Historical Analysis and Map of Vegetation Communities, Land Covers, and Habitats of the Burton-Derrickson, Hopkins, and West Farm Tracts Kent County, Delaware

Murderkill River Watershed

Submitted to:

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CHAPTER 1: INTRODUCTION AND METHODS

Setting of the Burton-Derrickson, Hopkins, and West Farm Tracts

The Burton-Derrickson, Hopkins, and West Farm Tracts are located east of Killens Pond State Park and in east central Kent County, Delaware (Figure 1.1). The tracts, which straddle the north side of the Murderkill River south of Frederica, Delaware, are a combined 132 acres in size; with an acreage breakdown of Burton-Derrickson (69 acres), Hopkins (51 acres), and West Farm (12 acres).

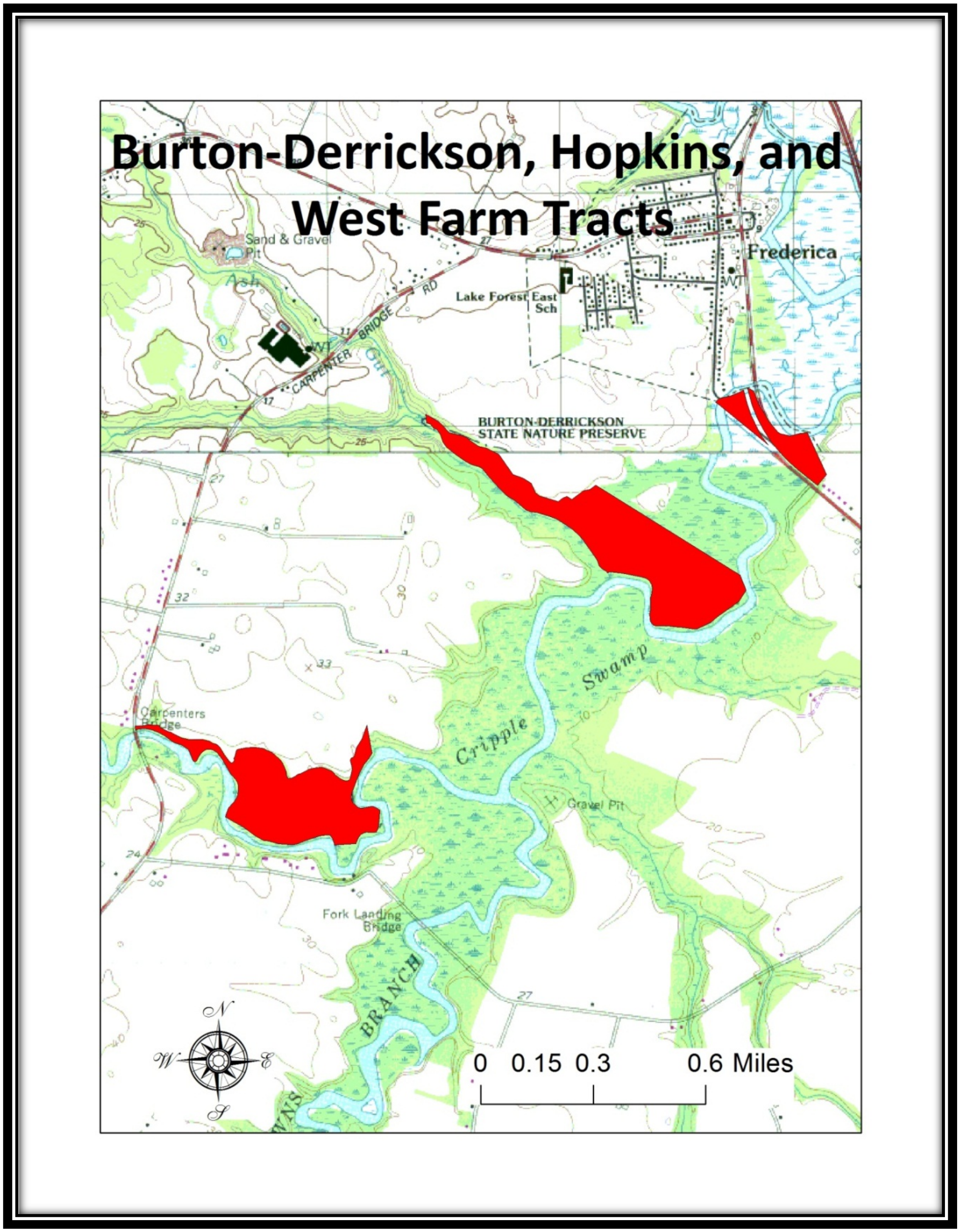

Figure 1.1. Burton-Derrickson, Hopkins, and West Farm Tracts (Burton-Derrickson is furthest west, Hopkins is in the middle, and West Farm is to the east)

Soils and Geology of the Burton-Derrickson, Hopkins, and West Farm Tracts

Underlying Geology

The tidal woodlands in the nature preserve are underlaid by swamp deposits and the marshes by marsh deposits. The uplands are mostly the Lynch Heights Formation, with a very small amount in the Scotts Corners Formation in the Burton-Derrickson Tract. The Lynch Heights formation is described as a "heterogeneous unit of light-gray to brown to light yellowish brown, medium to fine sand with discontinuous beds of coarse sand, gravel, silt, fine to very fine sand, and organic-rich clayey silt to silty sand."[1] The Scotts Corners Formation is described as a "heterogeneous unit of light-gray to brown to light-yellowish brown, coarse to fine sand, gravelly sand and pebble gravel with rare discontinuous beds of organic-rich clayey silt, clayey silt, and pebble gravel."[2] The elevation of the tracts range from sea level on the Murderkill River to about 10 feet near the upper end of Ash Gut in the Burton-Derrickson Tract.

Soils

Lenape Mucky Peat (64 acres) is the primary soil underlying the Burton-Derrickson, Hopkins, and West Farm Tracts. Other minor soils include Transquaking and Mispillion Soils (32 acres), Longmarsh and Indiantown Soils (13 acres), and Downer Sandy Loam (12 acres). Elevations of the preserves range from sea level to about 20 feet in the Hopkins Tract.

[1] Ramsey, Kelvin W. 2007. Geologic Map of Kent County, Delaware. Delaware Geological Survey, Geologic Map Series No. 14.
[2] Ramsey, Kelvin W. 2007. Geologic Map of Kent County, Delaware. Delaware Geological Survey, Geologic Map Series No. 14.

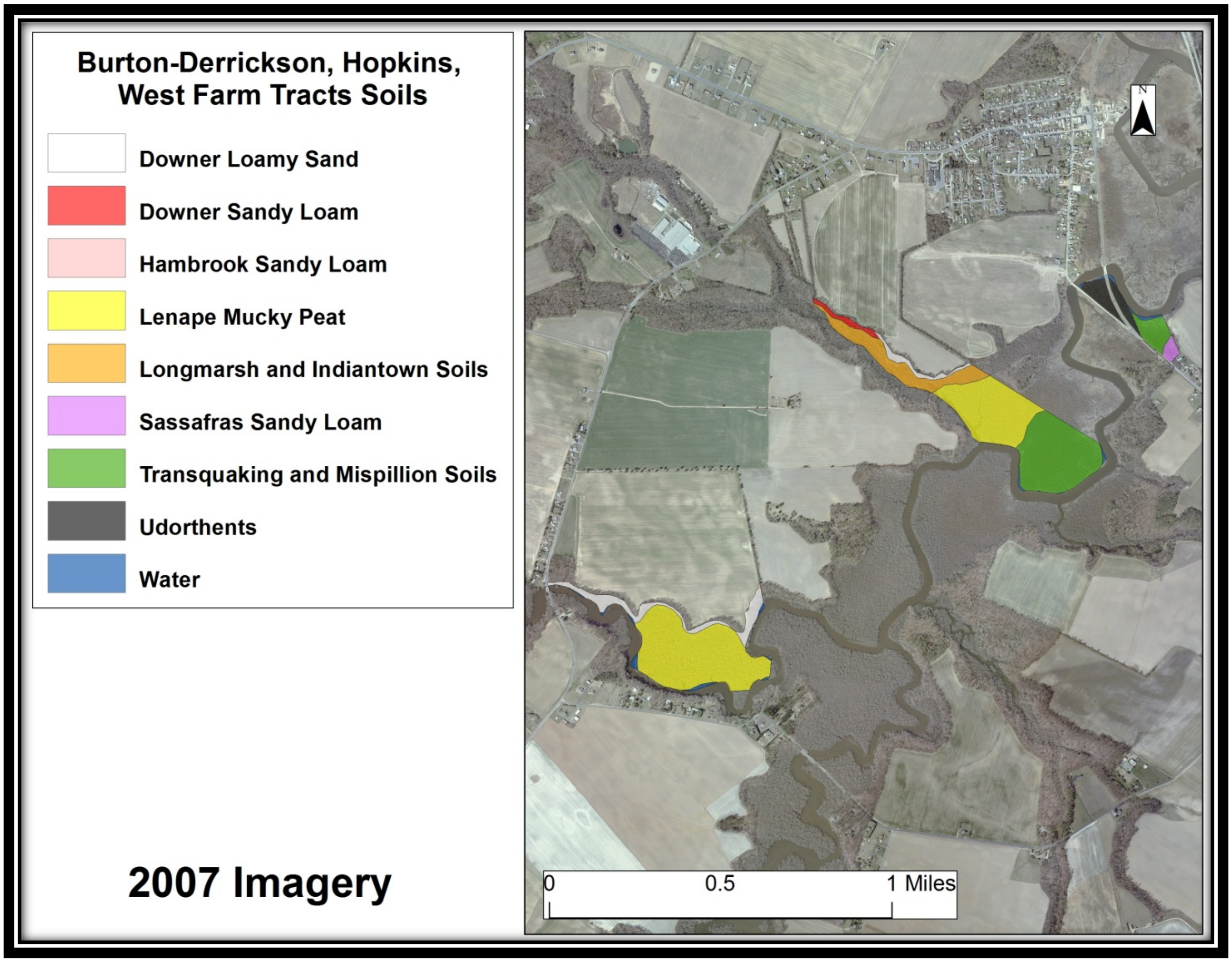

Figure 1.2. Burton-Derrickson, Hopkins, and West Farm Tracts Soil Map

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

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

Discussion of Sea-Level Rise and why it may affect the vegetation communities at the Burton-Derrickson, Hopkins, and West Tracts

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

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

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

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

Components of Sea Level Rise

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

Eustatic Rise

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

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[7] Rappleye, L. and W.M. Gardner. 1979. A cultural resources reconnaissance and impact assessment of the Great Dismal Swamp National Wildlife Refuge, City of Suffolk, Chesapeake, and Nansemond Counties, Virginia. Manuscript on file. Department of Anthropology, Catholic University, Washington, DC in Custer (1989).

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

[9] Gardner, W.M. 1978. Comparison of Ridge and Valley, Blue Ridge, Piedmont, and Coastal Plain Archaic Period Site Distribution: An idealized transect (preliminary model). Paper presented at the 1978 Middle Atlantic Archeological Conference, Rehoboth Beach, Delaware in Custer (1989).

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

[11] Nikitina, Daria L., James E. Pizzuto, Reed A. Schwimmer, and Kelvin W. Ramsey. 2000. An updated Holocene sea-level curve for the Delaware Coast. Marine Geology 171 (1-4): 7-20.

[12] Barth, M.C. and J.G. Titus. 1984. Greenhouse Effect and Sea Level Rise: A Challenge for this Generation. (New York: Van Nostrand Reinhold Co., Inc.) 238 pp.

[13] Kraft, John C. and Md. Khalequzzaman. 1992. Geologic and human factors in the decline of the tidal salt marsh lithesome: the Delaware Estuary and Atlantic coastal zone. Sedimentary Geology 80 (3-4): 233-246.

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

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

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

Stearic Rise

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

Isostatic Rise

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

All of these factors added together

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

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

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

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

[18] Ditto

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

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

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

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

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

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

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

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

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

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

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[25] Klemas, Vytautas. 1972. Use of remote sensing to determine natural and man-made changes in the coastal zone. Transactions of the Delaware Academy of Science. 2: 13-34.

[26] Vytautas, Klemas. 1972. Use of remote sensing and to determine natural and man-made changes in the coastal zone. Transactions of the Delaware Academy of Science 2:13-34.

[27] Kadmon, R. and R. Harari-Kremer. 1999. Studying the long term vegetation dynamics using digital processing of historical aerial photographs. Remote Sensing of the Environment 68:164-176.

[28] Smith, Carrie, Merryl Alber, and Alice Chalmers. 2001. Linking shifts in historic estuarine vegetation to salinity changes using a GIS. Proceedings of the 2001 Georgia Water Resources Conference.

[29] Earle, J.C. and K.A. Kershaw. 1988. Vegetation patterns in James Bay coastal marshes. III. Salinity and elevation as factors influencing plant zonations. Canadian Journal of Botany 67: 2967-2974.

[30] Kirwan, Matthew L. and A. Brad Murray. 2007. A coupled geomorphic and ecological model of tidal marsh evolution. Proceedings of the National Academy of Science 104(15):6118-6122.

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

[32] Kirwan, Matthew L. and A. Brad Murray. 2007. A coupled geomorphic and ecological model of tidal marsh evolution. Proceedings of the National Academy of Science 104(15):6118-6122.

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

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

Purpose of the Study

This study was conducted with the following goals in mind:

1. Classify and map vegetation communities, land covers, and assess habitat conditions for Species of Greatest Conservation Need (SGCN)[as defined in the Delaware Wildlife Action Plan (DEWAP)] for the Burton-Derrickson, Hopkins, and West Farm Tracts 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 preserves.
3. Determine the forest blocks located within or partially within the preserves.
4. Produce Ecological Integrity Assessments (EIAs) for vegetation communities that ranked S2 or higher.

Surveys were conducted during 2012 by Robert Coxe, an Environmental Scientist with the Delaware Natural Heritage and Endangered Species Program (DNHESP) within the Delaware Division of Fish and Wildlife, Department of Natural Resources and Environmental Control (DNREC).

Vegetation Community and Land Cover Surveys

Vegetation communities and land covers were determined by qualitative analysis using observations made in the field and aerial photo-interpretation using 1937, 2002, and 2007 aerial imagery. Vegetation communities are named according to the *Guide to Delaware Vegetation Communities* [35]which follows the National Vegetation Classification System (NVCS). The NVCS classifies vegetation on a national scale for the United States and is linked to international vegetation classification. The NVCS helps provide a uniform name and description of vegetation communities found throughout the country and helps determine relative rarity. Descriptions of the vegetation communities are provided in Chapter 4 and for land covers in Chapter 5. A crosswalk to the Delaware Wildlife Action Plan (DEWAP) and Northeast Habitat Classification (NHC) is provided at the top of each individual description.

Analysis of Historical Imagery

Historical imagery of the Burton-Derrickson, Hopkins, and West Farm Tracts from 1937 and 2002 and current imagery from 2007 were examined. A vegetation community map was produced for each year in order to compare vegetation and land cover change over a 5, 65, and 70 year time frame. Changes in the respective vegetation communities and land covers are discussed in the descriptions while broader changes are discussed in the wildlife area discussion. There is more imagery available but these were not used due to registration problems in the image tiles.

Ecological Integrity Assessment (EIA)

An EIA was conducted for those communities in the 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 in the Burton-Derrickson, Hopkins, and West Farm Tracts included in the EIA analysis are listed in Table 2.2.

Forest Block Analysis

Current forest blocks within or partially within the preserves that are greater than 100 acres were mapped. Each current block is described for current total acres and current forest interior habitat, potential acres, potential forest interior habitat, vegetation communities currently present, and major drainage (Table 2.3). A block is defined as contiguous forest habitat that is contained with 30 feet of non-forested and is the method used by the Maryland's Strategic Forest Lands Assessment.[36] Forest interior is forested area that is 100m from a forest edge. Potential blocks were extended out to areas of noncontiguous habitat (such as roads, powerline right-of-ways, and developed areas) that were considered to be immovable. Most of the area that could be reverted to forest is currently old field

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

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

Sea Level Rise Analysis

An analysis was performed for the wildlife area as whole using the DNREC Sea Level Rise Scenarios. Acreage lost for the various scenarios is projected for each preserve, vegetation community, and land cover.

Natural Capital Analysis

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

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

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

Wetlands

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

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

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

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

Cropland: $37/acre/year

Grassland/fields: $94/acre/year

Open Ocean: $102/acre/year

Values were rounded off to the nearest whole dollar.

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

Chapter 2: Results of Forest Blocks and General Observations

Summary of Findings from this study

1. **Vegetation Communities:** Nine vegetation communities and two land covers were found in the Burton-Derrickson, Hopkins, and West Farm Tracts. Freshwater Tidal Woodland (66 acres) is the largest vegetation community, followed by Wax-Myrtle Shrub Swamp with 35 acres. Water (7 acres) is the largest land cover, followed by Agricultural Field with 0.3 acres.

2. **Rare Plants:** Two rare plants are known to exist in the Burton-Derrickson, Hopkins, and West Farm Tracts (Table 2.1).

Scientific Name	Common Name	Rank	Last Observed
Calamagrostis canadensis	Blue-joint Reedgrass	S1	???
Schoenoplectus novae-angliae	Saltmarsh Bulrush	S1	???

Table 2.1. Rare Plants at the Burton-Derrickson, Hopkins, and West Farm Tracts

3. **Rare Animals:** No rare animals are known to exist in the Burton-Derrickson, Hopkins, and West Farm Tracts

Table 2.2. EIA Vegetation Communities located in the Burton-Derrickson, Hopkins, and West Farm Tracts

Community Map	Community Name/EIA Score	Description
	**BDHW 1** **Freshwater Tidal Woodland (425 acres)** **EIA = 3.56 (B rank)**	This woodland community is found along the Murderkill River and its tributaries.
	**BDHW 2** **Wax-Myrtle Shrub Swamp (35 acres)** **EIA = 4.02 (B rank)**	This shrubland is located on the Burton-Derrickson and West Farm Tracts.

Forest Block Analysis

Importance of Forest Blocks

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

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

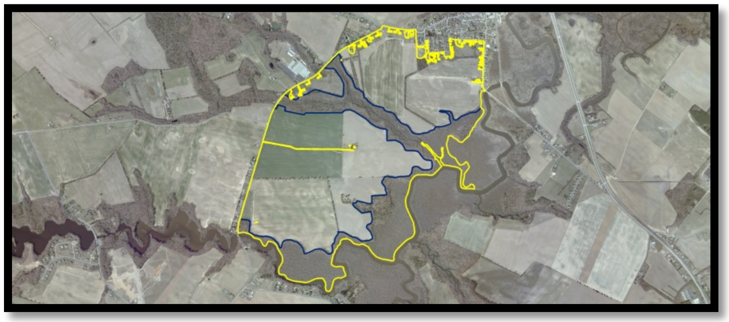
In protecting forest blocks, those blocks which are circular contain the most interior area per unit area. The next best shape is a square and linear configurations produce the least forest interior due to shape.

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

Analysis of Forest Blocks at the Burton-Derrickson, Hopkins, and West Farm Tracts

One forest block is present that is more than 100 acres in size and are located in whole or part in the preserve (Table 2.3). All forest blocks are bounded by a road, agricultural field, or other non-forested habitat. These areas are considered to be barriers to the passage of forest dwelling wildlife. A description is provided for this forest block.

Table 2.3. Forest Blocks located in whole or part on the Burton-Derrickson, Hopkins, and West Farm Tracts

Forest Block Map	Block Name/Acreage	Description
	**BDHW A** **Current Block = 255 acres (25 acres interior)** **Potential Block = 935 acres (613 acres interior)**	BDHW A is located in the Hopkins and Burton-Derrickson Tracts. It is bounded by agricultural fields and Carpenter Bridge Road on the north, agricultural fields on the east, the Murderkill River on the south, and Carpenter Bridge Road on the west. Four vegetation communities are located within this block and include Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp, Freshwater Tidal Woodland, Mid-Atlantic Mesic Mixed Hardwood Forest, and Northeastern Modified Successional Forest. The Murderkill River drains this block. Currently this block contains 25 acres of interior habitat. Potentially this block could be 935 acres and contain 613 acres of interior habitat.

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

Vegetation communities located adjacent to the shore of Delaware Bay 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.

Chapter 3: Broad Trends at the Burton-Derrickson, Hopkins, and West Farm Tracts

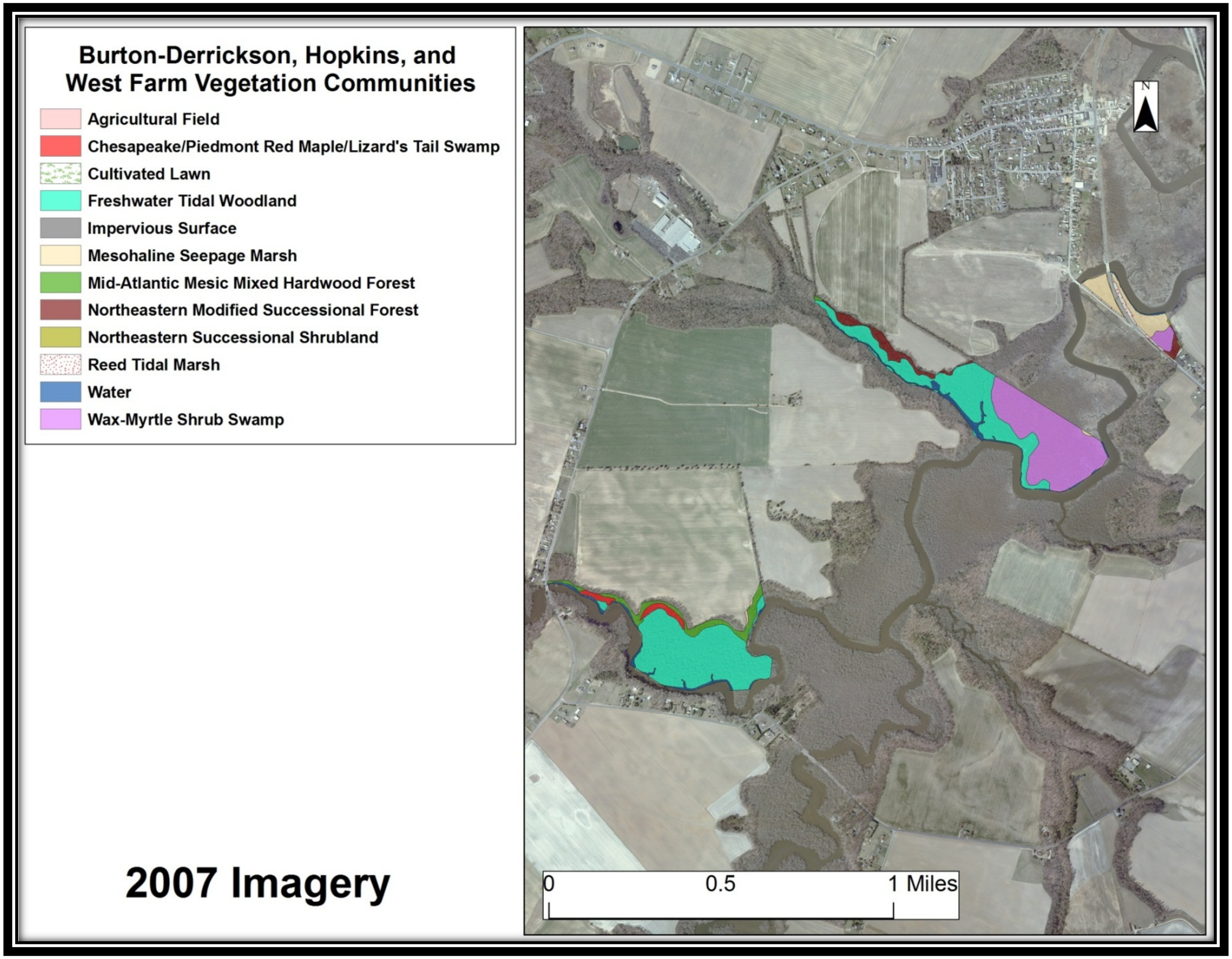


Figure 3.1. 2007 Vegetation Community Map of the Burton-Derrickson, Hopkins, and West Farm Tracts

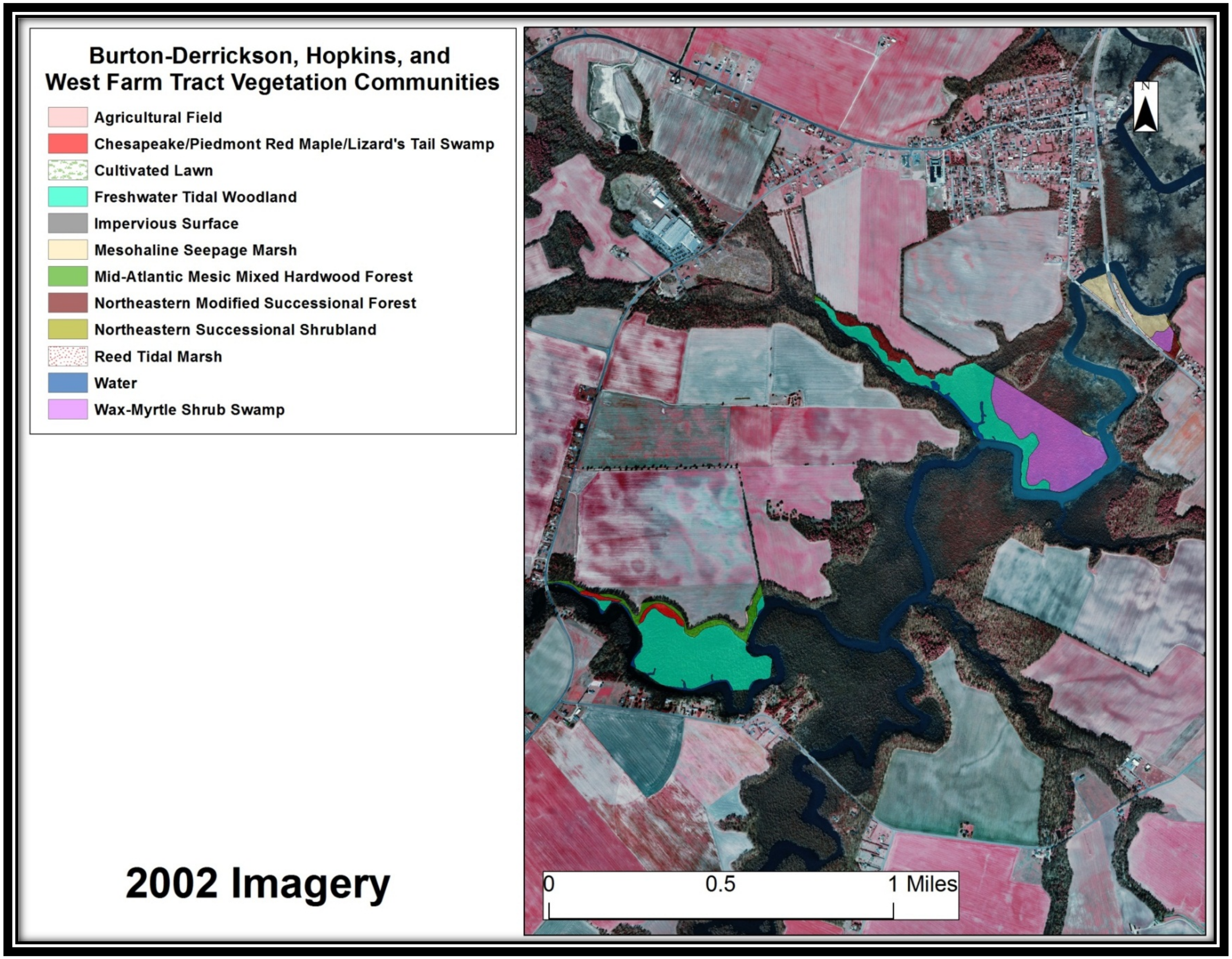


Figure 3.2. 2002 Vegetation Community Map of the Burton-Derrickson, Hopkins, and West Farm Tracts

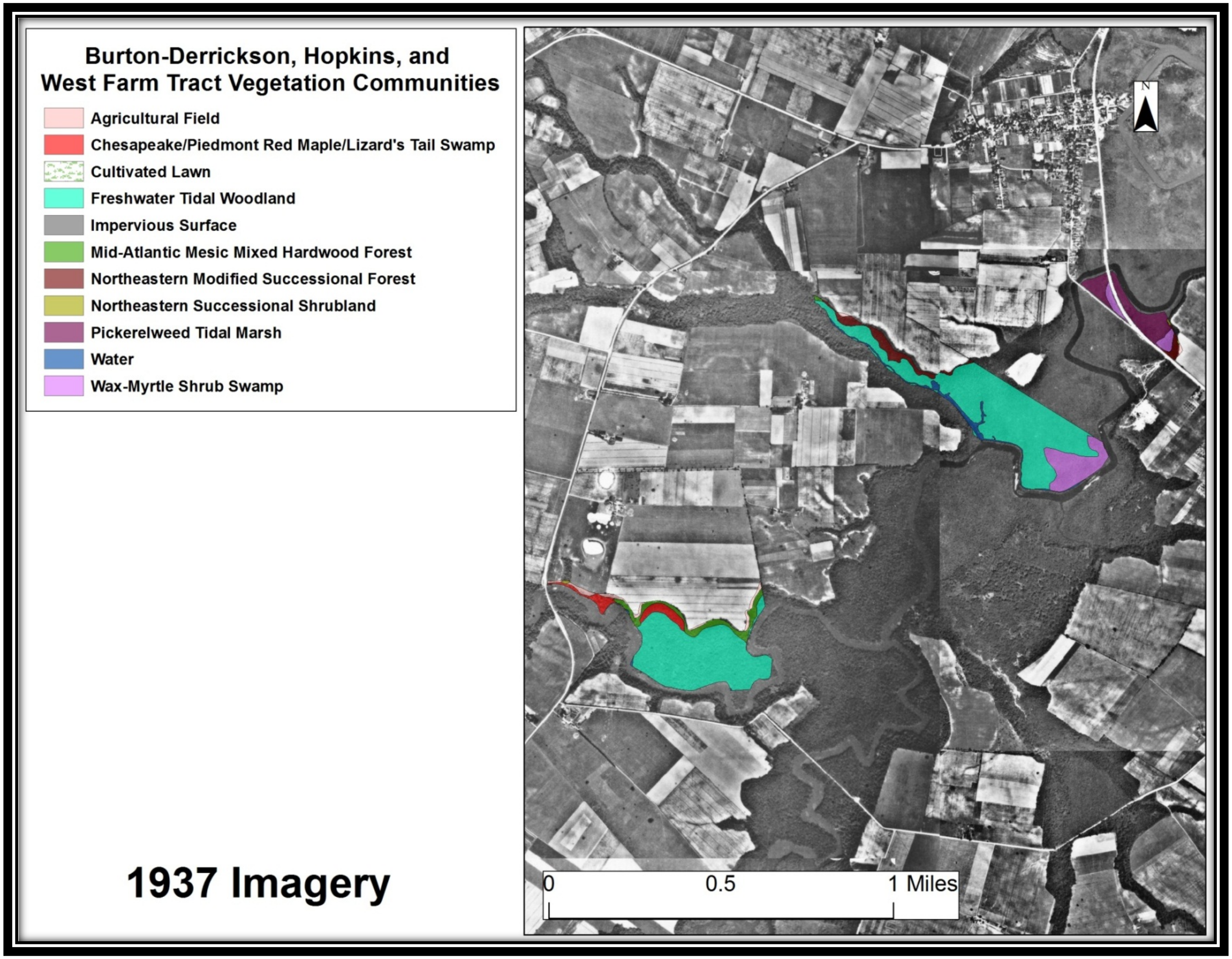
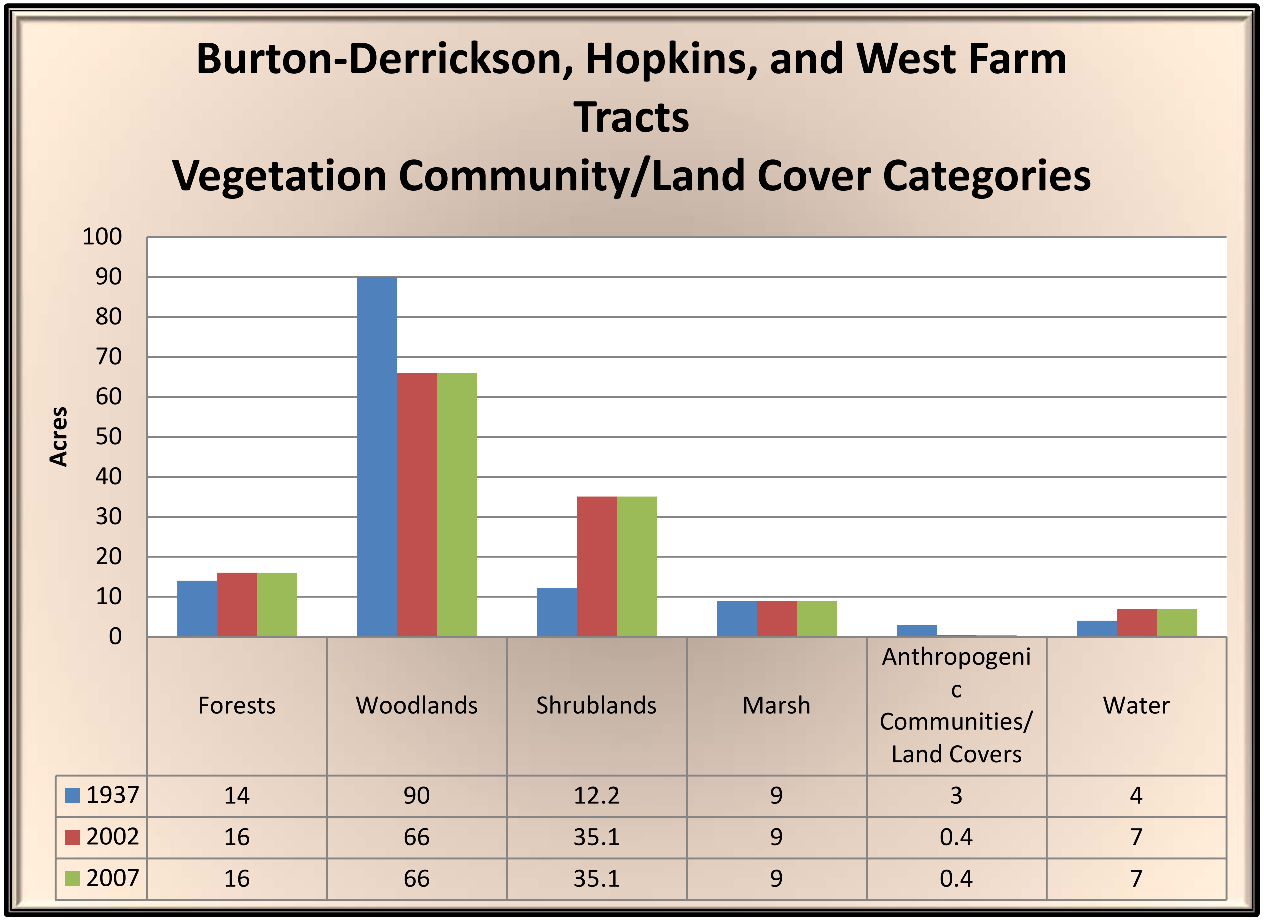


Figure 3.3. 1937 Vegetation Community Map of the Burton-Derrickson, Hopkins, and West Farm Tracts



	Forests	Woodlands	Shrublands	Marsh	Anthropogenic Communities/ Land Covers	Water
1937	14	90	12.2	9	3	4
2002	16	66	35.1	9	0.4	7
2007	16	66	35.1	9	0.4	7

Figure 3.4. Burton-Derrickson, Hopkins, and West Farm Tracts Vegetation Categories/Land Covers (1937, 2002, and 2007)

Burton-Derrickson, Hopkins, and West Farm Tracts Broad Trends (Figure 3.4): Most of the Burton-Derrickson, Hopkins, and West Farm tracts is covered by woodland (Freshwater Tidal Woodland), followed by shrubland. This may change in the future as these areas convert to marsh or water.

DNREC Sea Level Rise Analysis (Table 3.1)

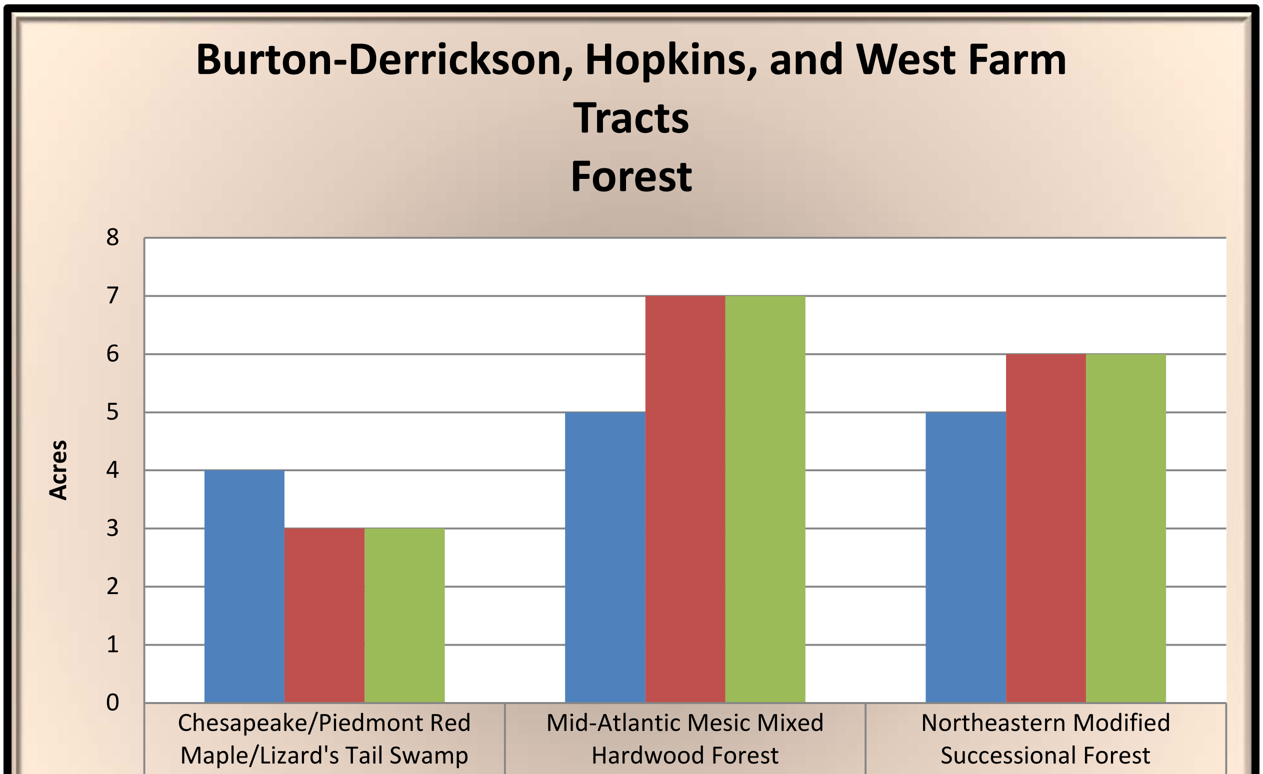
About 93% of the Burton-Derrickson, Hopkins, and West Farm tracts will be inundated with 0.5 m of sea level rise. An additional 0.5 m of rise to 1 m of total rise will inundate an additional 2 acres. Another 0.5 m of rise will inundate an additional 2 acres.

Table 3.1. Projected acres of the Burton-Derrickson, Hopkins and West Farm Tracts Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	123 acres
1 m	125 acres
1.5 m	127 acres

Natural Capital (Table 3.2)

Capital of the Burton-Derrickson, Hopkins, and West Farm Tracts has more than doubled since 1937 with gains in wetland shrubland.

Table 3.2. Natural Capital of the Burton-Derrickson, Hopkins, and West Farm Tracts	
Year	**Natural Capital (in 2012 dollars)**
1937	$190,402/year
2002	$433,971/year
2007	$433,971/year



	Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp	Mid-Atlantic Mesic Mixed Hardwood Forest	Northeastern Modified Successional Forest
1937	4	5	5
2002	3	7	6
2007	3	7	6

Figure 3.5. Forest at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

Burton-Derrickson, Hopkins, and West Farm Tracts Forest (Figure 3.5): Mid-Atlantic Mesic Mixed Hardwood Forest and Northeastern Modified Successional Forest are tied for the most common forest community.

DNREC Sea Level Rise Analysis (Table 3.3)

A little more than 50% of the total forest acreage currently present in the Burton-Derrickson, Hopkins, and West Farm Tracts will be flooded with 1.5 m of sea level rise.

Table 3.3. Projected acres of the Burton-Derrickson, Hopkins and West Farm Tracts Impacted by Sea Level Rise

Rise	Acres
0.5 m	5 acres
1 m	6 acres
1.5 m	7 acres

Natural Capital (Table 3.4)

Capital of forest in the Burton-Derrickson, Hopkins, and West Farm Tracts has increased since 1937 and has been stable in the recent period.

Table 3.4. Natural Capital of the Burton-Derrickson, Hopkins, and West Farm Tracts Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$1,702/year
2002	$2,269/year
2007	$2,269/year

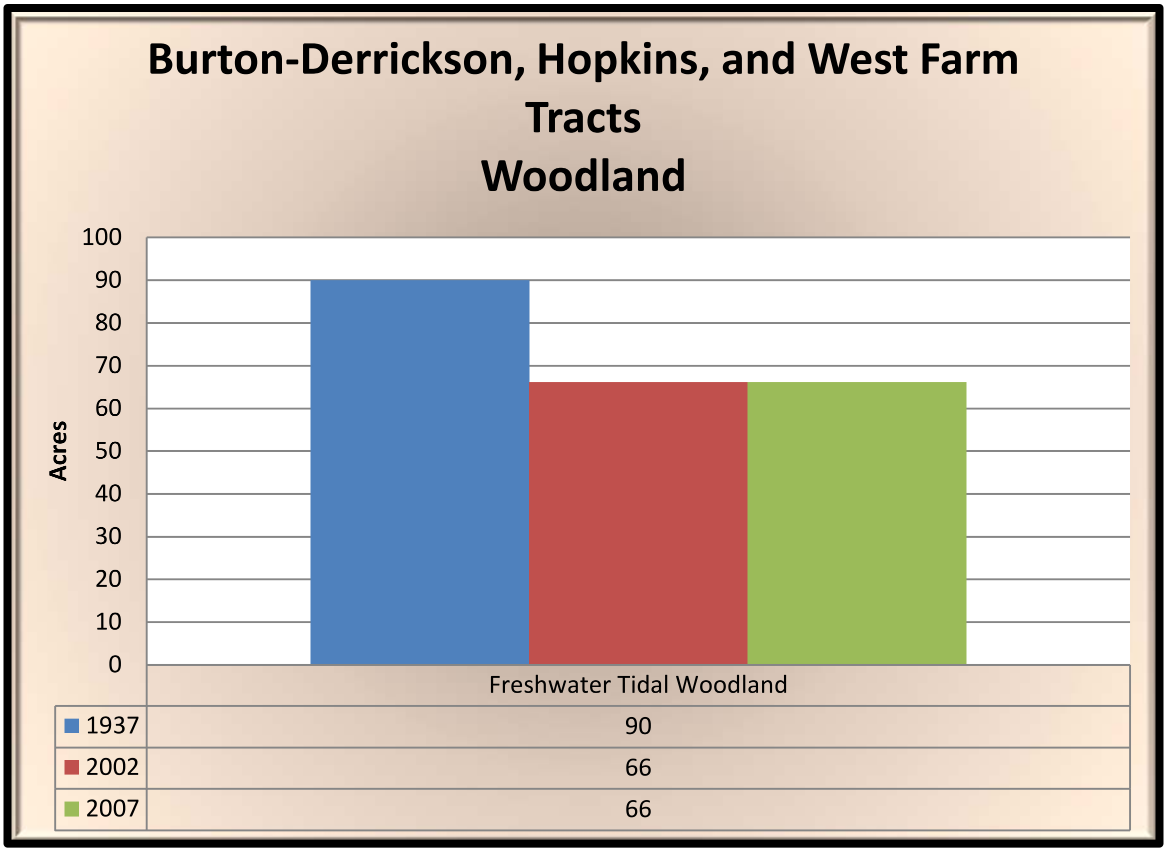


Figure 3.6. Woodland at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

Burton-Derrickson, Hopkins, and West Farm Tracts Woodland (Figure 3.6): Freshwater Tidal Woodland is the only woodland present in the three tracts.

DNREC Sea Level Rise Analysis (Table 3.5)

All of the woodland currently present in the Burton-Derrickson, Hopkins, and West Farm tracts will be flooded with 0.5 m of sea level rise.

Table 3.5. Projected acres of the Burton-Derrickson, Hopkins and West Farm Tracts Impacted by Sea Level Rise

Rise	Acres
0.5 m	68 acres
1 m	68 acres
1.5 m	68 acres

Natural Capital (Table 3.6)

Capital of Woodland in the Burton-Derrickson, Hopkins, and West Farm Tracts has decreased since 1937 with a loss of acreage in Freshwater Tidal Woodland.

Table 3.6. Natural Capital of Burton-Derrickson, Hopkins, and West Farm Tracts Woodland	
Year	**Natural Capital (in 2012 dollars)**
1937	$17,965/year
2002	$13,048/year
2007	$13,048/year

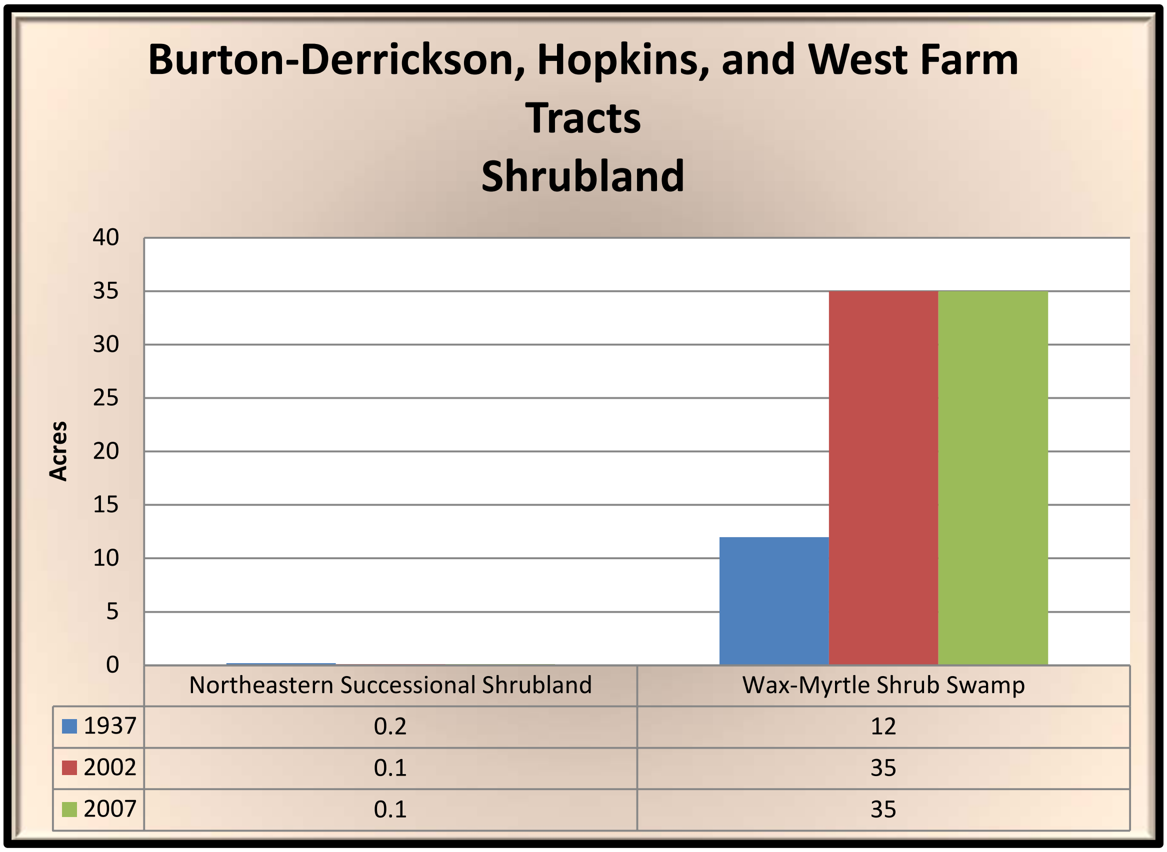


Figure 3.7. Shrubland at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

Burton-Derrickson, Hopkins, and West Farm Tracts Shrubland (Figure 3.7): Wax-Myrtle Shrub Swamp is the most common shrubland in the three tracts and has greatly increased the capital in the tracts.

DNREC Sea Level Rise Analysis (Table 3.7)

All of the shrubland present in the Burton-Derrickson, Hopkins, and West Farm tracts will be flooded with 0.5 m of sea level rise.

Table 3.7. Projected acres of the Burton-Derrickson, Hopkins and West Farm Tracts Impacted by Sea Level Rise

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

Natural Capital (Table 3.8)

Capital of shrubland in the Burton-Derrickson, Hopkins, and West Farm Tracts has increased markedly and is driven by gains in Wax-Myrtle Shrub Swamp.

Table 3.8. Natural Capital of Burton-Derrickson, Hopkins, and West Farm Tracts Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$92,839/year
2002	$324,850/year
2007	$324,850/year

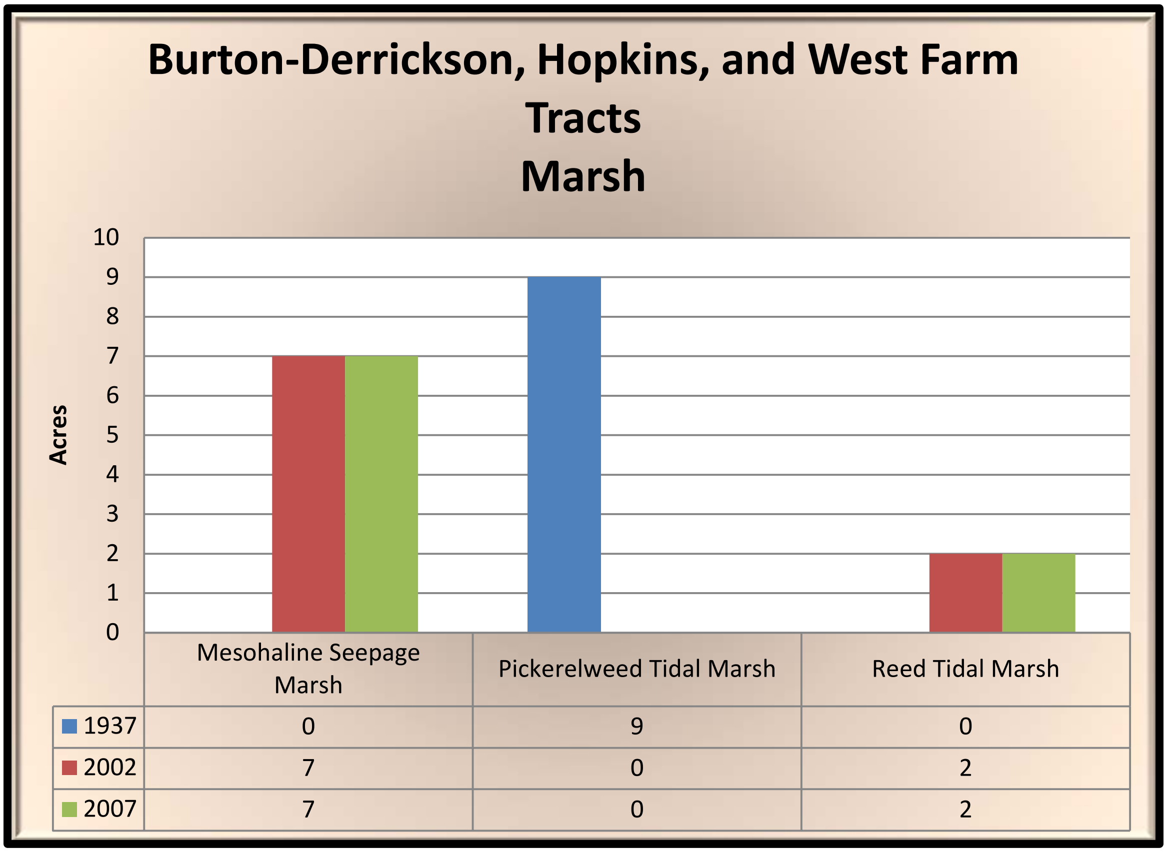


Figure 3.8. Marsh at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

Burton-Derrickson, Hopkins, and West Farm Tracts Marsh (Figure 3.8): Mesohaline Seepage is the most common marsh community the three tracts.

DNREC Sea Level Rise Analysis (Table 3.9)

All of the marshland in the Burton-Derrickson, Hopkins, and West Farm tracts will be flooded with 0.5 m of sea level rise.

Table 3.9. Projected acres of the Burton-Derrickson, Hopkins and West Farm Tracts Impacted by Sea Level Rise

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

Natural Capital (Table 3.10)

Capital of marsh in the Burton-Derrickson, Hopkins, and West Farm Tracts has remained the same throughout the study period.

Table 3.10. Natural Capital of Burton-Derrickson, Hopkins, and West Farm Tracts Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$56,442/year
2002	$56,442/year
2007	$56,442/year

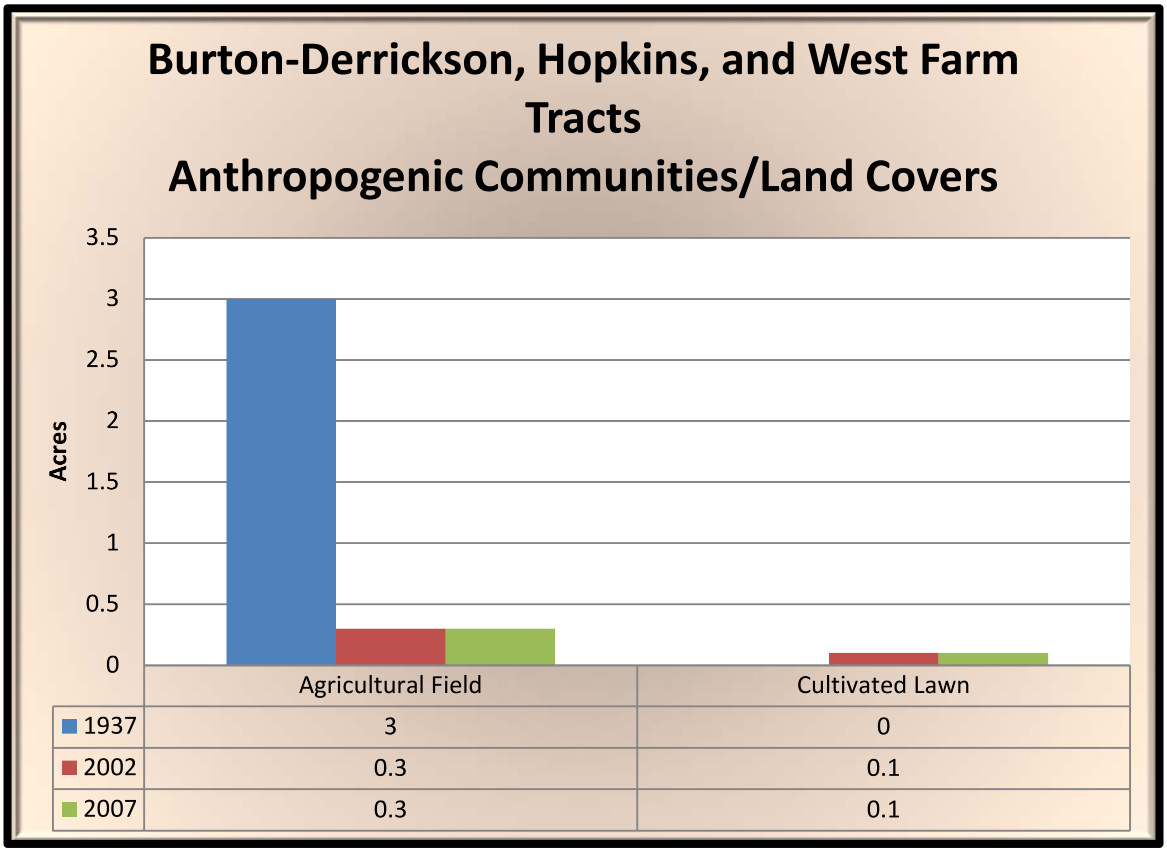


Figure 3.9. Anthropogenic Communities/Land Covers at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

Burton-Derrickson, Hopkins, and West Farm Tracts Anthropogenic Communities/Land Covers (Figure 3.9): Agricultural Field is the most common anthropogenic community in the three tracts.

DNREC Sea Level Rise Analysis (Table 3.11)

None of the anthropogenic communities/land covers will be inundated measurably at the highest amount of sea level rise (1.5 m).

Table 3.11. Projected acres of the Burton-Derrickson, Hopkins and West Farm Tracts Impacted by Sea Level Rise

Rise	Acres
0.5 m	123 acres
1 m	125 acres
1.5 m	127 acres

Natural Capital (Table 3.12)

Anthropogenic communities/land covers in the Burton-Derrickson, Hopkins, and West Farm Tracts have decreased with losses in agricultural field acreage.

Table 3.12. Natural Capital of Burton-Derrickson, Hopkins, and West Farm Tracts Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$115/year
2002	$17/year
2007	$17/year

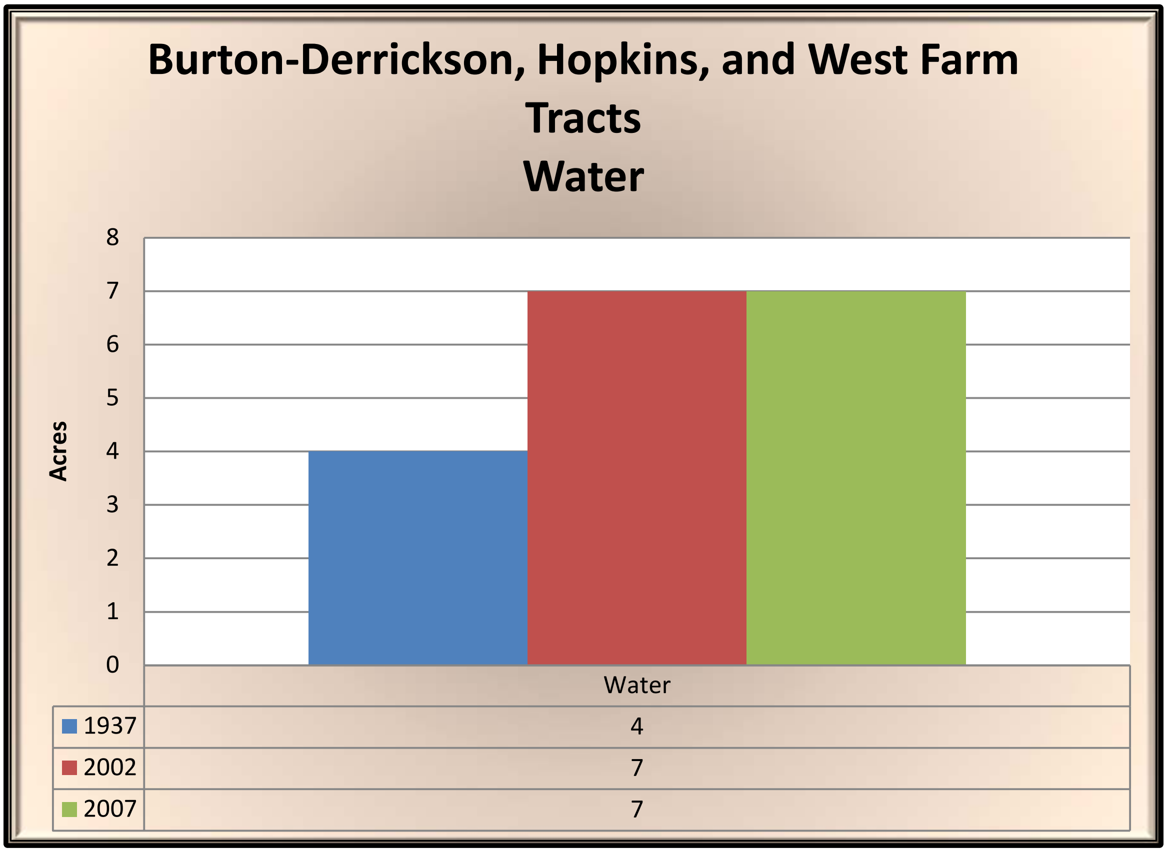


Figure 3.10. Water at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

Burton-Derrickson, Hopkins, and West Farm Tracts Water (Figure 3.10): Water has increased since 1937 to seven acres.

Natural Capital (Table 3.14)

Capital of water in the Burton-Derrickson, Hopkins, and West Farm Tracts has increased with an increase of water coverage in the tracts.

Table 3.14. Natural Capital of Burton-Derrickson, Hopkins, and West Farm Tracts Water

Year	Natural Capital (in 2012 dollars)
1937	$21,340/year
2002	$37,346/year
2007	$37,346/year

Chapter 4: Descriptions and Analysis of the Vegetation Communities

Nine vegetation communities and two land covers were noted in the survey (Figures 3.1-3.3). Below are the descriptions of the vegetation communities. The National Vegetation Classification (NVC) Association number is given with the vegetation community and their approximate acreage in the project area. Names of communities correspond with the common names as given in the NVC and the Guide to Delaware Vegetation Communities.

The vegetation communities include:

1. Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp (CEGL006606)—3 acres
2. Cultivated Lawn (CEGL006486)—0.1 acres
3. Freshwater Tidal Woodland (CEGL006165)—66 acres
4. Mesohaline Seepage Marsh (CEGL006418)—7 acres
5. Mid-Atlantic Mesic Mixed Hardwood Forest (CEGL006075)—7 acres
6. Northeastern Modified Successional Forest (CEGL006599)—6 acres
7. Northeastern Successional Shrubland (CEGL006451)—0.1 acres
8. Reed Tidal Marsh (CEGL004187)—2 acres
9. Wax-Myrtle Shrub Swamp (CEGL003840)—35 acres

***Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp* [3 acres (Figures 4.1-4.2, Tables 4.1-4.4)] G2 S2**

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

<u>*Description*</u>

Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp is found in a narrow fringe between the uplands and the Freshwater Tidal Woodland. Red maple (*Acer rubrum*) and green ash (*Fraxinus pennsylvanicus*) dominate the canopy. Understory species include sweetbay (*Magnolia virginica*), American hornbeam (*Carpinus caroliniana*), and spicebush (*Lindera benzoin*). The shrub and vine layer includes highbush blueberry (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), and winterberry (*Ilex verticillata*). Herbs in this community include skunk cabbage (*Symplocarpus foetidus*), lizard's tail (*Saururus cernuus*), wood reed (*Cinna arundinacea*), arrow-leaf tearthumb (*Polygonum arifolium*), netted chain fern (*Woodwardia areolata*), wetland blue violet (*Viola cucullata*), and false nettle (*Boehmeria cylindrica*).

The examples located in these tracts are in mature condition. Diameters-at-breast height range from 1 foot to 1.5 feet and layering is good.

Figure 4.1. Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp

<u>*Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts*</u>

In 2007, 2 acres of the original 4 acres from 1937 still existed. The other two acres had become 1 acre of Freshwater Tidal Woodland and 1 acre of water (Table 4.1). The progression of Freshwater Tidal Woodland and water shows the increase of water into the system. Since 1937, Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp has migrated into 0.3 acres of former agricultural field (Table 4.2).

Table 4.1. What was once Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp in 1937 has become X or remained in 2007	
X	**Acreage**
Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp	2 acres
Freshwater Tidal Woodland	1 acre
Water	1 acre
Mid-Atlantic Mesic Mixed Hardwood Forest	0.1 acres

Table 4.2. Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp has migrated into X or remained since 1937	
X	**Acreage**
Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp	2 acres
Agricultural Field	0.3 acres

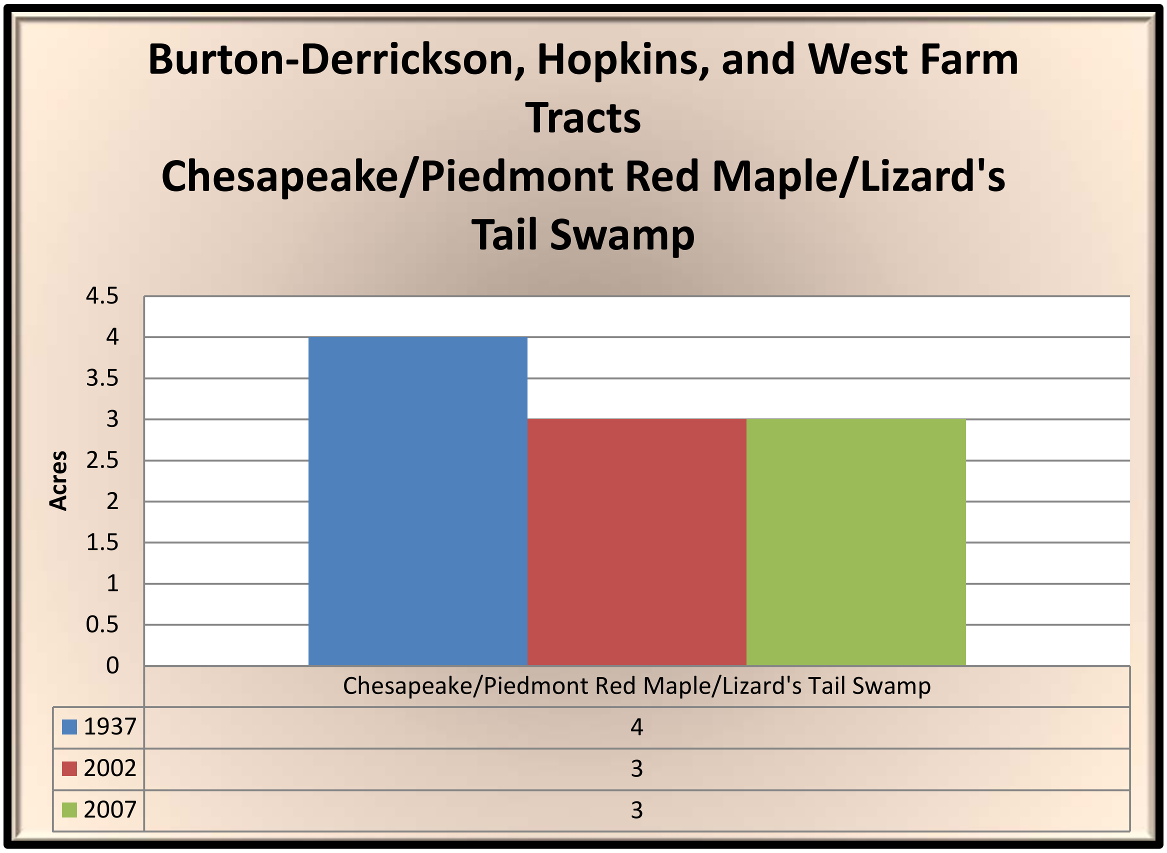


Figure 4.2. Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.3)

All of the Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp currently present will be flooded with 0.5 m of sea level rise.

Table 4.3. Projected acres of Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp Impacted by Sea Level Rise

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

Natural Capital (Table 4.4)

Capital of Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp has decreased with decreasing acreage. The loss of this community is resulting in an overall loss in capital for the tracts.

Table 4.4. Natural Capital of Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp	
Year	**Natural Capital (in 2012 dollars)**
1937	$49,166/year
2002	$36,875/year
2007	$36,875/year

***Cultivated Lawn* [0.1 acres (Figure 4.3, Table 4.5)]   GNA   SNA**

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

Description

This anthropogenic community is found on roadsides and the edge of the tract. Typically these areas are monocultures of tall fescue (*Festuca rubra*) that are mowed more than once a year.

Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts

A very negligible amount of cultivated lawn has become impervious surface since 1937, but it is below the threshold to record here. Since 1937, cultivated lawn has been developed in 0.1 acres of agricultural field (Table 4.5)

Table 4.5. Cultivated Lawn has migrated into X or remained since 1937	
X	**Acreage**
Agricultural Field	0.1 acres

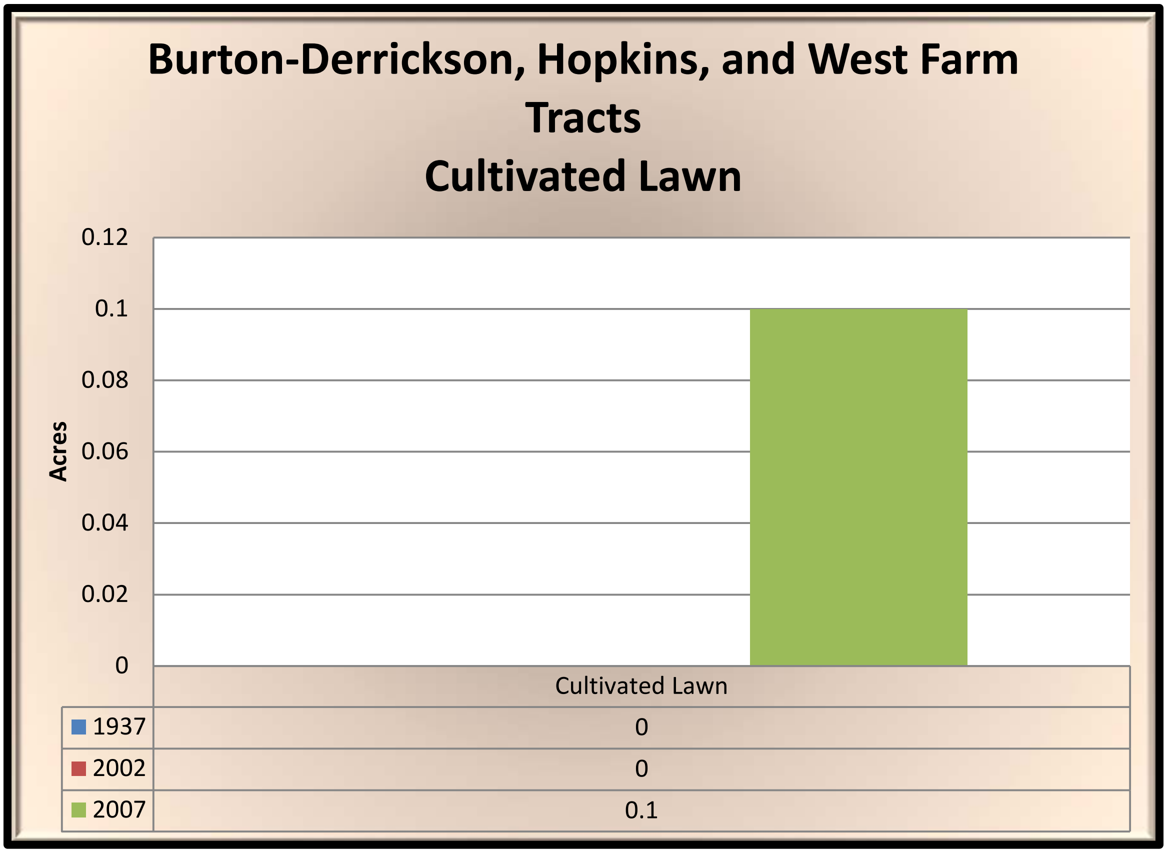


Figure 4.3. Cultivated Lawn at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis

Cultivated lawn will not be measurably affected with even 1.5 m of sea level rise.

Natural Capital

Cultivated lawn does not have any natural capital value.

***Freshwater Tidal Woodland* [66 acres (Figures 4.4-4.5, Tables 4.6-4.9)] G2 S2**

DEWAP: Freshwater Tidal Scrub/Shrub Wetlands
NHC: Northern Atlantic Coastal Plain Tidal Swamp

Description

This woodland is characterized by a stunted, scattered canopy of red maple (*Acer rubrum*) and an occasional blackgum (*Nyssa sylvatica*). The understory contains scattered spicebush (*Lindera benzoin*) and green ash (*Fraxinus pennsylvanica*); all of which are likely remnants of the previous community. The shrub and vine layer is composed of sweet pepperbush (*Clethra alnifolia*), common greenbrier (*Smilax rotundifolia*), and arrow-wood (*Viburnum dentatum*). Common herbs include arrow-leaf tearthumb (*Polygonum arifolium*), arrow-arum (*Peltandra virginica*), wetland blue violet (*Viola cucullata*), Pennsylvania bittercress (*Cardamine pennsylvanica*), and orange-spotted jewelweed (*Impatiens capensis*).

The examples of this community appeared to be mature or at least in the same condition as most examples of its type in Delaware. Because of its stunted nature and disturbance, this can be hard to determine for maturity.

Figure 4.3. Freshwater Tidal Woodland (in background)

Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts

In 2007, 65 acres of the original 95 acres from 1937 still existed. The rest of the acreage had converted to 23 acres of Wax-Myrtle Shrub Swamp, 1 acre of water, and 0.1 acres of Mesohaline Seepage Marsh (Table 4.6). The appearance of these communities shows an overall increase in the salinity present in the tracts. Since 1937, Freshwater Tidal Woodland has migrated into 1 acre of Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp (Table 4.7). Clearly the woodland is not keeping pace with the conversions elsewhere and is not migrating very well. The trend of converting Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp will likely continue until it runs out of this community.

Table 4.6. What was once Freshwater Tidal Woodland in 1937 has become X or remained in 2007	
X	**Acreage**
Freshwater Tidal Woodland	65 acres
Wax-Myrtle Shrub Swamp	23 acres
Water	1 acre
Mesohaline Seepage Marsh	0.1 acres

Table 4.7. Freshwater Tidal Woodland has migrated into X or remained since 1937	
X	**Acreage**
Freshwater Tidal Woodland	65 acres
Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp	1 acre

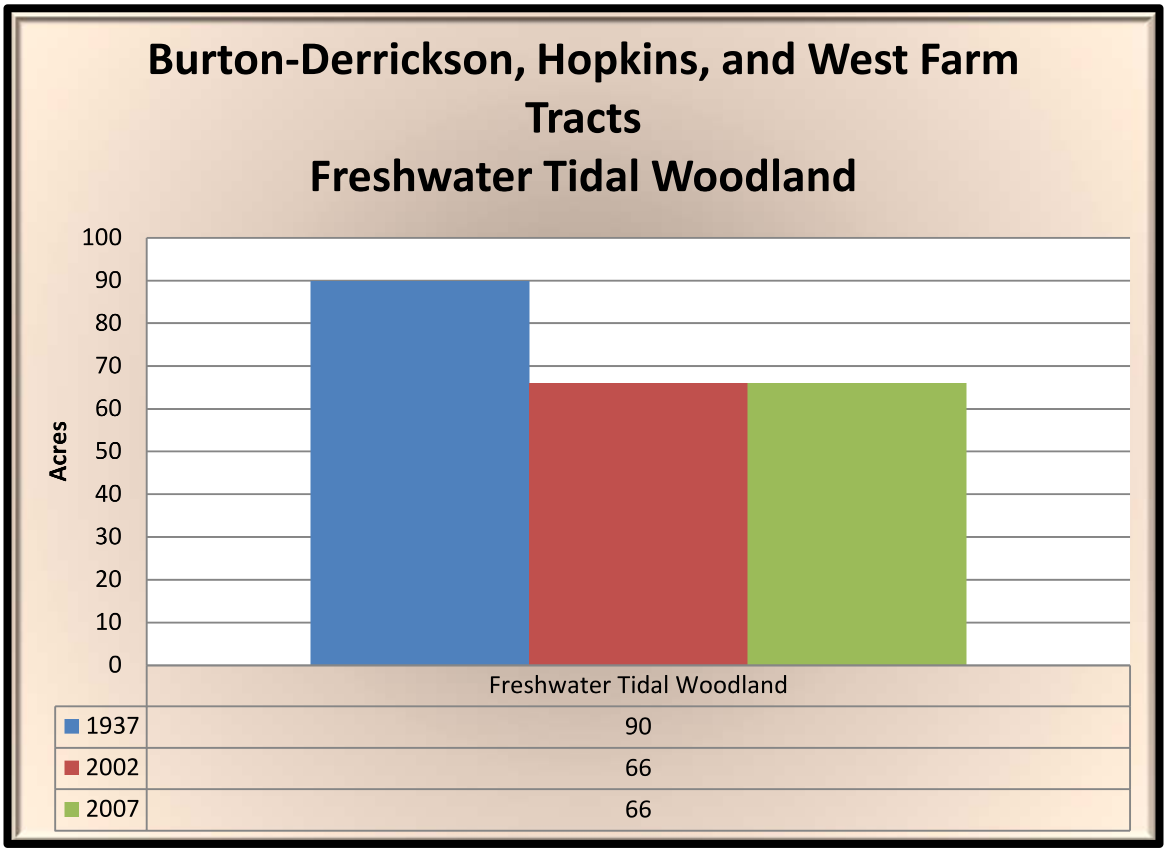


Figure 4.4. Freshwater Tidal Woodland at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.8)

All of the Freshwater Tidal Woodland currently present will be flooded with 0.5 m of sea level rise.

Table 4.8. Projected acres of Freshwater Tidal Woodland Impacted by Sea Level Rise

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

Natural Capital (Table 4.9)

Capital of woodland has decreased since 1937 as the overall salinity in the tracts has converted the woodland to shrubland or marshland. The capital has been stable in the recent period (2002-2007).

Table 4.9. Natural Capital of Freshwater Tidal Woodland	
Year	**Natural Capital (in 2012 dollars)**
1937	$564,442/year
2002	$413,906/year
2007	$413,906/year

***Mesohaline Seepage Marsh* [7 acres (Figures 4.5-4.6, Tables 4.10-4.12)] GNR S4**

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

Description

Mesohaline Seepage is located primarily in the West Tract, with a little bit present in the Burton-Derrickson Tract. Species in this marsh include salt marsh fleabane (*Pluchea odorata*), northern tickseed (*Bidens coronata*), and Virginia sea-shore mallow (*Kosteletzkya virginica*). Other species present include salt meadow hay (*Spartina patens*), waterhemp (*Amaranthus cannabinus*), and swamp rose mallow (*Hibiscus moscheutos*). The presence of the broad-leaf species gives this community a unique aerial signature that can be identified in current and historical imagery with a high degree of accuracy. Also a lot of muskrat burrows are often present in this community.

Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts

Mesohaline Seepage Marsh was not present in any of the tracts in 1937 and has since taken the place of Pickerelweed Tidal Marsh, a marsh which is not as saline as Mesohaline Seepage Marsh. In addition 1 acre of Wax-Myrtle Shrub Swamp and 0.1 acres of Freshwater Tidal Woodland have been converted to this community (Table 4.10). All of these incursions show an increase in salinity overall for the tracts.

Table 4.10. Mesohaline Seepage Marsh has migrated into X or remained since 1937

X	Acreage
Pickerelweed Tidal Marsh	6 acres
Wax-Myrtle Shrub Swamp	1 acre
Freshwater Tidal Woodland	0.1 acres

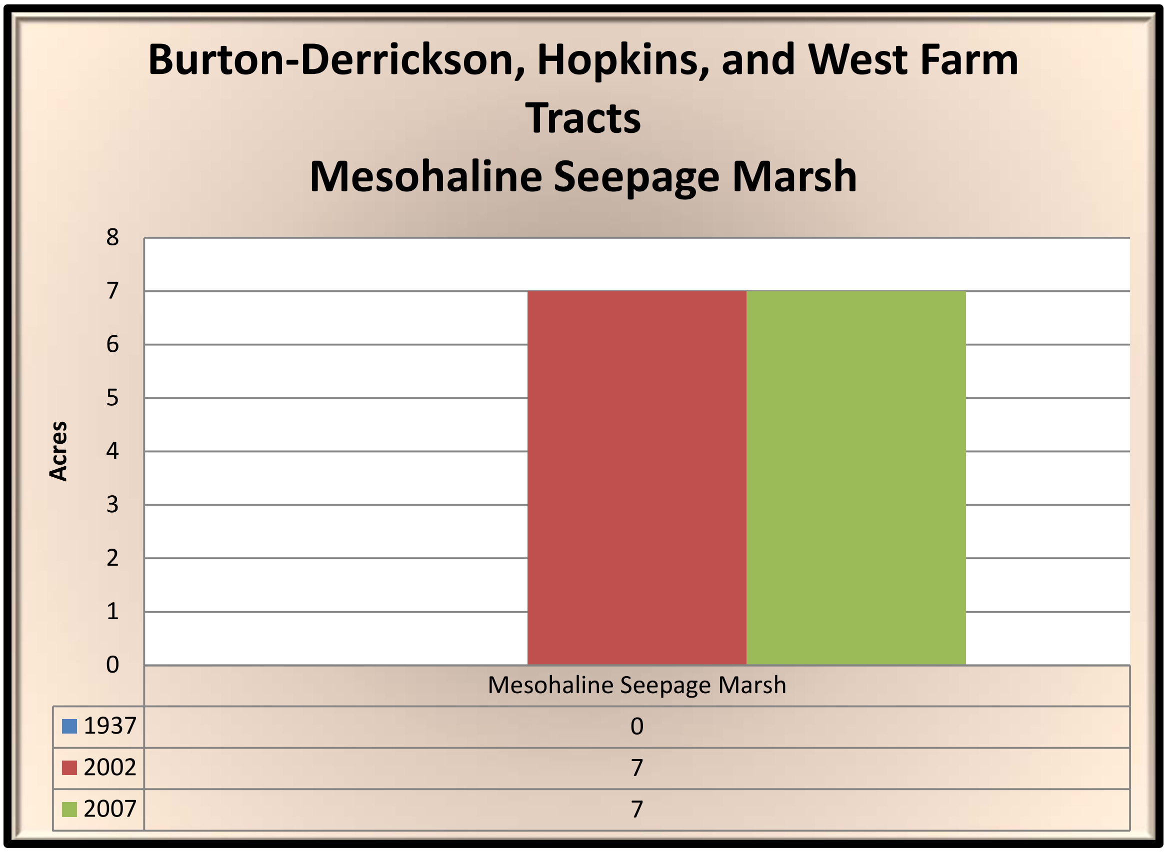


Figure 4.4. Mesohaline Seepage Marsh at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.11)

All of the Mesohaline Seepage Marsh present will be inundated with 0.5 m of sea level rise.

Table 4.11. Projected acres of the Mesohaline Seepage Marsh Impacted by Sea Level Rise

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

Natural Capital (Table 4.12)

Mesohaline Seepage Marsh has gained capital from Pickerelweed Tidal Marsh, Wax-Myrtle Shrub Swamp and Freshwater Tidal Woodland since 1937. The capital has been stable in the recent period (2002-2007).

Table 4.12. Natural Capital of Mesohaline Seepage Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$43,899/year
2007	$43,899/year

***Mid-Atlantic Mesic Mixed Hardwood Forest* [6 acres (Figure 4.5, Tables 4.13-4.16)] G5 S5**

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

Description

This community was determined through aerial interpretation, so a direct observation was not made of this occurrence. Typically these forest communities contain American beech (*Fagus grandifolia*), tuliptree (*Liriodendron tulipifera*), northern red oak (*Quercus rubra*), white oak (*Quercus alba*), and red maple (*Acer rubrum*) in the canopy. Understory associates can include flowering dogwood (*Cornus florida*), American hornbeam (*Carpinus caroliniana*), and sassafras (*Sassafras albidum*). The shrub and vine layers can include common greenbrier (*Smilax rotundifolia*), highbush blueberry (*Vaccinium corymbosum*), and sometimes sweet pepperbush (*Clethra alnifolia*) in wet areas. Herbs are generally few and include crane-fly orchid (*Tipularia discolor*), indian pipes (*Monotropa uniflora*), and spotted wintergreen (*Chimaphila maculata*).

Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts

All of the Mid-Atlantic Mesic Mixed Hardwood Forest present in 1937 was still present in 2007 (Table 4.13). Since 1937, Mid-Atlantic Mesic Mixed Hardwood Forest has grown into 2 acres of Agricultural field, 0.1 acres of Northeastern Successional Shrubland, and 0.1 acres of Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp (Table 4.14).

Table 4.13. What was once Mid-Atlantic Mesic Mixed Hardwood Forest in 1937 has become X or remained in 2007

X	Acreage
Mid-Atlantic Mesic Mixed Hardwood Forest	5 acres
Water	0.2 acres

Table 4.14. Mid-Atlantic Mesic Mixed Hardwood Forest has migrated into X or remained since 1937

X	Acreage
Mid-Atlantic Mesic Mixed Hardwood Forest	5 acres
Agricultural Field	2 acres
Northeastern Successional Shrubland	0.1 acres
Chesapeake/Piedmont Red Maple/Lizard's Tail Swamp	0.1 acres

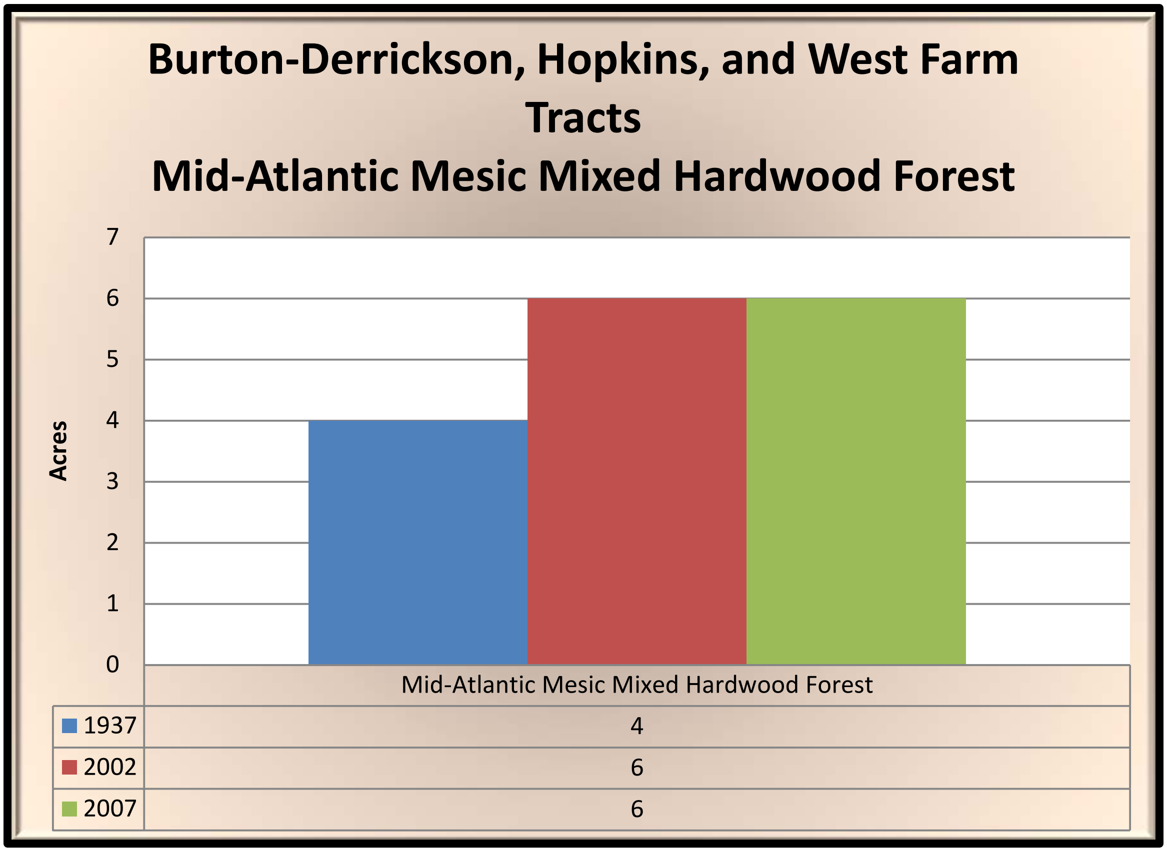


Figure 4.5. Mid-Atlantic Mesic Mixed Hardwood Forest at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.15)

About half of the Mid-Atlantic Mesic Mixed Hardwood Forest currently present will be flooded with 1 m of sea level rise.

Table 4.15. Projected acres of the Mid-Atlantic Mesic Mixed Hardwood Forest Impacted by Sea Level Rise

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

Natural Capital (Table 4.16)

Capital of Mid-Atlantic Mesic Mixed Hardwood Forest has increased since 1937 leading an increase in the total capital of the tracts.

Table 4.16. Natural Capital of Mid-Atlantic Mesic Mixed Hardwood Forest

Year	**Natural Capital (in 2012 dollars)**
1937	$756/year
2002	$1,135/year
2007	$1,135/year

Northeastern Modified Successional Forest **[7 acres (Figure 4.6, Tables 4.17-4.20)] GNA SNA**

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

Description

This forested community commonly has a dense understory of exotic invasive plants but an intact canopy. Common canopy species include wild black cherry (*Prunus serotina*), winged elm (*Ulmus rubra*), northern red oak (*Quercus rubra*), white oak (*Quercus alba*), and red maple (*Acer rubrum*). The understory is composed of sassafras (*Sassafras albidum*), spicebush (*Lindera benzoin*), and eastern red cedar (*Juniperus virginiana*). The shrub and vine layer includes multiflora rose (*Rosa multiflora*), blackberry (*Rubus* sp.), and Japanese honeysuckle (*Lonicera japonica*). Herbs noted in this community include enchanter's nightshade (*Circaea lutetiana*) and ebony spleenwort (*Asplenium platyneuron*).

The examples of this community can be considered to be late successional in these tracts. Because of the exotics present, these communities are in a perpetual state of change until the exotics are removed.

Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts

Practically all of the Northeastern Modified Successional Forest from 1937 was still present in 2007. Only about 0.1 acres had changed to cultivated lawn (Table 4.17). Since 1937, this community has grown into about 0.2 acres of agricultural field (Table 4.18).

Table 4.17. What was once Northeastern Modified Successional Forest in 1937 has become X or remained in 2007

X	**Acreage**
Northeastern Modified Successional Forest	5 acres
Cultivated Lawn	0.1 acres

Table 4.18. Northeastern Modified Successional Forest has migrated into X or remained since 1937

X	**Acreage**
Northeastern Modified Successional Forest	5 acres
Agricultural Field	0.2 acres

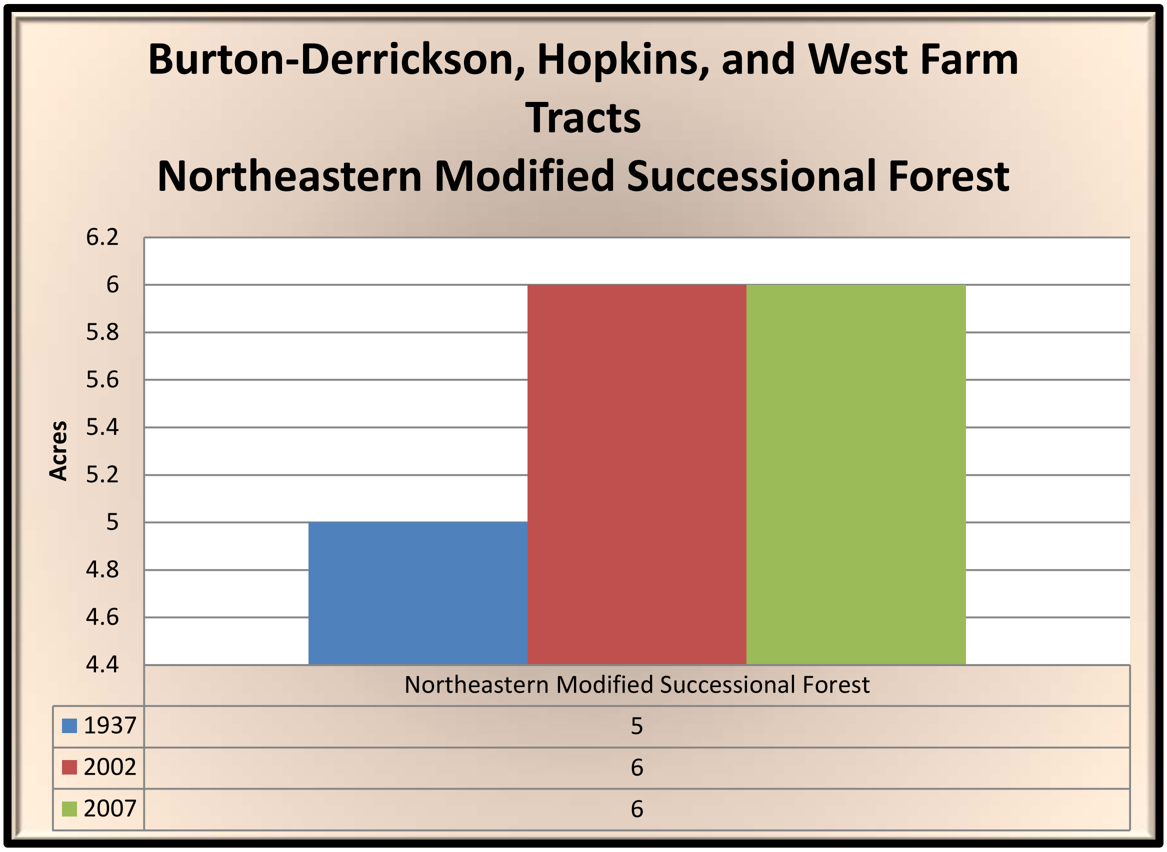


Figure 4.6. Northeastern Modified Successional Forest at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.19)

At the highest level of sea level rise, only about 4 acres of this community will be flooded.

Table 4.19. Projected acres of the Northeastern Modified Successional Forest Impacted by Sea Level Rise

Rise	Acres
0.5 m	3 acres
1 m	4 acres
1.5 m	4 acres

Natural Capital (Table 4.20)

Capital of Northeastern Modified Successional Forest has increased since 1937 leading an increase in the total capital of the tracts.

Table 4.20. Natural Capital of Northeastern Modified Successional Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$946/year
2002	$1,135/year
2007	$1,135/year

***Northeastern Successional Shrubland* [0.1 acres (Figure 4.7, Tables 4.21-4.24)] GNA SNA**

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

<u>Description</u>

This community was aerially interpreted for the Burton-Derrickson Tract. Typically this community is composed of a combination of aggressive shrubs and vines (often exotic invasive plants). These shrubs and vines may include blackberry (*Rubus* sp.), Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), common greenbrier (*Smilax rotundifolia*), and summer grape (*Vitis aestivalis*).

<u>Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts</u>

About half of the Northeastern Successional Shrubland present in 1937 was still present in 2007. The rest had grown into Mid-Atlantic Mesic Mixed Hardwood Forest (Table 4.21). Since 1937, Northeastern Successional Shrubland has grown into 0.1 acres of agricultural field (Table 4.22).

Table 4.21. What was once Northeastern Successional Shrubland in 1937 has become X or remained in 2007

X	Acreage
Mid-Atlantic Mesic Mixed Hardwood Forest	0.1 acres
Northeastern Successional Shrubland	0.1 acres

Table 4.22. Northeastern Successional Shrubland has migrated into X or remained since 1937

X	Acreage
Agricultural Field	0.1 acres
Northeastern Successional Shrubland	0.1 acres

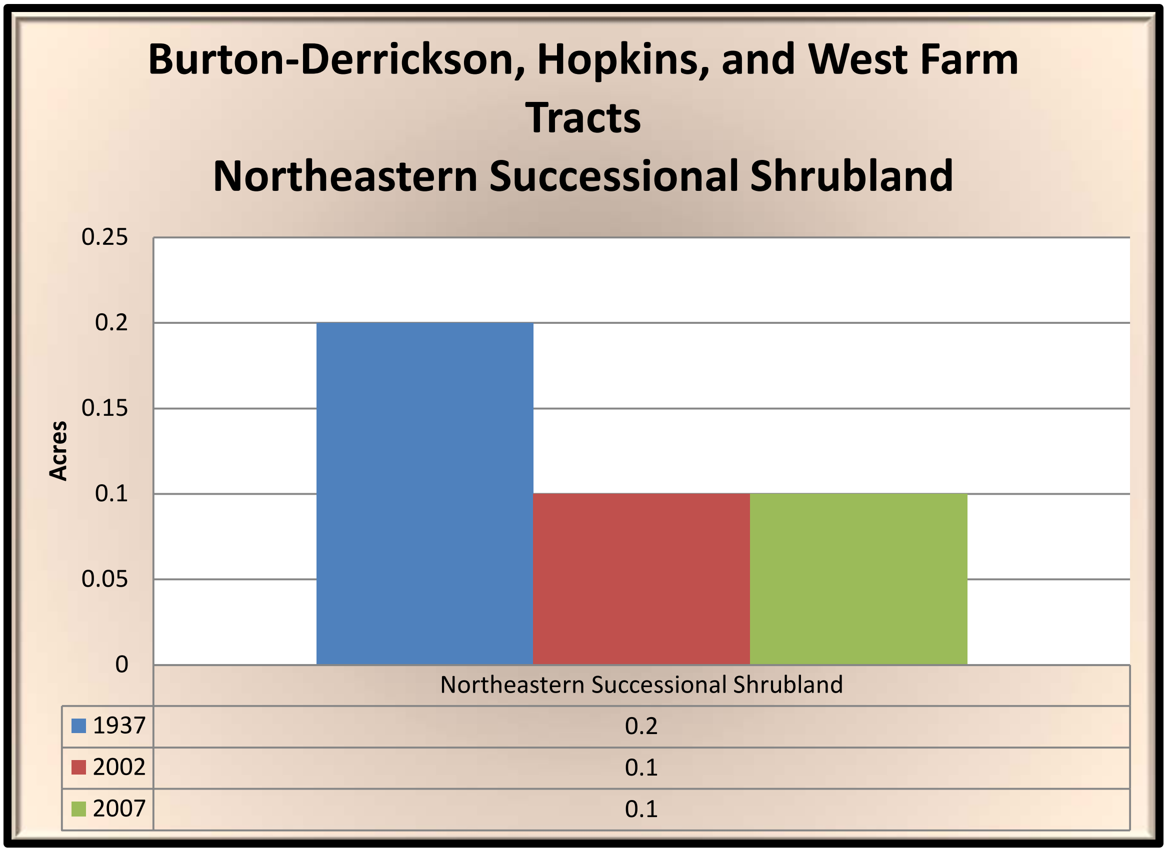


Figure 4.7. Northeastern Successioinal Shrubland at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.23)

All of the Northeastern Successional Shrubland present will be inundated with 1 m of sea level rise.

Table 4.23. Projected acres of the Northeastern Successional Shrubland Impacted by Sea Level Rise

Rise	Acres
0.5 m	0 acres
1 m	0.1 acres
1.5 m	0.1 acres

Natural Capital (Table 4.24)

Capital of Northeastern Successional Shrubland has decreased as this community matures to forest communities.

Table 4.24. Natural Capital of Northeastern Successional Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$30/year
2002	$15/year
2007	$15/year

***Pickerelweed Tidal Marsh* [0 acres (Figure 4.8, Tables 4.26-4.27)]   GNA   SNA**

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

Description

This brackish marsh community is no longer present in the tracts since the salinity has increased. Because of its absence, an exact species cannot be given. Arrow-arum (*Peltandra virginica*) and pickerelweed (*Pontederia cordata*) typically co-dominate this community and are associated by wild rice (*Zizania aquatica*), broadleaf arrowhead (*Sagittaria latifolia*), halbeard-leaf tearthumb (*Polygonum arifolium*), mild water pepper (*Polygonum hydropiperoides*), and arrow-leaved tearthumb (*Polygonum sagittatum*).

Analysis of Condition at the Burton-Derrickson, Hopkins, and West Tracts

Pickerelweed Tidal Marsh is no longer present in the tracts. Because of the rising salinities this marsh has converted to 6 acres of Mesohaline Seepage Marsh, 2 acres of Reed Tidal Marsh, 1 acre of Wax-Myrtle Shrub Swamp, and 0.4 acres of water (Table 4.26).

Table 4.26. What was once Pickerelweed Tidal Marsh in 1937 has become X or remained in 2007

X	**Acreage**
Mesohaline Seepage Marsh	6 acres
Reed Tidal Marsh	2 acres
Wax-Myrtle Shrub Swamp	1 acre
Water	0.4 acres

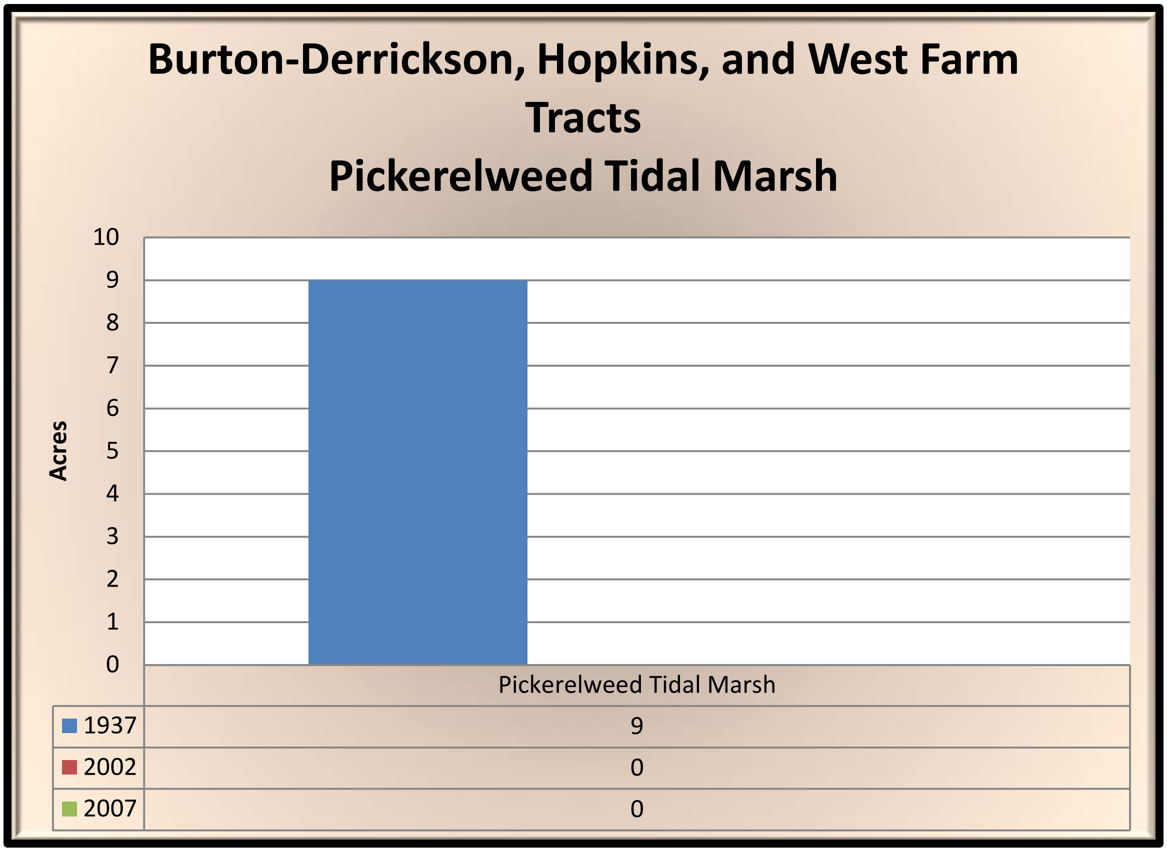


Figure 4.8. Pickerelweed Tidal Marsh at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

Natural Capital (Table 4.27)

Capital of Pickerelweed Tidal Marsh has been transferred to other marsh and shrubland communities since 1937.

Table 4.27. Natural Capital of Pickerelweed Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$56,442/year
2002	$0/year (not present)
2007	$0/year (not present)

Reed Tidal Marsh **[2 acres (Figures 4.9-4.10, Tables 4.28-4.30)] GNA SNA**

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

Description

Figure 4.9. Reed Tidal Marsh

This community is dominated by common reed (*Phragmites australis*) to near entirety in a tidal situation.

Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts

Reed Tidal Marsh was not present in the tracts in 1937 and has since colonized 2 acres of former Pickerelweed Tidal Marsh and 0.2 acres of Wax-Myrtle Shrub Swamp (Table 4.28).

Table 4.28. Reed Tidal Marsh has migrated into X or remained since 1937	
X	**Acreage**
Pickerelweed Tidal Marsh	2 acres
Wax-Myrtle Shrub Swamp	0.2 acres

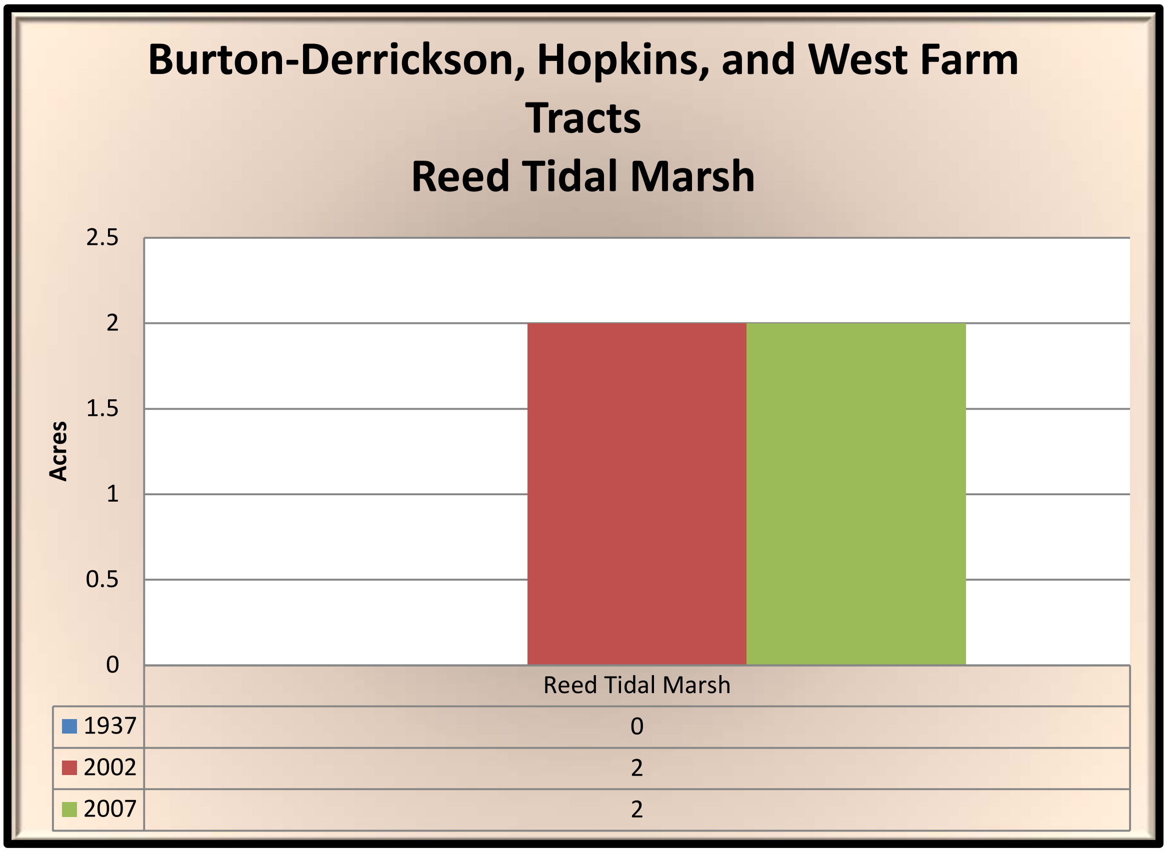


Figure 4.10. Reed Tidal Marsh at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.29)

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

Table 4.29. Projected acres of the Reed Tidal Marsh Impacted by Sea Level Rise

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

Natural Capital (Table 4.30)

Capital of Reed Tidal Marsh has increased as it has spread around the marsh.

Table 4.30. Natural Capital of Reed Tidal Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$12,543/year
2007	$12,543/year

***Wax-Myrtle Shrub Swamp* [35 acres (Figures 4.11-4.12, Tables 4.31-4.34)]   GNA   SNA**

DEWAP: Shrub Swamps
NHC: North Atlantic Coastal Plain Dune and Swale

Description

Figure 4.11. Wax-Myrtle Shrub Swamp

This shrubland is located on the edges of the marsh and is often a transition community from freshwater shrublands to saline marsh. A scattered red maple (*Acer rubrum*) is present in a shrubland of wax-myrtle (*Morella cerifera*). Other species noted in this community include common reed (*Phragmites australis*), salt shrub (*Baccharis halimifolia*), iris (*Iris* sp.), arrow-arum (*Peltandra virginica*), horsetail (*Equisetum arvense*), hibiscus (*Hibiscus moscheutos*), and wide-leaved cattail (*Typha latifolia*).

Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts

Nearly all of the Wax-Myrtle Shrub Swamp from 1937 (11 acres) was still present in 2007. Some, however, did convert to Mesohaline Seepage Marsh (1 acre), Reed Tidal Marsh (0.2 acres), and to water (0.2 acres) (Table 4.31). Since 1937, Wax-Myrtle Shrub Swamp has increased its acreage by converting 23 acres of Freshwater Tidal Woodland and 1 acre of Pickerelweed Tidal Marsh (Table 4.32). The changing of Freshwater Tidal Marsh to Wax-Myrtle Shrub Swamp shows the increasing salinity.

Table 4.31. Wax-Myrtle Shrub Swamp has migrated into X or remained since 1937

X	Acreage
Wax-Myrtle Shrub Swamp	11 acres
Mesohaline Seepage Marsh	1 acre
Reed Tidal Marsh	0.2 acres
Water	0.2 acres

Table 4.32. Wax-Myrtle Shrub Swamp has migrated into X or remained since 1937	
X	**Acreage**
Freshwater Tidal Woodland	23 acres
Wax-Myrtle Shrub Swamp	11 acres
Pickerelweed Tidal Marsh	1 acres

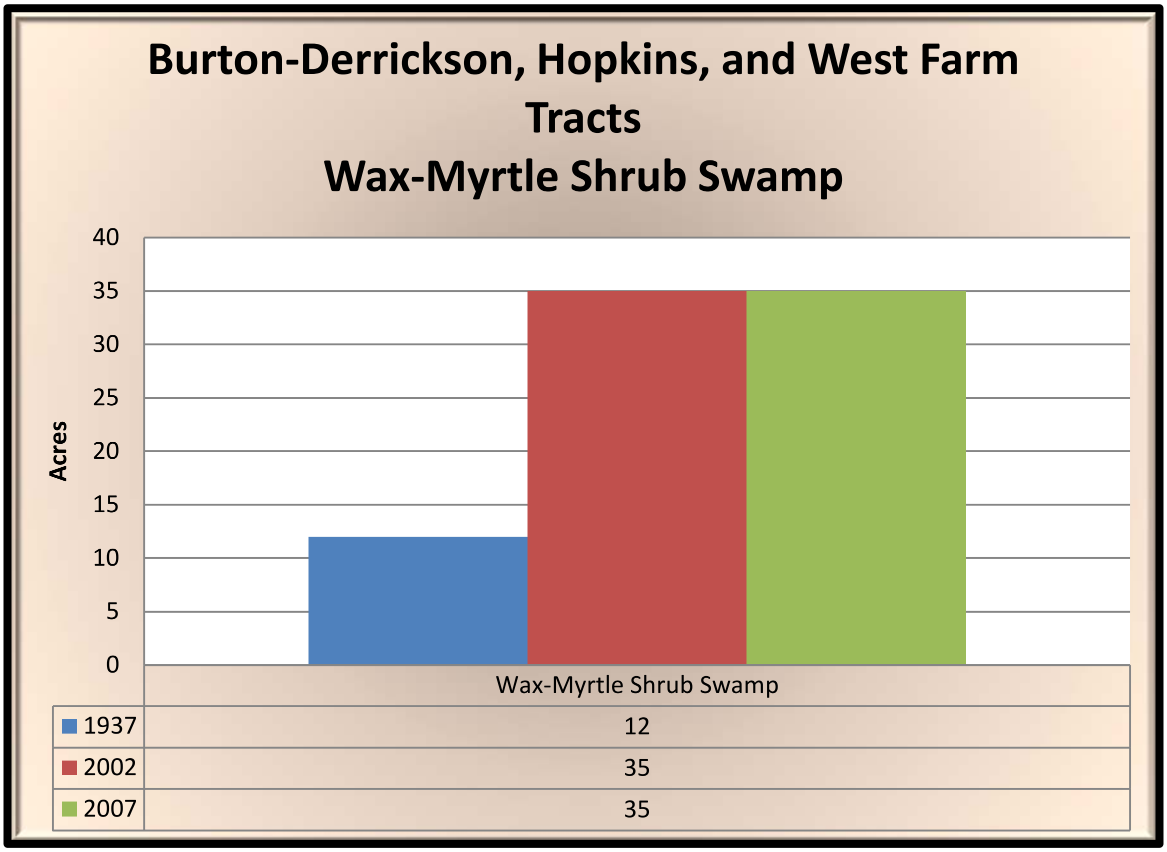


Figure 4.12. Wax-Myrtle Shrub Swamp at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 4.33)

All of the Wax-Myrtle Shrub Swamp present will be inundated with 0.5 m of sea level rise.

Table 4.33. Projected acres of the Wax-Myrtle Shrub Swamp Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	35 acres
1 m	35 acres
1.5 m	35 acres

Natural Capital (Table 4.34)

Capital of Wax-Myrtle Shrub Swamp has increased since 1937 as it eats into the Freshwater Tidal Woodland. The transfer of capital to this community has resulted in a capital loss for the tracts.

Table 4.34. Natural Capital of Wax-Myrtle Shrub Swamp	
Year	**Natural Capital (in 2012 dollars)**
1937	$111,377/year
2002	$324,849/year
2007	$324,849/year

Chapter 5: Descriptions and Analysis of the Land Covers

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

The land covers include:

1. Agricultural Field—0.3 acres
2. Water—7 acres

***Agricultural Field* [0.3 acres, (Figure 5.1, Tables 5.1-5.4)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

Agricultural fields in these tracts are often planted in corn or soybeans.

Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts

In 2007, only 0.3 acres of the 2 acres of agricultural field present in 1937 was still present. The rest of the fields had become 2 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, 0.3 acres of Freshwater Tidal Woodland, 0.2 acres of Northeastern Modified Successional Forest, and 0.1 acres of Cultivated Lawn (Table 5.1). Since 1937, no new agricultural fields have been developed (Table 5.2).

Table 5.1. Agricultural Field has migrated into X or remained since 1937	
X	**Acreage**
Mid-Atlantic Mesic Mixed Hardwood Forest	2 acres
Agricultural Field	0.3 acres
Freshwater Tidal Woodland	0.3 acres
Northeastern Modified Successional Forest	0.2 acres
Cultivated Lawn	0.1 acres

Table 5.2. Agricultural Field has migrated into X or remained since 1937	
X	**Acreage**
Agricultural Field	0.3 acres

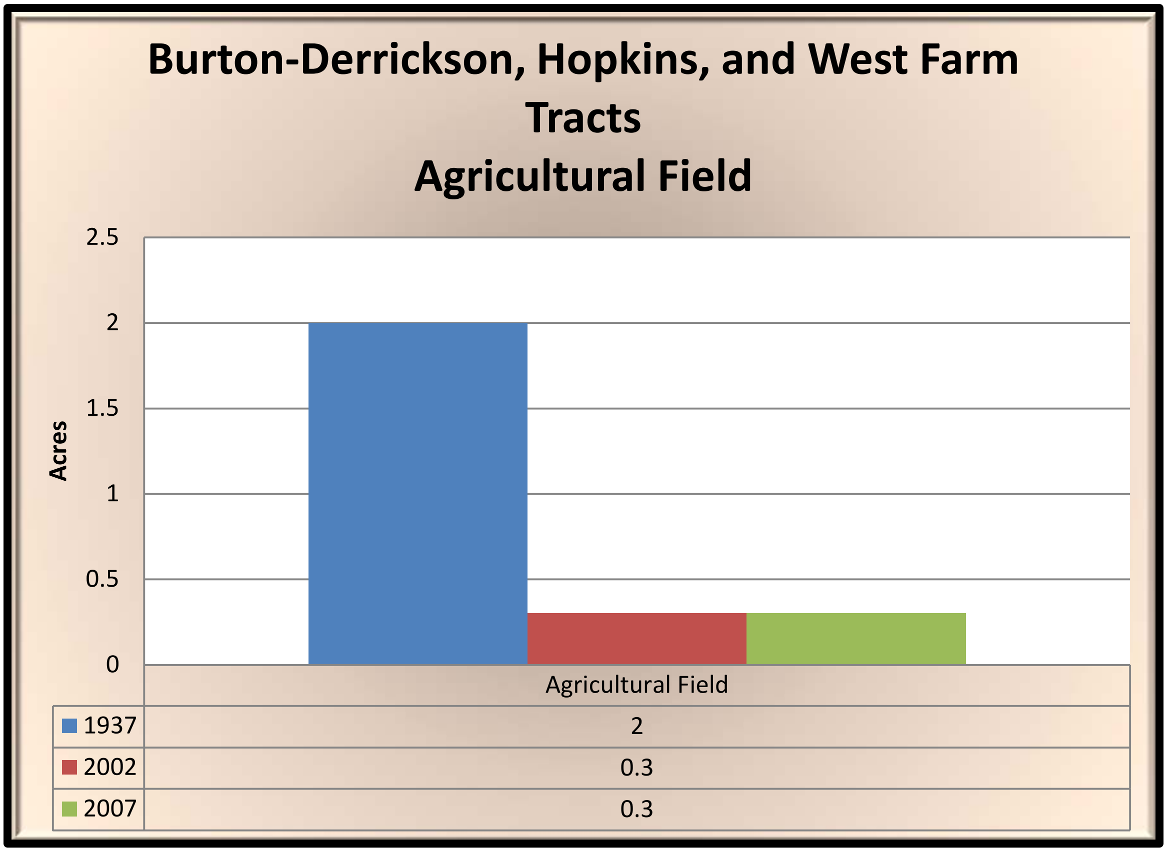


Figure 5.1. Agricultural Field at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

DNREC Sea Level Rise Analysis (Table 5.3)

None of the agricultural field currently present in the Burton-Derrickson, Hopkins, and West Farm Tracts will be impacted by 1.5 m of sea level rise.

Table 5.3. Projected acres of the Agricultural Field Impacted by Sea Level Rise	
Rise	**Acres**
0.5 m	0 acres
1 m	0 acres
1.5 m	0 acres

Natural Capital (Table 5.4)

Capital of agricultural field has declined with its acreage.

Table 5.4. Natural Capital of Agricultural Field	
Year	**Natural Capital (in 2012 dollars)**
1937	$115/year
2002	$17/year
2007	$17/year

***Water* [7 acres, (Figure 5.2, Tables 5.5-5.7)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

Water includes the water surface of the Murderkill River and tributaries.

Analysis of Condition at the Burton-Derrickson, Hopkins, and West Farm Tracts

The entire water surface present in 1937 was still present in 2007 (Table 5.5). Since 1937, water coverage has increased with water inundating 3 acres of Freshwater Tidal Woodland, 0.4 acres of Pickerelweed Tidal Marsh, and 0.2 acres of Wax-Myrtle Shrub Swamp (Table 5.6). The increase of water shows the rising sea level in the area since communities such as Freshwater Tidal Woodland and Wax-Myrtle Shrub Swamp are not exposed to erosion on the edge of the marsh.

Table 5.5. Water has migrated into X or remained since 1937

X	**Acreage**
Water	4 acres

Table 5.6. Water has migrated into X or remained since 1937

X	**Acreage**
Water	4 acres
Freshwater Tidal Woodland	3 acres
Pickerelweed Tidal Marsh	0.4 acres
Wax-Myrtle Shrub Swamp	0.2 acres

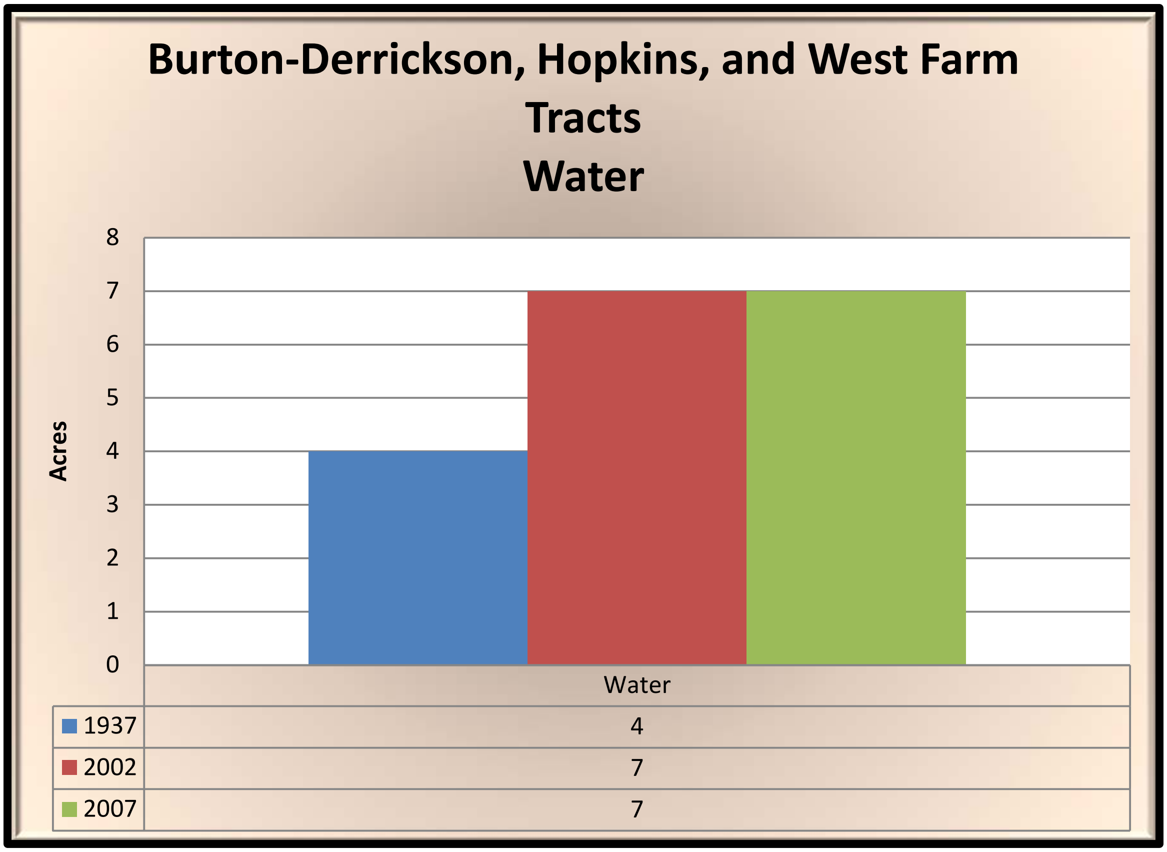


Figure 5.2. Water at the Burton-Derrickson, Hopkins, and West Farm Tracts (1937, 2002, and 2007)

Natural Capital (Table 5.7)

Capital of water has increased with its acreage.

Table 5.7. Natural Capital of Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$57,332/year
2002	$100,331/year
2007	$100,331/year

Appendix I: State rare vegetation ranking criteria

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

State Rank

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

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

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

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

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

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

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

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

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

SNR Unranked

SNA Not Applicable

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

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

APPENDIX II: SGCN IN KEY WILDLIFE HABITATS

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 Freshwater Tidal Forested and Scrub-Shrub Wetlands			
Species	**Common Name**	**Class**	**Tier**
Poanes massasaoit chermockii	Chermock's mulberry wing	Insect	1
Nannothemis bella	Elfin skimmer	Insect	1
Clemmys guttata	Spotted Turtle	Reptile	1
Podilymbus podiceps	Pied-billed grebe	Bird	1
Nycticorax nyticorax	Black-crowned night-heron	Bird	1
Nyctanassa violacea	Yellow-crowned night-heron	Bird	1
Pandion haliatus	Osprey	Bird	1
Lycaena hyllus	Bronze copper	Insect	2

Papaipema birdi	Umbellifer borer moth	Insect	2
Libellula axilena	Bar-winged skimmer	Insect	2
Argia bipunctulata	Seepage dancer	Insect	2
Nehalerinia gracilis	Sphagnum sprite	Insect	2
Botaurus lentiginosus	American bittern	Bird	2
Ixobrychus exilis	Least bittern	Bird	2
Ardea herodias	Great blue heron	Bird	2
Casmerodius albus	Great egret	Bird	2
Egretta thula	Snowy egret	Bird	2
Egretta caerulea	Little blue heron	Bird	2
Egretta tricolor	Tricolored heron	Bird	2
Bubulcus ibis	Cattle egret	Bird	2
Anas platyrhynchos	mallard	Bird	2
Rallus elegans	King rail	Bird	2
Porzana carolina	Sora	Bird	2
Dolichonyx oryzivorus	Bobolink	Bird	2

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

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