Historical Analysis and Map of Vegetation Communities, Land Covers, and Habitats of Marshyhope Wildlife Area Sussex County, Delaware

Marshyhope Creek Watershed

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CHAPTER 1: INTRODUCTION AND METHODS

Setting of Marshyhope Wildlife Area

Marshyhope Wildlife Area is located in western Sussex County, Delaware (Figure 1.1). The wildlife area totals 1,079 acres in three sections; middle section (143 acres), North Section (541 acres), South Section (394 acres). All of the wildlife area is located within the Marshyhope Creek watershed.

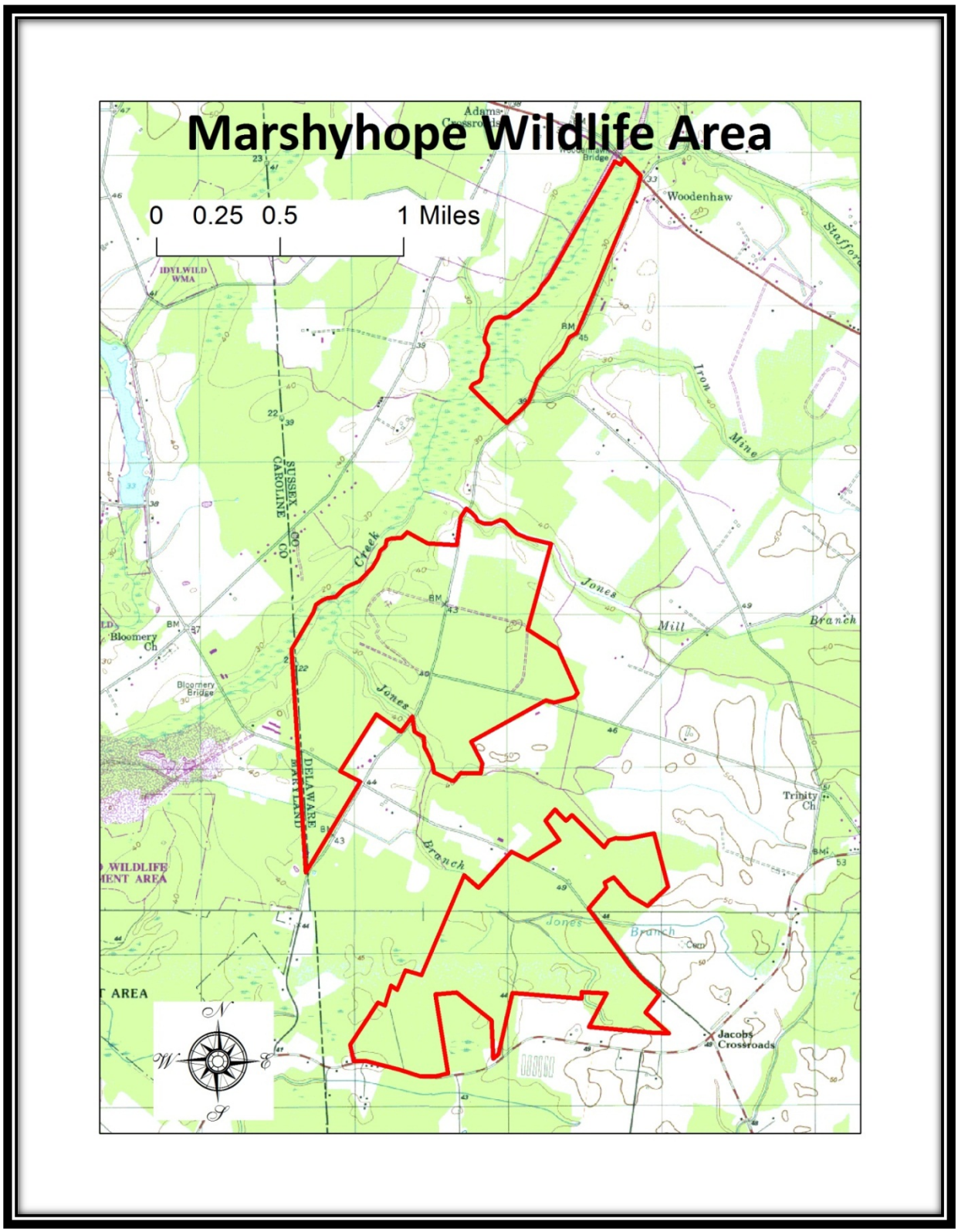

Figure 1.1. Location of Marshyhope Wildlife Area

Soils and Geology of Marshyhope Wildlife Area[1]

Underlying Geology

Marshyhope Wildlife Area is underlaid by Holocene Deposits in the floodplain of Marshyhope Creek and the Columbia Formation in the uplands and tributaries. Holocene deposits are of recent origin and are described as "gray to black organic rich silty clay to medium sand associated with marsh and swamp environments." The Columbia Formation is present in the uplands is described as "reddish-orange, brown to tan, light gray to white, medium to coarse, feldspathic sand with gravel and light gray silt beds."

Soils

Three soils are prominent in Marshyhope Wildlife Area and include Evesboro Loamy Sand (346 acres) in the uplands and Fallsington Sandy Loam (266 acres) and Longmarsh and Indiantown Soils in the lowlands. Other minor soils include Corsica Mucky Loam, Hambrook Sandy Loam, Rosedale Loamy Sand, and Woodstown Loam. Elevations of Marshyhope Wildlife Area range from 21 feet at the stateline where Marshyhope Creek flows out of Delaware to about 50 feet west of Jacobs Crossroads.

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

Middle Section Soils

Evesboro Loamy Sand (317 acres) is the prominent soil in the Middle Section. Other minor soils include Rosedale Loamy Sand (64 acres), Longmarsh and Indiantown Soils (61 acres), and Marshyhope Sandy Loam (38 acres).

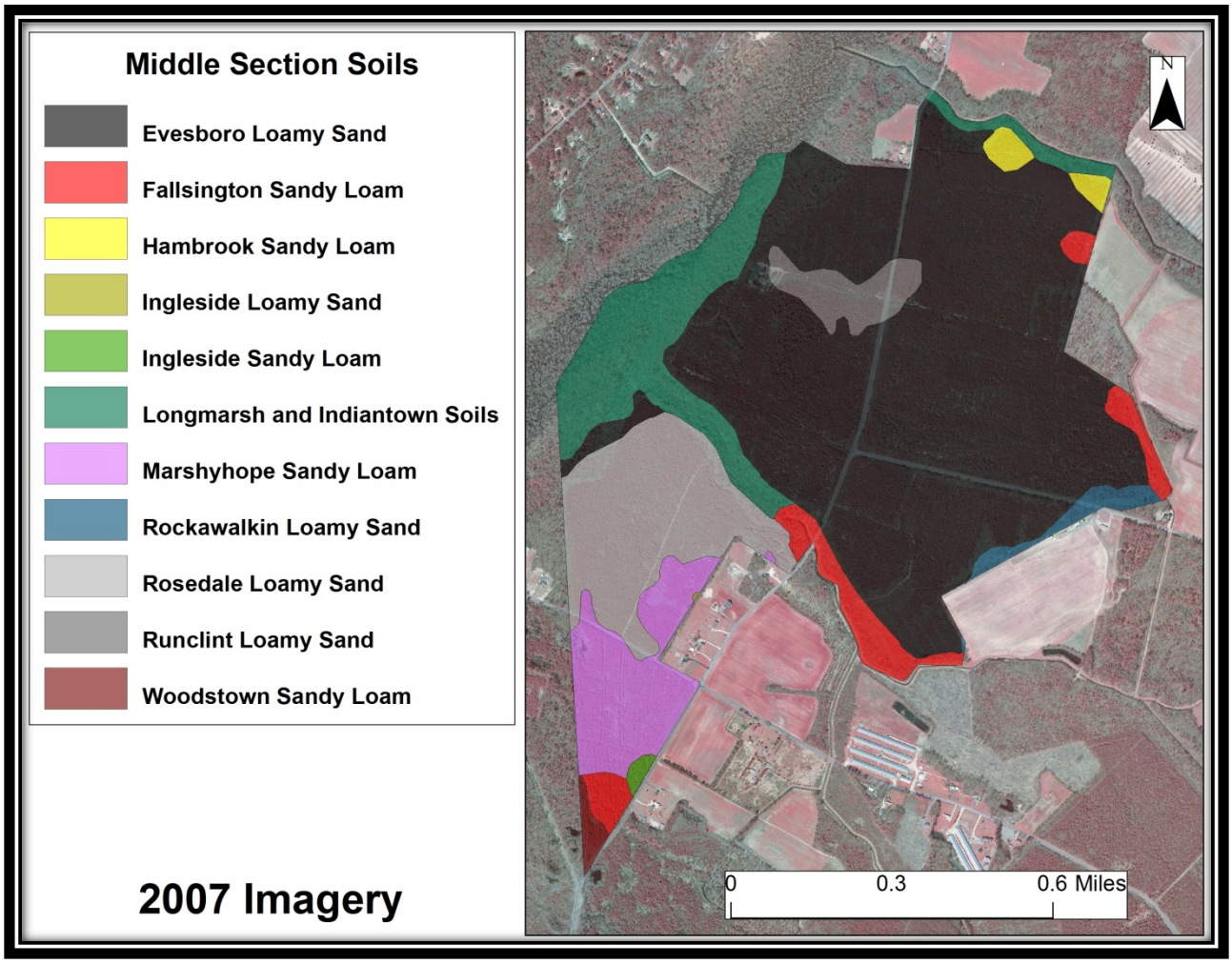

Figure 1.2. Middle Section Soil Map

North Section Soils

Longmarsh and Indiantown Soils (109 acres) is the prominent soil in the North Section, with Evesboro Loamy Sand being a minor soil.

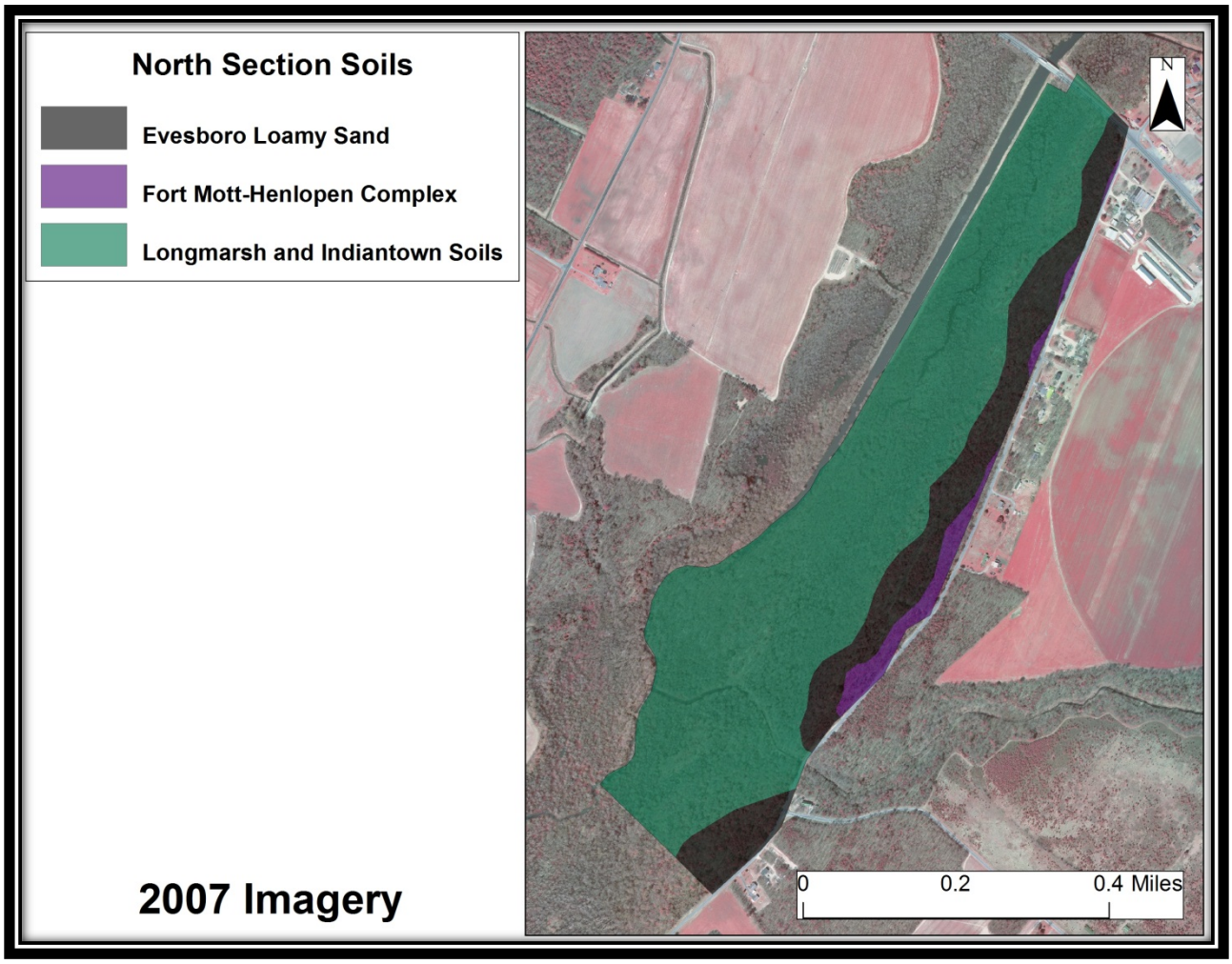

Figure 1.3. North Section Soil Map

South Section Soils

Fallsington Sandy Loam (242 acres) is the prominent soil in the South Section. Other minor soils include Corsica Mucky Loam (58 acres), Hambrook Sandy Loam (45 acres), and Woodstown Loam (39 acres).

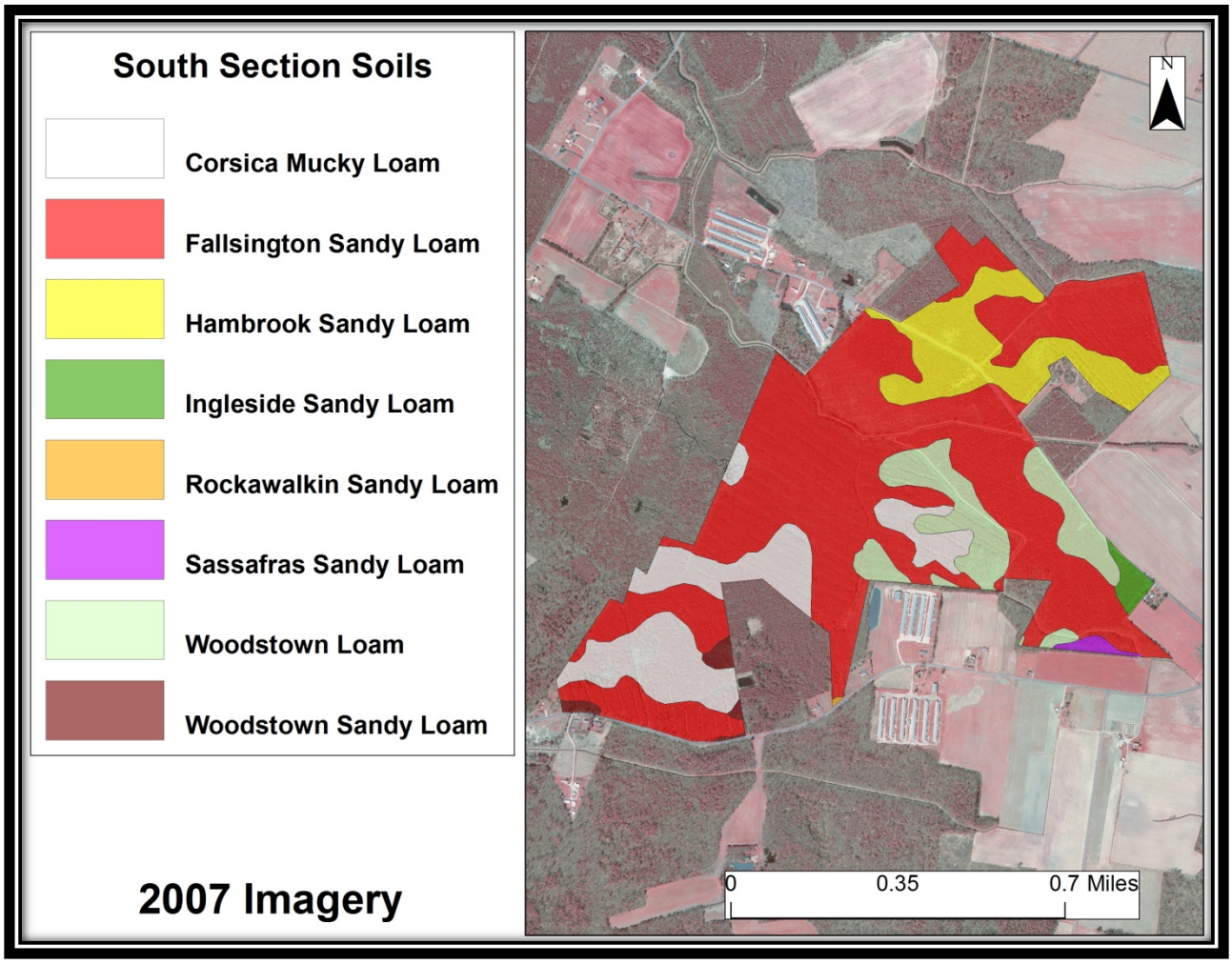

Figure 1.4. South Section Soil Map

Elevation

Elevations of Marshyhope Wildlife Area range from about 19 feet where Marshyhope Creek flows out of the wildlife area to 50 feet at the east end of the Middle Section and south end of the South Section.

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.

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 Marshyhope Wildlife Area based on 1954, 2002, and 2007 aerial imagery and field observations.
2. Use the maps above to determine changes in the vegetation communities over time.
3. Determine the forest blocks located within or partially within the wildlife area.
4. Produce Ecological Integrity Assessments (EIAs) for vegetation communities that are ranked S2 or higher.

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

Vegetation Community and Land Cover Surveys

Vegetation communities and land covers were determined by qualitative analysis using observations made in the field and aerial photo-interpretation using 1954, 2002, and 2007 aerial imagery. Vegetation communities are named according to the *Guide to Delaware Vegetation Communities* [2]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. A description of each community is provided. A crosswalk to the Delaware Wildlife Action Plan (DEWAP) and the Northeast Habitat Classification (NHC) is provided at the top of each individual community description.

Analysis of Historical Imagery

Historical imagery of Marshyhope Wildlife Area from 1954 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, 48, and 53 year time frame. Changes in the respective vegetation communities and land covers are discussed in the descriptions while broader changes are discussed in the nature preserve discussion. There is more imagery available (1937, 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 wildlife area that are ranked S2 or higher in Delaware. EIAs are an analysis being developed by Natureserve to determine the relative quality of vegetation communities across North America. Using Natural Heritage methodology, communities are ranked according to rarity (Appendix I). None of the vegetation communities in Marshyhope Wildlife Area are ranked S2 or higher.

Forest Block Analysis

Current forest blocks within or partially within the nature preserve 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.[3] Forest interior is forested area that is 100m from a forest edge. Potential blocks were extended out to areas of noncontiguous habitat (such as roads, power line right-of-ways, and developed areas) that were considered to be immovable. Most of the area that could be reverted to forest is currently old field habitat or in agricultural use. These blocks were determined for future planning in regards to improving and increasing forest interior habitat. Forest blocks are depicted in Figure 2.1.

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[2] Coxe, Robert. 2010. Guide to Delaware Vegetation Communities-Summer 2010 Edition. Unpublished report.

[3] 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.

Natural Capital Analysis

The natural capital of each vegetation community and land cover was determined using a table in Costanza, et al.[4] 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.

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

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

Summary of Findings from this study

1. **Vegetation Communities:** Thirteen vegetation communities and six land covers were found at Marshyhope Wildlife Area. Loblolly Pine Plantation (486 acres) is the largest vegetation community, followed by Early to Mid-Successional Loblolly Pine Forest with 307 acres. Water (9 acres) is the largest land cover, followed by impervious surface with 7 acres.

2. **Rare Plants:** One rare plant is known to exist in Marshyhope Wildlife Area (Table 2.1).

Scientific Name	Common Name	Rank	Last Observed
Carex joorii	Cypress-Swamp Sedge	S2	1994

Table 2.1. Rare Plants at Marshyhope Wildlife Area

3. **Rare Animals:** Three rare animals are known to exist in Marshyhope Wildlife Area (Table 2.2).

Scientific Name	Common Name	Rank	Last Observed
Anax longipes	Comet Darner	S1	???
Cincindela scutellaris	A Tiger Beetle	S1?	???
Strix varia	Barred Owl	S2	???

Table 2.2. Rare Animals at Marshyhope Wildlife Area

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

Management of state parks has traditionally favored recreational uses, which require cultivated lawns and edges running counter to the habitat needed for forest interior birds. Protecting forest interior birds runs contrary to the idea that artificially created edges creates more diversity. While this technique creates more diversity of some aggressive species it diminishes the populations of other species.

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

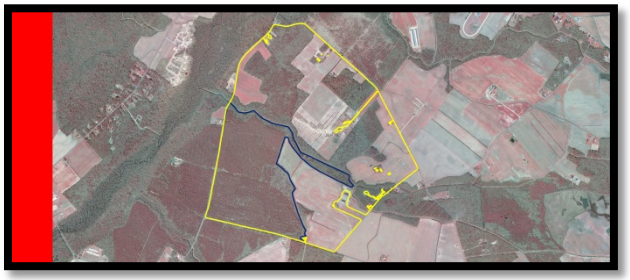
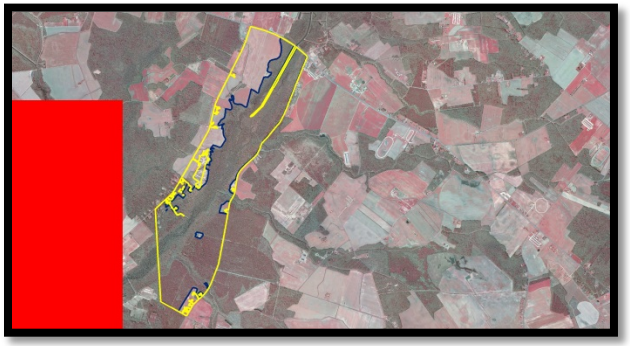
A study by Robbins et al. (1989) showed that most forest interior species require a forest of at least 150 ha (370 acres) in size. Very few forest tracts in Delaware are at least this size, one of the more notable being the Great Cypress Swamp.

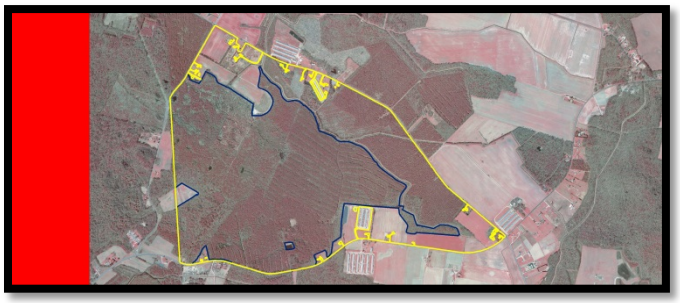
Analysis of Forest Blocks at Marshyhope Wildlife Area

Four forest blocks are present that are more than 100 acres in size and are located in whole or part in Marshyhope Wildlife Area (Table 2.3 and Figure 2.1). All forest blocks are bounded by a road, agricultural field, or other non-forested habitat. These areas are considered to be barriers to the passage of forest dwelling wildlife. A description is provided for the forest block.

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

Table 2.3. Forest Blocks located in whole or part in Marshyhope Wildlife Area

Forest Block Map	Block Name/Acreage	Description
	**Marshyhope A** **Current Block = 197 acres (99 acres interior)** **Potential Block = 666 acres (99 acres interior)**	Marshyhope A covers a forested area south of tributary to Marshyhope Creek. It is bounded by Sand Hill Road on the west, a tax ditch on the north, agricultural field on the east, and Whitney Swamp Road on the south. Two vegetation communities are located within this block and include Early to Mid-Successional Loblolly Pine Forest and Mid-Atlantic Mesic Mixed Hardwood Forest. Marshyhope Creek drains this block via an unnamed tributary. Currently this block contains 99 acres of interior habitat. Potentially this block could be 666 acres in size, and contain 438 acres of interior habitat.
	**Marshyhope B** **Current Block = 684 acres (331 acres interior)** **Potential Block = 942 acres (548 acres interior)**	Marshyhope B covers the forested floodplain of Marshyhope Creek. This block extends into Maryland. It is bounded by Road 571, agricultural field, and cultivated lawn on the west, DE 404 (Seashore Highway) on the north, Sand Hill Road on the east, and Road 572 on the south. Nine vegetation communities are located within this block in Delaware and include Coastal Plain Oak Floodplain Swamp, Early to Mid-Successional Loblolly Pine Forest, Loblolly Pine Plantation, Mid-Atlantic Mesic Mixed Hardwood Forest, Northeastern Modified Successional Forest, Northern Coastal Plain Successional Floodplain Forest, Reed Canarygrass Eastern Marsh, Southern Red Maple-Blackgum Swamp, and Virginia Pine Successional Forest. Marshyhope Creek drains this block. Currently this block contains 331 acres of interior habitat. Potentially this block could be 942 acres in size and contain 548 acres of interior habitat.

Forest Block Map	Block Name/Acreage	Description
	**Marshyhope C** **Current Block = 448 acres (275 acres interior)** **Potential Block = 717 acres (491 acres interior)**	Marshyhope C is located on a wooded upland that borders the stateline of Delaware and extends into Maryland. It is bounded by the Delaware stateline on the west, tax ditches and agricultural field on the north, tax ditches and agricultural fields on the east, and Road 31 on the south. Four vegetation communities are located within this block and include Early to Mid-Successional Loblolly Pine Forest, Loblolly Pine Plantation, Mid-Atlantic Mesic Mixed Hardwood Forest, Mid to Late Successional Loblolly Pine-Sweetgum Forest. A tributary to Marshyhope Creek drains this block. Currently this block contains 275 acres of interior habitat. Potentially this block could be 717 acres in size and contain 491 acres of interior habitat.
	**Marshyhope D** **Current Block = 152 acres (32 acres interior)** **Potential Block = 813 acres (586 acres interior**	Marshyhope D is located on a wooded upland on a tributary to Marshyhope Creek. It is bounded by a clear-cut on the west, tax ditches and agricultural field on the north, agricultural fields on the east, and tax ditches on the south. Two vegetation communities are located within this block and include Loblolly Pine Plantation and Mid-Atlantic Mesic Mixed Hardwood Forest. A tributary to Marshyhope Creek drains this block. Currently this block contains 32 acres of interior habitat. Potentially this block could be 813 acres in size and contain 586 acres of interior habitat.

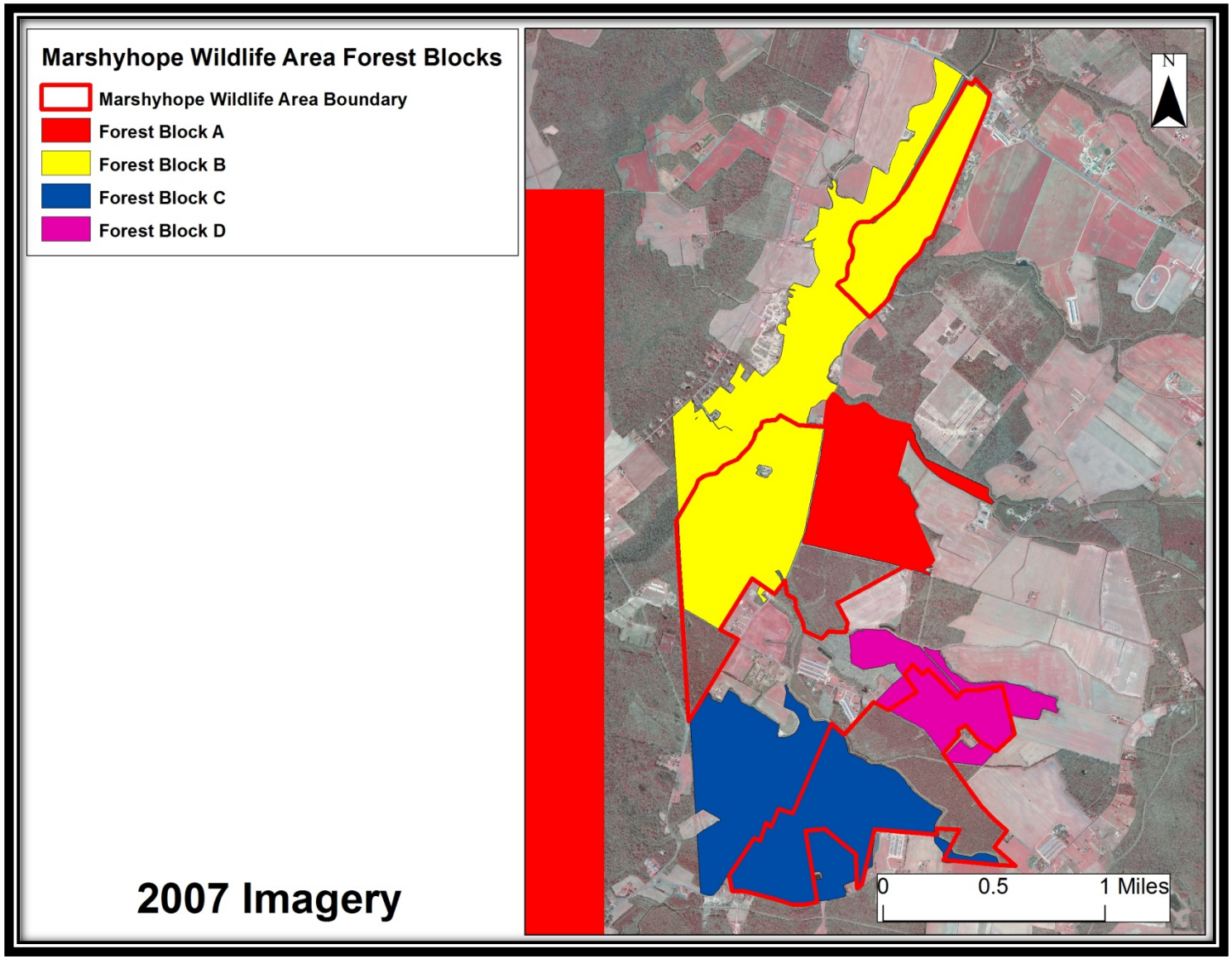
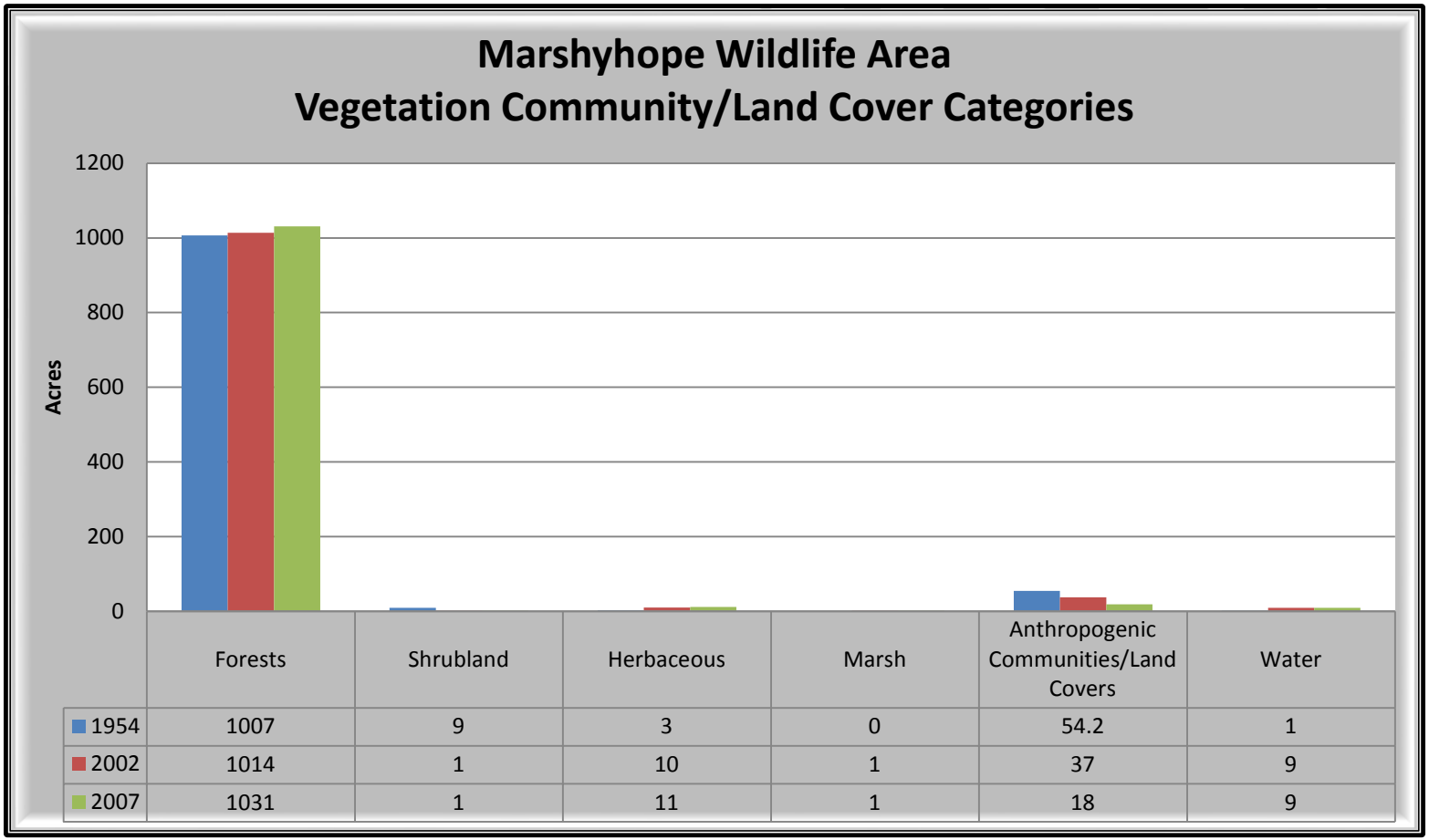


Figure 2.1. Marshyhope Wildlife Area Forest Blocks



	Forests	Shrubland	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Water
1954	1007	9	3	0	54.2	1
2002	1014	1	10	1	37	9
2007	1031	1	11	1	18	9

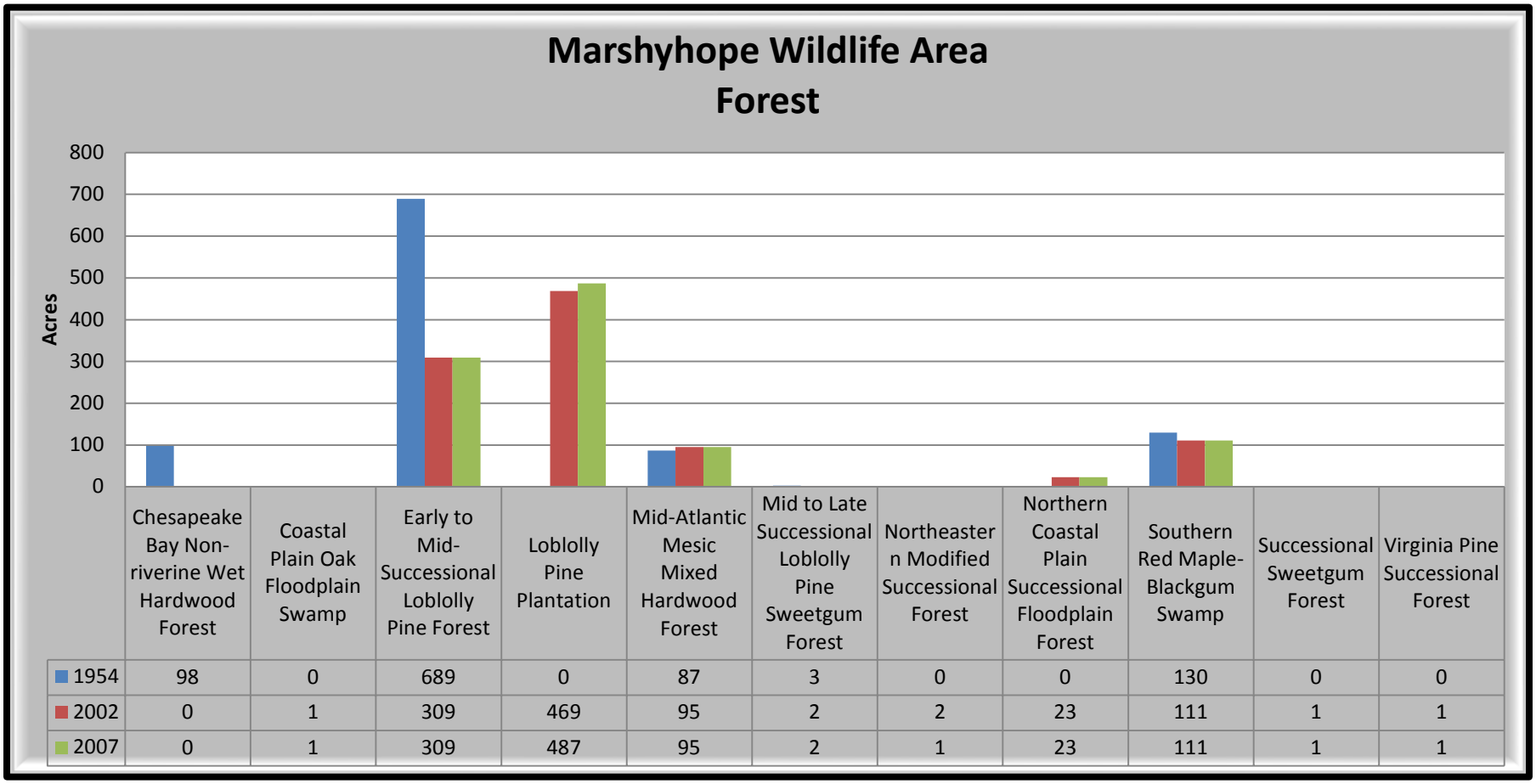
Figure 3.1. Marshyhope Wildlife Area Vegetation Categories/Land Covers (1954, 2002, and 2007)

Marshyhope Wildlife Area Broad Trends (Figure 3.1): Forestland is the largest vegetation type by far in Marshyhope Wildlife Area. Anthropogenic communities/land covers follows a very distant second.

Natural Capital (Table 3.1)

Capital of Marshyhope Wildlife Area has decreased since 1954 with the loss of a floodplain forest, in spite of a substantial increase in forest land.

Table 3.1. Natural Capital of Marshyhope Wildlife Area	
Year	**Natural Capital (in 2012 dollars)**
1954	$2,959,163/year
2002	$1,895,516/year
2007	$1,898,916/year



	Chesapeake Bay Non-riverine Wet Hardwood Forest	Coastal Plain Oak Floodplain Swamp	Early to Mid-Successional Loblolly Pine Forest	Loblolly Pine Plantation	Mid-Atlantic Mesic Mixed Hardwood Forest	Mid to Late Successional Loblolly Pine Sweetgum Forest	Northeastern Modified Successional Forest	Northern Coastal Plain Successional Floodplain Forest	Southern Red Maple-Blackgum Swamp	Successional Sweetgum Forest	Virginia Pine Successional Forest
1954	98	0	689	0	87	3	0	0	130	0	0
2002	0	1	309	469	95	2	2	23	111	1	1
2007	0	1	309	487	95	2	1	23	111	1	1

Figure 3.2. Forest at Marshyhope Wildlife Area (1954, 2002, and 2007)

Marshyhope Wildlife Area Forest (Figure 3.2): Loblolly Pine Plantation is the largest forest community in Marshyhope Wildlife Area followed by Early to Mid-Successional Loblolly Pine Forest.

Natural Capital (Table 3.2)

Capital of forestland has decreased with the loss of a floodplain forest in the South Section.

Table 3.2. Natural Capital of Marshyhope Wildlife Area Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$2,949,771/year
2002	$1,825,571/year
2007	$1,828,975/year

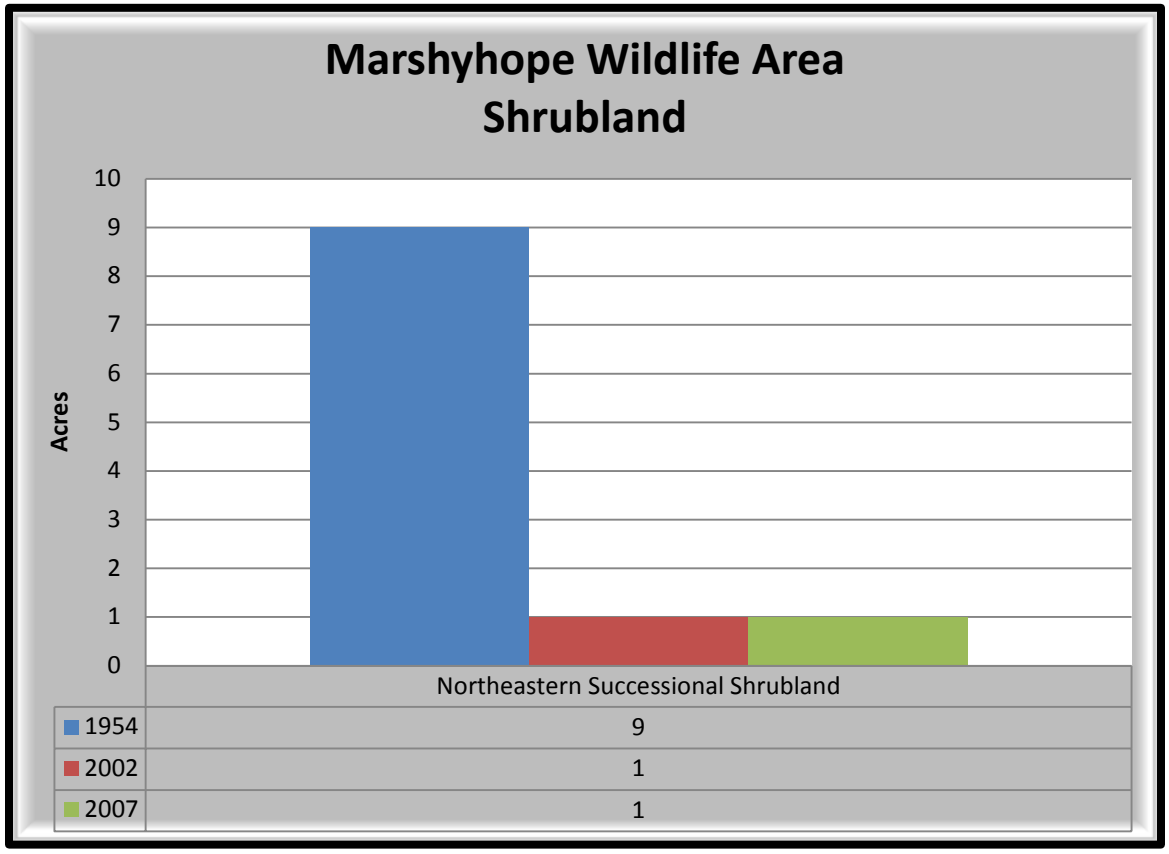


Figure 3.3. Shrubland at Marshyhope Wildlife Area (1954, 2002, and 2007)

Marshyhope Wildlife Area Shrubland (Figure 3.3): Northeastern Successional Shrubland is the only shrub community in Marshyhope Wildlife Area and has been decreasing in size as it matures to forest.

Natural Capital (Table 3.3)

Capital of shrubland has decreased as these communities mature to forest.

Table 3.3. Natural Capital of Marshyhope Wildlife Area Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,209/year
2002	$150/year
2007	$146/year

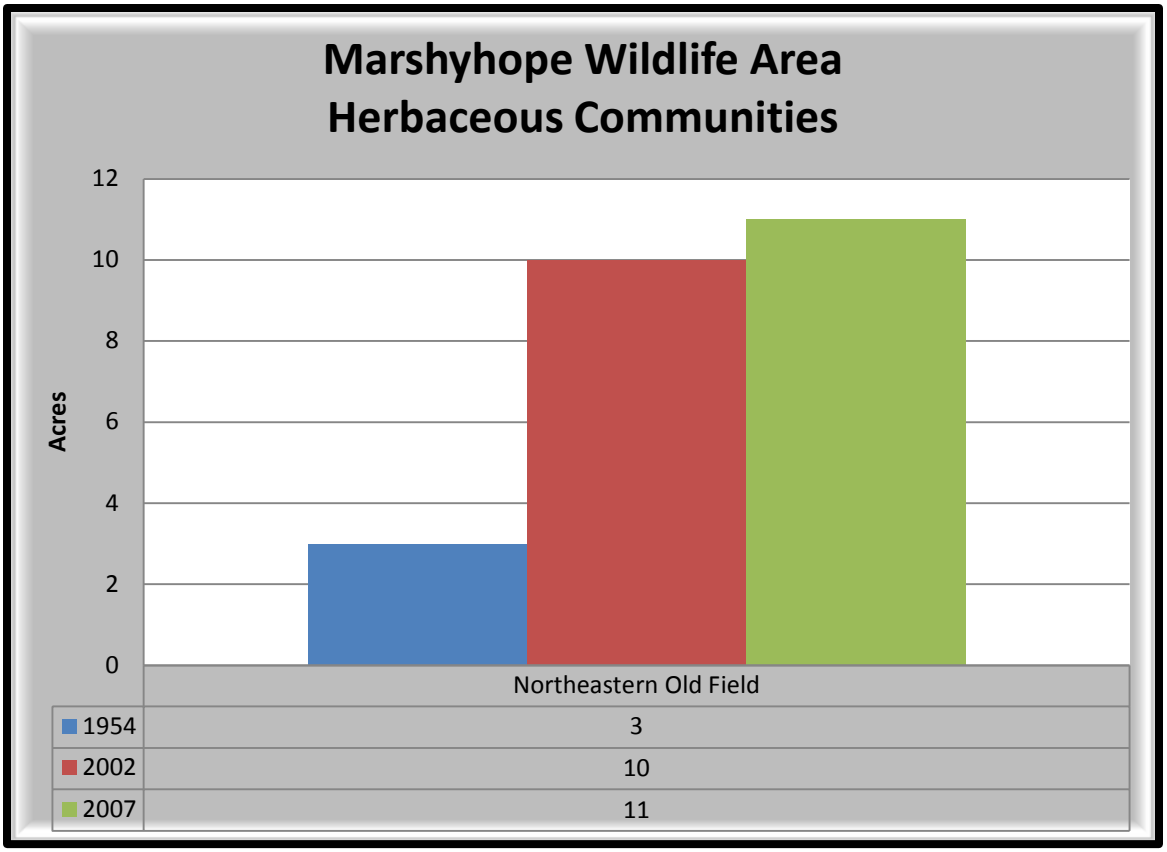


Figure 3.4. Herbaceous Communities at Marshyhope Wildlife Area (1954, 2002, and 2007)

Marshyhope Wildlife Area Herbaceous Communities (Figure 3.4): Northeastern Old Field is the only herbaceous community located in Marshyhope Wildlife Area. It has been increasing as agricultural fields are abandoned.

Natural Capital (Table 3.4)

Capital of herbaceous communities has increased with an increase in herbaceous communities due to drainage ditches and the abandonment of agricultural fields.

Table 3.4. Natural Capital of Marshyhope Wildlife Area Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$437/year
2002	$1,501/year
2007	$1,501/year

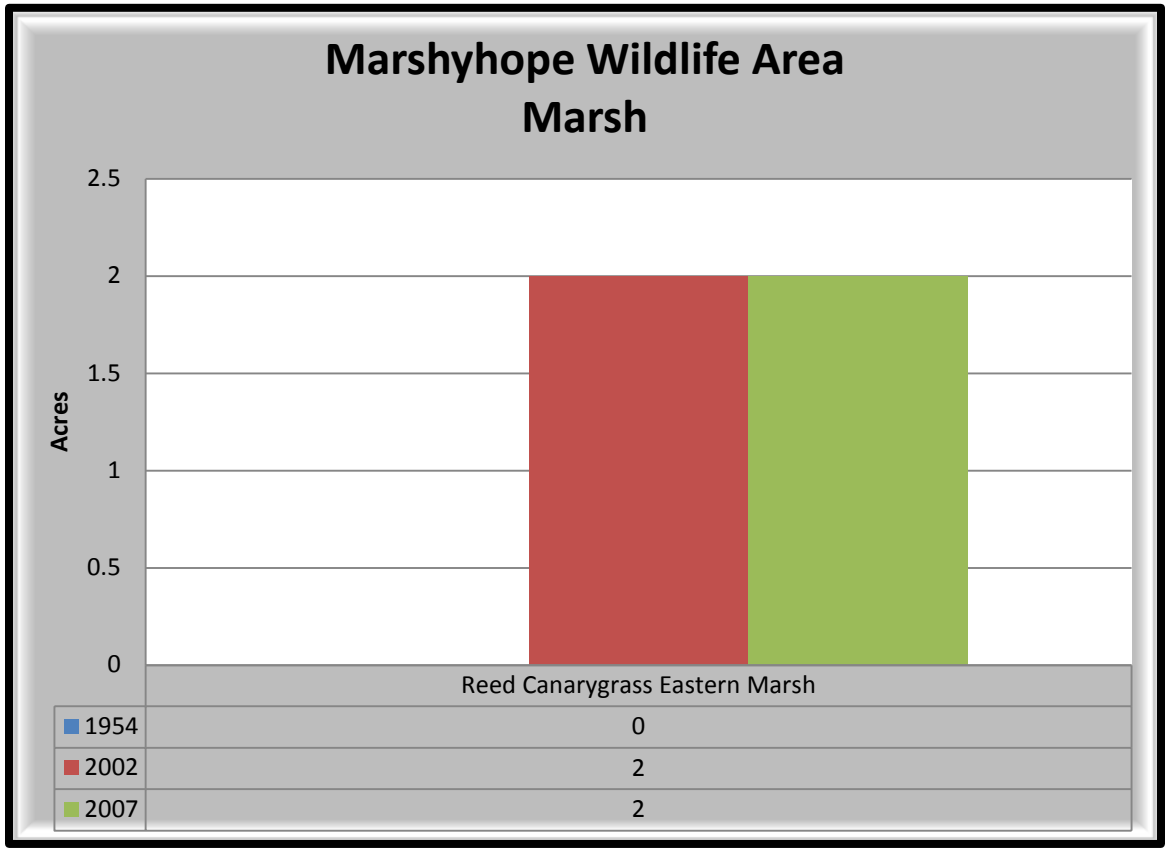


Figure 3.5. Marsh at Marshyhope Wildlife Area (1954, 2002, and 2007)

Marshyhope Wildlife Area Marsh (Figure 3.5): Reed Canarygrass Eastern Marsh is the only marsh community present in Marshyhope Wildlife Area. It was not present in 1954 and has since developed in an impounded area.

Natural Capital (Table 3.5)

Marshland was not present in the wildlife area in 1954 has since acquired $18,563/year in capital.

Table 3.5. Natural Capital of Marshyhope Wildlife Area Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$18,563/year
2007	$18,563/year

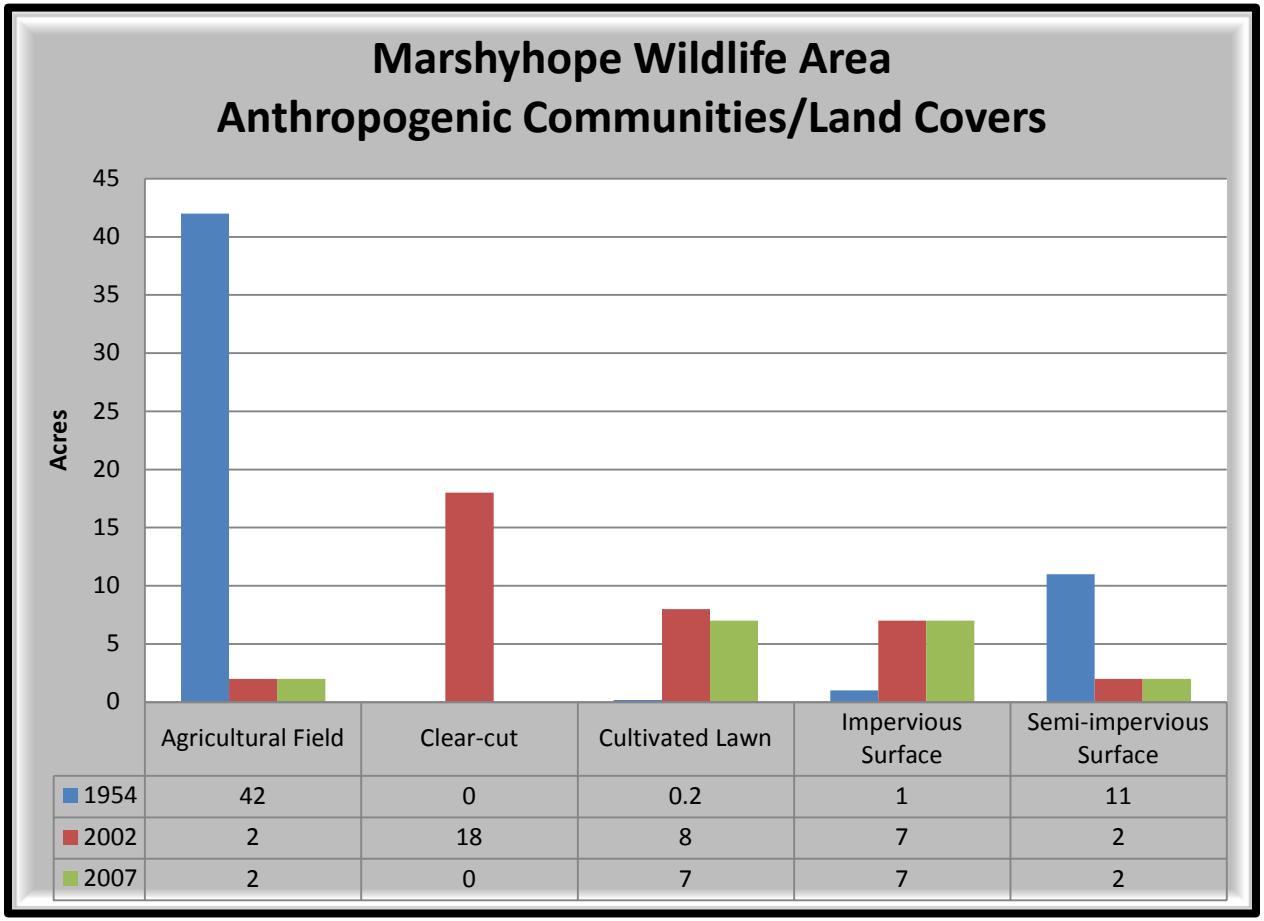


Figure 3.6. Anthropogenic Communities/Land Covers at Marshyhope Wildlife Area (1954, 2002, and 2007)

Marshyhope Wildlife Area Anthropogenic Communities/Land Covers (Figure 3.6): Cultivated Lawn and the related impervious surface are the largest anthropogenic communities/land covers in Marshyhope Wildlife Area.

Natural Capital (Table 3.6)

Agricultural field is the only Anthropogenic community/Land cover with capital value in the wildlife area. Its capital has decreased with decreasing acreage.

Table 3.6. Natural Capital of Marshyhope Wildlife Area Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1954	$2,411/year
2002	$1,715/year
2007	$1,715/year

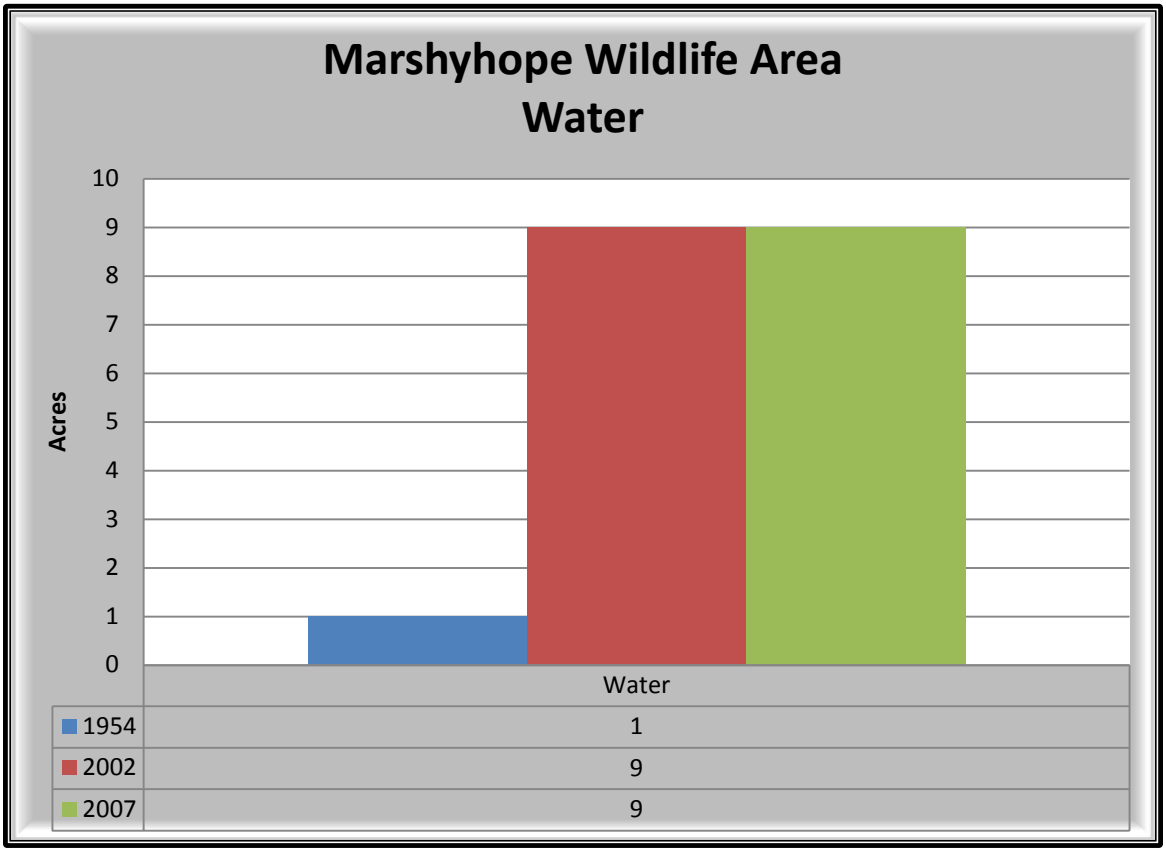


Figure 3.7. Water coverage at Marshyhope Wildlife Area (1954, 2002, and 2007)

Marshyhope Wildlife Area Water (Figure 3.7): Water coverage in Marshyhope Wildlife Area has increased greatly since 1954 with the development of drainage ditches and the impounding of water from channelization.

Natural Capital (Table 3.7)

Capital of water has increased substantially with development of drainage ditches and impounded water from channelization.

Table 3.7. Natural Capital of Marshyhope Wildlife Area Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$5,335/year
2002	$48,016/year
2007	$48,016/year

CHAPTER 4: VEGETATION COMMUNITIES BY SECTION

1. Middle Section

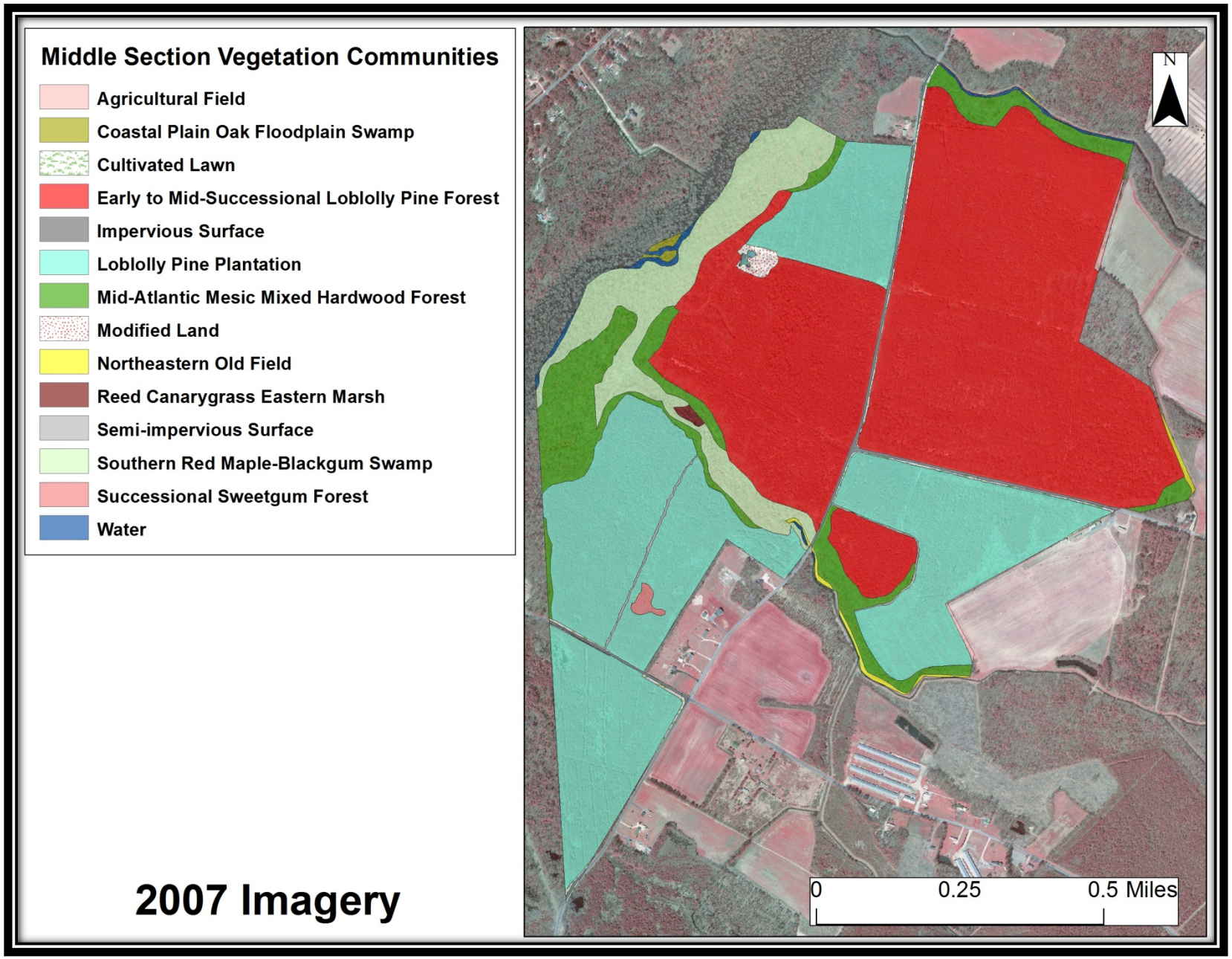


Figure 4-1.1. 2007 Vegetation Community Map of the Middle Section

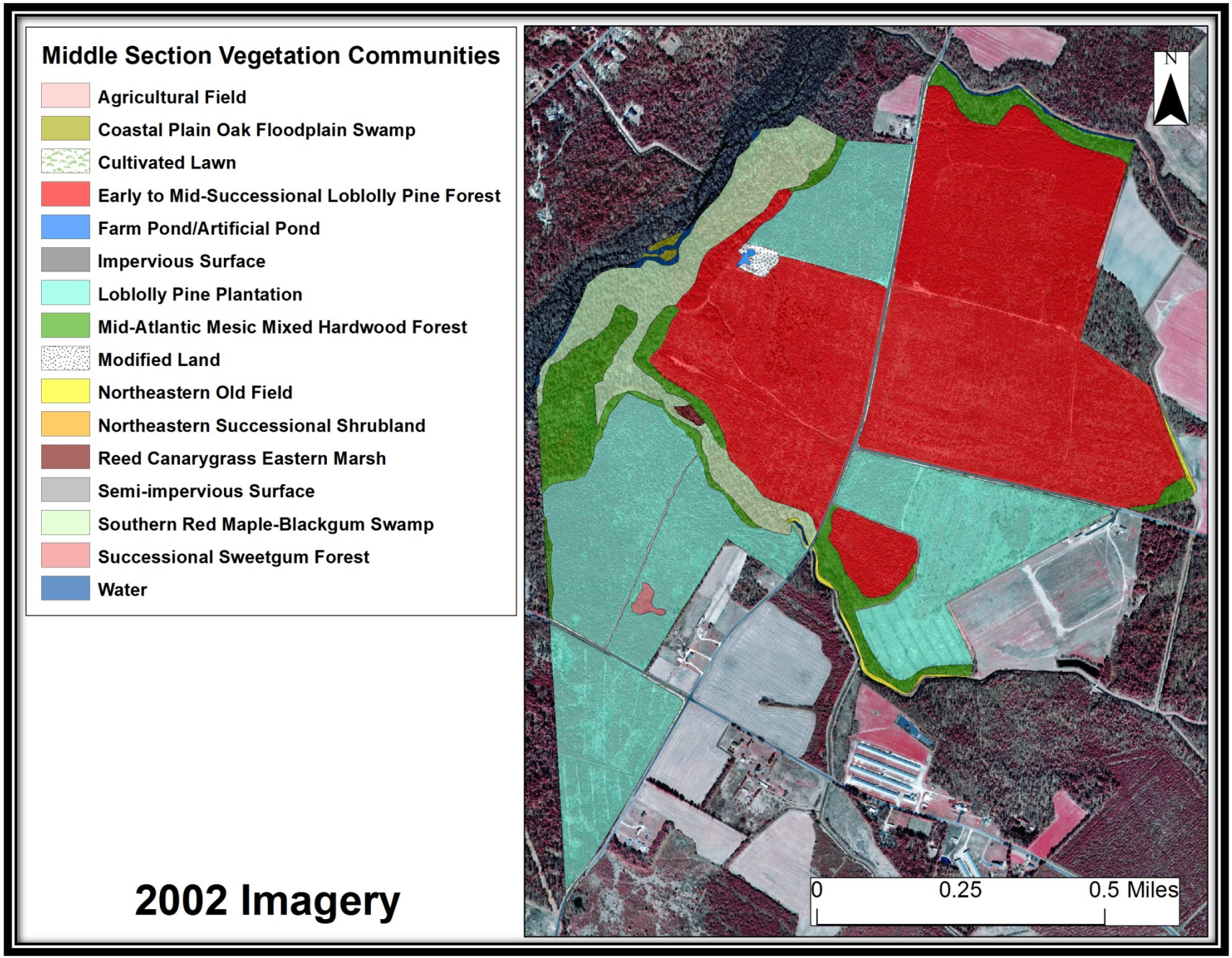


Figure 4-1.2. 2002 Vegetation Community Map of the Middle Section

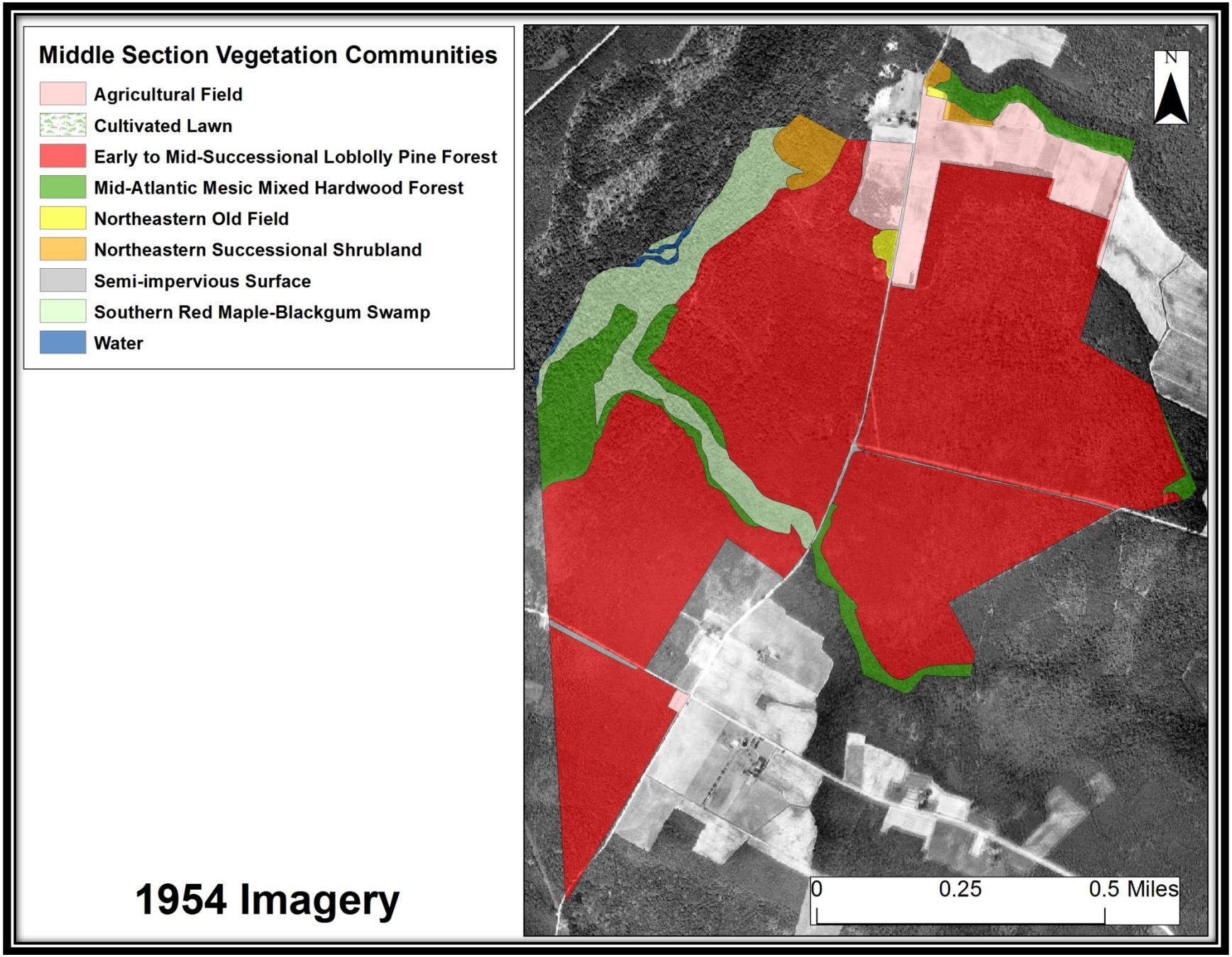


Figure 4-1.3. 1954 Vegetation Community Map of the Middle Section

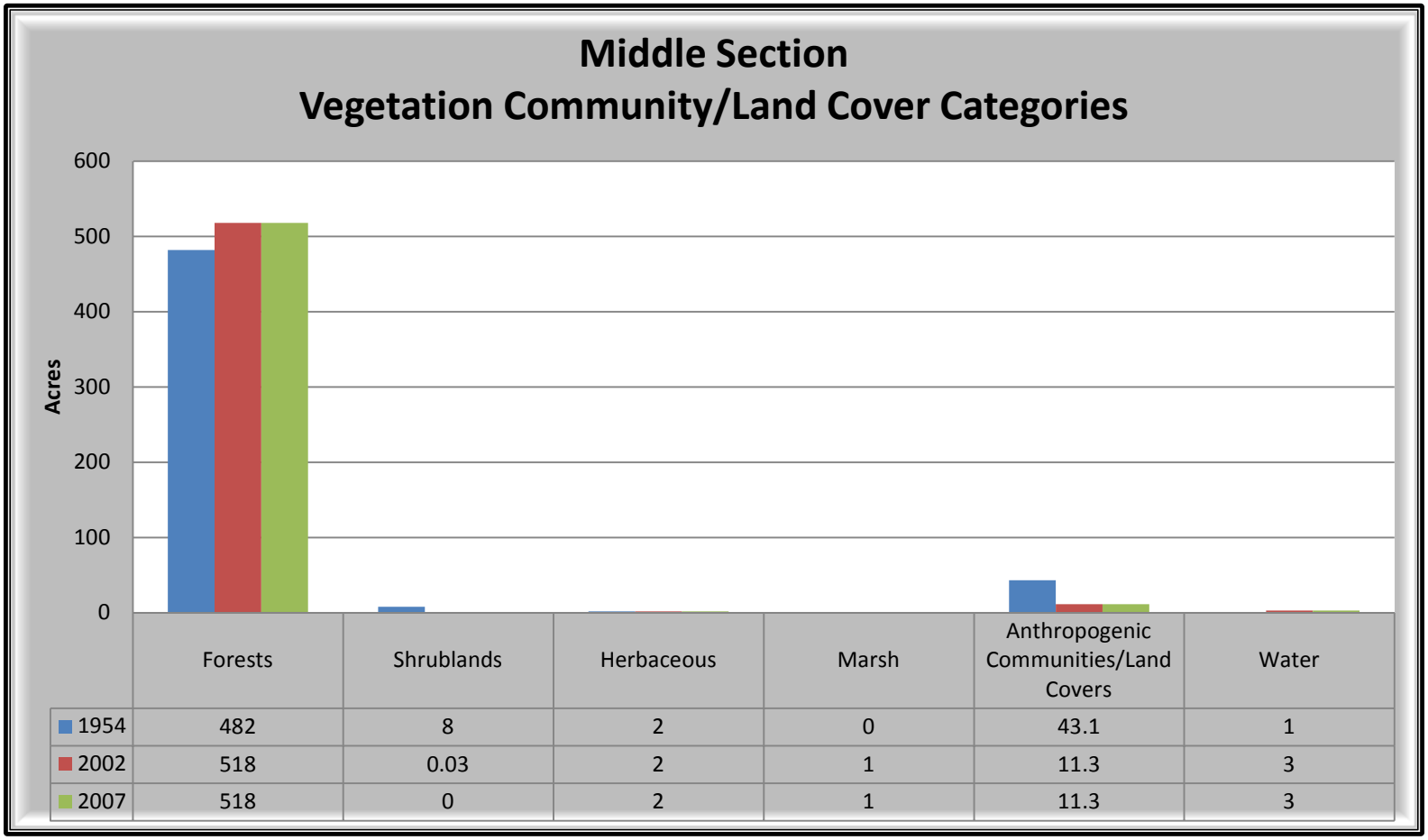


Figure 4-1.4. Middle Section Vegetation Categories/Land Covers (1954, 2002, and 2007)

Middle Section Broad Trends (Figure 4-1.4): Forest is the largest vegetation type in the Middle Section. The amount of forest has increased greatly with Loblolly Pine Plantation being developed in former agricultural fields.

Natural Capital (Table 4-1.1)

Capital of the Middle Section has increased since 1954 and is driven by gains in forest area.

Table 4-1.1. Natural Capital of Middle Section

Year	Natural Capital (in 2012 dollars)
1954	$572,167/year
2002	$645,597/year
2007	$645,593/year

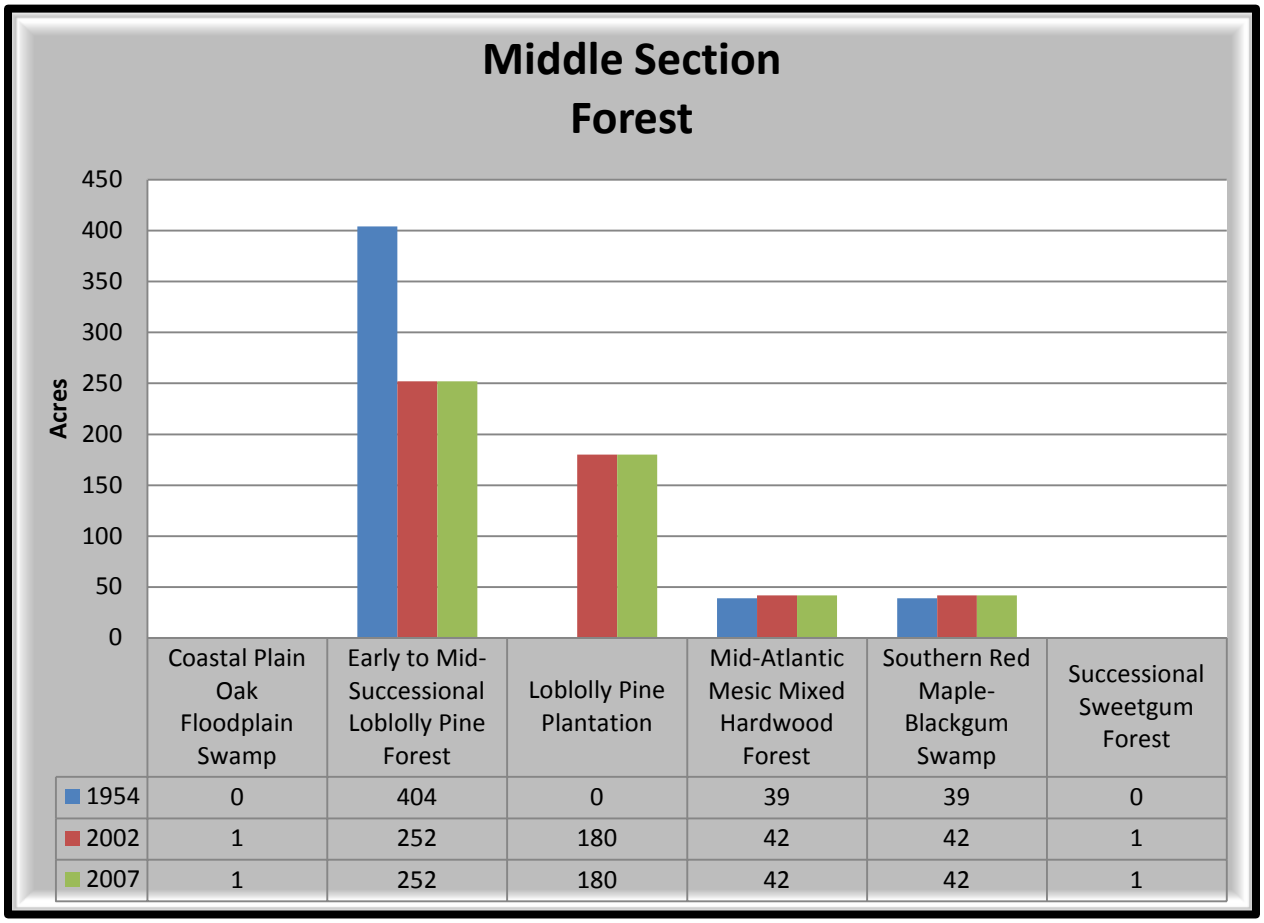


Figure 4-1.5. Forest in the Middle Section (1954, 2002, and 2007)

Middle Section Forest (Figure 4-1.5): Early to Mid-Successional Loblolly Pine Forest is the largest forest community with the related Loblolly Pine Plantation following a close second.

Natural Capital (Table 4-1.2)

Forest land in the Middle Section has increased since 1954 giving a capital gain to the section and the wildlife area.

Table 4-1.2. Natural Capital of Middle Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$563,140/year
2002	$618,357/year
2007	$618,357/year

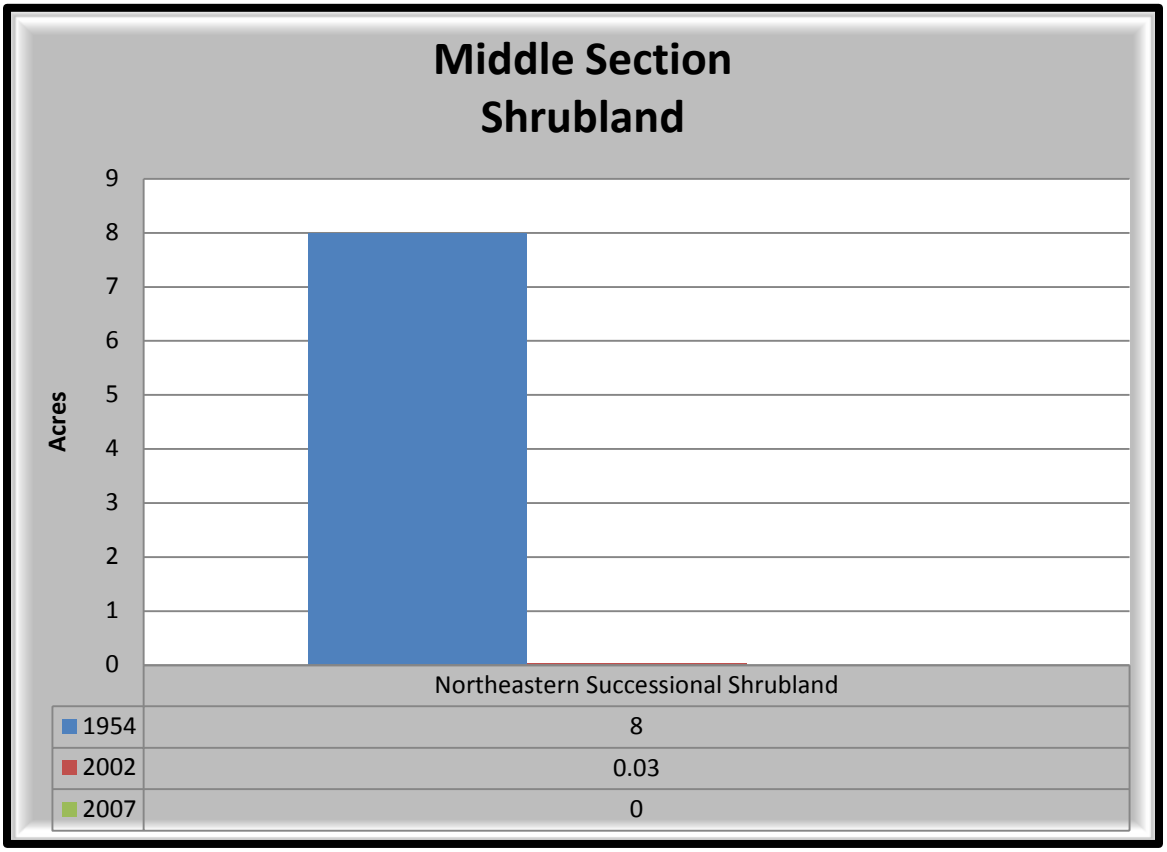


Figure 4-1.6. Shrubland in the Middle Section (1954, 2002, and 2007)

Middle Section Shrubland (Figure 4-1.6): Northeastern Successional Shrubland is no longer present as it has matured to forest communities.

Natural Capital (Table 4-1.3)

Shrubland in the Middle Section has matured into forest since 1954 and has transferred all of its capital.

Table 4-1.3. Natural Capital of Middle Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,166/year
2002	$4/year
2007	$0/year (not present)

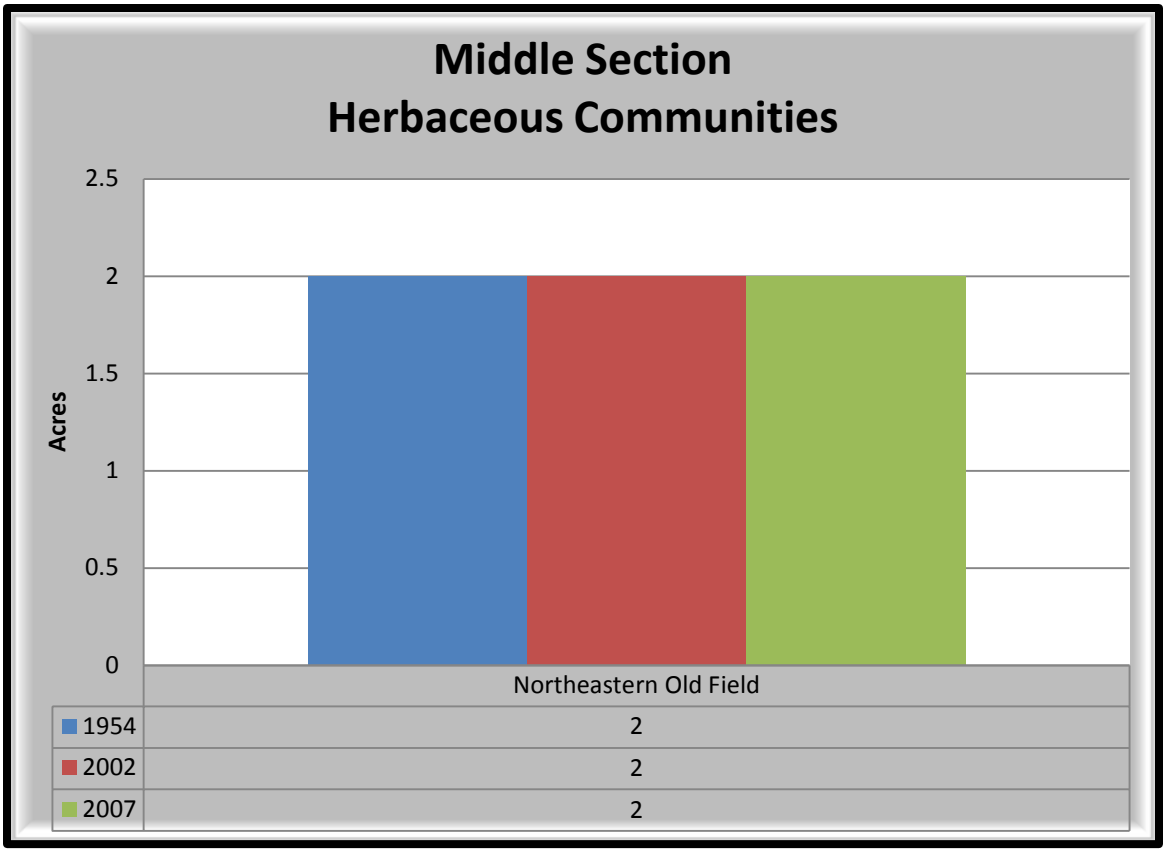


Figure 4-1.7. Herbaceous Communities in the Middle Section (1954, 2002, and 2007)

Middle Section Herbaceous Communities (Figure 4-1.7): Northeastern Old Field is the only herbaceous community and has stayed at the same amount of acreage through time.

Natural Capital (Table 4-1.4)

Capital of herbaceous communities has stayed the same since 1954.

Table 4-1.4. Natural Capital of Middle Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$291/year
2002	$291/year
2007	$291/year

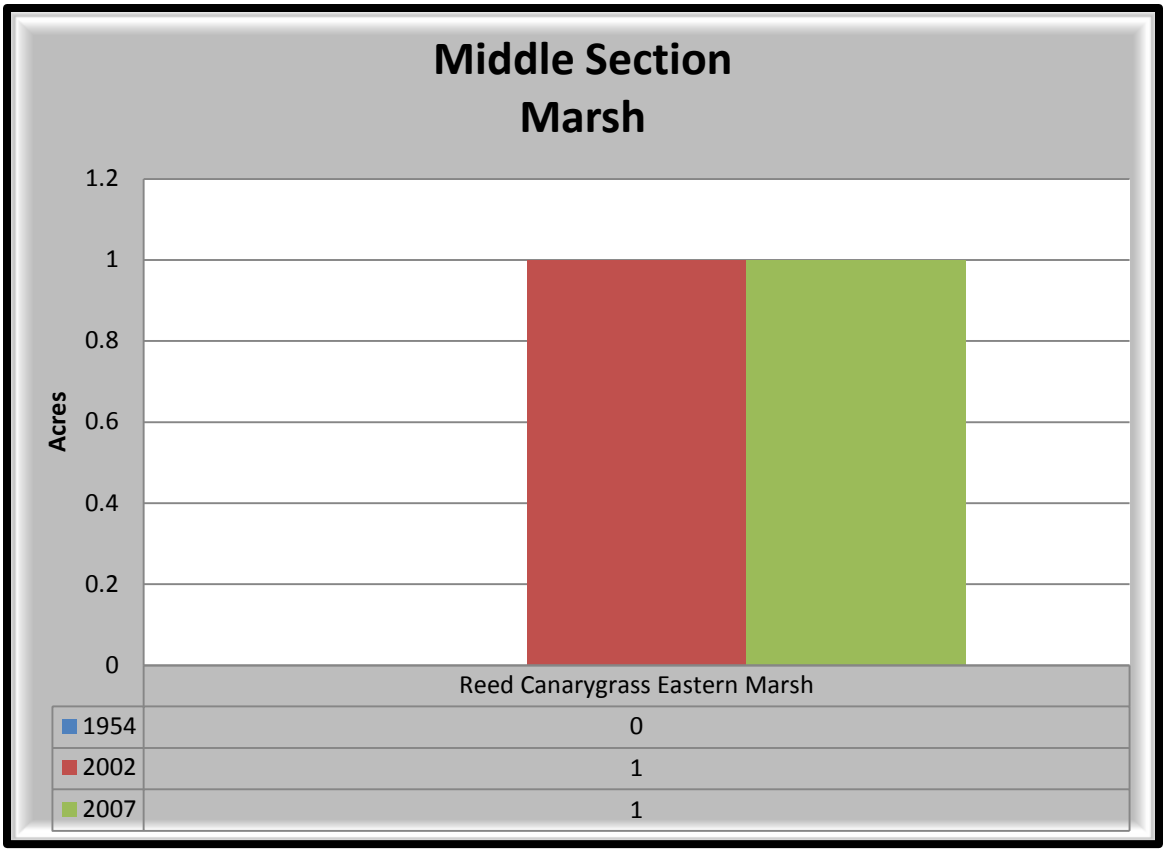


Figure 4-1.8. Marsh in the Middle Section (1954, 2002, and 2007)

Middle Section Marsh (Figure 4-1.8): Reed Canarygrass Eastern Marsh is the only marsh community in the Middle Section and was not present in 1954. It has come into an impounded area that was developed after 1954.

Natural Capital (Table 4-1.5)

No marsh was present in 1954, but marsh has since acquired $9,281 in capital.

Table 4-1.5. Natural Capital of Middle Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$9,281/year
2007	$9,281/year

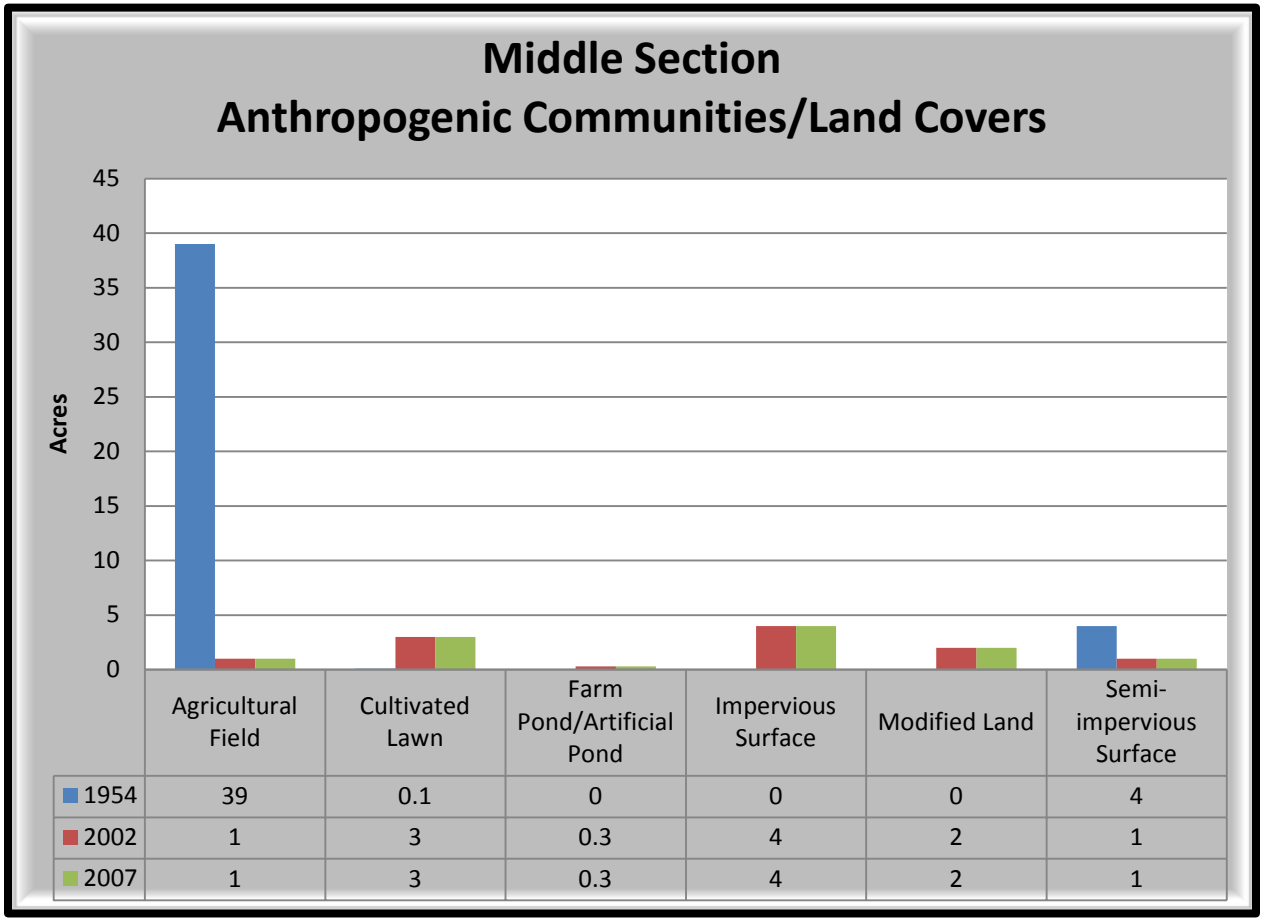


Figure 4-1.9. Anthropogenic Communities/Land Covers in the Middle Section (1954, 2002, and 2007)

Middle Section Anthropogenic Communities/Land Covers (Figure 4-1.9): Impervious Surface is the largest anthropogenic community/land cover in the Middle Section. Agricultural field that was once prominent has shrank to one acre of coverage.

Natural Capital (Table 4-1.6)

Agricultural field and farm ponds are the only anthropogenic communities/land covers with any capital value. The capital of these communities has decreased since 1954.

Table 4-1.6 Natural Capital of Middle Section Anthropogenic Communities/Land Covers

Year	Natural Capital (in 2012 dollars)
1954	$2,237/year
2002	$1,658/year
2007	$1,658/year

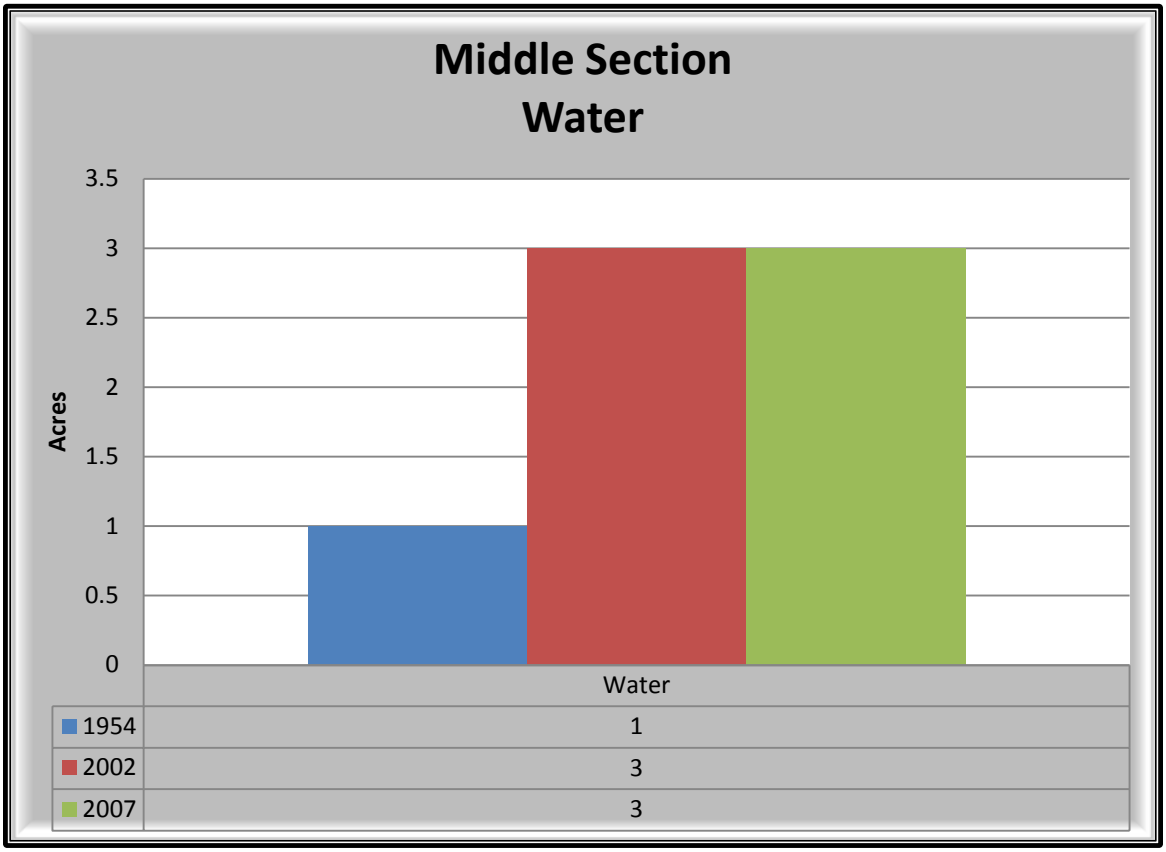


Figure 4-1.10. Water coverage in the Middle Section (1954, 2002, and 2007)

Middle Section Water (Figure 4-1.10): Water coverage in the middle section has increased since 1954.

Natural Capital (Table 4-1.7)

Capital of water has greatly increased since 1954 with the channelization of Marshyhope Creek.

Table 4-1.7. Natural Capital of Middle Section Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$5,335/year
2002	$16,005/year
2007	$16,005/year

2. North Section

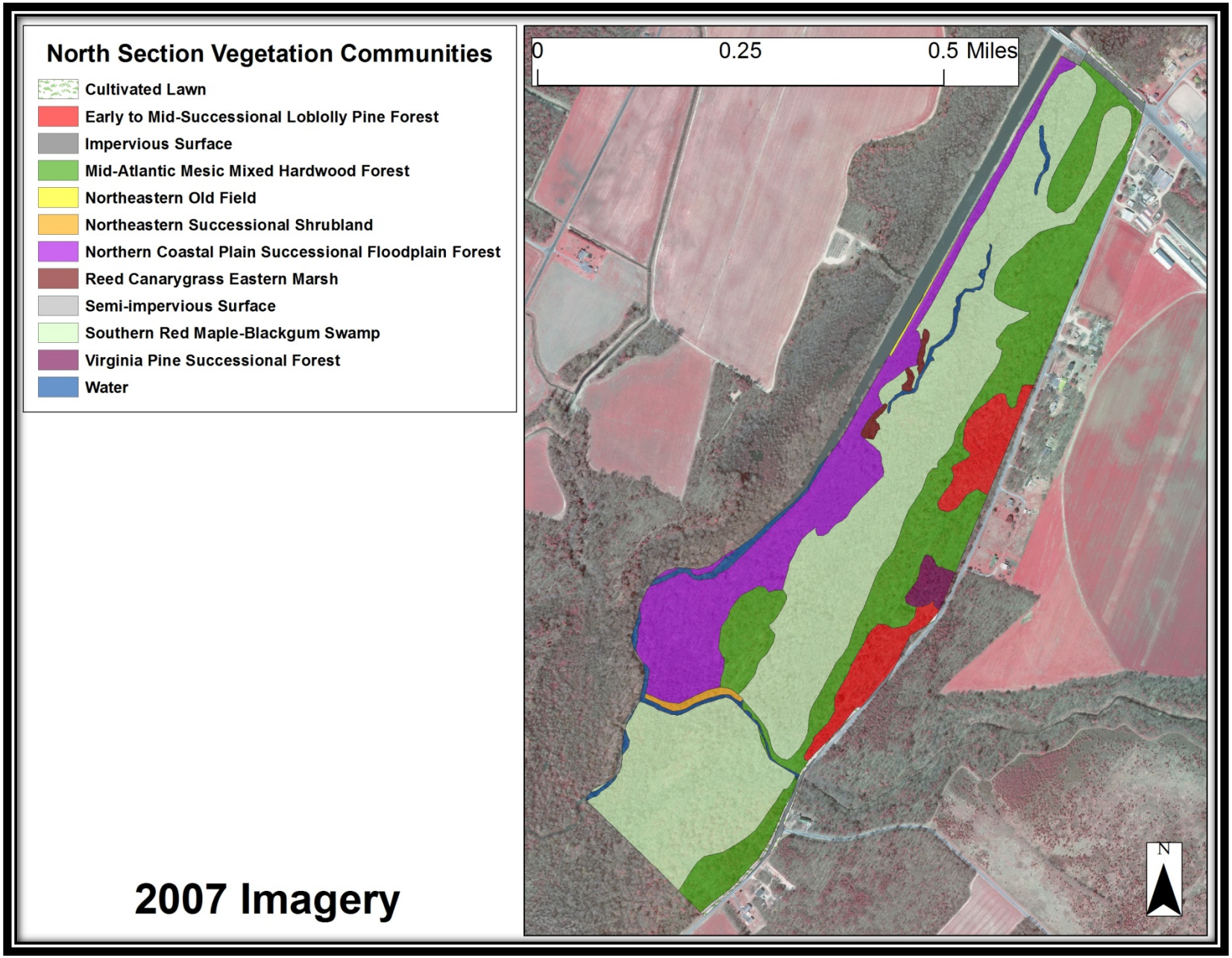


Figure 4-2.1. 2007 Vegetation Community Map of the North Section

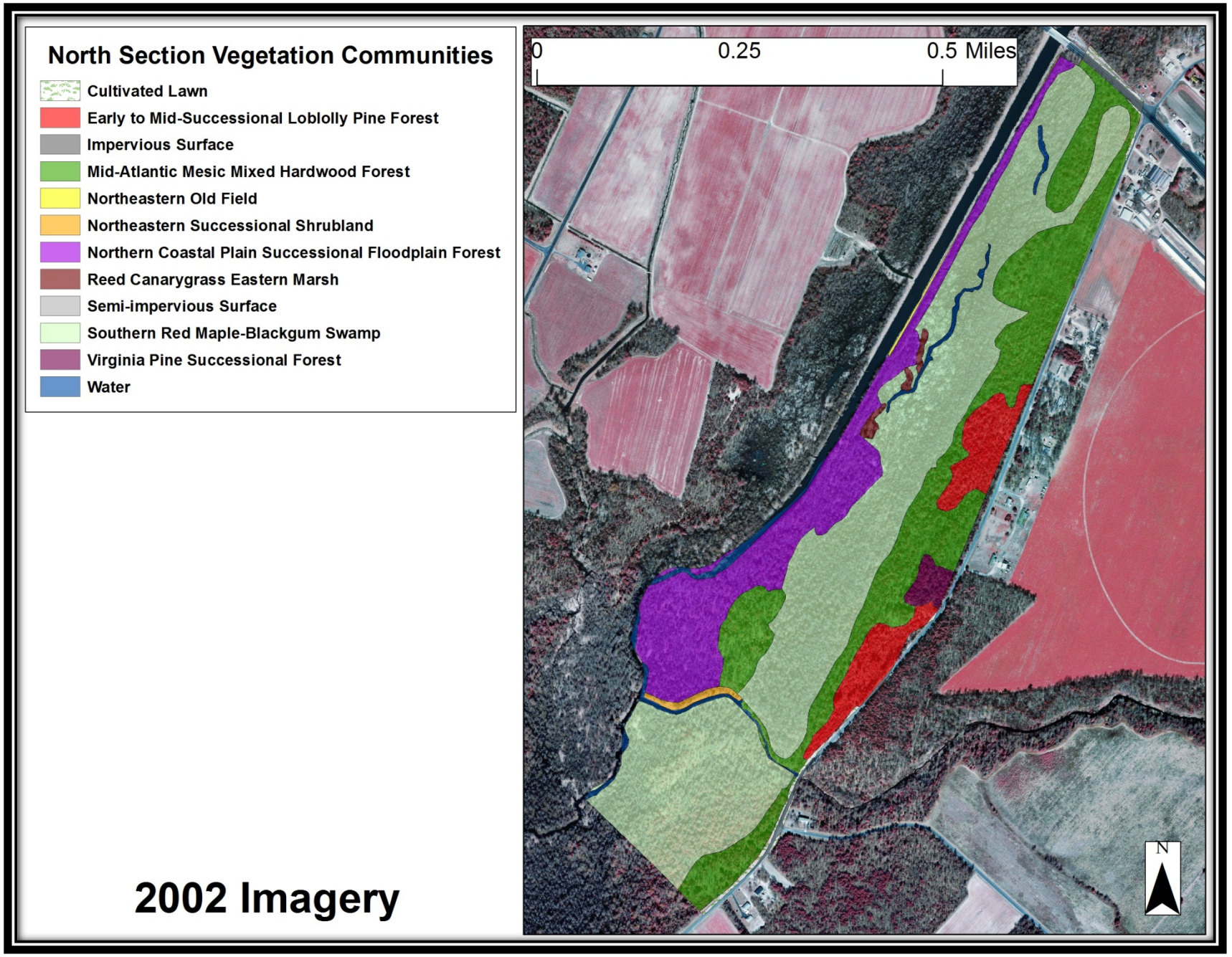


Figure 4-2.2. 2002 Vegetation Community Map of the North Section

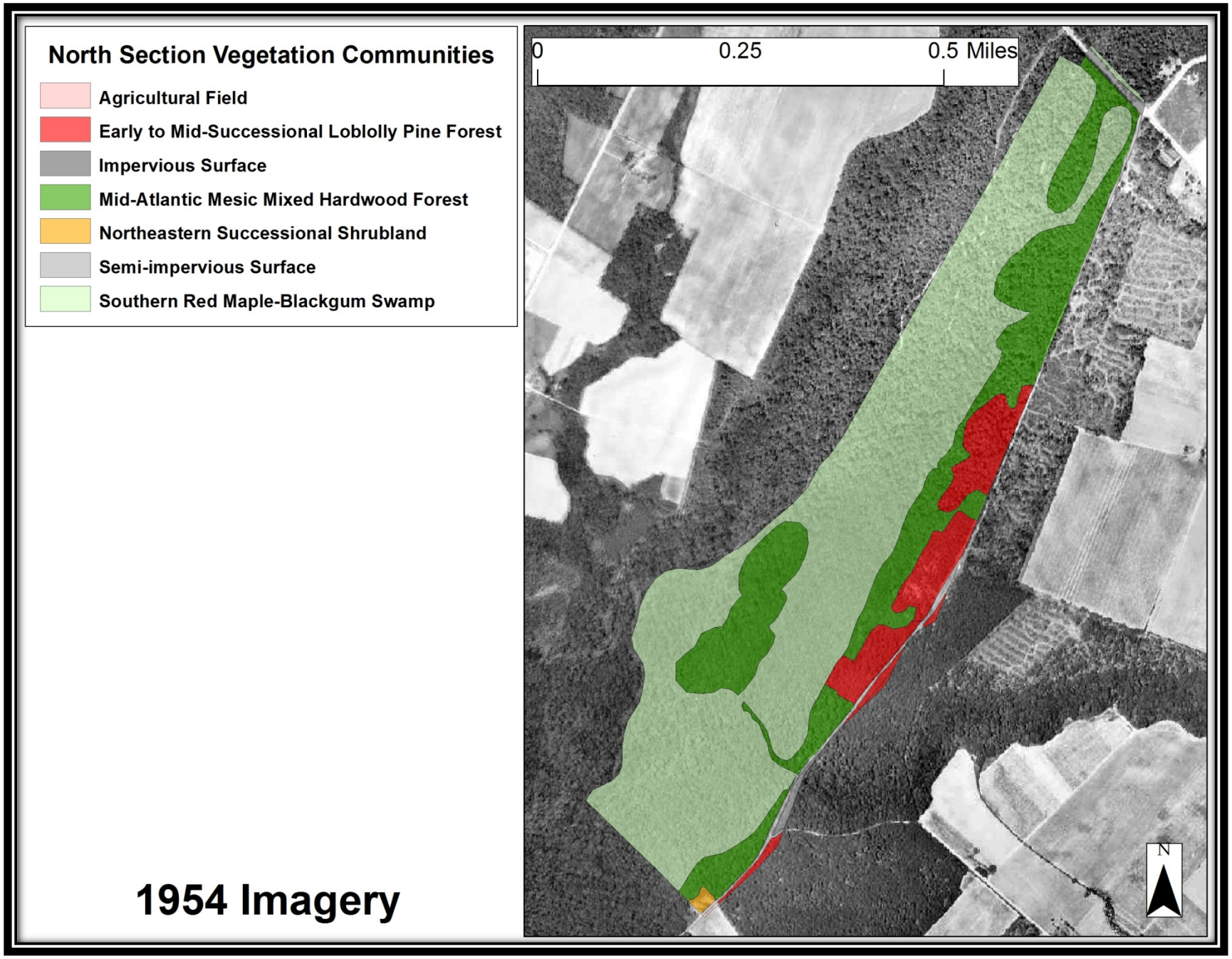


Figure 4-2.3. 1954 Vegetation Community Map of the North Section

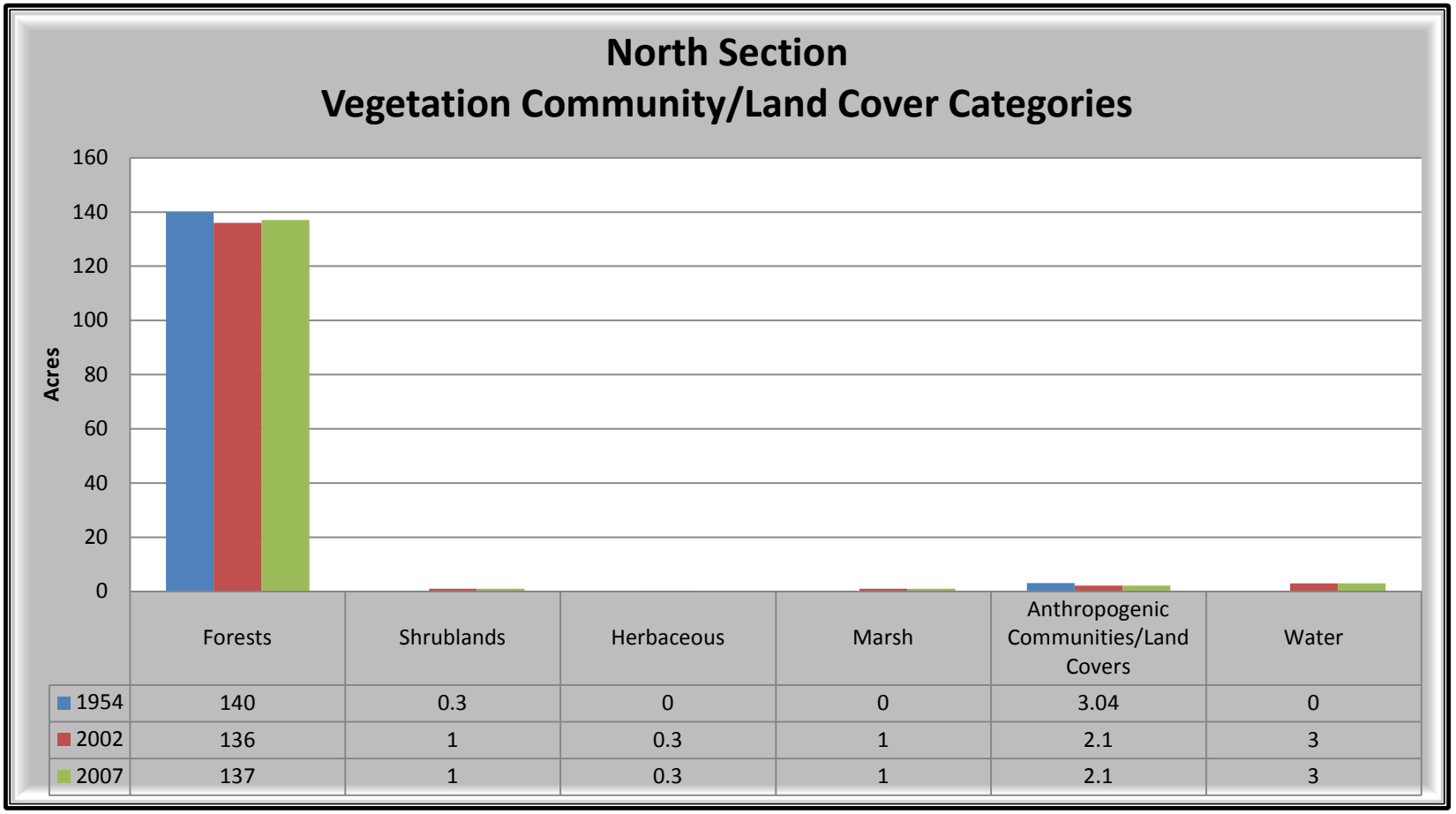


Figure 4-2.4. North Section Vegetation Categories/Land Covers (1954, 2002, and 2007)

North Section Broad Trends (Figure 4-2.4): Like the other sections, forest is the largest vegetation community type. Anthropogenic communities/land covers follow a distant second.

Natural Capital (Table 4-2.1)

Capital in the North Section has gradually increased since 1954 with the growth of more forest land.

Table 4-2.1. Natural Capital of the North Section	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,127,838/year
2002	$1,164,615/year
2007	$1,164,804/year

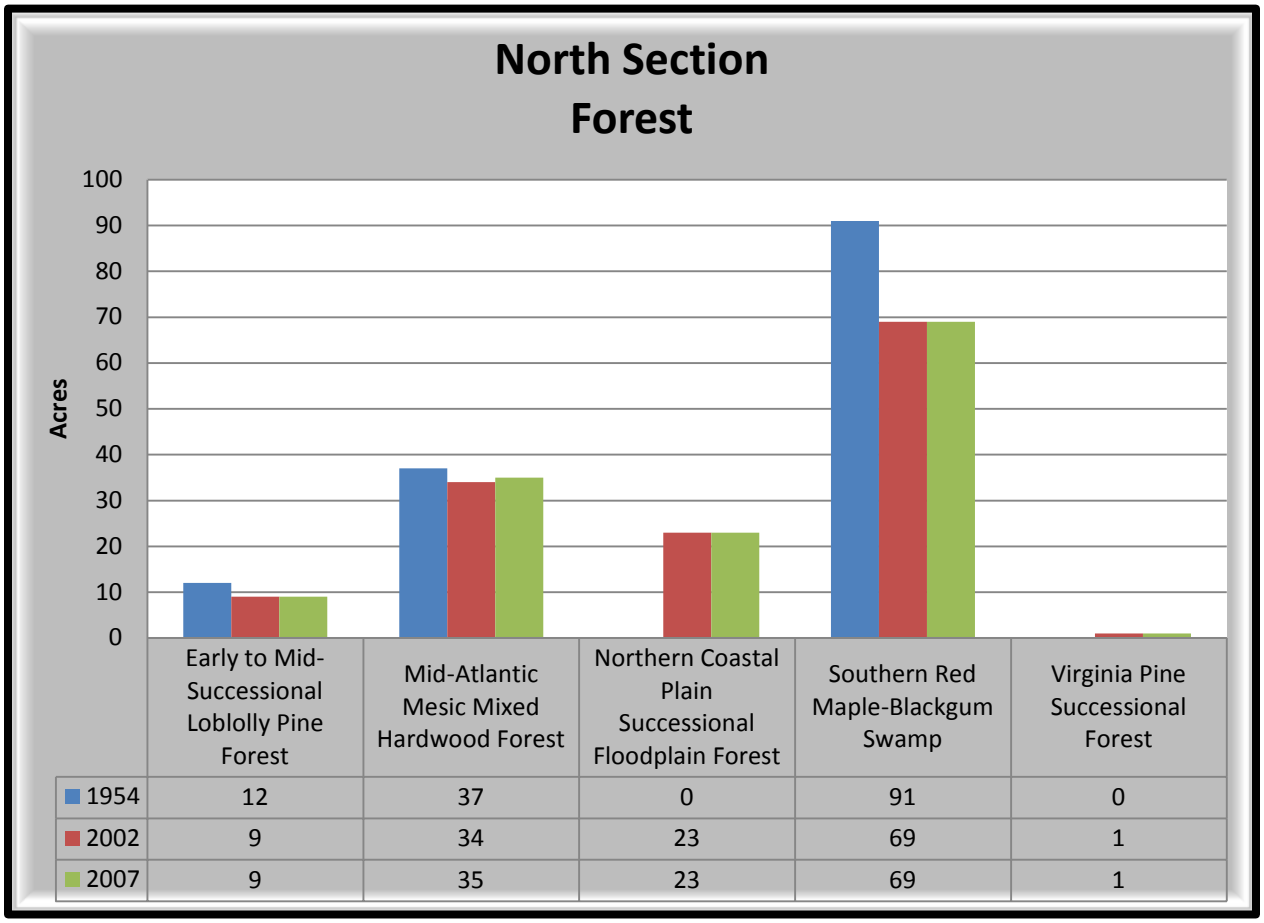


Figure 4-2.5. Forest in the North Section (1954, 2002, and 2007)

North Section Forest (Figure 4-2.5): Southern Red Maple-Blackgum Swamp is the largest forest community in the North Section. Its amount has decreased with the conversion to Northern Coastal Plain Successional Floodplain Forest.

Natural Capital (Table 4-2.2)

Capital of forest land has increased since 1954 with more areas maturing to forest.

Table 4-2.2. Natural Capital of North Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,127,792/year
2002	$1,139,138/year
2007	$1,139,328/year

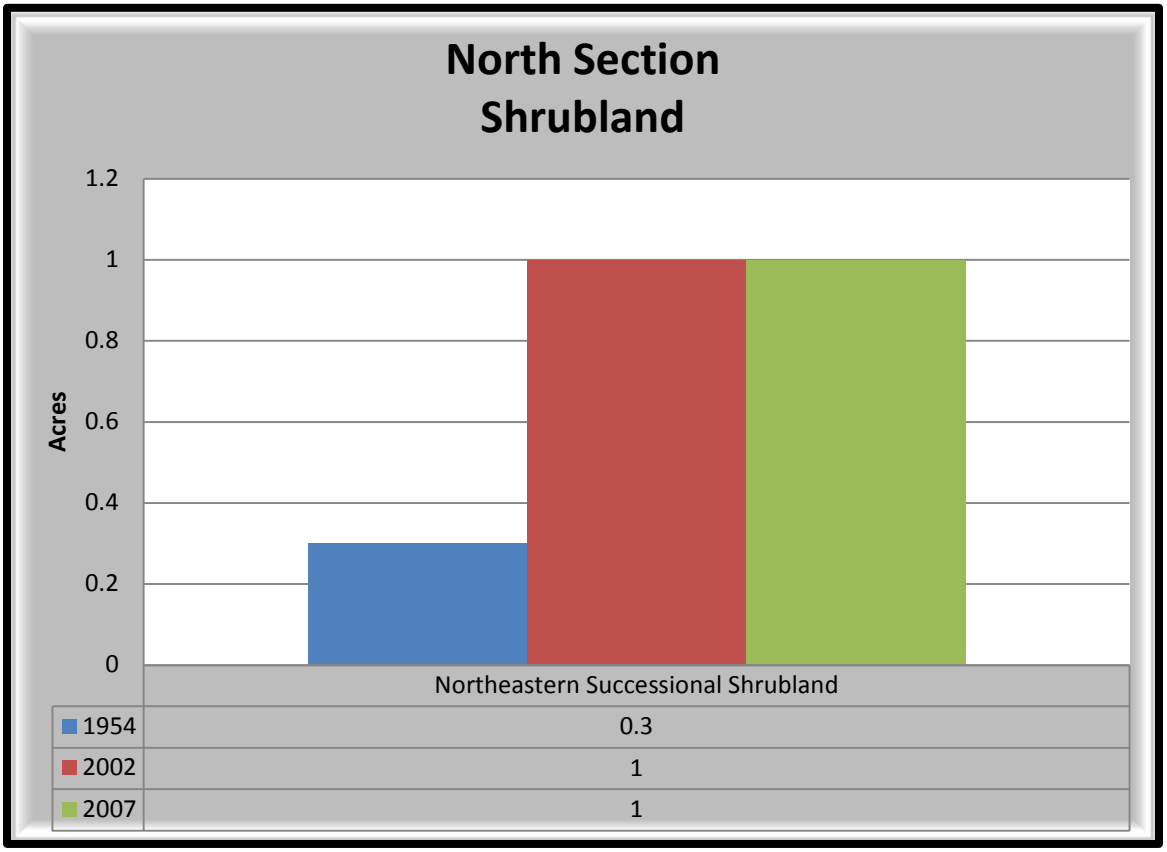


Figure 4-2.6. Shrubland in the North Section (1954, 2002, and 2007)

North Section Shrubland (Figure 4-2.6): Northeastern Successional Shrubland is the only shrubland in the North Section.

Natural Capital (Table 4-2.3)

Shrubland capital has increased with its acreage since 1954.

Table 4-2.3. Natural Capital of North Section Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$44/year
2002	$146/year
2007	$146/year

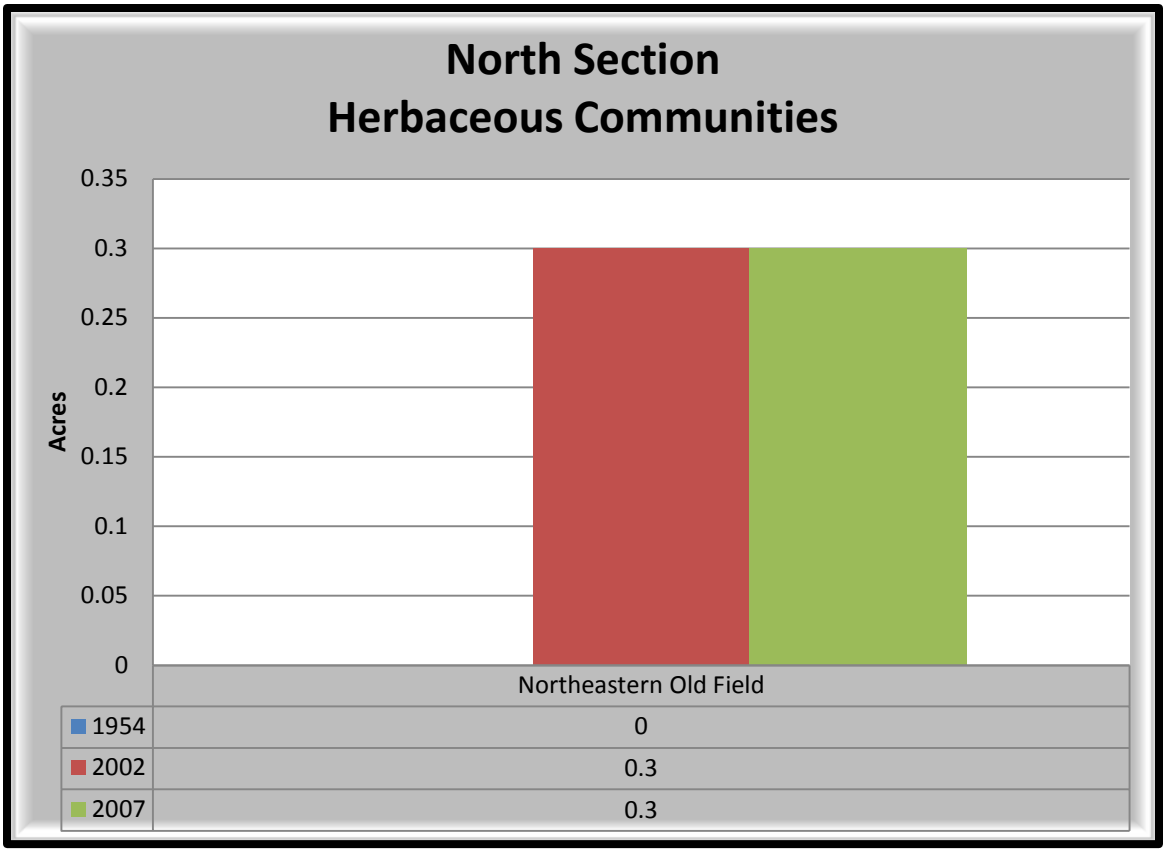


Figure 4-2.7. Herbaceous Communities in the North Section (1954, 2002, and 2007)

North Section Herbaceous Communities (Figure 4-2.7): Northeastern Old Field is the only herbaceous community in the North Section.

Natural Capital (Table 4-2.4)

Herbaceous communities were not present in 1954 and have since gained $44 in capital.

Table 4-2.4. Natural Capital of North Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$44/year
2007	$44/year

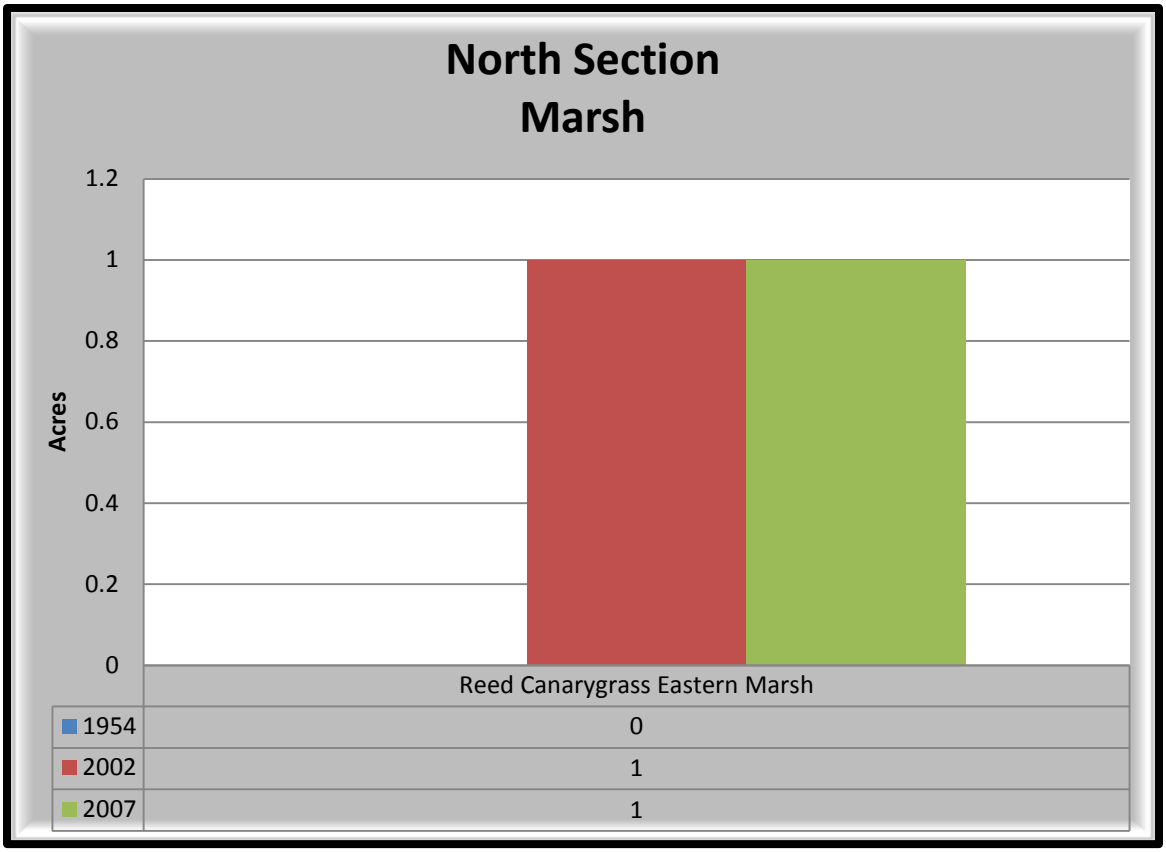


Figure 4-2.8. Marsh in the North Section (1954, 2002, and 2007)

North Section Marsh (Figure 4-2.8): Reed Canarygrass Eastern Marsh is the only marsh in the North Section. It has not gained or lost acreage since 2002.

Natural Capital (Table 4-2.5)

Marsh was not present in 1954 and has since gained $9,281 in capital.

Table 4-2.5. Natural Capital of North Section Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$9,281/year
2007	9,281/year

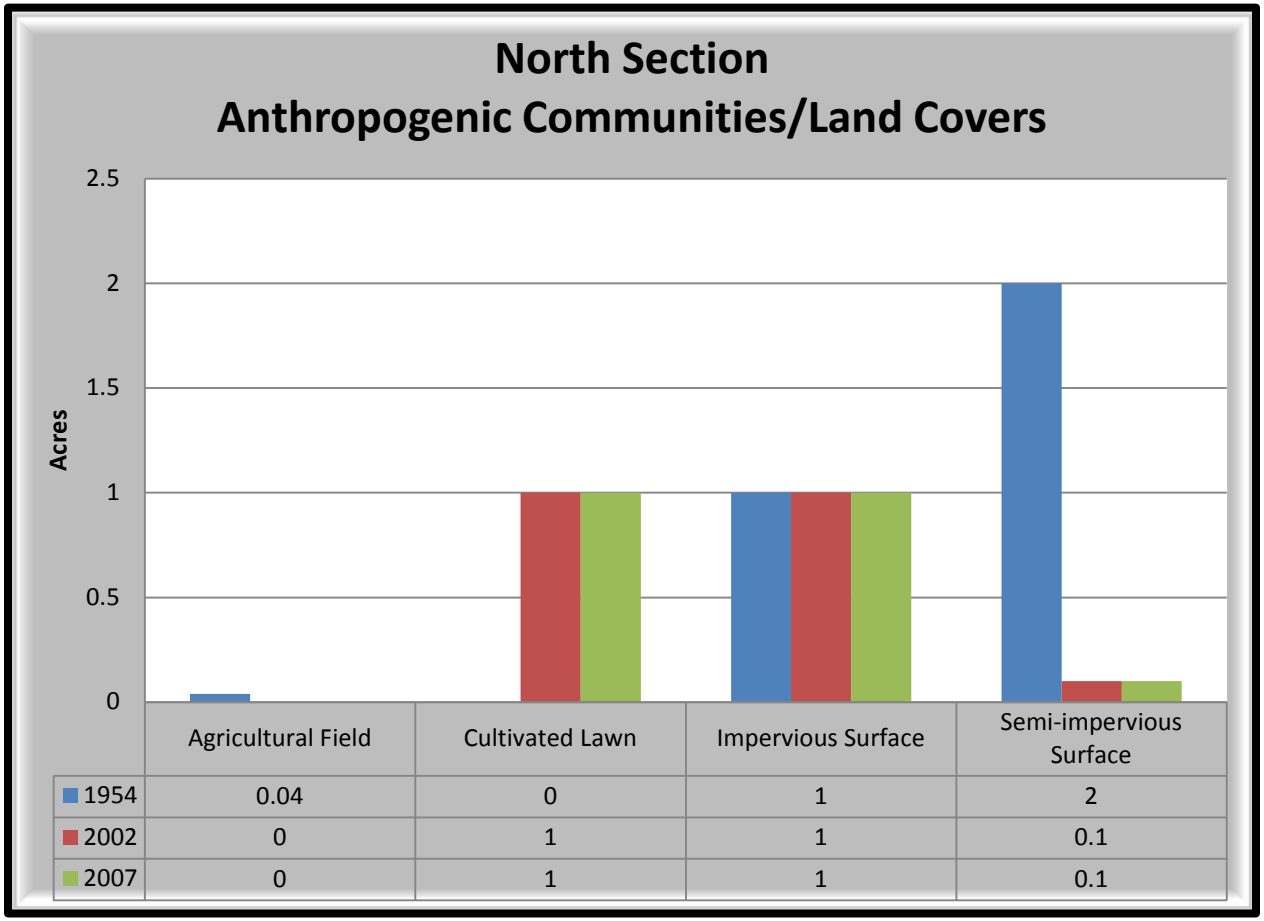


Figure 4-2.9. Anthropogenic Communities/Land Covers in the North Section (1954, 2002, and 2007)

North Section Anthropogenic Communities/Land Covers (Figure 4-2.9): Cultivated Lawn and Impervious Surface are tied at one acre each for the largest Anthropogenic Community/Land Cover in the North Section.

Natural Capital (Table 4-2.6)

Agricultural field was the only Anthropogenic Community/Land Cover with any capital in the North Section. It has since been abandoned and became an herbaceous community.

Table 4-2.6. Natural Capital of North Section Anthropogenic Communities/Land Covers

Year	Natural Capital (in 2012 dollars)
1954	$2/year
2002	$0/year (not present)
2007	$0/year (not present)

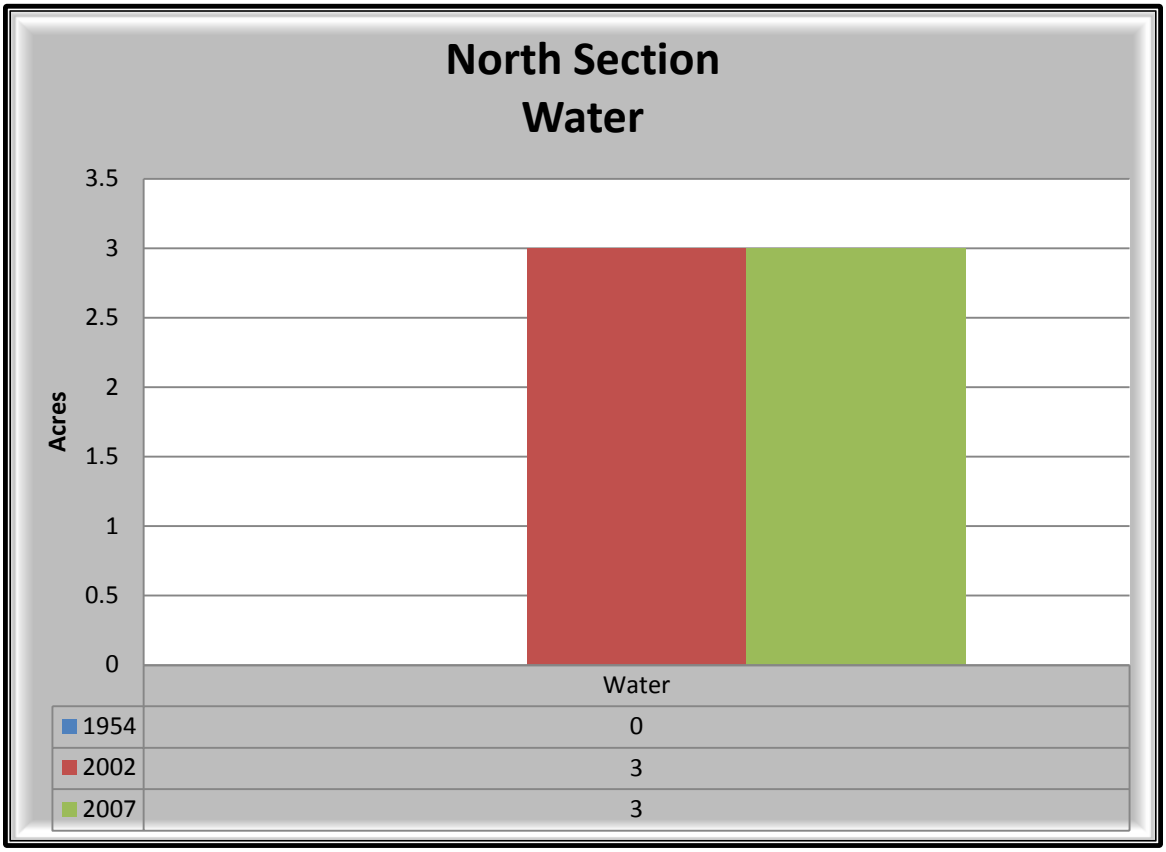


Figure 4-2.10. Water coverage in the North Section (1954, 2002, and 2007)

North Section Water (Figure 4-2.10): No water coverage was present in 1954. Since 1954, this land cover has covered three acres.

Natural Capital (Table 4-2.7)

Water in the North Section has acquired $16,005/year since 1954.

Table 4-2.7. Natural Capital of North Section Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$16,005/year
2007	$16,005/year

3. South Section

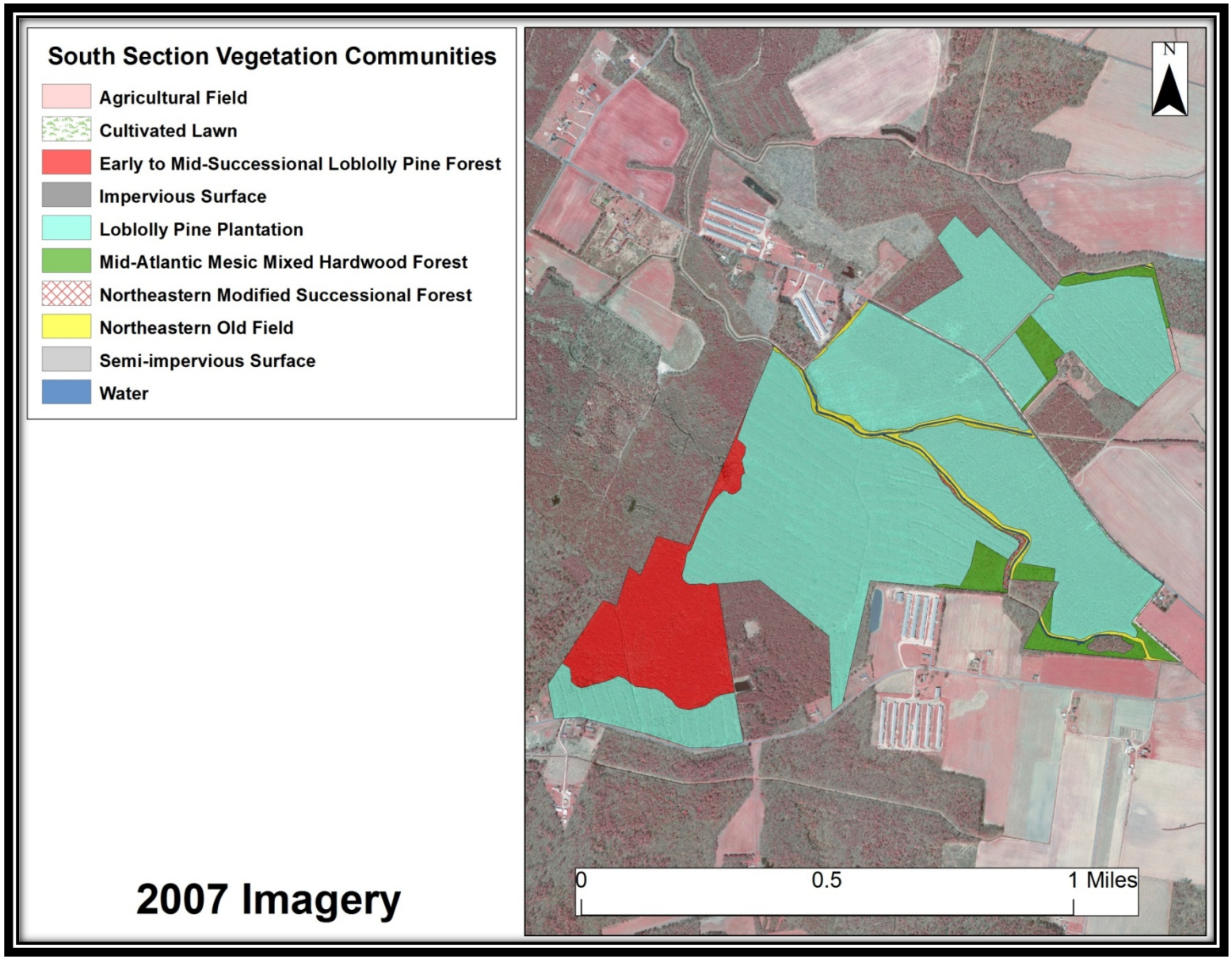


Figure 4-3.1. 2007 Vegetation Community Map of the South Section

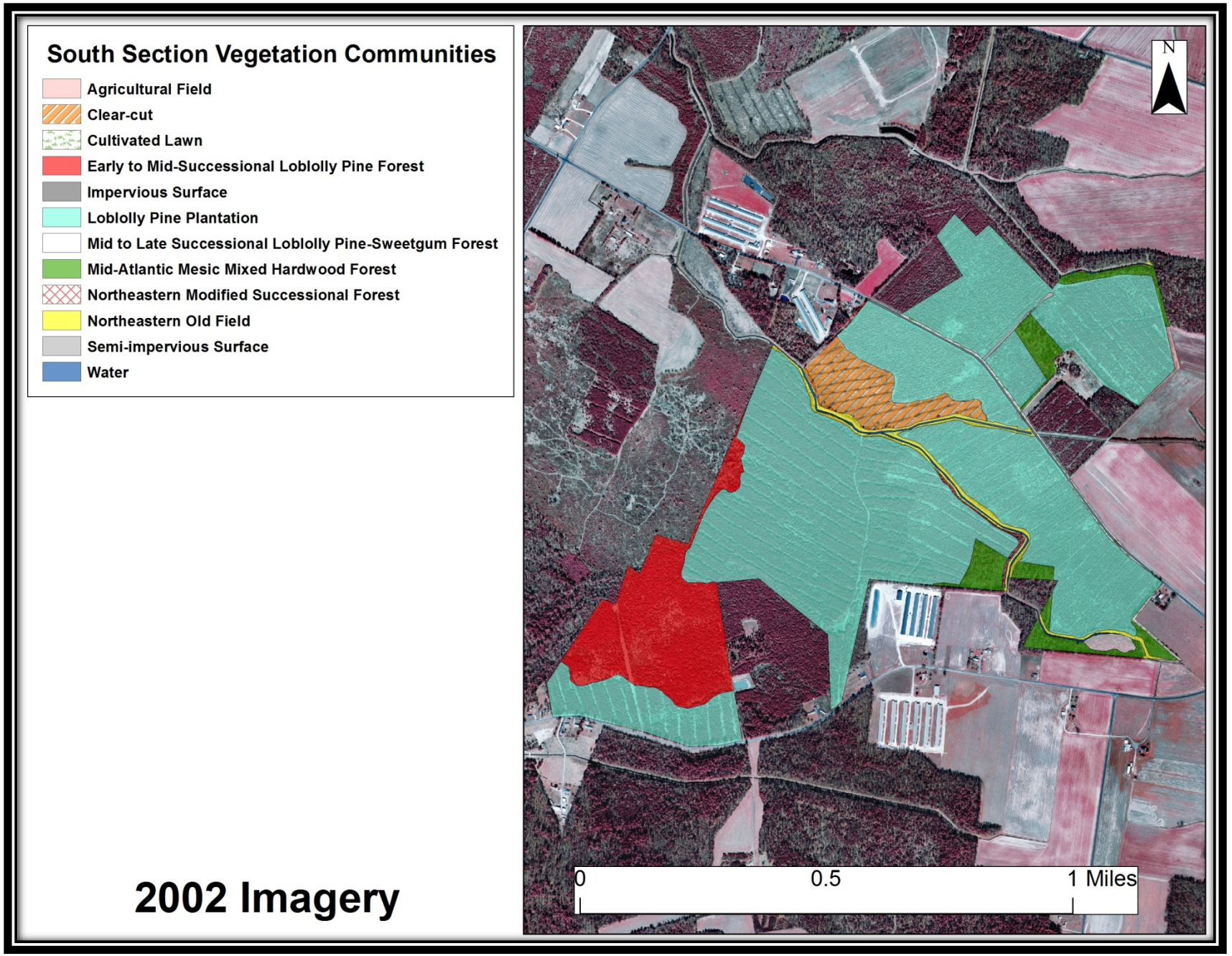


Figure 4-3.2. 2002 Vegetation Community Map of the South Section

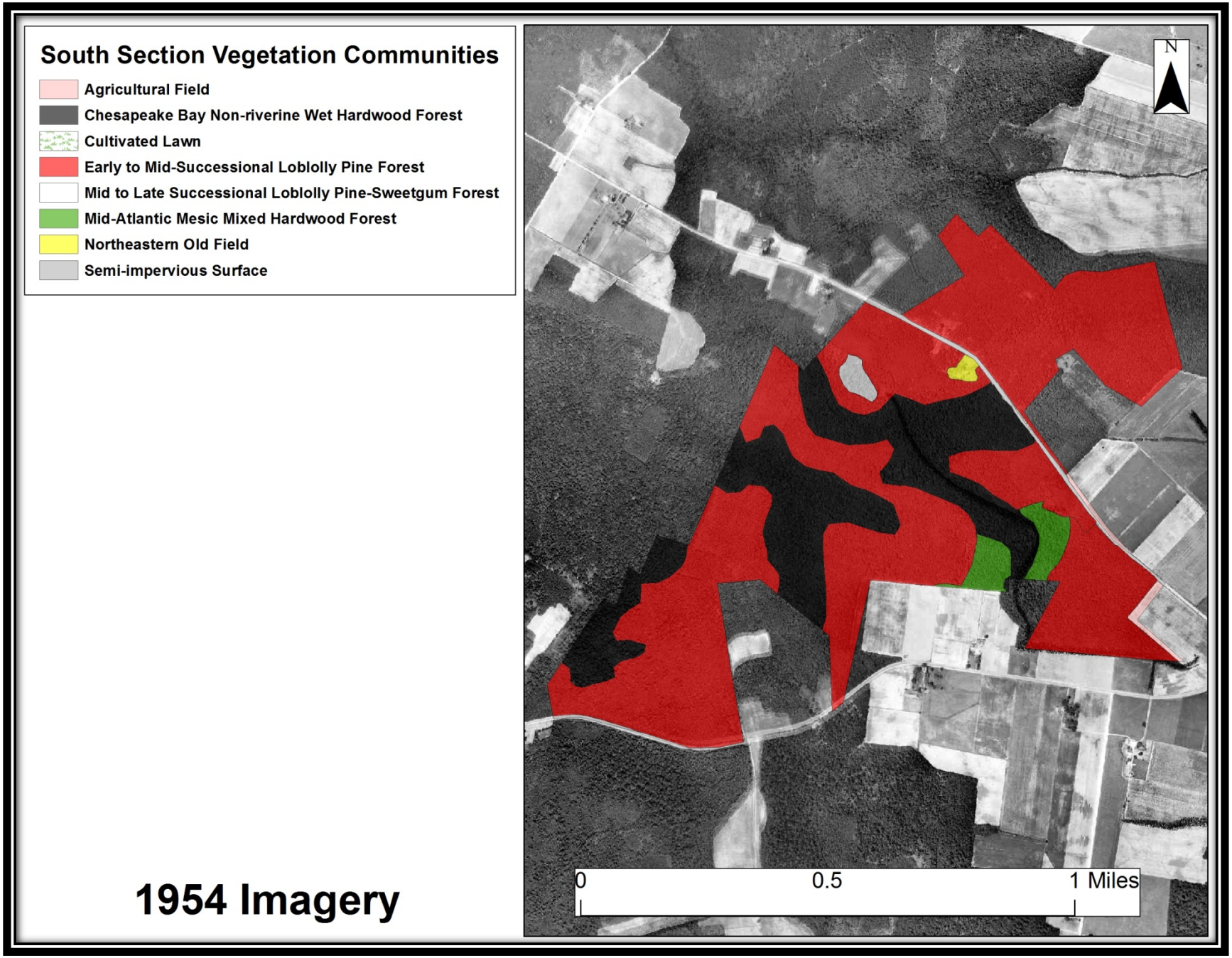


Figure 4-3.3. 1954 Vegetation Community Map of the South Section

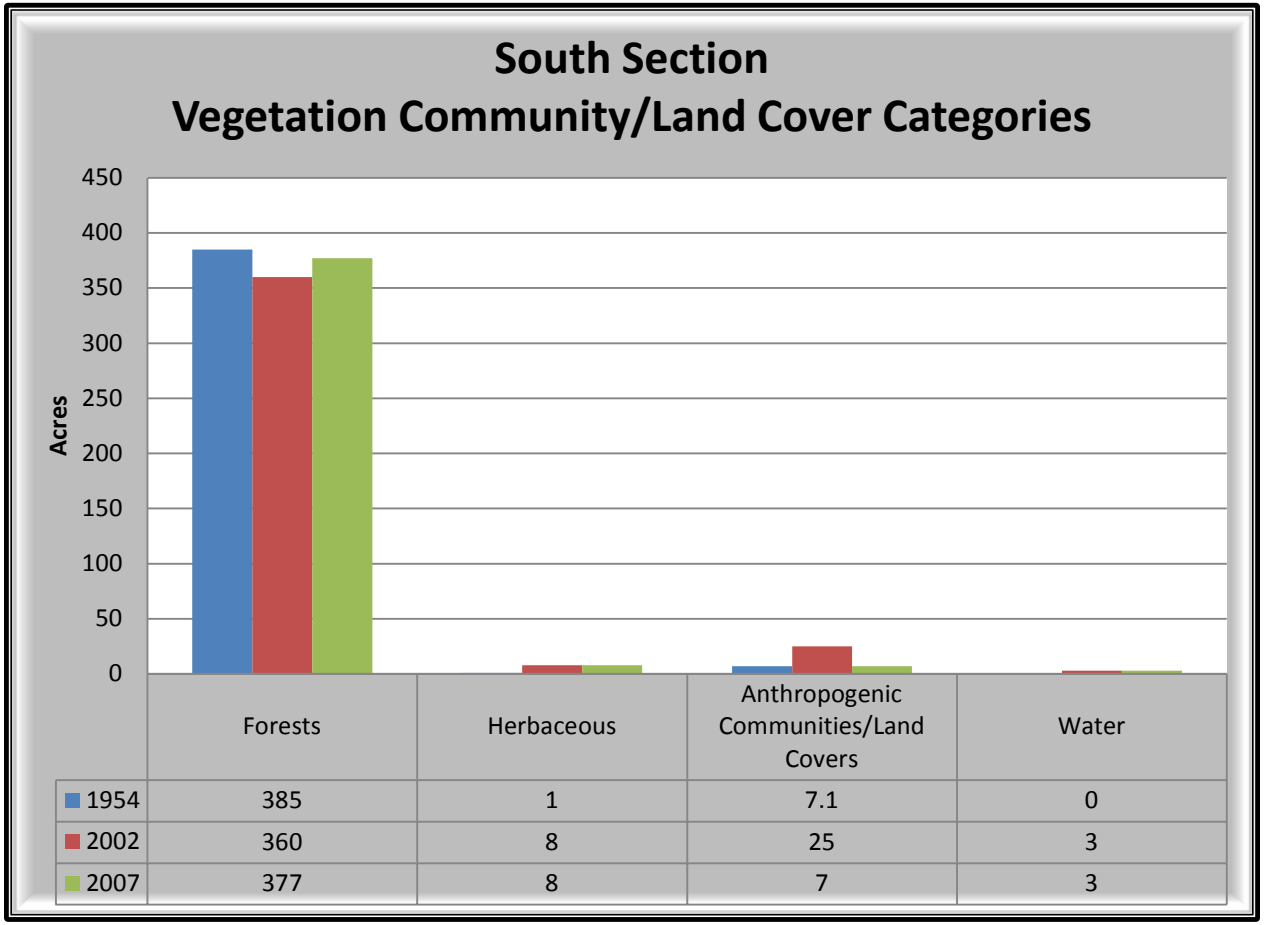


Figure 4-3.1. South Section Vegetation Categories/Land Covers (1954, 2002, and 2007)

South Section Broad Trends (Figure 4-3.1): Like the other sections, forest is the largest vegetation community type. Herbaceous Communities follow a distant second.

Natural Capital (Table 4-3.1)

Capital of the South Section has decreased greatly with the loss of a floodplain forest (Chesapeake Bay Non-riverine Wet Hardwood Forest) since 1954.

Table 4-3.1. Natural Capital of the South Section	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,259,156/year
2002	$85,304/year
2007	$88,519/year

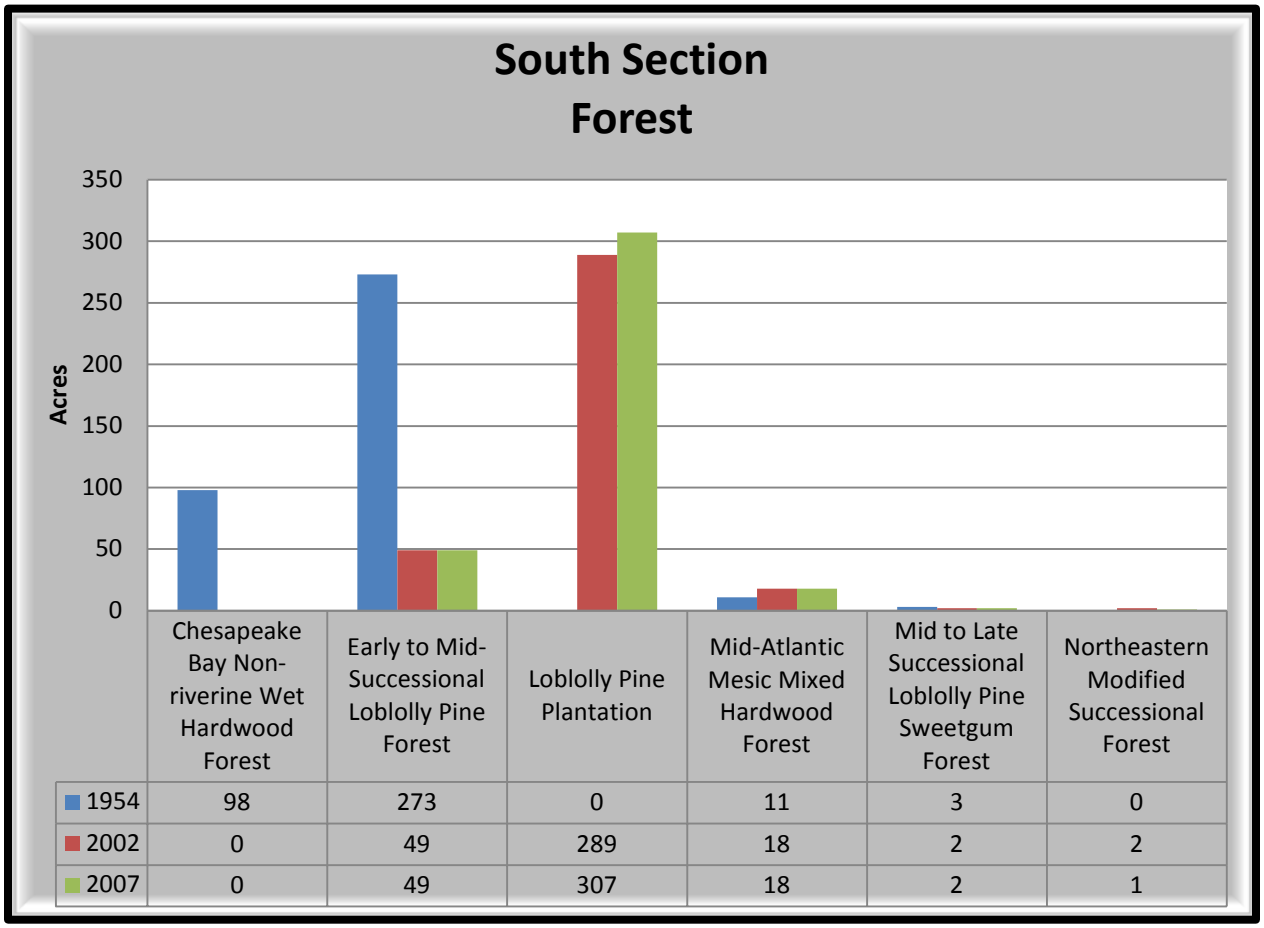


Figure 4-3.2. Forest in the South Section (1954, 2002, and 2007)

South Section Forest (Figure 4-3.2): Loblolly Pine Plantation is the largest forest community in the South Section, followed distantly by Mid-Atlantic Mesic Mixed Hardwood Forest.

Natural Capital (Table 4-3.2)

Capital of forest land has decreased in spite of the gains in overall forestland. The losses are from the conversion of a floodplain forest, which has great capital value, to Loblolly Pine Plantation, which has lesser value.

Table 4-3.2. Natural Capital of South Section Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,258,839/year
2002	$68,076/year
2007	$71,291/year

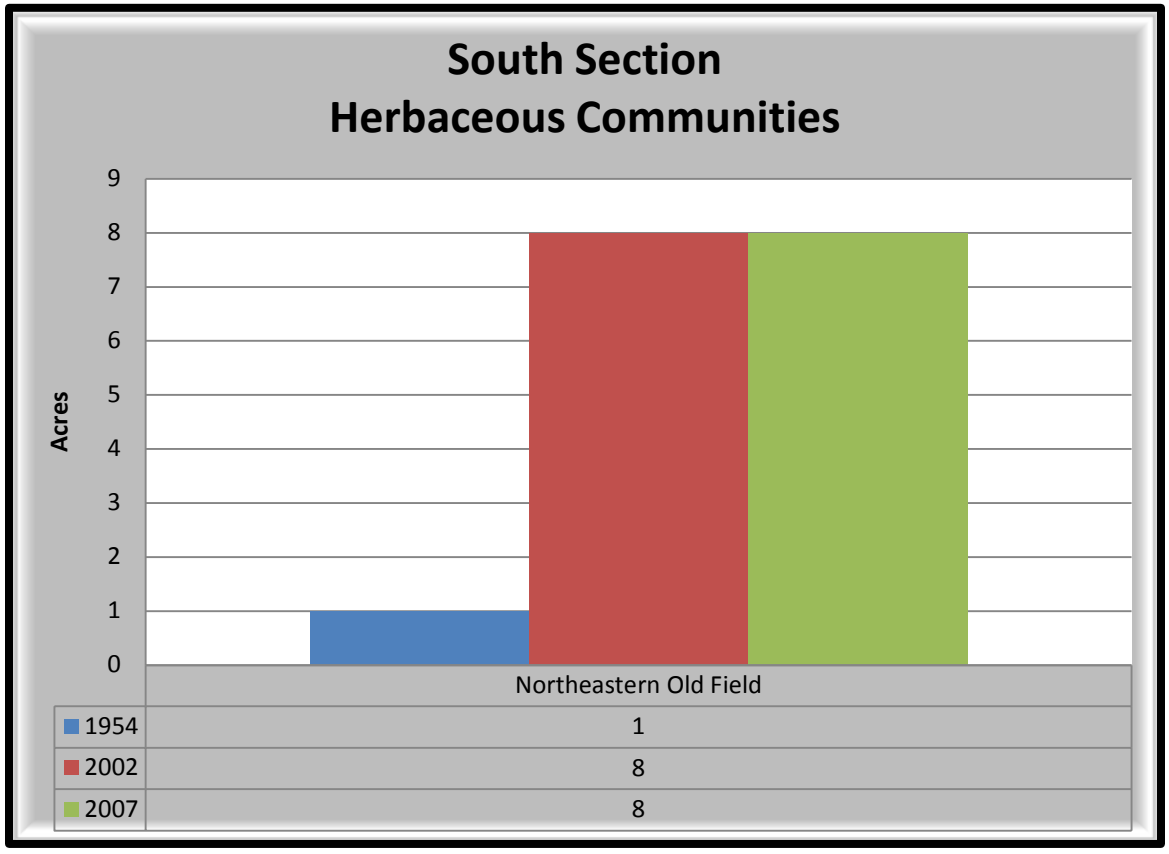


Figure 4-3.3. Herbaceous Communities in the North Section (1954, 2002, and 2007)

South Section Herbaceous Communities (Figure 4-3.3): Northeastern Old Field is the only herbaceous community in the South Section. Its amount has increased with the development of ditch areas and the abandonment of agricultural fields.

Natural Capital (Table 4-3.3)

Capital in herbaceous communities has increased since 1954.

Table 4-3.3. Natural Capital of South Section Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1954	$146/year
2002	$1,166/year
2007	$1,166/year

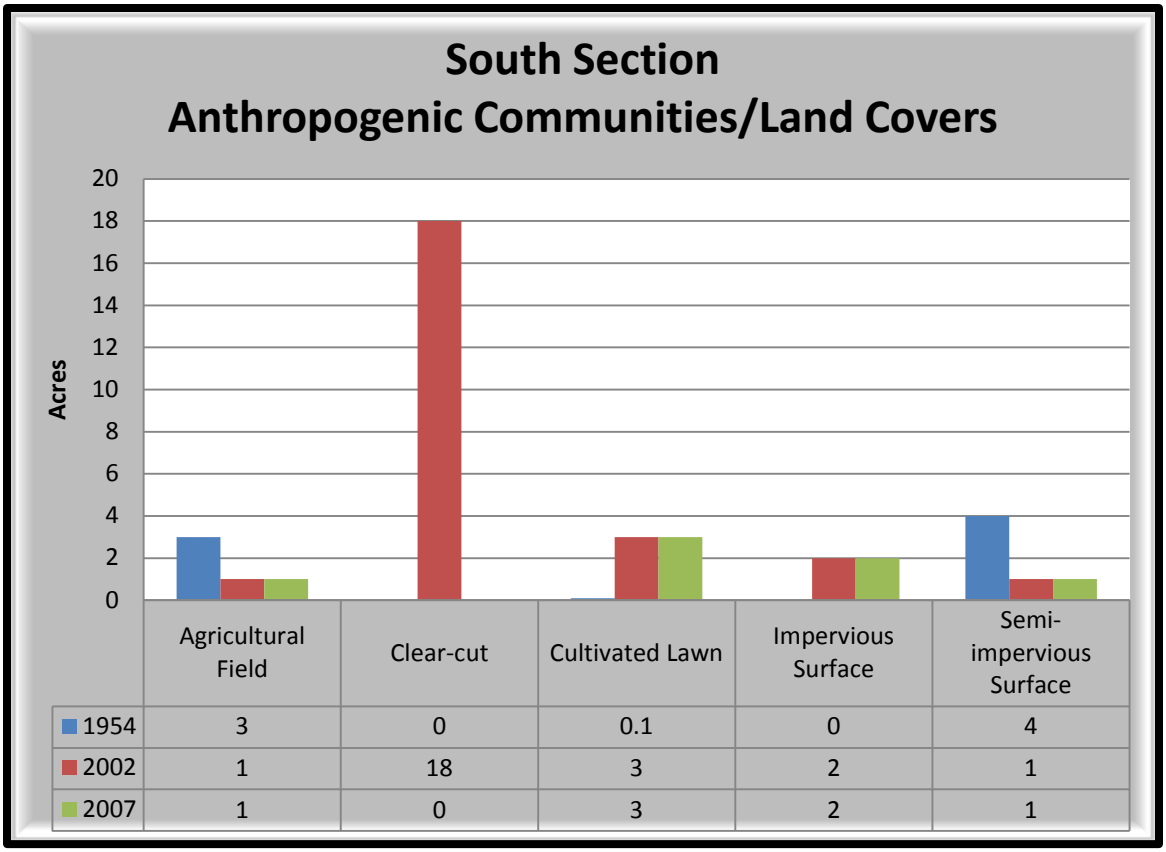


Figure 4-2.4. Anthropogenic Communities/Land Covers in the South Section (1954, 2002, and 2007)

South Section Anthropogenic Communities/Land Covers (Figure 4-3.4): Anthropogenic communities/land covers do not all that much of the South Section. Cultivated lawn that is located on roadsides is the largest community/land cover in this category.

Natural Capital (Table 4-3.4)

Agricultural field is the only Anthropogenic Community/Land Cover with natural capital in the South Section. It has decreased since 1954.

Table 4-2.4. Natural Capital of South Section Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1954	$172/year
2002	$57/year
2007	$57/year

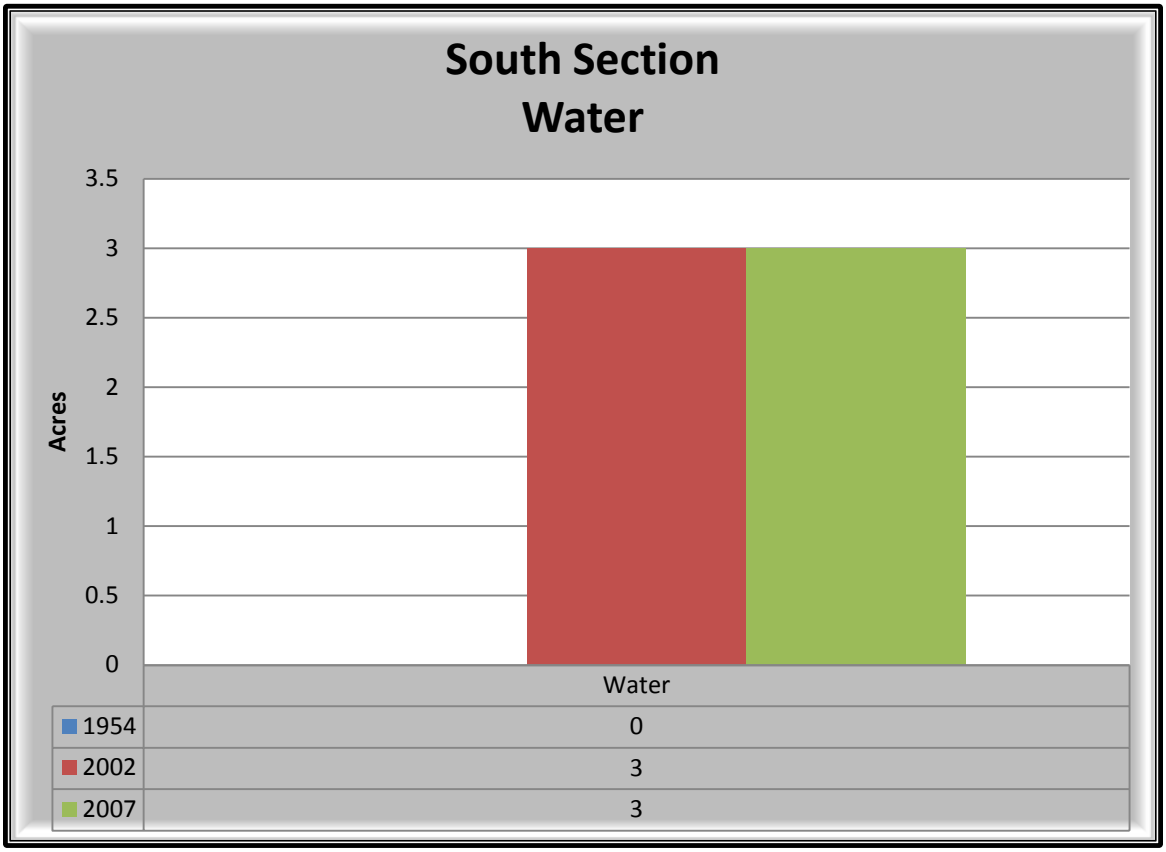


Figure 4-2.5. Water in the South Section (1954, 2002, and 2007)

South Section Water (Figure 4-2.5):

Natural Capital (Table 4-2.5)

Water was not present in 1954 and has since gained $16,005/year from a drainage ditch.

Table 4-2.5. Natural Capital of South Section Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$16,005/year
2007	$16,005/year

CHAPTER 5: DESCRIPTIONS AND ANALYSIS OF THE VEGETATION COMMUNITIES

Thirteen vegetation communities and six land covers were noted in the survey. 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. A crosswalk to the Delaware Wildlife Action Plan (DEWAP) and the Northeast Habitat Classification (NHC) is given at the top of each individual description.

The vegetation communities include:

1. Coastal Plain Oak Floodplain Swamp (CEGL006605)—1 acre
2. Cultivated Lawn (CEGL008462)--7 acres
3. Early to Mid-Successional Loblolly Pine Forest (CEGL006011)—307 acres
4. Loblolly Pine Plantation (CEGL007179)—486 acres
5. Mid to Late Successional Loblolly Pine Sweetgum Forest (CEGL008462)—2 acres
6. Mid-Atlantic Mesic Mixed Hardwood Forest (CEGL006075)—96 acres
7. Northeastern Modified Successional Forest (CEGL006599)—1 acre
8. Northeastern Old Field (CEGL006107)—11 acres
9. Northeastern Successional Shrubland (CEGL006451)—1 acre
10. Northern Coastal Plain Successional Floodplain Forest (CEGL006976)—23 acres
11. Reed Canarygrass Eastern Marsh (CEGL006044)—1 acre
12. Southern Red Maple-Blackgum Swamp (CEGL006238)—111 acres
13. Virginia Pine Successional Forest (CEGL002591)—1 acre

Historical Vegetation Communities (1954 or 2002)

1. Chesapeake Bay Non-riverine Wet Hardwood Forest (CEGL004644)—98 acres (1954)

The land covers include:

1. Agricultural Field—2 acres
2. Farm Pond/Artificial Pond—0.3 acres
3. Impervious Surface—7 acres
4. Modified Land—2 acres
5. Semi-impervious Surface—2 acres
6. Water—9 acres

Chesapeake Bay Non-riverine Wet Hardwood Forest **[0 acres (Figure 5.1, Tables 5.1-)] GNA SNA**

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

Description

This swamp community is no longer present in the wildlife area and has been replaced by other forests. Typical this forest community is found on flat areas, with moist or saturated soil. The canopy is typically dominated or co-dominated by red maple (*Acer rubrum*) or sweetgum (*Liquidambar styraciflua*) and associated by willow oak (*Quercus phellos*), white oak (*Quercus alba*), swamp chestnut oak (*Quercus michauxii*), pin oak (*Quercus palustris*), loblolly pine (*Pinus taeda*), and blackgum (*Nyssa sylvatica*). The understory is often composed of American holly (*Ilex opaca*), sweetbay (*Magnolia virginiana*), and smaller members of the canopy. Shrubs typically include highbush blueberry (*Vaccinium corymbosum*), arrowwood (*Viburnum dentatum*), and sweet pepperbush (*Clethra alnifolia*). Common herbs include netted chain fern (*Woodwardia areolata*), cinnamon fern (*Osmunda cinnamomea*), royal fern (*Osmunda regalis*). Higher places may include speargrass (*Chasmanthium laxum*), bladder sedge (*Carex intumescens*), and weak stellate sedge (*Carex seorsa*).

Analysis of Condition at Marshyhope Wildlife Area

Chesapeake Bay Non-riverine Wet Hardwood Forest is no longer present in the wildlife area and has been replaced by 70 acres of Loblolly Pine Plantation, 18 acres of Early to Mid-Successional Loblolly Pine Forest, 6 acres of Northeastern Old Field, 2 acres of water, and 1 acre of Northeastern Modified Successional Forest (Table 5.1).

Table 5.1. What was Chesapeake Bay Non-riverine Wet Hardwood Forest in 1954 has become X in 2007

X	**Acreage**
Loblolly Pine Plantation	70 acres
Early to Mid-Successional Loblolly Pine Forest	18 acres
Northeastern Old Field	6 acres
Water	2 acres
Northeastern Modified Successional Forest	1 acre
Other communities/land covers	1 acre

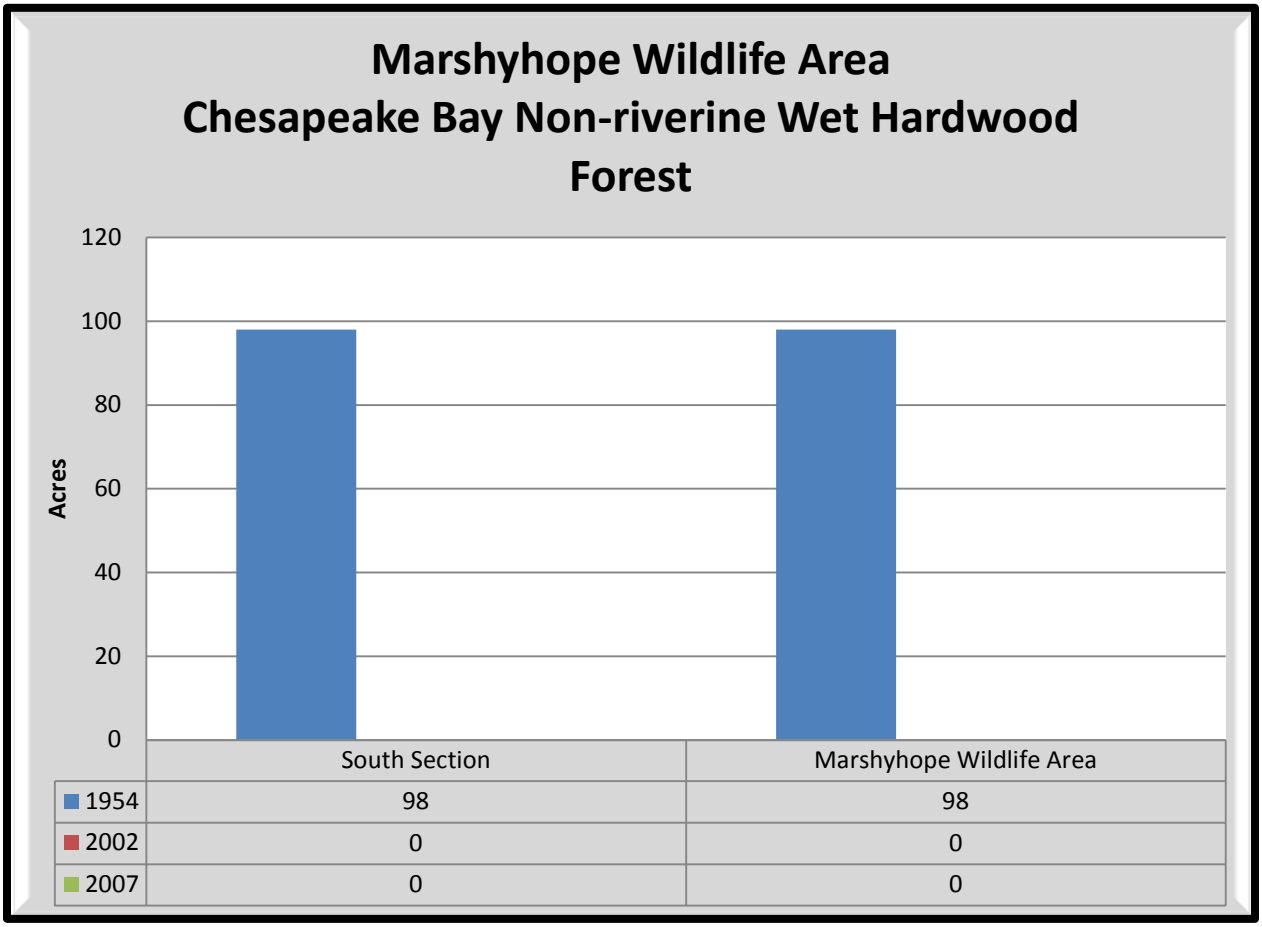


Figure 5.1. Chesapeake Bay Non-riverine Wet Hardwood Forest at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.2)

The capital of Chesapeake Bay Non-riverine Wet Hardwood Forest has been transferred to other forest communities and uses since 1954.

Table 5.2. Natural Capital of Chesapeake Bay Non-riverine Wet Hardwood Forest

Year	Natural Capital (in 2012 dollars)
1954	$1,204,567/year
2002	$0/year (not present)
2007	$0/year (not present)

Coastal Plain Oak Floodplain Swamp **[1 acre (Figure 5.2, Table 5.3)]** **GNR S2**

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

Description

This community is located in the floodplain of Marshyhope Creek. It is dominated by a number of wetland oak species including swamp chestnut oak (*Quercus michauxii*), swamp white oak (*Quercus bicolor*) and associated by blackgum (*Nyssa sylvatica*), northern red oak (*Quercus rubra*), and green ash (*Fraxinus pensylvanica*). Understory species include red maple (*Acer rubrum*), sweetbay (*Magnolia virginiana*), American holly (*Ilex opaca*), American hornbeam (*Carpinus caroliniana*), and a few water oak (*Quercus nigra*) and river birch (*Betula nigra*). The shrub and vine layer is composed of sweet pepperbush (*Clethra alnifolia*), highbush blueberry (*Vaccinium corymbosum*), strawberry-bush (*Euonymus americanus*), and pinxter-flower (*Rhododendron periclymenoides*). Common herbs include cinnamon fern (*Osmunda cinnamomea*), skunk cabbage (*Symplocarpus foetidus*), netted chainfern (*Woodwardia areolata*), Jack-in-the-pulpit (*Arisaema triphyllum*), sessile bellwort (*Uvularia sessilifolia*), wild yam (*Dioscorea villosa*), sallow sedge (*Carex lurida*), wetland blue violet (*Viola cucullata*), lizard's tail (*Saururus cernuus*), Virginia chainfern (*Woodwardia virginica*), royal fern (*Osmunda regalis*), and Turk's cap lily (*Lilium superbum*).

All of the occurrences in the wildlife are in the late successional to mature state with diameters ranging from 1 foot to 2 feet.

Analysis of Condition at Marshyhope Wildlife Area

All of the Coastal Plain Oak Floodplain Swamp currently present in the wildlife area came from Southern Red Maple-Blackgum Swamp that was present in 1954.

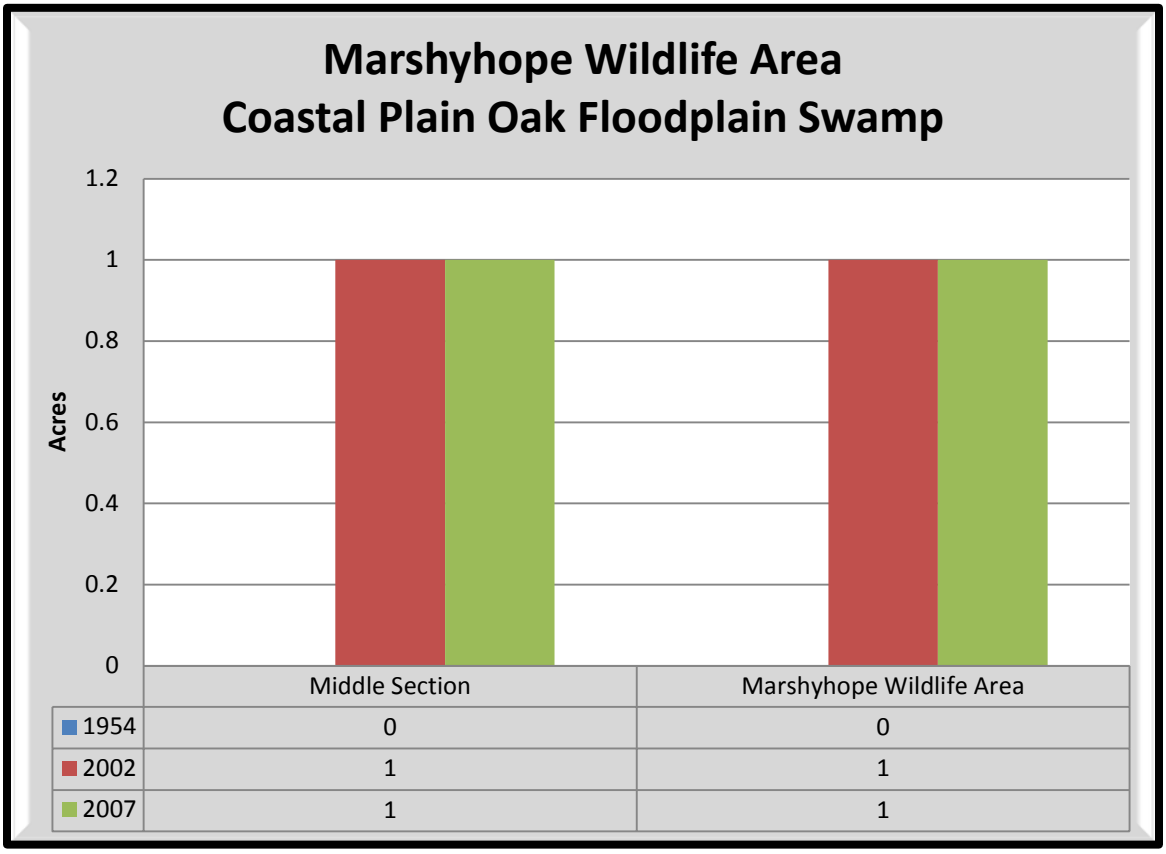


Figure 5.2. Coastal Plain Oak Floodplain Swamp at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.3)

Coastal Plain Oak Floodplain Swamp was not present in 1954 and has since transferred $12,292 in capital from Southern Red Maple-Blackgum Swamp.

Table 5.3. Natural Capital of Coastal Plain Oak Floodplain Swamp

Year	Natural Capital (in 2012 dollars)
1954	$0/year (not present)
2002	$12,292/year
2007	$12,292/year

Cultivated Lawn **[1 acre (Figure 5.3, Tables 5.4-5.5)] GNA SNA**

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

Description

Cultivated lawn is found on roadsides in the wildlife area. Tall fescue (*Festuca arundinacea*) is the main species found this community along with other weedy species. This community is distinguished from the Northeastern Old Field in that Cultivated Lawn is mowed more than once per year.

Analysis of Condition at Marshyhope Wildlife Area

About half of the cultivated lawn that existed in 1954 was still present in 2007. The rest of the lawns had become 0.1 acres of Loblolly Pine Plantation (Table 5.4). Since 1954, cultivated lawn has been developed in 3 acres of Early to Mid-Successional Loblolly Pine Forest, 2 acres of Agricultural Field, 2 acres of Semi-impervious Surface, 0.2 acres of Southern Red Maple-Blackgum Swamp, and 0.1 acres of Northeastern Successional Shrubland (Table 5.5).

Table 5.4. What was Cultivated Lawn in 1954 has become X in 2007

X	**Acreage**
Cultivated Lawn	0.1 acres
Loblolly Pine Plantation	0.1 acres

Table 5.5. Cultivated Lawn has migrated into X since 1954

X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	3 acres
Agricultural Field	2 acres
Semi-impervious Surface	2 acres
Southern Red Maple-Blackgum Swamp	0.2 acres
Northeastern Successional Shrubland	0.1 acres
Other communities/land covers	0.2 acres

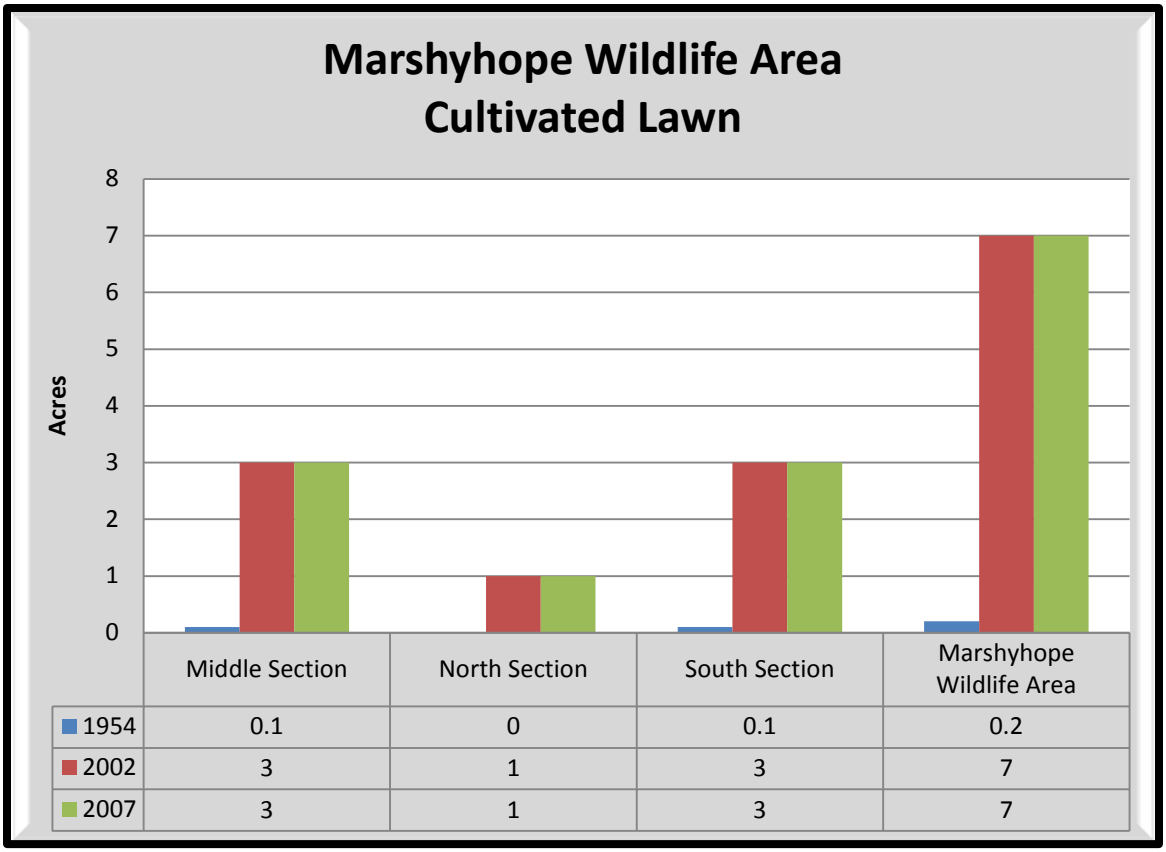


Figure 5.3. Cultivated Lawn at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital

Cultivated Lawn does not have any natural capital value.

Early to Mid-Successional Loblolly Pine Forest **[307 acres (Figures 5.4-5.5, Tables 5.6-5.8)] GNA SNA**

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

Description

Early to Mid-Successional Loblolly Pine Forest by definition contains only loblolly pine (*Pinus taeda*) or a few Virginia pine (*Pinus virginiana*) in the canopy. The understory is composed of water oak (*Quercus nigra*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), flowering dogwood (*Cornus florida*), and southern red oak (*Quercus falcata*). Common greenbrier (*Smilax rotundifolia*), creeping raspberry (*Rubus hispidus*), lowbush blueberry (*Vaccinium pallidum*), and white-leaf greenbrier (*Smilax glauca*) are found in the shrub and vine layer. Herbs include bracken fern (*Pteridium aquilinium*), wintergreen (*Gaultheria procumbens*), pink lady's slipper (*Cypripedium acaule*), and spotted wintergreen (*Chimaphila maculata*).

Figure 5.4. Early to Mid-Successional Loblolly Pine Forest (Middle Section)

Analysis of Condition at Marshyhope Wildlife Area

Early to Mid-Successional Loblolly Pine Forest has declined since 1954 as this community matures to more mature forest communities and is converted to Loblolly Pine Plantations. Only 260 acres of the 689 acres that were present in 1954 were still present in 2007. The rest of the acreage had become 393 acres of Loblolly Pine Plantation, 19 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, 3 acres of cultivated lawn, and 3 acres of impervious surface (Table 5.6). Since 1954, 29 acres agricultural field, 18 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 1 acre of Mid-Atlantic Mesic Mixed Hardwood Forest, and 1 acre of Northeastern Successional Shrubland has become Early to Mid-Successional Loblolly Pine Forest (Table 5.7).

Table 5.6. What was Early to Mid-Successional Loblolly Pine Forest in 1954 has become X in 2007	
X	**Acreage**
Loblolly Pine Plantation	393 acres
Early to Mid-Successional Loblolly Pine Forest	260 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	19 acres
Cultivated Lawn	3 acres
Impervious Surface	3 acres
Other communities/land covers	12 acres

Table 5.7. Early to Mid-Successional Loblolly Pine Forest has migrated into X since 1954	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	260 acres
Agricultural Field	29 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	18 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	1 acre
Northeastern Successional Shrubland	1 acre
Other communities/land covers	1 acre

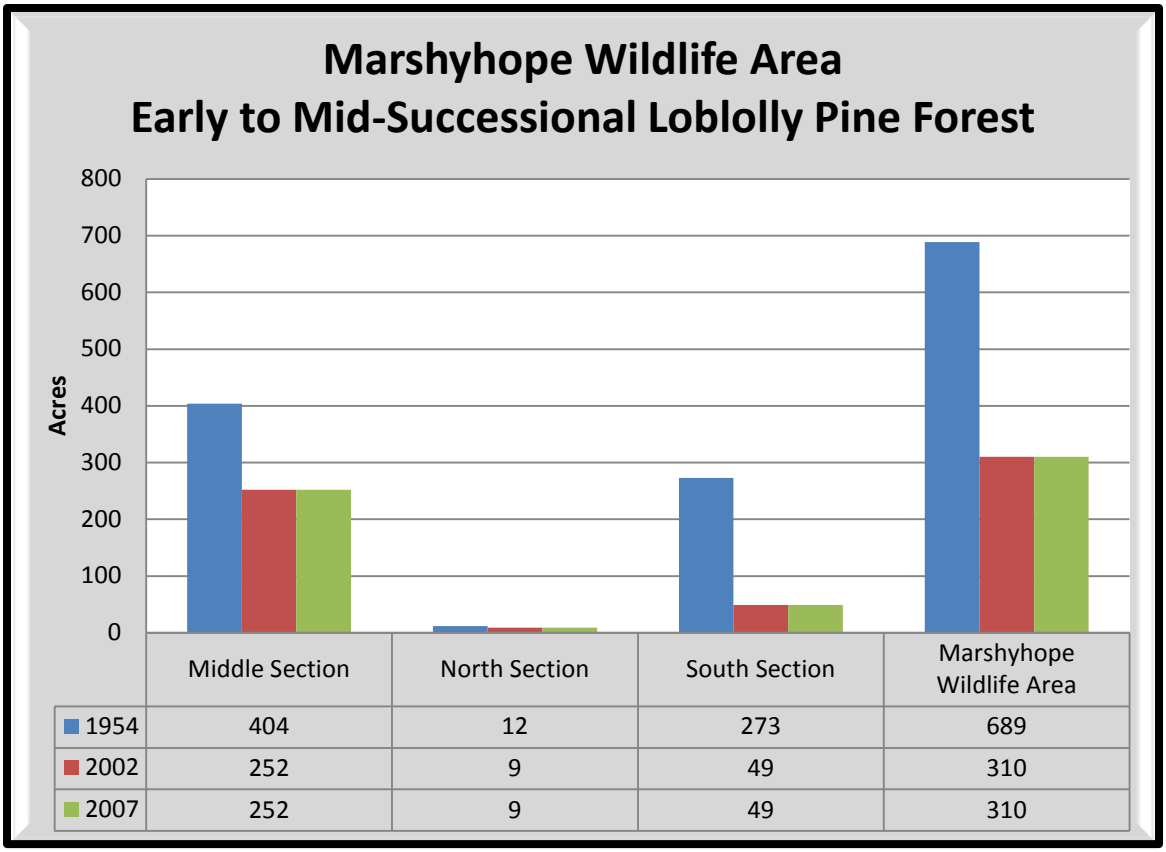


Figure 5.5. Early to Mid-Successional Loblolly Pine Forest at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.8)

Capital in Early to Mid-Successional Loblolly Pine Forest has decreased as this community matures to climax forests. The capital has been stable in the 2002 to 2007 period.

Table 5.8. Natural Capital of Early to Mid-Successional Loblolly Pine Forest

Year	Natural Capital (in 2012 dollars)
1954	$130,290/year
2002	$58,621/year
2007	$58,621/year

Loblolly Pine Plantation **[486 acres (Figure 5.6, Tables 5.9-5.10)] GNA SNA**

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

Description

Loblolly Pine Plantation is very similar to the Early to Mid-Successional Loblolly Pine Forest in younger forms. Loblolly pine (*Pinus taeda*) is planted in rows but otherwise the understory and other layers are the same as that in the Early to Mid-Successional Loblolly Pine Forest.

Analysis of Condition at Marshyhope Wildlife Area

Loblolly Pine Plantation did not appear to be present in 1954, but appeared within the 2002 imagery. This community converted 393 acres of Early to Mid-Successional Loblolly Pine Forest, which it is closely related to, 70 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 9 acres of agricultural field, 6 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, and 4 acres of Semi-impervious Surface (Table 5.9).

Table 5.9. Loblolly Pine Plantation has migrated into X since 1954

X	Acreage
Early to Mid-Successional Loblolly Pine Forest	393 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	70 acres
Agricultural Field	9 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	6 acres
Semi-impervious Surface	4 acres
Other communities/land covers	6 acres

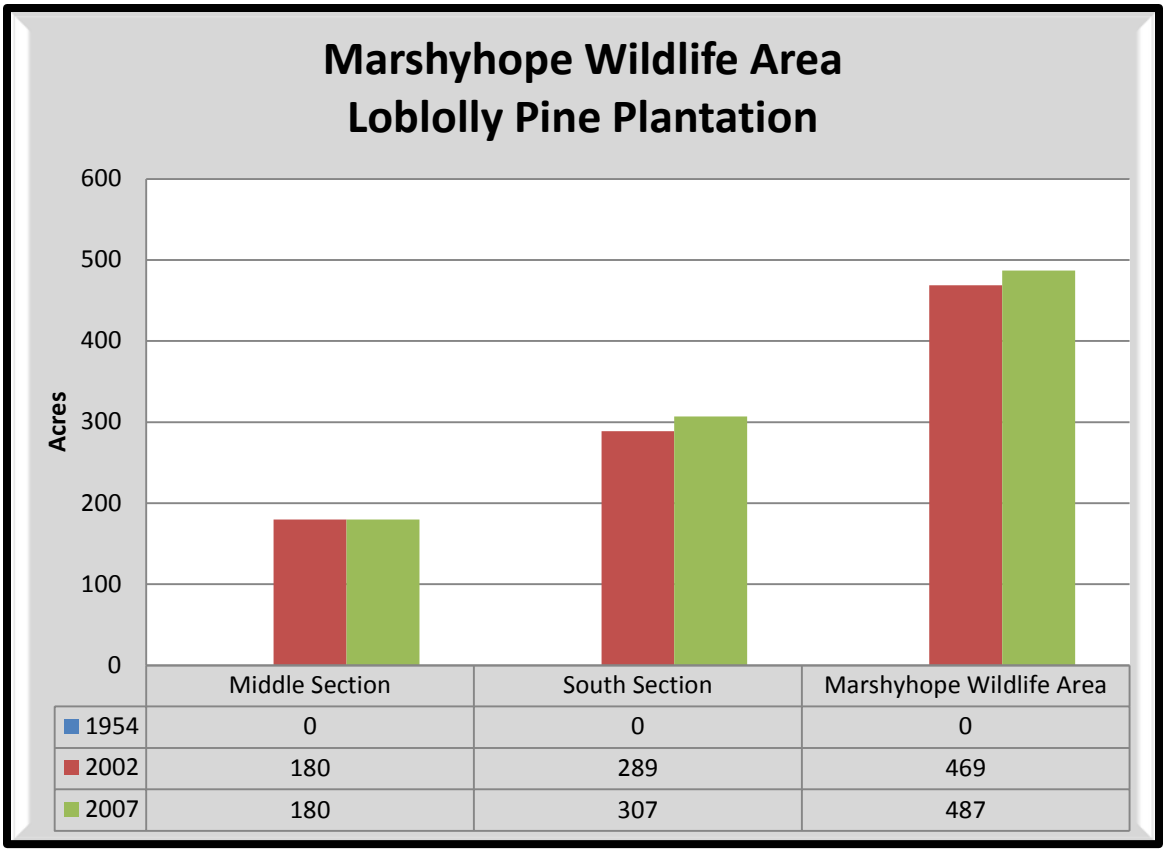


Figure 5.6. Loblolly Pine Plantation at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.10)

Capital of Loblolly Pine Plantation has been increasing as this community becomes more established in the wildlife area through planting.

Table 5.10. Natural Capital of Loblolly Pine Plantation	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$88,688/year
2007	$92,092/year

Mid to Late Successional Loblolly Pine-Sweetgum Forest **[2 acres (Figure 5.7, Tables 5.11-5.13)] G5 S5**

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

Description

This community is a later successional version of the Early to Mid-Successional Loblolly Pine Forest. It is differentiated from the earlier successional community by the presence of hardwoods, such as sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and white oak (*Quercus alba*) in the canopy. The other layers are essentially the same as the Early to Mid-Successional Forest in Marshyhope Wildlife Area.

Analysis of Condition at Marshyhope Wildlife Area

All of the Mid to Late Successional Loblolly Pine-Sweetgum Forest that was present in 1954 has been converted to Loblolly Pine Plantation (Table 5.11). All of the present (2007) community of Mid to Late Successional Loblolly Pine-Sweetgum Forest has matured from Early to Mid-Successional Forest (Table 5.12).

Table 5.11. What was Mid to Late Successional Loblolly Pine-Sweetgum Forest in 1954 has become X in 2007

X	**Acreage**
Loblolly Pine Plantation	3 acres

Table 5.12. Mid to Late Successional Loblolly Pine-Sweetgum Forest has migrated into X since 1954

X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	2 acres

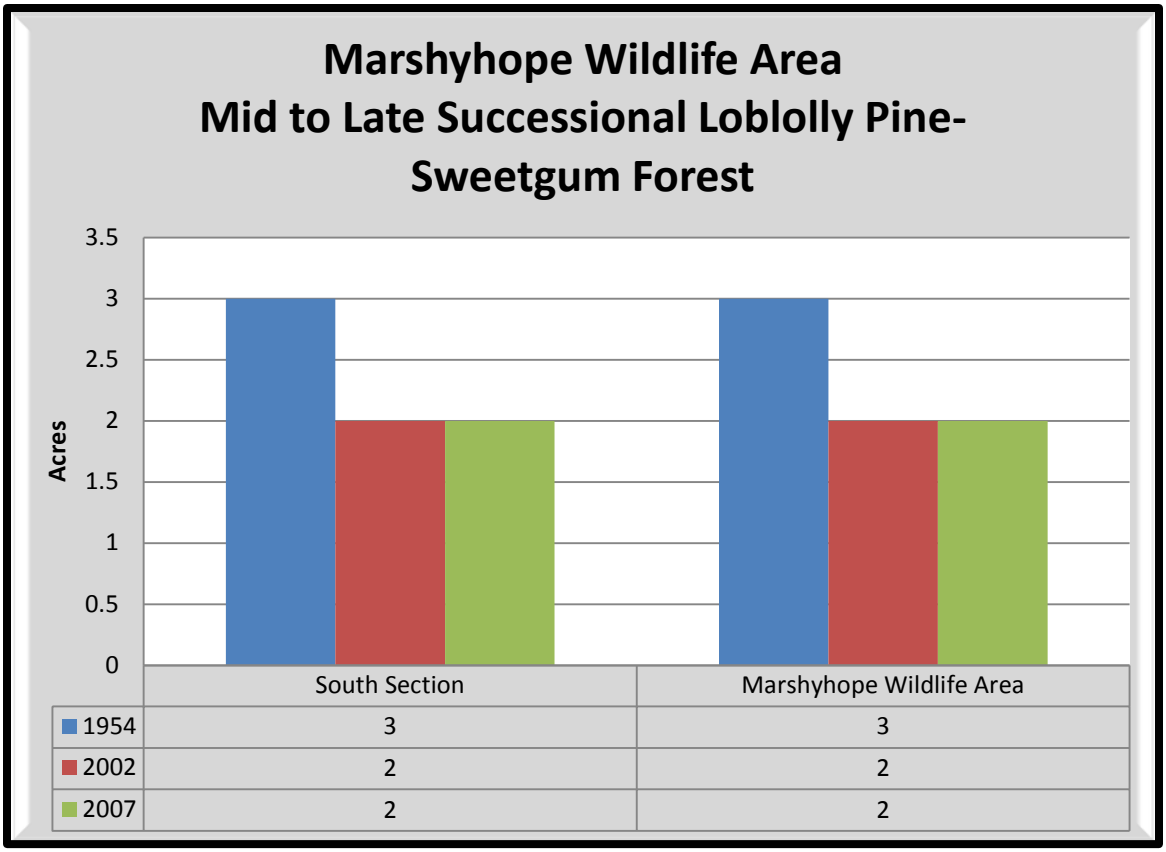


Figure 5.7. Mid to Late Successional Loblolly Pine-Sweetgum Forest at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.13)

Capital of Mid to Late Successional Loblolly Pine-Sweetgum Forest has decreased with the reduction of one acre of area since 1954.

Table 5.13. Natural Capital of Mid to Late Successional Loblolly Pine-Sweetgum Forest

Year	Natural Capital (in 2012 dollars)
1954	$567/year
2002	$378/year
2007	$378/year

Mid-Atlantic Mesic Mixed Hardwood Forest **[96 acres (Figure 5.8, Tables 5.14-5.15)] G5 S5**

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

Description

Most of the uplands that are not dominated by loblolly pine (*Pinus taeda*) are covered in this community. Canopy species here include American beech (*Fagus grandifolia*), white oak (*Quercus alba*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), southern red oak (*Quercus falcata*), and willow oak (*Quercus phellos*). Understory species include sassafras (*Sassafras albidum*), flowering dogwood (*Cornus florida*), eastern red cedar (*Juniperus virginiana*), and wild black cherry (*Prunus serotina*). Common greenbrier (*Smilax rotundifolia*), and lowbush blueberry (*Vaccinium pallidum*) make up the shrub and vine layer. Common herbs include ground pine (*Dendrolycopodium obscurum*), pokeweed (*Phytolacca americana*), Virginia creeper (*Parthenocissus quinquefolia*), and fireweed (*Erechtites hieracifolia*).

All of the examples on the wildlife area are in the late successional to mature state with diameters ranging from 1 foot to 1.5 feet.

Analysis of Condition at Marshyhope Wildlife Area

About 71 acres of the 87 acres present in 1954 was still present in 2007. The remaining 16 acres became 6 acres of Loblolly Pine Plantations, 5 acres of Northern Coastal Plain Successional Floodplain Forest, 2 acres of Northeastern Old Field, and 1 acre of Early to Mid-Successional Loblolly Pine Forest (Table 5.14). Since 1954, Mid-Atlantic Mesic Mixed Hardwood Forest has increased in acreage by growing from 19 acres of Early to Mid-Successional Loblolly Pine Forest, 2 acres of Northeastern Successional Shrubland, and converting 1 acre of Semi-impervious Surface, and 1 acre of agricultural field (Table 5.15).

Table 5.14. What was Mid-Atlantic Mesic Mixed Hardwood Forest in 1954 has become X in 2007

X	Acreage
Mid-Atlantic Mesic Mixed Hardwood Forest	71 acres
Loblolly Pine Plantation	6 acres
Northern Coastal Plain Successional Floodplain Forest	5 acres
Northeastern Old Field	2 acres
Early to Mid-Successional Loblolly Pine Forest	1 acre
Other communities/land covers	2 acres

Table 5.15. Mid-Atlantic Mesic Mixed Hardwood Forest has migrated into X since 1954	
X	**Acreage**
Mid-Atlantic Mesic Mixed Hardwood Forest	71 acres
Early to Mid-Successional Loblolly Pine Forest	19 acres
Northeastern Successional Shrubland	2 acres
Semi-impervious Surface	1 acre
Agricultural Field	1 acre
Other communities/land covers	1 acre

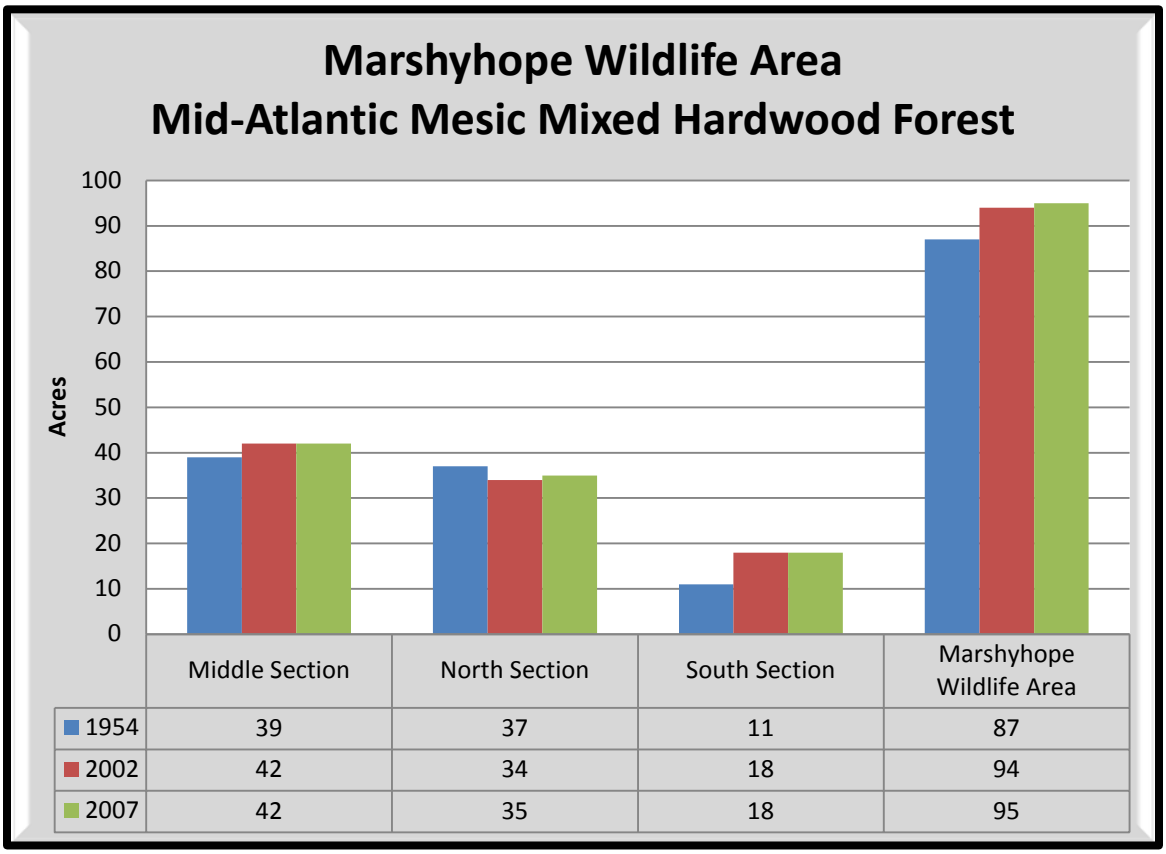


Figure 5.8. Mid-Atlantic Mesic Mixed Hardwood Forest at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.16)

Capital of Mid-Atlantic Mesic Mixed Hardwood has been gradually increasing as successional forest communities mature to it.

Table 5.16. Natural Capital of Mid-Atlantic Mesic Mixed Hardwood Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$16,542/year
2002	$17,775/year
2007	$17,965/year

Northeastern Modified Successional Forest **[1 acre (Figure 5.9, Tables 5.17-5.18)] GNA SNA**

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

Description

This community is similar in species composition to the Mid-Atlantic Mesic Mixed Hardwood Forest but contains infestations of exotic invasive species such as Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), and Japanese stiltgrass (*Microstegium vimineum*).

All of the examples of this community are perpetually late successional in the wildlife area due to exotic invasive plant species.

Analysis of Condition at Marshyhope Wildlife Area

Northeastern Modified Successional Forest was not present in 1954 and has since converted up to 2 acres in 2002 and is now 1 acre in size. The present acre of this community came about by converting 1 acre of Chesapeake Bay Non-riverine Wet Hardwood Forest and 0.2 acres of Mid-Atlantic Mesic Mixed Hardwood Forest (Table 5.17).

Table 5.17. Northeastern Modified Successional Forest has migrated into X since 1954

X	**Acreage**
Chesapeake Bay Non-riverine Wet Hardwood Forest	1 acre
Mid-Atlantic Mesic Mixed Hardwood Forest	0.2 acres

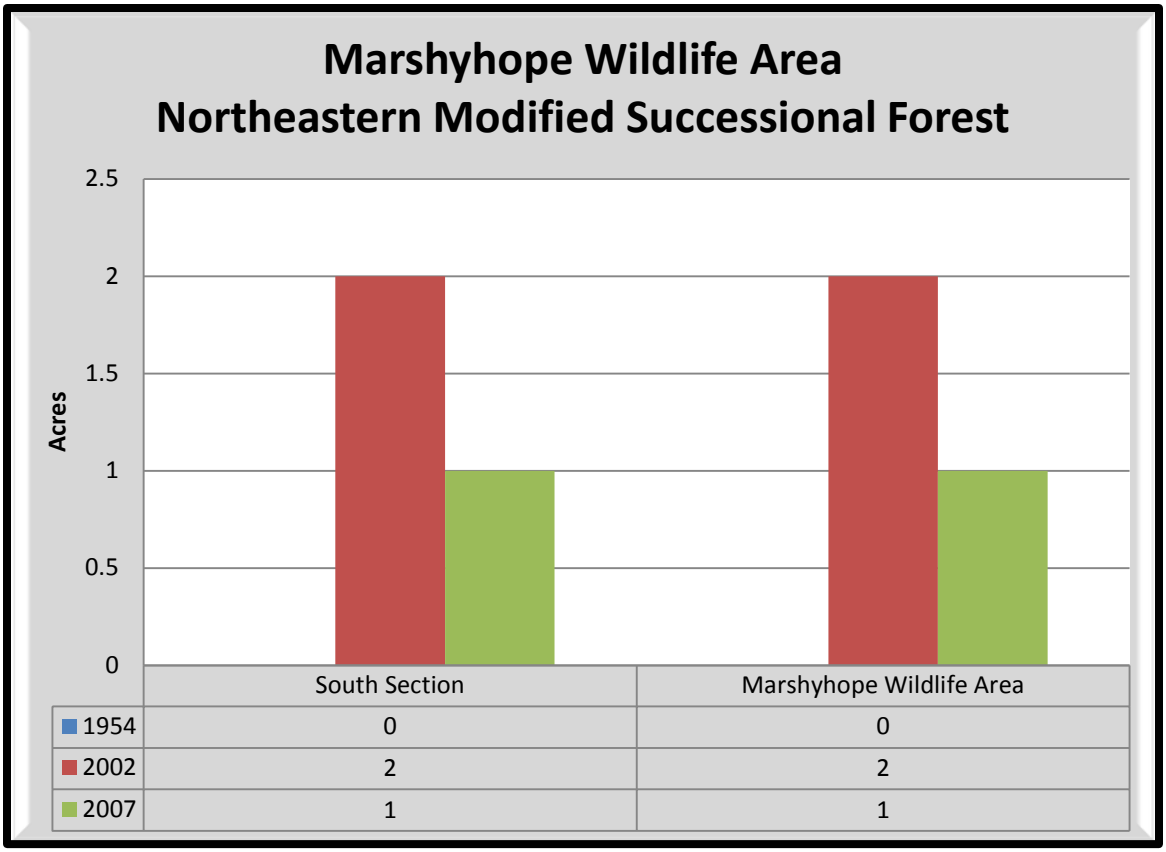


Figure 5.9. Northeastern Modified Successional Forest at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.18)

Northeastern Modified Successional Forest was not present in 1954 and has since accumulated $189 in capital from other forest communities.

Table 5.18. Natural Capital of Northeastern Modified Successional Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$378/year
2007	$189/year

Northeastern Old Field **[11 acres (Figure 5.10, Tables 5.19-5.20)]** **GNA SNA**

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

Description

Northeastern Old Field is found along the edges of ditches that are mowed once or less per year. Typical species in these areas include tall fescue (*Festuca rubra*), timothy (*Phleum pratense*), blackberry (*Rubus* sp.), and multiflora rose (*Rosa multiflora*).

Analysis of Condition at Marshyhope Wildlife Area

None of the Northeastern Old Fields from 1954 still exist in 2007. They have all become 3 acres of Loblolly Pine Plantation and 0.3 acres of Early to Mid-Successional Loblolly Pine Forest (Table 5.19). Since 1954, Northeastern Old Field has gained acreage due to the clearings around ditches. The fields were built into 6 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 2 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, 2 acres of Early to Mid-Successional Loblolly Pine Forest, 0.4 acres of Southern Red Maple-Blackgum Swamp, and 0.1 acres of Semi-impervious Surface (Table 5.20).

Table 5.19. What was Northeastern Old Field in 1954 has become X in 2007

X	Acreage
Loblolly Pine Plantation	3 acres
Early to Mid-Successional Loblolly Pine Forest	0.3 acres

Table 5.20. Northeastern Old Field has migrated into X since 1954

X	Acreage
Chesapeake Bay Non-riverine Wet Hardwood Forest	6 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	2 acres
Early to Mid-Successional Loblolly Pine Forest	2 acres
Southern Red Maple-Blackgum Swamp	0.4 acres
Semi-impervious Surface	0.1 acres

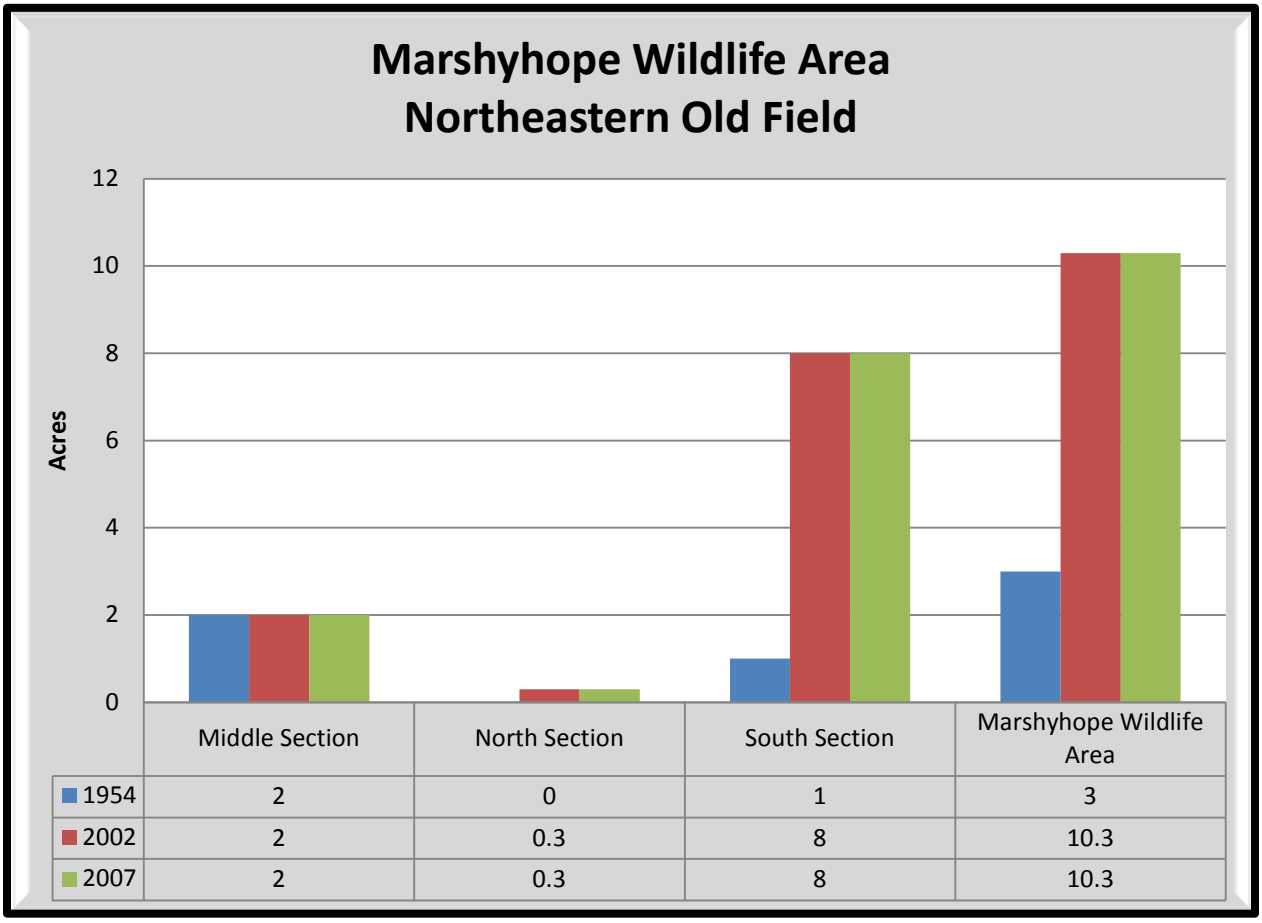


Figure 5.10. Northeastern Old Field at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.21)

Capital in fields has grown as these communities are placed around the edges of ditches.

Table 5.21. Natural Capital of Northeastern Old Field	
Year	**Natural Capital (in 2012 dollars)**
1954	$437/year
2002	$1,501/year
2007	$1,501/year

Northeastern Successional Shrubland **[1 acre (Figure 5.11, Tables 5.22-5.24)] GNA SNA**

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

Description

Northeastern Successional Shrubland is composed of shrubs that have grown up from Northeastern Old Fields. Common shrubs in this community include blackberry (*Rubus* sp.), Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), and autumn olive (*Elaeagnus umbellata*).

Analysis of Condition at Marshyhope Wildlife Area

None of the Northeastern Successional Shrubland present in 1954 was still present in 2007. What was this community had become 5 acres of Southern Red Maple-Blackgum Swamp, 2 acres of Mid-Atlantic Mesic Mixed Hardwood Forest, 1 acre of Early to Mid-Successional Loblolly Pine Forest, 0.1 acres of cultivated lawn, and 0.1 acres of impervious surface (Table 5.22). Since 1954, this community has greatly decreased its acreage going from 8 acres to 1 acre. The acre came from what was Southern Red Maple-Blackgum Swamp (Table 5.23).

Table 5.22. What was Northeastern Successional Shrubland in 1954 has become X in 2007

X	Acreage
Southern Red Maple-Blackgum Swamp	5 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	2 acres
Early to Mid-Successional Loblolly Pine Forest	1 acre
Cultivated Lawn	0.1 acres
Impervious Surface	0.1 acres

Table 5.23. Northeastern Successional Shrubland has migrated into X since 1954

X	Acreage
Southern Red Maple-Blackgum Swamp	1 acre

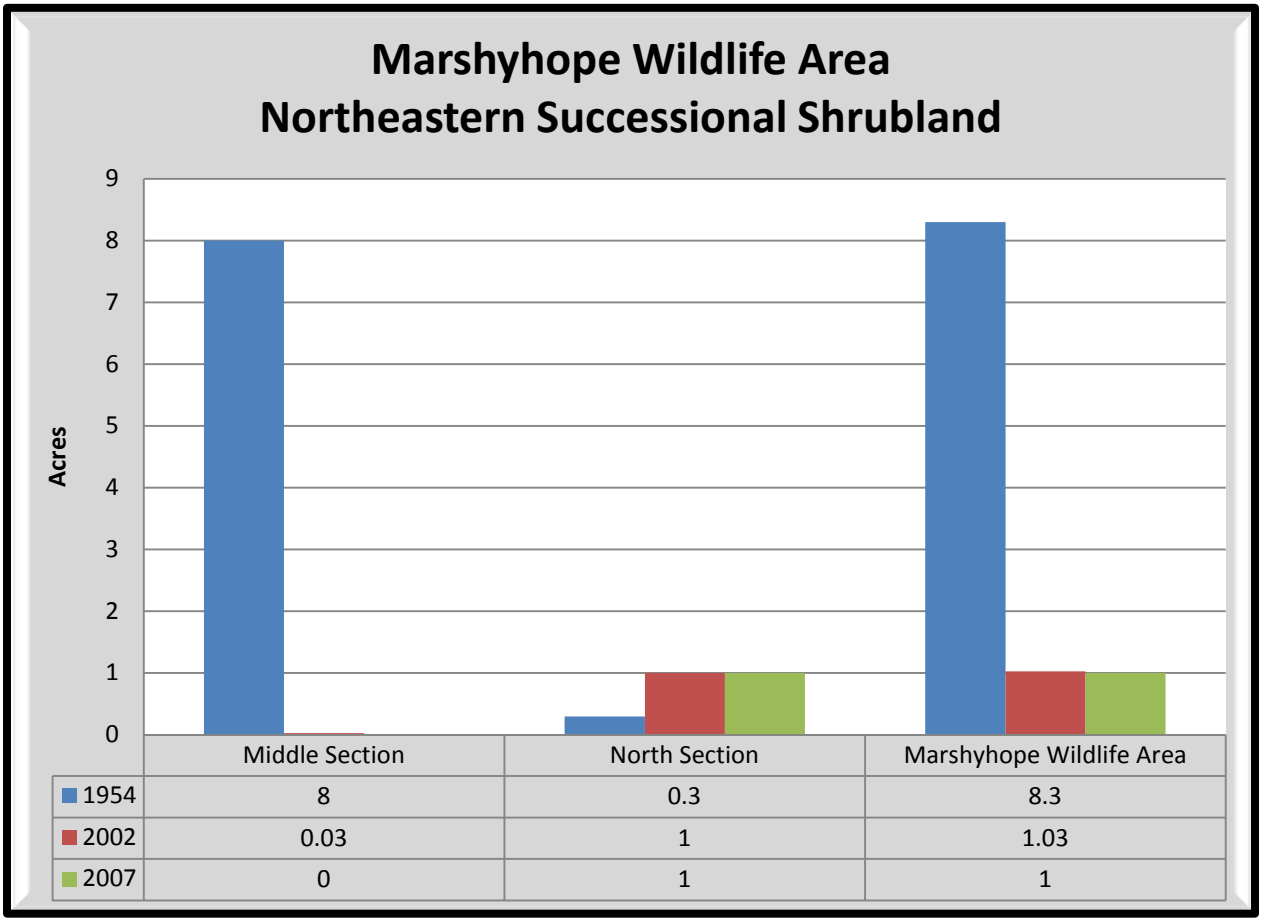


Figure 5.11. Northeastern Successional Shrubland at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.24)

Capital in Northeastern Successional Shrubland has been decreasing because of maturing to other forest communities.

Table 5.24. Natural Capital of Northeastern Successional Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,209/year
2002	$150/year
2007	$146/year

Northern Coastal Plain Successional Floodplain Forest **[23 acres (Figure 5.12-5.13, Tables 5.25-5.26)]**
GNA SNA

DEWAP: Coastal Plain Forested Floodplains and Riparian Swamps
NHC: No Equivalent Classification

Description

This floodplain community, when found in the wildlife area, was the first occurrence in Delaware. It has since been found in the Old Furnace Wildlife Area as well. River birch (*Betula nigra*) is common in the canopy and distinguishes this community from other floodplain communities. Other canopy associates include green ash (*Fraxinus pennsylvanica*) and red maple (*Acer rubrum*). The understory is composed of smaller members of the canopy. No shrubs and vines were observed here and herbs include Japanese stiltgrass (*Microstegium vimineum*), forget-me-not (*Myosotis* sp.), stinging nettle (*Urtica dioica*), orange-spotted jewelweed (*Impatiens capensis*), and lizard's tail (*Saururus cernuus*).

Figure 5.12. Northern Coastal Plain Successional Forest (North Section)

The example of this community in the wildlife area is in the late successional state with trees ranging from 0.8 feet to 1.2 feet dbh.

Analysis of Condition at Marshyhope Wildlife Area

This community was not present in 1954 and has since converted 18 acres of Southern Red Maple-Blackgum Swamp and 5 acres of Mid-Atlantic Mesic Mixed Hardwood Forest (Table 5.25).

Table 5.25. Northern Coastal Plain Successional Forest has migrated into X since 1954

X	**Acreage**
Southern Red Maple-Blackgum Swamp	18 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	5 acres

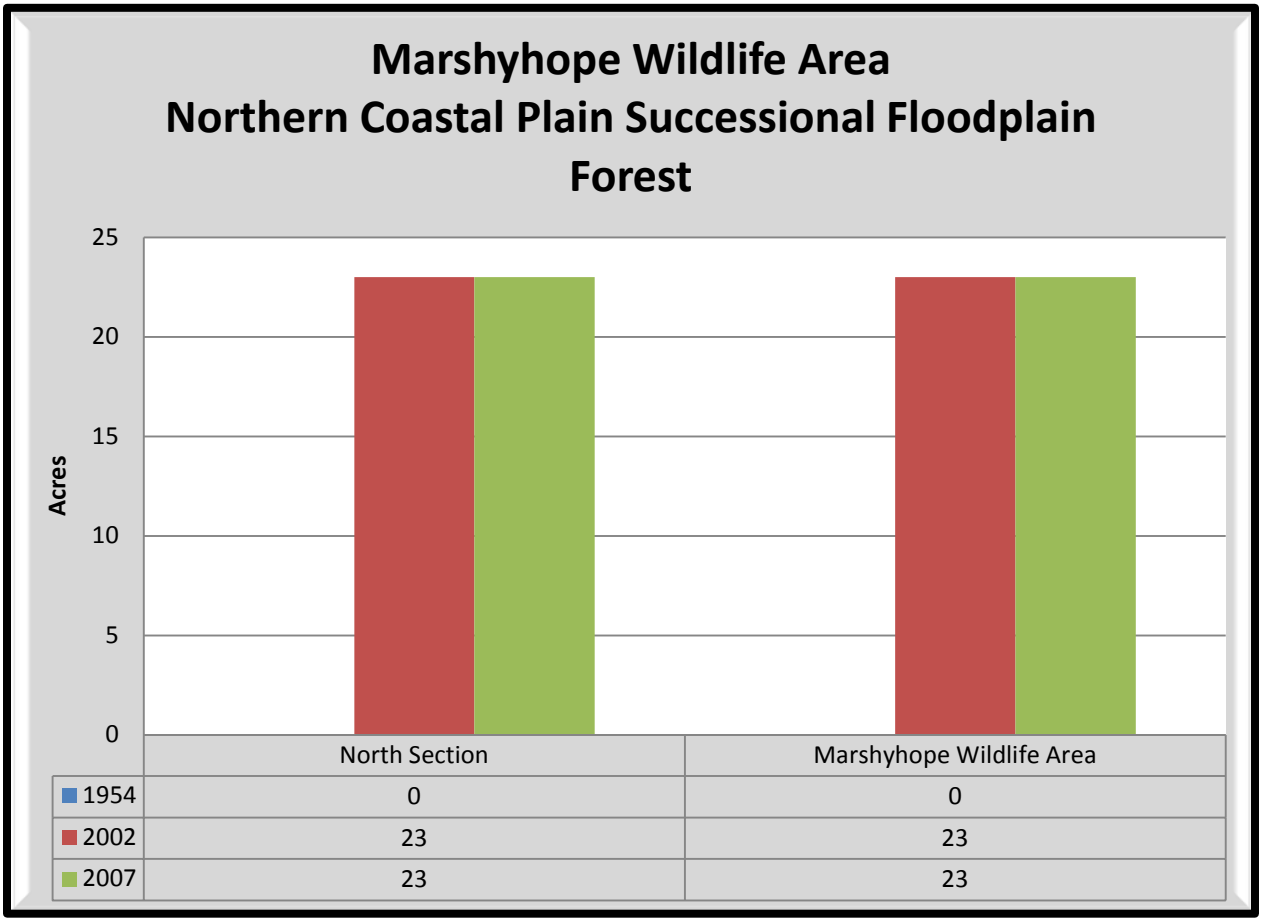


Figure 5.13. Northern Coastal Plain Successional Floodplain Forest at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.26)

Capital of Northern Coastal Plain Successional Floodplain Forest was not present in 1954 and has since gained $282,705 in capital, resulting in a great gain for the wildlife area.

Table 5.26. Natural Capital of Northern Coastal Plain Successional Floodplain Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$282,705/year
2007	$282,705/year

Reed Canarygrass Eastern Marsh **[1 acre (Figure 5.14-5.15, Table 5.27)]** **GNR S1**

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

Description

Figure 5.14. Reed Canarygrass Eastern Marsh (North Section)

This marsh community is found a wet area behind a levee parallel to Marshyhope Creek. Reed canarygrass (*Phalaris arundinacea*) dominates nearly entirely this marsh.

Analysis of Condition at Marshyhope Wildlife Area

Reed Canarygrass Eastern Marsh was not present in 1954. All of the current extent of this community came from Southern Red Maple-Blackgum Swamp.

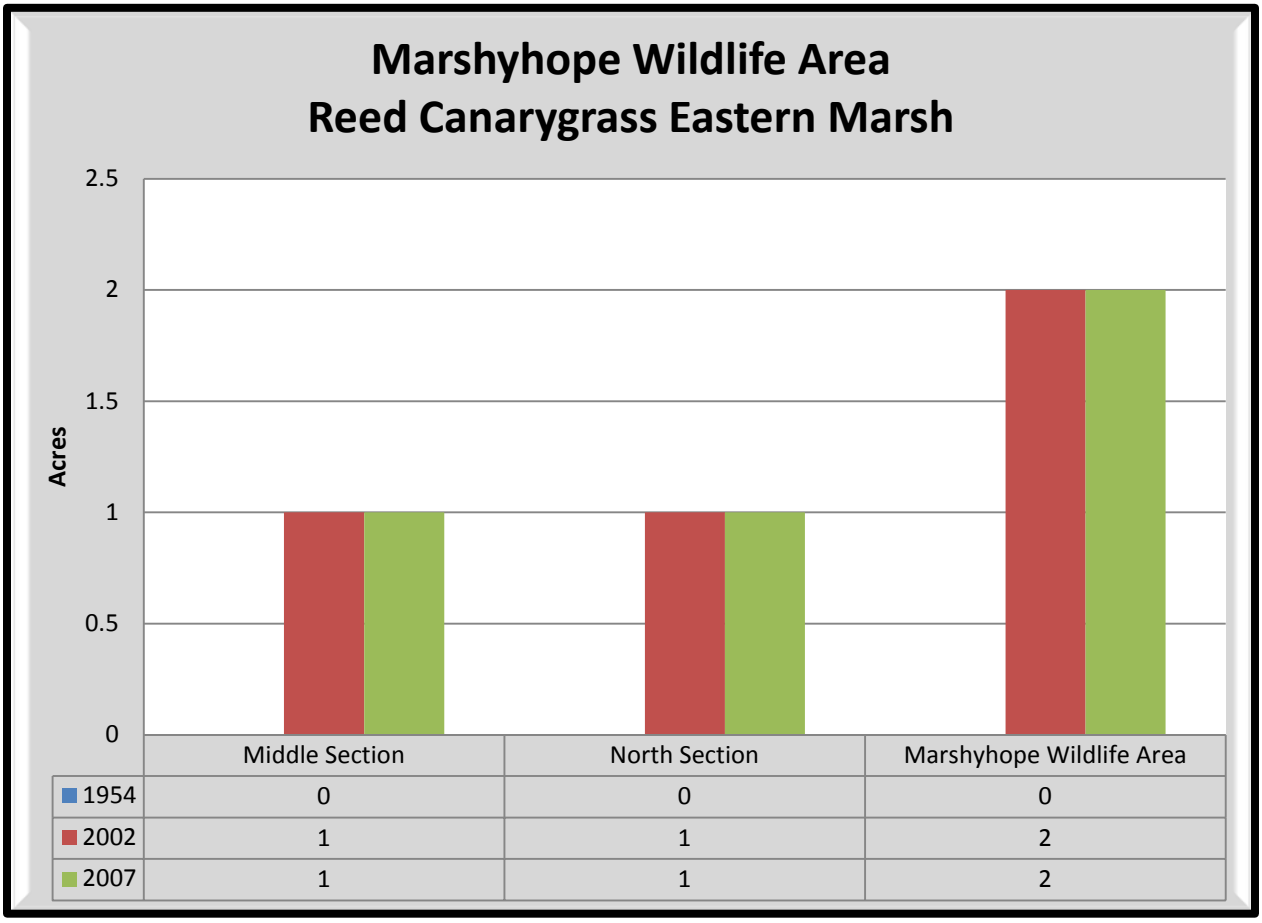


Figure 5.15. Reed Canarygrass Eastern Marsh at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.27)

Capital of Reed Canarygrass Eastern Marsh came from the transfer of capital for a forest community. Because this was a swamp community this transfer resulted in a capital loss for the wildlife area.

Table 5.27. Natural Capital of Reed Canarygrass Eastern Marsh	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$18,563/year
2007	$18,563/year

Southern Red Maple-Blackgum Swamp **[111 acres (Figure 5.16-5.17, Tables 5.28-5.30)] G3? S3**

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

Description

Southern Red Maple-Blackgum Swamp is the most common floodplain community in the wildlife area. Red maple (*Acer rubrum*), water oak (*Quercus nigra*), blackgum (*Nyssa sylvatica*), and swamp white oak (*Quercus bicolor*) compose the canopy. The understory contains swamp chestnut oak (*Quercus michauxii*), sweetbay (*Magnolia virginiana*), green ash (*Fraxinus pennsylvanica*), and a few spicebush (*Lindera benzoin*). Shrubs and vines include poison ivy (*Toxicodendron radicans*), winterberry (*Ilex verticillata*), Japanese honeysuckle (*Lonicera japonica*), and arrowwood (*Viburnum dentatum*). The herbaceous layer is composed of skunk cabbage (*Symplocarpus foetidus*), lizard's tail (*Saururus cernuus*), netted chainfern (*Woodwardia areolata*), Virginia creeper (*Parthenocissus quinquefolia*), wetland blue violet (*Viola cucullata*), and orange-spotted jewelweed (*Impatiens capensis*).

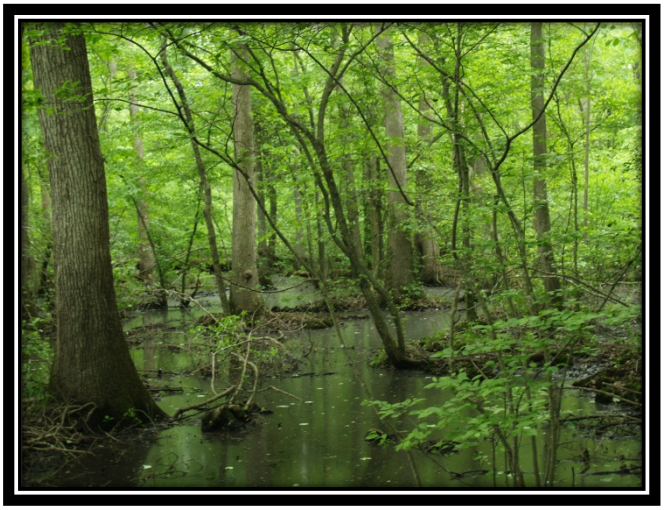


Figure 5.16. Southern Red Maple-Blackgum Swamp (North Section)

The examples of this community in the wildlife are late successional to mature with dbh's ranging from 1 foot to 1.5 feet. In the North Section this community contains small inclusions of Reed Canarygrass Eastern Marsh and Water-lily Aquatic Wetland.

Analysis of Condition at Marshyhope Wildlife Area

About 105 acres of 130 acres from 1954 still existed in 2007. The remaining acreage had become 18 acres of Northern Coastal Plain Successional Floodplain Forest, 3 acres of water, 1 acre of Reed Canarygrass Eastern Marsh, and 1 acre of Coastal Plain Oak Floodplain Swamp (Table 5.28). Since 1954 the acreage of this community has decreased but it has still managed to grow from 5 acres of Northeastern Successional Shrubland and convert 0.5 acres of Mid-Atlantic Mesic Mixed Hardwood Forest (Table 5.29).

Table 5.28. What was Southern Red Maple-Blackgum Swamp in 1954 has become X in 2007	
X	**Acreage**
Southern Red Maple-Blackgum Swamp	105 acres
Northern Coastal Plain Successional Floodplain Forest	18 acres
Water	3 acres
Reed Canarygrass Eastern Marsh	1 acre
Coastal Plain Oak Floodplain Swamp	1 acre
Other communities/land covers	1 acre

Table 5.29. Southern Red Maple-Blackgum Swamp has migrated into X since 1954	
X	**Acreage**
Southern Red Maple-Blackgum Swamp	105 acres
Northeastern Successional Shrubland	5 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	0.5 acres

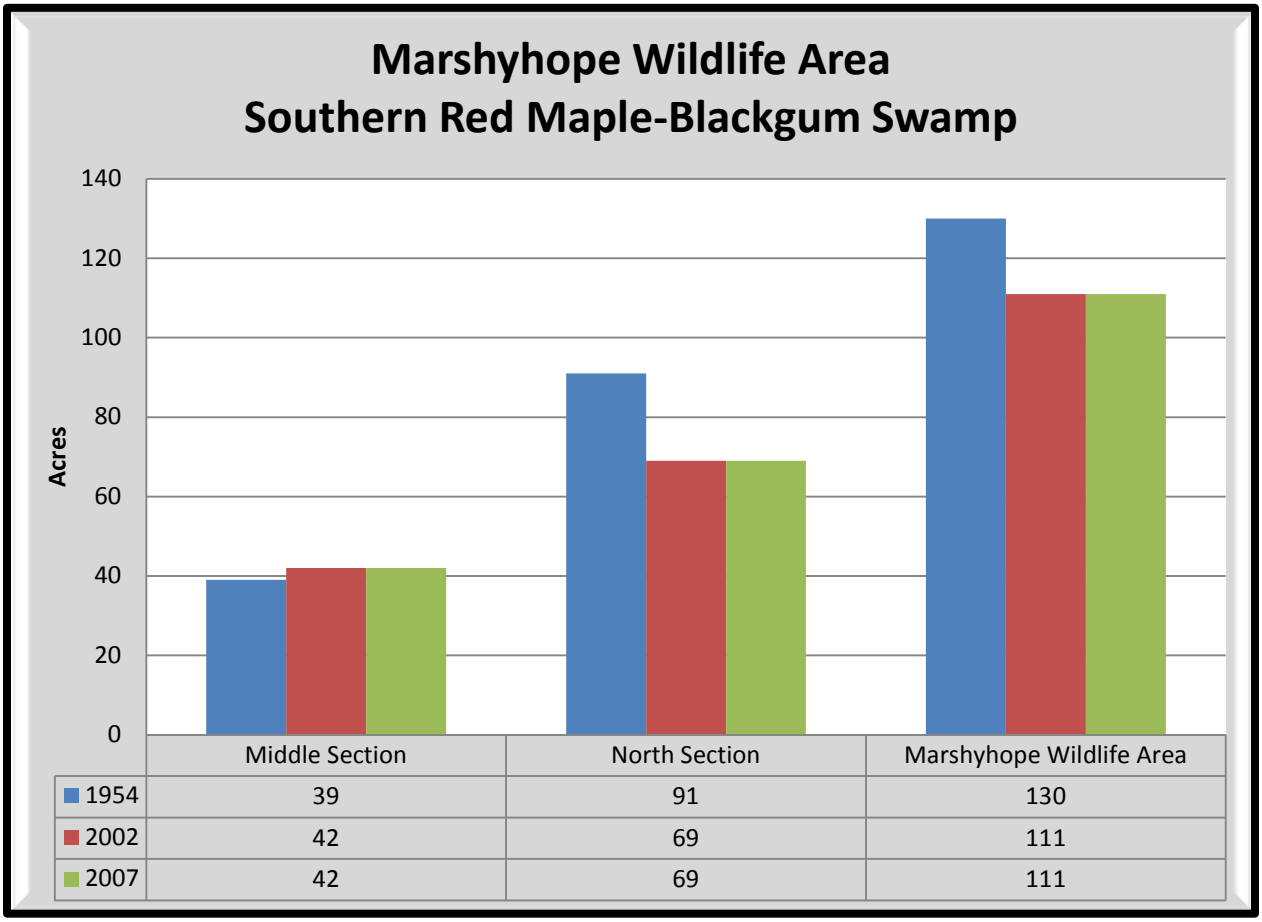


Figure 5.17. Southern Red Maple-Blackgum Swamp at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.30)

Capital of Southern Red Maple-Blackgum Swamp has decreased due to conversion to other forest types and an influx of water into the North Section.

Table 5.30. Natural Capital of Southern Red Maple-Blackgum Swamp	
Year	**Natural Capital (in 2012 dollars)**
1954	$1,597,895/year
2002	$1,364,357/year
2007	$1,364,357/year

***Successional Sweetgum Forest* [1 acre, (Figure 5.18, Table 5.31)] GNA SNA**

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

Description

Successional Sweetgum Forest is an early successional forest that is dominated by sweetgum (*Liquidambar styraciflua*) in the canopy. All of the examples of this community are of young age in the wildlife area.

Analysis of Condition at Marshyhope Wildlife Area

All of the Successional Sweetgum Forest present in the wildlife area came from 1 acre of Early to Mid-Successional Loblolly Pine Forest.

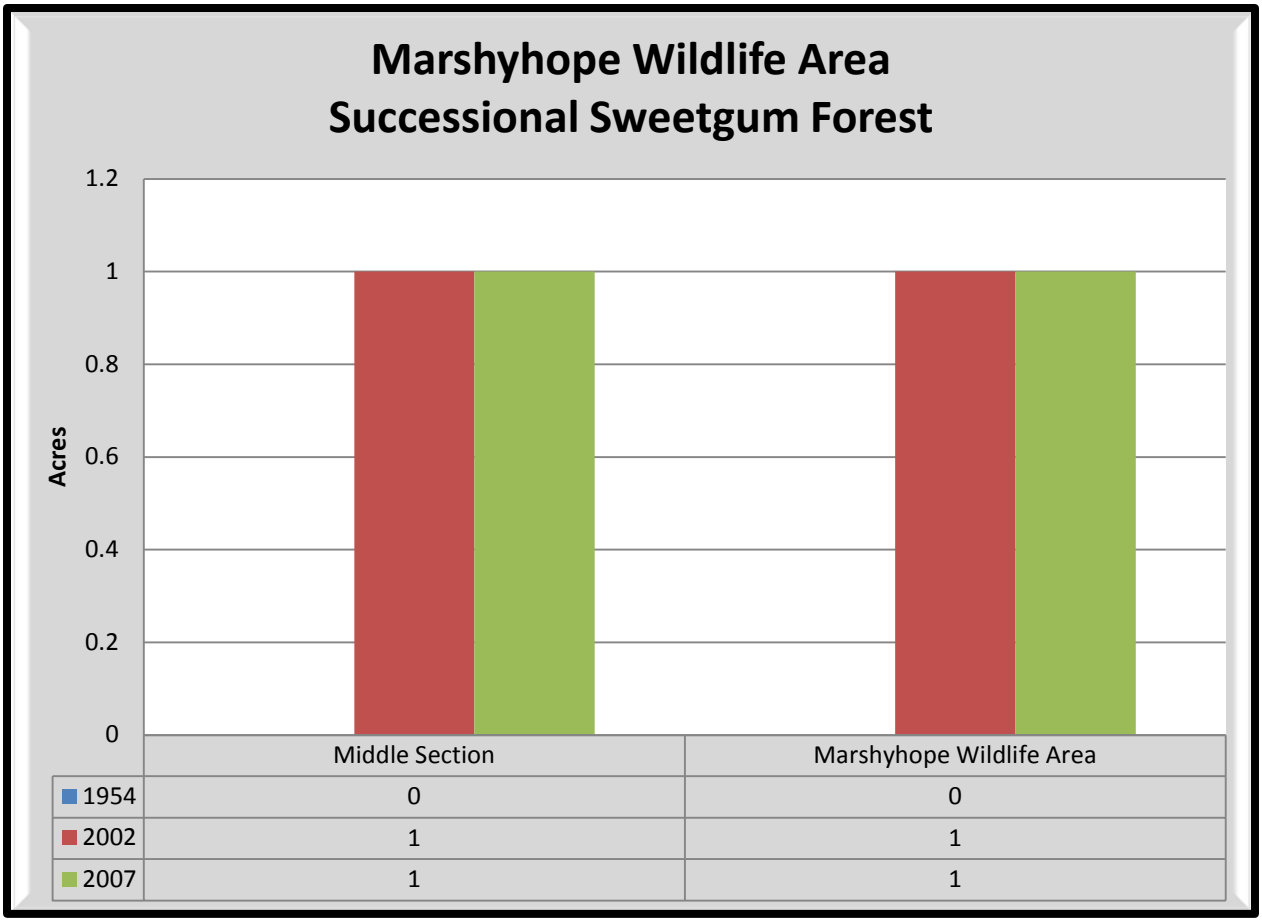


Figure 5.18. Successional Sweetgum Forest at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.31)

Successional Sweetgum Forest was not present in 1954 and has since acquired $189 from another forest community.

Table 5.31. Natural Capital of Successional Sweetgum Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$189/year
2007	$189/year

Virginia Pine Successional Forest **[1 acre (Figure 5.19, Tables 5.32-5.33)] GNA SNA**

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

Description

Virginia Pine Successional Forest is found in a high spot just west of Sand Hill Road. Virginia pine (*Pinus virginiana*) dominates the canopy with a few loblolly pine (*Pinus taeda*) mixed in. Little understory is present due to the acidity of the needles.

Analysis of Condition at Marshyhope Wildlife Area

Virginia Pine Successional Forest was not present in 1954 and has since grown from 1 acre of Early to Mid-Successional Loblolly Pine Forest and 0.2 acres of Semi-impervious Surface (Table 5.32).

Table 5.32. Virginia Pine Successional Forest has migrated into X since 1954

X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	1 acre
Semi-impervious Surface	0.2 acres

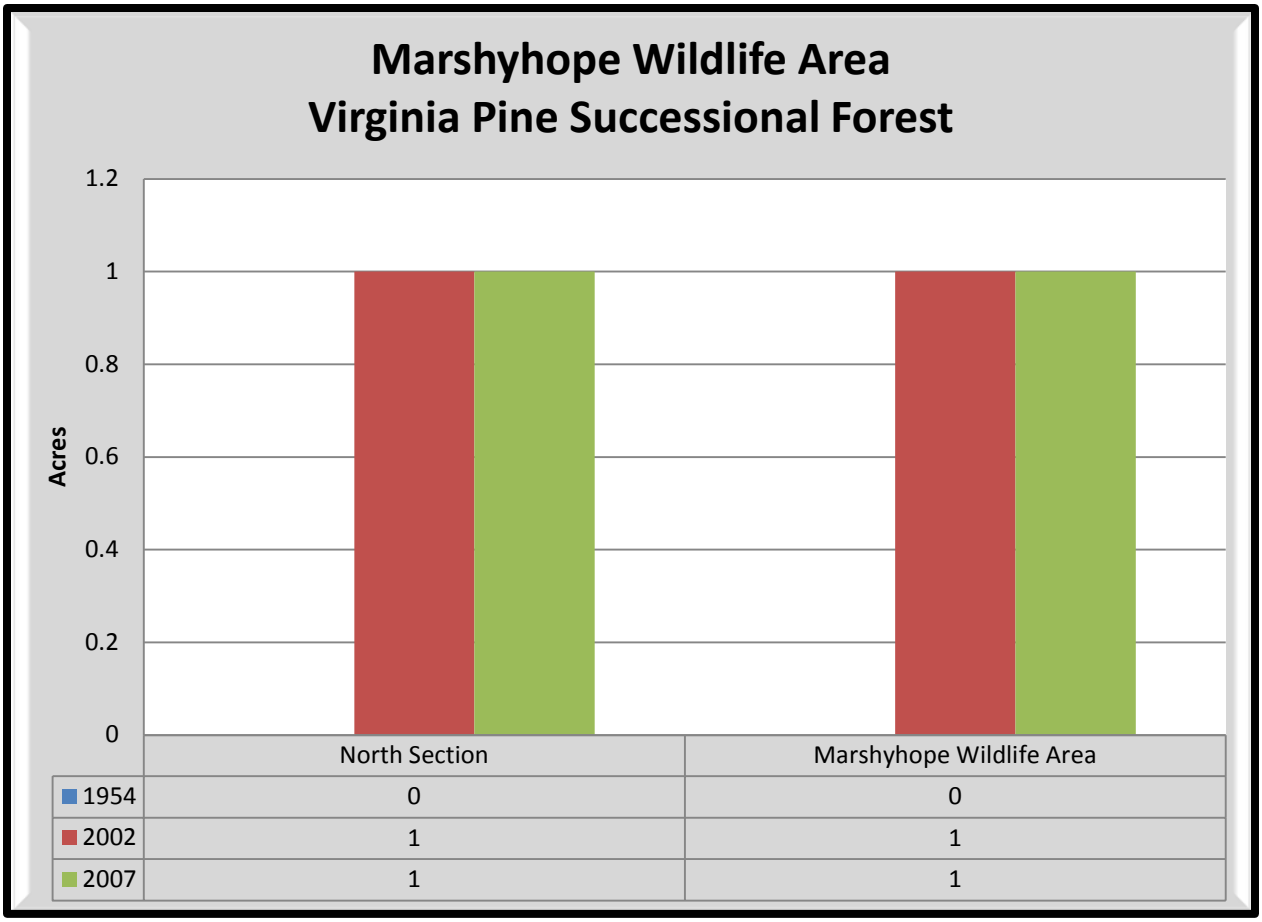


Figure 5.19. Virginia Pine Successional Forest at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 5.33)

Virginia Pine Successional Forest was not present in 1954 and has since acquired $189 from another forest community.

Table 5.33. Natural Capital of Virginia Pine Successional Forest	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$189/year
2007	$189/year

CHAPTER 6: 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 covers include:

1. Agricultural Field—2 acres
2. Farm Pond/Artificial Pond—0.3 acres
3. Impervious Surface—7 acres
4. Modified Land—2 acres
5. Semi-impervious Surface—2 acres
6. Water—9 acres

Agricultural Field **[2 acres, (Figure 6.1, Tables 6.1-6.3)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

The edges of the some of the adjacent agricultural fields come into the wildlife area. There are no active whole agricultural fields in the wildlife area.

Analysis of Condition at Marshyhope Wildlife Area

This is a man-made community and as such is dependent on human activities to maintain it. It is unknown what the future management plans are this area. Only 1 acre of the 42 acres of agricultural field in 1954 was still present in 2007. The remaining acreage has been abandoned and has become 29 acres of Early to Mid-Successional Loblolly Pine Forest, 9 acres of Loblolly Pine Plantation, 2 acres of cultivated lawn, and 1 acre of impervious surface (Table 6.1). Since 1954, land in agricultural field has greatly decreased. However, 1 acre of Early to Mid-Successional Loblolly Pine Forest has been developed into agricultural field (Table 6.2).

Table 6.1. What was Agricultural Field in 1954 has become X in 2007

X	Acreage
Early to Mid-Successional Loblolly Pine Forest	29 acres
Loblolly Pine Plantation	9 acres
Cultivated Lawn	2 acres
Impervious Surface	1 acre
Agricultural Field	1 acre
Other communities/land covers	1 acre

Table 6.2. Agricultural Field has migrated into X since 1954

X	Acreage
Early to Mid-Successional Loblolly Pine Forest	1 acre
Agricultural Field	1 acre

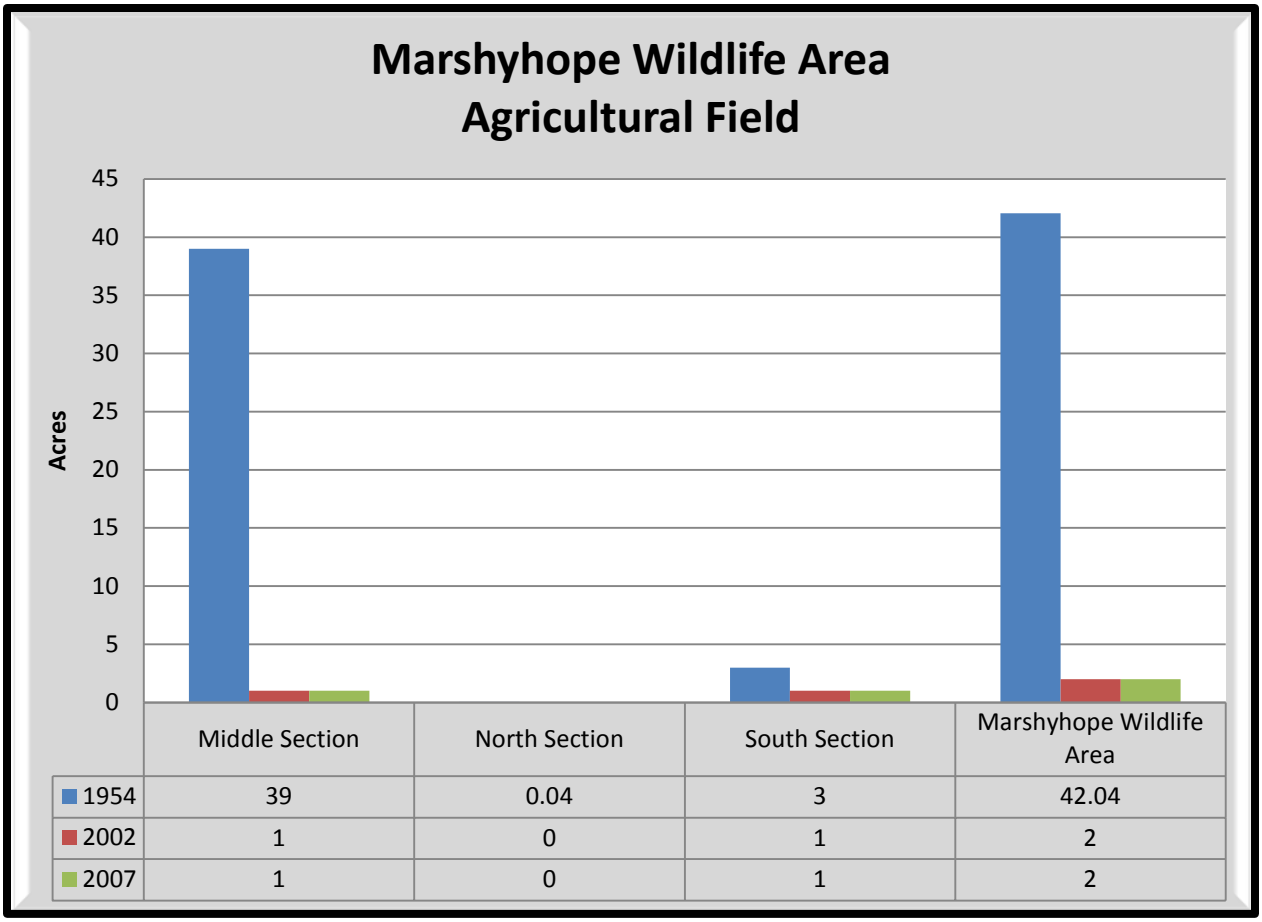


Figure 6.1. Agricultural Field at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 6.3)

Agricultural field is one of the few land covers with any natural capital value. Its capital has decreased as fields are abandoned, but most of these abandonments have resulted in capital gains for the wildlife area.

Table 6.3. Natural Capital of Agricultural Field	
Year	**Natural Capital (in 2012 dollars)**
1954	$2,411/year
2002	$115/year
2007	$115/year

Farm Pond/Artificial Pond **[0.3 acres, (Figure 6.2, Table 6.4)]**

DEWAP: Impoundment
NHC: No Equivalent Classification

Description

The edges of the some of the adjacent agricultural fields come into the wildlife area. There are no active whole agricultural fields in the wildlife area.

Analysis of Condition at Marshyhope Wildlife Area

All of the current acreage in farm pond/artificial pond came from 0.3 acres of Early to Mid-Successional Loblolly Pine Forest.

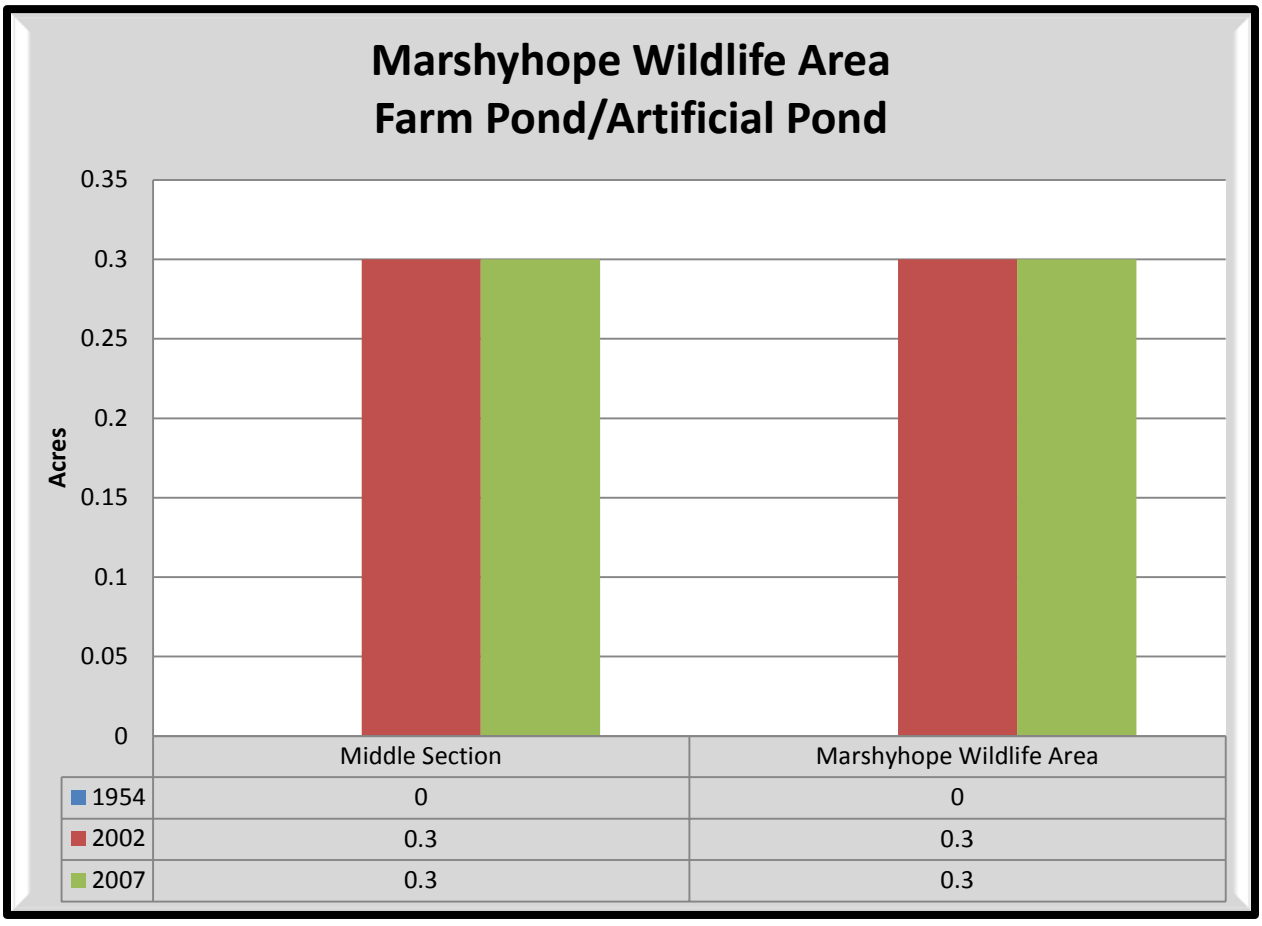


Figure 6.2. Farm Pond/Artificial Pond at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 6.4)

Since its appearance in 2002, capital in farm pond/artificial pond has remained stable.

Table 6.4. Natural Capital of Farm Pond/Artificial Pond	
Year	**Natural Capital (in 2012 dollars)**
1954	$0/year (not present)
2002	$1,601/year
2007	$1,601/year

Impervious Surface **[7 acres, (Figure 6.3, Tables 6.5-6.6)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

Impervious surface includes all of those areas that are impervious to water such as roads and buildings.

Analysis of Condition at Marshyhope Wildlife Area

About half of the impervious surface from 1954 was still present in 2007. The remainder had become cultivated lawn (Table 6.5). Since 1954, impervious surface has increased by being developed in 3 acres of Semi-impervious surface, 3 acres of Early to Mid-Successional Loblolly Pine Forest, 1 acre of agricultural field, and 0.1 acres of Northeastern Successional Shrubland (Table 6.6).

Table 6.5. What was Impervious Surface in 1954 has become X in 2007

X	Acreage
Impervious Surface	0.5 acres
Cultivated Lawn	0.1 acres

Table 6.6. Impervious Surface has migrated into X since 1954

X	Acreage
Semi-impervious Surface	3 acres
Early to Mid-Successional Loblolly Pine Forest	3 acres
Agricultural Field	1 acre
Impervious Surface	0.5 acres
Northeastern Successional Shrubland	0.1 acres
Other communities/land covers	0.1 acres

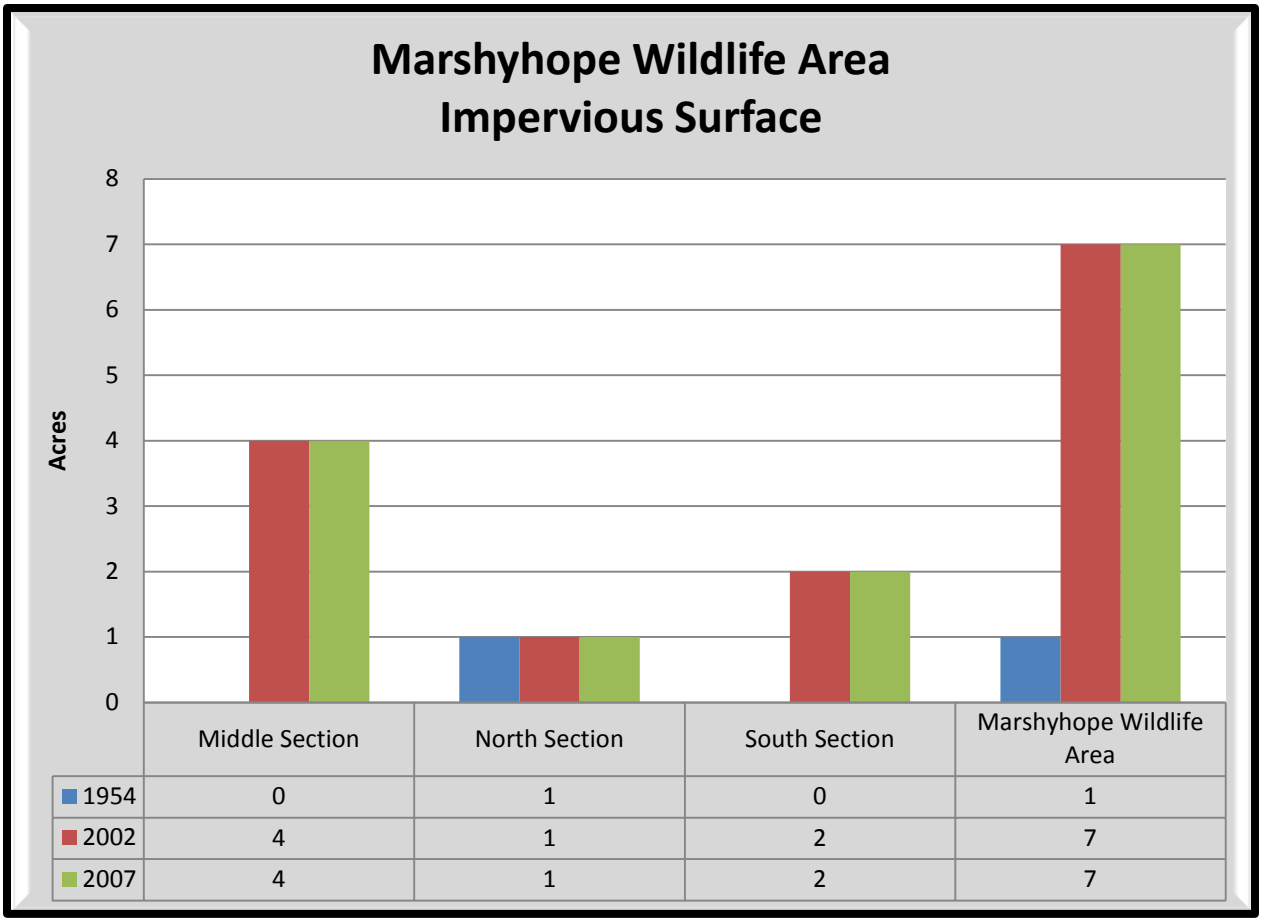


Figure 6.3. Impervious Surface at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital

Impervious surface does not contain any natural capital value.

Modified Land **[2 acres, (Figure 6.4)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

Modified Land includes those places where the soil has been disturbed and contains little or no vegetation.

Analysis of Condition at Marshyhope Wildlife Area

All of the current acreage of modified land came from 2 acres of Early to Mid-Successional Loblolly Pine Forest.

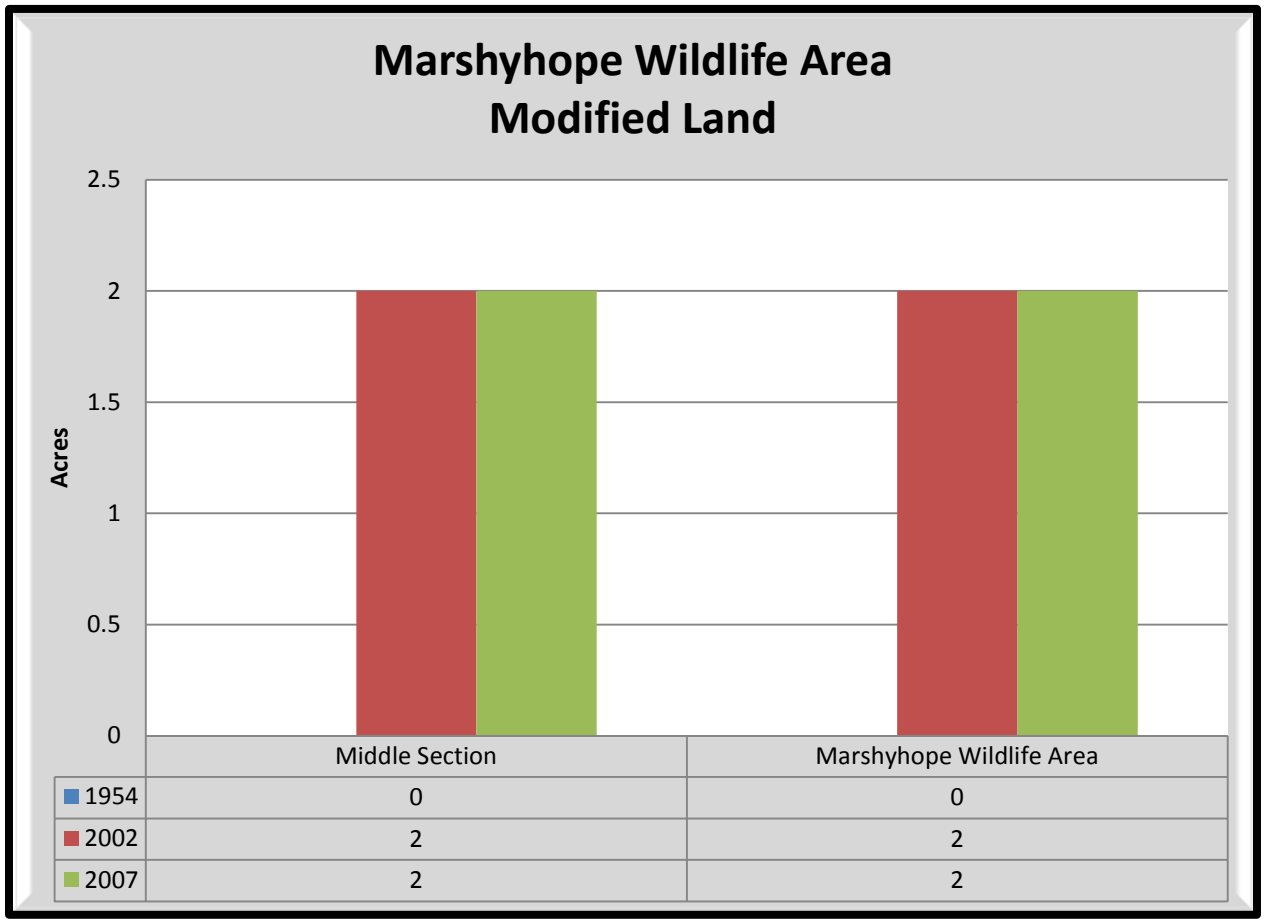


Figure 6.4. Modified Land at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital

Modified Land does not contain any natural capital value.

***Semi-impervious Surface* [7 acres, (Figure 6.5, Tables 6.7-6.8)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

Semi-impervious surface includes dirt roads that have packed soil that limits the absorption of water.

Analysis of Condition at Marshyhope Wildlife Area

None of the semi-impervious surface from 1954 still existed in 2007. What was once semi-impervious surface had become 4 acres of Loblolly Pine Plantation, 3 acres of impervious surface, 2 acres of cultivated lawn, 1 acre of Mid-Atlantic Mesic Mixed Hardwood Forest, and 1 acre of Early to Mid-Successional Loblolly Pine Forest (Table 6.7). Since 1954, the acreage of semi-impervious has decreased but it was still developed in 2 acres of Early to Mid-Successional Loblolly Pine Forest and 0.1 acres of Southern Red Maple-Blackgum Swamp (Table 6.8).

Table 6.7. What was Semi-impervious Surface in 1954 has become X in 2007	
X	**Acreage**
Loblolly Pine Plantation	4 acres
Impervious Surface	3 acres
Cultivated Lawn	2 acres
Mid-Atlantic Mesic Mixed Hardwood Forest	1 acre
Early to Mid-Successional Loblolly Pine Forest	1 acre
Other communities/land covers	0.3 acres

Table 6.8. Semi-impervious Surface has migrated into X since 1954	
X	**Acreage**
Early to Mid-Successional Loblolly Pine Forest	2 acres
Southern Red Maple-Blackgum Swamp	0.1 acres

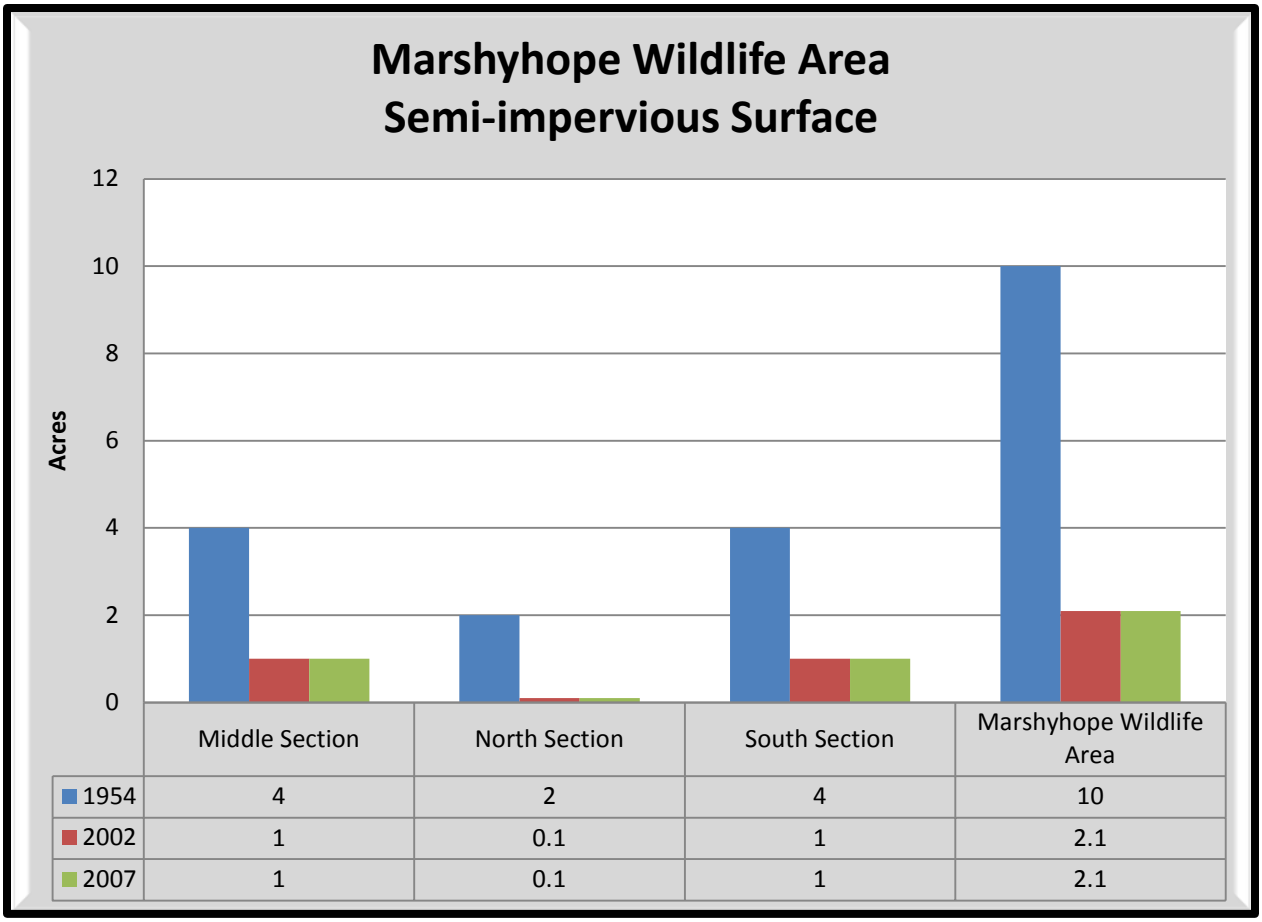


Figure 6.5. Semi-impervious Surface at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital

Semi-impervious surface does not contain any natural capital value.

***Water* [9 acres, (Figure 6.6, Tables 6.9-6.10)]**

DEWAP: Non-tidal Coastal Plain Streams
NHC: No Equivalent Classification

Description

Water includes the main stem of Marshyhope Creek and its tributaries.

Analysis of Condition at Marshyhope Wildlife Area

All of the water from 1954 was still present in 2007. Since 1954, the amount of water coverage in the wildlife area has increased by flooding 3 acres of Southern Red Maple-Blackgum Swamp, 2 acres of Chesapeake Bay Non-riverine Wet Hardwood Forest, 1 acre of Mid-Atlantic Mesic Mixed Hardwood Forest, and 0.5 acres of Early to Mid-Successional Loblolly Pine Forest (Table 6.9).

Table 6.9. Water has migrated into X since 1954

X	Acreage
Southern Red Maple-Blackgum Swamp	3 acres
Chesapeake Bay Non-riverine Wet Hardwood Forest	2 acres
Water	1 acre
Mid-Atlantic Mesic Mixed Hardwood Forest	1 acre
Early to Mid-Successional Loblolly Pine Forest	0.5 acres
Other communities/land covers	0.1 acres

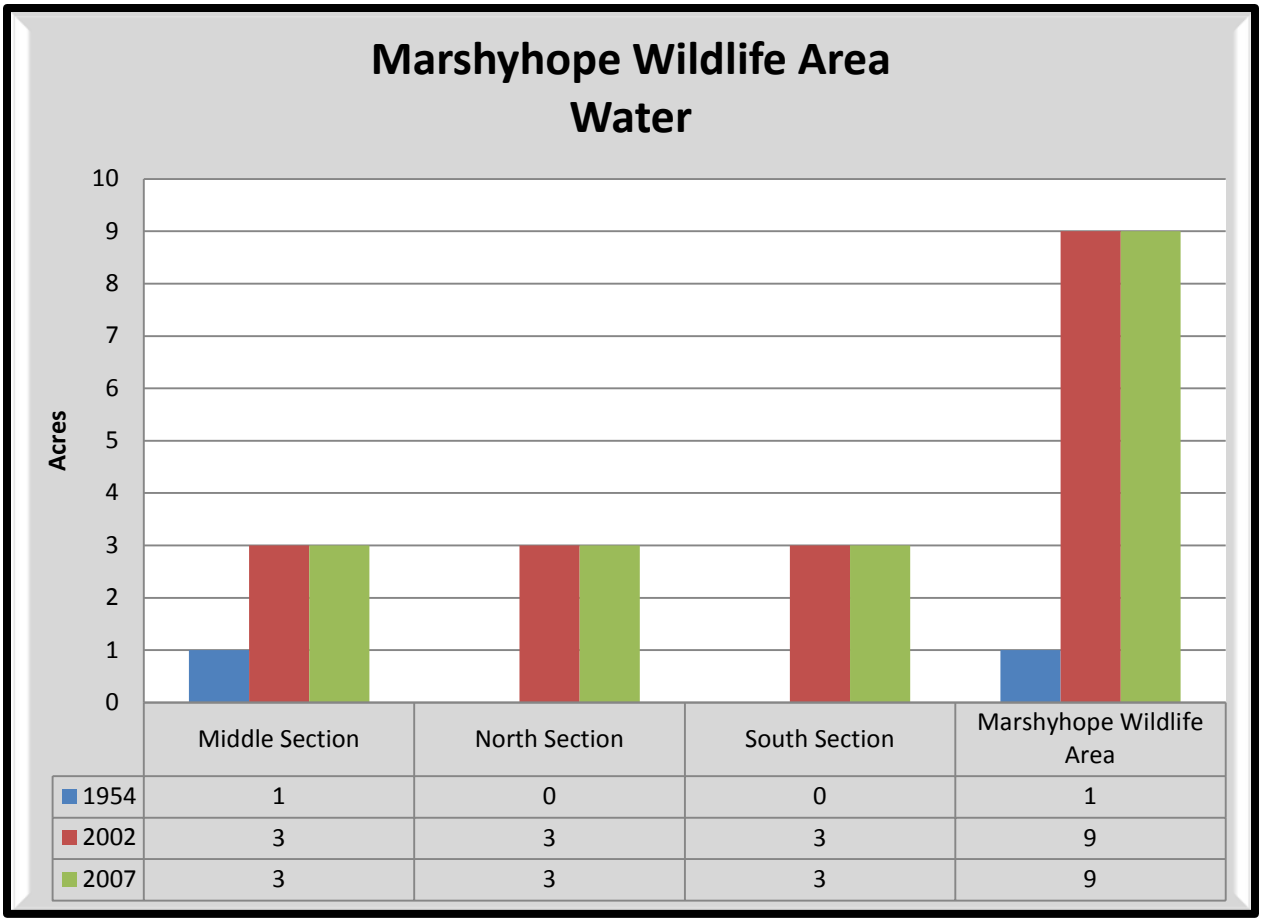


Figure 6.6. Water at Marshyhope Wildlife Area (1954, 2002, and 2007)

Natural Capital (Table 6.10)

Water has increased in capital because of flooding behind a berm in the North Section. It has been stable in the 2002 to 2007 period.

Table 6.10. Natural Capital of Water	
Year	**Natural Capital (in 2012 dollars)**
1954	$5,335/year
2002	$48,016/year
2007	$48,016/year

APPENDIX I: STATE RARE VEGETATION RANKING CRITERIA

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

State Rank

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

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

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

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

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

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

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

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

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

SNR Unranked

SNA Not Applicable

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

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

APPENDIX II: SGCN SPECIES EXPECTED FOR KEY WILDLIFE HABITATS

SGCN Species expected in Coastal Plain Upland Forest			
Species	**Common Name**	**Class**	**Tier**
Cicindela patruela consentanea	Northern barrens tiger beetle	Insect	1
Callophrys irus	frosted elfin	Insect	1
Catocala antinympha	sweetfern underwing	Insect	1
Catocala lacrymosa	tearful underwing	Insect	1
Terrapene carolina	Eastern box turtle	Reptile	1
Eumeces laticeps	broadhead skink	Reptile	1
Cemophora coccinea	scarlet snake	Reptile	1
Elaphe guttata	corn snake	Reptile	1
Lampropeltis triangulum	milk snake	Reptile	1
Haliaeetus leucocephalus	Bald eagle	Bird	1
Accipiter cooperii	Cooper's Hawk	Bird	1
Buteo platypterus	broad-winged hawk	Bird	1
Asio otus	long-eared owl	Bird	1
Melanerpes erythrocephalus	red-headed woodpecker	Bird	1
Certhia americana	brown creeper	Bird	1
Hylocichla mustelina	wood thrush	Bird	1
Wilsonia citrina	hooded warbler	Bird	1
Sciurus niger cinereus	Delmarva fox squirrel	Mammal	1
Discus catskillensis	angular disc	Gastropod	2
Cicindela patruela	Northern barrens tiger beetle	Insect	2
Cicindela unipunctata	one-spotted tiger beetle	Insect	2
Photuris frontalis	a firefly	Insect	2
Erynnis martialis	mottled duskywing	Insect	2
Erynnis baptisiae	wild indigo duskywing	Insect	2
Battus philenor	pipevine swallowtail	Insect	2
Polygonia progone	gray comma	Insect	2
Caripeta aretaria	a geometer moth	Insect	2
Tolype notialis	a lasiocampid moth	Insect	2
Hemileuca maia maia	the buckmoth	Insect	2
Cisthene kentuckiensis	Kentucky lichen moth	Insect	2
Cisthene tenuifascia	a lichen moth	Insect	2
Grammia phyllira	phyllira tiger moth	Insect	2
Zale metata	a noctuid moth	Insect	2
Catocala flebilis	mournful underwing	Insect	2
Catocala residua	residua underwing	Insect	2
Catocala cerogama	Yellow banded underwing	Insect	2
Acronicta exilis	Exiled dagger moth	Insect	2
Acronicta lithospila	Streaked dagger moth	Insect	2
Papaipema araliae	Aralia shoot borer moth	Insect	2
Papaipema baptisiae	Wild indigo borer moth	Insect	2

Lepipolys perscripta	A noctuid moth	Insect	2
Scincella lateralis	Ground skink	Reptile	2
Heterodon platirhinos	Eastern hognose snake	Reptile	2
Lampropeltis getula	Common kingsnake	Reptile	2
Storeria occipitomaculata	Redbelly snake	Reptile	2
Virginia valeriae	Smooth earth snake	Reptile	2
Agkistrodon contortix	Copperhead	Reptile	2
Coragyps atratus	Black vulture	Bird	2
Strix varia	Barred owl	Bird	2
Caprimulgus vociferus	whip-poor-will	Bird	2
Colaptes auratus	Northern flicker	Bird	2
Myiarchus crinitus	Great crested flycatcher	Bird	2
Sitta pusilla	Brown-headed nuthatch	Bird	2
Vireo flavifrons	Yellow-throated vireo	Bird	2
Dendroica dominca	Yellow-throated warbler	Bird	2
Mniotilta varia	Black-and-white warbler	Bird	2
Seiurus motacilla	Louisiana waterthrush	Bird	2
Oporornis formosus	Kentucky warbler	Bird	2
Piranga olivacea	Scarlet tanager	Bird	2
Piplio erythrophthalmus	Eastern towhee	Bird	2
Icterus galbula	Baltimora oriole	Bird	2
Lasionycteris noctivagans	Silver-haired bat	Mammal	2
Lasiurus borealis	Eastern red bat	Mammal	2
Lasiurus cinereus	Hoary bat	Mammal	2
Canis latrans	coyote	Mammal	2

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

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

SGCN Species expected in Early Successional Upland Habitats			
Species	**Common Name**	**Class**	**Tier**
Nicrophorus americanus	American burying beetle	Insect	1
Callophrys irus	frosted elfin	Insect	1
Papaipema maritima	maritime sunflower borer moth	Insect	1
Terrapene carolina	Eastern box turtle	Reptile	1

Lampropeltis triangulum	milk snake	Reptile	1
Branta canadensis	Canada goose (migratory)	Bird	1
Circus cyaneus	Northern harrier	Bird	1
Bartramia longicauda	upland sandpiper	Bird	1
Scolopax minor	American woodcock	Bird	1
Asio flammeus	short-eared Owl	Bird	1
Chordeiles minor	common nighthawk	Bird	1
Lanius ludovicianus	loggerhead shrike	Bird	1
Dendroica discolor	prairie warbler	Bird	1
Ammodramus henslowii	Henslow's sparrow	Bird	1
Cincindela scutellaris	festive tiger beetle	Insect	2
Atrytonopsis hianna	dusted skipper	Insect	2
Satyrium liparops	striped hairstreak	Insect	2
Satyrium liparops strigosum	stiped hairstreak	Insect	2
Callophrys gryneus	juniper hairstreak	Insect	2
Speyeria aphrodite	aphrodite fritillary	Insect	2
Speyeria idalia	regal fritillary	Insect	2
Boloria bellona	meadow fritillary	Insect	2
Paratrea plebeja	trumpet vine sphinx	Insect	2
Calyptra canadensis	Canadian owlet	Insect	2
Acronicta rubricoma	a dagger moth	Insect	2
Papaipema rigida	rigid sunflower borer moth	Insect	2
Cirrhophanus triangulifer	a noctuid moth	Insect	2
Schina septentrionalis	a noctuid moth	Insect	2
Plegadis falcinellus	glossy ibis	Bird	2
Cygnus columbianus	tundra swan	Bird	2
Coragyps atratus	black vulture	Bird	2
Colinus virginianus	Northern bobwhite	Bird	2
Pluvialis squatarola	black-bellied plover	Bird	2
Coccyzus erythropthalmus	black-billed cuckoo	Bird	2
Chaetura pelagica	chimney swift	Bird	2
Colaptes auratus	Northern flicker	Bird	2
Empidonax minimus	least flycatcher	Bird	2
Tyrannus tyrannus	Eastern kingbird	Bird	2
Toxostoma rufum	Brown thrasher	Bird	2
Dendroica pensylvanica	Chestnut-sided warbler	Bird	2
Icteria virens	Yellow-breasted chat	Bird	2
Piplio erythrophthalmus	Eastern towhee	Bird	2
Spizella pusilla	field sparrow	Bird	2
Pooecetes gramineus	vesper sparrow	Bird	2
Passerculus sandwichensis	savannah sparrow	Bird	2
Ammodramus savannarum	grasshopper sparrow	Bird	2
Dolichonyx oryzivorus	bobolink	Bird	2
Cryptotis parva	least shrew	Bird	2

SGCN Species expected in Impoundments			
Species	**Common Name**	**Class**	**Tier**
Podilymbus podiceps	Pied-billed grebe	Bird	1
Branta canadensis	Canada goose (migratory)	Bird	1
Anas rubripes	American black duck	Bird	1
Pandion haliaetus	osprey	Bird	1
Actitus macularia	Spotted sandpiper	Bird	1
Cygnus columbianus	Tundra swan	Bird	2
Anas platyrhynchos	mallard	Bird	2
Anas clypeata	Northern shoveler	Bird	2
Aythya valisneria	canvasback	Bird	2
Aythya marila	Greater scaup	Bird	2
Aythya affinis	Lesser scaup	Bird	2
Bucephala albeola	bufflehead	Bird	2
Lophodytes cucullatus	Hooded merganser	Bird	2
Pluvialis squatarola	Black-bellied plover	Bird	2
Himantopus mexicanus	Black-necked stilt	Bird	2
Catoptrophorus semipalmatus	willet	Bird	2
Calidris pusilla	Semipalmated sandpiper	Bird	2
Calidris alpina	dunlin	Bird	2

SGCN Species expected in Non-tidal Coastal Plain Streams			
Species	**Common Name**	**Class**	**Tier**
Alasmidonta heterodon	Dwarf Wedgemussel	Bivalves	1
Alasmindonta undulata	Triangle floater	Bivalves	1
Lampsilis cariosa	Yellow lampmussel	Bivalves	1
Lampsilis radiata	Eastern lampmussel	Bivalves	1
Leptodea ochracea	Tidewater mucket	Bivalves	1
Ligumia nasuta	Eastern pondmussel	Bivalves	1
Gomphus fraternus	Midland clubtail	Insects	1
Cottus caeruleomentum	Blueridge Sculpin	Fishes	1
Acipenser brevirostrum	Shortnose sturgeon	Fishes	1
Acipenser oxyrinchus	Atlantic sturgeon	Fishes	1
Notropis bifrenatus	Bridle shiner	Fishes	1
Notropis chalybaeus	Ironcolor shiner	Fishes	1
Moxostoma macrolepidotum	Shorthead redhorse	Fishes	1
Ictalurus natalis	Yellow bullhead	Fishes	1
Acantharchus pomotis	Mud sunfish	Fishes	1
Percina peltata	Shield darter	Fishes	1
Actitis macularia	Spotted sandpiper	Birds	1
Anodonta implicata	Alewife floater	Bivalves	2
Elliptio fisheriana	Northern Lance	Bivalves	2

Strophitus undulatus	creeper	Bivalves	2
Photuris pensylvanica	A firefly	Insects	2
Photuris hebes	A firefly	Insects	2
Cordulegaster bilineata	Brown spiketail	Insects	2
Domogomphus spinosus	Black-shouldered spinyleg	Insects	2
Gomphus rogersi	Sable clubtail	Insects	2
Gomphus apomyius	Banner clubtail	Insects	2
Macromia taeniolata	Royal river cruiser	Insects	2
Tetragoneuria costalis	Stripe-winged baskettail	Insects	2
Helocordulia selysii	Sely's sundragon	Insects	2
Somatochlora filosa	Fine-lined emerald	Insects	2
Somatochlora provocans	Treetop emerald	Insects	2
Celithemis ornata	Faded pennant	Insects	2
Enallagma dubium	Burgundy bluet	Insects	2
Enallagma durum	Big bluet	Insects	2
Enallagma pallidum	Pale bluet	Insects	2
Enallagma weewa	Blackwater bluet	Insects	2
Nehalennia integricollis	Southern Sprite	Insects	2
Archilestes grandis	Great spreadwing	Insects	2
Gomphus plagiatus	Russet-tipped clubtail	Insects	2
Gomphus villosipes	Unicorn clubtail	Insects	2
Lampetra aepyptera	Least brook lamprey	Fishes	2
Lampetra appendix	American brook lamprey	Fishes	2
Anguilla rostrata	American eel	Fishes	2
Alosa mediocris	Hickory shad	Fishes	2
Notropis amoenus	Comely shiner	Fishes	2
Noturus insignis	Margined madtom	Fishes	2
Apeltes quadracus	Fourspine stickleback	Fishes	2
Enneacanthus chaetodon	Blackbanded sunfish	Fishes	2
Enneacanthus obesus	Banded sunfish	Fishes	2
Etheostoma vitreum	Glassy darter	Fishes	2
Pseudemys rubriventus	Redbelly turtle	Reptiles	2
Regina septemvitta	Queen snake	Reptiles	2
Anas platyrhynchos	Mallard	Birds	2
Lophodytes cucullatus	Hooded merganser	Birds	2