilax glauca*) making up the vine layer. Switchgrass (*Panicum virgatum*) was the only herb noted and is present on the edges of the forest. A few small logs are present in this forest.

Figure 4.3. Early to Mid-Successional Loblolly Pine Forest

Analysis of Condition at Thompson Island Nature Preserve

This successional forest community waxes and wanes over the long term as former fields and shrublands succeed to this type and on into more mature forests such Mid to Late Successional Loblolly Pine-Sweetgum Forest and Southern Red Oak/Heath Forest. This forest will likely be around for the near future at Thompson Island.

Table 4.4. What was once Early to Mid-Successional Loblolly Pine Forest in 1937 has become X or remained in 2007

X	**Acreage**
Mid to Late Successional Loblolly Pine-Sweetgum Forest	18 acres
Southern Red Oak/Heath Forest	5 acres
Early to Mid-Successional Loblolly Pine Forest	4 acres
Reed Tidal Marsh	0.3 acres
North Atlantic High Salt Marsh	0.2 acres
Other communities/land covers	0.4 acres

Table 4.5. Early to Mid-Successional Loblolly Pine Forest has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	21 acres
Early to Mid-Successional Loblolly Pine Forest	4 acres
Sand	2 acres
North Atlantic Low Salt Marsh	0.1 acres

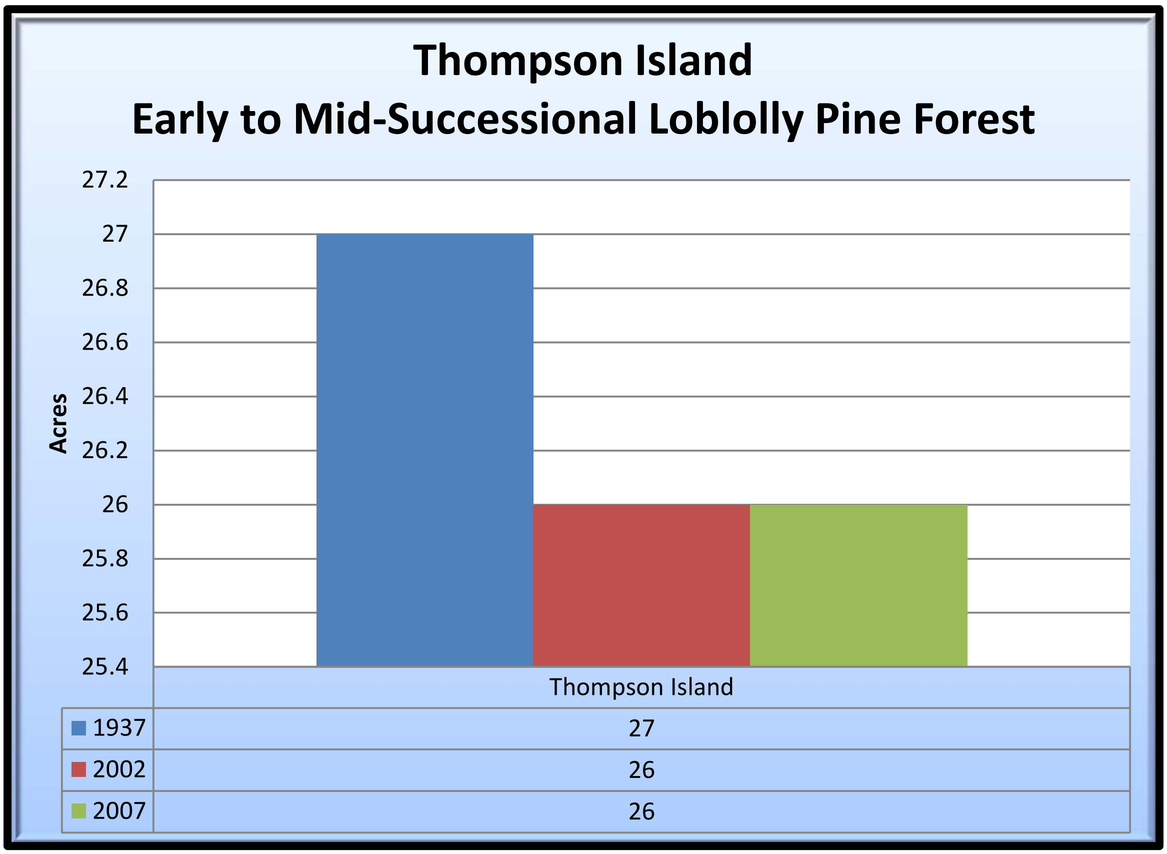


Figure 4.4. Early to Mid-Successional Loblolly Pine Forest at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.6)

A little more than 1/3 of the current acreage of Early to Mid-Successional Loblolly Pine Forest will be inundated by water with 1.5 m of sea level rise.

Table 4.6. Projected acres of Early to Mid-Successional Loblolly Pine Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	3 acres
1 m	6 acres
1.5 m	9 acres

Natural Capital (Table 4.7)

Capital of Early to Mid-Successional Loblolly Pine Forest has declined with the loss of one acre.

Table 4.7. Natural Capital of Early to Mid-Successional Loblolly Pine Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$5,106/year
2002	$4,917/year
2007	$4,917/year

***Eastern Reed Marsh* [1 acre (Figure 4.5; Tables 4.8-4.11)]** **GNA SNA**

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

Description

Eastern Reed Marsh is present in low wet areas that do not receive tidal influence. It is totally dominated by eastern reed (*Phragmites australis*).

Analysis of Condition at Thompson Island Nature Preserve

This community is composed of an exotic invasive plant species in a non-tidal situation. While present in small amount in 1937, this community has gone on to populate more wetlands in the preserve. Since open wetlands are few in the preserve, this community may remain at the same amount in the near future unless it is eradicated.

Table 4.8. What was once Eastern Reed Marsh in 1937 has become X or remained in 2007	
X	**Acreage**
Eastern Reed Marsh	0.2 acres

Table 4.9. Eastern Reed Marsh has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	1 acre
Southern Red Oak/Heath Forest	0.1 acres

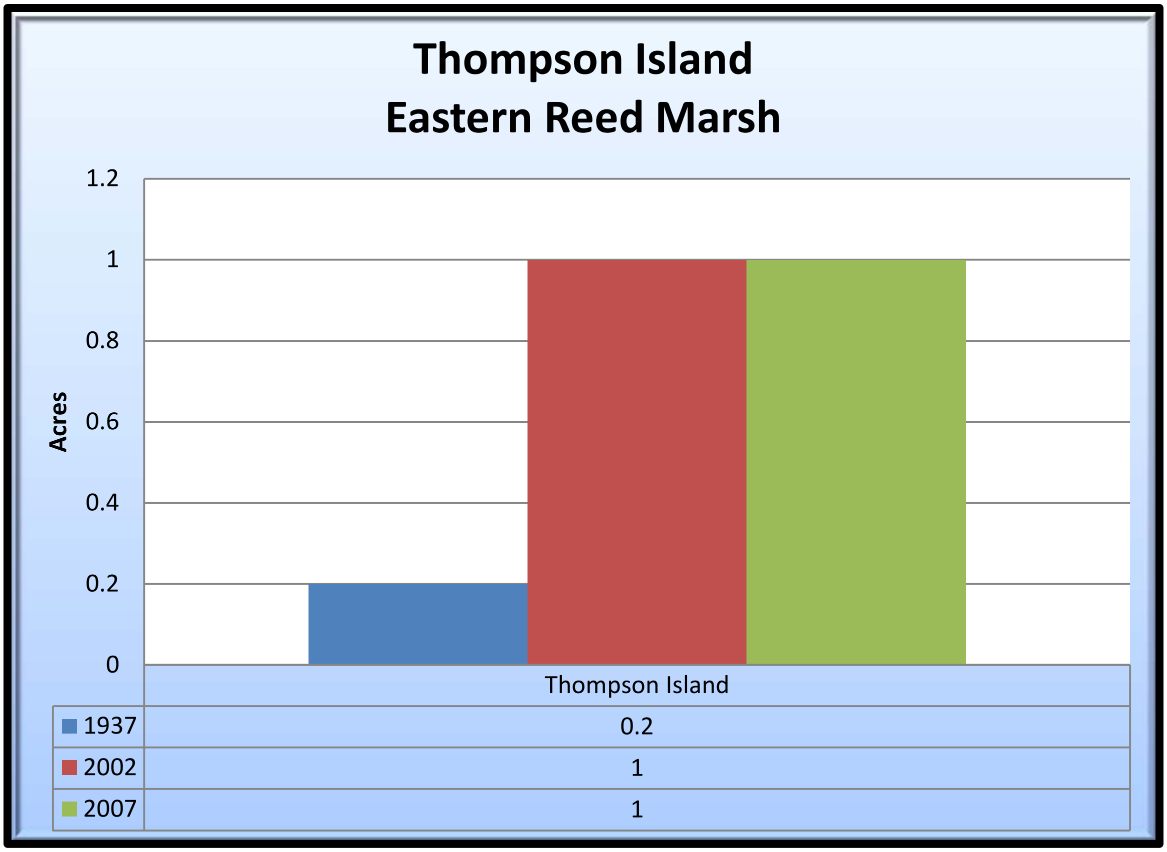


Figure 4.5. Eastern Reed Marsh at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.10)

All of the current extent of Eastern Reed Marsh will be inundated by water with 0.5 m of sea level rise.

Table 4.10. Projected acres of Eastern Reed Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital (Table 4.11)

Capital of Eastern Reed Marsh has increased with the spread of the nominal species in this community.

Table 4.11. Natural Capital of Eastern Reed Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,806/year
2002	$9,281/year
2007	$9,281/year

***Irregularly Flooded Eastern Tidal Salt Shrub* [2 acres (Figures 4.6-4.7; Tables 4.12-4.15)] G5 S5**

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

<u>Description</u>

Figure 4.6. Irregularly Flooded Eastern Tidal Salt Shrub

This shrub community is co-dominated by salt shrub (*Baccharis halimifolia*) and marsh elder (*Iva frutescens*). It is often found just above the elevation of the North Atlantic High Salt Marsh.

<u>Analysis of Condition at Thompson Island Nature Preserve</u>

Irregularly Flooded Eastern Tidal Salt Shrub appears to be losing ground in Delaware due to sea level rise or at the very least not gaining any or much ground. At Thompson Island Nature Preserve, this community has never covered all that much area during the study period and has lost half of its acreage at that. In the past five years this community has been stable in extent and given the amount of data it is not possible to predict the future fate conclusively. Given the conditions in other areas it might not be good.

Showing the dynamic nature of this community, none of the 1937 acreage was still present in 2007. All of the acreage has been converted to 3 acres of North Atlantic Low Salt Marsh and 1 acre of North Atlantic High Salt Marsh (Table 4.12). The acreage that exists today has all come from the migration landward. Since 1937, Irregularly Flooded Eastern Tidal Salt Shrub has converted 0.3 acres of Northeastern Old Field, 0.3 acres of North Atlantic High Salt Marsh, 0.2 acres of Reed Tidal Marsh, 0.2 acres of beach, and 0.2 acres of North Atlantic Low Salt Marsh (Table 4.13).

Table 4.12. What was once Irregularly Flooded Eastern Tidal Salt Shrub in 1937 has become X or remained in 2007	
X	**Acreage**
North Atlantic Low Salt Marsh	3 acres
North Atlantic High Salt Marsh	1 acre

Table 4.13. Irregularly Flooded Eastern Tidal Salt Shrub has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	0.3 acres
North Atlantic High Salt Marsh	0.3 acres
Reed Tidal Marsh	0.2 acres
Beach	0.2 acres
North Atlantic Low Salt Marsh	0.2 acres
Other vegetation communities/land covers	0.3 acres

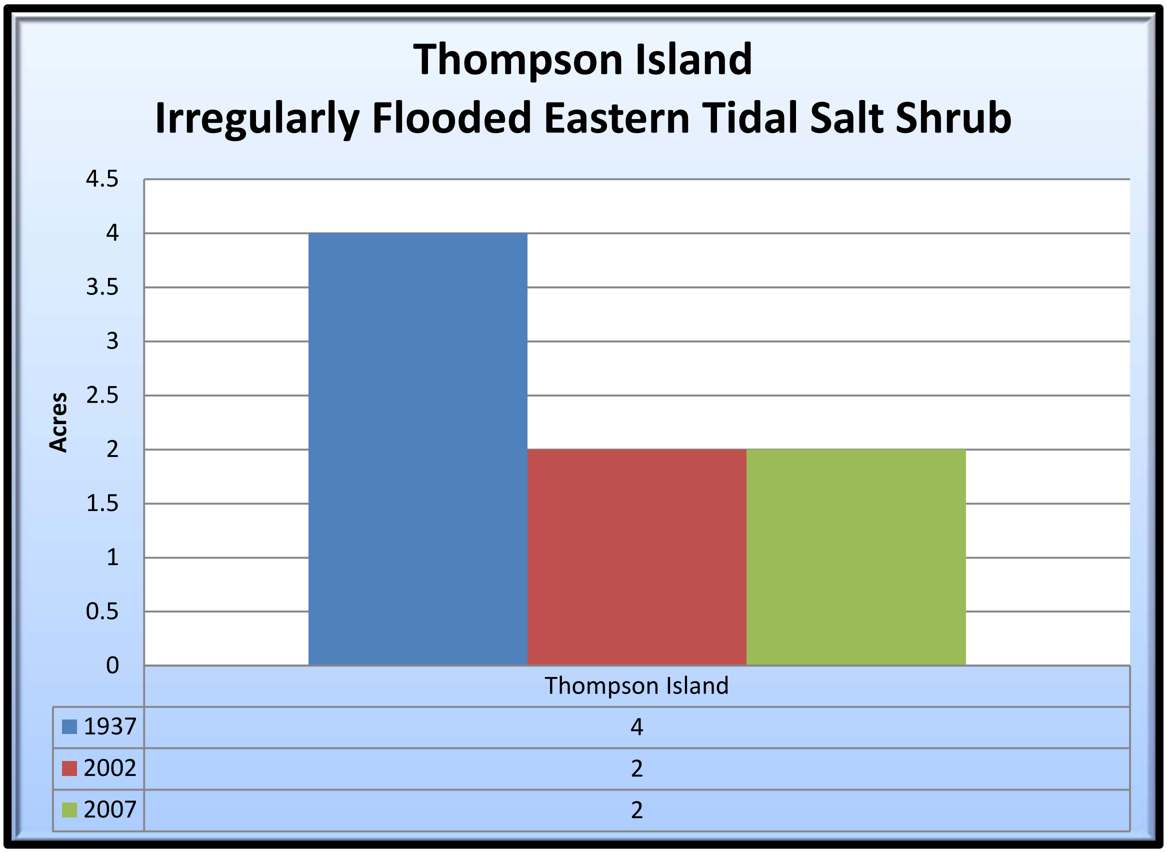


Figure 4.7. Irregularly Flooded Eastern Tidal Salt Shrub at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.14)

All of the current extent of Irregularly Flooded Eastern Tidal Salt Shrub will be inundated by water with 0.5 m of sea level rise.

Table 4.14. Projected acres of Irregularly Flooded Eastern Tidal Salt Shrub Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 4.15)

Capital of Irregularly Flooded Eastern Tidal Salt Shrub has decreased with the loss of acreage.

Table 4.15. Natural Capital of Irregularly Flooded Eastern Tidal Salt Shrub

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

***Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland* [1 acre (Figures 4.8-4.9; Tables 4.16-)] GNR S3**

DEWAP: Dune Forests and Woodlands
NHC: Northern Atlantic Coastal Plain Maritime Forest

Description

This woodland community is located on the edge of the North Atlantic High Salt Marsh in thin strips and contains a woodland canopy of loblolly pine (*Pinus taeda*) with an understory of wild black cherry (*Prunus serotina*), eastern red cedar (*Juniperus virginiana*), and southern red oak (*Quercus falcata*). A sometimes thick shrub and vine layer of common greenbrier (*Smilax rotundifolia*) and salt shrub (*Baccharis halimifolia*) is present. Salt meadow cordgrass (*Spartina patens*) dominates the herbaceous layer is associated by switchgrass (*Panicum virgatum*), spear grass (*Chasmanthium laxum*), and shore little bluestem (*Schizachyrium littorale*). No logs were observed in this community which has a thick shrub layer.

Figure 4.8. Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland

Analysis of Condition at Thompson Island Nature Preserve

This woodland community is found primarily on old spoil banks created from the digging of the canal. In more natural areas it is found at the edges of marshes where it receives occasional flooding from brackish water. This community is present in small amount but may be present in the preserve over the long term as more forests, namely the Early to Mid-Successional Loblolly Pine and the Mid to Late Successional Loblolly Pine-Sweetgum, transition into this type as more brackish water reaches them.

Table 4.16. Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has migrated into X or remained since 1937	
X	**Acreage**
Sand	1 acre
Early to Mid-Successional Loblolly Pine Forest	0.2 acres
Modified Land	0.1 acres

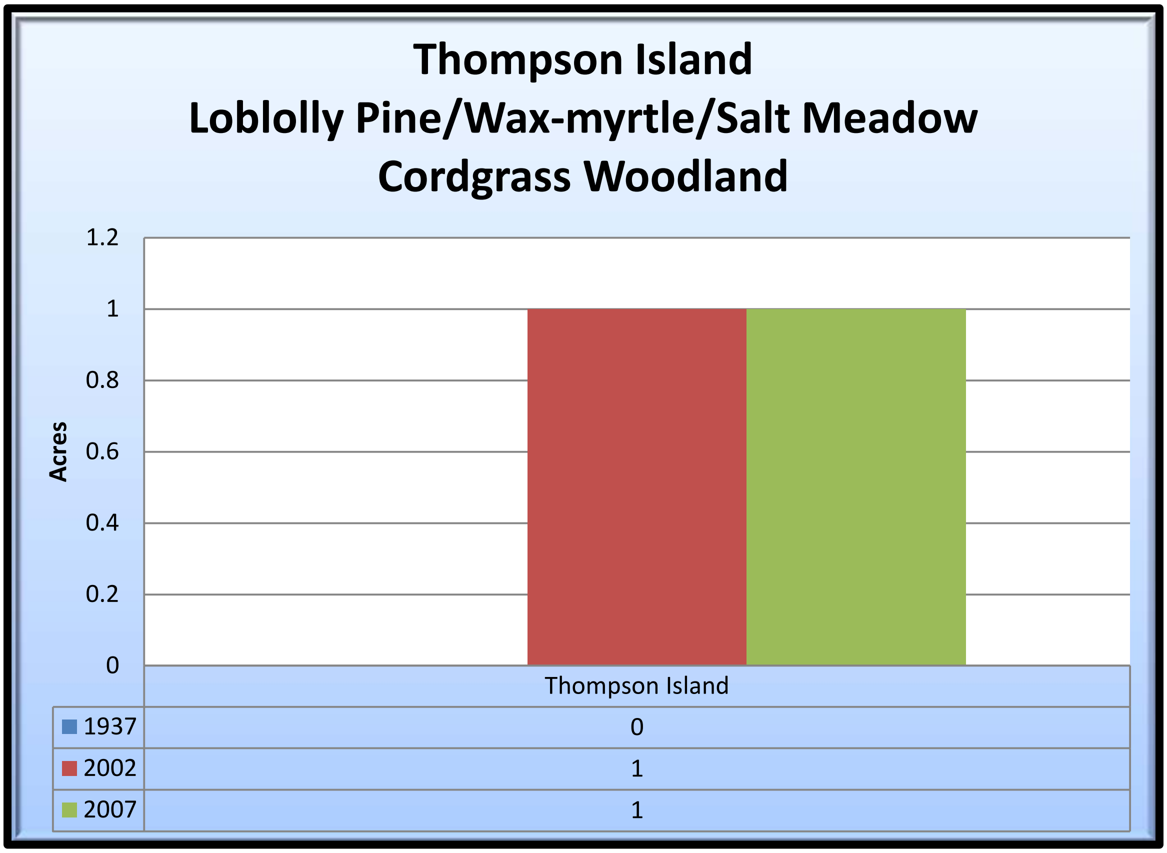


Figure 4.9. Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.17)

All of the current extent of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland will be inundated by water with 0.5 m of sea level rise.

Table 4.17. Projected acres of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland Impacted by Sea Level Rise

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

Natural Capital (Table 4.18)

Capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has increased the overall capital for the nature preserve.

Table 4.18. Natural Capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$9,281/year
2007	$9,281/year

***Mid to Late Successional Loblolly Pine-Sweetgum Forest* [33 acres (Figures 4.10-4.11; Tables 4.19-4.21)]**

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

Description

This mid to late successional community is present on the middle peninsula of the Thompson Island tract. Loblolly pine (*Pinus taeda*) still dominates the canopy but is joined by tuliptree (*Liriodendron tulipifera*), and sweetgum (*Liquidambar styraciflua*). In time this community may become a Successional Tuliptree-Loblolly Pine Upland Forest. Smaller members of the understory plus red maple (*Acer rubrum*), American holly (*Ilex opaca*), and wild black cherry (*Prunus serotina*) compose the understory. No shrubs were noted and summer grape (*Vitis aestivalis*) and Japanese honeysuckle (*Lonicera japonica*) are in the vine layer. No herbs were noted in this forest. Scattered dense areas of logs are present in this forest with a fairly open understory.

Figure 4.10. Mid to Late Successional Loblolly Pine-Sweetgum Forest

Analysis of Condition at Thompson Island Nature Preserve

This late successional loblolly pine community is the most common forested community at Thompson Island. Most of the area that community covers was present as Early to Mid-Successional Loblolly Pine Forest (18 acres) in 1937 and a lot of what is Early to Mid-Successional Loblolly Pine Forest now will become Mid to Late Successional Loblolly Pine-Sweetgum Forest. As such this community will likely be present at Thompson Island for the near and long term future. Other communities that this community has arisen from include agricultural field (12 acres), Northeastern Old Field (2 acres), modified land (1 acre), and North Atlantic Low Salt Marsh (0.3 acres) (Table 4.19).

Table 4.19. Mid to Late Successional Loblolly Pine-Sweetgum Forest has migrated into X or remained since 1937	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	18 acres
Agricultural Field	12 acres
Northeastern Old Field	2 acres
Modified Land	1 acre
North Atlantic Low Salt Marsh	0.3 acres
Other vegetation communities/land covers	0.4 acres

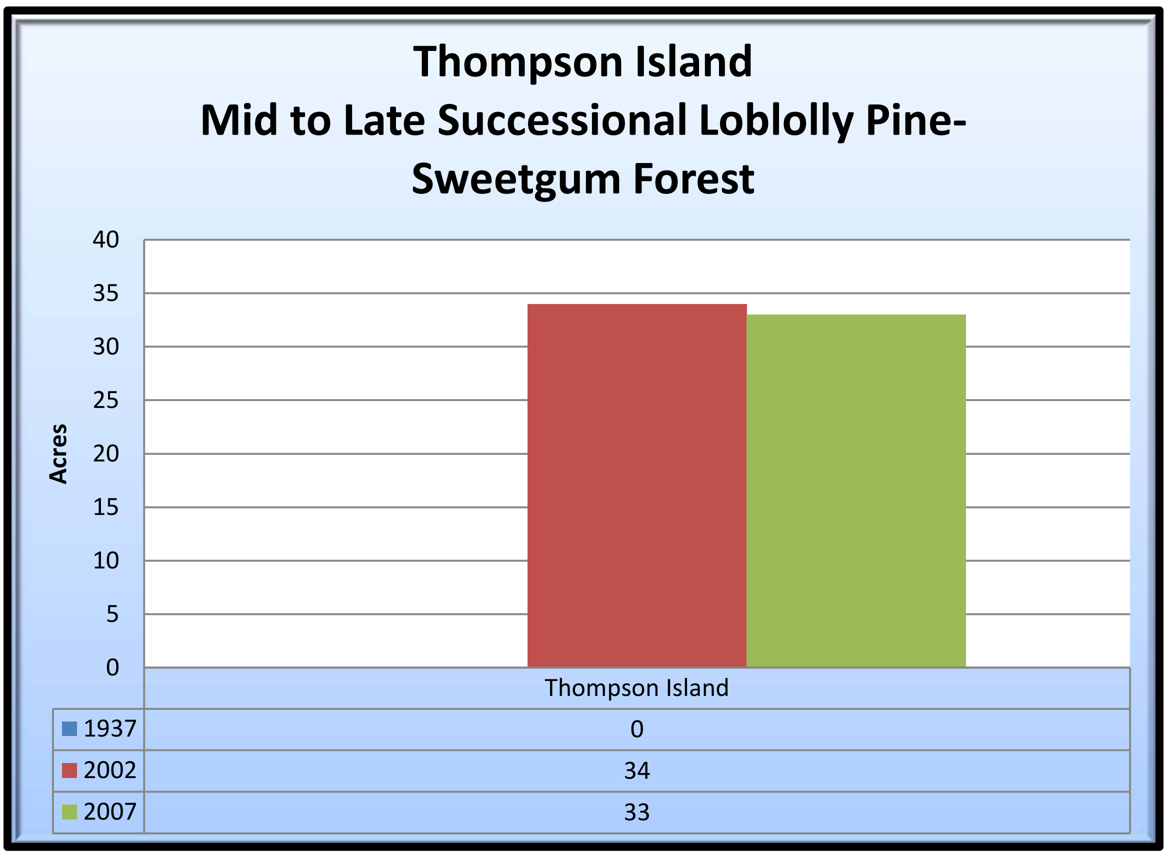


Figure 4.11. Mid to Late Successional Loblolly Pine-Sweetgum Forest at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.20)

About 2/3 of the current extent of this community will be inundated by water with 1.5 m of sea level rise.

Table 4.20. Projected acres of Mid to Late Successional Loblolly Pine-Sweetgum Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	5 acres
1 m	15 acres
1.5 m	21 acres

Natural Capital (Table 4.21)

Capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland has increased the overall capital for the nature preserve.

Table 4.21. Natural Capital of Loblolly Pine/Wax-Myrtle/Salt Meadow Cordgrass Woodland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$6,429/year
2007	$6,240/year

North Atlantic High Salt Marsh **[9 acres (Figures 4.12-4.13; Tables 4.22-4.25)]**

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

Description

Figure 4.12. North Atlantic High Salt Marsh

This marsh community lies just above the elevation of the North Atlantic Low Salt Marsh and receives tide during storm events. It is dominated by salt meadow cordgrass (*Spartina patens*) and associated by salt-grass (*Distichlis spicata*) and in higher places a scattered salt shrub (*Baccharis halimifolia*).

Analysis of Condition at Thompson Island Nature Preserve

High salt marsh communities are found just above the elevation of low marsh communities. While they do not receive diurnal tide they do receive an occasional seasonal or storm tide. It has declined since 1937 and is a trend reflective of the rest of the state. Most of the lost acreage has converted to North Atlantic Low Salt Marsh (15 acres) with lesser amounts going to water (2 acres), Irregularly Flooded Eastern Tidal Salt Shrub (0.3 acres), and Reed Tidal Marsh (0.3 acres) (Table 4.22). North Atlantic High Salt Marsh has managed to migrate some into 3 acres of Northeastern Old Field, 3 acres of North Atlantic Low Salt Marsh, 1 acre Irregularly Flooded Eastern Tidal Salt Shrub, and 1 acre of beach. No losses have been accrued in the short term but the long term prospects do not look good for its continued survival given what is happening elsewhere.

Table 4.22. What was once North Atlantic High Salt Marsh in 1937 has become X or remained in 2007

X	Acreage
North Atlantic Low Salt Marsh	15 acres
Water	2 acres
North Atlantic High Salt Marsh	1 acre
Irregularly Flooded Eastern Tidal Salt Shrub	0.3 acres
Reed Tidal Marsh	0.3 acres

Table 4.23. North Atlantic High Salt Marsh has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	3 acres
North Atlantic Low Salt Marsh	3 acres
North Atlantic High Salt Marsh	1 acre
Irregularly Flooded Eastern Tidal Salt Shrub	1 acre
Beach	1 acre
Other vegetation communities/land covers	1 acre

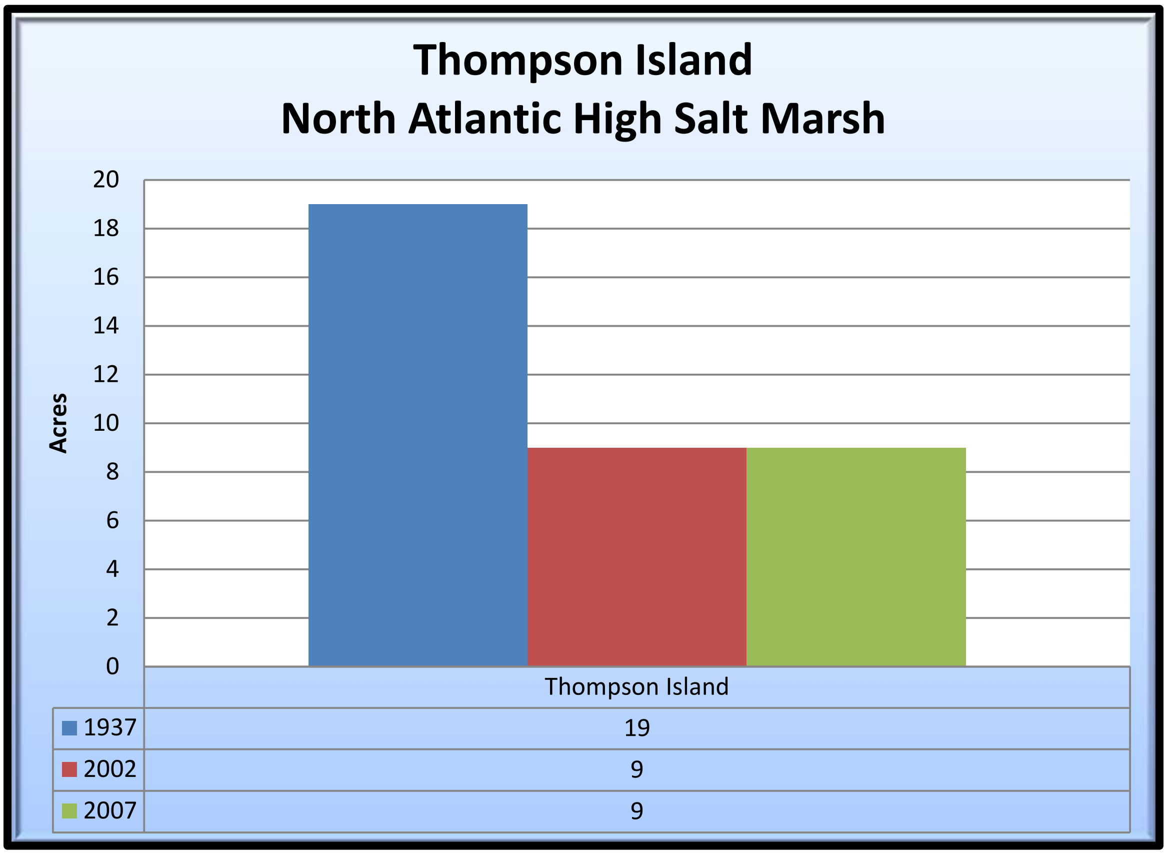


Figure 4.13. North Atlantic High Salt Marsh at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.24)

All of the current extent of North Atlantic High Salt Marsh will be inundated with 0.5 m of sea level rise.

Table 4.24. Projected acres of North Atlantic High Salt Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	9 acres
1 m	9 acres
1.5 m	9 acres

Natural Capital (Table 4.25)

Capital of North Atlantic High Salt Marsh has been going down as it is transferred to other marsh types and water.

Table 4.25. Natural Capital of North Atlantic High Salt Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$119,155/year
2002	$56,442/year
2007	$56,442/year

***North Atlantic Low Salt Marsh* [86 acres (Figures 4.14-4.15; Tables 4.26-4.29)]**

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

Description

Figure 4.14. North Atlantic Low Salt Marsh

This is the lowest elevation marsh community, which receives inundation by tide two times a day. It is dominated by salt marsh cordgrass (*Spartina alterniflora*).

Analysis of Condition at Thompson Island Nature Preserve

This is the lowest elevation marsh community on the coast and hence is affected most by rising rates of sea level rise and other factors. This community has increased in area since 1937, likely at the expense of North Atlantic High Salt Marsh. With rising rates of sea level rise this community may start to decrease in area as it has in some other areas.

Table 4.26. What was once North Atlantic Low Salt Marsh in 1937 has become X or remained in 2007

X	Acreage
North Atlantic Low Salt Marsh	61 acres
Water	3 acres
North Atlantic High Salt Marsh	3 acres
Reed Tidal Marsh	0.4 acres
Mid to Late Successional Loblolly Pine-Sweetgum Forest	0.3 acres
Other vegetation communities/land covers	1 acre

Table 4.27. North Atlantic Low Salt Marsh has migrated into X or remained since 1937	
X	**Acreage**
North Atlantic Low Salt Marsh	61 acres
North Atlantic High Salt Marsh	15 acres
Northeastern Old Field	4 acres
Irregularly Flooded Eastern Tidal Salt Shrub	3 acres
Southern Red Oak/Heath Forest	1 acre
Other vegetation communities/land covers	2 acres

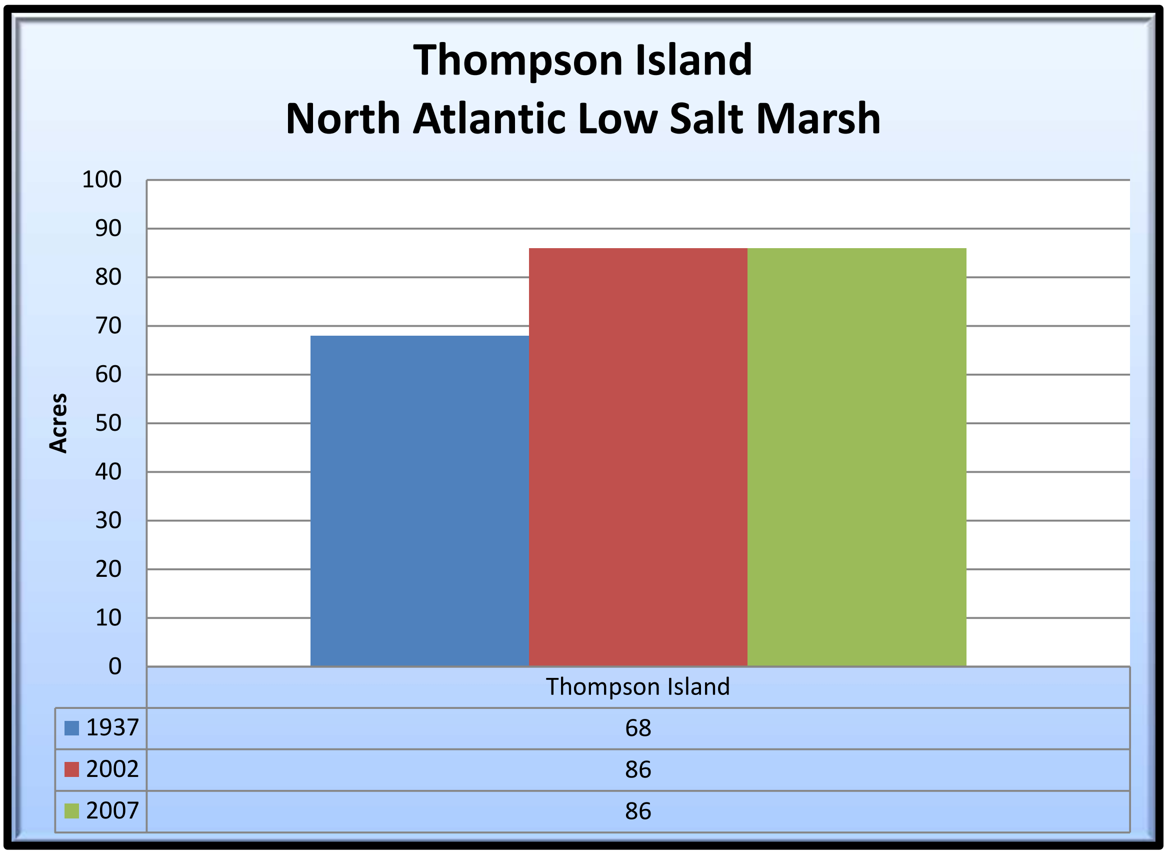


Figure 4.15. North Atlantic Low Salt Marsh at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.28)

All of the current extent of North Atlantic Low Salt Marsh will be inundated with 0.5 m of sea level rise.

Table 4.28. Projected acres of North Atlantic Low Salt Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	86 acres
1 m	86 acres
1.5 m	86 acres

Natural Capital (Table 4.29)

Capital of North Atlantic High Salt Marsh has been going down as it is transferred to other marsh types and water.

Table 4.29. Natural Capital of North Atlantic High Salt Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$426,448/year
2002	$539,332/year
2007	$539,332/year

Red Maple-Sweetgum Swamp **[2 acres (Figures 4.16-4.17; Tables 4.30-4.32)]   G4G5   S3**

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

Description

A canopy of Red maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*) with a few pin oak (*Quercus palustris*) that are present in a depression typify this community. American holly (*Ilex opaca*) and sweetbay (*Magnolia virginiana*) are present in the low understory. Most of the area is thick with highbush blueberry (*Vaccinium corymbosum*) and eastern reed (*Phragmites australis*) was the only herb seen at this time of the year. There are likely more herbs present.

Figure 4.16. Red Maple-Sweetgum Swamp

The example on the Thompson Island Nature Preserve property could be considered mature even though it has a low stunted canopy. The inundated site conditions likely cause the low canopy.

Analysis of Condition at Thompson Island Nature Preserve

This wetland forest has been present in the same amount since 1937. Since there is no trend, the future of this community cannot be determined. However, because of the low elevation it is believed that groundwater inundation caused by sea level rise may eventually impact this community. All of the acreage from 1937 was still present in 2007. Since 1937, this community has converted about 0.1 acres of Reed Tidal Marsh (Table 4.30).

Table 4.30. Red Maple-Sweetgum Swamp has migrated into X or remained since 1937

X	**Acreage**
Red Maple-Sweetgum Swamp	2 acres
Reed Tidal Marsh	0.1 acres

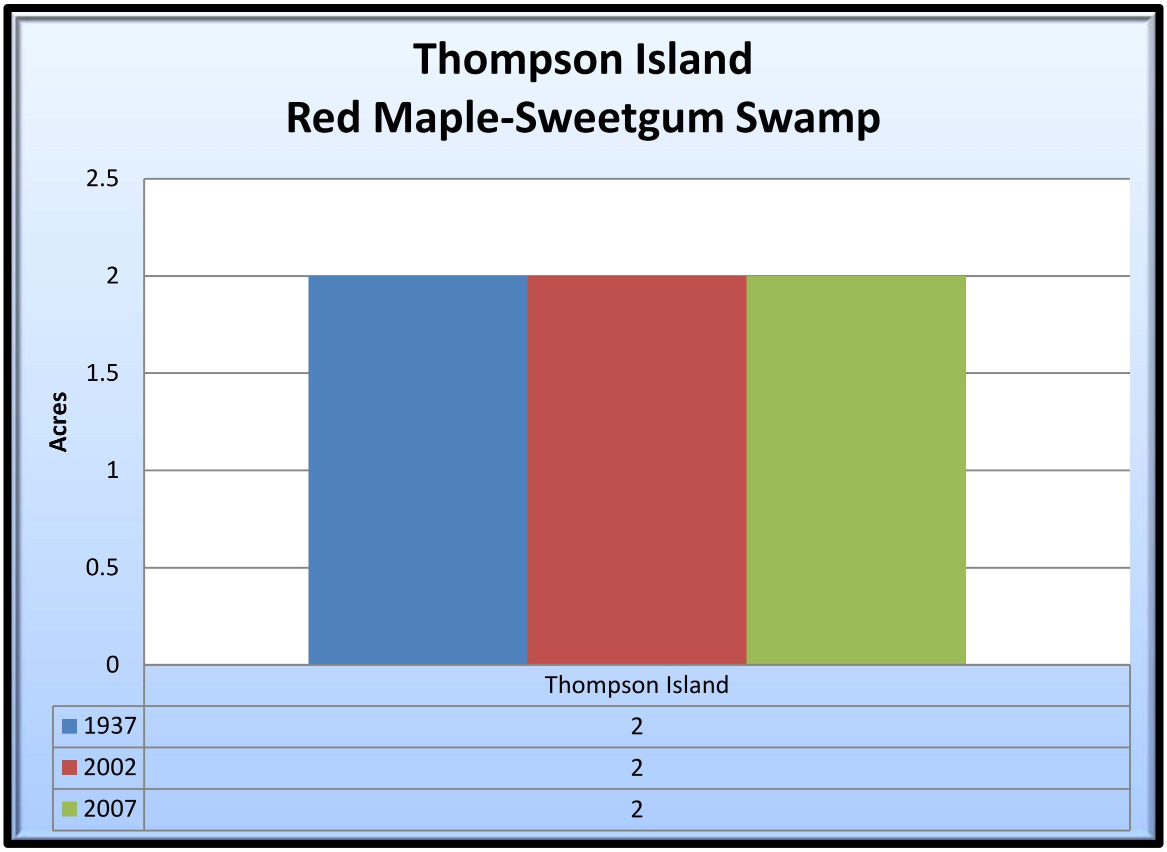


Figure 4.17. Red Maple-Sweetgum Swamp at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.31)

All of the current extent of Red Maple-Sweetgum Swamp will be "captured" by tidal water with 0.5 m of sea level rise.

Table 4.31. Projected acres of Red Maple-Sweetgum Swamp Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	2 acres
1 m	2 acres
1.5 m	2 acres

Natural Capital (Table 4.32)

Capital of Red Maple-Sweetgum Swamp has not changed during the study period.

Table 4.32. Natural Capital of Red Maple-Sweetgum Swamp	
Year	**Natural Capital (in 2012 dollars)**
1937	$24,583/year
2002	$24,583/year
2007	$24,583/year

***Reed Tidal Marsh* [3 acres (Figures 4.18-4.19; Tables 4.33-4.36)]** **GNA** **SNA**

DEWAP: Tidal High Marshes
NHC: Semi-natural/Altered Vegetation and Conifer Plantations

Description

Figure 4.18. Reed Tidal Marsh

This tidal marsh community is totally dominated by eastern reed (*Phragmites australis*). It is often located in at about the same elevation as the North Atlantic High Salt Marsh on the edges of the forests.

Analysis of Condition at Thompson Island Nature Preserve

Reed Tidal Marsh is the tidal analogue to the Eastern Reed Marsh. It has increased slightly since 1937 in spite of losing one acre and may continue into the future. However, some of what was this community has become other communities including 0.3 acres of Mid to Late Successional Loblolly Pine-Sweetgum Forest, 0.2 acres of Irregularly Flooded Eastern Tidal Salt Shrub, 0.2 acres of North Atlantic Low Salt Marsh, and 0.1 acres of Red Maple-Sweetgum Swamp (Table 4.33). Since 1937, Reed Tidal Marsh has spread into 1 acre of Northeastern Old Field, 0.4 acres of North Atlantic Low Salt Marsh, 0.4 acres of sand, and 0.3 acres of Early to Mid-Successional Loblolly Pine Forest (Table 4.34). This community is composed of an exotic invasive plant species it would be better to be eradicated from the preserve.

Table 4.33. What was once Reed Tidal Marsh in 1937 has become X or remained in 2007

X	Acreage
Reed Tidal Marsh	1 acre
Mid to Late Successional Loblolly Pine-Sweetgum Forest	0.3 acres
Irregularly Flooded Eastern Tidal Salt Shrub	0.2 acres
North Atlantic Low Salt Marsh	0.2 acres
Red Maple-Sweetgum Swamp	0.1 acres

Table 4.34. Reed Tidal Marsh has migrated into X or remained since 1937	
X	**Acreage**
Reed Tidal Marsh	1 acre
Northeastern Old Field	1 acre
North Atlantic Low Salt Marsh	0.4 acres
Sand	0.4 acres
Early to Mid-Successional Loblolly Pine Forest	0.3 acres
Other vegetation communities/land covers	0.4 acres

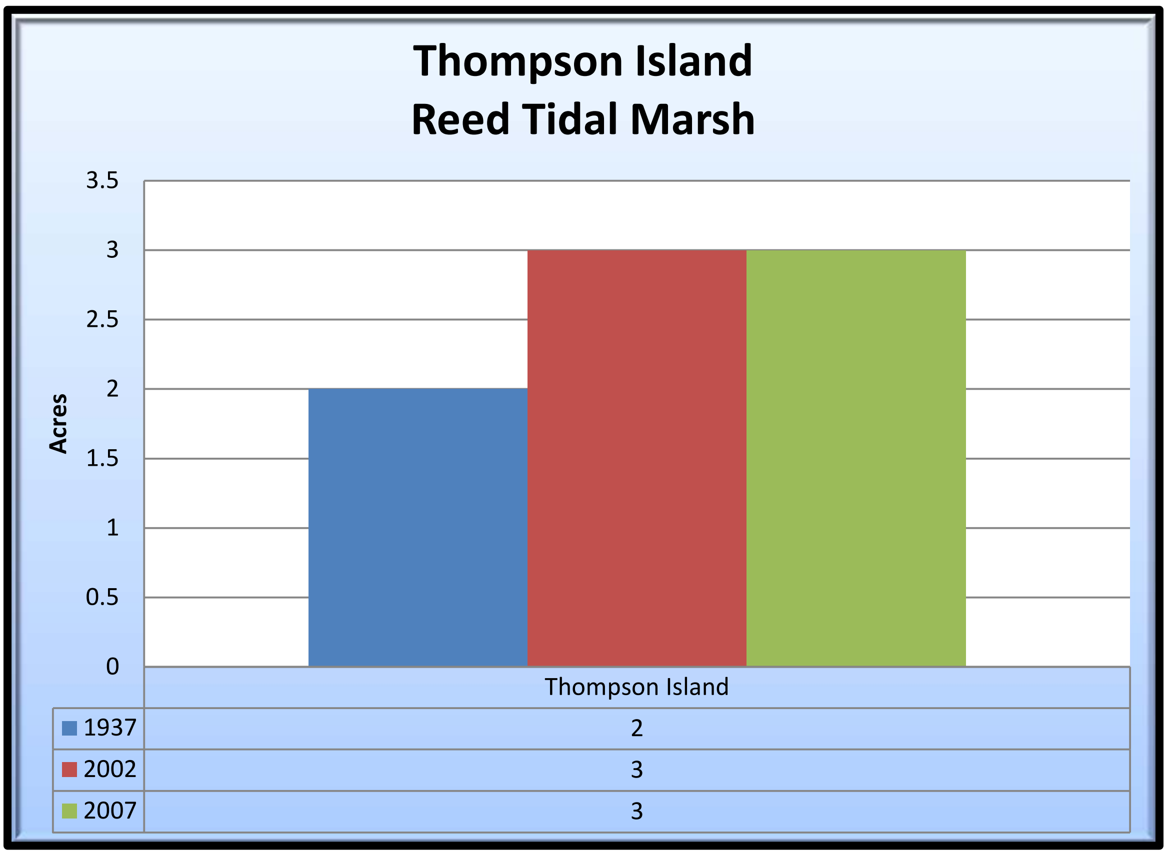


Figure 4.19. Reed Tidal Marsh at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.35)

All of the current extent of Reed Tidal Marsh will be inundated with 0.5 m of sea level rise.

Table 4.35. Projected acres of Reed Tidal Marsh Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	3 acres
1 m	3 acres
1.5 m	3 acres

Natural Capital (Table 4.36)

Capital of Reed Tidal Marsh has increased with acreage since 1937.

Table 4.36. Natural Capital of Reed Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$12,543/year
2002	$18,814/year
2007	$18,814/year

***Salt Panne* [0.04 acres (Figures 4.20-4.21; Tables 4.37-4.40)] G5 S3**

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

Description

Figure 4.20. Salt Panne

This herbaceous community is present in pools and tidal flats in the North Atlantic Low Salt Marsh, where the evaporation of water creates a more saline environment than that found on the marsh. These pannes are composed of glasswort (*Salicornia virginica*), sea lavender (*Limonium carolinianum*), and halbeard-leaf orache (*Atriplex patula*).

Analysis of Condition at Thompson Island Nature Preserve

This is a very small and ephemeral community at Thompson Island and has arisen from North Atlantic Low Salt Marsh (Table 4.37). Given the trend below it appears that it is becoming less common and could be due to sea level rise or it could convert to a tidal mudflat. It is unknown what the future of this community may be, but they may present in some amount in the long term future.

Table 4.37. Salt Panne has migrated into X or remained since 1937

X	Acreage
North Atlantic Low Salt Marsh	0.04 acres

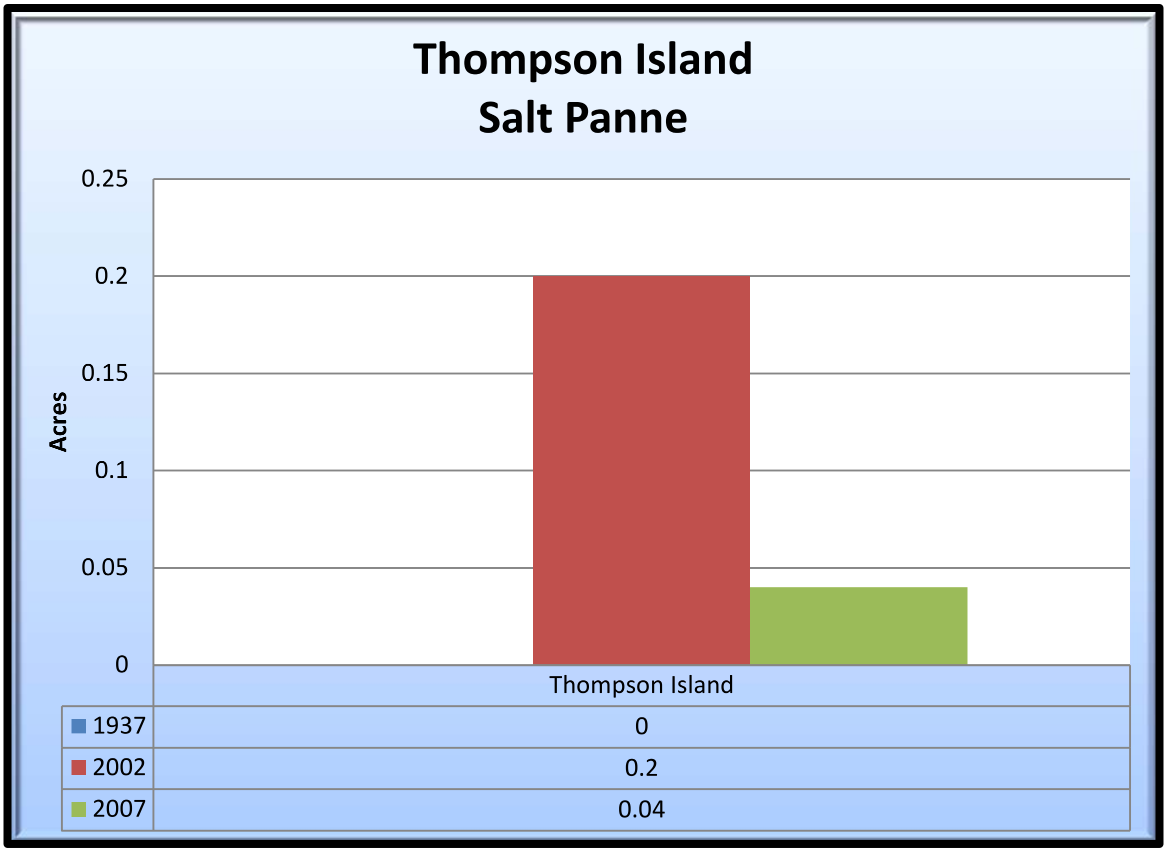


Figure 4.21. Salt Panne at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.38)

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

Table 4.38. Projected acres of Salt Panne Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0.04 acres
1 m	0.04 acres
1.5 m	0.04 acres

Natural Capital (Table 4.39)

Salt Panne has gained capital in the preserve since 1937, and since 2002 it has lost capital due to loses in acreage. This pattern is typical for an ephemeral community.

Table 4.39. Natural Capital of Salt Panne	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$1,254/year
2007	$251/year

***Southern Red Oak/Heath Forest* [15 acres (Figures 4.22-4.23; Tables 4.40-4.43)] G4G5 S4S5**

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

Description

Southern Red Oak/Heath Forest is the upland hardwood forest for the nature preserve. This forest is composed of a canopy of southern red oak (*Quercus falcata*), white oak (*Quercus alba*), loblolly pine (*Pinus taeda*), scarlet oak (*Quercus coccinea*), post oak (*Quercus stellata*) and a few tuliptree (*Liriodendron tulipifera*). Understory associates include smaller members of the canopy plus red maple (*Acer rubrum*), Virginia pine (*Pinus virginiana*), mockernut hickory (*Carya alba*), sassafras (*Sassafras albidum*), and wild black cherry (*Prunus serotina*). The shrub layer is sparse with lowbush blueberry (*Vaccinium pallidum*) and could be an indication of heavy deer browsing.

Most of the occurrences in the preserve can be considered to be at least late successional if not mature. Diameters of canopy trees range from 1 foot to 2 feet.

Figure 4.22. Southern Red Oak/Heath Forest

Analysis of Condition at Thompson Island Nature Preserve

This forest community has become more common over time as more forest has succeeded into this type. This forest contains long lived species and is located on higher ground and as such will likely be present in Thompson Island for the long term future.

Table 4.40. What was once North Atlantic High Salt Marsh in 1937 has become X or remained in 2007	
X	**Acreage**
Southern Red Oak/Heath Forest	9 acres
North Atlantic Low Salt Marsh	1 acre
Reed Tidal Marsh	0.1 acres
Eastern Reed Marsh	0.1 acres

Table 4.41. Southern Red Oak/Heath Forest has migrated into X or remained since 1937	
X	**Acreage**
Southern Red Oak/Heath Forest	9 acres
Early to Mid-Successional Loblolly Pine Forest	5 acres
Agricultural Field	1 acre

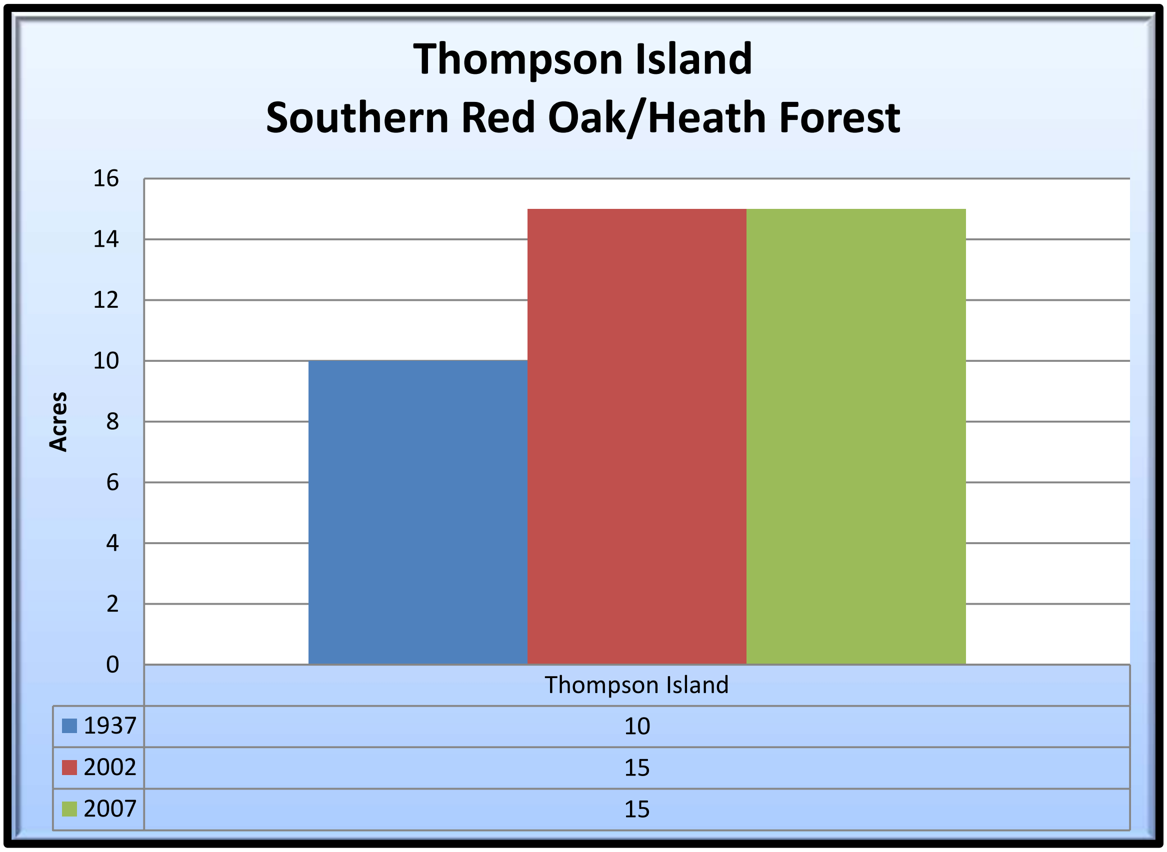


Figure 4.23. Southern Red Oak/Heath Forest at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.42)

All of the current extent of North Atlantic High Salt Marsh will be inundated with 0.5 m of sea level rise.

Table 4.42. Projected acres of Southern Red Oak/Heath Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	9 acres
1 m	9 acres
1.5 m	9 acres

Natural Capital (Table 4.43)

Capital of Southern Red Oak/Heath Forest has been going up as other successional forests mature to it.

Table 4.43. Natural Capital of Southern Red Oak/Heath Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,891/year
2002	$2,837/year
2007	$2,837/year

Successional Maritime Forest [15 acres (Figures 4.24-4.25; Tables 4.43-4.45)] G2G3 S3

DEWAP: Dune Forests and Woodlands
NHC: Northern Atlantic Coastal Plain Maritime Forest

Description

This community is located on the edges of Thompson Island, adjacent to the salt marshes. The stunted canopy is composed of southern red oak (*Quercus falcata*), persimmon (*Diospyros virginiana*), eastern red cedar (*Juniperus virginiana*), wild black cherry (*Prunus serotina*), sassafras (*Sassafras albidum*), and white oak (*Quercus alba*). Common greenbrier (*Smilax rotundifolia*), highbush blueberry (*Vaccinium corymbosum*), and wax-myrtle (*Morella cerifera*) compose the shrub/vine understory. Salt meadow cordgrass (*Spartina patens*) was the only herb noted in this community.

Figure 4.24. Successional Maritime Forest

Analysis of Condition at Thompson Island Nature Preserve

This often stunted forest is located on the edge of marshes where occasional salt spray is experienced. While not present in 1937, it has since populated 2 acres of former Northeastern Old Field and 0.1 acres of North Atlantic Low Salt Marsh (Table 4.43).

Table 4.43. Successional Maritime Forest has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	2 acres
North Atlantic Low Salt Marsh	0.1 acres

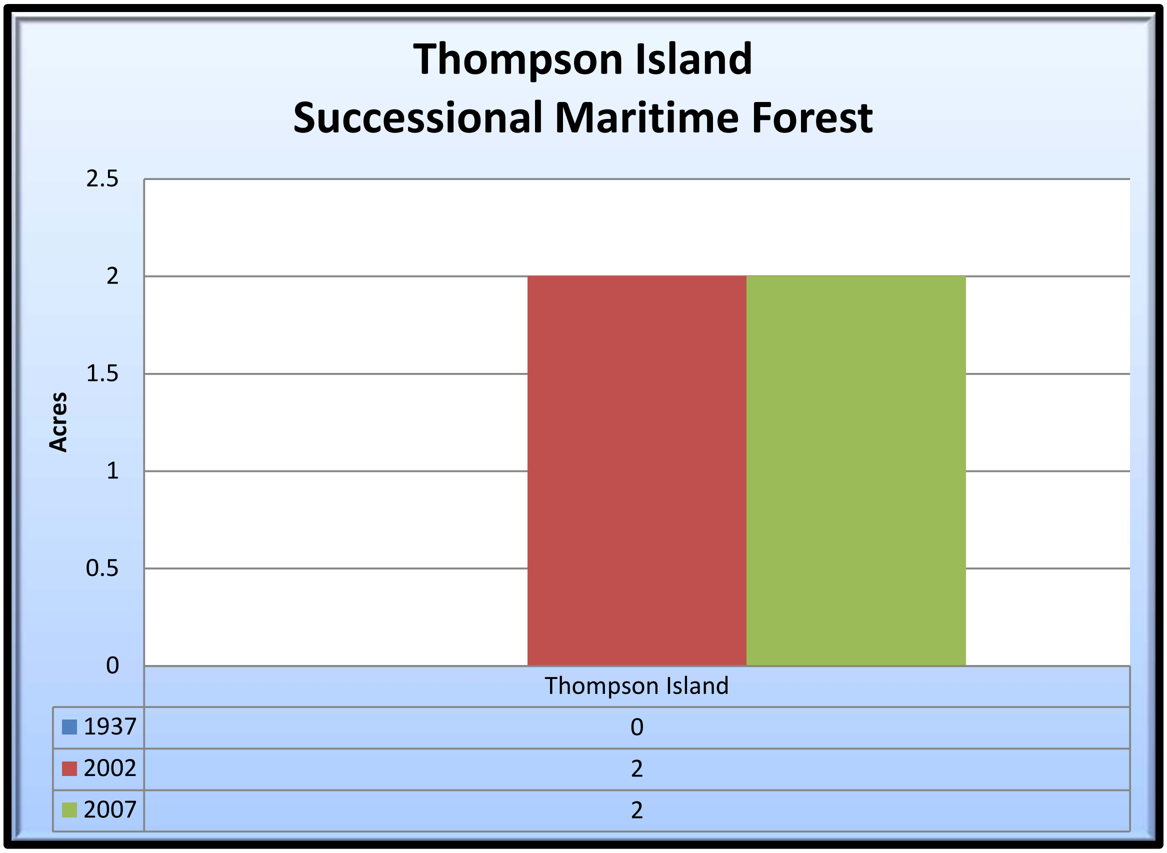


Figure 4.25. Successional Maritime Forest at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.44)

All of the current extent of Successional Maritime Forest will be inundated with 1 m of sea level rise.

Table 4.44. Projected acres of Successional Maritime Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	2 acre
1.5 m	2 acre

Natural Capital (Table 4.45)

Capital of Successional Maritime Forest has been stable in the recent period (2002-2007).

Table 4.45. Natural Capital of Successional Maritime Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$378/year
2007	$378/year

Successional Sweetgum Forest **[0.4 acres (Figures 4.26-4.27; Tables 4.46-4.48)]**

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

Description

Figure 4.26. Successional Sweetgum Forest

One small occurrence of this community is located on the middle peninsula. Sweetgum (*Liquidambar styraciflua*) is the dominant species in the canopy with a few wild black cherry (*Prunus serotina*) mixed in that overtop a few American holly (*Ilex opaca*) and southern red oak (*Quercus falcata*) in the understory. Common greenbrier (*Smilax rotundifolia*) is present in the vine layer and no herbs were noted. Some larger logs are present on the forest floor in this community.

Analysis of Condition at Thompson Island Nature Preserve

This successional forest covers a very small of the portion of the preserve in a small depression that used to be part of an agricultural field (Table 4.46). This forest will likely succeed into a Red Maple-Sweetgum Forest in time and but should remain this type in the short term future.

Table 4.46. Successional Sweetgum Forest has migrated into X or remained since 1937	
X	**Acreage**
Agricultural Field	0.4 acres

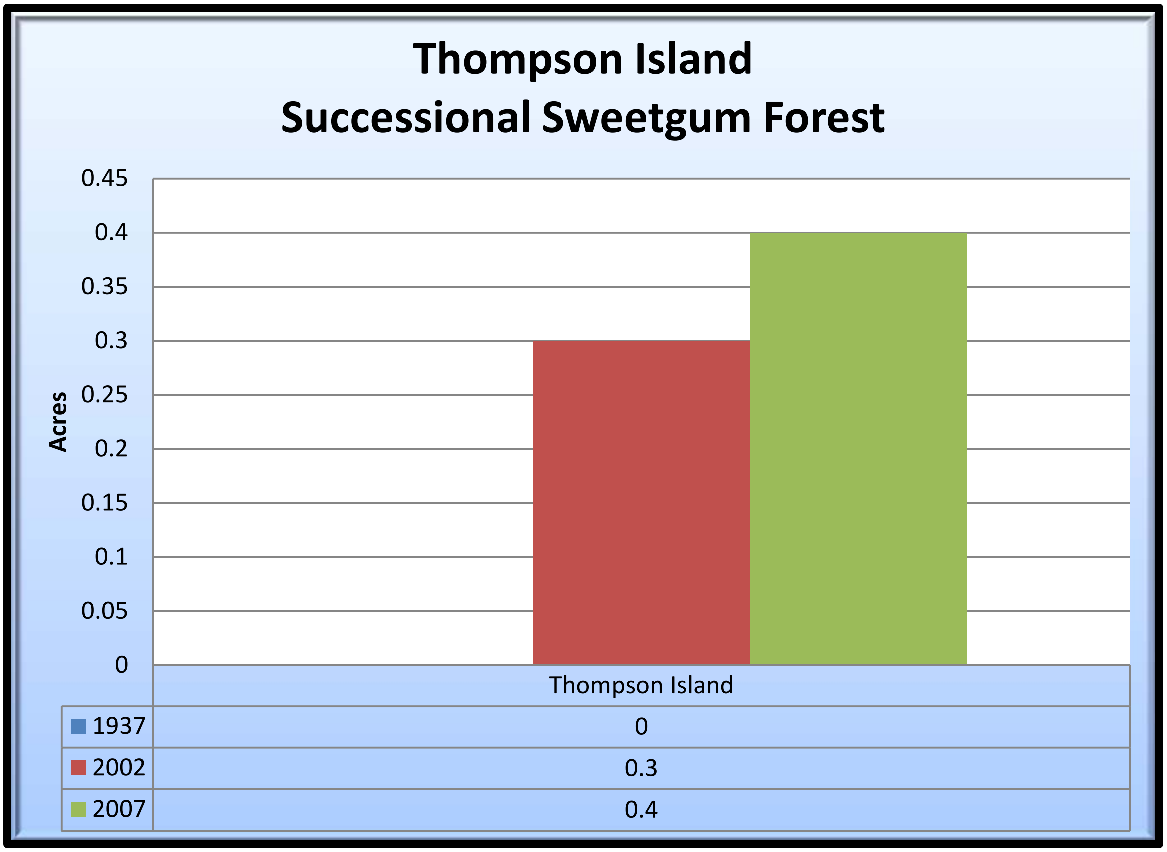


Figure 4.27. Successional Sweetgum Forest at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.47)

All of the current extent of Successional Sweetgum Forest will be inundated with 1.5 m of sea level rise.

Table 4.47. Projected acres of Successional Sweetgum Forest Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0.2 acres
1.5 m	0.4 acres

Natural Capital (Table 4.48)

Successional Sweetgum Forest has been expanding as it grows into more area, thereby raising the natural capital.

Table 4.48. Natural Capital of Successional Sweetgum Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$38/year
2007	$76/year

CHAPTER 5: DESCRIPTIONS AND ANALYSIS OF THE LAND COVERS

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

The land cover types include:

1. Beach—1 acres
2. Tidal Mudflat—0.1 acres
3. Water—10 acres

Beach **[1 acre, (Figure 5.1, Tables 5.1-5.4)]**

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

Description

This land covers includes sandy areas that front Rehoboth Bay and are not part of the spoil piles that line the canal.

Analysis of Condition at Thompson Island Nature Preserve

About 0.3 acres of the 3 acres of beach present in 1937 still existed in 2007. The rest of the beach area had become 1 acre of Chesapeake Bay Tall Maritime Shrubland, 1 acre of North Atlantic High Salt Marsh, 0.3 acres of North Atlantic Low Salt Marsh, and 0.2 acres of Irregularly Flooded Eastern Tidal Salt Shrub (Table 5.1). Since 1937, beach has covered 1 acre of water and 0.2 acres of Northeastern Old Field (Table 5.2).

Table 5.1. What was once Beach in 1937 has become X or remained in 2007	
X	**Acreage**
Chesapeake Bay Tall Maritime Shrubland	1 acre
North Atlantic High Salt Marsh	1 acre
North Atlantic Low Salt Marsh	0.3 acres
Beach	0.3 acres
Irregularly Flooded Eastern Tidal Salt Shrub	0.2 acres

Table 5.2. Beach has migrated into X or remained since 1937	
X	**Acreage**
Water	1 acre
Beach	0.3 acres
Northeastern Old Field	0.2 acres

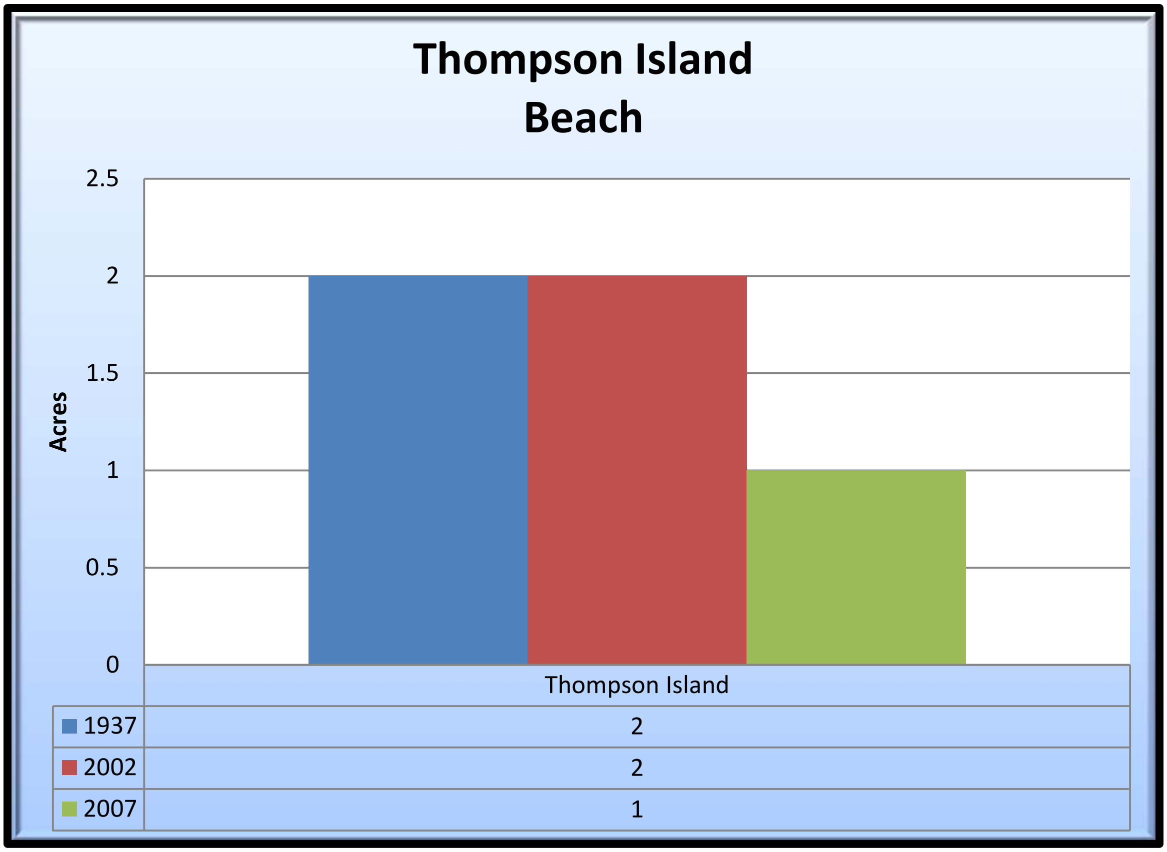


Figure 5.1. Beach at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.3)

All of the current extent of Beach will be inundated with 0.5 m of sea level rise.

Table 5.3. Projected acres of Beach Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	1 acre
1 m	1 acre
1.5 m	1 acre

Natural Capital

Beach area does not carry any natural capital value.

***Tidal Mudflat* [0.1 acres, (Figure 5.2)]**

DEWAP: Tidal Low Marshes
NHC: No Equivalent Classification

Description

Tidal Mudflats occur in North Atlantic Low Salt Marshes where the vegetation has been removed by water action or dieback. This is often an intermediate step in the transition from marsh to open water.

Analysis of Condition at Thompson Island Nature Preserve

The area and location of tidal mudflat has not changed from 1937 to 2007 and therefore a change analysis was not conducted.

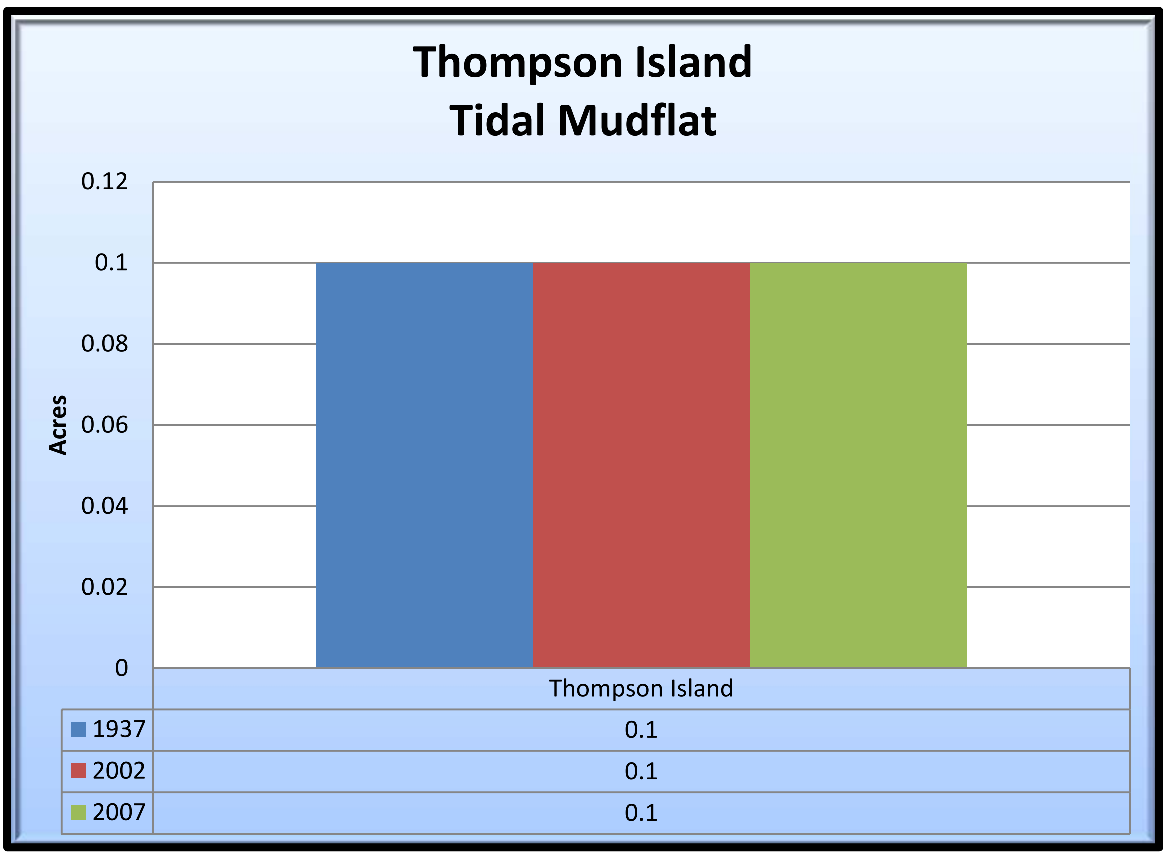


Figure 5.2. Tidal Mudflat at Thompson Island Nature Preserve (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.4)

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

Table 5.4. Projected acres of Tidal Mudflat Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0.1 acres
1 m	0.1 acres
1.5 m	0.1 acres

Natural Capital (Table 5.5)

Capital of tidal mudflat has not changed over the study period.

Table 5.5. Natural Capital of Tidal Mudflat	
Year	**Natural Capital (in 2012 dollars)**
1937	$627/year
2002	$627/year
2007	$627/year

***Water* [10 acres, (Figures 5.3 and 5.4, Tables 5.6-5.9)]**

The amount of water present is often a bellwether of sea level rise. These calculations account for that water not present in an impoundment. In 1937 there were 5 acres covered in water. The number has increased to 8 acres in 2002 and 10 acres in 2007. Between 1937 and 2002 the amount of acreage in water increased to 8 acres or 3 acres giving an inundation rate of 0.05 acres/yr. Between 2002 and 2007 the amount of water inundation increased by 2 acres to 10 acres or about 0.4 acres/yr. Between 1937 and 2007 the amount of water increased by 5 acres or 0.07 acres/yr. At some point between these years the rate of inundation increased and possibly also sea level rise.

Analysis of Condition at Thompson Island Nature Preserve

Three acres of the water coverage from 1937 still existed in 2007. The rest of the water area has become 1 acre of beach, 0.3 acres of Chesapeake Bay Tall Maritime Shrubland, 0.3 acres of North Atlantic High Salt Marsh, and 0.2 acres of North Atlantic Low Salt Marsh (Table 5.6). Since 1937, water has increased in acreage by inundating 3 acres of North Atlantic Low Salt Marsh, 2 acres of North Atlantic High Salt Marsh, 1 acre of Northeastern Old Field, and 1 acre of modified land (Table 5.7).

Table 5.6. What was once Water in 1937 has become X or remained in 2007	
X	**Acreage**
Water	3 acres
Beach	1 acre
Chesapeake Bay Tall Maritime Shrubland	0.3 acres
North Atlantic High Salt Marsh	0.3 acres
North Atlantic Low Salt Marsh	0.2 acres

Table 5.7. Water has migrated into X or remained since 1937	
X	**Acreage**
Water	3 acres
North Atlantic Low Salt Marsh	3 acres
North Atlantic High Salt Marsh	2 acres
Northeastern Old Field	1 acre
Modified Land	1 acre
Other communities/land covers	0.1 acres

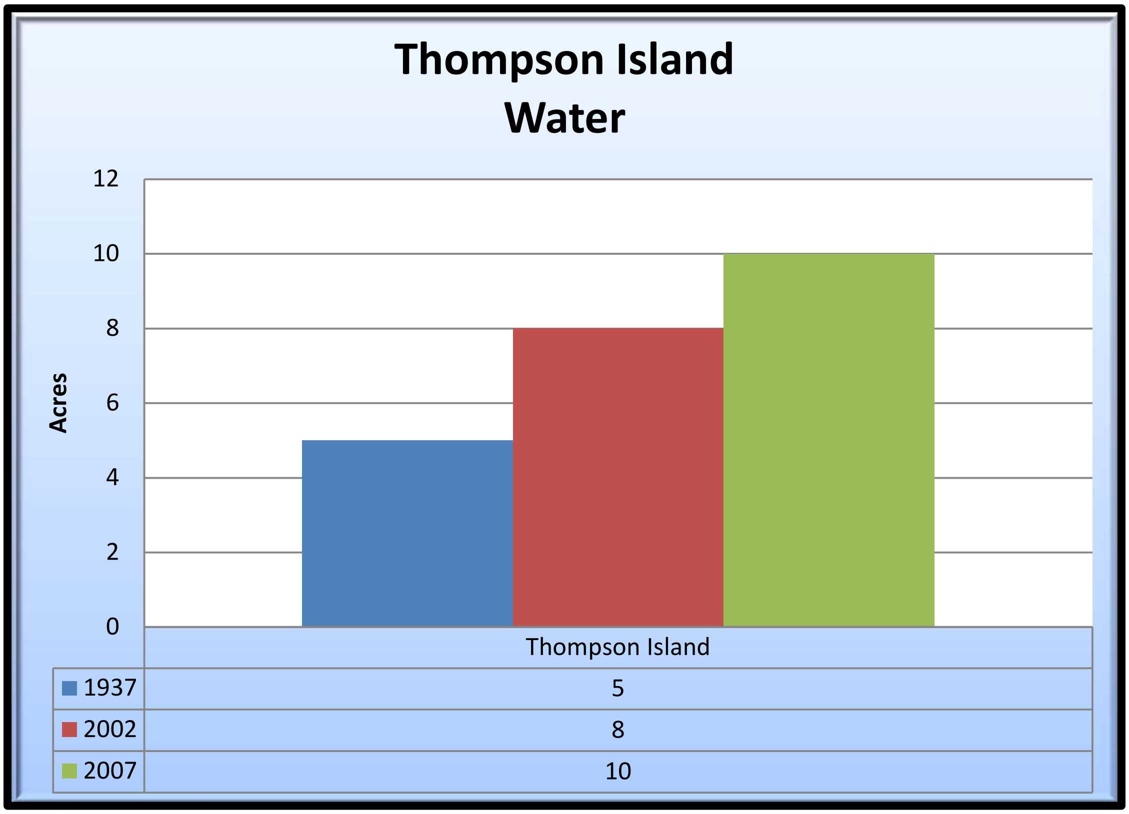


Figure 5.3. Water at Thompson Island Nature Preserve (1937, 2002, and 2007)

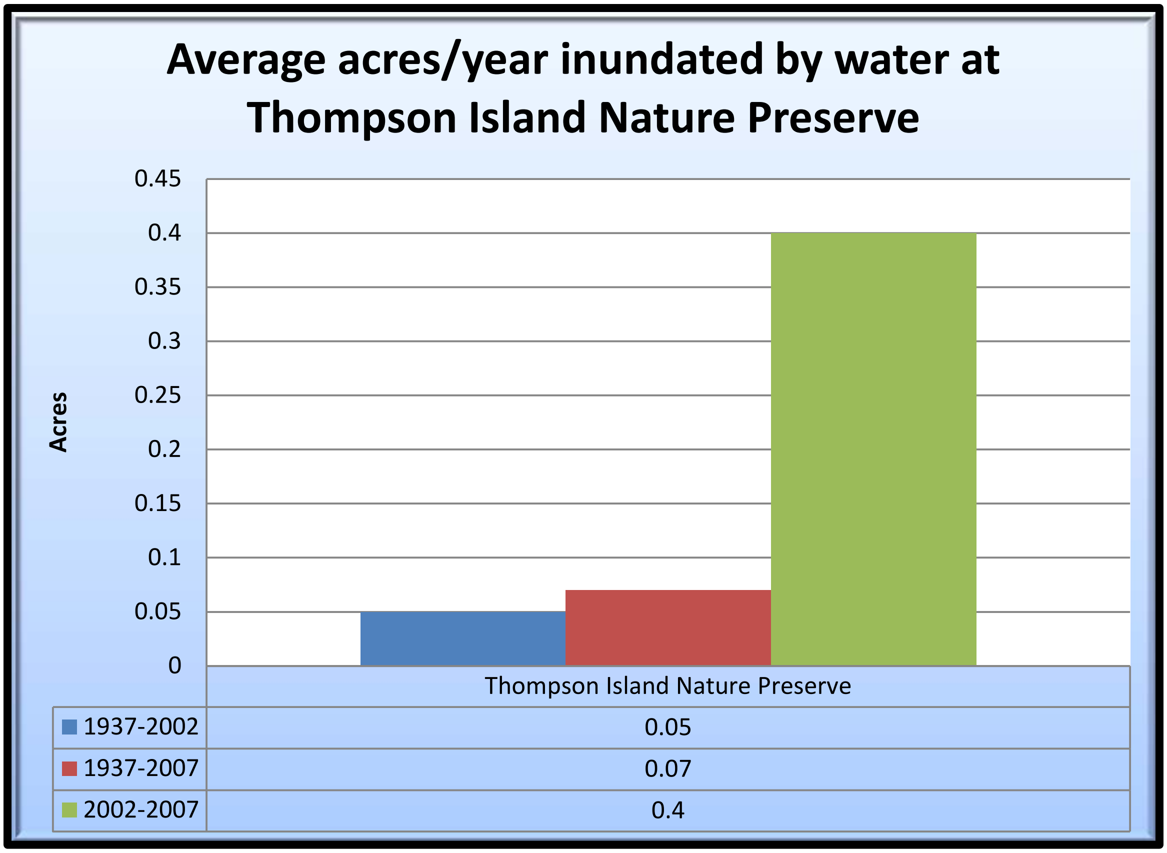


Figure 5.4. Average acres/year inundated by water at Thompson Island Nature Preserve

Natural Capital

Natural capital of water can be found in the preserve description.

APPENDIX I: STATE RARE VEGETATION RANKING CRITERIA

Ranks are based on a system developed by The Nature Conservancy and Natureserve to measure the relative rarity of vegetation communities within a given state. State rarity ranks are used to prioritize conservation and protection efforts so that the rarest of vegetation communities receive immediate attention. The primary criteria for ranking vegetation communities are the total number of documented occurrences with consideration given to the total number of occurrences and total amount of acreage in the state. Ranks for vegetation communities are updated annually and are based on current knowledge and mapping being done for the Guide to Delaware Vegetation Communities.

State Rank

S1 Extremely rare (i.e., typically 5 or fewer occurrences statewide), or may be susceptible to extirpation because of other threats to its existence.

S1.1 Only a single occurrence or population of the species is known to occur. (this rank is only applied to plants.)

S2 Very rare, (i.e., typically 6 to 20 occurrences statewide), or may be susceptible to extirpation because other threats to its existence.

S3 Rare to uncommon, not yet susceptible to extirpation but may be if additional populations are destroyed. Approximately 21 to 100 occurrences statewide.

S4 Common, apparently secure in the state under present conditions.

S5 Very common, secure in the state under present conditions.

SH Historically known, but not verified for an extended period (usually 15+ years); there are expectations that the species may be rediscovered.

SX Extirpated or presumed extirpated from the state. All historical locations and/or potential habitat have been surveyed.

SU Status uncertain within the state. Usually an uncommon species which is believed to be of conservation concern, but there is inadequate data to determine the degree of rarity.

SNR Unranked

SNA Not Applicable

SW Weedy vegetation or vegetation dominated by invasive alien species (this rank is only applied to natural communities).

SM Vegetation resulting from management or modification of natural vegetation. It is readily restorable by management or time and/or the restoration of original ecological processes (this rank is only applied to natural communities).

APPENDIX II: SGCN SPECIES EXPECTED FOR KEY WILDLIFE HABITATS

SGCN Species expected in Beach and Dune Habitats			
Species	**Common Name**	**Class**	**Tier**
Cincindela dorsalis media	white tiger beetle	Insect	1
Cincindela lepida	little white tiger beetle	Insect	1
Malaclemys terrapin terrapin	Northern diamondback terrapin	Reptile	1
Charadrius melodus	Piping plover	Bird	1
Haematopus palliatus	American Oystercatcher	Bird	1
Arenaria interpres	ruddy turnstone	Bird	1
Calidris canutus	Red knot	Bird	1
Calidrius alba	sanderling	Bird	1
Sterna hirundo	common tern	Bird	1
Sterna antillarum	least tern	Bird	1
Rynchops niger	black skimmer	Bird	1
Chordeiles minor	common nighthawk	Bird	1
Cincindela dorsalis	Eastern beach tiger beetle	Bird	2
Cincindela hirticolis	beach-dune tiger beetle	Bird	2
Melitara prodenialis	a snout-moth	Bird	2
Drasteria graphica atlantica	Atlantic graphic moth	Bird	2
Schinia spinosae	a noctuid moth	Bird	2
Falco peregrinus	peregrine falcon	Bird	2
Pluvialis squatarola	black-bellied plover	Bird	2
Catoptrophorus semipalmatus	willet	Bird	2
Calidris pusilla	semi-palmated sandpiper	Bird	2
Calidris maritima	purple sandpiper	Bird	2
Calidris alpina	dunlin	Bird	2
Larus marinus	great black-backed gull	Bird	2
Piplio erythrophthalmus	Eastern towhee	Bird	2
Passerculus sandwichensis	savannah sparrow	Bird	2

SGCN Species expected in Coastal Plain Forested Floodplains and Riparian Swamps			
Species	**Common Name**	**Class**	**Tier**
Satyrium kingi	King's hairstreak	Insect	1
Clemmys guttata	Spotted turtle	Reptile	1
Terrapene carolina	Eastern box turtle	Reptile	1
Nerodia erythrogaster	Plainbelly water snake	Reptile	1
Nycticorax nyticorax	Black crowned night-heron	Bird	1
Nyctanassa violacea	yellow-crowned night-heron	Bird	1
Buteo platypterus	Broad-winged hawk	Bird	1
Melanerpes erythrocephalus	Red-headed woodpecker	Bird	1
Hylocichla mustelina	Wood thrush	Bird	1
Parula americana	Northern parula	Bird	1
Setophaga ruticella	American redstart	Bird	1
Limnothlypis swainsonii	Swainson's warbler	Bird	1
Amblyscirtes aesculapius	Lace-winged roadside-skipper	Insect	2

Libytheana carinenta	American snout	Insect	2
Anacamptodes pergracilis	Cypress looper	Insect	2
Chloropteryx tepperaria	Angle winged emerald moth	Insect	2
Manduca jasminearum	Ash sphinx	Insect	2
Dolba hyloeus	Black alder or pawpaw sphinx	Insect	2
Haploa colona	A tiger moth	Insect	2
Orgyia detrita	A tussock moth	Insect	2
Catocala unijuga	Once-married underwing	Insect	2
Catocala praeclara	Praeclara underwing	Insect	2
Parapamea buffaloensis	A borer moth	Insect	2
Papaipema stenocelis	Chain fern borer moth	Insect	2
Gomphaeschna antilope	Taper-tailed darner	Insect	2
Gomphaeschna furcillata	Harlequin darner	Insect	2
Sympetrum ambiguum	Blue-faced meadowhawk	Insect	2
Enallagma weewa	Blackwater bluet	Insect	2
Hemidactylum scutatum	Four-toed salamander	Amphibian	2
Pseudotriton montanus montanus	Mud salamander	Amphibian	2
Hyla chrysoscelis	Cope's gray treefrog	Amphibian	2
Rana virgatipes	Carpenter frog	Amphibian	2
Opheodrys aestivus	Rough green snake	Reptile	2
Thamnophis sauritus	Eastern ribbon snake	Reptile	2
Agkistrodon contortix	copperhead	Reptile	2
Ardea herodias	Great blue heron	Bird	2
Casmerodius albus	Great egret	Bird	2
Egretta thula	Snowy egret	Bird	2
Egretta caerulea	Little blue heron	Bird	2
Egretta tricolor	Tricolored heron	Bird	2
Bubulcus ibis	Cattle egret	Bird	2
Plegadis falcinellus	Glossy ibis	Bird	2
Buteo lineatus	Red-shouldered hawk	Bird	2
Strix varia	Barred owl	Bird	2
Vireo flavifrons	Yellow-throated vireo	Bird	2
Protonotaria citrea	Prothonotary warbler	Bird	2
Helmitheros vermivorus	Worm-eating warbler	Bird	2
Oporornis formosus	Kentucky warbler	Bird	2
Piranga olivacea	Scarlet tanager	Bird	2
Icterus galbula	Baltimore oriole	Bird	2
Lasionycteris noctivagans	Silver-haired bat	Mammal	2
Nycticeius humeralis	Evening bat	Mammal	2

SGCN Species expected in Coastal Plain Upland Forest			
Species	**Common Name**	**Class**	**Tier**
Cicindela patruela consentanea	Northern barrens tiger beetle	Insect	1
Callophrys irus	frosted elfin	Insect	1
Catocala antinympha	sweetfern underwing	Insect	1
Catocala lacrymosa	tearful underwing	Insect	1

Terrapene carolina	Eastern box turtle	Reptile	1
Eumeces laticeps	broadhead skink	Reptile	1
Cemophora coccinea	scarlet snake	Reptile	1
Elaphe guttata	corn snake	Reptile	1
Lampropeltis triangulum	milk snake	Reptile	1
Haliaeetus leucocephalus	Bald eagle	Bird	1
Accipiter cooperii	Cooper's Hawk	Bird	1
Buteo platypterus	broad-winged hawk	Bird	1
Asio otus	long-eared owl	Bird	1
Melanerpes erythrocephalus	red-headed woodpecker	Bird	1
Certhia americana	brown creeper	Bird	1
Hylocichla mustelina	wood thrush	Bird	1
Wilsonia citrina	hooded warbler	Bird	1
Sciurus niger cinereus	Delmarva fox squirrel	Mammal	1
Discus catskillensis	angular disc	Gastropod	2
Cicindela patruela	Northern barrens tiger beetle	Insect	2
Cicindela unipunctata	one-spotted tiger beetle	Insect	2
Photuris frontalis	a firefly	Insect	2
Erynnis martialis	mottled duskywing	Insect	2
Erynnis baptisiae	wild indigo duskywing	Insect	2
Battus philenor	pipevine swallowtail	Insect	2
Polygonia progone	gray comma	Insect	2
Caripeta aretaria	a geometer moth	Insect	2
Tolype notialis	a lasiocampid moth	Insect	2
Hemileuca maia maia	the buckmoth	Insect	2
Cisthene kentuckiensis	Kentucky lichen moth	Insect	2
Cisthene tenuifascia	a lichen moth	Insect	2
Grammia phyllira	phyllira tiger moth	Insect	2
Zale metata	a noctuid moth	Insect	2
Catocala flebilis	mournful underwing	Insect	2
Catocala residua	residua underwing	Insect	2
Catocala cerogama	Yellow banded underwing	Insect	2
Acronicta exilis	Exiled dagger moth	Insect	2
Acronicta lithospila	Streaked dagger moth	Insect	2
Papaipema araliae	Aralia shoot borer moth	Insect	2
Papaipema baptisiae	Wild indigo borer moth	Insect	2
Lepipolys perscripta	A noctuid moth	Insect	2
Scincella lateralis	Ground skink	Reptile	2
Heterodon platirhinos	Eastern hognose snake	Reptile	2
Lampropeltis getula	Common kingsnake	Reptile	2
Storeria occipitomaculata	Redbelly snake	Reptile	2
Virginia valeriae	Smooth earth snake	Reptile	2
Agkistrodon contortix	Copperhead	Reptile	2
Coragyps atratus	Black vulture	Bird	2
Strix varia	Barred owl	Bird	2
Caprimulgus vociferus	whip-poor-will	Bird	2
Colaptes auratus	Northern flicker	Bird	2
Myiarchus crinitus	Great crested flycatcher	Bird	2
Sitta pusilla	Brown-headed nuthatch	Bird	2

Vireo flavifrons	Yellow-throated vireo	Bird	2
Dendroica dominca	Yellow-throated warbler	Bird	2
Mniotilta varia	Black-and-white warbler	Bird	2
Seiurus motacilla	Louisiana waterthrush	Bird	2
Oporornis formosus	Kentucky warbler	Bird	2
Piranga olivacea	Scarlet tanager	Bird	2
Piplio erythrophthalmus	Eastern towhee	Bird	2
Icterus galbula	Baltimora oriole	Bird	2
Lasionycteris noctivagans	Silver-haired bat	Mammal	2
Lasiurus borealis	Eastern red bat	Mammal	2
Lasiurus cinereus	Hoary bat	Mammal	2
Canis latrans	coyote	Mammal	2

SGCN Species expected in Early Successional Upland Habitats			
Species	**Common Name**	**Class**	**Tier**
Nicrophorus americanus	American burying beetle	Insect	1
Callophrys irus	frosted elfin	Insect	1
Papaipema maritima	maritime sunflower borer moth	Insect	1
Terrapene carolina	Eastern box turtle	Reptile	1
Lampropeltis triangulum	milk snake	Reptile	1
Branta canadensis	Canada goose (migratory)	Bird	1
Circus cyaneus	Northern harrier	Bird	1
Bartramia longicauda	upland sandpiper	Bird	1
Scolopax minor	American woodcock	Bird	1
Asio flammeus	short-eared Owl	Bird	1
Chordeiles minor	common nighthawk	Bird	1
Lanius ludovicianus	loggerhead shrike	Bird	1
Dendroica discolor	prairie warbler	Bird	1
Ammodramus henslowii	Henslow's sparrow	Bird	1
Cincindela scutellaris	festive tiger beetle	Insect	2
Atrytonopsis hianna	dusted skipper	Insect	2
Satyrium liparops	striped hairstreak	Insect	2
Satyrium liparops strigosum	stiped hairstreak	Insect	2
Callophrys gryneus	juniper hairstreak	Insect	2
Speyeria aphrodite	aphrodite fritillary	Insect	2
Speyeria idalia	regal fritillary	Insect	2
Boloria bellona	meadow fritillary	Insect	2
Paratrea plebeja	trumpet vine sphinx	Insect	2
Calyptra canadensis	Canadian owlet	Insect	2
Acronicta rubricoma	a dagger moth	Insect	2
Papaipema rigida	rigid sunflower borer moth	Insect	2
Cirrhophanus triangulifer	a noctuid moth	Insect	2
Schina septentrionalis	a noctuid moth	Insect	2
Plegadis falcinellus	glossy ibis	Bird	2
Cygnus columbianus	tundra swan	Bird	2
Coragyps atratus	black vulture	Bird	2
Colinus virginianus	Northern bobwhite	Bird	2
Pluvialis squatarola	black-bellied plover	Bird	2

Coccyzus erythropthalmus	black-billed cuckoo	Bird	2
Chaetura pelagica	chimney swift	Bird	2
Colaptes auratus	Northern flicker	Bird	2
Empidonax minimus	least flycatcher	Bird	2
Tyrannus tyrannus	Eastern kingbird	Bird	2
Toxostoma rufum	Brown thrasher	Bird	2
Dendroica pensylvanica	Chestnut-sided warbler	Bird	2
Icteria virens	Yellow-breasted chat	Bird	2
Piplio erythrophthalmus	Eastern towhee	Bird	2
Spizella pusilla	field sparrow	Bird	2
Pooecetes gramineus	vesper sparrow	Bird	2
Passerculus sandwichensis	savannah sparrow	Bird	2
Ammodramus savannarum	grasshopper sparrow	Bird	2
Dolichonyx oryzivorus	bobolink	Bird	2
Cryptotis parva	least shrew	Bird	2

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

SGCN Species expected in Tidal Low Marsh Habitats			
Species	**Common Name**	**Class**	**Tier**
Problema bulenta	rare skipper	Insect	1
Malaclemys terrapin terrapin	Northern diamondback terrapin	Reptile	1
Podilymbus podiceps	Pied-billed grebe	Bird	1
Nycticorax nycticorax	Black-crowned night-heron	Bird	1
Branta canadensis	Canada goose (migratory)	Bird	1
Anas rubripes	American black duck	Bird	1
Nyctanassa violacea	yellow-crowned night-heron	Bird	1
Circus cyaneus	northern harrier	Bird	1
Arenaria interpres	Ruddy turnstone	Bird	1
Asio flammeus	short-eared owl	Bird	1
Calidris canutus	Red knot	Bird	1
Sterna hirundo	Common tern	Bird	1
Sterna forsteri	Forster's tern	Bird	1
Rhynchops niger	Black skimmer	Bird	1
Ammodramus caudacutus	Saltmarsh sharp-tailed sparrow	Bird	1
Ammodramus maritimus	Seaside sparrow	Bird	1
Cicindela marginata	Margined tiger beetle	Insect	2
Pero zalissaria	A geometer moth	Insect	2
Acontia delecta	A noctuid moth	Insect	2
Brachymesia gravida	Four-spotted pennant	Insect	2
Pelecanus occidentalis	Brown pelican	Bird	2
Phalacrocorax carbo	Great cormorant	Bird	2
Phalacrocorax auritus	Double-crested cormorant	Bird	2
Ardea herodias	Great blue heron	Bird	2
Casmerodius albus	Great egret	Bird	2
Egretta thula	Snowy egret	Bird	2
Egretta caerulea	Little blue heron	Bird	2
Egretta tricolor	Tricolored heron	Bird	2
Bubulcus ibis	Cattle egret	Bird	2
Plegadis falcinellus	Glossy ibis	Bird	2
Anas platyrhynchos	mallard	Bird	2
Falco peregrinus	Peregrine falcon	Bird	2
Rallus elegans	King rail	Bird	2
Fulica americana	American coot	Bird	2
Pluvialis squatarola	Black-bellied plover	Bird	2
Himantopus mexicanus	Black-necked stilt	Bird	2
Catoptrophorus semipalmatus	Willet	Bird	2
Calidris pusilla	Semipalmated sandpiper	Bird	2
Calidris alpina	dunlin	Bird	2
Sterna nilotica	Gull-billed tern	Bird	2
Tyto alba	Barn owl	Bird	2
Cistothorus palustris	Marsh wren	Bird	2