Historical Analysis and Map of Vegetation Communities, Land Covers, and Habitats of Brandywine Creek State Park New Castle County, Delaware

Brandywine Creek Watershed

Submitted to:

Delaware State Parks
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CHAPTER 1: INTRODUCTION AND METHODS

Setting of Brandywine Creek State Park

Brandywine Creek State Park is located in northern New Castle County, Delaware (Figure 1.1). The State Park totals 939 acres. Brandywine Creek State Park is wholly within the Brandywine Creek watershed.

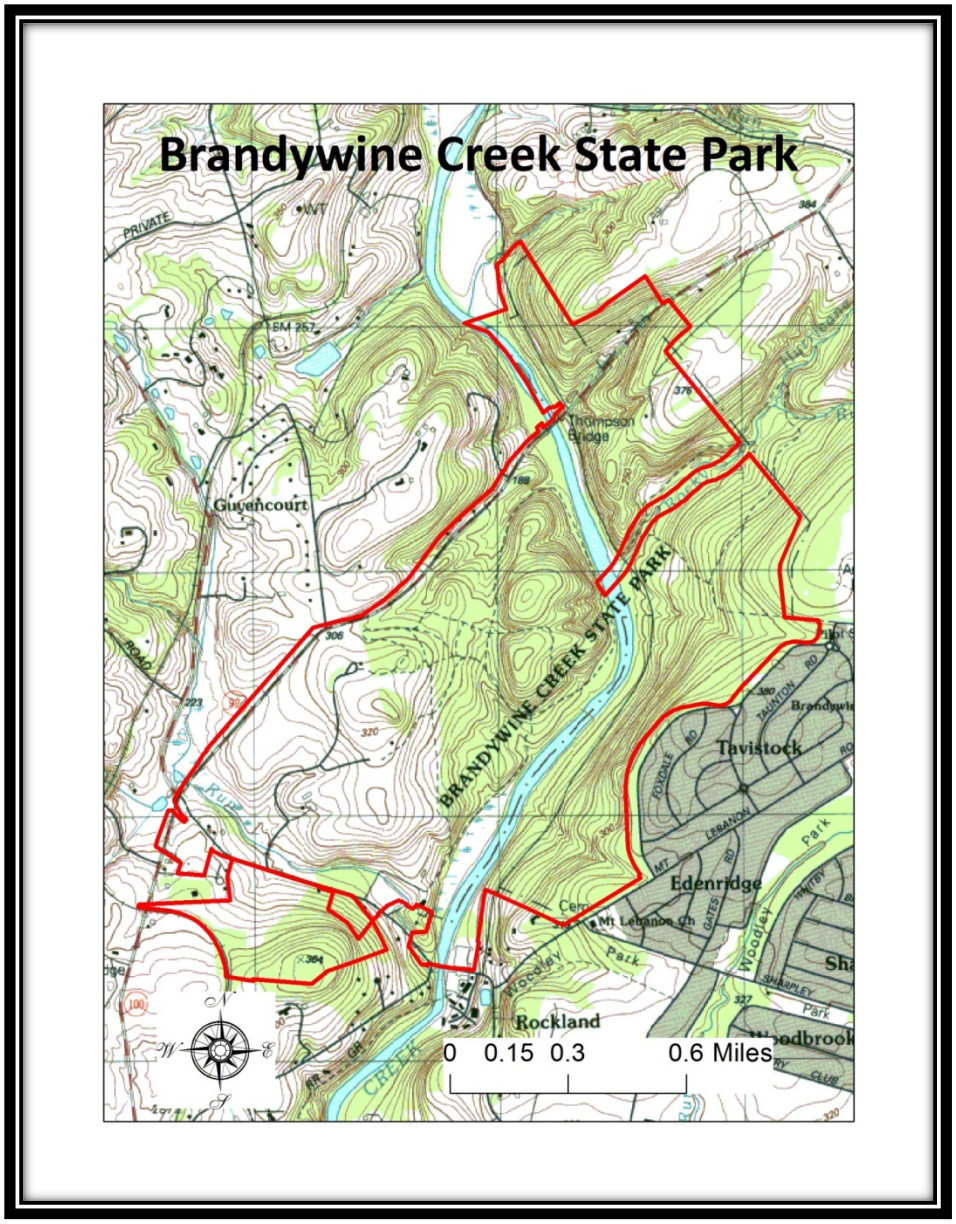


Figure 1.1. Location of Brandywine Creek State Park

Soils and Geology of Brandywine Creek State Park[1]

Underlying Geology

Brandywine Creek State Park is located in the Piedmont physiographic province of Delaware and underlaid by four formations, Brandywine Blue Gneiss, Montchanin Metagabbro, Rockford Park Gneiss, and Wissahickon Formation, and one deposit, Alluvial.

Brandywine Blue Gneiss dating from the Ordovician Period underlies most of the eastern portion of the park and is described as "medium to coarse grained granulites and gneisses composed of plagioclase, quartz, orthopyroxene, clinopyroxene, brown-green hornblende, magnetite, and ilmenite."

Montchanin Metagabbro dating from the Ordovician Period is located in localized areas in the western part of the park and very small amount in the northeast section. It is described as "coarse-grained gabbroic and metagabbroic rocks, variably metamorphosed and deformed."

A very small amount of Rockford Park Gneiss dating from the Ordovician Period is located just south of Rocky Run on the east side. This gneiss is described as "fine-grained mafic and fine to medium-grained felsic gneisses interlayered on the decimeter scale."

Most of the western side of the park is underlaid by the Wissahickon Formation. This formation dates from the Cambrian to Ordovician and is described as "Interlayered psammitic and politic gneiss with amphibolite."

A small amount of Alluvial deposits are located in the floodplain of Brandywine Creek near the Thompson Mill Bridge. These deposits date from the Holocene and are described as "brown, light yellow-orange, and gray fine to coarse quartz sand, silt, clay, and fine to medium gravel."

[1] Ramsey, Kelvin W. 2005. Geologic Map of New Castle County. Delaware Geological Survey, Geologic Map Series No. 13.

Soils

One soil, Neshaminy-Montalto Silt Loam, is prominent in the park and covers 302 acres. Other minor soils include Glenelg Loam (122 acres), Hatboro-Codorus Complex (109 acres), Brinklow-Blocktown Complex (93 acres), Neshaminy Silt Loam (92 acres), and Gaila Loam (80 acres).

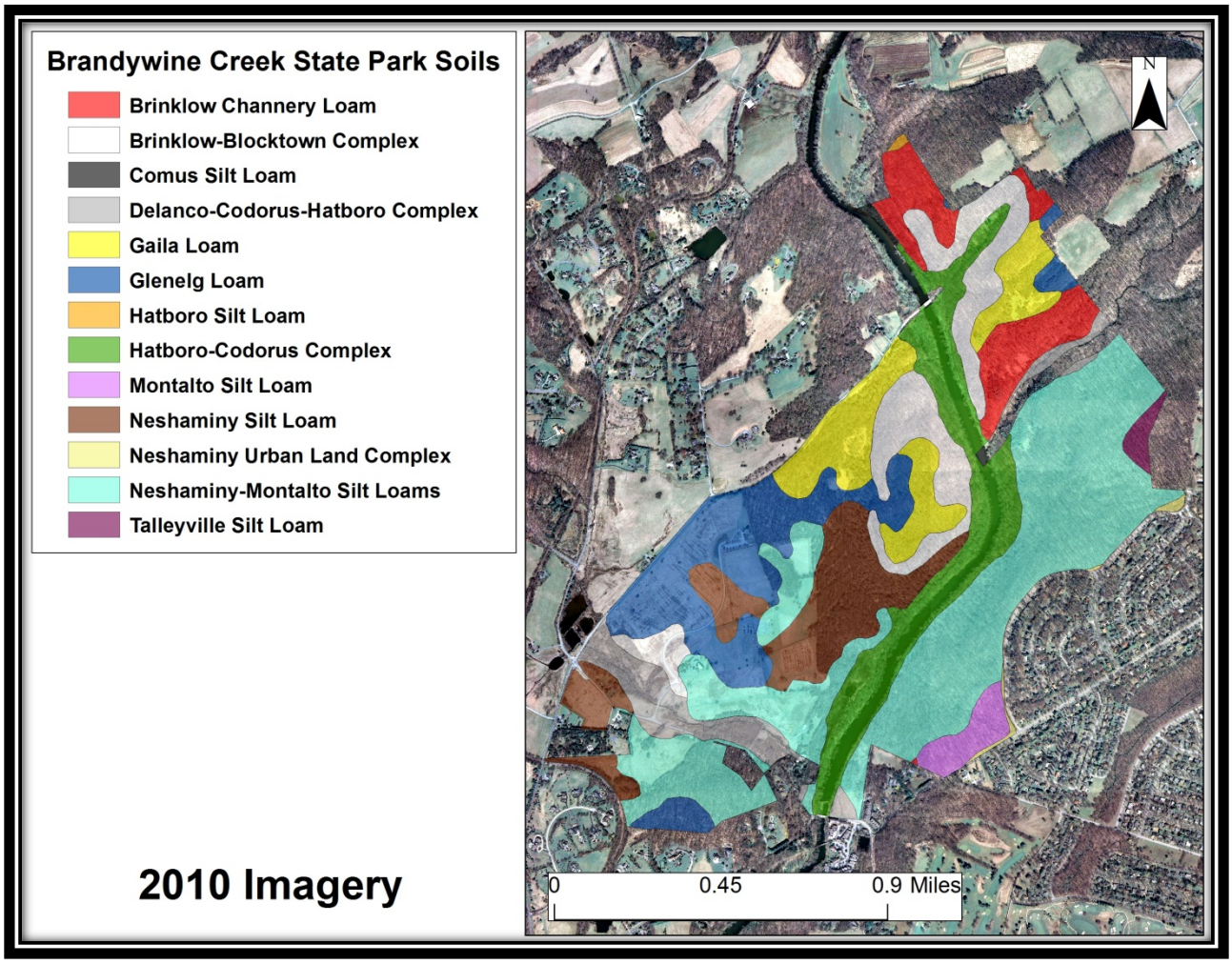


Figure 1.2. Brandywine Creek State Park Soil Map

Elevation

Elevations at Brandywine Creek State Park range from 130 feet at the Rockland Bridge to 395 feet near Talleyville. Most of the park is located in small "mini-gorge" with steep slopes.

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 Brandywine Creek State Park based on 1937, 2002, 2007, and 2010 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 state park.
4. Produce Ecological Integrity Assessments (EIAs) for vegetation communities that are ranked S2 or higher.

Surveys were conducted during 2006 and 2007 by Robert Coxe, an Environmental Scientist with the Delaware Natural Heritage and Endangered Species Program (DNHESP) within the Delaware Division of Fish and Wildlife, Department of Natural Resources and Environmental Control (DNREC).

Vegetation Community and Land Cover Surveys

Vegetation communities and land covers were determined by qualitative analysis using observations made in the field and aerial photo-interpretation using 1937, 2002, 2007, and 2010 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. Descriptions of the vegetation communities are provided in Chapter 4 and of land covers in Chapter 5. A crosswalk to the Delaware Wildlife Action Plan (DEWAP) and the Northeast Habitat Classification (NHC) is given at the top of each individual description.

Analysis of Historical Imagery

Historical imagery of Brandywine Creek State Park from 1937, 2002, 2007, and current imagery from 2010 were examined. A vegetation community map was produced for each year in order to compare vegetation and land cover change over a 5, 65, 70, and 73 year time frame. Changes in the respective vegetation communities and land covers are discussed in the descriptions while broader changes are discussed in the state park discussion. There is more imagery available (1954, 1961, 1968, 1992, and 1997) but these sets were not used due to geo-registration problems in the image tiles.

Ecological Integrity Assessment (EIA)

An EIA was conducted for those communities in the access area that are ranked S2 or higher in Delaware. EIAs are an analysis being developed by Natureserve to determine the relative quality of vegetation communities across North America. Using Natural Heritage methodology, communities are ranked according to rarity (Appendix I). The vegetation communities at Killens Pond State Park included in the EIA analysis are listed in Table 2.3.

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

Forest Block Analysis

Current forest blocks within or partially within the state park that are greater than 100 acres were mapped. Each current block is described for current total acres and current forest interior habitat, potential acres, potential forest interior habitat, vegetation communities currently present, and major drainage (Table 2.4). 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.

Natural Capital Analysis

The natural capital of each vegetation community 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.

[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.

[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:** Twenty-two vegetation communities and three land covers were found at Brandywine Creek State Park. Northern Piedmont Mesic Oak-Beech Forest (288 acres) is the largest vegetation community, followed by Northeastern Modified Successional Forest with 161 acres. Water (37 acres) is the largest land cover.

2. **Rare Plants:** Forty-four rare plants are known to exist in Brandywine Creek State Park (Table 2.1).

Scientific Name	Common Name	Rank	Last Observed
Agrimonia rostellata	Woodland Agrimony	S3	1991
Asclepias purpurascens	Purple Milkweed	S2	1988
Aureolaria flava var. *flava*	Yellow False-foxglove	S1	1988
Botrychium matricariifolium	Chamomile Grapefern	S1	1989
Bromus pubescens	Hairy Wood Brome Grass	S2	1989
Cardamine angustata	Slender Toothwort	S2	1993
Carex bushii	Bush's Sedge	S2	???
Carex davisii	Davis' Sedge	S1	1996
Carex sparganioides	Bur-reed Sedge	S2	1994
Carex torta	Twisted Sedge	S2	2000
Chaerophyllum procumbens var. *procumbens*	Spreading Chervil	S2	2000
Conophilus americana	Squaw-root	S2	1997
Cunila oreganoides	Common Dittany	S2	1996
Cypripedium parviflorum var. *pubescens*	Large Yellow Lady's Slipper	S1	1996
Cystopteris protrusa	Lowland Brittle Fern	S2	2000
Danthonia compressa	Flattened Oatgrass	S2	2000
Desmodium glutinosum	Large Tick-trefoil	S2	2000
Diervilla lonicera	Northern Bush-honeysuckle	S1	1988
Elymus hystrix	Bottle-brush Grass	S2	1993
Fraxinus nigra	Black Ash	S2	???
Galium lanceolatum	Torrey's Wild Lettuce	S3	1995
Geum virginianum	Pale Avens	S1	2000
Heteranthera dubia	Grassleaf Mud-Plantain	S2	1989
Hybanthus concolor	Green Violet	S1	2000
Hydrastis canadensis	Golden-seal	PDS3	2000
Hypericum prolificum	Shrubby St. John's Wort	S1.1	1992
Lactuca floridana var.	Woodland Lettuce	S2	1991

floridana			
Lobelia spicata var. *spicata*	Pale-spiked Lobelia	S2	1996
Monarda clinopodia	Basil Bee-balm	S2	1996
Muhlenbergia sobolifera	Cliff Muhly	S2	1991
Orobanche uniflora	One-flowered Broomrape	S3	1997
Ostyra virginiana	Eastern Hop Hornbeam	S2	???
Panax quinquefolius	American Ginseng	S2	2000
Paronychia fastigiata var. *fastigiata*	Cluster-stemmed Nail-wort	S2	1988
Podostemum ceratophyllum	Threadfoot	S1	???
Pyrola elliptica	Shinleaf	S2	1988
Ranunuculus caricetorum	Hispid Buttercup	S1	2000
Scirpus expansus	Red-stem Bulrush	S2	1994
Smallanthus uvedalius	Yellow-flowered Leafcup	S3	2010
Smilax tamnoides	Halbeard-leaf Greenbrier	S1	???
Solidago arguta	Cutleaf Goldenrod	S1	???
Solidago ulmifolia var. *ulmifolia*	Elm-leaf Goldenrod	S2	1994
Thaspium barbinode	Hairy-jointed Meadow-parsnip	S1	1996
Trichophorum planifolium	Bashful Bulrush	S2	1989
Trillium cernuum	Nodding Trillium	S2	1991
Triosteum perfoliatum	Perfoliate Tinker's Weed	S1.1	1988
Viola pedata	Bird's-foot Violet	S1	1992
Woodsia obtusa var. *obtusa*	Blunt-lobe Woodsia	S1	2003

Table 2.1 Rare Plants at Brandywine Creek State Park

3. **Rare Animals:** Fifteen rare animals are known to exist in Brandywine Creek State Park (Table 2.2).

Scientific Name	Common Name	Rank	Last Observed
Ambystoma maculatum	Spotted Salamander	S2	1991
Boloria bellona	Meadow Fritillary	SU	1989
Buteo platypterus	Broad-winged Hawk	S1B	1974
Dendroica dominica	Yellow-throated Warbler	S2B	1999
Dendroica pensylvanica	Chestnut-sided Warbler	S1B	???
Dolichonyx oryzivorus	Bobolink	SU	1991
Euphydryas phaeton	Baltimore Checkerspot	S1	1989
Eurycea longicauda	Longtail Salamander	S1	1982
Glyptemys muhlenbergii	Bog Turtle	S1	2002
Parula americana	Northern Parula	S1B	1996
Setophaga ruticilla	American Redstart	S1B	1969
Sympetrum semicinctum	Band-winged Meadowhawk	S1	1974
Vermivora pinus	Blue-winged Warbler	S1B	1974
Vireo gilvus	Warbling Vireo	S2B	1994
Wilsonia citrina	Hooded Warbler	S1B	1988

Table 2.2 Rare Animals at Brandywine Creek State Park

Ecological Integrity Assessment (EIA)

Seven vegetation communities are ranked S2 or higher. These areas include Box-elder Floodplain Forest, Central Appalachian Cutgrass Marsh, and Central Appalachian/Northern Piedmont Chestnut Oak Forest and are mapped and summarized in Table 2.3 and Figure 2.1.

Table 2.3. EIA Vegetation Communities located in Brandywine Creek State Park

Community Map	Community Name/EIA Score	Description
	**Brandywine 1** **Box-elder Floodplain Forest (28.6 acres)** **EIA = 3.23 (C rank)**	The floodplain forest is located on the floodplain of Brandywine Creek.
	**Brandywine 2** **Central Appalachian Cutgrass Marsh (2 acres)** **EIA = 3.74 (B rank)**	This wetland, called "Freshwater Marsh" is located in the floodplain of Brandywine Creek.
	**Brandywine 3** **Central Appalachian/Northern Piedmont Chestnut Oak Forest (26.5 acres)** **EIA = 3.3 (C rank)**	This upland forest community is located on west-facing slopes overlooking Brandywine Creek.

Community Map	Community Name/EIA Score	Description
	**Brandywine 4** **Mid-Atlantic Terrace Floodplain Forest (2.6 acres)** **EIA = 3.67 (B rank)**	This forest community is located on the floodplain of Brandywine Creek upstream of Thompson Mill Road.
	**Brandywine 5** **Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest (48.0 acres)** **EIA = 3.66 (B rank)**	This upland forest community is located on west-facing slopes overlooking Brandywine Creek.
	**Brandywine 6** **Northern Coastal Plain/Piedmont Basic Mesic Forest (33.6 acres)** **EIA = 3.70 (B rank)**	This "rich forest" community is located near the nature center of Brandywine Creek State Park.
	**Brandywine 7** **Southern New England Red Maple Seepage Swamp (4.8 acres)** **EIA = 4.09 (B rank)**	This wetland community is located in the floodplain of Rocky Run.

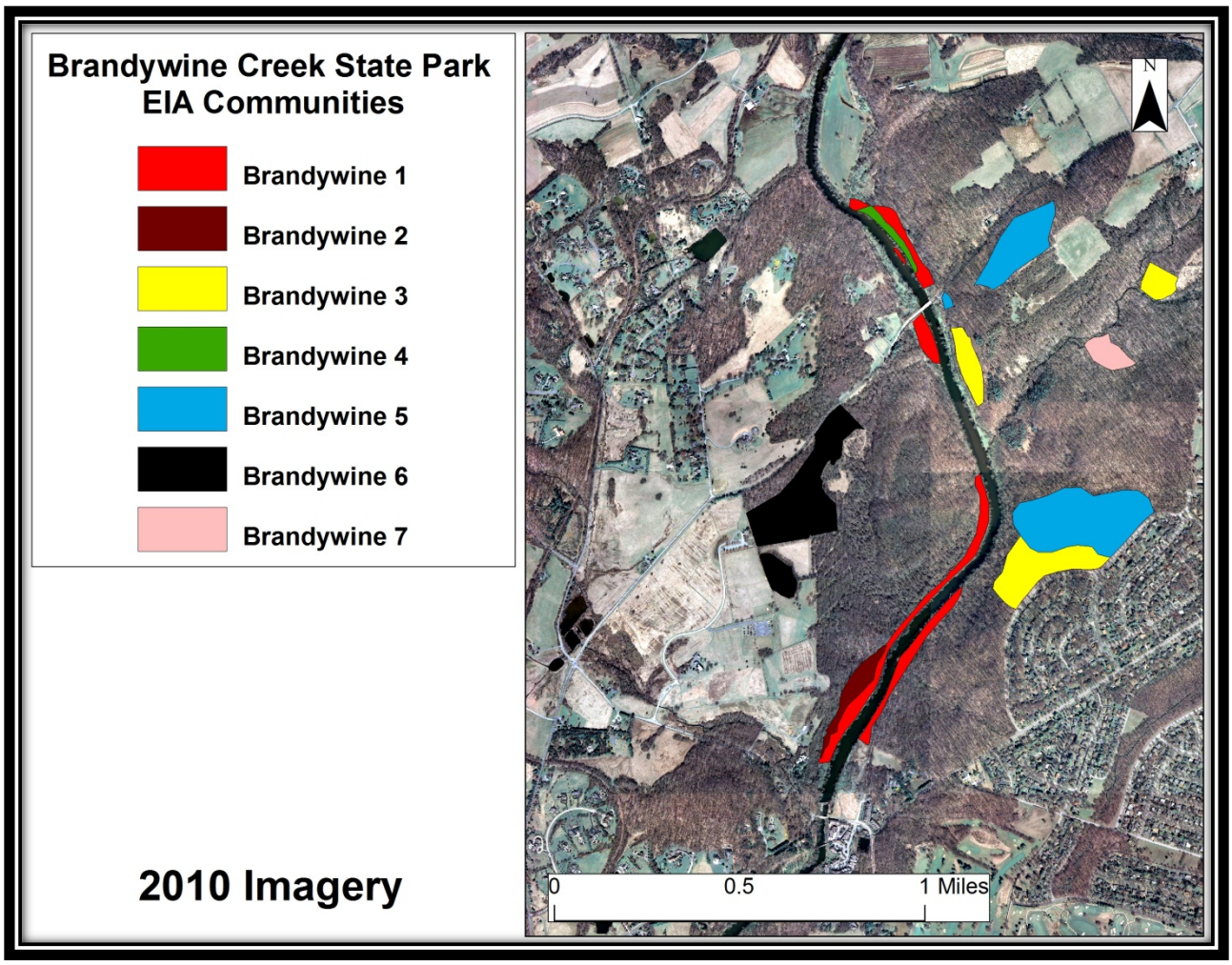


Figure 2.1. EIA Communities in Brandywine Creek State Park

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.

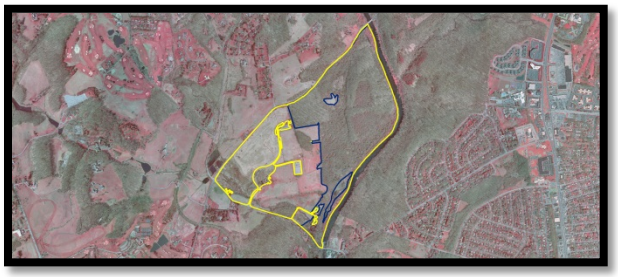
A study by Robbins et al. (1989) showed that most forest interior species require a forest of at least 150 ha (370 acres) in size. Very few forest tracts in Delaware are at least this size, one of the more notable being the Great Cypress Swamp.

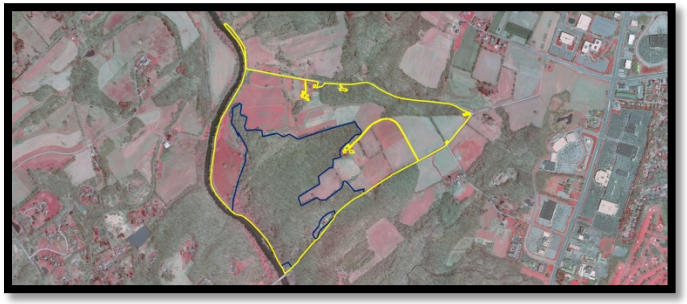
Analysis of Forest Blocks at Brandywine Creek State Park

Three forest blocks are present that are more than 100 acres in size and are located in whole or part in the preserve (Table 2.4 and Figure 2.2). 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 each forest block.

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

Table 2.4. Forest Blocks located in whole or part in Brandywine Creek State Park

Forest Block Map	Block Name/Acreage	Description
	**Brandywine Creek A** **Current Block = 235 acres (102 acres interior)** **Potential Block = 423 acres (200 acres interior)**	Brandywine Creek A covers the wooded area west of Brandywine Creek. It is bounded by Thompsons Bridge Road on the north, Brandywine Creek on the east, fields and Adams Dam Road on the south, and fields on the west. Five vegetation communities are located within this block and include Box-elder Floodplain Forest, Northeastern Modified Successional Forest, Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest, and Northern Piedmont Mesic Oak-Beech Forest. Brandywine Creek and Wilson Run drain this block. Currently this block contains 102 acres of interior habitat. Potentially this block could be 423 acres in size and contain 200 acres of interior habitat.
	**Brandywine Creek B** **Current Block = 490 acres (211 acres interior)** **Potential Block = 631 acres (381 acres interior)**	Brandywine Creek B covers the wooded area east of Brandywine Creek. It is bounded by Thompsons Bridge Road on the north, development on the east, development and Rockland Road on the south, and Brandywine Creek on the west. Nine vegetation communities are located within this block and include Box-elder Floodplain Forest, Central Appalachian/Northern Piedmont Chestnut Oak Forest, Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest, Northeastern Modified Successional Forest, Northern Piedmont Mesic Oak-Beech Forest, Red Spruce Planted Forest, Southern New England Red Maple Seepage Swamp, Successional Tuliptree Forest, and White Pine Planted Forest. Brandywine Creek and Rocky Run drain this block. Currently this block contains 211 acres of interior habitat. Potentially this block could be 631 acres in size and contain 381 acres of interior habitat.

Forest Block Map	Block Name/Acreage	Description
	**Brandywine Creek C** **Current Block = 115 acres (34 acres interior)** **Potential Block = 303 acres (151 acres interior)**	Brandywine Creek C covers the wooded area north of Thompson Bridge Road and east of Brandywine Creek. It is bounded by agricultural field on the north, fields on the east, Thompson Bridge Road on the south, and Brandywine Creek on the west. Four vegetation communities are located within this block and include Box-elder Floodplain Forest, Northeastern Modified Successional Forest, Northern Piedmont Mesic Oak-Beech Forest, and Successional Tuliptree Forest. Brandywine Creek drains this block. Currently this block contains 34 acres of interior habitat. Potentially this block could be 303 acres in size and contain 151 acres of interior habitat.

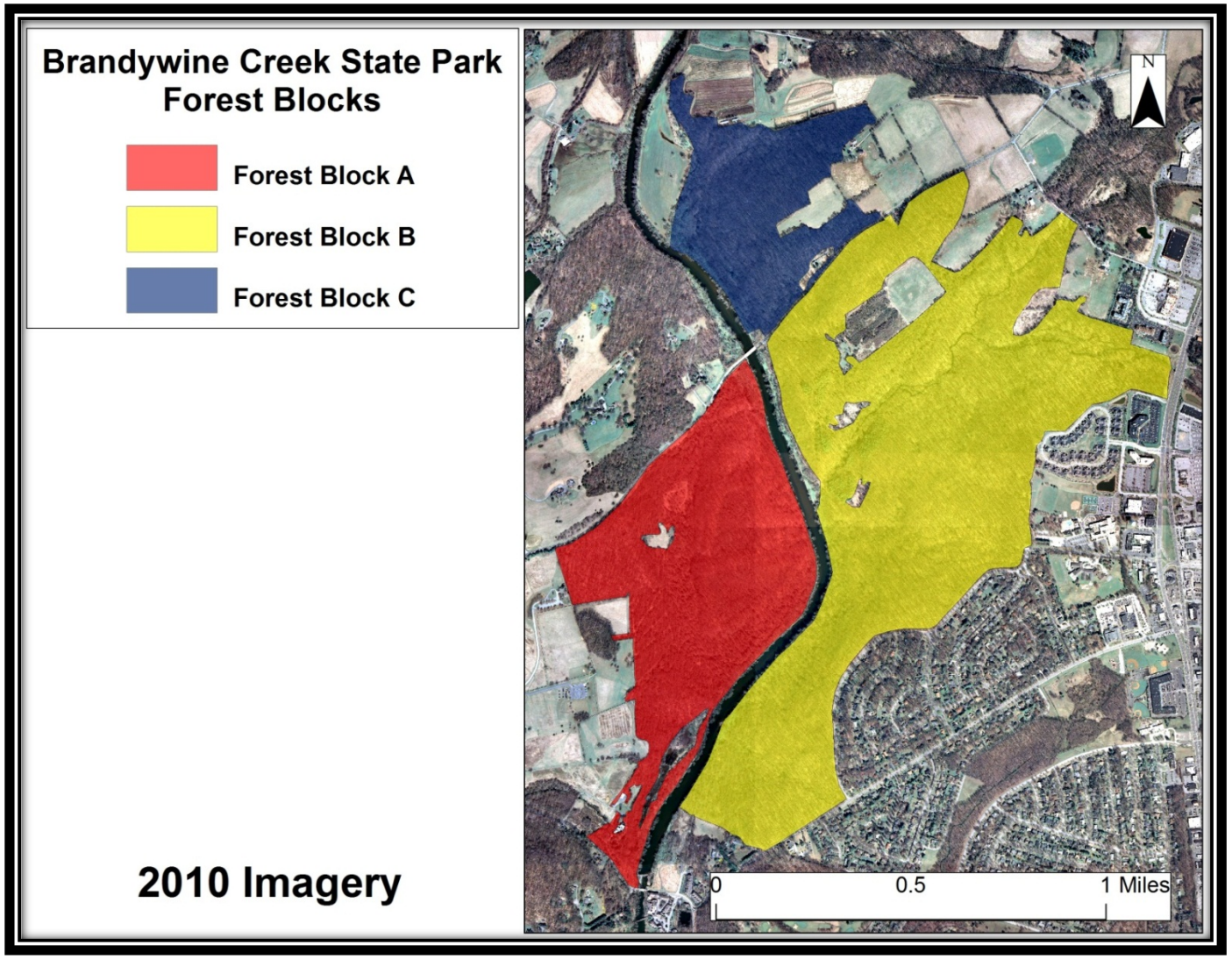


Figure 2.2. Forest Blocks at Brandywine Creek State Park

CHAPTER 3: BROAD TRENDS AT BRANDYWINE CREEK STATE PARK

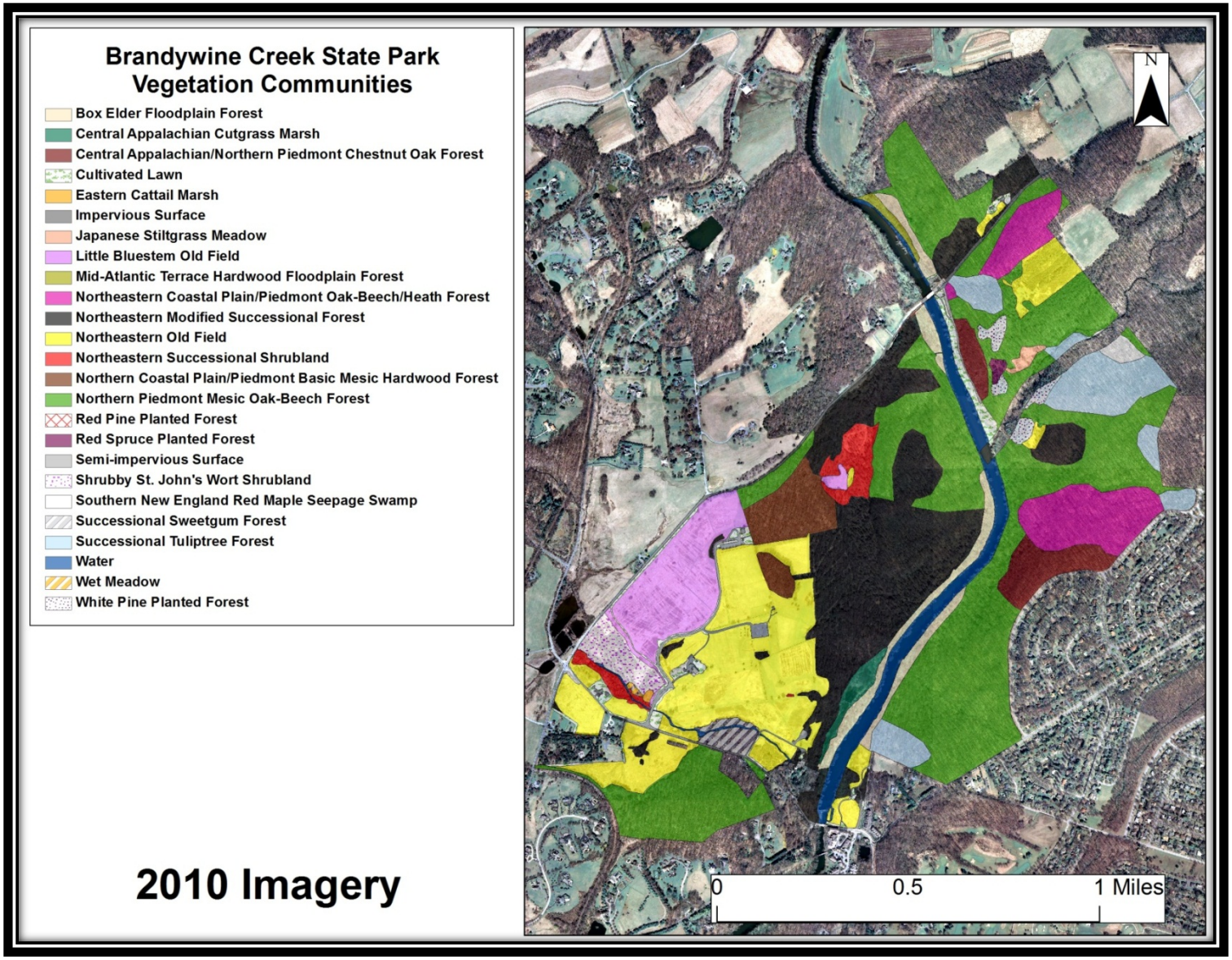


Figure 3.1. 2010 Vegetation Community Map of Brandywine Creek State Park

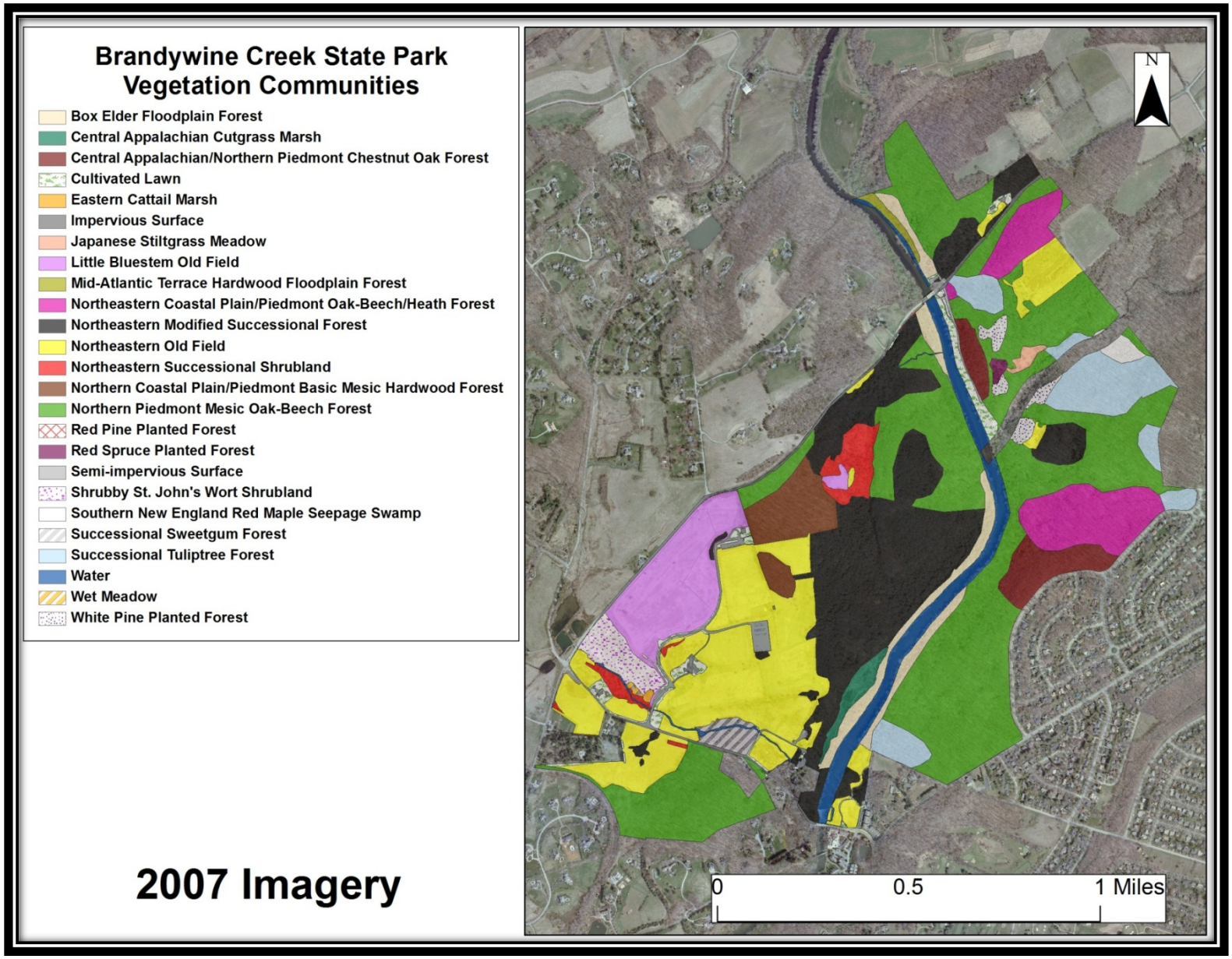


Figure 3.2. 2007 Vegetation Community Map of Brandywine Creek State Park

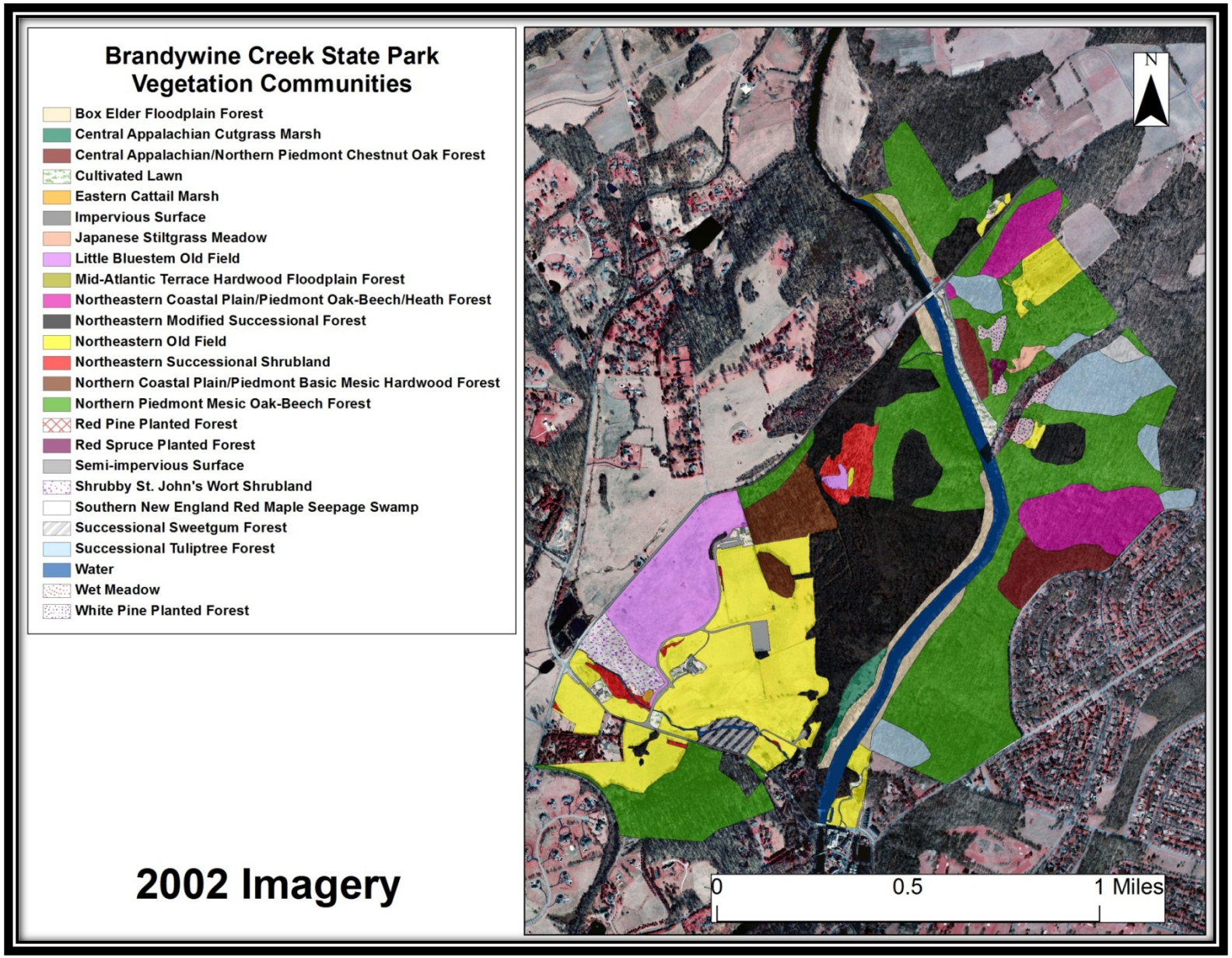


Figure 3.3. 2002 Vegetation Community Map of Brandywine Creek State Park

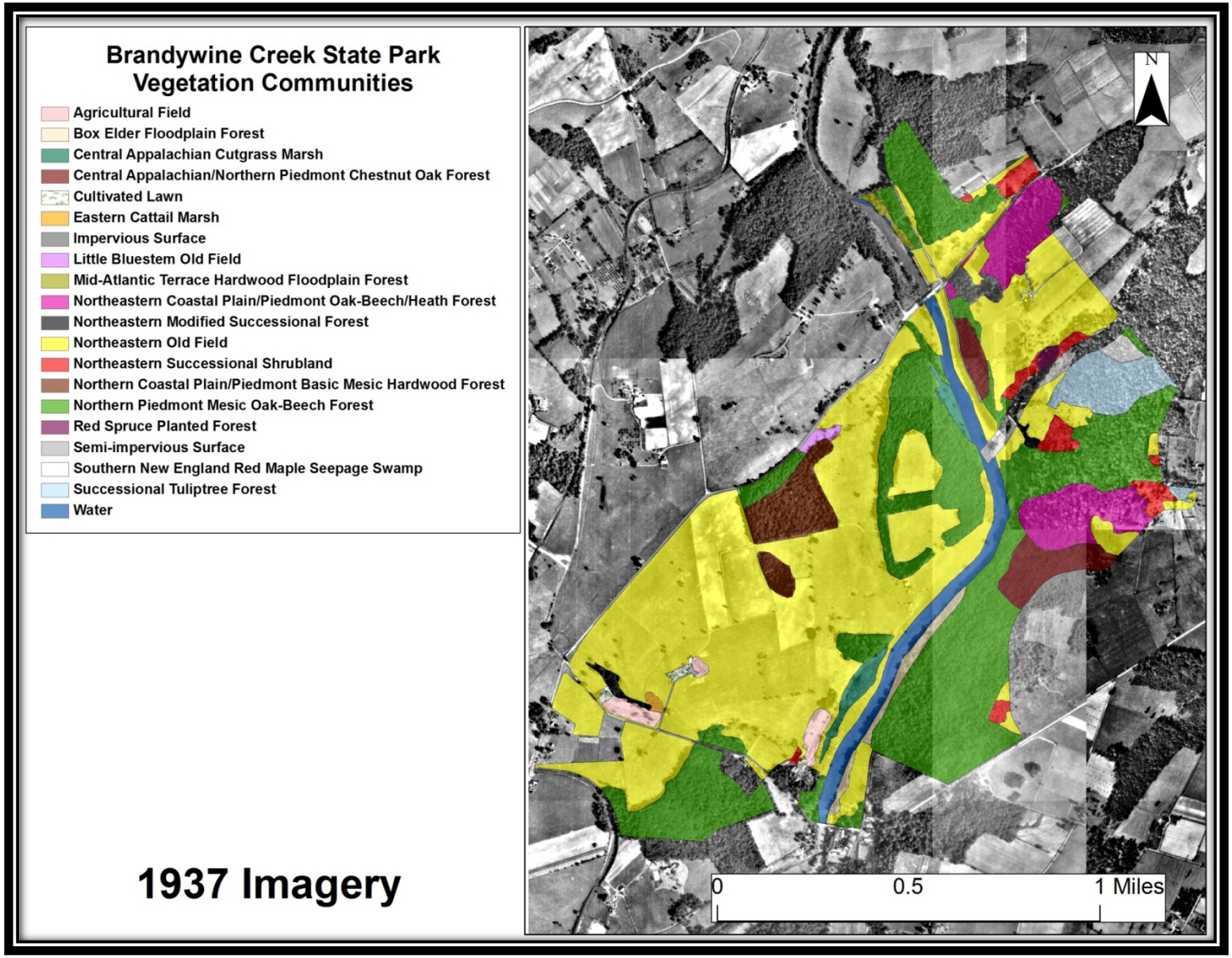
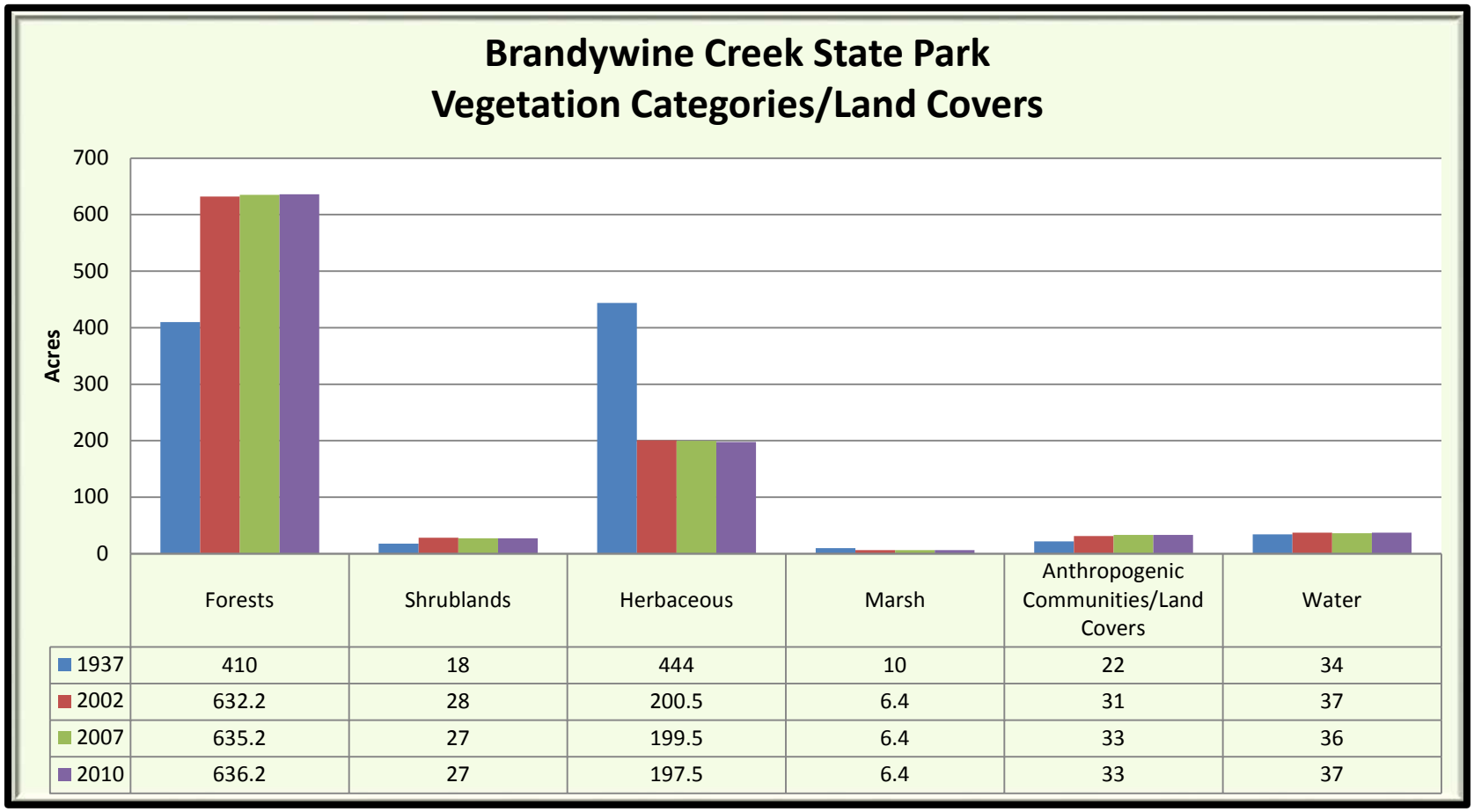


Figure 3.4. 1937 Vegetation Community Map of Brandywine Creek State Park



	Forests	Shrublands	Herbaceous	Marsh	Anthropogenic Communities/Land Covers	Water
1937	410	18	444	10	22	34
2002	632.2	28	200.5	6.4	31	37
2007	635.2	27	199.5	6.4	33	36
2010	636.2	27	197.5	6.4	33	37

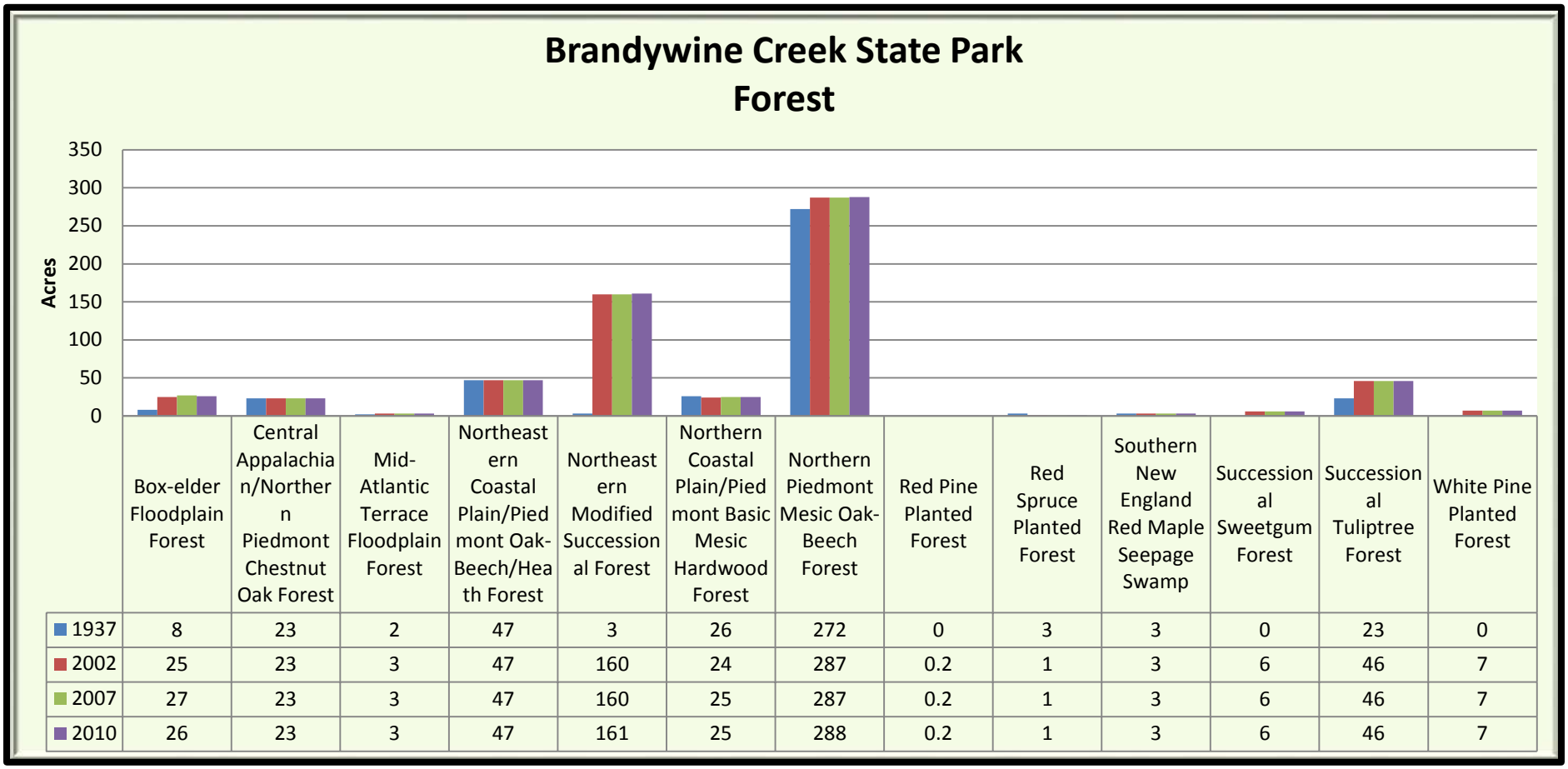
Figure 3.5. Brandywine Creek State Park Vegetation Categories/Land Covers (1937, 2002, 2007, and 2010)

Brandywine Creek State Park Broad Trends (Figure 3.5): Forest is the most vegetation community type in Brandywine Creek State Park. Herbaceous communities rank a distant second.

Natural Capital (Table 3.1)

Natural capital of Brandywine Creek State Park has increased overall since 1937 with reforestation of former fields. A recent decline was experienced in the 2007 to 2010 period.

3.1. Natural Capital of Brandywine Creek State Park	
Year	**Natural Capital (in 2012 dollars)**
1937	$576,899/year
2002	$899,007/year
2007	$918,153/year
2010	$911,283/year



	Box-elder Floodplain Forest	Central Appalachian/Northern Piedmont Chestnut Oak Forest	Mid-Atlantic Terrace Floodplain Forest	Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest	Northeastern Modified Successional Forest	Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest	Northern Piedmont Mesic Oak-Beech Forest	Red Pine Planted Forest	Red Spruce Planted Forest	Southern New England Red Maple Seepage Swamp	Successional Sweetgum Forest	Successional Tuliptree Forest	White Pine Planted Forest
1937	8	23	2	47	3	26	272	0	3	3	0	23	0
2002	25	23	3	47	160	24	287	0.2	1	3	6	46	7
2007	27	23	3	47	160	25	287	0.2	1	3	6	46	7
2010	26	23	3	47	161	25	288	0.2	1	3	6	46	7

Figure 3.6. Forest at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Brandywine Creek State Park Forest (Figure 3.6): Northern Piedmont Mesic Oak-Beech Forest is the most common forest community in the park and in the Piedmont of Delaware. Northeastern Modified Successional Forest is the second most common forest.

Natural Capital (Table 3.2)

Forest capital has increased since 1937, with a slight decline in the 2007 to 2010 period.

Table 3.2. Natural Capital of Brandywine Creek State Park Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$234,862/year
2002	$494,723/year
2007	$519,496/year
2010	$507,582/year

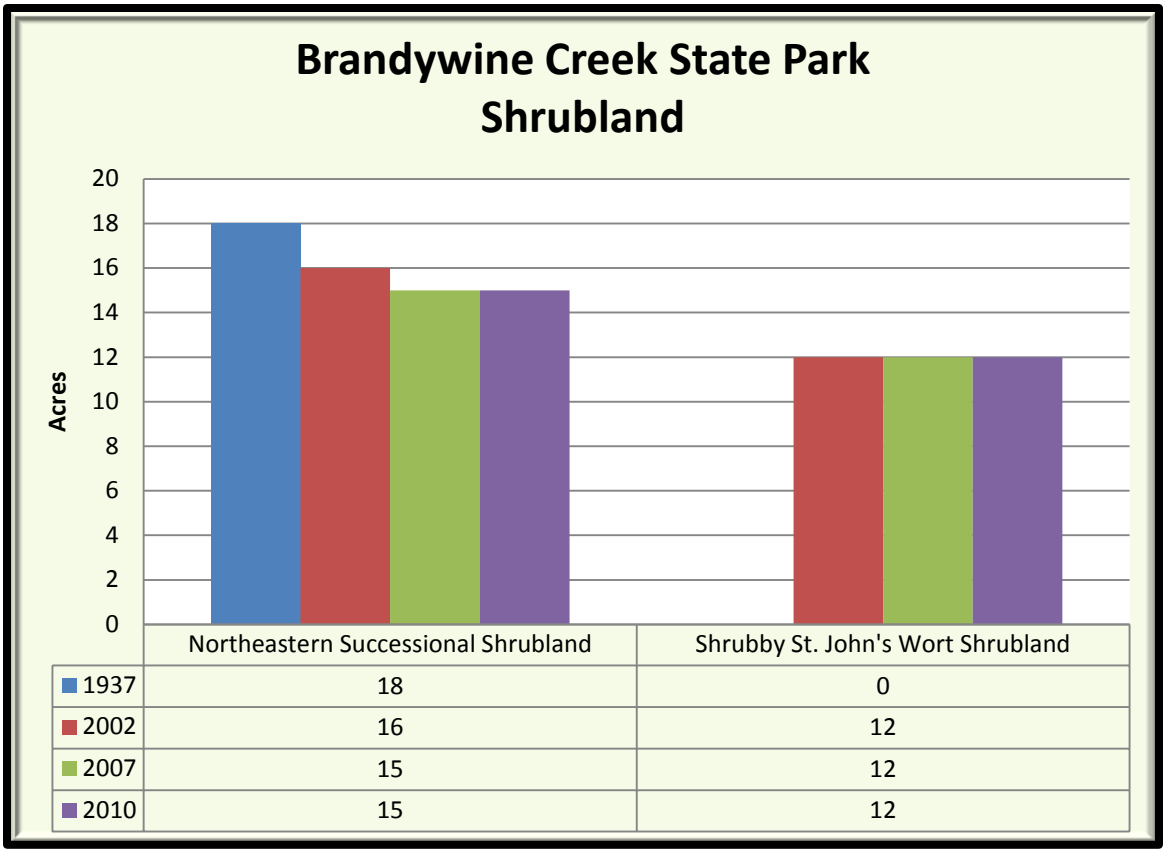


Figure 3.7. Shrubland at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Brandywine Creek State Park Shrubland (Figure 3.7): Northeastern Successional Shrubland decreased slightly in the park since 1937 and Shrubby St. John's Wort Shrubland has come into the park since 1937.

Natural Capital (Table 3.3)

Shrubland capital has increased since 1937 with the appearance of Shrubby St. John's Wort Shrubland. In the recent period the amount has been amount roughly stable.

Table 3.3. Natural Capital of Brandywine Creek State Park Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$2,623/year
2002	$113,703/year
2007	$113,558/year
2010	$113,558/year

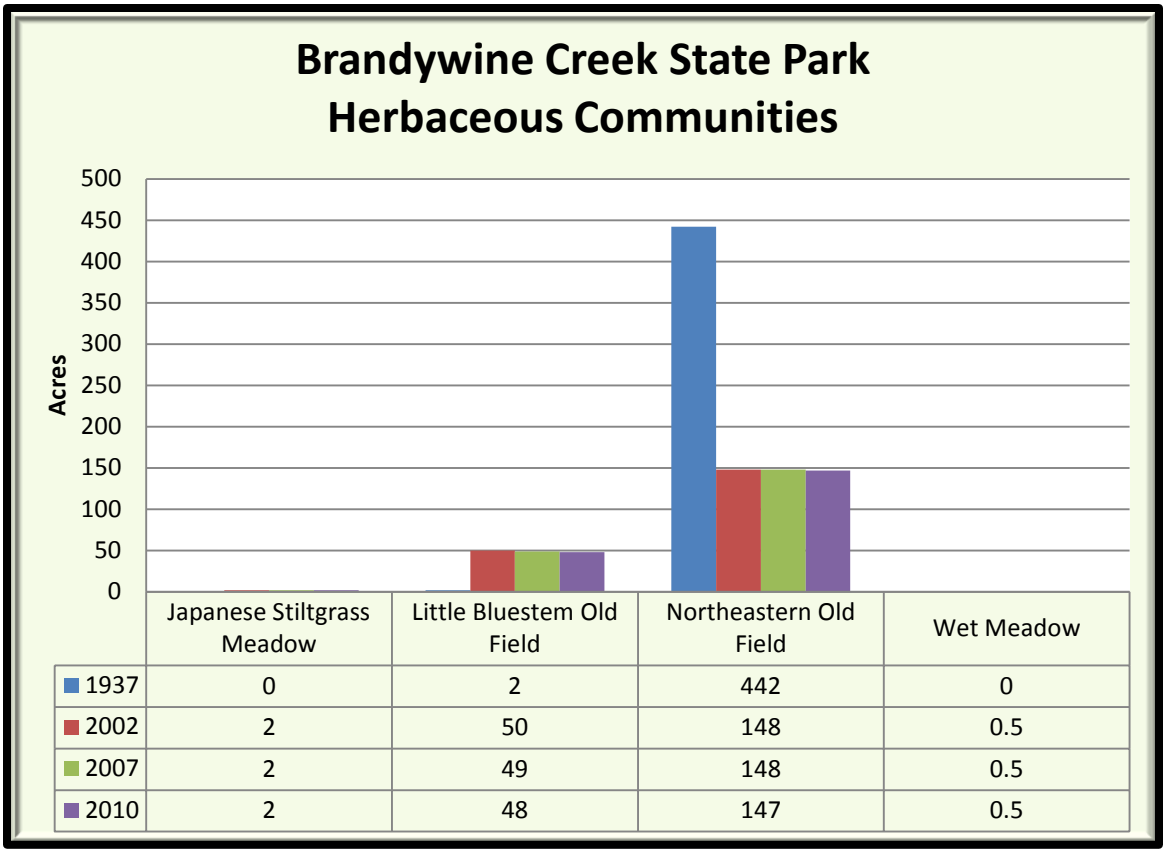


Figure 3.8. Herbaceous Communities at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Brandywine Creek State Park Herbaceous Communities (Figure 3.8): Northeastern Old Field is the most prominent herbaceous community in the park followed by Little Bluestem Old Field. Most of the Northeastern Old Field present in 1937 has grown into forested communities. Little Bluestem Old Field approximates the native prairies that were once in the area.

Natural Capital (Table 3.4)

Natural capital of herbaceous communities has decreased since 1937 as these communities mature into shrubland and forest. This has led to an increase in capital.

Table 3.4. Natural Capital of Brandywine Creek State Park Herbaceous Communities	
Year	**Natural Capital (in 2012 dollars)**
1937	$64,691/year
2002	$33,781/year
2007	$33,635/year
2010	$33,344/year

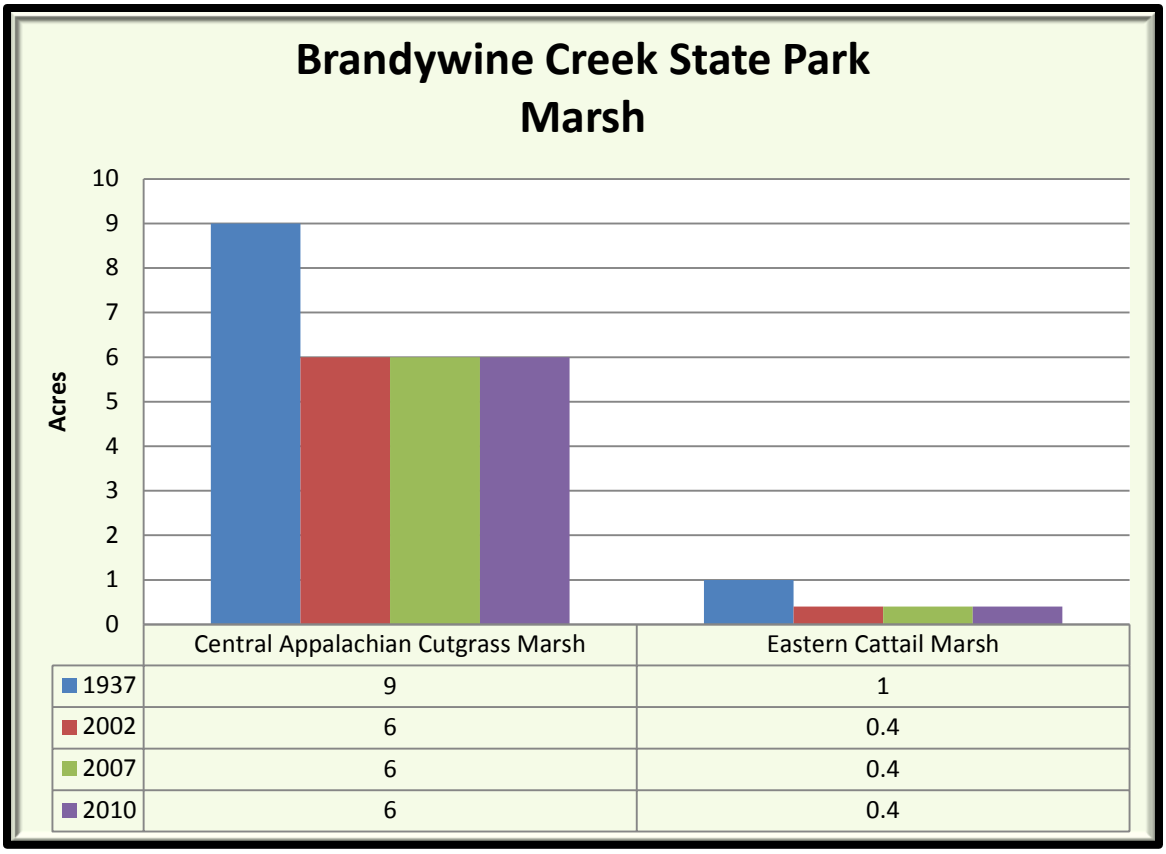


Figure 3.9. Marsh at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Brandywine Creek State Park Marsh (Figure 3.9): Two marsh communities, Central Appalachian Cutgrass Marsh and Eastern Cattail Marsh, are present in the park.

Natural Capital (Table 3.5)

Natural capital of marshland has decreased with a reduction in the acreage of Central Appalachian Cutgrass Marsh.

Table 3.5. Natural Capital of Brandywine Creek State Park Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$92,814/year
2002	$59,401/year
2007	$59,401/year
2010	$59,401/year

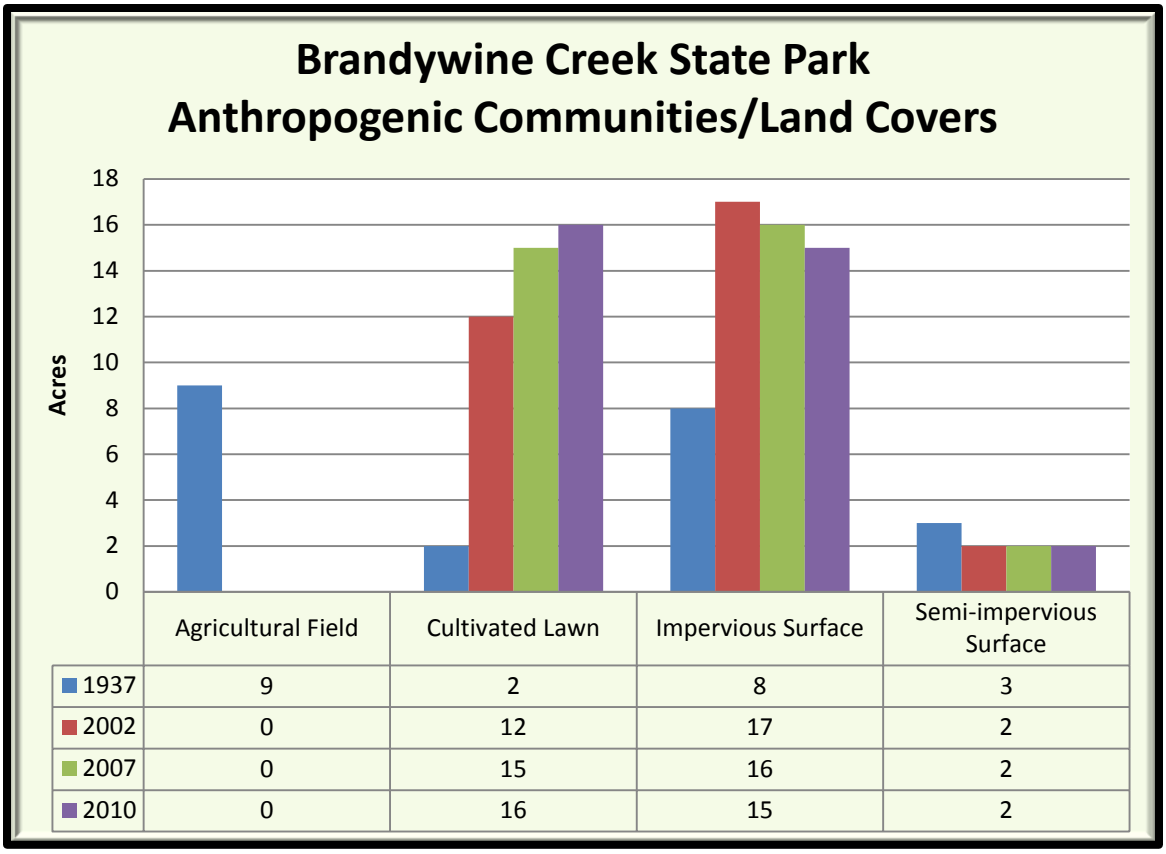


Figure 3.10. Anthropogenic Communities/Land Covers at Brandywine State Park (1937, 2002, 2007, and 2010)

Brandywine Creek State Park Anthropogenic Communities/Land Covers (Figure 3.10): Cultivated Lawn followed closely by Impervious Surface is the most common anthropogenic communities in the park.

Natural Capital (Table 3.6)

Agricultural field is the only Anthropogenic Community/Land Cover with any natural capital. It is no longer present in the park and has transferred its capital to herbaceous communities.

Table 3.6. Natural Capital of Brandywine Creek State Park Anthropogenic Communities/Land Covers	
Year	**Natural Capital (in 2012 dollars)**
1937	$516/year
2002	$0/year (not present)
2007	$0/year (not present)
2010	$0/year (not present)

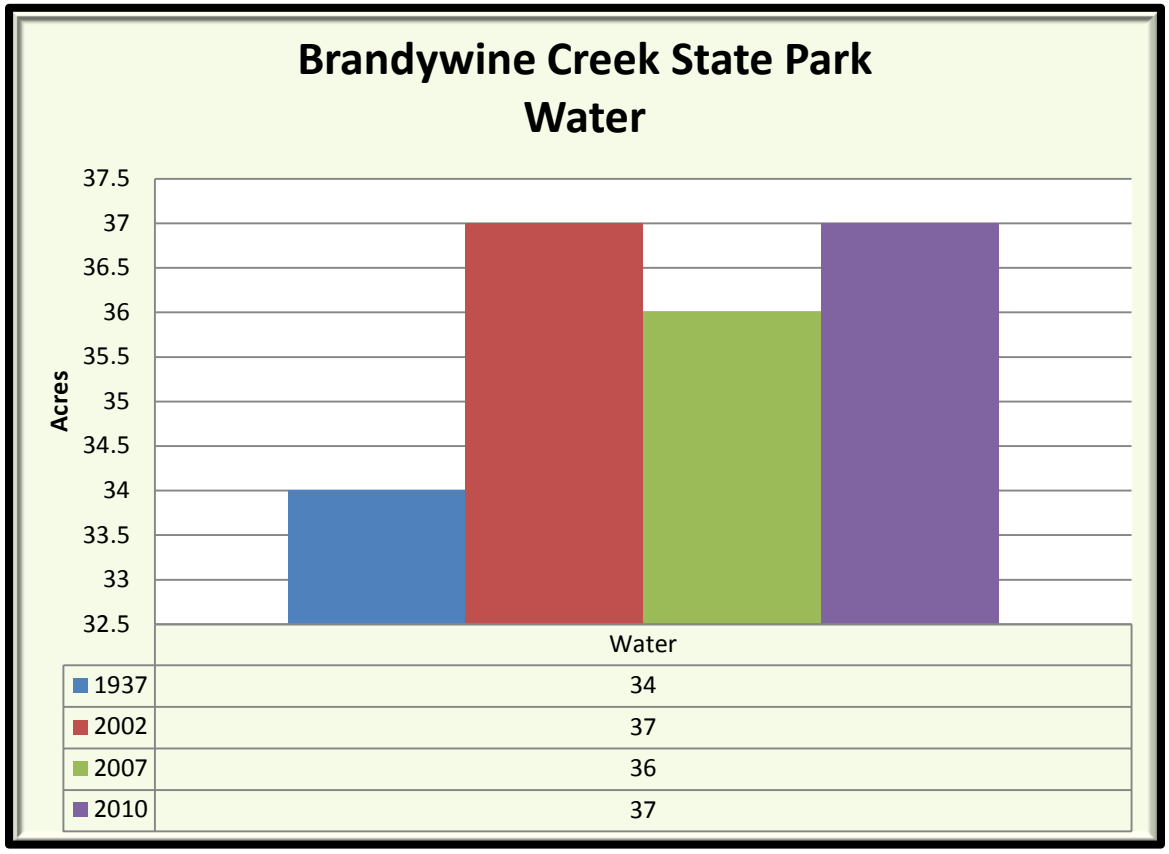


Figure 3.11. Water at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Brandywine Creek State Park Water (Figure 3.11): Water has increased overall but has oscillated in acreage over the recent period.

Natural Capital (Table 3.7)

The amount of water has increased over time, likely through erosion of the bank of Brandywine Creek. The amount has oscillated in the recent period (2002 to 2010).

Table 3.7. Natural Capital of Brandywine Creek State Park Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$181,393/year
2002	$197,399/year
2007	$192,064/year
2010	$197,399/year

CHAPTER 4: DESCRIPTIONS AND ANALYSIS OF THE VEGETATION COMMUNITIES

Twenty-one vegetation communities and three land covers were noted in the survey (Figures 3-6). Below is a list of the vegetation communities present in 2010 and historical in previous years and descriptions. The National Vegetation Classification (NVC) Association number is given with the vegetation community and their approximate acreage in the project area. Names of communities correspond with the common names as given in the NVC and the Guide to Delaware Vegetation Communities.

The vegetation communities include:

1. Box-elder Floodplain Forest (CEGL005033)—26 acres
2. Central Appalachian Cutgrass Marsh (CEGL006461)—6 acres
3. Central Appalachian/Northern Piedmont Chestnut Oak Forest (CEGL006299)—23 acres
4. Cultivated Lawn (CEGL008462)—16 acres
5. Eastern Cattail Marsh (CEGL006153)—0.5 acres
6. Japanese Stiltgrass Meadow (No NVCS Classification)—2 acres
7. Little Bluestem Meadow (CEGL006333)—48 acres
8. Mid-Atlantic Terrace Floodplain Forest (CEGL006314)—3 acres
9. Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest (CEGL006919)—47 acres
10. Northeastern Modified Successional Forest (CEGL006599)—161 acres
11. Northeastern Old Field (CEGL006107)—147 acres
12. Northeastern Successional Shrubland (CEGL006451)—15 acres
13. Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest (CEGL006055)—25 acres
14. Northern Piedmont Mesic Oak-Beech Forest-(CEGL006921)—288 acres
15. Red Pine Planted Forest (CEGL007177)—0.2 acres
16. Red Spruce Planted Forest (CEGL004758)—1 acre
17. Shrubby St. John's Wort Shrubland (No NVCS Classification)—12 acres
18. Southern New England Red Maple Seepage Swamp (CEGL006406)—3 acres
19. Successional Sweetgum Forest (CEGL007216)—6 acres
20. Successional Tuliptree Forest (CEGL007220)—46 acres
21. Wet Meadow (CEGL006485)—0.5 acres
22. White Pine Planted Forest (CEGL007178)—7 acres

The land covers include:

1. Impervious Surface—15 acres
2. Semi-impervious Surface—2 acres
3. Water—37 acres

Box-elder Floodplain Forest **[26 acres (Figures 4.1-4.2, Tables 4.1-4.3)] G4G5 S2**

DEWAP: Forested Floodplains and Riparian Swamps
NHC: Central Appalachian River Floodplain

Description

Box-elder Floodplain Forest is found on the larger floodplains in Brandywine Creek State Park. This community is dominated or co-dominated by box-elder (*Acer negundo*) and associated by silver maple (*Acer saccharinum*), wild black cherry (*Prunus serotina*), and tuliptree (*Liriodendron tulipifera*). The understory is composed of smaller members of the canopy. Multiflora rose (*Rosa multiflora*) and winged Euonymus (*Euonymus alatus*) composed the shrub and vine layer. The herb layer is composed of lesser celandine (*Ficaria verna*), garlic mustard (*Alliaria petiolata*), stinging nettle (*Urtica dioica*), Virginia blue bell (*Mertensia virginica*), false mermaidweed (*Floerkea proserpinacoides*), and Jacob's ladder (*Polemonium reptans*).

Figure 4.1. Box-elder Floodplain Forest

The examples of this community in the park are in the late successional stage with average dbh's of 1 foot to 1.5 feet. A lot of these communities are punctuated by disturbance because of occasional flooding from the creek.

Analysis of Condition at Brandywine Creek State Park

This community is located in places of natural disturbance from flooding and scouring. As such exotic invasive plant species such as Japanese hops (*Humulus japonicus*) may invade and cover the herbaceous layer.

In 2010, six acres of the eight acres of Box-Elder Floodplain Forest from 1937 was still present. The remaining acreage had become 1 acre of Northeastern Modified Successional Forest, 1 acre of Northeastern Old Field, and 1 acre of water (Table 4.1). Since 1937, this community has increased in acreage by growing into 16 acres of Northeastern Old Field, converting 3 acres of Northern Piedmont Mesic Oak-Beech Forest, been covered by 1 acre of water, and 0.2 acres of Semi-impervious Surface (Table 4.2).

Table 4.1. What was once Box-elder Floodplain Forest in 1937 has become X or remained in 2007	
X	**Acreage**
Box-elder Floodplain Forest	6 acres
Northeastern Modified Successional Forest	1 acre
Northeastern Old Field	1 acre
Water	1 acre

Table 4.2. Box-elder Floodplain Forest has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	16 acres
Box-elder Floodplain Forest	6 acres
Northern Piedmont Mesic Oak-Beech Forest	3 acres
Water	1 acre
Semi-impervious Surface	0.2 acres

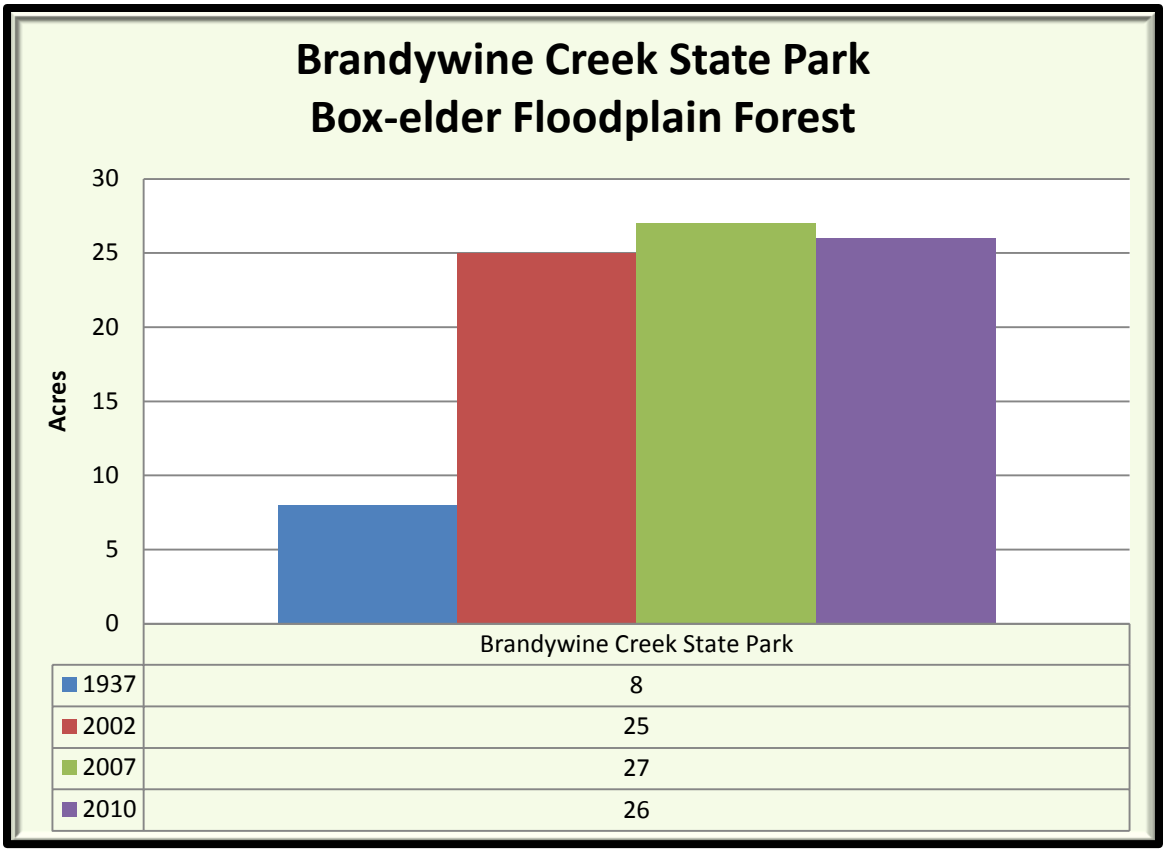


Figure 4.2. Box-elder Floodplain Forest at Brandywine Creek State Park (1937, 2002, 2007, 2010)

Natural Capital (Table 4.3)

Natural capital of Box-elder Floodplain Forest has increased overall as this forest covers previously open floodplains.

Table 4.3. Natural Capital of Box-elder Floodplain Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$98,332/year
2002	$307,288/year
2007	$331,871/year
2010	$319,579/year

Central Appalachian Cutgrass Marsh **[6 acres (Figures 4.3-4.4, Tables 4.4-4.6)] GNR S1**

DEWAP: Piedmont Stream Valley Wetland
NHC: Central Appalachian Stream and Riparian

Description

This community composes Freshwater Marsh in the park and is the location of a large wetland in the floodplain of Brandywine Creek. Dominant species include European sweetflag (*Acorus calamus*), rice-cutgrass (*Leersia oryzoides*), large bur-reed (*Sparganium eurycarpum*), and halbeard-leaf tearthumb (*Polygonum sagittatum*). Other common species include reed canarygrass (*Phalaris arundinacea*), arrow-leaf tearthumb (*Polygonum arifolium*), three-way sedge (*Dulichium arundinaceum*), false nettle (*Boehmeria cylindrica*), orange-spotted jewelweed (*Impatiens capensis*), stiff marsh bedstraw (*Galium tinctorium*), and Canadian clearweed (*Pilea pumila*).

Figure 4.3. Central Appalachian Cutgrass Marsh (photo: Chris Bennett)

This wetland has been the focus of many restoration efforts by varying the level of Brandywine Creek to grazing cattle in the wetland.

Analysis of Condition at Brandywine Creek State Park

This community is located in places of natural disturbance from flooding and scouring. As such exotic invasive plant species such as Japanese hops (*Humulus japonicus*) may invade and cover the herbaceous layer.

In 2007, six acres of the eight acres of Central Appalachian Cutgrass Marsh present in 1937 was still present. The rest had become 3 acres of Northern Piedmont Mesic Oak-Beech Forest (Table 4.4). Central Appalachian Cutgrass Marsh has decreased in acreage since 1937 and has not gained any new acreage.

Table 4.4. What was once Central Appalachian Cutgrass Marsh in 1937 has become X or remained in 2007	
X	**Acreage**
Central Appalachian Cutgrass Marsh	6 acres
Northern Piedmont Mesic Oak-Beech Forest	3 acres

Table 4.5. Central Appalachian Cutgrass Marsh has migrated into X or remained since 1937	
X	**Acreage**
Central Appalachian Cutgrass Marsh	6 acres

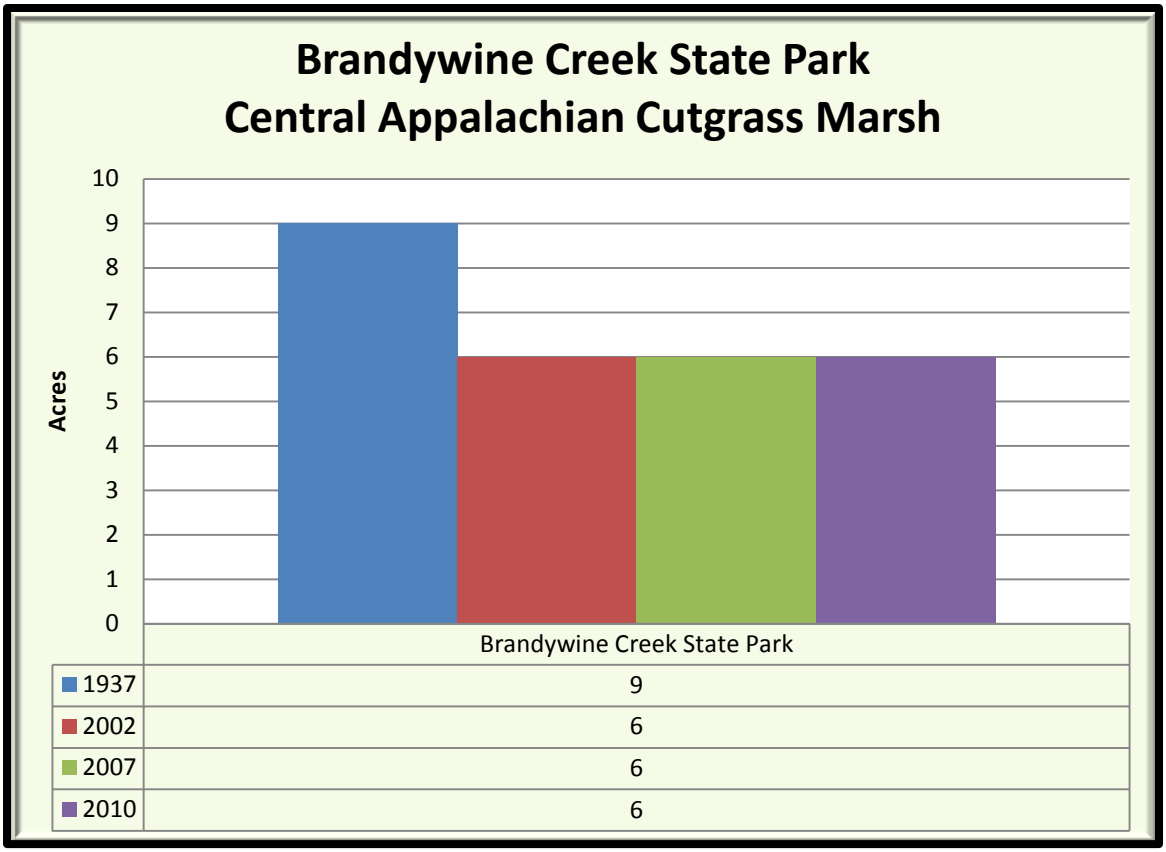


Figure 4.4. Central Appalachian Cutgrass Marsh at Brandywine Creek State Park (1937, 2002, 2007, 2010)

Natural Capital (Table 4.6)

Capital of Central Appalachian Cutgrass Marsh has decreased with a loss in acreage since 1937.

Table 4.6. Natural Capital of Central Appalachian Cutgrass Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$83,533/year
2002	$55,688/year
2007	$55,688/year
2010	$55,688/year

Central Appalachian/Northern Piedmont Chestnut Oak Forest **[23 acres (Figures 4.5-4.6, Table 4.7)] G5 S2**

DEWAP: Piedmont Upland Forests
NHC: Central Appalachian Dry Oak-Pine Forest

Description

This upland forest community is located on steep west-facing slopes in the park. Chestnut oak (*Quercus prinus*) is the dominant canopy species and is associated by white oak (*Quercus alba*), black oak (*Quercus velutina*), tuliptree (*Liriodendron tulipifera*), and a few black gum (*Nyssa sylvatica*). The understory is composed of witch-hazel (*Hamamelis virginiana*), red maple (*Acer rubrum*), spicebush (*Lindera benzoin*), and American beech (*Fagus grandifolia*). Mountain Laurel (*Kalmia latifolia*) is dominant in the shrub and vine layer and is associated by pinxter flower (*Rhododendron periclymenoides*), lowbush blueberry (*Vaccinium pallidum*), white-leaf greenbrier (*Smilax glauca*), and maple-leaf viburnum (*Viburnum acerifolium*). Small-fruited witch-grass (*Dichanthelium dichotomum*), partridge-berry (*Mitchella repens*), white-wood aster (*Eurybia divaricata*), Japanese stiltgrass (*Microstegium vimineum*), and New York Fern (*Thelypteris novaboracensis*).

Figure 4.5. Central Appalachian/Northern Piedmont Chestnut Oak Forest

The examples of this community in the park can be considered to be mature with dbh's ranging from 1 foot to 2 feet, which is large considering the dry nature of the community. These communities are relatively free of exotic invasive plants because of the extreme dry conditions.

Analysis of Condition at Brandywine Creek State Park

Central Appalachian/Northern Piedmont Chestnut Oak Forest has not changed since in acreage or extent since 1937. As a result no change analysis is conducted.

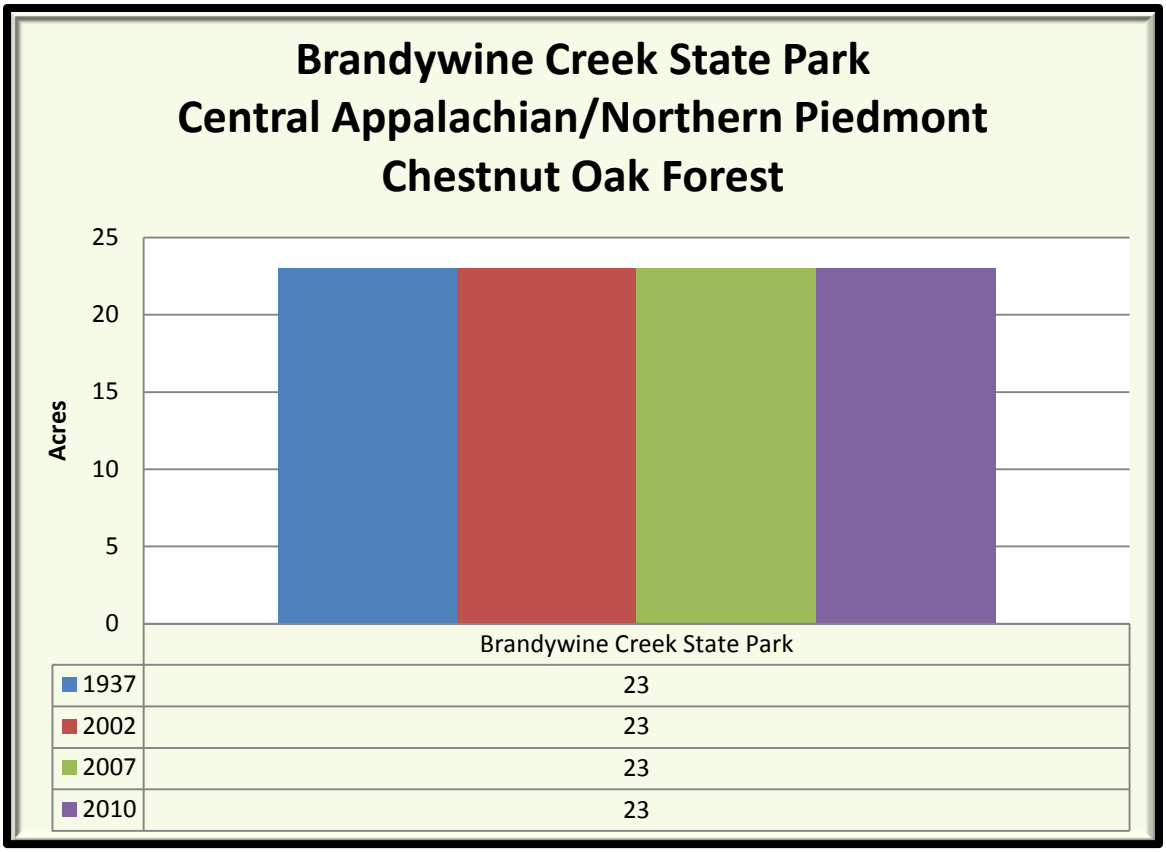


Figure 4.6. Central Appalachian/Northern Piedmont Chestnut Oak Forest at Brandywine Creek State Park (1937, 2002, 2007, 2010)

Natural Capital (Table 4.7)

Capital of Central Appalachian/Northern Piedmont Chestnut Oak Forest has not changed over the study period.

Table 4.7. Natural Capital of Central Appalachian/Northern Piedmont Chestnut Oak Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$4,349/year
2002	$4,349/year
2007	$4,349/year
2010	$4,349/year

Cultivated Lawn **[16 acres (Figure 4.7, Tables 4.8-4.9)]** **GNA SNA**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

This community is located primarily along roadsides, and buildings in the park. It is composed mostly of tall fescue (*Festuca arundinacea*).

Analysis of Condition at Brandywine Creek State Park

About 1 acre of cultivated lawn from 1937 still survived into 2010. The rest of the lawns had become 1 acre of Impervious Surface and 0.1 acres of Northeastern Old Field (Table 4.8). Since 1937, cultivated lawns have increased in the park and have been developed on 12 acres of Northeastern Old Field, 2 acres of agricultural field, 1 acre of Northern Piedmont Mesic Oak-Beech Forest, and 1 acre of impervious surface (Table 4.9).

Table 4.8. What was once Cultivated Lawn in 1937 has become X or remained in 2007	
X	**Acreage**
Cultivated Lawn	1 acre
Impervious Surface	1 acre
Northeastern Old Field	0.1 acres

Table 4.9. Cultivated Lawn has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	12 acres
Agricultural Field	2 acres
Cultivated Lawn	1 acre
Northern Piedmont Mesic Oak-Beech Forest	1 acre
Impervious Surface	1 acre
Other vegetation communities/land covers	0.4 acres

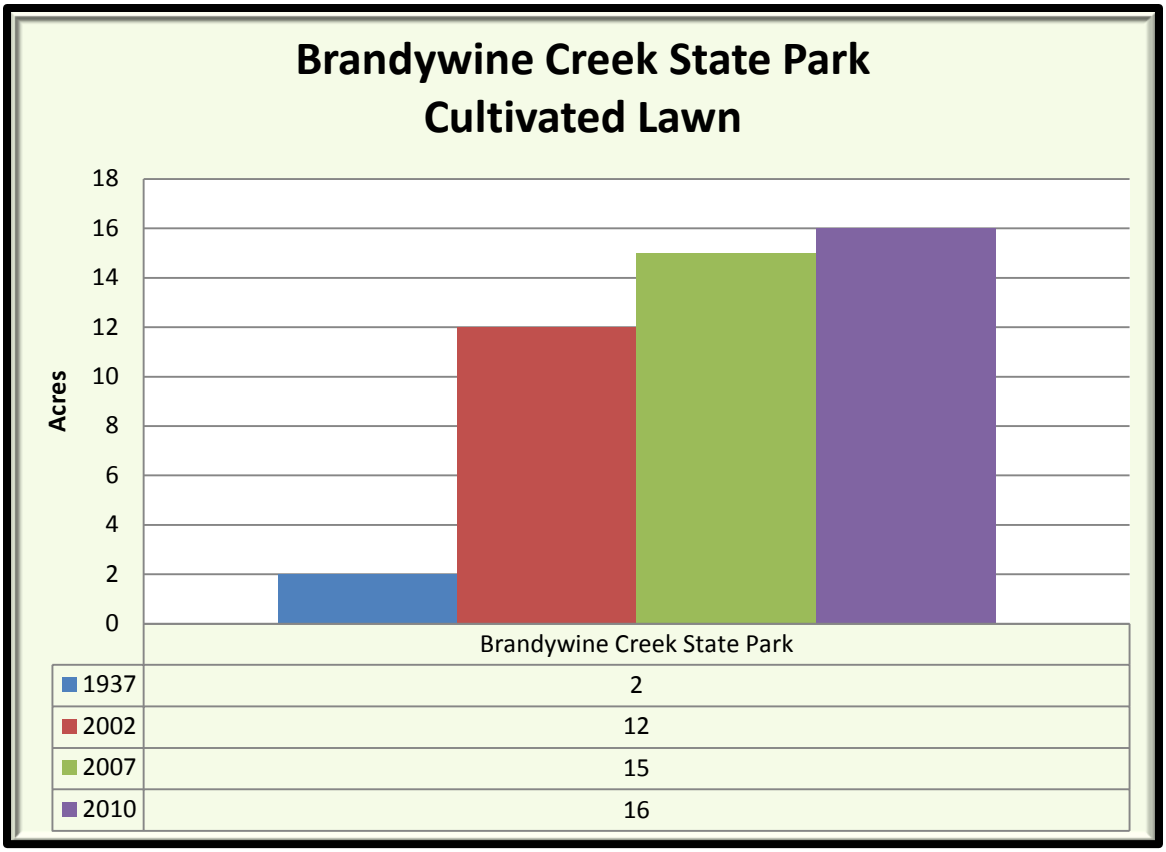


Figure 4.7. Cultivated Lawn at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital

Cultivated lawn does not have any natural capital value.

Eastern Cattail Marsh **[0.5 acres (Figures 4.8-4.9, Tables 4.)] G5 S4**

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

Description

This marsh community is located in a wetland near the "nature center" entrance to the park. Wide-leaved cattail (*Typha latifolia*) dominates the wetland with a few narrow-leaf cattail (*Typha angustifolia*), and sensitive fern (*Onoclea sensibilis*).

Figure 4.8. Eastern Cattail Marsh

Analysis of Condition at Brandywine Creek State Park

About 0.2 acres of the 1 acre present of Eastern Cattail Marsh in 1937 was still present in 2010. The rest had become 0.2 acres of impervious surface, 0.2 acre of Northeastern Old Field, 0.2 acres of cultivated lawn, and 0.1 acres of Little Bluestem Old Field (Table 4.10). Since 1937, Eastern Cattail Marsh has reduced its size, but has still converted 0.2 acres of Northeastern Old Field (Table 4.11).

Table 4.10. What was once Eastern Cattail Marsh in 1937 has become X or remained in 2010	
X	**Acreage**
Eastern Cattail Marsh	0.2 acres
Impervious Surface	0.2 acres
Northeastern Old Field	0.2 acres
Cultivated Lawn	0.2 acres
Little Bluestem Old Field	0.1 acres

Table 4.11. Eastern Cattail Marsh has migrated into X or remained since 1937	
X	**Acreage**
Eastern Cattail Marsh	0.2 acres
Northeastern Old Field	0.2 acres

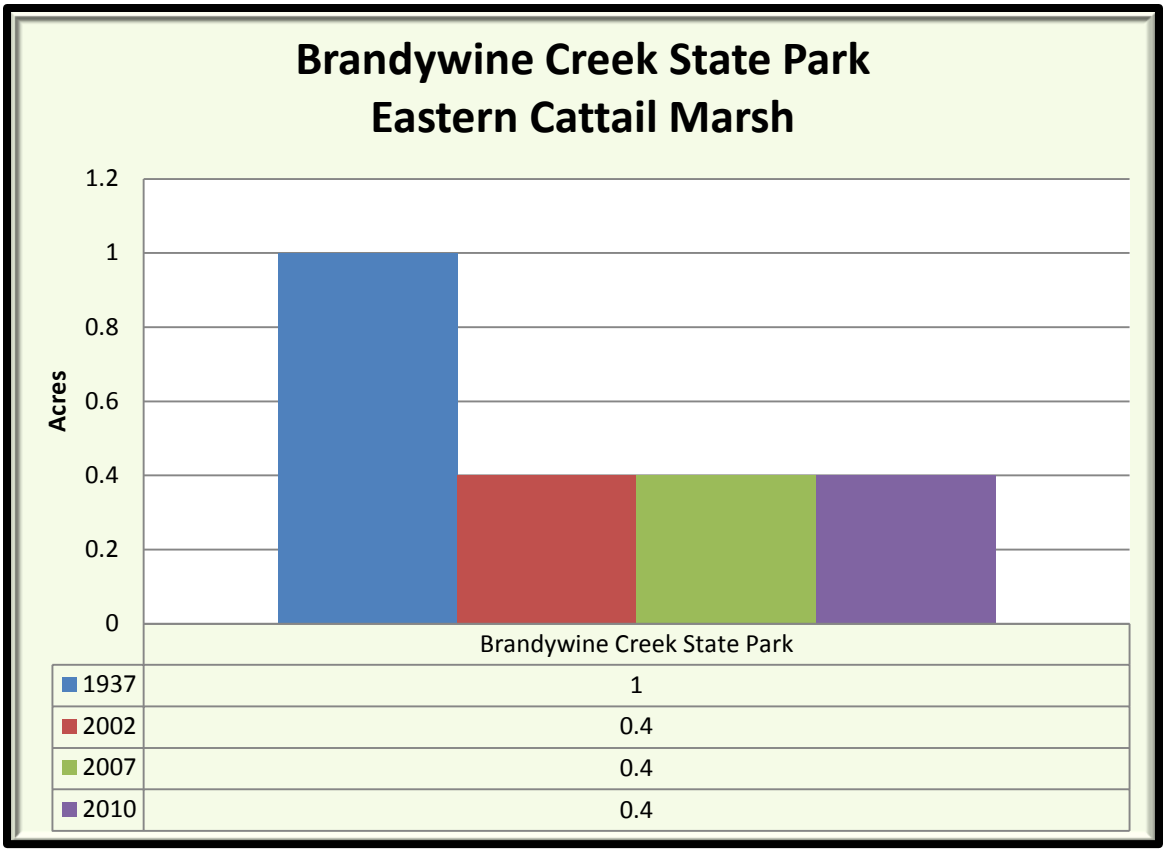


Figure 4.9. Eastern Cattail Marsh at Brandywine Creek State Park (1937, 2002, 2007, 2010)

Natural Capital (Table 4.12)

Capital of Eastern Cattail Marsh has decreased with its acreage since 1937.

Table 4.12. Natural Capital of Eastern Cattail Marsh	
Year	**Natural Capital (in 2012 dollars)**
1937	$9,281/year
2002	$3,713/year
2007	$3,713/year
2010	$3,713/year

Japanese Stiltgrass Meadow **[2 acres (Figure 4.10, Tables 4.13-4.14)] GNA SNA**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

This community is located in large field just north of Rocky Run. This field is entirely covered by Japanese Stiltgrass (*Microstegium vimineum*).

Analysis of Condition at Brandywine Creek State Park

This community was present in 1937 and has since taken over 2 acres of Northeastern Old Field (Table 4.13).

Table 4.13. Japanese Stiltgrass Meadow has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	2 acres

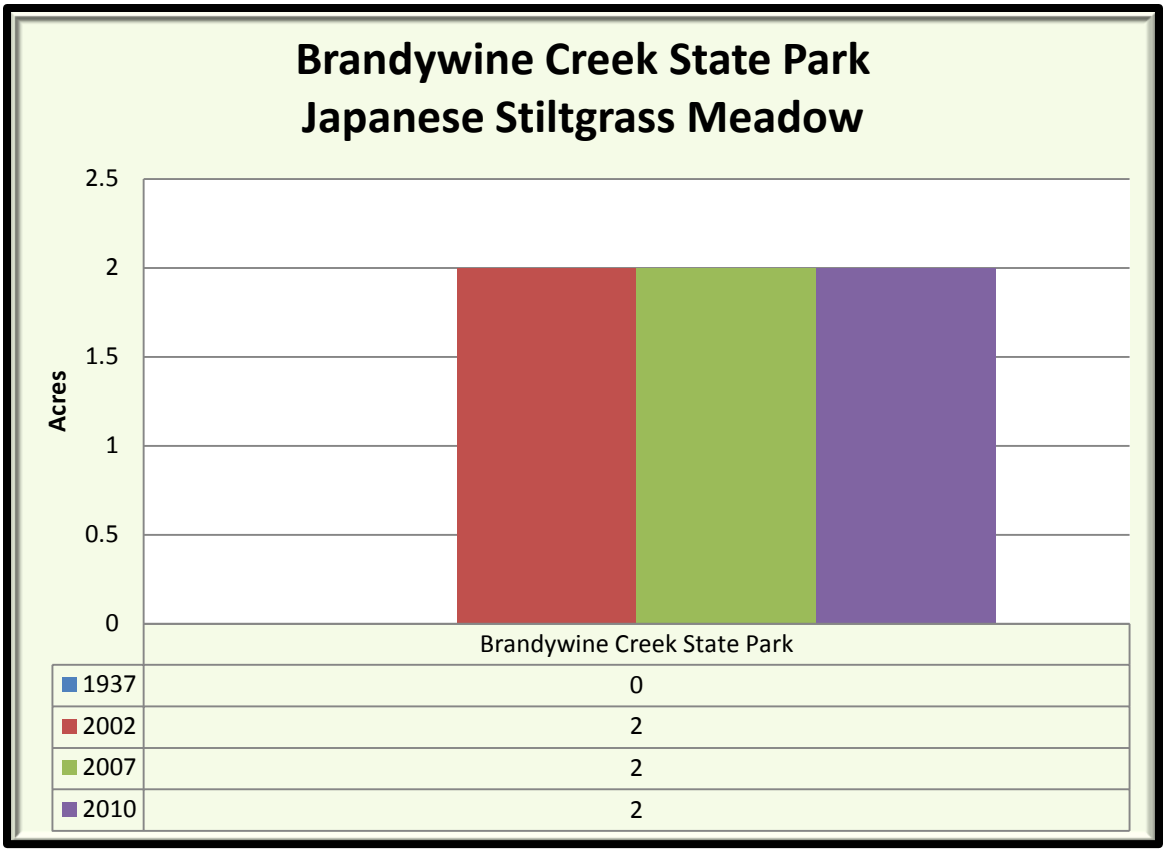


Figure 4.10. Japanese Stiltgrass Meadow at Brandywine Creek State Park (1937, 2002, 2007, 2010)

Natural Capital (Table 4.14)

Japanese Stiltgrass has gained $291 in capital from Northeastern Old Field since 1937.

Table 4.14. Natural Capital of Japanese Stiltgrass Meadow	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$291/year
2007	$291/year
2010	$291/year

Little Bluestem Old Field **[48 acres (Figures 4.11-4.12, Tables 4.15-4.17)]** **GNA** **SNA**

DEWAP: Herbaceous Early Successional Upland Habitats
NHC: No Equivalent Classification

Description

This field community can be considered to be similar to the native Piedmont prairies that used to be in the area. They are now kept open artificially. Species in this community include little bluestem (*Schizachyrium scoparium*), early goldenrod (*Solidago juncea*), gray goldenrod (*Solidago nemoralis*), dogbane (*Apocynum cannabinum*), yarrow (*Achillea millefolium*), and indian tobacco (*Linaria canadensis*). Other less common species include tall fescue (*Festuca arundinacea*), woolly witchgrass (*Dichanthelium acuminatum*), pussytoes (*Antennaria plataginifolia*), and hawkweed (*Hieracium pratense*). Some scattered individuals of autumn olive (*Elaeagnus umbellata*) are also present.

Figure 4.11. Little Bluestem Old Field

Analysis of Condition at Brandywine Creek State Park

All of the previous Little Bluestem Old Field from 1937 has grown into 1 acre each of Northeastern Modified Successional Forest and Northern Piedmont Mesic Oak-Beech Forest (Table 4.15) showing the need to keep these communities open. Since 1937, this community has converted 48 acres of Northeastern Old Field and 0.1 acres of Eastern Cattail Marsh (Table 4.16).

Table 4.15. What was once Little Bluestem Old Field in 1937 has become X or remained in 2007	
X	**Acreage**
Northeastern Modified Successional Forest	1 acre
Northern Piedmont Mesic Oak-Beech Forest	1 acre

Table 4.16. Little Bluestem Old Field has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	48 acres
Eastern Cattail Marsh	0.1 acres

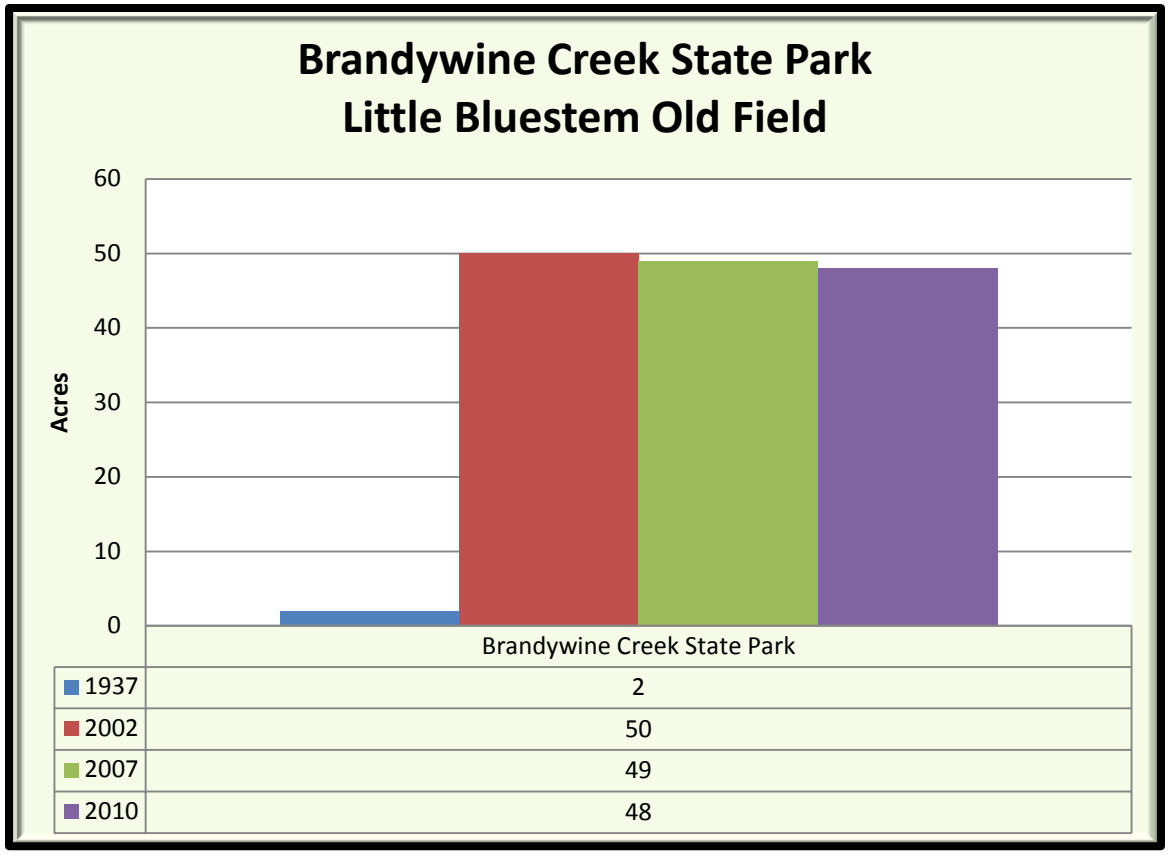


Figure 4.12. Little Bluestem Old Field at Brandywine Creek State Park (1937, 2002, 2007, 2010)

Natural Capital (Table 4.17)

Capital in Little Bluestem Old Field has been decreasing from its high in 2002, probably due to encroachment from adjacent shrublands. It has increased overall since 1937 though.

Table 4.17. Natural Capital of Little Bluestem Old Field	
Year	**Natural Capital (in 2012 dollars)**
1937	$291/year
2002	$7,285/year
2007	$7,139/year
2010	$6,994/year

Mid-Atlantic Terrace Floodplain Forest **[3 acres (Figure 4.13, Tables 4.18-4.20)] GNR S1**

DEWAP: Forested Floodplains and Riparian Swamps
NHC: Central Appalachian River Floodplain

Description

This floodplain forest community has a canopy of tuliptree (*Liriodendron tulipifera*) and box-elder (*Acer negundo*) with an understory of spicebush (*Lindera benzoin*). The shrub and vine layer is composed of elderberry (*Sambucus canadensis*), summer grape (*Vitis aestivalis*), multiflora rose (*Rosa multiflora*), and Morrow's honeysuckle (*Lonicera morrowii*). The presence of a high amount of Virginia bluebell (*Mertensia virginica*) is diagnostic of this community. Other herbs include ramps (*Alllium tricoccum*), wild ginger (*Asarum canadense*), smooth yellow violet (*Viola eriocarpa*), lesser celandine (*Ficaria verna*), smartweed (*Polygonum virginianum*), broad-leaf goldenrod (*Solidago flexicaulis*), and garlic mustard (*Alliaria petiolata*).

Analysis of Condition at Brandywine Creek State Park

All of the acreage of this community was still present in 1937 showing the stability of this community. About one acre did go to water presumably by erosion (Table 4.18). Since 1937, this community has increased by one acre by converting 1 acre of Northern Piedmont Mesic Oak-Beech Forest and 0.2 acres of Northeastern Old Field (Table 4.19).

Table 4.18. What was once Mid-Atlantic Terrace Floodplain Forest in 1937 has become X or remained in 2007

X	Acreage
Mid-Atlantic Terrace Floodplain Forest	2 acres
Water	1 acre

Table 4.19. Mid-Atlantic Terrace Floodplain Forest has migrated into X or remained since 1937

X	Acreage
Mid-Atlantic Terrace Floodplain Forest	2 acres
Northern Piedmont Mesic Oak-Beech Forest	1 acre
Northeastern Old Field	0.2 acres

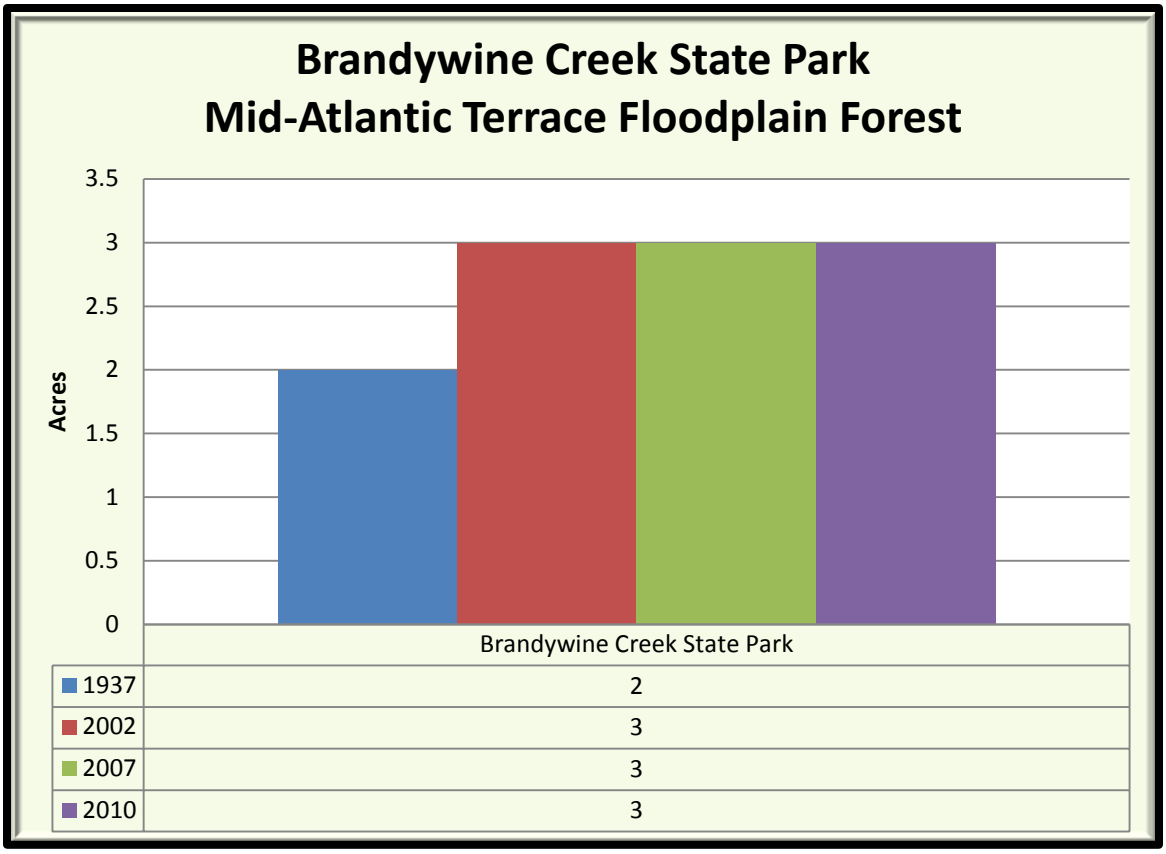


Figure 4.13. Mid-Atlantic Terrace Floodplain Forest at Brandywine Creek State Park (1937, 2002, 2007, 2010)

Natural Capital (Table 4.20)

Capital of Mid-Atlantic Terrace Floodplain Forest has increased with its one acre expansion since 1937.

Table 4.20. Natural Capital of Mid-Atlantic Terrace Floodplain Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$24,583/year
2002	$36,875/year
2007	$36,875/year
2010	$36,875/year

Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest **[47 acres (Figures 4.14-4.15, Tables 4.21-4.23)] GNR S1**

DEWAP: Piedmont Upland Forests
NHC: Central Appalachian Dry Oak-Pine Forest

Description

This upland forest community has a canopy of American beech (*Fagus grandifolia*), chestnut oak (*Quercus prinus*), and white oak (*Quercus alba*). The understory is composed of red maple (*Acer rubrum*), mockernut hickory (*Carya ovata*), and smaller members of the canopy. The shrub layer has a high amount of mountain laurel (*Kalmia latifolia*) that is associated by lowbush blueberry (*Vaccinium pallidum*) and white-leaf greenbrier (*Smilax glauca*). Common herbs in this community include white wood aster (*Eurybia divaricata*), beech-drops (*Epifagus virginiana*), indian pipes (*Monotropa uniflora*), hair-grass (*Deschampsia flexuosa*), and Pennsylvania sedge (*Carex pensylvanica*).

Figure 4.14. Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest

All of the examples of this community in Brandywine Creek State Park in a mature state. Diameters-at-breast height range from 1.5 feet to 2.5 feet in most occurrences.

Analysis of Condition at Brandywine Creek State Park

This community has been stable in acreage amount since 1937 but has had some changes in that only 41 acres of the 47 acres present in 1937 were still around in 2010. The rest had become 6 acres of Northern Piedmont Mesic Oak-Beech Forest and 0.3 acres of Northeastern Old Field (Table 4.21). Since 1937, this community has grown from 5 acres of Northeastern Old Field and 2 acres of Northeastern Successional Shrubland (Table 4.22).

Table 4.21. What was once Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest in 1937 has become X or remained in 2010

X	**Acreage**
Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest	41 acres
Northern Piedmont Mesic Oak-Beech Forest	6 acres
Northeastern Old Field	0.3 acres

Table 4.22. Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest	41 acres
Northeastern Old Field	5 acres
Northeastern Successional Shrubland	2 acres

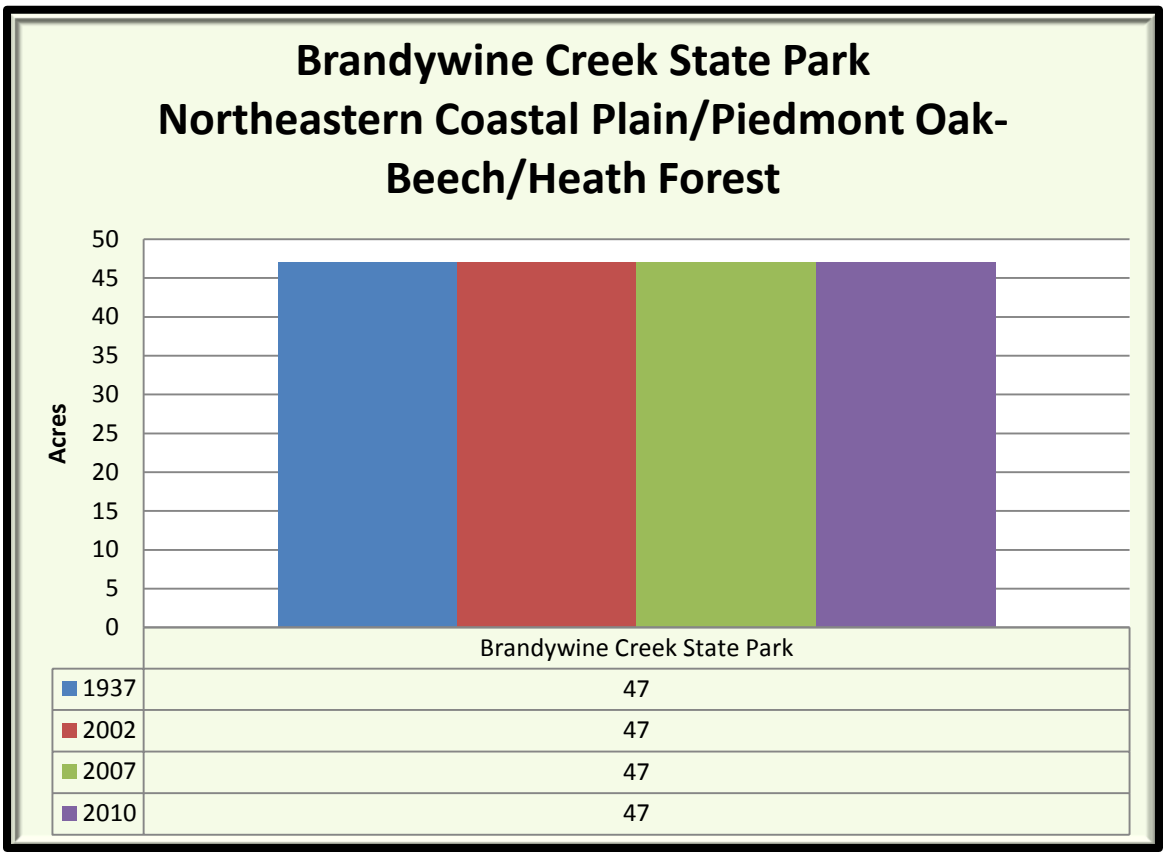


Figure 4.15. Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest at Brandywine Creek State Park (1937, 2002, 2007, 2010)

Natural Capital (Table 4.23)

Capital of Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest has stayed the same since 1937.

Table 4.23. Natural Capital of Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$8,888/year
2002	$8,888/year
2007	$8,888/year
2010	$8,888/year

Northeastern Modified Successional Forest **[161 acres (Figures 4.16-4.17, Tables 4.24-4.26)]**
GNA SNA

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

Description

This forest community is characterized by a dense presence of exotic invasive plant species in the shrub, vine, and herbaceous layers. The canopy is composed of tuliptree (*Liriodendron tulipifera*), mockernut hickory (*Carya alba*), blackgum (*Nyssa sylvatica*), wild black cherry (*Prunus serotina*), sweet cherry (*Prunus avium*), white oak (*Quercus alba*), and northern red oak (*Quercus rubra*), which overtops an understory of serviceberry (*Amelanchier canadensis*), flowering dogwood (*Cornus florida*), spicebush (*Lindera benzoin*), red maple (*Acer rubrum*), and smaller members of the canopy. The shrub and vine layer includes Oriental bittersweet (*Celastrus orbiculatus*), privet (*Ligustrum sinense*), multiflora rose (*Rosa multiflora*), summer grape (*Vitis aestivalis*), Morrow's honeysuckle (*Lonicera morrowii*), Siebold's viburnum (*Viburnum sieboldii*), and autumn olive (*Elaeagnus umbellata*). Common herbs include garlic mustard (*Alliaria petiolata*), jack-in-the-pulpit (*Arisaema triphyllum*), horsebalm (*Collinsonia canadensis*), smartweed (*Polygonum virginianum*), false nettle (*Boehmeria cylindrica*), path rush (*Juncus tenuis*), Japanese stiltgrass (*Microstegium vimineum*), beefsteak plant (*Perilla frutescens*), and yarrow (*Achillea millefolium*).

Figure 4.16. Northeastern Modified Successional Forest

Most of the examples of this community are perpetually in the late successional state. The density of the exotics prevents regeneration of the canopy or anything else from proceeding to maturity. The canopy trees range from 1 foot to 2 feet in diameter at breast height.

Analysis of Condition at Brandywine Creek State Park

None of the Northeastern Modified Successional Forest that was present in 1937 still existed in 2010. It had all become 2 acres of Northeastern Successional Shrubland, 1 acre of Northeastern Old Field, 0.4 acres of White Pine Planted Forest, and 0.1 acres of water (Table 4.24). Since 1937, Northeastern Modified Successional Forest has increased in acreage and has grown into 116 acres of Northeastern Old Field, converted 30 acres of Northern Piedmont Mesic Oak-Beech Forest, grown into 8 acres of Northeastern Successional Shrubland, 3 acres of

agricultural field, and converted 2 acres of Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest (Table 4.25).

Table 4.24. What was once Northeastern Modified Successional Forest in 1937 has become X or remained in 2010	
X	**Acreage**
Northeastern Successional Shrubland	2 acres
Northeastern Old Field	1 acre
White Pine Planted Forest	0.4 acres
Water	0.1 acres

Table 4.25. Northeastern Modified Successional Forest has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	116 acres
Northern Piedmont Mesic Oak-Beech Forest	30 acres
Northeastern Successional Shrubland	8 acres
Agricultural Field	3 acres
Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest	2 acres
Other communities/land covers	3 acres

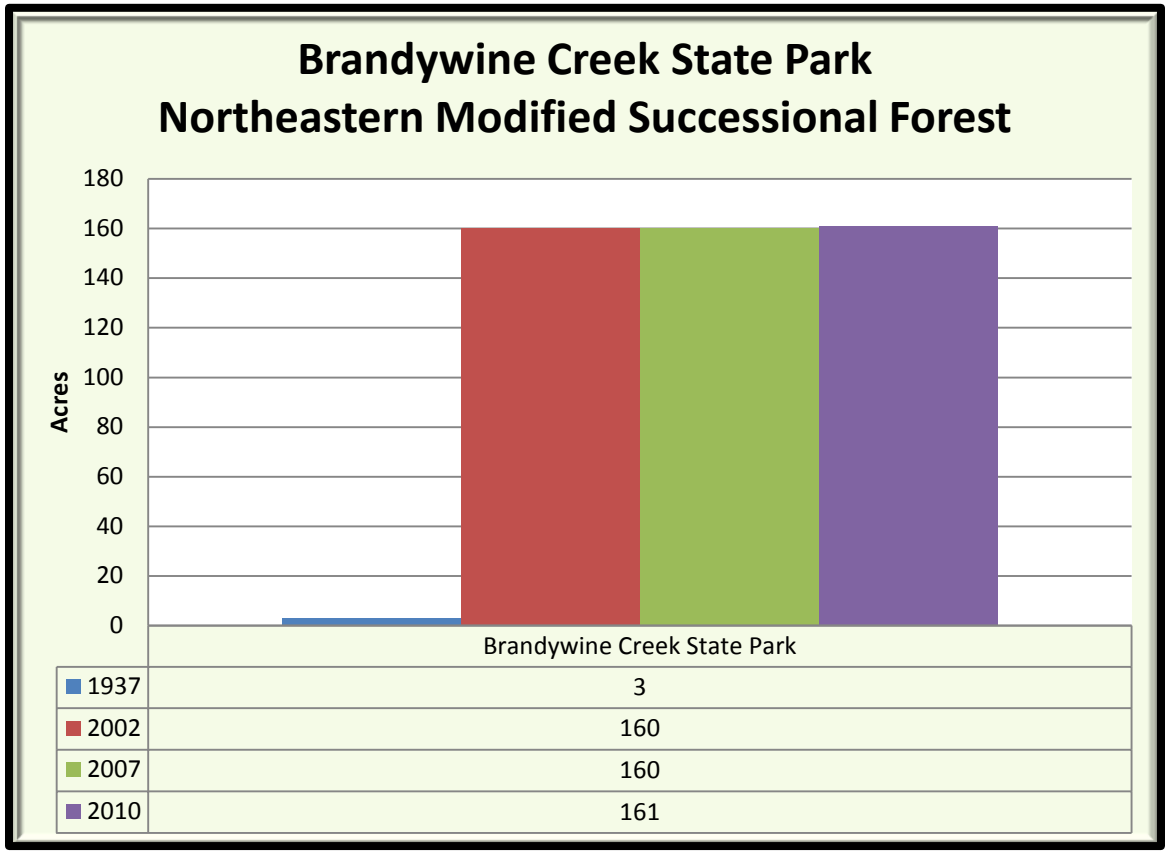


Figure 4.17. Northeastern Modified Successional Forest at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.26)

Capital of Northeastern Modified Successional Forest has greatly increased since 1937 and is still increasing as the exotic invasive plant species spread.

Table 4.26. Natural Capital of Northeastern Modified Successional Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$567/year
2002	$30,256/year
2007	$30,256/year
2010	$30,445/year

Northeastern Old Field **[147 acres (Figures 4.18-4.19, Tables 4.27-4.29)]GNA SNA**

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

Description

This community is located primarily in the fields around the nature center. Typical species here include red fescue (*Festuca rubra*), sweet vernal grass (*Anthoxanthum odoratum*), orchard grass (*Dactylis glomerata*), broom-sedge (*Andropogon virginicus*), common velvet grass (*Holcus lanatus*), and timothy (*Phleum pratense*). Other non-grass species include red clover (*Trifolium pratense*), daisy fleabane (*Erigeron strigosus*), whorled mountain-mint (*Pycnanthemum verticillata*), and white sweetclover (*Melilotus alba*). Some woody species such as multiflora rose (*Rosa multiflora*), summer grape (*Vitis aestivalis*), and sweetgum (*Liquidambar styraciflua*) are scattered around the fields.

Figure 4.18. Northeastern Old Field

Analysis of Condition at Brandywine Creek State Park

About 139 acres of the 442 acres of Northeastern Old Field from 1937 still existed in 2010. The rest had grown into 116 acres of Northeastern Modified Successional Forest, 51 acres of Northern Piedmont Mesic Oak-Beech Forest, 48 acres of Little Bluestem Old Field, and 16 acres of Box-elder Floodplain Forest (Table 4.27). Since 1937, Northeastern Old Field has grown into 4 acres of agricultural field, and converted 1 acre each of Northern Piedmont Mesic Oak-Beech Forest, Box-elder Floodplain Forest, and Semi-impervious Surface (Table 4.28).

Table 4.27. What was once Northeastern Old Field in 1937 has become X or remained in 2010	
X	**Acreage**
Northeastern Old Field	139 acres
Northeastern Modified Successional Forest	116 acres
Northern Piedmont Mesic Oak-Beech Forest	51 acres
Little Bluestem Old Field	48 acres
Box-elder Floodplain Forest	16 acres
Other communities/land covers	73 acres

Table 4.28. Northeastern Old Field has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	139 acres
Agricultural Field	4 acres
Northern Piedmont Mesic Oak-Beech Forest	1 acre
Box-elder Floodplain Forest	1 acre
Semi-impervious Surface	1 acre
Other communities/land covers	2 acres

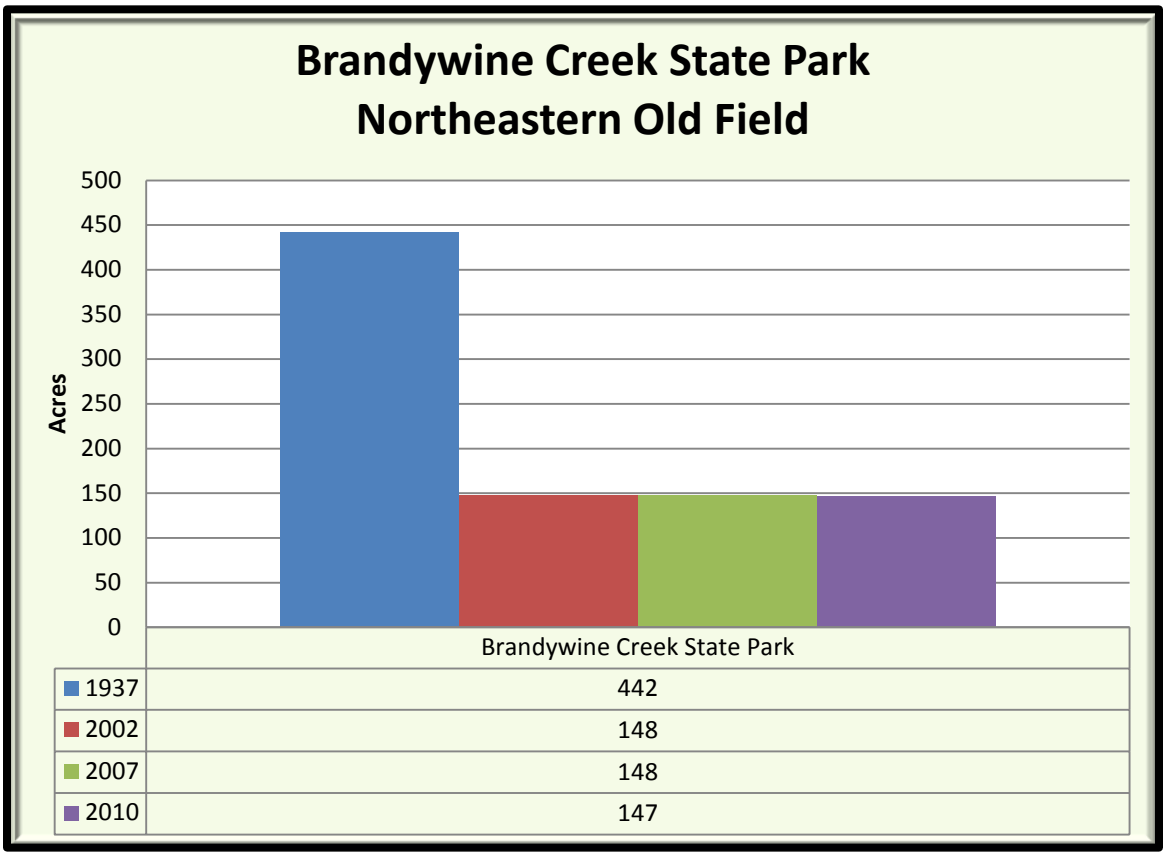


Figure 4.19. Northeastern Old Field at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.29)

Capital of Northeastern Old Field has been gradually decreasing as these fields grow into shrubland and forests.

Table 4.29. Natural Capital of Northeastern Old Field	
Year	**Natural Capital (in 2012 dollars)**
1937	$64,399/year
2002	$21,564/year
2007	$21,564/year
2010	$21,418/year

Northeastern Successional Shrubland **[15 acres (Figure 4.20, Tables 4.30-4.32)] GNA SNA**

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

Description

This shrubland community is successional between the Northeastern Old Field and the forest. Often these communities are filled with exotic invasive shrub and vine species such as multiflora rose (*Rosa multiflora*), Oriental bittersweet (*Celastrus orbiculatus*), Japanese honeysuckle (*Lonicera japonica*), English ivy (*Hedera helix*), and autumn olive (*Elaeagnus umbellata*). Other native shrubs and vines include blackberry (*Rubus* sp.) and summer grape (*Vitis aestivalis*). The herb layer is also generally filled with exotics such Japanese stiltgrass (*Microstegium vimineum*), garlic mustard (*Alliaria petiolata*) and some natives such as Canada goldenrod (*Solidago canadensis*) and switchgrass (*Panicum virgatum*). Sometimes a sparse woody canopy of wild black cherry (*Prunus serotina*) and red maple (*Acer rubrum*) may be present.

Analysis of Condition at Brandywine Creek State Park

None of the Northeastern Successional Shrubland from 1937 was still present in 2010. It had all grown into 8 acres of Northeastern Modified Successional Forest, 6 acres of Northern Piedmont Mesic Oak-Beech Forest, 2 acres of Successional Tuliptree Forest, 2 acres of Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest, and 0.1 acres of cultivated lawn (Table 4.30). Since 1937, this community has decreased slightly but has still grown into 13 acres of Northeastern Old Field and has converted 2 acres of Northeastern Modified Successional Forest (Table 4.31).

Table 4.30. What was once Northeastern Successional Shrubland in 1937 has become X or remained in 2010

X	Acreage
Northeastern Modified Successional Forest	8 acres
Northern Piedmont Mesic Oak-Beech Forest	6 acres
Successional Tuliptree Forest	2 acres
Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest	2 acres
Cultivated Lawn	0.1 acres
Other communities/land covers	0.1 acres

Table 4.31. Northeastern Successional Shrubland has migrated into X or remained since 1937	
X	**Acreage**
Northeastern Old Field	13 acres
Northeastern Modified Successional Forest	2 acres

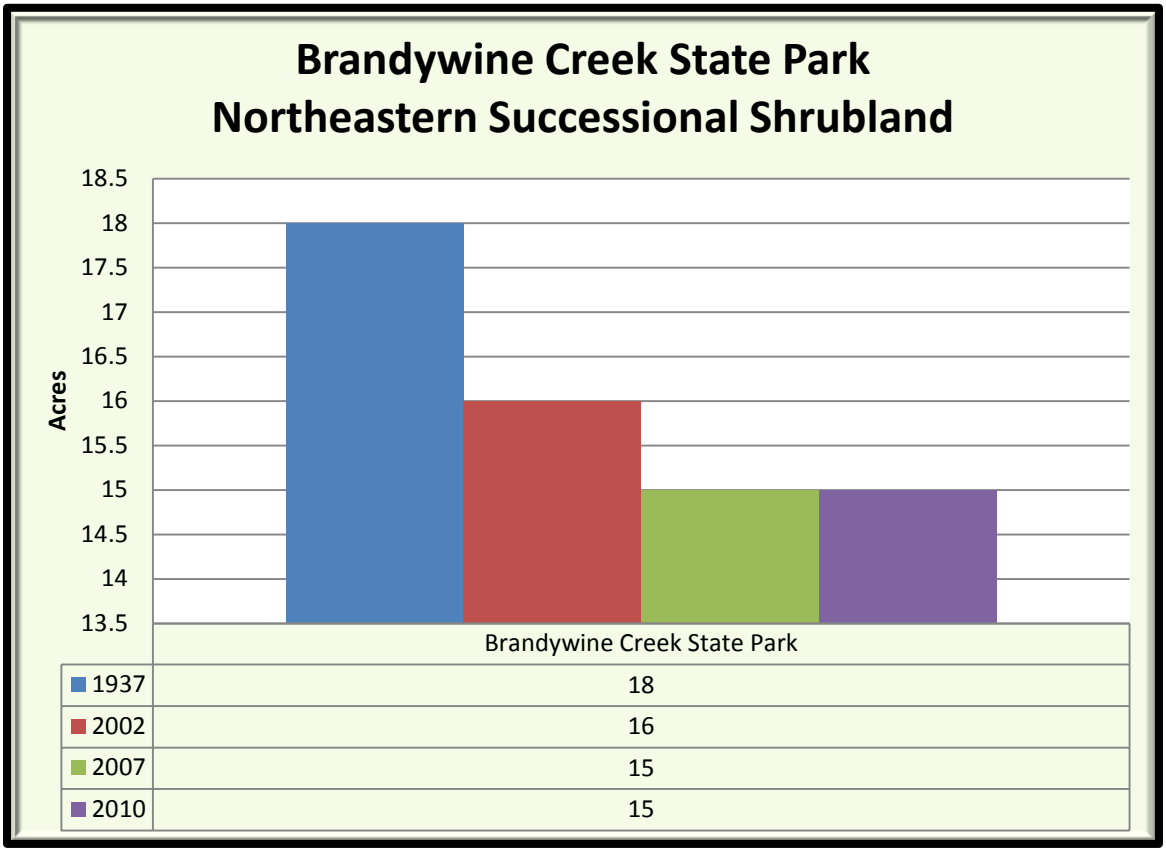


Figure 4.20. Northeastern Successional Shrubland at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.32)

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

Table 4.32. Natural Capital of Northeastern Successional Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$2,622/year
2002	$2,331/year
2007	$2,186/year
2010	$2,186/year

Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest **[25 acres (Figures 4.21-4.22, Tables 4.33-4.35)] G4? S2**

DEWAP: Piedmont Upland Forests
NHC: Northern Atlantic Coastal Plain Calcareous Ravine

Description

Tuliptree Woods is a mature example of this community in Delaware and is located in Brandywine Creek State Park. American beech (*Fagus grandifolia*) and tuliptree (*Liriodendron tulipifera*) are the primary canopy species and are associated by red maple (*Acer rubrum*), wild black cherry (*Prunus serotina*), and bitternut hickory (*Carya cordiformis*). Understory species include spicebush (*Lindera benzoin*), Norway maple (*Acer plantanoides*), and smaller members of the canopy. The shrub and vine layer is composed of maple-leaf viburnum (*Viburnum acerifolium*), Oriental bittersweet (*Celastrus orbiculatus*), white ash (*Fraxinus americana*), winged euonymus (*Euonymus alatus*), poison ivy (*Toxicodendron radicans*), and blackhaw viburnum (*Viburnum prunifolium*). The herbaceous layer is especially rich, classifying it as a "rich forest" and contains cut-leaf toothwort (*Cardamine concatenata*), mayapple (*Podophyllum peltatum*), Japanese stiltgrass (*Microstegium vimineum*), Solomon's seal (*Polygonatum biflorum*), bloodroot (*Sanguinaria canadensis*), broad-beech fern (*Phegopteris hexagonoptera*), Virginia creeper (*Parthenocissus quinquefolia*), clustered black snakeroot (*Sanicula odorata*), common blue violet (*Viola sororia*), grape fern (*Botrychium virginianum*), black cohosh (*Cimicifuga racemosa*), woodland sedge (*Carex blanda*), Canada honewort (*Cryptotaenia canadensis*), and downy yellow violet (*Viola pubescens*).

Figure 4.21. Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest

The examples of this community in Brandywine Creek State Park are the most mature in Delaware. Diameters at breast height range from 1.5 feet to above 4 feet, with tuliptree being among the largest trees. The examples also show good layering between overstory and understory.

Analysis of Condition at Brandywine Creek State Park

Since this community is mature, it is very stable with 24 of 26 acres from 1937 still remaining in 2010. The other two acres were converted to Northeastern Modified Successional Forest when exotic invasive plant species invaded (Table 4.33). Since 1937, this community has decreased in size but has grown into 1 acre of Northeastern Old Field (Table 4.34).

Table 4.33. What was once Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest in 1937 has become X or remained in 2010	
X	**Acreage**
Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest	24 acres
Northeastern Modified Successional Forest	2 acres

Table 4.34. Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest has migrated into X or remained since 1937	
X	**Acreage**
Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest	24 acres
Northeastern Old Field	1 acre

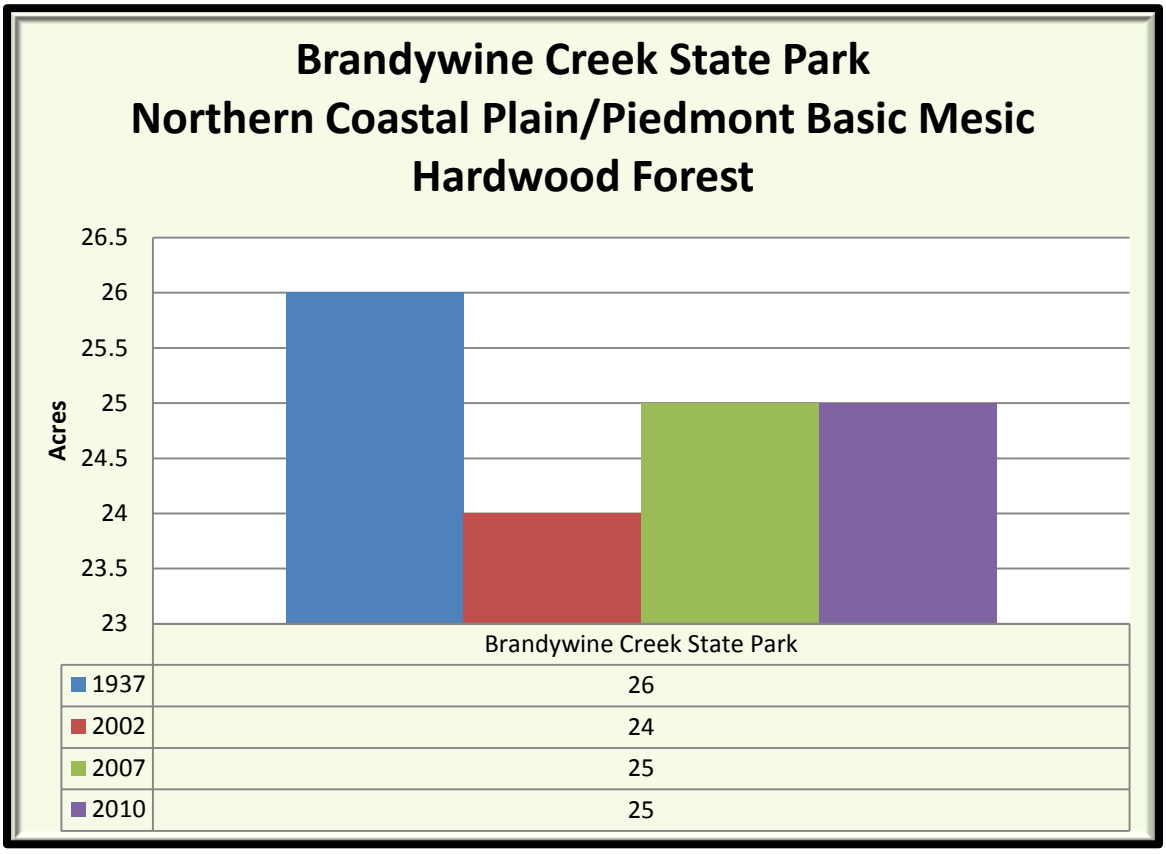


Figure 4.22. Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.35)

Capital of Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest has oscillated some because of conversions to Northeastern Modified Successional Forest and efforts to reclaim the forest from exotic invasive plant species. Overall the capital has decreased from its 1937 level.

Table 4.35. Natural Capital of Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$4,917/year
2002	$4,538/year
2007	$4,728/year
2010	$4,728/year

Northern Piedmont Mesic Oak-Beech Forest **[288 acres (Figures 4.23-4.24, Tables 4.36-4.38)]**
GNR S5

DEWAP: Piedmont Upland Forests
NHC: Central Appalachian Dry Oak-Pine Forest

Description

This is the most common forest community in the park. American beech (*Fagus grandifolia*) is the characteristic species in the canopy and sub-canopy. Other canopy species include white oak (*Quercus alba*), northern red oak (*Quercus rubra*), tuliptree (*Liriodendron tulipifera*), pignut hickory (*Carya glabra*), and small amount of shagbark hickory (*Carya ovata*). The understory is composed of mockernut hickory (*Carya alba*), spicebush (*Lindera benzoin*), bladdernut (*Staphylea trifoliata*), flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), and blackgum (*Nyssa sylvatica*). Common shrub and vine species include multiflora rose (*Rosa multiflora*), Oriental bittersweet (*Celastrus orbiculatus*), arrow-wood (*Viburnum dentatum*), maple-leaf viburnum (*Viburnum acerifolium*), alternate-leaf dogwood (*Cornus alternifolia*), and wineberry (*Rubus phoenicalasius*). None of the exotics are of large enough extent to disrupt the normal conditions of the forest. The herbaceous layer includes common blue violet (*Viola sororia*), Virginia creeper (*Parthenocissus quinquefolia*), false solomon's seal (*Maianthemum racemosum*), woodland goldenrod (*Solidago caesia*), black cohosh (*Cimicifuga racemosa*), wild licorice (*Galium circaezans*), downy agrimony (*Agrimonia pubescens*), herbaceous green-brier (*Smilax herbacea*), and loose-flowered sedge (*Carex laxiflora*).

Figure 4.23. Northern Piedmont Mesic Oak-Beech Forest

Most examples of this community in the park are in the late successional to mature state. Diameters-at-breast height range from 1 foot to 2 feet generally. Layering is good in most examples with some showing effects of deer browsing.

Analysis of Condition at Brandywine Creek State Park

In 2010, 219 acres of the Northern Piedmont Mesic Oak-Beech Forest from 1937 was still present. The rest had become 30 acres of Northeastern Modified Successional Forest through invasion of exotic invasive plant species, 14 acres of Successional Tuliptree Forest, 3 acres of Successional Sweetgum Forest, and 3 acres of Box-elder Floodplain Forest (Table 4.36). Since 1937, this forest has grown into 51 acres of Northeastern Old Field, 6 acres of Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest, 6 acres of Northeastern Successional Shrubland, and 3 acres of Central Appalachian Cutgrass Marsh (Table 4.37).

Table 4.36. What was once Northern Piedmont Mesic Oak-Beech Forest in 1937 has become X or remained in 2010	
X	**Acreage**
Northern Piedmont Mesic Oak-Beech Forest	219 acres
Northeastern Modified Successional Forest	30 acres
Successional Tuliptree Forest	14 acres
Successional Sweetgum Forest	3 acres
Box-elder Floodplain Forest	3 acres
Other communities/land covers	4 acres

Table 4.37. Northern Piedmont Mesic Oak-Beech Forest has migrated into X or remained since 1937	
X	**Acreage**
Northern Piedmont Mesic Oak-Beech Forest	219 acres
Northeastern Old Field	51 acres
Northeastern Coastal Plain/Piedmont Oak-Beech/Heath Forest	6 acres
Northeastern Successional Shrubland	6 acres
Central Appalachian Cutgrass Marsh	3 acres
Other communities/land covers	3 acres

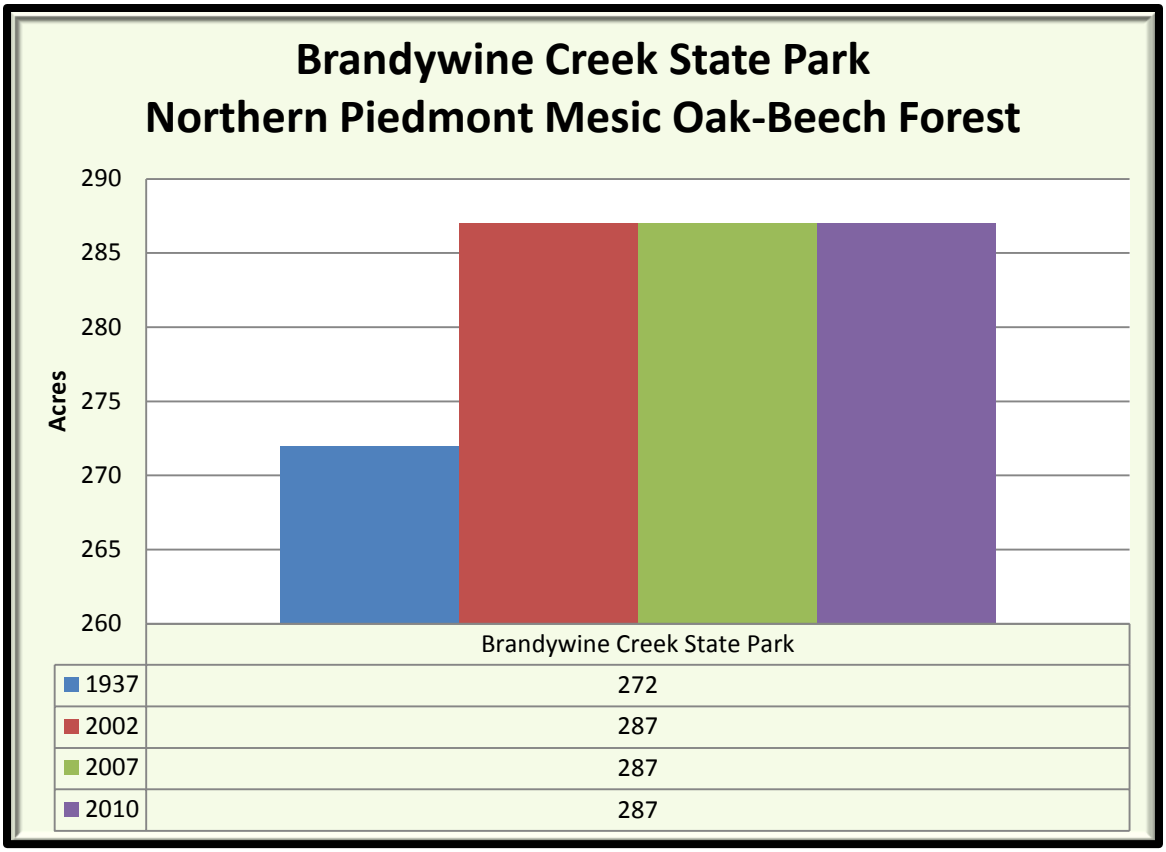


Figure 4.24. Northern Piedmont Mesic Oak-Beech Forest at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.38)

Capital of Northern Piedmont Mesic Oak-Beech Forest has increased since 1937 with gains in its acreage.

Table 4.38. Natural Capital of Northern Piedmont Mesic Oak-Beech Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$51,435/year
2002	$54,272/year
2007	$54,272/year
2010	$54,272/year

***Red Pine Planted Forest* [0.2 acres (Figure 4.25, Table 4.39)]** **GNA** **SNA**

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

Description

This planted community is composed of a monoculture of red pine (*Pinus resinosa*). The example of this community is in a late successional state.

Analysis of Condition at Brandywine Creek State Park

All of the current Red Pine Planted Forest in the forest grew from Northeastern Old Field in 1937. Because of this an analysis was not completed.

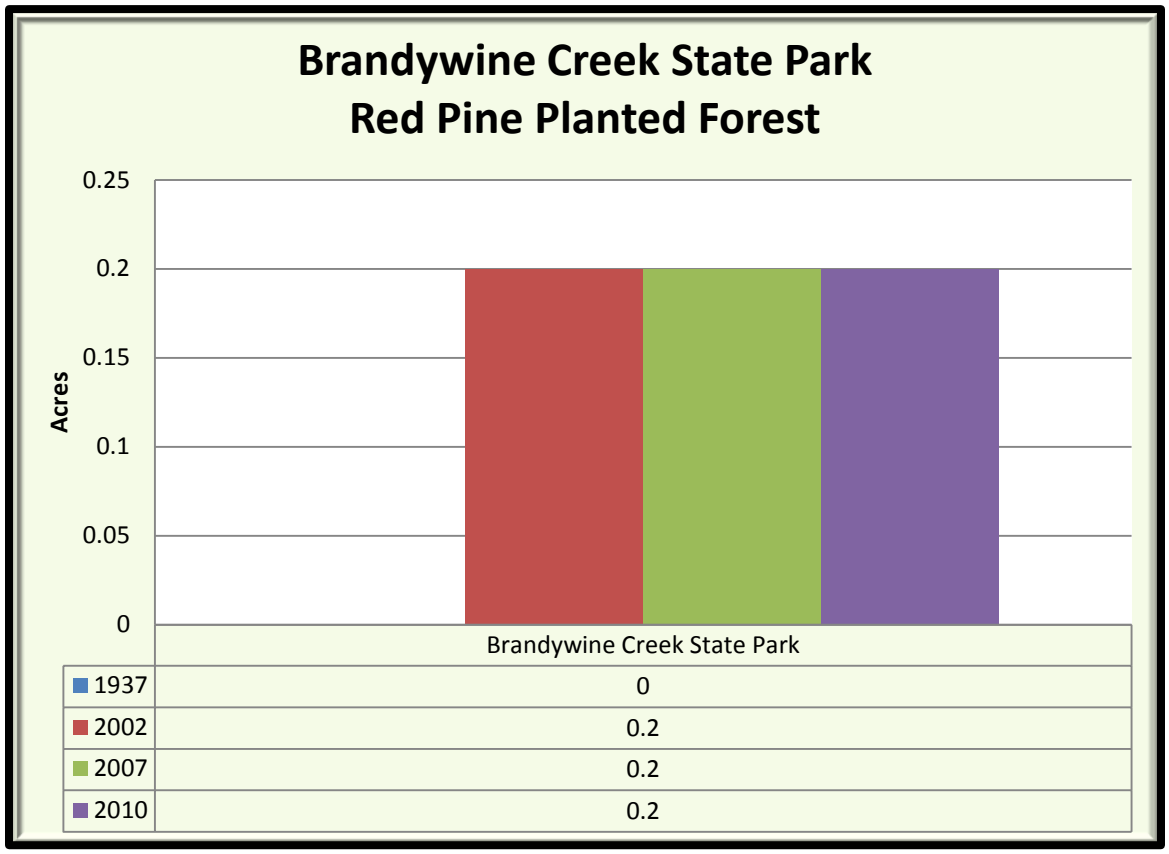


Figure 4.25. Red Pine Planted Forest at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.39)

Capital of Red Pine Planted Forest has stayed the same since its appearance in 2002.

Table 4.39. Natural Capital of Red Pine Planted Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$38/year
2007	$38/year
2010	$38/year

Red Spruce Planted Forest **[1 acre (Figure 4.26, Tables 4.40-4.42)] GNA SNA**

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

Description

This community is located between Thompson Mill Road and Rocky Run and is a monoculture of red spruce (*Picea rubens*). The example of this community is in a mid to late successional state.

Analysis of Condition at Brandywine Creek State Park

None of the Red Spruce Planted Forest from 1937 was still present in 2010. It had become 1 acre each of Northern Piedmont Mesic Oak-Beech Forest and Successional Tuliptree Forest (Table 4.40). Since 1937, this community has been planted in 1 acre of Northeastern Old Field (Table 4.41).

Table 4.40. What was once Red Spruce Planted Forest in 1937 has become X or remained in 2010

X	Acreage
Northern Piedmont Mesic Oak-Beech Forest	1 acre
Successional Tuliptree Forest	1 acre

Table 4.41. Red Spruce Planted Forest has migrated into X or remained since 1937

X	Acreage
Northeastern Old Field	1 acre

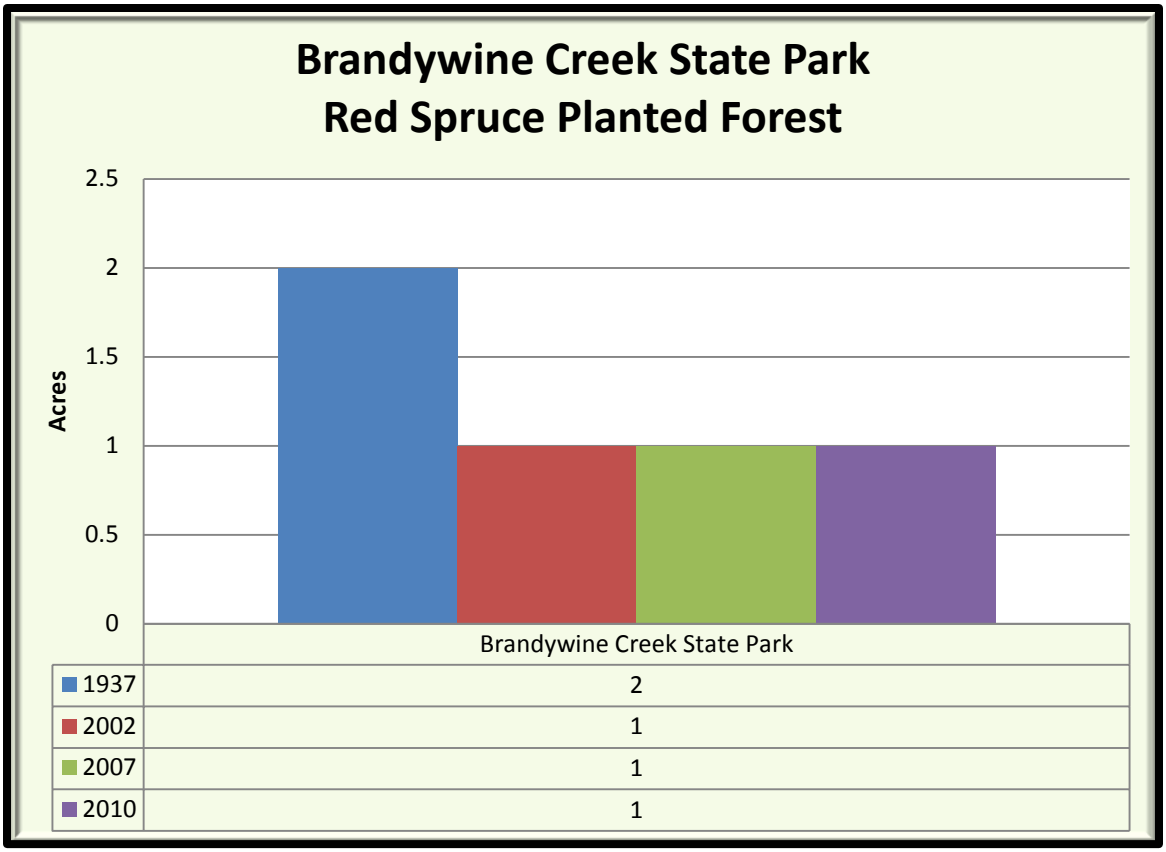


Figure 4.26. Red Spruce Planted Forest at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.42)

Capital of Red Spruce Planted Forest has decreased with its acreage since 1937.

Table 4.42. Natural Capital of Red Spruce Planted Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$378/year
2002	$189/year
2007	$189/year
2010	$189/year

Shrubby St. John's Wort Shrubland **[12 acres (Figures 4.27-4.28, Tables 4.43)] GNA SNA**

DEWAP: Streamside Herbaceous Wetlands
NHC: No Equivalent Classification

Description

Figure 4.27. Shrubby St. John's Wort Shrubland

This community is located in a wetland and adjoining slope north of Wilson Run near the "nature center" entrance to the park. This shrubland is dominated by shrubby St. John's Wort (*Hypericum prolificum*) with associates that are similar to those in the Little Bluestem Old Field description.

Analysis of Condition at Brandywine Creek State Park

All of the current acreage of Shrubby St. John's Wort came from Northeastern Old Field. Because of this an analysis was not completed.

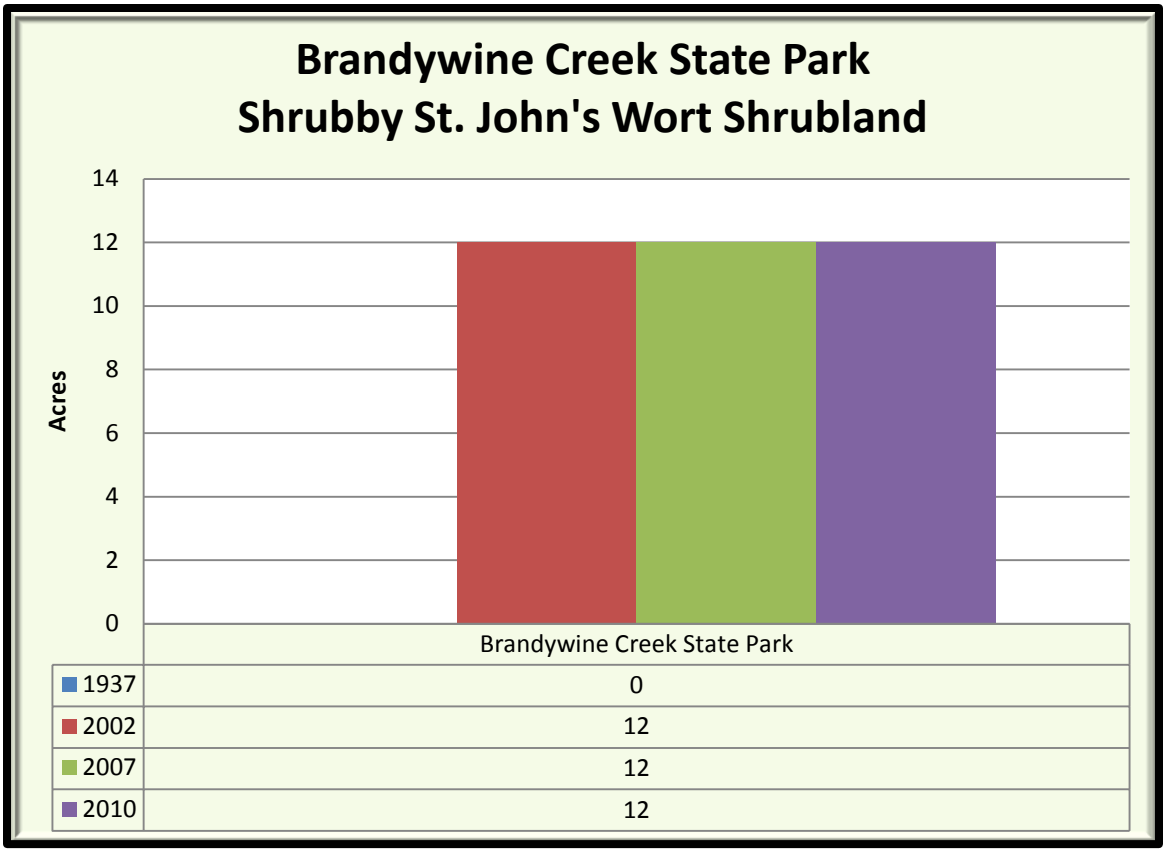


Figure 4.28. Shrubby St. John's Wort Shrubland at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.43)

Capital of Shrubby St. John's Wort Shrubland was been stable since its appearance after 1937.

Table 4.43. Natural Capital of Shrubby St. John's Wort Shrubland	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$111,377/year
2007	$111,377/year
2010	$111,377/year

Southern New England Red Maple Seepage Swamp **[3 acres (Figures 4.29-4.30, Table 4.44)]**
G4G5 S1

DEWAP: Forested Floodplains and Riparian Swamps
NHC: Central Appalachian Stream and River

Description

This forested wetland seep is located on the south side of Rocky Run, which is a major tributary to the Brandywine in Delaware. Common canopy species include red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), tuliptree (*Liriodendron tulipifera*), and American beech (*Fagus grandifolia*) with lesser amounts of black oak (*Quercus velutina*). The understory is composed of witch-hazel (*Hamamelis virginiana*), American hornbeam (*Carpinus caroliniana*), and a few mountain laurel (*Kalmia latifolia*). The shrub and vine contains common greenbrier (*Smilax rotundifolia*), winterberry (*Ilex verticillata*), blackberry (*Rubus* sp.), Oriental bittersweet (*Celastrus orbiculatus*), and arrow-wood (*Viburnum dentatum*). Common herbs include New York fern (*Thelypteris novaboracensis*), jack-in-the-pulpit (*Arisaema triphyllum*), Japanese stiltgrass (*Microstegium vimineum*), skunk cabbage (*Symplocarpus foetidus*), wetland blue violet (*Viola cucullata*), and thicket sedge (*Carex abscondita*).

Figure 4.29. Southern New England Red Maple Seepage Swamp

This community appears to be generally in a late successional to almost mature state. The site conditions makes the understory somewhat thick giving it the appearance of being younger. Diameters-at-breast height range from 1 foot to 1.5 feet generally.

Analysis of Condition at Brandywine Creek State Park

Southern New England Red Maple Seepage Swamp has not changed in acreage or extent since 1937. Because of this an analysis was not completed.

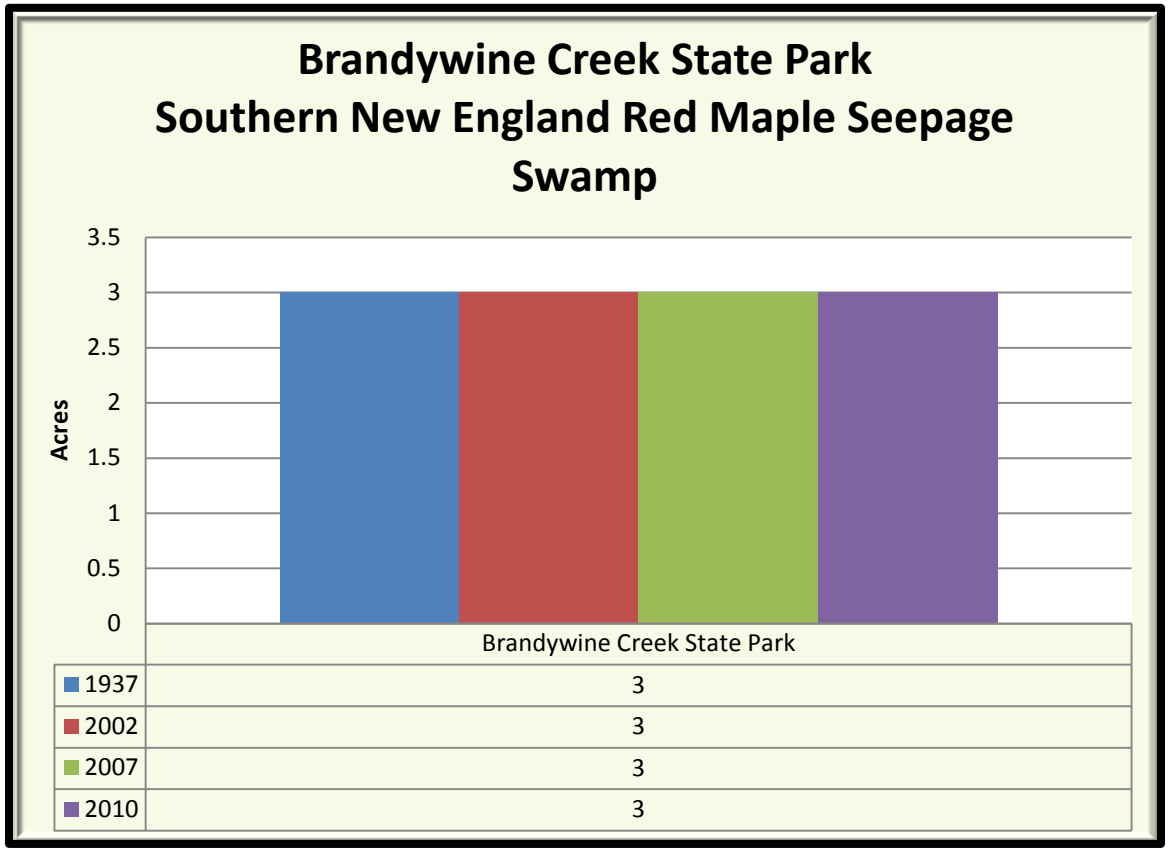


Figure 4.30. Southern New England Red Maple Seepage Swamp at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.44)

Capital of Southern New England Red Maple Seepage Swamp has not changed since 1937.

Table 4.44. Natural Capital of Southern New England Red Maple Seepage Swamp	
Year	**Natural Capital (in 2012 dollars)**
1937	$36,875/year
2002	$36,875/year
2007	$36,875/year
2010	$36,875/year

Successional Sweetgum Forest **[6 acres (Figure 4.31, Tables 4.45-4.46)] GNA SNA**

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

Description

This successional forested community is located on Wilson Run. Sweetgum (*Liquidambar styraciflua*) is common in the canopy and is joined by red maple (*Acer rubrum*), northern red oak (*Quercus rubra*), tuliptree (*Liriodendron tulipifera*), and white oak (*Quercus alba*). The understory is composed of green ash (*Fraxinus pennsylvanica*), slippery elm (*Ulmus rubra*), and smaller members of the overstory. The shrub and vine layer is composed of multiflora rose (*Rosa multiflora*), Oriental bittersweet (*Celastrus orbiculatus*), arrowwood (*Viburnum dentatum*), and poison ivy (*Toxicodendron radicans*). Common herbs include jack-in-the-pulpit (*Arisaema triphyllum*), orange-spotted jewelweed (*Impatiens capensis*), partridgeberry (*Mitchella repens*), enchanter's nightshade (*Circaea lutetiana*), and sensitive fern (*Onoclea sensibilis*).

Analysis of Condition at Brandywine Creek State Park

Successional Sweetgum Forest was not present in 1937 and has since grown into 3 acres of Northeastern Old Field, 3 acres of Northern Piedmont Mesic Oak-Beech Forest, and 0.1 acres of Impervious Surface (Table 4.45).

Table 4.45. Successional Sweetgum Forest has migrated into X or remained since 1937

X	**Acreage**
Northeastern Old Field	1 acre

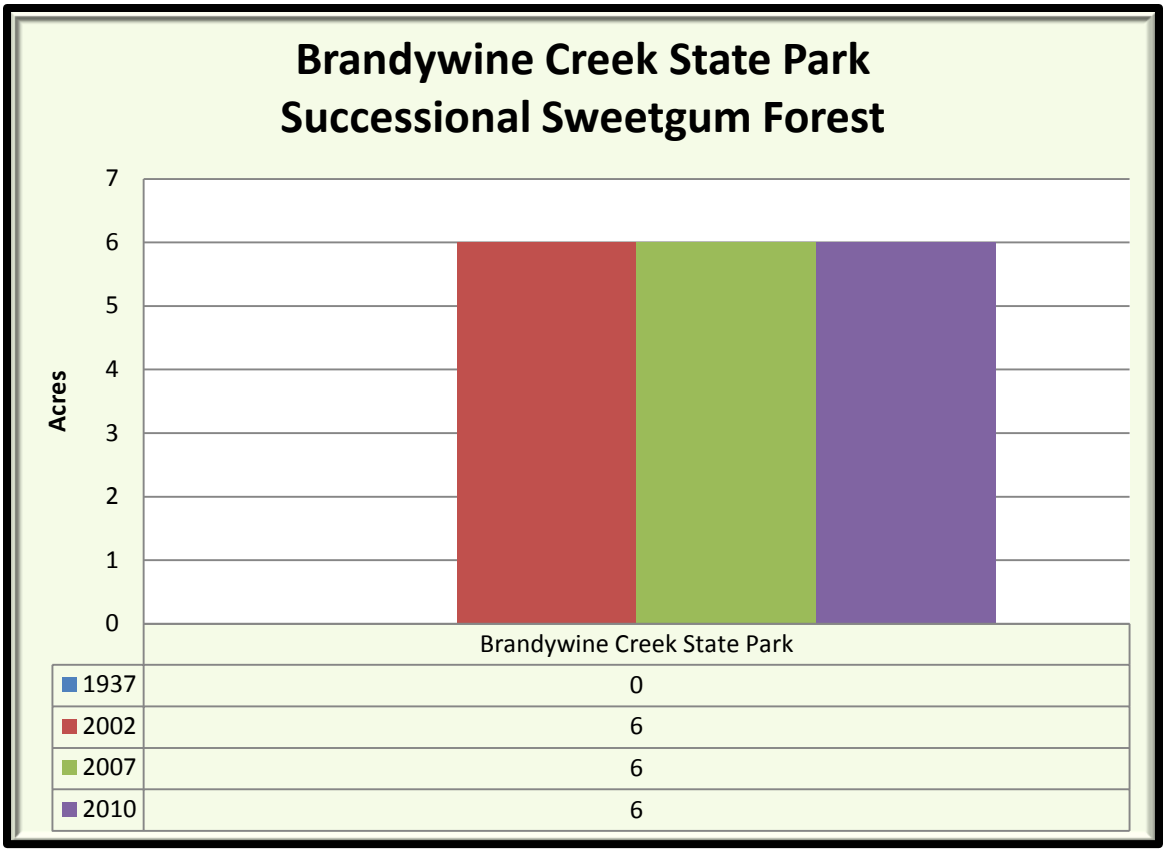


Figure 4.31. Successional Sweetgum Forest at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.46)

Capital of Successional Sweetgum Forest has been steady since its appearance after 1937.

Table 4.46. Natural Capital of Successional Sweetgum Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$1,135/year
2007	$1,135/year
2010	$1,135/year

Successional Tuliptree Forest **[46 acres (Figures 4.32-4.33, Tables 4.47-4.49)] GNA SNA**

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

Description

This forested community is dominated by tuliptree (*Liriodendron tulipifera*) in the canopy. Other canopy associates include northern red oak (*Quercus rubra*), and few black oak (*Quercus velutina*), white ash (*Fraxinus americana*), wild black cherry (*Prunus serotina*), and pignut hickory (*Carya glabra*). The understory is composed of American hornbeam (*Carpinus caroliniana*), sassafras (*Sassafras albidum*), mockernut hickory (*Carya alba*), and flowering dogwood (*Cornus florida*). The shrub and vine layer is contains Oriental bittersweet (*Celastrus orbiculatus*), poison ivy (*Toxicodendron radicans*), multiflora rose (*Rosa multiflora*), common greenbrier (*Smilax rotundifolia*), and Siebold's viburnum (*Viburnum sieboldii*). Common herbs include Christmas fern (*Polystichum acrostichoides*), jack-in-the-pulpit (*Arisaema triphyllum*), broad-beech fern (*Phegopteris hexagonoptera*), wood nettle (*Laportea canadensis*), and black cohosh (*Cimicifuga racemosa*).

Figure 4.32. Successional Tuliptree Forest

Analysis of Condition at Brandywine Creek State Park

All 23 acres of Successional Tuliptree Forest was still present in 2010 with about 0.2 acres changing to Northern Piedmont Mesic Oak-Beech Forest (Table 4.47). Since 1937, Successional Tuliptree Forest has expanded by converting 14 acres of Northern Piedmont Mesic Oak-Beech Forest, growing into 6 acres of Northeastern Old Field, 2 acres of Northeastern Successional Shrubland, and 1 acre of Red Spruce Planted Forest (Table 4.48).

Table 4.47. What was once Successional Tuliptree Forest in 1937 has become X or remained in 2010

X	Acreage
Successional Tuliptree Forest	23 acres
Northern Piedmont Mesic Oak-Beech Forest	0.2 acres

Table 4.48. Successional Tuliptree Forest has migrated into X or remained since 1937	
X	**Acreage**
Successional Tuliptree Forest	23 acres
Northern Piedmont Mesic Oak-Beech Forest	14 acres
Northeastern Old Field	6 acres
Northeastern Successional Shrubland	2 acres
Red Spruce Planted Forest	1 acre

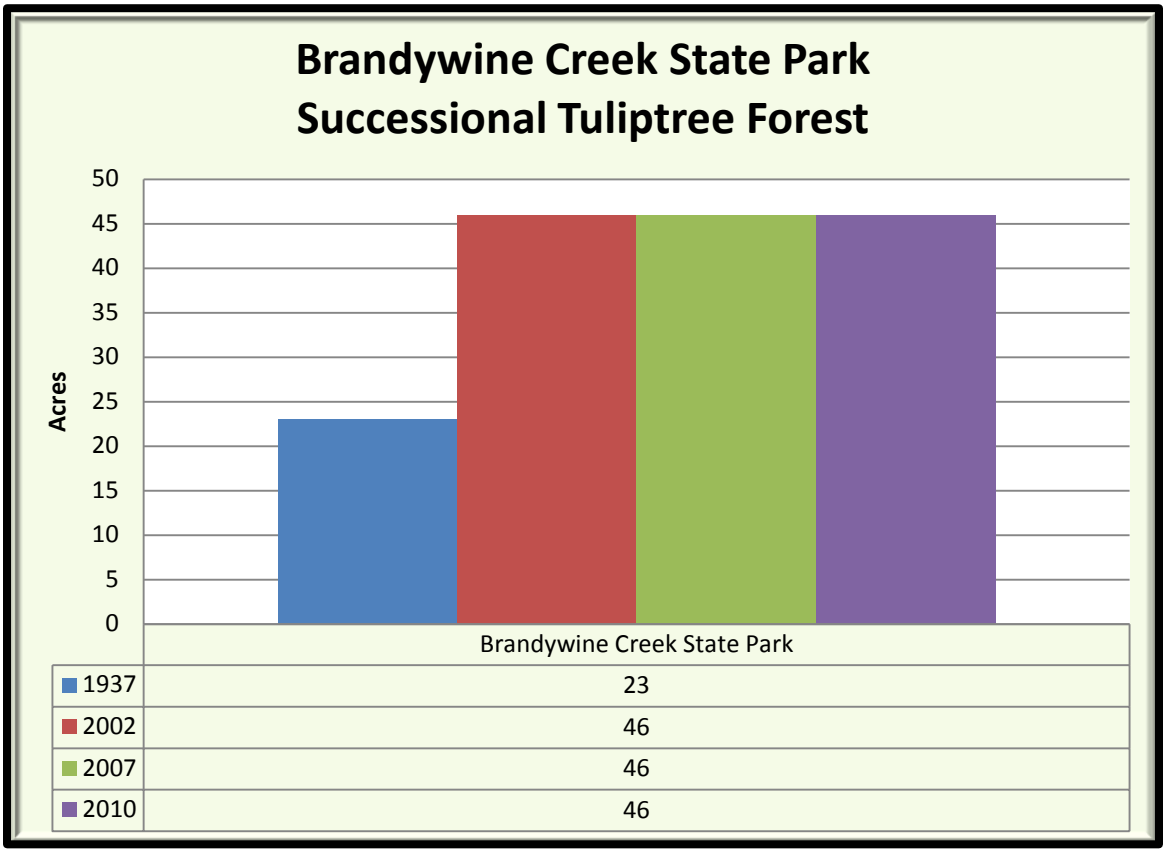


Figure 4.33. Successional Tuliptree Forest at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.49)

Capital of Successional Tuliptree Forest has increased since 1937 and has been stable in the 2002 to 2010 period.

Table 4.49. Natural Capital of Successional Sweetgum Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$4,349/year
2002	$8,699/year
2007	$8,699/year
2010	$8,699/year

Wet Meadow **[0.5 acres (Figures 4.34-4.35, Table 4.50)]** **GNA** **SNA**

DEWAP: Streamside Herbaceous Wetlands
NHC: No Equivalent Classification

Description

This community is located in a wetland depression by the "nature center" entrance to the park. This wetland is almost entirely dominated by sensitive fern (*Onoclea sensibilis*) with a few cattail (*Typha latifolia*) mixed in.

Figure 4.34. Wet Meadow

Analysis of Condition at Brandywine Creek State Park

All of the current acreage of Wet Meadow came from Northeastern Old Field in 1937. Because of this no analysis was completed.

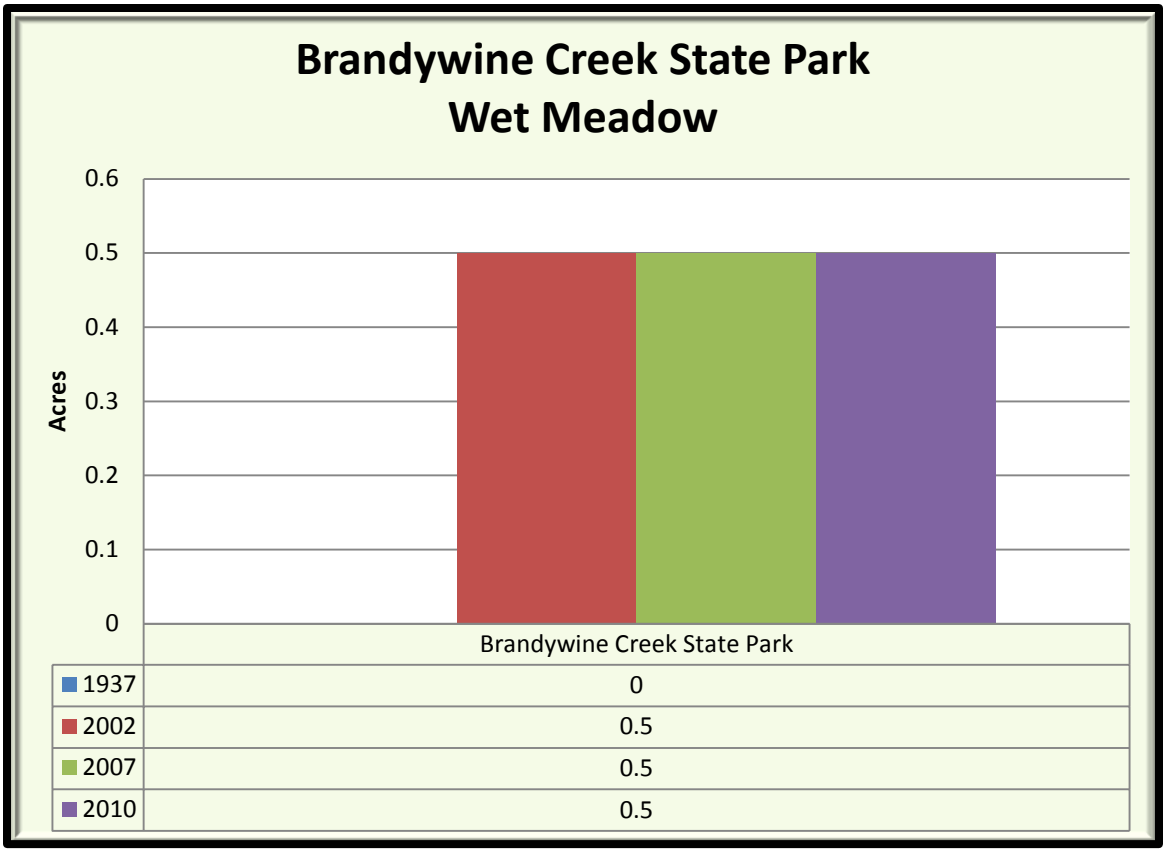


Figure 4.35. Wet Meadow at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.50)

Wet Meadow was not present in 1937 and since gained $4,641 in capital. This amount has been steady in the 2002 to 2010 period.

Table 4.50. Natural Capital of Wet Meadow	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$4,641/year
2007	$4,641/year
2010	$4,641/year

White Pine Planted Forest **[7 acres (Figure 4.36, Tables 4.51-4.52] GNA SNA**

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

Description

This planted community is most prominent south of Wilson Run, but is planted around the park. It is composed of a near monoculture of white pine (*Pinus strobus*) in the canopy with a few tuliptree (*Liriodendron tulipifera*) in the canopy. The understory contains American beech (*Fagus grandifolia*) and spicebush (*Lindera benzoin*). Oriental bittersweet (*Celastrus orbiculatus*), multiflora rose (*Rosa multiflora*), and poison ivy (*Toxicodendron radicans*) compose the shrub and vine layer. The herbaceous layer is composed of enchanter's nightshade (*Circaea lutetiana*), Japanese stiltgrass (*Microstegium vimineum*), garlic mustard (*Alliaria petiolata*), and Virginia stickseed (*Hackelia virginica*).

The example of this community in the park is in the late successional state.

Analysis of Condition at Brandywine Creek State Park

White Pine Planted Forest was not present in 1937 and has since grown into 6 acres of Northeastern Old Field, 0.4 acres of Northeastern Modified Successional Forest, and 0.2 acres of Northern Piedmont Mesic Oak-Beech Forest (Table 4.51).

Table 4.51. White Pine Planted Forest has migrated into X or remained since 1937

X	**Acreage**
Northeastern Old Field	6 acres
Northeastern Modified Successional Forest	0.4 acres
Northern Piedmont Mesic Oak-Beech Forest	0.2 acres

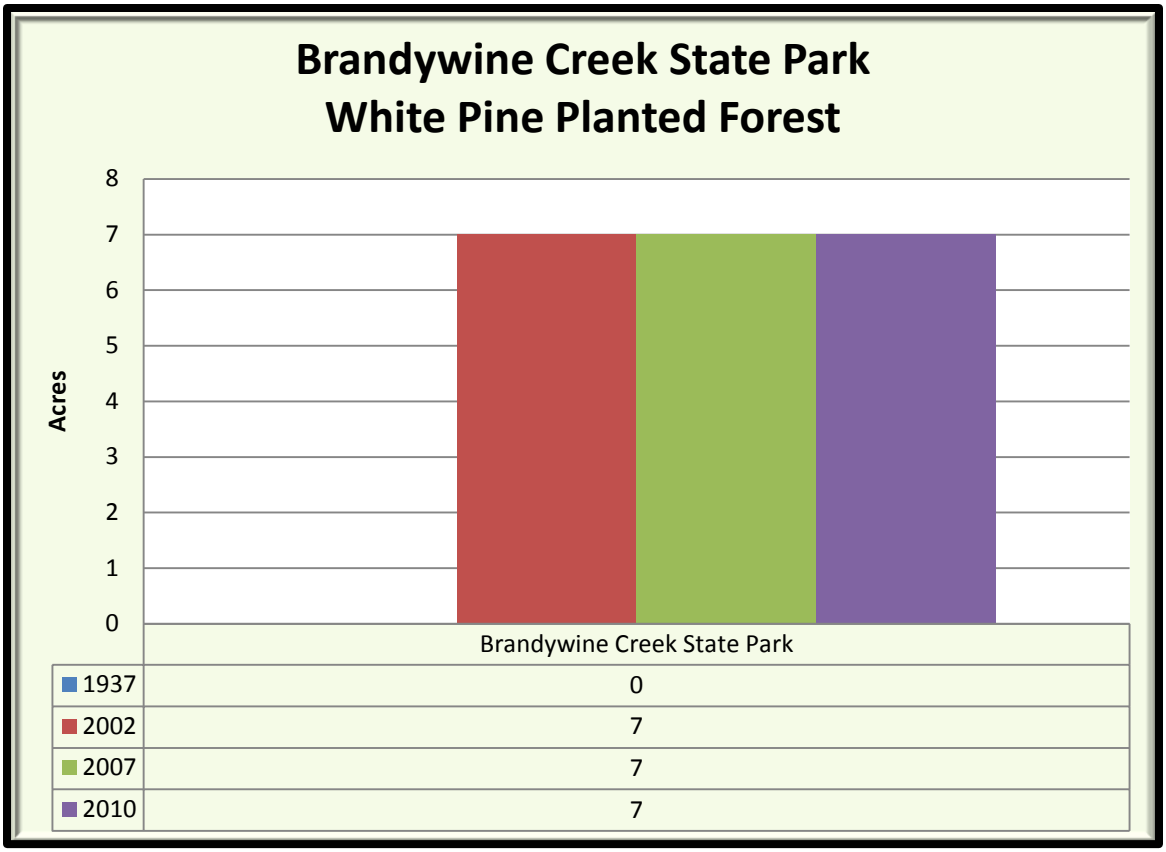


Figure 4.36. White Pine Planted Forest at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 4.52)

White Pine Planted Forest was not present in 1937 and has since acquired $1,324 in capital. The capital has been stable in the 2002 to 2007 period.

Table 4.52. Natural Capital of White Pine Planted Forest	
Year	**Natural Capital (in 2012 dollars)**
1937	$0/year (not present)
2002	$1,324/year
2007	$1,324/year
2010	$1,324/year

CHAPTER 5: DESCRIPTIONS AND ANALYSIS OF THE LAND COVERS

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

Impervious Surface **[15 acres, (Figure 5.1, Tables 5.1-5.2)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

In Brandywine Creek State Park this cover type consists of roads, buildings, and parking lots which are impervious to the flow of water.

Analysis of Condition at Brandywine Creek State Park

Most of the impervious surface present in 1937 (7 acres vs. 8 acres) was still present in 2010. The rest had become 1 acre of Northeastern Old Field, 1 acre of cultivated lawn, 0.1 acres of Northeastern Modified Successional Forest, and 0.1 acres of Successional Sweetgum Forest (Table 5.1). Since 1937, impervious surface has been developed on 6 acres of Northeastern Old Field, 1 acre of Northern Piedmont Mesic Oak-Beech Forest, 1 acre of cultivated lawn, and 1 acre of agricultural field (Table 5.2).

Table 5.1. What was once Impervious Surface in 1937 has become X or remained in 2010

X	Acreage
Impervious Surface	7 acres
Northeastern Old Field	1 acre
Cultivated Lawn	1 acre
Northeastern Modified Successional Forest	0.1 acres
Successional Sweetgum Forest	0.1 acres

Table 5.2. Impervious Surface has migrated into X or remained since 1937	
X	**Acreage**
Impervious Surface	7 acres
Northeastern Old Field	6 acres
Northern Piedmont Mesic Oak-Beech Forest	1 acre
Cultivated Lawn	1 acre
Agricultural Field	1 acre
Other communities/land covers	0.4 acres

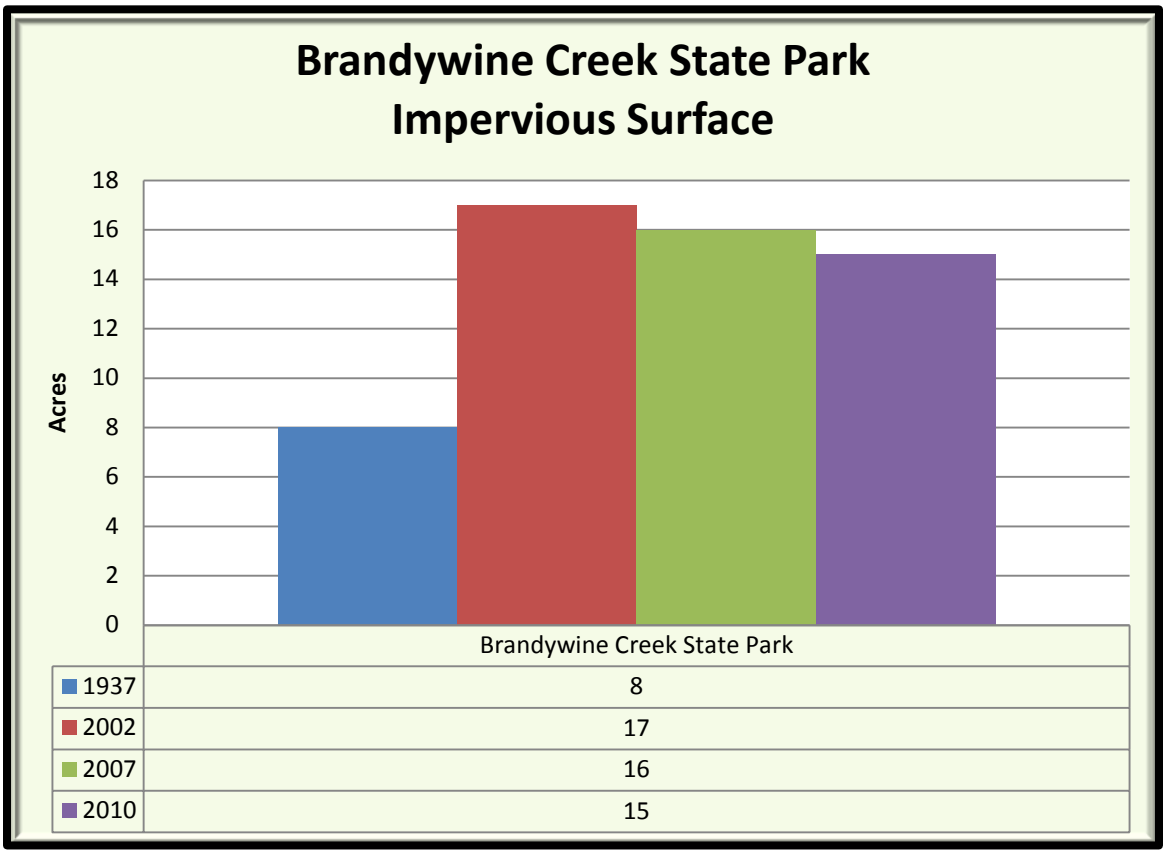


Figure 5.1. Impervious Surface at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital

Impervious surface does not contain any natural capital value.

Semi-impervious Surface **[2 acres, (Figure 5.2, Tables 5.3-5.4)]**

DEWAP: No Equivalent Classification
NHC: No Equivalent Classification

Description

In Brandywine Creek State Park this cover type consists of dirt roads which are semi-impervious to the flow of water.

Analysis of Condition at Brandywine Creek State Park

Only about a 1/3 of the semi-impervious surface present in 1937 was still present in 2010. The rest had become 1 acre of Northeastern Modified Successional Forest, 1 acre of Northeastern Old Field, 1 acre of Northern Piedmont Mesic Oak-Beech Forest, and 0.2 acres of impervious surface (Table 5.3). Since 1937, semi-impervious surface has reduced its acreage but it has still been developed on 1 acre of Northeastern Old Field and 0.1 acres of Northern Piedmont Mesic Oak-Beech Forest (Table 5.4).

Table 5.3. What was once Semi-impervious Surface in 1937 has become X or remained in 2010	
X	**Acreage**
Semi-impervious Surface	1 acre
Northeastern Modified Successional Forest	1 acre
Northeastern Old Field	1 acre
Northern Piedmont Mesic Oak-Beech Forest	1 acre
Impervious Surface	0.2 acres
Other communities/land covers	0.3 acres

Table 5.4. Semi-impervious Surface has migrated into X or remained since 1937	
X	**Acreage**
Semi-impervious Surface	1 acre
Northeastern Old Field	1 acre
Northern Piedmont Mesic Oak-Beech Forest	0.1 acres

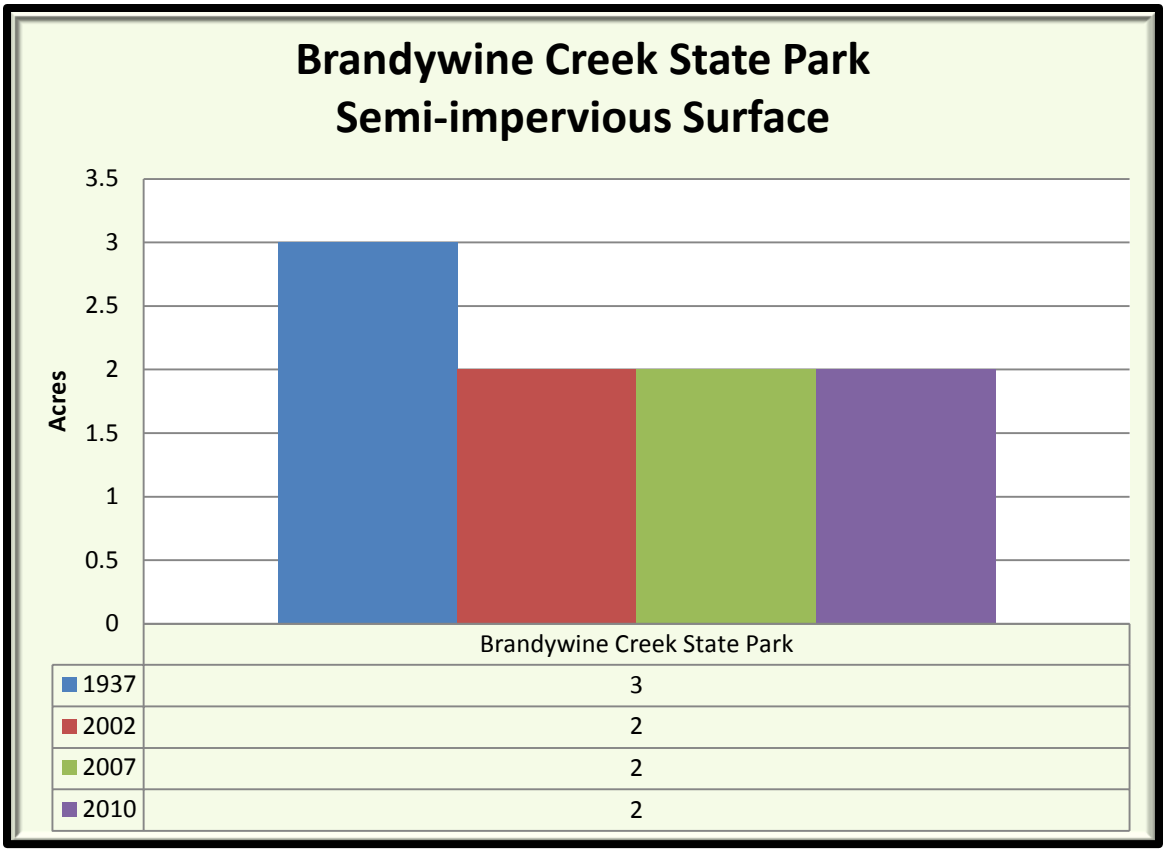


Figure 5.2. Semi-impervious Surface at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital

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

***Water* [37 acres, (Figure 5.3, Tables 5.5-5.7)]**

DEWAP: Piedmont Streams
NHC: No Equivalent Classification

Description

Most of the water coverage in the park is present in the main stem of Brandywine Creek and Wilson Run. The acreage varies depending on the sandbars that are present.

Analysis of Condition at Brandywine Creek State Park

Most of the water surface located in the park in 1937 was still present in 2010 (34 acres vs. 33 acres). The rest had become 1 acre of Box-elder Floodplain Forest and 1 acre of Northern Piedmont Mesic Oak-Beech Forest (Table 5.5). Since 1937, Water has flooded 3 acres of Northeastern Old Field, 1 acre of Mid-Atlantic Terrace Floodplain Forest, 1 acre of Box-elder Floodplain Forest, and 0.3 acres of Northern Piedmont Mesic Oak-Beech Forest (Table 5.6).

Table 5.5. What was once Water in 1937 has become X or remained in 2010

X	Acreage
Water	33 acres
Box-elder Floodplain Forest	1 acre
Northern Piedmont Mesic Oak-Beech Forest	1 acre

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

X	Acreage
Water	33 acres
Northeastern Old Field	3 acres
Mid-Atlantic Terrace Hardwood Floodplain Forest	1 acre
Box-elder Floodplain Forest	1 acre
Northern Piedmont Mesic Oak-Beech Forest	0.3 acres
Other communities/land covers	0.2 acres

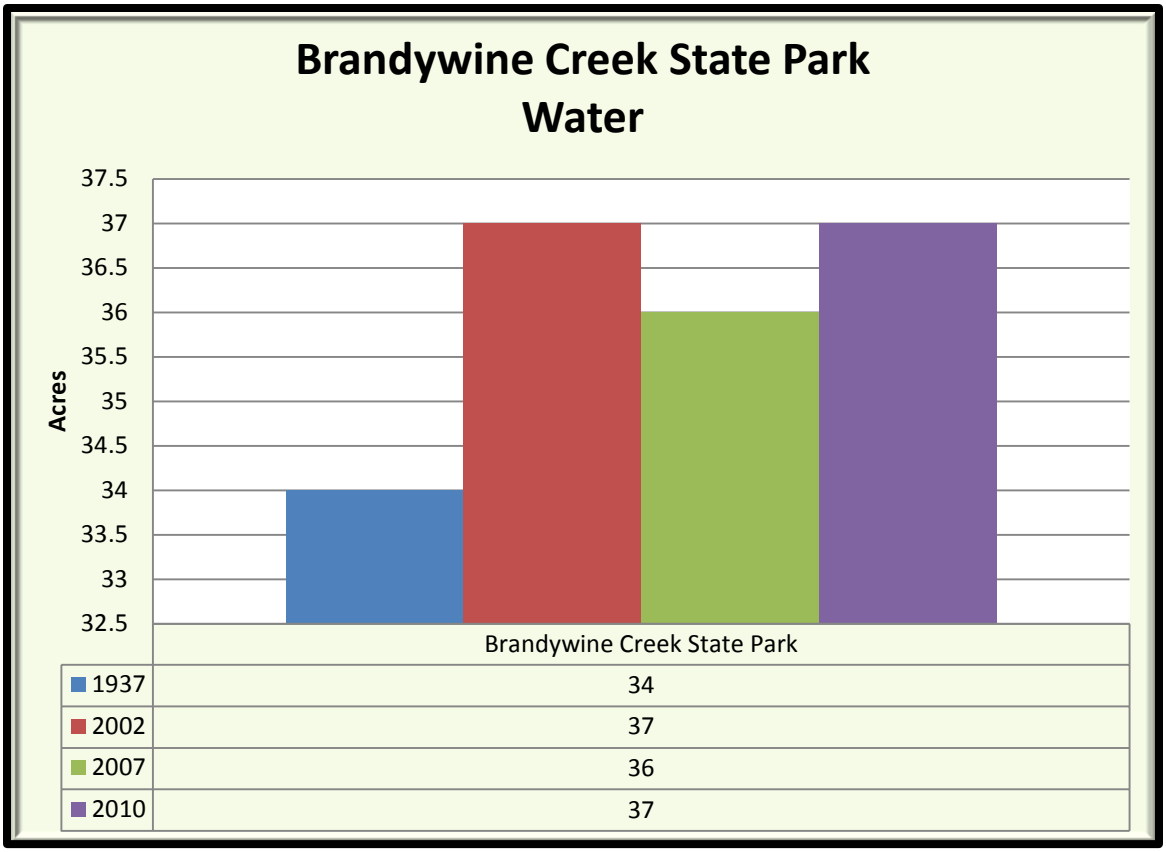


Figure 5.3. Water at Brandywine Creek State Park (1937, 2002, 2007, and 2010)

Natural Capital (Table 5.7)

Capital of water has fluctuated with erosion and sedimentation since 1937. Overall the amount of water has increased.

Table 5.7. Natural Capital of Water	
Year	**Natural Capital (in 2012 dollars)**
1937	$181,393/year
2002	$197,399/year
2007	$192.064/year
2010	$197,399/year

APPENDIX I: STATE RARE VEGETATION RANKING CRITERIA

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

State Rank

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

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

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

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

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

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

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

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

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

SNR Unranked

SNA Not Applicable

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

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

APPENDIX II: SGCN IN KEY WILDLIFE HABITATS

SGCN Species expected in 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 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 Piedmont Stream Valley Wetlands			
Species	**Common Name**	**Class**	**Tier**
Poanes massasoit	Mulberry Wing	Insect	1
Euphyes conspicua	Black Dash	Insect	1
Papaipema eupatorii	Eupatorium borer Moth	Insect	1
Glyptemys muhlenbergii	Bog Turtle	Reptiles	1
Euphyes dion	Dion Skipper	Insect	2
Boloria selene	Silver-bordered fritillary	Insect	2
Boloria selene myrina	Myrina fritillary	Insect	2
Euphydryas phaeton	Baltimore checkerspot	Insect	2
Satyrodes Eurydice	Eyed brown	Insect	2
Acronicta connecta	A noctuid moth	Insect	2
Parapamea buffaloensis	A borer moth	Insect	2
Cordulegaster erronea	Tiger spiketail	Insect	2
Cordulegaster bilineata	Brown spiketail	Insect	2
Libellula flavida	Yellow-sided skimmer	Insect	2
Sympetrum semicinctum	Band-winged meadowhawk	Insect	2
Eurycea longicauda	Longtail salamander	amphibians	2
Regina septemvittata	Queen snake	Reptiles	2
Thamnophis sauritus	Eastern Ribbon Snake	Reptiles	2